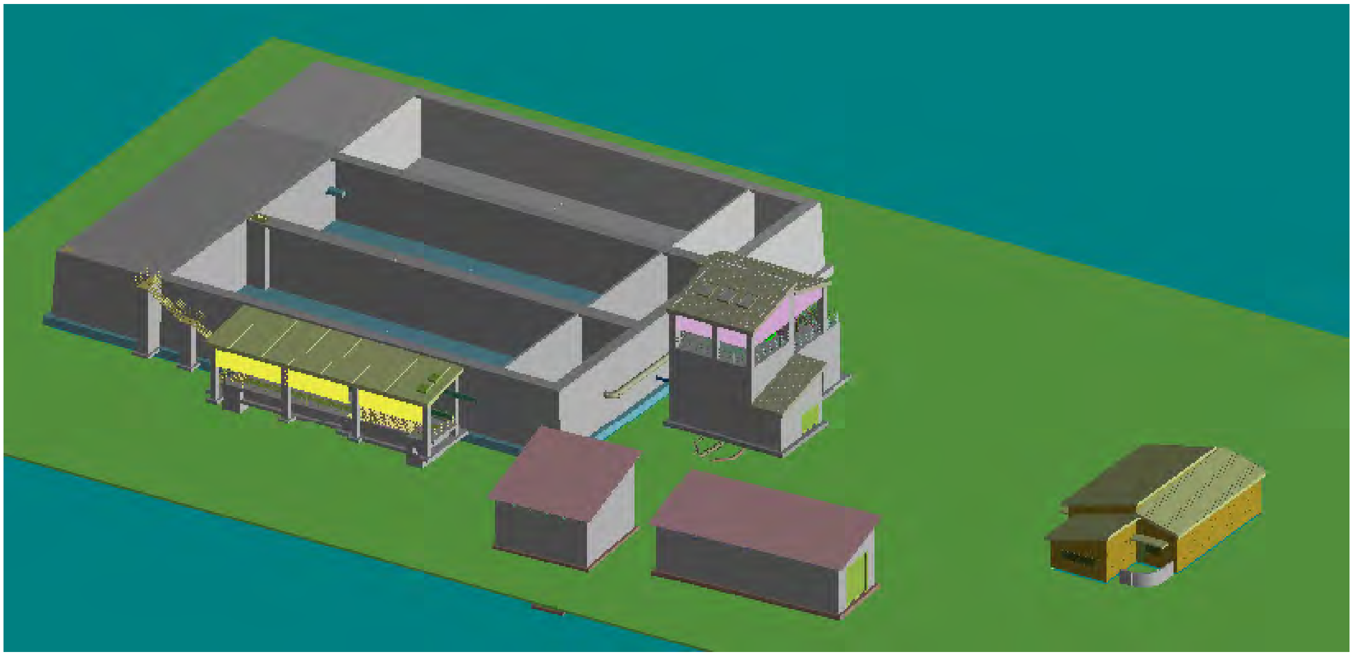
Design Report

Coos Bay Wastewater Treatment Plant #2 Preliminary Design



Prepared for

City of Coos Bay

August 2013

SHN
275 Market Avenue
Coos Bay, OR 97420-2228

CH2MHILL®
1100 NE Circle Boulevard
Suite 300
Corvallis, OR 97330

Reference: 612035

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PD.01 – Predesign Overview and Summary

PREPARED BY: Craig Massie/CH2M HILL
REVIEWED BY: Steve Donovan/SHN

DATE: August 2013

Introduction

The purpose of this technical memorandum (TM) is to provide the City of Coos Bay an overview of the predesign report and a summary of some of its content.

The predesign engineering for this project includes the design development of the City's new wastewater treatment plant adjacent to the existing Wastewater Treatment Plant 2. The new plant will consist of an influent pump station, headworks screening and grit removal facility, sequencing batch reactor activated sludge process and ultraviolet disinfection prior to discharging to Coos Bay through an existing outfall pipe and diffuser.

Overview

The predesign report is organized into 18 technical memoranda, including this PD.01, Predesign Overview and Summary TM. The remaining TMs are organized in three categories:

1. Engineering discipline technical memoranda that outline the discipline specific guidelines, standards, codes, and materials and equipment used in the design. These memoranda include:

PD.02	Architectural Design Criteria
PD.03	Structural Design Criteria
PD.04	Mechanical Design Criteria
PD.05	Heating, Ventilation, and Air Conditioning/Plumbing Design Criteria
PD.06	Electrical Design Criteria
PD.07	Instrumentation and Control Design Criteria
PD.08	Geotechnical Conditions
PD.09	Site Work and Landscaping

2. Overall process and specific unit process technical memoranda that summarize the specific design criteria for the entire plant and individual unit processes. Where appropriate, calculations summarizing the capacity of systems that convey the entire wastewater flow, such as influent pumping, are included. Also included in these technical memoranda are overall process and hydraulics summaries; and manufacturer's catalog cuts for major equipment. These memoranda include:

PD.10	Process and Facilities Overview
PD.11	Influent Pump Station
PD.12	Screening and Grit Removal
PD.13	Sequencing Batch Reactor and Flow Equalization
PD.14	Ultraviolet Disinfection
PD.15	Plant Hydraulics
PD.16	Odor Control

3. General project sequencing, delivery and cost summaries are contained in the following technical memoranda:

PD.17	Construction Sequencing and Alternative Delivery
PD.18	Cost Estimate

Summary

Influent Flows and Loads

Design of the new wastewater treatment plant (WWTP) is based on the flow and load projections developed in the *Wastewater Treatment Plant #2 Facilities Plan Amendment* (Civil West, November 2012). The Facility Plan Amendment (FPA) determined the projected 2037 design influent flows and loadings and the preferred treatment scheme. The FPA design flow and load values are shown in Table 1-1.

TABLE 1-1
Design Influent Flows and Loads

Flow Condition	Annual (Jan–Dec)	Winter (Wet Weather) (Nov–Apr)	Summer (Dry Weather) (May–Oct)
Flows (mgd)			
Average Daily	1.24	1.50	0.99
Maximum Month[2]	-	2.09	1.51
Peak Week	-	3.57	-
Peak Daily Average	-	6.31	-
Peak Instantaneous	-	8.20	-
5-day Biochemical Oxygen Demand (pounds per day)			
Average Daily		2,334	
Maximum Month		3,314	
Maximum Day		4,567	
Total Suspended Solids (pounds per day)			
Average Daily	2,926	2,929	2,923
Maximum Month		4,648	
Maximum Day		6,792	
Total Kjeldahl Nitrogen-N (pounds per day)[1]			
Average Daily	324	325	323
Maximum Month		421	
Maximum Day		500	
Ammonia-N (pounds per day)			
Average Daily	243	244	242
Maximum Month		316	
Maximum Day		375	

Notes:

1. Total Kjeldahl Nitrogen (TKN) loading data was not provided in the FPA. The ammonia to TKN ratio was assumed to equal 0.75.
2. Maximum Month Dry Weather Flow or Maximum Month Wet Weather Flow

Effluent Requirements

Effluent requirements for discharge of plant effluent in Coos Bay were listed in the FPA and are shown in Table -1-2. The requirements are based on the existing NPDES permit and the expected enterococcus limit.

TABLE 1-2
Effluent Requirements

Parameter	Unit	Winter (Wet Weather) (Nov-Apr)	Summer (Dry Weather) (May-Oct)
5-Day Biochemical Oxygen Demand			
Monthly Average Concentration	mg/L	30	20
Weekly Average Concentration	mg/L	45	30
Monthly Average Loading	lbs/day	510	340
Weekly Average Loading	lbs/day	760	510
Daily Maximum Loading	lbs/day	1,000	670
Total Suspended Solids (TSS)			
Monthly Average Concentration	mg/L	30	20
Weekly Average Concentration	mg/L	45	30
Monthly Average Loading	lbs/day	510	340
Weekly Average Loading	lbs/day	760	510
Daily Maximum Loading	lbs/day	1,000	670

Additional Requirements:

1. BOD_5 and TSS removal efficiency shall not be less than 85 percent monthly average.
2. pH shall be within 6.0 - 9.0.
3. Ammonia-N shall not exceed a monthly average concentration of 20 mg/L and a daily maximum concentration of 30 mg/L from May 1 to October 31.
4. Fecal coliform bacteria shall not exceed a monthly median of 14 organisms per 100 mL. Not more than 10 percent of the samples shall exceed 43 organisms per 100 mL.
5. Enterococcus shall not exceed a monthly geometric mean of 35 organisms per 100 mL. No single sample may exceed 104 organisms per 100 mL.
6. Total residual chlorine shall not exceed a daily median value of 0.5 mg/L and no single sample shall exceed 1.0 mg/L.

Plant Reliability Criteria

The U.S. Environmental Protection Agency (EPA) requires that wastewater facilities meet the requirements for reliability and redundancy in their treatment components and associated equipment. The reliability standards establish minimum levels of reliability for three classes of wastewater works.

The Oregon Department of Environmental Quality (DEQ) has also established minimum standards governing the reliability of mechanical, electrical, and fluid systems used in wastewater systems. The standards are intended to protect the environment (particularly receiving waters) against unacceptable degradation resulting from power failure, flood, peak loads, equipment failure, and maintenance shutdowns. The standards are divided into three, decreasingly stringent, classes of reliability: I, II, and III. Plant #2 will discharge to Coos Bay's shellfish habitat; therefore, DEQ has determined that reliability Class I is appropriate.

General Process Description

The proposed facility will utilize the Xylem/Sanitaire Intermittent Cycle Extended Aeration System (ICEAS) Sequencing Batch Reactor process for secondary activated sludge treatment in conjunction with raw sewage screening and grit removal, and ultraviolet (UV) disinfection.

The City of Coos Bay (City) is evaluating long term biosolids management options for the Coos Bay area. While this evaluation is being performed and planned, the existing influent pump station, headworks, primary clarifier, primary sludge pumping, and anaerobic digesters will continue to be used (approximately 3 to 5 years) until the long term biosolids management solution is implemented. During this interim period, primary effluent from the existing primary clarifier will be routed to the new Influent Pump Station and pumped to the new headworks, sequencing batch reactors, and UV disinfection facilities for final treatment. Discharge of the plant effluent will be through the existing outfall pipe and diffuser.

The following unit processes will be part of the upgraded facility:

- Trench style Influent Pump Station
- Headworks incorporating influent screening, grit removal, screenings conveying and storage, and screened raw sewage flow splitting
- Sequencing batch reactors with effluent flow equalization and waste-activated sludge pumping
- Positive displacement aeration blower system within the Headwork's Facility
- UV disinfection system with non-potable water pumping system
- Odor control system located at existing site
- Control Building
- Electrical Building
- Maintenance/Garage Building

Construction Sequence

The construction of the new facilities to the east of the existing WWTP 2, across Empire Blvd., can be done as a "greenfield" construction, with a majority of the work completed independent of interface with the existing plant. The following facilities can be completely constructed and clean water tested prior to connection to the existing sewer system and outfall piping:

- Influent Pump Station
- Headwork's screening and grit removal
- Sequencing batch reactors
- UV disinfection
- Storage/Garage Building
- Electrical Building
- Control Building (offices, lab, lockers, etc.)
- Site wide electrical systems
- Site wide supervisory control and data acquisition systems
- Civil site work
- Civil yard piping, except final connections to raw sewage and outfall piping

Project Delivery

For the sake of recommending a project delivery approach, at this planning level of project development, the following assumptions are made:

- The project size as bid may be $18 to $25 million.
- The project and its constraints are well understood.
- A major owner-furnished equipment package may or may not be possible; this will be determined with the City.
- The City will take an active role during detailed design.
- The existing WWTP 2 is beyond its useful life and some components are in need of replacement as early as practically possible, thus favoring a faster project delivery.
- The complexity of the project is high given the points of interface that will be required between the new plant and the old plant, and the requirement that the old plant operate without interruption during the construction and startup phases.
- The City has adequate funding to deliver the project by any of the approaches outlined herein.

Given these assumptions, SHN/CH2M HILL evaluated traditional design-bid-build, design-build, and construction manager general contractor (CMGC) approaches. As described in Technical Memorandum PD.18, SHN/CH2M HILL recommends a CMGC approach for the following reasons:

- SHN/CH2M HILL and the City have a good track record with construction by this method in western Oregon using this approach.
- It allows for completing the facility early which is advantageous.
- Construction complexity relating to the interface with the existing plant and maintaining the existing plant in operation is anticipated.
- Minimizing and containing overall project costs is of high importance.
- Design engineering procurement efforts have been expended. Alternative delivery approaches may cause the City to start this effort over, delaying project implementation which rules out typical design-build.

If it is determined that an owner-furnished equipment package is warranted, CMGC is still recommended. Assignment of the contract to the CMGC or retainage by the City can be determined at a later date.

PD.02 – Architectural Design Criteria

PREPARED BY: Robert Taverna/CH2M HILL
REVIEWED BY: Steve Payne/CH2M HILL
DATE: August 2013

Introduction

The architectural concept for the City Coos Bay Wastewater Treatment Plant is to:

- Present an architectural image of quality and good design.
- Provide architectural exterior treatments that are uniform and complimentary across all structures on site.
- Provide visual screening of process equipment from adjacent roadways and residential neighborhoods.
- Use durable, low-maintenance, corrosion-resistant construction materials.

Codes and Standards

- 2010 Oregon Structural Specialty Code, based on the 2009 International Building Code
- 2010 Oregon Fire Code, based on the 2009 International Fire Code
- 2010 Oregon Energy Efficiency Specialty Code, based on the 2009 International Energy Conservation Code

Contacts

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Mike Smith, 541-269-1181, Ext 2235. msmith@coosbay.org

Fire Chief
Stan Gibson, 541-269-1181, Ext 2260. sgibson@coosbay.org

Facilities Overview

Non-process facilities included in the architectural scope include:

- **Control Building** - The Control Building will house the plant control room for two operators, a unisex restroom and shower room, lunchroom, conference room, server room, sampling room, storage room, and mechanical room. The Control Building has a clerestory style roof which allows natural daylight into the lobby, corridor and indirectly into the conference room and control room.
  - Interior finishes include:
    - Control Room: Painted gypsum wall board, suspended ceiling, plastic laminate countertops, and epoxy flooring
    - Conference Room: Painted gypsum wall board, suspended ceiling, epoxy or vinyl flooring.
    - Lunch Room: Painted gypsum wall board, suspended ceiling, plastic laminate cabinets and countertops and epoxy or vinyl flooring.
    - Restroom and Shower room: Ceramic tile wall and floor covering.

    - Mechanical room, Server room, Storage room: Painted CMU walls and concrete floor slab with sealer.

- **Garage/Shop/ Building** - The Garage/Shop Building is a concrete building housing the vactor truck, work area and electrical room. The interior finish is anticipated to be utilitarian and durable in nature having exposed concrete floor and wall surfaces and exposed painted or galvanized metal deck. A shed style roof with metal roof panels will be installed matching the other process buildings.

Process facilities included in the architectural scope include:

- **Headwork's Building** - The Headwork's Building is a concrete building and will have an interior finish that is utilitarian and durable in nature having exposed concrete floor and wall surfaces and exposed ceiling structure in the ground level blower room. A clerestory style canopy with metal roof panels will be installed on the upper level. The canopy will be fitted with three removable hatches for screening equipment removal. The canopy frame will be fitted with fiberglass screening panels on at least three sides to help minimize the visual impact of the process equipment.

- **UV Facility** - The UV Facility is an open structure and will have a shed style canopy with metal roof panels. The canopy frame will be fitted with fiberglass screening panels on three sides to help minimize the visual impact of the process equipment.

- **Influent Pump Station** - The Influent Pump Station is a three-sided concrete structure. It will have an interior finish that is utilitarian and durable in nature having concrete floor and wall surfaces and an exposed, painted or galvanized roof deck. A shed style roof with metal roof panels will be installed to help reduce the visual impact of the process equipment.

- **Sequencing Batch Reactors (SBRs) and Equalization Basins** - Various exterior architectural wall treatments of the concrete SBRs and equalization basins will be considered in an attempt to minimize the visual impact of these surfaces from the adjacent roadways. Vertical score form liners are used to provide texture to the wall. This treatment will be used throughout the site to provide a unifying treatment. The SBR wall surface is visually divided with vertical reveals to section off the wall into smaller visual sections.

PD.03 - Structural Design Criteria

PREPARED BY: Sterling Rose/CH2M HILL
REVIEWED BY: Ben Herman/CH2M HILL
DATE: July 2013

Introduction

The purpose of this technical memorandum (TM) is to establish design criteria that will provide a uniform, efficient, and effective approach to the structural design for the Coos Bay Wastewater Treatment Plant 2 Expansion and Upgrade project. This TM presents the structural concepts including building systems, foundation schemes, and materials of construction. All facilities will be designed to provide high performance and low maintenance structural systems.

Project Structures and Facilities

New Facilities

Several new facilities will be constructed as part of this expansion/upgrade project. Summaries of the new structures to be added are provided below.

Influent Pump Station

- *Structure Type*: Cast-in-place concrete vault with above grade concrete building and metal roof.

- *Foundation System*: Cast-in-place mat slab.

- *Lateral Load-resisting System*: The lateral load-resisting system consists of a flat-bottom ground-supported reinforced concrete tank with reinforced non-sliding base. Superstructure lateral load resisting system will be special reinforced concrete shear walls. Seismic design parameters are as follows:
    - Response Modification Coefficient, R: Tank 2, Shear Walls 5
    - System Overstrength Factor, Ω_o: Tank 2, Shear Walls 2.5
    - Deflection Amplification Factor, C_d: Tank 2, Shear Walls 5

- *Maximum Liquid Level*: Grade.

- *Special Conditions or Considerations to be Addressed in Design*: Additional soil surcharge of 2’-0” to account for minor traffic loading in the surrounding area.

Headworks

- *Structure Type*: The building will have two stories; the upper level will consist of water channels and screening while the bottom level will provide space for a roll-off dumpster, electrical equipment, and blowers. The building will be combined with a headcell (grit removal) that is essentially a two story tank.

- *Foundation System*: The building will be supported from a reinforced concrete slab-on-grade with grade beams at the perimeter and thickened footings at interior walls. Grade beams will be extended down to frost depth.

- *Framing Materials*: The structure will be reinforced concrete construction and includes hydraulic channels for the influent screens suspended below the second floor level.

- *Lateral Load-resisting System*: The lateral load-resisting system for the lower concrete structure is composed of special reinforced concrete shear walls. Seismic design parameters are as follows:
    - Response Modification Coefficient, R: 5
    - System Overstrength Factor, Ω_o: 2.5

  - Deflection Amplification Factor, C_d: 5

- *Maximum Liquid Level*: Enclosed channels and hydraulic spaces will be designed with contents to the underside of the top slab.

Sequencing Batch Reactors and Equalization Basin

- *Structure Type*: The structure is an open-top multi-basin reinforced concrete tank structure. Elevated concrete walkways are provided along the tops of the basin walls.
- *Foundation System*: The basin will sit on a reinforced concrete mat foundation.
- *Lateral Load-resisting System*: The lateral load-resisting system consists of a flat-bottom ground-supported reinforced concrete tank with a reinforced non-sliding base. Seismic design parameters are as follows:
  - Response Modification Coefficient, R: 2
  - System Overstrength Factor, Ω_o: 2
  - Deflection Amplification Factor, C_d: 2

Electrical Building

- *Structure Type*: Cast-in-place concrete building with metal roof.
- *Foundation System*: The building will be supported from stem walls and conventional footings.
- *Framing Materials*: The structure will be reinforced concrete.
- *Lateral Load-resisting System*: The lateral load-resisting system for the structure is composed of special reinforced concrete shear walls. Seismic design parameters are as follows:
  - Response Modification Coefficient, R: 5
  - System Overstrength Factor, Ω_o: 2.5
  - Deflection Amplification Factor, C_d: 5

Shop Building

- *Structure Type*: Cast-in-place concrete building with metal roof.
- *Foundation System*: The building will be supported from stem walls and conventional footings.
- *Framing Materials*: The structure will be reinforced concrete.
- *Lateral Load-resisting System*: The lateral load-resisting system for the structure is composed of special reinforced concrete shear walls. Seismic design parameters are as follows:
  - Response Modification Coefficient, R: 5
  - System Overstrength Factor, Ω_o: 2.5
  - Deflection Amplification Factor, C_d: 5

Ultraviolet Disinfection

- *Structure Type*: The structure is an open-top reinforced concrete tank structure with aluminum grating and aluminum checkered plate walking surfaces. The entire facility will be covered by a metal canopy.
- *Foundation System*: The structure will be supported by mat foundations located at varying elevations.
- *Lateral Load-resisting System*: For the concrete tank portion of the structure, the lateral load-resisting system is considered to be a flat-bottom ground-supported reinforced concrete tank with reinforced nonsliding base. Seismic design parameters are as follows:
  - Response Modification Coefficient, R: 2
  - System Overstrength Factor, Ω_o: 2
  - Deflection Amplification Factor, C_d: 2

For the metal canopy, the lateral system will be a cantilevered column system detailed to conform to the requirements for special reinforced moment frames. Seismic design parameters are as follows:

- Response Modification Coefficient, R: 2.5
- System Overstrength Factor, Ω_o: 1.25
- Deflection Amplification Factor, C_d: 2.5

- *Maximum Liquid Level*: The structure will be designed assuming liquid at the top of wall.

Control Building

- *Structure Type*: Cast-in-place concrete building with metal roof.
- *Foundation System*: The building will be supported from stem walls and conventional footings.
- *Framing Materials*: The structure will be reinforced concrete.
- *Lateral Load-resisting System*: The lateral load-resisting system for the structure is composed of special reinforced concrete shear walls. Seismic design parameters are as follows:
  - Response Modification Coefficient, R: 5
  - System Overstrength Factor, Ω_o: 2.5
  - Deflection Amplification Factor, C_d: 5

Codes, Standards, and Regulations

Codes

The design will be in accordance with the 2012 International Building Code (IBC). The code will likely be amended by the 2014 Oregon Structural Specialty Code (OSSC) which has not been published at this date. Additionally, criteria from local agencies will be included.

Standards

- CH2M HILL, Structural Design Guide (SDG).
- American Society of Civil Engineers (ASCE) 7-10, Minimum Design Loads for Buildings and Other Structures.
- American Concrete Institute (ACI) 350, Code Requirements for Environmental Engineering Structures, Latest Edition.
- ACI 318, Building Code Requirements for Structural Concrete, Latest Edition.
- ACI 530, Building Code Requirements for Masonry Structures, Latest Edition.
- American Institute of Steel Construction (AISC), Steel Construction Manual, Latest Edition.

Design Loads

Design loads are summarized in Table 3-1.

TABLE 3-1
Design Loads

Item	Value
Roof Live Load (unreduced)	20 psf
Roof Dead Load (add operating weight of roof-mounted equipment)	Actual weight
Roof Snow Load	
Ground Snow Load	P_g = 1 psf
Terrain Category	C
Exposure Factor	C_e = 1.0
Thermal Factor	C_t = 1.0
Importance Factor	I = 1.1
Roof Snow Load	25 psf (minimum)
Floor Live Loads	
Office/Administration Areas	100 psf
Electrical Equipment Areas	300 psf
Process Areas (includes roofs of pump stations and basins)	200 psf
Walkways, Corridors, Exits, and Stairways	100 psf
Catwalks and Elevated Platforms	60 psf
Seismic Parameters	
Mapped Spectral Response Accelerations:	
Short Period	S_S = 1.500g
1s Period	S_1 = 0.718g
Design Spectral Response Accelerations	
Short Period	S_{DS} = 1.000g
1s Period	S_{D1} = 0.623g
Site Class	C
Occupancy Category	III
Seismic Design Category	D
Wind Load	
Basic Wind Speed (3s Gust)	95 mph[1]
Exposure	C
Occupancy Category	III

g = acceleration
mph = mile(s) per hour
psf = pound(s) per square foot
NOTES:
[1] Wind speed is in a special wind region and has not been defined for ASCE 7-10 level loads. 95mph conforms to the 2010 OSSC.

Special Loads

- Cranes and Monorails: See IBC 1607.13. Impact: 25 percent of maximum wheel loads. Horizontal Force on Rails:
    - Normal to Rail: 20 percent of capacity + trolley weight
    - Longitudinal Force: 10 percent of maximum wheel loads
- Additional loads and design strengths will be shown on the plans, where required.

Load Combinations

The basic load combinations of Section 1605.3.1 of the IBC will be used for project design. Application of allowable stress increases will be as provided in 1605.3.1.1.

Geotechnical Design Parameters

The geotechnical design criteria for the project are provided in the Draft Geotechnical Report, dated June 2013.

Stability Criteria

A safety factor of 1.5 should be used to resist overturning and sliding under earthquake loads and lateral soil pressures. A safety factor of 1.0 should be used to resist overturning and sliding under wind load and to resist uplift at 100-year flood elevation. All safety factors are against unfactored loads.

Resistance to uplift includes the dead weight of the structure and the column of soil above the footing extension. The buoyant weight of soil will be used below the water table. Side friction will not be included in uplift resistance calculations unless there are significant cost implications.

Basis of Schematic Design

Materials Criteria

Materials criteria are shown in Table 3-2.

TABLE 3-2
Materials Criteria

Item	Criteria
Concrete— Type IP or II	f'c = 4,000 psi at 28 days 4,500 psi at 56 days.
Reinforcing Steel (ASTM A615, grade 60)	fy = 60 ksi
Masonry	f’m = 1,500 psi
Steel	
W-shapes	fy = 50 ksi
Plates, angles, shapes except W (including channels)	fy = 36 ksi
Square or rectangular steel tubing	fy = 46 ksi
Bolts	
High-strength bolts	A325N
Machine or anchor bolts	A307
Stainless steel	A193, Type 316

TABLE 3-2
Materials Criteria

Item	Criteria
Aluminum	Alloy 6061-T6
Stainless Steel	Type 316, fy = 30 ksi (Type 316L, fy = 25 ksi where welded)

ASTM = American Society of Testing and Materials
f'c = compressive strength
fy = yield strength
ksi = kilopound(s) per square inch
psi = pound(s) per square inch

Fasteners

A fastener schedule will be provided in the specifications for the appropriate type of fastener to be used for various exposure conditions as the project progresses.

In submerged or wet areas, Type 316 stainless steel shall be used for cast-in-place anchor bolts, drilled-in wedge anchors and adhesive anchors, and aluminum beam connections.

Adhesive anchors should not be used in direct pullout, to support fire-resistive construction, or where temperatures will exceed 120 degrees Fahrenheit (120 °F).

Wedge or expansion anchors shall not be used to support vibrating machinery, in direct pullout unless approved for use in cracked concrete, or in masonry walls.

Rehabilitation of Existing Structures

Alterations to existing structures will be designed in accordance with Chapter 34 of the IBC, as amended by the OSSC. Alterations that increase the seismic force in an existing structural element by more than 10 percent cumulative since the original construction or decrease the design strength of a structural element by more than 5 percent cumulative are not permitted unless the affected seismic force-resisting system will carry the forces as required by ASCE 7 for a new structure.

Bracing and Anchorage

Bracing and anchorage of nonstructural elements, including mechanical equipment, will be specified as the design progresses to be Contractor designed. Calculations and details are required to be submitted for all items not exempted by 13.1.4 of ASCE 7-10, as referenced by the IBC, and not provided with flexible connections.

Design Development Issues

As design progresses, seismic upgrade provisions for existing structures presented in this TM will be updated and modified as required for new openings, loadings, changes to planned equipment, or other items that may affect the need for code-mandated upgrades.

PD.04 - Mechanical Design Criteria

PREPARED BY: Jason Riegler/CH2M HILL
REVIEWED BY: Steve Donovan/SHN
Marv Murray/CH2M HILL
DATE: August 2013

Introduction

The purpose of this technical memorandum (TM) is to define and document the mechanical design criteria that influence the Coos Bay Wastewater Treatment Plant #2 Expansion and Upgrade Project.

Design Codes and Standards

Mechanical system design will conform to the applicable U.S. codes and standards. The codes and standards of the following organizations will govern:

- American National Standards Institute (ANSI)
- American Society of Mechanical Engineers (ASME)
- American Water Works Association (AWWA)
- American Welding Society (AWS)
- Hydraulic Institute Standards (HIS)
- National Fire Protection Association (NFPA)
- Occupational Safety and Health Administration (OSHA)

Design Criteria

Plant Hydraulics

Open channel flow through the plant components will be analyzed with CH2M HILL HYDRO software. The results will be used to develop the plant hydraulic profile, refer to PD.15, Plant Hydraulics.

Pumped System Hydraulics

Pumping of wastewater with solids concentration of less than 2 percent will be analyzed using the Newtonian Fluid Model.

Sludge system hydraulics, solids concentration of 2 percent or greater, will be analyzed using the Non-Newtonian Bingham Laminar Plastic Model built into Fathom software.

Equipment Selection

Process equipment will be selected for the chosen plant process alternative to meet the performance requirements of that alternative. Input from plant operations and maintenance personnel will be solicited throughout the design for preferred manufacturers or equipment vendors. Final process equipment selections will be made based on equipment performance requirements, reliability, cost, efficiency, SHN/CH2M HILL experience, and the City’s preferences.

The process mechanical engineer(s) will be responsible for compiling the equipment specifications, which will include at least two named manufacturers for each piece of equipment, unless there are overriding reasons to procure equipment from a sole-source to match existing equipment or to obtain a performance guarantee.

Piping Selection

A Preliminary Pipe Schedule is included as Attachment A to this TM.

Wastewater and sludge system piping will generally be cement-lined ductile iron (CLDI) pipe. Welded steel pipe or high-density polyethylene (HDPE) pipe will be used for process piping 30-inch and above as CLDI is not cost effective in these sizes. For exposed piping installations, CLDI pipe joints shall be grooved joint or flanged, and CLDI pipe joints will be restrained joints for buried installation. Welded steel and HDPE pipe joints will be welded or flanged.

Process air system piping will be carbon steel or stainless steel. Steel and stainless steel pipe shall be provided with flanged joints connections to valves and other equipment.

Piping materials and joint types for pressurized systems will be selected to provide thrust restraint of all joints exposed or buried.

Valve Selection

Manually operated and power-operated valve schedules will be developed and updated as design progresses. Valve selection will generally be as follows:

- For raw sewage and sludge systems, gate valves and plug valves will be used except where flow control is required. Flow control valves for sludge systems will be V-port type ball valves or rotary control valves.
- For process air system, final effluent, and plant water systems, valves 3 inches and larger will be butterfly valves. Valves 2½ inches and smaller will be ball valves.
- In chemical systems, non-metallic diaphragm valves will be used.
- Check valves for wastewater and sludge systems will generally be swing-check valves. Check valves in chemical systems will be non-metallic ball-check valves.
- The default actuator type for power-operated valves will be electric actuators. Electric actuators will generally be 120-volt (120 V); single-phase on valves 4 inches and smaller and will generally be 480-volt; three-phase on valves larger than 4 inches.

Gate Selection

Gate schedules will be developed and updated as the design progresses.

Fabricated stainless steel or aluminum slide gates will be used in low head and modulating gate applications, if required. Stainless steel or aluminum materials will be selected based on corrosion engineer’s recommendations.

Cast iron slide gates (sluice gates) will be used in higher head and where lower leakage rates than provided with fabricated slide gates are required.

Gates will be either manually actuated or powered by electric actuators (460V, three phase), where deemed necessary. A portable electric valve operator (drill motor) will be provided to allow powered operation of gates provided with manual actuators.

Code Issues

Mechanical and supporting electrical equipment will be designed in accordance with NFPA 820, 2012 Standard for Fire Protection in Wastewater Treatment and Collection Facilities. The incorporation of NFPA 820 requirements is a task that will be coordinated by the process mechanical engineer(s) with all other involved engineering disciplines including electrical, building mechanical, and instrumentation and control.

Reliability/Redundancy

EPA/DEQ requires that wastewater facilities meet the requirements for reliability and redundancy in their treatment components and associated equipment. The reliability standards establish minimum levels of reliability for three classes of wastewater works.

Oregon DEQ has also established minimum standards governing the reliability of mechanical, electrical, and fluid systems used in wastewater systems. The standards are intended to protect the environment, particularly receiving waters, against unacceptable degradation resulting from power failure, flood, peak loads, equipment failure, and maintenance shutdowns. The standards are divided into three, decreasingly stringent, classes of reliability: I, II, and III. DEQ has determined that reliability Class I is appropriate for Plant #2. These requirements provide the basis for process mechanical equipment included in the design.

Basis of Design

Drawing Guidelines

At a minimum, provide the following information on the layout drawings:

- Dimensioning: Locate equipment and piping centerlines, as required, using a minimum of two dimensions. Dimension from interior wall surfaces or from exterior wall surfaces.
- Pipe elevations: When indicating pipe elevations, use the following conventions:
    - Centerline for pressure pipes except when two or more pipes rest on a common support.
    - Invert elevation (IE) for gravity-flow pipes (including gravity-flow pipes through walls) except when two or more pipes rest on a common support.
    - Bottom-of-line (BOL) elevation when two or more pipes rest on a common support.
    - Equipment elevations: Be aware of differences in equipment dimensions among manufacturers. Ensure that a satisfactory installation will result for any probable equipment. For example, a pump should normally be set by indicating inlet or outlet piping elevations.
- Show any piping reducers/increasers required to connect piping to equipment, valves, etc.
- Properly reference design details (*to be developed in final design*). Create custom details only when necessary.
- Ensure that drawing notes are clear and concise and that terms on the drawings agree exactly with the terms used in the general abbreviation sheets and/or the specifications.

Layout and Access

Certain conventions should be followed to make the wastewater treatment plant optimally functional, operable, and maintainable. When developing layouts, observe the following guidelines:

Equipment

- Typically, one type of equipment will be chosen as the basis of design. This make or model is referred to as the “design standard.” Layout should be based on this selection. Where other manufacturer’s products are also suitable, the layout should be checked to ensure that the arrangement does not preclude the use of these alternatives.
- Required space for equipment removal/replacement/maintenance will be provided in the layout on the drawings.
- Mount equipment and panels on equipment pads to protect them from wash down and flooding.
- The minimum clearance on sides around rotating equipment over 10 horsepower (hp) should be 4 feet.
- Leave at least 4 feet of clearance between the outermost extremities of adjacent pieces of equipment or between a wall and a piece of equipment.
- Clearance in front of any other equipment face or panel requiring maintenance should be 4 feet.
- Pressure vessels should be at least 2 feet from the back wall and 3 feet apart. Sufficient space in front of the vessel should be provided for the face piping plus 4 feet.

- For pumps, compressors, and other rotating equipment where parallel units are provided, the orientation of the drive and the rotation should be identical.
- Pumps used for sludge pumping should be arranged to minimize the distance and number of bends through which the liquid must be conveyed to the pump suction.
- Provide adequate headroom for removal of vertical turbine pumps, and/or specify shafts, shaft enclosure tubes (where applicable), and columns in specific length sections that are removable.
- Provide ladders and/or hatches to access and remove equipment.
- Motorized hoists, monorails, or cranes should be provided where equipment component weights exceed 2,000 pounds and/or when frequent lifting for maintenance is necessary.
- Provide adequate lifting headroom for equipment. Also, an allowance for sling length or lifting beams between equipment lift points and crane or hoist hook needs to be included.
- Provide lifting eyes, in accordance with the design details, above equipment not otherwise provided with lifting means.
- Place wash down stations in logical areas to facilitate clean-up and pipe flushing.

Piping and Valves

- Locate piping so that it is not a tripping hazard, a head-banger, or a barrier to equipment access.
- To facilitate lifting, minimal piping should be located above blowers, compressors, or pumps.
- In general, lay out piping close to walls where it can be easily supported, particularly in spaces with high ceilings.
- If piping must be run close to a wall, but not supported from it, leave at least 2 feet of clearance between the outermost pipe flange and the wall.
- To permit purging of air from the pipeline while it is being filled with water, locate a manual vent valve on the highest point of every pipeline to be filled with liquid or is to be hydrostatically tested.
- To permit water drainage, locate a manual drain valve on the lowest point of every pipeline.
- Pipe supports and seismic bracing are generally not shown on the layout drawings; however, verify that adequate space is available for installation of these supports.
- Provide flexible connections to permit easy assembly and disassembly of piping and connections to equipment.
- When laying out piping, keep the placement of anchors and expansion joints in mind. These must be located on the drawings.
- If piping reducers are required on the suction side of pumps, provide eccentric reducers that are flat on top (FOT).
- Wall penetrations should be perpendicular to the wall.
- Make an effort to keep valves within operator reach (below 8 feet). For any valve over 8 feet above the operating floor, provide a chain operator.
- Do not place swing check valves in vertical piping runs.
- Install an easy disassembly coupling or pipe joint within four pipe diameters of valves.

- Provide thrust restraint for sleeve and other couplings that are not capable of internal thrust restraint.
- Allow ample space for valve and gate actuators.
- Provide adequate clearances for rising stem valves and gates.
- Install buried valves in valve vaults, where practical.
- Provide sufficient straight runs for flow meters and other instrumentation and control (I&C) elements.

Pipe Insulation and Freeze Protection

- Exterior small diameter process piping, such as chemical piping, will be insulated and heat traced for freeze protection.
- Insulation will be provided on air low pressure (ALP) piping, on the discharge near the blowers, to protect personnel from potential burn hazards, and on other areas as necessary.

Equipment Removal System

Provisions will be made to ensure all equipment is installed to allow means for its removal and replacement, as necessary.

The primary means for removal of equipment that is mounted outdoors will be through the use of boom trucks and cranes. Outdoor equipment will be accessible using available rental boom trucks or cranes.

The facility designs for equipment mounted indoors, or in shelters, shall take into consideration the method of equipment removal. Where practical, access shall be provided to allow removal by forklift, dolly, or cart. Where this type of access is not available, permanent means of equipment removal shall be provided in the design. It is anticipated that the following area(s) will require a permanently installed equipment removal system.

- Influent Pump Station – Pumps: monorail with hoist and trolley
- UV Disinfection – Modules: Bridge crane with hoist and trolley

Construction Constraints

Process mechanical construction constraints will be coordinated between the engineering disciplines to develop a detail construction sequencing plan. General items that will be considered in this plan from a mechanical standpoint shall include:

- Determination of existing pipe material and detailing of connection methods for tie-ins to existing buried pipe systems. This information will allow estimation of time required to complete the work.
- Consideration of sequencing of the construction of system components to allow start-up of facilities and process flow switch over to the new facilities from existing.
- Consideration of requirements for performance testing of equipment, such as: clean water test water supply provisions, measurement of pumped volumes, and pressure reading requirements. Verifying installed flow meters and pressure indicators are sufficient for testing or verify means of flow and pressure measurement are achievable. Provide gauge cocks for pressure testing, if permanently installed gauges are not required.
- Evaluation of pipe system leakage testing feasibility including, but not limited to, new and old pipe connections and large diameter piping connected to basins. Process engineer(s) shall verify that leakage testing is practical at the test pressures indicated in the Piping Schedule. Where required, flanges shall be provided on open end pipe systems to allow blind flange installation for testing purposes.

Design Development Issues

The design development phase (60 %) of the project is the appropriate time to incorporate input in the mechanical design from the plant operators and maintenance personnel. The following is a list of items where input will be solicited from plant staff regarding their preferences.

- Valve manufacturers
- Electric valve actuator manufacturers
- Pump manufacturers
- Pump seal designs
- Pipe system labeling and/or color coding
- Review of pipe materials selections
- Exterior piping freeze protection preferences (i.e. heat tracing versus drain down systems)
- Review of equipment access and equipment removal systems

PIPING SCHEDULE

Service	Legend	Size(s) (in.) (Note 2)	Installation (Note 4)	Material (Note 3)	Specification Section	Joint Type (Note 5)	Lining/Coating (Note 6)	Test Pressure and Type (Note 7)	Remarks
AIR, LOW PRESSURE	ALP	ALL	EXP	WS	33 05 01.01	F, GR, W	Bare/No.5	20, P	
			SUB	SST	40 27 00.08	F, GR, W	Bare/Bare		Extend to 1'-6" above WS
			BUR, EMB	CLDI	40 27 00.01	F, GR, MJ	Cement Mortar		Cathodically Protect. Polyethylene Encase
DRAIN (PROCESS)	XX/DR								Use primary service for info.
FOUL AIR	FA	ALL	ENC, EXP	FRP	23 31 16.16	FL, S, W	Bare/No. 25	2, P	Outside building
			ENC, EXP	SST	23 31 13		None		Inside building
		<=8	BUR, S	PVC	40 27 00.10		None		
		>=10	BUR, S	HDPE	33 41 01.07	HU, W	None		
GRIT SLURRY	GS	<=3	ENC, EXP	STL	40 27 00.03	FL, GR, S, W	None/No. 5	150, H	
		>=4		CLDI	40 27 00.01	FL, GR, PRJ	Cement Mortar/No. 5		
			BUR				Cement Mortar/Cement Mortar		
PLANT DRAIN	PD	< =4	EMB, EXP	GALV	40 27 00.07	FL, GR, S	Bare/No. 5	100, H	
			BUR, SUB	PVC	40 27 00.10	FL, S, W	None		
		>= 4	ALL	CLDI	40 27 00.01	FL, GR	Cement Mortar/No. 5		
						PRJ	Cement Mortar/Poly Encase		
RAW SEWAGE	RS	4-24	EXP, SUB, EMB	CLDI	40 27 00.01	FL / GR	Cement Mortar/Remarks	150, H	Coat EMB No. 7, EXP No. 4, SUB No. 2
		>=30		WS	33 05 01.01	FL, GR, W	Cement Mortar/No. 5		
		4-24	BUR	CLDI	40 27 00.01	PRJ	Cement Mortar/Poly Encase		Cathodically Protect. Polyethylene Encase
		>=30		HDPE	33 05 01.10	FL, W	None		
SCREENED RAW SEWAGE	SRS	<=3	EXP	PVC	40 27 00.10	FL, S, W	Bare/No. 25	100, H	
		4-24	ALL	CLDI	40 21 00.01	FL, GR	Cement Morter / Remarks		Coat EMB No. 7, except BUR end No. 29 and SUB end No. 2.
		>=30	EMB, EXP	WS	33 05 01.01	FL, GR, W	Cement Mortar/No. 5		
			BUR, SUB	HDPE	33 05 01.10	FL, W	None		
SECONDARY EFFLUENT	SE	<=3	EXP	PVC	40 27 00.10	FL, S, W	Bare/No. 25	100, H	
		4-24	ALL	CLDI	40 21 00.01	FL, GR	Cement Morter / Remarks		Coat EMB No. 7, except BUR end No. 29 and SUB end No. 2.
		>=30	EMB, EXP	WS	33 05 01.01	FL, GR, W	Cement Mortar/No. 5		
			BUR, SUB	HDPE	33 05 01.10	FL, W	None		
PRIMARY EFFLUENT	PE	4-24	EXP, SUB, EMB	CLDI	40 27 00.01	FL / GR	Cement Mortar/Remarks	150, H	Coat EMB No. 7, EXP No. 4, SUB No. 2
		>=30		WS	33 05 01.01	FL, GR, W	Cement Mortar/No. 5		
		4-24	BUR	CLDI	40 27 00.01	PRJ	Cement Mortar/Poly Encase		Cathodically Protect. Polyethylene Encase
		>=30		HDPE	33 05 01.10	FL, W	None		
PLANT EFFLUENT	PLE	<=3	ALL	PVC	40 27 00.10	FL, S, W	Bare/No. 25	150, H	
		4-24	EXP,EMB,SUB	CLDI	40 27 00.01	FL, GR	Cement Mortar/No. 5		
			BUR			PRJ	Cement Mortar/Poly Encase		
		>=30		HDPE	33 05 01.10	FL / W	None		
			EXP,EMB,SUB	WS	33 05 01.01	FL, GR, W	Cement Mortar/No. 5		
NO. 1 (POTABLE) WATER	W1	'4-24	BUR	CLDI	40 27 00.01	PRJ	Cement Mortar/Remarks	150, H	Cathodically protect Polyethylene encase
		>=30	EXP, SUB,	WS	33 05 01.01	FL, GR, W	Cement Mortor/No. 5		
			BUR	HDPE	33 05 01.10	FL, W	None		
NO. 2 (NON-POTABLE) WATER	W2	<=3	EXP, SUB,	COP	40 27 00.13	FL, S, W	bare/no. 5	150, H	
			BUR	PVC	40 27 00.10	S, W	None		
		'4-24	EXP, SUB,	CLDI	40 27 00.01	FL / GR	Cement Mortar/Remarks		Coat EMB No. 7, EXP No. 4, SUB No.
			BUR			PRJ			Cathodically protect Polyethylene encase
		>=30	EXP, SUB,	WS	33 05 01.01	FL, GR, W	Cement Mortor/No. 5		
			BUR	HDPE	33 05 01.10	FL, W	None		

PIPING SCHEDULE

Service	Legend	Size(s) (in.) (Note 2)	Installation (Note 4)	Material (Note 3)	Specification Section	Joint Type (Note 5)	Lining/Coating (Note 6)	Test Pressure and Type (Note 7)	Remarks
NO. 3 WATER	W3	<=3	EXP, SUB,	COP	40 27 00.13	FL, S, W	bare/no. 5	150, H	
			BUR	PVC	40 27 00.10	S, W	None		
		'4-24	EXP, SUB,	CLDI	40 27 00.01	FL / GR	Cement Mortar/Remarks		Coat EMB No. 7, EXP No. 4, SUB No.
			BUR			PRJ			Cathodically protect Polyethylene encase
		>=30	EXP, SUB,	WS	33 05 01.01	FL, GR, W	Cement Mortor/No. 5		
			BUR	HDPE	33 05 01.10	FL, W	None		
WASTE ACTIVATED SLUDGE	WAS	<=3	EXP, SUB,	COP	40 27 00.13	FL, S, W	bare/no. 5	150, H	
			BUR	PVC	40 27 00.10	S, W	None		
		'4-24	EXP, SUB,	CLDI	40 27 00.01	FL / GR	Cement Mortar/Remarks		Coat EMB No. 7, EXP No. 4, SUB No.
			BUR			PRJ			Cathodically protect Polyethylene encase
		>=30	EXP, SUB,	WS	33 05 01.01	FL, GR, W	Cement Mortor/No. 5		
			BUR	HDPE	33 05 01.10	FL, W	None		

NOTES:

1. Where piping carries two or more service designations the piping material shall conform to the requirement for the first service listed, e.g. CGW/OF would require the material used for CGW piping.

2. ">" Greater Than
   "<" Less Than
   "<=" Less Than or Equal To
   ">=" Greater Than or Equal To
   "All" All sizes

3. A20: Alloy 20
   CISP: Cast Iron Soil Pipe
   CLDI: Cement-Lined Ductile Iron
   CPVC: Chlorinated Polyvinyl Chloride
   COP: Copper
   FRP: Fiberglass Reinforced Plastic
   GALV: Galvanized Steel
   GLDI - Glass Lined Ductile Iron
   GLSTL - Glass Lined Carbon Steel
   HDPE - High Density Polyethylene
   PIP - Preinsulated Pipe
   PP: Polypropylene
   PT: Plastic tubing
   PVC: Polyvinyl Chloride
   RCP - Reinforced Concrete Pipe
   RCPP: Reinforced Concrete Pressure Pipe
   SST: Stainless Steel
   STL: Mill Type Carbon Steel
   WS: Fabricated Welded Steel

4. Installations
   EXP: Exposed (interior or exterior)
   BUR: Buried
   EMB: Embedded (in concrete)
   SUB: Submerged
   ALL: All installations

5. Joints as specified in Section 40 27 00 PROCESS PIPING - GENERAL and in the sections referenced
   FL - Flanged
   GR - Grooved
   HU - Hub and Spigot
   MJ - Mechanical Joint
   PRJ - Proprietary Restrained Joint
   S - Screwed
   W - Welded

6. Coating system number as specified in Section 09 90 00, PAINTING AND COATING, and as specified in Article,
   PIPE CORROSION PROTECTION.
   Poly: Polyethylene wrap
   Tape: Tape wrap

7. H: Hydrostatic Test
   P: Pneumatic Test
   G: Gravity Pipe - Test pressure is not shown on gravity pipes.
   Test to highest liquid level that pipe can be subject to.
   PC: Test per Uniform Plumbing Code
   PSIG: Pressure

Remarks:
1) Heat trace as specified in Section 40 05 33 PIPE HEAT TRACING.
2) Insulate as
3) All piping to be restrained joint pipe and fittings.

TECHNICAL MEMORANDUM

PD.05 – Heating, Ventilation, and Air Conditioning/Plumbing Design Criteria

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DATE: August 2013

Introduction

This technical memorandum documents design parameters and characteristics for heating, ventilation, and air conditioning (HVAC) and plumbing for the Coos Bay Wastewater Treatment Plant (WWTP 2) Expansion and Upgrade project.

Design Codes and Standards

Applicable codes and standards are as follows:

- 2010 State of Oregon Mechanical Specialty Code (2009 International Mechanical Code [IMC])
- 2010 Oregon Fire Code
- 2010 State of Oregon Structural Specialty Code (2009 International Building Code [IBC])
- 2010 Oregon Energy Efficiency Specialty Code
- 2011 State of Oregon Plumbing Specialty Code
- National Fire Protection Agency (NFPA) 820, 2012 Standard for Fire Protection in Wastewater Treatment and Collection Facilities
- American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE) Standard 62.1-2010, “Ventilation for Acceptable Indoor Air Quality”
- Sheet Metal and Air Conditioning Contractors’ National Association (SMACNA) HVAC Duct Construction Standards, 2005
- Air Moving and Conditioning Association (AMCA)

HVAC

Design Criteria

Exterior Design Air Temperature Conditions

Design temperature data from ASHRAE for North Bend, Oregon.

- Winter exterior design temperature for normal heating: 32 degrees Fahrenheit (˚F) (99.0 percent occurrence).
- Summer exterior design temperature: 69 dry bulb/60 wet bulb degrees F (1.0 percent occurrence).

Space Temperature Design Criteria

- Control Building: 70˚F in winter and 75˚F in summer.
- Restroom Spaces: 70˚F in winter and 75˚F in summer.
- Process Spaces: 50˚F in winter. Cooling ventilation will maintain process spaces 5 to 10 degrees warmer than outside air temperature.
- Electrical Building: 50˚F in winter and 79˚F in summer (in order to keep inside of variable frequency drive enclosures below 104˚F).

Corrosion Protection

Protection from corrosion is a design criterion for the HVAC systems. All HVAC coils will be specified with a corrosion-resistant coating, and HVAC interior ductwork will be aluminum, welded type 316 stainless steel; or type 304 coated stainless steel depending on the level of exposure to hydrogen sulfide. Paint will be applied to HVAC systems to protect materials exposed to chemicals used in, or resulting from, the processes.

Duct Design

Ductwork for HVAC systems will be specified to be in compliance with SMACNA HVAC Duct Construction Standards. Ductwork for odor control systems will be specified to be in compliance with SMACNA HVAC Industrial Duct Construction Standards. In general, ducts will be sized for 0.1 inch static pressure per 100 feet or less to reduce fan energy consumption.

Energy Code Compliance

HVAC systems and equipment will be designed and specified to perform at levels dictated by the 2010 Oregon Energy Efficiency Specialty Code. Also, facility insulation levels will be selected to comply with this code, as required. This code does not recognize semi-heated spaces as a justification for reduced envelope insulation (as opposed to the previous code).

Any new heated or cooled buildings should be insulated to meet the energy code requirements tabulated in Table 5-1.

TABLE 5-1
Required Envelope R and U Values

Assembly	Minimum R Values or Maximum U Factor
Roof	U = 0.048
Exterior walls	U = 0.150[1]
Slab on grade	F = 0.730

Note:

[1] Exception: Integral insulated concrete block walls that comply with American Society of Testing and Materials (ASTM) C90 with (1) at least 50 percent of cores filled with vermiculite or equivalent fill insulation and (2) building is a wastewater treatment facility.

Basis of Design

The following are proposed HVAC approaches for key spaces.

Control Building

This space will be served by a filtered makeup air unit with outdoor heat pump for providing cooling and heating.

Electrical Building

This space will be cooled and heated by a dedicated outdoor heat pump air conditioning unit. This unit will be located outdoors adjacent to the new electrical building.

Maintenance Shop

This space will be provided with a filtered supply fan and an exhaust fan. Electric unit heaters will provide space heating.

Headwork's Blower Room

This space will be provided with ventilation cooling via a filtered supply fan. Wall louvers will be provided for exhaust.

Headworks Screening Dumper Room

This space will be ventilated through the odor control system. Wall louvers will provide makeup air to the space. Electric unit heaters will provide space heating.

Materials

As mentioned previously, aluminum, welded type 316 stainless steel or coated type 304 stainless steel ductwork will be used for interior applications, depending on corrosion exposure. For buried applications, ductwork will be HDPE drain pipe and will be sloped appropriately for collection and removal of condensate.

Interior Foul Air Ductwork and Hazardous Exhaust Systems

Since odor control ductwork is considered a hazardous exhaust system, fiberglass reinforced plastic (FRP) duct is no longer allowed in interior locations per the mechanical code for odor control systems. A hazardous exhaust system is defined as a ducting system handling a gas with a health hazard rating of 4 in any concentration. Since hydrogen sulfide has a health hazard rating of 4, any foul air ducting system for hydrogen sulfide is considered a hazardous exhaust system. Duct material must have a flame spread index of 25 or less and a smoke-development index of 50 or less. All foul air ductwork located in interior locations for this project will be constructed of aluminum, welded type 316 stainless steel, or coated type 304 stainless steel. All foul air ductwork located in exterior locations for this project will be constructed of FRP or coated stainless steel. Buried foul air ducts shall be PVC and HDPE.

HVAC Ductwork

Aluminum ductwork will generally be used for interior ductwork. Ductwork requiring insulation will be internally insulated in process spaces and locations exposed to view. Blanket fiberglass duct insulation with vapor barrier will be used in concealed locations.

Piping Materials

Natural gas piping will be carbon steel above grade and high-density polypropylene (HDPE) below grade.

General Equipment Selection Criteria

Quality

Systems will be selected that exhibit high reliability and long service life. Process areas will be served by industrial grade heavy-duty equipment. Non-process areas will be served by commercial grade equipment.

Redundancy

In general, equipment redundancy will not be provided for HVAC systems. A recommended spare parts list may be included with equipment specifications to guide warehousing of critical parts.

Seismic and Wind Loading

Seismic restraints will be performance specified to prevent permanent displacement of equipment in any direction caused by lateral motion, overturning or uplift, as appropriate for the seismic zone for this site. HVAC external components, such as gas vents, will be designed and installed to withstand specified wind loads.

Plumbing

Plumbing Design Criteria

Potable Water Supply

A new potable water line will serve the new facilities. Required metering and service connection requirements will be provided as required by City of Coos Bay.

Non-Potable Water Supply

A non-potable water (W3) line will serve the new facilities. The line will cross Empire Blvd. from the existing WWTP 2 site. W3 is a process flow and as such is not under the jurisdiction of the plumbing code. Hose valves, hoses, and hose rack stations will be provided and identified for all W3 wash-down locations.

Process Drainage, Sanitary Sewer, and Roof Drainage

Process drainage includes drainage piping connected directly to process equipment or systems and area drainage in process areas. For the Expanded/Upgraded WWTP 2 facilities it is expected that these two systems will be combined. Sanitary sewer and process drainage will be routed to the new Influent Pump Station.

Roof drainage from new facilities will be collected and routed to the storm drain system.

Storm Water Drainage

Stormwater site drainage is discussed seprarately in PD.09, Site Work and Landscaping.

Natural Gas

It is not anticipated that a new natural gas service will be required for the new facilities. If a natural gas service is required, any new loads will be coordinated with the local utility company.

Domestic Water Heating

A point of use electric water heater will serve the new restroom and service sink.

Cross-Connection Control

Cross-connection control is required in accordance with the plumbing code and local amendments as stipulated by the Coos Bay/North Bend water board. Backflow prevention assemblies are generally required, as a minimum, at the following locations:

- Water supply for mechanical and process equipment
- As a separation between potable and non-potable systems
- As a separation between potable water and fire sprinkler systems

It is proposed that a reduced pressure type backflow preventer be provided for cross-connection control. It is expected that this level of cross-connection control will be required to satisfy the water connection requirements.

Insulated Plumbing Piping

In accordance with local plumbing code requirements, insulation will be specified for the following piping systems:

- Potable water
- Potable hot water
- Non-potable water
- Roof drains

Piping Materials

Piping materials for the respective services are as follows:

- Sanitary sewer drainage—all sizes: bell and spigot cast iron soil pipe (CISP)
- Sanitary vents—all sizes: exposed to be cast iron and concealed to be polyvinyl chloride (PVC)
- Rain drainage—all sizes: no-hub CISP and concealed to be polyvinyl chloride (PVC).Potable water, hot water, tepid water, and W3:
- Less than 4-inches:stainless steel, copper, or Schedule 80 PVC
- 4-inches and larger: cement-lined ductile iron (flanged or victaulic)
- Natural gas fuel piping—all sizes: exposed to be Schedule 10 black steel pipe and buried to be HDPE

PD.06 – Electrical Design Criteria

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DATE: August 2013

Introduction

The section describes the electrical design process and will set the basic electrical design criteria for the City of Coos Bay Wastewater Treatment Plant 2 Expansion and Upgrade project. The objective of this technical memorandum is to tailor the electrical design approach to the specific needs of this project. Drawings showing the site plan and electrical one-line diagram are in a separate volume.

The memorandum is organized as follows:

1. Design Criteria
2. Design Codes and Standards
3. Basis of Schematic Design
4. Construction Constraints
5. Design Development Issues

Design Criteria

The basic goals of the design criteria are as follows:

- Develop safe, reliable, and maintainable electrical systems.
- Promote a consistent and uniform design approach and standardize the types and quality level of equipment specified.
- Establish a uniform basis for specifications and drawings.

Design Codes and Standards

The design will be based on the codes and standards outlined below.

Codes

- 2011 National Electrical Code (NEC, NFPA-70)
- 2012 Life Safety Code (NFPA-101)
- 2012 International Fire Code (IFC)
- 2012 Standard for Electrical Safety in the Workplace (NFPA-70E)

Standards

- American National Standards Association (ANSI)
- National Electrical Manufacturers Association (NEMA)
- Institute of Electrical and Electronic Engineers (IEEE)
- Instrument Society of America (ISA)
- Insulated Cable Engineers Association (ICEA)
- Occupational Safety and Health Administration (OSHA)
- American Society for Testing Materials (ASTM)
- Underwriters Laboratory (UL)

- Illuminating Engineering Society (IES)
- National Fire Protection Association (NFPA)

Basis of Schematic Design

Distribution System

The new facilities, on the east side of Empire Blvd., will be fed from the existing overhead power line on the west side of the site, as shown on the electrical site plan in Volume 2 of this Predesign Report. Preliminary coordination with Pacific Power has revealed that a new power pole will need to be installed on this line to facilitate a new service drop. New buried conduit and conductors will be routed from this power pole to a new pad mounted transformer adjacent to the new Electrical Building. This transformer will feed a new service rated switchboard in the new Electrical Building. The distribution equipment in the new Electrical Building will feed the new loads for all the facilities on the east side of Empire Blvd.

A new standby generator will be included to provide backup power to the new facilities. An automatic transfer controller will be installed in the new switchboard to control the electrically operated main and generator breakers, and transfer between utility and standby generator power.

A stand alone uninterruptible power supply (UPS) will be installed to provide backup power for the ultraviolet (UV) disinfection system. This UPS system will have battery capacity to allow for ride through until the standby generator comes online, plus a safety factor. A second smaller UPS system will be installed to provide backup power for critical loads such as supervisory control and data acquisition (SCADA) equipment.

The distribution system will be designed for the capacity of the process, under the scope of this contract, with additional capacity for future process equipment.

The electrical service at the existing treatment plant, on the west side of Empire Blvd., will be reconfigured to accommodate modifications being made to solids processing loads.

Standby Power Distribution System

Preliminary calculations indicate that a single standby diesel engine generator, rated at 750 kW, will be required. This generator will be connected to the 480V main switchboard bus. The generator is sized to provide power to all the new process facilities during a power outage or voltage dip. The plant control system will sequence the restartup of process equipment to provide an easier reapplication of loads to the generator. This generator will be installed in a <u>prefabricated walk-in enclosure</u> and have a sub base fuel tank to allow for 24 hours of fuel storage at rated load. The enclosure will be suitable for installation in a marine environment.

Listed and Labeled Equipment

Electrical equipment, materials, or services to be provided will have an attached label, symbol, or other identifying mark of an organization that is concerned with product evaluation, compliance with appropriate standards, and performance of the equipment. Typically, this is the Underwriter’s Laboratories Label or Listing (UL).

Area Classifications

Area classifications (such as hazardous locations, corrosive areas, wet areas, and high temperature locations) will be called out on the drawings. All materials and methods used will be rated for use in such areas.

The following areas are classified as Class 1, Division 1, Group D areas:

- Influent Pump Station wetwell and 3 foot radius around vent

The following areas are classified as Class 1, Division 1, Group D areas, but ventilated at 12 air changes per hour to reduce the classification to Division 2:

- Interior to headwork’s raw sewage screenings channels and grit basins

The following areas are classified as Class 1, Division 2, Group D areas:

- Influent Pump Station 5 foot radius around vent and 1.5 feet above hatch extending 3 feet from sides of hatch.
- 3 feet around potential leakage sources of odor control equipment and ductwork
- 18 inches above sequencing batch reactor structure walls, 18 inches horizontally from the walls, and 18 inches above grade out from the walls for 10 feet

The following areas are classified as nonhazardous, wet, and corrosive:

- Influent Pump Station areas not listed above
- Headwork's areas not covered elsewhere
- Top of basins not covered elsewhere
- Secondary effluent flow control station
- UV disinfection
- Outdoor above-grade areas not covered elsewhere.

The following areas are classified as indoor and normally dry:

- Office
- Electrical Building
- Blower Room
- Shop/Garage

The following areas are not classified:

- Areas not covered above

Lightning Protection System

No lightning protection system will be required for this project.

Distribution Voltage Selection

Standard distribution systems to be used are as follows:

- 480 volts, ungrounded delta, 3-phase, 3-wire
- 480Y/277 volts solidly grounded wye, 3-phase, 4-wire
- 208Y/120 volts solidly grounded, 3-phase, 4-wire

Utilization Voltages

The equipment utilization voltages listed in Table 6-1 will be used.

TABLE 6-1
Equipment Utilization Voltages

	Volts	Phase
Indoor Lighting	120	Single
Outdoor Lighting	120 or 277	Single
Convenience Outlets	120	Single
Motor Control	120	Single
Motors, less than 3/4 hp	115	Single
Motors, 3/4 hp and larger	460	Three

Voltage Drop

Steady-state voltage drop calculations will be prepared for heavily loaded or long branch circuits and feeders. Calculations for motor circuits will be based on an 80 percent power factor and loading consistent with the maximum expected peak load (will not include standby motors). The following total voltage drop from the transformer secondary to the point of utilization, including feeder, branch circuit, and transformation, will not be exceeded:

Lighting	3 percent
Motors	4 percent
Receptacles	4 percent
Electric Heaters	4 percent

Voltage dip calculations for motor starting will be made whenever an individual motor exceeds 20 percent of the serving transformer capacity.

Demand Factors

The demand factors listed in Table 6-2 will be used for sizing power switchboards, motor control centers (MCCs), panelboards and transformers. Connected load will be used for circuit and equipment sizing, per NEC requirements. Ten to 20 percent spare capacity will be provided at MCCs and panelboards.

TABLE 6-2
Demand Factors

Service	Demand Factor
Lighting	1.0 x Connected Load
Emergency Lighting	1.0 x Connected Load
Air-Conditioning Equipment	1.0 x Connected Load
Ventilation Equipment	1.0 x Connected Load
Convenience Receptacles	180 VA each[1]

TABLE 6-2
Demand Factors

Service	Demand Factor
Process Loads	Sum of constant speed + adjustable speed + 25% of largest motor
• Constant Speed	1.0 x Connected Load of non-standby loads
• Adjustable Speed	0.85 x Connected Load of non-standby loads

NOTE:

[1] Apply NEC demand factor of 50 percent for totals over 10 kW.

Metering

Multifunction digital meters will be provided for switchboard and generator mains. Meters shall interface with SCADA over the plant's network.

Branch Circuits

Connected load and NEC requirements will be used for sizing branch circuit breakers and conductors.

A minimum wire size of No. 12 American wire gauge (AWG) copper will be used for lighting and receptacle branch circuits. No. 10 AWG will be used when voltage drop requires a larger conductor on lighting circuits, and when receptacle circuits are longer than 75 feet. Where electronic ballasts are specified for fluorescent lighting a dedicated neutral will be provided for each lighting circuit.

In general, lighting branch circuit loads will be limited to 1,500 watts.

Lighting and receptacle branch circuits will be combined into common conduits, where appropriate.

The number of convenience receptacles, on any one branch circuit, will be limited to five duplex in process areas and six duplex in office areas.

Panelboards

Branch circuits or feeders on the drawings will identify the panelboard and device protecting the individual circuit or feeder.

Each panelboard will be equipped with a minimum of 20 percent spare breakers with spaces, bus work, and terminations to complete the standard size panelboard.

Panelboard schedules will be prepared indicating circuit identification, protective device trip rating, number of poles, load in volt-amps by phase, rating of main lugs or main circuit breaker, neutral bus size, ground bus size, and integrated short circuit rating of the panelboard.

A separate panelboard will be provided for instrumentation and controls (I&C) devices and field panels, if needed.

Motor Control

Elementary (ladder type) control diagrams will be prepared for each motor showing control wiring, pilot devices, auxiliary contacts and external connections. A single diagram will be used for more than one motor having the same control.

Graphic symbols shown on the electrical legend sheet will be used. Each component will be identified with a unique letter or name. Wiring and devices inside the controller will be shown as solid lines, and wiring and devices remote from the controller with a dashed line. The location of remote devices will be indicated by symbol or description.

Remote control assemblies that have complex internal wiring will be shown as dashed rectangles. Only the interconnecting terminal or interface will be identified, and the location of the unit or responsibility of the internal wiring will be referenced.

Motor controllers provided will either be mounted inside a MCC or as a standalone piece of equipment. Motor starters internal to the MCC and all adjustable frequency drives provided by the electrical equipment manufacturer shall interface with SCADA over the plant’s EtherNet network. Motor starters shall contain electronic overload relays with EtherNet communication capabilities.

Equipment Identification

I&C process and instrumentation diagrams (P&ID) tag numbers will be used for motors, I&C devices, and other process equipment shown on electrical drawings. This same numbering method will be used to create unique tags for major electrical distribution equipment.

Distribution System Equipment

Distribution equipment criteria include the following:

- 480-volt switchboard with group mounted feeder circuit breakers.
- 480-volt MCCs with combination motor starters, of the motor circuit protector type, rated for the available fault current. Starters larger than NEMA size 3 (50 horsepower [hp]) will be the solid-state, soft-start type or adjustable speed drives. MCCs will be sized to accept future loads and either allow for space in the structures or floor space for future sections.
- 480-volt and 208Y/120-volt power distribution and lighting panelboards with molded case, bolt-in-place and plug-in, respectively, circuit breakers with integrated short-circuit rating suitable for the available fault current.

Raceway Systems

A common duct bank system, with separate manholes, will be used for the following systems:

- 480-volt power wiring and 120-volt control wiring
- Communications systems, including low-voltage signal for fire alarm, telephone and data systems, and fiber optic cabling

Special consideration will be given to separation of raceways involving low-level process control signal wiring and power system wiring to minimize the possibility of interference.

General guidelines for raceway sizing, selection, and installation are as follows:

- Conduit sizing will be based on Thermoplastic Heat and Water Resistant Insulated (THW), insulation.
- The following minimum sizes will be used:
  - 3/4-inch minimum diameter for conduit installed exposed on walls and ceilings
  - 3/4-inch minimum diameter for conduit concealed in frame construction and finished ceilings
  - 1-inch minimum diameter for conduit embedded in masonry, encased in concrete, and underground
- Raceways will be concealed in middle of concrete floor slab in process areas.
- Raceways will be concealed in walls and ceilings in control rooms, offices, and areas that have finished interiors.
- Polyvinyl chloride (PVC) -coated rigid galvanized steel conduit will be used for the transition from underground direct burial and under slab PVC conduit and concrete encased (in floor slab) PVC and rigid

galvanized steel conduit to exposed rigid galvanized steel conduit. The transition section will extend from 1 foot below grade or top of floor slab or the last foot of conduit in the floor slab, to 6 inches out of the floor slab, concrete encasement, or above grade.

- The number of conduit bends will be limited to an equivalent of 270 degrees on long runs without pull boxes.
- PVC-coated rigid galvanized steel conduit and fittings that are resistant to direct sunlight and include an interior urethane coating will be used in exposed corrosive interior areas. PVC-coated rigid galvanized steel conduit and fittings will be used in exposed outdoor locations.
- PVC-coated rigid galvanized steel conduit will be used for underground direct burial low-voltage status/control (less than 100 volts) and analog signal circuits.
- PVC Schedule 40 conduit and fittings will be used for underground direct burial, under slab, and concrete-encased 120-volt circuits.
- PVC Schedule 40 conduit and fittings will be used for underground concrete-encased 480V power circuits.
- Rigid galvanized steel conduit and fittings will be used when exposed or concealed in interior noncorrosive process and nonprocess areas.
- Flexible, nonmetallic, liquid-tight conduit 4-inch or smaller in size will be used for connections to motors, transformers, and other equipment, as required. Fittings will be PVC-coated in wet or corrosive areas.
- Underground conduit routes will be identified nonmetallic warning tape above underground direct burial conduits.
- Spare raceways will be tagged with a nonferrous metal tag attached to the raceway with stainless steel strap. Raceway tags with approved tag number provided by the contractor will identify the raceway origin and destination and will be located at each terminus and at the midpoint in long raceway runs.
- Cable trays may be used in indoor non-corrosive locations.

Wire and Cable

Wire and cable criteria include the following:

- Stranded copper conductors will be used for all except lighting and receptacle wiring. Solid conductors #10 AWG and smaller will be used for lighting and receptacle wiring.
- Minimum conductor size of No. 12 AWG will be used for power and lighting branch circuits. Type thermoplastic high heat resistant nylon coated (THHN)/ thermoplastic high heat and water resistant nylon coated (THWN-2) insulation will be used for No. 10 AWG and smaller conductors (conduit will be sized for Type THW conductors). Type cross-linked high heat water resistant (XHHW-2) insulation will be used for No. 8 AWG and larger conductors (conduit will be sized for THW conductors). 60°C conductor ampacity ratings will be used for sizing conductors No. 1 AWG and smaller. 75°C ratings will be used for sizing conductors larger than No. 1 AWG.
- Minimum conductor size of No. 14 AWG will be used for individual 120-volt control circuits.
- Minimum conductor size of No. 12 AWG will be used for 120-volt control circuits routed in a common conduit with the power conductors to the motor circuit controls. Combining individual motor power and control conductors in a common conduit will be done up to a maximum power conductor size of #2 AWG.
- Power and control conductors will be color-coded. Conductors No. 8 AWG and smaller will have colored insulation. Conductors No. 6 AWG and larger will be color-coded with tape at each end and at accessible intermediate points.

- Conductors and control cables will be tagged with a permanent sleeve or nylon marker plate attached with a nylon strap. Conductor tags with approved tag number will be provided by the contractor and will be located at each termination and in accessible locations.
- Under normal conditions, the maximum wire size will be limited to 600 kcmil. Parallel conductors will be used for circuits requiring greater capacity.
- 120-volt control circuits will be combined in control cables containing multiple #14 AWG stranded copper conductors with type THHN insulation and a common PVC outer jacket.
- 600-volt multicircuit control cable will be used where grouping control circuits is practical, and the number of individual wires exceeds six conductors. When selecting control cable size, 25 percent spare (plus or minus 10 percent) conductors will be used.
- Multiconductor control cable color coding will be ICEA S-61-402 Appendix K, Method 1, Table K-2.
- Low-voltage status/control (less than 100 volts) and analog signal circuits will be routed in 600-volt single twisted shielded pair instrumentation control cables. The cables will consist of #16 AWG stranded copper conductors with combination PVC/nylon insulation, drain wire, shield, and PVC outer jacket. Signal circuits will be combined in multitwisted shielded pair instrumentation control cables with common overall shield. The cables will consist of #18 AWG stranded copper conductors, with a combination PVC/nylon insulation, pair and common drain wires, pair and common shields, and PVC outer jacket. Instrumentation control cables will be per ICEA S-82-552. Low-voltage status/control and analog signal circuits will not be routed in the same control cable or conduit with 120-volt control or power circuits. Low-voltage status/control and analog signal circuits will be routed in the same conduit, but not in the same control cable.
- Adequate separation of power and I&C wiring will be provided to avoid signal interference. Long parallel runs will be avoided, and analog wiring will be installed in steel conduit.
- Shielded power cables will be used between adjustable frequency drives and the driven motor when the motor is greater than 150 feet from the drive.

Color Coding

Conductor insulation colors will be as shown in Table 6-3.

TABLE 6-3
System Color Coding

System	Conductor	Color
All Systems	Ground	Green
208Y/120 Volts	Neutral	White
	Phase A	Black
	Phase B	Red
	Phase C	Blue

TABLE 6-3
System Color Coding

System	Conductor	Color
480Y/277 Volts	Neutral	White
	Phase A	Brown
	Phase B	Orange
	Phase C	Yellow

Circuit Identification

Circuit names will be assigned based on device or equipment at load end of circuit. Circuit identification will be at each termination and in accessible manholes and pull boxes. Plastic sleeves for conductor #3 AWG or smaller and plastic marker plates for larger conductors will be used.

For lighting circuits, the panel and circuit number for each fixture will be identified.

Enclosures

NEMA 1 enclosures will be used for equipment in electrical rooms and finished areas. NEMA 12 enclosures will be used for electrical equipment in dry industrial locations. NEMA 4X enclosures will be used in exterior locations and interior corrosive locations. NEMA 7 enclosures will be used for equipment in classified locations.

Fiber Optics Cabling

Where used, fiber optic cabling will be installed either in conduit (2-inch-diameter minimum) or in a cable tray. Routing of the raceway system will provide for large-radius turns to prevent breaking of the fiber optic cable.

Convenience Receptacles

General service duplex receptacles will be spaced no more than 50 feet apart in process areas. Receptacles will be surface-mounted on walls or columns.

Waterproof receptacles will be installed in damp areas or areas subject to washdown.

Outlet-mounted ground-fault circuit-interrupters will be provided, where required by the NEC. Panelboard or feed-through type devices will not be used.

Distribution System Protection

General

Equipment will be selected with adequate momentary and interrupting capacity for the point in the system where it is used. Series rated criteria will not be used, except for self-contained equipment.

Phase and ground fault protective devices and device settings will be selected that will function selectively to disconnect that portion of the system that is malfunctioning with as little disturbance to the rest of the system as possible.

Preliminary Fault and Coordination Analysis

A preliminary analysis of the fault duty and device coordination will be made to produce a design that can be accurately bid by the contractor.

Maximum fault duty will be analyzed with sufficient accuracy to establish the required interrupting ratings of circuit protective devices specified. An infinite bus will be assumed on the source (primary) side of the utility service substation transformer.

Final coordination studies based on actual equipment purchased will be made by the contractor to establish the range of protective device settings that will result in reasonable selectivity of device operation for both three-phase and ground faults. The following protective device characteristics will be specified:

- Circuit breaker frame size, trip setting range, time delay ranges
- Current transformer ratios

Motor Protection and Control

General

- Each motor will be provided with a suitable controller and devices that will protect the equipment and perform the functions required.

- MCC-type construction will be used.

- MCCs located in the same room with the switchboard that powers them will not have a main circuit breaker. MCCs located in areas remote from the common MCC or switchboard that powers them will have a main circuit breaker.

- MCCs will include feeder circuit breakers and motor starters. Motor starters for motors through 50 hp will be the full voltage, non-reversing, combination type with magnetic-only circuit breaker. Motor starters for motors larger than 50 hp will be the solid-state, soft-start, reduced voltage, combination type with magnetic-only circuit breaker.

- For additional information on motor control features, see PD.07, Instrumentation and Control Design Criteria.

Overload Protection

Each constant speed motor, 50 hp and larger, and all adjustable frequency drive motors will be provided with thermal overload protection in ungrounded phases. Controller-mounted relays will be provided with external manual reset.

Motor Control

Oil-tight pilot devices will be specified for mounting on unit starters.

Motor control circuits will be designed at 120 volts and an individual control power transformer with 120-volt control voltage will be provided in each motor starter.

Alternating Current Induction Motors

General

Motors will be specified to be the energy efficient premium type per Energy Trust of Oregon requirements.

Enclosures for both horizontal and vertical motors will be totally enclosed, fan cooled (TEFC) severe duty for indoor and outdoor locations. In corrosive locations, chemical industry severe-duty (CISD-TEFC) motors will be used. Submerged motors will be totally submersible, air- or oil-sealed. Bearings will be rated per 100,000-hour Anti-Friction Bearings Manufacturers' Association (AFBMA) B-10 life.

Alternating current induction motors will be the premium efficiency type with the following:

- Non-inverter duty motors will have a 1.15 service factor.
- Inverter duty motors will have a 1.0 service factor.
- Motors powered from a variable frequency drive will be inverter duty rated.
- NEMA design letter will fit the application (usually NEMA design B), and locked rotor will be kV-amps (kVA) Code G or lower.
- Motors will be cast iron.
- Bearings for horizontal and vertical motors will be grease-lubricated, with grease addition and relief fittings.
- Motor windings will be copper wire, aluminum windings are not acceptable.
- TEFC motors will be equipped with weep holes and drain plugs to withdraw condensed moisture.

Grounding

Electrodes

An integrated grounding system will be installed throughout the expansion and upgrade project facilities. A facility ground system will be installed near each of the buildings. This ground system will consist of a bare copper ground wire and driven ground rods at or near each corner of a building. Each facility ground system will be connected to an adjacent facility ground system, and routed with the site power ducts to provide an overall integrated grounding system.

Grounding electrode embedded rods and cables will be designed for a maximum resistance to ground of 5 ohms. Where more than one rod is required, rods will be installed at least 20 feet apart. Minimum of No. 3/0 AWG stranded bare copper cable will be used for interconnecting to ground rods and footing rebar.

Separate grounding systems will be provided for communication and computer systems. Grounds will be tied together per NEC requirements.

Equipment Grounding

A separate ground conductor sized in accordance with NEC requirements will be installed in raceways for power feeders and branch circuit raceways for motor control, lighting, and receptacle loads.

Shields of shielded instrumentation cables will be grounded to the ground bus at the power supply for the analog or low voltage discrete signal circuit. Shielded instrumentation cables will not be grounded at more than one point.

Lighting

General Requirements

Interior and exterior areas will be provided with lighting. Interior lighting will include switched lights, continuous-on (24 hour) lights, emergency egress lights, and exit lights. Emergency egress and exit lights will each include a battery charger and battery. Exterior lighting will include photocell-controlled lights mounted on buildings near doors or on structures.

Lighting levels in maintained foot-candles will be designed to meet recommendations of the Illuminating Engineering Society of North America (IESNA) 10th edition, IES Lighting Handbook, and the guidelines given herein.

Exterior lights will be sharp cut-off type to minimize light trespass outside the project site. Exterior lighting will be laid out to minimize any impacts to future site expansions, both above and below grade.

Luminaires are to meet UL requirements for intended use.

Lighting Calculations

Recommended foot-candle levels for each space will be calculated for maintained illumination per IESNA, procedures. The following assumptions will be made, unless specific information is available:

Reflectances for finished rooms:

Ceilings	80 percent reflectance
Walls	50 percent reflectance
Floors	20 percent reflectance

Reflectances for unfinished rooms:

Ceilings	50 percent reflectance
Walls	30 percent reflectance
Floors	10 percent reflectance

Maintenance factor (light loss factor):

Fluorescent lighting	.80

Interior Illumination

Interior light fixtures will be fluorescent type. Fluorescent recessed luminaires will be used in control room type areas with lay-in ceilings. Fluorescent “enclosed and gasekted” luminaires of non-metallic type construction will be used for applications in locations subject to saturation with water, or locations exposed to weather and unprotected. Units will be specified to carry the UL “suitable for wet locations” label.

Fluorescent lights will typically be ceiling mounted; however, their use will be examined on an individual room basis. The final location for luminaires will be field-verified to provide easy access for maintenance. Lower mounting heights may be specified for individual task lighting.

Exterior Illumination

Outdoor illumination will be provided outside exterior doors, on roads and parking lots, and where deemed appropriate for visibility.

Exterior lighting will be the light-emitting diode (LED) type powered at 120 or 277 volts, single-phase, and controlled by a photocell. Exterior lighting will be full cutoff, limiting the migration of light.

Emergency and Egress Lighting Systems

Emergency illumination will be provided in appropriate spaces, as required by code to provide life safety, property, and equipment protection.

Adequate lighting levels will be provided to maintain safe building egress and critical process plant functions. Emergency lighting will be located near MCCs and any equipment locations that need to be monitored on a continuing basis.

In large process areas, emergency standby lighting units with a battery pack, and two lamps and lighted exit signs with a battery pack will be provided. The battery pack will power the lights for at least 90 minutes.

Continuous on (24 hours) lights will be provided along egress paths, where required by code.

Circuiting and Switching

Each room will be circuited and switched to provide adequate lighting for the anticipated use, and reduced or no lighting when not occupied by switching alternate luminaires, or by switching alternate ballasts. Occupancy and daylight sensors will be used to automatically adjust light levels to save energy, where appropriate.

Exterior lighting will be controlled by an ON/OFF/AUTO selector switch and roof-mounted photocell. In the AUTO mode, lights turn on at dusk and off at dawn via the photocell.

Lamps

Energy-efficient lamps will be installed in fluorescent light fixtures.

LED lighting is preferred for exterior lighting.

High bay fluorescent lamps are preferred for use in large areas where calculations indicate low bay fluorescent lamps will be inadequate for the tasks to be performed.

Outdoor lighting in landscaped areas and areas visible to the public will be planned in concert with architectural input.

Ballasts

Energy-efficient two-lamp fluorescent ballasts will be used whenever possible. Fluorescent ballasts are sound-rated by a letter code with “A” used to designate the quietest and “D” for the loudest. Lamp ballasts with a code designation of “A” will be used whenever possible.

Lamp/Luminaire Combinations

The following conditions will be considered in selecting lamp/luminaire combinations:

- Higher lumen per watt rapid start and high-output type fluorescent lamps will be used whenever possible.
- Fluorescent luminaires will be used in damp area applications with an enclosed and gasketed lamp compartment. Fluorescent lamps will not be exposed to the weather.
- Types of lamps will be kept to a minimum to reduce the inventory requirements for spares.

Explosion-Proof Luminaires

Any room or space listed as a hazardous atmosphere area will have explosion-proof type luminaires UL listed for installation in the hazardous area classifications, as required by Article 500 of the NEC.

Damp Atmosphere Luminaires

Rooms with a damp atmosphere will preferably have non-corrosive-type enclosed and gasketed fluorescent luminaires.

Lighting Levels

Design lighting levels in maintained foot-candles will be as shown in Table 6-4.

TABLE 6-4
Design Lighting Levels

Area	Foot-candles
General Lighting	20
Control Rooms	30-50
Laboratories	50
Toilets	10-20
Stair Landings	10-20
Corridors	10
Storage	10-20
Process Areas	30
Offices	30-50
Pump Areas	30
Maintenance Area	30-50
Electrical Room	30-40
Mechanical Room	30

Telephone and Personnel Computing Network

The existing voice or data communication systems will be extended to the new facilities. Telephones and data ports will be installed in select locations in process facilities. For additional SCADA data connection information, see PD.07, Instrumentation and Control Design Criteria.

Paging System

No paging system is required. Communications will be via cell phone or two-way radios.

Fire Alarm System

A fully addressable fire alarm system will be installed in all facilities that connect together via a dedicated network. The network will allow the status of any one panel to be checked at any fire panel on the network. Each major facility will have a fire alarm panel that will monitor devices in that facility, as well those in any nearby smaller facility. The master fire panel, located in the Electrical Building, will provide the status of the remote panels and will be connected to the plant control system to notify plant operators, as well as a central monitoring station. The central monitoring station will alert the local responding agency to the nature of the alarm and the location. The fire alarm system will monitor for presence of fire as well as combustible gas detection and ventilation presence in hazardous areas where required by code.

Design Presentation

Drawings

Legend Sheet - The standard CH2M HILL legend sheet of electrical symbols and abbreviations will be modified for this specific project and used on design drawings.

Site Plans - Site plans will show facility and major equipment locations, duct banks, and manholes. Site plans will also show facility designs where the facility does not require a separate drawing. Site plans will use civil backgrounds.

Process and Facility Plans - Process and facility plans will show the location of, and connection to, equipment that requires raceways and/or conductors. Spare raceways for future equipment will also be shown, where appropriate. Separate process and facility plans will generally be prepared. Receptacles, lights, and HVAC will be shown on the facility plans. General locations for process equipment will be shown on the process plans. Raceway size, conductor quantities and sizes, and homerun designations will be shown for facility circuits (e.g., power and lighting) on the plans. Three-phase HVAC loads will be shown on the appropriate one-line diagram. Major raceway (conduit and cable trays) rights-of-way will also be shown on the plans, as appropriate. Cable Block Diagram drawings will be used for general circuit and raceway sizes, and routing.

One-Line Diagrams - One-line diagrams will show the entire electrical distribution system from the 480V main electrical service switchboard to 480- and 208Y/120-volt panelboards. Information on one-line diagrams will include available short circuit, connected load at each major bus, bus ratings, overcurrent device sizes and types, instrument transformers, and transformer ratios.

Motor Control Schematic Diagrams - Motor control schematic diagrams will be prepared in a standard style and format. One standard diagram may apply to more than one motor with the same requirements. The diagrams will include control circuit devices supplied as part of the MCC equipment, but do not include devices mounted in I&C panels. Single controls in an I&C panel (for example, on-off selector switch, and start-stop pushbuttons) may be shown in special cases. Complex control in an I&C panel will be shown as two terminals in a dashed rectangle, with a reference to the I&C panel, such as “FP-2.” Except as noted below, control devices will be shown on the P&IDs. The following control devices, which may not be shown on the P&IDs, will be shown on the motor control schematic diagrams:

- Instruments for power monitoring
- Motor space heaters
- Motor winding temperature detectors and relays
- Motor safety shutdown features

Schedules - Schedules include a luminaire schedule; panelboard schedules; manhole and handhole schedules.

Cable Block Diagrams - Cable block diagrams will be used to show conduit and conductors required between major process components.

Details - Details will generally be selected from CH2M HILL design details. Special details will be developed for this project, as required for clarity.

Specifications - CH2M HILL master electrical specifications will be used as the basis for the electrical design. The master electrical specifications will be revised as required for project-specific situations. The master electrical specifications describe specific construction materials and products, and provide direction that influences the design approach and required calculations.

Construction Constraints

Installation of the new electrical distribution system will occur in parallel with the existing system. Since the expansion and upgrade is being developed on an undeveloped site no electrical construction sequencing will be necessary. Once the new system is running the old system can be reconfigured to accommodate the reduced load at the existing WWTP 2.

Design Development Issues

The following design development activities are anticipated:

- Meeting on site with Pacific Power to coordinate new electrical service.
- Further development of reconfiguration and sequencing of the electrical distribution system at existing WWTP 2 on the west side of Empire Blvd.

PD.07 – Instrumentation and Control Design Criteria

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DATE: August 2013

Introduction

This section describes the instrumentation and control system design elements for the Coos Bay WWTP 2 Expansion and Upgrade project, including the plant control system (PCS) architecture, process control strategies, design standards, and existing equipment modifications. The Coos Bay SCADA Master Plan, dated 07/26/2010,was used as a basis for many of the details contained within this technical memorandum (TM), and will continue to be referenced as the design progresses.

PCS Architecture

The PCS consists of programmable logic controllers (PLCs), human machine interface (HMI) workstations, data historian servers, and network communication equipment, as shown on the Control System Block Diagram. The PCS interfaces with field devices such as instruments, valves, motor starters, and drives to automatically control the process. All of the PCS equipment will be new, with none of the existing control system being reused. If existing field devices are reused, new wiring interfaces to the PCS shall be included . The PCS shall be designed to minimize loss of automatic control by implementing the design approaches described in this TM which align with the Coos Bay SCADA Master Plan.

Networks and Communications

The control system supervisory local area network (LAN) will provide communications between the PLCs and the HMI servers and workstations. It shall use both fiber optic and category 6 copper cables. In general, fiber optic cable shall be used for outdoor routing between different buildings/structures and category 6 cable shall be used for Ethernet connectivity within a facility. Each main facility shall contain at least one Ethernet switch.

This LAN will be configured in a self-healing ring topology such that a single segment failure on the fiber backbone will not disrupt the control system operation. Where redundant hot standby PLCs are required, redundant network switches will be used.

Programmable Logic Controllers

PLCs consist of processors, communication modules, input/output (I/O) modules and I/O networks. They contain custom software applications that provide the automatic control functions necessary for plant operations.. Redundant hot standby PLC processors and power supplies will be used in process areas requiring continuous automatic operation at all times. If the primary PLC or power supply fails, an alarm shall be triggered and the secondary PLC shall take over without interrupting control. For process areas not requiring redundancy, single PLC processors with redundant power supplies shall be used.

Note: At this time CH2M HILL does not anticipate needing redundant hot standby processors; however, consideration will be given as the design progresses.

Plant PLCs

The design shall be based on Allen-Bradley ControlLogix PLCs, which aligns with the Coos Bay SCADA Master Plan. Siemens model S7-400 and Modicon Quantum PLCs can be listed as acceptable alternates if the City prefers. PLCs shall be provided for each process area in order to minimize the impact to the entire plant during routine control system maintenance, upgrades, or troubleshooting activities. It is anticipated that 3-4 plant PLCs will meet the automation and construction sequencing requirements..

PLC systems will be programmed in such a way that, if the control system supervisory network connection is lost, local functionality will be maintained in a safe mode that will run independently of the rest of the network until the network can be restored.

Licensed copies of all PLC software shall be provided to allow for future troubleshooting and modifications when needed.

Package Control System PLCs

Package control system PLCs shall be single small processor systems. The design shall be based on Allen-Bradley CompactLogix PLCs or ControlLogix PLCs, if redundancy is required. Siemens model S7-300 and Modicon M340 PLCs can be listed as acceptable alternates if the City prefers. Alternates will only be allowed if the corresponding manufacturer has been selected for the plant PLCs. Package control system PLCs are anticipated for the following systems:

- UV Disinfection
- Blowers

Field I/O Networks

Field I/O networks are device-level networks that connect multiple signals from devices, such as variable frequency drives and electric motor operators, to a PLC via a dedicated communications link instead of hardwired I/O.

Dedicated Ethernet I/O networks at each PLC for variable frequency drives and motor starters are planned for this project. All other I/O shall be hardwired to the PLC I/O racks. To reduce the possibility of a plant disruption due to a single point of failure, I/O for related equipment will be wired to different modules where practical.

Human-Machine Interface System

The HMI system consists of HMI servers, data I/O servers, historian server, domain server, and operator workstations. This system of computers contains custom software applications that provide a graphical operator control interface to the PLCs including process status, alarms, historical data collection, trending and reports. The following design elements will be included:

- Redundant HMI servers providing graphics and data to multiple HMI workstations shall be used.

- Redundant data I/O servers providing data to the redundant HMI servers and the historian server shall be used. Data I/O servers shall also provide storage and forwarding of data for the historian server. If the historian server fails, the I/O server shall store historical data and forward the data to the historian once it has been repaired.

- All servers (HMI, I/O, historian, and domain controller) will be implemented using virtualization. This technology is widely used in the information technology field and is rapidly expanding into the control systems environment. Two physical servers, each with 4 virtual server operating systems (equivalent to 8 servers), is anticipated for this project. This configuration will greatly simplify server failure recovery and future software upgrades. These servers shall provide the necessary redundancy to prevent a single server failure from interrupting automatic plant operations.

- The design shall be based on using Rockwell Software FactoryTalk View SE software for all personal computer (PC) based plant HMI and data historian functions, which aligns with the Coos Bay SCADA Master Plan. Wonderware Application Server and GE iFix can be listed as acceptable alternates if the City prefers. Licensed copies of all HMI software shall be provided to allow for future troubleshooting and modifications when needed.

PC-Based Graphical Interface

Two HMI desktop workstations with dual desktop monitors and 65 inch wall mounted flat screen monitors shall be provided for use in the Empire WWTP 2 control room. This will be the primary control interface for the operating staff. One HMI laptop shall be provided for offsite remote network access. Tablet (iPad or Android) computers are also an option for mobile onsite access and remote access if the City prefers this functionality.

Panel-Mounted Graphical Interface

Up to four HMI industrial workstation PCs with single panel mounted touch screen monitors shall be located at strategic operator locations in the plant. All control, alarming, and monitoring functions available in the control room workstations shall also be available at these panel mounted HMIs. Zero client technology will be assessed during the design as an alternative to industrial workstation PCs.

Alarm Handling

Alarms shall be displayed and acknowledged via the HMI workstations. Alarm history shall be stored on the historian server at the plant. Remote alarm handling for the WWTP shall be accomplished using Win911 remote alarm notification software, which can provide telephone, email, and pager notification.

Computer Subsystem Equipment Purchase

Section 40 90 00 specifications shall provide an allowance for the purchase of computer subsystem equipment, including HMI workstations, network switches, and HMI software. Because computer subsystem equipment and software features are upgraded so frequently, the City would be at a significant disadvantage if the components were specified and purchased far in advance of the time when they were actually needed. The “allowance” approach provides a mechanism for ensuring that the City receives current hardware and software technology at the appropriate time.

Remote Network Access

Remote access to the control system via the Internet will be included in the design. This will allow operators to quickly respond to alarms and plant upsets from outside the plant. It will also allow remote troubleshooting of the control system including the vendor furnished package systems. The remote access design will include proper security measures including:

- Industry standard firewall(s) with a default deny inbound/outbound policy
- Virtual privacy network(s) with two factor authentication
- Proper network segmentation with firewalls to separate PCS networks from administrative networks

Software Development and Implementation

The PCS PLC and HMI applications software for this project can be included as part of the construction specifications, provided by CH2MHILL under a separate contract, or as part of services during construction. The developer will be required to have 10 years of experience programming similar systems. The PCS application software will align with the following industry standards:

- International Electrotechnical Commission (IEC) 61131-3 standard PLC function block programming
- ASM Consortium Guidelines Effective Operator Display Design
- Standard HMI objects aligning with custom PLC function blocks and data types
- Alarm management aligning with ANSI/ISA standard 18.2, Management of Alarm Systems for Process Industries

Delivery of the PCS application software will follow a rigorous testing, review, and approval cycle in order to meet process requirements and City preferences. The following delivery approach shall be used. City and/or operating staff can be involved with each step.

- Programming Standards Review

- Preliminary Process Graphic Review
- Factory Acceptance Test: Demonstrates all aspects of application software, simulating I/O states by forcing in software.
- Functional Test 1: Verifies field devices (instruments, starters, drives, etc) are properly wired and providing correct input and output functions.
- Functional Test 2: Verifies all aspects of application software function as described in the process control narratives.
- System Acceptance Test: Verifies that the PCS functions as a complete operating system.

Process Control Strategies

Three different control modes will be available, Local, Remote Automatic, and Remote Manual. Each serves a different purpose and provides a different level of automation.

Local

Local refers to a control interface local to the equipment being controlled. A hardwired local control option shall be provided for all equipment (excluding minor items such as solenoid valves). A local indication and a Local/Remote control switch shall be provided at or near the field device, where practical (for example, open/close controls and indicators on valve actuators, start/stop and speed controls and indicators on variable speed equipment panels, start/stop controls and indicators at the MCCs starters, and integral process displays on field instruments).

The local control will provide local manual control only and does not require the PLC to be operational. All automatic functions and interlocks provided by the PLC are bypassed in this mode. This mode is intended for maintenance purposes and is not recommended for long-term operations.

Remote

Remote refers to a control interface remote from the equipment being controlled. When the Local/Remote control switch is in the Remote position, the equipment is controlled by the PLC. Once remote mode is selected, the operator can then select Remote Automatic or Remote Manual from the HMI.

Remote Automatic

In Remote Automatic, the equipment is automatically sequenced and adjusted by the PLC, as described in the process control narratives, based on the automatic setpoints entered by the operator. This is the primary operating mode that will be used.

Remote Manual

In Remote Manual, the equipment can be manually operated from the HMI through the PLC. This provides a method for staff to manually operate equipment from the control room. All automatic functions and interlocks provided by the PLC are bypassed in this mode. This mode is intended for maintenance purposes and is not recommended for long term operations.

Design Standards

Single Point of Failure

In general, single points of failure will be avoided. This does not mean that all control and equipment has to be duplicated, but there are specific components for which redundancy is required for safety or continued operation. Redundancy will be used for the following components:

- HMI servers
- HMI data I/O servers

- PLCs used in process areas requiring continuous automatic operation at all times
- Network switches where redundant PLCs are used
- Network switches providing network connectivity for HMI servers and data I/O servers

PLC Input/Output Signals

PLC I/O signal types shall follow industry standards:

- Discrete Inputs: Dry contact field devices such as level or pressure switches and motor starter auxiliary contacts shall be powered from 120 VAC source in the PLC cabinet. PLC digital input modules shall be designed to accept isolated input signals if external power sources are necessary.

  Note: The Coos Bay SCADA Master Plan requires 24 VDC discrete input signals. CH2M HILL recommends keeping discrete inputs and outputs at 120 VAC as they will be more reliable over the life of the project.

- Discrete Outputs: PLC digital outputs shall be individually isolated, rated for 2 amps at 120 VAC. For current requirements greater than 2 amps, interposing relays mounted in the PLC cabinet shall be used.
- Analog Inputs: PLC analog input signals shall be 4 to 20 mA at 24 VDC. PLC analog inputs shall be individually isolated, allowing for 2-wire transmitters powered from independent DC power supplies in the PLC cabinet and 4-wire transmitters powered from 120 VAC UPS supply from the PLC cabinet.
- Analog Output: PLC analog output signals shall be isolated 4 to 20 mA at 24 VDC into 750 ohms, powered from the PLC.
- Special Signals: 1 to 5 VDC analog inputs may be used within control cabinets.

Instrumentation

New instrumentation will be used throughout the plant and will be wired directly from the field device to the new PLC control system. Instrument types and selected manufacturers shall follow those listed in the Coos Bay SCADA Master Plan when applicable. Listed below are instrument types that are anticipated on the project.

Liquid Flow

- Magnetic flowmeters
- Mass flowmeters; chemical flowrates where required

Air Flow

- Thermal mass flowmeters

Level

- Ultrasonic level measurement
- If ultrasonic is not suitable (for example, foam applications), radar-type level measurements will be used
- Pressure cell level measurement

Temperature

- Resistance Temperature Detection elements

Pressure

- Electronic variable capacitance or silicon strain gauge transmitters (will be used on the discharge of influent pumps for example)

Analytical (Turbidity, Dissolve Oxygen, Combustible Gas, Mixed Liquor Suspended Solids)

- Specific instrument technologies will be determined during the detailed design phase of the project.
- ZAPS Technologies will be considered for wastewater monitoring.

Failsafe Alarms

All alarm signals shall be designed as failsafe. This means a field device shall provide a powered signal back to the PLC during normal process conditions, with power being disrupted during an alarm condition. Therefore, if power is lost or a device or wiring fails, an alarm shall be generated.

Emergency Stop Control

Selected equipment shall have a mushroom-type emergency stop (E-STOP) pushbutton. This pushbutton is hardwired to the motor starter. The E-STOP pushbutton must be surrounded by a metal guard.

Personnel Safety

Switches and relays hardwired to the equipment starter or controller shall be used for personnel safety interlocks, such as E-STOP pushbuttons and conveyor/press trip wires. The operation of these interlocks shall be independent of, but monitored by the PCS. Local RESET pushbuttons shall be used to reset lockout functions as required at the MCCs.

Equipment Protection

Switches and relays hardwired to the equipment starter or controller shall be used for protective interlocks, such as motor overload and critical process conditions. The operation of these interlocks shall be independent of, but monitored by the PCS. Local RESET pushbuttons shall be used to reset lockout functions, as required.

Valve and Gate Control

Actuated valves and gates will be provided with local OPEN/STOP/CLOSE pushbuttons and LOCAL/REMOTE selector switches integral with the actuator. OPEN/CLOSE service valves will be provided with OPEN and CLOSED limit switches that actuate at the end of travel. Modulating valves will be provided with OPEN and CLOSED limit switches that actuate at the end of travel, and with continuous 4-20 milliamp position feedback transmitters.

Indicating Light Colors

Indicating lights shall follow the convention described in the Coos Bay SCADA Master Plan, as listed below.

- GREEN to indicate an inactive condition, such as motor OFF, valve CLOSED
- RED to indicate operation, such as motor RUNNING, valve OPEN
- YELLOW/AMBER to indicate an abnormal condition, such as high pressure or level, or motor ALARM
- WHITE to indicate remote control
- BLUE to indicate local control

Uninterruptible Power Supply

Uninterruptible power supply (UPS) shall be provided for the following loads (at a minimum):

- PLC power supplies
- Power for all 4-wire analog devices monitored by a PLC
- Loop power for all analog I/O monitored or controlled by a PLC
- All computer equipment and panel-mounted HMI components (including servers, workstations, keyboard/video/mouse (KVM) modules, and panel-mounted operator interface components)
- All network equipment (including network switches and firewalls)

The UPS shall provide a minimum 30 minutes of backup power, allowing adequate time for the standby generator to startup and transfer. The UPS shall receive incoming power from either utility power or standby generator power. The UPS will include a bypass switch to allow removal and/or repair to the UPS without disrupting power to the load.

Note: The minimum of 30 minutes backup power does not directly align with the 60 minute requirement listed in the Coos Bay SCADA Master Plan, but does meet the intent when combined with the backup time of the standby generator.

Fire Alarms, Security, Closed-circuit Television, and Telephone

These systems will be provided where necessary and coordinated with the appropriate designers where interface to the SCADA system is required or preferred.

Equipment Numbering

This section is an outline of the equipment numbering system to be used on the project. This standard is based on the American National Standards Institute/Instrument Society of America (ANSI/ISA)-S5.1, and follows the convention described in the Coos Bay SCADA Master Plan.

Objectives

1. Provide unique numbers for all equipment and control signals in the plant.
2. Incorporate numbering system with existing WWTP 2 equipment, where practical.

Equipment numbers shall be used in project drawings, specifications, field equipment tagging, and control system databases.

Overview

This numbering system shall consist of a series of letters and numbers as shown in the tables below. It shall be used for tagging all process equipment, instruments, automatic valves, and non-process equipment (such as electrical switchgear; heating, ventilation, and air conditioning (HVAC) equipment; and plumbing equipment).

General Format

The tag format is outlined in Tables 7-1 through 7-9.

TABLE 7-1
Tag Format

Format:	**SNNFFFFLLUUCC where:**
S	Site (E = Empire) Single letter
NN	NN= Unit process number within the facility (00-99) 2-digit number (each Site can be assigned Unit Process Numbers 00-99)
FFFF	Equipment or ISA Abbreviation One to four letter(s), Unique for each type of instrument and equipment
LL	Loop Number 2-digit number (each Unit Process can be assigned Loop Numbers 00-99) 00-79 reserved for process equipment 80-89 reserved for electrical equipment 90-99 reserved for building services equipment – 90-91 HVAC equipment – 92-93 plumbing – 94-95 architectural equipment – 96-99 other
UU	Unit Number 2-digit number (each Loop Number can be assigned Unit Numbers 00-99)

TABLE 7-1
Tag Format

Format:	**SNNFFFFLLUUCC where:**
S	Site (E = Empire) Single letter
CC	Clarifying Abbreviation (used only as needed) 1 or 2 letter(s) (each Unit Number can be assigned Clarifying Abbreviations Letters A-Z as needed)

TABLE 7-2
Site Letters

Site Letter	**Site Name**
E	Empire

TABLE 7-3
Unit Process Numbers

Unit No.	**Unit Process Name**
10	Influent Pump Station
20	Headworks
30	Sequencing Batch Reactors
32	Blowers
40	UV Disinfection
50	Solids Thickening
60	Control Building
70	Odor Control

TABLE 7-4
Process Equipment Abbreviations

Abbreviation	**Process Equipment**
P	Pump
T	Tank
M	Mechanical Equip
G	Manual Gate
FV	Powered Open/Close Valve
FCV	Powered Modulating Valve
FG	Powered Gate
E	Ejector
ARV	Air Release Valve

TABLE 7-5
Instrument Abbreviations

Abbreviation	Process Instruments
AE	Analytical Element
AIT	Analytical Indicating Xmtr
LSH	Level Switch High
ZIT	Position Indicating Xmtr

TABLE 7-6
Electrical Equipment Abbreviations

Abbreviation	Electrical Equipment
AFD	Adjustable Frequency Drive
ATS	Automatic Transfer Switch
MCC	Motor Control Center
XFMR	Transformer

TABLE 7-7
HVAC Equipment Abbreviations

Abbreviation	HVAC Equipment
AHU	Air Handling Unit
UH	Unit Heater
EF	Exhaust Fan

TABLE 7-8
Process Equipment Examples

Tag	Device	Explanation
E10LIT0101	Transmitter	Empire Plant, Influent Pump Station, Level Indicating Transmitter (ISA), Loop Number 01, Unit Number 01
E10P0201	Pump	Empire Plant, Influent Pump Station, Pump, Loop Number 02, Unit Number 01
E10HS0201A	Hand Switch	Empire Plant, Influent Pump Station, Hand Switch, Loop Number 02, Unit Number 01, Switch A

TABLE 7-9
Non-process Equipment Examples

Tag	Device	Explanation
E40MCC8001	Motor Control Center	Empire Plant, UV Disinfection, MCC, Loop Number 80, Unit Number 01
E20AHU9001	Air Handling Unit	Empire Plant, Headworks, Air Handling Unit, Loop Number 90, Unit Number 01

PCS Software Tag Format

Each PCS software tag must be unique. Software tags shall be formatted as identified in the equipment numbering scheme described above, with the addition of a suffix at the end of the tag. The suffix is necessary to provide a unique tag for all signals connected to the control system. For example, a pump may have several input and output signals wired to the control system. Each of these signals must have a unique software tag, which is made possible by adding the appropriate suffix to the equipment tag, as shown in Table 7-10.

TABLE 7-10
PCS Software Tag Examples

Software Tag	Description
E10P0201.ON	Influent Pump 1 On
E10P0201.REM	Influent Pump 1 Remote
E10P0201.FAIL	Influent Pump 1 Fail
E10P0201.AUTO	Influent Pump 1 Auto Select
E10P0201.STRT	Influent Pump 1 Start Command
E10P0201.STOP	Influent Pump 1 Stop Command
E10P0201.RUN	Influent Pump 1 Run Output
E10P0201.RT	Influent Pump 1 Runtime Hours

Suffix Abbreviations

Additional suffix abbreviations will be developed during the programming phase of the project.

Existing Equipment Modifications

Where existing process equipment is re-used, the associated instrumentation and automated controls will be replaced in order to integrate the control of these processes with the rest of the plant. Updating the instrumentation and controls for the existing processes listed below is anticipated.

Influent Pump Station

- Raw sewage pumps
- Level control

Primary Clarifier

- Scraper mechanism
- Primary sludge pumps

Anaerobic Digester

- Mixer
- Heat exchangers
- Recirculation pumps

Digester Holding Tank

- Sludge load-out pumps

Geotechnical Investigation

Coos Bay Wastewater Treatment Plant #2
Cape Arago Highway
Coos Bay, Oregon

Prepared for:

City of Coos Bay

SHN Consulting Engineers & Geologists, Inc.

275 Market Avenue
Coos Bay, OR 97420-2228
541-266-9890

August 2013
612035.200

SHN
CONSULTING ENGINEERS & GEOLOGISTS, INC.
275 Market Ave. • Coos Bay, OR 97420-2228 • 541-266-9890 • FAX: 541-266-9496 •shninfo@shn-coosbay.com

Reference: 612035

August 12, 2013

Public Works & Development
Attn: Mr. Jim Hossley, Director
City of Coos Bay
500 Central Avenue
Coos Bay, OR 97420

Subject: **Geotechnical Report, Coos Bay Wastewater Treatment Plant #2, Cape Arago Highway, Coos Bay, Oregon**

Dear Mr. Hossley:

SHN is pleased to submit this Geotechnical Investigation Report for the proposed Coos Bay Wastewater Treatment Plant #2 located north of Fulton Avenue, between Cape Arago Highway and Marple Street in Coos Bay, Oregon. This report was prepared in accordance with the Professional Service Agreement between the City of Coos Bay and SHN Consulting Engineers & Geologists, Inc. executed January 2013, and the engineering scope of work submitted by SHN and CH2M Hill, and dated November 1, 2012.

The purpose of this report is to provide geotechnical recommendations in support of the design and construction of the new wastewater treatment plant. This report provides pre-design geotechnical findings regarding site geology, soil, bedrock and groundwater conditions encountered during our field investigation, and recommendations for site preparation and foundation support for the proposed structures.

We appreciate this opportunity to work with you on this project. If there are any questions as to the content of this report or if we can be of further service, please call either of us.

Sincerely,

SHN Consulting Engineers & Geologists, Inc.

Mark Denning
Project Manager
541-266-9890

John H. Dailey, PE, GE
Senior Geotechnical Engineer
707-459-4518

GAV:JHD

Enclosure: Geotechnical Report

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Reference: 612035

Geotechnical Investigation

Coos Bay Wastewater Treatment Plant #2
Cape Arago Highway
Coos Bay, Oregon

Prepared for:

City of Coos Bay
Public Works & Development
500 Central Avenue
Coos Bay, OR 97420

Giovanni Anthony Vadurro
E 2385

EXPIRES: 5/31/14

79564PE
May 8, 20[illegible]
JOHN H. DAILEY

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541-266-9890

August 2013

QA/QC: GDS___

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Appendices

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Abbreviations and Acronyms

pcf	pounds per cubic foot
pci	pounds per cubic inch
psf	pounds per square foot
psi	pounds per square inch
APN	Assessor's parcel number
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials-International
BH-#	boring-number
BGS	below ground surface
CSZ	Cascadia Subduction Zone
H:V	horizontal to vertical
IBC	International Building Code
K_1	coefficient of subgrade reaction for 1 foot square plate
M	magnitude
MCS	modified California sampler
NR	no reference
OD	outside diameter
OSHA	U.S. Occupational Health and Safety Administration
SHN	SHN Consulting Engineers & Geologists, Inc.
SPT	standard penetration test
USGS	U.S. Geological Survey

1.0 Introduction

1.1 General

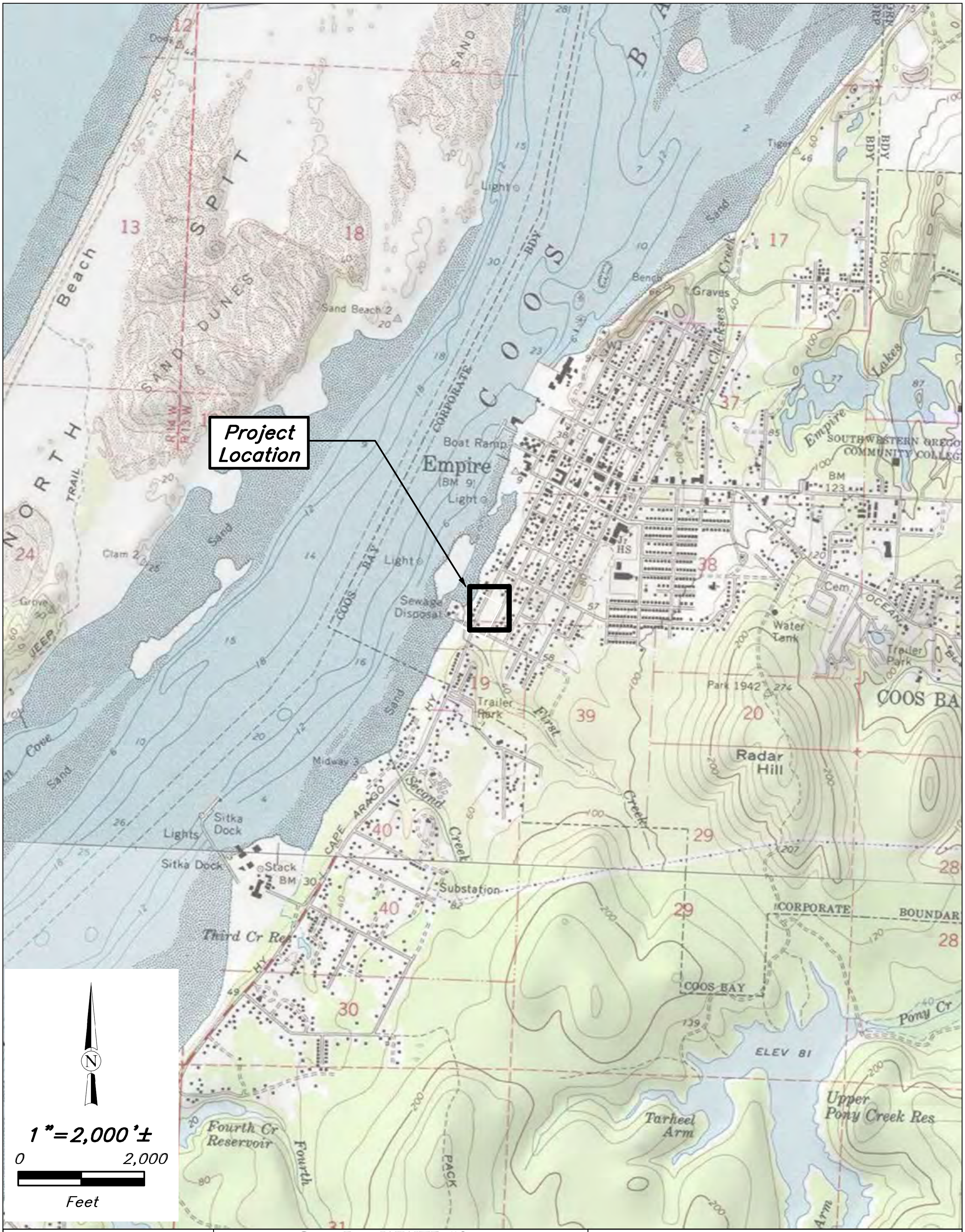
This report presents the results of SHN Consulting Engineers and Geologists (SHN) field explorations and laboratory testing, and geotechnical engineering evaluation for the proposed Coos Bay Wastewater Treatment Plant #2 (WWTP) improvements. The WWTP will be constructed on currently vacant land located at the intersection of Cape Arago Highway and Fulton Avenue in Coos Bay, Oregon. A site location map is provided on Figure 1.

This document has been prepared for the City of Coos Bay Public Works and Development Department, and the SHN/CH2M Hill design team. The information from this report is intended to be utilized for final design and construction of the project.

1.2 Project Understanding

Our general understanding of the proposed project is based on the structural design criteria technical memorandum dated June 2013, and the most recent conceptual site plan dated July 2013, both of which were prepared by SHN and CH2M Hill. The locations of the proposed structures are as illustrated on Figure 2. The project will consist of the following improvements:

- The site will be accessed at its south end from Fulton Avenue. Two paved driveways will provide ingress and egress.
- Influent pump station: A new influent pump station and wet well will be constructed near the west edge of the site. The structure will be founded at a depth of approximately 20 feet below grade on a cast-in-place mat slab foundation. The structure type will be a cast-in-place concrete vault.
- Headworks: A new headworks will be constructed near the center of the site. This structure is approximately 35 feet high and will include a first-floor blower room. The upper level will consist of water channels and screening. The structure is to be supported with a reinforced concrete slab-on-grade with grade beams at the perimeter and thickened footings at the interior walls. The structure will be reinforced concrete construction. The hydraulic channels for the influent screens will be suspended below the second floor level.
- Sequencing Batch Reactors (SBR) and Equalization Basin (EB): The SBR and EB will be built on the northern half of the site. The SBR and EB is an open-top multi-basin reinforced concrete structure. Elevated concrete walkways will be constructed along the tops of the basin walls. The total dimension of the SBR system is approximately 100 feet wide by 144 feet long. The wall heights are approximately 20 feet with a top liquid depth of 18.5 feet. The EB will have a dimension of 36 feet wide by 100 feet long. The wall heights are approximately 15 feet. The basins will be supported by a reinforced concrete mat foundation. Ground improvements will be required due to the presence of up to 6 feet of non-engineered fill material beneath the SBR/EB footprint.
- Shop/Garage/Electrical Building: This new building will be constructed in the area along the west edge of the site. Dimensions of the building are 36 feet wide by 65 feet long. We



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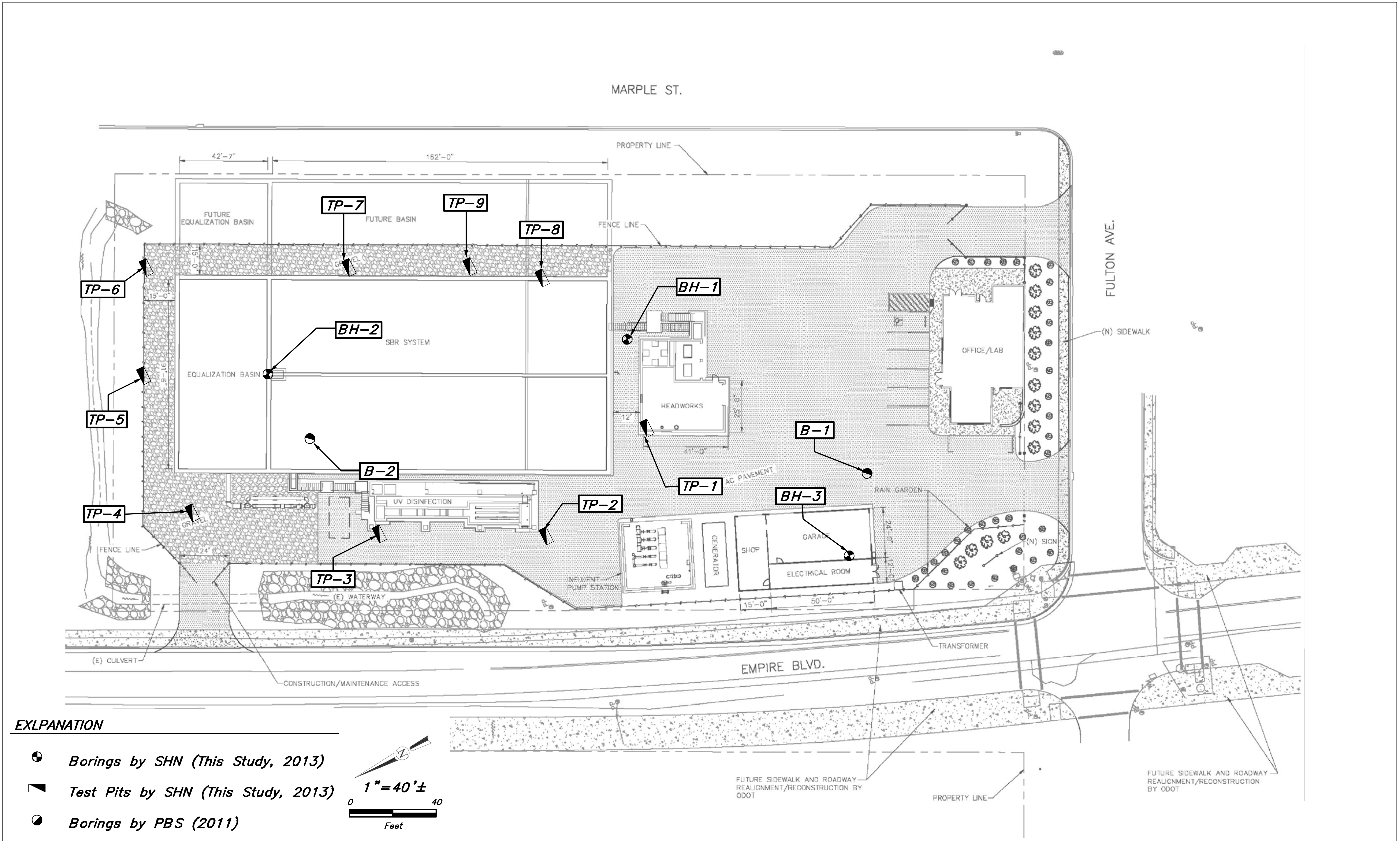
SHN
Consulting Engineers
& Geologists, Inc.

Coos Bay WWTP #2
City of Coos Bay
Coos Bay, Oregon

Location Map

SHN 612035.200

June 2013 | Figure1_LocationMap | Figure 1



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SHN
Consulting Engineers
& Geologists, Inc.

Coos Bay WWTP #2
City of Coos Bay
Coos Bay, Oregon

Site Plan showing
Test Locations
SHN 612035.200

August 2013

Figure2_SitePlan

Figure 2

anticipate this building will consist of concrete walls and will be supported by a slab-on-grade with perimeter footings and footings at the interior walls.

- Office/Lab Building: This new building will be located on nearly level ground at the south end of the site. Dimensions of the building are approximately 40 feet wide by 60 feet long and will consist of a CMU building. The building will be supported by a slab-on-grade with perimeter footings and footings at the interior walls.

2.0 Purpose and Scope

The primary purposes of this investigation are to explore and evaluate subsurface soil conditions at the site and to develop geotechnical recommendations and design criteria for earthwork and foundation support for the proposed structures.

The scope of services included reviewing available subsurface information, supervising the drilling of machine-excavated geotechnical borings, excavating shallow test pits, performing laboratory tests on selected soil samples, and developing recommendations for site grading and foundation support. Specifically, the following information, recommendations, and design criteria are presented in this report:

- description of site terrain and local geology;
- description of subsurface soil, bedrock, and groundwater conditions interpreted based on our field exploration, laboratory testing, and review of existing geotechnical information;
- logs of geotechnical borings (Appendix A), and results of laboratory tests conducted for this investigation (Appendix B);
- assessment of potential earthquake-related geologic/geotechnical hazards (e.g., strong earthquake ground shaking, surface fault rupture, liquefaction, differential settlement) and discussion of possible mitigation measures, as necessary;
- seismic design parameters in accordance with the applicable portions of the 2012 International Building Code (IBC), including site soil classification, seismic design category, and spectral response accelerations;
- recommendations for earthwork, including site and subgrade preparation, fill material, placement and compaction requirements, and criteria for temporary excavation support;
- discussion of appropriate foundation options;
- recommendations regarding foundation elements, including:
    - allowable bearing pressures or capacities (dead, live, and seismic loads),
    - modulus of subgrade reaction for design of mat foundations,
    - estimates of settlement (total and differential),
    - allowable lateral passive and sliding resistance characteristics for footings, and
    - minimum foundation embedment;
- recommendations for support of slabs-on-grade;
- recommendations for design and construction of asphalt pavements; and

- recommendations for observation of foundation installation, materials testing and inspection, and other construction considerations.

In addition to the geotechnical investigation performed for this study, we have reviewed geologic and geotechnical data from a report prepared previously for this site (PBS Engineering + Environmental, 2011).

3.0 Field Investigation and Laboratory Testing

The field investigation was designed to evaluate subsurface soil and groundwater conditions at the project site. Our subsurface investigation for this project included three machine borings and eight exploratory test pits.

On May 14 through May 15, 2013, an engineering geologist from SHN logged and sampled three machine borings and eight exploratory test pits. The three borings, denoted as BH-1 through BH-3, were drilled to depths ranging from 36.5 to 41.5 feet below ground surface (BGS). Eight exploratory test pits (TP-1 to TP-8) were excavated to depths of up to 9 feet BGS to delineate the lateral extent and thickness of non-engineered fill material, and the depth to free groundwater. Approximate boring and test pit locations are as shown on Figure 2, Site Plan with Test Locations. Borings were advanced using mud rotary drilling equipment by Western States Drilling of Hubbard, Oregon. The test pits were excavated with a mini-excavator owned and operated by a local licensed contractor.

Penetration resistance during sample driving was recorded as the borings were advanced. Split-spoon samplers were driven by a 140-pound hammer dropping 30-inches inside the boring, controlled with an auto-hammer. Two samplers were used: a Modified California split-spoon, with nominal inside diameter of 2.5 inches, with liners; and a 2-inch outside diameter Standard Penetration Test (SPT) sampler, without liners. Sampler types are noted on the boring logs. The subsurface materials encountered were logged and field classified in general accordance with the Manual-Visual Classification Method (ASTM D 2488).

Borings were backfilled with bentonite chips. The test pits were backfilled with excavated soils following completion of soil logging. Backfill material was tamped with the excavator bucket. Laboratory testing was performed on selected samples. Interpreted borehole and test pit logs are presented in Appendix A.

Selected soil samples were tested in SHN's certified soils testing laboratory in Eureka, California, to determine selected index properties and strength characteristics of the subsurface materials. The laboratory testing program included analysis of in-place moisture content, dry density, percent fines, and unconsolidated, undrained, triaxial shear strength on selected relatively undisturbed soil samples. Laboratory test data sheets are provided in Appendix B, and are presented graphically on logs for borings BH-1 through BH-3 in Appendix A.

4.0 Site Conditions

The following sections describe the project site and current surface conditions, the geologic setting of the site, and subsurface soil and groundwater conditions encountered at the time of our field exploration.

4.1 Surface Description

The site is located approximately 400 feet from the eastern shoreline of Coos Bay and on the east side of Cape Arago Highway. A residence was formerly located near the southern edge of the site where its concrete slab-on-grade foundation remains in place. The western half of the property is relatively flat with a range in elevation of approximately 14 feet to 20 feet. The eastern half of the property ascends to an elevation of about 30 feet where it borders Marple Street.

A drainage swale was formerly located in the northern half of the property that ran diagonally from northeast to southwest, beginning near the northeast property corner. Surface flow exited the property via a culvert located along the western edge of the site. The drainage alignment has been previously modified and the flow redirected within a drainage ditch that runs along the northern and western property boundary. The former drainage swale has been filled in with soils derived from on-site to create a mostly level site. The fill material used in the drainage swale appears to have been derived from the graded slopes that ascend toward Marple Street in the eastern half of the site.

4.2 Geologic Setting

Published geologic mapping (Lund, 1973; Madin et al, 1995; Black and Madin, 1995) indicates that the project site is underlain by Pleistocene age marine terrace deposits composed of weakly consolidated shallow marine sediments. The referenced geologic mapping indicates that the site area bedrock is a structurally complex sequence consisting of the Eocene-aged Coaledo Formation that locally includes faulted sections of younger Miocene-aged Empire Formation and Bastendorff Shale. Directly underlying the marine terrace deposits beneath the project site is the upper member of the Coaledo Formation. The Coaledo Formation is composed principally of sandstone, siltstone, and shale. Thickness of the beds in the Coaledo Formation ranges from fractions of an inch in the thin shale laminae to tens of feet in the massive sandstone beds. The Coaledo Formation's resistance to erosion varies depending on its composition and accounts for the irregularity of the coastline around Cape Arago. Bedding in the Coaledo Formation is generally steeply dipping as evidenced in outcrops near the coastline.

The project site lies north of the South Slough syncline and its associated thrust and high angle reverse faults (United States Geological Survey, 2006). The Barview fault is the nearest Pleistocene-Holocene age fault to the project site and is located about 1.5 miles to the south, where it projects offshore toward the northwest into Coos Bay. The numerous north-striking thrust and reverse faults associated with the South Slough syncline were formed during ongoing east-west compression in the forearc of the Cascadia subduction zone. The faults and associated folds are an onshore extension of a broad fold and thrust belt that is actively deforming the accretionary wedge offshore. Many of these faults are parallel to bedding attitudes in the west limb of the South Slough syncline in the Cape Arago area and thus are bedding plane (flexural-slip) faults; these structures may not be seismogenic, but rather move in tandem with coseismic deformation related to folding. Other north-striking reverse and thrust faults have strikes and dips that are somewhat discordant with bedding attitudes in the axis and east limb of the South Slough; the structural relationship between these latter faults and folding in the syncline is unknown. Most of these faults offset middle and late Quaternary marine terrace deposits and platforms, and at least one appears to have been active in the Holocene. As with other folds and faults located in the Cascadia forearc, it is unknown if coseismic displacements on these structures are always related to great megathrust earthquakes on the subduction zone, or whether some displacements are related to smaller earthquakes in the North American Plate.

4.3 Subsurface Conditions

Non-engineered Fill

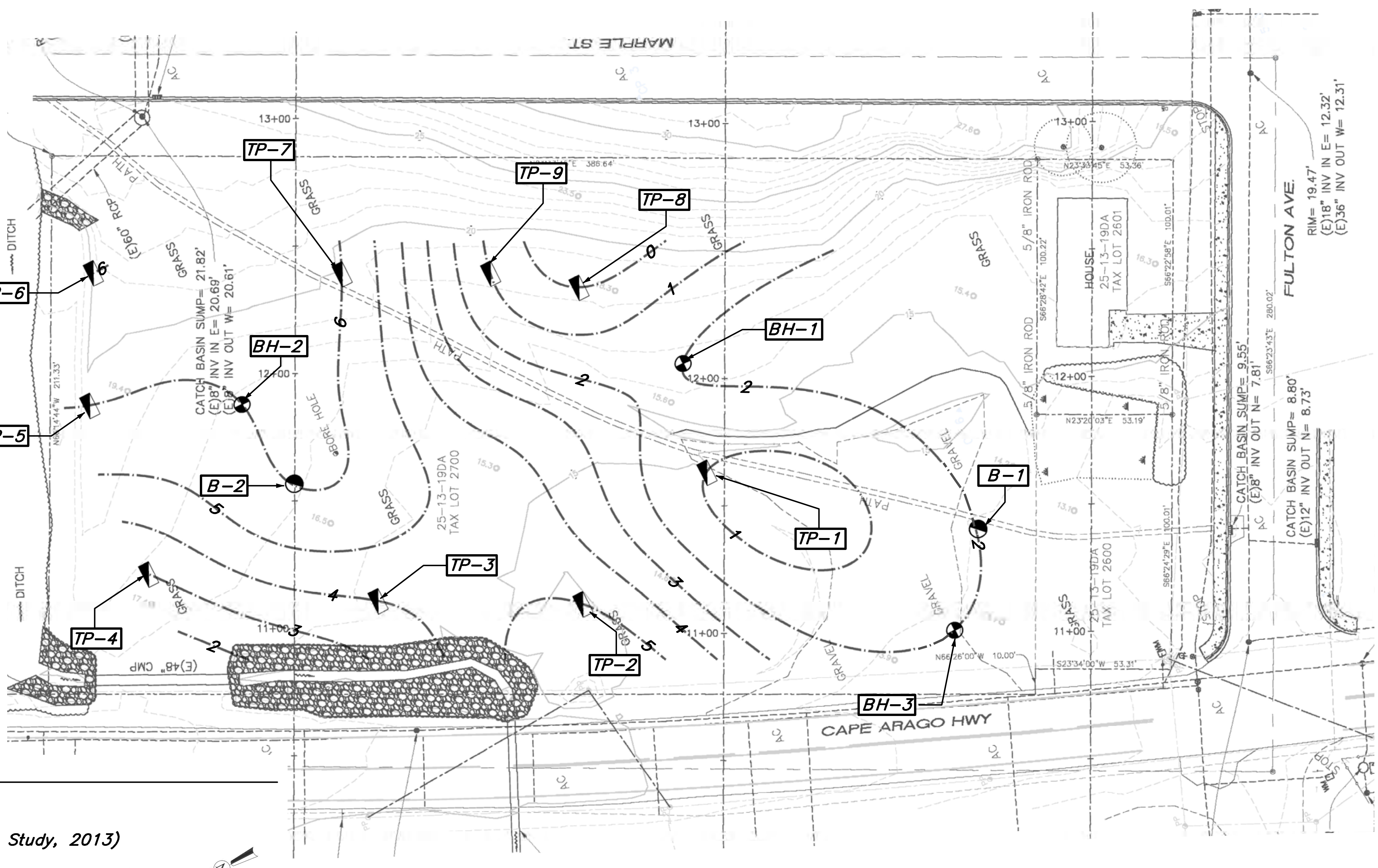
Refer to Figure 3 depicting the thickness and lateral distribution of non-engineered fill material at the site. A surface layer of non-engineered fill was encountered throughout the area of the proposed footprints for the Sequencing Batch Reactor system (SBR) and Equalization Basin (EB). Up to 6 feet of fill is present in the northeast corner and center of the SBR and EB footprint. About 5 feet of fill is present near the southwest corner of the SBR footprint. Fill thicknesses decrease toward the southeast and northwest corners of the SBR and EB, away from the axis of the former stream drainage that previously flowed through the site. About 2 feet of fill/disturbed native soil is present at the location of BH-1 in the vicinity of the headworks, and at BH-3 in the vicinity of the wet well.

Fill material consists of a mix of unconsolidated and loose poorly graded sand and soft silt with varying amounts of fine rounded gravel. Fill material is assumed to have been derived from on-site grading based on the similarity in texture as compared to the underlying in-place native soils. In general, the fill material was emplaced on the former ground surface and atop the native silty topsoil as indicated by the presence of a buried root zone at the fill/native contact. The degree of compactive effort used during fill emplacement is unknown. All fill material currently in place at the site should therefore be considered unsuitable as structural load bearing subgrade.

Quaternary Marine Terrace Deposits

Terrace deposits consist of loose to medium dense poorly graded sand (SP) capped by a thin (<2 feet) veneer of silty and clayey (ML/CL) soil that comprises the native topsoil. In general the marine sands are relatively clean with only a trace amount of fines. Sand grain size is typically fine to medium and grades coarser with depth. The sediments are non-plastic and non-cemented. The sands were typically oxidized beginning within the upper 5 feet of the ground surface and is interpreted to represent shallow transient groundwater conditions.

Sampler penetration resistance and the recorded blow counts increase notably below about 7.5 feet. The thickness of the marine terrace deposits as measured from the base of the fill to the top of bedrock is relatively uniform across the site varying from about 10 feet to 12 feet, thinning toward the southwest.



EXPLANATION

Test Locations

- ◒ Borings by SHN (This Study, 2013)
- ◣ Test Pits by SHN (This Study, 2013)
- ◑ Borings by PBS (2011)
- -·6·- 1 Foot Fill Contour (Value indicates Fill Thickness)

1"=40'±
0 40
Feet

Coos Bay WWTP #2
City of Coos Bay
Coos Bay, Oregon

Fill Isopach Map
SHN 612035.200

June 2013 | Figure3_FillThicknesses1 | Figure 3

Coaledo Formation Bedrock
Coaledo Formation siltstone was encountered at all boring locations. Bedrock was encountered in BH-3 at 10 feet BGS in the southwest corner of the site, and at about 17 feet BGS in BH-2 in the northern portion of the site. The top of the bedrock surface (i.e. terrace/bedrock contact) in all three borings occurs at an elevation of about 0 feet relative to sea level and is interpreted to be relatively planar and level across the site.

Bedrock is composed of generally dense to very dense, dark gray siltstone. Bedrock is fine grained and is moderately cemented with moderate strength. At the location of BH-3, bedrock is medium dense based on the relatively lower blow counts as compared to the other boring locations. The lower relative density of the bedrock at this location is attributed to its weak strength, and the densely fractured and blocky nature of the material. Sample recovery in BH-3 was generally poor and the material disaggregated.

Groundwater
We were unable to make direct observations of the ground water surface in the boreholes due to the use of drilling fluid. However, wet soils were initially encountered in samples collected between 3 feet to 5 feet of the ground surface. Below 5 feet, samples from the entire section of marine sands were wet. Free water was observed flowing from the test pit walls at about 5 feet BGS. Bedrock samples were generally dry to moist indicating the zone of saturation to be perched on the bedrock surface. Groundwater levels at the site during field exploration would be expected to be at or near their seasonal high. A seasonal variation of at least several feet in groundwater elevation is expected to occur at this site. Groundwater elevation is also likely to be tidally influenced due to the site's proximity to Coos Bay.

The groundwater elevation lies more than 15 feet above the base of the excavation for the foundation of the influent pump station. It also lies at or slightly above the elevation of the base of the thickest section of fill material. All fill material will be required to be excavated and replaced with engineered fill. Therefore, it should be expected that shallow groundwater conditions will be encountered during site excavation and grading, and during construction of the influent pump station.

5.0 Geologic Hazards

Potential geologic/geotechnical hazards common to the local project site area include seismic ground shaking, surface fault rupture, seismically induced ground deformation (liquefaction and lateral spreading), and tsunami inundation. Our assessment of these potential hazards is presented below.

5.1 Seismic Ground Shaking

The Cascadia subduction is located approximately 50 miles west of the project site . The Cascadia subduction zone is a regional-scale thrust fault (megathrust) that forms the plate boundary between the subducting Juan de Fuca Plate and the overriding North America Plate in the offshore areas of Coos Bay. It extends 750 miles from offshore northern California to southern British Columbia. Subduction is driven by westward migration of the North America Plate and eastward migration of the Juan de Fuca Plate (Personius and Nelson, 2005). Few if any historical earthquakes have been located on the boundary between the subducting and overriding plates. However, geological studies show that great (>M8) earthquakes have repeatedly occurred in the past 7,000 years, and geodetic studies indicate strain accumulation consistent with the assumption that the Cascadia subduction zone is locked beneath offshore northern California, Oregon, Washington, and southern British Columbia. Numerous geological and geophysical studies suggest that the Cascadia subduction zone may be segmented. Other studies suggest that, at least for the most recent great earthquake on January 26, 1700, much of the subduction zone ruptured in a single M9 earthquake. A great subduction earthquake along the Cascadia subduction zone would generate long duration, very strong ground shaking at the project site.

5.2 Surface Fault Rupture

The Barview fault is the nearest Pleistocene-Holocene age fault to the project site and is located about 1.5 miles to the south, where it projects offshore toward the northwest into Coos Bay (Madin et al, 1995). Based on a field reconnaissance of the site and vicinity, and a review of available geologic maps, literature, and aerial imagery, there is no geomorphic evidence to suggest that active faults cross the site. The late Pleistocene age of the undeformed marine terrace surface in the project vicinity precludes the potential for a Holocene age fault to be present. Therefore, the potential for surface fault rupture to occur at the project site is considered low.

5.3 Liquefaction

Liquefaction is described as the sudden loss of soil shear strength due to a rapid increase of soil pore water pressures caused by cyclic loading from a seismic event. In simple terms, a liquefied soil acts more like a fluid than a solid when shaken during an earthquake. In order for liquefaction to occur, the following are typically needed:

- non-cohesive granular soils (such as, poorly graded sand and silty sand),
- a shallow groundwater table, and
- low density granular soils (typically associated with young geologic deposits).

The adverse effects of liquefaction include local and regional ground settlement, ground cracking and expulsion of water and sand, the partial or complete loss of bearing and confining forces used to support loads, amplification of seismic shaking, and lateral spreading.

Based on the published results of geotechnical testing and post-earthquake studies, the susceptibility of sediments to liquefaction can be directly correlated to the type, origin, and age of the deposits. Geologic materials most susceptible to liquefaction are geologically recent (that is, late Holocene age) sand- and silt-rich deposits, located adjacent to streams, rivers, bays, or ocean shorelines. Susceptibility to liquefaction generally decreases with increasing geologic age (Youd and Perkins, 1978). Youd and Perkins indicate the liquefaction susceptibility for Holocene marine terraces to be low, and Pleistocene marine terraces to be very low. All portions of the subject property are concluded to be underlain by Pleistocene age marine terrace materials and Eocene age siltstone bedrock.

Quantitative liquefaction modeling was not completed for this project, as our initial geologic screening did not identify conditions conducive to liquefaction. Based on the blow counts recorded during standard penetration testing in our borings, the non-cohesive soils encountered below the water table appear to be sufficiently dense and well-consolidated to preclude the hazard of liquefaction. The geologic age of the site's marine terrace deposits (> 80,000 years) suggest that the liquefaction hazard at the site is very low. The risk to the proposed development associated with seismically-induced liquefaction is, therefore, judged to be low.

5.4 Lateral Spreading

Lateral spreading is defined as lateral earth movement of liquefied soils, or competent strata riding on a liquefied soil layer, downslope toward an unsupported slope face (such as, a coastal bluff or an inclined slope face). In general, lateral spreading has been observed on low to moderate gradient slopes, but has also been noted on slopes inclined as flat as one degree.

The distance of the nearest descending slope face to the project site is about 300 feet. Due to the low liquefaction hazard and the distance to the edge of Coos Bay from the site, we judge the potential for lateral spreading to occur to be low.

5.5 Tsunami Inundation

On the basis of the current Tsunami Inundation Map (Priest, 1995), the eastern shoulder of Cape Arago Highway along the west edge of the project site is the assumed extent of tsunami inundation and wave run-up. However, recent investigations by Witter and others (2011) conducted at Bandon, Oregon, indicate that tsunami wave run-up heights may be substantially greater than those previously reported. Given the uncertainty in tsunami wave run-up heights, the low-lying elevation of the site (14 feet to 30 feet), and the proximity to Coos Bay and the bay entrance, tsunami inundation should be expected to occur at this site as a result of a great subduction earthquake along the Cascadia subduction zone.

6.0 Geotechnical Site Conditions

6.1 Discussion

The critical at-grade structures at this site include the headworks, the Sequencing Batch Reactors, and the Equalization Basin. The headworks will be a free standing structure separated from the SBR by a horizontal distance of 10 feet. The SBR and EB are underlain by loosely consolidated, low-density fill material to a depth of about 6 feet BGS. Soft, disturbed native topsoil is also likely to be encountered beneath the fill. The fill and disturbed native soils are not suitable for the support of structure foundations. All the non-engineered fill material and underlying disturbed native soil will need to be over-excavated and replaced with structural engineered fill. The geotechnical engineer or their representative should be present during construction to verify the extents of the non-engineered fill and the replacement with structural engineered fill. The extent of over-excavation and replacement should be assumed to extend over the entire SBR and EB footprint. Over-excavation and replacement should be completed to a uniform depth to provide a uniformly thick mat of structural fill to support the new structure. At the headworks location, over-excavation and replacement to a depth of about 2- to 3-feet will be required to remove all non-engineered fill and disturbed native soil. A geotextile such as Mirafi 500X, or equivalent should be placed in all over-excavated areas exposed during construction to provide subgrade stabilization and prevent mixing of subgrade soils and base aggregates.

The new influent pump station and shop/garage/electrical building will be constructed at the west edge of the site and toward the southwest corner. The influent pump station will be installed to a depth of approximately 24 feet BGS. The shop/garage/electrical building will be constructed at grade. The subsurface conditions at the influent pump station consist of up to about 5 feet of fill/disturbed native soil underlain by up to about 10 feet or more of loose to medium dense, saturated poorly graded sand. Siltstone bedrock is expected to be present beginning at about 15 feet BGS. Lesser amounts of fill are expected beneath the shop/garage/electrical building. In general, the thickness of fill and native poorly graded sand, and the depth to bedrock are all expected to decrease toward the southwest corner of the site. Samples collected from BH-3 indicate bedrock to contain closely spaced fractures with a blocky fabric at the influent pump station location. The bedrock material appears rippable with large excavation equipment based on the penetration resistance observed during drilling. Dewatering and shoring for the deep excavation will therefore be the main concern at this location. Due to the fractured nature of the bedrock, we recommend a 2-foot layer of structural engineered fill at the base of the deep excavation to provide a firm surface for installation of the foundation.

The office/lab building will be constructed at grade in the area of an existing cut pad that is nearly level. The foundation of the former residence remains in-place and will be required to be demolished to allow for construction of the new building.

6.2 Below-Grade Excavations

We understand that an approximately 24-foot deep excavation may be required for construction of the influent pump station. Due to the presence of OSHA Type C Soils consisting non-cemented marine sands in the upper 15 feet, the high groundwater level, and the fractured nature of the bedrock, it is expected that tall, near-vertical, unsupported cuts will not be feasible at the proposed location. In lieu of tall, unsupported cuts, temporary shoring may be used for excavation support. We recommend that the contractor be responsible for selecting the appropriate shoring and dewatering systems. Shoring will be required in order to stabilize the walls of the excavation during construction of the below-grade structure. Excavations should be made in accordance with applicable OSHA and state regulations.

6.3 Dewatering and Uplift Pressures

To construct the below-grade structure for the influent pump basin, the groundwater will need to be drawn down to a depth of at least 3 feet below the bottom of the planned excavation and maintained at that elevation until sufficient weight and/or tie-down capacity is available to resist the hydrostatic uplift forces. For evaluating hydrostatic forces on the proposed shoring system and below-grade floor and walls, a design groundwater elevation of 11 feet (approximately 3 feet below existing grade at the location of boring BH-3) should be used.

The groundwater at the site can be drawn down by using either an active dewatering system that pumps the groundwater from the site and surrounding area, or a passive dewatering system that includes a low-permeability cut off wall and a series of subdrains, sumps, and pumps to collect and remove water that seeps into the excavation.

6.3.1 Active Dewatering System

An active dewatering system typically consists of a series of groundwater extraction wells that are positioned around the perimeter of the proposed excavation. The wells are pumped to draw the groundwater to a depth of at least 3 feet below the bottom of the proposed excavation. The pumped groundwater is typically discharged directly to the sewer or storm drain system.

A disadvantage of using an active dewatering system is the cost of pumping a large volume of water from the site. The primary advantage of using an active system is that it can be used in conjunction with a conventional shoring system consisting of soldier beams and lagging with tie-back anchors. Furthermore, the proposed shoring system will not need to be designed to resist hydrostatic pressures because the groundwater at the site will be drawn down by the active dewatering system.

6.3.2 Passive Dewatering System

A passive dewatering system with a low permeability cut-off wall can be used to dewater the proposed excavations. A passive system typically consists of a network of subdrains, sumps, and pumps that are installed at the bottom of the proposed excavation and are capable of collecting and removing groundwater that may enter the excavation. The performance of a passive dewater system is sensitive to changes in groundwater level and depth of the excavation, especially if excavations extend below the foundation subgrade level.

A low permeability wall around the perimeter of the excavation should be used in conjunction with a passive dewatering system to cut off the lateral flow of groundwater toward the excavation and to reduce the potential for bottom heave. Types of low permeability walls include, but are not limited to, interlocking sheetpile walls, mixed-in-place soil-cement column walls, and slurry walls.

7.0 Recommendations

7.1 Grading and Earthwork

7.1.1 Site Preparation

Site preparation includes demolition/removal of existing surface and subsurface improvements, and removal of debris, organics, organic topsoil, loose soil, and any other unsuitable material. Site preparation operations should extend at least 5 feet beyond the limits of improvements. We anticipate that stripping to a depth of about 2 to 4 inches will be required to remove the organics and topsoil.

Organic-rich topsoil and vegetation, including sod and roots greater than 2 inches in diameter, debris, and any other unsuitable material should be stripped and removed within the limits of grading. Loose soils caused by demolition or stripping should be excavated and the resulting depression filled with engineered fill that has been uniformly moisture-conditioned or aerated to near optimum moisture content and compacted to at least 90 percent relative compaction[1]. Where mentioned in this report, "organic soil" is defined as soil containing more than 2 percent by weight of organic material.

All non-engineered fill present within the limits of grading should be identified and excavated to expose firm natural ground. In areas intended to support new structures and engineered fill, and for a distance of at least 5 feet beyond the limits of these improvements, topsoil and soft or loose native soils should be excavated to expose firm, undisturbed soil. The resulting surface created by removal of the loose soils should be checked by the Geotechnical Engineer or qualified representative to determine whether further excavation is required to remove any loose or unsuitable materials. The approved surface may then be brought to pad grade with placement of properly compacted engineered fill.

Structures should not be constructed over a cut/fill transition within a structure footprint unless the building pad is over-excavated, as necessary, to accommodate a minimum of 18 inches of engineered fill below the footings across the entire structural area. The Geotechnical Engineer or qualified representative should check the earth surfaces exposed by over-excavation to determine if additional over-excavation is necessary to remove soft, wet, yielding, or otherwise unsuitable material. Proof rolling of the excavated surface may be employed to evaluate the suitability of the exposed ground. Approved excavated surfaces to support foundations, slabs-on-grade, or pavements should be scarified to a minimum depth of 8 inches, moisture conditioned close to the optimum value, and compacted to at least 90 percent relative compaction.

7.1.2 Engineered Fill

Fill placed in areas to support foundations, slabs-on-grade, or pavements should meet the requirements for select engineered fill. Engineered fill should have less than 2 percent by dry weight of vegetation and deleterious material and should meet the gradation requirements presented in Table 1:

Table 1 - Fill Gradation Criteria

Sieve Designation	Percent Passing by Dry Weight
4-inch square	100
2.5-inch square	85 minimum
0.75-inch square	70 minimum
US No. 4	60 minimum
U.S. No. 200	5 minimum, 50 maximum

Fine-grained soil with a liquid limit greater than 35 and a plasticity index greater than 12 should not be used as engineered fill. If clayey soils do not meet the plasticity requirements, mixing of the clayey soils with sandier soils may be required. Crushing and/or removal of rock particles greater

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[1] Relative compaction refers to the in-place dry density of a soil expressed as a percentage of the maximum dry density of the same soil, as determined by the ASTM D1557 Test Method. Optimum moisture content is the water content (percentage by dry weight) corresponding to the maximum dry density.

than 4 inches in size may be required. The Geotechnical Engineer or qualified representative should approve all fill prior to placement.

Areas to receive engineered or compacted general fill should be prepared as discussed in "Section 7.1.1 Site Preparation." Engineered or compacted general fill meeting the requirements given in the preceding paragraph should be uniformly moisture-conditioned or aerated to near optimum moisture content. Engineered fill should be placed in horizontal lifts that are less than 8 inches in loose thickness, and compacted prior to placing subsequent lifts to the following minimum values based on ASTM Test Method D1557:

- 90 percent relative compaction beneath building footprints and within the zone extending downward at a 1H:1V line from the outside edge of the building perimeter foundations,
- 95 percent relative compaction for the upper 6 inches of all pavement subgrades, and
- 90 percent elsewhere.

A qualified representative of the Geotechnical Engineer should be present to observe fill placement and perform field density tests at random locations throughout each lift to verify that the specified compaction is being achieved by the contractor.

7.1.3 Utility Trench Backfill

Utility trenches excavated parallel to spread footing foundations should be set back from the footings such that the trench bottoms lie outside a projected hypothetical 1.5H:1V line extending downward from the footing bottom.

Unless concrete bedding is required around utilities, bedding should consist of sand having a sand equivalent of at least 30. The bedding should extend from 6 inches below to 1 foot above the conduit or pipe. Sand bedding should not be jetted or ponded into place and should be mechanically compacted to a minimum of 90 percent relative compaction.

In areas to support improvements (such as, slabs and pavements) and adjacent to structure foundations, backfill placed above the bedding in utility trenches (including culvert and sprinkler lines) should be properly placed and adequately compacted to minimize settlement and provide a stable subgrade. If possible, the trench backfill should be compacted following rough grading but prior to final grading and compaction. Onsite inorganic soils meeting the requirements for engineered fill may be used as trench backfill. Backfill consisting of onsite soils should be placed in layers not exceeding 8 inches in loose thickness, water-conditioned, and compacted to at least 90 percent relative compaction as described for engineered fill. Trench backfill need only be compacted to 85 percent relative compaction in landscape areas or in areas more than 5 feet beyond the limits of buildings, pavements, concrete slabs-on-grade, sidewalks, or other flatwork. The upper 6 inches of trench backfill under pavements should be surface compacted to at least 95 percent relative compaction.

7.1.4 Compaction Adjacent to Walls

Backfill within 5 feet, measured horizontally, behind retaining structures should be compacted with relatively lightweight, hand-operated compaction equipment to reduce the potential for creation of relatively large compaction-induced stresses. If large or heavy compaction equipment is used, compaction-induced stresses could result in increased lateral earth pressures on retaining walls in addition to those presented in this report. In this case, the walls may need to be temporarily braced.

Backfill material should be brought up uniformly around below-grade structures (i.e. backfill should be at about the same elevation all around the structure as the backfill is placed and compacted). The elevation difference of the backfill surface around the structure should not be greater than about 2 feet, unless the structure walls are designed for those differences.

7.1.5 Temporary Shoring

Excavations should be made in accordance with OSHA specifications and conditions. Excavations deeper than 4 feet BGS (or shallower if excavations appear unsafe) should be laid back to a safe slope inclination or supported by an appropriate shoring system. Slopes for excavations deeper than 20 feet are required to be designed by an engineer licensed in the State of Oregon. It should be noted that the Contractor is solely responsible for site safety and safe working conditions during construction. A temporary or permanent shoring system should be installed in a configuration that will allow vertical side slopes for deep excavations where laying back the excavation is impractical.

For the type of soils and conditions encountered, temporary braced shoring systems should be designed using a rectangular pressure distribution of magnitude 40H pounds per foot, where H is the excavation depth in feet. This pressure distribution does not account for pressures from water depths above the base of the excavation. If the groundwater level is not lowered to, and maintained at, an elevation below the depth of the excavation, the shoring must be designed for the water pressure in addition to the rectangular pressure distribution of magnitude 40H. Passive pressure below the bottom of the excavation may be taken as an equivalent fluid pressure of 250 pounds per cubic foot (pcf) for the design.

Excavated soils should be placed a minimum of 15 feet away from the edge of the below-grade excavation to reduce surcharge loads on the temporary cut slopes. If shoring systems are used, the effects of the soil stockpile on the shoring system should be taken into account during design if the soils are placed in the area between the top of the excavation and a 1H:1V projection from the toe of the excavation, to reduce the potential of a shoring failure.

Similarly, heavy equipment should be operated in a safe manner and should be kept an adequate distance from unshored excavation sidewalls to prevent a cut slope stability hazard. If shoring is used, surcharge loads from heavy equipment should be considered in the design calculations to prevent a surcharge failure during construction. For an unshored excavation, a heavy equipment exclusionary zone should be established based on soil type, depth of excavation, presence of groundwater, and configuration of the open cut. As a general guideline, heavy equipment should be excluded from a zone located between the top of the excavation and a 1H:1V projection from the bottom toe of the adjacent excavation sidewall. This may be modified in the field for specific geotechnical conditions.

7.2 Foundations

7.2.1 Spread Footing Foundations

The proposed shop/garage, electrical, and lab/office buildings may be supported on conventional reinforced concrete spread footing foundations bearing on a level pad underlain by undisturbed, firm competent native soil or by properly compacted engineered fill that has been prepared as described in this report. Spread footing foundations for structures supported by engineered fill may be designed to support dead loads plus normal duration live loads using an allowable bearing capacity of 2,500 pounds per square foot (psf) provided the footings are embedded at least 18 inches below lowest adjacent finish grade. For structures underlain entirely by firm native soil, the spread footings may be designed using an allowable bearing capacity of 2,000 psf provided the footings are embedded at least 12 inches into the competent native soil. Footing widths should meet the minimum values given in the 2012 IBC. The allowable bearing capacities given above may be increased by one-third when considering short-term wind and seismic loads.

The maximum total settlement of foundations designed as described above and using the allowable bearing values given above is not expected to exceed 1 inch. The maximum differential settlement between adjacent wall and/or column footings is not expected to exceed ½ inch. Most of the settlement will occur relatively rapidly as the loads are applied due to the granular nature of the soil.

It is important that the footing excavations are moist, clean, and free of drying cracks, debris, loose soil, and water at the time the footings are cast. Footing excavations should be checked and approved by the geotechnical engineer or qualified representative immediately prior to placing concrete.

7.2.2 Mat Foundations

Foundation support for the Sequencing Batch Reactor and Equalization Basins, and headworks building may be achieved with a mat foundation bearing on properly compacted engineered fill. Mat foundations for these structures meeting the above-mentioned conditions may be designed using a maximum allowable bearing capacity of 2,000 psf for dead plus normal duration live loads. Some settlement of the structures may occur due to elastic compression of the soil that underlies the site, with the amount of such settlement dependent upon the magnitude of the load applied by the building. Total settlement is not expected to exceed 1 inch.

A mat foundation should also be used to support the influent pump station structure. Because this structure will be founded below-grade on Coaledo Formation siltstone bedrock, we recommend the mat be designed for a maximum dead plus long-term live load bearing capacity of 3,000 psf. This value can be increased by one-third for total design loads including wind and seismic forces.

All mat foundation systems should be constructed on properly placed engineered fill or firm native soils. At the location of the proposed SBR and EB, the entire structure footprint should be excavated to a uniform elevation of at least 6 feet below the existing ground surface. At the location of the proposed headworks building, the entire structure footprint should be excavated to a uniform elevation of at least 2 feet below the existing ground surface. Greater excavation depths may be required if native topsoil or other deleterious material is encountered at the bottom of the excavations. All exposed surfaces should be scarified to a minimum depth of 8 inches and moisture conditioned to near optimum. The scarified material should be compacted to at least 95 percent relative compaction. The approved surface may then be brought to finished subgrade with placement of engineered fill.

For mat design, we recommend using the following equation to estimate the subgrade modulus:

$$K_s = k_1 \left\{ \frac{(B+1)}{2B} \right\}^2$$

where:

k_1 = coefficient of subgrade reaction for 1 foot square plate = 200 pci (pounds per cubic inch)
B = width beneath column or bearing wall, in feet, where stresses are imposed on ground

The value of B and the corresponding K_s value should be consistent with the calculated deflected shape of the foundation beneath columns and bearing walls.

All foundation excavations should be observed and approved by the Geotechnical Engineer or his designated representative prior to the placement of forms and reinforcing steel. The excavations should be trimmed neat, level, and square. All loose, sloughed, and moisture-softened materials should be removed prior to setting reinforcing steel and placement of concrete. Soil from footing excavations should not be spread in concrete slab areas unless it is compacted and tested.

7.2.3 Sliding and Passive Resistance

Resistance to lateral loading by spread footings may be calculated using a coefficient of friction of 0.35 (ultimate) between cast-in-place concrete footings and the underlying engineered fill. The ultimate friction coefficient may be as low as 0.15 if waterproofing is used, depending on the waterproofing. The passive resistance provided by footings or keys embedded in engineered fill may be calculated using an allowable equivalent fluid unit weight of 300 pcf assuming the adjacent grade is level. This allowable equivalent fluid unit weights for passive resistance has been reduced by a factor of 1.5 from the ultimate value to limit the foundation movement required to mobilize passive pressure. Both the allowable passive pressure and ultimate base friction may be combined in calculating total lateral resistance. The passive resistance contributed by engineered fill or soils within 1 foot of the ground surface should be neglected unless these materials are protected and confined by a slab-on-grade or pavement. The foundation should be cast neat against the engineered fill or in-place soil to develop the design passive resistance. Alternatively, any gap between the footing and the adjacent ground should be completely backfilled using lean concrete or cement grout.

For below-grade structures, lateral forces can be resisted by a combination of friction along the base of the foundation and passive resistance against the vertical faces of the mat foundation. Friction along the bottom of the foundations should be reduced if a waterproofing material is applied at the base of the mat. Frictional resistance will depend on the type of waterproofing material used.

7.2.4 Tie-down Anchors

If the weight of the influent pump station is not sufficient to overcome the hydrostatic uplift loads, tiedown anchors will be required. Tiedown anchors should consist of high-strength steel bars or tendons embedded in small-diameter, drilled and grouted shafts. The anchors should extend into the dense Coaledo Formation siltstone beneath the mat and spaced at least three shaft diameters apart or 3 feet (center to center), whichever is greater. Uplift resistance will be developed in skin friction (bond stress) between the anchor shafts and surrounding soil. We recommend using an allowable bond stress (soil-grout) of 6.0 psi for computing anchor capacities. This value includes a factor of safety of 2.0. Special attentions should be given to waterproofing the connections between the tiedown anchors and the mat slab. Because the tiedowns will be permanent, we recommend that all exposed reinforcing steel be adequately protected from corrosion.

The Contractor should use an auger-cast system or be prepared to case the drilled shafts to prevent holes from caving. If an open shaft is used, grout should be placed using a tremie system. For stressing, the steel bar or tendon should have at least a 5-foot free length. We recommend that at least two tiedown anchors be performance tested to at least 200 percent of the deign load under the observation of the Geotechnical Engineer. The remaining anchors should be proof-tested to 150 percent of the design load. The tiedown anchors should be tested in increments of approximately 10 percent of the design load. The proof test load should be held for a minimum of 10 minutes with a reading taken after ½, 1, 2, 3, 4, 5, and 10 minutes. If the difference between the 1- and 10-minute readings is more than 0.04 inches, or if the cumulative deflection is greater than ½ inch at the working load, the load should be held for an additional 50 minutes. If the deflection is more than 0.08 inches between the 10- and 60-minute readings, the tieback design loading should be re-evaluated. Replacement anchors should be provided, as directed by the Structural Engineer, for tiedown anchors that fail the performance or proof tests. After testing, the tiedown anchors should be loaded to 10 percent of the design load (or higher if specified by the Structural Engineer) and locked off.

7.3 Retaining Wall Design

7.3.1 Conventional Retaining Walls

Below-grade walls should be designed to resist both static lateral earth pressures and lateral pressures caused by earthquakes. We recommend that permanent below-grade walls be designed for the more critical of either at-rest pressures or assumed static active pressure and a dynamic component.

For restrained backfill conditions, use an at-rest equivalent fluid pressure of 60 pcf above the design groundwater level and 95 pcf below, plus a traffic surcharge where the wall is adjacent to access roads or streets. The traffic surcharge consists of a uniform (rectangular distribution) lateral pressure of 100 psf applied to the upper 10 feet of the wall. Foundation loads not considered as surcharges should bear behind a 1H:1V line projected upward from the base of the wall. If conditions such as surcharge resulting from footings are expected, we should be advised so that we can provide additional recommendations as needed.

Active earth pressures may be used for design of unrestrained retaining walls where the top of the wall is free to translate or rotate. To develop active earth pressures, the walls should be capable of deflecting by at least 0.004H (where H is the height of the wall). At-rest earth pressures should be used for design of retaining walls where the wall top is restrained such that the deflections required to develop active soil pressures cannot occur or are undesirable. Retaining walls for below-grade structures should be designed to resist at-rest earth pressures. Cantilever walls retaining rock or engineered fill may be designed for active or at-rest lateral earth pressures for various backfill slopes using the equivalent fluid unit weights presented in Table 2, Equivalent Fluid Unit Weight (pcf).

Table 2 - Equivalent Fluid Unit Weight (pcf)

Backfill Slope	At-Rest Conditions	Active Conditions
Level	62	36
3H:1V	81	46
2H:1V	89	55

Lateral earth pressures for backfill slopes other than those given above can be estimated by interpolation. The lateral earth pressures should be applied to a plane extending vertically upward from the base of the heel of the retaining wall to the ground surface.

The lateral earth pressures given above apply where the wall backfill is fully drained, is not subject to traffic or other surcharge loads, and the backfill is not subject to heavy compaction equipment within a distance of one-third the height of the backfill. Lateral surcharge pressures are discussed later in this section.

In addition to the active or at-rest lateral soil pressures, retaining walls should be designed to resist additional dynamic earth pressures during earthquake loading. The additional dynamic pressure increment may be calculated using an equivalent fluid pressure of 13 pcf for back slopes up to 3H:1V. The dynamic pressure increment should be applied to the wall as an inverted triangular distribution so the resultant force acts at a distance of 0.6H above the base of the wall (where H is the height of the wall). Under the combined effects of static and dynamic loading, a factor of safety of 1.1 against sliding or overturning is acceptable. The dynamic component of the lateral earth pressure was calculated using the Mononabe-Okabe equation and, therefore, assumes that sufficient deformation of the wall will occur during seismic loading to develop active soil conditions. For walls that are restrained at the top, such as below-grade portions of structures, the walls should be designed using the most critical condition, either at-rest lateral pressure or the combined effects of static active and seismic loading.

If retaining wall backfill will be subject to passenger vehicle or light truck traffic loading within a distance of H/2 from the top of the wall (where H is the wall height), the wall should be designed to resist an additional uniform lateral pressure of 72 psf applied to the back of yielding walls (active conditions), or 124 psf applied to the back of non-yielding walls (at-rest conditions). Surcharge loads imposed by greater loads or unusual loads within a distance of H of the back of the wall should be considered on a case-by-case basis.

A drainage system should be constructed on the backside of all retaining walls. The drainage system for backfilled walls should consist of a 4-inch diameter perforated pipe surrounded by clean coarse gravel or drain rock, provided the gravel or rock is completely separated from the surrounding soil by an engineering filter fabric such as Mirafi 140N or similar fabric. The section of permeable material should be at least 12 inches wide and should extend up the back of the wall to within about 18 inches of finished grade. The drainage material should be capped with compacted fine-grained soil, soil-cement, or other relatively impermeable material or barrier. The pipe should be PVC Schedule 40 or ABS with a Standard Dimension Ratio (SDR) of 35 or less. Perforations in the drainpipe should be ¼ inch in diameter. The perforated pipe should be placed holes-down near the bottom of the section of permeable material and should discharge by gravity to a suitable outlet. Accessible subdrain cleanouts should be provided and maintained on a regular basis. The invert of the perforated pipe should be at least 8 inches lower than interior floor slabs.

If approved by the Geotechnical Engineer, pre-fabricated wall drain systems may also be used instead of an aggregate drainage system. To minimize seepage or dampness through the concrete walls, waterproofing should be applied between the drainage system and the wall, as specified by the designer.

To protect against moisture migration, below-grade walls should be waterproofed and water stops should be placed at all construction joints.

7.3.2 Tied-Back Walls

Permanent tied-back shotcrete or concrete walls may be considered as an alternative to conventional retaining walls. Permanent tied-back walls are well-suited for applications where deflection of the wall is not desired. Tieback walls may be designed using an apparent earth pressure diagram equivalent to a trapezoidal horizontal pressure distribution ranging from 0 psf at the ground surface to a maximum pressure of 25H psf at a depth of 0.2H (where H is the wall height in feet) for level backfill conditions. The maximum pressure should be increased to 29H psf for a 3H:1V back slope and 34H psf for 2H:1V back slope. All permanent tiebacks should include multiple corrosion protection. The minimum unbonded length for tiebacks should be 12 feet for bar tendons or 15 feet for strand tendons and should extend at least H/5 beyond the critical potential failure surface (where H is wall height in feet). The back of the wall face should be fully drained using a prefabricated wall drain system. Tiebacks should be designed and constructed in accordance with the latest edition of the Post-Tensioning Institute’s specifications.

7.4 Seismic Parameters

We recommend that the structure be designed and constructed to withstand seismic shaking as required by the IBC. Based on the subsurface conditions encountered at our exploration locations and our general knowledge of the soil conditions within 100 feet of the ground surface, we classify the site as a Site Class C consisting of a “very dense soil and soft rock” (Table 1613.5.2, 2012 IBC). On this basis, the mapped and design spectral response accelerations were determined using the seismic calculator software provided by the United States Geological Survey (USGS, 2013) in accordance with the American Society of Civil Engineers (ASCE) Standard 7-05, Minimum Design Loads for Buildings and Other Structures. Calculated values are presented in Table 3.

Table 3
Code-Based Seismic Design Criteria
Coos Bay WWTP #2

Latitude	43.3858° N
Longitude	-124.2810° W
Site Class	C
S_S	1.500
S_1	0.718
F_a	1.0
F_v	1.3
S_{MS}	1.500
S_{M1}	0.934
S_{DS}	1.000
S_{D1}	0.623
Occupancy Category	III
Seismic Design Category	D

7.5 Slabs-on-Grade

Concrete slabs-on-grade used in conjunction with spread footings should be structurally reinforced and be supported by engineered fill that has been prepared as described previously in "Section 7.1: Grading and Earthwork."

Where upward transmission of water vapor through floor slabs is undesirable (and to limit mold growth potential, floor covering problems, etc.), the concrete slabs-on-grade should be constructed on a minimum 4-inch thick layer of compacted capillary break material covered with a high quality impermeable membrane vapor barrier/vapor retarder. The capillary break material should be free-draining, clean gravel or rock, such as No. 4 by ¾-inch pea gravel or 1-inch minus clean crushed aggregate. If the vapor retarder is placed over crushed rock or rough granular fill, a thin (approximately ½-inch thick) protective layer of fine-graded material should be compacted over the base prior to installation of the vapor retarder to reduce the possibility of puncture. In addition, we recommend that the vapor retarder be protected using a 3-inch thick cover of trimable, compactable, granular fill which will remain stable and support construction traffic. Sand is difficult, if not impossible, to compact and maintain until concrete placement is complete, and is not recommended. The vapor retarder should be installed in conformance with ASTM Test Method E1643. Where dampness or water vapor transmission through the slab is not objectionable, such as for exterior slabs-on-grade, the vapor barrier and capillary break material may be omitted and the slab may be constructed directly on the prepared subgrade or on a layer of compacted base rock.

Slab surfaces to receive moisture sensitive floor coverings should have considerations for maximum vapor emission levels. Most floor coverings require a 3 to 5 pound emission level for a warranted installation. Emission levels may be controlled by use of a vapor barrier meeting ASTM E 1745 Class A, ASTM E 15493 resistance to puncture of not less than 3,000 grams and ASTM E 154-93 tensile strength after soaking of not less than 55.5 MD/TD (machined direction/transverse direction) average.

It is important that the subgrade be moist and free of desiccation cracks at the time the slab is cast. Recommendations for slab reinforcement, strength, thickness, control and construction joints, etc., should be provided by others. Although cracks in concrete slabs are common and should be expected, the following measures may help to reduce cracking of slabs.

- Slabs should be cast using concrete with a maximum slump of 4 inches or less.
- Add a water reducing agent or plasticizer to the concrete to increase slump while maintaining a low water-cement ratio to reduce concrete shrinkage. (Concrete having a high water-cement ratio is a major cause of concrete cracking.)
- Control joints should be provided at appropriate intervals to control the location of shrinkage cracks.

7.6 Surface Drainage

Surface drainage should be planned to prevent ponding and enable water to drain away from foundations, slabs-on-grade, edges of pavements, and tops of slopes, and toward suitable collection or discharge facilities. A positive surface drainage of at least 5 percent is recommended within 10 feet of all building foundations in unpaved areas. Elsewhere, a positive surface drainage of at least 2 percent is recommended to allow for rapid removal of surface water. Pavements should be designed with minimum gradients of about 2 percent in their principal direction of drainage, unless drainage reaches are short or specifically designed for flatter gradients. Roof drainage systems should be planned to direct rainwater away from building foundations.

Concentrated water should not be discharged onto bare ground or slopes, but should be carried in pipes or lined channels to suitable disposal points. Because onsite soils generally have a moderate potential for erosion, we recommend that approved temporary and permanent erosion control measures be implemented to limit erosion. An onsite storm water prevention permit (DEQ 1200C) will be required during construction.

8.0 Additional Services

We suggest communications be maintained during the design phase between the design team and SHN to optimize compatibility between the design and soil conditions. We also recommend that SHN be retained during the construction phase to verify the implementation of our recommendations related to earthwork.

8.1 Plan and Specification Review

We have assumed, in preparing our recommendations, that SHN will be retained to review those portions of the plans and specifications, if prepared by others, which pertain to earthwork and foundations. The purpose of this review is to confirm that our earthwork and foundation recommendations have been properly interpreted and implemented during design. If we are not provided this opportunity for review of the plans and specifications, our recommendations could be misinterpreted.

8.2 Construction-Phase Monitoring

In order to assess construction conformance with the intent of our recommendations, it is important that a representative of SHN perform the following tasks:

1. Verify the removal of the undocumented fill material and buried topsoil, and any other unsuitable material prior to the placement of structural fill.
2. Monitor subgrade preparation.
3. Observe and test placement of structural fill and backfill.
4. Observe foundation excavations.
5. Observe backfilling and drainage behind retaining walls.

This construction-phase monitoring is important, because it provides the stakeholders and SHN the opportunity to verify anticipated site conditions, and recommend appropriate changes in design or construction procedures if site conditions encountered during construction vary from those described in this report. It also allows SHN to recommend appropriate changes in design or construction procedures if construction methods adversely affect the competence of onsite soils to support the structural improvements.

9.0 Limitations

The geotechnical conclusions and recommendations presented in this report are intended for planning and design of the new proposed improvements at the project site as described in this report. These conclusions and recommendations may not apply if:

- Changes are made to the proposed construction.
- The report is used for a different site.
- The recommendations given in this report are not followed.
- Any other change is made that materially alters the proposed project.

The analyses and recommendations presented in this report are based upon interpretation of data obtained from the exploration locations located approximately as shown on Figure 2 and on general field observations made during the site investigation. Subsurface exploration of any site is necessarily confined to selected locations and subsurface conditions may, and usually do, vary between and around these locations. Any person associated with this project who observes conditions or features of the site or its surrounding areas that are different from those described in the report should report them immediately to SHN for evaluation. Should varied conditions come to light during project development, SHN should be given the opportunity to evaluate the need for additional exploration, testing, or analysis.

The validity of the recommendations contained in this report is also dependent upon an adequate testing and observation program during the construction phase.

This report was prepared in accordance with the generally accepted standards of geotechnical engineering practice in Coos County at the time this report was written. No other warranty, express or implied, is made. It is the owner's responsibility to see that all parties to the project, including the designers, contractors, and subcontractors, are made aware of this report in its entirety.

It should be noted that changes in the standards of practice in the field of geotechnical engineering, changes in site conditions (such as, new excavations or fills, new agency regulations, or modifications to the proposed project) are grounds for this report to be professionally reviewed. In light of this, there is a practical limit to the usefulness of this report without critical professional review. It is suggested that two years be considered a reasonable time for the usefulness of this report.

10.0 References

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Appendix A

Boring Logs

SHN Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Coos Bay WWTP #2
LOCATION: Headworks, Center of Site
GROUND SURFACE ELEVATION: ~16 Feet (Proj. Datum)
EXCAVATION METHOD: Mud Rotary
LOGGED BY: G. Vadurro

JOB NUMBER: 612035.200
DATE DRILLED: 5/14/13
TOTAL DEPTH OF BORING: 36.5 Feet
SAMPLER TYPE: MCS/SPT

BORING NUMBER
BH-1

DEPTH (FT)	BULK SAMPLES	SS SAMPLES	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (psf) by P.P.	% Passing 200	REMARKS
0.0						DISTURBED GROUND; FILL						
-1.0												
-2.0												
-3.0			2 4	ML		SILT with CLAY; Dark brown (7.5YR 3/3), wet, medium stiff, low plasticity, non-cemented, low strength.						
-4.0			7	SP		POORLY GRADED SAND with SILT; Dark brown, wet, medium dense, non-plastic, fine- to medium-grained sand, non-cemented.	21	96			5	Quaternary Marine Terrace Deposits
-5.0 ▽			10	SP								
-6.0			13 17			POORLY GRADED SAND; Dark yellowish-brown (10YR 4/6), wet, dense, non-plastic, non-cemented, fine- to medium-grained sand, trace coarse sand, <10% fines.	25	95				
-7.0												
-8.0			14 18	SM							19	
-9.0			19			Grades to SILTY SAND, sand fraction grades finer.	24	95				
-10.0			14									
-11.0			15 16			Color grades to 10YR 4/4 Dark yellowish-brown.	24	98				
-12.0												
-13.0			17 14	SP		POORLY GRADED SAND; Dark reddish-brown (5YR 3/2), wet, dense, non-plastic, fine sand, trace silt/clay, trace fine gravel.					6	
-14.0			16			SILTSTONE (Coaledo formation); Yellowish-red (5YR 5/8), moist, moderate strength, oxidized, fine grained, moderately cemented, moderately decomposed, competent, unfractured.						Coaledo Formation
-15.0			38									
-16.0			52 49									
-17.0						SILTSTONE; Very dark gray (2.5Y 3/1), dry, very dense, moderate strength, fine-grained, moderately cemented, trace of shell fragments, moderately decomposed, competent, unfractured.						
-18.0												
-19.0												
-20.0												

LOG OF BORING

PROJECT: Coos Bay WWTP #2
LOCATION: Headworks, Center of Site
GROUND SURFACE ELEVATION: ~16 Feet (Proj. Datum)
EXCAVATION METHOD: Mud Rotary
LOGGED BY: G. Vadurro

JOB NUMBER: 612035.200
DATE DRILLED: 5/14/13
TOTAL DEPTH OF BORING: 36.5 Feet
SAMPLER TYPE: MCS/SPT

BORING NUMBER
BH-1

DEPTH (FT)	BULK SAMPLES	SS SAMPLES	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (psf) by P.P.	% Passing 200	REMARKS
-20.0	☒	☐	14 12		^ ^ ^							
-21.0	☒	☐	20		^ ^ ^							
-22.0					^ ^ ^							
-23.0					^ ^ ^							
-24.0					^ ^ ^							
-25.0	☒	☐	19 23		^ ^ ^	Very dense, trace of very fine sand.						
-26.0	☒	☐	29		^ ^ ^							
-27.0					^ ^ ^							
-28.0					^ ^ ^							
-29.0					^ ^ ^							
-30.0	☒	☐	14 19		^ ^ ^	Dense, trace of shell fragments, laminated.						
-31.0	☒	☐	20		^ ^ ^							
-32.0					^ ^ ^							
-33.0					^ ^ ^							
-34.0					^ ^ ^							
-35.0	☒	☐	19 38		^ ^ ^							
-36.0	☒	☐	50		^ ^ ^							
-37.0						Boring terminated at a depth of 36.5 feet. Groundwater initially encountered at a depth of approximately 5 feet.						
-38.0												
-39.0												

LOG OF BORING

SHN Consulting Engineers & Geologists, Inc.
812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

BORING NUMBER BH-2

PROJECT: Coos Bay WWTP #2
LOCATION: Equalization Basin/SBR/*North End of Site
GROUND SURFACE ELEVATION: ~18 Feet (Proj. Datum)
EXCAVATION METHOD: Mud Rotary
LOGGED BY: G. Vadurro
JOB NUMBER: 612035.200
DATE DRILLED: 5/14/13
TOTAL DEPTH OF BORING: 36.5 Feet
SAMPLER TYPE: MCS/SPT

DEPTH (FT)	BULK SAMPLES	SS SAMPLES	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (psf) by P.P.	% Passing 200	REMARKS
0.0						FILL; Disturbed Ground						
-2.5			3 3 4	SM-CL		FILL; SAND GRADING TO CLAY; Grayish-brown (2.5Y 5/2), soft, wet, medium plasticity, low strength. Grades to silty sand fill.	23	99				
-5.0	▽		6 7 11	SP-SM		POORLY GRADED SAND with SILT; Light yellowish-brown (2.5Y 6/4; mottled), medium dense, wet, non-plastic, non-cemented, fine- to medium-grained sand.	27	96				Quaternary Marine Terrace Deposits
-7.5			12 14 19	SP		POORLY GRADED SAND; Yellowish-brown (10YR 5/6), dense, non-plastic, non-cemented, fine- to medium-grained sand, <5% fines.	23	98				increased drill resistance
-10.0			10 12 17	SP		POORLY GRADED SAND; medium dense, wet, non-plastic, medium- to coarse-grained sand, trace fine rounded gravel, oxidized.						drilling rig chattering
-15.0			12 14 17	SP		POORLY GRADED SAND; Dark gray, dense, non-plastic, non-cemented.						
-17.0												increased drilling resistance
-20.0												

LOG OF BORING

PROJECT: Coos Bay WWTP #2
LOCATION: Equalization Basin/SBR/*North End of Site
GROUND SURFACE ELEVATION: ~18 Feet (Proj. Datum)
EXCAVATION METHOD: Mud Rotary
LOGGED BY: G. Vadurro

JOB NUMBER: 612035.200
DATE DRILLED: 5/14/13
TOTAL DEPTH OF BORING: 36.5 Feet
SAMPLER TYPE: MCS/SPT

BORING NUMBER
BH-2

DEPTH (FT)	BULK SAMPLES	SS SAMPLES	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (psf) by P.P.	% Passing 200	REMARKS
-20.0			24 34 40			SILTSTONE (Coaledo formation); Dark gray, very dense, moderate strength, fine-grained, moderate cementation, vertically oriented laminations, moderately decomposed, unfractured.						Coaledo Formation
-21.0												
-22.0												
-23.0												
-24.0												
-25.0			29 39 35			Same.						
-26.0												
-27.0												
-28.0												
-29.0												
-30.0			30 35 50			Same.						
-31.0												
-32.0												
-33.0												
-34.0												
-35.0			27 34 35			Same; very dense, becomes foliated with foliations parallel to bedding.						
-36.0												
-37.0						Boring terminated at a depth of 36.5 feet. Groundwater initially encountered at a depth of 5 feet.						
-38.0												
-39.0												

Consulting Engineers & Geologists, Inc.
812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Coos Bay WWTP #2
LOCATION: Influent Pump Station
GROUND SURFACE ELEVATION: ~14 Feet (Proj. Datum)
EXCAVATION METHOD: Mud Rotary
LOGGED BY: G. Vadurro
JOB NUMBER: 612035.200
DATE DRILLED: 5/15/13
TOTAL DEPTH OF BORING: 41.5 Feet
SAMPLER TYPE: MCS/SPT

BORING NUMBER
BH-3

DEPTH (FT)	BULK SAMPLES	SS SAMPLES	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (psf) by P.P.	% Passing 200	REMARKS
0.0						FILL						
-1.0												
-2.0												
-3.0			4 4 3	SP		POORLY GRADED SAND; Strong Brown (7.5YR 4/6; oxidized), loose, moist, non-plastic, non-cemented, fine- to medium-grained sand, trace fines.						Quaternary Marine Terrace Deposits
-4.0												
-5.0 ▽			3 5 6			Becomes wet, medium dense, grades finer.						
-6.0												
-7.0												
-8.0			4 8 11			Becomeds strongly oxidized.						
-9.0												
-10.0			9 15 14			SILTSTONE (Coaledo formation); Dark gray, moist, medium dense, moderate strength, fine-grained, unfractured; about 75% recovery, RQD = 90% .						Coaledo Fromation
-11.0												
-12.0												
-13.0												
-14.0												
-15.0			3 6 8			Medium dense, weak strength, becomes blocky, fractured; about 40% recovery, RQD = 60%.						
-16.0												
-17.0												down pressure increases to ~200psi
-18.0												
-19.0												
-20.0			10 16 24									poor sample recovery
-21.0						Becomes dense, moist.						
-22.0												

LOG OF BORING

PROJECT: Coos Bay WWTP #2
LOCATION: Influent Pump Station
GROUND SURFACE ELEVATION: ~14 Feet (Proj. Datum)
EXCAVATION METHOD: Mud Rotary
LOGGED BY: G. Vadurro

JOB NUMBER: 612035.200
DATE DRILLED: 5/15/13
TOTAL DEPTH OF BORING: 41.5 Feet
SAMPLER TYPE: MCS/SPT

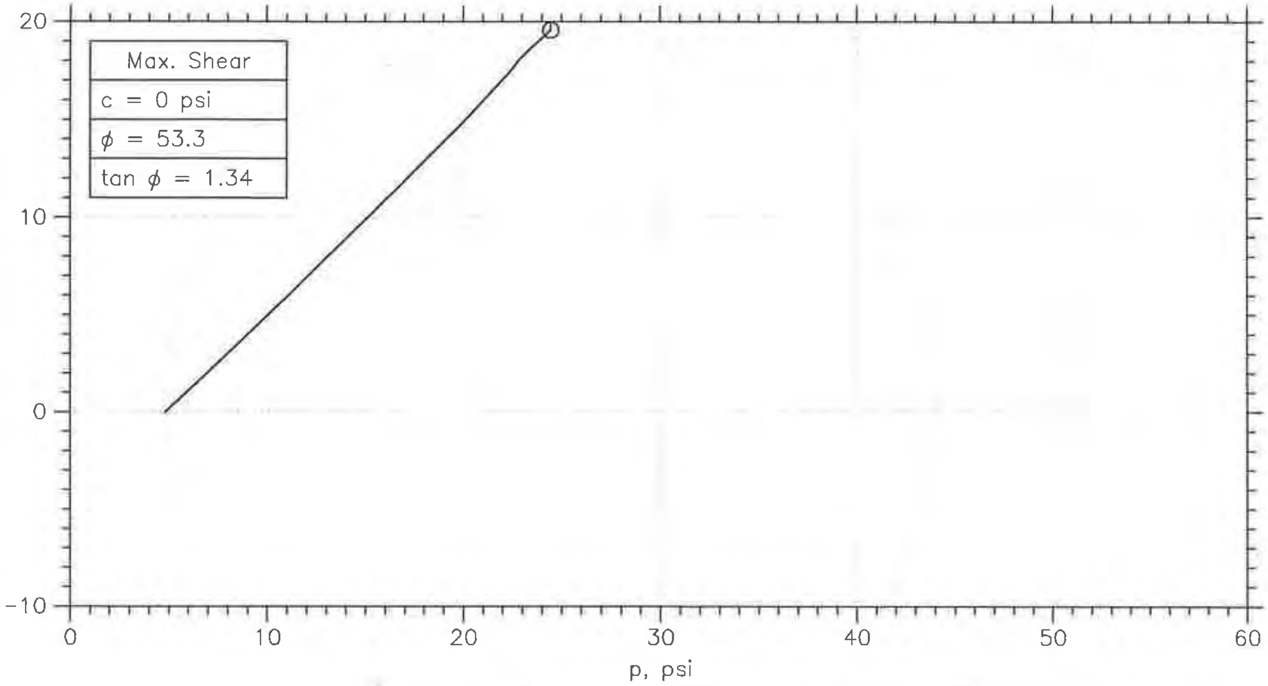
BORING NUMBER
BH-3

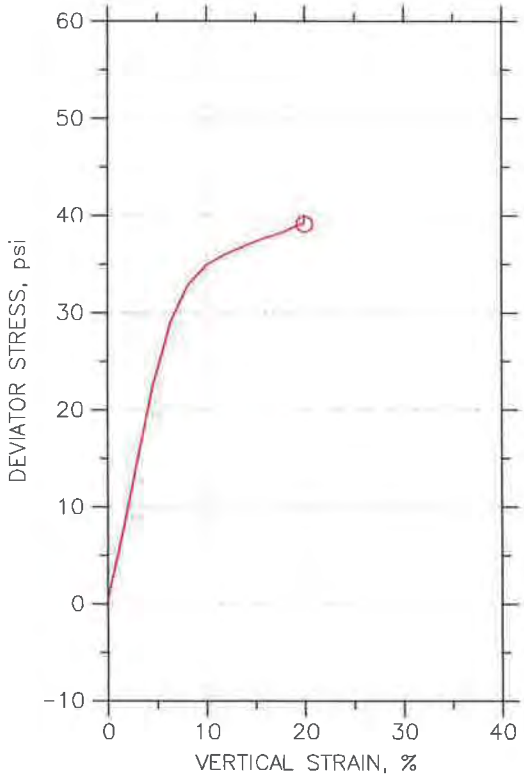
DEPTH (FT)	BULK SAMPLES	SS SAMPLES	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	U.C. (psf) by P.P.	% Passing 200	REMARKS
-23.0					^ ^ ^							
-24.0					^ ^ ^							
-25.0		▨	8 16 25		^ ^ ^							
-26.0					^ ^ ^		27	94				
-27.0					^ ^ ^							
-28.0					^ ^ ^							
-29.0					^ ^ ^							
-30.0		▦	7 8 16		^ ^ ^							
-31.0					^ ^ ^	Becomes medium dense, weak to moderate strength, fractured; about 50% recovery, RQD = <60%.						
-32.0					^ ^ ^							
-33.0					^ ^ ^							
-34.0					^ ^ ^							
-35.0	☒	▦	5 9 16		^ ^ ^	About 80% recovery, RQD = 75%.						
-36.0					^ ^ ^							
-37.0					^ ^ ^							
-38.0					^ ^ ^							
-39.0					^ ^ ^							
-40.0	☒	▦	10 10 17		^ ^ ^	About 60% recovery, RQD = <50%.						
-41.0					^ ^ ^							
-42.0						Boring terminated at a depth of 41.5 feet. Groundwater initially encountered at a depth of approximately 5.5 feet.						
-43.0												
-44.0												

Appendix B

Laboratory Data

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST





	Symbol	○			
	Sample No.	B1@5.5			
	Test No.	13-381a			
	Depth	5.5'			
Initial	Diameter, in	2.42			
	Height, in	5.15			
	Water Content, %	25.4			
	Dry Density, pcf	94.87			
	Saturation, %	89.7			
	Void Ratio	0.757			
Before Shear	Water Content, %	25.4			
	Dry Density, pcf	94.96			
	Saturation*, %	89.9			
	Void Ratio	0.755			
	Back Press., psi	.E-17			
	Ver. Eff. Cons. Stress, psi	4.809			
	Shear Strength, psi	19.59			
	Strain at Failure, %	20			
	Strain Rate, %/min	1			
	B-Value	---			
	Estimated Specific Gravity	2.67			
	Liquid Limit	---			
	Plastic Limit	---			

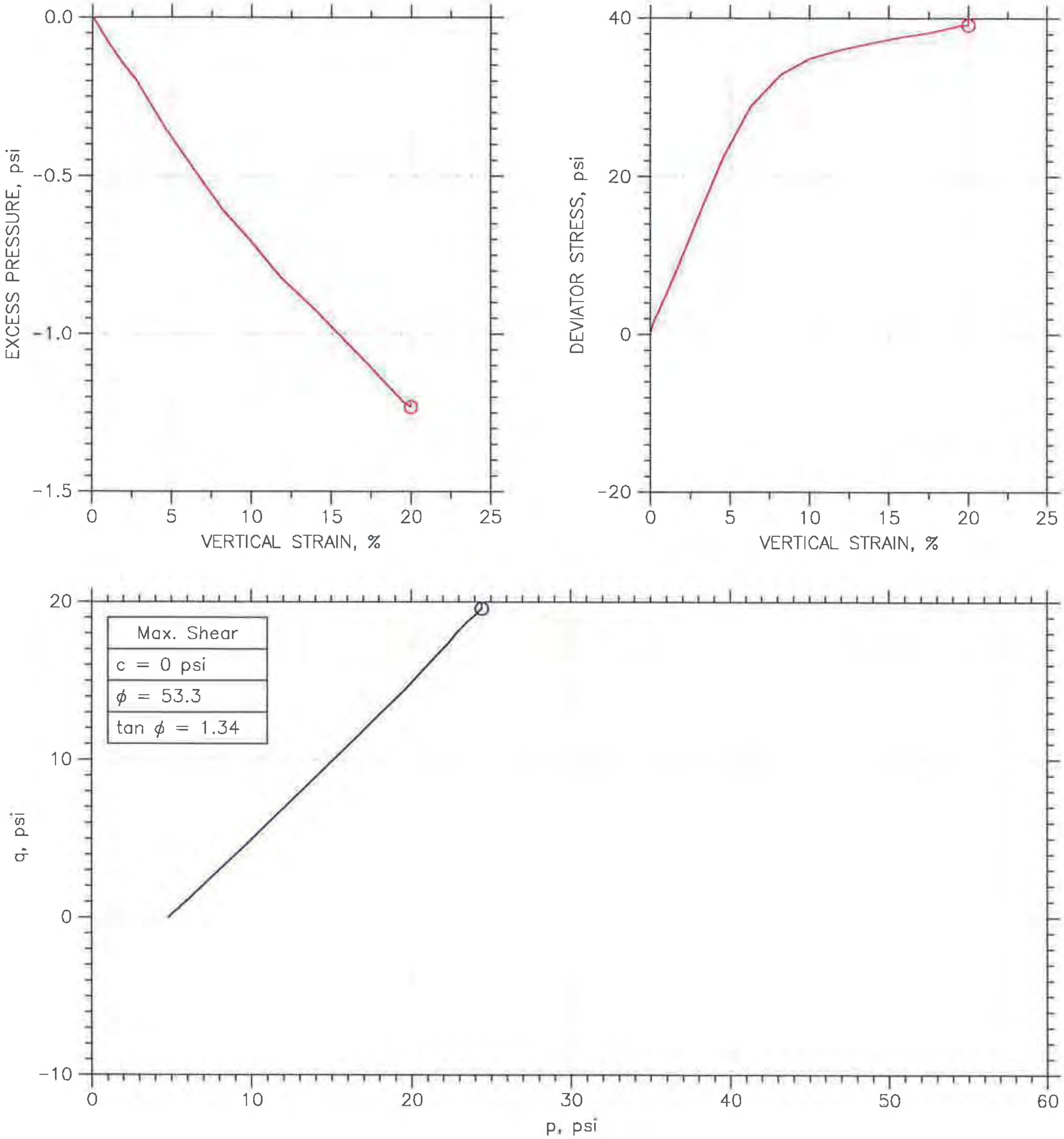
Project: Coos Bay WWTP2
Location:
Project No.: 612035
Boring No.: B1
Sample Type: 2.5 Liner
Description: SAND with silt
Remarks: Unconsolidated undrained

Phase calculations based on start and end of test.

* Saturation is set to 100% for phase calculations.

Fri, 07-JUN-2013 13:37:38

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST

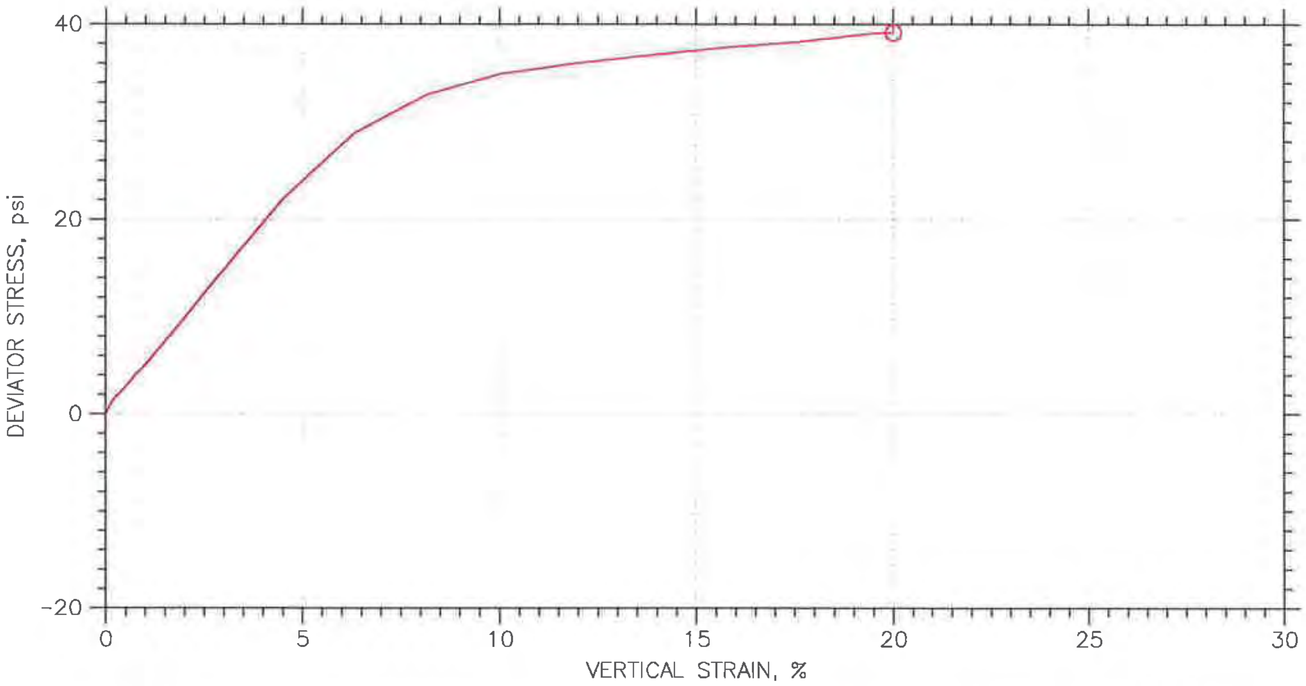


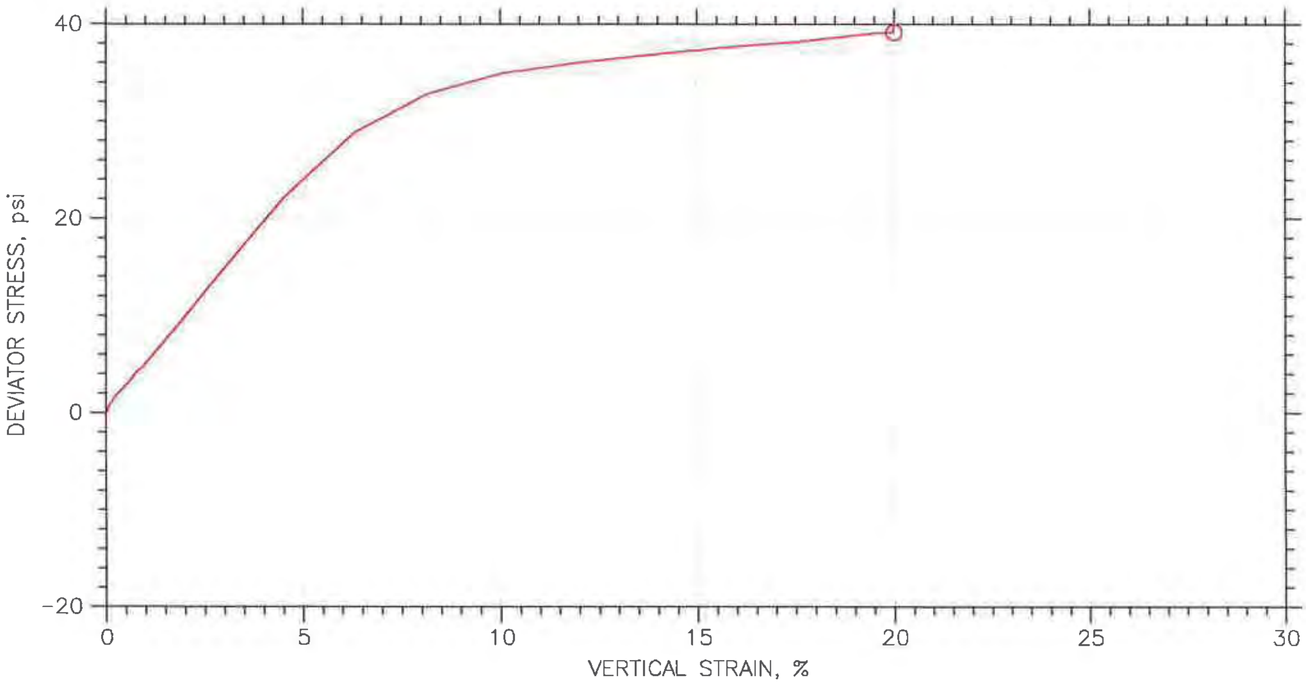
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	B1@5.5	13-381a	5.5'	DJG	5/31/13		6/11/13	13-381aCoos Bay B1@5.dat

Project: Coos Bay WWTP2	Location:	Project No.: 612035
Boring No.: B1	Sample Type: 2.5 Liner	
Description: SAND with silt		
Remarks: Unconsolidated undrained		

Fri, 07-JUN-2013 13:37:38

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST



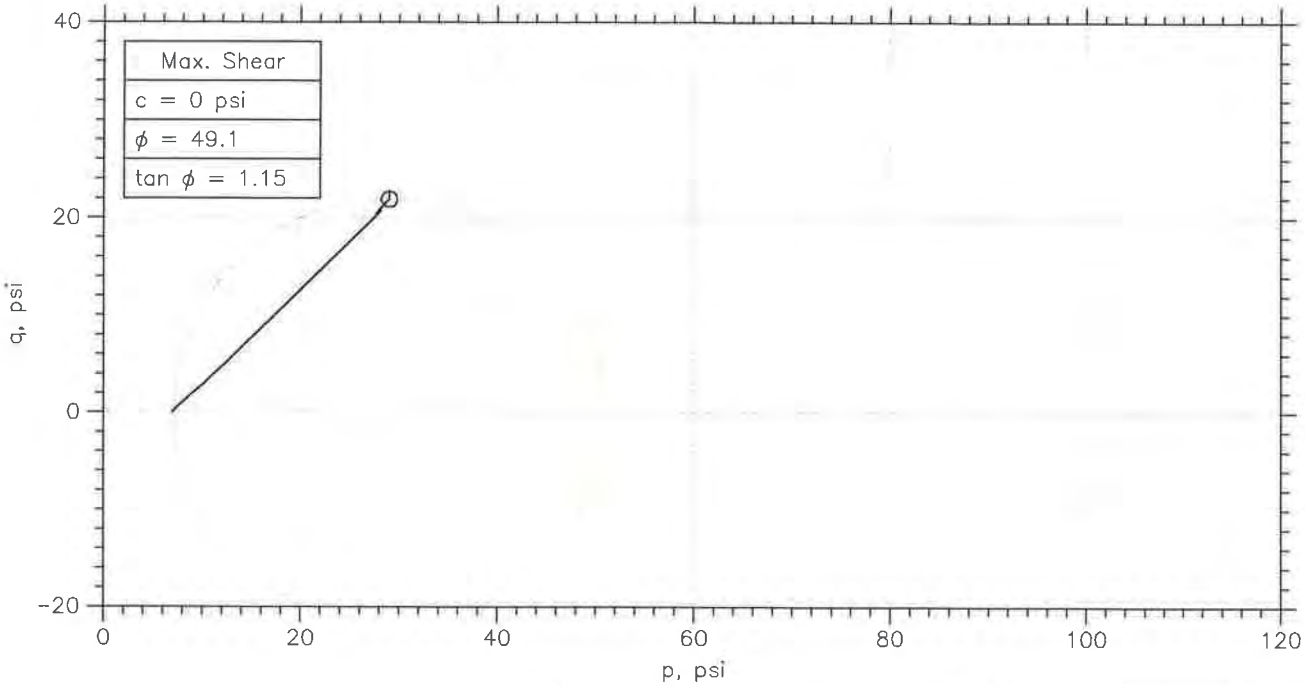


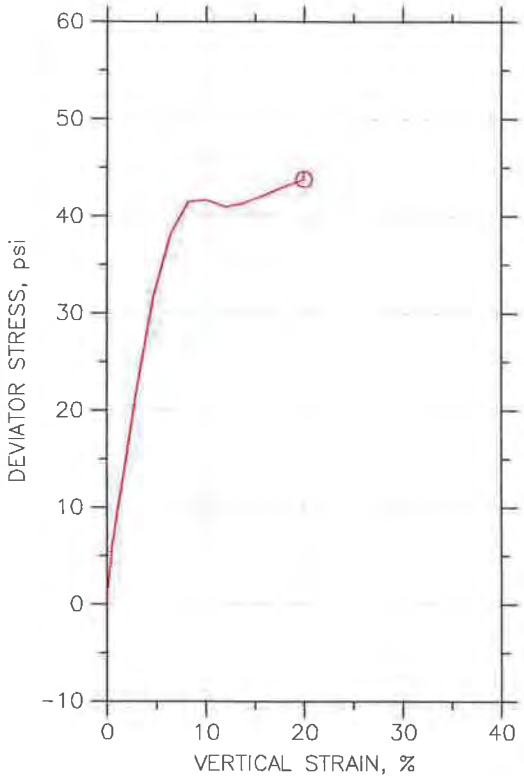
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
①	B1@5.5	13-381a	5.5'	DJG	5/31/13	DL	6/7/13	13-381aCoos Bay B1@5.dat

Project: Coos Bay WWTP2	Location:	Project No.: 612035
Boring No.: B1	Sample Type: 2.5 Liner	
Description: SAND with silt		
Remarks: Unconsolidated undrained		

Fri, 07-JUN-2013 13:37:39

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST





Symbol		⦶			
Sample No.		B1@8.5'			
Test No.		13-382			
Depth		8.5'			
Initial	Diameter, in	2.42			
	Height, in	5.25			
	Water Content, %	24.4			
	Dry Density, pcf	94.93			
	Saturation, %	86.3			
	Void Ratio	0.756			
Before Shear	Water Content, %	24.4			
	Dry Density, pcf	94.98			
	Saturation*, %	86.4			
	Void Ratio	0.755			
	Back Press., psi	-.008152			
Ver. Eff. Cons. Stress, psi		6.932			
Shear Strength, psi		21.92			
Strain at Failure, %		20			
Strain Rate, %/min		1			
B-Value		---			
Estimated Specific Gravity		2.67			
Liquid Limit		---			
Plastic Limit		---			

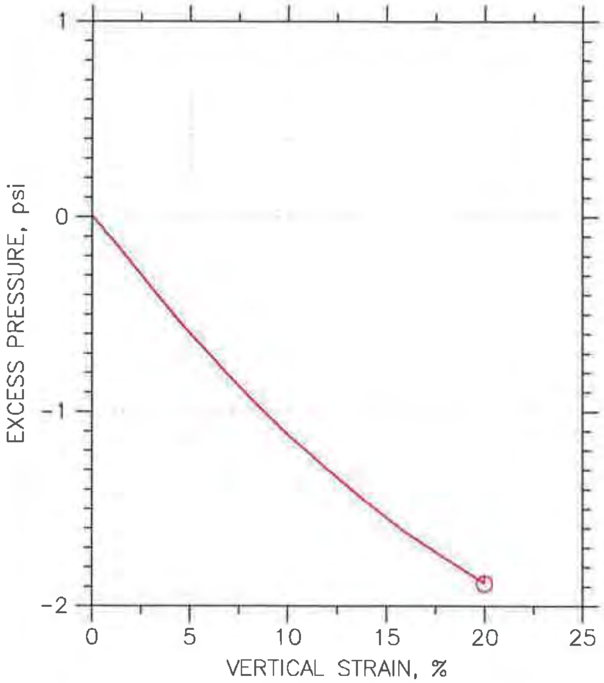
Project: Coos Bay WWTP2
Location: Coos Bay
Project No.: 612035
Boring No.: B1
Sample Type: 2.5" liner
Description: silty SAND
Remarks: Unconsolidated undrained

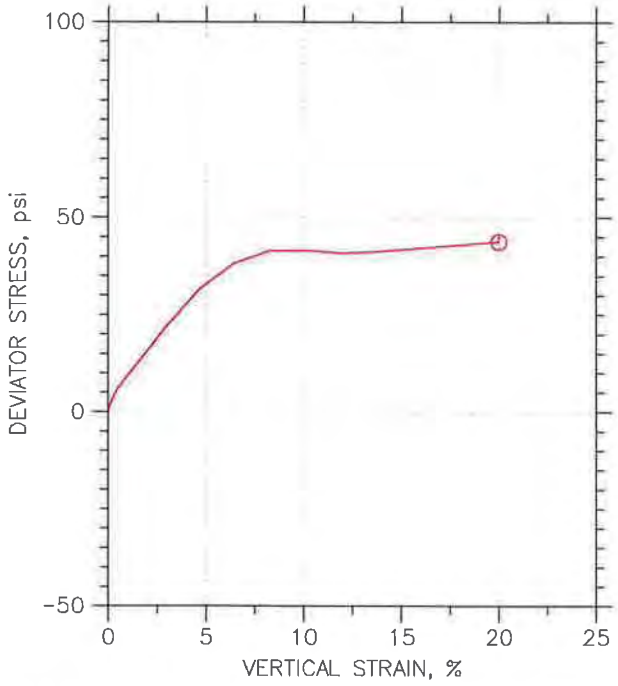
Check DL 6/7/13

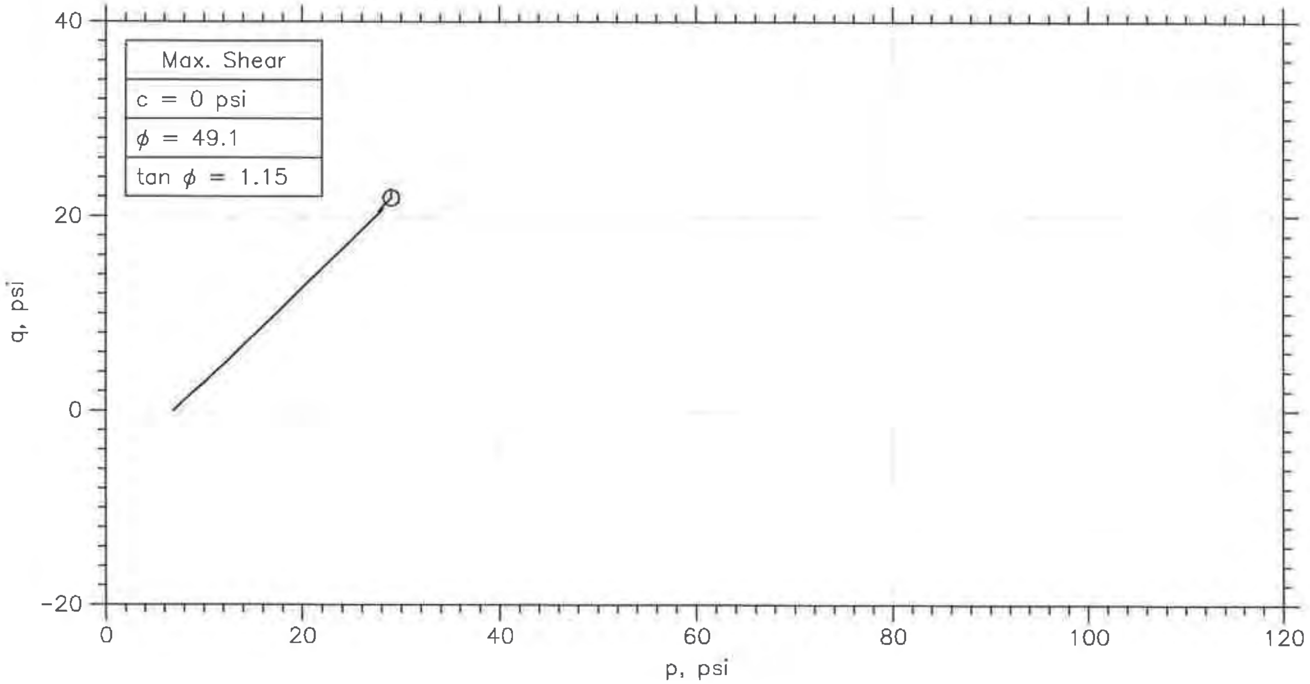
Phase calculations based on start and end of test.
* Saturation is set to 100% for phase calculations.

Fri, 07-JUN-2013 13:41:56

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST





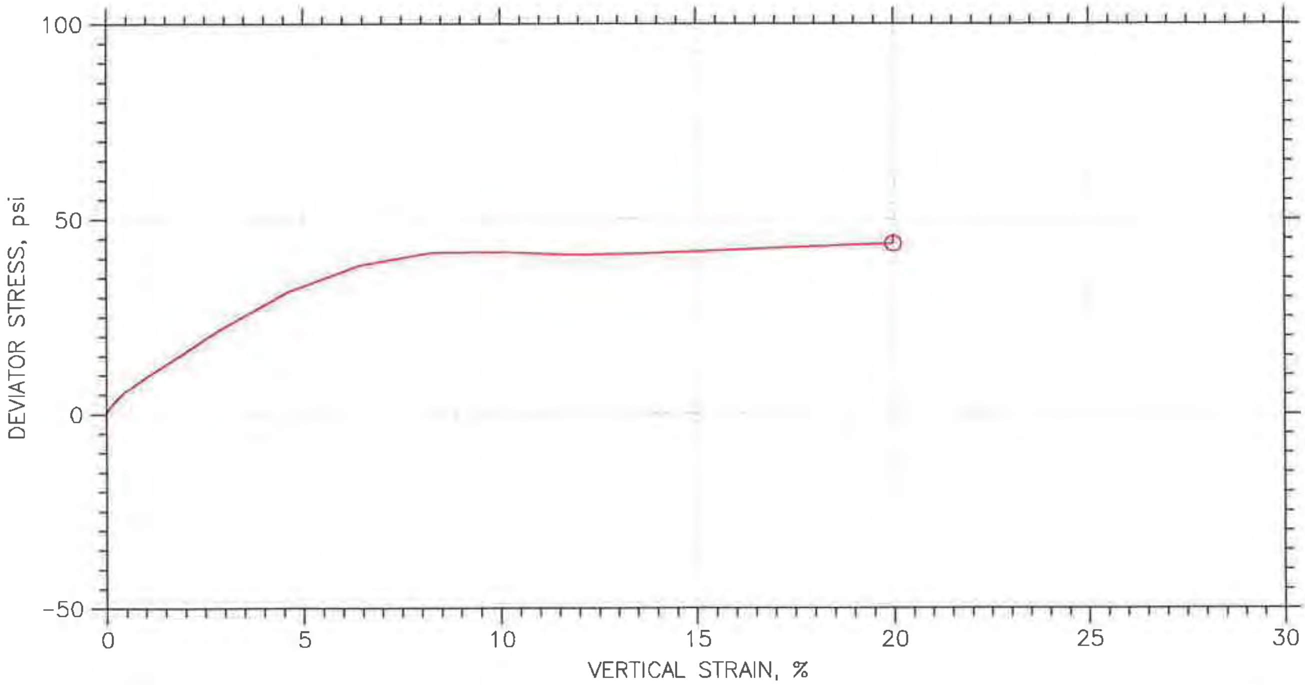


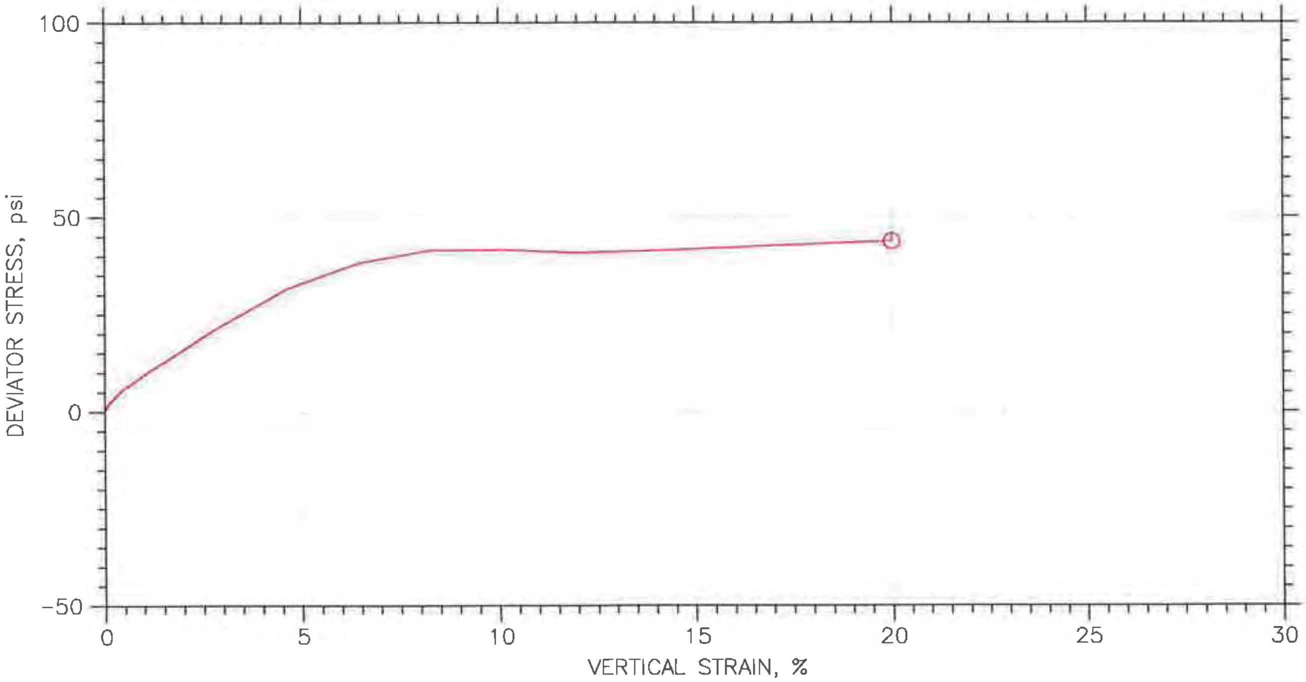
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
⦶	B1@8.5'	13-382	8.5'	DJG	5/30/13	DR	6/7/13	13-382 Coos Bay B1@8.dat

Project: Coos Bay WWTP2	Location: Coos Bay	Project No.: 612035
Boring No.: B1	Sample Type: 2.5" liner	
Description: silty SAND		
Remarks: Unconsolidated undrained		

Fri, 07-JUN-2013 13:41:57

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST



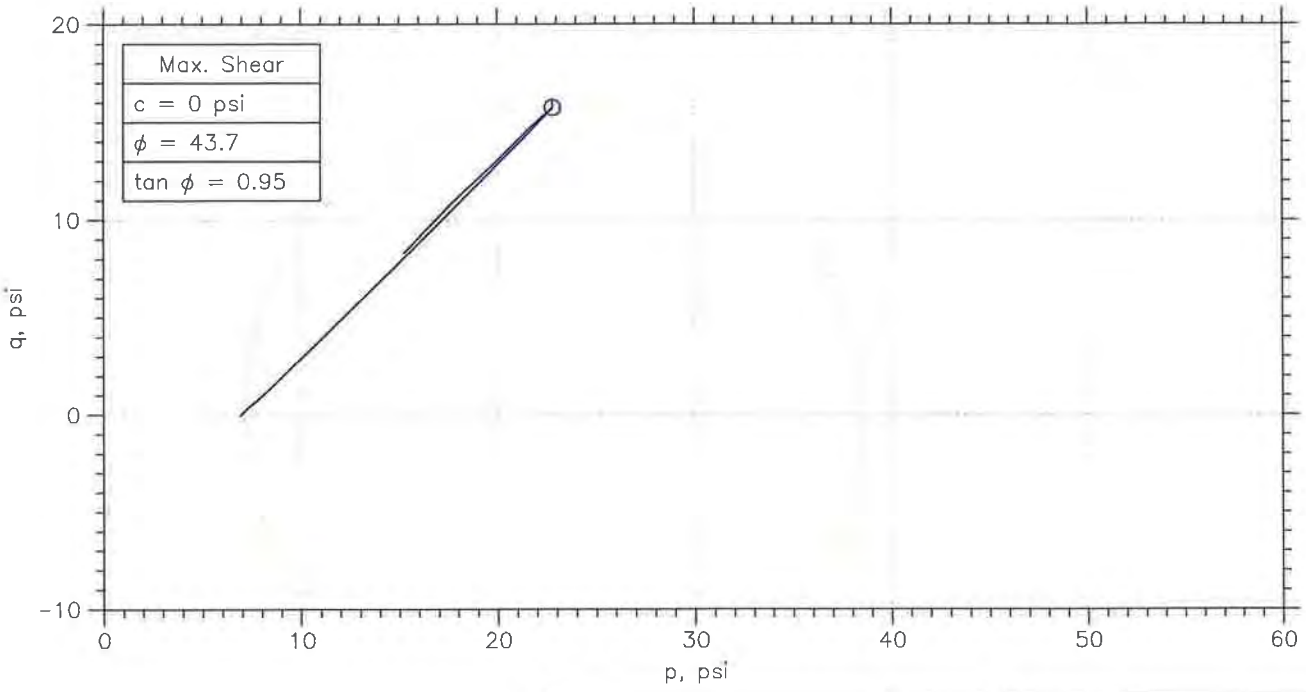


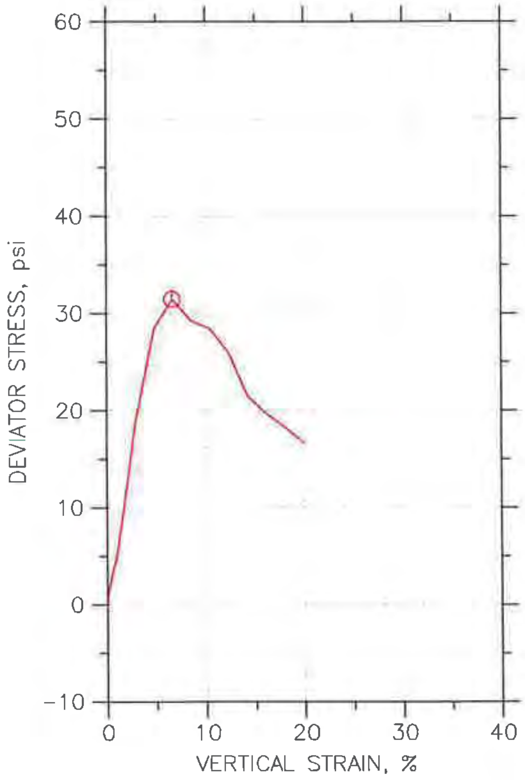
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
⦶	B1@8.5'	13-382	8.5'	DJG	5/30/13		6/7/13	13-382 Coos Bay B1@8.dat

Project: Coos Bay WWTP2
Location: Coos Bay
Project No.: 612035
Boring No.: B1
Sample Type: 2.5" liner
Description: silty SAND
Remarks: Unconsolidated undrained

Fri, 07-JUN-2013 13:41:57

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST





Symbol		⌽			
Sample No.		B2@8.5'			
Test No.		13-386			
Depth		8.5'			
Initial	Diameter, in	2.42			
	Height, in	4.35			
	Water Content, %	22.5			
	Dry Density, pcf	97.71			
	Saturation, %	85.2			
	Void Ratio	0.706			
Before Shear	Water Content, %	22.5			
	Dry Density, pcf	97.89			
	Saturation*, %	85.7			
	Void Ratio	0.703			
	Back Press., psi	.E-17			
Ver. Eff. Cons. Stress, psi		6.916			
Shear Strength, psi		15.76			
Strain at Failure, %		6.65			
Strain Rate, %/min		1			
B-Value		---			
Estimated Specific Gravity		2.67			
Liquid Limit		---			
Plastic Limit		---			

Project: Coos Bay WWTP2

Location:

Project No.: 612035

Boring No.: B2

Sample Type: 2.5 Liner

Description: SAND wih silt

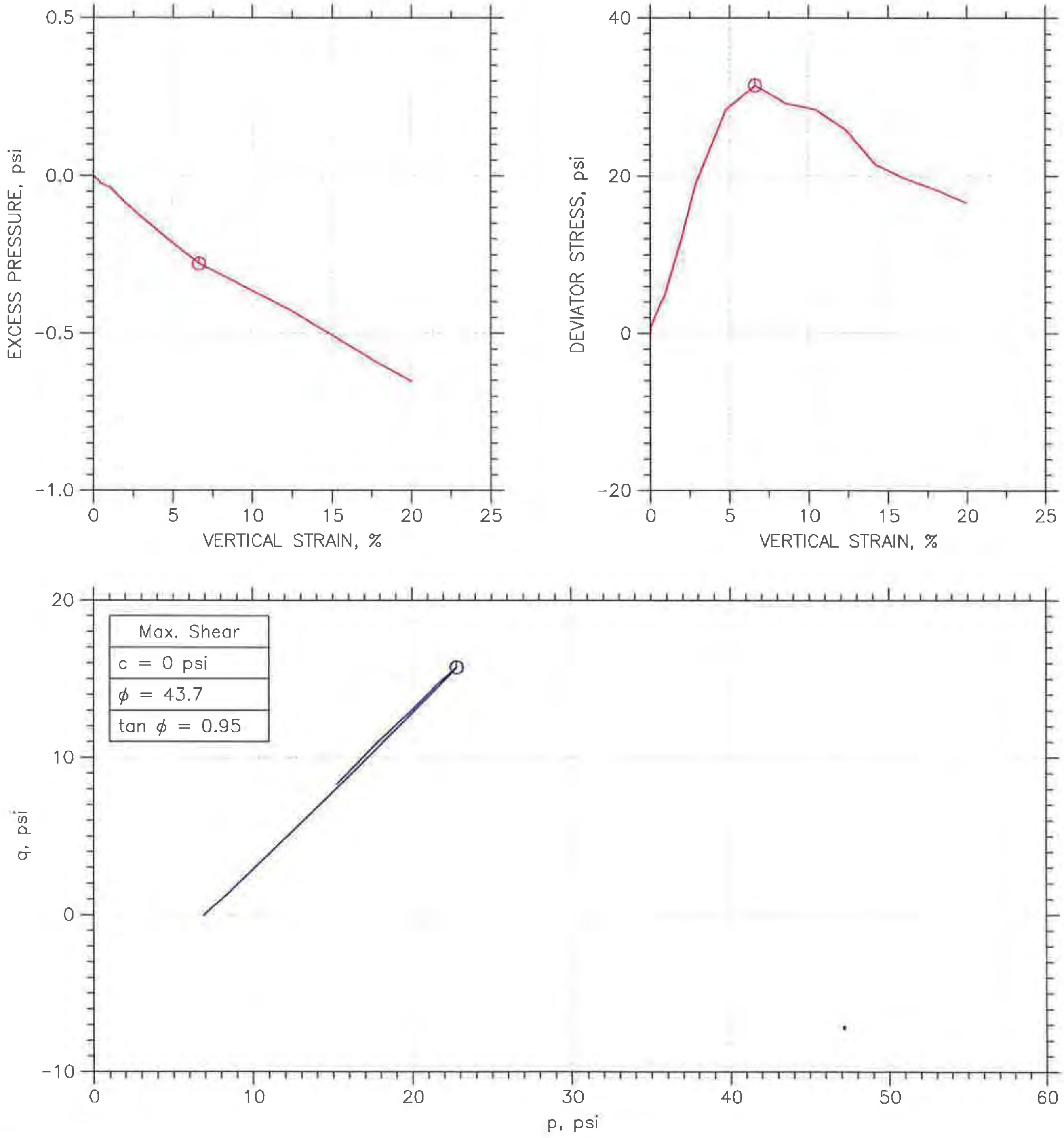
Remarks: Unconsolidated undrained L/D Ratio less than 2:1

Phase calculations based on start and end of test.

∗ Saturation is set to 100% for phase calculations.

Fri, 07-JUN-2013 15:57:39

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST

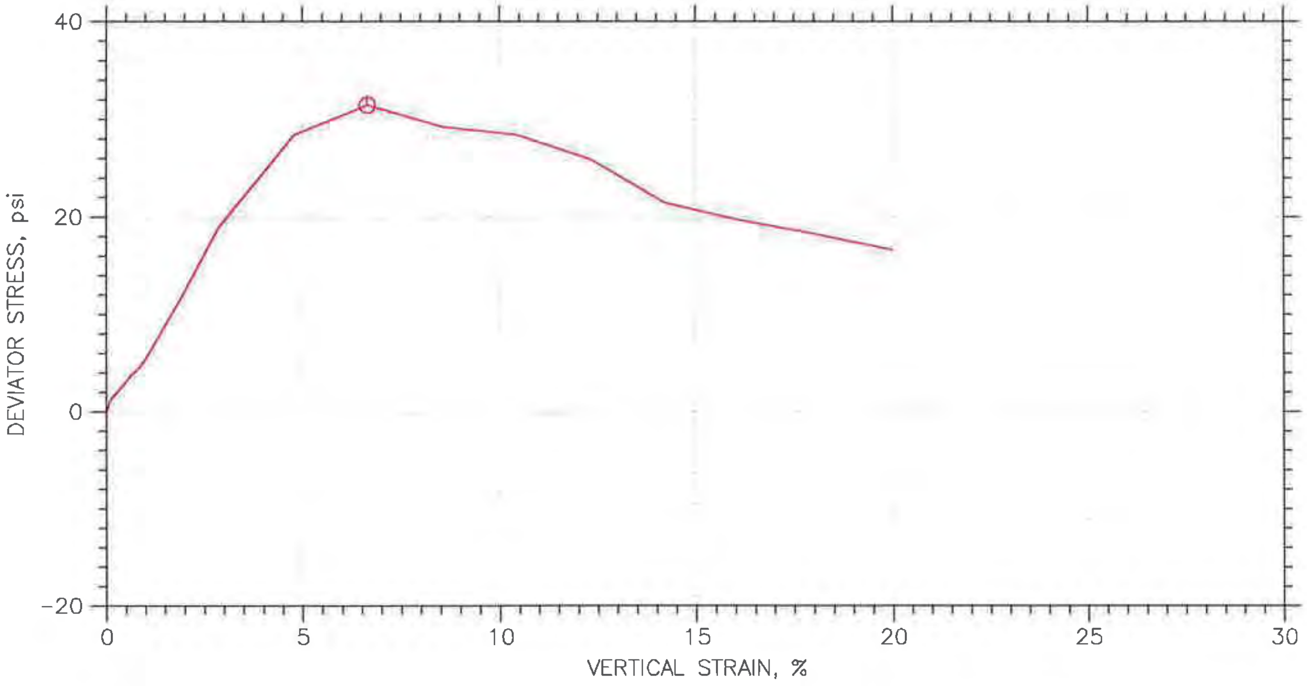


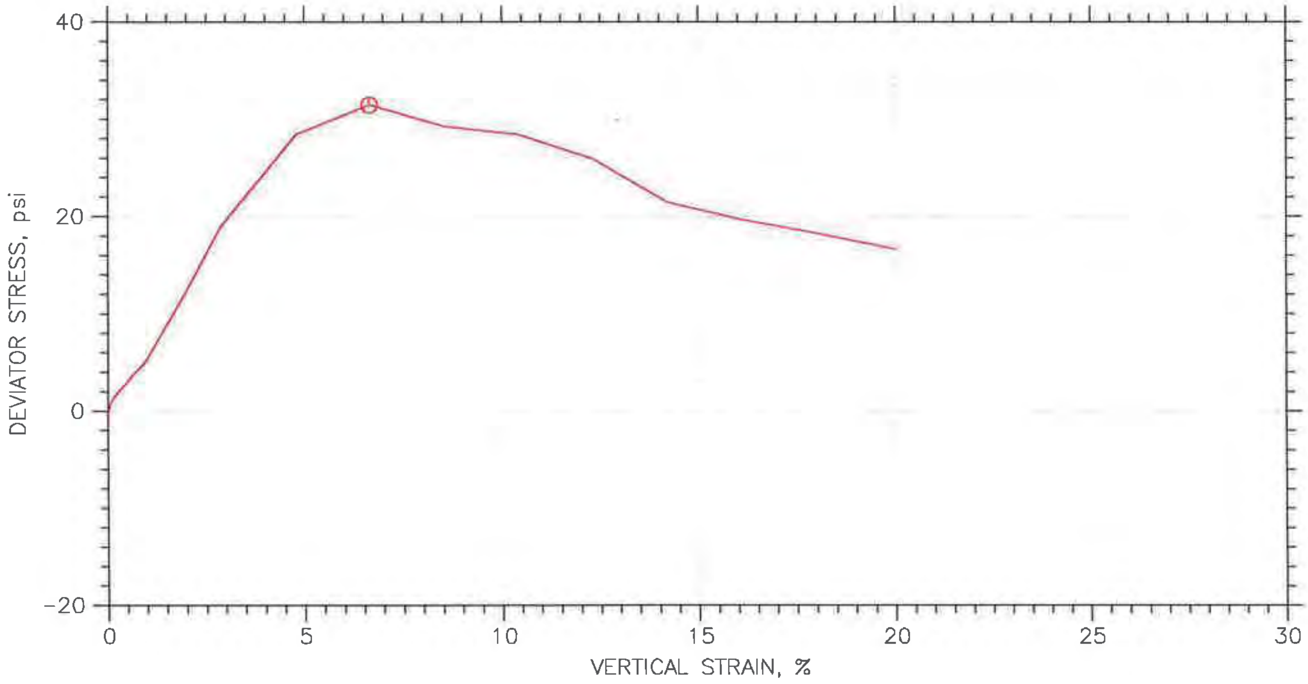
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	B2@8.5'	13-386	8.5'	DJG	5/30/13	DL	6/7/13	13-386 Coos Bay B2@8.dat

Project: Coos Bay WWTP2	Location:	Project No.: 612035
Boring No.: B2	Sample Type: 2.5 Liner	
Description: SAND wih silt		
Remarks: Unconsolidated undrained L/D Ratio less than 2:1		

Fri, 07-JUN-2013 15:57:40

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
⊕	B2@8.5'	13-386	8.5'	DJG	5/30/13	DL	6/9/13	13-386 Coos Bay B2@8.dat

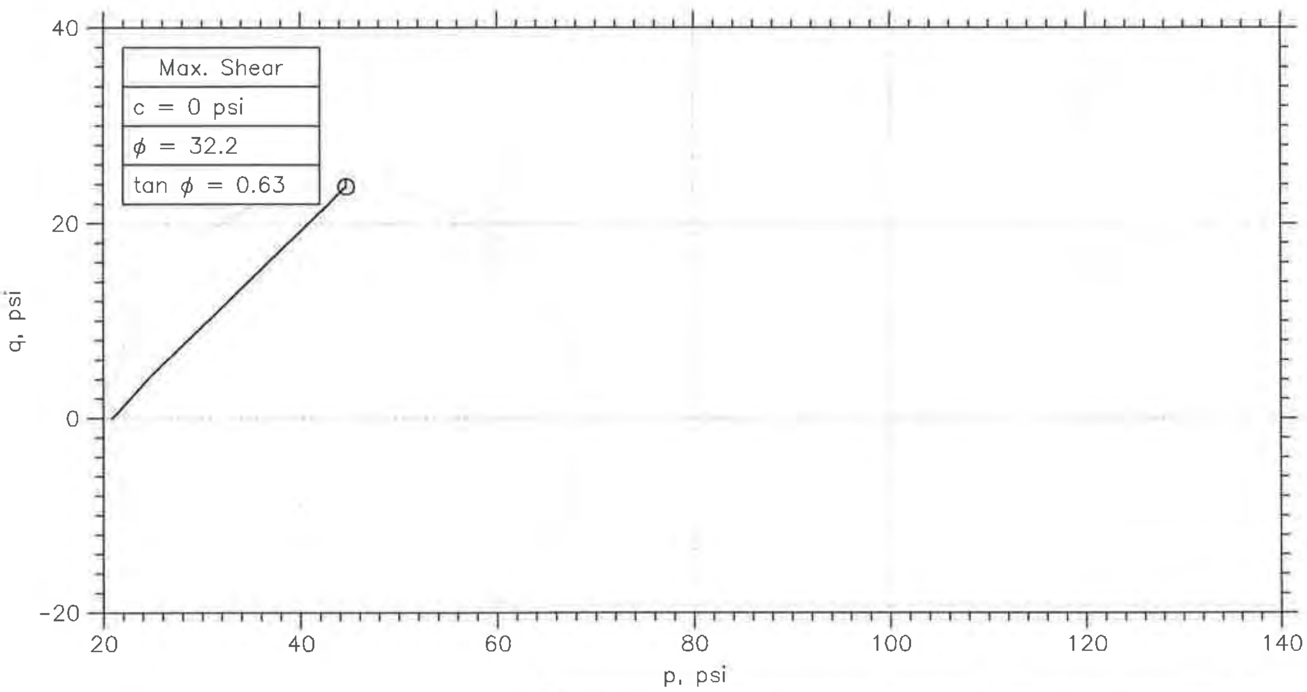
Project: Coos Bay WWTP2	Location:	Project No.: 612035
Boring No.: B2	Sample Type: 2.5 Liner	

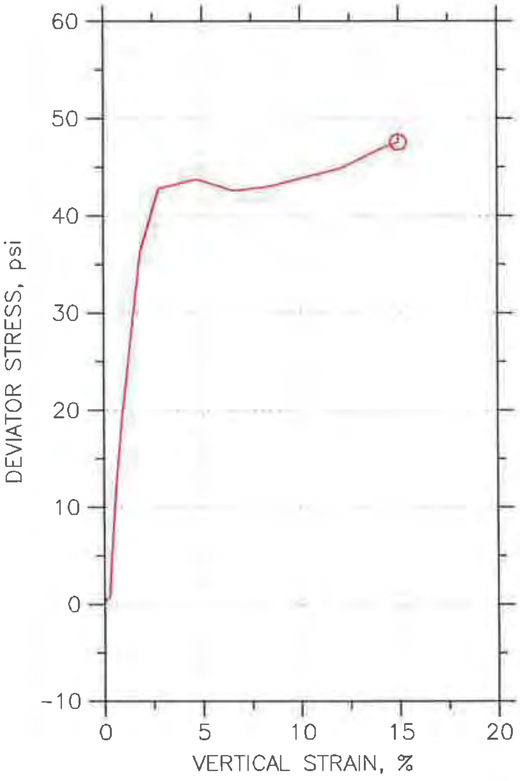
Description: SAND wih silt

Remarks: Unconsolidated undrained L/D Ratio less than 2:1

Fri, 07-JUN-2013 15:57:40

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST





Symbol		○				
Sample No.		B3@26'				
Test No.		13-387				
Depth		26'				
Initial	Diameter, in	2.42				
	Height, in	5.55				
	Water Content, %	27.4				
	Dry Density, pcf	94.19				
	Saturation, %	95.1				
	Void Ratio	0.77				
Before Shear	Water Content, %	27.4				
	Dry Density, pcf	94.49				
	Saturation*, %	95.8				
	Void Ratio	0.764				
	Back Press., psi	.E-17				
Ver. Eff. Cons. Stress, psi		20.8				
Shear Strength, psi		23.81				
Strain at Failure, %		15				
Strain Rate, %/min		1				
B-Value		---				
Estimated Specific Gravity		2.67				
Liquid Limit		---				
Plastic Limit		---				

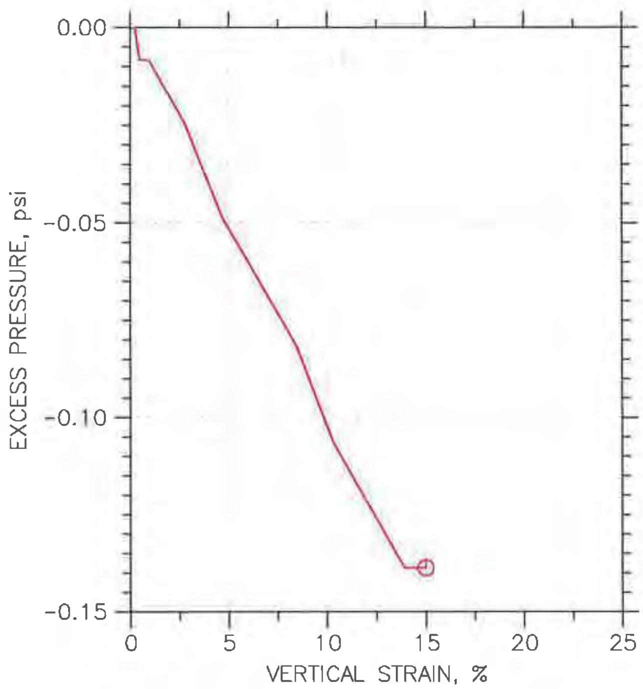
Project: Coos Bay WWTP2
Location:
Project No.: 612035
Boring No.: B3
Sample Type: 2.5" Liner
Description: stiff brown SILT
Remarks: Unconsolidated undrained

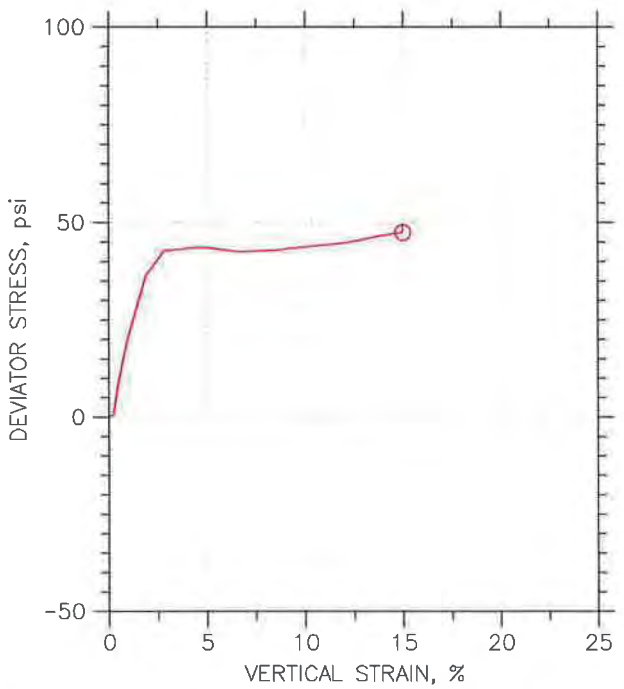
6/7/13

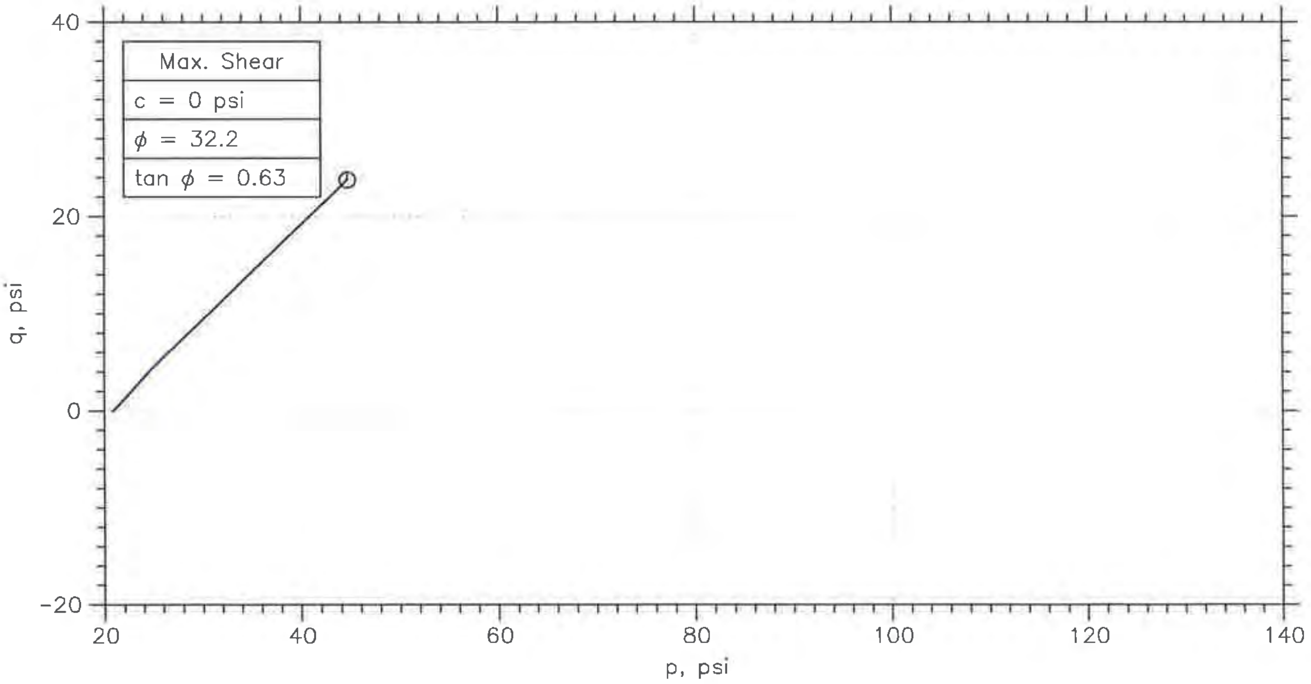
Phase calculations based on start and end of test.
* Saturation is set to 100% for phase calculations.

Fri, 07-JUN-2013 13:47:42

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST





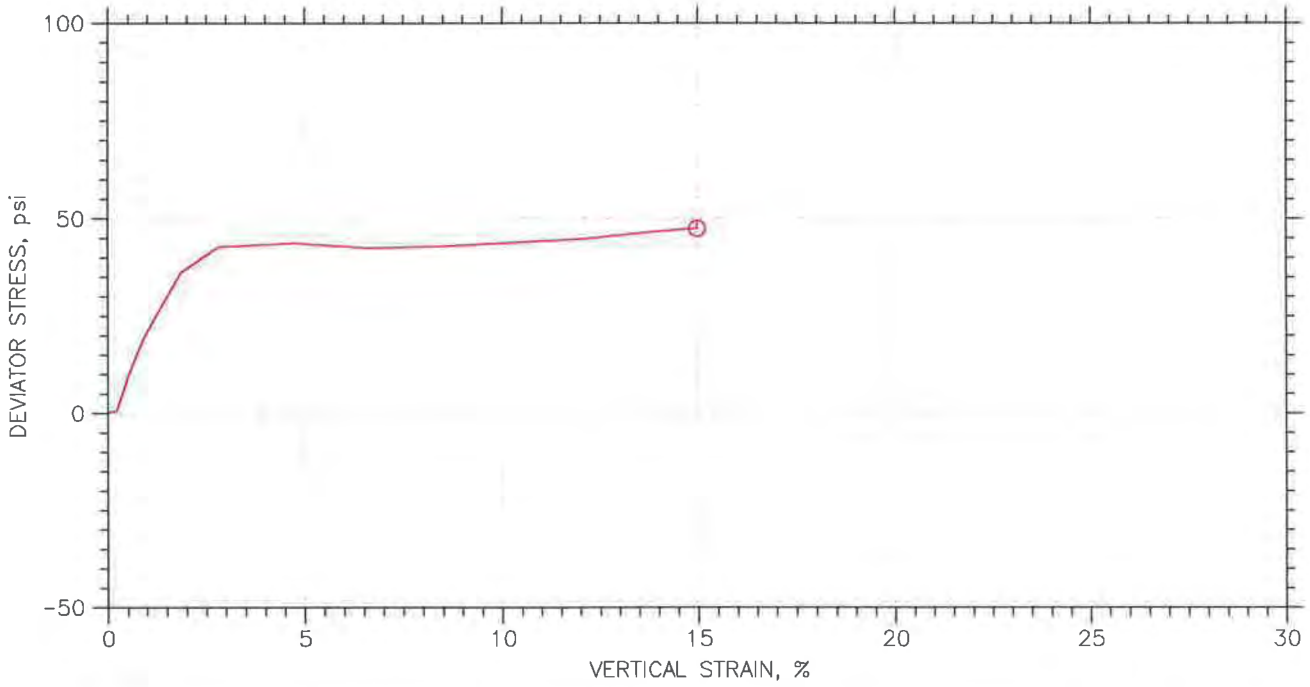


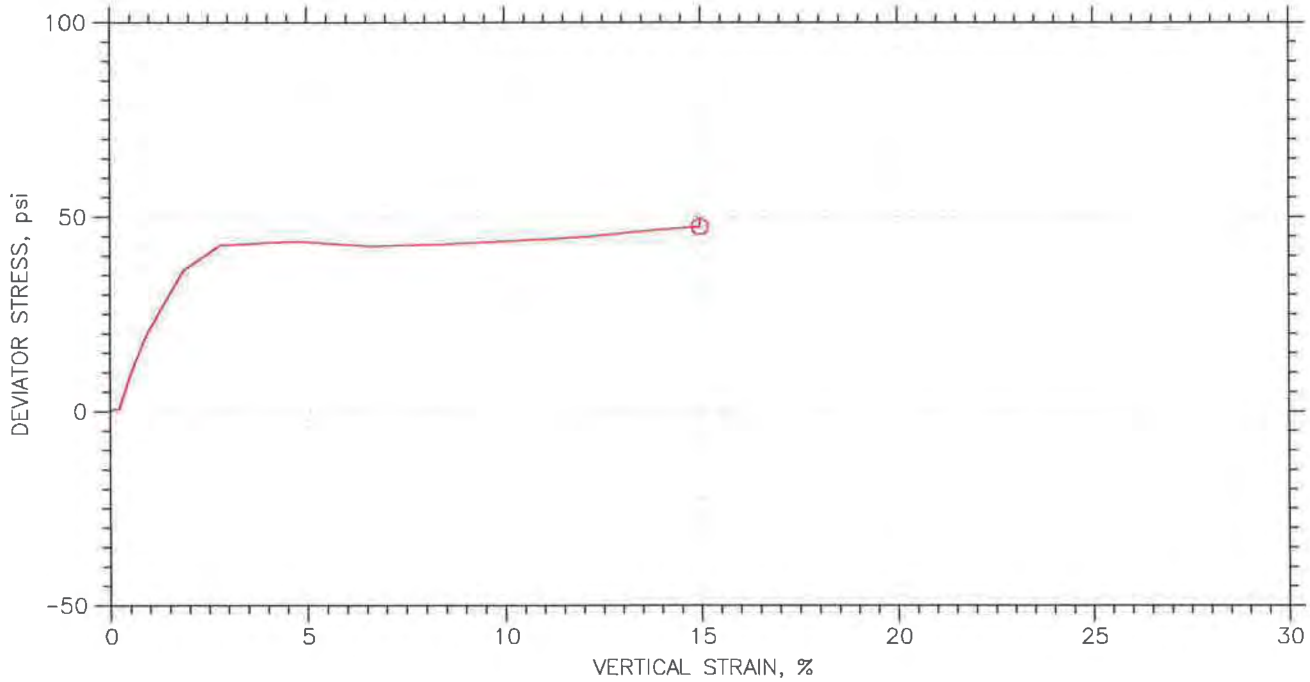
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
Ø	B3@26'	13-387	26'	DJG	5/30/13	Dh	6/7/13	13-387 Coos Bay B3@26.dat

Project: Coos Bay WWTP2	Location:	Project No.: 612035
Boring No.: B3	Sample Type: 2.5" Liner	
Description: stiff brown SILT		
Remarks: Unconsolidated undrained		

Fri, 07-JUN-2013 13:47:43

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	B3@26'	13-387	26'	DJG	5/30/13	DL	6/7/13	13-387 Coos Bay B3@26.dat

Project: Coos Bay WWTP2	Location:	Project No.: 612035
Boring No.: B3	Sample Type: 2.5" Liner	
Description: stiff brown SILT		
Remarks: Unconsolidated undrained		

Fri, 07-JUN-2013 13:47:43

CONSULTING ENGINEERS & GEOLOGISTS, INC.
812 W. Wabash Eureka, CA 95501-2138 Tel: 707/441-8855 FAX: 707/441-8877 E-mail: shninfo@shn-engr.com

PERCENT PASSING # 200 SIEVE (ASTM - D1140)

Project Name: Coos Bay WWTP Ph 2 **Project Number:** 612035
Performed By: DJG **Date:** 6/7/13
Checked By: **Date:** 6/7/13
Project Manager: MD

Lab Sample Number	13-388	13-389	13-390		
Boring Label	B1	B1	B1		
Sample Depth (ft)	3'	8'	13'		
Pan Number	A7	A11	A5		
Dry Weight of Soil & Pan	194.6	194.5	204.9		
Pan Weight	86.7	86.2	87.4		
Weight of Dry Soil	107.9	108.3	117.5		
Soil Weight Retained on #200&Pan	188.9	173.9	197.9		
Soil Weight Passing #200	5.7	20.6	7.0		
Percent Passing #200	**5.3**	**19.0**	**6.0**		

Lab Sample Number					
Boring Label					
Sample Depth (ft)					
Pan Number					
Dry Weight of Soil & Pan					
Pan Weight					
Weight of Dry Soil					
Soil Weight Retained on #200&Pan					
Soil Weight Passing #200					
Percent Passing #200					

CONSULTING ENGINEERS & GEOLOGISTS, INC.
812 W Wabash Eureka, CA 95501-2138 Tel: 707/441-8855 FAX: 707/441-8877 E-mail: shninfo@shn-engr com

DENSITY BY DRIVE- CYLINDER METHOD (ASTM D2937)

Project Name:	Coos Bay WWTP	**Project Number:**	612035
Performed By:	DJG	**Date:**	6/7/2013
Checked By:	DL	**Date:**	6/7/13
Project Manager:	MD		

Lab Sample Number	13-380	13-383	13-384	13-385	
Boring Label	B1	B1	B2	B2	
Sample Depth (ft)	3.5''	11'	3.5'	6'	
Diameter of Cylinder, in	2.42	2.42	2.42	2.42	
Total Length of Cylinder, in.	6.00	6.02	6.00	6.00	
Length of Empty Cylinder A, in.	0.00	0.00	0.00	0.00	
Length of Empty Cylinder B, in.	1.82	0.67	1.55	2.05	
Length of Cylinder Filled, in	4.18	5.35	4.45	3.95	
Volume of Sample, in^3	19.23	24.61	20.47	18.17	
Volume of Sample, cc.	315.06	403.25	335.41	297.73	

Pan #	SS11	SS5	SS6	S26	
Weight of Wet Soil and Pan	779.8	983.9	852.4	744.0	
Weight of Dry Soil and Pan	677.7	831.0	729.8	622.0	
Weight of Water	102.1	152.9	122.6	122.0	
Weight of Pan	194.8	195.5	196.4	165.9	
Weight of Dry Soil	482.9	635.5	533.4	456.1	
Percent Moisture	21.1	24.1	23.0	26.7	
Dry Density, g/cc	1.53	1.58	1.59	1.53	
Dry Density, lb/ft^3	95.7	98.4	99.3	95.6	

PD.09 – Site Work and Landscaping

PREPARED BY: Anders Rasmussen, PE/SHN

REVIEWED BY: Steve Donovan, PE/SHN, Dan Peterson/CH2M HILL

DATE: August 2013

This technical memorandum discusses the site predesign of the proposed City of Coos Bay Wastewater Treatment Plant No. 2 (WWTP 2) Expansion and Upgrade project.

Site Work

Description

The expansion and upgrade of WWTP 2 will be located on the northeast corner of Empire Boulevard and Fulton Avenue. The site is approximately 2.3 acres and consists of 4 lots. All of the lots are undeveloped and are zoned C-2, General Commercial.

The existing WWTP2 facilities located on the west side of Empire Boulevard will remain and minor upgrades will occur.

Additional site work will be performed along Empire Blvd where the Oregon Department of Transporation is planning an upgrade to the sidewalks and pavement. Prelimianry plans for the ODOT improvements have been incorporated in the WWTP 2 site plan.

Project Description

The facilities on the new site include an Influent Pump Station, headworks, sequencing batch reactor (SBR) system, office/laboratory building, , and a shop/garage/electrical building. Refer to sheet 006-C-2000.

Permitting

Development of the new site for the WWTP2 expansion/upgrade will require a site plan and architectural review (SPAR) pursuant to Coos Bay Municipal Code Chapter 17.345. The SPAR addresses aesthetics of the site including building architectural features, topography, and landscaping requirements.

Site Improvements

Grading

The existing topography of the site is slightly sloped with a significant hill on the eastern edge of the property that extends to Marple Street. Elevations on the site range from about 13 to 30 ft. The proposed finished grades of the developed portion of the site will range from 14.5 to 17. The existing topography along the eastern edge of the site will not be significantly modified. When the future SBR unit is constructed, a retaining wall will be built along the eastern property boundary.

The site is generally covered with fill material unsuitable for structural fill or pavement subgrade. It is anticipated that about 2 to 3 feet of overexcavation will be needed to accommodate adequate base rock under paved areas.

Paving

Paving on the site is proposed to be asphaltic concrete (AC)suitable for truck traffic. Thickness of the base rock and AC pavement will be determined during final design and suitable for truck traffic.

Drainage

The site generally slopes from the northeast corner to the southwest corner. A drainage way with delineated wetland resources is located on the north and northwestern edge of the property. The drainage way turns southward along Empire Boulevard, passing through a culvert at an existing access point to the property, and continuing south through an additional wetland area before turning west to cross under Empire Boulevard approximately 280 feet north of Fulton Avenue. The wetland area is part of a wetland mitigation site. Impacts to the wetland will be avoided.

Per direction from the City, all storm drainage from paved areas will be collected and discharged to the wastewater collection system, either at a connection to the collection system or to the Influent Pump Station. Runoff from unpaved areas and building rooftops will be collected and discharged to the existing ditch located along the northern and western edges of the site. Curbing along pavement edges will be utilized to direct runoff.

Utilities

Basic utilities (water, electric, natural gas, telecom) will be brought in to the site from existing utility lines located either along Empire Boulevard or Fulton Avenue. Sanitary sewer and water service will be provided to the operations building from Fulton Avenue.

Yard (Process) Piping

The new site is an expansion of the existing WWTP 2 site. Some treatment process elements will remain at the existing WWTP 2 location. Process piping will connect the two locations along Fulton Avenue and Empire Boulevard. Two crossings of Empire Blvd are anticipated.

Fencing

The entire new site will be fenced with chain link fence and screened using privacy slats. The chain link fence will be six feet high, with a 3-strand barbed wire at the top. The site fencing will follow City code requirements.

Parking

The proposed site plan incorporates seven parking stalls and one ADA stall. The parking requirements will be incorporated in the City's SPAR and discussed further at the pre-application review.

Sidewalks

A new sidewalk will be constructed on the north side of Fulton Ave to improve pedestrian access to and from local neighborhoods and Empire Blvd. Sidewalks will also be provided around the operations building to provide safe worker access to the building and related parking areas.

Landscaping

The site will be landscaped as required by the SPAR. Landscaping requirement pursuant to City Code (CBMC 17.200) could apply if 10 or more spaces are provided, however, only 8 parking stalls are currently envisioned. Therefore the SPAR requirements will dictate landscaping areas at the site.

Landscaping areas include the area along Empire Blvd away from the wetland resources, the Office Building and surrounding areas not proposed for pavement, and the east and west entry and exit gates. A planting island with a sign will be located on the south west corner of the site. Trees and larger shrubbery will also be incorporated into the eastern side of the site to soften the view of the large SBR tank. Plantings for landscaping areas will be suitable for the Southern Oregon Coast.

TECHNICAL MEMORANDUM

PD.10 – Process and Facilities Overview

PREPARED BY: Jason Riegler/CH2M HILL
REVIEWED BY: Bill Leaf/CH2M HILL
DATE: August 2013

Introduction

The purpose of this technical memorandum is to provide an overview of the proposed Coos Bay Wastewater Water Treatment Plant #2 (WWTP 2) Expansion and Upgrade project process units and facilities.

Influent Flows and Loads

Design of the WWTP 2 expansion and upgrade is based on the flow and load projections developed in the *Wastewater Treatment Plant #2 Facilities Plan Amendment* (Civil West, November 2012). The Facility Plan Amendment (FPA) determined the current 2010 and projected 2037 design influent flows and loadings and the preferred treatment scheme. The FPA design flow and load values are shown in Tables 10-1 and 10-2.

TABLE 10-1
Design Influent Flows and Loads (Startup Conditions[1])

Flow Condition	Annual (Jan–Dec)	Winter (Wet Weather) (Nov–Apr)	Summer (Dry Weather) (May–Oct)
Flows (mgd)			
Average Daily	1.06	1.28	0.84
Maximum Month[3]	-	1.79	1.29
Peak Week	-	3.05	-
Peak Daily Average	-	5.39	-
Peak Instantaneous	-	7.00	-
5-day Biochemical Oxygen Demand (pounds per day)			
Average Daily		1,993	
Maximum Month		2,830	
Maximum Day		3,900	
Total Suspended Solids (pounds per day)			
Average Daily	2,499	2,501	2,496
Maximum Month		3,960	
Maximum Day		5,800	
Total Kjeldahl Nitrogen-N (pounds per day)[2]			
Average Daily	277	277	276
Maximum Month		360	
Maximum Day		427	

TABLE 10-1

Design Influent Flows and Loads (Startup Conditions[1])

Flow Condition	Annual (Jan–Dec)	Winter (Wet Weather) (Nov–Apr)	Summer (Dry Weather) (May–Oct)
Ammonia-N (pounds per day)			
Average Daily	208	208	207
Maximum Month		270	
Maximum Day		320	

Notes:

1. Startup conditions are assumed to be equal the 2010 values determined in the Facility Plan Amendment.
2. Total Kjeldahl Nitrogen (TKN) loading data was not provided in FPA. The ammonia to TKN ratio was assumed to equal 0.75.
3. Maximum Month Dry Weather Flow or Maximum Month Wet Weather Flow

TABLE 10-2

Design Influent Flows and Loads (Projected 2037)

Flow Condition	Annual (Jan–Dec)	Winter (Wet Weather) (Nov–Apr)	Summer (Dry Weather) (May–Oct)
Flows (mgd)			
Average Daily	1.24	1.50	0.99
Maximum Month[2]	-	2.09	1.51
Peak Week	-	3.57	-
Peak Daily Average	-	6.31	-
Peak Instantaneous	-	8.20	-
5-day Biochemical Oxygen Demand (pounds per day)			
Average Daily		2,334	
Maximum Month		3,314	
Maximum Day		4,567	
Total Suspended Solids (pounds per day)			
Average Daily	2,926	2,929	2,923
Maximum Month		4,648	
Maximum Day		6,792	
Total Kjeldahl Nitrogen-N (pounds per day)[1]			
Average Daily	324	325	323
Maximum Month		421	
Maximum Day		500	

TABLE 10-2
Design Influent Flows and Loads (Projected 2037)

Flow Condition	Annual (Jan–Dec)	Winter (Wet Weather) (Nov–Apr)	Summer (Dry Weather) (May–Oct)
Ammonia-N (pounds per day)			
Average Daily	243	244	242
Maximum Month		316	
Maximum Day		375	

Notes:
1. Total Kjeldahl Nitrogen (TKN) loading data was not provided in FPA. The ammonia to TKN ratio was assumed to equal 0.75.
2. Maximum Month Dry Weather Flow or Maximum Month Wet Weather Flow

Effluent Requirements

Effluent requirements for discharge of plant effluent in Coos Bay were listed in the FPA. The requirements are based on the existing NPDES permit and the expected enterococcus limit and are shown in Table 10-3.

TABLE 10-3
Effluent Requirements

Parameter	Units	Winter (Wet Weather) (Nov-Apr)	Summer (Dry Weather) (May-Oct)
5-Day Biochemical Oxygen Demand			
Monthly Average Concentration	mg/L	30	20
Weekly Average Concentration	mg/L	45	30
Monthly Average Loading	lbs/day	510	340
Weekly Average Loading	lbs/day	760	510
Daily Maximum Loading	lbs/day	1,000	670
Total Suspended Solids (TSS)			
Monthly Average Concentration	mg/L	30	20
Weekly Average Concentration	mg/L	45	30
Monthly Average Loading	lbs/day	510	340
Weekly Average Loading	lbs/day	760	510
Daily Maximum Loading	lbs/day	1,000	670
Additional Requirements:			

NOTES:

1. BOD$_5$ and TSS removal efficiency shall not be less than 85 percent monthly average
2. pH shall be within 6.0-9.0
3. Ammonia-N shall not exceed a monthly average concentration of 20 mg/L and a daily maximum concentration of 30 mg/L from May 1 to October 31
4. Fecal coliform bacteria shall not exceed a monthly median of 14 organisms per 100 mL. Not more than 10 percent of the samples shall exceed 43 organisms per 100 mL
5. Enterococcus shall not exceed a monthly geometric mean of 35 organisms per 100 mL. No single sample may exceed 104 organisms per 100 mL.
6. Total residual chlorine shall not exceed a daily median value of 0.5 mg/L and no single sample shall exceed 1.0 mg/L

Plant Reliability Criteria

The U.S. Environmental Protection Agency requires that wastewater facilities meet the requirements for reliability and redundancy in their treatment components and associated equipment. The reliability standards establish minimum levels of reliability for three classes of wastewater works.

The Oregon Department of Environmental Quality (DEQ) has also established minimum standards governing the reliability of mechanical, electrical, and fluid systems used in wastewater systems. The standards are intended to protect the environment, particularly receiving waters, against unacceptable degradation resulting from power failure, flood, peak loads, equipment failure, and maintenance shutdowns. The standards are divided into three, decreasingly stringent, classes of reliability: I, II, and III. The facility will discharge to Coos Bay's shellfish habitat; therefore, DEQ has determined that reliability Class I is appropriate for the expanded/upgraded WWTP 2 treatment facilities. Table 10-4 shows the requirements for Class 1 Reliability stated in the Facility Plan Amendment.

TABLE 10-4
Requirements for Class 1 Reliability (adopted from Facility Plan Amendment)

Component	Reliability Criteria
All	In general, all components of the treatment process should be able to hydraulically contain peak hourly flow rate without overflowing or damaging equipment, with the largest unit out of service. The system should contain enough flexibility to enable the wastewater flow to any unit out of service to be distributed to the remaining units in service.
Influent Pumps	Minimum two pumps. Designed with a firm capacity of peak instantaneous flow (PIF) with largest pump off line.
Coarse Screens	Mechanically cleaned screen primary. Minimum two coarse screens. Manually cleaned bar screen may be used as backup. Each designed for peak (PIF).
Grit Removal	Single unit. If required for subsequent treatment processes, designed for peak instantaneous flow (PIF). If not, design for MMWWF is acceptable.
Aeration Basins[1]	Sized using modeling to generate preferred treatment to meet discharge permit limits during $MMDWF_{10}$ (Summer) and $MMWWF_5$ (Winter) events. Minimum of two basins designed for peak daily flow (PDF) and maximum month dry weather flow with largest basin off line.
Aeration Blowers	Supply the design air capacity with the largest blower out of service. Provide a minimum of two units.
Air Diffusers	Isolation of largest section of diffusers (within a basin) without measurably impairing oxygen transfer.
Sedimentation[1]	Minimum of two basins designed for peak daily flow (PDF) and maximum month dry weather flow with largest basin off line.
Disinfection	Minimum of two units. For UV, must treat with a minimum dose of 30 mJ/cm^2 peak hourly flow (PIF) with all units on or Maximum Daily Flow with largest unit out of service, whichever is greater.
Outfall Pipe	Sized for peak flow at worst case downstream hydraulic conditions (PIF).
Electrical Power	Two separate and independent sources of electrical power shall be provided. This may include primary power from the utility provider and an on-site generator. The backup generator shall have sufficient capacity to operate all vital process components, critical lighting, and ventilation during peak daily flow conditions (PDF).

Notes:
1. Sequencing batch reactor basins consist of both aeration and sedimentation processes in a shared basin.

General Process Description

The expanded/upgraded facility will utilize the Xylem/Sanitaire Intermittent Cycle Extended Aeration System (ICEAS) Sequencing Batch Reactor process for secondary activated sludge treatment in conjunction with raw sewage screening, grit removal and UV disinfection.

The City is evaluating long term biosolids management options for the Coos Bay area. While this evaluation is being performed and planned, the existing influent pump station, headworks, primary clarifier, primary sludge pumping and anaerobic digesters will continue to be used for the next 3 to 5 years until the long term biosolids management solution has been implemented. During this interim period, primary effluent from the existing primary clarifier will be routed to the new Influent Pump Station and pumped to the new headworks, sequencing batch reactors, and UV disinfection facilities for final treatment. Discharge of the plant effluent will be through the existing outfall pipe and diffuser.

The following unit processes will be part of the expanded/upgraded facility:

- Trench style Influent Pump Station
- Headworks incorporating influent screening, grit removal, screenings conveying and storage, and screened raw sewage flow splitting
- Sequencing batch reactors with effluent flow equalization and waste-activated-sludge pumping
- Positive displacement blower system within Headwork’s Facility
- Ultraviolet disinfection system with potable water pumping system
- Odor control system located at existing site
- Control Building
- Electrical Building
- Maintenance/Garage Building

PD.11 – Influent Pump Station

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Felicia Knox/SHN

REVIEWED BY: Steve Donovan/SHN

DATE: August 2013

Introduction

The purpose of the technical memorandum (TM) is to provide the elements and design of the Influent Pumps Station for the Coos Bay Wastewater Treatment Plant #2 (WWTP 2) Expansion and Upgrade project.

Pump Station Summary

The Influent Pump Station (IPS) at WWTP 2 is anticipated to involve the following elements:

- Pump station building
- Trench-style wet well structure
- Five submersible pumps
- Air release valves, check valves and isolation valves for each pump discharge
- Telemetry and auxiliary power integrated with the plant-wide system
- Main control from the plant’s primary control room, with HOA control for each pump at the IPS
- Two force mains (8-inch and 16-inch diameter) connecting to the headworks

All flows treated by WWTP 2 will be conveyed through the IPS, which is required to lift the influent sewerage to the headworks. Because of the large range of flow rates, two force mains (one 8-inch and one 16-inch) are proposed for the dry-weather and wet-weather flows, respectively. The design flow rates are explained in the Design Flows section below.

Based on an analysis of the system curves and cleaning velocity requirements for the 8-inch and 16-inch force mains, it is recommended that the 8-inch force main and two low-flow pumps be used for dry-weather flows, and the 16-inch force main and two high-flow pumps used for wet-weather flows. The pumping strategy is explained further in the Pumping Rate section below.

With this pumping strategy, during the dry season, two 17 HP pumps will operate, pumping dry weather flows to the headworks. During the winter, wet-weather flows will be pumped through the 16-inch main using two 45 HP pumps; an additional 45 HP pump is included for redundancy. This mode of operation minimizes the yearly power requirements for the IPS and reduces the number of pump start/stops. Given the space required for a 5-bay pumping facility, a trench style wet well is recommended. The trench style wet well provides self-cleaning capabilities and reduces the size of the wet well and subsequent excavations.

A proposed layout for the IPS is included in Volume 2, Drawings. The air release valves, check valves, and isolation valves will be located directly adjacent to the wet well, and the flow metering equipment will be located at the headworks.

Design

Design Flows

The IPS will convey all influent flows to the expanded/upgraded WWTP 2. Flows tributary to the pump station include all wastewater from the western half of the City of Coos Bay and all sewerage from Charleston Sanitary

District, as well as associated inflow and infiltration (I/I). The City has implemented an I/I reduction program; however, estimated and projected reductions in I/I were not considered when calculating flow volumes for the design of the IPS.

In accordance with DEQ regulations, the IPS must be capable of conveying peak instantaneous flows (PIF) for the planning period. As calculated in the *City of Coos Bay Wastewater Treatment Plant #2 Facility Plan Amendment* (Civil West, 2012), the PIF for the planning period is 8.20 million gallons per day (MGD), or 5,700 gallons per minute (gpm). The PIF was calculated based on a flow analysis using influent flow data included in the Discharge Monitoring Reports (DMRs) from 2006 through 2010. Inflow and Infiltration (I/I) rates were calculated based on flow studies and rainfall data and are included in the total PIF. The PIF was then projected for the 2037 planning year by assuming a 20 percent population increase.

In addition to conveying peak flows, the IPS must also be able to pump the dry weather flows without excessive starting and stopping. The current average dry weather flow (ADWF) for the lift station is 0.84 MGD, or 585 gpm (Civil West, 2012). The ADWF was calculated based on a flow analysis using influent flow data included in the Discharge Monitoring Reports (DMRs) from 2006 through 2010. As agreed to by the City and DEQ at the WWTP 2 Pre-design Kickoff meeting, a better goal for the IPS design is to be able to match flows that reach lower than the ADWFs, or that meet the current low diurnal flows. By designing a pump station to be able to match the lowest flow rates, the facility will minimize the number of start/stops on the pumps and will provide a more continuous flow to the headworks. After evaluating the current low diurnal influent flows, the minimum flow that results in an acceptable velocity in the 8-inch force main, and the turn-down that could be achieved by the low-flow pumps, it was determined that 0.58 MGD, or 400 gpm, is a reasonable target for the minimum pumping capacity of the IPS. Table 11-1 summarizes the design flow criteria.

TABLE 11-1
Design Flow Criteria

Flow Rate	2010 Flow Rate (gpm)	2037 Flow Rate (gpm)
Lowest diurnal flow [1]	<400	400
Average dry weather flow (ADWF) [2]	585	690
Average wet weather flow (AWWF) [2]	890	1,040
High flow (PIF) [2]	4,861	5,700

[1] From field evaluation of existing influent flows

[2] Wastewater Treatment Plant #2 Facilities Plan Amendment (Civil West, 2012)

Pumping Rate

Since there is a wide range of flows that the IPS must handle (from a current low flow of 400 gpm to a year 2037 peak instantaneous flow of 5,700 gpm), the analysis for the new pump station includes the use of multiple size pumps and an 8-inch and 16-inch force main for dry- and wet-weather flows, respectively.

DEQ guidelines recommend a fluid velocity range of 3.5 to 8 feet-per-second (fps) for sanitary sewer force mains. Flow rates associated with the recommended velocities in the 8-inch and 16-inch pipelines are provided in Table 11-2.

TABLE 11-2
Flow Rates at DEQ Minimum and Maximum Recommended Velocities

Velocity (fps)	Flow in 8-inch Pipe (gpm)	Flow in 16-inch Pipe (gpm)
3.5	550	2,200
8.0	1,250	5,020

TABLE 11-2
Flow Rates at DEQ Minimum and Maximum Recommended Velocities

Velocity (fps)	Flow in 8-inch Pipe (gpm)	Flow in 16-inch Pipe (gpm)

The maximum recommended capacity of the 8-inch force main (1,250 gpm) is insufficient to serve the peak instantaneous flow for the 20-year planning period. Additionally, the minimum capacity of the 16-inch force main (2,200 gpm) exceeds the acceptable pumping rate for dry-weather flows tributary to the IPS. Therefore, the proposed strategy is to use the 8-inch force main for low flows and the 16-inch force main for high flows.

The proposed capacity of each low-flow pump is 785 gpm. A pump of this size will accommodate the average dry-weather flows tributary to IPS, provide an acceptable force main velocity, and will turn-down sufficiently to avoid excessive starts and stops, with the inclusion of a variable frequency drive. The total dynamic head through the 8-inch force main at 785 gpm is 52-feet. With both pumps pumping, the combined capacity of the low flow pumps is 1,430 gpm. The total dynamic head through the 8-inch force main at 1,430 gpm is 56-feet. A system curve for the 8-inch force main and a pump curve for the proposed low-flow pump (Flygt NP3153) are provided in Attachment A to this TM.

Since the low-flow pumps discharge into a separate force main from the high-flow pumps, their capacity can be added to the capacity of the high-flow pumps when determining the total station capacity. Therefore, the capacity of the high-flow pumps would needs to be 4,270 gpm (the year 2037 PIF of 5,700 gpm, less the low-flow pump capacity of 1,430 gpm). The proposed strategy is to use a five-plex station, with two low flow pumps, two high flow pumps, and an additional high flow pump for redundancy. The total dynamic head through the 16-inch force main with two high flow pumps running at capacity (4,840 gpm) is 53-feet. A system curve for the 16-inch force main and a pump curve for the proposed high-flow pump (Flygt NP3202) are provided in Attachment A to this TM.

Wet Well Configuration

By utilizing a trench style sump in combination with variable speed pumps, reductions in the required sump storage and, consequently, excavation can be achieved. An added benefit of the trench style sump is that it can be designed to be “self-cleaning”, reducing the need for staff entry into the sump area for routine maintenance, cleaning, and repairs.

The trench style sump varies from the standard wet well sump by being significantly narrower than the typical round or rectangular wet well configuration. With a trench design, pump suctions are located in a narrow channel located just below the inlet sewer. The “trench” dimensions are defined by the size of the inlet bell to the pump, resulting in a sump with a much smaller overall footprint than a traditional circular wet well. Often, trench style sumps do not need to be as deep as traditional wet wells, since storage capacity is not necessary if pumping output can be matched to the influent flow.

The “self-cleaning” features of a trench style sump refers to a design that allows for the creation of hydraulic conditions within the sump that reduce the accumulation of grease, sludge, and grit; thereby minimizing the most common source of required maintenance in a pump station sump. The inlet to the sump is gated (typically with a sluice-type gate) to allow interruption of flow to the pump station. Wastewater accumulates behind the sluice gate as the sump is pumped to a minimum level. When the sluice gate is opened, an ogee weir at the sump entrance creates a hydraulic jump that produces turbulent hydraulic conditions within the sump. This turbulence helps to dislodge accumulated grease, sludge, and grit; which are then immediately pumped out of the pump station while still in suspension. By utilizing this feature, maintenance and the need for confined space entry to the sump area is greatly reduced. Also, the wet well will be made easier to clean by the addition of a coating system which will protect against hydrogen sulfide, include a smooth top glaze that resists adhesion of fats and grease, and is easy to wash down with a standard wash-up hose.

An additional feature of the trench style wet well is the inclusion of anti-rotation baffles at every pump. These baffles help insure that currents near pump intakes are low, almost stagnant, and water tends to enter suction bells uniformly around their peripheries. A section view of the preliminary plan and pump station showing the trench style wet well with self-cleaning features is included in Volume 2, Drawings.

Buoyancy Calculations

Preliminary buoyancy calculations were performed for the IPS wet well and are included as Attachment B to this TM. Sixteen-inch walls, a 12-inch thick lid, and a 24-inch thick floor slab were assumed for these preliminary calculations. Using these assumptions, the spread footing needs to be 1 foot on the sides of the wet well and 2 ½ feet on either end, with compacted crushed rock as backfill, to provide a safety factor for flotation prevention of 1.5. In final design, if the structural calculations determine that the walls can be thinner, the footing will be increased accordingly.

Force Main

As discussed in previous sections, the IPS will utilize dual force mains: an 8-inch main for dry-weather and low-flow conditions and a 16-inch main for wet-weather and high-flow conditions. By constructing 2 force mains, the maximum capacity of the pump station is increased due to the allowance of simultaneous discharges of the low-flow and high-flow pumps being additive. Also, having 2 force mains allows for acceptable velocities to be maintained regardless of the varying flow conditions.

Low Flow Pumps

Sewers should be designed to have a velocity sufficient to “self clean”, or transport constituent solids, to the treatment facility. The DEQ velocity requirements for self-cleaning flow conditions require a minimum of 2 fps, and a recommended flushing velocity of 3.5 fps. The proposed minimum flow rate of 400 gpm is designed to meet the lowest diurnal flows that currently occur at WWTP 2. The associated velocity through the 8-inch is 2.5 fps, which is adequate to suspend solids but not to scour the pipe clean. Higher flows that will be occurring throughout the day and a control strategy that calls for all pumps to initially ramp up to full speed with each pump cycle will allow for adequate flushing.

When both of the dry weather pumps are pumping at capacity, the 8-inch force main carries 1,430 gpm at 9.1 fps. Although slightly higher than ideal (8 fps), the increased velocity will produce a steeper system curve, allowing for better control of the pumping operations.

High Flow Pumps

Combined flow from two of the wet weather pumps is required to pump the remaining capacity of the wet well (PIF 2037), with a third wet-weather pump for redundancy. Therefore, the required capacity of two wet-weather pumps operating simultaneously is 4,270 gpm. Based upon a pump selection process that considered optimization of electric and hydraulic efficiency, the Flygt 3032 pumps, shown in Attachment A to this TM, were selected. Two of these pumps will have a combined capacity of 4,840 gpm. The total of low-flow and high-flow pumps will provide a firm capacity for the station of 6,270 gpm.

Velocities associated with the design pumping rates through the 8-inch and 16-inch pipelines are provided in Table 11-3. Full system curves for both force mains and the manufacturer’s data for the proposed pumps are included as Attachment A to this TM.

TABLE 11-3

Velocities at Minimum and Maximum Flow Rates

Flow Rate (gpm)	Velocity in 8-inch Pipe (fps)	Velocity in 16-inch Pipe (fps)
400 (min flow, small pump)	2.6	N/A
1430 (max flow, 2x small pumps/min flow, large pump)	9.1	2.3
4840 (max flow, 2x large pumps)	N/A	7.7

Overflow Point

In the event of an overflow, wastewater will back up and spill over from the nearest manhole located between the IPS and Empire Boulevard. Sewage will then flow overland to the existing drainage ditch, located north of the station. From there, the wastewater will flow through the existing culvert under Empire Boulevard to Coos Bay.

Overflow discharges occur near public traffic ways and have moderate potential for human or pet contact prior to reaching the existing drainage ditch.

Pump Station Hydraulic Redundancy

The reliability of the proposed pump station is ensured through redundancy in the pumps within the pump station, and an auxiliary power source with auto-transfer switching to supply power in the event of power outage. The auxiliary power source and auto-transfer switching mechanism are discussed in later sections.

A total of 5 pumps are proposed for the pump station. Total output for the station (with hydraulic redundancy) will range between 400 gpm to 6,270 gpm. All of the pumps will be equipped with variable frequency drives so that one of the low-flow pumps will handle low flow conditions, with a minimum pump rate of approximately 400 gpm. With both pumps running at capacity, the low flow pumps will convey a combined 1,430 gpm. For flows above 1,430 gpm, the large pumps will be used. One high flow pump will pump 2,600 gpm. During peak events, two of the 3 high-flow pumps will address high-flow requirements by providing a combined output of 4,840 gpm. For flows above 4,840 gpm, the small pumps will be added, as required. With 2 high flow and 2 low flow pumps running, the station capacity is 6,270 gpm. To provide redundancy (sufficient pump station capacity in the event one of the high-flow pumps is out of service), there will be a third high flow pump installed at the pump station. The projected peak instantaneous flow for the 20-year planning period (5,700 gpm) will be accommodated by four of the 5 pumps, with the firm capacity of the station being 6,270 gpm.

For preliminary pump selection purposes, Flyps, a proprietary software package provided by Flygt Pumps, was used to size the pumps for the new station. Flygt Pumps is a manufacturer of submersible pumps. For the 20-year duty, a motor size of 17 HP and 45 HP will be required for the low-flow and high-flow pumps, respectively. All pumps will utilize a self-cleaning, semi-open channel impeller. A summary of the pump conditions, impeller size, and motor requirements is provided below in Table 11-4. Preliminary pump data is included in Attachment A to this TM.

TABLE 11-4
Recommended Pumping Equipment Requirements

Pump Condition	Variable Speed Output (gpm)	Impeller Size	Motor Size	Full Load Power
Low flow pumps	192-785	253 mm	17 HP	157 A
High flow pumps	237-2,600	354 mm	45 HP	330 A

Electrical Supply

Electrical supply for the pump station will be supplied from the main WWTP 2 Electrical Building. Local, lockable disconnects for each pump motor will be provided at the IPS.

Power Source Redundancy- Generator and Auto Transfer Switching

Auxiliary power to the pump station will be provided by a diesel-powered generator providing backup power to the entire WWTP 2. The generator will be stored on site, near the main Electrical Building. During an electrical outage, power will be temporarily shut down to the pumping units. An auto transfer switch will initiate the generator operation and transfer the power supply from the line to the back-up generator once the generator has reached speed. Each pump will then restart in series until full pumping capacity is restored. Upon sensing the restoration of line feed, the auto-transfer switching mechanism will initiate a delay countdown prior to switching back to line feed, to ensure the restoration of line feed is reliable, then return power supply for the pump station to the line feed and shut down the auxiliary power supply.

Pump Control Panel

The controls for the pump station will be housed at the headworks. The pump control panel will include a human-machine interface (HMI), programmable logic controller (PLC), the auto-level sensing devices, the variable speed drives, flow meter display, and an auto-dialer system with emergency call-out features.

The PLC will manage set points for various functions of the pumps including starting, stopping, and pump speed adjustments to match the desired preferred wet well levels. Set points will also be established for alarm conditions and integrated into a new emergency call-out system. This equipment will allow automatic monitoring of the pump station status and will transmit alarm signals to the operator for emergency assistance, when appropriate. Alarm signals to be included in the control system include low wet well level, high wet well level, pump station overflow, pump failure, pump motor high temperature, seal water pressure failure, wet well intrusion, low flow (indicating pump trouble, blockage in the force main, or check valve failure), loss of utility power, and generator start-up failure. Alarm signals will be forwarded to the main operations office at WWTP 1 office or on-call maintenance personnel.

A new magnetic current flow meter will be installed on both force mains at the Headworks Building. Flow meter readings will be reported to the PLC and recorded for reporting purposes.

The auto-level sensing device will utilize a pressure sensor. The system installed will include back-up floats for auxiliary control, and high wet well level and sewage overflow level alarms, which will have direct connection to the call out system and will not go through the PLC.

Pumping Strategy

Each pump should have a HAND/OFF/AUTO switch on the control panel. HAND calls the pump on manually. The pump controls at the IPS will primarily be kept on AUTO, with the manual option only being used for emergencies, maintenance, or other various circumstances. When in AUTO, the pumps are controlled by the level sensors in the IPS wet well. There are 2 pairs of pumps, 1 pair of smaller pumps in the entry of the wet well and 2 pairs of larger pumps at the far end of the wet well (with a third large pump for redundancy). Each pair of pumps is considered a lead/lag. They are controlled in an arrangement that allows lead/lag alternation among the small pumps and the large pumps. After a pump cycle has ended the lead and lag pumps of each pair will swap positions.

The control modes are described below.

Level Mode

Level mode requires that, above a low set point, a pump will start at its minimum speed and the speed of the pump will linearly track the level, reaching maximum at a higher set point. The pumps run at a speed directly proportional to the level, varying on a line (level vs. speed).

PID Mode

PID mode includes a proportional-integral-derivative (PID) algorithm tuned to control the speed of the pumps. The process variable is the wet well level, the control variable is the pump speed, and the set point is operator adjustable. The PID is correctly tuned to prevent oscillation of the pump speed, yet provide sufficient response to keep the level close to the set point under varying conditions.

The IPS utilizes 2 pairs of differently sized pumps (high-flow and low-flow pumps). The set points of 1 pair of pumps is set independently of the other pair of pumps, yet the 2 pairs work in concert to control the wet well level. Once the lead minimum set point (level mode) or level set point (PID mode) is reached for the high-flow pumps, the low-flow pumps turn off. When this occurs, the low-flow pumps then operate with a new, higher lead minimum set point (or level set point) to handle extremely high station flows. The low-flow pumps operate with the higher set point until the wet well level reaches the “off” level, at which time the low-flow pumps revert to the original set points.

Wet Well Cleaning

The IPS has been designed with a trench-style, “self-cleaning” wet well. The purpose of frequently cleaning the wet well is to prevent odors, to protect the facilities from corrosion caused by hydrogen sulfide, to eject scum before it can form hard rafts, and to prevent banks of sludge from interfering with flow patterns. To eject scum, the scum must be concentrated into the smallest possible area close to a pump intake so that it can be quickly and easily sucked into the pump intake during the cleaning process.

To assist with the scouring process, the IPS wet well has been designed with an ogee ramp at the entrance. The ramp creates a higher fluid velocity, which results in a hydraulic jump at the toe of the ramp, and its turbulence suspends all solids beneath it. The moderate current following the jump washes the suspension to the downstream pumps.

On a specified schedule, the IPS operator will allow for self cleaning of the wet well by manually turning the pumps to the off position. The sluice gate will be closed to store fluid in the upstream piping while the wet well is drained by manually turning on the last pump until the wet well is dewatered. Upon the wastewater reaching a pre-determined level in the upstream piping, the sluice gate will be opened and the sump will continue to be dewatered until the hydraulic jump reaches the suction bell of the last pump.

Site Layout

The proposed site for the new pumping facility is located on site of the expanded/upgraded WWTP 2, approximately 60 feet west of the Headworks Building (see Site Plan in Volume 2). The pumping facility will include a 32 foot x 33 foot, 3-sided building, which will house the wet well and provide for adequate maintenance space.

Geotechnical Considerations

A geotechnical memorandum (TM PD.08) related to existing site conditions for the expanded/upgraded WWTP 2 site, including the IPS site, is included in the report. One construction challenge identified in the geological exploration of the existing site includes the presence of bedrock approximately 10 feet below the ground surface at the proposed site of the wet well. Additional construction difficulties may be encountered that relate to groundwater, as the wet well design is below 0-feet (MSL).

Pump and Equipment Removal

For removal of the submersible pumps from the wet well, a monorail with electric hoist and manual trolley will be installed. The monorail will run from the west side of the IPS and will extend a few feet beyond the open east side of the building so that the pumps may easily be loaded on to a flat bed truck or dolly. The weight of the largest pump and suction leg is approximately 1,500 lbs, so a 1-ton capacity lifting system will be installed, at a minimum. The number and location of pick points will be determined in final design, but pick points will be provided over the 12 inch plug valves and check valves, at a minimum.

Pump Station Design Data

Table 11-5 includes the proposed IPS design criteria.

TABLE 11-5
Proposed IPS Design Criteria

Description	Criteria
Type	5 pump, submersible
Pump Type	Variable speed, solids handling
Rated Capacity (low flow pumps-2)	1,430 gpm @ 56’ TDH
Rated Capacity (high flow pumps-2)	4,840 gpm @ 53’ TDH
(Third high flow pump for standby)	

TABLE 11-5

Proposed IPS Design Criteria

Description	Criteria
Pump Power (low flow pumps)	17 HP 460 V 3~
Pump Power (low flow pumps)	45 HP 460 V 3~
Level Control Type	Pressure switch
Overflow Point	MH along Empire Boulevard
Overflow Discharge	Overland flow to drainage ditch flowing to Coos Bay
Avg Time to Overflow	23.5 minutes
Auxiliary Power Type	Permanent standby generator
Location of Auxiliary Power	WWTP2
Transfer Switch	Automatic
Alarm Telemetry Type	Autodialer
EPA Reliability Class	I
Firm Capacity	6,270 gpm
Forcemain	
Length, Size (low flow pumps)	65-feet, 8-inch
Length, Size (high flow pumps)	60-feet, 16-inch
Profile	Ascending
Discharge Point	WWTP2 Headworks
Material	Ductile Iron
Air/Vacuum Release Valves	5 at pump station
Sulfide Control System	None

Attachment 1

System Curves and Pump Data

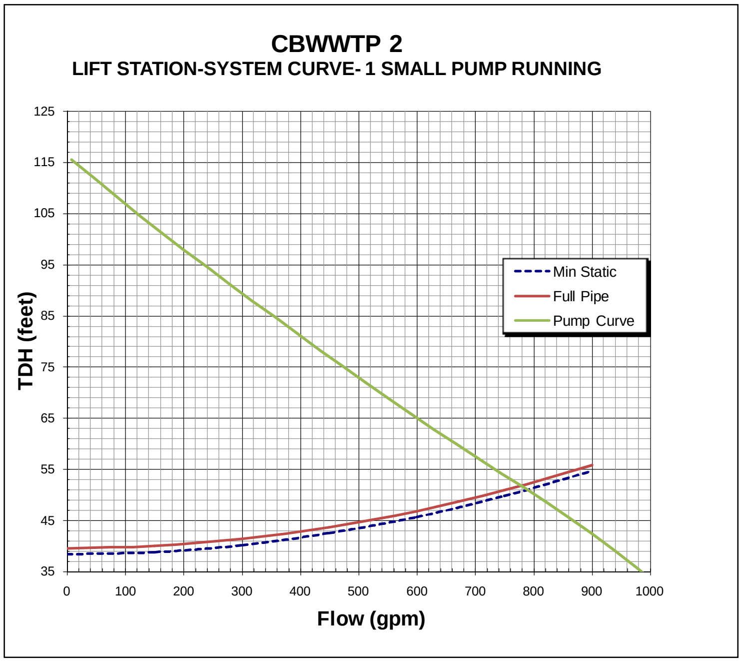
Force Main Friction Losses for CBWWTP2 Lift Station
One Small Pump Running

Project: CBWWTP2
Project No: 612035

Operating Point	**785**	gpm
Invert Discharge	41.37	ft. MSL
Invert PS Wet-well	1.83	ft.
Invert Suction	0.83	ft.
HWL	3	ft.
LWL	1.83	ft.
Max Static	39.54	ft.
Min Static	38.37	ft.
Max Static at Start-up	39.54	ft.
	39.54	ft.
TDH Operating Pt.	**52.00**	ft.

Full Pipe			
Flow	Static	Dynamic	TDH
0	39.54	0	39.5
150	39.54	0.47	40.0
300	39.54	1.86	41.4
450	39.54	4.14	43.7
600	39.54	7.32	46.9
750	39.54	11.38	50.9
900	39.54	16.34	55.9

						785	gpm
Item No.	Item of Friction Loss	Diameter	K or	Fixed	Length	Velocity	
		in.	C value	Loss	ft.	fps	Head, ft.
	Static Head			39.54			
1	Pump	4	1				
2	4" 90 deg elbow	4	0.25			20.04	1.56
3	4"x8" reducer	4	1.00			20.04	6.24
4	8" 45 deg elbow	8	0.18			5.01	0.07
5	8" 45 deg elbow	8	0.18			5.01	0.07
6	8" vertical DIP	8	125.00		11.7	5.01	0.15
7	8" 90 deg elbow	8	0.25			5.01	0.10
8	8" DIP	8	125.00		2	5.01	0.03
9	8" Check valve	8	1.50			5.01	0.58
10	8" Plug valve	8	1.00			5.01	0.39
11	8" DIP	8	125.00		4	5.01	0.05
12	8" tee, branch flow	8	0.75			5.01	0.29
13	8" DIP	8	125.00		1.5	5.01	0.02
14	8" Plug valve	8	1.00			5.01	0.39
15	8" Tee, line flow	8	0.30			5.01	0.12
16	8" 90 deg elbow	8	0.25			5.01	0.10
17	8" DIP	8	125.00		6	5.01	0.08
18	8" 90 deg elbow	8	0.25			5.01	0.10
19	8" DIP	8	125.00		64.5	5.01	0.81
20	8" 45 deg elbow	8	0.18			5.01	0.07
21	8" DIP	8	125.00		4	5.01	0.05
22	8" 45 deg elbow	8	0.18			5.01	0.07
23	8" DIP	8	125.00		6.5	5.01	0.08
24	8" 90 deg elbow	8	0.25			5.01	0.10
25	8" DIP	8	125.00		6	5.01	0.08
26	8" DIP	8	125.00		2.5	5.01	0.03
27	8" flow meter	8	0.10			5.01	0.04
28	8" DIP	8	125.00		1.5	5.01	0.02
29	8" DIP	8	125.00		14.25	5.01	0.18
30	8" 90 deg elbow	8	0.25			5.01	0.10
31	8" DIP	8	125.00		2	5.01	0.03
32	8" 90 deg elbow	8	0.25			5.01	0.10
33	10" exit loss	8	1.00			5.01	0.39
							12.46



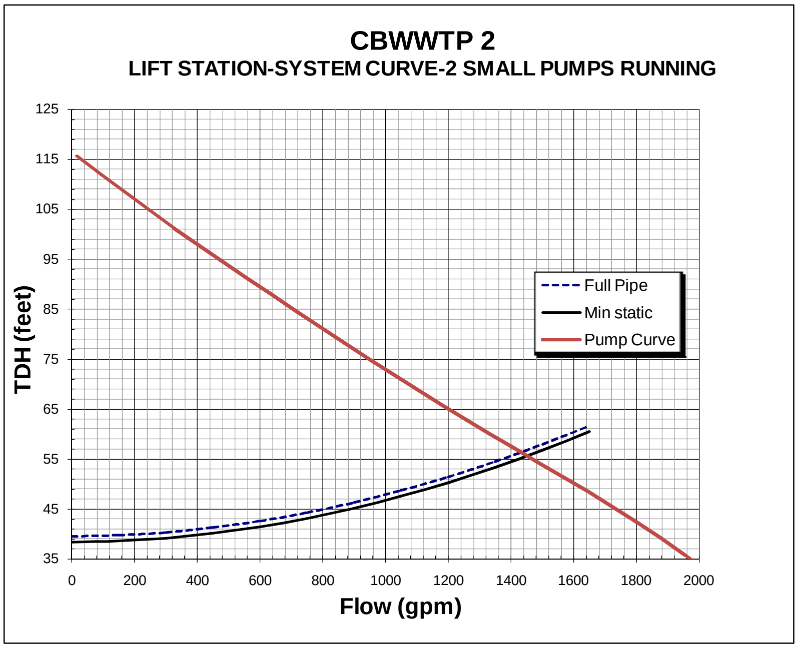
Force Main Friction Losses for CBWWTP2 Lift Station
Two Small Pumps Running

Project:	CBWWTP2
Project No:	612035

Operating Point	**1430**	gpm
Invert Discharge	41.37	ft. MSL
Invert PS Wet-well	1.83	ft.
Invert Suction	0.83	ft.
HWL	3	ft.
LWL	1.83	ft.
Max Static	39.54	ft.
Min Static	38.37	ft.
Max Static at Start-up	39.54	ft.
	39.54	ft.
TDH Operating Pt.	**56.31**	ft.

Full Pipe			
Flow	Static	Dynamic	TDH
0	39.54	0	39.5
150	39.54	0.21	39.7
300	39.54	0.79	40.3
450	39.54	1.75	41.3
600	39.54	3.07	42.6
750	39.54	4.75	44.3
900	39.54	6.78	46.3
1050	39.54	9.17	48.7
1200	39.54	11.90	51.4
1350	39.54	14.99	54.5
1500	39.54	18.42	58.0
1650	39.54	22.20	61.7

						1430	gpm
Item No.	Item of Friction Loss	Diameter	K or	Fixed	Length	Velocity	
		in.	C value	Loss	ft.	fps	Head, ft.
	Static Head			39.54			
1	Pump	4	1				
2	4" 90 deg elbow	4	0.25			18.26	1.29
3	4"x8" reducer	4	1.00			18.26	5.18
4	8" 45 deg elbow	8	0.18			4.56	0.06
5	8" 45 deg elbow	8	0.18			4.56	0.06
6	8" vertical DIP	8	125.00		11.7	4.56	0.45
7	8" 90 deg elbow	8	0.25			4.56	0.08
8	8" DIP	8	125.00		2	4.56	0.08
9	8" Check valve	8	1.50			4.56	0.49
10	8" Plug valve	8	1.00			4.56	0.32
11	8" DIP	8	125.00		4	4.56	0.15
12	8" tee, branch flow	8	0.75			4.56	0.24
13	8" DIP	8	125.00		1.5	4.56	0.06
14	8" Plug valve	8	1.00			4.56	0.32
15	8" Tee, line flow	8	0.30			9.13	0.39
16	8" 90 deg elbow	8	0.25			9.13	0.32
17	8" DIP	8	125.00		6	9.13	0.23
18	8" 90 deg elbow	8	0.25			9.13	0.32
19	8" DIP	8	125.00		64.5	9.13	2.47
20	8" 45 deg elbow	8	0.18			9.13	0.23
21	8" DIP	8	125.00		4	9.13	0.15
22	8" 45 deg elbow	8	0.18			9.13	0.23
23	8" DIP	8	125.00		6.5	9.13	0.25
24	8" 90 deg elbow	8	0.25			9.13	0.32
25	8" DIP	8	125.00		6	9.13	0.23
26	8" DIP	8	125.00		2.5	9.13	0.10
27	8" flow meter	8	0.10			9.13	0.13
28	8" DIP	8	125.00		1.5	9.13	0.06
29	8" DIP	8	125.00		14.25	9.13	0.55
30	8" 90 deg elbow	8	0.25			9.13	0.32
31	8" DIP	8	125.00		2	9.13	0.08
32	8" 90 deg elbow	8	0.25			9.13	0.32
33	10" exit loss	8	1.00			9.13	1.29
							16.77



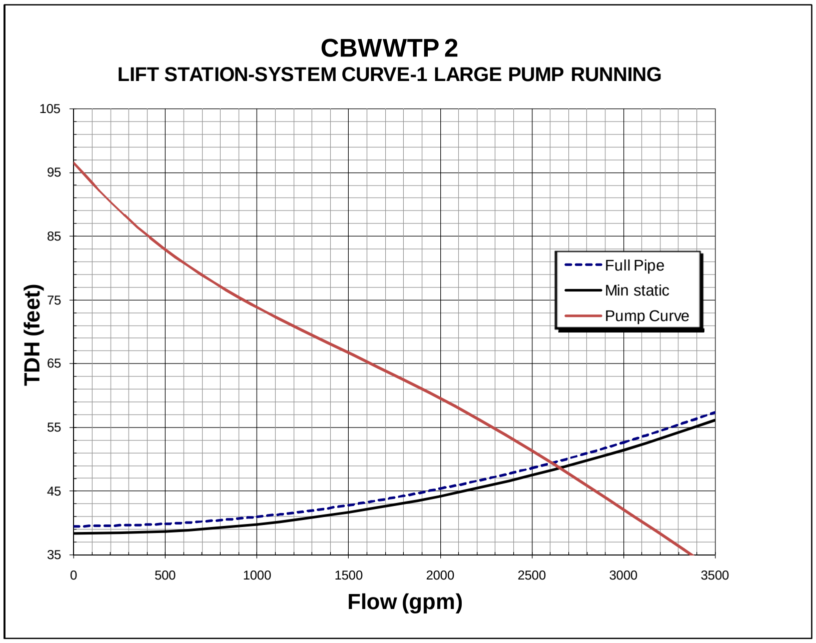
Force Main Friction Losses for CBWWTP2 Lift Station
One Large Pump Running

Project:	CBWWTP2
Project No:	612035

Operating Point	**2600**	gpm
Invert Discharge	41.37	ft. MSL
Invert PS Wet-well	1.83	ft.
Invert Suction	0.83	ft.
HWL	3	ft.
LWL	1.83	ft.
Max Static	39.54	ft.
Min Static	38.37	ft.
Max Static at Start-up	39.54	ft.
	39.54	ft.
TDH Operating Pt.	**49.40**	ft.

Full Pipe			
Flow	Static	Dynamic	TDH
0	39.54	0	39.5
500	39.54	0.37	39.9
1000	39.54	1.47	41.0
1500	39.54	3.30	42.8
2000	39.54	5.85	45.4
2500	39.54	9.12	48.7
3000	39.54	13.11	52.7
3500	39.54	17.82	57.4

							2600	gpm
Item No.	Item of Friction Loss		Diameter	K or	Fixed	Length	Velocity	
			in.	C value	Loss	ft.	fps	Head, ft.
	Static Head				39.54			
1	Pump		8	1				
2	8" 90 deg elbow		8	0.25			16.60	1.07
3	8"x12" reducer		8	0.92			16.60	3.93
4	12" 22 deg elbow		12	0.10			7.38	0.08
5	12" 22 deg elbow		12	0.18			7.38	0.15
6	12" vertical DIP		12	125.00		11	7.38	0.18
7	12" 90 deg elbow		12	0.25			7.38	0.21
8	12" DIP		12	125.00		2	7.38	0.03
9	12" Check valve		12	1.50			7.38	1.27
10	12" Plug valve		12	1.00			7.38	0.84
11	12"x16" tee, branch flow		16	0.75		4	4.15	0.20
12	16" plug valve		16	0.75			4.15	0.20
13	16" tee, line flow		16	0.30			4.15	0.08
14	16" Plug valve		16	1.00			4.15	0.27
15	16" Tee, line flow		16	0.30			4.15	0.08
16	16" 90 deg elbow		16	0.25			4.15	0.07
17	16" DIP		16	125.00		6	4.15	0.02
18	16" 90 deg elbow		16	0.25			4.15	0.07
19	16" DIP		16	125.00		60	4.15	0.24
20	16" 90 deg elbow		16	0.25			4.15	0.07
21	16" DIP		16	125.00		6	4.15	0.02
22	16"x14" reducer		14	0.05			5.42	0.02
23	14" DIP		14	125.00		5	5.42	0.04
24	14" flow meter		14	0.10			5.42	0.05
25	14" DIP		14	125.00		3	5.42	0.02
26	14"x16" reducer		14	0.43			5.42	0.20
27	16" DIP		16	125.00		10	4.15	0.04
28	16" 90 deg elbow		16	0.25			4.15	0.07
29	16" DIP		16	125.00		2	4.15	0.01
30	16" 90 deg elbow		16	0.25			4.15	0.07
31	10" exit loss		16	1.00			4.15	0.27
								9.86



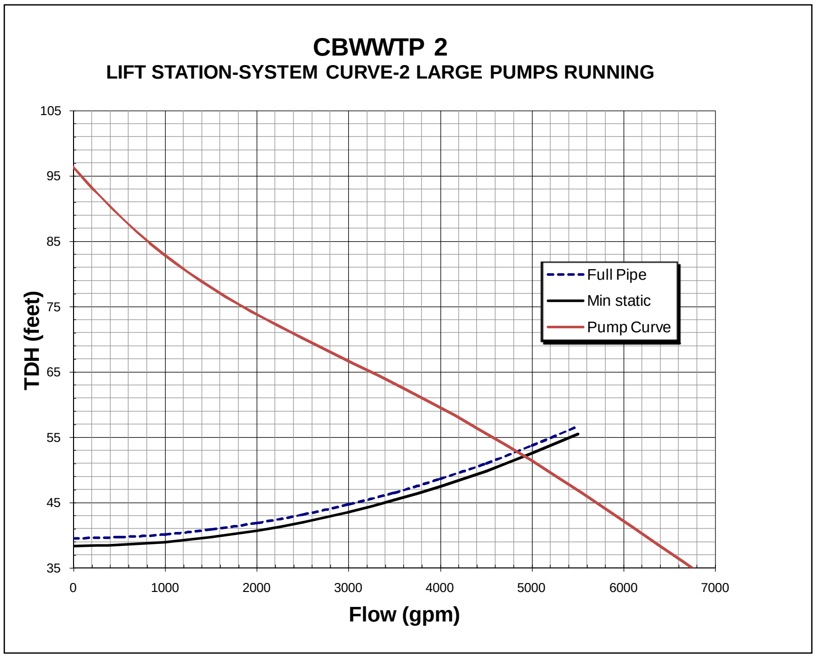
Force Main Friction Losses for CBWWTP2 Lift Station-
Two Large Pumps Running

Project: CBWWTP2
Project No: 612035

Operating Point	**4840**	gpm
Invert Discharge	41.37	ft. MSL
Invert PS Wet-well	1.83	ft.
Invert Suction	0.83	ft.
HWL	3	ft.
LWL	1.83	ft.
Max Static	39.54	ft.
Min Static	38.37	ft.
Max Static at Start-up	39.54	ft.
	39.54	ft.
TDH Operating Pt.	**52.83**	ft.

Full Pipe			
Flow	Static	Dynamic	TDH
0	39.54	0	39.5
500	39.54	0.15	39.7
1000	39.54	0.59	40.1
1500	39.54	1.31	40.9
2000	39.54	2.31	41.9
2500	39.54	3.60	43.1
3000	39.54	5.16	44.7
3500	39.54	7.00	46.5
4000	39.54	9.11	48.7
4500	39.54	11.50	51.0
5000	39.54	14.17	53.7
5500	39.54	17.11	56.7

							4840	gpm
Item No.	Item of Friction Loss		Diameter	K or	Fixed	Length	Velocity	
			in.	C value	Loss	ft.	fps	Head, ft.
	Static Head				39.54			
1	Pump		8	1				
2	8" 90 deg elbow		8	0.25			15.45	0.93
3	8"x12" reducer		8	0.92			15.45	3.41
4	12" 22 deg elbow		12	0.10			6.87	0.07
5	12" 22 deg elbow		12	0.18			6.87	0.13
6	12" vertical DIP		12	125.00		11	6.87	0.56
7	12" 90 deg elbow		12	0.25			6.87	0.18
8	12" DIP		12	125.00		2	6.87	0.10
9	12" Check valve		12	1.50			6.87	1.10
10	12" Plug valve		12	1.00			6.87	0.73
11	12"x16" tee, branch flow		16	0.75		4	3.86	0.17
12	16" plug valve		16	0.75			3.86	0.17
13	16" tee, line flow		16	0.30			7.72	0.28
14	16" Plug valve		16	1.00			7.72	0.93
15	16" Tee, line flow		16	0.30			7.72	0.28
16	16" 90 deg elbow		16	0.25			7.72	0.23
17	16" DIP		16	125.00		6	7.72	0.08
18	16" 90 deg elbow		16	0.25			7.72	0.23
19	16" DIP		16	125.00		60	7.72	0.75
20	16" 90 deg elbow		16	0.25			7.72	0.23
21	16" DIP		16	125.00		6	7.72	0.08
22	16"x14" reducer		14	0.05			10.09	0.08
23	14" DIP		14	125.00		5	10.09	0.12
24	14" flow meter		14	0.10			10.09	0.16
25	14" DIP		14	125.00		3	10.09	0.07
26	14"x16" reducer		14	0.43			10.09	0.68
27	16" DIP		16	125.00		10	7.72	0.13
28	16" 90 deg elbow		16	0.25			7.72	0.23
29	16" DIP		16	125.00		2	7.72	0.03
30	16" 90 deg elbow		16	0.25			7.72	0.23
31	10" exit loss		16	1.00			7.72	0.93
								13.29

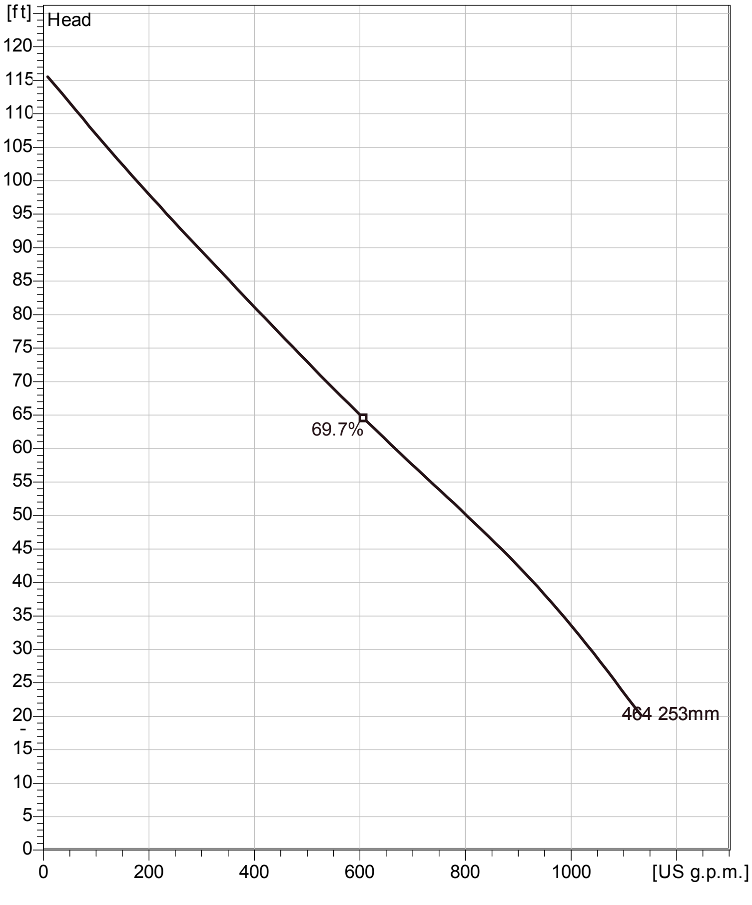


xylem
Let's Solve Water

NP 3153 HT 3~ 464

Technical specification

FLYGT



Curve according to: ISO 9906 grade 2 annex 1 or 2

Note: Picture might not correspond to the current configuration.

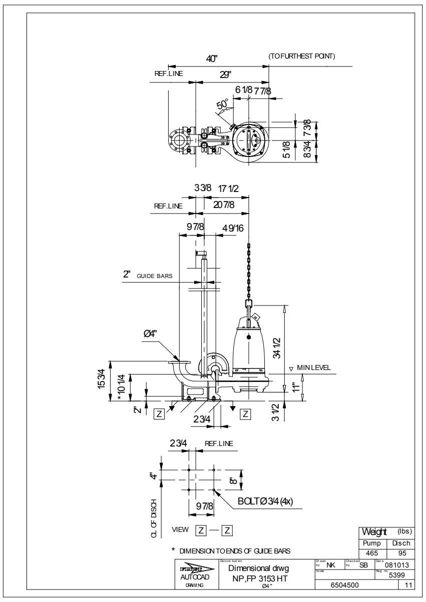
General

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Possible to be upgraded with Guide-pin® for even better clogging resistance. Modular based design with high adaptation grade.

Impeller

Impeller material	Hard-Iron ™
Outlet width	3 15/16 inch
Inlet diameter	150 mm
Impeller diameter	253 mm
Number of blades	2
	0 inch

Installation: P - Semi permanent, Wet



Motor

Motor #	N3153.830 21-18-4XS-W IE3 17hp
Stator variant	1
Frequency	60 Hz
Rated voltage	460 V
Number of poles	4
Phases	3~
Rated power	17 hp
Rated current	18 A
Starting current	157 A
Rated speed	1800 rpm
Power factor	
1/1 Load	0.96
3/4 Load	0.95
1/2 Load	0.90
Efficiency	
1/1 Load	92.5 %
3/4 Load	92.4 %
1/2 Load	90.9 %

Configuration

Project	Project ID	Created by	Created on	Last update
			2013-07-03	

NP 3153 HT 3~ 464

Performance curve

Pump

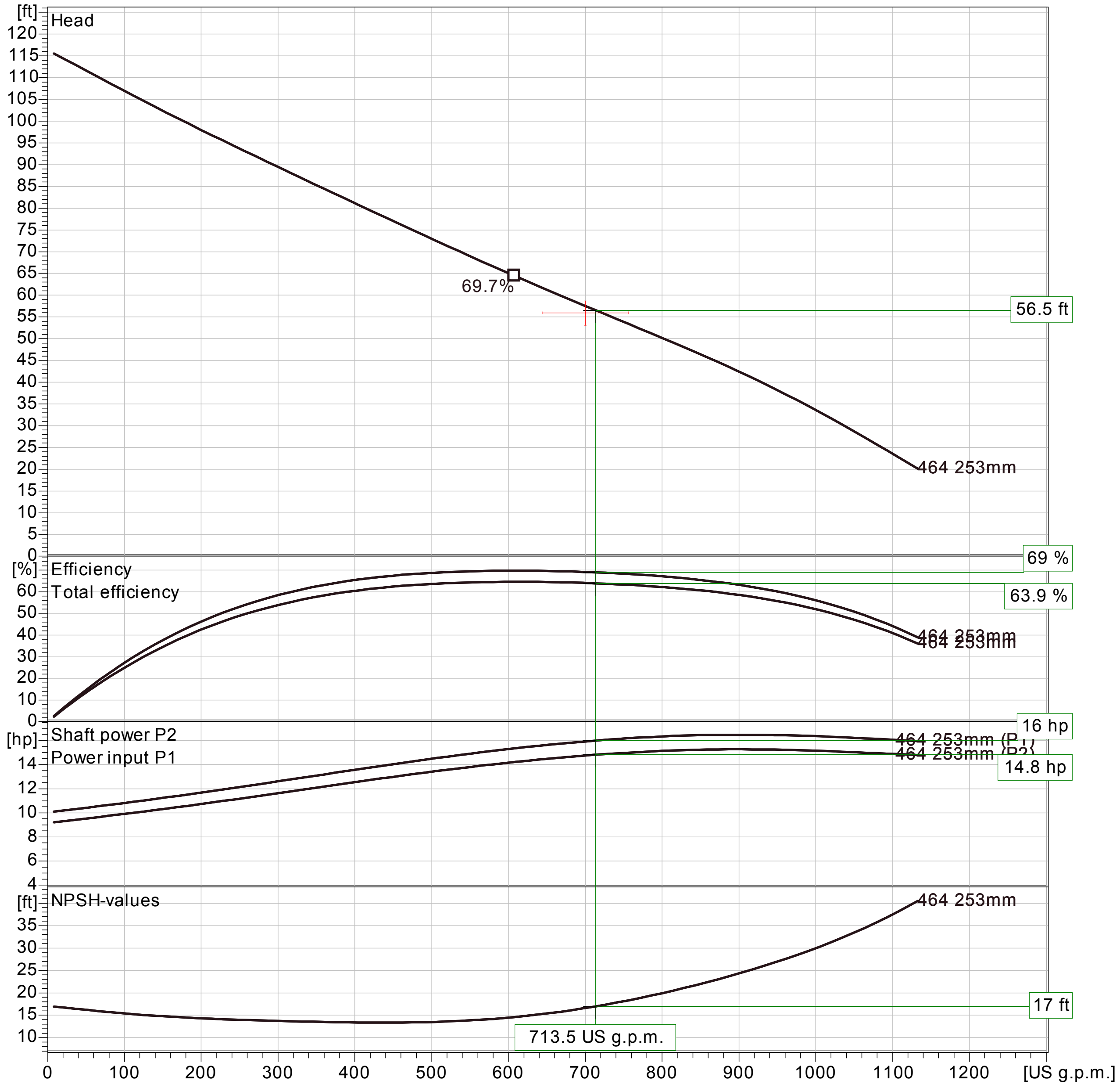
Outlet width	3 15/16 inch
Inlet diameter	150 mm
Impeller diameter	$9^{15}/_{16}$"
Number of blades	2
	0 inch

Motor

Motor #	N3153.830 21-18-4XS-W IE3 17hp
Stator variant	1
Frequency	60 Hz
Rated voltage	460 V
Number of poles	4
Phases	3~
Rated power	17 hp
Rated current	18 A
Starting current	157 A
Rated speed	1800 rpm

Power factor	
1/1 Load	0.96
3/4 Load	0.95
1/2 Load	0.90

Efficiency	
1/1 Load	92.5 %
3/4 Load	92.4 %
1/2 Load	90.9 %

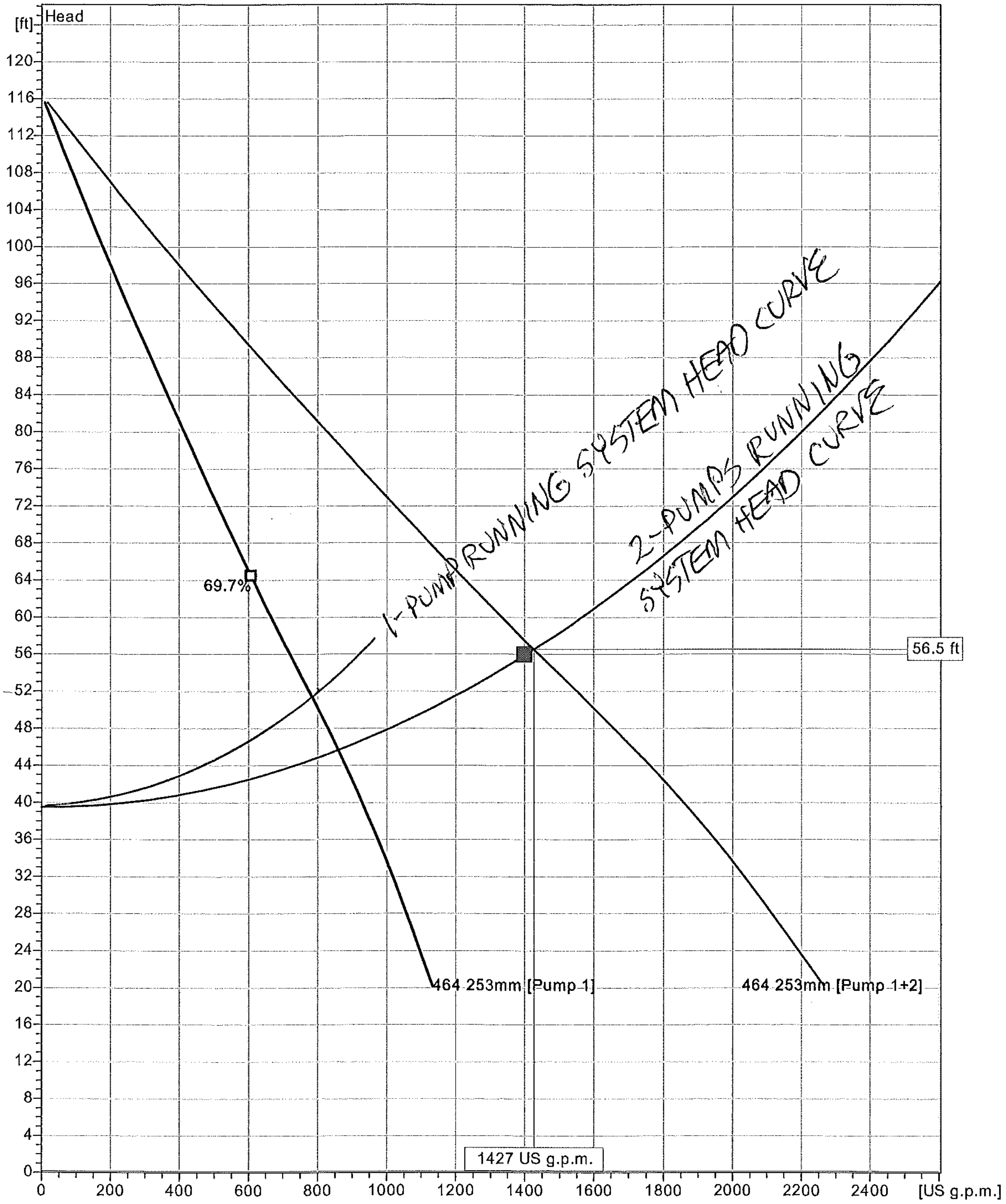


Curve according to: ISO 9906 grade 2 annex 1 or 2

Duty point					**Guarantee**
Flow	**Head**	**Shaft power**	**NPSHre**	**Hyd eff.**	**ISO_9906_Grade_2**
700 US g.p.m.	55.9 ft	<15.3 hp	17.3 ft	68.9 %	Yes

Project	Project ID	Created by	Created on	Last update
			2013-07-03	

NP 3153 HT 3~ 464
Duty Analysis



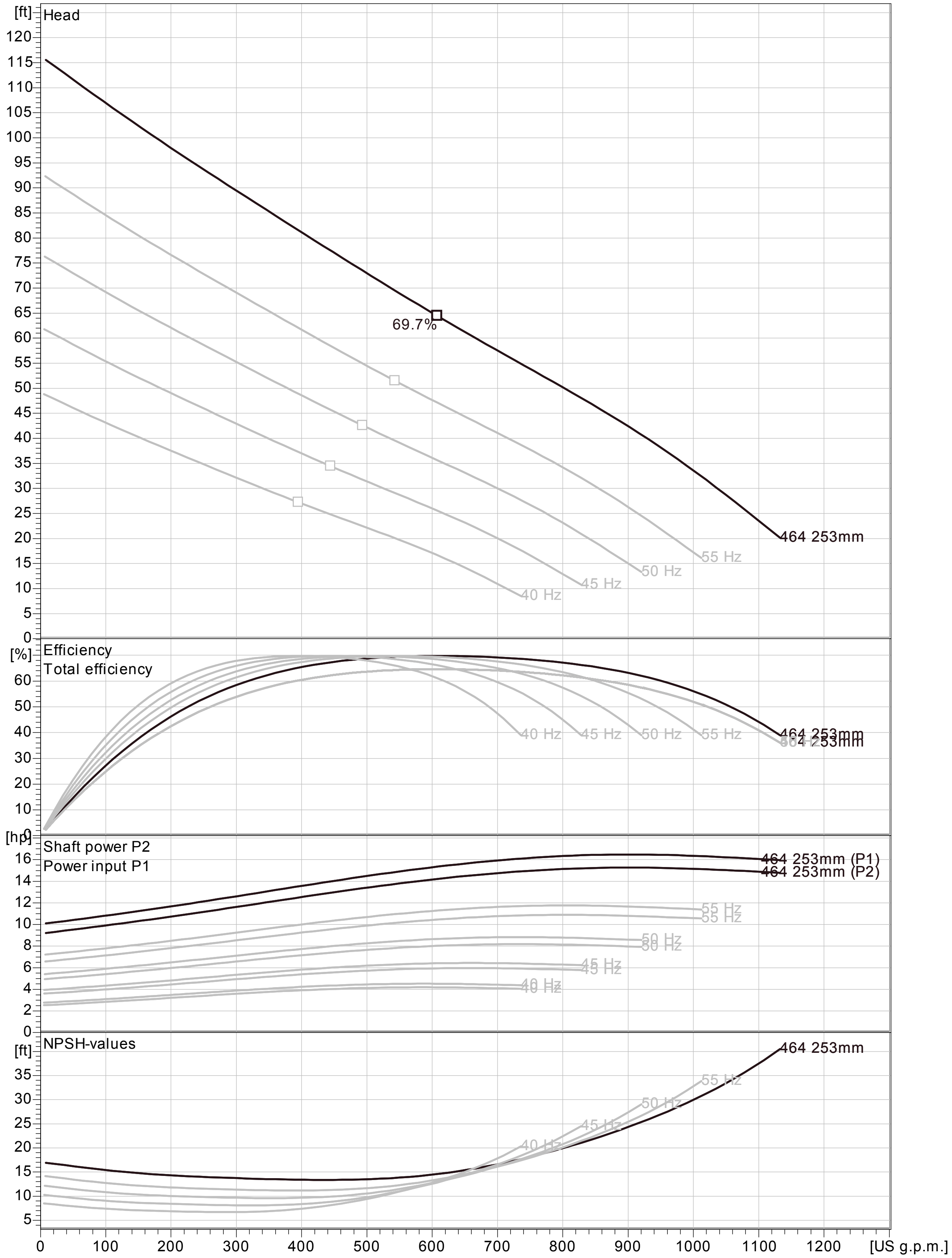
Curve according to: ISO 9906 grade 2 annex 1 or 2

	Individual pump			Total					
Pumps running /System	**Flow**	**Head**	**Shaft power**	**Flow**	**Head**	**Shaft power**	**Hyd eff.**	**Specific energy**	**NPSHre**
2	713 US g.p.m.	56.5 ft	14.8 hp	1430 US g.p.m.	56.5 ft	29.6 hp	69 %	279 kWh/US MG	17 ft
1	859 US g.p.m.	45.7 ft	15.2 hp	859 US g.p.m.	45.7 ft	15.2 hp	65.1 %	238 kWh/US MG	22.4 ft

Project	Project ID	Created by	Created on	Last update
			2013-07-03	

NP 3153 HT 3~ 464

VFD Curve

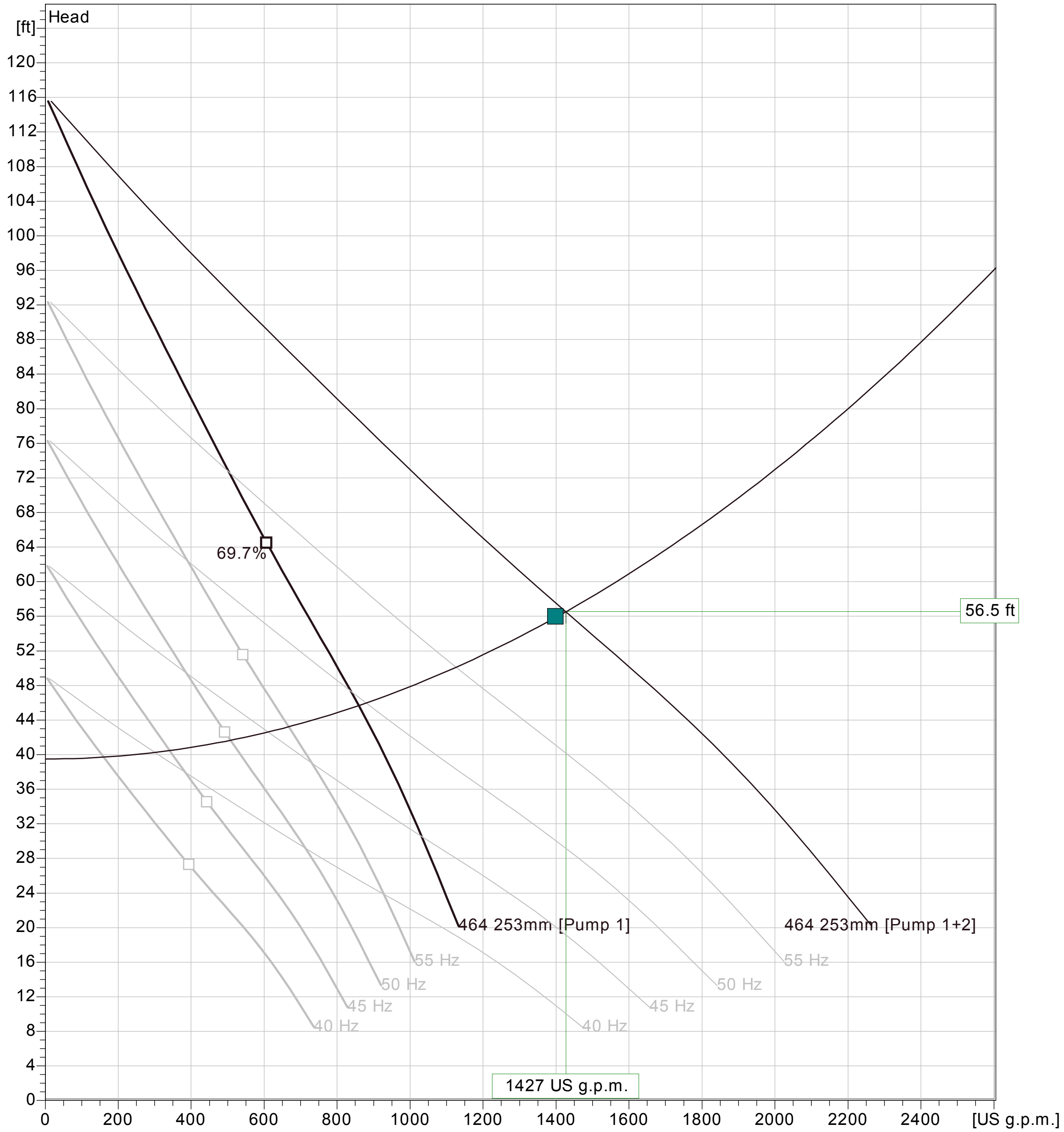


Curve according to: ISO 9906 grade 2 annex 1 or 2

Project	Project ID	Created by	Created on	Last update
			2013-07-03	

NP 3153 HT 3~ 464

VFD Analysis

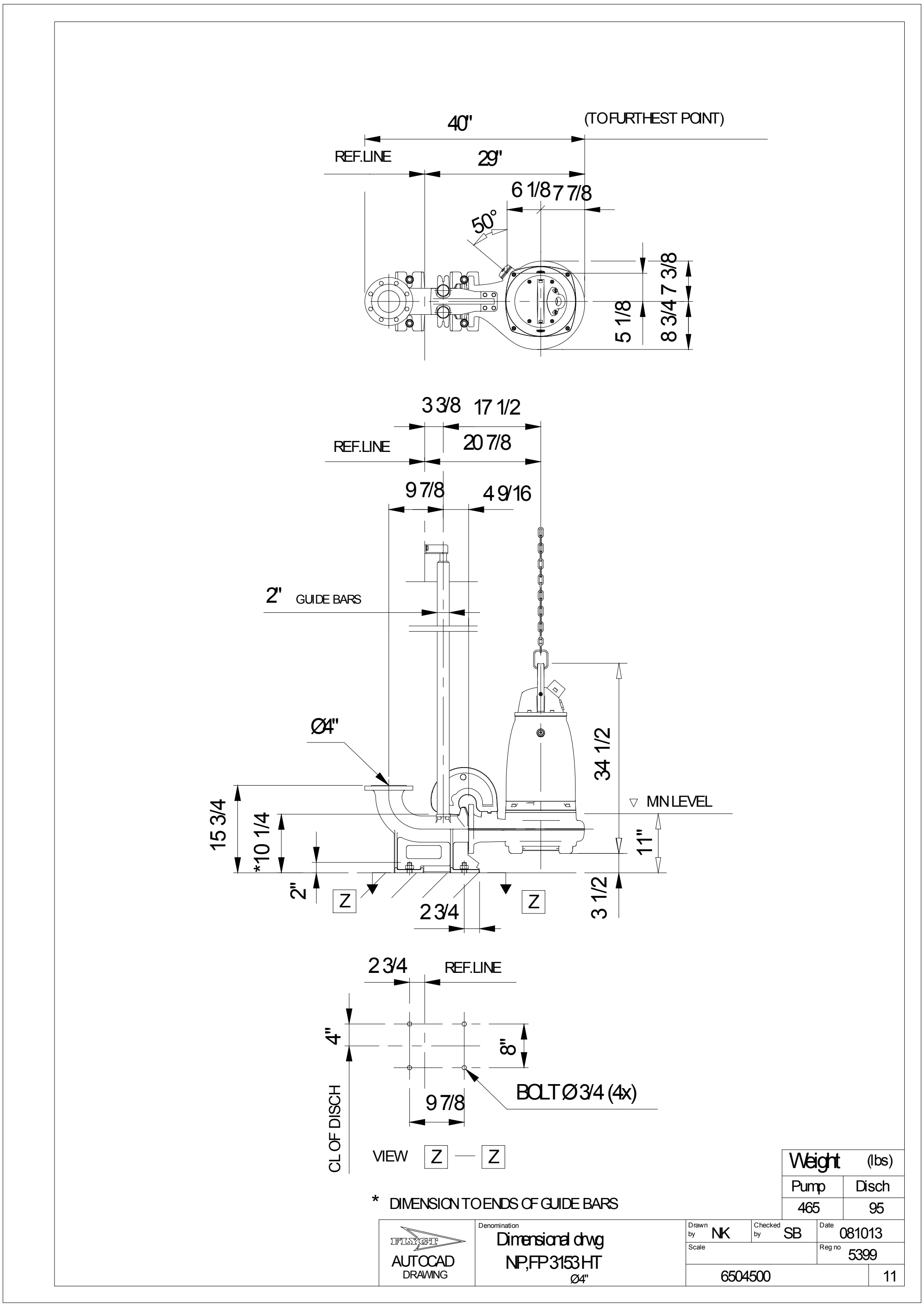


Curve according to: ISO 9906 grade 2 annex 1 or 2

	Indiv idual pump				Total					
Pumps running /System	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
2	60 Hz	713 US g.p.m.	56.5 ft	14.8 hp	1430 US g.p.m.	56.5 ft	29.6 hp	69 %	279 kWh/US MG	17 ft
2	55 Hz	563 US g.p.m.	50.1 ft	10.3 hp	1130 US g.p.m.	50.1 ft	20.5 hp	69.7 %	247 kWh/US MG	12.5 ft
2	50 Hz	440 US g.p.m.	46 ft	7.37 hp	880 US g.p.m.	46 ft	14.7 hp	69.4 %	231 kWh/US MG	9.88 ft
2	45 Hz	305 US g.p.m.	42.6 ft	4.97 hp	611 US g.p.m.	42.6 ft	9.93 hp	66.2 %	232 kWh/US MG	8.11 ft
2	40 Hz	150 US g.p.m.	40.3 ft	3.02 hp	301 US g.p.m.	40.3 ft	6.05 hp	50.7 %	313 kWh/US MG	7.08 ft
1	60 Hz	859 US g.p.m.	45.7 ft	15.2 hp	859 US g.p.m.	45.7 ft	15.2 hp	65.1 %	238 kWh/US MG	22.4 ft
1	55 Hz	667 US g.p.m.	43.2 ft	10.7 hp	667 US g.p.m.	43.2 ft	10.7 hp	68.4 %	218 kWh/US MG	15.1 ft
1	50 Hz	508 US g.p.m.	41.7 ft	7.69 hp	508 US g.p.m.	41.7 ft	7.69 hp	69.7 %	211 kWh/US MG	10.7 ft
1	45 Hz	341 US g.p.m.	40.5 ft	5.13 hp	341 US g.p.m.	40.5 ft	5.13 hp	67.9 %	219 kWh/US MG	8.12 ft
1	40 Hz	160 US g.p.m.	39.7 ft	3.06 hp	160 US g.p.m.	39.7 ft	3.06 hp	52.6 %	303 kWh/US MG	7.03 ft

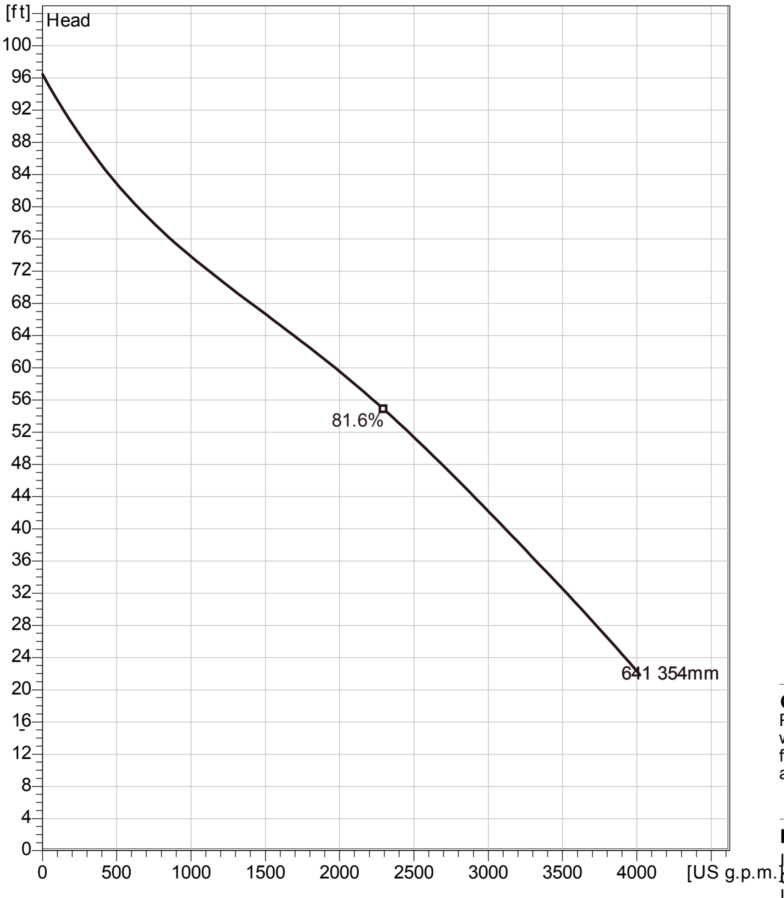
NP 3153 HT 3~ 464

Dimensional drawing



NP 3202 MT 3~ 641

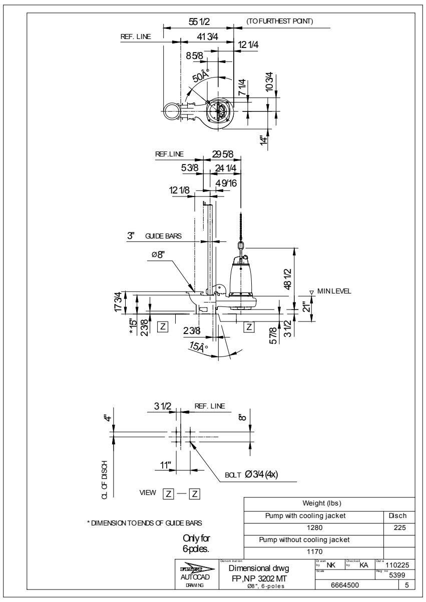
Technical specification



Curve according to: ISO 9906 grade 2 annex 1 or 2

Note: Picture might not correspond to the current configuration.

Installation: **P - Semi permanent, Wet**



General

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Possible to be upgraded with Guide-pin® for even better clogging resistance. Modular based design with high adaptation grade.

Impeller

Impeller material	Hard-Iron ™
Outlet width	7 7/8 inch
Inlet diameter	250 mm
Impeller diameter	354 mm
Number of blades	2
	0 inch

Motor

Motor #	N3202.095 30-23-6AA-W 45hp
Stator variant	1
Frequency	60 Hz
Rated voltage	460 V
Number of poles	6
Phases	3~
Rated power	45 hp
Rated current	55 A
Starting current	330 A
Rated speed	1170 rpm
Power factor	
1/1 Load	0.85
3/4 Load	0.82
1/2 Load	0.73
Efficiency	
1/1 Load	89.5 %
3/4 Load	90.0 %
1/2 Load	89.5 %

Configuration

Project	Project ID	Created by	Created on	Last update
			2013-07-03	

NP 3202 MT 3~ 641

Performance curve

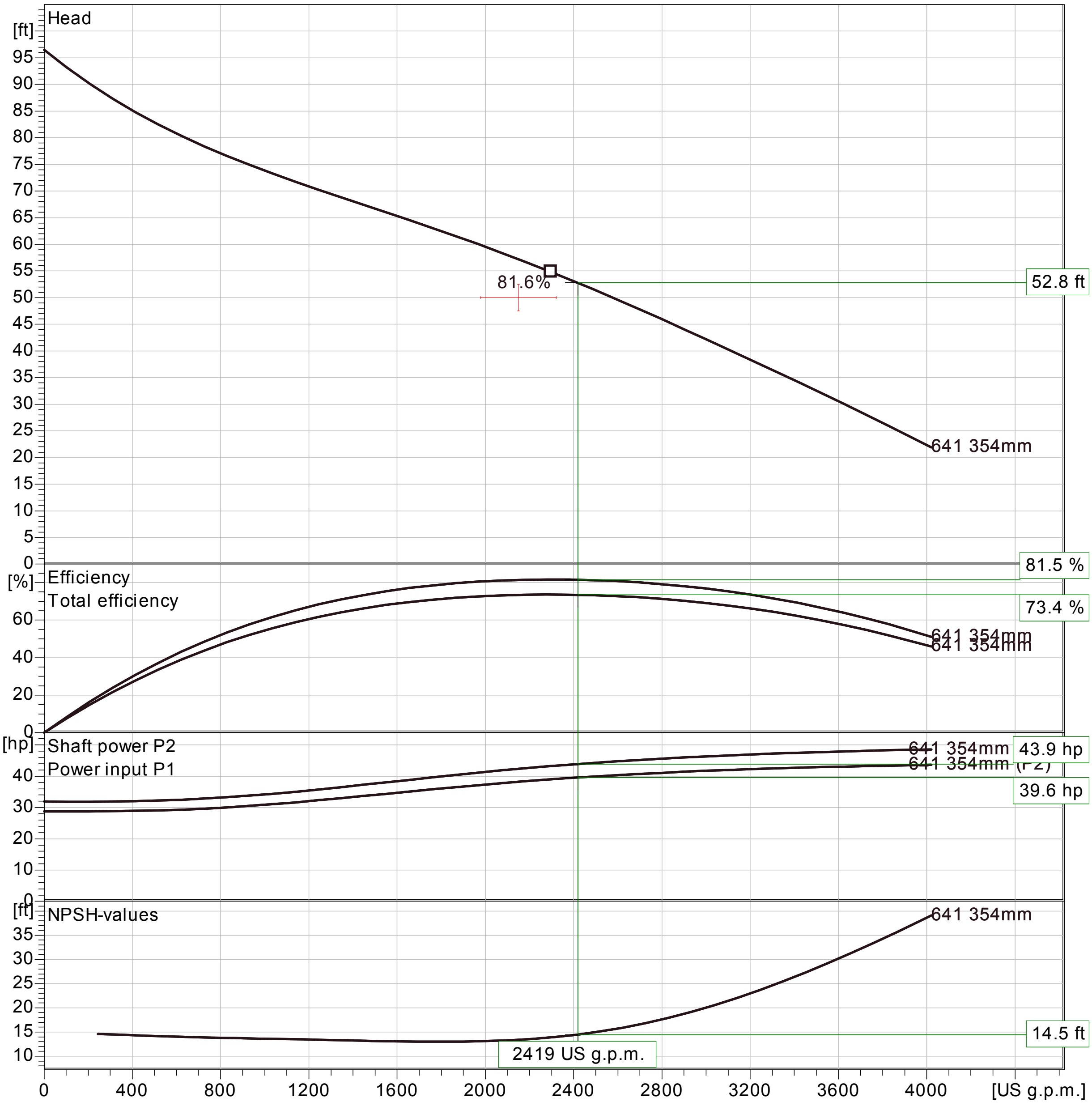
Pump

Outlet width	7 7/8 inch
Inlet diameter	250 mm
Impeller diameter	$13^{15}/_{16}$"
Number of blades	2
	0 inch

Motor

Motor #	N3202.095 30-23-6AA-W 45hp
Stator variant	1
Frequency	60 Hz
Rated voltage	460 V
Number of poles	6
Phases	3~
Rated power	45 hp
Rated current	55 A
Starting current	330 A
Rated speed	1170 rpm

Power factor	
1/1 Load	0.85
3/4 Load	0.82
1/2 Load	0.73
Efficiency	
1/1 Load	89.5 %
3/4 Load	90.0 %
1/2 Load	89.5 %



Curve according to: ISO 9906 grade 2 annex 1 or 2

Duty point					**Guarantee**
Flow	**Head**	**Shaft power**	**NPSHre**	**Hyd eff.**	**ISO_9906_Grade_2**
2150 US g.p.m.	50 ft			%	No

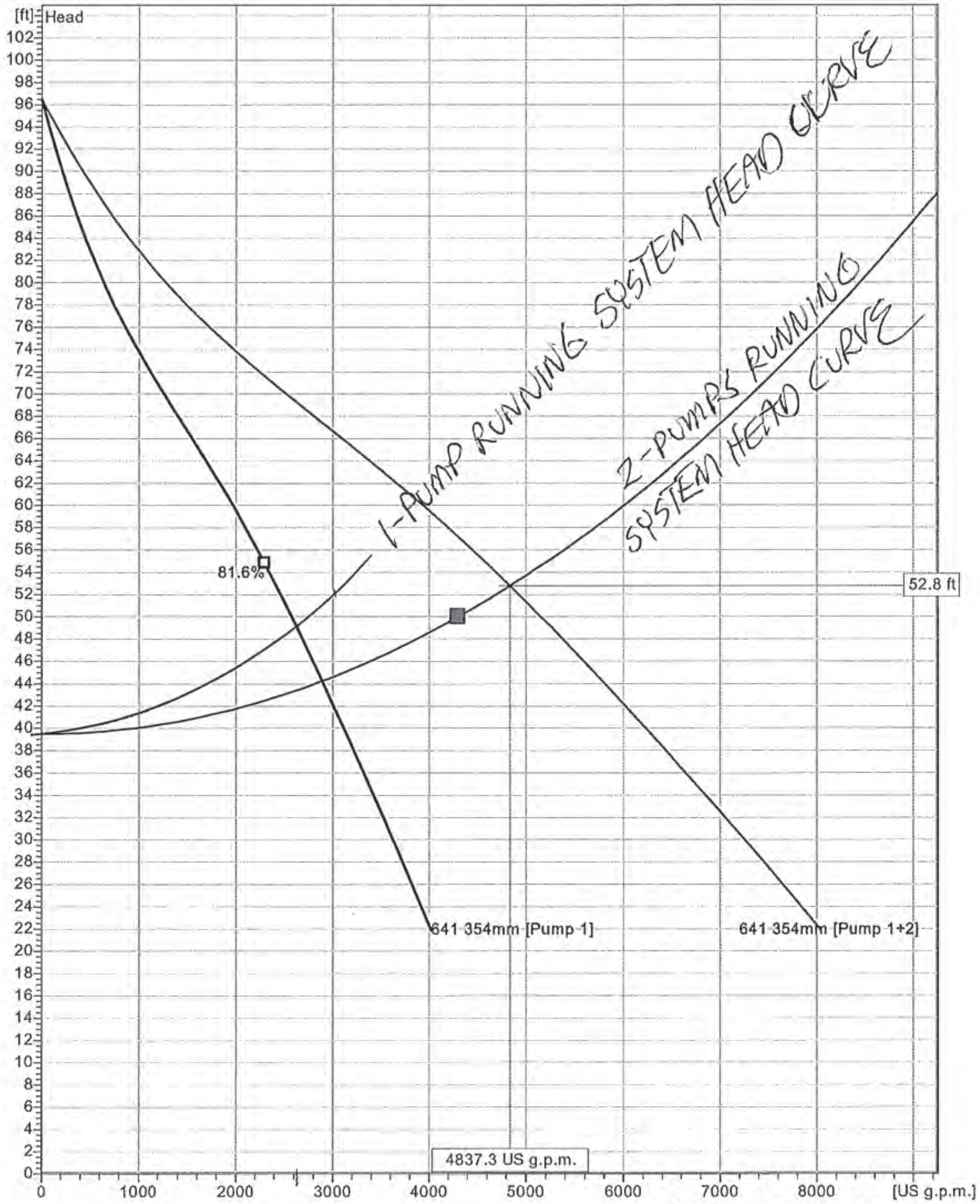
Project	Project ID	Created by	Created on	Last update
			2013-07-03	

xylem
Let's Solve Water

NP 3202 MT 3~ 641

FLYGT

Duty Analysis



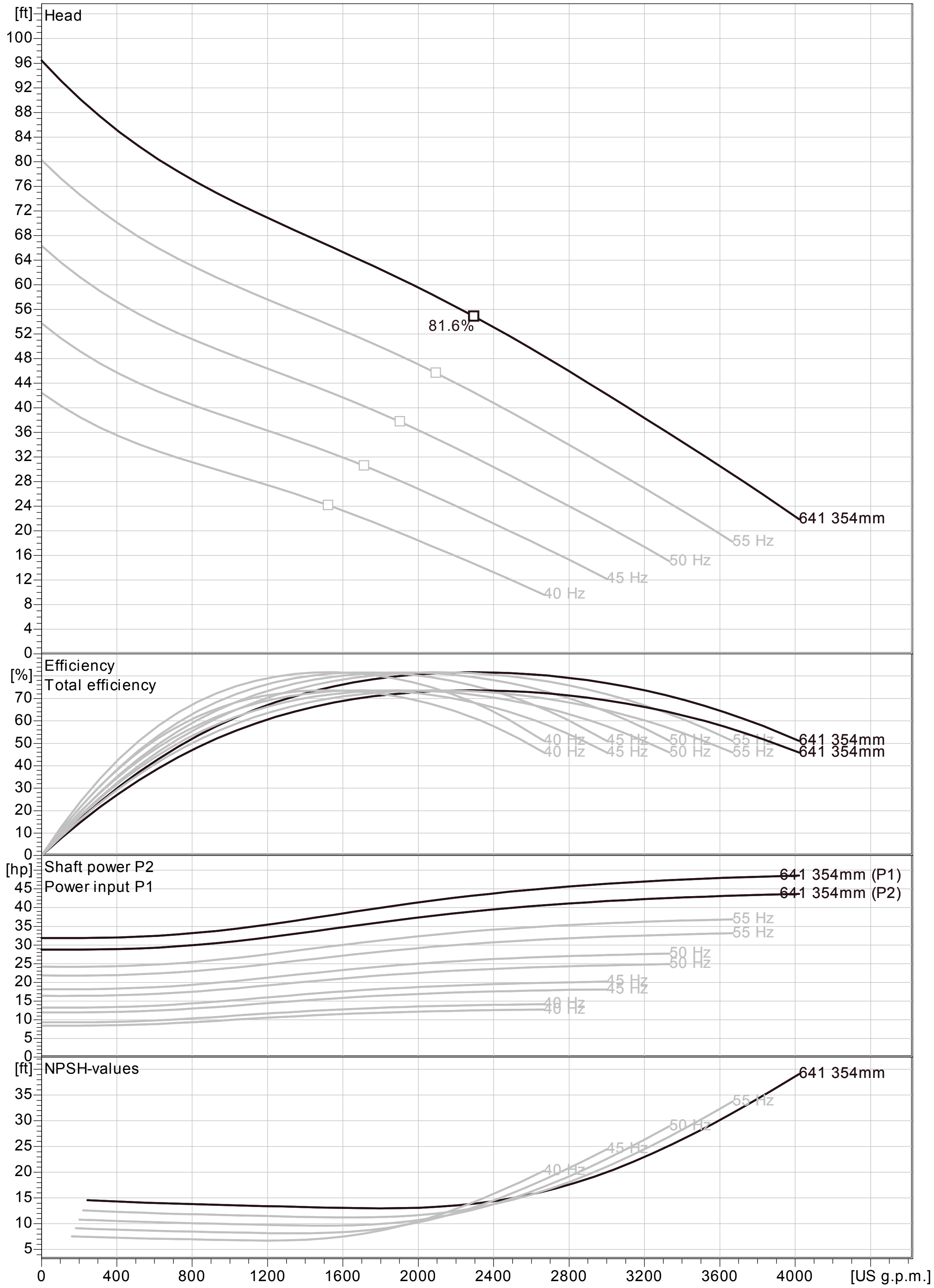
Curve according to: ISO 9906 grade 2 annex 1 or 2

	Individual pump			Total					
Pumps running /System	Flow	Head	Shaft power	Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
2	2420 US g.p.m.	52.8 ft	39.6 hp	4840 US g.p.m.	52.8 ft	79.2 hp	81.5 %	226 kWh/US MG	14.5 ft
1	2890 US g.p.m.	44.2 ft	41.4 hp	2890 US g.p.m.	44.2 ft	41.4 hp	78.2 %	197 kWh/US MG	18.6 ft

Project	Project ID	Created by	Created on	Last update
			2013-07-03	

NP 3202 MT 3~ 641

VFD Curve



Curve according to: ISO 9906 grade 2 annex 1 or 2

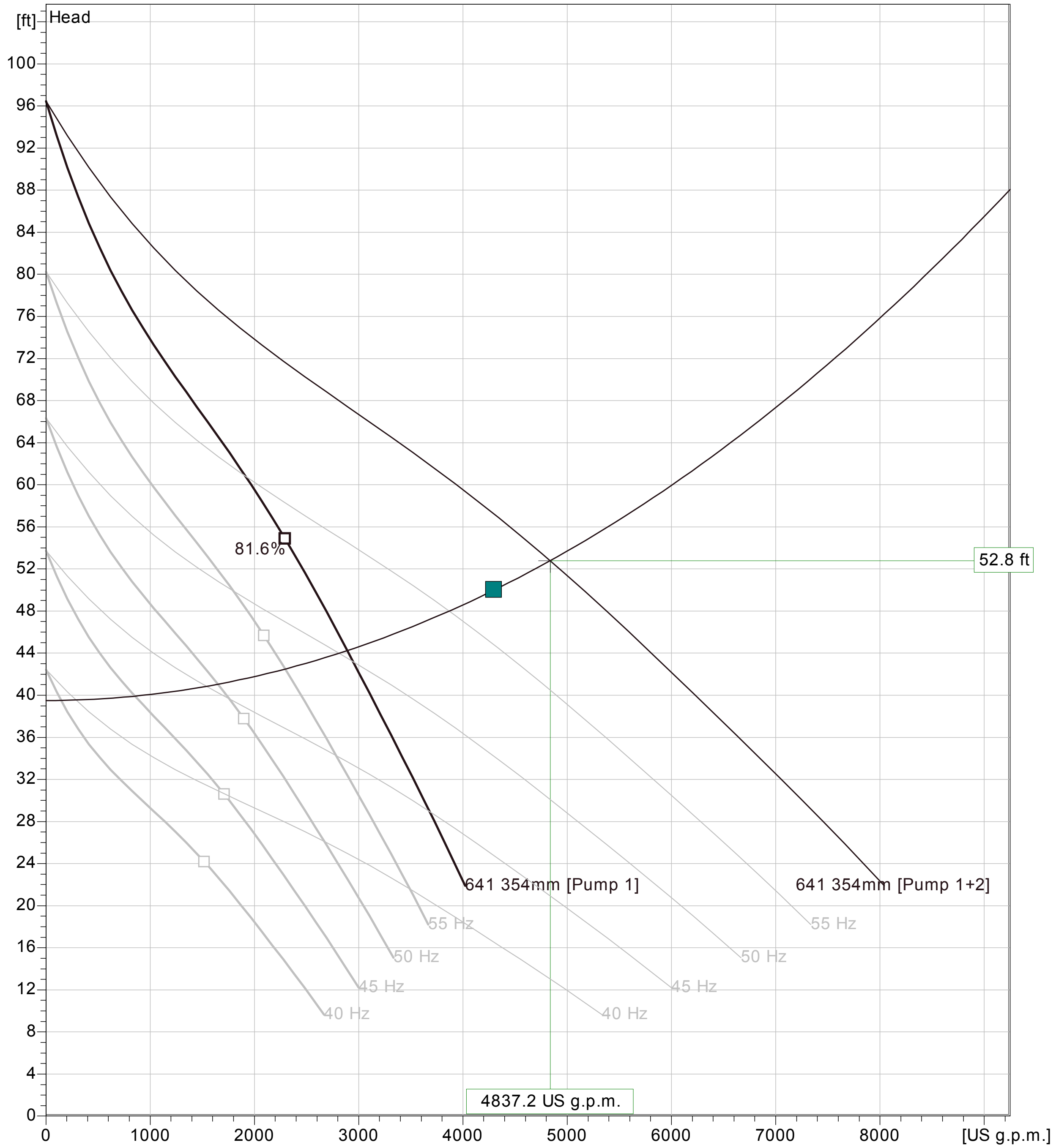
Project	Project ID	Created by	Created on	Last update
			2013-07-03	

xylem
Let's Solve Water

NP 3202 MT 3~ 641

VFD Analysis

FLYGT



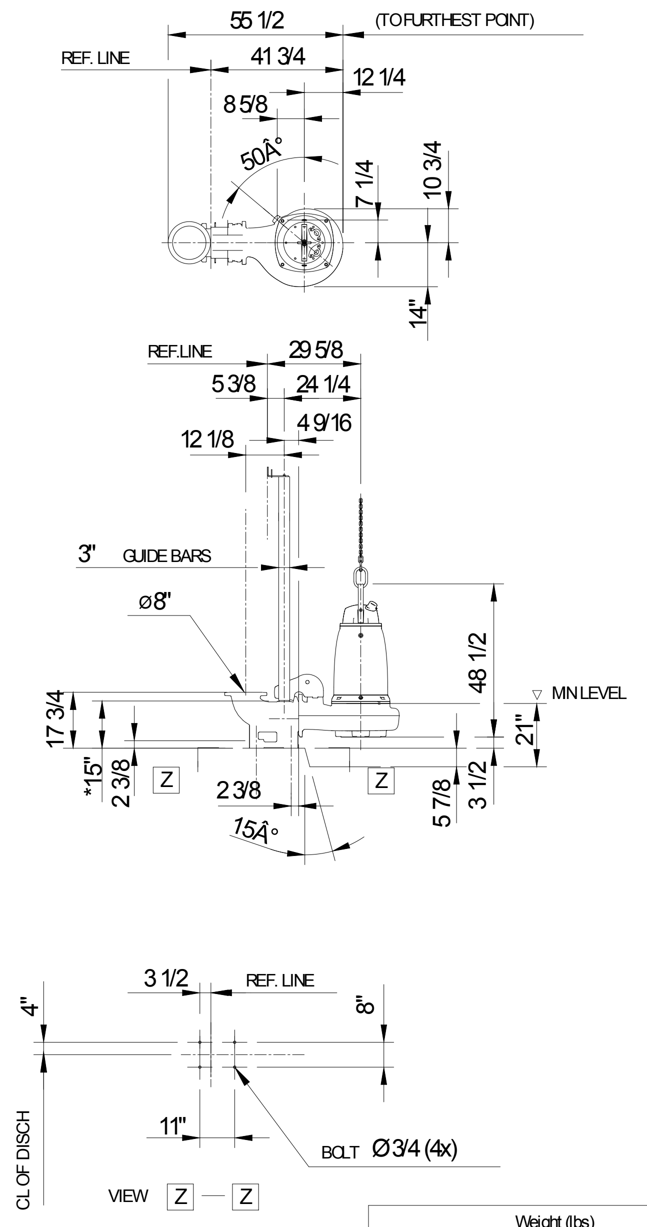
Curve according to: ISO 9906 grade 2 annex 1 or 2

	Individual pump				Total					
Pumps running /System	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
2	60 Hz	2420 US g.p.m.	52.8 ft	39.6 hp	4840 US g.p.m.	52.8 ft	79.1 hp	81.5 %	226 kWh/US MG	14.5 ft
2	55 Hz	1930 US g.p.m.	48 ft	28.9 hp	3870 US g.p.m.	48 ft	57.7 hp	81.3 %	206 kWh/US MG	11.5 ft
2	50 Hz	1410 US g.p.m.	44 ft	20.2 hp	2810 US g.p.m.	44 ft	40.3 hp	77.7 %	200 kWh/US MG	9.65 ft
2	45 Hz	770 US g.p.m.	40.8 ft	12.9 hp	1540 US g.p.m.	40.8 ft	25.8 hp	61.6 %	241 kWh/US MG	8.51 ft
2	40 Hz	144 US g.p.m.	39.5 ft	8.4 hp	289 US g.p.m.	39.5 ft	16.8 hp	17.2 %	891 kWh/US MG	
1	60 Hz	2890 US g.p.m.	44.2 ft	41.4 hp	2890 US g.p.m.	44.2 ft	41.4 hp	78.2 %	197 kWh/US MG	18.6 ft
1	55 Hz	2300 US g.p.m.	42.5 ft	30.4 hp	2300 US g.p.m.	42.5 ft	30.4 hp	81.2 %	183 kWh/US MG	13 ft
1	50 Hz	1650 US g.p.m.	41 ft	21.3 hp	1650 US g.p.m.	41 ft	21.3 hp	80.6 %	181 kWh/US MG	9.72 ft
1	45 Hz	855 US g.p.m.	39.9 ft	13.2 hp	855 US g.p.m.	39.9 ft	13.2 hp	65.4 %	224 kWh/US MG	8.44 ft
1	40 Hz	146 US g.p.m.	39.5 ft	8.4 hp	146 US g.p.m.	39.5 ft	8.4 hp	17.4 %	880 kWh/US MG	

Project	Project ID	Created by	Created on	Last update
			2013-07-03	

NP 3202 MT 3~ 641

Dimensional drawing



* DIMENSION TO ENDS OF GUIDE BARS

Only for
6-poles.

Weight (lbs)	
Pump with cooling jacket	Disch
1280	225
Pump without cooling jacket	
1170	

FLYGT
AUTOCAD
DRAWING

Denomination
Dimensional drwg
FP,NP 3202 MT
Ø8", 6-poles

Drawn by NK	Checked by KA	Date 110225
Scale		Reg no 5399
6664500		5

Project	Project ID	Created by	Created on	Last update
			2013-07-03	

Attachment 2

Buoyancy Calculation

COOS BAY PLANT II INFLUENT PUMP STATION

RE: 612035

Pump Station Buoyancy Calcultions

Dimensions of PS

l = 27.33 ft   a = 32.33   y = 2.5
w = 7.75 ft   b = 9.75   x = 1
h = 18.17 ft
SWt = 16 in   Side Wall Thickness
EWt = 16 in   End Wall Thickness
Rt = 12 in   Roof Slab Thickness
Ft = 24 in   Floor Slab Thickness

Estimated depth of Water Table at Highest Level 3 ft

Displacement = 4740 cu. ft.

Unit Wt of Water = 62.4 lb/cu. ft.

Buoyancy Force = 295,750 Lb

Unit Wt of Conc. = 150 lb/cu. ft.
Unit Wt. of Soil = 120 lb/cu. ft.   Buoyant Wt. of Soil = 57.6 lb/c. ft.

Wt of Conc.				Volume of		
	h	length of wall	Thicknes	Conc.		Weight
End Wall x 2	18.16666	10.417	1.33	252.3	cu. Ft.	75,694 lb
Side Wall x 2	18.16666	27.3333	1.33	662.1	cu. Ft.	198,622 lb
	a	b				
Floor	32.3333	9.75	2.00	630.50	cu. Ft.	94,575 lb
	l + edges	w + edges				
Top	30.00	10.42	1	312.50	cu. Ft.	46,875 lb
				Total Wt. of Conc. =		415,766 lb

Weight of soil over fottings

side footings negligable

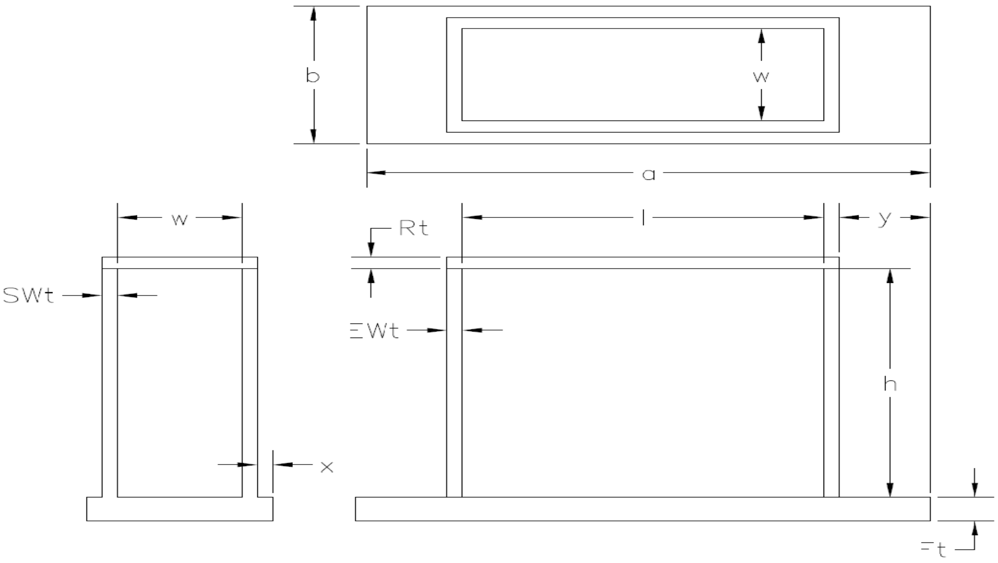
	y	b	h			Weight
end footing	2.5	9.75	18.17	442.81	cu. Ft.	25,506 lb

TOTAL CONCRETE AND SOIL WEIGHT = 441,272 lb

Factor of Safety For Floatation Prevention = 1.5

Existing Design Factor of Saftey = 1.49

FS w/o Roof Slab Weight = 1.33



PD.12 – Screening and Grit Removal

PREPARED BY: Mike Veach/SHN
REVIEWED BY: Steve Donovan/SHN
DATE: August 2013

Headwork Facility Summary

In accordance with Oregon Department of Environmental Quality (DEQ) regulations, WWTP 2 must be capable of treating the peak instantaneous flows (PIF) for the planning period. As calculated in *the City of Coos Bay Wastewater Treatment Plant #2 Facility Plan Amendment* (Civil West, 2012), the PIF for the planning period is 8.20 million gallons per day (MGD), or 5,700 gallons per minute (gpm). The headworks facility must also be able to treat the future dry weather flows of approximately 0.99 MGD, or 6 gpm. DEQ also requires the incorporation of appropriate redundant treatment capacity in the design.

Due to the wide range of flows to the headworks, the design for the headworks facility includes the use of multiple channels and screens.

The headworks facility at expanded/upgraded WWTP 2 is anticipated to include the following elements:

- The headworks structure
- Two mechanically cleaned fine screens
- One manually cleaned bar screen by-pass
- Transfer and discharge conveyors
- Influent sampling
- One headcell grit removal
- Two sequencing batch reactors (SBR) influent flow control weirs
- Two grit pumps
- One teacup grit classifier
- One grit snail
- Two dumpsters for the disposal of dewatered screenings and grit

Based on the hydraulic analysis for maintaining a cleaning velocity through the screening channels, it is recommended a single screen is used during dry-weather flows and that both screens are used during wet-weather flows.

Screens

The fine screening process is designed to remove inorganic material that floats or is suspended in the raw wastewater flow stream. This material includes paper, plastics, hair, and other material that does not breakdown during the wastewater treatment process. The removal of such material protects the downstream processes from damage and clogging. The proposed layout includes two active mechanically cleaned fine screens and one passive bypass channel with a manually cleaned bar screen.

Design Flows

With the wide range of flows from the Influent Pump Station (IPS), the screening facility must handle seasonal and diurnal flows from 400 gpm to 5,700 gpm. It is anticipated that night time flows will be intermittent when the influent flow falls below 400 gpm at the IPS.

In order to maintain the settleable solids in suspension and the re-suspension of solids, periodic velocities in excess of 2.0 feet per second are required in the screening channels.

The proposed design capacity of each mechanical screen is 4.1 MGD with the maximum flow rate per screen of 6.15 MGD.

The design criteria are defined as:

- Flow Rates

Maximum Design:	8.2 MGD peak Instantaneous flow (1 Hour Min)
Minimum Design:	500 gpm
Hydraulic capacity for expansion	12.3 PIF through 2 channels

- Mechanical Screens

Number of units	2
Type	Perforated Plate Belt Screen
Capacity	4,250 gpm
Size	6 mm (1/4-inch)
HP	0.5

- Manual Screen

Number of units	1
Type	Bar
Capacity	11,250 gpm
Size	3/8-inch
HP	NA

- Washer Compactor

Number of units	2
Type	Auger
Size	12-inch
HP	2

- Transfer Conveyor

Number of units	1
Type	Shaftless screw
Size	12-inch
HP	10

- Discharge Conveyor

Number of units	1
Type	Shaftless screw
Size	12-inch
HP	5

Channel Configuration

The selected channel configuration is based on the screening channel evaluation and the design criteria listed below:

- Convey a wide range of flows through 2037 (1 MGD – 8.2 MGD)
- Accommodate future flows up to 12.3 MGD
- Pass peak instantaneous flow with all screens in service
- Minimize accumulation of grit in screening channels upstream of screens and deliver grit to the headcell during low flows
- Meet reliability and redundancy standards

Screen Selection

The screen selection process evaluated two types of screen media: slotted and perforated plate. The perforated plate screen is recommended because it is extremely durable and has the highest capture rate and lowest headloss.

With the selection of the perforated plate media, three types of screens were evaluated:

1. moving media or belt screen set parallel to the channel
2. moving media or belt screen set perpendicular to the channel
3. a basket or barrel screen

We recommend the moving media screen set parallel to the channel. This screen would allow the narrowest channel configuration while maintaining the highest channel velocities. and would provide the highest exposed surface area, which would reduce the velocity (and, therefore, headloss) as the wastewater passes through the screen. The lower velocity as waste passes through the screen would reduce the carryover of inorganic material through the screen. The configuration does not expose any screening surface to the downstream water surface, providing additional reductions in material passing through the screen.

A key design criterion for screening performance is the selection of the size of the opening. During the evaluation three opening sizes were considered: 3 mm (1/8-inch), 6 mm (1/4-inch), and 9 mm (3/8-inch). The evaluation considered capture rate, headloss, installations, and screenings washing/compaction and disposal requirements. The SBR manufacture's require a maximum screen size of 6 mm, but generally recommend a maximum opening size of 3 mm. The 6 mm screen opening is recommended because it is the most commonly used screen, has a lower headloss than a 3 mm opening and has a higher capture rate than larger screens. The 6 mm screen captures less fecal matter along with the screenings which reduces the size and sophistication of the washer/compactor requirements.

During the evaluation process, SHN also considered the ability to convert the selected screen to a 2 mm screen that would be required if the City chose to upgrade the proposed SBR treatment system to a membrane batch reactor (MBR) in the future. The evaluation determined that none of the screens considered could be modified to accommodate a 2 mm perforated plate media. Although the channels would be able to handle the flow and headloss, it was determined a secondary screen and a more robust washer/compactor would be required to remove the amount of fecal material collected with a 2 mm screen. The recommended configuration and length of channels does not provide the additional space required to provide 2 mm screens.

To meet the SBRs manufacture's recommendations, the manually cleaned bar screen will be sized with a 3/8-inch opening between bars.

Washer/Compactor

The fine screens will be configured to include a washer/compactor. The screenings are collected and transported to the washer/compactor. This material contains some organic waste and a significant amount of water. The washer/ compactor requires approximately 30 gpm of chlorinated effluent (W3) water to flush the organic material from the screenings and return the wastewater back into the flow stream for treatment. The cleaned screenings are then transported into a compression section of the compactor to squeeze out the majority of the free water. The cleaned and dewatered screenings are transferred to a transfer screw conveyor system which delivers the screenings to a dumpster on the ground floor.

Odor Control

Typically, the headworks of a wastewater treatment facility produces significant odors which can create an unpleasant nuisance to the surrounding area, if not captured. For the expanded/upgraded WWTP 2, the screenings channels and equipment will be totally enclosed and the odorous air will be drawn off the channels by the odor control system. The screenings and grit dumpster room, located on the ground floor, will also have the odorous air captured and sent to the odor control system.

Redundancy and Reliability

Two screen channel alternatives were evaluated to determine whether the redundancy design criterion was achieved. Alternative 1 consisted of passing the PIF through 2 installed screens and would include a passive bypass with a manual bar rack, in the event 1 screen was out of service. Alternative 2 consisted of passing the PIF flow through 2 installed screens, with an additional channel for the installation of a future screen, if required. Both alternatives would include a passive bypass channel with a manual bar screen. Alternative 1 is recommended because of the following rationale:

- Reduces construction cost by constructing only three channels
- Provides redundancy at wet weather peak week flow
- Is consistent with Facility Plan Amendment concepts

Although the screens can be by-passed through the manual bar screen, the screens, washer compactor, and conveyors will be provided with backup power

Influent Sampling

DEQ requires the collection of an influent sample prior to the introduction of any recycle flows produced by the plant that may influence the results of the sample. DEQ does permit the influent sampling downstream of the fine screens. Although the headcell feed channel does receive the grit wash water from the grit removal process, it has been determined that the wash water will not have an impact on the sampling results. The proposed design recommends that a refrigerated composite sampler be located on the screenings floor of the headworks which draws the influent sample just downstream of the fine screens.

Grit Removal

The objective of grit removal is to remove inorganic material from the influent flow stream. Grit includes sand, gravel, cinder, or other solid materials that are “heavier” (higher specific gravity) than the organic biodegradable solids in the wastewater. Grit also includes eggshells, bone chips, seeds, coffee grounds, and large organic particles, such as, food waste. Removal of grit reduces maintenance of process equipment by preventing unnecessary abrasion and wear of mechanical equipment, and minimizes grit deposition in pipelines, channels, and the SBR basins.

Grit is defined as particles larger than 210 microns (65 mesh) and with a specific gravity of greater than 2.65 (U.S. EPA, 1987). Equipment design was traditionally based on removal of 95 percent of these 210 micron particles. However, with the recent recognition that smaller particles must be removed to avoid damaging downstream processes, many modern grit removal designs are capable of removing up to 95 percent or more of 100 microns (140 mesh) material or smaller.

Removal of particles down to the 110 micron size and below is important at WWTP 2 because it receives large amounts of fine sand which ranges from 125 to 250 microns and very fine sand, which ranges from 62 to 125 microns

Design Flows and Criteria

- Design Flow
    Peak Instantaneous Flow - 8.2 MGD
    Allowance for expansion - 12.3 MGD
    Performance - 95 percent efficiency at 110 microns (140 mesh)

- Grit Removal

Number of units	1
Type	Headcell®
Capacity	8.2 MGD
HP	NA
Storage method	Hopper

- Grit Pumps

Number of units	2
Type	Recessed impeller
Capacity	250 gpm
HP	10
Size	3-inch suction and discharge
Suction	3-inch
Discharge	3-inch

- Tea Cup

Number of units	1
Type	Cyclonic
Capacity	200 gpm
HP	NA
Size	24-inch
W3	20-30 gpm intermittent

- Grit Snail

Number of units	1
Type	Clarifier with cleated belt
Capacity	1 cubic yard per hour
HP	0.33
Size	60-inch clarifier
W3	5 gpm continuous

Headcell®

The Eutek Headcell® is an all-hydraulic grit concentrator, which uses vortex flow and a stacked tray design to capture fine grit efficiently. The headcell does not require external power, has no internal moving parts, and is self cleaning. The headcell is a modular design that allows for a wide range of influent flows.

To treat the PIF of 8.2 MGD, a single 8-tray unit will be constructed. The trays are 9-feet in diameter and will be installed in a square basin, approximately 12-feet by 12-feet. The proposed 8-tray headcell will treat the projected 8.2 MGD PIF. To provide for future expansion to handle a PIF of 12.3 MGD, the headcell basin will be constructed with an additional depth of approximately 4 feet, providing the ability to add 4 additional trays when increased flows require the installation of the additional trays. The inlet manifold will be designed with 12 nozzles, 4 of which will be flanged off to connect to the additional trays in the future.

For a system that is expandable to 12 trays, the Headcell basin requires just over 18 feet from top of floor to the outlet weir, 4 feet deeper than would be required for the 8 tray system. The height of the weir controls water depth in the headcell tank and is set by the downstream hydraulic grade line. The added height requirements do not increase the overall height of the headworks, as the SBR water surface requirements are higher than the required height of the headcell.

To provide access to the headcell by maintenance personnel, there is a bypass around the headcell. The headcell will be provided with a cover to contain odorous air. The odorous air will be drawn off by the odor control system.

Grit Pumps

The grit collected by the headcell is deposited at the bottom of the headcell cone. Grit pumps will draw the grit from the bottom of the headcell and deliver the grit to the teacup ® grit removal process. The proposed grit pumps are Wemco Model C recessed impeller pumps. The recessed impellers uses an induced vortex to provide pumping of the grit with reduced wear of the impeller and pump casing. Two grit pumps will be provided- one duty pump and one redundant pump. For sizing information see the ‘Design Flows and Criteria’ section above.

Grit Removal, Washing and Classification

The Teacup® grit removal system is an all hydraulic, high efficiency vortex separator designed to remove grit. Sediment and sand is removed from the influent using vortex motion and a boundary layer aids in organic removal. The Teacup® design provides for an improved removal performance as the flow rates increase. The discharge is a clean (low organic) grit slurry which requires dewatering to meet disposal regulations.

The dewatering unit uses a slow moving cleated belt to dewater grit by escalating grit from the clarifier. The clarifier provides sufficient time for fine grit to settle to be removed by the cleated belt. The grit snail dewaters and retains settleable solids as small as 75 micron. The unit is capable of producing one cubic yard per hour of dry grit with low organic content for land fill disposal. The estimated grit load during peak flow is 0.31 cubic yard per hour.

Odor Control

The headcell feed channels, the headcell, and all grit removal equipment will be totally enclosed and the odorous air will be drawn off the channels and individual units by the odor control system. Odors from the screenings and grit dumpster room, located on the ground floor, will also be captured and sent to the odor control system.

Flow Splitting

Flow splitting to the SBR process will be accomplished with two weir gates installed in the headcell outlet channel. The gates will be manually operated to provide an adjustable flow split and an equal flow to each SBR. A block out for a third weir gate is provided for the addition of a weir gate to feed a future SBR as the influent flows increase.

Redundancy and Reliability

Due to the high level of reliability and minimal moving parts, the grit removal system is not provided with a redundant unit. During times of low flow, the grit removal system may be taken off-line with the use of the by-pass channel.

TECHNICAL MEMORANDUM

PD.13 – Sequencing Batch Reactors, Flow Equalization, and Interim Biosolids Management

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REVIEWED BY: Bill Leaf/CH2M HILL
DATE: August 2013

Introduction

This technical memorandum (TM) documents design parameters and characteristics of the secondary treatment system, including the sequencing batch reactors (SBRs), waste activated sludge (WAS) pumping, process blowers, and flow equalization. Additionally, this TM discusses the interim biosolids plan involving the continued use of the existing WWTP 2 influent pump station, preliminary treatment, primary treatment, and anaerobic digesters until the City has completed a comprehensive biosolids management plan.

Existing Infrastructure/Systems

The existing infrastructure at the Coos Bay WWTP 2 includes influent pumping, headworks, 1 primary clarifier, primary sludge pumping, 2 aeration basins, aerated effluent pumping, 2 secondary clarifiers, return activated sludge (RAS) pumping, WAS pumping, chlorine disinfection, and anaerobic digestion. This entire infrastructure is located on the site west of Cape Arago Highway and west of the expansion and upgrade project site.

The extent of demolishing the existing infrastructure has yet to be determined; however, no existing infrastructure is intended to be used beyond the interim biosolids period. The City is evaluating long term biosolids management options for the Coos Bay area. The existing influent pump station, headworks, primary clarifier, primary sludge pumping, and anaerobic digesters will continue to be used until the long term biosolids management solution has been implemented. During this interim period, primary effluent from the existing primary clarifier will be routed to the new Influent Pump Station and pumped to the new headworks, SBRs, and ultraviolet (UV) disinfection facilities for final treatment. Discharge of the plant effluent will be through the existing outfall pipe and diffuser. Further discussion of the interim biosolids plan is included in this TM.

Design Codes and Standards

The following codes and standards apply:

- National Fire Protection Association (NFPA) 820: Standard for Fire Protection in Wastewater Treatment and Collection Facilities
- U.S. Occupational and Safety Health Administration Standards (OSHA) (Code of Federal Regulations 1910)
- U.S. Environmental Protection Agency: Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability

Process Description

Design of the expanded/upgraded WWTP follows the recommendations in the *Wastewater Treatment Plant #2 Facilities Plan Amendment* (Civil West, November 2012). The Facility Plan Amendment determined the projected 2037 design influent flows and loadings and the preferred secondary treatment alternative. The preferred treatment alternative is an intermittent cycle extended air system (ICEAS) SBR. Design data in Table 13-1 is based on 2037 design flows and loads without use of primary clarification as part of the interim biosolids plan.

The ICEAS SBR receives continuous inflow of screened and degritted wastewater into the reactor basin during all phases of the cycle. Flow is equally split at the headworks to each basin. One cycle consists of a react, settle, and decant phase.

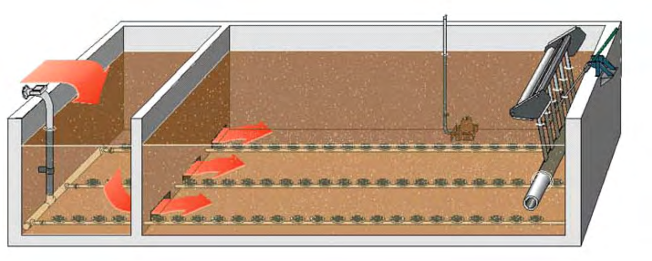
Each basin has 2 zones separated by a baffle wall with openings at the bottom to allow flow under the wall from one zone to the next. The first zone is the pre-react zone and the second is the main react zone. The pre-react zone acts as a biological selector and receives continuous influent flow from the headworks.

React Phase

During the react phase, raw wastewater flows into the pre-react zone continuously to react with the mixed liquor suspended solids. Depending on the process scheme, the basin contents are aerated or mixed under anoxic conditions. As the basin continues to fill, biological oxidation/reduction reactions take place simultaneously to treat the wastewater.

At the beginning of the react phase, the blowers will not run, but the submersible mixers will keep the mixed liquor in suspension to allow denitrification using the raw soluble organics and nitrate formed during the previous react phase. Denitrification reduces the aeration demand and recovers some alkalinity lost during the nitrification. Following the denitrification, the mixers are turned off and the mixed liquor is aerated. During aeration, the blowers force air through the fine bubble diffuser system to impart dissolved oxygen into the mixed liquor. Figure 13-1 is a schematic of the ICEAS React Phase.

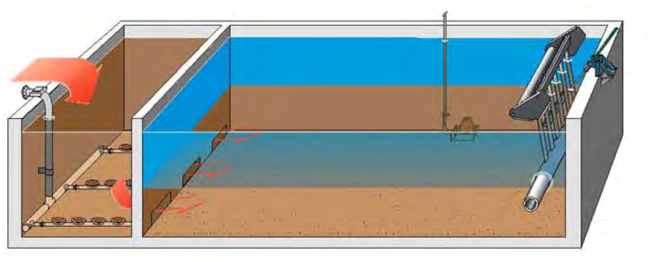
FIGURE 13-1
ICEAS React Phase



Settle Phase

During the settle phase, basin agitation from the react phase (i.e. aeration or mixing) is stopped to allow the solids to settle to the bottom of the basin. Raw wastewater continues to flow into the pre-react zone as the main-react zone settles. As the solids settle, a clear layer of water will remain on top of the basin. Figure 13-2 is a schematic of the ICEAS Settle Phase.

FIGURE 13-2
ICEAS Settle Phase



Decant Phase

During the decant phase, the decanter rotates downward to draw off the clarified supernatant and discharge it to the effluent line. Raw wastewater continues to flow into the pre-react zone as the main-react zone is decanted.

Sludge is typically wasted from the basin during this phase in the cycle. Figure 13-3 is a schematic of the ICEAS Decant Phase.

FIGURE 13-3
ICEAS Decant Phase

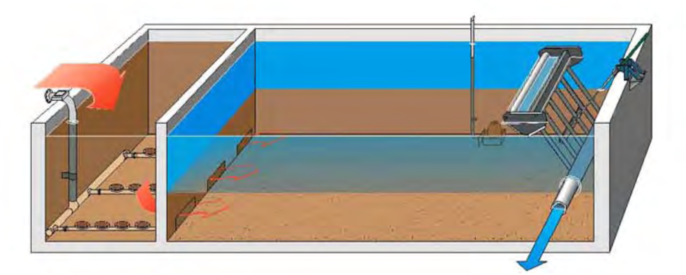


TABLE 13-1
Sequencing Batch Reactor Design Data

Description	Criteria
Number of basins	2
Volume per basin	830,000 gallons (bottom water level @ 15 feet above SBR floor)
	1,160,000 gallons (top water level @ 21 feet above SBR floor)
Design Solids Retention Time (SRT)	10 days
Nitrification Design:	
Design Temperature	14 degree Celsius
Nitrifier Minimum SRT	4.65 days
Nitrification SRT Safety Factor	2.15
Mixed Liquor Concentration:	
Maximum Month Scenario	4,600 mg/L (at bottom water level and normal 4 hour cycle)
Average Daily Scenario	3,800 mg/L (at bottom level and normal 4 hour cycle)
Wasting Rate	1,200 pounds per day (average influent loading)

Wet Weather Cycle Transitions

Since SBRs are not a continuous inflow and outflow system, the cycle time needs to be adjusted, as the influent flow rate changes seasonally, to prevent overfilling the basins. The ICEAS SBR system has 3 modes of operation to handle varying seasonal influent flow rates, they are normal, storm, and second storm. Each has an adjustable cycle time; however, the ICEAS manufacturer (Xylem) has proposed 4, 3, and 2 hours respectively. As the influent flow increases, the cycle time is shortened to allow the SBRs to process the incoming flow quicker and prevent overfilling the basins. The system switches from normal cycle operation to storm cycle operation when the level sensing equipment in a basin detects a water level that corresponds to a flow that is above a flow setpoint (e.g. peak week design flow). After the storm cycle is initiated, the system will stay in the storm cycle until the basin that indicated a storm event has completed its cycle (end of decant phase) and completed another full storm cycle.

At the completion of the full storm cycle for that basin, the system will switch back to normal cycle operation, if the basin is not indicating water levels that correspond to a flow above the flow setpoint (e.g. peak week design flow). If a basin detects high water levels that indicate a flow above the flow setpoint, the system will stay in the storm cycle until normal cycle water levels return. The system can switch into the storm cycle at any time during the normal cycle. However, the system cannot switch from storm back to normal cycle until the completion of the storm cycle for the initiating basin.

The system switches from storm cycle operation to the second storm cycle operation when the flow is above a secondary flow setpoint (e.g. maximum day design flow). The same mode of operation occurs for the second storm mode as with the first storm mode, the difference being that the cycle time is less.

A level transducer and float switch are installed in the ICEAS basins. The level transducer continuously indicates the basin water level. The programmable logic controller uses the water level reading to calculate the corresponding flow rate into the basin. If the basin water level indicates that a flow above the flow setpoint is entering the basin, the system will transition into the storm cycle.

The float switches have 2 functions. One function is to signal a high level in the basin and force the system into a settle phase to allow a minimum of 30 minutes of settle time prior to the water level overtopping the decanter. The second function is to signal that the system must transition into the storm cycle, if the level transducer has not already signaled this to take place.

Decanter

Each basin has a motorized decanter installed on the wall opposite where the influent flow enters the SBR. The decanter operates to remove clarified effluent from the top layer of the basin (drawdown) during the decant phase of the cycle. The drawdown is defined by the top water level (TWL) and the bottom water level (BWL). When the decanter is not operating, it remains in a parked position above the TWL, which eliminates the possibility of solids carryover during other phases in the cycle. In the parked position, the decanter can act as a passive overflow to prevent mixed liquor from spilling over the top of the basin walls.

The decanter is mechanically operated by the use of an electro-mechanical actuator that is mounted on the basin walkway for easy access. Whenever the decanter is in operation, the actuator moves the decanter between the top and bottom limit switches. The decanter speed is controlled through the use of a variable frequency drive. As a result, the decanter discharge rate will be relatively constant from the time the decanter enters the water to the time it reaches the BWL.

During the end of the settle phase, the decanter will travel from the park position to the TWL. When decant phase is started, the decanter will travel from the TWL to the BWL, in the allotted time, to remove the drawdown volume from the basin. Since influent flow to the plant varies, the water level in the basin at the start of each decant phase will be at differing levels above BWL. Consequently, during the decant phase, the decanter will travel downward for a period of time before reaching the water surface. Also mounted on the decanter, in front of the weir, is a floatable scum guard that operates to exclude floating material during the decant phase.

Aeration System

Blowers

Three adjustable speed positive displacement blowers are provided to supply oxygen to the biological process in the SBR. Low pressure air from the blowers is discharged through aeration piping and into the fine bubble diffuser system in each SBR basin. Two blowers are capable of delivering 100 percent of the oxygen requirements to each SBR basin. Air is only delivered to one basin at a time. Motorized butterfly valves, at each basin, control which basins receive air from the blower system. Two blowers operate as duty blowers with a single blower operating at low air demands; the third blower is a standby. The blowers will alternative duty and standby to evenly distribute the run time for each blower. Table 13-2 is the design data for the aeration system.

TABLE 13-2

Aeration System Design Data

Description	Criteria
Air Demands[1]	
2037 Maximum Month	2,100 scfm
2037 Peak Week[2]	2,520 scfm (maximum design condition)
Blowers	
Type	Adjustable speed, positive displacement
No. of duty blowers	2
No. of standby blowers	1
Discharge pressure	11 psi (approximate)
Maximum blower capacity	1,300 scfm per blower

Notes:

1. Air demands based on no anoxic phase during react cycle. Dissolved oxygen level during aeration is 2.0 mg/L.
2. Peak week loadings not defined in Facility Plan Amendment; therefore, peak week air demand assumed to equal 120 percent of maximum month conditions.

Flow Control Valves

Each SBR basin has 2 motorized butterfly control valves. One valve controls air flow to the pre-react zone and the second valve controls air flow to the main zone. When an SBR basin is in the settle or decant cycle, the air flow control valves are closed. While aerating, the valve disc position modulates to maintain the correct air flow rate to the basin.

Air flow to the SBR zones is regulated by the use of dissolved oxygen probes in each zone. Dissolved oxygen setpoints (e.g. 2 mg/L) are entered in the logic control system by the operation’s staff. As the dissolved oxygen level changes in each zone due to varying influent load or the elapsed time into a cycle, the logic control system will determine if an incremental increase or decrease in air is required by the blower system. The adjustable speed blowers will speed up or down to meet the new required air flow rate. Air flow rate is measured with flowmeters, at each zone. As the air flow rate is changed, the air flow control valves will change position to direct the proportional amount of total air flow from the blowers into each zone.

Anoxic Mixers

The main zone of each SBR is equipped with 2 submersible mixers. At the beginning of the react phase, the mixers will operate at the beginning of the react cycle to mix the SBR contents without aeration. By mixing without aeration, an anoxic cycle will be created in the main zone. Instead of oxygen as the electron acceptor, the microbes will be forced to use nitrate as the electron acceptor to remove carbonaceous biochemical oxygen demand. Creating an anoxic cycle will help control the growth of filamentous bacteria which adversely affect the settling characteristics of the mixed liquor. Additionally, alkalinity is partially recovered during the anoxic phase to offset the loss of alkalinity during nitrification occurring during the aeration phase. An oxidation-reduction potential probe will be used to determine when the nitrate has been depleted. After the nitrate has been depleted, the aeration system will turn on to provide oxygen as the electron acceptor. Table 13-3 is the design data for the anoxic mixer.

TABLE 13-3
Anoxic Mixer Design Data

Description	Criteria
Type	Submersible
No. of mixers per basin	2
Drive	Constant speed
Power	7 hp each

Scum and Foam Control

The primary cause of excessive scum and foaming events in wastewater treatment facilities is the trapping of foam or scum in the secondary system. Sequencing batch reactors are not flow through reactors which allow foam and scum to float to secondary clarifiers where typically a scum removal system captures the scum and foam. The scum and foam can then be discharged to the biosolids treatment system and not recycled back to the SBRs.

The presence of an anoxic cycle, coupled with the pre-react zone aerobic selector characteristics, will provide protection against the overgrowth of filamentous organisms that may cause foaming or bulking sludge as they provide selection pressures against their growth. Should foam become an issue, the inclusion of combined surface wasting and scum removal will provide an additional mechanism for foaming control. The filamentous organisms that cause foaming (i.e., Nocardia) accumulate at the surface of the mixed liquor and in the foam itself. Wasting from the surface of the mixed liquor preferentially wastes these filamentous organisms. Surface sprays with disinfectant injection above the scum wet well will provide the ability to disinfect the foam before it is wasted, killing the filamentous organisms and avoiding foaming in the digester.

In conversations with SBR suppliers, the removal of scum and foam is difficult due to the draw-and-fill operation coupled with the decanter removing only clarified water below the scum or foam layer. The addition of an appropriate scum removal system for the SBRs is being investigated and will be presented to the City and operation’s staff when the information is available.

Flow Equalization

The operation cycle of an SBR causes an increase in the effluent flow rate (decant) leaving the SBR relative to the influent flow rate. This increase in effluent flow rate requires downstream processes to be designed to handle a larger flow rate than the influent flow rate to the plant unless flow equalization is provided.

The downstream processes affected by the decant are the UV facility, yard piping, and outfall pipe and diffuser. The outfall pipe and diffuser were not recommended to be expanded in the Facility Plan Amendment. To maintain no outfall improvements and provide a reasonable hydraulic grade line, the design flow leaving the equalization basin was determined to be the peak daily average flow of 6.31 MGD. Discharge from the equalization basin is limited to 6.31 MGD by a flow control valve and flow meter between the equalization basin and UV facility. The flow control valve modulates to allow 6.31 MGD to pass through the UV facility and outfall. The equalization basin is sized to store or buffer the decant flow discharged from the SBRs based on a 6.31 MGD average flow to the plant. The storage is adequate to hold the decant volume from 1 SBR while slowly drawing the water level and stored volume in the equalization basin down at a rate of 6.31 MGD. The equalization basin water level will be at the normal low water level by the time the next decant from the second SBR discharges into the equalization basin.

Waste Activated Sludge Pumping

Each SBR is equipped with 2 adjustable speed submersible WAS pumps. The purpose of the pumps is to “waste” the microbes that have grown from the influent dissolved and particulate organics, as well as, inorganic or inert suspended solids. Controlled wasting will maintain a healthy concentration of microbes in the SBRs to meet effluent requirements. One WAS pump in each basin is duty and the second WAS pump is standby. Wasting will occur near the end of the decant phase before the basin starts a new cycle. The pumps will discharge to the existing sewer system and co-thickened with the primary sludge in the existing primary clarifier. Table 13-4 is the design data for WAS pumping.

TABLE 13-4

Waste Activated Sludge Pumping Design Data

Description	Criteria
Type	Submersible
No. of pumps per basin	2 (1 duty, 1 standby)
Capacity[1]	250 gpm
Drive	Adjustable speed
Power	3 hp each

Notes:

1. Wasting capacity based on removing settled mixed liquor during each decant phase of each SBR basin for 30 minutes during each decant phase.

Safety

Flotation rings will be provided along all walkways above the SBR. Another possible safety option involves installing davit bases for portable cranes or other means of connecting life lines for access into the SBRs.

Reliability/Redundancy

The United States Environmental Protection Agency requires that wastewater facilities meet requirements for reliability and redundancy in their treatment components and associated equipment. At least 2 equal-volume SBRs are required. The blowers shall be sized such that with the largest blower out of service the remaining units can maintain design oxygen transfer. With the largest section of diffusers isolated or out of service, oxygen transfer capacity shall not be measurably impaired.

A backup pump shall be provided for each set of the WAS pumps. The capacity of the pumps shall be such that, with any one pump out of service, the remaining pumps will have the capacity to handle the wasting requirements.

Interim Biosolids Management Plan

The Facility Plan Amendment recommended thickening WAS generated by the SBRs and storing the thickened waste activated sludge (TWAS) in the existing anaerobic digesters. The digesters were to be converted to holding tanks and the TWAS hauled to the City’s Plant #1. The City of Coos Bay opted to take a comprehensive view of its biosolids management and is currently evaluating long term alternatives to treat and manage biosolids with the anticipation of implementing the selected alternative in 3 to 5 years. Therefore, an alternate short term plan was developed to treat and manage biosolids.

Currently, WWTP 2 anaerobically digests blended primary and WAS to meet Class B requirements. The interim plan (until the selected long term alternative is implemented) is to continue anaerobically digesting the blended primary and waste activated sludges. Instead of WAS coming from the existing aeration basins, the WAS will come from the SBRs. The SBR WAS is similar in nature to the existing WAS since both are activated sludge systems. Raw sewage will continue to be diverted to the existing Influent Pump Station and pumped through the existing headworks and primary clarifier. The primary effluent from the primary clarifier will be routed to the new Influent Pump Station where the primary effluent will be discharged to the headworks, sequencing batch reactors, and UV disinfection facilities. Effluent piping from the UV facility will be connected to the existing outfall piping and diffusers. A diversion structure will allow part of the high wet weather raw sewage flow to overflow directly to the new IPS with the remaining diverted to the existing pump station. Should the existing influent pump station or other plant components or process fail, all the raw sewage will overflow to the new influent pump station. WAS from the SBRs will also be piped to the existing truck loading station as a backup if the existing plant process fails.

PD.14 – Ultraviolet Disinfection and Plant Water Pump Station

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Jason Riegler/CH2M HILL

REVIEWED BY: Steve Donovan/SHN
Bill Leaf/CH2M HILL

DATE: August 2013

Introduction

This technical memorandum summarizes the design criteria and features of the UV disinfection facility for the Coos Bay Wastewater Treatment Plant 2 (WWTP 2) Expansion and Upgrade project.

UV Disinfection System

Secondary effluent, from the sequencing batch reactors (SBR), will be disinfected using a low-pressure, high-intensity ultraviolet (UV) lamp system (UV System). The UV System will consist of one UV channel with 3 banks of UV modules, based on a Trojan 3000Plus system. An automated, in-channel, lamp sleeve cleaning system, UV Transmittance (UVT) instrument, UV intensity probe, and high/low water level switch will be provided.

A 120-ft long fixed finger weir will maintain a minimum water level in the UV channel. No inlet gate is required to isolate the channel since there are upstream automated and manual valves that can be used for isolation. The UV channel will be covered with slip resistant, removable 316 stainless steel plate. The area over the inlet box and the fixed effluent weir will have slip resistant aluminum grating.

Ramp and stair access is provided to the UV facility. The ramp will allow operators to roll or carry operation and maintenance (O&M) equipment from grade to the top of the channel. A stairway from the facility to the SBR perimeter walkway will be provided. A bridge crane will be used to facilitate O&M activities on the UV System and to move equipment to grade from the south end of the facility.

The predesign layout assumes a horizontal lamp configuration based on Trojan’s 3000Plus and Wedeco’s TAK55 systems. Should the City prefer, a vertical lamp configuration, like that of Ozonia’s AquaRay system, is available. Since channel dimension requirements vary between vendors, the channel width and depth used for the predesign are based on Trojan’s system. An environmentally controlled building is recommended to house the lamp ballast enclosures for the Wedeco and Ozonia systems; this building is shown just north of the UV facility on the Site Plan.

The UV system will be controlled by a vendor supplied control panel with graphical user interface. The control system will provide complete automatic control of the disinfection process, individual control of the disinfection equipment, and will monitor process conditions and instrumentation and equipment status. The system provides alarms to indicate to operators that maintenance attention is required, such as low UV intensity, and to indicate extreme conditions, such as high water level. The system will use flow-paced logic to meet the minimum required UV dose.

The UV System is sized for peak daily average flow of 6.31 mgd with one redundant bank. With all banks in service the system is capable of treating the peak instantaneous flow. However, due to existing outfall capacity limitations, the maximum flow will be limited to 6.31 mgd using an automated flow control valve located between the equalization basin and the UV facility.

Design Criteria

Table 14-1 is the 2037 design criteria for the UV System.

TABLE 14-1
Design Criteria

2037 Condition	Criteria
Average Dry Weather	0.99 mgd
Maximum Month Wet Weather Flow	1.51 mgd
Peak Daily Average (PDA) Flow	6.31 mgd
Average Process Water (W3) System Flow	200 gallons per minute (gpm)
UV Bank Redundancy	1 redundant bank @ PDA
UV Dose	Minimum 30 mJ/cm^2
UV Transmittance[1]	55 percent - 65 percent
Permit Requirements	
Fecal Coliform	
Monthly median	14 organisms/100 mL
<10 percent of all samples	43 organisms/100 mL
Enterococcus	
Monthly geometric mean	35 organisms/100 mL
Single sample	104 organisms/ 100 mL
Total Residual Chlorine[2]	
Daily median	0.5 milligrams per liter (mg/L)
Daily maximum	1.0 mg/L

mgd = million gallons per day

[1] There is no UV transmittance data for the facility. 55 percent UVT would be a conservative value for a biological nutrient removal facility.

[2] There will be no chlorination of plant effluent. Provisions for chlorination will only be for the plant water (W3) system to control biological growth in pipes.

Reliability/Redundancy

The U.S. Environmental Protection Agency (EPA) requires that wastewater facilities meet the requirements for reliability and redundancy in their treatment components and associated equipment. The reliability standards establish minimum levels of reliability for three classes of wastewater works. Oregon Department of Environmental Quality (DEQ) has determined that reliability Class I is appropriate for the WWTP 2 treatment facilities since plant effluent is discharged to waters where shellfish are harvested.

DEQ provides guidance on UV component reliability criteria for State Revolving Fund Loan projects. Per the guidelines, at least 2 modules of lamps, in series or multiple channels, must be provided so that disinfection will continue during maintenance. Adequate disinfection must be provided with the largest module out of service.

Backup power for the disinfection system is required; therefore, the UV System will be connected to the facility backup power generation system. An uninterruptible power supply will be provided for the system controller and the lamps to maintain power to the lamps during the transition between power loss and backup power startup.

System Safety

Since UV systems are based on a physical disinfection method, they are not governed by the EPA, OSHA, or any regulatory requirements. NFPA 820 does not define any specific requirements for UV. Although there are no specific regulations for the UV system, safety is a key concern. Specific design features will be incorporated and appropriate operator training provided to ensure the safety of operation's staff.

Plant Water Pump Station

Plant water (W3) is needed for process equipment demands throughout the facility, such as the headworks screens and hose washdown stations. The W3 pump station will be located in the UV facility downstream of the UV channel level control weir and will pump disinfected plant effluent. The pump station consists of 2 vertical turbine pumps with variable frequency drives, an automatic backwash strainer, piping, valves, and other appurtenances. There will be a manual bypass around the strainer.

Pump station operation will be based on a pressure control loop with pumps in a DUTY/STANDBY configuration. The estimated maximum flow is 200 gpm with an operating pressure of 100 pounds per square inch (psi). Each pump shall have maximum 200 gpm capacity at 100 psi total dynamic head.

Two to five mg/L of sodium hypochlorite will be injected into the W3 system on an as needed basis to minimize re-growth of pathogens using a chemical metering pump and a drum of sodium hypochlorite. The pump will be stored by plant staff. An injection quill with isolation valve will be provided for sodium hypochlorite feed on the W3 pump discharge piping. No sodium hypochlorite storage container or containment system will be provided and plant staff will utilize existing containers.

PD.15 – Plant Hydraulics

PREPARED BY: Alan Chang/CH2M HILL
REVIEWED BY: Rich Frankenfield/CH2M HILL
DATE: August 2013

Introduction

This technical memorandum documents the treatment plant gravity flow hydraulic analysis and results for the Coos Bay Wastewater Treatment Plant 2 (WWTP 2) Expansion and Upgrade Preliminary Design.

Hydraulic Profile Development

A hydraulic analysis was performed as part of the preliminary design for the Expansion and Upgrade project. The hydraulic computer model HYDRO, developed by CH2M HILL, was used to perform the hydraulic analysis. This model produces a hydraulic profile by calculating head loss through the hydraulic structures, channels, and pipes.

Hydraulic Analysis Methods

The HYDRO computer model calculates energy and hydraulic grade line elevations upstream and downstream of the hydraulic elements in the treatment plant. The hydraulic analysis begins at a water surface datum elevation at the downstream end of the treatment process. The hydraulic calculations proceed upstream from this datum elevation, one element at a time. The NAVD88 Datum was used as the basis for the elevations in the hydraulic calculations.

The 100-year flood stage elevation of 11.0 feet (FEMA FIRM 41011C0168D) in Coos Bay was used as the starting point for the calculations. Hydraulic elevations were calculated using the 2012 Facility Plan Amendment flows for Peak Instantaneous, Peak Daily Average, Maximum Month Wet Weather and Average Dry Weather flow. Governing criteria for wet weather conditions were to be able to treat the peak instantaneous flow at the Mean Higher High Water (or 100-year flood stage) elevation of 11.0 feet without submerging unit process weirs, assuming all treatment process units are in service. In addition, at Peak Daily Average wet weather flow conditions at the 100-year flood stage and with one of each type of treatment process unit out of service, no weirs are to be submerged.

The hydraulic grade line was calculated through the outfall pipelines, and upstream through the existing outfall manhole, ultraviolet (UV) disinfection, flow control valve, equalization basin, sequencing batch reactors (SBRs), grit chamber, and influent screens.

Plant recycle flows were not accounted for in the analysis because there is no return activated sludge flow stream with the SBR process and waste activated sludge (WAS) is processed offsite.

All treatment process units were assumed to be in service at the Peak Instantaneous Flow. During the Peak Instantaneous Flow, secondary effluent is stored in the equalization basin. The maximum design flow through UV disinfection is limited to 6.31 million gallons per day (mgd), which is also the 2037 Peak Daily Average flow, due to capacity limitations of the existing outfall diffuser. Influent screen 2 was assumed out of service during Peak Daily Average, Maximum Month Wet Weather conditions and Average Dry Weather conditions.

All pipe sizes mentioned assume inner diameter dimensions.

Hydraulic Analysis Basis and Results

Headworks (Influent Screens and Grit Chamber)

The headworks facility consists of 3 screening channels with two ¼-inch perforated plate mechanical band screens and 1 manually cleaned bar rack, and one Hydro International Headcell vortex grit chamber with bypass channel. During Peak Instantaneous Flow scenario, both mechanical screens are in service. For Peak Daily Average flows or lower, only 1 mechanical screen will be in service.

The top of wall elevation of the headworks was determined using a future Peak Instantaneous flow rate of 12.3 mgd passing through 2 screens and the grit chamber. It is assumed that other modifications downstream of the headworks (such as future outfall improvements, UV Disinfection Facility expansion, and addition of a third SBR) are completed to maintain the same hydraulic and energy grade lines downstream of the headworks. The maximum WSE upstream of the screens is approximately 41.79 feet at the future Peak Instantaneous Flow of 12.3 mgd. With approximately 1.71 feet of freeboard, the top of slab elevation is 43.5 feet.

Sequencing Batch Reactors and Flow Split

There are 2 continuous flow SBRs operating in parallel. SBR decanting to the equalization basin will be based on a timed sequence. Maximum water surface elevation (WSE) in the SBR is based on the operational cycle durations and water surface elevations predicted by the biological process model, Biowin. The maximum WSE for each scenario is summarized in Table 15-1. Influent flow is equally split between the SBRs with two 3.5 foot wide weir gates located at the headworks.

TABLE 15-1

SBR Maximum Water Surface Elevations from Biowin Model

Flow Scenario	Plant Influent Flow (mgd)	Maximum Water Surface Elevation (feet)
2037 Peak Instantaneous Flow	8.2	36.00
2037 Peak Daily Average Flow	6.31	36.00
2037 Maximum Month Wet Weather Flow	2.09	32.50
2037 Average Dry Weather Flow	0.99	30.75

[a] mgd – million gallons per day

Flow Equalization Basin and Flow Control

A single modulating 16-inch diameter flow control valve is used to maintain continuous flow through the UV system. At 2037 Peak Instantaneous and Peak Daily Average flow scenarios, the valve will limit the flow to a maximum of 6.31 mgd. Five feet of water level fluctuation, above the minimum water level in the equalization basin, is used to store secondary effluent when flows exceed the 2037 Peak Daily Average flow of 6.31 mgd. The flow rate out of the equalization basin will typically match the plant influent flow rate until the equalization basin minimum water level is achieved. The maximum flow setpoint minimizes the overall height of the facilities.

Disinfection

UV disinfection equipment will be located in a single channel with approximately 120 feet of V-notch weir at invert elevation of 18.55 feet that ensures that the UV lamps will always be submerged and the UV channel maintains a constant water surface elevation of about 19.13 feet. The disinfection equipment consists of 3 banks of lamps. 1.5 inches of head loss is assumed across each bank for a total of 4.5 inches. Head loss per bank differs between equipment manufacturers, the Trojan UV3000Plus system has approximately 1.1 inches of head loss per bank. A flow straightening baffle is included to protect the UV system from debris. UV channel inlet hydraulic conditions are adequate without the baffle. The straightening baffle adds a minimum 2 inches of head loss to the hydraulic profile.

The UV effluent channel downstream of the level control weir is kept at a minimum depth of 6 feet for plant water pump intake submergence.

Outfalls and Outfall Diversion Structure

The existing 24-inch diameter outfall for WWTP 2 will be maintained from the diffuser to the first upstream manhole located on the southwest corner of the existing WWTP 2 site. The outfall has a submerged diffuser with five 6-inch diameter ports. The condition of the outfall is unknown and is assumed to flow freely. The outfall connects to a 72-inch diameter manhole located in the southwest corner of the existing WWTP 2 site. The manhole's north rim elevation is 11.86 feet. The manhole invert is 3.33 feet.

Approximately 880 feet of 30-inch diameter pipe will connect the UV disinfection facility to the existing manhole. A 24-inch diameter pipe may be acceptable and should be evaluated as final design progresses.

```
/*
*City of Coos Bay WWTP SBR Project
*
*Project Number:469556.03.35.05.60
*
*Assumptions:
*All units in service
*Peak Instantaneous Flow: Q =  8.2 mgd
*SC three channels
*SBR: 2 in parallel
*EQ basin sized for concurrent SBR operation
*UV two channels one in future.
*All elevations must be checked for datum. include +4.2 ft to convert from 1974
vertical datum to NGVD 1988

*
*MINOR LOSS COEFFICIENTS (FROM D.S. MILLER INTERNAL FLOW SYSTEMS, 1978)
*90-deg elbow, K=0.45
*45-deg elbow, K=0.2
*180 deg. open channel bend, K=3.0
*90 deg. open channel bend, K=1.2
*45 deg. open channel bend, K=0.6
*Entrance loss, K=0.5
*Exit loss, K=1.0
*Orifice coefficient, C, 0.6
*21" Tee Through flow, dead branch, K=0.04
*21" Tee Branch flow, dead run, K=1.10
*
*
0 (0-10) EGL set at mean higher high water level (100-yr flood)
11 8.2 12.3 6.31 /
*
* Q1 = total plant influent peak instantaneous flow, 8.2 mgd
* Q2 = Future peak instantaneous flow, 12.3 mgd
* Q3 = EQ basin outlet flow, 6.31 mgd (Peak Daily Average)
*
* FEMA FIRM map 41011C0168D for flood elevation.


26 (10-20) existing diffuser outfall (1973 sht 38)
.025 -16.5 0 0 100 1 1 /
5 20.5 6 24 7.5 .0102 .019 0 0 / Line 3
/*

*Specific Gravity of Seawater = 1.025
*24" pipe w/ end invert at -17.5' therefor CL is at -16.5'
*100 %Q3
*Available engergy at Port 1 is at 1' reasonable??
*assumed divergence angle for 12" x 6" reducer = 20.5 deg.
*Absolute pipe roughness estimated at at 0.0102 inch following ex. in
* manual
*diffuser slope =.019
*assume 100% sharp edge diffuser--most conservative
*no risers


1 (20-30) Existing pipe from diffuser to existing MH (1973 sht 38)
24 880 .012 0.5 0 0 0 100 /

*CMP Design Guide Mannings n = .011 to .020; assumed 0.012 due to
* relining.
*Demo plan Sht 1 indicates demo and replacement of 24inch CMP outfall
*Entrance loss from upstream MH K= 0.5
```

```
6 (30-40) Flow through channel to represent existing MH (2013: 006-C-2001A)
3.33 72 0 .012 6 0 1000 0 0 0 100 /
* Manhole dimension information provided by SHN Engineers.

1 (45-50) Pipe from exst MH to UV basin (2013: 006-C-2001 and -2001A)
30 880 .012 5.2 3 0 0 100 /
* 2 45-deg bend, K=0.2*2 = 0.4
* 2 90-deg bend, K=0.45*2 = 0.9
* 2 90-deg open channel bend, K=1.2*2 = 2.4
* Entrance loss, K=0.5*3 = 1.5
* Total K = 5.2
* Exit loss, K=1*3 = 3
* Using open channel bend to represent 2 manholes along pipeline.
* No pipe profile has been established yet including yard pipe CL.

5 (50-55) Gravity pipe outlet from UV (2013: 40-M-3000)
16 30 0.012 10 0 30 0 0 0 100/

6 (55-60) Channel at downstream end of UV 2013: 40-M-2000)
10 48 0 0.013 10 0 144 0 0 0 100 /
*Invert  set at 10' to account for pipe bury (grd surface=15'
* (1973 sht 38))
*9' (108") width
*Mannings n = 0.013
*4 ft length
*slope= 0.
*Max depth is 12-ft

12 (60-65) Finger weir launder from UV channel (2013: 40-M-2000)
17.1 18 0 0.011 20 0.012 18 0 0 0 33.3 /

* SST launder, V-notch weirs on each side
* 3 launders, so flow is 33.3% of Q3

3 (65-70) V-notch weirs (2013: 40-M-2000)
18.55 20 6 3 16.84 0 0 16.67 90/
* 20-ft long weirs into 1-ft deep launders
* Two weir lengths along each launder x 3 launders
* total weir length 120-ft.  Trojan recommends 118 ft.
* based on standard detail

6 (70-80) Rectangular Open Channel (2013: 40-M-2000)
16.46 108 0 .013 23 0 62 0 0 0 100 /
* Expansion loss, K=0.45 (DS Miller, Fig 14.15)

6 (70-80) Rectangular Open Channel (2013: 40-M-2000)
16.46 40 0 .013 46.5 0 62 0 0 0 100 /
*40-inch width based on Trojan 2/27/2013

10 (80-90) Headloss for UV equipment in channel
0.55 0 /
*Assumes 1.5" HL per bank, 1.5"x3 = 4.5"
*Straightening baffle loss = 2"
*Total loss = 6.5" or 0.55 ft (rounded up)
*Trojan's headloss is ~1.1"/bank on average
*Check that max water depth is 2.66' from upstream bank per Trojan

6 (90-100) Rectangular channel upstream of UV (2013: 40-M-2000)
10 76 0 .013 4 0 144 2.4 0 0 100 /
* two 90-deg bends as flow transitions from below, K=2*1.2=2.4
*Invert  set at 10'
```

```
1 (100-105) Pressurized Circular Pipe to Expansion (2013: 30-M-2000)
24 50 .013 0.8 1.0 0 0 100 /
*Exit loss, K = 1
*Expansion to 24-in diam, K = 0.15
*50 ft of 24" pipe
* 1 90-deg bends, K=0.45
* 1 45-deg bend, K=0.2
* Total K = 0.8

1 (105-110) Pipe from expansion to FCV (2013: 30-M-2000)
16 5 0.013 1.12 0 0 0 100/
* 24x16 expansion, K = 0.31
* gate valve: K = 0.10
* Flow through tee: K = 0.26
* 1 90-deg bend, K=0.45
* Total K = 1.12

28 (110-115) Flow Control Valve (2013: 30-M-2000)
0 0 100 16 .15 5.76 .25 7.2 .37 8.64 /
*Data for 16-inch BF valve from ValMatic

1 (115-120) Pipe from Flow control valve to Contraction (2013: 30-M-2000)
16 20 0.013 0.36 0 0 0 100/
* includes 16" mag meter
* gate valve: K = 0.10
* Flow through tee: K = 0.26
* Total K = 0.36

1 (120-130) Pipe from contractor to EQ Basin (2013: 30-M-2000)
24 30 .013 1.01 0 0 0 100 /
*Entrance loss K=0.5
*contraction to 16-in, K= 0.06
* 1 90-deg elbow, K=0.45
* Total K = 1.01
* 30 ft of 24" pipe

6 (130-140) EQ basin (2013:30-M-2000)
17 420 0 .011 98 0 1000 0 0 0 100 /

* 35' W x 98'L

10 (140-150) Headloss to represent fluccuation in EQ basin (2013: 30-M-2000)
5 /

*Max 5' per Jason Riegler/CVO

*Effluent Level from SBR should not exceed the invert of the decant
*collection pipe currently set at 11'2" from bottom of basin.
*NEW CONFIGURATION CHECK REQUIREMENTS

********************************************
* ICIAS SBR               *
********************************************

0 (0-10) EGL set at the SBR water level based on BioWin (2013: 30-M-2001)
36 8.2 12.3 6.31 /
*
* Q1 = total plant influent peak hour, 8.2
* Q2 = Future peak hour, 12.3
* Q3 = EQ basin outlet flow, 6.31 mgd (Max Day)
*
* 2037 Peak Instantaneous Flow 8.2 mgd --> 36.00 ft Max WSE
* 2037 Peak Daily Average Flow 6.31 mgd --> 36.00 ft Max WSE
```

```
* 2037 Max Month Wet Weather 2.09 mgd --> 32.50 ft Max WSE
* 2037 Average Dry Weather 0.99 mgd --> 30.75 ft Max WSE


6 (160-170) SBR main chamber (3013: 30-M-2001)
17 600 0 .013 123 0 276 0 50 0 0 /
*50% of peak hour flow Q1

8  (170-180) underflow baffle wall orifice (2013: 30-M-2001)
480 18 0.6 50 0 0/
* 40-ft of opening along 50-ft wall
* 18" height based on vendor input


6 (180-190) Pre-react Basin (2013: 30-M-2001)
17 600 0 .013 22 0 276 0 50 0 0 /
* 22 ft length

1 (200-210) Pipe from HW flow split to SBR (2013: 30-M-2001)
24 56 .013 2.3 1.0 50 0 0 /
* 24-inch diam
* 56 ft long pipe
* 4 90-deg bend, K=0.45*4=1.8
* Entrance Loss, K=0.5
* Total K = 2.3
* Exit Loss, K=1.0


2 (210-215) Split box (2013: 20-M-2000)
60 36 15 .013 2.2 0 50 0 0/
* 3'x6' drop box D/S of weir gate
* Turbulent flow, K=1.0
* 90-deg bends, K=1.2

4 (215-220) Weir gate (2013: 20-M-2000)
37.16 3.5 2 18 50 0 0/
*HGL 0.5 ft above D/S HGL

********************************************
*END OF ADDITION FOR SBR FLOW SPLIT        *
********************************************

6 (220-230) Grit outlet channel (2013: 20-M-3001)
18 36 0 .013 23 0 264 0 100 0 0 /

* Invert at 18'Channel
* Length = 23 ft based on SHN 5/11/13 dwg
* width = 3 ft based on SHN 5/11/13 dwg

4 (230-240) Grit Channel Weir (2013: 20-M-3001)
38.84 12 0 0 100 0 0 /

* 12'weir (no contractions)
* set invert 0.5' above downstream HGL

10 (260-270) Headloss across grit equipment (2013: 20-M-3001)
1.5 /
* based on 0.75-ft loss from vendor and 0.75-ft
* additional observed loss from SHN
* Grit equipment vendor is HydroInternational HeadCell

6 (273-275) Grit Inlet channel (2013: 20-M-2000)
38.84 36 0 .013 7 0 51 0.65 100 0 0 /
```

```
* symmetrical combining T-channel. K=0.65 (DS Miller Fig 13.16)

6 (273-275) Channel btwn screens and grit chamber (2013: 20-M-2000)
38.84 36 0 .013 8 0 51 2.4 50 0 0 /
* Flow split between two screens
* Invert match grit eff weir
* Length = 8 ft based on SHC 5/10/13 dwg
* width = 3 ft based on SHC 5/10/13 dwg
* 2 90-deg bends, K=2*1.2 = 2.4

6 (275-280) D/S Screen Channel (2013: 20-M-2000)
38.84 24 0 0.013 6 0 51 0 50 0 0/
* Invert to match grit eff weir
* Length = 6 ft based on SHC 5/10/13 dwg
* width = 24" based on SHC 5/10/13 dwg

10 (280-290) Arbitrary headloss across screens (2013: 20-M-2000)
0.5 /
* Assume 0.5 ft headloss (5/15/13 Mike Veach/SHN Email -
*  from Hydro-Dyne calculations)

6 (290-300) Channel screen channel 1/2 flow (2013: 20-M-2000)
38.84 18 0 .013 5 0 51 0 50 0 0 /

* Channel width 1.5' (18 in) based on SHC 5/10/13 dwg
* Length 5 ft based on SHC 5/10/13 dwg


6 (300-310) Channel flow  wide channel to screens (2013: 20-M-2000)
38.84 36 0 .013 15 0 51 2.4 100 0 0 /

* Channel width 13' (180 in)
* Length 3 ft
* 2 90-deg bend, K=2*1.2= 2.4

/*
```

```
********************************************
*                                          *
*                   HYDRO                  *
*        TREATMENT PLANT HYDRAULICS        *
*                                          *
*              CH2M Hill, Inc.             *
*         2300 NW Walnut Boulevard         *
*               P.O. Box 428               *
*         Corvallis, Oregon  97330         *
*                                          *
*              VERSION  9.56               *
*                24-JAN-02                 *
*                                          *
*           (C) COPYRIGHT 1902             *
*             CH2M-HILL INC.               *
*           ALL RIGHTS RESERVED            *
*                                          *
*       RUN ON  08/14/13   08:53:23        *
*                                          *
*                   NOTE                   *
* This page contains valuable information  *
* that should be saved.  If it becomes     *
* necessary to rerun this analysis in the  *
* future, this page will allow retrieval   *
* of the proper program and data files.    *
********************************************
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE   1
Q1=    0.00     Q2=    0.00     Q3=    0.00
=======================================================================

City of Coos Bay WWTP SBR Project

Project Number:469556.03.35.05.60

Assumptions:
All units in service
Peak Instantaneous Flow: Q =  8.2 mgd
SC three channels
SBR: 2 in parallel
EQ basin sized for concurrent SBR operation
UV two channels one in future.
All elevations must be checked for datum. include +4.2 ft to convert fr

MINOR LOSS COEFFICIENTS (FROM D.S. MILLER INTERNAL FLOW SYSTEMS, 1978)
90-deg elbow, K=0.45
45-deg elbow, K=0.2
180 deg. open channel bend, K=3.0
90 deg. open channel bend, K=1.2
45 deg. open channel bend, K=0.6
Entrance loss, K=0.5
Exit loss, K=1.0
Orifice coefficient, C, 0.6
21" Tee Through flow, dead branch, K=0.04
21" Tee Branch flow, dead run, K=1.10
```

```
♀


 UNITS OPTION SPECIFIED = 0
 LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
           WIDTH/HEIGHT = IN     DIAM = IN

                                                                PAGE   2
 Q1=    8.20     Q2=   12.30     Q3=    6.31
 =======================================================================


 CONDITIONS SET -                                               SEQ =  1
 (0-10) EGL set at mean higher high water level (100-yr flood)
 ENERGY LINE =  11.00  Q1 =   8.20  Q2 =  12.30  Q3 =   6.31  VEL = 0.00

  Q1 = total plant influent peak instantaneous flow, 8.2 mgd
  Q2 = Future peak instantaneous flow, 12.3 mgd
  Q3 = EQ basin outlet flow, 6.31 mgd (Peak Daily Average)

  FEMA FIRM map 41011C0168D for flood elevation.
 ELEMENT NO. 26                                                 SEQ =  2
  (10-20) existing diffuser outfall (1973 sht 38)
 NUMBER OF PORTS ------------------------      5
 PERCENT BETWEEN SHARP EDGE PORT (0.0) --    0.0
      AND BELL MOUTH PORT (100.0)
 AVAILABLE ENERGY AT PORT NO. 1 --------    3.92
 SPECIFIC GRAVITY DIFFERENCE ------------ 0.0250


 *------ PORT PARAMETERS ------*   *--------- PIPE PARAMETERS ---------*
     DIAM  CD   FLOW  VEL ENERGY    LNTH  DIAM         FLOW  VEL  H LOSS
 NUM                                           FRICT
   1 6.00 0.63  1.27 10.00  3.92     7.5  24.0 0.034   1.27  0.63  0.001
   2 6.00 0.63  1.27 10.01  3.93     7.5  24.0 0.028   2.54  1.25  0.003
   3 6.00 0.63  1.27  9.97  3.94     7.5  24.0 0.025   3.80  1.87  0.005
   4 6.00 0.62  1.26  9.91  3.94     7.5  24.0 0.024   5.06  2.49  0.009
   5 6.00 0.62  1.25  9.83  3.96     7.5  24.0 0.023   6.31  3.11  0.013
                                 -------                          ------
                                    37.5                           0.030
 HYDRAULIC GRADE LINE ELEV. HLOSS =  3.97    DN =   11.69  UP =    15.56
 ENERGY LINE ELEVATION                       DN =   11.69  UP =    15.66
 TOTAL FLOWRATE       ----       6.310

 Specific Gravity of Seawater = 1.025
 24" pipe w/ end invert at -17.5' therefor CL is at -16.5'
 100 %Q3
 Available engergy at Port 1 is at 1' reasonable??
 assumed divergence angle for 12" x 6" reducer = 20.5 deg.
 Absolute pipe roughness estimated at at 0.0102 inch following ex. in
  manual
 diffuser slope =.019
 assume 100% sharp edge diffuser--most conservative
 no risers
♀


 UNITS OPTION SPECIFIED = 0
 LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
           WIDTH/HEIGHT = IN     DIAM = IN

                                                                PAGE   3
```

```
Q1=    8.20     Q2=   12.30     Q3=    6.31
=======================================================================


ELEMENT NO.  1                                                 SEQ =  3
(20-30) Existing pipe from diffuser to existing MH (1973 sht 38)
PRESSURE LINE (CIR)     FLOWRATE =     6.31            VELOCITY =  3.11
PIPE ------ DIA = 24.0       LEN = 880.0                      N = 0.012
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  0.50    EXIT K =  0.00
HEAD LOSS: MISC =  0.07     EXIT =  0.00 PIPE =  1.40     TOTAL =  1.47
HYDRAULIC GRADE LINE ELEVATION              DN =   15.51  UP =    16.98
ENERGY LINE ELEVATION                       DN =   15.66  UP =    17.13
CMP Design Guide Mannings n = .011 to .020; assumed 0.012 due to
 relining.
Demo plan Sht 1 indicates demo and replacement of 24inch CMP outfall
Entrance loss from upstream MH K= 0.5

ELEMENT NO.  6                                                 SEQ =  4
(30-40) Flow through channel to represent existing MH (2013: 006-C-2001
RECT/TRAP CHANNEL       FLOWRATE =     6.31     MINOR LOSS K =    0.000
BASE =  72.0     SLP = 0.0   LEN =   6.0     N =0.012  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.12  UP =     0.12
CHANNEL BOTTOM ELEVATION                    DN =    3.33  UP =     3.33
DEPTH ---- CRIT =  0.43   NORMAL = 999.99   DN =   13.80  UP =    13.80
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   17.13  UP =    17.13
ENERGY LINE ELEVATION                       DN =   17.13  UP =    17.13
 Manhole dimension information provided by SHN Engineers.

ELEMENT NO.  1                                                 SEQ =  5
(45-50) Pipe from exst MH to UV basin (2013: 006-C-2001 and -2001A)
PRESSURE LINE (CIR)     FLOWRATE =     6.31            VELOCITY =  1.99
PIPE ------ DIA = 30.0       LEN = 880.0                      N = 0.012
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  5.20    EXIT K =  3.00
HEAD LOSS: MISC =  0.32     EXIT =  0.18 PIPE =  0.42     TOTAL =  0.93
HYDRAULIC GRADE LINE ELEVATION              DN =   17.07  UP =    18.00
ENERGY LINE ELEVATION                       DN =   17.13  UP =    18.06
 2 45-deg bend, K=0.2*2 = 0.4
 2 90-deg bend, K=0.45*2 = 0.9
 2 90-deg open channel bend, K=1.2*2 = 2.4
 Entrance loss, K=0.5*3 = 1.5
 Total K = 5.2
 Exit loss, K=1*3 = 3
 Using open channel bend to represent 2 manholes along pipeline.
 No pipe profile has been established yet including yard pipe CL.
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE   4
Q1=    8.20     Q2=   12.30     Q3=    6.31
=======================================================================


ELEMENT NO.  5                                                 SEQ =  6
(50-55) Gravity pipe outlet from UV (2013: 40-M-3000)
CIRCULAR CHANNEL        FLOWRATE =     6.31     MINOR LOSS K =    0.000
PIPE ------ DIA = 30.0       LEN =  10.0     N =0.012  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    2.35  UP =     2.34
CHANNEL BOTTOM ELEVATION                    DN =   16.00  UP =    16.00
```

```
DEPTH ---- CRIT =  1.04   NORMAL = 999.99   DN =    1.97  UP =     1.98
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.005  TOTAL = 0.005
HYDRAULIC GRADE LINE ELEV                   DN =   17.97  UP =    17.98
ENERGY LINE ELEVATION                       DN =   18.06  UP =    18.06

ELEMENT NO.  6                                               SEQ =  7
(55-60) Channel at downstream end of UV 2013: 40-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     6.31     MINOR LOSS K =    0.000
BASE =  48.0     SLP = 0.0   LEN =  10.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.30  UP =     0.30
CHANNEL BOTTOM ELEVATION                    DN =   10.00  UP =    10.00
DEPTH ---- CRIT =  0.57   NORMAL = 999.99   DN =    8.06  UP =     8.06
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   18.06  UP =    18.06
ENERGY LINE ELEVATION                       DN =   18.06  UP =    18.06
Invert  set at 10' to account for pipe bury (grd surface=15'
 (1973 sht 38))
9' (108") width
Mannings n = 0.013
4 ft length
slope= 0.
Max depth is 12-ft

ELEMENT NO. 12                                               SEQ =  8
 (60-65) Finger weir launder from UV channel (2013: 40-M-2000)
RECT/TRAP LAUNDER       FLOWRATE =     2.10     MINOR LOSS K =  0.00000
BASE =  18.0     SLP = 0.0   LEN =  20.0     N =0.011  SLOPE =  0.01200
TOP WIDTH    IN                             DN =   18.00  UP =    18.00
VELOCITY --------------------------         DN =    2.51  UP =     0.00
CHANNEL BOTTOM ELEVATION ----------         DN =   17.10  UP =    17.34
DEPTH --------------------- CRIT =  0.53    DN =    0.87  UP =     0.82
HEAD LOSS -- MINOR =0.000 HLOSS = 0.1000 TOTAL = 0.10004 QUP =     0.00
HYDRAULIC GRADE LINE ELEVATION              DN =   17.97  UP =    18.16
ENERGY LINE ELEVATION                       DN =   18.06  UP =    18.16
 SST launder, V-notch weirs on each side
 3 launders, so flow is 33.3% of Q3
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                             PAGE   5
Q1=    8.20     Q2=   12.30     Q3=    6.31
=======================================================================


ELEMENT NO.  3                                               SEQ =  9
(65-70) V-notch weirs (2013: 40-M-2000)
V-NOTCH WEIR            FLOWRATE =     1.05          NON SUBMERGED WEIR
WEIR - ANGLE 90. DEG;    40 NOTCHES AT  0.026 MGD EACH; ELEV =    18.55
LENGTH =  20.0       SUBMERGENCE =  0.00                  HEAD =     0.19
HYDRAULIC GRADE LINE ELEV. HLOSS =  0.58    DN =   18.16  UP =    18.74
ENERGY LINE ELEVATION                       DN =   18.16  UP =    18.74
 20-ft long weirs into 1-ft deep launders
 Two weir lengths along each launder x 3 launders
 total weir length 120-ft.  Trojan recommends 118 ft.
 based on standard detail

ELEMENT NO.  6                                               SEQ = 10
(70-80) Rectangular Open Channel (2013: 40-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     6.31     MINOR LOSS K =    0.000
```

```
BASE = 108.0     SLP = 0.0   LEN =  23.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.48  UP =     0.47
CHANNEL BOTTOM ELEVATION                    DN =   16.46  UP =    16.46
DEPTH ---- CRIT =  0.33   NORMAL = 999.99   DN =    2.28  UP =     2.28
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   18.74  UP =    18.74
ENERGY LINE ELEVATION                       DN =   18.74  UP =    18.74
 Expansion loss, K=0.45 (DS Miller, Fig 14.15)

ELEMENT NO.  6                                              SEQ = 11
(70-80) Rectangular Open Channel (2013: 40-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     6.31     MINOR LOSS K =    0.000
BASE =  40.0     SLP = 0.0   LEN =  46.5     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    1.30  UP =     1.29
CHANNEL BOTTOM ELEVATION                    DN =   16.46  UP =    16.46
DEPTH ---- CRIT =  0.64   NORMAL = 999.99   DN =    2.26  UP =     2.27
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.008  TOTAL = 0.008
HYDRAULIC GRADE LINE ELEV                   DN =   18.72  UP =    18.73
ENERGY LINE ELEVATION                       DN =   18.74  UP =    18.75
40-inch width based on Trojan 2/27/2013

ELEMENT NO. 10                                              SEQ = 12
 (80-90) Headloss for UV equipment in channel
******ADDITIONAL HEAD LOSS SPECIFIED******
HL =  0.55     K =  0.00   VHEAD =  0.00
HYDRAULIC GRADE LINE EL.   HLOSS =  0.55    DN =   18.73  UP =    19.30
ENERGY LINE EL.                             DN =   18.75  UP =    19.30
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                            PAGE   6
Q1=    8.20     Q2=   12.30     Q3=    6.31
=======================================================================

Assumes 1.5" HL per bank, 1.5"x3 = 4.5"
Straightening baffle loss = 2"
Total loss = 6.5" or 0.55 ft (rounded up)
Trojan's headloss is ~1.1"/bank on average
Check that max water depth is 2.66' from upstream bank per Trojan

ELEMENT NO.  6                                              SEQ = 13
(90-100) Rectangular channel upstream of UV (2013: 40-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     6.31     MINOR LOSS K =    2.400
BASE =  76.0     SLP = 0.0   LEN =   4.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.17  UP =     0.17
CHANNEL BOTTOM ELEVATION                    DN =   10.00  UP =    10.00
DEPTH ---- CRIT =  0.42   NORMAL = 999.99   DN =    9.30  UP =     9.30
HEAD LOSS -----            MINOR =  0.001  HLOSS = 0.001  TOTAL = 0.002
HYDRAULIC GRADE LINE ELEV                   DN =   19.30  UP =    19.30
ENERGY LINE ELEVATION                       DN =   19.30  UP =    19.30
 two 90-deg bends as flow transitions from below, K=2*1.2=2.4
Invert  set at 10'

ELEMENT NO.  1                                              SEQ = 14
(100-105) Pressurized Circular Pipe to Expansion (2013: 30-M-2000)
PRESSURE LINE (CIR)     FLOWRATE =     6.31            VELOCITY =  3.11
PIPE ------ DIA = 24.0       LEN =  50.0                      N = 0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  0.80    EXIT K =  1.00
HEAD LOSS: MISC =  0.12     EXIT =  0.15 PIPE =  0.09     TOTAL =  0.36
```

```
HYDRAULIC GRADE LINE ELEVATION              DN =   19.15  UP =    19.52
ENERGY LINE ELEVATION                       DN =   19.30  UP =    19.67
Exit loss, K = 1
Expansion to 24-in diam, K = 0.15
50 ft of 24" pipe
 1 90-deg bends, K=0.45
 1 45-deg bend, K=0.2
 Total K = 0.8

ELEMENT NO.  1                                                SEQ = 15
(105-110) Pipe from expansion to FCV (2013: 30-M-2000)
PRESSURE LINE (CIR)     FLOWRATE =     6.31            VELOCITY =  6.99
PIPE ------ DIA = 16.0       LEN =   5.0                     N = 0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  1.12    EXIT K =  0.00
HEAD LOSS: MISC =  0.85     EXIT =  0.00 PIPE =  0.08     TOTAL =  0.93
HYDRAULIC GRADE LINE ELEVATION              DN =   18.91  UP =    19.84
ENERGY LINE ELEVATION                       DN =   19.67  UP =    20.60
 24x16 expansion, K = 0.31
 gate valve: K = 0.10
 Flow through tee: K = 0.26
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                              PAGE   7
Q1=    8.20     Q2=   12.30     Q3=    6.31
=======================================================================

 1 90-deg bend, K=0.45
 Total K = 1.12

ELEMENT NO. 28                                                SEQ = 16
 (110-115) Flow Control Valve (2013: 30-M-2000)
PRESSURE LINE (CIR)     FLOWRATE =     6.31             VELOCITY =  6.99
TOTAL HEAD LOSS ACROSS VALVE                                  =     0.19
HYDRAULIC GRADE LINE ELEVATION               DN =   19.84  UP =    20.03
ENERGY LINE ELEVATION                        DN =   20.60  UP =    20.79
Data for 16-inch BF valve from ValMatic

ELEMENT NO.  1                                                SEQ = 17
(115-120) Pipe from Flow control valve to Contraction (2013: 30-M-2000)
PRESSURE LINE (CIR)     FLOWRATE =     6.31            VELOCITY =  6.99
PIPE ------ DIA = 16.0       LEN =  20.0                     N = 0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  0.36    EXIT K =  0.00
HEAD LOSS: MISC =  0.27     EXIT =  0.00 PIPE =  0.32     TOTAL =  0.60
HYDRAULIC GRADE LINE ELEVATION              DN =   20.03  UP =    20.62
ENERGY LINE ELEVATION                       DN =   20.79  UP =    21.38
 includes 16" mag meter
 gate valve: K = 0.10
 Flow through tee: K = 0.26
 Total K = 0.36

ELEMENT NO.  1                                                SEQ = 18
(120-130) Pipe from contractor to EQ Basin (2013: 30-M-2000)
PRESSURE LINE (CIR)     FLOWRATE =     6.31            VELOCITY =  3.11
PIPE ------ DIA = 24.0       LEN =  30.0                     N = 0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  1.01    EXIT K =  0.00
HEAD LOSS: MISC =  0.15     EXIT =  0.00 PIPE =  0.06     TOTAL =  0.21
HYDRAULIC GRADE LINE ELEVATION              DN =   21.23  UP =    21.44
ENERGY LINE ELEVATION                       DN =   21.38  UP =    21.59
```

```
Entrance loss K=0.5
contraction to 16-in, K= 0.06
 1 90-deg elbow, K=0.45
 Total K = 1.01
 30 ft of 24" pipe
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE   8
Q1=    8.20     Q2=   12.30     Q3=    6.31
=======================================================================


ELEMENT NO.  6                                                 SEQ = 19
(130-140) EQ basin (2013:30-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     6.31     MINOR LOSS K =    0.000
BASE = 420.0     SLP = 0.0   LEN =  98.0     N =0.011  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.06  UP =     0.06
CHANNEL BOTTOM ELEVATION                    DN =   17.00  UP =    17.00
DEPTH ---- CRIT =  0.13   NORMAL = 999.99   DN =    4.59  UP =     4.59
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.003  TOTAL = 0.003
HYDRAULIC GRADE LINE ELEV                   DN =   21.59  UP =    21.59
ENERGY LINE ELEVATION                       DN =   21.59  UP =    21.59
 35' W x 98'L

ELEMENT NO. 10                                                 SEQ = 20
 (140-150) Headloss to represent fluccuation in EQ basin (2013: 30-M-20
******ADDITIONAL HEAD LOSS SPECIFIED******
HL =  5.00     K =  0.00   VHEAD =  0.00
HYDRAULIC GRADE LINE EL.   HLOSS =  5.00    DN =   21.59  UP =    26.59
ENERGY LINE EL.                             DN =   21.59  UP =    26.59
Max 5' per Jason Riegler/CVO
Effluent Level from SBR should not exceed the invert of the decant
collection pipe currently set at 11'2" from bottom of basin.
NEW CONFIGURATION CHECK REQUIREMENTS
*******************************************
 ICIAS SBR               *
*******************************************
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE   9
Q1=    8.20     Q2=   12.30     Q3=    6.31
=======================================================================


CONDITIONS SET -                                               SEQ = 21
(0-10) EGL set at the SBR water level based on BioWin (2013: 30-M-2001)
ENERGY LINE =  36.00  Q1 =   8.20  Q2 =  12.30  Q3 =   6.31  VEL = 0.06

 Q1 = total plant influent peak hour, 8.2
 Q2 = Future peak hour, 12.3
 Q3 = EQ basin outlet flow, 6.31 mgd (Max Day)

 2037 Peak Instantaneous Flow 8.2 mgd --> 36.00 ft Max WSE
```

```
 2037 Peak Daily Average Flow 6.31 mgd --> 36.00 ft Max WSE
 2037 Max Month Wet Weather 2.09 mgd --> 32.50 ft Max WSE
 2037 Average Dry Weather 0.99 mgd --> 30.75 ft Max WSE

ELEMENT NO.  6                                                SEQ = 22
(160-170) SBR main chamber (3013: 30-M-2001)
RECT/TRAP CHANNEL       FLOWRATE =     4.10     MINOR LOSS K =    0.000
BASE = 600.0     SLP = 0.0   LEN = 123.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.01  UP =     0.01
CHANNEL BOTTOM ELEVATION                    DN =   17.00  UP =    17.00
DEPTH ---- CRIT =  0.08   NORMAL = 999.99   DN =   19.00  UP =    19.00
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.004  TOTAL = 0.004
HYDRAULIC GRADE LINE ELEV                   DN =   36.00  UP =    36.00
ENERGY LINE ELEVATION                       DN =   36.00  UP =    36.00
50% of peak hour flow Q1

ELEMENT NO.  8                                                SEQ = 23
 (170-180) underflow baffle wall orifice (2013: 30-M-2001)
RECTANGULAR ORIFICE     FLOWRATE =     4.10      ORIFICE VEL =     0.11
GATE -- WIDTH = 480.0      DEPTH =  18.0        ORIFICE COEF =    0.600
HYDRAULIC GRADE LINE EL.   HLOSS =  0.00    DN =   36.00  UP =    36.00
ENERGY LINE EL.                             DN =   36.00  UP =    36.00
 40-ft of opening along 50-ft wall
 18" height based on vendor input

ELEMENT NO.  6                                                SEQ = 24
(180-190) Pre-react Basin (2013: 30-M-2001)
RECT/TRAP CHANNEL       FLOWRATE =     4.10     MINOR LOSS K =    0.000
BASE = 600.0     SLP = 0.0   LEN =  22.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.01  UP =     0.01
CHANNEL BOTTOM ELEVATION                    DN =   17.00  UP =    17.00
DEPTH ---- CRIT =  0.08   NORMAL = 999.99   DN =   19.00  UP =    19.01
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   36.00  UP =    36.01
ENERGY LINE ELEVATION                       DN =   36.00  UP =    36.01
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                              PAGE  10
Q1=    8.20     Q2=   12.30     Q3=    6.31
=======================================================================

 22 ft length

ELEMENT NO.  1                                                SEQ = 25
(200-210) Pipe from HW flow split to SBR (2013: 30-M-2001)
PRESSURE LINE (CIR)     FLOWRATE =     4.10           VELOCITY =  2.02
PIPE ------ DIA = 24.0       LEN =  56.0                     N = 0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  2.30    EXIT K =  1.00
HEAD LOSS: MISC =  0.15     EXIT =  0.06 PIPE =  0.04     TOTAL =  0.25
HYDRAULIC GRADE LINE ELEVATION              DN =   35.94  UP =    36.19
ENERGY LINE ELEVATION                       DN =   36.01  UP =    36.26
 24-inch diam
 56 ft long pipe
 4 90-deg bend, K=0.45*4=1.8
 Entrance Loss, K=0.5
 Total K = 2.3
 Exit Loss, K=1.0
```

```
ELEMENT NO.  2                                                 SEQ = 26
(210-215) Split box (2013: 20-M-2000)
PRESSURE LINE (RECT)    FLOWRATE =     4.10           VELOCITY =   0.42
PIPE- H =  36.0 W =  60.0    LEN =  15.0                     N =  0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  2.20    EXIT K =  0.00
HEAD LOSS: MISC =  0.01     EXIT =  0.00 PIPE =  0.00     TOTAL =  0.01
HYDRAULIC GRADE LINE ELEVATION              DN =   36.26  UP =    36.26
ENERGY LINE ELEVATION                       DN =   36.26  UP =    36.26
 3'x6' drop box D/S of weir gate
 Turbulent flow, K=1.0
 90-deg bends, K=1.2

ELEMENT NO.  4                                                 SEQ = 27
(215-220) Weir gate (2013: 20-M-2000)
RECTANGULAR WEIR        FLOWRATE =     4.10          NON SUBMERGED WEIR
WEIR ------------ SIDE CONTRACTION COEFFICIENT =2.00    ELEV =    37.16
LENGTH =   3.5       SUBMERGENCE =  0.00                HEAD =     0.68
HYDRAULIC GRADE LINE ELEV. HLOSS =  1.57    DN =   36.26  UP =    37.84
ENERGY LINE ELEVATION                       DN =   36.26  UP =    37.84
HGL 0.5 ft above D/S HGL
*******************************************
END OF ADDITION FOR SBR FLOW SPLIT        *
*******************************************
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE  11
Q1=    8.20     Q2=   12.30     Q3=    6.31
=======================================================================


ELEMENT NO.  6                                                 SEQ = 28
(220-230) Grit outlet channel (2013: 20-M-3001)
RECT/TRAP CHANNEL       FLOWRATE =     8.20     MINOR LOSS K =    0.000
BASE =  36.0     SLP = 0.0   LEN =  23.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.21  UP =     0.21
CHANNEL BOTTOM ELEVATION                    DN =   18.00  UP =    18.00
DEPTH ---- CRIT =  0.82   NORMAL = 999.99   DN =   19.84  UP =    19.84
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   37.84  UP =    37.84
ENERGY LINE ELEVATION                       DN =   37.84  UP =    37.84
 Invert at 18'Channel
 Length = 23 ft based on SHN 5/11/13 dwg
 width = 3 ft based on SHN 5/11/13 dwg

ELEMENT NO.  4                                                 SEQ = 29
(230-240) Grit Channel Weir (2013: 20-M-3001)
RECTANGULAR WEIR        FLOWRATE =     8.20          NON SUBMERGED WEIR
WEIR ------------ SIDE CONTRACTION COEFFICIENT =0.00    ELEV =    38.84
LENGTH =  12.0       SUBMERGENCE =  0.00                HEAD =     0.47
HYDRAULIC GRADE LINE ELEV. HLOSS =  1.47    DN =   37.84  UP =    39.31
ENERGY LINE ELEVATION                       DN =   37.84  UP =    39.31
 12'weir (no contractions)
 set invert 0.5' above downstream HGL

ELEMENT NO. 10                                                 SEQ = 30
 (260-270) Headloss across grit equipment (2013: 20-M-3001)
******ADDITIONAL HEAD LOSS SPECIFIED******
HL =  1.50     K =  0.00   VHEAD =  0.00
```

```
HYDRAULIC GRADE LINE EL.   HLOSS =  1.50    DN =   39.31  UP =    40.81
ENERGY LINE EL.                             DN =   39.31  UP =    40.81
 based on 0.75-ft loss from vendor and 0.75-ft
 additional observed loss from SHN
 Grit equipment vendor is HydroInternational HeadCell

ELEMENT NO.  6                                               SEQ = 31
(273-275) Grit Inlet channel (2013: 20-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     8.20     MINOR LOSS K =    0.650
BASE =  36.0     SLP = 0.0   LEN =   7.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    2.24  UP =     2.16
CHANNEL BOTTOM ELEVATION                    DN =   38.84  UP =    38.84
DEPTH ---- CRIT =  0.82   NORMAL = 999.99   DN =    1.89  UP =     1.95
HEAD LOSS -----            MINOR =  0.050  HLOSS = 0.004  TOTAL = 0.054
HYDRAULIC GRADE LINE ELEV                   DN =   40.73  UP =    40.79
ENERGY LINE ELEVATION                       DN =   40.81  UP =    40.86
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                             PAGE  12
Q1=    8.20     Q2=   12.30     Q3=    6.31
=======================================================================

 symmetrical combining T-channel. K=0.65 (DS Miller Fig 13.16)

ELEMENT NO.  6                                               SEQ = 32
(273-275) Channel btwn screens and grit chamber (2013: 20-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     4.10     MINOR LOSS K =    2.400
BASE =  36.0     SLP = 0.0   LEN =   8.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    1.05  UP =     1.03
CHANNEL BOTTOM ELEVATION                    DN =   38.84  UP =    38.84
DEPTH ---- CRIT =  0.52   NORMAL = 999.99   DN =    2.01  UP =     2.05
HEAD LOSS -----            MINOR =  0.041  HLOSS = 0.002  TOTAL = 0.043
HYDRAULIC GRADE LINE ELEV                   DN =   40.85  UP =    40.89
ENERGY LINE ELEVATION                       DN =   40.86  UP =    40.91
 Flow split between two screens
 Invert match grit eff weir
 Length = 8 ft based on SHC 5/10/13 dwg
 width = 3 ft based on SHC 5/10/13 dwg
 2 90-deg bends, K=2*1.2 = 2.4

ELEMENT NO.  6                                               SEQ = 33
(275-280) D/S Screen Channel (2013: 20-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     4.10     MINOR LOSS K =    0.000
BASE =  24.0     SLP = 0.0   LEN =   6.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    1.56  UP =     1.56
CHANNEL BOTTOM ELEVATION                    DN =   38.84  UP =    38.84
DEPTH ---- CRIT =  0.68   NORMAL = 999.99   DN =    2.03  UP =     2.03
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.003  TOTAL = 0.003
HYDRAULIC GRADE LINE ELEV                   DN =   40.87  UP =    40.87
ENERGY LINE ELEVATION                       DN =   40.91  UP =    40.91
 Invert to match grit eff weir
 Length = 6 ft based on SHC 5/10/13 dwg
 width = 24" based on SHC 5/10/13 dwg

ELEMENT NO. 10                                               SEQ = 34
 (280-290) Arbitrary headloss across screens (2013: 20-M-2000)
******ADDITIONAL HEAD LOSS SPECIFIED******
HL =  0.50     K =  0.00   VHEAD =  0.00
```

```
 HYDRAULIC GRADE LINE EL.   HLOSS =  0.50    DN =   40.87  UP =    41.41
 ENERGY LINE EL.                             DN =   40.91  UP =    41.41
  Assume 0.5 ft headloss (5/15/13 Mike Veach/SHN Email -
   from Hydro-Dyne calculations)
♀


 UNITS OPTION SPECIFIED = 0
 LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
           WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE  13
 Q1=    8.20     Q2=   12.30     Q3=    6.31
 ========================================================================


 ELEMENT NO.  6                                                SEQ = 35
 (290-300) Channel screen channel 1/2 flow (2013: 20-M-2000)
 RECT/TRAP CHANNEL       FLOWRATE =     4.10     MINOR LOSS K =    0.000
 BASE =  18.0     SLP = 0.0   LEN =   5.0     N =0.013  SLOPE =  0.00000
 VELOCITY ---------------- NORMAL =999.99    DN =    1.67  UP =     1.67
 CHANNEL BOTTOM ELEVATION                    DN =   38.84  UP =    38.84
 DEPTH ---- CRIT =  0.82   NORMAL = 999.99   DN =    2.53  UP =     2.53
 HEAD LOSS -----           MINOR =  0.000  HLOSS = 0.003  TOTAL = 0.003
 HYDRAULIC GRADE LINE ELEV                   DN =   41.37  UP =    41.37
 ENERGY LINE ELEVATION                       DN =   41.41  UP =    41.41
  Channel width 1.5' (18 in) based on SHC 5/10/13 dwg
  Length 5 ft based on SHC 5/10/13 dwg

 ELEMENT NO.  6                                                SEQ = 36
 (300-310) Channel flow  wide channel to screens (2013: 20-M-2000)
 RECT/TRAP CHANNEL       FLOWRATE =     8.20     MINOR LOSS K =    2.400
 BASE =  36.0     SLP = 0.0   LEN =  15.0     N =0.013  SLOPE =  0.00000
 VELOCITY ---------------- NORMAL =999.99    DN =    1.67  UP =     1.60
 CHANNEL BOTTOM ELEVATION                    DN =   38.84  UP =    38.84
 DEPTH ---- CRIT =  0.82   NORMAL = 999.99   DN =    2.53  UP =     2.64
 HEAD LOSS -----           MINOR =  0.104  HLOSS = 0.004  TOTAL = 0.108
 HYDRAULIC GRADE LINE ELEV                   DN =   41.37  UP =    41.48
 ENERGY LINE ELEVATION                       DN =   41.41  UP =    41.52
  Channel width 13' (180 in)
  Length 3 ft
  2 90-deg bend, K=2*1.2= 2.4
^
```

```
/*
*City of Coos Bay WWTP SBR Project
*
*Project Number:469556.03.35.05.60
*
*Assumptions:
*All units in service
*Peak Daily Average: Q =  6.31 mgd
*SC three channels
*SBR: 2 in parallel
*EQ basin sized for concurrent SBR operation
*UV two channels one in future.
*All elevations must be checked for datum. include +4.2 ft to convert from 1974
vertical datum to NGVD 1988

*
*MINOR LOSS COEFFICIENTS (FROM D.S. MILLER INTERNAL FLOW SYSTEMS, 1978)
*90-deg elbow, K=0.45
*45-deg elbow, K=0.2
*180 deg. open channel bend, K=3.0
*90 deg. open channel bend, K=1.2
*45 deg. open channel bend, K=0.6
*Entrance loss, K=0.5
*Exit loss, K=1.0
*Orifice coefficient, C, 0.6
*21" Tee Through flow, dead branch, K=0.04
*21" Tee Branch flow, dead run, K=1.10
*
*
0 (0-10) EGL set at mean higher high water level (100-yr flood)
11 8.2 12.3 6.31 /
*
* Q1 = total plant influent peak instantaneous flow, 8.2 mgd
* Q2 = Future peak instantaneous flow, 12.3 mgd
* Q3 = EQ basin outlet flow, 6.31 mgd (Peak Daily Average)
*
* FEMA FIRM map 41011C0168D for flood elevation.


26 (10-20) existing diffuser outfall (1973 sht 38)
.025 -16.5 0 0 100 1 1 /
5 20.5 6 24 7.5 .0102 .019 0 0 / Line 3
/*

*Specific Gravity of Seawater = 1.025
*24" pipe w/ end invert at -17.5' therefor CL is at -16.5'
*100 %Q3
*Available engergy at Port 1 is at 1' reasonable??
*assumed divergence angle for 12" x 6" reducer = 20.5 deg.
*Absolute pipe roughness estimated at at 0.0102 inch following ex. in
* manual
*diffuser slope =.019
*assume 100% sharp edge diffuser--most conservative
*no risers


1 (20-30) Existing pipe from diffuser to existing MH (1973 sht 38)
24 880 .012 0.5 0 0 0 100 /

*CMP Design Guide Mannings n = .011 to .020; assumed 0.012 due to
* relining.
*Demo plan Sht 1 indicates demo and replacement of 24inch CMP outfall
*Entrance loss from upstream MH K= 0.5
```

```
6 (30-40) Flow through channel to represent existing MH (2013: 006-C-2001A)
3.33 72 0 .012 6 0 1000 0 0 0 100 /
* Manhole dimension information provided by SHN Engineers.

1 (45-50) Pipe from exst MH to UV basin (2013: 006-C-2001 and -2001A)
30 880 .012 5.2 3 0 0 100 /
* 2 45-deg bend, K=0.2*2 = 0.4
* 2 90-deg bend, K=0.45*2 = 0.9
* 2 90-deg open channel bend, K=1.2*2 = 2.4
* Entrance loss, K=0.5*3 = 1.5
* Total K = 5.2
* Exit loss, K=1*3 = 3
* Using open channel bend to represent 2 manholes along pipeline.
* No pipe profile has been established yet including yard pipe CL.

5 (50-55) Gravity pipe outlet from UV (2013: 40-M-3000)
16 30 0.012 10 0 30 0 0 0 100/

6 (55-60) Channel at downstream end of UV 2013: 40-M-2000)
10 48 0 0.013 10 0 144 0 0 0 100 /
*Invert  set at 10' to account for pipe bury (grd surface=15'
* (1973 sht 38))
*9' (108") width
*Mannings n = 0.013
*4 ft length
*slope= 0.
*Max depth is 12-ft

12 (60-65) Finger weir launder from UV channel (2013: 40-M-2000)
17.1 18 0 0.011 20 0.012 18 0 0 0 33.3 /

* SST launder, V-notch weirs on each side
* 3 launders, so flow is 33.3% of Q3

3 (65-70) V-notch weirs (2013: 40-M-2000)
18.55 20 6 3 16.84 0 0 16.67 90/
* 20-ft long weirs into 1-ft deep launders
* Two weir lengths along each launder x 3 launders
* total weir length 120-ft.  Trojan recommends 118 ft.
* based on standard detail

6 (70-80) Rectangular Open Channel (2013: 40-M-2000)
16.46 108 0 .013 23 0 62 0 0 0 100 /
* Expansion loss, K=0.45 (DS Miller, Fig 14.15)

6 (70-80) Rectangular Open Channel (2013: 40-M-2000)
16.46 40 0 .013 46.5 0 62 0 0 0 100 /
*40-inch width based on Trojan 2/27/2013

10 (80-90) Headloss for UV equipment in channel
0.55 0 /
*Assumes 1.5" HL per bank, 1.5"x3 = 4.5"
*Straightening baffle loss = 2"
*Total loss = 6.5" or 0.55 ft (rounded up)
*Trojan's headloss is ~1.1"/bank on average
*Check that max water depth is 2.66' from upstream bank per Trojan

6 (90-100) Rectangular channel upstream of UV (2013: 40-M-2000)
10 76 0 .013 4 0 144 2.4 0 0 100 /
* two 90-deg bends as flow transitions from below, K=2*1.2=2.4
*Invert  set at 10'
```

```
1 (100-105) Pressurized Circular Pipe to Expansion (2013: 30-M-2000)
24 50 .013 0.8 1.0 0 0 100 /
*Exit loss, K = 1
*Expansion to 24-in diam, K = 0.15
*50 ft of 24" pipe
* 1 90-deg bends, K=0.45
* 1 45-deg bend, K=0.2
* Total K = 0.8

1 (105-110) Pipe from expansion to FCV (2013: 30-M-2000)
16 5 0.013 1.12 0 0 0 100/
* 24x16 expansion, K = 0.31
* gate valve: K = 0.10
* Flow through tee: K = 0.26
* 1 90-deg bend, K=0.45
* Total K = 1.12

28 (110-115) Flow Control Valve (2013: 30-M-2000)
0 0 100 16 .15 5.76 .25 7.2 .37 8.64 /
*Data for 16-inch BF valve from ValMatic

1 (115-120) Pipe from Flow control valve to Contraction (2013: 30-M-2000)
16 20 0.013 0.36 0 0 0 100/
* includes 16" mag meter
* gate valve: K = 0.10
* Flow through tee: K = 0.26
* Total K = 0.36

1 (120-130) Pipe from contractor to EQ Basin (2013: 30-M-2000)
24 30 .013 1.01 0 0 0 100 /
*Entrance loss K=0.5
*contraction to 16-in, K= 0.06
* 1 90-deg elbow, K=0.45
* Total K = 1.01
* 30 ft of 24" pipe

6 (130-140) EQ basin (2013:30-M-2000)
17 420 0 .011 98 0 1000 0 0 0 100 /

* 35' W x 98'L

10 (140-150) Headloss to represent fluccuation in EQ basin (2013: 30-M-2000)
5 /

*Max 5' per Jason Riegler/CVO

*Effluent Level from SBR should not exceed the invert of the decant
*collection pipe currently set at 11'2" from bottom of basin.
*NEW CONFIGURATION CHECK REQUIREMENTS

********************************************
* ICIAS SBR               *
********************************************

0 (0-10) EGL set at the SBR water level based on BioWin (2013: 30-M-2001)
36 6.31 12.3 6.31 /
*
* Q1 = total plant influent , 6.31
* Q2 = Future peak hour, 12.3
* Q3 = EQ basin outlet flow, 6.31 mgd (Maximum)
*
* 2037 Peak Instantaneous Flow 8.2 mgd --> 36.00 ft Max WSE
* 2037 Peak Daily Average Flow 6.31 mgd --> 36.00 ft Max WSE
```

```
* 2037 Max Month Wet Weather 2.09 mgd --> 32.50 ft Max WSE
* 2037 Average Dry Weather 0.99 mgd --> 30.75 ft Max WSE


6 (160-170) SBR main chamber (3013: 30-M-2001)
17 600 0 .013 123 0 276 0 50 0 0 /
*50% of peak hour flow Q1

8  (170-180) underflow baffle wall orifice (2013: 30-M-2001)
480 18 0.6 50 0 0/
* 40-ft of opening along 50-ft wall
* 18" height based on vendor input


6 (180-190) Pre-react Basin (2013: 30-M-2001)
17 600 0 .013 22 0 276 0 50 0 0 /
* 22 ft length

1 (200-210) Pipe from HW flow split to SBR (2013: 30-M-2001)
24 56 .013 2.3 1.0 50 0 0 /
* 24-inch diam
* 56 ft long pipe
* 4 90-deg bend, K=0.45*4=1.8
* Entrance Loss, K=0.5
* Total K = 2.3
* Exit Loss, K=1.0


2 (210-215) Split box (2013: 20-M-2000)
60 36 15 .013 2.2 0 50 0 0/
* 3'x6' drop box D/S of weir gate
* Turbulent flow, K=1.0
* 90-deg bends, K=1.2

4 (215-220) Weir gate (2013: 20-M-2000)
37.16 3.5 2 18 50 0 0/
*HGL 0.5 ft above D/S HGL

********************************************
*END OF ADDITION FOR SBR FLOW SPLIT        *
********************************************

6 (220-230) Grit outlet channel (2013: 20-M-3001)
18 36 0 .013 23 0 264 0 100 0 0 /

* Invert at 18'Channel
* Length = 23 ft based on SHN 5/11/13 dwg
* width = 3 ft based on SHN 5/11/13 dwg

4 (230-240) Grit Channel Weir (2013: 20-M-3001)
38.84 12 0 0 100 0 0 /

* 12'weir (no contractions)
* set invert 0.5' above downstream HGL

10 (260-270) Headloss across grit equipment (2013: 20-M-3001)
1.5 /
* based on 0.75-ft loss from vendor and 0.75-ft
* additional observed loss from SHN
* Grit equipment vendor is HydroInternational HeadCell

6 (273-275) Grit Inlet channel (2013: 20-M-2000)
38.84 36 0 .013 7 0 51 0.65 100 0 0 /
```

```
* symmetrical combining T-channel. K=0.65 (DS Miller Fig 13.16)

6 (273-275) Channel btwn screens and grit chamber (2013: 20-M-2000)
38.84 36 0 .013 8 0 51 2.4 50 0 0 /
* Flow split between two screens
* Invert match grit eff weir
* Length = 8 ft based on SHC 5/10/13 dwg
* width = 3 ft based on SHC 5/10/13 dwg
* 2 90-deg bends, K=2*1.2 = 2.4

6 (275-280) D/S Screen Channel (2013: 20-M-2000)
38.84 24 0 0.013 6 0 51 0 50 0 0/
* Invert to match grit eff weir
* Length = 6 ft based on SHC 5/10/13 dwg
* width = 24" based on SHC 5/10/13 dwg

10 (280-290) Arbitrary headloss across screens (2013: 20-M-2000)
0.5 /
* Assume 0.5 ft headloss (5/15/13 Mike Veach/SHN Email -
*  from Hydro-Dyne calculations)

6 (290-300) Channel screen channel 1/2 flow (2013: 20-M-2000)
38.84 18 0 .013 5 0 51 0 50 0 0 /

* Channel width 1.5' (18 in) based on SHC 5/10/13 dwg
* Length 5 ft based on SHC 5/10/13 dwg


6 (300-310) Channel flow  wide channel to screens (2013: 20-M-2000)
38.84 36 0 .013 15 0 51 2.4 100 0 0 /

* Channel width 13' (180 in)
* Length 3 ft
* 2 90-deg bend, K=2*1.2= 2.4

/*
```

```
********************************************
*                                          *
*                   HYDRO                  *
*        TREATMENT PLANT HYDRAULICS        *
*                                          *
*              CH2M Hill, Inc.             *
*         2300 NW Walnut Boulevard         *
*               P.O. Box 428               *
*         Corvallis, Oregon  97330         *
*                                          *
*              VERSION  9.56               *
*                24-JAN-02                 *
*                                          *
*           (C) COPYRIGHT 1902             *
*             CH2M-HILL INC.               *
*           ALL RIGHTS RESERVED            *
*                                          *
*       RUN ON  08/14/13   09:03:08        *
*                                          *
*                   NOTE                   *
* This page contains valuable information  *
* that should be saved.  If it becomes     *
* necessary to rerun this analysis in the  *
* future, this page will allow retrieval   *
* of the proper program and data files.    *
********************************************
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE   1
Q1=    0.00     Q2=    0.00     Q3=    0.00
========================================================================

City of Coos Bay WWTP SBR Project

Project Number:469556.03.35.05.60

Assumptions:
All units in service
Peak Daily Average: Q =  6.31 mgd
SC three channels
SBR: 2 in parallel
EQ basin sized for concurrent SBR operation
UV two channels one in future.
All elevations must be checked for datum. include +4.2 ft to convert fr

MINOR LOSS COEFFICIENTS (FROM D.S. MILLER INTERNAL FLOW SYSTEMS, 1978)
90-deg elbow, K=0.45
45-deg elbow, K=0.2
180 deg. open channel bend, K=3.0
90 deg. open channel bend, K=1.2
45 deg. open channel bend, K=0.6
Entrance loss, K=0.5
Exit loss, K=1.0
Orifice coefficient, C, 0.6
21" Tee Through flow, dead branch, K=0.04
21" Tee Branch flow, dead run, K=1.10
```

```
♀


 UNITS OPTION SPECIFIED = 0
 LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
           WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE   2
 Q1=    8.20     Q2=   12.30     Q3=    6.31
 =======================================================================


 CONDITIONS SET -                                              SEQ =  1
 (0-10) EGL set at mean higher high water level (100-yr flood)
 ENERGY LINE =  11.00  Q1 =   8.20  Q2 =  12.30  Q3 =   6.31  VEL = 0.00

  Q1 = total plant influent peak instantaneous flow, 8.2 mgd
  Q2 = Future peak instantaneous flow, 12.3 mgd
  Q3 = EQ basin outlet flow, 6.31 mgd (Peak Daily Average)

  FEMA FIRM map 41011C0168D for flood elevation.
 ELEMENT NO. 26                                                SEQ =  2
  (10-20) existing diffuser outfall (1973 sht 38)
 NUMBER OF PORTS ------------------------     5
 PERCENT BETWEEN SHARP EDGE PORT (0.0) --    0.0
      AND BELL MOUTH PORT (100.0)
 AVAILABLE ENERGY AT PORT NO. 1 --------    3.92
 SPECIFIC GRAVITY DIFFERENCE ------------ 0.0250


 *------ PORT PARAMETERS ------*   *--------- PIPE PARAMETERS ---------*
     DIAM  CD   FLOW  VEL ENERGY    LNTH  DIAM         FLOW  VEL  H LOSS
 NUM                                          FRICT
   1 6.00 0.63  1.27 10.00  3.92     7.5  24.0 0.034   1.27  0.63  0.001
   2 6.00 0.63  1.27 10.01  3.93     7.5  24.0 0.028   2.54  1.25  0.003
   3 6.00 0.63  1.27  9.97  3.94     7.5  24.0 0.025   3.80  1.87  0.005
   4 6.00 0.62  1.26  9.91  3.94     7.5  24.0 0.024   5.06  2.49  0.009
   5 6.00 0.62  1.25  9.83  3.96     7.5  24.0 0.023   6.31  3.11  0.013
                                 -------                            ------
                                    37.5                             0.030
 HYDRAULIC GRADE LINE ELEV. HLOSS =  3.97    DN =   11.69  UP =    15.56
 ENERGY LINE ELEVATION                       DN =   11.69  UP =    15.66
 TOTAL FLOWRATE       ----       6.310

 Specific Gravity of Seawater = 1.025
 24" pipe w/ end invert at -17.5' therefor CL is at -16.5'
 100 %Q3
 Available engergy at Port 1 is at 1' reasonable??
 assumed divergence angle for 12" x 6" reducer = 20.5 deg.
 Absolute pipe roughness estimated at at 0.0102 inch following ex. in
  manual
 diffuser slope =.019
 assume 100% sharp edge diffuser--most conservative
 no risers
♀


 UNITS OPTION SPECIFIED = 0
 LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
           WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE   3
```

```
Q1=    8.20     Q2=   12.30     Q3=    6.31
=======================================================================


ELEMENT NO.  1                                                 SEQ =  3
(20-30) Existing pipe from diffuser to existing MH (1973 sht 38)
PRESSURE LINE (CIR)     FLOWRATE =     6.31            VELOCITY =  3.11
PIPE ------ DIA = 24.0       LEN = 880.0                      N = 0.012
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  0.50    EXIT K =  0.00
HEAD LOSS: MISC =  0.07     EXIT =  0.00 PIPE =  1.40     TOTAL =  1.47
HYDRAULIC GRADE LINE ELEVATION              DN =   15.51  UP =    16.98
ENERGY LINE ELEVATION                       DN =   15.66  UP =    17.13
CMP Design Guide Mannings n = .011 to .020; assumed 0.012 due to
 relining.
Demo plan Sht 1 indicates demo and replacement of 24inch CMP outfall
Entrance loss from upstream MH K= 0.5

ELEMENT NO.  6                                                 SEQ =  4
(30-40) Flow through channel to represent existing MH (2013: 006-C-2001
RECT/TRAP CHANNEL       FLOWRATE =     6.31     MINOR LOSS K =    0.000
BASE =  72.0     SLP = 0.0   LEN =   6.0     N =0.012  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.12  UP =     0.12
CHANNEL BOTTOM ELEVATION                    DN =    3.33  UP =     3.33
DEPTH ---- CRIT =  0.43   NORMAL = 999.99   DN =   13.80  UP =    13.80
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   17.13  UP =    17.13
ENERGY LINE ELEVATION                       DN =   17.13  UP =    17.13
 Manhole dimension information provided by SHN Engineers.

ELEMENT NO.  1                                                 SEQ =  5
(45-50) Pipe from exst MH to UV basin (2013: 006-C-2001 and -2001A)
PRESSURE LINE (CIR)     FLOWRATE =     6.31            VELOCITY =  1.99
PIPE ------ DIA = 30.0       LEN = 880.0                      N = 0.012
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  5.20    EXIT K =  3.00
HEAD LOSS: MISC =  0.32     EXIT =  0.18 PIPE =  0.42     TOTAL =  0.93
HYDRAULIC GRADE LINE ELEVATION              DN =   17.07  UP =    18.00
ENERGY LINE ELEVATION                       DN =   17.13  UP =    18.06
 2 45-deg bend, K=0.2*2 = 0.4
 2 90-deg bend, K=0.45*2 = 0.9
 2 90-deg open channel bend, K=1.2*2 = 2.4
 Entrance loss, K=0.5*3 = 1.5
 Total K = 5.2
 Exit loss, K=1*3 = 3
 Using open channel bend to represent 2 manholes along pipeline.
 No pipe profile has been established yet including yard pipe CL.
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE   4
Q1=    8.20     Q2=   12.30     Q3=    6.31
=======================================================================


ELEMENT NO.  5                                                 SEQ =  6
(50-55) Gravity pipe outlet from UV (2013: 40-M-3000)
CIRCULAR CHANNEL        FLOWRATE =     6.31     MINOR LOSS K =    0.000
PIPE ------ DIA = 30.0       LEN =  10.0     N =0.012  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    2.35  UP =     2.34
CHANNEL BOTTOM ELEVATION                    DN =   16.00  UP =    16.00
```

```
DEPTH ---- CRIT =  1.04   NORMAL = 999.99   DN =    1.97  UP =     1.98
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.005  TOTAL = 0.005
HYDRAULIC GRADE LINE ELEV                   DN =   17.97  UP =    17.98
ENERGY LINE ELEVATION                       DN =   18.06  UP =    18.06

ELEMENT NO.  6                                              SEQ =  7
(55-60) Channel at downstream end of UV 2013: 40-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     6.31     MINOR LOSS K =    0.000
BASE =  48.0     SLP = 0.0   LEN =  10.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.30  UP =     0.30
CHANNEL BOTTOM ELEVATION                    DN =   10.00  UP =    10.00
DEPTH ---- CRIT =  0.57   NORMAL = 999.99   DN =    8.06  UP =     8.06
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   18.06  UP =    18.06
ENERGY LINE ELEVATION                       DN =   18.06  UP =    18.06
Invert  set at 10' to account for pipe bury (grd surface=15'
 (1973 sht 38))
9' (108") width
Mannings n = 0.013
4 ft length
slope= 0.
Max depth is 12-ft

ELEMENT NO. 12                                              SEQ =  8
 (60-65) Finger weir launder from UV channel (2013: 40-M-2000)
RECT/TRAP LAUNDER       FLOWRATE =     2.10     MINOR LOSS K =  0.00000
BASE =  18.0     SLP = 0.0   LEN =  20.0     N =0.011  SLOPE =  0.01200
TOP WIDTH    IN                             DN =   18.00  UP =    18.00
VELOCITY --------------------------         DN =    2.51  UP =     0.00
CHANNEL BOTTOM ELEVATION ----------         DN =   17.10  UP =    17.34
DEPTH --------------------- CRIT =  0.53    DN =    0.87  UP =     0.82
HEAD LOSS -- MINOR =0.000 HLOSS = 0.1000 TOTAL = 0.10004 QUP =     0.00
HYDRAULIC GRADE LINE ELEVATION              DN =   17.97  UP =    18.16
ENERGY LINE ELEVATION                       DN =   18.06  UP =    18.16
 SST launder, V-notch weirs on each side
 3 launders, so flow is 33.3% of Q3
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                            PAGE   5
Q1=    8.20     Q2=   12.30     Q3=    6.31
=======================================================================


ELEMENT NO.  3                                              SEQ =  9
(65-70) V-notch weirs (2013: 40-M-2000)
V-NOTCH WEIR            FLOWRATE =     1.05          NON SUBMERGED WEIR
WEIR - ANGLE 90. DEG;    40 NOTCHES AT  0.026 MGD EACH; ELEV =    18.55
LENGTH =  20.0       SUBMERGENCE =  0.00                HEAD =     0.19
HYDRAULIC GRADE LINE ELEV. HLOSS =  0.58    DN =   18.16  UP =    18.74
ENERGY LINE ELEVATION                       DN =   18.16  UP =    18.74
 20-ft long weirs into 1-ft deep launders
 Two weir lengths along each launder x 3 launders
 total weir length 120-ft.  Trojan recommends 118 ft.
 based on standard detail

ELEMENT NO.  6                                              SEQ = 10
(70-80) Rectangular Open Channel (2013: 40-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     6.31     MINOR LOSS K =    0.000
```

```
BASE = 108.0     SLP = 0.0   LEN =  23.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.48  UP =     0.47
CHANNEL BOTTOM ELEVATION                    DN =   16.46  UP =    16.46
DEPTH ---- CRIT =  0.33   NORMAL = 999.99   DN =    2.28  UP =     2.28
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   18.74  UP =    18.74
ENERGY LINE ELEVATION                       DN =   18.74  UP =    18.74
 Expansion loss, K=0.45 (DS Miller, Fig 14.15)

ELEMENT NO.  6                                                SEQ = 11
(70-80) Rectangular Open Channel (2013: 40-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     6.31     MINOR LOSS K =    0.000
BASE =  40.0     SLP = 0.0   LEN =  46.5     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    1.30  UP =     1.29
CHANNEL BOTTOM ELEVATION                    DN =   16.46  UP =    16.46
DEPTH ---- CRIT =  0.64   NORMAL = 999.99   DN =    2.26  UP =     2.27
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.008  TOTAL = 0.008
HYDRAULIC GRADE LINE ELEV                   DN =   18.72  UP =    18.73
ENERGY LINE ELEVATION                       DN =   18.74  UP =    18.75
40-inch width based on Trojan 2/27/2013

ELEMENT NO. 10                                                SEQ = 12
 (80-90) Headloss for UV equipment in channel
******ADDITIONAL HEAD LOSS SPECIFIED******
HL =  0.55     K =  0.00   VHEAD =  0.00
HYDRAULIC GRADE LINE EL.   HLOSS =  0.55    DN =   18.73  UP =    19.30
ENERGY LINE EL.                             DN =   18.75  UP =    19.30
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                              PAGE   6
Q1=    8.20     Q2=   12.30     Q3=    6.31
=======================================================================

Assumes 1.5" HL per bank, 1.5"x3 = 4.5"
Straightening baffle loss = 2"
Total loss = 6.5" or 0.55 ft (rounded up)
Trojan's headloss is ~1.1"/bank on average
Check that max water depth is 2.66' from upstream bank per Trojan

ELEMENT NO.  6                                                SEQ = 13
(90-100) Rectangular channel upstream of UV (2013: 40-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     6.31     MINOR LOSS K =    2.400
BASE =  76.0     SLP = 0.0   LEN =   4.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.17  UP =     0.17
CHANNEL BOTTOM ELEVATION                    DN =   10.00  UP =    10.00
DEPTH ---- CRIT =  0.42   NORMAL = 999.99   DN =    9.30  UP =     9.30
HEAD LOSS -----            MINOR =  0.001  HLOSS = 0.001  TOTAL = 0.002
HYDRAULIC GRADE LINE ELEV                   DN =   19.30  UP =    19.30
ENERGY LINE ELEVATION                       DN =   19.30  UP =    19.30
 two 90-deg bends as flow transitions from below, K=2*1.2=2.4
Invert  set at 10'

ELEMENT NO.  1                                                SEQ = 14
(100-105) Pressurized Circular Pipe to Expansion (2013: 30-M-2000)
PRESSURE LINE (CIR)     FLOWRATE =     6.31           VELOCITY =  3.11
PIPE ------ DIA = 24.0       LEN =  50.0                     N = 0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  0.80    EXIT K =  1.00
HEAD LOSS: MISC =  0.12     EXIT =  0.15 PIPE =  0.09     TOTAL =  0.36
```

```
HYDRAULIC GRADE LINE ELEVATION              DN =   19.15  UP =    19.52
ENERGY LINE ELEVATION                       DN =   19.30  UP =    19.67
Exit loss, K = 1
Expansion to 24-in diam, K = 0.15
50 ft of 24" pipe
 1 90-deg bends, K=0.45
 1 45-deg bend, K=0.2
 Total K = 0.8

ELEMENT NO.  1                                                 SEQ = 15
(105-110) Pipe from expansion to FCV (2013: 30-M-2000)
PRESSURE LINE (CIR)     FLOWRATE =     6.31            VELOCITY =  6.99
PIPE ------ DIA = 16.0       LEN =   5.0                      N = 0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  1.12    EXIT K =  0.00
HEAD LOSS: MISC =  0.85     EXIT =  0.00 PIPE =  0.08     TOTAL =  0.93
HYDRAULIC GRADE LINE ELEVATION              DN =   18.91  UP =    19.84
ENERGY LINE ELEVATION                       DN =   19.67  UP =    20.60
 24x16 expansion, K = 0.31
 gate valve: K = 0.10
 Flow through tee: K = 0.26
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE   7
Q1=    8.20     Q2=   12.30     Q3=    6.31
=======================================================================

 1 90-deg bend, K=0.45
 Total K = 1.12

ELEMENT NO. 28                                                 SEQ = 16
 (110-115) Flow Control Valve (2013: 30-M-2000)
PRESSURE LINE (CIR)     FLOWRATE =     6.31             VELOCITY =  6.99
TOTAL HEAD LOSS ACROSS VALVE                                  =     0.19
HYDRAULIC GRADE LINE ELEVATION               DN =   19.84  UP =    20.03
ENERGY LINE ELEVATION                        DN =   20.60  UP =    20.79
Data for 16-inch BF valve from ValMatic

ELEMENT NO.  1                                                 SEQ = 17
(115-120) Pipe from Flow control valve to Contraction (2013: 30-M-2000)
PRESSURE LINE (CIR)     FLOWRATE =     6.31            VELOCITY =  6.99
PIPE ------ DIA = 16.0       LEN =  20.0                      N = 0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  0.36    EXIT K =  0.00
HEAD LOSS: MISC =  0.27     EXIT =  0.00 PIPE =  0.32     TOTAL =  0.60
HYDRAULIC GRADE LINE ELEVATION              DN =   20.03  UP =    20.62
ENERGY LINE ELEVATION                       DN =   20.79  UP =    21.38
 includes 16" mag meter
 gate valve: K = 0.10
 Flow through tee: K = 0.26
 Total K = 0.36

ELEMENT NO.  1                                                 SEQ = 18
(120-130) Pipe from contractor to EQ Basin (2013: 30-M-2000)
PRESSURE LINE (CIR)     FLOWRATE =     6.31            VELOCITY =  3.11
PIPE ------ DIA = 24.0       LEN =  30.0                      N = 0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  1.01    EXIT K =  0.00
HEAD LOSS: MISC =  0.15     EXIT =  0.00 PIPE =  0.06     TOTAL =  0.21
HYDRAULIC GRADE LINE ELEVATION              DN =   21.23  UP =    21.44
ENERGY LINE ELEVATION                       DN =   21.38  UP =    21.59
```

```
 Entrance loss K=0.5
 contraction to 16-in, K= 0.06
  1 90-deg elbow, K=0.45
  Total K = 1.01
  30 ft of 24" pipe
♀


 UNITS OPTION SPECIFIED = 0
 LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
           WIDTH/HEIGHT = IN     DIAM = IN

                                                                PAGE   8
 Q1=    8.20     Q2=   12.30     Q3=    6.31
 =======================================================================


 ELEMENT NO.  6                                                 SEQ = 19
 (130-140) EQ basin (2013:30-M-2000)
 RECT/TRAP CHANNEL       FLOWRATE =     6.31     MINOR LOSS K =    0.000
 BASE = 420.0     SLP = 0.0   LEN =  98.0     N =0.011  SLOPE =  0.00000
 VELOCITY ---------------- NORMAL =999.99    DN =    0.06  UP =     0.06
 CHANNEL BOTTOM ELEVATION                    DN =   17.00  UP =    17.00
 DEPTH ---- CRIT =  0.13   NORMAL = 999.99   DN =    4.59  UP =     4.59
 HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.003  TOTAL = 0.003
 HYDRAULIC GRADE LINE ELEV                   DN =   21.59  UP =    21.59
 ENERGY LINE ELEVATION                       DN =   21.59  UP =    21.59
  35' W x 98'L

 ELEMENT NO. 10                                                 SEQ = 20
  (140-150) Headloss to represent fluccuation in EQ basin (2013: 30-M-20
 ******ADDITIONAL HEAD LOSS SPECIFIED******
 HL =  5.00     K =  0.00   VHEAD =  0.00
 HYDRAULIC GRADE LINE EL.   HLOSS =  5.00    DN =   21.59  UP =    26.59
 ENERGY LINE EL.                             DN =   21.59  UP =    26.59
 Max 5' per Jason Riegler/CVO
 Effluent Level from SBR should not exceed the invert of the decant
 collection pipe currently set at 11'2" from bottom of basin.
 NEW CONFIGURATION CHECK REQUIREMENTS
 *******************************************
  ICIAS SBR               *
 *******************************************
♀


 UNITS OPTION SPECIFIED = 0
 LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
           WIDTH/HEIGHT = IN     DIAM = IN

                                                                PAGE   9
 Q1=    6.31     Q2=   12.30     Q3=    6.31
 =======================================================================


 CONDITIONS SET -                                               SEQ = 21
 (0-10) EGL set at the SBR water level based on BioWin (2013: 30-M-2001)
 ENERGY LINE =  36.00  Q1 =   6.31  Q2 =  12.30  Q3 =   6.31  VEL = 0.06

  Q1 = total plant influent , 6.31
  Q2 = Future peak hour, 12.3
  Q3 = EQ basin outlet flow, 6.31 mgd (Maximum)

  2037 Peak Instantaneous Flow 8.2 mgd --> 36.00 ft Max WSE
```

```
  2037 Peak Daily Average Flow 6.31 mgd --> 36.00 ft Max WSE
  2037 Max Month Wet Weather 2.09 mgd --> 32.50 ft Max WSE
  2037 Average Dry Weather 0.99 mgd --> 30.75 ft Max WSE

 ELEMENT NO.  6                                                 SEQ = 22
 (160-170) SBR main chamber (3013: 30-M-2001)
 RECT/TRAP CHANNEL       FLOWRATE =     3.15     MINOR LOSS K =    0.000
 BASE = 600.0     SLP = 0.0   LEN = 123.0     N =0.013  SLOPE =  0.00000
 VELOCITY ---------------- NORMAL =999.99    DN =    0.01  UP =     0.01
 CHANNEL BOTTOM ELEVATION                    DN =   17.00  UP =    17.00
 DEPTH ---- CRIT =  0.07   NORMAL = 999.99   DN =   19.00  UP =    19.00
 HEAD LOSS -----           MINOR =  0.000  HLOSS = 0.004  TOTAL = 0.004
 HYDRAULIC GRADE LINE ELEV                   DN =   36.00  UP =    36.00
 ENERGY LINE ELEVATION                       DN =   36.00  UP =    36.00
 50% of peak hour flow Q1

 ELEMENT NO.  8                                                 SEQ = 23
  (170-180) underflow baffle wall orifice (2013: 30-M-2001)
 RECTANGULAR ORIFICE     FLOWRATE =     3.15      ORIFICE VEL =     0.08
 GATE -- WIDTH = 480.0      DEPTH =  18.0        ORIFICE COEF =    0.600
 HYDRAULIC GRADE LINE EL.   HLOSS =  0.00    DN =   36.00  UP =    36.00
 ENERGY LINE EL.                             DN =   36.00  UP =    36.00
  40-ft of opening along 50-ft wall
  18" height based on vendor input

 ELEMENT NO.  6                                                 SEQ = 24
 (180-190) Pre-react Basin (2013: 30-M-2001)
 RECT/TRAP CHANNEL       FLOWRATE =     3.15     MINOR LOSS K =    0.000
 BASE = 600.0     SLP = 0.0   LEN =  22.0     N =0.013  SLOPE =  0.00000
 VELOCITY ---------------- NORMAL =999.99    DN =    0.01  UP =     0.01
 CHANNEL BOTTOM ELEVATION                    DN =   17.00  UP =    17.00
 DEPTH ---- CRIT =  0.07   NORMAL = 999.99   DN =   19.00  UP =    19.00
 HEAD LOSS -----           MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
 HYDRAULIC GRADE LINE ELEV                   DN =   36.00  UP =    36.00
 ENERGY LINE ELEVATION                       DN =   36.00  UP =    36.00
♀


 UNITS OPTION SPECIFIED = 0
 LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
           WIDTH/HEIGHT = IN     DIAM = IN

                                                                PAGE  10
 Q1=    6.31     Q2=   12.30     Q3=    6.31
 =======================================================================

  22 ft length

 ELEMENT NO.  1                                                 SEQ = 25
 (200-210) Pipe from HW flow split to SBR (2013: 30-M-2001)
 PRESSURE LINE (CIR)     FLOWRATE =     3.15           VELOCITY =  1.55
 PIPE ------ DIA = 24.0       LEN =  56.0                      N = 0.013
 MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  2.30    EXIT K =  1.00
 HEAD LOSS: MISC =  0.09     EXIT =  0.04 PIPE =  0.03     TOTAL =  0.15
 HYDRAULIC GRADE LINE ELEVATION              DN =   35.97  UP =    36.12
 ENERGY LINE ELEVATION                       DN =   36.00  UP =    36.15
  24-inch diam
  56 ft long pipe
  4 90-deg bend, K=0.45*4=1.8
  Entrance Loss, K=0.5
  Total K = 2.3
  Exit Loss, K=1.0
```

```
ELEMENT NO.  2                                                 SEQ = 26
(210-215) Split box (2013: 20-M-2000)
PRESSURE LINE (RECT)    FLOWRATE =     3.15           VELOCITY =   0.33
PIPE- H =  36.0 W =  60.0    LEN =  15.0                    N =  0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  2.20    EXIT K =  0.00
HEAD LOSS: MISC =  0.00     EXIT =  0.00 PIPE =  0.00     TOTAL =  0.00
HYDRAULIC GRADE LINE ELEVATION              DN =   36.15  UP =    36.16
ENERGY LINE ELEVATION                       DN =   36.15  UP =    36.16
 3'x6' drop box D/S of weir gate
 Turbulent flow, K=1.0
 90-deg bends, K=1.2

ELEMENT NO.  4                                                 SEQ = 27
(215-220) Weir gate (2013: 20-M-2000)
RECTANGULAR WEIR        FLOWRATE =     3.15         NON SUBMERGED WEIR
WEIR ------------ SIDE CONTRACTION COEFFICIENT =2.00    ELEV =    37.16
LENGTH =   3.5       SUBMERGENCE =  0.00                HEAD =     0.57
HYDRAULIC GRADE LINE ELEV. HLOSS =  1.57    DN =   36.16  UP =    37.73
ENERGY LINE ELEVATION                       DN =   36.16  UP =    37.73
HGL 0.5 ft above D/S HGL
*******************************************
END OF ADDITION FOR SBR FLOW SPLIT        *
*******************************************
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE  11
Q1=    6.31     Q2=   12.30     Q3=    6.31
=======================================================================


ELEMENT NO.  6                                                 SEQ = 28
(220-230) Grit outlet channel (2013: 20-M-3001)
RECT/TRAP CHANNEL       FLOWRATE =     6.31     MINOR LOSS K =    0.000
BASE =  36.0     SLP = 0.0   LEN =  23.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.16  UP =     0.16
CHANNEL BOTTOM ELEVATION                    DN =   18.00  UP =    18.00
DEPTH ---- CRIT =  0.69   NORMAL = 999.99   DN =   19.73  UP =    19.73
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   37.73  UP =    37.73
ENERGY LINE ELEVATION                       DN =   37.73  UP =    37.73
 Invert at 18'Channel
 Length = 23 ft based on SHN 5/11/13 dwg
 width = 3 ft based on SHN 5/11/13 dwg

ELEMENT NO.  4                                                 SEQ = 29
(230-240) Grit Channel Weir (2013: 20-M-3001)
RECTANGULAR WEIR        FLOWRATE =     6.31         NON SUBMERGED WEIR
WEIR ------------ SIDE CONTRACTION COEFFICIENT =0.00    ELEV =    38.84
LENGTH =  12.0       SUBMERGENCE =  0.00                HEAD =     0.39
HYDRAULIC GRADE LINE ELEV. HLOSS =  1.50    DN =   37.73  UP =    39.23
ENERGY LINE ELEVATION                       DN =   37.73  UP =    39.23
 12'weir (no contractions)
 set invert 0.5' above downstream HGL

ELEMENT NO. 10                                                 SEQ = 30
 (260-270) Headloss across grit equipment (2013: 20-M-3001)
******ADDITIONAL HEAD LOSS SPECIFIED******
HL =  1.50     K =  0.00   VHEAD =  0.00
```

```
HYDRAULIC GRADE LINE EL.   HLOSS =  1.50    DN =   39.23  UP =    40.73
ENERGY LINE EL.                             DN =   39.23  UP =    40.73
 based on 0.75-ft loss from vendor and 0.75-ft
 additional observed loss from SHN
 Grit equipment vendor is HydroInternational HeadCell

ELEMENT NO.  6                                               SEQ = 31
(273-275) Grit Inlet channel (2013: 20-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     6.31     MINOR LOSS K =    0.650
BASE =  36.0     SLP = 0.0   LEN =   7.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    1.76  UP =     1.72
CHANNEL BOTTOM ELEVATION                    DN =   38.84  UP =    38.84
DEPTH ---- CRIT =  0.69   NORMAL = 999.99   DN =    1.85  UP =     1.88
HEAD LOSS -----            MINOR =  0.031  HLOSS = 0.003  TOTAL = 0.034
HYDRAULIC GRADE LINE ELEV                   DN =   40.69  UP =    40.72
ENERGY LINE ELEVATION                       DN =   40.73  UP =    40.77
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                             PAGE  12
Q1=    6.31     Q2=   12.30     Q3=    6.31
=======================================================================

 symmetrical combining T-channel. K=0.65 (DS Miller Fig 13.16)

ELEMENT NO.  6                                               SEQ = 32
(273-275) Channel btwn screens and grit chamber (2013: 20-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     3.15     MINOR LOSS K =    2.400
BASE =  36.0     SLP = 0.0   LEN =   8.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.85  UP =     0.83
CHANNEL BOTTOM ELEVATION                    DN =   38.84  UP =    38.84
DEPTH ---- CRIT =  0.43   NORMAL = 999.99   DN =    1.92  UP =     1.95
HEAD LOSS -----            MINOR =  0.027  HLOSS = 0.001  TOTAL = 0.028
HYDRAULIC GRADE LINE ELEV                   DN =   40.76  UP =    40.79
ENERGY LINE ELEVATION                       DN =   40.77  UP =    40.80
 Flow split between two screens
 Invert match grit eff weir
 Length = 8 ft based on SHC 5/10/13 dwg
 width = 3 ft based on SHC 5/10/13 dwg
 2 90-deg bends, K=2*1.2 = 2.4

ELEMENT NO.  6                                               SEQ = 33
(275-280) D/S Screen Channel (2013: 20-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     3.15     MINOR LOSS K =    0.000
BASE =  24.0     SLP = 0.0   LEN =   6.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    1.26  UP =     1.26
CHANNEL BOTTOM ELEVATION                    DN =   38.84  UP =    38.84
DEPTH ---- CRIT =  0.57   NORMAL = 999.99   DN =    1.93  UP =     1.93
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.002  TOTAL = 0.002
HYDRAULIC GRADE LINE ELEV                   DN =   40.77  UP =    40.77
ENERGY LINE ELEVATION                       DN =   40.80  UP =    40.80
 Invert to match grit eff weir
 Length = 6 ft based on SHC 5/10/13 dwg
 width = 24" based on SHC 5/10/13 dwg

ELEMENT NO. 10                                               SEQ = 34
 (280-290) Arbitrary headloss across screens (2013: 20-M-2000)
******ADDITIONAL HEAD LOSS SPECIFIED******
HL =  0.50     K =  0.00   VHEAD =  0.00
```

```
 HYDRAULIC GRADE LINE EL.   HLOSS =  0.50    DN =   40.77  UP =    41.30
 ENERGY LINE EL.                             DN =   40.80  UP =    41.30
  Assume 0.5 ft headloss (5/15/13 Mike Veach/SHN Email -
   from Hydro-Dyne calculations)
♀


 UNITS OPTION SPECIFIED = 0
 LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
           WIDTH/HEIGHT = IN     DIAM = IN

                                                                PAGE  13
 Q1=    6.31     Q2=   12.30     Q3=    6.31
 =======================================================================


 ELEMENT NO.  6                                                 SEQ = 35
 (290-300) Channel screen channel 1/2 flow (2013: 20-M-2000)
 RECT/TRAP CHANNEL       FLOWRATE =     3.15     MINOR LOSS K =    0.000
 BASE =  18.0     SLP = 0.0   LEN =   5.0     N =0.013  SLOPE =  0.00000
 VELOCITY ---------------- NORMAL =999.99    DN =    1.34  UP =     1.33
 CHANNEL BOTTOM ELEVATION                    DN =   38.84  UP =    38.84
 DEPTH ---- CRIT =  0.69   NORMAL = 999.99   DN =    2.43  UP =     2.43
 HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.002  TOTAL = 0.002
 HYDRAULIC GRADE LINE ELEV                   DN =   41.27  UP =    41.27
 ENERGY LINE ELEVATION                       DN =   41.30  UP =    41.30
  Channel width 1.5' (18 in) based on SHC 5/10/13 dwg
  Length 5 ft based on SHC 5/10/13 dwg

 ELEMENT NO.  6                                                 SEQ = 36
 (300-310) Channel flow  wide channel to screens (2013: 20-M-2000)
 RECT/TRAP CHANNEL       FLOWRATE =     6.31     MINOR LOSS K =    2.400
 BASE =  36.0     SLP = 0.0   LEN =  15.0     N =0.013  SLOPE =  0.00000
 VELOCITY ---------------- NORMAL =999.99    DN =    1.34  UP =     1.30
 CHANNEL BOTTOM ELEVATION                    DN =   38.84  UP =    38.84
 DEPTH ---- CRIT =  0.69   NORMAL = 999.99   DN =    2.43  UP =     2.50
 HEAD LOSS -----            MINOR =  0.066  HLOSS = 0.003  TOTAL = 0.069
 HYDRAULIC GRADE LINE ELEV                   DN =   41.27  UP =    41.34
 ENERGY LINE ELEVATION                       DN =   41.30  UP =    41.37
  Channel width 13' (180 in)
  Length 3 ft
  2 90-deg bend, K=2*1.2= 2.4
^
```

```
/*
*City of Coos Bay WWTP SBR Project
*
*Project Number:469556.03.35.05.60
*
*Assumptions:
*All units in service
*Maximum Month Wet Weather: Q =  6.31 mgd
*SC three channels, one screen in service
*SBR: 2 in parallel
*EQ basin sized for concurrent SBR operation
*UV two channels one in future.
*All elevations must be checked for datum. include +4.2 ft to convert from 1974
vertical datum to NGVD 1988

*
*MINOR LOSS COEFFICIENTS (FROM D.S. MILLER INTERNAL FLOW SYSTEMS, 1978)
*90-deg elbow, K=0.45
*45-deg elbow, K=0.2
*180 deg. open channel bend, K=3.0
*90 deg. open channel bend, K=1.2
*45 deg. open channel bend, K=0.6
*Entrance loss, K=0.5
*Exit loss, K=1.0
*Orifice coefficient, C, 0.6
*21" Tee Through flow, dead branch, K=0.04
*21" Tee Branch flow, dead run, K=1.10
*
*
0 (0-10) EGL set at mean higher high water level (100-yr flood)
11 2.09 12.3 2.09 /
*
* Q1 = total plant influent max month wet weather, 2.09 mgd
* Q2 = Future peak instantaneous flow, 12.3 mgd
* Q3 = EQ basin outlet flow, 2.09 mgd (Max Month)
*
* FEMA FIRM map 41011C0168D for flood elevation.


26 (10-20) existing diffuser outfall (1973 sht 38)
.025 -16.5 0 0 100 1 1 /
5 20.5 6 24 7.5 .0102 .019 0 0 / Line 3
/*

*Specific Gravity of Seawater = 1.025
*24" pipe w/ end invert at -17.5' therefor CL is at -16.5'
*100 %Q3
*Available engergy at Port 1 is at 1' reasonable??
*assumed divergence angle for 12" x 6" reducer = 20.5 deg.
*Absolute pipe roughness estimated at at 0.0102 inch following ex. in
* manual
*diffuser slope =.019
*assume 100% sharp edge diffuser--most conservative
*no risers


1 (20-30) Existing pipe from diffuser to existing MH (1973 sht 38)
24 880 .012 0.5 0 0 0 100 /

*CMP Design Guide Mannings n = .011 to .020; assumed 0.012 due to
* relining.
*Demo plan Sht 1 indicates demo and replacement of 24inch CMP outfall
*Entrance loss from upstream MH K= 0.5
```

```
6 (30-40) Flow through channel to represent existing MH (2013: 006-C-2001A)
3.33 72 0 .012 6 0 1000 0 0 0 100 /
* Manhole dimension information provided by SHN Engineers.

1 (45-50) Pipe from exst MH to UV basin (2013: 006-C-2001 and -2001A)
30 880 .012 5.2 3 0 0 100 /
* 2 45-deg bend, K=0.2*2 = 0.4
* 2 90-deg bend, K=0.45*2 = 0.9
* 2 90-deg open channel bend, K=1.2*2 = 2.4
* Entrance loss, K=0.5*3 = 1.5
* Total K = 5.2
* Exit loss, K=1*3 = 3
* Using open channel bend to represent 2 manholes along pipeline.
* No pipe profile has been established yet including yard pipe CL.

5 (50-55) Gravity pipe outlet from UV (2013: 40-M-3000)
16 30 0.012 10 0 30 0 0 0 100/

6 (55-60) Channel at downstream end of UV 2013: 40-M-2000)
10 48 0 0.013 10 0 144 0 0 0 100 /
*Invert  set at 10' to account for pipe bury (grd surface=15'
* (1973 sht 38))
*9' (108") width
*Mannings n = 0.013
*4 ft length
*slope= 0.
*Max depth is 12-ft

12 (60-65) Finger weir launder from UV channel (2013: 40-M-2000)
17.1 18 0 0.011 20 0.012 18 0 0 0 33.3 /

* SST launder, V-notch weirs on each side
* 3 launders, so flow is 33.3% of Q3

3 (65-70) V-notch weirs (2013: 40-M-2000)
18.55 20 6 3 16.84 0 0 16.67 90/
* 20-ft long weirs into 1-ft deep launders
* Two weir lengths along each launder x 3 launders
* total weir length 120-ft.  Trojan recommends 118 ft.
* based on standard detail

6 (70-80) Rectangular Open Channel (2013: 40-M-2000)
16.46 108 0 .013 23 0 62 0 0 0 100 /
* Expansion loss, K=0.45 (DS Miller, Fig 14.15)

6 (70-80) Rectangular Open Channel (2013: 40-M-2000)
16.46 40 0 .013 46.5 0 62 0 0 0 100 /
*40-inch width based on Trojan 2/27/2013

10 (80-90) Headloss for UV equipment in channel
0.55 0 /
*Assumes 1.5" HL per bank, 1.5"x3 = 4.5"
*Straightening baffle loss = 2"
*Total loss = 6.5" or 0.55 ft (rounded up)
*Trojan's headloss is ~1.1"/bank on average
*Check that max water depth is 2.66' from upstream bank per Trojan

6 (90-100) Rectangular channel upstream of UV (2013: 40-M-2000)
10 76 0 .013 4 0 144 2.4 0 0 100 /
* two 90-deg bends as flow transitions from below, K=2*1.2=2.4
*Invert  set at 10'
```

```
1 (100-105) Pressurized Circular Pipe to Expansion (2013: 30-M-2000)
24 50 .013 0.8 1.0 0 0 100 /
*Exit loss, K = 1
*Expansion to 24-in diam, K = 0.15
*50 ft of 24" pipe
* 1 90-deg bends, K=0.45
* 1 45-deg bend, K=0.2
* Total K = 0.8

1 (105-110) Pipe from expansion to FCV (2013: 30-M-2000)
16 5 0.013 1.12 0 0 0 100/
* 24x16 expansion, K = 0.31
* gate valve: K = 0.10
* Flow through tee: K = 0.26
* 1 90-deg bend, K=0.45
* Total K = 1.12

28 (110-115) Flow Control Valve (2013: 30-M-2000)
0 0 100 16 .15 5.76 .25 7.2 .37 8.64 /
*Data for 16-inch BF valve from ValMatic

1 (115-120) Pipe from Flow control valve to Contraction (2013: 30-M-2000)
16 20 0.013 0.36 0 0 0 100/
* includes 16" mag meter
* gate valve: K = 0.10
* Flow through tee: K = 0.26
* Total K = 0.36

1 (120-130) Pipe from contractor to EQ Basin (2013: 30-M-2000)
24 30 .013 1.01 0 0 0 100 /
*Entrance loss K=0.5
*contraction to 16-in, K= 0.06
* 1 90-deg elbow, K=0.45
* Total K = 1.01
* 30 ft of 24" pipe

6 (130-140) EQ basin (2013:30-M-2000)
17 420 0 .011 98 0 1000 0 0 0 100 /

* 35' W x 98'L

10 (140-150) Headloss to represent fluccuation in EQ basin (2013: 30-M-2000)
5 /

*Max 5' per Jason Riegler/CVO

*Effluent Level from SBR should not exceed the invert of the decant
*collection pipe currently set at 11'2" from bottom of basin.
*NEW CONFIGURATION CHECK REQUIREMENTS

********************************************
* ICIAS SBR               *
********************************************

0 (0-10) EGL set at the SBR water level based on BioWin (2013: 30-M-2001)
32.5 2.09 12.3 2.09 /
*
* Q1 = total plant influent , 2.09
* Q2 = Future peak hour, 12.3
* Q3 = EQ basin outlet flow, 2.09 mgd (Max month)
*
* 2037 Peak Instantaneous Flow 8.2 mgd --> 36.00 ft Max WSE
* 2037 Peak Daily Average Flow 6.31 mgd --> 36.00 ft Max WSE
```

```
* 2037 Max Month Wet Weather 2.09 mgd --> 32.50 ft Max WSE
* 2037 Average Dry Weather 0.99 mgd --> 30.75 ft Max WSE


6 (160-170) SBR main chamber (3013: 30-M-2001)
17 600 0 .013 123 0 276 0 50 0 0 /
*50% of peak hour flow Q1

8  (170-180) underflow baffle wall orifice (2013: 30-M-2001)
480 18 0.6 50 0 0/
* 40-ft of opening along 50-ft wall
* 18" height based on vendor input


6 (180-190) Pre-react Basin (2013: 30-M-2001)
17 600 0 .013 22 0 276 0 50 0 0 /
* 22 ft length

1 (200-210) Pipe from HW flow split to SBR (2013: 30-M-2001)
24 56 .013 2.3 1.0 50 0 0 /
* 24-inch diam
* 56 ft long pipe
* 4 90-deg bend, K=0.45*4=1.8
* Entrance Loss, K=0.5
* Total K = 2.3
* Exit Loss, K=1.0


2 (210-215) Split box (2013: 20-M-2000)
60 36 15 .013 2.2 0 50 0 0/
* 3'x6' drop box D/S of weir gate
* Turbulent flow, K=1.0
* 90-deg bends, K=1.2

4 (215-220) Weir gate (2013: 20-M-2000)
37.16 3.5 2 18 50 0 0/
*HGL 0.5 ft above D/S HGL

*********************************************
*END OF ADDITION FOR SBR FLOW SPLIT         *
*********************************************

6 (220-230) Grit outlet channel (2013: 20-M-3001)
18 36 0 .013 23 0 264 0 100 0 0 /

* Invert at 18'Channel
* Length = 23 ft based on SHN 5/11/13 dwg
* width = 3 ft based on SHN 5/11/13 dwg

4 (230-240) Grit Channel Weir (2013: 20-M-3001)
38.84 12 0 0 100 0 0 /

* 12'weir (no contractions)
* set invert 0.5' above downstream HGL

10 (260-270) Headloss across grit equipment (2013: 20-M-3001)
1.5 /
* based on 0.75-ft loss from vendor and 0.75-ft
* additional observed loss from SHN
* Grit equipment vendor is HydroInternational HeadCell

6 (273-275) Grit Inlet channel (2013: 20-M-2000)
38.84 36 0 .013 7 0 51 0.65 100 0 0 /
```

```
* symmetrical combining T-channel. K=0.65 (DS Miller Fig 13.16)

6 (273-275) Channel btwn screens and grit chamber (2013: 20-M-2000)
38.84 36 0 .013 8 0 51 2.4 100 0 0 /
* Flow split between two screens
* Invert match grit eff weir
* Length = 8 ft based on SHC 5/10/13 dwg
* width = 3 ft based on SHC 5/10/13 dwg
* 2 90-deg bends, K=2*1.2 = 2.4

6 (275-280) D/S Screen Channel (2013: 20-M-2000)
38.84 24 0 0.013 6 0 51 0 100 0 0/
* Invert to match grit eff weir
* Length = 6 ft based on SHC 5/10/13 dwg
* width = 24" based on SHC 5/10/13 dwg

10 (280-290) Arbitrary headloss across screens (2013: 20-M-2000)
0.5 /
* Assume 0.5 ft headloss (5/15/13 Mike Veach/SHN Email -
*  from Hydro-Dyne calculations)

6 (290-300) Channel screen channel 1/2 flow (2013: 20-M-2000)
38.84 18 0 .013 5 0 51 0 100 0 0 /

* Channel width 1.5' (18 in) based on SHC 5/10/13 dwg
* Length 5 ft based on SHC 5/10/13 dwg


6 (300-310) Channel flow  wide channel to screens (2013: 20-M-2000)
38.84 36 0 .013 15 0 51 2.4 100 0 0 /

* Channel width 13' (180 in)
* Length 3 ft
* 2 90-deg bend, K=2*1.2= 2.4

/*
```

```
********************************************
*                                          *
*                   HYDRO                  *
*        TREATMENT PLANT HYDRAULICS        *
*                                          *
*              CH2M Hill, Inc.             *
*         2300 NW Walnut Boulevard         *
*               P.O. Box 428               *
*         Corvallis, Oregon  97330         *
*                                          *
*              VERSION  9.56               *
*                24-JAN-02                 *
*                                          *
*           (C) COPYRIGHT 1902             *
*             CH2M-HILL INC.               *
*           ALL RIGHTS RESERVED            *
*                                          *
*       RUN ON  08/14/13   09:34:50        *
*                                          *
*                   NOTE                   *
* This page contains valuable information  *
* that should be saved.  If it becomes     *
* necessary to rerun this analysis in the  *
* future, this page will allow retrieval   *
* of the proper program and data files.    *
********************************************
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE   1
Q1=    0.00     Q2=    0.00     Q3=    0.00
=======================================================================

City of Coos Bay WWTP SBR Project

Project Number:469556.03.35.05.60

Assumptions:
All units in service
Maximum Month Wet Weather: Q =  6.31 mgd
SC three channels, one screen in service
SBR: 2 in parallel
EQ basin sized for concurrent SBR operation
UV two channels one in future.
All elevations must be checked for datum. include +4.2 ft to convert fr

MINOR LOSS COEFFICIENTS (FROM D.S. MILLER INTERNAL FLOW SYSTEMS, 1978)
90-deg elbow, K=0.45
45-deg elbow, K=0.2
180 deg. open channel bend, K=3.0
90 deg. open channel bend, K=1.2
45 deg. open channel bend, K=0.6
Entrance loss, K=0.5
Exit loss, K=1.0
Orifice coefficient, C, 0.6
21" Tee Through flow, dead branch, K=0.04
21" Tee Branch flow, dead run, K=1.10
```

```
♀


 UNITS OPTION SPECIFIED = 0
 LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
           WIDTH/HEIGHT = IN     DIAM = IN

                                                                        PAGE   2
 Q1=    2.09     Q2=   12.30     Q3=    2.09
 =======================================================================


 CONDITIONS SET -                                                       SEQ =  1
 (0-10) EGL set at mean higher high water level (100-yr flood)
 ENERGY LINE =  11.00  Q1 =   2.09  Q2 =  12.30  Q3 =   2.09  VEL = 0.00

  Q1 = total plant influent max month wet weather, 2.09 mgd
  Q2 = Future peak instantaneous flow, 12.3 mgd
  Q3 = EQ basin outlet flow, 2.09 mgd (Max Month)

  FEMA FIRM map 41011C0168D for flood elevation.
 ELEMENT NO. 26                                                         SEQ =  2
  (10-20) existing diffuser outfall (1973 sht 38)
 NUMBER OF PORTS ------------------------      5
 PERCENT BETWEEN SHARP EDGE PORT (0.0) --    0.0
      AND BELL MOUTH PORT (100.0)
 AVAILABLE ENERGY AT PORT NO. 1 --------    0.42
 SPECIFIC GRAVITY DIFFERENCE ------------ 0.0250


 *------ PORT PARAMETERS ------*   *--------- PIPE PARAMETERS ---------*
     DIAM  CD   FLOW  VEL ENERGY    LNTH  DIAM         FLOW  VEL  H LOSS
 NUM                                          FRICT
   1 6.00 0.63  0.42  3.29  0.42     7.5  24.0 0.047   0.42  0.21  0.000
   2 6.00 0.63  0.42  3.30  0.43     7.5  24.0 0.038   0.84  0.41  0.000
   3 6.00 0.63  0.42  3.30  0.43     7.5  24.0 0.034   1.26  0.62  0.001
   4 6.00 0.62  0.42  3.30  0.44     7.5  24.0 0.031   1.67  0.82  0.001
   5 6.00 0.62  0.42  3.28  0.44     7.5  24.0 0.029   2.09  1.03  0.002
                                 -------                          ------
                                    37.5                           0.004
 HYDRAULIC GRADE LINE ELEV. HLOSS =  0.44    DN =   11.69  UP =    12.12
 ENERGY LINE ELEVATION                       DN =   11.69  UP =    12.13
 TOTAL FLOWRATE       ----       2.090

 Specific Gravity of Seawater = 1.025
 24" pipe w/ end invert at -17.5' therefor CL is at -16.5'
 100 %Q3
 Available engergy at Port 1 is at 1' reasonable??
 assumed divergence angle for 12" x 6" reducer = 20.5 deg.
 Absolute pipe roughness estimated at at 0.0102 inch following ex. in
  manual
 diffuser slope =.019
 assume 100% sharp edge diffuser--most conservative
 no risers
♀


 UNITS OPTION SPECIFIED = 0
 LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
           WIDTH/HEIGHT = IN     DIAM = IN

                                                                        PAGE   3
```

```
Q1=    2.09     Q2=   12.30     Q3=    2.09
=======================================================================


ELEMENT NO.  1                                                SEQ =  3
(20-30) Existing pipe from diffuser to existing MH (1973 sht 38)
PRESSURE LINE (CIR)     FLOWRATE =     2.09            VELOCITY =  1.03
PIPE ------ DIA = 24.0       LEN = 880.0                        N = 0.012
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  0.50    EXIT K =  0.00
HEAD LOSS: MISC =  0.01     EXIT =  0.00 PIPE =  0.15     TOTAL =  0.16
HYDRAULIC GRADE LINE ELEVATION              DN =   12.11  UP =    12.28
ENERGY LINE ELEVATION                       DN =   12.13  UP =    12.29
CMP Design Guide Mannings n = .011 to .020; assumed 0.012 due to
 relining.
Demo plan Sht 1 indicates demo and replacement of 24inch CMP outfall
Entrance loss from upstream MH K= 0.5

ELEMENT NO.  6                                                SEQ =  4
(30-40) Flow through channel to represent existing MH (2013: 006-C-2001
RECT/TRAP CHANNEL       FLOWRATE =     2.09     MINOR LOSS K =    0.000
BASE =  72.0     SLP = 0.0   LEN =   6.0     N =0.012  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.06  UP =     0.06
CHANNEL BOTTOM ELEVATION                    DN =    3.33  UP =     3.33
DEPTH ---- CRIT =  0.21   NORMAL = 999.99   DN =    8.96  UP =     8.96
HEAD LOSS -----          MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   12.29  UP =    12.29
ENERGY LINE ELEVATION                       DN =   12.29  UP =    12.29
 Manhole dimension information provided by SHN Engineers.

ELEMENT NO.  1                                                SEQ =  5
(45-50) Pipe from exst MH to UV basin (2013: 006-C-2001 and -2001A)
PRESSURE LINE (CIR)     FLOWRATE =     2.09            VELOCITY =  0.66
PIPE ------ DIA = 30.0       LEN = 880.0                        N = 0.012
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  5.20    EXIT K =  3.00
HEAD LOSS: MISC =  0.04     EXIT =  0.02 PIPE =  0.05     TOTAL =  0.10
HYDRAULIC GRADE LINE ELEVATION              DN =   12.29  UP =    12.39
ENERGY LINE ELEVATION                       DN =   12.29  UP =    12.39
 2 45-deg bend, K=0.2*2 = 0.4
 2 90-deg bend, K=0.45*2 = 0.9
 2 90-deg open channel bend, K=1.2*2 = 2.4
 Entrance loss, K=0.5*3 = 1.5
 Total K = 5.2
 Exit loss, K=1*3 = 3
 Using open channel bend to represent 2 manholes along pipeline.
 No pipe profile has been established yet including yard pipe CL.
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                              PAGE   4
Q1=    2.09     Q2=   12.30     Q3=    2.09
=======================================================================


ELEMENT NO.  5                                                SEQ =  6
(50-55) Gravity pipe outlet from UV (2013: 40-M-3000)
CIRCULAR CHANNEL        FLOWRATE =     2.09     MINOR LOSS K =    0.000
PIPE ------ DIA = 30.0       LEN =  10.0     N =0.012  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    3.49  UP =     2.93
CHANNEL BOTTOM ELEVATION                    DN =   16.00  UP =    16.00
```

```
DEPTH ---- CRIT =  0.59   NORMAL = 999.99   DN =    0.61  UP =     0.69
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.023  TOTAL = 0.023
HYDRAULIC GRADE LINE ELEV                   DN =   16.61  UP =    16.69
ENERGY LINE ELEVATION                       DN =   16.80  UP =    16.82

ELEMENT NO.  6                                               SEQ =  7
(55-60) Channel at downstream end of UV 2013: 40-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     2.09     MINOR LOSS K =    0.000
BASE =  48.0     SLP = 0.0   LEN =  10.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.12  UP =     0.12
CHANNEL BOTTOM ELEVATION                    DN =   10.00  UP =    10.00
DEPTH ---- CRIT =  0.27   NORMAL = 999.99   DN =    6.82  UP =     6.82
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   16.82  UP =    16.82
ENERGY LINE ELEVATION                       DN =   16.82  UP =    16.82
Invert  set at 10' to account for pipe bury (grd surface=15'
 (1973 sht 38))
9' (108") width
Mannings n = 0.013
4 ft length
slope= 0.
Max depth is 12-ft

ELEMENT NO. 12                                               SEQ =  8
 (60-65) Finger weir launder from UV channel (2013: 40-M-2000)
RECT/TRAP LAUNDER       FLOWRATE =     0.70     MINOR LOSS K =  0.00000
BASE =  18.0     SLP = 0.0   LEN =  20.0     N =0.011  SLOPE =  0.01200
TOP WIDTH    IN                             DN =   18.00  UP =    18.00
VELOCITY -------------------------          DN =    2.85  UP =     0.00
CHANNEL BOTTOM ELEVATION ----------         DN =   17.10  UP =    17.34
DEPTH --------------------- CRIT =  0.25    DN =    0.25  UP =     0.24
HEAD LOSS -- MINOR =0.000 HLOSS = 0.1007 TOTAL = 0.10075 QUP =     0.00
HYDRAULIC GRADE LINE ELEVATION              DN =   17.35  UP =    17.58
ENERGY LINE ELEVATION                       DN =   17.48  UP =    17.58
 SST launder, V-notch weirs on each side
 3 launders, so flow is 33.3% of Q3
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                             PAGE   5
Q1=    2.09     Q2=   12.30     Q3=    2.09
=======================================================================


ELEMENT NO.  3                                               SEQ =  9
(65-70) V-notch weirs (2013: 40-M-2000)
V-NOTCH WEIR            FLOWRATE =     0.35          NON SUBMERGED WEIR
WEIR - ANGLE 90. DEG;    40 NOTCHES AT  0.009 MGD EACH; ELEV =    18.55
LENGTH =  20.0       SUBMERGENCE =  0.00                HEAD =     0.12
HYDRAULIC GRADE LINE ELEV. HLOSS =  1.10    DN =   17.58  UP =    18.67
ENERGY LINE ELEVATION                       DN =   17.58  UP =    18.67
 20-ft long weirs into 1-ft deep launders
 Two weir lengths along each launder x 3 launders
 total weir length 120-ft.  Trojan recommends 118 ft.
 based on standard detail

ELEMENT NO.  6                                               SEQ = 10
(70-80) Rectangular Open Channel (2013: 40-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     2.09     MINOR LOSS K =    0.000
```

```
BASE = 108.0     SLP = 0.0   LEN =  23.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.16  UP =     0.16
CHANNEL BOTTOM ELEVATION                    DN =   16.46  UP =    16.46
DEPTH ---- CRIT =  0.16   NORMAL = 999.99   DN =    2.21  UP =     2.21
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   18.67  UP =    18.67
ENERGY LINE ELEVATION                       DN =   18.67  UP =    18.67
 Expansion loss, K=0.45 (DS Miller, Fig 14.15)

ELEMENT NO.  6                                                SEQ = 11
(70-80) Rectangular Open Channel (2013: 40-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     2.09     MINOR LOSS K =    0.000
BASE =  40.0     SLP = 0.0   LEN =  46.5     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.44  UP =     0.44
CHANNEL BOTTOM ELEVATION                    DN =   16.46  UP =    16.46
DEPTH ---- CRIT =  0.31   NORMAL = 999.99   DN =    2.21  UP =     2.21
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.002  TOTAL = 0.002
HYDRAULIC GRADE LINE ELEV                   DN =   18.67  UP =    18.67
ENERGY LINE ELEVATION                       DN =   18.67  UP =    18.68
40-inch width based on Trojan 2/27/2013

ELEMENT NO. 10                                                SEQ = 12
 (80-90) Headloss for UV equipment in channel
******ADDITIONAL HEAD LOSS SPECIFIED******
HL =  0.55     K =  0.00   VHEAD =  0.00
HYDRAULIC GRADE LINE EL.   HLOSS =  0.55    DN =   18.67  UP =    19.23
ENERGY LINE EL.                             DN =   18.68  UP =    19.23
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                              PAGE   6
Q1=    2.09     Q2=   12.30     Q3=    2.09
=======================================================================

Assumes 1.5" HL per bank, 1.5"x3 = 4.5"
Straightening baffle loss = 2"
Total loss = 6.5" or 0.55 ft (rounded up)
Trojan's headloss is ~1.1"/bank on average
Check that max water depth is 2.66' from upstream bank per Trojan

ELEMENT NO.  6                                                SEQ = 13
(90-100) Rectangular channel upstream of UV (2013: 40-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     2.09     MINOR LOSS K =    2.400
BASE =  76.0     SLP = 0.0   LEN =   4.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.06  UP =     0.06
CHANNEL BOTTOM ELEVATION                    DN =   10.00  UP =    10.00
DEPTH ---- CRIT =  0.20   NORMAL = 999.99   DN =    9.23  UP =     9.23
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   19.23  UP =    19.23
ENERGY LINE ELEVATION                       DN =   19.23  UP =    19.23
 two 90-deg bends as flow transitions from below, K=2*1.2=2.4
Invert  set at 10'

ELEMENT NO.  1                                                SEQ = 14
(100-105) Pressurized Circular Pipe to Expansion (2013: 30-M-2000)
PRESSURE LINE (CIR)     FLOWRATE =     2.09           VELOCITY =  1.03
PIPE ------ DIA = 24.0       LEN =  50.0                     N = 0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  0.80    EXIT K =  1.00
HEAD LOSS: MISC =  0.01     EXIT =  0.02 PIPE =  0.01     TOTAL =  0.04
```

```
HYDRAULIC GRADE LINE ELEVATION              DN =   19.21  UP =    19.25
ENERGY LINE ELEVATION                       DN =   19.23  UP =    19.27
Exit loss, K = 1
Expansion to 24-in diam, K = 0.15
50 ft of 24" pipe
 1 90-deg bends, K=0.45
 1 45-deg bend, K=0.2
 Total K = 0.8

ELEMENT NO.  1                                                 SEQ = 15
(105-110) Pipe from expansion to FCV (2013: 30-M-2000)
PRESSURE LINE (CIR)     FLOWRATE =     2.09            VELOCITY =  2.32
PIPE ------ DIA = 16.0       LEN =   5.0                      N = 0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  1.12    EXIT K =  0.00
HEAD LOSS: MISC =  0.09     EXIT =  0.00 PIPE =  0.01     TOTAL =  0.10
HYDRAULIC GRADE LINE ELEVATION              DN =   19.18  UP =    19.29
ENERGY LINE ELEVATION                       DN =   19.27  UP =    19.37
 24x16 expansion, K = 0.31
 gate valve: K = 0.10
 Flow through tee: K = 0.26
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE   7
Q1=    2.09     Q2=   12.30     Q3=    2.09
=======================================================================

 1 90-deg bend, K=0.45
 Total K = 1.12

ELEMENT NO. 28                                                 SEQ = 16
 (110-115) Flow Control Valve (2013: 30-M-2000)
PRESSURE LINE (CIR)     FLOWRATE =     2.09             VELOCITY =  2.32
TOTAL HEAD LOSS ACROSS VALVE                                  =     0.05
HYDRAULIC GRADE LINE ELEVATION               DN =   19.29  UP =    19.34
ENERGY LINE ELEVATION                        DN =   19.37  UP =    19.42
Data for 16-inch BF valve from ValMatic

ELEMENT NO.  1                                                 SEQ = 17
(115-120) Pipe from Flow control valve to Contraction (2013: 30-M-2000)
PRESSURE LINE (CIR)     FLOWRATE =     2.09            VELOCITY =  2.32
PIPE ------ DIA = 16.0       LEN =  20.0                      N = 0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  0.36    EXIT K =  0.00
HEAD LOSS: MISC =  0.03     EXIT =  0.00 PIPE =  0.04     TOTAL =  0.07
HYDRAULIC GRADE LINE ELEVATION              DN =   19.34  UP =    19.41
ENERGY LINE ELEVATION                       DN =   19.42  UP =    19.49
 includes 16" mag meter
 gate valve: K = 0.10
 Flow through tee: K = 0.26
 Total K = 0.36

ELEMENT NO.  1                                                 SEQ = 18
(120-130) Pipe from contractor to EQ Basin (2013: 30-M-2000)
PRESSURE LINE (CIR)     FLOWRATE =     2.09            VELOCITY =  1.03
PIPE ------ DIA = 24.0       LEN =  30.0                      N = 0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  1.01    EXIT K =  0.00
HEAD LOSS: MISC =  0.02     EXIT =  0.00 PIPE =  0.01     TOTAL =  0.02
HYDRAULIC GRADE LINE ELEVATION              DN =   19.47  UP =    19.50
ENERGY LINE ELEVATION                       DN =   19.49  UP =    19.51
```

```
Entrance loss K=0.5
contraction to 16-in, K= 0.06
 1 90-deg elbow, K=0.45
 Total K = 1.01
 30 ft of 24" pipe
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE   8
Q1=    2.09     Q2=   12.30     Q3=    2.09
=======================================================================


ELEMENT NO.  6                                                 SEQ = 19
(130-140) EQ basin (2013:30-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     2.09     MINOR LOSS K =    0.000
BASE = 420.0     SLP = 0.0   LEN =  98.0     N =0.011  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.04  UP =     0.04
CHANNEL BOTTOM ELEVATION                    DN =   17.00  UP =    17.00
DEPTH ---- CRIT =  0.06   NORMAL = 999.99   DN =    2.51  UP =     2.52
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.003  TOTAL = 0.003
HYDRAULIC GRADE LINE ELEV                   DN =   19.51  UP =    19.52
ENERGY LINE ELEVATION                       DN =   19.51  UP =    19.52
 35' W x 98'L

ELEMENT NO. 10                                                 SEQ = 20
 (140-150) Headloss to represent fluccuation in EQ basin (2013: 30-M-20
******ADDITIONAL HEAD LOSS SPECIFIED******
HL =  5.00     K =  0.00   VHEAD =  0.00
HYDRAULIC GRADE LINE EL.   HLOSS =  5.00    DN =   19.52  UP =    24.52
ENERGY LINE EL.                             DN =   19.52  UP =    24.52
Max 5' per Jason Riegler/CVO
Effluent Level from SBR should not exceed the invert of the decant
collection pipe currently set at 11'2" from bottom of basin.
NEW CONFIGURATION CHECK REQUIREMENTS
*******************************************
 ICIAS SBR               *
*******************************************
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE   9
Q1=    2.09     Q2=   12.30     Q3=    2.09
=======================================================================


CONDITIONS SET -                                               SEQ = 21
(0-10) EGL set at the SBR water level based on BioWin (2013: 30-M-2001)
ENERGY LINE =  32.50  Q1 =   2.09  Q2 =  12.30  Q3 =   2.09  VEL = 0.04

 Q1 = total plant influent , 2.09
 Q2 = Future peak hour, 12.3
 Q3 = EQ basin outlet flow, 2.09 mgd (Max month)

 2037 Peak Instantaneous Flow 8.2 mgd --> 36.00 ft Max WSE
```

```
 2037 Peak Daily Average Flow 6.31 mgd --> 36.00 ft Max WSE
 2037 Max Month Wet Weather 2.09 mgd --> 32.50 ft Max WSE
 2037 Average Dry Weather 0.99 mgd --> 30.75 ft Max WSE

ELEMENT NO.  6                                                 SEQ = 22
(160-170) SBR main chamber (3013: 30-M-2001)
RECT/TRAP CHANNEL       FLOWRATE =     1.04     MINOR LOSS K =    0.000
BASE = 600.0     SLP = 0.0   LEN = 123.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.00  UP =     0.00
CHANNEL BOTTOM ELEVATION                    DN =   17.00  UP =    17.00
DEPTH ---- CRIT =  0.03   NORMAL = 999.99   DN =   15.50  UP =    15.50
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.004  TOTAL = 0.004
HYDRAULIC GRADE LINE ELEV                   DN =   32.50  UP =    32.50
ENERGY LINE ELEVATION                       DN =   32.50  UP =    32.50
50% of peak hour flow Q1

ELEMENT NO.  8                                                 SEQ = 23
 (170-180) underflow baffle wall orifice (2013: 30-M-2001)
RECTANGULAR ORIFICE     FLOWRATE =     1.04      ORIFICE VEL =     0.03
GATE -- WIDTH = 480.0      DEPTH =  18.0        ORIFICE COEF =    0.600
HYDRAULIC GRADE LINE EL.   HLOSS =  0.00    DN =   32.50  UP =    32.50
ENERGY LINE EL.                             DN =   32.50  UP =    32.50
 40-ft of opening along 50-ft wall
 18" height based on vendor input

ELEMENT NO.  6                                                 SEQ = 24
(180-190) Pre-react Basin (2013: 30-M-2001)
RECT/TRAP CHANNEL       FLOWRATE =     1.04     MINOR LOSS K =    0.000
BASE = 600.0     SLP = 0.0   LEN =  22.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.00  UP =     0.00
CHANNEL BOTTOM ELEVATION                    DN =   17.00  UP =    17.00
DEPTH ---- CRIT =  0.03   NORMAL = 999.99   DN =   15.50  UP =    15.50
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   32.50  UP =    32.50
ENERGY LINE ELEVATION                       DN =   32.50  UP =    32.50
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE  10
Q1=    2.09     Q2=   12.30     Q3=    2.09
=======================================================================

 22 ft length

ELEMENT NO.  1                                                 SEQ = 25
(200-210) Pipe from HW flow split to SBR (2013: 30-M-2001)
PRESSURE LINE (CIR)     FLOWRATE =     1.04           VELOCITY =  0.51
PIPE ------ DIA = 24.0       LEN =  56.0                     N = 0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  2.30    EXIT K =  1.00
HEAD LOSS: MISC =  0.01     EXIT =  0.00 PIPE =  0.00     TOTAL =  0.02
HYDRAULIC GRADE LINE ELEVATION              DN =   32.50  UP =    32.52
ENERGY LINE ELEVATION                       DN =   32.50  UP =    32.52
 24-inch diam
 56 ft long pipe
 4 90-deg bend, K=0.45*4=1.8
 Entrance Loss, K=0.5
 Total K = 2.3
 Exit Loss, K=1.0
```

```
ELEMENT NO.  2                                                 SEQ = 26
(210-215) Split box (2013: 20-M-2000)
PRESSURE LINE (RECT)    FLOWRATE =     1.04           VELOCITY =   0.11
PIPE- H =  36.0 W =  60.0    LEN =  15.0                     N =  0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  2.20    EXIT K =  0.00
HEAD LOSS: MISC =  0.00     EXIT =  0.00 PIPE =  0.00     TOTAL =  0.00
HYDRAULIC GRADE LINE ELEVATION              DN =   32.52  UP =    32.52
ENERGY LINE ELEVATION                       DN =   32.52  UP =    32.52
 3'x6' drop box D/S of weir gate
 Turbulent flow, K=1.0
 90-deg bends, K=1.2

ELEMENT NO.  4                                                 SEQ = 27
(215-220) Weir gate (2013: 20-M-2000)
RECTANGULAR WEIR        FLOWRATE =     1.04          NON SUBMERGED WEIR
WEIR ------------ SIDE CONTRACTION COEFFICIENT =2.00    ELEV =    37.16
LENGTH =   3.5       SUBMERGENCE =  0.00                HEAD =     0.27
HYDRAULIC GRADE LINE ELEV. HLOSS =  4.91    DN =   32.52  UP =    37.43
ENERGY LINE ELEVATION                       DN =   32.52  UP =    37.43
HGL 0.5 ft above D/S HGL
*******************************************
END OF ADDITION FOR SBR FLOW SPLIT        *
*******************************************
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE  11
Q1=    2.09     Q2=   12.30     Q3=    2.09
=======================================================================


ELEMENT NO.  6                                                 SEQ = 28
(220-230) Grit outlet channel (2013: 20-M-3001)
RECT/TRAP CHANNEL       FLOWRATE =     2.09     MINOR LOSS K =    0.000
BASE =  36.0     SLP = 0.0   LEN =  23.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.06  UP =     0.06
CHANNEL BOTTOM ELEVATION                    DN =   18.00  UP =    18.00
DEPTH ---- CRIT =  0.33   NORMAL = 999.99   DN =   19.43  UP =    19.43
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   37.43  UP =    37.43
ENERGY LINE ELEVATION                       DN =   37.43  UP =    37.43
 Invert at 18'Channel
 Length = 23 ft based on SHN 5/11/13 dwg
 width = 3 ft based on SHN 5/11/13 dwg

ELEMENT NO.  4                                                 SEQ = 29
(230-240) Grit Channel Weir (2013: 20-M-3001)
RECTANGULAR WEIR        FLOWRATE =     2.09          NON SUBMERGED WEIR
WEIR ------------ SIDE CONTRACTION COEFFICIENT =0.00    ELEV =    38.84
LENGTH =  12.0       SUBMERGENCE =  0.00                HEAD =     0.19
HYDRAULIC GRADE LINE ELEV. HLOSS =  1.60    DN =   37.43  UP =    39.03
ENERGY LINE ELEVATION                       DN =   37.43  UP =    39.03
 12'weir (no contractions)
 set invert 0.5' above downstream HGL

ELEMENT NO. 10                                                 SEQ = 30
 (260-270) Headloss across grit equipment (2013: 20-M-3001)
******ADDITIONAL HEAD LOSS SPECIFIED******
HL =  1.50     K =  0.00   VHEAD =  0.00
```

```
HYDRAULIC GRADE LINE EL.   HLOSS =  1.50    DN =   39.03  UP =    40.53
ENERGY LINE EL.                             DN =   39.03  UP =    40.53
 based on 0.75-ft loss from vendor and 0.75-ft
 additional observed loss from SHN
 Grit equipment vendor is HydroInternational HeadCell

ELEMENT NO.  6                                              SEQ = 31
(273-275) Grit Inlet channel (2013: 20-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     2.09     MINOR LOSS K =    0.650
BASE =  36.0     SLP = 0.0   LEN =   7.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.64  UP =     0.64
CHANNEL BOTTOM ELEVATION                    DN =   38.84  UP =    38.84
DEPTH ---- CRIT =  0.33   NORMAL = 999.99   DN =    1.68  UP =     1.69
HEAD LOSS -----            MINOR =  0.004  HLOSS = 0.001  TOTAL = 0.005
HYDRAULIC GRADE LINE ELEV                   DN =   40.52  UP =    40.53
ENERGY LINE ELEVATION                       DN =   40.53  UP =    40.53
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                            PAGE  12
Q1=    2.09     Q2=   12.30     Q3=    2.09
=======================================================================

 symmetrical combining T-channel. K=0.65 (DS Miller Fig 13.16)

ELEMENT NO.  6                                              SEQ = 32
(273-275) Channel btwn screens and grit chamber (2013: 20-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     2.09     MINOR LOSS K =    2.400
BASE =  36.0     SLP = 0.0   LEN =   8.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.64  UP =     0.63
CHANNEL BOTTOM ELEVATION                    DN =   38.84  UP =    38.84
DEPTH ---- CRIT =  0.33   NORMAL = 999.99   DN =    1.69  UP =     1.70
HEAD LOSS -----            MINOR =  0.015  HLOSS = 0.001  TOTAL = 0.016
HYDRAULIC GRADE LINE ELEV                   DN =   40.53  UP =    40.54
ENERGY LINE ELEVATION                       DN =   40.53  UP =    40.55
 Flow split between two screens
 Invert match grit eff weir
 Length = 8 ft based on SHC 5/10/13 dwg
 width = 3 ft based on SHC 5/10/13 dwg
 2 90-deg bends, K=2*1.2 = 2.4

ELEMENT NO.  6                                              SEQ = 33
(275-280) D/S Screen Channel (2013: 20-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     2.09     MINOR LOSS K =    0.000
BASE =  24.0     SLP = 0.0   LEN =   6.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.95  UP =     0.95
CHANNEL BOTTOM ELEVATION                    DN =   38.84  UP =    38.84
DEPTH ---- CRIT =  0.43   NORMAL = 999.99   DN =    1.70  UP =     1.70
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.002  TOTAL = 0.002
HYDRAULIC GRADE LINE ELEV                   DN =   40.54  UP =    40.54
ENERGY LINE ELEVATION                       DN =   40.55  UP =    40.55
 Invert to match grit eff weir
 Length = 6 ft based on SHC 5/10/13 dwg
 width = 24" based on SHC 5/10/13 dwg

ELEMENT NO. 10                                              SEQ = 34
 (280-290) Arbitrary headloss across screens (2013: 20-M-2000)
******ADDITIONAL HEAD LOSS SPECIFIED******
HL =  0.50     K =  0.00   VHEAD =  0.00
```

```
 HYDRAULIC GRADE LINE EL.   HLOSS =  0.50    DN =   40.54  UP =    41.05
 ENERGY LINE EL.                             DN =   40.55  UP =    41.05
  Assume 0.5 ft headloss (5/15/13 Mike Veach/SHN Email -
   from Hydro-Dyne calculations)
♀


 UNITS OPTION SPECIFIED = 0
 LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
           WIDTH/HEIGHT = IN     DIAM = IN

                                                                PAGE  13
 Q1=    2.09     Q2=   12.30     Q3=    2.09
 ======================================================================


 ELEMENT NO.  6                                                 SEQ = 35
 (290-300) Channel screen channel 1/2 flow (2013: 20-M-2000)
 RECT/TRAP CHANNEL       FLOWRATE =     2.09     MINOR LOSS K =    0.000
 BASE =  18.0     SLP = 0.0   LEN =   5.0     N =0.013  SLOPE =  0.00000
 VELOCITY ---------------- NORMAL =999.99    DN =    0.98  UP =     0.98
 CHANNEL BOTTOM ELEVATION                    DN =   38.84  UP =    38.84
 DEPTH ---- CRIT =  0.52   NORMAL = 999.99   DN =    2.20  UP =     2.20
 HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.002  TOTAL = 0.002
 HYDRAULIC GRADE LINE ELEV                   DN =   41.04  UP =    41.04
 ENERGY LINE ELEVATION                       DN =   41.05  UP =    41.05
  Channel width 1.5' (18 in) based on SHC 5/10/13 dwg
  Length 5 ft based on SHC 5/10/13 dwg

 ELEMENT NO.  6                                                 SEQ = 36
 (300-310) Channel flow  wide channel to screens (2013: 20-M-2000)
 RECT/TRAP CHANNEL       FLOWRATE =     2.09     MINOR LOSS K =    2.400
 BASE =  36.0     SLP = 0.0   LEN =  15.0     N =0.013  SLOPE =  0.00000
 VELOCITY ---------------- NORMAL =999.99    DN =    0.49  UP =     0.48
 CHANNEL BOTTOM ELEVATION                    DN =   38.84  UP =    38.84
 DEPTH ---- CRIT =  0.33   NORMAL = 999.99   DN =    2.21  UP =     2.22
 HEAD LOSS -----            MINOR =  0.009  HLOSS = 0.001  TOTAL = 0.010
 HYDRAULIC GRADE LINE ELEV                   DN =   41.05  UP =    41.06
 ENERGY LINE ELEVATION                       DN =   41.05  UP =    41.06
  Channel width 13' (180 in)
  Length 3 ft
  2 90-deg bend, K=2*1.2= 2.4
^
```

```
/*
*City of Coos Bay WWTP SBR Project
*
*Project Number:469556.03.35.05.60
*
*Assumptions:
*All units in service
*Dry Weather Average: Q =  0.99 mgd
*SC three channels, one screen in service
*SBR: 2 in parallel
*EQ basin sized for concurrent SBR operation
*UV two channels one in future.
*All elevations must be checked for datum. include +4.2 ft to convert from 1974
vertical datum to NGVD 1988

*
*MINOR LOSS COEFFICIENTS (FROM D.S. MILLER INTERNAL FLOW SYSTEMS, 1978)
*90-deg elbow, K=0.45
*45-deg elbow, K=0.2
*180 deg. open channel bend, K=3.0
*90 deg. open channel bend, K=1.2
*45 deg. open channel bend, K=0.6
*Entrance loss, K=0.5
*Exit loss, K=1.0
*Orifice coefficient, C, 0.6
*21" Tee Through flow, dead branch, K=0.04
*21" Tee Branch flow, dead run, K=1.10
*
*
0 (0-10) EGL set at mean higher high water level (100-yr flood)
11 0.99 12.3 0.99 /
*
* Q1 = total plant influent max month wet weather, 0.99 mgd
* Q2 = Future peak instantaneous flow, 12.3 mgd
* Q3 = EQ basin outlet flow, 0.99 mgd (DWA)
*
* FEMA FIRM map 41011C0168D for flood elevation.


26 (10-20) existing diffuser outfall (1973 sht 38)
.025 -16.5 0 0 100 1 1 /
5 20.5 6 24 7.5 .0102 .019 0 0 / Line 3
/*

*Specific Gravity of Seawater = 1.025
*24" pipe w/ end invert at -17.5' therefor CL is at -16.5'
*100 %Q3
*Available engergy at Port 1 is at 1' reasonable??
*assumed divergence angle for 12" x 6" reducer = 20.5 deg.
*Absolute pipe roughness estimated at at 0.0102 inch following ex. in
* manual
*diffuser slope =.019
*assume 100% sharp edge diffuser--most conservative
*no risers


1 (20-30) Existing pipe from diffuser to existing MH (1973 sht 38)
24 880 .012 0.5 0 0 0 100 /

*CMP Design Guide Mannings n = .011 to .020; assumed 0.012 due to
* relining.
*Demo plan Sht 1 indicates demo and replacement of 24inch CMP outfall
*Entrance loss from upstream MH K= 0.5
```

```
6 (30-40) Flow through channel to represent existing MH (2013: 006-C-2001A)
3.33 72 0 .012 6 0 1000 0 0 0 100 /
* Manhole dimension information provided by SHN Engineers.

1 (45-50) Pipe from exst MH to UV basin (2013: 006-C-2001 and -2001A)
30 880 .012 5.2 3 0 0 100 /
* 2 45-deg bend, K=0.2*2 = 0.4
* 2 90-deg bend, K=0.45*2 = 0.9
* 2 90-deg open channel bend, K=1.2*2 = 2.4
* Entrance loss, K=0.5*3 = 1.5
* Total K = 5.2
* Exit loss, K=1*3 = 3
* Using open channel bend to represent 2 manholes along pipeline.
* No pipe profile has been established yet including yard pipe CL.

5 (50-55) Gravity pipe outlet from UV (2013: 40-M-3000)
16 30 0.012 10 0 30 0 0 0 100/

6 (55-60) Channel at downstream end of UV 2013: 40-M-2000)
10 48 0 0.013 10 0 144 0 0 0 100 /
*Invert  set at 10' to account for pipe bury (grd surface=15'
* (1973 sht 38))
*9' (108") width
*Mannings n = 0.013
*4 ft length
*slope= 0.
*Max depth is 12-ft

12 (60-65) Finger weir launder from UV channel (2013: 40-M-2000)
17.1 18 0 0.011 20 0.012 18 0 0 0 33.3 /

* SST launder, V-notch weirs on each side
* 3 launders, so flow is 33.3% of Q3

3 (65-70) V-notch weirs (2013: 40-M-2000)
18.55 20 6 3 16.84 0 0 16.67 90/
* 20-ft long weirs into 1-ft deep launders
* Two weir lengths along each launder x 3 launders
* total weir length 120-ft.  Trojan recommends 118 ft.
* based on standard detail

6 (70-80) Rectangular Open Channel (2013: 40-M-2000)
16.46 108 0 .013 23 0 62 0 0 0 100 /
* Expansion loss, K=0.45 (DS Miller, Fig 14.15)

6 (70-80) Rectangular Open Channel (2013: 40-M-2000)
16.46 40 0 .013 46.5 0 62 0 0 0 100 /
*40-inch width based on Trojan 2/27/2013

10 (80-90) Headloss for UV equipment in channel
0.55 0 /
*Assumes 1.5" HL per bank, 1.5"x3 = 4.5"
*Straightening baffle loss = 2"
*Total loss = 6.5" or 0.55 ft (rounded up)
*Trojan's headloss is ~1.1"/bank on average
*Check that max water depth is 2.66' from upstream bank per Trojan

6 (90-100) Rectangular channel upstream of UV (2013: 40-M-2000)
10 76 0 .013 4 0 144 2.4 0 0 100 /
* two 90-deg bends as flow transitions from below, K=2*1.2=2.4
*Invert  set at 10'
```

```
1 (100-105) Pressurized Circular Pipe to Expansion (2013: 30-M-2000)
24 50 .013 0.8 1.0 0 0 100 /
*Exit loss, K = 1
*Expansion to 24-in diam, K = 0.15
*50 ft of 24" pipe
* 1 90-deg bends, K=0.45
* 1 45-deg bend, K=0.2
* Total K = 0.8

1 (105-110) Pipe from expansion to FCV (2013: 30-M-2000)
16 5 0.013 1.12 0 0 0 100/
* 24x16 expansion, K = 0.31
* gate valve: K = 0.10
* Flow through tee: K = 0.26
* 1 90-deg bend, K=0.45
* Total K = 1.12

28 (110-115) Flow Control Valve (2013: 30-M-2000)
0 0 100 16 .15 5.76 .25 7.2 .37 8.64 /
*Data for 16-inch BF valve from ValMatic

1 (115-120) Pipe from Flow control valve to Contraction (2013: 30-M-2000)
16 20 0.013 0.36 0 0 0 100/
* includes 16" mag meter
* gate valve: K = 0.10
* Flow through tee: K = 0.26
* Total K = 0.36

1 (120-130) Pipe from contractor to EQ Basin (2013: 30-M-2000)
24 30 .013 1.01 0 0 0 100 /
*Entrance loss K=0.5
*contraction to 16-in, K= 0.06
* 1 90-deg elbow, K=0.45
* Total K = 1.01
* 30 ft of 24" pipe

6 (130-140) EQ basin (2013:30-M-2000)
17 420 0 .011 98 0 1000 0 0 0 100 /

* 35' W x 98'L

10 (140-150) Headloss to represent fluccuation in EQ basin (2013: 30-M-2000)
5 /

*Max 5' per Jason Riegler/CVO

*Effluent Level from SBR should not exceed the invert of the decant
*collection pipe currently set at 11'2" from bottom of basin.
*NEW CONFIGURATION CHECK REQUIREMENTS

********************************************
* ICIAS SBR               *
********************************************

0 (0-10) EGL set at the SBR water level based on BioWin (2013: 30-M-2001)
30.75 0.99 12.3 0.99 /
*
* Q1 = total plant influent , 0.99
* Q2 = Future peak hour, 12.3
* Q3 = EQ basin outlet flow, 0.99 mgd (Max month)
*
* 2037 Peak Instantaneous Flow 8.2 mgd --> 36.00 ft Max WSE
* 2037 Peak Daily Average Flow 6.31 mgd --> 36.00 ft Max WSE
```

```
* 2037 Max Month Wet Weather 2.09 mgd --> 32.50 ft Max WSE
* 2037 Average Dry Weather 0.99 mgd --> 30.75 ft Max WSE


6 (160-170) SBR main chamber (3013: 30-M-2001)
17 600 0 .013 123 0 276 0 50 0 0 /
*50% of peak hour flow Q1

8  (170-180) underflow baffle wall orifice (2013: 30-M-2001)
480 18 0.6 50 0 0/
* 40-ft of opening along 50-ft wall
* 18" height based on vendor input


6 (180-190) Pre-react Basin (2013: 30-M-2001)
17 600 0 .013 22 0 276 0 50 0 0 /
* 22 ft length

1 (200-210) Pipe from HW flow split to SBR (2013: 30-M-2001)
24 56 .013 2.3 1.0 50 0 0 /
* 24-inch diam
* 56 ft long pipe
* 4 90-deg bend, K=0.45*4=1.8
* Entrance Loss, K=0.5
* Total K = 2.3
* Exit Loss, K=1.0


2 (210-215) Split box (2013: 20-M-2000)
60 36 15 .013 2.2 0 50 0 0/
* 3'x6' drop box D/S of weir gate
* Turbulent flow, K=1.0
* 90-deg bends, K=1.2

4 (215-220) Weir gate (2013: 20-M-2000)
37.16 3.5 2 18 50 0 0/
*HGL 0.5 ft above D/S HGL

********************************************
*END OF ADDITION FOR SBR FLOW SPLIT        *
********************************************

6 (220-230) Grit outlet channel (2013: 20-M-3001)
18 36 0 .013 23 0 264 0 100 0 0 /

* Invert at 18'Channel
* Length = 23 ft based on SHN 5/11/13 dwg
* width = 3 ft based on SHN 5/11/13 dwg

4 (230-240) Grit Channel Weir (2013: 20-M-3001)
38.84 12 0 0 100 0 0 /

* 12'weir (no contractions)
* set invert 0.5' above downstream HGL

10 (260-270) Headloss across grit equipment (2013: 20-M-3001)
1.5 /
* based on 0.75-ft loss from vendor and 0.75-ft
* additional observed loss from SHN
* Grit equipment vendor is HydroInternational HeadCell

6 (273-275) Grit Inlet channel (2013: 20-M-2000)
38.84 36 0 .013 7 0 51 0.65 100 0 0 /
```

```
* symmetrical combining T-channel. K=0.65 (DS Miller Fig 13.16)

6 (273-275) Channel btwn screens and grit chamber (2013: 20-M-2000)
38.84 36 0 .013 8 0 51 2.4 100 0 0 /
* Flow split between two screens
* Invert match grit eff weir
* Length = 8 ft based on SHC 5/10/13 dwg
* width = 3 ft based on SHC 5/10/13 dwg
* 2 90-deg bends, K=2*1.2 = 2.4

6 (275-280) D/S Screen Channel (2013: 20-M-2000)
38.84 24 0 0.013 6 0 51 0 100 0 0/
* Invert to match grit eff weir
* Length = 6 ft based on SHC 5/10/13 dwg
* width = 24" based on SHC 5/10/13 dwg

10 (280-290) Arbitrary headloss across screens (2013: 20-M-2000)
0.5 /
* Assume 0.5 ft headloss (5/15/13 Mike Veach/SHN Email -
*  from Hydro-Dyne calculations)

6 (290-300) Channel screen channel 1/2 flow (2013: 20-M-2000)
38.84 18 0 .013 5 0 51 0 100 0 0 /

* Channel width 1.5' (18 in) based on SHC 5/10/13 dwg
* Length 5 ft based on SHC 5/10/13 dwg


6 (300-310) Channel flow  wide channel to screens (2013: 20-M-2000)
38.84 36 0 .013 15 0 51 2.4 100 0 0 /

* Channel width 13' (180 in)
* Length 3 ft
* 2 90-deg bend, K=2*1.2= 2.4

/*
```

```
********************************************
*                                          *
*                  HYDRO                   *
*        TREATMENT PLANT HYDRAULICS        *
*                                          *
*             CH2M Hill, Inc.              *
*         2300 NW Walnut Boulevard         *
*              P.O. Box 428                *
*         Corvallis, Oregon  97330         *
*                                          *
*             VERSION  9.56                *
*               24-JAN-02                  *
*                                          *
*           (C) COPYRIGHT 1902             *
*             CH2M-HILL INC.               *
*           ALL RIGHTS RESERVED            *
*                                          *
*       RUN ON  08/14/13   09:31:49        *
*                                          *
*                  NOTE                    *
* This page contains valuable information  *
* that should be saved.  If it becomes     *
* necessary to rerun this analysis in the  *
* future, this page will allow retrieval   *
* of the proper program and data files.    *
********************************************
♀

UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE   1
Q1=    0.00     Q2=    0.00     Q3=    0.00
=======================================================================

City of Coos Bay WWTP SBR Project

Project Number:469556.03.35.05.60

Assumptions:
All units in service
Dry Weather Average: Q =  0.99 mgd
SC three channels, one screen in service
SBR: 2 in parallel
EQ basin sized for concurrent SBR operation
UV two channels one in future.
All elevations must be checked for datum. include +4.2 ft to convert fr

MINOR LOSS COEFFICIENTS (FROM D.S. MILLER INTERNAL FLOW SYSTEMS, 1978)
90-deg elbow, K=0.45
45-deg elbow, K=0.2
180 deg. open channel bend, K=3.0
90 deg. open channel bend, K=1.2
45 deg. open channel bend, K=0.6
Entrance loss, K=0.5
Exit loss, K=1.0
Orifice coefficient, C, 0.6
21" Tee Through flow, dead branch, K=0.04
21" Tee Branch flow, dead run, K=1.10
```

```
♀


 UNITS OPTION SPECIFIED = 0
 LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
           WIDTH/HEIGHT = IN     DIAM = IN

                                                                        PAGE   2
 Q1=    0.99     Q2=   12.30     Q3=    0.99
 =======================================================================


 CONDITIONS SET -                                                       SEQ =  1
 (0-10) EGL set at mean higher high water level (100-yr flood)
 ENERGY LINE =  11.00  Q1 =   0.99  Q2 =  12.30  Q3 =   0.99  VEL = 0.00

  Q1 = total plant influent max month wet weather, 0.99 mgd
  Q2 = Future peak instantaneous flow, 12.3 mgd
  Q3 = EQ basin outlet flow, 0.99 mgd (DWA)

  FEMA FIRM map 41011C0168D for flood elevation.
 ELEMENT NO. 26                                                         SEQ =  2
  (10-20) existing diffuser outfall (1973 sht 38)
 NUMBER OF PORTS -----------------------      5
 PERCENT BETWEEN SHARP EDGE PORT (0.0) --    0.0
      AND BELL MOUTH PORT (100.0)
 AVAILABLE ENERGY AT PORT NO. 1 --------    0.09
 SPECIFIC GRAVITY DIFFERENCE ------------ 0.0250


 *------ PORT PARAMETERS ------*   *--------- PIPE PARAMETERS ---------*
     DIAM  CD   FLOW  VEL ENERGY    LNTH  DIAM         FLOW  VEL  H LOSS
 NUM                                          FRICT
   1 6.00 0.63  0.19  1.51  0.09     7.5  24.0 0.057   0.19  0.09  0.000
   2 6.00 0.63  0.20  1.54  0.09     7.5  24.0 0.048   0.39  0.19  0.000
   3 6.00 0.63  0.20  1.56  0.10     7.5  24.0 0.042   0.59  0.29  0.000
   4 6.00 0.62  0.20  1.58  0.10     7.5  24.0 0.038   0.79  0.39  0.000
   5 6.00 0.62  0.20  1.60  0.10     7.5  24.0 0.036   0.99  0.49  0.000
                                 -------                           ------
                                    37.5                            0.001
 HYDRAULIC GRADE LINE ELEV. HLOSS =  0.11    DN =   11.69  UP =    11.79
 ENERGY LINE ELEVATION                       DN =   11.69  UP =    11.79
 TOTAL FLOWRATE       ----       0.990

 Specific Gravity of Seawater = 1.025
 24" pipe w/ end invert at -17.5' therefor CL is at -16.5'
 100 %Q3
 Available engergy at Port 1 is at 1' reasonable??
 assumed divergence angle for 12" x 6" reducer = 20.5 deg.
 Absolute pipe roughness estimated at at 0.0102 inch following ex. in
  manual
 diffuser slope =.019
 assume 100% sharp edge diffuser--most conservative
 no risers
♀


 UNITS OPTION SPECIFIED = 0
 LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
           WIDTH/HEIGHT = IN     DIAM = IN

                                                                        PAGE   3
```

```
Q1=    0.99     Q2=   12.30     Q3=    0.99
=======================================================================


ELEMENT NO.  1                                                 SEQ =  3
(20-30) Existing pipe from diffuser to existing MH (1973 sht 38)
PRESSURE LINE (CIR)     FLOWRATE =     0.99            VELOCITY =  0.49
PIPE ------ DIA = 24.0       LEN = 880.0                      N = 0.012
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  0.50    EXIT K =  0.00
HEAD LOSS: MISC =  0.00     EXIT =  0.00 PIPE =  0.03     TOTAL =  0.04
HYDRAULIC GRADE LINE ELEVATION              DN =   11.79  UP =    11.83
ENERGY LINE ELEVATION                       DN =   11.79  UP =    11.83
CMP Design Guide Mannings n = .011 to .020; assumed 0.012 due to
 relining.
Demo plan Sht 1 indicates demo and replacement of 24inch CMP outfall
Entrance loss from upstream MH K= 0.5

ELEMENT NO.  6                                                 SEQ =  4
(30-40) Flow through channel to represent existing MH (2013: 006-C-2001
RECT/TRAP CHANNEL       FLOWRATE =     0.99     MINOR LOSS K =    0.000
BASE =  72.0     SLP = 0.0   LEN =   6.0     N =0.012  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.03  UP =     0.03
CHANNEL BOTTOM ELEVATION                    DN =    3.33  UP =     3.33
DEPTH ---- CRIT =  0.13   NORMAL = 999.99   DN =    8.50  UP =     8.50
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   11.83  UP =    11.83
ENERGY LINE ELEVATION                       DN =   11.83  UP =    11.83
 Manhole dimension information provided by SHN Engineers.

ELEMENT NO.  1                                                 SEQ =  5
(45-50) Pipe from exst MH to UV basin (2013: 006-C-2001 and -2001A)
PRESSURE LINE (CIR)     FLOWRATE =     0.99            VELOCITY =  0.31
PIPE ------ DIA = 30.0       LEN = 880.0                      N = 0.012
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  5.20    EXIT K =  3.00
HEAD LOSS: MISC =  0.01     EXIT =  0.00 PIPE =  0.01     TOTAL =  0.02
HYDRAULIC GRADE LINE ELEVATION              DN =   11.83  UP =    11.85
ENERGY LINE ELEVATION                       DN =   11.83  UP =    11.85
 2 45-deg bend, K=0.2*2 = 0.4
 2 90-deg bend, K=0.45*2 = 0.9
 2 90-deg open channel bend, K=1.2*2 = 2.4
 Entrance loss, K=0.5*3 = 1.5
 Total K = 5.2
 Exit loss, K=1*3 = 3
 Using open channel bend to represent 2 manholes along pipeline.
 No pipe profile has been established yet including yard pipe CL.
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE   4
Q1=    0.99     Q2=   12.30     Q3=    0.99
=======================================================================


ELEMENT NO.  5                                                 SEQ =  6
(50-55) Gravity pipe outlet from UV (2013: 40-M-3000)
CIRCULAR CHANNEL        FLOWRATE =     0.99     MINOR LOSS K =    0.000
PIPE ------ DIA = 30.0       LEN =  10.0     N =0.012  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    2.79  UP =     2.34
CHANNEL BOTTOM ELEVATION                    DN =   16.00  UP =    16.00
```

```
DEPTH ---- CRIT =  0.40   NORMAL = 999.99   DN =    0.42  UP =     0.48
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.022  TOTAL = 0.022
HYDRAULIC GRADE LINE ELEV                   DN =   16.42  UP =    16.48
ENERGY LINE ELEVATION                       DN =   16.54  UP =    16.57

ELEMENT NO.  6                                               SEQ =  7
(55-60) Channel at downstream end of UV 2013: 40-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     0.99     MINOR LOSS K =    0.000
BASE =  48.0     SLP = 0.0   LEN =  10.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.06  UP =     0.06
CHANNEL BOTTOM ELEVATION                    DN =   10.00  UP =    10.00
DEPTH ---- CRIT =  0.17   NORMAL = 999.99   DN =    6.57  UP =     6.57
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   16.57  UP =    16.57
ENERGY LINE ELEVATION                       DN =   16.57  UP =    16.57
Invert  set at 10' to account for pipe bury (grd surface=15'
 (1973 sht 38))
9' (108") width
Mannings n = 0.013
4 ft length
slope= 0.
Max depth is 12-ft

ELEMENT NO. 12                                               SEQ =  8
 (60-65) Finger weir launder from UV channel (2013: 40-M-2000)
RECT/TRAP LAUNDER       FLOWRATE =     0.33     MINOR LOSS K =  0.00000
BASE =  18.0     SLP = 0.0   LEN =  20.0     N =0.011  SLOPE =  0.01200
TOP WIDTH    IN                             DN =   18.00  UP =    18.00
VELOCITY -------------------------          DN =    2.22  UP =     0.00
CHANNEL BOTTOM ELEVATION ----------         DN =   17.10  UP =    17.34
DEPTH --------------------- CRIT =  0.15    DN =    0.15  UP =     0.08
HEAD LOSS -- MINOR =0.000 HLOSS = 0.0944 TOTAL = 0.09442 QUP =     0.00
HYDRAULIC GRADE LINE ELEVATION              DN =   17.25  UP =    17.42
ENERGY LINE ELEVATION                       DN =   17.33  UP =    17.42
 SST launder, V-notch weirs on each side
 3 launders, so flow is 33.3% of Q3
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                             PAGE   5
Q1=    0.99     Q2=   12.30     Q3=    0.99
=======================================================================


ELEMENT NO.  3                                               SEQ =  9
(65-70) V-notch weirs (2013: 40-M-2000)
V-NOTCH WEIR            FLOWRATE =     0.17          NON SUBMERGED WEIR
WEIR - ANGLE 90. DEG;    40 NOTCHES AT  0.004 MGD EACH; ELEV =    18.55
LENGTH =  20.0       SUBMERGENCE =  0.00                HEAD =     0.09
HYDRAULIC GRADE LINE ELEV. HLOSS =  1.22    DN =   17.42  UP =    18.64
ENERGY LINE ELEVATION                       DN =   17.42  UP =    18.64
 20-ft long weirs into 1-ft deep launders
 Two weir lengths along each launder x 3 launders
 total weir length 120-ft.  Trojan recommends 118 ft.
 based on standard detail

ELEMENT NO.  6                                               SEQ = 10
(70-80) Rectangular Open Channel (2013: 40-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     0.99     MINOR LOSS K =    0.000
```

```
BASE = 108.0     SLP = 0.0   LEN =  23.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.08  UP =     0.08
CHANNEL BOTTOM ELEVATION                    DN =   16.46  UP =    16.46
DEPTH ---- CRIT =  0.10   NORMAL = 999.99   DN =    2.18  UP =     2.18
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   18.64  UP =    18.64
ENERGY LINE ELEVATION                       DN =   18.64  UP =    18.64
 Expansion loss, K=0.45 (DS Miller, Fig 14.15)

ELEMENT NO.  6                                                SEQ = 11
(70-80) Rectangular Open Channel (2013: 40-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     0.99     MINOR LOSS K =    0.000
BASE =  40.0     SLP = 0.0   LEN =  46.5     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.21  UP =     0.21
CHANNEL BOTTOM ELEVATION                    DN =   16.46  UP =    16.46
DEPTH ---- CRIT =  0.19   NORMAL = 999.99   DN =    2.18  UP =     2.18
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.002  TOTAL = 0.002
HYDRAULIC GRADE LINE ELEV                   DN =   18.64  UP =    18.64
ENERGY LINE ELEVATION                       DN =   18.64  UP =    18.64
40-inch width based on Trojan 2/27/2013

ELEMENT NO. 10                                                SEQ = 12
 (80-90) Headloss for UV equipment in channel
******ADDITIONAL HEAD LOSS SPECIFIED******
HL =  0.55     K =  0.00   VHEAD =  0.00
HYDRAULIC GRADE LINE EL.   HLOSS =  0.55    DN =   18.64  UP =    19.19
ENERGY LINE EL.                             DN =   18.64  UP =    19.19
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                              PAGE   6
Q1=    0.99     Q2=   12.30     Q3=    0.99
=======================================================================

Assumes 1.5" HL per bank, 1.5"x3 = 4.5"
Straightening baffle loss = 2"
Total loss = 6.5" or 0.55 ft (rounded up)
Trojan's headloss is ~1.1"/bank on average
Check that max water depth is 2.66' from upstream bank per Trojan

ELEMENT NO.  6                                                SEQ = 13
(90-100) Rectangular channel upstream of UV (2013: 40-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     0.99     MINOR LOSS K =    2.400
BASE =  76.0     SLP = 0.0   LEN =   4.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.03  UP =     0.03
CHANNEL BOTTOM ELEVATION                    DN =   10.00  UP =    10.00
DEPTH ---- CRIT =  0.12   NORMAL = 999.99   DN =    9.19  UP =     9.20
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   19.19  UP =    19.20
ENERGY LINE ELEVATION                       DN =   19.19  UP =    19.20
 two 90-deg bends as flow transitions from below, K=2*1.2=2.4
Invert  set at 10'

ELEMENT NO.  1                                                SEQ = 14
(100-105) Pressurized Circular Pipe to Expansion (2013: 30-M-2000)
PRESSURE LINE (CIR)     FLOWRATE =     0.99           VELOCITY =  0.49
PIPE ------ DIA = 24.0       LEN =  50.0                     N = 0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  0.80    EXIT K =  1.00
HEAD LOSS: MISC =  0.00     EXIT =  0.00 PIPE =  0.00     TOTAL =  0.01
```

```
HYDRAULIC GRADE LINE ELEVATION              DN =   19.19  UP =    19.20
ENERGY LINE ELEVATION                       DN =   19.20  UP =    19.20
Exit loss, K = 1
Expansion to 24-in diam, K = 0.15
50 ft of 24" pipe
 1 90-deg bends, K=0.45
 1 45-deg bend, K=0.2
 Total K = 0.8

ELEMENT NO.  1                                                 SEQ = 15
(105-110) Pipe from expansion to FCV (2013: 30-M-2000)
PRESSURE LINE (CIR)     FLOWRATE =     0.99            VELOCITY =  1.10
PIPE ------ DIA = 16.0       LEN =   5.0                      N = 0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  1.12    EXIT K =  0.00
HEAD LOSS: MISC =  0.02     EXIT =  0.00 PIPE =  0.00     TOTAL =  0.02
HYDRAULIC GRADE LINE ELEVATION              DN =   19.19  UP =    19.21
ENERGY LINE ELEVATION                       DN =   19.20  UP =    19.23
 24x16 expansion, K = 0.31
 gate valve: K = 0.10
 Flow through tee: K = 0.26
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE   7
Q1=    0.99     Q2=   12.30     Q3=    0.99
=======================================================================

 1 90-deg bend, K=0.45
 Total K = 1.12

ELEMENT NO. 28                                                 SEQ = 16
 (110-115) Flow Control Valve (2013: 30-M-2000)
PRESSURE LINE (CIR)     FLOWRATE =     0.99             VELOCITY =  1.10
TOTAL HEAD LOSS ACROSS VALVE                                  =     0.03
HYDRAULIC GRADE LINE ELEVATION               DN =   19.21  UP =    19.23
ENERGY LINE ELEVATION                        DN =   19.23  UP =    19.25
Data for 16-inch BF valve from ValMatic

ELEMENT NO.  1                                                 SEQ = 17
(115-120) Pipe from Flow control valve to Contraction (2013: 30-M-2000)
PRESSURE LINE (CIR)     FLOWRATE =     0.99            VELOCITY =  1.10
PIPE ------ DIA = 16.0       LEN =  20.0                      N = 0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  0.36    EXIT K =  0.00
HEAD LOSS: MISC =  0.01     EXIT =  0.00 PIPE =  0.01     TOTAL =  0.01
HYDRAULIC GRADE LINE ELEVATION              DN =   19.23  UP =    19.25
ENERGY LINE ELEVATION                       DN =   19.25  UP =    19.27
 includes 16" mag meter
 gate valve: K = 0.10
 Flow through tee: K = 0.26
 Total K = 0.36

ELEMENT NO.  1                                                 SEQ = 18
(120-130) Pipe from contractor to EQ Basin (2013: 30-M-2000)
PRESSURE LINE (CIR)     FLOWRATE =     0.99            VELOCITY =  0.49
PIPE ------ DIA = 24.0       LEN =  30.0                      N = 0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  1.01    EXIT K =  0.00
HEAD LOSS: MISC =  0.00     EXIT =  0.00 PIPE =  0.00     TOTAL =  0.01
HYDRAULIC GRADE LINE ELEVATION              DN =   19.26  UP =    19.27
ENERGY LINE ELEVATION                       DN =   19.27  UP =    19.27
```

```
Entrance loss K=0.5
contraction to 16-in, K= 0.06
 1 90-deg elbow, K=0.45
 Total K = 1.01
 30 ft of 24" pipe
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE   8
Q1=    0.99     Q2=   12.30     Q3=    0.99
=======================================================================


ELEMENT NO.  6                                                 SEQ = 19
(130-140) EQ basin (2013:30-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     0.99     MINOR LOSS K =    0.000
BASE = 420.0     SLP = 0.0   LEN =  98.0     N =0.011  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.02  UP =     0.02
CHANNEL BOTTOM ELEVATION                    DN =   17.00  UP =    17.00
DEPTH ---- CRIT =  0.04   NORMAL = 999.99   DN =    2.27  UP =     2.28
HEAD LOSS -----           MINOR =  0.000  HLOSS = 0.003  TOTAL = 0.003
HYDRAULIC GRADE LINE ELEV                   DN =   19.27  UP =    19.28
ENERGY LINE ELEVATION                       DN =   19.27  UP =    19.28
 35' W x 98'L

ELEMENT NO. 10                                                 SEQ = 20
 (140-150) Headloss to represent fluccuation in EQ basin (2013: 30-M-20
******ADDITIONAL HEAD LOSS SPECIFIED******
HL =  5.00     K =  0.00   VHEAD =  0.00
HYDRAULIC GRADE LINE EL.   HLOSS =  5.00    DN =   19.28  UP =    24.28
ENERGY LINE EL.                             DN =   19.28  UP =    24.28
Max 5' per Jason Riegler/CVO
Effluent Level from SBR should not exceed the invert of the decant
collection pipe currently set at 11'2" from bottom of basin.
NEW CONFIGURATION CHECK REQUIREMENTS
*******************************************
 ICIAS SBR               *
*******************************************
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE   9
Q1=    0.99     Q2=   12.30     Q3=    0.99
=======================================================================


CONDITIONS SET -                                               SEQ = 21
(0-10) EGL set at the SBR water level based on BioWin (2013: 30-M-2001)
ENERGY LINE =  30.75  Q1 =   0.99  Q2 =  12.30  Q3 =   0.99  VEL = 0.02

 Q1 = total plant influent , 0.99
 Q2 = Future peak hour, 12.3
 Q3 = EQ basin outlet flow, 0.99 mgd (Max month)

 2037 Peak Instantaneous Flow 8.2 mgd --> 36.00 ft Max WSE
```

```
 2037 Peak Daily Average Flow 6.31 mgd --> 36.00 ft Max WSE
 2037 Max Month Wet Weather 2.09 mgd --> 32.50 ft Max WSE
 2037 Average Dry Weather 0.99 mgd --> 30.75 ft Max WSE

ELEMENT NO.  6                                               SEQ = 22
(160-170) SBR main chamber (3013: 30-M-2001)
RECT/TRAP CHANNEL       FLOWRATE =     0.50     MINOR LOSS K =    0.000
BASE = 600.0     SLP = 0.0   LEN = 123.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.00  UP =     0.00
CHANNEL BOTTOM ELEVATION                    DN =   17.00  UP =    17.00
DEPTH ---- CRIT =  0.02   NORMAL = 999.99   DN =   13.75  UP =    13.75
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.004  TOTAL = 0.004
HYDRAULIC GRADE LINE ELEV                   DN =   30.75  UP =    30.75
ENERGY LINE ELEVATION                       DN =   30.75  UP =    30.75
50% of peak hour flow Q1

ELEMENT NO.  8                                               SEQ = 23
 (170-180) underflow baffle wall orifice (2013: 30-M-2001)
RECTANGULAR ORIFICE     FLOWRATE =     0.50      ORIFICE VEL =     0.01
GATE -- WIDTH = 480.0      DEPTH =  18.0        ORIFICE COEF =    0.600
HYDRAULIC GRADE LINE EL.   HLOSS =  0.00    DN =   30.75  UP =    30.75
ENERGY LINE EL.                             DN =   30.75  UP =    30.75
 40-ft of opening along 50-ft wall
 18" height based on vendor input

ELEMENT NO.  6                                               SEQ = 24
(180-190) Pre-react Basin (2013: 30-M-2001)
RECT/TRAP CHANNEL       FLOWRATE =     0.50     MINOR LOSS K =    0.000
BASE = 600.0     SLP = 0.0   LEN =  22.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.00  UP =     0.00
CHANNEL BOTTOM ELEVATION                    DN =   17.00  UP =    17.00
DEPTH ---- CRIT =  0.02   NORMAL = 999.99   DN =   13.75  UP =    13.75
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   30.75  UP =    30.75
ENERGY LINE ELEVATION                       DN =   30.75  UP =    30.75
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                             PAGE  10
Q1=    0.99     Q2=   12.30     Q3=    0.99
=======================================================================

 22 ft length

ELEMENT NO.  1                                               SEQ = 25
(200-210) Pipe from HW flow split to SBR (2013: 30-M-2001)
PRESSURE LINE (CIR)     FLOWRATE =     0.50           VELOCITY =  0.24
PIPE ------ DIA = 24.0       LEN =  56.0                      N = 0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  2.30    EXIT K =  1.00
HEAD LOSS: MISC =  0.00     EXIT =  0.00 PIPE =  0.00     TOTAL =  0.00
HYDRAULIC GRADE LINE ELEVATION              DN =   30.75  UP =    30.76
ENERGY LINE ELEVATION                       DN =   30.75  UP =    30.76
 24-inch diam
 56 ft long pipe
 4 90-deg bend, K=0.45*4=1.8
 Entrance Loss, K=0.5
 Total K = 2.3
 Exit Loss, K=1.0
```

```
ELEMENT NO.  2                                                 SEQ = 26
(210-215) Split box (2013: 20-M-2000)
PRESSURE LINE (RECT)    FLOWRATE =     0.50           VELOCITY =   0.05
PIPE- H =  36.0 W =  60.0    LEN =  15.0                     N =  0.013
MINOR LOSS COEFFICIENTS ----- MISCELLANEOUS K =  2.20    EXIT K =  0.00
HEAD LOSS: MISC =  0.00     EXIT =  0.00 PIPE =  0.00     TOTAL =  0.00
HYDRAULIC GRADE LINE ELEVATION              DN =   30.76  UP =    30.76
ENERGY LINE ELEVATION                       DN =   30.76  UP =    30.76
 3'x6' drop box D/S of weir gate
 Turbulent flow, K=1.0
 90-deg bends, K=1.2

ELEMENT NO.  4                                                 SEQ = 27
(215-220) Weir gate (2013: 20-M-2000)
RECTANGULAR WEIR        FLOWRATE =     0.50          NON SUBMERGED WEIR
WEIR ------------ SIDE CONTRACTION COEFFICIENT =2.00    ELEV =    37.16
LENGTH =   3.5       SUBMERGENCE =  0.00                HEAD =     0.17
HYDRAULIC GRADE LINE ELEV. HLOSS =  6.57    DN =   30.76  UP =    37.33
ENERGY LINE ELEVATION                       DN =   30.76  UP =    37.33
HGL 0.5 ft above D/S HGL
*******************************************
END OF ADDITION FOR SBR FLOW SPLIT        *
*******************************************
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE  11
Q1=    0.99     Q2=   12.30     Q3=    0.99
=======================================================================


ELEMENT NO.  6                                                 SEQ = 28
(220-230) Grit outlet channel (2013: 20-M-3001)
RECT/TRAP CHANNEL       FLOWRATE =     0.99     MINOR LOSS K =    0.000
BASE =  36.0     SLP = 0.0   LEN =  23.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.03  UP =     0.03
CHANNEL BOTTOM ELEVATION                    DN =   18.00  UP =    18.00
DEPTH ---- CRIT =  0.20   NORMAL = 999.99   DN =   19.33  UP =    19.33
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   37.33  UP =    37.33
ENERGY LINE ELEVATION                       DN =   37.33  UP =    37.33
 Invert at 18'Channel
 Length = 23 ft based on SHN 5/11/13 dwg
 width = 3 ft based on SHN 5/11/13 dwg

ELEMENT NO.  4                                                 SEQ = 29
(230-240) Grit Channel Weir (2013: 20-M-3001)
RECTANGULAR WEIR        FLOWRATE =     0.99          NON SUBMERGED WEIR
WEIR ------------ SIDE CONTRACTION COEFFICIENT =0.00    ELEV =    38.84
LENGTH =  12.0       SUBMERGENCE =  0.00                HEAD =     0.11
HYDRAULIC GRADE LINE ELEV. HLOSS =  1.63    DN =   37.33  UP =    38.95
ENERGY LINE ELEVATION                       DN =   37.33  UP =    38.95
 12'weir (no contractions)
 set invert 0.5' above downstream HGL

ELEMENT NO. 10                                                 SEQ = 30
 (260-270) Headloss across grit equipment (2013: 20-M-3001)
******ADDITIONAL HEAD LOSS SPECIFIED******
HL =  1.50     K =  0.00   VHEAD =  0.00
```

```
HYDRAULIC GRADE LINE EL.   HLOSS =  1.50    DN =   38.95  UP =    40.45
ENERGY LINE EL.                             DN =   38.95  UP =    40.45
 based on 0.75-ft loss from vendor and 0.75-ft
 additional observed loss from SHN
 Grit equipment vendor is HydroInternational HeadCell

ELEMENT NO.  6                                               SEQ = 31
(273-275) Grit Inlet channel (2013: 20-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     0.99     MINOR LOSS K =    0.650
BASE =  36.0     SLP = 0.0   LEN =   7.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.32  UP =     0.32
CHANNEL BOTTOM ELEVATION                    DN =   38.84  UP =    38.84
DEPTH ---- CRIT =  0.20   NORMAL = 999.99   DN =    1.61  UP =     1.62
HEAD LOSS -----           MINOR =  0.001  HLOSS = 0.001  TOTAL = 0.002
HYDRAULIC GRADE LINE ELEV                   DN =   40.45  UP =    40.46
ENERGY LINE ELEVATION                       DN =   40.46  UP =    40.46
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                               PAGE  12
Q1=    0.99     Q2=   12.30     Q3=    0.99
=======================================================================

 symmetrical combining T-channel. K=0.65 (DS Miller Fig 13.16)

ELEMENT NO.  6                                               SEQ = 32
(273-275) Channel btwn screens and grit chamber (2013: 20-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     0.99     MINOR LOSS K =    2.400
BASE =  36.0     SLP = 0.0   LEN =   8.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.32  UP =     0.31
CHANNEL BOTTOM ELEVATION                    DN =   38.84  UP =    38.84
DEPTH ---- CRIT =  0.20   NORMAL = 999.99   DN =    1.62  UP =     1.62
HEAD LOSS -----           MINOR =  0.004  HLOSS = 0.001  TOTAL = 0.005
HYDRAULIC GRADE LINE ELEV                   DN =   40.46  UP =    40.46
ENERGY LINE ELEVATION                       DN =   40.46  UP =    40.46
 Flow split between two screens
 Invert match grit eff weir
 Length = 8 ft based on SHC 5/10/13 dwg
 width = 3 ft based on SHC 5/10/13 dwg
 2 90-deg bends, K=2*1.2 = 2.4

ELEMENT NO.  6                                               SEQ = 33
(275-280) D/S Screen Channel (2013: 20-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     0.99     MINOR LOSS K =    0.000
BASE =  24.0     SLP = 0.0   LEN =   6.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.47  UP =     0.47
CHANNEL BOTTOM ELEVATION                    DN =   38.84  UP =    38.84
DEPTH ---- CRIT =  0.26   NORMAL = 999.99   DN =    1.62  UP =     1.62
HEAD LOSS -----           MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   40.46  UP =    40.46
ENERGY LINE ELEVATION                       DN =   40.46  UP =    40.46
 Invert to match grit eff weir
 Length = 6 ft based on SHC 5/10/13 dwg
 width = 24" based on SHC 5/10/13 dwg

ELEMENT NO. 10                                               SEQ = 34
 (280-290) Arbitrary headloss across screens (2013: 20-M-2000)
******ADDITIONAL HEAD LOSS SPECIFIED******
HL =  0.50     K =  0.00   VHEAD =  0.00
```

```
HYDRAULIC GRADE LINE EL.   HLOSS =  0.50    DN =   40.46  UP =    40.96
ENERGY LINE EL.                             DN =   40.46  UP =    40.96
 Assume 0.5 ft headloss (5/15/13 Mike Veach/SHN Email -
  from Hydro-Dyne calculations)
♀


UNITS OPTION SPECIFIED = 0
LENGTH/ELEVATION/DEPTH = FT    FLOWS = MGD    VELOCITY = FPS
          WIDTH/HEIGHT = IN     DIAM = IN

                                                                PAGE  13
Q1=    0.99     Q2=   12.30     Q3=    0.99
=======================================================================


ELEMENT NO.  6                                                  SEQ = 35
(290-300) Channel screen channel 1/2 flow (2013: 20-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     0.99     MINOR LOSS K =    0.000
BASE =  18.0     SLP = 0.0   LEN =   5.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.48  UP =     0.48
CHANNEL BOTTOM ELEVATION                    DN =   38.84  UP =    38.84
DEPTH ---- CRIT =  0.32   NORMAL = 999.99   DN =    2.12  UP =     2.12
HEAD LOSS -----            MINOR =  0.000  HLOSS = 0.001  TOTAL = 0.001
HYDRAULIC GRADE LINE ELEV                   DN =   40.96  UP =    40.96
ENERGY LINE ELEVATION                       DN =   40.96  UP =    40.96
 Channel width 1.5' (18 in) based on SHC 5/10/13 dwg
 Length 5 ft based on SHC 5/10/13 dwg

ELEMENT NO.  6                                                  SEQ = 36
(300-310) Channel flow  wide channel to screens (2013: 20-M-2000)
RECT/TRAP CHANNEL       FLOWRATE =     0.99     MINOR LOSS K =    2.400
BASE =  36.0     SLP = 0.0   LEN =  15.0     N =0.013  SLOPE =  0.00000
VELOCITY ---------------- NORMAL =999.99    DN =    0.24  UP =     0.24
CHANNEL BOTTOM ELEVATION                    DN =   38.84  UP =    38.84
DEPTH ---- CRIT =  0.20   NORMAL = 999.99   DN =    2.12  UP =     2.13
HEAD LOSS -----            MINOR =  0.002  HLOSS = 0.001  TOTAL = 0.003
HYDRAULIC GRADE LINE ELEV                   DN =   40.96  UP =    40.97
ENERGY LINE ELEVATION                       DN =   40.96  UP =    40.97
 Channel width 13' (180 in)
 Length 3 ft
 2 90-deg bend, K=2*1.2= 2.4
^
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PD.16 – Odor Control Design Criteria

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REVIEWED BY: Neal Forester/CH2M HILL
DATE: August 2013

Introduction

This technical memorandum (TM) documents design parameters and characteristics of the proposed centralized odor control system to serve the Expanded and Upgraded Coos Bay Wastewater Treatment Plant (WWTP 2) odor sources.

This Preliminary Design report provides a thorough technology evaluation, findings, and recommendations for odor mitigation measures at the Existing WWTP 2 and at the Expanded/Upgraded WWTP 2. Also included are preliminary findings related to dispersion modeling and specific design criteria related to the recommended odor control system.

System Sizing Criteria

Recommended ventilation rates for sizing odor control systems should comply with National Fire Protection Association (NFPA) 820 and CH2M HILL engineering design practice for similar type facilities. In general, ventilation rates should meet the following objectives:

- Provide adequate ventilation to protect maintenance personnel within occupied spaces per NFPA 820, "Fire Protection in Wastewater Treatment and Collection Facilities," 2012 Edition.
- Maintain a minimum negative pressure of 0.1-inch water column (WC) within wastewater holding tanks, channels, or enclosures to contain odors under the following conditions:
    - Dynamic liquid level changes
    - Estimated crack openings in storage tank covers treated as sharp-edged orifices
- When a single access cover is removed, maintain sufficient velocities across the opening to prevent fugitive odors.
- Provide adequate turnover rate and air scavenging within storage tanks, channels, or enclosures to reduce corrosion resulting from H_2S pockets.

Table 16-1 summarizes flow rates and sizing criteria for each odor source area for the Expanded/Upgraded WWTP 2.

TABLE 16-1
Foul Air Flow Rates and Sizing Criteria Summary[1]

Location	Air Flow (CFM)	Air (ACH)	Sizing Criteria Summary
Influent Pump Station			
Wet well(s)	500	>12	Flow rate necessary to 1) maintain a negative 0.1-inch WC within wetwell(s) under normal operating conditions, 2) outrun frictional drag natural ventilation flows from collection system, 3) comply with NFPA 820 ventilation requirements for reducing interior classification rating, 4) maintain high capture velocity of > 200 feet per minute (fpm) across open access hatches, and 5)

TABLE 16-1

Foul Air Flow Rates and Sizing Criteria Summary[1]

Location	Air Flow (CFM)	Air (ACH)	Sizing Criteria Summary
			prevent pockets of corrosive H_2S from accumulating by creating adequate scavenging velocities (~ 25 fpm).
Headworks			
Interior Space and Channels	1,150	>12	Flow rate necessary to 1) maintain a negative 0.1-inch WC within interior space and channels under normal operating conditions, 2) comply with NFPA 820 ventilation requirements for reducing interior classification rating, and 3) prevent pockets of corrosive H_2S from accumulating by creating uniform scavenging velocities

Notes: CFM = cubic feet per minute; ACH = air changes per hour; fpm = feet per minute

[1] Existing solids process odor sources currently open and untreated will remain as such.

Performance Criteria

Odor Potential

The Expanded/Upgraded WWTP 2 has a potential for generation of hydrogen sulfide (H_2S) odors as well as lesser quantities of other organic odor compounds. In general, odor levels depend heavily on the levels of dissolved sulfides entering the plant within the influent raw wastewater, as well as turbulence at launder weirs and other hydraulic drops.

Another measure of odor is detection threshold (DT). DT is defined via odor tests conducted in an odor laboratory where air samples containing a combination of odorous compounds are diluted with clean air to below detectable concentrations and then introduced to a gas delivery system. A panel of eight members trained in odor response serves as the odor “detectors” for the sample. Panel members are asked to smell air samples delivered to a nose cone piece by the gas delivery system. By depressing buttons, the panelist introduces three distinct samples, 1 with the diluted sample, and 2 with clean odor-free dilution air. Panel members are then asked whether they can detect a difference in the odor of the 3 samples. If they cannot, the sample concentration is then increased by a given dilution amount and the test repeated. This process continues until half the panel members can detect the sample odor. The final level of sample concentration is called the detection threshold (DT). By this means broad spectrum odor concentration is determined based on how many dilutions are required to make the odor barely perceptible to one half of the odor panelists regardless of what odor compound(s) is causing the odor.

Typical odor levels (based on past experience) from process areas similar to those at Coos Bay WWTP 2 are summarized in Table 16-2 below.

TABLE 16-2

Estimated Odor Concentrations

	Hydrogen Sulfide		Organic Reduced Sulfur Compounds[1]		General Odor (DT)	
Process Area	Average (ppmV)	Peak (ppmV)	Average (ppbV)	Peak (ppbV)	Average	Peak
Influent Pump Station Wetwell	10	20	10	25	10,000	15,000
Headworks	4	8	5	10	4,000	7,000

TABLE 16-2
Estimated Odor Concentrations

	Hydrogen Sulfide		Organic Reduced Sulfur Compounds[1]		General Odor (DT)	
Process Area	**Average (ppmV)**	**Peak (ppmV)**	**Average (ppbV)**	**Peak (ppbV)**	**Average**	**Peak**
Sequencing Batch Reactors (SBR's)	0.08	0.2	2	4	50	150

ppmV = part per million by volume; ppbV = parts per billion by volume

[1] Organic reduced sulfur (ORS) compounds include methyl mercaptans, dimethyl disulfides, etc.

Offsite Odor Limits

Odors generated from plant odor sources consist primarily of H_2S. Other odor constituents, including mercaptans, dimethyl disulfide, and others will likely occur in trace amounts only (refer to Table 16-2). The SBR basins are expected to generate more complex odors, but at low concentrations. Odor control systems must be capable of removing both H_2S and general odor (DT).

Odor sources considered in this TM negatively affect nearby odor receptors. Therefore, the odor control technology selected must be capable of a high degree of odor removal efficiency to prevent odor complaints and improve public relations.

The selected odor reduction goal, based on past experience at similar applications, is to reduce offsite H_2S concentrations to 15 µg/m3 (10 parts per billion by volume [ppbV]) or below, the concentration in air likely to cause odor complaints. Similarly, general odor (DT) offsite should be reduced to 10 DT or below. These odor goals should be met based on predicted hourly offsite levels as determined by dispersion modeling, peak inlet odor concentrations, and 100 percent compliance (meaning odor limits must not be exceeded for any hour of the year). The State of Oregon does not have a regulatory value for H_2S but does enforce a “nuisance” clause.

Dispersion Modeling

A dispersion model was be set up of the entire Expanded/Upgraded WWTP 2 facility to verify that the proposed design of the WWTP 2 Expansion and Upgrades will meet the offsite odor goal set forth herein. Required model inputs include:

- Odor levels from process areas developed from CH2M HILL's data base
- Most recent 5 years of meteorological data
- Most recent 5 years of upper atmospheric data
- Terrain data specific to the vicinity

To demonstrate that the WWTP 2 Expansion and Upgrade project meets the offsite odor limit, an air quality modeling analysis using EPA-approved methods was performed. Air dispersion models are the tools approved by EPA to predict offsite impacts. Air dispersion models estimate air quality impacts from emissions released by:

- point sources (for example, stacks)
- area sources (for example, water holding basins)
- volume sources (such as, open truck-loading areas).

Methodology

The American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) was used to predict offsite odor impacts based on the proposed WWTP 2 Expansion and Upgrades. Effective December 9, 2005, EPA promulgated AERMOD to replace Industrial Source Complex Short-Term Dispersion Model Version 3 (ISCST3) as the model used to demonstrate permit compliance. Standard EPA-approved methodology and approaches were used to develop the Expanded/Upgraded WWTP 2 air dispersion model. These approaches are based on criteria consistent with the EPA's *Guideline on Air Quality Modeling*.

The dispersion model predicts dispersion over a land area based on emission rates, local meteorological data, and surface parameters. The model inputs are emission rates from odorous processes and local meteorological and terrain data. The model output predicts variations in odor concentration as a function of distance from the source.

Meteorological Data

The meteorological data was processed using the EPA-approved AERMET (version 06341) meteorological data preprocessor, which is part of the AERMOD air dispersion modeling system. The AERMET dataset used US National Climatic Data Center (NCDC) surface observations from the Southwest Oregon International Airport, formerly known as North Bend International Airport, which is less than 5 miles from the project site. In dispersion modeling, both surface air and upper air data are used. Upper air data are from weather balloons that are released from the ground and travel thousands of feet in the air to gather pressure, temperature, relative humidity, wind speed, and wind direction data. Data from the Salem Airport were used in the dispersion modeling. Five years of data (that is, 2008, 2009, 2010, 2011 and 2012) were used for the analysis.

Terrain Data

U.S. Geological Survey digital elevation map terrain data were used in conjunction with the AERMAP pre-processor (version 07026) to determine receptor elevations and terrain maxima for the Expanded/Upgraded WWTP 2 site and beyond. It should be noted that the specific Expanded/Upgraded WWTP 2 site can be characterized as generally flat.

Dispersion Model Description

The EPA recommended AERMOD dispersion model system was used to estimate air quality impacts offsite. AERMOD (Version 07026) was run with the following default options:

- Use stack-tip downwash
- Use of the PRIME algorithm for sources influenced by building downwash
- Use default wind profile exponents
- Use default vertical potential temperature gradients

The ambient air was assumed to be the area beyond the fence that surrounds the treatment plant. Receptor locations in AERMOD were selected as follows:

- Discrete receptors at 15-meter intervals around the property line
- A 30-meter grid extended approximately 500 meters
- A 100-meter grid extended approximately 500 meters
- A 500-meter grid extended approximately 3 kilometers.

Figure 16-1, located at the end of this TM, plots the wind rose representing onsite meteorological conditions using 5-year data (year 2008 through 2012). A wind rose is a graphical representation of wind speed and direction over a discrete period of time. It is a 360-degree compass that looks like a flower with petals that represent the direction from which the wind is blowing. The wind rose petals represent the 16 compass points. The length of each segment of a petal represents the frequency of wind within a speed category, as noted by the labeled rings. The wind speed categories are identified by different colors in the legend at the bottom of the wind rose figure. The percentage frequency of light and variable wind (winds less than 2.0 miles per hour) is printed below the figure. The figure shows that the winds predominantly blow from the north and to a lesser extent out of the southeast. Data used for the wind rose plot was collected from the nearby Southwest Oregon International Airport.

Emission Sources

Sources of odor emissions at the Expanded/Upgraded WWTP 2 input into the dispersion model were limited to new sources only. Existing sources including primary clarifiers, secondary clarifiers, and solids loadout located at the existing WWTP 2 site were not included. Since historically, negligible offsite odor impacts have occurred from the existing plant, neglecting these sources was believed to be appropriate. New sources inputted into the dispersion model include the odor control stack (serving the headworks and IPS) and open SBR basins. The single stack source was modeled as a point source. The SBR basins were modeled as area sources. Table 16-3 details the specific emission sources entered into the model.

TABLE 16-3
Modeled Emission Sources

Source	Diameter (inches)	Exit Air Flow Rate (cfm)	Height (ft)	Odor Strength (D/T)	H2S Conc. (ppbV)
Odor Control Stack	10	1,650	15	1000	150
SBR Basin 1	NA[1]	5,844[2]	20[4]	150	100
SBR Basin 2	NA[1]	3,244[3]	20[4]	150	100

Notes:
[1] Modeled as an area source with dimensions of 144 feet x 50 feet
[2] SBR Basin 1 includes process air flow rate of 2600 cfm and evaporation rate of 3,244 cfm.
[3] SBR Basin 2 is modeled as the resting basin and includes only the evaporation rate of 3,244 cfm.
[4] Height of SBR is 20 feet above finished grade.

The justification for assumptions made regarding odor strength and H_2S concentration for each source is summarized below.

- Odor Control Stack: The 1000 D/T is based on 90 percent removal of the expected peak inlet concentration of 10,000 DT. Similarly, the 150 ppbV is based on 99 percent removal of the expected peak inlet H_2S concentration of 15 ppm.
- SBR Basins: Odor levels of 150 DT and 100 ppbV H_2S are based on CH2MHILL's extensive data base of sample data from multiple wastewater treatment plants.

Dispersion Model Results

Modeling was performed to confirm hydrogen sulfide and general odor (DT) compliance with the project specific maximum offsite odor criteria of 10 ppbV H_2S and 10 DT. Ammonia was not modeled since its DT is approximately 2,800 ppbV and the predicted emissions concentration is expected to be significantly below this value.

The results of the odor dispersion modeling indicate that predicted offsite impacts will fall below the project specific maximum offsite odor criteria for both H_2S and DT. Tables 16-4 and 16-5 compare the maximum modeled DT and H_2S values, respectively, for each year for each source and for all sources combined.

TABLE 16-4
Maximum Offsite DT Impacts

Odor Source	2012	2011	2010	2009	2008
Odor Control Stack[1]	2.3	2.2	2.3	2.1	2.2
SBR Basins[1]	1.2	1.2	1.2	1.2	1.8
All[1,2]	2.3	2.2	2.3	2.1	2.2

Notes:
[1] Concentrations represent maximum 1-hr concentration
[2] The "all" values are not totals (i.e.; they are not a mathematical summation of individual sources). This is because each source contributes to offsite impacts uniquely and is non-additive. AERMOD was used to evaluate individual source impacts as well as overall impact due to all sources.

TABLE 16-5

Maximum Offsite H_2S Impacts, ppbV

Odor Source	2012	2011	2010	2009	2008
Odor Control Stack[1]	0.4	0.4	0.4	0.4	0.4
SBR Basins[1]	0.8	0.8	0.8	0.8	0.8
All[1,2]	0.8	0.8	0.8	0.8	0.8

Notes:

[1] Concentrations represent maximum 1-hr concentration

[2] The “all” values are not totals (i.e.; they are not a mathematical summation of individual sources). This is because each source contributes to offsite impacts uniquely and is non-additive. AERMOD was used to evaluate individual source impacts as well as overall impact due to all sources.

As indicated in Table 16-4, the maximum predicted offsite concentrations for general odor (DT) occurs in the year 2010 and 2012 but is roughly the same through each year. The2.3 value is 77 percent below the offsite limit of 10 DT. As indicated in Table 16-5, the maximum predicted offsite concentrations for hydrogen sulfide is consistently the same over the five selected years. Th3 0.8 ppbV value is 92 percent below the offsite limit of 10 ppbV.

Specific isopleths for maximum predicted overall offsite DT and hydrogen sulfide levels are provided in Figures 16-2 and 16-3. These correspond to the year representing the respective maximum offsite impact.

FIGURE 16-1

Maximum Predicted Overall Offsite DT

FIGURE 16-2
Overall Maximum Predicted Offsite Hydrogen Sulfide (ug/m^3). Note: 1.0 ppbV (H_2S) =1.4 ug/m^3 (H_2S)

Dispersion Model Conclusions

Based on the dispersion model results, the project specific offsite odor limits can be met for an odor control system exhibiting the following key parameters:

- Minimum stack height of 15 feet and stack exit velocity of 3000 fpm
- Minimum H_2S performance removal rate of 99 percent.
- Minimum general odor (DT) performance removal rate of 90 percent.

Therefore, any odor control system considered herein must be able to meet these key parameters.

Initial Screening of Odor Control technologies

Odor control technologies considered in this evaluation include the following:

- Biological (including biological packed bed towers and biofilters)
- Carbon adsorption
- Chemical packed bed scrubbers
- Masking agents
- Thermal oxidizers
- Liquid phase treatment.

Technologies screened out from further evaluation along with reasons why are summarized as follows:

- Chemical Packed Bed Scrubbers: This technology represents high initial cost due to extra equipment components (recirculation pump, chemical feed) and controls (instrumentation including pH and ORP controls) as well as bulk chemical storage facilities. In addition, this technology exhibits high O&M costs due to ongoing chemical usage and maintenance related to the extra equipment components. Finally, this technology represents safety concerns due to handling of hazardous chemicals.

Conclusion: This technology is most suitable to:

1. multi-stage applications with high odor levels and strict off-site odor criteria whereby the scrubber is utilized upstream of a polishing unit
2. intermittent flows precluding the use of biotechnology
3. where the plant already has chemical feed infrastructure and plant staff have a comfort level with this technology

For the Expanded/Upgraded WWTP 2, none of these conditions exist; therefore, this technology is not carried forward in this evaluation.

- Masking Agents: Masking agents are marginally effective and can cause fogging of areas which can be problematic for plant personnel. They are normally used at perimeter fence-lines or around the perimeter of odor sources. Due to their marginal effectiveness and fogging issues, this technology is not carried forward in this evaluation.
- Thermal Oxidizers: Thermal processes destroy odors by converting them to fully oxidized compounds through combustion in an environment of excess oxygen. Potential thermal treatment approaches include flares, recuperative thermal oxidizers, regenerative oxidizers, and catalytic oxidizers.

  Although thermal treatment can be effective in removing a wide range of odors, it is typically the most expensive approach. As a result, thermal treatment is used only where incinerators already exist, where digestion processes provide a high Btu (methane) gas to fire a flame, or where air emissions issues under the Clean Air Act require it. Therefore, this technology is not carried forward in this evaluation.
- Liquid Phase Treatment: Liquid phase treatment reduces dissolved sulfide levels in the liquid phase which results in reduced off-gassing and subsequent vapor phase odors. Chemicals include oxidants (e.g.; sodium hypochlorite), precipitants (e.g.; ferrous chloride), pH adjusters (e.g.; sodium hydroxide), and oxygenation (e.g.; oxygen injection). Liquid phase treatment normally requires large amounts of chemicals which results in high operating costs. This technology is normally utilized for pump station forcemains to control odors along collections systems. It is rarely utilized as a stand-alone odor control measure at treatment plants due to marginal effectiveness (typically controls dissolved sulfides to 0.5 mg/L only) and due to high operating costs. Therefore, this technology is not carried forward in this evaluation.

Technology Evaluation and Recommendation

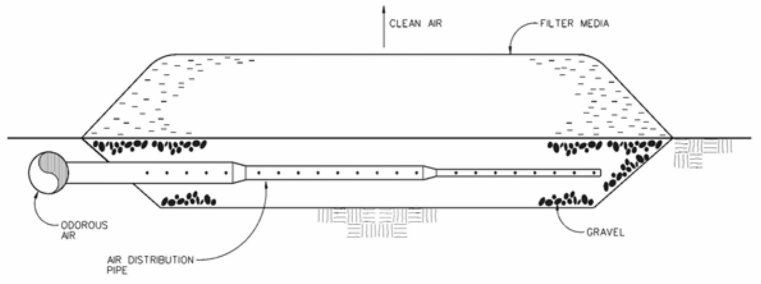
As previously discussed, the scope of this evaluation is limited to biological technologies and carbon technology only. A detailed evaluation of these technologies is provided in this section.

Organic Biofilters

In an organic biofilter, organic material such as wood chips and compost are used as a medium to grow sulfur-consuming bacteria. Foul air is forced into the bottom of the biofilter bed and treated air is released from the surface. The bacteria also use other odor compounds as a food source, including ammonia, amines, and various reduced sulfur compounds.

Figure16- 4 is a simplified schematic of a typical in-ground, open-vessel biofilter system.

FIGURE 16-4
Simplified Biofilter Schematic



Design flow rates for organic biofilters range from 3 to 5 cubic feet per minute (cfm) per square foot. Because of loading rate limitations, the required footprint for an organic biofilter is greater than for an engineered media biofilter. Typically, an air plenum is provided below the media bed to provide air distribution throughout the unit. A mixture of wood chips and compost to a depth of about 5 feet is placed above the rock bed. The design head loss through the media is generally about 0.5-inch WC per foot of bed depth. To facilitate media replacement every 2 to 5 years, many organic biofilter designs allow for front end loader access by locating the inlet plenum below a concrete slab and providing flush-to-floor air distribution inlets, trench grates, or slotted precast concrete pier-mounted panels.

For efficient odor removal, the biofilter media must be moist. Moisture can be maintained through the use of spray nozzles, soaker hoses, air humidifiers, water scrubbers, or some combination of these. The H_2S-consuming bacteria produce an acid by-product that tends to lower the pH of the media; therefore, provisions are often made to maintain a pH above neutral. This may be accomplished by adding pelletized lime or other amendments to provide buffering capacity throughout the media. However, because of the potential for lowered pH, provisions should be made to collect and dispose of leachate from the media.

The advantages of organic biofilters include:

- A wide range of odorous constituents may be removed
- The system O&M is relatively simple
- Chemical storage and delivery is not required
- Media may be readily available and affordable, depending on local suppliers
- Pressure drop through the media is relatively low compared to engineered media
- The control systems are either manual or relatively simple

Organic biofilters have the following disadvantages:

- Media requires frequent change-out (between 2 to 5 years), depending on media type and loading characteristics
- The required footprint is greater than that of engineered media biofilters
- Design should incorporate means to remove and replace media, which typically results in higher capital cost
- Since bacterial populations provide the removal mechanism, the system can handle gradual cyclic loadings but cannot accommodate rapid load spikes effectively

Engineered Media (High Rate) Packaged Biofilter

High rate packaged biofilters are proprietary biofilter systems that utilize a proprietary media that performs well under high loading rates. The advantage is that they are less land intensive than organic-type biofilters. High rate biofilters exhibit similar performance characteristics as organic mediums but with higher pressure drop. The media tends to be costlier because it is a unique proprietary composition. Three system suppliers include Bohn, Enduro, and Biorem. Bohn utilizes their soil media, Enduro utilizes their proprietary media, and Biorem utilizes their biosorbens media. Figure 16-5 is a photo of a small packaged

FIGURE 16-5
Packaged Engineered Media Biofilter

engineered media biofilter currently in operation in Oregon.

Design flow rates for high rate biofilters range from 5.0 cfm to 11.0 cfm per square foot. Typically, for a packaged system, a fiberglass reinforced plastic (FRP) vessel is utilized along with fan, ducting, stack, and control panel. Media life is normally guaranteed for 10 to 20 years. The appropriate empty bed gas residence time (EBGRT) for high rate media is dependent upon the target odor and respective loading rate but will typically range between 30 to 60 seconds.

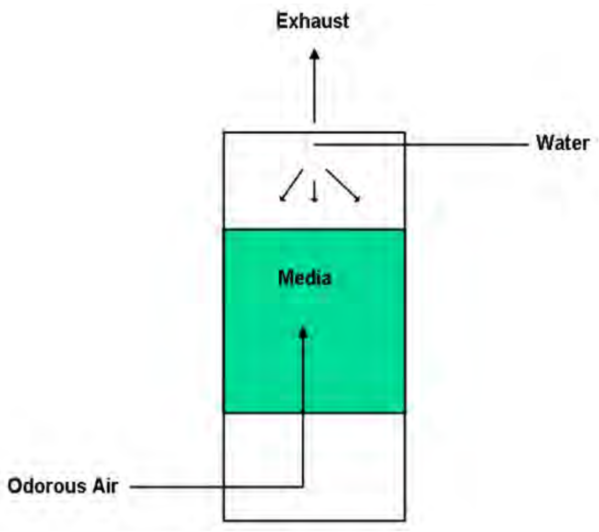
Generally, high rate biofilter media do not require a nutrient source because they have a nutrient constituent built into the media recipe. The advantages of high rate packaged biofilters include:

- A wide range of odorous constituents may be removed
- The system O&M is relatively simple
- Chemical storage and delivery is not required
- High rate proprietary media requires less frequent change-out (generally guaranteed for 10 to 20 years)
- The control systems are either manually operated or are relatively simple
- The collected leachate is typically not odorous, as with compost biofilters
- The required footprint is approximately half that of organic media biofilters
- High-velocity stack that allows for better dispersion/dilution than open area biofilters without cover and stack

High rate biofilters have the following disadvantages:

- Media costs can be high
- Because bacterial populations provide the removal mechanism, the system can handle gradual cyclic loadings but cannot accommodate rapid load spikes effectively

FIGURE 16-6
Simplified Schematic Diagram of a Bio-Trickling



Bio-Trickling Filter

In a bio-trickling filter, odorous air is blown into the bottom of the tower and flows up through the media material, exiting through an exhaust stack. The media may be a synthetic material, or a natural material such as lava rock. Media is normally guaranteed for 10 to 20 years. The bacteria also use other odor compounds as a food source, including ammonia and various ORS compounds. Achievable removal rates are 99 percent for H_2S and 85-90 percent for general odor. Figure 16-6 illustrates a simplified schematic of a bio-trickling filter system.

Design bed velocities for bio-trickling filters are 60 fpm maximum. The required minimum EBGRT is approximately 10 seconds but can vary depending on the specific application. The design head loss through the media is generally about 0.3-inch WC per foot of bed depth. The required footprint is smaller than that of biofilters. For some bio-trickling filter systems, a scrubbant recirculation pump is required to keep the media moist, to add necessary nutrients, and to maintain pH (these are generally called bioscrubbers). One manufacturer, BioAir, uses a once-through arrangement by which makeup water is sprayed over the top of the media and is drained out the bottom without recirculation. The advantage with this type of arrangement is that a pH gradient is maintained within the media that supports both low pH bacteria (thiobacillus – specifically targets H_2S) and neutral pH bacteria (heterotrophic – targets ORS compounds). The disadvantage to a once-through system is higher makeup water usage. Treated plant effluent, if available, can be used as the scrubbant makeup in lieu of adding nutrient feed unless high H_2S levels are present; in which case nutrient is required.

The advantages of bio-trickling filters include:

- Small footprint compared to biofilters
- Excellent track record for removal of H_2S
- No chemical delivery or storage
- Media guaranteed for 10 years (minimum)
- High-velocity stack that allows for better dispersion/dilution than open area biofilters without cover and stack

Bio-trickling filters have the following disadvantages:

- Control system and associated O&M is more complex than biofilters
- Pressure drop through the media is relatively high compared to organic media biofilters
- Because bacterial populations provide the removal mechanism, the system cannot accommodate excessive rapid loading spikes effectively
- Collected leachate is acidic and should be routed to a process flow stream for dilution or neutralized
- Bio-trickling filters can use large quantities of irrigation water (once-through systems only)
- If plant effluent is not available or is available but not suitable, nutrient feed must be provided which results in ongoing operating costs. However, alternatives to the proprietary nutrient solution could be used (e.g.; Miracle Grow) to significantly reduce the operating costs associated with nutrient consumption.

Carbon Adsorber

Activated carbon is commonly used for removing odors in airstreams. Multiple carbon bed configurations are available depending on space, size or flow rate restrictions. These include vertical multi-bed, horizontal single bed, radial bed and horizontal dual bed. The horizontal dual bed configuration is shown in Figure 16-7 and is the best configuration for plants with limited spaced.

There are several types of activated carbon available, the most common include:

- impregnated activated carbon
- virgin activated carbon
- high-rate activated carbon
- catalytically activated carbon (called Centaur™ by Calgon)

Impregnated carbon has a higher capacity for removal of H_2S than virgin activated carbon. This is because the impregnated carbon is given an additive such as caustic (sodium hydroxide or potassium hydroxide). After the carbon is spent, normally on-site regeneration can be performed by flooding the vessel with caustic and then rinsing it with water. However, this regeneration only restores the carbon adsorption capability to approximately 80 percent of its original capacity. Therefore, after several regenerations the carbon must be replaced. After the impregnated carbon has depleted its adsorption capability, it is sometimes considered a special waste and may be difficult to dispose of, depending on local landfill rules. Due to safety issues related to regeneration and disposal, this type of carbon is not considered appropriate for the Expanded/Upgraded WWTP 2.

Virgin activated carbon comes in several forms including coconut shell carbon and coal based carbon. In addition, pelletized media or granular media are both available. Coal based carbon exhibits a broader distribution of pores and exhibits relatively better settling of

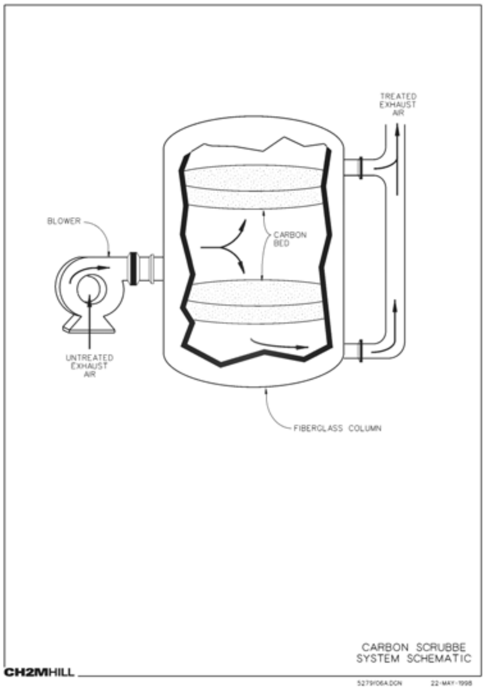


FIGURE16- 7

Dual Bed Carbon Vessel

the media, which allows more media to be placed in a specified volume than the coconut shell carbon. The coconut shell carbon is harder, more expensive, exhibits higher surface area per unit volume, and adsorbs organics better than coal based carbon. The pelletized carbon is better than granular coal for settling. Virgin activated carbon is generally suited to odor levels up to 10 ppmV H_2S. Odor levels greater than this make this media cost prohibitive due to frequent media change-out requirements. Due to this fact, this type of carbon is not considered appropriate for the Expanded/Upgraded WWTP 2.

High-rate activated carbon has exceptionally high H_2S breakthrough capacity and is relatively new in the odor control market place. Because of its high odor adsorption capacity, this type of media can be considered viable for systems handling higher H_2S concentrations as is expected for the Expanded/Upgraded WWTP 2. This is a result of less frequent media change-out requirements versus conventional virgin activated carbon systems. High-rate activated carbon has nearly 6 times the adsorption capacity of virgin activated carbon. Although this carbon media exhibits excellent H_2S removal performance, this media is expected to remove only about 60 percent of the ORS compounds. Examples of this type of carbon media are “Midas OCM” (as marketed by US Filter) and Minotaur (as marketed by Calgon). This type of carbon media is most favorable when considering odor conditions specific to this project and is therefore considered the most viable of the various carbon media types.

The advantages of catalytically activated carbon are its relatively higher H_2S adsorption capacity when compared to virgin activated carbon and its ability to be regenerated by water. Centaur has nearly 5 times the adsorption capacity of virgin activated carbon. Moreover, after the Centaur is spent it can be regenerated, obtaining 80 percent of its original performance. After approximately four regenerations, the maximum adsorption capacity levels off at approximately 65 percent of its original performance. After 6 to 10 regenerations, the media must be replaced. Due to initial higher costs coupled with regeneration limitations, this type of carbon is not carried forward in this evaluation.

Advantages of carbon adsorption are:

- Simplicity of system and operation
- Requires a relatively small footprint

Disadvantages of carbon adsorption are as follows:

- At high loadings, the carbon must be replaced often
- Pressure drops through the carbon bed are high
- Breakthrough of odor may occur if the media is not replaced once it is saturated
- Carbon has poor ability to handle peak H_2S loads

Technology Evaluation

Both economic (cost) and non-economic (benefit) criteria were used to evaluate the four technologies described above. A technology with the lowest cost to benefit ratio is the most appropriate technology for the Expanded/Upgraded WWTP 2 vapor phase odor control system.

Economic Evaluation

Economic criteria include capital cost and life cycle cost.

A conceptual level cost estimate has been developed for each evaluated technology. The cost estimates are considered a Study or Feasibility, Class 4 estimate as defined by the Association for the Advancement of Cost Engineering International (AACEI). These estimates are considered accurate from +20 to +50 percent on the high side to -15 to -30 percent on the low side, based on a preliminary design, level of information available, and estimating techniques used.

Capital costs for all odor control technology alternatives include site work, equipment, mechanical, electrical, instrumentation and control (I&C), piping, and ductwork. Capital costs are estimated using the following approach:

- Equipment costs are based on recent equipment supplier cost quotes received.
- Percentage markups applied for unknown costs such as site work, instrumentation, electrical, and yard piping.

Additional project costs were developed by escalating the equipment sub-cost by the markups illustrated below.

Markups applied to equipment cost:

	Percent
Equipment installation	15
Field painting/finishes	2
Mechanical	10
Electrical	18
Instrumentation	8

Contractor markups applied to equipment subtotal + project costs:

	Percent
General conditions	7
Overhead	10
Profit	5
Bonds/insurance	2
Contingency	20
Escalation (3% per year)	6[1]

[1] assumes construction completed end of 2015

Non-construction cost markups applied to construction cost after contractor markups and escalation.

	Percent
Permitting	3
Engineering	10
Services during construction	5
Commissioning/startup	5

O&M and life cycle costs were developed using the following inputs:

Electricity costs	\$0.08/kilowatt-hour
Operator labor costs	\$40/hr
Financing costs	20-year life, 6 percent discount rate
Organic biofilter media	\$30 per cubic yard plus \$69 per cubic yard for labor, equipment, hauling, and tipping fees
High-capacity carbon (Midas)	\$4.75/lb (includes \$3.75/lb for carbon and \$1/lb for carbon replacement labor, hauling, and tipping fees)

Table 16-6 summarizes the cost estimate for evaluated odor control technologies. The bio-trickling filter alternative and the carbon alternative have highest present worth cost. The carbon system alternative has the lowest capital cost but higher O&M costs due to higher pressure drop and media change-out costs. The engineered media packaged biofilter system alternative has the lowest O&M cost and the second lowest present worth cost. The organic media biofilter alternative has the lowest present worth cost but requires frequent media change-out.

TABLE 16-6
Cost Estimate Summary of Technologies

Item	Engineered Media Packaged Biofilter (x$1,000)	Bio-Trickling Filter (x$1,000)	Organic Media Biofilter(x$1,000)	Carbon Adsorber (x$1,000)
Capital Costs				
Equipment Subtotal	$ 140	$ 153	$ 132	$ 82
Allowance Costs	$ 74	$ 81	$ 70	$ 43
Contractor Markups	$ 51	$ 56	$ 49	$ 30
Contingency (20%)	$ 53	$ 58	$ 50	$ 31
Escalation (3% per year)	$ 19	$ 21	$ 18	$ 11
Non-Construction Costs	$ 98	$ 107	$ 93	$ 57
Annual Costs				
Electrical Power	$ 2.3	$ 1.0	$ 0.9	$ 1.8
Maintenance	$ 1.8	$ 4.7	$ 1.8	$ 1.8
Biofilter Media	-	-	$2.3	-
Carbon	-	-	-	$22
Chemicals	-	-	-	-
Subtotal – Annual Costs	$ 4.1	$ 5.7	$ 5.0	$ 26
Present Worth Annual Costs	$ 48	$ 69	$ 58	$ 299
Total Capital Cost	$ 437	$ 476	$ 413	$ 255
Total Project Present Worth	$ 485	$ 545	$ 471	$ 554

Non-Economic Evaluation

Non-economic evaluation criteria include the following categories:

- Ability to handle spikes
- Aesthetics
- Environmental impact
- High temperature sensitivity
- Implementation and constructability
- Media disposal
- O&M complexity
- Odor removal efficiency

- Safety
- Space requirements and layouts
- Technical reliability and redundancy

Each criterion was given a weighting factor, depending on the importance of the criterion for this specific application. Then a score was given for each criterion within the technology. The final score is a weighted overall score of all criteria for the technology. Table 16- 7 summarizes the weighing of the criteria and score of each evaluated technology. The weighted scores resulted in the following rankings:

1. Engineered media packaged biofilter
2. Carbon adsorber
3. Organic media biofilter
4. Biotower

TABLE 16-7
Non-Economic Evaluation of Technologies

		Weighed Score			
Evaluation Criteria	**Criteria Weight**	Engineered Media Packaged Biofilter	Biotower	Organic Media Biofilter	Carbon Adsorber
Ability to Handle Spikes	10	0.7	0.6	0.7	0.9
Aesthetics	10	0.8	0.4	0.8	0.8
Environmental Impact	6	0.48	0.42	0.48	0.36
High Temperature Sensitivity	5	0.15	0.15	0.15	0.5
Implementation and Constructability	5	0.4	0.4	0.4	0.4
Media Disposal	7	0.56	0.49	0.35	0.14
O&M Complexity	15	1.35	0.9	1.2	1.35
Odor Removal Efficiency	9	0.81	0.81	0.81	0.81
Safety	8	0.64	0.64	0.64	0.56
Space Requirements and Layouts	15	1.05	1.2	0.9	1.05
Technical Reliability and Redundancy	10	0.8	0.7	0.8	06
Total Weighed Score (out of 10)		**7.74**	**6.71**	**7.23**	**7.47**
Ranking		**1**	**4**	**3**	**2**

Cost Benefit Analysis

Figure 16-8 shows the capital and life cycle costs and the breakdown of non-economic evaluation scores for each odor control technology. The bar charts represent the non-economic evaluation scores and the two lines show the costs. The cost benefit of each technology was estimated by dividing the 20-year life cycle cost by the non-economic weighed score. Figure 16-9 shows the cost to benefit ratio of each odor control technology. The alternative with the lowest cost to benefit ratio would be the preferred technology since it represents the system that costs the least when providing the same non-economic benefit.

Although the engineered media packaged biofilter has a higher present worth cost than the organic biofilter, its cost to benefit ratio is the lowest since it is ranked the first in the non-economic evaluation.

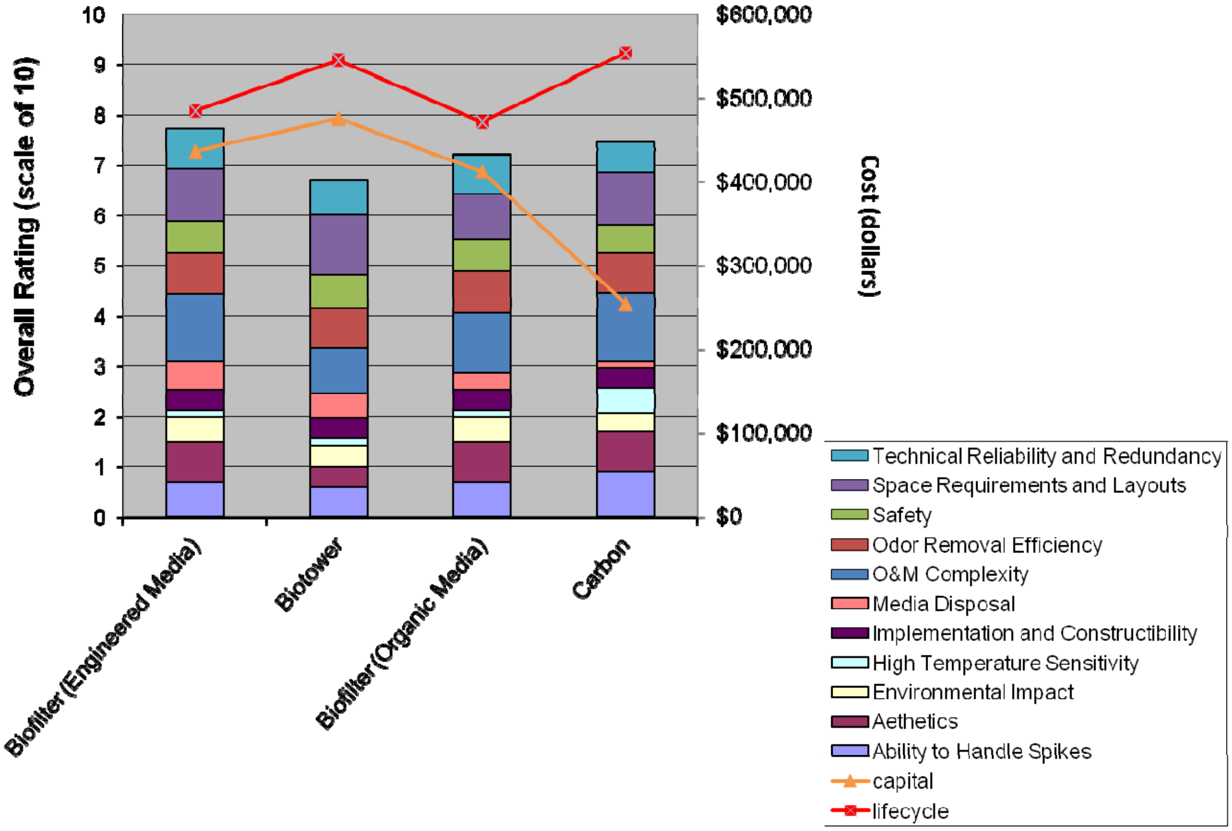


FIGURE 16-8
Rating scale, capital costs and life cycle costs

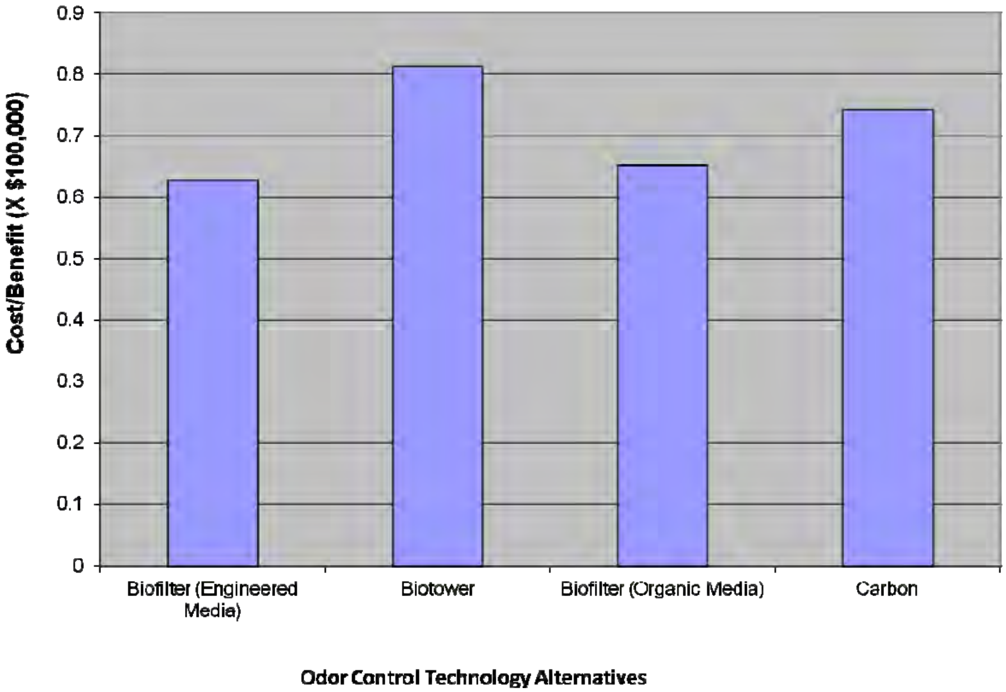


FIGURE 16-9
Cost/Benefit Analysis

Conclusions, Recommendations, and Proposed Design Criteria

The cost benefit analysis indicates that the engineered media packaged biofilter is the best odor control technology to provide the most benefit with a moderate cost for the Expanded/Upgraded WWTP 2 vapor phase odor control system. Although the cost to benefit ratios of the organic biofilter and carbon are fairly close, frequent organic media and carbon media replacement makes these alternatives less favorable. Also, the large footprint required by the organic biofilter makes this alternative less favorable. For the engineered media packaged biofilter, its sustainable operation and compact space requirement make it the preferred alternative.

Table 16-8 summarizes the preliminary design criteria of the proposed engineered media packaged biofilter for serving the Expanded/Upgraded WWTP 2. The entire system, including biofilter vessel, odorous air exhaust fan, and control panel will be located at grade. The exhaust fan pulls odorous air from the headworks and IPS and delivers the foul air to the biofilter vessel for treatment. Given the size of the fan, it is expected that the sound impact of the fan will not be significant. However an enclosure could be provided around the fan to attenuate the sound, if noise is a concern. The quantity of make-up water is estimated to be around 1 to 2 gpm on an intermittent basis.

TABLE 16-8

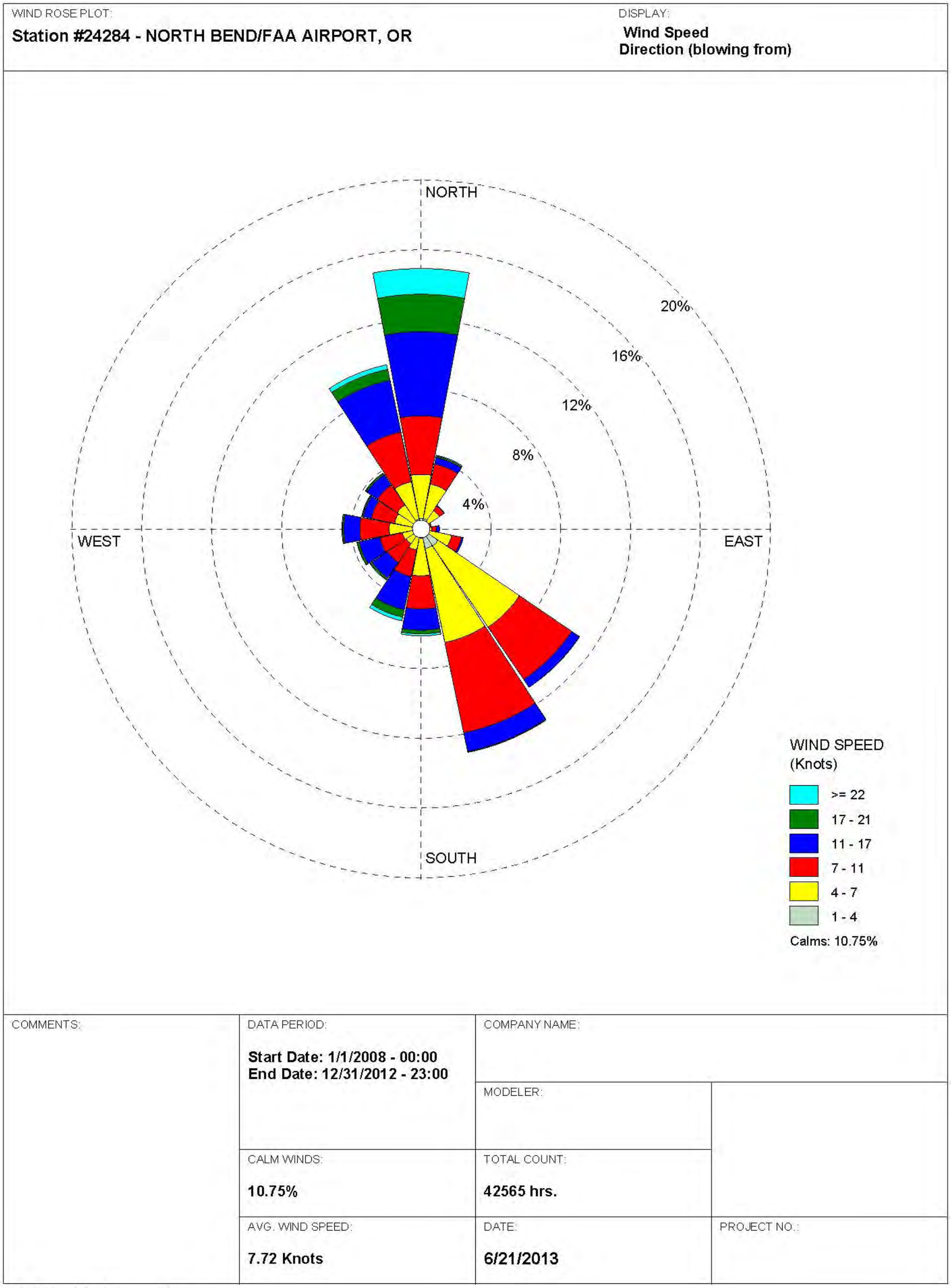
Odor Control System Design Criteria

Parameter	Value
Engineered Media Packaged Biofilter	
Minimum Odor Removal Rate, H2S	For inlet concentrations > 10 ppm, 99% removal
	For inlet concentrations < 10 ppm, outlet concentration < 100 ppb
Minimum Odor Removal Rate, DT	90%
Process Served	Headworks and IPS
Number of vessels	1
Configuration	Vertical, countercurrent
Diameter , each	12 feet
Capacity & Pressure Drop, each	1650 cfm; 8-inch WC
Media Depth & Type	10 feet; engineered media
Stack Size	10-inch dia.
Stack Exit Velocity	3,000 fpm
Minimum Contact Time	30 seconds
Design Bed Velocity	50 fpm
Make-up Water	Potable water
Nutrient System	None

TABLE 16-8

Odor Control System Design Criteria

Parameter	Value
Odorous Air Exhaust Fan	
Number of Units	1
Type	FRP Centrifugal
Capacity	1650 cfm
Static Pressure	9.0-inch WC
Motor Size	5.0 hp
Motor Type	TEFC (Class 1, Div. 2)



WIND ROSE PLOT:

Station #24284 - NORTH BEND/FAA AIRPORT, OR

DISPLAY:

Wind Speed
Direction (blowing from)

COMMENTS:

DATA PERIOD:

Start Date: 1/1/2008 - 00:00
End Date: 12/31/2012 - 23:00

COMPANY NAME:

MODELER:

CALM WINDS:

10.75%

TOTAL COUNT:

42565 hrs.

AVG. WIND SPEED:

7.72 Knots

DATE:

6/21/2013

PROJECT NO.:

FIGURE 16-1
Wind Rose Plot from Southwest Oregon International Airport

PD.17 – Construction Sequencing and Alternative Delivery

PREPARED BY: Craig Massie/CH2M HILL
REVIEWED BY: Steve Donovan/SHN
DATE: August 2013

Introduction

This technical memorandum (TM) documents suggested construction sequence and delivery method for the construction phase of the WWTP 2 Expansion and Upgrade project.

Construction Sequence

The construction sequence outlined in this TM is general in nature, recognizing the major components of the construction and specific interties between the collection system, outfall piping, and the piping configuration associated with the interim biosolids management plan. The City will be executing the project using the construction manager/general contractor (CMGC) method which creates the opportunity for this collaboration with the CMGC on a more detailed construction sequence and a schedule ahead of development of the guaranteed maximum price (GMP).

The construction of the new facilities to the east of the existing WWTP 2, across Empire Blvd., can been done as a “greenfield” construction, with a majority of the work completed independent of interfacing with the existing plant. The following facilities can be constructed and clean water tested prior to connection to the existing sewer system and outfall piping:

- Influent Pump Station
- Headworks screening and grit removal
- Sequencing batch reactors
- UV disinfection
- Storage/Garage Building
- Electrical Building
- Office/Lab Building
- Site wide electrical systems
- Site wide SCADA systems
- Civil site work
- Civil yard piping, except final connections to raw sewage and outfall piping

Following completion of the new facilities, a clean water test can be done on all systems by circulating water through the new facilities using the influent pump station and a temporary piping connection from UV disinfection to the influent pump station wet well. This will allow for clean water testing of all new systems prior to raw sewage being introduced. To facilitate the startup of the treatment process, seeding the plant with several thousand gallons of mixed liquor from the Coquille Wastewater Treatment Plant may be the fastest way to introduce appropriate, acclimated aerobic organisms to the new facilities.

The interim biosolids approach adds some complication to the construction sequence and the startup of the expanded/upgraded WWTP 2 and will require the connection of the waste activated sludge (WAS) piping to the collection system for delivery to the existing plant influent pump station. A similar connection from the existing plant primary effluent piping system to the collection system serving the new Influent Pump Station will need to be established at the same time. To accomplish this, the yard piping connections will need to be constructed close to their tie-in points. The suggested construction sequence may be as follows:

1. Construct new sewer line tie-in to existing sewer system, but do not make final connection.

2. Construct yard piping from existing primary clarifiers' effluent piping to sewer system to new Influent Pump Station; provide a valve in this line to isolate it at the existing primary clarifiers.
3. Construct WAS piping from the new facilities to the existing sewer system to allow flow to the existing Influent Pump Station. Provide an isolation valve to isolate the WAS line from the sewer system.
4. Construct the plant effluent piping connection to the existing outfall piping at the existing plant, provide valved isolation.

The sequence for startup of the new facilities to treat primary effluent received from the existing WWTP 2 and discharge final effluent from the outfall would involve the following sequence:

1. Connect the primary effluent pipe from the existing plant to the new sewer connection to the new Influent Pump Station.
2. Open the valve in the WAS pipe to allow discharge to the existing sewer system.
3. Make final tie-in of the plant effluent line to the existing outfall.

With the interim biosolids utilizing portions of the existing WWTP 2 for treatment, the flow path for influent and flow through the treatment process will be as follows:

1. All influent flows to enter the existing Influent Pump Station.
2. Flow receives preliminary and primary treatment at the existing WWTP 2.
3. Primary effluent flows from the existing WWTP 2 to the new Influent Pump Station.
4. Primary effluent receives full secondary treatment and disinfection at the expanded/upgraded facilities.
5. Plant effluent leaves the expanded/upgraded facilities and uses the existing outfall pipe and diffuser.
6. WAS from the expanded/upgraded facilities flows to the existing Influent Pump Station to combine with plant influent and co-settle with primary sludge in the primary clarifier and with the primary sludge to be anaerobically digested in the existing digesters.

Project Delivery

The City of Coos Bay will be making significant improvements to their Wastewater Treatment Plant 2 (WWTP2) as outlined in the Facility Plan Amendment and the ongoing Preliminary Design. There are several options available to the City to implement the design and construction of the improvements. The purpose of this TM is to outline the options and recommend an approach for project implementation.

Design-Bid-Build

The design-bid-build scenario is the traditional approach and very familiar to the City and common within the municipal wastewater industry. With this scenario the following sequential activities are typically required:

1. Prequalify contractors (optional but allowed in Oregon)
2. Finalize the 100 percent final contract documents for the purpose of bidding and for construction
3. Advertise for bids
4. Open bids
5. Make notice of award
6. Execute agreement with contractor
7. Construct facilities

8. Start-up and test facilities
9. Place facilities into operation

Under this scenario, the engineering is performed by an engineering firm, and the procurement of materials and construction are provided by a Construction Contractor. Design-bid-build is a traditional delivery method and therefore, has been used most often in the state of Oregon for municipal wastewater plant construction. Some alternatives within the design-bid–build approach include a single-prime contract for construction (which is most common), and multi-prime contractors for construction (which is less common). With the multi-prime approach, multiple design packages are put out for separate bids, and the multiple prime contractors are managed on the project either by the City's staff or by the engineering firm. Multiple prime contractors can be used to accelerate certain aspects of the construction work ahead of other parts of the work, such as civil sitework ahead of mechanical equipment installation. Disadvantages include additional contract management and potential for contractor's claims relating to questions of work responsibility within the multiple contracts. A single prime contractor is used unless rapid implementation of the project is critical.

Advantages

- Allows the City to be presented with a set bid price for the work before making a complete commitment to proceed with the project.
- It is a familiar process to the City and the engineering and construction industry.
- There are several well-qualified contractors within Oregon and the northwest who would provide competitive bids on a project of this size.

Disadvantages

- Of the alternatives presented herein, this approach has the longest implementation schedule, assuming the design engineering firm has already been selected for all alternatives.
- City has little or no control over the contractor selected.
- Potential for change orders during construction, based on scope changes and unanticipated conditions.

Design-Bid–Build with Owner-Furnished Equipment

This method is a variation of the design-bid-build approach, although it could be part of a design-build approach, also. In this approach, the City is responsible for the procurement of certain materials or equipment (e.g. ICEAS sequencing batch reactors), and then furnishes them to a contractor for installation as part of a larger contract. Certain package treatment components, which the City may choose by either competitive or sole-source procure means, are candidates for owner-furnished equipment. The City may continue to hold the purchase contract with the equipment supplier or may assign the contract to the successful bidder.

Advantages

- City has a greater degree of control over the selection and purchase of critical or large systems of equipment.
- City may save the cost of construction contractor markup and may get a lower purchase price from the equipment vendor.
- This method has the potential to reduce the time to bring facilities into operation. This is most applicable with short duration construction contracts that would otherwise have long lead equipment items that are to be purchased by the construction contractor.

Disadvantages

- Additional effort by the City and the City's engineer is required in order to procure the equipment
- Additional effort by the City and the City's engineer is required to administer, deliver, and insure equipment requirements with the installing contractor

- The potential for “finger pointing” between equipment supplier under contract with the City and the installing contractor

Construction Manager-General Contractor

As the City knows from their recent experience with a CMGC delivery, in this approach a CMGC contractor is selected on qualifications and cost factors through a proposal process similar to how engineering services are procured. The CMGC contractor works collaboratively with the engineer and City under a professional services contract during the design period. Once the design progresses far enough to negotiate a cost of construction, the CMGC contract converts to a construction contract (which can be reimbursable instead of lump sum).

Also, CMGC is attractive if there is specialized construction involved (retrofit of operating facilities is included) or if schedule is critical and the City wants a larger role in contractor selection.

Advantages

- Allows the flexibility to start the work with partially completed design work, allowing collaborative completion of the design to proceed with contractor input and site investigation. This allows construction to proceed in a manner more efficient to the City, contractor, and engineer.
- Allows the City to select the contractor on qualifications and cost factors (such as overhead and profit, insurance, bonds, and markup on equipment and subcontractors) with the final GMP being developed in an open-book cost competitive manned as design proceeds.
- Facilitates the implementation of equipment procurement, either by the City or contractor through construction.
- Equipment, materials, and subcontractors can be competitively procured in an open book manner.
- May reduce overall project schedule.

Disadvantages

- Introduces a second selection process for the CMGC, similar to engineering selection.
- City needs to document cost savings and submit to the state.

Design-Build

Design-build is most appropriate when the work scope is well defined and is not expected to change over the life of the project. It provides one-stop shopping for engineering and construction for the City. Typically, one design-build firm is selected on qualifications and a pricing basis. As the name implies, the same firm performs the design and constructs the project. It is very common to see joint venture firms made up of a design firm teamed with a construction firm proposing on design-build projects.

Advantages

- Design-build provides the best method of reducing the overall delivery time for many types of projects.
- With a scope of work defined primarily in performance related terms, overall project costs can be less than with other delivery methods. This is primarily due to the design-build firm having the flexibility to be innovative with the design of facilities that meet the scope requirements while minimizing the cost of the constructed facility.

Disadvantages

- Projects that are not well suited for the design-build approach include those that are expected to require a considerable amount of input from the City for detail definition, including significant aesthetic features; have many operational constraints; have a high probability for unknowns to be discovered during construction; or are expected to contain many changes during construction.

- Although the overall schedule of a project can often be reduced, cost is often equal or higher, and quality can be lower. This may not be the case with highly reputable firms and procurement processes, but in the open marketplace it is a risk for the City, and difficult to sort out in the engineer/contractor selection process without extensive selection procedures.

Design-Build and CMGC in Oregon

Unlike some other states, Oregon does not have too many laws that directly govern the process of design-build and CMGC. Instead, both CMGC and design-build are done under Oregon Revised Statutes (ORS) as an exemption to the normal public works competitive bidding process. Applicable statutes are found under ORS 279C. In addition, local entities may have their own procurement rules that can have an impact on design-build procurements.

In order for a public contracting entity to do CMGC or design-build under the exemption to the competitive bidding process, it must complete three basic steps:

1. Prepare findings related to the exemption
2. Hold a public hearing on the findings with a minimum of 14-days notice
3. Prepare a report after the project is completed summarizing cost savings and other benefits of the alternative delivery

The exemption must meet two tests:

1. That it is unlikely that the exemption will encourage favoritism or substantially diminish competition.
2. That awarding the contract pursuant to the exemption will result in “substantial cost savings”.

The findings must provide a justification for the decision that includes, but is not limited to, information regarding:

- Operational, budget and financial data
- Public benefits
- Value engineering
- Specialized expertise required
- Public safety
- Market conditions
- Technical complexity
- Funding sources

Once the public contracting entity makes the findings and exempts the project from competitive bidding, it can secure the services as best suits the project, again consistent with its local procurement policies.
There are no real restrictions about the findings that the public contracting entity must make. The case for the exemption can be made based on what makes sense – schedule needs, operational savings, project complexity, secondary impacts to the entity, etc. The key is to write it down and hold a hearing about the decision.

The project completion report that is required happens after final payment. It should:

- Compare actual costs to estimated costs
- Identify change orders
- Provide a narrative of successes and failures
- Provide an “objective assessment” of the use of the alternative contracting process as compared to the findings that were made at the beginning of the project

Given this framework, it is relatively easy for an Oregon public contracting entity to do CMGC or design-build – if it makes sense and if the entity is willing to hold the hearing on the decision.

Determining Factors

The following list of determining factors may be helpful in deciding how to proceed with the Expansion and Upgrade project for WWTP 2.

- The overall time that is available to complete the project
- The level of complexity and uniqueness of the project
- The extent of the unknowns that are expected to be encountered during construction
- The project budget
- Major system/equipment items needed for the project

Recommendations

For the sake of recommending a project delivery approach at this planning level of project development, the following assumptions are made:

- The project size as bid may be $18 to $25 million.
- The project and its constraints are well understood.
- A major owner furnished equipment package may or may not be possible, this will be determined with the City.
- The City will take a very active role during detailed design, providing detailed input and review at each project milestone.
- The existing WWTP 2 is in need of replacement, as early as practically possible; thus favoring accelerated project delivery.
- The complexity of the project is high, given the points of interface that will be required between the new facilities and the existing WWTP 2; and the requirement that the existing WWTP 2 operate without interruption during the construction and startup phases for the expanded/upgraded facilities.
- The City has adequate funding to deliver the project by any of the approaches outlined herein

Given these assumptions, we recommend a CMGC approach for the following reasons:

- Both CH2M HILL and the City have a good track record with construction by this method in western Oregon. The City used this approach on the City Hall seismic upgrade project, and CH2M HILL has been involved with five water and wastewater plant project expansions using CMGC in Oregon in the last 4 years.
- Completing the facility early is advantageous.
- Construction complexity relating to the interface with the existing WWTP 2, and maintaining the existing plant in operation is anticipated.
- Minimizing and containing overall project costs is of high importance.
- Design engineering procurement efforts have been expended. A design-build approach may cause the City to start this effort over, delaying project implementation which rules out a typical design-build.

If it is determined that an owner-furnished equipment package is warranted, CMGC is still recommended. Assignment of the contract to the CMGC or retainage by the City can be determined at a later date.

Basis of Estimate

Wastewater Treatment Plant 2
Expansion and Upgrade

Prepared for

City of Coos Bay, Oregon

July, 2013

CH2MHILL

Contents

WWTP2 Expansion and Upgrade
Basis of Estimate

TABLE 0.1
Estimate Information
WWTP2 Expansion and Upgrade

Estimate Classification	Class 4
Requested By	Craig Massie/CVO
Estimated By	Tom Jones/CVO
Estimator Phone	541.768.3255
Estimate Date	July 26, 2013

1. Purpose of Estimate

The purpose of this Estimate of Construction Cost is to establish an Engineer's opinion of probable construction cost at the Preliminary Design level of design development.

2. General Project Description

The City of Coos Bay is the largest community on the Oregon coast and provides wastewater collection, treatment, and disposal services to retail customers within the city limits. The City operates two treatment plants owing the topography of the city. WWTP 2 is located in the Empire area and has a 2.02 mgd dry weather design flow. It has been in service since 1973 and was upgraded in 1990. The existing plant includes influent pumping, headworks with screening and grit separation, primary clarification, activated sludge secondary treatment, secondary clarification, disinfection, de-chlorination and anaerobic digestion for stabilization of biosolids.

Because of changes to, and deviations from, the original Facility Plan completed in 2007, DEQ requested that the City prepare a Facility Plan Amendment (FPA) prior to proceeding forward with pre-design. Additionally a value analysis (VA) of the FPA was performed, lead by CH2M HILL. The VA team included CH2M HILL staff, City Staff, Charleston Sanitation District representatives, and a DEQ representative.

3. Overall Costs

The following is a summary breakdown of the costs.

TABLE 3.1
Overall Costs
WWTP2 Expansion and Upgrade

Low Range (-30%)	**Estimated Costs**[a]	**High Range (+50%)**
$10,480,000	**$14,970,000**	$22,460,000

[a] See Appendix for cost estimate details

This cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor and material costs, competitive market conditions, final project costs, implementation schedule and other variable factors. As a result, the final project costs will vary from the estimate presented herein. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific financial decisions.

4. Scope of Work

This project consists of the following areas of improvement:

- **Sitework**
- **Yard Piping**
- **Influent Pump Station**
- **Plant Drain Pump Station**
- **Headworks / Blower Building**
- **Sequencing Batch Reactor**
- **Shop**
- **Ultraviolet Disinfection**
- **Control Building**
- **Odor Control Treatment**

5. Markups

These markups are based upon general assumptions about how the project will be contracted. It is assumed that a General Contractor will self-perform major portions of the project to gain a competitive advantage. Actual markup percentages and procurement strategy may vary from those shown here, and are the responsibility of the bidding contractor.

TABLE 5.1
General Contractor Markups
WWTP2 Expansion and Upgrade

Contractor General Conditions	**7.00%**
Contractor Overhead	**10.00%**
Contractor Profit	**5.00%**
Bonds and Insurance	**2.10%**
Estimate Contingency	**20.00%**
Escalation Rate	**5.62%**

TABLE 5.2
Subcontractor Markups
WWTP2 Expansion and Upgrade

Architectural	**15.00%**
Mechanical (HVAC Domestic Plumbing)	**20.00%**
Electrical and Instrumentation Controls	**20.00%**
Site/Civil	**15.00%**

6. Escalation Rate

This estimate includes Escalation with the assumption that construction will start in June 2014 with the midpoint of construction being June 2015. It is assumed that there will be 18 months of construction. (See appendix for Escalation Analysis.)

This CH2M HILL escalation forecast is based upon economic data from Global Insight, Inc. and the United States Bureau of Labor Statistics.

7. Estimate Classification

This cost estimate prepared is considered a Study, Feasiblity, or Class 4 estimate as defined by the Association for the Advancement of Cost Engineering International (AACEI). It is considered accurate to +50% to -30%, based on a Project Definition design deliverable.

8. Estimate Methodology

This cost estimate is considered a bottom rolled up type estimate with cost items and breakdown of Labor, Materials and Equipment. Some quotations were obtained for various items. The estimate may include allowance cost and dollars per SF cost for certain components of the estimate.

9. Cost Resources

The following is a list of the various cost resources used in the development of the cost estimate:

- R.S. Means
- CH2M HILL Historical Data
- Vendor Quotes on Equipment and Materials where appropriate
- Estimator Judgment

10. Labor Costs

The estimate has been adjusted for local area labor rates, based upon 2013 national rates.

Labor unit prices reflect a burdened rate, including: workers compensation, unemployment taxes, Fringe Benefits, and medical insurance.

11. Taxes

This project is considered Tax Exempt.

12. Major Assumptions

The estimate is based on the assumption the work will be done on a competitive bid basis and the contractor will have a reasonable amount of time to complete the work. All contractors are equal, with a reasonable project schedule, no overtime, constructed as under a single contract, no liquidated damages.

This estimate should be evaluated for market changes after 90 days of the issue date. It is assumed that much of the fabricated equipment and material will be acquired domestically.

13. Allowances

The estimate includes allowances for known work that is not sufficiently detailed at this time:

- Plant Drain Pump Station - $100,000

- Electrical and I&C work is based on previous and similar projects.
- Building HVAC and Electrical Distribution and Lighting are based on $/sf.

14. Excluded Costs

The cost estimate excludes the following costs:

- Bypass Pumping
- Temporary facilities for existing processes (MOPO)
- Non-construction or soft costs for design, services during construction, land, legal and owner administration costs
- Material Adjustment allowances above and beyond what is included at the time of the cost estimate

15. Reference Documents

This cost estimate is based upon CH2M HILL Draft Preliminary Design Report documents, July 2013.

Cost Estimate Appendix

CH2MHILL

Summary Report

Job Size:
Duration:

Project: 469556 Coos Bay WWTP
Project No.: 469556
Design Stage: PDR

Estimator: Jones T
Revision / Date: 01 - 07-26-2013
Estimate Class: 4

Bid Item	Work Pkg	Description	Takeoff Quantity	Total Cost/Unit	Total Amount
06		**SITEWORK**			
	13.0	Buildings Complete		/LS	90,548
	26.0	Electrical Work	1.00 LS	613,784.00 /LS	613,784
	31.0	Site/Civil	1.00 LS	752,168.92 /LS	752,169
		06 SITEWORK	**1.00 LS**	**1,456,501.39 /LS**	**1,456,501**
07		**YARD PIPING**			
	33.0	Buried Piping	2,380.00 LF	416.30 /LF	990,798
		07 YARD PIPING	**1.00 LS**	**990,797.57 /LS**	**990,798**
10		**INFLUENT PUMP STATION**			
	03.0	Concrete Work	200.08 CY	1,532.10 /CY	306,542
	05.0	Metal Work	1.00 LS	27,085.08 /LS	27,085
	07.0	Thermal & Moisture Protection	1.00 LS	13,415.30 /LS	13,415
	14.0	Conveying Equipment	1.00 LS	7,552.08 /LS	7,552
	26.0	Electrical Work	1.00 LS	204,020.00 /LS	204,020
	31.0	Site/Civil	1.00 LS	124,925.01 /LS	124,925
	40.0	Process Piping	1.00 LS	171,059.74 /LS	171,060
	43.0	Process Equipment	1.00 LS	344,201.23 /LS	344,201
		10 INFLUENT PUMP STATION	**1.00 LS**	**1,198,800.17 /LS**	**1,198,800**
11		**PLANT DRAIN PUMP STATION**			
	43.0	Process Equipment	1.00 LS	166,096.95 /LS	166,097
		11 PLANT DRAIN PUMP STATION	**1.00 LS**	**166,096.95 /LS**	**166,097**
20		**HEADWORKS / BLOWER BUILDING**			
	03.0	Concrete Work	34.44 CY	11,154.56 /CY	384,163
	04.0	Architectural	1,000.00 SF	12.13 /SF	12,126
	23.0	HVAC	1,000.00 SF	16.61 /SF	16,610
	26.0	Electrical Work	1.00 LS	437,327.81 /LS	437,328
	40.0	Process Piping	1.00 LS	70,512.15 /LS	70,512
	43.0	Process Equipment	1.00 LS	1,712,644.56 /LS	1,712,645
		20 HEADWORKS / BLOWER BUILDING	**1.00 LS**	**2,633,383.59 /LS**	**2,633,384**
30		**SEQUENCING BATCH REACTOR**			
	03.0	Concrete Work	4,700.15 CY	895.05 /CY	4,206,888
	26.0	Electrical Work	1.00 LS	195,401.80 /LS	195,402
	40.0	Process Piping	1.00 LS	183,944.26 /LS	183,944
	43.0	Process Equipment	1.00 LS	1,062,997.94 /LS	1,062,998
		30 SEQUENCING BATCH REACTOR	**1.00 LS**	**5,649,231.95 /LS**	**5,649,232**
32		**SHOP**			
	03.0	Concrete Work	159.91 CY	1,754.78 /CY	280,607
	05.0	Metal Work	1.00 LS	38,628.85 /LS	38,629
	07.0	Thermal & Moisture Protection	1.00 LS	19,134.38 /LS	19,134
	08.0	Openings	1.00 LS	14,669.77 /LS	14,670
	14.0	Conveying Equipment	1.00 LS	7,552.05 /LS	7,552
	23.0	HVAC	1,567.00 SF	16.61 /SF	26,027
	26.0	Electrical Work	1.00 LS	54,211.02 /LS	54,211
		32 SHOP	**1.00 LS**	**440,830.32 /LS**	**440,830**
40		**ULTRAVIOLET DISINFECTION**			
	03.0	Concrete Work	210.46 CY	1,124.80 /CY	236,726
	40.0	Process Piping	1.00 LS	206,381.82 /LS	206,382
	43.0	Process Equipment	1.00 LS	1,083,847.79 /LS	1,083,848
		40 ULTRAVIOLET DISINFECTION	**1.00 LS**	**1,526,955.56 /LS**	**1,526,956**
60		**CONTROL BUILDING**			
	03.0	Concrete Work	121.81 CY	2,908.22 /CY	354,250
	04.2	Masonry	880.00 SF	24.45 /SF	21,514
	05.0	Metal Work	1.00 LS	52,880.64 /LS	52,881

Bid Item	Work Pkg	Description	Takeoff Quantity	Total Cost/Unit	Total Amount
	07.0	Thermal & Moisture Protection	1.00 LS	26,192.81 /LS	26,193
	08.0	Openings	1.00 LS	37,245.93 /LS	37,246
	09.0	Finishes	1.00 LS	70,127.44 /LS	70,127
	10.0	Specialties	1.00 LS	6,663.81 /LS	6,664
	21.0	Fire Protection	1.00 LS	19,625.89 /LS	19,626
	22.0	Plumbing	1.00 LS	18,006.14 /LS	18,006
	23.0	HVAC	2,105.00 SF	34.38 /SF	72,374
	26.0	Electrical Work	1.00 LS	100,636.49 /LS	100,636
		60 CONTROL BUILDING	**2,105.00 SF**	**370.32 /SF**	**779,518**
70		**ODOR CONTROL TREATMENT**			
	03.0	Concrete Work	8.91 CY	718.96 /CY	6,406
	43.0	Process Equipment	1.00 LS	124,945.48 /LS	124,945
		70 ODOR CONTROL TREATMENT	**1.00 LS**	**131,351.39 /LS**	**131,351**

Estimate Totals

Description	Amount	Totals	Hours	Rate
Labor	3,405,895		45,842.795 hrs	
Material	3,747,673			
Subcontract	3,165,595			
Equipment	264,175		2,919.633 hrs	
Other	4,390,128			
Construction Total	**14,973,466**	**14,973,466**		

CH2MHILL

Job Size:
Duration:

Detail Report

Project: 469556 Coos Bay WWTP
Project No.: 469556
Design Stage: PDR

Estimator: Jones T
Revision / Date: 01 - 07-26-2013
Estimate Class: 4

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
06			SITEWORK									
	13.0		Buildings Complete									
		13-10	Buildings Complete									
			Electrical Building									
			Special Construction, Other									
			Electrical building allowance	200.00 sf				50,000	-	-	250.00 /sf	50,000
			Special Construction, Other					50,000			/SF	50,000
			Electrical Building					50,000			/SF	50,000
			13-10 Buildings Complete					50,000			/LS	50,000
			13.0 Buildings Complete					50,000			/LS	50,000
	26.0		Electrical Work									
		26-10	Site Electrical									
			Generator									
			Electrical Equipment, Generators - General									
			Generator Package Quote	1.00 E	96.0	4,819		-	-	325,000	329,819.49 /E	329,819
			Electrical Equipment, Generators - General	1.00 LS	96.0	4,819				325,000	329,819.49 /LS	329,819
			Generator	1.00 EA	96.0	4,819				325,000	329,819.49 /EA	329,819
			26-10 Site Electrical	1.00 LS	96.0	4,819				325,000	329,819.49 /LS	329,819
			26.0 Electrical Work	1.00 LS	96.0	4,819				325,000	329,819.49 /LS	329,819
	31.0		Site/Civil									
		31-20	Earthworks, Site									
			Site Clearing and Grading									
			Earthworks, Sitework, Site Grading									
			Site Clearing and Grading Allowance	115,000.00 SF				115,000	-	-	1.00 /SF	115,000
			Earthworks, Sitework, Site Grading	12,777.77 SY				115,000			9.00 /SY	115,000
			Site Clearing and Grading	115,000.00 SF				115,000			1.00 /SF	115,000
			31-20 Earthworks, Site	1.00 LS				115,000			115,000.00 /LS	115,000
		31-35	Site Landscaping									
			Landscape Allowance									
			Site Improvements, Landscaping									
			Landscape Allowance	43,000.00 SF				86,000	-	-	2.00 /SF	86,000
			Wetlands Landscape Allowance	6,000.00 SF				30,000	-	-	5.00 /SF	30,000
			Site Improvements, Landscaping	5,444.44 SY				116,000			21.31 /SY	116,000
			Landscape Allowance	1.00 LS				116,000			116,000.00 /LS	116,000
			31-35 Site Landscaping	1.00 LS				116,000			116,000.00 /LS	116,000
		31-40	Paving									
			Asphalt Paving									
			Site Improvements, Paving, Bituminous Asphalt									
			Road Survey (Blue tops)	1.00 ls	100.0		-	7,500	-	-	7,500.00 /ls	7,500
			Bituminous Pavement Subgrade Prep	3,023.00 sy	27.2		-	4,535	-	-	1.50 /sy	4,535
			Bituminous Asphalt (sy - 4")	3,023.00 sy	108.8		-	51,391	-	-	17.00 /sy	51,391
			Pavement Marking, 4" Pavement striping	200.00 lf	0.4		-	300	-	-	1.50 /lf	300
			Pavement Marking, Disabled Parking Symbol	1.00 ea	2.0		-	250	-	-	250.00 /ea	250
			Permanent Street Signs	4.00 ea	24.0		-	1,400	-	-	350.00 /ea	1,400
			Site Improvements, Paving, Bituminous Asphalt	3,023.00 SY	262.4			65,376			21.63 /SY	65,376
			Asphalt Paving	3,023.00 SY	262.4			65,376			21.63 /SY	65,376
			31-40 Paving	3,023.00 SY	262.4			65,376			21.63 /SY	65,376
		31-45	Fencing									
			Fencing									
			Fencing, Chain Link									

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Job Size:
Duration:

Detail Report

Project: 469556 Coos Bay WWTP
Project No.: 469556
Design Stage: PDR

Estimator: Jones T
Revision / Date: 01 - 07-26-2013
Estimate Class: 4

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
			Fencing, Chain Link									
			Security Fence, Chain Link, 8'	1,200.00 lf	156.0		-	30,000	-	-	25.00 /lf	30,000
			Automatic Sliding Gate, 8'	2.00 ea	48.0		-	48,000	-	-	24,000.00 /ea	48,000
			Fencing, Chain Link	1,200.00 LF	204.0			78,000			65.00 /LF	78,000
			Fencing	**1,200.00 LF**	**204.0**			**78,000**			**65.00 /LF**	**78,000**
			31-45 Fencing	1,200.00 LF	204.0			78,000			65.00 /LF	78,000
		31-50	Site, Improvements									
			Sidewalks									
			Site Improvements, Flatwork, Sidewalk									
			Concrete Curb Subgrade Prep	10.00 sy	0.1		-	15	-	-	1.50 /sy	15
			Concrete Curbs	700.00 lf	70.0		-	12,600	-	-	18.00 /lf	12,600
			Pedestrian Access Ramps	1.00 ea	24.0		-	350	-	-	350.00 /ea	350
			Concrete Sidewalk Subgrade Prep	666.66 tn	6.0		-	1,000	-	-	1.50 /tn	1,000
			Concrete Sidewalk (4")	6,000.00 sf	240.0		-	27,000	-	-	4.50 /sf	27,000
			Site Improvements, Flatwork, Sidewalk	6,000.00 SF	340.1			40,965			6.83 /SF	40,965
			Sidewalks	**6,000.00 SF**	**340.1**			**40,965**			**6.83 /SF**	**40,965**
			31-50 Site, Improvements	1.00 LS	340.1			40,965			40,964.99 /LS	40,965
			31.0 Site/Civil	1.00 LS	806.5			415,340			415,340.49 /LS	415,340
			06 SITEWORK	**1.00 LS**	**902.5**	**4,819**		**465,340**		**325,000**	**795,159.98 /LS**	**795,160**
07			**YARD PIPING**									
	33.0		Buried Piping									
		33-00	Yard Piping									
			Trench Dewatering									
			Yard Pipe, General Conditions									
			Dewatering Wellpoints, Complete System, Mob	1.00 ea	24.0	0	-	15,000	-	-	15,000.00 /ea	15,000
			Dewatering Wellpoints, Complete System, Install	60.00 ch	360.0	14,219	-	-	9,525	-	395.74 /ch	23,745
			Dewatering Wellpoints, Complete System, Rental, First Month	1.00 mo		-	-	-	35,000	-	35,000.00 /mo	35,000
			Dewatering Wellpoints, Complete System, Rental, after first month, Monthly	1.00 mo		-	-	-	20,000	-	20,000.00 /mo	20,000
			Dewatering Wellpoints, Complete System, Operation - Labor to maintain / check pumps/ fuel and lube	2.00 mo	180.0	6,695	-	-	1,297	-	3,996.03 /mo	7,992
			Dewatering Wellpoints, Complete System, Domob	1.00 ea	24.0	0	-	10,000	-	-	10,000.00 /ea	10,000
			Yard Pipe, General Conditions	1.00 LS	588.0	20,915		25,000	65,822		111,736.64 /LS	111,737
			Trench Dewatering	**2,380.00 LF**	**588.0**	**20,915**		**25,000**	**65,822**		**46.95 /LF**	**111,737**
			12" Foul Air									
			Yard Pipe, HDPE, 12"									
			Bedding Stone, Material Only	213.33 tn		-	2,987	-	-	-	14.00 /tn	2,987
			12" HDPE pipe, excav/backfill included	800.00 LF	480.0	22,722	12,464	-	16,071	-	64.07 /LF	51,257
			12" HDPE Ell, 90	7.00 ea		-	1,400	-	-	-	200.00 /ea	1,400
			12" HDPE Ell, 45	1.00 ea		-	133	-	-	-	133.33 /ea	133
			12" HDPE tee	1.00 ea		-	293	-	-	-	293.33 /ea	293
			12" HDPE flange	3.00 ea		-	750	-	-	-	250.00 /ea	750
			12" DI back-up ring	3.00 ea		-	122	-	-	-	40.59 /ea	122
			Field weld fusion joints, Subcontracted (S), 12"	40.00 ea		-	-	4,344	-	-	108.60 /ea	4,344
			12" Bolt & Gasket Kits, CS, 150#	3.00 ea	7.2	359	60	-	-	-	139.57 /ea	419
			Pipe Marking, Detection Tape	800.00 lf	8.0	408	104	-	-	-	0.64 /lf	512
			Pipe Marking, Copper Wire	800.00 lf	8.0	408	176	-	-	-	0.73 /lf	584
			Yard Pipe, HDPE, 12"	800.00 LF	503.2	23,897	18,489	4,344	16,071		78.50 /LF	62,801
			12" Foul Air	**800.00 LF**	**503.2**	**23,897**	**18,489**	**4,344**	**16,071**		**78.50 /LF**	**62,801**
			08" Plant Influent									
			Yard Pipe, Ductile Iron, 8"									
			Bedding Stone, Material Only	16.00 tn		-	224	-	-	-	14.00 /tn	224

Job Size:
Duration:

Detail Report

Project: 469556 Coos Bay WWTP
Project No.: 469556
Design Stage: PDR

Estimator: Jones T
Revision / Date: 01 - 07-26-2013
Estimate Class: 4

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
			Yard Pipe, Ductile Iron, 8"									
			8" pipe, DI, RJ, excav/bkfill included, 350#	60.00 LF	36.0	1,704	1,459	-	1,205	-	72.80 /LF	4,368
			8" DI, RJ, Ell, 90	2.00 ea		-	420	-	-	-	210.00 /ea	420
			8" DI, RJ, Ell, 45	2.00 ea		-	380	-	-	-	190.00 /ea	380
			Megalugs for DI Pipe w/ Accessories, 8"	8.00 ea	8.0	379	675	-	268	-	165.14 /ea	1,321
			Polywrap, 8" pipe	60.00 lf		-	25	-	-	-	0.41 /lf	25
			Pipe Marking, ID Tape	60.00 lf	0.6	31	8	-	-	-	0.64 /lf	38
			Yard Pipe, Ductile Iron, 8"	60.00 LF	44.6	2,113	3,190		1,473		112.94 /LF	6,776
			08" Plant Influent	60.00 LF	44.6	2,113	3,190		1,473		112.94 /LF	6,776
			16" Plant Influent									
			Buried Pipe, Ductile Iron, 16"									
			Bedding Stone, Material Only	16.00 tn		-	224	-	-	-	14.00 /tn	224
			16" pipe, DI, RJ, excav/bkfill included, 350#	60.00 LF	36.0	1,704	3,894	-	1,205	-	113.39 /LF	6,803
			16" DI, RJ, Ell, 90	2.00 ea		-	2,060	-	-	-	1,030.00 /ea	2,060
			Megalugs for DI Pipe w/ Accessories, 16"	4.00 ea	6.0	284	1,181	-	201	-	416.56 /ea	1,666
			Polywrap, 16" pipe	60.00 lf		-	40	-	-	-	0.67 /lf	40
			Pipe Marking, ID Tape	60.00 lf	0.6	31	8	-	-	-	0.64 /lf	38
			Buried Pipe, Ductile Iron, 16"	60.00 LF	42.6	2,019	7,407		1,406		180.54 /LF	10,832
			16" Plant Influent	60.00 LF	42.6	2,019	7,407		1,406		180.54 /LF	10,832
			30" Plant Influent									
			Yard Pipe, HDPE, 30"									
			Bedding Stone, Material Only	273.33 tn		-	3,827	-	-	-	14.00 /tn	3,827
			30" HDPE pipe, excav/backfill included	820.00 LF	615.0	29,113	70,159	-	20,590	-	146.17 /LF	119,862
			Field weld fusion joints, Subcontracted (S), 30"	41.00 ea		-	-	11,125	-	-	271.35 /ea	11,125
			Pipe Marking, Detection Tape	820.00 lf	8.2	418	107	-	-	-	0.64 /lf	525
			Pipe Marking, Copper Wire	820.00 lf	8.2	418	180	-	-	-	0.73 /lf	599
			Yard Pipe, HDPE, 30"	820.00 LF	631.4	29,949	74,273	11,125	20,590		165.78 /LF	135,938
			30" Plant Influent	820.00 LF	631.4	29,949	74,273	11,125	20,590		165.78 /LF	135,938
			24" Plant Effluent									
			Yard Pipe, HDPE, 24"									
			Bedding Stone, Material Only	170.67 tn		-	2,389	-	-	-	14.00 /tn	2,389
			24" HDPE pipe, excav/backfill included	640.00 LF	384.0	18,178	35,200	-	12,856	-	103.49 /LF	66,234
			Field weld fusion joints, Subcontracted (S), 24"	32.00 ea		-	-	6,946	-	-	217.05 /ea	6,946
			Pipe Marking, Detection Tape	640.00 lf	6.4	326	83	-	-	-	0.64 /lf	410
			Pipe Marking, Copper Wire	640.00 lf	6.4	326	141	-	-	-	0.73 /lf	467
			Yard Pipe, HDPE, 24"	640.00 LF	396.8	18,831	37,813	6,946	12,856		119.45 /LF	76,446
			24" Plant Effluent	640.00 LF	396.8	18,831	37,813	6,946	12,856		119.45 /LF	76,446
			33-00 Yard Piping	2,380.00 LF	2,206.6	97,724	141,172	47,415	118,219		169.97 /LF	404,529
		33-01	Casing									
			72" Steel Casing									
			Yard Pipe, Carbon Steel, 72"									
			72" CS pipe assembly, shop fab, excav/bkfill NOT incl., 3/8" wall	120.00 LF	72.0	3,371	88,473	-	3,027	-	790.59 /LF	94,871
			72" CS butt weld, 3/8" wall	4.00 ea		-	-	5,330	-	-	1,332.50 /ea	5,330
			72" CS butt-strap weld, 3/8" wall	4.00 ea		-	-	11,154	-	-	2,788.50 /ea	11,154
			Pipe Marking, ID Tape	120.00 lf	1.2	61	16	-	-	-	0.64 /lf	77
			Yard Pipe, Carbon Steel, 72"	120.00 LF	73.2	3,432	88,489	16,484	3,027		928.60 /LF	111,432
			72" Steel Casing	120.00 LF	73.2	3,432	88,489	16,484	3,027		928.60 /LF	111,432
			33-01 Casing	120.00 LF	73.2	3,432	88,489	16,484	3,027		928.60 /LF	111,432
		33-15	Yard Structures									
			Influent Manholes									
			Yard Structures, Manholes, 72" Dia									
			Manholes, precast, 6' inside dia, 20' deep	5.00 ea	125.0	5,917	27,000	-	4,185	-	7,420.45 /ea	37,102

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
			Yard Structures, Manholes, 72" Dia									
			Cast-in-Place Base, 6'	5.00 ea	80.0	3,787	5,100	-		-	1,777.41 /ea	8,887
			Slab Top, 6'	5.00 ea	15.0	710	3,000	-	502	-	842.45 /ea	4,212
			Reducer, 6'	5.00 ea	15.0	710	2,250	-	502	-	692.45 /ea	3,462
			Grade Ring, 6'	5.00 ea	5.0	237	125	-	167	-	105.82 /ea	529
			Frame & Cover, 6'	5.00 ea	10.0	473	1,125	-	335	-	386.64 /ea	1,933
			Grout Invert, 6'	5.00 ea	20.0	947	300	-	167	-	282.83 /ea	1,414
			Yard Structures, Manholes, 72" Dia	5.00 EA	270.0	12,781	38,900		5,859		11,508.05 /EA	57,540
			Influent Manholes	5.00 EA	270.0	12,781	38,900		5,859		11,508.05 /EA	57,540
			Effluent Manholes									
			Yard Structures, Manholes, 72" Dia									
			Manholes, precast, 6' inside dia, 20' deep	2.00 ea	50.0	2,367	10,800	-	1,674	-	7,420.45 /ea	14,841
			Cast-in-Place Base, 6'	2.00 ea	32.0	1,515	2,040	-		-	1,777.41 /ea	3,555
			Slab Top, 6'	2.00 ea	6.0	284	1,200	-	201	-	842.46 /ea	1,685
			Reducer, 6'	2.00 ea	6.0	284	900	-	201	-	692.46 /ea	1,385
			Grade Ring, 6'	2.00 ea	2.0	95	50	-	67	-	105.82 /ea	212
			Frame & Cover, 6'	2.00 ea	4.0	189	450	-	134	-	386.64 /ea	773
			Grout Invert, 6'	2.00 ea	8.0	379	120	-	67	-	282.83 /ea	566
			Yard Structures, Manholes, 72" Dia	2.00 EA	108.0	5,113	15,560		2,344		11,508.06 /EA	23,016
			Effluent Manholes	2.00 EA	108.0	5,113	15,560		2,344		11,508.06 /EA	23,016
			33-15 Yard Structures	7.00 EA	378.0	17,894	54,460		8,203		11,508.05 /EA	80,556
			33.0 Buried Piping	2,380.00 LF	2,657.8	119,050	284,121	63,899	129,448		250.64 /LF	596,518
			07 YARD PIPING	**1.00 LS**	**2,657.8**	**119,050**	**284,121**	**63,899**	**129,448**		**596,517.63 /LS**	**596,518**
10			**INFLUENT PUMP STATION**									
	03.0		**Concrete Work**									
		03-10	Cast-In-Place Concrete Work									
			Sump Foundation									
			Cast-In-Place Concrete, Slabs on Grade, 18" thick									
			Fine grade, for slab on grade, by hand	374.00 sf	2.6	94	4	-	-	-	0.26 /sf	98
			Fill, gravel subbase, under building slab on grade	13.85 cy	6.9	248	346	-	-	-	42.91 /cy	594
			Concrete pumping, subcontract, all inclusive price	20.78 cy		-	-	249	-	-	12.00 /cy	249
			Base slab edge forms, 12" to 24"	130.50 sf	28.7	1,274	131	-	-	-	10.77 /sf	1,405
			Reinforcing in place, A615 Gr 60, priced per lbs.	4,155.56 lb		-	2,078	831	-	-	0.70 /lb	2,909
			Concrete, ready mix, 4000 psi	20.78 CY		-	2,140	-	-	-	103.00 /CY	2,140
			Add for concrete waste, 4000 psi	1.04 cy		-	107	-	-	-	103.00 /cy	107
			Placing concrete, concrete pump, for base slab 12" to 24"	20.78 cy	12.5	447	-	-	-	-	21.49 /cy	447
			Finishing floors, monolithic, float finish	374.00 sf	7.5	308	4	-	-	-	0.84 /sf	312
			Curing, water	374.00 sf	1.2	45	19	-	-	-	0.17 /sf	63
			Polyothelene vapor barrier, 6 mil thick	3.74 sq	0.8	36	11	-	-	-	12.57 /sq	47
			Cast-In-Place Concrete, Slabs on Grade, 18" thick	20.78 CY	60.3	2,452	4,839	1,080			402.85 /CY	8,371
			Sump Foundation	20.78 CY	60.3	2,452	4,839	1,080			402.85 /CY	8,371
			Sump Walls									
			Cast-In-Place Concrete, Straight Walls, 12" thick									
			Concrete pumping, subcontract, all inclusive price	47.69 cy		-	-	572	-	-	12.00 /cy	572
			Forms in place, structural walls, > 16' high, hand set	2,575.50 sf	437.8	19,435	3,477	-	-	-	8.90 /sf	22,912
			Forms in place, wall bulkheads	68.68 sf	20.6	915	86	-	-	-	14.57 /sf	1,000
			Form Pipe Penetrations, 4" - 8"	2.00 ea	4.0	178	-	-	-	-	88.78 /ea	178
			Form Pipo Penetrations, 10" - 14"	4.00 ea	14.0	621	-	-	-	-	155.36 /ea	621
			Form Pipe Penetrations, 30" - 36"	1.00 ea	12.0	533	-	-	-	-	532.67 /ea	533
			Waterstop, PVC, center bulb, 6" wide	156.00 lf	12.5	554	312	-	-	-	5.55 /lf	866
			Reinforcing in place, A615 Gr 60, priced per lbs.	11,923.61 lb		-	5,962	2,385	-	-	0.70 /lb	8,347
			Concrete, ready mix, 4000 psi	47.69 CY		-	4,912	-	-	-	103.00 /CY	4,912
			Add for concrete waste, 4000 psi	2.39 cy		-	246	-	-	-	103.00 /cy	246
			Placing concrete, concrete pump, for structural wall to 12" thick	47.69 cy	40.5	1,452	-	-	-	-	30.44 /cy	1,452

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
			Cast-In-Place Concrete, Straight Walls, 12" thick									
			Patch & plug tieholes	2,575.50 sf	38.6	1,384	52	-	-	-	0.56 /sf	1,435
			Sack rub	2,575.50 sf	103.0	3,690	77	-	-	-	1.46 /sf	3,767
			Curing, water	2,575.50 sf	8.6	307	129	-	-	-	0.17 /sf	436
			Cast-In-Place Concrete, Straight Walls, 12" thick	47.69 CY	691.7	29,068	15,252	2,957			991.35 /CY	47,278
			Sump Walls	47.69 CY	691.7	29,068	15,252	2,957			991.35 /CY	47,278
			PS Building SOG									
			Cast-In-Place Concrete, Slabs on Grade, 12" thick									
			Fine grade, for slab on grade, by hand	981.00 sf	6.9	246	10	-	-	-	0.26 /sf	256
			Fill, gravel subbase, under building slab on grade	36.33 cy	18.2	651	908	-	-	-	42.91 /cy	1,559
			Base slab edge forms, 12" to 24"	208.00 sf	45.8	2,031	208	-	-	-	10.77 /sf	2,239
			Reinforcing in place, A615 Gr 60, priced per lbs.	5,450.00 lb		-	2,725	1,090	-	-	0.70 /lb	3,815
			Concrete, ready mix, 4000 psi	36.33 CY		-	3,742	-	-	-	103.00 /CY	3,742
			Add for concrete waste, 4000 psi	1.82 cy		-	187	-	-	-	103.00 /cy	187
			Placing concrete, crane & bucket, for base slab 12" to 24"	36.33 cy	29.1	1,041	-	-	-	-	28.65 /cy	1,041
			Finishing floors, monolithic, trowel finish (machine)	981.00 sf	19.6	809	20	-	-	-	0.85 /sf	829
			Curing, water	981.00 sf	3.3	117	49	-	-	-	0.17 /sf	166
			Polyethelene vapor barrier, 6 mil thick	9.81 sq	2.2	94	29	-	-	-	12.57 /sq	123
			Cast-In-Place Concrete, Slabs on Grade, 12" thick	36.33 CY	124.9	4,989	7,879	1,090			384.19 /CY	13,958
			PS Building SOG	36.33 CY	124.9	4,989	7,879	1,090			384.19 /CY	13,958
			PS Building Walls									
			Cast-In-Place Concrete, Straight Walls, 12" thick									
			Concrete pumping, subcontract, all inclusive price	95.28 cy		-	-	1,143	-	-	12.00 /cy	1,143
			Forms in place, structural walls, > 16' high, hand set	5,145.18 sf	874.7	38,826	6,946	-	-	-	8.90 /sf	45,772
			Forms in place, wall bulkheads	122.50 sf	36.8	1,631	153	-	-	-	14.57 /sf	1,784
			Form liner (for special textured finish)	3,917.00 sf	78.3	3,477	7,834	-	-	-	2.89 /sf	11,311
			Reinforcing in place, A615 Gr 60, priced per lbs.	19,056.22 lb		-	9,528	3,811	-	-	0.70 /lb	13,339
			Concrete, ready mix, 4000 psi	95.28 CY		-	9,814	-	-	-	103.00 /CY	9,814
			Add for concrete waste, 4000 psi	4.76 cy		-	491	-	-	-	103.00 /cy	491
			Placing concrete, concrete pump, for structural wall to 12" thick	95.28 cy	81.0	2,901	-	-	-	-	30.44 /cy	2,901
			Patch & plug tieholes	5,145.18 sf	77.2	2,764	103	-	-	-	0.56 /sf	2,867
			Stone rub	5,145.18 sf	257.3	9,214	154	-	-	-	1.82 /sf	9,368
			Curing, water	5,145.18 sf	17.2	614	257	-	-	-	0.17 /sf	872
			Cast-In-Place Concrete, Straight Walls, 12" thick	95.28 CY	1,422.3	59,428	35,280	4,955			1,046.00 /CY	99,663
			PS Building Walls	95.28 CY	1,422.3	59,428	35,280	4,955			1,046.00 /CY	99,663
			03-10 Cast-In-Place Concrete Work	200.08 CY	2,299.2	95,937	63,250	10,082			846.01 /CY	169,269
			03.0 Concrete Work	200.08 CY	2,299.2	95,937	63,250	10,082			846.01 /CY	169,269
	05.0		Metal Work									
		05-00	Metals									
			Structural Steel									
			Metals, Structural Steel									
			Topcoat, epoxy, sprayed	115.25 sf		-	-	52	-	-	0.45 /sf	52
			Structural steel one story with roof trusses, masonry bearing	0.41 tn		-	-	1,005	-	-	2,450.00 /tn	1,005
			Base plates, column, to 150 lb.	323.14 lb		-	-	420	-	-	1.30 /lb	420
			Metals, Structural Steel	0.57 TN				1,476			2,590.25 /TN	1,476
			Metals, Miscellaneous									
			Anchor Bolts, embedded, L-type, 3/4" dia x 12"	32.78 ea	11.8	524	41	-	-	-	17.23 /ea	565
			Metals, Miscellaneous	1.00 LS	11.8	524	41				564.82 /LS	565
			Metals, Metal Decking									
			Metal deck, open type, galv., 1-1/2" deep, 20 gauge	1,262.06 sf		-	-	2,524	-	-	2.00 /sf	2,524
			Metals, Metal Decking	1,262.00 SF				2,524			2.00 /SF	2,524

Detail Report

Project: 469556 Coos Bay WWTP
Project No.: 469556
Design Stage: PDR

Estimator: Jones T
Revision / Date: 01 - 07-26-2013
Estimate Class: 4

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
			Metals, Steel Joists									
			Open web joists, K series, 30' - 50' span, average cost	3.56 tn		-	-	5,337	-	-	1,500.00 /tn	5,337
			Open web joists, LH series, to 96' span, average cost	3.56 tn		-	-	6,404	-	-	1,800.00 /tn	6,404
			Metals, Steel Joists	7.12 TN				11,741			1,649.07 /TN	11,741
			Structural Steel	1.00 LS	11.8	524	41	15,742			16,306.78 /LS	16,307
			05-00 Metals	1.00 LS	11.8	524	41	15,742			16,306.78 /LS	16,307
			05.0 Metal Work	1.00 LS	11.8	524	41	15,742			16,306.78 /LS	16,307
07.0			Thermal & Moisture Protection									
	07-00		Thermal & Moisture Protection									
			Roofing									
			Thermal & Moisture Protection, Insulation									
			Roof deck insulation, polystyrene, 40psi, 2", R10	1,262.00 sf		-	-	1,514	-	-	1.20 /sf	1,514
			Roof deck vapor barrier on metal deck	12.62 sq		-	-	252	-	-	20.00 /sq	252
			Thermal & Moisture Protection, Insulation	1,262.00 SF				1,767			1.40 /SF	1,767
			Thermal & Moisture Protection, Metal Roofing									
			Steel roof, flat profile, 1 3/4" standing seam, 24 ga	1,262.00 sf		-	-	6,310	-	-	5.00 /sf	6,310
			Thermal & Moisture Protection, Metal Roofing	1,262.00 SF				6,310			5.00 /SF	6,310
			Roofing	1,262.00 SF				8,077			6.40 /SF	8,077
			07-00 Thermal & Moisture Protection	1.00 LS				8,077			8,076.80 /LS	8,077
			07.0 Thermal & Moisture Protection	1.00 LS				8,077			8,076.80 /LS	8,077
14.0			Conveying Equipment									
	14-00		Conveying Equipment									
			Manual Trolley Hoist									
			Conveying Equipment, Other									
			Material handling,hoists,elec ovhd,chain,hook hung,15' lift, 3 ton cap	1.00 ea	24.0	1,047	3,500	-	-	-	4,546.78 /ea	4,547
			Conveying Equipment, Other	1.00 LS	24.0	1,047	3,500				4,546.78 /LS	4,547
			Manual Trolley Hoist	1.00 EA	24.0	1,047	3,500				4,546.78 /EA	4,547
			14-00 Conveying Equipment	1.00 LS	24.0	1,047	3,500				4,546.78 /LS	4,547
			14.0 Conveying Equipment	1.00 LS	24.0	1,047	3,500				4,546.78 /LS	4,547
26.0			Electrical Work									
	26-00		Electrical									
			Electrical									
			Electrical									
			Service and Distribution	1,056.00 sf		-	-	6,347	-	-	6.01 /sf	6,347
			Lighting and Branch Wiring	1,056.00 sf		-	-	13,284	-	-	12.58 /sf	13,284
			Electrical	1.00 LS				19,631			19,631.04 /LS	19,631
			Electrical	1.00 LS				19,631			19,631.04 /LS	19,631
			26-00 Electrical	1.00 LS				19,631			19,631.04 /LS	19,631
	26-15		Process Electrical									
			Process Electrical Allowance									
			Process Electrical									
			Process Electrical Allowance for Pump Station	1.00 LS				60,000	-	-	60,000.00 /LS	60,000
			Instrumentation and Controls Allowance for Pump Station	1.00 LS				30,000	-	-	30,000.00 /LS	30,000
			Process Electrical	1.00 LS				90,000			90,000.00 /LS	90,000
			Process Electrical Allowance	1.00 LS				90,000			90,000.00 /LS	90,000
			26-15 Process Electrical	1.00 LS				90,000			90,000.00 /LS	90,000
			26.0 Electrical Work	1.00 LS				109,631			109,631.04 /LS	109,631
31.0			Site/Civil									

Job Size:
Duration:

Detail Report

Project: 469556 Coos Bay WWTP
Project No.: 469556
Design Stage: PDR

Estimator: Jones T
Revision / Date: 01 - 07-26-2013
Estimate Class: 4

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
		31-20	Earthworks, Site									
			Mass Excavation									
			Earthworks, Sitework, Cut/Fill									
			Shoring, sheet pile, Drive, Extract, & Salvage	2,440.00 sf	390.4	16,974	18,300		12,713	-	19.67 /sf	47,988
			Mass Excavation, Cut To Stockpile, Excavator, Medium Crew	500.00 cy	22.9	877	-	-	1,460	-	4.67 /cy	2,337
			Import Site Fill - Medium Crew, per cy	400.00 cy	20.0	795	10,000	-	845	-	29.10 /cy	11,639
			Load Excess Spoils for Off-Site Hauling, Excavator, Cat 330	500.00 cy	2.5	114	-	-	288	-	0.80 /cy	402
			Haul Excess Spoils Off-Site, 17 yd capacity, 10 miles RT	500.00 cy	17.2	608	-	-	858	-	2.93 /cy	1,466
			Excess Spoils Dump Charges for 17 yd end dumps, per cy	500.00 cy		-	5,150	-	-	-	10.30 /cy	5,150
			Earthworks, Sitework, Cut/Fill	500.00 CY	453.0	19,367	33,450		16,165		137.97 /CY	68,982
			Mass Excavation	**500.00 CY**	**453.0**	**19,367**	**33,450**		**16,165**		**137.97 /CY**	**68,982**
			31-20 Earthworks, Site	1.00 LS	453.0	19,367	33,450		16,165		68,982.40 /LS	68,982
			31.0 Site/Civil	1.00 LS	453.0	19,367	33,450		16,165		68,982.40 /LS	68,982
40.0			Process Piping									
	40-10		Exposed Process Pipe									
			12" Influent Pump Sta Piping									
			Process Pipe, Ductile Iron, 12"									
			Paint pipe supports, subcontracted, (Need Price)	6.00 ea		-	-	300	-	-	50.00 /ea	300
			Paint process pipe and fittings, subcontracted, priced per LF, 12" dia.	259.00 lf		-	-	4,662	-	-	18.00 /lf	4,662
			Stencil process pipe, subcontracted, priced per LF	92.50 lf		-	-	93	-	-	1.00 /lf	93
			Air release valves	3.00 ea	7.5	327	-	-	-	-	109.04 /ea	327
			Add for hydrotesting	1.00 line	21.3	1,061	-	-	-	-	1,061.19 /line	1,061
			FURNISH 12" DI pipe	43.00 lf		-	1,382	-	-	-	32.13 /lf	1,382
			Install 12" DI, flanged, spool <= 10'	2.00 ea	11.0	548	-	-	-	-	274.02 /ea	548
			Install 12" DI, flanged, spool > 10'	3.00 ea	20.6	1,028	-	-	-	-	342.77 /ea	1,028
			FURNISH 12" DI flange	59.00 ea		-	13,169	-	-	-	223.20 /ea	13,169
			12" DI, FL, Ell, 22 1/2	6.00 ea	33.0	1,644	2,040	-	-	-	614.02 /ea	3,684
			12" DI, FL, tee, 12" x 12"	3.00 ea	20.6	1,028	2,066	-	-	-	1,031.27 /ea	3,094
			12" DI, FL, blind flange	1.00 ea	5.1	255	136	-	-	-	391.08 /ea	391
			12" DI, FL, reducer, 12" x 8"	3.00 ea	16.5	822	740	-	-	-	520.52 /ea	1,562
			12" DI, bellows coupling (Check Mat'l Price)	3.00 ea	15.4	765	351	-	-	-	372.08 /ea	1,116
			Add for glass lining	5,123.00 lb		-	3,074	-	-	-	0.60 /lb	3,074
			Harness assembly, 12"	3.00 ea	3.0	149	450	-	-	-	199.82 /ea	599
			Pipe stand support, CS, 12"	6.00 ea	18.0	897	1,998	-	-	-	482.46 /ea	2,895
			12" Bolt & Gasket Kits, CS, 150#	31.00 ea	68.2	3,398	620	-	-	-	129.61 /ea	4,018
			Pipe Information Labels	10.00 ea	1.7	83	100	-	-	-	18.32 /ea	183
			FURNISH plug valves	1.00 ls		-	12,000	-	-	-	12,000.00 /ls	12,000
			Install plug valve, Flgd, DIP, 12"	3.00 ea	18.0	897	-	-	-	-	298.93 /ea	897
			FURNISH check & flap valves	1.00 ls		-	14,000	-	-	-	14,000.00 /ls	14,000
			Install check valve, Flgd, DIP, 12"	3.00 ea	18.0	897	-	-	-	-	298.93 /ea	897
			Process Pipe, Ductile Iron, 12"	43.00 LF	277.9	13,800	52,124	5,055			1,650.67 /LF	70,979
			12" Influent Pump Sta Piping	**43.00 LF**	**277.9**	**13,800**	**52,124**	**5,055**			**1,650.67 /LF**	**70,979**
			8" Influent Pump Sta Piping									
			Process Pipe, Ductile Iron, 8"									
			Paint pipe supports, subcontracted, (Need Price)	12.00 ea		-	-	600	-	-	50.00 /ea	600
			Paint process pipe and fittings, subcontracted, priced per LF, 8" dia.	243.66 lf		-	-	3,289	-	-	13.50 /lf	3,289
			Stencil process pipe, subcontracted, priced per LF	150.66 lf		-	-	151	-	-	1.00 /lf	151
			Air release valves	2.00 ea	5.0	218	-	-	-	-	109.04 /ea	218
			Add for hydrotesting	2.00 line	14.6	726	-	-	-	-	362.95 /line	726
			FURNISH 8" DI pipe	39.66 lf		-	775	-	-	-	19.53 /lf	775
			Install 8" DI, flanged, spool > 10'	2.00 ea	10.5	522	-	-	-	-	261.06 /ea	522
			FURNISH 8" DI flange	54.00 ea		-	5,625	-	-	-	104.16 /ea	5,625
			8" DI, FL, Ell, 90	2.00 ea	8.4	418	476	-	-	-	446.75 /ea	894
			8" DI, FL, Ell, 22 1/2	4.00 ea	16.8	835	612	-	-	-	361.75 /ea	1,447
			8" DI, FL, tee, 8" x 8"	4.00 ea	21.0	1,044	1,122	-	-	-	541.56 /ea	2,166
			8" DI, FL, blind flange	2.00 ea	6.7	336	136	-	-	-	235.90 /ea	472

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
			Process Pipe, Ductile Iron, 8"									
			8" DI, FL, reducer, 8" x 4"	2.00 ea	8.4	418	221	-	-	-	319.25 /ea	639
			Add for glass lining	2,739.46 lb		-	1,644	-	-	-	0.60 /lb	1,644
			Harness assembly, 8"	4.00 ea	4.0	199	600	-	-	-	199.82 /ea	799
			Pipe stand support, CS, 8"	12.00 ea	36.0	1,794	2,664	-	-	-	371.46 /ea	4,458
			8" Belt & Gasket Kits, CS, 150#	27.00 ea	32.4	1,614	243	-	-	-	68.79 /ea	1,857
			Pipe Information Labels	10.00 ea	1.7	83	100	-	-	-	18.32 /ea	183
			Install plug valve, Flgd, DIP, 8"	2.00 ea	6.6	329	-	-	-	-	164.41 /ea	329
			FURNISH Ecc Plug valve, iron body, Flgd, 150#, HWO, 8"	2.00 ea		-	2,488	-	-	-	1,244.00 /ea	2,488
			Install check valve, Flgd, DIP, 8"	2.00 ea	6.6	329	-	-	-	-	164.41 /ea	329
			FURNISH Check valve, iron body, swing check, flgd, 150#, 8"	2.00 ea		-	2,400	-	-	-	1,200.00 /ea	2,400
			Process Pipe, Ductile Iron, 8"	39.66 LF	178.5	8,864	19,105	4,040			807.08 /LF	32,009
			8" Influent Pump Sta Piping	39.66 LF	178.5	8,864	19,105	4,040			807.08 /LF	32,009
			40-10 Exposed Process Pipe	82.66 LF	456.5	22,664	71,229	9,095			1,245.92 /LF	102,988
			40.0 Process Piping	1.00 LS	456.5	22,664	71,229	9,095			102,987.88 /LS	102,988
	43.0		Process Equipment									
		43-05	Furnish and Install Process Equipment									
			Influent Pumps									
			Process Equipment, Install									
			Functional Testing, Submersible Pumps, 6 - 20 hp	2.00 ea	8.0	349	100	-	-	-	224.47 /ea	449
			Functional Testing, Submersible Pumps, 21 - 50 hp	3.00 ea	12.0	523	150	-	-	-	224.46 /ea	673
			System panel	5.00 ea	40.0	1,745	30,000	-	-	-	6,348.93 /ea	31,745
			Float switch	20.00 ea	40.0	1,745	-	-	-	-	87.23 /ea	1,745
			Float switch bracket	5.00 ea	20.0	872	750	-	-	-	324.46 /ea	1,622
			FURNISH Submersible Pump, 6 - 20 hp	2.00 EA		-		-	-	34,620	17,310.00 /EA	34,620
			FURNISH Submersible Pump, 21 - 50 hp	3.00 EA		-		-	-	125,115	41,705.00 /EA	125,115
			Set base elbow / pump assembly, 6 - 20 hp	2.00 ea	48.0	2,094	100	-	-	-	1,096.79 /ea	2,194
			Set base elbow / pump assembly, 21 - 50 hp	3.00 ea	108.0	4,711	150	-	-	-	1,620.18 /ea	4,861
			Stainless steel guide rails, 2", (labor & material)	60.00 lf	15.0	654	540	-	-	-	19.90 /lf	1,194
			Stainless steel guide rails, 3", (labor & material)	90.00 lf	27.0	1,178	1,080	-	-	-	25.09 /lf	2,258
			Install intermediate guide rail bracket	5.00 ea	7.5	327	50	-	-	-	75.42 /ea	377
			Install upper guide rail bracket	5.00 ea	7.5	327	50	-	-	-	75.42 /ea	377
			Process Equipment, Install	1.00 LS	333.0	14,524	32,970			159,735	207,229.13 /LS	207,229
			Influent Pumps	5.00 EA	333.0	14,524	32,970			159,735	41,445.83 /EA	207,229
			43-05 Furnish and Install Process Equipment	1.00 LS	333.0	14,524	32,970			159,735	207,229.13 /LS	207,229
			43.0 Process Equipment	1.00 LS	333.0	14,524	32,970			159,735	207,229.13 /LS	207,229
			10 INFLUENT PUMP STATION	**1.00 LS**	**3,577.4**	**154,063**	**204,441**	**152,626**	**16,165**	**159,735**	**687,030.23 /LS**	**687,030**
11			PLANT DRAIN PUMP STATION									
	43.0		Process Equipment									
		43-00	Process Equipment - General Items									
			Plant Drain Pump Station Allowance									
			Process Equipment, Install									
			Plant Drain Pump Station Allowance	1.00 LS				100,000	-	-	100,000.00 /LS	100,000
			Process Equipment, Install	1.00 LS				100,000			100,000.00 /LS	100,000
			Plant Drain Pump Station Allowance	1.00 LS				100,000			100,000.00 /LS	100,000
			43-00 Process Equipment - General Items	1.00 LS				100,000			100,000.00 /LS	100,000
			43.0 Process Equipment	1.00 LS				100,000			100,000.00 /LS	100,000
			11 PLANT DRAIN PUMP STATION	**1.00 LS**				**100,000**			**100,000.00 /LS**	**100,000**
20			HEADWORKS / BLOWER BUILDING									
	03.0		Concrete Work									
		03-10	Cast-In-Place Concrete Work									
			Base Slab									

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
			Cast-In-Place Concrete, Slabs on Grade, 12" thick									
			Fine grade, for slab on grade, by hand	930.00 sf	6.5	233	9	-	-	-	0.26 /sf	242
			Fill, gravel subbase, under building slab on grade	34.44 cy	17.2	617	861	-	-	-	42.91 /cy	1,478
			Concrete pumping, subcontract, all inclusive price	34.44 cy		-	-	413	-	-	12.00 /cy	413
			Slab on grade edge forms, 7" to 12"	122.00 sf	22.0	975	122	-	-	-	8.99 /sf	1,097
			Slab on grade box-out form	60.00 sf	15.0	666	75	-	-	-	12.35 /sf	741
			Reinforcing in place, A615 Gr 60, priced per lbs.	8,611.11 lb		-	4,306	1,722	-	-	0.70 /lb	6,028
			Concrete, ready mix, 4000 psi	34.44 CY		-	3,548	-	-	-	103.00 /CY	3,548
			Add for concrete waste, 4000 psi	1.72 cy		-	177	-	-	-	103.00 /cy	177
			Placing concrete, concrete pump	34.44 cy	25.8	925	-	-	-	-	26.86 /cy	925
			Finishing floors, monolithic, trowel finish (machine)	930.00 sf	18.6	767	19	-	-	-	0.85 /sf	786
			Curing, water	930.00 sf	3.1	111	47	-	-	-	0.17 /sf	158
			Polyethelene vapor barrier, 10 mil thick	9.30 sq	2.0	89	56	-	-	-	15.57 /sq	145
			Cast-In-Place Concrete, Slabs on Grade, 12" thick	34.44 CY	110.3	4,383	9,219	2,136			456.95 /CY	15,737
			Base Slab	34.44 CY	110.3	4,383	9,219	2,136			456.95 /CY	15,737
			Support Columns									
			Cast-In-Place Concrete, Columns, 24"									
			Concrete pumping, subcontract, all inclusive price	51.78 cy		-	-	621	-	-	12.00 /cy	621
			Forms in place, columns, rectangular, over 18" sq.	2,795.98 sf	559.2	24,822	4,194	-	-	-	10.38 /sf	29,016
			Forms in place, column capitals, rectangular	36.00 sf	7.2	320	54	-	-	-	10.38 /sf	374
			Reinforcing in place, A615 Gr 60, priced per lbs.	18,122.07 lb		-	9,061	3,624	-	-	0.70 /lb	12,685
			Concrete, ready mix, 4000 psi	51.78 CY		-	5,333	-	-	-	103.00 /CY	5,333
			Add for concrete waste, 4000 psi	2.59 cy		-	267	-	-	-	103.00 /cy	267
			Placing concrete, concrete pump	51.78 cy	38.8	1,391	-	-	-	-	26.86 /cy	1,391
			Sack rub	2,795.98 sf	111.8	4,006	84	-	-	-	1.46 /sf	4,090
			Curing, water	2,795.98 sf	9.3	334	140	-	-	-	0.17 /sf	474
			Cast-In-Place Concrete, Columns, 24"	51.78 CY	726.4	30,872	19,132	4,246			1,047.70 /CY	54,250
			Support Columns	51.78 CY	726.4	30,872	19,132	4,246			1,047.70 /CY	54,250
			Walls									
			Cast-In-Place Concrete, Tilt Up Walls, 10" thick									
			Concrete pumping, subcontract, all inclusive price	115.06 cy		-	-	1,381	-	-	12.00 /cy	1,381
			Forms in place, structural walls, > 16' high, hand set	9,319.92 sf	1,584.4	70,329	12,582	-	-	-	8.90 /sf	82,911
			Form liner (for special textured finish)	3,262.00 sf	65.2	2,896	6,524	-	-	-	2.89 /sf	9,420
			Reinforcing in place, A615 Gr 60, priced per lbs.	17,259.11 lb		-	8,630	3,452	-	-	0.70 /lb	12,081
			Concrete, ready mix, 4000 psi	115.06 CY		-	11,851	-	-	-	103.00 /CY	11,851
			Add for concrete waste, 4000 psi	5.75 cy		-	593	-	-	-	103.00 /cy	593
			Placing concrete, concrete pump, for structural wall to 12" thick	115.06 cy	97.8	3,503	-	-	-	-	30.44 /cy	3,503
			Patch & plug tieholes	9,319.92 sf	139.8	5,007	186	-	-	-	0.56 /sf	5,193
			Sack rub	9,319.92 sf	372.8	13,352	280	-	-	-	1.46 /sf	13,632
			Curing, water	9,319.92 sf	31.1	1,113	466	-	-	-	0.17 /sf	1,579
			Cast-In-Place Concrete, Tilt Up Walls, 10" thick	115.06 CY	2,291.1	96,200	41,111	4,833			1,235.39 /CY	142,144
			Walls	115.06 CY	2,291.1	96,200	41,111	4,833			1,235.39 /CY	142,144
			03-10 Cast-In-Place Concrete Work	34.44 CY	3,127.7	131,455	69,463	11,214			6,159.44 /CY	212,131
			03.0 Concrete Work	34.44 CY	3,127.7	131,455	69,463	11,214			6,159.44 /CY	212,131
04.0			Architectural									
	05-00		Metals									
			Standing Seam Metal Roof									
			Metals, Metal Decking									
			Roof deck insulation, polystyrene, 40psi, 4", R20	930.00 sf		-	-	1,860	-	-	2.00 /sf	1,860
			Roof deck vapor barrier on metal deck	9.30 sq		-	-	186	-	-	20.00 /sq	186
			Steel roof, flat profile, 1 3/4" standing seam, 24 ga	930.00 sf		-	-	4,650	-	-	5.00 /sf	4,650
			Metals, Metal Decking	930.00 SF				6,696			7.20 /SF	6,696
			Standing Seam Metal Roof	930.00 SF				6,696			7.20 /SF	6,696
			05-00 Metals	1.00 LS				6,696			6,696.00 /LS	6,696

Job Size:
Duration:

Detail Report

Project: 469556 Coos Bay WWTP
Project No.: 469556
Design Stage: PDR

Estimator: Jones T
Revision / Date: 01 - 07-26-2013
Estimate Class: 4

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
			04.0 Architectural	1,000.00 SF				6,696			6.70 /SF	6,696
	23.0		HVAC									
		23-00	HVAC									
			HVAC Allowance									
			Mechanical, HVAC									
			HVAC Allowance	1,000.00 SF				10,000	-	-	10.00 /SF	10,000
			Mechanical, HVAC	1,000.00 SF				10,000			10.00 /SF	10,000
			HVAC Allowance	1,000.00 SF				10,000			10.00 /SF	10,000
			23-00 HVAC	1,000.00 SF				10,000			10.00 /SF	10,000
			23.0 HVAC	1,000.00 SF				10,000			10.00 /SF	10,000
	26.0		Electrical Work									
		26-15	Process Electrical									
			Process Electrical Allowance									
			Process Electrical									
			Process Electrical Allowance for Return Sludge Pump Station	1.00 LS				105,000	-	-	105,000.00 /LS	105,000
			Instrumentation and Controls Allowance for Return Sludge Pump Station	1.00 LS				115,000	-	-	115,000.00 /LS	115,000
			Process Electrical	1.00 LS				220,000			220,000.00 /LS	220,000
			Process Electrical Allowance	1.00 LS				220,000			220,000.00 /LS	220,000
			26-15 Process Electrical	1.00 LS				220,000			220,000.00 /LS	220,000
		26-18	Facility Electrical									
			Facility Electrical Allowance									
			Facility Electrical, Complete $/SF Cost									
			Facility Power and Lighting Allowance	1,000.00 SF				15,000	-	-	15.00 /SF	15,000
			Facility Electrical, Complete $/SF Cost	1,000.00 SF				15,000			15.00 /SF	15,000
			Facility Electrical Allowance	1,000.00 SF				15,000			15.00 /SF	15,000
			26-18 Facility Electrical	1,000.00 SF				15,000			15.00 /SF	15,000
			26.0 Electrical Work	1.00 LS				235,000			235,000.00 /LS	235,000
	40.0		Process Piping									
		40-15	Odor Control Duct									
			Foul Air Duct									
			FRP Duct, Round, 14"									
			14" FRP Pipe, flanged, type FRP-1	240.00 LF	26.4	1,315	15,360	-	-	-	69.48 /LF	16,675
			14" FRP, flanged, Ell, 90	4.00 ea	11.6	578	1,380	-	-	-	489.48 /ea	1,958
			14" FRP, flanged, Ell, 45	2.00 ea	5.8	289	470	-	-	-	379.48 /ea	759
			14" FRP, flanged, tee	3.00 ea	8.7	433	2,235	-	-	-	889.48 /ea	2,668
			14" flange, 125#, FRP (Need Material $)	12.00 ea	7.2	359	1,980	-	-	-	194.89 /ea	2,339
			14" expansion joint	2.00 ea	1.2	60	690	-	-	-	374.90 /ea	750
			Saddle, belled, side outlet, 14" x 6"	12.00 ea	300.0	14,946		-	-	-	1,245.53 /ea	14,946
			Pipe Information Labels	10.00 ea	1.7	83	100	-	-	-	18.32 /ea	183
			Butterfly valve damper, 8" Model 203 - low leakage	3.00 ea	6.6	329	1,845	-	-	-	724.61 /ea	2,174
			FRP Duct, Round, 14"	240.00 LF	369.2	18,392	24,060				176.89 /LF	42,452
			Foul Air Duct	240.00 LF	369.2	18,392	24,060				176.89 /LF	42,452
			40-15 Odor Control Duct	240.00 LF	369.2	18,392	24,060				176.89 /LF	42,452
			40.0 Process Piping	1.00 LS	369.2	18,392	24,060				42,452.41 /LS	42,452
	43.0		Process Equipment									
		43-05	Furnish and Install Process Equipment									
			Influent Screens									
			Process Equipment, Install									
			Sleeved anchor bolts, SS - Medium	24.00 ea	18.0	785	432	-	-	-	50.71 /ea	1,217
			Sleeved anchor bolts, SS - Large	8.00 ea	8.0	349	176	-	-	-	65.62 /ea	525
			FURNISH Influent Screens	2.00 ea		-		-	-	350,000	175,000.00 /ea	350,000

Detail Report

Project: 469556 Coos Bay WWTP
Project No.: 469556
Design Stage: PDR

Estimator: Jones T
Revision / Date: 01 - 07-26-2013
Estimate Class: 4

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
			Process Equipment, Install									
			Install Influent Screens	2.00 ea	232.0	10,119	-	-	-	-	5,059.46 /ea	10,119
			Process Equipment, Install	1.00 LS	258.0	11,253	608			350,000	361,860.93 /LS	361,861
			Influent Screens	2.00 EA	258.0	11,253	608			350,000	180,930.47 /EA	361,861
			Compactor									
			Process Equipment, Install									
			FURNISH Hydraulic Compactor	2.00 ea		-		-	-	30,000	15,000.00 /ea	30,000
			Install Hydraulic Compactor	2.00 ea	96.0	4,187	-	-	-	-	2,093.55 /ea	4,187
			Process Equipment, Install	1.00 LS	96.0	4,187				30,000	34,187.10 /LS	34,187
			Compactor	2.00 EA	96.0	4,187				30,000	17,093.55 /EA	34,187
			Transfer Screw Conveyor									
			Process Equipment, Install									
			FURNISH Dewatering Screw Conveyor, 8" - 12" Dia.	1.00 ea		-		-	-	30,000	30,000.00 /ea	30,000
			Install Dewatering Screw Conveyor, 8" - 12" Dia.	1.00 ea	48.0	2,094	-	-	-	-	2,093.55 /ea	2,094
			Process Equipment, Install	1.00 LS	48.0	2,094				30,000	32,093.55 /LS	32,094
			Transfer Screw Conveyor	1.00 EA	48.0	2,094				30,000	32,093.55 /EA	32,094
			Discharge Screw Conveyor									
			Process Equipment, Install									
			FURNISH Dewatering Screw Conveyor, 8" - 12" Dia.	1.00 ea		-		-	-	30,000	30,000.00 /ea	30,000
			Install Dewatering Screw Conveyor, 8" - 12" Dia.	1.00 ea	48.0	2,094	-	-	-	-	2,093.55 /ea	2,094
			Process Equipment, Install	1.00 LS	48.0	2,094				30,000	32,093.55 /LS	32,094
			Discharge Screw Conveyor	1.00 EA	48.0	2,094				30,000	32,093.55 /EA	32,094
			Headcell									
			Process Equipment, Install									
			Sleeved anchor bolts, SS - Medium	16.00 ea	12.0	523	288	-	-	-	50.71 /ea	811
			FURNISH Headcell	1.00 ea		-		-	-	125,000	125,000.00 /ea	125,000
			Install Headcell	1.00 ea	192.0	8,374	-	-	-	-	8,374.21 /ea	8,374
			Process Equipment, Install	1.00 LS	204.0	8,898	288			125,000	134,185.60 /LS	134,186
			Headcell	1.00 EA	204.0	8,898	288			125,000	134,185.60 /EA	134,186
			Grit Pump									
			Process Equipment, Install									
			Functional Testing, Pumps, 5-20 hp	2.00 ea	4.0	174	100	-	-	-	137.23 /ea	274
			Align Pump & Motor, 5-20 hp	2.00 ea	6.0	262	-	1,050	-	-	655.85 /ea	1,312
			Vibration Testing, Pumps, 5-20 hp	2.00 ea	2.0	87	-	350	-	-	218.62 /ea	437
			Local panel	2.00 ea	12.0	523	3,000	-	-	-	1,761.70 /ea	3,523
			Pressure indicators	4.00 ea	6.0	262	1,000	-	-	-	315.43 /ea	1,262
			Sleeved anchor bolts - Small	8.00 ea	2.4	105	96	-	-	-	25.09 /ea	201
			Non-Shrink Machine Grout	4.00 cuft	3.8	166	296	-	-	-	115.44 /cuft	462
			Grease, Oil, and Lube Pumps, 5-20 hp	2.00 ea	4.0	174	150	-	-	-	162.23 /ea	324
			FURNISH Horizontal End-Suction Centrifugal Pump, 5 - 20 hp	2.00 EA		-		-	-	60,000	30,000.00 /EA	60,000
			Set pump assembly, 5 - 20 hp	2.00 ea	64.0	2,791	50	-	-	-	1,420.71 /ea	2,841
			Process Equipment, Install	1.00 LS	104.2	4,545	4,692	1,400		60,000	70,636.78 /LS	70,637
			Grit Pump	2.00 EA	104.2	4,545	4,692	1,400		60,000	35,318.39 /EA	70,637
			Blowers									
			Process Equipment, Install									
			Functional Testing, Blowers, 51-100 hp	3.00 ea	12.0	523	150	-	-	-	224.46 /ea	673
			Align Blower & Motor, 51-100 hp	3.00 ea	9.0	393	-	1,575	-	-	655.85 /ea	1,968
			Vibration Testing, Blowers, 51-100 hp	3.00 ea	3.0	131	-	525	-	-	218.62 /ea	656
			Local panel	3.00 ea	18.0	785	4,500	-	-	-	1,761.70 /ea	5,285
			Grease, Oil, and Lube Blowers, 51 - 100 hp	3.00 ea	12.0	523	150	-	-	-	224.46 /ea	673
			Rotary Lobe Blower, 51 - 100 hp - FURNISH	3.00 EA		-		-	-	96,000	32,000.00 /EA	96,000

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
			Process Equipment, Install									
			Set blower, 51 - 100 hp	3.00 ea	96.0	4,187	-	-	-	150	1,445.71 /ea	4,337
			Process Equipment, Install	1.00 LS	150.0	6,542	4,800	2,100		96,150	109,592.40 /LS	109,592
			Blowers	3.00 EA	150.0	6,542	4,800	2,100		96,150	36,530.80 /EA	109,592
			Teacup Grit Washer									
			Process Equipment, Install									
			FURNISH Teacup Grit Washer	1.00 ea		-		-	-	63,000	63,000.00 /ea	63,000
			Install Teacup Grit Washer	1.00 ea	96.0	4,187	-	-	-	-	4,187.10 /ea	4,187
			Process Equipment, Install	1.00 LS	96.0	4,187				63,000	67,187.10 /LS	67,187
			Teacup Grit Washer	1.00 EA	96.0	4,187				63,000	67,187.10 /EA	67,187
			Grit Dewater Snail									
			Process Equipment, Install									
			FURNISH Grit Dewater Snail	1.00 ea		-		-	-	85,000	85,000.00 /ea	85,000
			Install Grit Dewater Snail	1.00 ea	96.0	4,187	-	-	-	-	4,187.10 /ea	4,187
			Process Equipment, Install	1.00 LS	96.0	4,187				85,000	89,187.10 /LS	89,187
			Grit Dewater Snail	1.00 EA	96.0	4,187				85,000	89,187.10 /EA	89,187
			Manual Bar Screen									
			Process Equipment, Install									
			Manual Bar Screen	1.00 ea	48.0	2,094		-	-	20,000	22,093.55 /ea	22,094
			Process Equipment, Install	1.00 LS	48.0	2,094				20,000	22,093.55 /LS	22,094
			Manual Bar Screen	1.00 EA	48.0	2,094				20,000	22,093.55 /EA	22,094
			Misc. Gates									
			Process Equipment, Install									
			Slide Gate, Stainless Steel - FURNISH	2.00 ea		-		-	-	24,000	12,000.00 /ea	24,000
			Wier Gate, Stainless Steel - FURNISH	2.00 ea		-		-	-	16,000	8,000.00 /ea	16,000
			Slide Gate - Installation	2.00 ea	96.0	4,187	-	-	-	-	2,093.55 /ea	4,187
			Wier Gate - Installation	2.00 ea	48.0	2,094	-	-	-	-	1,046.78 /ea	2,094
			Grout Behind Gate Frame	1.70 cf	2.6	111	61	-	-	-	101.42 /cf	172
			Boxout Concrete at Slide Gate Frame	196.00 lf	39.2	1,710	265	-	-	-	10.07 /lf	1,974
			Grout Boxout at Slide Gate Frame	29.40 cf	44.1	1,923	1,058	-	-	-	101.42 /cf	2,982
			Slide Gate Anchor Bolts	76.00 ea	15.2	663	570	-	-	-	16.22 /ea	1,233
			Stop Log Frame, 4' Wide Channel - FURNISH	1.00 ea		-		-	-	10,000	10,000.00 /ea	10,000
			Stop Log Frame, 4' Wide Channel - Installation	1.00 ea	18.0	785	-	-	-	-	785.09 /ea	785
			Boxout Concrete at Stop Log Frame	100.00 lf	33.0	1,439	210	-	-	-	16.49 /lf	1,649
			Grout Boxout at Stop Log Frame	15.00 cf	22.5	981	540	-	-	-	101.42 /cf	1,521
			Install Stop Log Storage Rack	1.00 ea	16.0	698	-	-	-	-	697.86 /ea	698
			Process Equipment, Install	1.00 LS	334.6	14,592	2,704			50,000	67,295.89 /LS	67,296
			Misc. Gates	5.00 EA	334.6	14,592	2,704			50,000	13,459.18 /EA	67,296
			Plant Influent Sampler									
			Process Equipment, Install									
			FURNISH Automatic Composite Sampler	1.00 ea				-	-	10,000	10,000.00 /ea	10,000
			Install Automatic Composite Sampler	1.00 ea	16.0	698		-	-	-	697.86 /ea	698
			Process Equipment, Install	1.00 LS	16.0	698				10,000	10,697.86 /LS	10,698
			Plant Influent Sampler	1.00 EA	16.0	698				10,000	10,697.86 /EA	10,698
			43-05 Furnish and Install Process Equipment	1.00 LS	1,498.8	65,369	13,092	3,500		949,150	1,031,111.41 /LS	1,031,111
			43.0 Process Equipment	1.00 LS	1,498.8	65,369	13,092	3,500		949,150	1,031,111.41 /LS	1,031,111
			20 HEADWORKS / BLOWER BUILDING	**1.00 LS**	**4,995.7**	**215,216**	**106,615**	**266,410**		**949,150**	**1,537,391.02 /LS**	**1,537,391**
30			**SEQUENCING BATCH REACTOR**									
	03.0		Concrete Work									

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
		03-10	Cast-In-Place Concrete Work									
			Batch Reactor Basin									
			Cast-In-Place Concrete, Slabs on Grade, 24" thick									
			Fine grade, for slab on grade, by hand	29,184.00 sf	204.3	7,317	292	-	-	-	0.26 /sf	7,609
			Fill, gravel subbase, under building slab on grade	1,080.89 cy	540.4	19,357	27,022	-	-	-	42.91 /cy	46,379
			Concrete pumping, subcontract, all inclusive price	2,161.78 cy		-	-	25,941	-	-	12.00 /cy	25,941
			Slab on grade edge forms, 12" to 24"	1,424.00 sf	313.3	13,906	1,424	-	-	-	10.77 /sf	15,330
			Waterstop, PVC, center bulb, 9" wide	1,112.00 lf	89.0	3,949	3,336	-	-	-	6.55 /lf	7,285
			Reinforcing in place, A615 Gr 60, priced per lbs.	324,266.67 lb		-	162,133	64,853	-	-	0.70 /lb	226,987
			Concrete, ready mix, 4000 psi	2,161.78 CY		-	222,663	-	-	-	103.00 /CY	222,663
			Add for concrete waste, 4000 psi	108.09 cy		-	11,133	-	-	-	103.00 /cy	11,133
			Placing concrete, concrete pump	2,161.78 cy	1,621.3	58,070	-	-	-	-	26.86 /cy	58,070
			Finishing floors, monolithic, trowel finish (machine)	29,184.00 sf	583.7	24,068	584	-	-	-	0.85 /sf	24,652
			Curing, water	29,184.00 sf	97.3	3,484	1,459	-	-	-	0.17 /sf	4,943
			Polyethelene vapor barrier, 10 mil thick	291.84 sq	64.2	2,793	1,751	-	-	-	15.57 /sq	4,544
			Cast-In-Place Concrete, Slabs on Grade, 24" thick	2,161.78 CY	3,513.5	132,943	431,798	90,795			303.24 /CY	655,536
			Cast-In-Place Concrete, Straight Walls, 24" thick									
			Concrete pumping, subcontract, all inclusive price	2,538.37 cy		-	-	30,460	-	-	12.00 /cy	30,460
			Forms in place, structural walls, > 16' high, hand set	74,464.00 sf	12,658.9	561,915	100,526	-	-	-	8.90 /sf	662,441
			Form liner (for special textured finish)	5,930.00 sf	118.6	5,265	11,860	-	-	-	2.89 /sf	17,125
			Waterstop, PVC, center bulb, 9" wide	1,144.00 lf	91.5	4,062	3,432	-	-	-	6.55 /lf	7,494
			Reinforcing in place, A615 Gr 60, priced per lbs.	634,592.59 lb		-	317,296	126,919	-	-	0.70 /lb	444,215
			Concrete, ready mix, 4000 psi	2,538.37 CY		-	261,452	-	-	-	103.00 /CY	261,452
			Add for concrete waste, 4000 psi	126.92 cy		-	13,073	-	-	-	103.00 /cy	13,073
			Placing concrete, concrete pump, for structural wall >12" - 24" thick	2,538.37 cy	1,903.8	68,186	-	-	-	-	26.86 /cy	68,186
			Patch & plug tieholes	74,464.00 sf	1,117.0	40,005	1,489	-	-	-	0.56 /sf	41,494
			Sack rub	74,464.00 sf	2,978.6	106,680	2,234	-	-	-	1.46 /sf	108,914
			Curing, water	74,464.00 sf	248.2	8,890	3,723	-	-	-	0.17 /sf	12,613
			Cast-In-Place Concrete, Straight Walls, 24" thick	2,538.37 CY	19,116.5	795,003	715,086	157,379			656.91 /CY	1,667,468
			Batch Reactor Basin	4,700.15 CY	22,630.0	927,946	1,146,883	248,174			494.24 /CY	2,323,003
			03-10 Cast-In-Place Concrete Work	4,700.15 CY	22,630.0	927,946	1,146,883	248,174			494.24 /CY	2,323,003
			03.0 Concrete Work	4,700.15 CY	22,630.0	927,946	1,146,883	248,174			494.24 /CY	2,323,003
	26.0		Electrical Work									
		26-15	Process Electrical									
			Process Electrical Allowance									
			Process Electrical									
			Process Electrical Allowance for Aeration Basin	1.00 LS				80,000	-	-	80,000.00 /LS	80,000
			Instrumentation and Controls Allowance for Aeration Basin (Installation only)	1.00 LS				25,000	-	-	25,000.00 /LS	25,000
			Process Electrical	1.00 LS				105,000			105,000.00 /LS	105,000
			Process Electrical Allowance	1.00 LS				105,000			105,000.00 /LS	105,000
			26-15 Process Electrical	1.00 LS				105,000			105,000.00 /LS	105,000
			26.0 Electrical Work	1.00 LS				105,000			105,000.00 /LS	105,000
	40.0		Process Piping									
		40-10	Exposed Process Pipe									
			12" ALP Piping									
			Process Pipe, Stainless Steel, 12"									
			25 tn Rough Terrain	1.00 mo	173.3	8,094	-	-	11,960	-	20,054.46 /mo	20,054
			12" SS, 304L, pipe assembly, shop fabricated, Sch. 10	93.00 LF	40.0	1,992	9,821	-	-	-	127.02 /LF	11,813
			12" SS, 304L, Ell, 90	6.00 ea	14.4	717	1,214	-	-	-	321.97 /ea	1,932
			12" SS butt weld, Sched 5	2.00 ea		-	-	221	-	-	110.50 /ea	221
			12" Bolt & Gasket Kits, SS	13.00 ea	28.6	1,425	988	-	-	-	185.61 /ea	2,413
			Pipe Information Labels	10.00 ea	1.7	83	100	-	-	-	18.32 /ea	183

Job Size:
Duration:

Detail Report

Project: 469556 Coos Bay WWTP
Project No.: 469556
Design Stage: PDR

Estimator: Jones T
Revision / Date: 01 - 07-26-2013
Estimate Class: 4

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
			Process Pipe, Stainless Steel, 12"	93.00 LF	258.0	12,312	12,123	221	11,960		393.73 /LF	36,617
			12" ALP Piping	93.00 LF	258.0	12,312	12,123	221	11,960		393.73 /LF	36,617
			16" Screened Reactive Sludge									
			Process Pipe, Ductile Iron, 16"									
			Paint process pipe and fittings, subcontracted, priced per LF, 16" dia.	178.00 lf		-	-	4,005	-	-	22.50 /lf	4,005
			Stencil process pipe, subcontracted, priced per LF	178.00 lf		-	-	178	-	-	1.00 /lf	178
			Add for High Painting, subcontracted, priced per LF	178.00 lf		-	-	151	-	-	0.85 /lf	151
			Add for hydrotesting	1.00 line	19.3	960	-	-	-	-	960.05 /line	960
			FURNISH 16" DI pipe	85.00 lf		-	3,661	-	-	-	43.07 /lf	3,661
			Install 16" DI, flanged, spool <= 10'	3.00 ea	25.9	1,290	-	-	-	-	429.96 /ea	1,290
			Install 16" DI, flanged, spool > 10'	5.00 ea	54.0	2,688	-	-	-	-	537.57 /ea	2,688
			FURNISH 16" DI flange	26.00 ea		-	6,161	-	-	-	236.98 /ea	6,161
			16" DI, FL, Ell, 90	5.00 ea	43.2	2,150	8,206	-	-	-	2,071.21 /ea	10,356
			Wall Pipe, DI, FLxFL, 16"	2.00 ea	6.0	299	1,152	-	-	-	725.27 /ea	1,451
			Add for glass lining	8,766.00 lb		-	5,260	-	-	-	0.60 /lb	5,260
			Wall bracket support, CS, 16"	9.00 ea	18.0	897	2,160	-	-	-	339.64 /ea	3,057
			16" Bolt & Gasket Kits, SS	13.00 ea	44.2	2,202	2,444	-	-	-	357.39 /ea	4,646
			Pipe information Labels	9.00 ea	1.5	75	90	-	-	-	18.32 /ea	165
			Process Pipe, Ductile Iron, 16"	85.00 LF	212.0	10,560	29,134	4,334			517.98 /LF	44,028
			16" Screened Reactive Sludge	85.00 LF	212.0	10,560	29,134	4,334			517.98 /LF	44,028
			6" ALP Piping									
			Process Pipe, Stainless Steel, 6"									
			6" SS pipe, sched. 10, 316, butt-weld	70.00 LF	22.4	1,116	3,658	-	-	-	68.19 /LF	4,773
			6" SS, 316, Sched 10, Ell, 90	2.00 ea	14.1	701	123	-	-	-	412.34 /ea	825
			6" SS, 316, Sched 10, cap	2.00 ea	7.0	350	40	-	-	-	194.67 /ea	389
			6" butt-weld, SS, Sched 40	2.00 ea	3.2	166	11	-	15	-	96.51 /ea	193
			Pipe Information Labels	7.00 ea	1.2	58	70	-	-	-	18.32 /ea	128
			Process Pipe, Stainless Steel, 6"	70.00 LF	47.9	2,392	3,902		15		90.13 /LF	6,309
			6" ALP Piping	70.00 LF	47.9	2,392	3,902		15		90.13 /LF	6,309
			8" ALP Piping									
			Process Pipe, Stainless Steel, 8"									
			8" SS, 304L, pipe assembly, shop fabricated, Sch. 10	270.00 LF	97.2	4,843	15,876	-	-	-	76.74 /LF	20,719
			8" SS, 304L, Ell, 90	6.00 ea	7.2	359	384	-	-	-	123.79 /ea	743
			8" SS butt weld, Sched 5	4.00 ea		-	-	312	-	-	78.00 /ea	312
			8" Bolt & Gasket Kits, SS	16.00 ea	19.2	957	512	-	-	-	91.79 /ea	1,469
			Pipe Information Labels	30.00 ea	5.0	250	300	-	-	-	18.32 /ea	550
			Process Pipe, Stainless Steel, 8"	270.00 LF	128.6	6,407	17,072	312			88.12 /LF	23,791
			8" ALP Piping	270.00 LF	128.6	6,407	17,072	312			88.12 /LF	23,791
			40-10 Exposed Process Pipe	518.00 LF	646.4	31,672	62,231	4,867	11,975		213.79 /LF	110,745
			40.0 Process Piping	1.00 LS	646.4	31,672	62,231	4,867	11,975		110,745.13 /LS	110,745
43.0			Process Equipment									
	43-05		Furnish and Install Process Equipment									
			Aeration Equipment Package									
			Aeration Equipment, Oxidation Ditch									
			Set pump assembly, 5 - 20 hp	4.00 ea	128.0	5,583	100	-	-	-	1,420.71 /ea	5,683
			Install Rapid Mixer, Right-Angle Drive, 41 - 50 hp	4.00 ea	96.0	4,187	-	-	-	-	1,046.79 /ea	4,187
			Install Decanter	2.00 ea	192.0	8,374		-	-	-	4,187.11 /ea	8,374
			Aeration Basin Equipment Package	1.00 LS				-	-	550,000	550,000.00 /LS	550,000
			Install Coarse Bubble Aeration System	14,400.00 sf	1,440.0	71,742	-	-	-	-	4.98 /sf	71,742
			Aeration Equipment, Oxidation Ditch	1.00 LS	1,856.0	89,886	100			550,000	639,986.44 /LS	639,986
			Aeration Equipment Package	1.00 LS	1,856.0	89,886	100			550,000	639,986.44 /LS	639,986
			43-05 Furnish and Install Process Equipment	1.00 LS	1,856.0	89,886	100			550,000	639,986.44 /LS	639,986

CH2MHILL

Job Size:
Duration:

Detail Report

Project: 469556 Coos Bay WWTP
Project No.: 469556
Design Stage: PDR

Estimator: Jones T
Revision / Date: 01 - 07-26-2013
Estimate Class: 4

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
			43.0 Process Equipment	1.00 LS	1,856.0	89,886	100			550,000	639,986.44 /LS	639,986
			30 SEQUENCING BATCH REACTOR	**1.00 LS**	**25,132.4**	**1,049,504**	**1,209,214**	**358,041**	**11,975**	**550,000**	**3,178,734.85 /LS**	**3,178,735**
32			**SHOP**									
	03.0		Concrete Work									
		03-10	Cast-In-Place Concrete Work									
			Slab on Grade									
			Cast-In-Place Concrete, Slabs on Grade, 12" thick									
			Fine grade, for slab on grade, by hand	1,750.58 sf	12.3	439	18	-	-	-	0.26 /sf	456
			Fill, gravel subbase, under building slab on grade	64.84 cy	32.4	1,161	1,621	-	-	-	42.91 /cy	2,782
			Concrete pumping, subcontract, all inclusive price	64.84 cy		-	-	778	-	-	12.00 /cy	778
			Base slab edge forms, 12" to 24"	186.66 sf	41.1	1,823	187	-	-	-	10.77 /sf	2,010
			Reinforcing in place, A615 Gr 60, priced per lbs.	9,725.44 lb		-	4,863	1,945	-	-	0.70 /lb	6,808
			Concrete, ready mix, 4000 psi	64.84 CY		-	6,678	-	-	-	103.00 /CY	6,678
			Add for concrete waste, 4000 psi	3.24 cy		-	334	-	-	-	103.00 /cy	334
			Placing concrete, concrete pump, for base slab 12" to 24"	64.84 cy	38.9	1,393	-	-	-	-	21.49 /cy	1,393
			Finishing floors, monolithic, trowel finish (machine)	1,750.58 sf	35.0	1,444	35	-	-	-	0.85 /sf	1,479
			Construction Joint Prep.	145.00 sf	11.6	415	7	-	-	-	2.92 /sf	423
			Curing, water	1,750.58 sf	5.8	209	88	-	-	-	0.17 /sf	297
			Cast-In-Place Concrete, Slabs on Grade, 12" thick	64.84 CY	177.1	6,884	13,830	2,723			361.46 /CY	23,437
			Slab on Grade	**64.84 CY**	**177.1**	**6,884**	**13,830**	**2,723**			**361.46 /CY**	**23,437**
			Concrete Walls									
			Cast-In-Place Concrete, Straight Walls, 8" thick									
			Concrete pumping, subcontract, all inclusive price	95.07 cy		-	-	1,141	-	-	12.00 /cy	1,141
			Forms in place, structural walls, > 8' to 16' high, hand set	2,090.56 sf	418.1	18,560	2,613	-	-	-	10.13 /sf	21,173
			Forms in place, structural walls, > 16' high, hand set	5,610.52 sf	953.8	42,338	7,574	-	-	-	8.90 /sf	49,912
			Forms in place, wall bulkheads	190.00 sf	57.0	2,530	238	-	-	-	14.57 /sf	2,768
			Form liner (for special textured finish)	3,394.00 sf	67.9	3,013	6,788	-	-	-	2.89 /sf	9,801
			Expansion joint material, closed cell neoprene, 1/2"	126.67 sf	3.8	169	443	-	-	-	4.83 /sf	612
			Rainforcing in place, A615 Gr 60, priced per lbs.	19,015.01 lb		-	9,508	3,803	-	-	0.70 /lb	13,311
			Concrete, ready mix, 4000 psi	95.07 CY		-	9,793	-	-	-	103.00 /CY	9,793
			Add for concrete waste, 4000 psi	4.75 cy		-	490	-	-	-	103.00 /cy	490
			Placing concrete, concrete pump, for structural wall to 12" thick	95.07 cy	80.8	2,894	-	-	-	-	30.44 /cy	2,894
			Patch & plug tieholes	7,701.08 sf	115.5	4,137	154	-	-	-	0.56 /sf	4,291
			Stone rub	7,701.08 sf	385.1	13,791	231	-	-	-	1.82 /sf	14,022
			Curing, water	7,701.08 sf	25.7	919	385	-	-	-	0.17 /sf	1,304
			Cast-In-Place Concrete, Straight Walls, 8" thick	95.07 CY	2,107.6	88,351	38,216	4,944			1,383.31 /CY	131,511
			Concrete Walls	**95.07 CY**	**2,107.6**	**88,351**	**38,216**	**4,944**			**1,383.31 /CY**	**131,511**
			03-10 Cast-In-Place Concrete Work	159.91 CY	2,284.7	95,236	52,046	7,667			968.97 /CY	154,948
			03.0 Concrete Work	159.91 CY	2,284.7	95,236	52,046	7,667			968.97 /CY	154,948
	05.0		Metal Work									
		05-00	Metals									
			Structural Steel									
			Metals, Structural Steel									
			Topcoat, epoxy, sprayed	164.36 sf		-	-	74	-	-	0.45 /sf	74
			Structural steel one story with roof trusses, masonry bearing	0.58 tn		-	-	1,431	-	-	2,450.00 /tn	1,431
			Base plates, column, to 150 lb.	460.86 lb		-	-	599	-	-	1.30 /lb	599
			Metals, Structural Steel	1.00 TN				2,104			2,103.88 /TN	2,104
			Metals, Miscellaneous									
			Anchor Bolts, embedded, L-type, 3/4" dia x 12"	46.75 ea	16.8	747	58	-	-	-	17.23 /ea	806
			Metals, Miscellaneous	1.00 LS	16.8	747	58				805.54 /LS	806
			Metals, Metal Decking									
			Metal deck, open type, galv., 1-1/2" deep, 20 gauge	1,799.95 sf		-	-	3,600	-	-	2.00 /sf	3,600

CH2MHILL

Job Size:
Duration:

Detail Report

Project: 469556 Coos Bay WWTP
Project No.: 469556
Design Stage: PDR

Estimator: Jones T
Revision / Date: 01 - 07-26-2013
Estimate Class: 4

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
			Metals, Metal Decking	1,800.00 SF				3,600			2.00 /SF	3,600
			Metals, Steel Joists									
			Open web joists, K series, 30' - 50' span, average cost	5.08 tn		-	-	7,613	-	-	1,500.00 /tn	7,613
			Open web joists, LH series, to 96' span, average cost	5.08 tn		-	-	9,135	-	-	1,800.00 /tn	9,135
			Metals, Steel Joists	10.16 TN				16,748			1,648.38 /TN	16,748
			Structural Steel	1.00 LS	16.8	747	58	22,451			23,256.82 /LS	23,257
			05-00 Metals	1.00 LS	16.8	747	58	22,451			23,256.82 /LS	23,257
			05.0 Metal Work	1.00 LS	16.8	747	58	22,451			23,256.82 /LS	23,257
07.0			Thermal & Moisture Protection									
	07-00		Thermal & Moisture Protection									
			Roofing									
			Thermal & Moisture Protection, Insulation									
			Roof deck insulation, polystyrene, 40psi, 2", R10	1,800.00 sf		-	-	2,160	-	-	1.20 /sf	2,160
			Roof deck vapor barrier on metal deck	18.00 sq		-	-	360	-	-	20.00 /sq	360
			Thermal & Moisture Protection, Insulation	1,800.00 SF				2,520			1.40 /SF	2,520
			Thermal & Moisture Protection, Metal Roofing									
			Steel roof, flat profile, 1 3/4" standing seam, 24 ga	1,800.00 sf		-	-	9,000	-	-	5.00 /sf	9,000
			Thermal & Moisture Protection, Metal Roofing	1,800.00 SF				9,000			5.00 /SF	9,000
			Roofing	1,800.00 SF				11,520			6.40 /SF	11,520
			07-00 Thermal & Moisture Protection	1.00 LS				11,520			11,520.00 /LS	11,520
			07.0 Thermal & Moisture Protection	1.00 LS				11,520			11,520.00 /LS	11,520
08.0			Openings									
	08-00		Openings									
			Door and Frames									
			Openings, Doors, Windows & Hardware									
			Commercial steel door, w/ vision lite, 3'-0" x 7'0"	1.00 ea	4.0	174	320	-	-	-	494.01 /ea	494
			Commercial steel door, insulated, panel, 3'-0" x 7'0"	1.00 ea	4.0	174	365	-	-	-	539.01 /ea	539
			H M door frame, 4" single	2.00 ea	4.0	174	290	-	-	-	232.01 /ea	464
			Door hardware, average - H.M., wood, or aluminum	2.00 set	8.0	348	700	-	-	-	524.01 /set	1,048
			Panic device, average	1.00 ea	2.0	87	450	-	-	-	537.01 /ea	537
			Openings, Doors, Windows & Hardware	2.00 EA	22.0	957	2,125				1,541.03 /EA	3,082
			Door and Frames	2.00 EA	22.0	957	2,125				1,541.03 /EA	3,082
			Overhead Door									
			Openings, Overhead Doors									
			Overhead door, steel sectional, manual, incl frame, 12' x 12'	1.00 ea		-	-	1,700	-	-	1,700.00 /ea	1,700
			Overhead door, steel sectional, manual, incl frame, 12' x 16'	1.00 ea		-	-	2,100	-	-	2,100.00 /ea	2,100
			Overhead, for electric trolley operator, to 12' x 12'	1.00 ea		-	-	750	-	-	750.00 /ea	750
			Overhead, for electric trolley operator, over 12' x 12'	1.00 ea		-	-	1,200	-	-	1,200.00 /ea	1,200
			Openings, Overhead Doors	2.00 EA				5,750			2,875.00 /EA	5,750
			Overhead Door	2.00 EA				5,750			2,875.00 /EA	5,750
			08-00 Openings	1.00 LS	22.0	957	2,125	5,750			8,832.06 /LS	8,832
			08.0 Openings	1.00 LS	22.0	957	2,125	5,750			8,832.06 /LS	8,832
14.0			Conveying Equipment									
	14-00		Conveying Equipment									
			Manual Trolley Hoist									
			Conveying Equipment, Other									
			Material handling,hoists,elec ovhd,chain,hook hung,15' lift, 3 ton cap	1.00 ea	24.0	1,047	3,500	-	-	-	4,546.78 /ea	4,547
			Conveying Equipment, Other	1.00 LS	24.0	1,047	3,500				4,546.78 /LS	4,547
			Manual Trolley Hoist	1.00 EA	24.0	1,047	3,500				4,546.78 /EA	4,547

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
			14-00 Conveying Equipment	1.00 LS	24.0	1,047	3,500				4,546.78 /LS	4,547
			14.0 Conveying Equipment	1.00 LS	24.0	1,047	3,500				4,546.78 /LS	4,547
	23.0		HVAC									
		23-00	HVAC									
			HVAC Allowance									
			Mechanical, HVAC									
			HVAC Allowance	1,567.00 SF				15,670	-	-	10.00 /SF	15,670
			Mechanical, HVAC	1,567.00 SF				15,670			10.00 /SF	15,670
			HVAC Allowance	1,567.00 SF				15,670			10.00 /SF	15,670
			23-00 HVAC	1,567.00 SF				15,670			10.00 /SF	15,670
			23.0 HVAC	1,567.00 SF				15,670			10.00 /SF	15,670
	26.0		Electrical Work									
		26-00	Electrical									
			Electrical									
			Electrical									
			Service and Distribution	1,567.00 sf		-	-	9,418	-	-	6.01 /sf	9,418
			Lighting and Branch Wiring	1,567.00 sf		-	-	19,713	-	-	12.58 /sf	19,713
			Electrical	1.00 LS				29,131			29,130.53 /LS	29,131
			Electrical	1.00 LS				29,131			29,130.53 /LS	29,131
			26-00 Electrical	1.00 LS				29,131			29,130.53 /LS	29,131
			26.0 Electrical Work	1.00 LS				29,131			29,130.53 /LS	29,131
			32 SHOP	**1.00 LS**	**2,347.6**	**97,987**	**57,729**	**92,189**			**247,904.60 /LS**	**247,905**
40			**ULTRAVIOLET DISINFECTION**									
	03.0		Concrete Work									
		03-10	Cast-In-Place Concrete Work									
			UV Basin Concrete									
			Cast-In-Place Concrete, Slabs on Grade, 24" thick									
			Fine grade, for slab on grade, by hand	1,788.75 sf	12.5	448	18	-	-	-	0.26 /sf	466
			Fill, gravel subbase, under building slab on grade	66.25 cy	33.1	1,186	1,656	-	-	-	42.91 /cy	2,843
			Concrete pumping, subcontract, all inclusive price	185.18 cy		-	-	2,222	-	-	12.00 /cy	2,222
			Slab on grade edge forms, 12" to 24"	408.00 sf	89.8	3,984	408	-	-	-	10.77 /sf	4,392
			Hung floor depression form	1,080.00 sf	216.0	9,588	1,350	-	-	-	10.13 /sf	10,938
			Forms in place, structural walls, to 8' high, hand set	1,764.90 sf	264.7	11,751	1,765	-	-	-	7.66 /sf	13,516
			Forms in place, structural walls, > 8' to 16' high, hand set	1,080.00 sf	216.0	9,588	1,350	-	-	-	10.13 /sf	10,938
			Form Pipe Penetrations, 20" - 24"	2.00 ea	11.0	488	-	-	-	-	244.14 /ea	488
			Waterstop, PVC, center bulb, 9" wide	300.00 lf	24.0	1,065	900	-	-	-	6.55 /lf	1,965
			Reinforcing in place, A615 Gr 60, priced per lbs.	33,045.83 lb		-	16,523	6,609	-	-	0.70 /lb	23,132
			Concrete, ready mix, 4000 psi	185.18 CY		-	19,074	-	-	-	103.00 /CY	19,074
			Add for concrete waste, 4000 psi	9.26 cy		-	954	-	-	-	103.00 /cy	954
			Placing concrete, concrete pump	132.50 cy	99.4	3,559	-	-	-	-	26.86 /cy	3,559
			Placing concrete, concrete pump, for structural wall to 12" thick	52.68 cy	44.8	1,604	-	-	-	-	30.44 /cy	1,604
			Finishing floors, monolithic, trowel finish (machine)	1,788.75 sf	35.8	1,475	36	-	-	-	0.85 /sf	1,511
			Patch & plug tieholes	2,844.90 sf	42.7	1,528	57	-	-	-	0.56 /sf	1,585
			Sack rub	2,844.90 sf	113.8	4,076	85	-	-	-	1.46 /sf	4,161
			Curing, water	4,633.65 sf	15.4	553	232	-	-	-	0.17 /sf	785
			Polyethelene vapor barrier, 10 mil thick	17.80 sq	3.9	171	107	-	-	-	15.57 /sq	279
			Cast-In-Place Concrete, Slabs on Grade, 24" thick	185.18 CY	1,222.9	51,067	44,515	8,831			563.85 /CY	104,413
			Cast-In-Place Concrete, Columns, 24"									
			Concrete pumping, subcontract, all inclusive price	25.28 cy		-	-	303	-	-	12.00 /cy	303
			Forms in place, columns, rectangular, over 18" sq.	1,365.12 sf	273.0	12,119	2,048	-	-	-	10.38 /sf	14,167
			Reinforcing in place, A615 Gr 60, priced per lbs.	8,848.00 lb		-	4,424	1,770	-	-	0.70 /lb	6,194
			Concrete, ready mix, 4000 psi	25.28 CY		-	2,604	-	-	-	103.00 /CY	2,604

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
			Cast-In-Place Concrete, Columns, 24"									
			Add for concrete waste, 4000 psi	1.26 cy		-	130	-	-	-	103.00 /cy	130
			Placing concrete, concrete pump	25.28 cy	19.0	679	-	-	-	-	26.86 /cy	679
			Sack rub	1,365.12 sf	54.6	1,956	41	-	-	-	1.46 /sf	1,997
			Curing, water	1,365.12 sf	4.6	163	68	-	-	-	0.17 /sf	231
			Cast-In-Place Concrete, Columns, 24"	25.28 CY	351.1	14,917	9,315	2,073			1,040.54 /CY	26,305
			UV Basin Concrete	210.46 CY	1,574.1	65,984	53,829	10,904			621.11 /CY	130,718
			03-10 Cast-In-Place Concrete Work	210.46 CY	1,574.1	65,984	53,829	10,904			621.11 /CY	130,718
			03.0 Concrete Work	210.46 CY	1,574.1	65,984	53,829	10,904			621.11 /CY	130,718
	40.0		**Process Piping**									
		40-10	**Exposed Process Pipe**									
			Secondary Effluent									
			Process Pipe, Ductile Iron, 16"									
			Paint process pipe and fittings, subcontracted, priced per LF, 16" dia.	75.00 lf		-	-	1,688	-	-	22.50 /lf	1,688
			FURNISH 16" DI pipe	45.00 lf		-	1,938	-	-	-	43.07 /lf	1,938
			Install 16" DI, flanged, spool <= 10'	2.00 ea	17.3	860	-	-	-	-	429.96 /ea	860
			Install 16" DI, flanged, spool > 10'	5.00 ea	54.0	2,688	-	-	-	-	537.57 /ea	2,688
			FURNISH 16" DI flange	8.00 ea		-	1,896	-	-	-	236.98 /ea	1,896
			16" DI, FL, Ell, 90	2.00 ea	17.3	860	3,283	-	-	-	2,071.21 /ea	4,142
			Pipe stand support, CS, 16"	6.00 ea	24.0	1,196	2,772	-	-	-	661.28 /ea	3,968
			16" Bolt & Gasket Kits, CS, 150#	4.00 ea	13.6	678	188	-	-	-	216.39 /ea	866
			Install gate valve, Flgd, DIP, 16"	4.00 ea	34.8	1,734	-	-	-	-	433.44 /ea	1,734
			FURNISH Gate valve, iron body, dbl disk, Flgd, 150#, HWO, 16"	4.00 ea		-	19,000	-	-	-	4,750.00 /ea	19,000
			Install butterfly valve, Flgd, DIP, 16"	1.00 ea	8.7	433	-	-	-	-	433.44 /ea	433
			FURNISH Butterfly valve, iron body, Flgd, MTR OPER, 150#, 16"	1.00 ea		-	4,930	-	-	-	4,930.00 /ea	4,930
			Install magnetic flow meter, (material FBO), 16"	1.00 ea	8.7	433	-	-	-	-	433.44 /ea	433
			Process Pipe, Ductile Iron, 16"	45.00 LF	178.3	8,882	34,006	1,688			990.57 /LF	44,576
			Process Pipe, Ductile Iron, 24"									
			Paint process pipe and fittings, subcontracted, priced per LF, 24" dia.	202.00 lf		-	-	6,363	-	-	31.50 /lf	6,363
			FURNISH 24" DI pipe	100.00 lf		-	7,080	-	-	-	70.80 /lf	7,080
			Install 24" DI, flanged, spool <= 10'	2.00 ea	24.0	1,194	-	-	-	-	596.86 /ea	1,194
			Install 24" DI, flanged, spool > 10'	5.00 ea	74.9	3,732	-	-	-	-	746.32 /ea	3,732
			FURNISH 24" DI flange	14.00 ea		-	7,202	-	-	-	514.42 /ea	7,202
			24" DI, FL, Ell, 90	3.00 ea	35.9	1,791	12,090	-	-	-	4,626.86 /ea	13,881
			24" DI, FL, Ell, 45	1.00 ea	12.0	597	2,048	-	-	-	2,644.36 /ea	2,644
			24" DI, FL, tee, red, 24" x 16"	2.00 ea	30.0	1,493	6,175	-	-	-	3,833.82 /ea	7,668
			Wall Pipe, DI, FLxFL, 24"	2.00 ea	8.0	399	2,006	-	-	-	1,202.09 /ea	2,404
			Add for glass lining	27,663.00 lb		-	16,598	-	-	-	0.60 /lb	16,598
			Pipe stand support, CS, 24"	6.00 ea	24.0	1,196	6,822	-	-	-	1,336.28 /ea	8,018
			24" Bolt & Gasket Kits, CS, 150#	7.00 ea	32.2	1,604	742	-	-	-	335.18 /ea	2,346
			Pipe Information Labels	30.00 ea	5.0	250	300	-	-	-	18.32 /ea	550
			Process Pipe, Ductile Iron, 24"	100.00 LF	246.0	12,253	61,062	6,363			796.78 /LF	79,678
			Secondary Effluent	145.00 LF	424.2	21,135	95,068	8,051			856.92 /LF	124,254
			40-10 Exposed Process Pipe	145.00 LF	424.2	21,135	95,068	8,051			856.92 /LF	124,254
			40.0 Process Piping	1.00 LS	424.2	21,135	95,068	8,051			124,253.83 /LS	124,254
	43.0		**Process Equipment**									
		43-05	**Furnish and Install Process Equipment**									
			W3 Pumps									
			Vertical Turbine Pump: 5hp-20hp									
			Functional Testing, Pumps, 5-20 hp	3.00 ea	6.0	262	150	-	-	-	137.23 /ea	412
			Align Pump & Motor, 5-20 hp	3.00 ea	9.0	393	-	1,575	-	-	655.85 /ea	1,968
			Vibration Testing, Pumps, 5-20 hp	3.00 ea	3.0	131	-	525	-	-	218.62 /ea	656
			Sleeved anchor bolts - Small	12.00 ea	3.6	157	144	-	-	-	25.09 /ea	301
			Anchor bolts for leveling pump cans	12.00 ea	12.0	523	240	-	-	-	63.62 /ea	763
			Non-Shrink Machine Grout	6.00 cuft	5.7	249	444	-	-	-	115.44 /cuft	693

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
			Vertical Turbine Pump: 5hp-20hp									
			Grease, Oil, and Lube Pumps, 5-20 hp	3.00 ea	6.0	262	225	-	-	-	162.23 /ea	487
			FURNISH Vertical Turbine Pump, SS, 5 - 20 hp	3.00 EA		-		-	-	84,093	28,031.00 /EA	84,093
			Set pump assembly, @ 16 hrs / each	3.00 ea	48.0	2,094	60	-	-	-	717.86 /ea	2,154
			Set base plate @ 8 hrs / each	3.00 ea	24.0	1,047	150	-	-	-	398.93 /ea	1,197
			Set pump can @ 1.2 hrs / lf	45.00 lf	54.0	2,355	450	-	-	-	62.34 /lf	2,805
			Service Water Supply, Copper, 1/2"	30.00 lf	1.2	60	23	-	-	-	2.76 /lf	83
			Tubing, Soft Copper, 3/8"	30.00 lf	0.0	0		-	-	-	/lf	0
			90 Degree Elbow, Copper, 3/8"	6.00 ea	0.5	25		-	-	-	4.15 /ea	25
			90 Degree Elbow, Copper, 3/4"	9.00 ea	0.7	37		-	-	-	4.15 /ea	37
			Tee, Copper, 1/2"	6.00 ea	0.5	25		-	-	-	4.15 /ea	25
			Union, Copper, 1/2"	3.00 ea	0.5	25		-	-	-	8.31 /ea	25
			Needle Valve, Bronze, 1/2"	3.00 ea	0.5	25		-	-	-	8.31 /ea	25
			Pressure Regulator	3.00 ea	0.5	25		-	-	-	8.31 /ea	25
			Pressure Gauge, 1/2"	3.00 ea	0.5	25		-	-	-	8.31 /ea	25
			Sight Indicator	3.00 ea	0.5	25		-	-	-	8.31 /ea	25
			Bushing, Copper, 1/2" x 3/8'	3.00 ea	0.5	25		-	-	-	8.31 /ea	25
			Seal Water Hose, 3/8"	3.00 lf	0.5	25		-	-	-	8.31 /lf	25
			Female Coupling, 3/8"	6.00 ea	0.5	25		-	-	-	4.15 /ea	25
			Male Adapter, Copper, 3/4"	3.00 ea	0.5	25		-	-	-	8.31 /ea	25
			Copper Pipe Pump Frame Drain, 3/4"	30.00 lf	0.0	0		-	-	-	/lf	0
			Vertical Turbine Pump: 5hp-20hp	3.00 EA	178.8	7,843	1,886	2,100		84,093	31,973.91 /EA	95,922
			W3 Pumps	3.00 EA	178.8	7,843	1,886	2,100		84,093	31,973.91 /EA	95,922
			UV Equipment									
			Process Equipment, Install									
			FURNISH UV Bank	3.00 ea		-		-	-	530,000	176,666.67 /ea	530,000
			Install UV Bank	3.00 ea	288.0	12,561	-	-	-	-	4,187.10 /ea	12,561
			Process Equipment, Install	1.00 LS	288.0	12,561				530,000	542,561.31 /LS	542,561
			UV Equipment	3.00 EA	288.0	12,561				530,000	180,853.77 /EA	542,561
			Chemical Tote & Pump									
			Process Equipment, Install									
			Functional Testing, Chemical Metering Pumps, 0 - 5 GPH	1.00 ea	4.0	174	50	-	-	-	224.46 /ea	224
			Grease, Oil, and Lube Chemical Metering Pumps, 0 - 5 GPH	1.00 ea	2.0	87	75	-	-	-	162.23 /ea	162
			FURNISH Chemical Metering Pump, 0 - 5 GPH	1.00 ea		-		-	-	5,000	5,000.00 /ea	5,000
			Set Chemical Metering Pump, 0 - 5 GPH	1.00 ea	4.0	174	10	-	-	-	184.46 /ea	184
			Pump stand	1.00 ea	4.0	174	300	-	-	-	474.46 /ea	474
			Wall brackets	1.00 ea	2.0	87	150	-	-	-	237.23 /ea	237
			Y-strainer	1.00 ea		-	100	-	-	-	100.00 /ea	100
			Calibration column	1.00 ea		-	200	-	-	-	200.00 /ea	200
			Pressure relief valve	1.00 ea		-	150	-	-	-	150.00 /ea	150
			Pulsation dampener	1.00 ea		-	300	-	-	-	300.00 /ea	300
			Pressure gauge	1.00 ea		-	150	-	-	-	150.00 /ea	150
			Back pressure valve	1.00 ea		-	200	-	-	-	200.00 /ea	200
			Chemical injector	1.00 ea		-	500	-	-	-	500.00 /ea	500
			FURNISH pre-assembled distribution panel	1.00 ea		-	4,500	-	-	-	4,500.00 /ea	4,500
			Set pre-assembled distribution panel	1.00 ea	12.0	523	150	-	-	-	673.39 /ea	673
			Chemical Tote	1.00 ea				-	-	1,000	1,000.00 /ea	1,000
			Process Equipment, Install	1.00 LS	28.0	1,221	6,835			6,000	14,056.23 /LS	14,056
			Chemical Tote & Pump	1.00 LS	28.0	1,221	6,835			6,000	14,056.23 /LS	14,056
			43-05 Furnish and Install Process Equipment	1.00 LS	494.8	21,625	8,721	2,100		620,093	652,539.28 /LS	652,539
			43.0 Process Equipment	1.00 LS	494.8	21,625	8,721	2,100		620,093	652,539.28 /LS	652,539
			40 ULTRAVIOLET DISINFECTION	1.00 LS	2,493.0	108,744	157,619	21,055		620,093	907,510.91 /LS	907,511
60			**CONTROL BUILDING**									
	03.0		**Concrete Work**									

CH2MHILL

Job Size:
Duration:

Detail Report

Project: 469556 Coos Bay WWTP
Project No.: 469556
Design Stage: PDR

Estimator: Jones T
Revision / Date: 01 - 07-26-2013
Estimate Class: 4

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
		03-10	Cast-In-Place Concrete Work									
			Spread Footings									
			Cast-In-Place Concrete, Pad Footings, 12" thick									
			Fine grade, for slab on grade, by hand	32.00 sf	0.2	8	0	-	-	-	0.26 /sf	8
			Fill, gravel subbase, under building slab on grade	0.40 cy	0.2	7	10	-	-	-	42.91 /cy	17
			Concrete pumping, subcontract, all inclusive price	0.79 cy		-	-	9	-	-	12.00 /cy	9
			Forms in place, column footings	42.67 sf	8.5	379	43	-	-	-	9.88 /sf	421
			Reinforcing in place, A615 Gr 60, priced per lbs.	142.22 lb		-	71	28	-	-	0.70 /lb	100
			Concrete, ready mix, 4000 psi	0.79 CY		-	81	-	-	-	103.00 /CY	81
			Add for concrete waste, 4000 psi	0.04 cy		-	4	-	-	-	103.00 /cy	4
			Placing concrete, concrete pump	0.79 cy	0.6	21	-	-	-	-	26.86 /cy	21
			Finishing footings, screed finish	32.00 sf	0.5	20	-	-	-	-	0.62 /sf	20
			Cast-In-Place Concrete, Pad Footings, 12" thick	0.79 CY	10.0	435	209	38			863.65 /CY	682
			Spread Footings	0.79 CY	10.0	435	209	38			863.65 /CY	682
			Continuous Footings									
			Cast-In-Place Concrete, Continuous Footings, 12" thick									
			Fine grade, for slab on grade, by hand	385.35 sf	2.7	97	4	-	-	-	0.26 /sf	100
			Fill, gravel subbase, under building slab on grade	4.76 cy	2.4	85	119	-	-	-	42.91 /cy	204
			Forms in place, continuous footing, sides	113.75 sf	11.4	505	114	-	-	-	5.44 /sf	619
			Reinforcing in place, A615 Gr 60, priced per lbs.	1,713.19 lb		-	857	343	-	-	0.70 /lb	1,199
			Concrete, ready mix, 4000 psi	10.71 CY		-	1,103	-	-	-	103.00 /CY	1,103
			Add for concrete waste, 4000 psi	0.54 cy		-	55	-	-	-	103.00 /cy	55
			Placing concrete, direct chute	10.71 cy	5.4	192	-	-	-	-	17.91 /cy	192
			Finishing footings, screed finish	385.35 sf	5.8	238	-	-	-	-	0.62 /sf	238
			Curing, water	385.35 sf	1.3	46	19	-	-	-	0.17 /sf	65
			Cast-In-Place Concrete, Continuous Footings, 12" thick	10.71 CY	28.9	1,163	2,270	343			352.55 /CY	3,776
			Continuous Footings	10.71 CY	28.9	1,163	2,270	343			352.55 /CY	3,776
			Slab on Grade									
			Cast-In-Place Concrete, Slabs on Grade, 6" thick									
			Fine grade, for slab on grade, by hand	2,105.00 sf	14.7	528	21	-	-	-	0.26 /sf	549
			Fill, gravel subbase, under building slab on grade	25.99 cy	13.0	465	650	-	-	-	42.91 /cy	1,115
			Fill, sand subbase, under building slab on grade	19.49 cy	14.6	524	409	-	-	-	47.86 /cy	933
			Concrete pumping, subcontract, all inclusive price	25.99 cy		-	-	312	-	-	12.00 /cy	312
			Slab on grade edge forms, up to 6"	260.00 lf	13.8	612	68	-	-	-	2.61 /lf	679
			Expansion Board, asphalt impregnated fiber, 1/2"	74.67 sf	2.2	99	52	-	-	-	2.03 /sf	152
			Speed Dowels, #3	2.00 ea		-	10	-	-	-	5.00 /ea	10
			Wire welded fabric, 6 x 6 - W1.4 x W1.4	2,105.00 sf	21.1	1,196	168	-	-	-	0.65 /sf	1,364
			Concrete, ready mix, 4000 psi	25.99 CY		-	2,677	-	-	-	103.00 /CY	2,677
			Add for concrete waste, 4000 psi	1.30 cy		-	134	-	-	-	103.00 /cy	134
			Placing concrete, concrete pump	25.99 cy	19.5	698	-	-	-	-	26.86 /cy	698
			Finishing floors, monolithic, trowel finish (hand)	2,105.00 sf	63.2	2,604	42	-	-	-	1.26 /sf	2,646
			Construction Joint Prep.	74.67 sf	6.0	214	4	-	-	-	2.92 /sf	218
			Contraction Joint Option, Slabs, Sawcut 1/8" x 1/5"	140.00 lf		-	-	420	-	-	3.00 /lf	420
			Contraction Joint Option, Slabs, Preformed Joint	140.00 lf		-	280	-	-	-	2.00 /lf	280
			Curing, water	2,105.00 sf	7.0	251	105	-	-	-	0.17 /sf	357
			Polyethelene vapor barrier, 6 mil thick	21.05 sq	4.6	201	63	-	-	-	12.57 /sq	265
			Cast-In-Place Concrete, Slabs on Grade, 6" thick	25.99 CY	179.7	7,392	4,683	732			492.77 /CY	12,807
			Slab on Grade	25.99 CY	179.7	7,392	4,683	732			492.77 /CY	12,807
			Structural Walls									
			Cast-In-Place Concrete, Straight Walls, 12" thick									
			Concrete pumping, subcontract, all inclusive price	84.32 cy		-	-	1,012	-	-	12.00 /cy	1,012
			Forms in place, structural walls, > 8' to 16' high, hand set	3,820.00 sf	764.0	33,913	4,775	-	-	-	10.13 /sf	38,688
			Forms in place, structural walls, > 16' high, hand set	3,010.00 sf	511.7	22,714	4,064	-	-	-	8.90 /sf	26,777
			Forms in place, wall bulkheads	1,066.67 sf	320.0	14,204	1,333	-	-	-	14.57 /sf	15,538
			Forms in place, wall blockouts	4,722.00 sf	1,274.9	56,593	5,903	-	-	-	13.24 /sf	62,496

CH2MHILL

Job Size:
Duration:

Detail Report

Project: 469556 Coos Bay WWTP
Project No.: 469556
Design Stage: PDR

Estimator: Jones T
Revision / Date: 01 - 07-26-2013
Estimate Class: 4

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
			Cast-In-Place Concrete, Straight Walls, 12" thick									
			Expansion Board, asphalt impregnated fiber, 1"	138.33 sf	4.1	184	104	-	-	-	2.08 /sf	288
			Expansion joint material, closed cell neoprene, 1/2"	6.67 sf	0.2	9	23	-	-	-	4.83 /sf	32
			Speed Dowels, #4	58.00 ea		-	522	-	-	-	9.00 /ea	522
			Reinforcing in place, A615 Gr 60, priced per lbs.	13,491.36 lb		-	6,746	2,698	-	-	0.70 /lb	9,444
			Concrete, ready mix, 4000 psi	84.32 CY		-	8,685	-	-	-	103.00 /CY	8,685
			Add for concrete waste, 4000 psi	4.22 cy		-	434	-	-	-	103.00 /cy	434
			Placing concrete, concrete pump, for structural wall to 12" thick	84.32 cy	71.7	2,567	-	-	-	-	30.44 /cy	2,567
			Patch & plug tieholes	6,830.00 sf	102.5	3,669	137	-	-	-	0.56 /sf	3,806
			Construction Joint Prep.	160.00 sf	12.8	458	8	-	-	-	2.92 /sf	466
			Curing, membrane spray	6,830.00 sf	13.7	489	273	-	-	-	0.11 /sf	762
			Cementitious Coating, Concrete Wall	3,415.00 sf		-	-	6,830	-	-	2.00 /sf	6,830
			Cast-In-Place Concrete, Straight Walls, 12" thick	84.32 CY	3,075.6	134,802	33,006	10,540			2,115.14 /CY	178,348
			Structural Walls	84.32 CY	3,075.6	134,802	33,006	10,540			2,115.14 /CY	178,348
			03-10 Cast-In-Place Concrete Work	121.81 CY	3,294.1	143,792	40,169	11,653			1,605.89 /CY	195,614
			03.0 Concrete Work	121.81 CY	3,294.1	143,792	40,169	11,653			1,605.89 /CY	195,614
	04.2		Masonry									
		04-00	Masonry									
			Brick Veneer									
			Masonry, Other									
			Masonry reinforcing per square foot	880.00 sf		-	-	1,320	-	-	1.50 /sf	1,320
			Masonry anchor / ties per square foot	880.00 sf		-	-	880	-	-	1.00 /sf	880
			Brick, standard 4" x 2 2/3" x 8"	880.00 SF		-	-	9,680	-	-	11.00 /SF	9,680
			Masonry, Other	880.00 SF				11,880			13.50 /SF	11,880
			Brick Veneer	880.00 SF				11,880			13.50 /SF	11,880
			04-00 Masonry	880.00 SF				11,880			13.50 /SF	11,880
			04.2 Masonry	880.00 SF				11,880			13.50 /SF	11,880
	05.0		Metal Work									
		05-00	Metals									
			Structural Steel									
			Metals, Structural Steel									
			Topcoat, epoxy, sprayed	225.00 sf		-	-	101	-	-	0.45 /sf	101
			Structural steel one story with roof trusses, masonry bearing	0.80 tn		-	-	1,960	-	-	2,450.00 /tn	1,960
			Base plates, column, to 150 lb.	630.88 lb		-	-	820	-	-	1.30 /lb	820
			Metals, Structural Steel	0.80 TN				2,881			3,601.74 /TN	2,881
			Metals, Miscellaneous									
			Anchor Bolts, embedded, L-type, 3/4" dia x 12"	64.00 ea	23.0	1,023	80	-	-	-	17.23 /ea	1,103
			Metals, Miscellaneous	1.00 LS	23.0	1,023	80				1,102.72 /LS	1,103
			Metals, Metal Decking									
			Metal deck, open type, galv., 1-1/2" deep, 20 gauge	2,464.00 sf		-	-	4,928	-	-	2.00 /sf	4,928
			Metals, Metal Decking	2,464.00 SF				4,928			2.00 /SF	4,928
			Metals, Steel Joists									
			Open web joists, K series, 30' - 50' span, average cost	6.95 tn		-	-	10,421	-	-	1,500.00 /tn	10,421
			Open web joists, LH series, to 96' span, average cost	6.95 tn		-	-	12,505	-	-	1,800.00 /tn	12,505
			Metals, Steel Joists	6.95 TN				22,925			3,298.58 /TN	22,925
			Structural Steel	1.00 LS	23.0	1,023	80	30,734			31,837.21 /LS	31,837
			05-00 Metals	1.00 LS	23.0	1,023	80	30,734			31,837.21 /LS	31,837
			05.0 Metal Work	1.00 LS	23.0	1,023	80	30,734			31,837.21 /LS	31,837
	07.0		Thermal & Moisture Protection									
		07-00	Thermal & Moisture Protection									

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
			Roofing									
			Thermal & Moisture Protection, Insulation									
			Roof deck insulation, polystyrene, 40psi, 2", R10	2,464.00 sf		-	-	2,957	-	-	1.20 /sf	2,957
			Roof deck vapor barrier on metal deck	24.64 sq		-	-	493	-	-	20.00 /sq	493
			Thermal & Moisture Protection, Insulation	2,464.00 SF				3,450			1.40 /SF	3,450
			Thermal & Moisture Protection, Metal Roofing									
			Steel roof, flat profile, 1 3/4" standing seam, 24 ga	2,464.00 sf		-	-	12,320	-	-	5.00 /sf	12,320
			Thermal & Moisture Protection, Metal Roofing	2,464.00 SF				12,320			5.00 /SF	12,320
			Roofing	2,464.00 SF				15,770			6.40 /SF	15,770
			07-00 Thermal & Moisture Protection	1.00 LS				15,770			15,769.60 /LS	15,770
			07.0 Thermal & Moisture Protection	1.00 LS				15,770			15,769.60 /LS	15,770
	08.0		Openings									
		08-00	Openings									
			Doors and Frames (including Hardware)									
			Openings, Doors, Windows & Hardware									
			H M door frame, 4" single	8.00 ea	16.0	696	1,160	-	-	-	232.01 /ea	1,856
			Wood doors, interior, solid, 3'-0" x 7'-0"	8.00 ea	16.0	696	1,280	-	-	-	247.01 /ea	1,976
			Door hardware, average - H.M., wood, or aluminum	8.00 set	32.0	1,392	2,800	-	-	-	524.01 /set	4,192
			Openings, Doors, Windows & Hardware	8.00 EA	64.0	2,784	5,240				1,003.03 /EA	8,024
			Doors and Frames (including Hardware)	8.00 EA	64.0	2,784	5,240				1,003.03 /EA	8,024
			Storefronts									
			Openings, Entrances & Storefronts									
			Aluminum entrance door w/ std hardware, single 3' x 7'	2.00 ea		-	-	1,600	-	-	800.00 /ea	1,600
			Aluminum entrance door w/ std hardware, pair 3' x 7'	2.00 pr		-	-	3,000	-	-	1,500.00 /pr	3,000
			Openings, Entrances & Storefronts	4.00 EA				4,600			1,150.00 /EA	4,600
			Storefronts	4.00 EA				4,600			1,150.00 /EA	4,600
			Windows									
			Openings, Doors, Windows & Hardware									
			Aluminum windows, double hung, incl casement	140.00 sf		-	-	9,800	-	-	70.00 /sf	9,800
			Openings, Doors, Windows & Hardware	10.00 EA				9,800			980.00 /EA	9,800
			Windows	10.00 EA				9,800			980.00 /EA	9,800
			08-00 Openings	1.00 LS	64.0	2,784	5,240	14,400			22,424.20 /LS	22,424
			08.0 Openings	1.00 LS	64.0	2,784	5,240	14,400			22,424.20 /LS	22,424
	09.0		Finishes									
		09-00	Finishes									
			Partition Walls									
			Finishes, Metal Support Systems									
			Non-load bearing metal studs, 3 5/8" wide , 20 ga, 16" o.c.	1,556.00 sf		-	-	2,334	-	-	1.50 /sf	2,334
			Non-load bearing metal studs, 6" wide , 20 ga, 16" o.c.	900.00 sf		-	-	1,485	-	-	1.65 /sf	1,485
			Finishes, Metal Support Systems	2,105.00 SF				3,819			1.81 /SF	3,819
			Finishes, Plaseter & Gypsum Board									
			Furring channels, ceilings, galv., 1 5/8" channels, 12" o.c.	3,697.00 sf		-	-	7,949	-	-	2.15 /sf	7,949
			Gypsum drywall, 5/8" thick, on ceilings, level 4 finish	296.00 sf		-	-	518	-	-	1.75 /sf	518
			Gypsum drywall, 5/8" thick, on walls, level 4 finish	2,456.00 sf		-	-	3,684	-	-	1.50 /sf	3,684
			Partition stud wall, 5/8" gyp brd both sides, 4" thick	1,560.00 sf		-	-	4,680	-	-	3.00 /sf	4,680
			Partition stud wall, 5/8" gyp brd both sides, fire resistant, 6" thick	900.00 sf		-	-	4,500	-	-	5.00 /sf	4,500
			Finishes, Plaseter & Gypsum Board	2,105.00 SF				21,331			10.13 /SF	21,331
			Partition Walls	2,105.00 SF				25,150			11.95 /SF	25,150
			Accoustical Ceiling									

CH2MHILL

Detail Report

Job Size:
Duration:

Project: 469556 Coos Bay WWTP
Project No.: 469556
Design Stage: PDR

Estimator: Jones T
Revision / Date: 01 - 07-26-2013
Estimate Class: 4

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
			Finishes, Acoustical Treatment									
			Suspended accoustical ceiling, complete, 2' x 4' x 3/4" mineral fiber	1,435.00 sf		-	-	5,740	-	-	4.00 /sf	5,740
			Sound attenuation, urethane plastic foam, 2" thick	261.00 sf		-	-	914	-	-	3.50 /sf	914
			Finishes, Acoustical Treatment	1,435.00 SF				6,654			4.64 /SF	6,654
			Accoustical Ceiling	1,435.00 SF				6,654			4.64 /SF	6,654
			Painting: Architectural - Subcontracted Items									
			Finishes, Painting & Coatings									
			Paint exterior doors & windows	2.00 ea		-	-	200	-	-	100.00 /ea	200
			Primer / sealer on concrete floors, brushwork	317.00 sf		-	-	159	-	-	0.50 /sf	159
			Paint trusses & wood frames, (oil base primer plus 2 coats)	321.00 sf		-	-	401	-	-	1.25 /sf	401
			Paint exterior, oil base, stucco, EIFS or concrete	2,521.00 sf		-	-	3,151	-	-	1.25 /sf	3,151
			Paint exterior trim, gutters, etc.	208.00 lf		-	-	260	-	-	1.25 /lf	260
			Paint interior walls & ceilings, latex	8,329.00 sf		-	-	6,247	-	-	0.75 /sf	6,247
			Finishes, Painting & Coatings	1.00 LS				10,418			10,417.75 /LS	10,418
			Painting: Architectural - Subcontracted Items	2,105.00 SF				10,418			4.95 /SF	10,418
			09-00 Finishes	1.00 LS				42,221			42,220.80 /LS	42,221
			09.0 Finishes	1.00 LS				42,221			42,220.80 /LS	42,221
10.0			Specialties									
	10-00		Specialties									
			Lockers									
			Specialties Lockers									
			Lockers, steel, baked enamel, 12" x 18" x 72"	4.00 ea		-	-	900	-	-	225.00 /ea	900
			Locker benches, laminated top only	24.00 lf		-	-	480	-	-	20.00 /lf	480
			Locker bench pedestals, steel pipe	8.00 ea		-	-	520	-	-	65.00 /ea	520
			Specialties Lockers	4.00 EA				1,900			475.00 /EA	1,900
			Lockers	4.00 EA				1,900			475.00 /EA	1,900
			Storage Room Assembly									
			Specialties Partitions									
			Partitions, woven wire, for tool or stockrooms	256.00 sf		-	-	1,408	-	-	5.50 /sf	1,408
			Specialties Partitions	1.00 LS				1,408			1,408.00 /LS	1,408
			Specialties, Other									
			Shelving, storage, metal industrial, 24" deep	64.00 sf		-	-	704	-	-	11.00 /sf	704
			Specialties, Other	1.00 LS				704			704.00 /LS	704
			Storage Room Assembly	1.00 LS				2,112			2,112.00 /LS	2,112
			10-00 Specialties	1.00 LS				4,012			4,012.00 /LS	4,012
			10.0 Specialties	1.00 LS				4,012			4,012.00 /LS	4,012
21.0			Fire Protection									
	21-05		Fire Sprinkler									
			Mechanical, Fire Sprinklers System									
			Mechanical, Fire Sprinklers System									
			Sprinkler assembly and standpipe	2,105.00 sf		-	-	10,546	-	-	5.01 /sf	10,546
			Mechanical, Fire Sprinklers System	2,105.00 SF				10,546			5.01 /SF	10,546
			Mechanical, Fire Sprinklers System	2,105.00 SF				10,546			5.01 /SF	10,546
			21-05 Fire Sprinkler	1.00 LS				10,546			10,546.05 /LS	10,546
			21.0 Fire Protection	1.00 LS				10,546			10,546.05 /LS	10,546
22.0			Plumbing									
	22-00		Plumbing									
			Mechanical, Plumbing									
			Mechanical, Plumbing									
			Pluming all Inclusive	2,105.00 sf		-	-	10,841	-	-	5.15 /sf	10,841

Detail Report

Project: 469556 Coos Bay WWTP
Project No.: 469556
Design Stage: PDR

Estimator: Jones T
Revision / Date: 01 - 07-26-2013
Estimate Class: 4

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
			Mechanical, Plumbing	2,105.00 SF				10,841			5.15 /SF	10,841
			Mechanical, Plumbing	2,105.00 SF				10,841			5.15 /SF	10,841
			22-00 Plumbing	1.00 LS				10,841			10,840.75 /LS	10,841
			22.0 Plumbing	1.00 LS				10,841			10,840.75 /LS	10,841
	23.0		HVAC									
		22-05	Plumbing, Purchase									
			Mechanical, HVAC									
			Mechanical, HVAC									
			Terminal and Package units all inclusive	2,105.00 sf		-	-	43,574	-	-	20.70 /sf	43,574
			Mechanical, HVAC	2,105.00 SF				43,574			20.70 /SF	43,574
			Mechanical, HVAC	1.00 LS				43,574			43,573.50 /LS	43,574
			22-05 Plumbing, Purchase	1.00 LS				43,574			43,573.50 /LS	43,574
			23.0 HVAC	2,105.00 SF				43,574			20.70 /SF	43,574
	26.0		Electrical Work									
		26-00	Electrical									
			Electrical									
			Electrical									
			Service and Distribution	2,105.00 sf		-	-	12,651	-	-	6.01 /sf	12,651
			Lighting and Branch Wiring	2,105.00 sf		-	-	26,481	-	-	12.58 /sf	26,481
			Communication and Security	2,105.00 sf		-	-	14,946	-	-	7.10 /sf	14,946
			Electrical	1.00 LS				54,077			54,077.45 /LS	54,077
			Electrical	1.00 LS				54,077			54,077.45 /LS	54,077
			26-00 Electrical	1.00 LS				54,077			54,077.45 /LS	54,077
			26.0 Electrical Work	1.00 LS				54,077			54,077.45 /LS	54,077
			60 CONTROL BUILDING	**2,106.00 SF**	**3,381.2**	**147,599**	**45,489**	**249,707**			**210.35 /SF**	**442,795**
70			**ODOR CONTROL TREATMENT**									
	03.0		Concrete Work									
		03-10	Cast-In-Place Concrete Work									
			Biotower Conc Slab									
			Cast-In-Place Concrete, Slabs on Grade, 12" thick									
			Fine grado, for slab on grade, by hand	240.50 sf	1.7	60	2	-	-	-	0.26 /sf	63
			Fill, gravel subbase, under building slab on grade	8.91 cy	4.5	160	223	-	-	-	42.91 /cy	382
			Concrete pumping, subcontract, all inclusive price	8.91 cy		-	-	107	-	-	12.00 /cy	107
			Slab on grade edge forms, 7" to 12"	63.00 sf	11.3	503	63	-	-	-	8.99 /sf	566
			Reinforcing in place, A615 Gr 60, priced per lbs.	1,336.11 lb		-	668	267	-	-	0.70 /lb	935
			Concrete, ready mix, 4000 psi	8.91 CY		-	917	-	-	-	103.00 /CY	917
			Add for concrete waste, 4000 psi	0.45 cy		-	46	-	-	-	103.00 /cy	46
			Placing concrete, concreto pump	8.91 cy	6.7	239	-	-	-	-	26.86 /cy	239
			Finishing floors, monolithic, trowel finish (machine)	240.50 sf	4.8	198	5	-	-	-	0.85 /sf	203
			Curing, water	240.50 sf	0.8	29	12	-	-	-	0.17 /sf	41
			Polyethelene vapor barrier, 10 mil thick	2.41 sq	0.5	23	14	-	-	-	15.57 /sq	37
			Cast-In-Place Concrete, Slabs on Grade, 12" thick	8.91 CY	30.3	1,213	1,951	374			397.00 /CY	3,537
			Biotower Conc Slab	8.91 CY	30.3	1,213	1,951	374			397.00 /CY	3,537
			03-10 Cast-in-Place Concrete Work	8.91 CY	30.3	1,213	1,951	374			397.00 /CY	3,537
			03.0 Concrete Work	8.91 CY	30.3	1,213	1,951	374			397.00 /CY	3,537
	43.0		Process Equipment									
		43-05	Furnish and Install Process Equipment									
			Odor Control - Biofilter									
			Odor Control Equipment									
			Sleeved anchor bolts, SS - Medium	8.00 ea	6.0	262	144	-	-	-	50.71 /ea	406
			FURNISH Scrubber Tower, 12' Dia.	1.00 ea		-	25,000	-	-	-	25,000.00 /ea	25,000

Bid Item	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
			Odor Control Equipment									
			Install Scrubber Tower, 12' Dia.	1.00 ea	120.0	5,234	-	-	-	-	5,233.92 /ea	5,234
			FURNISH Scrubber Tower Media, Polyethylene	905.00 cf		-	27,150	-	-	-	30.00 /cf	27,150
			Install Scrubber Tower Media, Polyethylene	905.00 cf	181.0	7,895	-	-	-	-	8.72 /cf	7,895
			FURNISH FRP Centrifugal Fan, 1 - 2500 CFM	1.00 ea		-	4,800	-	-	-	4,800.00 /ea	4,800
			Install FRP Centrifugal Fan, 1 - 2500 CFM	1.00 ea		3,750	-	-	-	-	3,750.00 /ea	3,750
			16" FRP Pipe, flanged, type FRP-2	20.00 LF	2.2	110		-	-	-	5.48 /LF	110
			16" FRP, flanged, Ell, 90	2.00 ea	7.4	369		-	-	-	184.34 /ea	369
			16" flange, 125#, FRP (Need Material $)	10.00 ea	6.0	299		-	-	-	29.89 /ea	299
			16" expansion joint	1.00 ea	0.6	30		-	-	-	29.89 /ea	30
			Pipe Information Labels	10.00 ea	1.7	83	100	-	-	-	18.32 /ea	183
			Odor Control Equipment	1.00 LS	324.9	18,030	57,194				75,224.43 /LS	75,224
			Odor Control - Biofilter	1.00 LS	324.9	18,030	57,194				75,224.43 /LS	75,224
			43-05 Furnish and Install Process Equipment	1.00 LS	324.9	18,030	57,194				75,224.43 /LS	75,224
			43.0 Process Equipment	1.00 LS	324.9	18,030	57,194				75,224.43 /LS	75,224
			70 ODOR CONTROL TREATMENT	**1.00 LS**	**355.2**	**19,243**	**59,145**	**374**			**78,761.72 /LS**	**78,762**

Estimate Totals

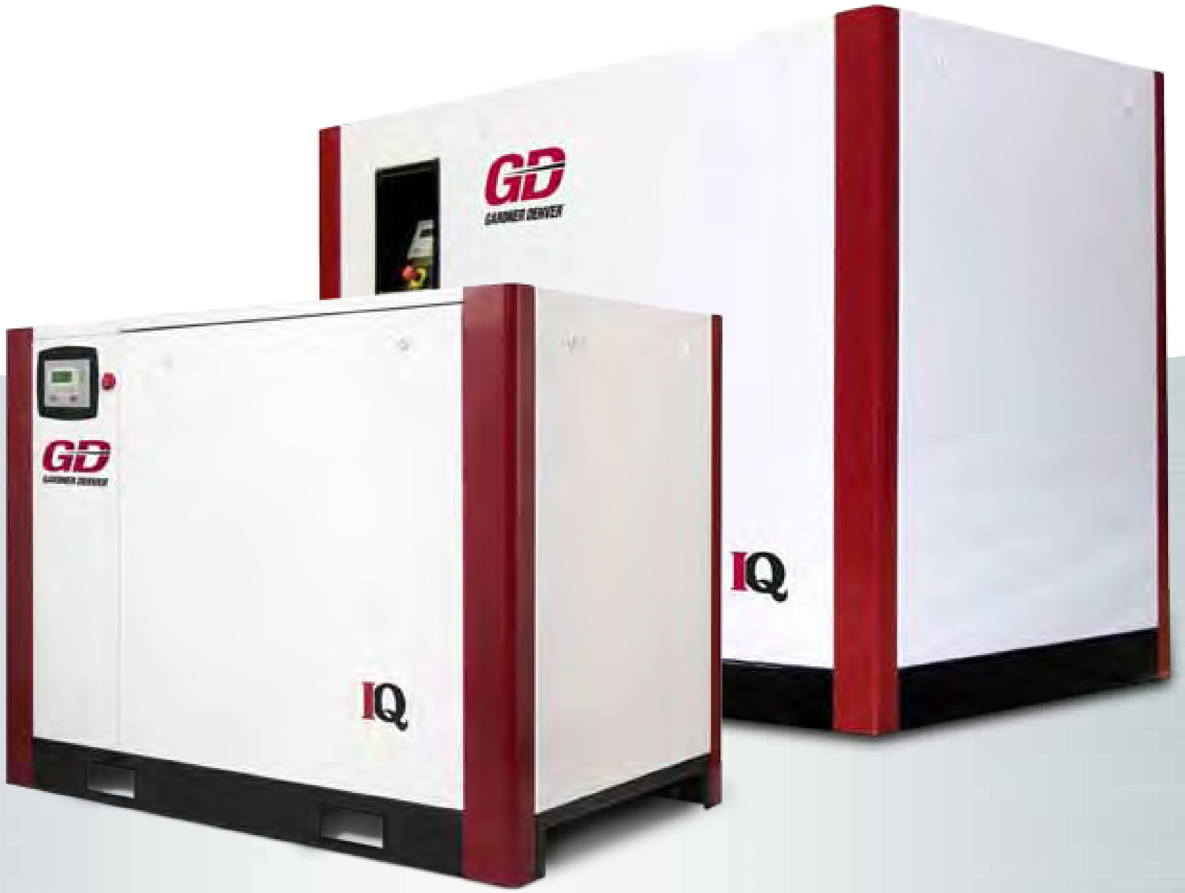
Description	Amount	Totals	Hours	Rate
Labor	1,916,226		45,842.795 hrs	
Material	2,124,372			
Subcontract	1,769,642			
Equipment	157,589		2,919.633 hrs	
Other	2,603,978			
Total Before Markups	**8,571,807**	**8,571,807**		
Concrete Work OH&P	478,383			15.000 %
Architectural OH&P	2,786			15.000 %
Building Complete OH&P	7,500			15.000 %
Mechanical Work OH&P	2,109			20.000 %
Electrical Work OH&P	172,532			20.000 %
Site/Civil OH&P	72,648			15.000 %
Total Subcontractor OH&P	**735,958**	**9,307,765**		
General Conditions	651,544			7.000 %
Total General Conditions	**651,544**	**9,959,309**		
Project Staff & Home Office OH	995,931			10.000 %
Profit on Previous Subtotal	497,965			5.000 %
Blder's Risk & Gen Liab Ins -%	149,735			1.000 %
Payment & Performance Bond	173,692			1.160 %
Total Bonds and Insurances	**1,817,323**	**11,776,632**		
Contingency - %	2,355,326			20.000 %
Total Contingency	**2,355,326**	**14,131,958**		
Escalation on Estimate Total	841,509			5.620 %
Total Escalation	**841,509**	**14,973,467**		
Construction Total		**14,973,467**		

Appendix A

Equipment Catalog Cut Sheets

IQ

Positive Displacement Blower & Vacuum Pump Packages



WHAT CAN IQ DO FOR YOU?

Smart made simple with total control at your fingertip

GARDNER DENVER™

Experience Proven Results™

SMART Maintenance

Predictive Maintenance can reduce maintenance costs by up to 30 percent and downtime up to 45 percent.

The AirSmart controller uses customizable timers to track maintenance schedules and notify the operator when routine service is required.

The belt tensioner keeps the drive belt at the specified tension and indicates when it needs to be changed.

IQ & YOU

Maintenance

- Reduces Downtime
- Helps Reduce Maintenance Costs

With just the top open, the air filter, conduit box, and oil fill are easily accessible.

Once all panels are removed, all major components and maintenance items are within easy access.

SMART Operation

Integrated System Controls

- SCADA compatibility allows for system reporting & monitoring
- External drivers help keep operating costs down by matching blower performance to plant needs

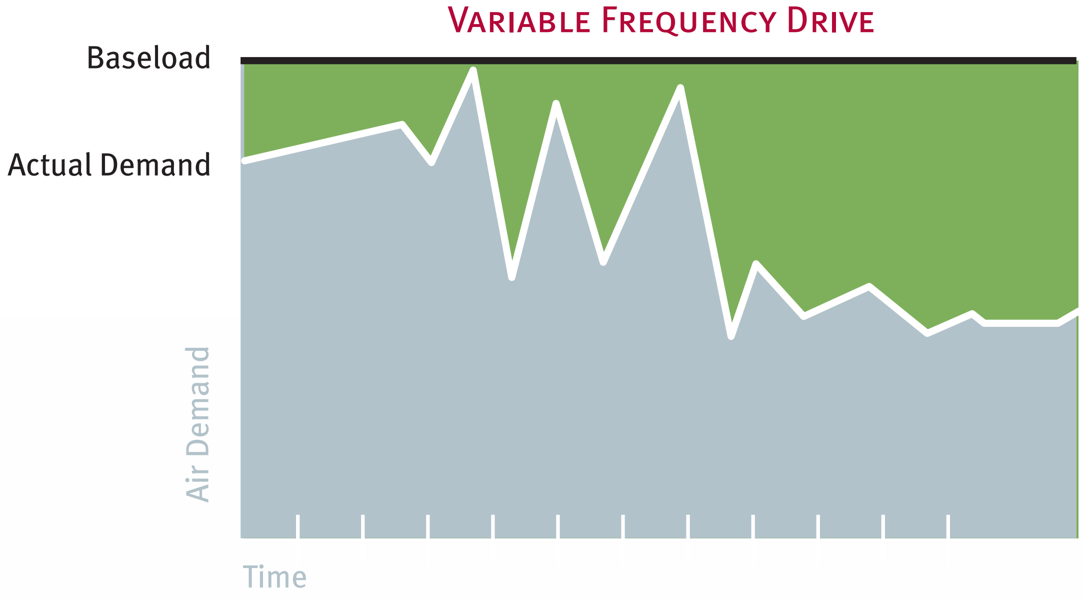
You know what's happening even when you aren't there.

Sequencing

The AirSmart controller allows you to sequence up to eight blower packages.

- Can be process or timer operated
- Allows distribution of operating hours
- Reduces downtime for maintenance

Air when you need it…
…Savings when you don't



Take Charge

Using external drivers, such as a dissolved oxygen sensor or tank level sensor, the AirSmart controller can adjust to the application demand.

IQ & YOU

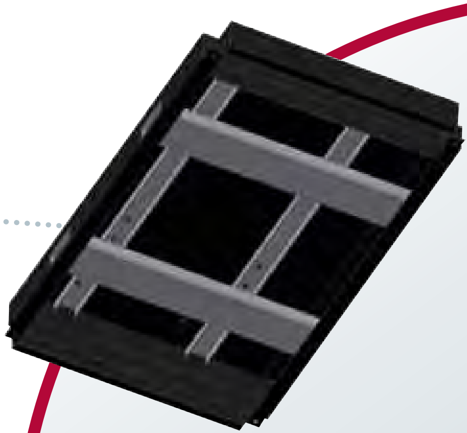
Operations Manager

- Reduced Operating Cost
- Reduced Downtime

SMART Design

Improved Belt Life

Smart base design extends belt life, prolonging bearing life in the blower.



Easy Installation

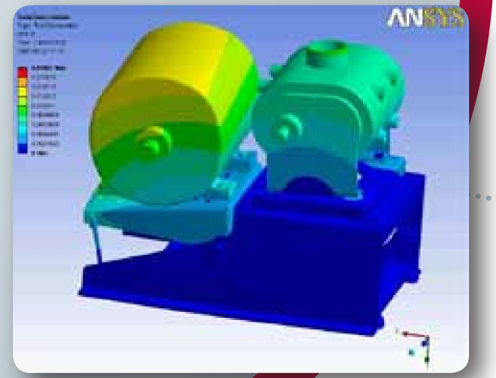
Rigid base design allows the IQ package to be placed on a level surface, with no need for special foundations.

Simple Connections

Electrical and pipework connections are all that need to be made to get the IQ package installed in the system.

SMART
From The Ground Up!

> “The easiest equipment installation we’ve ever had.”
>
> – Plant Superintendent,
> Municipal Wastewater Plant



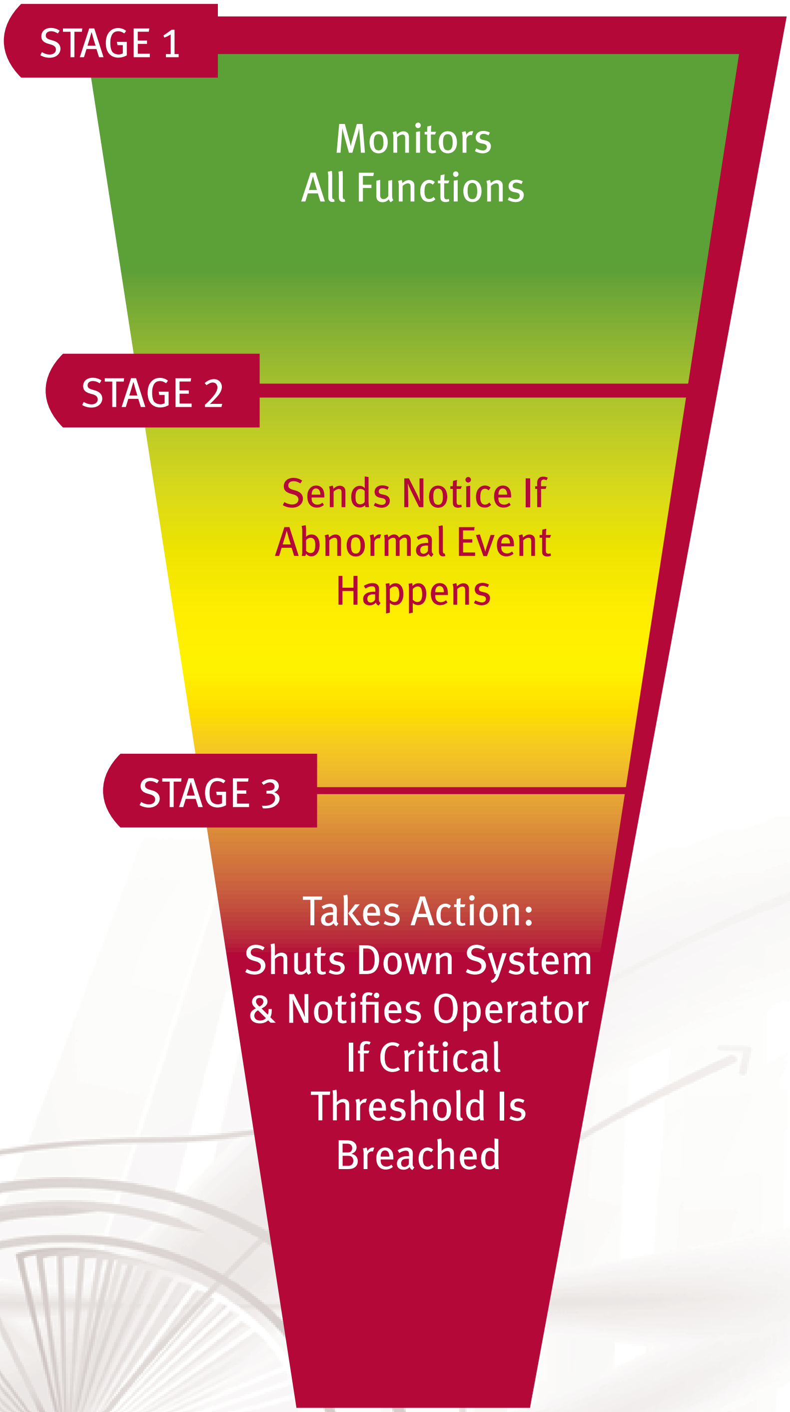
Premium Vibration Isolators

Reduce vibration, helping lower noise levels by up to 20 dBA

Simple Transit

Forkable slots on enclosure provide easy unloading, movement, and setting into place

3 Stages of Protection



STAGE 1

Monitors
All Functions

STAGE 2

Sends Notice If
Abnormal Event
Happens

STAGE 3

Takes Action:
Shuts Down System
& Notifies Operator
If Critical
Threshold Is
Breached

It Never Sleeps

STAGE 1

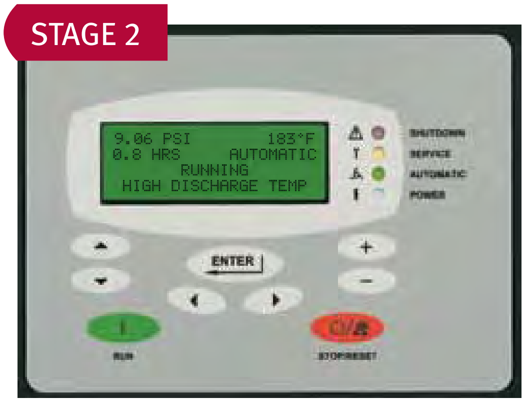
What can a machine tell you about itself?

While operating, the AirSmart checks vital parameters 30 times per second and displays the current conditions.

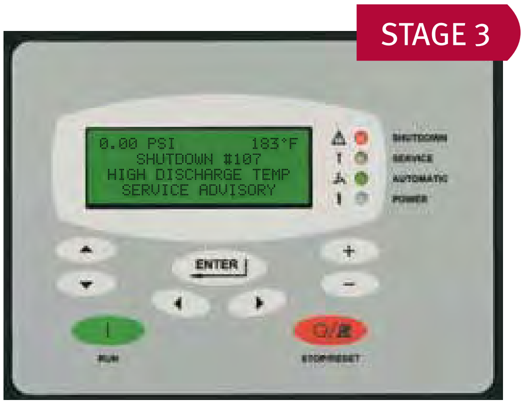
Can it know when it needs help or when it doesn't?

When one or more preset thresholds is exceeded, the AirSmart controller displays an advisory notice.

STAGE 2



STAGE 3

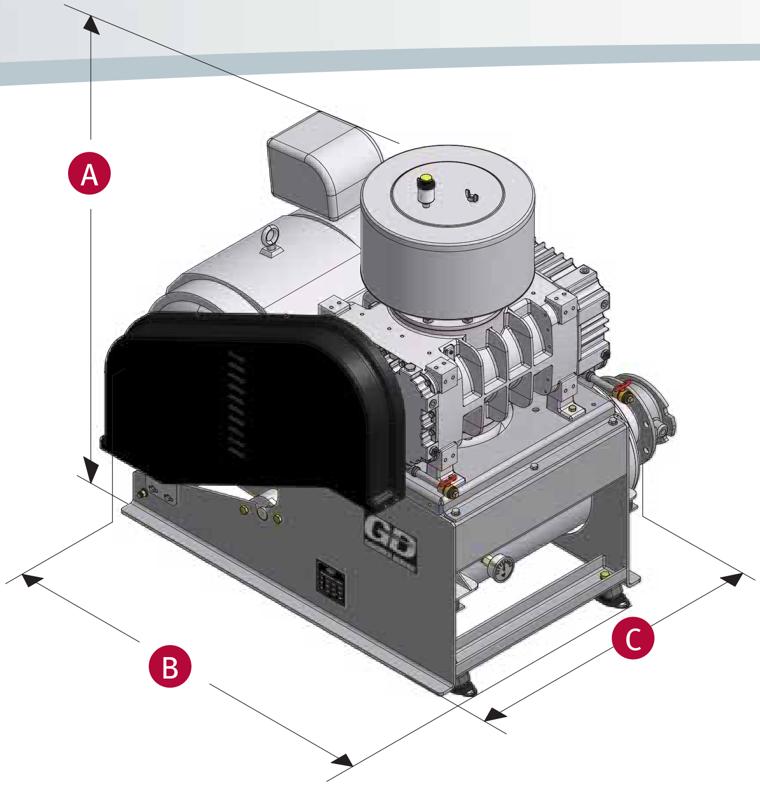


Can a machine seek help before it is broken?

When a critical parameter is exceeded, the AirSmart will shut the blower down.

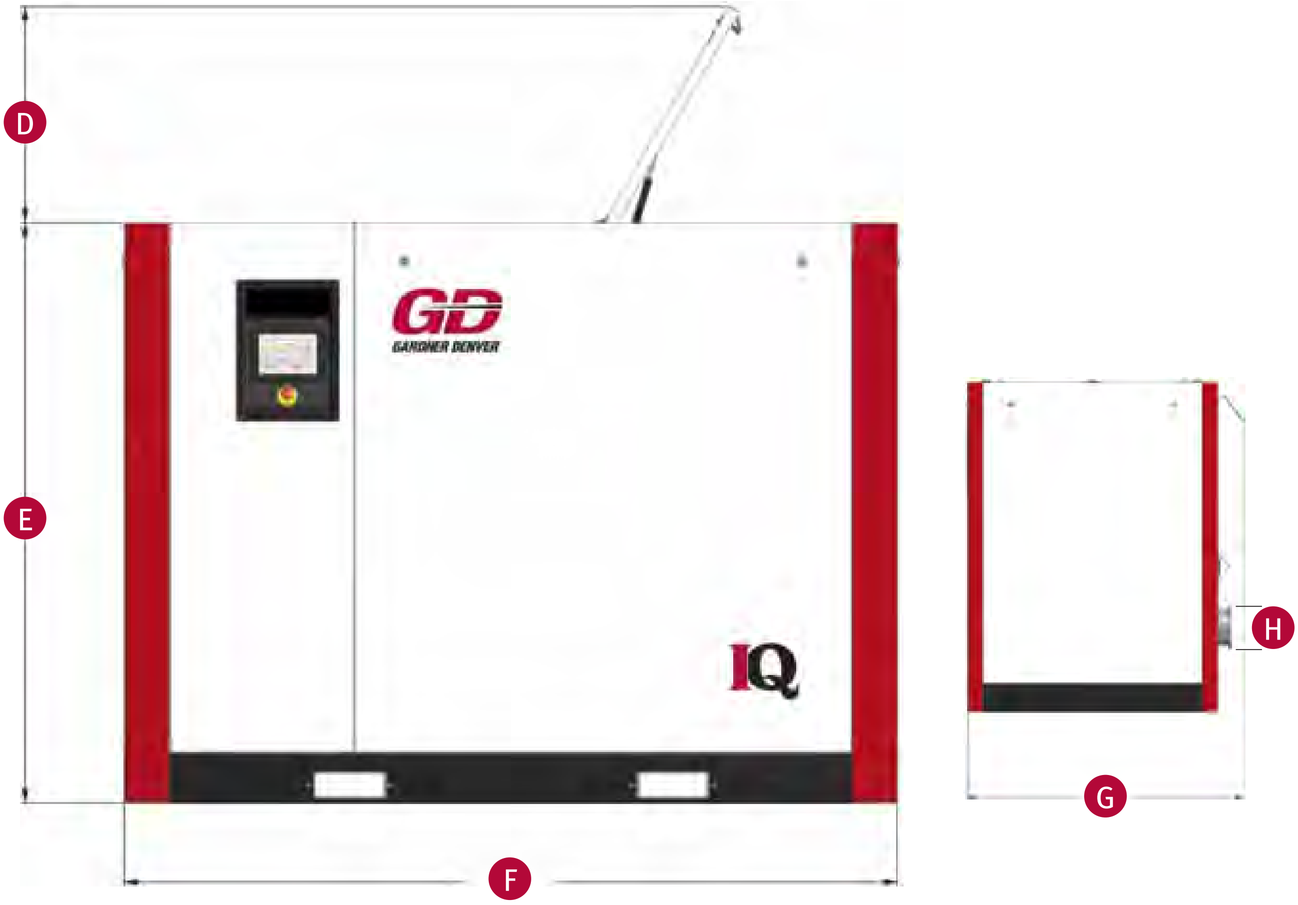
- Prevents damage and keeps repair costs down
- Once shutdown occurs the AirSmart controller can send a notice to the operator
- Records advisory and shutdown history to allow for reporting, troubleshooting and repair

By The Numbers



IQ Blower Package Delivers

- Pressure to 15 psig 1034 mbarg
- Vacuum to 16" Hg 542 mbar
- 200–1,500 icfm 2549 m3/h
- 7.5–100 hp 6–75 kW



Performance & Sound

Performance based on inlet air at standard temperature of 68˚F, an ambient pressure of 14.7 psia and 36% relative humidity. For performance at non-standard conditions, contact your authorized Gardner Denver representative.

Air and sound maps represent non-VFD IQ packages.

Dimensions (in inches)

Section	Medium IQ Package	Large IQ Package
A	47.5	60.91
B	39.57	55.69
C	32.38	49.94
D	29	24
E	51	64.52
F	65	86
G	41.76	53.99
H	4	6

Medium IQ Package Weight

Type	Max. Weight	
	lbs	kg
Enclosed package	2100	953
Unenclosed package	1300	590

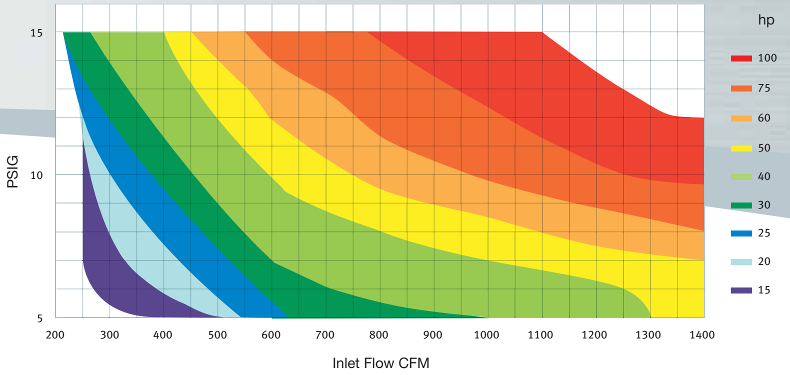
Weights are approximate.

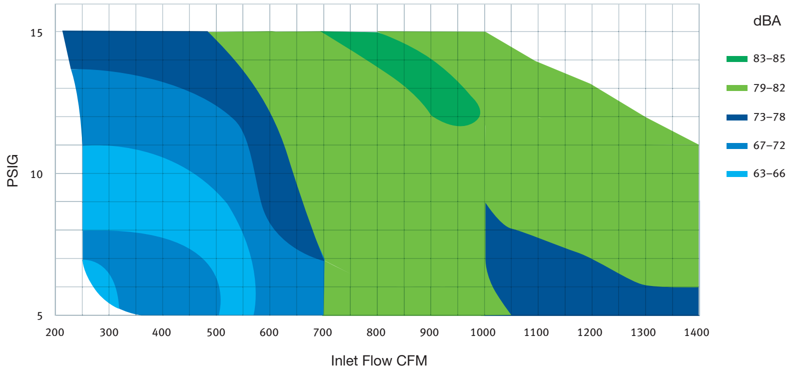
Large IQ Package Weight

Type	Max. Weight	
	lbs	kg
Enclosed package	4200	1905
Unenclosed package	3000	1361

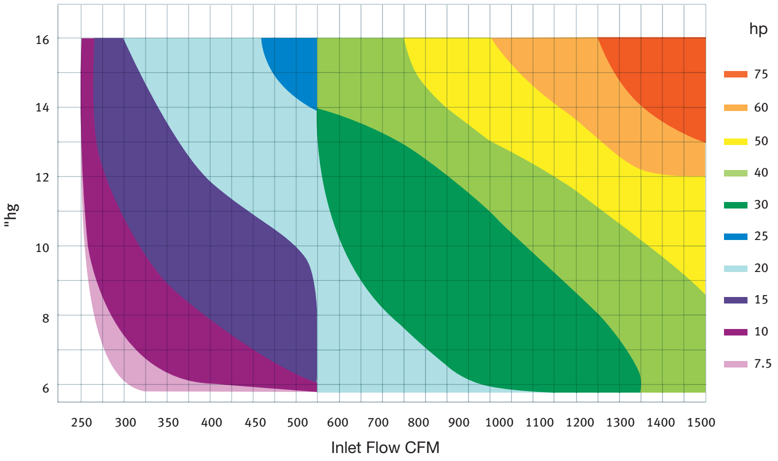
Weights are approximate.

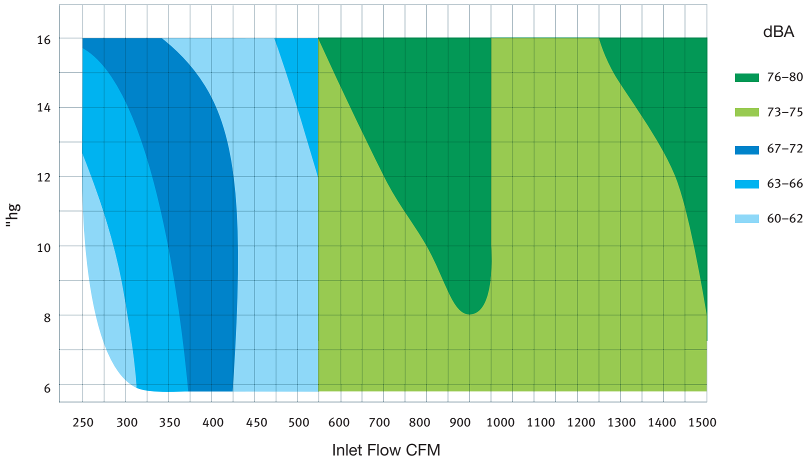
IQ Pressure Package





IQ Vacuum Package





Features

1. Quiet Sound Enclosure

- Sound levels as low as 60 dBA
- Removable and hinged panels provide easy access for maintenance

2. TEFC EISA Motors

- EISA compliant Premium efficiency motors
- Standard 5-year warranty
- Available voltages: 200/3/60, 230/3/60, 460/3/60, 575/3/60, 380/3/50, and 415/3/50

3. Starter Options

- Standard less starter
- Full volt starter
- VFD

4. Removable Discharge Silencer

- Provides minimal pressure drop
- Significantly reduces sound and pulsation
- Available ASME coded silencer

5. Vacuum/Pressure Connections

Medium:
- 4" NPT pressure discharge
- 4.5" ID hose vacuum inlet

Large:
- 6" 150 lb. ANSI flange pressure discharge
- 6" or 8" ID hose vacuum inlet

6. Pre-Mounted Valves

- Relief and check valves standard
- Unloaded start valve available

7. Enclosure Cooling Fan

- Removes hot air from enclosure
- Can operate when blower is not

Installations

Aftermarket Parts & Optional Equipment

Optional Equipment

Oil level sensors and oil temp sensors

Variable frequency drive

Additional Options:

- EMC Filter
- Line Reactors
- Full Voltage Starter
- AirSmart Controller Communication Module

Genuine Gardner Denver Parts & Lubricants

All Gardner Denver IQ packages are initially shipped with AEON® PD-XD, the only lubricant specially formulated for all blowers in any environment.

Also available:

- AEON® PD-FG (Food Grade)
- AEON® PD

Service & Support

Gardner Denver's extensive distributor network provides fast access to genuine Gardner Denver replacement parts and lubricants and 24 hour service support from factory certified technicians.

WHAT CAN IQ DO FOR YOU?

Smart made simple with total control at your fingertip

For an interactive presentation on the IQ Blower Package, scan the QR code or visit:

http://www.iqblower.com

Gardner Denver®

www.GardnerDenverProducts.com

Gardner Denver, Inc. 1800 Gardner Expressway, Quincy, IL 62305
www.contactgd.com/blowers

Printed in U.S.A. PD-IQ-FAM 4th Ed. 9/12

IQ PACKAGE – MEDIUM AND LARGE
STANDARD PACKAGE SELECTION MATRIX (FIXED FREQUENCY – PRESSURE)

DELTA PSI	NOMINAL FLOW ICFM														
	MEDIUM IQ PACKAGE					LARGE IQ PACKAGE									
	200	250	300	350	400	500	600	700	800	900	1000	1100	1200	1300	1400
15	2229 **30**	2502 **40**	2746 **40**	3045 **40**	2502 **50**	2275 **60**	2575 **75**	2833 **75**	1712 **100**	1840 **100**	1985 **100**				
14	2229 **30**	2502 **30**	2746 **40**	3045 **40**	2502 **50**	2746 **50**	2575 **60**	2833 **75**	3124 **75**	1840 **100**	1985 **100**	2149 **100**			
13	2229 **30**	2502 **30**	2746 **40**	3045 **40**	2502 **50**	2746 **50**	2575 **60**	2833 **60**	3124 **75**	3332 **75**	1985 **100**	2149 **100**	2276 **100**		
12		2229 **25**	2502 **30**	2746 **30**	3157 **40**	3688 **40**	3157 **50**	2833 **60**	3124 **75**	3332 **75**	1878 **75**	2149 **100**	2276 **100**	2359 **100**	
11		2229 **25**	2502 **30**	2746 **30**	3157 **40**	3688 **40**	3157 **50**	2833 **60**	3124 **60**	3332 **75**	1878 **75**	2035 **75**	2276 **100**	2359 **100**	2507 **100**
10		2229 **20**	2502 **25**	2746 **25**	3157 **30**	3688 **40**	3157 **50**	2674 **50**	3124 **60**	3332 **60**	1878 **75**	2035 **75**	2149 **75**	2359 **100**	2507 **100**
9		2229 **20**	2502 **25**	2746 **25**	3157 **30**	3688 **40**	3157 **40**	2674 **50**	2958 **50**	3332 **60**	1878 **60**	2035 **60**	2149 **75**	2228 **75**	2418 **75**
8		2229 **20**	2502 **20**	2746 **25**	3157 **25**	3688 **30**	3157 **40**	2674 **40**	2958 **50**	3290 **50**	1875 **50**	2035 **60**	2149 **60**	2228 **60**	2418 **75**
7		2053 **15**	2229 **20**	2502 **20**	2746 **20**	3688 **30**	3045 **40**	2674 **40**	2958 **40**	3290 **40**	1875 **50**	2035 **50**	2149 **50**	2228 **60**	2418 **60**
6		2053 **15**	2229 **15**	2502 **20**	2746 **20**	3688 **25**	3045 **40**	2560 **30**	2958 **40**	3290 **40**	1670 **40**	1775 **40**	1879 **50**	2036 **50**	2359 **50**
5		2053 **15**	2229 **15**	2502 **15**	2746 **15**	3688 **25**	3045 **30**	2560 **30**	2873 **30**	3157 **30**	1670 **40**	1775 **40**	1879 **40**	2036 **40**	2359 **50**

Notes:

- Actual flow and blower horsepower requirements to be determined using QuickPik blower sizing software for specific customer application.
- Performance based on inlet air at standard temperature of 68°F, an ambient pressure of 14.7 psia and 36% relative humidity.
- For performance requirements other than referenced above, round delta psi/"hg to nearest whole number.
- Consult Gardner Denver Customer Service for special package configurations.

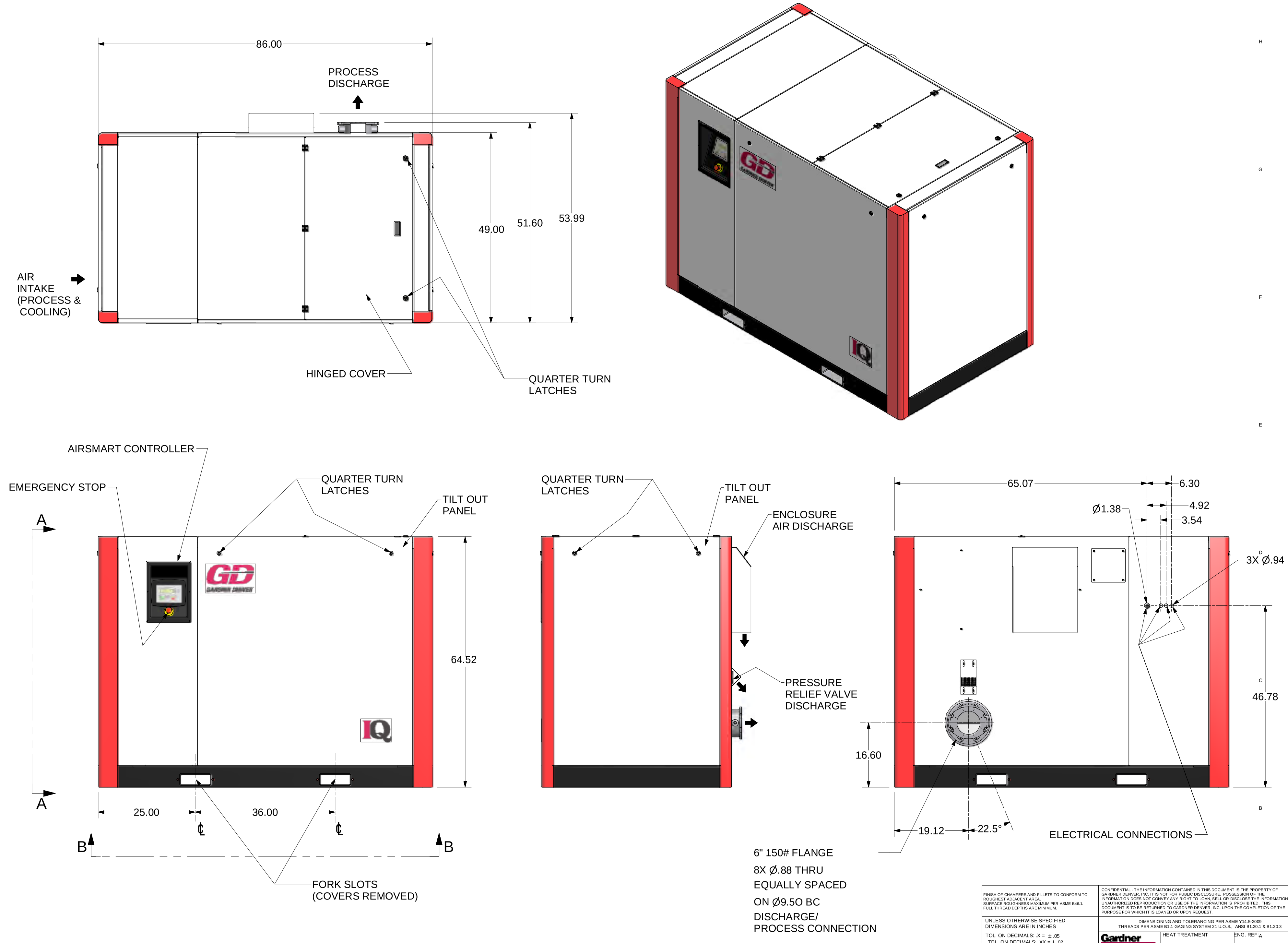
Normal Text = Blower RPM
Bold Text = **Blower Motor HP**

Blower Key

DuroFlow 4506
DuroFlow 4509
DuroFlow 4512
HeliFlow 408
HeliFlow 616
Sutorbilt Legend 4L
Legend 6L DSL

REVISION HISTORY

ZONE	REV	DESCRIPTION	DATE	DWN	CHK
	A	RELEASED PER ECN 1051531	-	-	-



FINISH OF CHAMFERS AND FILLETS TO CONFORM TO ROUGHEST ADJACENT AREA.
SURFACE ROUGHNESS MAXIMUM PER ASME B46.1.
FULL THREAD DEPTHS ARE MINIMUM.

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOL. ON DECIMALS: .X = ±.05
TOL. ON DECIMALS: .XX = ±.02
TOL. ON DECIMALS: .XXX = ± AS SPECIFIED
TOL. ON ANGLES: ±0°-30' 2

DIMENSIONING AND TOLERANCING PER ASME Y14.5-2009
THREADS PER ASME B1.1 GAGING SYSTEM 21 U.O.S., ANSI B1.20.1 & B1.20.3

THIRD ANGLE PROJECTION

Gardner Denver
Gardner Denver Inc.
Quincy, IL.

HEAT TREATMENT
ENG. REF: A

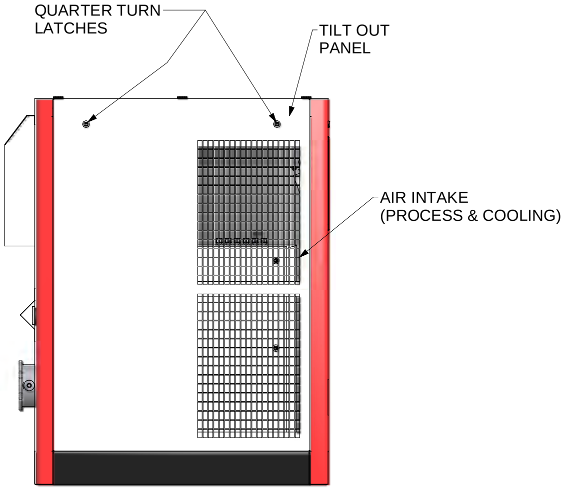
TITLE OUTLINE- UNIT/PKG
ENCLOSED PRESSURE PKG

DWN BY	RRB	4/19/2010
CK'D BY	CRB	4/19/2010

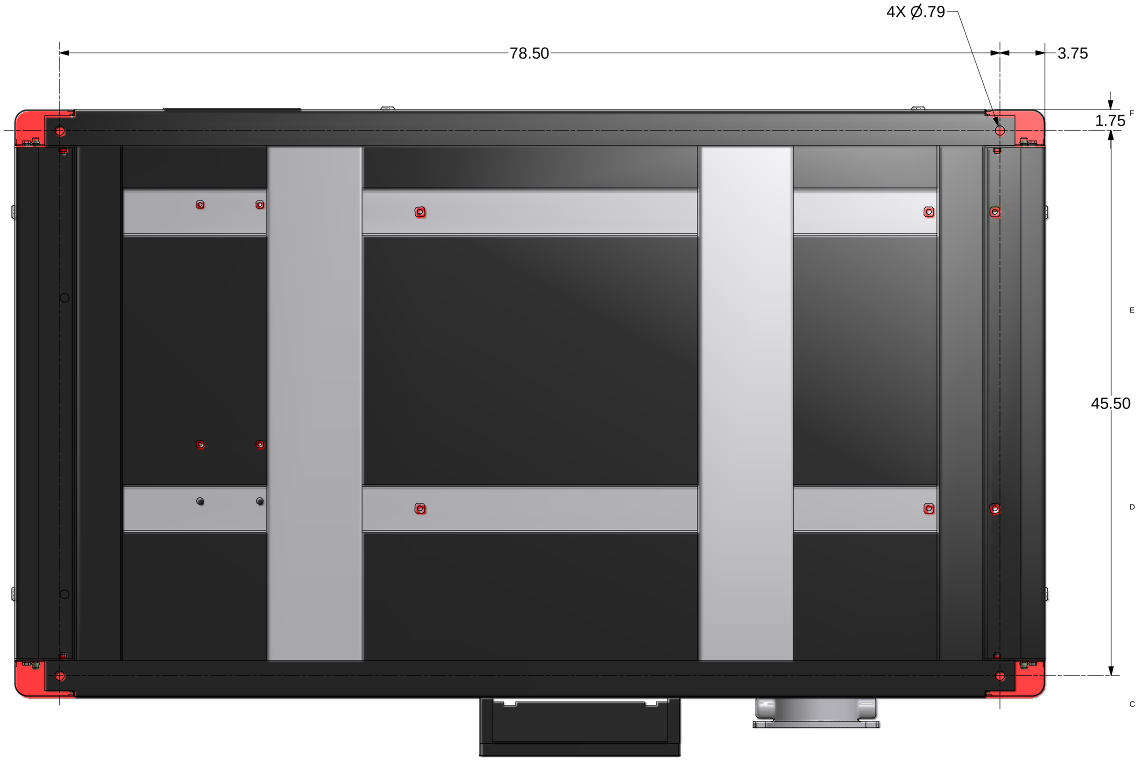
SIZE	ENGR. APPROVAL	DWG.NO.	REV
E	CRB	302BPC804	A

SCALE 1:8
SHEET 1 OF 3

REVISION HISTORY					
ZONE	REV	DESCRIPTION	DATE	DWN	CHK
	A	SEE SHEET 1 FOR REVISIONS			



VIEW A-A



VIEW B-B
SCALE 1 / 4

FINISH OF CHAMFERS AND FILLETS TO CONFORM TO ROUGHEST ADJACENT AREA.
SURFACE ROUGHNESS MAXIMUM PER ASME B46.1.
FULL THREAD DEPTHS ARE MINIMUM.

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES

TOL. ON DECIMALS: .X = ±.05
TOL. ON DECIMALS: .XX = ±.02
TOL. ON DECIMALS: .XXX = ± AS SPECIFIED
TOL. ON ANGLES: ±0°-30'
2

DIMENSIONING AND TOLERANCING PER ASME Y14.5-2009
THREADS PER ASME B1.1 GAGING SYSTEM 21 U.O.S., ANSI B1.20.1 & B1.20.3

THIRD ANGLE PROJECTION

Gardner Denver
Gardner Denver Inc.
Quincy, IL.

HEAT TREATMENT
ENG. REF: A

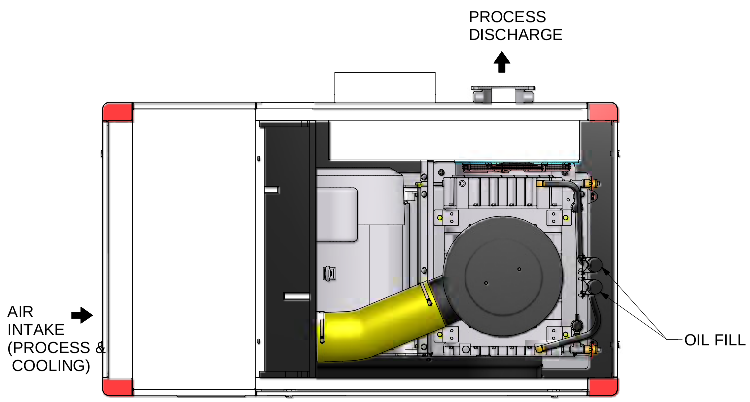
TITLE OUTLINE- UNIT/PKG
ENCLOSED PRESSURE PKG

DWN BY RRB 4/19/2010
CK'D BY CRB 4/19/2010

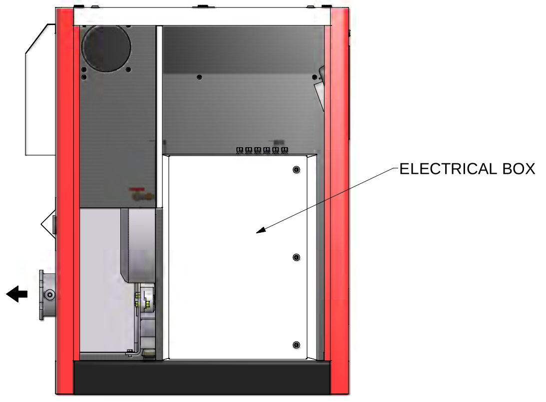
SIZE	ENGR. APPROVAL	DWG.NO.	REV
E	CRB	302BPC804	A

SCALE 1:8
SHEET 2 OF 3

REVISION HISTORY					
ZONE	REV	DESCRIPTION	DATE	DWN	CHK
	A	SEE SHEET 1 FOR REVISIONS			

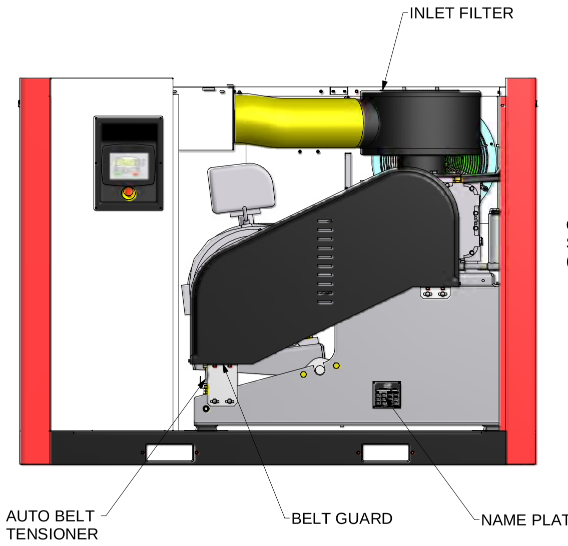


TOP W/ COVERS REMOVED

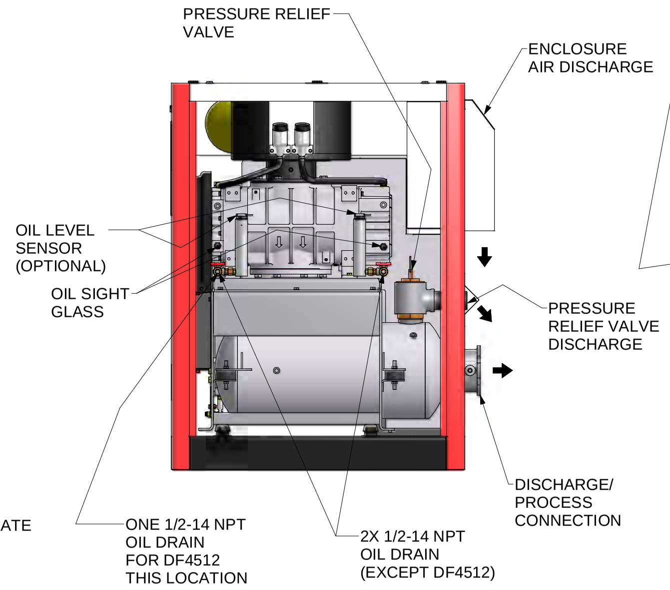


VIEW C-C

SIDE WITH PANEL REMOVED



FRONT W/ PANEL REMOVED



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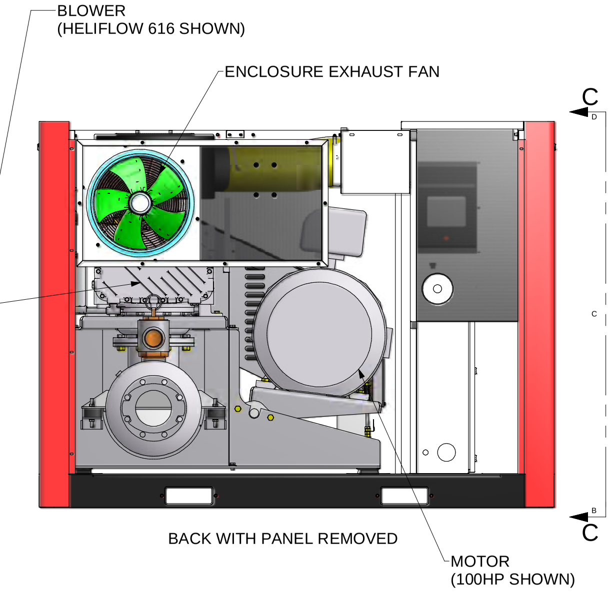


BACK WITH PANEL REMOVED

FINISH OF CHAMFERS AND FILLETS TO CONFORM TO ROUGHEST ADJACENT AREA.
SURFACE ROUGHNESS MAXIMUM PER ASME B46.1.
FULL THREAD DEPTHS ARE MINIMUM.

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOL. ON DECIMALS: .X = ± .05
TOL. ON DECIMALS: .XX = ± .02
TOL. ON DECIMALS: .XXX = ± AS SPECIFIED
TOL. ON ANGLES: ± 0°-30' 2

DIMENSIONING AND TOLERANCING PER ASME Y14.5-2009
THREADS PER ASME B1.1 GAGING SYSTEM 21 U.O.S., ANSI B1.20.1 & B1.20.3

THIRD ANGLE PROJECTION

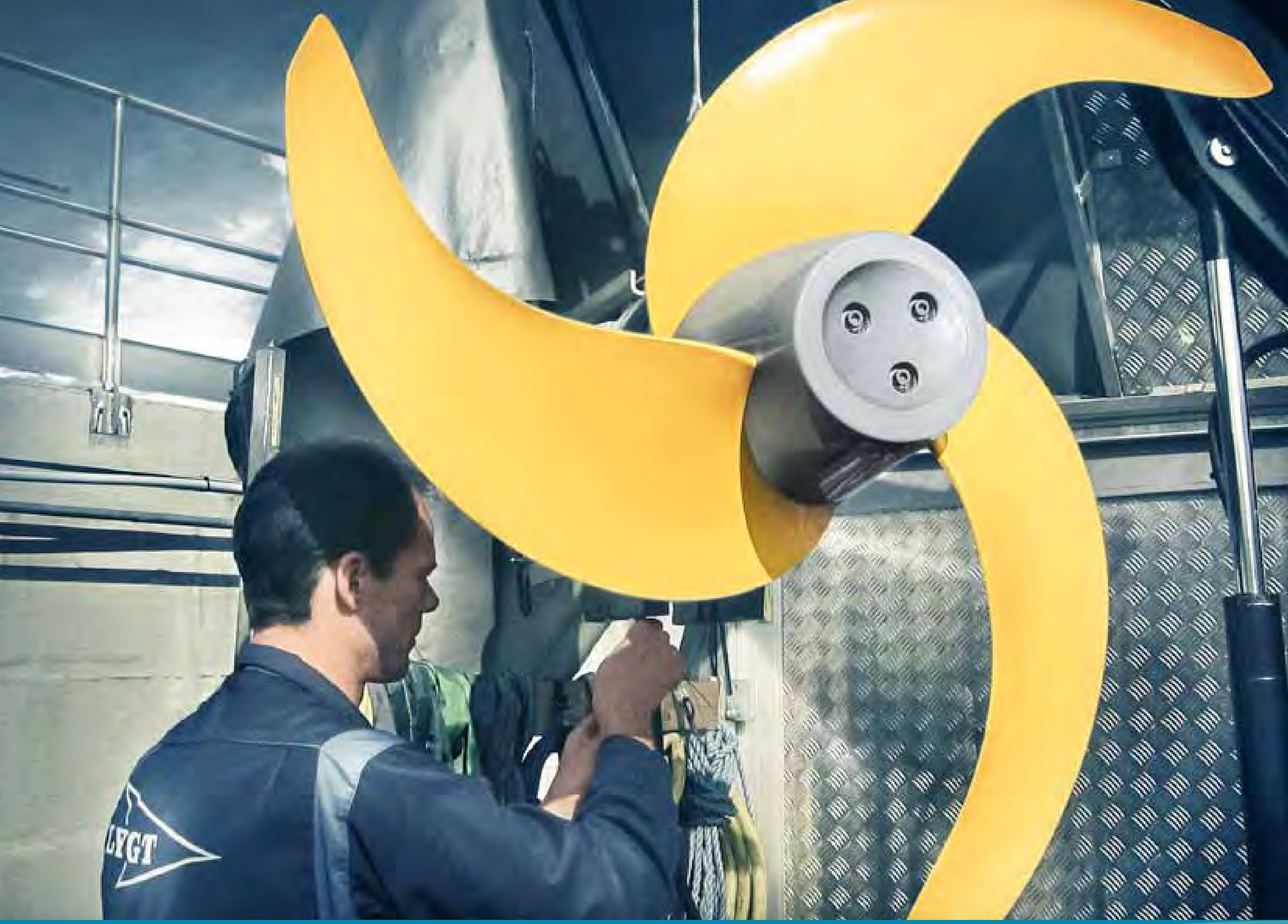
Gardner Denver
Gardner Denver Inc.
Quincy, IL.

DWN BY RRB 4/19/2010
CK'D BY CRB 4/19/2010

HEAT TREATMENT
ENG. REF: A

TITLE OUTLINE- UNIT/PKG
ENCLOSED PRESSURE PKG

SIZE E
ENGR. APPROVAL CRB
DWG.NO. 302BPC804
REV A
SCALE 1:8
SHEET 3 OF 3



Flygt mid-size mixers

OPTIMAL EFFICIENCY IN A NEW DIMENSION

FLYGT
a xylem brand

A step up in mid-size mixing

The newest addition to the Flygt range of innovative mixers and agitators, the Flygt 4530 incorporates a state-of-the-art propeller and proven drive unit for optimal efficiency in medium size treatment tanks. Typical applications are mixing in activated sludge processes, sludge holding tanks, and digesters.

Improved energy consumption
Our aim is to help you achieve operational efficiency in energy intensive treatment facilities. Getting the right design and size in your mixing application can make the difference for cost effective operations.

The Flygt 4530 mixer is an excellent choice when the propeller diameter of a full-size low-speed mixer is too large, but there's room for something larger than a compact mixer. Compared to a direct-drive compact mixer, for example, the energy savings with the Flygt 4530 can be over 50% for a similar duty. With the most advantageous size, you'll also get a dynamic duo of innovative propeller geometry and proven drive unit that's all the better for high efficiency and smaller carbon footprint.

Reliability you can count on
Hundreds of thousands of mixer installations around the world are confirmation of the reliability and robustness of our solutions. Designed and built to the same consistent high standards, the Flygt 4530 ensures minimum maintenance and fewer unexpected process interruptions, which add up to lower overall life-cycle costs.

Simplicity in the exchange
Changing out an existing installation is simple with the Flygt 4530. The mid-size mixer can be easily installed on a wall-mounted single guide bar, just like a compact mixer. What's more, rapid, straightforward installation helps to reduce expenditure on your staff time and your budget.

Let's solve the mixing challenge
We understand that efficient, uninterrupted treatment operations are critical to communities and industries. Mixing is an important part of the equation.

Flygt pioneered the use of thrust as the main performance parameter for mixing. In fact, you'll benefit from over fifty years of engineering know-how and practical field experience that lie behind our full range of compact, mid-size and low-speed mixers. We can help you evaluate the tank geometry, liquid characteristics, installation restrictions and mixing duty, and deliver the mixer technology, size and tank layout suited to just your requirements.

Lean, robust, smart, reliable and thoroughly field tested, our comprehensive portfolio of mixers and agitators ensures you get just the solution you need for optimum mixing and best energy use.

Innovative propeller design

Finding inspiration in the standard-setting Flygt low-speed mixer, the 4530 propeller takes hydraulic efficiency and clog-free performance to new levels. A thin-section design that incorporates generous backsweep and double-curvature, the rigid propeller is built for the best in efficiency and dependability.

Patented propeller assembly

Mounting is simple and easy. The attachment of the propeller requires no special tools – the design itself ensures correct mounting so you can be certain of optimal performance. In addition, the propeller bending and torsional loads are not taken by bolts, but rather recessed faces in the hub, for the assurance of reliability.

Standard guide bar installation

The Flygt 4530 can replace mixers installed on single guide bar systems. There is no special floor-mounted pedestal required on which to place the mixer. This makes it easier to exchange out a compact mixer for the Flygt 4530, and achieve up to 50% savings on energy consumption.

Robust and adjustable, Flygt installation equipment directs thrust exactly where it is required and can withstand the weight and reaction forces exerted by the mixer throughout its operating life.

Proven drive unit

The drive unit design is based on the Flygt low-speed mixer, with its Class H insulation, trickle-impregnated stator and rugged gearbox. Proof of design for the utmost in dependability and non-stop operations is demonstrated in tens of thousands of drive installations worldwide.

Global service network

Should you have questions or need support regarding your Flygt mixers and agitators, professional assistance and original spare parts are always nearby through our extensive worldwide service network.

Replacing your mixer is a simple, rapid procedure with Flygt 4530 – for a long life of efficiency.

	50 Hz	60 Hz
Thrust range (N)	900 – 2200	900 – 2200
Efficiency (N/kW)[1]	up to 700	up to 700
Propeller speed range (rpm)	90 – 140	90 – 140
Rated motor power	4.3 kW	4.6 kW (6.2 hp)
Propeller diameter	1.2 m (47 in.)	
Explosion proof versions	Yes	
Installation method	100x100 mm (4x4 in.) guide bar or tripod 100x150 mm (4x6 in.) guide bar or tripod	

[1] Per ISO 21630

Greater reliability comes with the three-blade design which minimizes dynamic loading on installation equipment.

Xylem |'zīləm|

1) The tissue in plants that brings water upward from the roots;
2) a leading global water technology company.

We're 12,000 people unified in a common purpose: creating innovative solutions to meet our world's water needs. Developing new technologies that will improve the way water is used, conserved, and re-used in the future is central to our work. We move, treat, analyze, and return water to the environment, and we help people use water efficiently, in their homes, buildings, factories and farms. In more than 150 countries, we have strong, long-standing relationships with customers who know us for our powerful combination of leading product brands and applications expertise, backed by a legacy of innovation.

For more information on how Xylem can help you, go to www.xyleminc.com

1411 . Flygt mid-size mixers . 1 . Master . 1 . 20120419

xylem
Let's Solve Water

Flygt is a brand of Xylem. For the latest version of this document and more information about Flygt products visit
www.flygt.com

FLYGT
a xylem brand

4530

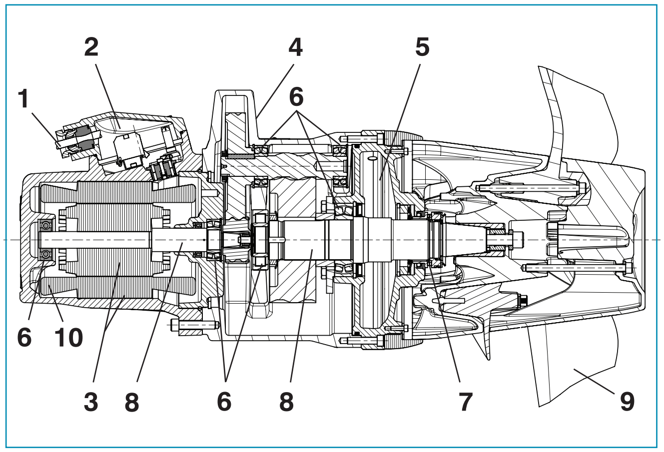
Submersible Mixer

Mid - Size, Gear Driven Mixer

Nominal Thrusts: 790 to 2,230 N

Applications:

The submersible 4530 mixer is used for high-efficiency mixing of wastewater and sludge containing solids and fibers, in municipal and industrial applications. Ideally suited to anoxic and anaerobic treatment steps, it is also used for MBBR, blending, flocculation and de-icing in other applications. The mixer is equipped with three blade propeller and reduction gear and designed to be operated completely immersed in the liquid. Available in standard and explosion-proof versions.



Materials of Construction:

Major castings: Cast Iron ASTM A48 Class 35B
Propeller: Epoxy coated Aluminum
Shafts: ASTM/AISI 431 Stainless Steel

Approvals:

CSA tested and approved to UL Standard for Safety #778.

Factory Mutual Research tested and approved.
Suitable for use in:
Class I Div 1 groups C and D
Class II Div 1 groups E; F and G
Class III Div 1 Hazardous locations

Factory Mutual System Approved

US

Specifications

1. Cable
SubCab cable. Jacket is Chloroprene Rubber, Insulation is high density Ethylene Propylene Rubber. Bushing and strain relief on the cable prevent leakage into the motor.

2. Junction box
The junction box is completely sealed off from the surrounding mixed media by utilizing an O-ring around the perimeter of the junction box sealing interface.

3. Motor
Flygt motors are tested according to IEC 34-1. Dry shell type, NEMA design B, induction squirrel cage motor. Motor insulation is class H with a maximum working temperature of 180°C (356°F) using the trickle impregnation method. The stator is cooled by the mixed media surrounding the stator casing.

4. Gear box
The gear box is a two-stage cylindrical helical gear box equipped with high precision low loaded gears. The gears are designed, according to AGMA for 50,000 hours of operation.

5. Oil casing
An environmentally friendly white paraffin based, FDA approved non-toxic, oil lubricates and cools the seals between the liquid and the gearbox. Pressure build-up within the oil casing is reduced by means of a built-in air volume.

6. Bearings
The motor shaft is supported by an inner single-row deep-groove ball bearing and an outer double-row roller bearing. The intermediate shaft is supported by two double-row roller bearings. The propeller shaft is supported by an inner single-row deep-groove ball bearing and an outer double-row angular contact ball bearing. All bearings are designed for more than 50,000 hours of operation.

7. Shaft seals
The mixer has one corrosion resistant cemented carbide WCCR / WCCR mechanical seal and one lip seal.

8. Shafts
The motor is delivered with the rotor as an integral part. Shaft material is stainless steel, ASTM/AISI 431. The shafts are completely sealed and will not come into contact with the mixed media.

9. Propeller
The propeller is non-clogging and designed with three generous back swept propeller blades. It is designed to deliver the greatest possible mixing effect in relation to motor output. The propeller blade is made of epoxy coated aluminum. The propeller shaft is constructed of 431 stainless steel.

10. Monitoring system
The stator incorporates three thermal switches, connected in series. The thermal switches open at 125°C (257°F). Optional stator housing leakage sensor (FLS) available.

Flygt products are affiliated with the following associations:

american rental association

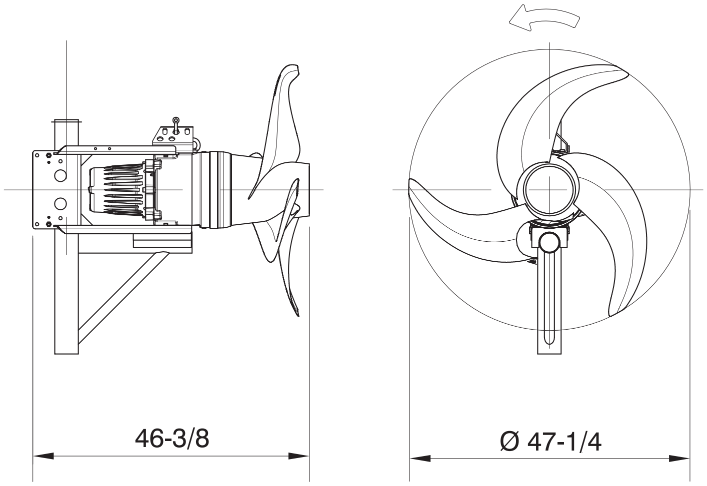
AEM
ASSOCIATION OF EQUIPMENT MANUFACTURERS

Submersible Wastewater Pump Association
SWPA

WE DIG AMERICA
NATIONAL UTILITY CONTRACTORS ASSOCIATION

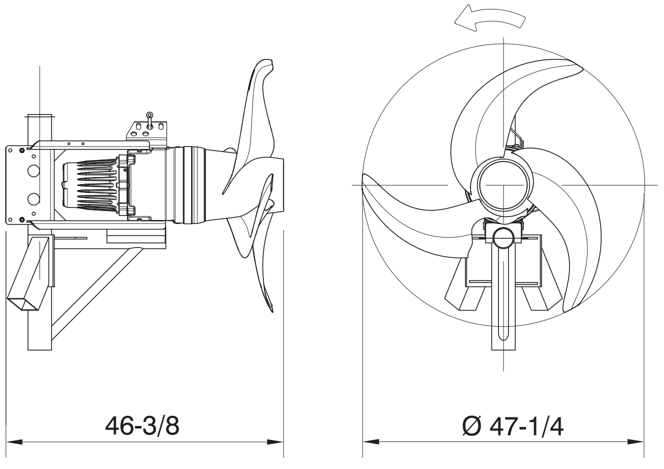
NMA
THE AMERICAN RESOURCE

Mixer can be installed on a single guide bar or tripod mounting system.



- **Single guide bar, 4" x 4" or 4" x 6"**

WEIGHT (LBS.)	
TOTAL	460



- **Tripod guide bar system, 4" x 4"**

WEIGHT (LBS.)	
TOTAL	460

Propeller Performance Range (Best-in-class efficiency per ISO 21630)

Prop. Code	Ø	Poles	Shaft *HP	Power Input (kW)	Motor Speed (RPM)	Prop. Speed (RPM)	Prop. Dia. (inches)	Nominal Thrust (N)
400	3	4	3.5	1.1	1765	88	47-1/4	790
|						|		|
460	3	4	6.2	4.5	1695	148	47-1/4	2,230

*Horsepower consumed at the motor shaft between motor and gear in clear water.

Motor Data

Rated Output Power HP (kW)	Ø	Volts nom.	Full Load Amps	Locked Rotor Amps	Locked Rotor KVA	NEC Code Letter	Rated Input Power (kW)	Poles/RPM	Cable Size	Cable Part Number	Max. Cable Length (FT.)
3.5(2.6)	3	230	11.0	83.0	33.1	L	3.1	4/1765	4G2.5+2x1.5	94 20 59	150
		460	5.1	41.0	32.7	L	3.1	4/1765	4G2.5+2x1.5	94 20 59	640
		575	3.9	29.0	28.9	K	3.0	4/1760	4G2.5+2x1.5	94 20 59	1,045
6.2(4.6)	3	230	17.0	83.0	33.1	F	5.5	4/1765	4G2.5+2x1.5	94 20 59	85
		460	8.2	39.0	32.7	F	5.5	4/1730	4G2.5+2x1.5	94 20 59	350
		575	6.5	29.0	28.9	E	5.6	4/1720	4G2.5+2x1.5	94 20 59	555

	Efficiency (460v)			Power Factor			Electrical Service Specifications
HP	100% Load	75% Load	50% Load	100% Load	75% Load	50% Load	Voltage Tolerances: ±5% (Rated Output), ±10% (without overheating) Frequency Tolerance: ±5% Voltage Balance (Phase to Phase): ±1% VFD Compatible
3.5	85.5	84.0	80.5	0.74	0.66	0.53	
6.2	84.0	85.5	85.0	0.84	0.80	0.70	

Xylem Inc., U.S.A.

Flygt/WEDECO products, 14125 South Bridge Circle, Charlotte, NC 28273. Tel. (704) 409-9700 Fax.(704) 295-9080
Leopold, 227 S. Division Street Zelienople, PA 16063 Tel (724) 452-6300 Fax (724) 452-1377,
Sanitaire, 9333 N. 49th Street Brown Deer, WI 53223-1472 Tel (414) 365-2200 Fax (414) 365-2210.

Project data MiDS 9.1.14 Sales

Project name	**DefaultABJ**
Case name	Coos Bay, OR
Proposal number	Job Number - 22448-11a
Customer	
Contact	
Selection by	sm /6/12/2013
Comments	

Input Data

Wastewater > Biological Treatment

Anox/Ox - Aeration turned off
Pre-treatment > Screen <=10 mm, no primary sedimentation
Outlet location in tank Bottom
Type of Diffuser 9" Sanitaire
Diffusers per aerated area 0.15 #/ft2
Covered Bottom Area 100.00 %
Number of Aerated Zones 1 no.

For mixer performance tolerances, refer to the mixer data chart.
Xylem guarantees that the proposed mixer selection will perform the specified duty when all mixers are operating positioned according to Xylem's recommendation. The selection is a function of the input data and the supplier of the data is fully responsible for its correctness.

Project data — MiDS 9.1.14 Sales

Project name	**DefaultABJ**
Case name	Coos Bay, OR
Proposal number	Job Number - 22448-11a
Customer	
Contact	
Selection by	sm /6/12/2013
Comments	

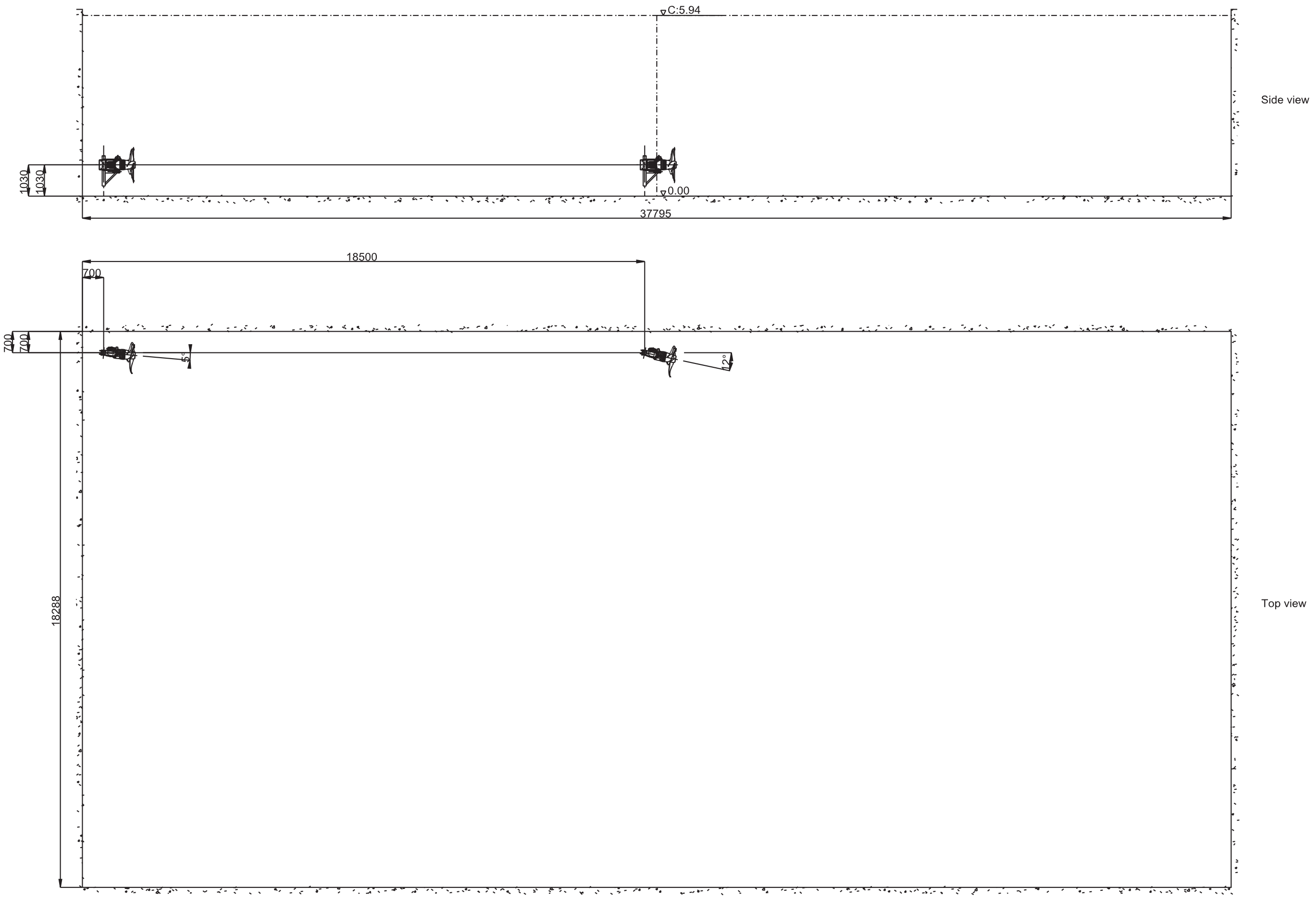
Tank dimensions — Rectangular Tank

Length	124.00	ft	Depth	19.50	ft
Width	60.00	ft			

Product data

Number of mixers	**2**				
Mixer type	**4530**	**without jetring**			
Propeller code	**440**	**Aluminum**			
Nominal thrust	1980	N	Frequency	60	Hz
Rated shaft power	6.17	hp	Phases	3	
Max input power	5.50	kW	Poles	4	
Propeller diameter	47.24	inch	Approval	STD	
Propeller speed	139	rpm	Rated temperature	40 °C / 104 °F	
Thrust produced/mixer	1790	N	(3580 N total thrust produced)		
Power uptake/mixer	3.81	kW	(69% of max input power)		
Total thrust required	3350	N			
Recom. min submergence	2.33	ft	(Surface to propeller tip)		

For mixer performance tolerances, refer to the mixer data chart.
Xylem guarantees that the proposed mixer selection will perform the specified duty when all mixers are operating positioned according to Xylem's recommendation. The selection is a function of the input data and the supplier of the data is fully responsible for its correctness.



AutoMIX	
Number of mixers	2
Mixer model	4530
Propeller code	Not available
Propeller diameter [m]	1.20
Min. Submergence [m]	0.77
Min. distance propeller to bottom [m]	0.60
Min. distance propeller to wall [m]	0.60

Disclaimer
The accuracy of the output is based on the accuracy of the input data, and it is the responsibility of those supplying that information to verify that this data is correct. The drawing is supplied for reference only, based on Flygt equipment, and is meant for preliminary sump design and system evaluation. A professional engineer, licensed in the appropriate field of engineering, should always conduct the final evaluation of the application if there are liabilities involved.

A1

Designed by
EX approved by
Draft
Weight
A-class
M-class
Checked by
Date 6/12/2013
Denomination Conceptual drawing
Material
Drawn/Redrawn by
Blank
Applicable to
Treatment
xylem Let's Solve Water

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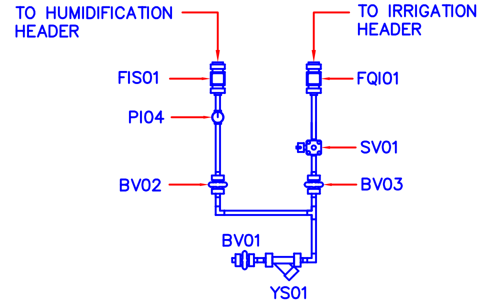
Scale 1:75
Approval
Drawing No DefaultABJ / Coos Bay, OR
Rev

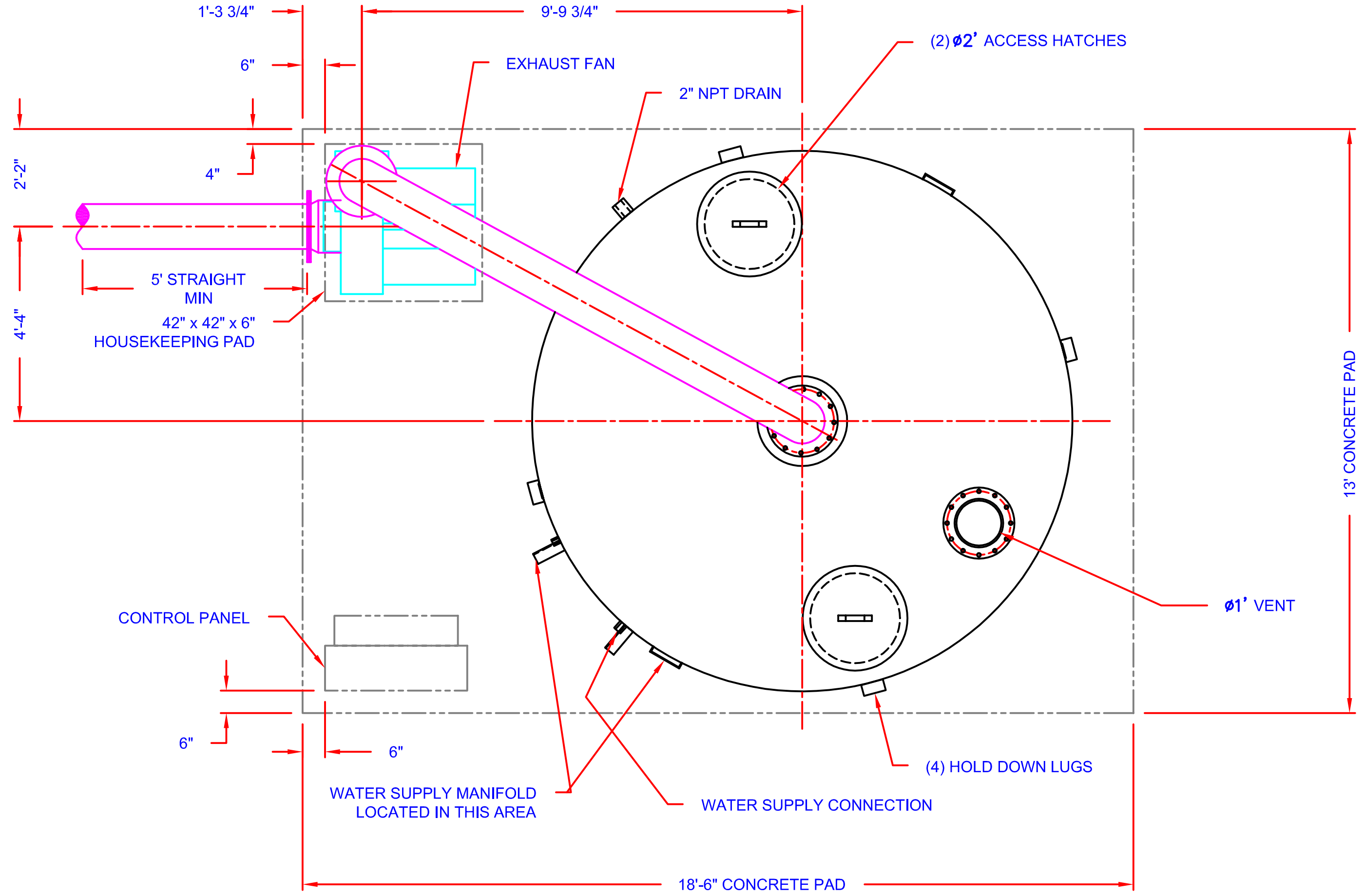
SECAD™ 5.2.4 (99.-1) Standard

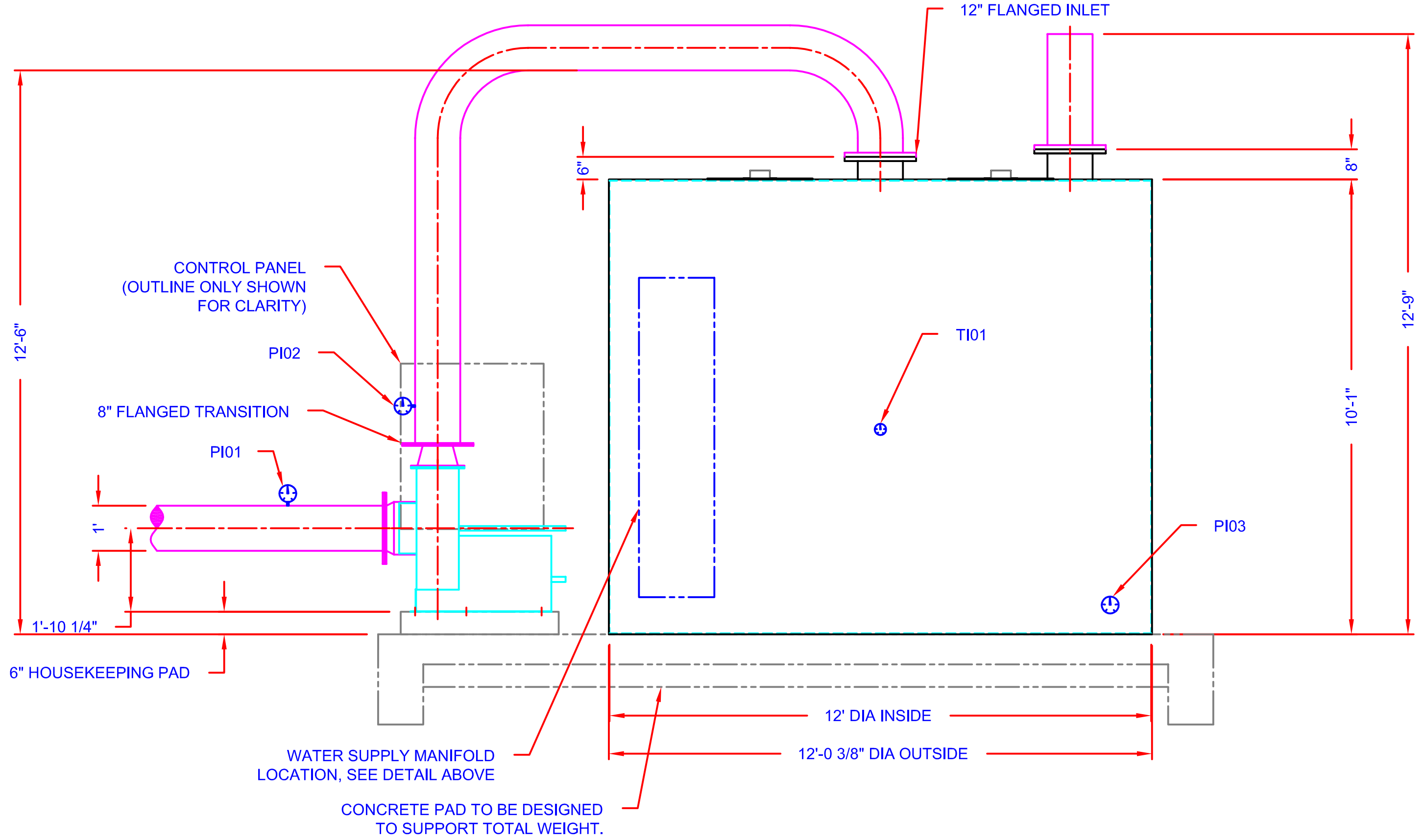
WATER SUPPLY MANIFOLD
(NOT TO SCALE)



MANIFOLD NOTES:

1. SEE PID FOR PART DESCRIPTIONS OF LABELED MANIFOLD COMPONENTS SHOWN ABOVE.
2. ASSEMBLED BY CONTRACTOR.
3. GENERAL LAYOUT TO BE COMPLETED BY CONTRACTOR, INSTRUMENTATION BY BIOREM.





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TAG	DESCRIPTION
TI01	MEDIA TEMPERATURE GAUGE
PI01-04	STATIC PRESSURE GAUGE

REV.	DATE:	DESCRIPTION

CERTIFIED
FOR PRODUCTION
BY:............................
DATE: ....

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DRAWING FOR:

DRAWING TITLE:
BASYS™ 12 E-SERIES BIOFILTER 8' MEDIA

DESCRIPTION:
GENERAL ARRANGEMENT

PROPERTY OF:
BIOREM TECHNOLOGIES INC.

BIOREM
TECHNOLOGIES INC.

DRAWN BY: TCD	DATE: MAY 2/07
JOB #:	DRAWING #: BASYS 12E 8 GA
SHEET:1 of 1 SCALE: 1:50	SIZE: B REVISION:

Robert M Tanzer
Sales Engr/Project Mngr
Peterson Power Systems
(503) 280-1544 Office
(503) 280-1552 Fax
(503) 704-7062 Mobile
rmtanzer@petersonpower.com

SCOPE LETTER / MATERIAL LIST

TO: Mr. Brian Pilmer, CH2M Hill DATE: July 10, 2013

RE: Coos Bay WWTP

Generator Desc: 800kW EPA Tier2 (also applic T4i) having rear-facing controls & MCB
Generator Dimensions: 184“L x 75“W x 82“H
Generator Air Requirements: 43,754 cfm Radiator, 2,172 cfm Combustion

---

Enclosure Description:
Acoustical, walk-in, weather protective enclosure assembly for harsh coastal environment, factory-packaged & assembled together with sub-base fuel tank, for job-site arrival in one piece.

Dimensions:
Enclosure dimensions:
370“L x 132“W x 137“H
Sub-base dimensions: (UL 142) adds to enclosure height
296“L x 126“W x 18“H

Sound Performance:
80dBA measured at 23ft from the enclosure and 5ft above grade, in a free field environment. Sound performance based on mechanical engine noise not exceeding 112db at 1m.

Estimated Weight:
Approximately 45,000lbs (enclosure, fuel tank & genset)

Enclosure Construction:
Framing is A-36 structural steel tubing & channel members
304 Stainless Steel skin walls with stiffeners, 4” thick
304 Stainless Steel skin roof with stiffeners, 4” thick
Walls and roof include 4” mineral wool and 22 gauge SS perforated liner
Pitched roof, single slope
2 internal muffler support channels
4 lifting lugs marked “For Enclosure Removal Only”

Enclosure Ventilation:
Air intake:
Eyebrow hoods (updraft intake hoods)
24VAC or 120VAC motor operated intake damper (spring to open, power to close)
Bird screens (SS construction)

Air discharge:

Vertical elbow (Vertical discharge)
Bird screens (SS construction)

Mechanical:

Oil & coolant lines piped to the exterior including ball valves
Crank case vents piped to the exterior
Engine exhaust opening with weather cover
Radiator fill access in roof with lockable cover

Doors and Hardware:

2ea Single man doors with emergency egress hardware and SS hinges
Door hold opens
Bolting hardware is SS
Neoprene gasket single sealed around door perimeters
Rain lips over all doors

Exhaust:

Interior critical grade low profile engine exhaust muffler.
Horizontal 45° Mitered exhaust outlet, or vertical discharge, stainless steel piping
SS exhaust flex
SS Rain cap
Wire-on removable high temp insulation blanket on muffler and flex connector.

Electrical:

- Wall-mounted accessory power distribution Service Panel 120/208vac 1ph with branch circuit breakers and surface mounted conduit/wiring as required for:
  - ➢ Battery charger
  - ➢ Engine jacket water heater
  - ➢ (4) interior fluorescent lighting fixtures, dust and vapor tight
  - ➢ (2) exterior area lighting fixtures
  - ➢ Light switches at each personnel door opening
  - ➢ (2) interior convenience receptacles with GFI
  - ➢ Motorized ventilation inlet louver
  - ➢ (4) interior DC lighting fixtures with wall-mount timer
- Electrical components wired in flex and EMT as required

Base:

Integral double wall UL142 base fuel tank, useable gallons 1370 for 24 hours run time between re-fills @ 100% load (1660 gals capacity), complete with electrical stub-up and generator support cross members and also includes the following accessories:

- 1ea 2” x 3/4” Draw Line
- 1ea 2” x 3/4” Return Line
- 1ea 2” Mechanical Fuel Gauge
- 1ea 4” x 2” Drop Tube on Fill Port
- 1ea 2” Leak Detection in secondary containment

- 2ea 2" Spare Ports
- 2ea 2" Sensor Ports
- 1ea 2" Normal Vent (extended to 12' above grade)
- 1ea Emergency Vent (size adjusted to code)
- 1ea Secondary Emergency Vent (size adjusted to code)

Fuel tank tested to 3psi per UL. Concrete foundation design by others. Paint is Black MARINE GRADE PAINT.

Enclosure Painting: (MARINE GRADE PAINT)
All exterior galvanized surfaces will be solvent cleaned per SSPC – SP1 and painted as follows:

- Primer –Epoxy Primer-Sealer (2 - 5 mils DFT)
- Finish – Polyurethane (2-4 mils DFT)

All carbon steel surfaces power tool cleansed per SSPC – SP3 and painted as follows:

- Primer –Epoxy Primer-Sealer (2 - 5 mils DFT)
- Finish – Industrial enamel (2-4 mils DFT)

Miscellaneous:

- Roof-mounted safety rings for fall protection, per OSHA requirements

Certifications, Inspections, Special Engrg (IMPORTANT FOR QUALITY, AHJ COMPLIANCE, SAFETY):

- ISO 9001 Certified ASR Cert # 4896
- Tank and enclosure are designed, stamped, and constructed per IBC requirements.
- Oregon Gold Seal certification

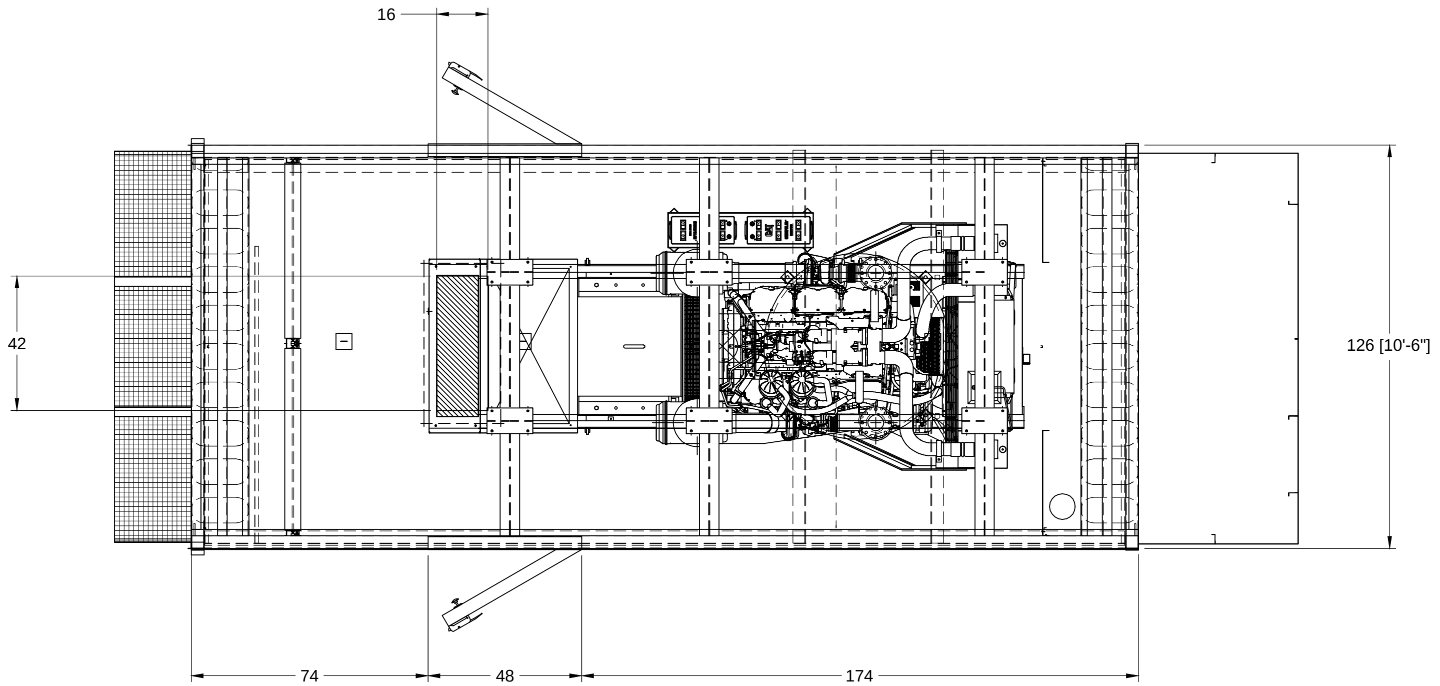
Schedule of Events

Thank you for considering this with project team, and of course we're available for discussions or meetings at your convenience!

Sincerely,
PETERSON POWER SYSTEMS

Robert M. Tanzer

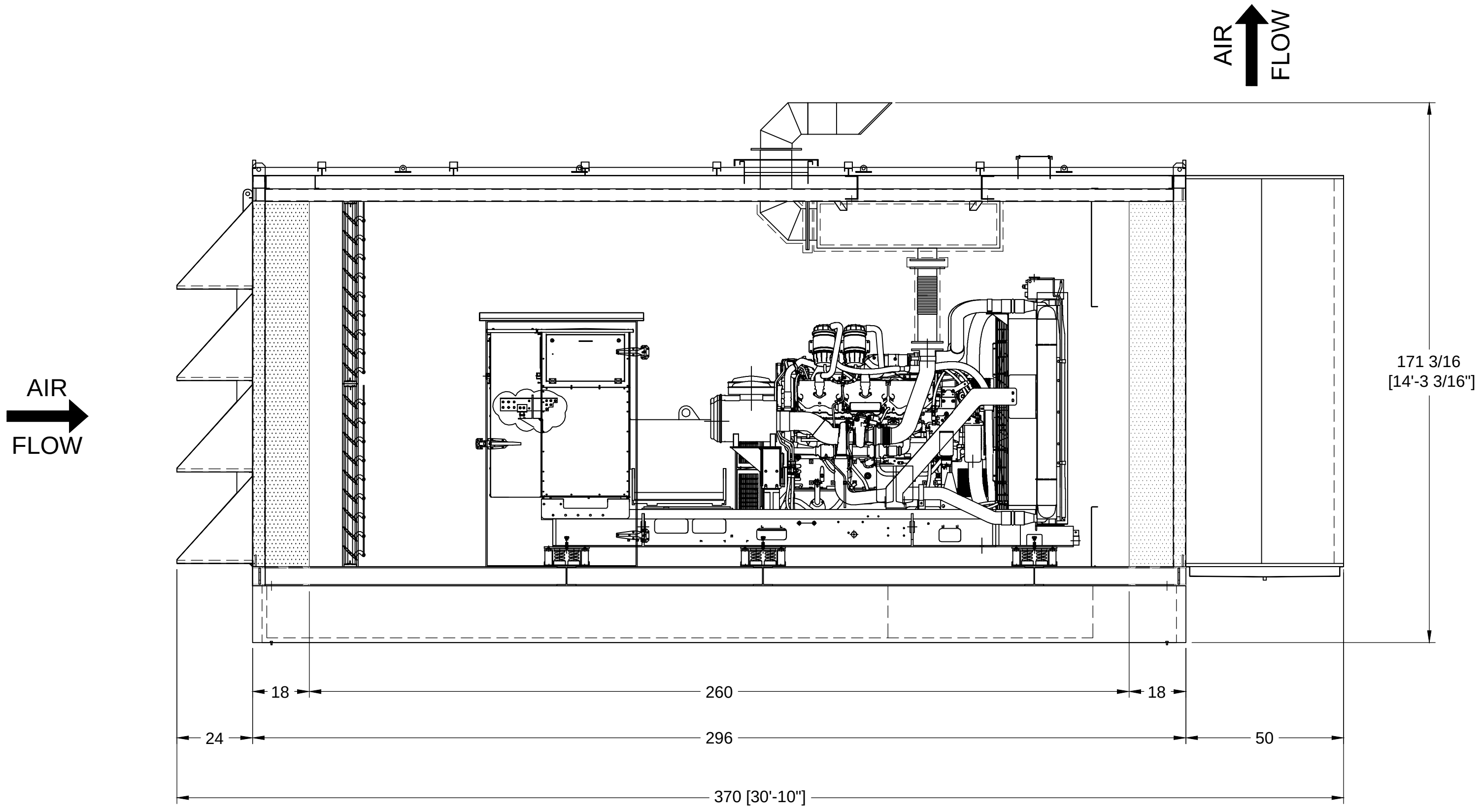
Robert M. Tanzer
Sales Engineer/Project Mngr



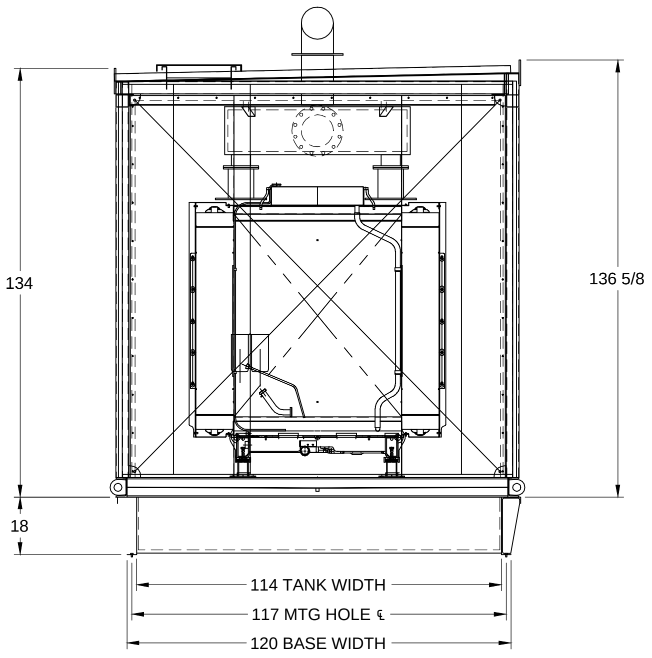
TOP VIEW

304 STAINLESS STEEL ENCLOSURE COMPLETE WITH MARINE GRADE PAINT
DRAWINGS REFERENCED:
800 kW C27 TIER4 GENERATOR,
DWG NUMBER 120353-0
FUEL TANK:
1660 GALLON UL-142 TANK
1370 GALLONS USABLE
SOUND REQUIREMENTS:
80dBA @23' AT 5' ABOVE GRADE IN A FREE FIELD ENVIRONMENT.

Applicable to EPA Tier 2 for standby as well.



SIDE VIEW



END VIEW

① GENERAL ASSEMBLY
SCALE = 1 : 60

IBI Power
ENGINEERED-MANUFACTURED-DELIVERED

CORPORATE HEADQUARTERS
20394 PINTO LANE
CALDWELL, ID 83606
PHONE: TOLL FREE (800) 497-8251
(208) 459-6077
FAX: (208) 459-9320

EASTERN DIVISION
6207 JIM SNOW WAY
CHATTANOOGA, TN 37421
PHONE: (423) 648-6528
FAX: (423) 305-7859
www.ibipower.com

REV:	DATE:	BY:	DESCRIPTION:
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Issued For Conceptual

The information on this document is intended only as conceptual information. This is not intended as a submittal for construction purposes.

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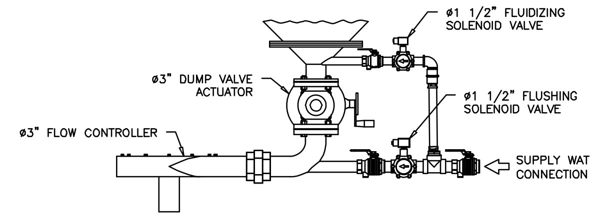
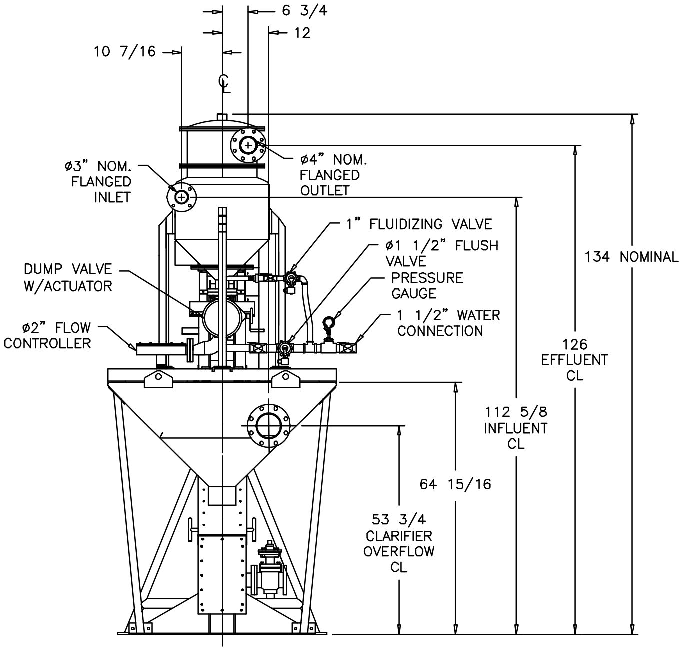
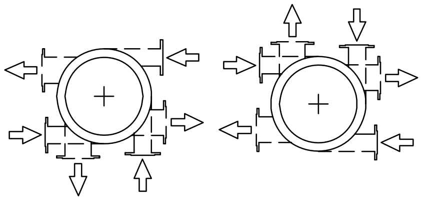
DO NOT SCALE

DRAWN BY: NC
DATE: 07-08-13
CHECKED BY: KJ
DATE: 07-08-13
PROJECT NAME: COOS BAY WWTP
PROJECT LOCATION: ---
CLIENT NAME: BOB TANZER
QUOTE NUMBER: Q1307110
JOB NUMBER: ---
DRAWING DESCRIPTION: GENERAL ASSEMBLY
DRAWING NO.: 01-02
REV.: CO

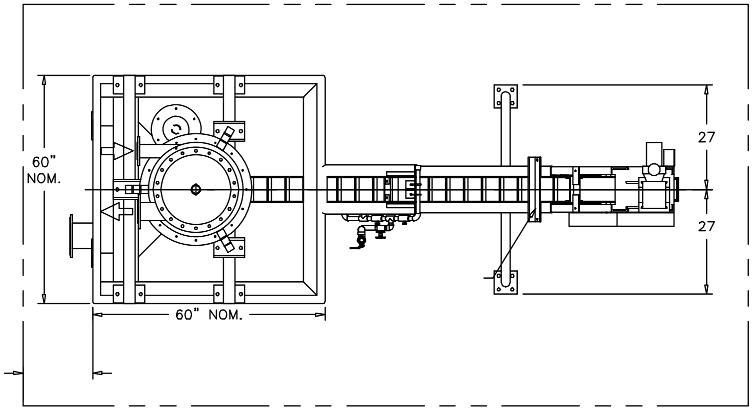


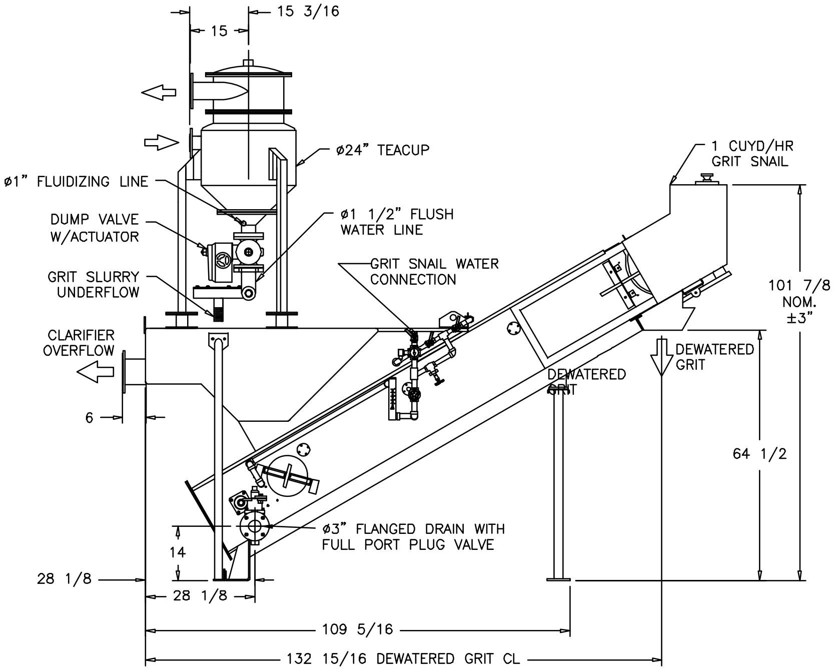
UNDERFLOW DETAIL
SCALE: N.T.S.





ALTERNATE FLOW CONFIGURATIONS





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UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES. TOLERENCES ARE:

FRACTIONS ± 1/16
DECIMALS ± .06
ANGLES ± 1°

Approximate Weight: SEE NOTE 4
Finish: -
Treatment: -
Sheet Size: B
Sheet: 1 OF 1

PROJECTION

1. TEACUPS ARE AVAILABLE IN CLOCKWISE AND COUNTER-CLOCKWISE ORIENTATION.
2. PLUMBING WILL BE LAYED OUT AND INSTALLED ON EQUIPMENT DURING FABRICATION TO INSURE PROPER FIT AND CORRECTNESS.
3. CONTRACTOR WILL BE REQUIRED TO MAKE A SINGLE WATER CONNECTION FOR EACH TEACUP/GRITSNAIL GROUPING.
4. EQUIPMENT WEIGHTS:
EACH TEACUP: DRY: 650 LBS.; WET: 750 LBS.
GRIT SNAIL: DRY: 1,350 LBS.; WET: 2,600 LBS.
5. PROVIDE ADEQUATE CLEARANCE AROUND EQUIPMENT FOR OPERATIONS AND MAINTENANCE.

REV	BY	DATE	DESCRIPTION
D	SR	05/13/10	RE-ISSUE NEW BORDER

REVISION HISTORY

Date: -
Scale: 3/8" = 1' 0"
Drawn By: AN
Checked By: -
Approved By: -

Title
EUTEK TEACUP
24 INCH - 50 MICRON
w/ EUTEK GRIT SNAIL
1 CU YD/HR
60 INCH CLARIFIER

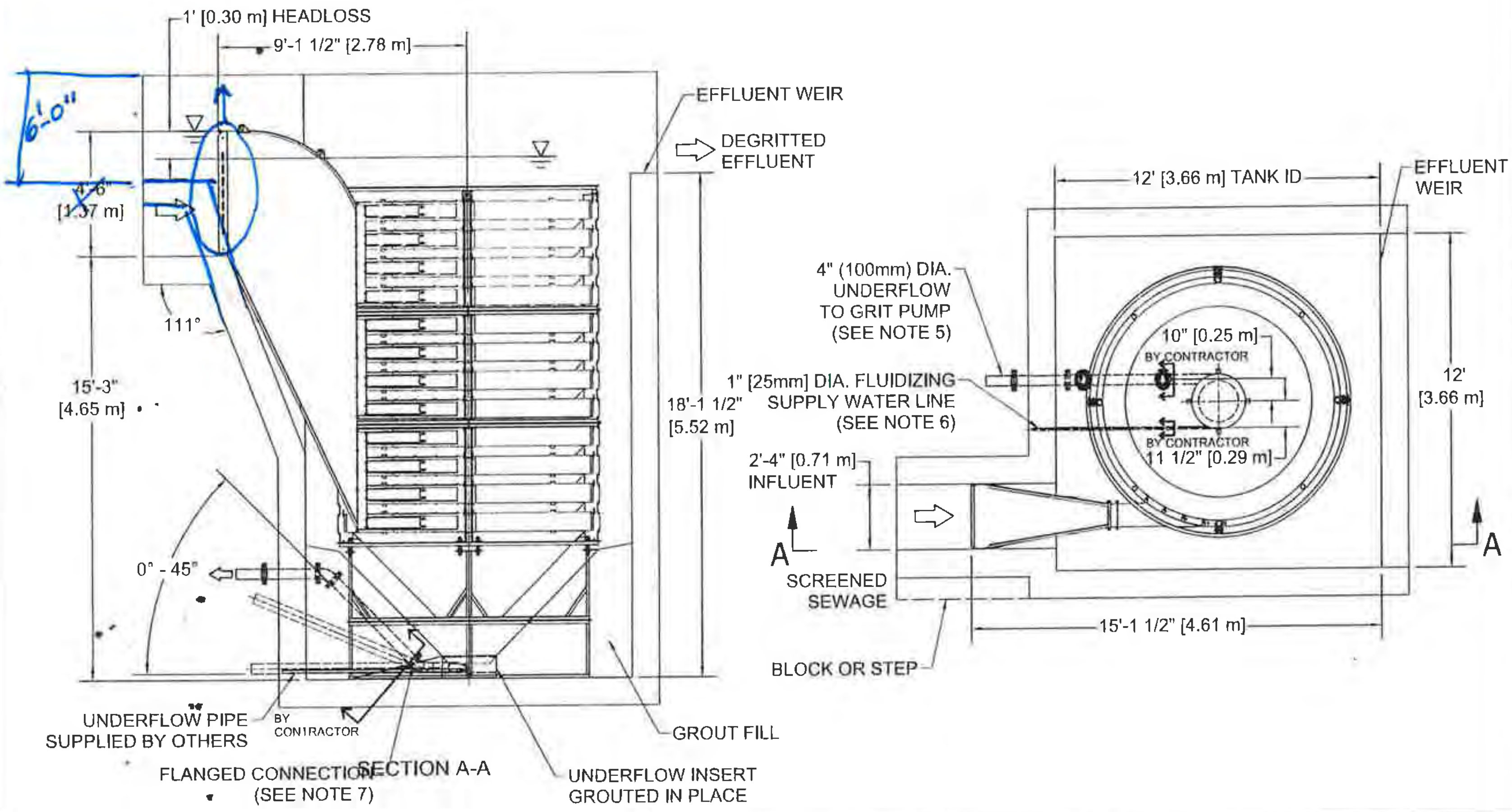
PROPOSAL DRAWING

Hydro International wastewater

2925 NW Aloclek Drive
Suite 140
Hillsboro, OR 97124
Tel: (503) 615-8130
Fax: (503) 615-2906
email: sales@eutek.com

Next Assembly: -
Ref. No. PROPOSAL
Drawing No. TC24-50PC-GS660
Rev D

DO NOT CHANGE DUCT LAYOUT OR PIPE ORIENTATION
WITHOUT CONSULTING HYDRO INTERNATIONAL



PROJECTION

1. ALLOW GRIT PUMP TO FULLY DRAIN HEADCELL TANK
2. PLANT FLOW BYPASS RECOMMENDED TO ALLOW THE HEADCELL TO BE TAKEN OUT OF SERVICE IF MAINTENANCE IS REQUIRED
3. CLOCKWISE & COUNTERCLOCKWISE UNITS ARE AVAILABLE.
4. ALTERNATE EFFLUENT CONFIGURATIONS ARE AVAILABLE
5. THE GRIT PUMP SUCTION LINE SHOULD BE DESIGNED FOR A 4-7 ft/s [1.2-2.2 m/s] LINE VELOCITY
6. FLUIDIZING WATER REQUIREMENTS
   11 gpm [0.7 l/s] FOR 4', 6', AND 9' HEADCELL
   20 gpm [1.3 l/s] FOR 12' HEADCELL
7. UNDERFLOW PIPE CONNECTION CAN BE SUPPLIED AT 0°, 22.5°, OR 45° ANGLE

REV	BY	DATE	DESCRIPTION
-	SR	9/9/2010	FIRST RELEASE

REVISION HISTORY

Date	Scale
02/07/2013	1/4" = 1'0"

Drawn By	Checked By	Approved By
DH	-	-

Title
EUTEK HEADCELL
PROPOSAL DRAWING

9' DIAMETER 8 TRAY
EXPANDABLE 12 TRAY
106 MICRON

Hydro International
wastewater

2925 NW Aloclek Drive
Suite 140
Hillsboro, OR 97124
Tel: (503) 615-8130
Fax: (503) 615-2906
email: sales@eutek.com

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERENCES ARE:

FRACTIONS ± 1/4
DECIMALS ± 0.25
ANGLES ± 1

Approximate Weight: 4100 LBS
Finish: -
Treatment: -
Sheet Size: B
Sheet: 1OF1
Next Assembly: -
Ref No: PROPOSAL
Drawing No: 09-3579-01
Rev: -

HYDRO-DYNE
Engineering, Inc.
www.hydro-dyne.com
Tel: 813-818-0777 Fax: 813-818-0770

5/2/2013

Hydro-Flo Sizing & Hydraulics Worksheet

Calculations show headloss for peak flow, channel width, 6mm opening size, and 50% obstruction.

Project: **Coos Bay, OR**
Date: **05/02/13**
Rep: **TEC**
By: **JRC** **Checked by:**

Please Enter Known Values in Shaded Areas Below

		Metric (SI)		CFS	
Q (MGD)	6.15	23282	m3/day	9.515	cfs
C (in)	18.00	457.2	mm		
H (in)	72.00	1828.8	mm		
S (mm)	6	Perf	Openings		
Obs	50%				
V_1 (fps)	1.59	0.48	m/s		
Y (in)	48.00	1219	mm		
F (in)	24.00	610	mm		
MΔ (in)	6.00				
	12	Gauge Links			

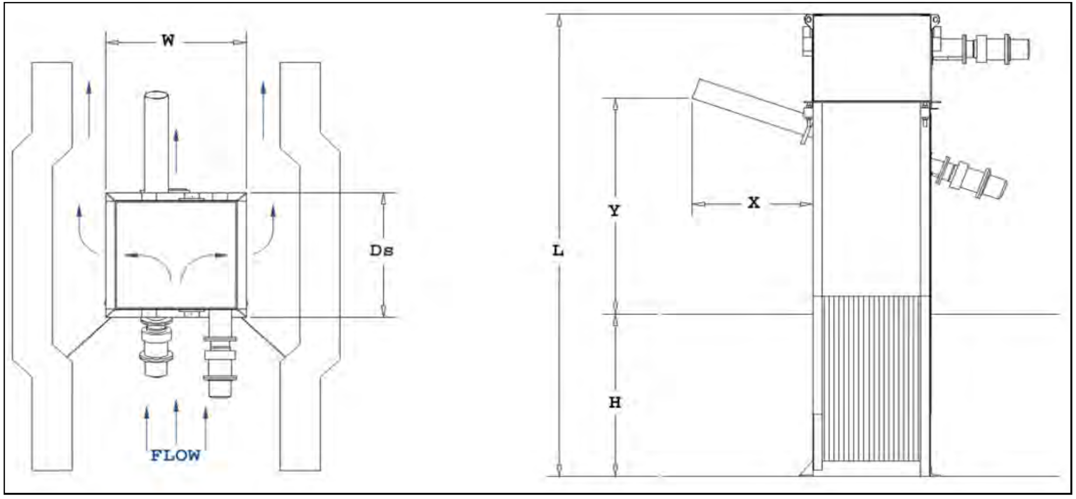
Summary of Analysis

		Metric (SI)		CFS			
Q (MGD)	6.15	23274	m^3/day	9.515			
C (in)	18.00	457	mm				
R_C (in)	36.00	914	mm				
R_D (in)	6.94	176	mm				
S (mm)	6						
Obs	50%						
V_1 (fps)	1.59	0.48	m/s				
V_T (fps)	2.31	0.71	m/s				
V_G (fps)	2.37	0.72	m/s				
Y (in)	48.00	1219	mm	4.00	ft		
F (in)	24.00	610	mm	2.00	ft		
H (in)	72.00	1829	mm	6.00	ft		
D_1 (in)	48.00	1219	mm	4.00	ft		
D_2 (in)	45.71	1161	mm	3.81	ft		
ΔH (in)	2.29	58	mm	0.19	ft	with	50% obs.
L (in)	127.34	3234	mm	10.61	ft		
W (in)	26.00	660	mm	2.17	ft		
D_S (in)	26.581	675	mm	2.22	ft		

Q = Flow
C = Channel Width
H = Channel Height
S = Grid Opening Spacing
Obs = Percent of Screen Obstructed
V_1 = Upstream Channel Velocity (assumed)
V_T = Throat Velocity of Screen
V_G = Velocity Through Screen's Grid
V_2 = Downstream Channel Velocity
Y = Discharge Height from Top of Channel
F = Freeboard
MΔ = Maximum Head Loss
R_C = Channel Recess Width
R_D = Channel Recess Depth
D_1 = Upstream Depth
D_2 = Downstream Depth
ΔH = Headloss at Q with %Obs.
L = Length of Screen
W = Width of Screen
D_S = Depth of Screen
TC = Top of Channel
CI = Channel Invert

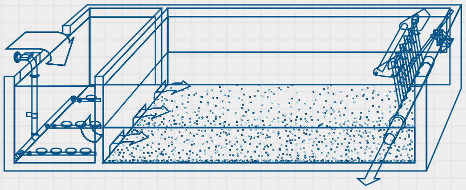
Hydraulic # HF — 26 — 27 — 6

Model # **HF** — 26 — 27 — 127 — 6 - P



ICEAS®

Advanced SBR Technology



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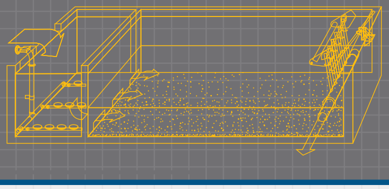
ITT Industries

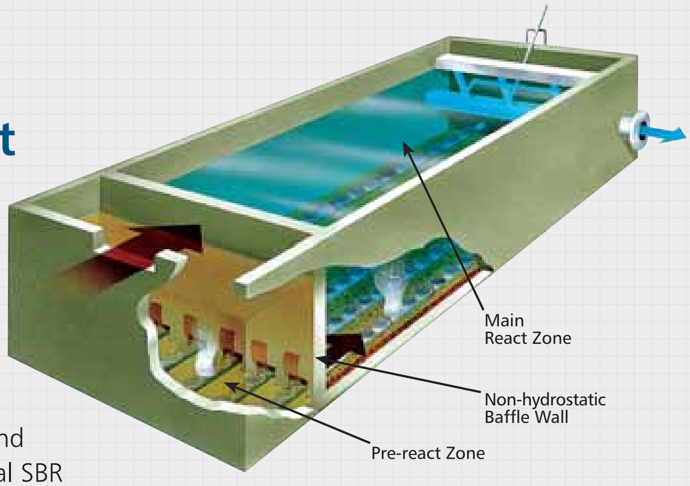
Engineered for life

ICEAS®

Advanced SBR Technology



ABJ®



Cost-Effective Wastewater Treatment

Sanitaire has provided the wastewater treatment industry with innovative and cost-effective treatment technologies for over 35 years. This tradition continues with the ABJ Intermittent Cycle Extended Aeration (ICEAS) process, which is an advance sequencing batch reactor (SBR) technology for municipal and industrial wastewater treatment.

The conventional SBR, a variant of the activated sludge process, operates on the fill and draw principle. Fill, react, settle, decant and idle phases occur sequentially on a cyclic basis. In the conventional SBR configuration, flow is diverted from the basin during settling and decanting and requires two or more basins or an influent equalization tank to receive flow when settling and decanting. Sanitaire can provide a conventional SBR but recommends the superior flexibility of the ICEAS design, which does not require any flow diversion.

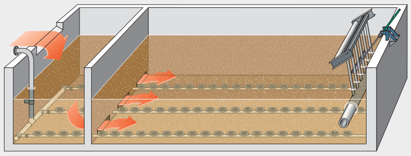
The ICEAS Process

The advanced ABJ ICEAS process is a fully automated and simple to operate biological treatment system that:

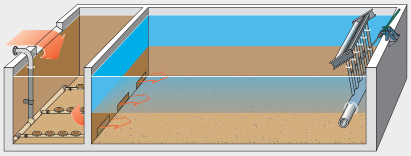
- Operates as a time-based control system allowing continuous inflow of wastewater during all phases of the cycle.
- Responds to flow and load variations.
- Can achieve processes of biological oxidation, nitrification, denitrification, phosphorus removal and liquid/solids separation continuously in a single basin.
- Easily expands and produces a high quality effluent.
- Provides two treatment zones (pre-react and main-react) separated by a non-hydrostatic baffle wall.
- Utilizes the pre-react zone as a biological selector for enhancing the growth of desirable organisms.
- Offers flexibility for meeting specific application needs with custom engineered process cycles.

The ICEAS Cycle

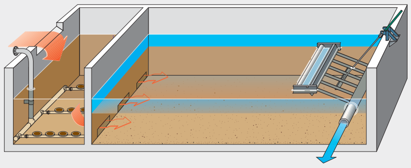
React – Periods of aeration and/or mixing are applied to achieve the desired biological treatment.
Settle – Aeration and/or mixing are discontinued allowing solids to settle to the bottom of the basin leaving a layer of clear, treated water at the top.
Decant – The clear, treated water is removed by an automated, time-controlled decant mechanism.



React



Settle



Decant

ICEAS Features

Continuous Inflow

- Provides equal loading and flow to all basins, simplifying operation and process control.
- Can be designed to accommodate up to six times average daily flow.
- Results in smaller basin size and less equipment, reducing construction and O&M costs.
- Eliminates primary and secondary clarifiers and return sludge pumps.
- Enables single-basin operation for maintenance and low flow conditions.

Decanter Design

- High quality workmanship and advanced engineering provide a long-lasting decanter.
- Rugged, corrosion resistant stainless steel construction.
- Decants from the top down withdrawing only the uppermost clear water from the basin preventing disruption of the settling solids.
- Uses a proprietary scum exclusion float to prevent the carryover of floating material with the treated effluent.
- Flow over the decanter weir is visible from the basin walkway providing a check of effluent quality.
- Actuator operates via a VFD providing a constant rate of effluent discharge to downstream facilities.
- Parked above top water level during react and settling phases serving as an emergency overflow device in the event of extreme storm conditions or power failure.
- Actuator drive mounted outside of basin at walkway level for easy maintenance.

Energy Efficient Aeration Systems

- State-of-the-art aeration systems have been applied worldwide in activated sludge and biological nutrient removal applications. SANITAIRE diffusers provide high oxygen transfer efficiency, require minimal maintenance and are time proven for their durability in wastewater treatment processes..
- Fine Bubble Membrane aeration systems include advanced membrane material specifically engineered for domestic and industrial applications providing resistance to material property changes. The time-proven piping system accommodates thermal expansion and contraction and prevents air leakage, pipe separation and distributor rollover.
- Coarse Bubble aeration systems provide efficient wide band aeration and mixing with minimal maintenance. Stainless steel material provides corrosion resistance and structural integrity and is fully passivated after fabrication. (Available in fixed header and removable header options).

Municipal and Industrial Wastewater Treatment

The ABJ ICEAS process provides high quality effluent for both municipal and industrial wastewater treatment facilities. Typical industrial applications include waste from meat processing, beverage, pharmaceutical, food processing, pulp and paper and chemical plants.

Typical ABJ ICEAS process

ICEAS effluent sample

Stainless steel decanter

Biological Nutrient Removal (BNR)

The ABJ ICEAS process can be designed as a BNR system for enhanced nitrogen and phosphorus removal.

- Cycles can incorporate alternating periods of "air on" and "air off" during the react phase to produce aerobic/anoxic/anaerobic conditions to promote nitrification/denitrification and phosphorus release and uptake.
- Mixers can be added for operation during periods of "air off" to achieve optimum substrate/microorganism contact.
- New and existing plants can be designed to accomodate future BNR requirements without requireing additional basins.
- Separate aeration drop legs in the pre-react zone can add operational flexibility.

Mixer

Industrial wastewater treatment plant in circular tanks

Control System

- Process control with a PLC based system with a graphic operator interface (HMI).
- Uses state-of-the-art Supervisory Control and Data Acquisition (SCADA) software installed on a PC with modem and remote monitoring capabilities.

World Leader in SBR Technology

ABJ ICEAS facilities have been installed throughout the world over the past three decades. With all installations, Sanitaire provides complete in-house support through its process, mechanical and control engineering departments. Customer assistance is available through in-house staff and representatives who market our products worldwide.

Contact Sanitaire for more information

9333 N. 49th Street
Brown Deer, WI 53223 USA
Tel 414 365 2200
Fax 414 365 2210
www.sanitaire.com

Sanitaire

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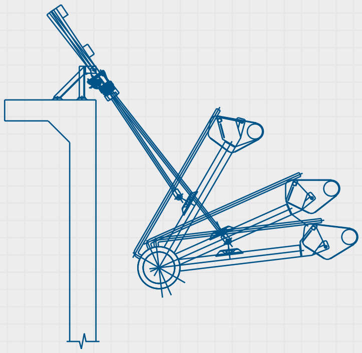

Decanter System

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ABJ®

Decanter System

Sanitaire has developed through years of experience, a high quality, advanced-engineered decanter.

- Rugged, corrosion resistant stainless steel construction.
- Uses an electromechanical actuator with redundant limit switches and variable frequency drives (VFDs) for speed control.
- Decants from the top down withdrawing only the uppermost clear water from the basin preventing disruption of the settling solids.
- Effluent flow is visible providing a quick check of effluent quality.
- Rests clear of liquid during aeration eliminating the need for valves that are subject to failure.
- Rests below the top of the basin wall acting as an emergency overflow device during power outages.
- Removes effluent from 2-3” below water surface level and excludes scum and other floatables.
- Visible and accessible from the walkway allowing easy access and service without the need to enter the basin.
- Constant overflow rate over entire length of decant period.
- Easy installation.

Contact Sanitaire for more information

9333 N. 49th Street
Brown Deer, WI 53223 USA
Tel 414 365 2200
Fax 414 365 2210
www.sanitaire.com

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ABJ® Control Systems

Integrated, Plant-Wide Monitoring and Control for Municipal and Industrial Wastewater Treatment Plants

Engineered for life

ABJ Control Systems

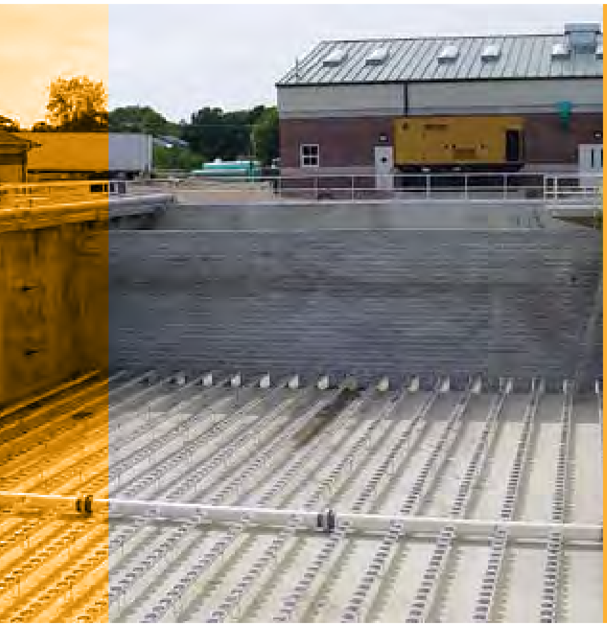
Providing a solution to meet your needs

Plant operation is the largest "life-cycle" cost component for a wastewater treatment facility. An integrated and well-engineered control system – customized for your specific requirements – is critical for efficient, long-term plant operation, process control and management.

With its ABJ® Control System, ITT provides comprehensive, integrated control solutions for a wide range of municipal and industrial wastewater treatment plants.

Fully automatic and simple to operate, the ABJ Control System typically consists of a PLC, Human Machine Interface (HMI), Variable Frequency Drives (VFD), control switches, pilot lights, motor starters and a Motor Control Center (MCC).

ABJ Control System Applications:
- ABJ ICEAS® SBR
- Conventional "true batch" SBR
- DrumFilter effluent filtration system
- Dual Stage MBR
- Sanitaire® aeration systems and blower control
- Plant-wide monitoring and control



Municipal WWTP Benefits from ITT's Plant Wide Monitoring and Control

While planning for a new wastewater treatment facility, the Rock Creek Public Sewer District in Kimmswick, MO, required a completely integrated controls package by one supplier who would provide single source support.

Through its Sanitaire / ABJ brands, ITT was able to fulfill the customer's needs by providing a completely integrated system which included a main PLC, SCADA system and instrumentation. In addition, individual vendor PLC's for all other plant equipment were networked together as part of the SCADA system, allowing the operator a single point of monitoring and control.

The ABJ Control System monitors and operates the following:

- Decanters
- Process and sludge holding tank blowers
- Air control valves
- Influent valves (SBR systems)
- Waste sludge pumps
- Submersible mixers (BNR applications)
- D.O. monitoring and control systems
- MLSS/WAS concentrations
- Level, flow and temperature instruments
- Other plant equipment

ABJ Process Control – A Perfect Fit:

- D.O. control for optimum energy efficiency - matches oxygen demand with blower operation and oxygen delivery
- Decanter speed control matches effluent flow rate (not available with floating decanters)
- Algorithm and VFD/electromechanical drive components provide robust, positive control – integral to overall SBR operation
- Decanter control allows integration with tertiary treatment and disinfection systems
- SIMS - ABJ's automatic sludge age control system for complete activated sludge process control. Simplifies operation, enhances biological nutrient removal, optimizes solids handling
- Flexible operator adjustability of cycle timing
- Automatic storm-flow monitoring and control
- Time-based rather than flow-based, and responds to flow and load variations

ABJ Control System Features and Benefits:

- As a total solutions provider, ITT provides complete control system integration, engineering, testing, installation, training, start-up and long-term system service and support
- Engineered to order and customized to meet project-specific needs
- Systems are completely shop tested prior to shipment – provides quality assurance and fast, trouble-free startup
- Complete 24/7 phone support
- Modem access for troubleshooting
- State of the art Allen-Bradley controls platform; PLC and color touch-screen HMI
- Ability to update and retrofit outdated or competitor controls
- Proven time-based SBR operation
- UL 508, C/UL rated controls, CSA optional
- Multiple communication protocol capability
- On-site customer start-up and training

SCADA (Supervisory Control and Data Acquisition) System:

- Plant-wide integration of ABJ and other plant processes and equipment
- Single point of monitoring, control and alarm handling for plant-wide operation
- Remote access capability for plant-wide operations or technical assistance
- Each selectable screen includes help button that provides operational assistance
- Data trending and reporting capabilities
- Screens are intuitive, easy to navigate and learn
- Monthly DMR reporting optional

ITT

About ITT Corporation

ITT Corporation (www.itt.com) is a global engineering company with products and systems working in countless fluid handling applications around the world. We are meeting the challenges of our customer's applications through advanced water and wastewater treatment technologies.

Biological Treatment Solutions from ITT

ITT's advanced biological wastewater treatment offerings include diffused aeration systems, sequencing batch reactor (SBR) systems, membrane bioreactor (MBR) wastewater treatment solutions and wastewater instrumentation. ITT also offers complete wastewater treatment systems to meet current and future requirements for high-quality effluent treatment.

For more information about ITT's ABJ Control Systems:

ITT Water & Wastewater
Sanitaire / ABJ
9333 N. 49th Street
Brown Deer, WI 53223
Tel: (414) 365-2200
Fax: (414) 365-2210

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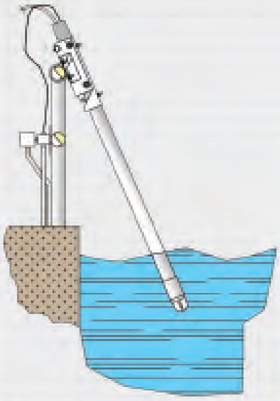


Solids Inventory Management System (SIMS)

Sanitaire

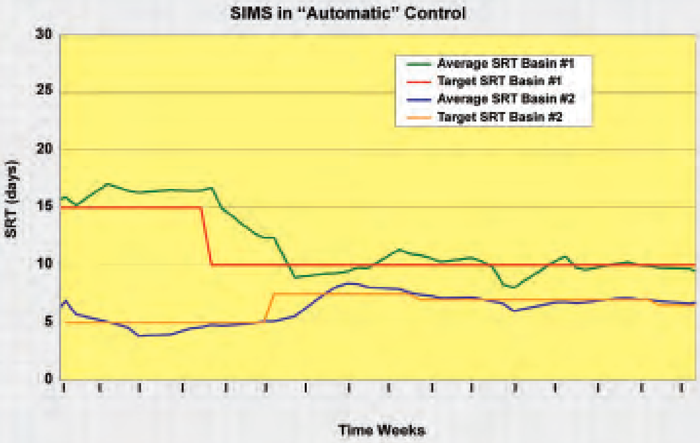
ITT Industries
Engineered for life

Solids Inventory Management System (SIMS)

Optimizing Process Control in Sequencing Reactors

Controlling system biomass is a key component to meeting consistent, high quality effluent in the activated sludge process. Of the available strategies for activated sludge process control, maintaining a constant sludge age or solids retention time (SRT) is a very effective tool. SRT is typically defined as:

$$\text{SRT} = (\text{days}) \quad \frac{\text{Mass of Solids in the Basin}}{\text{Mass of Solids Wasted per Day}}$$



SIMS Offers Consistent Sludge Age Control in SBR Systems

System Features

- Continuous, Real-Time MLSS Concentrations
- Current Wasting Rate Calculations
- SCADA Trending of MLSS and WAS Concentrations and Wasting Rates
- Operation in Manual or Automatic Modes with Fail-Safes
- Applicable for New and Existing ABJ Installations

Contact Sanitaire for more information

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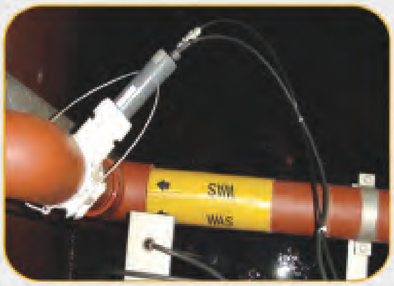
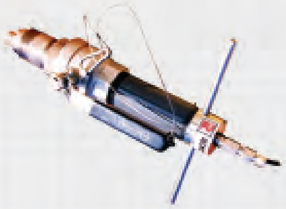
www.sanitaire.com



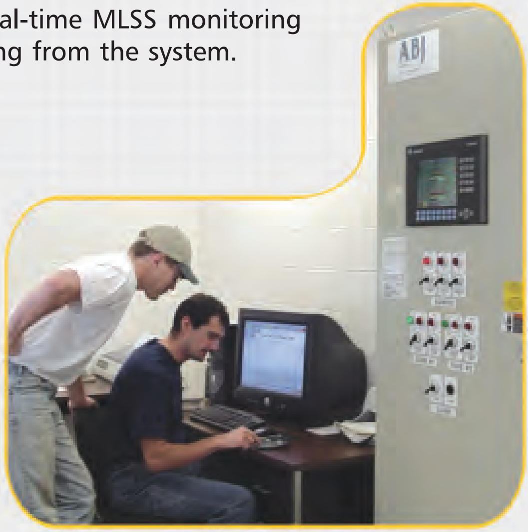


System Benefits

- Improved Control with Less Operator Attention
- Accurate, Real-Time Basin Mass Assessment
- Consistent Effluent Quality
- Reduction in Laboratory Testing and Operating Costs
- Ideal for Remote or Unattended Installations

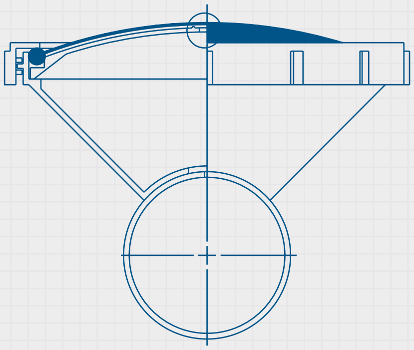
Measuring the mass of organisms to determine SRT in sequencing reactors such as SBR's and ICEAS plants presents some unique challenges. Due to variations in basin MLSS concentration from cycle to cycle, sequential effluent draw off and variations in influent flow and loading, maintaining a stable biomass inventory can be a trial and error process.

SIMS overcomes these challenges by offering automated control of basin SRT by continuous, real-time MLSS monitoring and sludge wasting from the system.



Sanitaire

ITT Industries
Engineered for life



Membrane Disc

Fine Bubble Aeration Systems

Sanitaire

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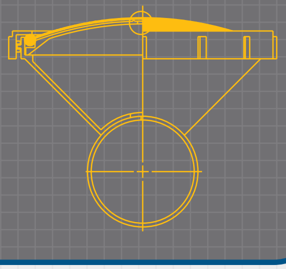
Membrane Disc

Fine Bubble Aeration Systems



SANITAIRE®

Technology You Can Count On

SANITAIRE® is the trade name recognized throughout the wastewater treatment industry for quality products and advanced technology. SANITAIRE Silver Series membrane fine bubble disc diffusers are recognized worldwide for their high oxygen transfer efficiency and durability in wastewater treatment plant aeration processes.

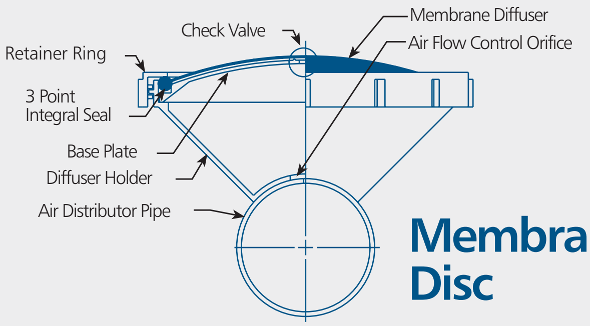
Owners and engineers prefer SANITAIRE fine bubble diffusers because:

- Power costs can be reduced by 50% or more.
- High oxygen transfer efficiency and low system headloss lead to low energy costs.
- Minimal maintenance is required.
- Gentle positive mixing action using full floor coverage aeration grids promotes excellent floc formation.

Sanitaire's leadership and experience in aeration technology has resulted in high quality SANITAIRE fine bubble disc aeration systems being specified more than any other. The SANITAIRE Membrane Disc fine bubble aeration system offers advantages in performance, ease of maintenance, construction integrity and quality. Ongoing research and developement shows Sanitaire's commitment to the most technologically advanced diffused aeration system.

Diffuser and Holder Features

- Diffuser holders are factory solvent welded to the air distribution piping providing superior mechanical strength and eliminating the necessity for field installation and leveling of individual assemblies.
- Membrane diffusers include an integral check valve. The non-perforated center portion of the membrane collapses onto the air release port of the base plate when the air is turned off. The diffuser slits also act as check valves and close onto the base plate when the air is turned off.
- Integral seal and threaded retainer ring design prevents air leakage and resulting contamination from mixed liquor solids leakage into the aeration system.



Membrane Disc

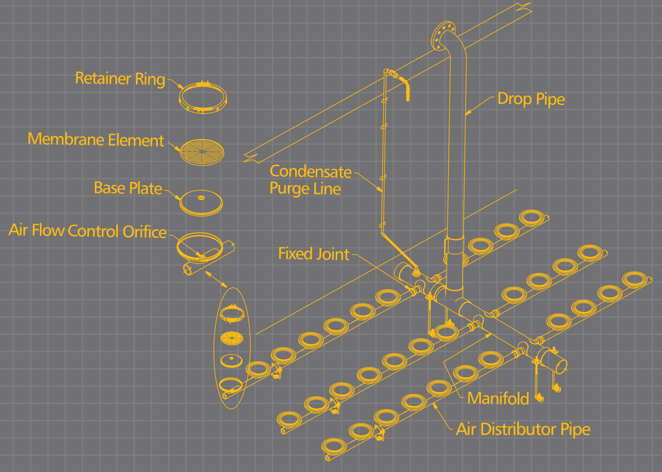
Top centerline diffuser mounting prevents cantilever or torque forces from being transmitted to piping system.

- Diffuser and holder are designed to provide full surface uniform air distribution and bubble release.
- The membrane is completely supported by the base plate, preventing reverse flexing.
- Available in 9-inch (229-mm) and 7-inch (178-mm) diameters.

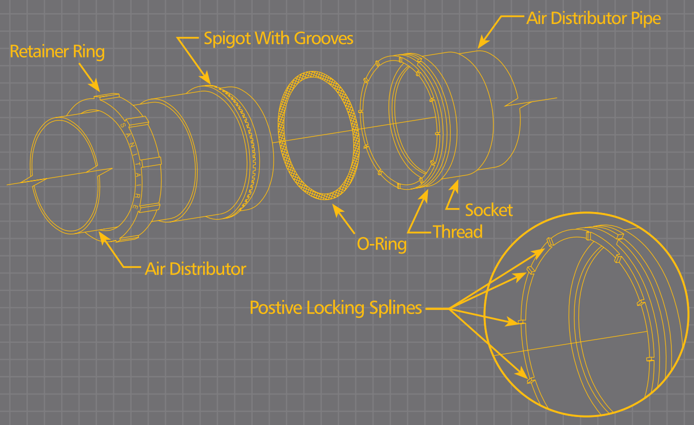
Proven System Components

- The SANITAIRE air distribution system incorporates patented locking pipe joints combined with guide type supports that do not positively grip the pipe to accommodate thermal expansion and contraction. The unique system design allows the individual distributor pipes to move freely through the pipe supports.
- The patented SANITAIRE fixed joint features an airtight O-ring seal, anti-rotational splines and a positive locking threaded retainer ring to prevent air leakage, pipe blow apart and distributor rollover.
- PVC air distribution piping system provides long-term mechanical integrity.
- Submerged components of corrosion resistant materials.
- Unique all stainless steel anchorage system with threaded supports for infinite adjustments on sloped or irregular floors.
- Joint components are factory solvent welded to the pipe ends, allowing for quick and easy field assembly of air distributor sections.
- Condensate removal with sumps and purge system.
- Over 10 million fine bubble diffusers installed worldwide.

Typical Membrane Disc Grid Layout



Sanitaire Positive Locking Fixed Joint



Membrane Disc Diffuser Advantages

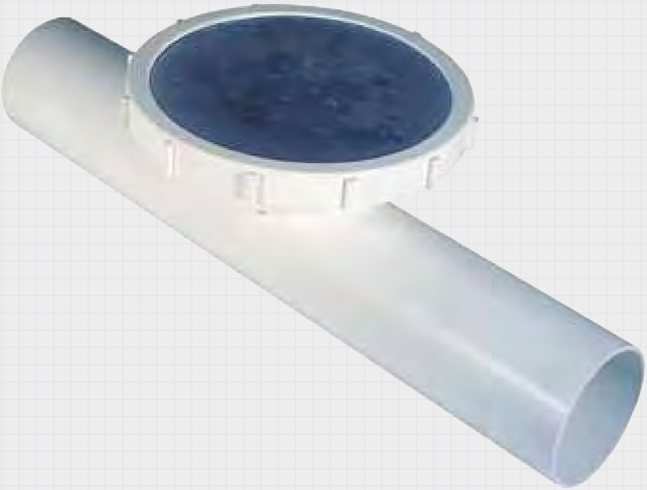
- Provides full surface, uniform air distribution and bubble release.
- Operating air pressure creates peripheral seal to eliminate air leakage.
- Precision die-formed slits are punched perpendicular to membrane grain direction for greater resistance to elongation and tearing.
- Proprietary technologically advanced membrane material blended from special synthetic rubber compound has been specifically engineered for domestic and industrial waste applications providing:
  - Extended service life.
  - Resistance to material property changes.
  - High modulus of elasticity.
  - Proper material thickness - lower unit stress.
  - Resistance to oils and ultraviolet light.
  - High oxygen transfer efficiency.
- Alternative materials and configurations available for specific applications.
- The unique design eliminates the use of hold-down bolts, lift limiters and metallic mechanical fasteners.
- Existing aeration tanks can be easily upgraded with membrane disc aeration, upgrading existing plant's organic treatment capacity without adding tankage.
- Convenient shipping - diffusers and piping are delivered in a compact palletized arrangement.
- Ease of installation - up to 12 units installed per man-hour. Step-by-step O&M manuals, educational videos and field service startup training provided with every system.
- Factory installed diffuser holders and pipe end fittings to reduce installation time.
- Pressure monitoring system available.

Applications

- Aeration Tanks
- Sludge Holding Tanks
- Aerobic Digesters
- Sequencing Batch Reactors
- Channel Aeration
- Air On/Air Off Processes
- Membrane Bioreactors

Those Who Choose Membrane Disc Aeration... get the best of all worlds when they choose proven SANITAIRE systems for their wastewater treatment needs.

Sanitaire provides time-tested aeration technology and products for municipal and industrial markets worldwide.



Call Sanitaire - the aeration leader for more information

9333 N. 49th Street
Brown Deer, WI 53223 USA
Tel 414 365 2200
Fax 414 365 2210
www.sanitaire.com

Sanitaire

ITT Industries
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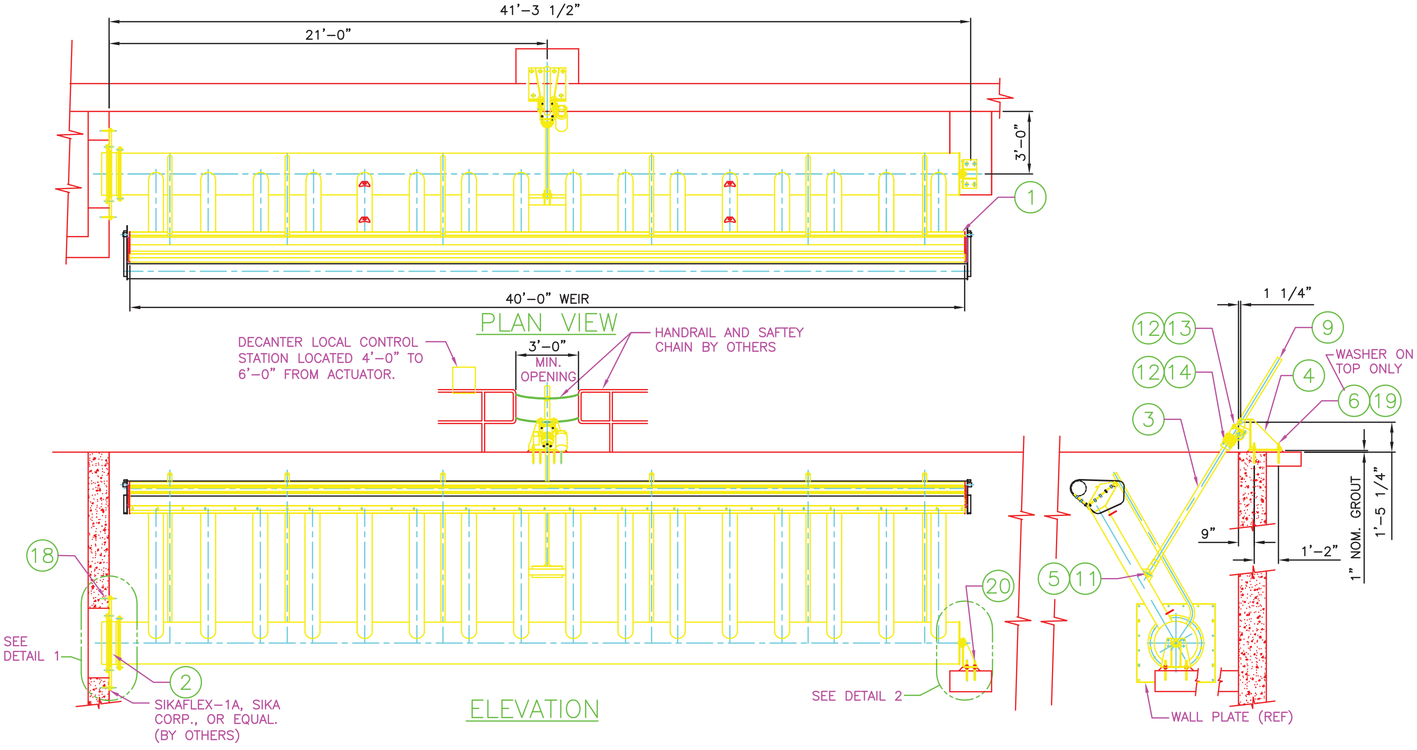
11/04 US Patent # 5,714,062



ITEM	QT'Y	DESCRIPTION	DWGS.	MAT'L.
1	1	DECANTER SUB-ASSEMBLY, 24" COLLECTOR	SRD2135	S.S.
2	1	BEARING SUB ASSEMBLY, 24" COLLECTOR	STD2035-24	S.S.
3	1	CONNECTING ROD	STD2136	S.S.
4	1	ACTUATOR BRACKET ASSEMBLY	STD1912	S.S.
5	1	PIN, CONNECTING STRUT, 1 3/4"ø	STD1518	S.S.
6	15	PLATEWASHER, 2 x 2 x 1/4 THK.	STD1540	S.S.
7	1	GASKET, 24" COLLECTOR PIPE	STD2145-24	NEOPRENE
8				
9	1	ACTUATOR, MODEL 9010		
10				
11	2	COTTER PIN, ø3/16" x 2 1/2" LONG		S.S.
12	8	BOLT, HEX HEAD, 3/4"-10UNC X 2 1/4" LG		S.S.
13	4	NUT, HEX HEAD, 3/4"-10UNC		S.S.
14	4	LOCK WASHER 3/4"		S.S.
15	16	BOLT HEX HD, 1"-8 UNC X 2 1/2" LG.		S.S.
16	16	NUT, HEX HEAD, 1"-8 UNC		S.S.
17				
18	20	1/2"ø X 4 1/2" LG WEDGE ANCHOR W/HEX NUT AND WASHER		S.S.
19	7	ø3/4" X 9 5/8" LG ADHESIVE ANCHOR W/2		S.S.
		NUTS & WASHER, 6 1/2" EMBEDMENT,		
		HILTI HVA OR EQUAL		
20	4	ø3/4" X 12" LG ADHESIVE ANCHOR W/2		S.S.
		NUTS, 6 5/8" EMBEDMENT, HILTI OR EQUAL		
21				
22	20	BOLT, HEX HEAD, 1 1/4"-7UNC X 2 1/2" LG.		S.S.
23	20	NUT, HEX HEAD, 1 1/4"-7UNC		S.S.
24				

GENERAL NOTES:

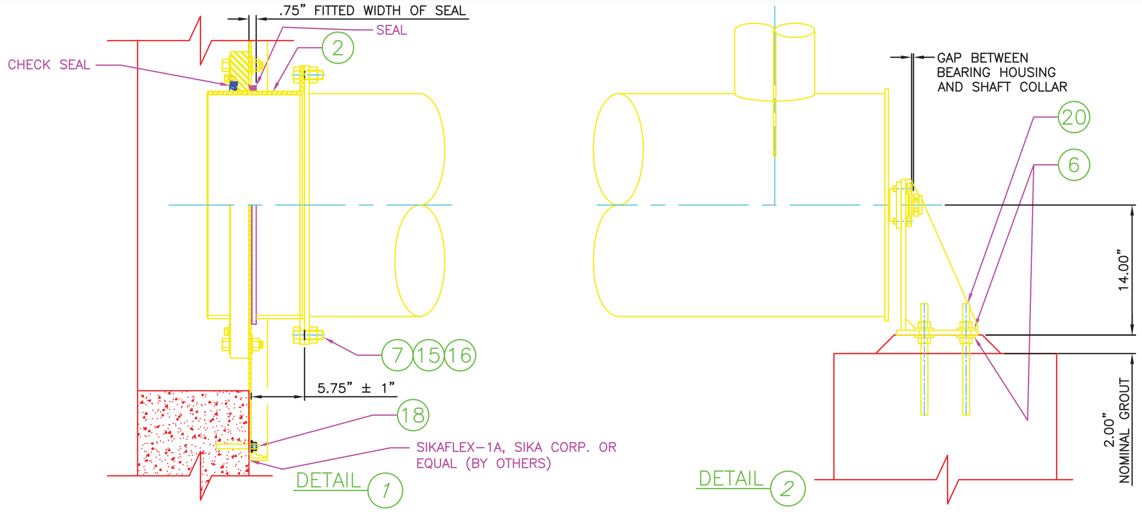
1.) REFERENCE DRAWING C10 & C11.

2.) QUANTITIES SHOWN ARE FOR ONE DECANTER.
TOTAL ASSEMBLIES REQUIRED:
X R.H. & X L.H.
(RIGHT HAND DECANTER SHOWN).

3 ALL THREADED CONNECTIONS MADE IN THE FIELD TO BE DRESSED WITH LOCTITE 262 OR EQUAL.

SHOP NOTES:

4.) ALL PARTS TO BE ASSEMBLED BY FABRICATOR TO CHECK FIT AND MATCH MARKED BEFORE DISASSEMBLY AND SHIPPING. MATCH MARKS TO BE ALPHA CHARACTERS (A,B,C,..), STEEL PUNCHED AND THE LOCATION HIGHLIGHTED W/1 1/2" CIRCLE OR YELLOW PAINT.



PRELIMINARY

DIMENSIONS SHOWN ON THIS DRAWING ARE PRELIMINARY.
CERTIFIED DIMENSIONS WILL BE PROVIDED AT FINAL DESIGN STAGE.
00/00/00

NO.	DATE	REVISION	BY
4			
3			
2			
1			

WASTEWATER TREATMENT PLANT

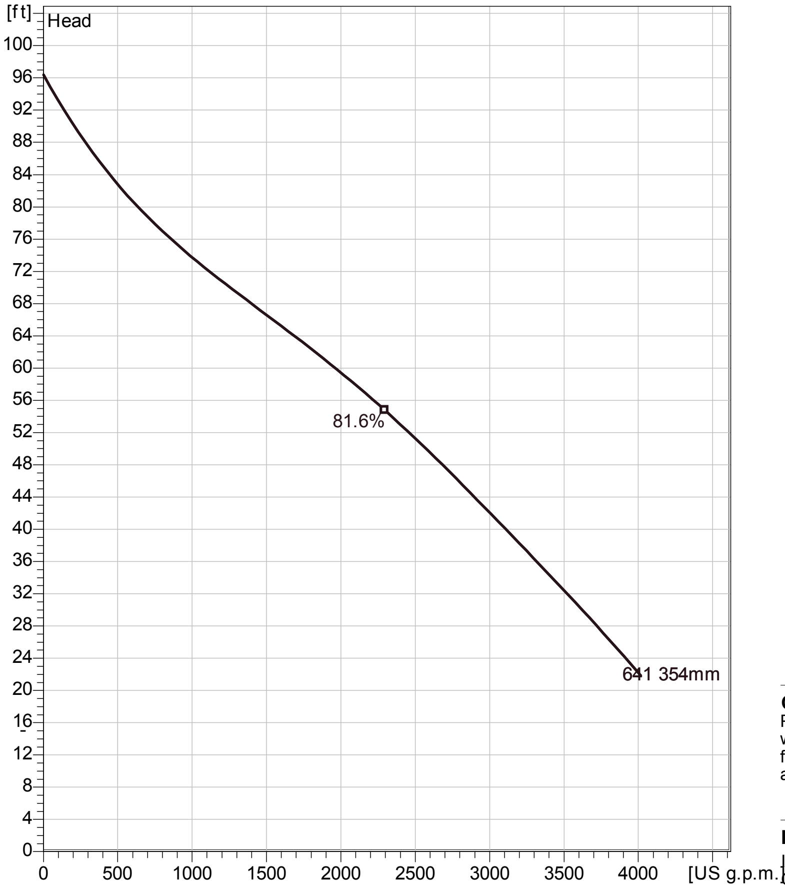
DECANTER/ ACTUATOR MAIN ASSEMBLY
40'-0" WEIR - 9010 ACTUATOR
24"ø COLLECTOR

Sanitaire
a xylem brand
BROWN DEER, WISCONSIN 53223

DRWN BY	DATE	EQUIP.	JOB. -M20	SHT.
CHKD BY	DATE	STD.	DWG.	OF
APPVD BY	DATE	SIZE D REV.		

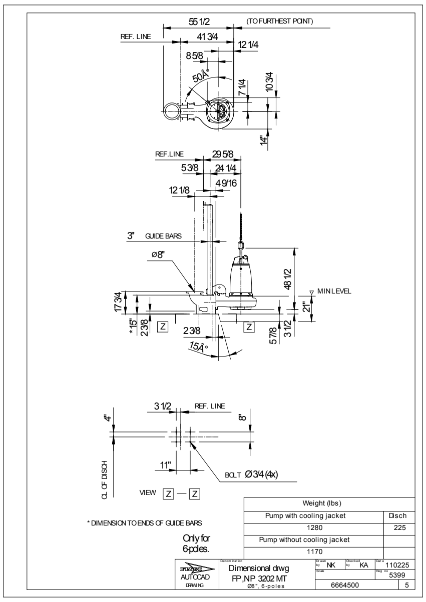
NP 3202 MT 3~ 641

Technical specification



Curve according to: ISO 9906 grade 2 annex 1 or 2

Installation: P - Semi permanent, Wet



Note: Picture might not correspond to the current configuration.

General

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Possible to be upgraded with Guide-pin® for even better clogging resistance. Modular based design with high adaptation grade.

Impeller

Impeller material	Hard-Iron ™
Outlet width	7 7/8 inch
Inlet diameter	250 mm
Impeller diameter	354 mm
Number of blades	2
	0 inch

Motor

Motor #	N3202.095 30-23-6AA-W 45hp
Stator variant	1
Frequency	60 Hz
Rated voltage	460 V
Number of poles	6
Phases	3~
Rated power	45 hp
Rated current	55 A
Starting current	330 A
Rated speed	1170 rpm
Power factor	
1/1 Load	0.85
3/4 Load	0.82
1/2 Load	0.73
Efficiency	
1/1 Load	89.5 %
3/4 Load	90.0 %
1/2 Load	89.5 %

Configuration

Project	Project ID	Created by	Created on	Last update
			2013-05-29	

NP 3202 MT 3~ 641

Performance curve

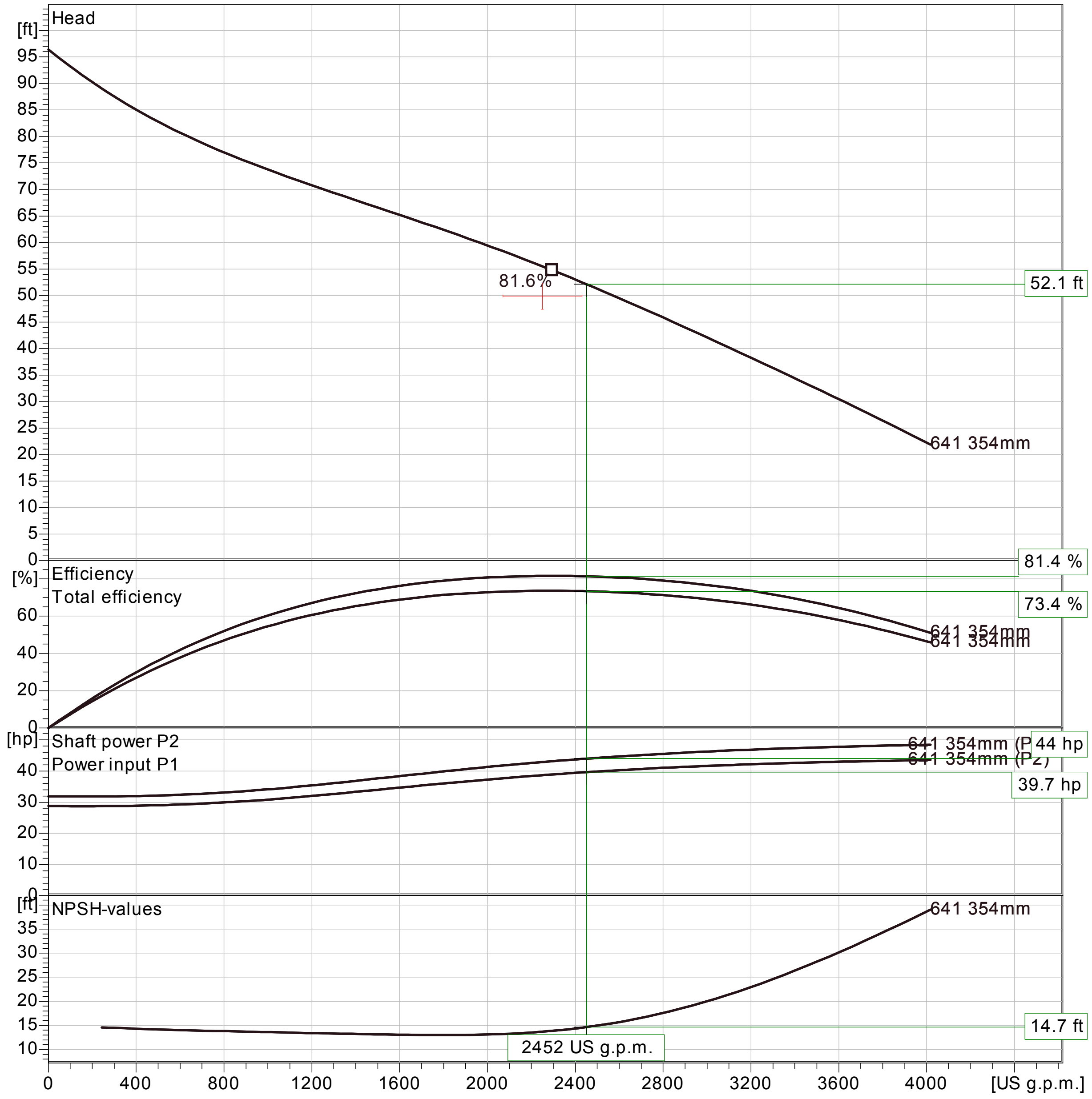
Pump

Outlet width	7 7/8 inch
Inlet diameter	250 mm
Impeller diameter	13 $^{15}/_{16}$"
Number of blades	2
	0 inch

Motor

Motor #	N3202.095 30-23-6AA-W 45hp
Stator variant	1
Frequency	60 Hz
Rated voltage	460 V
Number of poles	6
Phases	3~
Rated power	45 hp
Rated current	55 A
Starting current	330 A
Rated speed	1170 rpm

Power factor	
1/1 Load	0.85
3/4 Load	0.82
1/2 Load	0.73
Efficiency	
1/1 Load	89.5 %
3/4 Load	90.0 %
1/2 Load	89.5 %



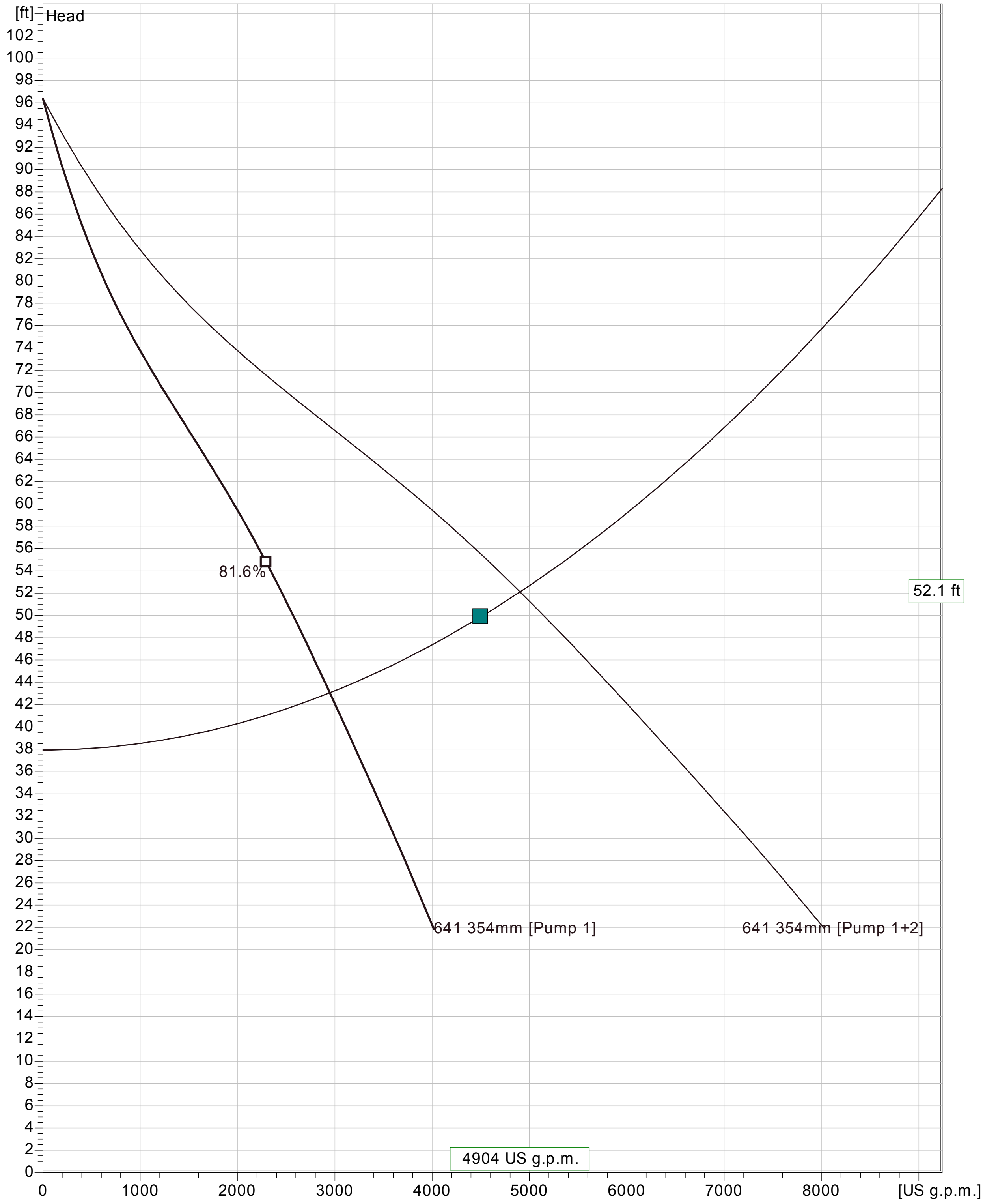
Curve according to: ISO 9906 grade 2 annex 1 or 2

Duty point					**Guarantee**
Flow	**Head**	**Shaft power**	**NPSHre**	**Hyd eff.**	**ISO_9906_Grade_2**
2250 US g.p.m.	49.9 ft			%	No

Project	Project ID	Created by	Created on	Last update
			2013-05-29	

NP 3202 MT 3~ 641

Duty Analysis



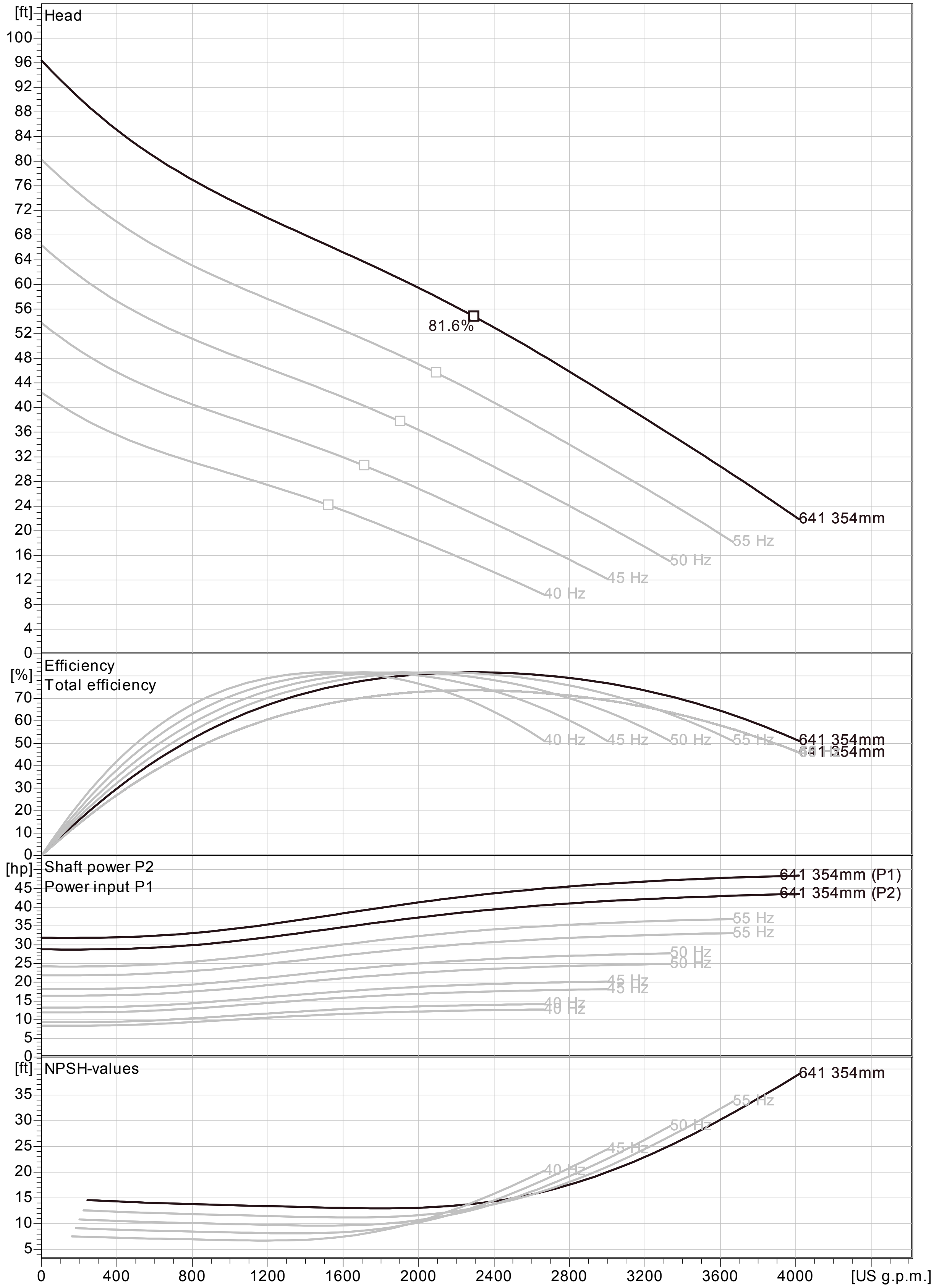
Curve according to: ISO 9906 grade 2 annex 1 or 2

	Individual pump			**Total**					
Pumps running /System	**Flow**	**Head**	**Shaft power**	**Flow**	**Head**	**Shaft power**	**Hyd eff.**	**Specific energy**	**NPSHre**
2	2450 US g.p.m.	52.1 ft	39.7 hp	4900 US g.p.m.	52.1 ft	79.3 hp	81.4 %	223 kWh/US MG	14.7 ft
1	2950 US g.p.m.	43.1 ft	41.5 hp	2950 US g.p.m.	43.1 ft	41.5 hp	77.4 %	194 kWh/US MG	19.3 ft

Project	Project ID	Created by	Created on	Last update
			2013-05-29	

NP 3202 MT 3~ 641

VFD Curve



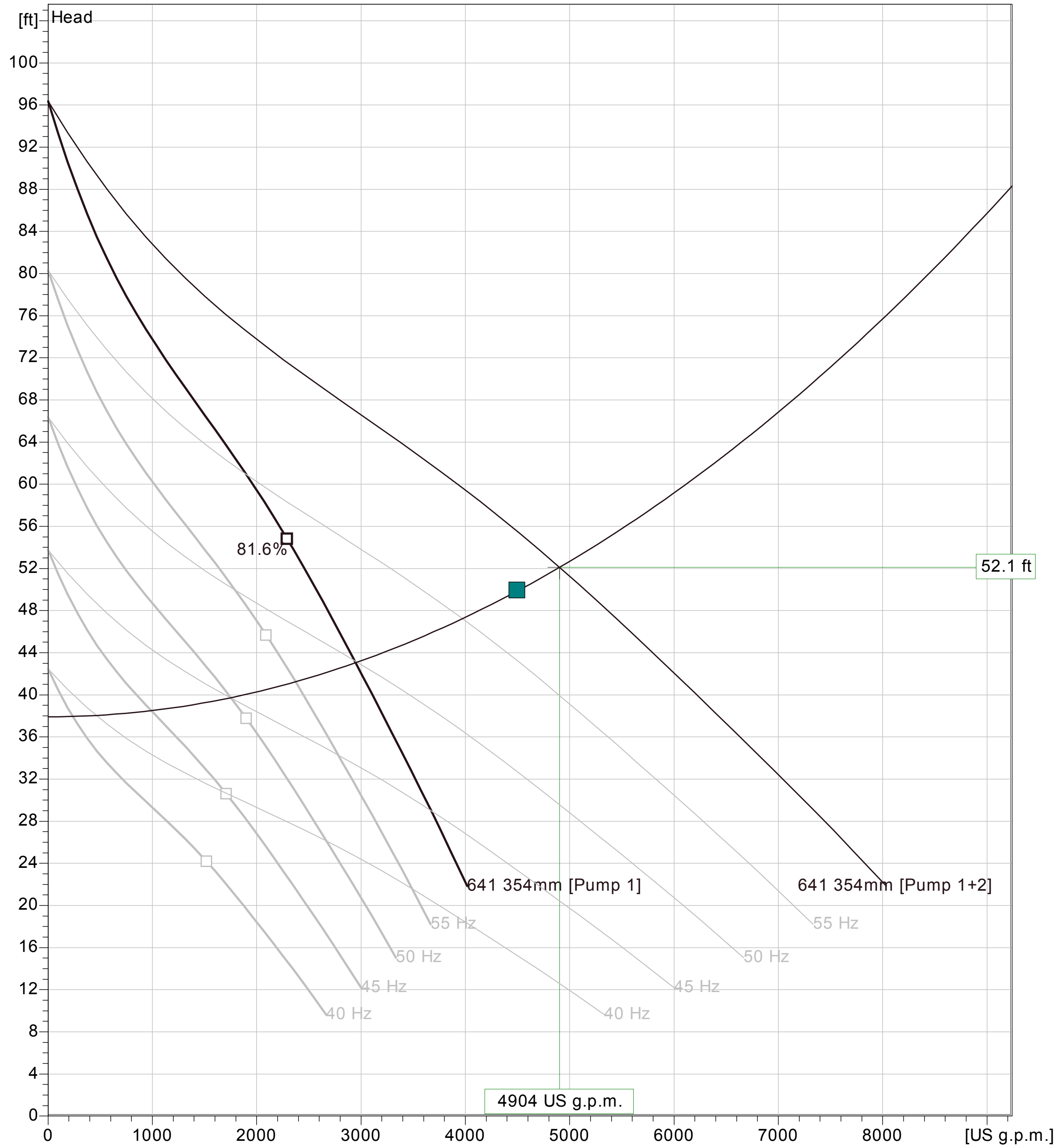
Curve according to: ISO 9906 grade 2 annex 1 or 2

Project	Project ID	Created by	Created on	Last update
			2013-05-29	

xylem
Let's Solve Water

FLYGT

NP 3202 MT 3~ 641
VFD Analysis



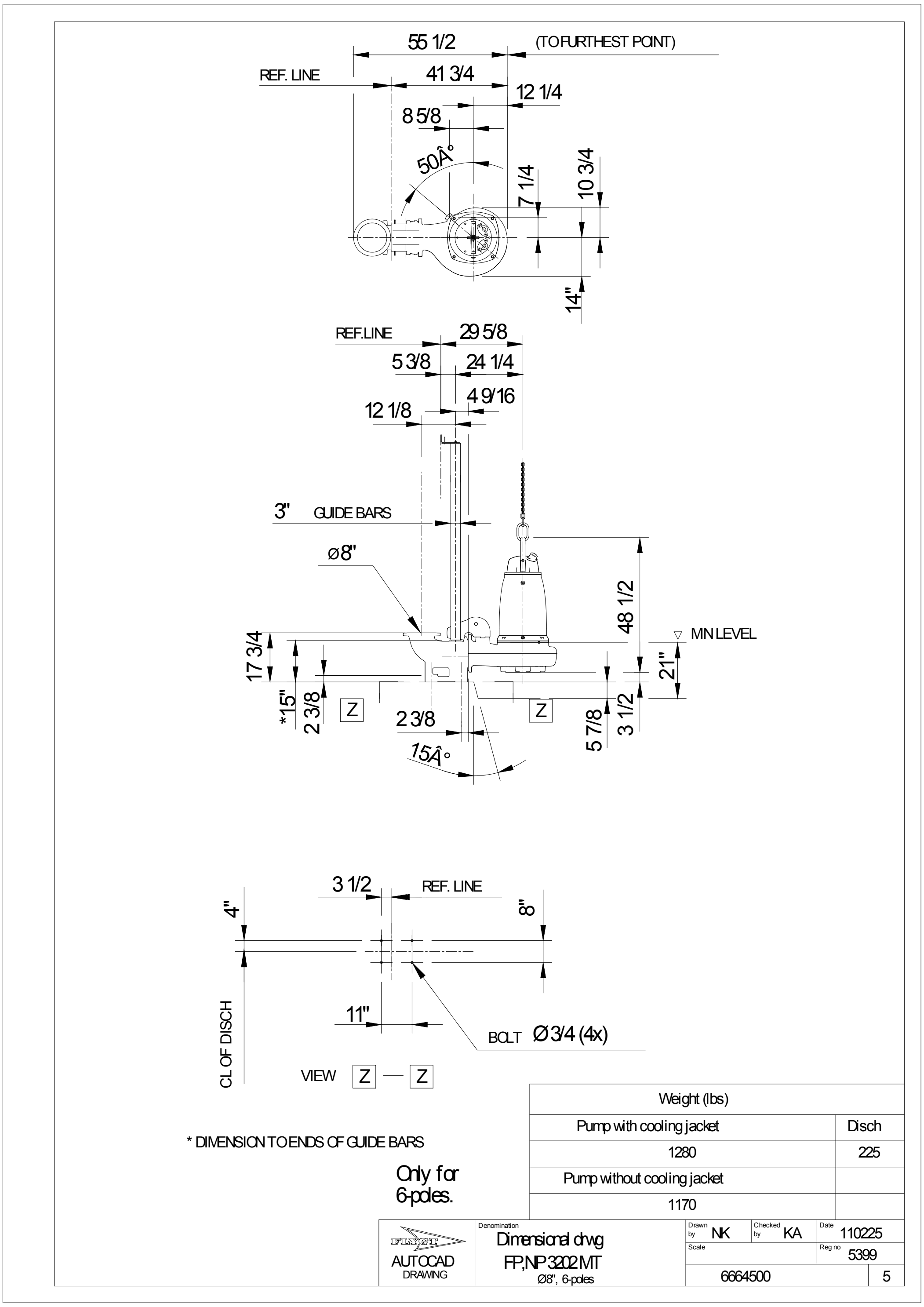
Curve according to: ISO 9906 grade 2 annex 1 or 2

	Individual pump				Total					
Pumps running /System	**Frequency**	**Flow**	**Head**	**Shaft power**	**Flow**	**Head**	**Shaft power**	**Hyd eff.**	**Specific energy**	**NPSHre**
2	60 Hz	2450 US g.p.m.	52.1 ft	39.7 hp	4900 US g.p.m.	52.1 ft	79.3 hp	81.4 %	223 kWh/US MG	14.7 ft
2	55 Hz	1990 US g.p.m.	47.2 ft	29.1 hp	3970 US g.p.m.	47.2 ft	58.2 hp	81.5 %	202 kWh/US MG	11.6 ft
2	50 Hz	1480 US g.p.m.	43.1 ft	20.5 hp	2960 US g.p.m.	43.1 ft	41 hp	78.8 %	193 kWh/US MG	9.64 ft
2	45 Hz	874 US g.p.m.	39.7 ft	13.2 hp	1750 US g.p.m.	39.7 ft	26.5 hp	66.2 %	218 kWh/US MG	8.43 ft
2	40 Hz	231 US g.p.m.	38 ft	8.43 hp	462 US g.p.m.	38 ft	16.9 hp	26.4 %	558 kWh/US MG	7.48 ft
1	60 Hz	2950 US g.p.m.	43.1 ft	41.5 hp	2950 US g.p.m.	43.1 ft	41.5 hp	77.4 %	194 kWh/US MG	19.3 ft
1	55 Hz	2370 US g.p.m.	41.2 ft	30.6 hp	2370 US g.p.m.	41.2 ft	30.6 hp	80.7 %	178 kWh/US MG	13.6 ft
1	50 Hz	1750 US g.p.m.	39.7 ft	21.7 hp	1750 US g.p.m.	39.7 ft	21.7 hp	81.3 %	173 kWh/US MG	9.87 ft
1	45 Hz	989 US g.p.m.	38.5 ft	13.7 hp	989 US g.p.m.	38.5 ft	13.7 hp	70.5 %	200 kWh/US MG	8.34 ft
1	40 Hz	237 US g.p.m.	38 ft	8.43 hp	237 US g.p.m.	38 ft	8.43 hp	27 %	545 kWh/US MG	7.48 ft

Project	Project ID	Created by	Created on	Last update
			2013-05-29	

NP 3202 MT 3~ 641

Dimensional drawing



Weight (lbs)	
Pump with cooling jacket	Disch
1280	225
Pump without cooling jacket	
1170	

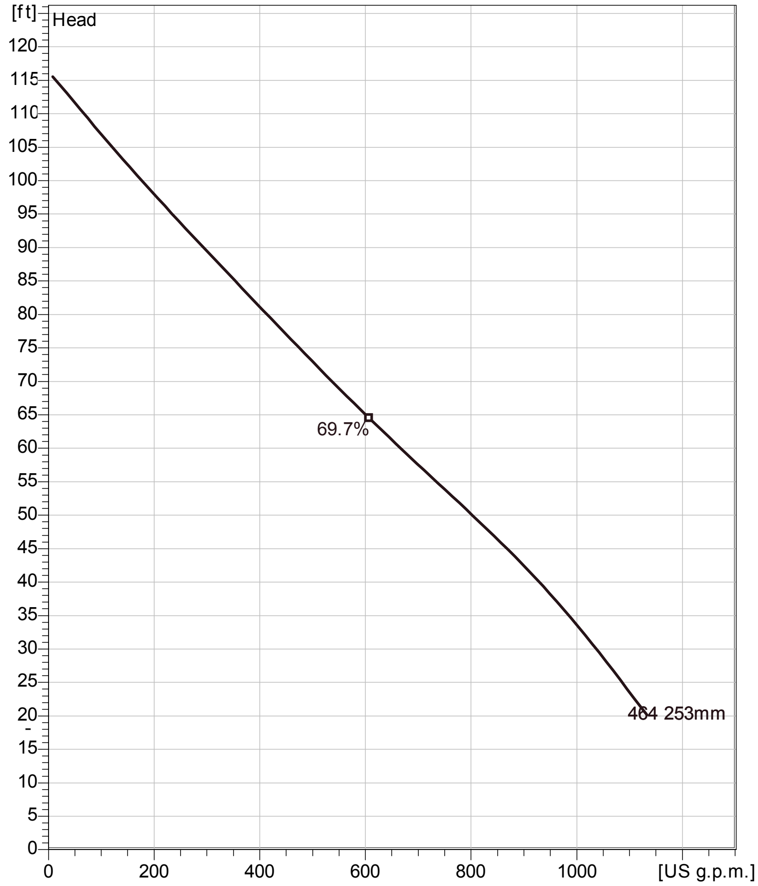
Project	Project ID	Created by	Created on	Last update
			2013-05-29	

xylem
Let's Solve Water

NP 3153 HT 3~ 464

Technical specification

FLYGT



Curve according to: ISO 9906 grade 2 annex 1 or 2

Note: Picture might not correspond to the current configuration.

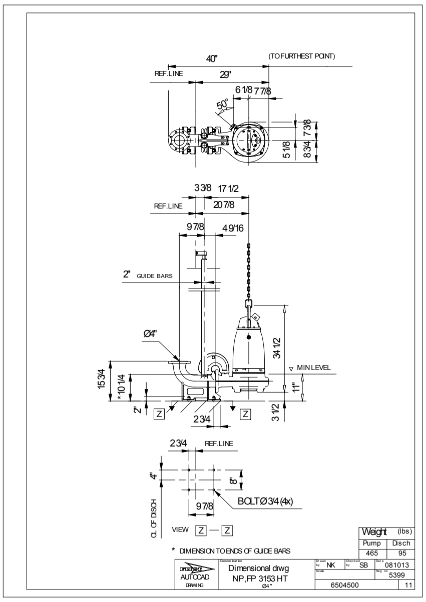
General

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Possible to be upgraded with Guide-pin® for even better clogging resistance. Modular based design with high adaptation grade.

Impeller

Impeller material	Hard-Iron ™
Outlet width	3 15/16 inch
Inlet diameter	150 mm
Impeller diameter	253 mm
Number of blades	2
	0 inch

Installation: P - Semi permanent, Wet



Motor

Motor #	N3153.830 21-18-4XS-W IE3 17hp
Stator variant	1
Frequency	60 Hz
Rated voltage	460 V
Number of poles	4
Phases	3~
Rated power	17 hp
Rated current	18 A
Starting current	157 A
Rated speed	1800 rpm
Power factor	
1/1 Load	0.96
3/4 Load	0.95
1/2 Load	0.90
Efficiency	
1/1 Load	92.5 %
3/4 Load	92.4 %
1/2 Load	90.9 %

Configuration

Project	Project ID	Created by	Created on	Last update
			2013-07-03	

NP 3153 HT 3~ 464

Performance curve

Pump

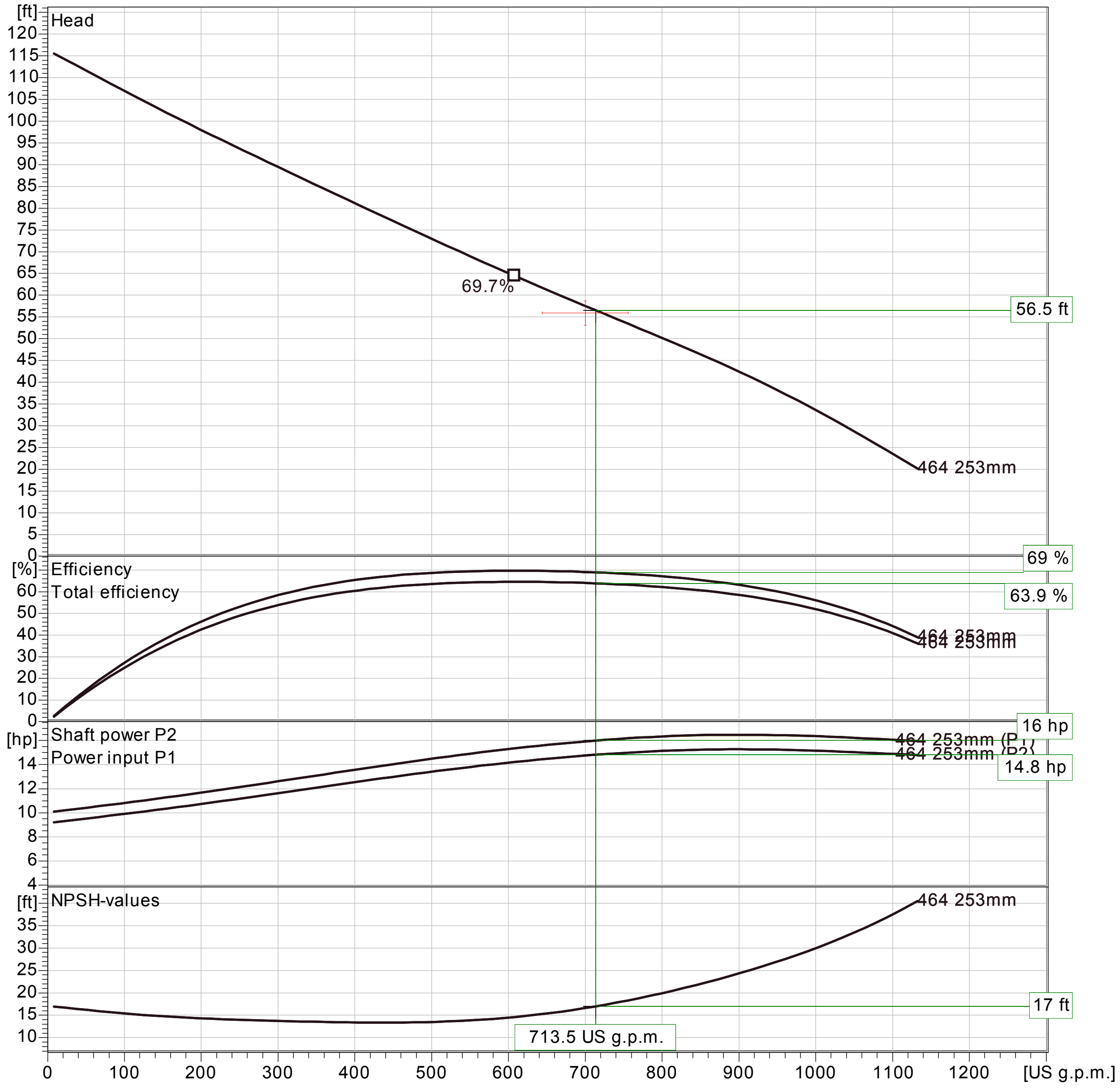
Outlet width	3 15/16 inch
Inlet diameter	150 mm
Impeller diameter	$9^{15}/_{16}$"
Number of blades	2
	0 inch

Motor

Motor #	N3153.830 21-18-4XS-W IE3 17hp
Stator variant	1
Frequency	60 Hz
Rated voltage	460 V
Number of poles	4
Phases	3~
Rated power	17 hp
Rated current	18 A
Starting current	157 A
Rated speed	1800 rpm

Power factor	
1/1 Load	0.96
3/4 Load	0.95
1/2 Load	0.90

Efficiency	
1/1 Load	92.5 %
3/4 Load	92.4 %
1/2 Load	90.9 %



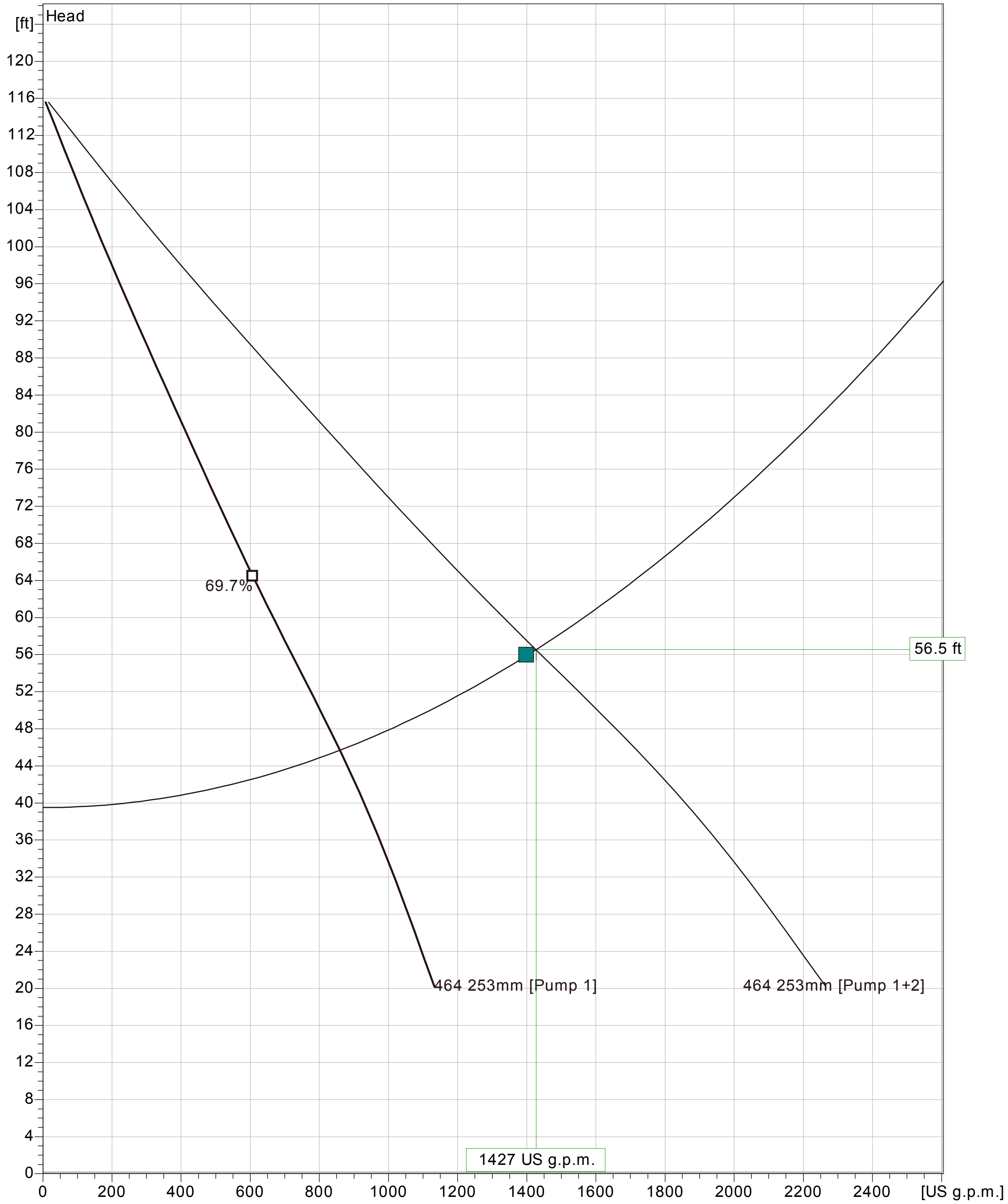
Curve according to: ISO 9906 grade 2 annex 1 or 2

Duty point					**Guarantee**
Flow	**Head**	**Shaft power**	**NPSHre**	**Hyd eff.**	**ISO_9906_Grade_2**
700 US g.p.m.	55.9 ft	<15.3 hp	17.3 ft	68.9 %	Yes

Project	Project ID	Created by	Created on	Last update
			2013-07-03	

NP 3153 HT 3~ 464

Duty Analysis



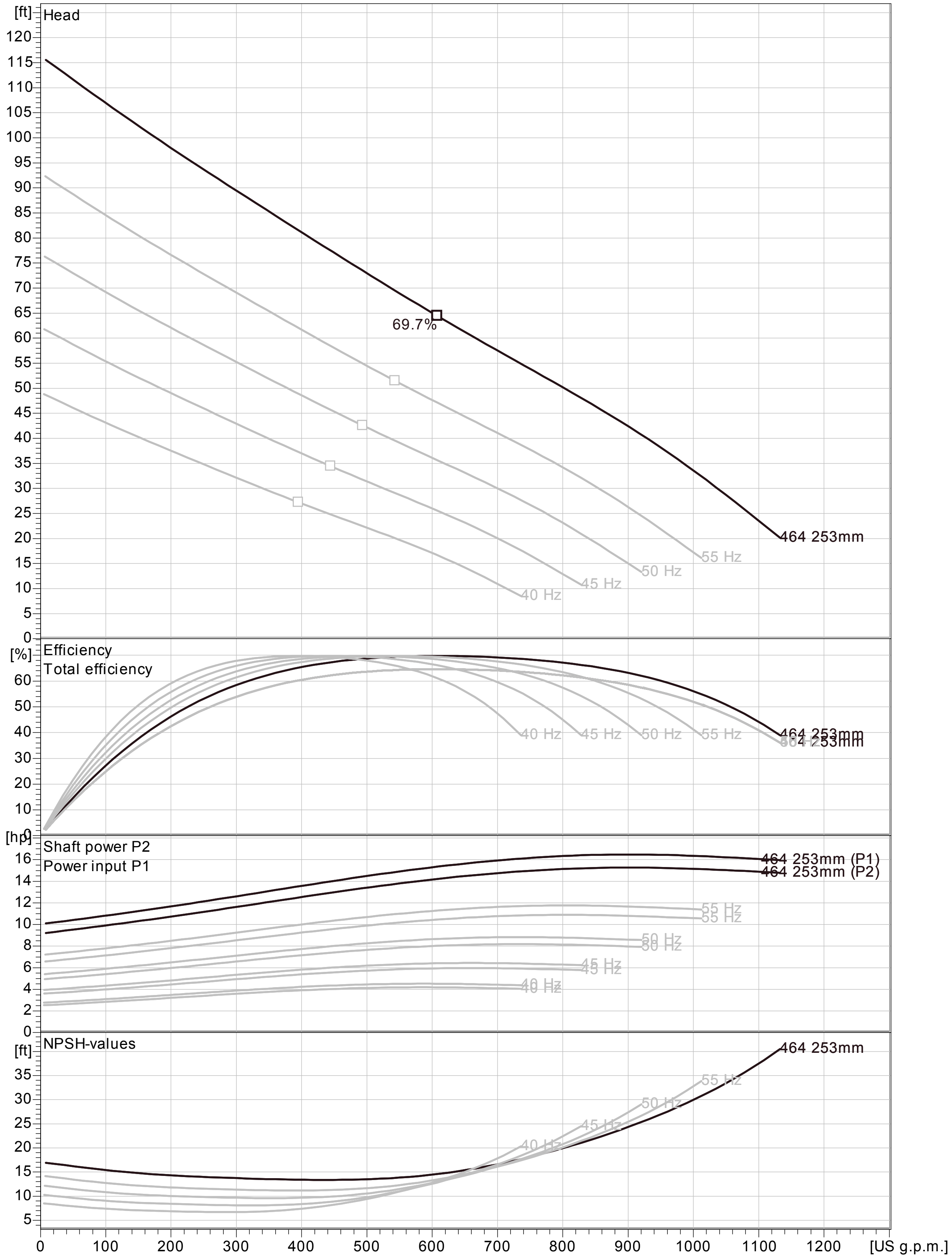
Curve according to: ISO 9906 grade 2 annex 1 or 2

	Individual pump			Total					
Pumps running /System	Flow	Head	Shaft power	Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
2	713 US g.p.m.	56.5 ft	14.8 hp	1430 US g.p.m.	56.5 ft	29.6 hp	69 %	279 kWh/US MG	17 ft
1	859 US g.p.m.	45.7 ft	15.2 hp	859 US g.p.m.	45.7 ft	15.2 hp	65.1 %	238 kWh/US MG	22.4 ft

Project	Project ID	Created by	Created on	Last update
			2013-07-03	

NP 3153 HT 3~ 464

VFD Curve

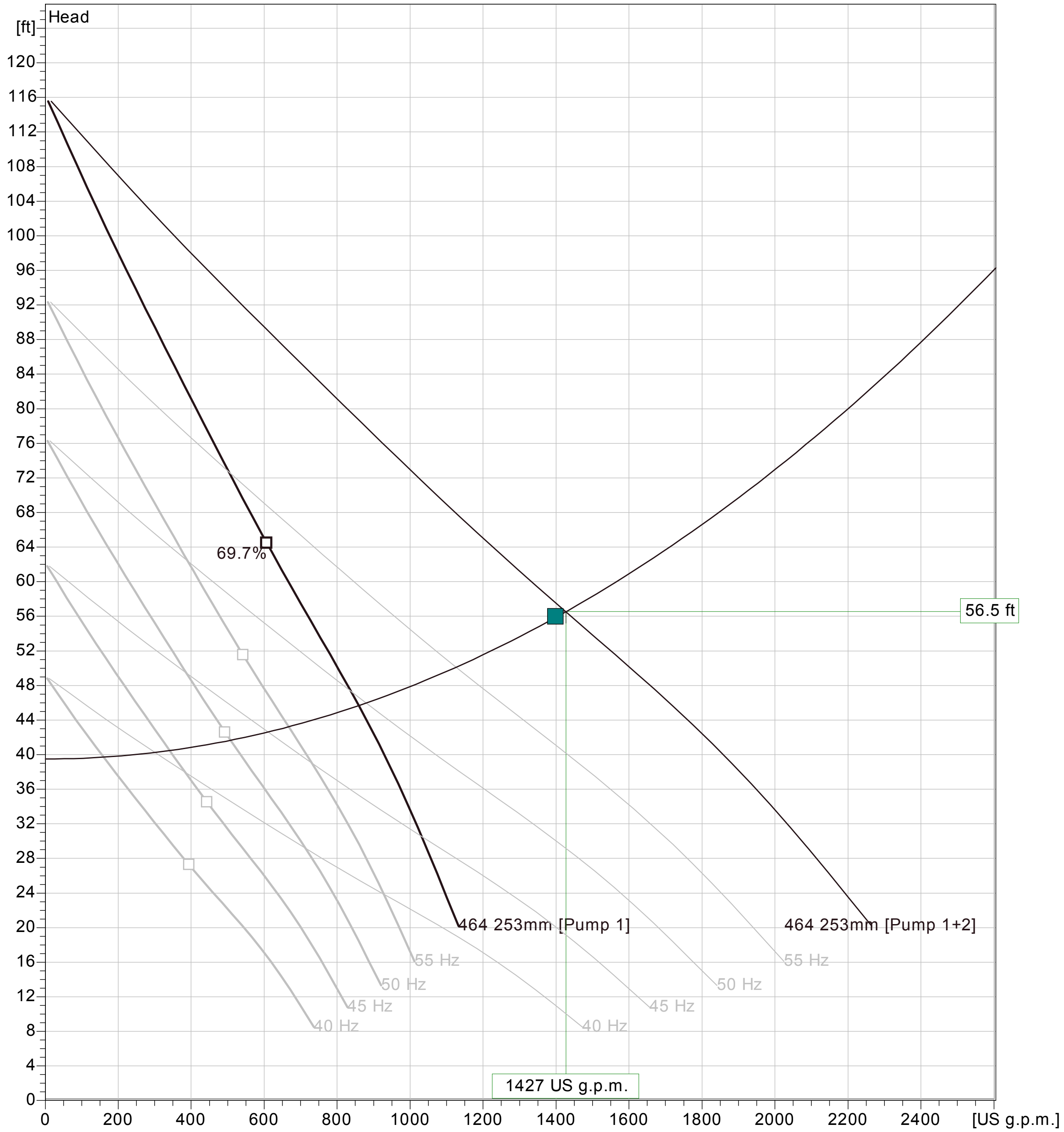


Curve according to: ISO 9906 grade 2 annex 1 or 2

Project	Project ID	Created by	Created on	Last update
			2013-07-03	

NP 3153 HT 3~ 464

VFD Analysis



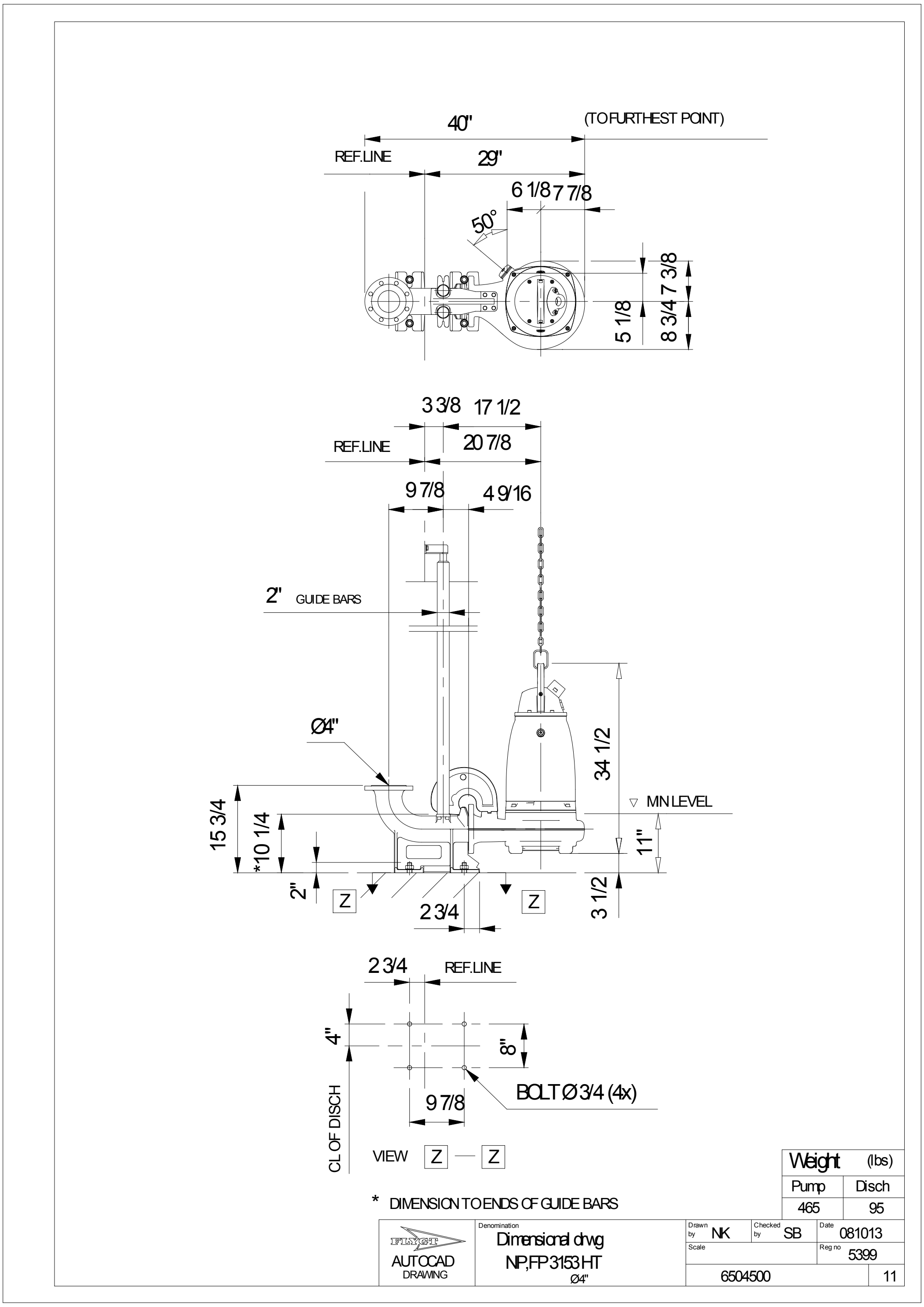
Curve according to: ISO 9906 grade 2 annex 1 or 2

	Individual pump				Total					
Pumps running /System	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
2	60 Hz	713 US g.p.m.	56.5 ft	14.8 hp	1430 US g.p.m.	56.5 ft	29.6 hp	69 %	279 kWh/US MG	17 ft
2	55 Hz	563 US g.p.m.	50.1 ft	10.3 hp	1130 US g.p.m.	50.1 ft	20.5 hp	69.7 %	247 kWh/US MG	12.5 ft
2	50 Hz	440 US g.p.m.	46 ft	7.37 hp	880 US g.p.m.	46 ft	14.7 hp	69.4 %	231 kWh/US MG	9.88 ft
2	45 Hz	305 US g.p.m.	42.6 ft	4.97 hp	611 US g.p.m.	42.6 ft	9.93 hp	66.2 %	232 kWh/US MG	8.11 ft
2	40 Hz	150 US g.p.m.	40.3 ft	3.02 hp	301 US g.p.m.	40.3 ft	6.05 hp	50.7 %	313 kWh/US MG	7.08 ft
1	60 Hz	859 US g.p.m.	45.7 ft	15.2 hp	859 US g.p.m.	45.7 ft	15.2 hp	65.1 %	238 kWh/US MG	22.4 ft
1	55 Hz	667 US g.p.m.	43.2 ft	10.7 hp	667 US g.p.m.	43.2 ft	10.7 hp	68.4 %	218 kWh/US MG	15.1 ft
1	50 Hz	508 US g.p.m.	41.7 ft	7.69 hp	508 US g.p.m.	41.7 ft	7.69 hp	69.7 %	211 kWh/US MG	10.7 ft
1	45 Hz	341 US g.p.m.	40.5 ft	5.13 hp	341 US g.p.m.	40.5 ft	5.13 hp	67.9 %	219 kWh/US MG	8.12 ft
1	40 Hz	160 US g.p.m.	39.7 ft	3.06 hp	160 US g.p.m.	39.7 ft	3.06 hp	52.6 %	303 kWh/US MG	7.03 ft

Project	Project ID	Created by	Created on	Last update
			2013-07-03	

NP 3153 HT 3~ 464

Dimensional drawing



Project	Project ID	Created by	Created on	Last update
			2013-07-03	

FLYGT

PERFORMANCE CURVE

PRODUCT	TYPE
CP3085.183	MT

DATE	PROJECT	CURVE NO	ISSUE
2010-08-02	FLYGT US Catalog	63-434-00-5303	3

	1/1-LOAD	3/4-LOAD	1/2-LOAD
POWER FACTOR	0.83	0.77	0.66
EFFICIENCY	78.0 %	79.0 %	77.0 %
MOTOR DATA	---	---	---

RATED POWER	3	hp
STARTING CURRENT ...	22	A
RATED CURRENT ...	4.3	A
RATED SPEED	1700	rpm
TOT.MOM.OF INERTIA ...	0.034	kgm2
NO. OF BLADES	1	

IMPELLER DIAMETER
160 mm

MOTOR #	STATOR	REV
15-10-4AL	12YSER	13

FREQ.	PHASES	VOLTAGE	POLES
60 Hz	3	460 V	4

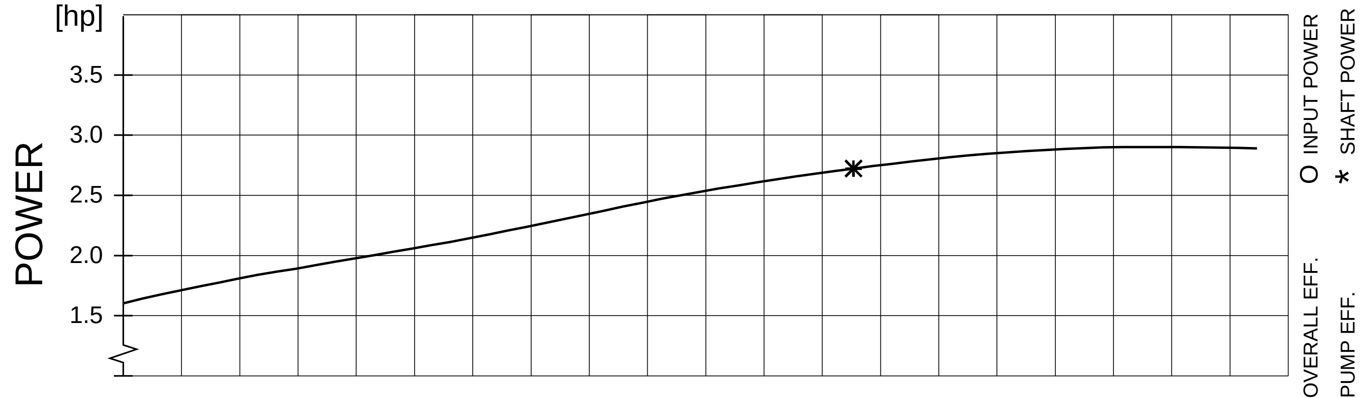
GEARTYPE	RATIO
---	---

COMMENTS

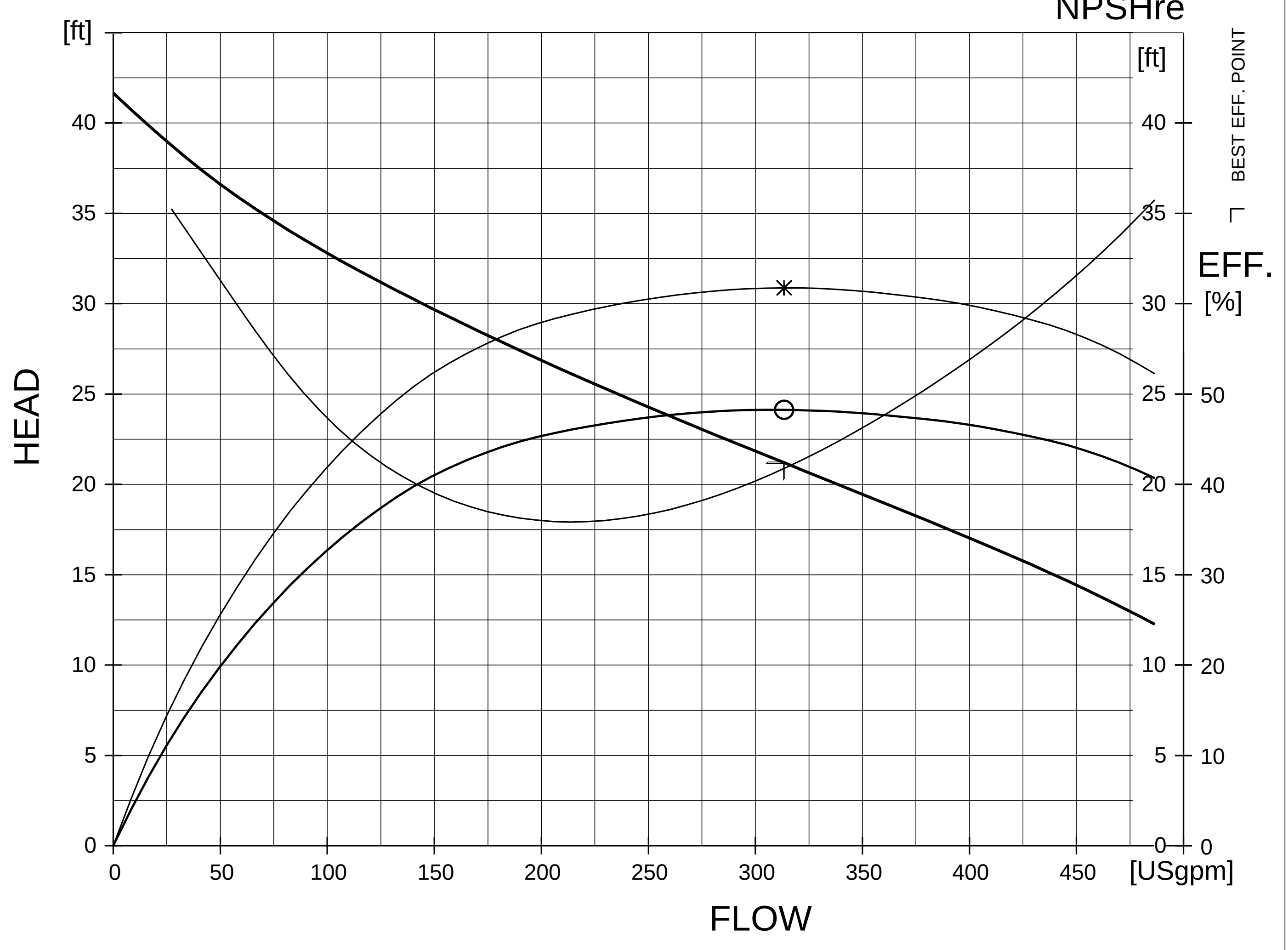
NEMA Code Letter: G

INLET/OUTLET
- / 3.0 inch

IMP. THROUGHLET
3.0 inch



DUTY-POINT	FLOW[USgpm]	HEAD[ft]	POWER [hp]	EFF. [%]	NPSHre[ft]
B.E.P.	313	21.2	(2.7)	48.3 (61.8)	20.9

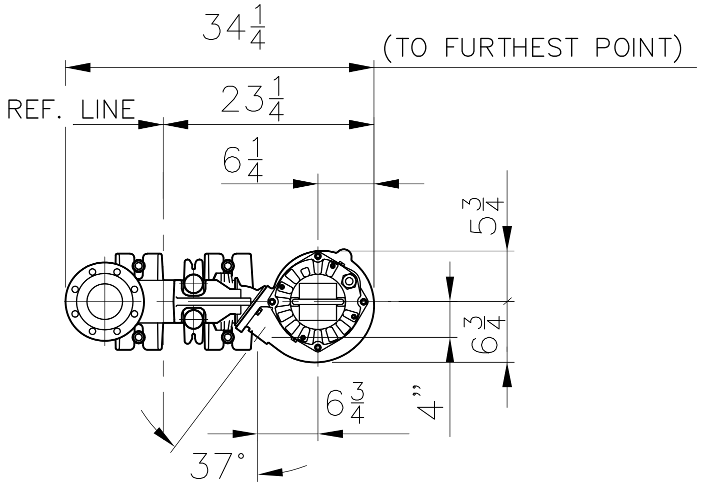


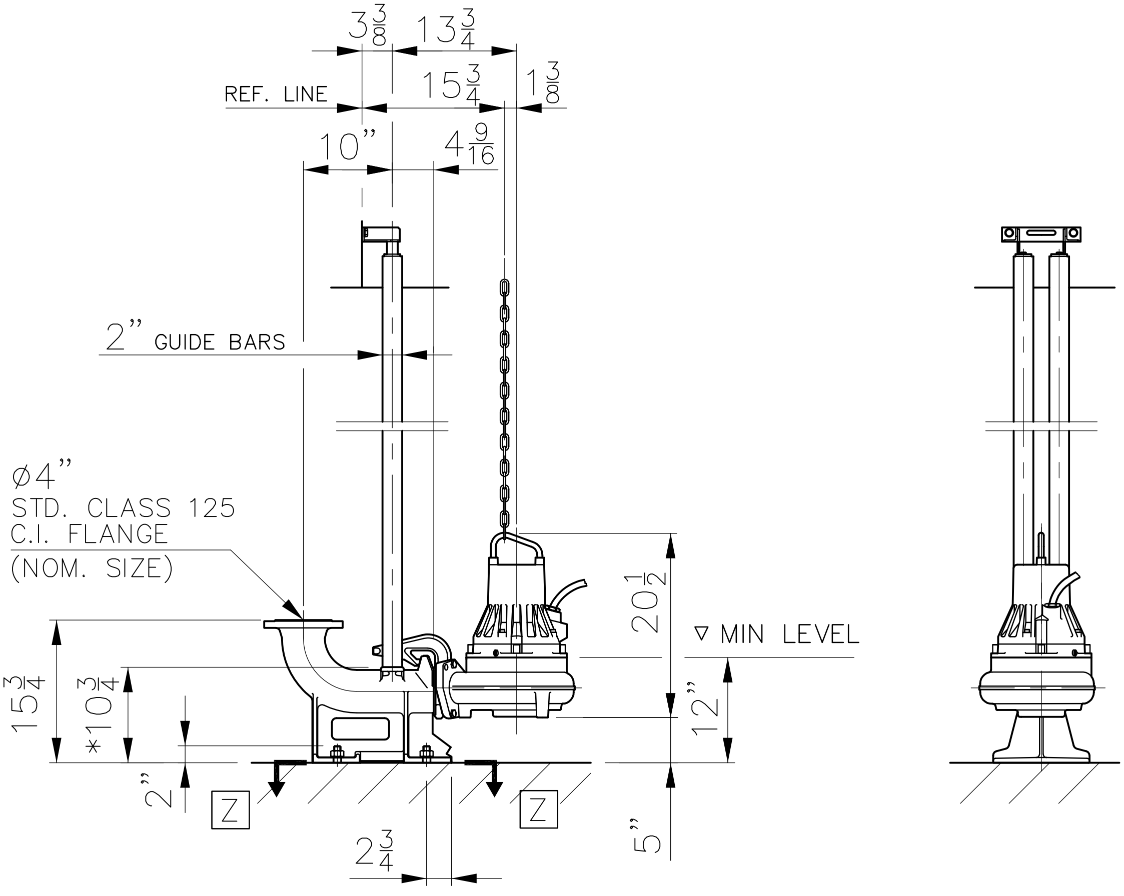
FLYPS 3.1.6.3 (20060531)

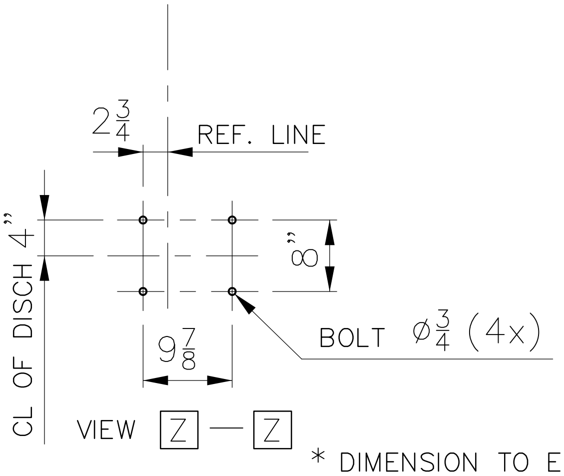
NPSHre = NPSH3% + min. operational margin

Performance with clear water and ambient temp 40 °C

FLYGT CURVE







* DIMENSION TO ENDS OF GUIDE BARS

Weight (lbs)	
Pump	Disch
150	80

FLYGT
AUTOCAD
DRAWING

Denomination
Dimensional drwg
CP 3085 MT
4" / 4"

Drawn by NK
Checked by
Date 080814
Scale
Reg no 5399
5383300
6

Customer Price Sheet

Customer	SHN Engineers	Size / Stages	3" Model C / 1
Item number	001	Pump speed	930 rpm
Customer reference		Quote number	269505

Totals

Grand Total	$ 28,031	Lead Time Total	N/A

Pump

Qty	Description
1	*3" Model C*
	General Pump Options
	Clockwise rotation (CW)
	Steel pump hardware
	Bearing lubrication
	Oil lubricated bearings
	Nitrile elastomers
	Case Assembly
	3x3 Case
	Vertical Top
	High chrome case (650+ BHN hardness)
	No case vent & drain
	Standard suction connection
	Rotating Assembly
	High chrome impeller (650+ BHN hardness)
	Static balance
	Steel shaft
	Steel impeller bolt
	Pump Sealing
	Pump sealing
	Seal Type: Single Mechanical Seal
	Slurry Dynamics Single Mechanical Seal Slurry Seal
	No shaft sleeve
	Hi-Chrome Gland Housing Material/Backplate
	Stainless steel gland
	Driver
	Motors
	WSP Supplied Motor: WSP Supplied Motor
	10HP 215T 1800RPM Premium Efficiency TEFC Horizontal motor
	Motor manufacturer - WSP Standard
	Baseplate and Drive
	Belt Drive Baseplate - Side Mount
	Steel Baseplate
	WSP Standard Baseplate Design
	Steel Baseplate Hardware
	Fiberglass/Polyethylene Guards
	Left Hand Side Mount Motor
	Belts and Sheaves
	Variable Speed Belts and Sheaves - Stationary Control
	Protective Coatings
	Paint manufacturer & type
	Paint Preparation: Standard paint preparation (clean and blast)

Pump

Qty	Description
	WSP Standard Blue Paint - Prime and Top Coat
	Packing & Shipping
	No Boxing
	WSP Decision Carrier
	Freight Rates
	Freight Rates - Oregon: Oregon
	Material Testing
	No Hardness Testing
	No Non-Destructive Testing
	Testing
	Testing Required
	Performance testing
	5 Point Performance Test, Multiple Speeds
	Bare Pump Test: Bare Pump Test
	Start-up
	Start-up
	Start-up by Rep
	Weights
	Bareshaft Pump 670.lbs
	Baseplate 410.lbs
	Driver 180.lbs
	Misc. Weight 0.lbs
	Misc. Weight 0.lbs
	Misc. Weight 0.lbs
	Total Per Unit Weight 1260.lbs

Pump Performance Datasheet

Customer : SHN Engineers
Customer reference :
Item number : 001
Service :
Quantity : 1

Quote number : 269505
Size : 3" Model C
Stages : 1
Based on curve number : 3C_P10C-D41
Date last saved : 30 Apr 2013 6:13 PM

Operating Conditions

Flow, rated : 250 USgpm
Differential head / pressure, rated (requested) : 28.0 ft
Differential head / pressure, rated (actual) : 28.1 ft
Suction pressure, rated / max : 0.00 / 0.00 psi.g
NPSH available, rated : Ample
Frequency : 60 Hz

Performance

Speed, rated : 930 rpm
Speed, maximum : 1,700 rpm
Speed, minimum : 500 rpm
Efficiency : 29.42 %
NPSH required / margin required : - / 0.00 ft
Ns (imp. eye flow) / Nss (imp. eye flow) : N/A US Units
MCSF : 20.0 USgpm
Head maximum, rated speed : 35.3 ft
Head rise to shutoff : 26.05 %
Flow, best eff. point (BEP) : 424 USgpm
Flow ratio (rated / BEP) : 58.96 %
Speed ratio (rated / max) : 54.71 %
Head ratio (rated speed / max speed) : 25.23 %
Cq/Ch/Ce [ANSI/HI 9.6.7-2010] : 1.00 / 1.00 / 1.00
Selection status : Acceptable

Liquid

Liquid type : User defined (no properties)
Additional liquid description :
Solids diameter, max : 0.00 in
Solids concentration, by volume : 0.00 %
Temperature, max : 68.00 deg F
Fluid density, rated / max : 1.000 / 1.000 SG
Viscosity, rated : 1.00 cP
Vapor pressure, rated : 0.00 psi.a

Material

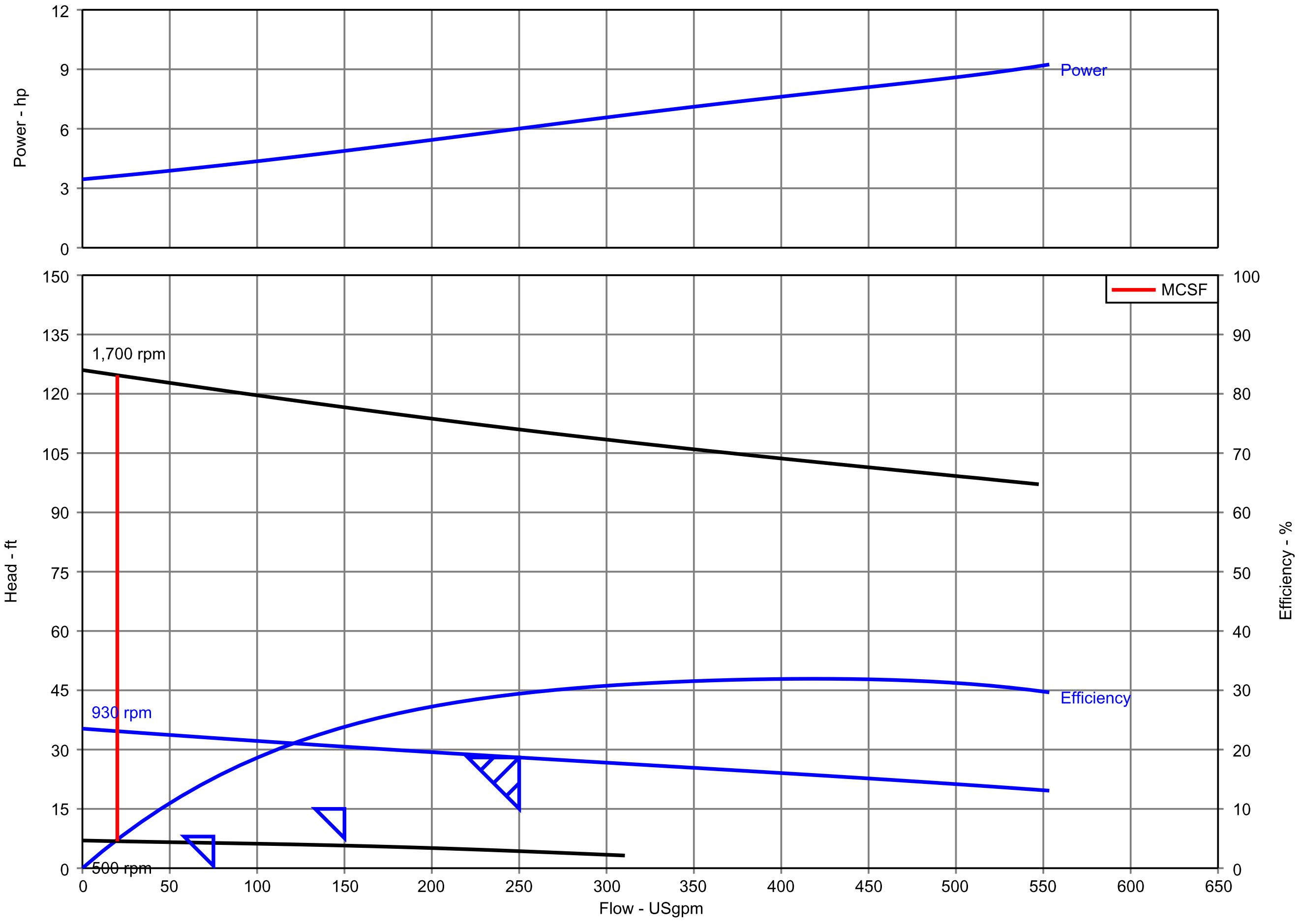
Material selected : Standard

Pressure Data

Maximum working pressure : 15.28 psi.g
Maximum allowable working pressure : 85.00 psi.g
Maximum allowable suction pressure : N/A
Hydrostatic test pressure : N/A

Driver & Power Data

Driver sizing specification : Rated power
Margin over specification : 0.00 %
Service factor : 1.00
Power, hydraulic : 1.77 hp
Power, rated : 6.01 hp
Power, maximum, rated speed : 9.24 hp
Minimum recommended motor rating : 7.50 hp / 5.59 kW



Construction Datasheet

Customer : SHN Engineers
Project :
Item number : 001
Service : -
Quantity of pumps : 1

Quote Number : 269505
Model / Size : 3" Model C
Stages : 1
Pump speed : 930 rpm
Date last saved : 30 Apr 2013 6:13 PM

Construction

Nozzle	Size	Rating (ANSI)	Face	Pos'n
Suction	3 in	125 lbs	FF	End
Discharge	3 in	125 lbs	FF	Right

Impeller Type : Recessed
Impeller Design : Cup Type
Pump Orientation : Horizontal
Bearing Type (Rad/Thr) : Ball/Ball
Bearing Lubrication : Oil
Rotation (view from shaft-end) : CW

Materials

Casing : High Chrome
Impeller : High Chrome
Wearplate/Backplate : High Chrome
Elastomer : Nitrile
Shaft : Steel
Sleeve : No Shaft Sleeve

Baseplate, Connection and Guard

Baseplate Type : Belt Drive - Side Mount
Baseplate Material : Steel
Orientation : Left Hand
Connection Type : Belt drive
Guard : Fiberglass/Polyethylene

Weights (Approx.)

Bareshaft pump : 670.0 lb
Baseplate : 410.0 lb
Driver : 180.0 lb
Total weight : 1,260.0 lb

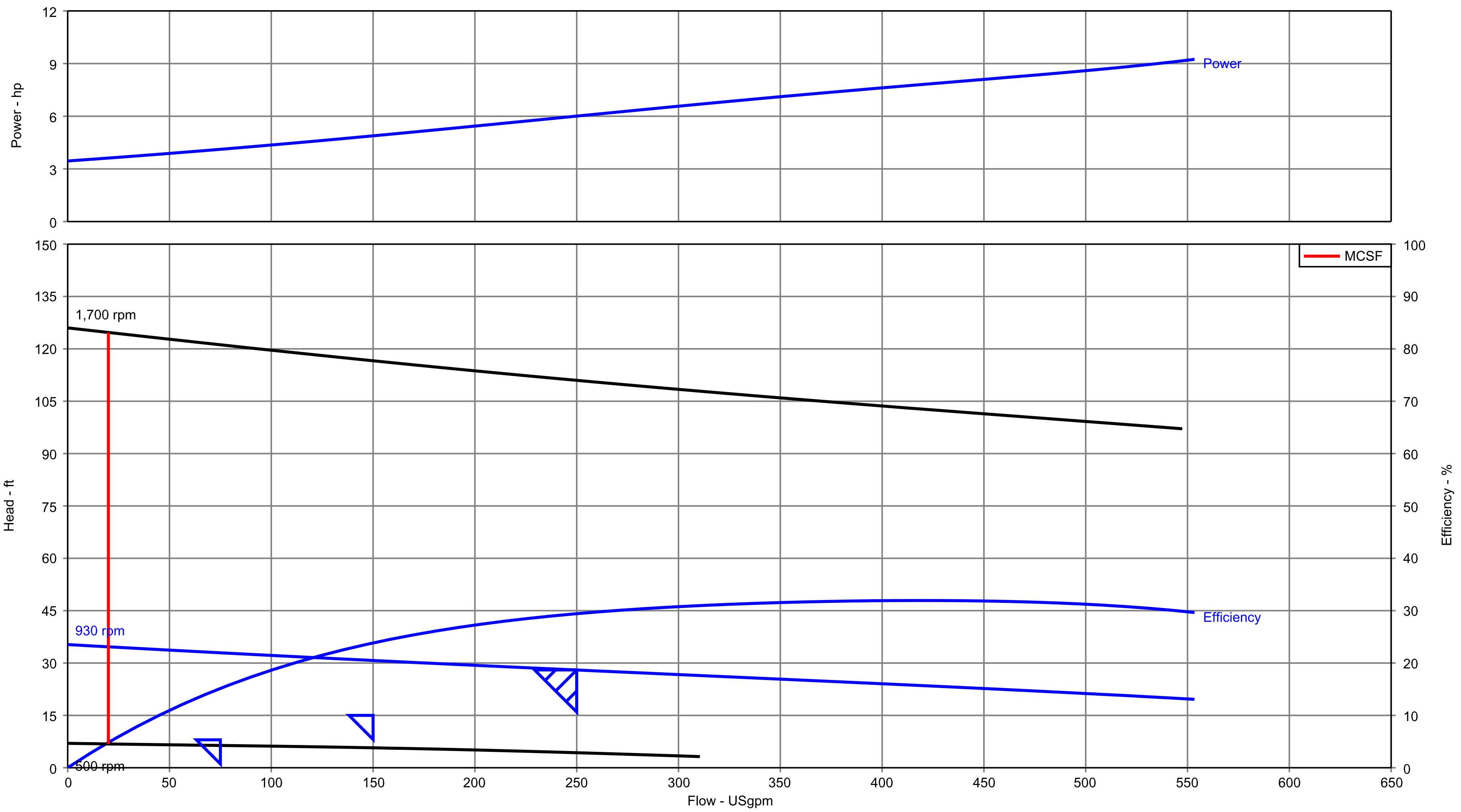
Driver Information

Manufacturer : WSP Choice
Power : 10.00 hp
Service factor : -
Speed : 1,800 rpm
Orientation / Mounting : Horizontal/Foot
Driver type : Horizontal
Frame-size : 215T
Enclosure : -
Hazardous area class : -
Explosion rating : -
Volts / Phase / Hz : -
Insulation : -
Temperature Rise : -
Motor mounted by : WSP

Seal, Gland and Piping

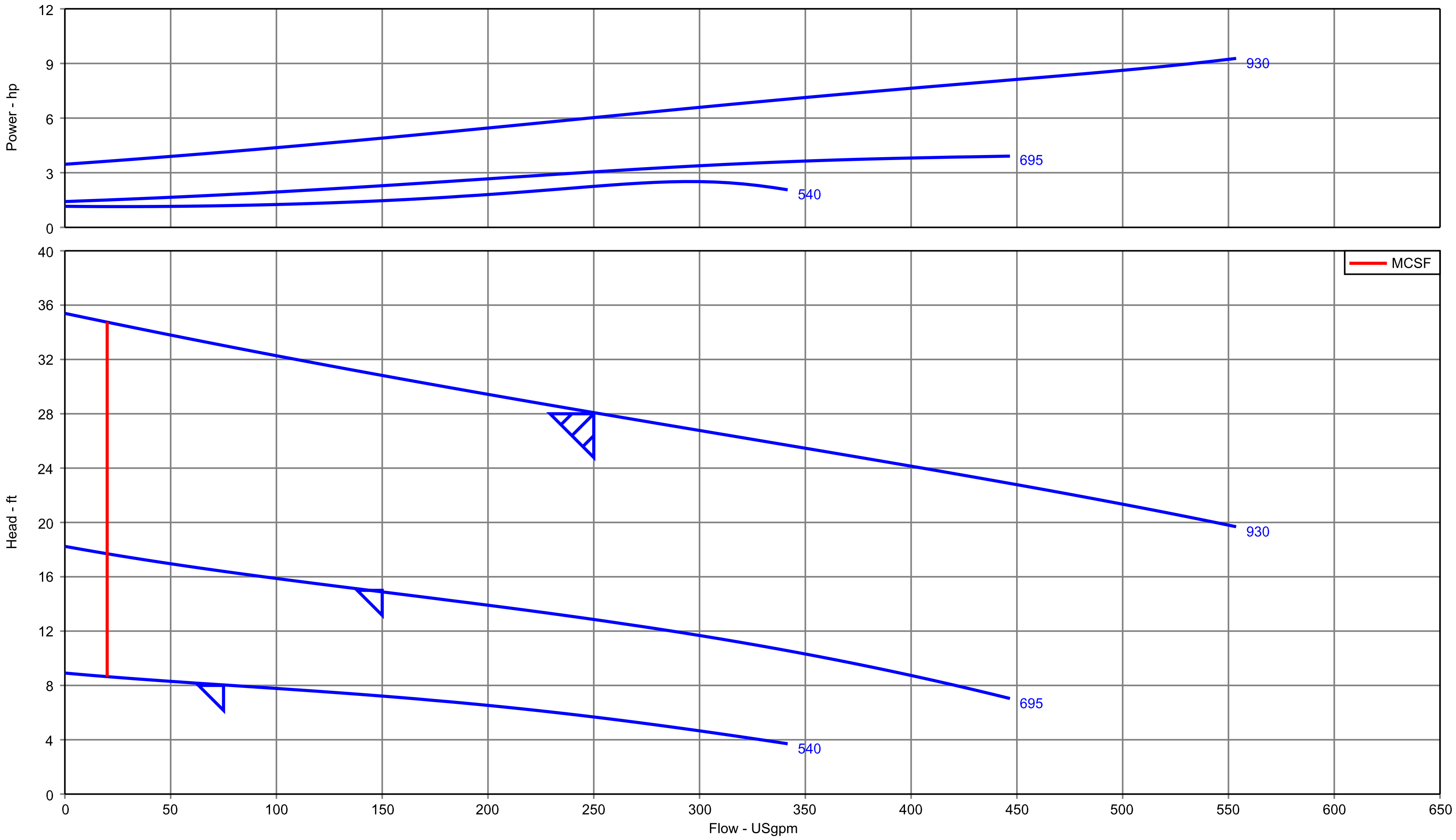
Seal Arrangement : Single
Seal Size : N/A
Manufacturer : Slurry Dynamics
Gland Material : Stainless Steel
Seal Face Mat'l : Tungsten Carbide / Tungsten Carbide
Throat Bushing : N/A
Seal Flush Plan : -
Seal Flush Construction : -

Pump Performance Curve



Customer	: SHN Engineers	Size	: 3" Model C	Flow, rated	: 250 USgpm
Customer reference	:	Stages	: 1	Differential head / pressure, rated	: 28.0 ft
Item number	: 001	Speed, rated	: 930 rpm	Fluid density, rated / max	: 1.000 / 1.000 SG
Service	:	Based on curve number	: 3C_P10C-D41	Viscosity	: 1.00 cP
Quantity	: 1	Efficiency	: 29.42 %	Cq/Ch/Ce [ANSI/HI 9.6.7-2010]	: 1.00 / 1.00 / 1.00
Quote number	: 269505	Power, rated	: 6.01 hp		
Date last saved	: 30 Apr 2013 6:13 PM	NPSH required	: -		

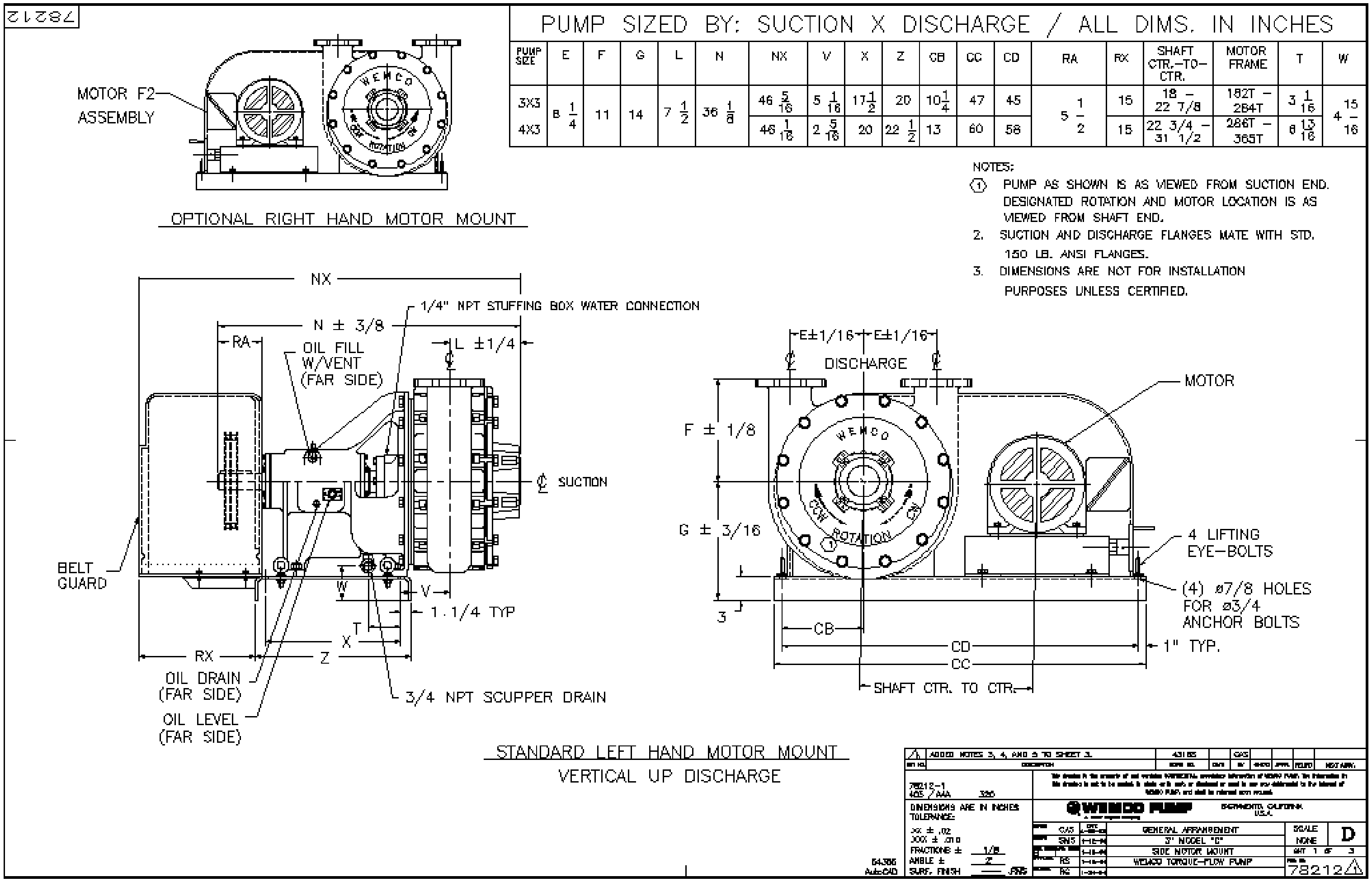
Multi-Speed Performance Curve



Customer	: SHN Engineers	Size	: 3" Model C	Flow, rated	: 250 USgpm
Customer reference	:	Stages	: 1	Differential head / pressure, rated	: 28.0 ft
Item number	: 001	Speed, rated	: 930 rpm	Fluid density, rated / max	: 1.000 / 1.000 SG
Service	:	Based on curve number	: 3C_P10C-D41	Viscosity	: 1.00 cP
Quantity	: 1	Efficiency	: 29.42 %	Cq/Ch/Ce [ANSI/HI 9.6.7-2010]	: 1.00 / 1.00 / 1.00
Quote number	: 269505	Power, rated	: 6.01 hp		
Date last saved	: 30 Apr 2013 6:13 PM	NPSH required	: -		

General Arrangement Drawing

Customer	: SHN Engineers	Quote number	: 269505
Customer reference	:	Size	: 3" Model C
Item number	: 001	Stages	: 1
Service	:	Pump speed	: 930 rpm
Quantity of pumps	: 1.0	Date last saved	: 30 Apr 2013 6:13 PM



PUMP SIZED BY: SUCTION X DISCHARGE / ALL DIMS. IN INCHES

PUMP SIZE	E	F	G	L	N	NX	V	X	Z	CB	CC	CD	RA	RX	SHAFT CTR.–TO–CTR.	MOTOR FRAME	T	W
3X3	8 1/4	11	14	7 1/2	36 1/8	46 5/16	5 1/16	17 1/2	20	10 1/4	47	45	5 1/2	15	18 – 22 7/8	182T – 284T	3 1/16	4 15/16
4X3						46 1/16	2 5/16	20	22 1/2	13	60	58		15	22 3/4 – 31 1/2	286T – 365T	8 13/16	

NOTES:

① PUMP AS SHOWN IS AS VIEWED FROM SUCTION END. DESIGNATED ROTATION AND MOTOR LOCATION IS AS VIEWED FROM SHAFT END.

2. SUCTION AND DISCHARGE FLANGES MATE WITH STD. 150 LB. ANSI FLANGES.

3. DIMENSIONS ARE NOT FOR INSTALLATION PURPOSES UNLESS CERTIFIED.

General Arrangement Drawing

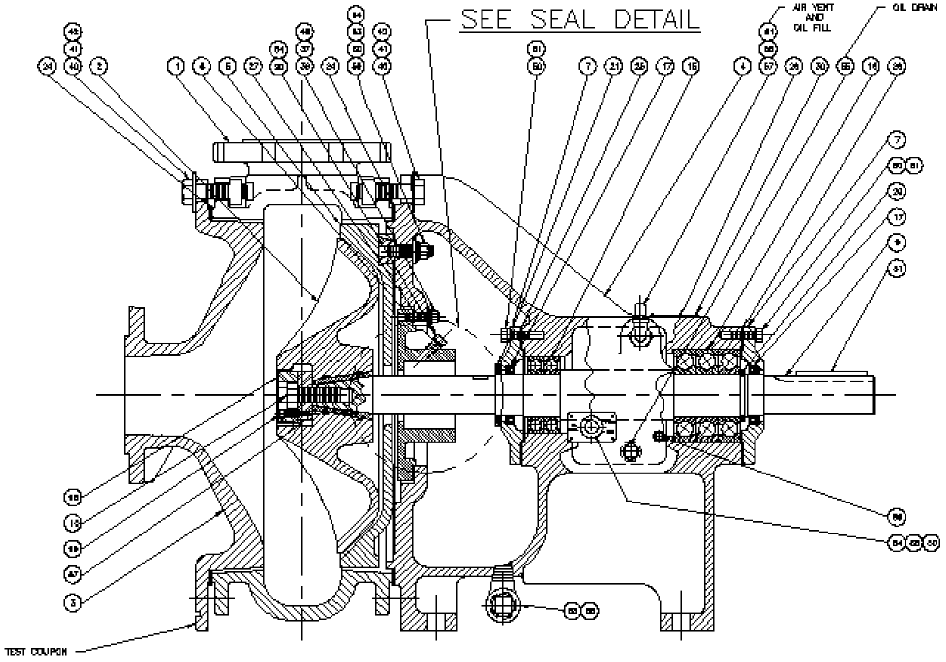
Customer	: SHN Engineers	Quote number	: 269505
Customer reference	:	Size	: 3" Model C
Item number	: 001	Stages	: 1
Service	:	Pump speed	: 930 rpm
Quantity of pumps	: 1.0	Date last saved	: 30 Apr 2013 6:13 PM

NOTE:
1. ITEMS 54 AND 58 ARE FOR SHIPPING PROTECTION ONLY
2. REFERENCE WEMCO SPECIFICATION 62122 FOR IMPELLER LOCKSCREW TORQUE VALUES.
3. REFERENCE WEMCO DATA SHEET P108-C211.1 FOR BEARINGS INSTALLATION AND SHIMMING. .003/.006 ENDPLAY REQUIRED.
4. PUMP SHOWN WITHOUT PACKING OR SEAL SEE DETAIL DRAWINGS FOR SEAL ARRANGEMENTS.

⑥ SURFACE PREP AND PAINT THESE PARTS PER PRODUCT STRUCTURE, TRANSMITTAL, OR DEFINITION SHEETS.

	QTY	ITEM NO.	PART NO.	DESCRIPTION
⑥	1	1		CASE
	1	2		IMPELLER
⑥	1	3		FLANGE, SUCTION
⑥	1	4		HOUSING, BEARING
	1	5		WEARPLATE
⑥	1	6		HOUSING, GLAND
⑥	2	7		CAP, BEARING
	1	9		SHAFT
	1	10		BOLT, HEX HD
	2	15		BEARING, INBOARD
	3	16		BEARING, OUTBOARD
	2	17		SEAL, OIL

QTY	ITEM NO.	PART NO.	DESCRIPTION
2	20		RING, RETAINING
1	21		SLINGER
2	24		GASKET, CASE
1	25		SHIM, BEARING CAP 1/16" THK
4	26		SHIM, BEARING CAP .032 THK
1	27		GASKET, GLAND HOUSING
1	29		PLATE, SERIAL
8	30		SCREW, DRIVE
1	31		KEY, SQUARE SHAFT
8	36		WASHER, RUBBER
8	37		WASHER, CUPPED
24	40		BOLT, HEX HD
24	41		WASHER, PLAIN
24	42		NUT, SQ HD
8	46		BOLT, HEX HD
12	50		BOLT, HEX HD
12	51		WASHER, LOCK
1	54		PLUG, PIPE NPTM
1	55		PLUG, PIPE NPTM
1	56		PLUG CAPLUG NPTM
1	57		BUSHING, NPTM
1	58		VENT, AIR
4	59		STUD, TAP END
4	60		NUT, HEX
1	61		ELBOW ST. 90° NPT
4	63		WASHER, CUPPED
4	64		WASHER, RUBBER
1	83		ELBOW, 90° STREET NPT F X M
1	84		SIGHT WINDOW, LOW PRES NPT
1	85		NAMEPLATE, OIL LEVEL
1	86		PLUG, PP NPT
1	87		WASHER, THRUST
1	80		PLUG, PP NPT
1	88		COLLAR, LOCKING
2	89		SCREW, SOC HD CAP



3" MODEL 'C' PUMP ASSEMBLY

SCALE NONE
D
SHT 4 OF 4
78218-4 AutoCAD
78218

Multiple Conditions Datasheet

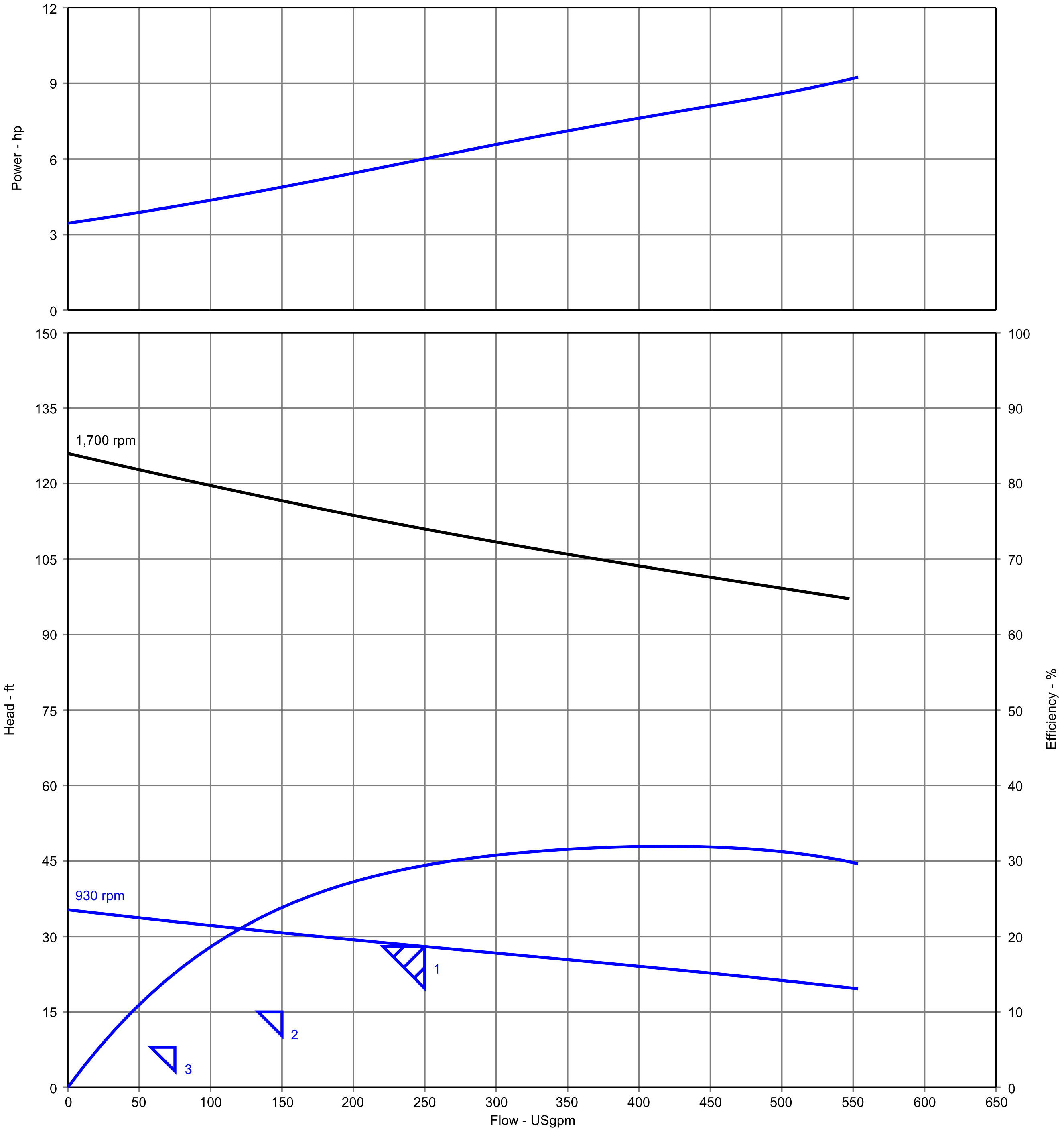
Customer : SHN Engineers
Customer reference :
Item number : 001
Service :

Quantity : 1
Quote number : 269505
Date last saved : 30 Apr 2013 6:13 PM

Size : 3" Model C
Stages : 1
Speed, rated : 930

Condition #		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Description		-	-	-					
Temperature, max	deg F	68.00	68.00	68.00					
Fluid density, rated / max	SG	1.000 / 1.000	1.000 / 1.000	1.000 / 1.000					
Viscosity, rated	cP	1.00	1.00	1.00					
Primary condition		●	○	○	○	○	○	○	○
Size		3" Model C							
Stages		1							
Flow, rated	USgpm	250	150	75.0					
Head, rated (requested)	ft	28.0	15.0	8.0					
Head, rated (actual)	ft	28.1	14.9	8.0					
Suction pressure, rated / max	psi.g	0.00 / 0.00	0.00 / 0.00	0.00 / 0.00					
NPSH available, rated	ft	Ample	Ample	Ample					
Speed, rated	rpm	930	695	540					
Selection status		Acceptable	Acceptable	Acceptable					
Cq/Ch/Ce [ANSI/HI 9.6.7-2010]		1.00 / 1.00 / 1.00	1.00 / 1.00 / 1.00	1.00 / 1.00 / 1.00					
Efficiency	%	29.42	24.69	12.74					
NPSH required	ft	-	-	-					
Power, rated	hp	6.01	2.30	1.19					

Multiple Conditions Curve



Customer	: SHN Engineers	Size	: 3" Model C
Customer reference	:	Stages	: 1
Item number	: 001	Speed, rated	: 930 rpm
Service	:	Based on curve number	: 3C_P10C-D41
Quantity	: 1	Efficiency	: 29.42 %
Quote number	: 269505	Power, rated	: 6.01 hp
Date last saved	: 30 Apr 2013 6:13 PM	NPSH required	: -
Flow, rated	: 250 USgpm	Viscosity	: 1.00 cP
Differential head / pressure, rated	: 28.0 ft	Cq/Ch/Ce [ANSI/HI 9.6.7-2010]	: 1.00 / 1.00 / 1.00
Fluid density, rated / max	: 1.000 / 1.000 SG		

Appendix B

Predesign Progress Report Technical Memoranda

Consulting Engineers
& Geologists, Inc.

Technical Memorandum

Reference: **612035.610**
Date: **March 25, 2013**
Revised: **July 1 , 2013**
To: **Jennifer Wirsing, City of Coos Bay**
Copy to: **Design Team, File**
From: **Mike Veach, PE**
Susan Foreman, PE
Jason Riegler, PE
Steve Donovan, PE
Subject: **Coos Bay Wastewater Treatment Plant #2, Pre-Design, Progress Report**

Background and Purpose of Technical Memorandum

The following Memorandum updates the City on the progress of the Coos Bay Plant 2 Predesign Project. Analysis of the major process components, discussed below, has allowed sufficient progress to size the facility components for development of the site plan. Major engineering decisions for the project include:

- Confimation of a secondary treatment SBR process.
- Configuration of the UV system to provide redundancy with multiple UV banks in a single channel rather than multiple channels.
- Biosolids holding and thickening will be performed according to the Facility Plan without the addition of aeration.
- Screening and grit removal equipment selection based on a complete evaluation of alternatives for the new headworks facility.

A site plan for the new facility is being prepared to reflect the sizing related to the new facilities.

Screening

Based on the analysis presented in the technical memorandum regarding the Headworks, we recommend the installation of two 6 mm band screens with integrated washer/compactors. The additional capital cost of these screens will be balanced by payback in decreased long-term maintenance and replacement costs and increased dewatering efficiency resulting in reduced land-fill cost and ragging problems in downstream pumping equipment.

The selected screens will also provide the City with the an efficient long term screening facility meeting the design criteria for the current design as well as providing the City with long term expandability and flexibility to meet future treatment requirements. Because of the larger surface area in contact with the raw wastewater, parallel band screens have significantly lower head-losses than barrel screens. The band screen can be retrofitted with finer screens if future effluent requirements require the installation of membrane treatment.

Grit Removal

The HeadCell® Grit Concentrator is the recommended grit removal system for Coos Bay Treatment Plant Number 2. The advantages of this system are outlined in technical memorandum regarding the Headworks and include: efficient removal of fine sands that are part of the grit load at the plant, no mechanical parts to be maintained, and the ability to be expanded in the future. Costs are comparable to other grit removal systems.

It is recommended that the HeadCell® be followed by Teacup® Grit Removal Washing/Classification Unit Grit and Snail® Dewatering Unit. This equipment is necessary for removal of fine sands. The saving to wear and maintenance of downstream equipment will provide payback for the additional cost of this equipment, which is estimated to be $45,000 more than a hydrcyclone classifier.

Sequencing Batch Reactors and Flow Equalization

The Facility Plan Amendment recommended plan for secondary treatment was Sequencing Batch Reactors (SBRs). In addition to traditional SBRs, the plan also recommended including ICEAS-type SBRs which are a type of SBR that feeds screened raw sewage into the SBR even during the settling and decant phase of the cycle. Traditional SBRs discontinue the feed of screened raw sewage during the settling and decant phase in order to provide an ideal quiescent settling and decant phase to produce a low total suspended solids secondary effluent. Despite flow entering the ICEAS-type SBR during the settling and decant phase, the ICEAS-type SBRs produces an acceptable total suspended solids secondary effluent as well by including a baffle wall to create a pre-react zone between the screened raw sewage input point and the treated secondary effluent decanter. Flow introduced into the pre-react zone travels from the top of the basin and down to the bottom of the baffle wall where openings at the bottom of the baffle wall direct flow into the settling zone of the ICEAS-type SBR. As the flow is directed through the openings and into the settling sludge blanket, the solids pass through the sludge blanket. These types of SBRs have been in use for over twenty years and the manufacturer (Xylem/Sanitaire) provides an effluent warranty.

There are certain potential operations and maintenance advantages to the ICEAS-type SBR, so the design will move forward based on that design. Procurement options will be developed as the design delivery approach is finalized.

Ultraviolet Disinfection

Ultraviolet disinfection will be accomplished with a one-channel design as opposed to a two-channel design. One channel provides adequate redundancy by providing a spare UV bank. Currently, the proposed UV design includes three UV banks. Two banks will provide treatment during the dry weather flow season and three banks will provide treatment during peak outflow from the flow equalization basin. During the dry weather period, each UV bank can be individually removed for maintenance while providing two banks online to meet disinfection requirements. The only other equipment within the UV channel is possibly an upstream isolation gate and a downstream water level control gate. The upstream isolation gate is not required at this time since a second channel is not provided. The downstream water level control gate will be a motorized gate that modulates or a weir to maintain a constant water level in the UV channel based on the feedback from a level instrument. Should the motorized actuator fail and need replacement, the gate can be operated in manual for a short period until an on-site spare actuator can be installed. The Facility Plan Amendment suggested multiple channels, however, the proposed one-channel design reduces construction costs associated with this facility. In the future, a mirror image of the single channel can be constructed to expand the UV facility capacity.

Biosolids Thickening and Holding

Waste activated sludge from the SBR process needs to be removed from the SBRs daily or less frequent (e.g. every few days or weekly) to maintain the correct process conditions in the secondary biological treatment process. In the SBR process, the mixed liquor inside the SBRs varies temporally in concentration since the contents are mixed during the react phase and settled and slightly thickened during the settling and decant phase. A varying mixed liquor feed concentration is an operational issue for thickening equipment, therefore wasting from the SBRs will need to be pumped to one of the existing tanks at the existing plant site. Additionally, the thickening equipment needs to operate continuously and cannot run reliably with intermittent flows. Typically, the thickening equipment will run constantly during a scheduled time during working hours. In order to take advantage of the high concentration of thickened sludge (about 8000-10,000 mg/l) in the SBR during the settling and decant phase, pumping of WAS out of the SBR will be intermittent. One tank will serve as storage of WAS from the SBR and provide a storage point for the intermittent flow from the WAS pumps and also help homogenize the WAS concentration. Two rotary drum thickeners (one duty, one redundant) inside a thickening building will process flow from the WAS storage tank and convey the thickened WAS (TWAS) to the second storage tank. The TWAS will be about 4-6%. At the 2037 average design loads, one thickener will operate approximately 30 hours per week on average. The second thickener can be brought on line for unusually high wasting events. Centrifugal screw pumps will be provided to pump from the WAS storage tank and into the thickeners. Progressing cavity pumps will pump TWAS into the TWAS holding tank from the discharge chute of the thickeners. Another set of progressing cavity pumps will pump TWAS from the TWAS holding tank to the transport truck. The tanker truck will fill in approximately 15 minutes. Filtrate from the thickening process will discharge to a wet well where it will be pumped to the influent ahead of the SBR.

The WAS and TWAS holding tanks will not be fitted with aeration equipment. The oxygen requirements of the WAS is high if fully aerobic conditions are maintained in the tanks. Providing aeration would also require additional and separate blowers from the SBRs as well as additional building space and increased energy usage; however, odor control would not be required since a fully aerobic tank does not produce offensive odors. Providing oxygen less than the requirement for fully aerobic conditions leads to the production of odorous sulfur compounds (mercaptans) which are difficult to treat by an odor control treatment system. The recommended approach is to allow the tanks to operate under non-aerobic conditions similar to an anaerobic digester, but without the production of methane. This approach will require the tanks to be vented to the odor control treatment system; however the cost to treat odors is much less than providing the aeration system for fully aerobic conditions.

The conditioned TWAS will be transported to WWTP #2 for anaerobic digestion. Filtrate generated from the solids thickening process will be pumped back to the pipeline that feeds the SBRs in order to keep this recycle stream from affecting the influent sampling located after the headworks screens.

SHN Consulting Engineers
& Geologists, Inc.
CH2MHILL®

Technical Memorandum

Reference: 612035.610
Date: **March 22, 2013**
Revised: **July 1, 2013**
To: **Jennifer Wirsing, City of Coos Bay**
Copy to: **Design Team, File**
From: **Mike Veach, PE**
Susan Foreman, PE
Subject: **Coos Bay Wastewater Treatment Plant #2, Pre-design, Headworks**

Background and Purpose of Technical Memorandum

As described in the Wastewater Treatment Plant #2 Facilities Plan Amendment (FPA), the headworks provides preliminary treatment of the raw sewage prior to the treatment process. Preliminary treatment is especially important in treatment systems that lack primary treatment. Typical headworks components consist of fine screening and grit removal.

Fine screens will remove rags, paper products, plastics and other large and floating debris from the liquid stream prior to the secondary treatment process. The grit removal process removes the sand, small rocks and other settleable detritus contained in the raw sewage which is harmful to the treatment process and causes excessive wear on the mechanical systems of the treatment process.

The FPA evaluated five fine screen alternatives providing advantages and disadvantages of each but did not provide a recommendation as to which alternative would be most effective. The five alternatives considered under the FPA were: step screens, spiral screens, basket or barrel screens, mechanically cleaned bar screens, and horizontal semicircular perforated plate screens. This memo will further address the effectiveness of the alternatives considered and evaluate a sixth alternative, the moving media type fine screen.

The FPA also evaluated a number of grit removal systems without providing a recommended system to carry forward to the preliminary design of the treatment plant. This memo will provide an evaluation of grit removal equipment and make a recommendation for the preferred option based on the evaluation criteria presented below.

Evaluation Objectives

The objective of the process evaluation is to identify the apparent best alternative technology for the Fine Screens and Grit Removal systems. Critical criteria for the process selection include:

- Effectiveness in meeting design criteria
- Compatibility with the selected Secondary Treatment process
- Space requirements
- Environmental considerations
- Reliability
- Power requirements
- Initial capital costs
- O&M Cost

The results of the evaluation process will be the selection and recommendation of the appropriate screening and grit removal technology for the final design. The recommendation for the design will include:

- Preliminary facility layout
- Process diagram
- Proposed flow rates
- Hydraulic profile requirements

Description of Alternative Screening Technologies

The fine screening process is designed to remove inorganic material that floats or is suspended in the raw wastewater flow stream. This material includes paper, plastics, hair and other material that does not breakdown during the wastewater treatment process. The removal of such material protects the downstream processes from damage and clogging. The shape and precise dimensions of the Headworks Building will not be determined until later in the design process. The preliminary footprint for the equipment that will be used for this evaluation is based on the equipment configuration of two active fine screens and one bypass channel with bar screen. The configuration will provide a redundant channel to allow for an additional future screen.

Design Criteria

The design criteria are based on the physical location and conditions consistent with the location of the WWTP along with the defined requirements of the selected secondary treatment process. The design criteria are defined as:

- Flow Rates:
  - Maximum Design Flow Rate: Peak Instantaneous flow 8.2 MGD (1 Hour Min):
  - Minimum Design Flow Rate: 400 GPM
  - Hydraulic capacity for expansion: 12.3 PIF through 3 channels
- Number of screens: two active, one manually cleaned bar screen bypass
- Maximum Opening size: 6 MM (1/4")
- Media Type: perforated plate

In addition to the screening alternatives discussed in the FPA, this memorandum will include the evaluation of additional moving media, self cleaning type screens. The moving media class of screens includes both slotted media and a perforated plate media. During discussions with the City and DEQ, it was stated perforated plate would be the preferred media. Rectangular screen openings were believed to allow for material larger than the selected screen size to pass through the screen depending on the materials orientation to the screen opening.

With the selection of perforated plate as the preferred media, two screen types, the step screen and the mechanically cleaned bar screen, will be eliminated and not carried forward with this evaluation. The spiral screen has been removed from consideration based on their poor performance under varying flow conditions and their tendency to collect rags during low flow events.
Perforated plate screens come in a variety of hole sizes with the most common be 2 mm, 3mm (1/8") and 6 mm (1/4"). SBR manufacturers recommend the maximum hole size to be no larger than 3/8" but have stated they would prefer 6 mm maximum screen openings.

Moving Media Screens (band screens)

General

Band screens operate much like a vertical or inclined conveyor belt that allows the wastewater to flow through the media while capturing the inorganic material on the surface of the media. The screens monitor the differential head loss through the screen. As the screens become blocked with screened material, the water surface raises on the upstream side of the belt. The increased head on the upstream side of the screen advances the screenings up the incline. The screen continues to operate until the upstream water surface decreases. As the screenings travel up the belt, the free water separates from the screenings and re-enters the flow stream. The screenings continue to travel up the screen media and are deposited into a hopper and transported to a washer compactor for disposal.

Band screens are typically configured to include a separate washer/compactor. The washer/compactor receives the screenings in a partially dewatered mat of material. This material generally contains some organic waste and a significant amount of water. The washer compactor uses recycled wastewater to flush the organic material from the screenings and return the wastewater back into the flow stream for treatment. The cleaned screenings are then transported into a compression section of the compactor to squeeze the majority of the free water from the screenings. The cleaned and dewatered screenings are then deposited into a dumpster for transport to the local landfill.

Band screens are manufactured in two basic configurations:

1) Screen perpendicular to channel flow,
2) Screen parallel to channel flow.

Band screens are provided with full stainless steel enclosures to provide odor capture and a connection point for the odor control system. The equipment enclosures along with channel cover plates provide odor containment and collection reducing nuisances to the surrounding area.

Band Screen Perpendicular to Channel

With a perpendicular band screen configuration, the screenings are collected on the upstream face of an inclined belt, carried out of the flow stream where they are allowed to dewater prior to being deposited into the screenings hopper. With the screenings removed, the belt reenters the flow stream on the downstream side. The significant disadvantage to this configuration is the screened wastewater passes through the media twice. This configuration reduces the exposed screen surface area, increases the velocity through the screen. The increased channel velocity forces some material through the screen and increases the headloss. On the downstream side the wastewater passes through the media in the reverse direction such that carryover of any residual screenings is allowed to reenter the flow stream.

Advantages include:

- High capture rate
- Effective over wide range of flows
- Reduced headloss
- No submerged bearings
- Intermittent operation, low power consumption
- Self cleaning
- Moving parts accessible above water level

Disadvantages include:

- Additional channel length required
- Possible screenings carryover
- High vertical clearance required
- Higher Capital costs

Estimated equipment capital costs for the perpendicular inclined band screen are:

Screen/washer/compactor $175,000 (per unit)…………...	$350,000
Manually cleaned bar bypass screen …………………..…...	$10,000

Band Screen Parallel to Channel

The alternate configuration places the screens media vertically mounted, parallel to the flow stream allowing the raw wastewater to enter the interior of the media belt. The wastewater passes through the media and is discharged into the downstream channel. The screenings are carried up the interior of the screen and deposited into a hopper. The advantage of this configuration is that the wastewater only passes through the screen once, from the inside out which reduces the possibility of screenings carryover.

The parallel screen configuration provides a larger surface area (approximately double) exposed to the wastewater stream compared to the perpendicular screen. The increased surface area reduces the velocity through the screen, which translates into a lower headloss and reduced material forced through the openings resulting in a higher capture rate.

Advantages include:

- Higher capture rate
- No screenings carryover
- Effective over wide range of flows
- Reduced headloss
- Reduced maintenance
- Shorter channel length
- No submerged bearings
- Intermittent operation, low power consumption
- Self cleaning
- Moving parts accessible above water level

Disadvantages include:

- Higher Capital costs
- High vertical clearance required
- Deeper channels required

Estimated capital equipment costs for the inclined parallel band screen are:

Screens/washer /compactor ($175,000 per unit) …...	$350,000
Manually cleaned bar bypass screen ....…...	$ 10,000

Basket /barrel Screens

General

A basket screen is a drum fabricated with either wedge wire or perforated plate. The screen is provided with a seal assembly at the front of the screen to prevent any wastewater from bypassing the screen. The raw wastewater enters the bottom of the drum where the screenings are collected on the inner surface of the screen. As the screen becomes blocked with material the upstream water surface rises. When the water surface reaches a predetermined level the screen is activated and the basket rotates and lifts the screened material out of the raw wastewater. As the screened material reaches the top of the drum, it falls into the central screw conveyor/compactor. A spray wash system removes any material still attached to the screen and washes organic material back into the wastewater stream.

The central screw conveyor/compactor transports the screened material out of the channel to a discharge chute. As the material is transported into the compaction section the screenings are dewatered and compacted to provide up to a 40 percent dry waste discharge. The waste is discharged either into bags or dumpsters for transport to the local landfill.

Due to the channel width required to house the screens, the approach velocity to the basket screens falls below one foot per second. The reduced velocity will allow a significant amount of grit to settle out upstream of the screens. Channel bottom design and the addition of channel agitation will be required to re-suspend the grit.

The maximum water level upstream of the screen is limited to 2.17 feet with a calculated headloss through screen at peak flows is 1.67 feet. The limit on the upstream water surface combined with the increased headloss through the screen provides limited flexibility in the hydraulic grade line.

The limited upstream water surface exposes a reduced surface area of the screen increasing the velocity through the screen. The increased velocity through the screen forces additional material into or through the orifices reducing the efficiency of the screen and increasing the maintenance required to remove the material embedded into the screen openings.

The shallow channel configuration and the increased headloss limits the future replacement of screens required to meet increased screening requirements for the conversion to an MBR treatment system.

Advantages include:

- No screenings carryover
- Intermittent operation, low power consumption
- Self cleaning
- Moving parts accessible above water level
- Low profile
- Shallower channels required
- Lower capital costs
- Separate compactors not required

Disadvantages include:

- Reduced capture rate
- Increased headloss requirement
- Larger foot print
- Additional channel length required
- Lower approach velocity (upstream grit settlement)

- Upstream channel agitation required
- Less effective cleaning of solids
- Limits future flexibility and expansion
- Not provided with odor control enclosure
- Spray wash water overspray containment
- Submerged shaft bearings

Estimated capital equipment costs for the inclined band screen are:

Screens ($105,000 per screen)	$210,000
Manually cleaned bar bypass screen	$ 10,000

Recommendations

Based on the criteria listed above, we recommend the installation of two 6 mm band screens configured to be parallel to the channel with integrated washer/compactors. The additional capital cost of these screens will be balanced by payback in decreased long-term maintenance and replacement costs and increased dewatering efficiency resulting in reduced land-fill cost and ragging problems in downstream pumping equipment.

The selected screens will also provide the City with the an efficient long term screening facility meeting the design criteria for the current design as well as providing the City with long term expandability and flexibility to meet future treatment requirements. Because of the larger surface area in contact with the raw wastewater, parallel band screens have significantly lower head-losses than barrel screens. The band screen can be retrofitted with finer screens if future effluent requirements require the installation of membrane treatment.

Grit Removal

Grit includes sand, gravel, cinder, or other solid materials that are "heavier" (higher specific gravity) than the organic biodegradable solids in the wastewater. Grit also includes eggshells, bone chips, seeds, coffee grounds, and large organic particles, such as food waste. Removal of grit prevents unnecessary abrasion and wear of mechanical equipment, grit deposition in pipelines, channels, and basins.

Grit is defined as particles larger than 210 microns (65 mesh) and with a specific gravity of greater than 2.65 (U.S. EPA, 1987). Equipment design was traditionally based on removal of 95 percent of these particles. However, with the recent recognition that smaller particles must be removed to avoid damaging downstream processes, many modern grit removal designs are capable of removing up to 95 percent or more of 100 microns (140 mesh) material or even smaller.

Removal of particles down to the 110 micron and below is important at Coos Bay Treatment Plant 2 because it receives large amounts of fine sand which ranges from 125 to 250 microns and very fine sand 62-125 microns

Description of Grit Removal Technologies

Two methods of grit collection were investigated in the FPA; an aerated grit channel and a vortex type grit removal system. This purpose of this memo is to evaluate a third method of grit collection. The Eutek HeadCell® supplied by Hydro International and compares its performance to the grit removal technologies discussed in the FPA.

Design Criteria

Design Flow: Peak Instantaneous Flow (PIF) 8.2 MGD
Allowance for expansion to 12 MGD
Performance 95% efficiency at 110 microns (140 mesh)

Aerated Grit Channel

In aerated grit chambers, grit is removed by creating a spiral flow pattern that separates grit using centrifugal motion. Air is introduced in the grit chamber along one side, creating a perpendicular velocity leading to a spiral pattern through the tank. Heavier particles are accelerated and diverge from the flow lines, before dropping to the bottom of the tank, while lighter organic particles are suspended and eventually carried out of the tank. Aerated grit chambers use a sloped tank bottom to enhance the air roll pattern and sweep grit along the tank bottom to the low side of the chamber. A horizontal screw conveyor is typically used to convey settle grit to a hopper at the head of the tank.

Aerated grit chambers are typically designed to remove particles of 70 mesh (210 micron) or larger, with a detention period of two to five minutes at peak hourly flow. When wastewater flows into the grit chamber, particles settle to the bottom according to their size, specific gravity, and the velocity of the induced roll in the tank. A velocity that is too high will result in lower grit removal efficiencies, while a velocity that it too low will result in increased removal of organic materials. Proper adjustment of air velocity will result in nearly 100 percent removal of the desired particle size and well-washed grit.

Advantages

- Consistent removal efficiency over a wide flow range.
- A relatively low putrescible organic content may be removed with a well-controlled rate of aeration.
- Performance of downstream units may be improved by using pre-aeration to reduce septic conditions in incoming wastewater.

- Aerated grit chambers are versatile, allowing for chemical addition, mixing, pre-aeration, and flocculation.

Disadvantages

- Potentially harmful volatile organics and odors may be released from the aerated grit chamber,
- Aerated grit chambers require more power than other grit removal processes.
- Maintenance and control of the aeration system requires additional labor.
- Size of the tank to provide adequate detention times is prohibitive at peak flows
- Does not meet criteria for removal of fine sand particles

Mechanically Induced Vortex Type Grit Removal

Mechanically induced vortex type grit removal was recommended in the FPA. The vortex-type grit removal system relies on a mechanically induced vortex to capture grit solids in the center hopper of a circular tank. The vortex is produced by a combination of an inlet flume, sloped baffle, and adjustable rotating paddles at the center of the flume. In some systems the vortex circulation pattern is maintained by pumps instead of paddles

Grit settles by gravity into the bottom of the tank (in a grit hopper) while effluent exits at the top of the tank. The grit that settles into the grit hopper may be removed by a centrifugal grit pump or an airlift pump,

Mechanically induced vortex systems provide more efficient removal of fine grit than aerated grit channels but cannot provide the efficiency of other non mechanical vortex separations. According to the *Wastewater Technology Fact Sheet* published by EPA vortex type systems remove 73 percent of 140-mesh (100 micron) size. According to manufacturers literature the Pista Grit, Smith and Loveless, with modified influent baffle can provide 95% removal but there is operational evidence from numerous engineering studies that larger tank sizes than specified are required.

Vortex Grit Separators

A vortex grit separator, also known as a HeadCell®, is a modular, multi-tray solids concentrator that removes grit down to 50 micron in size (200 mesh). Grit removal is based on creating a vortex across multiple tray layers that serve as settling basins (similar to settling tubes in clarifiers). Solids caught in the vortex flow are swept down each tray to a central core where they are collected and continuously pumped to a grit washing device. The use of stacked multiple trays creates a large surface area that effectively captures grit in a relatively small footprint across a wide range of flows.

Comparison of Grit Collection Systems

The disadvantages of the aerated grit channel make it unsuitable for further consideration at Plant #2. Therefore, recommendations regarding the preferred method of grit removal were based on a comparison of the mechanically induced vortex grit removal system and the HeadCell® . Both of these systems provide more efficient removal of fine material than the aerated grit channel. Both systems also have comparable equipment and construction costs.

Advantages of the HeadCell®

The HeadCell® has the following advantages when compared to a mechanically induced vortex system:

- Higher removal efficiency
- Ability to remove very fine sands
- Smaller footprint, large surface area provided by multiple tray configuration
- No mechanical components
- Operate efficiently over large flow ranges – vortex is maintained by influent manifold
- Flexibility to increase capacity after installation by adding additional trays.

Disadvantages of the HeadCell® when compared to induced vortex grit removal system include a higher head-loss. HeadCell® manifolds are generally designed for a head-loss of 1.0 ft[1] at PIF and induced vortex systems generally have minimal head-loss (less than 0.5 ft). However the minimal head-loss normally observed will be increased by the need to install influent baffles for induced vortex systems such as the Pista Grit in order to achieve the desired removal efficiencies over the design flow range.

A disadvantage of the HeadCell® is that it is a proprietary system requiring a sole source specification. It is expected that an induced vortex system meeting the required removal efficiency for fine sands would also require a sole source specification.[2]

Grit Removal Cost Comparison

Estimated equipment costs for the two grit removal systems are comparable:

- HeadCell® -$125,000
- Induced vortex system such as Pista Grit®- $100,000[3]

Construction cost for the induced vortex system would be greater because a larger size tank or multiple tanks would be required to provide a removal efficiency equivalent to the HeadCell®.

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[1] Based on SHNs operational experience some additional HL has been incorporated in the hydraulic profile (1.5 ft of headloss at future flow of 12 MGD).

[2] The only induced vortex system which advertises 95% removal of 140 mesh (100 micron) material is PistaGrit, manufactured by Smith and Loveless.

[3] Cost from FPA not including dewatering

Equipment costs for induced vortex system would also be greater than noted in FPA because of the need to have a modified system with additional influent baffling.

Since there will be no power cost and minimal operation and maintenance for the HeadCell® it is expected that a detailed present value analysis of both systems would indicate that the HeadCell® costs would be less than the induced vortex system once construction and installation costs were taken into account.

Grit Dewatering Methodologies

After the grit is removed from the liquid stream it must be pumped to a separate system for washing to remove organic material and dewatering to reduce the volume of grit and make it suitable for disposal in a landfill**.** Two options for grit washing and dewatering were evaluated:

- hydrocyclone /grit classifier
- grit teacup and grit snail

Cyclone/screw classifier

Most liquid cyclone/screw classifier systems are designed to remove 150 micron grit at best. If cyclone/screw classifier follows a HeadCell® the fine sands removed in the grit removal process would be washed out the overflow and recycled through the system.

Grit TeaCup® and Grit Snail ®

Eutek manufactures an enhanced grit washing and dewatering system to accompany the HeadCell®. These are called respectively the TeaCup® and the Grit Snail ®. The TeaCup® is a hydraulic high efficiency vortex separator designed to remove fine grit and high density fixed solids from the grit slurry pumped from the bottom of the HeadCell®. The washed and concentrated low organic grit is discharged to the grit snail.

The Grit Snail^{R} has a large clarifier area to retain 75 micron particles. A slow-moving belt lifts grit from the clarifier pool without resuspending the fine particles. The large clarifier, 5 feet in diameter, provides sufficient time for fine particles to settle.

The TeaCup/Grit Snail system is the only grit washing/dewatering system on the market that is guaranteed to remove 95% of 75 micron grit. The system delivers dry grit (greater than 60% total solids) with low organic content (less than 20% volatile solids) suitable for landfill disposal.

Cost Comparison

Equipment costs for washing and dewatering systems Coos Bay Plant #2:

- Cost of a hydrocyclone /grit classifier - $103,000

- Combined TeaCup^{R} Grit Snail^{R} - $148,000

Grit System Recommendation

The HeadCell® Grit Concentrator is the recommended grit removal system for Coos Bay Treatment Plant Number 2. The advantages of this system were outlined above and include: efficient removal of fine sands that are part of the grit load at the plant, no mechanical parts to be maintained, and the ability to be expanded in the future. Costs are comparable to other grit removal systems.

It is recommended that the HeadCell® be followed by Teacup® Grit Removal Washing/Classification Unit Grit and Snail® Dewatering Unit. This equipment is necessary for removal of fine sands. The saving to wear and maintenance of downstream equipment will provide payback for the additional cost of this equipment, which is estimated to be $45,000 more than a hydrcyclone classifier.

Preliminary Design

A proposal for the HeadCell®, Teacup®, and Grit Snail® has been obtained from Hydro-International and is included as an Appendix to this memo. To treat the PIF of 8.2 MGD an 8-tray HeadCell® was recommended. The trays are 9 ft in diameter and would be installed in a square basin, approximately 12-feet by 12-feet.

To provide for future expansion to handle a PIF of 12.3 MGD, the headcell basin would be constructed with additional depth of approximately four feet, providing the ability to add 4 additional trays. The City has the option of installing all 12 trays initially or installing eight trays initially and waiting until increased flows require the installation of the additional trays. If only eight trays are installed, the inlet manifold would be designed with 12 nozzles, four of which will be flanged off to connect to the additional trays in the future.

For a system that is expandable to 12 trays, the HeadCell® basin would be 18 feet from base to weir, four feet deeper than would be required for the 8 tray system. The additional tank depth required is available because the height of the weir that controls water depth in the HeadCell® tank is set by the downstream hydraulic grade and will need to be more than 18 feet above grade. Because of this height requirement, there will be space for additional trays to be installed in future without making the HeadCell® basin taller than it needs to be.

The installation of the four additional trays during the initial construction would add approximately $10,000 to the cost of constructing the headworks. The trays are not susceptible to wear and do not degrade over time. The installation of only eight trays during the initial construction would require placing blind flanges on the future nozzles. The addition of the trays in the future would require removing the blind flanges, hoisting the trays into place, attaching the trays to the nozzles and the existing frame, The operations staff would be able to complete the installation in just a few hours.

The minimal increase in cost and the relative ease of installing the additional trays in the future, the proposed design would install only eight trays at this time with a manifold with 12 nozzles, allowing the City to install the additional trays only when the peak influent flows increase to more than 8.2 MGD.

The grit removal equipment being recommended is proprietary and the City will need to sole source the procurement to Hydro-International. It is our opinion that the advantages of the HeadCell® and associated washing and dewatering equipment outweigh the disadvantage of having to sole source the equipment. By removing grit and fine sands efficiently, the City will realize long term savings in equipment maintenance and replacement costs.