Naval Facilities Engineering Command Mid-Atlantic
Norfolk, Virginia

Basis of Design Report
For Removal of 1,4-Dioxane From GM38 Area Groundwater Treatment System

Site 1 – Offsite Groundwater

Naval Weapons Industrial Reserve Plant
Bethpage, New York

June 2019

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BASIS OF DESIGN REPORT
FOR REMOVAL OF 1,4-DIOXANE FROM
GM38 AREA GROUNDWATER TREATMENT SYSTEM

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BETHPAGE, NEW YORK

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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Acronyms and Abbreviations

A	ampere
AOP	Advance oxidation process
bgs	Below ground surface
GAC	granular activated carbon
DCE	1,2-dichloroethene
GM38	GM38 Area Hotspot Groundwater Treatment System
gpm	gallons per minuteR
H_2O_2	hydrogen peroxide
KV	kilovolt
KVA	kilovolt-ampere
µg/L	microgram(s) per liter
MCL	Maximum Contaminant Level
mg/L	milligram(s) per liter
msl	mean sea level
nm	nanometer
NAVFAC	Naval Facilities Engineering Command
NWIRP	Naval Weapons Industrial Reserve Plant
O_2	oxygen
O_3	ozone
OU	Operable Unit
PCE	tetrachloroethene
PLC	programmable-logic controller
PSEG	Public Service Electric Group
PSF	Pound per Square Foot
ROD	Record of Decision
psig	pound(s)-force per square inch gauge
RW	Recovery well
TCE	trichloroethene
VOC	volatile organic compound

1.0 Introduction

This Basis of Design Report was prepared to identify and develop a treatment process to remove 1,4-dioxane from the current and future groundwater at the GM38 Area Hotspot Groundwater Treatment System (GM38 GWTS) at the Naval Weapons Industrial Reserve Plant (NWIRP) in Bethpage, New York (Figures 1-1 and 1-2). Construction and operation of the GM38 GWTS are identified in the 2003 Operable Unit (OU) 2 Record of Decision for the NWIRP Bethpage (Navy, 2003). This report has been prepared for the Mid-Atlantic Division of the Naval Facilities Engineering Command (NAVFAC) under Contract Task Order (CTO) WE-24 of the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract number N6247216D9008.

1.1 Background

The GM38 GWTS started operation in 2009 and currently removes volatile organic compounds (VOCs) from extracted groundwater in the vicinity of the GM38 Area Hotspot. A total of approximately 1,000 gallons per minute (gpm) of groundwater are extracted from Recovery Wells RW1 and RW3. The GM38 GWTS uses equalization, air stripping, particulate filtration, and liquid-phase granular activated carbon (GAC) to treat the extracted groundwater. The treated groundwater is infiltrated back into the aquifer via a nearby recharge basin (Figures 1-2 and 1-3). In addition, vapor-phase GAC is used to treat VOCs in vapors from the air stripping process, prior to discharge to the atmosphere.

The current VOCs in GM38 Area Hotspot groundwater that require treatment are trichloroethene (TCE), tetrachloroethene (PCE), and cis-1,2-dichloroethene (DCE) with a combined concentration of 142 micrograms per liter (μg/L) (Table 1). Other VOCs are also present in the groundwater. The treatment system reduces the concentrations of these VOCs to less than the maximum contaminant level (MCL)-based discharge limit of 5 μg/L for each of these chemicals, and more typically to less than 0.5 μg/L. Additional discussion on groundwater characteristics, discharge limits, and treatment system performance is presented below.

In the future (projected late 2019), groundwater from the Phase I RE108 Area Hotspot Recovery Well (RW4) will be discharged to the GM38 Area GWTS for treatment. The combined flow into the GM38 GWTS will remain at 1,000 gpm. To maintain this total flow rate, operation of RW3 will be discontinued, and the flow from RW1 will be reduced as needed to offset the flow from RW4. The blended RW1/RW4 water is anticipated to have a combined TCE, PCE, and DCE concentration of approximately 1,316 μg/L. The GM38 GWTS is designed to effectively treat these high concentrations of VOCs, although operating costs are anticipated to increase over current conditions.

The existing processes at GM38 GWTS do not remove 1,4-dioxane from the groundwater. The current 1,4-dioxane concentration in the GM38 groundwater is 2.5 µg/L and the projected future 1,4-dioxane concentration (with the addition of groundwater from the RW4 well) is 5 µg/L. The current New York State Department of Health (NYSDOH) Maximum Contaminant Level (MCL) for 1,4-dioxane is 50 µg/L, whereas there is a recommended NYSDOH MCL for 1,4-dioxane of 1 µg/L.

In 2019, a pilot study was conducted at GM38 using its process water (extracted groundwater) to evaluate the AOP technology for VOCs and 1,4-dioxane. This study evaluated both the current VOC and 1,4-dioxane concentrations in the GM38 treatment system, and potential future concentrations using spiked solutions. The results of the pilot study are presented in Appendix A.

1.2 Objectives and Rationale

The objective of this report is to identify and size a treatment process for the GM38 GWTS to remove 1,4-dioxane from current and planned future process water. 1,4-Dioxane is anticipated to be regulated in the near future (2019) to the recommended MCL of 1 µg/L. Although this value would not be directly applicable to the GM38 GWTS discharge, some of the water discharged will likely be captured in the future by public water supplies.

1.3 Organization

This 30 Percent Basis of Design Report is organized as follows:

- Section 1.0 - Introduction: Presents the background, purpose, scope, and organization of the design basis report.
- Section 2 - Design Criteria: Presents project background information and summarizes the technical parameters upon which the remedial design is based.
- Section 3 - Basis of Design: Presents the analyses that were conducted to select and guide the remedial design approach.
- Section 4 - References: Presents references for the information used in the report.

2.0 Design Criteria

This section presents background information for the project and summarizes the technical parameters of the remedial design.

2.1 Project Description

This project will consist of installing a treatment technology for the removal of 1,4-dioxane from the GM38 and RE108 Area Hotspot process waters (extracted groundwaters) prior to discharge. 1,4-Dioxane is not readily removed from water by most common air stripping, adsorption, filtration, ion exchange, biological, and chemical treatment processes. A review of literature identified only two commercially available types of treatment systems. The first system uses the advanced oxidation process (AOP) technology. The AOP technology is based on the oxidation potential of the hydroxyl radical formed by a combination of hydrogen peroxide with ultraviolet (UV) light or ozone. The second system utilizes a synthetic adsorption media coupled with onsite regeneration and supplemental treatment. Because of the availability of the existing VOC treatment equipment, relatively simple operation, and complete onsite destruction of the 1,4-dioxane, the AOP technology will be considered for further evaluation.

2.2 Site Characteristics

The Navy operates the GM38 GWTS, which is used to remove VOCs from the extracted GM38 Area Hotspot groundwater. The treatment plant location is bordered to the northwest, southwest, and south by residential housing. North of the treatment plant location is a public water supply. West of the treatment plant is a utility corridor and east of the treatment plant is Route 135 – Seaford Oyster Bay Expressway (Figure 1-2).

The treatment equipment is housed within a 75-foot by 75-foot by 25 feet high building. The building is surrounded by 10-foot high chain link fencing, with locked access gates to the east and west. The total area within the GM38 GWTS fence is approximately 21,000 square feet, of which approximately 7,200 square feet are compacted gravel north of the building. The north gravel area is used for vehicle parking and truck access to the door in the north central portion of the building.

Also, within the fence is a transformer and stickup monitoring well. Other components of the GM38 GWTS located outside the fenced area are storm water dry wells, recharge basin, potable water supply vault, recovery wells, and groundwater monitoring wells.

The compacted gravel ground surface within the fenced area is relatively flat and at an elevation of approximately 85 feet above mean sea level. Groundwater in the area is approximately 32 to 35 feet below ground surface. Except for the GM38 GWTS recharge basin which receives treated process water from the GM38 GWTS and storm water inflow, there is no surface water in the vicinity of the facility.

2.3 AOP Treatment Technologies

AOP Description

AOP treatment technologies utilize hydroxyl radicals (OH·) to degrade various organics. Hydroxyl radicals are electrophiles and react with organic compounds by extracting hydrogen atoms, or by addition reactions with double bonds. Hydroxyl radicals are not selective and react very quickly. (Crittenden, 2012). Two common AOP treatment technologies commercially available use UV light or ozone (O_3) with hydrogen peroxide (H_2O_2) to form the hydroxyl radical.

UV/Peroxide System

This system utilizes a UV light and hydrogen peroxide to generate hydroxyl radicals. Prior to entering the UV reactor, the water is dosed with hydrogen peroxide. In the reactor, the UV light (wave length of 200- to 280-nanometers) breaks the hydrogen peroxide into hydroxyl radicals.

- UV light and hydrogen peroxide; Equation: $\mathrm{UV} + \mathrm{H_2O_2} \rightarrow 2\mathrm{HO}\cdot$

The UV light AOP requires that the influent water be very clear and relatively free of iron and manganese and becomes ineffective in water with high turbidity. Additionally, high dosages of hydrogen peroxide are required to produce hydroxyl radicals which results in higher concentrations of hydrogen peroxide in the AOP effluent.

Ozone/Peroxide System

The ozone system generates the hydroxyl radicals by first generating ozone on-site from an oxygen enriched source and an ozone generator. The ozone and hydrogen peroxide are then blended into the water. The ozone breaks the hydrogen peroxide into hydroxyl radicals.

- Ozone and hydrogen peroxide; Equation: $2\mathrm{O_3} + \mathrm{H_2O_2} \rightarrow 2\mathrm{HO}\cdot + 3\mathrm{O_2}$

Ozone cannot be stored and is formed onsite with corona discharge generators as it is being used. The ozone is derived from oxygen. The oxygen can be generated from air using a dryer (-40 to -100 degrees Fahrenheit dew point) and membrane-based concentrators. These systems have high energy, cooling, waste, and noise mitigation requirements. Liquid oxygen is an alternative to dryers and concentrators, where cryogenic liquid oxygen tanks are used.

Factors that Could Potentially Affect AOP

Some of the major elements of the groundwater that can affect the AOP are:

- Carbonate and bicarbonate ions, which scavenge hydroxyl radicals and thus significantly reduce the rate of destruction of the target contaminant;
- pH which can affect the concentration of bicarbonate and carbonate, and can also affect the charge on weak acid and base organic compounds;
- Natural organic matter (NOM) reacts with the hydroxyl radicals and quench the reaction;
- Metal ions, such as iron and manganese, can scavenge hydroxyl radicals as well as precipitate on the quartz glass of the UV lamps and interfere with UV transmittance. (Crittenden, 2012).
- Nitrate and nitrite can also interfere with the process.

To address these concerns, a pilot study was conducted on GM38 wastewater (see Appendix A). As discussed in Section 3, none of these potential factors would be expected to adversely affect the operation of either the UV or ozone based AOP systems at the GM38 GWTS.

Safety Considerations

The AOP treatment components have potential operational, human health, and/or environmental issues associated with them. For example, UV lamps commonly contain mercury and require proper handling and disposal, during operation, the UV reactor chambers must remain sealed to prevent human exposure, hydrogen peroxide is a toxic liquid and can spontaneously pressurize vessels, and ozone is a toxic gas that can migrate from the facility. To ensure effective operation, activities such as for safe handling and secondary containment for hydrogen peroxide and monitoring for ozone are typically used.

Selected AOP Process

The pilot study conducted at GM38 demonstrated that both UV- and ozone-based AOP systems effectively removed 1,4-dioxane from the groundwater. The results of the pilot study showed that the concentrations of iron and manganese in the groundwater are low enough so as not to cause a scaling issue on the quartz glass of the UV lamps. The water transmittance is high enough that is would not cause UV transmittance concerns.

There are several advantages and disadvantages to both processes that would make one a better fit for a particular site. The ozone-based AOP uses cryogenic liquid oxygen or a generator and desiccator that takes up a relatively large area and generates high levels of heat. Ozone is a toxic gas that must be monitored and controlled. There is also potential for bromate formation; bromate has a maximum contaminant level (MCL) of 0.01 milligram per liter (mg/L). During the March 2019 pilot-scale testing, there was no formation of bromate. The primary advantage of the ozone-based AOP is that this technology is not as sensitive to iron, manganese, or other turbidity as the UV-based AOP.

The UV-based AOP system is simpler to operate because it does not require the use of liquid oxygen, an ozone generator, or ozone monitoring systems. Instead, only electricity and periodic bulb replacement are required.

Based on the simplicity of operation, and compatibility with the current and projected future groundwater, the UV-based AOP system was selected for further development at the GM38 GWTS.

3.0 Basis of Design

This section presents the civil/site related work and an analysis of the components of the proposed GM38 GWTS AOP treatment system, as follows.

- Civil/Site Work
- AOP Reactor Sizing
- Chemical Storage Tank and Peroxide Delivery System
- AOP System Safety Considerations
- Process System Piping (GM38 Process Water)
- AOP System Startup Bypass
- Geotechnical, Foundation, and Structural
- Electrical System
- Instrumentation and Controls
- Plumbing

3.1 Civil/Site Work

The storage tank and spill containment concrete pads will be located approximately 6 feet from the north face of the existing building to allow for clearance of existing underground utilities. The corner of the spill containment area pad will be located approximately 4.5 feet east of the northwest corner of the existing building. The spill containment pad and the storage tank pad will both be 12 feet wide by 12 feet long and placed side by side to allow for spill containment and access for tank filling. The existing site drainage slopes from the building to the north fence. The northwest corner of the containment pad will have a sump to collect rainwater and a connection to the existing storm drain that runs from the existing building to the dry wells north of the fenced site. The sump connection to the existing storm drain will have a manual control valve for release of the accumulated runoff. Erosion and sedimentation controls measures will be required.

3.2 AOP Reactor Sizing

The primary attributes to consider for the selection and sizing of the AOP reactor are dimensions (floor space), contact time, flow rate, water quality, and targeted 1,4-dioxane reduction. Since the reactors currently available are based on proprietary vendor-specific designs, this section will only provide general guidance.

Design Basis

The following are used in development of the AOP reactor system design:

- The AOP reactor will be installed after the air stripping tower and particulate filtration and before the liquid phase GAC.

- The anticipated Process Water quality for the AOP system is the Design Basis as presented in Table 1.
- The influent Process Water flow rate into the AOP will normally average 1,000 gpm. Due to the use of variable frequency drive pumps throughout the GM38 GWTS, the reactor should allow for a hydraulic flow rate of up to 1,400 gpm. The pressure drop at the maximum hydraulic flow rate across the reactor will be less than 5 pounds-force per square inch gauge (PSIG).
- Under initial operating conditions (pristine tubes and new bulbs), the reactor design is to be based on a Process Water influent and effluent 1,4-dioxane concentration of 5 µg/L and an effluent 0.1 µg/L respectively.
- Under variable conditions such as the maximum hydraulic flow rate, scaling of the UV tubes, and aging lamps, the design must achieve a 1,4-dioxane concentration consistently less than 0.5 µg/L
- The AOP system is anticipated to reduce the Process Water TCE concentrations to less than 0.5 µg/L. However, this is not a treatment goal for the AOP system, rather the existing GAC can be used to further reduce the TCE concentration.
- The iron and manganese concentration in the Process Water (AOP influent) range from 0.8 to 19.4 µg/L. At these concentrations it is anticipated that they will not cause significant scaling on the UV lamps.
- The background scavenging demand for nitrates, carbonate, and NOM, are anticipated to have a minor impact on performance. If necessary, as determined during system startup and during operation, a higher concentration of hydrogen peroxide would be used to offset any interference.
- The AOP process is not anticipated to effectively remove 1,1-DCA, and as such the air stripper will be needed to pretreat the groundwater for it and other similar chemicals (e.g. Freon 113).
- The Process Water UV transmittance was measured to be 97 to 99 percent, which is within the acceptable range for UV based AOP technology.
- A table detailing the pilot study results and the removal efficiencies of PCE, TCE, and 1,4-dioxane by the AOP process at varying flow rates and peroxide doses is shown in Appendix A.

Design Approach

The following outlines the general approach that will be taken in designing the AOP treatment system:

- Use the pilot study results to document the feasibility of using a UV-based AOP system to remove current and future concentrations of 1,4-dioxane in the GM38 GWTS.
- Compare design parameters to other pilot- and full-scale systems in the area.
- Determine if any other modifications are required for the GM38 GWTS.

Design Parameters

Using the information above and the results from the pilot study in Appendix A, the reactor can be sized using the proposed average flow rate of 1,000 gpm, the AOP influent water quality parameters in Table 1, and the pilot study reactor parameters. Since the AOP reactors depend heavily on vendor's proprietary information, this design report will only present general anticipated requirements as follows:

- Provide a reactor contact time of approximately 30 to 60 seconds.
- Provide a low-pressure UV lamps that emit a wavelength of 254 nanometers (nm), with a minimum efficiency of 30 percent.
- Provide a total power system in the range of 30 to 60 watts per gpm, or 30 to 60 kilowatts total.
- Provide self-contained control panels that will control the operation of AOP reactor, chemical feed pumps, chemical dosing system, chemical tank and the process pipe valves. The AOP programmable logic controller (PLC) will communicate with the existing Master PLC at the plant through an ethernet cable.
- Provide a hydrogen peroxide concentration of 3 to 20 mg/L in the process water entering the reactor.
- Provide an automatic UV lamp glass cleaner.
- Reactor materials will be 316 stainless steel and glass.
- Lamps will be accessible from both sides of the reactor.
- Provide for oxygen off gassing from the reactor/associated piping
- The reactor will contain the following monitors/alarms.
    - Temperature
    - Water Level
    - UV Transmittance
    - UV Dose
    - UV Intensity
    - Hydrogen peroxide

AOP Reactor

Based on the above design criteria and approach the commercially available single reactor, dual chamber - Trojan Model PHOX UV D72AL75 is a typical AOP, will fit within the space available, and provide the required treatment that can meet the treatment goals shown in Table 1. The maximum operating pressure of the reactor would be 65 pounds per square inch. The reactor would be mounted on a raised cradle (mid-mount) and concrete pad with the center of the reactor placed approximately 48 inches from finished floor to allow ease of operation and maintenance. Similar Equipment from other vendors are equally viable. The Trojan reactor includes 2 reactor zones and 144 lamps rated at 36 KW with two (2) wiping plates per chamber. Additional technical data on the

Trojan AOP reactor can be found in Appendix B. Any use of trade, firm, or product literature is for descriptive purposes only, and does not imply endorsement or selection by the Navy.

3.3 Chemical Storage Tank and Peroxide Delivery System

The size of the hydrogen peroxide storage tank is based on the hydrogen peroxide feed rate, the hydrogen peroxide concentration, and tank refilling rate. The hydrogen peroxide feed rate is based on desired hydrogen peroxide concentration in the AOP reactor.

Design Basis

The following assumptions are used in development of the peroxide storage tank design:

- Process water average flow rate is 1,000 gpm.
- Provide 3 to 20 mg/L of hydrogen peroxide in the process water. For tank sizing purposes, assume that the average concentration will be 12 mg/L.
- 27 to 35 percent hydrogen peroxide will be used to minimize regulation.
- The specific gravity of 27 percent hydrogen peroxide is 1.1 grams per cubic centimeter, or 9.2 pounds per gallon.
- Provide approximately four weeks of hydrogen peroxide storage.

Design

For the Storage Tank sizing, use the assumed average hydrogen peroxide concentration of 12 mg/L in the process water, with 27 percent hydrogen peroxide, and a minimum four-week storage capacity. Under these conditions:

- 144 Pounds per day of hydrogen peroxide will be used, or
- 58 gallons per day of 27 percent solution
- A four-week supply equals 1,624 gallons
- Provide a 2,500- to 3,200 -gallon tank

The Storage Tank is to be equipped with the following:

- Dual containment tank wall (to serve as secondary containment)
- Leak detection system
- Level monitoring and transmitter system
- A dual stage, backup level switch for Low-Low and High-High level detection
- Cover for UV protection of tank and hydrogen peroxide
- Vent system for oxygen off gassing
- Access Ladder
- Manway opening for inspection
- Fill line
- Drain pipe

- Liquid level gauge

For the pump sizing, provide a minimum and maximum hydrogen peroxide concentration in the process water of 3 to 20 mg/L. Under these conditions:

- Provide two manually adjustable hydrogen peroxide (27 percent) chemical metering pumps with a pumping range of 0.6 to 4.0 gallons per hour. One pump would be used for service and the other pump will be spare.
- Provide secondary containment on the suction and pressure side of the piping and the pumps.
- The secondary containment is to drain to a container for periodic manual inspection for leakage.
- Because of the anticipated short distance and associated contact time between the process water and hydrogen peroxide before the reactor, provide an injection quill and static mixer.
- A Process Water flow switch interlocked with the hydrogen peroxide pumps is needed to ensure water flow prior to the startup of chemical pump

The pressure in the existing air stripping system discharge is approximately 33 psi. Therefore, standard chemical metering pumps rated for 100 psi will provide adequate pressure to feed chemical upstream of the AOP reactor.

3.4 AOP System Safety Considerations

This AOP system will introduce hydrogen peroxide to the existing GM38 GWTS. As a result, the following several additional precautions will be required:

- The hydrogen peroxide storage tank will be a dual containment tank which will serve as secondary containment to protect workers and minimize potential release to the environment. This tank will be mounted on a 12-foot by 12-foot concrete pad with curb.
- The truck unloading station will be designed to contain small to moderate leaks (i.e., maximum of 100 gallons) of the hydrogen peroxide from the truck tank port during Storage Tank fill operations. The containment area pad will be 2” below grade and have 1 percent slope to allow for any incidental spill or leaks to be diverted to the existing drain pipe via a sump and buried valve box.
- New signage will be required for the building.

3.5 Process System Piping (GM38 Process Water)

The AOP Treatment System will tie into the existing GM38 Process Water piping after the air stripping tower/bag filtration system and before the existing liquid phase granular activated carbon. This piping will tee into the existing piping with valving to allow the AOP Treatment System to be bypassed in the future.

In addition, new GM38 Process Water piping and valves will be installed to allow the Air Stripping Tower to be bypassed.

The AOP System will discharge up to 20 mg/L of hydrogen peroxide to the existing GAC treatment System. In this unit, the GAC will catalytically break down the hydrogen peroxide to water and approximately 9 mg/L of oxygen. Some off gassing of oxygen in the GAC units may occur and the existing vents in the GAC units must be reevaluated and potentially replaced/rehabilitated.

3.6 AOP System Startup and Bypass

The AOP treatment system takes approximately 2 to 5 minutes for the UV lamps to warm up and obtain full power. During this time, the 1,4-dioxane is not effectively treated. Therefore, it is necessary to install an AOP start up bypass that prevents untreated water being discharged from GM38.

The bypass is to be connected into the GM38 Equalization Tank at the headworks of the plant. This piping should be sized to accommodate the full system flow rate of 1,000/1,400 gpm.

The existing horizontal centrifugal pumps 4A and 4B will be used to send the flow from the air stripper to the AOP system and then recycle back to the Equalization Tank during the AOP system warm up period. The flow will be circulated in this loop until the AOP reactors are ready to begin treatment. The design will include capability to send the flow to the Equalization Tank using automated valves with non-modulating actuators based on the operation status of the AOP reactors.

The design will also include capability to bypass the AOP system and send flow to the existing three (3) GAC units when the AOP system is temporarily unavailable for treatment due to shutdown for maintenance. The inlet valve to the AOP system will be manually operated using a chain wheel operator whereas the outlet valve from AOP system to GAC units will be automated valves with non-modulating actuator.

3.7 Geotechnical, Foundation, and Structural

The exterior Hydrogen Peroxide Storage Tank will be covered by a new, free-standing galvanized steel canopy structure that is approximately 150 square feet in size, constructed in accordance with applicable local and State of New York Building Codes and the 2015 International Building Code. This structure will be constructed of steel tube columns supporting steel wide-flange beams below a 1½-inch deep wide-ribbed metal roof deck (minimum 20 gage), thus creating an open structure with no interior columns. Steel design will be in compliance with American Institute of Steel Construction Manual of Steel Construction. All roof steel framing will be shop galvanized (G90) to help resist against corrosion due to moisture and chemical exposure.

A typical reinforced concrete mat slab foundation system shall be utilized to support the proposed canopy structure and UPS Tank. In addition, a reinforced concrete mat containment slab will be constructed adjacent to the UPS Tank slab, which will measure approximately 12 feet by 12 feet. Concrete members will be designed to American Concrete Institute 318 requirements, and frost protection will be provided by means of a 2" thick rigid insulation layer being placed directly below the bottom of the slab turned down edges and will extend out past the face of concrete slabs a minimum of 1 foot 6 inches.

Design will include all applicable containment slabs/curbs and sumps, waterstops, and concrete housekeeping pads. Concrete for containment and environmental structures will comply with the requirements of American Concrete Institute 350. Also, a chemical-resistant coating will be applied to all exterior floor slab surfaces for additional protection. Chemical-resistant containment coating and water stops, where required, will be products designed specifically for exposure to a 30% hydrogen peroxide solution during infrequent spills. If multiple systems are used, they shall be compatible and from a single supplier. The concrete slabs will be sloped towards the provided sump.

Site preparation activities will be required prior to construction of the tank mat foundation and containment slab due to the presence of the Stratum A historically fill soils. The Stratum A fill soils (including the organic soils) are considered unsuitable for direct support of the mat foundation because excessive and detrimental differential settlement of the mat foundation could result. Therefore, the Contractor is to remove all Stratum A fill soils from the slab foundations areas (minimum depth of 5 feet below grade surface). Removal of these materials is to extend a minimum of five (5) feet beyond the footprint of the slabs. Following removal of the Stratum A fill material and proper subgrade preparation, approved engineered fill may be used to bring these areas to design subgrade elevations. The existing building foundation, ground wire, and drains in the area must be protected as needed during excavation, backfill, and compaction.

The structures will be designed in accordance with applicable local and State of New York Building Codes and the 2015 International Building Code. The design criteria associated with the structural design is as follows:

Risk Category:

Risk Category = III

Snow:

Ground snow load, $p_{g.}$ = 30 pounds per square foot (PSF)
Importance Factor, I_S = 1.1 (Risk Category III)

Thermal Factor, C_t = 1.2
Exposure Factor, C_e = 1.0 (Exposure Category B, partially exposed)

Wind:

Ultimate Design Wind Speed = 136 miles per hour
Exposure Category = B
Importance Factor, I_W = 1.0 (Risk Category III)
Enclosure Classification = Open Building (+/- 0.00)

Seismic:

Building Risk Category III
Site Class D (Geotechnical Report dated April 23, 2019)
Short Period Spectral Response Acceleration, S_S = 0.234 g
1-Second Spectral Response Acceleration, S_1 = 0.066 g
Importance factor, I_E = 1.25 (Risk Category III)
Seismic Design Category = B

Following are the criteria that will be used to design the building's structure and foundation system associated with this project.

- Load combinations: Per ASCE 7-10.
- Roof dead load: Total material weight, in pounds per square foot, of final items to be supported by roof structural system.
- Total Collateral load = 4 PSF
  - Above listed collateral load is associated with supporting typical electrical and plumbing items.
  - In regard to the available roof dead load used in wind uplift calculations, all of the 4 PSF collateral loading will **not** be used to resist these loads.
- Roof live load (minimum) = 20 PSF
- Floor live load (minimum):
  - Typical Ground Floors = Weight of UPS Tank (30,000 pounds full, 2,300 pounds empty)
  - Light Storage = 125 PSF
  - Process Floor = 200 PSF
- Floor moving live load:
  - Large capacity pneumatic tire forklift (Toyota, Model 8FD7OU)
    - Load capacity = 15,500 pounds.
  - Truck Loading = H-20 Loading
- Frost depth = 48 inches below finished grade elevations.

3.8 Electrical System Design

Design Basis

The GM38 GWTS is currently served by a 500 kilovolt-ampere (KVA), three phase Delta /Star Outdoor Oil Cooled Pad Mounted Transformer, whose primary is 13.2 kilovolt (KV) and is fed from a nearby overhead pole (LIPA #18) through underground 15 KV cables. The secondary is connected to the existing 800 ampere (A) Main Circuit Breaker in MCC-1 located in the Office/ Control Room via exterior mounted CT Cabinet-Meter. The existing MCC-1 has 800A horizontal buses, 300A vertical buses, and an 800A neutral bus.

Based on the existing MCC-1 schedule and the load information obtained from the site, the existing 500 KVA transformer is currently loaded with 657 KVA at 480 volt, 3 phase, which means the utility transformer is 31 percent over loaded.

Design Approach

The additional load for the new AOP is estimated to be 206 KVA at 480 volt, 3 phase. The new total demand load would be approximately 863 KVA (657 plus 206). This new value does not allowance for future growth, if any. Considering a potential of 25 percent spare for future growth, the total design load would be 1,080 KVA at 480 volt, 3 phase.

Based on the design approach above, a new utility transformer of 1000 KVA would likely be used. Since the utility transformer is provided and maintained by the local Utility Company PSEG Long Island (PSEG), PSEG will determine the final size and location (to maintain clearances from building and other objects) of the transformer. Based on PSEG's instructions for Pad Mounted Transformer (refer to Attachment "A" to specification section 26 05 00), the new transformer shall be a minimum of twenty-five (25) feet from the existing building with at least five (5) feet of clearance on each side.

The feeder from secondary of the new Utility Transformer will terminate in the new Wire-Trough via the Current Transformer Cabinet for the new Service Meter. The feeder will be tapped in the Wire-Trough to two Service Entrance-type Fused Disconnect Switches-(a) 800A & (b) 400A. Item (a) will feed existing MCC-1 and item (b) will feed a new 400A, 480/277V, 3 phase, 4W Panelboard "P". The additional loads as noted above shall be fed from the Panel "P" including a 120/208V, 3 Phase, 4 W panel "L" (via a 45 KVA transformer) to handle take care of the additional 120/208V load. A new electronic digital KWH meter shall be provided next to Panel "P" to monitor power consumption for the new added equipment.

There will be two empty conduits for data wiring from controllers of new AOP to existing Main Controller Input/ Output Cabinet (located in the Control room) via new junction boxes in AOP area.

3.9 **Instrumentation and Controls**

The AOP instrumentation and controls are to be self-contained in the AOP panel as described above and in the drawings.

3.10 **Plumbing**

There are two (2) areas requiring combination eye wash & safety shower which include the following:

- AOP/Chemical Pump Area
- Exterior Hydrogen Peroxide Tank

A combination eye wash and safety shower will be provided in the AOP/Chemical Pump Area in the main process room. The unit will drain onto the existing floor and flow into the building sump.

The second combination eye wash and safety shower will be provided outside the building within the new truck unloading and Hydrogen Peroxide Storage Tank sump. Piping will be either under the 48-inch frost line or heat traced and insulated for freeze protection.

A new 120-gallon boiler and thermostatic mixing value will be used to provide 80-degree Fahrenheit water.

4.0 References

Navy, 2003. *Record of Decision for Operable Unit 2 Groundwater NYS Registry: 1-30-003B Naval Weapons Industrial Reserve Plant Bethpage, New York.* April.

Crittenden, J., Trussell, R., Hand, D., Howe, K., Tchobanoglous, G., 2012. *Water Treatment Principles and Design – 3rd Edition*. Hoboken, New Jersey: John Wiley & Sons, Inc.

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TABLES

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TABLE 1 - GM38 DESIGN BASIS AND OBJECTIVES

Paramater	Units	Current GM38 Area Hotspot	Planned Future GM38 Area Hotspot	Design Basis[3]	Treatment Goals[5]
Flow[1]	gpm	1,000	1,000	1,000 / 1,400	-
Tetrachloroethene	ug/L	24	16	0.20[4]	< 0.5
Trichloroethene	ug/L	110	1,293	19[4]	< 0.5
cis-1,2-Dichloroethene	ug/L	8	7.2	0.27[4]	< 0.5
trans-1,2-Dichloroethene	ug/L	ND	1	< 0.2	< 0.5
1,1-Dichloroethene	ug/L	1.4	3.5	< 0.2	< 0.5
Vinyl Chloride	ug/L	0.41	0.9	< 0.2	< 0.5
1,1,1-Trichloroethane	ug/L	0.97	1.1	< 0.2	< 0.5
Freon 113	ug/L	ND	6.6	< 0.2	< 0.5
1,1-Dichloroethane	ug/L	2	2.2	< 0.2	< 0.5
1,1,2-Trichloroethane	ug/L	ND	1.7	< 0.2	< 0.5
1,4-Dioxane	ug/L	2.5	5	5	50/< 0.5
Nitrate/Nitrite[2]	mg/L	-	-	3.2 / 4	-
Total Organic Carbon[2]	mg/L	-	-	0.15 / 0.49	-
Iron[2]	ug/L	-	-	0.8 / 19	-
Manganese[2]	ug/L	-	-	1.28 / 19	-
pH[2]		5 to 6	6.5 to 7.5	6.5 to 7.5	-

GWTS - Groundwater Treatment System.
VOC - Volatile Organic Compound.
1 - Average / Maximum.
2 - Minimum / Maximum.
3 - Post air stripper.
4- Calculated based on current air stripper performance.
5 - The New York State Department of Health (NYSDOH) Maximum Contaminant Level (MCL) for each of these VOCs is 5 ug/L. The current NYSDOH MCL for 1,4-dioxane is 50 ug/L. The anticipated future NSYDOH MCL for 1,4-dioxane is 1 ug/L. The treatment goals presented above are anticipated typical concentrations to be achieved by the treatment system. The actual treatment requirements are based on the MCLs.

gpm - Gallons per minute.
ug/L - Micrograms per liter.
mg/L - Milligrams per liter.

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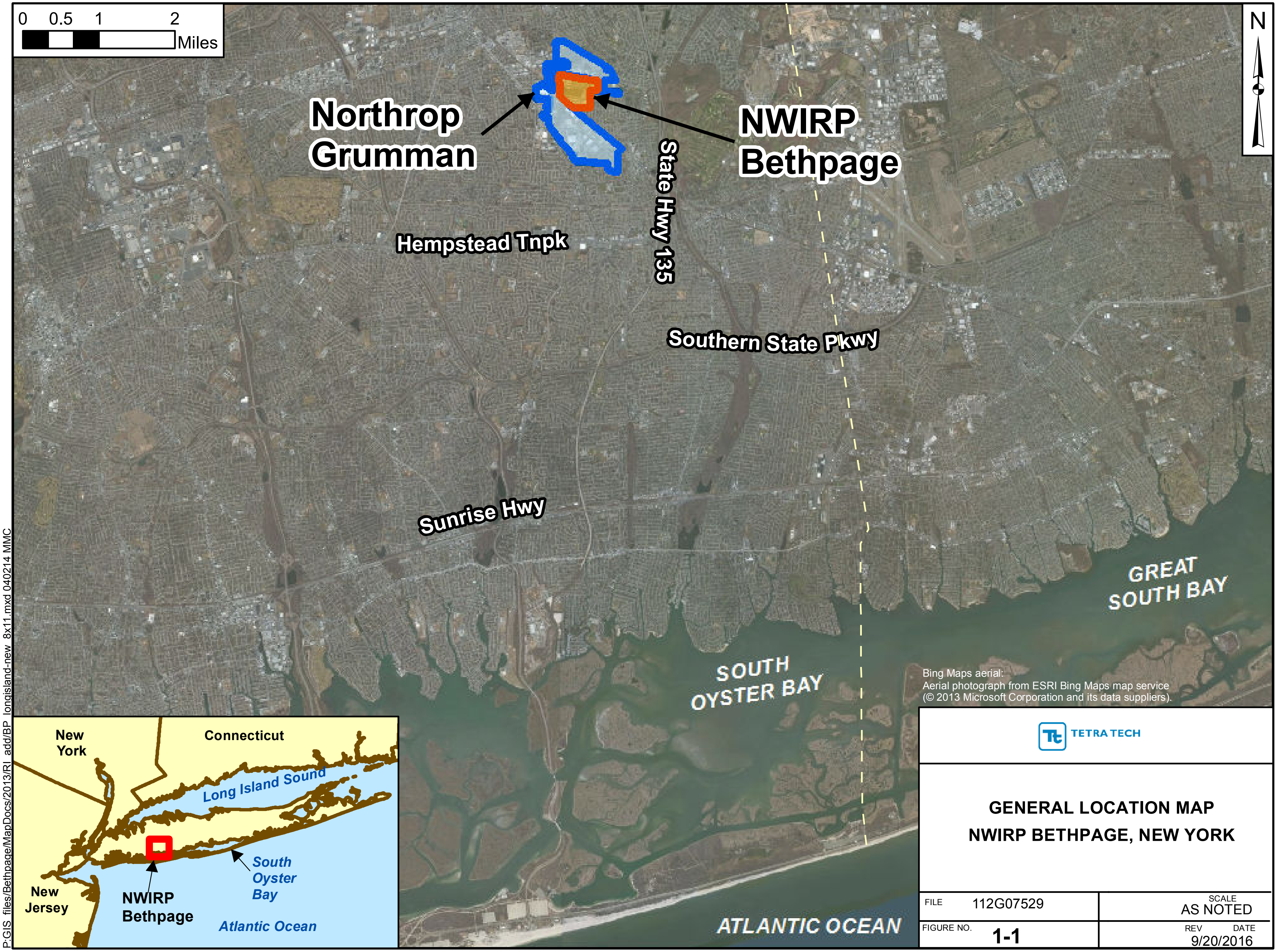
FIGURES

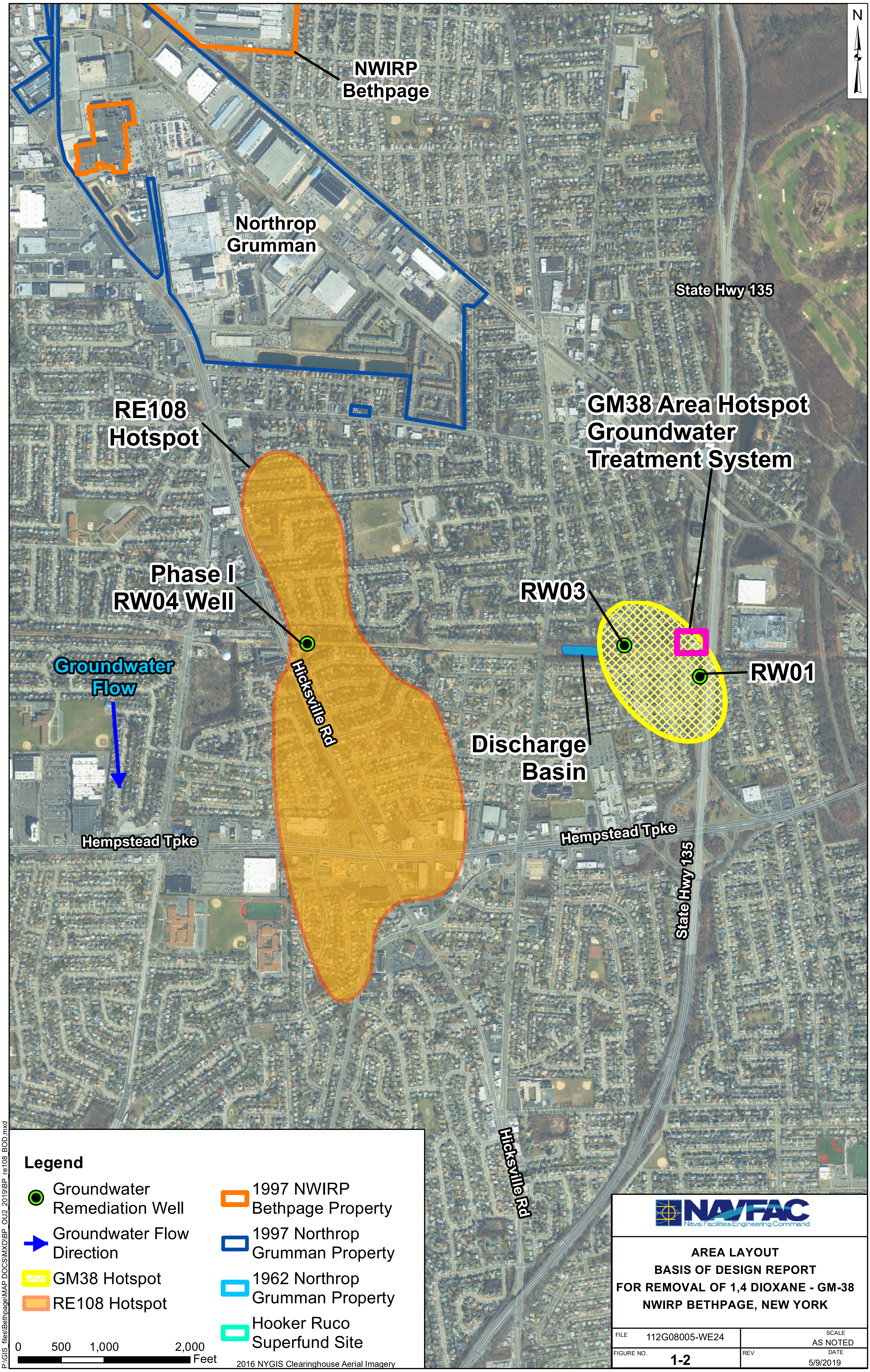


TETRA TECH

GENERAL LOCATION MAP
NWIRP BETHPAGE, NEW YORK

FILE	112G07529	SCALE	AS NOTED
FIGURE NO.	1-1	REV	DATE 9/20/2016

P:GIS_files/Bethpage/MapDocs/2013/RI_add/BP_longisland-new_8x11.mxd 040214 MMC



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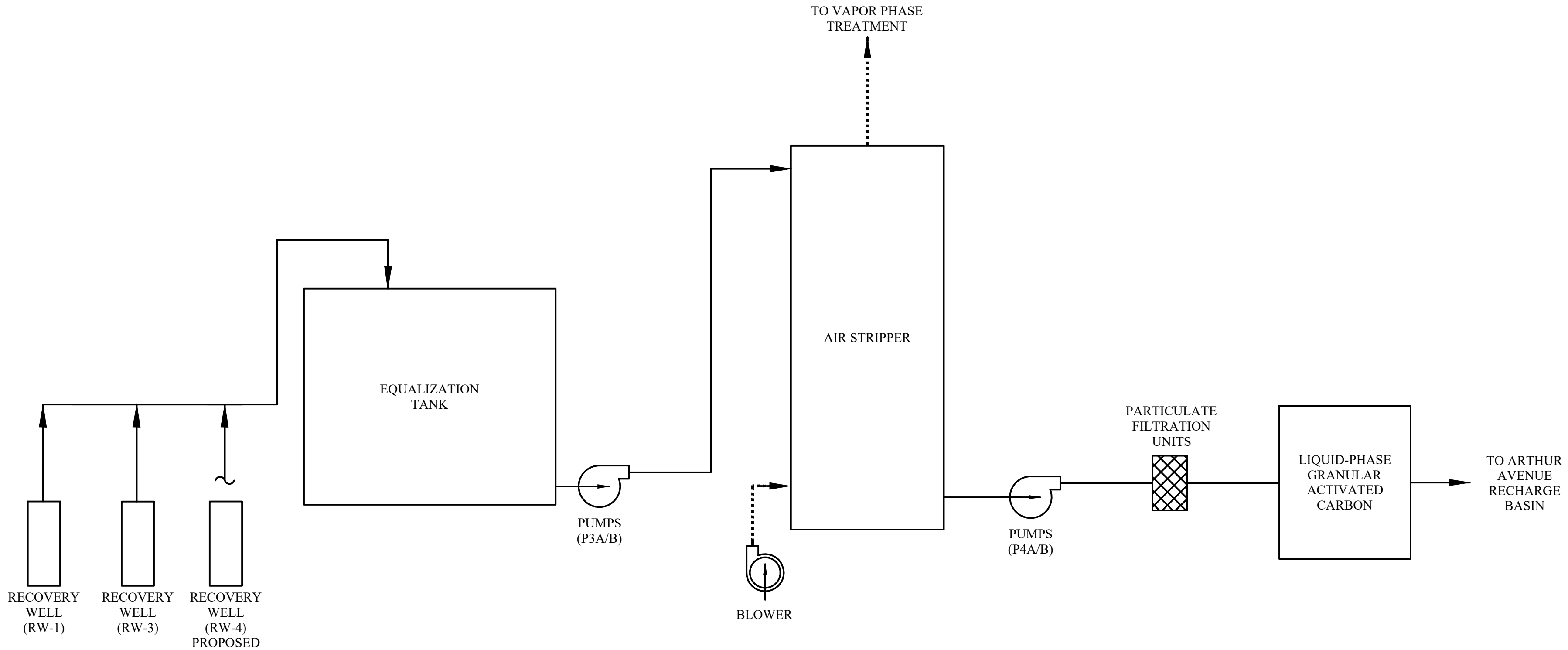
EXISTING GM38 AREA HOTSPOT GROUNDWATER TREATMENT PROCESS
(LIQUID PHASE TRAIN)



DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND, MID-ATLANTIC
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BETHPAGE, NEW YORK

FIGURE 1-3
GM38 GWTS PROCESS DIAGRAM
BASIS OF DESIGN REPORT
FOR REMOVAL OF 1,4-DIOXANE - GM38

SCALE : AS SHOWN

APPENDIX A

PILOT STUDY RESULTS REPORT

(TABLES 3A AND 3B ONLY, FULL REPORT IS PROVIDED UNDER SEPARATE COVER)

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TABLE 3A - ANALYTICAL RESULTS FOR THE UV/PEROXIDE AOP TECHNOLOGY FOR THE REMOVAL OF 1,4-DIOXANE PILOT SCALE STUDY GM38 GROUNDWATER TREATMENT PLANT, NWIRP BETHPAGE, NY

			Test Conditions					1,4 - Dioxane			TCE			PCE			1,1-DCA			TOC	
Test Number	Sample/ Test Name	Water Source	Reactor Contact Time (Min)	H_2O_2 Dose (ppm)	UV Dose[1] (mJ/cm^2)	UV Inten.[1] (w/m^2)	UV Usage (watt/ gpm)	Influent Conc. (ug/L)	Effluent Conc. (ug/L)	Removal Efficiency (%)	Influent Conc. (ug/L)	Effluent Conc. (ug/L)	Removal Efficiency (%)	Influent Conc. (ug/L)	Effluent Conc. (ug/L)	Removal Efficiency (%)	Influent Conc. (ug/L)	Effluent Conc. (ug/L)	Removal Efficiency (%)	Influent (mg/L)	Effluent (mg/L)
1	M1-T1-UV	Untreated EQ Tank	1.4	4.0	1,320	181	53	0.59	0.05 U	> 91.5	75.7	0.4 J	99.5	8.7	0.23 J	97.4	1.4	1.1	21.4	0.45 J	-
2	M1-T2-UV	Untreated EQ Tank	1.4	8.0	1,315	178	53	0.59	0.05 U	> 91.5	75.7	0.2 U	> 99.7	8.7	0.2 U	> 97.7	1.4	0.92 J	34.3	0.45 J	-
3	M1-T3-UV	Untreated EQ Tank	1.4	16.0	1,249	168	53	0.59	0.05 U	> 91.5	75.7	0.2 U	> 99.7	8.7	0.2 U	> 97.7	1.4	0.87 J	37.9	0.45 J	-
4	M1-T4a-UV	Untreated EQ Tank	1.4	8.0	1,350	175	53	0.59	0.05 U	> 91.5	75.7	0.2 U	> 99.7	8.7	0.2 U	> 97.7	1.4	0.89 J	36.4	0.45 J	0.37 J
5	M1-T4b-UV	Untreated EQ Tank	2.1	12.0	1,319	173	35	0.59	0.05 U	> 91.5	75.7	0.2 U	> 99.7	8.7	0.2 U	> 97.7	1.4	0.85 J	39.3	0.45 J	0.32 J
6	M1-T5-UV	Untreated EQ Tank	1.4	16.0	1,130	168	53	0.59	0.06 U	> 89.8	75.7	0.2 U	> 99.7	8.7	0.2 U	> 97.7	1.4	0.82 J	41.4	0.45 J	0.44 J
7	M1-T5-UV (Post Cl)[2]	Untreated EQ Tank	1.4	16.0	1,130	168	53	0.59	0.06 U	> 89.8	75.7	0.2 U	> 99.7	8.7	0.2 U	> 97.7	1.4	0.2 U	-	0.45 J	-
8	M2-T1-UV	Post AS	1.6	2.0	1,257	183	47	0.64	0.05 U	> 92.2	1.4	0.2 U	> 85.7	0.2 U	0.2 U	-	0.2 U	0.2 U	-	0.49 J	-
9	M2-T2-UV	Post AS	1.6	4.0	1,239	180	47	0.64	0.05 U	> 92.2	1.4	0.2 U	> 85.7	0.2 U	0.2 U	-	0.2 U	0.2 U	-	0.49 J	-
10	M2-T3-UV	Post AS	1.6	8.0	1,188	177	47	0.64	0.05 U	> 92.2	1.4	0.2 U	> 85.7	0.2 U	0.2 U	-	0.2 U	0.2 U	-	0.49 J	-
11	M2-T4a-UV	Post AS	2.5	8.0	792	183	30	0.64	0.06 U	> 90.6	1.4	0.2 U	> 85.7	0.2 U	0.2 U	-	0.2 U	0.2 U	-	0.49 J	0.16 J
12	M2-T4b-UV	Post AS	2.5	4.0	785	197	30	0.64	0.05 U	> 92.2	1.4	0.2 U	> 85.7	0.2 U	0.2 U	-	0.2 U	0.2 U	-	0.49 J	0.15 J
13	M2-T5-UV	Post AS	2.4	8.0	783	174	32	0.64	0.06 U	> 90.6	1.4	0.2 U	> 85.7	0.2 U	0.2 U	-	0.2 U	0.2 U	-	0.49 J	0.38 J
14	M2-T5-UV (Post Cl)[2]	Post AS	1.4	8.0	783	174	53	0.64	0.06 U	> 90.6	1.4	0.2 U	> 85.7	0.2 U	0.2 U	-	0.2 U	0.2 U	-	0.49 J	-
15	M3-T2-UV	Untreated EQ Tank+ Spike	1.4	4.0	1,379	176	53	12	0.05 U	> 99.6	370	1.2	99.7	8.6	0.2 U	> 97.7	1.3	0.2 U	> 84.6	0.37 J	-
16	M3-T3-UV	Untreated EQ Tank+ Spike	1.5	8.0	1,135	170	50	12	0.05 U	> 99.6	370	0.8 J	99.8	8.6	0.2 U	> 97.7	1.3	0.2 U	> 84.6	0.37 J	-
17	M3-T4-UV (Post Cl)[2]	Untreated EQ Tank+ Spike	1.4	16.0	1,247	159	53	12	0.05 U	> 99.6	370	2.0 U	> 99.5	8.6	2.0 U	> 76.7	1.3	2 U	-	0.37 J	-
18	M4-T2-UV	Post AS + Spike	1.5	2.0	1,364	180	50	10.3	0.05 U	> 99.5	3.8	0.2 U	> 94.7	0.2 U	0.2 U	-	0.2 U	0.2 U	-	0.37 J	-
19	M4-T3-UV	Post AS + Spike	1.5	4.0	1,276	180	50	10.3	0.05 U	> 99.5	3.8	0.2 U	> 94.7	0.2 U	0.2 U	-	0.2 U	0.2 U	-	0.37 J	-
20	M4-T4-UV	Post AS + Spike	1.5	8.0	1,348	177	50	10.3	0.05 U	> 99.5	3.8	2.0 U	> 47.4	0.2 U	2.0 U	-	0.2 U	2 U	-	0.37 J	-

1 - Six lamps at 70 watts each.

2 - "Post Cl" refers to post clorination. These samples were collected after the LGAC filters and were subsequently mixed with 2 mg/L of Clorine and quenched with sodium bisulfate to replication a potable water treatment plant and test for the formation of disinfection byproducts and trihalomethanes.

> - Greater than.
1,1-DCA - 1,1 - Dichloroethane.
AS - Airstripper.
Cl - Chlorine.
Conc. - Concentration.
EQ - Equalization.
gpm - Gallons per minute.
H_2O_2 - Hydrogen Peroxide.
Inten. - Intensity.
J - Estimated value.
mJ/cm^2 - Millijoule per square centimeter.
mg/L - Milligrams per liter.
PCE - Tetrachloroethene.
ppm - Parts Per Million.
TCE - Trichloroethene.
TOC - Total organic carbon.
Trans. - Transmittance.
U - Not detected.
ug/L - Micrograms per liter.
UV - Ultraviolet.
w/m^2 - Watts per square meter.

TABLE 3B - ANALYTICAL RESULTS FOR THE OZONE/PEROXIDE AOP TECHNOLOGY
FOR THE REMOVAL OF 1,4-DIOXANE PILOT SCALE STUDY
GM38 GROUNDWATER TREATMENT PLANT, NWIRP BETHPAGE, NY

			Test Conditions			1,4 - Dioxane			TCE			PCE			1,1-DCA			Bromate		TOC	
Test Number	Sample/ Test Name	Water Source	Reactor Contact Time (min)	H_2O_2 Dose (ppm)	Calc. Ozone Dose (ppm)	Influent Conc. (ug/L)	Effluent Conc. (ug/L)	Removal Efficiency (%)	Influent Conc. (ug/L)	Effluent Conc. (ug/L)	Removal Efficiency (%)	Influent Conc. (ug/L)	Effluent Conc. (ug/L)	Removal Efficiency (%)	Influent Conc. (ug/L)	Effluent Conc. (ug/L)	Removal Efficiency (%)	Influent (mg/L)	Effluent (mg/L)	Influent (mg/L)	Effluent (mg/L)
21	M1-T1-OZ	Untreated EQ Tank	2.8	4.0	3.2	0.65	0.05 U	> 92.3	75.9	7.8	89.7	8.2	3.6	56.1	1.5	1.3	13.3	1.25 U	0.25 U	0.58	-
22	M1-T2-OZ	Untreated EQ Tank	2.8	8.0	6.0	0.65	0.05 U	> 92.3	75.9	1.2	98.4	8.2	1.1	86.6	1.5	1.2	20.0	2.25 U	0.25 U	0.58	-
23	M1-T3-OZ	Untreated EQ Tank	3.3	16.0	12.0	0.65	0.05 U	> 92.3	75.9	0.48 J	99.4	8.2	0.2 U	97.6	1.5	0.83 J	44.7	3.25 U	0.25 U	0.58	-
24	M1-T4a-OZ	Untreated EQ Tank	4.6	11.0	8.3	0.65	0.06 U	> 90.8	75.9	0.2 U	> 99.7	8.2	0.2 U	97.6	1.5	1	33.3	4.25 U	0.25 U	0.58	0.15 J
25	M1-T5-OZ	Untreated EQ Tank	3.2	11.0	7.8	0.65	0.05 U	> 92.3	75.9	0.77 J	99.0	8.2	0.49 J	94.0	1.5	0.98 J	34.7	-	-	0.58	0.38 J
26	M1-T5-OZ (Post Cl)	Untreated EQ Tank	3.2	11.0	7.8	0.65	0.06 U	> 90.8	75.9	0.2 U	> 99.7	8.2	0.20	97.6	1.5	0.2	-	-	-	0.58	-
27	M2-T2-OZ	Post AS	1.8	4.0	2.8	0.05 U	0.05 U	> 0.0	0.83 J	0.45 J	45.8	0.2 U	0.20 U	-	0.2 U	0.2 U	-	2.25 U	0.25 U	1.2	-
28	M2-T3-OZ	Post AS	2.8	8.0	5.9	0.05 U	0.05 U	> 0.0	0.83 J	0.20 U	> 75.9	0.2 U	0.20 U	-	0.2 U	0.2 U	-	3.25 U	0.25 U	1.2	-
29	M2-T4-OZ	Post AS	4.0	8.0	6.0	0.05 U	0.06 U	> -20.0	0.83 J	0.2 U	> 75.9	0.2 U	0.2 U	-	0.2 U	0.2 U	-	4.25 U	0.25 U	1.2	0.16 J
30	M2-T5-OZ	Post AS	4.0	8.0	5.8	0.05 U	0.05 U	> 0.0	0.83 J	0.2 U	> 75.9	0.2 U	0.2 U	-	0.2 U	0.2 U	-	-	-	1.2	0.35 J
31	M2-T5-OZ (Post Cl)[1]	Post AS	4.0	8.0	5.8	0.05 U	0.05 U	> 0.0	0.83 J	0.2 U	> 75.9	0.2 U	0.2 U	-	0.2 U	0.2 U	-	-	-	1.2	-
32	M3-T1-OZ	Untreated EQ Tank+ Spike	4.1	8.0	5.8	8.4	0.05 U	> 99.4	140	17.2	87.7	7.3	1.0	86.3	1.1	0.93 J	15.5	1.25 U	0.25 U	0.25 J	0.25 J
33	M3-T2-OZ	Untreated EQ Tank+ Spike	4.1	16.0	11.7	8.4	0.05 U	> 99.4	140	22.3	84.1	7.3	0.2 U	> 97.3	1.1	0.2 U	81.8	2.25 U	0.25 U	0.25 J	
34	M3-T3-OZ	Untreated EQ Tank+ Spike	4.5	20.0	17.5	8.4	0.05 U	> 99.4	140	2.6	98.1	7.3	0.2 U	> 97.3	1.1	0.2 U	81.8	3.25 U	0.25 U	0.25 J	
35	M3-T4_OZ (Post Cl)[1]	Untreated EQ Tank+ Spike	4.5	20.0	17.5	8.4	0.06 U	> 99.3	140	2.0 U	> 98.6	7.3	2.0 U	> 72.6	1.1	2 U	-	-	-	0.25 J	-
36	M4-T1-OZ	Post AS + Spike	4.2	4.0	4.1	10.5	0.05 U	> 99.5	4	0.2 U	> 95.0	0.2 U	0.2 U	> -	0.2 U	0.2 U	-	1.25 U	0.25 U	0.22 J	0.22 J
37	M4-T2-OZ	Post AS + Spike	4.2	8.0	6.2	10.5	0.05 U	> 99.5	4	0.2 U	> 95.0	0.2 U	0.2 U	> -	0.2 U	0.2 U	-	2.25 U	0.25 U	0.22	
38	M4-T3-OZ	Post AS + Spike	4.2	16.0	12.3	10.5	0.05 U	> 99.5	4	0.53 J	86.8	0.2 U	0.2 U	> -	0.2 U	0.2 U	-	3.25 U	0.25 U	0.22	
39	M4-T4-OZ (Post Cl)[1]	Post AS + Spike	4.2	8.0	6.2	10.5	0.06 U	> 99.4	4	2.0 U	> 50.0	0.2 U	2.0 U	> -	0.2 U	2 U	-	4.25 U	0.25 U	0.22	-

1 - "Post Cl" refers to post clorination. These samples were collected after the LGAC filters and were subsequently mixed with 2 mg/L of Clorine and quenched with sodium bisulfate to replication a potable water treatment plant and test for the formation of disinfection byproducts and trihalomethanes.

mg/L - Milligrams per liter.
ug/L - Micrograms per liter.
PCE - Tetrachloroethene.
H_2O_2 - Hydrogen Peroxide.
J - Estimated value.
AS - Air Stripper.
ppm - Parts Per Million.
TCE - Trichloroethene.
EQ - Equalization.
TOC - Total organic carbon.
U - Not detected.

APPENDIX B
KEY PROCESS EQUIPMENT INFORMATION

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Any use of trade, firm, or product literature is for descriptive purposes only, and does not imply endorsement or selection by the US Navy.

PRODUCT DETAILS

Environmental Contaminant Treatment

TROJANUV™

Water Confidence™

Turn-key UV-oxidation Water Treatment

State-of-the-art solutions. One trusted source.

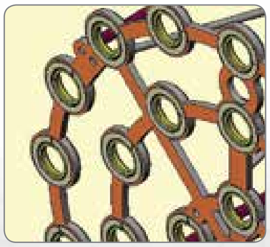
Water resources are under stress due to increasing population, changing rainfall patterns, widespread pollution, and a variety of other factors. For this reason, water providers must strive to make the most of every available water source, even those that have been impacted by contamination. Our Environmental Contaminant Treatment solutions continue our long-standing tradition of providing water confidence with proven UV technology and innovative solutions that help restore and preserve precious water supplies.

Our turn-key UV-oxidation solutions are enabling water suppliers to cost-effectively treat chemical and microbial contaminants that affect the purity of water in drinking water, wastewater reuse and groundwater remediation applications. The revolutionary TrojanUVPhox™, TrojanUVSwift™ECT and TrojanUVTorrent™ECT provide reliable delivery of UV energy to safeguard water against microorganisms and oxidize environmental contaminants. These robust systems work in tandem with our engineered hydrogen peroxide chemical management system.

Service is an integral part of our UV-oxidation solutions. ChemWatch™ technology remotely monitors hydrogen peroxide use, enabling us to automatically schedule hydrogen peroxide deliveries or notify you of unexpected changes in usage. We also oversee replenishment of hydrogen peroxide on an as-needed basis. From our performance guarantee of system sizing – to our trained local service technicians – we deliver a level of confidence that can only come from one source.

Optional Wiping System

Food-grade rubber wipers ensure maximum treatment efficiency by maintaining optimal transmittance of quartz sleeves.



Power Distribution Center

Houses the electronic ballasts and control board with local display. Each power distribution center provides power distribution for one UV chamber.

Control Board

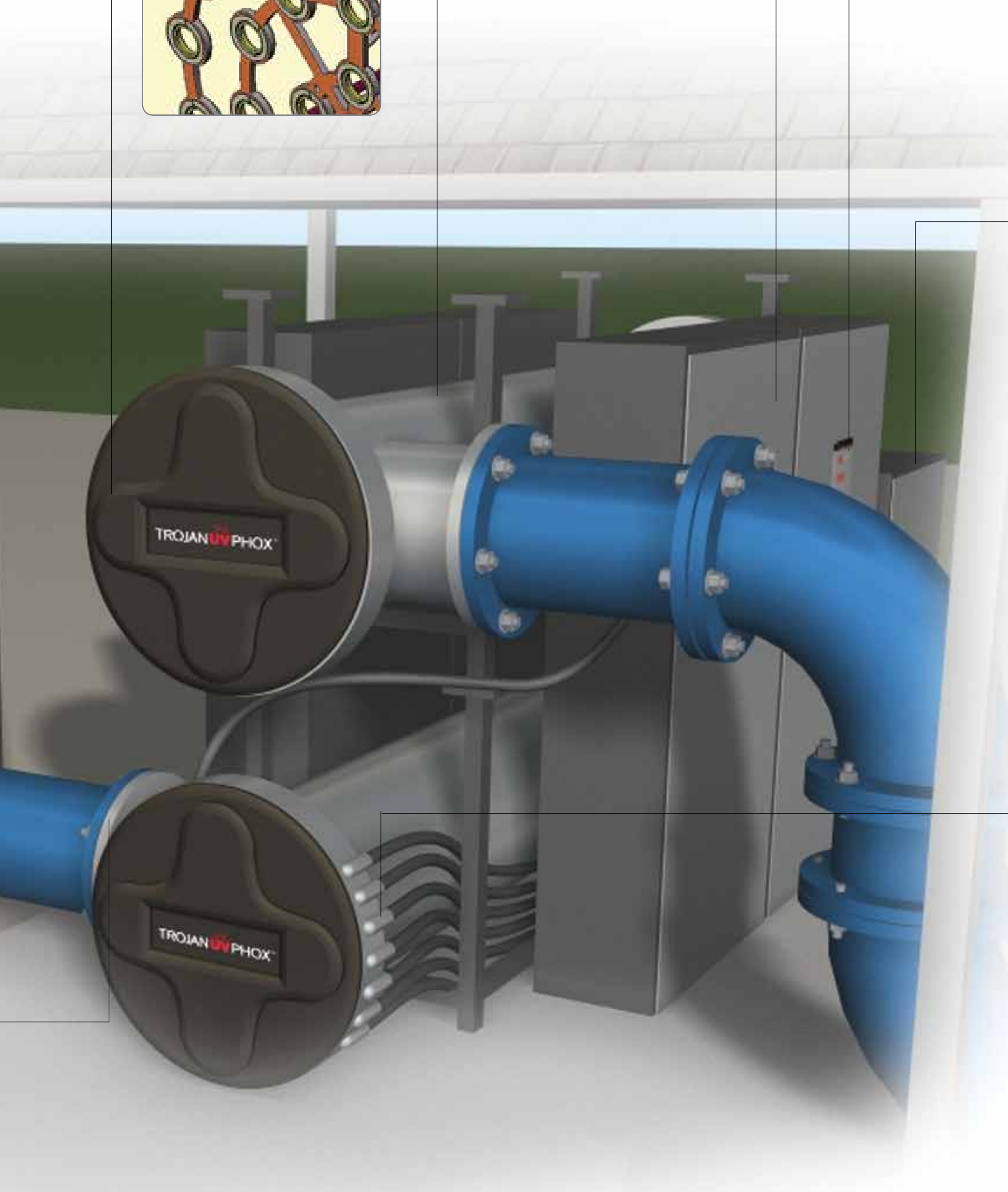
Door-mounted interface displays the UV Intensity (mW/cm^2), Elapsed Time (hours), Lamp Status/Ballast Status and Alarm Conditions.

Optional System Control Center

Optional programmable logic controller continuously monitors and controls UV system functions. This maintains optimum system operation by controlling hydrogen peroxide dose and power output to ensure maximum system efficiency.

UV Intensity Sensor

Highly accurate photodiode sensor monitors UV output within the chamber. Mounted in the sensor port on the side wall of the chamber for easy access.



Modular Compact Chamber

Innovative design maximizes efficiency and minimizes footprint

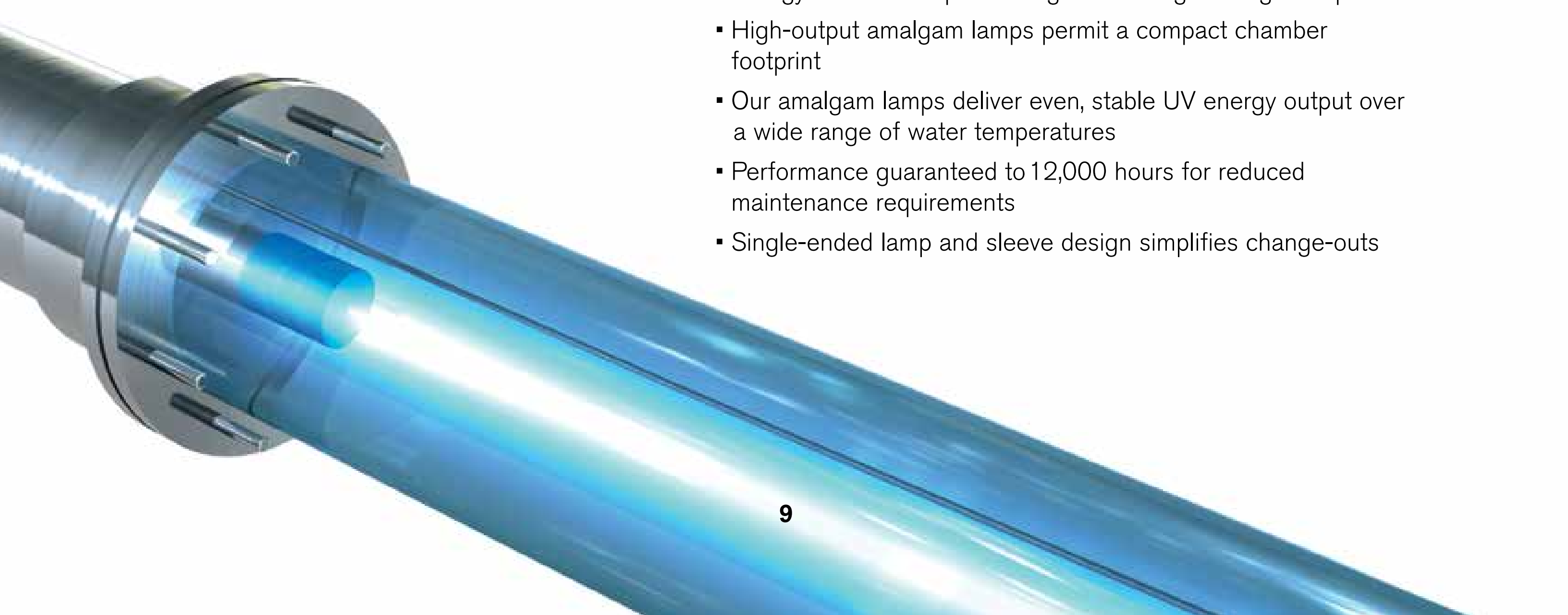
The modular design of the TrojanUVPhox allows space efficient configurations capable of treating large flow rates.

Benefits:

- More contaminant treatment per input power than competing contaminant treatment systems
- Vertically stackable, modular design allows for system expansion without increasing footprint
- Proven chamber design – configuration and components have demonstrated superior performance in hundreds of installations
- Scalable system is available in multiple configurations and various lamps per chamber to handle virtually any flow rate
- Designed using Computational Fluid Dynamics modeling and other advanced computer simulation tools to ensure optimum lamp spacing, uniform flow field, and significant efficiency advantages
- Constructed of electropolished 316L stainless steel for a smooth interior and exterior finish, long life, and durability

High-Output Amalgam Lamps

Advanced, energy-efficient lamps reduce electrical costs



Benefits:

- Energy efficient lamps with high UVC-range UV light output
- High-output amalgam lamps permit a compact chamber footprint
- Our amalgam lamps deliver even, stable UV energy output over a wide range of water temperatures
- Performance guaranteed to 12,000 hours for reduced maintenance requirements
- Single-ended lamp and sleeve design simplifies change-outs

APPENDIX C
CALCULATIONS

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PROCESS CALCULATIONS

FOR

GM-38

Bethpage, NY

TOTAL DYNAMIC HEAD and HP CALCULATION

SITE INFORMATION

SITE	**Bethpage, NY**	SPEC NO.	
PROJECT	**GM-38**	REV	**Rev 1**
PROJECT NO.	**112G08005-WE24**	DATE	**May 17, 2019**

PUMP AND PIPELINE DESCRIPTION

Type	Water is pumped from Equalization Tank (T-1) to top of Air Stripper (AS-1)	
Design Flowrate (gpm)	1000	Maximum flow rate
Pump Flowrate (gpm)	1000	Each Pump - flow rate
Pump Location	Outside Equalization Tank	
Pipeline Description	Water is pumped from Equalization Tank (T-1) to top of Air Stripper (AS-1)	

HEAD LOSSES

Static Discharge Head

Finished Floor Elevation 87.5

Air stripper top (ft MSL) 134.50

Total Elevation Head Loss (ft) 47.00

$$h_s = \Delta z$$

Pipe Friction Head Loss

Line No.	Description	Pipe Mat'l	Hazen Williams	ID	Length	Flow	Velocity	Head Loss
			Coeff.	(in)	(ft)	(gpm)	ft/s	(ft)
a	Pump Suction - EQ tank T-1 to pump P-3A/B	PVC	110	12	10	1000	2.8368	0.03
b	pump P-3A/B to air stripper AS-1	PVC	110	10	30	1000	4.085	0.25

HAZEN WILLIAMS EQUATION

$$h_f = \frac{0.2083\left(\frac{100}{C}\right)^{1.85} Q^{1.85} L}{100 D^{4.8655}}$$

Subtotal Straight Pipe Friction Head Loss (ft) 0.29

Miscellaneous Losses - estimate

Fittings:

Line No.	Type	LD	Flow	Qty	Diameter	K		Head Loss
			(gpm)					(ft)
Pump Suction - EQ tank T-1 to pump P-3A/B	Gate Valve	8	1000	2	12	0.10		0.03
	12"x 8" Reducer		1000	1	8	0.50		0.32
	Y Type strainer		1000	1	8			1.67
	90 degree bends	30	1000	2	12	0.40		0.10
Pump Discharge - pump P-3A/B to air stripper AS-1	6"x10" Expander		1000	1	6	0.50		1.00
	Gate Valve	8	1000	1	10	0.11		0.03
	Check Valve	50/100	1000	1	10	2.00		0.52
	TEE	20	1000	1	10	1.50		0.39
Subtotal of minor losses(ft)								4.05

$$h_m = \sum \frac{Kv^2}{2g}$$

Equipment losses

		psi		Qty				
Pump Discharge - pump P-3A/B to air stripper AS-1	Magnetic Flowmeter - 10	0	1000	1	10			0.00

Total piping headlosses 4.34

TOTAL DYNAMIC HEAD **51.34** **FT**

$$TDH = h_z + h_f + h_m$$

say (10% contingency) **56.47** **FT**

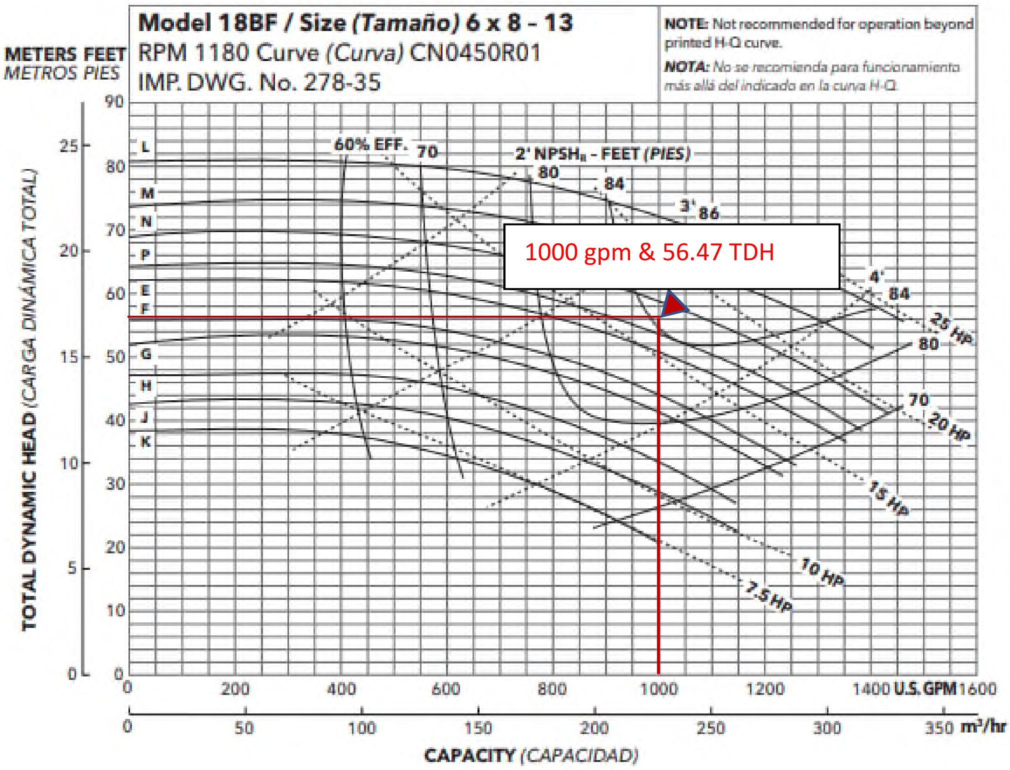
Computed HP **16.68**

Selected Motor HP **20.00** HP

Prepared By SK

Checked By: HKM

PERFORMANCE CURVES - 60 HZ, 1180 RPM
CURVAS DE DESEMPEÑO - 60 HZ, 1180 RPM



Optional Impeller *Impulsor optativo*	
Ordering Code *Código de pedido*	**Dia.** *Diá.*
L	13"
M	12½
N	12 5/16
P	11 7/8
E	11 5/8
F	11 3/8
G	10 7/8
H	10½
J	10
K	9½

NOTE: Pump will pass a sphere to 7/8" diameter.

NOTA: *La bomba dejará pasar una esfera de hasta 7/8 de pulgada de diámetro.*

Air Stripper Feed Pumps

Tag No: P-3A, P-3B
Name: Air Stripper Feed Pumps
Type: Horizontal Centrifugal
Rating: 1375 GPM, 60 ft TDH
Manufacturer: Goulds
Model: 3656
Serial: 18BF3P2L0
Motor
Manufacturer: Baldor Electric
Rating: 25 HP, 460V 60Hz 3Phase, Inverter Duty, TEFC
Model:
Serial: 40H026X115G2

Serial: 18BF3P2LO

3656/3756 L-GROUP NUMBERING SYSTEM
SISTEMA DE NUMERACIÓN DEL GRUPO L, MODELOS 3656/3756

The various versions of the 3656 and 3756 L-Group are identified by a product code number on the pump label. This number is also the catalog number for the pump. The meaning of each digit in the product code number is shown below. Not all combinations are possible; consult your Goulds Water Technology distributor for specific requirements.

Las diferentes versiones de los modelos 3656 y 3756 del Grupo L se identifican con un número de código de producto en la etiqueta de la bomba. Este número es también el número de catálogo de la bomba. A continuación se ilustra el significado de cada dígito en el código del producto. No todas las combinaciones son posibles, consulte a su distribuidor Goulds Water Technology para requisitos específicos.

Example Product Code, *Ejemplo del código de producto*

18 BF 2 Q 2 J 0 R

Casing Rotation, Optional — ***Rotación de la cubierta, opcional***

R = 3 o'clock B = 6 o'clock L = 9 o'clock

R = 3 hora B = 6 hora L = 9 hora

NOTE: Rotation when viewed from suction end of pump. Standard discharge position is 12 o'clock.

***NOTA:** Rotación cuando está visto del extremo de la succión de la bomba. La posición estándar de la descarga es las 12.*

Mechanical Seal/Packed Box and O-ring Material, ***Materiales del sello mecánico/empaque y anillo en O***

For Optional Mechanical Seal modify catalog order no. with Seal code listed below.

Para sellos mecánicos optativos, modificar el número de pedido del catálogo con los códigos de sello que se indican a continuación.

Seal Code, *Código del Sello*	Rotary, *Rotativo*	Stationary, *Estacionario*	Elastomers, *Elastómeros*	Metal Parts, *Partes Metálicas*	Part No., *Pieza Número* L-Group, *Grupo-L*
0	Carbon, *Carbone*	Ceramic, *Cerámica*	BUNA-N	316 SS, *316 Acero inoxidable*	10K84
1		Sil-Carbide, *Carburo de silicona*	EPR		NA
3			Viton		10K112
5	Sil-Carbide				10K144
8A*					
8B**					
9***	Packed Box Design with BUNA O-Ring, *Diseño de prensaestopas empacado con anillo en O de BUNA*				15K4

* Prime-Safe option with oiler, *Opción Primero-Segura con el engrasador* ** Prime-Safe option with grease, *Opción Primero-Segura con la grasa*

*** All Packed Box Units use JP style motors, *Todas las unidades de prensaestopas empacado utizilan motores estilo JP*

Impeller Option Code, *Código de opción de impulsor*

Impeller Code, *Código del impulsor*	L-Group Pump Size, *Tamaño de la bomba* 18 Dia.	19 Dia.	20 Dia.
A	■13"	■13"	■16"
B	■12½	■12¾	■15⅝
C	■12 5/16	■12⅛	■15 5/16
D	■11⅞	■11 15/16	■14½
E	11⅝	■11 11/16	■13¾
F	11⅛	■11¼	
G	10⅝	■10⅞	
H	10½	■9 15/16	
J	10	• 13	
K	9½	• 12¾	
L	• 13	• 12⅛	
M	• 12½	• 11 15/16	
N	• 12 5/16	• 11 11/16	
P	• 11⅞	• 11¼	
Q		• 10⅞	
R		• 9 15/16	

■ Indicates L-Group pump (1780 RPM, 60 to 150 HP)

• For 1180 RPM Close-Coupled applications only.

NOTE: For trimmed impellers, use T for impeller code.

■ Indica una bomba Grupo "L". (1780 RPM, de 60 a 150 HP)

• Para aplicaciones de acople cerrado de 1180 RPM únicamente.

***NOTA:** Para los impulsores cortados, utilice T para el código del impulsor.*

NOTE: Impellers will be trimmed in 1/16" increments only. If you are ordering a trim within 1/16" of the standard impeller, you will receive the standard impeller trim.

***NOTA:** Los impulsores serán cortados en 1/16" incrementos solamente. Si usted está pidiendo un ajuste dentro de 1/16" del impulsor estándar, usted recibirá el ajuste estándar del impulsor.*

Driver, *Elemento motor*

1 = 1 PH, ODP 4 = 1PH, TEFC 7 = 3 PH, XP 0 = 1 PH, XP C = 3 PH, WP PE F = 1 PH, ODP PE
2 = 3 PH, ODP 5 = 3 PH, TEFC 8 = 3 PH, 575 V, XP A = 3 PH, 575 TE PE D = 3 PH, 575 ODP PE
3 = 3 PH, 575 V, ODP 6 = 3 PH, 575 V, TEFC 9 = 3 PH, TE PE B = 3 PH, ODP PE E = 3 PH, XP PE
1PH = monofásico, 3PH = trifásico PE = Premium efficiency, *Eficiencia superior*

HP Rating, *Potencia nominal, HP*

G = 2 J = 5 L = 10 N = 20 Q = 30 S = 50 U = 75 W = 125
H = 3 K = 7½ M = 15 P = 25 R = 40 T = 60 V = 100 X = 150

Driver: Hertz/Pole/RPM, *Elemento motor: Hertz/Polos/RPM*

1 = 60 Hz, 2 pole, 3500 RPM 3 = 60 Hz, 6 pole, 1180 RPM 5 = 50 Hz, 4 pole, 1450 RPM
2 = 60 Hz, 4 pole, 1750 RPM 4 = 50 Hz, 2 pole, 2900 RPM

Drive Options, *Opciones de mando*

Substitute, *Substituto*	Description, *Descripción*
FRM	Bearing fame mount, *Montaje del bastidor del cojinete*
SAE1	SAE #1 mount, *Montura SAE #1*
SAE2	SAE #2 mount, *Montura SAE #2*
	SAE #3 mount, *Montura SAE #3*
SAE4	SAE #4 mount, *Montura SAE #4*
	SAE #5 mount, *Montura SAE #5*

SAE drive number is determined by the engine flywheel housing size.

El número del mando SAE se determina por el tamaño de la caja del volante del motor.

Material (Packed Box in BF), ***Material*** *(Caja prensaestopas en BF)*

BF = Bronze fitted, *BF = con accesorios de bronce*

Pump Size, *Tamaño de bomba*

18BF = 6 x 8 - 13 19BF = 8 x 10 - 13 20BF = 4 x 6 - 16

(BF Only) *(Accesorios de bronce únicamente)*

TOTAL DYNAMIC HEAD and HP CALCULATION

SITE INFORMATION

SITE	**Bethpage, NY**	SPEC NO.	
PROJECT	**GM-38**	REV	**Rev 1**
PROJECT NO.	**112G08005-WE24**	DATE	**May 17, 2019**

PUMP AND PIPELINE DESCRIPTION

Type	Water is pumped from Air Stripper (AS-1) through particulate filtration units,LGACs and AOP to the injection well IW -1	
Design Flowrate (gpm)	1000	Maximum flow rate
Pump Flowrate (gpm)	1000	Each Pump - flow rate
Pump Location		
Pipeline Description	Water is pumped from Air Stripper (AS-1) through particulate filtration units and LGACs to the injection well IW -1	

HEAD LOSSES

Static Discharge Head

Air Stripper (AS-1) Bottom Elevation	-12
LGAC top (ft MSL)	11.50
Total Elevation Head Loss (ft)	23.50

$$h_s = \Delta z$$

Pipe Friction Head Loss

Line No.	Description	Pipe Mat'l	Hazen Williams	ID	Length	Flow	Velocity	Head Loss
			Coeff.	(in)	(ft)	(gpm)	ft/s	(ft)
a	Air Stripper (AS-1) to TEE	PVC	110	12	22	1000	2.8368	0.08
b	TEE to Pump P-4A/P-4B	PVC	110	12	15	1000	2.8368	0.05
c	Pump P-4A/P-4B to 10" Flange TEE (going in the direction of particulate filtration units)	PVC	110	10	13	1000	4.085	0.11
d	10"Flange TEE (before particulate filtration units) to 10"Flange TEE (after particulate filtration units)	PVC	110	10	20	1100	4.4935	0.20
e	GAC Influent line-Full Flow	SCH 80 PVC	110	10	39	1100	4.4935	0.39
f	GAC Influent line-Two third Flow	SCH 80 PVC	110	10	12.5	737	3.0106	0.06
g	GAC Influent line-one third Flow	SCH 80 PVC	110	10	27	363	1.4829	0.03
h	GAC Influent line-one third Flow	6 inch hose	130	6	8	363	4.119	0.09
i	GAC Effluent line to Static mixer-one third Flow	6 inch hose	130	6	8	363	4.119	0.09
j	GAC Effluent line to Static mixer-one third Flow	SCH 80 PVC	110	10	27	363	1.4829	0.03
k	GAC Effluent line to Static mixer-Two third Flow	SCH 80 PVC	110	10	12.5	737	3.0106	0.06
l	GAC Effluent line to Static mixer-Full Flow	SCH 80 PVC	110	10	24	1100	4.4935	0.24
m	From Static mixer to 4x10 reducer	PVC	110	10	20	300	1.2255	0.02
n	From 4x10 reducer to Injection well IW-1	4"HDPE	150	4	5	300	7.6594	0.22

Subtotal Straight Pipe Friction Head Loss (ft) 1.69

HAZEN WILLIAMS EQUATION

$$h_f = \frac{0.2083\left(\frac{100}{C}\right)^{1.85} Q^{1.85} L}{100 D^{4.8655}}$$

Miscellaneous Losses - estimate

Fittings:

Line No.	Type	LD	Flow	Qty	Diameter	K		Head Loss
			(gpm)					(ft)
Air Stripper (AS-1) to Suction of Pump P-4A/P-4B	8 inch PVC 90° bend	30	1000	1	8	0.42		0.27
	8" check valve	100/50	1000	1	8	2.50		1.58
	8 x 12 reducer		1000	1	8	0.50		0.32
	12" TEE	20/60	1000	1	12	1.00		0.13
	12" Gate valve	8	1000	1	12	0.10		0.013
	??x 12 reducer not sure why reducer is shown in drawing..pipe size is same on both ends.may be wrong in drawing		1000	1	12	0.50		0.06
	12" Y type strainer		1000	1	12			0.67
	12 inch PVC 45° bend	16	1000	1	12	0.21		0.03
Discharge of Pump P-4A/P-4B to particulate filtration units (F-1A/F-1B)	10" gate valve	8	1000	1	10	0.11		0.03
	10" check valve	100/50	1000	1	10	2.50		0.65
	10" flange TEE	20/60	1000	1	10	1.00		0.26
	10" flange TEE	20/60	1100	2	10	1.00		0.63
	10" butterfly valve		1100	1	10	0.63		0.20
	8x10 flanged reducer		1100	1	8	0.50		0.38
	90° bend	30	1000	2	12	0.39		0.10
From particulate filtration units (F-1A/F-1B) to LGAC Inlet	8x10 flanged reducer		1100	1	8	0.50		0.38
	10" flange TEE		1100	1	10	1.00		0.31
	10" gate valve	8	1100	1	10	0.11		0.03
	??x 10 reducer not sure why reducer is shown in drawing..pipe size is same on both ends.may be wrong in drawing		1100	1	10	0.50		0.16
	8" gate valve	8	1100	2	8	0.11		0.17
	45° bend	16	363	2	6	0.24		0.13
	90° bend	30	1100	4	10	0.42		0.53
From LGAC outlet to injection well IW-1	45° bend	16	363	2	6	0.24		0.13
	90° bend	30	1100	4	10	0.42		0.53
	90° bend	30	300	1	10	0.42		0.01
	90° bend	30	300	1	4	0.51		0.47
	8" gate valve	8	363	1	8	0.11		0.01
	8x10 expander		1100	1	8	0.50		0.38
	10" flange TEE	20/60	1100	1	10	1.00		0.31
	10" gate valve	8	1100	1	10	0.11		0.03
	10" gate valve	8	300	1	10	0.11		0.003
	4 x 10 reducer		300	1	4	0.50		0.46
	4" gate valve	8	300	1	4	0.14		0.13
	4" check valve	100/50	300	1	4	2.50		2.28
						Subtotal of minor losses(ft)		11.75

$$h_m = \sum \frac{Kv^2}{2g}$$

Equipment losses

		psi	Flow	Qty	Dia(inch)	Velocity		
	Particulate filter(F-1A/F-1B) loss	5		1	8			11.5
	LGAC loss	8 *	363	1				18.4
	10" inline static mixer(M-2)	1.5	1100	1	10	4.4935		3.45
	10" orifice plate		1100	1	10	4.4935		0
	10" magnetic flowmeter			1	10			0.00
	Residual pressure required in injection line			1				0

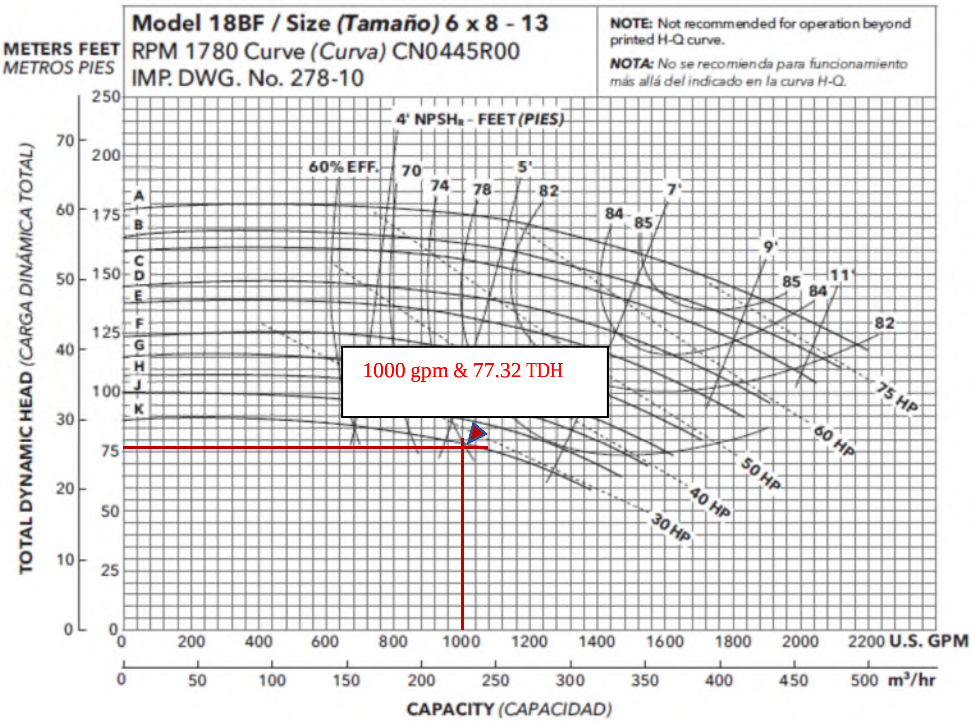
* Maximum pressure drop before backwash

Total piping headlosses 46.8

TOTAL DYNAMIC HEAD	**70.3**	**FT**
say (10% contingency)	**77.32**	**FT**
Computed HP	**25.13**	
Selected Motor HP	**30.00**	HP

Prepared By SK Checked By: HKM

PERFORMANCE CURVES – 60 HZ, 1750 RPM
CURVAS DE DESEMPEÑO – 60 HZ, 1750 RPM



Optional Impeller *Impulsor optativo*	
Ordering Code ***Código de pedido***	**Dia.** ***Diá.***
A	13"
B	12½
C	12 5/16
D	11 7/8
E	11 5/8
F	11 1/8
G	10 7/8
H	10½
J	10
K	9½

NOTE: Pump will pass a sphere to 7/8" diameter.

NOTA: *La bomba dejará pasar una esfera de hasta 7/8 de pulgada de diámetro.*

Liquid Carbon Feed Pumps

Tag No: P-4A, P-4B
Name: Liquid Carbon Feed Pumps
Type: Horizontal Centrifugal
Rating: 1375 GPM, 75 ft TDH
Manufacturer: Goulds
Model: 3656
Serial: 18BF2R2H0
Motor
Manufacturer: Baldor Electric
Rating: 40 HP, 460V 60Hz 3Phase, Inverter Duty, TEFC
Model: JPM2539T
Serial: 40H026W969

Serial: 18BF2R2H0

3656/3756 L-GROUP NUMBERING SYSTEM
SISTEMA DE NUMERACIÓN DEL GRUPO L, MODELOS 3656/3756

The various versions of the 3656 and 3756 L-Group are identified by a product code number on the pump label. This number is also the catalog number for the pump. The meaning of each digit in the product code number is shown below. Not all combinations are possible; consult your Goulds Water Technology distributor for specific requirements.

Las diferentes versiones de los modelos 3656 y 3756 del Grupo L se identifican con un número de código de producto en la etiqueta de la bomba. Este número es también el número de catálogo de la bomba. A continuación se ilustra el significado de cada dígito en el código del producto. No todas las combinaciones son posibles, consulte a su distribuidor Goulds Water Technology para requisitos específicos.

Example Product Code, *Ejemplo del código de producto*

18 BF 2 Q 2 J 0 R

Casing Rotation, Optional / ***Rotación de la cubierta, opcional***

R = 3 o'clock B = 6 o'clock L = 9 o'clock / *R = 3 hora B = 6 hora L = 9 hora*

NOTE: Rotation when viewed from suction end of pump. Standard discharge position is 12 o'clock.

***NOTA:** Rotación cuando está visto del extremo de la succión de la bomba. La posición estándar de la descarga es las 12.*

Mechanical Seal/Packed Box and O-ring Material,
For Optional Mechanical Seal modify catalog order no. with Seal code listed below.

Materiales del sello mecánico/empaque y anillo en O
Para sellos mecánicos optativos, modificar el número de pedido del catálogo con los códigos de sello que se indican a continuación.

Seal Code, *Código del Sello*	Rotary, *Rotativo*	Stationary, *Estacionario*	Elastomers, *Elastómeros*	Metal Parts, *Partes Metálicas*	Part No., *Pieza Número* L-Group, Grupo-L
0	Carbon, Carbone	Ceramic, Cerámica	BUNA-N	316 SS, *316 Acero inoxidable*	10K84
1		Sil-Carbide, *Carburo de silicona*	EPR		NA
3			Viton		10K112
5	Sil-Carbide				10K144
8A*					
8B**					
9***	Packed Box Design with BUNA O-Ring, *Diseño de prensaestopas empacado con anillo en O de BUNA*				15K4

* Prime-Safe option with oiler, *Opción Primero-Segura con el engrasador* ** Prime-Safe option with grease, *Opción Primero-Segura con la grasa*
*** All Packed Box Units use JP style motors, *Todas las unidades de prensaestopas empacado utilizan motores estilo JP*

Impeller Option Code, *Código de opción de impulsor*

Impeller Code, *Código del impulsor*	L-Group Pump Size, *Tamaño de la bomba* 18 Dia.	19 Dia.	20 Dia.
A	■13"	■13"	■16"
B	■12 1/2	■12 3/4	■15 1/2
C	■12 3/16	■12 1/2	■15 3/16
D	■11 7/8	■11 15/16	■14 1/2
E	11 5/8	■11 11/16	■13 3/4
F	11 1/4	■11 1/4	
G	10 3/4	■10 3/4	
H	10 1/2	■9 15/16	
J	10	• 13	
K	9 1/2	• 12 3/4	
L	• 13	• 12 1/2	
M	• 12 1/2	• 11 15/16	
N	• 12 3/16	• 11 11/16	
P	• 11 7/8	• 11 1/4	
Q		• 10 3/4	
R		• 9 15/16	

■ Indicates L-Group pump (1780 RPM, 60 to 150 HP)
• For 1180 RPM Close-Coupled applications only.
NOTE: For trimmed impellers, use T for impeller code.

■ *Indica una bomba Grupo "L". (1780 RPM, de 60 a 150 HP)*
• *Para aplicaciones de acople cerrado de 1180 RPM únicamente.*
***NOTA:** Para los impulsores cortados, utilice T para el código del impulsor.*

NOTE: Impellers will be trimmed in 1/16" increments only. If you are ordering a trim within 1/16" of the standard impeller, you will receive the standard impeller trim.

***NOTA:** Los impulsores serán cortados en 1/16" incrementos solamente. Si usted está pidiendo un ajuste dentro de 1/16" del impulsor estándar, usted recibirá el ajuste estándar del impulsor.*

Driver, *Elemento motor*

1 = 1 PH, ODP 4 = 1PH, TEFC 7 = 3 PH, XP 0 = 1 PH, XP C = 3 PH, WP PE F = 1 PH, ODP PE
2 = 3 PH, ODP 5 = 3 PH, TEFC 8 = 3 PH, 575 V, XP A = 3 PH, 575 TE PE D = 3 PH, 575 ODP PE
3 = 3 PH, 575 V, ODP 6 = 3 PH, 575 V, TEFC 9 = 3 PH, TE PE B = 3 PH, ODP PE E = 3 PH, XP PE
1PH = monofásico, 3PH = trifásico PE = Premium efficiency, *Eficiencia superior*

HP Rating, *Potencia nominal, HP*

G = 2 J = 5 L = 10 N = 20 Q = 30 S = 50 U = 75 W = 125
H = 3 K = 7 1/2 M = 15 P = 25 R = 40 T = 60 V = 100 X = 150

Driver: Hertz/Pole/RPM, *Elemento motor: Hertz/Polos/RPM*

1 = 60 Hz, 2 pole, 3500 RPM 3 = 60 Hz, 6 pole, 1180 RPM 5 = 50 Hz, 4 pole, 1450 RPM
2 = 60 Hz, 4 pole, 1750 RPM 4 = 50 Hz, 2 pole, 2900 RPM

Drive Options, *Opciones de mando*

Substitute, *Substituto*	Description, *Descripción*
FRM	Bearing frame mount, *Montaje del bastidor del cojinete*
SAE1	SAE #1 mount, *Montura SAE #1*
SAE2	SAE #2 mount, *Montura SAE #2*
	SAE #3 mount, *Montura SAE #3*
SAE4	SAE #4 mount, *Montura SAE #4*
	SAE #5 mount, *Montura SAE #5*

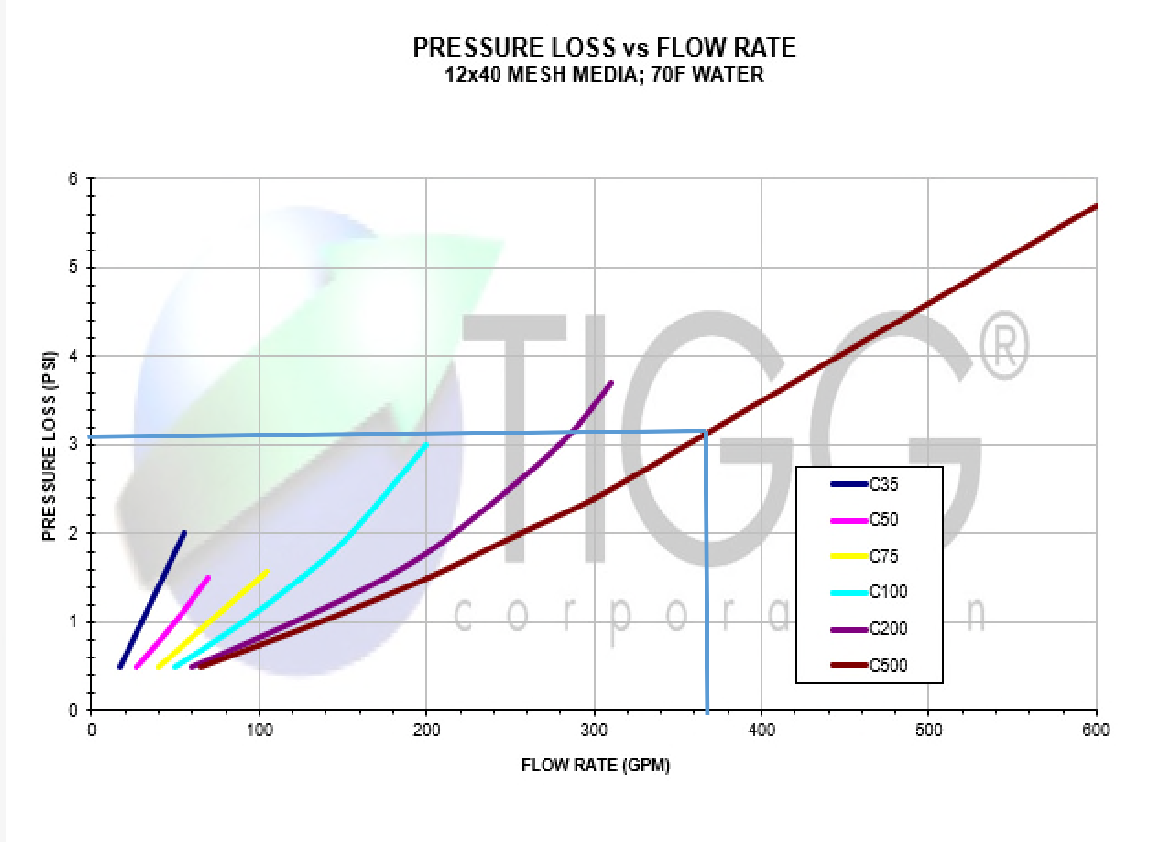
SAE drive number is determined by the engine flywheel housing size.
El número del mando SAE se determina por el tamaño de la caja del volante del motor.

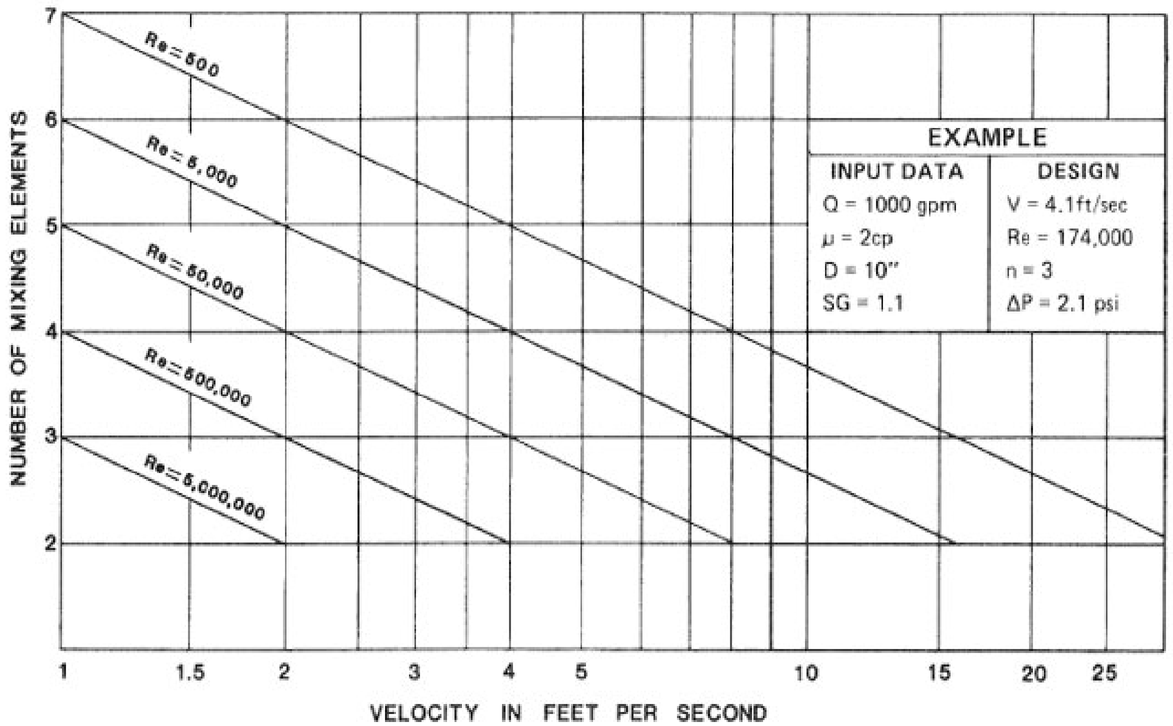
Material (Packed Box in BF), ***Material*** *(Caja prensaestopas en BF)*

BF - Bronze fitted, *BF = con accesorios de bronce*

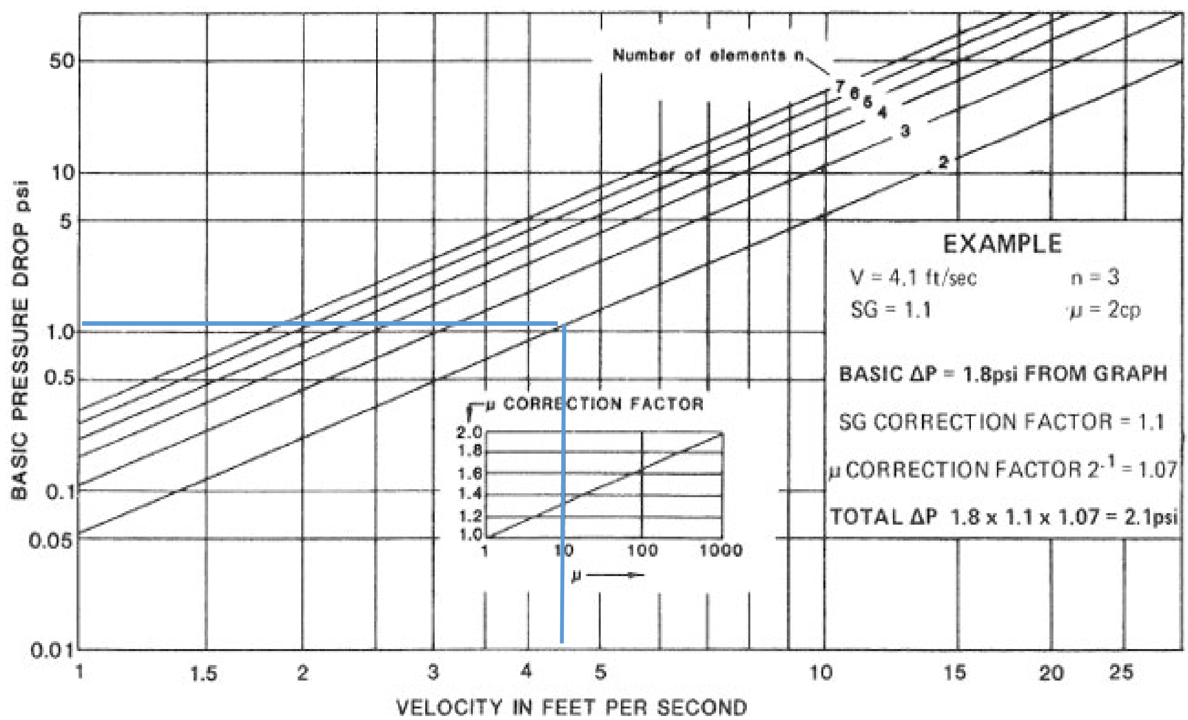
Pump Size, *Tamaño de bomba*

18BF = 6 x 8 - 13 **19BF = 8 x 10 - 13** **20BF = 4 x 6 - 16**
(BF Only) ***(Accesorios de bronce únicamente)***


PRESSURE LOSS vs FLOW RATE
12x40 MESH MEDIA; 70F WATER
PRESSURE LOSS (PSI)
FLOW RATE (GPM)
0
1
2
3
4
5
6
0
100
200
300
400
500
600
C35
C50
C75
C100
C200
C500
TIGG®
corporation



NUMBER OF MIXING ELEMENTS
VELOCITY IN FEET PER SECOND
Re=500
Re=5,000
Re=50,000
Re=500,000
Re=5,000,000
EXAMPLE
INPUT DATA
Q = 1000 gpm
μ = 2cp
D = 10"
SG = 1.1
DESIGN
V = 4.1ft/sec
Re = 174,000
n = 3
ΔP = 2.1 psi



BASIC PRESSURE DROP psi
VELOCITY IN FEET PER SECOND
Number of elements n
μ CORRECTION FACTOR
EXAMPLE
V = 4.1 ft/sec
n = 3
SG = 1.1
μ = 2cp
BASIC ΔP = 1.8psi FROM GRAPH
SG CORRECTION FACTOR = 1.1
μ CORRECTION FACTOR 2^-1 = 1.07
TOTAL ΔP 1.8 x 1.1 x 1.07 = 2.1psi

Shah, Nishant

From: Shah, Nishant
Sent: Monday, February 25, 2019 11:19 AM
To: Kumar, Shiva; Mital, Harish
Subject: Pentair - bag filters

I also spoke with Pentair regarding the Krsytal Klear bag filters currently installed upstream of the GAC units. The model currently installed has been discontinued but based on the information they had the clean bag filters will produce a differential press 1 to 2 psi whereas a completely spent filter would produce a max of 5 to 8 psi differential pressure for these series model. I will use worst case 8 psi and see how that fits into the pump hydraulics.

Thanks,
Nishant

Nishant Shah, ENV SP | Project Environmental Engineer
Direct **+1 (302) 283-2286** | Business **+1 (302) 738-7551** | Fax **+1 (302) 454-5988** | Nishant.Shah@tetratech.com

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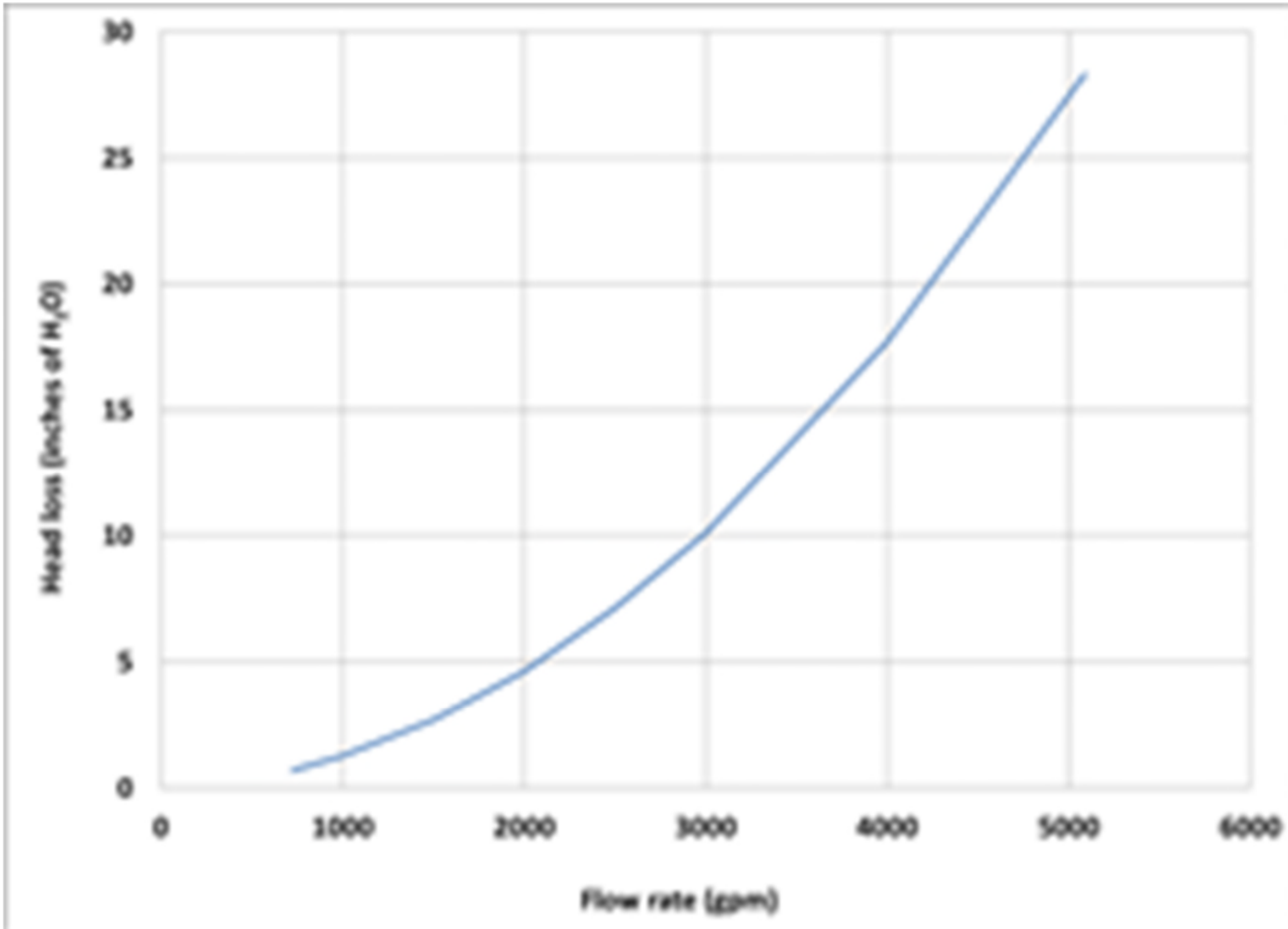


Headloss generated by the D72AL75 reactor

TOTAL DYNAMIC HEAD and HP CALCULATION

SITE INFORMATION

SITE	**Bethpage, NY**	SPEC NO.	
PROJECT	**GM-38**	REV	**Rev 1**
PROJECT NO.	**112G08005-WE24**	DATE	**May 17, 2019**

PUMP AND PIPELINE DESCRIPTION

Type	Water is pumped from Air Stripper (AS-1) through particulate filtration units,LGACs and AOP to the injection well IW -1	
Design Flowrate (gpm)	1000	Maximum flow rate
Pump Flowrate (gpm)	1000	Each Pump - flow rate
Pump Location		
Pipeline Description	Water is pumped from Air Stripper (AS-1) through particulate filtration units,LGACs and AOP to the injection well IW -1	

HEAD LOSSES

Static Discharge Head

Air Stripper (AS-1) Bottom Elevation	-12
LGAC top (ft MSL)	11.50
Total Elevation Head Loss (ft)	23.50

$$h_s = \Delta z$$

Pipe Friction Head Loss

Line No.	Description	Pipe Mat'l	Hazen Williams	ID	Length	Flow	Velocity	Head Loss
			Coeff.	(in)	(ft)	(gpm)	ft/s	(ft)
a	Air Stripper (AS-1) to TEE	PVC	110	12	22	1000	2.8368	0.08
b	TEE to Pump P-4A/P-4B	PVC	110	12	15	1000	2.8368	0.05
c	Pump P-4A/P-4B to 10" Flange TEE (going in the direction of particulate filtration units)	PVC	110	10	13	1000	4.085	0.11
d	10"Flange TEE (before particulate filtration units) to 10"Flange TEE (after particulate filtration units)	PVC	110	10	20	1100	4.4935	0.20
e	GAC Influent line-Full Flow	SCH 80 PVC	110	10	39	1100	4.4935	0.39
f	GAC Influent line-Two third Flow	SCH 80 PVC	110	10	12.5	737	3.0106	0.06
g	GAC Influent line-one third Flow	SCH 80 PVC	110	10	27	363	1.4829	0.03
h	GAC Influent line-one third Flow	6 inch hose	130	6	8	363	4.119	0.09
i	GAC Effluent line to Static mixer-one third Flow	6 inch hose	130	6	8	363	4.119	0.09
j	GAC Effluent line to Static mixer-one third Flow	SCH 80 PVC	110	10	27	363	1.4829	0.03
k	GAC Effluent line to Static mixer-Two third Flow	SCH 80 PVC	110	10	12.5	737	3.0106	0.06
l	GAC Effluent line to Static mixer-Full Flow	SCH 80 PVC	110	10	24	1100	4.4935	0.24
m	From Static mixer to 4x10 reducer	PVC	110	10	20	300	1.2255	0.02
n	From 4x10 reducer to Injection well IW-1	4"HDPE	150	4	5	300	7.6594	0.22
o	From 10"Flange TEE (after particulate filtration units) to UV Inlet	PVC	140	10	60	1100	4.4935	0.39
p	From UV Outlet to GAC	PVC	140	10	70	1100	4.4935	0.45
							Subtotal Straight Pipe Friction Head Loss (ft)	2.53

HAZEN WILLIAMS EQUATION

$$h_f = \frac{0.2083\left(\frac{100}{C}\right)^{1.85} Q^{1.85} L}{100 D^{4.8655}}$$

Miscellaneous Losses - estimate

Fittings:

Line No.	Type	LD	Flow	Qty	Diameter	K		Head Loss
			(gpm)					(ft)
Air Stripper (AS-1) to Suction of Pump P-4A/P-4B	8 inch PVC 90° bend	30	1000	1	8	0.42		0.27
	8" check valve	100/50	1000	1	8	2.50		1.58
	8 x 12 reducer		1000	1	8	0.50		0.32
	12" TEE	20/60	1000	1	12	1.00		0.13
	12" Gate valve	8	1000	1	12	0.10		0.013
	??x 12 reducer not sure why reducer is shown in drawing..pipe size is same on both ends.may be wrong in drawing		1000	1	12	0.50		0.06
	12" Y type strainer		1000	1	12			0.67
	12 inch PVC 45° bend	16	1000	1	12	0.21		0.03
Discharge of Pump P-4A/P-4B to particulate filtration units (F-1A/F-1B)	10" gate valve	8	1000	1	10	0.11		0.03
	10" check valve	100/50	1000	1	10	2.50		0.65
	10" flange TEE	20/60	1000	1	10	1.00		0.26
	10" flange TEE	20/60	1100	2	10	1.00		0.63
	10" butterfly valve		1100	1	10	0.63		0.20
	8x10 flanged reducer		1100	1	8	0.50		0.38
	90° bend	30	1000	2	12	0.39		0.10
From particulate filtration units (F-1A/F-1B) to LGAC Inlet	8x10 flanged reducer		1100	1	8	0.50		0.38
	10" flange TEE		1100	1	10	1.00		0.31
	10" gate valve	8	1100	1	10	0.11		0.03
	??x 10 reducer not sure why reducer is shown in drawing..pipe size is same on both ends.may be wrong in drawing		1100	1	10	0.50		0.16
	8" gate valve	8	1100	2	8	0.11		0.17
	45° bend	16	363	2	6	0.24		0.13
	90° bend	30	1100	4	10	0.42		0.53
From LGAC outlet to injection well IW-1	45° bend	16	363	2	6	0.24		0.13
	90° bend	30	1100	4	10	0.42		0.53
	90° bend	30	300	1	10	0.42		0.01
	90° bend	30	300	1	4	0.51		0.47
	8" gate valve	8	363	1	8	0.11		0.01
	8x10 expander		1100	1	8	0.50		0.38
	10" flange TEE	20/60	1100	1	10	1.00		0.31
	10" gate valve	8	1100	1	10	0.11		0.03
	10" gate valve	8	300	1	10	0.11		0.003
	4 x 10 reducer		300	1	4	0.50		0.46
	4" gate valve	8	300	1	4	0.14		0.13
	4" check valve	100/50	300	1	4	2.50		2.28
Minor losses due to bends	90° bend (in piping leading to and returning from UV system)	30	1100	6	10	0.42		0.79
							Subtotal of minor losses(ft)	12.54

$$h_m = \sum \frac{Kv^2}{2g}$$

Equipment losses

		psi	Flow	Qty	Dia(inch)	Velocity		
	Particulate filter(F-1A/F-1B) loss	5		1	8			11.5
	LGAC loss	8*	363	1				18.4
	10" inline static mixer(M-2)	1.5	1100	1	10	4.4935		3.45
	10" orifice plate		1100	1	10	4.4935		0
	10" magnetic flowmeter			1	10			0.00
	Residual pressure required in injection line			1				0
	D72AL75 UV reactor		1200	1				0.33

* Maximum pressure drop before backwash

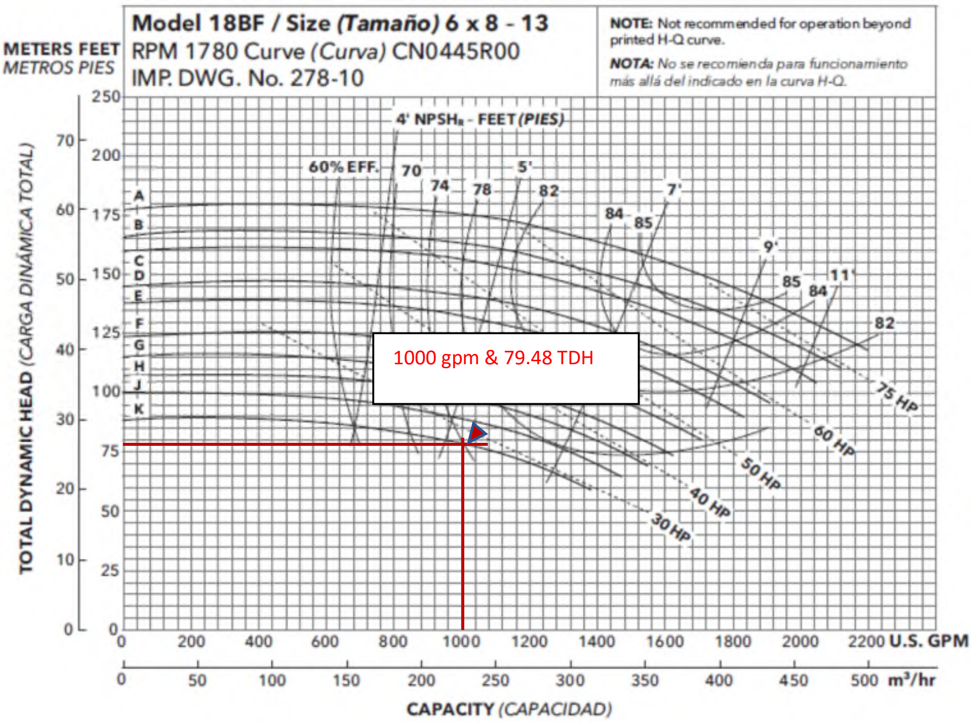
Total piping headlosses	48.8	
Add 30% contingency for older pipe conditions	63.38	
TOTAL DYNAMIC HEAD	**72.3**	**FT**
say (10% contingency)	**79.48**	**FT**
Computed HP	**25.83**	
Selected Motor HP	**26.00**	HP

$$TDH = h_z + h_f + h_m$$

Prepared By: SK

Checked By: HKM

PERFORMANCE CURVES – 60 HZ, 1750 RPM
CURVAS DE DESEMPEÑO – 60 HZ, 1750 RPM



Optional Impeller *Impulsor optativo*	
Ordering Code *Código de pedido*	**Dia.** *Diá.*
A	13"
B	12½
C	12 5/16
D	11⅞
E	11⅝
F	11⅛
G	10⅞
H	10½
J	10
K	9½

NOTE: Pump will pass a sphere to ⅞" diameter.

NOTA: *La bomba dejará pasar una esfera de hasta ⅞ de pulgada de diámetro.*

Pipe Sizing Calculations								
SITE INFORMATION								
	SITE	**Bethpage, NY**				SPEC NO.		**60% Design**
	PROJECT	**GM-38**				REV		**Rev 1**
	PROJECT NO.					DATE		**05/17/19**
Pipe Description	**Material**	**Operational Flow (gpm)**	**Operational Flow (ft3/s)**	**Nominal Pipe Size (inches)**	**Inside Building - Pipe size ID (inches) - Schedule 80 (320 - 370 psi)**	**Size (feet)**	**Area (ft2)**	**Velocity (ft/s)**
Bag Filters to AOP Inlet	Sch 80	1000	2.22	10	9.493	0.79	0.49	4.52
AOP Outlet to GAC	Sch 80	1000	2.22	10	9.493	0.79	0.49	4.52
AOP Outlet to EQ Tank (Startup Recycle)	Sch 80	1000	2.22	10	9.493	0.79	0.49	4.52
EQ Tank to Bag Filters (Air Stripper Bypass)	Sch 80	1000	2.22	10	9.493	0.79	0.49	4.52

Pipe Description	Material	Operational Flow (gpm)	Operational Flow (ft3/s)	Nominal Pipe Size (inches)	Inside Building - Pipe size ID (inches) - Schedule 80 (320 - 370 psi)	Size (feet)	Area (ft2)	Velocity (ft/s)
Bag Filters to AOP Inlet	Sch 80	1400	3.11	10	9.493	0.79	0.49	6.33
AOP Outlet to GAC	Sch 80	1400	3.11	10	9.493	0.79	0.49	6.33
AOP Outlet to EQ Tank (Startup Recycle)	Sch 80	1400	3.11	10	9.493	0.79	0.49	6.33
EQ Tank to Bag Filters (Air Stripper Bypass)	Sch 80	1400	3.11	10	9.493	0.79	0.49	6.33

Schedule 80 PVC Pipe
Dimensions & Pressure Ratings

COMMERCIAL INDUSTRIAL SUPPLY

Commercial-Industrial-Supply.com

Schedule 80 Pipe

Nom. Pipe Size (in)	O.D.	Average I.D.	Min. Wall	Nominal Wt./Ft.	Maximum. W.P. PSI*
1/8	.405	.195	0.095	0.063	1230
1/4	.540	.282	0.119	0.105	1130
3/8	.675	.403	0.126	0.146	920
1/2	.840	.526	0.147	0.213	850
3/4	1.050	.722	0.154	0.289	690
1	1.315	.936	0.179	0.424	630
1-1/4	1.660	1.255	0.191	0.586	520
1-1/2	1.900	1.476	0.200	0.711	470
2	2.375	1.913	0.218	0.984	400
2-1/2	2.875	2.290	0.276	1.500	420
3	3.500	2.864	0.300	2.010	370
3-1/2	4.000	3.326	0.318	2.452	350
4	4.500	3.786	0.337	2.938	320
5	5.563	4.768	0.375	4.078	290
6	6.625	5.709	0.432	5.610	280
8	8.625	7.565	0.500	8.522	250
10	10.750	9.493	0.593	12.635	230
12	12.750	11.294	0.687	17.384	230
14	14.000	12.410	0.750	20.852	220
16	16.000	14.213	0.843	26.810	220
18	18.000	16.014	0.937	33.544	220
20	20.000	17.814	1.031	41.047	220
24	24.000	21.418	1.218	58.233	210

Maximum PVC Service Temperature 140°F

Pressure De-rating at Elevated Temperatures

The pressure ratings above are for water at 73 degrees Fahrenheit. To calculate elevated temperature rating use the following formula:

Max Pressure = (73) x (Derating Factor)

PVC Pipe

Operating Temp (°F)	De-Rating Factor
73	1.00
80	0.88
90	0.75
100	0.62
110	0.51
120	0.40
130	0.31
140	0.22

EX: 2" PVC SCHEDULE 80 @ 120°F = 400 psi x 0.40 = 160 psi max. @ 120°F.

For more information or to order PVC pipe please speak to our product experts
Call Toll Free: **866-777-8001**

SITE INFORMATION			
SITE	Bethpage, NY	SPEC NO.	60% Design
PROJECT	GM-38	REV	1
PROJECT NO.		DATE	05/16/19

Hydrogen Peroxide Dosing and Tank Calculations

Treatment Plant Flow =	1000	gpm
Hydrogen peroxide dose	12	ppm
Lbs of hydrogen peroxide required on an hourly basis	6.0	lbs/hr
% of Hydrogen Peroxide be used at the site	27.0%	%
Density of 25% H2O2	9.22	lbs/gal
Peroxide in 25% solution	2.489	lbs/gal
Quantity of H2O2 Required	2.41	gal/hour
Quantity required per day	58	gpd
Volume for four weeks	1,621	gal/month

Hydrogen Peroxide Tank - Double Wall (Based on Trojan USP tank)

Outer Tank diameter, inches	102
Outer Tank diameter, feet	8.5
Inner Tank diameter, inches	95
Inner Tank diameter, feet	8
Tank Height, inches	107.5
Tank Height, feet	9.0
Operating Height, inches	90
Operating Height, feet	7.5
Total Volume of tank, ft3	441
Total Volume of tank, gallon	3297
Operating Volume of tank, ft3	369
Operating Volume of tank, gallon	2760
Quantity of hydrogen peroxide (70% working volume), gallons	1932
Feet of chemical in tank	5.25
Usage at 1,000 gpm flow; gal/day	58
Days of storage @ 1,000 gpm plant flow + 11 ppm dose	33.4

1. PRODUCT AND COMPANY IDENTIFICATION

Company

Arkema Inc.
900 First Avenue
King of Prussia, Pennsylvania 19406

Oxygenated and Derivatives

Customer Service Telephone Number: 1-800-346-5757
(Monday through Friday, 8:30 AM to 5:30 PM EST)

Emergency Information

Transportation:	CHEMTREC: (800) 424-9300 (24 hrs., 7 days a week)
Medical:	Rocky Mountain Poison Center: (866) 767-5089 (24 hrs., 7 days a week)

Product Information

Product name:	Hydrogen Peroxide 27-28% (All Grades)
Synonyms:	H2O2 27-28%
Molecular formula:	H2O2
Chemical family:	peroxides
Molecular weight:	34.01 g/mol
Product use:	Bleaching agent, Oxidizing agent, Cosmetics, Water treatment

2. HAZARDS IDENTIFICATION

Emergency Overview

Color:	colourless
Physical state:	liquid
Odor:	pungent

***Classification of the substance or mixture:**

Oxidizing liquids, Category 2, H272
Oral: Acute toxicity, Category 4, H302
Serious eye damage, Category 1, H318
Specific target organ toxicity - single exposure, Category 3, Respiratory system, H335
Chronic aquatic toxicity, Category 3, H412

*For the full text of the H-Statements mentioned in this Section, see Section 16.

GHS-Labelling

Hazard pictograms:

Signal word: **Danger**

Hazard statements:

H272 : May intensify fire; oxidiser.
H302 : Harmful if swallowed.
H318 : Causes serious eye damage.
H335 : May cause respiratory irritation.
H412 : Harmful to aquatic life with long lasting effects.

Precautionary statements:

Prevention:
P210 : Keep away from heat.
P220 : Keep/Store away from clothing/ combustible materials.
P221 : Take any precaution to avoid mixing with combustibles.
P261 : Avoid breathing gas/mist/vapours/spray.
P264 : Wash skin thoroughly after handling.
P270 : Do not eat, drink or smoke when using this product.
P271 : Use only outdoors or in a well-ventilated area.
P273 : Avoid release to the environment.
P280 : Wear protective gloves/ eye protection/ face protection.

Response:
P301 + P312 : IF SWALLOWED: Call a POISON CENTER or doctor/ physician if you feel unwell.
P304 + P340 : IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P305 + P351 + P338 : IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310 : Immediately call a POISON CENTER or doctor/ physician.
P330 : Rinse mouth.
P370 + P378 : In case of fire: Use dry sand, dry chemical or alcohol-resistant foam for extinction.

Storage:
P403 + P233 : Store in a well-ventilated place. Keep container tightly closed.
P405 : Store locked up.

Disposal:
P501 : Dispose of contents/ container to an approved waste disposal plant.

Supplemental information:

Potential Health Effects:
If swallowed:
May cause: gastrointestinal symptoms, ulceration, burns, accumulation of fluid in the lungs which may be delayed for several hours.(severity of effects depends on extent of exposure) .

3. COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Name	CAS-No.	Wt/Wt	GHS Classification**
Hydrogen peroxide (H2O2)	7722-84-1	> 27 - < 28 %	H272, H302, H318, H335, H412
Water	7732-18-5	>= 72 - <= 73 %	Not classified

**For the full text of the H-Statements mentioned in this Section, see Section 16.

4. FIRST AID MEASURES

Inhalation:
If inhaled, remove victim to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Skin:
In case of contact, immediately flush skin with plenty of water. Remove contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse.

Eyes:
In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention immediately.

Ingestion:
If swallowed, DO NOT induce vomiting unless directed to do so by medical personnel. Get medical attention immediately. If victim is fully conscious, give a cupful of water. Never give anything by mouth to an unconscious person. Rinse mouth.

Notes to physician:
Exposure to material may cause delayed lung injury resulting in pulmonary edema and pneumonitis. Exposed individuals should be monitored for 72 hours after exposure for the onset of delayed respiratory symptoms.

5. FIREFIGHTING MEASURES

Extinguishing media (suitable):
water spray, water fog

Protective equipment:
Fire fighters and others who may be exposed to products of combustion should wear full fire fighting turn out gear (full Bunker Gear) and self-contained breathing apparatus (pressure demand / NIOSH approved or equivalent).

Further firefighting advice:
Oxidizing material
In case of major fire and large quantities: Evacuate area. Fight fire remotely due to the risk of explosion.
Decomposition will release oxygen, which will intensify a fire.
Cool closed containers exposed to fire with water spray.
Closed containers of this material may explode when subjected to heat from surrounding fire.
Do not allow run-off from fire fighting to enter drains or water courses.
Fire fighting equipment should be thoroughly decontaminated after use.

Fire and explosion hazards:
Explosive when mixed with combustible material.
Avoid breathing fumes from fire exposed material.

6. ACCIDENTAL RELEASE MEASURES

In case of spill or leak:
Prevent further leakage or spillage if you can do so without risk. Evacuate area of all unnecessary personnel. Ventilate the area. Eliminate all ignition sources. Avoid generation of vapors. Avoid contact with cellulose, paper, sawdust or similar substances. Risk of self-ignition or promotion of fires. Combustible materials exposed to hydrogen peroxide should be rinsed immediately with large amounts of water to ensure that all the hydrogen peroxide is removed. Contain and collect spillage with non-combustible absorbent material such as clean sand, earth, diatomaceous earth or non-acidic clay and place into suitable properly labeled containers for prompt disposal. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Consult a regulatory specialist to determine appropriate state or local reporting requirements, for assistance in waste characterization and/or hazardous waste disposal and other requirements listed in pertinent environmental permits.

7. HANDLING AND STORAGE

Handling

General information on handling:
Do not taste or swallow.
Do not get in eyes, on skin, or on clothing.
Avoid breathing vapor or mist.
Keep from contact with clothing and other combustible materials.
Keep away from heat, sparks and flames.
Use only with adequate ventilation.
Wash thoroughly after handling.
Wear fire/ flame resistant/ retardant clothing.
Prevent product contamination.
Keep only in the original container.
Store in tightly closed container.
DO NOT CUT, DRILL, GRIND, OR WELD ON OR NEAR THIS CONTAINER.
Emptied container retains vapor and product residue.
Observe all labeled safeguards until container is cleaned, reconditioned or destroyed.
Avoid contamination.

Storage

General information on storage conditions:
Store in tightly closed container. Store in cool, dry, well ventilated area away from sources of ignition such as flame, sparks and static electricity. Store out of direct sunlight in a cool well-ventilated place. Store in original container. Store away from combustibles and incompatible materials. Refer to National Fire Protection Association (NFPA) 430, Code for the Storage of Solid and Liquid Oxidizers.

Storage incompatibility – General:
Store separate from acids, alkalies, reducing agents, and combustibles. Store separate from:

Organic materials

Metallic oxides

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Airborne Exposure Guidelines:

HYDROGEN PEROXIDE (7722-84-1)

US. ACGIH Threshold Limit Values

time weighted average	1 ppm

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

PEL:	1 ppm (1.4 mg/m3)

Only those components with exposure limits are printed in this section. Limits with skin contact designation above have skin contact effect. Air sampling alone is insufficient to accurately quantitate exposure. Measures to prevent significant cutaneous absorption may be required. Limits with a sensitizer designation above mean that exposure to this material may cause allergic reactions.

Engineering controls:
Investigate engineering techniques to reduce exposures below airborne exposure limits or to otherwise reduce exposures. Provide ventilation if necessary to minimize exposures or to control exposure levels to below airborne exposure limits (if applicable see above).If practical, use local mechanical exhaust ventilation at sources of air contamination such as open process equipment.

Consult ACGIH ventilation manual or NFPA Standard 91 for design of exhaust systems.

Respiratory protection:
Avoid breathing vapor or mist. Where airborne exposure is likely or airborne exposure limits are exceeded (if applicable, see above), use NIOSH approved respiratory protection equipment appropriate to the material and/or its components. Full facepiece equipment is recommended and, if used, replaces need for face shield and/or chemical goggles. Consult respirator manufacturer to determine appropriate type equipment for a given application. Observe respirator use limitations specified by NIOSH or the manufacturer. For emergency and other conditions where there may be a potential for significant exposure or where exposure limit may be significantly exceeded, use an approved full face positive-pressure, self-contained breathing apparatus or positive-pressure airline with auxiliary self-contained air supply. Respiratory protection programs must comply with 29 CFR § 1910.134.

Skin protection:

Wear appropriate chemical resistant protective clothing and chemical resistant gloves to prevent skin contact.

When handling this material, gloves of the following type(s) should be worn:

Neoprene

Polyvinylchloride

Impervious butyl rubber gloves

Wear a face shield, chemical goggles and chemical resistant clothing such as an approved splash protective suit made of SBR Rubber, PVC, Gore-Tex or a HAZMAT Splash Protective Suit (Level A, B, or C) when splashing may occur (such as connecting/disconnecting, mechanical first break). For foot protection, wear boots made of NBR, PVC, polyurethane, or neoprene. Overboots made of Latex or PVC, as well as firefighter boots or specialized HAZMAT boots are also permitted. DO NOT wear any form of boot or overboots made of nylon or nylon blends. DO NOT use cotton, wool or leather, as these materials react RAPIDLY with higher concentrations of hydrogen peroxide. Rinse immediately if skin is contaminated. Remove contaminated clothing and shoes immediately. Thoroughly rinse the outside of gloves and protective clothing with water prior to removal. Completely submerge hydrogen peroxide contaminated clothing or other materials in water prior to drying. Residual hydrogen peroxide, if allowed to dry on materials such as paper, fabrics, cotton, leather, wood or other combustibles can cause the material to ignite and result in a fire. Clean protective equipment before reuse. Provide a safety shower at any location where skin contact can occur. Wash thoroughly after handling.

Eye protection:
Where there is potential for eye contact, wear a face shield, chemical goggles, and have eye flushing equipment immediately available.

9. PHYSICAL AND CHEMICAL PROPERTIES

Color:	colourless
Physical state:	liquid
Odor:	pungent
Odor threshold:	No data available
Flash point	None.
Auto-ignition temperature:	Not applicable
Lower flammable limit (LFL):	Not applicable
Upper flammable limit (UFL):	Not applicable
pH:	No data available
Density:	1.105 g/cm3 (68 °F (20 °C))
Vapor pressure:	13.5 mmHg (68 °F (20 °C))

Relative vapor density:	1.0
Vapor density:	not determined
Boiling point/boiling range:	219 °F (104 °C)
Freezing point:	-9 °F (-23 °C)
Evaporation rate:	No data available
Solubility in water:	completely soluble
% Volatiles:	100 %
Molecular weight:	34.01 g/mol
Oil/water partition coefficient:	No data available
Thermal decomposition	No data available
Flammability (solid, gas):	Not applicable

10. STABILITY AND REACTIVITY

Stability:
This material is chemically stable under normal and anticipated storage, handling and processing conditions.

Materials to avoid:
Metals

Organic materials
Reducing agents
Metallic oxides
Dusts
Combustible materials (e.g., wood, sawdust)
Alkaline materials

Conditions / hazards to avoid:
Material decomposes with the potential to produce a rupture of unvented closed containers.

Hazardous decomposition products:

This material decomposes if contaminated, causing fire and possible explosions. Oxygen can be liberated at temperatures above ambient.

11. TOXICOLOGICAL INFORMATION

Data on this material and/or a similar material are summarized below.

Data for Hydrogen Peroxide 27-28% (All Grades)

Acute toxicity

Oral:
Harmful if swallowed. (Rat) LD50 = 1,200 mg/kg. (35 %) (as aqueous solution)

Dermal:
May be harmful in contact with skin. (Rabbit) LD50 > 2,000 mg/kg. (35 %) (as aqueous solution)

May be harmful in contact with skin. (Rat) LD50 > 2,000 mg/kg. (35 %) as aqueous solution

Inhalation:
No deaths occurred. (Rat) 4 h LC0 > 0.17 mg/l. (50 %) (saturated vapor)

Skin Irritation:
Causes mild skin irritation. (Rabbit) Irritation Index: 1.6 / 8. (35 %) (aqueous solution)

Eye Irritation:
Causes serious eye damage. (Rabbit) (35 %) (aqueous solution)

Data for HYDROGEN PEROXIDE (7722-84-1)

Acute toxicity

Specific target organ toxicity - single exposure:
May cause respiratory irritation.

Repeated dose toxicity
Repeated drinking water administration to rat and mouse / affected organ(s): Gastro-intestinal tract / signs: irritation

Repeated inhalation administration to Rat / affected organ(s): nose / signs: irritation

Carcinogenicity
Chronic drinking water administration to rat and mouse / affected organ(s): Gastro-intestinal tract / signs: Increased incidence of tumors was reported.
Classified by the International Agency for Research on Cancer as: Group 3: Unclassifiable as to carcinogenicity in humans.

Genotoxicity

Assessment in Vitro:
Genetic changes were observed in laboratory tests using: bacteria, animal cells

Genotoxicity

Assessment in Vivo:
Genetic changes were observed in a laboratory test using: mice, rats

Human experience
Inhalation:

Throat: irritation. (based on reports of occupational exposure to workers)

Human experience
Skin contact:
Skin: bleaching of hair. (based on reports of occupational exposure to workers)

Human experience
Eye contact:
Eye: irritating. (based on reports of occupational exposure to workers)

Human experience
Ingestion:
Gastrointestinal tract: bloating, ulceration, burns. (accidental exposure to concentrated solutions)

Lung: accumulation of fluid in the lungs, death. (severity of effects depends on extent of exposure)

12. ECOLOGICAL INFORMATION

Chemical Fate and Pathway
Data on this material and/or a similar material are summarized below.

Data for HYDROGEN PEROXIDE (7722-84-1)

Biodegradation:
Readily biodegradable. (0.02 d) biodegradation 99 %

Octanol Water Partition Coefficient:
log Pow = -1.57 (calculated)

Ecotoxicology
Data on this material and/or a similar material are summarized below.

Data for HYDROGEN PEROXIDE (7722-84-1)

Aquatic toxicity data:
Harmful. Pimephales promelas (fathead minnow) 96 h LC50 = 16.4 mg/l

Aquatic invertebrates:
Toxic. Daphnia pulex (Water flea) 48 h EC50 = 2.4 mg/l

Algae:
Toxic. Skeletonema costatum 72 h ErC50 = 1.38 mg/l

Microorganisms:
Activated sludge 0.5 h EC50 = 466 mg/l
Activated sludge 3 h EC50 > 1,000 mg/l

Chronic toxicity to aquatic invertebrates:
Harmful. Daphnia magna (Water flea) 21 d NOEC (reproduction) = 0.63 mg/l

13. DISPOSAL CONSIDERATIONS

Waste disposal:
Dilution with water is the preferred method of disposal. Dispose of in accordance with federal, state and local regulations. Consult a regulatory specialist to determine appropriate state or local reporting requirements, for assistance in waste characterization and/or hazardous waste disposal and other requirements listed in pertinent environmental permits. Note: Chemical additions to, processing of, or otherwise altering this material may make this waste management information incomplete, inaccurate, or otherwise inappropriate. Furthermore, state and local waste disposal requirements may be more restrictive or otherwise different from federal laws and regulations.

Take appropriate measures to prevent release to the environment.

14. TRANSPORT INFORMATION

US Department of Transportation (DOT)

UN Number	:	2014
Proper shipping name	:	Hydrogen peroxide, aqueous solutions
Class	:	5.1
Subsidiary hazard class	:	(8)
Packaging group	:	II
Marine pollutant	:	no

International Maritime Dangerous Goods Code (IMDG)

UN Number	:	2014
Proper shipping name	:	HYDROGEN PEROXIDE, AQUEOUS SOLUTION
Class	:	5.1
Subsidiary hazard class	:	(8)
Packaging group	:	II
Marine pollutant	:	no

15. REGULATORY INFORMATION

Chemical Inventory Status

EU. EINECS	EINECS	Conforms to
United States TSCA Inventory	TSCA	The components of this product are all on the TSCA Inventory.
Canadian Domestic Substances List (DSL)	DSL	All components of this product are on the Canadian DSL.
China. Inventory of Existing Chemical Substances in China (IECSC)	IECSC (CN)	Conforms to
Japan. ENCS - Existing and New Chemical Substances Inventory	ENCS (JP)	Does not conform

Japan. ISHL - Inventory of Chemical Substances	ISHL (JP)	Does not conform
Korea. Korean Existing Chemicals Inventory (KECI)	KECI (KR)	Conforms to
Philippines Inventory of Chemicals and Chemical Substances (PICCS)	PICCS (PH)	Does not conform
Australia Inventory of Chemical Substances (AICS)	AICS	Conforms to

United States – Federal Regulations

SARA Title III – Section 302 Extremely Hazardous Chemicals:

Chemical Name	CAS-No.	SARA Reportable Quantities	SARA Threshold Planning Quantity
HYDROGEN PEROXIDE	7722-84-1	1000 lbs	1000 lbs

SARA Title III - Section 311/312 Hazard Categories:
Acute Health Hazard, Fire Hazard, Reactivity Hazard

SARA Title III – Section 313 Toxic Chemicals:
This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) - Reportable Quantity (RQ):

The components in this product are either not CERCLA regulated, regulated but present in negligible concentrations, or regulated with no assigned reportable quantity.

United States – State Regulations

New Jersey Right to Know

Chemical Name	CAS-No.
HYDROGEN PEROXIDE	7722-84-1

New Jersey Right to Know – Special Health Hazard Substance(s)

Chemical Name	CAS-No.
HYDROGEN PEROXIDE	7722-84-1

Pennsylvania Right to Know

Chemical Name	CAS-No.
HYDROGEN PEROXIDE	7722-84-1

Pennsylvania Right to Know – Environmentally Hazardous Substance(s)

Chemical Name	CAS-No.
HYDROGEN PEROXIDE	7722-84-1

California Prop. 65
This product does not contain any chemicals known to the State of California to cause cancer, birth defects, or any other reproductive defects.

16. OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3.

H272	May intensify fire; oxidiser.
H302	Harmful if swallowed.
H318	Causes serious eye damage.
H335	May cause respiratory irritation.
H412	Harmful to aquatic life with long lasting effects.

Miscellaneous:

Other information: This MSDS covers the following grades of 27% - 28% H2O2: ALBONE®, PEROXAL®, VALSTERANE®; BMP; CG; DS; FG; MP; MS.

Latest Revision(s):

Revised Section(s):	Initial entry
Reference number:	000000053990
Date of Revision:	12/11/2014
Date Printed:	12/11/2014

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ELECTRICAL LOAD CALCULATIONS

FOR

GM-38

Bethpage, NY

SCHEDULE OF MOTOR CONTROL CENTER | **MCC-1** | **800A** | **277/480V, 3 PHASE, 4 W** | **FLOOR MOUNT** | **LOCATION: MCC ROOM-**

MAIN: 800A MCB | **SQUARE D MODEL 6, ENCLOSURE TYPE 1A. BUSES: 800A-HORIZONTAL, 600A VERTICAL & 300A NEUTRAL; FO: 2529330S-002** | **22KA INTERRUPTING CURRENT RATING**

SECTION	CKT#	DESCRIPTION	H.P./ KW	STARTER SIZE (NEMA)	PROTECTION DEVICE TYPE: CB OR FUSED SWITCH	FRAME AMP.	TRIP AMP.	POLES	WIRING C-QTY#AWG,G#AWG	KVA	DEVICES	NOTES a: PILOT LIGHT FOR RED (ON), b: GREEN (OFF); c: HAND-ON-AUTO; d: RESET BUTTON; e: START-STOP BUTTONS; f: AMPERE METER; g: VOLT-METER; h: SPEED STAT
1	A	MONITORING UNIT FOR MAIN						3	EX. TO REMAIN	XX		ELECTRONIC POWER METER
	B	BLANK										
	C	SERVICE ENTRANCE MCB			CB	800A	800A	3	TWO 4"C, EA W/ (4#500KCMIL, 1#2/0G)		f, g	MICROLOGIC POWERPACT, PL-800
2	A	45KVA TRANSFORMER FOR PANEL "LP-1"			CB	100A	80A	3	EX. TO REMAIN6	45.0		
	B	H-1 162KW AIR STREAM HEATER			CB	400A	250A	3	EX. TO REMAIN	162.0		
	C	P-2 EXTRACTION WELL RW-3	15	VFD	CB	100A	40A	3	EX. TO REMAIN	11.6	a, c, d, h	
	D	FUTURE EXTRACTION WELL RW-2	15	VFD	CB	100A	40A	3	EX. TO REMAIN	0.0	a, c, d, h	SPARE
3	A	P-3A PRIMARY AIR STRIPPER FEED PUMP	25	VFD	CB	250A	60A	3	EX. TO REMAIN	0.0	a, c, d, h	SPARE
	B	P-4A RE-INJECTION PUMP	40	VFD	CB	400A	100A	3	EX. TO REMAIN	0.0	a, c, d, h	SPARE
4	C	P-3B PRIMARY AIR STRIPPER FEED PUMP	25	VFD	CB	250A	60A	3	EX. 1 1/2"- (3#6, 1#10G)	28.3	a, c, d, h	
	D	P-4B RE-INJECTION PUMP	40	VFD	CB	250A	100A	3	EX. 1 1/2"- (3#4, 1#8G)	43.2	a, c, d, h	
5		CORNER 90 DEGREE SECTION										
6	A	AIR STRIP BLOWER B-1	100	VFD	CB	250A	200A	3	EX. 2"C-(3#2/0, 1#6G)	103.1	a, c, d, h	
7	A	AIR STRIP BLOWER B-2	100	VFD	CB	250A	200A	3	EX. 2"C-(3#2/0, 1#6G)	103.1	a, c, d, h	
8	A	P-1 EXTRACTION WELL RW-1 (SUBMERSIBLE PUMP)	60	VFD	CB	250A	125A	3	EX. 2"C-(3#1, 1#8G)	64.0	a, c, d, h	
9	A	10HP SPARE FVNR	10	1 FVNR	CB	100A	80A	3	XX	0.0	a, b, c, d	SPARE
	B	SPARE			CB	100A	70A	3	XX	0.0		SPARE
	C	SPD			CB	100A	60A	3	EX. TO REMAIN	6.0		SQ. D. 3PH. SURGE LOGIC DISPLAY
	D	SPARE			CB	100A	70A	3	XX	0.0		SPARE
	E	UH-2	5KW		CB	100A	20A	3	EX. 3/4"C- (3#10, 1#12G)	5.0		
	F	UH-4	5KW		CB	100A	20A	3	EX. 3/4"C- (3#10, 1#12G)	5.0		
	G	UH-3	5KW		CB	100A	20A	3	EX. 3/4"C- (3#10, 1#12G)	5.0		
	H	UH-1	5KW		CB	100A	20A	3	EX. 3/4"C- (3#10, 1#12G)	5.0		
	I	UH-9	5KW		CB	100A	20A	3	EX. 3/4"C- (3#10, 1#12G)	5.0		
	L	ASD OUTPUT FILTER FOR P-1 EXTRACTION PUMP RW-1										
10	A	SPARE			CB	100A	70A	3	XX	0.0		SPARE
	B	UH-8	5KW		CB	100A	20A	3	EX. 3/4"C- (3#10, 1#12G)	5.0		
	C	UH-12	5KW		CB	100A	20A	3	EX. 3/4"C- (3#10, 1#12G)	5.0		
	D	TEMP. FEED TO AOP			CB	100A	40A	3	TEMP. 3/4"C-(3#8, 1#10G)	0.0		** TEMPORARY SERVICE WITH APPROXIMATE LOAD OF 23.3KW
	E	3HP FVNR- M-1 EQUALIZATION TANK MIXER	4KW	0	CB	100A	20A	3	EX. 3/4"C- (3#10, 1#12G)	0.0	a, b, c, d	** IT'S REPORTED THAT THE MIXER IS NOT BEING USED
	F	V-1 EXHAUST FAN	2	0	CB	100A	20A	3	EX. 3/4"C- (3#10, 1#12G)	2.8	a, b, c, d	
	G	P-5A BUILDING SUMP	3/4	0	CB	100A	20A	3	EX. 3/4"C- (3#10, 1#12G)	1.3	a, b, c, d	
	H	P-5B BUILDING SUMP SPARE	0	0	CB	100A	20A	3	EX. 3/4"C- (3#10, 1#12G)	0.0	a, b, c, d	
	I	V-2 EXHAUST FAN	2	0	CB	100A	20A	3	EX. 3/4"C- (3#10, 1#12G)	2.8	a, b, c, d	
	J	UH-5	5KW		CB	100A	20A	3	EX. 3/4"C- (3#10, 1#12G)	5.0		
	K	UH-7	5KW		CB	100A	20A	3	EX. 3/4"C- (3#10, 1#12G)	5.0		
	L	UH-6	5KW		CB	100A	20A	3	EX. 3/4"C- (3#10, 1#12G)	5.0		
11	A	UH-11	5KW		CB	100A	20A	3	EX. 3/4"C- (3#10, 1#12G)	5.0		
	B	UH-10	5KW		CB	100A	20A	3	EX. 3/4"C- (3#10, 1#12G)	5.0		
	C	SPACE			XX	XX	XX	3	XX	0.0		SPACE
	D	SPACE			XX	XX	XX	3	XX	0.0		SPACE
	E	SPACE			XX	XX	XX	3	XX	0.0		SPACE
	F	SPACE			XX	XX	XX	3	XX	0.0		SPACE
	G	SPACE			XX	XX	XX	3	XX	0.0		SPACE
	H	SPACE	5KW		XX	XX	XX	3	XX	0.0		SPACE
	SUB-TOTAL=									633.3		
		WITH SPARE OF	0%	TOTAL=	633	KVA	CURRENT AT 277/480V, 3PHASE, 4 WIRES =			762	A	

STRUCTURAL CALCULATIONS

FOR

GM 38

NYC,NY

Code Search

Code: International Building Code 2015

Occupancy:

Occupancy Group = U Utility & Miscellaneous

Risk Category & Importance Factors:

Risk Category =	III
Wind factor =	1.00
Snow factor =	1.10
Seismic factor =	1.25

Type of Construction:

Fire Rating:

Roof =	0.0 hr
Floor =	0.0 hr

Building Geometry:

Roof angle (θ)	0.25 / 12	1.2 deg
Building length (L)	10.0 ft	
Least width (B)	10.0 ft	
Mean Roof Ht (h)	16.0 ft	
Parapet ht above grd	0.0 ft	
Minimum parapet ht	0.0 ft	

Live Loads:

Roof	0 to 200 sf:	20 psf
	200 to 600 sf:	24 - 0.02Area, but not less than 12 psf
	over 600 sf:	12 psf

Floor:

Typical Floor	125 psf
Partitions	15 psf
Offices	50 psf
	0 psf

Tetra Tech		JOB TITLE	GM 38
Address			
City, State		JOB NO.	112G08005_WE24 SHEET NO.
Phone		CALCULATED BY	SPS DATE 5/17/19
		CHECKED BY	ATC DATE 5/17/19

Wind Loads : ASCE 7- 10

Ultimate Wind Speed	136 mph
Nominal Wind Speed	105.3 mph
Risk Category	III
Exposure Category	B
Enclosure Classif.	Open Building
Internal pressure	+/-0.00
Directionality (Kd)	0.85
Kh case 1	0.701
Kh case 2	0.585
Type of roof	Monoslope

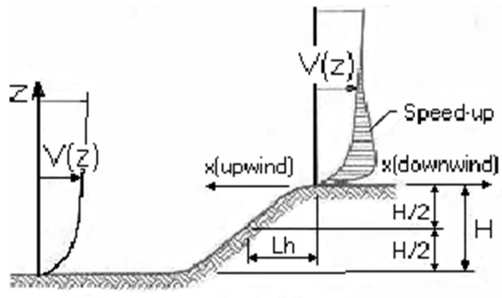
Topographic Factor (Kzt)

Topography	Flat	
Hill Height (H)	0.0 ft	H< 60ft;exp B
Half Hill Length (Lh)	0.0 ft	∴ Kzt=1.0
Actual H/Lh =	0.00	
Use H/Lh =	0.00	
Modified Lh =	0.0 ft	
From top of crest: x =	0.0 ft	
Bldg up/down wind?	downwind	

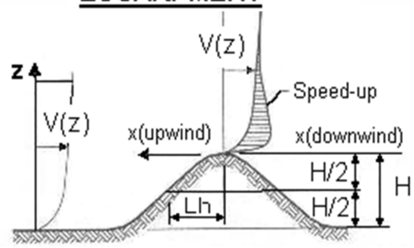
H/Lh= 0.00	K_1 = 0.000
x/Lh = 0.00	K_2 = 0.000
z/Lh = 0.00	K_3 = 1.000

At Mean Roof Ht:

$Kzt = (1+K_1K_2K_3)^2 = 1.00$



ESCARPMENT



2D RIDGE or 3D AXISYMMETRICAL HILL

Gust Effect Factor

h =	16.0 ft
B =	10.0 ft
/z (0.6h) =	30.0 ft

Flexible structure if natural frequency < 1 Hz (T > 1 second).
However, if building h/B < 4 then probably rigid structure (rule of thumb).
h/B = 1.60 Therefore, probably rigid structure

G = 0.85 Using rigid structure default

Rigid Structure

ē =	0.33
ℓ =	320 ft
z_{min} =	30 ft
c =	0.30
g_Q, g_v =	3.4
L_z =	310.0 ft
Q =	0.94
I_z =	0.30
G =	0.89 use G = 0.85

Flexible or Dynamically Sensitive Structure

Natural Frequency (η_1) =	0.0 Hz				
Damping ratio (β) =	0				
/b =	0.45				
/α =	0.25				
Vz =	87.6				
N_1 =	0.00				
R_n =	0.000				
R_h =	28.282	η =	0.000	h =	16.0 ft
R_B =	28.282	η =	0.000		
R_L =	28.282	η =	0.000		
g_R =	0.000				
R =	0.000				
G =	0.000				

Enclosure Classification

Test for Enclosed Building: A building that does not qualify as open or partially enclosed.

Test for Open Building: All walls are at least 80% open.
Ao ≥ 0.8Ag

Test for Partially Enclosed Building:

	Input			Test	
Ao	116.0	sf	Ao ≥ 1.1Aoi	YES	
Ag	223.2	sf	Ao > 4' or 0.01Ag	YES	
Aoi	5.0	sf	Aoi / Agi ≤ 0.20	YES	Building IS
Agi	483.6	sf			Partially Enclosed

Conditions to qualify as Partially Enclosed Building. Must satisfy all of the following:
Ao ≥ 1.1Aoi
Ao > smaller of 4' or 0.01 Ag
Aoi / Agi ≤ 0.20
Where:
Ao = the total area of openings in a wall that receives positive external pressure.
Ag = the gross area of that wall in which Ao is identified.
Aoi = the sum of the areas of openings in the building envelope (walls and roof) not including Ao.
Agi = the sum of the gross surface areas of the building envelope (walls and roof) not including Ag.

Reduction Factor for large volume partially enclosed buildings (Ri) :

If the partially enclosed building contains a single room that is unpartitioned , the internal pressure coefficient may be multiplied by the reduction factor Ri.

Total area of all wall & roof openings (Aog):		0 sf
Unpartitioned internal volume (Vi) :		0 cf
	Ri =	1.00

Altitude adjustment to constant 0.00256 (caution - see code) :

Altitude =	0 feet	Average Air Density =	0.0765	lbm/ft^3
Constant =	0.00256			

Tetra Tech
Address
City, State
Phone

JOB TITLE	GM 38		
JOB NO.	112G08005_WE24_G	**SHEET NO.**	
CALCULATED BY	SPS	**DATE**	5/17/19
CHECKED BY	ATC	**DATE**	5/17/19

Wind Loads - MWFRS all h (Enclosed/partially enclosed only)

Open Building - procedure doesn't apply

Kh (case 2) =	0.59	h =	16.0 ft	GCpi =	+/-0.00
Base pressure (q_h) =	**23.6 psf**	ridge ht =	16.1 ft	G =	0.85
Roof Angle (θ) =	1.2 deg	L =	10.0 ft	qi = qh	
Roof tributary area - (h/2)*L:	80 sf	B =	10.0 ft		
(h/2)*B:	80 sf				

Ultimate Wind Surface Pressures (psf)

	Wind Normal to Ridge				Wind Parallel to Ridge				
	B/L = 1.00		h/L = 1.60			L/B = 1.00		h/L = 1.60	
Surface	Cp	q_hGC_p	w/+q_iGC_{pi}	w/-q_hGC_{pi}	Dist.*	Cp	q_hGC_p	w/ +q_iGC_{pi}	w/ -q_hGC_{pi}
Windward Wall (WW)	0.80	16.0	see table below			0.80	16.0	see table below	
Leeward Wall (LW)	-0.50	-10.0	-10.0	-10.0		-0.50	-10.0	-10.0	-10.0
Side Wall (SW)	-0.70	-14.0	-14.0	-14.0		-0.70	-14.0	-14.0	-14.0
Leeward Roof (LR)		**				Included in windward roof			
Neg Windward Roof: 0 to h/2*	-1.30	-26.0	-26.0	-26.0	0 to h/2*	-1.30	-26.0	-26.0	-26.0
> h/2*	-0.70	-14.0	-14.0	-14.0	> h/2*	-0.70	-14.0	-14.0	-14.0
Pos/min windward roof press.	-0.18	-3.6	-3.6	-3.6	Min press.	-0.18	-3.6	-3.6	-3.6

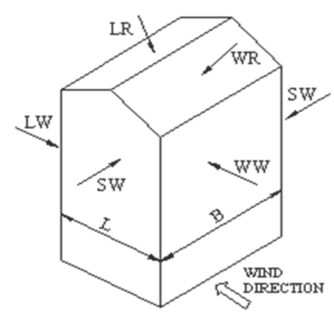
**Roof angle < 10 degrees. Therefore, leeward roof is included in windward roof pressure zones.

*Horizontal distance from windward edge

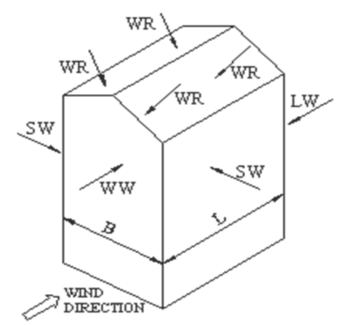
For monoslope roofs, entire roof surface is either windward or leeward surface.

Windward Wall Pressures at "z" (psf)

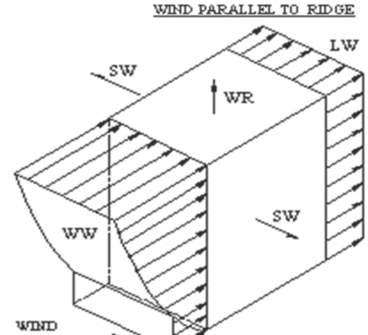
	z	Kz	Kzt	q_zGC_p	Windward Wall w/+q_iGC_{pi}	w/-q_hGC_{pi}	Combined WW + LW Normal to Ridge	Parallel to Ridge
	0 to 15'	0.57	1.00	15.7	15.7	15.7	25.7	25.7
h=	16.0 ft	0.59	1.00	16.0	16.0	16.0	26.0	26.0
ridge =	16.1 ft	0.59	1.00	16.1	16.1	16.1	26.1	26.1



WIND NORMAL TO RIDGE



WIND PARALLEL TO RIDGE



TYPICAL WIND LOADING

NOTE:
See figure in ASCE7 for the application of full and partial loading of the above wind pressures. There are 4 different loading cases.

Parapet

z	Kz	Kzt	qp (psf)
0.0 ft	0.57	1.00	0.0

Windward parapet:	0.0 psf	(GCpn = +1.5)
Leeward parapet:	0.0 psf	(GCpn = -1.0)

Windward roof overhangs (add to windward roof pressure) : 16.0 psf (upward)

Tetra Tech
Address
City, State
Phone

JOB TITLE GM 38

JOB NO. 112G08005_WE24_ SHEET NO.
CALCULATED BY SPS DATE 5/17/19
CHECKED BY ATC DATE 5/17/19

Wind Loads - MWFRS h≤60' (Low-rise Buildings) Enclosed/partially enclosed only

Kz = Kh (case 1) =	0.70		Edge Strip (a) =		3.0 ft
Base pressure (qh) =	**0.0 psf**	h>B - can't use low-rise method	End Zone (2a) =		6.0 ft
GCpi =	+/-0.00	Open Building - procedure doesn't apply	Zone 2 length	=	5.0 ft

Wind Pressure Coefficients

	CASE A				CASE B		
		θ = 1.2 deg					
Surface	GCpf	w/-GCpi	w/+GCpi		GCpf	w/-GCpi	w/+GCpi
1	0.40	0.40	0.40		-0.45	-0.45	-0.45
2	-0.69	-0.69	-0.69		-0.69	-0.69	-0.69
3	-0.37	-0.37	-0.37		-0.37	-0.37	-0.37
4	-0.29	-0.29	-0.29		-0.45	-0.45	-0.45
5					0.40	0.40	0.40
6					-0.29	-0.29	-0.29
1E	0.61	0.61	0.61		-0.48	-0.48	-0.48
2E	-1.07	-1.07	-1.07		-1.07	-1.07	-1.07
3E	-0.53	-0.53	-0.53		-0.53	-0.53	-0.53
4E	-0.43	-0.43	-0.43		-0.48	-0.48	-0.48
5E					0.61	0.61	0.61
6E					-0.43	-0.43	-0.43

Ultimate Wind Surface Pressures (psf)

1		0.0	0.0			0.0	0.0
2		0.0	0.0			0.0	0.0
3		0.0	0.0			0.0	0.0
4		0.0	0.0			0.0	0.0
5						0.0	0.0
6						0.0	0.0
1E		0.0	0.0			0.0	0.0
2E		0.0	0.0			0.0	0.0
3E		0.0	0.0			0.0	0.0
4E		0.0	0.0			0.0	0.0
5E						0.0	0.0
6E						0.0	0.0

Parapet

Windward parapet = 0.0 psf (GCpn = +1.5)
Leeward parapet = 0.0 psf (GCpn = -1.0)

Windward roof overhangs = 0.0 psf (upward) add to windward roof pressure

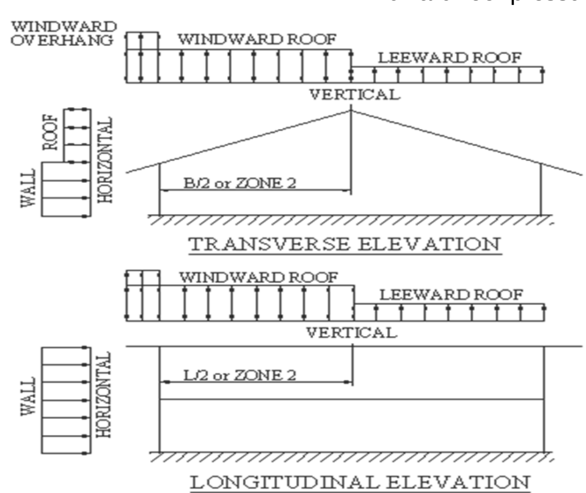
Horizontal MWFRS Simple Diaphragm Pressures (psf)

Transverse direction (normal to L)

Interior Zone:	Wall	0.0 psf
	Roof	0.0 psf
End Zone:	Wall	0.0 psf
	Roof	0.0 psf

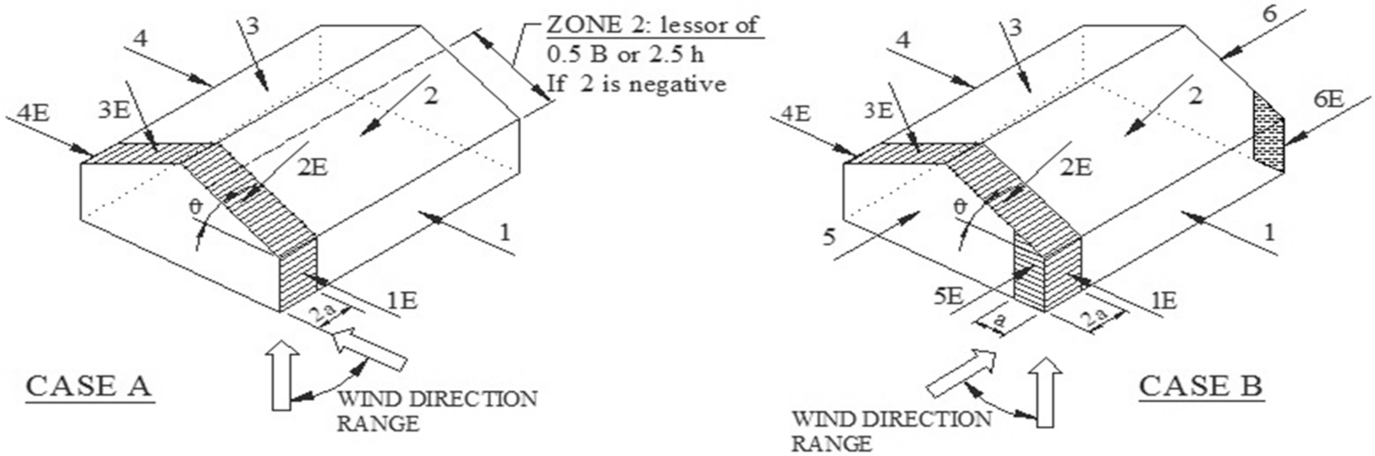
Longitudinal direction (parallel to L)

Interior Zone:	Wall	0.0 psf
End Zone:	Wall	0.0 psf



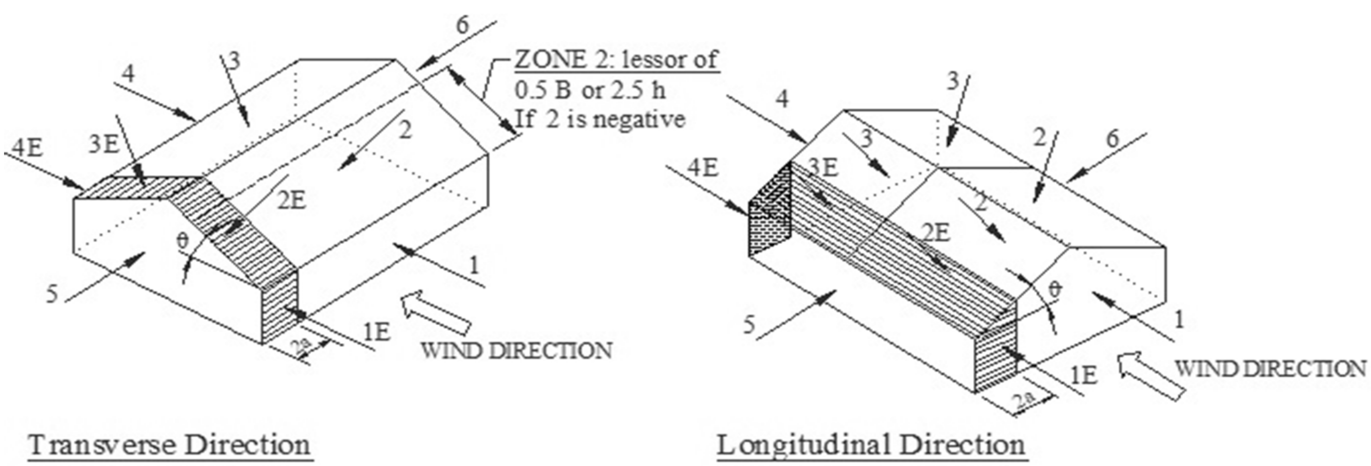
The code requires the MWFRS be designed for a min ultimate force of 16 psf multiplied by the wall area plus an 8 psf force applied to the vertical projection of the roof.

Location of MWFRS Wind Pressure Zones



NOTE: Torsional loads are 25% of zones 1 - 6. See code for loading diagram.

ASCE 7 -99 and ASCE 7-10 (& later)



NOTE: Torsional loads are 25% of zones 1 - 4. See code for loading diagram.

~~ASCE 7 -02 and ASCE 7-05~~

Wind Loads - Open Buildings: 0.25 ≤ h/L ≤ 1.0

Ultimate Wind Pressures

Type of roof = Pitched Free Roofs
Wind Flow = Clear

G = 0.85
Roof Angle = 1.2 deg

NOTE: The code requires the MWFRS be designed for a minimum pressure of 16 psf.

Main Wind Force Resisting System

Kz = Kh (case 2) = 0.59

Base pressure (qh) = **23.6 psf**

Roof pressures - Wind Normal to Ridge

Procedure not allowed h/L is greater than 1.0

Wind Flow	Load Case		Wind Direction ɣ = 0 & 180 deg Cnw	Cnl
Clear Wind Flow	A	Cn =	1.20	0.30
		p =	24.0 psf	6.0 psf
	B	Cn =	-1.10	-0.10
		p =	-22.0 psf	-2.0 psf

NOTE: 1). Cnw and Cnl denote combined pressures from top and bottom roof surfaces.
2). Cnw is pressure on windward half of roof. Cnl is pressure on leeward half of roof.
3). Positive pressures act toward the roof. Negative pressures act away from the roof.

Roof pressures - Wind Parallel to Ridge, ɣ = 90 deg

Wind Flow	Load Case		Horizontal Distance from Windward Edge ≤ h	>h ≤ 2h	> 2h
Clear Wind Flow	A	Cn =	-0.80	-0.60	-0.30
		p =	-16.0 psf	-12.0 psf	-6.0 psf
	B	Cn =	0.80	0.50	0.30
		p =	16.0 psf	10.0 psf	6.0 psf

h = 16.0 ft
2h = 32.0 ft

Fascia Panels -Horizontal pressures

qp = 23.6 psf

Windward fascia: 35.3 psf (GCpn = +1.5)
Leeward fascia: -23.6 psf (GCpn = -1.0)

Components & Cladding - roof pressures

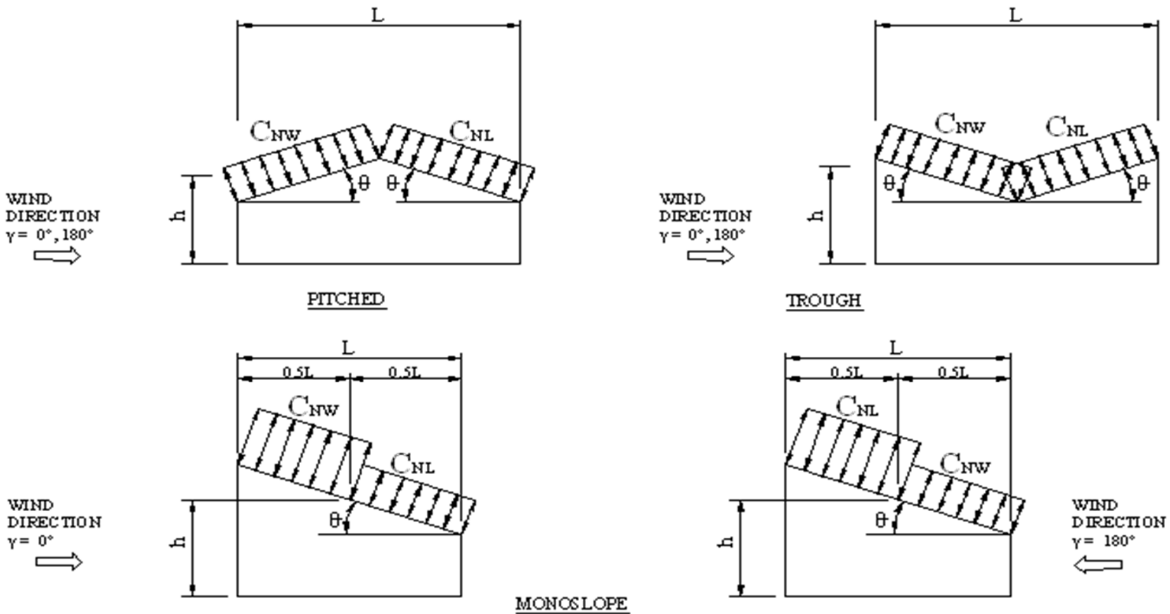
Kz = Kh (case 1) = 0.70
Base pressure (qh) = **28.2 psf**
G = 0.85

a = 3.0 ft

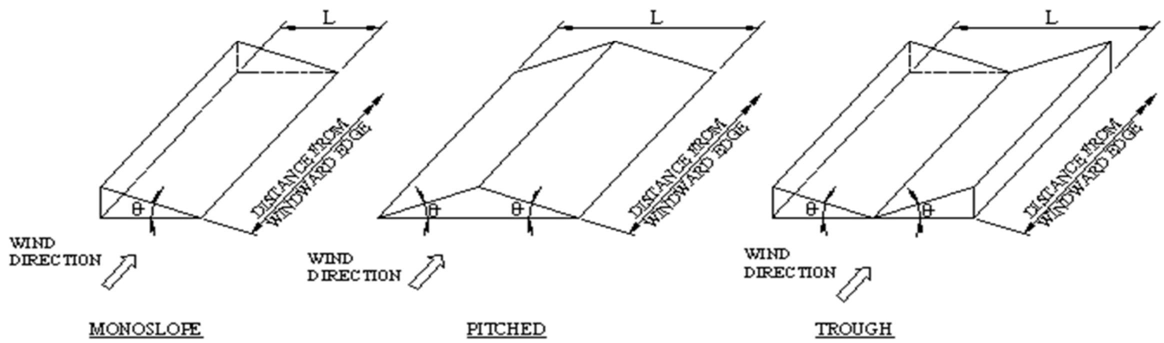
a^2 = 9.0 sf
$4a^2$ = 36.0 sf

	Effective Wind Area	Clear Wind Flow zone 3 positive	negative	zone 2 positive	negative	zone 1 positive	negative
C_N	≤ 9 sf	2.37	-3.35	1.78	-1.72	1.18	-1.12
	>9, ≤ 36 sf	1.78	-1.72	1.78	-1.72	1.18	-1.12
	> 36 sf	1.18	-1.12	1.18	-1.12	1.18	-1.12
Wind pressure	≤ 9 sf	56.8 psf	-80.2 psf	42.8 psf	-41.1 psf	28.4 psf	-26.7 psf
	>9, ≤ 36 sf	42.8 psf	-41.1 psf	42.8 psf	-41.1 psf	28.4 psf	-26.7 psf
	> 36 sf	28.4 psf	-26.7 psf	28.4 psf	-26.7 psf	28.4 psf	-26.7 psf

Location of Wind Pressure Zones

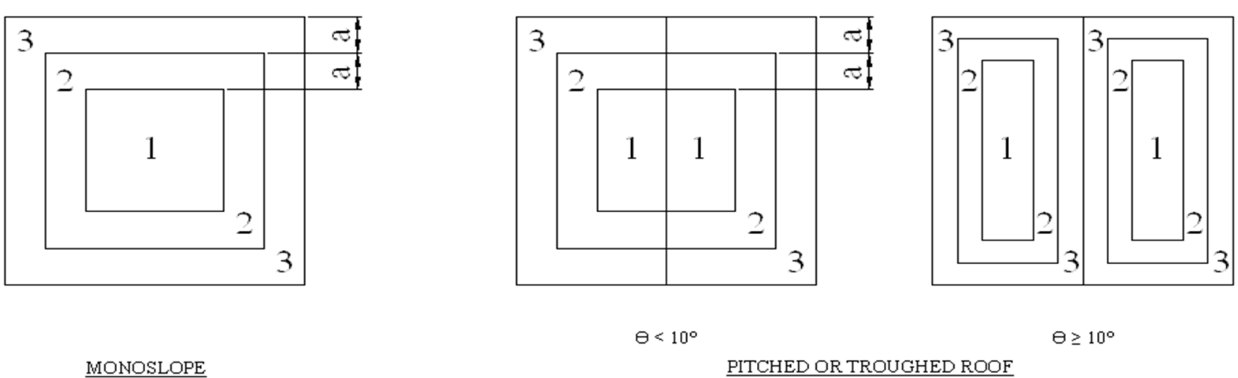


WIND DIRECTION $\gamma = 0°, 180°$



WIND DIRECTION $\gamma = 90°$

MAIN WIND FORCE RESISTING SYSTEM



Θ < 10°

Θ ≥ 10°

MONOSLOPE

PITCHED OR TROUGHED ROOF

COMPONENTS AND CLADDING

Tetra Tech	
Address	JOB TITLE GM 38
City, State	JOB NO. 112G08005_WE24 SHEET NO.
Phone	CALCULATED BY SPS DATE 5/17/19
	CHECKED BY ATC DATE 5/17/19

Snow Loads : ASCE 7-10

Nominal Snow Forces

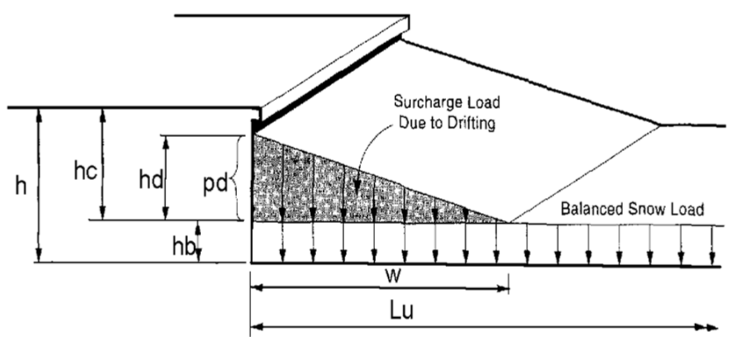
Roof slope	=	1.2 deg
Horiz. eave to ridge dist (W)	=	10.0 ft
Roof length parallel to ridge (L)	=	10.0 ft

Type of Roof			Monoslope
Ground Snow Load	Pg	=	30.0 psf
Risk Category		=	III
Importance Factor	I	=	1.1
Thermal Factor	Ct	=	1.20
Exposure Factor	Ce	=	1.0
Pf = 0.7*Ce*Ct*I*Pg		=	27.7 psf
Unobstructed Slippery Surface			no
Sloped-roof Factor	Cs	=	1.00
Balanced Snow Load	**Ps**	**=**	**27.7 psf**
Rain on Snow Surcharge Angle			0.20 deg
Code Maximum Rain Surcharge			5.0 psf
Rain on Snow Surcharge		=	0.0 psf
Ps plus rain surcharge		=	27.7 psf
Minimum Snow Load	Pm	=	22.0 psf
Uniform Roof Design Snow Load		=	**27.7 psf**

NOTE: Alternate spans of continuous beams and other areas shall be loaded with half the design roof snow load so as to produce the greatest possible effect - see code.

Windward Snow Drifts 1 - Against walls, parapets, etc more than 15' long

Upwind fetch	lu	=	163.0 ft
Projection height	h	=	13.0 ft
Snow density	g	=	17.9 pcf
Balanced snow height	hb	=	1.55 ft
	hd	=	3.31 ft
	hc	=	11.45 ft
hc/hb >0.2 = 7.4	**Therefore, design for drift**		
Drift height (hd)		=	3.31 ft
Drift width	w	=	13.22 ft
Surcharge load:	pd = γ*hd	=	**59.2 psf**
Balanced Snow load:		=	27.7 psf
			86.9 psf



Windward Snow Drifts 2 - Against walls, parapets, etc > 15'

Upwind fetch	lu	=	220.0 ft
Projection height	h	=	5.2 ft
Snow density	g	=	17.9 pcf
Balanced snow height	hb	=	1.55 ft
	hd	=	3.77 ft
	hc	=	3.65 ft
hc/hb >0.2 = 2.4	**Therefore, design for drift**		
Drift height (hc)		=	3.65 ft
Drift width	w	=	15.58 ft
Surcharge load:	pd = γ*hd	=	**65.4 psf**
Balanced Snow load:		=	27.7 psf
			93.1 psf

Seismic Loads: IBC 2015 Strength Level Forces

Risk Category : III
Importance Factor (I) : 1.25

Site Class : D

Ss (0.2 sec) = 23.40 %g
S1 (1.0 sec) = 6.60 %g

Fa =	1.600	Sms =	0.374	S_{DS} =	0.250	Design Category =	B
Fv =	2.400	Sm1 =	0.158	S_{D1} =	0.106	Design Category =	B

Seismic Design Category = **B**

Number of Stories: 1
Structure Type: All other building systems
Horizontal Struct Irregularities: No plan Irregularity
Vertical Structural Irregularities: No vertical Irregularity

Flexible Diaphragms: No
Building System: **Structural steel systems not specifically detailed for seismic resistance**
Seismic resisting system: **Structural steel systems not specifically detailed for seismic resistance**
System Structural Height Limit: **Height not limited**
Actual Structural Height (hn) = 16.1 ft

DESIGN COEFFICIENTS AND FACTORS

Response Modification Coefficient (R) = 3
Over-Strength Factor (Ωo) = 3
Deflection Amplification Factor (Cd) = 3
S_{DS} = 0.250
S_{D1} = 0.106

Seismic Load Effect (E) = ρQ_E +/- $0.2S_{DS}$ D = ρQ_E +/- 0.050D
Special Seismic Load Effect (Em) = $\Omega o\, Q_E$ +/- $0.2S_{DS}$ D = 3.0 Q_E +/- 0.050D

ρ = redundancy coefficient
Q_E = horizontal seismic force
D = dead load

PERMITTED ANALYTICAL PROCEDURES

Simplified Analysis - Use Equivalent Lateral Force Analysis

Equivalent Lateral-Force Analysis - Permitted

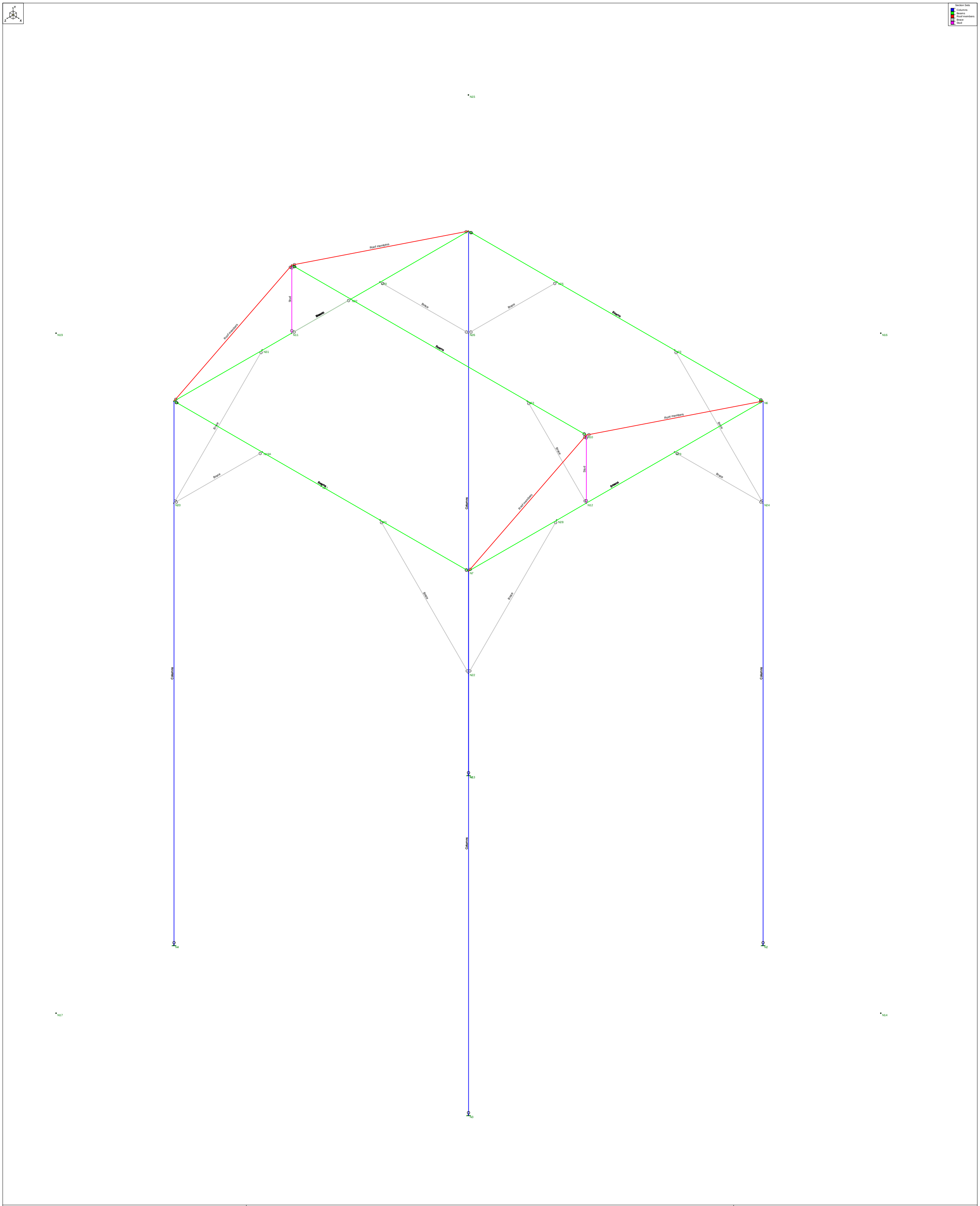
Building period coef. (C_T) = 0.020 Cu = 1.69
Approx fundamental period (Ta) = $C_T h_n^x$ = 0.161 sec x= 0.75 Tmax = CuTa = 0.271
User calculated fundamental period (T) = sec Use T = 0.161
Long Period Transition Period (TL) = ASCE7 map = 6
Seismic response coef. (Cs) = $S_{DS}I/R$ = 0.104
need not exceed Cs = Sd1 I /RT = 0.274
but not less than Cs = 0.044SdsI = 0.014
USE Cs = 0.104
Design Base Shear V = 0.104W

Model & Seismic Response Analysis - Permitted (see code for procedure)

ALLOWABLE STORY DRIFT

Structure Type: All other structures

Allowable story drift = 0.015hsx where hsx is the story height below level x



Tetra Tech	GM-38	GENERAL FRAMING 1
SPS		May 17, 2019 at 2:10 PM
112G08005		Canopy Framing .r3d

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E...	Density[k/ft...	Yield[ksi]	Ry	Fu[ksi]	Rt
1	A992	29000	11154	.3	.65	.49	50	1.1	65	1.1
2	A36 Gr.36	29000	11154	.3	.65	.49	36	1.5	58	1.2
3	A572 Gr.50	29000	11154	.3	.65	.49	50	1.1	65	1.1
4	A500 Gr.B RND	29000	11154	.3	.65	.527	42	1.4	58	1.3
5	A500 Gr.B Rect	29000	11154	.3	.65	.527	46	1.4	58	1.3
6	A53 Gr.B	29000	11154	.3	.65	.49	35	1.6	60	1.2
7	A1085	29000	11154	.3	.65	.49	50	1.4	65	1.3

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design R...	A [in2]	Iyy [in4]	Izz [in4]	J [in4]
1	Columns	HSS5X5X6	Column	Tube	A992	Typical	6.18	21.7	21.7	36.1
2	Beams	W6X20	Beam	Wide Fla...	A992	Typical	5.87	13.3	41.4	.24
3	Roof members	W6X20	Beam	Wide Fla...	A992	Typical	5.87	13.3	41.4	.24
4	Brace	L3X3X6	VBrace	Single An...	A992	Typical	2.11	1.75	1.75	.101
5	Stud	HSS4X4X6	Column	Tube	A992	Typical	4.78	10.3	10.3	17.5

Hot Rolled Steel Design Parameters

	Label	Shape	Length[ft]	Lbyy[ft]	Lbzz[ft]	Lcomp top[ft]	Lcomp bot[ft]	L-torqu...	Kyy	Kzz	Cb	Function
1	M1	Columns	16									Lateral
2	M2	Columns	16									Lateral
3	M3	Columns	16									Lateral
4	M4	Columns	16									Lateral
5	M5	Beams	10			Lbyy						Lateral
6	M6	Beams	10			Lbyy						Lateral
7	M7	Beams	10			Lbyy						Lateral
8	M8	Beams	10			Lbyy						Lateral
9	M9	Beams	10			Lbyy						Lateral
10	M10	Roof memb...	4.472			Lbyy						Lateral
11	M11	Roof memb...	6.325			Lbyy						Lateral
12	M12	Roof memb...	4.472			Lbyy						Lateral
13	M13	Roof memb...	6.325			Lbyy						Lateral
14	M14	Stud	2									Lateral
15	M15	Stud	2									Lateral
16	M16	Brace	4.243			Lbyy						Lateral
17	M17	Brace	4.243			Lbyy						Lateral
18	M18	Brace	4.243			Lbyy						Lateral
19	M19	Brace	4.243			Lbyy						Lateral
20	M20	Brace	4.243									Lateral
21	M21	Brace	4.243									Lateral
22	M22	Brace	4.243									Lateral
23	M23	Brace	4.243									Lateral
24	M24	Brace	2.828									Lateral
25	M25	Brace	2.828									Lateral

Member Point Loads

Member Label	Direction	Magnitude[k,k-ft]	Location[ft,%]
No Data to Print ...			

Member Area Loads (BLC 2 : Live)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[ksf]
1	N6	N10	N9	N5	Y	A-B	-.02
2	N10	N7	N8	N9	Y	A-B	-.02

Member Area Loads (BLC 3 : Snow)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[ksf]
1	N8	N9	N10	N7	Y	A-B	-.028
2	N9	N5	N6	N10	Y	A-B	-.028

Member Area Loads (BLC 4 : Wind X)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[ksf]
1	N19	N15	N13	N17	X	Open Structure	.037
2	N6	N10	N9	N5	Y	A-B	.035
3	N10	N7	N8	N9	Y	A-B	.035

Member Area Loads (BLC 5 : Wind Z)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[ksf]
1	N15	N16	N14	N13	Z	Open Structure	.037
2	N6	N10	N9	N5	Y	A-B	.035
3	N10	N7	N8	N9	Y	A-B	.035

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Z Gravity	Joint	Point	Distributed	Area(Me...	Surface(P...
1	Dead	DL		-1						
2	Live	LL							2	
3	Snow	SL							2	
4	Wind X	WLX							3	
5	Wind Z	WLZ							3	
6	Seismic X	ELX	.125							
7	Seismic Z	ELZ			.125					
8	BLC 2 Transient Area...	None						4		
9	BLC 4 Transient Area...	None						16		
10	BLC 5 Transient Area...	None						17		
11	BLC 3 Transient Area...	None						4		

Load Combinations

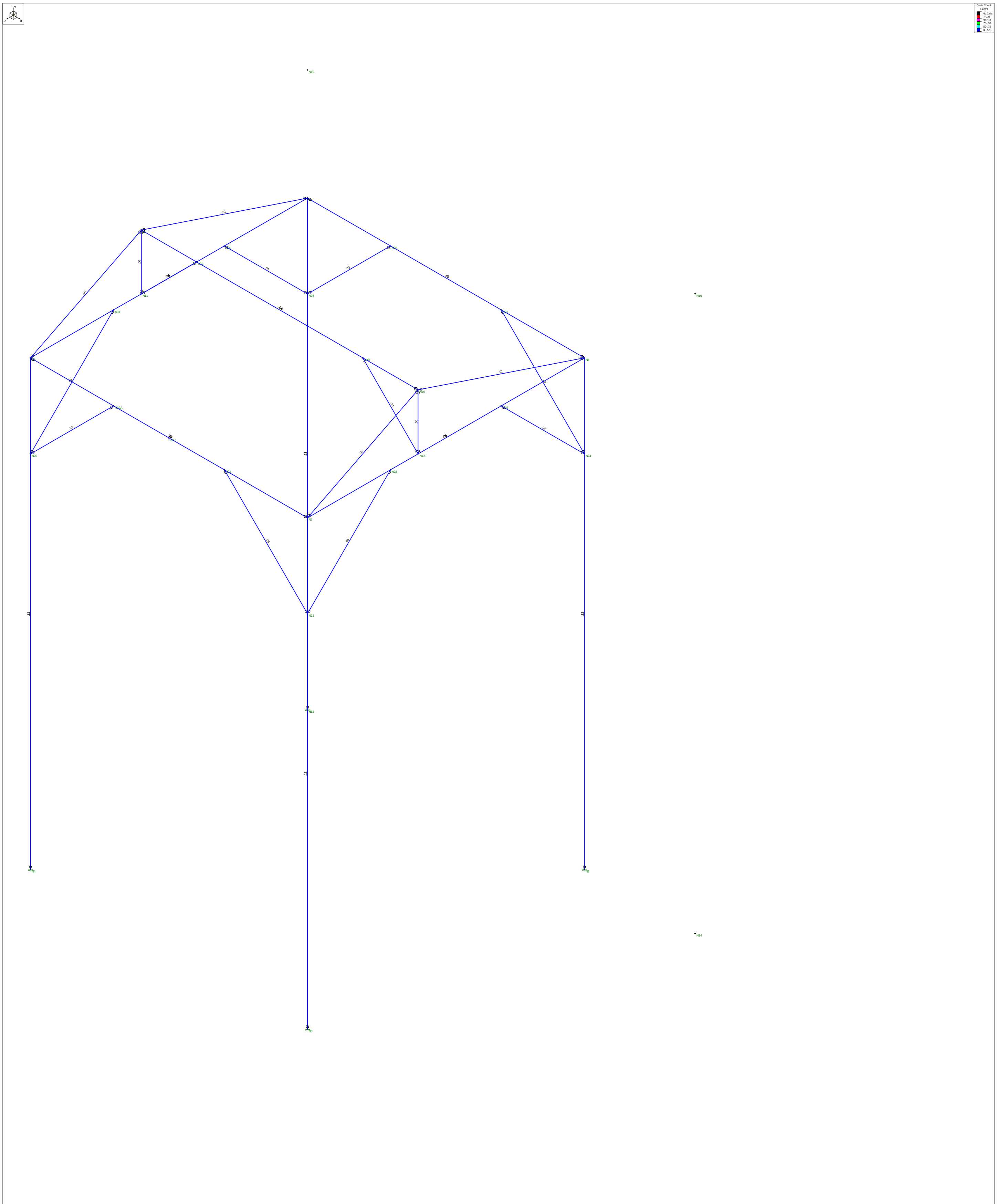
	Description	So..	P...	S...	BLC	Fac..	BLC	Fac..	BLC	Fac..	BLC	Fac..	BLC	Fac..	BLC	Fac..	BLC	Fac..	BLC	Fac..	BLC	Fac...
1	Deflection 4	Yes	Y		DL	1	LL	1	W...	.6												
2	Deflection 1	Yes	Y		DL	1																
3	Deflection 2	Yes	Y		LL	1																
4	Deflection 3	Yes	Y		DL	1	LL	1	W...	.6												
5	IBC 16-1	Yes	Y		DL	1.4																

Load Combinations (Continued)

	Description	So..	P...	S...	BLC	Fac..	BLC	Fac..	BLC	Fac..	BLC	Fac..	BLC	Fac..	BLC	Fac..	BLC	Fac..	BLC	Fac..	BLC	Fac..	BLC	Fac...
6	IBC 16-2 (a)	Yes	Y		DL	1.2	LL	1.6	LLS	1.6														
7	IBC 16-2 (b)	Yes	Y		DL	1.2	LL	1.6	LLS	1.6	SL	.5	SLN	.5										
8	IBC 16-3 (c)	Yes	Y		DL	1.2	SL	1.6	SLN	1.6	LL	.5	LLS	1										
9	IBC 16-3 (b) (a)	Yes	Y		DL	1.2	W...	.5																
10	IBC 16-3 (b) (b)	Yes	Y		DL	1.2	W...	.5																
11	IBC 16-4 (a) (a)	Yes	Y		DL	1.2	W...	1	LL	.5	LLS	1												
12	IBC 16-4 (a) (b)	Yes	Y		DL	1.2	W...	1	LL	.5	LLS	1												
13	IBC 16-6 (a)	Yes	Y		DL	.9	W...	1																
14	IBC 16-6 (b)	Yes	Y		DL	.9	W...	1																
15	IBC 16-5 (a)	Yes	Y		DL	1.2	ELX	1	LL	.5	LLS	1												
16	IBC 16-5 (b)	Yes	Y		DL	1.2	ELZ	1	LL	.5	LLS	1												
17	IBC 16-7 (a)	Yes	Y		DL	.9	ELX	1																
18	IBC 16-7 (b)	Yes	Y		DL	.9	ELZ	1																

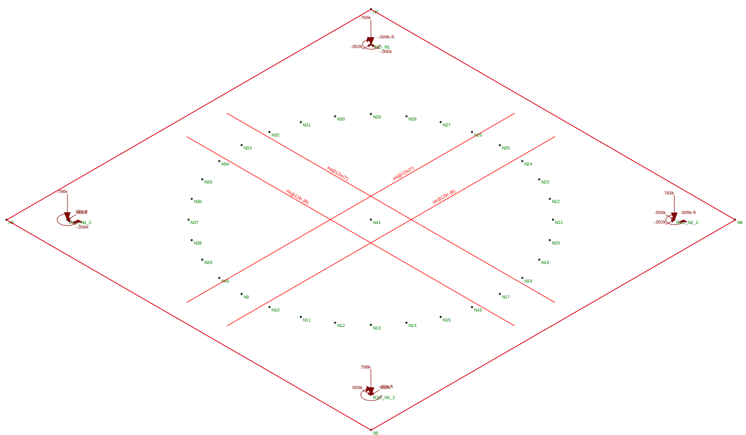
Envelope AISC 14th(360-10): LRFD Steel Code Checks

	Member	Shape	Code C...	Loc[ft]	LC	Shear ...	Loc[ft]	Dir	LC	phi*Pnc [k]	phi*Pnt [k]	phi*Mn y-...	phi*Mn z-...	Cb	Eqn
1	M1	HSS5X5X6	.124	13	13	.028	16	z	14	129.07	278.1	39.75	39.75	1....	H1-1b
2	M2	HSS5X5X6	.125	13	13	.027	16	y	13	129.07	278.1	39.75	39.75	1....	H1-1b
3	M3	HSS5X5X6	.118	13	14	.027	16	z	14	129.07	278.1	39.75	39.75	1....	H1-1b
4	M4	HSS5X5X6	.120	13	11	.028	16	z	14	129.07	278.1	39.75	39.75	1....	H1-1b
5	M5	W6X20	.053	2.917	14	.024	0	y	12	165.972	264.15	25.2	55.875	1....	H1-1b
6	M6	W6X20	.047	7.083	13	.025	3.021	y	13	165.972	264.15	25.2	55.875	1....	H1-1b
7	M7	W6X20	.053	7.083	14	.024	10	y	12	165.972	264.15	25.2	55.875	1....	H1-1b
8	M8	W6X20	.050	2.917	13	.026	6.979	y	13	165.972	264.15	25.2	55.875	1....	H1-1b
9	M9	W6X20	.059	5	8	.025	10	y	8	165.972	264.15	25.2	55.875	1....	H1-1b
10	M10	W6X20	.010	0	8	.001	4.472	y	8	240.706	264.15	25.2	55.875	1....	H1-1b*
11	M11	W6X20	.010	6.325	8	.002	6.325	y	5	219.343	264.15	25.2	55.875	1....	H1-1b*
12	M12	W6X20	.010	4.472	8	.001	4.472	y	8	240.706	264.15	25.2	55.875	1....	H1-1b*
13	M13	W6X20	.010	6.325	8	.002	0	y	5	219.343	264.15	25.2	55.875	1....	H1-1b*
14	M14	HSS4X4X6	.001	2	8	.000	0	y	13	210.937	215.1	23.963	23.963	1	H1-1b
15	M15	HSS4X4X6	.001	2	8	.000	2	z	14	210.937	215.1	23.963	23.963	1	H1-1b
16	M16	L3X3X6	.032	2.077	11	.003	0	y	12	54.158	94.95	3.205	7.054	1....	H2-1
17	M17	L3X3X6	.050	2.166	11	.003	4.243	y	12	54.158	94.95	3.205	7.054	1....	H2-1
18	M18	L3X3X6	.049	2.166	11	.003	0	y	14	54.158	94.95	3.205	7.054	1....	H2-1
19	M19	L3X3X6	.032	2.077	11	.003	4.243	y	14	54.158	94.95	3.205	7.054	1....	H2-1
20	M20	L3X3X6	.059	2.077	12	.004	0	y	11	54.158	94.95	3.205	7.054	1....	H2-1
21	M21	L3X3X6	.035	2.166	12	.004	0	y	11	54.158	94.95	3.205	7.054	1....	H2-1
22	M22	L3X3X6	.035	2.166	12	.004	0	y	11	54.158	94.95	3.205	7.054	1....	H2-1
23	M23	L3X3X6	.059	2.077	12	.004	0	y	11	54.158	94.95	3.205	7.054	1....	H2-1
24	M24	L3X3X6	.010	1.385	8	.000	0	y	11	73.982	94.95	3.205	7.392	1....	H2-1
25	M25	L3X3X6	.010	1.444	8	.000	0	y	11	73.982	94.95	3.205	7.392	1....	H2-1



Member Code Checks Displayed (Enveloped)
Results for LC 1, Deflection 4

Tetra Tech	GM-38	UNITY CHECK 2
SPS		May 17, 2019 at 2:14 PM
112G08005		Canopy Framing .r3d



Loads: DL - Dead Load
Results for LC 1, Service

Tetra Tech	GM-38	GENERAL LAYOUT 1
SPS		May 17, 2019 at 2:25 PM
112G08005_WE24		Canopy Framing .r3d

Concrete Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E..	Density[k/ft...	f'c[ksi]	Lambda	Flex Steel[...	Shear Stee...
1	Conc3000NW	3156	1372	.15	.6	.145	3	1	60	60
2	Conc3500NW	3409	1482	.15	.6	.145	3.5	1	60	60
3	Conc4000NW	3644	1584	.15	.6	.145	4	1	60	60
4	Conc3000LW	2085	907	.15	.6	.11	3	.75	60	60
5	Conc3500LW	2252	979	.15	.6	.11	3.5	.75	60	60
6	Conc4000LW	2408	1047	.15	.6	.11	4	.75	60	60

General Design Parameters

	Label	Max Bending Chk	Max Shear Chk	Top Cover[in]	Bottom Cover[in]
1	Typical	1	1	1.5	1.5

Soil Definitions

	Label	Subgrade Modulus[k/ft^3]	Allowable Bearing[ksf]	Depth Properties	Default?
1	Default	150	3	None	Yes

Point Loads and Moments (Cat 1 : DL)

	Label	Direction	Magnitude[k,k-ft]
1	R3D_N1	X	-.006
2	R3D_N1	Y	.765
3	R3D_N1	Z	-.002
4	R3D_N1	MY	-.009
5	R3D_N2_2	X	.006
6	R3D_N2_2	Y	.765
7	R3D_N2_2	Z	-.002
8	R3D_N2_2	MY	.009
9	R3D_N3_2	X	.006
10	R3D_N3_2	Y	.798
11	R3D_N3_2	Z	.002
12	R3D_N3_2	MY	-.01
13	R3D_N4_2	X	-.006
14	R3D_N4_2	Y	.798
15	R3D_N4_2	Z	.002
16	R3D_N4_2	MY	.01

Point Loads and Moments (Cat 2 : LL)

	Label	Direction	Magnitude[k,k-ft]
1	R3D_N1	X	-.015
2	R3D_N1	Y	.532
3	R3D_N1	Z	-.002
4	R3D_N1	MY	-.044
5	R3D_N2_2	X	.015
6	R3D_N2_2	Y	.532
7	R3D_N2_2	Z	-.002
8	R3D_N2_2	MY	.044
9	R3D_N3_2	X	.01
10	R3D_N3_2	Y	.548
11	R3D_N3_2	Z	.002
12	R3D_N3_2	MY	-.052
13	R3D_N4_2	X	-.01
14	R3D_N4_2	Y	.548

Point Loads and Moments (Cat 2 : LL) (Continued)

	Label	Direction	Magnitude[k,k-ft]
15	R3D_N4_2	Z	.002
16	R3D_N4_2	MY	.052

Point Loads and Moments (Cat 5 : SL)

	Label	Direction	Magnitude[k,k-ft]
1	R3D_N1	X	-.021
2	R3D_N1	Y	.745
3	R3D_N1	Z	-.003
4	R3D_N1	MY	-.061
5	R3D_N2_2	X	.021
6	R3D_N2_2	Y	.745
7	R3D_N2_2	Z	-.003
8	R3D_N2_2	MY	.061
9	R3D_N3_2	X	.015
10	R3D_N3_2	Y	.767
11	R3D_N3_2	Z	.003
12	R3D_N3_2	MY	-.072
13	R3D_N4_2	X	-.015
14	R3D_N4_2	Y	.767
15	R3D_N4_2	Z	.003
16	R3D_N4_2	MY	.072

Point Loads and Moments (Cat 26 : ELX)

	Label	Direction	Magnitude[k,k-ft]
1	R3D_N1	X	.097
2	R3D_N1	Y	-.245
3	R3D_N1	MY	.025
4	R3D_N2_2	X	.097
5	R3D_N2_2	Y	.245
6	R3D_N2_2	MY	.025
7	R3D_N3_2	X	.099
8	R3D_N3_2	Y	.253
9	R3D_N3_2	MY	-.012
10	R3D_N4_2	X	.099
11	R3D_N4_2	Y	-.253
12	R3D_N4_2	MY	-.012

Point Loads and Moments (Cat 28 : ELZ)

	Label	Direction	Magnitude[k,k-ft]
1	R3D_N1	Y	-.249
2	R3D_N1	Z	.096
3	R3D_N1	MY	-.0001076
4	R3D_N2_2	Y	-.249
5	R3D_N2_2	Z	.096
6	R3D_N2_2	MY	.0001076
7	R3D_N3_2	Y	.249
8	R3D_N3_2	Z	.099
9	R3D_N4_2	Y	.249
10	R3D_N4_2	Z	.099

Point Loads and Moments (Cat 29 : WLX)

	Label	Direction	Magnitude[k,k-ft]
1	N41	X	1.3
2	N41	MZ	5.85
3	R3D_N1	X	.482
4	R3D_N1	Y	-2.015
5	R3D_N1	Z	.003
6	R3D_N1	MY	.179
7	R3D_N2_2	X	.43
8	R3D_N2_2	Y	.152
9	R3D_N2_2	Z	.003
10	R3D_N2_2	MY	.025
11	R3D_N3_2	X	.441
12	R3D_N3_2	Y	.145
13	R3D_N3_2	Z	-.003
14	R3D_N3_2	MY	.01
15	R3D_N4_2	X	.478
16	R3D_N4_2	Y	-2.062
17	R3D_N4_2	Z	-.003
18	R3D_N4_2	MY	-.17

Point Loads and Moments (Cat 31 : WLZ)

	Label	Direction	Magnitude[k,k-ft]
1	N41	Z	1.3
2	N41	MX	5.85
3	R3D_N1	X	.025
4	R3D_N1	Y	-1.972
5	R3D_N1	Z	.437
6	R3D_N1	MY	.076
7	R3D_N2_2	X	-.025
8	R3D_N2_2	Y	-1.972
9	R3D_N2_2	Z	.437
10	R3D_N2_2	MY	-.076
11	R3D_N3_2	X	-.019
12	R3D_N3_2	Y	.083
13	R3D_N3_2	Z	.442
14	R3D_N3_2	MY	.091
15	R3D_N4_2	X	.019
16	R3D_N4_2	Y	.083
17	R3D_N4_2	Z	.442
18	R3D_N4_2	MY	-.091

Area Loads (Cat 2 : LL)

	Label	Base Mag[ksf]	Peak Mag[ksf]
1	AL2	.56	.56

Slabs

	Label	Thickness [in]	Material	Local Axis Angle [deg]	Analysis Offset...	Passive Pressure [ksf]	Soil Overburden [ksf]
1	S1	8	Conc4000NW	0	0	0	0

Load Combinations

	Label	So...	Se...	A...	SF	Cat...	Fac...	Cat...	Fac...	Cat...	Fac...	Cat...	Fac...	Cat...	Fac...	Cat...	Fac...	Cat...	Fac...	Cat...	Fac...	Cat...	Fac...	Cat...	Fac...
1	Service	Yes	Yes			DL	1	LL	1	HL	1														
2	Strength	Yes				DL	1.2	LL	1.6	HL	1.6														
3	IBC 16-8	Yes	Yes		1.5	DL	1																		
4	IBC 16-9	Yes	Yes		1.5	DL	1	HL	1	LL	1	LLS	1												
5	IBC 16-1...	Yes	Yes		1.5	DL	1	HL	1	RLL	1														
6	IBC 16-1...	Yes	Yes		1.5	DL	1	HL	1	SL	1	SLN	.75												
7	IBC 16-1...	Yes	Yes		1.5	DL	1	HL	1	RL	1														
8	IBC 16-1...	Yes	Yes		1.5	DL	1	HL	1	LL	.75	LLS	.75	RLL	.75										
9	IBC 16-1...	Yes	Yes		1.5	DL	1	HL	1	LL	.75	LLS	.75	SL	.75	SLN	.75								
10	IBC 16-1...	Yes	Yes		1.5	DL	1	HL	1	LL	.75	LLS	.75	RL	.75										
11	IBC 16-1...	Yes	Yes		1.5	DL	1	HL	1	WLX	.6														
12	IBC 16-1...	Yes	Yes		1.5	DL	1	HL	1	WLZ	.6														
13	IBC 16-1...	Yes	Yes		1.5	DL	1	HL	1	WLX	.45	LL	.75	LLS	.75	RLL	.75								
14	IBC 16-1...	Yes	Yes		1.5	DL	1	HL	1	WLZ	.45	LL	.75	LLS	.75	RLL	.75								
15	IBC 16-1...	Yes	Yes		1.5	DL	1	HL	1	WLX	.45	LL	.75	LLS	.75	SL	.75	SLN	.75						
16	IBC 16-1...	Yes	Yes		1.5	DL	1	HL	1	WLZ	.45	LL	.75	LLS	.75	SL	.75	SLN	.75						
17	IBC 16-1...	Yes	Yes		1.5	DL	1	HL	1	WLX	.45	LL	.75	LLS	.75	RL	.75								
18	IBC 16-1...	Yes	Yes		1.5	DL	1	HL	1	WLZ	.45	LL	.75	LLS	.75	RL	.75								
19	IBC 16-1...	Yes	Yes			DL	.6	HL	1	WLX	.6														
20	IBC 16-1...	Yes	Yes			DL	.6	HL	1	WLZ	.6														
21	IBC 16-1	Yes				DL	1.4																		
22	IBC 16-2...	Yes				DL	1.2	LL	1.6	LLS	1.6	HL	1.6	RLL	.5										
23	IBC 16-2...	Yes				DL	1.2	LL	1.6	LLS	1.6	HL	1.6	SL	.5	SLN	.5								
24	IBC 16-2...	Yes				DL	1.2	LL	1.6	LLS	1.6	HL	1.6	RL	.5										
25	IBC 16-3...	Yes				DL	1.2	RLL	1.6	HL	1.6	LL	.5	LLS	1										
26	IBC 16-3...	Yes				DL	1.2	RLL	1.6	HL	1.6	WLX	.5												
27	IBC 16-3...	Yes				DL	1.2	RLL	1.6	HL	1.6	WLZ	.5												
28	IBC 16-3...	Yes				DL	1.2	SL	1.6	SLN	1.6	HL	1.6	LL	.5	LLS	1								
29	IBC 16-3...	Yes				DL	1.2	SL	1.6	SLN	1.6	HL	1.6	WLX	.5										
30	IBC 16-3...	Yes				DL	1.2	SL	1.6	SLN	1.6	HL	1.6	WLZ	.5										
31	IBC 16-3...	Yes				DL	1.2	RL	1.6	HL	1.6	LL	.5	LLS	1										
32	IBC 16-3...	Yes				DL	1.2	RL	1.6	HL	1.6	WLX	.5												
33	IBC 16-3...	Yes				DL	1.2	RL	1.6	HL	1.6	WLZ	.5												
34	IBC 16-4...	Yes				DL	1.2	WLX	1	LL	.5	LLS	1	HL	1.6	RLL	.5								
35	IBC 16-4...	Yes				DL	1.2	WLZ	1	LL	.5	LLS	1	HL	1.6	RLL	.5								
36	IBC 16-4...	Yes				DL	1.2	WLX	1	LL	.5	LLS	1	HL	1.6	SL	.5	SLN	.5						
37	IBC 16-4...	Yes				DL	1.2	WLZ	1	LL	.5	LLS	1	HL	1.6	SL	.5	SLN	.5						
38	IBC 16-4...	Yes				DL	1.2	WLX	1	LL	.5	LLS	1	HL	1.6	RL	.5								
39	IBC 16-4...	Yes				DL	1.2	WLZ	1	LL	.5	LLS	1	HL	1.6	RL	.5								
40	IBC 16-6...	Yes				DL	.9	WLX	1	HL	1.6														
41	IBC 16-6...	Yes				DL	.9	WLZ	1	HL	1.6														
42	IBC 16-7...	Yes				DL	.9	WLX	1	HL	1.6														
43	IBC 16-7...	Yes				DL	.9	WLZ	1	HL	1.6														

Design Cuts

Label	Design Rule
No Data to Print ...	

Design Strips

	Label	Rebar Angle from Pl...	No. of Design Cuts	Design Rule
1	DS1	0	50	Typical
2	DS2	90	50	Typical

Envelope Soil Pressures

	Label	Max UC	Max LC	Soil Pressure[ksf]	Allowable Bearing[ksf]
1	N8	.093	15	.278	3
2	N5	.097	16	.291	3
3	N6	.097	16	.291	3
4	N7	.09	9	.27	3
5	R3D_N1	.096	1	.288	3
6	R3D_N2_2	.096	1	.288	3
7	R3D_N3_2	.099	16	.298	3
8	R3D_N4_2	.099	16	.298	3
9	N9	.121	1	.363	3
10	N10	.117	1	.351	3
11	N11	.125	1	.374	3
12	N12	.121	1	.363	3
13	N13	.121	1	.364	3
14	N14	.121	1	.363	3
15	N15	.125	1	.374	3
16	N16	.117	1	.35	3
17	N17	.121	1	.362	3
18	N18	.117	1	.35	3
19	N19	.124	1	.373	3
20	N20	.121	1	.362	3
21	N21	.121	1	.362	3
22	N22	.121	1	.362	3
23	N23	.124	1	.373	3
24	N24	.116	1	.349	3
25	N25	.12	1	.361	3
26	N26	.116	1	.349	3
27	N27	.124	1	.373	3
28	N28	.121	1	.362	3
29	N29	.121	1	.362	3
30	N30	.121	1	.362	3
31	N31	.124	1	.373	3
32	N32	.117	1	.35	3
33	N33	.121	1	.362	3
34	N34	.117	1	.35	3
35	N35	.125	1	.374	3
36	N36	.121	1	.363	3
37	N37	.121	1	.364	3
38	N38	.121	1	.363	3
39	N39	.125	1	.374	3
40	N40	.117	1	.351	3
41	N41	.146	1	.439	3
42	N42	.124	1	.373	3
43	N43	.12	1	.359	3
44	N44	.134	1	.403	3
45	N45	.14	1	.42	3
46	N46	.109	1	.326	3

Envelope Soil Pressures (Continued)

	Label	Max UC	Max LC	Soil Pressure[ksf]	Allowable Bearing[ksf]
47	N47	.095	1	.286	3
48	N48	.102	1	.307	3
49	N49	.12	1	.36	3
50	N50	.125	1	.374	3
51	N51	.106	1	.317	3
52	N52	.103	1	.31	3
53	N53	.12	1	.361	3
54	N54	.125	1	.374	3
55	N55	.105	1	.316	3
56	N56	.102	1	.307	3
57	N57	.12	1	.36	3
58	N58	.109	1	.328	3
59	N59	.12	1	.361	3
60	N60	.135	1	.404	3
61	N61	.12	1	.361	3
62	N62	.14	1	.421	3
63	N63	.134	1	.403	3
64	N64	.125	1	.374	3
65	N65	.14	1	.421	3
66	N66	.109	1	.328	3
67	N67	.12	1	.361	3
68	N68	.135	1	.404	3
69	N69	.109	1	.326	3
70	N70	.12	1	.359	3
71	N71	.102	1	.307	3
72	N72	.105	1	.315	3
73	N73	.102	1	.307	3
74	N74	.095	1	.286	3
75	N75	.14	1	.421	3
76	N76	.103	1	.31	3
77	N77	.103	1	.309	3
78	N78	.097	16	.29	3
79	N79	.1	16	.3	3
80	N80	.103	1	.309	3
81	N81	.105	1	.316	3
82	N82	.1	16	.3	3
83	N83	.097	16	.29	3
84	N84	.095	1	.286	3
85	N85	.095	1	.286	3

Slab Overturning Safety Factors

	LC	Slab	Angle[deg]	Mo-xx[k-ft]	Ms-xx[k-ft]	Mo-zz[k-ft]	Ms-zz[k-ft]	Ms-xx/Mo-xx	Ms-zz/Mo-zz
1	1	S1	0	0	305.158	0	304.668	9.999+	9.999+
2	3	S1	0	0	102.608	0	102.272	9.999+	9.999+
3	4	S1	0	0	305.158	0	304.668	9.999+	9.999+
4	5	S1	0	0	102.608	0	102.272	9.999+	9.999+
5	6	S1	0	0	120.961	0	120.41	9.999+	9.999+
6	7	S1	0	0	102.608	0	102.272	9.999+	9.999+
7	8	S1	0	0	254.52	0	254.069	9.999+	9.999+
8	9	S1	0	0	268.285	0	267.673	9.999+	9.999+
9	10	S1	0	0	254.52	0	254.069	9.999+	9.999+

Slab Overturning Safety Factors (Continued)

	LC	Slab	Angle[deg]	Mo-xx[k-ft]	Ms-xx[k-ft]	Mo-zz[k-ft]	Ms-zz[k-ft]	Ms-xx/Mo-xx	Ms-zz/Mo-zz
10	11	S1	0	13.765	102.608	24.466	102.272	7.454	4.18
11	12	S1	0	30.665	101.936	13.604	102.272	3.324	7.518
12	13	S1	0	10.324	254.52	18.35	254.069	9.999+	9.999+
13	14	S1	0	22.999	253.618	10.203	254.069	9.999+	9.999+
14	15	S1	0	10.324	268.285	18.35	267.673	9.999+	9.999+
15	16	S1	0	22.999	267.061	10.203	267.673	9.999+	9.999+
16	17	S1	0	10.324	254.52	18.35	254.069	9.999+	9.999+
17	18	S1	0	22.999	253.618	10.203	254.069	9.999+	9.999+
18	19	S1	0	13.765	61.565	24.466	61.363	4.473	2.508
19	20	S1	0	30.665	61.161	13.604	61.363	1.995	4.511

Slab Sliding Safety Factors

	LC	Slab	Angle[deg]	Va-xx[k]	Vr-xx[k]	Va-zz[k]	Vr-zz[k]	SR-xx	SR-zz
1	1	S1	0	0	15.233	0	15.233	9.999+	9.999+
2	3	S1	0	0	5.114	0	5.114	9.999+	9.999+
3	4	S1	0	0	15.233	0	15.233	9.999+	9.999+
4	5	S1	0	0	5.114	0	5.114	9.999+	9.999+
5	6	S1	0	0	6.021	0	6.021	9.999+	9.999+
6	7	S1	0	0	5.114	0	5.114	9.999+	9.999+
7	8	S1	0	0	12.703	0	12.703	9.999+	9.999+
8	9	S1	0	0	13.384	0	13.384	9.999+	9.999+
9	10	S1	0	0	12.703	0	12.703	9.999+	9.999+
10	11	S1	0	1.198	5.114	0	5.794	4.267	9.999+
11	12	S1	0	0	5.794	1.155	5.114	9.999+	4.429
12	13	S1	0	.899	12.703	0	13.214	9.999+	9.999+
13	14	S1	0	0	13.214	.866	12.703	9.999+	9.999+
14	15	S1	0	.899	13.384	0	13.894	9.999+	9.999+
15	16	S1	0	0	13.894	.866	13.384	9.999+	9.999+
16	17	S1	0	.899	12.703	0	13.214	9.999+	9.999+
17	18	S1	0	0	13.214	.866	12.703	9.999+	9.999+
18	19	S1	0	1.198	3.068	0	3.748	2.56	9.999+
19	20	S1	0	0	3.748	1.155	3.068	9.999+	2.657

Envelope Soil Pressures

	Label	Max UC	Max LC	Soil Pressure[ksf]	Allowable Bearing[ksf]
1	N8	.093	15	.278	3
2	N5	.097	16	.291	3
3	N6	.097	16	.291	3
4	N7	.09	9	.27	3
5	R3D_N1	.096	1	.288	3
6	R3D_N2_2	.096	1	.288	3
7	R3D_N3_2	.099	16	.298	3
8	R3D_N4_2	.099	16	.298	3
9	N9	.121	1	.363	3
10	N10	.117	1	.351	3
11	N11	.125	1	.374	3
12	N12	.121	1	.363	3
13	N13	.121	1	.364	3
14	N14	.121	1	.363	3
15	N15	.125	1	.374	3
16	N16	.117	1	.35	3

Envelope Soil Pressures (Continued)

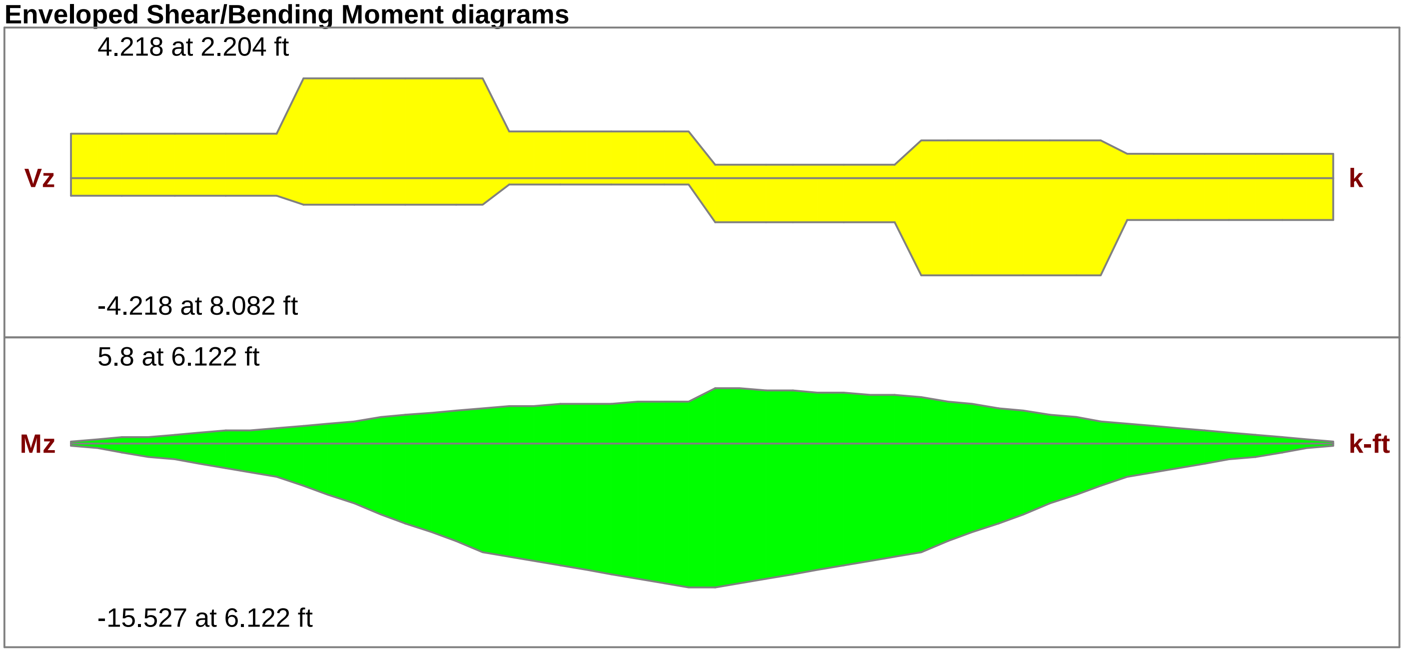
	Label	Max UC	Max LC	Soil Pressure[ksf]	Allowable Bearing[ksf]
17	N17	.121	1	.362	3
18	N18	.117	1	.35	3
19	N19	.124	1	.373	3
20	N20	.121	1	.362	3
21	N21	.121	1	.362	3
22	N22	.121	1	.362	3
23	N23	.124	1	.373	3
24	N24	.116	1	.349	3
25	N25	.12	1	.361	3
26	N26	.116	1	.349	3
27	N27	.124	1	.373	3
28	N28	.121	1	.362	3
29	N29	.121	1	.362	3
30	N30	.121	1	.362	3
31	N31	.124	1	.373	3
32	N32	.117	1	.35	3
33	N33	.121	1	.362	3
34	N34	.117	1	.35	3
35	N35	.125	1	.374	3
36	N36	.121	1	.363	3
37	N37	.121	1	.364	3
38	N38	.121	1	.363	3
39	N39	.125	1	.374	3
40	N40	.117	1	.351	3
41	N41	.146	1	.439	3
42	N42	.124	1	.373	3
43	N43	.12	1	.359	3
44	N44	.134	1	.403	3
45	N45	.14	1	.42	3
46	N46	.109	1	.326	3
47	N47	.095	1	.286	3
48	N48	.102	1	.307	3
49	N49	.12	1	.36	3
50	N50	.125	1	.374	3
51	N51	.106	1	.317	3
52	N52	.103	1	.31	3
53	N53	.12	1	.361	3
54	N54	.125	1	.374	3
55	N55	.105	1	.316	3
56	N56	.102	1	.307	3
57	N57	.12	1	.36	3
58	N58	.109	1	.328	3
59	N59	.12	1	.361	3
60	N60	.135	1	.404	3
61	N61	.12	1	.361	3
62	N62	.14	1	.421	3
63	N63	.134	1	.403	3
64	N64	.125	1	.374	3
65	N65	.14	1	.421	3
66	N66	.109	1	.328	3
67	N67	.12	1	.361	3
68	N68	.135	1	.404	3

Envelope Soil Pressures (Continued)

	Label	Max UC	Max LC	Soil Pressure[ksf]	Allowable Bearing[ksf]
69	N69	.109	1	.326	3
70	N70	.12	1	.359	3
71	N71	.102	1	.307	3
72	N72	.105	1	.315	3
73	N73	.102	1	.307	3
74	N74	.095	1	.286	3
75	N75	.14	1	.421	3
76	N76	.103	1	.31	3
77	N77	.103	1	.309	3
78	N78	.097	16	.29	3
79	N79	.1	16	.3	3
80	N80	.103	1	.309	3
81	N81	.105	1	.316	3
82	N82	.1	16	.3	3
83	N83	.097	16	.29	3
84	N84	.095	1	.286	3
85	N85	.095	1	.286	3

Strip:	DS2	Max Top bar Spac.:	12 in	Stress Block:	Rectangular
Material:	Conc4000NW	Min Top bar Spac.:	3 in	Rebar Orientation:	90
Strip Width:	144 in	Max Bot bar Spac.:	12 in	Rebar Spacing Inc:	1 in
Total Cuts:	50	Min Bot bar Spac.:	3 in	Design Rule:	Typical

Enveloped Shear/Bending Moment diagrams



ACI 318-14 Code Check

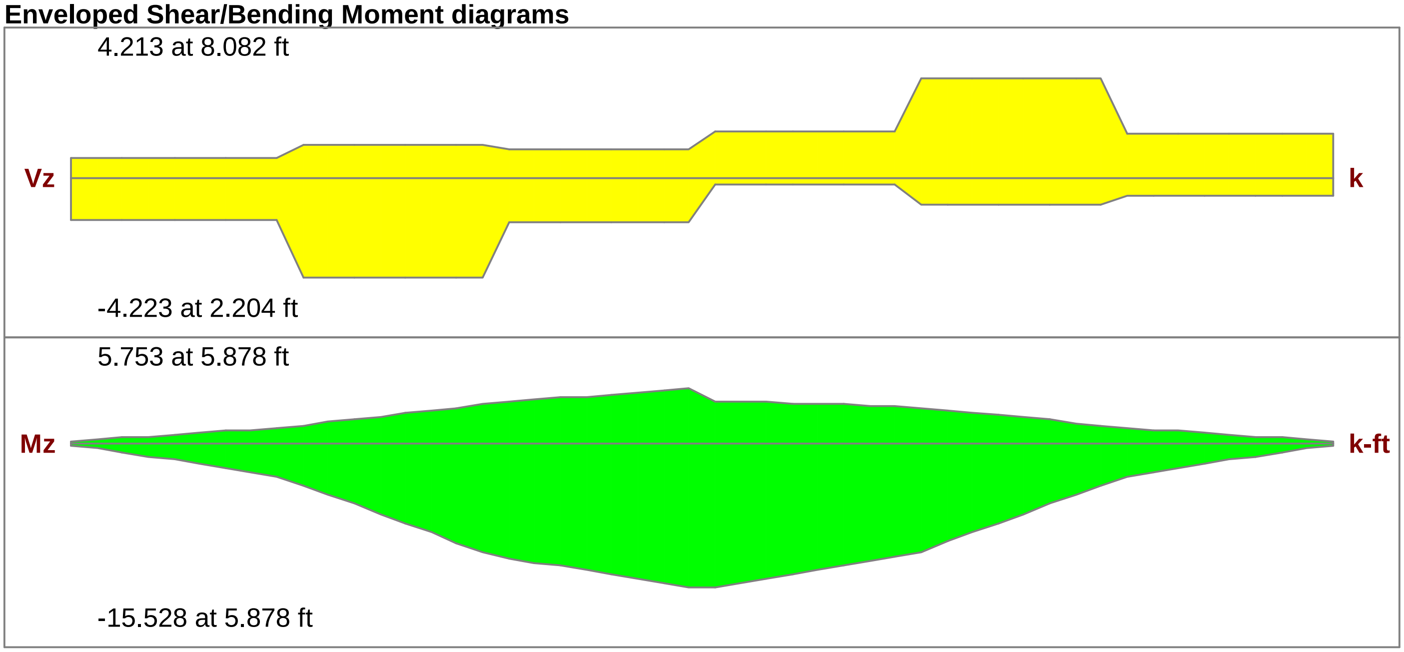
Top Bending Check	0.083	Bot Bending Check	0.222	1 Way Shear Check	0.049
Gov Mu Top	5.8 k-ft	Gov Mu Bot	-15.527 k-ft	Gov Vu	4.218 k
phi*Mn Top	69.994 k-ft	phi*Mn Bot	69.994 k-ft	phi*Vn	85.381 k
Governing Cut	DS2-X26	Governing Cut	DS2-X26	Governing Cut	DS2-X17
Governing LC	29	Governing LC	2	Governing LC	2
Tension Bar Fy	60 ksi	Concrete Weight	.145 k/ft^3	Top Cover	1.5 in
Shear Bar Fy	60 ksi	λ	1	Bottom Cover	1.5 in
F'c	4 ksi	E_Concrete	3644 ksi		
Flex. Rebar Set	ASTM A615	Rho Bot Prvd	0.00284	Rho Top Prvd	0.00284
		Prvd Bot Bar Spac.	#4@12in	Prvd Top Bar Spac.	#4@12in

Bending Steel Reqd/Prvd, Units: in^2)

Cut Label	Top As Reqd	Top As Prvd	Bot As Reqd	Bot As Prvd	Rho Reqd(T/S)	Rho Reqd(Flex)	Rho Prvd(Gross)
DS2-X26	.207	2.553	.555	2.553	0.00180	0.00180	0.00443

Strip:	**DS1**	Max Top bar Spac.:	**12 in**	Stress Block:	**Rectangular**
Material:	**Conc4000NW**	Min Top bar Spac.:	**3 in**	Rebar Orientation:	**0**
Strip Width:	**144 in**	Max Bot bar Spac.:	**12 in**	Rebar Spacing Inc:	**1 in**
Total Cuts:	**50**	Min Bot bar Spac.:	**3 in**	Design Rule:	**Typical**

Enveloped Shear/Bending Moment diagrams



ACI 318-14 Code Check

Top Bending Check	**0.082**	Bot Bending Check	**0.222**	1 Way Shear Check	**0.049**
Gov Mu Top	**5.753 k-ft**	Gov Mu Bot	**-15.528 k-ft**	Gov Vu	**4.223 k**
phi*Mn Top	**69.994 k-ft**	phi*Mn Bot	**69.994 k-ft**	phi*Vn	**85.381 k**
Governing Cut	**DS1-X25**	Governing Cut	**DS1-X25**	Governing Cut	**DS1-X17**
Governing LC	**30**	Governing LC	**2**	Governing LC	**2**
Tension Bar Fy	**60 ksi**	Concrete Weight	**.145 k/ft^3**	Top Cover	**1.5 in**
Shear Bar Fy	**60 ksi**	λ	**1**	Bottom Cover	**1.5 in**
F'c	**4 ksi**	E_Concrete	**3644 ksi**		
Flex. Rebar Set	**ASTM A615**	Rho Bot Prvd	**0.00284**	Rho Top Prvd	**0.00284**
		Prvd Bot Bar Spac.	**#4@12in**	Prvd Top Bar Spac.	**#4@12in**

Bending Steel Reqd/Prvd, Units: in^2)

Cut Label	Top As Reqd	Top As Prvd	Bot As Reqd	Bot As Prvd	Rho Reqd(T/S)	Rho Reqd(Flex)	Rho Prvd(Gross)
DS1-X25	**.205**	**2.553**	**.555**	**2.553**	**0.00180**	**0.00180**	**0.00443**

APPENDIX D
GEOTECHNICAL SUBSURFACE INVESTIGATION MEMO

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TETRA TECH

MEMO

To:	Harish Mital, PE
Cc:	Andrew Coats, PE
From:	Ralph Boedeker, PE (DE, PA, MD, VA, WV, OH)
Date:	April 23, 2019
Subject:	GM-38 Geotechnical Subsurface Investigation

This report presents results of a geotechnical subsurface investigation regarding a new chemical tank at the Bethpage GM-38 groundwater treatment plant, Bethpage, New York. Purposes of this study were to investigate subsurface conditions within the project site, formulate foundation design criteria for the proposed site development, and offer pertinent geotechnical site recommendations for construction.

This geotechnical study evaluated subsurface conditions within the project site, and the report offers recommendations based on an exploration of subsurface soil conditions by means of Standard Penetration Test (SPT) Borings (ASTM International [ASTM] D1586). The scope of this investigation included a test boring program, laboratory testing of representative soil samples, engineering analyses of the available data, and preparation of this engineering report.

Proposed exterior development includes furnishing a new chemical tank, a cover structure for the tank, and a truck access utility apron; all to be located on the north side of the treatment plant. The exterior of the treatment plant is currently developed with gravel with minor grades. The tank is to be approximately 15 feet high and is to be supported on a 12 x 12-foot mat foundation, turned-down on its perimeter for frost protection. Estimated structural loads provided by the project structural engineer are as follows:

- Maximum Tank Load on Mat Foundation: 1,200 pounds per square foot (psf)
- Maximum Canopy Column Load: 5 kips.

If actual design values vary appreciably from the above values, the project geotechnical engineer should be notified to determine if additional analyses are warranted.

GEOTECHNICAL SUBSURFACE INVESTIGATION PROGRAM

Three SPT borings were advanced at the site from April 9 to 10, 2019, to collect representative soil samples and identify conditions of subsurface soil and groundwater. Approximate locations of the borings are conveyed in Attachment A. Boring SB-01 was advanced within the proposed tank area, and boring SB-02 was advanced farther away to check on stratigraphy variations. Borings SB-01 and SB-02 were advanced to 30 feet below ground surface (bgs). Boring SB-03 was advanced within a proposed truck access apron area to 10 feet bgs.

Advancements of borings proceeded by use of truck-mounted drilling rig. SPT split-spoon samples (ASTM D1586) were collected from each boring at approximate 2-foot intervals to 10 feet bgs, and thereafter at 5-foot intervals. A hand auger was used within the top 4 feet to clear potential underground utilities. In the SPT procedure, a 2 inch-

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outside diameter (O.D.) split-barrel sampler is driven into the soil a distance of 18 or 24 inches by a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler from the 6- to 18-inch interval is termed the Standard Penetration Resistance (SPR) N value. This value can be used as a qualitative indication of the in-place relative density of cohesionless (e.g., granular) soils. It is also a secondary indicator of consistency of cohesive soils. Gravel, cobbles, and boulders may induce high blow counts not representative of the soil's relative density/consistency. This indication is qualitative because many factors can significantly affect the SPR value (i.e., drilling crew procedures, drill rigs, and hammer-rod assemblies, etc.).

Performances of the test borings were reviewed by a Tetra Tech, Inc. (Tetra Tech) geotechnical technician. Test boring logs (Attachment B) include soil and groundwater data obtained from the explorations. After completion of the borings, they were backfilled with the auger soil cuttings. Test boring surface elevations were estimated based on existing topographic survey data.

All soil samples collected during this investigation were inspected and described visually in Tetra Tech's geotechnical laboratory. Twenty-three Water Content Tests (ASTM: D2216) and Percent Finer than a No. 200 Sieve Tests (ASTM: D1140) were performed to assist in determining the general site stratigraphy, and to measure the amount of silt and clay particulate in the soil samples. Three Atterberg Limit Tests (ASTM D4318) were conducted to aid in classification of encountered soils at the boring locations. Results of the grain-size analysis and Atterberg Limits testing were referenced to determine the Unified Soil Classification System (USCS) designation for the soils encountered, which provides information regarding soil engineering behavior. A summary of laboratory testing results appears in Appendix C. The soil samples collected during this investigation will be retained for a period of 2 months, after which they will be discarded unless further instructions are received regarding their disposition.

SUBSURFACE CONDITIONS

Subsurface conditions encountered at boring locations are described in detail in the test boring logs (Appendix B). Subsurface conditions between boring locations were interpolated and may not reflect actual conditions.

- *Surficial Gravel* – An approximate 12-inch layer of surficial gravel was encountered at each of the boring locations. A geotextile filter fabric was encountered directly below the gravel at SB-01 and SB-03. Thicker and/or thinner layers of gravel may be encountered away from boring locations.

- *Stratum A – Historical Fill and Potential Remnant Topsoil:* Historical fill materials (previously placed fill) were encountered at boring locations SB-01 and SB-02 to 4 feet bgs. The fill material generally consisted of either a fine to coarse sand with trace fine gravel (USCS: SW, visual) or a fine to coarse sand with a little to some silt and trace fine to coarse gravel (USCS: SM, visual). A layer of dark brown to black organic silt (USCS: OL) was encountered at SB-01 from 3 to 4 feet bgs. This layer of organic silt may be a remnant topsoil layer that had been left in place prior to placement of the overlying fill material.

- *Stratum B – Coarse-Grained Soils*: Predominant subsurface conditions within the investigation area can generally be described as variable brown, fine to coarse sand with a trace fine to coarse gravel and with varying amounts of silt (USCS: SM, SW, SP, and SP-SM, visual). Thin lenses of silt or clay were observed within the granular soils. Each of the borings terminated within this stratum. SPR values ranged from 7 to 23 blows, with an average SPR value of 17, indicating a medium dense relative density. Laboratory and field SPR data indicated that the soils of Stratum B have relatively high shear strength and low compressibility characteristics.

Apparent groundwater was encountered within borings SB-01 and SB-02 (deeper borings) at depths from 18.5 to 19.0 feet bgs, corresponding to an elevation of approximately 67 to 68, project datum. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and seasonal and annual variations of precipitation. Groundwater fluctuations of several feet should be anticipated.

GEOTECHNICAL EVALUATION AND DESIGN/CONSTRUCTION RECOMMENDATIONS

Chemical Tank Mat Foundation

Site preparation activities will be required prior to construction of the chemical tank mat foundation because of presence of the Stratum A historically placed fill soils. The Stratum A fill soils (including the organic soils) are considered unsuitable for direct support of the mat foundation because excessive and detrimental differential settlement of the mat foundation could result. Therefore, recommendation is to remove all Stratum A fill soils from the mat foundation area; removal of these materials should extend a minimum of 5 feet beyond the footprint of the foundation. Also recommended is to remove Stratum A fill material under pavement areas, unless the Owner is willing to assume some risk of differential settlement of pavements and curbs, and potential associated long-term maintenance/rehabilitation costs. Following removal of the Stratum A fill material and proper subgrade preparation, engineered fill (described later in this Memo) may be used to bring these areas to design subgrade elevations.

The chemical tank will be supported on a 12 x 12-foot mat foundation with a maximum load of 1,200 psf. After completion of all site preparation work as recommended above (removal of Stratum A fill soils), the mat foundation should be placed on or within properly placed engineered fill material (used to bring the site to design subgrade elevations) and/or the undisturbed soils of Stratum B. Based on results of field and laboratory testing of soils encountered during this evaluation, as well as foundation and foundation loading information provided by the structural engineer, and to limit settlement, an engineering analysis indicates that the mat foundation may be designed for a maximum net allowable soil bearing pressure of 3,000 psf. The allowable soil bearing pressure may be increased 33% for temporary short-term wind or seismic live loads.

The actual maximum foundation load of 1,200 psf is much less than the allowable bearing capacity of the mat subgrade soils. Assuming an actual net soil bearing load of 1,200 psf, total and differential foundation settlement of the underlying soils is estimated to be less than 0.25 inch. An estimated 90% of dead-load induced settlement is expected to occur quickly (elastic settlement) and is expected to be "built out" during construction and initial placement of the chemical tank and its liquid service loading.

That tank mat foundation should be designed as a turn-down mat around its perimeter to protect against frost. The turn-down should extend a minimum 48 inches below exterior grades. To provide a uniform bearing surface with all-weather support, placement of a minimum 6-inch compacted layer of American Association of State Highway and Transportation (AASHTO) No. 57 Stone below the mat foundation is recommended. For a mat foundation installed as recommended herein, a modulus of subgrade reaction (Ks) of 150 pounds per cubic inch (pci) is estimated for use in concrete slab-on-grade design.

Canopy Shallow Foundation System

The shallow foundations for the canopy columns can be supported on either a conventional spread footing or drilled pier. The foundation should extend through the fill soils of Stratum A, and be placed directly on or within the granular soils of Stratum B. The spread footing or drilled pier should have a minimum width or diameter of 30 inches. Based on results of field and laboratory testing of soils encountered during this evaluation, as well as foundation and foundation loading information provided by the structural engineer, an engineering analysis indicates that the shallow canopy foundations may be designed for a maximum net allowable soil bearing pressure of 4,000 psf. The allowable soil bearing pressure may be increased 33% for temporary short-term wind or seismic live loads.

Based on the shallow foundation dimensions and loading, estimated net soil bearing load for the shallow foundation will be less than 1,200 psf. Assuming an actual net soil bearing load of 1,200 psf, total and differential foundation settlement of the underlying soils is estimated to be negligible. An estimated 90% of dead-load induced settlement is expected to occur quickly (elastic settlement) and is expected to be "built out" during construction and final loading of the foundation.

The base of the canopy foundation should extend a minimum 48 inches below exterior grades to protect against frost.

Truck Access Utility Pad

Prior to earthwork and construction of the truck access utility pad, the area should be proof-rolled with a minimum 15-ton vibratory smooth-wheeled roller in the presence of a qualified soils technician to expose potential localized soft and yielding areas. The exposed surfaces should be compacted to a visually firm and stable condition. Subgrade compaction will facilitate placement and compacting of engineered fill at the required densities. Proof-rolling should also occur at final "cut" or "at grade" areas to ensure a firm and stable subgrade. Special care should be taken (e.g., application of test pits) to confirm that no organic soils are present in the subsurface (see Chemical Tank Mat Foundation discussion). Although no historically placed fill material was encountered at boring location SB-03 (including organic soils), organic soils may be present at other areas of the truck pad.

Any localized soft and unstable areas encountered during the proof-rolling program that cannot be adequately stabilized and compacted should be undercut and replaced with engineered fill. If organic soils are encountered in the subsurface, these soils should be removed and replaced with engineered fill.

Because ponding water may destabilize soil during construction, soil subgrade disturbance should be minimized by providing positive surface drainage and limiting construction traffic on exposed subgrade soils.

Seismic Design

Based on subsurface conditions encountered during the test boring program and review of regional geologic maps, Tetra Tech recommends utilization of a site Class D for seismic design purposes. The site class definition is in Section 1613 of the International Building Code.

Engineered Fill

Engineered fill required to bring areas to grade should be free of organic material, topsoil, debris, and gravel greater than 3 inches in their largest dimension. Engineered fill should meet the USCS classifications of SW, SM, SC, or GW, with no more than 35% passing a No. 200 sieve (ASTM D1140), and a plasticity index (ASTM D4318) not exceeding 6. Engineered fill material should be placed in horizontal thin lifts with compacted thickness no greater than 8 inches. Engineered fill lifts for hand tampers should not exceed 4 inches. Each thin lift of fill/backfill material placed below structural elements (i.e., foundations) and pavements should be compacted according to the following criteria:

- Within proposed structural foundation areas, compaction should be to at least 95% of maximum dry density, as determined by the Modified Proctor Test (ASTM D1557).
- Within proposed pavement areas, compaction should be to at least 90% of maximum dry density, as determined by the Modified Proctor Test (ASTM D1557).

Moisture content of placed engineered fill should facilitate compaction (typically at +/ - 2 to 3% of optimum moisture, per ASTM D1557). Placement and compaction of engineered fill should be monitored and tested on a full-time basis by a qualified geotechnical technician.

AASHTO No. 57 Stone could also be used as engineered fill for foundation excavations or undercuts—placed in maximum 12-inch lifts and compacted by use of a hand-operated vibratory plate compactor. Proper strength flowable fill can also be utilized as engineered fill.

Foundation Construction

All foundations should be placed on dry, non-frozen, firm soil. When excessively soft, wet, or frozen soil is encountered at the foundation base, this material should be undercut to suitable bearing materials. The undercut zone may be replaced in accordance with engineered fill recommendations. AASHTO No. 57 Stone could also be used as backfill within foundation undercut zones—placed in maximum 12-inch lifts and compacted by use of a hand-operated vibratory plate compactor.

During excavation of foundations, disturbance of the subgrade soils may occur; therefore, compaction of the foundation subgrades should occur prior to placement of any reinforcing steel or concrete. All foundation excavations should be reviewed to verify the quality of the bearing material—by a qualified geotechnical technician working under the supervision of a geotechnical engineer familiar with the recommendations of this report. Subgrade review should occur prior to placement of reinforcing steel or concrete and should verify presence of suitable bearing soils.

All foundation excavations should be protected from ponding water and freezing conditions, and backfilled as soon as practical after placement of the foundation concrete. Backfilling should accord with recommendations regarding engineered fill.

Site Work Quality Control and Assurance

All site proof-rolling, fill placement and foundation excavation/construction should be monitored by a qualified geotechnical technician working under the supervision of a geotechnical engineer. The technician should observe and document site preparation, foundation subgrades, engineered fill construction, and foundation construction—and should conduct appropriate field tests, as necessary, to verify that construction proceeds in accordance with applicable plans, specifications, and acceptable construction practice. Conclusions and recommendations in this memo are based on the premise of competent field engineering and monitoring during construction.

REPRESENTATIONS

This memo was prepared in accordance with generally accepted engineering principles and practices, and is based on soil and groundwater conditions encountered during the field exploration. No warranty, expressed or implied, is made. Although generalized subsurface conditions have been inferred through interpolation and/or extrapolation of acquired field and laboratory data, actual subsurface conditions between soil boring locations are unknown. As a result, recommendations in this memo may require modifications based on subsurface conditions actually encountered during construction. Tetra Tech should be notified if conditions encountered during construction differ from those indicated by test borings, thus possibly requiring re-evaluation of recommendations offered in this report. This report applies solely to size, type, and location of the structures described herein. If changes are proposed, this report will not be considered valid unless and until Tetra Tech has reviewed the changes and accordingly altered and re-approved recommendations of this report.

Construction bidders should thoroughly familiarize themselves with the on-site subsurface soil and groundwater conditions described herein. Recommendation is to provide bidding contractors with this report so they can develop their own interpretations of the available data. Tetra Tech or the Owner assumes no responsibility for interpretation or deductions by the awarded contractor based on information in this report. Variations in subsurface conditions are expected.

ATTACHMENTS

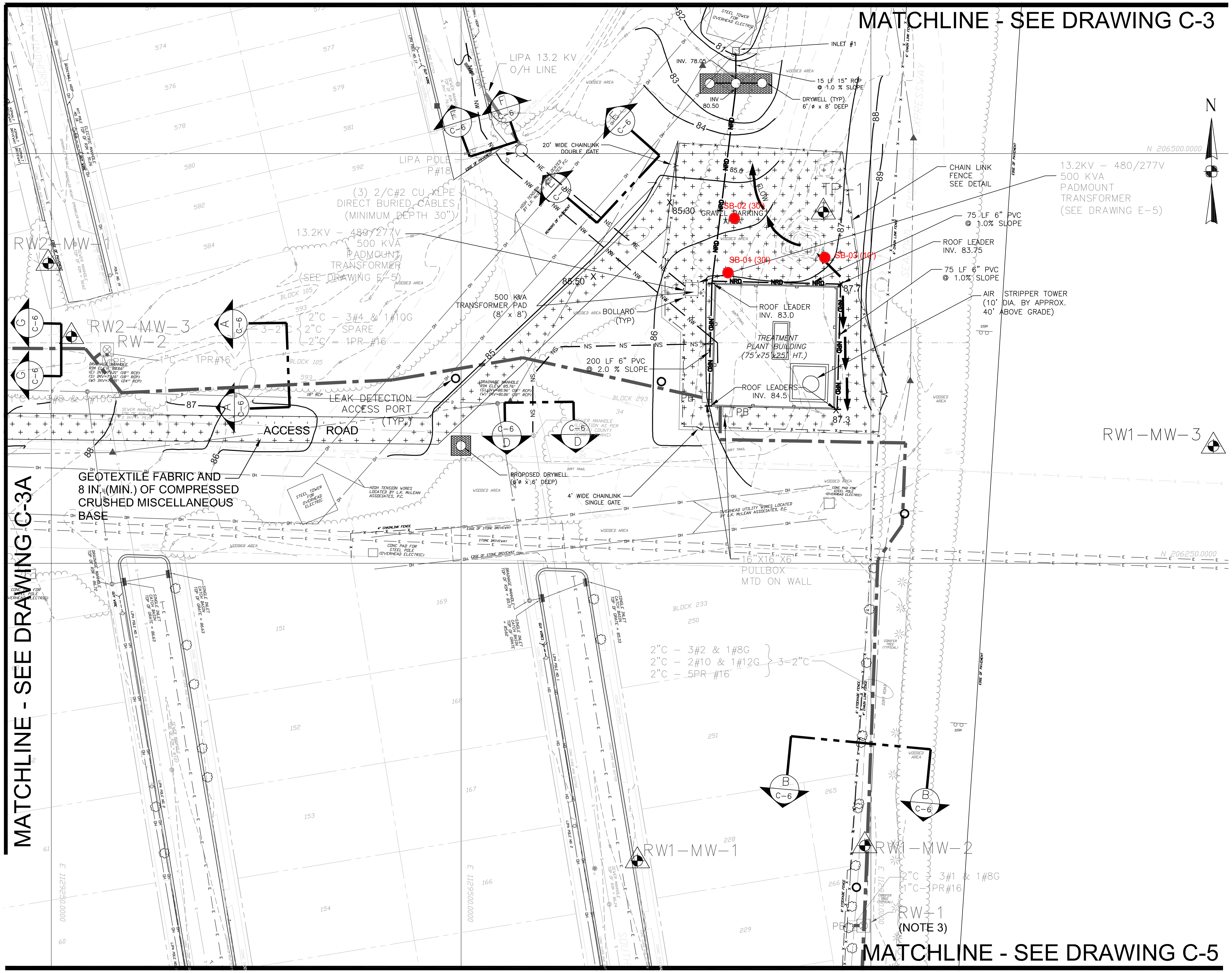
Attachment A: Test Boring Locations

Attachment B: Test Boring Logs

Attachment C: Laboratory Testing Summary

ATTACHMENT A

Test Boring Locations



NOTES:

1. SEE NOTES ON DRAWING C-2.
2. FOR CONCRETE PULL BOX SEE DETAIL 1 ON DRAWING E-4.
3. FOR RECOVERY WELL CONSTRUCTION DETAILS, SEE DETAIL 1 ON DRAWING C-10.
4. FOR LEAK DETECTION ACCESS PORT DETAILS, SEE DETAIL 5 ON DRAWING C-10.
5. MINIMUM 15 FEET OF SEPARATION MUST BE MAINTAINED BETWEEN ELECTRICAL/TELEPHONE TRENCH AND THE POTABLE WATER TRENCH.
6. ACTUAL SURVEYED EXISTING AND AS-BUILT CONDITIONS, INCLUDING LOCATION OF TREATMENT BUILDING, RECOVERY WELLS, AND MONITORING WELLS, ARE SHOWN ON AS-BUILT SURVEY OF "GM-38 GROUNDWATER TREATMENT SYSTEM" REVISION APRIL 23, 2010 BY L. K. MCLEAN ASSOCIATES, P.C. (SHEETS 4 OF 4).

REFERENCE:

L. K. McLEAN ASSOCIATES, P.C.
437 SO. COUNTRY ROAD, BROOKHAVEN, NY
TOPOGRAPHIC SURVEY, NAVAL WEAPONS INDUSTRIAL RESERVE PLANT, GM-38 AREA, FILE # 04033.000
FEB AND MAR 2009.

LEGEND:

- = EXISTING GRADE-MAJOR CONTOUR
- = EXISTING GRADE-MINOR CONTOUR
- = PROPOSED GRADE
- = TAX LOT LINE
- OH = OVERHEAD ELECTRIC WIRES
- E = UNDERGROUND ELECTRIC WIRES
- W = WATER MAIN
- G = GAS MAIN
- D = DRAINAGE LINES (STORM SEWER)
- S = SANITARY SEWER MAIN
- = WOODED AREA
- X = CHAIN-LINK OR BOARD FENCE
- = DIRT TRAIL
- NE = NEW UNDERGROUND ELECTRIC WIRES
- NW = NEW WATER LINE
- NS = NEW SANITARY SEWER MAIN
- NRD = NEW ROOF DRAINAGE LINE
- = HDPE PIPE AND ELECTRICAL CONDUIT
- 242 = TAX LOT NUMBER
- = WATER VALVE
- GV = GAS VALVE
- RW1-MW-1 = MONITORING WELL
- RW-1 = RECOVERY WELL
- IW-1 = INJECTION WELL
- PB = PULL BOX
- = LEAK DETECTION ACCESS PORT
- = EXISTING DECIDUOUS TREE
- = EXISTING CONIFEROUS TREE
- = WHITE PINE TREE LOCATION
- = SIGN
- = MANHOLE
- = GRAVEL ACCESS ROAD AND PARKING LOT
- 6916 = PUBLIC WATER SUPPLY WELL

GRAPHIC SCALE

30 0 15 30 60 120

SCALE: 1 INCH = 30 FEET

REV	DESCRIPTION	PREP BY	DATE	APPRVD
0	FINAL DESIGN	DL	05/05/06	CYC
1	ADD RW-3, RELOCATE PERMANENT ACCESS ROAD, REVISE GRADING TO ACCESS ROAD AND PROPOSED TRMT BLDG	DLB	03/31/08	CYC
2	REVISE PIPE ROUTE FROM BUILDING TO RW-2 AND RW-3. REVISE ROOF DRAINAGE PIPING AND LIMITS OF CLEARING. OF CLEARING. TEXT EDITS.	DLB	04/23/08	CYC
3	FINAL RECORD DRAWING	DLB	04/27/10	SGP

TETRA TECH ENGINEERING CORPORATION PC

DSGN: DR: CHK:
SUPV: CH ENG:
SUBMITTED BY: (FIRM MEMBER) (TITLE) (DATE)
NORTHDIV DM: HD: FPE: HD: DIR:
OFFICER IN CHARGE
APPROVED DATE

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
NAVAL FACILITIES ENGINEERING COMMAND, MID-ATLANTIC
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT BETHPAGE, NEW YORK

GM-38 AREA
GROUNDWATER TREATMENT PLANT
PIPING AND UTILITY ROUTE DETAIL (SHEET 3 OF 4)

APPROVED DATE FOR COMMANDER, NAVFAC MID-ATLANTIC

SEAL AREA

THIS DRAWING PRODUCED ON AUTOCAD DO NOT REVISE MANUALLY

SAT TO DATE
CODE I.D. NO. 80091
SCALE : AS SHOWN
SPEC. NO.
CONSTRN. CONTR. NO. N62472-99-D-0032
NAVFAC DRAWING NO.
SHEET OF
SIZE: D DIS. SH. NO. C-4

ATTACHMENT B

Test Boring Logs

FIELD DESCRIPTION AND LOGGING SYSTEM FOR SOIL EXPLORATION

GRANULAR SOILS
(Sand, Gravel & Combinations)

Density	***N (blows)****
Very Loose	5 or less
Loose	6 to 10
Medium Dense	11 to 30
Dense	31to 50
Very Dense	51 or more

Relative Proportions

Description Term	*Percent*
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

Particle Size Identification

Boulders	8 in. diameter or more	
Cobbles	3 to 8 in. diameter	
Gravel	Coarse (C)	3 in. to ¾ in. sieve
	Fine (F)	¾ in. to No. 4 sieve
Sand	Coarse (C)	No. 4 to No. 10 sieve (4.75mm-2.00mm)
	Medium (M)	No. 10 to No. 40 sieve (2.00mm – 0.425mm)
	Fine (F)	No. 40 to No. 200 sieve (0.425 – 0.074mm)
Silt/Clay	Less Than a No. 200 sieve (<0.074mm)	

COHESIVE SOILS
(Silt, Clay & Combinations)

Consistency	***N (blows)****
Very Soft	3 or less
Soft	4 to 5
Medium Stiff	6 to 10
Stiff	11 to 15
Very Stiff	16 to 30
Hard	31 or more

Plasticity

Degree of Plasticity	*Plasticity Index*
None to Slight	0 - 4
Slight	5 - 7
Medium	8- 22
High to Very High	> 22

ROCK
(Rock Cores)

Rock Quality Designation (RQD), %	***Rock Quality Description***
0-25	Very Poor
25-50	Poor
50-75	Fair
75-90	Good
90-100	Excellent

RQD: Rock Quality Designation
TCR: Total Core Recovery
SCR: Solid Core Recovery

****N - Standard Penetration Resistance.*** Driving a 2.0" O.D., 1-3/8" I.D. sampler a distance of 18 inches into undisturbed soil with a 140 pound hammer free falling a distance of 30.0 inches. The number of hammer blows to drive the sampler through each 6 inch interval is recorded; the number of blows required to drive the sampler through the final 12 inch interval is termed the Standard Penetration Resistance (SPR) N-value. For example, blow counts of 6/8/9 (through three 6-inch intervals) results in an SPR N-value of 17 (8+9).

Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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TEST BORING LOG

Project Name: NWIRP BETHPAGE GM-38		Project No.:	112G08005-WE24
Project Location: BETHPAGE, NEW YORK		Page 1 of 1	
Boring No.: SB-01	Dates(s) Drilled: 04-09-19	Inspector:	V. SHICKORA
Surface Elev: ~ 87.0	Drilling Method: SPT - ASTM D1586	Driller:	J. Gucci
Drilling Contractor: DELTA WELL + PUMP	Groundwater Depth (ft): 19.0	Total Depth (ft):	30.0

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	1.0			GRAY GRAVEL FILL MATERIAL. FILTER FABRIC BELOW GRAVEL.					
1	1.0	2.0	1.0			A (SW)	BROWN FINE TO COARSE, TRACE FINE GRAVEL.	-	-	-	-	-
				3.0			(FILL)					
2	3.0	4.0	3.0			A (OL)	DARK BROWN TO BLACK SILT (APPEARS ORGANIC) AND FINE SAND,	-	-	-	-	-
				4.0			TRACE WOODY MATTER.					
3	4.0	6.0	4.0		12	B (SP-SM)	BROWN FINE TO MEDIUM SAND, TRACE SILT, TRACE FINE GRAVEL.	2	7	9	13	**16**
4	6.0	8.0			13	B (SP)	YELLOW BROWN FINE TO MEDIUM SAND, TRACE FINE GRAVEL.	4	8	11	12	**19**
5	8.0	10.0			15	B (SW)	YELLOW BROWN FINE TO COARSE SAND WITH A LITTLE FINE	7	11	16	19	**27**
							GRAVEL.					
6	13.0	15.0			16		YELLOW BROWN FINE TO COARSE SAND, TRACE FINE GRAVEL.	7	7	8	10	**15**
7	18.0	20.0			16	B (SP)	BROWN FINE SAND, MICACEOUS, WET.	8	6	9	10	**15**
8	23.0	25.0			15	B (SM)	BROWN FINE SAND,MICACEOUS, WITH SOME SILT.	6	10	10	8	**20**
							(USCS: SM).					
9	28.0	30.0		30.0			BROWN FINE SAND,MICACEOUS, WITH SOME SILT.	8	5	6	9	**11**
			29.8	30.0		CL	BROWNISH GRAY SILTY CLAY.					
							WET ON SPOON AT 19'.					
							WATER LEVEL THROUGH AUGERS AT 26.8'.					
							CAVED AT 18.3'.					

Notes/Comments:

HAND AUGER USED IN 0.0 TO 4.0-FEET INTERVAL.
TREATMENT PLANT PERSONNEL INDICATED THAT GROUNDWATER AT THE SITE LOCATED APPROXIMATELY 20 FEET BGS.

Strata (USCS) Designations are approximated based on visual review, except where indicated in Description of Materials.

* Number of blows of 140 lb. Hammer dropped 30 in. required to drive 2 in. split-spoon sampler in 6 in. increments.
N: Number of blows to drive spoon from 6" to 18" interval.

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TEST BORING LOG

Project Name: NWIRP BETHPAGE GM-38		Project No.:	112G08005-WE24
Project Location: BETHPAGE, NEW YORK		Page 1 of 1	
Boring No.: SB-02	Dates(s) Drilled: 04-10-19	Inspector:	V. SHICKORA
Surface Elev: ~ 85.8	Drilling Method: SPT - ASTM D1586	Driller:	J. Gucci
Drilling Contractor: DELTA WELL + PUMP	Groundwater Depth (ft): 18.5	Total Depth (ft):	30.0

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	1.0			GRAY GRAVEL FILL MATERIAL.					
1	1.0	2.0	1.0			A (SM)	GRAY TO DARK BROWN FINE TO COARSE SAND WITH SOME SILT,	-	-	-	-	-
							TRACE FINE TO COARSE GRAVEL (FILL)					
2	3.0	4.0					DARK BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT, TRACE	-	-	-	-	-
				4.0			FINE TO COARSE GRAVEL. (FILL).					
3	4.0	6.0	4.0		16	B (SM)	BROWN FINE TO MEDIUM SAND WITH SOME SILT, TRACE FINE	3	3	4	4	**7**
				7.0			GRAVEL.					
4	6.0	8.0	7.0		15	B (ML)	LIGHT GRAY SANDY SILT LENSE	6	3	6	19	**9**
				7.9			(USCS: ML).					
5	8.0	10.0	7.9		17	B (SW)	LIGHT BROWN FINE TO COARSE SAND WITH A LITTLE FINE TO	5	8	13	16	**21**
							COARSE GRAVEL.					
6	13.0	15.0			15	B (SP)	LIGHT BROWN FINE TO MEDIUM SAND WITH A LITTLE FINE TO	7	9	12	16	**21**
							COARSE GRAVEL.					
7	18.0	20.0			15		LIGHT BROWN FINE TO MEDIUM SAND, TRACE FINE GRAVEL.	4	6	7	11	**13**
				24.3								
8	23.0	25.0	24.3		15	B (SM)	BROWN SILTY FINE SAND. MICACEOUS.	10	10	12	14	**22**
							(USCS: SM).					
9	28.0	30.0		30.0			BROWN FINE SAND WITH SOME SILT, MICACEOUS.	17	9	11	20	**20**
							WET ON SPOON AT 18.5'.					
							WATER LEVEL THROUGH AUGERS AT 25.9					
							CAVED AT 18.1'.					

Notes/Comments:

HAND AUGER USED IN 0.0 TO 4.0-FEET INTERVAL.
TREATMENT PLANT PERSONNEL INDICATED THAT GROUNDWATER AT THE SITE LOCATED APPROXIMATELY 20 FEET BGS.

Strata (USCS) Designations are approximated based on visual review, except where indicated in Description of Materials.

* Number of blows of 140 lb. Hammer dropped 30 in. required to drive 2 in. split-spoon sampler in 6 in. increments.
N: Number of blows to drive spoon from 6" to 18" interval.

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TEST BORING LOG

Project Name: NWIRP BETHPAGE GM-38		Project No.: 112G08005-WE24	
Project Location: BETHPAGE, NEW YORK		Page 1 of 1	
Boring No.: SB-03	Dates(s) Drilled: 04-09-19	Inspector:	V. SHICKORA
Surface Elev: ~86.9	Drilling Method: SPT - ASTM D1586	Driller:	J. Gucci
Drilling Contractor: DELTA WELL + PUMP	Groundwater Depth (ft): NOT ENCOUNTERED	Total Depth (ft):	10.0

Sample No.	Sample Depth (ft)		Strata Depth (ft)		Recov. (in)	Strata	Description of Materials	6" Increment Blows *				N
	From	To	From	To		(USCS)						
			0.0	1.0			GRAY GRAVEL FILL MATERIAL. FILTER FABRIC BELOW GRAVEL.					
1	1.0	2.0	1.0				BROWN FINE TO COARSE SAND, TRACE FINE GRAVEL.	-	-	-	-	-
2	3.0	4.0					LIGHT BROWN FINE TO COARSE SAND WITH A LITTLE FINE GRAVEL.	-	-	-	-	-
3	4.0	6.0			16	B (SW)	LIGHT BROWN FINE TO COARSE SAND WITH A LITTLE FINE GRAVEL.	9	11	12	12	**23**
4	6.0	8.0			16		LIGHT BROWN FINE TO COARSE SAND, TRACE FINE GRAVEL.	12	9	7	8	**16**
5	8.0	10.0		10.0	15		LIGHT BROWN FINE TO COARSE SAND, TRACE FINE GRAVEL.	5	7	8	9	**15**
							CAVED AT 7.6'.					

Notes/Comments:

HAND AUGER USED IN 0.0 TO 4.0-FEET INTERVAL.

Strata (USCS) Designations are approximated based on visual review, except where indicated in Description of Materials.

* Number of blows of 140 lb. Hammer dropped 30 in. required to drive 2 in. split-spoon sampler in 6 in. increments.
N: Number of blows to drive spoon from 6" to 18" interval.

ATTACHMENT C

Laboratory Testing Summary

LABORATORY TESTING SUMMARY
BETHPAGE GM-38 GROUNDWATER TREATMENT PLANT
BETHPAGE, NEW YORK

Test Boring No.	Sample No.	Stratum	Depth of Sample (ft.)		Water Content, % (ASTM D2216)	Percent Silts/Clays, % (ASTM D1140)	Atterburg Limits (ASTM D4318)			USCS Classif. (ASTM D2487)
			From	To			Liquid Limit, %	Plastic Limit, %	Plasticity Index, %	
SB-01	1	A	1.0	2.0	4.4	3.2	-	-	-	-
	2	A	3.0	4.0	30.1	63.0	-	-	-	-
	3	B	4.0	6.0	4.4	9.5	-	-	-	-
	4	B	6.0	8.0	2.9	4.2	-	-	-	-
	5	B	8.0	10.0	2.3	3.3	-	-	-	-
	6	B	13.0	15.0	2.9	2.9	-	-	-	-
	7	B	18.0	20.0	21.9	3.0	-	-	-	-
	8	B	23.0	25.0	23.4	25.2	NV	NP	NP	SM
	9	B	28.0	30.0	23.1	21.9	-	-	-	-
SB-02	1	A	1.0	2.0	10.6	22.1	-	-	-	-
	2	A	3.0	4.0	6.6	15.8	-	-	-	-
	3	B	4.0	6.0	10.2	28.6	-	-	-	-
	4	B	7.0	7.9	19.1	58.0	36	26	10	ML
	5	B	8.0	10.0	2.2	2.0	-	-	-	-
	6	B	13.0	15.0	2.7	2.0	-	-	-	-
	7	B	18.0	20.0	21.4	1.2	-	-	-	-
	8	B	24.3	25.0	26.2	40.0	30	26	4	SM
	9	B	28.0	30.0	21.5	31.7	-	-	-	-
SB-03	1	B	1.0	2.0	3.0	2.2	-	-	-	-
	2	B	3.0	4.0	2.1	0.7	-	-	-	-
	3	B	4.0	6.0	2.6	3.2	-	-	-	-
	4	B	6.0	8.0	2.5	2.0	-	-	-	-
	5	B	8.0	10.0	2.5	2.2	-	-	-	-

Notes:

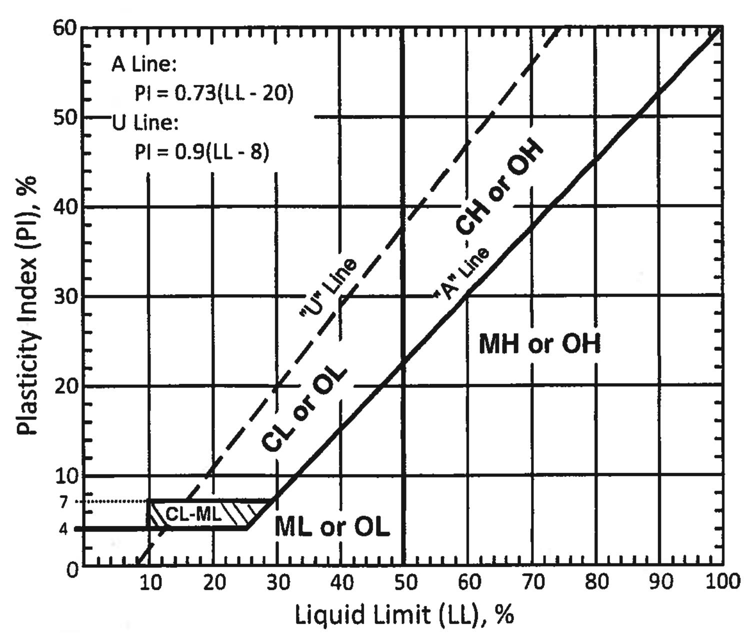
1) Sample depths based on feet below grade at time of exploration.

UNIFIED SOIL CLASSIFICATION SYSTEM [Casagrande (1948)]

Major Divisions			Group Symbols	Typical Descriptions	Laboratory Classifications		
Coarse Grained Soils (More than half of material is larger than No. 200 sieve)	Gravels More than half of coarse fraction is larger than No. 4 sieve size	Clean gravel (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Determine Percentage of sand and gravel from grain size curve. Depending on Percentage of fines (fraction smaller than No. 200 sieve), coarse-grained soils are classified as follows: Less than 5 percent GW, GP, SW, SP; More than 12 percent GM. GC, SM, SC; 5 to 12 percent Borderline cases requiring dual symbols(1)	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4: $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting C_u or C_c requirements for GW	
		Gravel with fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below A Line or I_p less than 4	Limits plotting in hatched zone with I_p between 4 and 7 are borderline cases requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above A line with I_p greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 Sieve)	Clean sands (Little or no fines)	SW	Well graded sands, gravely sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP	Poorly graded sands, gravelly sands, little or no fines		Not meeting C_u or C_c requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures		Atterberg limits below A Line or I_p less than 4	Limits Plotting in hatched zone with I_p between 4 and 7 are borderline cases requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits above A line with I_p greater than 7	

Major Divisions		Group Symbols	Typical Descriptions
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silts and clays (Liquid limit less than 50)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
		CL	Inorganic clays of low to medium plasticity, gravelly clays , sandy clays, silty clays, lean clays
		OL	Organic silts and organic silty clays of low plasticity
	Silts and Clays (Liquid limit greater than 50)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic clays of medium to high plasticity, organic silts
	Highly organic soils	Pt	Peat and other highly organic soils

For soils plotting nearly on A line use dual symbols i.e ., I_p = 29.5, w_L=60 gives CH-MH. When w_L is near 50 use CL-CH or ML-MH. Take near as ± 2 percent.



(1) Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC. well-graded gravel-sand mixture with clay binder.

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APPENDIX E
COST ESTIMATE

(ATTACHED SEPARATEDLY)

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APPENDIX F
TECHNICAL SPECIFICATIONS

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APPENDIX G
DRAWINGS

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