July 2, 2021

BENDER
CONSULTING, LLC
Applied Groundwater Solutions
PMB 154
1992 South Elger Bay Road
Camano Island, WA 98282
ph: 360.631.5600
cell: 425.894.8943
scott@benderllc.com
www.benderllc.com

Mr. Marc Luedke
R|MILLER Inc
18321 98th Ave NE Suite #1
Bothell, WA 98011

Revised Draft DEWATERING DESIGN RECOMMENDATIONS, 2885 78TH AVENUE SE, MERCER ISLAND, WASHINGTON

Dear Marc:

This document presents our dewatering design recommendations for the proposed development at 2885 78th Avenue SE in Mercer Island, Washington. This letter is intended to provide the basis of design and design recommendations for the installation and operation of the dewatering system. This letter does not detail the specific equipment intended for construction of the system, specific dewatering component layout, or schedule. This plan has been prepared based on the geotechnical report available for this project, the plans, our experience, and our conversations with you.

PROJECT DESCRIPTION

The site is located 2885 78th Avenue SE in Mercer Island, Washington. The building will consist of four above ground stories and two levels of underground parking. The building will be roughly L-shaped with longest dimensions of about 240 by 280 feet. Ground surface slopes from about 82 to 90 feet across the site.

The shoring design was provided by Ground Support, PLCC (October 12, 2020). We understand that the building will be shored by soldier pile and lagging methods with average soldier pile spacings on 8-foot centers.

The top of base slab elevation for the P2 level will be about 70.5 feet; the base of excavation elevation for most of the site will be about 67.7 feet. Two elevator pits will be constructed for the building with base of excavation elevations of 62.6 feet. No information has been provided on the location or base elevation of the crane pad excavation.

We understand that the site work will begin in the summer of 2021.

SUBSURFACE CONDITIONS

The soil conditions for the work are provided by Hart Crowser in a November 4, 2020 report titled "Geotechnical Engineering Design Report, Multi-Family Development, Mercer Island, Washington." This report includes borings by Hart Crowser, and earlier borings by Terra Associates and ABPB Consulting. No grain size distribution data of the underlying soils was provided but Hart Crowser did perform slug tests to estimate soil permeability at select monitoring wells.

Based on the geotechnical report, the site may be in a location of a marsh area that has been filled. The fill overlies soft silt and peat, which are underlain by hard clays and dense sand and silty sand.

Based on the subsurface profiles presented in the Hart Crowser report, the soil distribution beneath the site is complex. Below the fill and shallow soils, a discontinuous silt and clay is present at multiple elevations. This unit is commonly underlain by a hard silt, which is a low permeability soil that will not yield water to the dewatering system; this unit appears to be discontinuous as well. A water-bearing medium dense to dense sand and silty sand underlies the silt or clay and was commonly encountered below about elevation 60 to 65 feet; the thickness of this unit varies between about 10 feet to greater than 20 feet thick. It is not clear if the sand unit is continuous or not. The sand is in turn underlain by a hard silt. Given the complexity of the site soil distribution it is possible the soils may have been displaced by faulting, if so, the lack of continuity of the soils could impact the operation of the dewatering system if true.

Soil permeability is a fundamental variable for calculating dewatering system performance. The clay and silt soils discussed above are considered to be aquitards, which are low permeability soils that will not yield appreciable quantities of water to wells. The sand to silty sand layer is a pervious unit and will be the target soil layer for the dewatering system. Hydraulic testing of the soils was performed at select wells using slug tests; these are small scale tests that stress the aquifer in a very limited area; while they may be a good tool for estimating aquifer permeability, they are very much subject to the drilling, monitoring well installation, and development methods. Hart Crowser's slug test results ranged between $9x10^{-5}$ and $8x10^{-4}$ cm/s, or $2x10^{-4}$ and $2x10^{-3}$ feet per minute (ft/min). These are low values of permeability. Geotechnical grain size distribution analyses can also be used to estimate soil permeability however these were not provided in the geotechnical report. Given the slug test results and our experience using the soil descriptions in the borings we use a design range in permeability of $2x10^{-3}$ and $7x10^{-3}$ ft/min.

Monitoring wells were installed in borings HC-1, HC-2, and previous borings ABPB-M3 and Terra B-1. Results of measurements at the monitoring wells was not provided but for those plotted on the subsurface profiles; the profiles indicate groundwater elevations between elevation 75 and 79 feet. You have also presented us with a plot of groundwater levels at HC-2 collected by Hart Crowser using a datalogger between January and February 2021; these levels fluctuated between 78.6 and 79.6 feet. Since we do not have an indication of seasonal fluctuations, and that it appears that the water levels can spike due to precipitation events, we use a design groundwater elevation of 79 feet, to be conservative.

Based on the measured water levels being above the top of the sand aquifer, the unit is under confined (pressurized) conditions.

GROUNDWATER CONTROL APPROACH AND CALCULATIONS

The proposed excavation lies in a complex sequence of very low, and low to moderate permeability soils that may be discontinuous. The base of excavation elevation of the P2 level will be about elevation 67.7 feet, excavation to about elevation 63 feet or so will be required for the elevator pits. This deeper excavation will either be in the low to moderate permeability sands or can be proximate to the base of the aquifer.

The water-bearing sand lies within or near the base of the excavation. In some areas the excavation will require traditional dewatering; some other areas may require pressure relief. Calculations at various locations around the site where the base of excavation is underlain by silt indicate that the factor of safety against heave of the base of excavation may be less than 1.0. These calculations assumed the soil conditions in the geotechnical profiles, a groundwater elevation of 79 feet, and a silt unit weight of 128 pounds per cubic foot; independent calculations should be performed by your geotechnical engineer to verify. These observations indicate that groundwater control is required for the entire site.

Given that the sand unit is relatively thin, and lies close to or at the building subgrade excavation we recommend use of vacuum well points for dewatering and pressure reduction. These are small diameter closely spaced wells that withdraw ground water using vacuum pressures. Well points typically have a relatively short screen section, so in the complicated soil environment in which the site exists careful attention to the soil conditions will be required by the dewatering subcontractor during well point installation. Some of the well points may only be placed within two feet of excavation subgrade, while others may need to be placed up to 10 feet or more below subgrade. It is possible that some of the well points will not intercept pervious soils.

Given a deepest excavation elevation of 63 feet, groundwater levels should be lowered to about elevation 61 feet or so to provide a dry and stable excavation. This may require lowering the water level up to 18 feet, which is at or near the maximum design head lift value for vacuum-based well points.

The dewatering design calculations for the site were performed using the principle of superposition and the Theis and Jacob methods. The calculations assumed a static groundwater elevation of 79 feet and a 12 foot thick aquifer for the entire site. Figure 1 shows the locations of 64 well points used for calculation. Note that for the calculation these were located on a uniform spacing of about 16-feet, which will commonly be in about the middle of every-other shoring bay; during construction the dewatering subcontractor will place these in the middle of every other shoring bay (not as shown on Figure 1). Figure 2 shows a calculated dewatering groundwater elevation profile across the center of the site after about 2 weeks of operation and that system yields may be between about 64 and 102 gpm, Since the aquifer thickness (and presence) may vary across the site; we would rely more on the lower to mid part of this range. Discharge rates may drop on the order of 25 percent with time. The calculations indicate that all of the well points must be in continuous operation during excavation.

DEWATERING RECOMMENDATIONS

Dewatering and depressurization for the proposed development at 2885 78th Avenue SE in Mercer Island will be performed using vacuum based well point systems.

Well point systems operate with a central pump that provides vacuum to all of the wells, any break in the pump, header piping, or well point swing joints will disable the entire system. The well points must be installed in the center of every other shoring bay.

Vacuum-based well points have a design head lift capacity of about 18 feet; since parts of the excavation subgrade will be 20 feet or more below surface elevation, the well points will need to be drilled through the shoring wall at an angle to intercept the pervious sands. Because the elevation of the sand varies across the site, and may be as great as 10 feet below the excavation subgrade elevation, we recommend that the well points be installed at elevation 73 to 75 feet. The subsurface profiles indicate that the soils initially encountered during drilling will be low permeability, so while initial drilling below the water table should be dry, the driller should be prepared for heaving sands when the aquifer is encountered.

Caution should be used when excavating the elevator pits (and the crane pad excavation if it is deeper than the base of excavation elevation for the majority of the site). The elevator pit excavations may be close to the base of the aquifer, and it may be difficult to dewater to that elevation, depending on soil conditions. If piping or heaving of soils occurs, the excavation should be backfilled or flooded and we should be called for additional recommendations.

Perched water may be encountered at the site. Perched water should be collected and removed from the excavations using sumps constructed as described below.

The following provides specific information for construction and operation of the system.

Well Points: Well points should be constructed of minimum 1.5- to 2-inch-diameter PVC and have a minimum 2-inch-diameter 5-foot long 30-slot screen section and interior suction pipe to the bottom of the well point. The well points should be drilled through the shoring wall at an angle of 60 degrees below horizontal using a Klemm, or similar. Well point lengths should be up to 25 feet to encounter the pervious sand unit; many of these will need to be adjusted according to field conditions, the driller must continue drilling (to a maximum depth of 30 feet) to encounter pervious soil, or must terminate drilling if the boring encounters low permeability silt or clay below the sand. The drill cuttings should be carefully monitored, and the well point depths adjusted to avoid screening a low permeability soil. As stated above, the driller should be prepared for heaving sands when the aquifer is encountered.

A Colorado Product 12-20 washed, rounded sand filter pack should be placed in the annular space between the borehole wall and well point casing up to the static water table. A bentonite seal should be placed between the top of the sand pack and ground surface. The seal should be hydrated.

Well point swing hoses should be new or clean enough that the operator and site staff can clearly see the amount of air and water passing through the hose.

All well points should have valves placed in-line to control vacuum pressure, flow, and excess drawdown at each well point.

Well points should be installed in accordance with WAC 173-160.

Vacuum Pump: A vacuum pump capable of creating at least 22-inches (Hg) of vacuum across each well point should be provided. The pump should have a continuous power supply and be capable of providing continuous vacuum in the system throughout the length of the system. Place vacuum gage at ends of the well point systems to ensure a minimum of 18-inches of vacuum at all times.

Development: The well points should be developed immediately upon completion. Development methods should utilize flow surging and over-pumping. Development will improve the hydraulic connection with the aquifer and should provide a clean dewatering effluent with time. Development water should be discharged to the treatment system.

Piping: The discharge piping from the pumps will be routed to treatment tanks or systems provided by you. The discharge piping should be minimum 6-inch diameter HDPE or PVC and sized according to the system total yield calculations.

Flowmeters: A flowmeter should be installed downstream of the vacuum pump. Flowmeters should be installed to conform with the manufacturer's recommended distances from elbows and joints in the piping. Configure piping to ensure that the pipe is always pipe-full of water at the flowmeter location.

Power: We understand that power will be supplied by portable generators or diesel driven pumps. An automatic transfer switch and backup generator will need to be installed in the event of a failure in the primary power supply

Sumps: Sumps will be required during excavation. Sumps should be cased in a perforated housing or well screen surrounded by a washed, rounded gravel pack to avoid pumping of fines. Sump discharge should be to the settling tank.

Well Decommissioning: The well points should be decommissioned according to WAC 173-160.

Monitoring: The static water level in the well points and monitoring wells should be measured prior to dewatering. The existing monitoring wells should be maintained until the performance of the system has been confirmed to fully dewater the excavation. The water levels in the monitoring wells should be measured and recorded daily. Discharge rates should be monitored and recorded daily.

Operation: The systems should be operated continuously. Dewatering should commence a minimum of 3 days prior to excavation below the water table. The system should be checked daily for air leaks and all well point headers be adjusted to minimize air flow into the system and to maximize vacuum at the well point. Discharge should also be measured daily for sand content; we have found that an Imhoff cone works well for well point system sediment monitoring.

The system should be regularly inspected for piping leaks and pump malfunctions. Vacuum pressures should be monitored daily at a minimum. Vacuum pressures at the pump should be maintained above 22-inches of mercury, and above 18-inches at the end of the system at all times.

The dewatering design recommendations provided herein have been oriented to the various soil and groundwater conditions presented, further variations may exist. As such, we recommend that our staff be present during initial system installation and startup. Should well discharge rates and groundwater level drawdown not be similar than presented herein, we should be contacted so that we may observe the system performance and revise our design recommendations, as necessary.

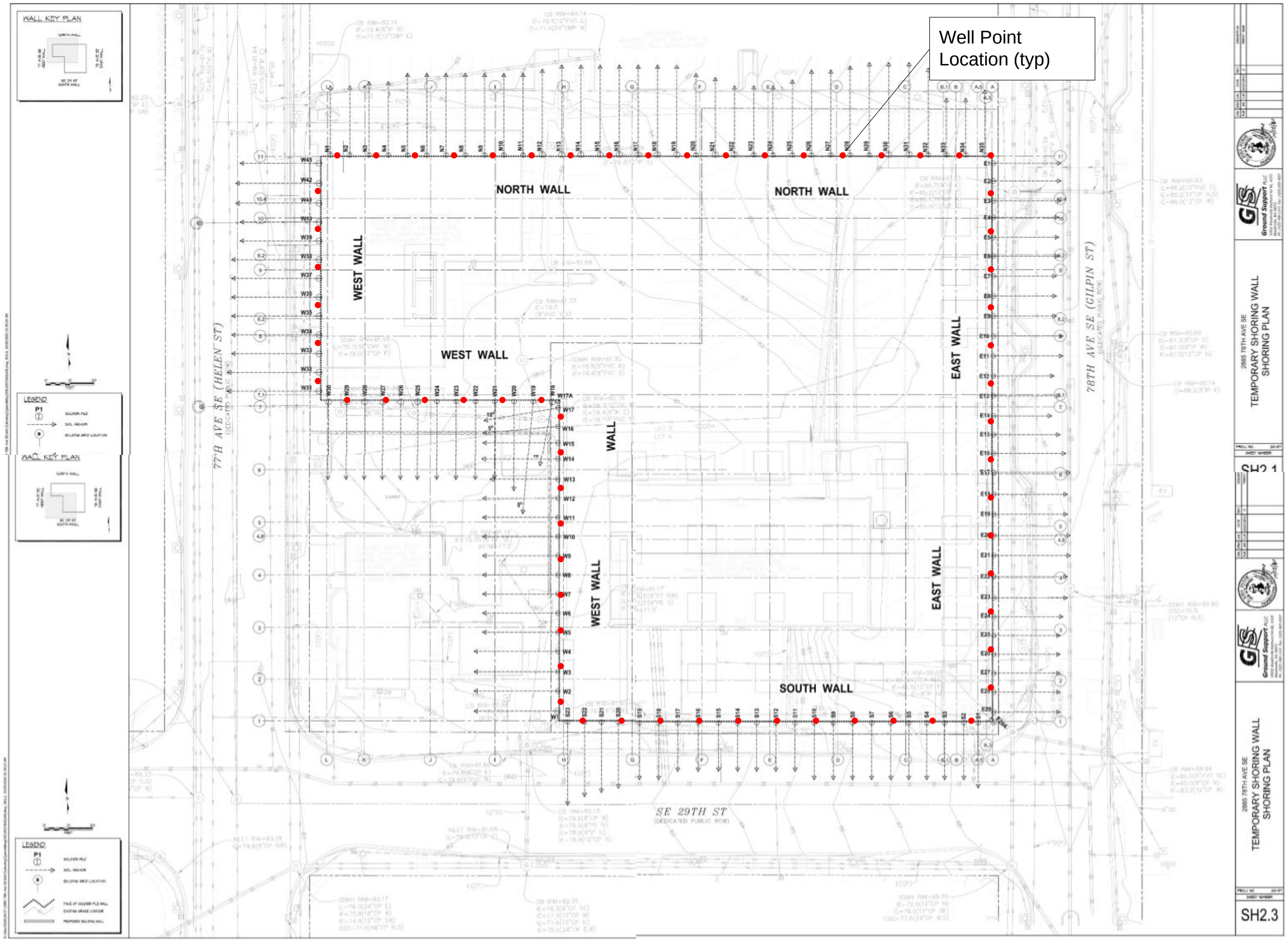
This design has been prepared in an attempt to meet the groundwater levels required by the work. Potential impacts to off-site structures or facilities has not been considered as part of this work. The geotechnical report has identified soils that may be subject to settlement in a dewatering situation. If there are potential affects to structures, such as groundwater drawdown inducing ground settlement, then the geotechnical engineer and Owner is responsible for identifying these risks and what constraints they may have on operation of the dewatering system. This design has not considered the effects or liabilities associated with pumping or migration of contaminated groundwater; as stated above, the design has been provided only to meet the specified drawdown criteria and we hold no liability for adverse effects related to groundwater and soil contamination.

Thank you for the opportunity to be of service. Please call us at (360) 631-5600 should you have any questions or comments.

Sincerely,

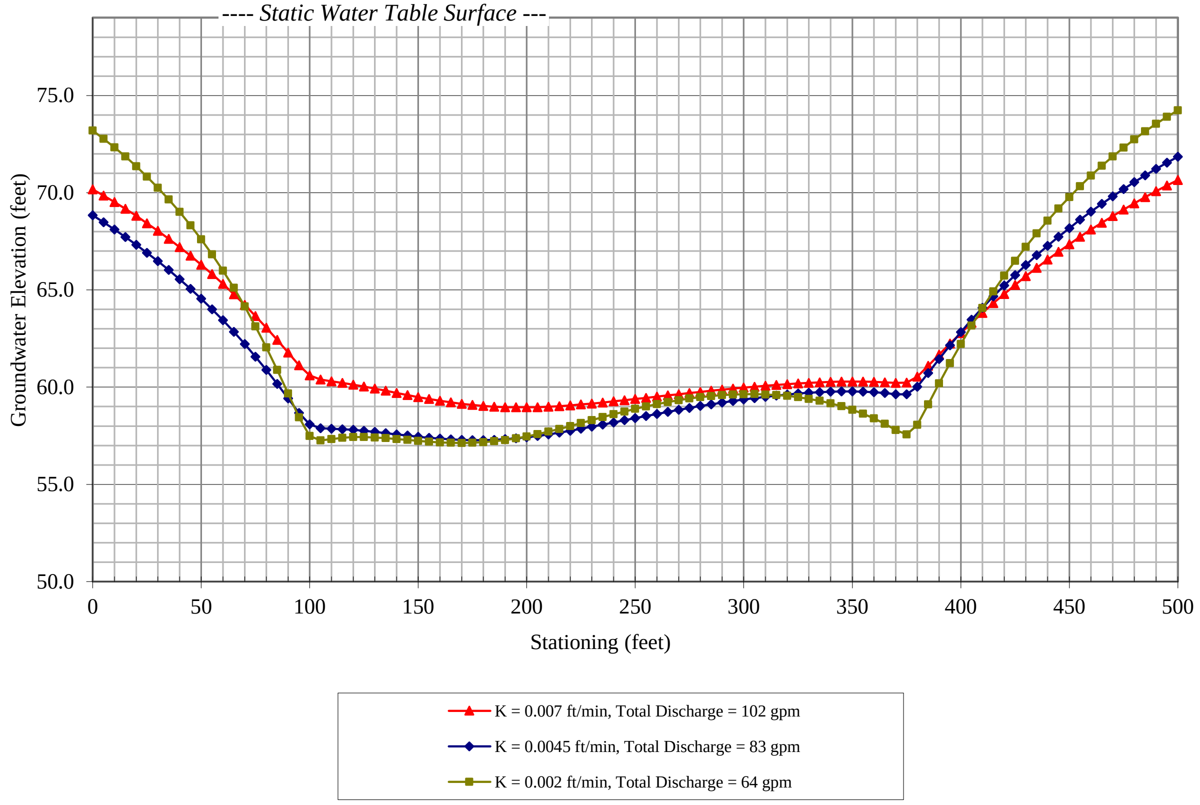
Scott F. Bender L.H.G., C.G.W.P.

Enclosures: Figures 1 and 2. Well Point Locations and System Calculations



Note: well points to be installed in the middle of every other shoring bay

BENDER CONSULTING, LLC Applied Groundwater Solutions	2885 78th Avenue SE Dewatering Design Recommendations R Miller, Inc	Well Point Locations	Project Number 2121-01 Figure 1



BENDER CONSULTING, LLC Applied Groundwater Solutions	2885 78th Avenue SE Dewatering Design Recommendations R Miller, Inc	Dewatering Groundwater Elevation Profile across Center of Excavation	Project Number 2121-01 Figure 2