Technical Memorandum

TO: Don J. Bache, Port of Olympia

FROM: Joe Kalmar, PE

DATE: April 19, 2019

RE: **Evaluation of Potential Improvements to the Groundwater Extraction System**
Port of Olympia Cascade Pole Site
Olympia, Washington
Project No. 0021041.010.019

INTRODUCTION

This technical memorandum has been prepared in response to a request from the Port of Olympia (Port) for Landau Associates, Inc. (LAI) to evaluate the various groundwater extraction system components of the Cascade Pole site (Site) groundwater extraction and treatment system. The purpose of the evaluation is to observe the present condition of the components, identify potential issues, and assist the Port with optimization to improve the operation of the extraction system. With more consistent operation and data collection, the Port would then be able to identify potential modifications required in the groundwater extraction system operation to maintain target levels.

The Port has completed several interim remedial actions to manage and contain contaminated Site groundwater including installation of a perimeter subsurface slurry wall, shoreline sheetpile wall, and a low-permeability cap. The last major modification to the groundwater extraction system occurred in 2001. The groundwater treatment system was more recently redesigned and rebuilt, and began operation in 2012. Evaluation of the performance of the groundwater treatment system was not conducted as part of this current assessment.

LAI reviewed groundwater extraction system documentation provided by the Port, and conducted a Site visit on November 19, 2018 to examine the extraction equipment and to observe system operation. The groundwater extraction system currently includes 11 connected extraction wells (CW-1 through CW-13, with CW-7 never being built and CW-13 no longer active). A summary of the apparent potential issues observed with the extraction system and recommended corrective actions are provided below.

POTENTIAL MECHANICAL ISSUES ASSOCIATED WITH THE GROUNDWATER EXTRACTION SYSTEM COMPONENTS

Following LAI's review of available documentation and the onsite inspection, a number of potential issues with system components and extraction well pumping equipment and operation were identified and evaluated. A summary listing of observed potential problems with the extraction system is presented below:

Water Level Monitoring

There is no functional water level monitoring in the groundwater extraction wells. Groundwater extraction wells were initially equipped with either pressure transducers or conductivity switches with which to control the on/off function of the extraction well pumps.

Failed Pressure Transducers

Some of the site extraction wells (CW-8, CW-9, CW-10, and CW-11) were initially equipped with submersible pressure transducer sensors for real-time water level monitoring. Each of the pressure transducers that were installed in these extraction wells are no longer functional. The Port has indicated that the pressure transducers were initially functional for a period of time, but, now, none of the units produces a signal that corresponds to a legitimate groundwater elevation. Documentation provided in the Port's onsite Operation and Maintenance (O&M) Manual indicates that the pressure transducers are equivalent to the current Seametrics PS9800 submersible pressure transmitter, with a 0.75-inch diameter. However, there is conflicting literature that indicates the pressure transducers were provided by Instrumentation Northwest, PS9105 with a 0.85-inch outer diameter. Both sets of literature indicate that the units have vented cables that need to be moisture protected with silica gel desiccant (to prevent moisture from contacting and corroding the internals of the transducer). Onsite observation at extraction wells by LAI, as well as recollection of Port staff, suggest that each of the pressure transducers was a closed (non-vented) type transducer that relied on an atmospheric pressure sensor located at the treatment system building to correct the readings for atmospheric pressure. There was no vented cable visible from the onsite transducers, and the Port has stated that no desiccant was installed or has been maintained for the pressure transducers.

Failed Conductivity Sensors

Based on visual observation of sensors that had been pulled from the extraction wells (CW-1, CW-2, CW-3, CW-4, CW-5, and CW-6), and based on photos provided by the Port, it appears that the conductivity sensors have failed due to a combination of corrosion (dissolving away the metal sensor tip) that prevents completion of an electrical circuit and from scaling (coating the metal sensor with mineral buildup) that adds resistance to completion of an electrical circuit and, thereby, disrupts a pump control signal. The current extraction well cap configuration for these wells requires a confined space entry effort in order to pull and inspect the water level sensor.

Lack of Pull Port to Remove Sensors

The well caps for extraction wells CW-8, CW-9, CW-10, and CW-11 are configured such that the pull port for the water level sensor (either transducer or conductivity sensors) is ½-inch diameter, which is adequate to pass a transducer cable and to install a cord grip. However, the diameter is too small to allow the sensor to be periodically removed, inspected, and cleaned without pulling up the entire well cap assembly. Pulling up the well cap assembly requires confined space entry and a pump truck or fork lift, so is not easily completed on a routine basis. Given the observed site groundwater conditions

where materials are subject to significant scaling, the lack of ability to easily remove a sensor significantly reduces the ability to monitor and maintain the sensors.

Lack of Easily Accessible Port for Manual Water Level Readings

Each of the extraction wells lack an accessible port to readily allow collection of manual water level readings without confined space entry. The well caps are configured with a 1-inch-diameter port, but the current elevation of the ports within the extraction well vaults are generally far enough below the vault rim elevation to easily collect a measurement from the surface. Without an easy way to periodically verify the extraction well water level from outside of the vault, it makes it less likely that there will be ongoing periodic verification that the pressure transducers are providing accurate water level readings.

No Submersible Pump On/Off Control

The aforementioned lack of functional water level sensing instrumentation eliminated the ability to automatically control the on and off function of the well pump. Without automatic control based on water level, the system operator must leave the submersible pumps on, which can cause:

- Extended periods of pumping dry or partially dry (below the minimum recommended flow rate) results in inadequate pump motor cooling and improper current draw and can lead to premature pump motor failure.
- An air lock condition (no groundwater flow) created by drawing water level down to the point that air is drawn into the pump intake and is pumped into the extraction system piping.

Extended Periods Without a Functional Submersible Pump

The aforementioned issues (lack of extraction well water level sensors and associated lack of proper pump control) result in operation of the pumps outside of the manufacturer's recommended operational conditions, and appears to have led to premature pump motor failure, unnecessary electrical power use, added O&M cost, and associated extended downtime for extraction wells until the pump motor can be replaced.

Inadequate Drainage of Extraction Well Vaults

The lack of proper drainage in the extraction well vaults has resulted in producing a high-humidity and high-moisture environment that appears to have contributed to corrosion of metal and wires of the electrical junction boxes in the vaults. There are also signs that, on past occasions, the water level in the vaults may have risen to levels that submerged the electrical junction boxes. Corroded wires may have contributed to problems with pump motor failure and inaccurate water level sensor readings. Inadequate drainage in the vaults is caused either by:

- lack of drain holes in the base of the concrete vaults, or
- lack of a functional sump pump in the vault that can pump accumulated water into the groundwater extraction piping.

Limited Records of Extraction Well Performance

There are no individual well instantaneous flow rate readings (only combined flow of all wells measured at the treatment system inlet), and/or no record of monthly volume of extracted groundwater from each well (due to lack of individual flow totalizers) that are currently available.

Uncertain Interference of Instrumentation Signal from Pump Electrical Current

The electrical current supplied to the submersible pumps could potentially create electromagnetic interference with low amperage control signals such as the 4-20 milliamp signals from the pressure transducers. However, separate conduits are provided for electrical and instrumentation wiring at Cascade Pole. Also, the Port reports that the pressure transducers did provide accurate readings for a period of time after installation. If the problem with the transducers was electrical current noise, then the transducers would likely have provided faulty readings from the beginning of their installation. It may be necessary to test future instrumentation for lack of signal interference.

Lack of Functional Flow Meters at Extraction Wells

The O&M Manual indicates that at least some of the extraction wells were equipped with inline turbine flow meters from EMCO Flowmeters. However, none of the extraction wells currently has a functional flow meter within the well vault. There is only an inlet flow meter at the treatment system than can monitor the combined groundwater extraction system flow rate (combined groundwater extraction flow rate was recently observed to be in the range of 1 to 10 gallons per minute [gpm]).

Inability to Correlate Extraction System Operational Data with Site Water Levels

The inability to monitor extraction well groundwater levels, to properly operate the well pumps in a consistent manner, and the lack of tracking of flow volumes from individual extraction wells have limited the ability to document conditions that can then be correlated with full site groundwater elevations.

RECOMMENDED IMPROVEMENTS FOR THE GROUNDWATER EXTRACTION SYSTEM COMPONENTS

Some of the issues identified above do not rise to a level of concern such that we are recommending that the Port address them as part of initial improvements to the extraction system. For example, the lack of flow meters at individual extraction wells does not prevent proper functioning of the groundwater extraction pumps or determining that the extraction system is adequately drawing down the groundwater level within the containment area to provide hydraulic control. As long as water levels can be continuously monitored at the extraction wells and the total combined extraction rate can be monitored at the treatment system inlet, then the primary function of water level drawdown can be tracked.

The actions that we do recommend the Port implement in the short-term to improve the functionality and performance of the groundwater extraction system are discussed below.

Install New Pressure Transducers

Install new pressure transducers in all 11 groundwater extraction wells. As previously discussed, water level sensing for submersible pump on/off control is critical to proper functioning of the extraction system. Conductivity sensors at the Cascade Pole Site have been found to be subject to fouling, rapid corrosion of the sensor tips, and moisture-related corrosion in the sensor wire junction boxes. Based on discussions with vendors of submersible instrumentation, pressure transducers may require periodic cleaning, but are resistant to permanent damage from corrosion. As previously noted, the Port's experience was that pressure transducers worked properly for a period of time. It is suspected that either proper desiccant filters were not provided for vented transducers, or non-vented transducers were provided, but were not properly sealed or terminated within a continuously dry junction box.

Reconfigure Well Caps

It is recommended that the Port either modify or replace the current extraction well caps to provide adequate 1-inch-diameter ports for both manual water level measurements and for the installation/ removal of pressure transducers. A cord grip should be fastened onto each transducer unit's cable at a proper distance to establish a known repeatable set depth within the extraction well. The 1-inch ports will allow the sensors to be periodically removed, inspected, and cleaned, without having to pull up the entire well cap assembly. It may be possible to also configure the installation as to avoid the need for confined space entry to pull, inspect, and clean the sensor. The port for the manual water level readings should be extended to within one foot of the vault rim, and the new monitoring point elevation surveyed, such that a manual water level measurement can be collected without the need for confined space entry. The water level port would allow for water level measurements to be collected to coincide with the monthly Site groundwater measurements collected from the monitoring wells to evaluate hydraulic gradients. Modification of the extraction well caps in this manner would not require a permit through the Washington State Department of Ecology (Ecology) and would not need to be completed by a licensed well driller.

Establish a Routine Monitoring Program

Establish a routine monitoring program to verify site groundwater hydraulic control. The inability to monitor extraction well groundwater levels and to properly operate the well pumps in a consistent and continuous manner significantly limits the ability to document and control water level drawdown. The current round of monthly manual groundwater level measurements at Site monitoring wells can be used to evaluate groundwater drawdown. When these measurements are collected at the same time that extraction system operational conditions are known, it allows determination of the groundwater extraction system operation that corresponds with Site water level conditions.

Development of a routine monitoring program would allow for a more precise assessment of system performance.

Install Functional Drainage

Install functional drainage for each extraction well vault. Penetrations should be installed in the base of each of the concrete extraction well vaults to allow passive drainage into the soil of any rainwater that leaks in through the vault lid. A 2-inch-diameter cored hole through the concrete base should be adequate for vault drainage, if a screen is maintained to filter out solid debris. If it is later determined that for some reason a drain in the bottom of the vault is inadequate to effectively drain accumulated stormwater and condensation at any specific well vault location, then the Port would want to install a sump pump in that vault that can pump accumulated water into the groundwater extraction piping.

Test All Electrical Lines and Connections

Test all electrical lines and connections to the extraction well vaults. Given the signs of corrosion at the electrical junction boxes in each of the extraction well vaults, it is recommended to have an electrician examine and test each of the power wires and signal (pressure transducer) wires to verify that they adequately pass electrical current and have not built up resistance from corrosion or physical damage over the years. From recent inspection work by Grundfos technicians at extraction well CW-5, some of this electrical testing has already been conducted. Corroded or damaged wires could contribute to motor damage of the submersible pumps or to faulty readings for the 4-20 milliamp signals from the pressure transducers. It may be determined from testing the wiring that some electrical wires will need to be removed and replacement wires re-pulled through the existing conduit.

Provide New Pump Motors for Damaged Submersible Pumps

It is known or suspected that some extraction well submersible pumps have fully failed or may have damaged motors from running for extended periods of time in a partially dry state. Until the recommended work is completed and the electrical wiring inspected and repaired, as necessary, the number of pump motors that will need to be replaced is not known. For preliminary planning purposes, we recommend that the Port assume that five pump motors will need to be replaced.

COST ESTIMATE

The full cost of the system inspection and repair work will depend on the results of the full electrical inspection of the groundwater extraction system. However, for the work recommended and described in this technical memorandum, it is roughly estimated that $100,000 should be budgeted for the recommended inspection and repair work. Following that inspection and repair work, a more accurate full budget estimate could be provided.

USE OF THIS REPORT

This Technical Memorandum has been prepared for the exclusive use of the Port of Olympia for specific application to the Cascade Pole Site. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of Landau Associates. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by Landau Associates, shall be at the user's sole risk. Landau Associates warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

Please feel free to contact me directly at (425) 329-0281 if the Port has any questions regarding these observations or recommendations, or if you would like to discuss these issues in more detail.

LANDAU ASSOCIATES, INC.

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