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**Subject:** Well Treatment Options

## 1.0 Background and Introduction

Olympic Water and Sewer Inc. (OWSI) had repeated total coliform detections in the Service Zone B distribution system, the area served by Teal Lake Reservoir, in the fourth quarter of 2017. The utility began investigating the system to determine the source of contamination in response to the coliform detections. OWSI retained HDR to conduct an investigation of the Zone B water system to determine the source of the coliform and identify ways to eliminate the risk of future events.

The following conclusions were developed based upon the investigation:

- A visual review of all system components by the utility and HDR found no obvious potential source of intrusion and contamination.
- The water quality sampling could not determine a specific source of the coliform contamination.
- The sampling did identify possible non-coliform bacterial contamination sources. The data indicates increased heterotrophic plate counts (HPC) throughout the Zone B system as Teal Lake Reservoir is drawing down and supplying the distribution system and that Well 14 groundwater had HPC. The other well, Well 16, had no counts.

After the initial investigation was completed, a maintenance procedure was done to remove a biological slime that was growing on the Well 16 source meter. The slime had become large enough that it caused flow reading disruptions. HDR hypothesizes that the presence of the slime and its removal may be linked to coliform detections in three investigative samples that were taken shortly after the meter cleaning.

The repeated coliform detections (albeit never detected again in replicate analyses), the inability to definitively identify a source of contamination, and the known presence of biological growth within the water system fixtures highlights the fact that OWSI is at risk of continued coliform detections in the future. This risk relates to the current OWSI operation of an unchlorinated water utility; the risk of coliform detections in chlorinated systems is considerably lower. However, the OWSI system purposefully operates without chlorine as the source water contains elevated manganese concentrations (0.077 mg/L for Well No. 14 and 0.079 mg/L for Well No. 16, compared to a state limit of 0.050 mg/L) and chlorinating the water would generate discolored water. In other words, the lack of chlorine was to avoid one issue (discolored water) but allows another issue to develop (bacterial growth) in Service Zone B.

Groundwater sources in Service Zone A are currently treated for high iron and manganese levels, however, water in the service zone is not chlorinated. There are interties between the two service zones and water can be conveyed between the two zones to meet fire flow demands. In addition, water is transferred from Zone B to Zone A several short durations a year to exercise and maintain the North Bay Booster Pump Station. The blending of unchlorinated and chlorinated water, albeit in small volumes, is prohibited by DOH and necessitates that Zone A water be chlorinated if Zone B water is also chlorinated.

This memorandum documents a high-level review of potential options to assist OWSI in identifying future operations of Well 14 and 16 along with the costs with adding chlorination, if required, to the groundwater sources (Wells 2,3 and 4N) in Service Zone A.

## 2.0 Treatment Alternatives for Service Zone B

A number of options were established for the treatment of Well 14 and 16 in Service Zone B. These options are:

1. Maintain current operations as-is (i.e. no change)
2. Regular, intermittent chlorination of the groundwater to kill off bacterial growth.
3. Constant chlorination of the groundwater to kill off the bacterial growth and prevent it from returning.
4. Constant groundwater chlorination with sequestrant addition to temporarily mask manganese-related color issues.
5. Constant groundwater chlorination and install greensand or pyrolusite filters to remove the manganese.

The order of these options is from simplest to implement to most difficult, which also corresponds to the amount of additional capital and operational costs incurred. Maintaining current operations is the base option for which requires no changes to be made to the current operations. This operation will not prevent coliform hits in the system, as no changes will occur.

Option 2, regular intermittent chlorination of each groundwater source Well 14 and Well 16, will minimize the risk of coliform occurrences throughout the system. However, it will not prevent the bacteria from growing back. This option would consist of the addition to a new chlorine feed system including a feed pump and storage drum to be installed at the Well 16 site inside the existing well house. The operations would be very similar to the temporary operation that was performed at the Well 14 site last year. It was assumed that the temporary chlorine system installed at the Well 14 site would be reused for intermittent chlorine feed at the Well 14 site.

Option 3, constant chlorination of the groundwater sources, would prevent coliform occurrences, as the initial bacteria growth is destroyed and the constant chlorination prevents future growth from happening. However, chlorine use causes dissolved manganese in the water to turn grey to black during the chlorination event. This color often leads to customer complaints regarding persistent staining of toilets, sinks, and bathtubs and causing permanent discoloration on laundry, especially white clothing and towels. Water color is regulated by the Washington Department of Health (DOH) and the level of discoloration will likely exceed state limits. OWSI will need to request a waiver from DOH to implement this option. If a waiver is granted, and whose likelihood is uncertain, a common condition of the waiver is that all customers be notified on an ongoing basis that OWSI is purposefully not meeting a state limit and the reasons why. Potential future customers (i.e. potential property purchasers) are often notified in the sales disclosure and property inspection documents. If this option is selected, a continuous chlorination feed system would be installed in the existing Well 14 house and would consist of two metering pumps (one duty and one standby), a sodium hypochlorite storage tote, chemical metering piping, and a chemical injection vault located on the combined Well 14 and Well 16 discharge line.

Option 4, constant chlorination along with sequestration, would provide all of the same benefits as the constant chlorination option but would temporarily mask manganese discoloration for 24 to 48 hours. After this period of time, the sequestration chemical breaks down and the chlorine in the water will once cause the manganese to turn the water grey to black, leading to the same discoloration and potential as Option 3. A duration of 48 hours is a very short time for the Zone B water. During winter, this time is often exceeded before the water even reaches the first customer. The cost of implementation is higher than Option 3 as it involves the storage and pumping of a second chemical. As a result, this option is more expensive than Option 3 with no additional benefits and nearly all the same disadvantages.

Manganese concentrations can be reduced using manganese greensand or pyrolusite filters. Option 5 would require a new filtration building on the existing Well 14 site. This system would be nearly identical to that installed to treat the groundwater from Well Nos. 2 and 3 in Zone A. The filters require a chlorine system to feed chlorine upstream of the filters. The filtration building would house the filter and new chlorination system along with chemical feed piping and storage tank. The raw water from Well 14 and 16

would be re-routed through the filters and discharged back into the existing combined Well 14 and 16 discharge main.

Table 1 presents a high-level summary of treatment options and the impacts each has with respect to the water quality coming from Well 14 and 16 and well operations. The water quality analysis is for coliform and manganese, but also arsenic. Arsenic is high in Well 14 and OWSI operations achieves drinking water compliance by constantly blending it with Well 16.

Table 2 provides a high-level summary of the requirements for implementation and of each treatment option along with the costs to implement.

**Table 1. Options and Impacts on Water Quality and Supply Operations**

Options	Coliform	Manganese	Arsenic
1. Maintain Current Operations	No change. Continued risk of coliform detections in the distribution system.	No change. Un-oxidized manganese still flows through distribution system. There is still a risk of discolored water.	Wells 14 and 16 must continue to be operated at the same time to blend arsenic concentration to below allowable limits.
2. Regular, Intermittent Chlorination	Minimizes risk of coliform occurrences as large bacteria growths are killed. However, bacteria will return and continue to grow between chlorination events.	Intermittent chlorine use causes dissolved manganese in the water to temporarily turn grey to black during the chlorination event. Customer notification prior to event is recommended along with unidirectional flushing afterwards.	Same as Option 1
3. Constant Chlorination	Prevents coliform occurrences as the initial bacteria growth dies off and the constant chlorination prevents future growth from restarting.	The chlorine causes the water to turn grey to black all the time for all Zone B customers.	Same as Option 1
4. Constant Chlorination with Sequestrant	Same as Option 3	The chlorine causes the water to turn grey to black all the time for most Zone B customers.	Same as Option 1
5. Constant Chlorination with Greensand or Pyrolusite Filters	Same as Option 3	Physically removes the manganese and eliminate water discoloration issues year-round.	Reduce arsenic concentrations and increase the operating capacity of Well 14.

**Table 2. Summary of Cost for Implementing Chlorination in Service Zone B**

<b>Management Options</b>	<b>Implementation Complexity</b>	<b>Ongoing Maintenance Complexity</b>	<b>Capital Cost to Implement</b>	<b>Annual Operational Cost</b>	<b>Additional 10-Year Net Present Cost</b>
Maintain Current Operations	None as there is nothing to implement	No change from current practices.	None	None – excluding labor expended to address potential future detections.	None - excluding labor expended to address potential future detections.
Intermittent Chlorination	Would require installation of new chemical feed system in existing well house	Low. Chlorine system would only be operated infrequently and would require chemical deliveries	\$16,000	\$1,900	\$33,700
Constant Chlorination	Would require installation of new chemical feed system in existing well house	Moderate. Chlorine system would be continuously operated and would require more frequent chemical deliveries. Chlorine residual monitoring	\$111,000	\$44,400 – disregards any costs incurred for damaged laundry and fixture staining	\$594,500 – disregards any costs incurred for damaged laundry and fixture staining
Constant Chlorination with Sequestrant	Would require installation of two new chemical feed systems in a new chemical building	Moderate. Chlorine system would be continuously operated and would require more frequent chemical deliveries. Chlorine residual monitoring	\$257,300	\$63,300 – disregards any costs incurred for damaged laundry and fixture staining	\$946,700 – disregards any costs incurred for damaged laundry and fixture staining
Constant Chlorination with Greensand or Pyrolusite Filters	Would require a new filtration building to be installed with a larger footprint	Moderate. Requires chlorine system. Media replacement and routine maintenance	\$1,667,800	\$112,600	\$2,893,900

All treatment options discussed above, with the exception of the Option 1, will reduce the occurrence of coliform hits throughout the distribution system. Option 2 does not provide a long-term solution for preventing coliform occurrences in the distribution system, but will provide a short-term solution that will temporarily kill off bacteria each time the system is chlorinated. Both Option 1 and Option 2 have a very high risk associated with them.

Option 3 provides a long-term treatment solution and will prevent coliform occurrences in the distribution system, however, due to high manganese concentrations in Well 14 and 16, there is a strong likelihood that water discoloration will occur in the distribution system, which may lead to increased customer complaints and damages. Option 4 provides long-term treatment to prevent the growth and re-growth of coliform in the distribution system. However, due to limitations with sequestrant and long water age throughout the system, water discoloration issues and risk of complaints and damages will still exist. When water usage is higher during summer months, water age will not pose as much of an issue as it would in the winter season when water age is much longer causing the sequestrant to become effectively useless for much of the distribution system. There is a high risk associated with Options 3 and 4 due to water discoloration events that could impact a large number of customers throughout the service area.

Option 5 would be the most effective long-term treatment option to prevent growth and prevent aesthetic water quality issues throughout the distribution system as it would significantly decrease manganese concentrations in Well 14 and 16. An ancillary benefit to the manganese filtration system is that it will also be capable of reducing arsenic concentrations, which would allow the operating capacity of Well 14 to be increased. Further, the system could be designed to be expanded to treat any additional water supplies in the future. OWSI has been preparing to install a treatment system for manganese removal as part of the water system improvements required to address the deficiencies identified in their Water System Plan.

### 3.0 Treatment for Service Zone A

The well sites in Service Zone A will need to be modified to incorporate chlorination if Zone B becomes chlorinated. Currently, Well 2 and Well 3 are treated to remove iron and manganese using greensand filters. Due to the existing treatment at each of the wells in Service Zone A, there is no additional treatment that will be required in addition to chlorination. Each of the three well houses in Service Zone A will require a new chemical feed system that will be installed in the existing buildings. The chemical feed system will consist of two chemical feed pumps, chemical storage drums, and a chlorine analyzer along with the associated controls. Table 3 presents the associated costs for each of the chlorination systems.

**Table 3. Summary of Options Implementation in Service Zone A**

Groundwater Source	Capital Cost to Implement	Annual Operational Cost
Well 2	\$62,000	\$38,000
Well 3	\$62,000	\$38,000
Well 4N	\$62,000	\$38,000

## 4.0 Recommendations

HDR recommends that Option 5 be implemented in Service Zone B, constant chlorination with greensand or pyrolusite filters be implemented in Zone B along with constant chlorination of Service Zone A. This option provides the most effective long-term solution to prevent coliform occurrences in the distribution system while eliminating aesthetic issues, allowing an increase in operating capacity and providing the ability to be expanded to treat additional water supplies.

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