Title: Oxidation Pond Infiltrometer Study to Determine if Compacted Bay Sediments Allows Pond Water To Transfer to the Bay

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Objective: Determine whether a difference in head between the oxidation pond and Humboldt Bay can result in transfer of wastewater through the historic bay sediments.

Similar Studies: N/A

Objective

The objective of this report is to determine whether or not a head differential can cause oxidation pond water to leak into Humboldt Bay.

Introduction and Background

The City of Arcata Wastewater Treatment Plant (AWWTP) is responding to a question concerning the potential that oxidation pond water is leaking into Humboldt Bay. This concern is a result of several claims that small streams of water can be seen flowing out of the exterior side of the pond levee during low tide at the interface of the rock siding with the bed sediments. Because of the potential water quality impacts and permitting concerns related to leaking water, AWWTP is requesting that an infiltrometer study be completed to determine if direct pond water is infiltrating through the historic bay sediments. These historic bed sediments are the bottom of the oxidation ponds , the treatment wetlands and the remnant fish ponds.

Infiltrometers are simple devices that separate a column of water from its surrounding body. This separation is important because it shows how hydraulically independent the column is to the surrounding pond. The only possible hydraulic connection through the infiltrometer is through the bottom soil layer. So, by tracking the changes in water elevation within an infiltrometer a conclusion can be made about hydraulic conductivity of the sealing soil. In this case, bay mud acts as a liner for both oxidation ponds. Information is needed to determine if the observed leaking is a result of transport through the mud.

Methodology

For this study, five infiltrometers were installed at various locations around the oxidation ponds (Figure 1). These infiltrometers were numerically labeled. Their locations, and coordinates, are listed below:

1. Fish Pond- Located on North side of the fish pond off the dock (40°51'09.71"N 124°05'29.38"W).
2. Pond 2- Located at the Northwest corner of oxidation pond 2 just of f the dock (40°51'06.47"N 124°05'30.47"W).
3. Pond 1 West- Located on the Western border of oxidation pond 1 (40°50'57.94"N 124°05'28.68"W)
4. Pond 1 South- Located on the Southern border of oxidation pond 1 (40°50'58.52"N 124°05'15.80"W)
5. Pond 1 East- Located on the Southern border of oxidation pond 1 (40°51'00.75"N 124°05'07.15"W).

Each infiltrometer is an 8-inch diameter PVC pipe that has 6-inch measuring increments marked along their lengths. These measuring marks were created manually using measuring tape and a Sharpie marker. The infiltrometers were then installed at each of Figure 1's marked locations

using a backhoe loader. A backhoe was used to drive the pipes into the sediments (about 2 ft) to a point of refusal. The action of driving the infiltrometers into the mud caused a natural head differential between the water in the pipe and the water in the surrounding oxidation pond. Using this head differential, and several measurements, an experimental method was created to measure if any water loss/gain is allowable through the bay mud. Depending on the site there is about 2 feet of sealing sediment in the tubes which trapped the water level at the point of sealing as the tubes were driven into the sediment.

Only one type of measurement was recorded to determine if water passage was possible through the bay mud: the distance to the water within each pipe. This measurement was recorded as often as possible.

Figure 1- Location of the 5 infiltrometers used. Initial measurements (total pipe depth, depth to mud, and water depth in pipe) were recorded shortly after their installation (Google Earth, 2016).

The distance to water within each pipe was recorded to within 1/16 of an inch, using a *Stanley TLM 99 Laser Distance Measurer* (referred to as TLM 99). The listed precision of this device was $^{3}/_{32}$ inch. To record reproducible measurements at each location with the TLM 99, two additional tools were needed. First, a flat, buoyant target for each infiltrometer was required to provide a constant surface for the laser to hit and reflect off. For this study, circular sections of styrofoam were cut out and dropped into each pipe. Second, a custom made plexiglass mount (Figure 2). Because the tops of each pipe were not level, this mount (and each pipe) was marked with a North and a South label to help position the apparatus before each measurement. These North and South labels were qualitative, but having at least two marks provides a line-up reference for the laser.

Figure 2- Plexiglass mount used for the TLM 99 laser measuring device. The mount has two marking, the visible "N" symbol and an "S" symbol on the opposite side. These two markings were made as a reference to take measurements from.

Results

There appears to be no significant change in water elevation after 27 days.

Site 1 showed no change at all for any of its measurements. Site 1 is also the most tidally influenced location of the five infiltrometers, with the fish pond being connected to the bay. The connection to the bay is indirect through pipes that allow bay water to enter these ponds an has a fixed lower water level with the pipe and higher level established by tide levels and head loses through the ponds and pipes. Even with a dynamic head, there was no observed difference in

water depth within the pipe. This is an indication that tidal pattern does not affect leaking potential.

Sites 3 and 5 show a change in water elevation ($^1/_{16}$ in) less than the precision of the measuring device ($^3/_{32}$ in), while site 4 shows only one notable change. The initial depth measurement for site 4 was 58.875 inches, but the next reading that occurred two weeks later showed a depth of 59.000 inches. This eighth of an inch (0.125 in) increase is the only change in Pond 1 that was greater than the precision of the instrument.

The greatest difference between measurements occurred at the site 2. Two weeks after installation there appeared to be a depth increase of a quarter of an inch (0.25 in). The following two weeks, the depth changed within $^1/_{16}$ of an inch. This initial increase is assumed to be due to the location and installation process. The Pond 2 infiltrometer was the most difficult unit to install because of its location. Also, site 2 is a location known to have a gravel bottom which may have interfered with the bay sediment seal. Present City operation allows stormwater drain cleanout to be discharged at this location, as result wer feel this was not a representative site to place an infiltrometer.

Table 1- Changes in water depth for each of the five infiltrometers: No significant change was measured in Pond 1 or the fish pond, while Pond 2 is argued to have implementation errors.

	Depth to water and change in depth to water in pipe at each site [in]									
Date	1	Δ 1	2	Δ 2	3	Δ 3	4	Δ 4	5	Δ 5
12/30/2016	72.688	-	63.125	-	58.125	-	58.875	-	44.000	-
1/6/2017	72.688	0.000	63.125	0.000	-	-	-	-	-	-
1/12/2017	72.688	0.000	62.875	-0.250	-	-	-	-	-	-
1/13/2017	72.688	0.000	62.938	0.063	58.188	0.063	59.000	0.125	44.063	0.063
1/26/2017	72.688	0.000	62.875	-0.063	58.125	-0.063	58.938	-0.063	44.125	0.063

Findings

- There was no change in depth for site 1, which is the infiltrometer location that has a small dynamic head that changes with the bay tide via a connection through several of the other ponds one of which is connected directly to the baay.
- The majority of depth changes in the infiltrometers were within the precision of the laser measuring device.
- The largest change in Pond 1 was an eighth of an inch (0.125 in), which happened over a two week period
- Site 2 (Pond 2) had the largest single change of a quarter of an inch (0.25 in).

Conclusions and Recommendations

The findings of this brief study shows that there is no indication that there is a change in water

level within the infiltrometers the in range of the measuring devices' accuracy. This is interpretative as there is no water loss resulting from leaking. The majority of depth changes were within the precision of the measuring device, and only two measurements were greater than the precision. Also, the findings for the fish pond infiltrometer indicate that there is little to no tidal influence on the leaking potential of bay mud.

If required, another study would be recommended to obtain a finer resolution of samples. Besides increasing the frequency of data collected, there would also be a large enough data pool to perform statistical analyses.