Hooven Bog Water Chemistry

Road Study

Snohomish County
Surface Water Management

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Abstract

In April 2014, Snohomish County purchased Hooven Bog, a 37-acre peat bog, for preservation. The bog is managed by the Snohomish County Parks and Surface Water Management (SWM). Since bogs are unique systems characterized by a specific plant community and chemical conditions, SWM decided to collect water quality samples to develop a baseline of the current chemical conditions of the bog. This study was completed in August 2016 (Snohomish County SWM, 2016).

In the 1970’s, a road was constructed bisecting the western portion of the bog (Figure 1). Concerns about the long term impacts this road may have on the bog led to the removal of the upper portions of the road in September 2016. To understand potential changes to the surface water from the removal of road, the County developed a surface water monitoring study.

Within the six week study period, the County was able to establish a statistically significant data set representing the chemistry of the road footprint. This data showed that most of the parameters of concern, including pH, alkalinity, calcium, magnesium and conductivity were lower or the same as the mean concentrations observed in the baseline study (Snohomish County SWM, 2016).
**Introduction**

In April 2014, Snohomish County purchased Hooven Bog, a 37-acre peat bog, for preservation. Some development has occurred to the north and west of the bog and in the 1970’s, an access road that bisected the western side of the bog was constructed. Prior to the purchase by the county, the land surrounding the bog on the south side had been slated for development, which would have added additional stress on the bog. The bog is now managed by the Snohomish County Parks and Surface Water Management (SWM).

Stakeholders were concerned that the road bisecting the bog was impacting its health. To respond to this concern, the County removed the upper one to one and a half feet of road and side cast materials in September 2016. This portion of the road was removed to improve hydraulic connectivity and reduce potential impacts to the water chemistry from the crushed concrete, while disturbing the bog as little as possible.

To understand potential changes to the surface water from the removal of the upper portions of the road and side cast areas, the County developed a surface water monitoring study. The short term study collected samples from randomly selected sites and analyzed those samples for parameters that typically define peatlands and that could be affected by the presence of concrete. These included pH, conductivity, alkalinity, hardness, calcium, and magnesium. The results were compared to the baseline chemistry study conducted by SWM in 2016. (Snohomish County SWM 2016)
Background

Site Description
Hooven Bog is located east of 75th Avenue Southeast between 238th Street Southeast and 242nd Street Southeast, and west of Crystal Lake. The County owns approximately 37 acres of land which includes the approximately 25 acre peatland complex, a forested area south of the peatland, and a house and abandoned pasture to the west.

Within the peatland complex there are four distinct features, a sphagnum mat, a lake in the center of the mat, a moat surrounding the sphagnum mat, and a moat on the west side of the complex that is separated by a road bisecting the complex. For the purposes of this report, the peatland complex will be referred to as Hooven bog or Bog (Figure 1).

Baseline Sampling
SWM conducted a baseline water chemistry sampling strategy from December 2014-November 2015 (Snohomish County SWM 2016). The study focused on characterizing the chemical characteristics of each of the features of the bog (Figure 1). The Hooven Bog Water Chemistry Baseline Study was completed in August 2016. The study produced a statistically significant data set representing the chemistry of the Bog, which corresponded to literature values for the chemical signatures of other bogs and transition waters. The road was considered one of the primary features of the Bog during the baseline study.

To characterize the waters around the road, two sample points were randomly selected per sample event, and at each point four grab samples were collected at 10 feet and 25 feet from the road on the east and west side of the road. Table 2 provides summary statistics for the baseline sampling period.

Road Removal
The road was installed in the early 1970’s and at some point was topped with crushed concrete, which also could be found side cast along the sides of the road into the edges of both the east and west moat. The Hooven Bog stakeholders and the County identified the road and the concrete as having a potential physical and chemical impact on the bog. The baseline water chemistry study did not find the bog water immediately surrounding the road to exceed the chemical concentration range of other reported transition waters, although mean values were slightly higher than the east and west moats.

In September 2016, the County removed the upper one to one and a half feet of road material, specifically targeting the existing crushed concrete. Additionally, the County cut a channel between the east and west moat to provide a surficial hydrologic connection. At the new elevation, the footprint of the road was intended to be inundated by water throughout the wet season.
Figure 1 Location Map

Legend

Hooven Bog Features
- Orange: West Moat
- Light Blue: East Moat
- Green: Mat
- Blue: Lake

North

Road

Inlet: Hooven III-2
Outlet

Inlet: Hooven III-3

Lake

Figure 1 Location Map
**Sampling Design**

The primary goal of sampling the road footprint after road removal was to identify water chemistry changes as compared to the 2015 baseline sampling. To accomplish this, a randomized sampling strategy was employed so that results could be grouped to improve the representativeness and significance of the data. The sampling was targeted to begin in Fall 2016 upon inundation of the footprint by water in the bog. The sampling was designed to be short term, six to eight sampling event, or until the County felt the data was statistically significant.

The potential sample locations were selected by overlaying a 20 foot by 20 foot grid over the entire area with a centroid in each square (Figure 2). Samples were collected within each square as close to the centroid as possible. A set of 20 sample locations were randomly selected using a random number generator for each sampling event. Of those 20 randomly selected sampling locations, 10 were randomly selected to be sampled for in-situ measurements only, while the remaining 10 were selected for in-situ and laboratory measurements.

Conductivity and pH (Table 1) were collected in-situ using a HACH Hydrolab. During the sampling period, if a pH or conductivity measurement collected exceeded the upper or lower 95% confidence limits of the baseline study, and that site was not scheduled for a grab sample, then a grab sample would be collected at that site.

Grab water samples were collected by submerging a laboratory prepared sample bottle in open water and sent to a laboratory to be analyzed for alkalinity, calcium, magnesium, and hardness (Table 1).

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Unit</th>
<th>Sample type</th>
<th>Method</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>NA</td>
<td>In-situ</td>
<td></td>
<td>Weekly</td>
</tr>
<tr>
<td>Conductivity</td>
<td></td>
<td>In-situ</td>
<td></td>
<td>Weekly</td>
</tr>
<tr>
<td>Alkalinity</td>
<td>mg/L</td>
<td>Grab</td>
<td>SM2320B</td>
<td>Weekly</td>
</tr>
<tr>
<td>Hardness</td>
<td>mg/L</td>
<td>Grab</td>
<td>EPA 200.7</td>
<td>Weekly</td>
</tr>
<tr>
<td>Calcium</td>
<td>mg/L</td>
<td>Grab</td>
<td>EPA 200.7</td>
<td>Weekly</td>
</tr>
<tr>
<td>Magnesium</td>
<td>mg/L</td>
<td>Grab</td>
<td>EPA 200.7</td>
<td>Weekly</td>
</tr>
</tbody>
</table>
Figure 2 Hooven Bog Monitoring Locations
Results and Conclusions

Sampling began October 20, 2016 and concluded November 30, 2016 for a total of six sample events. During the six-week study of the road footprint, 109 in-situ measurements were made and 53 water chemistry samples were collected. Table 2 presents the summary statistics for the road footprint (after removal) sampling study and the 2015 baseline study results for the road corridor (prior to removal). The data is also represented in box and whisker plots in Attachment A, to illustrate the distribution of the data and provide a comparison between features.

The confidence interval states that there is a 95 percent chance that the true population mean lies within the upper and lower intervals. Based on this analysis, the County believes that the mean of the data is statistically significant and represents the current conditions of the road footprint.

The primary goal of sampling the road footprint post road removal was to identify changes to the water chemistry based on the baseline sampling done in 2015. The mean values for alkalinity, calcium, hardness and pH are lower than observed in 2015, with conductivity and magnesium seeing minimal changes. No samples exceeded the maximum values from the 2015 baseline study. Figure 3 is a plot of the sample locations throughout the study and the pH results measured during the study. The legend break point of 6.25 is the mean pH value from the baseline study and 6.9 is the maximum pH observed in the baseline study. The figure illustrates that the majority of the pH data collected during this study is less than the mean pH value of the baseline study and that no measured points exceed the maximum pH from the baseline study.

Some key factors to acknowledge:

- The samples for this study were collected entirely in the months of October and November 2016, where only one sample was collected for the baseline study during the period in 2015 due to low water levels
- Approximately 95 percent of the baseline monitoring samples were collected outside of the months of October and November
- Samples for the baseline study (2015) were collected 10 feet and 25 feet to the east and west of the road, where this study collected samples on the road footprint as well as east and west of the road.
- The study cannot identify the causation of the change in water chemistry
### Table 2 Water Quality Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>Alkalinity</th>
<th>Calcium</th>
<th>Conductivity</th>
<th>Hardness</th>
<th>Magnesium</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Road Footprint 2016</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>19.264</td>
<td>6.098</td>
<td>88.712</td>
<td>24.585</td>
<td>2.256</td>
<td>6.131</td>
</tr>
<tr>
<td>Minimum</td>
<td>6.000</td>
<td>2.600</td>
<td>15.100</td>
<td>10.000</td>
<td>0.890</td>
<td>5.500</td>
</tr>
<tr>
<td>Maximum</td>
<td>32.000</td>
<td>8.200</td>
<td>119.700</td>
<td>32.000</td>
<td>3.000</td>
<td>6.710</td>
</tr>
<tr>
<td>Median</td>
<td>20.000</td>
<td>6.200</td>
<td>92.850</td>
<td>25.000</td>
<td>2.300</td>
<td>6.190</td>
</tr>
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<td>Standard Deviation</td>
<td>4.923</td>
<td>1.107</td>
<td>20.018</td>
<td>4.194</td>
<td>0.366</td>
<td>0.210</td>
</tr>
<tr>
<td>95% Lower Confidence Limit</td>
<td>17.911</td>
<td>5.714</td>
<td>84.819</td>
<td>23.096</td>
<td>2.156</td>
<td>6.091</td>
</tr>
<tr>
<td>95% Upper Confidence Limit</td>
<td>20.617</td>
<td>6.482</td>
<td>92.605</td>
<td>26.074</td>
<td>2.357</td>
<td>6.171</td>
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<tr>
<td>n</td>
<td>53</td>
<td>53</td>
<td>106</td>
<td>53</td>
<td>53</td>
<td>109</td>
</tr>
</tbody>
</table>

|                      |            |         |              |          |           |     |
| **Baseline Study Road Corridor 2015** |            |         |              |          |           |     |
| Mean                 | 26.440     | 8.175   | 89.417       | 29.927   | 2.313     | 6.255|
| Minimum              | 0.500      | 5.000   | 44.900       | 19.000   | 1.700     | 5.210|
| Maximum              | 78.000     | 30.000  | 192.600      | 88.000   | 3.300     | 6.900|
| Median               | 25.000     | 7.100   | 87.200       | 27.000   | 2.300     | 6.270|
| Standard Deviation   | 11.242     | 3.642   | 24.042       | 9.756    | 0.270     | 0.299|
| 95% Lower Confidence Limit | 23.486  | 7.145   | 83.151       | 27.290   | 2.240     | 6.177|
| 95% Upper Confidence Limit | 29.393  | 9.204   | 95.683       | 32.565   | 2.386     | 6.333|
| n                    | 58         | 55      | 59           | 55       | 55        | 59  |
Figure 3 pH Results Distribution

Legend

pH Results

- 5.5 - 6.25
- 6.25 - 6.9
- 6.9 - 7.2
References
Attachment A Box and Whisker Plots of Hooven Bog Data