

Port of Hood River Oregon: Nichols Basin Water Quality Study, 2007
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Final Report
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1 Introduction

The purpose of this study was to examine the water quality of Nichols Basin (Basin) during the warm weather months (June through October, 2007); investigate whether exceedences of DEQ water quality standards might occur that could have negative impacts to beneficial uses of the Basin by humans, fish and wildlife; briefly describe the beneficial uses of the Basin to humans and wildlife; and assess the Basin's connectivity to Hood River and the Columbia River during the warm weather months.

This draft final report presents SWCA's findings from analyses of bacteria (fecal coliform and *E. coli*), Total Suspended Solids (TSS), and water temperature data from the Basin and Hood River, and also incorporates data from nearby U.S. Geological Survey sites, and Oregon Department of Environmental Quality (DEQ) sampling locations on the Hood and Columbia Rivers, populated by data collected and provided by the Columbia RiverKeeper. The Port of Hood River (Port) contracted with SWCA, Inc. to conduct this study.

2 Summary

The Bullet points below were previously provided to the Port and are repeated here as the major findings of the study. Details of all of these conclusions are included in the report sections following the summary.

- The Basin was not impaired for beneficial use based on bacterial levels (fecal coliform and *E. coli*) during the course of the study (May 31-October 19, 2007). Although there is only one datum from the Columbia River for comparison, based on that datum, the bacteria levels were similar in the Basin and the Columbia River.
- The Basin was impaired for beneficial use by salmon and steelhead based on temperature exceedences (over 20°C) during a portion of the study period . The temperature regime of the Basin closely matches the temperature of the Columbia River in comparison with the Hood River. The Columbia River around Hood River is routinely temperature impaired during a portion of the warm weather months.
- The TSS data indicate that TSS in the Hood River and the Basin are not closely coupled. This neither proves nor disproves the question of whether Hood River water percolates through the levee separating the Hood River from the Basin. It is possible that percolation occurs, and that TSS levels are reduced in the process. Additional TSS assessments may help, and other parameters should be investigated to continue to inform this question. This is an important issue as beneficial use impacts (from temperature and other sources) might be ameliorated by input of Hood River water into the Basin.
- The Hood River Delta's (Delta) occlusion of the entrance to Nichols Basin has caused a reduction in boater access to the Basin and resulted in less use of the Basin for water contact recreation by boats entering the basin from the Columbia River. This observed change in the recreational use of

the Basin could be considered to be an impact from the Delta to the boating and water contact recreation beneficial uses of the Basin.

- Though diminished for some periods of this study, complete closure of the entrance to the Basin from the Columbia River did not occur during 2007's warm weather (low pool height) months.

3 Background

This Study provides an initial assessment of water quality and beneficial use impacts in Nichols Basin. It represents a proactive response by the Port towards assessing the effects of the (newly formed) Hood River Delta (Delta). The Delta rose to the surface of the Bonneville pool during very high sediment flows on the Hood River during the winter and spring of 2007. Delta formation at river mouths is a well understood process, and in the case of the Hood River, represents a process whereby the Hood River is once again reaching equilibrium with the Columbia River. This lengthy process is a response to the increased elevation of the Columbia River due to creation of the Bonneville Pool and the concomitantly altered flow regime of the Columbia River. The newly formed Delta is likely to be a permanent feature of the landscape unless there is an (unexpected) radical change to the hydrological processes of the Columbia River such as removal of the Bonneville dam, earthquakes or major flood events.

The Port recognized that the formation of the Delta caused shallowing and constriction of the entrance to the Basin, and that one of the results of this might be negative impacts to the Basin's water quality due to the potential of the shallowing and constriction to limit water exchange between the Basin and the Columbia River. Diminished water quality in the Basin, if it occurred, could be harmful to beneficial uses by humans, fish and wildlife, including species accorded special status and protection under the federal Endangered Species Act. The Basin receives much recreational use during the warm weather months, including: fishing, swimming, dog play, board sports and boating. The Basin also provides habitat for a variety of plants and animals, including fish, birds, mammals, and others. Though not documented as part of this study, multiple races of salmon and steelhead migrate past the Basin during upriver migration of adults to their spawning grounds, and during downriver migration of juveniles to the ocean. The Basin may serve as both habitat and feeding area for some of these fish, as well as possibly filling other important ecological roles.

4 Study Location

Nichols Basin is on Port of Hood River property. It is a man-made embayment of the Columbia River within the city of Hood River, Oregon. The Basin is essentially rectangular in shape, with the long axis of the rectangle oriented in a north-south direction. The Basin is just west of the Hood River and is separated from the Hood River by a levee that forms the east side of the Basin. The south side of the Basin is north of highway I-84, and the buildings of the former Nichols Basin Boatworks remain on the southern shoreline of the Basin. The west side of the Basin abuts the Hood River Events Center, and the north side is the connection to the Columbia River. On May 16, 2007, the Basin was 16-20 ft deep in the center and the entrance to the basin was 30-40 ft wide and 4-6 ft. deep at its deepest point. Prior to the formation of the Delta, the connection was both wider and deeper, allowing access of fairly large vessels to the Basin. At the onset of the study it was not clear whether lower pool heights during the summer or fall would result in separation of the Basin from the Columbia River due to the shallowness of the entrance.

5 Study Design

This study was designed to be a preliminary cost effective and proactive assessment of the effects of the Delta on the water quality of the Basin, and was also intended to investigate whether water from Hood River might be infiltrating through the Hood River levee (levee) that separates Hood River from the Basin. The shallowing and constriction of the Basin's connection to the Columbia caused by formation of the Delta has the potential to reduce water circulation and exchange in the Basin and might thereby result in diminished water quality parameters (impacts) including increased temperature, increased bacteria concentrations, decreased dissolved oxygen, and increases in the metabolic byproducts of bacterial degradation. Water temperature and bacteria concentrations were chosen as appropriate parameters to test the potential for water quality impacts during this initial investigation of the effects of the Delta. TSS, a measurement of the concentration of particulates in the water, was chosen to try to assess, together with water temperature, whether or not Hood River water might be infiltrating into the Basin through the levee.

Additionally, data from nearby Columbia River and Hood River DEQ locations collected and provided by The Columbia RiverKeeper was investigated as well, to help inform the study by allowing comparisons to the water quality parameters of these nearby locations. USGS temperature data were also investigated. Observations of beneficial uses were provided by the Port, and also provided by Eli Camero, a Columbia RiverKeeper volunteer and Hood River resident (M. McElwee, E. Camero, personal communications). Mr. Camero, a high school student, works at the Gorge Kiteboard School at the end of the levee nearest the Delta, during the summer. During the course of the study, he provided daily observations of beneficial uses of the Basin as well as observations of changes to the water level and quality in the Basin. SWCA Inc. hired and trained Mr. Camero (as a temporary employee during the course of this study) to acquire the bacteria and TSS samples, and to provide the daily observations of the Basin's water quality and beneficial uses.

In-season data reports of the results of the bacteria and TSS analyses were provided to the Port as well as a summary of these analyses after the last of this data was acquired. These reports were provided to keep the Port informed of the study's progress as well as to inform the Port of any exceedences of DEQ action levels based on measured bacteria concentrations, and of any observed impacts to the Basin's beneficial uses. These reports as well as this draft final report and the final report, which will incorporate requested changes or clarifications from the Port, are the contracted deliverable products of this study.

6 Beneficial Uses

The state of Oregon has established a list of beneficial uses for all water bodies in the state. The designated beneficial uses for the mainstem Columbia River (Nichols Basin falls under this designation) are: Public Domestic Water Supply, Private Domestic Water Supply, Industrial Water Supply, Irrigation, Livestock Watering, Fish & Aquatic Life, Wildlife and Hunting, Fishing, Boating, Water Contact Recreation, Aesthetic Quality, Hydro Power, and Commercial Navigation and Transportation. This list can be found at the following DEQ link: <http://www.deq.state.or.us/wq/rules/div041/dbutables/table101a.pdf>

In order to determine if impacts to beneficial uses are occurring, DEQ has set water quality standards for many parameters. The mainstem Columbia River is considered to have impaired beneficial uses for

migration of Salmon and Steelhead when water temperatures exceed 20°C. Beneficial uses for Public and Private Domestic Water Supply, and Water Contact Recreation are considered impaired when fecal coliform concentrations are over 400 MPN (most probable number) per 100 ml of source water; and are considered impaired when *E. coli* concentrations exceed a 30 day log mean of 126 *E. coli* organisms per 100ml of source water, and no single sample may exceed 406 *E. coli* organisms per 100ml source water. DEQ has not yet established standards for TSS.

7 Materials and Methods

SWCA staff scientist Mr. Jordan Gold installed the temperature monitoring gear on May 16, 2007. The temperature recording devices or Hobos®, (Onset brand, Water Temp Pro model) were set to record every half hour and were positioned at the surface and bottom in three separate locations on a north-south axis along the deepest portion of the Basin. The moorings consisted of two lead anchors on the bottom and a buoy on the surface. The buoy line was adjusted to be vertical in the water column and the second anchor was tied to the first anchor with 20-30 ft of line separating the two. This deployment method resulted in a vertical line between the surface buoy and the first bottom anchor, and insured that unanticipated increases in the water level would not allow the gear to be displaced to any great extent (even if the first anchor was lifted clear of the bottom due to increased water depth, the second anchor would limit the movement of the gear to a small area).

The hobos were placed in protective PVC cages that allowed unimpeded water flow, and the cages were cable-tied to the mooring lines. The surface hobos were positioned approximately six inches under the water surface, and the bottom hobos were approximately 1 foot off of the bottom. Additionally, single hobos were moored in subsurface locations in Columbia River just west of the Event Center and in the Hood River, next to the Gorge Kiteboard School at the end of the levee. The manufacturer's stated accuracy for these loggers is $\pm 0.2^{\circ}\text{C}$ at 0° to 50°C, with resolution of 0.02°C at 25°C. Each data point in this study should therefore be considered to be within 0.2°C of the value shown.

On May 31, 2007 Mr. Gold and Mr. Camero acquired the first of the samples for bacteria and TSS. Fecal Coliform was sampled from shore at two locations on the east bank of the Basin (NB1 and NB2), and TSS was sampled from one location on the east bank of the Basin (NB1) and one location on the west shore of the Hood River, just below the Gorge Kiteboard School. These grab samples were acquired using a pole style sampler with a clean jar held at the end of the pole. Once acquired, the sampled water was placed in pre-cleaned, laboratory supplied sample jars, sealed and labeled, then placed in a cooler filled with frozen blue ice. The samples were then shipped with a chain of custody form and a temperature blank to Columbia Analytical Laboratories, Inc. (Columbia) in Kelso, Washington, where the analyses were conducted. Beneficial uses of the Basin were also discussed and documented at this time. This event also served as the training event for Mr. Camero. All subsequent samples, beneficial uses, and observations of the Basin were acquired by Mr. Camero. Mr. Camero acquired the last water samples on October 19, 2007. He retrieved the temperature sampling equipment from the Basin and Hood River locations, but was unable to retrieve the equipment from the Columbia River as the cable locating and anchoring the equipment to the shoreline had parted. As described in the in-season data reports, the first bacterial samples were analyzed for fecal coliform rather than *E. coli*. It was then determined that the similar but more appropriate test for *E. coli* should be used due to its greater relevance to human health impacts. All subsequent analyses were then conducted for *E. coli* rather than fecal coliform.

The sample parameters, lat./long., sampling frequency and sampling depth are listed below in Table 1, and the sampling locations are depicted in Figure 1. The DEQ site at Bingen point and the USGS site at The Dalles are not depicted in this figure. Bingen point is on the Washington shoreline of the Columbia, and upriver from the basin, and The Dalles temperature site is also upriver from the Basin. Table 2 provides details of the nearby DEQ and Columbia RiverKeeper sites that we are using to compare our acquired data.

Table 1. Details of SWCA sampling type, frequency and location

location	Sample type	latitude	longitude	sampling frequency	Sampling Water Depth
Nichols Basin A surface and bottom	temperature	45°42'54.822N	121°30'38.512W	½ hr. (48/day)	surface and 16.0 ft.
Nichols Basin B surface and bottom	temperature	45°42'51.554N	121°30'36.535W	½ hr. (48/day)	surface and 17.2 ft.
Nichols Basin C surface and bottom	temperature	45°42'47.483N	121°30'35.751W	½ hr. (48/day)	Surface and 16.4 ft
Hood River	temperature	45°42'51.273N	121°30'30.352W	½ hr. (48/day)	≈2 ft.
*Columbia River	temperature	45°42'57.127N	121°30'49.971W	½ hr. (48/day)	≈ 3 ft.
Nichols Basin 1	bacteria, TSS	45°42.867'N	121°30'574W	monthly	surface
Nichols Basin 2	bacteria	45°42.742'N	121°30.504'W	monthly	surface
Hood River	TSS	45°42.854'N	121°30.504'W	monthly	surface

*Could not retrieve sampler at end of study due to tether failure.

Figure 1. Aerial photograph of the project area with project sampling locations depicted



8 DEQ/RiverKeeper Data

The Columbia RiverKeeper collects data from multiple locations in and around Nichols Basin as part of their ongoing water quality assessment activities (Columbia RiverKeeper, 2008, In Press). They sample a wide variety of parameters, of which only temperature and *E. coli* may be directly compared to the data produced by this study. Unfortunately, within the time frame of this study only a single *E. coli* sample was acquired by the Columbia RiverKeeper from nearby locations. This single sample came from the Columbia River at Hood River Hook, approximately 1 mile downriver from the Basin. The value acquired for this analysis was 4 MPN/100 ml source water. The temperature data set from the Columbia RiverKeeper is a bit more robust, most sites being sampled on a bi-monthly basis. There are two data points for temperature at a location inside Nichols Basin that allow direct comparison with SWCA temperature data, and eight data points from Hood river footbridge that also allow direct comparison with SWCA data. Unfortunately, loss of the Hobo in the Columbia River makes direct comparison to our temperature data impossible. However, we can still use the Columbia RiverKeeper (DEQ) data to compare to our Basin data so that temperature exceedences in the Basin can be viewed in a larger context. These data will also help assess sources of water to the basin by comparing Basin, Columbia River, and Hood river temperature regimes.

9 USGS Temperature Data

The nearest useful USGS temperature monitoring site is upstream from the Basin at The Dalles (station # 14105700). The USGS is sent the data at our request, and labeled it “provisional” though did not say why (USGS, 2008). This dataset is described in the results and discussion sections below, and provided as Appendix A of this report.

Table 2. Columbia RiverKeeper/DEQ data

location	Sample type	latitude	longitude	Sampling frequency	Sampling Water Depth
Columbia River at Bingen Pt.	temperature	45.7833	-120.4464	bi-monthly	2.5 ft.
Hood River Footbridge	temperature	45.7107	-121.5067	bi-monthly	surface
Columbia River inside Hood River Hook	temperature	45.7159	-120.5245	bi-monthly	2 ft.
Nichols Boatworks backwater	temperature	45.7143	-121.5097	2 times during this study	2 ft.
Columbia River at Hood River Hook	temperature and bacteria	45.7172	-121.5258	bi-monthly temperature, and a single bacteria sample	3 ft.

10 Results

The DEQ provides action levels for Fecal coliform, *E. coli* and temperature, but not for TSS. Table 3 below provides sample timing, location, analytical values for all bacterial and TSS sampling conducted by SWCA. There were no exceedences of DEQ action levels for the bacterial analyses during the course of this study.

There are no discernable trends in the TSS data between levels in the Hood River and the Basin. Levels in the basin were either low or non-detectable, while levels in the Hood River were mostly low with the exception of the last sampling event during which TSS was highly elevated over all of the previous values. This sampling event occurred during a rainstorm, and the elevated levels in Hood River reflect the high TSS levels carried in the runoff from this precipitation event.

Table 3. Fecal coliform, *E.coli* and TSS sampling timing, location and analytical values

Sampling Date	Sampling location	Fecal coliform MPN*/100ml	<i>E.coli</i> MPN*/100ml	TSS (mg/L)
5/31/2007	Nichols Basin 1	4		
5/31/2007	Nichols Basin 2	240		
5/31/2007	Hood River			12
5/31/2007	Nichols Basin 1			non-detect
6/25/2007	Hood River			6
6/25/2007	Nichols Basin 1			5
6/25/2007	Nichols Basin 1		22	
6/25/2007	Nichols Basin 2		50	
7/31/2007	Hood River			21
7/31/2007	Nichols Basin 1			22
7/31/2007	Nichols Basin 1		30	
7/31/2007	Nichols Basin 2		Non-detect	
8/27/2007	Hood River			13
8/27/2007	Nichols Basin 1			non-detect
8/27/2007	Nichols Basin 1		30	
8/27/2007	Nichols Basin 2		2	
10/19/2007	Hood River			219
10/19/2007	Nichols Basin 1			5
10/19/2007	Nichols Basin 1		4	
10/19/2007	Nichols Basin 2		19	

*MPN means: most probable number

Water temperature results are depicted in Figures 2 and 3, and Table 4 below. Figure 2 shows that there was very good agreement between the Hobo data from Hood River and the temperature data derived from the grab samples acquired by the RiverKeeper from the Hood River Footbridge. RiverKeeper also acquired two individual temperature datum from a site within the Basin. These datum also are in very close agreement to SWCA derived water temperatures in the Basin. Figure 3 graphically depicts all Hobo derived data from the Basin and also includes Hood River Hobo data from the same time period. The graphs illustrate that the water in the basin is fairly well mixed based on the similarity of water temperatures

between all Basin locations for the duration of the study. Basin water was consistently over 20°C at all measured locations from July 7 until September 7, 2007, or approximately 40% of the time period of this study. Figure 3 also documents the consistently lower temperatures in the Hood River during the same time frame. The plots of bottom B and Bottom C depict temperatures slightly lower than the other Basin Hobo locations until midway through the project (late July), and then those locations show close alignment with the other Basin locations for the duration of the study. Table 4 documents the DEQ (RiverKeeper) data from the sites in the Basin and Hood River, and three sites on the Columbia River that are nearby the Basin. These locations were sampled on an approximately bi-monthly basis during the period of this study. Within the time period of this study, there are a total of 24 temperature data points from the Columbia River and Basin locations combined, and of the 24 points, 14 (58.3 %) are 20°C or higher, exceeding the impairment standard of 20°C. The USGS temperature data shows a similar trend for Columbia River at The Dalles. Between May 15 and October 19, 2007, water temperature was 20°C or higher approximately 44% of the time. The water temperature at this station did not drop below 20°C from July 10 through Sept. 17, 2007. The Hood River water temperature only exceeded 20°C for approximately 2 hours late in the afternoon on July 12. The raw data files and laboratory reports are achieved at SWCA's office in Portland, OR and will be provided on request.

Figure 2. Comparison of SWCA versus RiverKeeper temperature in Hood River

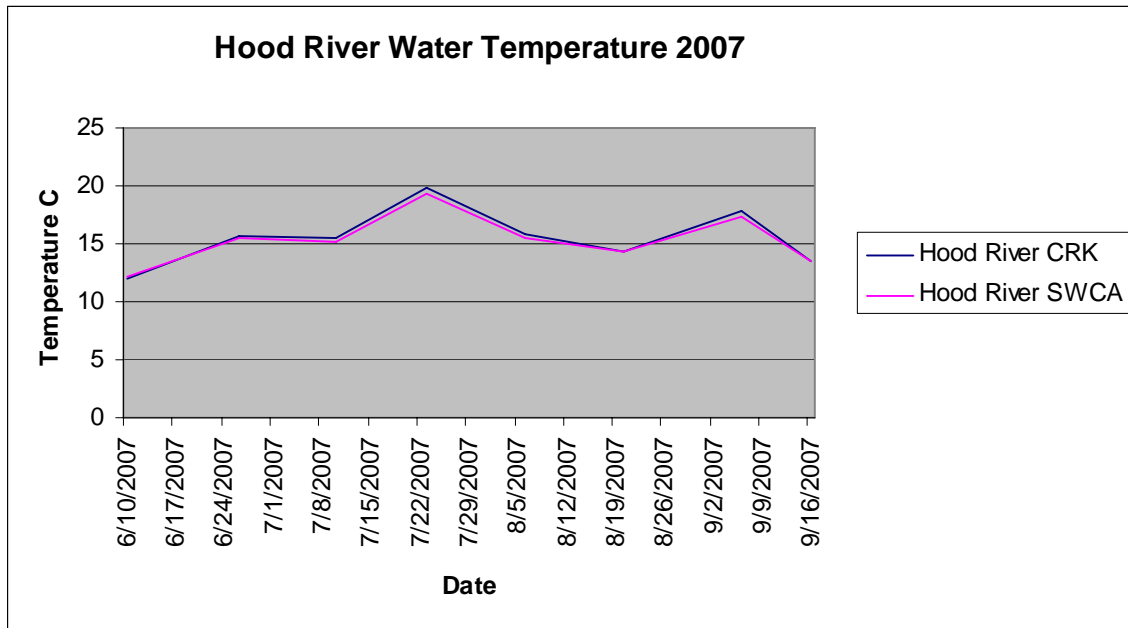


Figure 3. Comparison of SWCA Hobo temperature data at all SWCA sites in the Basin and Hood River (sA= surface site A, bA= bottom, site A, etc.)

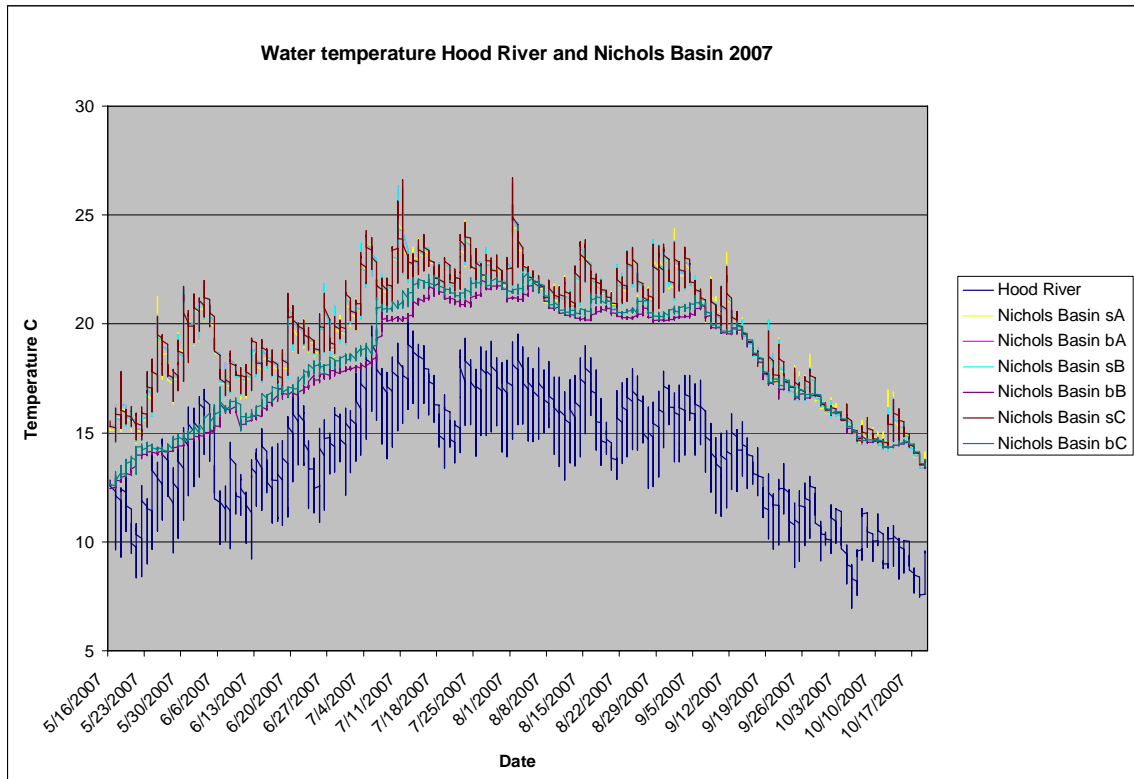


Table 4. This table documents water temperatures at DEQ sites in the Columbia River, Hood River, and Nichols basin during the period of the study. All dates are in 2007, all temperatures are degrees Celsius. Red highlights indicate temperatures over 20°C. These data were provided by the Columbia RiverKeeper.

	6/5	6/10	6/11	6/14	6/25	6/26	6/28	7/10	7/12	7/23	7/26	7/27	8/06	8/07	8/09	8/20	8/23	8/26	9/06	9/16	9/20	
Columbia River at Bingen Pt.				15.8			17.6		21.0		21.2				21.1		21.4		21.1			19.4
Hood River Footbridge		12.0				15.7		15.5		19.9			15.9			14.4			17.9	13.5		
Columbia River inside Hood River Hook	18.1		17.4		19.3			21.2				22.3		19.8					21.2			
Nichols Boatworks backwater											22.4		22.3									
Columbia River at Hood River Hook		16.0				17.8		20.0					21.8			20.5			21.2	19.2		

11 Observations of Physical Changes and Beneficial Uses

Most of the observed beneficial uses and physical changes observed and documented are tied to a particular date; however some of them are not. The dated observations are presented in a narrative format below, followed by the un-dated observations. With the exception of the first several observations made by Mr. Jordan Gold, all other observations were made by Mr. Eli Camero.

Dated observations:

May 16, 2007 The entrance to the Basin was 30-40 ft. wide and 4-6 ft. deep. The deepest portion of the Basin was 16-20 ft. deep. Beneficial uses observed included many people swimming their dogs, and 3 individual fishermen fishing inside the Basin. The fishermen related that the small mouth bass fishing in the Basin was often good. One of the fishermen informed Mr. Gold that ODFW had recently stocked the Basin with steelhead. This has not been confirmed with ODFW. Several species of birds were observed in the Basin at this time.

May 31, 2007 Several groups of large carp were observed swimming near the shoreline of the south east corner of the Basin.

June 12, 2007 The pool height was lowered and the channel entrance to the Basin was narrowed down to approximately 10 ft. wide and 3 to 4 ft. deep. Jet skis were still able to go in and out of the Basin through the channel entrance.

June 25 through July 28, 2007 The pool height was lowered again, and the channel entrance to the Basin was now approximately 6 ft. wide and 1 to 2 ft. deep.

July 29, 2007 The pool height was raised significantly, and the channel entrance to the Basin appeared to be approximately 90% of the original pre-Delta width.

July 30 through August 23, 2007 The Pool height remained high.

August 25, 2007 The Pool height dropped and the channel entrance to the Basin narrowed to half its former width.

October 19, 2007 It was raining, and many ducks and other birds were observed in the Basin.

General observations:

When the pool height is initially elevated the water in the basin turns black for a few days. This is likely a result of increased circulation in the basin stirring up anoxic bottom sediments.

Overall there was less use of the basin by people engaging in recreational activities during the warm weather months of 2007 than prior to the formation of the Delta. Previously, the basin was used as an anchorage by boaters, and was often used for swimming by the anchored boaters.

12 Discussion

12.1 Temperature

The temperature data from this study document several interesting and useful facts regarding the water quality of the Basin and the effects of the Delta. Though the basin water was impaired for beneficial uses due to temperature for a significant period of the study, so was the Columbia River. Temperature exceedences on the Columbia River in this reach are a routine occurrence and are a result of high summer temperatures acting on the impoundments behind the dams. The high water temperatures in the Basin reflect the fact that the basin is relatively enclosed, and that the obvious source water to the basin is the Columbia rather than the (cooler) Hood River. It is difficult to speculate how the situation was altered by the formation of the Delta, though it is possible that more Hood River water got into the Basin prior to the Delta's formation. This would result in lower summer water temperatures in the Basin if it occurred. The similarity of the Basin's temperature to the Columbia, and the disparity of the Basin's temperature with Hood River indicate that it is unlikely that significant amounts of Hood River water are infiltrating through the levee into the Basin. However, the lightly depressed temperatures at Bottom B and C locations in the Basin could be a result of cooler water infiltrating the basin from a source other than the Columbia River. The source could be the Hood River, or could be from other groundwater inputs. This slight temperature depression could also result from stratification in the Basin due to brief cessation of prevailing winds during the first half of the study. The overall similarity of the temperature of all six surface and bottom locations in the Basin during the course of the study indicate that the Basin's water remains well mixed throughout the warm weather months. This is likely to be a result of the consistent prevailing winds that occur in the area.

12.2 TSS

Lack of linkage between TSS levels in Hood River and the Basin indicate that it is unlikely that significant amounts of Hood River water infiltrate through the levee separating Hood River and the Basin. Additional TSS sampling and sampling of other parameters could help further refine the source(s) of the water in the Basin.

12.3 Bacteria

The basin's waters did not exceed beneficial use criteria for any beneficial use based on bacterial levels during the period of this study.

12.4 Beneficial Uses

The several days during this study that the basin waters were black and turbid, resulting from an increase in pool height after a drawdown, may also constitute an impact to Aesthetic quality beneficial use of the Basin.

The occlusion of the entrance by the Delta has impacted the boating and water contact recreation beneficial uses of the Basin by limiting access through the constricted entrance.

13 Recommendations

We feel that this proactive water quality assessment has provided a very useful initial look at water quality issues in the basin stemming from formation of the Hood River Delta. We recommend continued monitoring during the warm weather months to help ensure public safety and monitor beneficial uses and beneficial use impacts in the Basin. We also recommend further investigation of the sources of water to the Basin. Future development of the Basin and its beneficial uses could possibly benefit by utilizing the colder water available from Hood River. Establishing the presence of Hood River water in the Basin would help lay the ground work for utilization of this resource to ameliorate temperature impacts in the Basin to Beneficial use by salmon and steelhead.

14 References

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[2008](#)

15 APPENDIX A

USGS Temperature Data