Hatwai Creek Surface Water Quality Monitoring Report: 2018

State of Idaho
Department of Environmental Quality
November 2018; Revised February 2019

www.deq.idaho.gov

Acknowledgements

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Prepared by
Jason Williams
Idaho Department of Environmental Quality
Lewiston Regional Branch
1118 F Street
Lewiston, ID 83501

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Abbreviations, Acronyms, and Symbols

§303(d)	refers to section 303, subsection (d) of the Clean Water Act or to a list of impaired water bodies required by this section
°C	degrees Celsius
BURP	Beneficial Use Reconnaissance Program
cfs	cubic feet per second
CTD-10	METER brand sensor used to measure stream water level, temperature, and conductivity
CWA	Clean Water Act
CWAL	cold water aquatic life (beneficial use)
DEQ	Idaho Department of Environmental Quality
DO	dissolved oxygen
E. coli	*Escherichia coli*
EPA	United States Environmental Protection Agency
EXO-1	model name for water quality sonde used in project monitoring
HC67_02	monitoring site in 1st-order stream segment along Leon Road (Table 1, Figure 1)
HC67_03	monitoring site in 3rd-order segment of Hatwai Creek near the mouth (Table 1, Figure 1)
HCLO	monitoring site at outlet of pond holding spring water from HCSP (Table 1, Figure 1)
HCSP	spring monitoring site (Table 1, Figure 1)
HDPE	high-density polyethylene
IDAPA	numbering designation for all administrative rules in Idaho promulgated in accordance with the Idaho Administrative Procedure Act
IDFG	Idaho Department of Fish and Game
mg/L	milligrams per liter
mpn/100 mL	most probable number per 100 milliliters
MSL	mean sea level
NO_3+NO_2-N	nitrate plus nitrite nitrogen

NO_3-N	nitrate nitrogen
NPSWCD	Nez Perce Soil and Water Conservation District
PQL	practical quantitation limit
QA/QC	quality assurance and quality control
RPD	relative percent difference
SCR	secondary contact recreation (beneficial use)
TMDL	total maximum daily load
TP	total phosphorus (unfiltered, mixed forms)
QAPP	quality assurance project plan
YSI	Yellow Springs Instruments (brand name for water quality sonde used in project monitoring)

Revisions

This document was revised on February 14, 2019. Figure 12 was corrected; it initially displayed temperature data from HC67_03 rather than from HC67_02. It now displays temperature data from HC67_02.

Executive Summary

Hatwai Creek is a tributary to the Clearwater River in Nez Perce County, Idaho. The Idaho Department of Environmental Quality (DEQ) previously identified Hatwai Creek as impaired under the Clean Water Act by nutrients (nitrate plus nitrite nitrogen and total phosphorus) bacteria (*Escherichia coli*), and temperature. DEQ also previously developed a water quality improvement plan, the *Hatwai Creek Subbasin Assessment and TMDLs (Lower Clearwater HUC 17060306)* (Hatwai Creek TMDLs), to address the water impairments (DEQ 2010).

From March through September 2018, DEQ collected water quality data at the mouth and headwaters of Hatwai Creek to evaluate progress toward meeting water quality goals defined in the Hatwai Creek TMDLs. This report documents water quality monitoring methods and results and compares results to relevant targets established in the Hatwai Creek TMDLs and Idaho water quality standards.

In 2018, nutrient concentrations in Hatwai Creek exceeded target concentrations defined in the Hatwai Creek TMDLs at the mouth and in a headwaters stream segment. Nitrate plus nitrite nitrogen concentrations were higher in 2018 than in 2006–2007, when data were last collected, potentially due to greater precipitation, stream flow, and ground water nutrient inputs to the stream in 2018. Filamentous green algae growths were observed near the mouth in summer 2018, and were likely a symptom of elevated nutrient concentrations. Water column dissolved oxygen concentrations at the mouth did not meet Idaho's dissolved oxygen water quality standard for protection of salmonid spawning in early August. *Escherichia coli* (*E. coli*) concentrations exceeded Idaho's *E. coli* water quality standard at the headwaters and at the mouth. Stream temperature near the mouth exceeded Idaho's temperature water quality standards for protection of salmonid spawning during salmonid spawning periods. Stream temperature met Idaho's temperature water quality standards for protection of cold water aquatic life at the headwaters and the mouth.

DEQ will use these results and other available information to assess current support of beneficial uses in Hatwai Creek under the Clean Water Act, and to inform a periodic TMDL review required by Idaho Code §39-3611(7). DEQ's beneficial use support assessment and review of the Hatwai Creek TMDLs will be described in a separate document and, as required by Idaho Code §39-3615, the review will be conducted in consultation with a watershed advisory group composed of stakeholders affected by DEQ water quality management.

1 Introduction

The federal Clean Water Act (CWA) requires states and tribes to restore and maintain the chemical, physical, and biological integrity of the nation's waters. CWA section 303 requires states and tribes to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. In addition, CWA section 303(d) requires states and tribes to identify and prioritize water bodies where water quality does not meet water quality standards. States and tribes must periodically publish a list (a "§303(d) list") of waters where standards are not met. For these waters, states and tribes must develop a water quality improvement plan called a total maximum daily load (TMDL). A TMDL defines maximum inputs of a pollutant from all sources that can occur while still meeting water quality standards. The US Environmental Protection Agency (EPA) must review and approve TMDLs developed by states and tribes.

In 1989, the Idaho Department of Health and Welfare, Division of Environmental Quality, identified Hatwai Creek as not meeting water quality standards due to nutrients, bacteria, temperature, and habitat modifications (IDHW 1989). In 2010, the Idaho Department of Environmental Quality (DEQ) developed TMDLs for four pollutants: nitrite plus nitrate nitrogen (NO_3+NO_2-N), total phosphorus (TP), bacteria (*Escherichia coli*), and stream temperature (DEQ 2010). EPA approved the *Hatwai Creek Subbasin Assessment and TMDLs (Lower Clearwater HUC 17060306)* (Hatwai Creek TMDLs) in 2010 (EPA 2010).

Idaho Code §39-3611(7) requires DEQ to review approved TMDLs every 5 years to evaluate if assumptions, analyses, targets, and loads developed in TMDLs are still appropriate. In 2018, DEQ collected water quality data in Hatwai Creek for review of the Hatwai Creek TMDLs. This report documents monitoring methods and results, and compares results to relevant thresholds defined in the Hatwai Creek TMDLs and Idaho water quality standards.

DEQ's review of the Hatwai Creek TMDLs will be described in a separate document and, as required by Idaho Code §39-3615, will be conducted in consultation with a watershed advisory group composed of local stakeholders affected by DEQ water quality management.

1.1 Watershed Description

Hatwai Creek is a tributary to the Clearwater River in Nez Perce County, Idaho (Figure 1). The Hatwai Creek watershed spans 32 square miles (USGS 2017). The headwaters are 1st- and 2nd-order streams that begin in the rolling cropland of the Palouse at an elevation of approximately 2,900 feet above mean sea level (MSL). Hatwai Creek flows through a steep canyon and ranchland where it becomes a third order stream. It then flows through a culvert under U.S. Highway 95 and converges with the Clearwater River at an elevation of 788 feet above MSL. Land uses in the watershed include dryland agriculture, ranching, and rural residences. The watershed area is 66% agricultural land and less than 1% is covered by an impervious surface (USGS 2017). Anadromous Rainbow Trout (steelhead) spawn in Hatwai Creek (NPSWCD 2014; Joe DuPont personal communication August 28, 2018). The creek is also an important historical fishery for the Nez Perce Tribe. The eastern portion of the watershed lies within the Nez Perce

Reservation boundary (Figure 1). See the Hatwai Creek TMDL (DEQ 2010) for a more detailed watershed description.

1.2 Objectives

The objectives of this report are as follows:

- Document methods, data quality, and results associated with 2018 DEQ water quality monitoring in Hatwai Creek.
- Compare 2018 monitoring results to relevant TMDL targets and Idaho water quality standards.

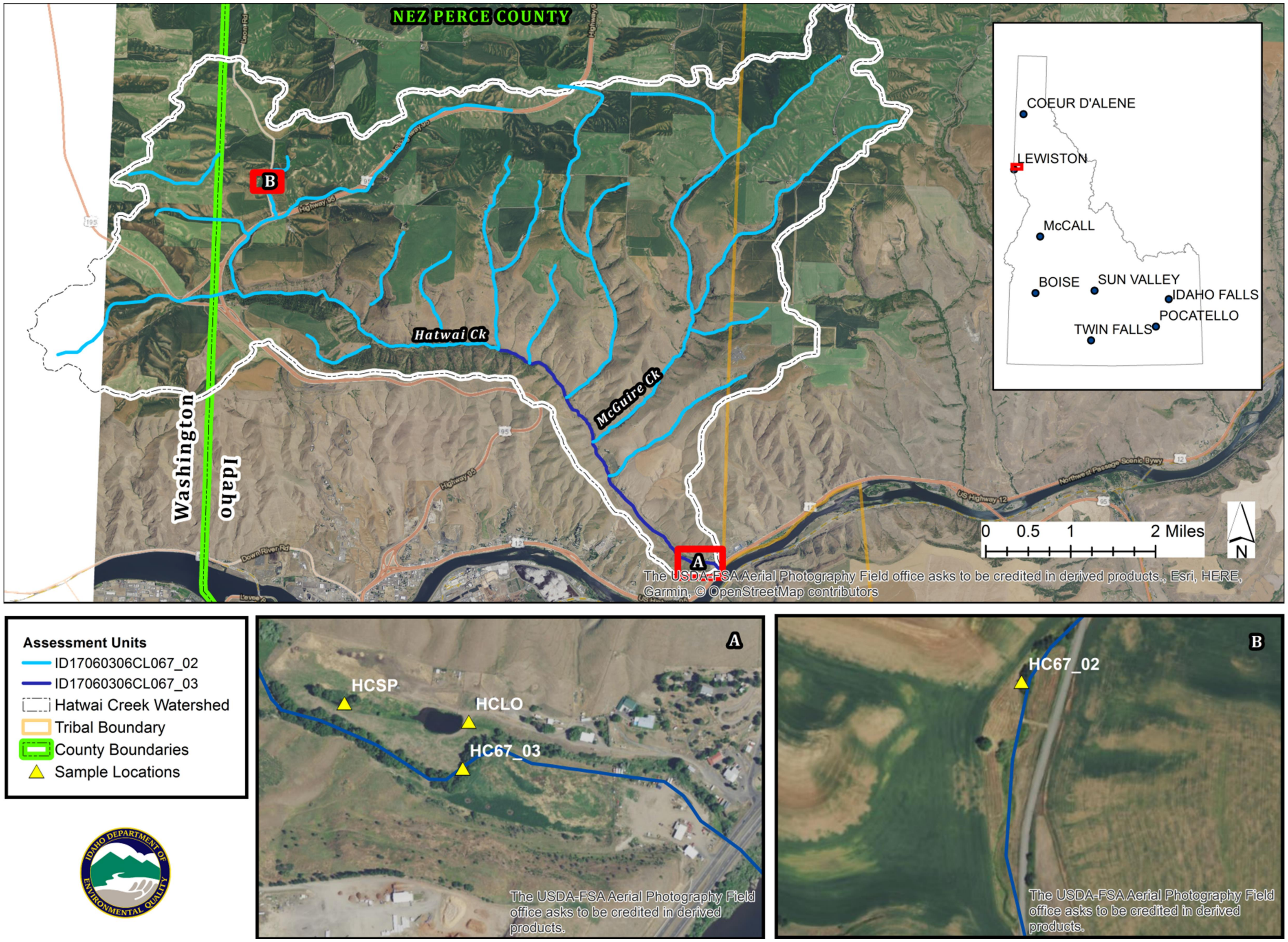

Figure 1. Hatwai watershed and 2018 sample locations. See Table 1 for sample location descriptions.

Table 1. Hatwai Creek 2018 monitoring sites and parameters monitored.

Site ID	Description	Assessment Unit (AU)	Latitude / Longitude[a]	Flow	Temp Logger	*E. coli*	NO_3+NO_2 (grab)	NO_3 (YSI)	TP	DO [b]
HC67_03	3rd-order stream segment near the creek mouth	ID17060306CL067_03	46.433462/ -116.918478	x	x	x	x	x	x	x
HCSP	Spring that flows into AU 67_03 downstream of HC67_03	ID17060306CL067_03	46.434379/ -116.921108			x	x		x	
HCLO	Outlet of pond holding spring water from HCSP	ID17060306CL067_03	46.43417 / -116.918385			x				
HC67_02	1st-order stream segment along Leon Road	ID17060306CL067_02	46.49644 / -117.027901	x	x	x	x	x	x	x

a. Coordinates use the WGS 84 Datum

b. Dissolved oxygen

2 Methods

In 2018, DEQ measured streamflow, stream temperature, and concentrations of nutrients, dissolved oxygen (DO), and *E. coli* at multiple locations in the Hatwai Creek watershed (Figure 1, Table 1). Prior to sampling, DEQ developed a Quality Assurance Project Plan (QAPP), which describes planned field and laboratory methodology, quality assurance and quality control (QA/QC) procedures, and data quality objectives (DEQ 2018). A summary of data QA/QC is provided in Appendix A. Nearly all data (99%) collected for this project met data quality objectives specified in the QAPP and are considered adequate for use in the Hatwai Creek TMDL review; one sample result was rejected due to a sample preservation concern (Appendix A) and was not used for analyses in this report.

2.1 Monitoring Sites

DEQ subdivides water bodies into assessment units (AUs) to assess and report if water quality standards are met. AUs are typically defined based on Strahler stream order, although additional factors such as land use, landscape physical characteristics, and local knowledge may also be considered. A detailed description of how DEQ subdivides state waters into AUs is provided in Idaho's most recent Integrated Report (DEQ 2017a). The Hatwai Creek watershed includes two AUs (Figure 1). AU ID17060306CL067_02 includes the Hatwai Creek tributaries (1st- and 2nd-order streams) and AU ID17060306CL067_03 includes the main stem of Hatwai Creek (a 3rd-order stream). Stream monitoring locations (Table 1, Figure 1) were selected to include sites within both AUs. Data were also collected at a spring (HCSP) and at the outflow point of a pond that holds spring water (HCLO) to monitor pollutant concentrations in ground water. Monitoring sites were selected to facilitate comparison with data used to develop the TMDL, and to evaluate pollutant sources while considering budget and property access constraints.

2.2 Stream Flow

2.2.1 Flow Measurements

DEQ measured stream flow twice per month at stream sites near the mouth (HC67_03) and the headwaters (HC67_02) (Figure 1). Flow was measured at site HC67_03 twice per month from March 6, 2018, through September 18, 2018. At site HC67_02, flow was measured twice per month from May 15, 2018 through September 18, 2018; DEQ did not gain site access until May. DEQ measured flow using a portable electromagnetic velocity meter and the velocity-area method. A stream transect was established perpendicular to stream flow. The transect was divided into equal-width cells, and water depth and velocity were measured within each cell. Flow was calculated by summing the product of velocity and area measurements calculated from each cell.

2.2.2 Stream Gage and Continuous Flow

In collaboration with the Nez Perce Soil and Water Conservation District (NPSWCD), DEQ installed a METER CTD-10 sensor and METER EM50G data logger at site HC67_03 near the

Hatwai Creek mouth (Figure 2). The CTD-10 sensor recorded stream water level, temperature, and conductivity at 15-minute intervals. DEQ used flow measurements made at HC67_03 (section 2.2.1) to develop an equation relating measured flow to CTD-10 water level (a rating curve). The rating curve was used to develop a stream hydrograph and estimate stream flow at 15-minute intervals. The rating curve is described in detail in Appendix B.

Figure 2. Sensor data, logger, and staff gauge in Hatwai Creek at HC67_03. The CTD-10 sensor is installed below the water surface in a PVC tube that is attached to a treated piece of wood and supported by two t-posts. The data logger is the white box at the top of the wood piece (left photo).

2.3 Water Chemistry

2.3.1 Grab Samples

Grab water samples were collected from the area within the stream channel that carries the greatest portion of flow (thalweg) by submerging a sample bottle below the stream surface. Water samples were analyzed at Anatek Labs in Moscow, Idaho. Analytical methods, preservatives, and holding times used are listed in Table 2. At least one field duplicate and one field blank sample were collected for every 20 regular samples (Appendix A).

Idaho's *E. coli* water quality standard is based on the geometric mean of at least five samples collected every 3-7 days over a 30-day period. Nutrient grab samples were collected twice per month at sites HC67_03, HCSP, and HC67_02. *E. coli* samples were collected at all four sites. At HC67_03 and HC67_02, *E. coli* samples were collected in spring and late summer. At HCSP and HCLO, *E. coli* samples were collected in spring 2018, but sampling did not continue into the summer because of low spring *E. coli* concentrations. *E. coli* samples were collected following procedures outlined in the QAPP (DEQ 2018) and DEQ's *E. coli* sampling standard operating procedure (DEQ 2017b).

Table 2. Analytical method, container, preservative, and holding times used, and reporting limit information for analytical parameters.

Parameter	Method	Units	Preservative	Container	Hold time	PQL/RL
E. coli	SM 9223B	mpn/100 mL	Sodium thiosulfate, 4 ºC	150 mL plastic	24 h	1
NO_3+NO_2-N	EPA 353.2	mg N/L	H_2SO_4 to pH < 2, 4 ºC	125 mL HDPE	28 d[a]	0.1
TP	SM4500 PF	mg P/L	H_2SO_4 to pH < 2, 4 ºC	125 mL HDPE	28 d[a]	0.01

Notes: PQL-Practical Quantitation Limit RL-Reporting Limit
a. Holding time is 28 days if preserved with H_2SO_4, 48 hours if unpreserved

2.3.2 YSI Sonde Measurements

2.3.2.1 Instantaneous Measurements

DEQ used a Yellow Springs Instruments (YSI) EXO-1 multiparameter sonde equipped with a nitrate sensor to measure stream nitrate (NO_3-N) in the field when a NO_3+NO_2-N grab water sample was collected. DEQ calculated multiple performance statistics (bias, error, relative percent difference [RPD], r^2, paired t-test) and qualitatively compared spatial and temporal patterns of sensor and laboratory values using graphs to describe NO_3-N sensor performance and evaluate the reliability of sensor measurements. Sensor performance analyses are described in Appendix C.

2.3.2.2 Deployment

DEQ deployed the YSI EXO-1 sonde near the Hatwai Creek mouth at HC67_03 to monitor stream water quality patterns during an April 6–9, 2018 rain event. The sonde was deployed below the water surface within a PVC tube, which was attached to the METER CTD-10 sensor set-up (Figure 2). The sonde recorded nitrate, turbidity, DO, temperature, and conductivity every 15 minutes. Nitrate, turbidity, and DO sensors were calibrated according to manufacturer specifications the day of deployment. Water samples were collected at the beginning and end of deployment, and then submitted to the laboratory for analysis to evaluate nitrate sensor performance. The METER CTD-10 sensor recorded water level, temperature, and conductivity every 15 minutes. A DEQ weather station at Sunset Park in Lewiston recorded precipitation amount every 15 minutes using a Texas Electronics TR-525USW tipping bucket rain gauge. Resulting data were plotted to evaluate how NO_3-N concentration changed along with precipitation and increasing stream water level during the rain event.

2.4 Temperature

DEQ deployed Onset Water Temp Pro V2 temperature loggers to measure stream water temperature at 15-minute intervals at sites HC67_03 and HC67_02. DEQ staff performed temperature calibration prior to and after deployment to verify temperature logger accuracy. Procedures followed standard DEQ protocols for temperature logger placement and deployment, retrieval, and data processing (DEQ 2013). Two Onset temperature loggers were placed at HC67_03 to evaluate temperature logger precision. The METER CTD-10 sensor deployed at

HC67_03 also recorded stream temperature at 15-minute intervals from March through September. The YSI temperature sensor and Hach LDO 101 DO meter recorded temperature at 15-minute intervals (see section 2.5 below) during deployments. Onset temperature logger data were used for comparison to water quality standards because the logger was subjected to the most rigorous QA/QC (pre- and post-deployment calibration checks).

2.5 Dissolved Oxygen

Water column DO was measured every 30 minutes at site HC67_03 over a 24-hour period with a Hach LDO 101 DO probe suspended in the water column. The Hach probe was deployed March 27–28 and August 7–8 of 2018. The water column DO was measured at HC67_03 using the YSI EXO-1 sonde DO sensor during sonde deployment from April 6–9.

2.6 Algal Growths

In August 2018, DEQ observed, documented, and photographed potential nuisance algal growths in Hatwai Creek at HC67_03. An Abraxis test strip tested the algal growths and yielded a negative result for the presence of microcystin toxins, which often originate from the cyanobacteria *Microcystis* (see section 3).

2.7 Data Analysis

Data collected in 2018 were compared to relevant TMDL target concentrations or Idaho water quality standards intended to protect beneficial uses in Hatwai Creek (Table 3). Federal regulations require states to specify the appropriate beneficial uses to be achieved and protected for their waters under the CWA (40 CFR 131.10). Cold water aquatic life (CWAL), secondary contact recreation (SCR) and salmonid spawning are beneficial uses protected in Hatwai Creek. Waters protected for CWAL are expected to maintain a viable aquatic life community for coldwater species. Waters protected for SCR are expected to allow for recreational activities, such as wading and fishing where water immersion and ingestion are unlikely. Waters protected for salmonid spawning are expected to maintain conditions that support spawning and rearing of salmonids during spawning and rearing periods.

Table 3. Water quality parameter thresholds for data analysis

Parameter	Threshold	Threshold Type
NO_3+NO_2-N	0.072 mg/L	Hatwai Creek TMDL target (DEQ 2010)
TP	0.03 mg/L	Hatwai Creek TMDL target (DEQ 2010)
E. coli	126 mpn/100 mL; geometric mean of at least five samples collected every 3-7 days over a 30-day period	Hatwai Creek TMDL target (DEQ 2010, IDAPA 58.01.02.251.01
DO (water column)	6 mg/L; during salmonid spawning: 6 mg/L or 90% saturation, whichever is greater	IDAPA 58.01.02.250.02a IDAPA 58.01.02.250.02f
Temperature	19ºC daily average, 22ºC daily maximum during salmonid spawning: 13ºC daily maximum, 9ºC daily average	IDAPA 58.01.02.250.02b IDAPA 58.01.02.250.02f

Protecting salmonid spawning beneficial use is required in the main stem of Hatwai Creek (AU 67_03), but is not required in the tributaries (AU 67_02). Steelhead spawn in the main stem, third order portion of Hatwai Creek (NPSWCD 2014; Joe DuPont personal communication August 28, 2018); however, steep canyon slopes below HC67_02 serve as a fish passage barrier (NPSWCD 2014), so DEQ does not consider salmonid spawning an existing beneficial use that must be protected in AU 67_02.

In salmonid spawning beneficial use areas, DEQ must apply more stringent temperature and DO criteria during salmonid spawning and incubation periods (IDAPA 58.01.02.250.f) (Table 3) than would be needed for protecting CWAL beneficial use areas. DEQ gathered information to determine salmonid species presence and timing of spawning in Hatwai Creek. Through the Beneficial Use Reconnaissance Program (BURP), DEQ observed Rainbow Trout, unidentified salmonid (*Oncorhynchus* sp), and Coho Salmon (*O. kisutch*) near the mouth of Hatwai Creek. Idaho Department of Fish and Game (IDFG) and NPSWCD reported Steelhead spawning in Hatwai Creek (NPSWCD 2014; Joe DuPont personal communication August 28, 2018). Joe DuPont (IDFG) reported that Rainbow Trout/steelhead are the only salmonids likely to spawn in Hatwai Creek, although other salmonids such as Chinook Salmon and Coho Salmon may occasionally enter Hatwai Creek. He also reported steelhead typically spawn in the Hatwai area April–June (personal communication August 28, 2018). According to *Geography and Timing of Salmonid Spawning in Idaho* (BioAnalysts 2014), A-run and B-run steelhead spawning and incubation/emergence periods in the Clearwater span February through mid–August (BioAnalysts 2014). Based on BioAnalysts (2014), DEQ compared temperature and DO data collected in Hatwai Creek to salmonid spawning criteria during February through August 15.

Data analyses and graphing were performed using the R Statistical Software (*www.R-project.org*), which is free open-source software. All R code was written by one DEQ staff member, and reviewed for accuracy as a quality control check by a second staff member who was not involved in writing the code. Data associated with this project are publically available (see section 5).

3 Results

3.1 Stream Flow

Stream flow measurements ranged from 0.8 to 12.5 cubic feet per second (cfs) at HC67_03. Flow had a strong seasonal pattern, with greatest flows during April (Figure 3). The seasonal pattern is consistent with flow patterns in 2006–2007 during TMDL development (Figure 4). Flows in 2018 were greater than in 2006–2007 likely because 2018 water year precipitation (15.24 inches) was nearly double that of water year 2007 precipitation (8.43 inches) (Lewiston Nez Perce County Airport, GHCND: US W00024149). Site HC67_03 is upstream of where outflow from a spring-fed pond (HCLO) enters Hatwai Creek (Figure 1); therefore flows downstream of HC67_03, closer to the Clearwater River, are likely slightly higher than those measured at HC67_03.

Flows estimated at 15-minute intervals through Sept 21, 2018 based on CTD-10 water level measurements and the rating curve ranged from 0.8 to 18.5 cfs. The 2018 hydrograph suggested Hatwai Creek has relatively quick and large magnitude responses to rain events (Figure 3). However, the rating curve may not accurately predict flows during storm events where flows exceed the maximum measured flow (12.5 cfs). The mean RPD between measured and predicted flow was -1% (range: -18 to 24%). Rating curve details are provided in Appendix B.

Measured flows at HC67_03 were consistently greater than those at the Leon Road headwater site (HC67_02) (Figure 5). Site HC67_02 had water throughout the study period, but flows were negligible (~0.01 cfs) in late summer.

3.2 NO_3+NO_2-N and NO_3-N

NO_3+NO_2-N concentrations ranged from 2.0 to 9.5 across all sites mg/L in 2018. All NO_3+NO_2-N results exceeded the TMDL target concentration of 0.072 mg/L. Considering that stream water at HC67_03 and spring water at HCSP have similar concentrations and seasonal patterns, the stream and spring are likely fed by the same source (Figure 4). Concentrations at HC67_02 were consistently greater than those at HC67_03 and HCSP (Figure 4). NO_3+NO_2-N concentrations at HC67_03 were consistently 3-4 mg/L greater in 2018 than in 2006–2007 (Figure 4). It is unclear why concentrations were higher in 2018, but increased precipitation in 2018 compared to 2006–2007 may have contributed to greater NO_3+NO_2-N concentrations.

During an April 6–9 rain event in 2018, NO_3-N concentrations ranged from 4.6 to 7.6 mg/L. NO_3-N generally increased as the water level increased and had a similar temporal pattern to DO concentrations (Figure 6). A confirmation sample collected at the end of the deployment period had a NO_3+NO_2-N concentration of 6.43 mg/L compared to 7.1 mg/L NO_3-N measured by the YSI sensor. Based on these confirmation samples and NO_3-N performance analyses (Appendix C), DEQ has confidence in the NO_3-N concentration trend pattern recorded during deployment.

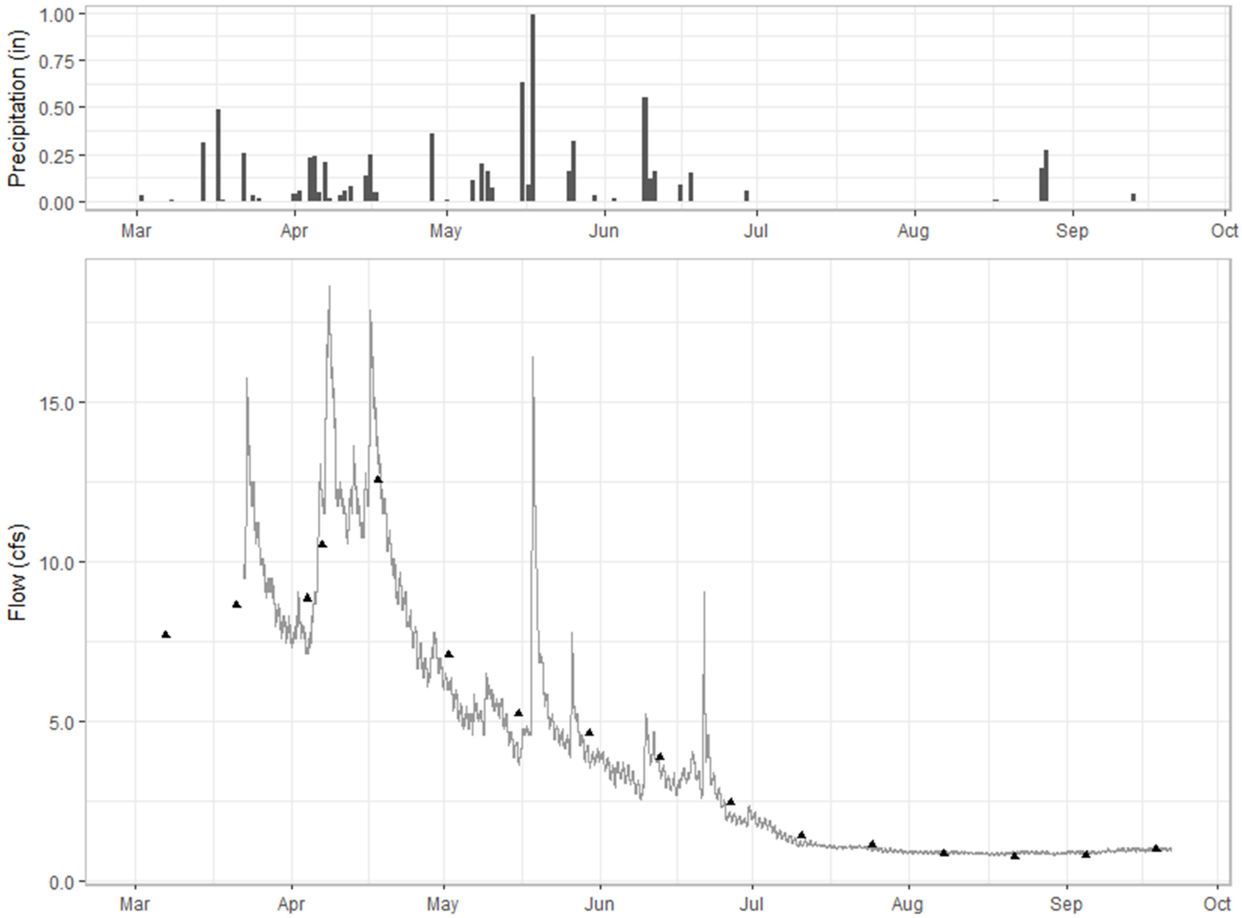

Figure 3. 2018 Hatwai Creek hydrograph and daily precipitation totals at the Lewiston airport. On the flow plot, triangles are flow measurements, and the line is flow estimated based on the HC67_03 rating curve.

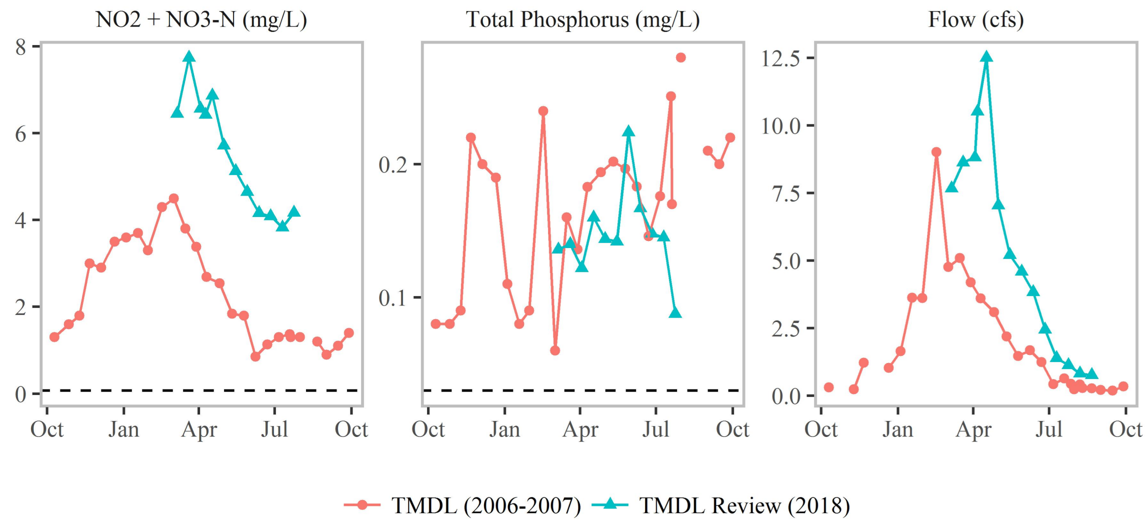

Figure 4. Comparison of nutrient concentrations and measured stream flow at the Hatwai Creek mouth (HC67_03) during TMDL development (2006-2007) and the TMDL review (2018). Dashed horizontal lines are TMDL target concentrations.

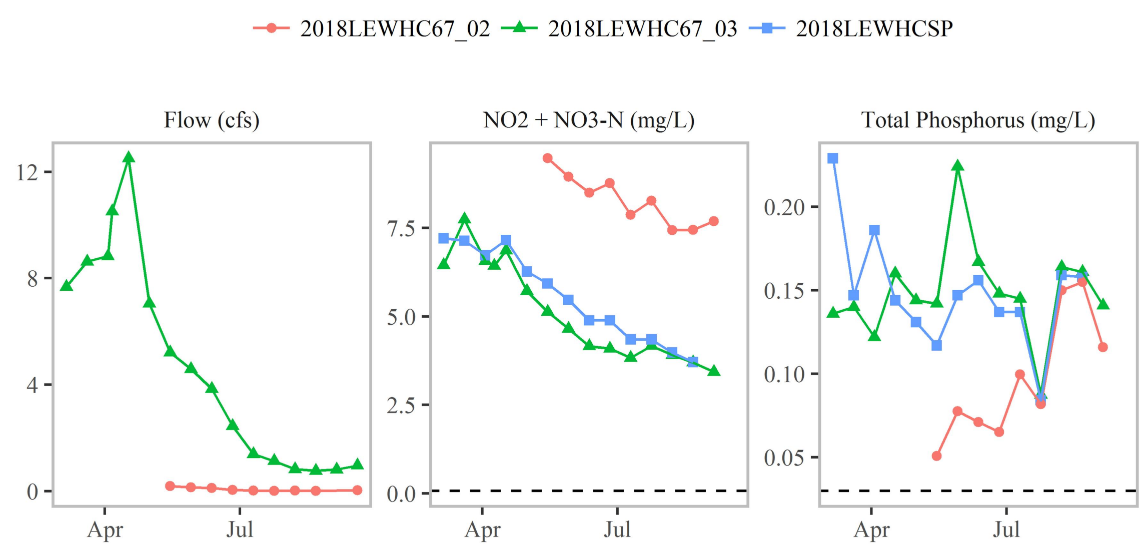

Figure 5. Comparison of Hatwai Creek 2018 nutrient concentrations and measured flow across sites.

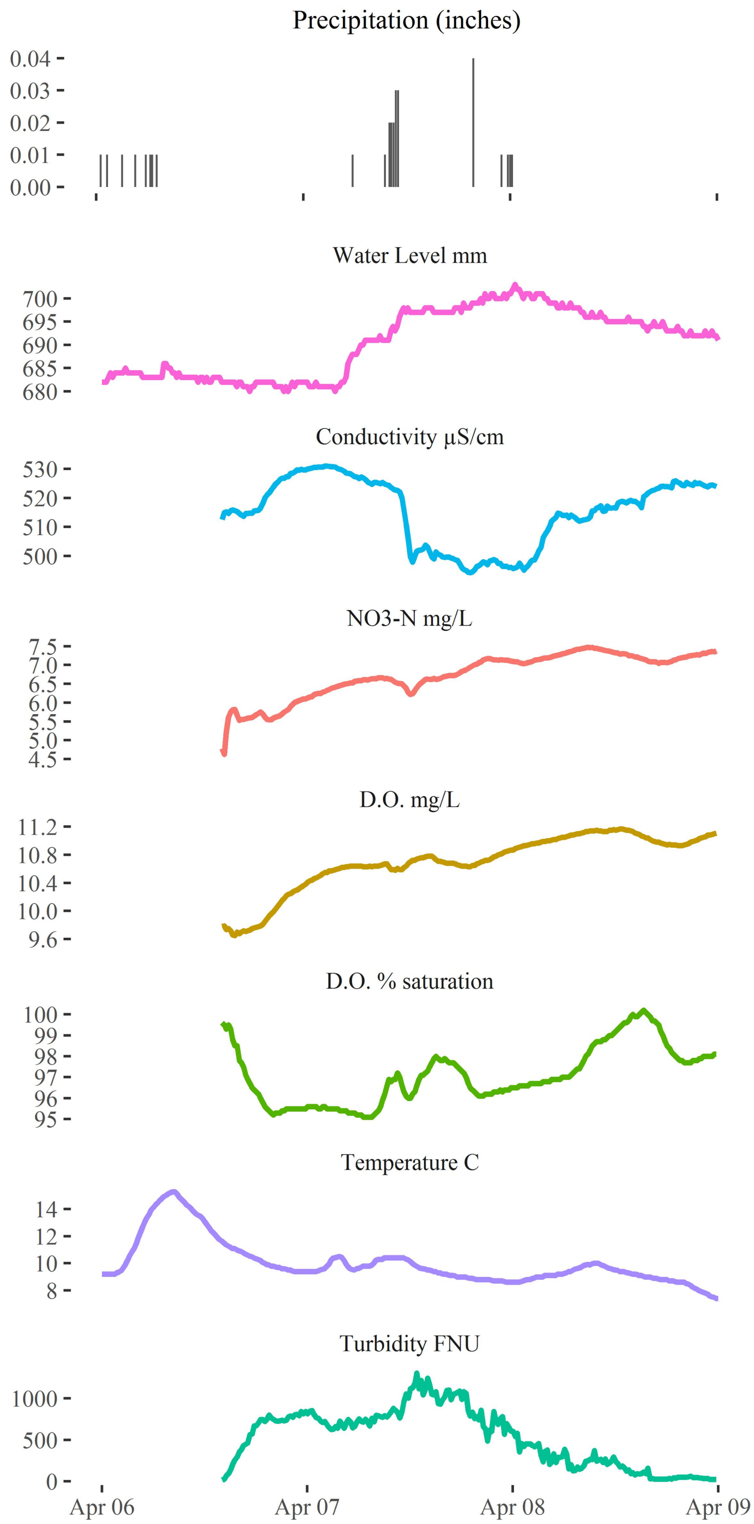

Figure 6. April 2018 sonde deployment results. Water level and temperature data were recorded by the CTD-10 sensor. All other water quality parameters were recorded by the YSI EXO-1 sonde.

3.3 Total Phosphorus

In 2018, TP concentrations ranged from 0.05 to 0.22 mg/L across all sites (Figure 5). All TP results exceeded the TP target concentration of 0.03 mg/L. Concentrations and seasonal patterns were similar between HC67_03 and HCSP (Figure 5). Concentrations at the HC67_02 site were less than those at HC67_03 and HCSP in spring, but converged with those at HC67_03 and HCSP in summer (Figure 5). At HC67_03, TP concentrations in 2018 were similar to those observed in 2006–2007 (Figure 4).

3.4 Algal Growths

On August 7–8, 2018, DEQ documented extensive algal growths at HCSP, HCLO, and HC67_03 (Figure 7–9). The growths appeared to be filamentous green algae. An Abraxis test strip yielded a negative result for the presence of microcystin toxins, which in some cases are produced by the cyanobacteria *Microcystis*. Growths at HCSP were persistent throughout most of the summer, whereas growths at HCLO and HC67_03 occurred primarily in late summer.

Figure 7. Filamentous green algae at HCSP on August 7, 2018.

Figure 8. Filamentous green algae at HCLO on August 7, 2018.

Figure 9. Filamentous green algae slightly downstream from HC67_03 on August 8, 2018.

3.5 Escherichia coli

Geometric mean *E. coli* concentrations exceeded Idaho's water quality standard of 126 mpn/100 mL at HC67_03 in spring and late summer and at HC67_02 in late summer (Table 4).

Table 4. *E. coli* load analysis based on 2018 data.

Location	Monitoring Period	*E. coli* Geometric Mean (mpn/100 mL)
HC67_03	3/6/18 to 4/3/18	645.1
HCSP	3/6/18 to 4/3/18	12.6
HC67_03	8/7/18 to 9/4/18	227.8
HC67_02	8/7/18 to 9/4/18	367.8

Four *E. coli* samples were collected at HCLO between March 6 and April 3, 2018. *E. coli* concentrations ranged from 20.6 to 145.5 mpn/100 mL. Although an insufficient number of samples were collected to calculate a geometric mean (five samples are needed), concentrations were similar to those observed at HCSP (Table 4). A geometric mean calculated using only four samples was 60.6 mpn/100 mL. If a fifth sample had been collected, the geometric mean could only have exceeded 126 mpn/100 mL if the fifth sample had the maximum concentration quantifiable through the analytical method (> 2419 mpn/100 mL).

3.6 Dissolved Oxygen

Water column DO concentrations at HC67_03 met salmonid spawning criteria (Table 3) during all monitored periods, except during a short period on August 8, 2018 (Figure 10). DO concentrations exceeded 6 mg/L during all monitoring periods, but DO percent saturation was < 90% for a short period on August 8, 2018. Air temperatures exceeded 100 ˚F and filamentous green algal growths were observed on this same date (Figure 7–9). DO was not monitored at HC67_02.

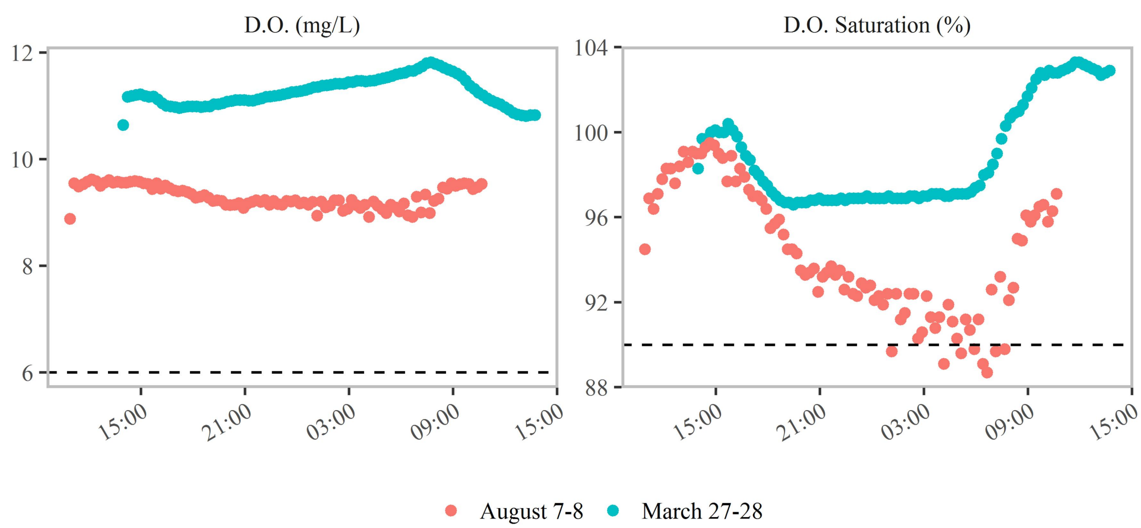

Figure 10. 2018 dissolved oxygen monitoring results at HC67_03. Dashed lines indicate Idaho water quality standards for DO.

3.7 Temperature

Temperature loggers at site HC67_03 recorded exceedance of temperature criteria for protection of salmonid spawning during most of the monitored salmonid spawning period (Figure 11). Both temperature loggers recorded one exceedance of the 22 ˚C daily maximum criteria for protection of CWAL use on June 22, 2018.

Only CWAL temperature criteria apply at site HC67_02 because DEQ does not consider salmonid spawning a beneficial use at the site. No exceedances of CWAL temperature criteria were recorded at site HC67_02 (Figure 12).

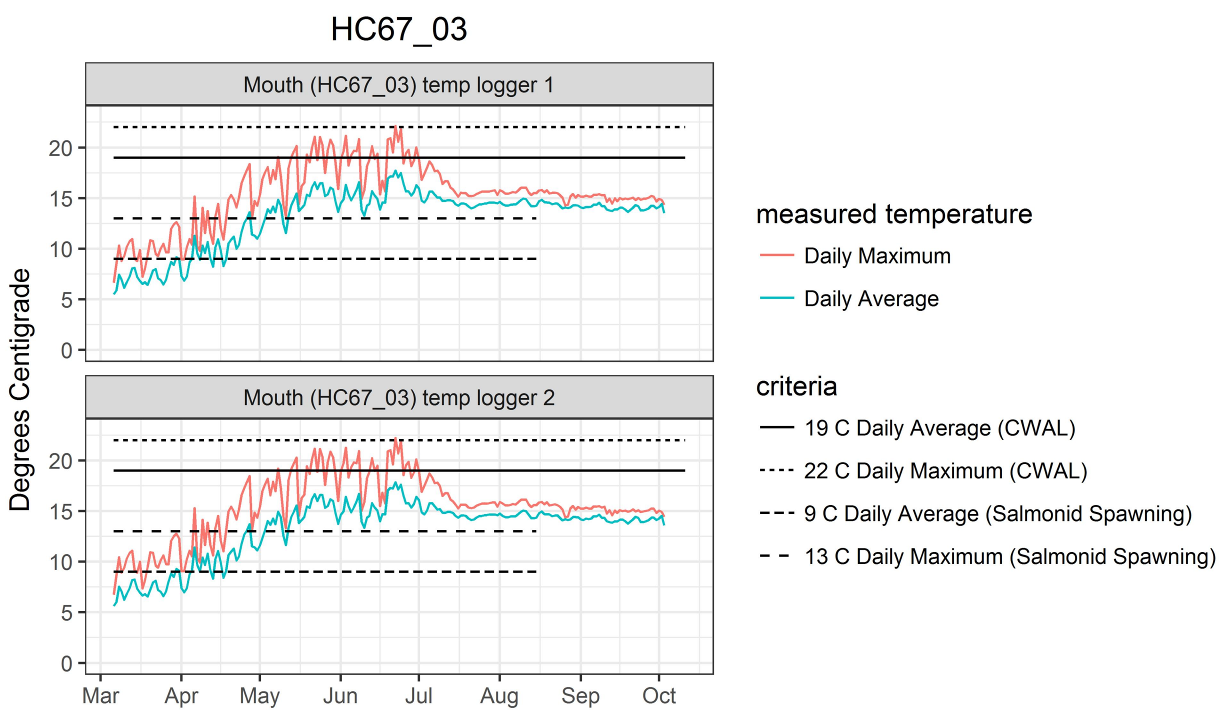

Figure 11. 2018 temperature logger results at HC67_03. CWAL = cold water aquatic life.

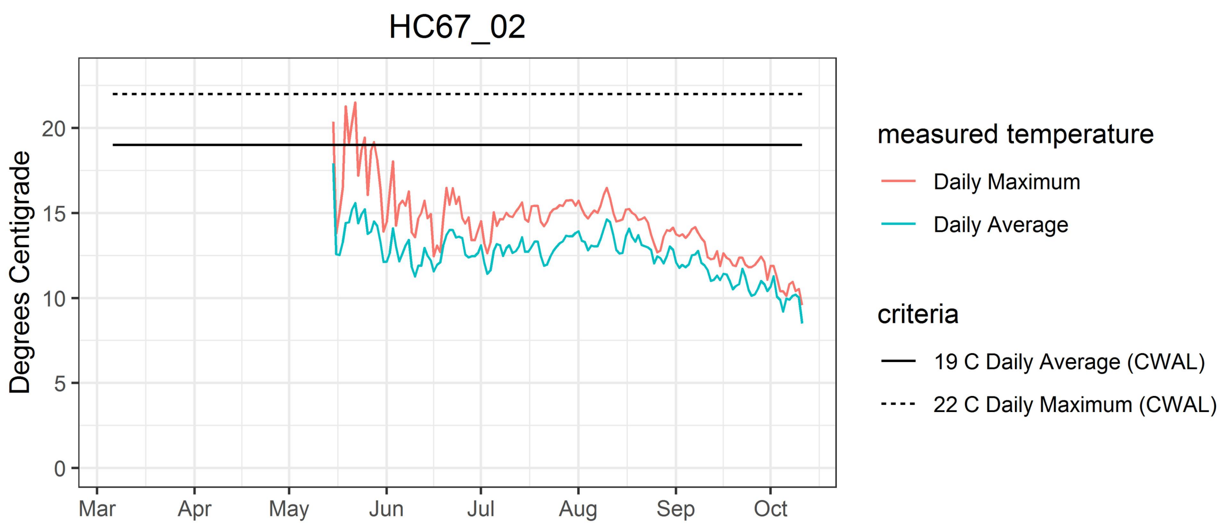

Figure 12. 2018 temperature logger results at HC67_02. CWAL = cold water aquatic life

4 Conclusions

Table 5 summarizes the comparison of 2018 monitoring results to the relevant thresholds.

Table 5. Comparison of 2018 monitoring results to relevant thresholds.

Parameter	Threshold	Threshold Source	Result	
			Headwaters (67_02)	Mouth (67_03)
NO_3+NO_2-N	0.072 mg/L	Hatwai Creek TMDL Target (DEQ 2010)	7.4-9.5 mg/L threshold exceeded	2.0-7.7 mg/L threshold exceeded
TP	0.03 mg/L	Hatwai Creek TMDL Target (DEQ 2010)	0.05-0.16 mg/L threshold exceeded	0.09-0.22 mg/L threshold exceeded
Escherichia coli	126 mpn/100 mL geometric mean	Hatwai Creek TMDL Target (DEQ 2010), IDAPA 58.01.02.251.01	367.8 mpn/100 mL (summer) threshold exceeded	645.1 mpn/100 mL (spring), 227.8 mpn/100 mL (summer) threshold exceeded
Dissolved Oxygen (year-around)	6 mg/L (minimum)	IDAPA 58.01.02.250.02a	No data	8.8-11.8 mg/L threshold not exceeded
Dissolved Oxygen (during salmonid spawning)	6 mg/L or 90% saturation, whichever is greater	IDAPA 58.01.02.250.02f	Not applicable	8.8-11.8 mg/L 88.7-103 % < 90% saturation on 8/8/18 threshold exceeded
Temperature (cold water aquatic life protection)	19ºC daily average	IDAPA 58.01.02.250.02b	8.51-17.9 ˚C threshold not exceeded	4.45-17.8 ˚C daily average threshold not exceeded
	22ºC daily maximum	IDAPA 58.01.02.250.02b	9.58-21.5 ˚C threshold not exceeded	4.51-22.2 ˚C daily maximum threshold exceeded one day
Temperature (during salmonid spawning)	13ºC daily maximum	IDAPA 58.01.02.250.02f	Not applicable	4.51-22.2 ˚C daily maximum threshold exceeded
	9ºC daily average	IDAPA 58.01.02.250.02f	Not applicable	4.45-17.8 ˚C daily average threshold exceeded

5 Data Availability

Project data will be publically available through the Water Quality Portal (*www.waterqualitydata.us/*), which is a national data repository that houses publically available data. DEQ will also provide project data to interested parties in response to data requests. R code files used for analyses and graphing in this report are available on request.

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Appendix A. Quality Assurance/Quality Control Summary

1 Background and Purpose

Prior to sampling, DEQ developed a QAPP for the Hatwai Creek TMDL review surface water sampling project (DEQ 2018). The QAPP described planned field and laboratory methodology, QA/QC procedures and data quality objectives. Data quality objectives and criteria were specified for data accuracy, precision, measurement range, representativeness, comparability, and completeness. This appendix reviews quality assurance data collected during the project and evaluates if data quality objectives and criteria were met.

2 Precision

Precision is a measure of agreement between two measurements of the same parameter under prescribed conditions. Laboratory and field duplicates were used to evaluate precision for NO_3+NO_2-N, TP, and *E. coli*. Temperature logger precision was evaluated by deploying two temperature loggers simultaneously and comparing concurrent measurements. Precision goals specified in the project QAPP were met.

2.1 NO_3+NO_2-N, TP, E. coli

The RPD between laboratory replicates and field duplicates were used to assess data precision for parameters analyzed at Anatek. RPD was calculated as:

$$RPD = \frac{(C_1 - C_2)}{(C_1 + C_2)/2} \times 100$$

Where: C_1 = concentration in first sample
C_2 = concentration in the second/duplicate sample

Analytical methods used by Anatek to quantify NO_3+NO_2-N (EPA 352.2) and TP (SM 4500PF) require analysis of laboratory duplicate samples. Anatek did not include results of laboratory duplicates in result reports. However, if the RPD of laboratory duplicates exceeds RPD goals specified by the analytical method, Anatek notes this in laboratory results reports and assigns a laboratory qualifier to associated results. Because Anatek did not apply laboratory qualifiers to any results associated with this project and thus, DEQ assumed laboratory duplicate RPD requirements were met. The QAPP required DEQ to collect one field duplicate sample for every 20 regular samples (5% field duplicates). This requirement was met for each analyte (NO_3+NO_2-N, TSS, and TP).

The QAPP established a RPD goal of +/- 50% for low level concentrations (< 20 x laboratory practical quantitation limit) and 25% for high level concentrations (>20 x laboratory practical quantitation limit). RPD goals were met (Table A1).

Table A1. Field duplicate results.

Sample Date	Parameter	Location	Original Result	Duplicate Result	PQL[1]	RPD (%)	Lab Report
4-3-18	*E. coli*	HC67_03	>2419.6	2419.6	1	0	180403065_REG2
5-1-18	NO_3+NO_2-N	HC67_03	5.72	5.76	1	-0.7	180502007_REG2
5-1-18	TP	HC67_03	0.144	0.146	0.01	-1.38	180502007_REG2
7-24-18	NO_3+NO_2-N	HC67_03	4.17	4.2	1	-0.72	180724027_REG2
7-24-18	TP	HC67_03	0.0876	0.0951	0.01	8.76	180724027_REG2
9-4-18	*E. coli*	HC67_03	206.4	178.9	1	14	180905001_REG2
9-18-18	NO_3+NO_2-N	HC67_03	3.34	3.36	0.05	1	180919043_REG2
9-18-18	TP	HC67_03	0.139	0.169	0.01	-19	180919043_REG2

[1]PQL = practical quantitation limit

2.2 Temperature logger precision

DEQ deployed two temperature loggers at site HC67_03. DEQ qualitatively compared plots of data from both temperature loggers and evaluated whether the loggers yielded the same exceedance/non-exceedance results in respect to water quality standards. The project QAPP did not specify RPD requirements for temperature logger data (DEQ 2018). The duplicate temperature loggers differed slightly in the percentage of monitored days where the 9 ˚C (133 days/82% vs 130 days/80%) and 13 ˚C (125 days/77% vs 123 days/75%) salmonid spawning criteria were exceeded. Both temperature loggers recorded a single exceedance of the 22 ˚C daily maximum criterion, but did not record any exceedances of the 19 ˚C daily average criterion. Patterns in temperature graphs were very similar for both loggers (Figure 11). DEQ believes observed temperature logger precision is adequate for the project because criteria exceedances were clear and consistent across both loggers, and observed differences between loggers would not affect conclusions about criteria exceedances.

3 Accuracy

Accuracy is a measure of agreement between a “true” or reference value and the associated measured value. Accuracy of parameters analyzed at Anatek was evaluated based on laboratory quality control samples and field blanks. Temperature logger accuracy was evaluated by comparing temperature logger measurements to those from a thermometer with certified accuracy. Accuracy goals specified in the project QAPP were met.

3.1 NO_3+NO_2-N, TP, E. coli

Analytical methods used by Anatek to quantify NO_3+NO_2-N (EPA 352.2) and TP (SM 4500PF) require analysis of laboratory control and laboratory-prepared matrix spike samples. Anatek did not provide results associated with laboratory control and laboratory-prepared matrix spike samples in their results reports. However, if results from these samples do not meet data quality goals, Anatek notes this in laboratory results reports and assigns a laboratory qualifier to associated results. Because Anatek did not apply laboratory qualifiers to any results associated with this project, DEQ assumed that laboratory control and matrix spike data quality objectives were met.

Field blanks were used to check for possible contamination of samples (analyte gain) during sample collection and processing for NO_3+NO_2-N, TP, and *E. coli*. The QAPP required one field blank sample to be collected for every twenty regular samples (5% blanks). This requirement was met.

The QAPP required that field blank results are less than the laboratory practical quantitation limit (PQL). All field blanks were less than the PQL (Table A2).

Table A2. Field blank results.

Sample Date	Parameter	Location	Field Blank Result	PQL	Lab Report
4-3-18	*E. coli*	HC67_03	< 1	1	180403065_REG2
5-1-18	NO_3+NO_2-N	HC67_03	ND	0.1	180502007_REG2
5-1-18	TP	HC67_03	ND	0.01	180502007_REG2
7-24-18	NO_3+NO_2-N	HC67_03	ND	0.1	180724027_REG2
7-24-18	TP	HC67_03	ND	0.01	180724027_REG2
9-4-18	*E. coli*	HC67_03	<1	1	180905001_REG2
9-18-18	NO_3+NO_2-N	HC67_03	ND	0.05	180919043_REG2
9-18-18	TP	HC67_03	ND	0.01	180919043_REG2

*ND = not detected

3.2 Temperature Logger Accuracy

The QAPP requires the accuracy of each temperature logger to be checked by comparing it to a NIST-certified thermometer at two temperatures, both before and after deployment. Each temperature logger placed for this project met QAPP specifications.

4 Sample Holding and Preservation Requirements

Project sample holding and preservation requirements are provided in Table 2. Results from one NO_3+NO_2-N sample collected April 6, 2018 at the beginning of sonde deployment were rejected because sample preservation requirements were not met. This sample was placed in a DEQ refrigerator between collection and transport to Anatek. The sample froze while in the refrigerator due to a refrigerator malfunction and was subsequently thawed before submission to Anatek. Anatek analyzed and reported a result for this sample (2.01 mg/L), but stated they would not have analyzed the sample if they had known it was frozen; Anatek policy is to not accept frozen samples (Todd Turascio, personal communication). DEQ decided to reject this result because the sample result (2.0 mg/L) was over 4 mg/L less than all other NO_3+NO_2-N samples collected at HC67_03 up until that point and because of conflict with Anatek's policy. Other than this one sample, sample holding and preservation requirements (Table 2) were met, and Anatek did not qualify any laboratory results based on holding or preservation time issues.

5 Data Representativeness

Data representativeness is the degree to which the sample data accurately and precisely represent site conditions. The project QAPP did not provide specific data representativeness criteria; however, it did provide guidelines for evaluating representativeness (DEQ 2018). All project data, except for one rejected NO_3+NO_2-N result, satisfied representativeness requirements because field sampling and laboratory analysis followed standard procedures, procedures were consistent with those during previous sampling, samples were collected in both AUs, laboratory accuracy and precision requirements were met, and there were no issues with laboratory QA review.

6 Data Comparability

Comparability is the confidence that one data set can be compared to another data set. The project QAPP provided did not provide specific comparability criteria; however, it does provide guidelines for ensuring data comparability (DEQ 2018). All project data, except for one rejected NO_3+NO_2-N result, satisfied representativeness requirements because standard sampling and laboratory procedures were followed, procedures were consistent with those used for previous DEQ sampling, and no issues were identified during project data verification and validation.

7 Data Completeness

Data completeness is the percentage of valid data relative to the total possible data points. The project QAPP defined a data completeness objective of 75% (DEQ 2018). Only one result was rejected, so project data completeness is 99% and satisfies the QAPP objective requirement.

8 Conclusion

DEQ requires several internal quality assurance procedures. Procedures include consultation with the DEQ quality assurance manager, registration of the project in a tracking spreadsheet, completion of three standardized quality assurance checklists, and review of all quality assurance data points. One sample result was rejected and omitted from project data analyses during data review, verification and validation. Project goals for data accuracy, precision, holding and preservation, representativeness, comparability, and completeness were met. DEQ considers all project data, except for the one rejected result, adequate for use in the Hatwai Creek TMDL review.

Appendix B. Hatwai Creek Rating Curve

DEQ used flow measurements (section 2.2.1) and CTD-10 water level records (section 2.2.2) to develop a rating curve relating flow and water level. DEQ used the rating curve to estimate stream flow at 15-minute intervals and plot a stream hydrograph (Figure 2).

To create the rating curve, each flow measurement was paired temporally with the closest CTD-10 water level measurement (N = 14). CTD-10 water depth was plotted on the x-axis, discharge was plotted on the y-axis, and a power function trend line was fit to the data in Microsoft Excel (Figure B1).

Rating curve performance was described using the r^2 statistic and by calculating the percentage difference between observed and predicted discharge ((observed-predicted/observed) * 100)). The percentage difference between observed and predicted values ranged from -18% to 24%, with a mean of -1%. The resulting hydrograph (Figure B1) indicates that predicted flows are likely not reliable during time periods where predicted flows fell outside the range of measured flows (0.76–12.5 cfs).

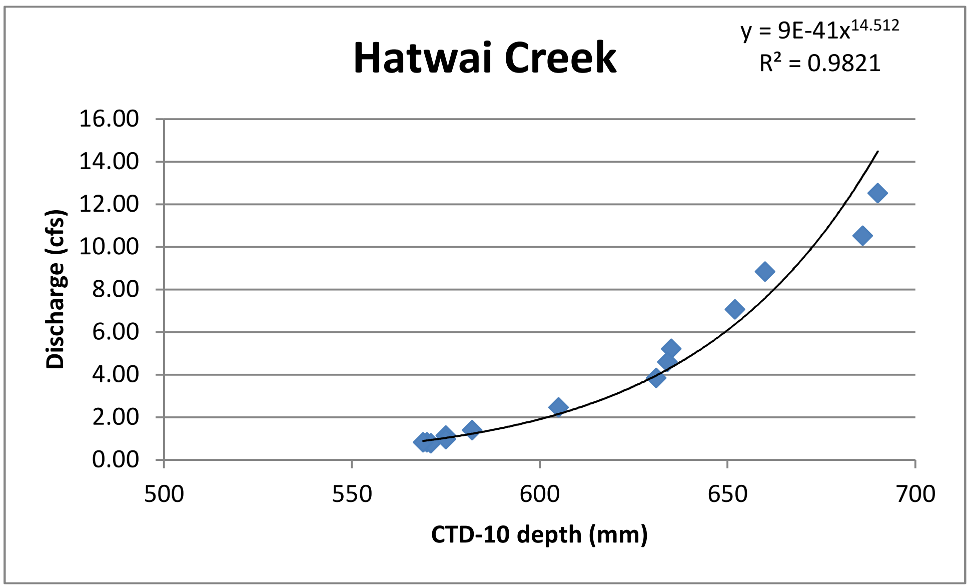

Figure B1. Hatwai site HC67_03 2018 rating curve.

The rating curve in Figure B1 is specific to the site and time period used to construct the curve. The relationship between water level measured by the CTD-10 and discharge may change over time due to changes in stream channel morphology during spring high flows, sensor measurement drift, or other factors. Before using CTD-10 depth measurements to estimate discharge in the future, discharge should be measured in the field to verify if the rating curve is still applicable.

Appendix C. Evaluation of YSI Nitrate Sensor Performance in the Hatwai Creek Watershed (2018)

1 Background and Objectives

DEQ used an YSI EXO-1 multiparameter sonde to measure stream NO_3-N in the field concurrently with each NO_3+NO_2-N sample collected in 2018. NO_3-N was measured with an YSI nitrate ion sensitive electrode sensor. The manufacturer reported a measurement range of 0–200 mg/L from 0–30 ˚C with a precision of +/- 10% of reading or 2 mg/L, whichever is greater. DEQ calibrated the sensor according to manufacturer specifications in the morning prior to each sample event using 1 and 100 mg/L standards. All calibration records and sensor results were saved electronically. This appendix describes analyses DEQ conducted to evaluate the performance of YSI nitrate and turbidity sensors during monitoring in the Hatwai Creek watershed.

2 Nitrate Sensor Performance

YSI sensor data from the first sample event March 6, 2018 were not used in performance analyses because the sensor was calibrated incorrectly prior to use. DEQ calculated multiple performance statistics to compare YSI and laboratory values (Table C1). Average bias was -0.8 mg/L (range -3.4 to 1.5 mg/L) (Table C2). The average RPD of field duplicates (-0.14%) was smaller than average RPD_{YSI} (14%) and $RPD_{predicted}$ (-2%) (Table C2). A paired t-test indicated a statistically significant difference between sensor and laboratory values ($p = 0.006$).

DEQ constructed simple linear regressions using paired sensor NO_3-N and lab NO_2+ NO_3-N measurements. Separate regressions were constructed using all data across sites and for individual sites. Regression r^2 values (Table C1) were calculated and compared to the target r^2 value specified in the QAPP. The QAPP stated regressions would be suitable for predicting lab results if the regression r^2 value is 0.9 or higher and the regression was developed based on at least 15 paired measurements spanning a wide range of flow conditions (DEQ 2018). When all data were pooled across sites, the resulting regression had a r^2 value of 0.65 with 22 data points (Figure C1). Site-specific regressions (Figure C2) had slightly greater r^2 values, but less than 15 data points.

DEQ qualitatively compared spatial and temporal patterns in plots of YSI and lab values (Figure C3). Sensor patterns within and across sites were similar to lab result patterns at site HC67_03, but large differences were observed between sensor and lab values on some occasions at site HC67_02 (Figure C3).

Table C1. Performance statistics.

Statistic	Description
Bias	YSI-lab
Error	| YSI – lab |
RPD (%) (lab samples)	(sample – field duplicate) / [sample + field duplicate)/2] x 100
RPD_{YSI} (%)	(YSI – lab) / [(YSI + lab)/2] x 100
$RPD_{predicted}$ (%)	(predicted – lab) / [(predicted + lab)/2] x 100, where predicted = lab value predicted based on a simple linear regression between YSI and lab values
Paired t-test	Test for a statistically significant (α = 0.05) difference between paired YSI sensor field readings and lab results from concurrently collected samples.
r^2	Indicates percentage of variation in lab values that can be explained by a simple linear regression model with YSI values as the predictor and lab values as the response. r^2 values range from 0-1 with 1 indicating 100% of variance is explained.

Table C2 Performance statistics results.

Statistic	N	Minimum	Maximum	Mean	Median
Bias (mg/L)	22	-3.4	1.5	-0.8	-0.9
Error (mg/L)	22	0.06	3.4	1.1	0.9
RPD (%)	3	-0.72	1	-0.14	-0.7
RPD_{YSI} (%)	22	-22	55	14	16
$RPD_{predicted}$ (%)	22	-42	37	-2	-5

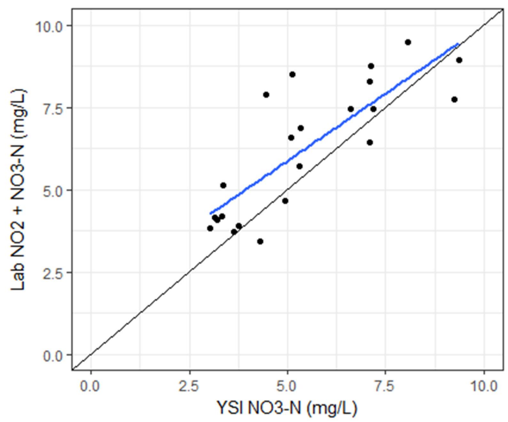

Figure C1. Relationship between YSI NO_3-N and lab NO_3+NO_2-N across sites. The blue line is the regression line (r^2 = 0.65, y = 1.7658 + 0.8198x). The solid line is a 1:1 line.

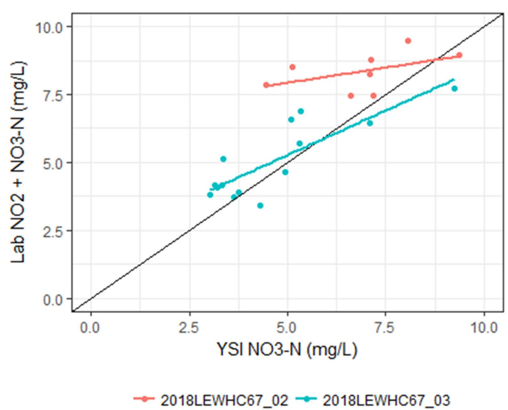

Figure C2. Relationship between YSI NO_3-N and lab NO_3+NO_2-N within sites

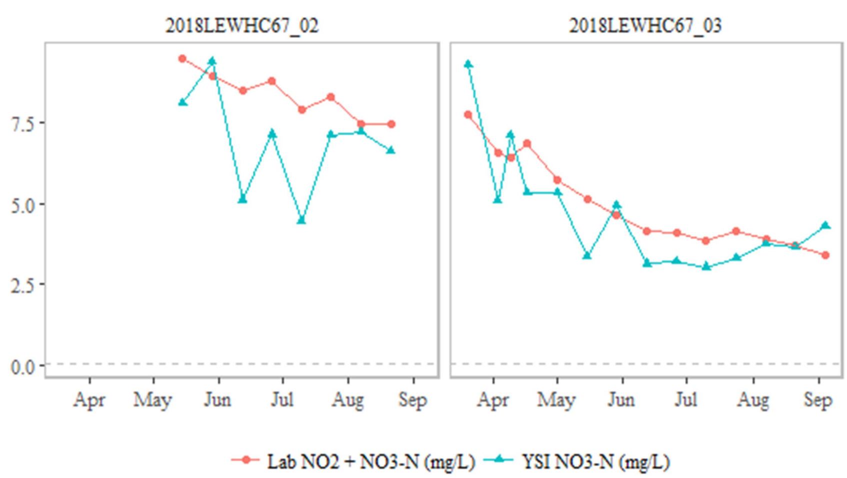

Figure C3. Comparison of YSI NO_3-N and lab NO_3+NO_2-N across sites and sample events in the Hatwai Creek watershed (2018). The dashed horizontal line is the TMDL NO3+NO2-N target (2 mg/L).

3. Conclusion

Given that the YSI sensor measures NO_3-N and the laboratory measures NO_3+NO_2-N in lab samples, one should not expect sensor and lab results to be the same. DEQ concluded that NO_3-N sensor results are not an adequate proxy for NO_3+NO_2-N lab results because of the poor r^2 values, significant paired t-test, and large RPD_{YSI} (%) and $RPD_{predicted}$ (%) values observed. However, because NO_3-N sensor spatial and temporal patterns tracked near lab result patterns at HC67_03, and confirmation samples collected at the end of the June sonde deployment yielded relatively small bias (~0.67 mg/L), DEQ has confidence in the NO_3-N concentration trend pattern observed during the June deployment. In combination with confirmation samples and adequate sensor performance information, future deployment of the NO_3-N sensor during rain events may yield reliable temporal concentration trend patterns that could help evaluate NO_3-N flow paths across different seasons and differing size rain events.