Indian Creek Temperature TMDL Strategy Paper

State of Idaho
Department of Environmental Quality

State Office of Technical Services

Draft

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Table of Contents

List of Tables

List of Figures

1 Background and Assessment

The Indian Creek watershed (HUC 1705011405) lies in the lower Boise River watershed (HUC 17050114) of southwest Idaho. The Indian Creek channel begins in the Danskin Mountains in Elmore County, but flow disappears before reaching the Indian Creek Reservoir. The Indian Creek channel is dry—and in some cases a channel is non-existent—from Indian Creek Reservoir to New York Canal. A portion of New York Canal lies in the historic creek bed before flowing to the west to drain into Lake Lowell. After this split near the city of Kuna, Indian Creek is perennial, flowing northwest through Nampa and Caldwell to enter the Boise River. Figure 1 shows the location of the Indian Creek drainage in the lower Boise River watershed, as well as the intersecting paths of Indian Creek and New York Canal.

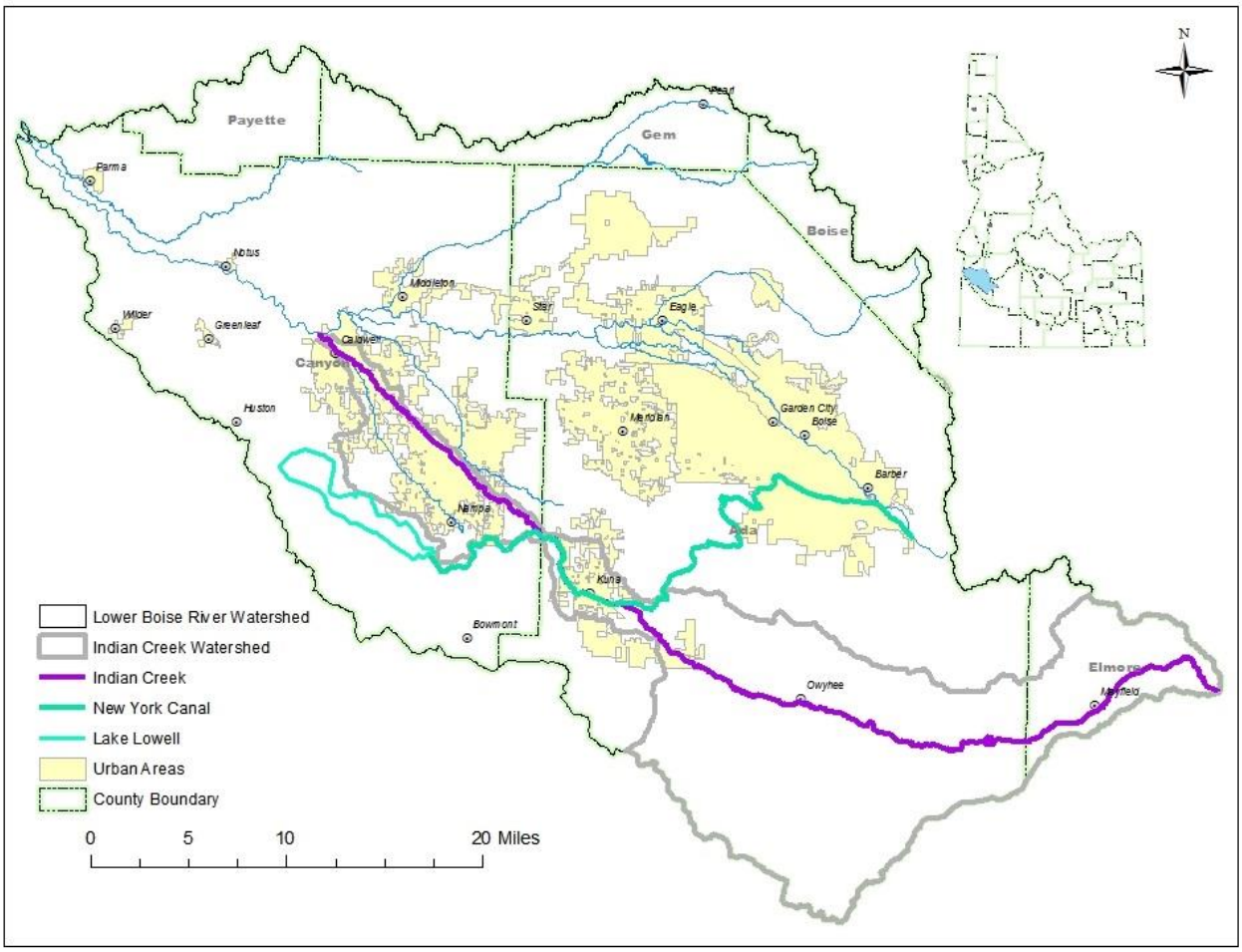

Figure 1. Indian Creek in the Lower Boise River watershed.

The New York Canal confluence acts as an artificial headwaters to this perennial stream reach, which is the target study area for the Indian Creek temperature TMDL. The Indian Creek study reach drainage area is 113 mi^2 and the stream is 17.56 miles long. Wilson Drain, with its headwaters at Wilson Pond in Nampa, is the only major tributary to Indian Creek in this reach.

The Indian Creek temperature study reach flows northwest through Nampa and Caldwell and intersects Riverside Canal near the Caldwell Wastewater Treatment Plant (WWTP). During

irrigation season, most of the water in Indian Creek is diverted into Riverside Canal and irrigates lands southwest of Caldwell. During non-irrigation season, Indian Creek flows through its natural drainage into Boise River.

The Indian Creek temperature study reach consists of two Assessment Units listed for temperature (Table 1).

Table 1. Indian Creek Assessment Units listed for temperature.

Location	Assessment Unit	Beneficial Uses[1]	Support Status
New York Canal to Sugar Avenue—5.61 miles	ID17050114SW003a_04 (SW-3a in standards)	CWAL, SS, SCR	Supporting SCR Not supporting CWAL and SS
Sugar Avenue to Boise River—11.95 miles	ID17050114SW002_04 (SW-2 in standards)	CWAL, SCR	Not supporting CWAL and SCR

[1]CWAL = Cold Water Aquatic Life
SS = Salmonid Spawning
SCR = Secondary Contact Recreation

These AUs have a long history in Idaho's water quality status reports and integrated reporting (see Appendix A for chronological listing history), but were first listed for temperature in the 2002 integrated report (DEQ 2005). Biological assessments for two locations in Indian Creek (Figure 2) confirmed impaired status.

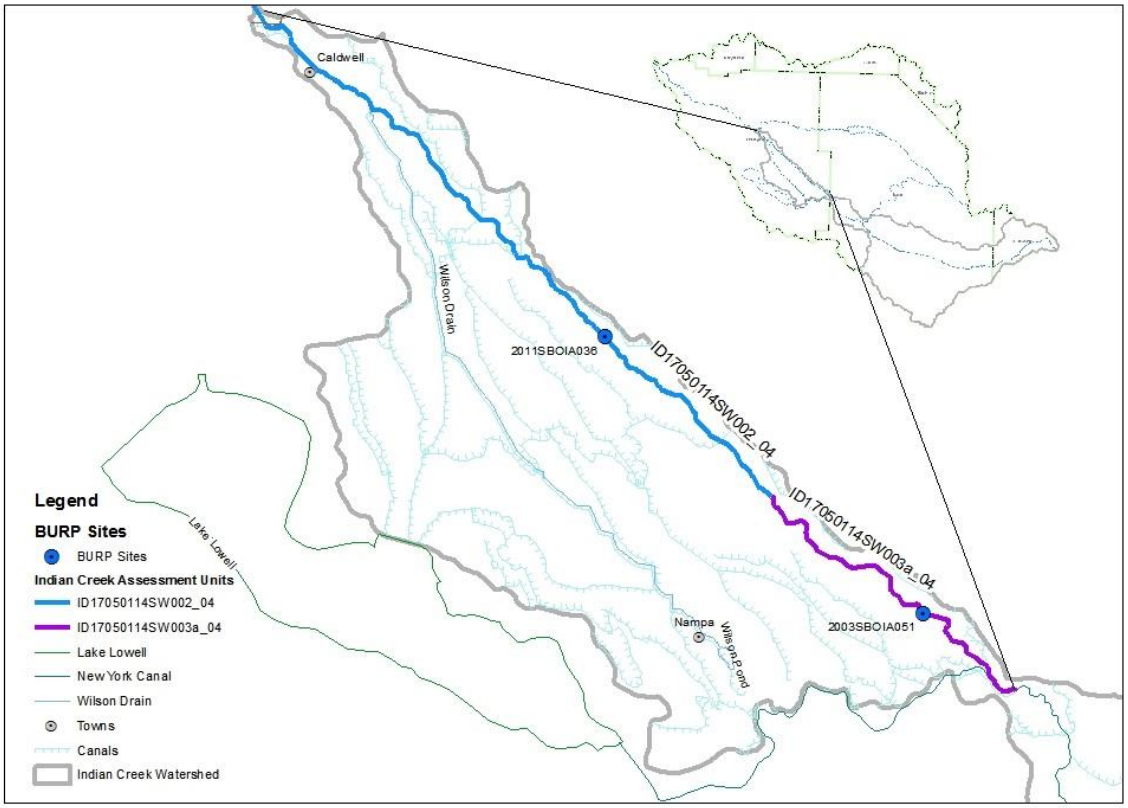

Figure 2. Indian Creek watershed with listed Assessment Units and BURP sites.

2 Temperature Regulatory Issues

Stream temperature is critical to aquatic life and instream processes. Water quality goals for Indian Creek are riparian restoration and habitat improvement to an extent to be able to achieve applicable federal and state standards:

- The federal Clean Water Act (CWA) 33 U.S.C. §1251 et seq. (1972) set out requirements to ensure that waters of the U.S. are fishable and swimmable by requiring states to restore and maintain the chemical, physical, and biological integrity of the nation's waters. Pursuant to Section 303 of the CWA, states are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters.

- Idaho Surface Water Quality standards protect the public welfare, support water quality, and meet requirements of the CWA. Provisions of these standards that specifically apply to Indian Creek include:

    - IDAPA 58.01.02.140.12—SW-2 Indian Creek – Sugar Ave (T03N, R02W, Sec. 15) to mouth designated for Cold Water Aquatic Life and Secondary Contact Recreation and SW-3a Split between New York Canal and historic creek bed to Sugar Ave. (T03N, R02W, Sec. 15) designated for Cold Water Aquatic Life, Salmonid Spawning, and Secondary Contact Recreation. This information was also available in Table 1 of the draft strategy paper. SW-2 in the standards equates with assessment unit (AU) ID17050114SW002_04 and SW-3a equates with ID17050114SW003a_04.

    - IDAPA 58.01.02.278.03—Indian Creek, SW-3a – Site-Specific Criteria for Water Temperature. A maximum weekly maximum temperature of thirteen degrees C (13°C) to protect brown trout and rainbow trout spawning and incubation applies from October 15 through June 30.

- The assessment units (AUs) of Indian Creek upstream of the New York Canal split are intermittent and have received sediment and bacteria TMDLs that apply when water is present (DEQ 2015).

- For the cold water aquatic life use designation, water temperatures should be 22°C or less with a maximum daily average of no greater than 19°C (IDAPA 58.01.02.250.02.b).

A modeling study is proposed to identify the stream temperatures that would occur under system potential shade. The temperature TMDL will provide load allocations to nonpoint sources in the Indian Creek study reach drainage and wasteload allocations for point sources that are based on the water quality standard:

> If temperature criteria for the designated aquatic life use are exceeded in the receiving waters upstream of the discharge due to natural background conditions, then wastewater must not raise the receiving water temperatures by more than three tenths (0.3) degrees C. (IDAPA 58.01.02.401.01.c)

3 Analytical Approach

Statewide, Idaho addresses non-point source temperature effects on water quality with potential natural vegetation analyses (Shumar and deVarona 2009) using appropriate plant communities and natural bankfull widths calculated from regional hydrology curves to estimate system potential shade. TMDL load allocations based on system potential shade identify reaches with shade deficits. During TMDL implementation, watershed improvement projects have the highest priority on stream reaches with the greatest lack of shade.

DEQ proposes using the dynamic version of QUAL2Kw to model existing conditions of Indian Creek. After calibrating the model to existing conditions, DEQ will use the calibrated model to predict stream temperatures that would be achievable under system potential shade. Modeled stream temperatures under system potential shade will be used to provide wasteload allocations based on a range of existing effluent flows and streamflows.

3.1 Data Requirements

Data needs for the QUAL2Kw model include:

- "Headwaters" flow and temperature, which equates with the stream just above the Columbia Bridge crossing for the study reach
- Tributary and point source flow and temperature
- Groundwater flow and temperature
    - Measure groundwater temperature in gaining reaches with piezometer
    - Groundwater flow is generally the remainder of the water mass balance
- Channel geometry
    - Width and depth of channel cross sections measured at regular intervals
    - Velocity measurements made at the time of channel measurements in order to develop rating curves
    - Observations of channel bed materials to inform thermal conductivity values
- Meteorological parameters
    - Air and dewpoint temperature (or humidity)
    - Wind speed
    - Cloud cover (% covered)
    - Solar radiation

The smaller a stream is, the more important it is to gather accurate groundwater and meteorological data. For this project, DEQ is developing the following standard operating procedures:

- Installing and Monitoring Instream Piezometers (TRIM 2016AKL3)
- Channel Profile and Streamflow Measurement with the StreamPro Acoustic Doppler Current Profiler (TRIM 2016AKL4)
- Temporary Meteorological Station Installation (TRIM 2016AKL5)

3.2 Existing Data

Existing data applicable to this temperature study include:

- DEQ continuous 15-minute temperature measurements 2011-2012 at the following locations in the watershed:
    - Columbia
    - Robinson
    - 11th Avenue
    - Sugar Street
    - Above Wilson Drain Confluence
    - Wilson Drain
    - Below Wilson Drain Confluence
    - Above Riverside Canal
- DEQ existing and system potential shade evaluations
- Sporadic U.S. Geological Survey (USGS) field measurements of channel parameters such as width and depth, which will help confirm rating curves
- USGS and Idaho Department of Water Resources (IDWR) streamflow measurements made at the following monitoring stations:
    - USGS 13211445 Indian Creek at mouth near Caldwell, ID—period of record 1981-1983 by USGS and 1996-2015 by IDWR. IDWR does not record streamflow during non-irrigation season
    - USGS 13211309 Indian Creek above waste water plant nr Nampa, ID—period of record 1981-1996. If no other streamflow data is found, this data can be used to create a calculated dataset for headwater flow in the model. For comparable periods of record at both gaging stations, the flow above the Nampa WWTP averaged 25% of the outflow near Caldwell.
- Sporadic USGS temperature measurements 1981-1983, 1994-2001, 2005, 2007, 2010, 2012, 2013 at USGS 13211445 Indian Creek at mouth near Caldwell, ID
- Sporadic USGS temperature measurements 1981-1995 at USGS 13211309 Indian Creek above waste water plant nr Nampa, ID

- Meteorological data at KEUL at 43.632175N, -116.633923 W in Caldwell and KMAN at 43.580268N, -116.522677W in Nampa

Monitoring locations described above are shown in Figure 3.

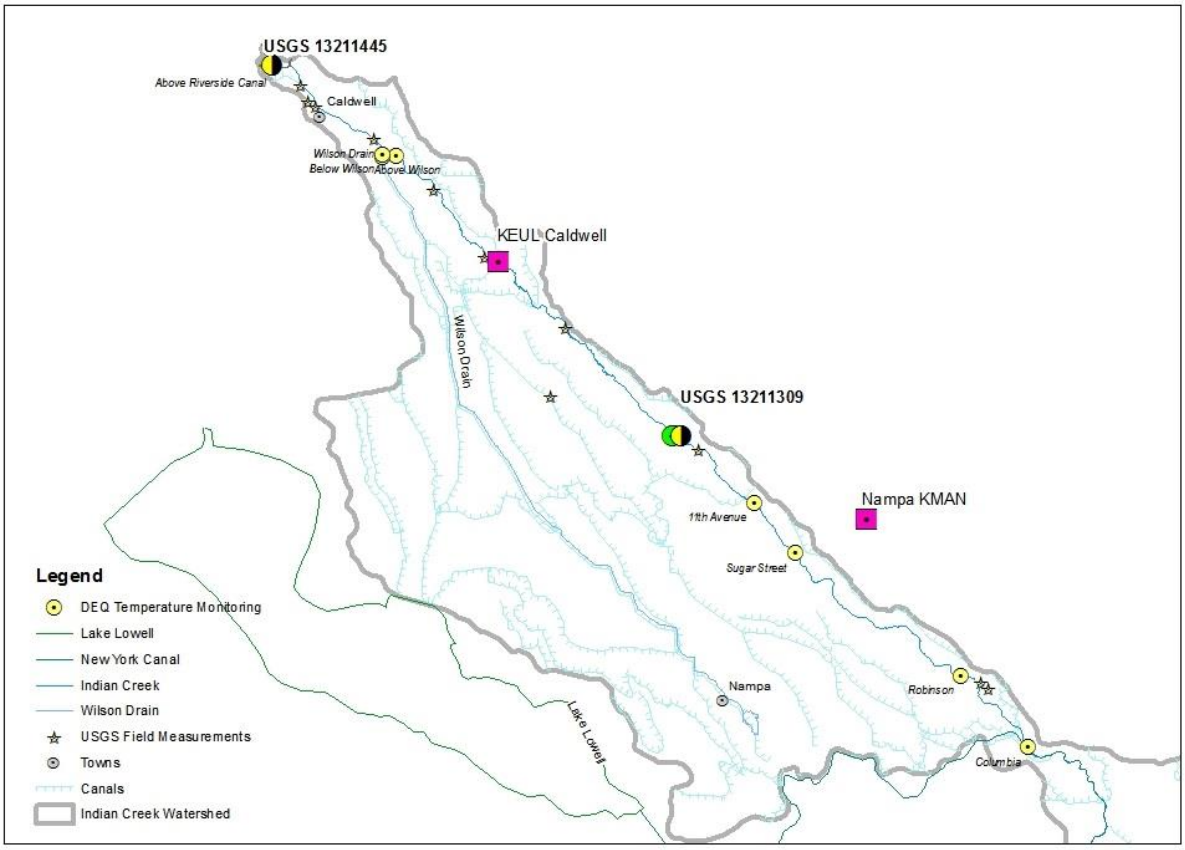

Figure 3. Monitoring locations with existing data.

The Nampa WWTP will provide existing data including:

- Indian Creek streamflow and temperature above and below the outfall
- Effluent volume and temperature
- Well discharge and temperature

3.3 Data Collection

3.3.1 Ground water flow and temperature

Ground water volume and temperature are required inputs for the QUAL2Kw model. The volume of the ground water inflow and outflow is an unknown variable, so the values in the model equal the remainder of the water mass balances for each reach, where:

$$\text{Surface Runoff} \pm \text{Groundwater Inflow or Outflow} = \text{Total Streamflow}$$

To evaluate the ground water temperature contribution to Indian Creek, piezometers equipped with thermistors will be installed in each of the listed assessment units at a minimum. Major lithology maps of the region show alluvium through the entire study reach (Figure 4). However, there is some evidence of mafic volcanic flows in the stream reach between Columbia and Robinson, and another piezometer will be installed in this reach.

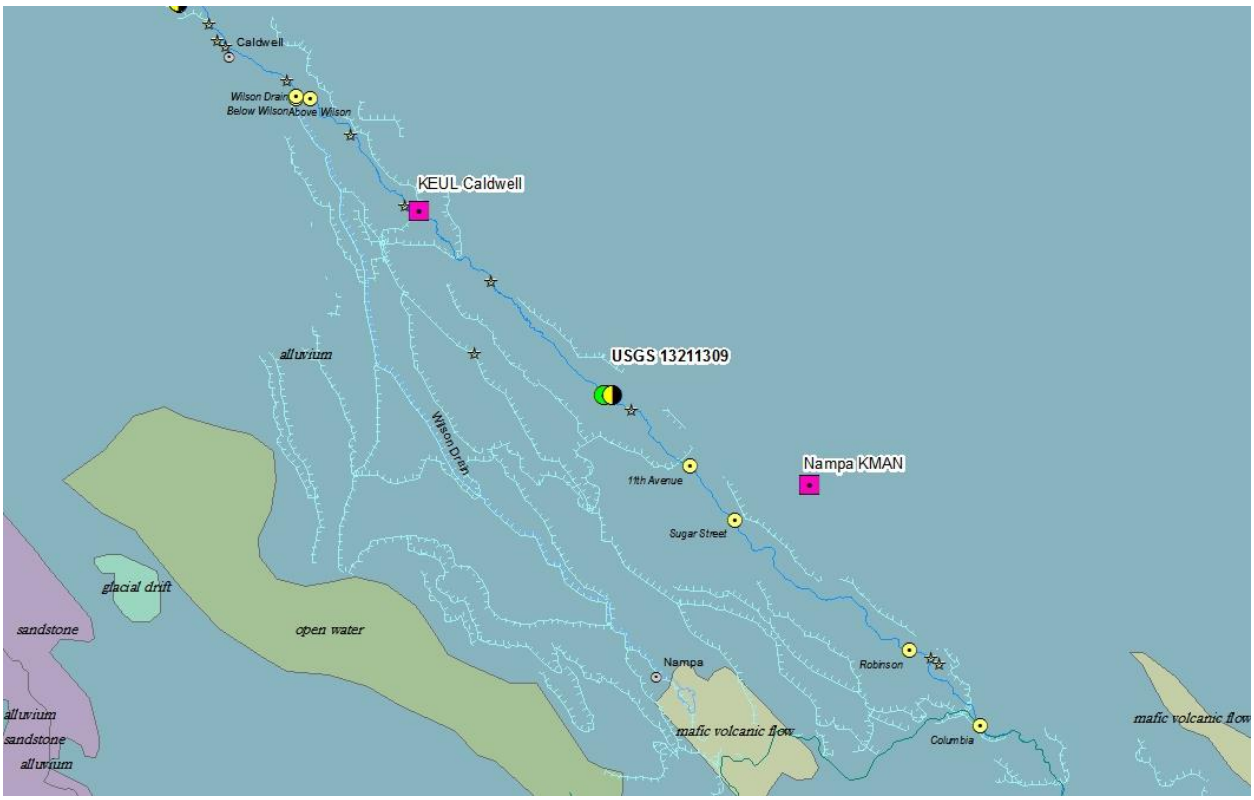

Figure 4. Major lithology of the Indian Creek temperature study reach is predominantly alluvial.

Preliminary investigation of available streamflow data indicates that all of the study area is gaining volume through groundwater flow. A particularly large jump in streamflow occurs between Columbian and Robinson Roads, where the basaltic outcrops are accompanied by groundwater seeps. Ultimately, locations of piezometer installation will be dependent upon private landowner permission and may be adjusted depending on what the initial data shows.

3.3.2 Channel geometry

Certain reach details such as elevation, location, and slope can be identified by geographic information system (GIS) analysis. However, accurate measurements of channel width, depth, and velocity are necessary for developing accurate rating curves for the hydraulic model. Additionally, observations of channel bed materials are helpful to inform thermal conductivity values. DEQ proposes to measure channel cross sections and velocity using a StreamPro Acoustic Doppler Current Profiler. The StreamPro uses this data to produce rating curves in real time as the field work progresses. DEQ proposes to collect this data in 2016.

3.3.3 Meteorological parameters

There are two national weather stations near the study reach with continuous meteorological data: KMAN in Nampa and KEUL in Caldwell.

Temperature, humidity and wind speed can differ greatly from riparian zones to measurements made at a long-term weather station surrounded by pavement and other reflective surfaces. It is very important for the calibration of diurnal stream temperature fluctuations to have air temperature and humidity measured at the same location near the stream. Heat exchange processes in the stream are greatly affected by meteorological parameters. Often, air and water temperatures are highly correlated, showing the same daily and seasonal patterns. However, air temperature is not the primary driver of water temperature. Heat exchange between air and water is from conduction, which is only a small part of the overall heat flux. During a clear day for an unshaded stream, shortwave solar radiation is generally the largest thermal input to water temperatures. The model will provide a complete heat budget for the Indian Creek system. Figure 5 shows an example output for one day on another system that typifies the components of a heat budget. This figure is a graphic output of the QUAL2Kw model that can be shown for any day of the model simulation period to identify the primary sources of heating and cooling.

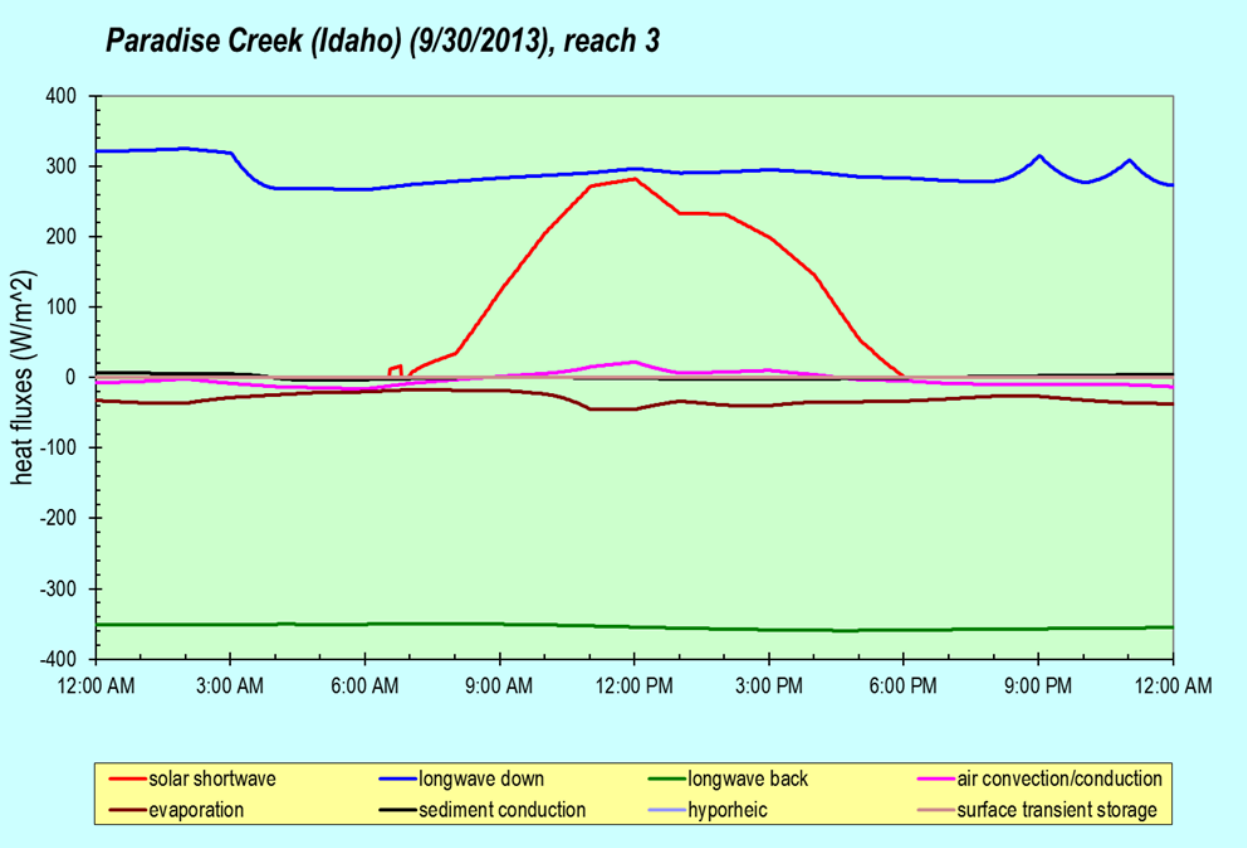

Figure 5. Heat exchange processes that affect stream temperature.

The Caldwell weather station is very near the stream channel, but the Nampa weather station is in a very different landscape than the nearby reaches of Indian Creek. For best model calibration, DEQ proposes to install a temporary station in the riparian zone of a less-urbanized reach to collect air and dewpoint temperature and wind speed as it affects the stream

temperatures more directly. The location will be dependent upon private landowner permission for access. The data collected for one month will then be compared to the longer-term record at the Nampa weather station for interpretation of the differences.

4 Timeline and Responsibilities

Monitoring and data analysis will occur this year from April through September, 2016. Timeline and responsibilities for accomplishing the Indian Creek temperature TMDL are provided in Table 2.

Table 2. Timeline for Indian Creek temperature TMDL.

Task	Resource	Individual	Estimated Completion
Modeling approach presented to WAG	DEQ Technical Services (TS) staff	Darcy Sharp	2/11/2016
Draft TMDL strategy paper presented to WAG	DEQ TS staff	Darcy Sharp	3/10/2016
System potential shade temperature TMDL approach presented to WAG	DEQ State Office staff	Mark Shumar	4/14/2016
Comments on strategy paper and response to data request	City of Nampa Brown and Caldwell	Michael Fuss Nate Runyan Matt Gregg	5/5/2016 letter date 5/11/2016 date received by DEQ
Meeting with Nampa wastewater program to review Nampa's and DEQ's goals for temperature TMDL	City of Nampa Brown and Caldwell DEQ TS staff	Michael Fuss Nate Runyan Matt Gregg Darcy Sharp	5/20/2016
Initial Data Collection Temperature logger placement	DEQ TS staff DEQ Regional Office staff	Darcy Sharp Graham Freeman	June 2016
Provide update to WAG meeting—Strategy Paper Review	DEQ TS staff DEQ Regional Office staff	Darcy Sharp Lance Holloway Graham Freeman	6/9/2016
Strategy paper review - DEQ	DEQ State Office staff	Mark Shumar Don Essig Barry Burnell	6/17/2016
Modeling QAPP draft, describing analytical methods and data collection	DEQ TS staff DEQ QAO	Darcy Sharp TBD	6/24/2016
Strategy paper review - EPA	EPA Idaho Operations Office staff	Bill Stewart	7/1/2016
Present final strategy paper and draft QAPP to WAG meeting	DEQ TS staff DEQ Regional Office staff	Darcy Sharp Lance Holloway Graham Freeman	7/14/2016

Task	Resource	Individual	Estimated Completion
Monitoring and data analysis	DEQ TS staff DEQ Regional Office staff	Darcy Sharp Graham Freeman	June - October
Comments on Modeling QAPP, including proposed scenarios	City of Nampa WAG EPA DEQ State Office staff	As needed	8/11/2016
Draft Model Report	DEQ TS staff	Darcy Sharp	November 2016
WAG consultation on draft Model Report	City of Nampa and WAG consultation DEQ BRO and TS staff	Nate Runyan Matt Gregg TBD	November - December 2016
Edit Model Report	DEQ TS staff	Darcy Sharp	December – January 2017
State Office Review and tech editing of draft	TMDL Program Manager DEQ SO	Mark Shumar Tech Editor	February 2017
Additional WAG consultation on edited model report, if necessary	City of Nampa and WAG consultation	Nate Runyan Matt Gregg	March 2017
Public comment period	Public WAG comments		April 2017
DEQ response to comments	DEQ BRO and TS staff	Graham Freeman Lance Holloway Darcy Sharp	May 2017
EPA draft TMDL	EPA review	Bill Stewart	June 2017
Final model report			July 2017

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Appendix A. Chronological Listing History

The 1988 water quality status report (DEQ 1989) lists Indian Creek from New York Canal to Boise River in its Appendix A, "Waters not fully supporting at least one beneficial use". At that time, pollutants included nutrients, sediment, and organic enrichment that depleted dissolved oxygen. Sources were listed as irrigated crop production, pasture land, feedlots. Construction, storm sewers, and land disposal were listed as additional sources of organic enrichment and oil and grease. Subsequent listing history includes:

- The 1992 Idaho Water Quality Status Report—Appendix D, "Stream segments requiring further assessment") lists Indian Creek from New York Canal to Boise River as supporting but threatened for the same pollutants and sources as described in the 1988 report.
- The 1994 and 1996 §303(d) lists both carry over this information from Appendix D of the 1992 report
- The 1998 §303(d) list refines the pollutants to dissolved oxygen, nutrients/organic enrichment, and sediment.
- The 2002 integrated report (DEQ 2005) marks the beginning of the use of AUs to categorize water bodies and lists ID17050114SW002_04 for bacteria and temperature impairments and ID17050114SW003_04 for nutrients, dissolved oxygen, sediment, and temperature impairments.
- The 2008 integrated report (DEQ 2009) also lists ID17050114SW002_04 for bacteria and temperature impairments and lists ID17050114SW003_04 for sediment, temperature, and cause unknown/low DO due to suspected organic enrichment
- The 2010 integrated report (DEQ 2011) lists ID17050114SW002_04 for bacteria, sediment and temperature impairments and ID17050114SW003_04 for temperature
- The 2012 integrated report (DEQ 2014) lists ID17050114SW002_04 for bacteria, sediment, cause unknown/nutrients suspected and temperature impairments. The upstream AU was edited to ID17050114SW003a_04 and listed for temperature and cause unknown/nutrients suspected
- The draft 2014 integrated report lists ID17050114SW002_04 for temperature and cause unknown and ID17050114SW003a_04 for temperature, cause unknown, and Chlropyrifos, a toxic insecticide. A sediment and bacteria TMDL addendum for the lower Boise River watershed was approved in 2015. Also, a total phosphorus TMDL was approved in 2015 that provided load and wasteload allocations for Indian Creek. DEQ will recommend placing these AUs in Category 4b of the integrated report because the phosphorus load allocations require pollution control requirements to be in place, which will remove the "cause unknown" listing from Category 5. This TMDL will address the remaining temperature impairment.

Appendix B. Response to Comments

City of Nampa representatives provided comments on the draft TMDL strategy paper on May 5, 2016. Their comments and DEQ's responses are provided below:

Comment #1: "The City is in favor of efforts to support the environmental health of Indian Creek and to better understand human impacts to the water body. The City recommends that water quality goals for Indian Creek, and the appropriate beneficial uses these water quality goals support, be more clearly defined. It has been widely established that Indian Creek is a unique water body because there is little historical evidence that it existed prior to human settlement in the area. Current Indian Creek flows to date are also human activity-dependent (i.e., irrigation season)."

Response #1: Water quality goals for Indian Creek are defined in federal law and state rules as defined in the bulleted list below, but the overall goals are habitat improvement and riparian restoration to be able to achieve federal and state standards. Beneficial uses are defined in Table 1 of the strategy paper. Questions about the legal basis for TMDLs were also brought up during Lower Boise Watershed Council meetings, so a summary is provided here:

- The federal Clean Water Act (CWA) 33 U.S.C. §1251 et seq. (1972) set out requirements to ensure that waters of the U.S. are fishable and swimmable by requiring states to restore and maintain the chemical, physical, and biological integrity of the nation's waters. Pursuant to Section 303 of the CWA, state are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters.

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    - IDAPA 58.01.02.278.03—Indian Creek, SW-3a – Site-Specific Criteria for Water Temperature. A maximum weekly maximum temperature of thirteen degrees C (13°C) to protect brown trout and rainbow trout spawning and incubation applies from October 15 through June 30.

- The assessment units (AUs) of Indian Creek upstream of the New York Canal split are intermittent and have received sediment and bacteria TMDLs that apply when water is present (DEQ 2015).

For the cold water aquatic life use designation, water temperatures should be 22°C or less with a maximum daily average of no greater than 19°C (IDAPA 58.01.02.250.02.b). The regulatory references in Section 2 of the strategy paper have been expanded to include these references.

DEQ disagrees that ". . . there is little historical evidence that it existed prior to human settlement in the area." Indian Creek is documented in General Land Office (GLO) original surveys dating 1867 and 1875. Table 3 lists each township and range showing Indian Creek in the original surveys, along with the survey date and plat number.

Table 3. Summary of original survey plats which show Indian Creek.

Township and Range	Region in current landscape	Survey Date	Plat	Notes
T04N R03W	Mouth of Indian Creek, Caldwell	3/5/1868	48067_1	Labeled Fifteen Mile Creek "Soil in Bottom 1st rate Timber Cottonwood"
Dependent Resurvey of T04N R03W		4/8/1921	48069_1	Correctly labels Indian Creek
T03N R03W	Small segment in NE corner	5/5/1891	48019_1	Phyllis Canal identified on this plat
T03N R02W	Nampa reach	7/1/1875	48017_1	"Soil in Bottom 1st rate"
T03N R01W	Small segment in SW corner	7/1/1875	48016_1	
T02N R01W	NY Canal lying in Indian Creek channel	8/11/1868	47972_1	western portion "Unfit for settlement or cultivation & unsurveyed" eastern portion "Land rolling - Soil 2nd rate-covered with grass & sage brush"
T02N R01E	Confluence of North Indian Creek	7/1/1875	43822_1	"Soil in Bottom 1st rate"
T01N R01E	Confluence of Sand Creek; Cloverdale Rd.	8/11/1868	43820_1	western portion "Land rocky unfit for settlement & unsurveyed" eastern portion "2nd rate covered with grass & wild sage"
T01N R02E	Pleasant Valley Road S of Penitentiary	7/1/1875	79312_1	"Soil in Bottom 1st rate"
T01N R03E	N of Orchard Ranch Road and S of I-84	7/1/1875	43690_1	"Soil in Bottom 1st rate"
T01N R04E	Indian Creek Reservoir	5/25/1868	43696_1	"Soil in Creek bottom 1st rate"
T01N R05E	Indian Creek headwaters	5/11/1868	43702_1	Topography depicted near stream

The GLO surveys are currently available on *https://www.glorecords.blm.gov/default.aspx*.

Notes throughout the plats have to do with quality of the soil, vegetation, and suitability for settlement and cultivation. In many of the plats, labeling adjacent to Indian Creek identifies "soil in bottom 1st rate". Riparian floodplains typically contain fine-grained sediments from annual inundation and deposition and have been targeted for agriculture (Verhoeven and Setter 2010) wherever settlement occurs. From depictions by the original surveyor indicating first-rate soil in the creek bottom, it appears that before extensive human settlement, Indian Creek existed from its origin in the Danskin Mountains to its confluence with the Boise River.

A history of the Nampa and Meridian Irrigation District (Stevens 2010) summarizes the GLO surveys of the area as follows:

> "The 19th-century surveys clearly demonstrate that only three creeks existed south of the Boise River before the 1890s: Five Mile, Ten Mile, and Indian Creeks, and that these were ephemeral, flowing only for a month or two in the springtime when snowmelt found its way through drainages to the Boise River. An unknown deep aquifer lay beneath these lands. It was fed from higher elevation precipitation, but was not visible to the human eye nor accessible until later in the 20th century when technology was developed to allow its use."

There is ample evidence that Indian Creek existed prior to human settlement and development of the Lower Boise River valley. There is also ample evidence that hydrology of the area has been developed for water supply to allow that settlement. As early as 1884, the Pioneer Irrigation District was formed, which began to change the natural surface water hydrology for the Indian Creek drainage. The history of this irrigation district is also well documented by Stevens (2009), which states:

> "By early 1886, two irrigation canals – the Caldwell and Phyllis – were transforming the landscape of Caldwell."

Both of these reports from Stevens are available in appendices in the 2015 sediment and bacteria TMDL document for lower Boise River (DEQ 2015). DEQ acknowledges the hydrologic alteration from natural background for the Indian Creek drainage and as such, does not propose modeling natural background hydrology. Instead, current hydrology, including its current patterns of distribution and temperature, will be used for both the model of existing and system potential conditions.

Comment #2: "The TMDL Strategy Paper should describe the process for considering alternative temperature management approaches. The same temperature targets might be achieved with different combinations of shading, point source controls, nonpoint source controls, or variances such as the 316(a) approach. Even if some such approaches would be defined during implementation phases, it would be necessary to consider different management approaches for the development of TMDL model allocation scenarios. As such the schedule should be modified to account for cooperative development of TMDL model allocation scenarios and potential alternative methods to achieve water quality goals."

Response #2: Many temperature management approaches are under consideration, including the possibility of trading credits for any potential temperature wasteload allocation when the Lower Boise River trading framework becomes active. A thermal mixing zone under section 316(a) of the CWA applies to NPDES permitting rather than to TMDLs.

The TMDL development schedule is being updated to include ample opportunity for cooperative development of TMDL model scenarios. DEQ and City of Nampa have proposed formation of an Indian Creek temperature TMDL technical advisory committee (TAC) to work on the application of model scenarios to wasteload and load allocation development. This TAC, if formed, will provide monthly information and updates to the Lower Boise Watershed Council as monitoring data is collected and analyzed; as model scenarios are being developed; and as regulatory applications are being coordinated.

Comment #3: "The definition of a baseline temperature condition is a critical component for modeling execution. The anthropogenic factors, as previously mentioned, bring into question the true applicability of natural background conditions for the system, because it behaves differently than other "more natural" streams. The City recommends that a baseline temperature condition take into consideration the acknowledgement of these factors"

Response #3: The listed segments of Indian Creek proposed to be the model study reach are predominantly flow-altered with urban and agricultural land uses adjacent to the stream. The Indian Creek subbasin assessment (DEQ 2001) documented that flow is intermittent from its headwaters to the New York Canal, with the exception of Indian Creek Reservoir. Just upstream of the model study reach, New York Canal uses the historic Indian Creek streambed. New York Canal flows during irrigation season according to the water management schedule set by Diversion Dam on the Boise River. Callopy Gates on New York Canal can be shut to divert water into a spillway into Indian Creek, but this rarely happens and occurs on no set schedule.

As detailed under the response to Comment #1, current hydrology, including its current patterns of distribution and temperature, will be used for both the model of existing and system potential conditions.

The model will predict stream temperatures under system potential shade. A 0.3°C allowance under IDAPA 58.01.02.401.01.c, allows point source wastewater treatment to raise the receiving waters 0.3°C if temperature criteria for the designated aquatic life use are exceeded due to natural background conditions.

Since DEQ has no jurisdiction over water quantity with its timing and distribution, no attempt to model natural background hydrology is proposed. The modeling scenarios will identify potential stream temperatures that will be achievable under the current hydrologic management. System potential equates with riparian restoration and habitat improvement of streambanks that are denuded of vegetation. Modeling will identify stream temperatures achievable under system potential shade.

Comment #4: "As discussed in the Strategy Paper, DEQ is proposing to calibrate a model of existing conditions on Indian Creek and then use it to predict stream temperatures that

would be achievable under system potential shade. The modeled temperatures, using the system potential shade approach, will serve to estimate point source wasteload allocations representative of a range of existing effluent flows and streamflow. Acknowledging that there is little definition of realistic, attainable goals for Indian Creek, this inherently introduces challenges to determining what is considered unattainable for the system based on current temperature limits. The TMDL Strategy Paper should describe a process for considering the need for a site-specific temperature criterion for Indian Creek, given that the default temperature criterion may be unachievable due to major alterations to flow and land use. The schedule should be adjusted to accommodate this possibility.

- The Strategy Paper references a document titled *The Potential Natural Vegetation (PNV) Temperature Total Maximum Daily Load (TMDL) Procedures Manual*. The document states, "These procedures lead to a temperature TMDL for a stream based on thermal loading from a lack of potential shade. They do not necessarily address the myriad of problems associated with flow alteration and its effects on stream temperature. Nor does it address thermal loading to a stream from point source discharges. To date, we have not developed comparable techniques for addressing these other sources of excess heat to a water body" (Page 30)

Response #4: In reference to the comment ". . . that there is little definition of realistic, attainable goals for Indian Creek. . ."—that is the purpose of the proposed model under system potential shade. The modeled stream temperatures predicted under system potential shade are the realistic, attainable goals for Indian Creek with today's current urbanized and agricultural landscape, current managed water withdrawals and returns, and current groundwater contributions. The output of the model will represent the seasonality of the system potential stream temperature. Additionally, DEQ proposes to use acceptable analytical tools to model 35 years of meteorological data to represent the 10^{th} percentile, mean and 90^{th} percentile response temperatures of Indian Creek under system potential shade.

The reference to page 30 of the PNV procedures manual is correct in that the shade analysis alone does not address flow. That is the reason a hydrologic model must be calibrated to existing conditions including flow, meteorology, channel parameters, and existing shade. The existing and system potential shade evaluation developed according to methods documented in this manual will be input files to the hydrologic model.

Regarding the comment about site-specific temperature criteria, there is already a site specific criterion for ID17050114SW003a_04 in IDAPA 58.01.02.278.03—Indian Creek, SW-3a – A maximum weekly maximum temperature of thirteen degrees C (13°C) to protect brown trout and rainbow trout spawning and incubation applies from October 15 through June 30.

Comment #5: "As previously mentioned, anthropogenic influences on Indian Creek are an important factor to consider in the modeling effort. The impacts of irrigation on the system are not addressed in the Strategy Paper and are significant to accurate model representation. Agricultural drains and tree growth (or lack thereof due to conflicting maintenance objectives) around these areas will be an important configuration point to include in the model. The City recommends additional consideration of said agricultural drains to better understand their influence and proper representation in modeling scenarios."

Response #5: The agricultural drains are not themselves included in modeling existing conditions, but are point sources to the dynamic model of Indian Creek. There are no changes proposed to the management of agricultural withdrawals and return drains. DEQ does not have jurisdiction over irrigation districts, water rights, or the timing and distribution of irrigation water throughout the Indian Creek watershed. The current managed water systems are an acknowledged part of the hydrology of Indian Creek and will be modeled as existing conditions to the extent data is available, measureable, or able to be estimated.

Comment #6: "The area considered for system potential shade is a critical component to the temperature TMDL development. The model boundaries are currently proposed to focus solely on two Assessment Units on Indian Creek that are on the 303(d) list for temperature. The City recommends that the boundary definition for the temperature model be clearly defined."

Response #6: As stated previously, the two assessment units of Indian Creek that are listed for temperature equate with the proposed model reach. The boundary conditions of the model include:

- Upstream boundary conditions will be upstream of the Columbia bridge crossing. DEQ has temperature data from May 2011 to February 2012, and is planning to collect more data to characterize temperature, streamflow, groundwater contribution, channel parameters, and possible meteorology during 2016. The extent of the data collection at this location will depend on property owner permissions.

- Streamflow data for canals as available from the Idaho Department of Water Resources water rights accounting system at < *https://maps.idwr.idaho.gov/qWRAccounting/*> for Riverside Canal (site ID 13210984) or from the National Water Information System from the U.S. Geological Survey at <waterdata.usgs.gov/id/nwis>.

- Additional boundary conditions include ground water flow and temperature, channel geometry, and meteorological parameters, which are described in Section 3.3 Data Collection.

Comment #7: "It is understood that a modeling Quality Assurance Project Plan will follow the TMDL strategy document. However, it is recommended that the TMDL strategy document provide some additional details on how the model will be used for TMDL development, including likely calibration and corroboration periods, critical hydrologic, meteorological, and seasonal conditions. For example, would allocations be based on a subset of conditions within the calibration period, a hypothetical streamflow, a time-averaged condition, etc?"

Response #7: DEQ is expecting to calibrate a model to existing conditions for the period from 2011 through 2012 when DEQ collected temperature data throughout the watershed. DEQ will further calibrate the existing conditions model for 2016. When existing conditions are calibrated to at least these two years, stream temperatures under system potential shade will be modeled. The output of the model will represent the seasonality of the system potential stream temperature. Additionally, DEQ proposes to use acceptable analytical tools to model 35 years of

meteorological data to represent the 10th percentile, mean, and 90th percentile response temperatures of Indian Creek under system potential shade. The proposed tool is rTemp, available from the Washington Department of Ecology site *http://www.ecy.wa.gov/programs/eap/models.html*. This tool provides the response temperature with 35 years of meteorological data. An example from a similar analysis for Paradise Creek is provided in Figure 6.

Figure 6. Response stream temperature under system potential shade.