

Columbia Water Use Plan

Physical Works Terms of Reference

**Kinbasket and Arrow Lakes Reservoirs
Recreational Management Plan**

**CLBWORKS-20A: Lower Columbia Indian Eddy Dredging: Definition
Phase**

June 2015

CLBWORKS 20A: Lower Columbia Indian Eddy Dredging Physical Works Terms of Reference

1.0 Introduction

This Terms of Reference (TOR) is submitted in response to the Conditional Columbia Works and Effective Monitoring Studies, Item 8 (a) attached to the Order for Columbia River Projects dated January 26, 2007. This project is included within the Kinbasket and Arrow Reservoirs Recreational Management Plan which is focused on recreational concerns including access to the reservoirs (boat launches), and debris and sedimentation management.

This document details the TOR for *CLBWORKS-20A: Lower Columbia Dredging at Indian Eddy: Definition Phase* (Definition Phase). This TOR follows reports and recommendations from CLBWORKS-19: Lower Columbia Indian Eddy Dredging Environment and Engineering Assessment. The engineering study (CLBWORKS-19A) and environmental study (CLBWORKS-19B) were completed on September 16, 2009 and March 18, 2010, respectively, and met the requirements of the Order dated January 26, 2007, Schedule E, Clause 1(b).

CLBWORKS-19 (A and B) addressed uncertainties identified by the Columbia Water Use Plan Consultative Committee (WUP CC) about whether attenuated flushing flows on the Columbia River upstream of Trail resulted in the deposition of excess sediment within Indian Eddy. In addition, there was some concern that sand deposited at Gyro Park found approximately 0.5 km upstream of Indian Eddy was eroding as a result of upstream flow dynamics and depositing in Indian Eddy. Findings from CLBWORKS-19A and 19B are presented in Section 1.1 below.

The Definition Phase objective is to complete a risk assessment and develop a dredging method to maintain boat access to the Columbia River at the Indian Eddy Boat Launch (hereafter referred to as Indian Eddy) located in Trail, B.C. Upon conclusion of sequential and related tasks throughout the Definition Phase, recommendations will be made on whether or not to proceed to dredging (see Section 1.4: Approach). If the risks associated with dredging can be suitably mitigated and these risks are acceptable to BC Hydro, First Nations, stakeholders and/or the regulators, BC Hydro would seek approval for the dredge work and associated costs in a subsequent TOR (Implementation Phase).

1.1 Background

This TOR follows reports and recommendations submitted under CLBWORKS-19: Lower Columbia Indian Eddy Dredging Environment and Engineering Assessment as well as additional relevant information about the current state of Indian Eddy. The following sections provide an overview of findings and recommendations from CLBWORKS-19A and CLBWORKS-19B.

1.1.1 CLBWORKS-19A: Lower Columbia River Dredging at Indian Eddy Engineering Assessment (September 16, 2009)

CLBWORKS-19A investigated whether there was a relationship between attenuated discharge fluctuations from dams upstream of Indian Eddy (i.e., Hugh Keenleyside (HLK) and Brilliant dams) and increased sediment deposition in Indian Eddy. CLBWORKS-19A also aimed to determine if sand placed on the beaches of

Gyro Park 0.5 km upstream of Indian Eddy was being transported downstream and into Indian Eddy.

The CLBWORKS-19A report was prepared by Northwest Hydraulic Consultants (NHC) in 2009. The report found that attenuated high flows resulting from dam emplacement and operations no longer provided sufficient high flow events capable of eroding and transporting deposited sediment out of Indian Eddy. Further, NHC (2009) concluded:

Model results indicate that sediment transport potential within Indian Eddy is sufficient to entrain sand but that there is no longer a flood of sufficient magnitude to disrupt the re-circulating flow pattern and flush sediment from the eddy (NHC 2009).

NHC (2009) also found that although there appears to be limited capacity for sediment erosion in Indian Eddy from high flushing flows, air photo interpretation from nine years between 1945 and 1999 indicates that the reach, including Indian Eddy, has remained “quite stable over the past 60 years.”

Regarding sand deposited at Gyro Park, NHC (2009) concluded:

As there is an ample supply of fine sediment present in the system [Castlegar to Trail], it is likely that sand would be deposited in Indian Eddy regardless of sediment inputs at Gyro Park (NHC 2009).

NHC (2009) further concluded that although it is likely that sediment from Gyro Park would be transported into Indian Eddy, the volume would only be a small compared with sediment supplied from other upstream sediment sources in the reach.

NHC (2009) investigated various physical interventions including physical structures to alter the flow pattern at Indian Eddy. The options ranged from minor alterations to lower the bars at the outlet of the eddy, to construction of small wing dams, to the constructions of very large rock or concrete flow diversion structures within the eddy. NHC (2009) concluded that:

Only the most intrusive of these structures would likely reduce sedimentation, but would make navigation in the eddy treacherous. It is recommended that periodic removal of sediment at Indian Eddy be investigated. (NHC 2009),

1.1.2 CLBWORKS-19B: Indian Eddy Impact Assessment: Lower Columbia River Dredging at Indian Eddy (March 18, 2010)

CLBWORKS-19B was an environmental review of the potential effects of dredging in Indian Eddy. The CLBWORKS-19B report was prepared by Knight Piésold Ltd. (KPL) in 2010 and detailed potential biophysical impacts of sediment removal in Indian Eddy, including the assessment of impacts to fish, wildlife, benthic macroinvertebrates, sediment and water quality. In their report, KPL (2010) propose impact mitigation and compensation strategies for potential dredging activities.

Regarding fish, KPL (2010) found that:

Indian Eddy has the potential to provide spawning areas for several species in the cobble sections of the eddy as well as nursing and rearing habitat for emergent fish in the sand layers (KPL 2010).

KPL (2010) noted the confirmation of Umitilla Dace (*Rhinichthys umatilla*) in Indian Eddy from prior fish sampling efforts as well as the potential for other fish of management concern and commercial, recreational and aboriginal fisheries as defined by the federal Fisheries Act. KPL (2010) provided a detailed list of potential effects on aquatic resources as a result of dredging for which mitigation could be designed.

The terrestrial foreshore and upland areas of Indian Eddy were found to provide “marginal” habitat for wildlife, due to the proximity of the habitat to “urban development” and the “proximity of the smelter (KPL 2010).” Further, KPL (2010) found that:

The site’s use by mammalian species is likely transient and infrequent. Amphibians and reptiles are more likely to be resident, making use of riparian vegetation and woody debris. Limited marginal quality habitat suggests that amphibian and reptile use of the eddy would be low. Bird habitat is limited and is not anticipated to be affected by Project activities.

The occurrence of two listed bat species was noted: Townsend’s big-eared bat (*Coryorhinus townsendii*), and fringed myotis (*Myotis thysanodes*) but as per the above quote, their habitat is unlikely affected by project activities (KPL 2010).

Water quality and sediment samples were collected and analyzed and compared to applicable provincial and federal guidelines, respectively. All samples did not exceed their respective guidelines. A recommendation for further sampling was recommended and will be accomplished by Task 3 in this TOR, as required. KPL (2010) identified that there is a potential that if sediment is found to be contaminated, disturbing sediment by means of dredging could result in the release of contaminants into Indian Eddy.

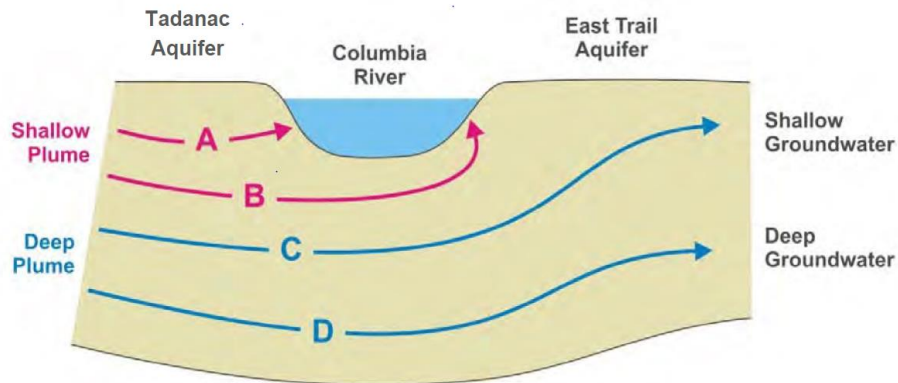
1.1.3 Contaminated Groundwater in Indian Eddy

In 2014, BC Hydro became aware of instream works at Indian Eddy installed by Teck Metals Ltd. to mitigate a ground water contamination issue at the bottom of Indian Eddy. As part of an overall remediation plan related to its historic operations in the area, Teck has implemented interim measures to address transient water quality conditions in Indian Eddy. This consists of a pipe and pump structure that pumps water from Indian Eddy during low flows (typically during April and October/November) and discharges it into the Columbia River mainstem. BC Hydro understands that this infrastructure will remain until a groundwater treatment plant is constructed and remediation is effective (Discussions with Teck staff, August 2014).

As noted in the Teck remediation report (Golder, 2012), and shown in the schematic diagram of the conceptual plume flow paths below:

While dilution is substantial along most river reaches of the river, in Indian Eddy there is less dilution during low-flow conditions and, consequently, higher concentrations of contaminants of concern are present. This appears to be correlated with low river stages and the reduction in flow through the eddy across shallow sections of the gravel bar exposed at low water levels. In extreme low river stages, in the middle and north end of the eddy is stagnant compared to the main river, and an area of poor water quality may form that encompasses a significant portion of the total eddy area. Primary

control measures for remediation of the ammonium Sulphate plume (pump-and-treat system), once implemented, and are anticipated to ameliorate the adverse water quality in Indian Eddy.



At the time the CLBWORKS-19A and CLBWORKS-19B were undertaken, some contamination was noted; however, sampling did not take into consideration the potential contamination mentioned above. In the approach for CLBWORKS-20A, sediment toxicity sampling, stakeholder discussions, and any subsequent dredge planning will account for these issues and related infrastructure.

1.2 Area Description

There are three primary inflow sources to the Lower Columbia River upstream of Indian Eddy in the City of Trail. These sources include: 1) local inflows; 2) discharge from the Arrow Lakes Reservoir through Hugh Keenleyside (HLK) Dam or Arrow Lakes Hydro (ALH); 3) and discharge from the Kootenay River through Brilliant Dam (BRD).

The Arrow Lakes Reservoir is controlled by the HLK Dam and ALH, located on the Columbia River approximately eight kilometres upstream from Castlegar and 38 km upstream from Trail (Figure 1). References to flows from the HLK Dam in this document include ALH discharges. Flows from the Kootenay River are regulated by BRD located on the Kootenay River less than five kilometres upstream from Castlegar and 33 km upstream from Trail. The study reach is shown in Figure 1. An aerial photograph of Indian Eddy is shown in Figure 2.

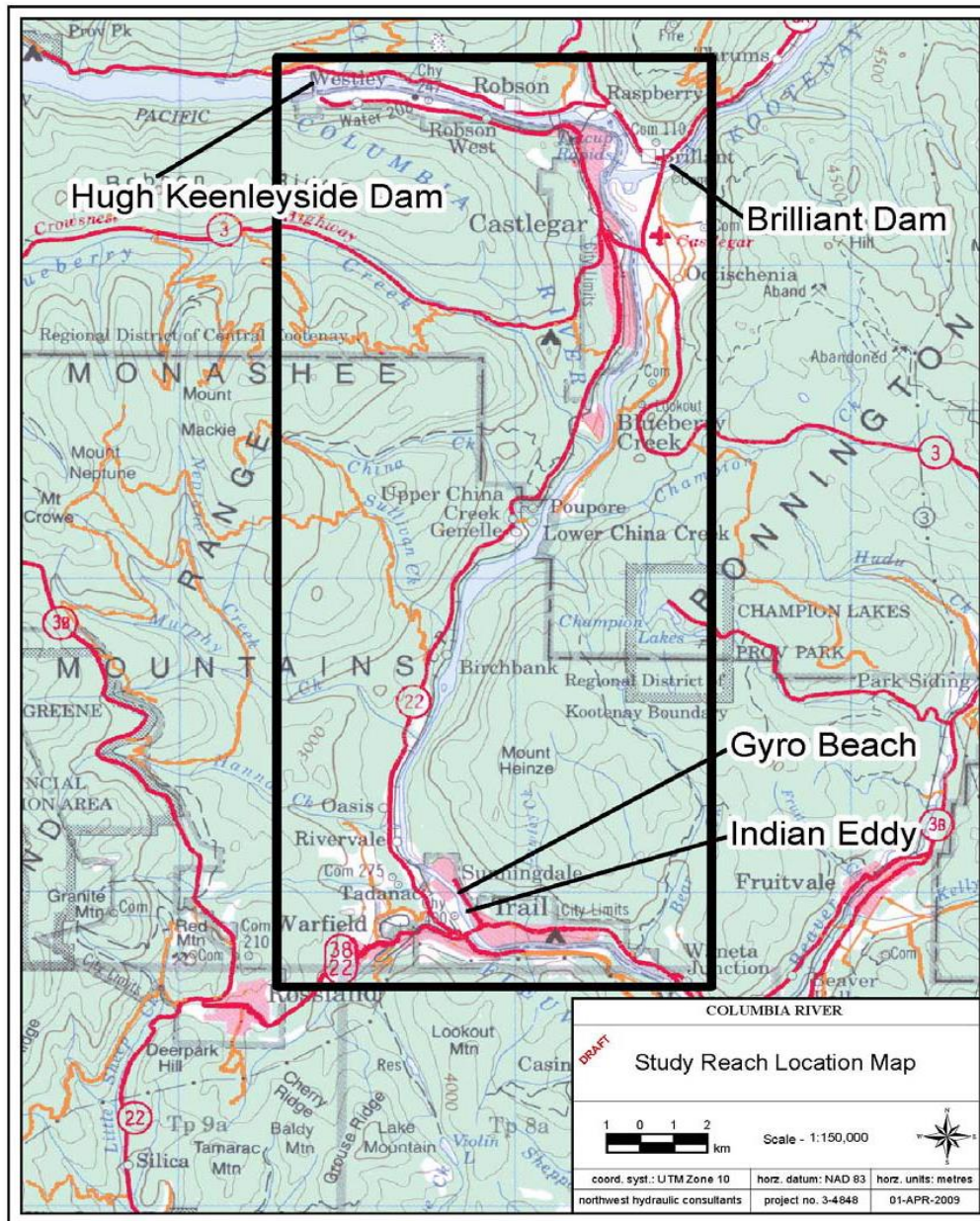


Figure 1. Overview of the lower Columbia River and Study Area for CLBWORKS-20A.



Figure 2. Aerial photograph of Indian Eddy Boat Launch (NHC 2009).

1.3 Project Description – Indian Eddy Dredging – Definition Phase

The following sections outline BC Hydro's approach to physical works, the objectives of CLBWORKS-20A and the Definition Phase approach.

1.3.1 BC Hydro's Approach to Physical Works

BC Hydro has recently aligned its approach to Water Use Plan physical works projects to BC Hydro's overall project and portfolio management approach. This approach reflects best practices principles of project management. For the purposes of common terminology, BC Hydro typically refers to the three phases for physical works projects:

- **Identification Phase:** This typically includes conceptual design and feasibility design. This will typically identify options and narrow them. Using this common terminology, CLBWORKS-19A and 19B are considered the Identification Phase.
- **Definition Phase (CLBWORKS-20A):** This typically includes the preliminary design associated with the selected option and includes a full cost estimate. In the case of WLR projects, this may also include the detailed design, as appropriate. At the end of this phase, the outcome will be a request to proceed to Implementation Phase with a related request for funding.

- **Implementation Phase (CLBWORKS-20B):** This phase typically includes procurement, permitting and construction, including all necessary safety, environmental and regulatory permitting and consultation requirements. It will typically conclude with a Completion Report.

This TOR in this document describes the work to be undertaken in the Definition Phase.

1.3.2 Definition Phase - Objectives

The objectives of this Definition phase include the following:

- 1) Completion of a series of risk assessments with a recommendation to proceed, or not to Implementation (dredging). Risk assessments will consider the following:
 - Stakeholder consultation and study of socioeconomic factors, specifically health and safety issues arising from the boat ramp being used as a rescue site.
 - An enhanced and statistically defensible water and sediment toxicity study.
 - Greater confidence in aquatic species presence and periodicity.
 - A detailed fish and wildlife habitat study specific to Indian Eddy.
 - A regional habitat analysis to put Indian Eddy in context of the region.
- 2) Should findings of the risk assessments recommend proceeding with evaluating a dredging program will be developed, which will include a dredging method, including the extent, magnitude and duration of dredging activities and remediation activities, if required.

As described in Section 1.4: Approach, the risk assessment will be undertaken incrementally, allowing for recommendations to be considered adaptively as the program moves forward.

1.4 Approach

Given the uncertainties associated with the need for dredging Indian Eddy, the approach has been designed to proceed through tasks sequentially so that recommendations to proceed are based on the information derived from the current and preceding tasks. As such, depending on the information gathered, the project may provide recommendations to conclude after Task 2, Task 3, Task 4 or carry through to Task 7.

The key tasks are summarized in Table 1 below:

Table 1. Work Approach for CLBWORKS-20A: Lower Columbia Dredging at Indian Eddy: Definition Phase		
Task #	Task Description	Summary of Task Deliverables
1	Bathymetry	Pre-Planning and Task Documentation, Task Summary Report 1, Data Files
2	Stakeholder Engagement	Interim Report 1 (Cumulative findings from Tasks 1 to 2), Meeting Minutes
If the current bathymetry presents hazards to navigation, proceed to Task 3:		
PROCEED		
↓		
3	Water and Sediment Toxicity Study	Pre-Planning and Task Documentation, Interim Report 2 (Cumulative findings from Tasks 1 to 3), Data Files
If toxicity metrics in the area of the proposed dredge area do not exceed provincial and federal guidelines for aquatic health then proceed to Task 4:		
PROCEED		
↓		
4	Fish & Wildlife Review	Interim Report 3 (Cumulative findings from Tasks 1 to 4)
If the likelihood of the dredge will not cause serious harm to wildlife, fish or aquatic species or management concern and their habitat then proceed to Task 5:		
PROCEED		
↓		
5	Dredge Method	Task Summary Report 2
6	Stakeholder and Regulatory Engagement	Task Summary Report 3, Meeting Minutes
7	Final Report	Final Report (Cumulative findings from Tasks 1 to 6)

A description of the tasks is provided below (Sections 1.4.1 to 1.4.7). Interim reports present current and cumulative findings from key tasks where decisions to proceed are made and Task Summary Reports are summaries of tasks used to present results and for decision making.

1.4.1 Project Management

Project management is identified as an ongoing task throughout the Definition Phase and is intended to allow for project management and oversight of the tasks. Project management involves the general administration and technical oversight of the program, which will include, but not be limited to:

- budget and schedule management

- study team selection
- work planning
- safety and environmental management, and
- technical oversight for field and analysis components.

A Site Specific Safety Management Plan, Occupational Health and Safety Plan and an Environmental Protection Plan will be developed and submitted to the BC Hydro contact for all aspects of the study involving field work, in accordance with BC Hydro procedures and guidelines. Both the Occupational Health and Safety Plan and Site Specific Safety Management Plan will be submitted and approved by BC Hydro before any field work commences.

1.4.2 Task 1: Bathymetric Survey

A bathymetric map is required to understand the current underwater bedform elevations in Indian Eddy and to assist in determining which areas of the eddy need to be dredged to improve navigability for boats.

A bathymetric survey will be completed in 2015 and compared with bathymetric data collected by NHC (2009) in 2008. BC Hydro will provide the 2008 data files. Task 1 is in support of a detailed dredge plan (Task 5), if required.

This task includes, but is not limited to:

- Complete a bathymetric survey with high density point cloud (xyz) representative of as much of the eddy as safely possible during flows greater than 2000 cms.
- Overlay 2015 bathymetric survey results on 2008 bathymetric data collected by NHC (2009).
- Illustrate areas of deposition and erosion in a comparison map between 2008 and 2015.
- Determine the volume of sediment deposited in and/or eroded from Indian Eddy between 2008 and 2015 based on bathymetric contours.
- Determine a proposed dredge area footprint and dredge volume, if applicable.
- Determine an estimate of annual sediment loading. Acquire 2012 air photograph of Indian Eddy from Teck and comment on morphological changes compared with the 2008 photo in the NCH (2009) report.
- Prepare a Task Summary Report detailing findings; the report will provide enough detail to be used for Task 2: Stakeholder Engagement.

Deliverables:

- Pre-Field Work Planning Documentation.
 - Project specific health and safety plan.
 - Environmental management plan for boat work.
- Copies of tailboard forms.
- xyz and CAD files.
- Bathymetric contour map with 2015 data.

- Comparison map of 2008 and 2015 survey data.
- A map identifying areas of erosion and deposition between survey years.
- If applicable, preliminary identification of a polygon of area(s) to dredge and estimated volume or material.
- A total volume of sediment deposited since 2008 compared with 2015 survey data.
- Task Summary Report 1, detailing findings from Task 1:
 - Introduction.
 - Survey methods.
 - Survey results.
 - Conclusion.

Note that xyz files will be provided for the 2008 bathymetric survey. BC Hydro has been assured that the point cloud from the 2008 survey is sufficient for a good comparison with the 2015 survey data.

1.4.3 Task 2: Stakeholder Engagement – Part 1

To understand the need for improve navigability in Indian Eddy, stakeholders will be engaged to review findings presented in the Task Summary Report for Task 1 as well as identify any additional concerns with the project. It is anticipated that stakeholders will provide input into the desired egress and ingress elevations for navigability from the Indian Eddy Boat Launch and dock to the Columbia River mainstem. Should it be determined that sediment is not causing a navigable hazard, and all parties agree, then a recommendation will be made to conclude the project.

This task includes, but is not limited to:

- Identify the interested stakeholders (including First Nations) and determine the approach for engagement.
- Document and present the findings of the bathymetric survey (Task 1) and seek input on desired dredge depths before proceeding with Task 3.
- Document any additional stakeholder comments related to other aspects of the project (e.g., environment).
- Completion of an Interim Report documenting the findings of Tasks 1 and 2.

Deliverables:

- Present Task Summary Report from Task 1 to identified stakeholders and actively solicit feedback.
- Minutes of Meetings with stakeholders.
- Prepare and submit Interim Report 1 detailing findings from Tasks 1 and 2:
 - Introduction.
 - Findings of Task Summary Report 1.
 - Feedback from Stakeholders.
 - Conclusions and recommendations to proceed to Task 3 or conclude.

Decision Point:

If after review of the Task 1 deliverables by BC Hydro, the City of Trail, search and rescue staff, and any interested key stakeholders, there is agreement that Indian Eddy appears to be in a stable state condition and there are no concerns with access between Indian Eddy Boat Launch and the Columbia River main stem, then recommendations to conclude the project would be put forward. If the 2015 bathymetric map shows an obvious change in sediment disposition since 2008 and it is agreed upon that dredging is required to permit safe navigability then the project will proceed to Task 3.

1.4.4 Task 3: Water and Sediment Toxicity

There is concern that sediment disturbed by dredging could result in the release of contaminants into the aquatic environment. Whether or not sediment in the eddy is contaminated will have implications on sediment disposal options (e.g., sediment reintroduction to the river versus on land disposal and treatment). Accurately describing the chemical characteristics of water and sediment within Indian Eddy compared with appropriate background sites is an important step towards a detailed dredge methodology (Task 5).

Knight Piésold Ltd. (2010) collected two near-surface sediment samples from a sandbar near the southeast corner of Indian Eddy, a sandbar visible still visible during a low flow survey May 7, 2015. Sediment sample results in 2010 did not exceed Canadian Council of Ministers of Environment's (CCME 1996): Interim Sediment Quality Guideline (ISQG), and Probable Effects Level (PEL) guidelines.

As mentioned previously, since KPL (2010) undertook their field research, Teck has installed temporary works to address contaminated groundwater flowing subsurface from the smelter and accumulating in the Eddy at low water periods. The increased testing will validate whether there are any residual contamination of the sediment in the area of the proposed dredge area (Golder 2012).

This task includes, but is not limited to:

- Develop a water and sediment toxicity study design.
- Obtain regulatory permits for sampling.
- Schedule sampling during low flow periods: March to April.
- Identify surface and sub-surface sediment sample sites at but not limited to the following locations:
 - Within the proposed dredge footprint polygon identified in Interim Report 1.
 - Within the channel bed adjacent to dredging footprint polygon (if applicable).
 - Within a defensibly selected control site upstream of all major outfalls.
 - On a bar downstream of Indian Eddy identified in NHC (2009).
- If sediment within the dredge polygon is found to be contaminated, estimate the volume of contaminated sediment.
- Reporting tasks include:
 - A summary of study findings Recommendations on mitigation for exposure to contaminated sediments, as well as methods to contain contaminants.

- Compare findings to Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of aquatic life.
- If sediment samples exceed CCME guidelines, provide an estimated cost for the disposal and treatment of sediment on land.
- If sediment samples exceed CCME guidelines, discuss how removal of this contaminated sediment would benefit or be of detriment to the aquatic habitat and organisms within Indian Eddy.
- Characterize water chemistry in Indian Eddy.

Sediment parameters analyzed shall include typical physical parameters plus chemical analyses based on a review of potential contaminants of concern (Knight Piésold, 2010). The parameters chosen include grain size distribution of sediment, percent moisture and pH, total organic carbon, acid volatile sulphides, metals, extractable metals and extractable petroleum hydrocarbons (EPH). For water samples, parameters include pH, dissolved oxygen, conductivity, total dissolved solids, turbidity, total and dissolved metals and EPH and polyaromatic hydrocarbons (PAH).

Deliverables:

- Pre-Field Work Planning Documentation.
 - Project specific health and safety plan.
 - Environmental management plan for boat work.
 - Copies of tailboard forms.
- Results of all analytical laboratory testing for water and sediment.
- Results compared with CCME sediment and water guidelines for the protection of aquatic life and the BC Approved and Working Water Quality Guidelines.
- Identification of appropriate disposal or containment options.
- Interim Report 2 detailing findings from Tasks 1 to 3, including:
 - Introduction.
 - Map of Sample Sites.
 - Methods.
 - Results .
 - Discussion.
 - Conclusions.

Decision Point:

If it is determined that disturbing sediment could lead to a deleterious condition for aquatic life and their respective habitat then then recommendations to conclude the project would be put forward. If toxicity metrics do not exceed provincial and federal guidelines for aquatic health, then dredge planning can proceed to Task 4.

1.4.5 Task 4: Fish and Wildlife Analysis

Previous studies on Indian Eddy (e.g., CLBWORKS-19A and 19B) have focused on identifying the fisheries and wildlife resources within Indian Eddy and other regional aquatic and terrestrial species and habitats within the Columbia River. These studies suggest there may be a wide diversity of fish species and life-history stages

present in Indian Eddy depending on the time of year. Wildlife values are thought to be minimal within Indian Eddy based on its proximity to urban and industrial development. A desktop based literature review is required to determine seasonal fish and wildlife presence and periodicity within Indian Eddy and to help identify when there are critical species or life history stages present through the year. The goal is to identify seasonal periods for dredging activities that offer the lowest impact to fish communities utilizing Indian Eddy.

Background information on terrestrial and aquatic species and habitats of the Columbia River and Indian Eddy is available from a number of studies related to project development, operational responses and mitigation, compensation planning, and research related to Species at Risk (e.g., Knight Piésold 2010, NHC 2009, AMEC Earth & Environmental 2003, Hildebrand et al. 1995, RL&L Environmental Services Ltd. 1995). Background information is also available specific to Indian Eddy (e.g., RL&L Environmental Services Ltd. 1996, Knight Piésold 2010). These reports serve as an entry point for gathering information on the terrestrial and aquatic ecosystem of the lower Columbia River, the Trail reach, and Indian Eddy itself. There are numerous biologists and academics who are working or have worked on the lower Columbia River and who may be able to provide additional information on the aquatic habitat of the area. BC Hydro may be able to assist with drafting a list of contacts. Information collected shall also include the effects of dredging on aquatic habitats specific to the Columbia River and the southern interior of British Columbia, and, more generally effects of dredging on freshwater habitat (e.g., Newcombe and Jensen 1996).

This task includes, but is not limited to:

- Conduct a literature review to determine the species (fish and wildlife) present in Indian Eddy (seasonally) and the life history stages of those species using the area, including those that are listed under the Species At Risk Act or any others of management concern. The review should also identify where insufficient information exists to make an informed decision on the impacts of the project. The literature review should focus on recent publications, consultant reports and reports by BC Hydro.
- Discussion on wildlife and vegetation attributes sustained within Indian Eddy and its riparian foreshore.
- Determining a site specific least risk work window that accounts for the presence of critical life stages for species at risk (i.e., chiselmouth, Columbia sculpin, Umatilla dace, white sturgeon) and those fish defined by Fisheries and Oceans Canada as having commercial, recreational and/or aboriginal value (CRA).

Provide a discussion on literature review findings and the relationship to proposed dredging activities, during and after dredging.

Deliverables:

- Interim Report 3, detailing findings from Tasks 1 to 4:
 - Introduction.
 - Methods.
 - Results.

- Discussion: Propose potential impact mitigation strategies to reduce or avoid harm to fish during dredging.
- Conclusions and Recommendations.

Decision Point:

If after review, BC Hydro decides that there is a likelihood of serious harm to CRA fish or aquatic species of management concern, the project recommendations to conclude the project will be presented. Further, if there is insufficient information for a particular species that complicates the ability to assess possible impacts as a result of this project, this could result in the project not continuing or additional data collection being proposed and discussed. If the findings of the interim report state that dredging can be undertaken with sufficient mitigation measures to avoid serious harm and limit the duration of impacts then the project will proceed to Task 5.

1.4.6 Task 5: Dredge Methodology

A dredge plan including design and constructability considerations is required to proceed with regulatory and environmental impact analysis and support the development of a schedule and cost estimate. The work will build off of findings from Tasks 1 to 4.

This task includes, but is not limited to:

- A detailed dredge plan that includes, depth of dredging required (Tasks 1 and 2), volume of sediment to be removed (Task 1), methodology of removal (work in low or high flow, clamshell vs. vacuum suction dredge, etc.), staging and site access and method for sediment deposition (reintroduction to the Columbia mainstem or on land stockpiling and treatment, if required).
- Conduct an alternatives analysis to select the preferred methodology. The analysis will take into account the following criteria: environmental impact and regulatory approvals needed, stakeholder and First Nations acceptance, technical challenges, efficiency of dredge method, regulatory requirements and cost.
- Dredge options to be compared against Knight Piésold (2010) list of potential effects based on the report's discussions of each potential effect (see KPL (2010) Section 4.5.2).
- Dredgate management: determine the recommended approach for treatment and disposal of dredgate.
- Environmental containment: determine the recommended approach to limit impacts on the environment i.e. cofferdam, silt curtains, dredging at high flows/high turbidity, etc.
- Develop a fish salvage or isolation protocol and methodology to be implemented prior to and during dredging activities to limit impacts on fish and wildlife, depending on the method chosen.
- Schedule and Cost Estimate – prepare a design-level schedule and cost estimate for implementation of the work. The schedule will consider seasonal constraints such as in-stream fisheries work windows, water levels and hazardous weather.

Deliverables:

- Task Summary Report 2 detailing findings from Tasks 1 to 5, including:
 - Introduction.
 - Table of dredge option methods and cost benefit analysis.
 - Proposed Dredging Method.
 - Discussion: including preliminary Regulatory Requirements.
 - Conclusion and Recommendations.

1.4.7 Task 6: Stakeholder Engagement – Part 2

Task 6 involves presenting Task Summary Report 2 to First Nations and other identified interested stakeholders (e.g., municipal staff, anglers and recreational boaters) confirming the findings of the preceding steps and validating any conclusions arising from the risk assessment.

Task 6 also involves liaising with municipal, provincial, and federal regulatory agencies to determine the requirements for implementation (dredging). The Ministry of Forests, Land and Natural Resource Operations shall be engaged as will DFO regarding the Species at Risk Act (if appropriate), and the Fisheries Act – with attention directed towards:

- Section 32 - Destruction of fish by any means other than fishing.
- Section 35 - Harmful alteration, disruption or destruction of fish habitat.
- Section 36 - Pollution of fish-frequented waters.

Deliverables:

- Develop the engagement plan for reviewing Task Summary Report 2 with stakeholders, First Nations and regulators.
- Minutes from the engagement forums, as required.
- Task Summary Report 3 detailing findings from Tasks 1 to 6, including:
 - Introduction.
 - Findings of Consultation.
 - Discussion.
 - Recommendations.

Decision Point:

If after these presentation(s) there is a general consensus that dredging at Indian Eddy should not proceed to Implementation Phase then the recommendation to conclude the project will be presented. If there is a general consensus that the dredging method proposed would be effective at improving navigability into and out of Indian Eddy then the Definition Phase will continue with Task 7.

1.4.8 Task 7: Final Report

Upon completion of Tasks 1 to 6, a final report detailing the findings is to be prepared and submitted to BC Hydro. A recommendation and supporting discussion on whether BC Hydro should move into Implementation Phase is required.

Reports will follow the standard format developed for WUP monitoring programs. All reports will be provided in hard-copy and as Microsoft Word and Adobe Acrobat (*.pdf) format, and all maps and figures will be provided either as embedded objects in the Word file or as separate files. Raw data will be provided in an Excel spreadsheet or other format acceptable to BC Hydro.

Deliverables:

- The final report shall provide the following:
 - Executive summary.
 - A discussion of the methods, results and findings/recommendations from Tasks 2 to 6.
 - A description of the feasibility-level design and construction methodology to be employed for the dredging with a specific focus on addressing stakeholder requirements and managing environmental impacts.
 - Drawings to support the descriptions above.
 - A feasibility level schedule and cost estimate for implementation of the work.
 - Recommendations regarding future work required to advance the dredging plan or for reconsideration of the costs and benefits associated with dredging of Indian Eddy.

Decision Point:

If the report concludes that the risks associated with the dredge program exceed the likely benefits to navigability, then recommendations to conclude the project will be presented. If there is a general consensus that the risks are manageable, that the costs are reasonable and that the dredging method proposed would be effective at improving navigability into and out of Indian Eddy then the report will include a recommendation will be to proceed to the Implementation phase.

1.5 Schedule

The Definition Phase investigation is expected to commence October 2015. Subject to confirmation in a detailed work plan, fieldwork is expected to take place 2015 and 2016 and if all tasks are completed, a final report is expected to be delivered by September 30, 2016, as shown in Table 2, the Work Schedule. Completion of all tasks in the Work Schedule is dependent upon decisions make sequentially throughout the completion of related tasks as shown in Table 2.

Table. 2 Work Schedule for CLBWORKS-20: Lower Columbia Indian Eddy Dredging - Definition Phase												
Description	2015			2016								
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep
Task 1: Bathymetric Survey												
Task 2: Stakeholder Engagement – Part 1												
		↓										
Task 3: Water and Sediment Toxicity												
		↓										
Task 4: Fish and Wildlife Analysis												
		↓										
Task 5: Detailed Dredge Plan												
Task 6: Stakeholder Engagement – Part 2												
Task 7: Final Report												
		↓										
Implimentation Phase												

1.6 Budget

As described in the Approach section above, as the project progresses through the tasks, should risks be identified and deemed unacceptable, then BC Hydro may put forward recommendations to conclude the project. Consequently, the total budget of the project reflects an upper and lower range.

If the entire work plan is completed, the total budget is estimated to be a maximum of \$68,280 in 2015 dollars.

REFERENCES

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