APPENDIX F

CONCEPTUAL COMPENSATION PLAN FOR FISH HABITAT

Kitimat to Summit Lake Natural Gas Pipeline Looping Project

— Conceptual Compensation Plan for Fish Habitat—

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cover photo: PNG crossing of the Stuart River.

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1. INTRODUCTION

Construction of the Kitimat to Summit Lake Natural Gas Pipeline Looping Project (the KSL Project) will enable delivery of natural gas from the Kitimat Liquefied Natural Gas (KLNG) facility to the Spectra Energy Transmission BC pipeline facilities located east of the Village of Summit Lake. To accommodate the construction and operation of the KSL Project, PNG and KLNG have jointly formed a new company, Pacific Trail Pipelines Inc. (PTP) that will own and operate the proposed pipeline loop as well as the existing PNG pipeline.

The KSL Project involves construction of 462 km of 914 mm (36-inch) diameter pipe between a location immediately north of the City of Kitimat, and a location immediately east of the Village of Summit Lake (Figure 1). The project also includes construction and operation of one new compressor station located at the mid-point of the new pipeline. The project will require construction of temporary camps, stockpile sites and other short-term work yards.

2. PURPOSE

The proposed KSL Project is subject to review under the B.C. Environmental Assessment Act (BCEA Act) 98 as well as the Canadian Environmental Assessment Act (CEA Act) 104. This review and approval process will be conducted under the auspices of the Harmonization Agreement by the B.C. Environmental Assessment Office (BCEAO) and the Canadian Environmental Assessment Agency (CEA Agency). Application will be made to the BCEAO for an Environmental Approval Certificate (EAC) for the purposes of constructing and operating the KSL Project.

During the initial review process Fisheries and Oceans Canada (DFO) has requested a conceptual compensation plan for the KSL Project. This document presents conceptual plans for fish habitat compensation to offset impacts from construction and operation of the KSL Project. The document briefly reviews the needs for compensation, the logic proposed to define the amount of compensation required, construction monitoring and post-construction assessment, the types of compensation proposed, and the timelines for compensation. Detailed compensation plans will be developed during the permitting phase of the project.

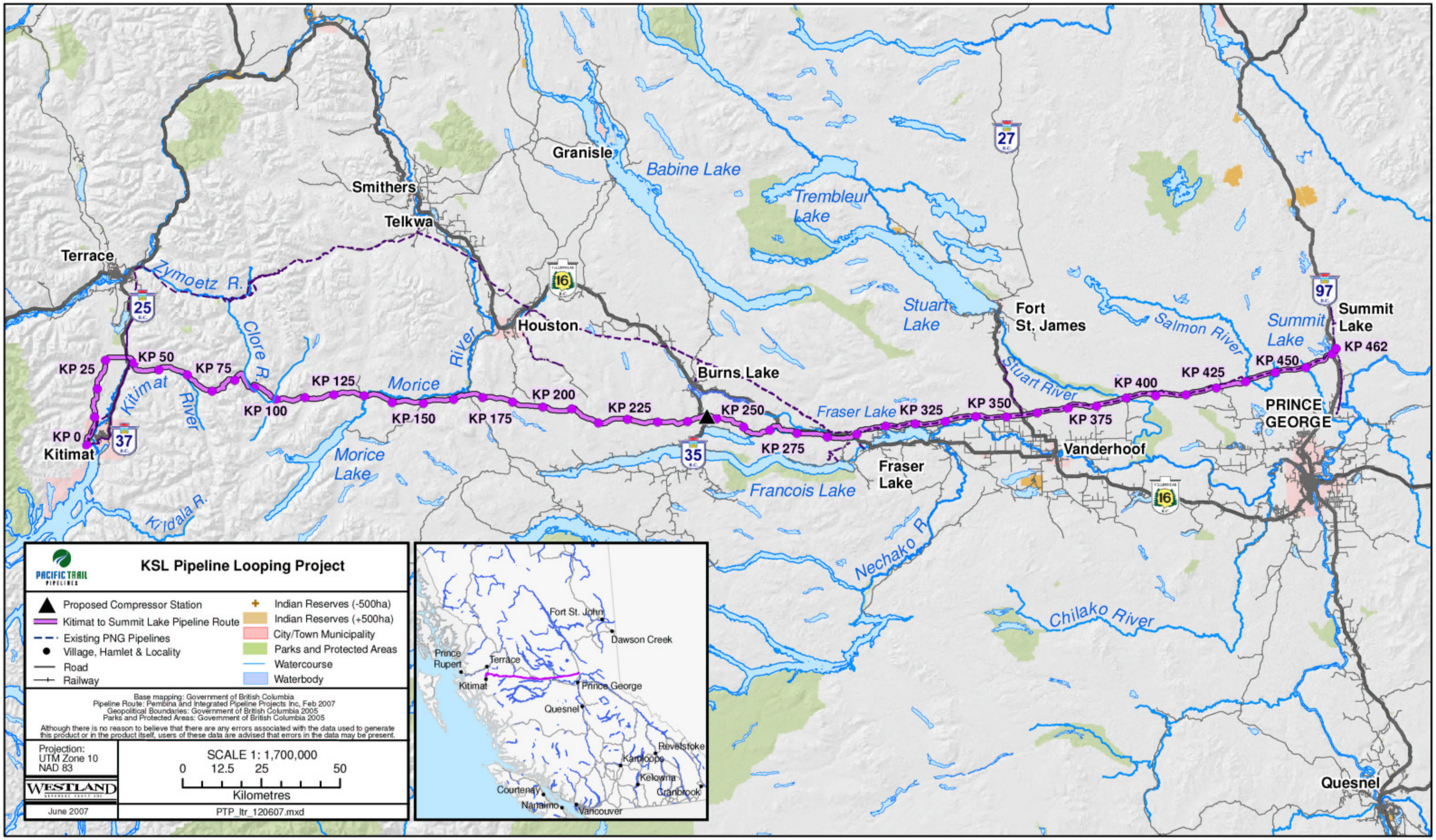

Figure 1. KSL pipeline route and general geographic setting.

3. Habitat Compensation Needs

3.1 Regulations and Legislation

The management of potential impacts to fish and fish habitat is governed by several key pieces of legislation. The dominant legislation is the *Fisheries Act* within which several sections define offences that may occur during a project such as the KSL Project. The key sections of the Act are Section 22, wherein sufficient flow for flooding of spawning grounds and free passage of fish must be maintained during construction, Section 32, which prohibits destruction of fish by any means other than fishing, Section 35, which prohibits the harmful alteration, disruption or destruction of fish habitat (HADD), and Section 36, which prohibits the deposit of deleterious substances.

DFO's long-term policy objective is an overall net gain of the productive capacity of fish habitats. This is to be accomplished through three actions: the conservation of the current productive capacity of habitats, the restoration of damaged fish habitats, and the development of habitats. The conservation of current productive capacity is implemented using the No Net Loss Guiding Principle. Unavoidable habitat losses are balanced with habitat replacement (i.e., habitat compensation) on a project-by-project basis to prevent a net habitat loss. DFO issues authorizations for HADD under Section 35(2) of the *Fisheries Act* when other options are unworkable.

The decision to authorize a HADD is made through a decision framework that identifies the information needed to answer a series of questions that clearly link to a decision on whether a Section 35(2) authorization can be granted. Although the determination of a HADD may be technically complex, the questions are quite simple:

1. Is fish habitat present at the project site or in an area affected by the project?
2. Could the proposed project cause a HADD of fish habitat?
3. Can the impacts to fish habitat be fully mitigated?
4. Should the HADD be authorized?
5. Can the HADD be compensated?

Construction-related impacts are those incurred during the construction phase of a project, and may be associated with activities such as land clearing, grading, and instream construction. Impacts are generally short-term and may include effects such as increases in suspended sediments, or other temporary disturbances to aquatic habitat. Where construction activities may cause HADD, a Fisheries Act authorization from DFO and habitat compensation are required.

Mitigation refers to measures taken to avoid or reduce the likelihood of negative impacts of construction and operation of an intake or diversion. Compensation on the other hand, refers to intentional activities undertaken to offset inevitable impacts once they occur. Compensation offsets negative impacts by providing benefits elsewhere in the system. Thus, the purpose of mitigation is to avoid impacts, whereas the use of compensation implies acceptance of impacts. Mitigation is a superior option to compensation, and proponents are expected to develop mitigation measures to ensure the fish resource is protected during construction and operation of the proposed project.

Where HADD is unavoidable and a Fisheries Act authorization is required, proponents are instructed to develop and submit compensation plans to compensate for habitat impacts and ensure that compensation is effective. This document describes needs for compensation that have been identified through the environmental impact assessment for the KSL Project, and lays out conceptual approaches to fish habitat compensation for project-related impacts.

3.2 Impact Assessment

The EAC application for the KSL Project provides a review of existing information and presents data collected specifically for this project. It describes potential impacts and assesses residual effects in relation to 16 species of fish and the habitats that support these species. Five classes of potential impact are discussed in relation to pipeline construction and vehicle access stream crossings:

1. Direct and indirect mortality of fish,
2. Loss or degradation of instream fish habitat,
3. Loss or degradation of riparian habitat,
4. Loss or degradation of habitat connectivity, and
5. Interbasin transfer of aquatic organisms.

Impact pathways and potential effects of each phase of the KSL Project on the 16 aquatic environment VECs are presented, and mitigation measures to minimize potential effects are discussed. Anticipated residual effects are identified, and assessments of significance are presented.

The assessment identified no significant residual effects from direct and indirect mortality of fish, loss or degradation of habitat connectivity, or interbasin transfer of aquatic organisms. Some residual effects were identified in relation to loss or degradation of instream fish habitat, and loss or degradation of riparian habitat and are discussed briefly below. The EAC application should be consulted for additional detail, such as information sources and assessment methods.

3.2.1 Loss or degradation of instream fish habitat

Potential Impacts.— Disturbance of instream habitat will occur at the majority of pipeline crossings, since trenching of the watercourse will be required to complete most crossings. On crossings requiring a buried pipeline, mitigation and restoration will offset most impacts to instream fish habitat, by controlling suspended sediment releases, restoring or maintaining streambank stability, and restoring or creating instream cover at all fish-bearing crossings. Residual impacts are not expected at crossings completed using isolation methods, provided the crossings are completed within the specified work windows and habitat is restored as indicated in the EAC Application and the KSL Restoration Plan. Compensation is not anticipated as a requirement for these crossings.

Ten crossings are intended to be completed using HDD or aerial techniques, which require no instream work and therefore have no effect on instream habitat. Residual impacts are not expected at crossings completed using HDD or aerial methods, provided habitat is restored as indicated in the EAC Application and the KSL Restoration Plan. Compensation is not anticipated as a requirement for these crossings.

Residual impacts to instream fish habitat have been identified under two scenarios: crossings constructed outside the instream work window, and crossings where open cut methods are used. Habitat compensation may be required to offset impacts in both cases and each scenario is described in greater detail before conceptual compensation plans are elaborated.

Construction Activities Outside the Instream Work Window.— Three crossings of the Salmon River are planned for winter construction, outside the preferred instream work window, for reasons of flow constraints and access. These crossings will be completed using flow isolation techniques, which will minimize release of suspended sediment to downstream habitat. Impacts to habitat may occur through settling of fines, but these effects are expected to be minimal, short-lived and be mostly offset by flushing flows during spring freshet or storm runoff events. Compensation will be provided to offset these temporary impacts within the zone of influence. The form and amount of compensation is described in Section 3.3.4.

PTP has committed sufficient construction resources to complete the great majority of the fish-bearing crossings within the instream work windows using isolation or HDD techniques, but some crossings may have to be completed at other times if construction progress is slower than expected. This is most likely to occur on construction spreads where the water crossing density is very high and terrain is especially rugged (e.g., upper Kitimat, Morice) and/or where wet weather or unanticipated construction difficulties negatively impact construction progress. Priorities have been set that determine the approximate order of crossings (crossing table in Section 6 of the EAC Application) and it is expected that instream construction outside the windows, if it occurs, will be on relatively small streams with relatively lower fish resource values. Impacts to habitat are expected to be short-lived and be diminished by flushing flows during spring freshet, but if instream construction is required outside the work windows then habitat compensation may be required to offset impacts in these instances. Conceptual plans for compensation are provided in Section 3.3.3.

Open Cut Crossings.— Pipeline crossings of the Little Wedeene, Wedeene, Chist and Stuart Rivers are proposed as HDD, with open cut as the contingency crossing method. Flow in these systems is too high year round to make use of isolation methods. It is intended to complete the crossings using HDD, but open cut remains a possibility if HDD is infeasible or fails. Geotechnical work is underway to support a preliminary evaluation of the feasibility of HDD crossings. Compensation will be provided to offset impacts within the zone of influence of all open cut crossings. Conceptual compensation plans are provided in Sections 3.3.1 and 3.3.2.

3.2.2 Loss or degradation of riparian habitat

Riparian zones form a physical transition zone between aquatic and terrestrial ecosystems, and there are often strong physical and biological interactions between the two. For fish, riparian zones offer three important functions: streambank stability (e.g., roots bind streambank soils and prevent erosion or sloughing), instream cover (e.g., large and small woody debris, overhanging vegetation), and food (e.g., contribution to invertebrate drift in streams). Streambank stability and instream cover are important primarily on fish-bearing watercourses; food inputs from riparian areas may be important on both fish-bearing and non-fish bearing watercourses. Losses of riparian habitat occur at both pipeline and vehicle crossings, within the spatial scale of the Project Footprint area.

Potential Impacts.— During the clearing, construction and restoration phases of the KSL project, loss or degradation of riparian habitat will occur at most pipeline crossings, since clearing of riparian trees and shrubs is essential to completing the crossing. Mitigation and restoration will offset most of the impact that is relevant to fish production, by restoring or maintaining streambank stability and providing instream cover at all fish-bearing crossings. Stream crossings will be restored with the intent of replicating or improving existing conditions. The streambed and banks will be restored, based on preconstruction habitat surveys, and the natural drainage and channel configurations will be maintained or restored. Additional cover will be provided, primarily through the use of boulder and large woody debris placement. Approach slopes will be seeded with a native seed mix and streambanks will be restored with shrubs; some larger tree species will be planted or allowed to recruit to disturbed areas.

On S3 and S4 streams, restoration activities will be guided by restoration “typicals” and onsite supervision by a restoration specialist. On S1 and S2 streams, restoration may require engineering input and will therefore be guided by engineering designs as well as onsite supervision by a restoration specialist. Details of fish habitat restoration will be provided in the Restoration Plan.

Mitigation and restoration measures will effectively address changes to streambank stability and instream cover associated with loss or degradation of riparian habitats at pipeline crossings. Riparian contributions of invertebrates to watercourses (a source of food for fish) will be lost or diminished within the project footprint area, but this loss is expected to be negligible and not significant.

Compensation Needs.— Additional compensation (i.e., over and above that already prescribed through mitigation and restoration) is deemed not necessary for KSL Project effects regarding riparian habitat losses.

3.3 Defining Compensation Needs

Compensation involves replacing damaged habitat with newly created habitat or improving the productive capacity of some other natural habitat. DFO’s hierarchy of preferred compensation options is:

1. create similar habitat at or near the development site within the same ecological unit;
2. create similar habitat in a different ecological unit that supports the same stock or species;
3. increase the productive capacity of existing habitat at or near the development site and within the same ecological unit;
4. increase the productive capacity of a different ecological unit that supports the same stock or species;

5. increase the productive capacity of existing habitat for a different stock or a different species of fish either on or off site.

To the extent feasible, compensation proposed for KSL will focus on the first compensation option, but will also consider other options.

The amount of habitat to be provided as compensation will consider four primary factors:

1. the type and area of habitat disturbed,
2. the duration of the disturbance,
3. the type and expected longevity of the compensation habitat, and
4. DFO compensation ratios.

As noted earlier, two scenarios may require compensation: crossings completed with isolation techniques outside the proposed instream work windows, and crossings completed with open cut techniques, should HDD prove infeasible. These scenarios are elaborated on below and the logic is presented for calculating the amount of compensation required in each case. The final determination of compensation will depend in part on assessments made during and after construction.

Note: Conceptual compensation needs are outlined in the following four sections using the above logic. There is, inevitably, overlap in the presentations but this format allows each section to be read independently, which in turn allows readers with specific geographic responsibilities to focus on certain sections of the document.

3.3.1 Little Wedeene, Wedeene and Chist

Pipeline crossings of the Little Wedeene, Wedeene, and Chist are proposed as HDD, with open cut as the contingency crossing method. Flow in these systems is too high to make use of isolation techniques as a contingency method. It is intended to complete the crossings using HDD, but open cut remains a possibility if HDD is infeasible or fails. Geotechnical work is underway to support a preliminary evaluation of the feasibility of HDD crossings. Where open cut techniques are required on fish-bearing watercourses, habitat compensation will be provided in addition to mitigation.

Mitigation of open cut on these systems would include careful selection of work windows and, to the extent feasible, use of specialized techniques to minimize suspended sediment. These techniques may include partial flow bypass, use of a clamshell excavator bucket, and reliance on natural bedload movement to backfill the trench. Timing of any open cut crossings would be selected to minimize potential effects to fish and fish habitat. Instream work windows for all streams are indicated in the EAC Application. For the Little Wedeene and Wedeene Rivers the work window is June 15 to July 15; for Chist Creek the work window is July 15 to August 1.

Type and area of habitat disturbed.— Fish habitat surveys conducted for the KSL Project (AAR 2007) indicate that a variety of high quality rearing, overwintering and spawning habitats occur near the proposed crossings of the Little Wedeene, Wedeene, and Chist.

Since the crossings would be completed during the instream work window, we assume that mobile life stages of fish would respond to increased suspended sediment by moving to appropriate habitat elsewhere in the system during construction activities such as trenching, provided that refuge habitats are available. By completing the crossings within the work window, impacts to spawning fish and incubating eggs are minimized.

However, the high number of species occurring in these systems, many of which have different life history timing, means that work windows cannot completely avoid all species' spawning and incubation times. A redd survey will be conducted prior to construction on these systems, if open cut is required. The redd survey will be completed for areas within the zone of direct disturbance and downstream for 500 m. The distance of this survey is greater than that proposed for situations where isolation methods are used outside the work windows, with the rationale that sediment movement will be greater when open cut is the method used in comparison to isolation methods. Compensation will be provided to offset habitat impacts within this zone.

Conceptually, compensation for the Little Wedeene, Wedeene and Chist will take the form of constructed off-channel rearing habitat in the general proximity of the crossings, with the rationale that fish production in these systems is believed to be limited primarily by accessible overwintering habitats with sufficient depth and cover. Examination of air photos (see Appendix A) confirms that there are numerous locations in close proximity to the proposed crossing locations, which have suitable land and drainage features and are accessible for construction equipment. Suitable locations on the Little Wedeene and Wedeene are in the floodplains of those systems. The most suitable compensation location near the Chist crossing is likely nearby on the mainstem Kitimat River.

The entire width of the river will be trenched, but the amount of useable rearing and overwintering habitat disturbed is considerably less than the full width, and likely less than half the wetted width, because rearing and overwintering habitat is typically associated with pools, stream margins or instream structures such as boulders and large woody debris. Habitat surveys (AAR 2007) indicate that the crossings are not at locations with large pools, and boulders and large woody debris are not distributed across the entire channel. A conservative estimate of half the wetted width to quantify the useable rearing and overwinter habitat is proposed. The strip of streambed directly disturbed is estimated to be about 20m. Thus, a total area of useable habitat that is directly disturbed is calculated as 20 m × half the wetted width. Compensation will be provided for this impact.

Disturbance will also occur some distance downstream due to mobilization and settling of fine sediments. Coarse materials, like fine gravels and larger, will settle almost immediately, whereas finer materials may travel longer distances. Impacts to habitat may occur through settling of fine sediments, but these effects are expected to be short-lived and be mostly offset by flushing flows during spring freshet or storm runoff events. To assess habitat impacts and determine the amount of compensation required, a detailed habitat survey will be conducted immediately prior to construction and immediately after. The survey will be completed for areas within the zone of direct disturbance (i.e., the area proposed for isolation) and downstream for 500 m. The survey will provide a plan-view map of habitat types, key habitat features and substrate qualities. Compensation will be based on before-after comparisons of habitat areas and habitat quality. Detailed habitat maps will be supplemented with cross-channel transects measuring substrate quality; transects will be spaced 50 m intervals within this zone of influence.

To assess potential impacts to spawning habitats, a redd survey will be conducted immediately prior to construction within the zone of direct disturbance (*i.e.* the area proposed for isolation) and downstream for 500 m. If spawning has occurred within this zone of influence additional compensation may be required.

Duration of the disturbance.— The duration of the disturbance from the crossing is expected to be a maximum of one year from the time of initiation of instream construction, because freshet flows are expected to redistribute the streambed and flush fines from the substrate. The disturbance is therefore relatively short-lived.

Type and expected longevity of the compensation habitat.— Compensation habitats are typically engineered to last at least five years, so the benefits from the compensation habitats accrue over a period that is considerably longer than the duration of physical disturbance from the pipeline construction. Longevity of the habitat compensation therefore allows the total area to be reduced to 20% or less of the total habitat disturbed. For the purpose of calculating habitat compensation requirements we use 20%.

DFO compensation ratios.— DFO typically requires a compensation ratio of 2:1 for instream habitats, so the total habitat required as compensation is twice the amount disturbed. This ratio is adopted for KSL fish habitat compensation.

Habitat Calculation Summary.— In summary, total habitat compensation requirements for open cut pipeline crossings of the Little Wedeene, Wedeene and Chist will be determined with the following calculation: 20 m width direct disturbance × half the channel width × 2:1 DFO compensation ratio × 0.20 impact duration factor. Added to this value will be an area based on pre- and post-construction assessments and water quality monitoring. The actual habitat calculations will be possible only when it is determined whether and which streams are crossed using open cut techniques, and the amount of habitat disturbed by the crossing.

Monitoring and Post-Construction Assessment.— During construction water samples will be taken at 100 m, 250 m and 500 m downstream of the construction site and be compared to an upstream control site. Water samples will be taken within 0.5 m above the streambed in mid-channel. Controls will be collected upstream of the construction activities. Samples will be taken during construction and for several hours after its completion. Suspended sediments will be measured as both NTU and TSS. TSS will be measured in the lab, and some samples will be fractionated into component size classes. Compensation will be provided to offset impacts to spawning habitats if spawning occurs within the zone of influence, and if the cumulative concentration of suspended coarse sediments exceeds a specified threshold. The threshold will be discussed with DFO during the permitting phase of the project, prior to initiation of construction.

Habitat surveys and a redd survey will be conducted prior to construction for comparison to post-construction conditions. The habitat surveys will be completed for areas within the zone of direct disturbance (i.e., the area proposed for isolation) and downstream for 500 m. If, prior to construction, spawning has occurred within this zone of influence additional compensation requirements will be discussed with DFO.

3.3.2 Stuart River

The pipeline crossing of the Stuart River is proposed as HDD, with open cut as the contingency crossing method. Flow in this river is too high year round to make use of isolation techniques as a contingency method. It is intended to complete the crossing using HDD, but open cut remains a possibility if HDD is infeasible or fails. Geotechnical work is underway to support a preliminary evaluation of the feasibility of HDD crossings. Where open cut techniques are required on fish-bearing watercourses, habitat compensation will be provided in addition to mitigation. Compensation plans for the Stuart River are discussed separately due to the very different habitat types observed near the proposed crossing site and the presence of high priority fish stocks.

Mitigation of open cut on this river would include careful selection of work windows and, to the extent feasible, use of specialized techniques to minimize suspended sediment. These techniques may include use of a clamshell excavator bucket and reliance on natural bedload movement to backfill the trench. Timing of any open cut crossings would be selected to minimize potential effects to fish and fish habitat. Instream work windows for all streams are indicated in the EAC Application. The proposed work window for the Stuart River is September 1 to October 31.

Type and area of habitat disturbed.— Fish habitat surveys conducted for the KSL Project (AAR 2007) indicate that a variety of rearing and overwintering habitats occur near the proposed crossing of the Stuart River, but spawning habitats are absent for species of management interest. Surface substrates on the streambed are primarily fines. The habitat in this location is most notable as a migration corridor for white sturgeon, which migrate between areas in Stuart Lake and Nechako River, and Stuart run sockeye, which migrate between the ocean and spawning grounds upstream of Stuart Lake. Areas around the proposed pipeline crossing have not been identified as candidate critical habitat (Wood et al. 2007), but are known to have supported white sturgeon in the past (Cadden 2000). It is possible that the area is used by lamprey ammocoetes, an important food source for white sturgeon.

Since the crossing would be completed during the instream work window, we assume that mobile life stages of fish would respond to increased suspended sediment by moving to appropriate habitat elsewhere in the system during construction activities such as trenching, provided that refuge habitats are available. By completing the crossings within the work window impacts to fish and fish habitat are minimized.

Habitat assessment in this portion of the river is made difficult by high turbidity and deep cross-sectional morphology. These conditions make it difficult to undertake meaningful measurements for the purpose of comparing habitat conditions before and after construction. For this reason we propose compensation based on the amount of habitat directly affected by trenching, plus an additional factor for downstream effects. Compensation will be provided to offset impacts within this zone. Monitoring during construction will allow assessment of whether additional compensation is required.

The amount of compensation habitat required to offset construction impacts will be based primarily on the amount of useable habitat available for lamprey ammocoetes, a key food item for white sturgeon. Available habitat is assumed to be the wetted width of the river at this location, because the substrate is primarily fines and therefore suitable across the full width of the river. Disturbance will occur within the trenched area and perhaps a short distance downstream. The strip of streambed directly disturbed by an open cut pipeline crossing is estimated to be about 20m. Thus, a total area directly disturbed is calculated as 20 m × the wetted width at the time of construction.

Disturbance will also occur some distance downstream due to mobilization and settling of fine sediments. Coarse materials, like fine gravels and larger, will settle almost immediately, whereas finer materials may travel longer distances. Impacts to habitat may occur through settling of fine sediments, but these effects are expected to be short-lived and be mostly offset by flushing flows during spring freshet or storm runoff events. This is a turbid river, with fines as dominant substrate in the vicinity of the proposed crossing. The factor proposed to quantify downstream impacts is twice the area directly disturbed by trenching. This factor is based on experience with open cut crossings of other rivers in Canada. Compensation will thus be based on the 20 m width that is directly disturbed by trenching, plus an additional 40 m width downstream of the trench.

Conceptually, compensation for the Stuart River crossing is expected to take the form of support for white sturgeon recovery initiatives in the Stuart and Nechako Rivers. The recovery strategy for white sturgeon (National Recovery Team for White Sturgeon 2007) describes several key information gaps that, if filled, will help define critical habitat for this species. There is an acute need for a study that would describe habitat use and requirements for juvenile rearing, because no information exists on this life stage of Nechako white sturgeon, the population occurring in the Stuart River. Technical details of the study would be worked out with input from the National Recovery Team for White Sturgeon.

An alternative to work on white sturgeon would be to participate in stock assessment and enumeration work for an important local stock of chinook, which spawn nearby in Dog Creek. There is a critical need to develop assessment techniques for this stock, which are difficult to work with given the challenges of large river morphology, turbid water, and physiological status of a stock in spawning condition (e.g., high loss rate of tags). Conceptual methods for assessment are under development by DFO Stock Assessment in Kamloops and the stock is of great interest to First Nations (Brian Toth, Carrier-Sekani Tribal Council, personal communication).

Studies directed at white sturgeon or chinook would be completed in partnership with the Carrier-Sekani Tribal Council. Funding for the study would be based on the cost of constructing off-channel rearing habitat, using an industry standard of \$50 m^{-2}.

Duration of the disturbance.— The duration of the disturbance from the crossing is expected to be a maximum of one year from the time of initiation of instream construction, because freshet flows are expected to redistribute the streambed and flush fines from the substrate. The disturbance is therefore relatively short-lived.

Type and expected longevity of the compensation habitat.— Compensation habitats are typically engineered to last at least five years, so the benefits from the compensation habitats accrue over a period that is considerably longer than the duration of physical disturbance from the pipeline construction. Longevity of the habitat compensation therefore allows the total area to be reduced to 20% or less of the total habitat disturbed. For the purpose of calculating habitat compensation requirements we use 20%.

DFO compensation ratios.— DFO typically requires a compensation ratio of 2:1 for instream habitats, so the total habitat required as compensation is twice the amount disturbed. This ratio is adopted for KSL fish habitat compensation.

Habitat Calculation Summary.— In summary, total habitat compensation requirements for the Stuart River, if an open cut technique is required, are proposed to be determined with the following calculation: (20 m direct disturbance + 40 m downstream impact) × 2:1 DFO compensation ratio × 0.20 duration factor. Added to this value will be an area based on water quality monitoring, if specific thresholds are exceeded. The actual habitat calculations will be possible only when it is determined whether an open cut technique is required, and construction monitoring is completed.

Monitoring and Post-Construction Assessment.— Monitoring of downstream water quality (NTU and TSS) will occur throughout the construction period on all fish-bearing streams to assess risks to downstream habitats. During construction water samples will be taken at 100 m, 250 m and 500 m downstream of the construction site and compared to an upstream control. Water samples will be taken within 1 m above the streambed in mid-channel. Controls will be collected upstream of the construction activities. Samples will be taken during construction and for several hours after its completion. Suspended sediments will be measured as both NTU and TSS. TSS will be measured in the lab, and some samples will be fractionated into component size classes. Compensation will be provided if the cumulative concentration of suspended coarse sediments exceeds a specified threshold. The threshold will be discussed with DFO during the permitting phase of the project, prior to initiation of construction.

3.3.3 Crossings completed outside instream work windows

Several crossings of fish-bearing streams may have to be completed outside the work windows if the rate of construction progress is slower than anticipated (see Section 3.2.1). Compensation needs for these crossings are discussed here.

Three crossings of the Salmon River are expected to occur in winter, outside the preferred instream work window. Compensation for those crossings is presented separately in Section 3.3.4.

Type and area of habitat disturbed.— Fish habitat surveys conducted for the KSL Project (AAR 2007) indicate that a variety of habitats occur near the proposed crossings of fish-bearing streams. Rearing, overwintering and spawning habitat in small streams is typically distributed across the full width of the stream. Note that this differs from the calculation for larger rivers, because fish habitat on small systems more typically encompasses the entire wetted width, or close to it. To calculate the area of habitat disturbed we use a conservative estimate of the mean wetted width to quantify the affected habitat. The strip of streambed directly disturbed by a pipeline crossing constructed with an isolation technique is estimated to be about 20m or less, including areas for the temporary upstream to downstream dams. Thus, a total area directly disturbed is conservatively calculated as 20 m × wetted width.

Short pulses of elevated concentrations of suspended sediment occur during installation and removal of temporary dams for isolated crossings, but these events are usually of short duration and lower magnitude than levels known to cause significant harm or mortality to juvenile and adult fish (Newcombe and Jensen 1996, Lévesque and Dubé 2007). Downstream habitat impacts are therefore not expected, and compensation will focus on offsetting impacts from the direct disturbance within the isolated work site.

Pre- and post-construction assessments will be conducted, and water quality monitoring will be conducted throughout construction to assess risks to downstream habitats. Prior to construction, fish will be salvaged and released to appropriate habitat beyond the work area.

Duration of the disturbance.— The duration of the disturbance from the crossing is expected to be temporary, lasting a maximum of one year from the time of instream construction. Freshet flows are expected to redistribute the streambed and flush fines from the substrate. The disturbance is therefore relatively short-lived.

Type and expected longevity of the compensation habitat.— Compensation habitats are typically engineered to last at least five years, so the benefits from the compensation habitats accrue over a period that is considerably longer than the duration of physical disturbance from the pipeline construction. Longevity of the habitat compensation therefore allows the total area to be reduced to 20% or less of the total habitat disturbed. For the purpose of calculating habitat compensation requirements we use 20%.

DFO compensation ratios.— DFO typically requires a compensation ratio of 2:1 for instream habitats, so the total habitat required as compensation is twice the amount disturbed. This ratio is adopted for KSL fish habitat compensation.

Habitat Calculation Summary.— In summary, total habitat compensation requirements for isolated pipeline crossings of small streams when completed outside the work windows will be determined with the following calculation: 20 m direct disturbance × wetted width × 2:1 DFO compensation ratio × 0.20 duration factor. The actual habitat calculations will be possible only when it is determined whether and which streams are crossed outside the work windows.

Monitoring and Post-Construction Assessment.— Monitoring of downstream water quality (NTU and TSS) will occur throughout the construction period on all fish-bearing streams to assess risks to downstream habitats. A redd survey will be conducted prior to construction to assess whether spawning habitats are potentially affected. The redd survey will be completed for areas within the zone of direct disturbance (i.e., the area proposed for isolation) and downstream for 250 m. If spawning has occurred within this zone of influence additional compensation requirements will be discussed with DFO.

3.3.4 Salmon River

Three crossings of the Salmon River are expected to occur in winter, outside the preferred instream work window. The crossings will be constructed using flow isolation techniques.

Type and area of habitat disturbed.— Fish habitat surveys conducted for the KSL Project (AAR 2007) indicate that a variety of high quality rearing, overwintering and spawning habitats occur near the three proposed crossings of the Salmon River. None of the crossing sites are known to be in the immediate vicinity of high use spawning areas for anadromous salmonids, and fish production in the Salmon River is believed to be limited primarily by accessible rearing and overwintering habitats with sufficient depth and cover (Aitken 1993). Spawning habitat is generally abundant and not limiting.

Rearing and overwintering habitat in large rivers is typically associated with pools, stream margins or instream structures such as boulders and large woody debris. Therefore the amount of useable rearing and overwintering habitat disturbed by each pipeline crossing is considerably less than the full width of the river. The Salmon River crossings are not at locations with large pools, and boulders and large woody debris are not distributed across the entire channel. We use a conservative estimate of half the mean channel width to quantify the useable rearing and overwinter habitat. The strip of streambed directly disturbed by a pipeline crossing that is implemented using an isolation technique is estimated to be about 20m or less, including areas for the temporary upstream to downstream dams. Thus, a total area directly disturbed is conservatively calculated as 20 m × half the channel width.

Short pulses of elevated concentrations of suspended sediment occur during installation and removal of temporary dams for isolated crossings, but these events are usually of short duration and lower magnitude than levels known to cause significant harm or mortality to juvenile and adult fish (Newcombe and Jensen 1996, Lévesque and Dubé 2007). Downstream habitat impacts are therefore not expected, and compensation will focus on offsetting impacts from the direct disturbance within the isolated work site.

As a precaution, pre- and post-construction assessments will nevertheless be conducted, and water quality monitoring will be conducted throughout construction to assess risks to downstream habitats. Prior to construction fish will be salvaged and released to appropriate habitat beyond the work area.

Duration of the disturbance.— The duration of the disturbance from the crossing is expected to be temporary, lasting a maximum of one year from the time of instream construction. Freshet flows are expected to redistribute the streambed and flush fines from the substrate. The disturbance is therefore relatively short-lived.

Type and expected longevity of the compensation habitat.— Compensation habitats are typically engineered to last at least five years, so the benefits from the compensation habitats accrue over a period that is considerably longer than the duration of physical disturbance from the pipeline construction. Longevity of the habitat compensation therefore allows the total area to be reduced to 20% or less of the total habitat disturbed. For the purpose of calculating habitat compensation requirements we use 20%.

DFO compensation ratios.— DFO typically requires a compensation ratio of 2:1 for instream habitats, so the total habitat required as compensation is twice the amount disturbed. This ratio is adopted for KSL fish habitat compensation.

Habitat Calculation Summary.— In summary, total habitat compensation requirements for isolated pipeline crossings of large rivers when completed outside the work windows are therefore proposed to be determined with the following: 20 m direct disturbance width × half the wetted width × 2:1 DFO compensation ratio × 0.20 duration factor. For the Salmon River crossings sample calculations and resulting habitat amounts are indicated in Table 2, using channel measurements from AAR 2007.

Monitoring and Post-Construction Assessment.— Monitoring of downstream water quality (NTU and TSS) will occur throughout the construction period to assess risks to downstream habitats. A redd survey will be conducted in August prior to construction to assess whether spawning habitats are potentially affected. The redd survey will be completed for areas within the zone of direct disturbance (i.e., the area proposed for isolation) and downstream for 250 m. If spawning has occurred within this zone of influence additional compensation requirements will be discussed with DFO.

4. TIMELINES FOR COMPENSATION

Compensation for HADD will commence within one year of completion of construction, and compensation activities will be completed within three years of project completion. This timeline will allow habitat assessments to be completed, which will in turn define the compensation requirements for the KSL Project. A full tally of compensation requirements will only be possible when it is known which methods will be used to cross each stream (e.g., on which streams HDD is infeasible and where construction delays cause work outside windows), and the measurement impacts that occur “on the ground.” Monitoring of TSS will also be used to assess potential impacts and compensation needs, and these results will be available only after crossings are completed.

5. SUMMARY OF PROPOSED HABITAT COMPENSATION

The following tables provide a summary of proposed fish habitat compensation for the KSL Project.

Table 1. Summary of compensation needs for KSL Project.

KP	System	Reason for Compensation	Proposed Compensation
0 to 78.7	Kitimat River system	potential work outside window, direct effects from trenching, possible downstream effects	construct off-channel rearing habitat in Kitimat floodplain, increase access on Cecil Ck
12.9	Little Wedeene River	open cut if HDD not feasible, direct effects from trenching, possible effects to downstream habitats	construct off-channel rearing habitat in floodplain of Little Wedeene River
17.0	Wedeene River	open cut if HDD not feasible, direct effects from trenching, possible effects to downstream habitats	construct off-channel rearing habitat in floodplain of Wedeene River
38.8	Chist Creek	open cut if HDD not feasible, direct effects from trenching, possible effects to downstream habitats	construct off-channel rearing habitat in Kitimat River floodplain
104.6 to 173.7	Morice River system	potential work outside window, direct effects from trenching, possible downstream effects	construct off-channel rearing habitat in Morice floodplain, improve access to floodplain habitats near KP 147-148
388.9	Stuart River	open cut if HDD not possible, direct effects from trenching, possible downstream effects	funding to white sturgeon recovery initiative, study juvenile habitat use and requirements, define study needs with White Sturgeon Recovery Team, partner with Carrier Sekani Tribal Council to complete study
430.3, 441.2, 449.2	Salmon River	winter construction (outside the window) on three crossings, likely effects to rearing and overwintering habitats	construct off-channel rearing and overwintering habitat in Salmon River floodplain

Table 2. Preliminary habitat compensation calculations for the KSL Project. Note that these amounts are based on measurements provided in AAR (2007) and will be updated based on measurements at the time of construction. Habitat amounts may be added to based on monitoring during construction and post-construction assessments.

Watercourse	Mean Wetted Width (m)	Disturbance [1] (m)	Rearing Habitat Factor	DFO Compensation Ratio	Duration Factor	Total Area (m^2)
winter flow isolation						
Salmon 1	33.3	20	0.5	2:1	0.2	133.2
Salmon 2	36.3	20	0.5	2:1	0.2	145.2
Salmon 3	30.5	20	0.5	2:1	0.2	122
						400.4
open cut contingency						
Little Wedeene	29	100	1	2:1	0.2	1160
Wedeene	33	100	1	2:1	0.2	1320
Chist	18.5	100	1	2:1	0.2	740
Stuart	79	60	1	2:1	0.2	1896

[1] note: disturbance widths for open cut of Little Wedeene, Wedeene and Chist will be based on post-construction assessments. An arbitrary value of 100 m is used here to demonstrate the calculation formula. Final figures may be greater or less than this amount.

6. REFERENCES

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