



global environmental solutions

## **Yukon Next Generation Hydro and Transmission Viability Study**

# **Positive and Negative Environmental & Socio-economic Effects**

16/11/2015

# Presentation Objectives

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1. To provide a summary of the technical paper on the Positive and Negative Environmental & Socio-economic Effects for six (6) priority Hydro sites
2. To ensure there is a clear understanding of the approaches that were used for this planning level assessment and the results.
3. To gather initial feedback.

Part	Description	Refinement
1	Screen 0: Reconciliation of Known Project Sites	200+ → 108
	Screen 1: Fundamental Development Barrier Project Screen	108 → 47
	Screen 2: Fundamentally Uneconomic Project Screen	47 → 16
2	Ranking 3: Initial Project Ranking & Variation Consolidation	16 → 10

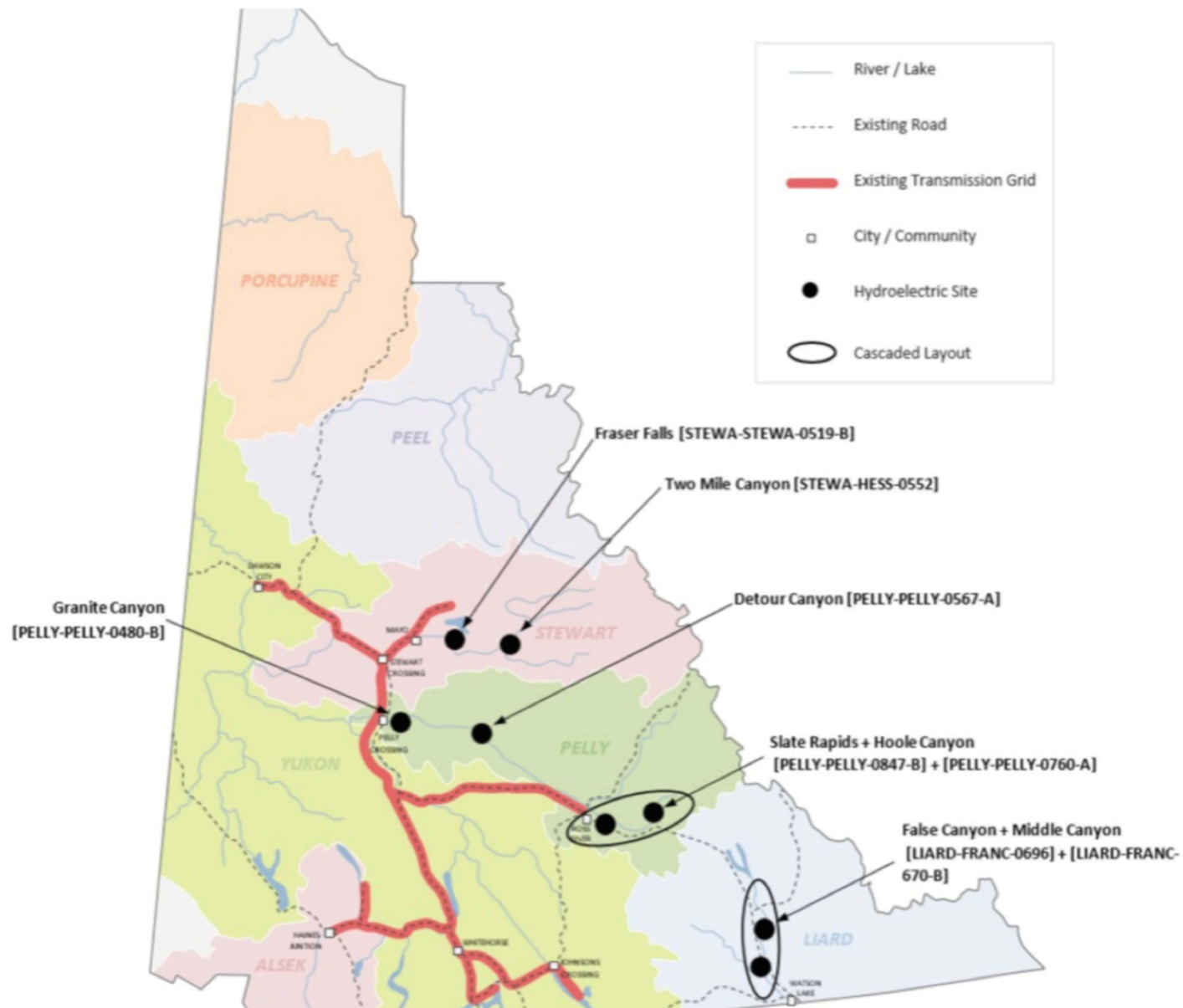
- Screening and short listing of potential sites has been the focus of this study,
- This is a planning exercise to provide some understanding of the options around long term hydro development in Yukon based on previous work, “desk top” analysis and the use of publically available information.

# The Priority Sites

**Six (6)** priority sites have been identified through the screening process:

1. **Fraser Falls** – in the Yukon River basin along the *Stewart River*;
2. **Two Mile Canyon** – in the Yukon River basin along the *Hess River*;
3. **Granite Canyon** – in the Yukon River basin along *the MacMillan and Pelly Rivers*;
4. **Detour Canyon** –in the Yukon River basin along the *Pelly River*;
5. **Slate Rapids and Hoole Canyon (Run-of-River, or ROR)** – in the Yukon River basin along the *Pelly River*; and
6. **False Canyon and Middle Canyon (ROR)** – in the Mackenzie River Basin along the *Frances River*.





# The Priority Sites

Priority Site	Basins and Rivers	Dam Dimensions	Ancillary Features	Total Reservoir Size (Ha)	Total Generation Capacity (MW)
Fraser Falls	Yukon River Basin: ▪ Stewart River	48 m (height) 56 m (height with excavation)	<ul style="list-style-type: none"> <li>▪ Spillway is on the west abutment.</li> <li>▪ Water intake, conveyance, powerhouse are on the east abutment.</li> <li>▪ 40 km new road and 48 km new transmission line.</li> </ul>	~ 31,200	57
Two Mile Canyon	Yukon River Basin: ▪ Hess River	62 m (height) 68 m (height with excavation)	<ul style="list-style-type: none"> <li>▪ Spillway and powerhouse.</li> <li>▪ Approximately 110 km new road and 113 km transmission line.</li> </ul>	~ 10,300	54
Granite Canyon	Yukon River Basin: ▪ MacMillan River ▪ Pelly River	52 m (height) 60 m (height with excavation)	<ul style="list-style-type: none"> <li>▪ Gated crest spillway is built into the dam.</li> <li>▪ Water intake, conveyance, powerhouse and tailrace are on the west abutment.</li> <li>▪ Approximately 15 km new road and transmission line.</li> </ul>	~ 17,600	57
Detour Canyon	Yukon River Basin: ▪ Pelly River	57 m (height) 72 m (height with excavation)	<ul style="list-style-type: none"> <li>▪ Spillway and control structure.</li> <li>▪ Water intake and conveyance and powerhouse are on the north abutment.</li> <li>▪ 90 km new road and 83 km new transmission line.</li> </ul>	~ 13,000	60

# The Priority Sites

Priority Site	Basins and Rivers	Dam Dimensions	Ancillary Features	Total Reservoir Size (Ha)	Total Generation Capacity (MW)
<b>Slate Rapids and Hoole Canyon ROR</b>	Yukon River Basin: ▪ Pelly River	Slate Rapids (main dam): 37 m (height); 57 m (height with excavation)  Hoole Canyon: 56 m (height) 71 m (height with excavation)	Slate Rapids: ▪ Spillway, saddle dams, penstock from intake to powerhouse located 20 km downstream of dam. ▪ Approximately 9 km of new road and transmission line.  Hoole Canyon: ▪ Spillway and water intake are on the west abutment. ▪ 600 m buried penstock cutting across the downstream river to the powerhouse. ▪ Approximately 2 km new transmission line and 50 km of new road required.	~ 19,100	Slate Rapids: 42  Hoole Canyon: 65  Total: 107
<b>False Canyon and Middle Canyon ROR</b>	Mackenzie River Basin: ▪ Frances River	False Canyon: 56 m (height) 65 m (height with excavation)  Middle Canyon: 13 m (height) 17 m (height with excavation)	False Canyon: ▪ Spillway is on the east abutment. ▪ Water intake, conveyance, powerhouse and tailrace are on the west abutment. ▪ Approximately 7 km of new road and new transmission line.  Middle Canyon: ▪ Spillway, water intake and powerhouse are constructed within the dam. ▪ Less than 6 km new transmission	~ 26,100	False Canyon: 56  Middle Canyon: 22  Total: 78

# Study Approach

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- General overview of potential effects of hydroelectric projects and best management practices available.
- High level but site-specific evaluation focused on:
  - Fish & fish habitat
  - Wildlife & wildlife habitat
  - Socio-economic Considerations
- Environmental effects are often characterized as “potential” given only desktop information was used without complete project descriptions of the hydro sites.

# Study Approach

- **Scorecards** were developed for each site similar to the ranking system that was used to identify the six priority sites.

Effect Category	Effect Rating
Fish and Fish Habitat	Moderate
Wildlife and Wildlife Habitat	Higher
Socio-economics	Higher

- Intent of ranking was to summarize the analysis to contribute to the overall planning process.
- Work was conducted at a “planning level” without site specific design or field studies to gain baseline information.
- For the purposes of this presentation, summaries of the research will be provided for each site.

# Study Approach

- A detailed environmental assessment will be required along with a number of permits, licenses and authorizations prior to any hydroelectric development proceeding.





# Fisheries Evaluation

- Key considerations were:
  - Barriers to fish movement and migration/spawning timing and triggers.
  - Potential for effects on spawning, rearing habitat or habitat that supports adult life stages (feeding, holding, etc.).
- Examined fish present in the reservoir footprint, upstream and downstream of each site
- Key data source was 2015 DFO Information Summary System



# Fisheries Evaluation

- Identified known presence of Aboriginal fishing camps, (historical and present), and known traditional fishing locations:
  - Key data sources were published literature and government websites (including aboriginal government websites).
  - This is not a complete list and additional important aboriginal fishing camps and fisheries are expected to be identified during future environmental studies.
  - Traditional Knowledge has not been included in this evaluation
- Given the importance of salmon in the Yukon River Drainage Basin, the approach in rating the effects is considered to be **“Precautionary”**.



# Wildlife Evaluation

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Key considerations were:

- The presence of protected or conservation areas in the reservoir footprint.
- Known or potential occurrences of “Species at Risk” within the reservoir footprint.
- Environment Yukon’s Wildlife Key Areas (WKAs) representing a large aggregation of individuals.
- Known caribou ranges in vicinity of the reservoirs.

# Socio-economic Evaluation

- Identified potential positive, neutral or adverse socio-economic effects.
- Used GIS to estimate the area (ha) of an attribute that overlaps with each reservoir.
- Examples of GIS data layers included:
  - First Nation Settlement Lands and Interim protected lands
  - Renewable Resources Areas (e.g. Timber Harvesting)
  - Non-Renewable Resources Area (surface rights for minerals)
  - Presence or absence of known historic and archaeological resources (provided by the Government of Yukon's Department of Tourism and Culture, 2015).

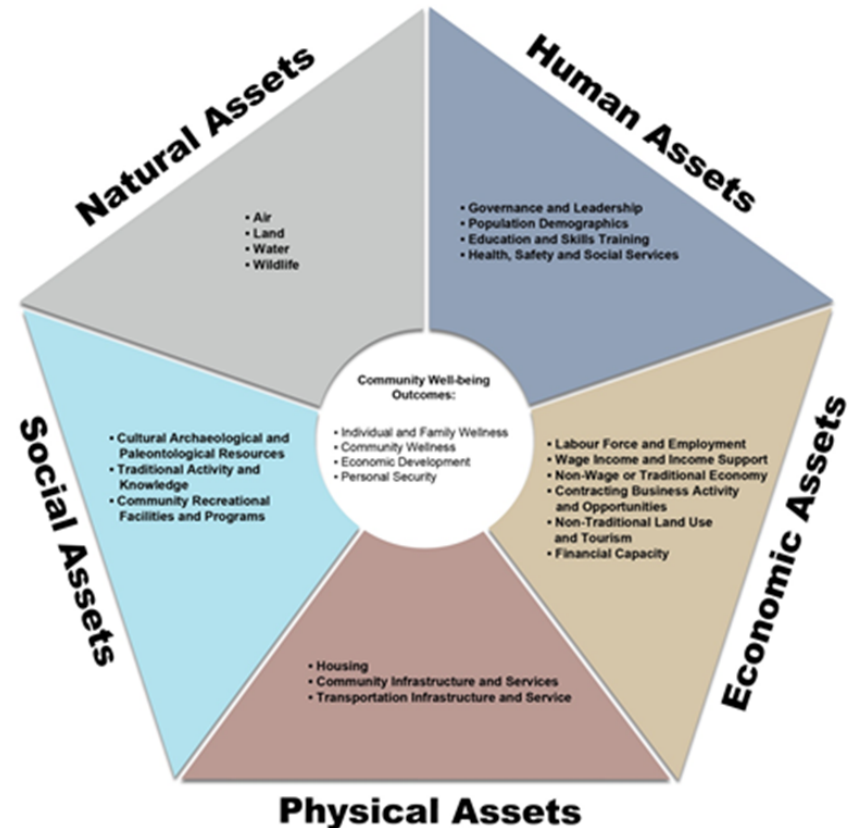
# Socio-economic Evaluation

- Estimated the potential for Employment and Business Activity benefits:
  - Potential for direct and indirect jobs created in the Yukon during construction and operations.
  - Potential contributions to Yukon GDP
  - Used high level capital and operating costs developed by Midgard.
  - Used Yukon Government's "Economic Impact Calculator".
  - Identified those communities nearest the six priority sites that have potential to supply local labour for construction.



# Socio-economic Evaluation

- An estimate of the approximate loss of areas available for traditional aboriginal activities due to flooding of reservoir areas
- Community Well-Being was also considered in terms of the general positive and negative effects of hydroelectric projects.



# Study Approach

**Table 13: False Canyon and Middle Canyon - Socio-economic Evaluation**

Factors	Positive Effects	Neutral / Uncertain Effects	Negative Effects
First Nation Settlement Lands and Other Dispositions		<ul style="list-style-type: none"> <li>No Aboriginal Settlement Lands affected.</li> </ul>	<ul style="list-style-type: none"> <li>Interim Protected Lands affected:                             <ul style="list-style-type: none"> <li>~ 1,500 ha</li> </ul> </li> <li>Other Land Tenure and Dispositions affected:                             <ul style="list-style-type: none"> <li>~ 30,000 ha</li> </ul> </li> </ul>
Land Use Plans		<ul style="list-style-type: none"> <li>Project site is not located within area of a draft or approved land use plan.</li> </ul>	
Renewable Resources		<ul style="list-style-type: none"> <li>No special management or protected areas directly affected</li> <li>No agricultural areas directly affected</li> <li>~ 10 km of new right-of-way for roads and transmission line will not substantially improve access to renewable resource areas from Ross River. Project site is adjacent to the Robert Campbell Highway which provides major access to resource areas.</li> </ul>	<ul style="list-style-type: none"> <li>Renewable resource areas directly affected:                             <ul style="list-style-type: none"> <li>~ 26,100 ha of trapping concession lands</li> <li>~ 5,000 ha of outfitting concession lands</li> <li>~ 320 ha of Timber Harvest Area</li> </ul> </li> <li>One outfitter affected</li> <li>Fifteen (15) trapline holders affected</li> </ul>
Non-renewable Resources		<ul style="list-style-type: none"> <li>No oil and gas resource areas directly affected</li> <li>No quarry permit areas affected</li> <li>~ 10 km of new right-of-way for roads and transmission line will not substantially improve access to renewable resource areas from Ross River. Project site is adjacent to the Robert Campbell Highway which provides major access to resource areas.</li> </ul>	<ul style="list-style-type: none"> <li>Non-renewable resource areas directly affected:                             <ul style="list-style-type: none"> <li>~3,000 ha of Mineral and Metal Mining Resource Area (e.g., Quartz claims or leases)</li> </ul> </li> </ul>

# Socio-economic Evaluation

- A full socio-economic assessment, including historic and archaeological surveys, traditional knowledge (TK) and traditional land use (TLU) studies, and economic modelling would be required.
- Construction would require the establishment of a self-contained construction camp operated as a fly-in-fly-out operation.
- Access roads for the transportation of materials and equipment would be co-located with transmission lines.
- Socio-economic impact management would be required to enhance and retain project benefits.

# The “Big Picture”

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## Hydroelectric projects are:

- A well-established technology that uses water in a renewable manner.
- Regarded as the most reliable renewable energy source (International Energy Agency, 2006)
- Readily integrated with other generation sources such as wind and solar.
- A clean energy source due to low greenhouse gases (GHG) emissions over the life of a project (International Energy Agency, 2006).



# The “Big Picture”

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## New hydro development in the Yukon will:

- Require the creation of reservoirs - that means:
  - flooding or inundation of land by the impoundment of rivers and the regulation of discharge.
  - loss of land where people have legal rights / claims to (e.g., settlement lands, interim protected lands).
  - loss of areas with potential for other uses or development (e.g., mining, forestry, agriculture).
- Require new road access and transmission rights-of-way – affecting wildlife and habitat and access to the land.
- Affect stream flow, fish and fish habitat.



# The “Big Picture”

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## **New hydro development in the Yukon will:**

- Change ecosystems – some will be positive and some adverse depending on species.
- Benefit local and regional economies - Yukoners and local communities will benefit from new jobs and business activity.
- Create new or additional demands on local and regional health, infrastructure, safety and social services.

# The “Big Picture”

**After many decades of experience with hydroelectric projects across Canada and internationally:**

- Key environmental and socio-economic issues are known and understood by the scientific community, various regulatory bodies and the waterpower industry as a whole.
- Best Management Practices (BMPs) are available to apply at a new generation hydro project in the Yukon.

# The “Big Picture”

Examples of Best Management Practices (BMP):

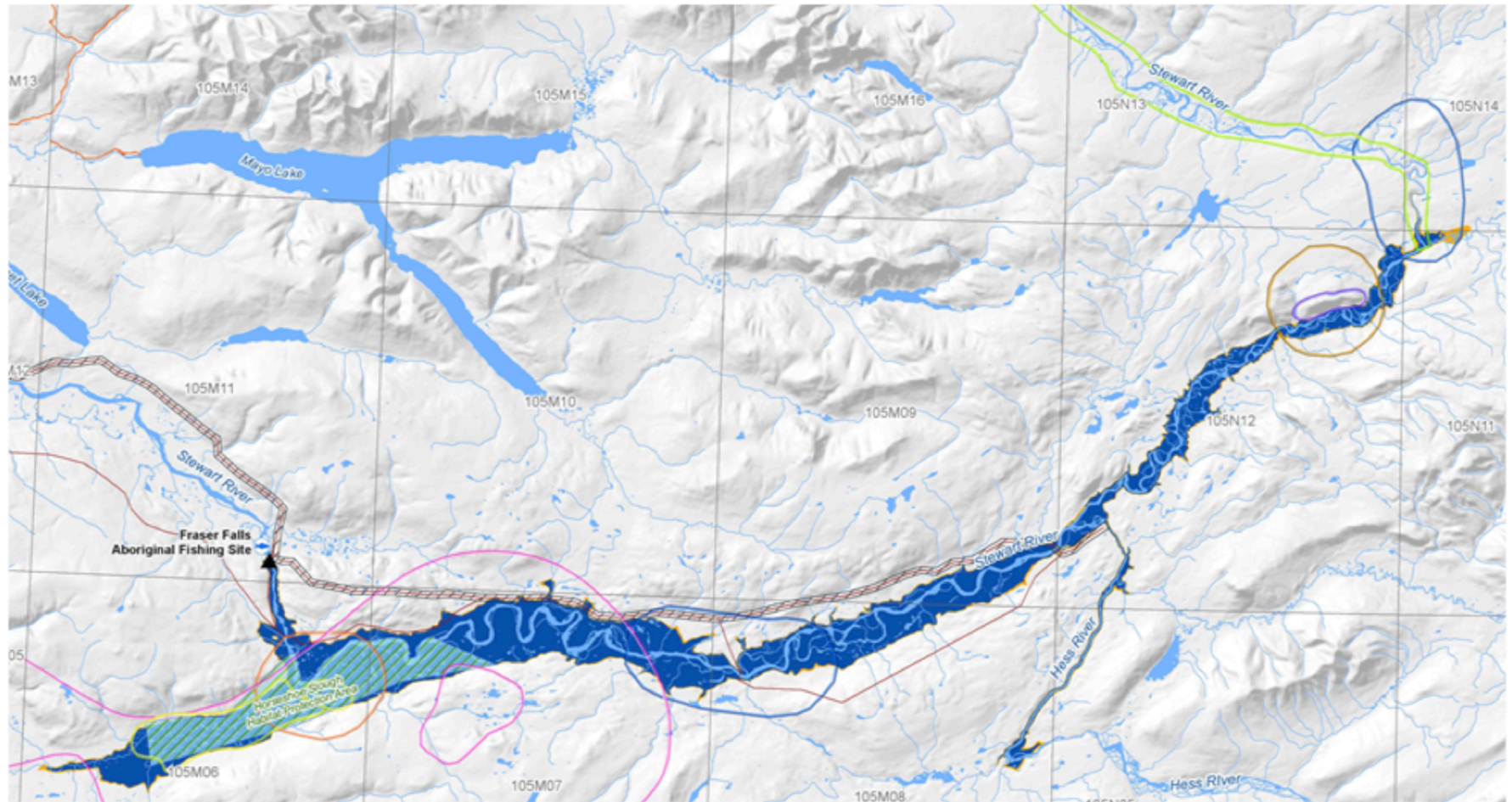
- Erosion & Sedimentation- shoreline controls such as rip-rap bank protection & re-vegetation measures.
- Water Flows- optimization of the operating flows to ensure downstream stability and protection of fish and fish habitat.
- Water Quality- removal of organic materials prior to inundation to limit decomposition in the reservoir.
- Fish Passage- designing and installing site-specific fish ladders or mechanical fish elevators.
- Ecological Diversity- fisheries offsets and compensation measures.

# Site 1- Fraser Falls (Stewart River)

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- Estimated full supply level of the water reservoir is 563 m above sea level, flooding a total area of approximately 31,200 ha.
- Approximately 40 km of new road and 48 km of new transmission line are required to access and interconnect the project.
- Fraser Falls is able to meet the forecasted Baseline 2065 energy demand for the Yukon on a year round basis.
- Capital cost estimate is approximately \$1,233 Million, over a 3 year construction time period and operational costs are estimated at \$8.7 Million.

# Fraser Falls





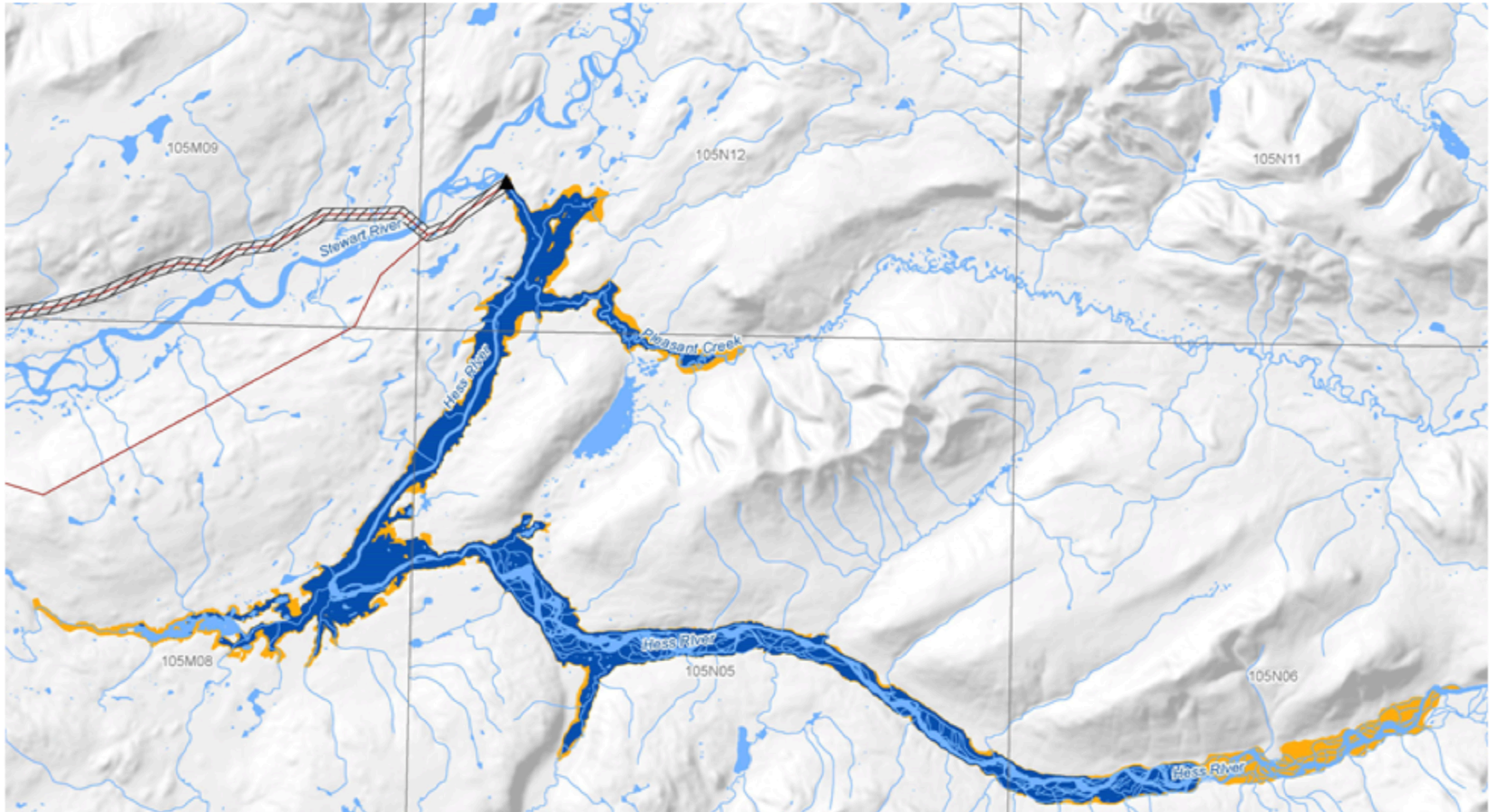
# Summary of Positive and Negative Effects

- **Fisheries:**
  - Flooding 31,200 ha of the Stewart River, Hess River and mouth of the Pleasant Creek.
  - Potential loss of spawning and rearing habitats for chinook and chum salmon within and downstream of reservoir footprint.
  - Potential migration barrier to upstream habitat for chinook and chum salmon and for out-migrating juveniles.
  - Potential loss of spawning and rearing habitat for Arctic grayling.
  - Changes in reservoir volumes may affect access to tributary streams.
- **Wildlife:**
  - The reservoir footprint will also flood Horseshoe Slough Habitat Protection Area.
  - Overlap of WKAs for duck, Canada goose, woodland caribou, peregrine falcon, bald eagle.
  - Documented presence of 2 species at risk (peregrine falcon and woodland caribou).
- **Socio-economic:**
  - Largest reservoir footprint area (31,200 ha) resulting in overlap area with Renewable Resource Areas such as trapping and outfitting concessions).
  - Presence of an Aboriginal fishing camp at Fraser Falls and fishing sites downstream of Fraser Falls.
  - The presence of known sites of heritage and cultural resources and the priority site is located in an area of high archaeological potential.
  - Overlap with 3,300 ha of NND Settlement Land.
  - Substantial economic benefits.

# Site 2: Two Mile Canyon (Hess River)

- The estimated full supply level of the water reservoir is 611 m above sea level, flooding a total area of approximately 10,300 ha.
- Approximately 110 km of new road and 113 km of new transmission line are required to access and interconnect the project.
- Two Mile Canyon is able to meet 97 % forecasted Baseline 2065 energy demand and therefore has a predicted energy shortfall in the winter months of March and April.
- Capital cost estimate of \$919 Million over a 3 year construction period and operating costs of \$8.5 Million per year over a 65 year lifespan.

# Two Mile Canyon





# Summary of Positive and Negative Effects

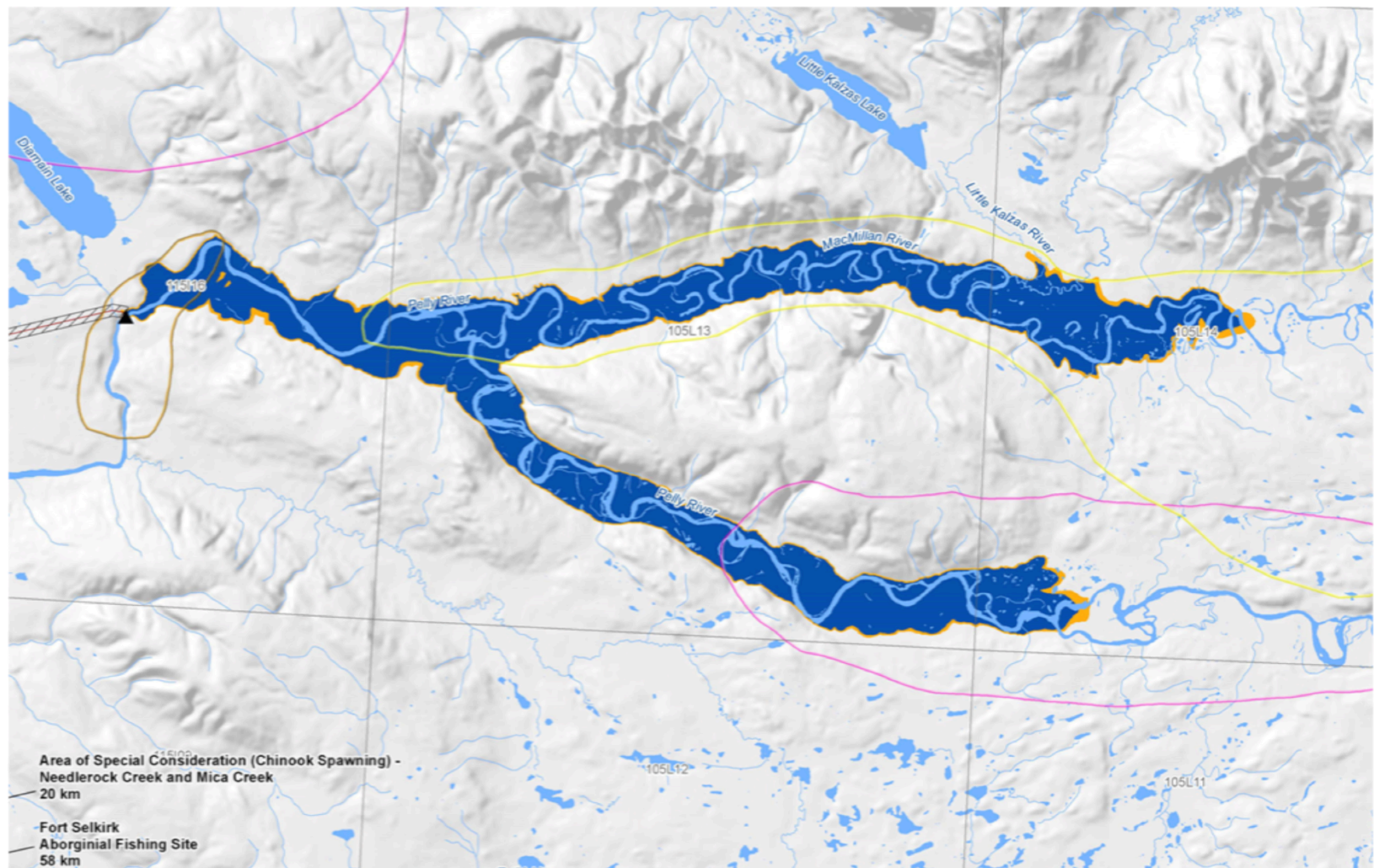
- Fisheries:
  - Flooding of 10,300 ha of Hess River and Pleasant Creek which may result in loss of spawning and rearing habitats for chinook and chum salmon.
  - Potential migration barrier to upstream habitat for chinook and chum salmon and for out-migrating juveniles.
  - Potential loss of spawning and rearing habitat for Arctic grayling.
  - Changes in reservoir volumes may affect access to tributary streams.
- Wildlife:
  - Absence of protected or conservation areas.
  - Lack of reservoir footprint area overlap with any Wildlife Key Areas.
  - Absence of documented species at risk within the reservoir footprint area.
- Socio-economic
  - Substantial economic benefits.
  - Lowest reservoir footprint area of overlap with Renewable Resource Areas (Trapping and Outfitting Concessions).
  - Low reservoir footprint area of overlap with Non-Renewable Resource Areas (Quartz Mineral Claims).
  - Smallest reservoir footprint.

# Site 3: Granite Canyon (MacMillan River & Pelly River)

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- The estimated full supply level of the water reservoir is 529 m above sea level, flooding a total area of approximately 17,600 ha.
- Approximately 15 km of new road and 15 km of new transmission line are required.
- Granite Canyon is able to meet the forecasted Baseline 2065 energy demand.
- Capital cost is approximately \$847 Million over 3 years and operational costs are estimated at \$7.2 Million per year.

# Granite Canyon



# Summary of Positive and Negative Effects

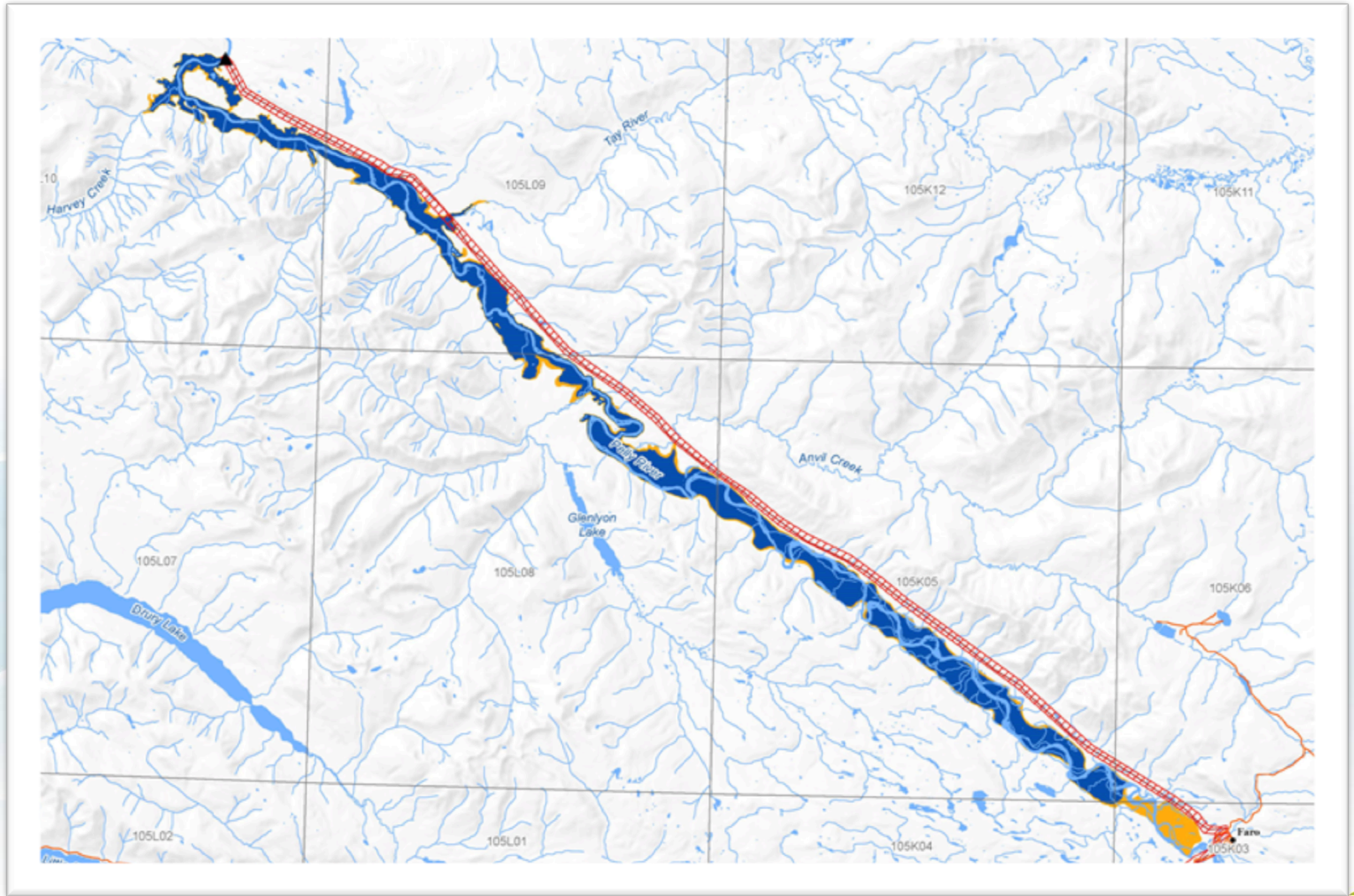
- Fisheries:
  - Downstream effects on Mica and Needle rock Creek Areas of Special Cultural Consideration.
  - Potential migration barrier to upstream habitat for chinook and chum salmon and for out-migrating juveniles.
  - Potential loss of spawning and rearing habitat for Arctic grayling.
  - Changes in reservoir volumes may affect access to tributary streams.
- Wildlife:
  - Absence of protected or conservation area.
  - Overlap of WKAs for waterfowl and woodland caribou (possibly Tatchun herd).
  - Presence of two documented species at risk within the reservoir footprint area (woodland caribou and trumpeter swan).
- Socio-economic:
  - Economic benefits are considered moderate.
  - Presence of Aboriginal fishing sites within the reservoir footprint and downstream.
  - High area of reservoir footprint overlap with Selkirk First Nation Settlement Land.
  - Known sites of heritage and cultural resources.
  - Project site is located within an area of high archaeological potential.

# Site 4: Detour Canyon (Pelly River)

- The estimated full supply level of the water reservoir is 621 m above sea level, flooding a total area of approximately 13,000 ha.
- Approximately 90 kilometres of new road and 83 kilometres of new transmission line are required.
- Detour Canyon is able to meet the forecasted Baseline 2065 energy demand.
- Capital cost estimate is approximately \$1,413 Million over 3 years and operational costs are estimated at \$9.5 Million per year.



# Detour Canyon



# Summary Positive and Negative Effects

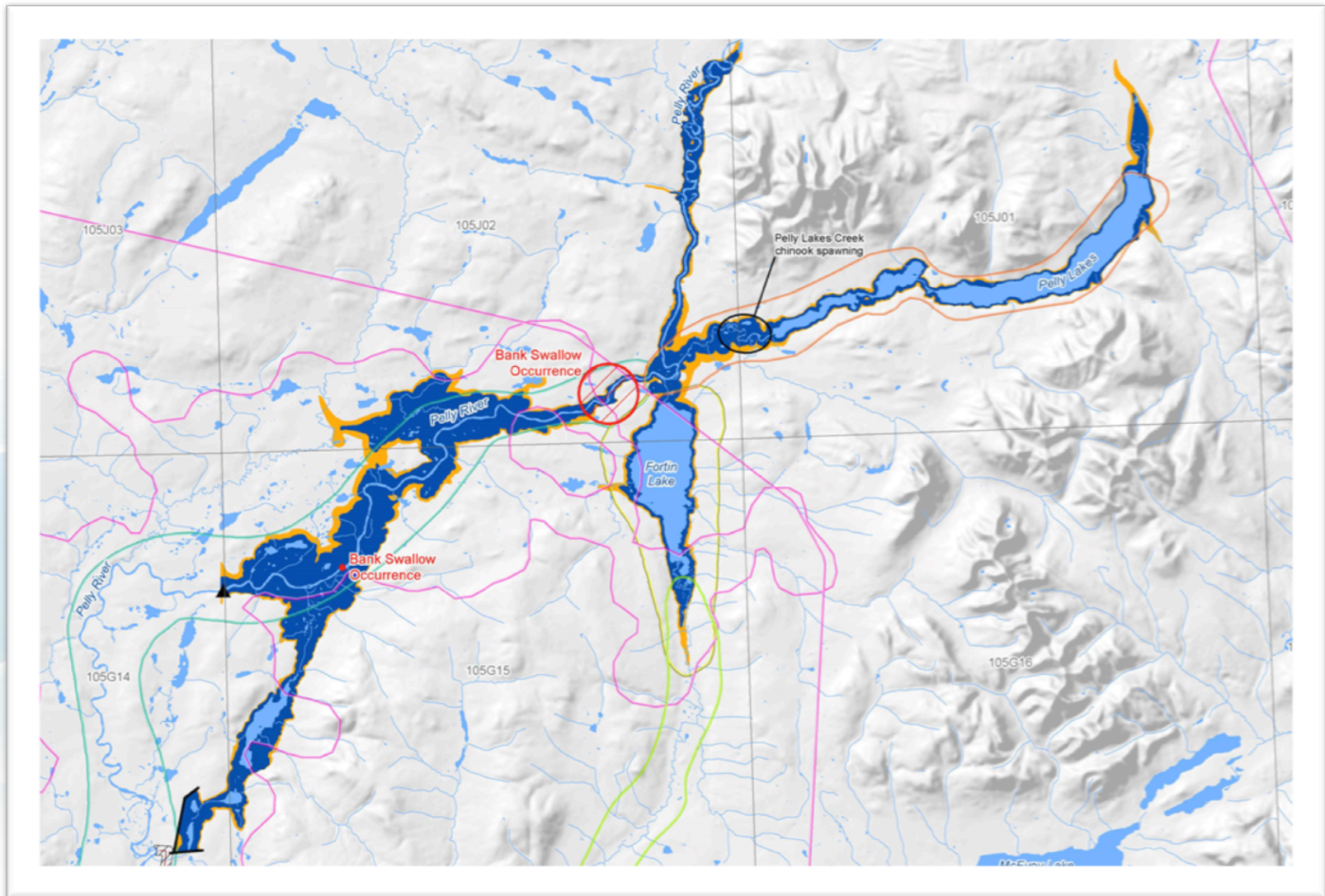
- **Fisheries:**
  - Potential migration barrier to upstream habitat for chinook and chum salmon and for out-migrating juveniles.
  - Potential loss of spawning and rearing habitat for Arctic grayling.
  - Changes in reservoir volumes may affect access to tributary streams.
  - Overlap with lower Anvil Creek Area of Special Cultural Consideration.
  - Downstream effects on Mica and Needle rock Creek Areas of Special Cultural Consideration.
- **Wildlife:**
  - Absence of protected or conservation areas.
  - Lack of reservoir footprint area overlap with any Wildlife Key Areas.
  - Absence of documented species at risk within the reservoir footprint area.
- **Socio-economic:**
  - Substantial economic benefits.
  - Smaller reservoir footprint (13,000 Ha).
  - Low reservoir footprint area overlap with Renewable Resource Areas.
  - Lowest overlap with Other Land Tenures and Dispositions.
  - Moderate overlap with Non-Renewable Resource Areas.

# Site 5: Slate Rapids & Hoole Canyon (ROR)

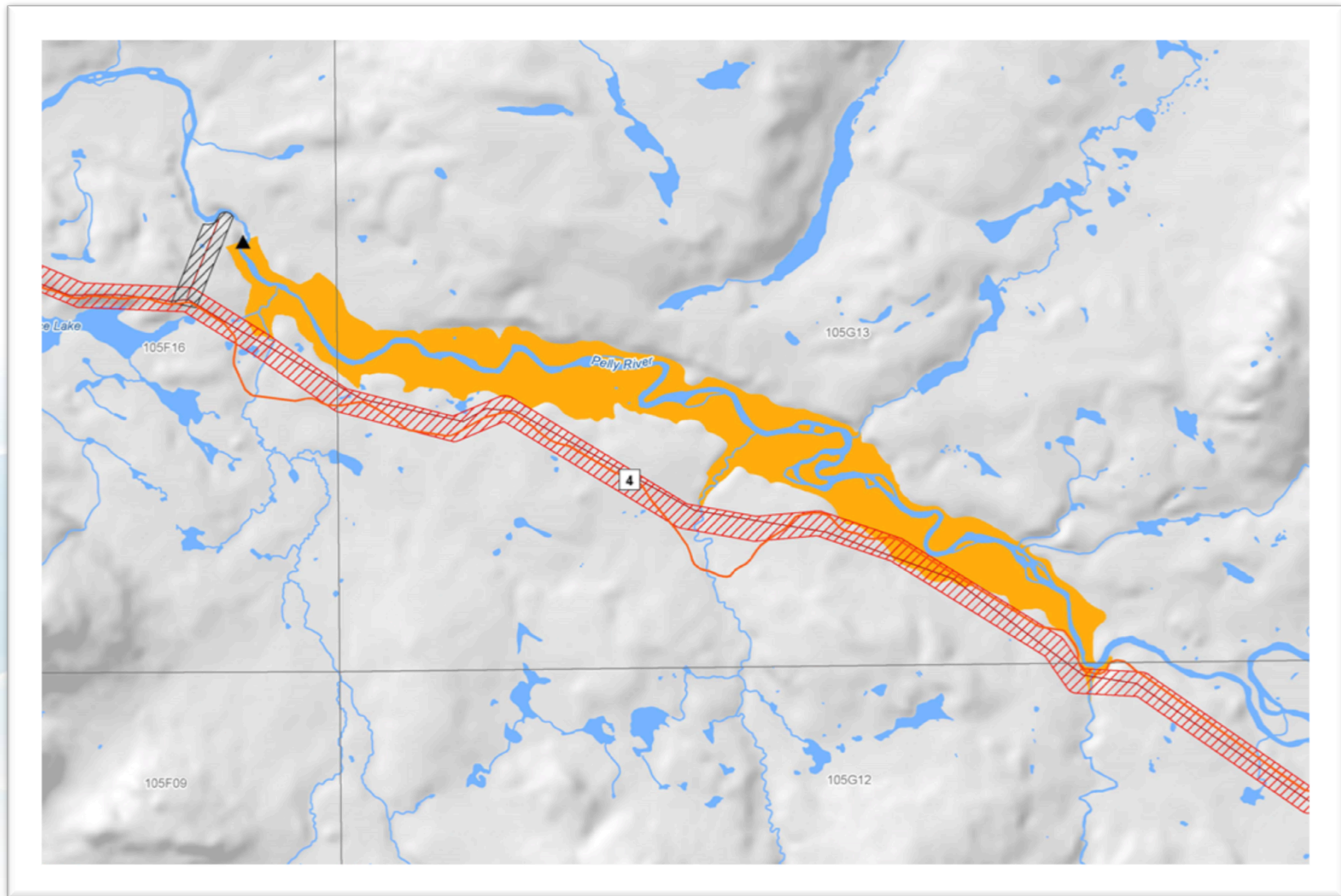
- Slate Rapids and Hoole Canyon run-of river (ROR) is cascade of two sites with:
  - Slate Rapids located upstream on the Pelly River providing water storage and generation
  - Hoole Canyon ROR located downstream operating as a run-of-river facility with no substantial water storage.
- Combined capital cost estimate of \$2,962 Million over 2-3 year construction time periods and operational costs of \$15.2 Million per year.
- Assumes that there will be a Faro to Watson Lake transmission line corridor.
- Combination of Slate Rapids & Hoole Canyon ROR is able to meet forecasted Baseline 2065 demand.



# Slate Rapids & Hoole Canyon (ROR)



# Slate Rapids & Hoole Canyon (ROR)



# Summary of Positive and Negative Effects

- **Fisheries:**
  - Flooding of 19,100 ha including Fortin Lake, Pelly Lakes, portions of the Pelly River, a number of smaller lakes.
  - Fluctuation of levels of Pelly Lakes and Fortin Lake (effects on shoreline habitat).
  - Potential migration barrier to upstream habitat for chinook and chum salmon and for out-migrating juveniles.
  - Changes in reservoir volumes may affect access to tributary streams.
  - Downstream effects on Mica and Needle rock Creek Areas of Special Cultural Consideration
- **Wildlife:**
  - Absence of protected or conservation areas.
  - Overlap of WKAs for woodland caribou (Finlayson herd), moose and riparian raptors.
  - Documented presence of 1 species at risk (bank swallows).
- **Socio-economic:**
  - Economic benefits (i.e., jobs and business activity) are considered substantial.
  - This project offers the potential for the highest economic benefits relative to the other six priority sites.
  - Highest area of reservoir footprint overlap with Liard First Nation & Ross River First Nation Interim Protected Land.
  - Highest area of reservoir footprint overlap with Non-Renewable Resource Areas.
  - Known sites of heritage and cultural resources.

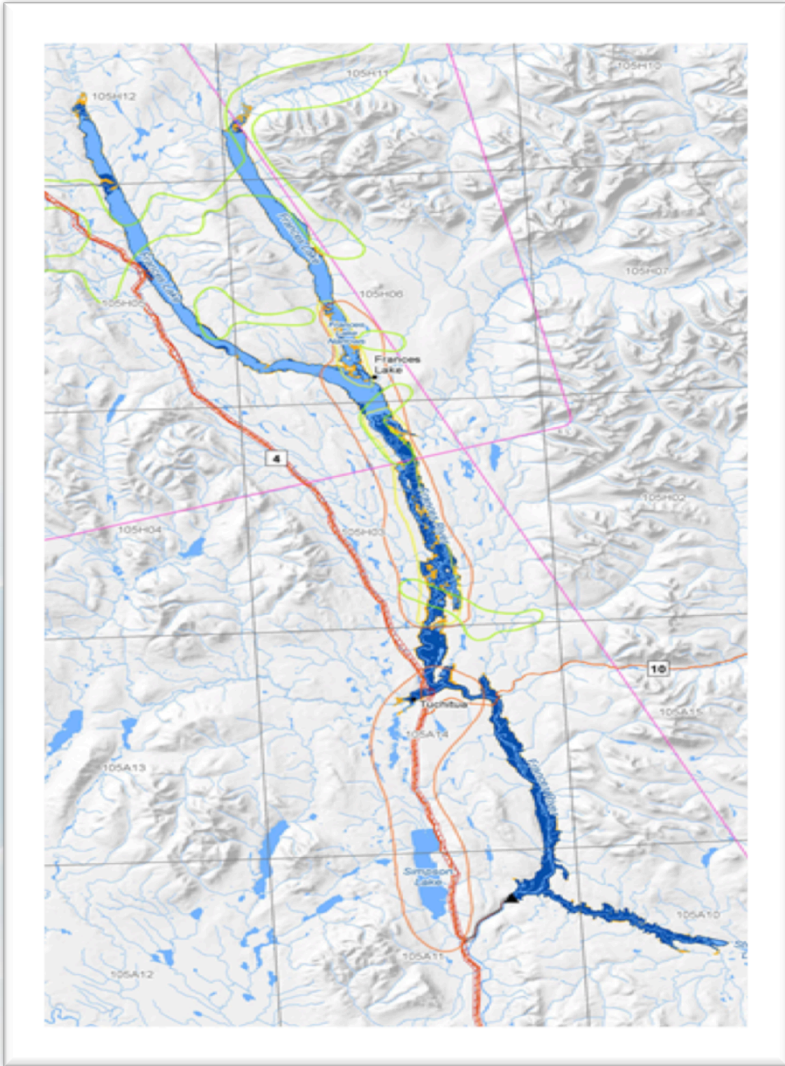
# Site 6: False Canyon & Middle Canyon (ROR)

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- False Canyon and Middle Canyon ROR is a cascade of two sites with:
  - False Canyon located upstream on the France River providing water storage and generation,
  - Middle Canyon ROR located downstream operating as a run-of-river facility with no water storage.
- Capital cost estimate of the combined project capital is approximately \$1,959 Million over 2-3 year construction time periods and operational costs are estimated at \$10.7 Million per year.
- Assumes that there will be a Faro to Watson Lake transmission line corridor.
- Combination of False Canyon and Middle Canyon ROR is able to meet forecasted Baseline 2065 demand.



## False Canyon & Middle Canyon (ROR)



# Summary of Positive and Negative Effects

- Fisheries:
  - Flooding of 26,100 ha including raising Frances Lake level by 8 m.
  - Potential loss of spawning and rearing habitat for arctic grayling and bull trout (species at risk).
  - The dam may act as a migration barrier to upstream habitats for arctic grayling and may present challenges to out-migrating juveniles.
- Wildlife:
  - Substantial overlap of WKAs for waterfowl, moose, bald eagle.
  - Presence of 2 documented species at risk (barn swallow, trumpeter swan).
  - Potential for occurrence of 4 other species at risk.
- Socio-economic:
  - High reservoir footprint area.
  - High area of reservoir footprint overlap with other Land Tenures and Dispositions.
  - Overlaps with known Heritage and Cultural Resource sites.
  - Potential displacement of Robert Campbell Highway and Nahanni Range Road.
  - Substantial economic benefits.

# Overall Evaluation

- Each of the six priority sites remain viable locations for a new hydroelectric project.
- Site-specific advantages or disadvantages represent:
  - Potential positive effects that could occur and might need to be enhanced; and
  - Potential Negative effects that will likely require attention through design, mitigation and adaptive management planning.



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