GROHMAN NARROWS CHANNEL IMPROVEMENT PROJECT

12 Sept 2013
BACKGROUND AND PROJECT DRIVERS

Grohman Narrows is a natural hydraulic constriction on the Kootenay River, ~3 km downstream of Nelson.

The constriction is primarily due to a naturally high river bed elevation through the reach.

The river narrows to an approximate width of 175 m at the upstream end of the reach.

Bed elevation through the reach varies between approximately El. 520 m (1706 ft) and El. 530 m (1739 ft).
BACKGROUND AND PROJECT DRIVERS

• The effects of the Grohman Narrows constriction include:
  • Higher peak flood levels on Kootenay Lake
  • Reduced ability to release water from Kootenay Lake, especially from March to June, to fully utilize the storage flexibility of the lake
  • Reduced head and generation at Corra Linn and Kootenay Canal and increased spill at Corra Linn and all of the downstream Kootenay River dams
  • Less operating flexibility at Kootenay Canal, Corra Linn, and the downstream Kootenay River plants
• Channel improvements at Grohman Narrows would improve all these effects
• In response to local government and community concerns, BC Hydro initiated the project to explore potential improvements to Grohman Narrows in late 2012
PREVIOUS EXCAVATION EFFORTS

- The benefits of channel improvements in the Grohman Narrows have been recognized since the 1890’s.

- **1890:**
  - An estimated 18,000 cubic yards of blasted rock, boulder and gravel removed from the riverbed

- **1931:**
  - Approximately 350,000 m³ of rock and 200,000 m³ of boulders and gravel
  - Material removed from six locations between Corra Linn Dam and Grohman Narrows

- **Further improvements in 1939:**
  - Approximately 14,000 m³ of rock from the left bank of the river opposite Grohman Creek
  - 256,000 m³ of boulders and gravel from the Grohman Creek fan and from either side of the wooded island in the Narrows
1939 DREDGING

Dredging in progress
Temporary railway across the streambed surface to facilitate dredging
Deposited excavated material
KEY CONSIDERATIONS

• Engineering
  • Evaluate project benefits
  • Estimate amount of excavation material
  • Assess composition of excavated material
  • Evaluate channel stability

• Environmental
  • Establish environmental requirements during construction
  • Confirm timing and duration of construction season
  • Assess effects on fish and wildlife during construction
  • Assess long-term effects on fish and wildlife
  • Assess effects on archeology resources
  • Plan to avoid environmental and archeological impacts
KEY CONSIDERATIONS

• **Regulatory / Permitting**
  • Compliance with IJC Order
  • BC Water Act Section 9 Approval Process
  • Determine applicability of Federal Fisheries and Environmental Assessment Act
  • Columbia River Treaty issues
  • International River Improvement Act requirements
  • Crown Land permits

• **Stakeholder Consultation**
  ▪ Stakeholder Consultation and Communications Plan

• **First Nations Consultation**
PROJECT TIMELINES AND NEXT STEPS

• The first phase of the project is now underway and will run until October 2013
  • Evaluation of the potential costs and benefits of the project
  • Feasibility of moving ahead with channel improvements

• The next phase, if undertaken, would involve additional investigations and planning for the potential improvements
  • Could take up to two years
  • A decision regarding whether or not to proceed could be made at that time
2012 OPERATIONS: COLUMBIA/KOOTENAY SYSTEM
2012 WEATHER & INFLOW SUMMARY

- 1 May snowpack in the Columbia/Kootenay region:
  - Above normal, but not extreme
- June & much of July: unprecedented rainfall in the basin
- Rainfall in June 2012:
  - 2 to 5 times the normal amounts across the upper Columbia & Kootenay basins
  - Wettest month ever at Castlegar Airport & other stations
- Inflows for Feb-July 2012:

<table>
<thead>
<tr>
<th>Basin</th>
<th>Rank</th>
<th>% of Average</th>
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<tbody>
<tr>
<td>Mica</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; of 40 yrs</td>
<td>136%</td>
</tr>
<tr>
<td>Revelstoke</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; of 28 yrs</td>
<td>130%</td>
</tr>
<tr>
<td>Arrow</td>
<td>3&lt;sup&gt;rd&lt;/sup&gt; of 42 yrs</td>
<td>127%</td>
</tr>
<tr>
<td>Duncan</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; of 40 yrs</td>
<td>130%</td>
</tr>
<tr>
<td>Kootenay Lake</td>
<td>4&lt;sup&gt;th&lt;/sup&gt; of 44 yrs</td>
<td>142%</td>
</tr>
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Surcharge allowed Libby to maintain a lower discharge, reducing downstream flooding.
Reservoir level was above normal full pool for 23 days.
Peak Libby discharge of 48 kcfs occurred in early July.
River level at Bonners Ferry peaked at 1766.6 ft, 2.6 ft above flood stage.
Reservoir drafted to near empty in late April ... then refilled during May-July
Discharge reduced to minimum during June & early July to reduce inflow into Kootenay Lake
After Kootenay Lake level peaked, Duncan discharge increased to manage refill of Duncan Reservoir
Duncan Reservoir surcharged by ~ 1 ft (0.3 m) to reduce peak discharge & downstream flooding
From March through July, FortisBC & BC Hydro discharged maximum possible out of Kootenay Lake, limited only by the Grohman Narrows channel restriction.

Kootenay Lake level peaked at 1753.8 feet→ highest level since 1974

With no surcharge of Libby Reservoir, the Kootenay Lake peak level would have been 0.3 ft (0.1 m) higher

Without Libby & Duncan, the Kootenay Lake peak level would have been 6.6 feet (2 m) higher
COLUMBIA RIVER AT BIRCHBANK AVERAGE DAILY DISCHARGE
( Brilliant Project + Brilliant Expansion + Brilliant Spill + Arrow Lakes Hydro + Hugh Keenleyside)
Summary 1937 - 2011 (unregulated) & Summary 1964 - 2011 (regulated) and Actual / Forecast 2012

Highest pre-dam recorded discharge = 374 kcfs (10600 m3/s) on 9 Jun 1961

2012 calculated peak discharge (no dams) = 365 kcfs (10340 m3/s) on 25 Jun

2012 recorded peak discharge (with dams) = 213 kcfs (6040 m3/s) on 21 Jul

Start of major regional flooding, 280 kcfs (7930 m3/s)

Start of localized minor flooding, 165 kcfs (4673 m3/s)

Mean Unreg Discharge
2012 Forecast Unreg Discharge
2012 Reg Discharge
1961 - Max Pre-Dam Recorded Discharge

2012 Unreg Discharge
Mean Reg Discharge
2012 Forecast Reg Discharge
2012 OPERATIONS SUMMARY

- Mica, Arrow, Duncan, Libby – reservoirs were refilled above their normal full pool levels (by up to 1.3 ft) to help manage downstream flood impacts.
  - Reservoir surcharge → trade-off between downstream flood impacts & upstream reservoir impacts.

- Mica, Duncan, Libby – highest-ever reservoir levels.

- Arrow – highest reservoir level since 1990.


- Mica, Revelstoke – spilled water for the first time since 1997.

- Columbia River at Revelstoke – highest flow since 1991.

- Columbia River at Trail – highest flow since 1972 (pre Mica dam).
Prior to, & during, the record-setting inflows of June-July 2012, BC Hydro and its partners operated the reservoirs with flood management as the highest priority.

All of the Columbia/Kootenay reservoirs have multiple purposes. These many interests (flood control, fisheries, recreation, energy, etc.) must be balanced subject to domestic laws and other requirements.

Upstream reservoir operations significantly reduced downstream flood peak flows.

Without the Treaty dams in place, damage to property would have been much greater and more widespread:

- Peak Kootenay Lake level would have been 6.6 ft higher.
- Peak Columbia River flow at Trail would have been about 70% higher, similar to the level of flood flows in 1948 & 1961.
HYDRAULIC STUDIES AND GEOTECHNICAL STUDY RESULTS TO-DATE
BATHYMETRIC SURVEY

• Boat based survey to map the elevation of the river bed
• Completed in October 2012
• Centreline survey of the West Arm from Queen’s Bay to Corra Linn Dam (approximately 50 km)
• 24 cross sections surveyed at select locations
• Detailed survey through, and in the vicinity of, the Grohman Narrows reach (approximately 5 km)
BATHYMETRIC SURVEY

Wooded Island

Grohman Creek

City of Nelson Sewage Treatment Plant

Highway & Railway Crossings

1 km
BATHYMETRIC SURVEY

- Detailed digital elevation model (DEM) developed from bathymetric data
- Updated map of river bed surface
BATHYMETRIC SURVEY
EXISTING CONDITIONS

Wooded Island
City of Nelson Sewage Treatment Plant
Rock shelf remaining from 1939 blasting & rock removal
CP Railway Line
Gravel bar downstream of island
Gravel bar upstream of island
Spoil piles from 1939 dredge
Rebuilding of Grohman creek fan since 1939

Grohman Creek
FLOW
HYDRAULIC MODELING

- Hydraulic model developed from Queens Bay to Corra Linn Dam
- Used to model changes in flow and water level

- 104 cross sections - 31 through detailed Grohman Narrows reach
- Calibrated to historical gauge data at Corra Linn, Nelson and Queens Bay
- Additional limited historical (1940’s) gauge data available along Grohman Reach
- Advanced model also under development to further refine analyses
HYDRAULIC MODELING

• Compare various improvement scenarios with existing conditions
• Preliminary sensitivity scenarios examined include dredge to bed elevations of 526 m (1726 ft) and 527 m (1729 ft), within approximately 2 km long reach from start of Narrows
  • Approximate volume of material in the range of 600,000 m³ (785,000 yd³)
  • Volume mostly in bars upstream and downstream of wooded island
  • Balance between benefits realized (flood peak reduction, improved operations, energy benefits) and amount/cost of dredging
    • Need to optimize dredge extents and locations
  • Consideration of environmental effects of different dredge levels and locations
Wooded Island
City of Nelson Sewage Treatment Plant
Rock shelf remaining from 1939 blasting & rock removal
CP Railway Line
Gravel bar downstream of island
Gravel bar upstream of island
Spoil piles from 1939 dredge
Rebuilding of Grohman creek fan since 1939
Grohman Creek
HYDRAULIC MODELING
DREDGE TO EL. 527 m
CP Railway Line

Gravel bar downstream of island

Spoil piles from 1939 dredge

Gravel bar upstream of island

Wooded Island

HYDRAULIC MODELING

DREDGE TO EL. 527 m
HYDRAULIC MODELING

PRELIMINARY RESULTS AND OBSERVATIONS (SENSITIVITY SCENARIOS)

• For average conditions and existing operating regimes:
  • Reduction in peak flood levels in the range of \(~ 0.5 - 0.8 \, \text{m} \) (\(1.5 - 2.5 \, \text{ft}\))
  • Also reduction in number of years and duration of time at higher lake levels
  • Range of potential discharge capacity increase \(~ 90 - 350 \, \text{m}^3/\text{s} \) (\(3,000 - 12,000 \, \text{cfs}\)), or \(~ 10 - 50\%\)
  • Highest potential discharge capacity increases (in terms of flow rate) during the March – July period
• Range of potential increased generation in the order of \(1 - 1.5 \%\) per year (includes BCH Kootenay Canal plant, 4 Fortis BC River Plants and CPC Brilliant Dam)
Model Water Surface Profile - Existing Conditions
March Average

Existing March average discharge ~ 510 m³/s (18,000 cfs)
Existing March average Corra Linn forebay elevation ~ 529.5 m (1737.2 ft)
Existing Conditions
- Corra Linn El. = 528.8 m (1734.9 ft)
- Discharge = 1000 m³/s (35,300 cfs)
Dredge to El. 527 m
- Corra Linn El. = 528.8 m (1734.9 ft)
- Discharge = 1000 m³/s (35,300 cfs)
HYDRAULIC MODELING

• Potential Operating implications:
  • Control of Kootenay Lake outflows/elevations remains with Corra Linn Dam for a longer period of time
  • In forecasted low freshet inflow years, could operate with higher Corra Linn forebay elevation during this period (i.e. spring water levels downstream of Grohman Narrows not as low as current operations)
  • In forecasted high freshet inflow years, can take advantage of additional flow capacity before freshet starts and during freshet rise to maximize outflow and reduce peak Kootenay Lake elevations upstream of Grohman Narrows
  • Very little change to lake elevations upstream and downstream of Grohman Narrows outside of freshet period (i.e. late summer, fall, and winter)
  • Review of full Kootenay system operating regimes would be required to optimize the added flexibility of an improved Grohman Narrows and assess seasonal effects
HYDRAULIC MODELING

• Additional Feasibility Study hydrotechnical engineering work:
  • Use of models to refine and optimize potential dredge volume and location, to maximize benefits and minimize cost
  • Assess longer term impacts of dredging on bed elevations and potential for sediment infilling
  • Refine project benefit estimates
GEOLOGICAL OVERVIEW

- Merged Alluvial fans
- Steeply sloping bedrock at surface or talus over shallow bedrock
- Glacially rounded low bedrock bluffs
- Bouldery colluvium deposit
- Rock excavation
- Bedrock bluffs
- 1939 gravel and rock spoils
GEOTECHNICAL STUDIES

GEOLOGICAL OVERVIEW
GEOTECHNICAL STUDIES

GEOPHYSICS SURVEYS

• Completed in March, 2013
• Overwater acoustic profiling and side-scan sonar survey
  • 3 km reach of Grohman Narrows
• Shoreline based seismic refraction surveying
  • 18 separate seismic profile lines
  • 2,645 m of seismic refraction data recorded
GEOTECHNICAL STUDIES

GEOPHYSICS SURVEYS
GEOPHYSICS RESULTS

EXAMPLE SEISMIC REFRACTION PROFILE

SL-3A on mid channel bar downstream of wooded island

60 m

Undifferentiated glacial and fluvial sediments

Bedrock surface

LEGEND

- GROUND SURFACE
- INTERPRETED BOUNDARY BETWEEN SURFICIAL LAYER AND UNDIFFERENTIATED SEDIMENTS
- INTERPRETED BEDROCK SURFACE
GEOTECHNICAL STUDIES

INTERPRETED BEDROCK ELEVATION CONTOURS
Geotechnical Studies – Preliminary Observations:

- Bedrock is relatively deep across most of the Grohman Narrows area and would not influence dredging operations
- Some bedrock exposed at shorelines
- Surficial bed materials generally consist of well graded mix of sand, rounded gravels and cobbles
- Some evidence of larger boulder material, especially along south bank
HYDRAULIC MODELING

• Updates since the June 2013 Public Meeting:

  • Optimizing of dredge location and extent
    • 3 scenarios developed (low, medium and high dredge volume = 200,000 m³, 400,000 m³ and 600,000 m³)
    • Most benefit realized from dredging the two bars u/s and d/s of wooded island and the area at Grohman Creek outlet (see figure next slide)
    • Low scenario dredge these areas to El. 527 m (1729 ft), medium to El. 526 m (1725.7 ft) and high to same as medium, but also dredge additional material from right bank bar complex d/s of island

  • Cost estimates under development for these scenarios
    • Biggest factor influencing costs is material spoiling
    • Other major factor is available construction duration (fisheries, operational, seasonal constraints)
HYDRAULIC MODELING

Main Dredge Areas:
Energy and flood reduction benefits being finalized for these scenarios
  - Up to 80 GWh per year energy benefit
  - Flood reduction in the order of 2 ft
  - Depends on final dredge volume

Overview geomorphic analysis completed
  - Only significant source of sediment input to the Grohman reach is from Grohman Creek
  - Some minor change in bed elevations since 1939 dredge, but no significant infilling observed
  - Most changes would occur immediately following dredging as bed adjusts (self-armours) to stable level

Preliminary examination of operational impacts
  - No significant impacts in late summer, fall or winter to existing lake levels (Corra Linn remains control)
  - Reduced KLK elevation in spring in high freshet years to allow further drawdown and reduced flood peak and duration (see next slide)
Hydraulic Modeling

Historic KLK Elevation (Queen’s Bay)
(1992 - 2012)