Northern Gateway Pipelines Limited Partnership
Section 52 of the *National Energy Board Act* Application for
Enbridge Northern Gateway Project
NEB File OF-Fac-Oil-N304-2010-01 01
Filed 27 May 2010

Information Request No. 3

Engineering

3.1 Pipeline Design and Specifications

Reference:

i) Exhibit B19-4 Volume 3 Application Update dated December 2010, Section 5.1 Line Pipe, page 18 (A1S9X8) (Adobe Page 6 of 10) which is an update of Exhibit B1-5 (Adobe Pages 41 & 42 of 132)

ii) Exhibit B1-5 Volume 3 - Application dated May 2010, Section 8.5, page 8-4 (A1Y3U9) (Adobe Page 62 of 132)

iii) Exhibit B20-2, Northern Gateway response to request for additional information dated March 2011, Section C1.1, page 14 (A1Y3U9) (Adobe Page 18 of 66)

iv) Exhibit B20-2, Northern Gateway response to request for additional information dated March 2011, Table C-1, pages 16 to 18 (A1Y3U9) (Adobe Pages 20 to 22 of 66)

Preamble:

In reference i) Northern Gateway provides two tables which summarize the pipeline design parameters for the oil and condensate lines. The tables provide a range of design pressures and wall thicknesses but no specifics regarding their distribution along the proposed route. The tables also indicate that the Canadian Standards Association (CSA) notch toughness is Category I. The text of section 5.1 indicates that the pipe:

- may be grade 483 or 550;
- may be manufactured to CSA Z245.1 or API Spec 5L; and
- may require Category II pipe at unspecified locations if air testing is determined to be the preferred method of testing.

In reference ii) Northern Gateway provides design criteria for its pump stations for both the oil and condensate stations which indicate the design pressure to be 14,900 kPa. This design pressure is lower than the highest design pressure for the oil pipeline (16 755 kPa) and higher than the highest design pressure for the condensate pipeline (12 040 kPa).

In reference iii) Northern Gateway points to its implementation of Enbridge Standard D06-101 as evidence of a risk-based approach to design.

In reference iv) Northern Gateway provides a list of Enbridge's Engineering Standards and Specifications.

The Panel requires further information with respect to the design of the pipelines.

Request: Please provide the following for the oil pipeline and condensate pipeline:

a) Detailed tables for each design pressure and corresponding pipe which specify:

- **a.1)** diameter;
- **a.2)** wall thickness;
- **a.3)** material grade;
- **a.4)** design factor;
- **a.5)** CSA notch toughness category;
- **a.6)** required notch toughness if air testing will be applied for;
- **a.7)** the pipe manufacturing specification;
- **a.8)** seam weld type;
- **a.9)** estimated length required for the project; and
- **a.10)** its intended use (e.g. crossings, HDD).

b) Figure(s) illustrating the distribution of these sections with different design pressures and a discussion of the reasons for the multiple design pressures.

c) A discussion of the specific notch toughness requirements for pipe sections used for aerial crossings and pipe sections which may be subject to air testing.

d) An explanation for the differences between the design pressures for the pipelines and corresponding pumping facilities.

e) A copy of all engineering reports and studies prepared for or by Northern Gateway supporting the conceptual and preliminary design of the pipelines and associated facilities which have not been previously provided.

f) A copy of Enbridge's Standards and Specifications listed in reference iv)

Response: a) **Attachment JRP IR 3.1 a)** reflects the current design of the oil and condensate pipelines as described in the Application dated May 10, 2010 and the Application Update dated December 2010. The final hydraulic design of the oil and condensate pipelines will be completed during detailed engineering after the detailed pipeline route is selected and the associated detailed engineering is completed. To supplement the hydraulic design, the pipe requirements for rail crossings and HDD's will be determined and further manufacturing, logistical, construction, and optimisation analysis of wall thicknesses, material grades (refer to response to JRP IR 3.15 (a)), and notch toughness requirements (refer to response to JRP IR 3.1 (c)) will also be conducted during detailed engineering to determine the final pipe requirements. Therefore, the pipe requirements, including wall thicknesses, material grades, segment lengths SMYS, and notch toughness categories listed in the attached table are preliminary and will be updated and finalized during detailed engineering.

b) **Attachment JRP IR 3.1 b) (Parts 1 to 4)** are tables and figures that provide the requested information. As discussed in the response to JRP IR 3.1(a), the information contained in this table reflects the current design of the oil and condensate pipelines and will be updated and finalized during detailed engineering.

The philosophy for pipeline wall thickness selection and pressure design is to ensure a flat Maximum Operating Pressure (MOP) head profile (with an emphasis on the MOP head profile expressed in terms of feet or metres of crude, and not flat MOP pressure profile expressed in psi or kPa). The reasoning is that a flat MOP head profile will reduce the risk of pipeline over-pressure in the event of a downstream blockage, and the philosophy also results in a design where the pipeline MOP at the station discharge should be the only pressure control set-point that is required to protect the pipeline between two consecutive pump stations from over-pressure under steady state conditions.

To implement this design philosophy, locations along the pipeline route with elevations lower than the elevation of the upstream pump station would require a higher design pressure (thicker wall pipe), and locations with elevations higher than the elevation of the upstream station would require lower design pressure (thinner wall pipe). This relationship is due to the static head of the fluid column in the pipeline during zero-flow conditions resulting in higher pipeline pressures in low laying areas, and lower pipeline pressures at high points. As discussed in the response to JRP IR 3.1(a), during detailed engineering the total number of wall thicknesses and wall thickness changes along the pipeline to yield a flat (or nearly flat) MOP head profile will be balanced with additional manufacturing, logistical, and construction considerations to finalize the pipe requirements.

c) The pipe Category specified shall be in accordance with the requirements listed in Table 5.1 of CSA Z662-07 and CSA Z662 11. When Category II pipe (pipe with proven notch toughness) is required or in situations where fracture initiation is of concern, the exact requirements will be determined during detailed engineering. The notch toughness requirements will be based on some high percentage (typically 90%) of the flow stress dependent criteria. This approach has been applied and accepted on other major pipeline projects. Preliminary calculations, utilizing the Battelle fracture initiation model, suggests that critical through-wall defect lengths would be in excess of 100 mm for all pipe thicknesses currently being considered. The preliminary calculations also indicate that a through-wall defect with a length of approximately 50 mm can be sustained with Charpy

V-notch absorbed energy values of less than 10 Joules.

d) Please see b) above.

e) The report entitled “Pipeline Hydraulic Design Proposal Northern Gateway Pipeline – 36” Crude Oil/20” Condensate” provides the requested information. The information contained in this report reflects the current design of the oil and condensate pipelines and will be updated and finalized during detailed engineering. The submission of this report is subject to a separately filed request to file the report confidentially with the JRP.

f) Enbridge’s Design Standards listed in reference iv) have previously been filed confidentially with the Board. Please see **Attachment JRP IR 3.1 f)** that provides a list of the Design Standards and the corresponding dates on which they were provided to the Board.

The submission of Enbridge’s Specifications for Facility Construction is subject to a separately filed request to file this information confidentially with the JRP.

3.2 Hydraulic Design

Reference:
i) Exhibit B1-5 Volume 3 - Application dated May 2010, Section 4.2.3, page 4-2 (A1S9X8) (Adobe Page 38 of 132)
ii) Exhibit B1-5 Volume 3 - Application dated May 2010, Section 5.1, page 4-3 (A1S9X8) (Adobe Page 39 of 132)
iii) Exhibit B1-5 Volume 3 - Application dated May 2010, Section 4.2.1, page 4-1 (A1S9X8) (Adobe Page 37 of 132)
iv) Exhibit B1-5 Volume 3 - Application dated May 2010, Section 4.3.1, page 4-3 (A1S9X8) (Adobe Page 39 of 132)

Preamble: **In reference i) and ii)** Northern Gateway states that hydraulic engineering parametric analyses were undertaken to optimize the pipeline and pump station system configuration based on a hydraulics comparison. Further, the analyses considered a range of pipeline diameters, pump station locations and design pressures.

Northern Gateway also stated that the hydraulic design incorporates the potential to expand the system capacity by adding additional pump stations and pumping facilities.

In reference iii) and iv) Northern Gateway indicates that it has assumed an overall average daily capacity of the pipelines to be equal to 90% of the theoretical design capacity.

The Panel requires further details surrounding the design process used by Northern Gateway.

Request: Please provide the following for both the oil and condensate pipeline:

a) A detailed description of the different system designs assessed by Northern Gateway;
b) Hydraulic engineering parametric analyses undertaken by Northern Gateway to optimize the system;
c) Reasons for retaining or discarding design options;
d) A detailed description of the potential expansion scenarios which could be possible by adding additional pump stations and pumping facilities, including corresponding capacities;
e) A discussion on how Northern Gateway determined the overall average daily capacity of 90% of theoretical capacity; and
f) Drawings illustrating the system designs described in a), b) and d) above.

Response: a) Various system configurations were assessed for the Northern Gateway Pipeline. During the front end engineering and concept screening phases of the project, considerations were given to the following:

- Evaluation of different Alberta Pipeline Terminus and Marine Terminus locations. This decision is discussed in detail in Volume 1 (Section 4) of the Application.

- Various routing and pump station location options. This issue is discussed in detail in Volume 3 (Section 2) of the Application.
- Optimizing pipeline diameter and number of pump stations for the target system capacities. This decision is discussed in further detail below in response to JRP IR 3.2 b) and c).
- Diluted bitumen vs. heated and insulated bitumen oil pipeline. Diluted bitumen was selected to avoid the operating parameters and challenges associated with operating a long and remotely located heated and insulated bitumen oil pipeline.
- System design pressures (PN 100 vs. PN 150). Northern Gateway determined that PN 150 design pressures would be required to minimize the number of pump station locations required along the pipeline route, and that PN 150 design would also manage the design issues presented by the elevation differences encountered crossing the Rocky Mountains.
- The evaluation of pipeline route alternatives through the Coast Mountain area, as described in Volume 3, Section 2.4.16, identified significant hydraulic advantages when routing through the tunnels as compared to routing over the mountains. These advantages included reduced hydraulic pumping requirements, and the associated operational power costs, and eliminating the potential need for a pressure let-down station on the oil pipeline.

b) In order to select the optimal diameter size for the oil and condensate pipelines, a parametric cost of service analysis (or “J-Curve Analysis”) was developed. This analysis considered various diameter and number of station options and determined the optimal pipeline size for a given target capacity of a specific commodity, assuming a fixed pipeline length and system discharge pressure rating.

The cost of service analysis took into account cost of capital and operating and maintenance costs in developing the cost of service for a given flow rate.

Figures 3.2a and 3.2b illustrate the Normalized Cost of Service curves for the respective oil and condensate pipelines:

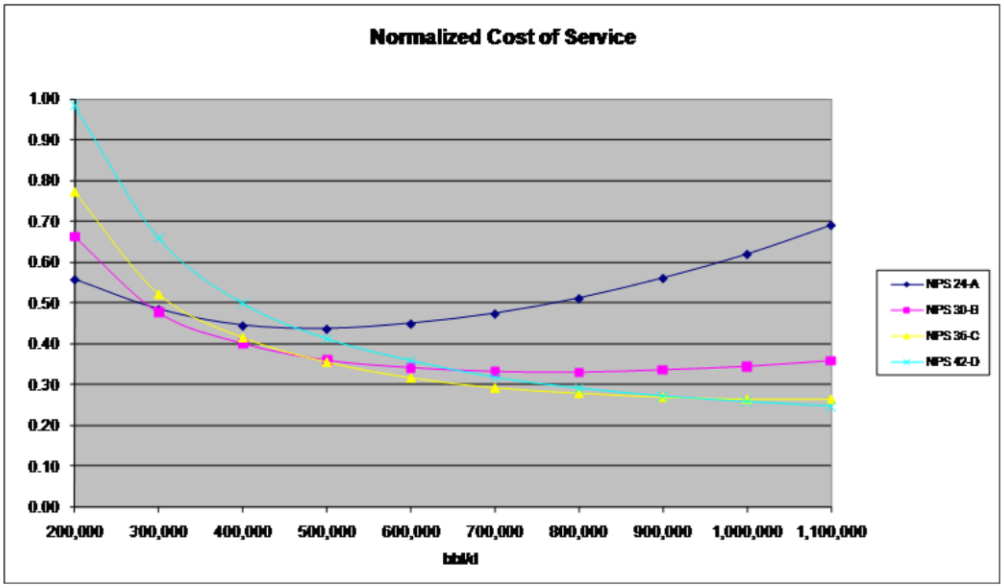

Figure 3.2a – *Oil Pipeline Cost of Service Curves*

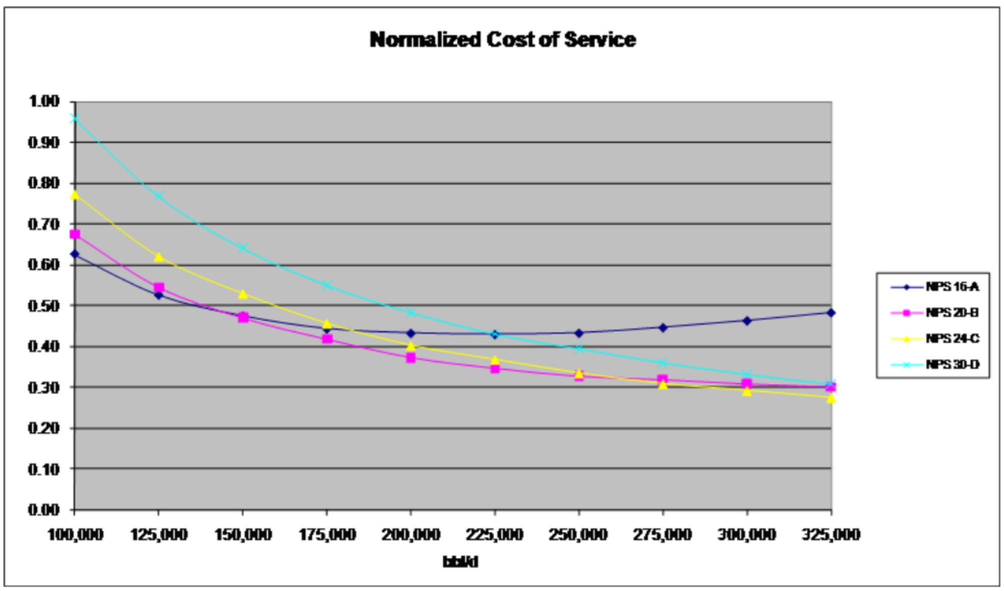

Figure 3.2b – *Condensate Pipeline Cost of Service Curves*

c) Oil Pipeline:

he target annual capacities in 100% diluted bitumen service for the oil pipeline system range from an initial of 525 kbpd annual, to an ultimate expansion capacity of up to 850 kbpd annual. The cost of service curves presented in Figure 3.2a (above) show that an NPS 36 pipeline has the lowest cost of service for a flow range between 500 kbpd and 900 kbpd. Therefore, the NPS 36 pipeline diameter was selected as the optimal size for the oil pipeline design.

In addition to the results of the cost of service analysis, the NPS 24 and NPS 30 options were eliminated because they are undersized. This conclusion is supported by the fact that at the target system capacity range of 525-850 kbpd, both diameter selections exceed the Enbridge typical maximum target pipeline velocity limitation of 10 ft/s and require additional closely spaced pump stations operating at higher rates, demonstrating an inefficient operating point for that pipeline size. Therefore, these options were eliminated as potential pipe diameter choices.

Similarly, the NPS 42 option was eliminated because it is oversized for the target flow rates and would result in low velocities at initial flow rates, and a Reynolds Number below the turbulent threshold. Maintaining turbulent flow is typically targeted in pipeline operations such as Northern Gateway, where batched operations are proposed, to maintain as minimum of a batch interface as possible.

Condensate Pipeline:

The target capacities for the condensate pipeline system range from an initial capacity of 193 kbpd annual, to an ultimate expansion capacity of up to 275 kbpd annual. The cost of service curves presented in Figure 3.2b (above) show that an NPS 20 pipeline has the lowest cost of service for a flow range between 150 kbpd and 250 kbpd. Even though the ultimate target capacity of 275 kbpd falls slightly outside the optimal range, the NPS 20 pipeline diameter was still selected as the optimal size for the condensate pipeline design. Phases I and II target capacities fall within the optimal range of the NPS 20. The Phase III capacity of 275 kbpd annual is a long range forecast with a relatively high level of uncertainty. Therefore, increasing the pipeline size based on this long range prediction is not justified given that the NPS 20 could handle these volumes should they materialize in the future.

In addition to the results of the cost of service analysis, the NPS 16 option was eliminated because it is undersized. This conclusion is supported by the fact that at the target system capacity range of 193-275 kbpd, the NPS 16 exceeds the Enbridge typical maximum target pipeline velocity limitation of 10 ft/s, demonstrating an inefficient operating point for that pipeline size. Therefore, this option was eliminated as a potential pipe diameter choice.

Similarly, the NPS 24 and 30 options were eliminated because they are oversized for the target flow rates and would result in low velocities at initial flow rates.

d) Tables 3.2a and 3.2b summarize the system pump station requirements for the potential expansion of the respective oil and condensate pipelines for the target annual capacities shown. Northern Gateway notes that these expansion scenarios and associated facilities are not part of the applied for Project and that the information provided in the tables has been primarily developed from a hydraulics perspective to assist in system design and pipe wall thickness selection. Further work would be done during detailed engineering to finalize the hydraulic design and to further define the locations of any potential future pump stations. Any future expansion scenarios and associated facilities beyond the applied for Project would be the subject of future regulatory applications and would include the required justification and technical and other studies.

Table 3.2a – *Northern Gateway Oil Pipeline Expansion Plan (Preliminary)*

Station	Chainage (km)	Phase I 525 kbpd	Phase II 600 kbpd	Phase III 750 kbpd	Phase IV 850 kbpd
Bruderheim	0.0	6 x 5,750 hp	6 x 5,750 hp	8 x 5,750 hp	9 x 5,750 hp
Majeau	98.0		2 x 5,750 hp	7 x 5,750 hp	9 x 5,750 hp
Whitecourt	203.3	5 x 5,750 hp	5 x 5,750 hp	7 x 5,750 hp	7 x 5,750 hp
Fox Creek	286.8		2 x 5,750 hp	7 x 5,750 hp	8 x 5,750 hp
Smoky River	400.7	5 x 5,750 hp	5 x 5,750 hp	7 x 5,750 hp	7 x 5,750 hp
Elmworth	506.6		2 x 5,750 hp	7 x 5,750 hp	7 x 5,750 hp
Tumbler Ridge	600.9	3 x 5,750 hp	3 x 5,750 hp	7 x 5,750 hp	7 x 5,750 hp
Bear Lake	719.7	3 x 5,750 hp	3 x 5,750 hp	7 x 5,750 hp	7 x 5,750 hp
Fort St. James	828.4	3 x 5,750 hp	5 x 5,750 hp	8 x 5,750 hp	8 x 5,750 hp
Burns Lake	929.3	3 x 5,750 hp	3 x 5,750 hp	6 x 5,750 hp	5 x 5,750 hp
Houston	1006.0		2 x 5,750 hp	5 x 5,750 hp	4 x 5,750 hp
Clearwater	1129.3				2 x 5,750 hp
Kitimat Terminal	1176.9				

<u>Oil Pipeline Expansion Requirements (Preliminary):</u>

- Phase I (525 kbpd Annual)
  - Construction of 7 Pump Stations for Initial Phase
  - Pumps and Motors selected to allow for expansion without full replacement.
- Phase II (600 kbpd Annual)
  - Additional Pump Stations (4)
  - Additional Pump Units (2) added to existing Stations
  - Modifications to existing pump units (28) consisting of impeller trims and/or volute modifications to avoid overloading of motors at higher flow rates.
- Phase III (750 kbpd Annual)
  - Additional Pump Units (38) added to existing Stations
  - Modifications to existing pump units (38) consisting of impeller trims and/or volute modifications to avoid overloading of motors at higher flow rates.
- Phase IV (850 kbpd Annual)
  - Additional Pump Station (1)
  - Additional Pump Units (4) added to existing Stations
  - Relocation of Pump Units (2) from Burns Lake and Houston to new Clearwater Station
  - Modifications to existing units (76) consisting of impeller trims and/or volute modifications to avoid overloading of motors at higher flow rates.

Table 3.2b – *Northern Gateway Condensate Pipeline Expansion Plan (Preliminary)*

Station	Chainage (km)	Phase I 193 kbpd	Phase II 250 kbpd	Phase III 275 kbpd
Kitimat Terminal	0.000	2 x 5,750 hp	2 x 5,750 hp	2 x 5,750 hp
Clearwater	47.577	2 x 5,750 hp	2 x 5,750 hp	2 x 5,750 hp
Clore	92.149		2 x 5,750 hp	2 x 5,750 hp
Houston	170.838	2 x 5,750 hp	2 x 5,750 hp	2 x 5,750 hp
Burns Lake	247.523	2 x 5,750 hp	2 x 5,750 hp	2 x 5,750 hp
New Future Station 1	293.249		2 x 5,750 hp	2 x 5,750 hp
Fort St. James	348.470	2 x 5,750 hp	2 x 5,750 hp	2 x 5,750 hp
Bear Lake	457.220	2 x 5,750 hp	2 x 5,750 hp	2 x 5,750 hp
New Future Station 2	503.723		2 x 5,750 hp	2 x 5,750 hp
Tumbler Ridge	575.964	2 x 5,750 hp	2 x 5,750 hp	2 x 5,750 hp
Elmworth	670.239		2 x 5,750 hp	2 x 5,750 hp
Smoky River	776.137	2 x 5,750 hp	2 x 5,750 hp	3 x 5,750 hp
Fox Creek	890.062		2 x 5,750 hp	2 x 5,750 hp
Whitecourt	973.604	2 x 5,750 hp	2 x 5,750 hp	2 x 5,750 hp
Majeau	1078.870		2 x 5,750 hp	2 x 5,750 hp
Bruderheim	1176.871			

Condensate Pipeline Expansion Requirements (Preliminary):

- Phase I (193 kbpd Annual)
  - Construction of 9 Pump Stations for Initial Phase
  - Pumps and Motors selected to allow for expansion without full replacement.
- Phase II (250 kbpd Annual)
  - Additional Pump Stations (6)
  - No changes required to existing pump units required. VFDs utilized to operate efficiently at full range of flow requirements.
- Phase III (275 kbpd Annual)
  - Additional Pump Unit (1) added to existing Station (Smoky River)
  - No changes required to existing pump units required. VFDs utilized to operate efficiently at full range of flow requirements.

e) For a given target annual average capacity, Enbridge will design the pipeline system with a theoretical design capacity equivalent to annual capacity/0.9 (or equivalently annual capacity = 0.9*design capacity). For operating systems, Enbridge will accept monthly nominations to 95% of Design Capacity less scheduled maintenance.

The design (or load) factor of 10% is based on historical experience on Enbridge's operating pipelines in which typically, over a one-year period, a pipeline system can be expected to achieve an overall average daily capacity equal to 90% of the theoretical design capacity of the system. Therefore, this factor is also utilized in the design of new systems to account for difference between theoretical capacity and the expected achievable throughput on an annual basis.

f) Drawings H-1, H-1(a), and H-1(b) illustrating the system designs described in response to JRP IR 3.2 a), 3.2 b) and 3.2 d) above are provided in **Attachment JRP IR 3.2 f)**.

3.3 Valve spacing

Reference:

i) CSA standard Z662-07, Section 4.4

ii) Exhibit B1-5 Volume 3 - Application dated May 2010, Section 5.5, page 5-3 (A1S9X8) (Adobe Page 43 of 132)

iii) Exhibit B20-25 to B20-28 inclusive, Northern Gateway response to request for additional information dated March 2011, Section B (A1Y3X2, A1Y3X3, A1Y3X5)

Preamble:

In reference i) the minimum design requirements for valve location and spacing are specified. In section 4.4.3 the standard specifies that a company shall perform an engineering assessment to determine the number and spacing of sectionalizing valves to be installed.

In section 4.4.8 the standard indicates that for oil pipelines, valves shall be installed on both sides of major water crossings and at other locations appropriate for the terrain in order to limit damage from accidental discharge. It is also noted that consideration should be given to the installation of check valves to provide automatic blockage of the pipeline.

In reference ii) Northern Gateway states that valves will be installed at strategic locations along the oil and condensate pipelines. These locations will include pump stations, major river crossings and other locations based on a review of engineering, environmental, Aboriginal traditional knowledge studies, geotechnical and volume factors and operation and maintenance need.

Northern Gateway indicates that the process for determining the proposed location of these valves considered potential release volumes, environmental sensitivity and potential environmental effects. Potential release volumes were calculated with a comprehensive proprietary model using a detailed profile of the proposed pipelines. Risk was assessed by a team of discipline experts. Specific locations were also adjusted taking into account terrain and service access requirements.

In reference iii) Northern Gateway provided maximum potential full-bore releases from the 914 mm pipeline within each 1 kilometre segment of the proposed pipeline route. The Panel notes that the calculated spill volumes at numerous locations greatly exceed the largest spills which have occurred on NEB regulated pipelines. The Panel also notes that a geotechnical hazard such as a landslide could cause both pipelines to rupture increasing the potential volumes provided in reference iii) and may not reflect the largest possible spill volume at a given location.

The Panel requires a greater understanding of how Northern Gateway developed its preliminary valve spacing design and what changes may be required during final design.

Request:

Please provide the following for both pipelines:

a) A current copy of the engineering assessment undertaken by Northern Gateway to determine its preliminary valve spacing.

b) A detailed explanation of how Northern Gateway assessed risk, including how the consequences of a spill were assessed (e.g. negative effects on the environment and human receptors, potential cost and difficulty of the emergency response and clean up; damage to reputation). As well please explain whether the probability of an incident along the length of the pipeline was assumed to be constant or variable over time.

c) An assessment of the suitability and relative importance of the following factors in determining valve spacing:

- **c.1)** limiting spill volume;
- **c.2)** limiting potential spill extents off right-of-way;
- **c.3)** the presence of geohazards which may affect both pipelines;
- **c.4)** accessibility of the pipeline for emergency responders (winter and summer);
- **c.5)** accessibility of the valve site;
- **c.6)** the need to limit damage to valued ecosystem components adjacent to or downstream of a rupture site;
- **c.7)** the need to protect sites that are culturally important to aboriginal communities;
- **c.8)** the need to protect community water intake locations;
- **c.9)** the need to protect agricultural land;
- **c.10)** potential difficulty of clean up and remediation;
- **c.11)** ability to maintain the pipeline;
- **c.12)** facilitate addition of future pipeline facilities; and
- **c.13)** other factors which Northern Gateway believes are important.

Response:

a) **Attachment JRP IR 3.3 a)** is the report “Preliminary Valve Location Engineering Assessment”. Northern Gateway notes that certain assumptions made in the report, such as valve closure time, are currently under review and will be updated in a future version of the report.

b) Northern Gateway’s risk assessment for the pipelines includes hazard identification, frequency analysis and consequence analysis. The resulting risk estimation, combining the frequency and consequence analyses, is used in the broader context of risk evaluation where the significance of risk is assessed and mitigation options are identified and implemented, where appropriate, to lower the risk.

As described in Northern Gateway response to request for additional information dated March 2011, to the JRP, Northern Gateway is employing a risk-based approach to the project design, construction and operations. The pipelines will be designed to comply with the latest NEB regulations and standards including Canadian Standards Association (CSA) Z662-11 as well as Enbridge’s Engineering

Standards and Construction Specifications which have been filed with the NEB.

At this phase of design of the Project the focus is also to identify a pipeline route that avoids geotechnical hazards, environmentally sensitive areas and provides a safe and secure installation. The evolution of the route is described in the Application, Volume 3, Section 2 and in the Update to Volume 3, December 2010, Section 2. The current pipeline route, revision T, avoids, or allows effective mitigation for, all high-risk geotechnical hazards and also avoids many environmentally sensitive areas.

Northern Gateway's pipeline risk assessment is ongoing and will continue through the detailed engineering phase and into operations. The risk assessment is currently addressing the following topics:

- Identification of hazards to the pipelines along the route,
- Analysis of historical pipeline failure frequencies from existing databases,
- Determination of failure frequencies to use in the Northern Gateway pipeline risk assessment based on modern pipeline design, routing, materials, construction and operations,
- Development of a Risk Assessment Program ("RAP") used to estimate risk and showing the process and assumptions used for frequency and consequence analyses,
- Semi-quantitative and/or qualitative risk estimation and risk evaluation along the length of the pipelines,
- Identification of mitigation measures to be considered for application during detailed engineering, construction and operations to lower risk,
- An update to the Preliminary Valve Location Engineering Assessment based on results from the preliminary risk assessment,
- Preparation of a pipeline public safety quantitative risk analysis.

Even though the likelihood of a full-bore rupture is extremely small, depending on the location of the failure and the sensitivity and number of environmental and human receptors impacted, the resulting risk could be significant without mitigation. For the consequence analysis Northern Gateway is using spill trajectory data to identify, in a worst case scenario, whether a potential full-bore rupture along each km of the oil pipeline could impact one or more consequence areas. Many conservative assumptions have been applied to modelling the oil spill extents. These assumptions are described in Northern Gateway's response to request for additional information dated March 2011, to the JRP.

The preliminary consequence analysis considers these factors:

1. identified project consequence areas ranked in order of increasing perceived sensitivity:
   - Officially designated protected areas (Federal and Provincial parks, conservancies, ecological and wildlife reserves),
   - Terrestrial areas with species at risk and wetlands,
   - Populated areas,
   - Watercourses with harvested species,
   - Watercourses with species at risk,
   - Indian reserves,
   - Water consumption for commercial use,
   - Water consumption for human use
2. Accessibility to each km of the pipeline ROW, including consideration for seasonal variability, based on existing highway and roads close to, or crossing, the proposed ROW, as well as future roads and potential helicopter pads proposed for the project.
3. Size of release volume from a potential full-bore rupture at each km of the pipeline.
4. Consequence analysis will consider factors such as potential cost and difficulty of the emergency response and clean-up.

The pipeline loss of containment (LOC) incident probability varies significantly along the length of the pipeline, but is considered to be constant over the pipeline life cycle. Thus, the LOC probability at any location along the pipeline reflects the specific failure cause intensity distribution at that location. There are 2 main failure causes that have been found to vary with pipeline life-time; namely, corrosion and third party impacts. Historically, corrosion has caused failures in older pipelines that were built more than 30 years ago without the current anti-corrosion measures. Regular maintenance techniques are used to monitor for corrosion on these pipelines. Modern pipelines are designed and built to limit corrosion infringement through high quality metallurgy, pipe manufacturing processes, welding materials and techniques, modern FBE coatings and numerous pipeline integrity provisions including regular internal MFL inspections, so that LOC from corrosion and cracking are virtually eliminated. Therefore, Northern Gateway does not expect the corrosion component of LOC probability to change over time. The second failure cause that can change with time is third party impact, which varies with the population and activity density in the vicinity of the pipeline. Public awareness of the dangers of digging along pipeline rights of way has been enhanced by “Call before you dig” programs. The current LOC probability estimates reflect current population characteristics along the pipeline; changes in these characteristics are not easily predicted at this time, but should they be observed or expected to occur, the pipeline LOC probability will be adjusted to reflect such change, and if needed, further mitigation measures would be implemented.

In addition to the above two principal time varying failure causes, system reliability generally follows a “bathtub’ curve indicating a higher propensity for failures during the initial year and final years of operation. The testing, commissioning, and initial operation of the pipelines will be subjected to specific detailed risk assessment and stringently monitored to avoid any LOC probability increases. The operation of the pipeline is expected to either terminate or involve retrofitting prior to the increase life cycle end time-related LOC probabilities.

c.1) Limiting potential spill volume, specifically in relation to consequence areas identified in the risk assessment, is a key factor in determining valve spacing. Northern Gateway used proprietary OILMAPLAND™ software provided by Applied Sciences Associates, Inc. Rhode Island (ASA) to estimate the potential spill volume from locations along the pipelines.

c.2) Valve spacing is primarily used to limit the potential spill volumes as described in c.1 above. Following the calculation of potential spill volumes, spill trajectory modeling, as demonstrated in Northern Gateway’s response to request for additional information dated March, 2011, is used to determine the potential spill extent, both on and off right-of-way. The relationship between the potential spill trajectory and the relevant consequence areas, whether on or off right-of-way, is a key factor. Additional measures including emergency response control points and design mitigation measures, where appropriate, will be developed during detailed engineering to further limit potential spill extents off RoW.

c.3) Valve placement is not considered to be an important mitigation measure to lower risk due to geohazards. The presence of geohazards which may affect the pipelines has been evaluated throughout the initial design and route evolution. Although many geohazards have been avoided some residual geohazards still remain with the potential to increase the likelihood of pipeline failure. The locations and magnitudes of these residual geohazards are included in the likelihood of failure analyses for the pipelines and are a contributing factor in the ongoing risk assessment. At present, with appropriate mitigations being considered for application during detailed engineering, construction and operations, none of these geohazards are expected to contribute significantly to the risk estimate. The mitigations for geohazards areas include pipeline route relocation, avoidance of problem areas by tunneling or trenchless methods to allow installation below hazard areas, grading and terrain geometry changes, groundwater and surface water control and drainage, increased depth of cover, watercourse crossing design, and geotechnical monitoring during operations. The locations of geohazards have been considered during valve location assessment. In addition, placement of valves in areas of potentially higher geohazard has been avoided (e.g., areas of potential lateral stream erosion or slide areas) or where above ground facilities are not appropriate due to geohazard conditions such as avalanches.

c.4) Accessibility to the ROW for emergency response in winter and summer is a factor affecting the consequence analysis. Some areas of poor access have been avoided by routing decisions and construction methods (i.e. tunnels). Mitigation measures are currently being considered to improve accessibility and response capability in potentially higher risk and difficult to access areas. Valve location will also be considered to limit the potential spill volume in these areas.

c.5) Accessibility to valve sites has been considered during valve location assessment. The detailed selection of valve locations considers ease of access.

c.6) As described in the response to IR 3.3b above, Northern Gateway's RAP is used to provide a risk profile along the length of the pipeline. The main contributing factor to risk is the relative sensitivity and number of potentially impacted consequence areas from a release. Valves are currently located to limit the potential spill volumes and lower the risk at sensitive water crossings. The preliminary valve locations will be further evaluated in conjunction with the risk assessment process currently underway, which includes consideration for other consequence areas.

c.7) Indian Reserves, as identified in Northern Gateway's response to request for additional information dated March, 2011, are currently included as consequence areas to be considered in the pipeline risk assessment (refer to c.6). Additional sites that are culturally important to aboriginal communities will be evaluated as the risk assessment and valve location assessment work progresses during detailed engineering.

c.8) The need to protect community water intakes is deemed to be a high priority and the risk assessment, including valve location assessment, will reflect this high priority (refer to c.6).

c.9) In general, agricultural land is not typically a high consequence area. Where high consequence areas do exist, they will be considered in the valve location assessment (refer to c.6).

c.10) The potential difficulty of clean-up and remediation is a function primarily of accessibility to the pipeline and the type of receptor (i.e. consequence area) impacted. A difficult to access location with a release into a watercourse and the resultant downstream transport and impact is expected to present the greatest difficulty for clean-up and remediation. Valve spacing and location is an important mitigating factor to reduce potential volume releases at difficult to access locations and to reduce the risk at consequence areas, in particular watercourses. Consideration will also be given to enhanced pipe wall thickness in areas with difficult access.

c.11) Valves will also be located to facilitate regular operational and maintenance requirements.

c.12) Valve and pipeline appurtenance requirements, such as tees, for future pipeline facilities, primarily pump stations, have not been included in the current valve location assessment. These requirements will be further evaluated during detailed engineering.

c.13) Other factors that are considered in determining the specific location of valves include:

- Proximity to local power supply.
- Level or gently sloping ground with sufficient room to service the valves.
- Other nearby land-use considerations including avoidance where possible of locations where placement of a valve could be a hindrance to other land uses or users.
- Avoidance of locations where third party strikes could increase risk.

3.4 Valve selection, installation and maintenance

Reference: **i)** Exhibit B1-5 Volume 3 - Application dated May 2010, Section 10.2.6, page 10-6 (A1S9X8) (Adobe Page 94 of 132)
ii) Exhibit B1-5 Volume 3 - Application dated May 2010, Section 12.2, page 12-4 (A1S9X8) (Adobe Page 116 of 132)
iii) Occupational Health and Safety Code, Part 10, Section 215.4, under the Alberta Occupational Health and Safety Act

Preamble: **In reference i)** Northern Gateway states that valve assemblies will be constructed through a combination of shop fabrication and field installation which will be completed by pipeline crews. There are no details on Northern Gateway's valve commissioning practices in the application.
In reference ii) Northern Gateway states that valves at pump stations, valve sites and the Kitimat Terminal will be inspected and cycled in accordance with industry standards as part of regular maintenance practices.
In reference iii) the Alberta Occupational Health and Safety Code defines a double block and bleed as an isolation system providing two blocking seals on either side of the isolation point, and an operable bleed-off between the two seals.

Request: Please provide the following for both pipelines:

a) A description of Northern Gateway's valve commissioning practices that will be used to verify that installed valves are fully functional and in good working order prior to line fill and operation.

b) Confirmation that block valves and isolation valves on the Project will employ double block and bleed as an isolation system as described in reference iii). If the answer is no or if there are exceptions, please justify and elaborate.

Response: a) Commissioning of each mainline block valve will consists of the following key activities:

- Integrity checks of the valve
- Mechanical checks of the mechanical components and systems associated with the valve
- Electrical checks of the electrical components and systems associated with the valve
- Local activation of the valve
- Remote activation of the valve by the SCADA system

- Remote activation of the valve by the Control Center Operator

  The valve commissioning requirements will be included in the Northern Gateway commissioning plan that will be developed during detailed engineering.

b) Mainline block valves and isolation valves on the Project will employ double block and bleed as an isolation system.

3.5 Pipeline coating

Reference: Exhibit B1-5 Volume 3 - Application dated May 2010, Section 5.3, page 5-2 (A1S9X8) (Adobe Page 42 of 132)

Preamble: In the reference above Northern Gateway indicates that line pipe will be coated with fusion bond epoxy and that field welds will be coated with a system compatible with the plant applied coating. Northern Gateway also indicates that the use of a three-layer coating system will be evaluated during detailed engineering.

The Panel notes that Northern Gateway has identified the presence of potential acid rock drainage (ARD) along the route which leads to potential corrosion protection challenges during operation.

The Panel requires more information regarding the relative merits of both coatings and the weight Northern Gateway would assign to these factors in determining the final coating choice.

Request: Please provide the following for both pipelines:

- **a)** A detailed comparison between fusion bond epoxy and the three-layer coating systems to be evaluated by Northern Gateway during final design which considers the following factors:
  - **a.1)** long term corrosion resistance;
  - **a.2)** compatibility with cathodic protection systems and its resistance to cathodic disbondment;
  - **a.3)** resistance to damage during transportation and handling;
  - **a.4)** resistance to damage from shear forces, abrasion and stone impacts during backfill;
  - **a.5)** resistance to UV degradation;
  - **a.6)** cost; and
  - **a.7)** any other factor Northern Gateway considers relevant in determining the pipeline coatings for the Project.
- **b)** Please discuss the relative importance of the above-noted factors in addressing the Project’s challenges and the weight Northern Gateway would assign to these factors in making its final coating design decision.

Response:

a) **Attachment JRP IR 3.5 a)** provides a comparison between the fusion bond epoxy and three-layer polyethylene coating systems.

b) Currently available coating technology is anticipated to be adequate to address the Project’s design, construction, and operating requirements. Decisions on a preferred coating for specific segments of the pipeline system will be made during detailed engineering and will incorporate Enbridge’s detailed coating standards. During detailed engineering Northern Gateway will work with coating producers and applicators, and with construction personnel, to ensure that the appropriate system for the appropriate location is selected to address the construction and operation plans.

During detailed engineering, the primary factors influencing the coating selection will be the resistance to damage, both during transportation and handling and from shear forces, abrasion, and impacts during backfill, and the cost.

Fusion bond epoxy is used extensively by Enbridge on large diameter pipeline projects and may be the preferred coating system for the majority of the Northern Gateway Project where appropriate transportation, handling, and backfill procedures are anticipated. Fusion bond epoxy in combination with the use of processed or screened backfill and/or additional protective measures such as rock shield or wooden lagging could also be used in stony or rocky trench conditions to ensure properly protected pipelines.

Three-layer polyethylene may be the preferred coating system where a higher resistance to coating damage is required, such as in rugged terrain. Three-layer polyethylene in combination with the use of processed or screened backfill and/or additional protective measures such as rock shield or wooden lagging could also be used in some trench conditions to ensure properly protected pipelines A cost comparison between fusion bond epoxy and three-layer polyethylene will include the differences in both coating cost and construction cost.

The potential for encountering a highly corrosive environment, specifically in locations where ARD is encountered, that could impact the long term corrosion resistance of FBE will be further evaluated during detailed engineering.

The potential for encountering environments with combined wet conditions, high temperatures, and abrasive backfill that could impact the resistance to cathodic disbondment of FBE will also be further evaluated during detailed engineering.

Additional coating system protection layers beyond those described above will also be required for specific construction situations. Line pipe for HDD and bored sections of the pipelines will receive an additional abrasive resistant coating to protect the base fusion bond epoxy coating. Rock jacket or concrete coating could also be used in more severe terrain conditions with handling and backfill challenges.

3.6 Qualification of NDE personnel

Reference:

i) Exhibit B20-2 Northern Gateway response to request for additional information from the JRP Session Results and Decision dated 19 January 2011, Section C, page 33, "Line Pipe Welding Design and Quality Control in Geotechnical and Seismic Areas" (A1Y3U9) (Adobe Page 37 of 66)

ii) CSA standard Z662-07, Sections 7.14.8.1 and 7.15.6

Preamble:

In reference i) Northern Gateway states that all non-destructive examination (NDE) will be conducted by suitably qualified and certified inspection personnel. Certification in accordance with Canadian General Standards Board (CGSB) or American Society for Non-destructive Testing (ASNT) will be required. As a minimum, any defect indications will be assessed by at least a Level II certified inspector.

In reference ii) the CSA Z662-07 standard requires that radiographers be qualified as specified in CAN/CGSB-48.9712 and that for radiographic image interpretation, radiographers shall be qualified as specified in CAN/CGSB-48.9712 to Level II or III. The CSA Z662-07 standard also requires that ultrasonic inspectors be qualified as specified in CAN/CGSB-48.9712 for Level II or III.

The Panel notes that ASNT certification and qualification requirements are not referenced publications in CSA Z662-07.

Request:

Please provide details regarding where Northern Gateway proposes to employ ASNT- qualified NDE inspectors and a justification for not using CGSB in these situations.

Response:

Northern Gateway will employ only CGSB certified radiographers and ultrasonic technicians for final NDT interpretation in accordance with CSA Z662. Should there be a shortage of qualified NDT personnel, operators and/or technicians who are not CGSB certified (i.e. ASNT certified) will be employed to assist with the inspection process. All final interpretations and acceptance of welds will be conducted and/or approved by operators and technicians who are certified by CGSB.

3.7 Air testing

Reference:

i) Exhibit B1-5 Volume 3 - Application dated May 2010, Section 5.11, page 5-7 (A1S9X8) (Adobe Page 47 of 132)

ii) CSA standard Z662-07, Sections 8.4.3

Preamble:

In reference i) Northern Gateway indicates that the pipelines will be designed to accommodate hydrostatic testing in accordance with the *Onshore Pipeline Regulations, 1999* (OPR-99) and CSA Z662-07 but specific sections of the pipelines may be designed to accommodate air testing if it is determined to be the preferred testing method. Northern Gateway states that the selection of pipeline sections to be considered for air testing will be determined during detailed engineering.

Section 8.4.3 of CSA Z662-07 states that air or another nonflammable, nontoxic gas may be used as the pressure-test medium, provided that the piping materials have notch toughness properties that are as specified in Clause 5.2 of the CSA standard, the pipe is not used pipe and has a longitudinal joint factor of 1.00, and at the time of such pressure testing, one or more of the following conditions exist:

- **a)** The ambient temperature is 0 °C or lower, or is expected to fall to such a temperature before the pressure test can be completed.
- **b)** A liquid of appropriate quality is not available in sufficient quantity.
- **c)** The piping is such that removal of a liquid pressure-test medium would be impractical.
- **d)** The elevation profile of the piping is such that an excessive number of test sections would be required for liquid-medium pressure testing.
- **e)** The strength test pressure does not produce a hoop stress in excess of 80% of the specified minimum yield strength of the pipe.

Request:

Please provide the following for both pipelines:

- **a)** The conditions, as identified under Section 8.4.3 of CSA Z662-07, which apply to the specific sections which Northern Gateway may want to test using air;
- **b)** The locations where the above noted conditions are expected to be encountered;
- **c)** The additional measures Northern Gateway proposes to employ to mitigate the safety hazards and sensitivity issues associated with air testing;
- **d)** An estimate of the largest test section which may be subject to an air test (i.e. diameter and length);
- **e)** An estimate of the highest potential air test pressure; and
- **f)** For comparative purposes, for both air and liquid test mediums, provide the calculations showing the times needed to reduce the pressure in the test section by 2.5% assuming a pre-existing

1.0 mm pinhole defect in a test section of the same size and at the same pressure as identified in d) and e).

Response: a-f) When Northern Gateway finalizes the pipeline route during detailed engineering, it is expected that all of the conditions described in clause 8.4.3 of CSA Z662.07 (Clause 8.7.2.3 (d) of CSA Z662-11) will be encountered in various locations along the pipeline such that the project may consider using air testing as an alternate. Elevation change over a short distance is anticipated to be the most common condition. Where the MOP yields a stress close to 80% of SMYS testing to a minimum of 1.25 times MOP leaves little room to accommodate elevation differences. For the lightest wall pipe with wall thickness of 10.3 mm that elevation difference is only 110 m. Other factors that will be considered when evaluating the feasibility of air testing for a specific section of the pipelines will include:

i) the various wall thicknesses and length of pipe

ii) pipeline route profile

iii) the access and ability to place testing equipment along the pipeline section

iv) the availability of source water

v) the ambient temperature during the anticipated time of testing

vi) the time frame available to complete the testing program

vii) options available to mitigate the problem conditions eg. forwarding of water in sequential sections, using thicker wall pipe

viii) safety and environmental constraints

ix) construction logistics

x) cost

In conclusion, Northern Gateway has not developed sufficient information at this phase of the Project to identify the specific locations for air testing or to formulate air testing plans. As stated in the preamble above and in Exhibit B1-5 Volume 3 - Application dated May 2010, Section 5.11 “the selection of pipeline sections to be considered for air testing will be determined during detailed engineering.” Prior to finalizing a decision regarding the use of air testing for any specific sections of the pipeline, considerable analysis of the foregoing factors relative to the finalized route must be conducted during detailed engineering.

3.8 Crossings

Reference:

i) Exhibit B1-5 Volume 3 - Application dated May 2010, Section 5.8, page 5-6 (A1S9X8) (Adobe Page 46 of 132)
ii) Exhibit B3-8 Volume 6A , Part 2 - Application dated May 2010, Tab 10, Section 10.4.3, page 10-19 to 10-21 (A1TOF8) (Adobe Pages 19 to 21 of 256)
iii) Exhibit B1-23 Volume 3 - Northern Gateway Application dated May 2010, Appendix J, page J-1 (A1TOH3)(Adobe Page 29 of 49)

Preamble:

In reference i) Northern Gateway provides the minimum depth of cover for various crossing situations. Northern Gateway has specified a minimum depth of cover of 1.2 metres for watercourse crossings underlain by soil and 0.6 metres for cover in rock. These depths of cover specifications are the minimum allowed by CSA Z662-07.

No increase in the minimum depth of cover (construction grade) is specified for access roads and trails.

In reference ii) baseline hydrological conditions are provided for each of the six distinct hydrological zones crossed by the pipeline based on published data. Figures 10-3 to 10-5 show significant differences in peak flows between zones.

In reference iii) Northern Gateway provides typical designs for a number of different crossings.

The Panel requires drawings illustrating the typical construction details for aerial crossings as well as drawings illustrating the placement and support of the pipelines in the Clore and Hoult tunnels.

Request:

Please provide the following:

a) Evidence demonstrating that the 1.2 metre minimum depth of cover specification, for all hydrological zones, is adequate to prevent exposure of the pipeline from scour;
b) A discussion of the suitability of the 0.9 metre specification for access roads and trails which could be used in the future by heavy off road equipment such as those used in the forestry and agricultural industries;
c) Preliminary engineering drawings for aerial crossings; and
d) Preliminary engineering drawings of the Clore and Hoult tunnels illustrating; access roads, tunnel access control, lighting, ventilation, valves, ground support and water drainage within the tunnels, the placement of the pipelines within the tunnels and how they will be supported.

Response:

a) The 1.2 m burial depth is the specified minimum pipeline burial depth for the Project's watercourse crossings. The design pipeline burial depth for individual crossings will be increased beyond the specified minimum depth to provide sufficient cover against channel degradation and scour that could occur during the design flood event over the life of the pipelines. Factors that will be considered in establishing burial depth requirements at watercourse crossings include:

- General channel bed scour
- Local bed scour arising from channel curvature, channel confluences, etc.
- Presence or absence of a floodplain (spilling or confined channel)
- Channel bed and bank material
- Channel bed form and irregularities (local highs and lows along the channel bed)
- Long-term channel degradation (lowering) or aggradation
- Anthropogenic factors such as instream structures (bridges, river training works, intakes and outfalls, bank erosion protection works) and changes to channel discharges, sediment loads or alignment
- Lateral channel movement
- Potential for debris jams and/or ice jams
- Beaver activity

The specified minimum burial depth of 1.2 m will apply only to crossings at watercourses or drainage paths characterized as being ephemeral, with poorly defined bed and banks that are grassed or comprise broken rock where no degradation or scour is expected. Channels of this type occur in every hydrologic zone but represent a small proportion of the total number of crossings along the proposed pipeline route.

b) The terms “Access roads” and “trails” conceptually cover a wide variety of potential access routes that could be used for construction of the pipeline. These will include seismic lines, trails used by trappers, hunters, ATV enthusiasts etc., deactivated or overgrown access from logging or mining activities or natural openings. Generally, “roads” are considered to have defined bed and ditches, are open to the public and are maintained by municipalities or private companies such as logging or oil and gas entities.

Some access roads or trails are actively travelled and have partially maintained surfaces but may not have a defined bed or ditches and would be treated similar to an improved road. Table 5-5 in Exhibit B1-5 Volume 3 - Application dated May 2010, Section 5.8 indicates that the Minimum Depth of Cover at Centreline of Road or Rail Bed for Access roads and trails is 1.2 m.

Prior to construction it is normal practice to obtain a permit or approval from the FMA or timber rights holders which includes accommodation of planned future haul roads where the location is known. This accommodation could be by extra depth, installing heavy wall pipe or minor deviation to avoid the crossing. Depending on the area and activity level, discussions will occur with mining and oil and gas firms. It is not practical to increase the depth at all access road and trail crossings. The depth of cover in general, is relative to construction grade. Construction grade is established after topsoil or duff is stripped and in some locations subsoil removed for grading purposes. On average, depth of cover will be closer to 1 m.

Future road crossings can be constructed a number of ways. Depending on the type of road, the actual depth of cover would be ascertained and the design standards reviewed to determine if the current cover is adequate. If the current cover is not adequate, the increased cover requirement would have to be built into the grade plan for a new permanent road. Temporary roads commonly cross the pipeline using ramps with a combination of timber and soil or bridge structures until use ends then the ramp would be removed. Lowering or replacement of the existing pipeline is possible but is rarely done.

The same approach would apply in agricultural lands although access roads and trails are fewer and most would be used by the landowner. The topsoil depth in most agricultural areas will be greater than in forested land which again results in a final depth of cover averaging greater than 1 m.

c) Four aerial crossings are proposed for the project, and the corresponding drawings are identified in the table below and attached as **Attachment JRP IR 3.8 c) (1-4)**.

Table 1 Aerial Crossings

KP (Route Rev T)	**Crossing**	**Drawing No.**	**Attachment**
601.4	Murray River	1847-100	JRP IR 3.8 c) (1)
1084.2	Tributary to Clore River	1847-300	JRP IR 3.8c) (2)
1091.3	Hoult Creek	1847-400	JRP IR 3.8 c) (3)
1169.7	Moore Creek	1847-600	JRP IR 3.8 c) (4)

Each drawing is a conceptual general arrangement for the specific crossing. The current route at the proposed Murray River crossing has been shifted slightly from the alignment shown on Drawing 1847-100; however, the conceptual design is representative of the proposed design.

d) Road access to the Clore and Hoult tunnels is described in the Application, Volume 3, Section,7 Clore and Hoult Tunnels. **Attachment JRP IR 3.8 (d-1)** is a map that shows the existing and proposed road access in the vicinity of the tunnels.

Tunnel access control is discussed in the Northern Gateway response to request for additional information, dated March 2011, Section C.2.4, page 27. The tunnels will be fitted with portal doors to prevent entry by the public and animals. Details of the access control measures including monitoring systems will be developed during detailed engineering.

A revised list of preliminary pipeline valve locations was provided in the Update to Application Volume 3, Appendix F (Revised Valve Site Selection, Table F-1). **Attachment JRP IR 3.8 (d-1)** also shows the locations of the proposed pipeline valves in the vicinity of the tunnels.

An initial discussion on proposed alternatives for tunnel construction and ground control methods was provided in the Application, Volume 3, Section 7, Clore and Hoult Tunnels. Additional discussion on tunnel construction and ground control measures was provided in the Northern Gateway response to request for additional information dated March, 2011, Section C.2.4, page 27 and 28. A range of ground control measures will be used to provide support for the tunnels. Primary ground support is installed close to the tunnel face during the tunnel excavation and support cycle. The type of support required to ensure the tunnel is stable will depend on local ground conditions.

Attachment JRP IR 3.8 (d-2) is a table that provides a summary of potential rock mass behaviour and geotechnical issues that may be encountered during construction of the tunnels. The range of rock mass behaviour and geotechnical issues are separated into five ground classes covering the range of anticipated ground conditions in the two tunnels. Specific ground support measures consisting of support type and installation sequence are provided for each of the five ground classes. Evaluation of the range of rock mass behaviour and corresponding support requirements are based on Barton's Q system (Barton, 1974)[1] with extension to include strain based design for very poor ground conditions following Hoek and Marinos (2000)[2].

Attachments JRP IR 3.8 (d-3) and JRP IR 3.8 (d-4) are typical tunnel cross section drawings showing the following conceptual details:

- Tunnels will have permanent lighting for inspection and maintenance activities. Lighting requirements will be developed during detailed engineering
- Tunnels will have permanent ventilation fans to be operated during inspection and maintenance activities. Ventilation requirements will be developed during detailed engineering. Design and operational requirements will be consistent with WorkSafe BC Regulations and

[1] Barton, N., Lien, R. and Lunde, J. 1974. Engineering classification of rock masses for the design of tunnel support. Rock Mechanics 6 (4): 189-236. Springer-Verlag.
[2] Hoek, E. 2001 Big tunnels in bad rock, 2000 Terzaghi Lecture. J. Geotech Engrg., ASCE, 127 (9): 726-74

the BC Occupational Health and Safety Act.

- Water drainage within the tunnels will be handled with separate full length invert drains.
- The conceptual design layout has the two pipelines installed on either side of the access roadway. The pipelines will be supported on regularly spaced concrete sleepers on a concrete floor. The pipe will be fixed to the concrete sleepers by a tie down system to prevent longitudinal and lateral deflection.

3.9 Quality Assurance and Quality Control

Reference: **i)** Exhibit B1-5 Volume 3 - Application dated May 2010, Section 1.6, page 1-3 (A1S9X8) (Adobe page 13 of 132)

ii) Department of Transportation, Pipeline and Hazardous Materials Safety Administration, Docket No. PHMSA-2009-01481, Advisory ADB-09-01, Potential Low and Variable Yield and Tensile strength and Chemical Composition Properties in High Strength Line Pipe

Preamble: **In reference i)** Northern Gateway indicates that the Project will be designed, constructed and operated to meet or exceed applicable regulations, codes and standards including OPR-99, CSA Z662-07 and Enbridge's engineering standards, specifications and manuals which meet or exceed these codes, standards and regulations.

Northern Gateway states that it will follow Enbridge's Quality Assurance and Quality Control (QA/QC) program to ensure the pipelines and facilities are designed, constructed and operated in accordance with the OPR-99 and other applicable environmental, regulatory and corporate standards and guidelines.

Northern Gateway further states that procured materials and equipment will comply with applicable codes and standards, including Enbridge's engineering equipment specifications and design standards. Material specifications will be developed for material and equipment not covered by existing Enbridge specifications.

Reference ii) is a 2009 Safety Advisory which alerts pipeline operators in the United States to recently identified issues with API 5L pipe used on pipeline projects which had yield strengths, tensile strengths and chemical compositions which did not meet the requirements of that standard. The advisory notes that pipe joints produced from plate or coil from the same heat may exhibit variable chemical and mechanical properties. The safety advisory suggests that manufacturing procedure specifications be closely reviewed and that mechanical property and chemical composition tests should be conducted throughout the steel making, steel rolling and pipe manufacturing process to ensure uniformity of chemical and mechanical properties of the pipe prior to shipment from the mills.

The Panel notes that the sourcing of materials for pipeline projects is worldwide and that while pipe and fittings may be manufactured on one continent, the material may come from another. Pipe and components manufactured to Canadian standards may be equally susceptible to the issues described above.

There are numerous references in OPR-99 and CSA Z662 which highlight the requirements for companies to record data, retain records, conduct inspections and have oversight over workmanship quality during design, procurement, construction and operation of the pipeline. In addition, the regulations and standards also require companies to develop components of quality management systems such as integrity and environment management programs.

Request: Please provide a detailed description of Northern Gateway's Quality Assurance and Control Program which describes how Northern Gateway will verify and ensure compliance including frequency of inspections, to specifications, codes, and standards. As part of the response include copies of all related:

- **a)** Manuals;
- **b)** Pipe and component specifications;
- **c)** Inspection plans which cover the lifecycle from design, material manufacture, receipt, transportation, installation;
- **d)** Inspector competency requirements; and
- **e)** Documentation requirements.

Response:

a) Each Enbridge major project is governed by a project execution plan. One of the key subordinate plans of the project execution plan is the quality management plan. A quality management plan will be prepared and executed for the Northern Gateway Project. The current Enbridge Major Projects Quality Management Plan template at time of writing is included as **Attachment JRP IR 3.9 a)** for reference. This template is expected to evolve with advances in the Enbridge quality program. The most up to date version will be applied to the Northern Gateway project.

b) Enbridge was part of the Industry group assembled under the auspices of the INGAA Foundation in 2009 to respond to PHMSA Advisory Bulletin ADB-09-01 "Potential Low and Variable Yield and Tensile Strength and Chemical Composition Properties in High Strength Line Pipe". This study group released a White Paper: "Identification of Pipe with Low and Variable Mechanical Properties in High Strength, Low Alloy Steels" in September 2009. A copy of this paper is included as **Attachment JRP IR 3.9 b)**. The findings of this study group were incorporated in the most recent revision of Enbridge's pipe specification: EES102-(2010), which supplements CSA Z245.1 07. The submission of this specification is subject to a separately filed request to file this information confidentially with the JRP. The measures taken in response to the INGAA White Paper were:

1. Requiring that pipe mill hydrotest pressures be set at 95% SMYS based on calculated hoop stress alone.
2. Require that each pipe be measured for outside diameter in five locations: each end and three points equidistance along the pipe, and that each of these measurements conform to outside diameter requirements.
3. Stringent material traceability requirements from the steel mill

through to coating to prevent product non-conformance due to breaks in traceability.

Note that Enbridge's pipe specification may change prior to purchasing line pipe for the Northern Gateway project due to revision to the CSA specifications or other enhancements.

c) As part of the procurement process, pipe and coating inspection and test plans must be submitted to Enbridge for review for conformance with Enbridge and regulatory requirements prior to the start of production.

Enbridge inspection is carried out at the pipe and coating mills by qualified third party inspectors. Pipe and coating inspection are conducted at the 100% level in accordance with plans submitted by the third party inspection firm in advance of production.

d) Internal pipe and coating inspection is carried out by the manufacturer in accordance with their Manufacturing Procedures Specification (MPS) documentation. This documentation is reviewed by Enbridge prior to manufacture.

Enbridge third party inspection is carried out by approved contractors. Third party inspection staff is required to have knowledge of governing standards, including CSA Z245.1 and Enbridge pipe specifications as well as experience conducting Owner inspections. Inspector qualifications are submitted to Enbridge for approval.

e) Pipe and coating Material Test Reports (MTRs) are submitted to Enbridge prior to construction. Enbridge's own inspection activities are documented in a report issued by Enbridge's third party inspection contractor. This report includes inspection results, documentation regarding process conditions during manufacture and verification of the conformance of manufacturer MTRs with Enbridge requirements. This report also documents the disposition of any product that is rejected by Enbridge inspection.

3.10 Kitimat Area Facilities

Reference:
i) KM LNG Hearing GH-1-2011, Response to NEB IR 1.2 Exhibit B 9-7 (A1S9X8) (Adobe page 10 of 53)
ii) KM LNG Hearing GH-1-2011, Exhibit 9-9 (Adobe page 19 of 281)
iii) Exhibit B1-5 Volume 3 - Application dated May 2010, Section 8.4, page 8-3 (A1S9X8) (Adobe page 61 of 132)
iii) Exhibit B1-5 Volume 3 - Application dated May 2010, Section 9.5.1, page 9-13 (A1S9X8) (Adobe page 77 of 132)

Preamble: The Panel notes that the proposed Northern Gateway facilities in Kitimat are in close proximity to the proposed KM LNG facilities at Bish Cove and that the proposed timeframes for construction are similar.

In reference i) the proponent of the KM LNG project indicates that a 36-inch diameter pipeline will extend the terminus of the proposed Pacific Trails Pipeline to the proposed KM LNG plant inlet. A parallel 6-inch pipeline is being considered as part of the overall plant design. This line would be used for the transportation and internal use of condensate and initial loading of ethylene and propylene refrigerants. Both these pipelines would be in a 30 metre right of way.

In reference ii) the Joint Assessment Report and Comprehensive Study Report dated 13 April 2006 for the Kitimat LNG project indicated that a 287-kV aerial transmission line will also be constructed by BC Hydro. This line will be parallel to the Bish Forestry Service Road and plant access road, to supply power to the LNG plant site. The transmission line will extend from Kitimat to Emsley or Bish Cove.

In reference iii) Northern Gateway states that power lines will be constructed to supply electrical power for the pump stations and that in British Columbia, Northern Gateway will be responsible for supplying connection facilities to BC Hydro.

In reference iv) Northern Gateway indicates that a new, approximately 10 km long 287-kV transmission power line will be constructed to supply electrical power for the Kitimat terminal. This power line will connect to the existing BC Hydro 287-kV transmission system. A 25/30-MVA main substation will also be constructed at the terminal.

Based on the above references there may be up to four pipelines and two separate 287- kV power lines proposed to be constructed on the west side of Kitimat Arm parallel to the Bish Forestry Service Road. The Panel requires more information regarding potential synergies, conflicts and rationalization between the two projects.

Request: Please provide the following:

a) A map at a scale of 1:25,000 or smaller depicting the area between KP 1158 and Bish Cove indicating the location of: (i) the proposed KM LNG pipelines and facilities described above; (ii) existing and proposed access roads and water courses; (iv) the proposed power line(s); and (v) the Northern Gateway pipelines and facilities;

b) A summary of the discussions between Northern Gateway, KM LNG and BC Hydro regarding potential conflicts, synergies and rationalization of facilities, right of way and work space requirements should both projects proceed.

Response:

a) **Attachment JRP IR 3.10 a)**, consists of three maps entitled Proposed Northern Gateway and KM LNG Pipelines and Facilities (Figure No's JRP IR 3.10a-1 to JRP IR 3.10a-3).

b) Numerous industrial project sites exist, are being constructed or are proposed for the Kitimat area and down the west side of Kitimat Arm/Douglas Channel. These sites, including Northern Gateway's Kitimat Terminal site have connecting pipeline and electrical transmission infrastructure requirements which will be constructed to the north and east of the terminal sites. Available right of way space for proposed KM LNG and Northern Gateway pipelines, together with the required electrical transmission power lines is limited along the west side of Kitimat Arm/Douglas Channel. In areas to the east of the District of Kitimat, particularly between approximately KP 1128 and KP 1092 along the proposed Northern Gateway pipeline route corridor width for parallel pipelines is limited. As a result of the limited available corridor width it is important that the various proponents work together to take advantage of synergies among projects, resolve potential conflicts and rationalize required infrastructure, right of way and work space requirements for the proposed projects.

Northern Gateway's efforts to meet and discuss routing and location issues include the following:

British Columbia Government

Northern Gateway has over the past six years dialogued with the B.C. Ministry of Economic Development regarding the Major Projects Inventory of proposed projects to be developed in the Kitimat area. As well, the project has been discussed with BC Ministry of Energy and Mines, and the BC Ministry of Forests, Lands and Natural Resources Operations and other ministries

A Map Reserve designation has been granted by the province for the Kitimat Terminal lands. This will ensure that no land disposition can occur on these lands without prior notification of Northern Gateway.

Discussions continue with a number of provincial ministries as the project moves through the regulatory and environmental assessment process. These discussions frequently include topics such as project coordination especially around corridor related issues.

Kitimat Terrace Industrial Development Society (KTIDS)

Northern Gateway has met with the Kitimat Terrace Industrial Development Society (KTIDS) regarding improving existing west side access roads and construction of new roads to existing and proposed projects. Northern Gateway has initiated discussions regarding potential conflicts, synergies and rationalization of facilities, right of way and work space requirements relative to other projects. Northern Gateway has informed KTIDS and its participants about Northern Gateway's requirements for improved road access and infrastructure plans for the Kitimat Terminal site and provided mapping describing the proposed alignments. Northern Gateway has sought permanent membership in the KTIDS organization, which it hopes to secure.

KM LNG

Northern Gateway engaged KM LNG and has attended a number of meetings to discuss project synergies, conflicts and right of way issues and general project timing issues. Subsequent to the change in operatorship of KM LNG, Northern Gateway has been working to engage Apache in discussions regarding potential conflicts, synergies and rationalization of facilities, right of way and work space requirements.

Based on available information, Northern Gateway notes that there appear to be some potential for conflicts with the proposed KM LNG pipelines and power line located within the proposed Northern Gateway tank terminal area and the proposed KM LNG use of the existing Bish Forest Service Road located adjacent to the proposed Northern Gateway marine terminal. As part of the development of the proposed Northern Gateway Kitimat Terminal access road, allowance has been made to extend this road west of the Kitimat Terminal and then further south to the proposed KM LNG Terminal.

Northern Gateway will continue its efforts to engage KM LNG in discussions concerning these regional development issues.

Pacific Trails Pipeline

Northern Gateway has sought to engage Pacific Trails Pipeline (Pacific Northern Gas), the former proponent of the proposed pipeline to transport natural gas from the Summit Lake area to the KM LNG Terminal at Kitimat. Efforts to initiate communication to discuss any potential conflicts, synergies and rationalization of facilities with Pacific Trails are continuing. Northern Gateway has also contacted Apache directly to discuss pipeline routing and related synergies, potential conflicts and facility rationalization and hopes to be able to establish an on-going dialogue on these matters as both projects proced through their respective regulatory approval processes.

Northern Gateway has obtained all publically available information regarding the Pacific Trails Pipeline project, particularly the proposed corridor.

BC Hydro

Northern Gateway, through its electrical consultant, has had numerous discussions with BC Hydro regarding electricity requirements and electrical infrastructure and power line routing for the Project. These discussions have not yet included discussion about synergies with other proposed and existing projects in the Kitimat area, which also require electrical infrastructure. Further discussions with BC Hydro are anticipated to address competing project power requirements in the Kitimat area.

Rio Tinto Alcan

Northern Gateway has contacted Rio Tinto Alcan (Alcan) to discuss the Northern Gateway Project and any potential conflicts synergies and rationalization of facilities, right of way and work space requirements. These discussions have not yet progressed, but Alcan has undertaken to have Northern Gateway invited into the joint industry planning discussions in the future. Rio Tinto Alcan has previously granted Northern Gateway survey consent to conduct engineering and environmental studies along the proposed infrastructure corridor which crosses Rio Tinto Alcan lands. Theses discipline studies have been completed.

3.11 Operations and Maintenance

Reference: Exhibit B1-5 Volume 3 - Application dated May 2010, Section 11.6, page 11-4 (A1S9X8) (Adobe Page 106 of 132)

Preamble: In the above reference Northern Gateway indicates that regional maintenance centres will be established at Kitimat and at a number of other unspecified locations along the pipeline route. Table 11-1 outlines the personnel skills of 105 operations personnel expected to be directly employed to operate and maintain the pipelines and related facilities. Northern Gateway also indicates that an additional 100 long-term personnel are expected to be employed for support services related to the Kitimat Terminal and shipping operations; there is no breakdown provided of the personnel skills required for these support services.

The Panel recognizes that the exact number of staff required may increase or decrease as Northern Gateway gains experience operating the Northern Gateway system.

Request: Please provide the following:

- **a)** The planned location of regional maintenance centres and offices for the Northern Gateway pipeline and their area of responsibility (e.g. KP 0 to KP 300);
- **b)** A table similar to Table 11-1 specifying the proposed number, personnel skills and maintenance centre locations for all 205 long term employees; and
- **c)** The anticipated number of field personnel in each location who would be trained to respond to emergencies.

Response:

a) The proposed locations of the Pipe Line Maintenance (PLM) and Electrical/Mechanical (E&M) maintenance bases are as follows, and approximate area of responsibility:

- Edmonton, AB (existing “PLM” shop), KP 0 to KP 150;
- Fox Creek, AB (proposed “PLM” shop), KP 150 to KP 325;
- Grande Prairie, AB (proposed “PLM” and “E&M” base), KP 325 to KP 500;
- Tumbler Ridge, BC (proposed “PLM” shop), KP 500 to KP 675;
- Prince George, BC (proposed “PLM” and “E&M” base), KP 675 to KP 850;
- Burns Lake, BC (proposed “PLM” shop), KP 850 to KP 1000;
- Kitimat, BC (proposed terminal site with “PLM” and “E&M” base), KP 1000 to KP 1150.

b) Subsequent to filing the Application, May 2010, Northern Gateway has conducted a further review of the estimated personnel requirements for project operations and these updated estimates form the basis for the table in **Attachment JRP IR 3.11 b)**.

The total number of long term personnel is currently estimated to be 228, inclusive of both Northern Gateway personnel and associated Services personnel for Kitimat Terminal and tug operations.

The total number of long term personnel will be finalized during detailed engineering and operational and emergency response planning. Final personnel numbers will also depend on resource sharing agreements with other industry, “Co-ops” and OSRO’s.

c) All operations personnel (field and office) will be trained for responsibilities to respond to emergencies. This will include:

- Emergency response and incident command awareness (all staff, but specifically for administrative staff with minor emergency response roles);
- Incident command role training (as appropriate for various roles in the incident command structure for all managers and supervisors, as well as responding professional staff and field personnel that could fill command roles);
- Tactical (field) response training (all managers, supervisors and field staff, as well as responding professional staff);
- Tactical (operational) response training (all control center personnel).

In addition to Northern Gateway personnel, and as described in the General Oil Spill Response Plan, March 2011, trained emergency response personnel will be available from other Enbridge business units to fill roles in both the incident command structure as well as for tactical (field) response.

Northern Gateway will also have relationships with various local cooperatives (Co-ops) and Oil Spill Response Organizations (OSROs) to provide additional emergency response equipment and trained responders. Marine and land based contractors and OSRO’s will be catalogued in a regional emergency response directory.

The current Transport Canada certified response organization for the BC coast is Western Canada Marine Response Corporation. Their resources in Kitimat would expand if the Northern Gateway Project was approved. The Canadian Coast Guard also maintains a spill response capability. All escort tugs will be equipped with first response capability and will have crews trained to respond to oil spills.

As part of their training, Northern Gateway operations personnel will perform joint emergency response exercises in cooperation with local government agencies, emergency responders (fire and police), “OSROs”, and other response contractors. All emergency response roles and responsibilities will been identified during the completion of the operational plans, and a training matrix will be developed. A specific training matrix will be included in each operational plan (pipelines, terminal, marine).

3.12 SCADA and Leak Detection

Reference: **i)** Exhibit B1-5 Volume 3 - Application dated May 2010, Section 11.9, page 11-7 (A1S9X8) (Adobe Page 109 of 132)
ii) Exhibit B1-5 Volume 3 - Application dated May 2010, Section 11.2, page 11-2 (A1S9X8) (Adobe Page 104 of 132)

Preamble: **In reference i)** Northern Gateway states that a real-time transient model (RTTM) Material Balance System (MBS) computer program will be used for pipeline leak detection. Northern Gateway indicated that hydrocarbon sensors and on-site personnel will be used for facilities leak detection. Northern Gateway indicated that the alarm thresholds will be established during the tuning period of the new system development. Northern Gateway noted that the alarm thresholds are different for each pipeline as each pipeline is unique in design and operation. Northern Gateway added that imbalance alarms from the MBS mainline leak detection system are annunciated in the Edmonton Control Centre and that the Control Centre response procedures for possible pipeline leak situations would be initiated.

In reference ii) Northern Gateway states that its supervisory control and data acquisition system (SCADA) was developed and is currently supported by Enbridge staff. Northern Gateway indicated that Enbridge's SCADA system had evolved over almost 40 years and has many proprietary features built in that allow Enbridge to safely maximize pipeline capacity while minimizing risk. Northern Gateway states that the initial response to a Control Centre MBS alarm will comply with current control centre operations (CCO) procedures and all applicable codes in effect at the time of the design. Enbridge's current procedures require initiation of a line shutdown within 10 minutes of receiving an unexplained MBS alarm. Initiation of the specific subsequent steps will depend on the nature of the alarm.

The Panel requires more information regarding the SCADA and leak detection systems for both the oil pipeline and the condensate line.

Request: Please provide the following:

- **a)** A description of how the Enbridge RTTM MBS detects leaks;
- **b)** A discussion of the effects of slack line flow on the ability of the Enbridge RTTM MBS to detect leaks;
- **c)** Results of analyses undertaken by Enbridge on the potential for slack line flow when the Northern Gateway system is operated at 100% of Maximum Operating Pressure (MOP), 80% of MOP and 50% of MOP;
- **d)** A description of the proprietary features incorporated into the SCADA system and how they maximize capacity and minimize risk;
- **e)** A description of the pipeline operating conditions which could trigger MBS alarms but would not require initiation of line shutdown;
- **f)** Details on the expected performance of Enbridge's RTTM MBS including but not limited to:
  - **f.1)** detectability (e.g. amounts leaked, time to detect, leakage rate);

- **f.2)** sensitivity (i.e. minimum leak size);
- **f.3)** reliability (i.e. false alarm rate, failure to alarm rate);
- **f.4)** system robustness (i.e. system availability in light of expected system operating conditions); and
- **f.5)** accuracy (i.e. size and location of a detected leak).

g) The location of the hydrocarbon sensors used in facilities to detect leaks and where Enbridge relies on on-site personnel only to detect facility leaks.

Response: (a) Enbridge uses a Computational Pipeline Monitoring (CPM) system as its primary real-time system for detecting leaks on all of its liquids pipelines. CPM is a computer-based monitoring approach that uses continuous measurements of pipeline conditions. This is an industry standard for dedicated leak detection. The industry standard that defines CPM is American Petroleum Institute publication API-1130.

CPM is a real-time system that utilizes measurements and pipeline data to detect anomalies that could be possible leaks. The type of CPM used by Enbridge is a Real Time Transient Model (RTTM). A RTTM is a sophisticated computer model of a pipeline that continuously monitors changes in the calculated volume of oil. At Enbridge, this model is referred to as the Material Balance System (MBS). The MBS is designed to meet the requirements of CSA Z662 Annex E, U.S. DOT's CFR 49 Part 195, and API 1130.

MBS Design

A standardized model design is used as the basis for MBS. This approach is then adapted for each MBS designed for a particular pipeline. All MBS systems have the same functional design and engineering hydraulic calculations. The models are designed to handle the entire range of liquids transported by Enbridge.

MBS models are integrated with the pipeline control system through an industry standard SCADA (Supervisory Control And Data Acquisition) system. The SCADA system collects real time pipeline measurements including pressures, flows, valve status, temperatures, and densities and passes them to the MBS leak detection software. The MBS software processes this data with the pipeline model data (i.e. pipe diameter, elevation, valve location, etc.) to create an accurate real-time simulation of the continually changing state of the pipeline. The MBS uses commercial software for hydraulic calculations.

Material balance calculations are based on pipeline sections bounded by flow meters. The MBS continuously calculates imbalances between the expected product amount in a pipeline section and the MBS measured amount. Imbalance thresholds are assigned that address measurement and modeling uncertainty. An MBS imbalance alarm is activated when the imbalance threshold is exceeded.

Leak detection thresholds are line specific to reflect the pipeline’s unique design, fluids shipped, and operation. The thresholds are established by MBS system tuning during application development and using test data. Alarm thresholds are optimized during the tuning period of the new system development and are set to be as low as possible without creating nuisance alarms, which would erode system credibility. Material balance calculation windows are standardized to 5 minutes, 20 minutes and 2 hours. Extensive graphical and tabular displays have been developed for MBS monitoring and alarm analysis.

Enbridge’s MBS systems are tested on an annual basis. The testing procedures follow API 1130 recommended practices.

b) Slack line flow or a column separation – presence of vapor due to low pressure in the pipeline – can mask and delay detection of a leak when all of the following apply:

(i) The leak is in the vicinity of column separation (or slack line flow)

(ii) The leak begins at approximately the same time the column separation (or slack line flow) is forming

(iii) There is significant error in the vapor pressure of the commodity and elevation of the pipeline at the location of the column separation (or slack line flow) in the MBS model.

Enbridge’s MBS can effectively model vapor in the pipeline. The rate of vapor formation and dissipation, however, is difficult to model accurately. As a result, an imbalance is calculated when a column separation (or slack line flow) forms, or when it collapses. In some cases the imbalance is large enough to trigger a leak alarm, but the alarm and imbalance are short-lived. If the above conditions apply, distinguishing the imbalance due to a leak from the imbalance due to the column separation (or slack line flow) forming is problematic. Persistence of the leak alarm would trigger further analysis of MBS data for other possible causes of the imbalance.

c) The expected Northern Gateway Hydraulic Profiles for both the Oil and Condensate Pipeline have been evaluated using both steady state simulators and transient state trainer models. Both the Oil and Condensate pipelines were evaluated at each of the following conditions as requested in JRP IR 3.12c:

- Station Discharge limited to 100% MOP
- Station Discharge Limited to 80% MOP
- Station Discharge Limited to 50% MOP*

<u>*Note:</u> The condensate pipeline cannot operate when station discharge is limited to 50% of MOP as requested in the IR as it does not provide enough pressure to overcome the static column leaving Kitimat. Therefore, the system was run at expected minimum rates based on current pump selection of ~1100 m3/h.

Based on the preliminary evaluation of the steady state profiles, and studies completed in conjunction with Enbridge Control Centre Operators on a transient state trainer model, the following table provides locations identified as higher risk areas for Column Separation that will need to be looked at or further reviewed or investigated:

Table 1 - Potential Column Separation Locations

Pipeline	Case	Critical Location (Approximate)	Additional Location Reference
Oil (Line 28)	100% MOP 80% MOP	KP 177	High Elevation Point Upstream of Whitecourt Station
	100% MOP 80% MOP	KP 600	High Elevation Point Upstream of Tumbler Ridge Station
	50% MOP	KP 625	System Overall High Elevation Point
	50% MOP	KP 972	System Overall High Elevation Point
	100% MOP 80% MOP	KP 1074	High Elevation Point Between Houston and Clearwater Station
Condensate (Line 29)	100% MOP 80% MOP	KP 625	System Overall High Elevation Point
	100% MOP 80% MOP	KP 972	System Overall High Elevation Point

Taking into account the critical points identified above, the following will be implemented in the Northern Gateway Detailed Design and Operating Philosophies for the mitigation and management of the higher risk column separation locations:

- Include pressure transmitters at the high points identified above. These pressure transmitters will have alarm settings such that a warning is received back to the Operator before column separation occurs. The warning alarm will allow the Pipeline Operator to take the corrective action necessary to prevent column separation.

Implementation of standard operating procedures to establish minimum station holding pressure control set-points that will help to maintain operating pressures at critical high points that are sufficient to prevent column separation from occurring.

d) Enbridge has a proprietary system that monitors control sections and will automatically reduce discharge pressures and/or shutdown pumps, stations, and pipelines should discharge pressures at any point approach a critical limit. In addition, the line will automatically be shutdown when there are line blockages or other pressures approaching critical limits. The critical limits are set to have maximum capacity while also ensuring the line is never over pressured.

e) A pipeline shutdown is not initiated if the root cause of an MBS alarm can be determined to be a non-leak event within 10 minutes of alarm initiation, and the cause of the alarm is not serious enough to compromise the integrity of the MBS.

Common causes of non-leak MBS alarms include instrument failure, modelling errors, communication outages in the SCADA system, and some transient events. These alarm causes are typically identified within 10 minutes.

Transient flow conditions that cause MBS alarms can occur as a result of line shutdowns, line start ups, pump loss, column separation or delivery location changes. Modelling errors can result because changes in pressure and flow may occur between data scans in the SCADA system.

f) An updated API 1149 calculation based on the most recent Northern Gateway pipeline configuration will be filed for this response by October 6th 2011. This calculation will provide a theoretical, but industry standard, leak detection performance.

g) The Facilities for the Project will include hydrocarbon sensors located in each building that houses process equipment. This is described in Section 8.6 – for the Pump Stations and Section 9.5 for the Terminal in the NEB Application. These Sections outline that hydrocarbon sensors are required for the pump houses at the pump stations and the pump houses and meter buildings at the Kitimat Terminal. All Electrical Switchgear Buildings at all of the Facilities location will have hydrocarbon sensors located at each end of the building for explosion protection.

Enbridge does not rely solely on "On Site" personnel for leak detection. By normal visual inspection and maintenance patrols, on site personnel can provide an additional level of leak detection ability. The inspection/maintenance/patrol programs will be incorporated into the respective Facility Operation and Maintenance procedures.

3.13 Alberta Facilities provided by Others

Reference: **i)** Exhibit B1-5 Volume 3 - Application dated May 2010, Section 1.2, page 1-2 (A1S9X8) (Adobe Page 12 of 132)
ii) Exhibit B1-2 Volume 1 - Application dated May 2010, Section 4.1, page 4-1 (A1S9X5) (Adobe Page 41 of 44)

Preamble: **In reference i)** Northern Gateway indicates that the shippers on the system will choose how they access the pipelines. Northern Gateway specifically mentions the Stonefell Terminal which is adjacent to the Bruderheim Station and indicates that other connections are also possible. Northern Gateway states that the choices and decisions relating to the connection facilities will be made during detailed engineering.
In reference ii) Northern Gateway states that it initially considered the areas around Fort McMurray and Edmonton as possible termini for the oil pipeline but shipper preference was for a terminus near Edmonton. Northern Gateway added that the need for condensate delivery was centred on the blending terminals in the Edmonton and Hardisty areas. The Panel notes that there are no tanks at Bruderheim to receive condensate deliveries or oil for shipment to Kitimat.
The Panel requires more information regarding existing and proposed pipeline systems necessary for operation of the Northern Gateway system.

Request: Please provide the following:

- **a)** A map identifying the existing and proposed pipelines and facilities required for the transportation and storage of Project oil and condensate;
- **b)** A brief description of these pipelines and facilities;
- **c)** The status of regulatory applications for the proposed pipelines and facilities identified in a) and b); and
- **d)** The time necessary to construct the required facilities.

Response: a) As stated in Volume 3 of the Application, Section 1.2, the shippers on the Northern Gateway pipelines will select how they will access the oil and condensate pipelines. The Northern Gateway Project includes the Bruderheim Station, the crude oil pipeline extending from the Bruderheim Station to the Kitimat Terminal and the condensate pipeline extending from the Kitimat Terminal to the Bruderheim Station. Consequently, pipelines and facilities upstream of the Burderheim Station, in the case of the oil pipeline, and downstream of the Bruderheim Station, in the case of the condensate pipeline, will be provided by parties other than Northern Gateway.

A map identifying Northern Gateway's understanding of the existing and proposed pipelines and facilities in the general area of the proposed Bruderheim Pump Station is included as **Attachment JRP**

IR 3.13 a).

b) Northern Gateway has identified the following existing and proposed facilities that may serve the Northern Gateway Project:

Enbridge Infrastructure:

- Waupisoo Pipeline – 30" pipeline transporting Crude from Cheecham Terminal in the oil sands area to Edmonton Terminal
- Woodland Pipeline Extension (PROPOSED) – 36" pipeline transporting Crude from Cheecham Terminal in the oil sands area to the Edmonton Terminal
- Enbridge Norlite Diluent Pipeline (PROPOSED) – 24" pipeline transporting diluent from Edmonton to the Cheecham Terminal and areas north of Cheecham
- Enbridge Stonefell Terminal (PROPOSED) – Contract terminal with an estimated 10 million barrels of storage when fully built out

3rd Party Infrastructure:

- Access Pipeline is a 24"crude pipeline and 16" diluent pipeline between Edmonton and the MEG Energy Christina Lake and Devon Jackfish oil sands projects
- MEG Energy Heartland Terminal (Formerly Enbridge/BA Tank Terminal) – 900,000 barrels of storage located adjacent to the proposed Enbridge Stonefell terminal. Tanks are constructed and are proposed to be connected to the Access pipeline system. Expected to be in service in 2013.
- IPF Cold Lake Pipeline System is a 24" crude pipeline & 12" diluent pipeline between Edmonton and the Cold Lake oil sands region.
- IPF Polaris is a 12" diluent pipeline that will transport condensate from the Stonefell/Heartland region to oil sands projects that are north and east of Fort McMurray (Athabasca oil sand region). Expected to be in service mid 2012.

c) Northern Gateway understands the status of regulatory applications for the proposed pipelines and facilities identified in a) and b) to be:

- Woodland Pipeline Extension – Regulatory application filed in May 2011 with a projected in-service date of 2014.
- Enbridge Norlite – No application filed. This pipeline is proposed and not contingent or tied to Northern Gateway.
- Enbridge Stonefell Terminal – No application filed. This pipeline is proposed and not contingent or tied to Northern Gateway.

d) **Enbridge Infrastructure:**

It is estimated that the time to construct the proposed Stonefell Terminal and the Norlite Diluent pipeline will be about 3 years from the date the Application is filed.

Enbridge cannot comment regarding scheduling of third party facilities.

3.14 Regulatory changes

Reference: Exhibit B1-5 Volume 3 - Application dated May 2010, Section 1.4, page 1-2 (A1S9X8) (Adobe Page 12 of 132)

Preamble: In the above reference, Northern Gateway states that since the Project falls under the jurisdiction of the NEB, it will be designed, constructed and operated to comply with the latest NEB regulations, including the OPR-99, which incorporate, by reference, CSA Z662-07, Oil and Gas Pipeline Systems.
The Panel notes that the new version of CSA Z662 (CSA Z662-11), is expected to be issued in July 2011.

Request: Provide details regarding how the design of the applied-for facilities will be modified to comply with the new requirements of CSA Z662-11.

Response: Northern Gateway and Enbridge are reviewing CSA Z662-11 to identify any changes that have occurred from the CSA Z662-07 edition regarding the design of the applied-for facilities. Northern Gateway will then review its design of the applied-for facilities and will modify the Project design, where needed during detailed engineering, to comply with CSA Z662-11

3.15 Pipe Strain Capacity and Loading in Geotechnical and Seismic Areas

Reference:

i) Exhibit B1-5 Volume 3 - Application dated May 2010, Section 5, page 5-2 (A1S9Y2) (Adobe Page 42 of 132)

ii) Exhibit B20-2 Northern Gateway response to request for additional information from the JRP Session Results and Decision dated March 2011, Section C.3.1, page 32, "Line Pipe Material Properties Including Effective Strain Capacity After Construction" (A1Y3U9) (Adobe Page 36 of 66)

iii) Duan D., Zhou J., "A Systemic Material Evaluation Program for High Grade Line Pipe Materials", ASME IPC 2008-64426, October 2008

iv) Suzuki N., Igi S., Masamura K., "Seismic Integrity of High Strength Pipelines", JFE Technical Report No. 12, 2008 (http://www.jfe-steel.co.jp/en/research/report/012/pdf/012-02.pdf)

Preamble:

In reference i) Northern Gateway indicates that the feasibility of using pipe grade 550 (X80) steel and the associated reduced wall thickness for all, or a portion of, the oil pipeline will be evaluated during detailed engineering. The Diameter/Wall Thickness (D/t) ratios for the oil pipeline range from 46 to 89 using pipe grade 483 (X70) steel.

In reference i) and ii) Northern Gateway proposed to use Category I pipe (i.e. pipe without proven notch toughness) indicating that the use of Category II pipe will be evaluated.

In reference ii) Northern Gateway indicated that the design mitigation techniques in geotechnical hazardous areas may include the installation of heavier wall pipe to reduce strain and to limit the possibility of buckling. Northern Gateway further indicated that the strain demand will be determined using industry accepted and/or Project specific methodologies such as pipe-soil interaction finite element analyses.

References iii) and iv) are examples of the knowledge acquired by pipe manufacturers and pipeline operators related to the high strength pipe evaluation programs and resistance requirements for displacement-controlled loading.

The Panel notes that :

1) A reduction of the pipe wall thickness (i.e. higher D/t ratios) compounded with an increase in pipe grade to 555 (X80) could potentially provide an actual strain capacity lower than grade 483 (X70), if pipe is manufactured to conventional CSA-Z245.1 or API 5L specification.

2) Steel with non-proven notch toughness (i.e. Category I) may not provide the reliable information (e.g. allowable longitudinal stress or the strain capacity) needed for designing against geotechnical hazards and seismic loading and ensuring girth weld overmatching in geotechnical and seismic areas.

3) Determination of the strain demand or geotechnical and seismic loading is fundamental in the design of the strain capacity of the pipe and girth welds in geotechnical hazardous or seismic areas.

The Panel requires more information regarding the relative merits of both pipe grades (i.e. 483/X70 and 555/X80) and pipe category (i.e. I and II); associated to the strain demand in geotechnical hazardous areas. The Panel also requires more information regarding the weight Northern Gateway would assign to these factors in determining its final selection of pipe strength.

Request: Please provide the following:

a) A detailed comparison and analysis of the benefits and limitations between pipe grade 483 (X70) and 555 (X80) should high strain line pipe be used by Northern Gateway during final design in geotechnical hazard and seismic areas. The comparison should include, but not limited to, the following factors:

- **a.1)** Diameter/Wall Thickness Ratios
- **a.2)** Yield Strength / Tensile Strength ratios and;
- **a.3)** associated strain capacity (tensile, compressive and bending)

b) The locations along the pipeline where Category I and/or II pipe will be used indicating whether it is within a geotechnical hazard or seismic area;

c) Confirm whether laboratory and full scale testing (specify type) will be conducted for determining the pipe and girth weld strain capacity for the pipe material property and characteristic combinations to be used in the final design; and

d) Describe the strain demand methodology and the technical criteria for selecting the geotechnical hazard and seismic areas to be assessed with such methodology.

Response:

a) The detailed comparison and analysis of the pipe grade to be used will be conducted during detailed engineering. While the use of Grade 550 pipe is expected to result in a reduction of the required pipe thickness and associated pipe cost, other criteria such as compatible components, pipe availability, field welding and girth weld strength overmatch would all need to be considered and addressed. For a strain based design, regardless of the pipe grade, the shape of the stress-strain curve and the ratio of yield stress to the stress at 2% strain are other considerations. These properties would be assessed on specimens taken parallel to the pipe axis (ie. longitudinal specimens).

b) The locations where Category II pipe will be considered will be determined during detailed engineering and may include aerial crossings, areas with potential geotechnical hazards or seismic activity, pipeline installed in tunnels and pipeline sections subject to air testing. Although Category I pipe may be specified, considering the chemistry and steelmaking practices applied to modern pipeline steels, it is expected that this material will have a sufficient degree of toughness.

As stated in response to JRP IR 3.1 c), preliminary analysis indicates that notch toughness requirements as low as 10 Joules would be sufficient to sustain a through wall defect approximately 50 mm in length. While Category II pipe may be considered for use as an additional safeguard in geotechnical hazard or seismic areas, from a fracture initiation perspective, this may not be necessary. Further analysis and assessments will be conducted during detailed engineering.

c) Considering the available published data related to strain based design, full scale tests are not expected to be necessary. Laboratory testing conducted on representative material would be carried out to verify weld and materials properties and behaviour. This testing would likely include crack tip opening displacement (CTOD) tests, and longitudinal tensile tests in the as-received and strain aged conditions.

d) Detailed analysis of the pipeline system with respect to strain during a seismic event will be carried out during detailed engineering. However, in this respect, it is noted that the seismic acceleration is only 12% at the west end of the project (1:2500 year return period Peak Ground Acceleration, Volume 3, Appendix E-1) and, therefore, pipeline strain for buried pipelines with field bends during a seismic event is not expected to drive the pipeline design. Detailed analysis of the response of buried factory bends and above ground piping and tie-ins will also be carried out during detailed engineering.

Attachment JRP IR 3.15 d) outlines areas of potential geotechnical hazards relative to pipeline Route Rev R as described in the Application, where appreciable pipe strain could potentially occur as a result of soil movement. The table is conservative at this point of the design – that is the segments defined in the table include areas where further investigation and design will likely indicate that soil movements are not a potential issue. In some cases, the table also defines relatively long pipeline segments that include both potential geohazard areas as well as intervening areas where no hazard exists. Additional background with respect to the areas shown in **Attachment JRP IR 3.15 d)** is discussed in the paragraphs below.

The pipeline routing has avoided all known areas of potential seismically induced liquefaction failure. One or two additional transitional areas are potentially present in the Kitimat Valley. These additional transitional areas will be investigated during detailed engineering and mitigative measures potentially including local rerouting or in situ densification will be considered as appropriate. These additional potential liquefaction areas are included in **Attachment JRP IR 3.15 d)**.

In general, all areas where seismically induced movement of slides could occur are also areas where soil movement might occur in the absence of a seismic event. Therefore, there is no need to separately break out areas of seismically induced sliding. Most areas of moderately deep or deep-seated slide movement that might induce unfavourable strain on the pipeline as a result of soil-pipeline interaction have been avoided during routing or, in some cases by mitigative methods such as the choice of stream crossing method (e.g., a trenchless crossing method below the slide area). Nevertheless, for the purposes of preliminary design, **Attachment JRP IR 3.15 d)** includes all areas where there is a potential for deep or moderately deep sliding.

All identified areas of sliding due to the presence of glaciomarine clays have been avoided by the presently considered routing and mitigative measures. However, other areas of glaciomarine clay might be found in the future in the Kitimat Valley where there is a potential for sliding to occur. Therefore, the entire Kitimat Valley has been included in **Attachment JRP IR 3.15 d)**.

Other geohazards such as lateral or scour erosion leading to pipeline exposure are less likely to induce unfavourable overall strain in the pipe. However, at this stage of the design, areas of potential scour, lateral erosion and avulsion hazard have also been included in **Attachment JRP IR 3.15 d)**.

Environment Matters

3.16 Mitigation of Cumulative Effects on Grizzly Bear

Reference:

- **i)** Exhibit B3-7, Volume 6A, page 9-229, (A1T0F7) Adobe page 166 of 233
- **ii)** Exhibit B3-7, Volume 6A, page 9-232, (A1T0F7) Adobe p.170 of 233
- **iii)** Exhibit B3-6, Volume 6A page 9-38, (A1TOF6) Adobe p. 56 of 81
- **iv)** Exhibit B3-7, Volume 6A page 9-233, Table 9-83, (A1T0F7) Adobe p. 170 of 233
- **v)** Exhibit B3-6, Volume 6A, page 9-19, (A1T0F6) Adobe p. 37 of 81
- **vi)** Exhibit B3-7, Volume 6A, page 9-243, (A1TOF7) Adobe p. 180 of 233
- **vii)** Exhibit B3-7, Volume 6A, page 9-258, (A1TOF7) Adobe p. 195 of 233

Preamble:

In reference i) Northern Gateway states that there is a reasonable expectation that the Project's contribution to cumulative environmental effects may affect the viability or sustainability of grizzly bear populations within Grizzly Bear Population Units (GBPUs).

In reference ii) Northern Gateway identifies that exceeding a linear density threshold of 0.6 km/km^2 would constitute a significant adverse effect on grizzly bears. Exceeding that density means bear populations can no longer sustain indirect and direct mortality **(reference iii)**.

Northern Gateway states that in seven of the nine GBPUs the Project traverses, the existing linear feature densities already exceed the established threshold, and the effects of other projects are already responsible for significant effects, to which the Project's effects would incrementally contribute **(reference iv)**.

Northern Gateway states that in the Bulkley-Lakes GBPU, the project effects would result in an incremental increase of linear feature density beyond the threshold of 0.6 km/km^2 **(reference iv)**.

Northern Gateway states that in regard to the Bulkley-Lakes GBPU, it will undertake a suite of mitigation measures to manage all project access aggressively, and will work with other interests to develop and implement the Access Management Plan to manage and reduce linear densities within these GBPUs and Bear Management Areas.

In reference vii) Northern Gateway also states that:

> *"it intends to explore with provincial regulators the potential to achieve a no net gain in linear access in the Bulkley-Lakes GBPU and, possibly, other GBPUs in British Columbia and Alberta. If there is agreement on this ambitious concept, Northern Gateway would undertake a process to engage government agencies, participating Aboriginal groups and affected stakeholders in developing and implementing site-specific plans to remove existing and unneeded access and linear features"*.

Northern Gateway has not provided details or the likelihood of success of this mitigation.

Northern Gateway also notes that one of the issues raised by Aboriginal Groups is noted to be "having Northern Gateway fund programs to enhance wildlife habitat elsewhere as part of a regional no-net loss policy" **(reference v)**.

Additionally, Northern Gateway states that it has low confidence in the effectiveness of mitigation measures to reduce mortality, and indicates that a program to manage linear feature density **(reference vi)** is one of several plans and approaches that together are the best tools for reducing grizzly bear mortality risk.

The Panel notes it is also unclear if the goal of no-net gain in linear feature density would be relative to the Base Case or to the Project Case scenario, or if the mitigation proposed would be ongoing through construction and operation.

Given Northern Gateway's prediction that the incremental effects of the project would result in significant adverse cumulative effects in the Bulkley Lakes GBPU, and because existing significant cumulative effects are already present in most of the other GBPU's, the Panel requests further information on the proposed mitigation concepts and programs.

Request: Please provide the following:

- **a)** A description of the proposed mitigation of "no net gain in linear feature density" in detail, including objectives, timelines, financial accountabilities, implementation tasks, criteria for measurement of success, the likelihood of success, and reporting plans.
- **b)** Whether Northern Gateway intends to fund, manage, or otherwise oversee the closure, reclamation, and/or restoration of existing unneeded access and linear features as part of the proposed mitigation during construction and operation of the Project.
- **c)** What parties would be involved or consulted with (including tenure holders, landowners, the public, Aboriginal groups, land managers, and Provincial regulators) on their current uses of linear features in the Bulkley Lakes GBPU.
- **d)** A summary of any discussions that have taken place or agreements reached with those parties listed above and the outcomes achieved, and provide a copy of your response to this Information Request to those parties.
- **e)** What other GBPU's in British Columbia or Alberta Northern Gateway intends to explore this concept for, and the status of those explorations in relation to requests (b) through (d) above.

Response: (a) Northern Gateway is committed to 'no net gain in linear feature density' in sensitive areas as the underlying objective of the Northern Gateway Access Management Plan.

Access management is identified as a key mitigation strategy for

Project-related effects on wildlife throughout the ESA. The summary of general mitigation measures for wildlife (Volume 6A, Part 2, Table 9-10, Section 9.3) lists the following measures specifically related to access management:

- Develop the Access Management Plan (see the Construction EMP, Volume 7A) in collaboration with wildlife agencies, participating Aboriginal groups and stakeholders; monitor the effectiveness of the plan and make adjustments as necessary.
- Use existing roads and RoWs, where possible, to reduce disturbance, by:
    - Developing the RoW parallel to or overlapping existing linear corridors (e.g., roads, seismic lines and pipeline). [Note that, as indicated in Table 9-1 of the ESA (Section 9.1.1), 17.2% of the project development area (PDA) intersects existing disturbances at baseline. These existing disturbance include existing RoWs, railway, cultivated area (outside White Area only), active and inactive industrial sites, roads, cutlines and trails, but does not include forestry cutblock. Thus, this is a conservative assessment, and the extent of the PDA that is disturbed at baseline is actually higher. Subsequent route revisions will likely increase this area of overlap with existing disturbances.]
    - Using existing access roads where available
    - Coordinating development of new (temporary) roads and other RoWs with other industrial operators
    - Locating infrastructure near existing roads to reduce disturbance of remote areas during maintenance
    - Using existing watercourse crossings where possible
- Confine all project traffic to the RoW, designated access roads and construction sites.
- Prohibit project personnel from the recreational use of temporary access roads and the RoW.
- Avoid unauthorized use of the RoW through use of large berms, rollback, coarse weedy debris, revegetation and vegetation screens (such as planted trees), slash/rock piles, guarded or locked gates, and appropriate signs at access point and other specified sites (wildlife movement corridors). Northern Gateway will monitor effectiveness of access control, and address deficiencies, as required.
- Deactivate and rehabilitate all temporary roads (including shoo-flies) and construction sites with native vegetation to prevent use

and provide cover for wildlife; monitor effectiveness of rehabilitation and address deficiencies, as required. In some site-specific cases, deactivation of existing access will be considered to avoid or reduce any net gain in access in a specific area that is deemed to be sensitive habitat for wildlife.

- Explore opportunities, in consultation with other stakeholders where needed, to reduce the density of linear features (such as roads and RoWs) in caribou herd ranges and GBPUs that are affected by project activities. The initiative would involve, as appropriate, provincial and federal wildlife management agencies, provincial land management agencies, other industry proponents, participating Aboriginal groups and directly affected public stakeholders.

Northern Gateway has initiated discussions with Alberta Sustainable Resource Development and the BC Ministry of Environment (now BC Ministry of Forest, Lands and Natural Resource Operations) Regions 6 and 7 to develop a comprehensive and detailed Access Management Plan. Affected Aboriginal groups and stakeholders will also be engaged.

Attachment JRP IR 3.16 a) is a summary of the meetings held with government agencies to date.

Northern Gateway is targeting October 2011 to renew engagement with BC Ministry of Environment (now BC Ministry of Forest, Lands and Natural Resource Operations) Regions 6 and 7. The intent is to work with the Ministry to:

- Refine geographic priorities with input from wildlife and fisheries experts (building on their knowledge and strengthen working relationships)
- Refine the technical approach to managing access (i.e. preferred methods to remove or restrict access)
- Identify concerns from other government agencies and identify appropriate solutions
- Identify support from other government agencies for the proposed measures
- Identify other important participants in the access management plans for specific areas along the pipeline RoW (i.e. Aboriginal groups, directly affected stakeholders)
- Apply the access management approach to one or more specific, high priority areas within the jurisdiction of the regulators participating in the meeting. The objective would be to generate concrete examples of how Northern Gateway could address access

issues

A similar approach will be used with the ASRD.

Northern Gateway will commit to continue to consult with government agencies, and to engage affected Aboriginal groups and stakeholders in the development of the Access Management Plan. Northern Gateway will use the information obtained through the consultation process to finalize objectives, timelines, financial accountabilities, implementation of tasks, criteria for measurement of success, the likelihood of success, and reporting plans for the Access Management Plan. Northern Gateway will finalize the Access Management Plan and submit it to the NEB following Project approval and at least 6 months prior to the commencement of construction.

The objective of “no net gain in linear feature density” is to maintain or reduce current levels of linear density in sensitive areas. The Project will report on the success achieving this objective through post-construction monitoring programs that will be developed specifically to measure success against this goal.

In discussions with ASRD and the BC Ministry of Environment (now BC Ministry of Forest, Lands and Natural Resource Operations), there has been discussion about having these multi-party discussions through the Northern Gateway Community Advisory Boards. These advisory boards would provide a venue for a wide-range of regulators, Aboriginal groups, stakeholders, and resource users to have input into shaping the Project’s Access Management Plan.

Northern Gateway will bear the costs of implementing the Access Management Plan and/or work with other industrial proponents active in the area to ensure costs are fairly and appropriately apportioned.

In addition to the Access Management Plan, Enbridge has a corporate ‘tree for a tree’ policy that is part of a strategy to reduce the overall effects of their activities. This policy will be applied to the Northern Gateway Project. The policy states: “Enbridge will plant a tree for every tree we remove to construct or expand our facilities or rights-of-way. The trees we count – and therefore replace – will be of adequate size to be considered ‘merchantable timber’ as defined by the relevant local regulator. When re-planting trees, Enbridge will do so taking into account the following considerations:

1. We will plant trees to meet regulatory commitments and approval conditions
2. We will plant trees to maintain slope stability, control erosion and meet reclamation guidelines and aesthetic requirements
3. We will plant trees to meet the needs of local communities

4. Within 5 years of a tree being removed, Enbridge will plant a replacement tree."

(b) As part of the Access Management Plan, Northern Gateway will take an active role in overseeing the closure, reclamation, and/or restoration of existing unneeded access and linear features during the construction and operations phases of the Project. Part of this role will include evaluation of funding opportunities and opportunities for collaboration with government agencies, participating Aboriginal groups, and other stakeholders (including other industrial proponents (see JRP 3.16a)).

(c) To date, the following parties have been identified for consultation on current uses of linear features within the Bulkley-Lakes GBPU:

- BC Ministry of Environment (now BC Ministry of Forest, Lands and Natural Resource Operations) Region 6,
- Kalum Forest District,
- Nadina Forest District,
- BC Ministry of Transportation District 10,
- Northern Interior Management Committee of the Integrated Land Management Bureau, and
- Aboriginal groups (Lax Kw'alaams, Carrier Sekani, Haisla, Kitselas, Wet'suwet'en, Nee Tahi Buhn, Tsimshian, Skin Tyee, Metlakatla, Ts'il Kaz Koh, and Stellat'en).

Additional groups will be identified as part of the consultation process and as details of the Access Management Plan are developed. These groups are expected to include forestry companies, oil and gas companies, guide-outfitters, recreational organizations, stewardship organizations, and local land owners.

(d) As summarized above (JRP 3.16a), Northern Gateway has been engaging regulators and participating Aboriginal groups on access management planning since 2005. With the exception of the Kitselas First Nations and BC Ministry of Environment (now BC Ministry of Forest, Lands and Natural Resource Operations) Region 6, these discussions have not been specific to the Bulkley-Lakes GBPU and have not necessarily focused only on grizzly bears (e.g., ASRD discussions have been specific to caribou). As stated previously, consultation will be ongoing until the Access Management Plan is finalized.

The response to this and all other IRs will be made publically available on the NEB web site and Northern Gateway will provide a copy of the response to this IR as part of the information package accompanying all access management-related meetings.

(e) As described above (JRP 3.16a), Northern Gateway intends to implement the Access Management Plan and the ‘no net gain in linear feature density’ in sensitive areas objective along the entire length of the proposed pipeline route. Therefore, all nine bear management units identified in the ESA, two in Alberta and seven in British Columbia, will be addressed under the plan. As indicated in JRP 3.16d, consultation on access management planning has begun but is in early stages and the parties engaged to date generally have interests beyond the Bulkley-Lakes GBPU.

3.17 Incremental Project Contribution to Cumulative Effects on Caribou

Reference:

i) Exhibit B3-1, Volume 6A, page 3-16, (A1T0F1) Adobe page 66 of 184

ii) Exhibit B3-7, Volume 6A, page 9-225 and 9-259, (A1T0F7) Adobe page 162 and 196 of 233

Preamble:

In reference i) Northern Gateway indicates that it assessed the cumulative effects of the Project and other activities and projects inclusive of:

- **a)** the overall cumulative environmental effect; and,
- **b)** the contribution of the project to overall cumulative effect.

In reference i) Northern Gateway also indicates that it determined the significance of residual cumulative environmental effects using standards or thresholds specific to the Valued Ecosystem Component, Key Indicator, or other appropriate measureable parameter.

Northern Gateway has stated that for the Little Smoky caribou herd in Alberta it appears that all effects combined for cumulative effects (habitat, movement, mortality risk) are considered significant. However, **in reference ii)** Northern Gateway also states that the project's contribution to cumulative effects on the Little Smoky caribou herd is not significant.

Northern Gateway states that it is prepared to participate in an initiative to reduce current linear density in the five caribou ranges that intersect with the Regional Effects Assessment Area. It also states that it will explore opportunities to achieve a no-net increase in access density as part of its Access Management Plan, and that options will be discussed with government agencies, participating Aboriginal groups, and stakeholders before implementation **(reference ii)**.

The Panel seeks clarity on Northern Gateway's methods for determining significance of the Project's incremental effects that contribute to cumulative effects that may affect the Little Smoky caribou herd, and the status of plans to reduce linear density in caribou herd ranges.

Request:

Please provide the following:

- **a)** The methods Northern Gateway used to determine the significance of the Project's incremental contribution to cumulative effects for the Little Smoky caribou herd.
- **b)** A justification for the methods chosen, including citation of appropriate scientific literature, Government agency guidance, or documents regarding best practices for environmental essessment.
- **c)** An explanation as to how the Project's incremental contribution to each of the parameters of cumulative effects considered for caribou (habitat, movement, mortality risk) were evaluated for their significance.
- **d)** Details of any plans Northern Gateway has to reduce linear density or achieve no-net increase in linear density in the five caribou herds that intersect the Regional Effects Assessment Area.

e) A summary of discussions that have taken place with relevant parties (including tenure holders, landowners, the public, Aboriginal groups, land managers, and Provincial regulators) about any plans to reduce linear density, the outcomes achieved, and provide a copy of your response to this Information Request to those parties.

Response: (a) The approach to significance determination for wildlife is described in Section 9.2.7 of the ESA (Volume 6A, Part 2). In brief, an effect is significant when a resource undergoes an unacceptable change or reaches an unacceptable level. Northern Gateway accepts that ultimately, it is the role of the responsible authority, the government authority charged with making a decision about whether a project is in the public interest and to determine the significance of an environmental effect. The ESA includes analyses intended to aid regulators and support their decision making process. The determination of significance is most straightforward when clear thresholds separate minor and major effects. However, accepted thresholds are less clear for most effects on wildlife in general, and even less so, for individual species and most population units.

For this assessment, an effect is considered not significant when the Project is not expected to result in an effect on the long-term viability of a wildlife population (e.g., a subpopulation, herd or management unit, as appropriate). It is considered significant when there is a moderate to high probability that the Project may result in an effect on the long-term viability of that same population (Page 9-38).

If cumulative effects are evident, then there are two alternative scenarios to consider (Page 3-39):

- If the project contribution to cumulative effects causes an unacceptable shift to occur (e.g., exceedance of a threshold), the effect is considered significant
- If the effects of other projects are already responsible for an unacceptable state of the resource, the Project is considered to contribute incrementally to an already significant cumulative effect.

Typically, in the latter case, the effect is only considered significant if Project mitigation is not able to effectively reduce or eliminate the Project contribution to cumulative effects.

The ESA evaluated cumulative effects with respect to three effects on wildlife: change in habitat availability (Section 9.6.4), change in movement (Section 9.7.4), and change in mortality risk (Section 9.8.4).

Cumulative effects on habitat are evaluated quantitatively for birds and mammals in Section 9.6.4.1. This evaluation included some discussion of the effect of habitat fragmentation on caribou.

Cumulative effects on movement patterns are evaluated qualitatively for birds, mammals and amphibians. The discussion for mammals is general and does not address caribou specifically (Section 9.7.4.2).

Cumulative effects on mortality risk were evaluated quantitatively for birds and mammals. Given the sensitivity of caribou and grizzly bear to the effects of linear disturbance, these species were selected for a detailed assessment of cumulative mortality risk (Section 9.8.4.2). Linear feature density was used as a surrogate to assist in determining the cumulative mortality risk for caribou (from humans and wolves). All five caribou herds were addressed specifically in this analysis. The methods used in this analysis are described in Section 9.4.3.2 (calculation of linear feature density) and in Section 3.2.3.2 (Description of Cumulative Environmental Effects).

As stated on Page 9-226: “as linear feature densities and the associated effects on habitat use patterns and mortality risk is an issue for woodland caribou in general in both British Columbia and Alberta (AWCRT 2005; McNay and Giguere 2007; Hebblewhite et al. 2008; Sorensen et al. 2008), Northern Gateway is committed to managing project access aggressively with the range of these five herds. Opportunities to achieve a no-net increase in access density will also be explored as part of the Access Management Plan. The Access Management Planning process is described in JRP IR3.16a.

(b) The methods used for the wildlife cumulative effects assessment presented in the ESA are based on current accepted best practice for environmental assessment, developed over years of practice by many assessment professionals (Section 3.2.1) and are consistent with direction from the following sources: the NEB Filing Manual; Environmental Assessment Best Practice Guide for Wildlife at Risk in Canada (Lynch-Stewart 2004); Draft Guidelines for Evaluating, Avoiding and Mitigating Impacts of Major Development Projects on Wildlife in British Columbia (Harper et al. 2001); A Practical Approach to Assessing Cumulative Effects for Pipelines (Hegmann et al. 2000) and Cumulative Effects Assessment Practitioners' Guide (Hegmann et al. 1999). The approach used in the ESA is also consistent with three recently released documents: CEAA Guidelines for the Preparation on an EIA for a Comprehensive Study Process (2011), Cumulati ve Effects Assessment in Environmental Impact Assessment Reports Required under the Alberta Environmental Protection and Enhancement Act as cited in the Guide to Preparing Environmental Impact Assessment Reports in Alberta February 9, 2011; and Addressing Species at Risk Act Considerations under the Canadian Environmental Assessment Act for Species under the

Responsibility of the Minister Responsible for Environment Canada and Parks Canada (2010).

Please see JRP IR 3.18 for a discussion of threshold selection for the cumulative effects assessment for caribou mortality risk.

(c) Please see response to JRP IR 3.17a

(d) Northern Gateway's Access Management Plan will also be applicable to caribou. The plan and its development approach are described in detail in JRP IR 3.16(a).

As described in JRP IR 3.16(e), Northern Gateway intends to implement the Access Management Plan and the 'no net gain in linear feature density' objective along the entire length of the proposed pipeline route. Therefore, all five caribou herds identified in the ESA will be addressed under the plan.

Refinement of the pipeline route within the Little Smoky and Narraway herd ranges to minimize potential Project effects on these caribou and maximize the use of existing disturbance features has been achieved in direct consultation with ASRD (see JRP IR 3.17(e)).

(e) As summarized in JRP 3.16(a), Northern Gateway has been engaging regulators and participating Aboriginal groups on access management planning since 2005 and will continue to do so until the Access Management Plan is finalized. However, to date, only the discussions with ASRD have been specifically focused on caribou (Little Smoky and Narraway herds).

The outcome of the ASRD meetings has been refinement of the pipeline route within the Little Smoky herd range to minimize potential Project effects on these caribou and maximize the use of existing disturbance features. The most recent meeting with ASRD was in June 2011. The current routing for the pipeline reflects ASRD's input to micro-routing of the centerline within the range of the Little Smoky herd to minimize effects on caribou habitat and mortality risk.

The response to this and all other IRs will be made publically available on the NEB web site and Northern Gateway will provide a copy of the response to this IR as part of the information package accompanying all access management-related meetings.

3.18 Threshold Selection for Cumulative Effects on Caribou

Reference:

i) Exhibit B3-1, Volume 6A, page 3-16, (A1T0F1) Adobe page 66 of 184

ii) Exhibit B3-7, Volume 6A, page 9-225, (A1T0F7) Adobe page 162 of 233

iii) Exhibit B3-7, Volume 6A, page 9-259, (A1T0F7) Adobe page 196 of 233

Preamble:

In reference i) Northern Gateway indicates that it determined the significance of residual cumulative environmental effects using standards or thresholds specific to a given Valued Ecosystem Component or Key Indicator species.

Northern Gateway identifies woodland caribou as a Key Indicator species for the wildlife Valued Ecosystem Component.

In reference ii) Northern Gateway cites a 2002 workshop presentation by Francis and Dyer that focused on threshold development for industrial impacts to woodland caribou in the Yukon. The thresholds proposed by Francis and Dyer (linear feature density of 1.8 km/km^2) were used as the basis for Northern Gateway's determination of significance of the cumulative effects for woodland caribou.

In reference iii) Northern Gateway cites a 2008 study of cumulative effects thresholds for caribou in Alberta (Sorensen et al. 2008) and indicates that a strong relationship exists between population viability of caribou herds and two alternate metrics: caribou range burned in the last 50 years and the proportion of the range within 250 m of anthropogenic disturbance.

Request:

Please provide the following:

- **a)** The rationale for the use of the 1.8 km/km^2 linear density threshold as the metric for determination of significant effects on caribou. In your response, please identify if the metrics developed in Sorensen et al. (2008) were considered and why those alternate threshold measures were not selected.
- **b)** An indication of how the assessment of cumulative effects to woodland caribou would differ if the Sorensen et al. (2008) study was used as a basis for a linear density threshold and significance determination.

Response:

(a) As indicated in the ESA (Section 9.4.3.2), linear feature density was identified as a suitable predictor of mortality risk for a number of species, including caribou. Linear feature density is also a measurable parameter that could be calculated with a fair degree of certainty using available data and at an appropriate scale for the assessment of cumulative effects (i.e. within the REAA).

Linear feature density is a commonly-used metric for quantifying and modeling the effect of development on large mammals, including caribou. For example:

- Salmo and Diversified (2003) and the BC Forest Practices Board (2011) used linear feature density as measurable parameter for assessing cumulative effects on caribou in northeast BC.
- Jones (2008) calculated linear feature density for three herds in the South Peace region, including the Quintette herd, as an indicator of level of range disturbance.
- The Athabasca Landscape Team developed a series of risk criteria to rate comparative risk to caribou persistence in each caribou range and planning area in the Athabasca Landscape Area (northern Alberta) that included linear corridor density (ALT 2009).
- Francis et al. (2002) identified linear feature density as a measurable parameter for assessing the effects on development on caribou in the Yukon.
- Weclaw and Hudson (2004) incorporated linear feature density into an interactive cumulative effects model developed for caribou in northern Alberta.

A density of 1.8 km/km2 of ‘corridor’ (including roads, cutlines and RoWs) was selected as the threshold for determining significance with respect to mortality risk for caribou for the Northern Gateway Project (Page 9-225). This threshold was first identified for boreal caribou in the Yukon (Francis et al. 2002) and adopted by Salmo and Diversified (2003) for northeast BC, a region that includes boreal, northern and mountain caribou. Salmo and Diversified (2003) identified this threshold as the ‘critical’ threshold for caribou in areas zoned for general development in northeast BC. Three of the five caribou herds that interact with the Project are found in northeast BC (Narraway, Quintette and Hart Ranges). This threshold was also considered to be suitable for northern caribou elsewhere in BC (i.e. the Telkwa herd) and for boreal caribou in Alberta (i.e. the Little Smoky herd). Thus, a single threshold was identified for all five herds.

Sorensen et al. (2008) examined the relationship between functional habitat loss resulting from the cumulative effects of natural and anthropogenic disturbances and the rate of population change for six boreal caribou populations in northern Alberta, including the Little Smoky. They defined functional habitat loss according to two variables: 1) percentage of caribou range within 250 m of industrial development; and 2) percentage of caribou range disturbed by wildfire within the last 50 years. Using these two variables, their model explained 96% of the variation in rate of population change among the six populations. Extrapolation from the model predicts sustainable caribou populations at a maximum of 61% of the range within 250 m of industrial development or at a maximum of 66% naturally disturbed. Only one of these thresholds, percentage of range within 250 m of disturbance, is applicable to an assessment of project-related effects. This threshold was not, however, selected for the cumulative effects assessment of mortality risk for caribou for the Northern Gateway Project primarily because it was developed for boreal caribou in northern Alberta and only one of the five caribou herds that interact with the Project is the boreal ecotype—the Little Smoky herd.

Northern Gateway recognizes that there are a number of measurable parameters (‘metrics’) available for assessing the effects of development on caribou but is confident that linear feature density is completely suitable as a measurable parameter for assessing cumulative effects of a pipeline development on mortality risk for caribou.

(b) The threshold for percentage of range within 250 m of industrial disturbance (61%) was already exceeded for the Little Smoky herd at the time Sorensen et al. (2008) completed their analysis, that is, 88.4% of the Little Smoky herd’s range was estimated to be within 250 m of industrial development. The relatively low linear feature densities estimated for the portion of the Little Smoky herd that intersects the REAA (Table 9-79, Section 9.8.4.2) are at odds with this finding. It seems likely, then, that the portion of the herd range within the REAA has less linear development than is typical in other parts of the range.

As described in JRP IR3.17e, Northern Gateway and ASRD have met several times to refine the pipeline route within the Little Smoky herd range to minimize potential Project effects on these caribou and maximize the use of existing disturbance features. In fact, ASRD preferred the currently proposed route, as opposed to an alternative that would have routed around the Little Smoky range, because the currently proposed route has minimal new linear disturbance. Consequently, the Project is predicted to not measurably increase linear feature density within this herd’s range. Therefore, regardless of which of the two thresholds is used, the outcome of the cumulative effects assessment is predicted to be the same with respect to the incremental contribution of the Project, that is, not significant.

With respect to the other four herds, given that linear feature density estimates in the portions of these herds that intersect the REAA are below even the more conservative (non-critical) thresholds (e.g., 1.22 km/km2 [Weclaw and Hudson 2004]; 1.5 km/km2 [Salmo and Diversified 2003]) and assuming that linear disturbances would be a main contributor to the Sorensen et al. (2008) metric, then it is unlikely that the 61% threshold would be approached in any case. Further, as noted in JRP IR 3.18a, the Sorensen et al. (2008) threshold was developed for boreal caribou, whereas these herds are northern and mountain caribou and their habitat use patterns and the disturbance regimes within their ranges are different that what was considered by Sorenson et al. (2008). Regardless of which of the two thresholds is used, the outcome of the cumulative effects assessment is predicted to be the same, that is, not significant.

Significant or not, to reiterate from JRP IR3.17a (from Page 9-226 of the ESA), as linear feature densities and the associated effects on habitat use patterns and mortality risk are an issue for caribou in general in both British Columbia and Alberta, Northern Gateway is committed to managing Project access aggressively within the range of the five herds that interact with the Project and opportunities to achieve no net gain in linear feature density will be sought as part of the Access Management Plan. In addition, within the range of the Little Smoky herd, Northern Gateway will commit to achieving a net decrease in linear feature density. This is possible given that the Project, by paralleling existing RoWs within the Little Smoky herd's range, will not measurably increase linear feature density. Therefore, any actions taken to reduce linear feature density in other parts of the range should result in a net decrease in linear feature density and a potential net benefit to the Little Smoky herd. Northern Gateway will work with ASRD and other industrial proponents active in the area to develop this approach further and identify opportunities to apply it.