

TERRAIN

Study geographic boundaries: PDA, PEAA

Study time boundaries: Construction, operations and decommissioning phases.

Project works and activities considered in the study*:

Construction (including (1) RoW and site preparation, including clearing, grubbing, temporary access, (2) surface and subsurface disturbance, including grade work, cuts, fills, trenching, (3) clean-up including backfilling of trench, placing disturbed material

back onto grade, final surface contouring, (4) temporary and permanent road or power line development (e.g., clearing, grading, drainage control), new power lines, and (5) infrastructure construction including tanks, pump stations, terminals), operations (including ongoing operations of infrastructure and pipelines) and decommissioning (including pipeline and road reclamation after pipeline ceases operations and removal of terminals).

Study methods: Terrain integrity was chosen as the only VEC because of its importance in landscape function. Terrain integrity refers to the stability of the landscape in respect to factors such as mass wasting, including erosion, settlement and Acid Rock Drainage (ARD). Changes in the natural equilibrium of bedrock and sediment controlled slopes commonly result in slope failure or instability that can cause other adverse environmental effects such as the sedimentation of fish-bearing streams or accidental releases of hazardous materials. Considerable consultation and

coordination with the Engineering Team, including geotechnical specialists occurred throughout the study.

Extensive field studies were undertaken in both 2006 and 2008. Data was obtained on parent materials (such as till, glaciomarine or organics), slope, textures, and geologic modifying processes (such as evidence of landsliding or excessive groundwater seepage). Detailed mapping of surficial materials occurred at a scale of approximately 1:7,500. Depth to bedrock mapping occurred at a scale of approximately 1:1,000.

VEC	Key Issues	KIR	Baseline Results	Measurable Parameter	Potential Project Effects**	Proposed Mitigation	Residual Effects	Cumulative Effects
Terrain Integrity	Stability of the landscape (landslides and accelerated gully erosion)	n/a	From east to west, the pipeline crosses a variety of landscapes including the Eastern Alberta Plains, Southern Alberta Uplands, Alberta Plateau, Rocky Mountains, Interior Plateau and the Coast Mountains. The topography of all but the Rocky Mountains and Coast Mountains is relatively subdued. A variety of glacial and post-glacial sediments are found along the route with glacial till being the most common surficial material. Other glacial materials include glaciolacustrine, glaciofluvial, and glaciomarine. Post glacial deposits include eolian, marine, lacustrine, and fluvial deposits. Bedrock is found at the highest elevations within the Rocky Mountains and Coast Mountains.	Mast wasting (including erosion)	Includes shallow, moderate and deep seated landslides, rock fall, debris flows, avalanches, lateral spreading, lateral stream erosion or scour and sedimentation, and wind, shallow stream or overland flow. During construction, there is the potential for changes in the natural equilibrium of the landscape, resulting in changes in mass wasting. While much of the proposed pipeline will be constructed on relatively subdued and stable topography, there are areas where the pipeline will cross problematic terrain that may be susceptible to mass wasting (e.g., landsliding) if proper mitigation techniques are not developed and applied. While slopes may have not failed during construction, they may fail during the lifespan of the pipeline, potentially affecting pipeline operation or integrity. However, changes in mass wasting are not likely to occur due to the nature of the activity and the mitigation measures planned.	Effects on sensitive terrain will be addressed primarily through project design, including site-specific routing and engineering.	Not significant given suggested mitigation	Adjacent RoWs should be operated as one, not separate corridors. It is likely that construction activities along this corridor, especially in areas prone to mass wasting, will result in cumulative environmental effects on Terrain Integrity unless suitable mitigation measures are undertaken by all projects.
			Areas of special concern include steep mountainous terrain such as the headwaters of the Imperial Creek and Missinka River, the upper Kitimat River valley including active alluvial fans (Hunter Creek), and areas with marine and/or glaciomarine sediments. The latter generally occur below the 200 metres elevation near Kitimat.	Settlement	Other effects include consolidation settlement and karst (three areas identified within the Rocky Mountains). Normally consolidated silt, clay or peat may be subject to settlement where additional loading, such as fills, are placed. This is an infrequent hazard along the proposed pipeline route, based on present conditions, although it could potentially occur in a few areas in the future due to road construction, site development or other causes. Apparent dolines, down-dropped areas formed by karst processes (i.e., solution of limestone), have been identified at some locations through the Rocky Mountains. Sink holes (smaller down-dropped areas or areas where loss of ground has occurred) are also present. Ground subsidence has also induced the formation of multiple scarps and/or other slope movements that may have associated lateral movements in a few areas.			

*Refer to Figure 3.1 in section 3, Project description, for the full list of physical works and activities. **The effects of spills and malfunctions will be included in the update for the supplemental filing.

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VEC	Key Issues	KIR	Baseline Results	Measurable Parameter	Potential Project Effects**	Proposed Mitigation	Residual Effects	Cumulative Effects
				Acid rock drainage	<p>Eight areas were identified along the proposed route, including three within the Rocky Mountains, two within the Interior Plateau and three within the Coast Mountains.</p> <p>Exposure of the rock to water and oxygen results in oxidation of the sulphide minerals, which produces sulphuric acid as a by-product. The acid produced by this reaction may dissolve other minerals and cause the release of metals to the environment. ARD is a natural process that is enhanced by the excavation of sulphide-bearing rock.</p>	Effects on sensitive terrain will be addressed primarily through project design, including site-specific routing and engineering.	Currently being assessed.	Currently being assessed.