PROSPERITY
A Gold-Copper Project of Taseko Mines Limited

Taseko Prosperity Gold-Copper Project

Appendix 5-4-B

Taseko Mines Limited

Introduction

To do: Correctly reference Maps in appropriate sections (currently Figures 1 and 2)

This terrain assessment describes and maps important landform features within the three kilometre wide transmission corridor (1.5 km on each side of the centre line), as well as geological hazards and constraints potentially affecting transmission line construction and maintenance. The transmission line corridor begins near Dog Creek (45 km west of 100 Mile House) and extends approximately 125 km west to the proposed mine site near the Taseko River and Fish Lake. The transmission corridor covers an area of 380 km^2 (38 080 ha), within which the transmission line right-of –way will be established, following detailed alignment studies. This report was prepared based on published maps and written reports, as well as data from the 1997 field program and air photo assessment.

The terrain assessment covers the entire corridor, however only areas of potential hazards or constraints related to terrain have been presented on Figure 2.

Geological hazards are naturally occurring geologic and terrain features or geomorphological processes and unstable conditions that present a risk to life or property (Ryder and McLean 1980). Volcanic and seismic risks are included in this definition but are not discussed in this assessment. Hazardous processes are those that are commonly impossible or unfeasible to control or prevent. Terrain constraints to development may be imposed by certain land surface conditions that include steep slopes (especially those with gradients over 60%), poor drainage, and soft (poorly trafficable or low bearing strength) soils. Constraints can often be overcome by technological means, although the economics of such applied technology may at times be prohibitive and alternate routes may be more economic.

Approach and Methodology

Mapping

This terrain assessment and appended mapping is based on an interpretative process that used a combination of published mapping bases (e.g. soils and landforms, Forest Cover Maps, topography) combined with air photo interpretation and a limited field investigation program. The sources of resource information are described in the following section.

Information on soils was obtained from existing soils maps and reports that included landform and terrain information. The reports used include:

- Regional soil mapping produced at a scale of 1:100 000 for most of the study area (Taseko Lakes, Valentine et al, 1987, map sheets: 92O/SW, 92O/NW and 92O/NE) and a small portion at the east end of the corridor, at a scale of 1:125 000 (Valentine et al, 1980, map sheet 92P/W1/2).

- Preliminary soil and terrain manuscript maps published by the BC Ministry of Environment (6 map sheets, 1:50 000 scale).

Forest Cover Maps, produced at a scale of 1:20 000 by the Planning and Inventory Branch, BC Ministry of Forests, were used as an aid in the interpretation of significant land or terrain features as reflected by vegetation cover. The maps and appurtenant data bases were queried for features that reflect changes in drainage, hydrographic information (creeks and streams), and road locations, using GIS (ARCINFO) techniques.

The topographic information (shown on the appended Terrain maps) was derived from Terrain Resource Information Management (TRIM) mapping purchased from the Surveys and Mapping Branch, BC Ministry of Environment, Lands, and Parks. This mapping is at a scale of 1:20 000 with 10 metre contour intervals, and was combined with the Forest Cover Map bases for the purposes of presenting the appended transmission corridor resource mapping.

The resource information described above was supplemented with information gained from air photo interpretation, aerial reconnaissance surveys, and a limited program of field checking. Air photo interpretation included stereoscopic review of 1:15 000 scale, 1993 to 1995 colour photos. Air photo interpretation was used to confirm landform boundaries and soil drainage conditions, as well as to identify potentially unstable slopes, erosional activity, and terrain features that require on-site symbols (e.g. gullies and escarpments, refer to appended Terrain maps).

The terrain polygons that delineated areas along the corridor with potentially significant hazards or constraints were transferred to the mapping base (combined TRIM and Forest Cover), using digital techniques. Published map information was digitized directly to the map bases, while interpretative air photo data was transferred using fully controlled, digital stereoscopic techniques.

The classification methods and terminology used for the terrain mapping followed the standards of the Provincial Resource Inventory Committee published as the *Terrain Classification System for B.C.* (Howes and Kenk 1997). The framework for the terrain hazards analysis followed that of the *Guide to the Preparation of a Geological Hazards Map* prepared by Ryder and McLean (1980). Constraints to development, as described by Maynard (1979) in *Terrain Capability for Residential Settlements: Background Report*, are primarily related to poor drainage, soft (low bearing strength) soils and steep slopes.

Two Terrain maps are appended to this report:

- The Terrain Assessment map shows , and
- The Terrain Materials map shows,

A detailed terrain assessment and mapping program, including laboratory analysis, may be required to develop impact avoidance and mitigative measures for sensitive areas, as part of the detailed transmission alignment studies. The BC Ministry of Forests will require terrain stability assessments for sensitive sections of the alignment, in support of any timber harvesting, road construction, or road maintenance activities, following methodologies provided in Forest Practices Code guidebooks (*Mapping and Assessing Terrain Stability Guidebook*. Forest Practices Code of British Columbia 1995).

Recently constructed roads that were identified on the 1993-1995 air photos but are not located on the Forest Cover or TRIM maps have not been transferred to the appended mapping base for the transmission corridor resource assessment. The updating of road locations will be carried out as part of a future, more detailed, alignment and construction access planning process.

The older published soil maps have a terrain component and are summarised in Appendix A, Table A.1. The terrain classification system used for these maps follows the *Canadian System of Soil Classification* (Canada Soil Survey Committee, Subcommittee on Soil Classification 1978).

Field Investigations

Helicopter reconnaissance of the corridor, including a limited number of ground investigations, was undertaken during August 5 to 7, 1997. The field investigations included the description of terrain and soil characteristics at each site, and the assessment of site features that may potentially affect the type and magnitude of terrain related impacts due to transmission line construction and operation. A total of 26 sites were described at 13 locations (refer to Appendix ? for site descriptions and attached Terrain Assessment map for site locations). The level of detail for each site investigation varied, however the following information was generally recorded:

- topography (slope gradient and aspect),
- surficial materials (genetic materials based on observations on natural embankments, road cuts and shallow (<1 m deep) hand excavations,
- texture (hand textures and visual estimate of coarse fragment content/type)
- drainage (soil drainage conditions were described according to the system outlined in the *Describing Ecosystems in the Field* (Walmsley et al. 1987),

- soil classification (approximate subgroup classification follows the *Canadian System of Soil Classification* (Agriculture Canada1987), and
- unique features (e.g. existing erosion patterns, surface water ponding, seepage, bedrock outcrops, talus deposits, apparent instability, etc.).

Assessment of Potential Impacts

Potentially adverse impacts on terrain and soils associated with the construction and maintenance of the transmission line may result from four major activities:

- right-of-way clearing (landings, haul roads, spur roads, permanent logging trails),
- access road construction (including associated gravel pits and borrow areas),
- tower foundation construction, and
- maintenance of the line.

The construction and use of access roads and the potential impacts associated with altered drainage patterns and subsequent soil erosion and sedimentation are of particular concern. Potential impacts associated with this aspect of transmission line construction include the following:

- erosion of fine or uniform-textured soil materials in disturbed areas,
- dry ravel of coarse-textured materials on disturbed, steep slopes and along cutbanks,
- gullying, mass wasting, or other slope failures that tend to occur in fine-textured soils, primarily along steep cutbanks,
- gullying and washouts that are caused by the concentration of surface runoff on disturbed areas or along roads where natural drainage paths have been disrupted,
- accelerated erosion in floodplains caused by diversion or disruption of the normal routing of flood water,
- slope failures along access roads that result from clearing vegetation that once stabilised the slope, excessively steep cut-banks, or slumping along areas with lateral

seepage and poor drainage, and

- compaction of fine-textured soils due to heavy equipment operation particularly during construction, which results in deep rutting and puddling.

Access Roads

The degree of impact on terrain from construction of access roads depends on the geological hazards, limitations, and development constraints associated with terrain units where new road construction is required. The more existing access roads can be used for construction and maintenance of the transmission line, the fewer new terrain-related impacts will occur. Major portions of the route will not require significant new road construction because the existing forestry road network can be used for line construction, with only minor access road construction required to specific tower locations. In other areas, linear road access may exist within a section of the corridor, but the adjacent terrain may prohibit construction of access to the tower locations (e.g. in the vicinity of the Fraser River crossing). If access roads are necessary within sensitive areas where no access currently exists, the potential impacts on terrain, soils and water quality may be significant, necessitating detailed, site-specific engineering and resource assessment studies.

This terrain assessment assumes that in areas where existing access roads can be used, the effects on terrain from construction have already occurred and that additional effects would be minimal. If necessary, however, spur roads to the new tower locations may be constructed. For portions of the route that are a significant distance from existing access, it is assumed that a new access road would be required, or that remote construction techniques such as helicopter erection of towers and line would be carried out on sensitive terrain.

Potential Impact Ratings

Impact hazard ratings and type and constraint type are recorded on the appended Terrain

Assessment map.

Baseline Conditions

Background

This section provides background information on general physiographic conditions, regional landform and soil resources, based on existing reports and mapping.

General Physiography (from Holland 1976)

The transmission line for the proposed Prosperity Project extends across the Fraser Plateau section of the Interior Plateau which is a major component of the Interior Physiographic System. The geology (dominantly level or gently dipping lava flows) and physiographic history (e.g. extensive Pleistocene glaciation) is similar across the Interior Physiographic System, which extends from the Coast Mountains in the west to the Rocky Mountains in the east.

The extensive Interior Plateau is of low to moderate relief underlain by Tertiary age basaltic flows within the southern Interior Physiographic System. The southern Interior Plateau is drained by the Fraser River. Holland described the area as being the “remnants of the very widespread late Tertiary erosion surface which was uplifted and dissected”. Subsequently, extensive Miocene and early Pliocene basalt lava flows resulted in the development of plains of low relief throughout this area.

Stream erosion was rejuvenated following the uplift of the plains created in early Pliocene time. The general surface of the Fraser Plateau was raised to 1525 metres above sea level and resulted in deep incisions in the main valleys (e.g. Fraser River) and much less so at the valley heads which were created in pre-Pleistocene times. Very little dissection or incision of the uplands had occurred on the western Fraser Plateau by the end of the Tertiary period. During Pleistocene glaciation the upper surface of the ice sheet was in excess of 2450 metres. The main effect of this period was the deposition of drift over the plateau surfaces and resultant rolling, drumlinized till plain configuration, with the same general configuration of the underlying basalt flows. During the subsequent warmer period of ice wasting, approximately 10 000 years before present, meltwater channels were occupied by large streams, resulting in numerous fluvioglacial landforms. Many of these former channels are drainage ways occupied by much smaller modern streams. Many lakes and organic filled depressions were formed as a result of the ice movement and subsequent melting and development of enclosed depressions.

The Fraser Plateau is further subdivided into eastern and western sections based on differences in moraine texture (Valentine et al 1987). The western plateau is generally coarse-textured which was attributed to water-washing by glacial meltwater from the Coast Mountains. This east-west boundary occurs near Mons Lake, near km 90 on the transmission corridor centre line. The physiographic area referred to as the Cariboo Midlands at the eastern end of the transmission corridor on map sheet NTS 92P, is similar to the area known as Fraser Plateau East (Valentine et al 1980).

Landform and Soils Resources (from Valentine et al 1980; Valentine et al 1987)

As mentioned earlier, past glacial activity and deposition on the near level basalt and andesitic flows has had a distinct impact on the current landforms along the proposed transmission corridor. Glacial drift created the most common landforms, dominantly composed of low relative relief ground moraine and glaciofluvial deposits. Shallow organic deposits occur in numerous wet depressions and are especially common along the western portion of the corridor.

The geology of the area is dominated by basalt and andesite lava which has strongly influenced soil development. These rock types are rich in basic cations that weather to produce fine-grained or moderately fine-textured, fertile soils. Throughout the Fraser Plateau, subsoils are often alkaline exhibiting high pH. In depressions, the soils are often alkaline and occasionally saline, containing salts of sodium, magnesium, and calcium. At higher elevations with cooler and wetter climate, the soil profile is weathered to greater depths and the upper layers often have acidic to neutral pH values.

The regional soil survey information for the proposed corridor was obtained from the Taseko Lakes and Lac La Hache soil surveys (Valentine et al 1987; Valentine et al 1980). Relevant information is summarized in Appendix A, Table A.2. The following five soil associations or map units occur the most frequently and are the primary soil units comprising approximately 85% of the corridor.

- Kloakut (KL): occupies 23 % of corridor (29 km along centreline) - Fraser Plateau West
  Orthic Gray Luvisols developed in loamy skeletal moraine on gently to strongly sloping or hummocky terrain that is moderately well-drained and moderately pervious.

- Shemwell (SH): occupies 21 % of corridor (29 km along centreline) - Fraser Plateau West
  Similar to KL except the soil surface has been water-washed and is less compact, and the soils are well drained and rapidly pervious.

- Tyee (TE): occupies 20 % of corridor (24 km along centreline) - Fraser Plateau East
  Orthic Gray Luvisols developed in gravely loamy glacial moraine derived from the underlying basalt. The soils are well-drained, slowly pervious, and cooler because of their relatively high elevation. These soils support a forest cover (associations TE1 and TE2).

- Williams Lake (WL): occupies 16 % of corridor (22 km along centreline) - Fraser Plateau East
  Orthic Gray Luvisols developed in gravely loamy glacial moraine derived from the underlying basalt. The soils are well-drained, moderately pervious, and cooler because of their relatively high elevation (associations WL1 and WL2). These soils

support a forest cover, however WL2 soils extend to grasslands at lower elevations.

- Chimney (CY1): occupies 6 % of corridor (4 km along centreline) - Fraser Plateau East
  Orthic Dark Brown Chernozems developed in well-drained, moderately pervious loamy-skeletal morainal material on undulating plateau grasslands at lower elevations with relatively dry climate.

The remaining soils comprise less than 15% of the corridor but have special significance with respect to the construction of the transmission line. Organic soils (soil association Chaunigan Lake - CL) are particularly important to ranchers because they provide feed for grazing animals and winter feed for cattle if cut for hay. The organic soils present a significant constraint to access road construction because of their low strength and, depending on their thickness, tower construction. Other poorly to imperfectly drained soils (shallow organic capped or mineral soils) include New Meadow (NW) and Elliot (EL), respectively. These soils pose some degree of constraint to transmission line construction related to problems draining the soils or low soil strength.

Dog Creek (DC3) soils occur on the relatively unstable, eroded, and gullied slopes of various types of parent material and are located primarily along the east side and lower west side of the Fraser River. Soils occurring in the active flood plain of Big Creek and Bambrick Creek include Big Creek (BC) soils, Taseko (TK) soils, and Purjue (PJ) soils. The shallow morainal-colluvial soils associated with steeper terrain and rock outcrops are mapped as Tete Hill (TT) soils.

Hydrography

The transmission line crosses a major river course, the Fraser River, near kilometre 26 and a major stream, Big Creek, near kilometre 79. Approximately 77 smaller creeks and ponds are crossed or are within 100 metres of the proposed centreline, according to the Forest Cover and TRIM base mapping (refer to attached Terrain maps). The important hydrography features along the corridor are summarised as follows:

Segment 1 (km 0 to 27): Eastern substation to the west side of the Fraser River
14 crossings: Rosetti Creek, Brigham Lake, Brigham Creek tributary, Meason Creek, Fraser River and ten unnamed creeks;

Segment 2 (km 27 to 78): West of the Fraser River to Big Creek
35 crossings: Word Creek, Farwell Creek, Vedan Creek, Mons Creek, and 31 unnamed creeks and ponds;

Segment 3 (km 78 to 103): west of Big Creek to Kloakut Lake
13 crossings: Big Creek, Bambrick Creek, Willan Creek, and ten unnamed creeks;

Segment 4 (km 103 to 125): south of Kloakut Lake to Fish Lake
15 crossings: Tete Angela Creek and 14 unnamed creeks or ponds.

A description of each crossing is provided in the route assessment summary.

Results of Field Inspections

The terrain inspections along the route generally confirmed the existing soils and landform mapping (Table A.1). The following terrain features were observed along the corridor:

- coarse to moderately fine-textured, predominantly gravel or mixed-size coarse fragments, deep morainal materials (Sites TL97-02, 03, 05, 11, 13, 15, 23, 25, 26);
- shallow, cobbly-stony, morainal deposits over bedrock (Sites TL97-16, 17);
- morainal material overlying other surficial materials (Sites TL97-04, 20);
- active and inactive, recent fluvial deposits of variable texture and coarse fragment content (Sites TL97-1, 6,14, 19, 21);

- ridged, terraced or undulating coarse-textured, gravely, inactive fluvioglacial deposits (Sites TL97-10, 12, 18, 22, 24);
- shallow organic soils (Sites TL97-07, 08, 09).

Inspection sites that were located in areas of potential constraint or hazard are indicated in Table A.1 with labels that identify the type of constraint or hazard and are the same as those used on the Terrain Assessment map.

Important Terrain Features

The proposed alignment crosses terrain that generally has low relief with highly stable, well-drained soils developed on compact glacial till and some gravely fluvioglacial deposits. The slopes generally range from gently undulating (2 to 5%) to steeply sloping (usually less than 30%), with less than ? of the corridor comprising slopes in excess of 60%. The landscape will present few problems for standard construction and soil protection practices as indicated on the Terrain Assessment map. Approximately 80% of the corridor does not have hazards or constraints.

There are, however, a few locations that will require further assessment and potentially minor modification of the centreline routing. These areas are of significance with respect to potential impacts related to access construction and/or long-term maintenance of the proposed transmission line. The areas that require careful placement of access roads and towers or require special tower protection or construction methods are identified on the appended Terrain maps which show areas of potential terrain hazards (flooding, unstable terrain) or constraints to development (poor ground conditions, non-trafficable wet mineral soils, or organic soils with high water tables). The categories are described in the following subsections and summarised in Table 1.

A brief discussion of potential sources of aggregate material suitable for project construction is provided in a later section of this assessment. However, on-site assessments of these potential sources would be required to confirm the utility of the material. If the aggregate resources are located within the Agricultural Land Reserve (ALR), an application to the Agricultural Land Commission (ALC) would be required in addition to the required Mine Permit.

Hazards

The potentially hazardous terrain identified on the appended Terrain maps occupies less than 8 % of the corridor. The most common hazards within the corridor are areas of potential flooding near the major creek crossings and areas of active or potential slope instability (especially gullying). The Fraser River crossing is particularly sensitive due to the extent, relief and nature of the terrain. However, there is also potential for flooding from spring-melt runoff associated with the valleys and floodplains of Big Creek, Bambrick Creek, and Tete Angela Creek, as well as other smaller streams and tributaries. Although most creeks and their floodplains can be spanned by strategic tower placement, any towers located within active floodplains of the larger creeks may require flood protection. Construction should be scheduled so that work in these areas is restricted to periods of low water flows. There may be further restrictions placed on timing and location of work activities in these areas by resource agencies responsible for fish habitat protection.

Many of the creeks and tributaries also have development constraints associated with poor drainage (high water table) and the presence of thin to moderately thick organic soils. These potentially flood prone areas are identified in Table 1 and on the attached Terrain maps.

Actively unstable lands were identified on air photos and during the reconnaissance study of the transmission line in August, 1997. Unstable lands (gullied, eroding, rockslides, slumps, or slides) comprise approximately ? % of the corridor. The most extensive area of hazardous terrain occurs along the precipitous eroding embankments of the Fraser River between kilometre 24 and 29 (Table 2).

Unstable cut banks are created by the undercutting of surficial materials by major creeks, such as Big Creek (Photos 5 and 6) and Bambrick Creek, in confined bottom lands. Other failing slopes occur along incised, steeper gradient creeks, such as Word Creek south of kilometre 31 to 33.

As indicated on the Terrain Assessment maps and in Table 1, the proposed centreline avoids most hazardous terrain units. However, crossing of hazardous terrain is unavoidable in some sections of the corridor. Avoidance of potential impacts in these areas through strategic tower placement and construction techniques and mitigation of potential impacts where avoidance of sensitive terrain is not possible, are discussed in a later section of the terrain assessment.

Constraints

Terrain constraints to construction of roads and towers are indicated on the appended Terrain Assessment map and are associated with slightly less than 18 % of the terrain units within the transmission corridor. Lands that exhibit constraints to development may occur in hazardous or non-hazardous terrain. For instance, a rock slide may be recorded as a hazard in steeply sloping bedrock. The presence of bedrock is recorded as a constraint, while the occurrence of rockslides is recorded as a hazard, and in some terrain units they are coincident. On the Terrain Assessment map, the terrain symbol indicates the hazard and constraint; terrain units exhibiting development constraints are shaded in yellow. On-site symbols indicate a variety of terrain features (i.e., escarpments, small channels with streams, large channels, gullies, borrow areas) which are difficult to express as terrain units. These features may be of limited extent, linear and narrow (e.g., gullies), or may be associated with a single point on the land as a result of characteristics noted at individual inspection sites.

The presence of bedrock generally results in greater construction disturbance and cost due to additional blasting for access roads and tower foundations. Shallow soils over bedrock and bedrock outcrops occur within the corridor, particularly near Brigham Creek (km 5), on the upper west side of the Fraser River crossing (km 28), Bambrick Creek (km 88), and occasionally on hilly terrain. The total area of bedrock and shallow soils over bedrock within the corridor is approximately 3 %.

Steep slopes (> 30 % slope) can impede access and make construction expensive, particularly where they are coincident with bedrock outcroppings or unstable (actively eroding) terrain. Approximately 6 % of the corridor is mapped as steep. The locations of extremely steep escarpments are noted by an on-site symbol on the Terrain Assessment map.

Land with poor to very poor drainage adversely affects trafficability when not frozen to significant depths and may provide poor (weak) foundation conditions. These areas often have near surface ground water in the valley bottoms or, if located at the base of slopes, perched water tables and evidence of lateral seepage. These conditions are especially common along the south-western portion of the corridor (km 95 - 125). Poorly to very poorly drained land occurs on approximately 10 % of the corridor. The wetlands within the corridor generally have a relatively shallow layer (<1m thick) of organic soil at the surface.

The maximum amount of soil disturbance allowed during clearing and construction of the transmission line may be partially restricted under the Forest Practices Code (FPC) guidelines related to soil conservation (Soil Conservation Guidebook, 1995). A description of the potential for various types of soil disturbance is included in this guidebook and may be applicable to portions of the transmission line.

Gravel or Aggregate Borrow Areas

A number of active or abandoned borrow areas were observed during the August reconnaissance survey and on the aerial photographs. The borrow areas are indicated as an on-site symbol on the Terrain Assessment map. The high coarse fragment content of many of the surficial materials along this corridor suggests that there is good potential for finding coarse fill for construction of access roads, where required. Areas of fluvioglacial deposits (soil types CI, CT, HA, HS) or well-drained, coarse-textured, recent fluvial deposits (soil types BC and PU) are likely sources of gravel or aggregate-grade material. The locations of these soils are listed by distance along the corridor in Table A.2.

Development of borrow areas on lands within the ALR are within the jurisdiction of the ALC. As such, they would normally be subject to the Soil Conservation Act and the appropriate application process before soil and aggregate removal can occur.

Assessment of Potential Environmental Effects

The environmental assessment is presented according to three phases of project implementation: construction, operations and closure. The most significant potential impacts related to terrain and soils are associated with construction phase disturbances and soil handling activities.

Construction Phase Impact Avoidance and Mitigation

The potential effects on terrain and soils resulting from transmission line construction, including right-of-way clearing activities, construction of temporary and permanent access roads, and tower construction, can be extensive. Accelerated erosion, mostly by runoff water but also in areas prone to local dust generation, may result from loss of vegetative cover, ground disturbances and local redirection (concentration) of runoff or drainage water. Cut and fill operations, usually associated with road construction, may cause local instability through over-steepening of the affected slopes.

Roads

The primary strategy to avoid access road construction impacts is to use the existing road networks to the extent possible thereby minimising new road construction and construction of new creek crossings. The existing road network is shown on the appended Terrain maps, based on digital information from TRIM and Forest Cover Maps, as well as aerial photos. Recently completed or proposed roads are shown on new logging plans prepared by the licensee.

Planning and design of additional temporary and permanent access roads required for transmission line construction and maintenance will be carried out in detail in subsequent project phases, in accordance with appropriate FPC guidelines (currently provided in the Forest Road Engineering Guidebook, 1995).

General Ground Disturbances

The typical mitigation procedures in areas where new roads or excavations are to be developed includes limiting the extent of ground clearing and disturbance to the extent possible, drainage and sediment control, soil salvage and storage, timely revegetation and weed control.

Words re drainage sediment control, Land Development Guidelines for Protection of Aquatic Habitat (MOE/DFO, 1995?) rework below para

Surface water drainage will be established early during construction to prevent excess water from damaging project facilities (roads or towers). Drainage control structures will be sized to accept expected flows and will be protected to prevent excess scour. The diversion of drainage water will be minimised and, where necessary, the water will be diverted onto stable, vegetated areas that are capable of accepting additional flows.

The depth and sequence of soil salvage depends on the thickness of topsoil and the existing root zone and the quality of the soil materials. A soil handling plan for all areas to be disturbed, especially as a result of access road construction, will be developed for both ALR and non-ALR areas along the transmission line. It will be prepared as part of the environmental protection plan in conjunction with road construction planning. The salvaged material will be stored in designated areas along the right-of-way and access roads, where suitable topographic and drainage conditions exist. As construction is completed, some of the stockpiled material will be used to reclaim disturbed areas along the access roads and around the towers, and the remainder will be left for eventual reclamation of disturbed areas at closure and rehabilitation of the right-of-way.

The closure and rehabilitation of temporary construction roads not required for on-going transmission line maintenance will be a primary mitigating strategy to be implemented during the latter part of the construction phase. Soil rehabilitation practises, such as those noted in the FPC Soil Rehabilitation Guidebook (1997), will be followed.

The project disturbances are generally classed as either short-term (1 to 2 years), construction related disturbances, or long-term (e.g., 20 years or more) disturbances that will persist as long as the transmission line is operational. The soil materials that are stored for short-term use are usually windrowed along the length of the disturbance, protected by ditching and sediment control fencing, and seeded to prevent erosion and weed establishment. Materials stored for long-term use are placed in large stockpiles that are stabilised through grading, drainage/sediment controls, and seeding to prevent erosion and weed establishment. The details on soil handling, stockpile configuration, locations, seed mixtures, rates, and application techniques will be developed as part of the detailed Environmental Protection Plan prepared during subsequent phases of project planning.

A Noxious Weed Control Plan will be developed prior to transmission line construction as part of the detailed Environmental Protection Plan. Key elements of the plan will include:

- The primary method of weed control will be prevention of weed growth via rapid reseeding and cover establishment of preferred perennial vegetation on disturbed areas (a variety of seed mixes, including native species where appropriate, will be specified in the environmental protection plan for various soil/climate conditions and wildlife habitat or grazing needs encountered along the transmission line route);

- equipment cleaning stations will be established at appropriate locations along the route if equipment is to be transferred from areas where noxious weeds present potential sources of contamination for areas along the right-of-way that are weed free;
- a comprehensive weed monitoring program will be developed as part of the plan;
- If weed infestations are identified during the environmental monitoring process, the appropriate mechanical, chemical, or biological control method will be applied (in accordance with agency standards, policy and regulations).

Impact Avoidance and Scheduling of Work in Difficult Terrain

Where possible, potentially difficult or hazardous terrain will be avoided through the careful placement of towers and access roads. There are a few areas along the corridor that appear to have little potential for re-alignment of the centreline to avoid difficult terrain. These areas will require further site-specific terrain-related investigations (geotechnical and/or hydrological) as part of future project planning and design phases.

The judicious scheduling of construction activities may reduce the potential for negative effects particularly for extensive poorly drained areas and soft soils. Construction activities during winter can take advantage of frozen soils to build temporary access roads and ease the installation of towers in wetter areas. The scheduling of construction near stream and river crossings will be developed as part of the detailed Environmental Protection Plan to avoid potentially deleterious effects of sediment release.

Specific Alignment Mitigation Measures

The following discussion relates specifically to the current centreline alignment as shown on the appended Terrain maps. The discussion that follows presents recommendations for re-alignment of the centre line to avoid difficult terrain, areas that require more detailed investigations, and general mitigation procedures for specific wetland, stream, and water body crossings.

Route Re-alignment

In general, the alignment selected within the corridor avoids or minimises to the extent possible the crossing of difficult terrain as noted on the Terrain Assessment map. In some areas the alignment impinges on areas of difficult terrain but through careful tower placement and avoiding access construction in these areas, adverse impacts can be prevented.

The sensitive terrain areas along the right-of-way where re-alignment or careful tower placement and access road construction measures should be considered are listed and discussed in Table 2.

<u>Terrain Hazards and Constraints Investigations</u>

Hazardous terrain conditions related to potential flooding and slope instability occur in a few areas along the centreline. In addition, poor drainage and high water tables may also affect soil strength and foundation conditions in isolated areas. The locations of the areas displaying terrain hazards or constraints along the alignment are noted in Table 1. The comments provided in Table 1 relate to each crossing of difficult or limiting terrain.

As required by the MoF, additional terrain studies related to site specific hazards or problem soil conditions identified along the selected alignment will be carried out as part of the detailed route planning.. It should be noted that the mapping convention highlights hazards and constraints for entire polygons even if less than 50% of the area has potentially difficult terrain. Air photos should be reviewed to help select inspection sites from within these polygons.

Detailed studies by geotechnical engineers and geologists that include deep inspection pits or drilling and sampling may be required to assess areas of potential instability of unconsolidated and consolidated materials. This is especially true in the vicinity of the Fraser River Crossing, and to a lesser extent, near Big Creek, Bambrick Creek, and Tete Angela Creek. It may not be possible to build access roads along the first three kilometres of the western side of the Fraser River Crossing because of significant slope constraints (slopes gradients in excess of 60% are common). The use of helicopters for construction and placement of towers in this area may be required. Other areas where slopes may be in excess of 60% grade are indicated on Figure 1 (terrain map) and listed in the Table A.2 (slope class H or h, grade > 60%, or associated with slope class G or g, grade range 30 – 60%).

A hydrologic assessment of the major river and creek crossings is required to enable the selection of tower sites and design of adequate flood protection for the towers if they are to be placed in these areas. The construction of temporary and permanent access roads in the floodplain areas will be planned carefully and monitored tightly as part of the Environmental Protection Plan. The transmission line will generally span most of the narrow creek crossings and roads for construction access will be carefully planned to protect the embankments of the stream crossing. The significant water crossings include:

- Fraser River,
- Big Creek,
- Bambrick Creek, and
- Tete Angela Creek.

Foundation stability in wet terrain will be the subject of further geotechnical investigations. The general strategy will be to avoid wet areas because of poor foundation conditions caused by excess water may. However, this may be unavoidable in places. Water seepage onto lower slopes or wetlands (high ground water) are commonly in the km 97 to km 125 segment of the line. There may be a need for an assessment of the need for cathodic protection of towers placed in saline or alkaline ringed depressions that are common near km 55.

Wetland, Stream and Water Crossings

Wetlands

It is important for the survival of wetland vegetation that normal water levels and drainage patterns be maintained following construction activities. After construction is complete, access road fill should be removed or, if the road is required for long-term access, opening of the road berm in sufficient frequency to allow for near normal water flow. The detailed plans to mitigate disturbances and protect wetlands will be included in the Environmental Protection Plan prepared for the final alignment.

Stream or Water Crossings

The protocols for construction near streams have been developed jointly by federal and provincial agencies and incorporated into a document entitled *Land Development Guidelines for The Protection of Aquatic Habitat* (Chilibeck, 1992). The strategies for specific stream crossings will be developed within the Environmental Protection Plan jointly by aquatic/fisheries resource personnel and geotechnical personnel.

The general guide will be to use existing stream crossings where possible. Development of new crossings will adhere to federal and provincial stream crossing guidelines. As discussed previously, construction in these areas may be subject to timing (scheduling) constraints that relate to temporal use of the stream by certain aquatic species.

Residual Environmental Effects Assessment

The residual effects of construction may be reduced by minimising the number of permanent access structures (especially new roads) related to both clearing and tower construction and with appropriate planning, and implementation of procedures reduce the impact of the unavoidable effects the new access roads.

Landscape modification, through cut and fill operations, results in the local over-steepening of road side slopes. Redirection of surface runoff water in road drainage ditches is a residual effect of road construction. Care will be taken to ensure drainage disruption is minimised and, where this is not possible, appropriate practises, such as the installation of check dams to reduce flow velocities and outlet protection at discharge points, will be implemented.

Monitoring and Management

A soil erosion control plan will be developed as part of the Environmental Protection Plan to meet the *Land Development Guidelines* and implemented along the alignment. Periodic inspection will be made to ensure that recommendations are being followed and mitigative procedures are adequate.

Monitoring of the construction of new access roads within the ALR is generally required by the ALC. It ensures compliance with the soil handling plan, a usual requirement of the ALC as part of its conditional approval. The approval may extend beyond soil salvage and stockpiling, to include erosion and weed control and the requirement for the construction of temporary or permanent fencing and cattle guards (see Agricultural Impacts).

Weed establishment and control is addressed under Agricultural Monitoring, but maybe monitored by the projects' environmental monitor(s).

Operations Phase

Potential Environmental Effects Assessment

With adequate drainage planning and erosion protection being implemented early on in the construction phase of this development there is likely to be a relatively low degree of negative effects on the terrain and soils along the alignment where good maintenance practises to control soil erosion, and drainage are followed.

Mitigation and Benefit Enhancement

Following good maintenance practises related to erosion control procedures (revegetation and structure maintenance), road drainage system maintenance (culvert cleanout and ditch protection) and standard spill protection and clean-up protocols will mitigate most operation phase impacts.

Residual Environmental Effects Assessment

None

Monitoring and Management

Ongoing monitoring is required to ensure adequacy of erosion control practices (usually vegetative cover), and road and tower stability (especially related to local drainage). Most monitoring can be undertaken by trained maintenance inspectors during routine site visits. Prior to winter and during spring snowmelt, careful examination should be made in areas of active, often ephemeral fluvial processes (near creeks and in floodplains) or of steep or unstable terrain. The inspection and clean-out, if necessary, of culverts and ditches in anticipation of runoff flows is essential to their proper functioning.

Closure Phase

The closure phase is for the decommissioning of the transmission line, removal of towers and closure / reclamation of associated, single purpose maintenance access roads.

Potential Environmental Effects Assessment

Temporary ground disturbance and the potential for accelerated erosion and sediment release is the likely effect of the implementation of the closure phase. This is associated with removal of tower platforms, substations, road reclamation, and the related site regrading. Extensive regrading of the road cut/fill areas is common in areas of sloping or irregular topography.

Mitigation and Benefit Enhancement

Land reclamation associated with the closure of the transmission line disturbances will generally follow the procedures indicated in the FPC Soil Rehabilitation Guidebook (1997). A typical prescription for reclamation involves:

- regrading of land to approximate its original contours allowing for the re-establishment of pre-development drainage patterns.
- the replacement of topsoil from long term stockpiles in sections of the alignment where topsoil handling / stockpiling was deemed necessary, and
- the deep ripping of soil, where required to alleviate soil compaction following regrading and topsoil replacement.

The reclaimed surfaces are then revegetated to vegetative species initially selected for erosion control but also as required for the long term use of the area (ie. appropriate for the common major land uses such as grazing – dryland rangeland or wetland meadows, and forestry). Specific planting patterns and specifies at or near stream crossings to meet *Land Development Guidelines* will also be developed.

Erosion control practises to reduce the potential for soil particle detachment (mulches) and to reduce the erosivity of concentrated water flows (slope cross berms and check dams and settling basins) will be implemented

Residual Environmental Effects Assessment

None

Monitoring and Management

Post reclamation monitoring of reclamation success (revegetation establishment and soil protection and stability) along the reclaimed alignment will follow site closure. Monitoring results will be reviewed and appropriate mitigative measures will be undertaken to ensure compliance with accepted reclamation standards for the alignment.

7.4 Summary of Key Conclusions

REFERENCES

Agriculture Canada, Expert Committee on Soil Survey. 1987. The Canadian system of soil classification. 2nd ed. Agric. Can. Publ. 1646. 164 pp

BC Agriculture Capability Manuscript Maps (1:50000 scale). 92P/14 – Lac La Hache, 92O/09 – Dog Creek, 92O/10 – Mount Alex, 92O/11 – Bambrick Creek, 92O/12 – Elkin Creek, and 92O/05 – Mount Tatlow

B.C. Ministry of Forests. 1995. Forest Road Engineering Guidebook. Forest Practices Code of British Columbia Co-published by B.C. Environment

B.C. Ministry of Forests. 1995. Mapping and Assessing Terrain Stability Guidebook. Forest Practices Code of British Columbia Co-published by B.C. Environment

B.C. Ministry of Forests. 1995. Soil Conservation Guidebook. Forest Practices Code of British Columbia Co-published by B.C. Environment

B.C. Ministry of Forests. 1997. Soil Rehabilitation Guidebook. Forest Practices Code of British Columbia Co-published by B.C. Environment

Canada Land Inventory. 1975. Soil Capability for Agriculture Maps. Taseko Lakes 92O/SW, Hanceville Lakes 92O/NW, Chilcotin River 92O/NE, and Lac La Hache 92P/NW.

Canada Soil Survey Committee, Subcommittee on Soil Classification. 1978. Canadian system of soil classification. Can. Dept. Agric. Publ. 1646. Supply and Services Canada, Ottawa, Ont. 164 pp.

Chilibeck, B. 1992. Land development guidelines for the protection of aquatic habitat. Ministry of Environment, Lands and Parks, Integrated Management Branch. Issued by

BC

Howes, D.E. and E. Kenk. 1997. Terrain classification system for BC (Version 2): A system for the classification of surficial materials, landforms and geological processes of British Columbia. MOE Manual 10 update by the Resource Inventory Branch, MoELP, Victoria

Preliminary Soil and Landform Maps (1:50000 scale). 92P/14 – Lac La Hache, 92O/09 – Dog Creek, 92O/10 – Mount Alex, 92O/11 – Bambrick Creek, 92O/12 – Elkin Creek, and 92O/05 – Mount Tatlow

Ryder, J.M. and B. McLean. 1980. Guide to the preparation of geological hazards maps. Ministry of Environment, Resource Analysis Branch (RAB). Working Report. Victoria, BC. 18 pp.

Valentine, K.G.W., W. Watt and A.L. Bedwany. 1987. Soils of the Taseko Lakes area, British Columbia. Agriculture Canada Research Branch, Report No. 36 of the B.C. Soil Survey, Land Resource Research Institute Contribution No. 85-35. 131 pp.

Valentine, K.G.W., and A. Schori. 1980. Soils of the Lac La Hache - Clinton Area, British Columbia. Agriculture Canada Research Branch, Report No. 25 of the B.C. Soil Survey Land Resource Research Institute Contribution No. LLRI 63. 118 pp.

Walmsley, M., G. Utzig, T. Vold, D. Moon, and J. van Barneveld. Describing ecosystems in the field. RAB Technical Paper # 2, Land Management Report No. 7. Ministry of Forests and Ministry of Environment. Victoria, BC. 224 pp