2.0 METHODS AND PROCEDURES

This section briefly describes the methodology, methods and procedures used for the Construction Power Transmission and Generation Outlet Transmission alternative route evaluations and the Project effects assessment, which were generally the same as those used for the Keeyask Generation Project environmental impact statement except where noted. Details regarding methodology, methods and procedures can be found in Sections 1 to 3 of the Keeyask Generation Project Environmental Impact Statement Terrestrial Supporting Volume (Keeyask HydroPower Partnership 2012b).

2.1 STUDY AREA DEFINITION

Local and **regional study area**s were used for the alternative route evaluations and preferred route effects assessments. The **local study area** captured potential Project effects on individual organisms or individual ecosystem elements while the Regional Study Area provided the comparison area for evaluating the potential significance of effects on individual organisms or individual ecosystem elements. Local and regional study areas are typically selected for each VEC since their spatial and temporal requirements differ.

An important consideration when delineating a regional study area is that it be large enough to capture the populations and the regional ecosystem attributes of interest but not so large that it is virtually impossible for most projects to have significant effects. Another important consideration is that the regional study area size and boundaries are ecologically relevant for the topics being examined.

The regional study area used for the Keeyask Generation Project environmental assessment was delineated using the above methodology. Because the Project is located near the center of the regional study area most commonly used for the Keeyask Generation Project assessment, and for compatibility with the other recently completed environmental impact assessments, the Project Regional Study Area was the same one that was used for most VECs in the Keeyask Generation Project Environmental Impact Statement (Section 1 of Keeyask HydroPower Partnership 2012b).

The 1,420,000 hectare Regional Study Area (Map 2-1) was an area surrounding the Project that was large enough to capture a region level ecosystem. A region level ecosystem is a relatively homogenous area in terms of its ecological context (e.g., climate, surface materials) that is large enough to capture the populations of most of the resident wildlife species and the key ecological processes operating at the regional ecosystem level (such as the **fire regime**). In practical terms, the Regional Study Area size was determined such that it was large enough to maintain a relatively stable habitat composition in response to the natural fire regime. In other words, one large fire was unlikely to substantially change the proportion of any **habitat type**, thereby providing alternative habitat for species to move to when large fires occur. All of the topics examined in this report used the same Regional Study Area. The Keeyask Generation Project Environmental Impact Statement further explains how the Regional Study Area was delineated (Sections 1 and 2 of Keeyask HydroPower Partnership 2012b).

The approach to delineating local study areas differed for the alternative route evaluations and preferred route effects assessments. Since multiple routes were evaluated for the alternative route evaluation, an overall Alternative Routes Local Study Area was identified using fragmentation because it was the VEC expected to have the largest Project zone of influence (see Section 2.3.1.1 for details). On this basis, the Alternative Routes Local Study Area was delineated as a 1,150 m buffer of the proposed alternative routes. Map 2-1 shows the 29,310 hectare Alternative Routes Local Study Area.

As described in Section 2.4, alternative route evaluation corridors were used for the detailed comparison of the Construction Power and Generation Outlet alternative routes.

For the Project effects assessment, a Local Study Area was identified independently for each VEC based on the potential Project zone of influence on that VEC using the approach described in Section 2.5.1.3.

A Project Study Area was also defined for the Project (Map 2-1) that generally captured the local study areas used by the various disciplines when completing their alternative route evaluations and Project effects assessments.

2.2 DATA COLLECTION AND ANALYSIS

2.2.1 Overview of Information Sources and Data

The information used for the alternative route evaluations and Project effects assessment was largely obtained from data and other information developed for the Keeyask Generation Project effects assessment (Sections 1 to 3 of Keeyask HydroPower Partnership 2012b). As noted above, the Project Regional Study Areas was the same as the most commonly used regional study area in the Keeyask Generation Project effects assessment. Additionally, most of the alternative Generation Outlet Transmission line ROWs and over half of the Construction Power Transmission route ROWs overlap the areas that were intensively studied for the Keeyask Generation Project effects assessment. Some additional field data were collected within the proposed alternative route evaluation corridors to supplement the data already collected for the Keeyask Generation Project assessment. Habitat and terrain mapping was completed for the portion of the overall Alternative Routes Local Study Area that was outside of the Keeyask Generation Project detailed mapping area.

A description of the information used for terrestrial habitat, ecosystem and plant alternative route evaluations and Project effects assessment is provided below. Further details are provided in Sections 1 to 3 of the Keeyask Generation Project environmental impact statement terrestrial supporting volume (Sections 1 to 3 of Keeyask HydroPower Partnership 2012b).

2.2.2 Terrestrial Habitat

Habitat is the place where an organism or a population lives. Because all natural areas are habitat for something, this report uses "habitat" to refer to terrestrial habitat for all species. Habitat for a particular species is identified with a species prefix (e.g., moose habitat, jack pine habitat).

Documenting the condition of and trends in terrestrial habitat and understanding the relationships between habitat components and the drivers for habitat change are the foundation for understanding and predicting potential Project effects on terrestrial ecosystems. As examples, plants and animals use habitat for survival and reproduction while most terrestrial environment effects predictions use qualitative and/or quantitative **model**s that require habitat maps as an input.

Reliable predictions of potential Project effects on habitat and ecosystems depend upon a detailed terrestrial habitat map for the existing environment and on an adequate understanding of local relationships between each of the major habitat components (e.g., vegetation, soils, permafrost, groundwater) and the factors that could have a substantial influence on ecosystem composition, structure and dynamics (e.g., water regime). Additionally, as described below, habitat types and habitat mapping are often used as proxies for ecosystem types and ecosystem mapping.

A stand level, 1:15,000 scale habitat and terrain map was completed for the central 221,500 ha of the Regional Study Area. Map 2-2 shows the detailed habitat mapping area, including the areas for which additional 1:15,000 stand level mapping was completed to provide coverage for the overall Alternative Routes Local Study Area.

Generation Outlet Alternative Route D was added late in the evaluation process. Consequently, ecosite mapping was completed for the entire Alternative D evaluation corridor while vegetation mapping was only available for approximately half of the route length. Vegetation information for the portion of the route lacking habitat mapping was obtained from helicopter-based oblique aerial photography taken on August 22, 2012. Older Forest Resource Inventory (FRI) data derived from 1991 stereo photography was also available for 7 of the 17 km lacking habitat mapping.

The habitat mapping methods are described in detail in Section 2 of Keeyask HydroPower Partnership (2012b). in summary, a hierarchical ecological habitat, ecosystem and land classification was developed for the alternative route evaluations and the Project effects assessment to reflect local conditions in the Regional Study Area and to provide a framework for characterizing terrestrial ecosystems and their components at multiple ecosystem levels (Section 2 of Keeyask HydroPower Partnership 2012b). From largest to smallest, the ecosystem levels relevant for the terrestrial habitat and ecosystems assessment were region, subregion, landscape, landscape element, stand and site. The region ecosystem level corresponds with the Regional Study Area in this report.

A nested habitat classification was applied to each of the ecosystem levels. From most general to most detailed, the nested levels in the habitat classification were **land cover**, **coarse habitat**, **broad habitat** and **fine habitat**. The categories within each classification level were combinations of vegetation type and **ecosite type** (Table 2-1). **Wetland** habitat classes were obtained from the Canadian Wetland Classification System (National Wetlands Working Group 1997), with enhancements to reflect dramatic differences in marsh water regimes along the Nelson River and between the Nelson River and off-system waterbodies. The attributes used to classify and map terrestrial habitat attributes were vegetation type, vegetation age class (where this could be determined), ecosite type, topographic position and either recent disturbance type (*e.g.*, large fires, ice scouring) or water depth duration zone. Ecosite type is a classification of soil, surficial material, surface water, groundwater and permafrost conditions that are associated with substantial differences in vegetation composition and/or structure.

Regionally relevant vegetation and ecosite types were developed through multivariate analysis of field data from the Regional Study Area (see Section 2 of Keeyask HydroPower Partnership 2012b for a description of methods). Table 2-2 provides the number of classes within each habitat classification level, an example of a habitat type and an example of how the classification level was used in this report. Appendix A provides a list of the land cover, coarse habitat and broad habitat types developed for the Regional Study Area. Each of the coarse ecosite and habitat types are described in Section 2 of Keeyask Generation Project environmental impact statement terrestrial supporting volume (Keeyask HydroPower Partnership 2012b).

The characteristics of each habitat type, as well as relationships between habitat components (*e.g.,* soils and vegetation) and drivers such as wildfire or permafrost melting, were derived from vegetation, soil and environmental data collected at over 500 habitat plots, along over 540 km of habitat transects and at over 4,000 soil profile sample points. Map 2-3 shows the locations of the 98 habitat plots sampled in the preliminary alternative route evaluation corridors during the summer of 2009.

Table 2-1: Coarse and Broad Ecosite Classes and Criteria

Broad Ecosite	Coarse Ecosite	Coarse Ecosite Code	Criteria*
Mineral land types			
Mineral Soil	Mineral Soil	1	Surface organic layer < 20 cm thick.
Thin peatland land types			
Thin Peatland	Thin Peatland	15	Surface organic layer >= 20cm and < 100 cm. Occurs on ridges and crests or sloped topography.
Peatland land types			
Shallow Peatland	Shallow Peatland	20	Surface organic layer > 20 cm and ≤ 200 cm thick.
Ground Ice Peatland	Ground Ice Peatland	30	Surface organic layer ≥ 20 cm; excess ice continuous. Level surface.
Wet Peatland	Other Permafrost Peatland	40	Surface organic layer ≥ 20 cm; evidence of excess ice actively forming or melting (e.g., collapse scar peatlands). Hummocky surface due to patchy excess ice.
	Deep Peatland	50	Surface organic layer > 200 cm; surface level and featureless. Excess ice usually absent and not confined by bedrock or mineral terrain.
	Wet Deep Peatland	60	Surface organic layer > 200 cm; surface level and featureless. Evidence of very high water table. Excess ice usually absent and not confined by bedrock or mineral terrain.
Shore zone peatland land types			
Riparian Peatland	Riparian Peatland	66	Surface organic layer ≥ 20 cm, floating. Open water present.
Shore zone- regulated land types			
Ice Scoured Upland	Ice Scoured Upland	70	Along Nelson River banks, disturbed by ice movement. Usually a terrace or steeply sloped mineral/ bedrock area.
Upper beach-regulated	Shoreline Wetland-regulated	75	Wet meadow, sloped transition between open water and upland. Herbaceous and/or tall shrub vegetation.
Sunken peat-regulated			
Lower beach-regulated			
Shore zone marsh land types			
Upper beach	Shoreline Wetland	75	Wet meadow, sloped transition between open water and upland or along fringes of floating peat. Emergent, Herbaceous and/or tall shrub vegetation.
Lower beach			
Littoral			

* Criteria refer to dominant conditions throughout the polygon.

Source: Section 2 of Keeyask HydroPower Partnership (2012b).

Table 2-2: Hierarchical Habitat Classification and Examples of its Uses in this Report

Classification Level (number of classes)	Example of a Habitat Type	Examples of Uses in Environmental Assessment	
		Habitat and Ecosystems	Plants and Animals
Land Cover Type (11)	Needleleaf treed on peatlands	Very general description of the study areas	Very general description of habitat use by a species
Coarse Habitat Type (23)	Black spruce treed on **shallow peatland**	Overview description of the study areas	Characterize the habitat preferences for a **generalist** species. Develop mixture types to relate to mammal 500m field transects.
Broad Habitat Type (65)	Black spruce mixture on ground ice peatland	Identify the regionally rare and **uncommon habitat type**s	Characterize the general habitat preferences for a species
Fine Habitat Type (114)	Black spruce mixture/ Tall shrub on ground ice peatland	Distinguish the nature and degree of effects for different Project linkages (*e.g.*, groundwater versus vegetation clearing)	Identify patches satisfying specialized needs for some wildlife species (*e.g.*, feeding habitat)

Source: Section 2 of Keeyask HydroPower Partnership (2012b)

2.2.3 Terrestrial Ecosystems

The terrestrial ecosystems component of this report addresses terrestrial ecosystem components except for wildlife and plants, focusing on VECs and other key topics relevant for a transmission line assessment. The methods used for terrestrial ecosystems are described in Section 2.3.

2.2.4 Plants

Including fieldwork conducted for the Keeyask Generation Project Environmental Impact Statement (Section 3 of Keeyask HydroPower Partnership 2012b), plant data was collected at over 500 habitat plots, along over 540 km of habitat transects and along over 507 km of rare and invasive plant transects during the summers of 2003 to 2011 and on August 22, 2012. Map 2-4 shows the locations of the 17 priority and invasive plant transects sampled in the alternative route evaluation corridors during the summers of 2009 and 2012.

Extensive rare plant surveys in the Regional Study Area did not detect rare plant species in certain habitat types (Section 3 of Keeyask HydroPower Partnership 2012b). On this basis, these habitat types were not surveyed further for the Project. The length of transect surveyed in each corridor was roughly proportional to the amount of habitat with relatively high potential to support rare plants rather than to total evaluation corridor area.

2.3 VALUED ENVIRONMENTAL COMPONENT SELECTION

Valued Environmental Components (VEC) are components of the biological or socio-economic environment that may be affected by the Project. VECs are species and/or environmental components that are used to highlight or focus an environmental assessment. VECs are defined as elements of the environment having scientific, social, cultural, economic, historical, archaeological or aesthetic importance and are proposed and identified and described under each environmental component. VECs are typically selected on the basis of their importance or relevance to stakeholders (e.g., species such as moose that are hunted) and/or as indicators of environmental effects to a broader range of animals. VECs are typically determined with the input from regulators and stakeholders, Aboriginal people and discipline experts, as well as literature reviews and experience with other projects. Environmental indicators and measurable parameters or variables are identified and described for each VEC. The same indicators and parameters/variables are used to describe environmental effects and residual environmental effects, and to monitor changes or trends over time during the Project construction and operation/maintenance phases.

The Keeyask Transmission Project selected VECs that were identified as being important or valued by members of the study team (e.g., species that are protected) and/or by the public and by other elements of the SSEA process. The identified VECs facilitated assessment of the interactions between the Project components and specific valued components of the environment.

2.3.1 Terrestrial Habitat Ecosystem and Plants

A stepwise screening process that focused on Project-related ecosystem health issues that were of relatively high ecological and/or social concern was used to select the key topics (Figure 2-1), from which the valued environmental components (VECs) were selected. In short, the key terrestrial environment issues of concern related to the Project were identified using the land use sustainability framework developed by the Canadian Council of Forest Ministers (CCFM), industry and others (CCFM 1995) as a component of an international process that culminated in the Santiago Declaration (Anonymous 1995). In brief, the overall goal of the CCFM framework is to maintain long-term ecosystem health for present and future generations while conducting human activities and development. Ecosystem health is maintained when biodiversity, ecosystem condition and productivity, soil and water quantity and quality and contributions to global ecological cycles are all maintained within their ranges of natural variability (after CCFM 1995). The CCFM framework is applicable to regional ecosystems that have not already been dramatically altered by human activities. This framework is consistent with many environmental assessment regulations, policies and guidelines (*e.g.*, Canadian Environmental Assessment Agency 1996; *Federal Sustainable Development Act*) because it is a scientific approach developed by governments in partnership with stakeholder groups following extensive international, national and local consultation.

There were many potential pathways for Project impacts to lead to effects on terrestrial ecosystem health. The first step in the screening process was identifying generic issues of particular concern that could have Project linkages. These linkages were identified using a number of tools such as conceptual diagrams, pathway diagrams and network linkage diagrams. Key Project specific issues of concern were identified from the generic list of concerns. VECs and other supporting topics were selected from this list using the following criteria:

- Key for ecosystem function;
- Umbrella indicator;
- Indicator species;
- Overall importance/value to people;
- Regulatory requirements;
- Potential for substantial Project effects; and,
- Amenable to scientific study in terms of the analysis of existing and post-construction conditions.

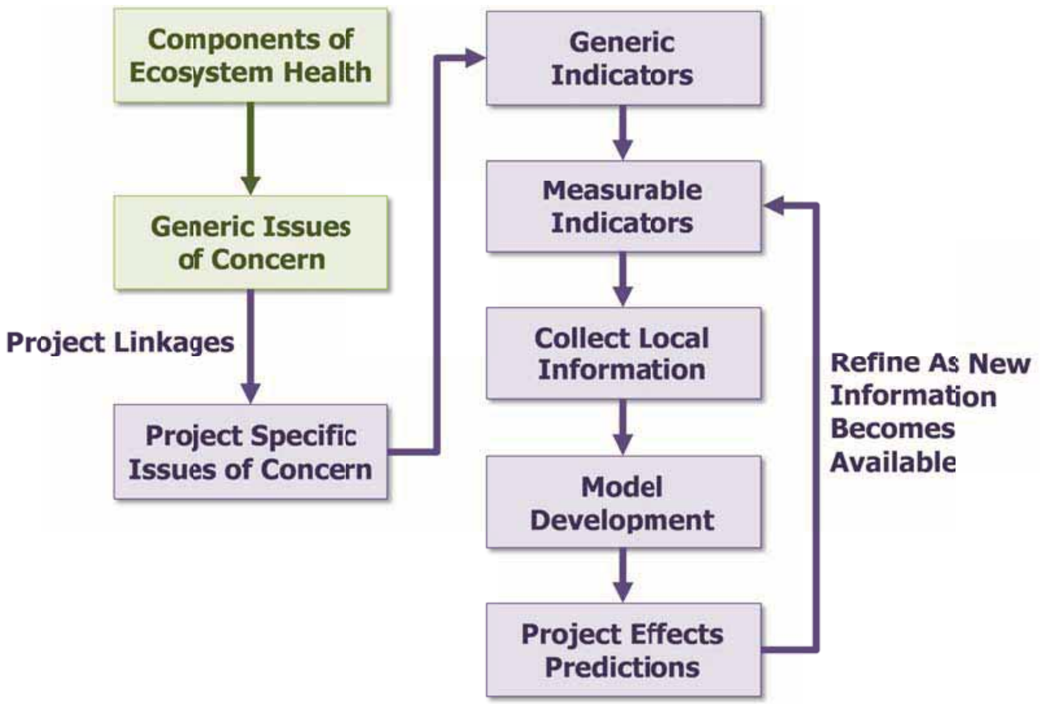


Figure 2-1: Steps to select Valued Environmental Components and Supporting Topics

Generic indicators and then measurable parameters were then identified to represent each VEC and supporting topics. These measurable parameters guided the data collection that was used to characterize the Project area and to improve understanding of local cause-effect relationships to the degree needed to predict Project effects with a reasonable level of uncertainty.

Based on the anticipated potential direct and indirect Project effects, the stepwise screening process described above led to the selection of **fragmentation**, **ecosystem diversity** and **priority plants** as the VECs for the alternative route evaluations and the Project effects assessment. Other important topics considered when evaluating and assessing potential Project effects on terrestrial ecosystems (*i.e.*, the supporting topics) were fire **regime** and **invasive plant**s. An explanation of what the VECs represent and why they were selected is provided in the following sections.

2.3.1.1 Fragmentation

Fragmentation is the degree to which an ecosystem has been altered by human development and activities that remove habitat and increase fragmentation (McGarigal and Cushman 2002). Fragmentation is a landscape-level process in which human features progressively subdivide habitat blocks into smaller and more isolated fragments.

Fragmentation affects ecosystem processes as well as species (Saunders *et al.* 1991; Soulé *et al.* 2004; McGarigal and Cushman 2002; Lindenmayer and Fischer 2006; Fischer and Lindenmayer 2007). Among other things, fragmentation reduces the size of interior areas, isolates habitat and creates edges. In the context of fragmentation, edges are the peripheral areas of intact habitat blocks where the adjacent human features create conditions (e.g., noise) that cause some animals to either partially or completely avoid areas that would otherwise be habitat for them (i.e., reduced habitat effectiveness). A **core area** is the interior area of an undisturbed habitat patch that remains after removing the edge area (e.g., the area of reduced habitat effectiveness for animals). Some wildlife species are sensitive to human disturbance and require large core areas (e.g., caribou) while other species can move between smaller habitat patches.

Human linear features such as roads, railway lines, transmission lines, cutlines and trails can have additional ecological effects compared with patch-like human features. For example, linear features can function as corridors for animal movement and plant dispersal while road traffic can cause wildlife injuries and mortality. FLCN noted that trappers are concerned about hunters that will use the transmission corridor to access areas (Keeyask Transmission Project Workshop 2012a).

A transmission line and its ROW could increase fragmentation by adding linear features, reducing the total amount of core area and subdividing core areas. Newly constructed transmission lines and associated access trails and roads add to linear feature density.

The fragmentation VEC provides an overall evaluation of fragmentation for species and ecosystems. Effects on wildlife species that are highly sensitive to fragmentation are not addressed by this VEC. It was recognized that intactness rather than fragmentation is what is valued as an environmental component. Because the word fragmentation is more widely recognized than intactness, this was used as the name for the VEC.

Road density (*i.e.*, km of roads per km^2 of study area) is often used as a single, synthetic indicator of fragmentation effects on plant and animal populations (Forman 1995). Among other things, higher road density improves access, which can lead to increased resource harvesting, collision mortality, habitat disturbance and fire frequency. Trails, cutlines and other linear features can also contribute to fragmentation but to a lesser degree (Mattson 1993 cited in AXYS 2001). Although some authors have recommended that each type of human linear feature be included and assigned a weight that reflects a qualitative degree of effects (Mattson 1993 cited in AXYS 2001), a literature review revealed no examples of a weighted linear feature density being applied in an environmental assessment or for management purposes. However, some authors implicitly weight the effects of different types of linear features when delineating core areas by using buffer widths that vary with the linear feature type (Mace *et al.* 1996; Anderson *et al.* 2002; Salmo Consulting Inc. *et al.* 2003; Strittholt *et al.* 2006).

Recent approaches to evaluating intactness have used linear feature density and core area abundance as indicators for intactness (*e.g.*, Salmo Consulting Inc. *et al.* 2003). Core area abundance is used as a complementary indicator because linear feature density ignores the spatial distribution of linear features. For example, are most of the linear features concentrated in a single corridor or are they dispersed throughout a study area? These two situations have very different implications for intactness and regional ecosystem health as demonstrated by the single large or several small (SLOSS) debate.

Linear feature density and core area percentage were the indicators used to evaluate fragmentation. Consideration of the spatial locations and size distribution of linear features and core areas (*i.e.*, the number of large core areas and the sizes of the large core areas) were also a component of the fragmentation evaluation.

Linear feature density was measured as the number of kilometres of linear features per square kilometre of land area in the Regional Study Area. All highways, roads outside of settlements, winter roads, rail lines, transmission lines, dykes and cutlines were included in the total linear feature length calculations. Total linear feature density in kilometres per square kilometre was measured as the total length of all linear features divided by the total land area in the Regional Study Area. Transportation density was the combined density of roads and rail lines.

Linear features in the Regional Study Area were mapped from a combination of digital ortho-rectified imagery produced from 1:60,000 stereo air photos acquired in 1999, Landsat 7 panchromatic imagery acquired circa 2000, large scale stereo air photos acquired over several years in the 1990s and infrastructure mapping from NTS and other sources. Large scale (1:15,000) stereo air photos acquired in 2003 and 2006 were available for the detailed habitat mapping area (Map 2-2). Portions of the linear feature mapping were validated during helicopter surveys.

Some of the cutlines mapped from the older remote sensing were regenerating back to shrubland or woodland. It is also possible for cutlines to revegetate within a forest landscape and become non-existent from the perspective of predators or prey. The point at which a cutline becomes sufficiently overgrown to no longer function as a predator travel corridor is not well understood. Following Salmo Consulting Inc. *et al.* (2003), cutlines with woody vegetation that was at least 1.5 m tall and having total canopy closure of either at least 75% or between 25% and 75% with no game trails or evidence of human use were assumed to no longer function as corridors. Vegetation regeneration was evaluated in 883 km of the mapped cutlines using low level oblique helicopter-based photography acquired during summer 2011.

Core areas were the residual areas left after buffering linear features and other human footprints. Linear features typically experiencing relatively low human use (transmission lines, trails, dykes and cutlines) were buffered 200 m (Mace *et al.* 1996) while high use linear features (railways and all types of roads) and settlements were buffered 500 m (Salmo Consulting Inc. *et al.* 2003). The non-linear human features relevant for the core area analysis were identified by selecting the human land cover class from the terrestrial habitat mapping completed for the detailed habitat mapping area and from air photos and satellite imagery for the remainder of the Regional Study Area.

2.3.1.2 Ecosystem Diversity

Maintaining native biodiversity is fundamental to maintaining overall **ecosystem function** and ecosystem health (CCFM 1995). Ecosystem diversity, species diversity and genetic diversity are the three generally recognized components of biodiversity (Noss 1990). Ecosystem diversity refers to the number of different ecosystem types and the distribution of area amongst them at various ecosystem levels. Maintaining the ecosystem types that are particularly important in the regional context (e.g., types that are species rich, structurally complex or rare for the Regional Study Area) is key to maintaining regional ecosystem health.

Terrestrial habitat mapping is often used as a proxy for terrestrial ecosystem mapping (Leitão et al. 2006; Noss et al. 2009).

Potential direct and indirect Project effects on ecosystem diversity through the pathways described in Section 2.5 include reducing the number of native ecosystem types, altering the distribution of area amongst the ecosystem types, reducing the total number of stands representing an ecosystem type and/or reducing the total area of a priority ecosystem type. The KCNs have noted that transmission lines reduce forest habitat (Split Lake Cree 1996).

Ecosystem diversity was selected as a VEC to provide information on ecosystem diversity, partial information on plant species diversity and serve as a proxy for other ecosystem components and functions. Given the nature of the ecosystem diversity measures (see below), they serve as proxies for potential Project effects on wetland function and soil quantity and quality. For example, since ecosite type is a component of habitat type and soil types can be grouped into ecosite types, Project effects on habitat provide information on how soil quantity and quality are affected. Likewise, the habitat types include wetland classes so that Project effects on wetland habitat types provide information on how wetland function is affected.

Numerous metrics have been developed to measure stand and landscape level ecosystem diversity. Leitão *et al.* (2006) review potential patch and landscape diversity metrics and reduce them to a core set that they expect will meet the typical needs of land use planning. The core set includes two composition metrics (patch richness and class area proportion) and eight configuration metrics (*e.g.*, patch number). The patch richness, class area proportion and patch number metrics can be alternative names for the number of broad habitat types, proportions of each habitat type and number of stands, depending on how these are measured.

Habitat mapping was used as a proxy for ecosystem mapping, as is often done (*e.g.*, Leitão *et al.* 2006; Noss *et al*. 2009). The mapped habitat attributes represent most of the major stand level ecosystem components, biomass and controlling factors.

The indicators used for the ecosystem diversity VEC were stand level habitat composition and **priority habitat type**s. Habitat composition addressed the number of different ecosystem types and the distribution of area amongst them. Priority habitat types were those native habitat types that were particularly important for ecological reasons and/or of particular social interest. Specifically, priority habitat types were the native broad habitat types that were regionally rare or uncommon, highly diverse (*i.e.*, species rich and/or structurally complex), highly sensitive to disturbance, had a high potential to support rare plants and/or were highly valued by people. Habitat types that are especially important to wildlife are not directly addressed.

Site level ecosystem diversity was also partially captured by the ecosystem diversity indicators in the sense that high species richness (*i.e.*, **alpha diversity**) and structural complexity were among the criteria for identifying priority habitat types.

Attributes measured for the habitat composition indicator were the number of native broad habitat types, the distribution of area amongst the native broad habitat types and the number of stands representing each native habitat type (ecosystem types represented by only a few stands in the Regional Study Area are more vulnerable to disappearing).

The attribute measured for the priority habitat indicator was the area of each priority habitat type. To evaluate cumulative historical effects, the estimated current area of a priority habitat type was compared with its estimated historical area prior to the development of infrastructure and the Nelson River for hydroelectric power generation. Table 2-3 lists the priority habitat types and the selection criteria they satisfied. The methods used for each of the priority habitat selection criteria were as follows. A broad habitat type was classified as being regionally rare if it comprised less than 1% of Regional Study Area land area and regionally uncommon if it covered between 1% and 10% of land area (note that the ground ice broad habitat types were not included as a priority habitat type because they are expected to disappear over time). Site level terrestrial habitat plot data were used to estimate the mean number of plant species, the occurrence of rare plant species and the typical number of distinct vegetation layers in each broad habitat type. Broad habitat types that had a mean number of plant species within the top 25th percentile for all of the inland broad habitat types were classified as having relatively high plant species density. Structurally diverse habitat types were those that typically had at least three distinct vegetation layers in most of the inland habitat plots. Broad habitat types that had high potential to support rare plant species were those in which the mean number of rare plant species per inland habitat plot was in the top 25th percentile of all of the inland broad habitat types. The Keeyask Cree Nations (KCNs), which includes Tataskweyak Cree Nation, War Lake First Nation, Fox Lake First Nation and York Factory First Nation, indicated that all terrestrial habitat types are important and did not identify any inland terrestrial habitat types that were of particular interest beyond the uses of these habitat types for other reasons such as habitat for favoured wildlife species (*e.g.* the importance of shrubby shoreline habitat for moose and other wildlife.

Existing and historical ecosystem diversity values were obtained from the Keeyask Generation Project Environmental Impact Statement (Section 2 of Keeyask HydroPower Partnership 2012b).

Table 2-3: Priority Habitat Types With Their Reasons for Inclusion and Their Historical and Current Areas in the Regional Study Area

Priority Habitat Type	Priority Criteria*	Estimated Historical Area (ha)**	Estimated Current Area (ha)
Balsam poplar dominant on all ecosites	RD	21	20
Trembling aspen dominant on all ecosites	RD	7,073	6,843
White birch dominant on all ecosites	RD	553	535
Balsam poplar mixedwood on all ecosites	RDS	12	11
Trembling aspen mixedwood on all ecosites	RDS	5,872	5,681
White birch mixedwood on all ecosites	R	446	432
Black spruce mixedwood on mineral	R	3,099	2,998
Black spruce mixedwood on thin peatland	RDS	885	856
Jack pine mixedwood on mineral	RD	2,166	2,095
Jack pine mixedwood on thin peatland	RDS	1,415	1,369
Jack pine dominant on mineral	UDS	15,584	15,077
Jack pine dominant on thin peatland	RDS	1,323	1,280
Jack pine mixture on thin peatland	R	5,255	5,084
Tamarack dominant on mineral	RDS	307	297
Tamarack mixture on mineral	RDS	1,067	1,033
Black spruce dominant on mineral	U	97,857	94,673
Black spruce mixture on mineral	RD	9,797	9,478
Black spruce mixture on thin peatland	R	8,132	7,868
Tamarack dominant on thin peatland	RDS	241	233
Tamarack mixture on thin peatland	RDS	3,029	2,930

Table 2-3: Priority Habitat Types With Their Reasons for Inclusion and Their Historical and Current Areas in the Regional Study Area

Priority Habitat Type	Priority Criteria*	Estimated Historical Area (ha)**	Estimated Current Area (ha)
Tall shrub on mineral	RD	490	474
Tall shrub on thin peatland	RDS	1,978	1,913
Low Vegetation on thin peatland	U	53,247	51,514
Jack pine dominant on shallow peatland	RS	137	132
Jack pine mixture on shallow peatland	RDS	526	509
Black spruce mixedwood on shallow peatland	RD	292	282
Jack pine mixedwood on shallow peatland	RS	103	100
Black spruce mixture on shallow peatland	RD	5,757	5,570
Black spruce dominant on wet peatland	UD	26,802	25,930
Black spruce mixture on wet peatland	R	1,759	1,702
Tamarack mixture on wet peatland	RD	9,648	9,334
Tamarack dominant on shallow peatland	R	440	426
Tamarack mixture on shallow peatland	RD	3,494	3,381
Tamarack dominant on wet peatland	R	2,048	1,982
Black spruce dominant on riparian peatland	RDS	8,522	8,245
Tamarack- black spruce mixture on riparian peatland	RD	435	421
Tamarack dominant on riparian peatland	R	82	79
Tall shrub on shallow peatland	RDS	3,351	3,242
Tall shrub on wet peatland	R	1,661	1,607
Low vegetation on shallow peatland	U	41,754	40,395
Low vegetation on wet peatland	U	20,026	19,374
Tall shrub on riparian peatland	R	7,606	7,358
Low vegetation on riparian peatland	U	23,495	22,731
Area of all types		*377,788*	*365,494*

*R = Rare, U = Uncommon, D = Diverse, S = Relatively high potential to support rare plant species.
**Historical areas estimated by multiplying the total Regional Study Area land area by the fraction of total native habitat area for each broad habitat type.
Source: Section 2 of Keeyask HydroPower Partnership (2012b).

2.3.1.3 Priority Plants

Plants perform key functions in terrestrial ecosystems. Among other things, they provide food and shelter for wildlife, contribute to soil development, store carbon, release oxygen and ultimately are the source for most life because they convert solar energy to biomass.

Priority plants are the native plant species that are especially important for ecological (*e.g.*, they are rare species) and/or social (e.g., food or cultural importance to the KCNs) reasons.

Direct Project effects on terrestrial plants will include loss, alteration and disturbance of plants and their habitats in the cleared ROW, borrow areas used for tower construction and any associated access roads and trails. These direct effects will lead to indirect effects on terrestrial plants, primarily through edge and access-related effects. The spatial extent of indirect Project effects on terrestrial plants in areas surrounding the Project Footprint (i.e., the terrestrial plants zone of influence) was expected to be the same as the terrestrial habitat zone of influence.

Priority plants was the VEC for terrestrial plants. Priority plants were native species that met one or more of the following criteria: highly sensitive to human features, thought to make high contributions to ecosystem function and/or were of particular interest to local people. A plant species was considered to be highly sensitive to human features if it was globally, provincially or regionally rare, near a range limit, had low reproductive capacity, depended on rare environmental conditions and/or depended on the natural **disturbance regime**.

The list of priority plants was selected from the list of species potentially occurring in the Regional Study Area. Globally, nationally and provincially rare species were identified from The *Manitoba Endangered Species Act* (MESA), *Schedule 1* of the *Species at Risk Act* (SARA), the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and Manitoba Conservation Data Centre conservation concern rankings. Regionally rare and range limit species were identified from field data, floras (*e.g.*, FNA 1993+), herbarium records (MBCDC *pers. comm.*; Manitoba Museum *pers. comm.*) and terrestrial habitat mapping. A list of plant species of particular interest to the KCNs was developed from documents produced by the KCNs and notes from Keeyask Generation Project working group meetings.

Plant species potentially occurring in the Regional Study Area were identified from field data, MBCDC information (*pers. comm.* 2011), herbarium records, floras and relevant literature. Plant nomenclature followed Flora of North America (FNA 1993+) where volumes currently exist for the genus and the Manitoba Conservation Data Centre elsewhere.

Invasive plants were also considered for the Project effects assessment. Invasive plants are considered a threat to other plant species and to ecosystems. Invasive plants are plant species that are growing outside of their country or region of origin and are able to out-compete or replace native plants (ISCM 2012). Highly invasive plants can crowd out other plant species and, in extreme cases, extirpate species and alter vegetation composition, ecosystem diversity and other ecosystem attributes.

Invasive plants potentially occurring in the Regional Study Area were identified from Scoggan (1978), FNA (1993+), White *et al.* (1993), Royer and Dickinson (1999), Riley (2003) and ISCM (2012).

The distribution and abundance of each plant species recorded during field studies was classified. Distribution classes were very widespread, widespread, scattered, localized or absent (Table 2-4) based on frequency of occurrence across the sample locations using the ranges shown in Table 2-5. Species abundance was classified as being very abundant, abundant, sporadic, scarce or absent (Table 2-4) based on mean percentage of presences in the sub-samples (*e.g.*, percentage of quadrats in plots) across the locations using the ranges shown in Table 2-5.

Table 2-4: Distribution, Abundance and Regional Rarity Classes Used in the Terrestrial Plants Assessment

Distribution (D)	Abundance (A)	Rarity (R)
Very Widespread	Very Abundant	Very Common
Widespread	Abundant	Common
Scattered	Sporadic	Uncommon
Localized	Scarce	Regionally rare
Absent	Absent	n/a

Table 2-5: Distribution and Abundance Class Names and Ranges

Distribution (D)*		Generalized Distribution	Abundance (A)**	
Very Widespread	90% ≤ D ≤ 100%	Widely	Very Abundant	80% ≤ A ≤ 100%
Widespread	75% ≤ D < 90%		Abundant	53% ≤ A < 80%
Scattered	25% ≤ D < 75%	Narrowly	Sporadic	33% ≤ A < 53%
Localized	0% < D < 25%		Scarce	0% < A < 33%
Absent	0%	Absent	Absent	0%

Notes:
*. Distribution measured as percentage of sample locations where the species occurred (*i.e.*, percentage of plots or percentage of paired transect locations).
**. Abundance was measured as the mean subsample frequency across all sample locations. For Inland plots this was mean quadrat frequency out of a maximum 15; for shoreline wetlands this was mean percentage of total transect length.

The probability of detecting a species increases with the density of sample locations in the study area sampled. The sample density in the Terrestrial Plants Local Study Area was approximately 11 times higher than in the rest of the Regional Study Area as a whole because sampling was more intensive in areas with potential Project effects. The sample density in the Terrestrial Plants Local Study Area was 1.03 sample locations per km^2 while in the rest of the Regional Study Area it was 0.09 sample locations per km^2, which was approximately 11 times higher sampling density (1.03/0.09).

To provide a crude correction so that the number of known locations in the Terrestrial Plants Local Study Area could be converted into an estimated percentage of Regional Study Area locations, the estimated number of locations in the Regional Study Area was obtained from calculations completed for the Keeyask Generation Project environmental impact assessment (Section 3 of Keeyask HydroPower Partnership 2012b) since this analysis included all of the Project and the Keeyask Generation Project sample locations. Since this was a crude method to adjust for differences in sampling intensity, the resulting number of Regional Study Area locations was treated as being an approximation with a wide range around the true value (which is considered adequate where the number of locations in the Terrestrial Plants Local Study Area is clearly a small proportion of the estimated number of known locations).

2.4 EVALUATION OF ALTERNATIVE ROUTES AND OTHER INFRASTRUCTURE

The alternative routes assessed for Construction Power Transmission and Generation Outlet Transmission were those provided by Manitoba Hydro in a Shape file (downloaded from Orientis April 20, 2012).

When the first iteration of the alternative route evaluation was completed, there was some uncertainty regarding the ROW widths and whether all of the Generation Outlet Transmission lines would be located within a single ROW. Consequently, a 400 m wide evaluation corridor was generated for each alternative route as a 200 m buffer of the route. A 400 m wide corridor was wide enough to capture the ROW width as well as the most likely extent of indirect Project effects on terrestrial habitat, to ensure that any sensitivities in the immediate vicinity were captured and to provide some flexibility for refining routing should the particular route be selected. These 400 m wide corridors are referred to as the **alternative route evaluation corridor**s. The alternative route evaluation corridors were used for the ecosystem diversity and priority plant evaluations.

2.4.1.1 Fragmentation

The potential fragmentation effects of the alternative routes were compared using total route length, the total amount of core area removed and how the largest core areas would be affected. Since the Regional Study Area is the same for all of the alternative routes, comparisons based on total route length and total core area are proportional to the changes in total linear feature density and total core area percentage.

2.4.1.2 Ecosystem Diversity

As described in Section 2.3.1.2, terrestrial habitat mapping was used as a proxy for ecosystem mapping.

Using the 400 m wide corridors to identify affected terrestrial habitat, the potential effects of the alternative routes on ecosystem diversity were compared based on the number of stand level habitat types that would be completely removed, changes in stand level habitat composition and area losses for each of the priority habitat types.

2.4.1.3 Priority Plants

Since the terrestrial plants and terrestrial habitat zones of influence were the same, the potential effects of the alternative routes on priority plants were compared based on the number of priority plant locations found in the 400 m wide alternative route evaluation corridors, with special emphasis on the species of highest conservation concern. To the extent that the rare priority plants were associated with particular habitat types, the priority habitat indicator of the ecosystem diversity VEC provided a comparison of the effects on priority plant habitats. Additionally, relatively high potential to support rare plant species was one of the criteria used to select the priority habitat types.

2.5 PROJECT EFFECTS ASSESSMENT

2.5.1 General Approach

2.5.1.1 Introduction

The assessment of Project effects was based on the existing environment, as described in in this report (Section 3). This existing environment incorporates the effects of past and current projects and activities. The Project effects assessment also considered interactions with reasonably foreseeable potential future projects. Monitoring recommendations were provided.

The technical analysis determined Project effects on the terrestrial environment by considering the linkages between the terrestrial environment and changes caused by the Project, both directly and indirectly. The Terrestrial Environment Supporting Volume of the Keeyask Generation Project Environmental Impact Statement (Keeyask HydroPower Partnership 2012b) details the potential pathways of Project effects and the expected changes to various terrestrial ecosystem components.

Several approaches were used in the technical assessment. Generally, potential effects were identified based on a combination of scientific knowledge of causal relationships (*e.g.*, how vegetation and soils are affected by elevated soil temperatures due to vegetation clearing), results from Project studies and information from other existing transmission projects that provided relevant examples of how the Project could affect ecosystem components and relationships between these components.

Although the terrestrial habitat, ecosystems and plants effects assessment considered a wide range of terrestrial ecosystem components, the assessment focussed on the VECs and supporting topics. As described above, the VECs were fragmentation, ecosystem diversity and priority plants while the supporting topics were fire regime and invasive plants. The rationale used to select the VECs was provided in Section 2.3.

The main steps used to complete the terrestrial habitat, ecosystems and plants assessment were as follows:

1. Scope the Project;
2. Scope the environmental assessment in terms of VECs (see Section 2.3) and supporting topics, spatial scope and temporal scope;
3. Describe the existing environment;
4. For each VEC:
   - 4.1. Describe existing environment conditions;
   - 4.2. Predict and assess potential Project effects in combination with other past and current projects before considering potential mitigation;
   - 4.3. Identify credible mitigation measures where potential effects are expected to be greater than desired;
   - 4.4. Assess residual Project effects after mitigation;
   - 4.5. Assess Project interactions with reasonably foreseeable future developments and activities; and,
   - 4.6. Recommend monitoring.

2.5.1.2 Project Scope

The Project components relevant for the terrestrial environment assessment included:

- Physical components that could directly remove or alter terrestrial habitat and/or ecosystems, including effects on wildlife and/or their habitat;
- Components that could indirectly remove or alter terrestrial habitat and/or ecosystems, including effects on wildlife and/or their habitat;

- Components that could disturb animals and/or cause them to avoid habitat they would otherwise use;
- Improved access since it could increase disturbance, mortality or resource harvesting;
- Conditions that could increase the risk that diseases or invasive species are introduced or further spread; and,
- Conditions that increase fragmentation or otherwise reduce regional intactness.

Section 1.2 provides details regarding Project components during construction and operation that are relevant for the terrestrial environment scoping. The locations and boundaries for the Project components used to define the Project Footprint and for the Project effects assessment were those provided by Manitoba Hydro (Shape file provided by Stantec on September 18, 2012).

2.5.1.3 Spatial Scope

Local and Regional Study Areas were selected separately for each VEC and supporting topic using a nested, cause-effect approach (FEARO 1994; CEAA 1996; Milko 1998a, 1998b; Hegmann 1999; Manitoba Hydro 2003). The scoping approach considered the hierarchical structuring of ecosystems and the potential pathways of Project effects on the VEC or supporting topic.

The rationale for the nested cause-effect approach was as follows. Project **impact**s such as vegetation clearing would have direct **effect**s on the VEC or supporting topic being assessed. These Project impacts could also have indirect effects on the topic in question through linkages such as those shown in Figure 2-2 (*e.g.*, Project-related clearing leads to higher soil temperatures which eventually alters soils and vegetation). For each VEC and supporting topic, the spatial extent of potential direct and indirect effects defined a potential **zone of influence** on individuals (*i.e.*, the local zone of influence), which became the Local Study Area for the topic in question. In the case of a wildlife topic, individuals were the individual animals that would be affected (*e.g.*, five moose are displaced). In the case of a non-species topic, individuals were the relevant ecosystem elements (*e.g.*, 10 jack pine stands will be cleared; two core areas will be fragmented).

Although effects on individuals are of interest, the question of ultimate concern for the Project effects assessment was how effects on individual animals would translate into long-term effects on population viability or how effects on individual ecosystem elements would translate into long-term effects on components of regional ecosystem health (which is a synthetic measure of ecosystem functions). For example, how would removing the habitat that supports five moose affect the long-term viability of the moose population, or, how would removing ten jack pine stands affect regional ecosystem diversity? On this basis, an area that was large enough to capture the local “population” (*i.e.*, the regional zone of influence) was used to assess the potential significance of Project effects (Miller and Ehnes 2000). The spatial extent of the regional zone of influence became the Regional Study Area for the key topic. Figure 2-3 illustrates the conceptual approach using the potential effects of a hypothetical project on moose. Section 1 of the Keeyask Generation Project environmental impact statement terrestrial supporting volume (Keeyask HydroPower Partnership 2012b) provides further details on the methodology.

In summary, the Local Study Area represented the potential Project zone of influence on “individuals” while the Regional Study Area provided the comparison area for evaluating the potential significance of those individual effects on populations or the relevant regional ecosystem health attribute.

Map 2-5 shows the Local Study Areas used for the VECs and the other study areas used for the Project effects assessment. The same Regional Study Area was used for all of the VECs.

2.5.1.4 Temporal Scope

Temporal scope was determined separately for each VEC based on potential pathways of Project effects, including where these interactions could overlap with other past, current and reasonably foreseeable future projects. An important consideration for temporal scoping was the time required for the regional or population measures relating to the VEC to stabilize. This was closely related to life cycle length for priority plants and the length of the natural post-disturbance recovery cycle for habitat and ecosystem key topics.

2.5.1.5 Effects Benchmarks

Currently there are no regulatory or generally accepted scientific **threshold**s or **benchmark**s for any of the selected VECs or supporting topics. Regulatory thresholds or benchmarks may be developed in the future for plants that are listed as endangered or threatened by the federal *Species At Risk Act*.

Given the lack of regulatory thresholds and generally accepted scientific standards, the benchmarks used to assess Project effects varied depending on the key topic and included one or more of the following:

- Principles or recommendations from federal or Provincial policies and guidelines;
- Quantitative values or qualitative conditions proposed in the scientific literature;
- Conditions in areas relatively unaffected by human development;
- The range of natural variability;

- Comparison to conditions that existed in the past (*i.e.*, has the key topic already experienced major stress or declines from events that occurred in the past?);
- Relative degree of change from current conditions; and/or
- Relative degree of change from relatively natural conditions.

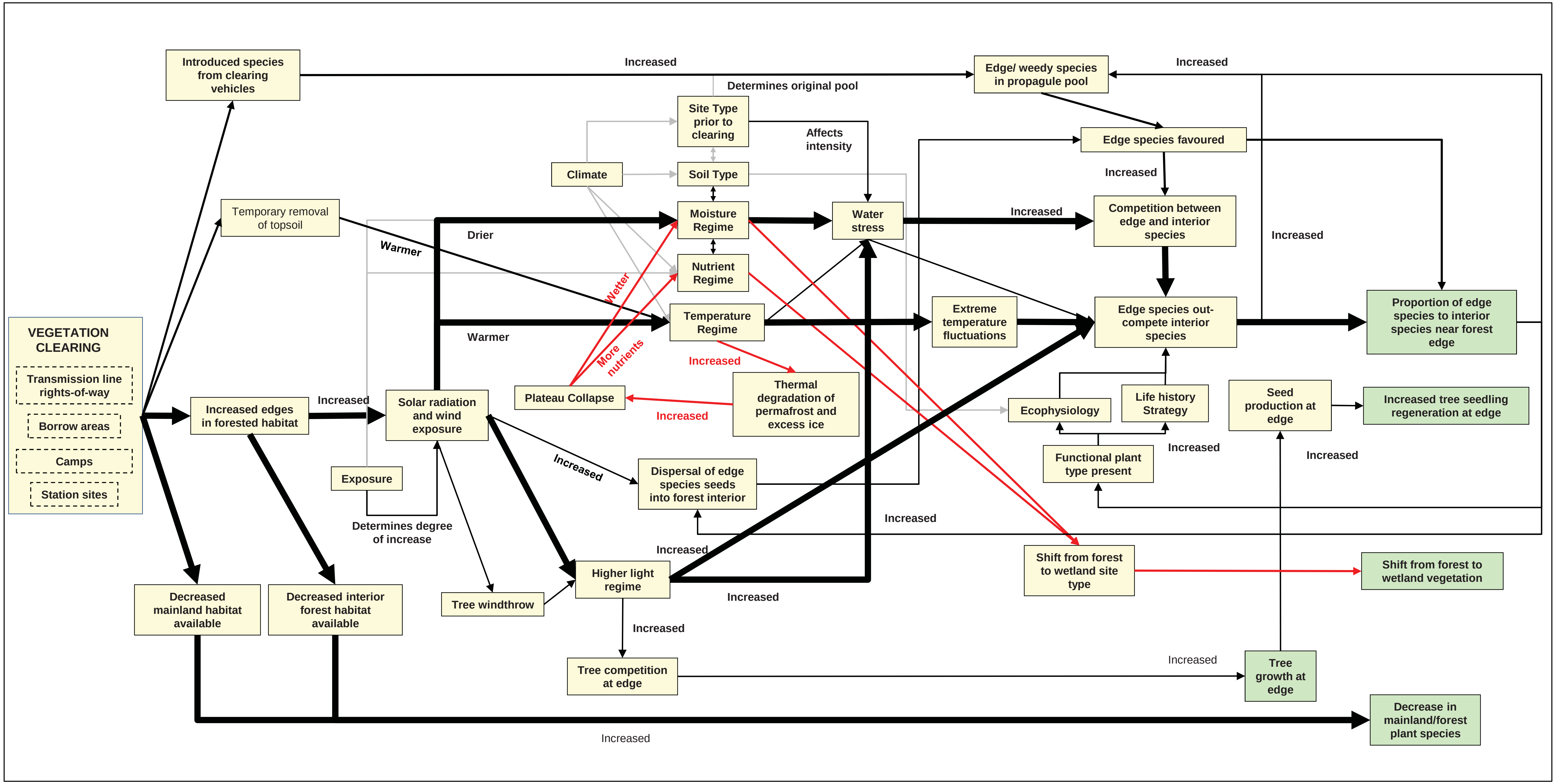


Figure 2-2: Network Linkage Diagram for Terrestrial Vegetation Changes Caused by Project Clearing

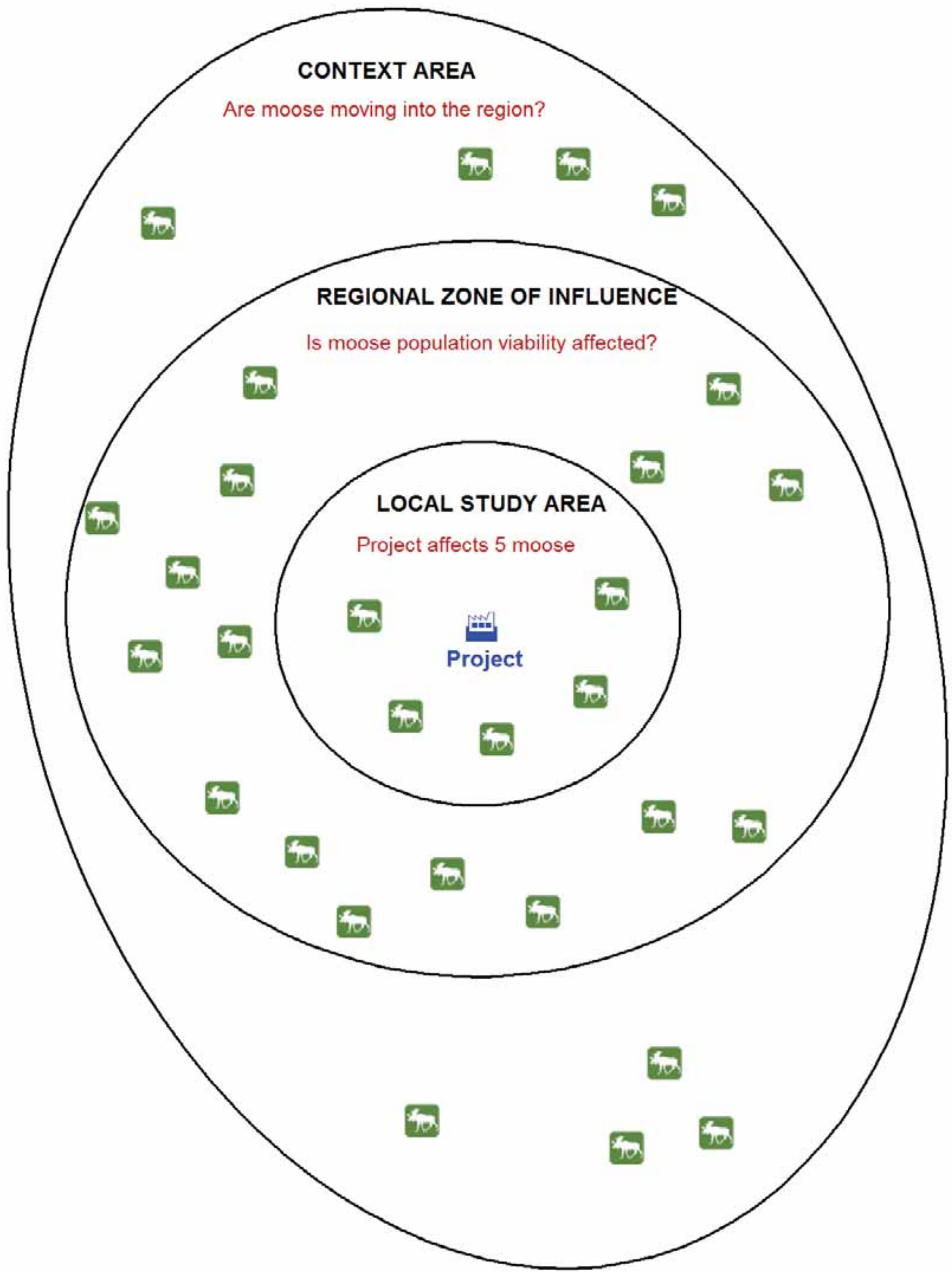


Figure 2-3: Nested Study Area Methodology for a Hypothetical Project

2.5.1.6 Evaluation of Residual Effects

Potential Project effects on the VEC were assessed using the selected benchmark. Potential mitigation measures that could avoid or reduce potential adverse Project effects were evaluated to determine which would be incorporated into the Project. The anticipated **residual effect**s of the Project, in combination with past and current existing developments and activities, were then assessed for each of the key topics in terms of nature, geographic extent, magnitude, duration, frequency and reversibility. Definitions for each of these criteria are provided in Table 2-6.

A two-step process was used to evaluate effects. Each VEC was first assessed for magnitude, geographic extent and duration. VECs with residual Project effects meeting the following criteria were further examined in step 2:

- Small in geographic extent, large in magnitude and long term in duration;
- Medium in geographic extent and either large in magnitude (regardless of duration) or moderate in magnitude and long-term in duration; or
- Large in geographic extent and either moderate or large in magnitude (regardless of duration).

In step 2, frequency, reversibility and ecological context were evaluated.

Ecological context refers to VEC's sensitivity to disturbance, capacity to adapt to change and past and future trends for the VEC. For example, if a VEC is known to be highly resilient (i.e., adaptable and recovers well from disturbance), effects that could otherwise be considered significant for the purposes of regulatory determination of significance, may be determined as insignificant. Conversely, where the loss of even a few individuals may affect the long-term viability of a population, the effect on a VEC may be significant, even where the residual effect is moderate magnitude and medium geographic extent.

Table 2-6: Criteria Used to Assess Residual Project Effects

Factor	Level	Definition
Step 1 - Each VEC is initially evaluated using the following criteria:		
Direction or Nature	Positive	• Beneficial or desirable on the environment
	Neutral or negligible	• No measurable change in the environment
	Adverse	• An undesirable effect on the environment
Magnitude	Small	• No definable, detectable or measurable effect • Below established benchmarks of acceptable change • Within range of natural variability • Minimum impairment of ecosystem component's function

Table 2-6: Criteria Used to Assess Residual Project Effects

Factor	Level	Definition
	Moderate	• Effects that could be measured and could be determined within a normal range of variation of a well designed monitoring program • Generally below or only marginally beyond guidelines or other established benchmarks of acceptable change • Marginally beyond the range of natural variability • Marginally beyond minimal impairment of ecosystem component's function
	Large	• Effects that are easily observable, measured and described • Well beyond guidelines or other established benchmarks of acceptable change • Well beyond the range of natural variability • Well beyond minimal impairment of ecosystem component's functions
Geographic Extent	Small	• Effects that are confined to a small portion of one or more areas where direct and indirect effects can occur (e.g., rights-of-way or component sites)
	Medium	• Effects that extend into local surrounding areas where direct and indirect effects can occur
	Large	• Effects that extend into the wider regional area where indirect and cumulative effects may occur
Duration	Short term	• Effects that generally occur within the construction period or initial period of impoundment • Occur within only one generation or recovery cycle of the VEC
	Medium term	• Effects extend through a transition period during the operations phase • Occur within one or two generations or recovery cycles for the VEC
	Long-term	• Effects extend for a long-term during the operations phase or are permanent • Extend for two or more generations or recovery cycles for a VEC
Frequency	Infrequent	• Effects that occur only once or seldom during life of the Project
	Sporadic/ Intermittent	• Effects that occur only occasionally and without predictable pattern during life of the Project •
	Regular/ Continuous	• Effects that occur continuously or at regular periodic intervals during life of Project •
Reversibility	Reversible	• Effect that is reversible during the life of the Project
	Irreversible	• A long-term effect that is permanent

Table 2-6: Criteria Used to Assess Residual Project Effects

Factor	Level	Definition
Ecological context	Low	• The VEC is not rare or unique, resilient to imposed change, or of minor ecosystem importance
	Moderate	• The VEC has some capacity to adapt to imposed change • The VEC is moderately/seasonally fragile • The VEC is somewhat important to ecosystem functions or relationship
	High	• The VEC is a protected/designated species • The VEC is fragile with low resilience to imposed change or a very fragile ecosystem

2.5.2 Valued Environmental Components (VECs)

The following subsections describe the Project effects assessment methods used for each VEC.

2.5.2.1 Fragmentation

Potential Project effects on fragmentation included increased fragmentation from linear features, lower total core area and fewer large core areas. Newly constructed transmission lines and access trails added to linear feature density. Core area was reduced by Project features that either remove existing core area or occur within 500 m of an existing core area.

The Fragmentation Local Study Area was a 1,150 m buffer of the Project Footprint as shown in Map 2-5. The Local Study Area was the area where Project features could directly or indirectly create linear disturbance and/or affect individual core areas. The Regional Study Area was large enough to represent a region level ecosystem in the Keeyask area (see Section 2.1).

Project effects on fragmentation were predicted by adding all Project features to the cumulative linear feature and cumulative human footprint maps developed for the Keeyask Generation Project environmental impact statement (Section 2 of Keeyask HydroPower Partnership 2012b).

The acceptability of residual Project effects on fragmentation was evaluated based on total linear feature density (especially outside of the Thompson portion of the Regional Study Area), core area percentage and the number of very large core areas. The complete removal of one or more very large core areas from the Regional Study Area was an unacceptable effect. For the linear feature density and core area percentage indicators, effects that were small to moderate in magnitude were generally be acceptable regardless of their duration or geographic extent because this degree of change was expected to fall within the range of natural variability. Exceptions could occur for a moderate magnitude residual effect if there was a substantial ongoing adverse trend in either of these indicators.

The benchmark values used to evaluate the magnitude of residual effects for the fragmentation indicators were as follows. For total linear feature density, adverse effects on fragmentation are: small magnitude for regional values below 0.40 km/km^2; moderate magnitude for regional values between 0.40 km/km^2 and 0.60 km/km^2; and, high magnitude for regional values greater than 0.60 km/km^2 (Salmo Consulting Inc. *et al.* 2003). For total core area as a percentage of land area, adverse effects on fragmentation are: small magnitude for regional values greater than 65%; moderate magnitude for regional values between 40% and 65%; and, high magnitude for regional values lower than 40% land area (Salmo Consulting Inc. *et al*. 2003; Athabasca Landscape Team 2009; and Dzus *et al.* 2010).

2.5.2.2 Ecosystem Diversity

Potential Project effects on ecosystem diversity include reducing the number of native ecosystem types, altering the distribution of area amongst the ecosystem types, reducing the total number of stands representing an ecosystem type and/or reducing the total area of a priority ecosystem type.

The Ecosystem Diversity Local Study Area was the area where Project features could directly or indirectly affect ecosystem diversity. Based on the anticipated maximum potential effects on terrestrial habitat described in Section 1.3, the Local Study Area was the area encompassed by a 50 m buffer of the transmission line ROWs and a 150 m buffer of the station sites (Map 2-5).

Project effects on ecosystem diversity during construction were predicted by converting all areas inside of the Ecosystem Diversity Local Study Area to the “human infrastructure” habitat type. This was a cautious approach in the sense that it was a substantial overestimate of the spatial extent of anticipated Project effects. In the case of transmission line ROWs, Project effects on terrestrial habitat were generally expected to extend approximately 10 m from the ROW edge (Section 1.3).

The acceptability of residual Project effects on ecosystem diversity was evaluated based on the number of stand level habitat types that would be completely removed, changes in stand level habitat composition (Noss *et al*. 2009) and cumulative historical area losses for each of the priority habitat types. The complete removal of one or more stand level habitat types from the Regional Study Area was an unacceptable effect. For the habitat composition and priority habitat type indicators, effects that were small to moderate in magnitude were generally acceptable regardless of their duration or geographic extent because this degree of change was expected to fall within the range of natural variability. Exceptions could occur for a moderate magnitude residual effect if there was a substantial ongoing adverse trend in the amount of a habitat type being considered.

The benchmark values used to evaluate the magnitude of residual effects on the priority habitat types were derived from two sources. Hegmann *et al.* (1999) cite rules of thumb for measurable indicator attributes for which accepted thresholds or benchmarks do not exist. The 10% value they cite as the transition from moderate to high magnitude effects was also used as the critical cutoff to evaluate cumulative effects risks to rare and unique physical and vegetation features for the Deh Cho Plan area (Salmo *et al.* 2004). The benchmark values for evaluating adverse residual effects of the Project in combination with past and current projects and human activities on priority habitat types were as follows: small magnitude for area losses below 1% of regional historical area; moderate magnitude for area losses between 1% and 10% of regional historical area; and, high magnitude for area losses greater than 10% of regional historical area.

2.5.2.3 Priority Plants

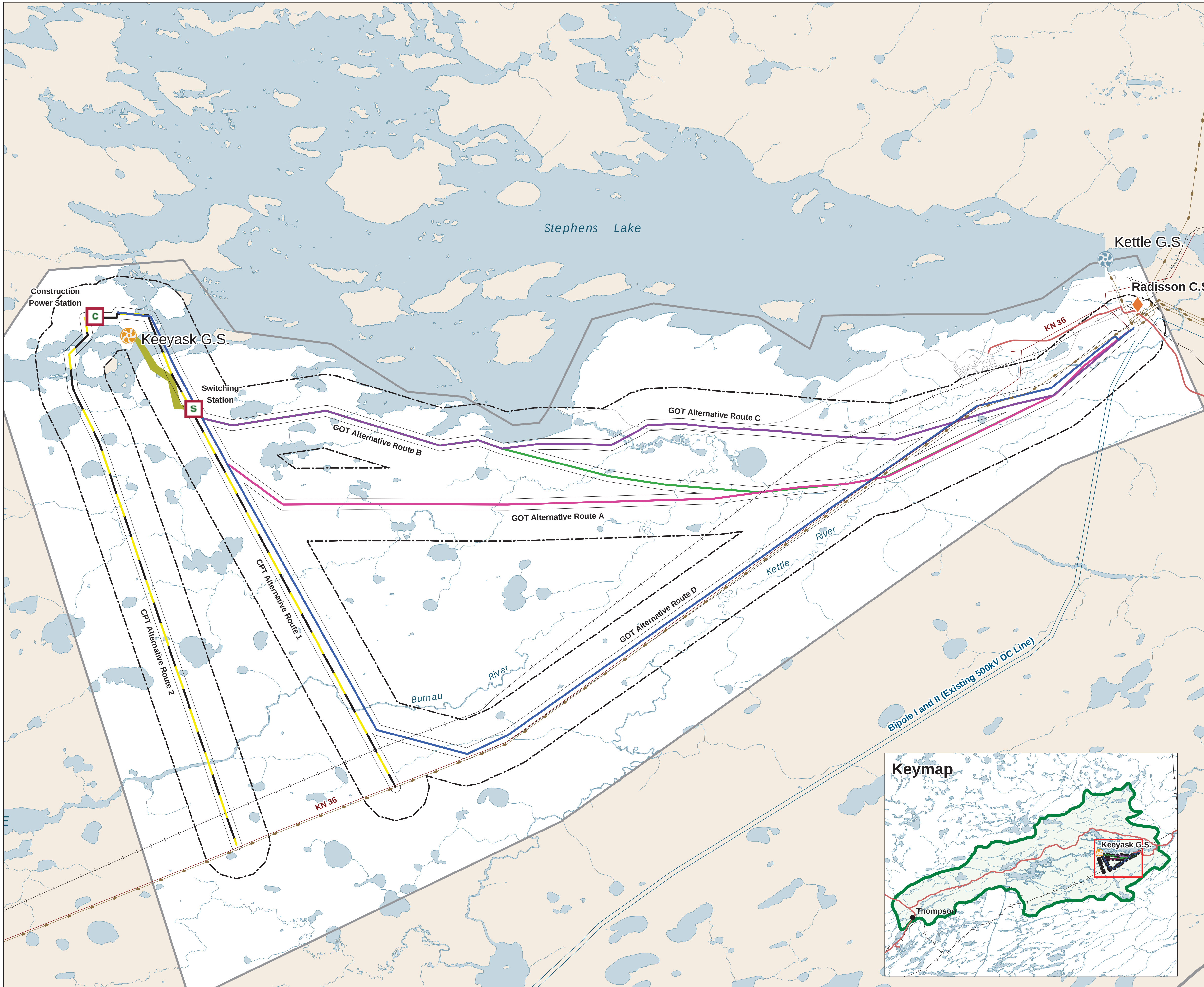
Potential Project effects on priority plants include removing and disturbing individual plants and plant populations as well as removing, altering or disturbing their habitats.

The Priority Plants Local Study Area was the area encompassed by a 50 m buffer of the Project Footprint as shown in Map 2-5. The Local Study Area is the area where Project features could directly or indirectly affect priority plants or their habitats.

The acceptability of residual Project effects on priority plants was evaluated based on the number of plant locations and/or the available priority plant habitat that could be affected by the Project. For both of these indicators, effects that were small to moderate in magnitude would generally be acceptable regardless of their duration or geographic extent because this degree of change was expected to fall within the range of natural variability. Exceptions could occur for a moderate magnitude residual effect on a species if there was a substantial ongoing adverse trend in either its population level or amount of available habitat.

The magnitude of residual Project effects on plant locations was measured as the predicted percentage of affected locations. Magnitude for residual effects on available habitat was measured as the cumulative percentage of habitat affected within the Regional Study Area. For the endangered, threatened, globally rare, provincially very rare species and provincially rare species, the percentage benchmarks for both indicators were as follows: small magnitude for percentage changes below 1%; moderate magnitude for percentage changes between 1% and 5%; and, high magnitude for percentage changes greater than 5% (Hegmann *et al*. 1999; Wagner 1991). For the remaining priority plants, the percentage benchmarks for both indicators were as follows:

small magnitude for percentage changes below 1%; moderate magnitude for percentage changes between 1% and 10%; and, high magnitude for percentage changes greater than 10% (Hegmann *et al*. 1999).



Manitoba Hydro

Keeyask Transmission Project

Project Infrastructure

- Generation Outlet Transmission (GOT) Alternative Route A
- Generation Outlet Transmission (GOT) Alternative Route B
- Generation Outlet Transmission (GOT) Alternative Route C
- Generation Outlet Transmission (GOT) Alternative Route D
- Construction Power Transmission (CPT) Alternative Route 1 and 2
- Unit Transmission Line Right-of-Way
- C Construction Power Station
- S Switching Station

Study Areas

- Project Study Area
- Regional Study Area
- Local Study Area for Alternative Routes Evaluation
- Detailed Analysis Corridor

Infrastructure

- Converter Station
- Generating Station (Proposed)
- Generating Station
- Transmission Line KN36
- Bipole I and II (Existing 500 kV DC Line)
- Other Existing Transmission Line

Coordinate System:UTM Zone 15N NAD83
Data Source: ECOSTEM Ltd., MB Cons, MB Hydro, NTS.
Date Created: September 27, 2012

N

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0 1 2 Miles

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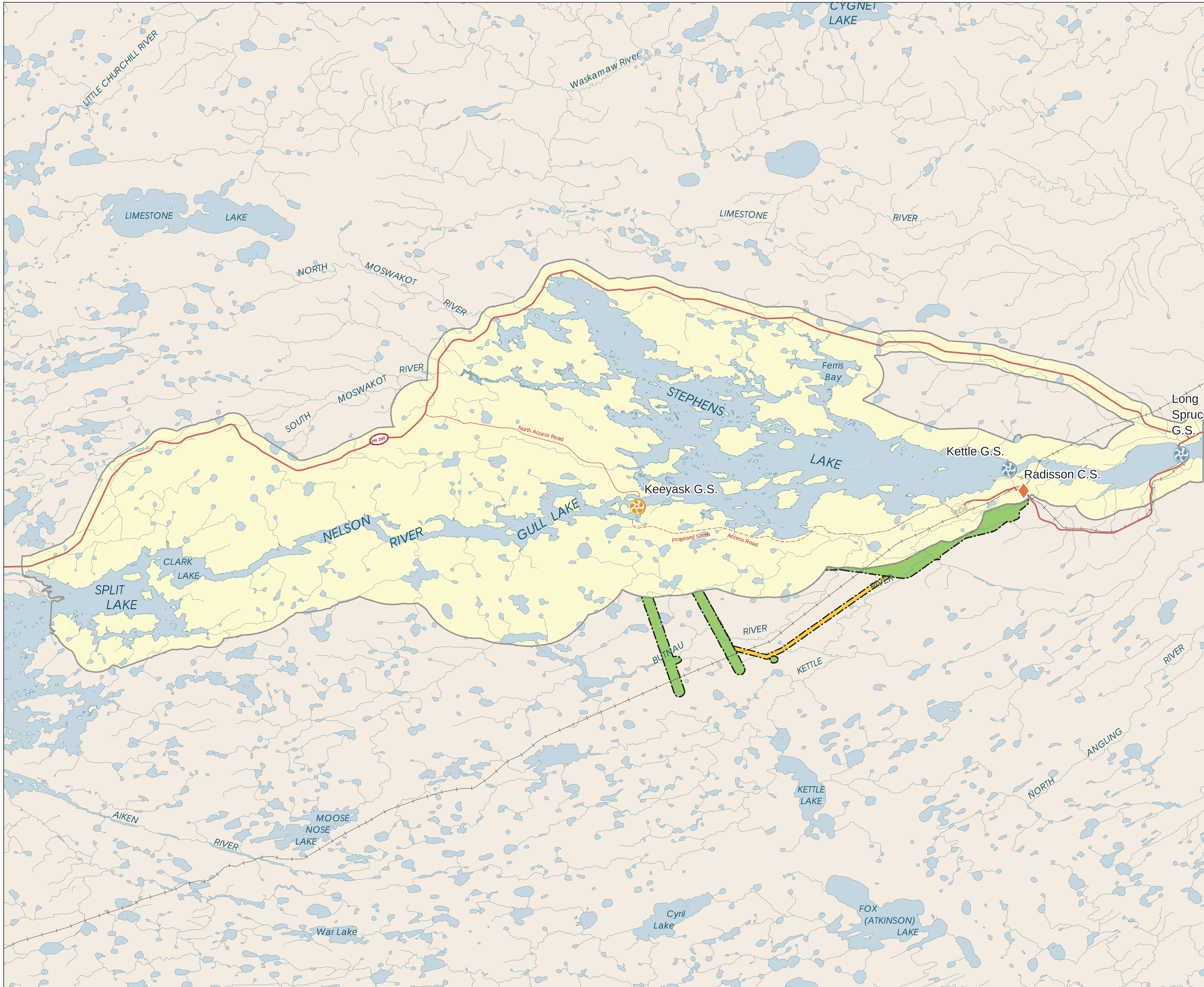
Local and Regional Study Area Used for the Alternative Routes Evaluation

Map 2-1

File Location: Z:\Workspaces\Keeyask Transmission\Figures\Map 2-1 Local and Regional Study Areas Used for the Terrestrial Habitat, Ecosystems and Plants Evaluation V8.wor



Manitoba Hydro

Keeyask Transmission Project

Mapping Areas
- Keeyask Transmission Detailed Mapping Area
- Ecosite and Priority Habitat Only Mapping Area
- Keeyask G.S. Detailed Mapping Area

Infrastructure
- Converter Station
- Generating Station (Proposed)
- Generating Station
- Keeyask G.S. North Access Road
- Proposed Access Road

Landbase
- Provincial Road
- Municipal Road
- Active Railway

Coordinate System:UTM Zone 15N NAD83
Data Source: MB Hydro, MB Cons, ECOSTEM Ltd., NTS.
Date Created: September 27, 2012

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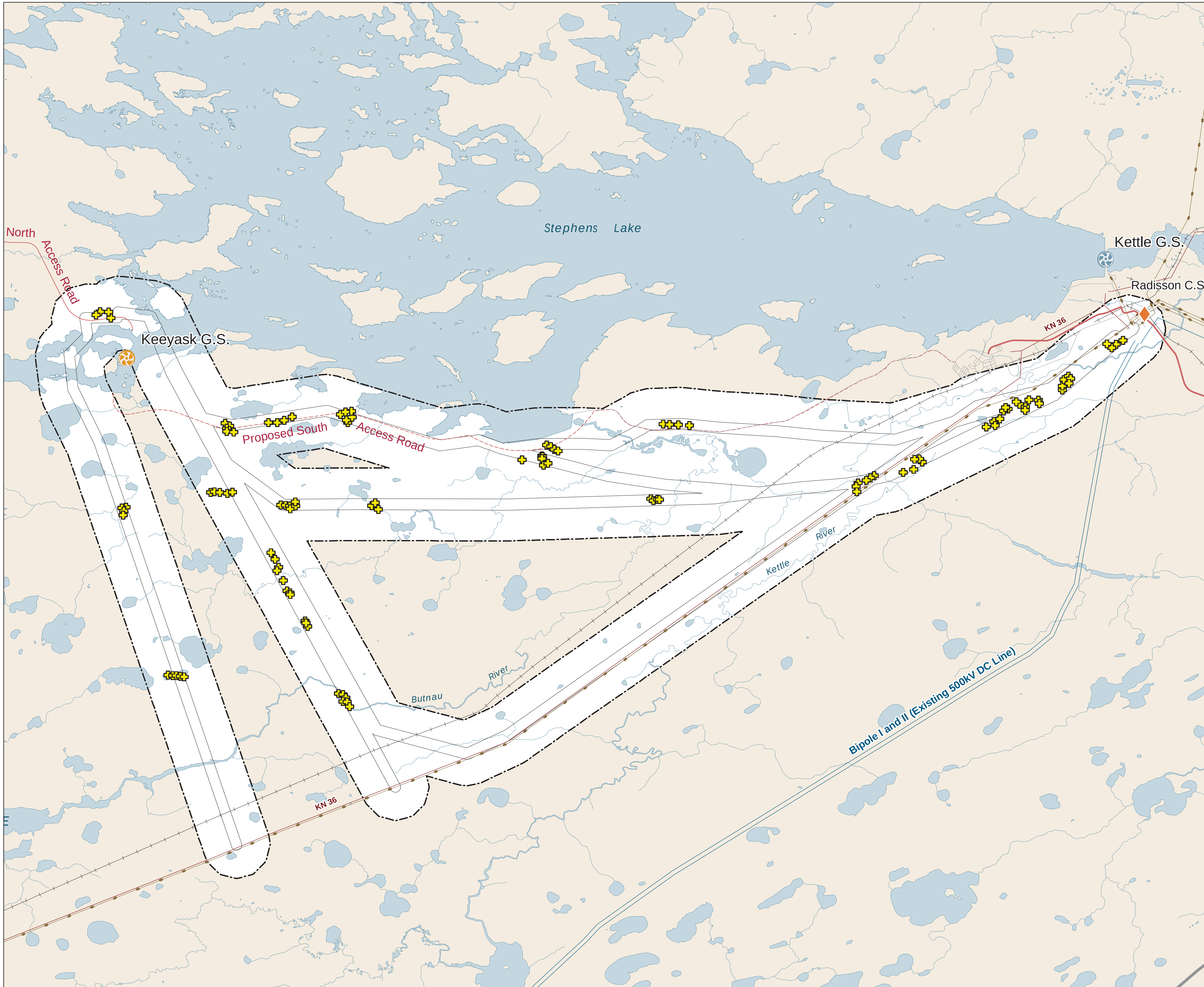
Detailed Terrestrial Habitat Mapping Area

Map 2-2

File Location: Z:\Workspaces\Keeyask Transmission\Figures\Map 2-2 Keeyask Transmission Detailed Habitat Mapping Area V5.wor



Keeyask Transmission Project

Upland and Peatland Sample Locations

- Sample Plot

Study Areas

- Local Study Area for Alternative Routes Evaluation
- Detailed Analysis Corridors

Infrastructure

- Converter Station
- Generating Station (Proposed)
- Generating Station
- Keeyask G.S. North Access Road
- Proposed Access Road
- Bipole I and II (Existing 500 kV DC Line)
- Other Existing Transmission Line
- Transmission Line KN36

Landbase

- Provincial Road
- Municipal Road
- Active Railway

Coordinate System:UTM Zone 15N NAD83
Data Source: ECOSTEM Ltd., MB Hydro, MB Cons, NTS
Date Created: September 27, 2012

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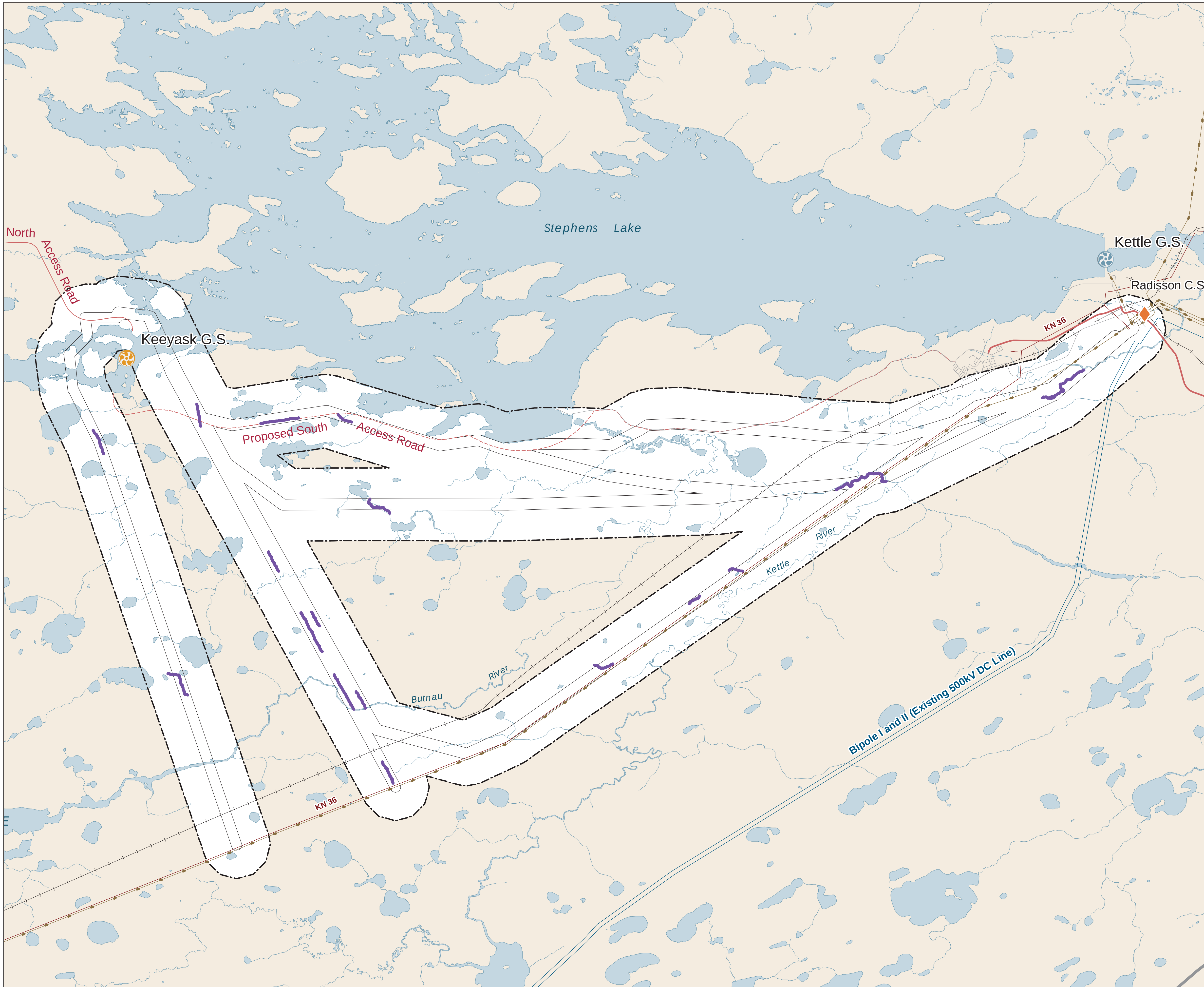
Habitat Sample Locations

Map 2-3

File Location: Z:\Workspaces\Keeyask Transmission\Keeyask Transmission\Figures\Map 2-3 Keeyask Transmission Priority Habitat Sample Locations V6.wor



Manitoba Hydro

Keeyask Transmission Project

Priority Plant Sample Locations

- Sample Transect

Study Areas

- Local Study Area for Alternative Routes Evaluation
- Detailed Analysis Corridors

Infrastructure

- Converter Station
- Generating Station (Proposed)
- Generating Station
- Keeyask G.S. North Access Road
- Proposed Access Road
- Bipole I and II (Existing 500 kV DC Line)
- Other Existing Transmission Line
- Transmission Line KN36

Landbase

- Provincial Road
- Municipal Road
- Active Railway

Coordinate System:UTM Zone 15N NAD83
Data Source: ECOSTEM Ltd., MB Hydro, MB Cons, NTS
Date Created: September 27, 2012

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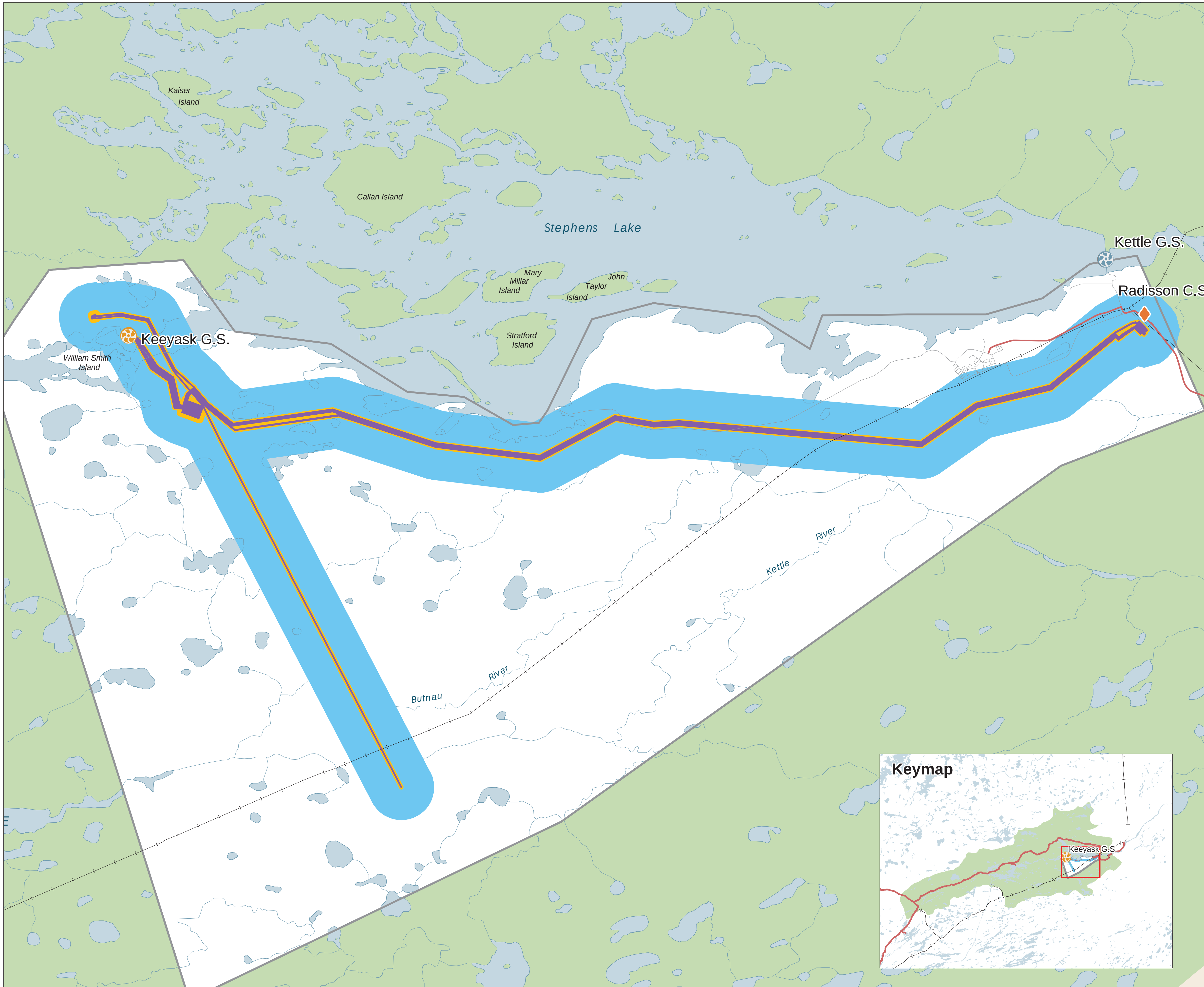
Priority and Invasive Plant Transect Locations

Map 2-4

File Location: Z:\Workspaces\Keeyask Transmission\Keeyask Transmission\Figures\Map 2-4 Keeyask Transmission Priority and Invasive Plant Sample Locations V6.wor



Manitoba Hydro

Keeyask Transmission Project

Study Areas

- Project Footprint
- Ecosystem Diversity and Terrestrial Plants Local Study Area
- Fragmentation Local Study Area
- Regional Study Area
- Project Study Area

Infrastructure

- Converter Station
- Generating Station (Proposed)
- Generating Station

Landbase

- Provincial Road
- Municipal Road
- Active Railway

Note: Each study area includes all of the study areas nested within it

Coordinate System:UTM Zone 15N NAD83
Data Source: ECOSTEM Ltd., MB Conservation, NTS.
Date Created: September 27, 2012

N

0 2 4 Kilometres
0 1 2 Miles

1:150,000

Local Study Areas Used for the Project Effects Assessment

Map 2-5

File Location: Z:\Workspaces\Keeyask Transmission\Figures\Map 2-5 Local Study Areas for Project Effects Assessment V6.wor