LABRADOR – ISLAND TRANSMISSION LINK ENVIRONMENTAL ASSESSMENT

Viewscapes Component Study

August 2011

nalcor energy
LOWER CHURCHILL PROJECT

LABRADOR – ISLAND TRANSMISSION LINK ENVIRONMENTAL ASSESSMENT
Environmental Component Studies: Introduction and Overview

Nalcor Energy is proposing to develop the *Labrador – Island Transmission Link* (the Project), a High Voltage Direct Current (HVdc) electrical transmission system extending from Central Labrador to the Avalon Peninsula on the Island of Newfoundland.

The Project was registered under the Newfoundland and Labrador *Environmental Protection Act* (*NLEPA*) and the *Canadian Environmental Assessment Act* (*CEAA*) in January 2009 (with subsequent amendments and updates), in order to initiate the provincial and federal environmental assessment (EA) processes. Following public and governmental review of that submission, an Environmental Impact Statement (EIS) was required for the Project. The EIS is being developed by Nalcor Energy, in accordance with the requirements of both *NLEPA* and *CEAA* and the *EIS Guidelines and Scoping Document* issued by the provincial and federal governments.

In support of the Project's EIS, Nalcor Energy has undertaken a series of environmental studies to collect and/or compile information on the existing biophysical and socioeconomic environments and to identify and assess potential Project-environment interactions. This environmental study program has included field surveys, associated mapping and analysis, environmental modeling, and the compilation and analysis of existing and available information and datasets on key environmental components. This report comprises one of these supporting environmental studies.

A general guide to these Environmental Component Studies, some of which are comprised of multiple associated reports, is provided on the opposite page.

The information reported herein will be incorporated into the Project's EIS, along with any additional available information, to describe the existing (baseline) environmental conditions and/or for use in the assessment and evaluation of the Project's potential environmental effects and in the identification and development of mitigation.

This study focuses on the relevant aspects of the proposed Project – including the proposed and alternative HVdc transmission corridors, marine cable crossings, and/or other Project components and activities – as known and defined at the time that the EA process was initiated and/or when the study commenced. Project planning and design are ongoing, and as is the case for any proposed development, the Project description has and will continue to evolve as engineering and EA work continue. The EIS itself will describe and assess the specific Project components and activities for which EA approval is being sought, and will also identify and evaluate other, alternative means of carrying out the Project that are technically and economically feasible as is required by EA legislation.

The EIS and these Component Studies will be subject to review by governments, Aboriginal and stakeholder groups and the public as part of the EA process.

Nalcor Energy – Lower Churchill Project

LABRADOR-ISLAND TRANSMISSION LINK: ENVIRONMENTAL COMPONENT STUDIES (CSs)

Component Study	Report	Report
1) Vegetation CS	Report 1a Ecological Land Classification	Report 1b Wetlands Inventory & Classification
	Report 1c Regionally Uncommon Plants Model	Report 1d Timber Resources
	Report 1e Vegetation Supplementary Report	
2) Avifauna CS		
3) Caribou & Other Large Mammals CS	Report 3a Caribou & Their Predators	Report 3b Moose & Black Bear
4) Furbearers & Small Mammals CS		
5) Marine Environment: Fish & Fish Habitat, Water Resources CS	Report 5a Marine Fish: Information Review	Report 5b Marine Flora, Fauna & Habitat Survey
	Report 5c Marine Habitats (Geophysical) Survey	Report 5d Water, Sediment & Benthic Surveys
	Report 5e Marine Surveys: Electrode Sites	Report 5f Marine Surveys: Supplementary
6) Freshwater Environment: Fish & Fish Habitat, Water Resources CS		
7) Marine Environment: Marine Mammals, Sea Turtles & Seabirds CS	Report 7a Marine Mammals, Sea Turtles & Seabirds: Information Review	Report 7b Marine Mammal & Seabird Surveys
	Report 7c Ambient Noise & Marine Mammal Surveys	
8) Species of Special Conservation Concern CS		
9) Marine Environment & Effects Modelling CS	Report 9a Strait of Belle Isle: Oceanographic Environment & Sediment Modelling	Report 9b Strait of Belle Isle: Marine Sound Modelling - Cable Construction
	Report 9c Electrodes: Environmental Modelling	
10) Historic & Heritage Resources CS		
11) Socioeconomic Environment: Communities, Land & Resource Use, Tourism & Recreation CS	Report 11a Communities, Land & Resource Use, Tourism & Recreation	Report 11b Current Levels of Accessibility Along the Transmission Corridor
12) Socioeconomic Environment: Aboriginal Communities & Land Use CS		
13) Socioeconomic Environment: Marine Fisheries in the Strait of Belle Isle CS		
14) Viewscapes CS		

Environmental Component Study Required Under the EIS Guidelines: Comprising Reports (Shaded cells above)	
Avifauna: 2, 7a, 7b	Furbearers: 4
Caribou (and Predators): 3a	Timber Resources: 1d
Water (Quality and Quantity): 5a, 5d, 5e, 5f, 6	Marine and Freshwater Fish and Fish Habitat: 5, 6, 7, 13
Species at Risk: 8	Historic Resources: 10
Viewscapes: 14	Socioeconomics: 11, 12, 13
Environmental study reports submitted as additional background information: 1a, 1b, 1c, 1e, 3b, 9	

Labrador – Island Transmission Link

Viewscapes Component Study:
Conceptual Illustrations and Viewshed Modelling

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1.0 INTRODUCTION

Nalcor Energy is proposing to develop the *Labrador – Island Transmission Link* (the Project), a High Voltage Direct Current (HVdc) transmission system extending from Central Labrador to the Island of Newfoundland's Avalon Peninsula.

The environmental assessment (EA) process for the Project was initiated in January 2009 and is in progress. An Environmental Impact Statement (EIS) is being prepared by Nalcor Energy, which will be submitted for review by governments, Aboriginal and stakeholder groups and the public.

In preparation for and support of the EA of the Project, this Viewscapes Component Study was completed with the objective of determining the likely appearance and potential visibility of the proposed transmission line within the defined Study Area. This report includes: 1) conceptual drawings of the transmission line in generic settings; 2) site- / location-specific modelled views (photosimulations); and 3) viewshed / visibility modelling.

1.1 Project Overview

The proposed Project involves the construction and operation of transmission infrastructure within and between Labrador and the Island of Newfoundland. Nalcor Energy is proposing to establish an HVdc transmission system extending from Central Labrador to Soldiers Pond on the Island of Newfoundland's Avalon Peninsula.

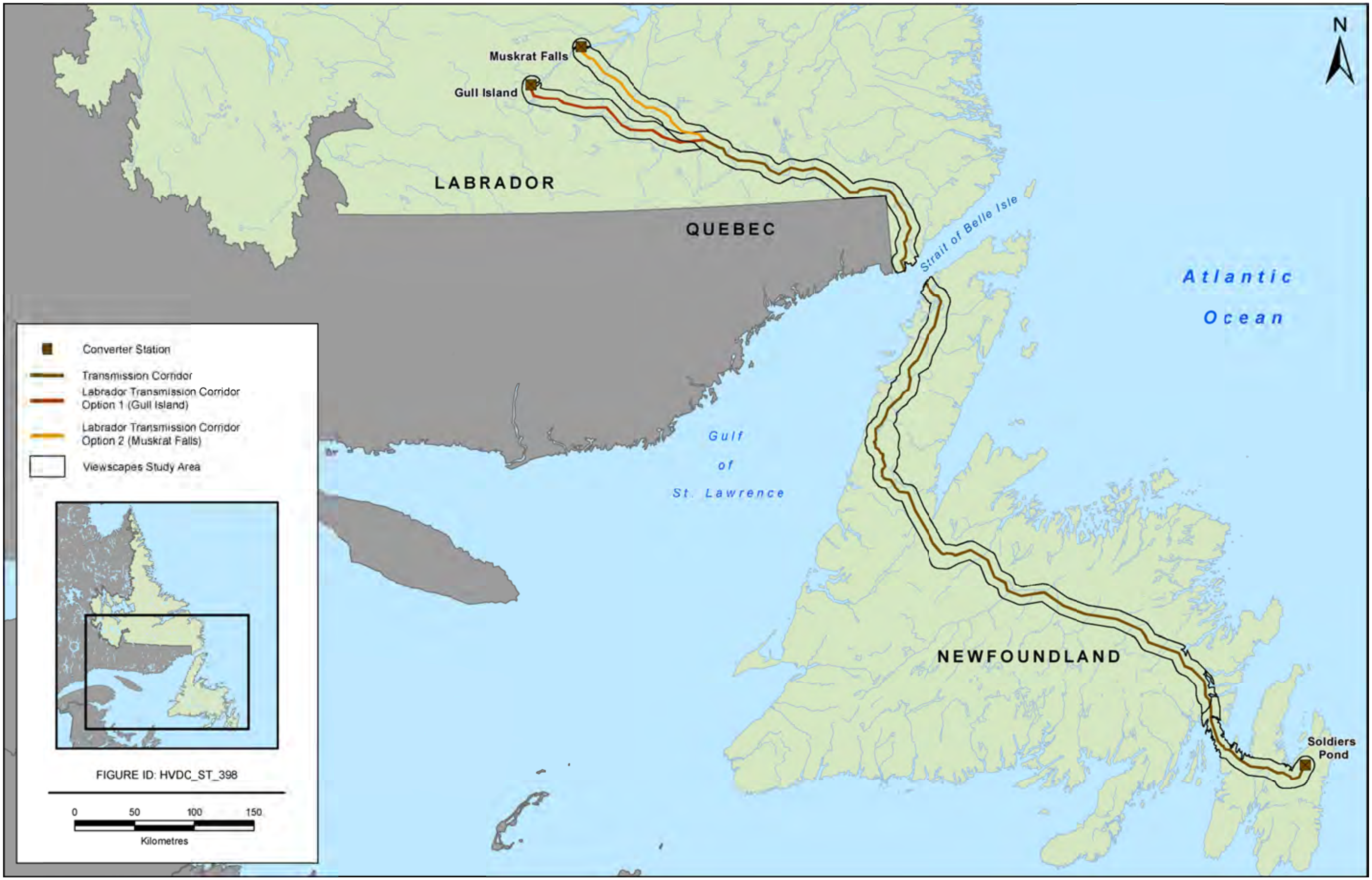
The proposed transmission system, as currently planned, will include the following key components:

- an ac-dc converter station in Central Labrador, on the lower Churchill River adjacent to the Lower Churchill Hydroelectric Generation Project;
- an HVdc transmission line extending across Southeastern Labrador to the Strait of Belle Isle. This overhead transmission line will be approximately 400 km in length with a cleared right-of-way averaging approximately 60 m wide, and consist of single galvanized steel lattice towers;
- cable crossings of the Strait of Belle Isle (SOBI) with associated infrastructure, including cables placed across the Strait through various means to provide the required cable protection;
- an HVdc transmission line (similar to that described above) extending from the Strait of Belle Isle across the Island of Newfoundland to the Avalon Peninsula, for a distance of approximately 700 km;
- a dc-ac converter station at Soldiers Pond on the Island of Newfoundland's Avalon Peninsula; and
- electrodes at each end of the HVdc transmission line in Labrador and on the Island of Newfoundland, with overhead lines connecting them to their respective converter stations.

Project planning and design are currently at a stage of having identified a 2 km wide corridor for the on-land portions of the proposed HVdc transmission line and 500 m wide corridors for the proposed Strait of Belle Isle cable crossings, as well as various alternative corridor segments in particular areas (Figure 1.1).

At the time of the commencement of the EA and its associated environmental studies, the Labrador component of the Project included a converter station facility at Gull Island on the lower Churchill River, as well as a

Figure 1.1 Labrador – Island Transmission Link: Viewscapes Study Area



proposed transmission corridor extending from Gull Island to the Strait of Belle Isle. In mid-November 2010, Nalcor Energy advised the provincial and federal governments that it would also be assessing the potential option of locating the Project's Labrador converter station at or near the Muskrat Falls site on the lower Churchill River. If that were to be the case, the Labrador transmission corridor would potentially extend from Muskrat Falls to the Trans Labrador Highway (TLH) Phase 3, and then follow generally along the south side of the highway to approximately its southernmost point before meeting and continuing along the previously identified corridor from that location to the Strait of Belle Isle (Figure 1.1).

This study includes consideration of both the Gull Island and Muskrat Falls corridor options in Labrador.

It is these proposed transmission corridors and components that were the subject of Nalcor Energy's environmental study program. Project planning is in progress, and it is anticipated that the Project description will continue to evolve as engineering and design work continue. The EA of the Project will also identify and evaluate alternative means of carrying out the Project that are technically and economically feasible.

In conjunction and concurrent with the EA process, Nalcor Energy will be continuing with its technical and environmental analyses of the corridors, in order to identify and select a specific routing for the Project. The eventual transmission routes and locations will be selected with consideration of technical, environmental and socioeconomic factors.

1.2 Study Purpose and Objectives

The objective of this Viewscapes Component Study was to determine the likely appearance and potential visibility of the proposed transmission line within the defined Study Area. This report includes:

1) conceptual drawings of the transmission line in generic settings;
2) site- / location-specific modelled views (photosimulations); and
3) viewshed / visibility modelling.

The visual assessment considers the potential appearance and visibility of the completed transmission line infrastructure based on the proposed transmission corridor centreline (approximately 415 km from Gull Island to the SOBI; approximately 385 km from Muskrat Falls to the SOBI) in Labrador and 687 km in Newfoundland) and hypothetical pole placement with 300 m spacing (1,387 in Labrador and 2,292 in Newfoundland).

2.0 APPROACH AND METHODS

This section describes the methodology used for each of the study components: conceptual illustrations, site-specific photosimulations and viewshed analysis. The proposed transmission corridor being assessed is illustrated in Figure1.1.

Using a methodology that is based on generally accepted standards and procedures by various government agencies (e.g., BC Ministry of Forest, Canadian Forest Service) and private industry, the visual assessment employs:

- a quantitative approach to viewshed analysis that identifies how many transmission towers are potentially visible from a specific location; and
- a composite visual exposure analysis that helps to explain the potential effect of the proposed infrastructure based on proximity to features such as highways, local roads, urban or built-up areas, etc.

The Study Area was based on the previously defined study area boundary for the HVdc Ecological Land Classification (ELC) (Stantec 2010, 2011), which is defined by an approximately 15 km wide study area from Central Labrador (Gull Island or Muskrat Falls) to Soldiers Pond in Newfoundland. All modeling and imagery within this report represents the data contained within the defined Study Area.

2.1 Data Sources

This study involved the collection, import, rectification and production of data from various sources. Much of the data used for this assessment were previously prepared by the Project team for other component studies. All data layers were further refined to present complete seamless data sets that cover the entire Study Area.

All data compiled for this study are documented in Table 2.1, which includes a brief description of the data and source.

Table 2.1 Data Used in this Study

Data Layer	Description	Data Source
Digital Elevation Model (DEM)	The DEM represents ground topography (ground elevations) based on the 1:50,000 National Topographic Data Base	Centre of Topographic Information - Natural Resources Canada (www.geobase.ca)
Aerial Photography	The orthocorrected digital aerial photography has a spatial resolution of 60 cm and is produced at a scale of 1:30,000. The vintage of the photography ranged from 1999 to 2006 and covers central Newfoundland	Air Photo and Map Library - Newfoundland and Labrador Department of Government Service and Lands
Satellite Imagery	The high-resolution SPOT 5 satellite imagery has a spatial resolution of 2.5 m (panchromatic) and 5 m (multispectral). The vintage of the imagery ranged from 2005 to 2008	Iunctus Geomatics Corp.
ELC	The regional ELC identifies, categorizes and evaluates vegetation types and associated habitats along the proposed transmission corridors	Stantec 2010, 2011

Table 2.1 Data Used in this Study (continued)

Data Layer	Description	Data Source
Forestry Stands	Provincial government digital forestry data identify merchantable timber stands and species composition, height, age and density	Government of Newfoundland and Labrador Natural Resources - Forestry Services Branch
Infrastructure and natural features	Roads, watercourses, water bodies and existing transmission lines were extracted from the 1:50,000 National Topographic Data Base. Existing transmission lines were updated by Nalcor Energy to improve accuracy	Centre of Topographic Information - Natural Resources Canada Nalcor Energy
3D Tower Structures	Draft proposed 3D tower structures and Project components were created from Nalcor Energy engineering specifications	Nalcor Energy

2.2 Technology Application

The GIS software used to assemble the spatial data and perform the analysis is ESRI's ArcGIS ArcINFO version 9.3, along with the 3D Analyst and Spatial Analyst extensions. In addition to the GIS tools, specialized 3D rendering and graphics packages were employed to create the conceptual illustrations and site-specific photosimulations. Google SketchUp, Autodesk 3DS Max2011 and Adobe Photoshop software were used to model the viewscapes, create the tower and Project components designs and output the final products.

At this stage of the EA, Project engineering is ongoing, and to create visual models of the Project involves several assumptions. For modeling purposes, the location of the right-of-way has been selected along the centreline of the proposed 2 km wide transmission corridor and has used information available at the current stage of engineering. Tower point locations were derived by placing a point every 300 m along the proposed transmission corridor centreline from Central Labrador (both Gull Island and Muskrat Falls corridor options were modelled) to Soldiers Pond on the Avalon Peninsula. The appearance of the proposed tower structures was based on engineering design specifications provided by Nalcor Energy. Average tower heights were estimated at 43 m for the entire line for modelling purposes. At this stage of the EA and conceptual stage of engineering design, the assumptions are appropriate for the purposes of the study. The specific tower characteristics, placements, and spacing will be determined post-EA.

2.2.1 Conceptual Illustrations

The conceptual illustrations were used to investigate the visibility of the proposed towers and right-of-way for five representative areas found within the corridor. Due to the remote nature of some of these locations, 3D models of each of these locations were constructed to help visualize the change in the baseline environment.

Using the land classification imagery and habitat definitions in the Ecological Land Classification (Stantec 2010), three dimensional "ecosystems" were constructed using DEM files of the corridor study area and Autodesk 3DS Max 2011 for each habitat classification. In all cases, realistic 3D models for ground cover and grasses, shrubs, understory vegetation, and mature vegetation and forests were constructed to simulate a specific land classification. Naturally occurring objects (i.e., rock outcrops, water bodies, etc.) were added to the models based on photographs and habitat descriptions in the ELC (Stantec 2010).

A terrain model was then constructed at a 7.5 km radius around each of the five representative areas using Autodesk 3DS Max 2011. ArcView Shape files for each land classification were imported and overlaid on the terrain models to provide a visual reference for how each location was sub-divided according to individually defined habitats. Using that, the previously modelled 3D ecosystems for each defined habitat were applied to the areas of the terrain that were covered by the corresponding land classification maps. For example, the 3D ecosystem that was built for the Conifer Forest habitat type was applied to the areas of the terrain model that were outlined by the Conifer Forest shape file. All bodies of water, roadways, existing transmission lines, and built structures identified in aerial photographs were modelled into the scene.

After the appropriate habitat types were applied to the terrain model, a 60 m wide swath of all the mature vegetation models along the corridor centreline was removed. The 3D models of the tower structures were inserted at the given intervals along the corridor centreline within this simulated right-of-way. Final views were selected to illustrate specific representative areas from a typical person's point of view (approximately 1.5 m above the ground) and from an elevated position (approximately 50 m to 75 m above the ground).

2.2.2 Site-specific Photosimulations

In many cases, direct comparison between the existing conditions and the proposed conditions is the most effective way to visualize the proposed project. Using the proposed plans, 3D models were generated, then overlaid on a photograph to help visualize the Project on the landscape at select locations.

2.2.2.1 Landscape Modelling

A series of DEM files were used to generate an existing conditions surface model for the entire length of the transmission corridor for the Study Area. These surface models were generated using the lowest possible contour interval. All fixed structures on the survey were constructed using as much detail as the survey had available (e.g., building footprints are extruded up to create solid shape). Then, supporting information was re-projected and overlaid on the surface (i.e., aerial photos, site plan renderings, GIS shape files, additional CAD layers, etc.).

2.2.2.2 Selection of Sites to be used for Photosimulations

Many of the sites of interest were selected in locations where the transmission corridor intersects travelled roads or passes near inhabited lands. Information was also obtained from the *Communities, Land and Resource Use, Tourism and Recreation* study (Amec 2010, 2011), as it contained relevant data on land use near the corridor. During Nalcor Energy's consultation initiatives with public and Aboriginal stakeholders, issues and concerns with the Project changing the viewscape were identified and were also considered in the selection of the sites. The selected sites, and the rationale behind their selection, are presented in Table 2.2 and are illustrated in Figure 2.1. Sites were visited and photographed. Sites on the Northern Peninsula and Central Newfoundland were accessed via helicopter, and all other sites were accessed via vehicle.

The number and sensitivity of users considered the following:

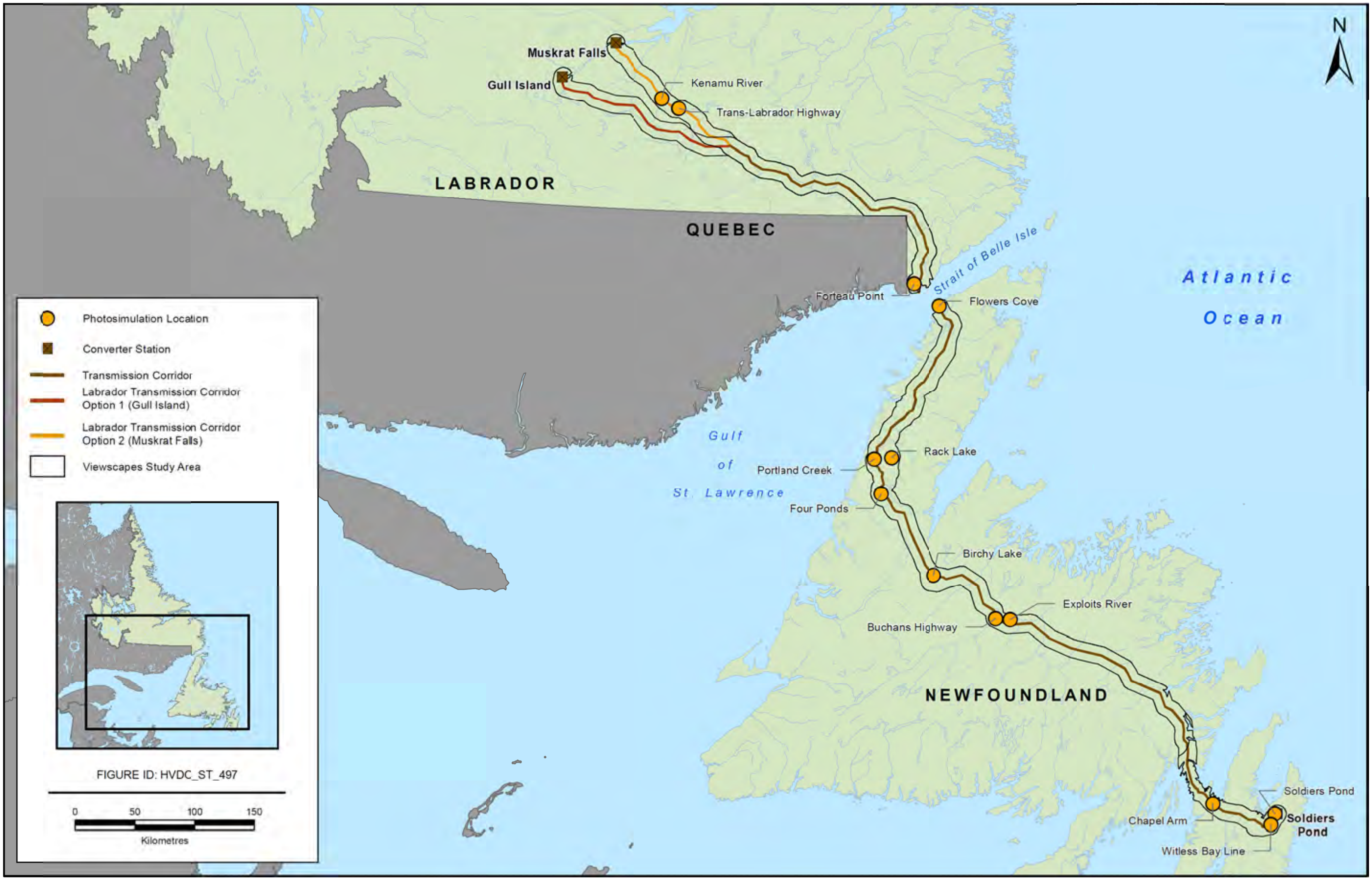
1) Public Road Crossings: The greatest number of transmission corridor views will be seen by people travelling highways. The transmission corridor crosses highways at the sites at Trans Labrador Highway, Kenamu River, Forteau Point, Flower's Cove, Birchy Lake, Buchans Highway, Chapel Arm, Witless Bay Line and Soldiers Pond.

2) Remote Sites: The transmission corridor traverses more than a 1,000 km of remote landscape scenery. Not a great number, but a select few people, interested in outdoor recreation, travel to the remote parts of the province. A representative sample of remote recreation sites, in the vicinity of the transmission corridor, was analyzed. The sample includes Portland Creek Pond, Rack Lake, Four Ponds, and Exploits River near the Riverfront Chalet.

Table 2.2 Sites Selected and their Rationale

Site #	Name / Location	Rationale
01	Trans Labrador Highway Phase III South-central Labrador	- Trans Labrador Highway - Area of interest based on consultation with stakeholders
02	Kenamu River South-central Labrador	- Kenamu River crossed by Trans Labrador Highway; Recreational use - Area of interest based on consultation with stakeholders
03	Forteau Point / Southeastern Labrador	- Crossing area near existing highways and communities
04	Flower's Cove / top of Northern Peninsula	- Main road to St. Anthony, L'Anse aux Meadows
05	Portland Creek Pond / middle of Northern Peninsula	- Outfitters, boating, International Appalachian Trail
06	Rack Lake / middle of Northern Peninsula	- Outfitters, high land, minimal tree cover
07	Four Ponds / lower middle of Northern Peninsula	- Outfitters, International Appalachian Trail
08	Birchy Lake / west side of Central Newfoundland	- Main route, recreation area
09	Buchans Highway Route 370 / Central Newfoundland	- Tall tree cover, community road, Exploits River
10	Exploits River / Central Newfoundland	- Recreational rafting, Exploits River
11	Chapel Arm Route 201 / Isthmus of Avalon	- Spur road off Trans-Canada Highway (TCH)
12	Witless Bay Line / Avalon Peninsula	- Existing transmission line, silhouettes on flat expanse of land
13	Soldiers Pond / Avalon Peninsula	- Converter station near TCH

Figure 2.1 Site-Specific Photosimulation Locations



2.2.2.3 Field Stage Photographic Recording Method

The preselected viewpoints were photographed. A Ricoh 500SE digital camera or a Nikon D60 was used to collect field images. The Ricoh camera was accessorized with a digital Global Positioning System (GPS) module to record x, y and z coordinates at each viewpoint. A handheld GPS was used with the Nikon, (and was also used as a backup with the Ricoh) and hard copy notes were also made. A digital compass Ricoh module was used to record horizontal view directions. All photographs were standardized with a lens focal length of 50 mm (or 55 mm). Note: either length approximates the view perceived by the human eye on site (and is the equivalent of 35 mm film) (British Columbia Ministry of Forestry 2001). The camera was mounted on a sturdy, rotating tripod adjusted to a height of 1.5 m – matching the average adult North American eye level (Henry Dreyfus Associates, 1973). The entire landform at each site was captured by rotating the camera through a 360° panoramic sequence.

2.2.2.4 Creation of Photosimulations

The GPS data and camera properties (i.e., lens focal length, aperture, pixel dimension and height above the ground) were used to build identical 3D, or "virtual cameras", into the landscape model. Using the selected photos as a backdrop behind a wireframe view of the terrain model, the virtual camera location and bearing could then be verified, allowing the natural shape of the terrain model to line up with the landforms in the photographs.

Once verified, the 'virtual cameras' were locked in place to prevent accidental movement. At this point, the approved tower structures were added to the landscape model using Autodesk 3DS Max 2011. The time of day and atmospheric conditions were entered into the environmental settings to ensure accurate lighting and shadow conditions. Once the proposed corridor and transmission towers were built, image files were rendered and overlaid on the photographs in Photoshop. If existing foreground elements needed to be removed, they were identified on the survey and erased from the photo.

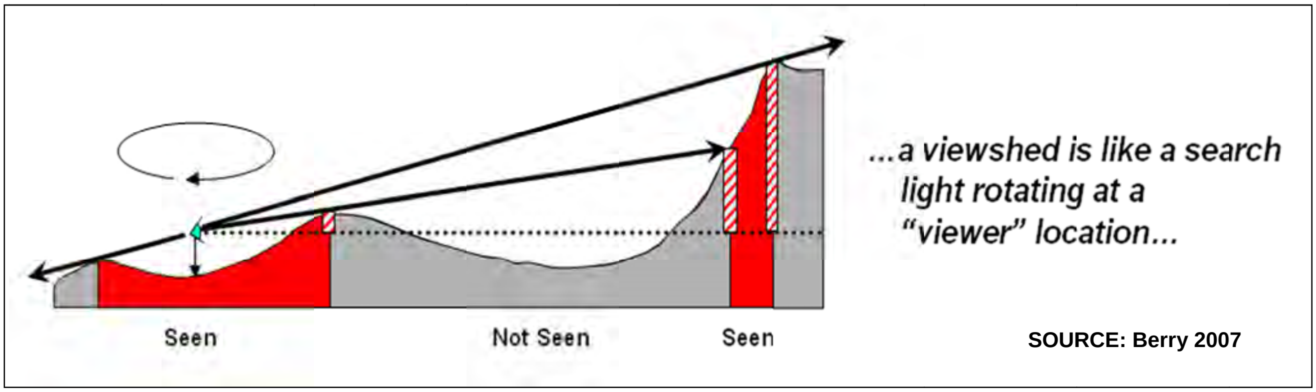
2.2.3 Viewshed Modelling

2.2.3.1 Potential Number of Transmission Towers Visible

Identifying potential visually affected areas was accomplished by generating a viewshed map to help predict whether or not a section of the proposed transmission line infrastructure is likely to be visible from any given location within the visual assessment area. Viewshed modelling is a useful approach to identify geographic areas on the landscape that could potentially see portions of the proposed Project. The viewshed map prepared for this Project is based upon two main inputs, the DEM (or surface of the Earth) and the vegetation. In this study, an individual's viewscape is a function of the distance away from an object, the line of sight as defined by the terrain, and the screening imposed by vegetation cover. A graphic representation of these elements is shown in Figure 2.2 (Berry 2007).

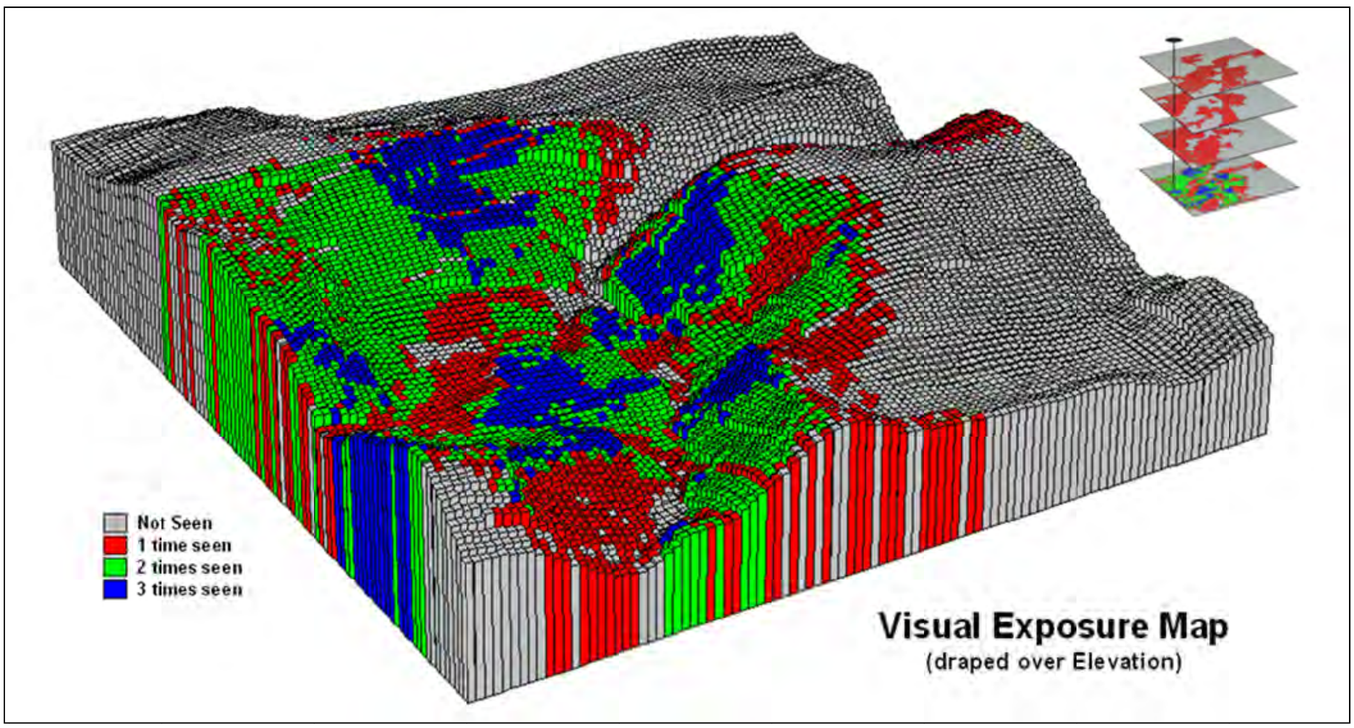
Viewshed analysis works by identifying cells in an input raster, usually a DEM, which can be viewed from one or more observation points. Each cell in the output raster is given a value that specifies the number of observer points that can be seen from any given location within the Study Area (ESRI 2009).

Figure 2.2 Graphic Representation of Viewshed Map Preparation



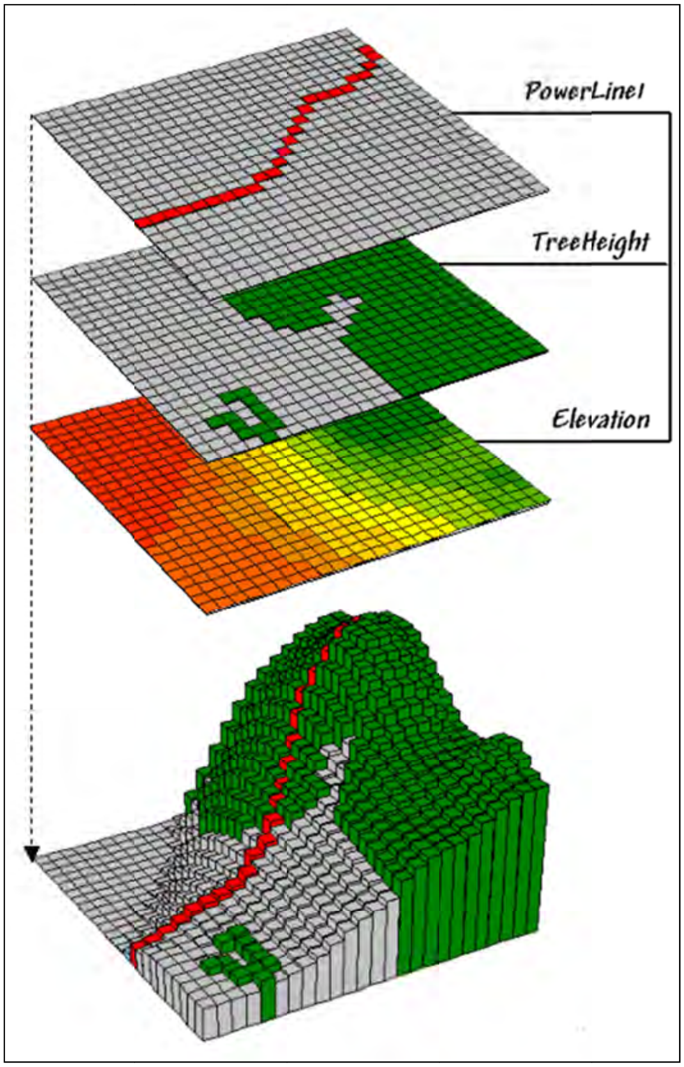
A graphic example of how a viewshed analysis works is provided in Figure 2.3. A series of waves radiate out from the observation point (e.g., transmission tower) and as the wave expands, the distance from the observation point (run) and the elevation difference between the observation point and any given cell (rise) are calculated to derive a rise / run ratio. If the rise / run ratio for each cell is greater than any of the previous ring rise / run values along a straight line from the observer point, the cell is marked as viewed. Similarly, if the rise / run ratio is smaller than the previous cells, the cell is marked as not seen (Berry 2007).

Figure 2.3 Graphic Example of How a Viewshed Analysis Works



To improve the accuracy of the viewshed analysis, forested areas have been added to the DEM. The forest canopy heights raise the surface elevation to equal the forest height. The forested areas act as vegetated screens, blocking the view of the observation point. How the GIS interprets the addition of vegetation height to a DEM and visual model is illustrated in Figure 2.4 (Berry 2007).

Figure 2.4 Interpreting Addition of Vegetation into Model



The viewshed modelling used DEMs (topography) from Natural Resources Canada and a combination of Newfoundland and Labrador Forest Resource Inventory (FRI) data and the ELC to account for vegetation cover heights. Using ESRI 9.3 ArcGIS software (ArcMap and ArcGIS Spatial Analyst extension), a vegetation layer was created by combining the FRI and the ELC datasets. Vegetation heights were calculated by summarizing overlapping forest cover data to get an average stand height for the ELC vegetation habitat types (polygons).

Road network data for the province were processed to create right-of-ways. The centreline data were buffered based on road class to better represent the actual existing cleared right-of-way for each road type. Existing transmission line and proposed transmission line corridor centreline right-of-ways were created and added to the vegetation layer with a zero tree height classification. The modified vegetation layer was then converted into a gridded raster reflecting vegetation heights. This vegetation height grid was then added to the base DEM to produce a new input grid that more closely represents the real world by incorporating vegetative screening. It should be noted that vegetation data were not available within populated areas and other barriers to line of sight such as building structures were not accounted for. This resulted in a likely overestimation of the potential visibility of proposed transmission line structures within developed areas, which are limited.

For the purpose of the viewshed study, the hypothetical tower locations were used as the vantage points when running the viewshed analysis. In other words, the computer model determines the cells in the DEM that can be seen from each of the 3,679 hypothetical tower location points. When a cell in the DEM was identified as being within line of sight of a tower, it is given a value of 1 and, conversely, if it is identified as not being seen it is given a value of 0. If a particular cell in the DEM was in view by more than one tower, then a value of 1 is added. Therefore cells that were visible from a higher number of towers would receive a higher score (equal to the number of towers that cell is visible from).

2.2.3.2 Visual Exposure

The purpose of the visual exposure analysis was to build from the viewshed analysis by identifying areas within the Study Area that have a greater potential to be visually affected by the Project. The exercise uses a variety of inputs that are weighted according to their potential interaction with the Project. The composite analysis is applied by multiplying the viewshed output grid by the input layers and its associated weight. All inputs were first combined into one grid and input rankings were multiplied together to produce an overall ranked dataset. Therefore, areas that overlap with multiple criteria have a greater probability of viewing the proposed transmission line.

2.2.4 Composite Analysis Input Layers

This study considers the input of 12 independent datasets which may affect the visual effect within the model. All data layers were quality checked for spatial accuracy by overlaying with satellite imagery and air photos. The following describes the input layers which are presented in Table 2.3.

2.2.5 Existing Transmission Right-of-Way

The presence of existing transmission lines and associated clearing can increase the probability of seeing the proposed transmission line (i.e., the centreline of the corridor). This data input was created by buffering the existing transmission line data from the National Topographic Database (NTDB) Utility Line coverage and modified by Nalcor Energy. The line was buffered by 80 m, which was estimated from random measurements of the existing transmission line right-of-way from satellite and air photo imagery. Existing transmission line right-of-ways have two potential visual effects. It can provide people (i.e., snowmobilers, hikers and berry pickers) access to areas that are considered remote but are within proximity of the proposed transmission line corridor. This could increase the amount of people that come in close proximity to the proposed infrastructure. On the other hand, existing transmission lines can help to decrease the visual effect of the new transmission line as the right-of-way is already cleared and infrastructure already exists. In areas where the proposed transmission tower may be located in close proximity to an existing transmission line, the landscape has already been affected and a new transmission line will have potentially less noticeable effect on the landscape. For these reasons, the existing transmission right-of-ways were given a weighted value of 2.

2.2.6 Transportation Corridors

Roads are classified as local roads, collector roads and highways for the purpose of the visual assessment modelling. Each of the road categories were ranked in accordance to the potential to increase one's ability to view any of the components of the proposed transmission corridor centreline. Local roads, on the bottom of the road hierarchy, were buffered to a width of 30 m (an estimated average) and given a weighted value of 2 based on the limited use of such roads by people. Collector roads, in the middle of the road hierarchy, are buffered to a width of 40 m (an average estimate) and given a weighted value of 3 as collector roads are more heavily used by people. Highways, on the top of the road hierarchy, were buffered to a width of 120 m (an estimated average) and given a weighted value of 5, again, based on usage.

2.2.7 Major River Crossings

Major river crossings represent areas where the proposed transmission line crosses a major river (a double-sided river feature from the NTDB). River crossings have the potential to be viewed by boaters and fishers. Although setbacks, vegetation screening and modified engineering tower design can hide or partially obstruct towers, there may still be a visual effect on the user. Although water crossings only represent a small fraction of the overall Study Area and may only affect a small number of people, the potential visual effect could be substantial and was given a weighted value of 5.

2.2.8 Ridge Crossings

Ridge crossings are the areas where the proposed transmission line crosses elevated peaks and ridges. This dataset is defined using manual interpretation and analysis of the DEM, hill shade and contours to identify areas that have a relatively 'peaked' increase in elevation. These areas were considered due to the potential for towers built on or near the top of a ridge to be more visible as a result of the potential silhouette effect by the sky. A ridge crossing can potentially cause some of the tower structures to be more visible, and therefore, they were given a weighted value of 5.

2.2.9 Urban and Built-up Areas

Urban and built-up areas of approximately 100 residents or more were extracted from the NTDB and were used to identify areas within the Study Area where large concentrations of people live. Urban areas are given a weighted value of 5 because of the potential for higher concentrations of people to view the proposed transmission line.

2.2.10 Proposed Transmission Line Corridor Centreline

The proposed transmission line corridor contains a centreline buffer that represents the hypothetical 60 m wide average cleared right-of-way. This was an important input and given a ranking of 10 due to the potential visual effect of the tower structures. Factors to consider when modelling visual effects include the number of features within a field of view (i.e., viewshed map) and also the observer's proximity to a feature, often referred to as human scale. Although a person may only see one or two tower structures if they are standing in the right-of-way, the proximity to the features will directly relate to the perception of size and scale of that feature. An observer on the cleared right-of-way will have an improved line of sight to the towers and the nearness to the structures will influence their perception of the visual effect. The greatest effect occurs when a right-of-way is cut in a straight line, allowing someone who is standing on the right-of-way to see an endless number of structures down the line for a measurable distance.

2.2.11 Parks and Protected Areas

Parks and protected areas were extracted from the landuse database provided by the Government of Newfoundland and Labrador. Parks and protected areas were considered a major visual assessment component because of their environmental importance and potential increased use and access by people. Parks and protected areas were given a weighted value of 3.

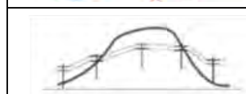
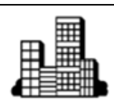
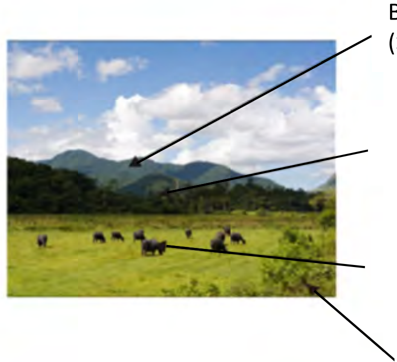
2.2.12 View Length (Distance Zones)

View length refers to an observer's ability to see an object within the landscape with the visual effect of a feature diminishing as the distance increases between the vantage point and the object. In essence, visual effect is directly proportional to distance and the level of contrast between the object and its surroundings decreases as distance increases (Hull and Bishop 1988).

Distances for view lengths were derived based on previous studies (US Forest Service 1973; ESS Group and Upstate NY Power Corp 2008), and were as follows:

- Near ground (0 to 400 m): Within near ground distances, observers will be highly affected due to proximity and scale of the Project components. At this distance, the visual effect is highest on the observer's impression of the proposed infrastructure because of the observer's ability to apply 'human scale' to the Project components. These areas were given a weighted value of 8.
- Foreground (400 to 1,600 m): At the foreground distance, observers will still be highly affected by the Project components due to proximity. At this distance, observers begin to lose the human scale of the components and therefore the visual effect is lessened. These areas were given a weighted value of 6.
- Middleground (1,600 to 4,800 m): At this distance, Project components begin to lose contrast with their surroundings and start to blend in with landscape elements. Project components are still identifiable but are usually muted, depending on where and how they fall within the landscape (i.e., they will blend into background when placed in front of tree cover but will stand out when silhouetted against the sky). These areas were given a weighted value of 4.
- Background (> 4,800 m): At this distance, Project components lose detail and blend into the surrounding landscape. The size of the component limits visibility to strong contrast background (e.g., sky). At this distance, atmospheric elements and the curvature of the Earth tend to blend objects and misrepresent colours. These areas were given a weighted value of 2.

Table 2.3 Composite Analysis Input Layers and Associated Weight

Input Type		Weighted Value	Description
	Existing Transmission Line Buffer (80 m)	2	This visual assessment component represents an estimated average existing transmission line corridor width. A buffer of 80 m is applied to the existing transmission line centreline. Extra importance is given to existing transmission line clearing because of possible use by people (snowmobilers, berry pickers, etc.) giving the area a higher weighted value than the surrounding landscape
	Local Road Buffer (30 m)	2	This visual assessment component represents an estimated average local road width. A buffer of 30 m is applied to the road centreline. Extra importance is given to local roads because of their use by commuter vehicles and residents, giving the area a higher weighted value than the surrounding landscape
	Collector Road Buffer (40 m)	3	This visual assessment component represents an estimated average collector road width. A buffer of 40 m is applied to the roadsides. Extra importance is given to collector roads because of their use by commuter vehicles and residents giving the area a higher weighted value than the surrounding landscape and local roads because collector roads are more heavily used
	Highway Buffer (120 m)	5	This visual assessment component represents an estimated average highway width. A buffer of 120 m is applied to the roadsides. Extra importance is given to highways because of heavy traffic volumes, giving the area a higher weighted value than the surrounding landscape and collector roads because highways have a greater number of users
	Major River Crossings	5	This visual assessment component represents an area along the proposed transmission line corridor centreline that crosses a major river. Extra importance is given to major river crossings because of potential use of waterways by people (boaters, fishers, etc.), giving the area a higher weighted value than the surrounding landscape
	Ridge Crossing	5	This visual assessment component represents an area along the proposed transmission line corridor centreline that crosses ridges or uplands in relation to the surrounding areas. Extra importance is given to ridge crossings because of the increased chance of transmission line towers being viewed at these sites, giving the area a higher weighted value than the surrounding landscape
	Urban and Built-Up Areas	5	This visual assessment component represents the urban and built-up areas found in the National Topographic Database within the Study Area. Extra importance is given to urban and built-up areas because there is a greater possibility of people living and using these areas, giving the areas a higher weighted value than the surrounding landscape
	Proposed Transmission Line Corridor Centreline Buffer (60 m)	10	This visual assessment component represents the proposed transmission line corridor centreline width. A buffer of 80 m is applied to the proposed transmission line corridor centreline. Extra importance is given to the proposed transmission line corridor centreline because of potential line of sight and the likelihood of theses clearings being used by people (snowmobilers, berry pickers, etc.), giving the area a higher weighted value than the surrounding landscape
	Parks and Protected Areas	3	This visual assessment component represents the parks and protected areas found in the Newfoundland and Labrador Government Land Use Database. Extra importance is given to parks and protected areas because of environmental importance and potential for increased use by people (hikers, boaters, tourists, etc.), giving the area a higher weighted value than the surrounding landscape
	Background View Length (> 4,800 m)	2	This visual assessment component represents areas that are greater than 4,800 m away from the proposed transmission line corridor centreline. At this distance, Project components lose detail and blend into the surrounding landscape. Size of the component limits visibility to strong contrast background (e.g., sky). At this distance, atmospheric elements and the curvature of the Earth tend to blend objects and distort colours
	Middleground View Length (1,600 m to 4,800 m)	4	This visual assessment component represents areas that are between 1,600 m and 4,800 m away from the proposed transmission line corridor centreline. Extra importance is given to the middle ground because observers are more likely to be affected by the transmission structures. At this distance, Project components begin to lose contrast with the surrounding landscape and start to blend into the landscape
	Foreground View Length (400 m to 1,600 m)	6	This visual assessment component represents areas that are between 400 m and 1,600 m away from the proposed transmission line corridor centreline. Added importance is given to the foreground because observers can potentially be highly affected by the transmission structures due to proximity. However, because of distance, one's visual impact is reduced compared to the near ground
	Near Ground View Length (0 m to 400 m)	8	This visual assessment component represents areas that are between 0 m and 400 m away from the proposed transmission line corridor centreline. Extra importance is given to the near ground because observers are more likely to be highly impacted by the transmission structures due to proximity and scale of the components

3.0 RESULTS

The results of the conceptual illustrations, photosimulations, and viewscape modelling are presented in this section.

3.1 Conceptual Illustrations

The detailed conceptual illustrations were created using data from the ELC (Stantec 2010) and other data sources. By creating a virtual world for representative and select locations within the Study Area, five locations were selected to provide a general representation of ecosystem types that will be affected by the proposed corridor within the various regions (e.g., black spruce-sphagnum ecosystem in Southeastern Labrador). The results of the conceptual illustrations are presented in Figures 3.1 to 3.10 and offer ground level and elevated views from five selected sites of interest along the proposed transmission line corridor. Post-construction views are presented to offer the reader an opportunity to view the potential right-of-way and scale of the new structures in relation to the existing natural environment.

3.2 Site-Specific Photosimulations

The site-specific photosimulations were created from real-world data and provide a meaningful representation of pre- and with-Project conditions. They represent the visual effect of the Project on specific viewscapes from select vantage points. The selected site locations along the proposed transmission line corridor are listed in Table 2.2 and shown in Figure 2.1. The existing conditions and with-Project photosimulations for 13 sites are presented in Figures 3.11 to 3.36.

3.3 Viewshed Modelling – Potential Number of Transmission Towers Visible

The visual assessment analysis results found that for the length of the proposed transmission corridor centreline, 43% of the Study Area is potentially visible from the hypothetical tower locations, 27% of the Study Area is potentially not visible due to forest cover and 30% of the Study Area is likely not visible due to topography. Conversely, 43% of the towers are potentially visible from within the Study Area, 27% of the towers are potentially not visible from within the Study Area, and 30% of the towers are likely not visible from within the Study Area. The potential number of transmission towers within view at any location within the 15 km wide Study Area is shown in Figures 3.37 to 3.93.

3.4 Viewshed Modelling - Visual Exposure

A regional presentation of the visual assessment is provided in Figures 3.94 to 3.97. Each figure presents the likely visibility of the proposed transmission line within the Study Area. In general, areas with more dense forest cover and/or obstructing terrain have lower percentages with respect to potentially viewing the proposed transmission line infrastructure. Conversely, more open or barren areas of the province will have higher visibility potential.

The visual exposure analysis presented in Figures 3.98 to 3.154 provides a more comprehensive presentation that considers multiple criteria and allows the reader to choose a location on the map to effectively determine the likelihood of seeing the proposed transmission towers from that vantage point.

The colour gradient in the legend shows the degree of likelihood of seeing transmission line towers. For example, areas that have the potential to experience higher pedestrian traffic are assigned a higher degree of visibility than an area where fewer people will access.

Figure 3.1 Conceptual Illustrations: Southeastern Labrador, Ground Level View

Figure 3.2 Conceptual Illustrations: Southeastern Labrador, Elevated View

Figure 3.3 Conceptual Illustrations: Northern Peninsula, Ground Level View

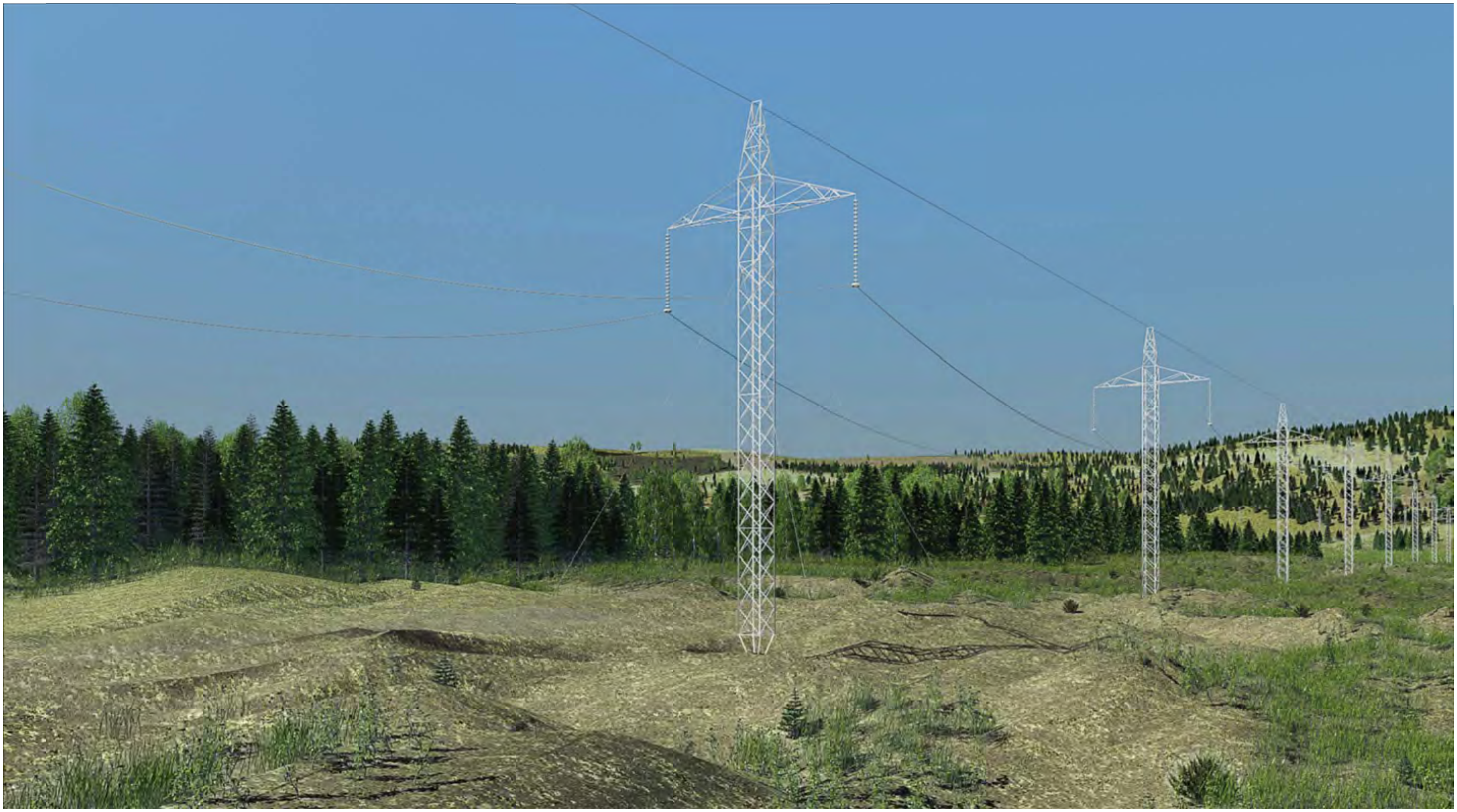


Figure 3.4 Conceptual Illustrations: Northern Peninsula, Elevated View

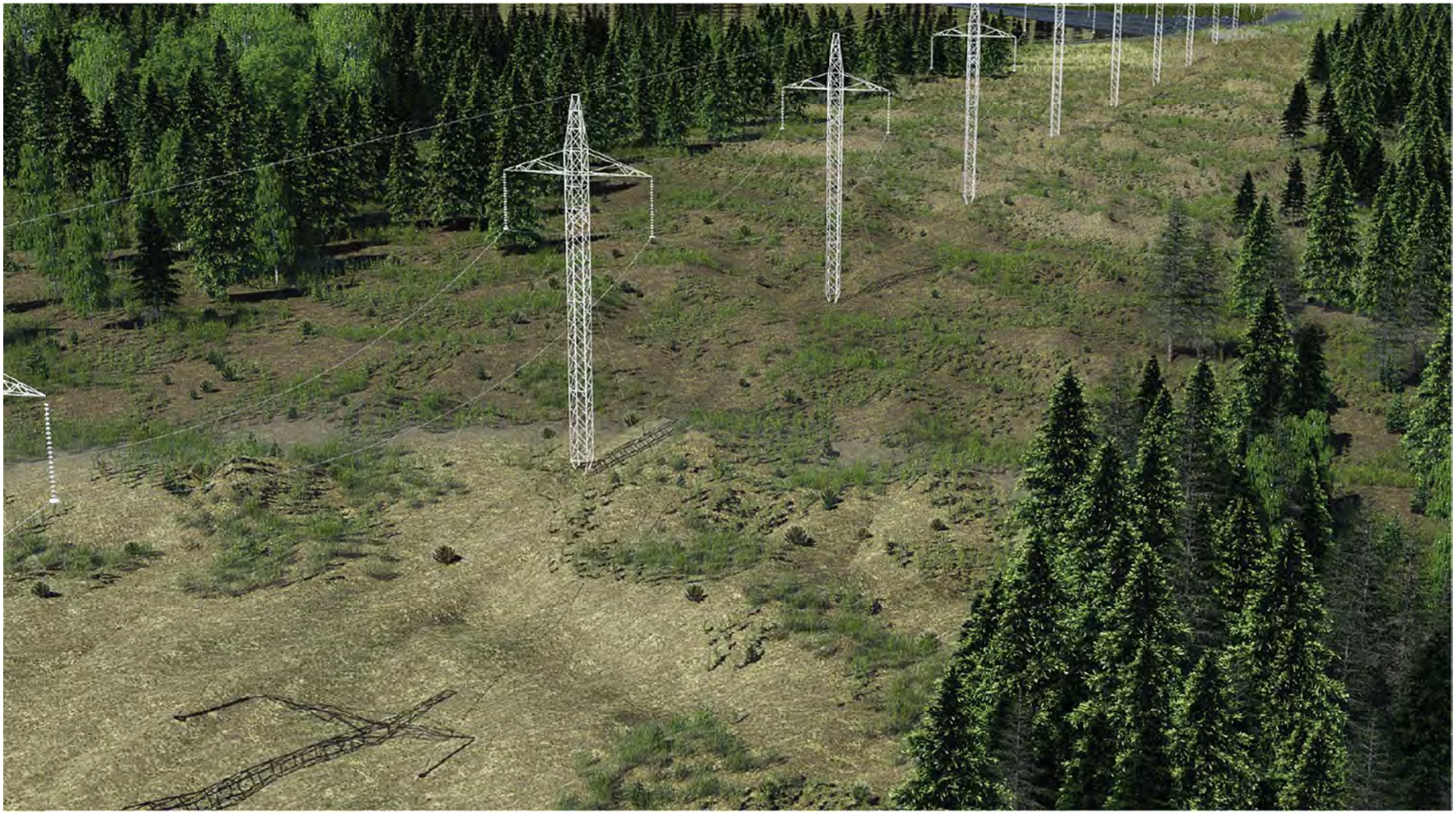


Figure 3.5 Conceptual Illustrations: Central Newfoundland, Ground Level View

Figure 3.6 Conceptual Illustrations: Central Newfoundland, Elevated View

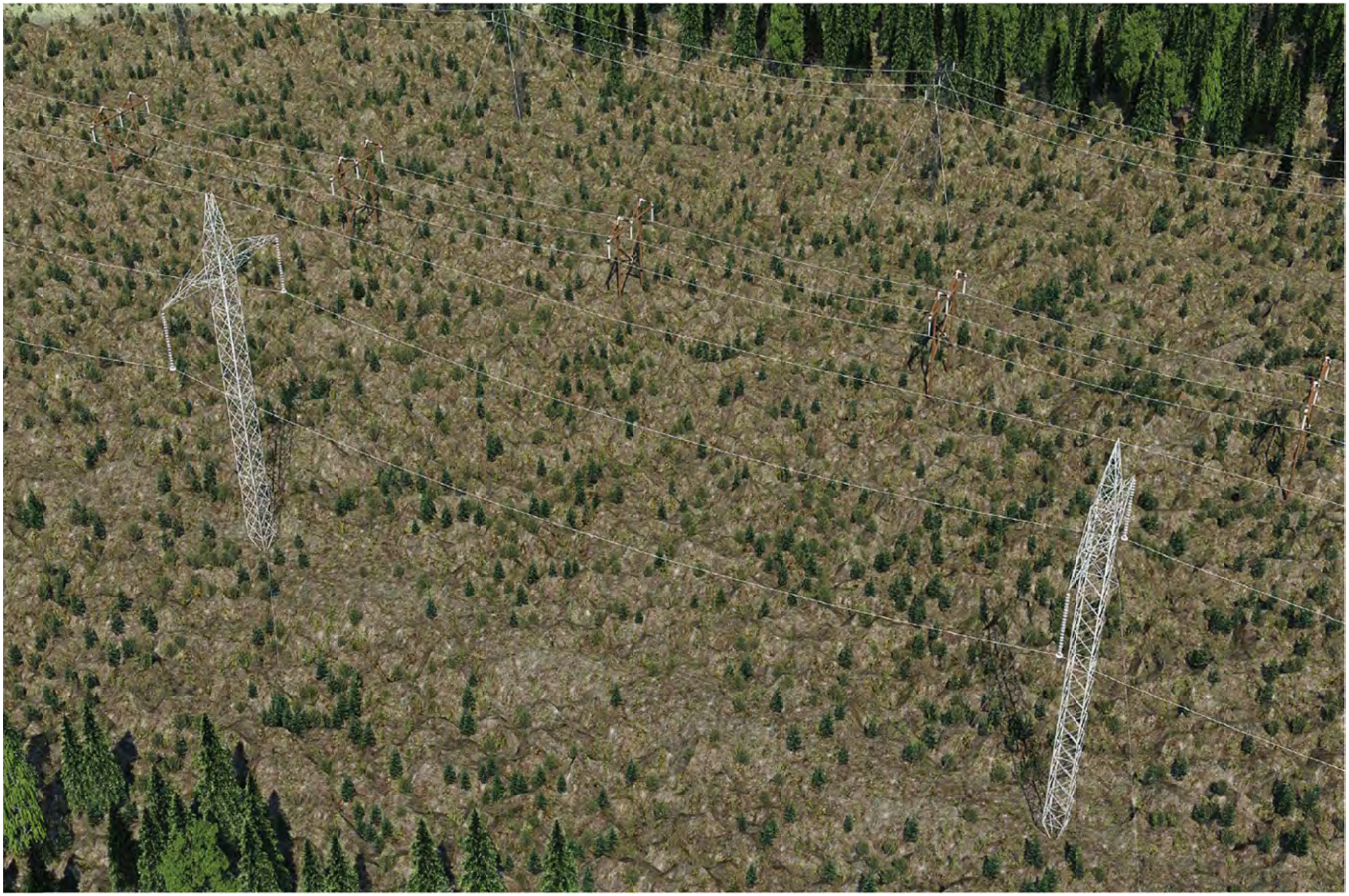


Figure 3.7 Conceptual Illustrations: Eastern Newfoundland, Ground Level View

Figure 3.8 Conceptual Illustrations: Eastern Newfoundland, Elevated View

Figure 3.9 Conceptual Illustrations: Avalon Peninsula, Ground Level View

Figure 3.10 Conceptual Illustrations: Avalon Peninsula, Elevated View

Figure 3.11 Site-specific Photosimulation: Trans Labrador Highway 3, Existing Conditions

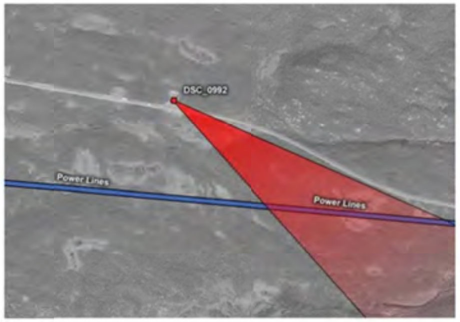


Figure 3.12 Site-specific Photosimulation: Trans Labrador Highway 3, With-Project Conditions

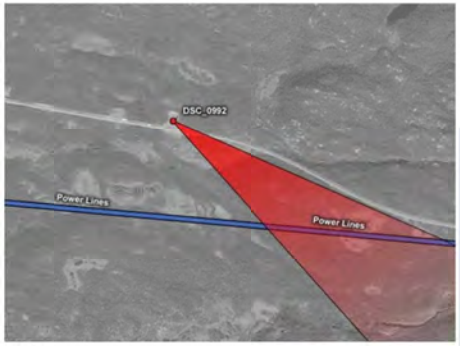


Figure 3.13 Site-specific Photosimulation: Kenamu River, Existing Conditions

Figure 3.14 Site-specific Photosimulation: Kenamu River, With-Project Conditions

Figure 3.15 Site-specific Photosimulation: Forteau Point, Existing Conditions

Figure 3.16 Site-specific Photosimulation: Forteau Point, With-Project Conditions

Figure 3.17 Site-specific Photosimulation: Flower's Cove, Existing Conditions

Figure 3.18 Site-specific Photosimulation: Flower's Cove, With-Project Conditions

Figure 3.19 Site-specific Photosimulation: Portland Creek, Existing Conditions

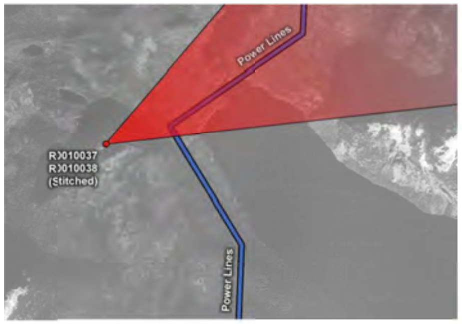


Figure 3.20 Site-specific Photosimulation: Portland Creek, With-Project Conditions

Figure 3.21 Site-specific Photosimulation: Rack Lake, Existing Conditions

Figure 3.22 Site-specific Photosimulation: Rack Lake, With-Project Conditions

Figure 3.23 Site-specific Photosimulation: Four Ponds, Existing Conditions

Figure 3.24 Site-specific Photosimulation: Four Ponds, With-Project Conditions

Figure 3.25 Site-specific Photosimulation: Birchy Lake, Existing Conditions

Figure 3.26 Site-specific Photosimulation: Birchy Lake, With-Project Conditions

Figure 3.27 Site-specific Photosimulation: Buchans Highway, Existing Conditions

Figure 3.28 Site-specific Photosimulation: Buchans Highway, With-Project Conditions

Figure 3.29 Site-specific Photosimulation: Exploits River, Existing Conditions

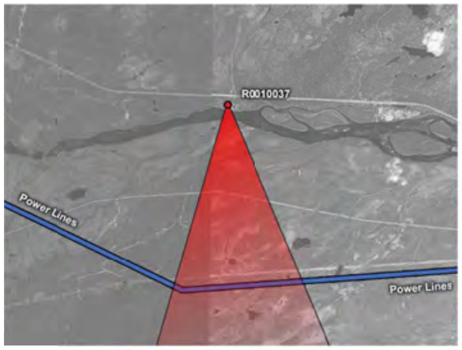


Figure 3.30 Site-specific Photosimulation: Exploits River, With-Project Conditions

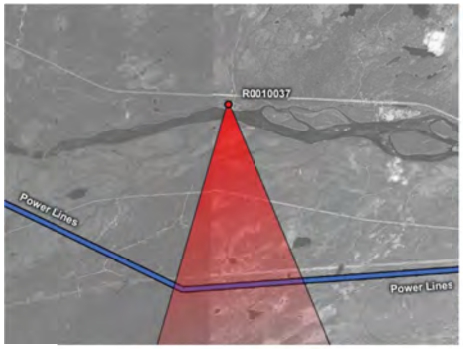


Figure 3.31 Site-specific Photosimulation: Chapel Arm Route 201, Existing Conditions

Figure 3.32 Site-specific Photosimulation: Chapel Arm Route 201, With-Project Conditions

Figure 3.33 Site-specific Photosimulation: Witless Bay Line, Existing Conditions

Figure 3.34 Site-specific Photosimulation: Witless Bay Line, With-Project Conditions

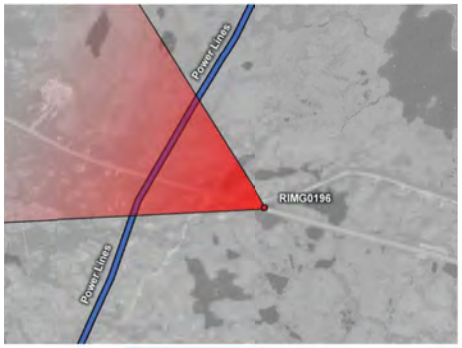


Figure 3.35 Site-specific Photosimulation: Soldiers Pond, Existing Conditions

Figure 3.36 Site-specific Photosimulation: Soldiers Pond, With-Project Conditions

Figure 3.37 Viewshed Modelling - Potential Number of Transmission Towers Visible, Index

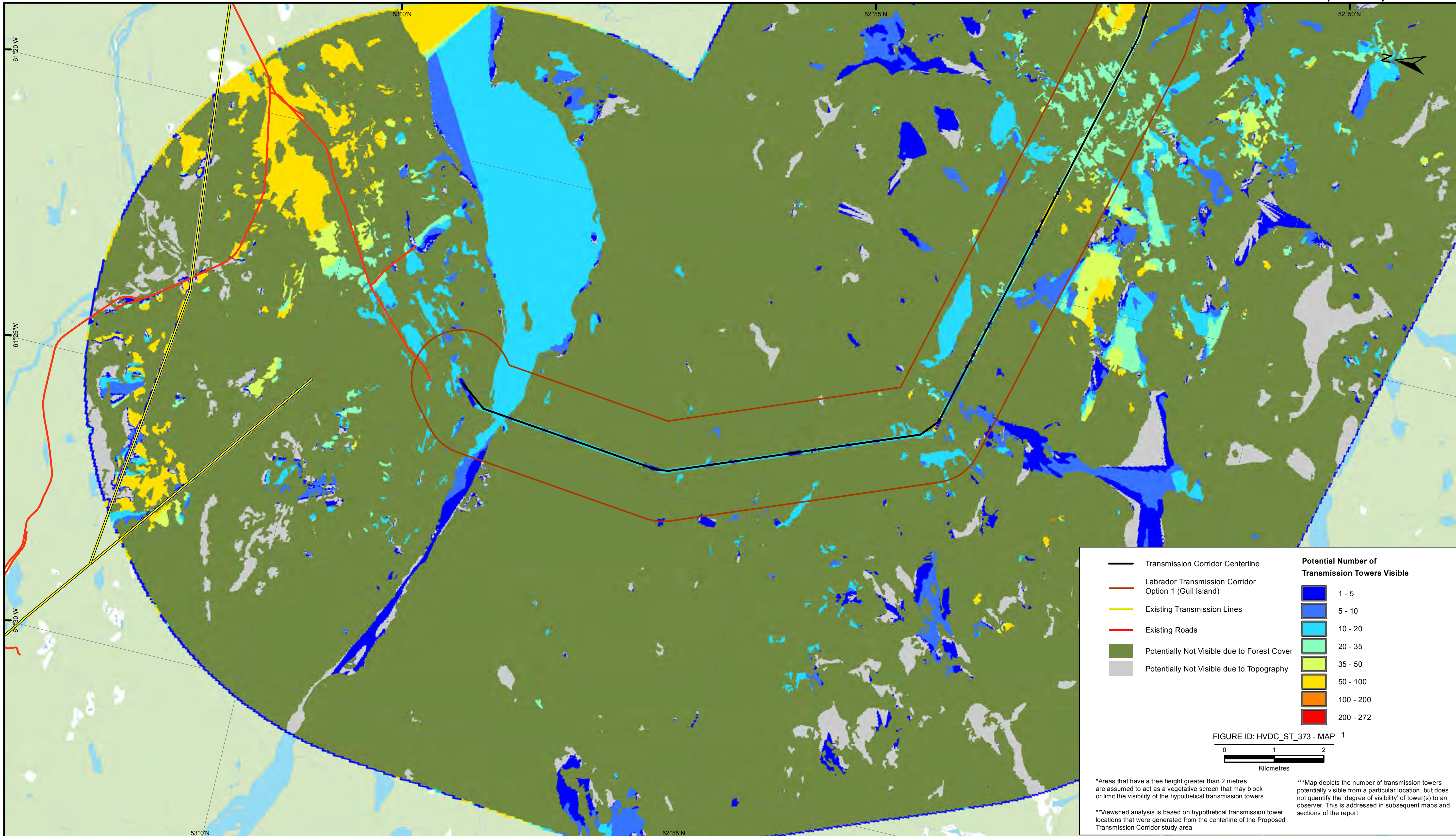


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Figure 3.38

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 1

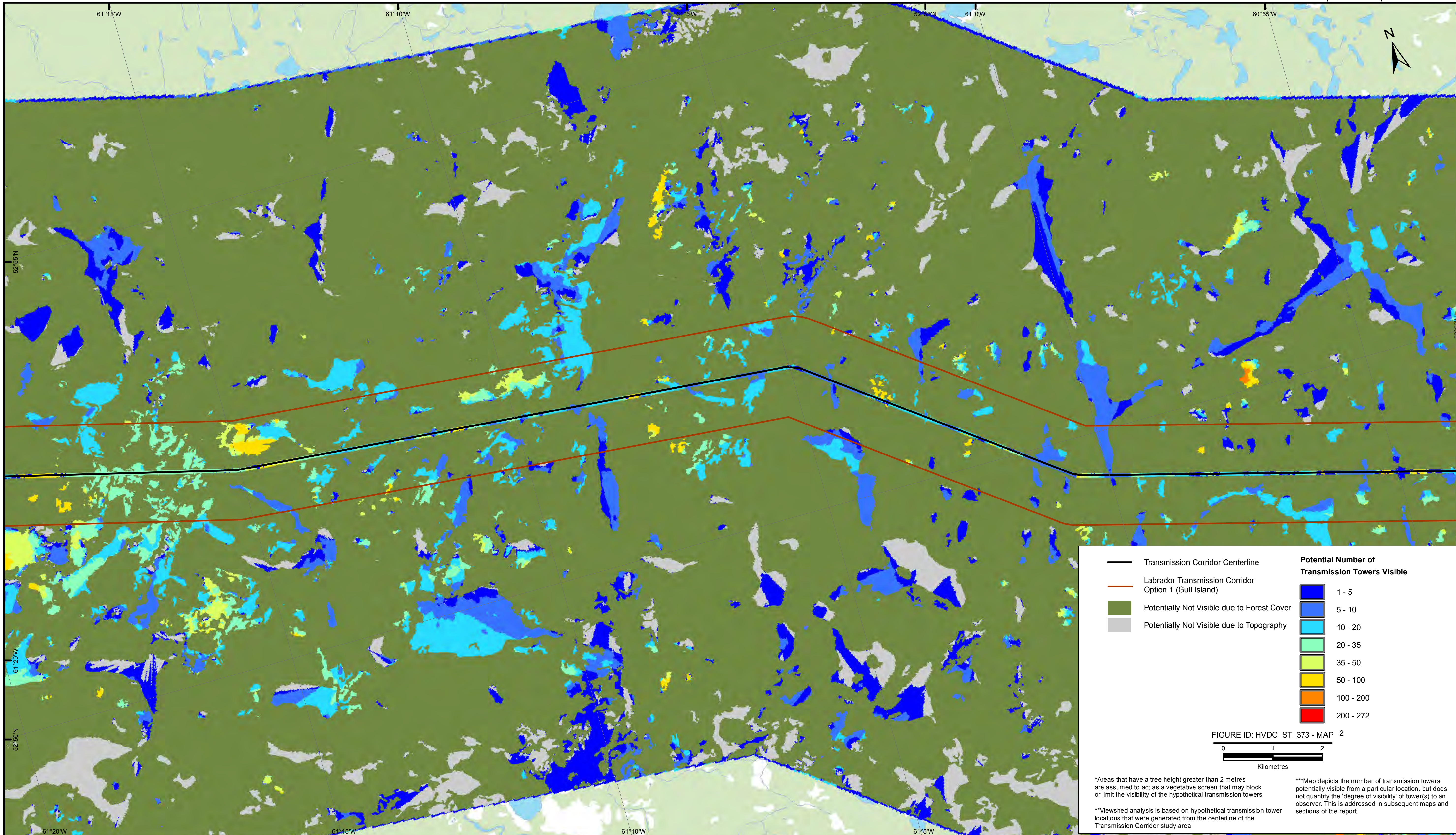

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Figure 3.39

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 2

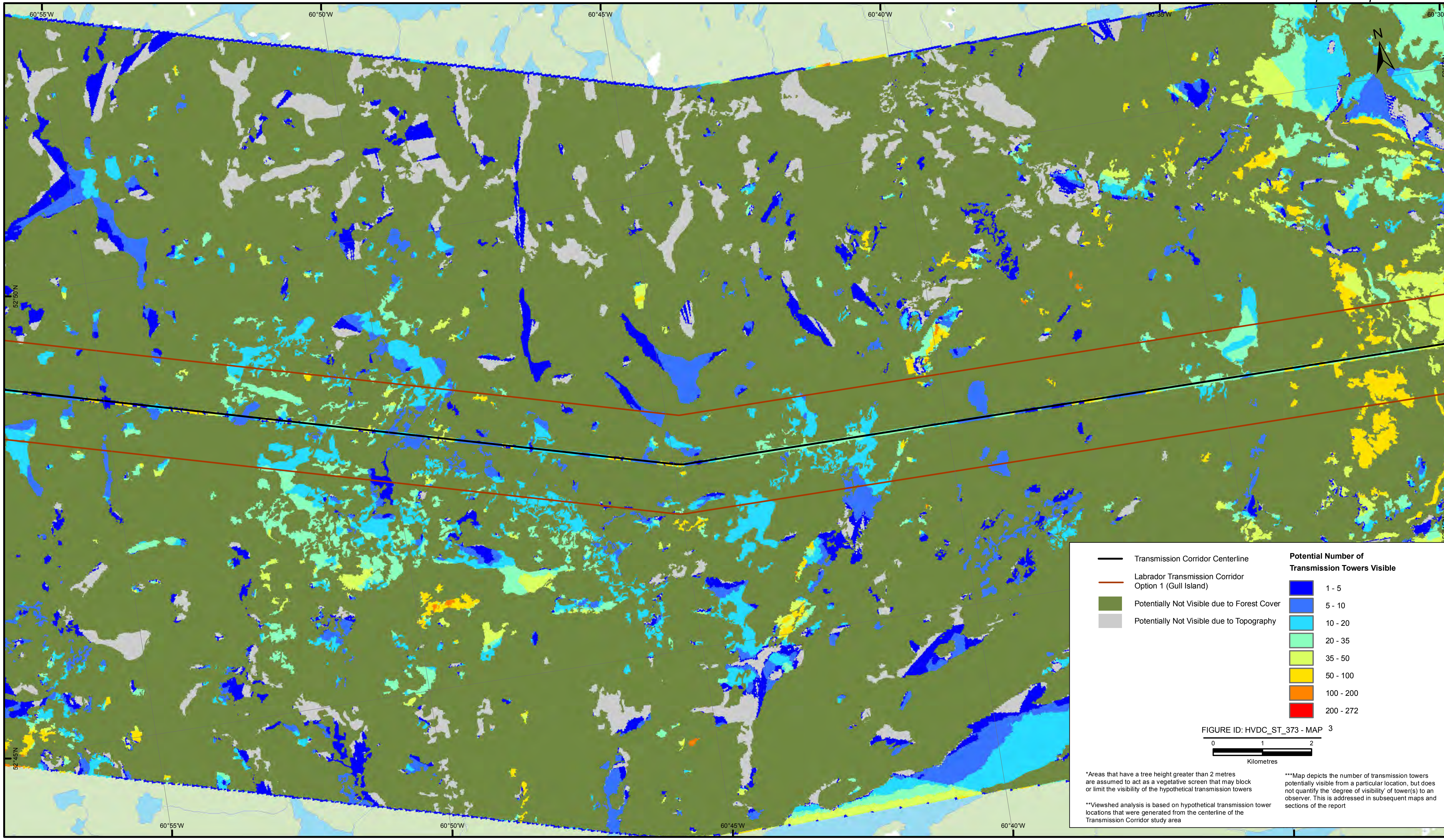

Figure 3.40

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 3

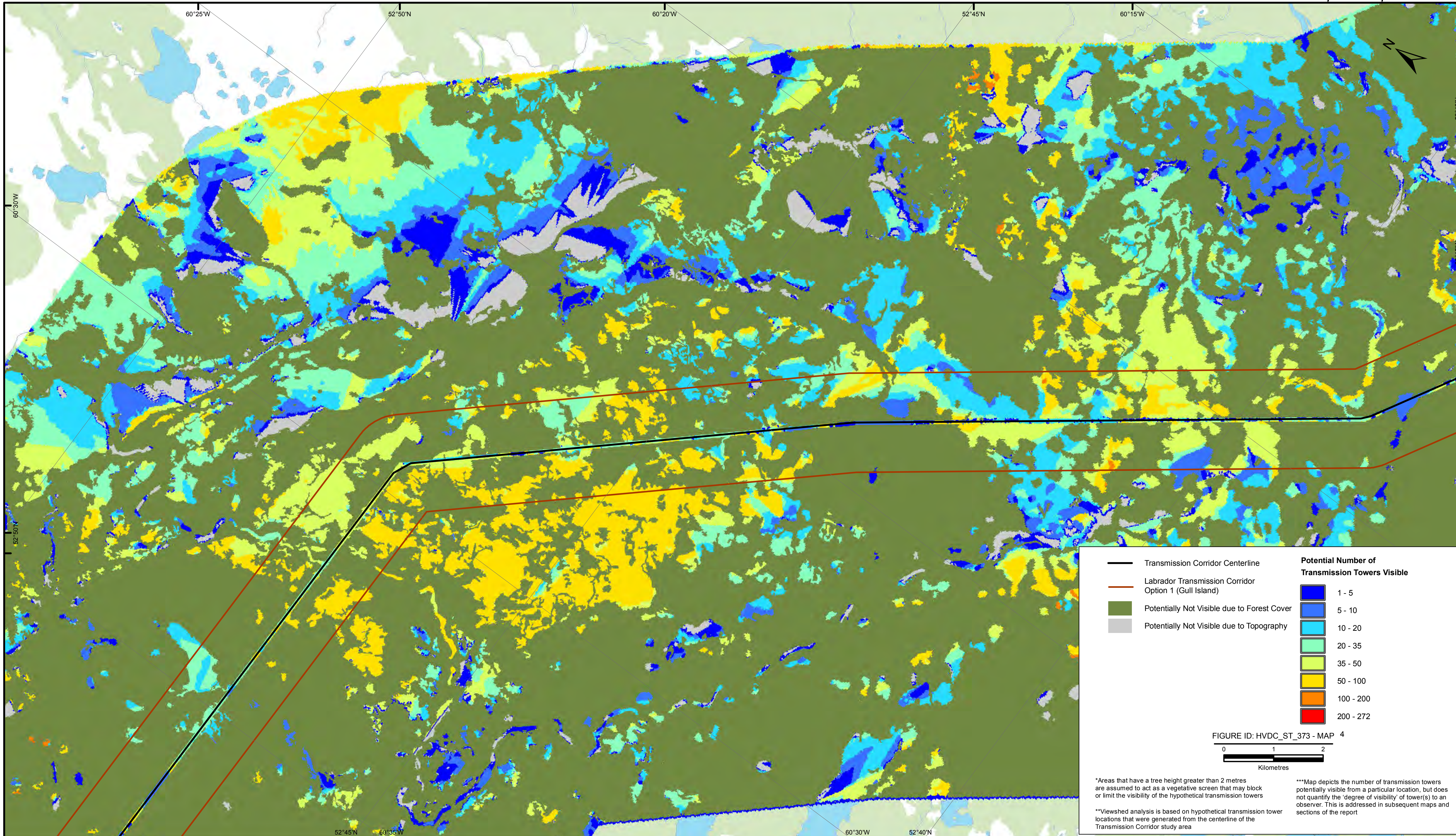

Figure 3.41

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 4

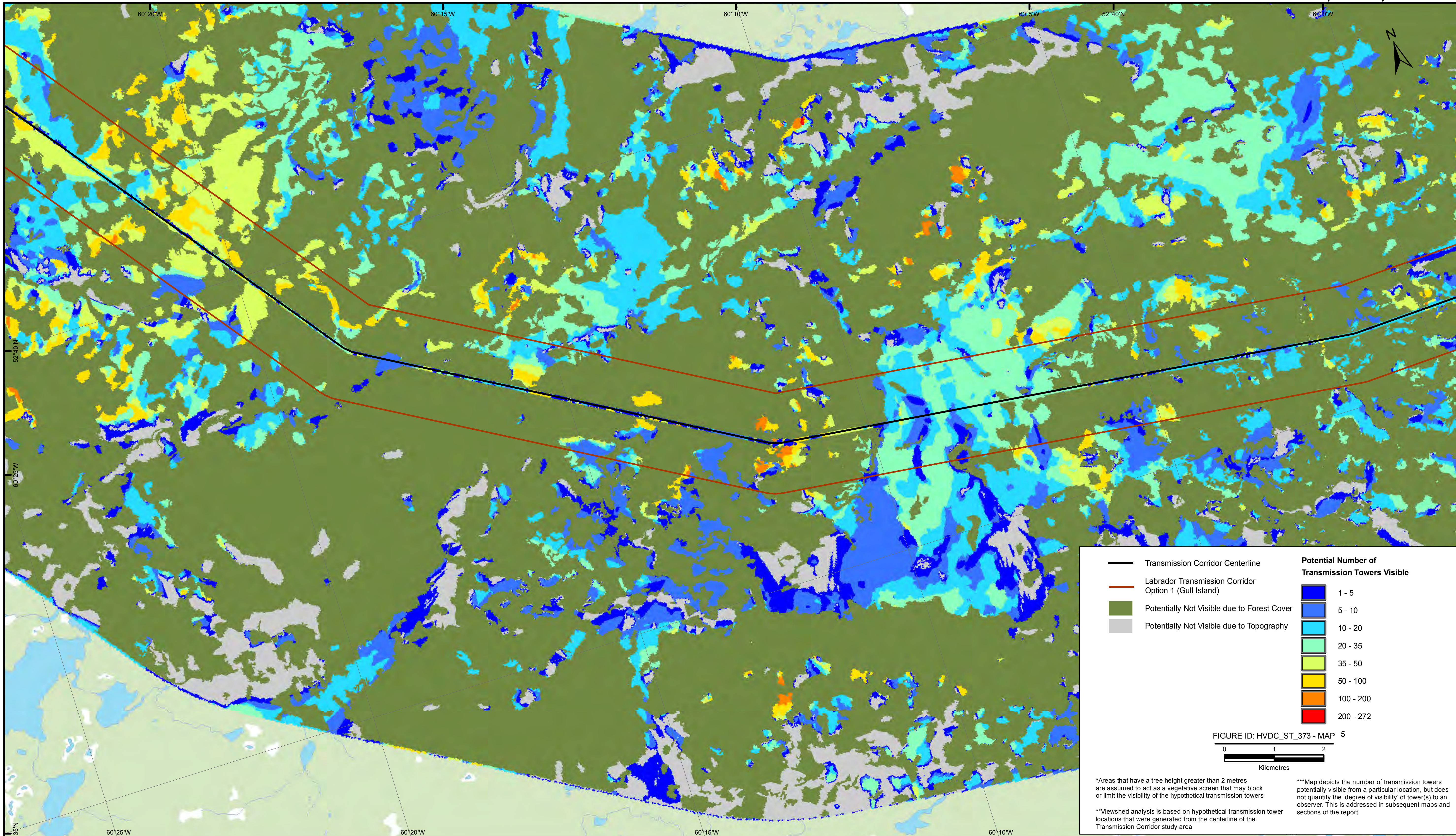

Figure 3.42

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 5

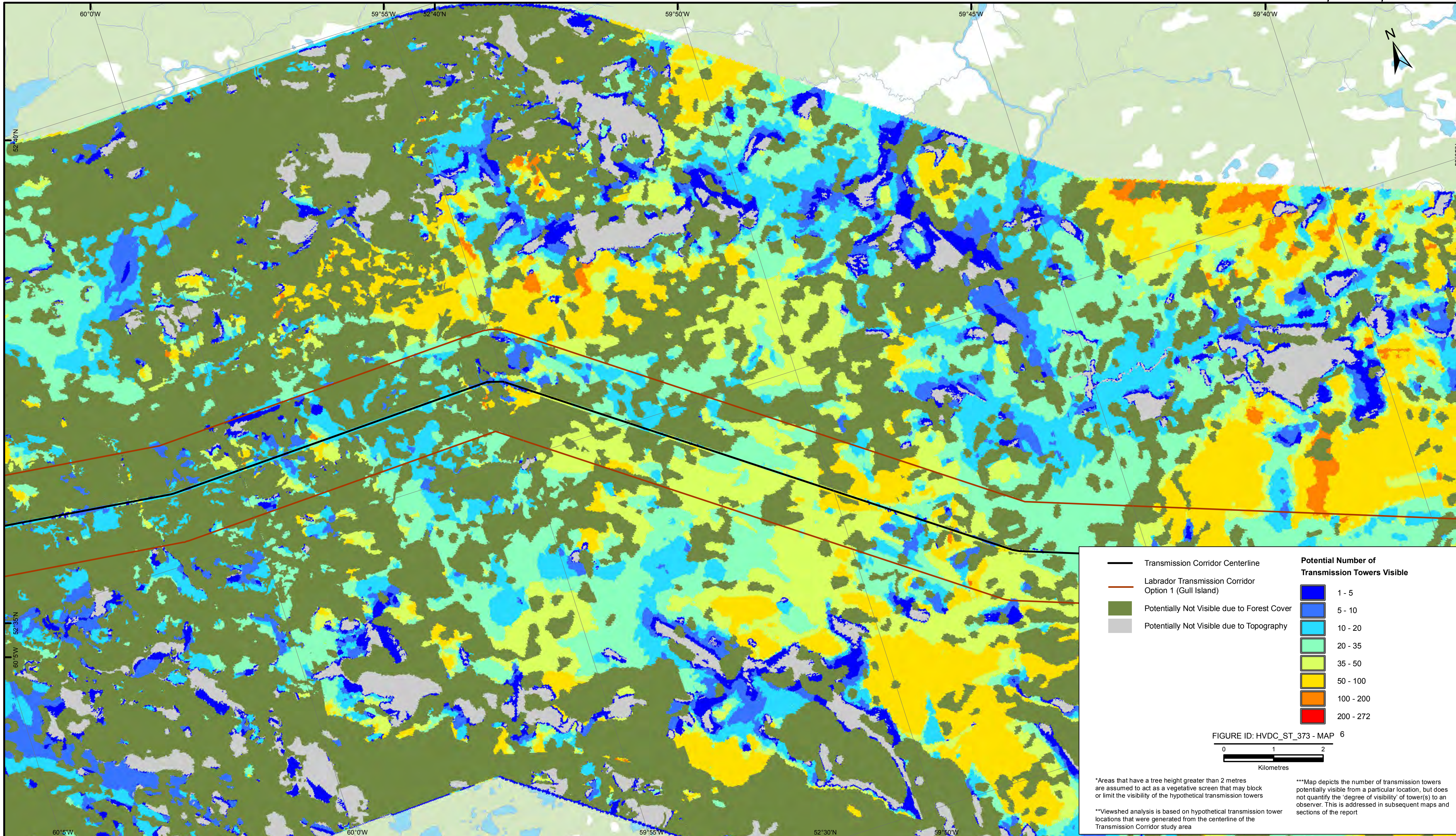

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Figure 3.43

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 6

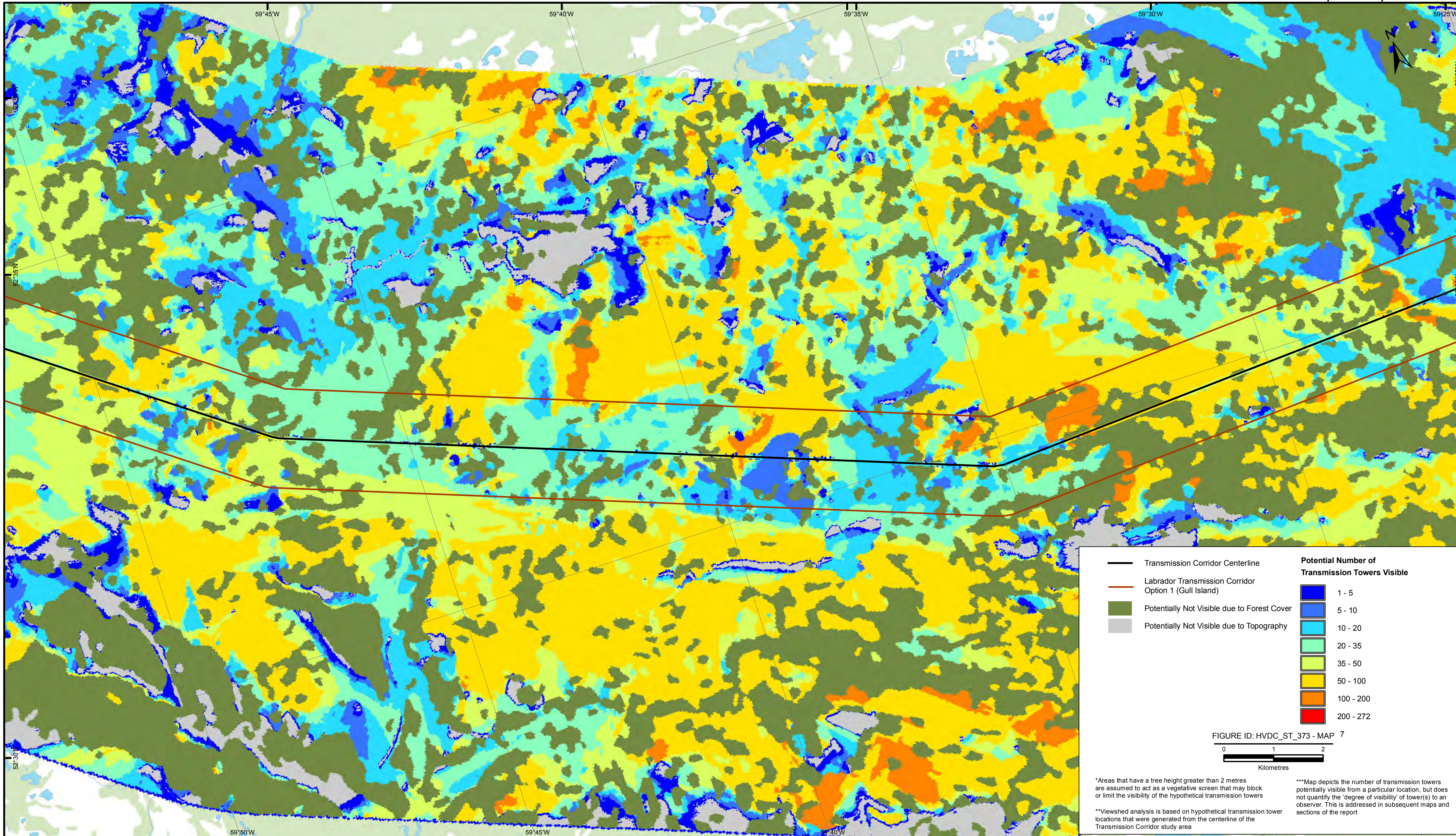

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Figure 3.44

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 7

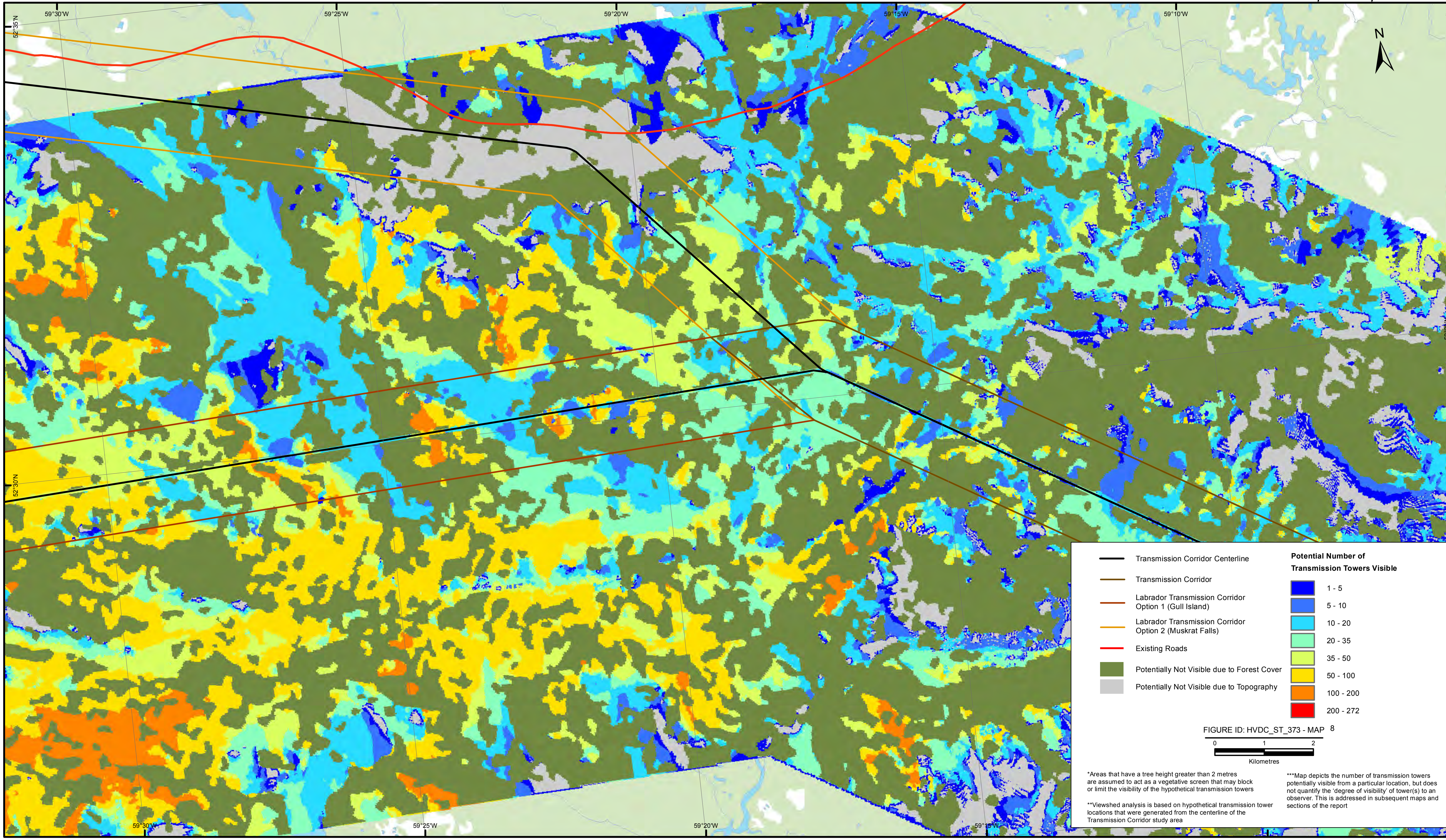

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Figure 3.45

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 8

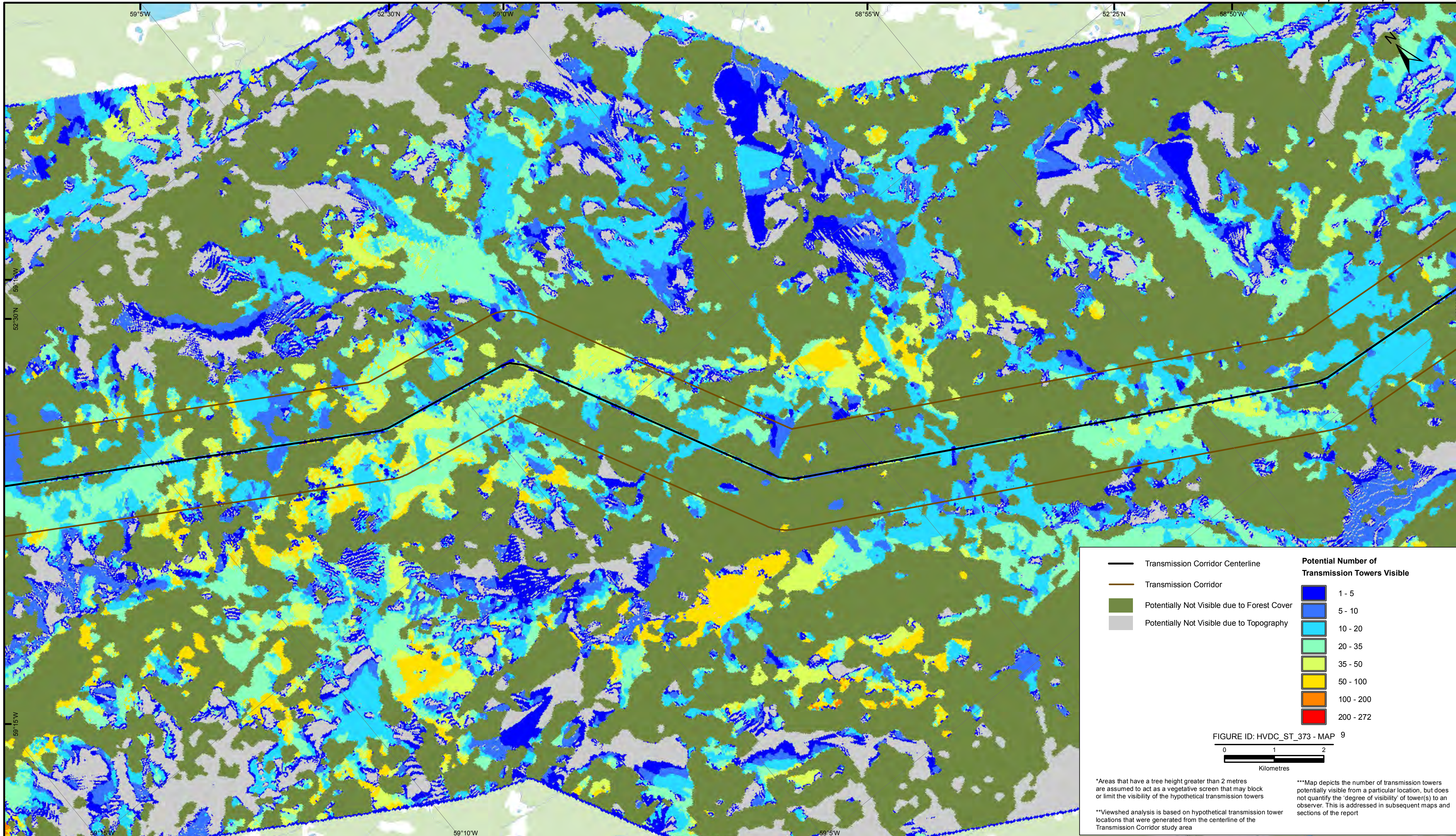

Figure 3.46

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 9

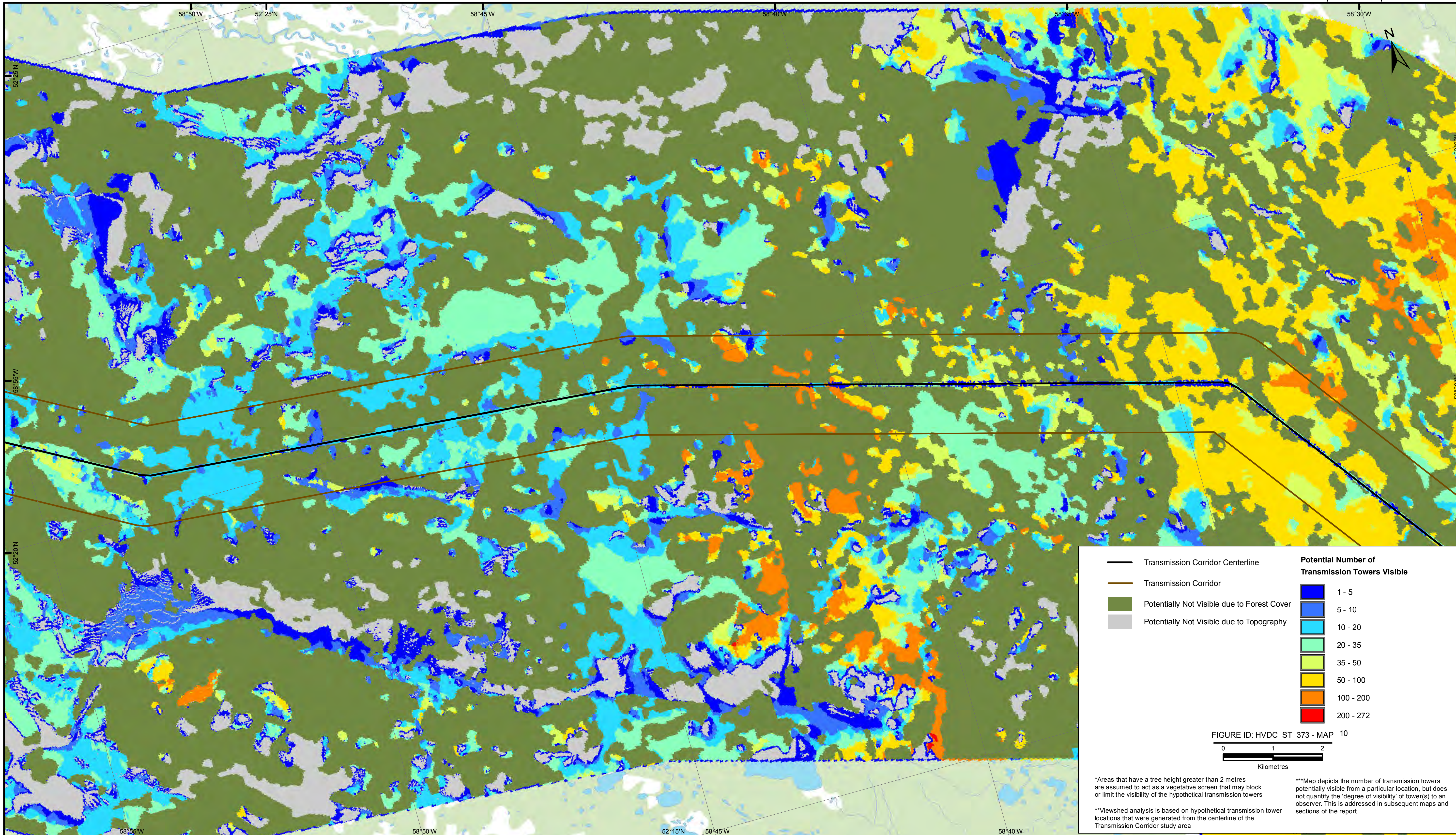

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Figure 3.47

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 10

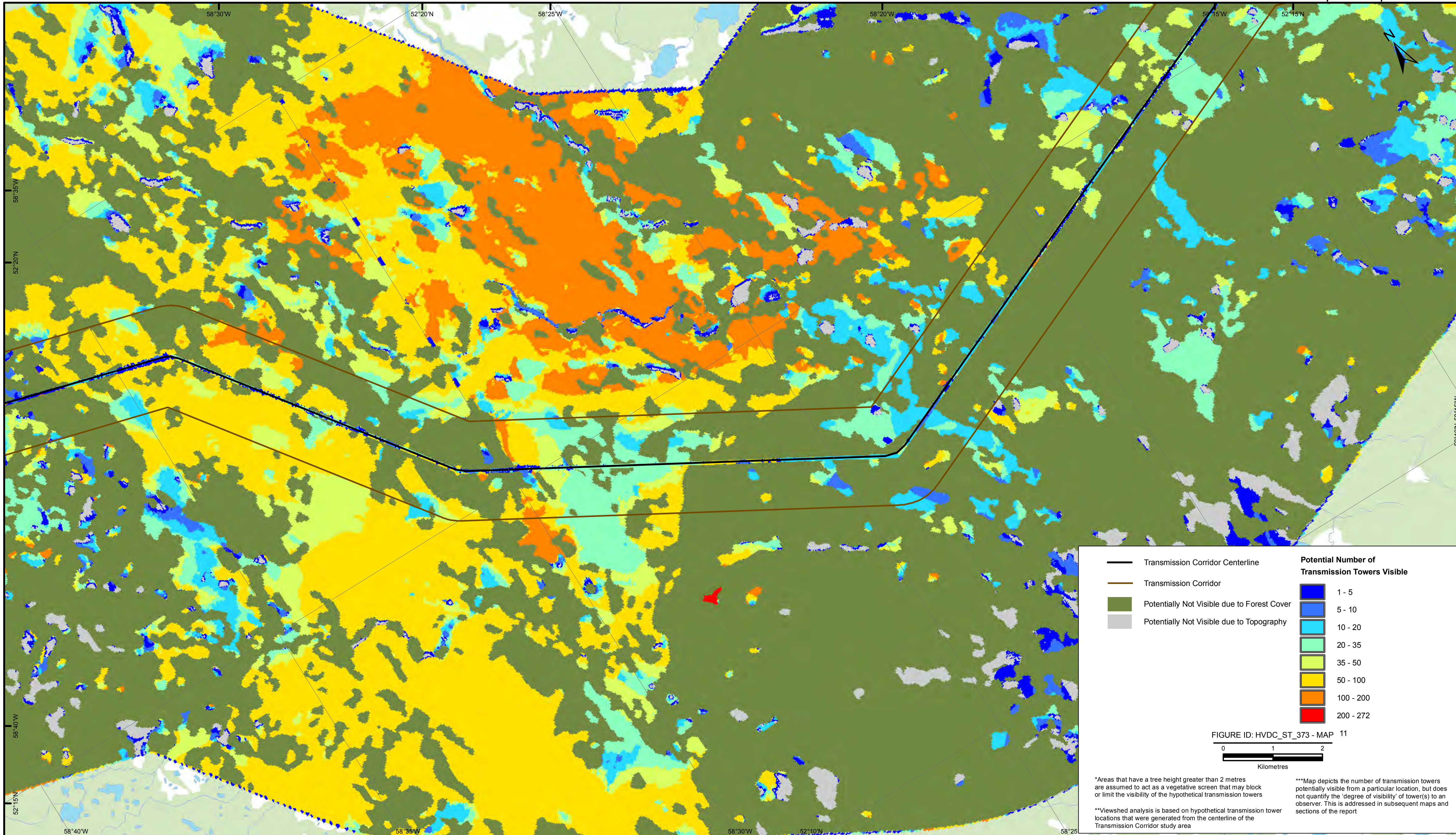

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Figure 3.48

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 11

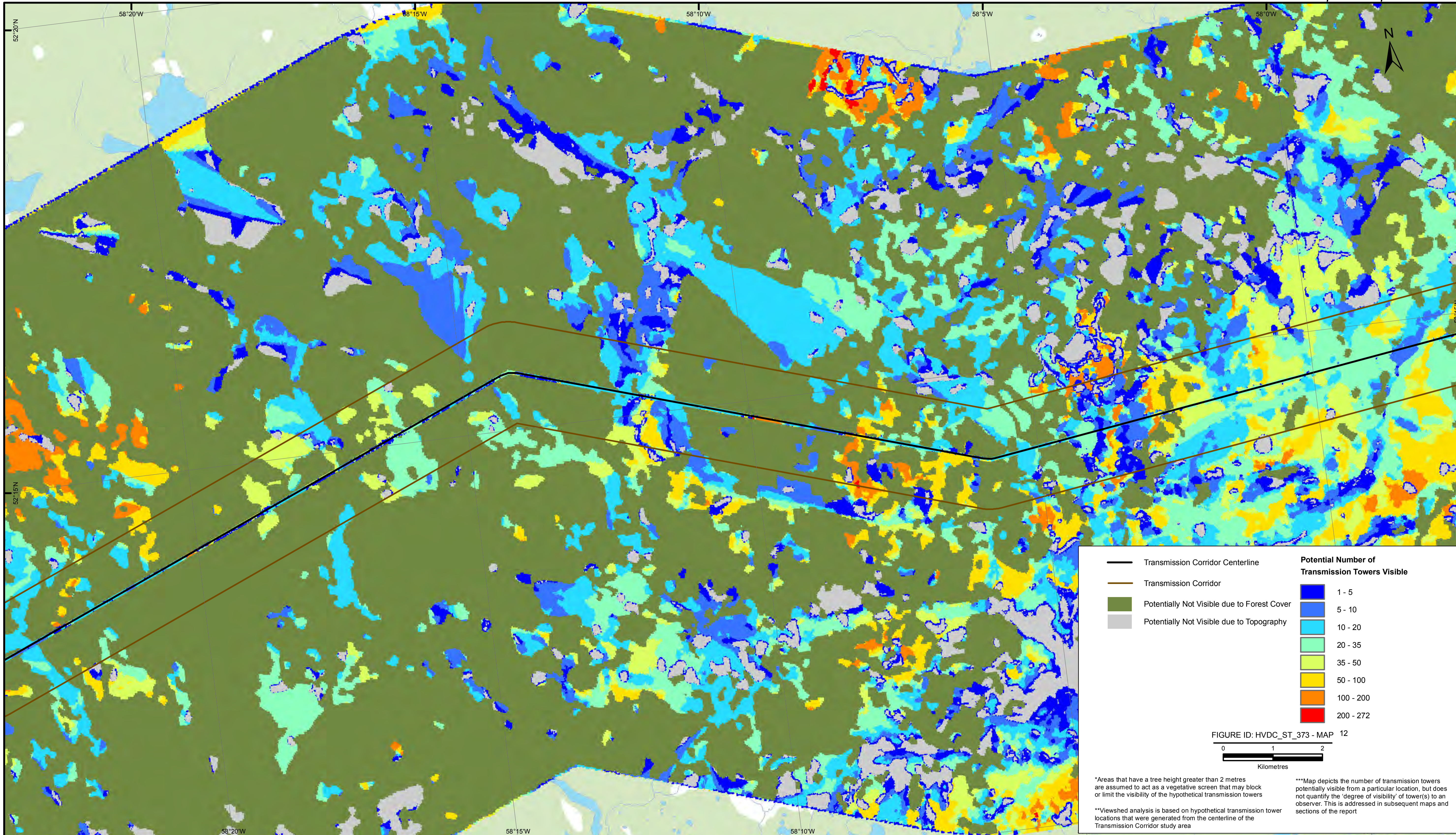
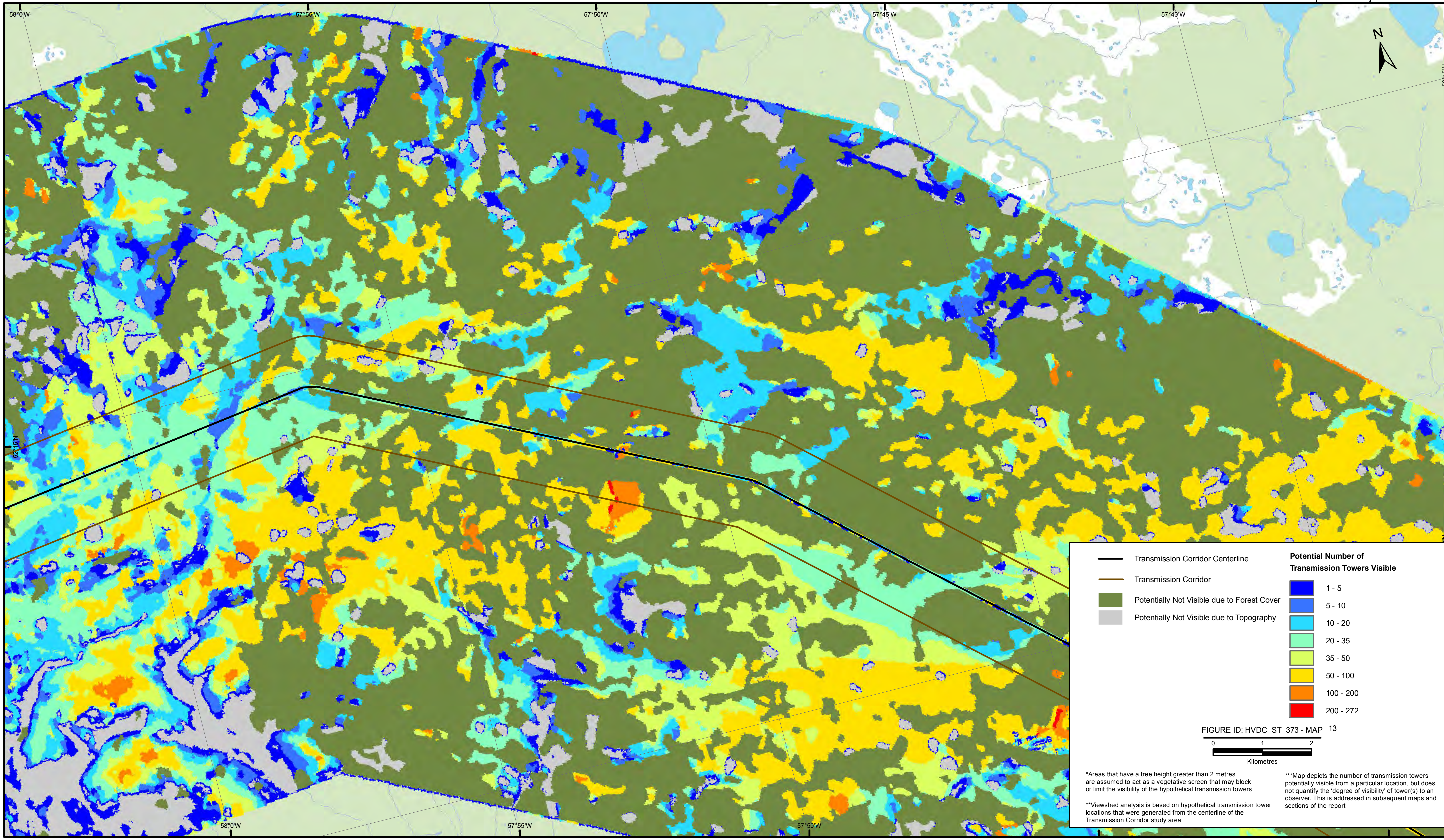


Figure 3.49

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 12



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	Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 13

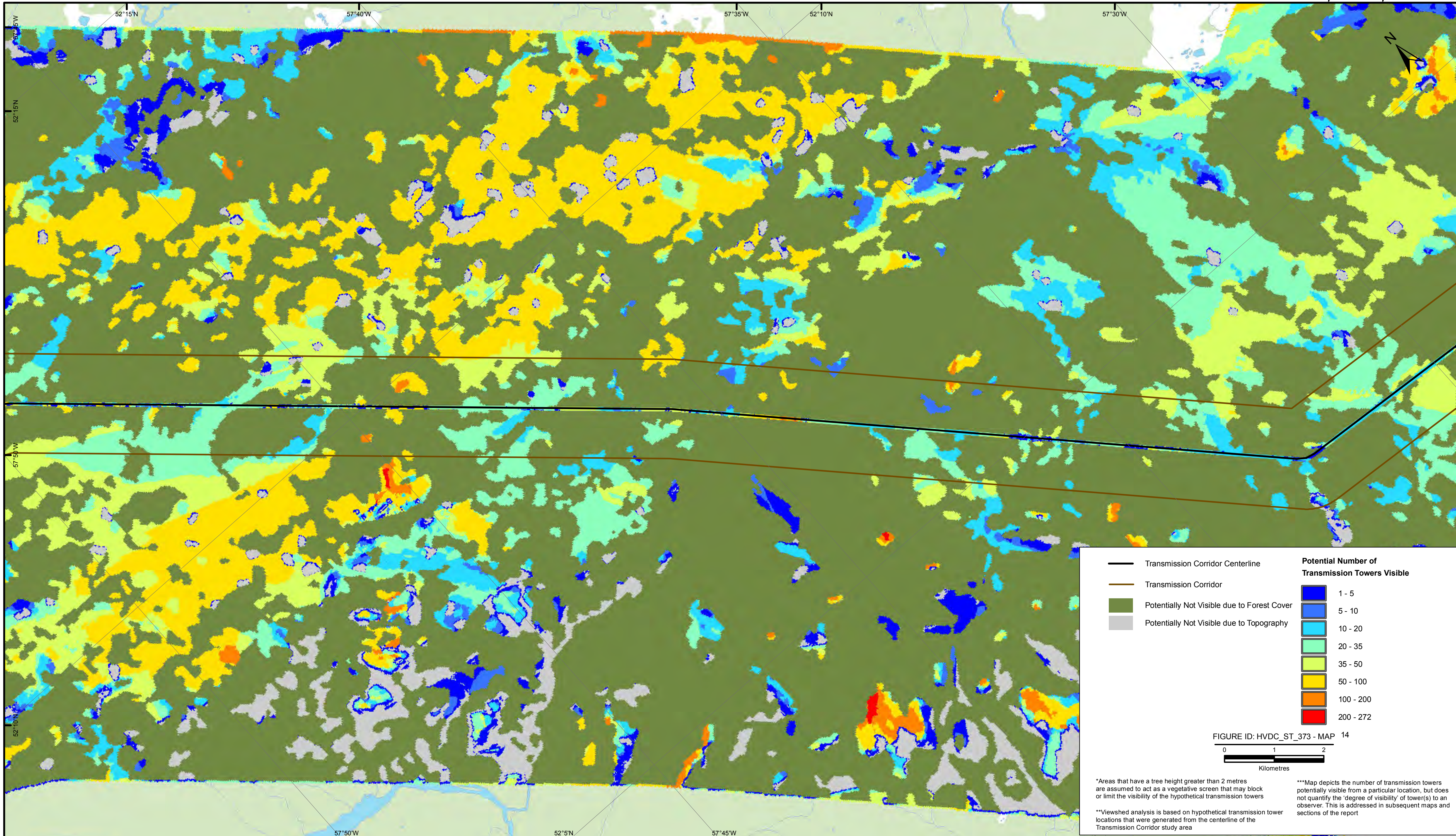

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Figure 3.51

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 14

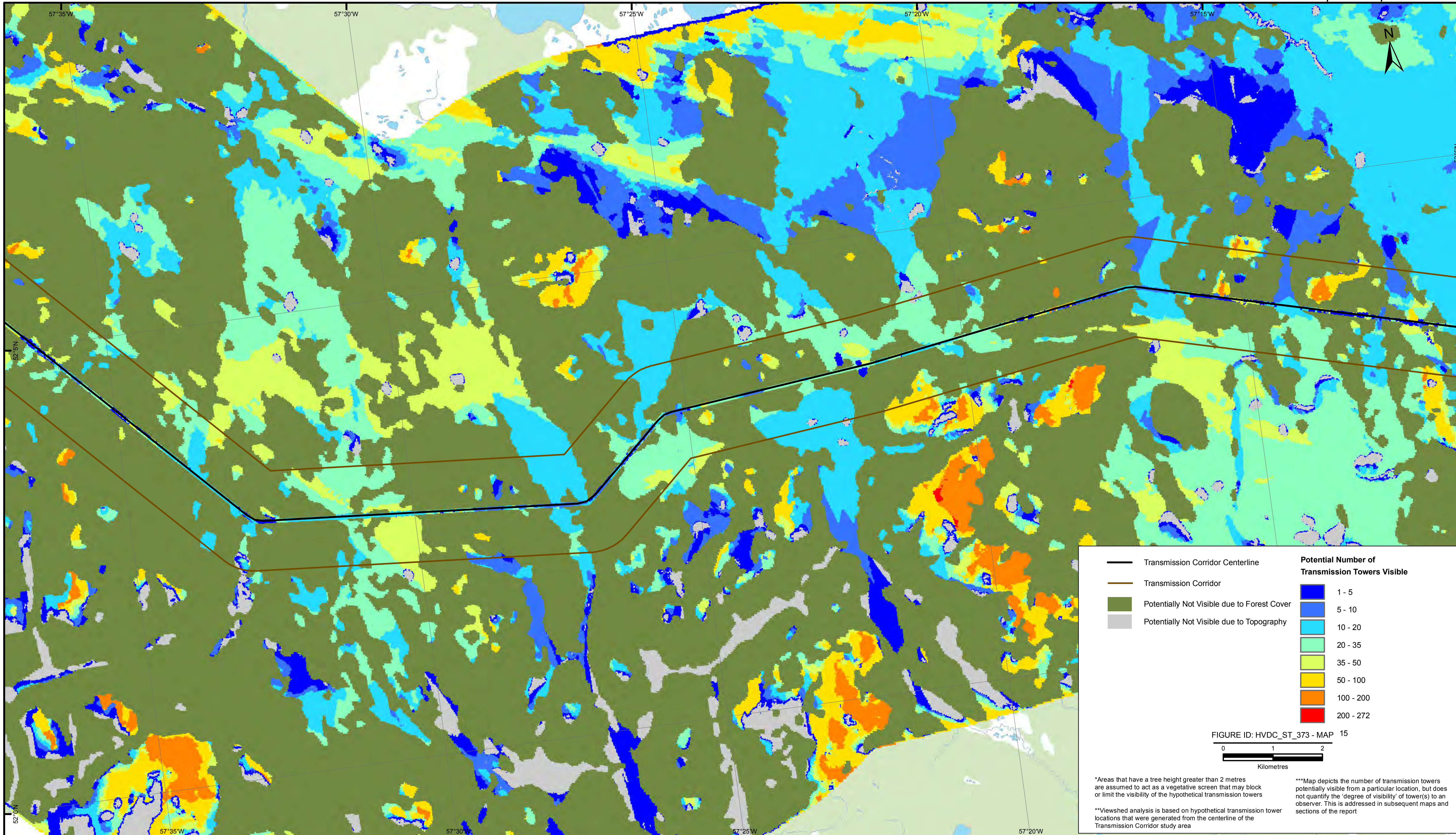

Figure 3.52

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 15

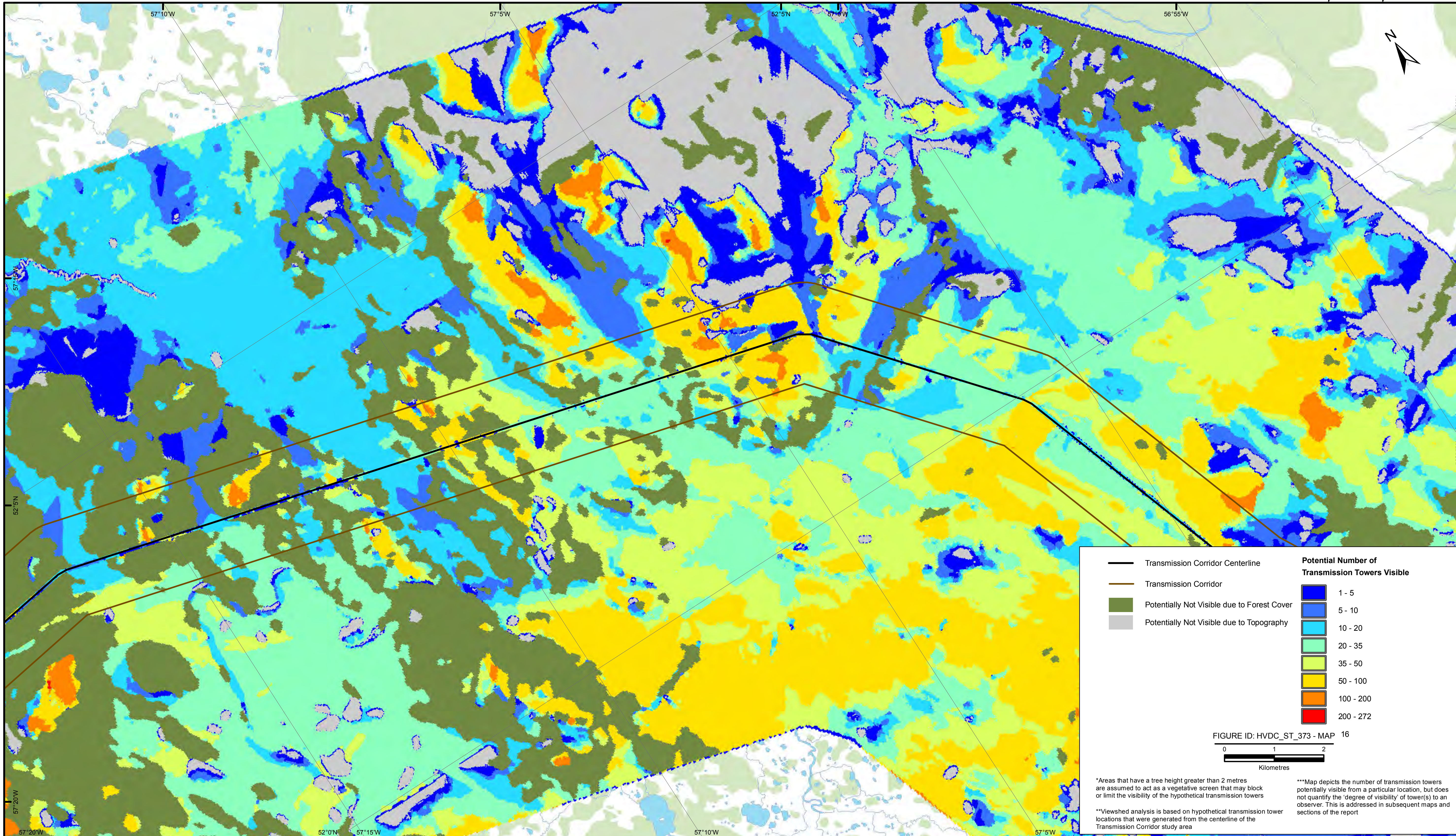

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Figure 3.53

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 16

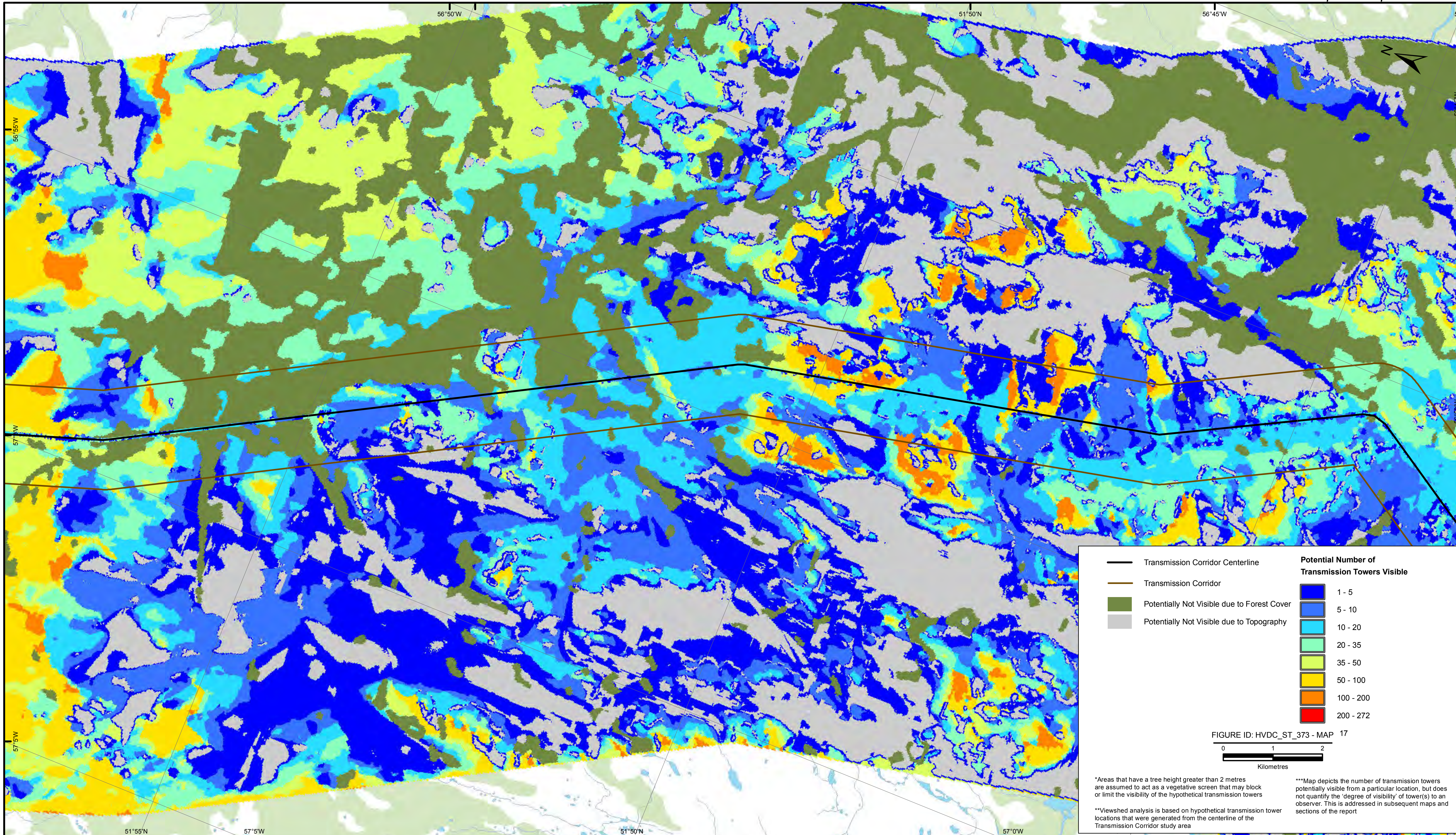

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Figure 3.54

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 17

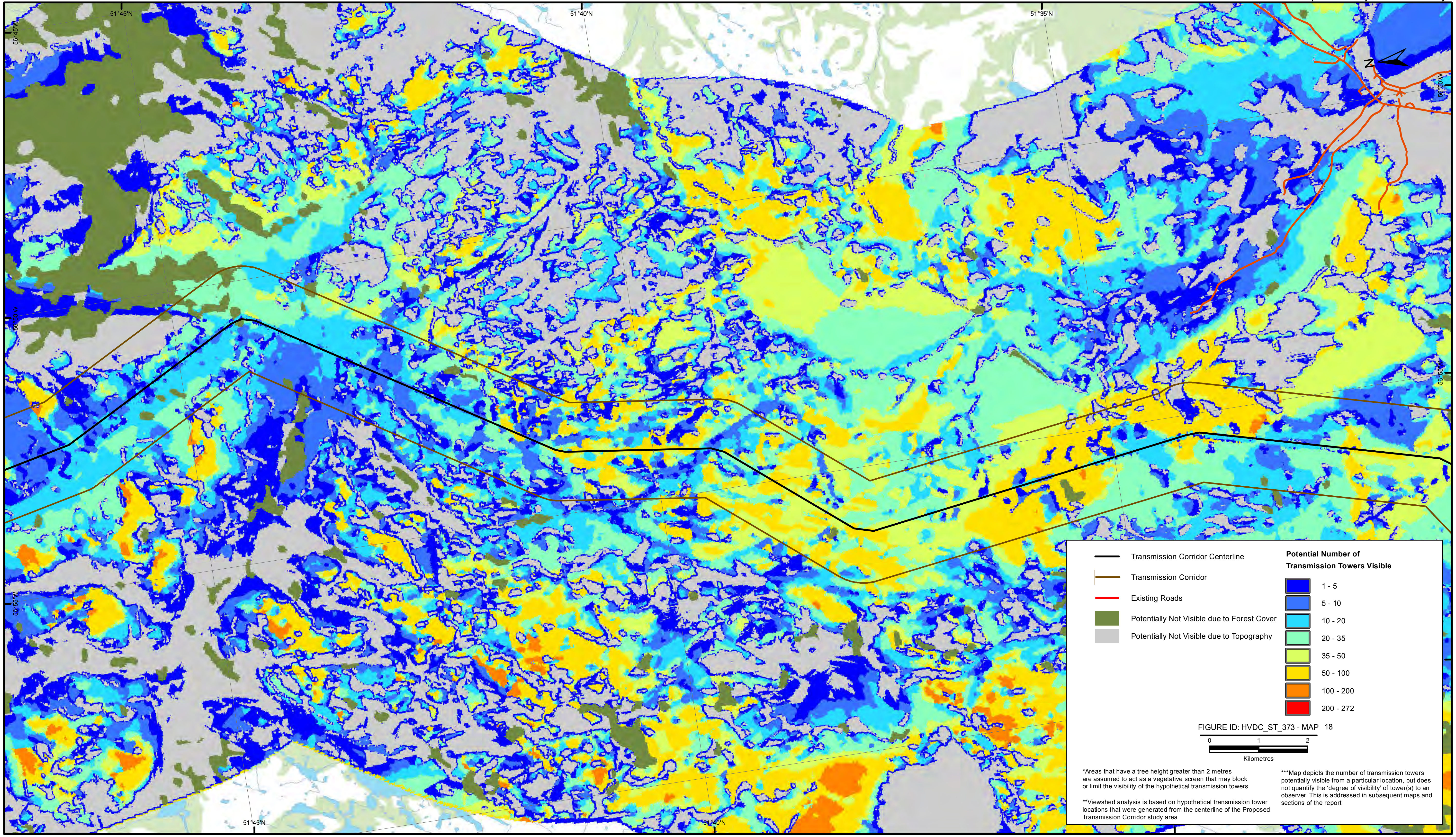

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Figure 3.55

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 18

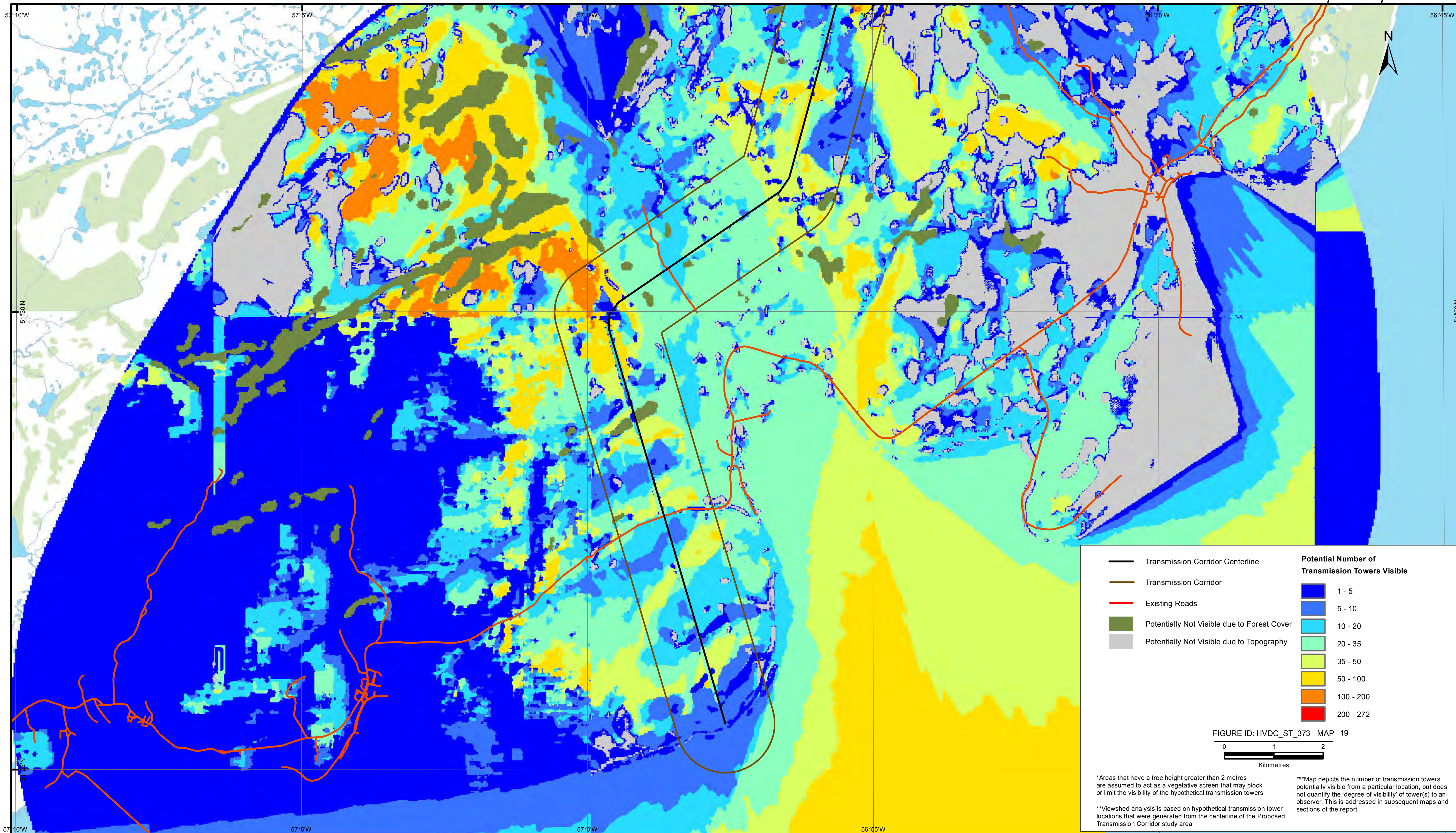

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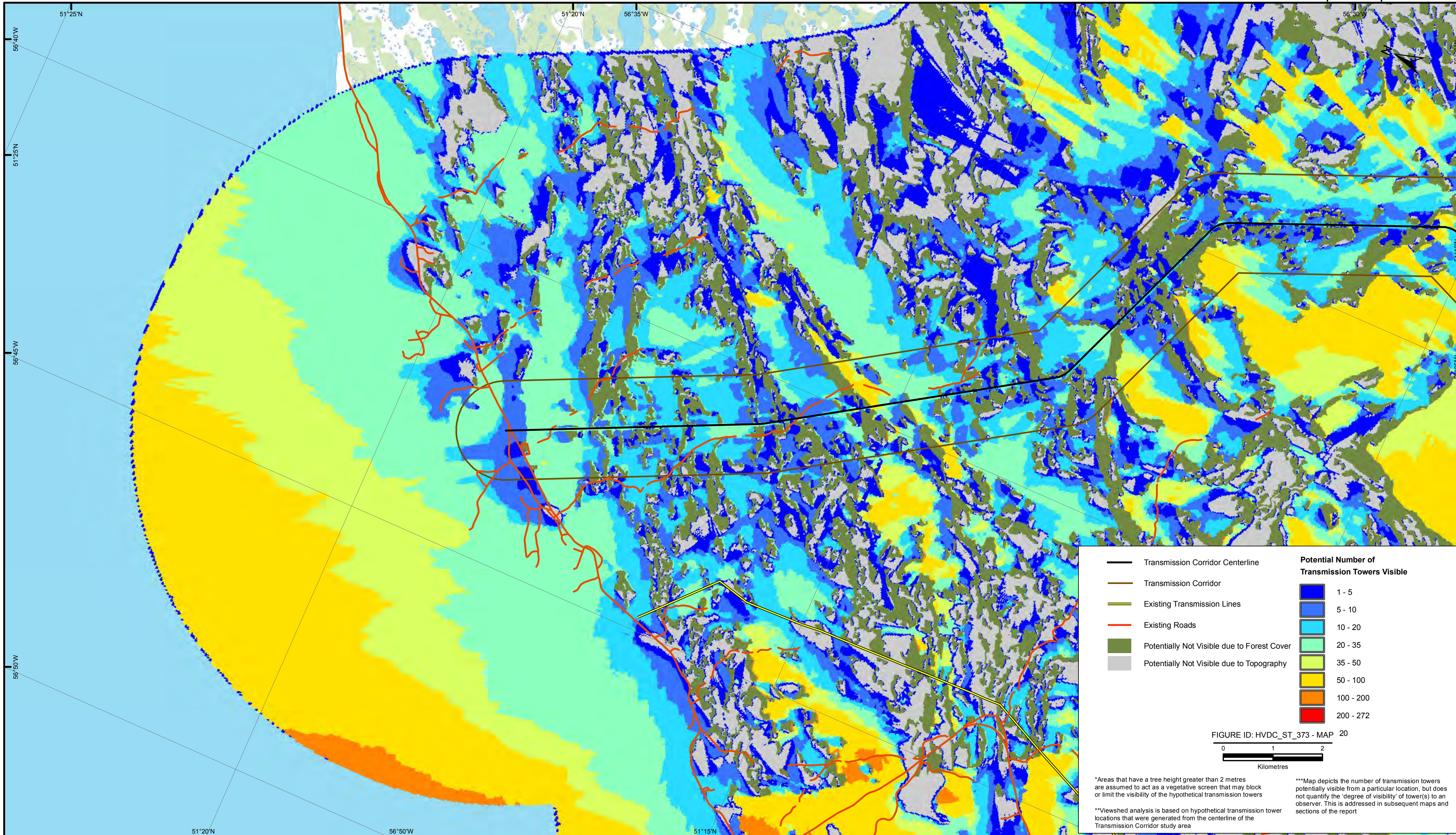
Figure 3.56

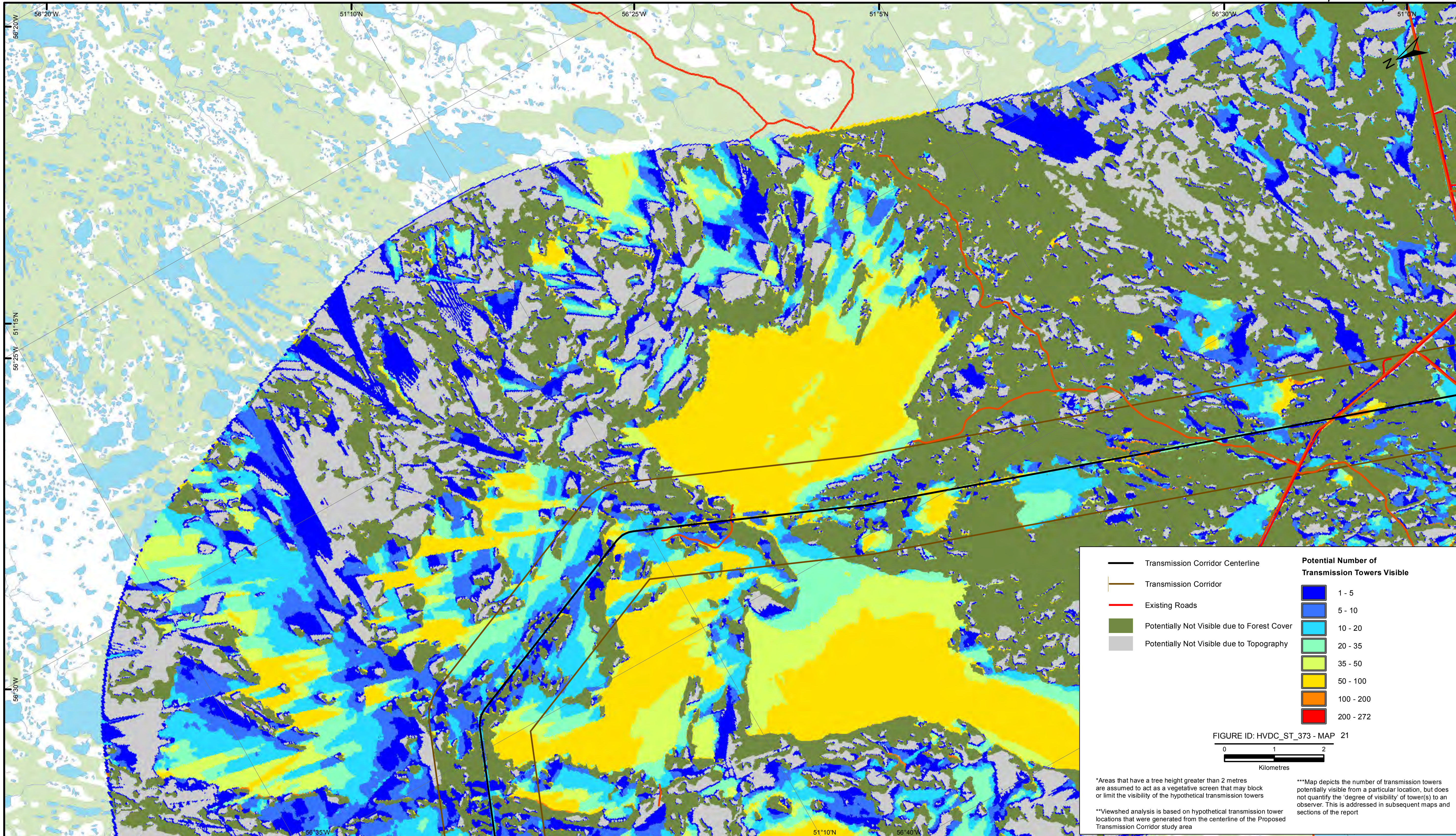
Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 19



nalcor energy

Figure 3.57

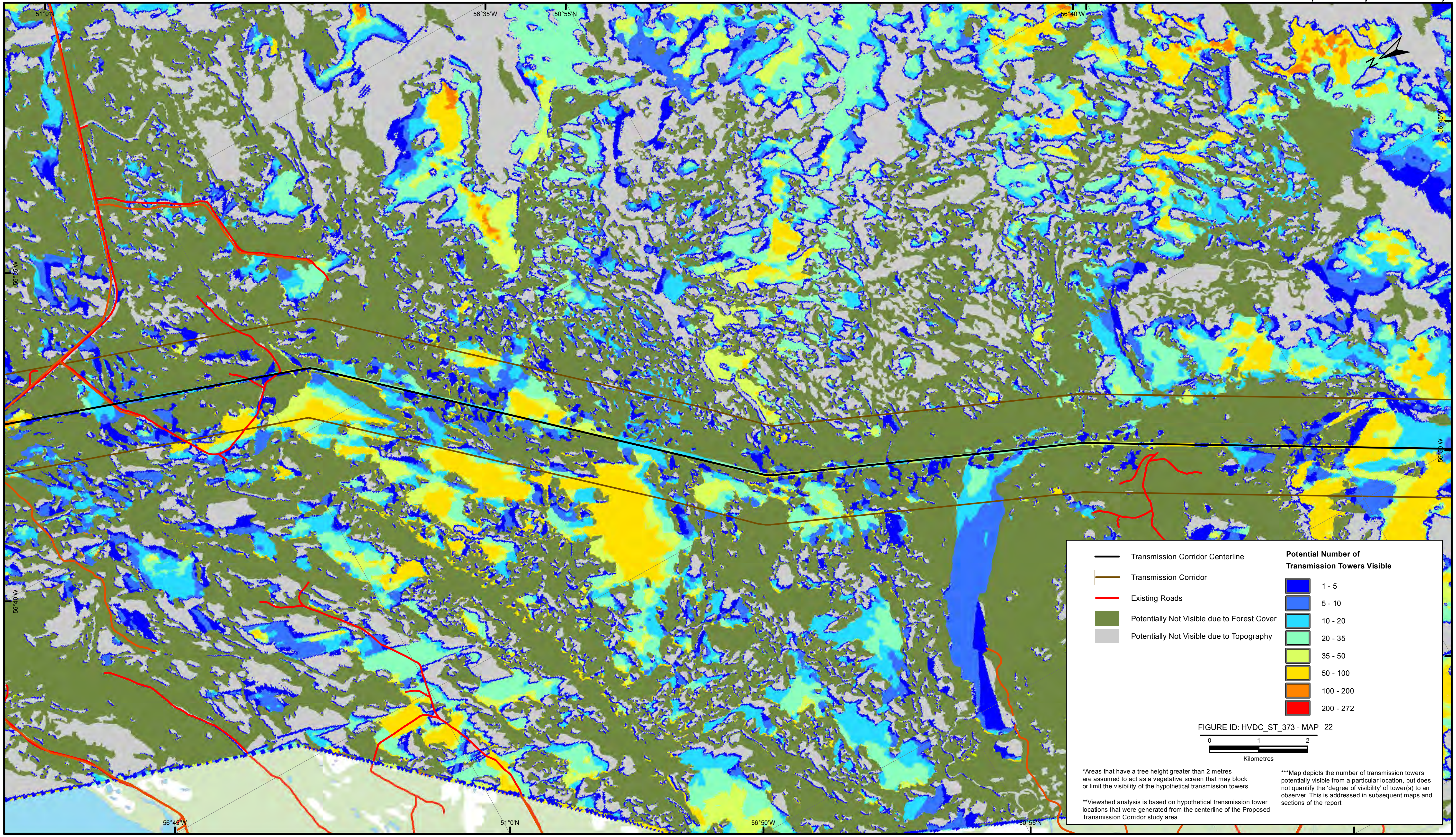
Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 20



nalcor energy

Figure 3.58

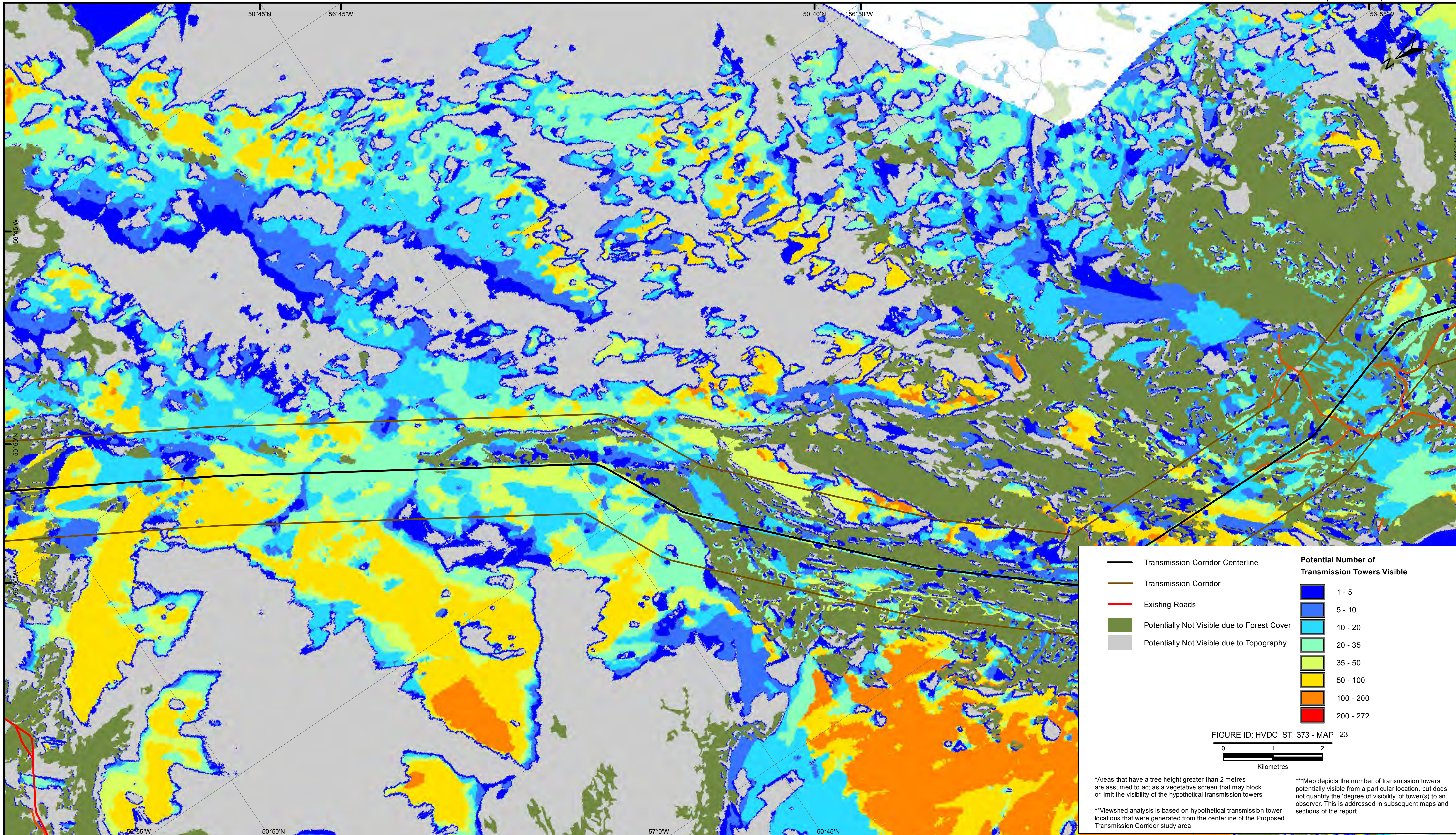
Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 21



nalcor energy

Figure 3.59

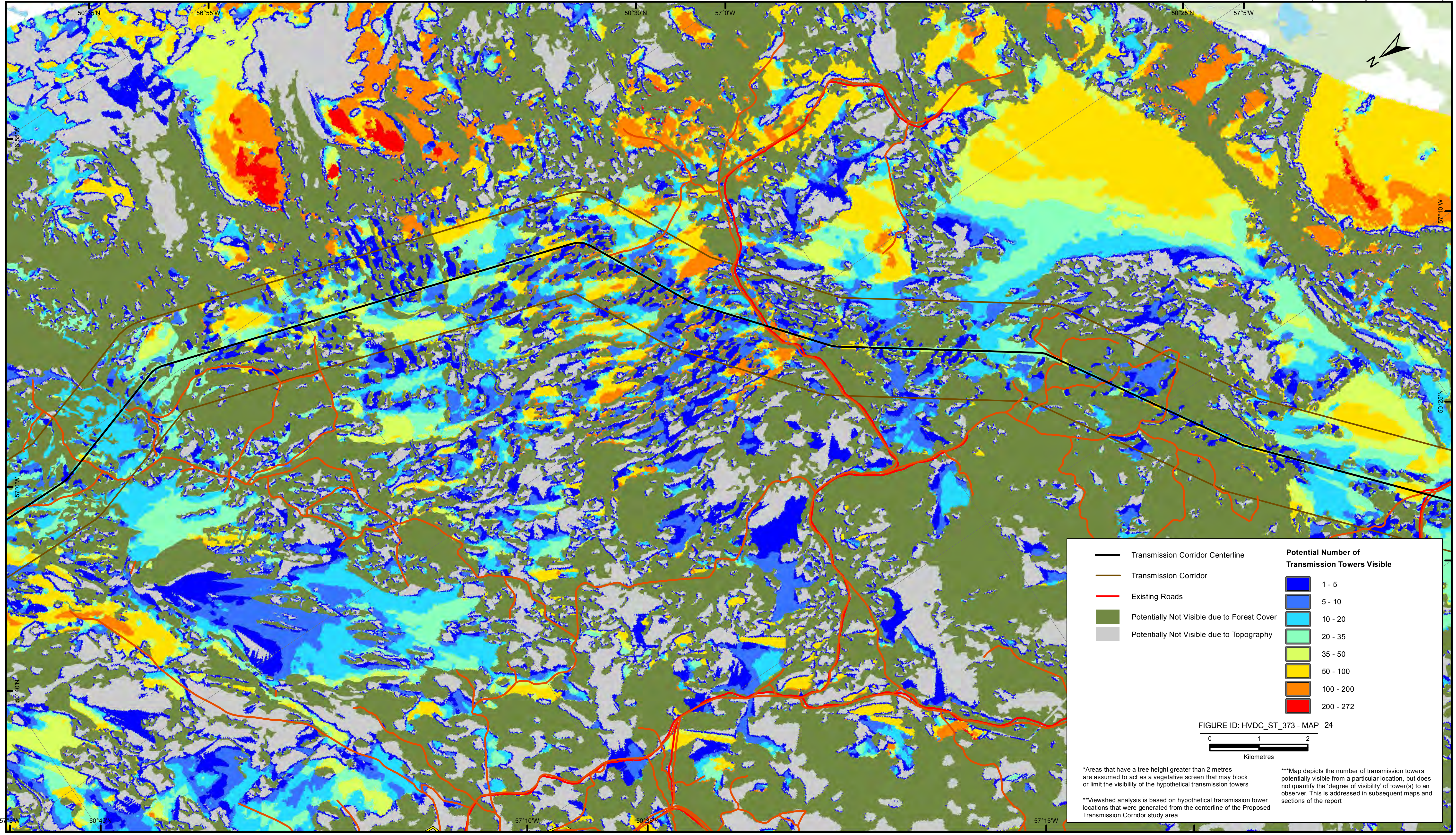
Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 22



nalcor energy

Figure 3.60

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 23



nalcor energy

Figure 3.61

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 24

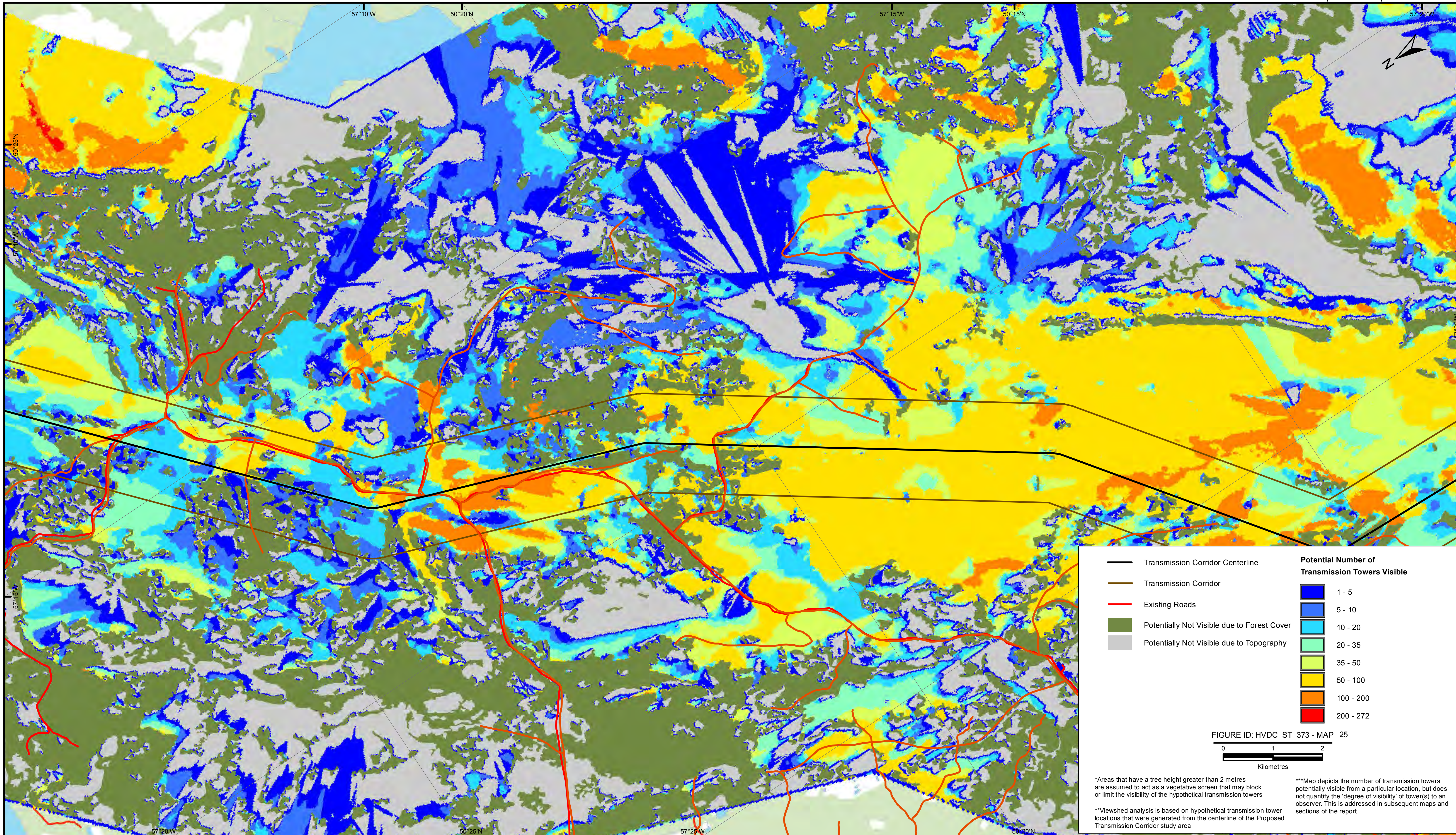
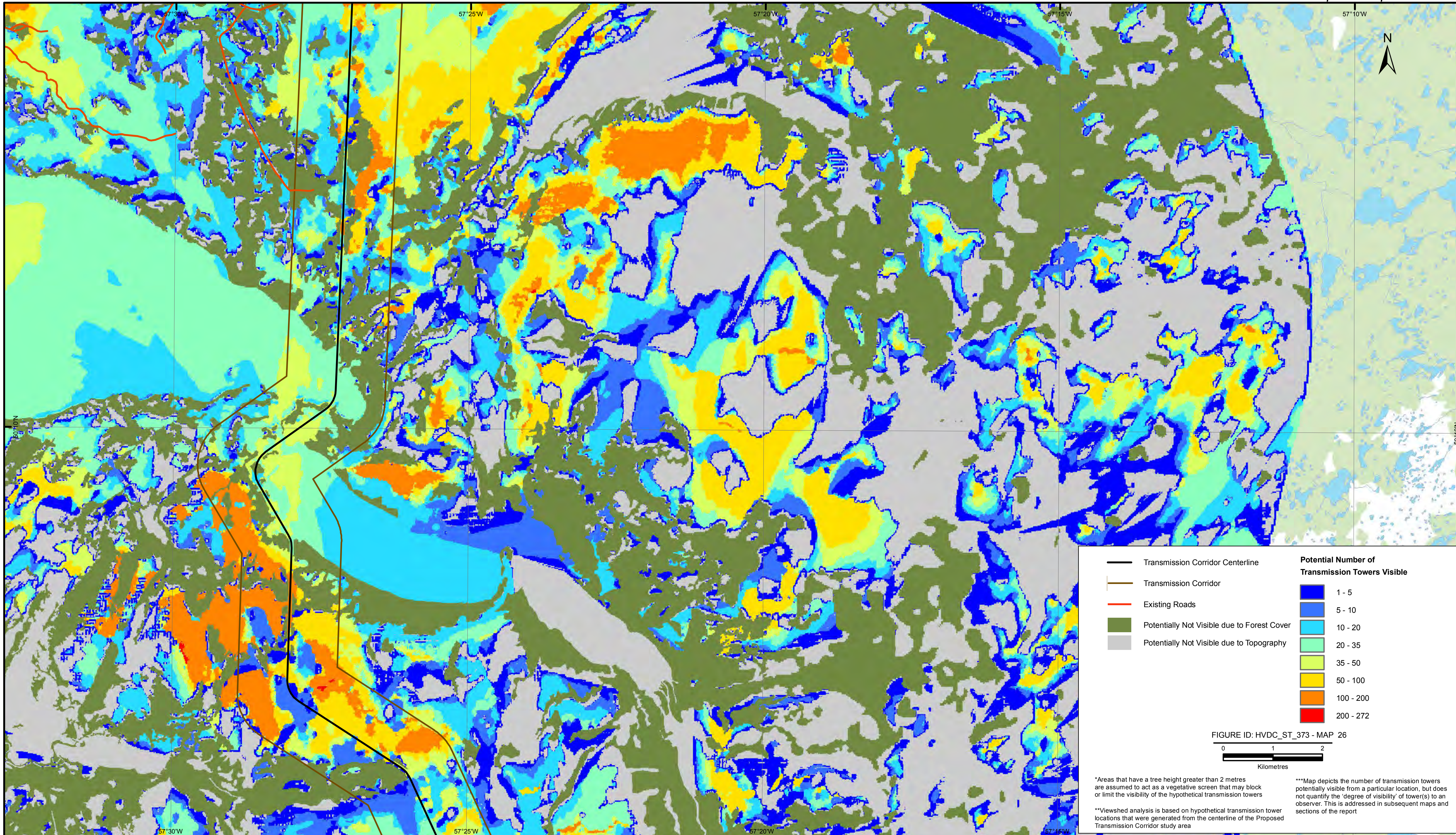


Figure 3.62

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 25



nalcor energy

Figure 3.63

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 26

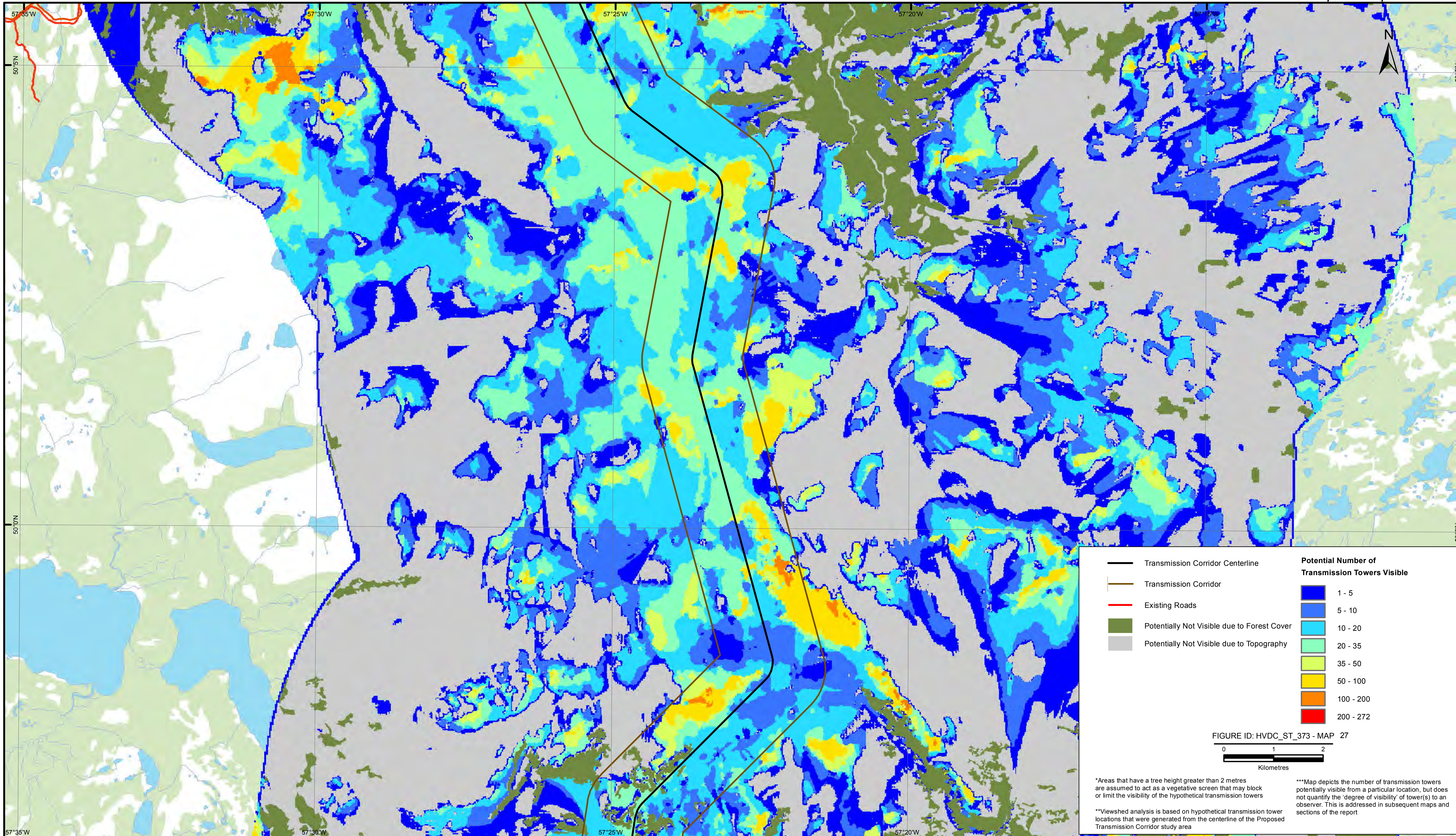
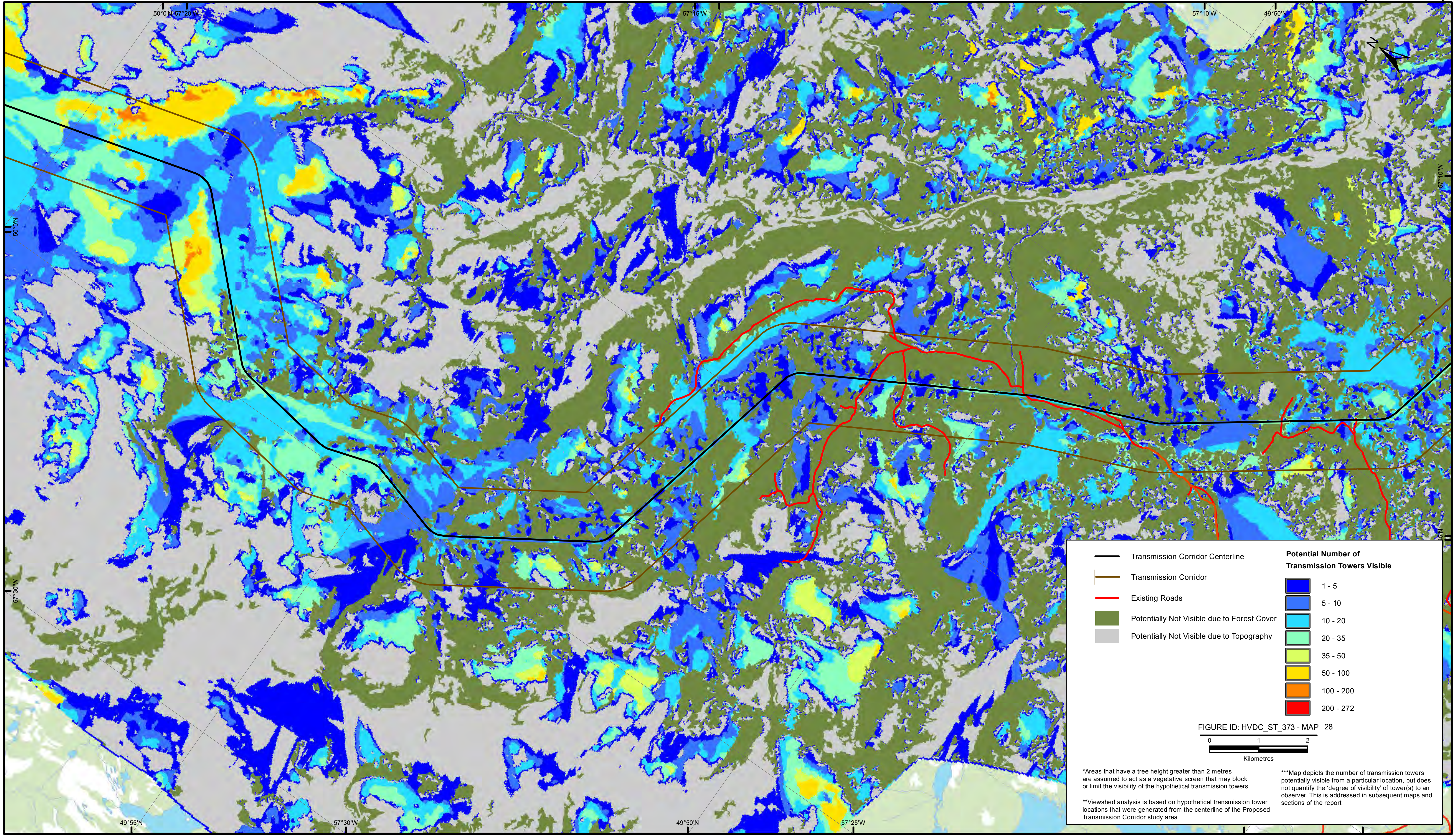


Figure 3.64

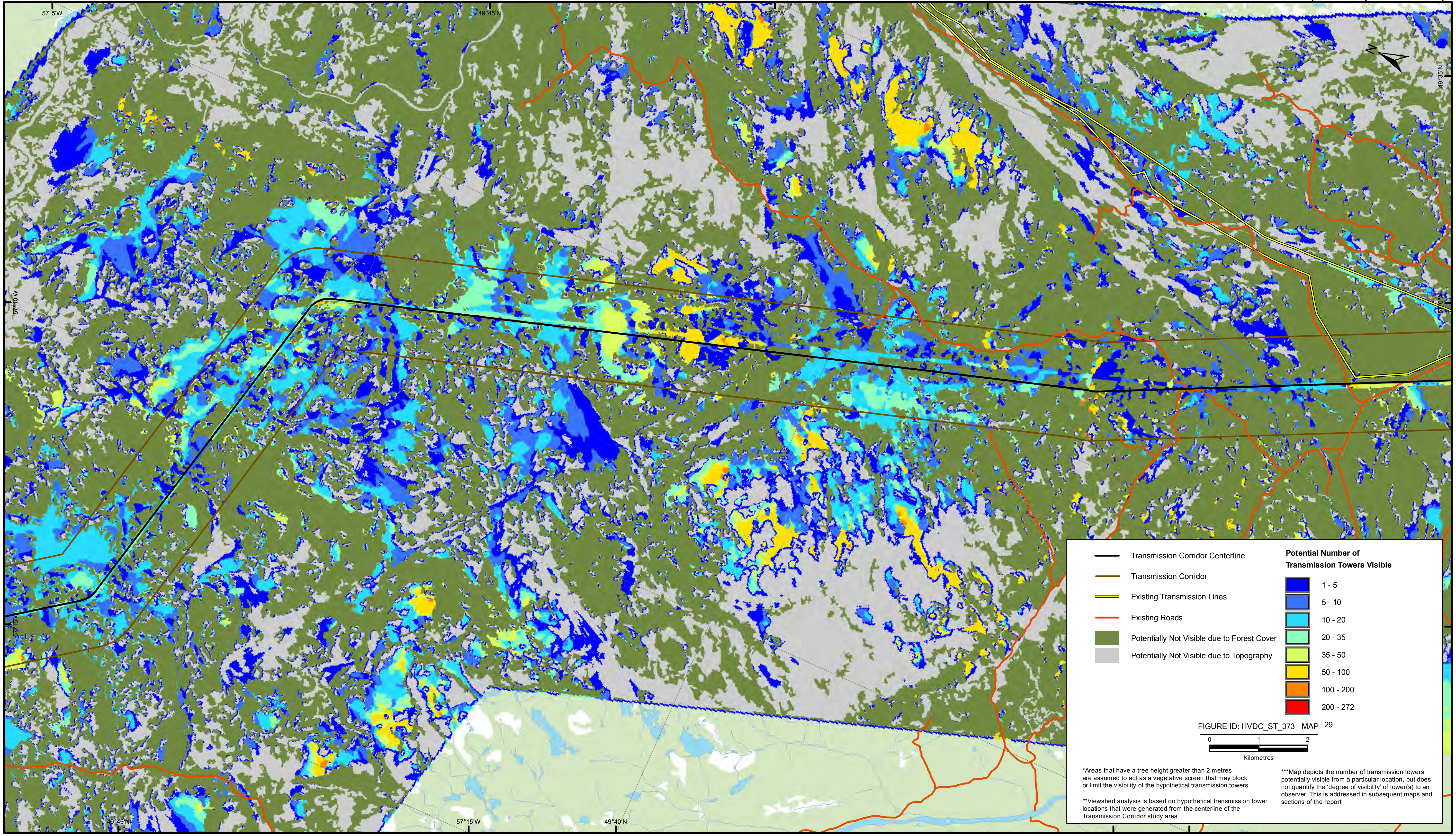
Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 27



nalcor energy

Figure 3.65

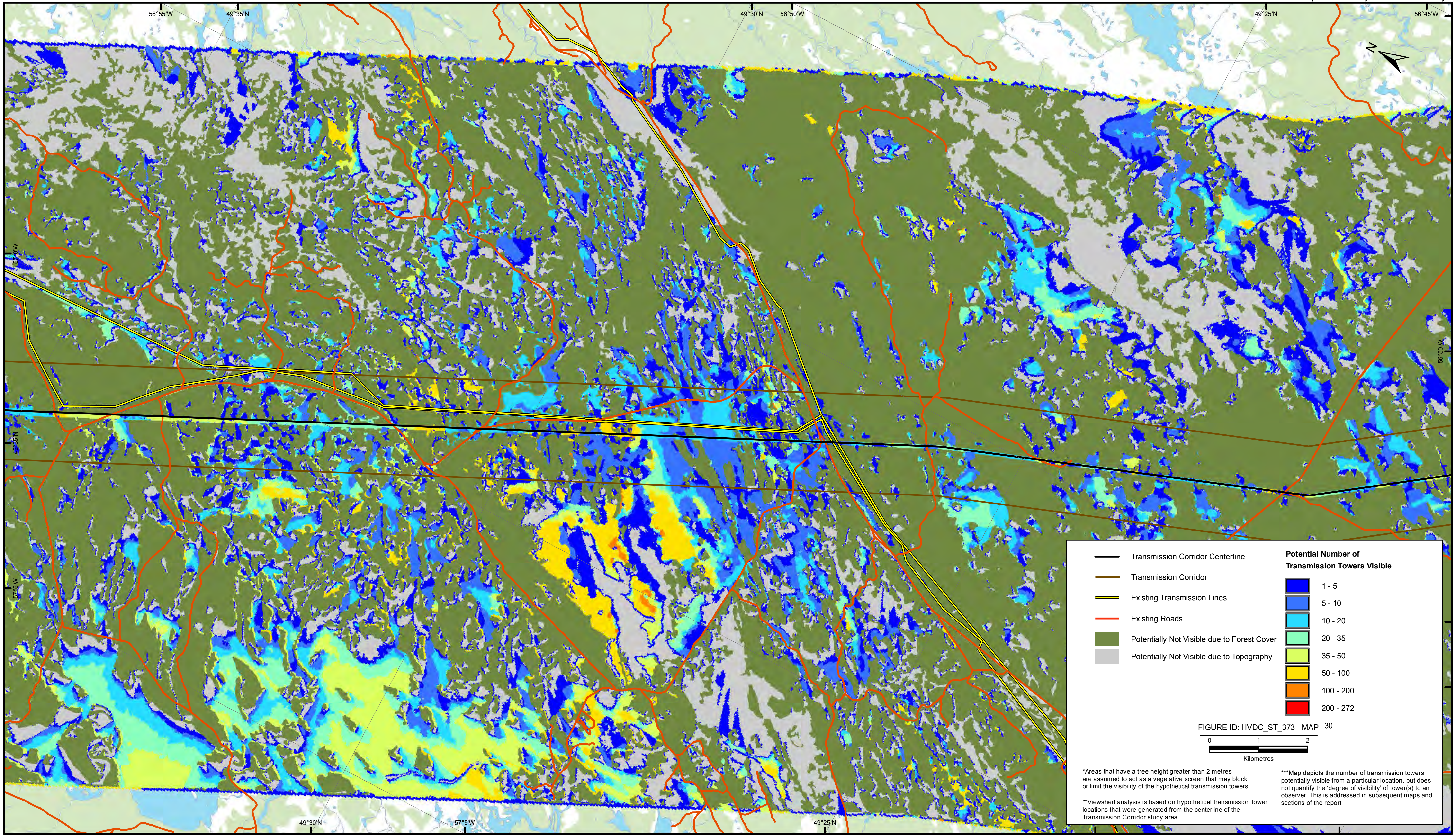
Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 28



nalcor energy

Figure 3.66

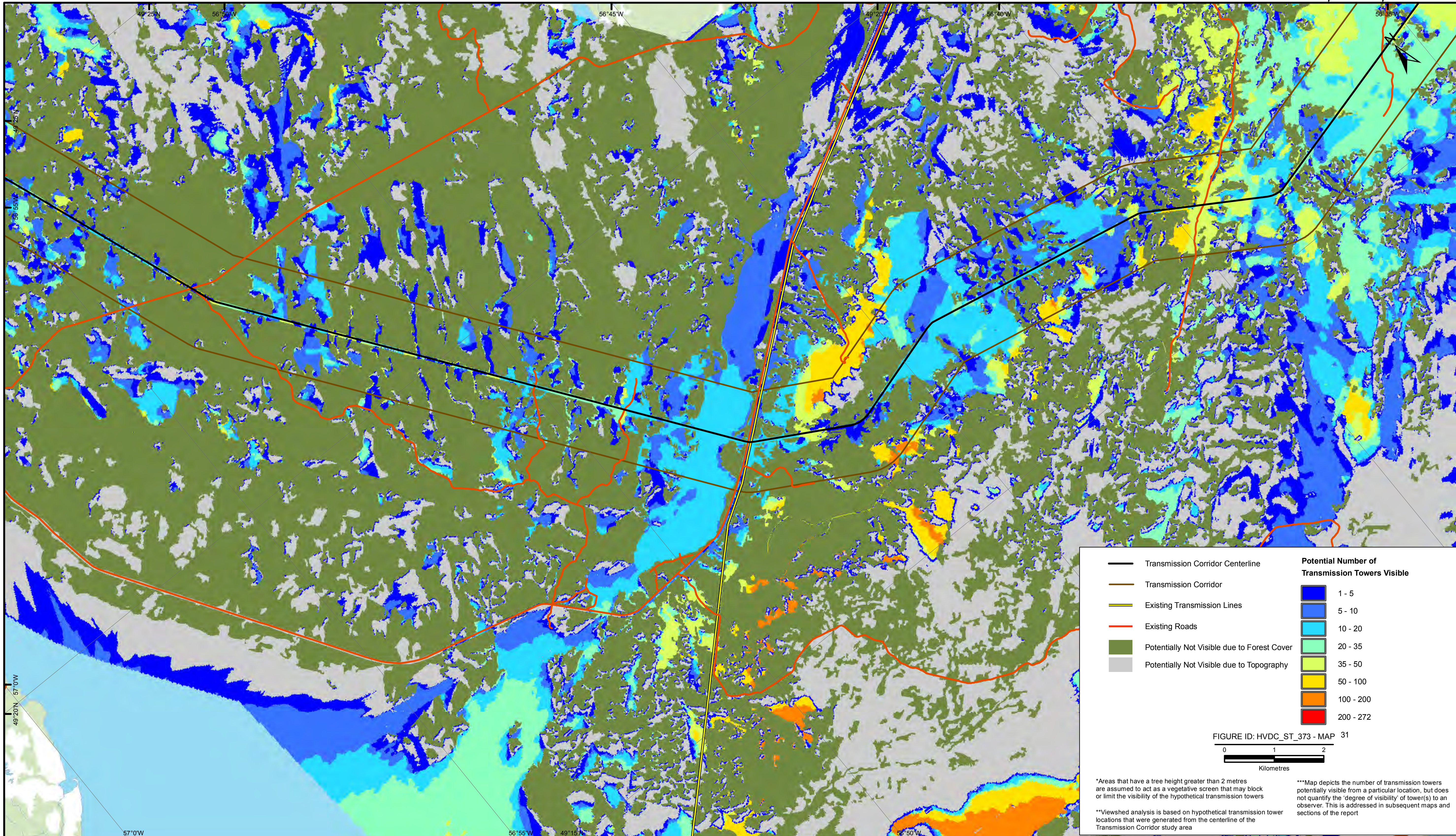
Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 29



nalcor energy

Figure 3.67

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 30



nalcor energy

Figure 3.68

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 31

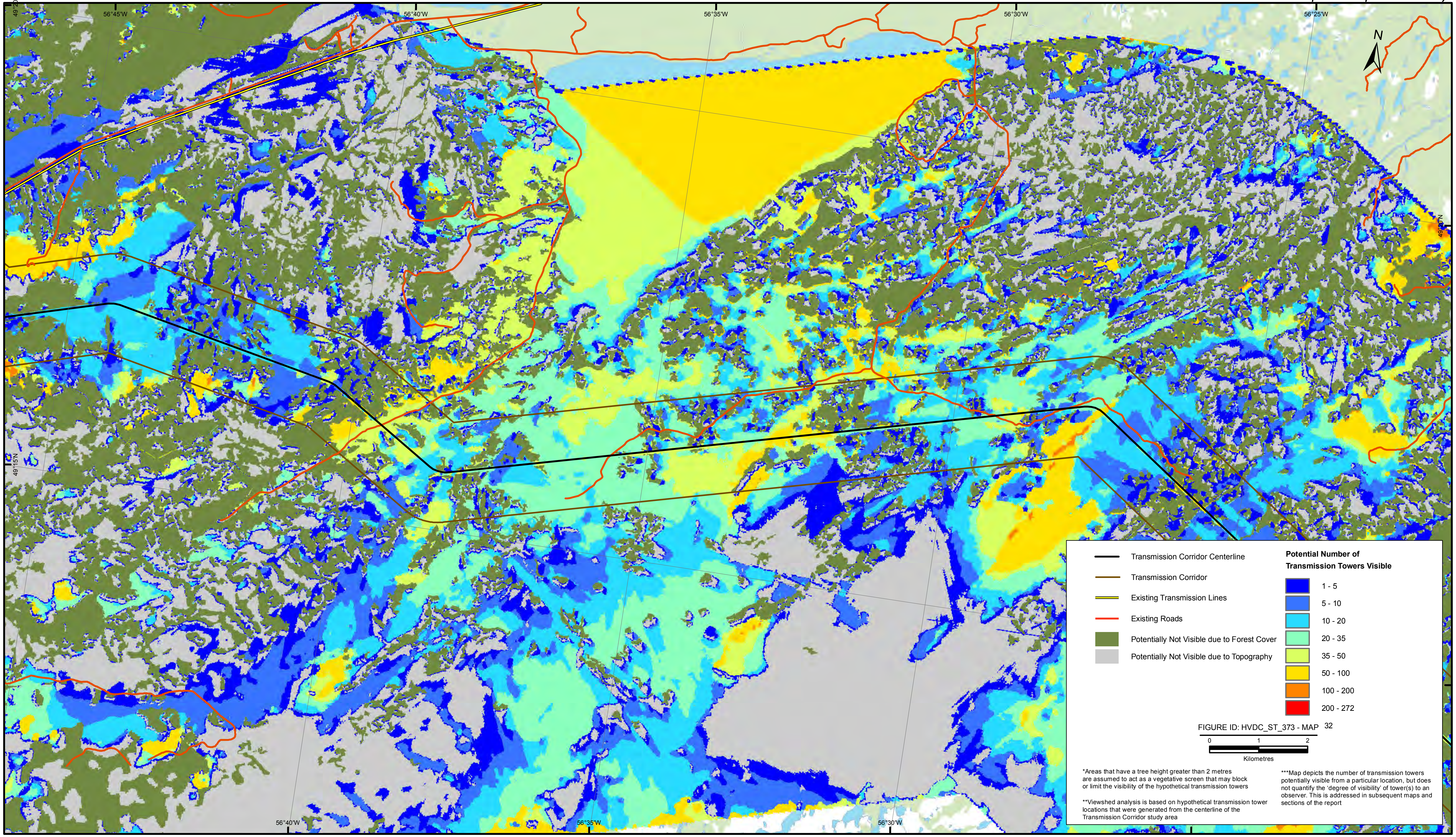


Figure 3.69

Viewshed Modelling - Potential Number of Transmission Towers Visible: Gull Island to Soldiers Pond, Map 32