

Appendix D:

Human Development Features and Zone of Influence Assumptions and References

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1. Background

In the Bathurst Caribou Range Plan (BCRP), **human disturbance** is defined as the area directly affected by human land use features (i.e., the development footprint) and its surrounding zone of influence (ZOI). Land use features such as roads, settlements and mine sites represent development footprints that directly result in habitat loss or alteration because of the space they occupy on the land. The ZOI is an associated area around the direct footprint that corresponds with an avoidance response (Johnson et al. 2005, Boulanger et al. 2012, Johnson and Russell 2014), where animals shift their distribution away from a development, alter behaviour in the vicinity of a facility, or change the types or quality of habitats used (Johnson and St. Laurent 2011). For barren-ground caribou a ZOI has been observed based on lower caribou abundance within a certain distance of established diamond mines than would be expected given available habitat (Boulanger et al. 2015, Caribou Zone of Influence Technical Task Group 2015). Some of the factors that are thought to influence caribou behavior or habitat use within the ZOI are sensory disturbances such as noise, dust, odors, and the visual stimuli from lights and viewscape – buildings, people, vehicles, and equipment. Thus, some implications of the indirect effect of a ZOI on caribou include the following:

- areas adjacent to development footprints are avoided or used less frequently resulting in reduced habitat availability;
- time spent feeding and intensity of feeding may be reduced concomitant with increased levels of activity (running and walking), which result in higher energetic costs to caribou leading to indirect population effects); or
- mortality risk may increase (direct population effect) in the case of roads and hunting access.

The area directly affected by human land use features is calculated directly from GIS mapping. Human land use features can be considered as either linear or areal (polygonal) features. Polygonal features include settlements, mine sites, gravel pits, and similar. Linear features include all-season roads, winter roads, trails, and electrical transmission corridors.

The ZOI around development footprints is the area indirectly affected by human activities, and is more difficult to define. The distance a ZOI may extend around a feature, and its effect on wildlife, varies depending on the nature of the development feature and the level of activity associated with the feature. Nonetheless, accounting for the ZOI around different development features is an important aspect of considering the total disturbance and cumulative effect of development footprints on wildlife. In GIS mapping, ZOI is estimated as a buffer of a defined distance around the development features.

2. Human Development Features and ZOI Extents

The ZOI extents used to represent indirect effects around the different linear and polygonal features contained in the Bathurst Caribou Range Plan GIS database are listed in **Table 1** and **Table 2**, respectively. The ZOI around different features types was estimated based on a literature review and values used in recent environmental assessments (e.g., Kiggavik Project Effects; Gahcho Kué Developer's Assessment Report; Golder Associates 2014b). References and a discussion of each human development feature and its assigned ZOI are provided. ZOI discussions are adapted from Russell (2014) and Golder Associates Ltd. (2014b) and attached for reference.

The NWT Cumulative Impact Monitoring Program (CIMP) database (CIMP 2015) was the main input for the Bathurst Caribou Range Plan GIS database. Given this, a large number of human development features have been identified, and each required estimates of their potential ZOI on barren-ground caribou. Average ZOI extents for different feature types have therefore been used, based on reported values and supportable rationale.

Table 1. Linear Human Development Features and ZOI Extents

Feature Code	Feature Name	Feature Width (m)	Feature Description	ZOI (km)	ZOI Discussion
AR	All-Season Access Road	10	Any all-season road, including industrial access roads and roads in and around Settlements.	5	<p>4 km ZOI around all-season roads identified by Vistnes and Nelleman (2001), Nelleman et al. (2003) and Weir et al. (2007). Abundance of calving barren-ground caribou less than expected within 4 km of roads (Cameron et al. 2005). 1.5 km ZOI used in Back River Project (Rescan 2013). Johnson and Russell (2014) found that Porcupine caribou demonstrated a definitive avoidance response to Main Roads and estimated a zone of influence of 30 km during 1985–1998 followed by a reduced distance of 18.5 km during 1999–2012. Data suggested that disturbance decreased over time or caribou became habituated to the footprint or associated disturbance activities.</p> <p><u>AR includes roads around Settlements; therefore 5 km average ZOI selected.</u></p>
EC	Major Electrical Transmission Corridor	30	Major electrical transmission corridors (e.g., Snare Lake, Bluefish and Taltson transmission lines).	4	<p>Major transmission lines found to have 4 km ZOI for barren-ground caribou (Vistnes and Nelleman 2001; Nelleman et al. 2003). Meliadine Project (Golder Associates Ltd. 2014) and Gachu Kué Project (Golder Associates Ltd. 2010) ZOIs ranged from 0 to 5 km.</p> <p><u>Average 4 km ZOI selected.</u></p>
HW	Public All-Season Paved Highway	60	NWT Highways #3 and #4.	5	<p>Same references as AR, All-season Access Road.</p> <p><u>5 km average ZOI selected.</u></p>
MAR	All-Season Mainline Access (Haul) Road	20	Major all-season industrial haul roads (e.g., currently Ekati Misery Road and proposed future haul roads such as IZOK and BIPAR corridors in Nunavut).	5	<p>Same references as AR, All-season Access Road. Observed lower probability of occurrence of caribou within 6-14 km of combined mines and roads (Boulanger et al. 2012).</p> <p><u>5 km average ZOI selected.</u></p>
WR	Winter Road	12	All winter roads <u>except</u> the Tibbit-Contwoyto Lake Winter Road. Winter roads are seasonal features	1	<p>200 m ZOI used for Back River Project (Rescan 2013). 5 km ZOI used for Meliadine Project (Golder Associates Ltd. 2014) and</p>

Feature Code	Feature Name	Feature Width (m)	Feature Description	ZOI (km)	ZOI Discussion
			that exist only during the January-early April period.		<p>Gachu Kué Project (Golder Associates Ltd. 2010).</p> <p>Johnson and Russell (2014) observed that Porcupine caribou showed relatively little avoidance of wells, trails, winter roads, and seismic lines once they achieved a distance of 6 km during 1999–2012 and 11 km during 1985–1998. For this disturbance type, the data suggested a habituation or vegetation recovery effect that reduced the zone of influence by nearly 50%; although, this relationship was imprecise.</p> <p><u>WR includes many different winter road types ranging from lower to higher use intensity; therefore 1 km average ZOI selected.</u></p>
WR_TC	Tibbitt to Contwoyto Winter Road	40	The main Tibbit to Contwoyto Lake Winter Supply Road. This is a seasonal feature that exists only during the January-early April period.	4	<p>Same references as WR, Winter Road.</p> <p><u>Given the high level of seasonal industrial truck traffic (and potentially public use) on Tibbit to Contwoyto Lake Winter Road, a 4 km average ZOI was selected (more than WR, less than HW).</u></p>

Table 2. Polygonal Human Development Features and ZOI Extents

Feature Code	Feature Name	Feature Description	ZOI (km)	ZOI Discussion
AIRSTRIP	Airstrip	Airstrip	5	<p>No literature references available.</p> <p><u>Most airstrips are associated with Camps, Mineral Exploration, Settlements, or similar; therefore 5 km ZOI selected.</u></p>
CAMP	Camp	A variety of camp types (mineral exploration, lodges, outfitting, highway, research, etc.)	5	<p>4 km ZOI identified for tourism and recreation camps by Vistnes and Nelleman (2001) and Vistnes et al. (2008). 5 km ZOI used for outfitting camps in Gahcho Kué Project (Golder Associates Ltd.</p>

Feature Code	Feature Name	Feature Description	ZOI (km)	ZOI Discussion
				2010). 5 km ZOI applied to mineral exploration camps/sites in Gahcho Kué Project (Golder Associates Ltd. 2010) and Meliadine Project (Golder Associates Ltd. 2014). <u>The most common Camp type identified in mapping database is mineral exploration camp; therefore 5 km ZOI selected.</u>
COMM	Communications	Communications towers	1	No literature references available. Communication towers are point features with limited human activity. <u>1 km ZOI selected.</u>
GEN_IND	General Industrial	General industrial features from CIMP database (culverts, staging areas, storage, etc.)	1	No literature references available. The General Industrial feature class contains a range of feature types. Most are located adjacent to existing All-Season Roads or Settlements. <u>1 km ZOI selected.</u>
MIN_EXPL	Mineral Exploration	Mineral exploration activities (drilling, trenching, etc.)	5	5 km ZOI applied to mineral exploration camps/sites in Gahcho Kué Project (Golder Associates Ltd. 2010) and Meliadine Project (Golder Associates Ltd. 2014), with 5 km ZOI applied to all active exploration permits for the entire 5-year period, over the entire year. <u>5 km ZOI selected.</u>
MINE_ACTIV	Minesite (Active)	Active minesites (e.g., Ekati, Diavik, Snap Lake, etc)	14	Observed lower probability of occurrence of caribou within 6-14 km of combined mines and roads (Boulanger et al. 2012). Hypothetical 15 km ZOI around active mines used by Johnson et al. (2005). The Back River Project considered two ZOIs at 4 km and 14 km (Rescan 2013). The Meliadine Project considered a three ZOI range with variable disturbance coefficients 0-1, 1 to 5, 5 to 14 km based on Boulanger (2012) (Golder Associates Ltd. 2014). The Gacho Kué Project assumed a 15 km ZOI was applied to all active mine sites regardless of the size of the footprint or the level of activity for each mine (Golder Associates Ltd. 2010).

Feature Code	Feature Name	Feature Description	ZOI (km)	ZOI Discussion
				<u>Average 14 km ZOI selected.</u>
MINE_PAST	Minesite (Past or Closed)	Past Minesites under care and maintenance or being actively reclaimed/remediated (e.g., Lupin, Jericho, Tundra, etc.)	5	No literature references available. Past Minesites are assumed to have levels of human activity and potential aerial traffic similar to Mineral Exploration or Camp features. <u>Average 5 km ZOI selected.</u>
MISC	Miscellaneous	Miscellaneous/uncertain features from CIMP database (most are located along highways)	1	No literature references available. There are relatively few Miscellaneous features in the Bathurst range. <u>1 km ZOI selected.</u>
PORT	Marine Port	Proposed marine ports or laydown areas associated with potential future mineral development projects in Nunavut (e.g., Grays Bay-Izok, Bathurst Inlet).	5	No literature references available. Future Marine Ports along the Nunavut Arctic coast are assumed to have similar levels of activity as Mineral Exploration sites or Camps. Depending on season of use and shipping methods, they may receive limited human activity for much of the year. <u>5 km ZOI selected.</u>
POWR_GEN	Power Generation Facility	Major hydro dams and associated power generation facilities (e.g., Snare River, Bluefish River and Taltson)	5	No literature references available. Nelleman et al. (2003) found reduced caribou use up to 4 km ZOI from hydro reservoirs. Gacho Kué Project (Golder Associates Ltd. 2010) and Meliadine (Golder Associates Ltd. 2014) used a 1 km ZOI for on-site power plants. Major hydro facilities have Airstrips, Major Electrical Transmission Lines, and may receive a relatively high level of human activity. <u>Assumed to be similar to Airstrips or Mineral Exploration; therefore 5 km ZOI selected.</u>
QUARRY	Quarry	Sand, gravel or rock quarries	5	No literature references available. <u>Assumed to be similar to Mineral Exploration or small-scale mining activities; therefore 5 km ZOI selected.</u>

Feature Code	Feature Name	Feature Description	ZOI (km)	ZOI Discussion
SETTLEMENT	Settlement	Permanent settlements (communities and municipal areas)	15	<p>15 km ZOI used by Gahcho Kué Project (Golder Associates Ltd. 2010) and Meliadine Project (Golder Associates Ltd. 2014).</p> <p>Although most communities were on the periphery of the winter range, Johnson and Russell found an avoidance distance of ~34.5 – 38 km to settlements by collared Porcupine caribou.</p> <p><u>Settlement ZOI is assumed to be extensive due to potential high harvest pressure and multiple land uses; therefore 15 km ZOI selected.</u></p>

References

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Russell (2014). Table 3 from Kiggavik Review (for reference)

Disturbance activity	ZOI (km)	References		Notes
		Published literature	Similar environmental assessments	
MU — Municipalities (Polygon)	15	Hypothetical 1,000 m (Johnson et al. 2005), but no disturbance coefficients identified.	Meliadine FEIS (Golder Associates Ltd. 2014) and Gahcho Kué (De Beers Canada Inc. 2010) used a 15 km extent with variable disturbance coefficients from 0.05 to 0.75	Presume community ZOI is extensive due to likely high harvest pressure and other land uses (e.g., traffic, noise). Use ZOI similar to other likely high disturbance activities; extend to 15 km, precedent set for Meliadine FEIS.
ASR — All Season Roads WR — Winter Road (Line)	4 (ASR) 0.2 (WR)	4 km (Vistnes and Nellemann 2001, Nellemann et al. 2003, Weir et al. 2007); Hypothetical 95% (i.e., DC = 0.05) reduction with 1 km radius of operating mine road (Misery road, (Johnson et al. 2005); Abundance of calving caribou less than expected within 4 km of a road (Cameron et al. 2005).	Hypothetical: All weather <u>construction</u> : 4 km radius (Rescan 2013); All weather <u>operations</u> : 1.5 km (Rescan 2013); Winter Road: 200 m (Rescan 2013); ZOI extended to 5 km for the Meliadine Project (Golder Associates Ltd. 2014) and the Gahcho Kué project (De Beers Canada Inc. 2010) with variable disturbance coefficients from 0.05 to 0.75.	
EX — Exploration (Point)	5	Mineral exploration sites affected a <i>hypothetical</i> 50% reduction [i.e., DC = 0.5] in the value of habitats found within a 10 km radius of the assumed development site, and a 25% reduction [i.e., DC = 0.75] within a 5 km zone around that buffered area [total 15 km] (Johnson et al 2005, pg. 16).	For the Meliadine and Gahcho Kué Project assessments, exploration projects were assumed to have a 500 m radius footprint (Golder Associates Ltd. 2014; De Beers Canada Inc. 2010b). Also for both projects, a 5 km ZOI was applied to all active exploration permits for the entire five-year period, and over the entire year.	The CEA for the Back River Project did not include exploration projects as disturbance activities. A review conducted by Areva showed that exploration footprints likely to represent a 7.4 ha area (~154 m radius)
MI — Mining (Polygon or Point)	14	Observed lower probability of occurrence of caribou within 6–14 km around combined mines and road (Boulanger et al. 2012). Hypothetical (not modelled) 15 km ZOI (Johnson et al. 2005). Caribou numbers decreased within 6 km of mine centre in late winter through calving seasons (Weir et al. 2007).	The Back River Project considered two ZOIs at 4 km and 14 km (Rescan 2013). The Meliadine Project considered a three ZOI range with variable disturbance coefficients 0-1, 1 to 5, 5 to 14 based on Boulanger (2012) (Golder Associates Ltd. 2014). The Gacho Kué Project assumed a 15 km ZOI was applied to all active mine sites regardless of the size of the footprint or the level of activity for each mine (De Beers Canada Inc. 2010).	
ERG — Energy corridors Point (plant); line(transmission)	4	Transmission lines: 4 km ZOI (Vistnes and Nelleman 2001 and Nelleman et al 2003)	Meliadine (Golder Associates Ltd. 2014); Gacho Kué (De Beers Canada Inc. 2010) used a 500 m radius footprint and a 1 km ZOI for power plants, and a 200 m footprint for transmission lines. A ZOI ranged from 0 to 5 km with variable disturbance coefficients from 0.05 to 0.75.	
TR — Tourism (e.g. guide and outfitting) Point	4	4 km ZOI (Vistnes and Nelleman 2001 and Vistnes et al 2003); 10% i.e., DC = 0.9) reduction in areas influenced by outfitters in a 500 m buffer (Johnson et al. 2005).	Not considered in cumulative effects for Meliadine or Back River CEAs. Gahcho Kue used a 200 m radius footprint and a 5 km radius ZOI with a DC of 0.1 (De Beers Canada Inc. 2010).	Accounts for seasonality and presumed quota (i.e., managed) harvest around outfitter camps.
TR — Traditional Harvest and Land Use	na	Johnson et al. (2005) noted specifically that they did not consider responses to subsistence harvest.	Not considered in cumulative effects for Meliadine, Gacho Kué or Back River CEAs	Not a spatial reference, background conditions

Golder Associates (2014b). Table 12.4-15 (for reference).



Table 12.4-15 Extent and Disturbance Coefficients for Development Footprints and Associated Zones of Influence for Caribou Seasonal Resource Selection Functions

Disturbance Type	Feature Type	Footprint		Concentric Zone of Influence #1		Concentric Zone of Influence #2		Concentric Zone of Influence #3	
		Extent (m)	Disturbance Coefficient	Range ^(a) (km)	Disturbance Coefficient ^(b)	Range ^(a) (km)	Disturbance Coefficient ^(b)	Range ^(a) (km)	Disturbance Coefficient ^(b)
Campgrounds	Point	250	0.00	n/a		n/a		n/a	
Community	Polygon ^(c)	Actual	0.00	0 to 1	0.05	1 to 5	0.50	5 to 15	0.75
Communications	Point	250	0.00	0 to 1	0.90	n/a		n/a	
Contaminated Site High and Medium Priority for Action ^(d)	Point	250	0.00	n/a		n/a		n/a	
Fuel Storage	Point	250	0.00	n/a		n/a		n/a	
Mine	Polygon ^(c)	Actual	0.00	0 to 1	0.05	1 to 5	0.50	5 to 15	0.75
Mineral Exploration	Point	500	0.00	0 to 1	0.50	1 to 5	0.75	n/a	
Power Plant	Point	500	0.00	0 to 1	0.50	n/a		n/a	
Quarrying	Point	250	0.00	0 to 5	0.75	n/a		n/a	
Staging Area	Point	250	0.00	0 to 5	0.75	n/a		n/a	
Tourism (lodge)	Point	250	0.00	0 to 5	0.10	n/a		n/a	
Transmission and Power Lines	Line	250	0.25	0 to 1	0.50	1 to 5	0.75	n/a	
All-season Roads and Highways	Line	250	0.00	0 to 1	0.05	1 to 5	0.75	n/a	
Winter Road	Line	250	0.00	0 to 1	0.05	1 to 5	0.75	n/a	
Winter Road Portage	Line	250	0.00	n/a		n/a		n/a	
Miscellaneous (Bridge, Culvert)	Point	250	0.00	0 to 1	0.90	n/a		n/a	

a) From edge of actual or hypothetical footprint.
 b) Disturbance coefficient (applied as a multiplier to cell RSF value), based on assumed disturbance.
 c) Footprints were delineated from remote sensing imagery.
 d) As defined by the Federal Contaminated Sites Inventory (TBCS 2013).
 n/a = Not applicable; km = kilometre; m = metre.