BP6/BP7 - CONSTRUCTION RELATED GREENHOUSE GAS EMISSIONS ASSESSMENT

Energy Supply Planning Department
Integrated Resource Planning

[redacted]

PREPARED BY:

K. M. SHAW, P. ENG.

[redacted]

REVIEWED BY:

S. COUGHLIN, M SC.

[redacted]

APPROVED BY:

NOTED BY:

[redacted]

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1 PURPOSE OF THIS REPORT

This report summarizes the estimate of greenhouse gas emissions (“emissions”) related to the rebuilding of a 8.5 km section (from the Portage-Saskatchewan Station to west of the Portage Bypass) of the BP6/BP7 transmission line damaged by the 2019 snowstorm and ongoing maintenance of that section (during the operation and maintenance (“O&M”) phase). BP6/BP7 is a 115 kV double circuit transmission line between Brandon and Portage la Prairie.

The main purpose of this report is to function as a point of reference for the environmental assessment (“EA”) of the BP6/BP7 Transmission Project and to document the applied emissions estimation methodologies and assumptions. Construction related emissions include construction activity emissions (including supply-chain emissions), permanent land-use change emissions along the right-of-way (“ROW”), and ongoing BP6/BP7 maintenance emissions.

While this assessment draws on methodologies from previous greenhouse gas (“GHG”) life cycle assessments (“LCAs”), such as Jeyakumar, B., & Kilpatrick, R. (2015), and it strives to follow LCA principles, it is considered a high level estimate of construction related GHG emissions, not a LCA. This was deemed an appropriate approach as potential emissions related to the construction of BP6/BP7 are small relative to other similar projects (e.g., Jeyakumar, B., & Kilpatrick, R. (2015)).

Only emissions related to the construction of the 8.5 km segment were assessed; this was not a comprehensive GHG mitigation assessment (e.g., Manitoba Hydro (2021)) which would incorporate estimates of all relevant GHG effects (both emissions and emission reductions), primary and secondary, of a project. For example, the beneficial impact of BP6/BP7 on Manitoba Hydro’s system-wide losses over the life of BP6/BP7 was not assessed herein: potential GHG benefits due to improved system efficiencies are considered a qualitative benefit (i.e., outside the scope of this assessment) of the BP6/BP7 Transmission Project but, due to the low level of direct GHG emissions, could easily outweigh the construction related emissions estimated herein. Emissions related to the salvage of damaged infrastructure has also not been assessed.

A GHG mitigation assessment, and normally an LCA, would compare a “project scenario” with a “baseline scenario”. The scope of this assessment did not consider potential alternatives to BP6/BP7 that could occur in the absence of the project. Emissions estimates presented herein are absolute BP6/BP7 emissions (i.e., the baseline scenario for this assessment is, by default, a “do-nothing” scenario), not incremental[1] BP6/BP7 emissions, which are normally lower.

[1] Note: For clarity, the methods related to land use change emissions (Section 4) are temporally incremental; but they are not incremental relative to project alternatives.

2 SUMMARY OF CONSTRUCTION RELATED EMISSIONS

Table 1 is intended to provide a high-level approximation of construction related emissions, indicating the order of magnitude of potential emissions. Aggregated construction related emissions for the 8.5 km section of BP6/BP7 are 2.5 kilotonnes ("kt") of carbon dioxide equivalent ("CO_2e"). While aggregated emissions are presented to the nearest tonne ("t") in Table 1, this is only done for comparison purposes; it is not intended to imply that this level of accuracy was achieved in the assessment of construction related emissions. The majority of construction related emissions are the result of supply-chain emissions embedded in the materials of BP6/BP7 components (e.g., towers and conductors).

Table 1 Summary of Construction Related Emissions

Activity	t CO_2e	% of total
Construction: Material Supply-Chain	1,827	74.1%
Construction: On-Site Energy	231	9.4%
Construction: Labour Transport	5	0.2%
BP6/BP7 Maintenance	200	8.1%
ROW Land Use Change	202	8.2%
Total	**2,465**	

Construction of BP6/BP7 is assumed to require minimal clearing (i.e., 1 hectare) of forested-land. As such land-use change emissions are minimal (i.e., 0.2 kt) for the BP6/BP7 Transmission Project. Emissions resulting from on-site energy use during construction are estimated to be 0.23 kt. For comparison, this is less than 1% of the annual emissions from Manitoba Hydro's existing fleet (25 kt of CO_2e in 2019) [2].

[2] [Manitoba Hydro, 2020a]

3 CONSTRUCTION ACTIVITY EMISSIONS – METHODOLOGY

Construction activity emissions will result from the construction of the 8.5 km segment of BP6/BP7. The first 3 km (approximate) follows the existing BP6/BP7 route and will therefore not require a new ROW or the construction of new towers as they have already been repaired. Some reconductoring may be required on the first 3 km, however, for the purposes of this assessment, all proportional assumptions (e.g., labour estimates, conductor length) herein are assumed to apply to 5.5 km, not 8.5 km. Based on input from Manitoba Hydro design staff, this was deemed a reasonable assumption. On-site construction emissions are compared to embedded supply-chain emissions; supply-chain emissions have been estimated at a high-level to provide a useful point of comparison with direct on-site construction emissions within the BP6/BP7 section.

The estimate of construction activity emissions incorporated into this assessment does not have a high-level of precision. As construction activity emissions are relatively small for BP6/BP7, this was deemed an appropriate approach; it was deemed reasonable to use readily available construction information[3] and LCA emissions factors ("EFs") and not undertake any comprehensive additional analyses. However, where detailed construction information was readily available it has been incorporated.

Assumptions related to the construction of BP6/BP7 are based on both project specific details and assumptions incorporated into the recent construction emissions assessment of PW75[4] (also a 115 kV line), which incorporate assumptions from the Pointe du Bois Transmission Project Environmental Assessment Report ("PdB Transmission Project EAR"[5]). Construction assumptions incorporated into this assessment are intended for emissions estimation purposes only.

3.1 Construction Activities

Construction activities for BP6/BP7 have been broken down into three major activities:

1. Manufacture of new BP6/BP7 components (supply-chain)
2. Transportation of BP6/BP7 construction materials (supply-chain)
3. Construction of the new BP6/BP7 section

[3] Note: All construction information incorporated into the final EA may not have been available at the time of this assessment. Some conservative assumptions made herein may not match final design and were chosen to avoid emission underestimation.
[4] PW75 is a proposed 115 kv transmission line between the Whiteshell station and Pointe Du Bois generation station.
[5] [Manitoba Hydro, 2014a; Manitoba Hydro, 2014b]

3.1.1 Manufacture of New BP6/BP7 Components (Supply-Chain)

Material estimates for BP6/BP7 components (Table 5) are both based on project specific details and assumptions incorporated into the recent construction emissions assessment of PW75[6]. Key assumed design elements are as follows:

1. The rebuilt section of BP6/BP7 will be 5.5 km long (of the 8.5 km total length).
2. BP6/BP7 is designed for six (two sets of three conductors) 336.4 kcmil 30/7 Strands "ORIOLE" ACSR (Aluminum Conductors, Steel Reinforced) conductors, 18.85 mm in diameter, to be carried by the structures. Each conductor is assumed to be 5% longer than the length of the line to account for jumpers, wastage, sag, and maintenance spares.
3. It is assumed BP6/BP7 will include one ground wire strung at the apices of the structures. This will be galvanized steel stranded conductor approximately 9 mm in diameter.
4. The spans between the structures will range between be 300 m and 345 m. With new towers only required for 5.5 km of the section, it is assumed 20 towers will be required (matching the number of assumed salvaged towers), but this may not match final design.
    a. "*Heavy angle and dead-end structures will be required at specific locations to accommodate line redirection and to terminate the transmission line into the stations."* [Manitoba Hydro, 2014a][7] Based on the number of directional changes in the Final Preferred Route, 12 dead-end towers will be self-supporting steel lattice structures. While they may not all be "F Structures", the strongest and heaviest dead-end structures, for conservativeness their weights were all assumed to be 13.6 tonnes. This weight was based on recent 115 kV projects.
    b. The remaining eight towers will be typical suspension towers, either guyed lattice or self-supporting. As the final design is undetermined, and its less likely guyed designs will be used, all towers were assumed to weigh 5.9 tonnes, the weight of the heavier typical self-supporting suspension towers in recent 115 kV projects (assumed weight of the guyed towers is 4.5 tonnes).
5. "*Mat foundations are typically 3 m x 3 m and 3 m deep. Where soil conditions permit, pile foundations are augured cast-in-place piles, generally about 0.9 m in diameter extending about 10 m deep. Heavy angle or dead-end structures can also require mat or pile foundations, with mat foundations being about 4 m x 4 m mats constructed 3 m deep. Pile foundations for heavy or dead-end structures consist of four 1.2 m diameter concrete piles extending about 12 m deep. Dimensions are subject to detailed design and will vary*

[6] [Manitoba Hydro, 2021]

[7] PdB Transmission Project EAR – Chapter 2.2.1.1 (*Project Description – Project Components - Pointe du Bois to Whiteshell Stations 115 kV Transmission Line (PW75) - Structures*), p.2

according to specific ground conditions." [Manitoba Hydro, 2014a][8] Helical piles could also be used, but concrete piles were assumed for this assessment.

   a. As mat foundations are heavier, it was assumed all dead-end towers would require 4 mat foundations (461 tonnes[9] per tower), one for each tower leg. For conservativeness, it was assumed the location of these towers may not be adjustable to ensure piled foundations could be used.
   b. The weight of one 3 m x 3 m mat foundation (65 tonnes) is slight larger than four 0.9 m in diameter pile foundations (61 tonnes). It was assumed that the final design would only select self-supporting suspension towers (requiring four foundations) on terrain where soil conditions permitted pile foundations, otherwise a guyed lattice tower with one mat foundation would be chosen. For conservativeness, the higher 65 tonne value was assumed for all suspension towers.

6. Based on general transmission design guidelines it was assumed each dead-end tower would require 54 insulators and each suspension tower would require 21 insulators. Based on recent Manitoba Hydro projects, each dead-end insulator was assumed to be 7 kg and each suspension insulator is assumed to be 4 kg.
7. For consistency and conservativeness, India will be the presumed source location for all above ground transmission components.
8. The original source for cement is assumed to be Edmonton, based on recent projects and Canadian availability. For PW75 it was assumed that "*Aggregate material will be required for tower foundation construction. This material will generally be obtained from within the ROW and existing licensed borrow areas. In the event that additional borrow area locations are developed, it is expected that these areas will be very small in size and situated close to existing access."* [Manitoba Hydro, 2014b][10] However, given the prairie land-cover for the BP6/BP7 ROW it is reasonable to expect aggregate material will likely be sourced from outside of the ROW from local suppliers (no new borrow areas would need to be developed).[11] It is assumed that concrete will be mixed near or on-site.
9. Although multiple manufacturing processes will be required for the manufacture of conductors and towers, uniform material specific EFs will be applied separately to the

[8] PdB Transmission Project EAR – Chapter 2.2.3.1 (*Project Description – Project Components – Project Construction – PW75 115 kV Transmission Line*), p.15

[9] Note: Assumed concrete density of 2.4 tonnes/m^3. Comparatively, four piles would weigh 130 tonnes.

[10] PdB Transmission Project EAR – Chapter 7.2.1.1 (*Effects Assessment and Mitigation – PW75 115 kV Transmission Line – Physical Environment - Physiography*), p.2

[11] Note: Based on the conservative estimate of the mass of concrete (Table 5) and the "Road Transport" EF (Table 2), "Material Supply-Chain" emissions would increase by 4 kt (cement to concrete ratio of 0.25 assumed) for every 10 km of distance between the aggregate source supplier location and the ROW. This is relatively small compared with the 1,950 kt total emissions value and has been excluded as no specific supplier has been identified.

weight of aluminum (wire EF) and steel (bars EF). EFs for other materials (e.g., ceramics) is based on the overall average of these two main materials.

3.1.2 Transportation of BP6/BP7 Construction Materials (Supply-Chain)

BP6/BP7 components will likely be manufactured internationally (but could possibly be manufactured in Canada). For this assessment, India was selected as the presumed source location because application of that assumption results in higher emissions; but, the actual source location of the units is unknown at this time. Metal-based materials and equipment will be assumed to be transported by ocean to Vancouver, then by rail to Portage la Prairie, and then by road to site. Cement is assumed to be transported by rail from Edmonton to Portage la Prairie and then by road to site. Transportation emissions for diesel are embedded in the "Produce and Deliver Diesel" EF (Table 2). Transportation emissions for aggregate are embedded in on-site emission calculations[12].

Alternative source locations (than India) for steel, aluminum, and other materials would likely result in lower transportation emissions. However, Table 3 shows that transportation emissions make up less than 10% of overall supply-chain (i.e., life cycle ("LC")) emissions for these materials, even with this conservative assumption.

3.1.3 Construction of the New BP6/BP7 Section

Estimated workforce requirements were assumed to be proportional to the project scope presented in the PdB Transmission Project EAR:

- 100 person-months (842 person-months[13] * 5.5 km/46.5[14] km) for the construction of BP6/BP7, including the mobilizing phase, clearing, construction, and demobilization.

"*It is expected that…existing local accommodations will be used for the most part for housing the transmission construction workforce*." [Manitoba Hydro, 2014a][15] The assumed housing location for the workforce is Portage la Prairie due to its relative proximity to BP6/BP7.

[12] Note: PW75 labour estimates, which were used as a reference, assume the inclusion of the use of borrow areas and collection/crushing of backfill material.

[13] [Manitoba Hydro, 2014a]

[14] Note: PW75 is assumed to be 46.5 km in length.

[15] PdB Transmission Project EAR – Chapter 2.2.3.1 (*Project Description – Project Components – Project Construction – PW75 115 kV Transmission Line*), p.17

Construction equipment will include feller-bunchers, skidders, bulldozers, drill rigs, backhoes, excavators, cranes, trucks, and other equipment. [Manitoba Hydro, 2014a][16] This assessment assumes that the typical construction vehicle would be an aerial device vehicle (e.g., a bucket truck) and that the vehicles would be left on-site while workers commuted from Portage la Prairie daily. It is assumed that there will be one major construction vehicle for every three workers and that workers will arrive on site using one light duty truck for every three workers. Construction vehicles are assumed to consume, on average, twice the 3.4 L/hour rate of fuel required to continually idle without load over the course of 10 hours a day. The doubling incorporates a high-level estimate of average vehicle loading under various seasons and work requirements.

An exception to the above is that, in addition to the assumed 6.4 L/hour average consumption rate (per vehicle) throughout construction, additional fuel is assumed to be consumed for the two most energy intense construction activities:

- Based on assumptions from similar projects, 900 L of diesel fuel is consumed for every hectare ("ha") of forested area cleared on the ROW. However, only 1 ha of ROW is assumed to require clearing.
- While crane erection of the towers is presumed, for conservativeness it has been assumed that all towers are erected via heavy duty helicopter at a rate of 750 L of fuel per tower.[17]

3.2 Key Assumptions and Inputs

Table 2 lists the EFs applied for the assessment of construction emissions. These EFs were selected for the LCA of the Manitoba–Minnesota Transmission Project ("MMTP")[18] and reapplied for this high-level estimate.

To provide a more complete understanding of the impact of specific input assumptions, Table 3 presents EFs for aggregated activities closely aligned with the three main activities laid out in Section 3.1. Table 4 lists the key assumptions used in the estimate of construction emissions. Rationale for the selection of these values are described in Section 3.1 and additional assumption detail is described in Section 3.1.

[16] PdB Transmission Project EAR – Chapter 2.2.3.1 (*Project Description – Project Components – Project Construction – PW75 115 kV Transmission Line*), p.16

[17] Note: Assumed helicopter burn rate of 500 gallons of fuel per hour and erection rate of 25 towers per 10-hour day. For the purposes of this assessment, the full LC EF for diesel combustion was assumed equivalent to that of aviation fuel.

[18] [Jeyakumar & Kilpatrick, 2015]

Table 2 Life Cycle Activity EFs

Activity	CO_2e	Unit	Source
Ocean Transport	15.84	g/tonne-km	NREL
Rail Transport	18.97	g/tonne-km	NREL
Road Transport	79.91	g/tonne-km	NREL
Mine Iron Ore	43.04	g/kg of ore	StatsCan
Produce Galvanized Steel Sheet	2,706.09	g/kg steel	NREL
Forge Steel into Bars/Wire/Other	354.61	g/kg steel	Chalmers University
Mine Bauxite	9,627.19	g/kg aluminum	NREL
Produce Aluminum Ingot			
Produce Aluminum Conductor	860.00	g/kg aluminum	Chalmers University
Produce Cement	928.39	g/kg of cement	LCI of Portland Cement
Produce and Deliver Diesel	979.29	g/L of diesel	GHGenius
Combust Diesel	2,803.53	g/L of diesel	ECCC

Table 3 Life Cycle EFs for Aggregated Activities

Activity	CO_2e	Unit
Transport from India to BP6/BP7	320	g/kg material
Transport from Edmonton to PB 6&7	24	g/kg material
Full LC - BP6/BP7 Material	4,929	g/kg material
Full LC - Cement for Concrete Foundations[19]	143	g/kg concrete
Full LC - Diesel Combustion	3,783	g/L of diesel
Labourer Transport to BP6/BP7	6,809	g/vehicle-day
Construction Vehicle Emissions	257,231	g/vehicle-day

[19] Note: "g/kg material" EFs exclude non-cement concrete materials (i.e., aggregate and water): supply-chain emissions for cement was incorporated into the "Full LC – Cement For Concrete Foundations" but "supply-chain" emissions for the extraction the manufacture of aggregate (and water) is incorporated into the calculation of direct onsite construction emissions (labour estimates assume the inclusion of the use of borrow areas and collection/crushing of backfill material). As noted in Section 3.1.1, potential emissions from the transportation of aggregate were excluded due to insignificance.

Table 4 Construction Emissions – Key Input Assumptions

Assumption	Value	Unit	Source
Total # of Transmission Towers	20		Manitoba Hydro
Average Transmission Tower Mass	10.52	tonnes	Manitoba Hydro
Conductor Mass - Steel	0.31	tonnes/km	[Midal Cable, 2010]
Conductor Mass - Aluminum	0.47	tonnes/km	[Midal Cable, 2010]
Ground Wire Mass (Steel)	0.39	tonnes/km	[Super Metal, 2009]
Light Duty Truck Mileage	0.15	L/km	Manitoba Hydro
"Aerial Device" Mileage	0.50	L/km	Manitoba Hydro
"Aerial Device" Vehicle Idling (no load)	3.4	L/hour	Oak Ridge National Lab
ROW Clearing - Additional Energy	900	L/ha	Manitoba Hydro
Tower Erection - Additional Energy	750	L/tower	Manitoba Hydro
India to Vancouver by Ocean	17,500	km	sea-distances.org
Vancouver to Portage la Prairie by Rail	2,220	km	Google Maps
Edmonton to Portage la Prairie by Rail	1,220	km	Google Maps
Portage la Prairie to BP6/BP7 by Road	6	km	Google Maps
Hours per Construction Day	10	hours	Manitoba Hydro
Construction Days Per Month	20	days	Manitoba Hydro
Vehicle Ratio (Labour & Construction)	3	persons/vehicle	Manitoba Hydro
Construction Labour for BP6/BP7	1,992	person-days	[Manitoba Hydro, 2014a]

Table 5 summarizes the mass of construction materials required for the construction of BP6/BP7. The majority of manufactured material is required for towers and conductors.

Table 5 Construction Material – Mass Summary (tonnes)

Construction Material	BP6/BP7
Aluminum	16
Steel	224
Other	5
Material Total (Excluding Foundation)	**245**
Concrete[20] Foundation	6,048

[20] Note: As detailed in Section 3.1.1, this is a conservatively high estimate. Actual concrete will likely be much less.

4 BP6/BP7 LAND USE CHANGE EMISSIONS – METHODOLOGY

For estimating land use change impacts, this assessment followed similar methods to those used for the LCA of the MMTP[21] and the GHG Mitigation Assessment of the PdB Unit Replacement Project[22]. From a carbon content perspective, only forestland within the project ROW footprint is permanently[23] disturbed. It is assumed it will be converted to "Non-Treed" land (Table 6). While this land could convert to a variety of low-lying vegetation land-types the "Non-Treed" carbon content of 15 tonne C/ha (Table 6) was deemed a reasonable approximation of the final mix. "*Other areas of low-lying vegetation such as wetlands, peatland, agricultural, riparian and shrub lands along the ROW are assumed to be minimally disturbed and, when disturbed for construction, are assumed to return to their natural state within the project life."* [Jeyakumar & Kilpatrick, 2015] This assessment assumes only above ground carbon content is permanently disturbed: "*Carbon content of soils is assumed to be unchanged after clearing*." [Jeyakumar & Kilpatrick, 2015]

Since most of the new route is on developed lands only minor clearing activities will be required in a few locations: While the actual transmission route is not final, only 1 ha (Table 7) of forestland is assumed to be permanently disturbed. That 1 ha of forestland is assumed to be completely cleared and converted to low-lying vegetation. Some land will be permanently converted to concrete for tower foundations. The total area covered by foundations will be less than 0.1 ha, thus, for conservativeness, 0.1 ha of is assumed to have a final modified carbon state of 0 t/ha (lowering the average modified state from 15.3 tonne C/ha to 13.8 tonne C/ha).

The BP6/BP7 ROW will require temporary land disturbances (e.g., borrow pits, temporary access roads, marshalling yards); however, net emissions from these temporary disturbances are assumed to be zero/immaterial within the full operational life of BP6/BP7; unless they are also within current forestland within the ROW, they are assumed to return their original state, from a carbon content perspective.

This assessment follows IPCC (2003) direction on calculation methodology while using Manitoba specific carbon contents, for different forestland types, from Shaw et al. (2005). Biomass assumptions in Table 6 are Manitoba specific, not ROW footprint specific.

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21 [Jeyakumar & Kilpatrick, 2015]

22 [Manitoba Hydro, 2020]

23 Note: The assumption of permanence focuses on the life of BP6/BP7. However, ROW impacts can be expected to persist beyond their end of life as well.

Table 6 Manitoba specific forest above ground biomass (tonne C/ha) [Shaw et al., 2005][24]

Dominant Stand Species	Stands in Sample	Total Live Tree Carbon
Non-Treed	**3**	**15.33**
Jack Pine	16	23.13
Black Spruce	19	32.37
White Spruce	2	88.50
Coniferous (i.e., Needle)	**37**	**31.41**
Balsam Popular	2	95.00
White Birch	3	50.67
Trembling Aspen	11	49.00
Deciduous (i.e., Broadleaf)	**16**	**55.06**
Mixed	**8**	**69.00**

For conservativeness, the entire 1 ha of converted forestland was assumed to be "Mixed Deciduous/Coniferous."[25]

Table 7 PW75 – Current State Forestry Breakdown Summary

Dominant Stand Species	Forestland Withdrawal (ha)	Above Ground Biomass (tonne C/ha)
Mixed Deciduous/Coniferous	1	69.00
All Stands	**1**	**69.00**

Land use change emissions are estimated using Equation A. Equation A assumes all carbon is released as carbon dioxide ("CO_2") as all biomass is combusted (either within the ROW or productively harvested for use elsewhere). CO_2 emissions are assumed to occur at, or soon after, the time of clearing; it is assumed that there is no significant decay[26]. These assumptions are consistent with mitigation measures outlined in Manitoba Hydro (2014b).

Equation A: CO_2e emissions (tonnes CO_2e) = Area Effected (ha) * [Original Carbon State (tonne C/ha) - Modified Carbon State (tonne C/ha)] * 44/12[27]

[24] Note: Based on data from 64 tree stand samples provided on pages 89-90 and 108-109 of Shaw et al. (2005). Above ground biomass includes stem wood, stem bark, branch, and foliage carbon. Shaw et al. (2005) listed both a dominant and co-dominant species for each tree stand. "Mixed" stands were stands where a coniferous species was dominant and a deciduous species was co-dominant, or vice versa.

[25] Note: The mixed stands in Shaw et al. (2005) had consistently higher above grounds carbon contents which is generally expected from more diverse forestlands.

[26] Note: The combustion of cleared debris is the preferable disposal method, compared with gradual decomposition, as the carbon is released as CO_2 and not methane, which has a higher global warming potential (25 compared to 1).

[27] Note: 44/12 is the approximate ratio of the molecular weight of CO_2 (44) to that of carbon (12).

Land use change emissions as a result of the construction of BP6/BP7 are estimated to be 0.2 kt of CO_2e; Table 8 summarizes the key inputs assumed for that estimate.

Table 8 BP6/BP7 – ROW Land Use Change Summary

Land Use Change Component	Value	Unit
Area Affected (ha)	1	ha
Carbon Content - Original State	69.0	tonne C/ha
Carbon Content - Modified State	13.8	tonne C/ha
Permanent Carbon Change	55.2	tonne C/ha
Total GHG Released	202.4	tonne CO_2e/ha
Total GHG Released	**0.20**	**kt CO_2e**

5 LINE MAINTENANCE EMISSIONS – METHODOLOGY

BP6/BP7 will require maintenance during the O&M phase:

1. *"The inspections of the transmission line will include air patrols, ground patrols and nonscheduled maintenance by air or ground in the event that unexpected repairs are required. Ground travel can include snowmobile, flex-track type or road vehicles. Regular inspections will typically occur once per year by ground and can occur up to three times per year by air."* [Manitoba Hydro, 2014a][28]
2. *Vegetation management within the ROW is required for public and employee safety, as well as the reliable operation of the line. The ROW will be maintained on an ongoing basis throughout the life cycle of operation. An integrated vegetation management approach will be undertaken to address undesirable and non-compatible vegetation issues within the ROW. Vegetation control methods on Manitoba Hydro's ROWs are achieved primarily through mechanical control (wheeled or tracked prime movers with drum or rotary cutters, mulcher, feller-bunchers, bulldozers with modified brush blades, etc.), herbicides, and manual control (chain saws, brush saws, and brush axes).* [Manitoba Hydro, 2014a][29]

Based on emissions from Manitoba Hydro's entire vehicle fleet (25 kt of CO_2e)[30] and the size of Manitoba Hydro's existing transmission (13,800 km) and distribution (75,500 km) infrastructure[31], at a high level additional O&M emissions due to BP6/BP7 are expected to be in the 0 to 5 tonnes of CO_2e per year range (including air patrols).

An assessment of supply-side emission related to O&M materials was excluded from this assessment and presumed to be relatively negligible. The quantity of material required to construct BP6/BP7 will be higher than any material required for repairs during ongoing maintenance.

At a high level, additional O&M emissions are expected to be less than 0.005 kt of CO_2e per year; a conservative upper limit of 0.2 kt will be assumed for the entire life of BP6/BP7.

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[28] PdB Transmission Project EAR – Chapter 2.2.4.1 (*Project Description – Project Components – Project Operations and Maintenance – PW75 115 kV Transmission Line*), p.20

[29] PdB Transmission Project EAR – Chapter 2.2.4.1 (*Project Description – Project Components – Project Operations and Maintenance – PW75 115 kV Transmission Line*), p.20-21

[30] [Manitoba Hydro, 2020a]

[31] [Manitoba Hydro, 2020b]

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