Appendix 13-5

Greenhouse Gas Emissions Assessment for East Side Road Authority All-Season Road Projects

DILLON CONSULTING

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1.0 Introduction

1.1 Background

This greenhouse gas assessment of the Manitoba East Side Road Authority (ESRA) All-Season Road (ASR) projects east of Lake Winnipeg provides information to inform the provincial and federal environmental impact assessment processes as required. Federally, the Canadian Environmental Assessment Agency (CEAA, 2003) in its guidance document recommends that practitioners address greenhouse gas (GHG) considerations that include:

1. Preliminary scoping for GHG considerations. This preliminary scoping assesses whether there are likely GHG considerations associated with the project.
2. Identify GHG considerations. This process considers the potential GHG emissions profile of the project in comparison to the industry profile.
3. Assess GHG considerations. This process determines the direct and indirect GHG emissions of the project, the impacts on carbon sinks, and comparison with industry, provincial / territorial and national inventories.
4. GHG management plans. Development of a GHG management plan to mitigate and / or offset emissions if the project results in medium or high emissions.
5. Monitoring, follow-up and adaptive management. This process monitors and verifies the GHG emissions forecast and determines the effectiveness of the GHG abatement / offset measures. Modification of the GHG management plan may be required during this process.

This GHG assessment addresses CEAA considerations 1, 2, and 3 above. Considerations of steps 4 and 5 are addressed by way of recommendations on developing mitigation plans and policies, monitoring, data collection and verification. Provincial requirements related to climate change implications are also addressed. The GHG assessment presented in this report generally follows the principles of CAN/CSA-ISO 14064 suite of protocols in quantifying and reporting GHG emissions and removals.

1.2 Greenhouse Gas Considerations

The proposed ESRA All-Season Road projects (Projects) will have GHG emissions associated with the construction and operational phases of the Projects due to vehicular emissions from the use of the ASRs.

The Projects involve the construction and operation of four all-seasons roads (ASRs) east of Lake Winnipeg within the cumulative effects assessment area with a total road length of approximately 419.5 km (**Section 2**). The Manitoba Infrastructure and Transportation (MIT,

2010a) constructs and maintains approximately 19,000 km of all-weather roads and 2,200 km of winter roads. The Projects will contribute to an increase of less than 2 % of the total roads in Manitoba.

Environment Canada (2010) provides annual national and provincial GHG emissions per sector since 1990. The most recent GHG inventory year of 2008 indicated that for construction activities in Manitoba, approximately 0.098 Mt CO_2e were emitted in 2008 and the total emissions for road transportation in the province was approximately 5.13 Mt CO_2e. Since 1990, the GHG emissions due to construction have increased in Manitoba by approximately 56 % and for road transportation the increase has been approximately 31 %.

Nationally, GHG emissions from the construction sector in 2008 was estimated to be approximately 1.26 Mt CO_2e, and for the road transportation sector it was estimated at approximately 135 Mt CO_2e (Environment Canada, 2010). The emissions due to construction decreased in 2008 by 33 % from 1990 levels and for the road transportation sector there was an increase of approximately 37 %. Manitoba contributed less than 8 % to the national GHG emissions due to construction and less than 4 % to the national road transportation GHG emissions in 2008.

The Projects will contribute to an increase in annual GHG emissions for the Province. Therefore, in order to determine the magnitude of the GHG emissions associated with the Projects, a cumulative GHG assessment is needed.

2.0 The Projects

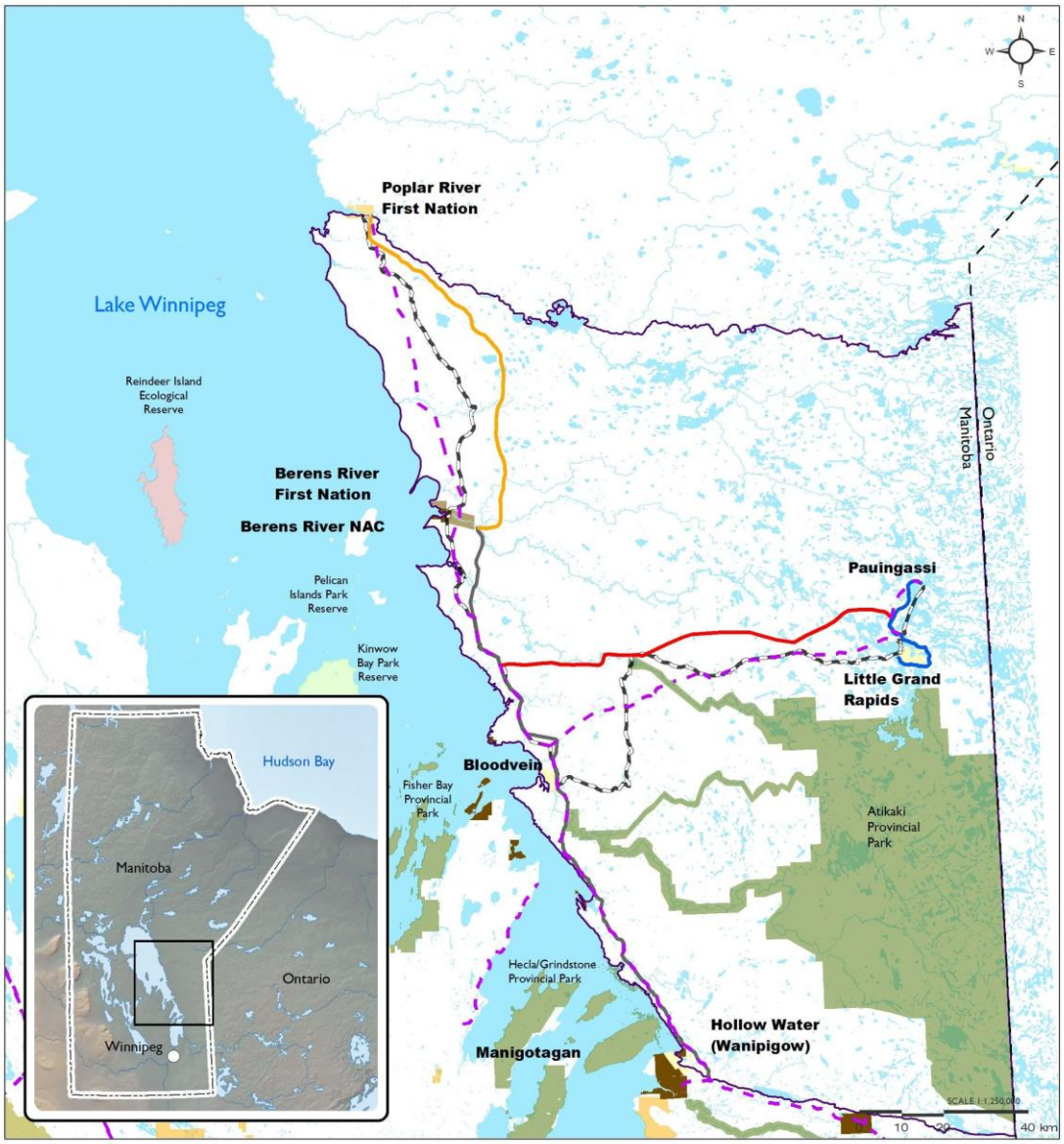
The GHG assessment study area, shown in **Figure 2.1**, is along the eastern shoreline of Lake Winnipeg and extends from the southern limit of the Hollow Water traditional lands north to Poplar River and east to Pauingassi and Little Grand Rapids First Nation on the Ontario border.

All ESRA ASR projects are summarized in **Table 2-1**. The P1 project which links PR304 to Berens River First Nation is currently under construction. All other ASR projects are proposed future projects.

TABLE 2-1: ESRA ALL-SEASON ROAD PROJECTS AND SCHEDULE

All-Season Road Projects	Length (km)	Start	Completion
PR304 to Berens River First Nation (P1)	156	2012 (under construction)	~2020
Pauingassi to Little Grand Rapids First Nation (P7A)	36.4	2016	~2020
P1 to Little Grand Rapids First Nation and Pauingassi First Nation (P7)	131	2020	~2027
Berens River First Nation to Poplar River First Nation (P4)	94.1	2018	~2025

FIGURE 2.1: STUDY AREA



2.1 Existing Conditions

The area to the north of Bloodvein and east of Lake Winnipeg (**Figure 2-1**) is not currently served by an ASR connecting to the southern Manitoba all-season road network (East Side Road Authority, 2010). The remoteness of communities in the area, their size and lack of economic development has resulted in dependence on a costly and limited transportation system. These communities included the Southeast Tribal Council (SERCA) communities of Poplar River, Berens River, Bloodvein, Little Grand Rapids, and Pauingassi, and the Island Lake Tribal Council (ILTC) communities of St. Theresa Point, Wasagamack, Garden Hill, and Red Sucker Lake. For the communities of Poplar River and Berens River, this transportation system relies on air service, seasonal ferry service during the non-winter months, and a seasonal winter road.

Air service is from Winnipeg and from Matheson Island. Ferry and barge service to Bloodvein occurs from April/May to October inclusive and is from Islandview and Pine Dock harbours. The seasonal road network consists of: an ice road across Lake Winnipeg from Pine Dock to Bloodvein; a winter road from PR 304 north to Bloodvein; a winter road from Bloodvein north to Berens River and then to Poplar River; and another winter road runs from Bloodvein to Little Grand Rapids and Pauingassi. This latter winter road is also connected to another winter road network that connects the communities of the ILTC. Matheson Island, Islandview and Pine Dock can be accessed from Winnipeg via Provincial Trunk Highway (PTH) 8 and Provincial Road (PR) 234 (a gravel road). PR 304 is a paved provincial trunk road and connects to Winnipeg via Highway 59.

2.2 Projects Description

The proposed ASR projects (**Table 2-1**) will be gravel roads for the entire length. The roadways will be 10 m in width with two 3.7 m wide lanes, 1.0 m shoulders and a 0.3 m shoulder rounding allowance. The roadways will be centred within a 100 m right of way (ROW) and the cleared limit of the roadways will be 60 m within this ROW. Further clearing will be on as required basis to maintain line of sight.

The proposed construction schedules and lengths of ASR projects are listed in **Table 2-1**.

3.0 GHG Emissions Assessment Methodology

In order to evaluate the change in GHG emissions due to the Projects, the estimated annual GHG emissions for the Baseline scenario without the Projects were compared to the scenario with the Projects. In both scenarios the annual GHG emissions were projected for the construction period and 10 years of operation of the Projects. The ASR will impact the communities of Berens River, Bloodvein, Poplar River Little Grand Rapids and Pauingassi, and transportation activities between these communities and Winnipeg. Therefore, this assessment focuses on the GHG implications associated with the transportation infrastructure linking all these communities to Winnipeg.

The natural ecosystem sources and sinks are also included in the assessment to demonstrate their contribution to the overall GHG profile of the Baseline and Project scenarios. The detailed methodologies for GHG quantification are the same as was completed for the PR304 to Berens River All-Season Road and are detailed in "PR304 to Berens River All-Season Road Environmental Impact Assessment Greenhouse Gas Emission Assessment Dillon Report No. 10-3402", July 2011 (Dillon 2011 Report).

This approach was taken based on the limited data availability for the P4, P7 and P7a projects, and to allow for consistency across all project assessments. In general, assumptions made within the P1 detailed assessment were applied to P4, P7 and P7a, unless project specific information was available. The assessment should therefore be reviewed as more project specific information becomes available for P4, P7 and P7a.

3.1 GHG Emissions Assessment for P1

The GHG emission assessment for P1 has been documented in the Dillon 2011 Report. Briefly, the P1 baseline scenario (i.e., business as usual, no P1 project) included the GHG emissions and sinks/removals and the resulting cumulative GHG emissions. The summary of the key components of the cumulative calculation is as follows:

Annual Baseline GHG Emissions (tonnes CO_2e/yr) =

Carbon sequestration due to forest cover along the proposed P1 ASR (tonnes CO_2e/yr)
+ Net GHG emissions due to wetlands along the proposed P1 ASR (tonnes CO_2e/yr)
+ GHG emissions due to air travel to Bloodvein and Berens River (tonnes CO_2e/yr)
+ GHG emissions due to ferry crossing from Islandview/Pine Dock to Bloodvein (tonnes CO_2e/yr)

+ GHG emissions due to transportation between Winnipeg and Islandview/Pine Dock (tonnes CO_2e/yr)
+ GHG emissions due to the construction and maintenance of seasonal road (tonnes CO_2e/yr)
+ GHG emissions due to vehicular travel during winter (tonnes CO_2e/yr).

The P1 ASR scenario GHG emissions and sinks / removals and the resulting cumulative GHG emissions were estimated as follows:

Annual Project GHG Emissions (tonnes CO_2e/yr) =
GHG emissions due to land clearing along the proposed P1 ASR (tonnes CO_2e/yr)
+ Methane emissions due to the wetlands along the proposed P1 ASR (tonnes CO_2e/yr)
+ GHG emissions due to construction of the P1 ASR (tonnes CO_2e/yr)
+ GHG emissions due to air travel to Bloodvein and Berens River (tonnes CO_2e/yr)
+ GHG emissions due to ferry crossing from Islandview/Pine Dock to Bloodvein (tonnes CO_2e/yr)
+ GHG emissions due to transportation on PTH 8 and PR234 (tonnes CO_2e/yr)
+ GHG emissions due to transportation between Winnipeg and Berens River (tonnes CO_2e/yr)
+ GHG sequestration due to reforestation of disturbed land (tonnes CO_2e/yr)

Methodologies that are used to quantify the emissions for individual activities are described in the Dillon 2011 Report.

3.2 GHG Emissions Assessment for P4

Following the same methodologies as described in the Dillon 2011 Report, the P4 baseline scenario (i.e., business as usual, no P4 project) GHG emissions and sinks / removals and the resulting cumulative GHG emissions were estimated as follows:

Annual Baseline GHG Emissions (tonnes CO_2e/yr) =
Carbon sequestration due to forest cover along the proposed P4 ASR (tonnes CO_2e/yr)
+ Net GHG emissions due to wetlands along the proposed P4 ASR (tonnes CO_2e/yr)
+ GHG emissions due to air travel to Poplar River (tonnes CO_2e/yr)
+ GHG emissions due to the construction and maintenance of seasonal road (tonnes CO_2e/yr)
+ GHG emissions due to vehicular travel during winter (tonnes CO_2e/yr).

The P4 ASR scenario GHG emissions and sinks/removals and the resulting cumulative GHG emissions were estimated as follows:

Annual Project GHG Emissions (tonnes CO_2e/yr) =

GHG emissions due to land clearing along the proposed P4 ASR (tonnes CO_2e/yr)
+ Methane emissions due to the wetlands along the proposed P4 ASR (tonnes CO_2e/yr)
+ GHG emissions due to construction of the P4 ASR (tonnes CO_2e/yr)
+ GHG emissions due to air travel to Poplar River (tonnes CO_2e/yr)
+ GHG emissions due to transportation between Poplar River and Berens River (tonnes CO_2e/yr)
+ GHG sequestration due to reforestation of disturbed land (tonnes CO_2e/yr)

As the ferry and/or barge traffic is not expected to change significantly with the construction of P4, the GHG emissions associated with ferry and/or barge traffic were not quantified[1].

All air movements from Poplar River Airport were assumed to be between Poplar River and Winnipeg. An 80% reduction in air movements were assumed when the P4 is in operation.

3.3 GHG Emissions Assessment for P7a

Without the Project 7a, access to Pauingassi and Little Grand Rapids First nations will continue to be by air, water and winter road, for the foreseeable future. Access between the two First Nation Communities is currently by air, water and all-terrain vehicles during the summer, and during the winter, spring and fall by air, snowmobile and all-terrain vehicle. With the Project 7a in operation, the major change in transportation means is a reduction (assumed 80% reduction) in helicopter use and an increased vehicle use on P7a ASR. Accordingly, the GHG emissions associated with air movement from Little Grand Rapids to Winnipeg is considered in Project 7a. With P7a in operation, transportation between the two First Nation Communities using water and snowmobile are not expected to change significantly. Accordingly, GHG emissions associated with these activities were not quantified.

The P7a baseline scenario (i.e., business as usual, no P7a project) GHG emissions and sinks/removals and the resulting cumulative GHG emissions were estimated as follows:

Annual Baseline GHG Emissions (tonnes CO_2e/yr) =

Carbon sequestration due to forest cover along the proposed P7a ASR (tonnes CO_2e/yr)
+ Net GHG emissions due to wetlands along the proposed P7a ASR (tonnes CO_2e/yr)
+ GHG emissions due to air travel (helicopters) between Little Grand Rapids and Pauingassi (tonnes CO_2e/yr)

[1] Subsequent to the completion of this report the daily ferry service to Bloodvein was terminated (November 2015) as the community is being serviced by an all-season road.

+ GHG emissions due to the construction and maintenance of seasonal road (tonnes CO_2e/yr)
+ GHG emissions due to vehicular travel during winter (tonnes CO_2e/yr).

The P7a ASR scenario GHG emissions and sinks/removals and the resulting cumulative GHG emissions were estimated as follows:

Annual Project GHG Emissions (tonnes CO_2e/yr) =
GHG emissions due to land clearing along the proposed P7a ASR (tonnes CO_2e/yr)
+ Methane emissions due to the wetlands along the proposed P7a ASR (tonnes CO_2e/yr)
+ GHG emissions due to construction of the P7a ASR (tonnes CO_2e/yr)
+ GHG emissions due to air travel (helicopters) between Little Grand Rapids and Pauingassi (tonnes CO_2e/yr)
+ GHG emissions due to transportation on P7a (tonnes CO_2e/yr)
+ GHG sequestration due to reforestation of disturbed land (tonnes CO_2e/yr)

3.4 GHG Emission Assessment for P7

With P7 in operation, the winter road between Little Grand Rapids and Bloodvein Communities will be replaced, and the air movements from Little Grand Rapids Airport to Winnipeg should be reduced significantly (assumed 80% reduction).

The P7 baseline scenario (i.e., business as usual, no P7 project) GHG emissions and sinks/removals and the resulting cumulative GHG emissions were estimated as follows:

Annual Baseline GHG Emissions (tonnes CO_2e/yr) =
Carbon sequestration due to forest cover along the proposed P7 ASR (tonnes CO_2e/yr)
+ Net GHG emissions due to wetlands along the proposed P7 ASR (tonnes CO_2e/yr)
+ GHG emissions due to air travel between Little Grand Rapids and Winnipeg (tonnes CO_2e/yr)
+ GHG emissions due to the construction and maintenance of seasonal road (tonnes CO_2e/yr)
+ GHG emissions due to vehicular travel during winter (tonnes CO_2e/yr).

The P7 ASR scenario GHG emissions and sinks / removals and the resulting cumulative GHG emissions were estimated as follows:

Annual Project GHG Emissions (tonnes CO_2e/yr) =
GHG emissions due to land clearing along the proposed P7 ASR (tonnes CO_2e/yr)
+ Methane emissions due to the wetlands along the proposed P7 ASR (tonnes CO_2e/yr)
+ GHG emissions due to construction of the P7 ASR (tonnes CO_2e/yr)

+ GHG emissions due to air travel between Little Grand Rapids and Winnipeg (tonnes CO_2e/yr)
+ GHG emissions due to transportation on P7 (tonnes CO_2e/yr)
+ GHG sequestration due to reforestation of disturbed land (tonnes CO_2e/yr)

3.5 Cumulative GHG Emission Assessment

The differences in GHG emissions between the ASR Projects and baseline (without the ASR Projects) for individual ASR Projects were quantified according to the approaches described above. The sum of the differences is the cumulative GHG emissions, i.e.

Cumulative annual net GHG Emission (tonnes CO_2e/yr) =
Annual P1 Project GHG emissions (tonnes CO_2e/yr)–annual P1 baseline GHG emissions (tonnes CO_2e/yr)
+ Annual P4 Project GHG emissions (tonnes CO_2e/yr)–annual P4 baseline GHG emissions (tonnes CO_2e/yr)
+Annual P7 Project GHG emissions (tonnes CO_2e/yr)–annual P7 baseline GHG emissions (tonnes CO_2e/yr)
+ Annual P7a Project GHG emissions (tonnes CO_2e/yr)–annual P7a baseline GHG emissions (tonnes CO_2e/yr)

The cumulative annual net GHG emission were compared with the provincial GHG emissions due to transportation.

4.0 GHG Emissions Estimates

Tables 4-1 through **4-8** summarize the GHG emissions under the Baseline scenario and ASR scenario, for all individual ASR Projects during the construction periods and 10 years of operation.

Table 4-9 lists the cumulative net change in annual GHG emissions for all ASR Projects.

As shown in **Table 4-9**, the annual GHG emissions under ASR scenario for each individual project are expected to be above those for the corresponding baseline scenario, due to the GHG emissions from construction activities during the construction periods. However, based on the available information for the new projects, during the ASR operational periods all individual projects except P1 will expect reductions in annual GHG emissions. When all four projects are in operation, the annual GHG emissions will be reduced by a total of 6,128 tonnes CO2e.

Therefore, there will be an increase in annual GHG emissions during the construction periods for each individual project, ranging from 1,514 tonnes CO2e for P7a to 4,295 tonnes CO2e for P7. Approximately after 13 years of operation of all four projects, a net reductions in annual GHG emissions by 5,794 tonnes CO2e, which is about a reduction of 0.1% of the Province's total GHG emissions of 5.13 Mt CO2e due to road transportation, will be realized.

It is important to note that the calculation approaches used in the determination above are the same as was used in the detailed assessment of P1 (Dillon 2011). This approach was taken based on the limited data availability for the P4, P7 and P7a projects, and to allow for consistency across all project assessments. In general, assumptions made within the P1 detailed assessment were applied to P4, P7 and P7a, unless project specific information was available. The assessment should therefore be reviewed as more project specific information becomes available for P4, P7 and P7a.

TABLE 4.1: BASELINE SCENARIO GHG EMISSIONS FOR P1 PROJECT

PERIOD CORRESPONDING TO PROJECT SCENARIO	GHG EMMISIONS (Tonnes CO2e)										TOTAL PER
	Seasonal Rd	Seasonal Rd	Vehicular Use	Vehicular Use	Vehicular Use	Ferry	Air	Land	Forest	Wetland	YEAR
	Construction	Maintenance	Highway 8	PR 234	Seasonal Road	Operation	Travel	Clearing	Carbon Sequestration	Net GHG Emissions	(Tonnes CO2e)
Construction*											
2010	83	74	296	214	7,805	73	1,054	0	-45	668	10,223
2011	83	74	275	199	7,805	73	977	0	-45	668	10,109
2012	83	74	253	183	7,805	73	905	0	-45	668	9,999
2013	83	74	231	167	7,805	73	838	0	-45	668	9,894
Operation											
2014	83	74	209	151	7,805	73	776	0	-45	668	9,794
2015	83	74	209	151	7,805	73	719	0	-45	668	9,737
2016	83	74	209	151	7,805	73	667	0	-45	668	9,685
2017	83	74	209	151	7,805	73	620	0	-45	668	9,638
2018	83	74	209	151	7,805	73	577	0	-45	668	9,596
2019	83	74	209	151	7,805	73	540	0	-45	668	9,559
2020	83	74	209	151	7,805	73	508	0	-45	668	9,527
2021	83	74	209	151	7,805	73	481	0	-45	668	9,500
2022	83	74	209	151	7,805	73	459	0	-45	668	9,478
2023	83	74	209	151	7,805	73	442	0	-45	668	9,461
Total per Mode	1,158	1,033	3,148	2,274	109,273	1,028	9,562	0	-630	9,356	
Overall Total (tonnes CO_2e)											**136,201**

*-Construction was assumed to begin in 2010 and complete in 2013 in the Dillon 2011 Report. The Project P1 is under construction and expected to complete in 2020.

TABLE 4.2: ASR SCENARIO GHG EMISSIONS FOR P1 PROJECT

PERIOD	GHG EMMISIONS (Tonnes CO2e)										TOTAL PER
	ASR Road	Vehicular Use	Vehicular Use	Vehicular Use	Ferry	Air	Land	Forest	Forest	Wetland	YEAR
	Construction	ASR	Winnipeg Connect.	PTH 8 + PR 234	Operation	Travel	Clearing	Biomass Decomposition	Carbon Sequestration	Net GHG Emissions	(Tonnes CO2e)
Construction											
2010	11,685	0	0	0	0	0	1,361	637	0	488	14,170
2011	11,685	0	0	0	0	0	1,361	0	0	488	13,533
2012	11,685	0	0	0	0	0	1,361	0	0	488	13,533
2013	11,685	0	0	120	49	838	1,361	0	0	488	14,541
Operation											
2014	0	5,921	4,274	69	24	155	0	0	-13	488	10,918
2015	0	5,921	4,274	0	0	0	0	0	-13	488	10,670
2016	0	5,921	4,274	0	0	0	0	0	-13	488	10,670
2017	0	5,921	4,274	0	0	0	0	0	-13	488	10,670
2018	0	5,921	4,274	0	0	0	0	0	-13	488	10,670
2019	0	5,921	4,274	0	0	0	0	0	-13	488	10,670
2020	0	5,921	4,274	0	0	0	0	0	-13	488	10,670
2021	0	5,921	4,274	0	0	0	0	0	-13	488	10,670
2022	0	5,921	4,274	0	0	0	0	0	-13	488	10,670
2023	0	5,921	4,274	0	0	0	0	0	-13	488	10,670
Total per Mode	46,739	59,213	42,735	189	74	993	5,443	0	-132	6,830	
Overall Total (tonnes CO_2e)											**162,720**

*-Construction was assumed to begin in 2010 and complete in 2013 in the Dillon 2011 Report. The Project P1 is under construction and expected to complete in 2020.

TABLE 4.3: BASELINE SCENARIO GHG EMISSIONS FOR P4 PROJECT

PERIOD	GHG ESTMATE (TONNE CO2e)								TOTAL PER
	Ice & Winter Rd	Ice & Winter Rd	Vehicular Use	Air	Land	Forest	Forest	Wetland	YEAR
	Construction	Maintenance	Ice Road & Winter	Travel	Clearing	Biomass decomp	Carbon Sequestration	Methane Emissions	(TONNE CO2e)
Construction									
Year 1	80	73	806	3,116	0	0	-27	403	4,450
Year 2	80	73	806	3,116	0	0	-27	403	4,450
Year 3	80	73	806	3,116	0	0	-27	403	4,450
Year 4	80	73	806	3,116	0	0	-27	403	4,450
Year 5	80	73	806	3,116	0	0	-27	403	4,450
Year 6	80	73	806	3,116	0	0	-27	403	4,450
Year 7	80	73	806	3,116	0	0	-27	403	4,450
Operation									
Year 1	80	73	806	3,116	0	0	-27	403	4,450
Year 2	80	73	806	3,116	0	0	-27	403	4,450
Year 3	80	73	806	3,116	0	0	-27	403	4,450
Year 4	80	73	806	3,116	0	0	-27	403	4,450
Year 5	80	73	806	3,116	0	0	-27	403	4,450
Year 6	80	73	806	3,116	0	0	-27	403	4,450
Year 7	80	73	806	3,116	0	0	-27	403	4,450
Year 8	80	73	806	3,116	0	0	-27	403	4,450
Year 9	80	73	806	3,116	0	0	-27	403	4,450
Year 10	80	73	806	3,116	0	0	-27	403	4,450
Total per Mode	1,356	1,233	13,702	52,969	0	0	-461	6,853	
Overall Total (tonne CO2e)									**75,651**

TABLE 4.4: ASR SCENARIO GHG EMISSIONS FOR P4 PROJECT

PERIOD	GHG ESTMATE (TONNE CO2e)							TOTAL PER
	ASR Road	Vehicular Use	Air	Land	Forest	Forest	Wetland	YEAR
	Construction	ASR	Travel	Clearing	Biomass decomp	Carbon Sequestration	Methane Emissions	(TONNE CO2e)
Construction								
Year 1	4,028	0	3,116	469	384	0	294	8,291
Year 2	4,028	0	3,116	469	0	0	294	7,907
Year 3	4,028	0	3,116	469	0	0	294	7,907
Year 4	4,028	0	3,116	469	0	0	294	7,907
Year 5	4,028	0	3,116	469	0	0	294	7,907
Year 6	4,028	0	3,116	469	0	0	294	7,907
Year 7	4,028	0	3,116	469	0	0	294	7,907
Operation								
Year 1	0	717	623	0	0	-8	294	1,626
Year 2	0	717	623	0	0	-8	294	1,626
Year 3	0	7174	623	0	0	-8	294	1,626
Year 4	0	7174	623	0	0	-8	294	1,626
Year 5	0	717	623	0	0	-8	294	1,626
Year 6	0	717	623	0	0	-8	294	1,626
Year 7	0	717	623	0	0	-8	294	1,626
Year 8	0	717	623	0	0	-8	294	1,626
Year 9	0	717	623	0	0	-8	294	1,626
Year 10	0	717	623	0	0	-8	294	1,626
Total per Mode	28,193	7,169	28,042	3,283	384	-80	5,002	
Overall Total (tonne CO2e)								**71,994**

TABLE 4.5: BASELINE SCENARIO GHG EMISSIONS FOR P7 PROJECT

PERIOD	GHG ESTMATE (TONNE CO2e)								TOTAL PER YEAR (TONNE CO2e)
	Ice & Winter Rd Construction	Ice & Winter Rd Maintenance	Vehicular Use Ice Road & Winter	Air Travel	Land Clearing	Forest Biomass decomp	Forest Carbon Sequestration	Wetland Methane Emissions	
Construction									
Year 1	119	108	1,701	4,065	0	0	-38	561	6,516
Year 2	119	108	1,701	4,065	0	0	-38	561	6,516
Year 3	119	108	1,701	4,065	0	0	-38	561	6,516
Year 4	119	108	1,701	4,065	0	0	-38	561	6,516
Year 5	119	108	1,701	4,065	0	0	-38	561	6,516
Year 6	119	108	1,701	4,065	0	0	-38	561	6,516
Year 7	119	108	1,701	4,065	0	0	-38	561	6,516
Operation									
Year 1	119	108	1,701	4,065	0	0	-38	561	6,516
Year 2	119	108	1,701	4,065	0	0	-38	561	6,516
Year 3	119	108	1,701	4,065	0	0	-38	561	6,516
Year 4	119	108	1,701	4,065	0	0	-38	561	6,516
Year 5	119	108	1,701	4,065	0	0	-38	561	6,516
Year 6	119	108	1,701	4,065	0	0	-38	561	6,516
Year 7	119	108	1,701	4,065	0	0	-38	561	6,516
Year 8	119	108	1,701	4,065	0	0	-38	561	6,516
Year 9	119	108	1,701	4,065	0	0	-38	561	6,516
Year 10	119	108	1,701	4,065	0	0	-38	561	6,516
Total per Mode	2,019	1,836	28,910	69,103	0	0	-642	9,540	
Overall Total (tonne CO2e)									**110,765**

TABLE 4.6: ASR SCENARIO GHG EMISSIONS FOR P7 PROJECT

PERIOD	GHG ESTMATE (TONNE CO2e)							TOTAL PER
	ASR Road	Vehicular Use	Air	Land	Forest	Forest	Wetland	YEAR
	Construction	ASR	Travel	Clearing	Biomass decomp	Carbon Sequestration	Methane Emissions	(TONNE CO2e)
Construction								
Year 1	5,607	0	4,065	653	535	0	410	11,269
Year 2	5,607	0	4,065	653	0	0	410	10,734
Year 3	5,607	0	4,065	653	0	0	410	10,734
Year 4	5,607	0	4,065	653	0	0	410	10,734
Year 5	5,607	0	4,065	653	0	0	410	10,734
Year 6	5,607	0	4,065	653	0	0	410	10,734
Year 7	5,607	0	4,065	653	0	0	410	10,734
Operation								
Year 1	0	1,701	813	0	0	-11	410	3,001
Year 2	0	1,701	813	0	0	-11	410	3,001
Year 3	0	1,701	813	0	0	-11	410	3,001
Year 4	0	1,701	813	0	0	-11	410	3,001
Year 5	0	1,701	813	0	0	-11	410	3,001
Year 6	0	1,701	813	0	0	-11	410	3,001
Year 7	0	1,701	813	0	0	-11	410	3,001
Year 8	0	1,701	813	0	0	-11	410	3,001
Year 9	0	1,701	813	0	0	-11	410	3,001
Year 10	0	1,701	813	0	0	-11	410	3,001
Total per Mode	39,249	28,910	36,584	4,570	535	-111	6,964	
Overall Total (tonne CO2e)								**105,687**

TABLE 4.7: BASELINE SCENARIO GHG EMISSIONS FOR P7A PROJECT

PERIOD	GHG ESTMATE (TONNE CO2e)							TOTAL PER
	Ice & Winter Rd Construction	Ice & Winter Rd Maintenance	Vehicular Use Ice Road & Winter	Air Travel	Land Clearing	Forest Carbon Sequestration	Wetland Methane Emissions	YEAR (TONNE CO2e)
Construction								
Year 1	14	13	203	492	0	-11	156	868
Year 2	14	13	203	492	0	-11	156	868
Year 3	14	13	203	492	0	-11	156	868
Year 4	14	13	203	492	0	-11	156	868
Operation								
Year 1	14	13	203	492	0	-11	156	868
Year 2	14	13	203	492	0	-11	156	868
Year 3	14	13	203	492	0	-11	156	868
Year 4	14	13	203	492	0	-11	156	868
Year 5	14	13	203	492	0	-11	156	868
Year 6	14	13	203	492	0	-11	156	868
Year 7	14	13	203	492	0	-11	156	868
Year 8	14	13	203	492	0	-11	156	868
Year 9	14	13	203	492	0	-11	156	868
Year 10	14	13	203	492	0	-11	156	868
Total per Mode	198	181	2,843	6,889	0	-147	2,183	
Overall Total (tonne CO2e)								**12,147**

TABLE 4.8: ASR SCENARIO GHG EMISSIONS FOR P7A PROJECT

PERIOD	GHG ESTMATE (TONNE CO2e)							TOTAL PER
	ASR Road	Vehicular Use	Air (Helicopter)	Land	Forest	Forest	Wetland	YEAR
	Construction	ASR	Travel	Clearing	Biomass decomp	Carbon Sequestration	Methane Emissions	(TONNE CO2e)
Construction								
Year 1	1,558	0	492	181	149	0	114	2,494
Year 2	1,558	0	492	181	0	0	114	2,345
Year 3	1,558	0	492	181	0	0	114	2,345
Year 4	1,558	0	492	181	0	0	114	2,345
Operation								
Year 1	0	107	98	0	0	-3	114	316
Year 2	0	107	98	0	0	-3	114	316
Year 3	0	107	98	0	0	-3	114	316
Year 4	0	107	98	0	0	-3	114	316
Year 5	0	107	98	0	0	-3	114	316
Year 6	0	107	98	0	0	-3	114	316
Year 7	0	107	98	0	0	-3	114	316
Year 8	0	107	98	0	0	-3	114	316
Year 9	0	107	98	0	0	-3	114	316
Year 10	0	107	98	0	0	-3	114	316
Total per Mode	6,232	1,070	2,952	726	0	-31	1,594	
Overall Total (tonne CO2e)								**12,691**

TABLE 4.9: CUMULATIVE NET CHANGE IN ANNUAL GHG EMISSIONS

Project	Period	ASR ANNUAL GHG EMISSIONS (TONNE CO2e)	BASELINE ANNUAL GHG EMISSIONS (TONNE CO2e)	DIFFERENCE BETWEEN ASR AND BASELINE (TONNE CO2e)**
P1	**Construction***	7,968	5,746	2,222
	Operation	10,694	9,598	1,097
P4	**Construction**	7,962	4,450	3,511
	Operation	1,626	4,450	-2,824
P7	**Construction**	10,811	6,516	4,295
	Operation	3,001	6,516	-3,515
P7a	**Construction**	2,382	868	1,515
	Operation	316	868	-551
ALL PROJECTS	**Construction**	29,123	17,580	11,543
	Operation	15,637	21,432	-5,794

***** Construction was assumed to begin in 2010 and completed in 2013 in the Dillon 2011 Report. The Project P1 is under construction and expected to be completed in 2020. The annual GHG emissions were prorated from 4 years to 7 years.

** Negative number indicates reduction in GHG emissions with ASR in operation.

5.0 Recommendations for Mitigation and Monitoring

GHG emissions due to the construction and operational phases of the Projects can be partially mitigated through the adoption of best management practices and GHG offsets. The following sections explore some of the potential options for the reduction of GHG emissions due to the Projects.

5.1 Construction Phase

During the construction of the ASR, construction best management practices should be followed in order to abate GHG emissions (US EPA, 2009) and include but are not limited to:

- Maintenance and upkeep of all construction equipment in order to meet performance standards set by the manufacturers of the equipment. This will result in efficient use of fuel when the equipment is in operation. Poorly maintained equipment will result in the inefficient use of fuel and the associated increase in GHG emissions.
- Properly size the equipment for the task. Over-sizing or under-sizing the equipment results in excess fuel being consumed and burned.
- Replacing or rebuilding old equipment with more fuel efficient new equipment. The fuel economy, emission rates, and maintenance costs will then be brought up to the current standard resulting in overall lower GHG emissions.
- Driver/operator training for the correct/optimal operation of equipment under different operating conditions. Fuel savings and hence reductions in GHG emissions can be realized through driver/operator training in order to correctly position, operate, and optimize the equipment under different operating conditions. The US EPA (2009) estimated that a typical excavator can save approximately 3 – 8 % in fuel use per year with correct operator training.
- Anti-idling policy for all mobile equipment. Idling of equipment when not in use will result in unnecessary fuel being burned and GHG emissions. Anti-idling policies typically limit the maximum idling time to between 3 and 5 minutes. This policy is especially effective in mitigating GHG emissions during the non-winter months. The installation of fuel-efficient auxiliary power for comfort heating and cooling for equipment operators can also be used in order to abate GHG emissions.
- Bussing of construction crew to the construction site and the remote work camp accommodation will reduce the use of private or individual vehicle travel to such sites on a daily basis thereby reducing overall GHG emissions.
- Alternatives to diesel generators. Use of dual fuel (natural gas / propane and diesel) generators can significantly reduce GHG emissions in comparison to diesel generators.

The US EPA (2009) estimated an approximate 30 % reduction in emissions for a large 500 kW generator.

- Materials selection, procurement and shipping should be optimized in order to minimize the environmental impact of such activities. It is noted that the aggregate and potentially other materials for the construction of the ASR is accessed from nearby site(s). This will therefore help to abate the GHG emissions associated with transportation.

5.2 Operations Phase

GHG emissions during the operation of the ASR can be partially mitigated or offset through the following:

- Inter-community Transit. Private bus transit between Winnipeg and First Nation Communities may potentially become economical. Such commuting has the potential to reduce the number of vehicles using the ASR.
- On-going maintenance of the ASR to provide an optimal (i.e., smooth) running surface.
- Carbon offsets through afforestation/revegetation. The GHG emissions due to the Projects have included a carbon offset due to afforestation/revegetation of disturbed land.
- It is recommended that the wetland areas within the ROW remain as wetlands in order to maintain their carbon sequestration potential. Provisions for the management of flows (e.g. equalization culverts) should be considered to protect and preserve the wetlands systems through appropriate design measures.

5.3 Monitoring

In order to improve upon the accuracy of this GHG assessment and to determine the effect of potential mitigation plans and offsets, it is recommended that monitoring of the Projects with respect to GHG emissions inventory calculations and verification be conducted. This procedure includes the development of Best Management Practices for the construction and operational phase of the Projects as outlined above.

This program to collect data pertaining to the construction phase should be extended to include data on air, water and vehicle travel volumes and statistics once the ASR is open to the public (i.e., during the operations phase of the Projects). This will allow for the recalculation of the GHG inventory of the operations phase of the Projects and evaluate potential abatement measures as outlined above.

The reassessment of the GHG emissions inventory will assist in evaluating the potential for carbon offsets, if considered necessary, as well as the potential to participate in any future Provincial, regional (e.g., Western Climate Initiative), and national carbon cap and trade system.

6.0 Conclusions and Limitations

The GHG assessment estimated the total direct and indirect GHG emissions due to the Projects and compared this estimate with the GHG emissions (direct and indirect) under the business as usual Baseline scenario (i.e., without the Projects). The assessment was conducted over the time period of construction and 10 years of operation of the ASR.

The Baseline scenario resulted in a total of approximately 17,580 and 21,432 tonnes CO2e being emitted annually during the periods of time when the construction phases and operational phases, respectively, would have been occurring for the four projects (assuming all four projects would have been under construction and operation at the same time, i.e., 'worst-case scenario'). The Projects scenario was estimated to emit a total of approximately 29,123 and 15,301 tonnes CO_2e annually for the same periods. The net cumulative change in GHG emissions due to the Projects was therefore estimated to be approximately -6,128 tonnes (kt) CO_2e annually. The significant portions of the GHG emission during the construction period are due to the construction of the ASR. The construction of the ASR was estimated to increase the Province's construction based GHG emissions by approximately 12 % based on the 2008 estimates of 0.098 Mt CO_2e. This increase is temporary so that once construction of the ASR has been completed it would result in the reduction of the Province's construction-based GHG emissions. Another increase is the estimated vehicular traffic between Winnipeg and Poplar River. However, the anticipated improvements in future vehicular technology that result in emissions reductions have not been included in this assessment. Approximately after 13 years of operation of all four projects, a net reductions in annual GHG emissions by 6,128 tonnes CO2e, which is about a reduction of 0.1% of the Province's total GHG emissions of 5.13 Mt CO2e due to road transportation in 2008, will be realized. Given that there would be a temporary overall increase in GHG emissions during the construction phase of the ASRs, but an overall decrease in GHG emissions during the operation years of the ASRs, the change in GHG emissions would not result in a detectable increase in greenhouse gas accumulations within the global atmosphere and therefore would not influence climate change.

Potential GHG emissions abatement and / or offsets during the construction and operational phases of the Projects were suggested. In particular, construction best management practices may help to reduce the GHG emissions associated with this phase of the Projects. For the operational phase of the projects, preservation of the wetland areas surrounding the ASR, revegetation of disturbed areas, inter-community transit service, and on-going maintenance of a smooth running surface on the gravel road may potentially reduce the GHG emissions during this phase of the Projects. Recommendations on developing mitigation plans and policies, monitoring and data collection, and verification were provided. This will help to verify the initial estimates of the GHG emissions associated with the Projects provided in this report and

assist in positioning the Province to participate in future provincial, regional and federal carbon trading mechanisms.

It should be noted that the assessment was limited by the assumptions made in the study methodology as a result of data limitations. These assumptions included those made in the calculations of the biogenic sources and sinks, calculations related to the construction of the seasonal (winter and ice) road, seasonal road traffic volumes, and the changes in air and vehicular traffic volumes as a result of the operation of the ASR. The study also did not consider the changes in travel patterns, potential development along the PR 304 and other routes from Winnipeg, and potential development within the First Nation Communities as a result of the increased ease in commuting on the resulting GHG emissions due to the Projects. Calculations of GHG emissions from the biogenic sources and sinks, construction and maintenance activities for P4, P7 and P7a were prorated based on the detailed calculations for Project P1. The projects will not be in operation at the same time. However, the differences in GHG emissions in different years were not considered.

7.0 Closure

This GHG assessment report has been prepared based on the information provided and/or approved by the East Side Road Authority. This report is intended to provide a high level assessment of net GHG emissions resulting from the construction of the ASR Projects, based on the limited available data. This report was prepared by Dillon for the sole benefit of the East Side Road Authority as supporting documentation for the EA Approvals process. The material in the report reflects Dillon's judgment in context of the limited information available to Dillon at the time of this report preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. Dillon accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

8.0 References

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