NFAT Review:

A Review of Manitoba Hydro's Macro Environmental Considerations

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On Behalf of the Manitoba Public Utilities Board

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EXECUTIVE SUMMARY

MNP is of the opinion that the supporting analysis of macro environmental impacts included in Manitoba Hydro's NFAT filing is satisfactory for the purposes of this hearing, with several notable limitations and potential opportunities for further consideration and/or improvement. Generally, the net environmental benefits of Manitoba Hydro's (MH) preferred plan are found to outweigh its overall environmental costs in a regional and global context. Although measurement and prioritization of the full macro environmental costs and benefits are inherently challenging to evaluate against each other, it is our opinion that the expected costs and risks are acceptable elements of projects of this nature.

By and large, the preferred plan's consideration for resource conservation, sustainable energy development and avoidance of contribution to ongoing human-driven climate change increases the attractiveness of the projects in comparison to most of the alternative plans studied as part of the NFAT. The preferred plan also provides the most upside value in a policy scenario that explicitly merits the avoidance of carbon emissions and provides mid-continent regional benefits that support reduction of the continued reliance on more intensely emitting forms of generation.

Conversely, some local environmental risks, specifically related to the alteration of land and aquatic ecosystems, are of concern and should be carefully weighed and mitigated.

MH's analysis provides an acceptable narrative of the macro environmental risks and concerns. That said, the conclusions of MH's filing do not always provide the Public Utilities Board Review Panel with a full set of assessment results and scenarios for consideration. Limitations of the filing include some lack of transparency around key assumptions; limited estimation of mitigation costs due in part to unique environmental impacts and reliance on concurrent studies (e.g. CEC's EIS) yet to be concluded. This report is intended to identify and in some cases offer further analysis related to these limitations.

It is acknowledged that the Clean Environment Commission is conducting and will be conducting direct project-specific environmental assessments of each preferred plan project. These hearings provide a more fulsome analysis and decision-making process as it relates to environmental issues. The purpose of the NFAT hearing is not to duplicate an already rigorous review of environmental issues and impacts.

In our view, there is insufficient examination of some key issues in the NFAT filing to provide the Review Panel with enough information upon which to base robust and informed commentary regarding the environmental externalities and related direct costs associated with development plan projects.

The findings of this report offer incremental analysis, augmented sensitivities and further review of analysis captured from other regulatory processes of the Keeyask and/or Conawapa projects, or general research on similar projects and experiences.

Our key observations include the following:

Review Issue	MNP's Observations	Further Consideration
Climate Change: Direct Impacts on Water Supply, River Flow and Evaporation	MH includes risk sensitivity analysis within its NFAT filing examining the affects of two key climate change impacts on the NPV of development plans: • Drought. • Changes to anticipated stream flow. Data from prolonged drought periods from the historic record is applied to represent future drought scenarios. Historic stream flows are also adjusted based on Global Climate Modelling (GCM) to determine overall annual average flow impacts. Although these analyses provide useful insight, they may not be adequate to capture the expected nuances of climate change impacts on the local watershed and on seasonal precipitation.	On an annual basis, greater precipitation and therefore greater run-off and higher stream flows are reasonable assumptions under standard climate change scenarios. However, the timing of increased precipitation may not align with periods of expected increases in demand or during peak exporting seasons. In this case, further examination of the system's ability to store and leverage seasonal changes could have been studied and described in greater detail to assist the Panel in its recommendations. Impacts of scenarios that limit water availability and increase the frequency and longevity of drought should have been included in the probabilistic analysis of NPV and articulated more clearly. Currently, only a qualitative discussion of the impacts of a drought worse than those on record exists in Chapter 10 of the NFAT filing. GCM models indicate that more severe drought periods are likely and therefore should have been specifically studied.
Climate Change: Greenhouse Gas Emissions and Air Pollutants Impacts	Current and future policies must be considered while selecting a development plan. [redacted] expects a federal level carbon premium will come into effect in [redacted] MNP's base case reflects [redacted] we place a [redacted] initial value per tonne of carbon. MH has performed extensive modelling of GHG emissions across the development plans. In comparing development plans, the preferred plan has comparatively low cumulative life cycle GHG emissions in relation to nearly all other plans. The preferred plan also includes comparatively low operating emissions. Some alternative plans (Wind/C26 for example) could have lower overall operating emissions. However, not all plans provide the same level of energy and potential for export and therefore prospective emissions displacement from in markets. The preferred plan results in the highest cumulative net GHG emissions displacement of any of the alternative plans.	The LCA analysis performed for Keeyask contains a number of risks and limitations. As a result, we caution that total life cycle emissions could be significantly different than reported. However, it is unlikely that the potential increase in life cycle emissions will be material to comparative analyses, or that it would result in the preferred plan being less favourable than alternative plans that do not include the development of Keeyask and Conawapa. Based on MNP's GHG modelling and financial sensitivities analysis, there is potential upside in the present value of carbon premium derived revenues, should policies develop favourably. That said, there is tremendous uncertainty exists regarding the stringency and nature of carbon policy. There is risk that Manitoba's exports may derive little from their inherent environmental attributes.
Macro-Environmental Consequences to Water Regime	The expected consequences of MH's preferred development plan will occur in the short-term. It is unclear whether meaningful medium- and long-term effects will result, which is a key concern of First Nations communities. MH has committed to substantial investment in mitigation measures commensurate with expectations of large hydro development, and will monitoring ongoing effects to support future changes in mitigation where necessary.	It is possible that longer-term water regime changes will occur. The Nelson River is an already highly altered system. It will be critical to monitor the ongoing changes to water regime during and upon completion of the development of Keeyask. There are indications that the Keeyask project could impact water levels at Split Lake during conditions requiring full release from Lake Winnipeg. Although noted as highly unlikely by MH, the risk is sufficient for consideration in this review. Water regime impacts are highly project specific and will be better understood for Conawapa once an EIS for the project has been completed.

Review Issue	MNP's Observations	Further Consideration
		However, the water regime impacts are expected to be far less intensive than for Keeyask.
Macro-Environmental Consequences to Caribou	Substantial study of the regional impacts of hydro development on caribou has been undertaken over many years in Manitoba. Although there are likely to be impacts to three distinct caribou herds that use the Lower Nelson region, their materiality is expected to be low and manageable. Migratory herds will continue to have sufficient access to habitat, but may face some risk when they interact closely with altered habitat near Keeyask. Resident caribou face the greatest challenges, but few relatively individuals exist in the region today.	As a unique subset of the species, the low numbers of resident caribou in the Lower Nelson region should be preserved. This goal aligns with the Caribou Management Plan of the province. Although the overall populations are expected to survive and remain healthy in the province, these animals have strong cultural ties to First Nations communities and traditional life. If caribou are extirpated from the region due to project development, it will be necessary to travel much further and more often for local communities to keep their connection. Calving habitat is of particular concern for resident caribou. Overall, MH expects there to be a net increase in calving habitat with new islands being formed in the reservoir and with artificial habitat being created. There is a strong risk however, that caribou will not respond to these habitat areas and choose to abandon use of the area.
Macro-Environmental Consequences to Lake Sturgeon	Consequences of the preferred development plan to lake sturgeon are regionally significant. Although Manitoba Hydro is committing substantial resources to mitigation and monitoring initiatives, the lack of comprehensive understanding of the fish and behaviour throughout its life stages leaves long-term results in question. There is some evidence that over the long-term, populations should recover and remain self-sustaining given the appropriate management by MH and its partners. The comprehensiveness of study, hydro effects mitigation and species management will overall, be enhanced by the development plan derived programs and resources to realize the province's goal of sustainable lake sturgeon populations.	Lake sturgeon have historically been a key resource of cultural and subsistence significance for First Nations in the Keeyask project area. Lake sturgeon have received more attention due to their vulnerability and status relative to endangered species regulations. The interest in hydro development directly impacts key viable habitat for the fish, which is currently already limited. The mitigation measures proposed by MH, such as stocking, were designed with the intent to enable the lake sturgeon population to become self sustaining. However, there is uncertainty regarding the effectiveness of these methods. There is limited evidence of success available from comparable projects, or in the scientific record. The results of previous stocking efforts in the region are partial at this time due to the long life stages of sturgeon. More study is necessary on the need and requirements for upstream fish passage, which will likely be necessary in order to support the goal of providing viable habitat for sturgeon. Also, a better understanding of fish mortality as a result of turbine injury and entrainment is needed.
Macro-Environmental Consequences to Other At-Risk Fauna	There are a number of species considered to be at-risk fauna. As a result of the preferred plan developments, there will be habitat loss and alteration. The loss of wetland habitat is a key consideration due to its criticalness to ecosystem function. The potential implications include a number of species being threatened and a decline in the quantity and quality of wildlife in the study area. Overall, effects will be low in significance, as general populations will be unaffected. MH's monitoring and habitat management should be adequate to mitigate the anticipated impacts, assuming there are no changes to underlying expectations.	It is important to measure the actual consequences throughout the development of Keeyask to confirm whether underlying expectations continue to be accurate. It will be critical to adapt mitigation strategies employed by MH if more drastic changes occur to at-risk fauna.

1. INTRODUCTION

The Manitoba Public Utilities Board (MPUB) is conducting a Needs For and Alternatives To (NFAT) review of Manitoba Hydro's (MH) Preferred Development Plan, which includes development of the Keeyask and Conawapa Generating Stations and their associated transmission infrastructure. As part of this review, MNP was tasked with performing a critical analysis of the macro environmental impacts and benefits of the plan and set of alternative plans.

As an independent expert consultant (IEC), MNP's specific role is to advise the NFAT Review Panel on a number of key environmental issues related to the preferred plan and alternative plans, including:

- Review of the preferred and alternative plans' relative contribution to direct and indirect greenhouse gas (GHG) emissions in Manitoba and globally.
- Review of project impacts to MISO electricity market generation mix and emissions profile.
- Review and comment on the impacts to valuable environmental components (VECs) such as lake sturgeon, caribou and other at-risk species.
- Assessment of and comment on the potential need for a lake sturgeon fishway.
- Review and comment on the likely changes to the Lake Winnipeg and Upper Nelson River water regime.
- Review of the incremental impacts of global warming on the future water supply, flows and reservoir on the Churchill-Nelson system.

Representing substantial provincial investment over the long-term and including a variety of inherent uncertainties, the projects of MH's preferred plan present a litany of physical and project cost risks that must be evaluated and considered as part of the approvals process. Included in these risks are macro environmental consequences and impacts, both locally and globally, to the air, water, flora and fauna with which the projects and related activities interact. These consequences and impacts have also been examined for their equitable distribution on present and future generations.

This critical review investigates a number of potential impacts to the macro environment and focuses on those considered to be material for the purposes of the NFAT hearing. The preferred plan represents a set of projects that will each individually require its own Environmental Impact Statement (EIS) as part of the overall environmental assessment requirements of the Clean Environment Commission (CEC). To date, only the Keeyask Generation Project has progressed substantially through an EIS process with the Keeyask Hydro Power Limited Partnership having completed a response to the EIS guidelines.

This critical review does not represent an EIS and aims to be non-redundant to the CEC's approvals requirements. This report provides the Review Panel with an overview of the critical issues of concern, their potential associated impacts and incremental costs to the projects. Given that other preferred plan components have not yet required an EIS, many of our findings and results are predicated on the review and evaluation of lessons learned from the Keeyask EIS documentation and supporting public hearing information.

The impacts of Conawapa and its associated infrastructure are expected to be similar in nature and magnitude to those of the Keeyask project. Although there are likely to be some differences and incremental impacts of the Conawapa project, it is reasonable for the purposes of this evaluation to assume and assess similar and interdependent macro environmental impacts for analytic purposes, while future CEC approvals processes will provide greater detail and rigour.

As part of the Keeyask EIS, the views and direct analysis of First Nations communities have been included significantly throughout the process. First Nations in the Keeyask study area, including the Tataskweyak Cree Nation, Fox Lake Cree Nation, (collectively the Keeyask Cree Nations (KCNs)), War Lake First Nation and York Factory First Nation, were given the opportunity to provide their own environmental assessments. These communities have a unique and critical knowledge of the ecosystems that will be impacted by project developments, alongside a strongly rooted history of the region. The knowledge of these groups is invaluable to understand baseline conditions and the interrelationships between human, economic activities and the land and water resources in the study area. Throughout this report, the view of the First Nations communities are included to support our analysis and to provide the Review Panel with a broad-based input on several key issues of concern, summarizing the impact of environmental consequences on land, water and people throughout time.

Our report is broken into separate sections for each critical issue of concern as follows:

- Climate Change: Greenhouse Gas Emissions, Air Pollutants and Other Direct Impacts.
- Water Regime.
- Macro Environmental: Caribou.
- Macro Environmental: Lake Sturgeon.
- Macro Environmental: Other At-Risk Fauna.
- Equitable Distribution.
- Summary of Observations.

1.1 CLIMATE CHANGE

As a global and critically important issue of our time, anthropogenic contributions of the development plans to global climate change and its associated impacts are material issues for the NFAT to consider. Both the province and MH generally accept the consensus-science related to climate change and recognize that evidence exists supporting the notion that emissions associated with human activities are increasing the content of GHGs in the atmosphere, leading to climate change.

The key issues for consideration and analysis include:

- Alignment of the preferred plan with current and expected global, national, regional and local policies and strategies.
- The direct and indirect lifecycle GHG emissions of the projects during the construction, operation and decommissioning phases.
- The contribution of preferred plan projects to GHG emissions release and displacement, whether they be positive or negative.
- The expectation and impacts of climate change and GHG emissions on MH's operations, assets and financial position.

To conduct our assessment, MNP has reviewed and commented on the development plans' alignment with current and future policy expectations, reviewed and assessed the reasonableness of assumptions and inputs into the life cycle assessment of GHG emissions associated with the development plan projects and performed simple economic modelling to provide the Review Panel with a sense of the financial implications of low-emitting electricity exports being sold in the MISO market and the environmental premium they might command in the future.

The direct physical impacts of climate change on the development plans and on the MH's resource availability have also been examined. As related issue, the resulting releases and impacts of other gaseous emissions associated with electricity generation are assessed as they relate to the NFAT filings, preferred and alternative plans.

1.2 WATER REGIME CHANGE

The hydro projects included in the preferred development plan will have direct impacts on the water regime of the Upper Nelson River watershed and potentially on other integrated water systems such as Lake Winnipeg. The associated flooding and change to the depth, turbidity and flow dynamics of portions of the river system will include direct impacts to habitat ecosystems of local fauna. Furthermore impacts to water regime will also alter relationships of First Nations communities with their homeland ecosystems, the land and the species upon which their traditional way of life depends. The expected water regime changes, as well as the costs of their mitigation are summarized and examined below to evaluate significance and level risk. For significance methodology applied, refer to the discussion under the following section 1.3.

1.3 MACRO-ENVIRONMENTAL (VECS)

The Canadian Environmental Assessment Agency defines VECs as environmental elements of an ecosystem that are identified as having unique scientific, social cultural, economic and aesthetic importance. One could argue that VECs are abundant and diverse in a part of the world as limited in change due to human development as part of northern Manitoba and the Keeyask Study Area.

We have selected a small number of VECs for representative purposes. Our critical review evaluates the robustness of the analysis conducted on the local VECs of the Lower Nelson River region as part of the NFAT and/or Keeyask EIS and assesses the results and conclusions of those analyses.

For the purposes of this NFAT review, VECs are identified as the following:

- Lake Sturgeon.
- Caribou.
- Other At-Risk Fauna such as endangered species and common species reliant on the local ecosystems that are a valued element.

For each VEC considered, we review the anticipated impacts predicted from the Keeyask and Conawapa projects, the consequences of each impact and the level of significance. The significance of each impact was determined based on three factors:

1. Magnitude of the impact.
2. Risk of occurrence.
3. Importance of the predicted impact for further MPUB consideration in MNP's opinion.

Each impact was given a rating of High, Medium or Low based on the definitions below:

- **Low** Significance – magnitude of the impact is small, has a low risk of occurrence and is less critical for the PUB to consider.
- **Medium** Significance – a mix of high impact and low risk, or low impact with high risk. In these cases there is moderate overall significance, but important for the Panel's consideration.
- **High** Significance – magnitude of the impact is large and the risk of occurrence is determined to be high, with a high level of priority for the Panel's consideration.

1.4 EQUITABLE DISTRIBUTION

The potential impacts of the preferred plan to climate change, water regime and other macro environmental issues are examined to determine their timing and significance over the 78 year planning horizon. Equitable distribution is rooted in the concept of sustainable development. According to the Institute for Sustainable Development (IISD):

> "*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:*
>
> - *the concept of **needs**, in particular the essential needs of the world's poor, to which overriding priority should be given; and*
> - *the idea of **limitations** imposed by the state of technology and social organization on the environment's ability to meet present and future needs.*[1]"

The province's objective is to minimize undue burdens on future generations and build new generation for the future in a sustainable manner. We have assessed the equitable distribution of macro-environmental changes within and between present and future generations.

1.5 SUMMARY OF OBSERVATIONS

We have compiled the observations made in each section of the report into a summary. The purpose of the final section of this report is to distil the key messages and conclusions of our analysis for the Review Panel's consideration as part of the NFAT hearing.

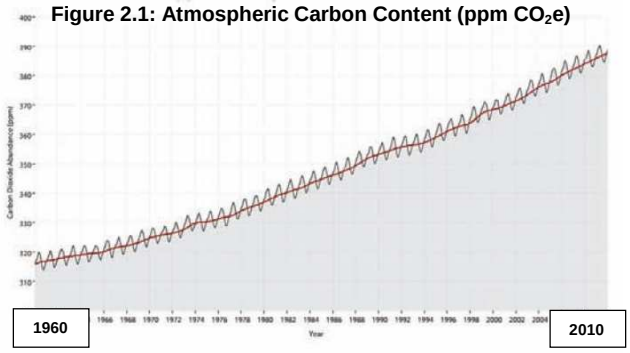
[1] Institute for Sustainable Development (IISD). *What is Sustainable Development?* Accessed in 2013. (http://www.iisd.org/sd/)

2. CLIMATE CHANGE: DIRECT IMPACTS

2.1 CLIMATE CHANGE AND RIVER FLOW

The Province of Manitoba and MH understand and accept that current global climatic trends indicate substantial deviation from the historical norm[2]and they recognize the need for Manitoba to prepare for changes to climatic functions that are already occurring and those that are likely to occur in the future. Although the earth's climate has changed at times in its history, it is commonly believed that the current trends are at least in part associated with human activity resulting in releases of GHG emissions. There is strong evidence that CO_2 composition in the atmosphere is increasing in proportion and at a magnitude and rate that appears unprecedented on the historic record. As demonstrated in the adjacent chart (presented by MH in their 2012-2013 climate change plan), CO_2 composition in the atmosphere has passed 380 ppm, with 450 ppm identified by many as a critical stabilization mark to avoid calamity[3].

Figure 2.1: Atmospheric Carbon Content (ppm CO_2e)



SOURCE: NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION HTTP://WWW.CLIMATEWATCH.NOAA.GOV/ARTICLE/2009/CLIMATE-CHANGE-ATMOSPHERIC-CARBON-DIOXIDE

With the expected continued release of global GHG emissions due to human economic activity, MH maintains a strategy of cultivating a comprehensive understanding of climate change science and the implications of climate change as a vital planning element. This ensures the appropriate adaptation strategies can be employed and socially-valued investments can be made over the long-term.

MH conducts ongoing study to increase its knowledge of the implications of future climate changes and uses adapted resource planning models to consider climate change outcomes on the water cycle and water availability for power generation purposes. From a resource planning perspective, these inputs are critical to the overall estimation of net present value of the preferred plan.

To date, several types of sophisticated climate modelling have been drawn on to inform MH's own hydrologic and system modelling. Largely, respected international scientific bodies operate global and regional climate models (GCM and RCM respectively) to determine the correlations between GHG emissions, climate change, increasing temperatures and precipitation levels. Much of the focus and robustness of the current science is at the macro level, while local level impacts are not yet well understood or supported. In this respect, MH is well-positioned to be a leader in understanding climate change impacts to the Nelson-Churchill watersheds and appears to be investing in stronger collaboration with climate modelling entities and in determining local impacts for the province.

Results at the local level do not provide the same level of rigour as those at the global scale. Much of the local data to date is based on historic temperature and precipitation trends, which are the same trends that global models illustrate, are highly likely to be altered as changes in the climate continue. Therefore, the projection of precipitation and climate conditions at the local scale includes much greater uncertainty[4]. A comprehensive research project conducted in 2012 by a number of Nordic and Baltic countries and including 33 institutions from across the region, found that precipitation and run-off projections under

[2] Manitoba Hydro. *Manitoba Hydro Climate Change Report Fiscal Year 2012-2013*. Accessed in 2013.
[3] Stern et al. *Stern Review: The Economics of Climate Change*. 2006. Accessed in 2013.
[4] Manitoba Hydro. *Manitoba Hydro Climate Change Report Fiscal Year 2012-2013*. Accessed in 2013.

climate change scenarios were highly variable, but generally were expected to increase in northern latitudes. Specifically, increases were marked in winter with large increases in early spring run-off in most results[5].

Global models indicate that northern watersheds will be overall hotter and experience greater annual precipitation with increased instances of severe weather conditions such as drought.

2.2 MANITOBA HYDRO'S USE OF THE DATA

MH has captured climate change outcomes in modelling by examining sensitivities that adjust the annual precipitation and water availability scenarios in its integrated resource planning, as well as by applying historic drought levels to representative sets of years in the economic forecasting of the NFAT analysis.

MH's NFAT filing indicates that hydrologic modelling is strongly based on many decades of historical data trends. Simple augmentations may not provide insight on the complete risk profile of likely climate outcomes. Without direct and clear study of altered climate conditions and forecasted hydrologic impacts, several risks could be left unidentified. Our review suggests to possible and notable limitations:

- It is unclear if the impacts of seasonality changes attributable to alternate climate change futures have been strongly considered and incorporated into development plan evaluation.
- It is unclear if climate change and the severity of increased drought risk have been adequately considered.

According to the MH 2012-2013 Climate Change Report, modelling scenarios being considered in typical resources planning include forecasts projecting annual average temperatures for northern river basins such as the Nelson, to be increasing toward +2.2 to +2.7 degrees Celsius and average total annual precipitation to be increasing by 6% to 8.7% by 2050. As we understand, MH's typical planning assumptions have been applied to the preferred plan studies prepared as part of the NFAT Review. Sensitivities include simple testing of increased annual precipitation and resulting stream flow. Given the amount of hydrologic data available, MNP believes this approach has merit as a base case scenario. However, consistent with the expected global changes and their impact on regional climatic conditions and resource availability in northern watersheds, we believe that analytic emphasis should be placed on sensitivities of alternative scenarios that take into account the following:

- Annual precipitation expected to increase between 6% and 8.7%, but not in a uniform manner.
- Total annual water availability will increase. However, seasonal precipitation will increase mostly in the late winter and spring.
- Increased average temperatures will lead to greater evaporation.
- Severe weather is expected to increase, thereby increasing the frequency and severity of drought years.
- Temperature increases will impact Manitoba by decreasing the domestic heating load in winter, but increasing the domestic and export peak cooling load in summer.

It is unclear if these nuances are captured in resource planning and/or economic modelling.

According to the *2006 Stern Review on the Economics of Climate Change*, patterns of global water availability and the intensity of the water cycle are likely to change. Droughts and floods will become more severe and there will be more precipitation at *higher latitudes*. The report explores the incredible

[5] Norden. *Climate Change and Energy Systems*. 2012. Accessed in 2013. (http://www.nordicenergy.org/wp-content/uploads/2011/12/Climate-Change-and-Energy-Systems-CES-project.pdf)

uncertainty associated with atmospheric GHG content and global surface temperature trends. Based upon a broad study set and Stern's recommended GHG stabilization level of 450 to 550 ppm, we believe a reasonable temperature increase estimate for analytic purposes of this NFAT review to be between +1.3 to +4.5 degrees Celsius[6] as the breadth and robustness of Stern's research is an unparalleled compilation of climate science.

Given that Stern's targets require deep cuts to global GHG output and immediate technical and policy response is not taking place globally in a meaningful way, it is MNP's view that temperature should be considered to increase +2.7 degree Celsius or more for analytic purposes. Other studies by the Intergovernmental Panel on Climate Change (IPCC) and the National Oceanic and Atmospheric Administration also suggest temperature increases in these ranges are a possibility by 2050 given current trends[7].

Because of the Nelson system's northern location, climate modelling provides strong evidence that temperature increases are nearly certain, with strong correlation between climate change and northern temperature increases. As a result, mean annual precipitation is expected to increase along with the following local characteristics:

Figure 2.2: Local Climate Change Impacts

Global Climate Change Drivers	Expected Local Impacts
Increased Annual Average Global Temperature	Increased annual average temperatures
	Increased precipitation in the winter and spring
	Greater aridity during summer seasons
	Greater overall evaporation
	Increased frequency and severity of drought
	Increased frequency of infrastructure damage from severe weather (ice storms)

Overall, precipitation and runoff, and therefore corresponding water availability are expected to increase due to the changing climate on an annual average basis. However, seasonality becomes an important consideration for MH given the increased water availability in the shoulder months[8], but likely decreased availability during major peak exporting summer months. During the increasingly dry summers, greater evaporation will mean less natural resource availability. Lake Winnipeg, as the key component in the flow control regime, is particularly vulnerable to a warming climate due to its large surface area and relative shallowness[9]. In all, conservative analysis suggests only modest increases in the availability of water on the Nelson system for generation purposes with the potential for net aridity during important peak exporting periods. The potential to capitalize on greater annual water resource availability will depend highly on the ability of MH to manage reservoirs under preferred plan conditions and make incremental energy available during exporting periods.

[6] Stern et al. *Stern Review: The Economics of Climate Change*. 2006. Accessed in 2013.
[7] Intergovernmental Panel on Climate Change (IPCC). *Climate Change 2007: Synthesis Report.* 2007. Accessed in 2013. (http://www.ipcc.ch/publications_and_data/ar4/syr/en/spms3.html)
[8] Note: Shoulder Season – Typical period of lower demand on an electrical system outside of the peak warming or cooling season.
[9] Institute for Sustainable Development (IISD). *Climate Change Impacts in Manitoba*. 2007. Accessed in 2013.

Another important consideration is the expected increase in severity and frequency of drought. With longer and deeper drought periods expected, competing provincial uses for water resources could lead to little capacity for the MH system to export during extended periods of drought. This is especially important to consider as cumulative climate change impacts are anticipated to intensify in the later years of the 78 year planning horizon. This reflects the reality that future generations will be more severely impacted by the effects of climate change than present generations. Since the preferred plan has the lowest lifecycle GHG emissions (as demonstrated in following sections), the preferred plan projects minimize Manitoba's contribution to inequitable distribution of climate change.

2.3 DIRECT IMPACTS AND POSSIBLE SENSITIVITY TESTING

For hydroelectric power generation companies, changes in temperature and precipitation patterns and the possibility of changes in the frequency and severity of extreme weather events are meaningful concerns. These risk factors have real potential to influence MH's energy production on a year to year basis, as well as energy demands on the MH system. Changing climatic conditions may also result in changes to the direct physical risks of large scale and linear assets.

Risk factors are influenced by the changing climate and will have the potential to modify available water supplies and river flow, thereby influencing the potential energy production of Keeyask and Conawapa Generating Stations and the capacity to generate the expected export revenues. The analysis of climate change risk should therefore be made more robust by including greater sensitivity on the expected changes in the levels and timing of precipitation and drought.

Ultimately, we caution that there is risk that the expected amount of energy for exports will not be available during appropriate periods due to:

- Seasonality changes in precipitation.
- Increased frequency and severity of drought conditions (especially extension of drought periods).
- Increased demand for water during summer for other uses (agricultural).
- Increased internal energy demand with higher summer average temperatures.

MH considered climate change impacts in their economic modelling and adjusted scenarios to examine general impacts consistent with expected local futures. However, detailed analysis of the impacts of seasonally altered precipitation patterns and longer, more severe droughts were not considered explicitly. Further, greater frequency in severe weather may also mean greater risk for significantly long transmission system outages due to storm-related and other damages. Scenarios considering these impacts would also enhance the overall sensitivity of NPV analyses.

3. CLIMATE CHANGE: GHGS AND AIR POLLUTANTS

3.1 ANALYTIC APPROACH

The following section of the report contains three major themes with the objective of assessing MH's preferred and alternative development plans relative to the effects of climate change, GHGs and other air emissions. The direct impacts and opportunities are evaluated quantitatively, where they are expected to impact project economics, and qualitatively to evaluate their risk profile and potential social costs. The three themes include:

- Policy risk and alignment with provincial environmental objectives.
- Net GHG and air pollutant emissions profile.
- Economic opportunity related to carbon policy and the environmental attributes of Manitoba's exports.

We evaluate the direct and indirect GHG emissions of the projects, the estimated global impacts, the relationship with the MISO electricity market and shifts in the MISO energy mix, particularly as related to growth in wind energy. This study also presents a comparative analysis of the overall emissions benefits of the preferred plan relational to alternative plans.

Several approaches were applied to perform the required analyses. Augmented by research, MNP has incorporated our extensive knowledge of electricity generation markets and renewable energy technologies, as well as expertise with their associated emissions profiles. We have also applied our knowledge of climate change and other air emissions policy to develop conclusions on the reasonableness of the data and assumptions used in the analysis of the NFAT filing.

MNP performed critical analyses of MH's NFAT filing and the related EIS documentation available for the Keeyask Generation Project. Our methodology includes the following key components:

- Policy Analysis – Risk Review of development plans' against Policy Objectives.
- Verification of Inputs and Assumptions – Review of Keeyask Life Cycle Assessment (LCA).
- Economic Cost-Benefit Analysis – Review of the Carbon Pricing, Market Forecasts and Net Emissions.
- Financial Impacts Assessment – Analysis of the Economic and Financial Implications Associated with the Environmental Attributes of MH Exports.

The Conawapa Generation Project had not yet completed a comprehensive EIS at the time of MH's NFAT filing and a full LCA analysis of GHG emissions associated with Conawapa has not yet been finalized. Therefore, MNP was unable to assess and conclude on the EIS and LCA for Conawapa. It is our view that it is reasonable to apply factors, findings and assumptions found during the Keeyask EIS to the material aspects of the Conawapa project to provide a strong gauge of its likely impacts related to climate change and air emissions.

3.2 POLICY REVIEW

As a provincial crown corporation, MH's strategic direction and planning activities should align with applicable federal and international policies and regulations, as well as provincial regulations and strategic objectives. Alignment of the proposed generation projects with future policy and regulation is an essential consideration. Given the lead time and long planning horizon for new hydro power generation, our analysis obtains insight and forecasts from a number of sources to present a picture of a possible future scenario and general range of consensus for the panel to consider.

MH clearly acknowledges that energy and environmental policies represent major factors influencing resource choice and the market price for electricity in the future. There is a growing concern for policy to address both the immediate and long-term effects of climate change. MH has included an overview of the current policy and regulatory environment in *Chapter 3* of the NFAT filing. This summary provides a strong understanding of the direction of policy and regulatory risk in the context of regulations that could directly impact MH and the projects of the preferred plan.

MH's external policy view is developed based on a consensus of the forecasts provided by several expert independent consultants who specialize in policy analysis and energy markets forecasting. This consensus projection forms the basis of carbon pricing assumptions, which in turn impacts energy price projections in the electricity export market forecast, critical to the NPV analysis of the development plans.

3.2.1 Policy Direction: A Global Perspective

Section 3.3.1 of the NFAT summarizes two pivotal international treaties under the United Nations Framework Convention on Climate Change (UNFCCC) – the Kyoto Protocol and the Copenhagen Accord. These treaties are generally considered to set the foundation for state level responses to climate change by setting targets and commitments for mitigation action.

The Kyoto Protocol was signed into effect by both Canada and the US in 1997 and ratified by much of the world community. However, following the treaty, the US elected not to ratify the protocol and as a result, did not participate in achieving its mandated targets. Canada ratified the protocol subsequent to signing the treaty. However, in 2012, Canada formally withdrew its participation and nullified its commitment to the achievement of the mandated Kyoto targets.

The Copenhagen Accord was signed in 2009 with a set of emission reduction targets designed to limit global temperature increases to 2 degrees Celsius or less. The Copenhagen Accord recognizes the scientific view that an increase in global temperatures must be limited to 2 degrees Celsius (from pre-industrial timeframes) and that we must "stabilize GHG concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system[10]." Under the Copenhagen Accord, Canada and the US committed to emission reductions of 17% below 2005 levels by 2020.

Several early initiatives adopted by other countries in Europe and elsewhere may ultimately guide the North American direction. These programs have provided learning opportunities for policy makers and industry. The European Union (EU) launched the European Union Emissions Trading System (EU ETS) in 2005 with a goal to reduce emissions from covered sectors by 21% below 2005 levels by 2020. Since inception, the main challenge in the EU ETS has been the growing surplus of emission allowances due to an initial over-allocation that has been exacerbated by the economic crisis.

Australia implemented a carbon tax of $23/tonne on July 1, 2012, which was planned to be increased by 2.5% per year before transitioning to flexible market price under an emission trading scheme linked to the

[10] United Nationals Framwork Convention on Climate Change (UNFCCC). *Draft Decision -/CP.15.* 18 December 2009. *Accessed in 2013.* (http://unfccc.int/resource/docs/2009/cop15/eng/l07.pdf)

EU ETS in 2015. One year ahead of schedule, the Prime Minister of Australia announced in 2013 that carbon tax would transition to market-based price in 2014.

A similar ETS was implemented in New Zealand, whereby emission units can be purchased from the federal government for $25/tonne or via international carbon markets (i.e. EU ETS) at their respective market prices.

3.2.2 Policy Direction: A Local Perspective

Manitoba's Climate Change and Emissions Reductions Act took effect on October 1, 2012. Under the Act, the province's initial emissions reduction target was to reduce Manitoba's emissions by December 31, 2012 to an amount that is at least 6% less than Manitoba's total 1990 emissions[11]. In December 2011, acting Conservation Minister Dave Chomiak signalled that Manitoba was unlikely to achieve this target. The most recent provincial emissions report shows that Manitoba's 2010 emissions were more than 12% above 1990 levels[12].

The most recent data indicates that MH's current annual GHG emissions are approximately 115 Kt of CO_2 (2011)[13]. The preferred development plan will result in total MH firm-wide GHG emissions of approximately 328 Kt starting in 2014 and reaching 1,425 Kt of CO_2 by 2047. In comparison, the most attractive alternative plans, based on the NPV probabilistic analysis in Chapter 10 of the NFAT filing, result in considerably more GHG emissions. For example, alternative plan #4 has 46% higher 2047 GHG emissions than the preferred development plan, or 2.04 Mt. These alternative plans would make maintaining strategic policy objectives much more difficult than the preferred plan.

With policy objectives designed to reduce absolute provincial GHG emissions, adding 2 Mt of CO_2 or more in the electricity generation sector from a negligible amount, would be counterproductive, especially when considering an already low emitting provincial economy (19.8 Mt in 2010).[14]

The following table summarizes our assessment of MH's policy assumptions and evaluates the most reasonable expected future policy environment over the NFAT planning horizon. It is recognized that considerable uncertainty exists on the actual direction these policies will take. It is possible that entirely new approaches may exist twenty or thirty years from now.

[11] Government of Manitoba. *The Climate Change and Emissions Reduction Act.* 2012. Accessed in 2013. (https://web2.gov.mb.ca/laws/statutes/ccsm/c135e.php)
[12] Manitoba Wildlands. *Manitoba 2010 Climate Report – Shows Rising Emissions.* 2012. Accessed in 2013. (http://manitobawildlands.org/cc_mb.htm)
[13] Environment Canada. *Canada's National GHG* Inventory, 1990-2011. 2013. Accessed in 2013.
[14] Ibid.

3.2.3 Canadian Perspective

<table>
<tr><th colspan="4">Canada National Policies</th></tr>
<tr><th></th><th>Broad-Based Carbon Trading Policy</th><th>Regulatory</th><th>MNP Assessment of Alignment & Outcomes</th></tr>
<tr><td>Consultants' Policy Expectations</td><td>Generally, consensus exists with the six consultants that Canadian national policy will align with the US on market-based approaches in order to achieve objectives relating to emission reductions and to ensure the trading approach is economically viable and functionally harmonized.

Although some experts believe there may never be a national or North American market-based carbon policy, the aggregate policy forecast includes a moderate carbon pricing scheme.</td><td rowspan="2"><u>Environment Canada Regulations</u>

• Coal fired electricity generation regulation, which requires existing coal plants to retire at 50 years of age or meet stringent performance standards. New coal plants built after July 1, 2015 must match the GHG emissions of combined cycle natural gas generation.

• Environment Canada is currently drafting regulations for Canada's oil and gas sector and is expected to release them shortly.

• Absent broader policy, it is expected by many that Canada will implement performance standards on natural gas-fired generation similar to those on coal facilities.</td><td rowspan="2">Preferred Plan Aligns

• The preferred development plan includes technologies viable from a national policy standpoint.

• Any alternative plans that could include coal do not align with the federal regulations.

• Alternative plans that include heavy reliance on gas-fired generation are at risk of facing similarly difficult performance standards for gas in the future.

• Greater natural gas generation included in alternative plans could face carbon pricing penalties decreasing the margins they could earn in export and domestic markets.

• Market based mechanisms most likely to be further developed into the next decade would favour the preferred development plan and development of hydro projects.</td></tr>
<tr><td>Manitoba Hydro Policy Expectations</td><td><u>Relevant Signals</u>

• Federal government signalling alignment with US policy activities on market-based mechanisms.
• Release of sector-by-sector control-based mitigation measures to address GHG emissions in the short term.

Canadian government is not currently pursuing an economy-wide carbon-pricing mechanism.

[redacted]s the expected start date of a federal cap-and-trade program included in MH's carbon price forecast.</td></tr>
<tr><td>MNP Analysis</td><td colspan="3">We believe the policy assumptions and expectations of analysis included in the NFAT filing are reasonable in nature and timing.

<u>Summary Analysis:</u>

Based on the expected policies and regulations, the potential impacts to MH planning and operations include:

• MH is unlikely to build and operate coal-fired generation plants due to regulatory limitations.
• MH's preferred development plan aligns well with Canada's national strategies and expected regulations.

There is potential for a new source performance standard for natural gas-fired generation, similar to the Canadian coal regulation noted above. In the US, the EPA's new source performance standards also affect new natural gas-fired generation. Canada is yet to regulate new natural gas generation. However, there is strong potential for Canada to implement a similar regulation in the near-term.

Under the assumption that a new source performance standard could be released by Environment Canada for natural gas-fired generation, the following considerations are relevant:

• Alternative development plans including greater reliance on natural gas could have further reduced NPVs and less favourable economics.
• Alternative development plans with all renewable energy technologies and hydro generation would see improved NPVs, resulting in more favourable economics.
• The preferred development plan, which includes new natural gas-fired generation to begin in 2041, would face significant regulatory challenges at that time, which would result in less favourable economics of natural gas-based projects. However, given the reliance on renewables and hydro, the preferred plan is in a stronger position to manage these challenges.</td></tr>
</table>

3.2.4 Regional Perspective

<table>
<tr><th></th><th colspan="3">Relevant Regional Policies</th></tr>
<tr><th></th><th>Broad-Based Carbon Trading Policy</th><th>Regulatory</th><th>MNP Assessment of Alignment & Outcomes</th></tr>
<tr><td>Consultants' Policy Expectations

Manitoba Hydro Policy Expectations</td><td>Possible Participation in or Influence From

MH and all six consultants exhibited considerable consensus on the expected paths of regional regulation.

<u>Midwest Greenhouse Gas Reduction Accord</u>
• Commitment by six Midwest states and Manitoba to a regional cap and trade program. Signed in 2007.
• No longer being pursued, but not formally suspended.

<u>Western Climate Initiative (WCI)</u>
• Cap-and-trade program.
• California and Quebec officially linked on January 1, 2014.
• Includes electricity generation, industrial facilities and fuel distributors with annual emissions greater than 25 kt of CO_2 equivalent in its current scope.

<u>Regional Greenhouse Gas Initiative (RGGI)</u>
• Cap-and-trade program for electricity sector only.
• Introduced in January 2009.
• In 2013, there were several amendments, which included the lowering of emissions caps by 45% and cancelling unused 2012 and 2013 allowances due to an oversaturation of market for carbon allowances.

<u>Alberta's Specified Gas Emitters Regulation (SGER)</u>
• Introduced July 1, 2007.
• Sets floor price for GHG emissions of $15 per tonne.

<u>BC's Carbon Tax</u>
• Introduced in 2008.
• Tax originally set at $20/tonne and increased over 5 years to $30/tonne. Currently frozen for next 5 years.</td><td><u>Manitoba's Emissions Tax on Coal Act</u>
• Introduced January 1, 2012.
• Requires purchasers of coal for use in Manitoba to pay an emissions tax of approx. $10/tonne of CO_2.

<u>Manitoba's Coal-Fired Emergency Operations Regulation</u>
• Came into force on January 1, 2010.
• Precludes coal-fired electricity generation except for emergency operations.

<u>Other Noteworthy Initiatives and Regulations</u>
• Renewable Portfolio Standards (RPS) – State level mandatory RPS standards in the MISO market are as follows (% of total GWh delivered):
o North Dakota – 10% by 2015.
o Minnesota – 25% by 2025.
o Wisconsin – 10% by 2015.
o Illinois – 25% by 2025.
o Michigan – 10% by 2015.
o Ohio – 25% by 2025.
o Iowa – 1000 MW wind by 2010.
o Missouri – 15% by 2021.
• Feed-in-Tariff (FIT) programs – used in Ontario to incent investment in renewable energies.</td><td>Preferred Plan Aligns

• Manitoba is an observer of WCI and may elect to participate at some point. It has not yet passed legislation to do so.

• Other regional regulations act as potential templates for Manitoba and/or MISO states, which could further impact capacity mix and value of non-emitting generation in MISO.

• Manitoba's direct regulation prevents the use of coal for electricity generation.

• Potential regional cap and trade policy could increase the operating costs of natural gas-fired generation included in any development plan in the long-term.</td></tr>
<tr><td>MNP Analysis</td><td colspan="3">We believe the policy assumptions and expectations of analysis included in the NFAT filing are reasonable in nature and timing.

<u>Summary Analysis:</u>

Based on the expected policies and regulations, the potential impacts to MH planning and operations include:

• MH cannot build and operate coal-fired generation plants due to direct regulation.
• Other regional regulations could impact MH over the lifespan of the preferred development plan, but the plan's foundation on hydro generation limits the policy impacts on MH due to limited liabilities from fossil generation.
• If MH elects to participate in WCI, there may be additional opportunities to improve the economics of the preferred plan earlier in the planning period.
• As state-level RPS requirements begin to influence generation investment decisions in the MISO market, MH could potentially see the value of hydro generation increase over time as more renewable-based generation is required.</td></tr>
</table>

3.2.5 US Perspective

	US National Policies		
	Broad-Based Carbon Trading Policy	**Regulatory**	**MNP Assessment of Alignment & Outcomes**
Consultants' Policy Expectations	The six consultants have mixed opinions without a general consensus for an expected US national policy: • [redacted] • [redacted] • [redacted]	*Environmental Protection Agency Regulations* • Proposed regulation for new fossil-fuel-fired power plants greater than 25MW to meet an output-based standard of 1,000 lb CO_2/MWh gross generation-equivalent to about 450 t CO_2/MWh, comparable to new natural gas combined cycle power plants (effectively precludes building new coal due to high costs of CCS technologies and covers natural gas-fired generation under the one standard). • Mercury Air Toxic Standards (MATS) requirement for new and existing plants to reduce air pollutants up to 90% by April 2015. • Cross-State Air Pollution Rule (CSAPR) was designed to reduce SO_2 by 73% and NO_x by 54% from 2005 levels starting January 1, 2012 with further tightening of emissions caps in 2014; struck down on December 31, 2011. • Resource Conservation and Recovery Act (RCRA) proposed to regulate the disposal of coal fly ash in landfills and surface impoundments. • *Clean Water Act* requires that new power plants use the best available cooling water intake technologies to prevent the impingement and entrainment of aquatic organisms; EPA to release Cooling Water regulations in near future.	**Preferred Plan Risk** • With little likelihood of a federal cap-and-trade or market based mechanisms to mitigate GHG emissions in the near term, no environmental value is likely placed on non-emitting generation until the mid part of the next decade. At this point, tempered pricing is expected, which could negatively impact the economics of the preferred development plan. • Other direct regulations will likely favour imports for energy purposes. The materiality of these interdependent regulations cannot be understated as it relates to MISO electricity markets. Although these regulations will continue to develop in stringency and form, any combination of regulations of this nature will lead to significant impacts on the operations and investment decisions of Midwest electricity generators. • MISO estimates that current or proposed EPA regulation will affect 84% of its 295 coal-fired plants. • The capacity mix in MISO is likely to change significantly over time and coal generation will be reduced. The emissions intensity of MISO is likely to experience downward pressure, also negatively impacting export values.
Manitoba Hydro Policy Expectations	*Relevant Signals* • US did not ratify the Kyoto Protocol. • Bipartisan legislative process has yielded little forward action. • Economic recession and other administration concerns have led to further in-action. The current administration has released the 2013 Climate Action Plan demonstrating favour for regulatory approaches in the near term to push environmental objectives and no comprehensive market-based mechanism is likely to gain traction until the next decade at minimum.		
MNP Analysis	**We believe these policy expectations are reasonable in nature and timing.** Summary Analysis: Based on the expected policies and regulations, the potential impacts to MH planning and operations include: • MH will not benefit in the near-term from a US federal cap-and-trade system placing value on low GHG emitting generation sources due to a lack of political direction. • MH's exports will be favourably impacted by proposed EPA regulations in the MISO market as coal-fired generation is retired and energy needs are supported by greater importing to MISO states. • Moderate incremental environmental value may be placed on low emitting GHG generation sources in the long-term providing some enhancement to the total NPV of revenues of preferred plan projects (see analysis in section 3.5). • Alternative plans will continue to suffer from less incremental value as the proportion of natural gas-fired exports increases.		

3.3 GHG EMISSIONS LIFE CYCLE ASSESSMENT

A life cycle assessment (LCA) of GHGs and select criteria air contaminants was prepared for the Keeyask Generation Project by the Pembina Institute and submitted on February 16, 2012 as part of the EIS for the project. This section of the critical review performs an objective analysis of the LCA completed for Keeyask to confirm the reasonableness of assumptions, inputs and results.

3.3.1 Pembina Institute LCA and Critical Review

The Pembina Institute is a national non-profit think tank that advances sustainable energy solutions through research, education, consulting and advocacy. It promotes environmental, social and economic sustainability in the public interest by developing practical solutions for communities, individuals, governments and businesses. The Pembina Institute provides policy research leadership and education on climate change, energy issues, green economics, energy efficiency and conservation, renewable energy, and environmental governance[15]. Given the expertise of the organization and a strong reputation for high quality research and analysis, Pembina is well suited to analyse the long-term climate-related impacts of energy infrastructure projects. However, the organization's mandate and position with respect to climate change mitigation and renewable energy advancement could bring objectivity into question when evaluating hydro and renewable-based plans against alternatives relying on other clean and/or lower emitting forms of generation, such as gas.

The Pembina Institute engaged a critical reviewer to assess the quality of their LCA report. The critical reviewer was Maryse Lambert, Senior Advisor – Air Quality with Hydro Quebec. Ms. Lambert reviewed the Keeyask report and life cycle model and provided quality review comments to Pembina. This aligns with best practice guidance on LCA methodology under *ISO 14040: Environmental Management – Life Cycle Assessment – Principles and Framework*. In her review comments, Ms. Lambert identified an inconsistency regarding the assumptions on steel replacement. The Pembina report is unclear on whether the steel replacement emissions reported are based on a 10% or 100% steel replacement over the life cycle.

It is MNP's opinion that the inconsistency identified is of limited materiality to the overall calculation of life cycle GHG emissions. The result of 10,025 tonnes of CO_2e representing emissions associated with steel replacement is likely attributable to replacing 10% of steel. Replacing 100% of the steel components would result in a much higher volume of GHG emissions given that the initial steel manufacture and transportation to site alone (not counting assembly and construction activities) results in over 164,000 tonnes of CO_2e.

Actual steel replacement would contribute a volume less than 164,000 tonnes as 100% steel replacement in unrealistic. Mechanical steel may be replaced, but the majority of steel used in the project as rebar within the damming structures would not be assumed to be replaced, lowering the percentage of steel replacement to a much lower figure, likely closer to 10%.

3.3.2 Assumptions and Inputs Assessment

MNP reviewed several material qualitative and quantitative inputs applied in the Keeyask LCA, specifically focusing on the following sections of the LCA report:

- Section 4.5 – Limitations of Study.
- Section 4.3 – Key Assumptions and Notable Facility Details.
- Section 6 – Sensitivity Analysis (qualitative descriptions provided).

[15] Pembina Institute. *Keeyask Generation Project – A Life Cycle Assessment of Greenhouse Gases and Select Criteria Air Contaminants.* 16 February 2012. Accessed in 2013.

- Section 8.7 – Appendix 7 – Sensitivity Analysis (quantitative information provided).

In a number of cases, material assumptions were identified to have inherent limitations regarding the availability and/or potential accuracy of supporting data. In these cases, as well as with all LCA components determined to be material, the Pembina Institute performed sensitivity analysis to gauge the potential impact of differing driving factors. MNP also conducted a materiality assessment of LCA component calculations and performed sensitivity testing, as summarized in the following sections. A high-level scan of immaterial assumptions and inputs included in the LCA report was also carried out. We do not note any unusual or disconcerting assumptions, inputs or sources applied by MH or Pembina Institute.

Under each of the following analyses, a brief overview of the reported sensitivity information from the LCA is provided, followed by our assessment of the reasonableness of the impacts to overall life cycle emissions estimates of the project.

In our assessment and quantification, MNP was constrained by the lack of transparency regarding the LCA report's assumed activity-based emissions factors, or how they were derived for both the base case and sensitivity analyses. All of the sensitivities below required MNP to estimate reasonable emissions factors in order to calculate impacts on total emissions. Where possible, we have recalculated the base case using the information throughout the LCA report. In other cases, we have utilized emissions factors based on credible and independent sources of publicly-available information. These sources include, but are not limited to, the International Energy Agency (IEA), the Environmental Protection Agency (EPA), the Clean Environment Commission (CEC), the Organization for Economic Cooperation and Development (OECD), IHS CERA, ICF International and the UNFCC.

Sensitivity #1: Transportation Distances

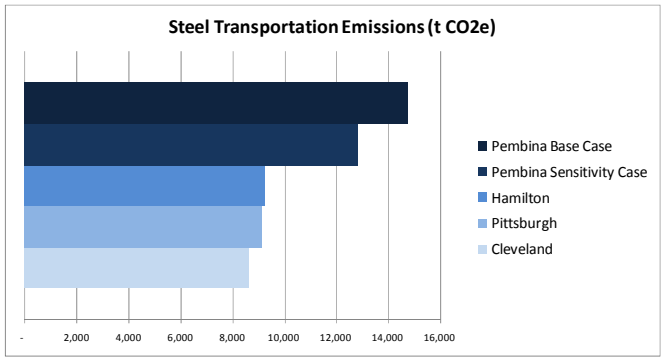
Transportation distances of materials and equipment required for construction and operation of the Keeyask and Conawapa projects can have material impact on the total life cycle emissions estimates. Specifically, the sources of steel materials and components may come from many different global suppliers. Differences in sourcing locations may result in significant differences in transportation-based emissions due to the high emissions intensity of transporting steel. At the time of this NFAT review, MH has not fully contracted suppliers for all materials and equipment. Therefore, an inherent limitation of the analysis is that all transportation related emissions can only be quantified based on estimated distances travelled. The transports of other materials are deemed to be more trivial and are therefore not tested with sensitivity analysis.

Limitation Identified:	Transportation Distance
LCA Approach	MH provided some insight on the expected distances of key transported materials. However, the final sources of many materials, such as steel, are unknown. In place of actual data, the assessment uses plausible and conservative transport distances based on previous MH experience. A list of all transport distances is available in Appendix 2 of the NFAT– Scoping.
MNP Impact Assessment & Conclusion	MNP reviewed the transportation distances assumptions. Based on our review, the distances assumed are conservative and estimate plausibly considerable distances based on MH's previous experience building hydroelectric generating stations. **Overall, we are satisfied that this limitation will *not* result in a *material understatement* of life cycle emissions for preferred plan projects.**

The LCA report analyzes the percentage reductions in life cycle emissions by life cycle phase if steel is transported from a plant in North America instead of China[16].

Assumption Category:	Transportation Distance
LCA Base Case Assumptions	Base case assumes all steel used in the manufacture of the generating station to come from China. Steel transportation route includes: • Ocean transport from Shanghai to Vancouver (9,797 km). • Rail transport from Vancouver to Winnipeg (2,202 km). Truck transport from Winnipeg to Keeyask (1,071 km).
LCA Sensitivity Assumptions	Some steel will come from North American sources. This sensitivity *reduces* life cycle emission intensity. 13% decrease in transportation emissions during the construction phase when shipping from China is removed.
MNP Sensitivity Assumptions	• All steel is assumed to be produced in North America in either Pittsburgh, Hamilton or Cleveland.[17] • Transportation distances assumed are 3,199 km for Pittsburgh, 3,231 km for Hamilton, and 3,013 km for Cleveland.[18] • Trucking emission factor used for all three = 71.6 tons of CO_2 per million ton-miles.[19] • Conversion factor of 0.621371[20] for kms to miles.
MNP Conclusion	Across the three cities assumed, we calculated an average 30% reduction in steel transportation emissions by sourcing all steel from North America vs. China. Our analysis indicates that Pembina's sensitivity case is at the low end of the range of potential transportation emissions reductions. Based on the results of both analyses, the range of possible transportation emissions reductions is approximately 13% to 30% if some or all of steel is sourced from North America. **Overall, a further reduction beyond the 13% in transportation emissions within the LCA sensitivity analysis could be realized if all steel is sourced from Pittsburgh, Hamilton, or Cleveland.** ***The figure below provides summary of the transportation emissions across the various cases. These findings indicate that the Base Case calculations, assuming steel transportation from China, is sufficiently conservative and provides the panel with a view of the highest level of emissions likely possible, as associated with this factor.***

Figure 3.1: Steel Transportation Emissions



[16] Pembina Institute. *Keeyask Generation Project – A Life Cycle Assessment of Greenhouse Gases and Select Criteria Air Contaminants. (*Appendix 7, Table 28). 16 February 2012. Accessed in 2013.
[17] Selected based on proximity to Winnipeg.
[18] Calculated based on Google Maps driving distances between the city and Winnipeg plus truck transport distance of 1,071 km from Winnipeg to Keeyask, consistent with the base case.
[19] Texas Transportation Institute. *Sustainability and Freight Transportation in North America*. Prepared for the Commission on Environmental Cooperation. March 2010. Accessed in 2013.
[20] Conversion factor according to Google.

Sensitivity #2: Steel Source and Emissions Factor

Offsite steel production is the most energy-intensive and therefore emission-intensive activity associated with the construction of the hydro generating stations. The steel components used are produced in many different countries including South East Asia, Eastern Europe, South America and North America.

Limitation Identified:	Steel Production Emissions Factor
LCA Approach	Pembina assumes all steel is produced in China so that transportation related emissions are as conservative as possible (particularly with transportation distances and described above). However steel production emission factors for China are known to be uncertain and non-transparent. Pembina has therefore opted to use a generic North American steel emissions factor based on typical steel production and forging including mining, transportation of raw materials, processing and steel production. Although this emission factor is likely representative of emissions from steel facilities it may be different than the actual emissions factor from the facilities used to produce the final components and is likely different than those facilities in China where the materials are assumed to derive from. For average global steel production, up to 67% of iron in steel comes from recycled sources. The LCA analysis assumes 100% virgin material. This assumption ensures the analysis is *conservative*.
MNP Impact Assessment & Conclusion	The following two conflicting assumptions used with respect to steel production create the potential for flawed estimation: 1. All steel is assumed to come from China. 2. Steel production emissions are based on a North American emission factor. The scale of the potential misstatement in life cycle emissions depends on the following factors: 1. Difference between China steel emissions factor and North American steel emissions factor (tested below). 2. Transportation distances (discussed in a separate section below). 3. Specific company contracted to provide steel for construction due to facility-specific nature of steel making emissions intensity (i.e. percentage of virgin vs. recycled iron used in production). In assuming 100% of iron in steel is virgin material, the potential impact of this key assumption can only be to *reduce overall life cycle emissions*. Since this is a *conservative* approach by MH in their assumptions, we have not quantified the potential reductions in overall life cycle emissions intensity as this only serves to *improve* the economics of the project. **The inconsistency results in the *potential* for life cycle emissions to be *materially erroneous*. However, overall, we are satisfied that this limitation will *not* result in a *material understatement* of total life cycle emissions.**

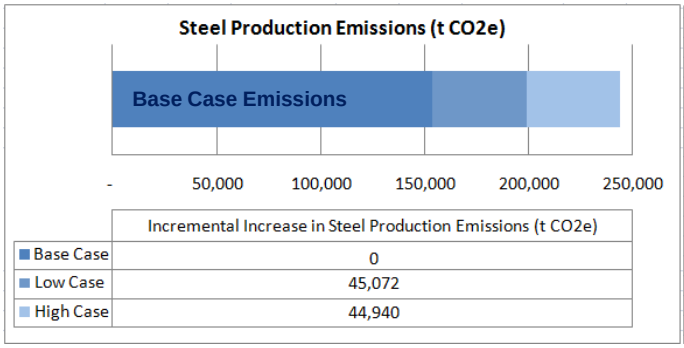
The LCA analyzes the percent increase in life cycle emissions assuming 30% more intensive steel production as a sensitivity case[21] to proxy typical Chinese producers. Other factors impact steel making emissions and some data limitations are addressed as below.

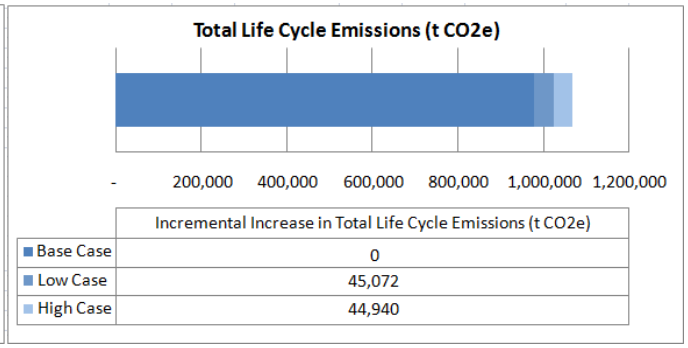
Assumption Category:	Steel Production Emissions Factor
LCA Base Case Assumptions	• Emission factor used is for North American steel production. • Total amount of steel required to build Keeyask = 64,200 tonnes. • Total emissions from steel production = 153,948 tonnes of CO_2e.
LCA Sensitivity Assumptions	Steel is assumed to come from China. Assumes 30% more intensive steel production as a sensitivity case to proxy typical Chinese producers. This sensitivity *increases* life cycle emission intensity.

[21] Pembina Institute. *Keeyask Generation Project – A Life Cycle Assessment of Greenhouse Gases and Select Criteria Air Contaminants. (*Appendix 7, Table 29). 16 February 2012. Accessed in 2013.

Assumption Category:	Steel Production Emissions Factor
MNP Sensitivity Assumptions	- Implied US emission factor of 2.40 t CO_2e/tonne of steel in base case. - Chinese emission factor between 3.1 and 3.8 t CO_2e/tonne of steel in sensitivity case. - Low case scenario assumed 3.1 t CO_2e/tonne of steel emission intensity. - High case scenario assumed a 3.8 t CO_2e/tonne of steel emission intensity. [22]
MNP Conclusion	The low case scenario resulted in a *29% increase in steel production emissions (consistent with the LCA report findings)*, with a *5% increase in total life cycle emissions* for the Keeyask project. Overall, it is a *reasonable sensitivity result,* but on the low end of the range. The high case scenario resulted in a *58% increase in steel production emissions*, with a *9% increase in total life cycle emissions* for Keeyask. **Overall, producing steel in China could increase total life cycle emissions between 5 and 9%, which is material to the LCA calculation. However, it is immaterial in comparison with other generation technologies included in development plans reliant on gas generation.** ***The figure below provides a visual summary of the low, base and high case life cycle emissions.***

Figure 3.2: Impact of Steel Sensitivity Cases on Steel Production & Total Life Cycle Emissions





These graphs demonstrate that steel production emissions could be at least 45 Kt, or as much as 90 Kt greater if emissions factors representative of Chinese steel production are applied. This could represent a material change in the total life cycle emissions of the Keeyask project. However, when compared to the emissions produced by alternative project types in gas plans, the amount becomes immaterial.

Sensitivity #3: Cement Emission Factor

Emissions from cement production are significant contributors to total life cycle emissions of Keeyask. However, individual cement production facilities experience significant variability in their emissions intensities. This is also the case from state to state and country to country cement production emissions intensities.

Limitation Identified:	Cement Supplier
LCA Approach	MH has not contracted cement suppliers at this design stage. The base case assumes that all cement is produced in Edmonton and transported to the construction sites by truck. MH has, in the past, sourced cement from Edmonton for the construction of hydro facilities.
MNP Impact Assessment &	There are 2 key considerations in this assumption, which are both dependent on the supplier contracted to provide cement:

[22] Global Carbon Capture and Storage Institute. *CCS for Iron and Steel Production*. 23 August 2013. Accessed in 2013. (http://www.globalccsinstitute.com/insights/authors/dennisvanpuyvelde/2013/08/23/ccs-iron-and-steel-production)

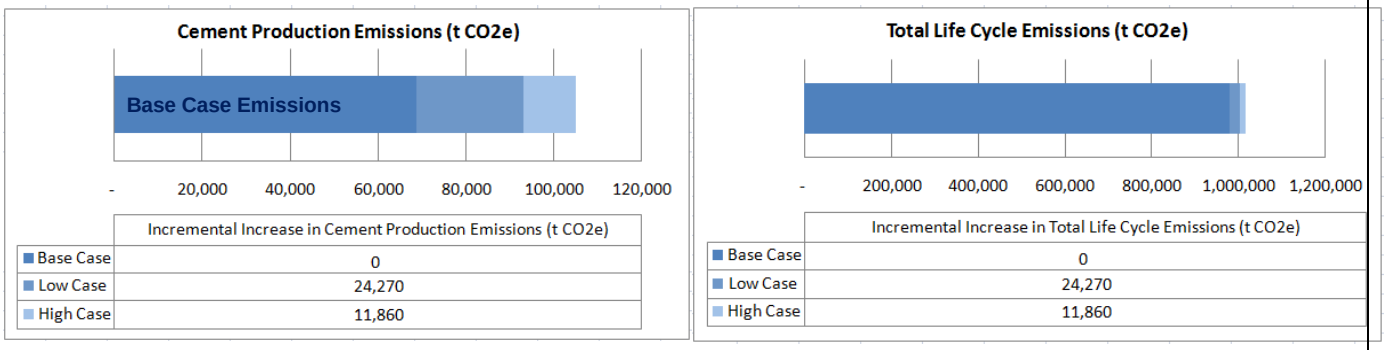
Limitation Identified:	Cement Supplier
Conclusion	1. Emission intensity of production. 2. Emission intensity of transportation. Other plausible locations for cement suppliers could include: 1. Southern Ontario. 2. Illinois. 3. Wisconsin. Production and transportation of cement represents 7.03% and 1.39% of total life cycle CO_2 emissions, respectively. Therefore, the risk of material error comes from production rather than transportation. In the LCA calculation, Pembina applied the assumption that cement used by MH is produced in a manner similar to the average Portland cement manufacture in the US. This assumption is plausible as the majority of large cement producers in Canada and the US manufacture Portland cement. **The selection of a cement supplier will impact the actual cement emissions factor as it varies by plant. See conclusion and results of the sensitivity assessment in the table below.**

The LCA report analyzes the percentage increase in life cycle emissions by life cycle phase if cement manufacturing is 30% more emission intensive than the base case[23] as a proxy for a more intensive supplier.

Assumption Category:	Cement Emissions Factor
LCA Base Case Assumptions	The base case analysis uses a generic concrete emissions factor for the average emissions intensity of producing cement in the United States. • Total amount of cement required to build Keeyask = 124,100 tonnes. • Total emissions from cement production = 68,805 tonnes of CO_2e.
LCA Sensitivity Assumptions	Individual cement production facilities may have higher or lower emissions. This sensitivity assumes emission intensity from cement production is 30% higher. This sensitivity *increases* life cycle emission intensity.
MNP Sensitivity Assumptions	• Base Case Implied US emission factor of 0.55 t CO_2/tonne of cement. • US Average Cement Emission Intensity = 0.95 t CO_2/tonne of cement.[24] • High Case Cement Emission Intensity (Kansas) = 1.4 t CO_2/tonne of cement.[25] • Low Case Cement Emission Intensity (Michigan) = 0.75 t CO_2/tonne of cement.[26]
MNP Conclusion	The low case scenario resulted in a *35% increase in cement production emissions*, with a *2% increase in total life cycle emissions* for the Keeyask project. Our *low* case emission factor is 0.20 t CO_2/tonne *higher* than the emission factor applied in the Pembina report. We feel the use of 0.55 t CO_2/tonne is questionable. The high case scenario resulted in a *58% increase in cement production emissions*, with a *11% increase in total life cycle emissions* for Keeyask. **Overall, the cement emission factor could increase total life cycle emissions between 2 and 9%, which is material to the LCA calculation. However, it is immaterial in comparison with with other generation technologies included in development plans reliant on gas generation.** ***The figure below provides a visual summary of the low, base and high case life cycle emissions.***

[23] Pembina Institute. *Keeyask Generation Project – A Life Cycle Assessment of Greenhouse Gases and Select Criteria Air Contaminants. (*Appendix 7, Table 31). 16 February 2012. Accessed in 2013.
[24] Loreti Group. *Greenhouse Gas Emissions Reductions from Blended Cement Production*. 19 December 2008. Accessed in 2013.
[25] Ibid.
[26] Ibid.

Figure 3.3: Impact of Cement Sensitivity Cases on Cement Production & Total Life Cycle Emissions



In our analysis, we found that emission intensity for cement manufacturing varies by more than 60% from state to state in the US based on 2004 EPA data[27]. In addition, the US national average emission intensity for cement manufacturing is 21% higher than the state with the lowest emission intensity. The US national average emission intensity for cement manufacturing is 47% lower than the state with the highest emission intensity.

Variability in cement manufacturing emission intensity is attributable to:

- Kiln technology used to produce the cement clinker (i.e. fuel efficiency).
- Carbon intensity of kiln fuel (i.e. use of coal to fire kiln).[28]

Ultimately, we caution the Review Panel that dependent on the cement manufacturer selected for the construction of Keeyask, the emissions from cement manufacturing will likely be *higher* than reported by Pembina in this high case sensitivity.

Sensitivity #4: Fuel Source

The construction of the generating station will require significant amounts of diesel fuel. Diesel is refined from crude oil which can come from many sources. However, crude oil derived from oil sands is replacing conventional crude oil sources in the analysis. The LCA report analyzes the percentage increase in life cycle emissions by life cycle phase if 100% of crude oil is sourced from heavy oil sources[29].

Assumption Category:	Fuel Source
LCA Base Case Assumptions	The base case uses the average volume of crude oils produced in Alberta to estimate the emissions associated with overall crude production for the diesel used in the project. • Assumes 40% of the crude comes from heavy oil and 60% from light oil sources. • Total amount of diesel fuel required to build Keeyask = 47,800 m^3.
LCA Sensitivity Assumptions	Assumes all crude used to produce diesel comes from heavy crude oil sources. This sensitivity *increases* life cycle emission intensity. Inputs summarized here are derived from Pembina's LCA report. • Emissions intensity to produce light crude = 300,024 g CO_2e/m^3. • Emissions intensity to produce heavy crude = 836,274 g CO_2e/m^3. • Emissions intensity to upgrade bitumen = 458,232 g CO_2e/m^3. • Emissions intensity to refine crude = 176,438 g CO_2e/m^3. • Emission allocation factor of 0.36:1 for diesel: crude based on volume (1 barrel).

[27] Ibid.
[28] Ibid.
[29] Pembina Institute. *Keeyask Generation Project – A Life Cycle Assessment of Greenhouse Gases and Select Criteria Air Contaminants. (*Appendix 7, Table 30). 16 February 2012. Accessed in 2013.

Assumption Category:	Fuel Source
MNP Sensitivity Assumptions	General Assumptions: • 10 gallons of diesel fuel from a barrel (42 gallons) of crude oil[30], resulting in an emissions allocation factor of 0.24 based on volume. • Total amount of crude oil required to produce 47,800 m^3 of diesel fuel = 200,760 m^3. Emission Intensities: • Produce light crude[31] = 180 t CO_2e/1000 m^3. • Produce heavy crude[32] = 675.8 t CO_2e/1000 m^3. • Upgrade bitumen[33] = 8.3 g CO_2e/MJ. • Refine crude[34] = 8.6 g CO_2e/MJ.
MNP Conclusion	We calculated a 63% increase in total emissions from diesel fuel production. Overall, this translates to a 7% increase in life cycle emissions during the construction phase attributed to building materials manufacturing. The Pembina report calculated an 86% increase in total emissions from diesel fuel production. Overall, this translates to a 10% increase in life cycle emissions during the construction phase attributed to building materials manufacturing. **Overall, the approach taken by MH in the sensitivity case calculation is *conservative*, by overestimating the likely emissions level. Therefore, MH calculation is *not* reasonably likely to result in a *material understatement* of life cycle emissions.**

3.3.3 Untested Data Limitations

As part of any life cycle assessment of GHG emissions, inherent data limitations and uncertainties exist. For development projects, limitations are most often derived from unknown or undecided upon elements of the plan or capital budget. For example, for the Keeyask and Conawapa projects, many of the materials and equipment suppliers have not yet been contracted. As a result, only estimates of sources and related operational activity can be used in the LCA. Other data limitations include the amount and nature of component replacements over time and the effects of temperature, humidity and other environmental conditions, as well as the expected design and performance of comparison technologies. Comparison to theoretic facilities allows for only reasonable estimates and not for inputs based on historical performance. These limitations present some intrinsic uncertainty in final estimates.

For most limitations of this nature, the LCA did not provide scenario or sensitivity testing. The materiality of the potential differences is likely low and we believe this approach to be reasonable. MNP did however provide some testing comparison technology emissions intensities as noted below as a key factor in determining each plans' overall emissions displacement potential.

[30] US Energy Information Administration (EIA). *Frequently Asked Questions.* 2013. Accessed in 2013. (http://www.eia.gov/tools/faqs/faq.cfm?id=327&t=9)
[31] Canadian Association of Petroleum Producers. *A National Inventory of Greenhouse Gas (GHG), Criteria Air Contaminant (CAC) and Hydrogen Sulphide (H2S) Emissions by the Upstream Oil and Gas Industry, Volume 1, Overview of the GHG Emissions Inventory."* 246: CAPP, 2005. Accessed in 2013.
[32] Ibid.
[33] Jacobs Consultancy. *EU Pathway Study: Life Cycle Assessment of Crude Oils in a European Context.* 2012. Accessed in 2013.
[34] ICF International. *Independent Assessment of the European Commission's Fuel Quality Directive's "Conventional" Default Value.* 9 October 2013. Accessed in 2013.

Limitation Identified:	Comparison Data			
LCA Approach	The life cycle data for the comparison technologies is based on a literature survey. The data are therefore not specific to Manitoba, or in some cases North America. The difference between the maximum and minimum values is in some cases quite significant. For example, published life cycle SO_2 emissions for a coal fired power plant ranged from 114 kg/GWh to 12,271 kg/GWh. The actual emission intensities will depend on a number of different factors such as the type of coal, pollution control technologies, equipment efficiencies and maintenance programs.			
Quantitative Sensitivity Test Performed (Y/N)?	Pembina Institute:	N	MNP:	Y
Pembina Impact Assessment	The number of literature sources reviewed provides a reasonable analysis. It is likely that facilities constructed in Manitoba or in its export markets will fit within the minimum or maximum values.			
MNP Impact Assessment & Conclusion	We performed further extensive independent research to assess the range values of emission intensities of some comparison technologies, based on both theoretic performance and actual in-field performance. **Our results show that the LCA report findings are generally reasonable.**			

3.3.4 Comparison Technologies

To evaluate preferred plan technology options against alternatives, six comparison technologies were examined as part of the Keeyask LCA report. The comparison technologies' life cycle emissions, as reported by Pembina Institute are based on the results of a literature review of published life cycle values, assuming a 100 year life cycle, which is consistent with Keeyask's life cycle. There were a minimum of six values for each technology and the median, average, maximum and minimum values were reported in *Appendix 5* Keeyask LCA report.

Overview of Comparison Technologies[35]

Technology	Overview and Description
Pulverized Coal Combustion (PCC)	As generation facilities, coal plants have achievable energy efficiencies are between 38-45%. These plants generate a reliable supply, which is typically used to provide base load power to the grid. Average capacity factor ranges from 70-90%.
Coal with Carbon Capture and Storage (CCS)	During the CCS process, CO_2 is separated from other exhaust gases by using a commercial capture technology such as chemical or physical absorption. This captured CO_2 is compressed and transported in pipelines at high pressure to a storage location. Capturing and compressing CO_2 requires a large amount of energy and increases the fuel requirements of a coal-fired plant by 25–40%, according to the IPCC.
Natural Gas Combined Cycle (NGCC)	Combusts natural gas in a gas turbine to produce electricity. The turbine produces a significant amount of hot exhaust gas, which, in a combined cycle power plant is used to generate steam. This steam is then used to produce additional electricity in a steam turbine. Typically used for base load and peak demands. Capacity factors for a natural gas fired power plant are typically between 50-70%.
Single Cycle Natural Gas	Combusts natural gas in a gas turbine to produce electricity. Excess heat is wasted and not captured for further electricity generation. Sometimes installed as emergency or peaking capacity to balance production and loads on the grid. The efficiency of a simple cycle natural gas plant is 35–40%.

[35] Pembina Institute. *Keeyask Generation Project – A Life Cycle Assessment of Greenhouse Gases and Select Criteria Air Contaminants. (*Chapter 3). 16 February 2012. Accessed in 2013.

Technology	Overview and Description
Wind (Larger than 100 MW)	Wind farms consist of multiple wind turbines that convert wind energy into electricity from blades turning a generator. Turbines are built to adapt to changing wind conditions. Since wind speeds are not constant, typical wind farms exhibit capacity factors of 20–40%. Wind power is intermittent therefore one critique is that wind cannot supply reliable base load electricity to the grid.
Nuclear	Fission heat is used to generate steam which is subsequently used to generate electricity in a steam turbine. Nuclear power generation is a consistent source of electricity for base load power, but there is almost no flexibility to meet peak demand.

3.3.5 Assessment

The median values found in the literature review were used to compare the life cycle emissions of other technologies to Keeyask. The table below contains a summary of the median values reported. Based on our research, we have identified the 2012 Intergovernmental Panel on Climate Change (IPCC) report as a reasonable and robust source of information for this assessment. We have summarized the values from the IPCC report in the table below as well. This table identifies areas where the comparison technologies life cycle emissions in the Pembina report may be subject to uncertainty or material differences.

Life Cycle Emission Intensity (t CO_2e / GWh)[36]

Technology	Keeyask LCA Median	IPCC Report Minimum	IPCC Report Median	IPCC Report Maximum	MNP Assessment
Pulverized Coal Combustion (PCC)	**975**	675	**1001**	1689	IPCC median values reported for coal are aligned with the Pembina Report (IPCC +3%).
Coal with Carbon Capture and Storage (CCS)	**183**	98	**N/A**	396	Pembina reported values are within the range of minimum and maximum values and the two reports are aligned overall.
Natural Gas Combined/ Single Cycle	**509/764**	290	**469**	930	This includes both single cycle and combined cycle natural gas plants. Thus, the difference between minimum and maximum values is substantial. Overall, both single and combined cycle natural gas reported values are aligned and within the ranges outlined by IPCC.
Wind (Larger than 100 MW)	**13**	2	**12**	81	IPCC and Pembina values are strongly aligned for wind technologies. Pembina's median value is only 1 tonne higher than the IPCC's median value.
Nuclear	**15**	1	**16**	220	IPCC and Pembina values are strongly aligned for nuclear technologies. Pembina's median value is only 1 tonne lower than the IPCC's median value.

For each technology, Pembina reviewed between 6 and 11 literature studies and used between 5 and 10 life cycle emission intensity values from these studies. In contrast, IPCC reviewed between 231 and 273 literature studies for each technology and used between 90 and 181 life cycle emission intensity values from these studies. The IPCC report is significantly more comprehensive than the Pembina report given

[36] Special Report of Intergovernmental Panel on Climate Change (IPCC). *Renewable Energy Sources and Climate Change Mitigation*. 2012. Accessed in 2013.

its global scope. This explains the variations in the minimum, maximum and median values between the two reports.

In performing our independent research, we have been able to assess the overall reasonableness of comparison technology values reported in the Keeyask LCA. We are comfortable that the median values reported and used to assess the life cycle emissions of Keeyask relative to other comparison technologies are reasonable.

3.3.6 Other Air Pollutants

As a related issue, regional air emissions will also be impacted by development choices in Manitoba. Our examination of GHG emissions finds that the preferred plan results in significantly fewer total life cycle emissions than alternative plans with high levels of gas generation and specifically, the all gas plan.

Although some NO_x and SO_2 emissions would be associated with the manufacture, delivery and construction of hydro project components, electricity generation at Keeyask and Conawapa would result in no significant air pollutant release. Conversely, natural gas generation projects result in direct NO_x emissions and some life cycle SO_2 emissions.

As determined in the LCA, a project like Keeyask is estimated to result in about 4 Kt of NO_x emissions and less than 1 Kt of SO_2 over its lifetime. We are confident that the data inputs on which these estimates rely are reasonable and conservative for the analytic purposes of this NFAT. Combined-cycle facilities, like those expected to be used in alternative plans, could lead to the following levels of air pollutant emissions. It is clear in direct comparison, that the preferred plan hydro projects are more attractive from an air pollutant production perspective.

Air Pollutant	Average EI[37] (Kg/GWh)	Average Annual Generation Expected (GWh)[38]	Annual Emissions (tonnes)	Estimated Total Emissions for All Gas Plan Gas CC Projects (tonnes over 68 years)
NO_x	970	613	594	40,392
SO_2	360	613	220	14,960

Given the expected emissions intensity of MH exports, there will also be incremental regional benefit to the preferred plan versus the all gas plan. Exports will displace marginal generation in MISO, known to be a mix of coal and gas generation, both of which will have substantially high NO_x and SO_2 emissions profiles. Therefore, preferred plan exports will also lower regional air pollution by direct displacement.

3.4 GHG AND CARBON PRICE MODELLING

As an export product, MH's generation enters a dynamic market in MISO, influenced by investment decisions in new generation, natural gas prices and environmental charges (i.e. carbon prices) over the long-term. As a low or non-emitting source of electricity, hydro generation from the preferred development plan could hold incremental value in its environmental attributes, as discussed in the Policy Review (section 3.2) above.

In order to assess the economic impacts of climate change, MNP has modelled the GHG emissions and carbon prices to 2090 (end of the project life). The outputs of these two models are interrelated inputs to

[37] Average of LCA Report market survey of facility EIs
[38] Average of annual new combined cycle output for Plan 1 (All Gas)

the financial impact assessment. The objective of modelling is to provide the PUB with the potential impact of changes in underlying macro-environmental factors within the preferred development plan on project economics.

3.4.1 GHG Modelling (NFAT filing Appendix 9.1)

According to MH, the *Cumulative GHG Operating Emissions* are the summation of the direct domestic GHG emissions from existing and proposed thermal generating stations associated with each of the development plans listed over the lifetime of the plan. For the preferred development plan, the value of 7.5 Mt CO_2e includes the cumulative direct GHG emissions from existing gas and coal-fired facilities within MH's system.

The *Cumulative GHG Operating Emissions* values are distinct from the Pembina LCAs for the Keeyask and Conawapa projects. The LCA for Keeyask also includes indirect GHG components beyond the borders of Manitoba, as well as land-use change GHG implications. These are *not* considered in the *Cumulative GHG Operating Emissions* calculation in Appendix 9.1 of the NFAT.

3.4.2 Assumptions in GHG Modelling

Assumption	MH	MNP
New Build Plant Emissions Intensities	Simple Cycle = 506 t CO_2e. Combined Cycle = 333 t CO_2e.	Simple Cycle = 557 t CO_2e.[39] Combined Cycle = 413 t CO_2e.[39]
Export Displacement Emission Factor	According to the NFAT filing, this assumes coal marginal generation of 93% for the entire duration of the projects. Assumes an export GHG displacement factor of 750 tonnes CO_2e/GWh reflecting a mixture of fossil-fuel resources and a variety of technologies and efficiencies.	Assumes coal marginal generation of 85% in 2014 declining to 50% in 2050 due to MISO energy mix shift away from coal and wind energy expansion. Assumes an export GHG displacement factor of 890 tonnes CO_2e/GWh in 2014 declining over time to 649 tonnes CO_2e/GWh in 2050.

3.4.3 MISO Capacity Mix

Several driving factors are expected to change the generation mix in MISO over time. As noted in our policy review, several US federal and other regional environmental policies are growing in importance for electricity generators and will increase the level of coal retirement as regulations bind and compound. At the same time, state level renewable portfolio standards drive wind and solar investment to meet utilities' efforts to achieve renewable generation targets. MISO is expected, by all of MH's market forecasting consultants, to be a significant region for wind development with strong resources in several areas.

By 2020, as coal plants grapple with compliance of CO_2 policy, mercury policy, new water use regulations and more stringent air pollutant regulations, many will choose to retire. As a result, the consultants and others expect between 10 and 20 GW of coal to retire by 2025, representing a likely reduction in coal generation of at least 17%. As a result, energy requirements will be met with a combination of gas combined cycle and wind investments over the period 2015 to 2037. Net outcomes will dampen the amount of coal setting marginal prices in the MISO market and move more gas to the marginal fuel. Substantial increases in wind generation have the opposite effect and push the supply stack upwards moving lower merit coal plants to the margin. Overall, we expect some increases in gas generation on the margin and therefore reductions in average marginal emissions intensity given that MISO currently reports coal on the margin more than 90% of the time[40]. By 2020, we expect a 20% decline in marginal coal generation, growing to a 35% decline in the later years of study.

MH's conservative assumption of a 750 tonne/GWh displacement factor is reasonable for analytic purposes and controls the potential net upside emissions displacement. Our testing shows that even conservative sensitivities accounting for the changing supply mix toward natural gas and wind all result in annual average marginal intensities that remain higher than 750 tonne/GWh and therefore serve to the benefit of preferred plan economics.

3.4.4 Carbon Price Modelling

MH engaged six independent consultants to prepare carbon pricing forecasts as part of their *2013 Electricity Export Forecasts*. Each of the independent consultants prepared their carbon price forecasts based on their respective policy outlooks as discussed in the Policy Review (section 3.2). Each consultant prepared a low, reference (base) and high case carbon price forecast. MNP has developed an alternative

[39] New build plant emissions intensities are based on data from 34 facilities' actual emissions performance, augmented by technical specifications from EIA, NETL (DOE), EPRI and California Energy Commission data.
[40] Potomac Economics. *2011 State of the Market Report for the MISO Electricity Markets.* June 2012. Accessed in 2013.

set of carbon pricing cases to compare against MH's analysis from the NFAT filing, based on our expectations of policy stringency and timing.

Each carbon price trajectory is considered an indicator of the carbon price premium embedded in the respective electricity price forecasts and was not determined as a discrete financial instrument valuing avoided emissions. The table below outlines the assumptions applied to determine the carbon price forecasts of MH and MNP.

Assumptions

Assumption Category	MH	MNP
Average Annual Real Growth Rate	MH does not apply an average annual real growth rate in their carbon price forecast. Growth is based on consultants projection.	• 5% based on EIA reference cases for the period from 2014/15 to 2041/42 (inflation of 2% thereafter).
Low Case Assumptions	MH determined the consensus forecast cases by applying the same percentage weightings as were applied to the electricity price forecast. In both situations, an equal percentage weighting is given to each of the six independent consulting firms. This is the methodology applied for the low, base and high case carbon price forecasts.	• Assumes no federal cap-and-trade legislation comes into effect until 2030. • Assumes a $10 floor price based on our judgement considering a number of low case carbon price forecasts, including the consultants and publicly available trends and escalating using the EIA 5% growth factor. Our forecast is an aggregate of several sources.
Base Case Assumptions		• Assumes a federal cap-and-trade legislation comes into effect in 2021. • Assumes a $13.14 floor price based on our judgement considering a number of reference case carbon price forecasts, including the consultants and publicly available trends and escalating using the EIA 5% growth factor. Our forecast is an aggregate of several sources.
High Case Assumptions		• Assumes a federal cap-and-trade legislation comes into effect in 2020. • Assumes a $15.80 floor price based on our judgement considering a number of reference case carbon price forecasts, including the consultants and publicly available trends and escalating using the EIA 5% growth factor. Our forecast is an aggregate of several sources.

The data table below is a condensed version of MNP and MH's carbon price forecasts. The carbon prices for 2034/35 are highlighted as this represents the end of MH's actual forecast. The carbon prices for 2041/42 are highlighted as this represents the completion of the new build generation under the preferred development plan.

Figure 3.5: Range of Carbon Price Outlooks

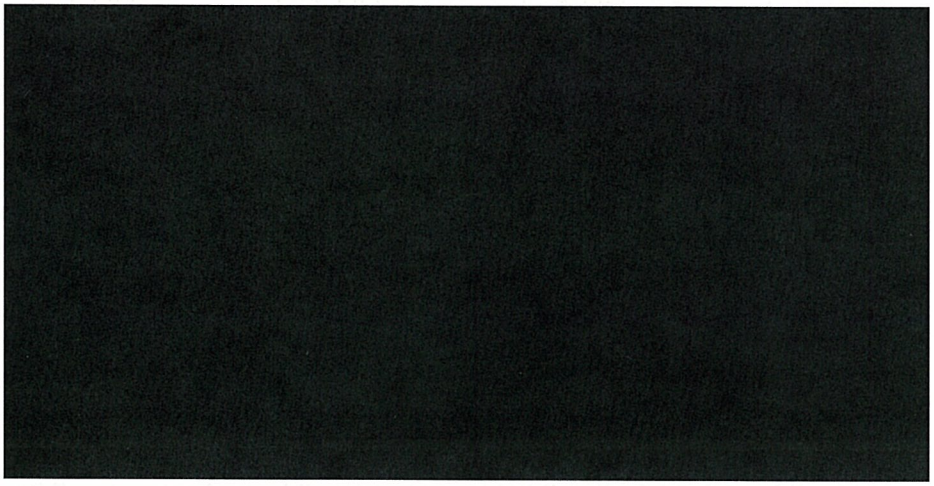
MH Forecast				MNP Forecast			
CO_2 Price (2013 Real US$/Ton Midwest Region)				*CO_2 Price (2013 Real US$/Ton Midwest Region)*			
Fiscal Year	MH Low Case	MH Base Case	MH High Case	Fiscal Year	MNP Low Case	MNP Base Case	MNP High Case
[redacted]				2014/15	$ -	$ -	$ -
2019/20				2019/20	$ -	$ -	$ -
2024/25				2024/25	$ -	$ 15.21	$ 19.20
2029/30				2029/30	$ -	$ 19.41	$ 24.51
2034/35				**2034/35**	**$ 12.16**	**$ 24.78**	**$ 31.28**
2041/42				**2041/42**	**$ 17.10**	**$ 34.86**	**$ 44.02**
2049/50				2049/50	$ 21.24	$ 43.29	$ 54.65
2059/60				2059/60	$ 25.89	$ 52.77	$ 66.62
2069/70				2069/70	$ 31.55	$ 64.32	$ 81.21
2079/80				2079/80	$ 38.47	$ 78.41	$ 99.00
2089/90				2089/90	$ 46.89	$ 95.58	$ 120.68
2090/91				2090/91	$ 47.83	$ 97.49	$ 123.09

The timeframe for MH's carbon price forecast is 2014/15 to 2034/35. In order to assess the financial impacts of GHG modelling on the NPV of the preferred development plan, the carbon price forecasts must extend to 2090/91 in line with MH's adjusted planning horizon.

For the period from 2034/35 to 2041/42, we have applied the existing growth rate trajectory to MH's forecast.
For the period from 2041/42 to 2090/91, we have assumed a 2% average annual inflation rate for both MH and MNP.

In order to visualize the differences in carbon price trajectories between MH's consensus carbon price forecast and MNP's carbon price forecast, we present the carbon price forecasts graphically below.

Figure 3.6: Comparison of MH and MNP Carbon Price Forecasts



3.5 Financial Impacts of Sensitivities

Our analysis focuses on the potential and direct incremental revenue associated with the environmental attributes of MH derived exports into the MISO market. This analysis provides a representation of the direct NPV benefits to MH of selling electricity into MISO under a variety of reasonable carbon pricing scenarios.

3.5.1 Assumptions in Financial Impacts

There are 2 key assumptions underlying the financial impacts calculation:

1. Net Emissions Displacement.
2. Carbon Price Forecast.

In the table below, we outline the permutations of scenarios applied to test financial impacts of macro-environmental factor sensitivities. Refer to the ‘Assumptions in GHG Modelling’ (section 3.4.2) and ‘Assumptions in Carbon Price Modelling’ (section 3.4.4) tables above for detailed underlying assumptions applied.

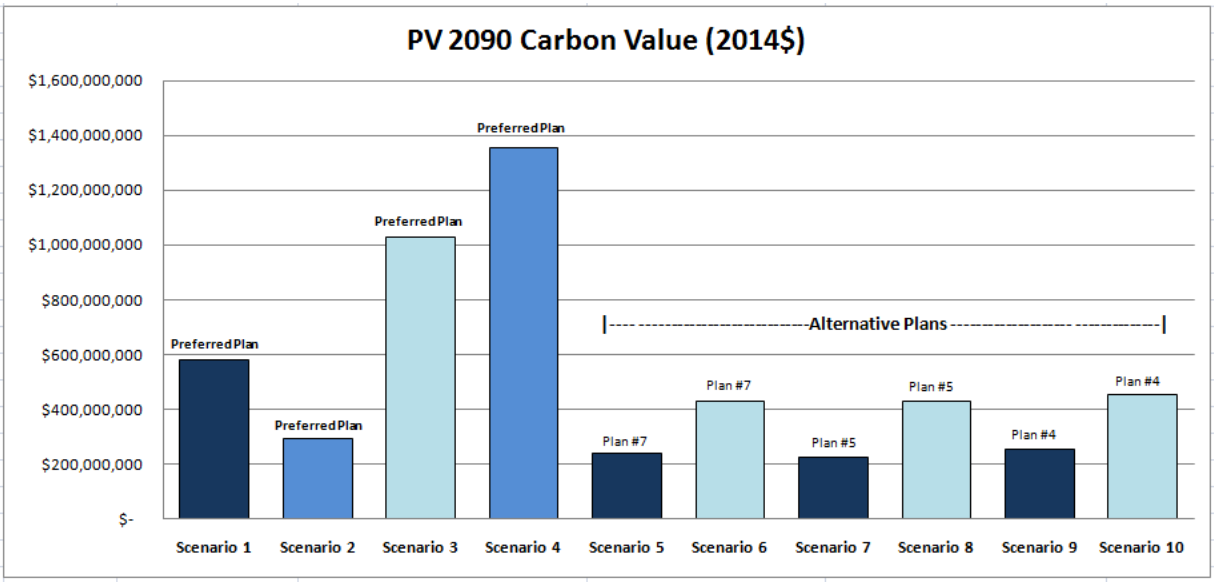
Scenario	Development Plan	Net Emissions Displacement	Carbon Price Forecast
Scenario 1	Preferred Plan #14 K19/C25/750MW (WPS Sale & Inv)	MH Market Displacement Assumptions	MH Base Case
Scenario 2		MNP Market Displacement Assumptions	MNP Low Case
Scenario 3		MNP Market Displacement Assumptions	MNP Base Case
Scenario 4		MNP Market Displacement Assumptions	MNP High Case
Scenario 5	Alternative Plan #7 SCGT/C26	MH Market Displacement Assumptions	MH Base Case
Scenario 6		MNP Market Displacement Assumptions	MNP Base Case
Scenario 7	Alternative Plan #5 K19/Gas25/750MW (WPS Sale & Inv)	MH Market Displacement Assumptions	MH Base Case
Scenario 8		MNP Market Displacement Assumptions	MNP Base Case
Scenario 9	Alternative Plan #4 K19/Gas24/250MW	MH Market Displacement Assumptions	MH Base Case
Scenario 10		MNP Market Displacement Assumptions	MNP Base Case

In order to determine the economic impact of the carbon value to the NPV of the preferred and selected alternative plans, we were required to make some assumptions in the present value calculation as follows:

- ***Discount Rate*** – 7.58% - This is based on MH's cost of capital discount rate of 5.05% plus a risk premium of 2.53% to reflect the inherent uncertainty of the outcomes of carbon policy in the long-term.
- ***Total Study Life*** – 2014 to 2090 (consistent with MH).
- ***Annual Net Emissions Displacement Values*** – Displacements have been included in the calculation of carbon value netting out internally derived emissions associated with MH exports.

The figure below outlines the PV in 2014$ of the carbon value associated with exports into the MISO market.

Figure 3.7: Range of Carbon Values



We offer the following observations with respect to the comparative carbon values under the scenarios[41]:

MH Base Case (Scenarios 1, 5, 7, 9):

- Preferred plan carbon value represents approximately $582M (or 9%) of the total PV of revenues for the preferred plan, which is $6,348M according to NFAT filing appendix 9.3 (pg. 496).
- Preferred plan carbon value is approximately $343M *higher* than the average carbon value of the alternative plans, which are in the range of $225M to $251M.

MNP Base Case (Scenarios 3, 6, 8, 10):

- Preferred plan carbon value is approximately $446M *higher* than the MH base case, which results in an *increase* in the total PV of revenues for the preferred plan to $6,794M.
- Preferred plan carbon value is approximately $591M *higher* than the average carbon value of the three alternative plans, which are in the range of $427M to $454M.

MNP Low and High Cases (Scenarios 2, 4):

- Under the MNP low case, the preferred plan carbon value is approximately $287M *lower* than the MH base case, which results in a *decrease* in the total PV of revenues of the preferred plan to $6,061M.
- Under the MNP high case, the preferred plan carbon value is approximately $772M *higher* than the MH base case, which results in an *increase* in the total PV of revenues of the preferred plan to $7,120M.

[41] All of our observations are focused solely on the changes in assumptions outlined above. Revised incremental revenue PVs assume all else is equal.

3.6 CLIMATE CHANGE SUMMARY OBSERVATIONS

Based on the analysis performed, the following observations are relevant for the Review Panel:

1. The preferred plan more *strongly aligns* to the current and expected international, Canadian, US and regional/local climate change policies and strategies.
2. The Keeyask LCA includes *inherent risks and limitations* that are found to be *immaterial* to the total lifecycle GHG emissions and relative to the emissions of alternative comparison generation technologies.
3. In comparison with alternative plans and the associated project types, the preferred plan has relatively low expected life cycle emissions.
4. The preferred plan has comparatively low cumulative operating GHG emissions versus all other plans and the *highest* cumulative regional GHG displacement potential relative to the alternative plans that do not include Keeyask and Conawapa hydro developments.
5. The implied preferred plan carbon value (in 2014$) in the MH base case is $582M. The present value of carbon revenues *could increase* to $1,028M under other reasonable policy outcomes. This represents a *potential upside in the total revenues* for the preferred plan.

4. WATER REGIME

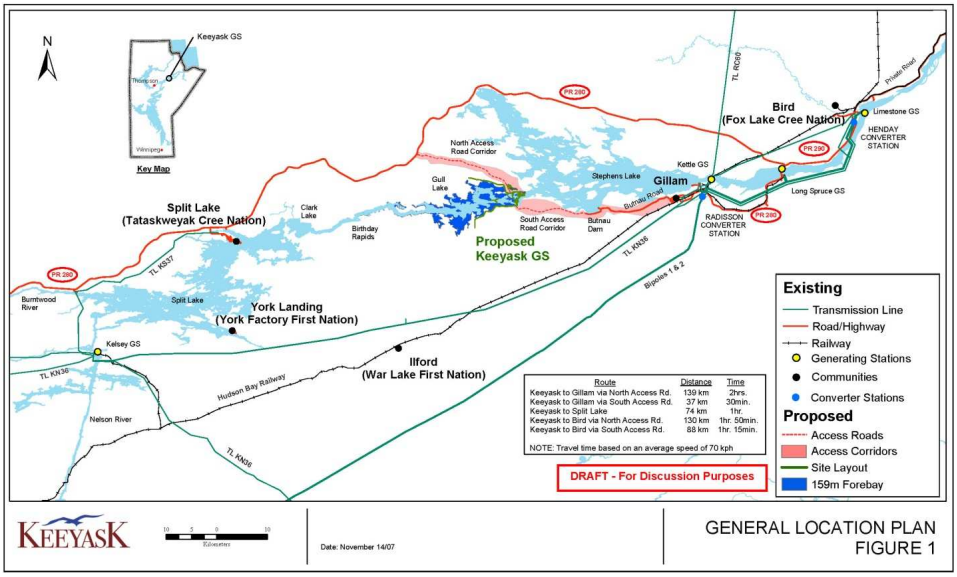
The EIS for the Keeyask project identifies and assesses issues of flooding, erosion and sedimentation related to the construction and operation of the Keeyask project along 205 kilometres of the existing Nelson River shoreline. The project will be built in the Split Lake Resource Management Area, which is traditionally used by all of the First Nations project partners. The ecosystem and its water regime have already been altered considerably by previous hydroelectric developments and are therefore vulnerable to further change. According to the NFAT filing, the water regime changes anticipated, as a result of the preferred plan, include flooding and increased water levels downstream of Lake Winnipeg on the Upper Nelson River and more specifically, changes to the surface water regime in the vicinity of the project itself, both upstream and downstream.

Specific elements of the flows within the Keeyask reach, including Birthday Rapids, Gull Lake and Gull Rapids, are most similar to the state of the water regime before hydroelectric development began in the 1950s[42]. These elements and the expected changes to them should be considered carefully before undergoing further alteration. This section primarily addresses the Keeyask project because a detailed environmental assessment for Conawapa is not available at this time. Given their interrelated and similar nature, we believe Keeyask is likely a reasonable gauge of expectations at the Conawapa site. However, specific changes to the water near Conawapa will have unique aspects to be considered later.

4.1 KEEYASK

The reservoir will stretch from the generating station approximately 93 km^2 in area and it will extend 42 km upstream to the outlet of Clark Lake. The reservoir will consist of approximately 48 km^2 of existing waterways, 45 km^2 of *newly submerged lands and 264 km of shoreline*. Earth dykes will be situated along both sides of the river for approximately 11 km and three earthfill dams (the north dam, central dam and south dam) will be constructed across Gull Rapids, creating the reservoir upstream of the powerhouse.

The figure below[43] provides a visual representation of the proposed Keeyask generating station and its surroundings.

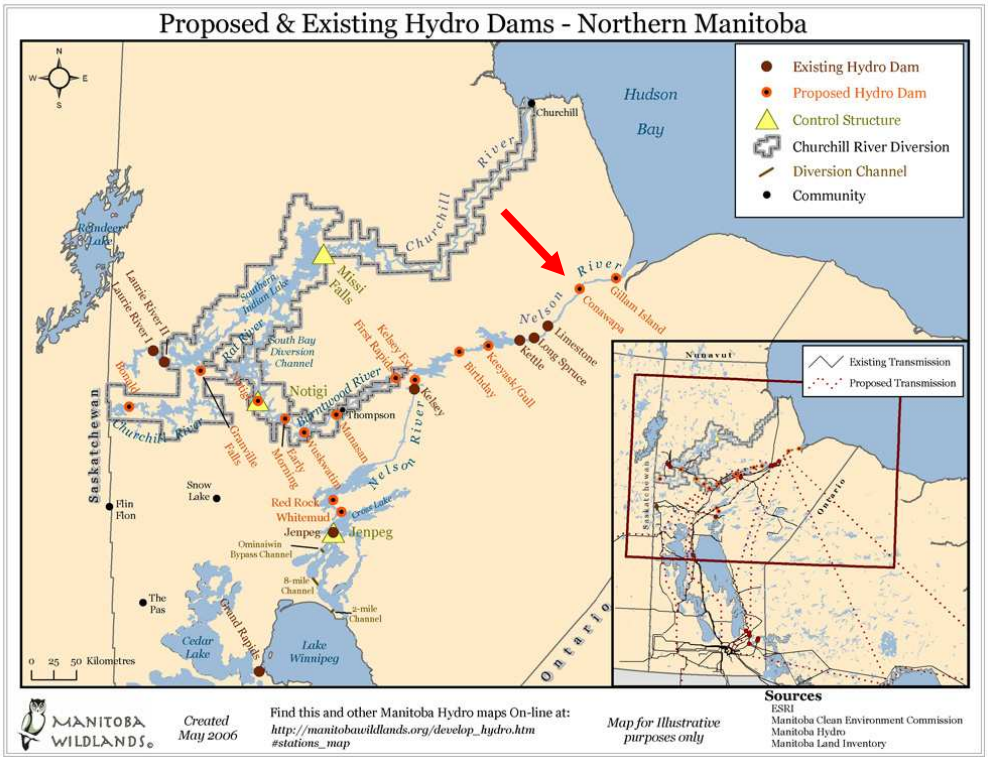


[42] Cree Nation Partners. Keeyask Environmental Evaluation: A Report on the Environmental Effects of the Proposed Keeyask Project on Tataskweyak Cree Nation and War Lake First Nation. Present State Of Major Waterways in the SLRMA. http://keeyask.com/wp/wp-content/uploads/2012/07/CNP-Keeyask-Environmental-Evaluation-Web-Jan2012.pdf . January 2012.

[43] Manitoba Wildlands. *Keeyask General Location.* 2013. (http://manitobawildlands.org/maps/Keeyask-General-Location_lg.jpg).

4.2 CONAWAPA

The reservoir will be 37.4 km^2 of which 32.3 km^2 represents higher water on existing waterways. Preliminary information indicates that the impacts of the Conawapa project are similar in nature to Keeyask, but will flood *significantly less new land* at only 5.1 km^2. Although a full EIS is not yet available for Conawapa, we will assess the information provided in the NFAT filing to determine potential impacts to water regime. The figure below shows the approximate location of the proposed generating station[44].



4.3 IMPACTS

The projects will impact the water regime (water flow over time), the level of consumption and quality. The following impacts are predicted to result from Keeyask:

- Complete loss of Gull Rapids.
- Slower, deeper water through Gull Lake, Birthday Rapids, and as far upstream as the outlet of Clark Lake.
- Changes in erosion patterns and water quality downstream of Keeyask, but not upstream in Split Lake.
- Flooding of several Caribou calving islands in Gull Lake.
- No changes to open water levels in Split Lake.
- No changes to water quality near York Landing.

[44] Manitoba Wildlands. *Proposed and Existing Hydro Dams.* 2013. (http://manitobawildlands.org/maps/201305_ProposedExistingHydroDams_lg.png)

- No changes to winter ice travel and safety.[45]

4.3.1 Keeyask

In the table below, we offer an analysis outlining the consequences and significance of the expected water regime changes of Keeyask. The following definitions apply:

- **Low** Significance – magnitude of the impact is small, has a low risk of occurrence and is less critical for the PUB to consider.
- **Medium** Significance – a mix of high impact and low risk, or low impact with high risk. In these cases there is moderate overall significance, but important for the Panel's consideration.
- **High** Significance – magnitude of the impact is large and the risk of occurrence is determined to be high, with a high level of priority for the Panel's consideration.

Impact	Project Phase(s)	Description	Consequence	Significance
Clearing of land	Construction	The land area of future reservoir inundation that has trees and woody vegetation will be cleared to limit the negative effects of anaerobic decomposition of organic material and the amount of debris hazard in the reach.	Loss of aquatic habitat, alteration of habitat, changes to edge habitat and interaction of fauna with river front.	**Medium**
Altered flows in the Lower Nelson River	Construction and Operation	This hydro development will replace large rapids with dams and change sections of the river into reservoirs (slower, deeper flows).	Loss of large rapids will affect the success of several life stages of lake sturgeon. A portion of the existing south channel of Gull Rapids downstream of the dam will be dewatered. Flow velocities at Birthday Rapids will be reduced. Changes in distribution of flow are expected to occur 3 km downstream of the project.	**High**
Flooding	Construction	The project would entail the flooding of 45 km^2 of land initially.	Gull Rapids will be submerged. There would be increases in water levels on the Nelson River – upstream of the generating station water levels will raise 15 metres above existing levels. Groundwater levels will rise at existing and newly formed islands in the reservoir and near the new reservoir shorelines. Death to muskrats and beavers. Alteration to and/or loss of habitat for various species.	**High**
Flooding	Operation	The project would entail flooding of 45 km^2 of land initially.	During open-water conditions, the resulting backwater effect will extend 41 kms upstream (3 kms downstream	**Medium**

[45] York Factory First Nation. *Future Development*. 2012. Accessed in 2013. (http://www.yffd.ca/EnvironmentalEffects.html)

Impact	Project Phase(s)	Description	Consequence	Significance
			of the outlet of Clark Lake). There will be no effect on Split Lake water levels in open-water conditions and only small changes during winter with lower flow volume. Water levels in the reservoir may fluctuate up to 1 m on a daily or weekly basis during peaking operation.	
Erosion, Sedimentation	Construction	Diversion of the river flow due to cofferdam construction will increase erosion in some areas. South shore of the south channel of Gull Rapids has the most potential for erosion due to changes in flow, water levels and velocity.	Suspended solids and turbidity – mineral suspended sediment concentration will increase in Gull Rapids and the inflow into Stephens Lake. River will deposit around 30% of increased sediment into Stephens Lake and the rest will be transported downstream to Kettle. Elevated methylmercury concentrations in water as a result of disturbed soils and vegetation along the Nelson River.	**Medium**
Shoreline Erosion, Peatland Disintegration and Sedimentation	Operation	The flooded area is primarily low-lying peatlands that will disintegrate into floating peat with a breakdown of shorelines, which will result in mineral sediment deposits into the water (greatest in the first year and declining over time).	Presence of debris and floating peat makes boat travel less safe. Decreased **water quality**, falling trees, exposure of ancient graves, sacred sites immersed. Elevated mercury levels in the water. Fishing by net will be more difficult due to presence of debris, unsafe boating conditions and sediment. The reservoir area is predicted to increase by 7 to 8 km^2 (1,730 acres to 1,977 acres) during the first 30 years of operations due to shoreline erosion and peat land disintegration causing instability and unpredictability for local community land users, especially First Nations groups.	**Medium**
Ice formation	Operation	Ice formation on the reservoir.	Winter ice will form earlier and extend further upstream than currently. Thin ice will form on the reservoir and downstream of the project to the inlet of Stephens Lake (replacing rough, thick ice that currently forms), which could create a drowning hazard for caribou.	**Low**

4.3.2 Conawapa

In the table below, we offer an analysis outlining the consequences and significance of the expected water regime changes of Conawapa.

Impact	Project Phase(s)	Description	Consequence	Significance
Flooding	Construction and Operation	The project will flood 5.1 km^2 of land.	The reservoir will be a total of 37.4 km^2, of which 32.3 km^2 is higher water on existing waterways.	**Low**

Other impacts are expected to be similar in nature to those summarized above for Keeyask. Scope and scale of impacts will be similar but for those impacts associated with flooding, it will be relative in scale to the smaller flooding area. Flow regime will alter the flow conditions upstream and downstream of the proposed Conawapa site. Detailed study of these flow changes were not made available.

4.2 POLICY RISKS

4.2.1 Water Power Act

A Water Power Act license governs the use of water resources at each generating station including storage, diversion and water levels. In addition, Manitoba Hydro will be operating the station within the constraints of the overall system needs and dependency on Nelson River flows. MH must take into consideration the conditions of the operating licenses of the Lake Winnipeg Regulation (LWR) and the Churchill River Diversion (CRD), which determine the seasonal flow patterns of the Nelson River. Flow through the study area mostly originates from the upper Nelson with approximately 68% from Kelsey Generating Station outflows, 29% from the Burntwood River and CRD and local inflow of about 3%.

MH will address some aspects of shoreline erosion in part through the Water Power Act licensing process. They are proposing to create a severance line for land upstream of the Keeyask dam. By doing this, any third party that wants to build a structure such as a dock, cabin, or boathouse inside the severance line requires permission beforehand from both the province and MH. This reduces the risk of future property damage as a result of the project's operation and allows for alignment of land use planning and future mitigation.

4.2.2 Manitoba's Water Strategy / Integrated Water Resources Management

This strategy provides a framework to ensure Manitoba's water resources are managed sustainably. It addresses water quality, conservation, use and allocation, flooding, supply and drainage. The Keeyask project will have impacts in a number of these policy areas and potentially create conditions that misalign with the provincial strategy, including:

- **Water quality** – Keeyask may cause higher nutrient levels in surface water. The province has a Nutrient Management Strategy and conducts scientific assessments of nutrient loads in surface waters.
- **Conservation** – the province encourages watershed-based integrated resource management to retain water and moderate flows for water supply, ground water recharge and wetland habitat, while reducing erosion and deposition. Keeyask will have a negative impact on nearby wetlands and will cause some erosion and deposition.
- **Supply** – the province acknowledges that there are increasing and competing demands on existing water supplies and that there are gaps in their knowledge and

management of ground surface water supply and how climate change impacts could affect water supply over time.

- **Flooding** – the province acknowledges that the Manitoba basins remain vulnerable to flooding and that hydroelectric projects have caused some of the flooding in the past. Flooding poses a serious threat by eroding and destabilizing shorelines, eliminating wetland habitats and natural, seasonal fluctuations.

While there are clear risks and disadvantages associated with water regime change, "the opportunities from renewable hydroelectric power and a diverse agricultural sector are among the most significant benefits we derive from our dependable flow of water", as stated in the Manitoba Water Strategy. To address the above concerns in the areas of water quality, conservation, supply and flooding, as well as First Nations partners' concerns, Manitoba Hydro has incorporated features into the design of the project to mitigate flooding and other impacts and is largely proposing a comprehensive monitoring program to manage residual risks. The design of the project itself, having been changed to specifically limit the amount of flooding and related consequences, makes the project unique in comparison with similarly sized generating stations. MNP believes the amount of flooding to be comparatively low impact for a project of this size and nature.

4.2.3 Lake Winnipeg Regulation

Lake Winnipeg acts as a distinctive hydroelectric reservoir on MH's system, which is licensed by the Province of Manitoba to be regulated for power production purposes at a height between 711 and 715 feet. When levels are at or above 715 feet, MH must release the maximum volume of water from the Jenpeg Generating Station (the only control structure on Lake Winnipeg) into the Upper Nelson River until Lake Winnipeg is lowered below 715 feet. Manitoba Hydro expects that fluctuations in in-flow to this lake will not impact the operation of Keeyask.

Impacts of the development plan projects on the LWR and CRD are of particular importance to the Province and to First Nations communities. The historic effects of LWR and CRD are generally accepted to be the most significant contributors to the degradation of First Nations homeland ecosystems and their interaction with the land. The already changed water regime as a result of these past projects severely impacted transportation and shorelines, contributed to contaminated fish and disrupted seasonal cycles. These sensitivities rightfully lead to concern for the development of two new large-scale projects on the same river system. However, as agreed to by Manitoba Hydro in the JKDA, operation of the Keeyask project will not require any changes to the CRD or LWR licenses and the operation of Keeyask will not affect water levels on Split Lake during open water conditions.

4.3 PHYSICAL ENVIRONMENTAL RISKS

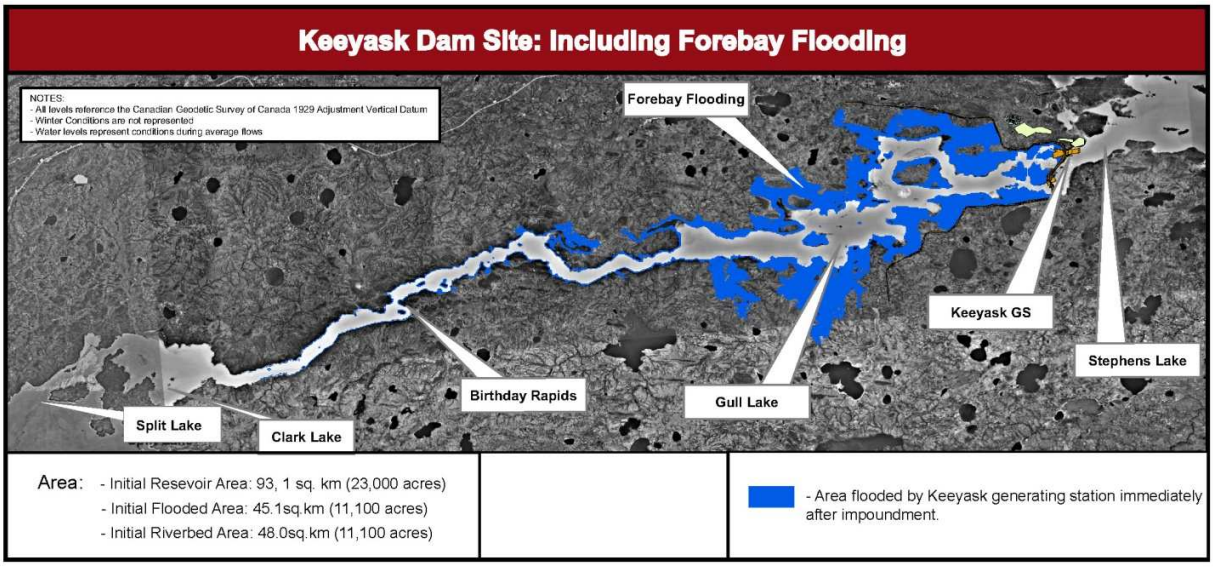
Historical and recent data, as well as observations from Stephens Lake and other Manitoba Hydro reservoirs, were used as a proxy to determine the impacts of the project on the study area. In conjunction, First Nations partners were also asked to identify physical environmental risks associated with Keeyask.

4.3.1 Changes in Water Levels and Flooding

Nelson River – The Keeyask Generating Station will be the fifth generating station on the Lower Nelson River, located between existing Kettle and Kelsey generating stations. The Nelson River is the only river that flows out of Lake Winnipeg and is no longer a natural functioning river system as a result of the existing hydro projects. After the CRD project, water was diverted into the Nelson River, reversing the seasonal flow volumes so water levels are higher in the winter months and lower in the summer months.

The physical environment along the Nelson River has already been significantly altered and there is variability in water levels from year to year as a result[46].

Early estimates of flooding associated with Keeyask and Conawapa are conservative but there is a risk that there may be more flooding than initially anticipated. According to the NFAT filing, the extent of the flooding on the Nelson River for Keeyask will not be known until at least 8 years *after* the powerhouse begins operation.[47] Manitoba Hydro is aware of the risk of greater flooding than predicted. In the event that this occurs, MH anticipates incremental flooding would be due mostly to unexpected erosion of the peatlands along the Nelson River. Due to the concerns of local inhabitants around flooding, MH changed the initial design of the Keeyask dam to reduce the amount of flooding (from 183 km^2 to 45 km^2) while maintaining the economic feasibility of the 695-megawatt facility. By comparison, the Kettle generating station (1,220 MW) following its construction in 1974 flooded a 220-square-kilometre area along the Nelson River. Manitoba Hydro plans to monitor the velocity and depth of the reservoir during operation.



Gull Lake – Water levels will increase on Gull Lake and reduce upstream. Portage Creek and Two Goose Creek, which flow into Gull Lake, will have fluctuating levels of flooding. This will negatively impact wildlife in the area by creating habitat variability distinct from the norm, as has been observed with previous hydroelectric developments.

Split Lake – Split Lake receives altered flows from the Winnipeg, Saskatchewan, Red Assiniboine and other smaller rivers that flow into Lake Winnipeg. Water levels on Split Lake are already regulated and controlled by Manitoba Hydro. Water flowing from the Churchill River Diversion (Burntwood River) and Lake Winnipeg Regulation (Nelson River) combine at Split Lake. The water level of Split Lake is determined in part by MH's control and release of water flows at Jenpeg, Notigi Control Structure and Missi Falls Control Structure. While engineering studies have concluded that water levels on Split Lake will not be affected during open water season, members of the Cree Nation Partners are concerned that

[46] Luttermann, Annette. "System Effects due to Keeyask?" Presentation: Comments on Some Issues of Concern to Pimicikamak regarding the Keeyask Generation Project Environmental Assessment. Manitoba Clean Environment Commission Hearings. http://www.cecmanitoba.ca/resource/hearings/39/PIM-008%20Issues%20of%20Concern%20Presentation%20Luttermann.pdf, page 66. December 2013.

[47] The Brandon Sun. *Hydro reveals forecast for Keeyask flooding*. 25 October 2013. Accessed in 2013. (http://www.brandonsun.com/breaking-news/hydro-reveals-forecast-for-keeyask-flooding-229212911.html)

there is a greater risk of flooding in the community of Split Lake, as has occurred in 1997 and 2005[48]. More recently, there have been high water levels on Split Lake (July 2011), which were attributed largely to the operation of the Lake Winnipeg Regulation project and sustained maximum releases of water from Jenpeg[49]. Flow changes and flooding as a result of Keeyask could exacerbate flooding issues near Split Lake when LWR is sustained. MH determines this to be unlikely, but we believe a risk worth considering given the recent observations of increased flooding and the Split Lake community's concern and potential risk. MH will undertake monitoring to ensure there is no impact on water levels of Split Lake and Clark Lake.

Lake Winnipeg – There is no risk Keeyask will affect the operation of the Lake Winnipeg Regulation and no risk that MH will not be able to release the maximum volume of water when required from Jenpeg, due to the requirements of their operating licence. MH anticipates that Keeyask will operate within its 1m operating range as determined and there will be no rise in water levels on Split Lake during open water conditions. However, recent history has shown that when water levels are high or above the licensed maximum water level at Lake Winnipeg (715 feet) and maximum flows are released down the Nelson River, higher than average water levels on Split Lake and along the Nelson River are observed. We believe there is a potential concern for water levels at Split Lake to be impacted by these joint effects and that further examination may be in the interests of project developers and the communities living near Split Lake.

4.3.2 Erosion and Sedimentation

The reservoir is expected to increase in size by 7-8 km2 over the next 30 years as the peatland and mineral shoreline erode. After 15 years of operation, the rate of reservoir expansion is expected to decline. According to the EIS, erosion is expected to happen primarily in the first five years and sediment deposition is expected to be 1 cm per year during operation. In general, the sediment concentration in the upstream reach is low under a variety of flow conditions, and therefore the risk of significant impact is low. Construction activities will lead to the deposition of 0.1-0.6 cm of sediment on the bottom of Stephens Lake within 4-6 km of Gull Rapids during development of cofferdams and while flows are diverted to construct station infrastructure. However it is expected that the composition of the Lake's substrate will not change[50]. This is not considered to be significant and therefore is not being mitigated.

There are concerns from the Cree Nations partners that the project will create many miles of unsightly new shoreline, due to erosion, slumping and debris. There is also a risk that the effects of erosion, debris and water levels will impact navigation and reduce safety and reliability of travel on open water. According to the Fox Lake Cree Nation Environmental Evaluation Report, a high rate of shoreline erosion is still being observed on the Stephens Lake reservoir, more than 35 years after its creation. The Fox Lake Cree Nation (FLCN) believes the timeline and scale of shoreline erosion for Keeyask being estimated is too conservative. Manitoba Hydro intends to monitor and report on the rate of reservoir expansion and conversion of peatland into mineral materials.

4.3.3 Water Quality

Flooding, which causes erosion and sedimentation, will also increase methylmercury concentrations in water and consequently in fish and aquatic wildlife. The Fox Lake Cree Nation noted that existing debris released into waterways from previous projects has resulted in lowered total dissolved oxygen and made

[48] Cree Nation Partners. *Keeyask Environmental Evaluation: A Report on the Environmental Effects of the Proposed Keeyask Project on Tataskweyak Cree Nation and War Lake First Nation.* (Pg. 38). January 2012. Accessed in 2013. (http://keeyask.com/wp/wp-content/uploads/2012/07/CNP-Keeyask-Environmental-Evaluation-Web-Jan2012.pdf)
[49] Clean Environment Commission of Manitoba. *Water Regime and Waterways Management Issues: High Water Levels on Split Lake in 2011.* 18 July 2011. Accessed in 2013. (http://www.cecmanitoba.ca/resource/hearings/39/DOC0021.PDF)
[50] Hydropower Sustainability. *Official Assessment: Keeyask Hydropower Limited Partnership*. 18 July 2013. Accessed in 2013.

it difficult for people and wildlife to access shorelines for safe travel and migration[51]. Water velocities will change differently at different parts of the reach, with the creation of the reservoir. The biggest impacts to water quality are anticipated in the off-current shallower water bodies where debris, drought and damage will be more visible. It has also been reported that the colour and smell of the water has changed and water is no longer clean enough to drink. If this is a concern, detailed water quality testing should be completed and estimated under future conditions. It is likely that these tests were completed as part of the Keeyask EIS, but were not reviewed by MNP. For theYork Factory First Nation, they are concerned the water quality at York Landing will worsen and that the numbers and quality of fish and wildlife will be reduced further as a result of Keeyask.[52]

4.3.4 Ice

During the winter, there is a risk of hanging ice, slush ice, and altered ice formation impacting travel near and around the Keeyask reach. In addition, the ice is expected to be thinner than usual, making it dangerous to traverse and this is expected to exacerbate with the addition of Keeyask. As part of their monitoring of water regime changes, MH intends to also monitor ice formation.

4.4 MITIGATION STRATEGIES

MH is developing an Environmental Protection Program to mitigate, manage and monitor the environmental effects described in the EIS in the construction and operation phases. This program includes environmental protection, management and monitoring plans. The program will cover erosion control from the shoreline, roads, stream crossings, earth dams and dykes, and will guide compliance with relevant legislation. To date, MH has provided more detail on the mitigation measures for Keeyask than Conawapa. Many mitigation measures are monitoring-based and are associated with future actions. Similar mitigation strategies are assumed to be used for Conawapa impacts.

4.4.1 Keeyask

Impact	Project Phase(s)	Mitigation	Considerations
Loss of habitat	Operation	Replacement habitat will be created. Operation will ensure sufficient water velocities in the lake sturgeon spawning area (downstream of the powerhouse) during the spring spawning period. Operation may also be constrained if monitoring shows lake sturgeon eggs are deposited downstream of the spillway, which may necessitate its continued operation until the eggs have hatched even if spilling is no longer required for operational purposes.[53]	MH has a wide-ranging plan in place to create new habitat and replace damaged habitat where possible. There is risk that these artificial enhancements are not accepted or not successful.
Flooding	Operation	A low-level development option was selected (183 km^2 to 45 km^2) that will cause less flooding, avoid a 3,000-year-old heritage find, and reduce construction time by a year. The Keeyask reservoir has limited storage and MH will operate the reservoir within its one-metre operating range at any time.	Although there is potential for more flooding than initially anticipated, this strategy is adequate under the current design parameters.

[51] Fox Lake Cree Nation. *Environmental Evaluation Report*. (Pg. 82). September 2012. Accessed in 2013. (http://keeyask.com/wp/wp-content/uploads/2012/07/FLCN-Environment-Evaluation-Report_Sept_2012.pdf)
[52] York Factory First Nation. *Change & Damage to the Water, Land & People.* (Pg. 94). June 2012. Accessed in 2013. (http://keeyask.com/wp/wp-content/uploads/2012/07/Kipekiskwaywinan_Our-Voices_June_2012_Part-5.pdf)
[53] Hydropower Sustainability. *Official Assessment: Keeyask Hydropower Limited Partnership*. 18 July 2013. Accessed in 2013.

Impact	Project Phase(s)	Mitigation	Considerations
Increase in water levels upstream	Construction, Operation	The forebay full supply level of 521.7 feet (159 metres) was agreed to such that the operation will not affect the water level on Split Lake during open water conditions.[54] MH routinely monitors existing water levels and flows along the Nelson River and this will continue during open water and winter periods, specifically in the reach below Split Lake. Spillway will manage the surplus river flows. Dams and dykes will contain the reservoir created upstream of the principal structures.	Although Manitoba anticipates that the water level on Split Lake will not be affected, there are conflicting opinions. This is an important consideration for the Panel.
Peatland disintegration	Operation	Impacts of floating peat to navigation mitigated by the Waterways Management Program. Expected to reduce after 1st year of operation. Monitoring of suspended solids will take place upstream and downstream for first several years of operation.	This type of debris could represent a significant concern for navigation and water quality. Monitoring should be robust to ensure mitigation is implemented in a timely manner.
Erosion and sedimentation	Construction	Sediment Management Plan – monitor effects of construction activity on suspended sediment concentrations and turbidity, upstream and downstream of the project. Actions that can be taken if target levels exceeded: • Directing river flow away from in-stream construction. • Minimizing cofferdam erosion through design. • Vegetative buffer zones to reduce sediment content in construction site run off. • Water will not be discharged unless below specified sediment concentration levels. • Rehab of disturbed land towards end of construction. • Fine cofferdam material to be covered with rocks. Reservoir Clearing Plan – removal of trees and woody vegetation before the reservoir is flooded.	A significant risk exposure exists as it is not clear what actions will be taken if levels are exceeded. Collection of debris will be effective and was requested by local community. This was not done on past projects and shorelines were littered with debris as a result.
Erosion and sedimentation	Operation	Waterways Management Program – collect debris from the reservoir once it is impounded. Shoreline erosion will be monitored in the initial operating period. Mineral suspended solids and sediment concentrations are expected to decrease from current levels due to reduced velocities. Reservoir Depth Charts and Travel Routes – will be developed to illustrate the depth of water through the reservoir upstream for aid in boat travel and routes to be used during various water conditions. Environmental Protection Program – mitigate, manage and monitor the environmental effects which will include erosion control from the shoreline, roads, in-stream crossings, earth	Collection of debris will be effective and was requested by local community. This was not done on past projects and shorelines were littered with debris as a result. If shoreline erosion occurs at the rate anticipated by MH, it

[54] Fox Lake Cree Nation. *Environmental Evaluation Report*. September 2012. Accessed in 2013. (http://keeyask.com/wp/wp-content/uploads/2012/07/FLCN-Environment-Evaluation-Report_Sept_2012.pdf)

Impact	Project Phase(s)	Mitigation	Considerations
		dams and dykes and compliance with relevant legislation.	will be minimal.
Ice	Operation	Ice monitoring and safe trails program – ice travel may become dangerous in places especially in the first few winters. Safe routes will be marked.	MH's plan would appear to be adequate, but there is a risk of unanticipated impacts that would require adaptations to the plan over time.

4.4.2 Conawapa

Impact	Project Phase(s)	Mitigation	Considerations
Flooding	Operation	The net amount of flooding in the Long Spruce-Conawapa reach of the Nelson River was reduced from 35 km^2 to 7 km^2 by developing two projects instead of one, with Limestone as a lower-head option and Conawapa located at its planned axis.	Although there is potential for more flooding than initially anticipated, this strategy is adequate under the current design parameters.

4.6 OBSERVATIONS

The key driver of water regime change is the creation of the reservoir, which will significantly alter water flows in the study area, including displacing large rapids at Gull Lake. Upstream and downstream impacts are considered to be moderate in comparison with historical impacts from hydroelectric development. A high degree of disruption has already taken place in the study area due to prior development. First Nations and others are concerned the Keeyask project will only compound existing damage to this water system and its dependent ecosystem elements.

Based on our review of the mitigation strategies of the development plan, physical elements such as coffer dam management and upstream dyking, as well as the unique facility and reservoir design are commensurate with expectations of a project this size. There is always risk that mitigation features are not as effective as expected, but we do not believe MH is missing any important elements in their mitigation planning.

All First Nations partners agree that Keeyask represents another step in what is likely to be continuing hydroelectric development on an already highly damaged river system. Manitoba Hydro is confident in their assessment of impacts to the physical environment due to water regime change given the nature of this particular study area – existing flows along Nelson River are highly altered and tightly regulated in the present. However, impacts of the Lake Winnipeg Regulation continue to affect communities today, long after the expectation estimated. As a result, First Nations communities are sceptical of MH's predictions of project effects and have identified a number of issues such as changes in water levels and flow which could have larger widespread, interrelated effects on the land, water quality, fauna and mobility.

It is clear impacted First Nations groups are disappointed with the manner in which hydroelectric development projects have been handled in the past, the impacts these projects have had on the land and their people's ability to maintain their traditions and the potential impacts of the Keeyask and

Conawapa projects. But due to the extent of consultation, being included as a partner in the project and compensated for the anticipated adverse effects of the projects, many have come to accept that despite the negatives, there is much to be gained.

We believe the most significant impacts that should be considered include the following:

- **Loss of Gull Rapids** – As one of the few remaining naturally valued river components and its importance as fish habitat, Gull Rapids hold unique value that should be considered.
- **Split Lake Flooding** – Although no anticipated by MH, it is unclear what effects will occur on and around Split Lake. There is concern for greater than expected flooding, which has consequences for communities residing on the lake.
- **Continued Erosion** – Shoreline erosion occurring over time can present hazards for animals and for First Nations and other groups using the area. Erosion estimates appear to be robust, however there is always risk of unanticipated consequences.
- **Wetlands** – Loss of wetlands leads to several noteworthy impacts, including loss of key habitat, increased debris in the flow regime and reduced water quality that is difficult to mitigate.

6. MACRO ENVIRONMENTAL: CARIBOU

In depth study of caribou in and around the northern portion of the Nelson River, their habitat and behaviour was conducted as part of the Keeyask Generation Project EIS. The obligation of MH to conduct these studies was a critical part of the Keeyask EIS and the company has fulfilled its role in combination with local First Nations communities. As a VEC, caribou were studied in detail as part of Keeyask project development and approvals requirements. Cree Nation Environmental Evaluation Reports also include study of caribou in the area, as well as the project related risks identified from the First Nations perspective. Regionally, three discrete groupings of caribou are noted as inhabiting parts of the Keeyask Caribou Local and Regional Study Areas[55] and these include the barren-ground caribou, coastal caribou and summer resident caribou. These same groupings have not been reported as studied in detail as part of the Conawapa Generation Project as yet by MH. For the purposes of this report, MNP makes some assumptions as to the likelihood of the presence and impact to caribou herds in the impacted areas of the proposed Conawapa Generation Project.

- **Barren-ground caribou**: These caribou from the Beverly and Qamanirjuaq herds migrate from Nunavut in the autumn to spend winters in northern Manitoba forests. This group leaves study areas in spring to calve. Atypically, some members of the herd may reach as far south as the impacted areas in the Keeyask affected region and the northern shore of the Nelson River[56]. From a population size of about 348,000 (estimated in 2008), 10,000 animals arrived in the study area once in the last ten years and mostly around the northern arm of Stephens Lake. It is worth noting that oral histories of the First Nations describe migrations of significance into the region as a regular occurrence in decades past (50 years), but declining in frequency since early development of hydro on the Nelson River.

  It is possible that elements of these herds may reach Conawapa affected areas more often, if Conawapa were developed, but in general, similar significance and impacts are likely to result from development of Conawapa as from Keeyask.

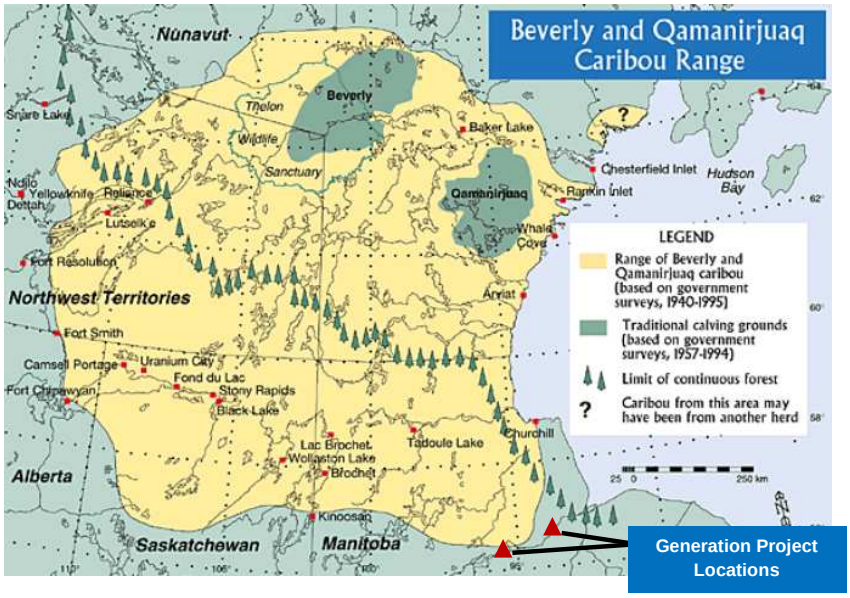
- **Coastal caribou**: Caribou from the Cape Churchill and Pen Islands herds migrate from northern Manitoba and northern Ontario into parts of the study area and Keeyask affected region in the winter and leave in the summer to calve. Small numbers of individuals from these herds are likely to migrate into Keeyask affected areas. Observations have indicated that numbers in the hundreds are most common, with groupings reaching the southern bank of the Nelson River near Stephens Lake. It is possible that as many or more individuals will spend winters in the proposed Conawapa affected region, being it is substantially closer to their known migration routes on Hudson's Bay. However, it is currently expected that very low numbers of individuals will populate the region in the winter. Elements of the Pen Islands herd who migrate often between Pen Islands and Northern Ontario, as well as into the southern bank of the Nelson are more likely to frequent the regional study area. Their migration and behaviour may be impacted by development in the region as noted below.

- **Boreal woodland caribou**: These summer resident caribou likely move within and beyond the Keeyask study area and affected areas. However the extent of the animals' core range is unknown. These caribou remain in the study area to calve. The herd's population is estimated to be less than 3,000[57] and are listed as a threatened species by the Committee on the Status of

[55] Defined as Zones 4 and 6 as identified in Map 7-1 of the Terrestrial Environment Supporting Volume of the Keeyask EIS
[56] Fox Lake Cree Nation. *Environmental Evaluation Report*. September 2012. Accessed in 2013. (http://keeyask.com/wp/wp-content/uploads/2012/07/FLCN-Environment-Evaluation-Report_Sept_2012.pdf)
[57] Government of Manitoba. *Manitoba's Conservation and Recovery Strategy for Boreal Woodland Caribou.* 2005. Accessed in 2013. (http://www.gov.mb.ca/conservation/wildlife/sar/pdf/bw_caribou_strategy.pdf)

Endangered Wildlife in Canada (COSEWIC) and by the federal Species at Risk Act (SARA). Manitoba's Endangered Species Advisory Committee has also classified the species in Manitoba as endangered. The number of individuals that reside in the Keeyask study area is estimated to be very low and possibly in the hundreds. Keeyask EIS population studies indicate that very few individuals are consistently found in the local study area with population density perhaps 0.26 per km^2 in the region[58]. Resident caribou are more often found farther south and south of Long Spruce. The summer resident woodland caribou are however the most at risk of the caribou groupings from development of Keeyask and Conawapa within their ranges.

All groupings of caribou keep ranges and interact regionally in northern Manitoba. However, few individuals typically reside in reach of directly affected project areas. According to the Beverly and Qamanirjuaq Caribou Management Board, the Nelson River intersects on the very margins of each herd's range only. Similarly, evidence suggests that the Cape Churchill coastal caribou would occasionally be impacted by Keeyask and Conawapa projects in a limited manner, given the frequency of their range intersecting with affected areas.



6.1 IMPACTS

Project related impacts to caribou are numerous, but most likely to be minor in significance to the population health of migratory groupings. For the population components that do use significantly impacted areas, either regularly or occasionally, habitat loss and alteration are the most disruptive impacts. In Zone 2, representing the edge areas of the Zone 1 direct project footprint, habitat loss will result in reduction of food accessibility, useable cover and some preferred calving habitat for the caribou. The below table demonstrates the impacts of note:

Impact	Project Phase(s)	Description	Consequence	Significance
Habitat loss	Construction, Operation	Up to 6% of the total physical caribou habitat in the Local Study Area will be affected by the Keeyask project.	Reduction of food and cover availability in the affected areas leading to distribution and behavioural adaptations. This is likely to be largely non-consequence to the migratory herds in the long-term as they choose	**Medium**

[58] Keeyask Environmental Impact Statement, Terrestrial Environment – Section 7: Mammals

Impact	Project Phase(s)	Description	Consequence	Significance
			different regions that are unaffected or minimally affected by the projects within their vast ranges. The resident population is expected to decrease due to mortality and be impacted more directly and meaningfully. Resident calving habitat will be affected.	
Increase edge habitat and access	Construction, Operation	Increased edge habitat along roadways, transmission corridors and other linear alterations.	Increased access of predators to caribou habitat and particularly calving grounds that may result in increased predation mortality. Particularly Gray Wolves use edge habitats to move more easily while hunting. Increased mortality due to hunting pressure and access effects as well as by increased chance encounters with human movements (Highways).	**Medium**
Loss of calving habitat	Operation	Approximately 2% of primary calving habitat of resident caribou will be affected in the reservoir.	Direct habitat loss and island flooding will affect the amount and quality of historic calving habitat. A 65% increase in in-lake islands is expected. However, it is difficult to determine if this new habitat will be favoured or used. Lost habitat could lead to individuals abandoning the region for calving purposes post-disturbance.	**Low**
Navigation and migration disturbances	Operation	Based on past experience with hydro projects, KCNs note concerns regarding increased chance of drowning due to altered ice regimes in winter and river flows at other times. Evidence from other jurisdictions supports these observations.	Mortality of large numbers is possible where ice regimes change and increase risk near typical river crossing routes. In 1984 an estimated 10,000 caribou were found drowned in hydro reservoirs near Fort Chimo Quebec[59]. Similar incidents have been recorded as recently as 2007 in Quebec, involving 300 caribou.[60]	**Medium**
Sensory disturbances	Construction, Operation	Increased noise and visual disturbances near project sites and near roads where increase traffic is expected.	Caribou will encounter sensory disturbances more often which may alter general behaviour and preference for calving habitat. However, caribou are known to show a high level of site fidelity and do not abandon habitat entirely due to temporary disturbances according to MH.	**Low**

[59] The Ottawa Citizen. *Inuit blame drowning of 10,000 caribou on Hydro Quebec dam.* October 3, 1984. Accessed in 2013.
[60] CBC News, Caribou Found Dead in Nunavik-area River. Oct 11, 2007

6.2 POLICY RISKS

6.2.1 Species at Risk Act (SARA)

SARA aims to prevent wildlife species from becoming extinct and secures the necessary actions for their recovery and for sustainment of viable populations.

The preferred plan could lead to conflict with the objectives of SARA in the long-term. It is noted that two of the likely affected caribou populations, the barren ground and coastal groupings, are estimated to be very healthy populations and impacts are expected to be limited in significance overall. However, the woodland caribou populations, particularly in areas in and around the Keeyask project could face pressures from rapid increases in habitat loss and alteration, as well as increased predation in the Keeyask affected areas. Local numbers, as reported by Cree Nations and found during EIS studies, are very low. Therefore, even small impacts could have deleterious effects to the presence of this type of caribou in local areas for two or more generations.

We believe the likelihood of significant risk at the population level is fairly low. However, given the local grouping risk, the potential for pressure on population groupings is an important consideration that may result in conflict with the federally and provincially accepted objectives of SARA.

6.2.2 Conservation and Recovery Strategy for Boreal Woodland Caribou

The objectives of the 2005 strategy include maintaining current local populations that are self-sustaining and to address declining populations, promote recovery and increase boreal caribou habitat to ensure sufficient quality. The strategy also aims to reduce direct threats, increase the understanding of the boreal caribou and increase outreach and communication with First Nations.

The preferred plan developments at Keeyask and Conawapa have led to great success in enhancing the study of the woodland variety of caribou and have increased outreach with First Nations. However, the threats posed by the projects are in direct contention with the other objectives of the conservation strategy. Particularly troublesome is the goal of increasing viable habitat. The projects will certainly decrease viable habitat overall, but in some cases, increases in calving habitat my result. It is unknown if these new habitat areas (calving islands for example) will be preferred by the populations in the area.

6.2.3 The Sustainable Development Strategy

In support of promoting and incorporating sustainable development in Manitoba, the province's Sustainable Development Strategy outlines ten key principles.

Impacts of the preferred plan could be in conflict with several of these principles, including: Prevention, Rehabilitation and Reclamation, Stewardship, Conservation and Enhancement, regarding project impacts to caribou. In this case, preferred plan projects do not directly support sustainability objectives of managing Manitoba's caribou herds.

6.3 PHYSICAL/MACRO ENVIRONMENTAL RISKS

6.3.1 Increased Vulnerability of Caribou Populations

The woodland resident caribou are currently highly vulnerable to hydro development in the region. With a fairly small recognized population, augmented at times by migratory woodland caribou and those from the Pen Island herd, there is a chance that they could be pushed out of the region entirely. A number of considerations should be evaluated carefully:

- Habitat loss due to infrastructure, flooding and changes to habitat composition and diversity.
- Loss of quality resident caribou calving grounds.
- Changes in ice conditions and navigation risks.
- Increased hunting and predation.

Although populations of northern barren land caribou are expected to remain strong regardless of new hydro development, their migration into the Keeyask affected areas and the Gillam region, may be reduced due to habitat change, physical and sensory disturbance, increased encounter with vehicles along highway 280 and the chance of un-navigable winter ice conditions. Chance of increases in drowning incidents is a possibility as river dynamics at crossing points change and winter ice conditions become altered by reservoir development and changing flow patterns[61].

6.3.2 Traditional Hunting Opportunities

Given the traditional importance of caribou to First Nations communities in the region, preservation and sustainable management of the caribou herds is critical. Cree Nations identify several risks as significant in their own environmental reports. The Cree have a tremendous oral history of caribou activities and behaviours. Their knowledge and experience provides accounts of the changes in migration habits and the activities of populations in the region. The migratory caribou tend to be the favoured sub-species for hunting due to their size, flavour and recognizability. The Pen Island coastal caribou is known to converge with northern migratory caribou into one herd at times in late autumn, but in recent years declining numbers have been noted in both the number of resident caribou in the region and the frequency and volume of migrating populations. Migrations of barren-land and coastal caribou into the Keeyask are becoming less significant and frequent due to hydro development. Further disruption could have substantial impacts on the ability of current and future generations to hunt in areas affected by the projects and the Cree have noted that the behaviour and presence of the animals has been declining consistently since the first hydro developments on the Lower Nelson.

[61] Fox Lake Cree Nation. *Environmental Evaluation Report*. September 2012. Accessed in 2013. (http://keeyask.com/wp/wp-content/uploads/2012/07/FLCN-Environment-Evaluation-Report_Sept_2012.pdf)

6.4 MITIGATION STRATEGIES

Key mitigation strategies summarized in the Keeyask EIS include those demonstrated in the table below. The mitigation measures described in the EIS generally do not align well with the most material risks.

Impact	Project Phase(s)	Mitigation	Considerations
Habitat loss	Construction	Removal and disposal of vegetation cleared from the reservoir to avoid creation of artificial barriers.	Limits some habitat alteration.
Habitat loss	Construction, Operation	Newly formed calving islands and existing islands remaining greater than 0.5 ha in the reservoir will be left undisturbed. Map effects to summer resident caribou calving and rearing habitat in project affected areas during construction and up to 30 years of operation. Monitor productivity, mortality and recruitment of caribou populations in the lower Nelson River area during construction and up to 30 years of operation.	Uncertain if caribou populations will utilize the constructed calving islands. Will indicate whether mitigation measures are sufficient. Monitoring will address uncertainties regarding viability of caribou populations and cumulative effects of projects in this region.
Habitat loss and increase edge habitat and access	Construction, Operation	Access roads were routed to avoid caribou calving habitats. Study caribou activity, movements and mortality where project effects are predicted to occur.	Will provide data on productivity, distribution, movements and causes of mortality.
Calving habitat disruption	Construction	Some activities will be limited during calving season.	Dependent on caribou response and behavioural adaptations.
Increased access mortality	Construction, Operation	Firearms will be prohibited at camp and work sites.	May limit hunting encounters, but will not prevent them entirely.
Habitat alteration	Construction, Operation	Rehabilitation of habitat to encourage return of individuals and reduce overall impacts of lost cover and increased access to predation.	May limit the long term impacts of altered habitat if individuals return to areas previously used.

6.5 OBSERVATIONS

Typically, there are fewer caribou present in the region as a result of declining migrations in more recent years and lower population numbers of resident caribou due to low utilization of the regional study area. These findings are supported by First Nations oral record as well as by population monitoring conducted as part of the Keeyask EIS work. The caribou population as a whole are expected to be impacted minimally in a direct manner by the Keeyask and Conawapa projects. However, sensory disturbance and habitat loss and alteration, will likely result in caribou frequenting the area even less, further exacerbating a trend initiated by past hydroelectric developments along the Nelson.

The resident woodland caribou subspecies are of particular concern due to their local vulnerability to hydroelectric development. Caribou may continue to access the area despite increased threats as they have high site fidelity, but may be at greater risk of mortality if mitigation measures are not effective. It is uncertain, even with the mitigation measures proposed by MH, that caribou will return to the area once Keeyask is in operation and how long the impacts of this development will last. As pressures increase

and impact the caribou's natural behaviour, there is significant risk and a combination of mortality from human and site interactions and abandonment will lead to long-term extirpation from the Keeyask area. Loss of acceptable breeding habitat may also increase the rate of abandonment and lead to several generations of uninhabited territory where migrations and local resident caribou were once abundant.

First Nations in the area may lose the ability to hunt caribou locally and may be forced to travel much farther distances to find migrating herds. In this scenario, the traditional way of life could be in jeopardy as decreased access creates too many barriers for future generations to follow traditional methods.

7. MACRO ENVIRONMENTAL: LAKE STURGEON

The EIS for the Keeyask generation project outlines the anticipated impacts to lake sturgeon populations in the study area, which includes the Nelson River, Stephens Lake, Gull Lake, Split Lake and Clark Lake. The aquatic studies focused on the expected changes in water levels, impacts to habitat and associated effects on fish behaviour. MH conducted these studies in partnership with the Cree Nations as a part of the Keeyask EIS.

Lake sturgeon are of particular concern in relation to the preferred plan because their populations were nearly completely depleted by commercial fishing in the late 19th and 20th centuries. The lake sturgeon's historic spawning sites, which are typically large rapids, have also been heavily impacted by hydroelectric development. Lake sturgeon are culturally and spiritually important to the Cree Nations and they hold special status as a heritage species in Manitoba.

In addition, lake sturgeon are particularly vulnerable due to a number of unique characteristics:

- They have a late sexual maturity (spawn after age of 25).
- Infrequent spawning patterns (every 3 to 7 years).
- Slow growth rate to maturity.
- Large body size.
- Longevity (greater than 60 years).

As a result, lake sturgeon are highly susceptible to overfishing and are slow to recover from events impacting temporal populations. For the purposes of this project, lake sturgeon are categorized as a VEC. In order to address the special concern surrounding lake sturgeon, MH has also developed a Lake Sturgeon Mitigation and Enhancement Strategy to reduce some of the impacts that this project (and others) will have on this species of fish.

The Conawapa generation project EIS is not yet completed. We have made assumptions regarding impacts using the information available in the NFAT filing. It is believed that impacts to lake sturgeon due to development of Conawapa will be similar in nature. Although, we caution that the specific degree, scale and location of impacts will differ.

7.1 IMPACTS

At the proposed Keeyask Generating Station site, there will be an alteration of habitat in the river channels between Gull Rapids and Stephens Lake due to creation of the reservoir. Aquatic habitat shifts are likely to result in habitat more suitable for species that favour lake-like conditions. Adult sturgeon, who favour riparian conditions, are likely to emigrate in response to the water regime change. MH has noted that stocking programs will increase the total number of sturgeon in the area, but that population structure will certainly change[62]. The largest concerns are the permanent loss of lake sturgeon spawning habitat at Gull Rapids and changes in water levels and flow of Birthday Rapids upstream of the proposed site. This disruption and loss of habitat is expected to impact spawning activities and result in a reduction in the number of new lake sturgeon in the region.

Moreover, the presence of a generating station will block connectivity between downstream and upstream populations. Despite uncertainty, it has been reported that there are already a low number of lake sturgeon in Stephens, Gull and Clark Lakes[63]. Gull Rapids is reported to be one of the last spawning

[62] Response to Information Request MNP-005, NFAT 2013.
[63] Keeyask Environmental Impact Statement, Chapter 6, Section 6.2.3.3.5: Environmental Impacts Assessment.

areas on the lower Nelson River[64] by First Nations inhabitants. The First Nations' knowledge of the fish and its behaviour and their observations should be considered strongly, given the unique relationship and intergenerational knowledge the northern communities can share. Turbine design is a mitigation feature expected to prevent undue mortality to fish passing through the generating station. 90% of small fish (up to 500 mm) passing through are expected to survive. It is identified that larger fish may experience injury or mortality if they come into contact with the turbines. There is a clear risk that the large size of sturgeon makes them vulnerable in this context. Studies conducted relative to the turbine design were largely based on different species under much different environmental characteristics. For example, results from studies conducted on operating turbines and fish mortality showed survival rates mostly 90% and above, but the proxy conditions were for many different species including walleye, pike and salmon. Results from Kelsey station were used to proxy the Keeyask conditions as well, but were for walleye and pike species[65] and found the lowest survival rates and highest injury rates. We believe there could be greater risk than that identified in the NFAT submission with respect to fish mortality and injury.

The table below summarizes the expected impacts of note:

Impact	Project Phase(s)	Description	Consequence	Significance
Disturbance of fish	Construction	Inputs of total suspended solids, blasting, dewatering.	Potential impact to spawning activities resulting in reduction of sturgeon being born in a specific age cohort and reaching adulthood. Movement of adults from the reservoir resulting in a shift in age structure of the population.	**High**
Loss and disruption of habitat	Construction, Operation (initial years only)	Sturgeon require a large turbid rapids habitat. Permanent loss of Gull Rapids (Stephen's Lake) as a spawning habitat. Rising water in Gull Lake and construction of the reservoir. Water level increases at Birthday Rapids making it a less suitable habitat for spawning.	Reduction in new sturgeon being produced due to spawning habitat alteration and loss. Movement of sturgeon likely upstream or downstream due to higher water levels in Gull Lake. Loss of young-of-the-year habitat due to reservoir construction. Long-term effects on occurrence and distribution of habitat for other life stages.	**High**
Impediments to fish movement	Construction, Operation	Fish movement altered due to presence of generating station and changes in water regime.	Downstream movement of fish will be altered and upstream movement will be blocked by the presence of the dam. Due to the size of lake sturgeon, injury and mortality (especially for fish near or over 500 millimetres in length) are expected when they encounter turbines downstream. When the lake water freezes, fish could become trapped or stranded in off-current bay and downstream of the spillway when it is not in operation.	**High**

[64] Ibid.
[65] Keeyask Environmental Impact Statement, Aquatic Environment Supporting Volume Appendix 1A. 2012

Impact	Project Phase(s)	Description	Consequence	Significance
Increased risk of over-harvesting	Construction, Operation	Domestic harvesters users.	Increased access for domestic harvesters resulting in overharvest.	**High**

7.2 POLICY RISKS

7.2.1 Lake Sturgeon Management Strategy

In 2012, Manitoba Conservation and Water Stewardship released the Lake Sturgeon Management Strategy for the recovery and protection of populations in the province. The objectives of the strategy are to ensure that existing populations are protected from depletion and in those areas with suitable habitat, lake sturgeon populations are restored to levels where they can be considered stable and self-sustaining. Although MH has committed to limit the number of lake sturgeon lost directly as a result of the construction and operation of Keeyask and increase the population long term, the project will have short term ramifications for the local lake sturgeon population and is therefore in direct conflict with this strategy.

1. MH plans to use stocking as a mitigation strategy to maintain the existing population. It has been suggested by MH that their conservation stocking program would include either developing another hatchery on the lower Nelson River or using the facilities at the Grand Rapids hatchery. The strategy calls for the genetic integrity and diversity of existing stocks to be preserved. If the option to use the Grand Rapids hatchery is employed, they must ensure local fish are used to supply the brood stock in order to maintain separate genetic stocks.
2. MH plans to create a temporary fish passage to allow connectivity while conducting further studies to validate the need for and cost of a lake sturgeon fishway. The provincial strategy states that the desirability of providing passage must be considered on a site by site basis. However, it does note that in some cases, upstream access to habitats that have been altered does *not* help to address all life stages needs and *may result in increased* downstream movement through generating stations[66]. In this case, there is a known lake sturgeon spawning habitat at Birthday Rapids upstream of Keeyask. It is unknown if lake sturgeon will journey to this location. In addition, more studies will need to be conducted on spawning patterns to ensure fish passage upstream will be beneficial to the affected populations. Given that the majority of the existing sturgeon population are adults, there will be a risk for injury or mortality when moving downstream since they will have to pass through the turbines or spillway with the addition of Keeyask.
3. The strategy supports the development of artificial spawning habitat and enhancement of habitat where they are limited and sites successes in other jurisdictions. Lake sturgeon populations currently suffer from limited suitable spawning areas and this issue is compounded by the permanent loss of Gull Rapids as a result of Keeyask. Lake sturgeon will be forced to find new spawning habitat and MH's plan to construct an artificial spawning habitat alongside the creation of upstream fish passage will support the provincial strategic objective of having a stable and self-sustaining population in the long run.
4. The strategy promotes the role of Sturgeon Management Boards, which arose out of concerns about the condition of lake sturgeon stocks and the desire of First Nations communities to ensure

[66] Government of Manitoba. *Manitoba Lake Sturgeon Management Strategy 2012.* 11 April 2012. Accessed in 2013. (http://www.gov.mb.ca/waterstewardship/fish/pdf/mb_sturgeon_mgmt_2012.pdf)

that there would continue to be lake sturgeon available to harvest[67]. The Saskatchewan River and Nelson River Sturgeon Management boards are largely made up of representatives from the provincial government and First Nations groups. The boards are responsible for conducting population studies and educational initiatives to support the recovery and stabilization of lake sturgeon populations. According to the strategy, it is felt that both boards have proven to be highly effective mechanisms for coordinating lake sturgeon studies involving local fishers, communities and First Nations in ongoing discussions on lake sturgeon management, and have the potential to expand their scope to encompass their respective river systems[68]. Additionally, the strategy calls for the Split Lake Resource Management Board to develop a lake sturgeon management plan with ongoing monitoring of stocks and harvests to ensure harvests are sustainable. The Nelson River Sturgeon Board has been stocking fingerlings in this reach since 1994, as well as stocking yearlings in 2008, 2009, 2011 and 2012. It is unclear what percentage of these stocks has survived.

Despite the risk of negative impacts to lake sturgeon in the short term post-construction, MH's proposed mitigation strategies and ongoing monitoring plans align with the overall strategy and provide a conduit for the investment required to meet the objectives of the provincial strategy. In addition, the studies funded by MH as part of the planning for the proposed Keeyask Generating Station have benefited the province by adding to the collective knowledge of lake sturgeon populations and their habitat.

7.2.2 Species at Risk Act (SARA)

SARA aims to prevent wildlife species from becoming extinct and secure the necessary actions for their recovery and sustainment of viable populations. Due to the historic near depletion and the resulting vulnerability of the lake sturgeon species, they have been listed as 'endangered' by the Committee on Status of Endangered Wildlife in Canada and are currently being considered for protection under the Species at Risk Act (SARA).

If the project proceeds without lake sturgeon being listed as 'protected' under SARA, there is a risk that populations will not adequately recover after construction, making extinction more likely. If protected under SARA, Keeyask and Conawapa could be significantly delayed or cancelled if issues cannot be addressed appropriately, depending on the requirements of the SARA listing on development projects. If the projects proceed, federal permits for the allowance of certain impacts would be required. The impact to timelines and cost of the project should be considered in the economic analysis. It is unclear whether it has already been included by MH.

7.2.3 Manitoba Fisheries Branch – Fisheries Management Objectives

At the request of MH, Fisheries Management Objectives were created for the area between Birthday Rapids and the outflow of Stephens Lake. These objectives assume the project has been approved and are based on the optimal accepted outcomes. With respect to lake sturgeon, the objectives call for *"a viable population of lake sturgeon above the proposed Keeyask Generating Station site"*; *"conditions that support self-sustaining populations"* and an evidence-based *"determination of the needs for fish passage developed in consultation with provincial fisheries managers"*[69].

In order to create a sustainable population above the generating station, MH must consider the construction of a fish passage to remedy habitat fragmentation caused. The approach MH has committed to take is to conduct, at a minimum, a three-year study working together with key stakeholders, such as

[67] Ibid.
[68] Ibid.
[69] Fisheries and Oceans Canada. *Re: Fish Passage, Keeyask Generating Station Project*. 12 July 2013. Accessed in 2013. (http://keeyask.com/wp/wp-content/uploads/2013/08/Fish-Passage-Letter-from-DFO-to-KHLP.pdf)

the province, to observe the impact of the constructed environment on fish behaviour to better understand their movement patterns and needs.

7.3 PHYSICAL/MACRO ENVIRONMENTAL RISKS

7.3.1 Habitat Fragmentation and Loss

There are a number of impacts to the physical habitat of the lake sturgeon as a result of the preferred plan:

- Loss of Birthday Rapids as spawning habitat due to increased water levels, submerging the rapids following impoundment. It is unknown if lake sturgeon will continue to use this location.
- Changes in water regime and flow due to creation of the reservoir will make the young-of-the-year habitat north of Caribou Island in Gull Lake unavailable after impoundment. Lake sturgeon are *not* expected to continue to use this habitat.
- Fish access to Stephens Lake will be reduced due to presence of the generating station.
- A portion of Gull Rapids will be dewatered for installation of the principle structures (dams, powerhouse and spillway) eliminating the use of this area for spawning.
- Fish access from Stephens Lake, upstream of Gull Rapids will be lost.
- Fish have the potential to become stranded in isolated pools of water when the spillway ceases, and when water levels change in Stephens Lake and may be susceptible to winterkill if they remain in Little Gull Lake.

7.3.2 Increased Threat to Existing Lake Sturgeon Population

The Keeyask project is being developed in an area where lake sturgeon have already been impacted negatively by hydroelectric development and remaining populations estimated to be low in numbers. Lake sturgeon were once a key source of traditional food for First Nations communities in the area, but this is no longer the case due to drastic declines in the population of this fish since hydroelectric development began in the 1950's. The Fox Lake Cree Nation have argued that construction of the Keeyask Generating Station will lead to further declines in population levels due to impacts on water quality, spawning habitat loss and introduction of the dam[70].

Fish moving downstream of the generating station will be subject to a higher rate of turbine mortality if they are larger than 500 millimetres in length (the survival rate for those under 500 millimetres is 90%). Given that most of the lake sturgeon in the study area are larger than 500 millimetres, the survival rate is lower for downstream passage. However, based on available research to date, there is a small percentage of fish moving downstream and with a generating station in place they are less likely to do so. It has also been reported by the Cree Nations that post-impoundment lake sturgeon populations have decreased downstream of previous hydroelectric generating stations[71], which is an important consideration for MH and the province.

Adult lake sturgeon migrate upstream to spawn in specific locations (clean, coarse cobble, rubble), which are typically below impassable barriers, such as a waterfall or dam. Studies at this time have not revealed whether lake sturgeon will spawn near the dam. With the disappearance of spawning grounds and fragmentation of their habitat, material barriers exist to lake sturgeon productivity if Keeyask is developed.

[70] Fox Lake Cree Nation. *Environmental Evaluation Report*. September 2012. Accessed in 2013. (http://keeyask.com/wp/wp-content/uploads/2012/07/FLCN-Environment-Evaluation-Report_Sept_2012.pdf)
[71] Keeyask Environmental Impact Statement, Chapter 6, Section 6.4.2: Environmental Impacts Assessment.

Once the young-of-the-year sturgeon hatch, the velocity of the water helps them to drift down stream to shallow parts of the river where there is sand or detritus substrates. This is the least understood life stage of lake sturgeon and more study on the Nelson River in particular is required in order to understand the impact the project will have, as lake sturgeon are more vulnerable to mortality at this life cycle stage.

7.4 MITIGATION STRATEGIES

Key mitigation strategies summarized in the Keeyask EIS include those demonstrated in the table below. The mitigation measures described in the EIS partially align with the most material risks.

Impact	Project Phase(s)	Mitigation	Considerations
Disturbance of fish	Construction	Avoiding spawning periods and implementation of in-stream construction timing windows, blasting guidelines, screening water intakes and salvaging fish prior to dewatering.	Sufficient.
Disturbance of fish and loss of habitat	Operation	Replacement of spawning habitat provided at several locations including the tailrace of the generating station and in Stephens Lake. Stocking fry, fingerlings and yearlings in areas directly impacted by the project and broader regions to compensate for lost production of lake sturgeon. Monitor to determine if the fast-water habitat of the reservoir is suitable habitat to attract spawning fish and modify if unsuitable.	Concerns raised by First Nations on the effectiveness of constructed spawning area below Keeyask powerhouse. Lack of immediate mitigation measures may not reduce effects in a timely manner. MH has never constructed young-of-year habitat and cannot guarantee it will be successful.
Increased risk of overharvesting	Construction, Operation	Long term conservation-stocking program is expected to increase sturgeon numbers in the region in the long term. Lake sturgeon awareness initiative will be created to inform domestic harvesters about the vulnerability of the lake sturgeon populations in Keeyask reservoir and Stephens Lake. First Nations Partnership has developed an access management plan that will strictly monitors site visitors on site and provide transportation and access to Thompson off duty. Fishing licences will also potentially be limited during construction as a measure to prevent overharvest by migrant workers.	Stocking will not produce results in the short term. Measures are already in place to prevent domestic overharvest, thereby reducing the impact of MH mitigation strategies in this area.
Impediments to fish movement	Construction, Operation	Upstream and downstream fish passage will be provided to maintain existing connections. Fish passage downstream will be facilitated via turbines and spillway (designed to reduce risk of injury and mortality). Barriers will be erected to prevent larger fish from passing through the powerhouse. Fish passage upstream will be facilitated by a trap and catch transport system, but avoiding depleting the Stephen's Lake remnant population. Channels will be constructed to connect large off-current bay in the reservoir with deeper sections of the reservoir and to	Fish moving downstream of the generating station will be subject to turbine mortality (~10%) if they are larger than 500 millimetres in length. Sturgeon mortality due to turbine, spillway or trash rack contact is not

Impact	Project Phase(s)	Mitigation	Considerations
		connect spillway pools with Stephen's Lake to prevent fish from becoming stranded.	well studied. Trap and catch is experimental until MH has collected more data on need and requirements for upstream fish passage.

7.4.1 Lake Sturgeon Stewardship Enhancement Program

MH has also implemented the Lake Sturgeon Stewardship Enhancement Program with the vision "*to maintain and enhance lake sturgeon populations in areas affected by MH's operations, now and in the future*".

The stated long term objectives are to:

- Ensure that the net effect of MH's current activities does not contribute to a decrease in existing lake sturgeon abundance in Manitoba.
- Operate and develop MH's facilities in a manner that will not jeopardize the sustainability of lake sturgeon populations in Manitoba.
- Promote recovery of lake sturgeon populations in Manitoba.

MH plans to stock fish to maintain and enhance the current population. However, it will take in excess of 20-25 years (a generation) in order to assess the effectiveness of the stocking strategy. There are also genetic risks inherent in stocking including outbreeding depression, domestication and inadequate representation of genetic diversity in the cultured population (Welsh et al 2007)[72]. Young sturgeon have a higher mortality rate. Consequently, even with stocking efforts, there is no guarantee the fish will survive to maturity and support a self sustaining population. In addition, plans to use the Grand Rapids hatchery as a source is not ideal since the species in Gull Rapids are of different variety than the species in that location.

Part of population recovery is also providing various types of habitat for lake sturgeon at different life stages. There is limited research to support the success of stocking and of artificial spawning habitat for lake sturgeon. Therefore, at this time it is unclear whether the mitigation measures that will be employed by MH will support conditions for a self-sustaining population in the Keeyask reservoir and Stephens Lake. MH plans to undertake comprehensive monitoring and to modify mitigation measures or supplement them, as required.

7.4.2 Lake Sturgeon Stewardship Agreement for the Lower Nelson River

The Cree Nations and MH are in the process of developing this agreement, which aims to recover the lake sturgeon population through partnership with First Nations in the area and Fisheries Branch of Manitoba Conservation and Water Stewardship. This agreement established the Lower Nelson River Sturgeon Stewardship Committee in spring 2013, which is mandated to protect and enhance sturgeon populations in the lower Nelson River from Kelsey to Hudson Bay.

Core activities include:

[72] Smith, A.L. Fisheries Section Fish and Wildlife Branch, Ontario Ministry of Natural Resources. *Lake Sturgeon (Acipenser fulvescens) Stocking in North America*. 2009. Accessed in 2013. (http://www.mnr.gov.on.ca/stdprodconsume/groups/lr/@mnr/@letsfish/documents/document/stdprod_070696.pdf)

- Development of a stewardship plan complete with detailed measures, objectives and strategies.
- Establishing research and monitoring priorities.
- Undertaking research and monitoring activities based on both Western science and Aboriginal Traditional Knowledge to gain a better understanding of sturgeon populations in the Lower Nelson River.
- Undertaking protection and enhancement projects in the Lower Nelson River area.
- Creating a forum for the sharing of expertise, resources and capacity, including consultation and/or coordination, with relevant Resource Management Boards and the Nelson River Sturgeon Board (which operates on the Upper Nelson River between Lake Winnipeg and the Kelsey G.S.).
- Working to create a comprehensive repository of available information on Lake Sturgeon.
- Carrying out public education activities.
- Undertaking consultations regarding decisions about voluntary sturgeon harvest levels for member communities.

This agreement is in effect for 20 years and if the objectives are not met, the agreement would be renewed.

7.5 FISHWAY NEEDS AND COSTS

As part of our scope of work, we reviewed MH's NFAT filing with respect to the need and cost for a sturgeon fishway at either Keeyask Generating Station or Conawapa Generating Station. MH has determined that while a fishway for upstream passage *may* need to be constructed, the current designs incorporate sufficient features to support downstream passage only.

Lake sturgeon require habitat for spawning, foraging and overwintering. Adult lake sturgeon in Stephens Lake, which is downstream of the proposed generating station, typically swim upstream to spawn at Gull Rapids. With the construction of Keeyask, these sturgeon will end up in either Gull Lake or Stephens Lake, will require assistance moving upstream and will have to pass through turbines or spillway to move downstream. Though Gull Rapids will no longer exist, Birthday Rapids and other known lake sturgeon spawning habitat are upstream of the proposed generating station. Manitoba plans to construct habitat to fulfill all life stages upstream and downstream of Keeyask. However, it is not known how sturgeon will respond to the constructed habitat, passage is necessary to ensure they are able to fulfill all of their life stage requirements for population sustainability. There are also challenges for upstream fish passage due to the large size of sturgeon relative to the turbines.

Correspondence from the federal Department of Fisheries and Oceans Canada (DFO) to the Keeyask Hydropower Limited Partnership regarding fish passage noted that there is *"insufficient data at this time to conclude that there is or is not significant upstream movement of fish past the site of the proposed Keeyask Generating Station*[73]." DFO has concluded that is *"premature to warrant installation of a long term upstream fish passage facility"* but recommends that MH include elements necessary to allow for economically and technically feasible retrofit of fish passage facilities, should they be required. Also, requirements for fish passage facilities will be determined at a future date based on monitoring of fish movement, ability of the habitat to support all life history requirements, fisheries management objectives and support for ongoing fisheries productivity.

[73] Fisheries and Oceans Canada. *Re: Fish Passage, Keeyask Generating Station Project*. 12 July 2013. Accessed in 2013. (http://keeyask.com/wp/wp-content/uploads/2013/08/Fish-Passage-Letter-from-DFO-to-KHLP.pdf)

MH plans to install a temporary, experimental catch and transport system and conduct studies of fish habitat and behaviour for a minimum period of 3 years to determine the requirements for a more permanent fish passage system. We believe this is a sensible approach since fish passage systems must be site specific and can be expensive to construct. Due to the lack of research on successful fish passage systems in the study area for lake sturgeon and in the absence of sufficient data on lake sturgeon behaviour, studies are necessary to ensure the appropriate facility is constructed from a cost-benefit perspective. In addition, MH needs to understand how lake sturgeon populations respond to the altered and constructed habitat.

While MH's approach is prudent, there are a number of concerns with the catch and transport system including:

- Interrupted and unnatural migration.
- Greater potential for injury and post-handling losses (mortality and drop out system).
- Response to catch and release tends to be species-specific.
- Relies heavily on human interactions.
- Typically requires a fish collection mechanism or trap to collect fish.
- May return fish to river it did not originate from, causing them to become disoriented.[74]
- Other fish may also get trapped and injured as a result.

Measures must be taken to ensure any negative effects of this method of fish passage are mitigated as much as possible.

7.5.1 Costs of Fishways

Costs for fishways are known to vary based on site characteristics, method of capture and amount of fish to be transported. There was no cost estimate provided by MH in the NFAT filing for fish passage facilities for the Keeyask or Conawapa Generating Stations. We have performed research to estimate a range of potential costs. In developing the expected cost of a sturgeon fishway, the purchase, installation, operational and ongoing improvement costs must be considered.

7.5.2 Purchase and Installation Costs

In a report by Katopodis Ecohydraulics Ltd. entitled "*Fish passage considerations for developing small hydroelectric sites and improving existing water control structures in Ontario* (May 2013)", the total costs and unit costs for fish passage systems are provided and summarized below:

[74] US National Oceanic and Atmospheric Administration. *Diadromous Fish Passage: A Primer on Technology, Planning and Design for the Atlantic and Gulf Coasts.* Accessed in 2013. (http://www.nero.noaa.gov/hcd/docs/FishPassagePrimer.pdf)

Fishway Cost as a Percentage of Total Project Cost for Various Fish Passage Systems[75]

Province	Location / Passage System	Passage System Construction Information	Key Species	Total Rise	Total Fishway Cost	Total Project Cost	Fishway Cost as % of Total Cost	MW
Quebec	Rupert River, weir at KP290; part of Eastmain-1-A Project (Pierre Vaillancourt)	2010 –nature-like rock ramp fishway; cost includes weir, access road (14 km) & bridge	Sturgeon	2 m	$9,700,000	$5,000,000,000	**0.2%**	918
Quebec	Lac Portneuf - remote area	1997 - vertical slot (4 m wide; 0.2 m drops; attraction flow chamber)	Brook trout	1.4 m	$1,000,000	Not available	**Not available**	25.9
Quebec	Rivière-des-Prairies (Richard	1985 - vertical slot (3 m wide; 45MW power dam)	Multispecies	8 m	$1,500,000	$14,000,000	**10.7%**	45
Manitoba	Churchill River Weir Fishway cost assumed as 1/3	1998 –nature-like rock ramp fishway; cost for entire rockfill Weir & fishway $7 million;	Lake cisco	2 m	$2,300,000	$220,500,000	**1.0%**	n/a
Alberta	Dunvegan Hydroelectric Project*	Ramp fishway, riffle/pool sequences with rock riprap (upstream) and fish sluices (downstream)	Whitefish, Walleye	11.4 m	$22.7 - $32.7 million	$620,000,000	**3.8-5.5%**	100

The Katopodis Ecohydraulics Ltd. report also provided a breakdown of the costing for the development of what is characterized as an “innovative fish passage system” for the 100 MW Dunvegan Hydroelectric Project, which is currently under construction. Below is a detailed breakdown of the cost:

Dunvegan Hydroelectric Project – Total and Fish Passage Costs[76]

Items	Cost
Research and Development - Hydraulic modeling, Fisheries Study, Engineering Support	$2.66 million
2 upstream fish passage ramps (cost estimate)	$20-30 million
Downstream bypasses	$1 million

[75] Katopodis Ecohydraulics Ltd. *Fish passage considerations for developing small hydroelectric sites and improving existing water control structures in Ontario.* May 2013. Accessed in 2013. (http://www.mnr.gov.on.ca/stdprodconsume/groups/lr/@mnr/@renewable/documents/document/stdprod_109381.pdf)
[76] Ibid.

Based on the historical analysis of 'Fishway Costs as a Percentage of Total Project Cost' in the table above, and given the MWs and total rise of the Keeyask project, we estimate the cost of the fishway for the Keeyask Generating Station to range between **$12 million and $50 million.** At 4% of total project cost, it is calculated that a fishway could be much more expensive (see table below). However, we believe that the relationship between total cost and fishway cost becomes less linear as size increases. The approximate cut off of $50 million is a reasonable assumption for analytic purposes of this NFAT. We also anticipate the fishway cost for Conawapa to fall in the same range based on the total rise and MWs of the project.

Three Cost Estimates for the Keeyask Fishway

Scenario	Key Species	Total Rise	MW	Total Project Cost	*Fishway % of Cost*	*Estimated Total Fishway Cost*
Keeyask 1	Sturgeon, Brook Trout, Whitefish	27 m	695	$6,200,000,000	*0.2%*	**$12,400,000**
Keeyask 2				$6,200,000,000	*2.1%*	**$130,200,000**
Keeyask 3				$6,200,000,000	*4.0%*	**$248,000,000**

7.5.3 Operational Costs

The Off-ladder Adult Fish Trap facility at Priest Rapids Dam diverts fish from the fish ladder into a holding tank for research and management activities before returning them to the fish ladder. Completed in 2007, the facility costs $4.2 million to operate annually and is operational from July to mid-October each year[77]. The fishway at Keeyask is not expected to exhibit this level of overall operational complexity. Therefore, the ongoing operational costs would likely be something less that noted for the Priest Rapids Dam.

7.5.4 Ongoing Improvements

In February 2013, the fish lift at the St. Stephen Powerhouse and Dam on Santee River in South Carolina underwent a $2 million redesign and renovation[78]. In this system, fish are lifted and prompted to swim up and out of the lift to continue their travel upstream rather than being transported to another location.

More recently in Washington State, the fish trap located ½ mile downstream from the Lower Baker Dam was completely renovated, improved and made larger for returning adult salmon. The facility had a budget of $25 million to construct a facility that allowed higher flows of water into the trap; an automated system for segregating the fish by species; four separate elevated holding ponds; a 3 story, 8-foot-diameter, water-filled elevator with a movable floor for lifting trapped fish and an adjacent survey room for data collection and scientific analysis of fish[79]. The fish are trapped and transported upstream by truck past two high-wall dams.

We believe the ongoing improvements to fishway technologies will improve the effectiveness in the long-term. Since MH is not planning to construct a sturgeon fishway until after Keeyask is constructed, this will

[77] Grant PUD. *Adult Fishways and Detection – Off-ladder Adult Fish Trap.* Accessed in 2013. (http://www.grantpud.org/environment/fish-wildlife/fish-survival/adult-fishways-and-detection)
[78] Puget Sound Energy. *Puget Sound Energy investing $50 million on new hatchery, fish trap to further aid Baker River salmon.* 1 April 2009. Accessed in 2013. (http://www.sac.usace.army.mil/Media/NewsStories/tabid/5721/Article/10326/passing-600000-fish.aspx)
[79] US Army Corps of Engineers. *Passing 600,000 Fish.* 19 February 2013. Accessed in 2013. (http://pse.com/aboutpse/PseNewsroom/NewsReleases/Pages/Puget-Sound-Energy-investing-$50-million-on-new-hatchery,-fish-trap-to-further-aid-Baker-River-salmon.aspx)

be beneficial from a cost perspective and improves the likelihood of success in increasing the lake sturgeon populations in the long-term.

7.5.5 Conclusion

Fishways are a common and often necessary feature for new hydro developments. Costs for designing, constructing and maintaining a fishway can vary greatly depending on the specifics of the site but should be aligned with the size and complexity of the facility. In this case, it is difficult to ascertain whether a fishway is necessary due to the lack of understanding about the movement of mature lake sturgeon in the study area. Despite this, MH has agreed to study fish movement during operation and include elements in their design to facilitate the retrofit of a technically sound and economical fishway should it be required. MNP believes that based on the information available and the related constraints discussed in this section, the “wait and see” approach is appropriate.

7.6 OBSERVATIONS

MH’s overall approach is to maintain and enhance lake sturgeon populations in the study area through stocking, conservation and habitat reconstruction. This supports the province’s goal to recover and sustain lake sturgeon populations long term. While MH has made efforts to develop a comprehensive strategy to enhance the lake sturgeon population, insufficient data on the effectiveness of these methods in this particular area makes it difficult to ascertain if these strategies are will be successful. It will also take 25 years or more to see results, which is substantial relative to the MH planning horizon of 78 years.

Since there is much uncertainty about whether the fish will return to the reservoir and Stephens Lake post-construction and since the fish passage systems lack supporting evidence of success in other regions, it is prudent to monitor sturgeon behaviour, which includes their use of the altered and constructed habitat prior to finalizing the design of the structure. While the First Nations partners recognize the negative impact hydroelectric development has had on sturgeon populations in the region, they support MH’s approach to mitigating further declines with the development of Keeyask.

Ultimately, MH’s plans will bolster and add additional resources to the role currently being played by the Saskatchewan and Nelson River Lake Sturgeon Management Boards, Split Lake Resource Management Board, academia and the government on lake sturgeon protection and conservation.

8. MACRO ENVIRONMENTAL: OTHER AT-RISK FAUNA

The Local and Regional Study Areas consist primarily of wetlands and boreal forest which provide habitat for various species of fauna. Impacts to the fauna native to the Keeyask study area and their habitats were comprehensively assessed as part of the Keeyask Generation Project EIS and in the Environmental Evaluation Reports of the Keeyask Cree Nations. These assessments of at-risk fauna included the terrestrial and aquatic VECs identified below:

- Ecosystem diversity, intactness, wetlands functions and priority plants.
- Birds – Canada goose, mallard, bald eagle, olive-sided flycatcher, common nighthawk, and rusty blackbird.
- Fish – pickerel, jackfish, lake whitefish and lake sturgeon.
- Mammals – caribou, moose, and beaver.

Previous sections of this report have addressed impacts to Caribou and Lake Sturgeon specifically due to the priority status of these species.

8.1 IMPACTS

Other fauna are considered to be at risk due to anticipated impacts to the ecosystem and habitats in which they live. Habitat quality, including fragmentation, human disturbance and habitat loss, is not expected to diminish to a significant degree for most other valued animal species.

Impact	Project Phase(s)	Description	Consequence	Significance
Habitat disruption	Construction, Operation	Habitat will be altered, priority plants will be lost, sizes of large core habitat area will be reduced. Sensory disturbance due to increased traffic and human presence (e.g. noise). Construction activities such as installation of cofferdams, dewatering of Gull Rapids, blasting and water withdrawals will disturb fish. Habitat will be altered, priority plants will be lost. Reservoir flooding, expansion, changes in water regime, higher ground water will have effects on habitat. Creation of new waterbodies leads to lowered dissolved oxygen.	Sound of water flowing through Gull Rapids will no longer be heard. Reduction of spawning habitat in Stephens Lake for pickerel and lake whitefish resulting in fewer being produced. Avoidance by birds and mammals. Increased risk of wire strikes for birds. Moose, caribou and beaver habitat in the vicinity of construction will potentially be disturbed. Slight reduction in regional amount of undisturbed core area. Blocked upstream movement and altered downstream movement for fish due to generating station. Fish can become trapped when spillway operations ceases. Brook trout are sensitive to lowered oxygen in waterbodies leading to a reduction of population.	**Low**
Habitat loss	Construction and Operation	Loss of terrestrial habitat including wetland areas due to land clearing, flooding and higher groundwater levels will affect mammals, birds and waterfowl.	Ecosystem diversity will be affected due to loss of priority habitat types. Losses of wetlands and nesting habitat. Reduced quality of Canada goose	**Medium**

Impact	Project Phase(s)	Description	Consequence	Significance
		Core habitat area will be reduced and sizes of large core habitat will be reduced. Loss of spawning habitat at Gull Rapids.	migratory staging habitat. Small losses of breeding habitat for Canada goose and mallard. Permanent and long-term loss of some waterbird nesting habitat. Fragmentation of habitat for caribou, moose and beaver. Sturgeon, pickerel, whitefish and smelt will lose important spawning habitat.	
Increased traffic and access for hunting	Construction	Greater pressure on hunting due to increased traffic and human presence. Mammals vulnerable to harvesting by construction workers.	Waterfowl may be exposed to greater risks of harvesting by construction workers. Increased long-term resource harvest, vehicle mortality and predation of some species. Diminished presence, quantity and quality of wildlife population. Increased competition for local resources.	**Low**

For the Conawapa project, a detailed environmental assessment has not been undertaken. Preliminary assessments indicate that the impacts will be similar to the Keeyask project. This is subject to a project-specific environmental assessment review.

8.2 POLICY RISKS

8.2.1 Species at Risk Act (SARA)

The VECs olive-sided flycatcher, common nighthawk and rusty blackbird are protected under Species at Risk Act. A small amount of breeding habitat will be lost to these species but habitat of these species is widespread in the area, and new open- and edge-habitat, preferred by the flycatcher and nighthawk, will be created. It is expected that some initial habitat will be gained during construction for some species, while breeding habitat will be lost over the long term due to reservoir filling.

8.2.2 Moose Conservation

Manitoba has a moose conservation initiative to increase moose populations to sustainable levels through the development of a long-term moose management strategy. Though the impact to moose from the Keeyask project is anticipated to be small, it could conflict with this initiative in the short term.

8.3 PHYSICAL/MACRO ENVIRONMENTAL RISKS

The terrestrial habitat of the Keeyask area is composed of boreal forest, wetlands, tall shrubs and low vegetation types. The habitat is critical for survival and reproduction of a diversity of plants and animals in this ecosystem and any effect to the habitat will invariably impact the species living there.

8.3.1 Increased Mercury Concentration in Fish

Keeyask Cree Nations are concerned about methylmercury exposure and contamination of fish due to mineral bank erosion and peatland disintegration. It is being predicted that the maximum mean mercury concentrations for lake whitefish, northern pike, and walleye from the Keeyask reservoir and Stephens

Lake will be reached within 3 to 7 years post-construction, and return to pre-project levels at least 30 years post-impoundment[80]. There is also recognition by MH that the duration of elevated levels of mercury may be longer than predicted and may be stabilized in the longer-term at levels higher than pre-project baseline concentrations[81]. Conversely, the Fox Lake First Nations members contend that mercury levels in pickerel, jackfish and some aquatic mammals will increase substantially, exceeding the safe consumption limits set by Health Canada for as long as 20 to 30 years after initial flooding which will equate to the loss of these animals as a source of food for at least one generation[82]. Studies completed as part of the FLCN EER provide some evidence to support this concern.

The Partnership has agreed to some measures to mitigate the effects of elevated mercury concentrations in fish populations due to Keeyask. Fishers will be provided with measuring sticks to help them select a size of fish less likely to have elevated mercury levels which exceed safe consumption limits. The Community Fish program for the Wolf Lake First Nations and the Healthy Food Fish Program for the Tataskweyak Cree Nation aim to help provide access to wholesome fish by providing equipment and transportation to alternative fishing locations since fish will not be safe to consume due to increased methylmecury levels caused by Keeyask.

8.3.2 Availability of Traditional Food

The Keeyask Cree Nations are concerned that wildlife and fish populations of high importance to their culture and livelihoods may be locally diminished adding to historical reductions that they have experienced, partly as a result of past hydroelectric development[83]. All First Nations have expressed concern regarding further declines in existing populations of moose, caribou, sturgeon at the Keeyask dam location. Hydroelectric development has already compromised the ability of KCNs to pursue, obtain and consume traditional foods due to habitat loss and declining quality of wildlife in the area. If the anticipated effects on the local wildlife are larger than MH has predicted, the project will result in grave consequences for local members.

For example, Fox Lake Cree Nation anticipates that moose, a VEC, will decline as a result of habitat disturbance, increased hunting pressure from the presence of humans and loss of feeding locations with the creation of the Keeyask reservoir[84]. It is reported in the FLCN EER that after the creation of the Stephens reservoir for Kettle Generating Station, moose moved inland after the initial flooding and did not return to the area for several years, resulting in local population having to travel further to hunt moose[85]. In addition to active mitigation, MH plans to monitor moose populations and distribution during construction and up to 30 years of operation to verify if predicted effects occur.

Also, furbearers, particularly beavers, also a VEC, are noted as a concern. MH asserts that beavers cannot use the Nelson River as habitat with or without the project because it is no longer suitable habitat due to fluctuating water levels[86]. MH also states that habitat losses to beaver are “larger but regionally acceptable[87] because beaver are resilient to project related effects” since they create their own habitat, compensate for population reductions and adjust to some changing conditions in the reservoir[88]. But

[80] Keeyask Environmental Impact Statement, Aquatic Environment – Section 8: Sensitivity of Effects Assessment to Climate Change
[81] Keeyask Environmental Impact Statement, Aquatic Environment – Section 8: Sensitivity of Effects Assessment to Climate Change
[82] Fox Lake Cree Nation. *Environmental Evaluation Report*. (Pg. 76). September 2012. Accessed in 2013. (http://keeyask.com/wp/wp-content/uploads/2012/07/FLCN-Environment-Evaluation-Report_Sept_2012.pdf)
[83] Hydropower Sustainability. *Official Assessment: Keeyask Hydropower Limited Partnership*. 18 July 2013. Accessed in 2013.
[84] Fox Lake Cree Nation. *Environmental Evaluation Report*. (Pg. 70). September 2012. Accessed in 2013. (http://keeyask.com/wp/wp-content/uploads/2012/07/FLCN-Environment-Evaluation-Report_Sept_2012.pdf)
[85] Fox Lake Cree Nation. *Environmental Evaluation Report*. (Pg. 80). September 2012. Accessed in 2013. (http://keeyask.com/wp/wp-content/uploads/2012/07/FLCN-Environment-Evaluation-Report_Sept_2012.pdf)
[86] Hydropower Sustainability. *Official Assessment: Keeyask Hydropower Limited Partnership*. 18 July 2013. Accessed in 2013.
[87] **Note:** Regionally Acceptable was determined by MH by comparing values for several ecosystem diversity indicators to benchmark values representing acceptable change. Environmental Assessment guidance provides much of the theoretical basis.
[88] Keeyask Environmental Impact Statement, Executive Summary

local First Nations have reported dramatic furbearer population declines after the shoreline was inundated with water from the creation of the reservoir. Additionally, FLCN members anticipate that the availability of furbearers will further decline through mortality related to flooding, habitat loss and increased access, impacting the viability of trapping[89]. In addition to mitigating activities noted below, MH plans to monitor beaver populations and changes to their habitat during construction and up to 15 years of operation to verify if predicted effects occur.

8.3.3 Bird Collision with Transmission Infrastructure

Transmission infrastructure associated with the projects may also pose further consequence to at-risk avian species. Bird diverters are being used to discourage flight path collisions and MH continues its research using Edison Electric Institute, Avian Power Lines Interaction Committee (APLIC) guidance as a basis. Study of the APLIC suggests that bird diverters have high success rates when strategies are employed that align with the specific local and/or migratory conditions present.

8.4 MITIGATION STRATEGIES

MH is of the opinion that the implementation of these mitigation measures and widespread availability of habitat types affected will mean the residual impacts would be relatively small.

Impact	Project Phase(s)	Mitigation	Considerations
Habitat disruption	Operation	Cumulative effects for all priority habitat types would be maintained below 10% of existing habitat, a key indicator of ecosystem sustainability. Channels to be created to prevent fish from being stranded. Trap/catch transport system for upstream passage of fish to be implemented. Vegetated buffers will be established around lakes and creeks to minimize disturbances (for birds). Revegetation and blockage of access trails. Prevention of impacts on and development of new marshes.	Amount of core area should remain over 80% of regional land area and no very large core areas will be lost. Pickerel and whitefish populations expected to return to today's levels once station in operation in Stephen's Lake. Jackfish population expected to decline in reservoir but return to normal levels. Will be unchanged in Stephens Lake.
Habitat disruption	Construction	Salvage fish prior to dewatering. Detailed surveys to avoid and minimize impacts on sensitive vegetation. Clearing and blasting activity will be restricted to the extent practical during the bird-breeding season from April 1 to July 31. If plant surveys identify very rare species the site will be avoided or plants transported. Priority plants to be rehabilitated. Beavers in the area where the reservoir will be created will be trapped by	Priority plants of interest to KCN are widespread and there are no impacts on very rare species. After reservoir is formed pickerel and whitefish populations are expected to increase after initial decline due to more habitat. Beaver are expected to continue to create their own habitat, compensate for population reductions and adjust to changing conditions.

[89] Fox Lake Cree Nation. *Environmental Evaluation Report*. (Pg. 81). September 2012. Accessed in 2013. (http://keeyask.com/wp/wp-content/uploads/2012/07/FLCN-Environment-Evaluation-Report_Sept_2012.pdf)

Impact	Project Phase(s)	Mitigation	Considerations
		licensed trappers. A 100 metre buffer will be created at most creeks, streams and ponds to protect shoreline habitat. Beaver bafflers will be installed along culverts and control structures that are blocked by beaver activity.	
Loss of habitat (i.e. wetlands)	Construction	Spawning shoals to be created for lake whitefish and pickerel at tailrace and in Stephens Lake. Careful siting of infrastructure facilities away from sensitive sites such as caribou calving habitat and regionally rare habitats types. Portions of the excavated materials placement area and borrow areas will be rehabilitated. Off-system marsh wetlands will be developed to provide some replacement habitat for species such as Canada goose, mallard and rusty blackbird. Retain trees in some flooded back bays as olive-sided flycatcher habitat.	No ecosystem types lost and proportion of habitat types is not expected to change substantially. No significant wetlands will be affected and there is not net loss of off-system marshes. Loss of native wetlands remains below 10% of historical area. Sufficient – habitat loss is low compared to widespread regional availability and there is negligible change to intactness and mortality. Whitefish are expected to continue to spawn at Stephens Lake. Caribou and moose are expected to lose less than 1% of their useable habitat.
Loss of habitat (i.e. wetlands)	Operation	New wetland habitat and nesting areas would be developed resulting in no net loss. Enhance existing colonial waterbird nesting islands, creating new sites and installing nesting platforms (e.g. predator fencing). Erect bald eagle nesting structures to replace nests disturbed by the project; nests will be removed from trees which may fall into the reservoir during fall or winter. Standing dead trees will be retained for olive-sided flycatcher breeding habitat. Enhance borrow areas as potential nesting sites for common nighthawk (open flat areas).	Cumulative area losses for all of the priority habitat types remains below 10% supporting habitat conservation and enhancing the ability to recover and adapt. Large amount of staging habitat in the region for Canada goose and local/ regional breeding habitat not affected. Limited breeding habitat of mallard being affected. Olive-sided catcher, rusty blackbird and common nighthawk breeding habitat losses are small and is abundant in other areas.
Increased traffic and access for hunting	Construction and operation	Access Management and Hunting Control Plan would also be implemented. Prohibition of firearms on construction site. Entrance to some access trails and cutlines will be blocked and re-vegetated to reduce access-related waterfowl and mammal losses. Tataskweyak Cree Nation Moose Harvest Sustainability Plan for the Split Lake Resource Management Area	Planned measures are sufficient and supported by KCN. FLCN has noted the need to limit fishing licenses during the construction period to alleviate harvest by migrant workers. This has been proposed but not yet approved.

Impact	Project Phase(s)	Mitigation	Considerations
		(includes Keeyask). Measures to deter moose and caribou from roads. Establishment of wetlands for moose and vegetation buffers around water bodies for beavers. Environmental Protection Program includes extensive monitoring to detect and respond to emerging issues.	

8.5 OBSERVATIONS

Hydropower development on the Nelson has already impacted this area in terms of biodiversity and habitat alteration and loss, specifically to wetlands, which is critical to the functioning of this ecosystem. The Keeyask project will continue to impact on this habitat, threatening a number of species. According to the Cree Nations, this will result in a decline in the quality and quantity of wildlife present locally and if not adequately mitigated, could have detrimental impacts on the area. Provided that MH manages the effects of the project as stated and replaces habitat of these threatened species, impacts to this ecosystem should be sustainable and will not affect the long-term viability of wildlife populations in the region.

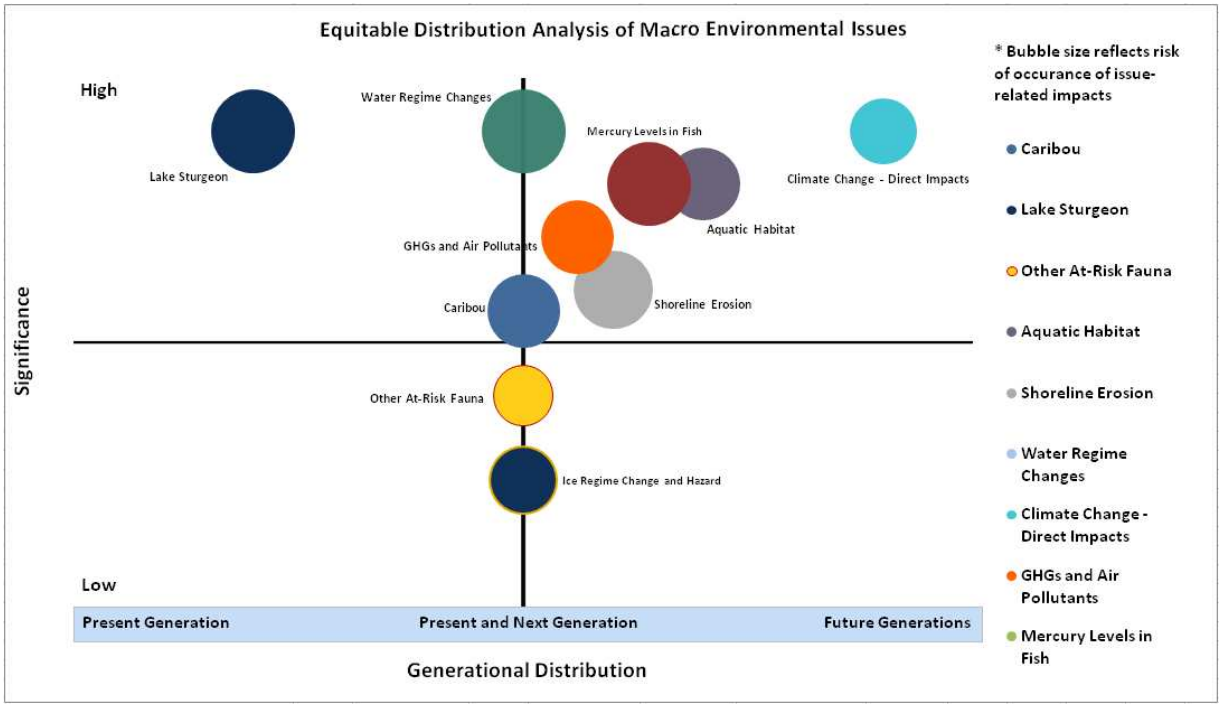
Though the effects on the fauna are not expected to be extremely adverse or widespread based on the studies conducted to date and presence of these fauna in other areas, precaution must be taken to ensure that all potential impacts are understood and the proper procedures are in place to prevent and manage any adverse effects.

9. EQUITABLE DISTRIBUTION

We have assessed each critical macro-environmental issue to determine the distribution of preferred plan impacts over the short- and long-term and relative to current and future generations. In performing this analysis, we assigned weightings to each issue as follows:

- ***Significance*** – this is defined to align with our impact assessment macro-environmental issues.
- ***Generational Distribution*** – this represents the timeframe of the issue and the level of impact expected on present and/or future generations.
- ***Bubble Size*** – a large bubble represents a high risk of occurrence; a small bubble represents a low risk of occurrence.

Figure 9.1: Equitable Distribution of Macro-Environmental Issues



9.1 OBSERVATIONS

Based on the figure above, we offer the following high-level observations with respect to the timing and significance of macro-environmental impacts as a result of the preferred development plan:

1. The *majority of significant impacts* (i.e. those with a medium or high rating) occur in the *medium-term*. This indicates that current generations will carry the bulk of the burdens of negative impacts from, water regime changes, aquatic habitat changes, shoreline erosion mercury levels, GHGs and air pollutants and impacts to caribou.
2. The *most significant short-term impact* occurs on water regime and lake sturgeon. Based on research and analysis performed, we are unclear on the duration of the effects beyond the short-term. As a result, there is *potential* for these impacts to *extend to the medium- to long-term*.

3. The *most significant long-term impact*s are the *direct impacts of climate change*, which may be further exacerbated by GHGs and air pollutants in the short- to medium-term. This represents the largest area of inequitable distribution, as climate change will impact future generations much more significantly than the current generation.

Ultimately, we recognize that the addition of new generation in the province of Manitoba will face some forms of inequitable distribution of costs and benefits regardless of the development plan selected. However, the preferred plan minimizes the effect of inequitable distribution of macro-environmental impacts on future generations as this plan has the lowest overall GHG emissions and air pollutants.

10. SUMMARY OF OBSERVATIONS

10.1 CLIMATE CHANGE

10.1.1 Climate Change – Direct Impacts

Climate modelling provides strong evidence that temperature increases are nearly certain due to a strong correlation between increases in GHG emissions, climate change and northern climate conditions. Risk factors influenced by the changing climate will have the potential to modify available water supplies and river flow. Therefore the analysis of climate change risk should include greater sensitivity of the expected changes in the levels/severity and timing of precipitation and drought including:

- Annual precipitation changes being non-uniform and seasonal.
- Total annual water availability will increase. However, seasonal precipitation will increase mostly in the late winter and spring.
- Increased average temperatures will lead to greater evaporation.
- Severe weather is expected to increase, thereby increasing the frequency and severity of drought years.
- Temperature increases will impact Manitoba by decreasing the domestic heating load in winter, but increasing the domestic and export peak cooling load in summer.

Ultimately, we caution that there is risk to the expected amount of energy for exports due to:

- Seasonality of changes in precipitation.
- Increased frequency and severity of drought conditions (especially extension of drought periods).
- Increased demand for water during summer for other uses (agricultural).
- Increased internal energy demand with higher summer average temperatures.

Detailed analysis of the impacts of seasonally altered precipitation patterns and longer, more severe droughts were not considered explicitly in analysis supporting the NFAT filing. Further, greater frequency in severe weather may also mean greater risk for significantly long transmission system outages due to storm-related and other damages. Scenarios considering these impacts would also enhance the overall sensitivity of NPV analyses.

10.1.2 Climate Change – GHGs and Air Pollutants

Policy Analysis

We believe the policy assumptions and expectations of analysis included in the NFAT filing representing the Canadian, US and Regional perspectives are reasonable in nature and timing. Based on the expected policies and regulations, the following are considerations for MH planning and operations:

- MH's preferred development plan aligns well with Canada's national strategies and expected regulations.
    - Alternative plans with greater reliance on natural gas could have further reduced NPVs and those with all renewable energy could see improved NPVs, resulting in more favourable economics.

    - The preferred plan's foundation on hydro generation limits potential future negative policy impacts due to limited liabilities from fossil generation.
- MH will not benefit in the near-term from a US federal cap-and-trade system, but it is expected that environmental attributes will realize value at some point in the future.
- MH's exports will be favourably impacted by proposed EPA regulations in the MISO market as coal-fired generation is retired and there is increased importation of energy to MISO states.
- Alternative plans will continue to suffer from less incremental value as the proportion of natural gas-fired exports increases.

GHG Emissions Life Cycle Assessment

Based on the analysis performed, the following observations are relevant for the Review Panel:

- The Keeyask LCA includes *inherent risks and limitations* that are found to be *immaterial* to the total lifecycle GHG emissions and relative to the emissions of alternative comparison generation technologies. The preferred plan has comparatively low cumulative life cycle GHG emissions in relation to nearly all other plans. The preferred plan also includes comparatively low operating emissions. Some alternative plans (Wind/C26 for example) have lower overall operating emissions. However, not all plans provide the same level of energy and potential for export and therefore the amount of displacement from importing markets.
- The preferred plan results in the highest cumulative net GHG emissions displacement potential of any of the alternative plans. The implied preferred plan carbon value (in 2014$) in the MH base case is $582M. The present value of carbon revenues *could increase* to $1,142 under other reasonable policy outcomes. This represents a *potential upside in the total revenues* for the preferred plan.

10.2 WATER REGIME CHANGE

Based on our review of the mitigation strategies of the development plan, physical elements such as coffer dam management and upstream dyking, as well as the unique facility and reservoir design are commensurate with expectations of a project this size. There is always risk that mitigation features are not as effective as anticipated, but we do not believe MH is missing any important elements in their mitigation planning.

We believe the most significant impacts to water regime that should be considered include the following:

- **Loss of Gull Rapids** – As one of the few remaining naturally valued river components and its importance as fish habitat, Gull Rapids hold unique value that should be considered.
- **Split Lake Flooding** – Although not anticipated by MH, it is unclear what effects will occur on and around Split Lake. There is concern for greater than expected flooding, which has consequences for communities residing on the lake.
- **Continued Erosion** – Shoreline erosion occurring over time can present hazards for First Nations and for animals and other groups using the area. Erosion estimates appear to be robust, however there is always risk of unanticipated consequences.
- **Wetlands** – Loss of wetlands leads to several noteworthy impacts, including loss of key habitat, increased debris in the flow regime and reduced water quality that is difficult to mitigate.

10.3 MACRO-ENVIRONMENTAL (VECS)

10.3.1 Caribou

It is uncertain, even with the mitigation measures proposed by MH, that caribou will return to the area once Keeyask is in operation.. Caribou may continue to access the area despite increased threats because they have high site fidelity, but may also be at greater risk of mortality if mitigation measures are not effective. Based on past experience we anticipate their migration into the Keeyask affected areas and the Gillam region will be reduced. Impacts to local resident caribou are of significant concern. Based on observation of relatively few individuals in the study area, habitat impacts could drive the subspecies away from the Keeyask area entirely, particularly if new calving habitat is not favoured and sensory disturbance leads to abandonment.

We believe the most significant impacts to caribou that should be considered include the following:

- **Increased vulnerability of caribou populations** - Habitat loss due to infrastructure, flooding and changes to habitat composition and diversity; loss of quality resident caribou calving grounds; changes in ice conditions and navigation risks and increased hunting and predation.
- **Threats to traditional hunting opportunities** – Further disruption could have substantial impacts on the ability of current and future generations to hunt in areas affected by the projects.

10.3.2 Lake Sturgeon

It is difficult to ascertain whether strategies proposed by MH aimed at preserving or enhancing the lake sturgeon population will be sufficient due to lack of data on the effectiveness of stocking methods and reliance on constructed habitat. Therefore, at this time it is unclear whether the mitigation measures that will be employed by MH will support conditions for a self-sustaining population in the Keeyask reservoir and Stephens Lake areas. In addition, given that it will take 25 years or more to see the results of stocking efforts and the fact that MH's planning horizon is 78 years, the proposed strategy presents some concern in terms of addressing short term declines to lake sturgeon population levels.

MH's plans will bolster and add additional resources to the role currently being played by the Saskatchewan and Nelson River Lake Sturgeon Management Boards, Split Lake Resource Management Board, academia and the government on lake sturgeon protection and conservation in the medium- to long-term, but in the short-term, the risk of extirpation is notable.

We believe the most significant impacts to lake sturgeon that should be considered include the following:

- **Habitat Fragmentation and Loss** – loss of spawning habitat in Birthday Rapids and Gull Lake and blocked upstream movement, as well as altered downstream movement represent material barriers to lake sturgeon productivity.
- **Increased Threat to Existing Lake Sturgeon Population -** impacts on water quality, spawning habitat loss, introduction of the dam and impoundment of Gull Lake will result in a decline in lake sturgeon population levels.

It is not known how sturgeon will respond to the constructed spawning habitat. Passage is necessary to ensure they are able to fulfill all of their life stage requirements for population sustainability. MNP believes it is prudent to monitor sturgeon use of altered and constructed habitat prior to finalizing the design of a fishway. We estimate the fishway cost between **$12 million and $50 million.** Continued study of fish behaviour is prudent prior to committing to the construction. This will be beneficial from a cost

perspective and improves the likelihood of success in increasing the lake sturgeon populations in the long-term.

10.3.3 Other At-Risk Fauna

Provided MH manages the effects of the project as expected, including replacement of habitat for threatened species, impacts to the ecosystems in the Keeyask area are anticipated to be manageable and will not affect the long-term viability of wildlife populations in the region. Though the effects on fauna are not expected to be extremely adverse or widespread based on the studies conducted to date, precaution must be taken to ensure that all potential impacts are understood and the proper procedures are in place to prevent and manage any adverse effects.

We believe the most significant impacts to other at risk fauna that should be considered include the following:

- **Increased Mercury Concentration in Fish** – Fish and aquatic animals are at risk of mercury contamination, causing them to become unsafe to consume if their mercury concentration exceeds healthy limits. Impacts could last as long as 20-30 years post-initial flooding of the reservoir which will equate to the loss of these animals as a source of food for at least one generation.
- **Availability of Traditional Food –** Hydroelectric development compromises the ability of KCNs to pursue, obtain and consume traditional foods due to habitat loss and declining quality of wildlife in the area.
- **Bird Collision with Transmission Infrastructure –** Transmission infrastructure associated with the projects may also pose further consequence to at-risk avian species.

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