Gunn and Olagunju, Macro-Environmental

Manitoba Hydro's NFAT Review of Keeyask and Conawapa Generating Stations

PUB-CAC Information Request Responses, Round 1

February 20, 2014

No	Preamble	Question	Response
1	The report states that "to generate a high level overview of potential macro environmental impacts and benefits of power supply options….academic literature in the field of EA, including literature on strategic environmental assessment, and cumulative effects assessment was consulted."	Which sources if any were dealing with northern Canadian development?	A core aim of the report was to broadly characterize the macro-environmental impacts and benefits "commonly associated" (p. 15) with various power supply technologies associated with Manitoba Hydro's preferred development plan and three other major power supply options. As such, the information contained in the report is largely not region specific, nor project specific. That being said, Zhong and Power (1996) is based on case study involving New Brunswick, Quebec, and Manitoba (Churchill River) and Phillips and Goldberg (2013) dedicate a section of their paper to Canadian cases, particularly in Quebec and New Brunswick. It should be noted that most of the works cited are from either the United States or European countries that share certain climatic similarities with Canada.
2	Table 4.1 sets out a general list of macro environmental impacts and benefits of hydropower generation.	Which of these factors do not apply to Keeyask and Conawapa, and why?	Earthquake – current and historical seismic studies suggest that Manitoba, and particularly the locations of the two dams, are not prone to significant seismic activities. See: Seismic zones in Western Canada. Available at: http://www.earthquakescanada.nrcan.gc.ca/zones/westcan-eng.php *(Note: Gunn and Olagunju do not claim research expertise in seismology.)*

			Resettlement – the projects as proposed will not result in any human displacement. The hydropower sustainability assessment protocol report states that resettlement is not considered for analysis because it's not relevant to the project (Rydgren 2013: 74). Rydgren, B. (2013) Hydropower Sustainability Assessment Protocol. Keeyask Hydropower Limited Partnership. Available at: www.hydro.mb.ca/projects/keeyask/keeyask_sustainability_assessment_201307.pdf)
3	The report discusses the impacts of fish, fisheries, and mercury levels of hydropower projects generally.	Are these issues applicable to Keeyask and Conawapa? If so, do you agree with Manitoba Hydro's characterization of these issues? If not, please elaborate.	Impacts on fish, fisheries and mercury levels are applicable to Keeyask and Conawapa. The Keeyask Environmental Impact Statement Aquatic Environment Supporting Volume explicitly addresses potential impacts to fish (e.g. Lake Sturgeon, Sec. 6.0), fisheries (e.g. fish community and movements, Sec. 5.0) and mercury (e.g. fish quality, Sec. 7.2). The cumulative effects of Keeyask, Conawapa and other projects on the aquatic environment are not well addressed in Section 7 of the Aquatic Supporting Volume (Noble and Gunn 2013), however, both the Keeyask and Conawapa projects would be located on the Nelson River system, which has already been substantially altered by hydro-electric development over the past 55 years. The same types of aquatic impacts associated with previously developed hydro-electric generating stations, and as noted in the Keeyask Environmental Impact Statement, would more than likely also apply to the Conawapa development. *(Note: Gunn and Olagunju do not claim research expertise related to fish, fisheries, or aquatic environments. Gunn and Olagunju wish*

			to defer to fisheries and mercury experts such as Steve Peake (Peake 2013) and Gordon Brown (G&P Resources Services Inc. 2013), respectively, with respect to an evaluation of Manitoba Hydro's characterization of potential impacts in these areas.) G &P Resource Services Inc. (2013) Review of Keeyask partnership human health risk assessment associated with mercury in fish. Manitoba Clean Enviroment Commission Hearings, 2013. Research report prepared for the Public Interest Law Centre, Manitoba, on behalf of the Consumers Association of Canada (Manitoba Branch) under contract agreement. Winnipeg, MB: Public Interest Law Centre. Keeyask Hydropower Limited Partnership (2012) Keeyask Generation Project Environmental Impact Statement Aquatic Environment Supporting Volume. Available at: http://keeyask.com/wp/wp-content/uploads/2012/07/Table-of-Contents.pdf Noble, B., and Gunn, J. (2013) Review of KHLP's approach to the Keeyask generation project cumulative effects assessment. Manitoba Clean Enviroment Commission Hearings, 2013. Research report prepared for the Public Interest Law Centre, Manitoba, on behalf of the Consumers Association of Canada (Manitoba Branch) under contract agreement. Winnipeg, MB: Public Interest Law Centre. Peake, S. (2013) Proposed Keeyask Hydro Facility: Final Report on Concerns Related to Mitigation Plans for Lake Sturgeon. Manitoba Clean Enviroment Commission Hearings, 2013. Research report prepared for the Public Interest Law Centre, Manitoba, on behalf of the Consumers Association of Canada (Manitoba Branch) under contract agreement. Winnipeg, MB:

			Public Interest Law Centre.
4	The report discusses earthquake potential.	Please confirm that this is not an anticipated risk with Keeyask and Conawapa. If it is, please set out the supporting evidence	Agreed – the region is not prone to significant seismic activities. See response to question 2 above.
5	The report discusses inundation of agricultural areas.	Please confirm that there is no agricultural land in the vicinity of Keeyask and Conawapa.	Inundation of agricultural areas (as noted in the Rosenberg et al. 1997; Oud 2002; Cermea 2004; and Tilt 2009 studies) is a common environmental impact associated with hydro-electric power generation due to reservoir flooding and downstream effects on agricultural and woodlands; but it is not necessarily a potential impact of the Keeyask or Conawapa projects. Gunn and Olagunju cannot confirm with certainly that there is no agricultural land in the vicinity of Keeyask and Conawapa. According to the Land Cover Map of Canada 2005, it does not appear that there is significant potential for western-style agricultural production in the Nelson River sub-watershed near the proposed projects. However, in the Keeyask EIS Terrestrial Supporting Volume, there is discussion of priority plants relevant to the project, some of which would be cultivated or harvested. “Priority plants were the native plant species that are highly sensitive to Project features, make high contributions to ecosystem function and/or are of particular interest to the KCNs (Keeyask Cree Nations) (*e.g.*, spiritually important, used as medicine or food) (Sec 3, p.3-5)”. The cumulative effects of Keeyask, Conawapa and other projects on priority plants are summarized in Sec. 3.5 of the Keeyask Terrestrial Supporting Volume. It is concluded in part (Sec 3.5, p. 3-44) that:

			"cumulative losses for all priority plants are predicted to remain in the nil to **moderate** magnitude range, **depending on the species**." The PUB is referred to this Volume for further details. Natural Resources Canada. Land Cover Map of Canada 2005. Government of Canada. Available at: http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/earthsciences/images/optical/images/nlcc_fig1_e_.jpg Keeyask Hydropower Limited Partnership (2013) Keeyask Generation Project Environmental Impact Statement Terrestrial Environment Supporting Volume, Section 3: Plants. Available at: http://keeyask.com/wp/wp-content/uploads/2012/07/TE-SV-3.0-Terrestrial-Plants-web-version-text-only.pdf
6	The report discusses the potential for resettlement.	Please advise whether any required resettlement is anticipated with respect to Keeyask and Conawapa. If so, please elaborate.	The projects as proposed will not result in any human displacement. The hydropower sustainability assessment protocol report states that resettlement is not considered for analysis because it's not relevant to the project (Rydgren 2013: 74). Rydgren, B. (2013) Hydropower Sustainability Assessment Protocol. Keeyask Hydropower Limited Partnership. Available at: www.hydro.mb.ca/projects/keeyask/keeyask_sustainability_assessment_201307.pdf)
7	The report discusses potential uses for flood management, irrigation, or drinking water supply.	Please advise whether any of these are applicable to Keeyask and Conawapa. If so, please elaborate.	These uses are not applicable under current proposals. The potential for a dam to serve flood management purposes is generally realized in areas where there has been history of inundation downstream with adverse effects on humans and economic activities (See Frey & Linke 2002). There is no evidence that such is the case with Keeyask and Conawapa. Based on the Keeyask EIS and online searches – the proposed

			developments are solely intended for energy generation and not for multipurpose uses. If this is correct, then irrigation and drinking water supply directly from the dams is not applicable. Rydgren (2013: 107) states: "It is noted that all communities in the area live outside of the project's open-water hydraulic zone of influence, so drinking water supplies will not be affected". In other words, the project will not impact drinking water quality and supply, but the projects are not designed to supply water. The same applied to irrigation. Frey, G. and Linke, D. (2002) Hydropower as a renewable and sustai nable energy resource meeting global energy challenges in a rea sonable way. *Energy Policy*, 30: 1261–1265. Rydgren, B. (2013) Hydropower Sustainability Assessment Protocol. Keeyask Hydropower Limited Partnership. Available at: www.hydro.mb.ca/projects/keeyask/keeyask_sustainability_ass essment_201307.pdf)
8a	Table 4.2 sets out a general list of impacts and benefits with respect to gas generation.	Please confirm that while the Preferred Development Plan is a northern generation project, any gas generation facility in Manitoba would most likely be located in southern Manitoba.	Agreed – new gas generation facilities would most likely be located in southern Manitoba. Manitoba Hydro (2013) Needs For and Alternatives To: Business Case Submission. Available at: http://www.hydro.mb.ca/projects/development_plan/bc_documents/nfat_business_case_complete.pdf
8b	Table 4.2 sets out a general list of impacts and benefits with respect to gas generation.	If (a) is confirmed, how does this affect the comparative "strategic" analysis, if at all?	The specific location of gas generation facilities does not affect the nature of the strategic questions that need to be asked via the NFAT review, which are: (1) What is the preferred future direction for long-term energy infrastructure investment in Manitoba?; (2) What is the vision for the Nelson sub-watershed region, and can or should it sustain further development?; (3) What are the values

			and/or performance indicators against which the Plan and its alternatives are being assessed?; and (4) What are the likely macro or cumulative environmental impacts of the Plan and each alternative and how well does each perform with respect to the broad vision, values and performance indicators that have been identified?
9	The report discusses some of the environmental risks of hydraulic fracturing to extract shale gas ("fracking"). While not mentioned, fracking has significantly reduced the price of natural gas as an input.	How does a macro or strategic environmental assessment reconcile these two factors? Or is the cost of an input a matter for the economic but not the environmental evaluation?	Agreed – several new studies have reported the direct and indirect gains of hydraulic fracking including the possibility of a cheaper energy option due to significantly increase in availability (see: IPAA 2008; Fitzgerald 2013; Hassett and Mathur 2013). The so-called 'frackonomics' has, however, given little attention to both the long-term spatial and temporal costs of repeated fracking to the environment – which is a macro environmental issue. We agree that more studies are required to determine these long-term effects; however, giving that "fracking occurs far underground, where verification is costly if not impossible" (Fitzgerald 2013: 1356), we suggest that precautionary principles apply in the light of available evidence on the environmental costs of fracking. Strategic environmental assessment generally does not include detailed economic analysis as it was introduced as a means to consider the environmental implications of proposed development initiatives *alongside* other economic studies. However, it can account for economic factors at a high-level. For example, in a strategic environmental assessment of potential energy futures for Saskatchewan (White 2013) identified eight criteria against which to assess a range of alternative energy futures based on similar recent assessments in the international electricity sector, current academic literature, and expert opinion. The criteria included: adaptive capacity; emissions management; employment and

			income sufficiency; ecological integrity; security of supply; **electricity production and transmission efficiency**; aboriginal rights; and public health and safety (p. 77). Fitzgerald, T. (2013) Frackonomics: some economics of hydraulic fracturing. *Case Western Reserve Law Review*, 63(4): 1337-1362. Hassett, K. and Mathur, A. (2013) Benefits of hydraulic fracking. American Enterprise Institute http://www.aei.org/article/economics/benefits-of-hydraulic-fracking/ IPAA (2008) Hydraulic fracturing: effects on energy supply, the economy, and the environment. The Independent Petroleum Association of America http://energyindepth.org/docs/pdf/Hydraulic-Fracturing-3-E's.pdf White, L. (2013) Sustainable Energy Futures: Toward an Integrated Strategic Environmental Assessment Process for Energy Planning. PhD Dissertation. University of Saskatchewan.
10a	Figure 4.5 shows a schematic of an off-shore wind farm, not an on-shore wind farm.	To the best of your knowledge, is off-shore wind a technically feasible alternative in an area where lakes (such as Lake Winnipeg) develop significant surface ice?	The figure is used for the purpose of illustrating the generating and distributing components of a wind turbine. There have been studies on the potential for off-shore wind turbine installations on inland waters of temperate regions; but concerns over floating ice during winter months have been raised (see Manwell et al. 2007; Sun et al. 2012). We suggest that an off-shore option is viewed with some cautiousness given other available alternative locations for wind farms. Manwell, J., Elkinton, A., Rogers, A., and McGowan, J. (2007) Renewable and Sustainable Energy Reviews, 11(2): 210–234. Sun, X., Huang, D., and Wu, G. (2012) The current state of offshore

			wind energy technology development. *Energy*, 41(1): 298-312.
10b	Figure 4.5 shows a schematic of an off-shore wind farm, not an on-shore wind farm.	If so, how are the general environmental effects of offshore wind different from on-shore wind?	The offshore siting of wind farms is believed to address certain problems associated with onshore farms such as noise, visibility, and high fluctuation in wind speeds. The costs and risks associated with offshore wind farm operations such as personnel travels, insurance costs, and corrosion of electrical and structural equipment, however, have however been reported (see Henderson et al. 2003; Snyder and Kaiser 2009). An onshore wind farm may also be preferred considering cost of transmission and distribution equipment. Henderson, A., Morgan, C., Smith, B., Sorensen, H., Barthelmie, R., and Boesmans, B. (2003) Offshore wind energy in Europe — a review of the state-of-the-art. *Wind Energy*, 6:35–52. Snyder, B. and Kaiser, M. (2009) Ecological and economic cost-benefit analysis of offshore wind energy. *Renewable Energy*, 34(6): 1567–1578.
11a	Table 4.3 lists the general environmental impacts and benefits of wind development.	Please confirm that wind, as an alterative in Manitoba, would be primarily constructed in Southern Manitoba. If not, please elaborate.	Agreed – wind energy development is talked about primarily in the context of southern Manitoba. Manitoba Hydro (2013) Needs For and Alternatives To: Business Case Submission. Available at: http://www.hydro.mb.ca/projects/development_plan/bc_documents/nfat_business_case_complete.pdf
11b	Table 4.3 lists the general environmental impacts and benefits of wind development.	Broadly speaking, what would be the key species in southern Manitoba affected by wind (e.g., is southern Manitoba a migratory bird path to any specific species?)	Dr. Kiel Drake, PhD, Program Manager and Biologist, Bird Studies Canada had the following to say in response to the question posed: “There are several important staging areas (i.e., places where birds would congregate in high numbers) or breeding areas in southern Manitoba: probably most significant are those designated as

			Important Bird Areas (IBAs) by IBA Canada (see: http://www.ibacanada.ca/maps/regions/MB_prov.pdf). Although most IBAs are afforded no protection whatsoever, they are 'on the radar' as areas important to birds. The southern shores of the big lakes in Manitoba, e.g. Lake Winnipeg and Lake Manitoba, and can be important staging areas for several species of passerine birds. Lots of birds touch down on the adjacent uplands along the shores of those big lakes. Based on the distribution of IBAs, the core area of concern is probably at the southern end of those lakes (roughly at a latitude of Dauphin and ranging south to Winnipeg)." Dr. Drake further offers the following observations on the impacts of wind energy development on birds: "Wind turbines and towers do more damage to some species than others. Any bird that is a nocturnal migrant will be more susceptible. However, tower kills are context specific: damage to bird species will depend on the situation. For example, lots of birds do well in navigating around the towers, but if you get a night that's foggy bird strikes can increase. The lights on wind towers can create a 'lighted room effect'. Once a bird enters into it, they won't exit and end up being struck by the blades on turbines and hitting guy wires. Bird species such as Golden eagles may be more susceptible to tower strikes. Golden eagles range all over north America and would be in southern Manitoba due to migration. Golden-winged warblers are particularly susceptible to towers, according to the American Bird Conservancy (see: http://www.abcbirds.org/abcprograms/policy/collisions/towers.html). They are a listed species in Canada that has the remaining stronghold of their existence in Manitoba."

			(Note: Gunn and Olagunju do not claim research expertise in ornithology. Dr. Drake's advice is provided as a courtesy to the PUB and should be confirmed and/or supplemented by further ornithological studies specific to the Keeyask/Conawapa proposal.)
12a	Table 4.4 lists the general impacts and benefits for solar photovoltaic ("PV") generation.	Which of the impacts are applicable to small-scale residential and commercial (i.e., de-centralized rooftop) PV projects?	Glare (including visual impact) from the reflection of the direct sunlight; installation cost is dropping but still comparatively higher than alternatives; occupational and domestic safety issues (e.g. electrocution, unsafe battery disposal) are also potential hazards.
12b	Table 4.4 lists the general impacts and benefits for solar photovoltaic ("PV") generation.	Leaving aside issues of economics such as sun intensity, please comment on the relative impacts of southern Manitoban PV vs. northern Manitoban PV? Is one inherently less impactful than the other? E.g., how would the loss of farmland compare to the loss of boreal forest?	Accurate data quantifying the comparative impacts of loss of boreal forests and loss of farmlands is difficult to obtain, particularly for PV installation and operation. It can be argued though from a macro environmental perspective that since forests act as carbon sinks, any alteration to an existing boreal ecosystem has the potential to add to the effect of natural climate change. Additionally, there are concerns about the potential for micro climate change, habitat fragmentation, and interference with fauna and flora. Conversely, loss of farmland presents a more challenging situation, socially – the problems of displacement and loss of livelihood can make such an approach more controversial. Again, from macro environmental perspective, the challenge is to select a development option that ensures minimal human and environmental impacts. PV locations should be carefully selected based on a preferred strategic direction for energy development in the province and net sustainability gains for regions affected.
13	The report comments on the effect of DSM on low-income consumers.	Are the effects of DSM costs on low-income consumers different from cost increases low-income consumers would have to face with	This effect is flagged as a concern from equity perspective rather than a demerit of DSM policy. It is a concern that can be addressed through continuous consumer awareness and widening of choices available to such category of consumers.

		respect to electricity rates? If so, how?	
14a	Table 4.6 reproduces a study that found that wind is more sustainable than hydroelectric generation. Keeyask will have a nameplate capacity of 695 megawatts with an average annual production of 4,400 GWh, Conawapa of 1,485 megawatts, with an average annual production of 7,000 GWh (all numbers are Manitoba Hydro's). For wind, the industry rule of thumb is that total production is around 30% of nameplate capacity due to the intermittent nature of wind. This means a 100 MW wind farm would produce about 260 GWh of wind. This means, Keeyask and Conawapa would produce the same amount of energy as 43 100MW wind farms.	Do you agree with the study quoted? Please state your reasons.	Yes, we agree to a large extent. The study is based on global aggregates and the results are justified based on their assumption that the indicators applied have equal importance to sustainable development when considering global implications of each energy alternative. The authors also indicate that what is most sustainable would depend on contextual and location characteristics of each region.
14b	Table 4.6 reproduces a study that found that wind is more	Is your answer affected if you consider not only the nature of the	Evans et al. (2009) study relies on life cycle analysis to conduct the ranking using the global international conditions. Their conclusion

	sustainable than hydroelectric generation. Keeyask will have a nameplate capacity of 695 megawatts with an average annual production of 4,400 GWh, Conawapa of 1,485 megawatts, with an average annual production of 7,000 GWh (all numbers are Manitoba Hydro's). For wind, the industry rule of thumb is that total production is around 30% of nameplate capacity due to the intermittent nature of wind. This means a 100 MW wind farm would produce about 260 GWh of wind. This means, Keeyask and Conawapa would produce the same amount of energy as 43 100MW wind farms.	energy source, but also the quantity needed for equivalent output? Please elaborate.	on wind as the most sustainable option is consistent with findings from other studies (see Devine-Wright 2005 and Jaber 2013). Evidently, hydro ranks better than wind on the scales of *efficiency* and *availability and limitations*. The authors themselves note that some of the sustainability indicators applied may become more important than others depending on geographical locations. Regarding the current proposal (Keeyask and Conawapa), from a macro environmental perspective, decisions should be based on the aggregate consideration of all relevant indicators including emissions levels, land use, water consumption, and associated social impacts. Devine-Wright, P. (2005) Beyond NIMBYism: towards an integrated framework for understanding public perceptions of wind energy. Wind Energy, 8:125–139. Evans, A., Strezov, V., and Evans, T. (2009) Assessment of sustainability indicators for renewable energy technologies. *Renewable and Sustainable Energy Reviews*, 13:1082–1088. Jaber, S. (2013) Environmental impacts of wind energy. *Journal of Clean Energy Technologies*, 1(3): 251-254.
15a	The report states that “the Manitoba Clean Environment Commission recently called upon the province to perform a regional [cumulative effects assessment] resulting from 55 years of	Please confirm that this recommendation came out of the report of the Clean Environment Commission with respect to the Bipole III transmission line.	Agreed – this recommendation resulted from the Clean Environment Commission’s review of the Bipole III transmission line.

	continuous hydro-electric development in the Nelson River sub-watershed."		
15b	The report states that "the Manitoba Clean Environment Commission recently called upon the province to perform a regional [cumulative effects assessment] resulting from 55 years of continuous hydro-electric development in the Nelson River sub-watershed."	Was any cumulative effects assessment part of the Recent Clean Environment Commission hearing into Keeyask?	It was. Noble and Gunn (2013) provide a critical review of the Keeyask Hydropower Limited Partnership's approach to the cumulative effects assessment (CEA) performed for the Keeyask Generation Project. The Keeyask CEA was found to be deficient in a number of important ways, notably with respect to prospective analysis (i.e., predicting cumulative effects into the future). The Keeyask CEA does not constitute a regional CEA. The Noble and Gunn (2013) analysis conducted as part of the Keeyask EIS also does not constitute a regional CEA. Noble, B., and Gunn, J. (2013) Review of KHLP's approach to the Keeyask generation project cumulative effects assessment. Manitoba Clean Enviroment Commission Hearings, 2013. Research report prepared for the Public Interest Law Centre, Manitoba, on behalf of the Consumers Association of Canada (Manitoba Branch) under contract agreement. Winnipeg, MB: Public Interest Law Centre.
15c	The report states that "the Manitoba Clean Environment Commission recently called upon the province to perform a regional [cumulative effects assessment] resulting from 55 years of continuous hydro-electric development in the Nelson River sub-watershed."	Conceptually, does the presence of existing development and its related impact in a region militate in favour of continued development (i.e., less loss of pristine area) or against it (limit total effects to acceptable limits). Please elaborate on the factors to be taken into account in making this trade-off.	Noble and Gunn (2013: 18) address this issue, stating: "Perhaps, one could argue that the incremental effects caused by further hydroelectric (or other) development in the Nelson River sub-watershed are insignificant given the magnitude of change and the degree of hydrological alteration that has already occurred over the last 55 years, and that the future of the region is to be designated as a hydroelectric development area. In other words, any incremental change from point forward doesn't matter given the already 'substantially altered' state of the Nelson River sub-

			watershed environment. **But, given that the region has already been substantially altered by hydroelectric development, and that it is agreed past alterations have been cumulatively significant, one could also argue that any further development must be also considered cumulatively significant and should not proceed unless net positive contributions to the sustainability of the sub-watershed, including its ecological functions and people, can be demonstrated.** There is no 'scientific' answer, but the question is more than philosophical – it is **fundamental** to determining whether the additional effects caused by the Keeyask project, in an already significantly altered environment, are acceptable to (decision making authorities) and to the citizens of Manitoba. Given the magnitude and imminence of the future Conawapa hydro-electric generation project, the Keeyask Project represents a critical decision point in the future of hydroelectric development and sustainability in northern Manitoba and in the province as a whole. Duinker and Greig (2006: 153) perhaps put it best: "…continuing the kinds and qualities of CEA currently undertaken may be doing more harm than good." Looking back on the Keeyask EIS two, five or ten years from now, the quality of the CEA will not be judged by the number of maps produced or volumes of information about VECs, but by the role it played in supporting a sound decision about the overall significance of the Project in the broader Nelson River sub-watershed." The reason there is 'no scientific' answer to this question is that research exists to support either perspective. For example,

			extensive research by Jaeger and others (e.g. Jaeger 2000; Jaeger et al. 2007; Jaeger and Schwick 2014) on the environmental impacts of landscape fragmentation via road development clearly indicates it is more harmful to disturb pristine areas than those already affected by development. At the same time, other research stresses that it is critical not to exceed ecological carrying capacities and other known environmental thresholds (e.g. Gunderson and Holling 2002) to ensure ecosystems remain viable when subjected to the stress of intensive human development. It is up to the PUB to decide which factors, scientific or otherwise, are most important when making a trade-off in this regard. It is a question of reconciling the best available science with public values and provincial economic development imperatives; as such, the decision to further develop the Nelson River sub-watershed—or not—constitutes a philosophical question. Duinker P., Greig, L. (2006) The impotence of cumulative effects assessment in Canada: ailments and ideas for redeployment. *Environmental Management* 37(2): 153–61. Gunderson, L. and Holling, C. (eds.) (2002) Panarchy: Understanding Transformations in Systems of Humans and Nature. Island Press: Washington, DC. Jaeger, J. (2000) Landscape division, splitting index, and effective mesh size: new measures of landscape fragmentation. *Landscape ecology* 15(2): 115-130. Jaeger, J., Bertiller, R., and Schwick, C. (2007) Degree of Landscape Fragmentation in Switzerland: Quantitative Analysis 1885-2002 and Implications for Traffic Planning and Regional Planning. Condensed version. Federal

			Statistical Office, Neuchâtel. Jaeger, J. and Schwick, C. (2014) Improving the measurement of urban sprawl: Weighted urban proliferation (WUP) and its application to Switzerland. Ecological Indicators, 38: 294-308. Noble, B., and Gunn, J. (2013) Review of KHLP's approach to the Keeyask generation project cumulative effects assessment. Manitoba Clean Enviroment Commission Hearings, 2013. Research report prepared for the Public Interest Law Centre, Manitoba, on behalf of the Consumers Association of Canada (Manitoba Branch) under contract agreement. Winnipeg, MB: Public Interest Law Centre.