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REPORT

NORTH SASKATCHEWAN RIVER WATER RESOURCE DEVELOPMENT FEASIBILITY STUDY

Submitted to:

North Saskatchewan River Water Resource Committee

DISTRIBUTION:

20	**North Saskatchewan River Water Resource Committee** **North Battleford, Saskatchewan**
5	**Golder Associates Ltd.** **Saskatoon, Saskatchewan**

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ACKNOWLEDGEMENTS

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Note: PFRA = Prairie Farm Rehabilitation Administration; REDA = Regional Economic Development Authority; RM = Rural Municipality

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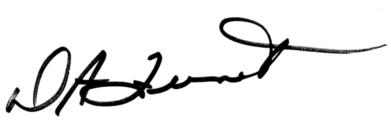

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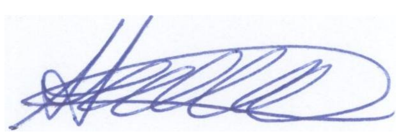

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EXECUTIVE SUMMARY

The North Saskatchewan River Water Resource Committee (Committee) (www.nsrwrc.ca) commissioned a study of potential water storage and supply options for the North Saskatchewan River (NSR) within western Saskatchewan, in the vicinity of North Battleford (Study). The Study was funded by the Canada-Saskatchewan Water Supply Expansion Program, with partial matching funds from the Committee.

The purpose of the Study was to compare a range of water storage and supply options for the NSR in terms of the likely costs and benefits and the potential socio-environmental issues. A total of five options were considered, including one option representing the existing conditions.

The five options were:

- No Investment (status quo) - representing existing conditions and a reference point for the other options.
- Non-Structural Investment (i.e., small-scale irrigation) - representing a possible future scenario involving the economic development of available water from the NSR without major infrastructure investment. This option assume that six farms along the NSR will develop irrigation using seasonal river intakes and pipelines to the top of the NSR valley wall.
- Off-Channel Storage – an option to withdraw water from the NSR for seasonal storage and distribution, focused on using the water to support regional irrigation. An off-channel storage concept and candidate site were selected among many possible off-channel storage opportunities.
- NSR Weir(s) – an option to illustrate the possible use of in-stream weirs along the NSR, in response to previous discussions by residents. A weir development concept was selected, and a candidate site was investigated assuming that the primary water use would be industrial water supply. An in-stream weir was included, if necessary, to provide sufficient water depth at the intake – but the weir is likely not necessary. Therefore, this option evolved into a similar off-channel storage option for industrial water use.

- Highgate Dam – an on-stream dam and reservoir located near the hamlet of Highgate, about 15 km from the City of North Battleford. This option wasa based primarily on a previous feasibility-level engineering design (PFRA 1970).

The work consisted of an evaluation of these five options and public consultation. A conceptual layout (design) was used as the basis for estimating the costs and for estimating the corresponding benefits and possible issues. The net benefits and potential issues were summarized and compared. As part of this work, a relatively large portion of the effort was allocated to the identification of possible social and environmental issues based on available information with no field studies. Public consultation consisted of seven public meetings in total, including three meetings at the start of the Study, three meetings to report the progress and preliminary findings, and a final public meeting prior to issuing the report.

The water allocation along the NSR in Saskatchewan is currently about 50% of the available limit. The current amount of water available for withdrawal from the NSR was estimated to be 3.3 m^3/s on an average annual basis without storage (14.1 m^3/s during the summer months), and up to 31 m^3/s with large storage (equivalent to about 15% of the average annual stream flow). Water availability was based on historical NSR stream flows, the inter-provincial apportionment agreement managed by the Prairie Provinces Water Board, and existing water withdrawal licences issued by the Saskatchewan Watershed Authority. The available water was estimated on a very conservative basis (i.e., low), and the estimated availability is more than sufficient to supply the water demands that were considered in this Study.

Potential water uses initially focused on irrigation. Industrial water use was added because the marginal value of irrigation in the Study Area was estimated to be relatively small based on a mixed crop scenario and the associated infrastructure costs for irrigation. Therefore, options with the highest ratio of benefits to costs were due to the selection of industrial water supply uses instead of irrigation.

Both the “Off-Channel Storage” and the “NSR Weirs” options provide similar opportunities to develop relatively small off-channel storage along the NSR at multiple locations. The difference between the two options is the end use of water for irrigation (“Off-Channel Storage”) and industry (“NSR Weirs”). In both cases, storage is provided to reduce the peaking requirements of the river intake out of the 80 m deep NSR valley. An instream side-channel location (i.e., along one of the Channel Islands) for the intake was considered, but the site suitability will need to be confirmed by field studies.

The use of in-stream weirs along the NSR were considered but generally discounted, because weirs do not provide water storage and can be dangerous to the public. They can also result in negative environmental consequences such as sedimentation and causing a barrier to fish passage. Weirs have been used historically in combination with water intakes and diversions. Alternative measures include river training structures such as dykes or groynes.

The Highgate Dam option was based on a feasibility level design completed by PFRA (1970), with modifications to include a power plant for hydropower generation, widening of the embankment dam to provide a road and rail transportation corridor across the dam, an adjustment to the spillway invert to accommodate a greater design flood, and a fish ladder.

The Highgate Dam option is expected to provide total economic benefits that are about 40% of the estimated costs, based on the estimated net present value and assuming debt financing at 6%. Without debt financing, the benefits are expected to be 80% of the costs. For the Highgate Dam to be economically viable, the sale price of hydropower to the SaskPower grid will need to be $0.15 per kWh or greater by 2015. Any increases in the cost of capital will erode the economic viability of the dam.

The key (potential) social and environmental issues are related to the Highgate Dam option. Two potential fatal flaws were identified among the issues:

- First Nations consultations may negatively impact the viability of the Highgate Dam, due to infringement on First Nations lands by reservoir flooding of the NSR valley.
- Lake Sturgeon formally under review for listing by the Species At Risk Act (SARA). This listing may preclude the construction of another large dam on the Saskatchewan River system, because this fish species typically has a large home range and a preference for moving water with limited or no past successes at passage through fishways (i.e., fish ladders).

This Study does not attempt to recommend an option to proceed. The Study was intended to provide the Committee and others with the information necessary to assess opportunities for water storage and economic development based on the available water resource.

The report CD includes a Google Earth file containing relevant data layers that were collected or derived as part of this Study.

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1. INTRODUCTION

1.1 Background

Residents of western Saskatchewan in the vicinity of North Battleford and Lloydminster, near the North Saskatchewan River, have for many years been discussing the potential utilization of local water resources for regional economic development. Specifically, the North Saskatchewan River (NSR) is a significant resource that is currently uncontrolled in this part of Saskatchewan and the water rights are only partially allocated.

The water supply potential of the NSR was investigated in the 1960s by the Prairie Farm Rehabilitation Administration (PFRA) for the Saskatchewan-Nelson Basin Board as part of a regional initiative to develop water storage. The engineering feasibility study published by PFRA in 1970 identified a suitable location for a dam near the hamlet of Highgate (PFRA 1970). After the study was completed, no further actions were taken (related to construction of the dam) for over 30 years.

In recent years, the topic of water storage in the NSR was re-initiated by some residents for the purpose of promoting the economic development of the region. Initial discussions centered on the previous PFRA Highgate Dam feasibility study. The discussions were then expanded to include all potential water resource development opportunities along the NSR in western Saskatchewan. The North Saskatchewan River Water Resource Committee (Committee) was formed in March 2004 as a result of these discussions, and funding was subsequently secured for a study to investigate potential opportunities. The Canada-Saskatchewan Water Supply Expansion Program (CSWSEP) provided a grant for the study, coupled with local contributions from Committee member organizations. The Committee consists of interested regional municipalities, regional economic development authorities, private members, and a government technical advisory group.

In the fall of 2006, the Committee commissioned an investigation into the feasibility of water storage along the NSR, with the purpose of investigating and comparing a range of options. The options would be considered in terms of engineering feasibility, the potential for economic benefits, infrastructure-related costs, and a relatively large effort to investigate the potential social and environmental issues. The options included off-channel storage and instream weirs along the NSR, as well as the Highgate Dam previously investigated by PFRA.

Golder Associates Ltd. (Golder) was commissioned to undertake the North Saskatchewan Water Supply Feasibility Study (Study) in October 2006. The Study was arranged in two phases to allow opportunities for public consultation and refinement of the scope as the study progressed. Phase 1 scoping studies were conducted during the spring of 2007, followed by Phase 2 tasks in the fall of 2007. This report describes the completed Study as presented in the public meeting at Maidstone on February 27, 2008 – including comments and suggestions provided by the public to the Study team at that meeting.

1.2 Purpose and Scope

The purpose of the Study was to compare a range of water storage and supply options for the NSR in terms of the likely costs and benefits and the potential socio-environmental issues. Other water sources were outside the scope of this Study.

The Study investigations focused on a range of appropriate design concepts sufficient for the preliminary evaluation of potential costs and benefits. In particular, the Committee requested Golder to determine the following:

- Regional water supply limitations, based on apportionment agreements with the other prairie provinces, current regulatory rules for water licensing in Saskatchewan, and the effect of storage on the distribution and availability of water supply.
- A range of water storage opportunities.
- Estimated costs for water-related infrastructure.
- Estimated economic benefits due to development of water resources.
- Potential environmental and social consequences of utilizing the water for economic development, and;
- Communication of the Committee’s activities with the public.

This Study is primarily a water supply options screening study. As part of the work, potential economic uses and benefits are identified. However, the Study is not intended to serve as an economic development study or as a business plan.

The Study was divided into two main phases:

- Phase 1 investigated four options that were intended to represent the range of feasible options, and included public meetings both at the start of the Study and at the end of Phase 1 investigations. The four options were:
  - No investment (i.e., status quo)
  - Non-structural investment (i.e., no major infrastructure)
  - Off-channel storage
  - Highgate Dam
- Phase 2 further investigated the options based on important data gaps and issues identified during Phase 1, including additional public consultation and reporting. All four of the options were carried forward to Phase 2. A fifth option was added as part of Phase 2. The additional option was to develop instream weirs along the NSR. Originally, the Committee had anticipated that Phase 2 would focus on a relatively detailed evaluation of one option. Therefore, the Study Terms of Reference for Phase 2 were adjusted based on the results of the Phase 1 investigations and feedback provided at the public meetings.

Phase 1 of the Study included the following tasks:

- Public meetings were held at North Battleford, Turtleford, and Lloydminster in February 2007 to report the purpose of the Study prior to the start of the investigations.
- The water availability in the NSR was determined based on full apportionment of flows at the Alberta-Saskatchewan and Saskatchewan-Manitoba borders.
- The relative value of water was summarized for various uses.
- The Highgate Dam feasibility-level engineering design by PFRA was reviewed and updated.
- The potential for hydropower generation at the Highgate Dam was assessed.
- The potential suitability for regional irrigation projects was investigated, including an appropriate crop mix.
- The expected irrigation benefits and costs were estimated for on-farm infrastructure and the selected crop mix.
- Potential off-channel storage concepts and locations were investigated.
- A conceptual layout and costing was completed for each of four options.

- Potential economic benefits of the four options were estimated.
- A regional economic evaluation was completed for each of the four options.
- A financial analysis was completed for the four options.
- A preliminary socio-environmental assessment was completed for the purpose of identifying potential social and environmental issues associated with the four options. The socio-environmental assessment documented the existing conditions and potential impacts of the options based on available information only. Key issues were then identified.
- A meeting was held with the Committee in June 2007 to report the preliminary results of the Phase 1 investigations.
- Public meetings were held at North Battleford, Turtleford, and Lloydminster in September 2007 to report the results of the Phase 1 investigations. Additional questions from the public were answered by email.

Phase 2 included the following:

- A meeting was held with the Committee to determine the appropriate Phase 2 tasks.
- The Highgate Dam option was updated to include an additional road and rail crossing.
- The Highgate Dam safety requirements were estimated, including an updated design flood. The dam spillway invert was adjusted to suit updated design flood estimates.
- Potential NSR instream weir concepts and locations were investigated.
- Conceptual layout and costing was completed for the selected NSR weir concept and example location.
- Potential economic benefits of the NSR weir option were estimated.
- A regional economic assessment was completed for the NSR weir option.
- The financial analysis was updated for the five options.
- Social and environmental issues were identified for the NSR weir option.
- A public meeting was held in Maidstone on February 27, 2008.
- This report was provided to the Committee, documenting the Study results.

1.3 Study Limits

The extent of the Study was defined by the Committee as the area bounding the North Saskatchewan River (NSR) for 50 km on either side of the NSR from the Alberta – Saskatchewan River to the confluence of Eagle Creek downstream of North Battleford. This limitation was adopted in general by the Study team, but was expanded where necessary to account for upstream and downstream interests.

The Terms of Reference (TOR) for the Study provided limitations on the extent of the investigations, except for refinements to the scope of work for Phase 2. The final scope of work, discussed in the previous section, differs significantly from the original TOR in the following areas:

- All of the options were carried through Phase 2 of the Study, instead of selecting one option.
- The number of public meetings was reduced from 10 to 7.
- The Study exceeded the TOR by completing a site selection investigation for potential off-channel storage concepts and locations.
- The Study exceeded the TOR by completing a similar site selection investigation for potential instream weir options along the NSR.
- The Study exceeded the TOR by adding a fifth option.

Other limitations: The options described in this Study have not been developed to the level suitable for implementation. The economic analysis is preliminary and is intended to provide realistic ballpark costs and benefits for comparison. The potential socio-environmental issues have not been verified by field work, and are intended as an inventory of possible impacts. No formal First Nations consultations have occurred. The Study also does not attempt to identify water conservation measures as a means of reducing the existing river water withdrawals, or measures to ensure suitable water quality of drinking water sources.

2. STUDY AREA

A detailed description of the Study Area is provided as part of Appendix A. The following is a brief summary.

2.1 Location

The Study Area is located in western Saskatchewan and extends roughly 220 km along the North Saskatchewan River (NSR) from the Alberta-Saskatchewan border to the confluence of Eagle Creek near Radisson. The Study Area encompasses 50 km on either side of the river, a total of about 25,000 km^2 of land and a population of about 66,000 people (2006 census). The Study Area includes the cities of North Battleford and Lloydminster, numerous First Nations and associated TLE lands, several rural municipalities, and a major transportation corridor along Highway 16 running roughly parallel to the NSR between Lloydminster and North Battleford. The Study Area and these major features are shown on Figure 2.1 and on Figure 2.2.

2.2 Water Resources

Major water features of the Study Area include the NSR valley which is 50 m to 80 m below the surrounding landscape and about 1,500 m wide. Other features include Jackfish Lake and the Battle River confluence with the NSR near North Battleford.

The NSR has a mean annual flow of 218 m^3/s and drains an area of about 57,000 km^2 from the Alberta Rocky Mountains. The next largest water feature is the Battle River, with a historical mean annual flow of 13.5 m^3/s. Both rivers originate in Alberta and are both partially allocated by Alberta water licences, and regulated by dams in Alberta. The Battle River is over-allocated by Alberta by about three times the mean annual flow, although most of this water is returned to Battle River as municipal or industrial discharges. The selected focus of this Study is the NSR, which is described in more detail as part of the Water Availability section of this report.

2.3 Land Resources

Rural areas within the Study Area can be characterized primarily as part of the aspen parkland natural eco-region, with some boreal transition areas North of the NSR and West of Jackfish

Lake. The Study Area supports a number of significant wildlife protection areas that are shown as part of Figure 2.1. Natural eco-regions are presented on Figure 2.3.

A large portion of the landscape has been converted to agricultural use, whereby the majority of the current land use is either cropland or grassland. About 1 million hectares (46%) of the Study Area is currently cultivated crop land. The distribution of land uses is shown on Figure 2.4.

Historical heritage resources are also present throughout the Study Area, with the highest concentration of sites identified along the NSR. These include historically significant sites such as the Pine Island Trading Post which is currently a provincial park on a channel island in the NSR near the Town of Paynton. Historical heritage resource locations are illustrated on Figure 2.5.

The Study Area currently has significant oil and gas activity West of North Battleford along both sides of the NSR. Oil and gas wells in the Study Area are shown on Figure 2.6.

2.4 Irrigation Suitability

Irrigation operations within the Study Area are currently limited to a few relatively small farm operations along the NSR. Additional areas along the NSR are suitable for irrigation, but have not been developed. Other suitable irrigation areas are located near the Town of Cut Knife. The irrigation suitability for the Study Area is presented on Figure 2.7.

The feasibility of irrigation within the Study Area was determined based on an irrigation suitability assessment using irrigation soil suitability mapping from the Saskatchewan Institute of Pedology (SCSR 1996). The available information included a regional map that identifies areas of irrigation suitability with ratings of Very Good to Good, Moderate, and Poor to Very Poor. The ratings were simplified for the purpose of this Study to: Good (i.e., Very Good or Good); Fair (i.e., Moderate), Poor (i.e., Poor or Very Poor), and none (i.e., water bodies). In total, there are about 519,000 ha of Good irrigable land within the Study Area.

3. STUDY APPROACH

The selected approach for the Study is summarized below. Major tasks include: water availability, selected water uses, identification of appropriate water resource development options, concept layout for each option, estimation of benefits and costs, identification of potential environmental and social issues, and the selected approach for First Nations and public consultation. The selected approach for investigating potential irrigation or industrial development is also described below.

3.1 Water Availability

The amount of available water from the NSR was estimated based on personal communications with the Saskatchewan Watershed Authority (SWA), the provincial regulatory agency responsible for water licensing. SWA provided the recommended basis for determining water availability, and provided information on the current water withdrawal licences. The approach for determining water availability is described in detail in the next chapter of this report.

3.2 Selected Water Uses

The selected water uses for the Study included irrigation water supply and industrial water supply assuming the development of an ethanol production facility. These uses were selected because they are typical of the types of regional economic development that is currently being considered in Saskatchewan. Irrigation was the original focus in the Terms of Reference for this Study, is currently being investigated in a number of areas across the province, and continues to be the focus of recent studies such as the Westside Irrigation Project (UMA 2006). Industrial development of biofuel facilities also has a strong focus on the Canadian prairie provinces. There is currently a 130 ML/yr (i.e., millions of litres per year) ethanol plant in Lloydminster, and additional biofuel development is proposed or is being considered in Saskatchewan including a biodiesel plant in North Battleford. Therefore, these two (consumptive) water uses were assumed to be appropriate types of water use for consideration by this Study.

Other water uses considered by this Study included using the NSR for hydropower generation, controlling the NSR for downstream flood control, and utilizing the NSR for new recreation opportunities.

3.3 Water Resource Development Options

Five water storage options were investigated as part of this Study:

- No Investment (status quo) - representing existing conditions and a reference point for the other options.
- Non-Structural Investment (i.e., small-scale irrigation) - representing a possible future scenario involving the economic development of available water from the NSR without major infrastructure investment. This option assume that six farms along the NSR will develop irrigation using seasonal river intakes and pipelines to the top of the NSR valley wall.
- Off-Channel Storage – an option to withdraw water from the NSR for seasonal storage and distribution, focused on using the water to support regional irrigation. An off-channel storage concept and candidate site were selected among many possible off-channel storage opportunities.
- NSR Weir(s) – an option to illustrate the possible use of in-stream weirs along the NSR, in response to previous discussions by residents. A weir development concept was selected, and a candidate site was investigated assuming that the primary water use would be industrial water supply. An in-stream weir was included, if necessary, to provide sufficient water depth at the intake – but the weir is likely not necessary. Therefore, this option evolved into a similar off-channel storage option for industrial water use.
- Highgate Dam – an on-stream dam and reservoir located near the hamlet of Highgate, about 15 km from the City of North Battleford. This option wasa based primarily on a previous feasibility-level engineering design (PFRA 1970).

3.4 Conceptual Layout of the Development Options

The selected options were presented to the level of a concept layout sufficient to estimate the relevant infrastructure requirements and costs. The layout consists of potential locations and alignments of the water-related structures such as intakes, pump stations, pipelines, and major earthworks. The considerations for the layout included existing rights-of-way, land use, distances, topography, and elevation. Detailed layouts were not provided for water distribution networks such as irrigation water supply laterals to individual pivots.

The concept design layout for the Highgate Dam option was based on the PFRA high head design, with minor modifications.

3.5 Benefits and Costs

Benefits and costs for each option were estimated based on information available from the concept and design layouts, preliminary sizing of infrastructure, and the following:

- Updated assumptions from the previous Highgate Dam investigations (PFRA 1970).
- Updated assumptions presented in the Meridian Dam feasibility study (Golder 2002).
- Westside Irrigation Project (UMA 2006).
- Agricultural crop market conditions as of May 2007.
- Irrigation on-farm costs based on Saskatchewan SAF Irrigation Development Branch 2007 information, and Alberta AAFRD.
- Hydropower capital investment costs based on current standard industry costs (See Appendix D).
- Regional economic factors based on 2003 Saskatchewan provincial economic data (See Appendix E).
- Typical construction costs for reinforced concrete, earthworks, pipelines, pump station, river intakes, power supply, road and rail.
- Preliminary inquiries to relevant responsible agencies such as Saskatchewan Ministry of Highways and Infrastructure.
- Likely environmental mitigation measures.

The following sections describe the basis for estimating benefits and costs of several common aspects among the options. Detailed assumptions of economic benefits and costs for all five options are provided in Appendix B.

Irrigation Benefits and Costs

Irrigation benefits and costs were estimated from available information in Saskatchewan and Alberta for potential costs and crop prices. Regional census information was used to identify a typical existing dryland crop mix, and anecdotal historical information was used to select a likely irrigation crop mix.

A typical dryland crop mix was estimated based on census data for the rural Municipality of Battle River. The mix consists of spring wheat (38%), barley (12%), canola (20%), and field pea (8%), with 21% of cultivated land left fallow.

A mixed-crop scenario was selected to represent the possible regional irrigation development. The mixed crop scenario was assumed to be equal parts canola, potato, soft wheat, and timothy seed. A homogeneous high-value crop mix, such as potatoes, was not selected because of the poor results of previous attempts to test the market feasibility of potatoes in the North Battleford area.

The estimated benefits of irrigation are $316 per year per acre based on increased crop yield and prices, and on-farm irrigation infrastructure costs of $900 per acre. Regional water distribution costs vary among the options. Crop prices were based on market conditions in May 2007 when the bulk of the Study investigations were completed. Current prices may be significantly greater for some crops but do not significantly affect the overall estimated benefits of irrigation, based on the selected mixed crop scenario. Details of the estimated irrigation benefits and costs are provided as part of Appendix B.

Industry Benefits

Industry benefits and costs were based on the development of 50 ML/yr of ethanol production. The capacity to produce ethanol was assumed based on the limitations of surrounding cropland to support ethanol production (i.e., and not based on water availability limitations). A potential 75,000 acres may be needed to support the ethanol production. Industry net benefits assume $0.60 per L of ethanol at 15% net revenue. Initial capital investment for industry was assumed to be private and external to the scope of the Study financial analysis.

Regional Economic Assessment

A regional economic assessment was completed for each of the options for the initial four years from the start of construction, based on SJ Research Service's Saskatchewan Input-Output (Economic) Model. The Saskatchewan Input-Output Model (Model) is a tool to assess the provincial-level economic impact of an event, tourist spending, a new industry, or other shock to the provincial economy. Therefore, the Model does not quantify the existing economic activity. The Model reflects 21 industries and 57 commodities, and variables related to the provincial economy are based on Statistics Canada's 2003 Saskatchewan input-output table (latest available to date). Impacts on the local economy are expressed in terms of gross output, gross domestic product, new employment, and labour income. With the exception of employment, impacts are reported in millions of current dollars.

The regional economic assessment is provided in Appendix E.

Other Costs

Other costs that are common to the options include the following assumptions:

- Project management costs are 10% of capital costs.
- Engineering and Survey costs are 8% of capital costs
- Contingency was selected as 20% of all capital costs, including project management and engineering.
- Operating and maintenance costs are 0.5% of capital costs.
- Infrastructure lifespan and replacement costs are provided for the Highgate Dam option only, based on an expected life span of 100 years.

3.6 Financial Analysis

The financial analysis for each option assumed 6% opportunity cost of capital, for an assumed 3% inflation rate and an assumed 9% return on investment for competing opportunities. Debt financing for the five options assumed an interest rate of 6% and amortization over 50 years.

The expected benefits of the options consisted of short-term regional economic assessment and other long-term benefits. Short-term economic spinoffs were estimated for the initial four years. Other long-term benefits were estimated for a 50-year period, including the effect of inflation. All benefits and costs were converted to 2007 net present value or cost, assuming start of construction in 2012 for all options except Highgate Dam which would commence in 2015.

3.7 Environmental and Socio-economic Issues

Environmental and socio-economic issues were reviewed to identify an inventory of potential issues that may or may not exist but have the potential to exist based on typical impacts from similar activities. The existing baseline conditions were also documented.

The identification and evaluation of the environmental and socio-economic issues associated with each of the options was conducted using the following approach:

- Identificationn of existing environmental conditions for each component under study.
- An overview of major potential issues applicable to water supply and management projects.
- Inventory of potential issues.
- Identification and discussion of typical mitigation strategies to prevent or minimize potential effects.
- An evaluation of the potential significance of the issues.
- An outline of information and studies that are expected to be required to complete a detailed environmental impact assessment.

The detailed inventory of baseline conditions and possible issues is provided in Appendix A.

3.8 First Nations

First Nations are expected to play a significant role in helping to frame and to select a project to be implemented. A formal consultation process will be necessary when a specific project is proposed. The consultation process for First Nations is outlined later in this report. For this Study, First Nations representatives declined to participate on the Committee, but provided information at the public meetings.

3.9 Public Consultation

Public consultation was a major component of the Study, and the Committee relied on public meetings to gather feedback on the direction of the Study.

Public consultation consisted of a total of seven public meetings grouped over three time frames: prior to the start of the Study investigations (February 2007); after Phase 1 investigations were completed (September 2007); and after Phase 2 investigations were completed (February 2008). The meetings were held in North Battleford, Lloydminster, and Turtleford for the first two sets of meetings, and in Maidstone after completion of Phase 2 investigations.

Each public meeting was hosted by a facilitator and consisted of an introduction by the Committee, a formal technical presentation by the Study team, and a question period. Advertisements, venue selection, and refreshments were provided by the Committee. The meetings did not restricted the number of people who could attend or the duration of the meeting.

The Phase 2 Maidstone presentation is provided as Appendix G (previous presentations are not provided because they are superceded by the Maidstone presentation due to information updates and the addition of new information). The meeting minutes were recorded at each meeting and are provided in Appendix H, Appendix I, and Appendix J for the three sets of meetings respectively.

4. WATER AVAILABILITY

The water availability for this Study was estimated as the amount of water available for allocation and withdrawal from the North Saskatchewan River (NSR).

4.1 North Saskatchewan River Flows

The NSR drains an area of about 57,000 km^2 from the Alberta Rocky Mountains to Saskatchewan near the Deer Creek monitoring station on the Saskatchewan side of the border with Alberta. The river flows through the Study Area, and joins the South Saskatchewan River (SSR) near Prince Albert before continuing to Manitoba.

The NSR is currently regulated by two large dams located in the Alberta foothills: Brazeau Dam and Bighorn Dam. The Brazeau Dam was constructed in 1965, and the Bighorn Dam was completed in 1972. Together, these two dams partially regulate the NSR flows for TransAlta hydropower generation. Downstream of the Study Area, SaskPower manages two additional dams downstream of the SSR confluence for the purpose of hydropower generation (Nipawin, Squaw Rapids). Most other dams in the Saskatchewan River basin are located in the SSR basin. The Saskatchewan River basin, including the SSR basin and existing impoundments or dams, is shown on Figure 4.1.

The NSR stream flow is monitored in Saskatchewan by two long-term hydrometric monitoring stations. The station near Deer Creek is located near the Alberta border and has a 58-year period of record between 1917 and the present. The second station at Prince Albert has a period of record of 96 years between 1910 and 2005.

The NSR stream flow varies both seasonally and annually. The highest flows occur in the summer months and the lowest flows occur during the winter. On average, the NSR discharges at a rate of 218 m^3/s based on the long-term average flow near the Alberta border. At Prince Albert, the average annual flow is roughly 10% higher, or 241 m^3/s, despite an increase in the basin area from 57,000 km^2 to 131,000 km^2. Therefore, there is very little contribution of flow from tributaries in Saskatchewan. The lowest recorded annual average flow on the NSR was 136.5 m^3/s at Prince Albert in 1941. The seasonal variability of NSR flows is illustrated on Figure 4.2. The recorded average annual stream flows are presented on Figure 4.3.

Since 1970, after construction of the Brazeau Dam, the NSR average flow has been about 213 m^3/s (i.e., at Deer Creek). More significantly, the winter low flows have increased from approximately 30 m^3/s to about 100 m^3/s (on a monthly average basis) due to regulation by the dams. The lowest recorded daily average flow in the NSR, since 1970, was 25.6 m^3/s at Deer Creek in the winter, and 70.5 m^3/s in the summer based on a summer period of May 15 to October 15. The variability of NSR stream flow on a monthly basis is presented on Figure 4.4. The minimum recorded daily average flows since 1970 are presented for each calendar day on Figure 4.5.

4.2 Regulation of Water Withdrawals

The amount of water available from the NSR for allocation in the province of Saskatchewan is based on an Inter-provincial Apportionment Agreement (Environment Canada 2008). In 1969, the provinces of Alberta, Saskatchewan, and Manitoba signed an agreement to manage the water allocation and quality of eastward flowing inter-provincial streams. Flows in the North Saskatchewan River are governed by this apportionment agreement which is managed by the Prairie Provinces Water Board (PPWB). Under the agreement, Alberta must allow 50% of the natural stream flow that flows through or arises within Alberta to flow into Saskatchewan (i.e., 50% of the natural flows at the Alberta-Saskatchewan border must be allowed to pass). Similarly, Saskatchewan must allow 50% of the natural flow entering or originating in the province to pass into Manitoba. Saskatchewan is, in effect, entitled to 25% of the natural flows in the NSR that enter the province (50% of the 50% natural flow at the Alberta-Saskatchewan border). Saskatchewan is also entitled to use 50% of the natural flow that originates within the province via tributary streams. If small tributaries are neglected, the apportionment of water is as follows:

North Saskatchewan River (natural) flows

Minus 50% allocated to Alberta

<u>Minus 25% allocated to Manitoba</u>

Equals 25% of the NSR natural flow allocated to Saskatchewan

The NSR is not currently regulated by an Instream Flow Needs (IFN) minimum requirement for fisheries or other environmental purposes.

4.3 Existing Water Licences

Alberta Water Allocation

NSR water allocation by Alberta Environment (AENV) in Alberta was about 63 m^3/s or 2 Bm^3/yr (i.e., billions of cubic metres) in 2005 (Source: AENV), with most water licences dated between 1950 and 1980. Of this allocation amount, about 6 m^3/s is estimated to be consumed (i.e. not returned to the NSR) (Source: North Saskatchewan River Watershed Alliance). Therefore, the net reduction of flow to the NSR is estimated to be 6 m^3/s, equivalent to about 3% of the recorded average annual flow.

Saskatchewan Water Allocation

Current water allocation along the NSR in Saskatchewan was based on existing water licences issued by the Saskatchewan Watershed Authority (SWA). The total volume of water allocated is 99.0 Mm^3 per year, equivalent to an average of 3.1 m^3/s (Source: SWA in May 2007). The summer withdrawal is estimated to be 46.7 Mm^3 (3.6 m^3/s), based on the seasonal portions of these water licences. The primary water use along the NSR is manufacturing (76.5%), followed by agriculture (8.4%) and rural municipal (6.4%). The breakdown of Saskatchewan water licences along the NSR is provided by Table 4.1.

4.4 Water Availability

The limits of water availability, or the allowable water allocation for future licences, was estimated for the Study Area based on the conservative assumption of providing approximately 100% water supply security for new licences, and based on the Saskatchewan Watershed Authority's current approach for issuing licences to comply with the Inter-provincial Apportionment Agreement that entitles Saskatchewan to withdraw or divert up to 25% of the natural flows in the NSR.

The selected conservative assumption is that the amount of available water is defined by the lowest recorded flows. For licences with no water storage, the available water was based on the recorded minimum *daily* flow. For applications with large storage, the water availability could be based on the recorded minimum *annual* flow assuming that there is sufficient storage to balance the year-over-year variability of stream flows. This conservative basis for defining water availability is applicable due to the relatively low demand for water in Saskatchewan.

The amount of available water with large storage was estimated to be 31 m^3/s on an average annual basis, or about 15% of the average annual flow, based on the following logic:

Water Availability with Large Storage

- 136.5 m^3/s lowest recorded average annual flow at Prince Albert in 1941.
- 34.1 m^3/s apportioned to Saskatchewan, based on 25% of the 136.5 m^3/s lowest recorded annual average flow (measured prior to any significant allocation of NSR flows in Alberta).
- 31.0 m^3/s water available, based on 34.1 m^3/s apportioned to Saskatchewan minus 3.1 m^3/s currently allocated in Saskatchewan on an annual average basis.

The amount of available water is significantly lower when no storage is available. The conservative assumption is to define the limits of water availability based on short-duration or daily average flows instead of annual average flows. The lowest recorded daily flows since 1970 were used to estimate the water availability as 14 m^3/s for summer withdrawals (e.g., irrigation) and 3.3 m^3/s for year-round withdrawals (e.g., most industrial water uses), based on the following logic:

Summer Water Availability with No Water Storage

- 70.5 m^3/s lowest recorded daily average summer flow since 1970, assuming continued future operation of the Brazeau and Bighorn dams similar to the past 40 years.
- 17.6 m^3/s apportioned to Saskatchewan, based on 25% of the 70.5 m^3/s.
- 14 m^3/s water available, based on 17.6 m^3/s apportioned to Saskatchewan minus 3.6 m^3/s currently allocated during the summer months.

Winter Water Availability with No Water Storage

- 25.6 m^3/s lowest recorded daily average winter flow since 1970, assuming continued future operation of the Brazeau and Bighorn dams similar to the past 40 years.
- 6.4 m^3/s apportioned to Saskatchewan, based on 25% of the 25.6 m^3/s.
- 3.3 m^3/s water available, based on 6.4 m^3/s apportioned to Saskatchewan minus 3.1 m^3/s currently allocated during the winter months.

The amount of available water is summarized by Table 4.2.

This conservative basis for defining water availability results in a lower limit of total future water allocations that could be licensed. In the future, if the total water allocation approaches this limit, there are alternative (less conservative) means of determining the available water limit. In water-scarce regions of western Canada, the Water Resources Management Model (WRMM) is used to establish withdrawal limits.

4.5 Water Resource Development Limits

Based on the conservatively-estimated water availability along the NSR, there are limits to future development. The maximum development limits for a variety of agricultural and industrial uses are presented in Table 4.3.

For example, Saskatchewan could support an additional 700,000 population using the NSR as the water source (assuming an average 400 Lpd per capita municipal water requirements), without new storage. Providing large storage would increase this limit to 6.4 million population. These estimates are based on the assumption that no other water uses are allowed. If the water is instead used to support irrigation, the NSR could support 183,000 irrigated acres (or about 350 sections of land assuming 130 irrigated acres per quarter section and 1 ft/yr average annual application rate). The difference between these two uses is that municipal uses tend to return 80% of the water back to the river while irrigation tends to return only 20% back to the river.

Most industrial uses are not water intensive. Therefore, single industries could be developed with less than 1% of the available water without storage. The exceptions include large meat packing plants (about 3% of the available water), petrochemical processing plants (about 5%), and nuclear generating stations. A nuclear generating station with efficient air-cooled systems would require large storage to supply about 6 m^3/s.

5. WATER RESOURCE DEVELOPMENT OPTIONS

This section presents a summary of each of the five options considered by this Study. The following information is presented herein:

- A description of the option is provided in the following sections, including site selection (where applicable), a summary of the benefits and costs, and a summary of the potential environmental and social issues.
- A detailed discussion of the potential environmental and social issues is provided in Appendix A, including a description of additional environmental information and studies that may be required to advance the various options through the environmental assessment process.
- A detailed accounting of the expected costs and benefits, and related assumptions, is provided in Appendix B.

5.1 No Investment (Status Quo) Option

The existing conditions within the Study Area are represented by the No Investment option (or Status Quo). This option represents a future with no water-related infrastructure investments or no coordination of water resource development. Therefore, it is intended as a reference point for comparing the other options.

The existing conditions within the Study Area can be characterized by the following example activities:

- Dryland agricultural and livestock operations.
- Oil and gas activity throughout the western portion of the Study Area.
- Major transportation corridor between Edmonton and Saskatoon/Winnipeg.
- Ethanol plant in Lloydminster (130 ML/yr).
- Proposed biofuel facility in North Battleford.
- Recreation and guiding activities along the NSR.

The transportation route includes an older rail trestle bridge across the NSR near North Battleford, that will require replacement in the near-term at a cost of about $30M.

In terms of the future water demand for municipal or rural supply, the available water allocation for future licences is 3.3 m^3/s is sufficient to support about 500,000 additional population growth with corresponding commercial and industrial water uses. Future economic development, such as attracting new industry to the region, may be possible with the current availability of water. Possible deterrents include the cost of a large river intake and pumping out of the NSR valley (50 m to 80 m from the river level to the top of the valley wall). There is also a potential for lost opportunities due to inaction and/or inefficient (i.e. uncoordinated) development of the available water resources.

The expected benefits and costs of the No Investment option, for the purposes of this Study, are assumed to be zero. This is not intended to account for the existing economic activity in the area. It is intended as a reference point for comparing the other options.

In the future, it is anticipated that watershed and aquifer and drinking water source protection planning will be the main focus of water supply discussions.

5.2 Non-Structural Investment Option

5.2.1 Description

The Non-Structural Investment option is intended to represent a future scenario where the development of the available NSR water resource is encouraged and supported by funding for initiatives that do not include large infrastructure. It was assumed that this option would attract a number of small-scale irrigation projects to individual farms. A total of six farms were assumed for this option, with three irrigated sections at each farm for a total of 9, 360 acres. It was also assumed that the areas to be irrigated will be adjacent to the NSR or near the edge of the NSR valley in an attempt to reduce the development costs.

The water supply for these irrigation projects are assumed to consist of seasonal (floating) river intakes in the NSR and that water withdrawals would only occur during the summer months when water is required for irrigation. It was assumed that the intakes would be at different locations along the NSR and that development of all six projects would proceed concurrently.

The water requirement for this option is a total of 11.6 Mm^3 (millions of cubic metres) per year, with a combined peak withdrawal rate of 0.9 m^3/s during the summer months (i.e., 0.15 m^3/s or 2,400 gpm peak rate for each farm) assuming 300 mm equivalent depth of irrigation water demand per year. This represents about 6% of the 14.1 m^3/s available water during the summer months.

5.2.2 Expected Benefits and Costs

The expected net benefit of the Non-Structural Investment option is $1M (net present value), or a benefit/cost ratio of 1.01. The net benefits include the following:

- Initial capital costs of $36M, or an average of $3,850 per irrigated acre.
- Financing charges plus operations and maintenance of $28.4M (net present cost).
- Short-term regional economic benefits, due to the construction of the irrigation projects, of $19M (net present value) based on the initial four years.

- Long-term net benefits of irrigation of $46M (net present value), based on a net benefit of $316 per acre per year for the selected mixed crop scenario.

5.2.3 Potential Environmental and Social Issues

No significant environmental or social issues are anticipated from this option, provided that best management practices are used for the site selection process and for construction in and around water. See Appendix A for additional details.

5.3 Off-Channel Storage Option

5.3.1 Description

Off-channel storage is often used to supply water when water availability is intermittent or unreliable, or to supply water during emergencies. For example, off-channel storage is often used on the Canadian prairies for small-scale irrigation projects that utilize smaller creeks that flow only in the spring.

The Off-Channel Storage option is intended to represent a future initiative in which water would be withdrawn from the NSR during the summer months when the river flows are highest, and stored at a separate location for distribution. It was assumed that off-channel storage would be developed for the purpose of supplying irrigation water. The rationale for this option would be the relative benefits and cost savings of distributing water from an off-channel storage location outside of the NSR river valley. This strategy reduces the peak water requirements for pumping out of the NSR valley. This option also has the potential to maximize the utilization of available water when water is scarce, depending on the amount of off-channel storage.

There are several regional opportunities for off-channel storage. A brief site-selection investigation was completed to identify an appropriate and cost-effective location for the Off-Channel Storage option.

5.3.2 Candidate Concepts and Locations

The following candidate concepts and locations were considered for the Off-Channel Storage option. The last option below “Existing Water Bodies near the NSR” was selected as an appropriate and potentially cost-effective off-channel storage option.

Tramping Lake

A pump-storage scheme was identified and assessed by PFRA (PFRA 1992). It involved a river intake located on the NSR downstream of North Battleford and pumping via conveyance works 70 km to Tramping Lake for storage. The cost of this project was estimated at $100 million for the pump stations and pipeline from the NSR to Tramping Lake, not including local distribution and on-farm equipment costs. Tramping Lake is relatively saline (12,000 mg/L) which could pose significant implementation and management issues for an irrigation district.

Large Integrated System

A large integrated irrigation system would consist of a large pump station to withdraw water from the NSR near the Alberta border for distribution to a system of reservoirs and canals or pipelines. Such a system would support 50,000 acres or larger, and would be similar to the irrigation districts in southern Alberta or to the undeveloped irrigation system that was previously considered for the Meridian Dam (Golder 2002). This type of irrigation system would require a relatively large irrigated area to support the infrastructure development. However, the regional irrigation suitability is marginal because the areas that are suitable for irrigation are disconnected along 100 km on both sides of the NSR. This candidate was considered to be too costly based on the regional distribution of irrigable land within the Study Area.

Vawn Dam

Another possible off-channel storage concept is to construct a dam on one of the small tributaries to the NSR, and pump water from the NSR to fill the reservoir behind the dam. This utilizes the tributary water yield to offset some of the pumping from the NSR. One such tributary is located on the North side of the NSR, South of the Village of Vawn. Such a project may also include small-scale hydropower development. This option was not investigated in detail.

Multiple Dams on Gully Tributaries

Small-scale storage is currently provided by many small earth embankments constructed on small gullies and coulees across the prairie provinces. There are numerous suitable locations along the NSR, and some have already been developed by local farmers. While this option could be used to supply livestock watering needs, it is not a secure supply for irrigation because the storage volumes would be too small and water availability would be highly sensitive to drought conditions when irrigation water is needed most.

Existing Water Bodies near the NSR

There are a number of existing small non-saline water bodies or wetland areas near the NSR that could be developed for off-channel storage. The storage capacity of the selected water body would be sized to provide a one year supply or a partial supply for a seasonal water user such as an irrigation district, assuming continuous summer pumping from the NSR. Existing water bodies would be advantageous because they typically have a relatively impervious bottom and the storage capacity could be increased in a cost-effective manner by constructing perimeter berms.

An irrigation district would develop off-channel storage by pumping water from the NSR to the selected water body for seasonal storage and subsequent distribution to a small or medium-sized irrigation district (10,000 to 15,000 acres), focusing on areas that are suitable for irrigation. The process could then be repeated for other irrigation districts. In this way, the infrastructure requirements and storage capacity could be sized to support a relatively contiguous irrigation district and reasonable distances.

There are several locations along the NSR within the Study Area that have a contiguous area suitable for irrigation and opportunities for off-channel storage in an existing water body. It may be possible to develop of up to 10 irrigation districts in this manner. Potential irrigation districts are identified on Figure 5.1, including a location near North Battleford that was subsequently selected for layout and costing.

5.3.3 Layout of 8-mile Lake Off-Channel Storage Option

An existing water body known as 8-Mile Lake near North Battleford was selected as a suitable location for off-channel storage, based on the site-selection exercise described above. A conceptual design layout and cost estimate was prepared for this location.

This off-channel storage option would support 13,130 irrigable acres from land that is currently cultivated. The layout includes a river intake in a NSR side channel (site suitability not confirmed by field studies). The intake would be operated over an 8-month period each year and would pump water from the NSR to two storage ponds (1.3 km^2 each). The ponds are surrounded by 3.5 m high dykes and provide a total of 8.1 Mm^3 of storage. Two additional pump stations would convey water from the storage ponds to the nearby irrigation district. The pipeline from the river and the piped distribution network is expected to follow existing provincial road rights-of-way except for the laterals to the irrigation pivots. A possible concept layout is presented on Figure 5.2.

The water volume in the ponds is expected to fluctuate because the river intake system would be sized for average flow conditions and the irrigation pumping systems that draw water from the pond(s) would be sized for peak flow requirements. The off-channel storage pond is expected to be operated by pumping river water to the ponds over an eight month period, while distributing the water for irrigation over a shorter five month period. Pumping would be scheduled to fill the storage pond(s) in the spring. The reservoir would fill in fall and early spring, while irrigation would tend to draw down the pond over the summer despite continuous filling.

The annual water requirement for irrigation water is expected to be 16.2 Mm^3, assuming an average 300 mm (1 foot) total water application each year. Therefore, the storage capacity of the ponds is about 50% of the summer water needs. A corresponding river intake capacity of 0.75 m^3/s represents about 5% of the 14.1 m^3/s available water during the summer months.

5.3.4 Expected Benefits and Costs

The expected net benefit of the Off-Channel Storage 8-Mile Lake option is $10M (net present value), or a benefit/cost ratio of 1.1. The net benefits include the following:

- Initial capital costs of $57M, or an average of $4,300 per irrigated acre.
- Financing charges plus operations and maintenance of $45.5M (net present cost).
- Short-term regional economic benefits, due to the construction of the irrigation projects, of $48M (net present value) based on the initial four years.
- Long-term net benefits of irrigation of $65M (net present value), based on a net benefit of $316 per acre per year for the selected mixed crop scenario.

5.3.5 Potential Environmental and Social Issues

Potential environmental or social issues may include the following:

- Local employment opportunities may provide a net benefit.
- The First Nations consultation process may identify opportunities or constraints.
- Existing landowners may not cooperate.

- Local disturbances to fish habitat in the NSR near the river intake due to construction of the intake and/or the construction of a weir across the side channel.
- Ecological or social issues associated with the disturbance and alteration of 8-Mile Lake for water storage.

See Appendix A for additional details.

5.4 NSR Weirs Option

5.4.1 Description

The NSR Weirs option originated from preliminary discussions by residents and the Committee. It was originally intended as an NSR instream storage option that avoided a large dam.

Weirs are sometimes used to control river water levels for river boat traffic, to control upstream erosion, or as part of a diversion to raise the river level into a diversion channel, or to provide sufficient depth for a river intake. For example, the SSR weir in Saskatoon is associated with a river intake. The Bow River weir in Calgary is associated with a diversion to an irrigation canal. However, weirs do not provide any storage capacity for withdrawals. Weirs can also be very dangerous to boaters and swimmers due to the circular vortex currents in the standing wave on the downstream side of the weir. Finally, weirs are typically a barrier to fish passage. Alternatives to weirs include river training structures such as dykes or groynes, and water intake or diversion designs that do not require a weir. For example, large water intakes for petrochemical facilities along the NSR near Edmonton do not require a weir.

The "NSR Weirs" option was envisioned as an opportunistic water control structure (if necessary) for an NSR water intake, to be used for industrial water supply. In this way, the concept for an appropriate "Weirs" option is similar to the "Off-Channel Storage" option – except for the end use of water. The selection of an industrial water supply as an alternative to irrigation rounds out the range of possible options and contrasts the relative water demands and benefits associated with these different water uses.

The best locations, based on the above assumptions, are expected to be near existing infrastructure and transportation where future industrial development is more likely to be feasible and economical. One location was selected among the candidates described below, but it may be possible to develop a river intake for industrial water use anywhere along the NSR.

5.4.2 Candidate Locations

Suitable locations along the NSR for an intake and potential weir have not been surveyed. However, it is assumed that river conditions are suitable for a weir across the NSR at the

Highgate Dam location (PFRA 1970). Other locations may also be suitable for an intake, including river side channels. There are a number of channel islands along the NSR, and a feasible side-channel location would minimize the cost and environmental footprint of an intake and a weir. The site selection process for an intake would consider whether a weir or other river training structure is necessary to provide sufficient water depth at the intake location.

Along the NSR within the Study Area, the best locations for water intakes to support future industrial development are near North Battleford where the road and rail transportation infrastructure and workforce are concentrated near the NSR. Candidate river intake locations were selected near inland terminal locations so that any future industrial development will have easy access to both rail and road transportation.

Four potential weir locations are shown on Figure 5.3:

- Highgate Weir, a weir across the entire NSR channel at the location selected by PFRA as a feasible location for a large dam.
- Battleford Weir, located along a side channel of the NSR near the town of Battleford.
- Saskatchewan Wheat Pool (SWP) Weir, located in a NSR side channel near the Saskatchewan Wheat Pool East Inland Terminal along Highway 16 East of North Battleford.
- Parrish and Heimbecker (P&H) Weir, located in a NSR side channel near the Parrish and Heimbecker Inland Terminal along Highway 4 North of North Battleford.

The P&H Weir river intake location was used to illustrate the "NSR Weirs" option. This location at the P&H Inland Terminal is also where a biodiesel production facility is currently proposed and is in the planning stages.

5.4.3 Layout of NSR Weirs P&H Weir Option

The layout for the P&H Weir option includes an in-stream weir constructed on a side channel of the NSR to create sufficient depth for the water intake, assuming that a weir is needed. A pump station would convey river water out of the NSR valley to a temporary storage pond. The selected pond storage area is an existing low-lying wetland area that would be controlled by constructing perimeter dykes and an outlet control structure on a small tributary channel. Water would then be pumped to the adjacent Parrish and Heimbecker (P&H) inland terminal for industrial water supply, grey water uses, and to supply emergency fire water. It was assumed that the likely industrial development would be a 50 ML/yr ethanol production facility. The conceptual layout is shown on Figure 5.4.

The river intake peak design capacity was selected as 0.2 m^3/s, and the annual water requirement is expected to be 0.4 Mm^3/yr. This represents about 6% of the 3.3 m^3/s available water during the winter months.

The P&H Weir option could be used to support additional industrial development or intensive livestock water supply. This would require some additional costs to increase the size of the pumps and pipes, depending on the additional development. Irrigation development could also be supported, similar to the Off-Channel Storage option. However, infrastructure support for irrigation would significantly increase the costs due to the relatively large water volumes that are required.

An alternative design for this option could consider pumping directly from the NSR to the industrial water use area, without temporary pond storage. This would reduce the need for dyking and water control structure and a second pump, but would require greater pump capacity in the river for peak water needs.

5.4.4 Expected Benefits and Costs

The expected net benefit of the P&H Weir option is $128M (net present value), or a benefit/cost ratio of 6.9. The benefits assume that capital investments to construct the ethanol production facility are private costs and are not included. The net benefits include the following:

- Initial capital costs of $12M for the water-related infrastructure.
- Financing charges plus operations and maintenance of $9.5M (net present cost).
- Short-term regional economic benefits, of $79M (net present value) based on job creation and other regional economic spinoffs over the initial four years.
- Long-term net benefits of industrial production of $71M (net present value), assuming an average ethanol sale price of $0.60 per litre and 15% net revenue.

5.4.5 Potential Environmental and Social Issues

Potential environmental or social issues are expected to be similar to the Off-Channel Storage option, and may include the following:

- A weir may not be needed to provide sufficient depth for the river intake.
- Local employment opportunities may provide a net benefit.
- The First Nations consultation process may identify either opportunities or constraints.
- Existing landowners may not cooperate.
- Local disturbances to fish habitat in the NSR side channel near the river intake.
- Potential increased sedimentation of the side channel due to the weir.
- Ecological or social issues associated with the disturbance and alteration of the wetland area and small tributary to be used for water storage.

See Appendix A for additional details.

5.5 Highgate Dam Option

The Highgate Dam option represents a large capital investment compared to the other options. A greater effort was therefore made to identify and characterize the costs and benefits and potential issues. The following sections summarize the assumptions and estimates related to this option.

Additional information is provided in Appendix A for potential environmental and social issues, in Appendix B for detailed estimates of benefits and costs, and in Appendix D for the hydropower feasibility assessment. Dam location information and potential infrastructure damages are shown by the alignment sheets in Appendix F. The PFRA feasibility design report is provided in Appendix C.

5.5.1 Dam Location and Layout

The Highgate Dam option location and layout was based on the PFRA high-head feasibility design (PFRA 1970), with some (minor) modifications. A second lower head-dam design by PFRA was not considered as part of this Study because it would result in a similar environmental footprint but provide fewer benefits related to hydropower generation and water supply security.

The dam location and layout are presented on Figure 5.5 and Figure 5.6.

PFRA High-Head Dam Design

In 1970, the PFRA completed an engineering feasibility design to develop a reservoir on the North Saskatchewan River, near the hamlet of Highgate, Saskatchewan (PFRA 1970). The proposed dam site was located immediately downstream of the confluence of the Jackfish River, about 16 kilometres upstream of the City of North Battleford.

The PFRA designed the dam for water supply and potentially for downstream flood control. It is assumed that the primary purpose of water storage in the reservoir was for irrigation development. At the time of the PFRA study, additional uses such as hydropower generation were not considered.

PFRA designed the Highgate Dam as an earth embankment with a dam crest of 520.29 m. The embankment would be up to 1,100 m wide at the base, 54 m high and 1,430 m long. Borrow areas for embankment materials would be located adjacent to the dam site on both sides of the NSR valley.

Three diversion tunnels on the North side of the valley would be constructed to divert the NSR stream flows during construction of the embankment, and to provide for riparian releases during operation. The tunnels would be approximately 6 m (20 ft) in diameter.

A gated spillway would be located in the northeast abutment near the diversion tunnels. The spillway was designed with an invert elevation of 515 m based on the selected 500-yr return period design flood. The spillway would include seven radial gates, a concrete chute, and stilling basin. The spillway length would be about 880 m.

The dam would be constructed over a 4-year period. Water storage in the reservoir is assumed to accumulate during a period of relatively high flows. The timing of filling would be subject to natural variability of flows in the NSR.

Design Modifications

The PFRA design was modified for the purpose of this Study to accommodate updated dam safety requirements and additional water uses. The modifications are listed below:

- Addition of a 114 MW capacity power plant for hydropower generation, assuming that two of the three diversion tunnels would be used as penstocks for the turbines. The design was based on a design plant flow of 300 m^3/s, with relief valves on Francis turbines.
- Addition of an electrical transmission line from the power plant to the existing electrical sub-station on the East side of North Battleford.
- Widening of the dam crest by 12 m to accommodate rail and road traffic. The rail crossing would replace the existing trestle bridge located about 4 km downstream of the dam location. The road crossing would provide 2-lane local traffic access to either side of the valley, but would not replace the existing Highway 16 bridge. This widening is considered the minimum width required to accommodate the transportation corridor. A 50m long bridge is necessary to span the spillway gates as part of this new transportation corridor.

- Lowering of the spillway invert by 5 m from 515 m to 510 m, to accommodate the updated design flood based on current dam safety requirements.
- Addition of a fishway to allow fish passage around the dam.

Several design changes would be required to accommodate a power plant, as noted below:

- Increasing separation of tunnels #1 and #2 to facilitate dewatering of the plant area.
- Dewatering of the powerhouse area by construction of a sheet steel pile cellular cofferdam approximately 20 m in height and 160 m long.
- Lowering the stilling basins for tunnels #2 and #3 to conform to the underside of the powerhouse.
- Lowering the centerline of tunnels #2 and #3 to match the turbine spiral casings.
- Adding an access road to the powerhouse.
- Lining two of the penstocks with steel to accommodate increased internal pressure imposed by the turbines.
- Adding surge tanks ~200 m upstream of the powerhouse; with water hammer and surge allowances of +45% and -35%.

Reservoir

The Highgate Dam reservoir would flood the upstream NSR valley for about 200 km. It would extend into Alberta and would cover an area of about 18,400 ha. At the full supply level (FSL) of 510 m (1673 ft), the maximum depth would be about 45 m at the face of the dam. About 4,000 Mm^3 (millions of cubic meters) of water would be stored in the reservoir (equivalent to about 220 days of stream flow at the annual average flow rate). The reservoir capacity and area capacity curves are presented by Figure 5.7.

The reservoir is expected to cause instabilities in the NSR valley walls, as described by PFRA in terms of existing landslides and slumps along the valley. It was estimated that buildings and other infrastructure may require a 100 m setback from the valley wall to avoid slope failures or erosion along the length of the reservoir. This setback distance along the length of the reservoir has not been quantified or verified by field studies or by detailed analyses.

Over time, the reservoir is expected to accumulate sediment due to suspended sediment from inflows, and erosion of the valley walls. This sediment accumulation is one measure for defining the expected lifespan of the dam. It was estimated that the reservoir sedimentation may begin to affect dam operations as soon as 100 years from the time of construction, assuming 15% loss of storage capacity and upper limit estrimates for sedimentation.

The reservoir is expected to result in a net loss of water due to evaporation from the reservoir water surface. Lake evaporation is expected to be greater than precipitation, resulting in a net loss of about 48 Mm^3 per year or 1.5 m^3/s on an average annual basis. Additional net groundwater recharge from the reservoir was not estimated or include in the expected losses.

Reservoir Operations

Reservoir operations would allow the water levels to fluctuate seasonally and year-by-year. Preliminary development of the reservoir operating rules assumed the following:

- Hydropower operating range of 10 m between 510 m and 500 m, with all water releases through the power plant while in this range.
- Downstream releases to maintain the existing monthly average flows while in the hydropower operating range.
- Downstream releases of 50% of the existing monthly average flows while the reservoir is below the hydropower operating range.
- Flood releases over the spillway when water levels exceed 510 m.

Based on the selected operating rules and the variability of NSR stream flow, the reservoir is expected to fluctuate by more than 10 m, including periods of several years below the 510 m FSL. Simulated reservoir levels are shown on Figure 5.8.

Design Flood

The design flood for the Highgate Dam is based on current dam safety requirements by the Canadian Dam Association (CDA) dam safety guidelines (CDA 2007). These guidelines were used to determine an appropriate spillway invert elevation for the PFRA spillway design and embankment dam. This updates the PFRA design, which assumed a 500-year return period design flood of 6,800 m^3/s peak flow.

The dam safety classification for the Highgate Dam was rated as VERY HIGH consequence of dam failure, due to the potential loss of 10 or more lives and $1B (billion) or more damage to the cities of North Battleford and Prince Albert in the event of a catastrophic dam failure. Based on this classification, the appropriate design flood peak stream flow was selected as 2/3 of the difference between the 1,000-yr return period flood peak and the probable maximum flood (PMF) peak flow rate.

Based on this classification, the Highgate Dam is expected to have 0.65 m of freeboard below the top of the dam (520.29 m) during the design flood. This is based on a 510.11 FSL, spillway radial gates stuck in the closed position to force the discharge over the top of the gates (510.75 m), assuming no low level releases through the tunnels. The design flood inflows were based on the estimated flood peak and hydrograph shape described below.

The design flood peak flow was estimated to be 13,700 m^3/s, based on an estimated 7,000 m^3/s 1,000-yr return period flood peak and 17,100 m^3/s PMF peak flow. The flood peak estimates were based on the following:

- The 1,000-yr flood peak was derived by a statistical analysis of the historical record of NSR flows at both Deer Creek and Prince Albert stream flow monitoring stations. The flood peak is due to summer rain events.
- The PMF flood peak was assumed to be 4.3x the 100-yr flood, based on a comparison of PMF estimates of other rivers in the Canadian prairies (Alberta Transportation 2004).

Routing of the design flood through the Highgate Dam reservoir was based on daily inflows, and hourly recalculation of water levels and spillway discharges. The inflow hydrograph shape for the design flood was based on the shape of the largest flood on record in 1915, which had a flood peak of 5,400 m^3/s (daily average).

The design flood peak, compared to other flood peaks, is presented on Figure 5.9. The design flood maximum water level is presented on Figure 5.10.

Design Life

The assumed design life for the Highgate Dam is 100 years. The dam is then assumed to be decommissioned. Decommissioning of the dam was included in the estimated costs for the dam.

5.5.2 Expected Uses

The Highgate Dam is expected to provide the following uses or benefits:

- Hydropower generation from downstream releases through the power plant.
- Irrigation water supply.
- Industrial water supply.
- Downstream flood control for the City of Prince Albert.
- Transportation corridor for rail and a local access road.
- Recreation property development near the reservoir.

Hydropower

Hydropower generation assumes an average 60% utilization of the 114 MW generation capacity, integration with the SaskPower grid, and a sale price of $0.10 per kWh subject to 3% inflation starting in 2015.

Irrigation

Irrigation water supply is based on 0.3 m per year water application rate for a mixed crop scenario with net benefits of $316 per acre per year, assuming 50,000 acres total irrigation area situated in 5 districts of about 10,000 acres each. Assumed infrastructure costs are $3,500 per acre plus on-farm costs of $900 per acre.

Industrial Development

Industrial development is based on the construction of an ethanol production facility with 50 ML/yr capacity, assuming 8 L of water is required for each 1 L of ethanol production and that up to 75, 000 acres of crop land maybe required to support this development. The benefits of industrial development were based on a sale price of $0.60 per L of ethanol and 15% net revenue.

Transportation

The road and rail transportation links provided by the Highgate Dam were included assuming that the nearby rail trestle bridge is near the end of its design life. The Highgate Dam embankment was widened by 12 m to accommodate a two-lane road and a single rail line, including a 50 m span bridge over the spillway. It was assumed that no measurable economic benefits would be derived from these transportation links.

Downstream Flood Control

Downstream flood control due to the Highgate Dam in the City of Prince Albert is assumed to protect the city up to and including the 500-yr return period (pre-dam) flood. Information on the 500-yr floodplain limit was the maximum available flood inundation area (Rogers and Scott 1984). Flood control benefits were based on estimates of the residential and commercial infrastructure within the 500-yr floodplain limit, assuming that the Highgate Dam results in avoiding one future flood equivalent to a 500-yr return period event.

Recreation Property Development

Potential recreational property development along the Highgate Dam reservoir was estimated as a possible benefit of the dam. Recreation properties were assumed to be near transportation corridors and in areas not currently dominated by oil and gas activity. The benefits assumed parcels of land and development set back a minimum of 100 m from the valley wall to avoid potential instability of the valley wall after the reservoir is filled. The property values were estimated to be lower than prime lake front properties in the region.

5.5.3 Water Allocation

The expected annual water allocation requirements associated with the Highgate Dam option could include the following (in millions of cubic meters):

48 Mm^3 to account for reservoir net evaporation.
61.7 Mm^3 required for 50,000 acres of irrigation.
0.4 Mm^3 for 50 ML of ethanol production.
7.3 Mm^3 for municipal water uses, assuming up to 50,000 population growth.
1.6 Mm^3 for livestock watering, assuming up to 100,000 additional cattle.
119 Mm^3 total annual water requirements (3.8 m^3/s annual average)

The expected water requirement of 3.8 m^3/s represents about 12% of the 31 m^3/s available water (for large storage), and a possible 2% reduction in the annual average stream flow.

5.5.4 Expected Benefits and Costs

The expected net benefit of the Highgate Dam option is $-3,282M (net present value) or a benefit/cost ratio of 0.39, assuming that dam construction starts in 2015. The costs and benefits include the following:

- Initial capital costs of $3,043M for the water-related infrastructure, including the following major components:
  - $370M earth embankment dam
  - $256M spillway
  - $209M diversion (tunnels)
  - $164M power plant
  - $ 60M rail and road corridor across the dam
  - $220M irrigation infrastructure and on-farm costs
  - $545M damage or replacement/mitigation of infrastructure
  - $146M engineering and project management (8% of capital costs)
  - $416M contingency (20% of all costs))
  - $546M interest charges during construction (6% loan interest)
  - $110M other costs
- Operations and maintenance costs of $2,361M (net present cost), where the majority of this cost is due to debt financing.
- Short-term regional economic benefits of $336M (net present value) are based on job creation and other regional economic spin-offs over the initial four years.
- Long-term benefits are expected to be $1,786M (net present value), based on the following:
  - $1,046M hydropower generation (about 60% of the total benefits)
  - $248M irrigation
  - $71M ethanol production
  - $146M flood control benefits at Prince Albert
  - $276M recreation property development along the reservoir.

A key sensitivity of the cost estimate for the Highgate Dam is the expected cost of reinforced concrete. The assumed installed cost of reinforced concrete was $1,000 per cubic yard. This cost is relatively uncertain and an increase in concrete costs would significantly increase the cost of the dam. For example, a cost of $1,500 per cubic yard would increase the cost of the dam by $500 million ($300 million additional capital cost plus $200 million interest costs due to debt financing).

Costs associated with construction of the Highgate Dam were based on quantities reported by the 1970 PFRA design, based on unit costs derived from professional experience, construction blue book rates, and Meridian Dam costs (Golder 2002) adjusted for inflation, and based on personal communications with Saskatchewan Highways and SaskPower and Saskatchewan Watershed Authority.

Cost estimates for the hydropower power plant and associated works were developed using the HydroHelp 2 program, based on the following:

- Use of union labour.
- Design standard to "Utility" quality (includes supervision of site work along with inspection/documentation/testing of equipment supply and installation).
- Continued use of contractor equipment used for dam construction.
- 210 frost-free days at site.

5.5.5 Infrastructure Mitigation or Replacement

Construction of a dam and reservoir is subject to secondary costs related to land acquisition and infrastructure damage. The expected infrastructure impacts or replacement/mitigation costs include:

- Dam decommissioning funds to be placed In Trust prior to construction.
- First Nations claims, to be determined.
- A fishway to allow fish passage around the dam.
- Additional environmental mitigation or compensation, to be determined.
- 17,300 acres of land purchased or compensated (including 6,600 cultivated acres, of which 3,500 acres can not be recovered).
- 10,700 acres of land cleared prior to reservoir filling.
- 150 abandoned oil and gas wells.

- Pipeline abandonment or repair associated with oil and gas wells.
- 120 abandoned or replaced water wells.
- 10 river intakes to be replaced.
- 50 homes, farms, or businesses may be affected and may need to be relocated, including 1 golf course.
- 2 major bridges to be replaced (Maidstone and Deer Creek bridges).
- Paynton Ferry to be replaced.
- 15 smaller (culvert or bridge) stream crossings to be replaced or removed.
- Minor railway grade and alignment modifications.
- Minor power transmission line modifications.

Alignment sheets are provided in Appendix F showing the locations of infrastructure impacts along the reservoir and at the dam site.

5.5.6 Potential Environmental and Social Issues

Potential environmental or social issues for the Highgate Dam option include the loss or disruption of the infrastructure listed above. Additional potential issues (either negative or positive) include the following:

Broad-Based Issues

- Public opinion appears to be significantly against the construction of a dam, based on public meeting participation and comments.
- The availability of a suitable skilled labour force may challenge the timing and feasibility of Highgate Dam construction due to current economic conditions and a general shortage of skilled labour.
- The First Nations consultation process may identify high impact issues that could prevent the construction of the Highgate Dam, including mundation of First Nations lands.
- Lake sturgeon fish species is formally under review for the Federal Species At Risk Act (SARA) listing. This may prevent the construction of the Highgate Dam. The Fisheries and Oceans Canada (DFO) is currently reviewing all projects as if lake sturgeon is listed by SARA.
- Potential additional future economic benefits, in addition to those listed, are unknown and undefined, but may add to the net economic benefits of the dam.

Dam and Reservoir Issues

- A feasible fishway concept has not been identified. Lake Sturgeon fish species, in particular, has not successfully migrated past conventional fishways.
- Some rural areas, located South of the Town of Vawn, may have reduced accessibility to North Battleford due to inundation of NSR tributary valleys.
- Landowners along the NSR valley may not participate.
- Loss or alteration of existing recreational uses, including hunting, fishing, guiding.
- Loss of heritage resource sites in the NSR valley, including channel island trading posts (e.g., Pine Island).
- The water quality in the reservoir may be negatively affected by high nutrient loading from inflows.
- The NSR valley walls along the reservoir may be unstable or less stable than anticipated, and the 100 m nominal setback distance may be insufficient.
- Riparian areas along the reservoir shoreline may be devoid of vegetation due to operation of the dam for hydropower with relatively large water level fluctuations.
- The fluctuation of reservoir water levels over a range of 10 m may result in intermittent inundation at the upstream end of the reservoir, and prevent the development of aquatic vegetation around the reservoir.
- Reservoir levels may tend to be lower based on climate change trends over the past century toward lower inflows and increased river withdrawals in Alberta.
- Sediment accumulation in the reservoir may begin to affect dam operations as soon as 100 years from the time of initial dam construction.
- Dam decommissioning requirements have not been identified.
- Wildlife habitat may be disrupted and fragmented, and direct disturbances to wildlife are expected.
- The appearance of the NSR valley along the reservoir will be significantly different, and the associated aesthetic values may be different.
- Groundwater recharge to the local aquifers near the reservoir may be increased.
- There may be direct effects due to fish mortality through the hydro-electric power plant.

Downstream Issues

- The downstream suspended sediment loading in the NSR may be insufficient to maintain the current morphological characteristics and fish habitat.
- Downstream flood peaks may be significantly reduced.
- Downstream winter flows may be greater during dry conditions.
- Prince Albert may be able to remove existing flood protection works due to increased flood protection from the dam.

Potential environmental and social issues are described in Appendix A.

6. COMPARISON OF WATER RESOURCE DEVELOPMENT OPTIONS

The five options presented by this Study are presented below in terms of the net benefits and key potential issues. The information presented below is also provided in Appendix A (potential environment and social issues) and Appendix B (benefits and costs).

6.1 Benefits and Costs

A summary of the benefits and costs is shown in Table 6.1.

The following is a comparison of the benefits and costs among the options:

- The highest net benefits are due to industrial use of water. The NSR Weirs P&H Weir option provides water only for industrial use, and has a benefit/cost (B/C) ratio of 6.9, compared to 1.1 or less for the irrigation options. Industrial water use for ethanol and similar industries is significantly less water-intensive compared to irrigation.
- Irrigation within the Study Area provides a relatively small net benefit, based on the selected mixed crop scenario. Additional work would be necessary to prove soil suitability and market conditions for higher value crops such as potatoes. If the marginal net benefits of irrigation can be increased from $316 per acre per year to $500, the net result would be an increase in the B/C ratio from about 1.0 to more than 1.4 for the Non-Structural Investment, and off channel storage options.
- The Highgate Dam does not provide adequate net benefits if debt financing is required.

The relatively low net benefits of the Highgate Dam include significant costs due to debt financing, consistent with the other options presented in this Study. However, large infrastructure projects such as the Highgate Dam are often constructed without debt financing using public funding, assuming no expectation to repay the initial capital costs. The Meridian Dam Study (Golder 2002), for example, assumed public funding and therefore did not include debt financing. Public funding is a common practice for large-scale infrastructure projects with diverse benefits and multiple recipients of those benefits. In other words, public funding is used for the greater public good.

Without debt financing, the Highgate Dam net benefits would be $-476M with a benefit/cost ratio of 0.81. The Highgate Dam may provide a net benefit if debt financing is avoided, and if the electricity sale price in 2015 is significantly greater than the assumed $0.10 per kWh. A sale price of $0.15 per kWh starting in 2015 would increase the net benefits of the Highgate Dam option by about $500M (net present value) and result in a benefit/cost ratio of 1.0.

Without debt financing, the irrigation options of “Non-Structural Investment” and “Off-Channel Storage” would have a B/C ratio of about 2.0 because about 50% of the costs are due to principal repayment and interest charges. The industrial water supply option “NSR Weirs” would have a B/C more than 10.0 without debt financing.

The attractiveness of each option, in terms of the B/C ratio, is also highly sensitive to the relative cost of capital. If the cost of capital is greater than the assumed 6%, the irrigation options will have B/C less than 1.0. Likewise, a low 3% cost of capital would result in a Highgate Dam B/C ratio greater than 1.0.

The benefits and costs were also compared in terms of the relative value of water use. The selected industrial use has the highest relative value per unit water, while irrigation has a relatively low value of less than $1 per cubic metre of water due to the cost of infrastructure. Hydropower has a relative value of greater than $1 per cubic metre if infrastructure costs are neglected (due to shared costs with other purposes). The relative value of water for different uses is summarized in Table 6.2.

6.2 Key Social and Environmental Issues

6.2.1 Rating Method

Key potential social and environmental issues were summarized for the five options based on a rating scale for the potential significance of an issue to a project moving forward. The potential significance relates to the effect that the issue may have on the viability of the project. The rating scale represents a combination of potential significance of issues, ease of mitigation, and overall effort for assessment. These combinations were ranked using the following “Issue Rating Scale”:

1. Negligible
2. Minor
3. Moderate

4. High
5. Potential fatal flaw

6.2.2 Key Socio-Economic Issues

The most significant socio-economic issue is the potential result of First Nations consultations on the Highgate Dam option. First Nations issues are a potential fatal flaw for the Highgate Dam option.

The key potential socio-economic issues for each of the options are provided in Table 6.3. Issues considered to have a net positive effect are marked with a plus sign (+).

6.2.3 Key Environmental Issues

The most significant environmental issue is the possible listing of lake sturgeon by SARA. This could be a fatal flaw to the Highgate Dam option. The key potential environmental issues for each of the options are provided in Table 6.4.

7. NEXT STEPS

7.1 Process for Selecting a Preferred Option

A preferred or recommended option was not selected in this Study. Instead, this Study provides the information to compare a range of options prior to proceeding to the next steps. The next step for the Committee or another entity may be to select a preferred option.

Considerations for selecting the preferred option include the following:

- Availability of funding sources.
- Scheduling constraints.
- Regulatory or administrative requirements.
- Unanticipated engineering feasibility issues.

If a preferred option is not obvious, then a formal decision analysis in a workshop setting may prove beneficial. A formal decision analysis allows a group of decision-makers to express opinions or perspectives combined with the quantitative benefits/cost information and the qualitative socio-economic issue information. There are a variety of multi-criteria decision analysis techniques available to structure such a formal process. In general, these techniques organize the options with the evaluation metrics (e.g., cost) in a matrix format. Some interpretation is usually necessary to include qualitative metrics such as labour force availability. The ranking of options typically follows with a structured process for describing the relative importance of evaluation metrics. This process can also be used to identify key data gaps and to target areas for building consensus.

7.2 Environmental Assessment and Legislative Requirements

Once a preferred option has been selected, it will be necessary to obtain regulatory approval prior to construction. Regulatory approval is contingent upon governmental review of an environmental assessment (EA) for the proposed project, and submission of applications for approvals, authorizations, permits and/or licences as necessitated by various Federal and Provincial Acts and regulations. This section describes the provincial Saskatchewan and federal Canada EA processes and regulatory permitting requirements, including considerations for the five options described in this Study.

7.2.1 Definitions Applicable to the Environmental Approval Process

A variety of terms pertaining to EA are used to describe both the process and the different documents that could be required for project approval. The following section provides a summary of these terms and the context in which they pertain to Saskatchewan's regulatory process, while cross-referencing them to the Federal process.

- **EA** – the general term used to describe a wide range of Environmental Assessments of varying size and scope. This is the assessment process by which the environmental baseline conditions and environmental and social effects are determined and then reported for regulatory review.
- **Development** – According to Provincial legislation (Government of Saskatchewan 2002), a 'development' is: any project, operation or activity or any alteration or expansion of any project, operation or activity which is likely to:
    1. have an effect on any unique, rare or endangered feature of the environment;
    2. substantially use any provincial resource and in so doing pre-empt the use, or potential use, of that resource for any other purpose;
    3. cause the emission of any pollutants or create by-products, residual or waste products which require handling and disposal in a manner that is not regulated by another Act or regulation;
    4. cause widespread public concern because of potential environmental changes;
    5. involve a new technology that is concerned with resource use and that may induce significant environmental change; or,
    6. have a significant impact on the environment or necessitate a further development, which is likely to have a significant impact on the environment.

- **Project Description** – in the Federal process, the Project Description is an introductory document presented to federal regulatory agencies that gives a basic description of the project and describes how and when the project will be constructed. The Project Description is typically brief and initiates the federal EA process.
- **Project Proposal** – the Provincial report that is required to determine whether or not a project is a development. The scope and detail of this report can vary from a brief project summary (equivalent to a federal project description) to a more detailed

preliminary EA (which could fulfill federal screening requirements) depending on the complexity of the proposed project. A detailed Project Proposal describes the proposed project in detail, summarizes the environmental baseline conditions, provides a discussion of the potential environmental effects that could occur as a result of the project, and describes proposed mitigation measures that can reduce the potential impacts to the environment. Regardless of the details contained in the Project Proposal, it should provide enough information to the Saskatchewan Ministry of Environment so that each of the 'development' criteria can be accurately evaluated.

- **Provincial Environmental Impact Assessment (EIA)** – if a proposed project is considered to be a 'development', it must receive provincial ministerial approval to proceed. The proponent will be required to complete an EIA and document the results in a report called an Environmental Impact Statement (EIS). This incorporates a considerable multidisciplinary baseline assessment combined with an extensive impact and cumulative effects assessment of the project. An EIA is typically warranted for larger projects that have potential for significant adverse environmental effects and/or may generate public concern.

A comparison of the Federal and Provincial EA processes is illustrated on Figure 7.1 and further described below.

7.2.2 Federal Process

The *Canadian Environmental Assessment Act* (*CEAA*) is the legal basis for the federal EA process. This Act defines the responsibilities and procedures for EAs of projects that involve the Federal Government. The *CEAA* applies whenever the Government of Canada exercises a power, duty, or function by involvement through one or more of the following activities (or triggers) by a Proponent:

- proposes a project;
- sells, leases, or otherwise transfers control or administration of land to enable a project to be carried out;
- contributes money or any other form of financial assistance to a project; and,
- exercises, in relation to a project, a regulatory duty (such as issuing a licence, permit, or approval) under legislation included in the Law List Regulation.

Four levels of EA are defined under the *CEAA* that generally correlate to provincial EIA requirements and involve increasing levels of effort on behalf of the proponent for both project applications and approvals:

- **Screening** – involves documenting the environmental effects of a proposed project to determine if there is a need to eliminate or mitigate any adverse effects, to modify the project plan or to recommend further assessment through mediation or a review panel. A Class Screening is an additional type of screening that may apply to certain projects within a class, or similar type of project with well understood impacts. The information required by a screening can sometimes be equivalent to that contained in a detailed provincial Project Proposal or can be addressed in a provincial EIA.
- **Comprehensive Study** – generally includes large projects that have potential for significant adverse environmental effects and/or may generate public concern. Projects that qualify as Comprehensive Studies are also described in the Comprehensive Study List Regulations in the *CEAA* (1992). The Minister of the Environment will decide early on if the project should remain as a Comprehensive Study or if it should be referred to a mediator or review panel. The Comprehensive Study is approximately equivalent to a provincial EIA.
- **Mediation** – a voluntary process of negotiation that involves an impartial mediator who helps the interested parties to resolve their issues regarding the project. Mediation is generally used when the interested parties are willing to participate, and reaching a consensus is possible. This process can be used alone or in combination with a review panel. Mediation can be included in the Project Specific Guidelines for a provincial EIA.
- **Review Panel** – a group of experts appointed by the Minister of the Environment. They are responsible for an impartial and objective review and assessment of the project. A Review Panel is sometimes required for a federal EA if the project generates significant public concern or the EA has identified issues that cannot be sufficiently mitigated.

7.2.3 Saskatchewan Provincial Process

The main provincial Act that governs EA approvals in Saskatchewan is the *Environmental Assessment Act*. This Act determines if the Project is a 'development' and subsequently requires an EIA. If the Project is deemed to not be a development, it may then proceed subject to applicable regulatory requirements.

The Province of Saskatchewan is responsible for five key components in the provincial EA process:

1. determining whether or not a project is a development;
2. preparation of Project Specific Guidelines;
3. preparation of supplemental information requests;
4. completing public review of final EIS; and,
5. Minister's decision to approve or not to approve the development and preparation of approval conditions (if required).

The provincial EA and review process is summarized on Figure 7.2.

The process begins with the submission of a Project Proposal to the Saskatchewan Environmental Assessment Branch (EAB) by the Proponent. The Project Proposal provides a project description, a description of the existing environment in the project area and a discussion of potential issues. The EAB will review the Project Proposal and make one of two decisions:

1. the project is not a development, no further study is needed and the project can proceed to regulatory permitting; or,
2. the project is a development and will require an EIA.

If the Project is considered a 'development', the EAB will develop Project Specific Guidelines for the preparation of an EIS. The Project Specific Guidelines will be drafted considering the nature of the development, information and issue scoping contained in the Project Proposal, and input from technical specialists within the EAB and the Government of Saskatchewan. On occasion, the EAB may also consult Federal agencies to confirm if the *CEAA* does or does not apply. The Project Specific Guidelines outline the required scope of the EIA and provide a set of criteria to judge the completeness of the EIS. The Project Specific Guidelines vary from project to project based on the specific characteristics of the development.

Once the EIS document is submitted to the EAB by the Proponent according to the Project Specific Guidelines, the EAB will coordinate a technical inter-departmental review. The EIS will be compared to the Project Specific Guidelines to determine if there are any deficiencies. Typically, technical information requests are returned to the proponent for response and clarification.

Following the technical review, the EIA process also includes notification of, and consultation with, the potentially-affected stakeholders. Stakeholders include the general public, aboriginal peoples, environmental and social interest organizations, and individuals who are directly affected by the Project.

Once these reviews are completed, the EAB will make a recommendation to the Minister for a decision on the Project. The Minister can make one of three decisions:

1. the Minister may approve the Project, allowing the Project to proceed to regulatory permitting;
2. the Minister may approve the Project and may choose to impose conditions on the development in the approvals document; or,
3. the Minister may not approve the Project.

7.2.4 Level of Environmental Assessment

The level of EA required differs among the various options. The greatest level of effort would be required for the Highgate Dam. The EA associated with this option would likely involve a Comprehensive Study - Environmental Impact Assessment (both federally and provincially), which would require detailed field surveys, public hearings, and extensive public, regulatory, and First Nations consultation. Intermediate levels of environmental assessment would be required for the non-structural investment, off-channel storage, and low-head weirs; this level of assessment would generally include a screening level EIA, and cursory to detailed field surveys.

7.2.5 Regulatory Permitting

Once the Project has Federal and Provincial EA approval, the proponent is in a position to advance into the second phase of the environmental approval process: regulatory permitting. A number of permits, approvals, authorizations, and/or licenses may be required depending on the specifics of the Project.

7.2.6 Regulatory Requirements

Federal and Province legislation that may be applicable to the options is summarized by Table 7.1. Other legislation may also be applicable. Similarly, Alberta legislation may be relevant to the Highgate Dam option due to potential flooding of land within Alberta. Alberta legislation applicable to the Highgate Dam option may include:

- *Water Act;*
- *Environmental Protection and Enhancement Act;*
- *Natural Resources Conservation Board Act; and,*
- *Hydro and Electric Energy Act.*

As identified in previous sections, the *CEAA* and the Saskatchewan *Environmental Assessment Act* represent the Federal and Provincial legislation, respectively, that dictates the need for an EA. Associated with the *CEAA* are the Comprehensive Study List Regulations that specify projects that require EAs to be conducted in the form of Comprehensive Studies. Depending on the scale of the development options, a Comprehensive Study may be required (http://laws.justice.gc.ca/en/showdoc/cr/sor-94-638/bo-ga:s_1::bo-ga:s_2?page=2). For example, Schedule 3 Part II sub-section 4b of the Comprehensive Study List Regulations specify that a Comprehensive Study would be required for:

> *"The proposed construction, decommissioning or abandonment of…..a hydroelectric generating station with a production capacity of 200 MW or more."*

Schedule 3 Part III sub-sections 8 and 9 state that a Comprehensive Study would be required for:

8. *The proposed construction, decommissioning or abandonment of a dam or dyke that would result in the creation of a reservoir with a surface area that would exceed the annual mean surface area of a natural water body by 1500 hectares or more, or an expansion of a dam or dyke that would result in an increase in the surface area of a reservoir of more than 35 per cent.*

9. *The proposed construction, decommissioning or abandonment of a structure for the diversion of 10 000 000 m^3/a or more of water from a natural water body into another natural water body or an expansion of such a structure that would result in an increase in diversion capacity of more than 35 per cent."*

Construction and operation activities occurring for the four development options (e.g., non-structural investment, Highgate Dam, off-channel storage, low-head weirs) may cause an alteration of fish habitat that would require an assessment under the *CEAA* through the *Fisheries Act* (Government of Canada 1985). This assessment could lead to the requirement of authorizations from Fisheries and Oceans Canada (DFO). For example, if fish habitat is altered or destroyed, a Habitat Compensation Plan will be required. Further, any option involving a water intake may require an authorization for fish screens under Section 30 of the *Fisheries Act*; any option involving diversion infrastructure would require an authorization under Section 35(2) of the *Fisheries Act*.

Other relevant federal legislation may include the *Navigable Waters Protection Act* (*NWPA*), the *Species at Risk Act* (*SARA*) and the *Migratory Birds Convention Act* should the project impact any known habitats of these species. Other legislation such as the Federal *Pest Control Products Act*, *Transportation of Dangerous Goods Act* and *Hazardous Products Act* and similar regulations associated with the Saskatchewan *Environmental Management and Protection Act* have been included due to the responsibilities that apply to the project proponent in terms of keeping people and the environment safe when using potentially harmful substances during construction and/or operation of the project.

Provincially, some of the Acts and regulations require attention early in the start-up process, as they have the potential to delay project construction. Some examples are provided in Table 7.2. Consideration of the permitting requirements during the planning process can reduce delays by reducing project re-design. To expedite the timing of the Project, these permits will need attention as soon as possible after an approval from the EA process has been granted.

Energy production in association with the Highgate Dam option may result in the application of additional federal and provincial legislation. As stated above, if the Highgate Dam has a production capacity of 200 MW or more then a Comprehensive Study would be required under the *CEAA*. Another example includes the *Hydro and Electric Energy Act* (Alberta).

7.2.7 Estimated Project Costs

In general, the total EA cost is related to the degree of environmental disturbance caused by the option and the type of EA process required as a result. For example, the Highgate Dam option has the potential to result in the largest degree of environmental disturbance, and is estimated to cost about $10 million. EA costs for the other development options are generally estimated to be below $1 million, depending on the number of sites that are selected.

7.2.8 Estimated Project Schedule Requirements

The Highgate Dam option is estimated to require 12 to 36 months for the EA and six to 12 months for regulatory approval.

The estimated time requirement to complete the EA process for the other options is 12 months or less (i.e., Non-Structural Investment; Off-Channel Storage; NSR Weirs). The time requirement for the EA in these cases is influenced by whether seasonal sampling is required as part of the EA, and the selected number of sites. The estimated time requirements for regulatory approval of these options, once the EA document is submitted, are:

- 4 to 18 months for non-structural investment option;
- 2 to 6 months for off-channel storage option; and,
- 2 to 6 months for the low-head weir option.

The timing for regulatory approval will be dependant on the NGO/Regulatory environment, including meeting the needs of the Joint Watershed Advisory and Technical Committees.

7.3 Aboriginal Issues

The proposed options are located within the territory covered under Treaty 6. Treaty 6 was signed in 1876 at Fort Carlton and Fort Pitt. Of the nearly 30 Saskatchewan bands that are included under this Treaty, nine have their Reserves within the Regional Study Area:

- Onion Lake
- Thunderchild
- Saulteaux
- Moosomin
- Little Pine
- Poundmaker
- Sweetgrass
- Mosquito-Grizzly Bear's Head
- Red Pheasant

Other bands not listed above may also consider areas within the Study Area as falling under their traditional lands.

The Reserves were created through a Treaty relationship between the Federal government and the First Nations through the *Indian Act*. As a result, any project that has the potential to impact reserve land must receive approval from the Federal Government.

In addition to their Reserves, some bands have acquired Treaty Land Entitlement (TLE) lands within the Study Area. These lands have been purchased by a First Nation to settle a land claim where the First Nation did not receive all the land in which they were entitled. TLE lands will eventually obtain Reserve status in accordance with Federal policy regarding additions to Reserve land. Until it achieves Reserve status, TLE land is subject to all provincial laws and municipal by-laws.

Finally, any one of the First Nations from Saskatchewan may be actively pursuing land entitlements within the Study Area. Any First Nation can buy land that is Federal or Provincial Crown or private land from a willing seller. Once the land is purchased, it too may eventually become part of the Reserve.

As a proposed Project has a potential impact on Aboriginal or Treaty rights, there is a "Duty to Consult" with First Nations and Métis people (Ministry of First Nations and Métis Relations 2006). This Duty has been clearly established in the Canadian case law and there is a legal obligation to consult with Aboriginal and Métis people where their Aboriginal or Treaty rights may be impacted. The consequence of failing to provide adequate consultation with First Nations and Métis people can have a variety of consequences for the project. These may include delays if the project is challenged, delays receiving government approvals until consultation has occurred or increased costs for compensation.

None of the Reserves appear to be in conflict with the options. However, some TLE would potentially be impacted. Although, TLE land remains under the jurisdiction of the Province and municipality, the status may change and become Reserve land before the project proceeds. In addition to direct infringement on the TLE or reserve land, consideration for Traditional Land Use of the study area is also an important element of consultation and determining the potential impacts to Aboriginal communities.

The Highgate Dam option would potentially flood portions of TLE land of two Bands:

- Thunderchild – South of the NSR in 2-51-24 W3M.
- Poundmaker – West of the NSR in 20-47-20 W3M; and in 30-47-20 W3M.

The NSR Weirs SWP (Terminal East) Weir of the potential NSR Weir candidate locations is also in potential conflict with TLE land:

- Sweetgrass – 1-43-16 W3M.

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