Respect Excellence
Integrity Leadership

Engineering Services

TERMS OF REFERENCE

PWGSC
Western Region

Dam Safety Review: St. Andrews Lock & Dam

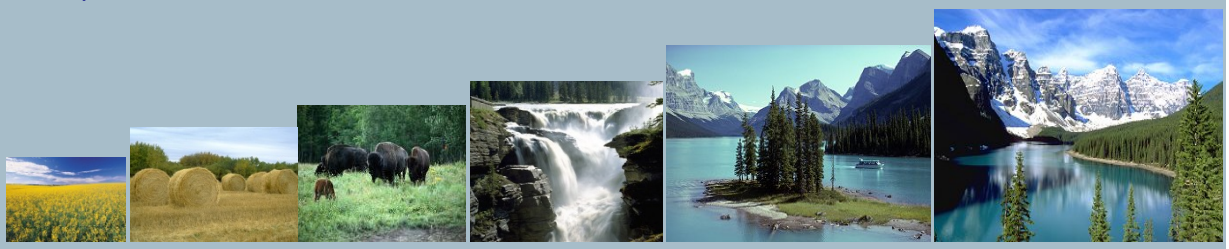
For: Public Works & Government Services Canada

Site Location: St. Andrew's Lock & Dam, Lockport Mb.

Public Works and Government Services Canada

Real Property Services
Western Region
Project No. R.067899.004

June, 2014



Public Works and Government Services Canada
Travaux publics et Services gouvernementaux Canada

Canada

Terms of Reference

Engineering Services

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1 PROJECT DESCRIPTION

1.1 TERMS OF REFERENCE

1.1.1 PURPOSE

.1 Public Works and Government Services Canada (PWGSC) requires the services of a firm of consulting engineers experienced in dam safety reviews for the provision of the services required for this project.

.2 The present contract will be a baseline Dam Safety Review; there have been no previous Dam Safety Reviews.

.3 A Dam Safety Review is a systematic review of design, construction, operation, maintenance, processes, and other systems affecting a dam's safety, including the dam safety management system.

.4 *Consultant* must use the Canadian Dam Association (CDA) *Dam Safety Guidelines* 2007 as the principle source of standard engineering practice for dam safety. See www.cda.ca

1.1.2 THE PWGSC GENERAL PROCEDURES AND STANDARDS DOCUMENT (GP&S)

.1 The Terms of Reference document must be used in conjunction with the GP&S, as the two documents are complimentary

.2 The TOR describes project-specific requirements, services and deliverables while the GP&S document outlines with minimum standards and procedures common to all projects.

.3 In the case of a conflict between the two documents, the requirements of the TOR override the GP&S Document.

1.2 PROJECT INFORMATION

Project Information		
.1	Project Title:	Dam Safety Review and Consequence of Failure Study: St. Andrew's Lock & Dam.
.2	Project Location:	Lockport, Mb
.3	PWGSC Project Number:	R.067899.004
.4	User Department:	PWGSC

1.3 PROJECT BACKGROUND

1.3.1 SERVICES

.1 The Dam Safety Review and Consequence of Failure Study is to be carried out by a Professional Engineer licensed to work in Manitoba leading a multidisciplinary team, all of whom must be qualified by their background in design, construction, performance analysis and operation of dams.

.2 The lead engineer on the project must assume professional responsibility for the final content of the Dam Safety Review.

.3 The multidisciplinary team must be capable of providing all structural, mechanical, hydrotechnical, geotechnical, and other engineering specialities required for the Dam Safety Review, either directly or via the use of sub-consultants.

1.3.2 CONTEXT

.1 **Watershed description**

.1 The Red River watershed flows north from its headwaters in Minnesota and empties into Lake Winnipeg. About 35% of the watershed is the USA (Minnesota, North Dakota, and South Dakota) with the rest being in Canada (Manitoba and Saskatchewan). The watershed is quite flat: the elevation difference being only 70 m over 877 km of river giving an average river slope of about 0.08 m/km. The geography of the watershed is such that freshet occurs in the upstream tributaries before ice is out of the downstream portions of the watershed, making the river particularly vulnerable to ice jams and subsequent backwater flooding.

.2 **Dam description**

.1 St. Andrew's Lock and Dam (SALD) is located in Lockport, Manitoba, which is 27 km downstream of Winnipeg and approximately 44 km upstream from the mouth of the Red River at Lake Winnipeg. The roadway bridge on the dam carries Provincial Highway No. 44 across the Red River.

.2 The SALD facility was built in the early 20th century to facilitate commercial navigation from Lake Winnipeg to the City of Winnipeg by raising the water level to a depth of 9 feet drown out the Lister Rapids located immediately upstream. Today, it continues to perform this function during the navigation season to allow for recreational boating.

.3 The fixed dam component (i.e. weir) is founded directly on limestone bedrock. It contains five piers which, together with the two abutments, form six sluice spans each having a clear opening 36.6m wide. The navigation lock is 65.532m x 14.935m.

.4 Water control above the elevation of the fixed dam is effected by a unique adaptation of a Camere-style moveable curtain system. The Camere-style curtains are made of narrow horizontal slats of wood hinged together and are raised or lowered into the water on moveable steel frames.

.5 Each span contains 15 individual Camere-style curtains, except span 6 which carries 14 curtains to leave space for a fish ladder. There is a total of 89 moveable curtains on the dam

.6 This type of flow control mechanism was selected by the original designers to allow free passage of ice during spring freshets and because their speed of operation; water levels can change relatively quickly at this location along the river and the Camere-style curtains can be quickly removed from the water.

.7 On November 16, 1990, the dam was declared to be a National Historic Site by the Historic Sites and Monuments Board of Canada because this engineering work is perhaps the only surviving moveable dam of its type in the world. The dam was designated as a National Historic Civil Engineering Site by the Canadian Society for Civil Engineering. It is also recognized as a Historic Site of Manitoba.

.8 SALD is the only Camere curtain bridge-dam built in North America, and by far the largest ever constructed. H. E. Vautelet, the Canadian engineer responsible for its design, adapted a French technological achievement to deal with the destructive and unpredictable floodwaters of the Red River. The Canadian government constructed the dam, lock, and machine shop and electrical powerhouse in 1907-1910 as part of a proposed river steamboat navigation extending from Winnipeg to Edmonton.

.9 Stable water levels achieved by the operation of SALD have provided opportunities for the Red River to enhance the value and usage of riverbank property for community

aesthetics, recreation, downtown revitalization, and tourism. The area around the facility is a well-known recreational fishing destination in North America. Thus, SALD sustains much economic activity within the Region for both the private and public sectors.

.3 **Dam operation**

.1 The Camere-style curtains of SALD are deployed when required during the navigational season to raise water over the Lister Rapids to a navigable depth. Usually, moveable dam installation would begin in mid-May with full installation occurring by the Victoria Day weekend. While these dates are desirable for the boating community, they can only be met when river conditions are suitable. This is generally when flows are 354 m^3/s or less.

.2 At flows above this, or when water elevation is 754 ±0.5 ft at James Avenue, partial or total removal of the Camere-style curtains may be necessary to maintain sustainable water levels.

.3 During weather events when the Floodway is in operation (its discharge is only about 1 km downstream of SALD), the Camere-style curtains at SALD are removed from the water. Note that the SALD and the Floodway do not work in conjunction with each other; the Floodway is a high-flow structure where SALD is a low-flow structure. In any summer flood event that would require the operation of the Floodway, all spans at the SALD would be open and the dam would not be retaining water.

.4 Outside the navigation season, the Camere-style curtains and frames are removed to allow free flow of water and ice through the spans.

.4 **Historical project inventory of dam inspections and repairs**

Since its construction over a century ago, the SALD structure has received much maintenance and repair work. The following are the major changes which have been made to the SALD facility:

.1 1949 – west approach realigned to current configuration

.2 late 1960s – jacketing of bottom sections of piers & selected rollway repairs

.3 1976 – east approach rebuilt to current grades

.4 1993 – west approach and bascule span replaced with current structure, traffic deck repairs including new expansion joints, new sidewalk on east approach, new highway lighting.

.5 1994-1996 – steel of working and main decks replaced with hot dipped galvanized

.6 1996 – cleaning and painting of steel on Span 7 and minor structural repairs

.7 1998-1999 – cleaning and painting of steel on Spans 1 to 6.

.8 2002 – lower underwater portions of curtain frames replaced wiht new hot dipped galvanized steel and bolted with splice plates to old webs. Older portions of steel (dating to 1910) were hot-spray zinc metallized in-situ to improve corrosion resistance.

.9 2003 – concrete repairs to abutments, piers, and vertical surfaces

.10 2007-2010 – coating touch-up program

.11 2009 – repairs to spalls, cracks, and undermining on downstream faces of fixed dam

.12 2012 – navigation channel dredged upstream of dam

.2 The dam structure receives regular above water and underwater inspections according to the PWGSC Dam Inspection Policy and Procedure. The last above water inspection

was done in 2011 and the last underwater inspection in 2013. Neither of these inspections found any defects that needed to be repaired on an urgent-priority basis.

.3 There are no recent reports available on the condition of the machinery for the deployment of the camere-curtains.

.4 There were comprehensive bridge inspections taken in 2005, 2007, 2009 and 2011.

.5 As of 2011, the traffic bridge was posted for a maximum GVW of 36 tonnes and the speed limit was restricted to 50 km/hr.

1.3.3 SITE SAFETY

.1 **Health and Safety**

.1 *Consultant* is responsible for health and safety for all of their team on site, and for protection of general public and government employee adjacent to site to the extent that they may be affected by conduct of the field work.

.2 Before performing any work on site, submit a Site Specific Health and Safety Plan (SSHSP) and implement the SSHSP during all field activities. *Departmental Representative*'s review of *Consultant*'s final SSHSP should not be construed as approval and does not reduce *Consultant*'s overall responsibility for Health and Safety at the project site. The SSHSP must contain at minimum the following:

.1 Site specific hazard assessment;

.2 Site-specific mitigation and precaution measures to be take to address each hazard identified;

.3 *Consultant* Team's Safety Communication Plan; and,

.4 Contingency and Emergency Response Plan addressing procedures specific to the project site that would be implemented during emergency situations.

.3 Submit the following:

.1 Workplace Safety and Insurance Board certificate, or proof of insurance coverage from a private company;

.2 General Commercial Liability Insurance Certificate;

.3 *Consultant*'s Heath and Safety Policy Statement;

.4 Agendas and checklists to be used at pre-start health and safety briefing, which *Consultant* must give to the members of the project team before starting any work on site. After this meeting, submit a copy of the attendance sheet proving that all members of the project team attended the briefing;

.5 *Consultant*'s Health and Safety Program; and,

.6 For all employees and sub-consultant employees who will be present on site during the course of Work:

.1 Names and dates of birth;

.2 WHMIS training cards;

.3 Fall protection cards;

.4 First Aid Certification card (one employee per site);

.5 Other certificates as required (e.g. confined space, manlift, etc.); and,

.6 Cards for all employees who will be present on site during the course of Work.

.4 Provide all required Personnel Protective Equipment, equipment, and material as required to meet the intent of the safety requirement set in the SSHSP or as required by the Provincial Occupational Health and Safety Legislation.

.5 *Departmental Representative* may respond in writing, where deficiencies or concerns are noted with any submittal and may request re-submission with correction of deficiencies or concerns either accepting or requesting improvements..

.2 **Authorization**

.1 Before proceeding with any examination that may interrupt vehicular traffic and/or pedestrian traffic, obtain approval from *Departmental Representative*.

.3 **Site Regulations**

.1 Comply with all regulations, federal and provincial, in force on the site where the services are to be performed, relating to the safety of persons on the site or the protection of property against loss or damage from any and all causes.

1.4 PROJECT OBJECTIVES

1.4.1 GENERAL SCOPE

.1 Carry out a Dam Safety Review of St. Andrew's Lock and Dam in Lockport Manitoba to review the ability of this water-retaining structure to safely withstand all forces that could be expected to act on it during its lifetime and to demonstrate that:

.1 the dam is safe, operated safely, and maintained in a safe condition;

.2 the public safety around the dam is addressed appropriately;

.3 surveillance is adequate to detect any developing safety problem; and,

.4 appropriate emergency plans are in place;

or to make recommendations for actions required to achieve this.

.2 Note that all recommended options for improving the safety of the SALD site must be made with a view to conserving the historic fabric and heritage character of the lock and dam.

1.5 SCOPE OF SERVICES

1.5.1 TASK 1 – REVIEW EXISTING DATA

.1 *Departmental Representative* will provide documents for review and reference in PDF format unless otherwise noted. The existing documentation is listed in Section 1.8.

.2 Review the existing data and note to *Departmental Representative* all gaps where additional information would be required to complete the work of this Contract. Depending on the nature of the information gaps, *Departmental Representative* may either authorize additional work (to be paid as an extra to the Contract), or alternatively may instruct *Consultant* to make conservative assumptions and proceed with the analysis.

.3 Incorporate existing information into the work.

1.5.2 TASK 2 – VISIT THE SITE AND INTERVIEW STAFF

.1 PWGSC has the dam and bridge structure inspected at regular intervals; therefore, assume that the structural condition at the last Comprehensive Detailed Inspection is current and that no further condition inspection is required.

.2 The purpose of the site visit is to:

.1 become familiar with the dam and its surroundings and their physical, geographical, and hydrological features;

.2 observe in action the unique and historic operation mechanism of the Camere-style curtains;

.3 discuss with Operators:

.1 the practical aspects of the operation of this unique dam type,

.2 its operational history,

.3 practical limitations on response time and operations during adverse weather conditions

.4 incidents in corporate memory relevant to the safety of the dam, and

.5 all other site specific performance issues and operational requirements relevant to the Work;

.4 discuss extremes of ice formation around the dam and view photos taken during winter conditions (if available).

1.5.3 TASK 3 – CLASSIFY THE DAM

.1 Classify the SALD according to the Canadian Dam Association classification criteria for each of the “sunny day” and incremental “flood-induced” failure conditions.

.2 Select the appropriate annual exceedance probability (AEP) for the Inflow Design Flood (IDF) and the Earthquake Design Ground Motion (EDGM) for use in a “traditional standards-based analysis.”

.3 Explain rationale for classification and selection of IDF & EDGM in Dam Safety Report.

.4 Notes:

.1 Given the unique dam operation regime at this facility—where the Camere-curtain mechanisms are installed to retain water only at low water elevations and flows—the flow volume from a breached dam would actually be less than the unregulated flow during freshet or other flood events. Hence, PWGSC does not currently expect that the SALD will pose much risk in case of a flood, but that it may be found to pose an unacceptable hazard to the public during a "sunny day" failure. The extent of existing and potential development downstream of the SALD is such that there are transient recreational users in summer but no permanent populations at risk. On this basis:

.1 Assume that no formal dam break analysis using a numerical or computer model would be necessary in order to determine the dams’ incremental flood hazard potential classification.

.2 If *Consultant* believes that a formal dam break study actually is required in order to classify the dam, present the rationale for this to *Departmental Representative*. PWGSC may or may not authorize that work to proceed as an extra to the contract.

1.5.4 TASK 4 – GATHER EXISTING HYDROTECHNICAL INFORMATION

.1 The flood elevation and flowrate of the selected IDF is most likely available on the basis of previous work by the Province of Manitoba, the International Joint Commission, or other sources.

.2 Work with *Departmental Representative* in making liaisons with these or other bodies in order to obtain the information. If this information is available, then use it to conduct the hydrotechnical assessment of the SALD (portion of Task 6).

.3 If this information is not available, *Departmental Representative* will require a hydrotechnical study (Optional Task 4B) to derive these parameters before undertaking the assessment work.

1.5.5 TASK 4B – PERFORM HYDROTECHNICAL STUDY (OPTIONAL WORK)

.1 The purpose of the hydrotechnical study is in order to quantify water flows and elevations over a wide range of return periods including that required for the IDF in this Dam Safety Review.

.2 As such, the work of the optional hydrotechnical study must include:

- .1 Review existing documentation and available water level records:
  - .1 Obtain streamflow records from Water Survey Canada, supplemented by information *Consultant* obtains from Provincial or Municipal sources or from power companies. Obtain sufficient data to define the complete flood hydrograph.
  - .2 Perform surveying and bathymetry to obtain cross-sections at various representative locations, where changes occur in slope, in cross-sectional area, or in channel roughness. Survey upstream, at, and downstream of all channel restrictions. Consider if ice or debris jams are an issue at a specific location, and ensure additional cross-sections are surveyed at that point in the river in order to ensure model can take such events into account. Select sufficient sections at appropriate spacing to adequately define the river geometry and to ensure that in the interval between the sections, there is as close to a uniform water flow as possible. Include survey of flood plains and tributaries that are likely to experience backwater effects.
  - .3 Obtain stage-discharge information from regulation dams upstream and downstream of SALD along with the rule curves and operating procedures from these agencies.
  - .4 Obtain meteorologic data (precipitation, temperature, snow accumulation, snowmelt information, etc.) sufficient to determine flood magnitude. Validate model using known meteorologic data and historic flood information.
  - .5 Convert input to runoff using a hydrologic model of the watershed. Use the non-proprietary HEC suite as the modelling software for this study, so as to make the model available for future studies. Take care in selecting model, using the simplest model that is adequate to simulate observed discharges. Calibrate and verify model against actual historic flood information.
- .2 Establish the peak flood flows and hydrographs for the 2, 5, 10, 20, 50, 100, 500, 1000 and 10,000 year return period floods and the Probable Maximum Flood (PMF). Base the PMF based on the best information available (i.e., local PMP information and hydrological modelling).
- .3 Document historical high water levels and flows (if available) and compared to the above design floods in order to validate the analysis.
- .4 Apply the validated flood flow estimates to the dam safety review.
- .5 Provide flood flow estimate report including flood flows estimates and hydrographs.
- .6 Provide the computer models used in the analysis, including input and output. Provide this electronically (on USB flash drive) so that it can be used in future Dam Safety Reviews and studies.

1.5.6 TASK 5 – PERFORM SEISMIC STUDY

.1 In accordance with approach in CDA Dam Safety Guidelines, PWGSC understands that the earthquake information provided in the National Building Code of Canada may not be appropriate for dam projects and that it is essential to conduct a site-specific seismic hazard evaluation for dam safety reviews.

.2 Undertake a seismic hazard evaluation to arrive at the Earthquake Design Ground Motion (EDGM) through a site-specific seismic study conducted by qualified specialists.

.3 PWGSC currently expects that the study will be based on both geotechnical information and a statistical analysis of earthquakes experienced near the site, taking into account all potential seismic sources capable of contributing significantly to the seismic hazard at that site, and will include identifying all of the following aspects:

.1 Earthquake sources

.2 Historic earthquake occurrence rates

.3 Regional ground motion attenuation relations

.4 Probabilistic seismic hazard assessment

.4 PWGSC understands that seismic hazard evaluation is a developing science and is, to a large extent, based upon experience and judgment of qualified specialists. Further, as the dam itself is historic fabric of cultural significance, the seismic loadings for checking designs and for rehabilitating existing dams deserve extra careful considerations. PWGSC requires the Report include a full explanation of *Consultant*'s data found, assumptions made, and methods used.

1.5.7 TASK 6 – ASSESS DAM SAFETY

.1 Assess safety of the SALD facility using a "traditional standards based approach" as described in the CDA 2007 *Dam Safety Guidelines*, considering hydrotechnical, seismic, geotechnical, structural, mechanical, electrical, and other considerations as described therein.

.1 In undertaking the assessment of the SALD to pass the IDF:

.1 Assume the mitre gates at the navigation lock will remain closed.

.2 Consider the backwater effect from the Red River Floodway discharge that would reduce the flow through the dam if the floodway were being operated.

.2 Use strength parameters obtained from previous geotechnical and concrete testing reports or based on conservative but reasonable assumptions. Describe all loads used and how they were calculated, the load combinations, and the analysis methods.

.1 If the dam does not meet standards, then carry out sensitivity analyses to determine the strength parameters required to meet standards. Recommend for PWGSC consideration a field investigation program (e.g. drilling, sampling, testing, etc.) to obtain necessary data. Note that PWGSC may not necessarily proceed immediately with such investigations, but rather instead elect to defer such work.

1.5.8 TASK 7 – REVIEW EXISTING OPERATIONS, MAINTENANCE AND SURVEILLANCE PROCEDURES AND PRACTICES

.1 Review the existing operating manual and assess its suitability and sufficiency for against the requirements of the CDA Guidelines and against best practices for a facility with similar functions.

.1 The *Moveable Dam Operational Manual* contains the operating procedures (Section 4.0), inspection procedures (Section 6.0), and maintenance procedures (Section 7.0) used at the SALD facility. Roles and responsibilities are described in Section 5.0.

.2 Assess the efficiency and effectiveness of the process for communications amongst other authorities in the watershed about water control and dam operations. Ensure that there is proper delegation of authority for both decisions about water levels and communications about operations. If improvements are necessary, make recommendations how to improve co-ordination and communications.

.3 Assess the level of availability, training, and knowledge of the staff. Consider their normal hours of work, normal range of duties other than dam operation, necessary reaction time to the site relative to potential rate of reservoir rise under floods. Note all deficiencies found. In consultation with the technical authority, make recommendations for improvements to operator training, including costs and benefits. (Note: Do these interviews informally during the course of the site visit of Task #2).

.4 Assess need for additional instrumentation to monitor performance of structure and recommend monitoring equipment. For all equipment recommended, describe both costs and benefits to allow PWGSC to prepare a business case.

.5 Assess the frequency of inspections and other requirements for the overall care in management, oversight, inspection, maintenance, and safety assessment commensurate with the Incremental Consequence Category established in Task #3.

.6 Assess the adequacy of the existing record-keeping system, making visits to the site office and other PWGSC offices accordingly.

1.5.9 TASK 8 – REVIEW EMERGENCY PREPAREDNESS

.1 Review the emergency procedures and emergency communication plan as documented in Section 8.0 of the *Moveable Dam Operational Manual*. Verify that their scope and complexity is consistent with the classification of the dam and the requirements of the CDA 2007 *Dam Safety Guidelines*.

.2 Assess effect of the Camere-style curtain mechanisms become damaged and subsequently the dam cannot be opened for flood passage. Address this possible hazard in the assessment of the emergency planning.

.3 Make recommendations for improvements as required.

1.5.10 TASK 9 – ASSESS PUBLIC SAFETY AND SECURITY

.1 The SALD site has high rate of public visitation and this is intended to continue.

.2 Obtain information on past incidents involving public safety and vandalism.

.3 Examine the current public safety appurtenances at the site (railings, signage, landscaping, etc.) and evaluate the current level of lighting (make a visit at night to assess this).

.4 Assess the current facilities against CDA documents:

- .1 2007 *Dam Safety Guidelines*;
- .2 2011 *Guidelines for Public Safety Around Dams*;
- .3 2011 *Technical Bulletin: Public Safety Signage Around Dams*; and,
- .4 2011 *Technical Bulletin: Booms and Buoys for Public Safety Around Dams*.

.5 Develop options and made recommendations for public safety improvements to address deficiencies found.

.6 Make recommendations for the scope of a formal Public Safety Plan.

1.5.11 TASK 10 – ASSESS DAM SAFETY MANAGEMENT SYSTEM

.1 Assess the overall effectiveness of the current dam safety management system at SALD against the requirements of the 2007 CDA *Dam Safety Guidelines*.

1.5.12 TASK 11 – WRITE DAM SAFETY REPORT

.1 Using the results of the stability and hydraulic assessments, together with an assessment of the overall condition of the structure and issues such as public and workplace safety, prepare

recommendations and costs for measures to upgrade the structure to satisfy current dam safety requirements.

.2 Make recommendations regarding ongoing surveillance and the frequency of subsequent dam safety reviews commensurate with the dam classification.

1.6 PROJECT DELIVERY

1.6.1 GENERAL

.1 Carry out all site work during normal operating hours between 7:00 am - 5:00pm.

.2 The Peak traffic hours for the St. Andrew's Lock and Dam traffic bridge are 6:00 to 9:30 am and 15:00 to 18:30 pm. Traffic is very heavy on Friday afternoons. Obtain permission from *Departmental Representative* for disruption to traffic during these hours.

1.7 PROJECT SCHEDULE

1.7.1 GENERAL

.1 Complete the project in accordance with the project milestone listing identified below.

.2 Completion dates shown are relative to an assumed start date of June 2014.

.3 Prepare a Project Planning Schedule, in accordance with the milestone list.

1.7.2 ANTICIPATED MILESTONE DATES

Project Phase		Milestone Date
.1	Award *Consultant* Contract	September 2014
.2	Project Start-up Meeting	September 2014
.3	Submit Draft Report	35 weeks after project start-up
.4	Submit Final Report	5 weeks after receiving QA review commentary from PWGSC
.5	Close out Contract	August 2015

1.8 EXISTING DOCUMENTATION

1.8.1 DOCUMENTS AVAILABLE FOR THE CONSULTANT

.1 Information available on the internet

.1 Manitoba Water Stewardship Water Branch
Re-Computation of Natural Water Levels at the Floodway Inlet
Acres Manitoba, April 2004
http://www.floodwayauthority.mb.ca/reports_recomp.html
Terms of reference was to find the "natural" water levels at the Floodway Channel Inlet for a combination of Red River (downstream of the confluence with the Assiniboine River) flows and Assiniboine River flows complete with a calibrated hydraulic model to be given to the Manitoba Water Branch.

.2 *A Review of the Red River Floodway Operating Rules*
Red River Floodway Operation Review Committee
December 1999
http://www.gov.mb.ca/waterstewardship/reports/floodway/rr_floodway_operating_rules.pdf
Discusses then-potential modification to the Rules and provides some references to hydrotechnical studies having been done.

.3 *Flood Protection Studies for Winnipeg: Main Report*
KGS Group
November 2001
http://www.gov.mb.ca/mit/floodinfo/floodproofing/reports/pdf/fld_prot_studies-main_rpt.pdf
This study looked at two major flood protection options that had been recommended in a previous report for either an expansion of the Red River Floodway or the Ste. Agathe Detention Structure. The report contains a table of flood flow volumes in the Red River at both the Floodway inlet and at James Avenue for various annual exceedance probabilities and for the PMF.

Also see:

Flood Protection Studies for Winnipeg: Appendices A, C, D, E, and F
http://www.gov.mb.ca/mit/floodinfo/floodproofing/reports/pdf/fld_prot_studies-app_a,c,d,e,f.pdf

Flood Protection Studies for Winnipeg: Appendix B Floodway Expansion
http://www.gov.mb.ca/mit/floodinfo/floodproofing/reports/pdf/fld_prot_studies-app_b.pdf

.4 *Hydrometeorologic Parameter Generated Floods for Design Purposes*
A. A. Warkentin,
Manitoba Water Resources Branch,
September, 1999
http://www.ijc.org/rel/pdf/alfsflood.pdf
This report describes the generation of 2000 spring flood peaks at Winnipeg based on an analysis of causal flood parameters, using a formula to determine peak flow. The author says the study was done relatively quickly based primarily on collated data already available from flood forecasting studies. Given time and resources, he felt a more thorough approach to computation of design floods could be taken, by applying a suitable hydrologic model to long time series of hydrometeorlogic data. He had some doubt, however, whether such an approach would result in a significant improvement in accuracy and whether the large amount of additional work would be warranted. This study shows that natural flows on the Red River at James Avenue in Winnipeg could exceed 200,000 cfs once every 200 years, 245,000 cfs once every 500 years and

295,000 cfs once every 1000 years on average. The study recommended increasing the capacity of the Red River Floodway.

.5 Red River Basin Commission
Hydrology Report
September 2000
http://www.redriverbasincommission.org/hydrologyreport.PDF
Report is very general and compiles and summarizes a large amount of existing data and information and describes the soils, geology, groundwater, and hydrology of the Red River Basin in South Dakota, Minnesota, North Dakota, and Manitoba.

.6 Environment Canada Water Survey gauge 05OJ021 is located at SALD, but is operational only from March 1st - October 31st annually. Within that window, archived water elevation data is available back to 1996 at the Water Survey website http://www.wateroffice.ec.gc.ca

.2 Manuals:
- .1 Moveable Dam Operational Manual. April 2012.

.3 Drawings:
- .1 Original 1907 Construction Drawings, 28 pages.

.4 Recent Inspection Reports
- .1 2011 Comprehensive Detailed Inspection of Traffic Bridge
- .2 2013 Underwater Condition Report

1.8.2 DISCLAIMER

.1 Reference information will be available in the language in which it is written.

.2 The documentation may be unreliable and is offered, “as is” for the information of the *Consultant*.

1.9 CODES, STANDARDS & GUIDELINES

1.9.1 GENERAL

.1 CSA International:
- .1 CAN/CSA A23.3-04 (R2010) Design of Concrete Structures
- .2 CAN/CSA O86-09 Engineering design in wood
- .3 CAN/CSA S6-06 Canadian Highway Bridge Design Code
- .4 CAN/CSA S16-09 Design of steel structures

.2 Canadian Dam Association:
- .1 Dam Safety Guidelines, 2007, and associated Technical Bulletins
- .2 Guidelines for Public Safety Around Dams, 2011
- .3 Technical Bulletin: Public Safety Signage Around Dams October, 2011
- .4 Technical Bulletin: Booms and Buoys for Public Safety Around Dams October, 2011

.3 Canadian Geotechnical Society:
- .1 Canadian Foundation Engineering Manual, 4th Edition, 2006

.4 National Research Council of Canada:

.1 National Building Code of Canada, 2010

.5 Province of Manitoba:

.1 Occupational Health & Safety Regulations

.6 US Army Corps of Engineers :

.1 Shore Protection Manual, 1984

.7 US Bureau of Reclamation:

.1 Design of Small Dams, 1987

.2 A Procedure for Estimating Loss of Life Caused by Dam Failure (DSO-99-06)

.8 *Consultant* has the option of consulting other regulations, standards, and codes as he deems necessary to complete the work under this project.

1.9.2 PWGSC DOCUMENTS

.1 The National Project Management System (NPMS)

.2 PWGSC Dam Inspection Manual (D.I.M) 2010.

.3 General Procedure & Standards Documents.

2 PROJECT ADMINISTRATION

2.1 GENERAL REQUIREMENTS

2.1.1 SITE MEETING LOCATION

.1 Unless otherwise, the site meeting will be held at the PWGSC office located at 167 Lombard Avenue in Winnipeg, Manitoba.

2.1.2 MEETINGS

.1 *Departmental Representative* will arrange the exact date of meetings throughout the project.

.2 When urgent problem-solving meetings are required, the *Consultant* shall be available to attend such meetings in the PWGSC downtown office within two working day notice.

.3 The key personnel of the prime *Consultant* and sub-consultants or specialist firms must be available to attend meetings or respond to inquiries within two working days.

.4 The following meetings are currently estimated to be required:

.1 Kickoff meeting—at *Departmental Representative*'s office, at which PWGSC will review the scope of work and the constraints around the project. Be prepared to provide a presentation indicating the approach to be taken to complete the Work including identification of the principles involved, preliminary schedule for the various components of the works, and to identify any concerns or additional information that may be required to complete the Work.

.2 Meeting after Interim Report is complete;

.3 Progress bi-monthly teleconferences with the project management team (assume duration for up to 2 hours). As a minimum, the project management team will include the designated PWGSC Project Manager, the Proponent's Designated Project Manager and the Superintendent from the St. Andrews Lock

.4 Presentation of the Draft Report.

2.2 ROLES AND RESPONSIBILITIES

2.2.1 CONSULTANT

.1 The "*Consultant* Team"

.1 All team members must be eligible to work in the province of Manitoba.

.2 The Engineer of Record, who must lead the team and sign off on the final dam safety report, must have at least 10 years experience in the design, construction, and performance evaluation of dams and who must assume responsibility for coordinating the work of any sub-consultants and sub-specialists retained by the *Consultant*.

.3 Be prepared to provide the following services:

.1 Structural engineering

.2 Dam safety engineering

.3 Hydrology and hydraulics engineering

.4 Geotechnical engineering

.5 Electrical engineering

.6 Mechanical engineering

.7 Surveying.

.2 In addition to the responsibilities outlined in the GP&S document the *Consultant* shall:

.1 Attend meetings,

.2 Record the issues and decisions,

.3 Prepare and distribute minutes within two working days of the meeting,

.4 Ensure all meetings are green i.e. using electronic documents or double -sided hard copies and

.5 Ensure sub-consultants attend required meetings.

2.2.2 PWGSC RESPONSIBILITIES

.1 In addition to the general responsibilities outlined in the GP&S document, PWGSC is also responsible for:

.1 **PWGSC Project Management**.—The Project Manager assigned to the project is the *Departmental Representative* and this person is directly concerned with the project and responsible for its progress. *Departmental Representative* is the liaison between the *Consultant* and PWGSC, administers the project, and exercises continuing control over the *Consultant*'s work. Unless directed otherwise by *Departmental Representative*, *Consultant* obtains all Federal requirements and approvals necessary for the work.

.2 **Lines of Communication**.—Unless otherwise arranged with *Departmental Representative*, *Consultant* shall communicate only with *Departmental Representative* only. *Consultant* shall not respond to requests for project related information or questions from the media. Such inquiries are to be directed to *Departmental Representative*.

2.3 PROJECT REVIEW AND APPROVAL

2.3.1 GENERAL

.1 In addition to the review procedures outlined in the P&S document the *Consultant* shall ensure that the reports will undergo the following review and approval.

3 REQUIRED SERVICES

3.1 GENERAL REQUIREMENTS

3.1.1 FORMAT

.1 Submit all documents in PDF format via email or FTP site.

3.1.2 DELIVERABLES

.1 General

- .1 Prepare and submit DRAFT REPORTS at 95 % completion for review and approval by the Departmental Representative.
- .2 Revise as required by the Departmental Representative and submit Final Report.
- .3 Submit a pdf copy and three (3) hard copies of each draft report.
- .4 Submit a pdf copy and three (3) hard copies of the final report.

.2 Emergency Conditions Reporting (Within a 24 hour Period)

- .1 Based on site inspections, if any serious deficiencies were observed during the analysis of the dam structure, related to the Occupational Health and Safety Act (OHSA) or public safety, please immediately contact the PWGSC verbally, then followed up by a brief e-mail outlining the concern.

.3 For each submission, allot up to 15 workdays for review by PWGSC.

3.1.3 INSPECTION REPORT

.1 The Consultant shall prepare an inspection report. A draft report is to be forwarded to the Departmental Representative for review.

.2 The Consultant is NOT to stop their work on the Dam Safety Review while the Inspection report is being reviewed by PWGSC.

.3 As a minimum, the Inspection Report shall include, but not limited to the following:

- .1 Table of Contents
- .2 Condition assessment and records of observation/findings of
  - .1 Upstream and downstream condition;
  - .2 Concrete dam structure (including deck and underwater observations);
  - .3 Earthworks (embankments);
  - .4 Lock Structure (including lock gates and lock discharge);
  - .5 Mechanical equipment(stoplogs, log lifter, winches, vertical steel roller gates and lifting mechanism,etc.); and
  - .6 Public and operators safety questionnaire, which have been filled-out.

.4 Review of operation procedures.

.5 Records of interviews with the SALD asset manager, superintendant, and operation & engineering staff:

- .1 SALD staff reported issues with the dam and lock;
- .2 Dam and lock operation issues;
- .3 Operator and public safety issues;
- .4 Public usage of the site; and
- .5 Other

.6 Appendices

- .1 Photographs of significant areas of deterioration or interest, in addition, photographs of the general condition of structures and site are important even if the structure is in good condition.
- .2 Copy of the preliminary geotechnical/material investigation report.

3.1.4 PUBLIC SAFETY ASSESSMENT REPORT

.1 The consultant shall prepare a detailed Public Safety Assessment (PSA) Report. A draft report is to be forwarded to the Departmental Representative for review.

.2 The Consultant is NOT to stop their work on the Dam Safety Review while the Inspection Reports are being reviewed.

.3 The Inspection Report shall include, but not limited to the following:

.1 Title Page
.2 Table of Contents
.3 Introduction
.4 Background
.5 Public Safety Risk Assessment
.6 Site Observations and Risk Evaluation
- .1 Introduction
- .2 Upstream Location
- .3 Headpond
- .4 Structures (including earthworks and Locks)
- .5 Spillway
- .6 Downstream Location

.7 Conclusion
.8 List of Figures (if applicable)
.9 List of Tables (if required)
.10 Appendices
- .1 Location Maps
- .2 Site Inspection Photos
- .3 Public Safety Around Dam’s Risk Assessment Tool

.4 Questions to Operators and Staff and correlating responses.

3.1.5 ASSET CONDITION RISK CLASSIFICATION REPORT

.1 Details of the rating methodology and the table are to be provided in a separate report

.2 The Report shall include but not limited to the following:
- .1 Covering memorandum explaining the details of the rating methodology.
- .2 Table in excel format.

3.1.6 DAM SAFETY REVIEW REPORT

.1 The Consultant shall prepare a detailed Dam Safety Review Report. A submission of the draft report is to be submitted to the Departmental Representative.

.2 All assumptions, parameters and calculations, which were made to assess the dam safety, dam classification and dam stability, are to be clearly identified in the report.

.3 The Dam Safety Report shall cover all aspects of the Dam Safety Review. The content of the report will be based on the 2007 CDA Dam Safety Guidelines and include, but not necessarily be restricted to:

- .1 Title Page
- .2 Covering memorandum
- .3 Project Team
- .4 Site Photo
- .5 Executive Summary
- .6 Recommendation Table and Cost Estimate (Class D)
- .7 Introduction
  - .1 Purpose and Objectives
  - .2 Site Description/Location
- .8 Background Information
  - .1 General
  - .2 Background
    - .1 General
    - .2 Construction/Repair History
    - .3 Geology and Geotechnical Characteristics
    - .4 Operation
  - .3 Drawings
    - .1Site layout
    - .2 As-found drawings of the dam and lock showing the plan view, elevation view, appropriate sections, details and any text notes for clarification.
  - .4 Inspection, Document Review and Deficiencies
    - .1 Record of Observation
      - .1 Review of the dam, lock and earthworks (including underwater observations)

.2 Review of the stoplogs, log lifter, winches, lock gates and valves, etc.
.3 Review of the vertical steel roller gates (where applicable)
.4 Review of the radial-arm gates (where applicable)
.5 Review of operation procedures
.6 Review of operation and public safety
.7 Geotechnical aspect
.8 Review of existing operation procedures and policies, OMS, EPP and ERP Documents

.5 Dam Classification Review
.1 Review of preliminary assigned Dam Classification (Dam and Lock)
.2 Dam Break Analysis and Inundation Mapping
.3 Confirmation of Dam Classification

.6 Dam Safety Analysis
.1Hydro-Technical
.1 Description of the watershed
.2IDF/PMF assessment
.2 Hydraulic Capacity
.1 Operational procedures
.2 Dam discharge capacity
.3 Discharge analysis/Operating Rule Curve
.4 Adequacy of discharge capacity
.5 Freeboard and Wave Action
.3 Structural Analysis
.1 Stability Assessment/Analysis
.1 Concrete Dam
.2 Lock Gates
.3 Earthworks (embankments)
.4 Structural assessment of stoplogs, lock gates, vertical steel roller gates.

.7 Dam and Lock Operation

.8 Safety
.1 Operational Safety
.2 Public Safety

.9 Recommendations
.1Recommendations for additional studies
.2Recommendations for rehabilitation/repair and their priority for work required:
.1 Immediately
.2 Within 2 years
.3 Within 5 years
.4 Long term (over 5 years)
.3 Class D cost estimates for each recommendation

.10 Conclusions

.11 Appendices

3.1.7 LANGUAGE OF DELIVERABLES

.1 English.

3.1.8 ACCEPTANCE CRITERIA FOR DELIVERABLES

.1 While PWGSC acknowledges *Consultant*'s obligations to meet project requirements; the project delivery process entitles PWGSC to review work. PWGCS reserves the right to reject undesirable or unsatisfactory work. *Consultant* must obtain *Departmental Representative* acceptances during each of the project stages.

.2 In general, PWGSC expects all written work to be of good quality and judges the acceptability of reports by three criteria: fulfilment of overall project objectives as set forth in the Terms of Reference, adequacy of documentation, and clarity of presentation. Reports must be complete in all their parts, organized appropriately to serve their purposes, correct in matters of fact and documentation, grammatically correct, and edited for basic uniformities of style and usage.

.3 The acceptance does not relieve *Consultant* of professional responsibility for the work and compliance with the Contract.

.4 PWGSC acceptances do not prohibit rejection of work, which is determined to be unsatisfactory at later stages of review. If progressive inspection and reporting development or time / cost / risk updates or technical investigation reveals that earlier acceptances must be withdrawn, *Consultant* is responsible for correcting work and re-submitting for acceptance at *Consultant*'s cost.

3.2 PROJECT CLOSEOUT PHASE

3.2.1 SERVICES

.1 Before handing over the final report to PWGSC, revise all documentation to reflect all changes, revisions and adjustments after completion of *Departmental Representative*'s review of the submitted draft document.