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# EMERGENCY REDUCTION OF LAKE MANITOBA AND LAKE ST. MARTIN WATER LEVELS

Manitoba
INFRASTRUCTURE AND TRANSPORTATION

KGS GROUP REPORT
11-0300-18

November 2015

in association with

North/South Consultants Inc.
Aquatic Environment Specialists

**BINDER 2 OF 5**

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November 30, 2015

File No. 11-0300-18

Manitoba Infrastructure and Transportation
Water Management Engineering & Construction
7th Floor, 215 Garry Street
Winnipeg, Manitoba
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ATTENTION: Mr. Ron Kaatz
Senior Hydraulic Engineer

RE: Emergency Reduction of Lake Manitoba and Lake St. Martin Water Levels Binder Series of Deliverables (Final) – November, 2015

Dear Mr. Kaatz:

KGS Group is pleased to provide the binder series representing Final deliverables produced for the Emergency Reduction of Lake Manitoba and Lake St. Martin Water Levels Project by the KGS Group Project Team, which included North/South Consultants.

On February 21, 2014, KGS Group provided MIT with a Mock-Up of the binder series for the project deliverables. The intent of the Mock-Up was for MIT to verify completeness of the data files used to produce figures and appendices and agree to the format of the binder series. MIT reviewed the binder series and provided comments on December 19, 2014. The comments included suggested changes to the text within several documents previously issued as Final. KGS Group compiled the comments from all MIT reviewers into a single summary document that included proposed changes to the text to address the comments and submitted to MIT on May 4, 2015. Through discussions and emails culminating on October 7, 2015, KGS Group received verification as to which comments should be incorporated into revised Final documents and which were not compulsory to include.

Any report that had technical content changed as a result of comments provided by MIT on the Mock-Up of the binder series were included in the Final binder series as a revision and assigned a new issue date. Documents that were left unchanged or had changes that were strictly non-technical, were included in the binder series with the original issue date. Details for reports in each binder that were modified for technical content, modified for non-technical content, or left unchanged are provided in the table below:

**TABLE 1**
**STATUS OF REPORTS ISSUED WITH FINAL BINDER SERIES FOR PROJECT**

| Binder | Report | Update | Issued Final | Revised Final |
|---|---|---|---|---|
| 1 | 1 | Non-technical | Nov-13 | - |
| 2 | 1 | Non-technical | Mar-14 | - |
| 3 | 1 | Technical Content | Jan-13 | Nov-15 |
| | 2 | Unchanged | Jan-13 | - |
| | 3 | Non-technical | Mar-12 | - |
| | 4 | Unchanged | Nov-13 | - |
| | 5 | Technical Content | Aug-12 | Nov-15 |
| 4 | 1 | Technical Content | Dec-13 | Nov-15 |
| | 2 | Unchanged | Mar-12 | - |
| | 3 | Unchanged | Jan-13 | - |
| 5 | 1 | Non-technical | Nov-13 | - |
| | 2 | Technical Content | Nov-13 | Nov-15 |
| | 3 | Non-technical | Nov-13 | - |
| | 4 | Non-technical | Feb-14 | - |
| | 5 | Non-technical | Apr-13 | - |

All binders within the series contain a Table of Contents (TOC) indicating the names of the reports in the series and in which binder they can be located. The subsequent pages of the TOC for the binder series provide general details for each report.

Two DVDS are included with each binder within the series; one DVD with report(s) in PDF format attached to the front cover and a data files DVD attached to the back cover. The information on these DVDs only contain reporting/files for the specific binder in which they are located. The data files DVDs contain a geodatabase for figures/appendices created using GIS data and individual folders with background data for figures/appendices created using laboratory data, tables for modelling/Excel files, AutoCAD data, Grapher files, or Jpeg/PDF for photos/images. Any figures created in AutoCAD were converted into MicroStation and a copy of the MicroStation data was included in the data files DVD. Figures and appendices that do not require data files to reproduce are not included on the data files DVD.

Please contact the undersigned if you have any questions regarding the compilation of Final deliverables.

Yours truly, <Original signed by>

Colin Siepman, P.Eng.
Senior Project Manager

SO/
Enclosure

cc: Bert Smith – KGS Group

# EMERGENCY REDUCTION OF LAKE MANITOBA AND LAKE ST. MARTIN WATER LEVELS
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MANITOBA INFRASTRUCTURE AND TRANSPORTATION

# Emergency Reduction of Lake Manitoba and Lake St. Martin Water Levels Analysis & Monitoring of Discharges & Ice Processes

## FINAL REPORT

KGS File No. 11-0300-18
March 2014

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**Winnipeg, Manitoba**

| Review History | Date |
|---|---|
| Draft report issued to MIT | 16-Aug-13 |
| MIT comments received | 3-Feb-14 |
| Final report issued to MIT | 7-Mar-14 |

# EXECUTIVE SUMMARY

In June 2011, The Province of Manitoba commissioned Kontzamanis Graumann Smith Macmillan Inc. (KGS Group) and AECOM to urgently explore options to bring the water levels of Lake St. Martin and Lake Manitoba down to the desirable range on an emergency basis. In July 2011, KGS Group and AECOM issued the draft report, *"Analysis of Options for Emergency Reduction of Lake Manitoba and Lake St. Martin Levels"* with immediate actions to construct Reach 1 of the Lake St. Martin Emergency Outlet Channel (LSMEOC) to address the hydraulic flow restriction out of Lake St. Martin to Lake Winnipeg and to allow unrestricted maximum outflow of water from Lake Manitoba through the Fairford River Water Control Structure (FRWCS) throughout the winter of 2011/2012.

Following the decision to construct Reach 1, KGS Group provided assistance to Manitoba Infrastructure and Transportation (MIT) in the forecasting of water levels and outflows in Lake Manitoba and Lake St. Martin. Concurrent with the forecasts, KGS Group was also requested to provide assistance in the study of ice formation and processes within the various reaches of the Lake Manitoba and LSMEOC System. This report summarizes the various ice studies and the water level and discharge forecasts completed between August 2011 and December 2012 by KGS Group. It includes the results and findings of the river ice analyses, as well as a summary of all forecasts prepared for MIT during the study duration. The results of the flow metering and water level measurements that were surveyed between November 2011 and August 2012 are also summarized in this report.

Early in the project, MIT identified concerns with the potential of ice formation causing flooding. MIT established the "Frazil Ice Team" (FIT) to assess the potential impact of ice formation to the water levels and effects to the local communities along the system. The FIT consisted of senior engineers experienced in river ice conditions and hydraulic computer modeling. KGS Group's involvement in the FIT ice studies was led by Rick Carson.

For the winter of 2011-2012, unprecedented outflow magnitudes were predicted for Lake Manitoba and Lake St. Martin. Several issues related to the ice processes on the Fairford and Dauphin Rivers, as well as the LSMEOC and Buffalo Creek for these unprecedented conditions are identified and discussed in the report.

Spreadsheet routing models were developed to forecast water levels on Lake Manitoba and Lake St. Martin and outflows from these lakes. The models calculated daily changes in water levels and outflows based on predetermined stage-discharge relationships at the outlet of the lakes and available storage. Lake Manitoba inflow forecasts provided by MIT were used as input. A copy of all the forecasts formally issued to MIT is provided with the report.

Flow metering and water level measurements taken during operation of the LSMEOC were completed to calibrate flood routing and backwater models, and to confirm the true capacity of Reach 1 under open water conditions. An Acoustic Doppler Current Profiler (ADCP) mounted on a tethered miniature boat was used to measure flows in Reach 1 on four occasions. A cableway system was installed in March 2012 for the purpose of safely operating the ADCP. The data was processed according to the Water Survey of Canada (WSC) Procedure for the Review and Approval of ADCP Discharge Measurements. Measured flows ranged from 172 $m^3/s$ (6074 cfs) on November 18, 2011, to 115 $m^3/s$ (4061 cfs) on August 9, 2012.

Water levels were measured on Reach 1 and on Buffalo Creek using Global Positioning System (GPS) survey equipment, or from temporary benchmarks, during the flow metering trips and on five more occasions in February 2012. Water levels from WSC were also processed and compared to the surveyed water levels. A rating curve was developed for Reach 1 based on the flow metering data and the water levels recorded by WSC.

Combined results from the forecasts and the river ice simulations formed an integral part of the decision to construct dikes in the Dauphin River communities and also contributed to the decision to construct the Reach 3 Emergency Channel. A summary of the forecasted conditions, which led to those decisions, is discussed in the report.

KGS Group developed a numerical model of the Fairford River to simulate its winter characteristics. The model was developed based on a combination of old and new bathymetric data, historical observations, and experience of the Engineers involved. It was concluded that the worst case scenario of immediate ice generation within released flow from Lake Manitoba would be entirely possible.

Results of the analyses indicated that the Lake Manitoba level could rise approximately 0.25 m, compared to open water conditions without an ice jam. However, the winter of 2011-2012 was extremely mild. The formation of ice on the Fairford River was minimal and rises in water levels due to ice accumulation did not occur as had been predicted by the numerical models using conservatively severe assumptions.

On the Dauphin River, historical observations showed that frazil ice production on the river occurred every year and could cause significant water level rises in the Dauphin River communities. The ice cover also affects the discharge capacity from Lake St. Martin. A numerical model of the Dauphin River was developed to simulate the ice cover development. Data was collected to help generate the model including river bathymetry, water temperature data, historical observations and water level surveys.

Results of the simulations predicted that the water levels in the lower Dauphin River, as the ice cover developed, could increase by up to 4 m depending on the location along the river. The design elevation of the dikes in the Dauphin River communities was set based on the results of the numerical model simulations. In the upper Dauphin River, simulated ice conditions were used to predict the potential staging of water levels on Lake St. Martin with Reach 1 in operation. The forecast showed that the lake could stage up to 1.2 m.

In spite of the extremely mild winter conditions that occurred during 2011-2012, the observed peak levels along the dikes in the Dauphin River communities compared closely to the predicted levels for the ice formation event, and staging of 3 to 4 m was measured at some locations. The recorded water levels indicated that, had the dikes not been built, flooding would have occurred in the communities.

On the upper Dauphin River, ice conditions turned out to be less severe than had been expected. However, a review of the ice conditions that occurred in this reach during 2011-2012 indicated that without the LSMEOC in operation, significant staging would have occurred on Lake St. Martin, which could have exacerbated flood conditions around the Lake and on the Dauphin River. These conditions would have been worse if the winter conditions had been normal or more severe than normal.

A numerical model of Reach 1 was developed to simulate ice conditions in the channel. Similar assumptions adopted for the Fairford River were used in the Reach 1 model. Results from the analysis were used to assist with the prediction of ice staging on Lake St. Martin throughout the 2011-2012 winter period. However, ice conditions in Reach 1 did not occur as had been originally predicted; and it remained free of an ice cover. Only 0.2 m of staging occurred on Lake St. Martin.

On Buffalo Creek, the diversion of the flow through the LSMEOC from Lake St. Martin resulted in winter flows in the creek being several orders of magnitude greater than what would normally occur, which made previous information on ice conditions in the channel not relevant. It was, therefore, reasonable to consider the worst case scenario possible on the creek, based on experience with other rivers. A numerical model was developed using a combination of LiDAR data and survey data along the creek. The results showed that there was a significant risk of inundation during construction along many of the proposed Reach 3 alignment options. The final Reach 3 alignment was chosen, in part, to minimize this risk. Due to the extremely mild winter, ice conditions in Buffalo Creek did not occur as had been predicted by the numerical models.

The analysis and monitoring of discharges and ice processes was discontinued in December 2012, shortly after, the LSMEOC was closed as required under the federal terms and conditions for emergency operations. Additional analysis and monitoring may be required in the future if the LSMEOC is made permanent and/or a Lake Manitoba outlet channel is to be constructed.

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# 1.0 INTRODUCTION

The extremely wet conditions of 2010 and 2011 led to unprecedented flood inflows and rises in water levels on Lake Manitoba and Lake St. Martin. In June 2011, the Province of Manitoba commissioned Kontzamanis Graumann Smith Macmillan Inc. (KGS Group) to urgently explore options to bring the water levels of Lake St. Martin and Lake Manitoba down to the desirable range on an emergency basis. As part of this work, in collaboration with others as described below, KGS Group conducted river ice studies of the Lake Manitoba and Lake St. Martin Emergency Outlet Channel System from August 2011 to April 2012. This included the Fairford River, Dauphin River, Lake St. Martin Emergency Outlet Channel (LSMEOC) and Buffalo Creek. Concurrent with the ice studies and throughout operation of the LSMEOC, KGS Group prepared, at the request of MIT, water level and outflow forecasts from August 2011 to December 2012 for Lake Manitoba and Lake St. Martin.

To complete the ice studies, KGS Group and MIT developed river ice models of the various reaches of the system using computer software. Several scenarios were analyzed based on a range of assumptions on freeze-up dates and the rate of decline of the river flows in the system. The results from the simulations were analyzed to assess the potential extents of the effects from ice on flooding to local communities (e.g. Dauphin River First Nation (DRFN)), and the impacts on lake levels and outflows. Stage-discharge relationships for winter conditions were developed at the outlet of Lake St. Martin and at Lake Manitoba for forecasting purposes. Ice conditions in the various reaches of the system were monitored throughout the winter of 2011-2012 to compare model predictions to observations and surveys of actual conditions that occurred during the winter.

The water level and outflow forecasts were developed by KGS Group based on a numerical flood routing model of Lake Manitoba and Lake St. Martin. The numerical model was formulated as an Excel spreadsheet to enable rapid and efficient deployment during the course of the studies. The model was used to prepare forecasts that were used by the Province of Manitoba for planning and operating purposes of the Lake Manitoba and LSMEOC System. The forecasts were issued monthly or as requested by MIT and modified based on different operating conditions and river ice conditions in the system. The forecasts were also updated and adjusted as appropriate to best represent actual conditions as they were unfolding at the time.

This report focuses on the various ice studies and water level and discharge forecasts prepared between August 2011 and December 2012 by KGS Group for MIT. It includes the results and findings of the river ice analyses, as well as a summary of all forecasts prepared for MIT during the study duration.

To keep the overall structure of this report organized and easy to follow, the contents of the report are not presented in the order that they actually occurred. Section 2.0 includes background information. Section 3.0 provides an overview of ice processes and issues. Section 4.0 discusses the forecasts of water levels and discharges. Sections 5.0 to 8.0 discuss the results and findings of the river ice analyses organized by stream: Fairford River, Dauphin River, Reach 1 and Buffalo Creek. The four areas each have data sources / historical observations presented first, followed by numerical simulations and findings, and observations in 2011 – 2012 presented last.

## 2.0 BACKGROUND

In June 2011, the Province of Manitoba commissioned KGS Group and AECOM to urgently explore options to accelerate the rate of return of water levels of Lake St. Martin and Lake Manitoba to the desirable range. In July 2011, KGS Group and AECOM issued a draft report titled, "*Analysis of Options for Emergency Reduction of Lake Manitoba and Lake St. Martin Levels",* which recommended the following actions to the Province of Manitoba:

- Begin immediate work on construction of an emergency channel (Reach 1) from Lake St. Martin towards Lake Winnipeg to address the hydraulic flow restrictions out of Lake St. Martin and to accommodate additional Lake Manitoba outflows over the winter; and
- Allow unrestricted maximum outflow of water from Lake Manitoba through the Fairford River Water Control Structure (FRWCS) throughout the winter of 2011-2012, allowing for several times more outflow than past typical winter flows.

Subject to the successful implementation of the above, KGS Group and AECOM also provided the following conditional recommendations for the Province of Manitoba to consider:

- Construct a bypass channel around the north side of the FRWCS to allow additional outflow from Lake Manitoba; and
- Expand the emergency channel from Lake St. Martin to offset the additional inflows from Lake Manitoba on the principle of "no net addition of water" to Lake St. Martin.

Due to logistical challenges associated with the development of Reach 1, the conditional recommendations were not implemented.

Following the decision to construct Reach 1, KGS Group provided assistance to MIT in the forecast of water levels and outflows in Lake Manitoba and Lake St. Martin for a range of possible conditions. These forecasts were requested to consider the most up to date hydrometric data and Lake Manitoba inflow forecast available at the time. Concurrent with the forecasts, KGS Group was also asked by MIT to provide assistance in the study of ice formation and processes within the various reaches of the Lake Manitoba and LSMEOC System. A range of ice formation scenarios were simulated to assess the potential flooding of communities and infrastructure adjacent to the water courses in the system.

As the design of Reach 1 evolved, results from the river ice studies and forecasting indicated that there was a significant risk of major flooding of the Dauphin River communities in the fall of 2011 and in the spring of 2012 due to ice jam formations and unprecedented flows, as discussed in Section 6.0. It was concluded that construction of the Reach 3 Emergency Channel should be carried out to divert flows away from the Dauphin River prior to spring break up. In combination with this, the dikes being constructed along the banks of the Dauphin River would significantly reduce the risk of flooding for the Dauphin River communities. Figure 1 shows the location plan of the project area.

## 2.1 FRAZIL ICE TEAM

Early during the project, MIT identified concerns with the potential of ice formation causing flooding. To address these concerns, MIT established the “Frazil Ice Team” (FIT) to assess the potential impacts of ice formation to the water levels and effects to the local communities along the system. The FIT consisted of the following senior engineers experienced in river ice conditions and hydraulic computer modeling:

- Steve Topping, P.Eng. – Chairman of FIT.
- Rick Carson, P.Eng. – Senior Consultant, KGS Group.
- Dr. Karl-Erich Lindenschmidt, P.Eng. – Associate Professor, University of Saskatchewan (formerly Hydrologic Modeling Research Engineer at Manitoba Water Stewardship at the time the FIT was established).
- Mike Morris, P.Eng. – Ice expert from Manitoba Hydro.

KGS Group’s involvement in the ice studies was led by Rick Carson who provided advice on the effective deployment of engineering software for the analysis of the ice conditions in the system. Dr. Karl-Erich Lindenschmidt prepared and ran the simulation models, with assistance provided by Maurice Sydor, a contract employee of KGS Group, and recently retired from Environment Canada. Mr. Sydor had been previously involved with KGS Group in the development of the software used in the studies and is highly skilled at model setup and trouble-shooting. Dr. Lindenschmidt ran the simulations for Manitoba Water Stewardship (MWS) until his departure to take a new position at the University of Saskatchewan in early 2012. He was then hired by KGS Group as a contract employee (concurrent with his responsibilities as an Associate Professor at the University of Saskatchewan) to complete his assignment as part of the study. KGS Group also provided ongoing support throughout the study with surveys and continuous monitoring during the winter. KGS Group's involvement and the findings of the FIT are documented in this report.

At the request of MIT, an independent review and confirmation of the key aspects of the ice studies done by the FIT for the Fairford and Dauphin rivers was conducted by Jean-Philippe Saucet of the LaSalle Consulting Group of LaSalle, Quebec. The findings of Mr. Saucet are documented in this report.

# 3.0 OVERVIEW OF ICE PROCESSES AND ISSUES

## 3.1 FAIRFORD RIVER

Outflow from Lake Manitoba occurs at the Fairford River located at the northeast end of the lake. The Fairford River is approximately 17 km long and the desirable water level descends from 247.0 to 247.7 m (810.5 to 812.5 ft) at Lake Manitoba to 242.9 to 243.8 m (797 to 800 ft) at Lake St. Martin. This is consistent with the recommendations made in 2003 by the Lake Manitoba Regulation Review Advisory Committee that the “water level management regime should permit Lake Manitoba to fluctuate between El 810.5 to 812.5 ft asl over a period of years insofar as this may be reasonably possible, with the expectation that as a result of water level variations, the lake will rise to 813.0 ft asl in some years and drop to 810 ft asl in others”. Normally the outflows are quite limited in magnitude in the winter, and are controlled by the installation of stoplogs at the Fairford Dam, located a short distance along the river from the lake, to promote the formation of a stable ice cover in the Fairford River and the Dauphin River downstream. Under these conditions of low flow, the ice formations on the river both upstream or downstream from the dam do not have significant influence on the outflow discharge capacity from the lake.

However, the issue that was foreseen for the winter of 2011-2012 was that the lake outflow would be so large that hanging ice dams could form in the channels downstream of the Fairford Dam and in Lake Pineimuta. This would potentially cause high water levels along the Fairford River/Lake Pineimuta and conceivably constrict the outflow capacity from Lake Manitoba.

A mitigating aspect, however, that makes this phenomenon particularly difficult to analyze is the fact that the water stored in Lake Manitoba and released over the winter has some residual heat. Only the surface of the lake immediately below its ice cover has cold water that is consistently at zero degrees Celsius. The temperature of the water well below the surface may be above freezing. It may only be a few tenths of a degree Celsius above zero. However, the extent of heat that represents may still be capable of preventing ice forming in the water for some significant distance downstream from the lake outlet. Most outlets from lakes of this size have this characteristic “residual heat”.

The main issue foreseen was the generation of ice and how it could affect the outflow capacity from Lake Manitoba. However, addressing this had to be accompanied by consideration of how, and to what extent, the creation of ice dams would be mitigated by the natural effects from residual heat in Lake Manitoba.

## 3.2 DAUPHIN RIVER

The Dauphin River is the only natural outlet from Lake St. Martin. It traverses a distance of about 50 km from Lake St. Martin to its outlet into Lake Winnipeg and the desirable water descends from approximately El 242.9 to 243.8 m (El 797 to 800 ft) at Lake St. Martin to El 216.7 to 217.9 m (El 711 to 715 ft) at Lake Winnipeg. Over the first 25 km, the river gradient is relatively flat and the flow has a low velocity. The discharge capacity at the outlet from Lake St. Martin is dominated by the frictional effects of the flow in the upper Dauphin River. Winter conditions can cause formation of an ice cover in this reach and further affect the discharge capacity. Typically, it has been observed that the greater the outflow prior to formation of an ice cover, the larger the percentage of discharge capacity reduction due to ice relative to what would be possible with fully open water conditions (i.e. ice formation is proportional to outflow).

The lower 30 km of the river is steeply inclined, with a gradient of about 25 m over the relatively short length of the lower river. Velocities are relatively high. The formation of a smooth ice cover is rarely possible. In most years, the ice cover forms as the result of an accumulation of frazil ice pans formed in the fast flowing lower river. Rises in water level in the freeze-up period have, prior to 2011, been observed to be in the range of 1 to 2 m. The higher the flow, the higher the river water level must rise to create a stable ice cover. Conditions in the lower Dauphin River do not affect Lake St. Martin water levels or outflow.

In spring, the sudden increase in flow due to resumption of open water conditions at the outlet of Lake St. Martin could trigger ice jams in the lower river. This is not known to be a concern in most years but the carryover of high flows from 2011 could have brought this phenomenon forward and could have raised water levels to an undesirable extent.

The issues pertaining to river ice were:

- When and by how much the open water outflow capacity into the upper Dauphin River would be reduced by ice formation.
- The extent to which the increased water levels during freeze-up would threaten the Dauphin River communities and PR 513 that leads to it from the west. Predictions were required to form the basis of design of flood protection dikes in the Dauphin River communities.
- The extent to which ice jams could form in the spring thaw and cause rises in water level in the lower river.

## 3.3 LAKE ST. MARTIN EMERGENCY OUTLET CHANNEL AND BUFFALO CREEK

Normally Buffalo Creek is a small stream with little or no flow in winter. However, the LSMEOC planned to release excess water from Lake St. Martin through Buffalo Creek, into the Dauphin River and onwards into Lake Winnipeg. The increased flows in Buffalo Creek would create the potential for production of frazil ice and the accumulation of hanging ice dams and ice jams along the creek. There could ultimately have been a backwater effect onto the LSMEOC due to ice on Buffalo Creek.

The LSMEOC would have velocities low enough to permit the formation of ice and the potential establishment of an ice cover that would affect the discharge capacity from the lake and slow the response of declining flood levels in Lake St. Martin. That could be exacerbated by the effect of an ice cover on Buffalo Creek.

The issue with ice was to what extent it could affect the discharge capacity at the outlet from Lake St. Martin.

## 3.4 LAKE WINNIPEG AT THE MOUTH OF THE DAUPHIN RIVER

The outflow from the Dauphin River releases into Lake Winnipeg adjacent to the Community of Dauphin River. The river flow is swift in the river channel upstream of the community and continues with little reduction in intensity until it expands into the lake. In theory, if the ice that is carried down from the river could spread under the ice cover in the lake, the accumulation of an ice cover and the rise in water levels on the river in the community would not occur. Prior to 2011, this potential stalling of the ice cover advance from Lake Winnipeg had not occurred, and the ice historically was always able to back up the river water levels to the extent that the ice cover could develop and advance upstream from the lake.

The issue in 2011-2012 was whether the unprecedented flow magnitudes in the Dauphin River, supplemented by the inflow from Reach 1 through Buffalo Creek, would be large enough to prevent an ice cover formation. Furthermore, if the ice could advance, it would be necessary to estimate the rise in water level at the bay, and how it would influence the backwater profile along the river in the community.

# 4.0 FORECASTS OF WATER LEVELS AND DISCHARGES

## 4.1 ROUTING MODEL

KGS Group developed a spreadsheet routing model to forecast water levels on Lake Manitoba and Lake St. Martin and discharges from these lakes. The routing model consisted of two individual water balance models: one for Lake Manitoba, and the other for Lake St. Martin. The water balance models calculated changes in water levels and outflows during a time period when inflows to the lakes are known (i.e. Inflow = Change in Storage + Outflow). A 1-day simulation window was used for the time period in the model. Output from the Lake Manitoba model was used as input for the Lake St. Martin model.

The following steps outline the computation process, as well as the inputs and outputs of the Lake Manitoba model:

1. Daily inflows were input into the Lake Manitoba model based on the inflow forecasts provided on a regular basis by the Hydrologic Forecast Center, MIT (formerly MWS). The inflow forecasts were updated by KGS Group as deemed necessary to reflect actual conditions observed at the time. Each forecast provided by MIT considered all sources of inflow to the lake including precipitation and evaporation and all other miscellaneous inputs such as seepage and groundwater inflow. Copies of the Lake Manitoba inflow forecasts provided by MIT are available in Appendix A, Annex A1.

2. A starting water level on Lake Manitoba was input into the model. The water level was based on observed lake levels as reported by Water Survey of Canada (WSC). The starting water level was used to define the beginning-of-day water level for the first day of simulation in the model.

3. Based on the beginning-of-day water level, the Lake Manitoba storage was computed. The storage was calculated using a stage-storage relationship developed from the surface area of the lake for water levels ranging from approximately El 247.0 to 249.2 m (810.4 to 817.6 ft).

4. An outflow was computed for the lake based on the beginning-of-day water level. Outflow from Lake Manitoba is through the Fairford River. The outflow was calculated using a predetermined stage-discharge relationship from the Fairford River. The open water stage-discharge relationship for the Fairford River was based on historical water levels on Lake Manitoba and corresponding measured Fairford River discharges by WSC at Station 05LM001, supplemented with results from a backwater model of the Fairford River. The backwater model considered that the Fairford River Water Control Structure (FRWCS) would be fully open. The stage-discharge relationship for winter ice conditions was based on results from numerical backwater models in the river. A discussion on winter ice conditions in the Fairford River and inherent assumptions is

provided in Section 5.0 of this report. A copy of the open water and winter rating curves is also provided in Section 5.0.

5. An end-of-day water level was computed for this water level using the same stage-discharge relationship that was outlined in Step 4. The final value for the end-of day wl was computed by trial and error following steps 6 to 10.

6. A mean outflow was computed for the day based on the outflows computed in steps 4 and 5.

7. The daily change in storage was then computed based on the known inflow outlined in step 1 and the mean daily outflow outlined in step 6 (Change in Storage = [inflow – Outflow] x change in time).

8. The daily change in storage computed in Step 7 was added to the beginning-of-day storage computed in Step 3 to compute the end-of-day storage and the corresponding end-of-day water level from the storage curve.

9. The actual end of day water level from step 8 was compared to the assumed end-of-day water level in Step 5.

10. Steps 5 to 9 were repeated until the assumed end-of-day water level equaled the computed end-of-day water level.

11. The end of day water level was used as the starting water level for the next day.

12. Steps 3 to 11 were then repeated for each day of simulation in the model.

The computed Lake Manitoba mean outflow values were used as input into the Lake St. Martin Water Balance Model and were adjusted to account for additional inflow sources such as precipitation and evaporation. The same computation process, as outlined above, was then applied for the Lake St. Martin model.

The stage-discharge relationship for outflow from Lake St. Martin for open water conditions in the Dauphin River was based on historical water level and flow data available from WSC. The stage-discharge relationship used for 2011-2012 winter ice conditions was based on results from numerical models in the river developed by the FIT. The stage-discharge relationship was then modified in the late spring of 2012 following observations of actual conditions that occurred during the winter of 2011-2012. A discussion on winter ice conditions in the Dauphin River and inherent assumptions is provided in Section 6.0 of this report. Copies of the open water and winter stage-discharge relationships are also provided in Section 6.0.

The stage-discharge relationship for outflow from Lake St. Martin into Reach 1 under open water conditions was based on a numerical backwater model of the channel and was calibrated and adjusted based on flow meterings. Flow metering results and the estimated stage-discharge relationship for Reach 1 are provided in Appendix B in the report titled, *"Flow Metering and Water Level Measurement of the Lake St. Martin Emergency Channel System"*. The stage-discharge relationship for Reach 1 that was developed for winter conditions was also based on a numerical model of the channel and was adjusted based on observations of actual conditions in Reach 1. A discussion on winter ice conditions in Reach 1 is provided in Section 7.0 of this report.

The stage-storage relationship for Lake St. Martin was developed from the surface area of the lake for water levels ranging from approximately El 243.2 to 247.0 m (797.9 to 810.4 ft).

## 4.2 SUMMARY OF FORECASTS AND RESULTS

A copy of all the forecasts formally issued to MIT is provided in Appendix A, Annex A2. The forecast figures are organized by issue date and include a copy of e-mails issued with the forecast. A table summarizing all of the forecasts that were issued and date of issue is included at the front of the Annex (Table A2-1).

Results from the forecasts formed the basis of the river ice simulations described in this report. Combined results from the forecasts and the river ice simulations formed an integral part of the decision to construct dikes in the Dauphin River communities. They also contributed to the decision to construct the Reach 3 Emergency Channel. A summary of the forecasted conditions, which led to those decisions, is discussed in Sections 4.2.1, 4.2.2 and 4.2.3.

### 4.2.1 Scenarios for Dauphin River Ice Simulations

A total of seven discharge scenarios were considered for the Lower Dauphin River ice simulations as follows.

1. Early Freeze Up (2011) at Q = 500 m3/s (17,620 cfs).
2. Best Estimate Freeze Up (2011) at Q = 400 m3/s (14,160 cfs).

3. Late Freeze Up (2011) at Q = 365 m3/s (12,900 cfs).
4. Spring Break Up at Q = 700 $m^3$/s (24,720 cfs).
5. Spring Break Up at Q = 1000 $m^3$/s (35,310 cfs).
6. Spring Break Up at Q = 444 $m^3$/s (15,680 cfs).
7. Early Freeze Up (2012) - 269 m3/s (9,500 cfs).

On August 30, 2011, three ice freeze-up scenarios with ice jam formation at the Dauphin River communities were identified. The forecast indicated that the estimated discharge in the lower Dauphin River for early, best estimate and late freeze up conditions on Lake Winnipeg was approximately 500 $m^3$/s (17,620 cfs), 400 $m^3$/s (14,160 cfs), and 365 $m^3$/s (12,900 cfs) respectively. These discharges formed the basis for Scenarios 1, 2 and 3 for the simulations of the lower Dauphin River described in Section 6.4.

On September 20, 2011, the model results indicated that the discharge in the lower Dauphin River during ice breakup would be approximately 1000 $m^3$/s (35,310 cfs). This condition formed the basis of Scenario 5 since the potential for an ice jam formation during a rapid spring melt could cause the water levels to exceed the water levels for the spring ice formation phase. However, due to construction limitations, the Dauphin River dykes could not be raised to the maximum level; and, therefore, a discharge of 700 $m^3$/s (24,720 cfs) for spring ice breakup was also selected for modeling (Scenario 4).

Due to the extremely mild winter conditions that occurred in the winter of 2011-2012, the ice jam conditions on both Reach 1 and the Dauphin River outlet, as well as the effects on outflow from Lake St Martin, were much less severe than forecasted in early winter (Scenario 4 and 5). A discussion on the extremely mild winter conditions that occurred is provided in Section 5.3. By February 22, 2012, the revised forecast model runs predicted that the peak outflow from Lake St Martin during the spring would be between 410 $m^3$/s (14,480 cfs) and 476 $m^3$/s (16,810 cfs). At the request of MIT, Scenario 6 for the average discharge of 444 $m^3$/s (15,680 cfs) was analyzed.

The February 22, 2012 forecast also indicated that the discharge in the lower Dauphin River during the early winter 2012 ice formation period would be approximately 269 $m^3$/s (9,500 cfs).

This formed the basis of the Scenario 7 simulation, which was requested by MIT to determine if the Dauphin River dikes could be removed or lowered.

### 4.2.2 Basis for Design of the Dikes in the Dauphin River Communities

The computed water level profile for Scenario 1, which was comprised of an early date for the start of the ice formation with a predicted discharge of 500 $m^3/s$ (17,620 cfs), was initially used for the design of the crest level for the dikes in the Dauphin River communities. A freeboard of 0.6 m above the computed water level was included in the design. However, due to the potential that an ice jam during a rapid severe spring melt season could cause water levels to exceed those estimated for the ice formation phase, an additional 0.7 m was added to the Scenario 1 profile for the design of the dikes.

As discussed in Section 4.2.1, the September 20 forecast indicated that the discharge in the lower Dauphin River during ice breakup could reach approximately 1000 $m^3/s$ (35,310 cfs). The model results for Scenarios 4 and 5 later showed that the design level of the dikes was too low in some areas. The details and results of the spectrum of simulations of the Dauphin River are discussed in depth in Section 6.0 of this report.

Scenario 4, 700 $m^3/s$ (24,720 cfs) for spring ice breakup was, therefore, selected for the design of the dikes, with due consideration of the limited capacity for emergency raising of dikes at the Dauphin River communities. Scenario 4 required a top-up above the Scenario 1 profile (plus 0.7 m allowance) of up to 0.4 m in some locations to maintain 0.6 m of freeboard. This elevation was deemed to be the maximum feasible to suit the area for the proposed dike footprints. It would also require volumes of soil that would be the maximum that could be placed during the available construction period prior to winter freeze-up.

The risk of overtopping of the dikes was still deemed unacceptable by MIT. The following options were considered to protect against the severe spring breakup scenario with a potential flow of 1000 $m^3/s$ (35,310 cfs).

1. Widen and raise the dikes even higher at the Dauphin River communities utilizing a winter access road and winter construction techniques. This option had constructability concerns due to access and winter conditions and high construction costs for the temporary works.

2. Temporarily close off Reach 1 by constructing a temporary cofferdam across Reach 1 approximately two weeks prior to spring breakup to reduce Dauphin River flows during the spring ice staging period. However, it was concluded that the cofferdam would not be practical due to constructability concerns; and it would be difficult to judge the optimal timing for the closure. It would also have resulted in increased Lake St. Martin water levels.

3. Reduce water levels on Lake St Martin by reducing flows at the FWRCS during the winter. Installing stoplogs in the winter would have been very difficult and the reduced Lake Manitoba outflows would have increased the water level on Lake Manitoba.

4. Construct Reach 3 of the Lake St. Martin Emergency Outlet Channel during the winter to divert Reach 1 flows away from the Dauphin River directly to Lake Winnipeg, thereby reducing Dauphin River flows at the communities in the spring. This option was considered the most favorable and was ultimately adopted for construction.

### 4.2.3 Basis for Hydraulic Design of Reach 3

Based on the September 20, 2011 water level and discharge forecasts, a discharge of 240 $m^3$/s (8,500 cfs) was selected for the hydraulic design of the Reach 3 Emergency Channel to divert Reach 1 flows away from the Dauphin River directly to Lake Winnipeg. Also, the September 20, 2011 forecasts showed that the predicted peak flow of 1000 $m^3$/s (35,310 cfs), ice simulation Scenario 5, in the lower Dauphin River was only expected to exceed 700 $m^3$/s (24,720 cfs), ice simulation Scenario 4, for a brief period during ice breakup. It was, therefore, concluded that the Reach 3 Emergency Channel would only need to be operated for a period of approximately four weeks. The Reach 3 Emergency Channel tender package was prepared based on these design assumptions and issued on the following dates:

- November 17, 2011: issued for tender.
- November 25, 2011: issued for tender with Amendment No.1.

Contract 6178 for the construction of the Reach 3 Emergency Channel was awarded to Hugh Munro in December 2011. However, the January 5, 2012 forecast revised downward the predicted discharge in the Dauphin River communities from 1000 $m^3$/s (35,310 cfs) to 765 $m^3$/s (27,000 cfs) during ice breakup. This reduction was due to reduced staging on Lake St. Martin resulting from the extremely mild winter conditions. Therefore, based on recommendations from KGS Group, MIT requested on January 13, 2012 that the design discharge for Reach 3 Emergency Channel be reduced by half to 120 $m^3$/s (4250 cfs). The Reach 3 Emergency Channel design was correspondingly revised and re-issued on the following dates:

- February 3, 2012: issued for construction (IFC).
- March 1, 2012: re-issued for construction (RFC).

Due to continuing extremely mild winter conditions, the February 22, 2012 “worst case” forecast for the spring breakup discharge in the Dauphin River communities had decreased to 475 $m^3/s$ (16,800 cfs). The revised forecasted spring breakup flow was well below the 700 $m^3/s$ (24,720 cfs) capacity of the dikes in the communities. Operation of the Reach 3 Emergency Channel was therefore no longer required. Design and construction details of the Reach 3 Emergency Channel are included in *“Reach 3 Design and Construction Report”* by KGS Group. Table 1 summarizes the evolution of the predicted peak discharge in the Dauphin River communities and the proposed design discharge of Reach 3

**TABLE 1**
**SUMMARY OF PREDICATED PEAK SPRING DISCHARGE IN DAUPHIN RIVER COMMUNITIES AND CORRESPONDING DESIGN DISCHARGE OF REACH 3**

| Date of Forecast | Predicted Peak Discharge in Dauphin River communities | Corresponding Design Discharge of Reach 3 |
|---|---|---|
| September 20, 2011 | 1000 $m^3/s$ (35,310 cfs) | 240 $m^3/s$ (8,500 cfs) |
| January 5, 2012 | 765 $m^3/s$ (27,000 cfs) | 120 $m^3/s$ (4250 cfs) |
| February 22, 2012 | 475 $m^3/s$ (16,800 cfs) | No longer required |
| Actual Peak | 307 $m^3/s$ (10,800 cfs) | n/a |

# 5.0 FAIRFORD RIVER

## 5.1 DATA SOURCES

### 5.1.1 River Bathymetry

Previous bathymetric surveys of the Fairford River were provided to KGS Group by MIT dating from 1980. The surveyed cross sections only extended over a short length of the river from Lake Manitoba approximately 1 km upstream of the Fairford River Water Control Structure (FRWCS) to the mouth of Lake Pineimuta approximately 800 m downstream of the old railway bridge. A copy of the data is provided in Appendix C, Annex C1. Typical cross sections are provided with the Fairford River HEC-RAS backwater model attached in Appendix L.

Additional field surveys were carried out by KGS Group on August 31 and September 1, 2011 covering the river from the FRWCS to Lake St. Martin. Plan drawings showing the extent of the survey are provided in Appendix C, Annex C2. Typical cross sections are provided with the Fairford River HEC-RAS backwater model attached in Appendix L. The raw bathymetric data is provided on the Data DVD.

### 5.1.2 Historical Observations and Relevance

Historical photographic records of the Fairford River in winter are not extensive. Photos from January 26, 2004 as well as November 30, 2007, which show ice conditions in the Fairford River, were provided by MIT and are attached in Appendix D, Annex D1 and D2.

Of particular interest were the photographs from November 30, 2007, which showed ice forming on the surface of the open water early in the winter season. This showed that there was strong evidence that ice could form on the surface of the outflow from Lake Manitoba almost immediately upon its release from under the lake ice. It was deduced from the evidence that residual heat content normally occurring in other lakes is typically suppressed in Lake Manitoba due to its shallow depth. It is recognized that the conditions shown in the few photos available may not prevail throughout the entire winter. However, it was not possible with the data available to predict the extent to which the residual heat may be relied upon.

#### 5.1.3 Water Temperature Data

Two water temperature loggers were installed on the Fairford River to monitor the ice producing potential and the residual heat in the water released from Lake Manitoba. The loggers were installed in December 2011 and removed in March 2012. One logger was installed at the Fairford Dam and the other was installed at the old railway bridge. Data obtained from the loggers is provided in Appendix E, Annex E1.

### 5.2 NUMERICAL SIMULATIONS

#### 5.2.1 Models Applied

***VARY-ICE Model***

KGS Group applied its in-house numerical model “VARY-ICE” to simulate the winter characteristics of the Fairford River. VARY-ICE was selected due to its ability to model hydrodynamic conditions in a river and account for the upstream progression of an ice cover or jam. A brief description of VARY-ICE is provided in Appendix F.

***La Salle Model***

The ice studies done by the FIT for the Fairford/Dauphin River system used leading edge techniques and relied to a large extent on the experience of the engineers involved. MIT also requested an independent review and confirmation of the methodology and results of the ice studies. MIT selected, for these purposes, the services of a specialist consultant, Jean-Philippe Saucet, of LaSalle Consulting Group of LaSalle, Quebec.

Mr. Saucet has diverse experience with river ice problems, primarily in Quebec. He used this experience in parallel with the application of a proprietary numerical model of ice processes. That software had been previously developed jointly by the Danish Hydraulic Institute and LaSalle Consulting Group. It operates as a subroutine of the well-known software called Mike 11.

The LaSalle Consulting Group concluded in their November 2, 2011 report entitled, "*Ice Effects on the Fairford River during the Coming Winter"* that "the VARY-ICE model used by KGS incorporated the main ice processes which would control the winter flow of the Fairford River".

The LaSalle Consulting Group concluded in their November 17, 2011 report entitled, "*Numerical Modelling of the Fairford River Ice Conditions during the 2011 – 2012 Winter Season",* that "the results differ somewhat from those presented by KGS. The change of flow is more gradual in early winter and spring, and the minimum flow in the middle of winter is larger. The total volume of water leaving the lake is, however, comparable; and the minimum level reached during winter is the same".

The complete findings of Mr. Saucet on the Fairford River are described in Appendix G, Annex G1. A copy of the model files from Mr. Saucet are provided in Appendix G, Annex G3.

#### 5.2.2 Assumptions Adopted

As described above, the most critical assumption for any calculation of potential ice generation in the Fairford River is how much heat is in the lake outflow. Observation of almost all other major lakes shows that there is some residual heat in the water that must be released into the cold air before ice can begin to form. Examples include the Nelson River at the outlet of Lake Winnipeg, the Churchill River Diversion at the outlet of South Indian Lake, the Reindeer River at the outlet of Reindeer Lake in northern Saskatchewan, the Niagara River at the outlet of Lake Erie, and the Winnipeg River at the outlet of Lake of the Woods.

A parallel assumption is at what point the surface layers of the river flow can begin to form ice. Surface ice generation can occur even though the main body of the flow beneath it is still at temperatures above the freezing point. Flow depths and turbulence of the river flow of course influence this phenomenon significantly.

There are no data records of water temperature in Lake Manitoba, nor are there records of water temperature in the Fairford River. Due to the emergent nature of the project, the water temperature loggers discussed in Section 5.1.3 could only be installed later in the modeling process, and therefore assumptions for the calculation of ice generation had to be selected from experience elsewhere and from indirect anecdotal evidence.

Three key points influenced the development of this assumption:

1. Photographs from early-winter 2007 indicated that the water exiting from Lake Manitoba showed clear signs of surface ice generation almost immediately below the exit point from under the lake ice cover. This indicated that on the days that the photographs were taken the water temperature was so close to freezing that surface ice formation was immediate.
2. Manitoba Hydro's experience of the Nelson River at the outlet of Lake Winnipeg was that open water can persist for some distance below Warren Landing, but eventually it becomes ice covered later in the winter. This indicates that the residual heat in the water at that point is negligible.
3. Lake Manitoba is shallow. Based on Lake Manitoba depth charts, the average normal depth in the lake is approximately only 5 m. The shallow depths reduce the possibility of stratification of the water body and allow for cooling of the water body to lower temperatures.

It was concluded that the worst case scenario of immediate ice generation within released flow from Lake Manitoba would be entirely possible. Consequently, it was necessary to assume that the temperature of the water releasing from Lake Manitoba would be at the freezing point throughout the winter. Based on past experience, the ice front was assumed to be at the upstream end of Lake Pineimuta on January 1, 2012. This assumption formed the cornerstone of all the numerical analyses done to predict the response of the river to ice formation.

Other assumptions used in the ice model included:

- **Air Temperature –** The air temperature is used to determine the daily volume of ice produced in the area of open water upstream from the ice front. The monthly average air temperature in January and February was assumed to range between approximately -7$^{o}$ and -17$^{o}$ Celsius, which was similar to historic air temperatures recorded in the area.
- **Maximum Froude Number at Ice Jam for Ice Juxtaposition –** The maximum Froude Number at the leading edge of the ice jam required for juxtaposition of ice at the ice front typically ranges from 0.08 to 0.12. The lower Froude Number applies when the incoming ice is comprised of frazil ice particles, and the higher value typically used when the incoming ice is primarily ice pans or floes. A Froude number of 0.08 was used for the Fairford River ice model.
- **The Maximum Velocity for Deposition under the Ice Cover –** The maximum velocity for deposition under the ice cover is 0.6 m/s. Incoming ice is carried under the ice cover when

the Froude Number at the leading edge is greater than the critical Froude Number. That submersed ice is deposited only when the velocity is less than the maximum deposition velocity. The ice cover is scoured out when the velocity exceeds 1.2 m/s.

- **Roughness Coefficient for Ice Jam Cover –** The roughness coefficient for the ice cover varies according to the thickness of the ice cover. The Manning's n-value for the ice cover varied from 0.035 when the ice cover was 0.6 m thick to 0.054 when the ice cover thickness was 4.25 m.
- **Channel Bed Manning's Roughness –** The Manning's n-value for the channel bed was assumed as 0.030.

The VARY-ICE model was run using a constant discharge of 300 $m^3/s$ (10,600 cfs). This discharge corresponded to the estimated average outflow from Lake Manitoba during the winter without ice effects in the Fairford River. The VARY-ICE model was used to compute the ice jam progression starting on January 1, 2012. The model assumed a constant discharge throughout the ice simulation period. Since storage routing was not included in the VARY-ICE model, Lake Manitoba water levels continued to rise in response to the increasing head loss from the advancing ice jam. The model was not capable of reducing the discharge due to the increased backwater. The ice thicknesses in the model computed at the end of each day were used in a HEC-RAS backwater model to develop end-of-day stage discharge relationships that were input into the Lake Manitoba flood routing model discussed in Section 4.1. The routing model was then used to determine the storage effects in Lake Manitoba.

### 5.2.3 Findings

The computed Lake Manitoba water level based on an ice cover forming on the Fairford River starting on January 1, 2012 was included in the November 8, 2011 forecast. The effect of the ice jam on the Fairford River caused the level on Lake Manitoba to rise approximately 0.8 feet, compared to the open water conditions without the ice jam. The results of the simulations showed a reduction in Lake Manitoba outflow from approximately 370 $m^3/s$ (13,070 cfs) for the open water conditions to 105 $m^3/s$ (3,710 cfs) by January 24, 2012, for the ice jam conditions. Figure 2 shows the stage-discharge relationships for open water conditions and maximum winter ice conditions on the Fairford River. The computed water surface profile of the Fairford River under winter ice conditions at the end of January 2012 is provided on Figure 3.

## 5.3 OBSERVATIONS IN 2011–2012

The winter of 2011-2012 was extremely mild. Figure 4 shows the trace of degree-days of freezing at Fisher Branch located approximately 90 km south-east of the Lake Manitoba outlet, compared to other recorded years of data, and clearly shows the extent of warm weather that prevailed through the entire season. Water temperature data collected on the Fairford River (Appendix E) showed that the water in the river never declined to zero degrees for extended periods. This had profound effects on the ice development downstream. The formation of ice was minimal and rises in water levels due to ice accumulation did not occur as had been predicted by the numerical models using conservatively severe assumptions.

To document ice conditions during the winter of 2011-2012, a time lapse camera was installed on the Fairford River at the old railway bridge and collected photos every 30 min between November 29, 2011 and March 22, 2012. The photos are provided in Appendix H, Annex H1. Air photos and Satellite Imagery were also collected periodically during the winter. The air photos are provided in Appendix H, Annex H1. The satellite imagery is provided in Appendix H, Annex H2.

# 6.0 DAUPHIN RIVER

## 6.1 ICE REGIME AND HISTORICAL OBSERVATIONS

The Dauphin River slopes relatively gently over the first 40 km from its source at Lake St. Martin, with a gradient of about 0.3 m per 1000 m. This is comparable to many slowly moving streams in the flat topography of central Manitoba. However, it then steepens significantly over the next 10 km to a gradient that averages about 1 m per 1000 m of length, and in short portions of that reach, approaches 1 m per 700 m of length. Even in the last few kilometres where the river enters Lake Winnipeg the river slope remains steep. Flow velocities typically range between 0.5 to 1.5 m/s, irrespective of flow, over the first 40 km and increase to approximately 2 m/s over the next 10 km.

This wide variation in slope of the river results in widely varying ice conditions. In the upper river, the sluggish flow can develop an ice cover due to border ice advancement, skim ice formation, and bridging of moving slush ice between border ice edges, even before the ice cover advances from downstream.

In the steep lower part of the river where the velocities are high, the river surface typically cools to freezing in early November. At that point, frazil ice begins to generate and coalesce into slush ice pans that travel down into Lake Winnipeg. The surface of Lake Winnipeg typically ices over in the area of the Dauphin River mouth by early November. At that point, the slush ice being delivered by the Dauphin River begins to amass at the river mouth and back up the water levels. This is the classic formation of a hanging ice dam, and would be expected to occur at this location when river flows are greater than about 70 $m^3$/s (2,470 cfs) and velocities are greater than approximately 0.5 m/s.

In the late fall of 2010, the river flow was in the order of 200 $m^3$/s (7,060 cfs). The ice cover advanced from Lake Winnipeg, being supplied continuously by a steady inflow of slush ice. Water levels were estimated to have risen over 2 m as the ice cover formed and stabilized. Photographs of the river ice were supplied by local residents and are shown in Appendix D, Annex D3. These photos showed recognizable landmarks such as roads, therefore, the water levels occurring at that time could be estimated. In addition, MIT provided notes on ice conditions in the Dauphin River taken from 2007 to 2011. It was reported that the road near Cranberry Creek was overtopped by November 21, 2010, which provided more evidence of the rising stage of the river with the ice cover advancement. A copy of the notes on Dauphin River ice conditions is provided in Appendix D, Annex D4.

In spite of the high flow in the Dauphin River, the water and ice levels did not exceed the bankfull stage in the Dauphin River communities and no serious damages occurred in 2010. Upstream, water did exceed bankfull stage and flooded part of PR 513 and an access road west of the Dauphin River community, but only at a few minor locations.

MIT reported that the river developed a full ice cover extending from Lake Winnipeg to Lake St. Martin by mid-December in 2010. Only minor short reaches of open water remained by that time.

This mode of ice formation and advancement, or variations of it, occurs every year, and affects the discharge capacity from Lake St. Martin. MWS has estimated that in previous years, with normal river flow conditions, the stage-discharge relationship at the outlet of Lake St. Martin rises approximately 60 cm due to the formation of the ice cover.

A further remark from local residents was also important. It was stated that there had been no flooding in the communities due to ice jams or ice cover formations in the recorded history of the communities.

There are no records available on conditions during spring ice breakup. However, local observers have indicated to KGS Group that the ice typically releases slowly and ice jams are not of particular concern in spring.

### 6.2 INFLUENCE BY RECORD FLOOD FLOWS AND LSMEOC

The record-setting flood runoff in the spring and summer of 2011 caused severe flood conditions on Lake Manitoba, the Fairford River, Lake Pineimuta and on Lake St. Martin. The effects had not subsided by the early fall of 2011 and flows were still in excess of 600 $m^3/s$ (21,190 cfs) in the Dauphin River.

The Government of Manitoba took proactive steps to plan and construct an emergency outlet channel from the northeast end of Lake St. Martin to Big Buffalo Lake at the headwaters of Buffalo Creek. The flow from Big Buffalo Lake and Buffalo Creek discharged into the Dauphin River approximately 5 km upstream of Lake Winnipeg. This channel (called “Reach 1”) was constructed and opened to pass flow on November 1, 2011. The increase in the total outflow from Lake St. Martin via Reach 1 assisted in the lowering of the high Lake St. Martin water levels.

The lower Dauphin River was already exposed to unprecedented early winter flows prior to the opening of Reach 1. The releases from Reach 1 were only expected to temporarily increase the flow in the lower river during the first few weeks of operation until Lake St. Martin water levels receded to a level where its outflow was approximately equal to its inflow. Regardless of the opening of Reach 1, the projected flows in the lower Dauphin River would result in unprecedented water and ice levels within the Dauphin River communities. The Frazil Ice Team predicted that water and ice staging levels could potentially cause flooding in the Dauphin River communities in 2011.

Protection of the infrastructure at the Dauphin River communities would be required. A dike was planned to be built in parallel with the Reach 1 construction so that by the time the ice conditions commenced, there would be preventive measures in place to minimize damage along the river. It was this scenario that formed the main focus of the ice studies and is described in the sections that follow.

## 6.3 DATA SOURCES

### 6.3.1 River Bathymetry

Field surveys were carried out on the Dauphin River by KGS Group from June 29 to July 2, 2011 to capture bathymetry data for the model. The surveys covered the entire river extending from the Lake St. Martin outlet to the mouth at Lake Winnipeg. Plan drawings showing the extent of the survey are provided in Appendix C, Annex C3. The raw bathymetric data is provided on the Data DVD.

#### 6.3.2 Water Temperature Data

Water temperature loggers were installed on October 19, 2011 in the Dauphin River and Lake Winnipeg near the Dauphin River community to be used as an indicator of when ice would start to be generated and accumulated. Data obtained from the loggers as well as a plan showing their location is provided in Appendix E, Annex E2. The loggers were removed while ice developed on the lake and in the river in late November.

#### 6.3.3 River Observations

***Open Water***

Prior to 2011 open water levels along the Dauphin River were not recorded, except at the Water Survey of Canada gauge located at approximately the midpoint between Lake Winnipeg and Lake St. Martin.

During the 2011 event, MIT regularly surveyed water levels along the Fairford and Dauphin Rivers at over 15 separate locations. A copy of the data provided by MIT is attached in Appendix I, Annex I1. The data provided was collected from October 2011 to March 2012, during open water conditions and also during the winter when ice effects were present. Additional data collected on May 19, 2011 was also provided when the estimated flow in the River was approximately 420 $m^3/s$ (14,830 cfs) and was used for the calibration of the model. Table 2 shows the water levels measured on May 19, 2011. The measured water levels are also plotted on the profile provided on Figure 7 and discussed in Section 6.4.2.

**TABLE 2**
**MEASURED DAUPHIN RIVER WATER LEVELS ON MAY 19, 2011**
**420 $M^3$/S (14,830 CFS)**

| Location ID | Dauphin R. Station (m) | Water Surface Elevation (m) |
|---|---|---|
| Gauge 8 | 0 | 244.97 |
| Gauge 9 | 7251 | 244.54 |
| Gauge 10 | 11780 | 243.77 |
| Gauge 11 | 26721 | 238.78 |
| Gauge 12 | 31319 | 237.04 |
| Gauge 13 | 32295 | 236.96 |
| Gauge 14 | 35579 | 235.65 |
| Gauge 15 | 38692 | 234.83 |
| Gauge “Reserve” | 52015 | 218.12 |

KGS Group also undertook field surveys in June and July of 2011 that included both the bathymetric surveys described in Section 6.3.1 and water surface profiles that could be linked to river discharge measurements. Figure 5 shows the river profile measured during the June and July 2011 survey. The flow at the time of the survey was approximately 565 $m^3$/s (19,950 cfs).

***Winter***

As described in Section 6.1 above, KGS Group used photographic and anecdotal evidence to reconstruct the water levels that occurred in the winter of 2010-2011. Table 3 shows the estimated maximum water levels that occurred at five different locations in November 2010 at a river flow of approximately 190 $m^3$/s (6,710 cfs).

**TABLE 3**
**ESTIMATED MAXIMUM DAUPHIN RIVER WATER LEVELS WITH ICE**
**190 $M^3/S$ (6,710 CFS)**

| Station (m) | Elevation (m) |
|---|---|
| 2000 | 244.85 |
| 27700 | 238.5 |
| 48200 | 224.8 |
| 49300 | 222.3 |
| 49700 | 221.8 |

Water levels were also surveyed by KGS Group along the Dauphin River communities during the ice formation period between November 20 and December 17, 2011 as well as January 6, 2012. A copy of the data is provided in Appendix I, Annex I2. Three monitoring stations were initially selected for the survey, which was increased to nine stations as ice conditions developed in the river. Due to impeding ice formations, water levels could not be surveyed daily at all locations. Water levels could not be surveyed after January 6, 2012, due to restricted access and flooding of PR 513.

***Spring Breakup***

There are no known water level observations of ice conditions in spring.

### 6.3.4 Historical Stage-Discharge Relationship

***Open Water***

Figure 6 shows the estimated stage-discharge relationship for the Dauphin River at the outlet of Lake St. Martin under open water conditions. This was developed over years of observations by MWS and formed a sound basis for the studies of the flood conditions of 2011.

***Winter***

As described in Section 6.1, ice can significantly affect the open water levels displayed in Figure 6. The estimated winter stage-discharge relationship for the Dauphin River at the outlet of Lake St. Martin is also shown on Figure 6, and was developed by MWS based on years of winter observations. The historical flows used to develop the winter stage discharge relationship were much lower than the flows that were expected during the winter of 2011-2012.

## 6.4 NUMERICAL MODELING OF RIVER ICE CONDITIONS

### 6.4.1 Model(s) Applied

***RIVICE***

***History***

In late 1989, a group of consulting engineering firms prepared an unsolicited proposal for the development of a non-proprietary numerical model of river ice processes. A group of client companies and agencies formed a Steering Committee to administer the process of program development. A “design report” was submitted in 1992 that outlined the basic intent of the computer model, and after discussions with the Steering Committee, preparation of programming instructions defining the implementation of the new software commenced. A subsequent report was submitted including flowcharts and detailed line-by-line programming instructions. The development of the program code was undertaken by the programming group at Environment Canada. Individual subroutines were developed first, and were tested with sample input. However, the amalgamation of the entire program proved to be difficult and by 1995, a successfully working model had not yet been developed. At that point, the project went into abeyance, although some funds remained in the pooled financial support that had been raised for the project by the client organizations.

In 2003, KGS Group was approached by Environment Canada to complete the software. One of KGS Group’s lead engineers had participated in the original development work and had a working knowledge of the software.

By late 2008, the concept was essentially proven to be workable and several test cases had been run. The version of RIVICE that emerged from this process was similar in functionality to what had been envisaged by the original developers, but differed in one major aspect. This was the abandonment of a separate “driver” for the program and adoption of the driver logic that was already embodied in the parent software "ONED", which had been in use at Environment Canada for several decades.

Manitoba Water Stewardship has been experimenting with the "beta-version" of RIVICE since 2007. MWS's experience with this model was reasonably successful for their studies of ice jams during breakup and formation in the lower Red River. As a result MWS promoted the use of the model for studies of the Dauphin River, in collaboration with KGS Group.

***Model Objectives***

The basic objectives of RIVICE are to:

- Permit the simulation of river ice cover development, primarily in swift rivers that do not permit the formation of a smooth, stable, thermally developed ice cover like that on a lake.
- Apply the most current understanding of the ice processes involved, and allow the user the flexibility of choosing optional means of representing ice development.
- Permit representation of the hydrodynamic effects of changing flows and the influence of the ice cover evolution on the changes in river flow.
- Provide a framework for the insertion of user developed subroutines that could be adopted in lieu of the logic that has been developed for RIVICE. Specific examples would be:
    - heat loss from open water,
    - rate of ice generation, or rate of ice cover melting when the incoming water temperature exceeds zero degrees Celsius,
    - criteria for the stability of ice approaching the leading edge of an ice cover, the mechanism that governs whether ice entrained in the flow beneath an established ice cover will deposit on the ice under-surface, or continue to be transported downstream with the flow,
    - border ice formation and breakup,
    - estimation of roughness characteristics of the under surface of the ice cover,
    - estimation of transport characteristics of entrained ice within the flow under an ice cover,
    - calculation of the ability of a fragmented ice cover to resist the hydraulic loads imposed upon it, and thickening to become stable.

***Numerical Model Used by LaSalle Consulting Group***

As discussed in Section 5.2.1, the ice studies done by the FIT for the Fairford/Dauphin River system used leading edge techniques and relied to a large extent on the experience of the study engineers on that committee. MIT retained the services of Jean-Philippe Saucet, of LaSalle Consulting Group, to conduct an independent review and confirmation of the key aspects of the ice studies.

The findings of Mr. Saucet on the Dauphin River are described in Appendix G, Annex G2. A copy of the model files from Mr. Saucet are provided in Appendix G, Annex G3.

### 6.4.2 Assumptions for Modeling

***Lake Winnipeg Water Levels***

Water levels on Lake Winnipeg during the late fall 2011 were obtained from Water Survey of Canada. Projections of the water levels during the winter were provided by Manitoba Hydro.

At the time the studies were being conducted in September, 2011, the water level on Lake Winnipeg was approximately El 218.5 m (717 ft). The projection by Manitoba Hydro was that the lake levels would subside to approximately El 217.5 m (714 ft) by the spring of 2012. This range of the levels became the basis for the simulations at the lower end of the Dauphin River.

***Hanging Ice Dam at Dauphin River Outlet***

Even with the relatively high water level on Lake Winnipeg, the velocity of flow in the river at the outlet of the Dauphin River was expected to be much greater than 1 m/s in the fall of 2011. This could prevent the normal formation of a stable ice cover. An ice cover would, however, be able to develop on the quiet waters of Lake Winnipeg beyond the river release point. Incoming slush ice from the swift turbulent river would be driven under the lake ice. The submersed ice would be carried to points in the lake where the lower velocity would allow the ice to deposit on the underside of the lake ice. This is the classic formation process for a “hanging ice dam”. Hanging ice dams typically develop to such an extent as to impede the flow under the ice and cause significant rises in the upstream water levels at the leading edge of the ice cover. As the water level at the leading edge of the ice cover rises, the local velocity at the leading edge is reduced below the critical value for upstream progression of the cover, which then allows the ice cover to advance in an upstream direction.

Examples of hanging ice dams at other locations include the hanging ice dam that typically forms in winter in the deep pool of the Niagara River beneath Niagara Falls. Ice thicknesses in excess of 40 m have been observed in this pool. A comparably scaled hanging ice dam forms each winter at Muskrat Falls on the lower Churchill River in Labrador and typically accumulates ice that exceeds 45 m in thickness, and raises river water levels by as much as 10 m.

The following criteria for the assessment of the hanging dam at the mouth of Dauphin River was based on KGS Group's experience with this ice formation process, and knowledge of the stable limits of ice deposition:

1. The rate of inflow of ice from the Dauphin River into Lake Winnipeg was estimated to reach 5 $m^3$/s (175 cfs) when the air temperature decreases below -20ºC for several days at a time. Under more extreme winter conditions concurrent with strong winds, the rate of incoming ice could be as high as 10 $m^3$/s (350 cfs). At this rate of ice inflow, it was estimated that a deposit of ice in the shape of an inverted sector of a cone could reach major proportions within a short period of time.

2. With a rapid rate of ice delivery, it was estimated that ice deposition at the hanging ice dam would occur with velocities of about 0.8 to 1.0 m/s. At this limiting condition, the hydraulic gradient within the hanging dam was estimated to be potentially 1 m vertical in 1000 m horizontal, and possibly as much as 1 m in 700 m.

3. Based on the combination of the parameters described in points 1 and 2, it was concluded that the local rise in water level at the mouth of the Dauphin River would occur as required to allow the ice cover to accumulate and progress up the river. Separate analyses of the velocity and Froude number at the river mouth indicated that a stage at that location of about El 218.5 m for a projected river flow of 600 $m^3$/s (21,190 cfs) would allow the ice to progress. This became the basis for the starting elevation for the simulations of ice progression along the Dauphin River. There was no attempt to mathematically represent the formation of a conical shape of ice deposition in the bay beyond the river. It was accepted that the limitations in the scientific knowledge of this highly two-dimensional process would make it difficult to credibly represent the phenomenon with a one-dimensional numerical model.

***Controlling Ice Characteristics***

**Winter**

A number of ice processes can be represented by RIVICE. Each process is controlled in the software by a selection of site-specific characteristics. Some processes that were not specifically included in the simulations of the Dauphin River using RIVICE included:

1. Border ice advancement – a worst case scenario was adopted that maintained fully open water without border ice advancement.
2. Bridging of the incoming slush ice cover at narrow channel locations – there were no means to reliably predict these closures, so the process was excluded from the simulations.
3. Stability of the ice cover to resist shoving at the leading edge of the ice cover advancement – this was deemed not to be of dominant importance in the process because of the rapid influx of ice and the rapid telescoping of the ice cover to reach a stable ice thickness within the ice cover downstream of the leading edge.

The key factors that were adopted for the Dauphin River simulations including the maximum Froude number at ice jam for ice juxtaposition, the maximum velocity for deposition under the ice cover, and the roughness coefficient of the ice cover were similar to those adopted for the VARY-ICE simulations of the Fairford River, as discussed in Section 5.2.2.

These parameters were selected to allow the RIVICE model to first represent the known open water conditions and the estimated ice conditions that had occurred in the late fall of 2010. They were also considered appropriate for the worst case conditions that may have occurred with the flows that would prevail in the winter of 2011-2012.

Figure 7 shows the computed open water profile for a river flow of 420 $m^3/s$ (14,830 cfs). This discharge was the flow at the time of the water level measurements provided by MIT (May 2011). This condition formed the basis of the channel hydraulics for the simulation of the ice processes.

Figure 8 shows the estimated peak water surface profile in the lower Dauphin River in November 2010, when the river flow was estimated at 190 $m^3/s$ (6,710 cfs) compared to the computed water surface profile using RIVICE at the same flow. The match between the computed water levels and actual water levels appeared to be reasonably good. The model was deemed to be reasonably well calibrated for conditions similar to those that prevailed in 2010. However, it was recognized that the flows that would be occurring in early winter 2011-2012 would be significantly greater than in the previous year. The projections by RIVICE for the much higher flows expected in 2011-2012 would be approximations at best, and considerable safety factors should, therefore, be incorporated in any water level predictions used for the design of dikes.

***Spring Breakup***

Since there were no historical measurements of ice staging during the spring breakup, there was some degree of uncertainty whether the spring ice breakup can trigger the formation of a fragmented ice jam, and what volume of ice would be expected from ice runs upstream. Precise prediction of these factors is not possible. As a result, KGS Group selected a design criterion that was considered reasonably extreme, but not impossible to occur, based on judgment developed from experience. The following scenario was developed for the prediction of water levels in the lower river:

- Rapid release of ice cover in the upper Dauphin River and sudden increase in river flow in the Dauphin River due to the resumption of open water conditions at the outlet of Lake St. Martin. A peak flow of approximately 1,000 $m^3/s$ (35,310 cfs) was estimated from hydraulic studies of the outlet from Lake St. Martin. The peak flow was highly dependent on the level of staging on Lake St. Martin during the winter.
- Formation of an ice jam with an upstream limit approximately 4 km upstream of the confluence with Lake Winnipeg.
- Spring ice jam formation assumed to have the same ice characteristics as those for the winter ice cover formation, as described above.

***Air Temperatures***

Detailed air temperatures were not necessary for the purposes of simulating the ice development on the Dauphin River. Based on information from previous years, it was known that the volume of frazil ice generated on the river surface was large and that ice development occurred within weeks from the onset of winter. Detailed consideration of the winter severity (i.e. air temperatures) was not needed for the simulations.

For the upper river, the uncertainty in border ice coverage and the surface area of open water that would be exposed was so large it was considered futile to do a detailed accounting of ice volumes that could be generated. As a result, it was considered impractical in the short time available to undertake a detailed analysis of atmospheric temperatures. It was therefore assumed that the ice cover would be capable of being formed during the winter, regardless of the variation in temperatures that may occur. This decision was supported by observations from the previous winter of 2010-2011, and to be conservative in this important aspect of the studies.

### 6.4.3 Findings

## Lower Dauphin River

A total of seven scenarios were modeled for the Lower Dauphin River and are summarized in Table 4.

**TABLE 4**
**SUMMARY OF LOWER DAUPHIN RIVER RIVICE MODEL SCENARIOS**

| Scenario | Description | Inflow from Upper Dauphin River | | Inflow from Buffalo Creek | | Total Flow | |
|---|---|---|---|---|---|---|---|
| | | $m^3/s$ | cfs | $m^3/s$ | cfs | $m^3/s$ | cfs |
| 1 | Early Freeze Up (2011) | 420 | 14,720 | 80 | 2,900 | 500 | 17,620 |
| 2 | Best Estimate Freeze Up (2011) | 335 | 11,790 | 65 | 2,370 | 400 | 14,160 |
| 3 | Late Freeze Up (2011) | 304 | 10,750 | 61 | 2,150 | 365 | 12,900 |
| 4 | Spring Break up at Q = 700 $m^3/s$ | 700 | 24,720 | 0 | 0 | 700 | 24,720 |
| 5 | Spring Break up at Q = 1000 $m^3/s$ | 1000 | 35,310 | 0 | 0 | 1000 | 35,310 |
| 6 | Spring Break up at Q = 444 $m^3/s$ | 297 | 10,490 | 147 | 5,190 | 444 | 15,680 |
| 7 | Early Freeze Up (2012) | 269 | 9,500 | 0 | 0 | 269 | 9,500 |

In 2011, the water level as the ice cover developed was projected to increase by up to 4 m depending on the scenario and location along the river. The projected water surface profiles for the different ice formation simulations (Scenarios 1 to 3) are provided in Figures 9 to 11.

The simulation of a potential ice jam during a rapid severe spring melt season showed that water levels could exceed those estimated for the formation phase. Figures 12 to 14 show the results of the analyses for spring ice jams (Scenarios 4 to 6).

As discussed in Section 4.2.2, results from the simulations described above were used for selecting the crest elevations of the dikes. In addition, the dikes were designed to have 0.6 m of freeboard above the water surface profile for Scenario 1 plus a 0.7 m allowance to consider the potential effects of an ice jam during a rapid severe spring melt ( the spring ice jam scenarios were not complete during the dike design phase).

During the construction of the dikes, it was decided to top up the dikes locally to provide a minimum freeboard of 0.6 m for Spring Scenario 4 at all locations. A table is included in Appendix J, which shows the tendered dike elevation, required “top up” during construction and as-built elevations. The estimated water surface profile with ice along the dikes, as well as the freeboard for each dike condition, is included in the table. The as-built elevation of the dikes is included on Figures 9 to 14.

As discussed in Section 4.2.1, Scenario 7 was modeled to simulate the ice formation period in 2012. The projected water surface profile for this scenario is shown in Figure 15. Inundation maps for the Dauphin River communities were generated based on the results of Scenario 7, assuming that the dikes were completely removed. A copy of the maps is provided in Appendix K, Annex K1. The results from Scenario 7 showed that there would be no flooding of buildings within the communities.

***Upper Dauphin River***

The upper Dauphin River is particularly difficult to represent with a numerical model for the following reasons:

- The ability to predict border ice advancement and the reduction of the open water area capable of generating frazil ice is crude at best. Consequently, it was assumed that the open water area would be at a maximum and the ice generated would be sufficient to cause the formation of significant ice dams. The estimated maximum profile that was computed for Scenario 1 outlined in Section 6.4.3 (Early Freeze up (2011)) is shown in Figure 16.

- Storage routing could not be analyzed with the model. The model computes water levels during the ice staging process that would equate to significant rises in the level on Lake St. Martin. The flood routing effect would cause lower flows to occur than were used in the ice calculations. Routing effects were modeled separately as described in Section 4.1.
- It also ignores the effects of erosion of the ice cover as the winter progresses, especially under conditions with frequent warm spells.

KGS Group, therefore, applied judgment to the results of the theoretical simulations, based on the observations from previous years and past experience with other rivers of similar characteristics, to reduce the maximum staging to consider the ameliorating effect of border ice advancement and the gradual erosion of ice dams that would occur during the winter. The peak winter rating curve that would be expected at the outlet of Lake St. Martin is shown on Figure 17, and is compared to the rating curves provided by MWS provided in Figure 6. This rating curve was used in the routing models to determine winter water level forecasts discussed in Section 4.0.

At the request of MIT, KGS Group also plotted the water surface profile for Scenario 7 outlined in Section 6.4.3 and projected the pre-2011 and post-2011 upgraded PR 513 profile to the river stationing to identify the location of potential flooding. This is shown on Figure 18. The open water levels surveyed in July 2011 are also shown on the figure.

The results showed that PR 513 was raised above the peak summer open water levels in 2011 to provide construction access to the downstream communities. However, winter ice staging could still cause localized flooding of PR 513, depending on weather conditions and the magnitude of Dauphin River flows. It should be noted, however, that there may be some discrepancy in the estimated water levels due to the projection of the highway profile to the river stationing.

## 6.5 OBSERVATIONS IN 2011–2012

### 6.5.1 Lower Dauphin River

The winter of 2011-2012 was exceptionally warm. Figure 4 shows the degree-days of freezing at Fisher Branch, located approximately 90 km south-east of the Lake St. Martin outlet, compared to other recorded years of data. The total degree days of freezing for the 2011-2012 winter were the lowest of the previous thirty years on record. The ice development during the winter was significantly affected by this, not only on the timing of the occurrence of the ice cover, but also the maximum staging during the formation process.

As discussed in Section 6.3.3, KGS Group surveyed water levels along the Lower Dauphin River during the winter of 2011-2012; and the data is provided in Appendix I, Annex I2. Figure 19 shows the surveyed water level for all nine monitoring stations. In general, the mild temperature conditions allowed the ice cover to form and stabilize at lower water levels than predicted under normal conditions. Nevertheless, water level staging of 3 to 4 m was measured at some locations. At Stations 8 and 9, it appears that the peak water level was not measured and that staging likely occurred before the monitoring began at the two stations. Also since the frequency of the measurements were not continuous, it is possible that the peak water was not measured at the other monitoring locations. The peak water level may have occurred either between two measurements or possibly later in the winter. The monitoring program ended on January 6, 2012. At that time, the ice front was located just upstream of Buffalo Creek; therefore, it was possible that additional staging at monitoring Stations 3 and 5 could still occur.

Figure 20 shows the peak water level surveyed by KGS Group and the computed maximum profile in the lower Dauphin River for Scenario 2. This scenario was selected for the comparison as the simulated discharge of 14,160 cfs was the closest to the 15,500 cfs that occurred during the survey period.

In spite of the extremely mild conditions that occurred in the winter, the observed peak levels compared closely to the predicted levels for the ice formation event. At Stations 8 and 9, the maximum surveyed water level is shown to be lower than the simulated results. However, as discussed above, it is possible that the peak water level may not have been captured at this location. It was, therefore, assumed that the actual peak water level that occurred at Stations 8 and 9 was equal to the water level obtained from the results of Scenario 2, due to the similarity in peak surveyed water levels and modeled results at adjacent monitoring stations. A best estimate of the maximum water surface profile that occurred in 2011 during the ice formation stage, based on the surveyed water levels and model results from Scenario 2, is shown on Figure 20.

Nevertheless, even with the warm winter, the recorded water levels were sufficiently close to the calculated worst case scenario that the construction of the dikes was shown to be clearly well justified. Inundation maps for the Dauphin River communities, for the condition without the dikes were generated from the best estimate of the maximum water surface profile described above. This is shown in Appendix K, Annex K2. On the maps, a 0.6 m high buffer was included above the water surface profile to account for the potential of ice being pushed up the shoreline. The results showed that had the dikes not been built, flooding would have occurred in the communities, and many other properties would have been at risk due to ice shoving on the shoreline.

Two time lapse cameras were installed on the Dauphin River: one in the Dauphin River community, and the other near the Buffalo Creek outlet, to monitor the formation and breakup of the ice cover during the 2011-2012 winter. Photos were taken every 30 minutes between November 16, 2011 and March 28, 2012, with the exception of a period when the batteries could not be recharged due to access difficulties. The photos are provided in Appendix H, Annex H1. Air photos and Satellite Imagery were also collected periodically during the winter. The air photos are provided in Appendix H, Annex H1. The satellite imagery is provided in Appendix H, Annex H2.

#### 6.5.2 Upper Dauphin River

The ice model of the upper Dauphin River considered that a hanging ice dam would form at the foot of Frenchman's Rapids. That process would have required significant local staging before the conditions for ice front progression upstream from Frenchman's Rapids to Lake St. Martin would occur. During the formation of the hanging ice dam, the reach of river from the rapids to Lake St. Martin was assumed to remain open, resulting in the continual production of frazil ice for the formation of the ice dam downstream of the rapids. This assumption was selected to remain conservative in the analysis, since historic ice conditions within this reach were unknown, and to ensure that the results of the model would not underestimate the potential staging in water levels from Frenchman's Rapids to Lake St. Martin.

Due to the extremely mild winter, the advancement of the ice cover from Lake Winnipeg did not arrive at Frenchman's Rapids until mid-January, at least one month later than normal and two months later than under severe winter conditions. The rate of frazil ice that was produced in the reach from Lake St. Martin to Frenchman's Rapids was generally low. Border ice through this reach, however, did occur, albeit at a generally slow rate. By mid-January, the width of border ice had extended sufficiently to allow bridging of the ice surface at a sharp bend in the river just upstream from the rapids. This allowed a thin ice cover to advance to Lake St. Martin and stop the supply of frazil ice to the hanging ice dam at Frenchman's Rapids. As a result, the ice front never staged through the rapids with essentially open water levels at the head of the rapids.

The actual ice conditions in the upper Dauphin River and its effects on Lake St. Martin water levels turned out to be less severe than had been expected, with a maximum staging of 0.2 m occurring. In summary, the moderate ice effects occurred for the following reasons:

1. The warmth of the winter and the effects it had on the severity of the ice dams that formed from frazil ice production. The weather was so consistently warm the ice dams that formed did not have the impeding effect of flow anticipated from experience elsewhere. However, it is expected that, had the winter been colder than normal, much more severe effects could have been expected.

2. The method by which the ice formed in the upper Dauphin River occurred differently than originally anticipated. As described above, the worst case scenario in which the channel upstream from Frenchman's Rapids remained fully open water without border ice advancement or bridging at narrow or constricted channel locations did not occur. Consequently, it was assumed that maximum open water conditions would exist to produce frazil ice and that the ice front would progress along the entire river, including through Frenchman's Rapids. Instead, during the winter of 2011-2012, portions of the upper Dauphin River formed an ice cover from border ice, and bridging of the ice occurred upstream of Frenchman's Rapids. Due to this condition, the production of frazil ice was less than anticipated; and the ice front did not progress through the rapids.

3. The capacity of the LSMEOC was increased between January 24 and February 1, 2012, by improvements at the channel inlet at Lake St. Martin, as documented in the report provided in Appendix B titled, *"Flow Metering and Water Level Measurement of the Lake St. Martin Emergency Channel System"*. On February 1, the improvements were completed which provided additional outflow capacity at Reach 1, and water levels on Lake St. Martin resumed a receding trend.

Figure 21 shows the estimated winter stage-discharge relationship on the Dauphin River at the outlet of Lake St. Martin based on observed conditions in the winter of 2011-2012, the original winter relationship provided by MWS, and the estimated peak winter relationship based on model results.

Using the estimated ice conditions occurring in 2011-2012 as described above, the staging that would have occurred on Lake St. Martin during the winter without the LSMEOC in operation was calculated using the routing model described in Section 4.1 and the computed Lake Manitoba outflow between July 1, 2011 and July 1, 2012. This is shown on Figure 22. As shown on the figure, significant staging would have occurred on Lake St. Martin without Reach 1. These conditions would have been worse if the winter conditions had been normal or more severe than normal.

Based on the 2011-2012 winter experience, it was concluded that a fully advanced ice dam at Frenchman's Rapids that was assumed in the RIVICE ice model was not likely to occur and; therefore, a partial staging at Frenchman's Rapids and a thin cover upstream from the rapids would be the likely scenario. For the purpose of forecasting water levels and discharges during the winter of 2012-2013, the estimated winter rating curve adopted in the routing model was based on 2011-2012 experience.

# 7.0 REACH 1

## 7.1 PREDICTED ICE REGIME

Reach 1 was designed with velocities greater than 1.1 m/s and with a Froude number greater than 0.08. As a result, staging of the water level on Big Buffalo Lake would be required before an ice cover could advance upstream in Reach 1. The ice staging on Big Buffalo Lake and the ice cover in Reach 1 was determined using the numerical model VARY-ICE discussed in Section 5.2.1 due to its ability to model hydrodynamic conditions and account for the upstream progression of an ice cover or jam.

## 7.2 NUMERICAL ICE MODELING

The assumptions used in the numerical model VARY-ICE were similar to those adopted for the Fairford River, as discussed in Section 5.2.2. Other assumptions, which formed the basis of the numerical analyses to predict the ice cover in Reach 1 included:

- The water temperature on Lake St. Martin was assumed to be $0^{o}$ Celsius on November 1.
- Frazil ice generation was assumed to occur immediately at the entrance to the Reach 1 channel.
- Based on past experience, the ice front was assumed to be at the upstream end of Big Buffalo Lake by early November, 2011.
- The upper Dauphin River would remain ice free at the Lake St. Martin outlet until after the ice cover formed in Reach 1.

Because the VARY-ICE model could not account for the storage effect on Lake St Martin, an upstream boundary condition was based on a predetermined water level on Lake St Martin. The Lake St. Martin water level was first determined by routing outflows from the Fairford River (Lake Manitoba) through Lake St Martin using the open water rating curve in Reach 1 and Dauphin River. The 30-day forecast of Lake St. Martin water levels was then used in VARY-ICE to determine the time varying discharge and the formation of the ice cover for the 30-day forecast period. The 30-day period was used since it was assumed that the ice cover would advance through the channel reach, given the fact that only minor staging of Big Buffalo Lake would be required to satisfy the Froude number criteria for upstream ice advancement.

The final ice cover determined in "VARY-ICE" was then used to define the ice cover thickness for the ice dam at Big Buffalo Lake and in the channel to be used in a HEC-RAS model. The HEC-RAS model with the defined ice cover was then run to estimate an ice cover stage-discharge relationship for Reach 1. This is shown on Figure 23. This relationship was then used for subsequent flood routings for the prediction of ice staging on Lake St. Martin throughout the 2011-2012 winter period. A copy of the HEC-RAS model is included in Appendix L.

## 7.3 OBSERVATIONS IN 2011–2012

The ice conditions in Buffalo Creek and in Reach 1 were monitored during the 2011-2012 winter. Water levels and discharge measurements taken in Reach 1 are documented in the report provided in Appendix B titled, *"Flow Metering and Water Level Measurement of the Lake St. Martin Emergency Channel System"* by KGS Group.

Additional excavation work at the inlet of Reach 1 occurring between January 24 and February 1, 2012 to complete the plug and "finger" removal towards the barge access channel made it difficult to determine the total effects of the ice on the capacity of the channel. However, as noted previously, the 2011-2012 winter was the warmest on record as measured by the total degree-days of freezing in Fisher Branch. The result was that Reach 1 remained free of an ice cover. Minor border ice developed along the length of the channel. Some frazil ice was produced in the channel, which caused only minor staging downstream of Reach 1 within the area surrounding Big Buffalo Lake; but the staging did not progress to Lake St. Martin.

It is likely that in a winter in which the air temperatures are at least normal, the ice cover would have progressed to Lake St. Martin, as predicted by the ice model. However, the winter rating curve for Reach 1 shown on Figure 23 was generated based on a model calibrated for the capacity of Reach 1 prior to the additional excavation work at the inlet. Further analysis of potential ice conditions in Reach 1 would, therefore, be required should it be operated again in the winter.

# 8.0 BUFFALO CREEK

## 8.1 PREDICTED ICE REGIME

Buffalo Creek is a small but steeply sloping channel, which under natural conditions, carries very little flow, especially in winter. The diversion of the flow through the LSMEOC at the outlet of Lake St. Martin resulted in winter flows in Buffalo Creek being several orders of magnitude greater than what would normally occur. Therefore, previous information on ice conditions in the channel was not relevant; and the ice modeling computations could not be calibrated to observed conditions. Input parameters for modeling were based on experience with other rivers. Because the model could not be verified with historical measurements, it was considered reasonable to consider the worst case scenario possible. KGS Group's previous experience on small streams and rivers was applied in the development of the model.

## 8.2 DATA SOURCES

A combination of LiDAR data and survey data was used to define the channel for the Buffalo Creek models. The survey data was provided by AECOM and extended from the Buffalo Creek inlet (Station 13+600) to approximately 2.5 km downstream (Station 16+100). Cross sections generated from LiDAR data was used downstream of the AECOM survey (Station 16+100) and extended to the Buffalo Creek outlet into the Dauphin River (Station 27+500). Plan drawings showing the extent of the survey are provided in Appendix C, Annex C4.

For modeling purposes, a different stationing system was adopted than the one presented in the appendix. Station 12+500 was set to 0+000 in the model. At the Buffalo Creek outlet into the Dauphin River, Station 27+500 was set to station 15+000 in the model.

## 8.3 NUMERICAL MODELING

### 8.3.1 Models Used

The RIVICE software was considered applicable and was used to estimate the worst case scenario of ice effects in this creek. It was assumed that there would be essentially unlimited volumes of frazil ice generated upstream, and the RIVICE model was used to estimate the hydraulic effects of that ice accumulation. Results obtained from RIVICE were then also used to provide input parameters for a HEC-RAS model of the creek.

The same RIVICE model parameters as described in Section 6.4.2 for the Dauphin River were adopted for Buffalo Creek. The starting/downstream water level at the Dauphin River was assumed to be El 225.0 m (738.2 ft). However, a significant variation to this assumption was determined to have no impact on the ultimate profile computed.

The RIVICE model was originally applied for a discharge of 80 $m^3/s$ (2,825 cfs), based on the August 30, 2011 forecast, assuming an early ice formation in Reach 1. Subsequent channel improvements to the Reach 1 channel and further analysis of ice conditions in the outlet channel showed that a discharge of 140 $m^3/s$ (4,950 cfs) was possible. This scenario was, therefore, also considered in the analysis of ice effects in Buffalo Creek.

The 140 $m^3/s$ (4,950 cfs) scenario was modeled using the US Army Corps of Engineer HEC-RAS software. The ice cover that was included in the model, including the ice cover thickness and Manning's n-value for the ice cover, were taken from the RIVICE model results for the 80 $m^3/s$ (2,825 cfs) RIVICE scenario.

### 8.3.2 Findings

Figure 24 shows the computed maximum water surface profile with ice estimated for a continuous discharge of 80 $m^3/s$ (2,825 cfs). Figure 25 shows the computed maximum water surface profile with ice estimated for a continuous discharge of 140 $m^3/s$ (4,950 cfs).

An inundation map was prepared for the 140 $m^3/s$ (4,950 cfs) scenario and is included in Appendix K, Annex K3. The inundation map showed that there was a significant risk of flooding along many of the proposed Reach 3 alignments. An alternate Reach 3 alignment was, therefore, selected to minimize the risk of flooding by selecting an inlet location further upstream on Buffalo Creek, and by relocating the channel alignment around the area most at risk of flooding. The different Reach 3 alignments investigated are discussed in detail in the *"Reach 3 Design and Construction Report"* by KGS Group.

## 8.4 OBSERVATIONS IN 2011–2012

The water surface of Buffalo Creek remained essentially free of ice except for minor border ice cover that formed along the entire length of the channel. The extremely mild winter conditions were thought to have reduced the volume of frazil ice produced in the open water. Fluctuations in the water level in the creek during the winter resulted in portions of the border ice cover breaking free, causing an ice bridge to occur in Buffalo Creek approximately 5 km downstream from the Reach 3 entrance location. The ice cover advanced from the ice bridge location, but only for a short distance, and resulted in localized inundation along the creek. Photos of the conditions in Buffalo Creek during the winter of 2011-2012 are included in Appendix H, Annex H1.

Ice formation on Buffalo Creek did not occur as expected. The volumes of frazil ice formed seemed to be influenced by the relatively small exposed area of open water per unit length of the channel. It may also have been influenced by heat sources in the boggy area between Buffalo Creek and the downstream end of the excavated LSMEOC.

Detailed measurements of water levels were not made in Buffalo Creek, but it is expected that the winter water surface profile was not significantly higher than under open water conditions. It is also not clear whether the ice would form as modeled, even if winter temperatures were normal or severe. Further advancement of the technology of predicting ice behavior on such small narrow streams is needed.

# 9.0 PROJECT COMPLETION

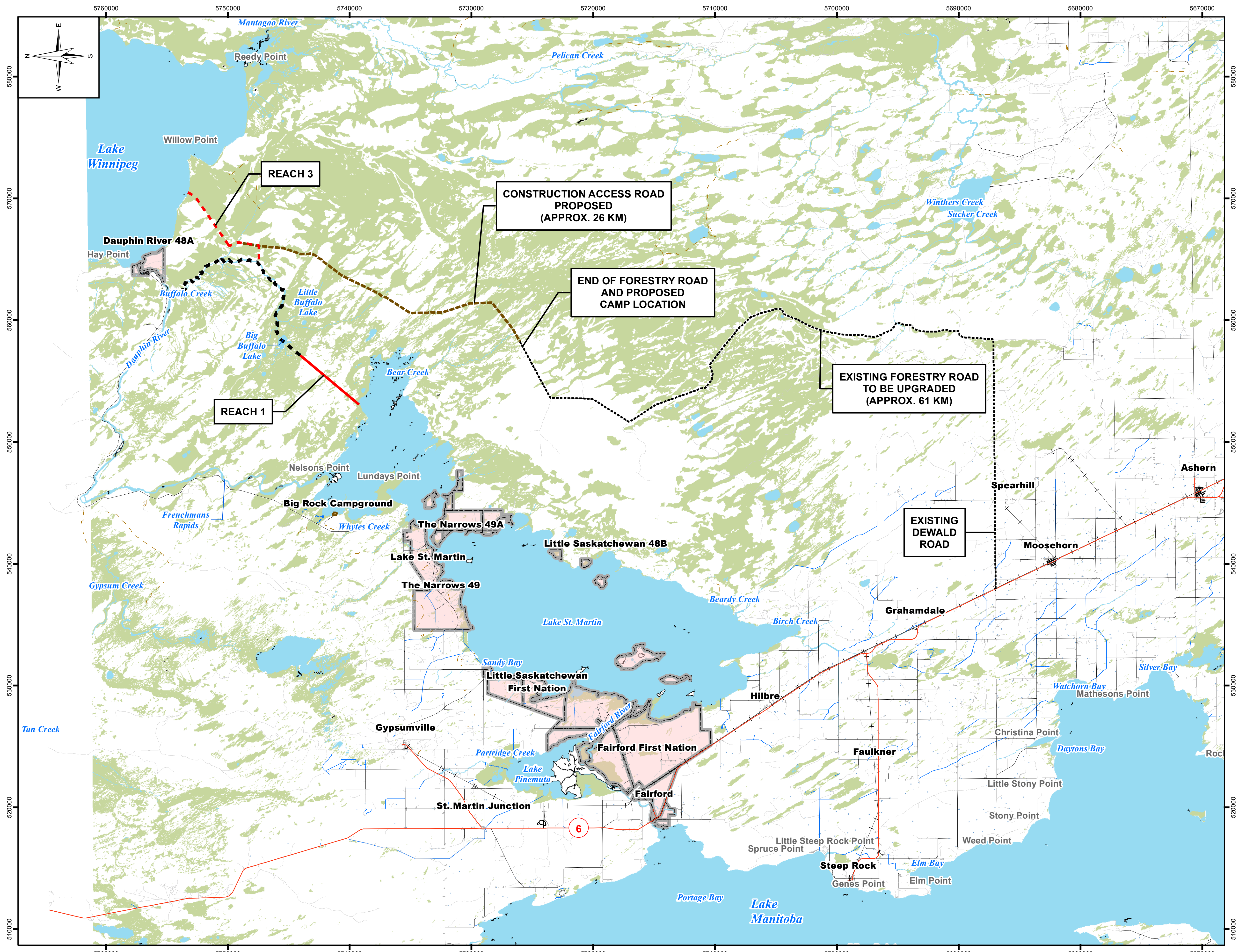
The analysis and monitoring of discharges and ice processes was discontinued in December 2012, shortly after the LSMEOC was closed as required under the federal terms and conditions for emergency operations, at which point this report was prepared to document the efforts for future reference. Additional analysis and monitoring may be required in future if the LSMEOC is made permanent and/or a Lake Manitoba Outlet Channel is to be constructed.

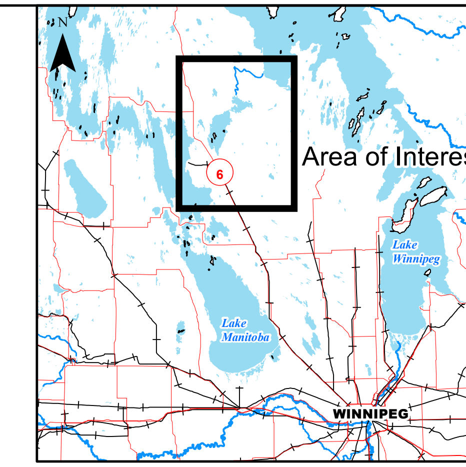
# 10.0 STATEMENT OF LIMITATIONS AND CONDITIONS

## 10.1 THIRD PARTY USE OF REPORT

This report has been prepared for Manitoba Infrastructure and Transportation to whom this report has been addressed and any use a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. KGS Group accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions undertaken based on this report.

**FIGURES**




LEGEND:

- Proposed Construction Access Road
- Forestry Road
- Reach 3 Emergency Channel (Proposed)
- Buffalo Creek Channel
- Reach 1 Emergency Channel
- Road Paved 2 or more lanes
- Paved Street or Road
- Gravel Road
- Unclassified Road
- Accessway or Backlane
- Trail
- Railway
- Ditch
- River/Stream, Indefinite
- River/Stream
- Dugout, Pond
- Lake
- Marsh
- First Nation
- Campsite

5 0 5 10

Kms

SCALE: 1:300,000 METRIC 11"x17"

All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983, Zone 14. Elevations are in metres above sea level (MSL)

| NO. | YY/MM/DD | DESCRIPTION | BY |
|---|---|---|---|
| 0 | 14/03/05 | ISSUED WITH FINAL REPORT | PAL |

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba INFRASTRUCTURE AND TRANSPORTATION

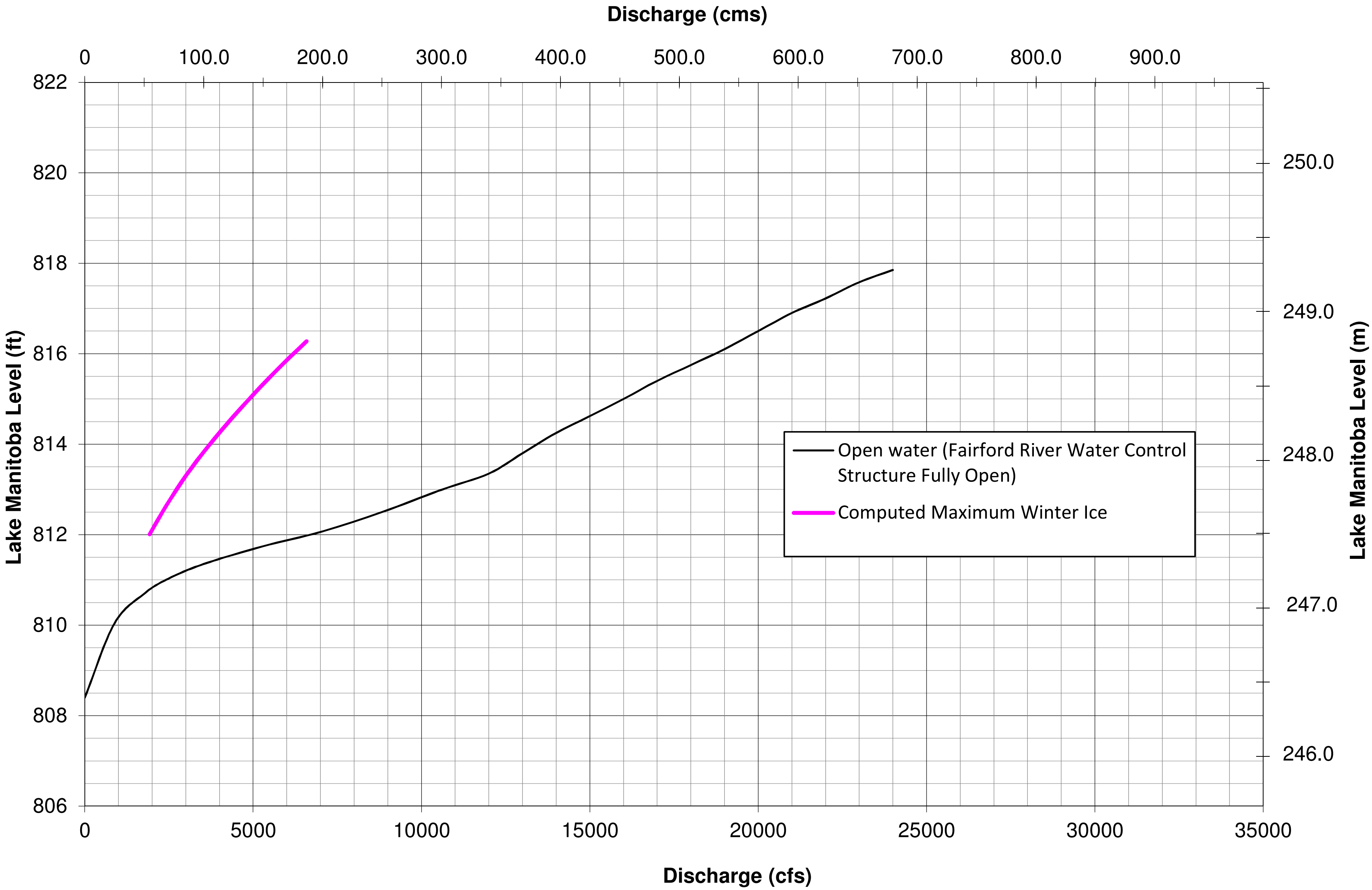
EMERGENCY REDUCTION OF LMB & LSM WATER LEVELS – ANALYSIS & MONITORING OF DISCHARGES & ICE PROCESSES

GENERAL SITE PLAN

MARCH 2014 | FIGURE 1 | REV: 0

FileName: P:\Projects\2011\11-0300-18\Dwg\GIS\MXD\REV0\ICE_PROCESSES_REPORT\11-0300-18-F01_REV0.mxd
11"x17" PLOT SCALE 1:1

**FIGURE 2**
**Fairford River Stage Discharge Relationships**



## FIGURE 3
## Computed Water Surface Profile on Upper Fairford River Under Maximum Winter Ice
## End of January 2012

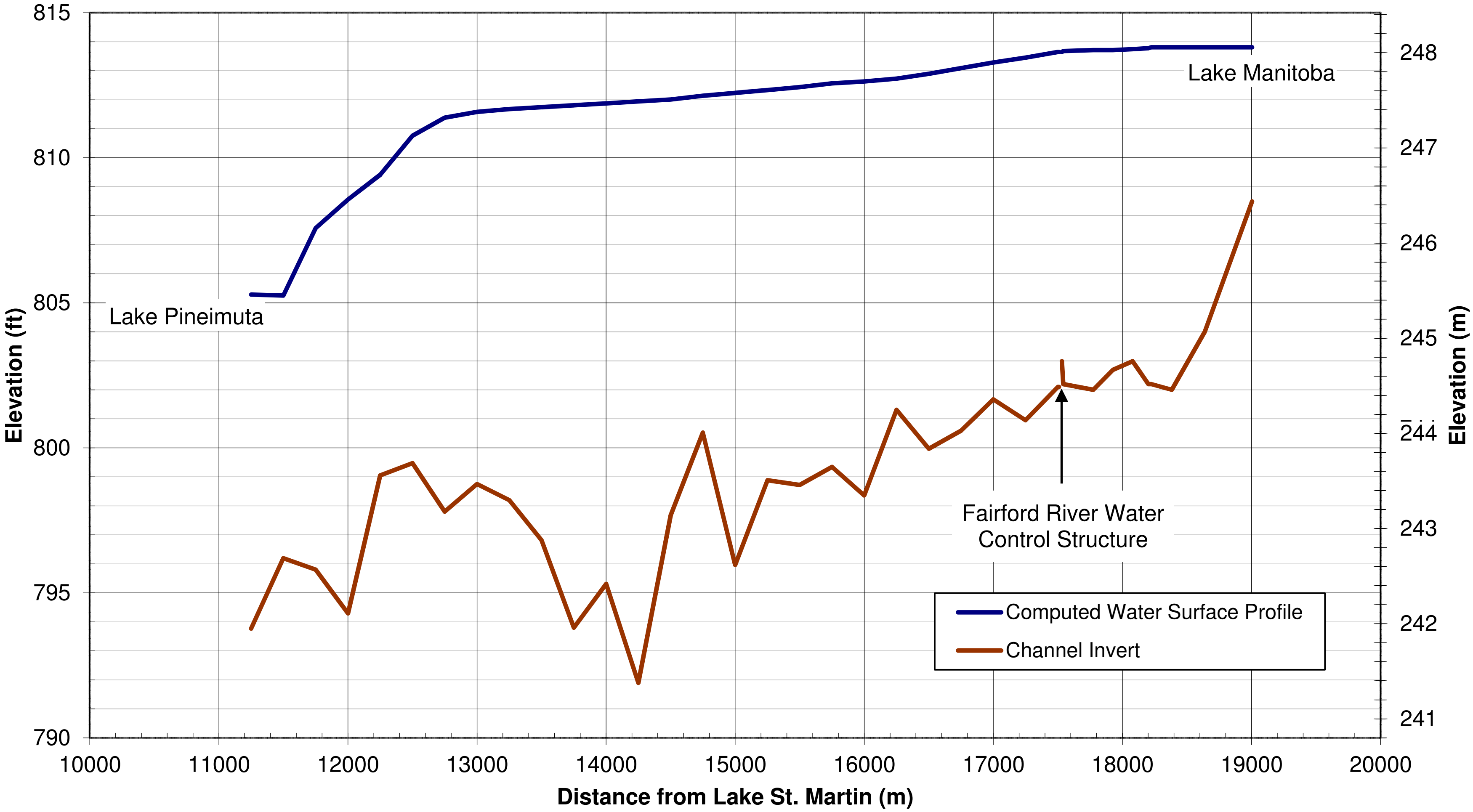


**FIGURE 4**
**2011-2012 Accumulated Degree Days of Freezing in Fisher Branch**

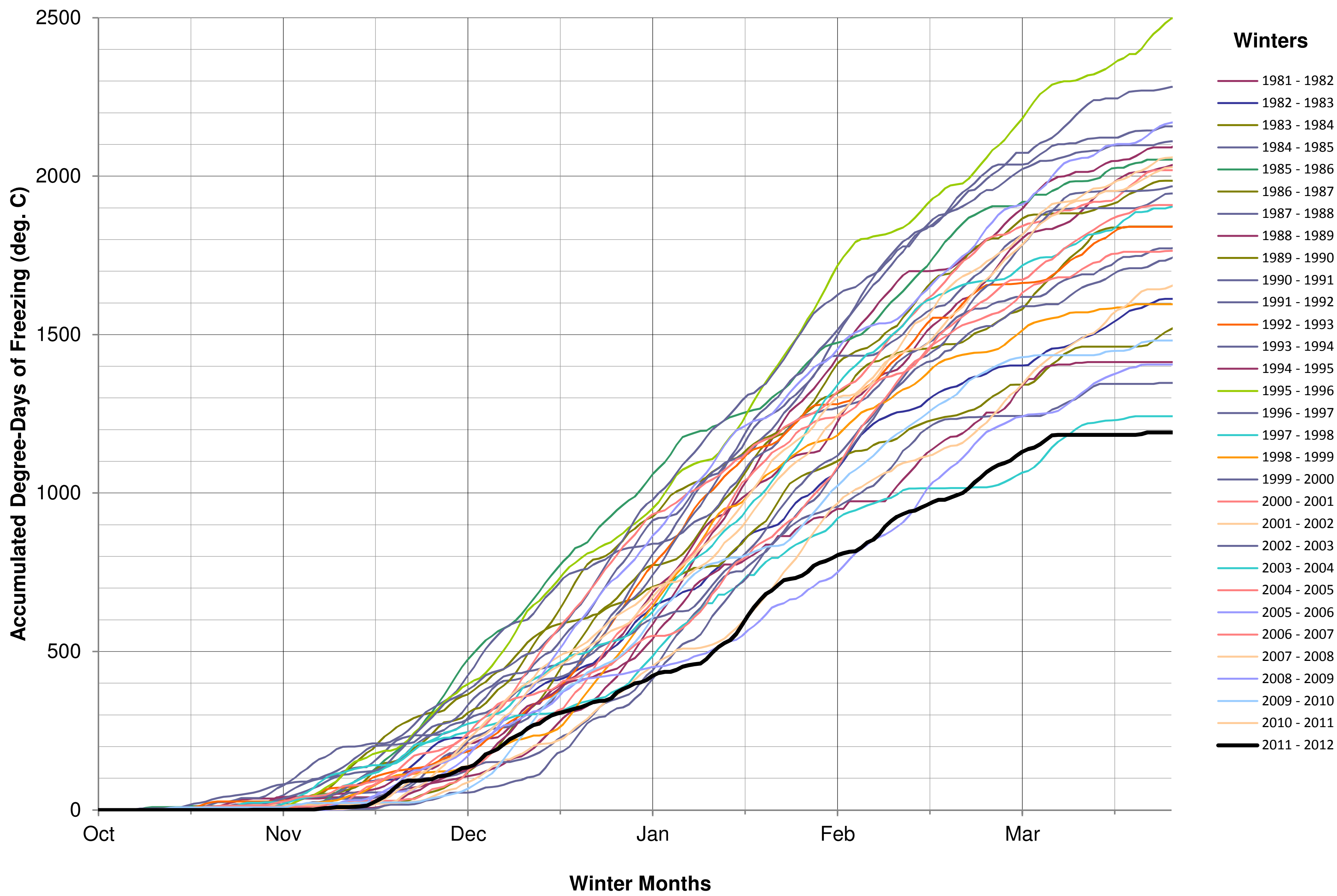


**FIGURE 5**
**Dauphin River Open Water Surface Profile**
***June 29 - July 1, 2011 Survey - 565 cms (19,950 cfs)***

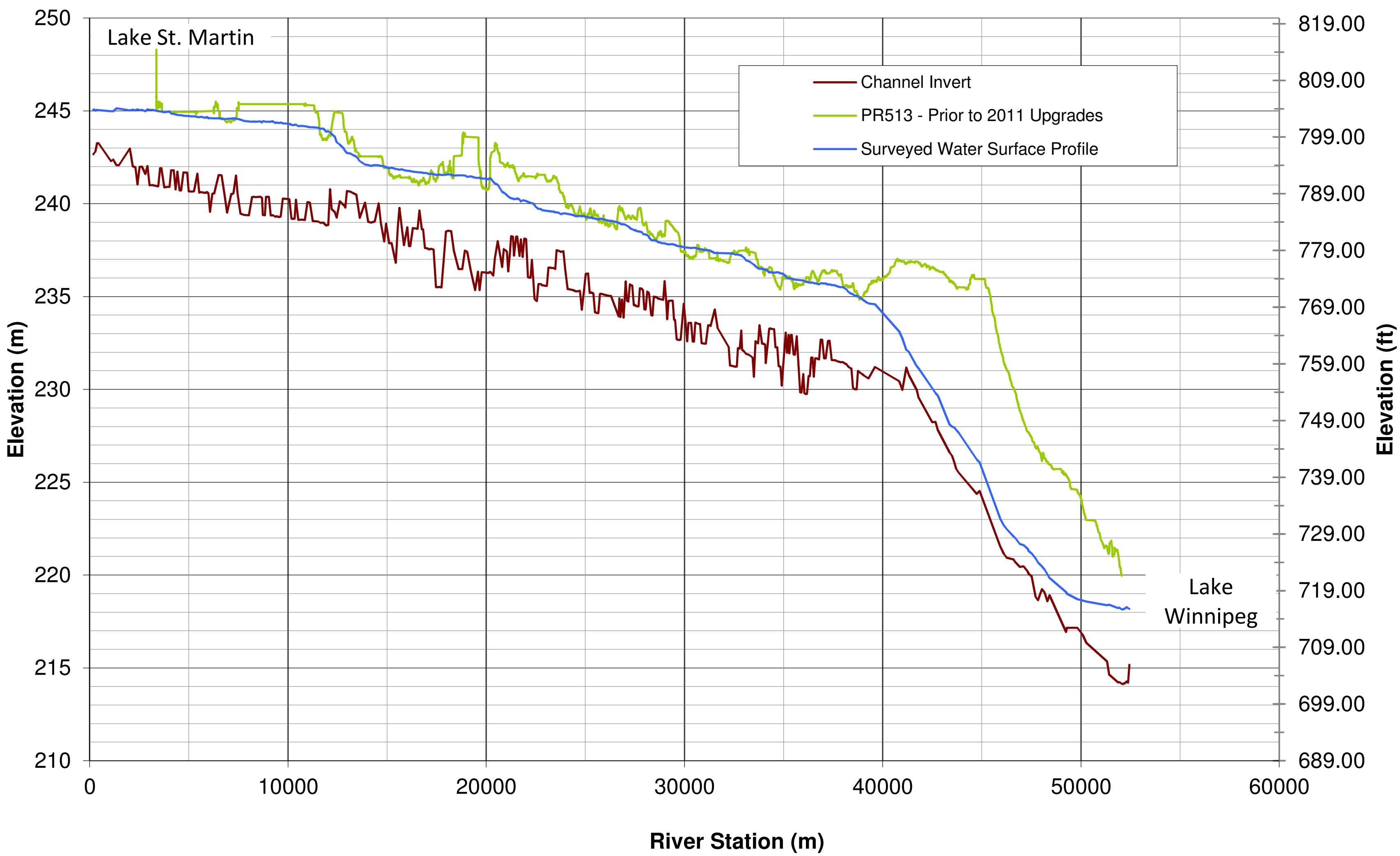


**FIGURE 6**
**Lake St. Martin Outlet at Dauphin River Stage Discharge Relationship**

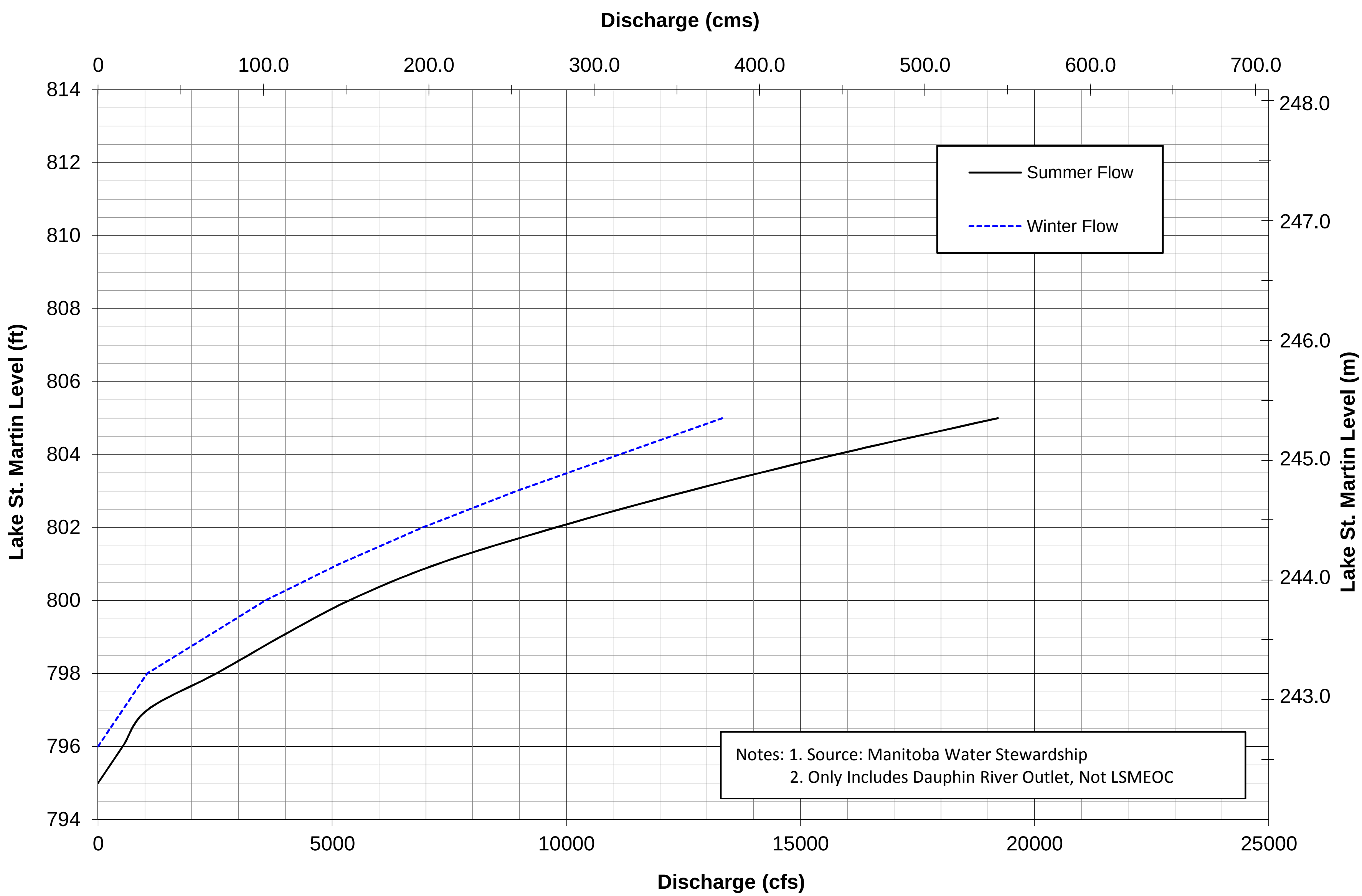


**FIGURE 7**
**Dauphin River Open Water Model Calibration**
***May 19, 2011 – 420 cms (14,830 cfs)***

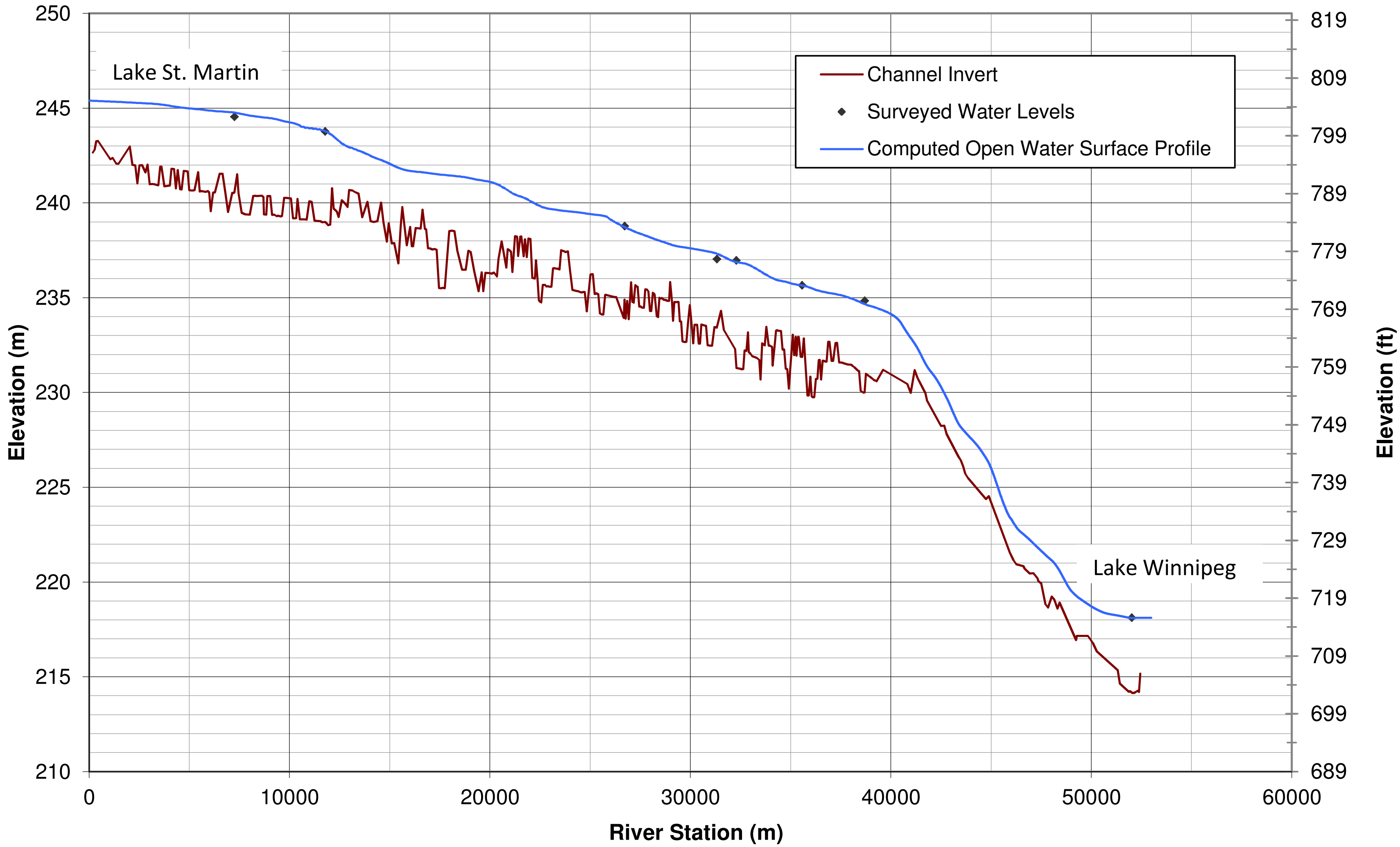
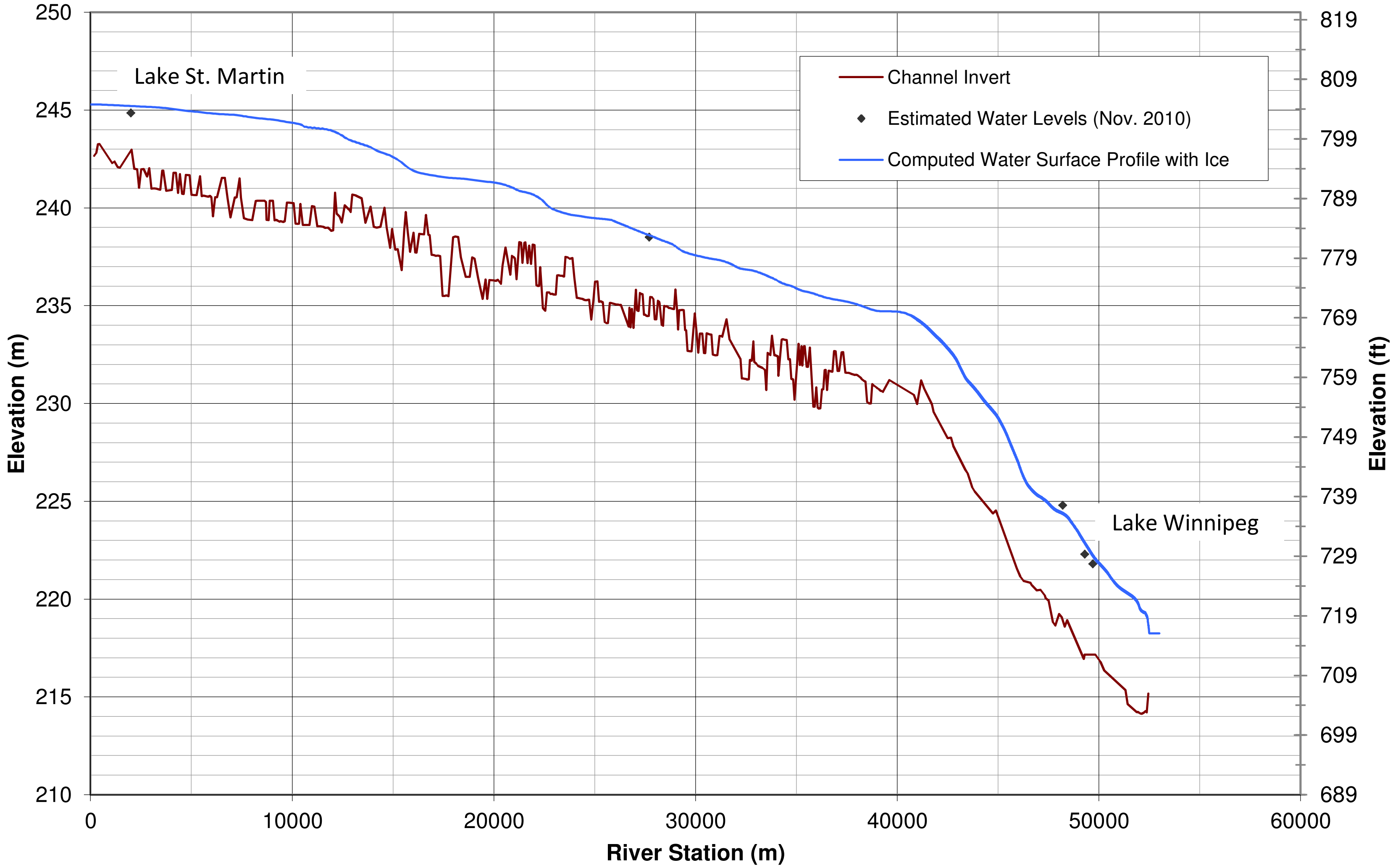


**FIGURE 8**
**Dauphin River Ice Cover Model Calibration**
***Nov 2010 – 190 cms (6,710 cfs)***



## FIGURE 9
## Estimated Maximum Water Surface Profile for Lower Dauphin River
***Scenario 1: Early Freeze-up (2011) - 500 cms (17,620 cfs)***

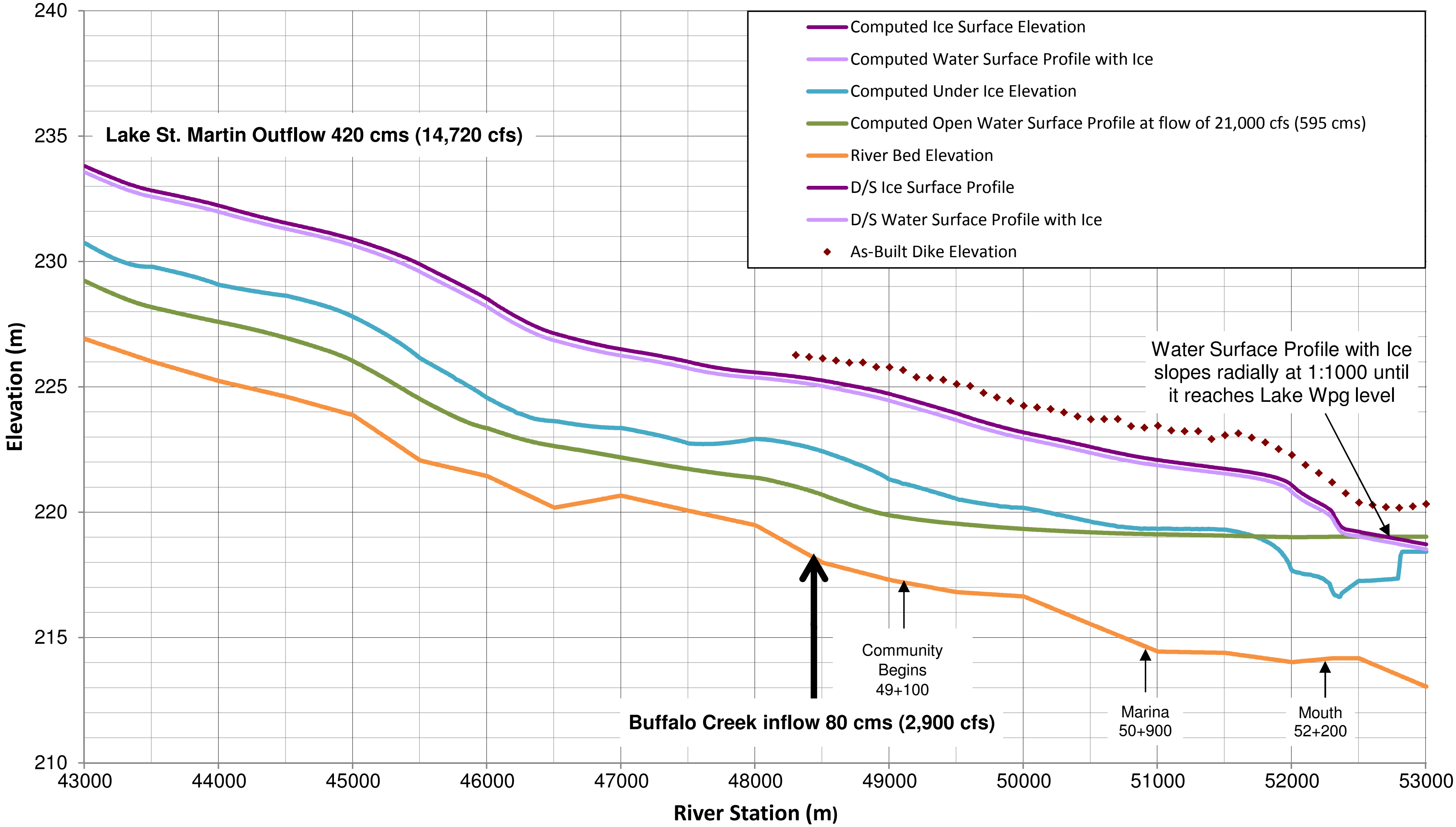


**FIGURE 10**
**Estimated Maximum Water Surface Profile for Lower Dauphin River**
***Scenario 2: Best Estimate Freeze-up (2011) - 400 cms (14,160 cfs)***

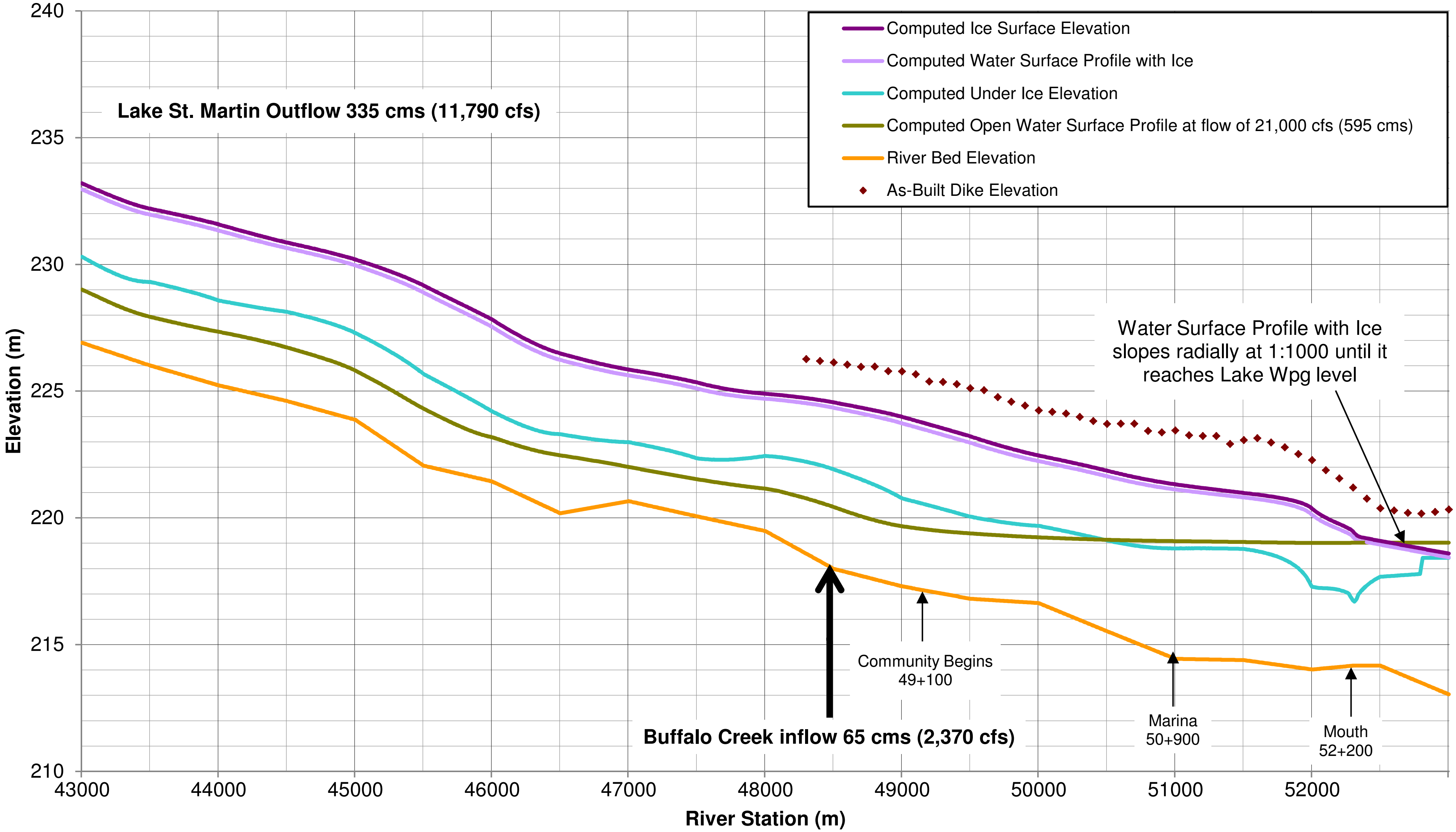


**FIGURE 11**
**Estimated Maximum Water Surface Profile for Lower Dauphin River**
***Scenario 3: Late Freeze-up (2011) - 365 cms (12,900 cfs)***

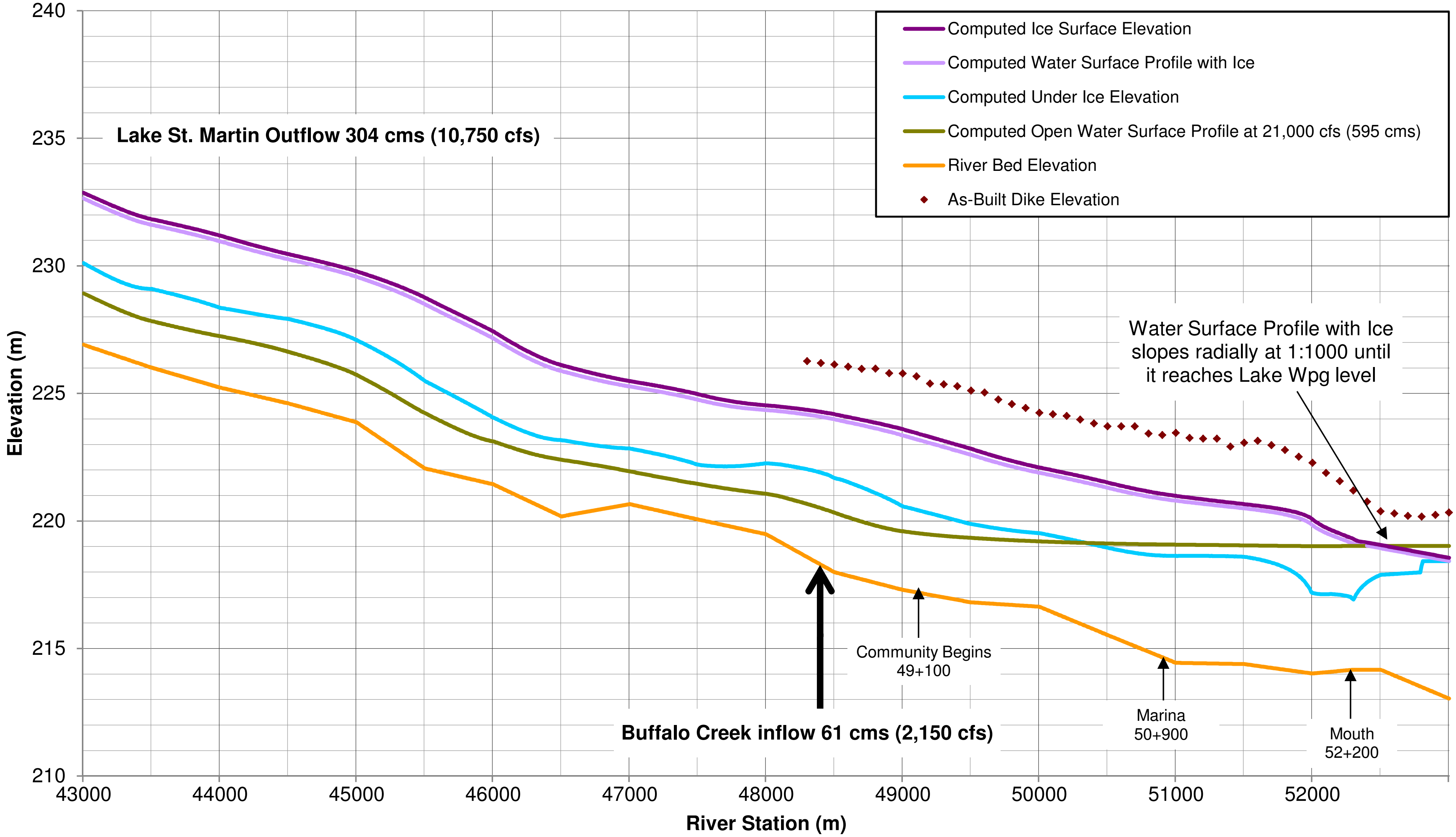


**FIGURE 12**
**Estimated Maximum Water Surface Profile for Lower Dauphin River**
***Scenario 4: Spring Breakup - 700 cms (24,720 cfs)***

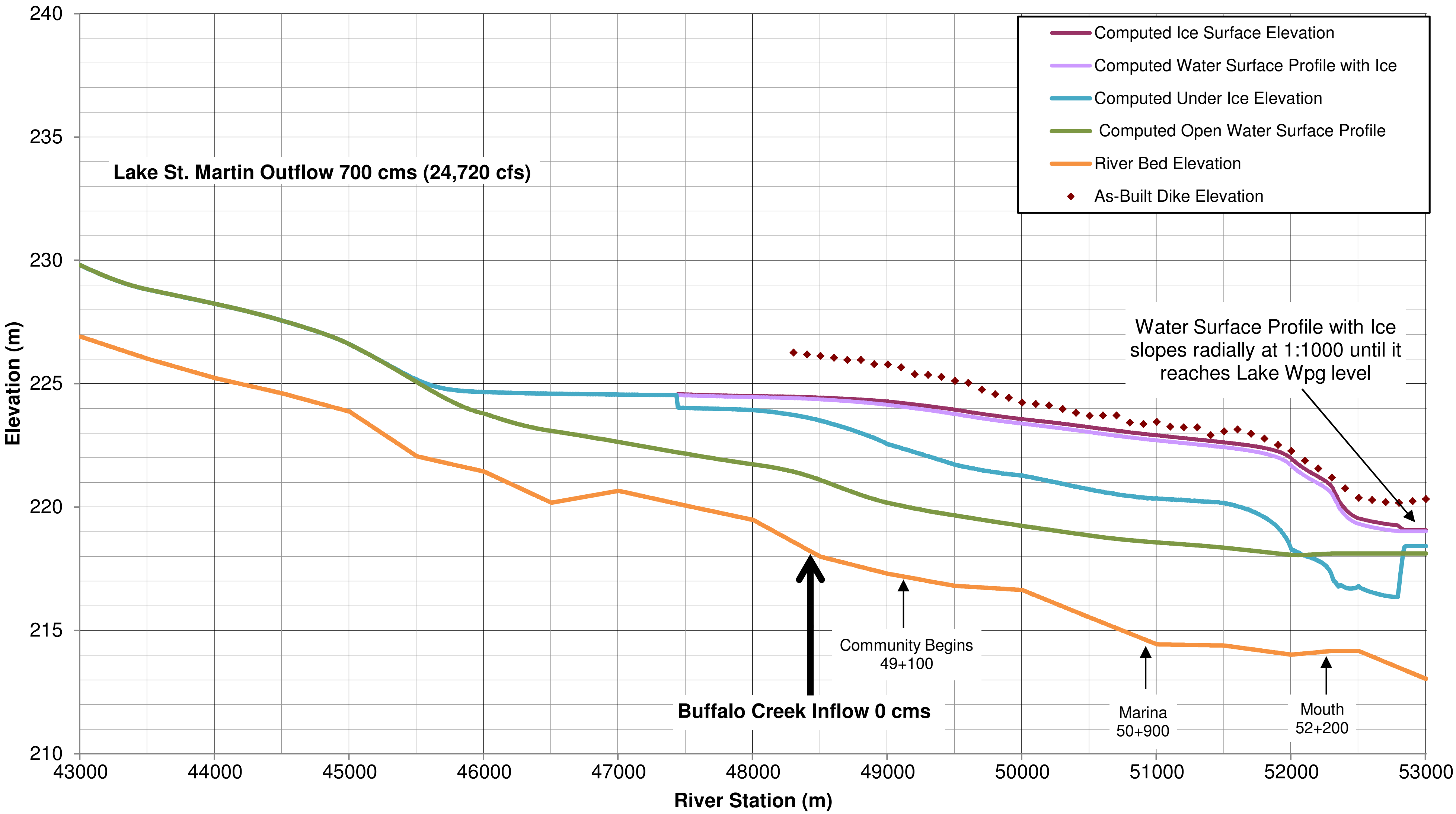


**FIGURE 13**
**Estimated Maximum Water Surface Profile for Lower Dauphin River**
***Scenario 5: Spring Breakup - 1,000 cms (35,310 cfs)***

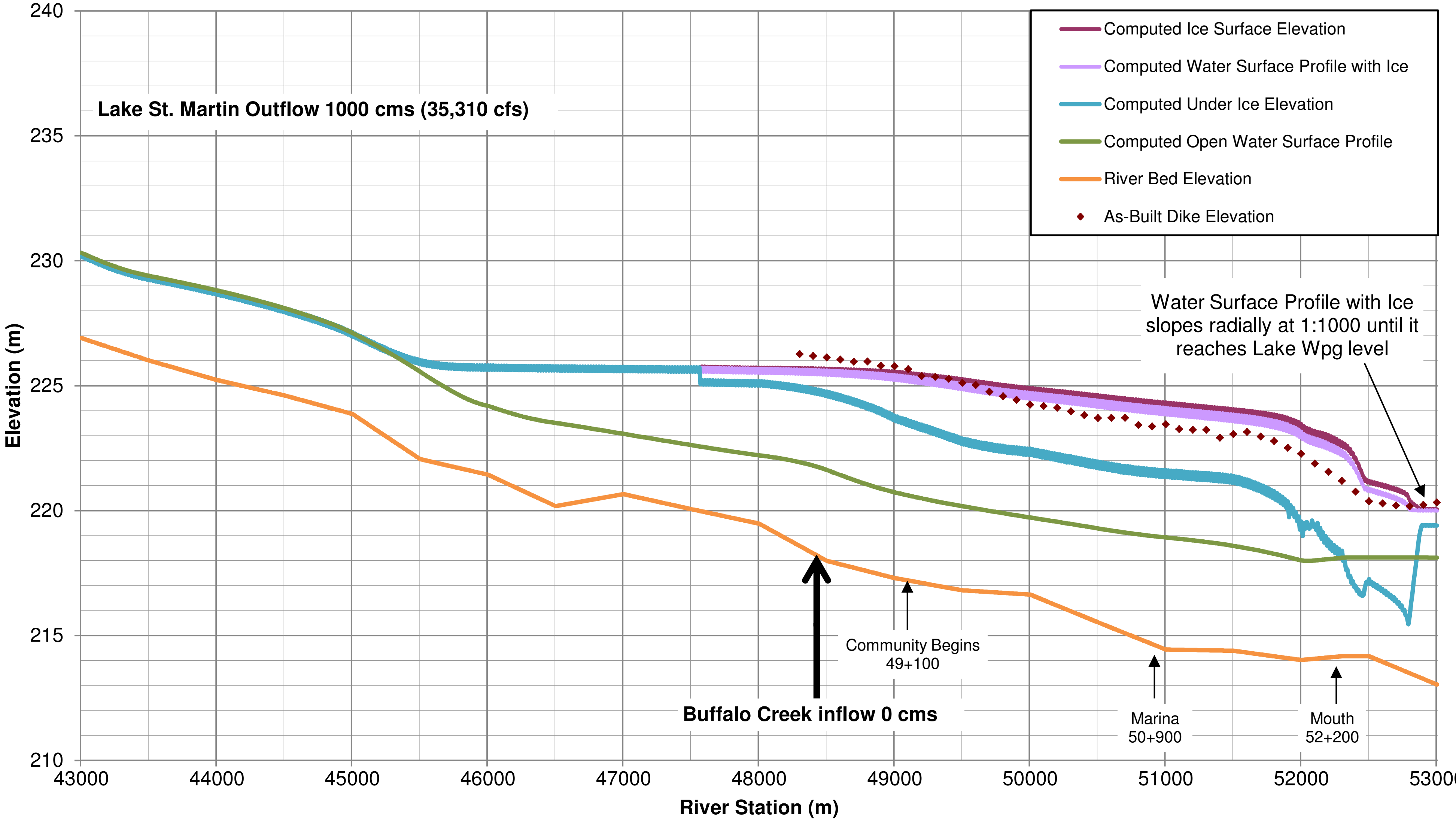


**FIGURE 14**
**Estimated Maximum Water Surface Profile for Lower Dauphin River**
***Scenario 6: Spring Breakup - 444 cms (15,680 cfs)***

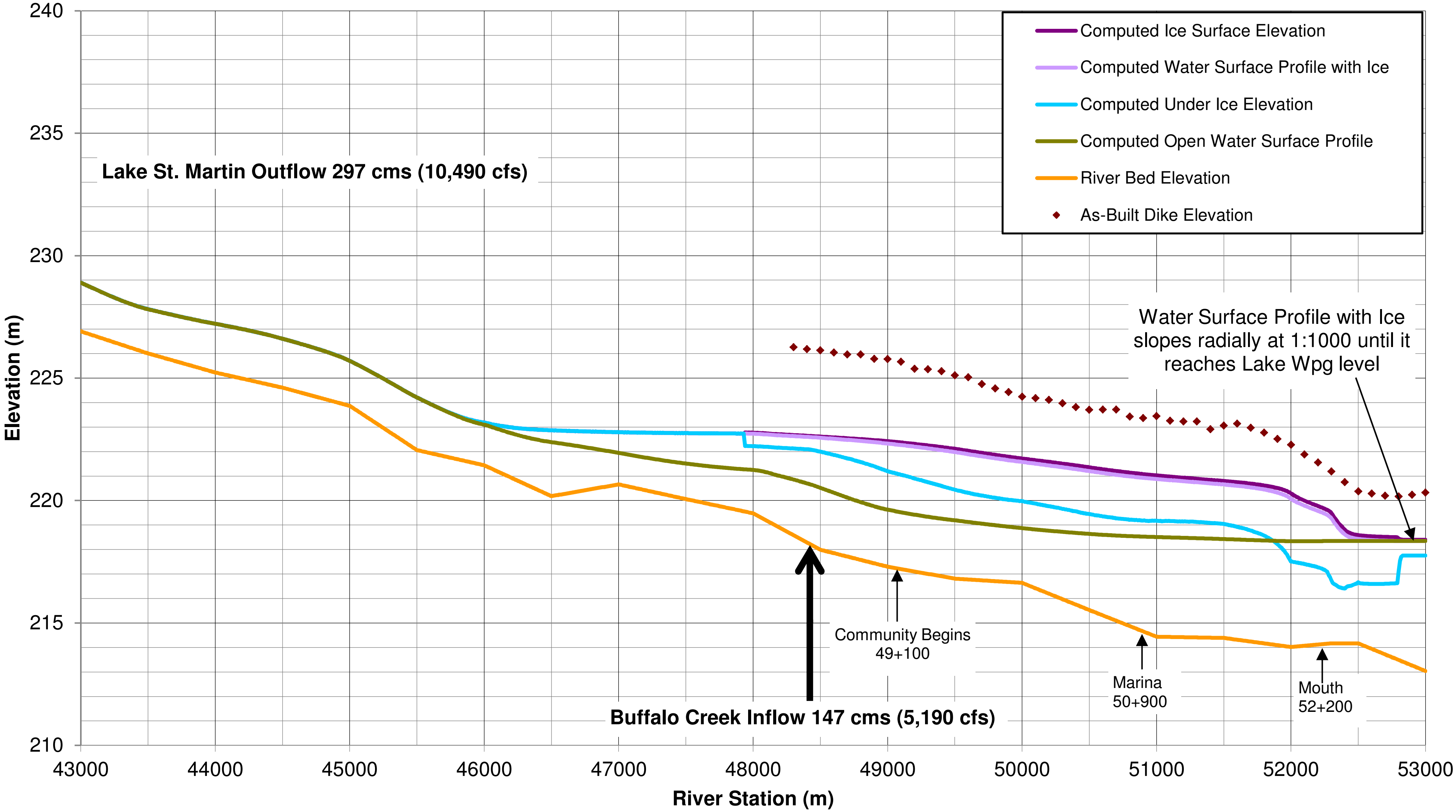


**FIGURE 15**
**Estimated Maximum Water Surface Profile for Lower Dauphin River**
***Scenario 7: Early Fall Freeze-up (2012) - 269 cms (9,500 cfs)***

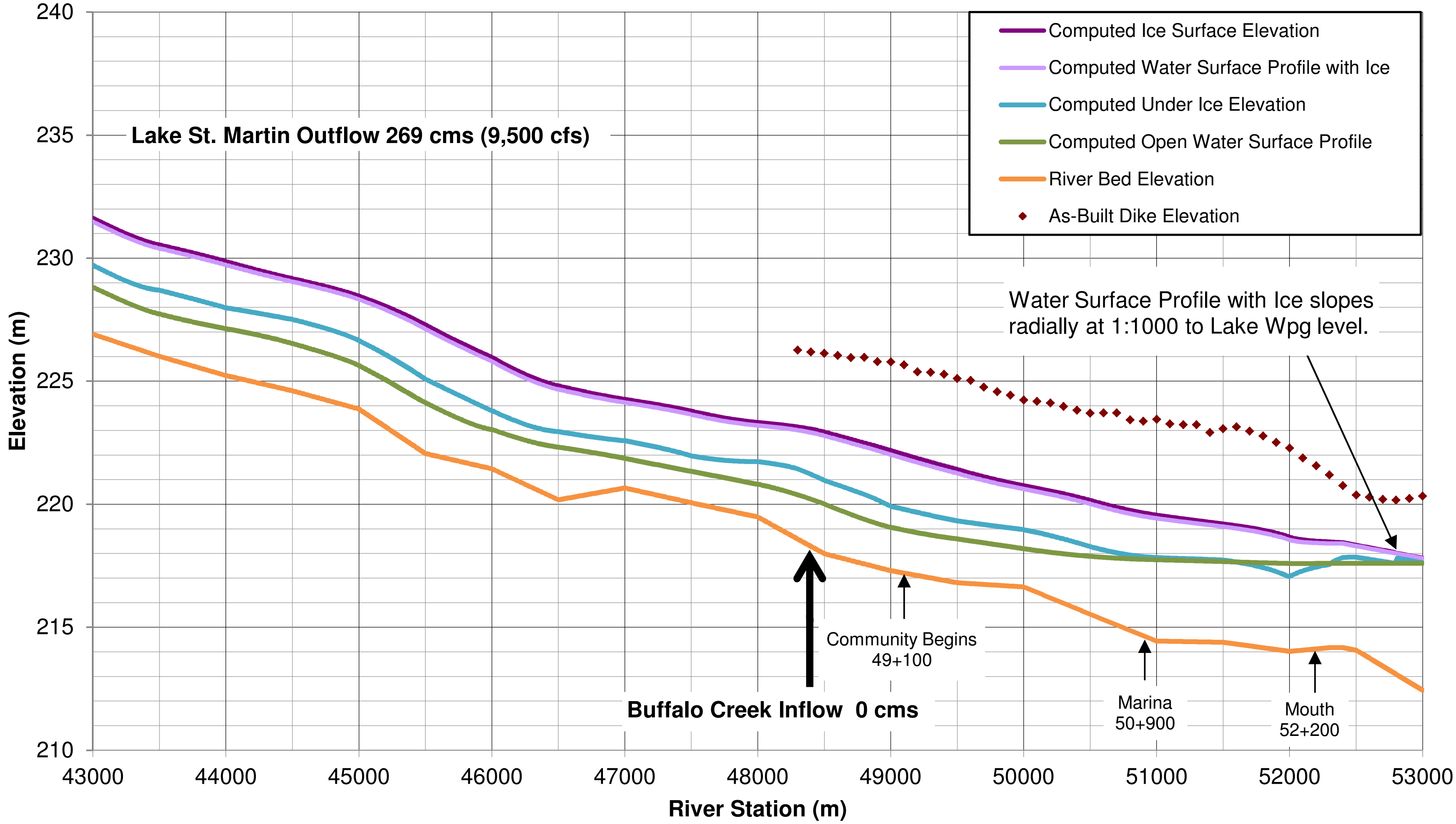


**FIGURE 16**
**Estimated Maximum Water Surface Profile for Dauphin River**
***Scenario 1: - Early Freeze-up (2011) - 500 cms (17,660 cfs)***

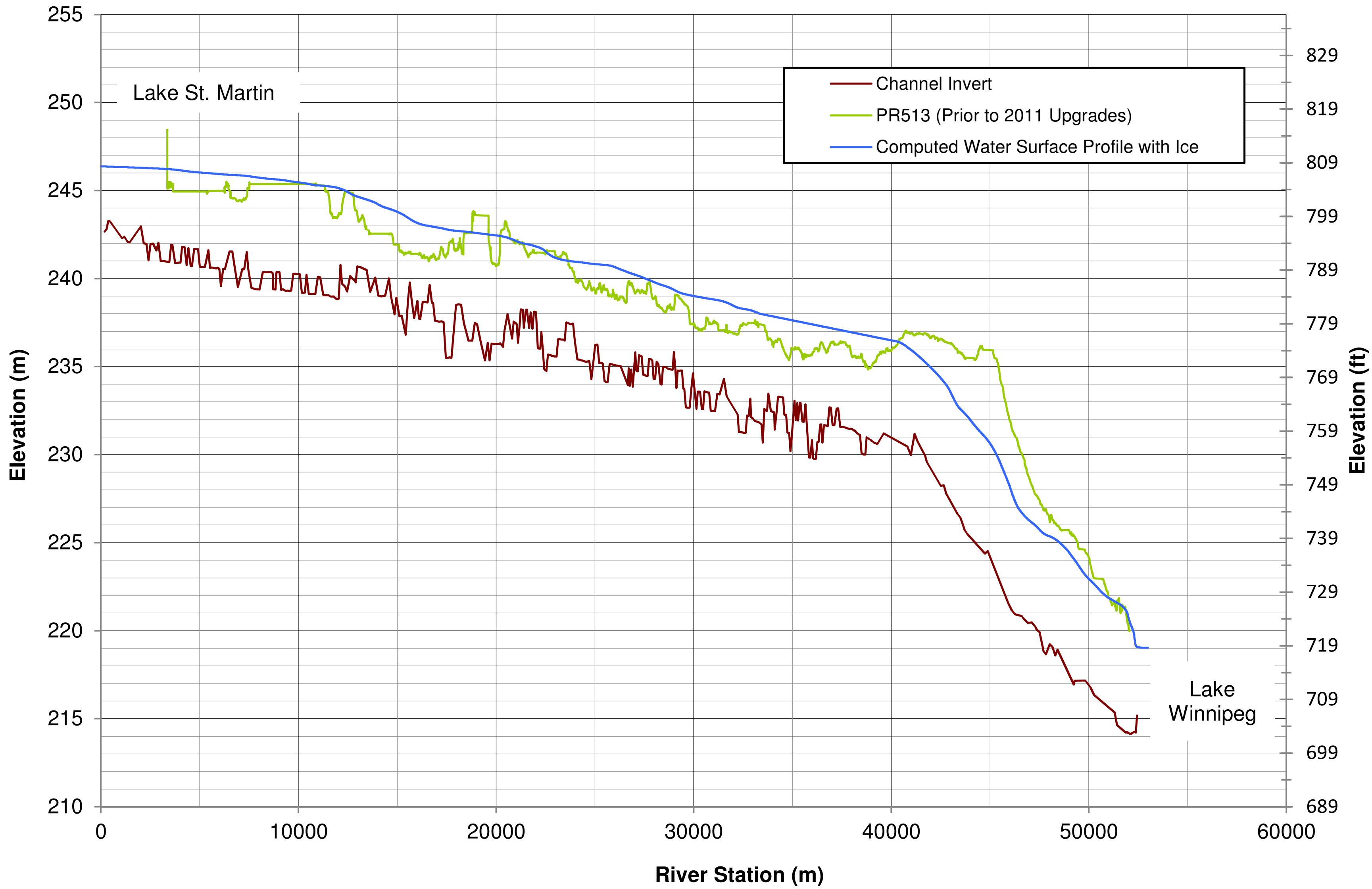


**FIGURE 17**
**Estimated Peak Winter Stage Discharge Relationship on Dauphin River at Lake St. Martin Outlet**

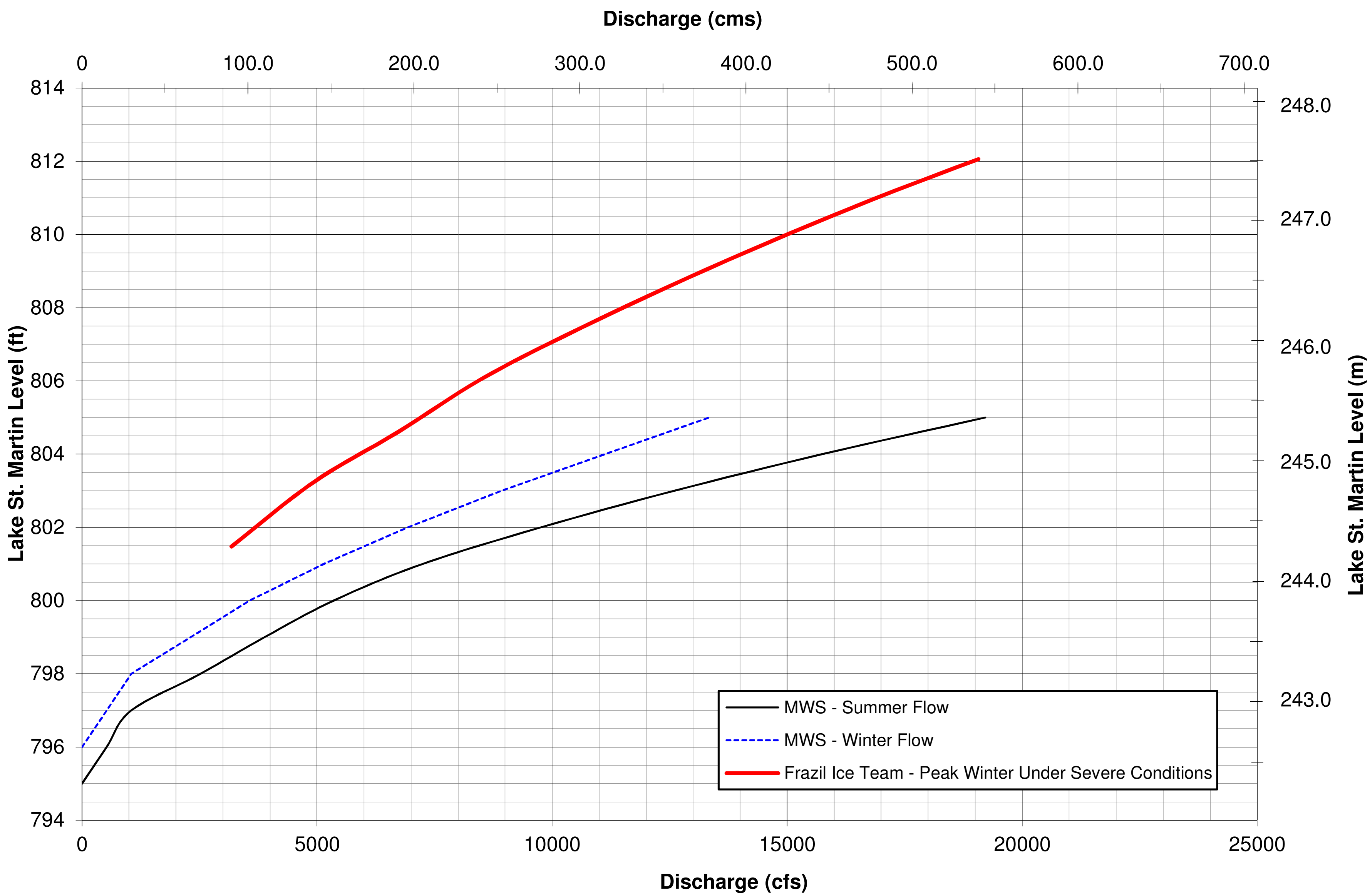
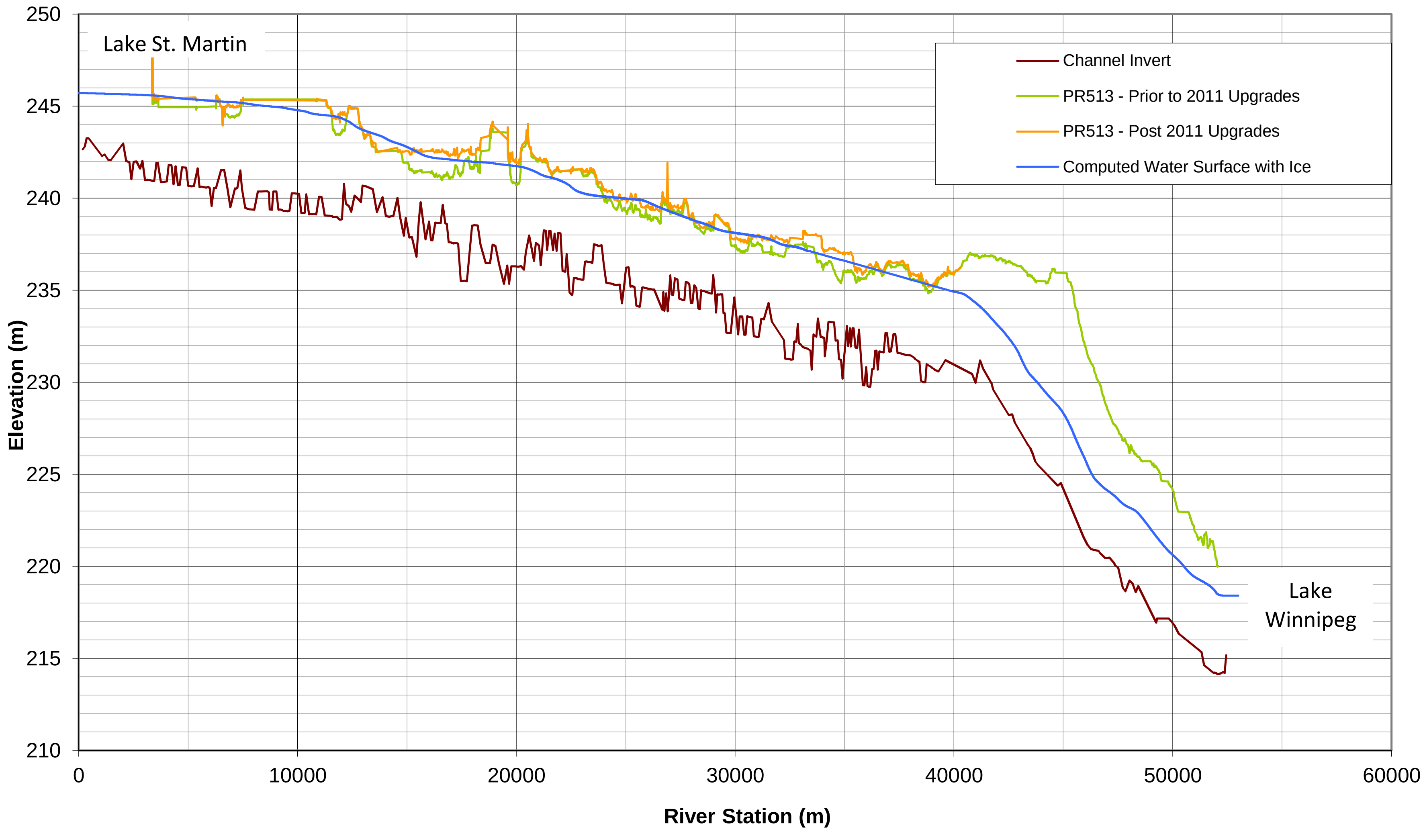


**FIGURE 18**
**Estimated Maximum Water Surface Profile for Dauphin River**
***Scenario 7: Early Freeze Up (2012) - 269 cms (9,500 cfs)***



# FIGURE 19
## Surveyed Water Levels in Lower Dauphin River during Winter of 2011-2012

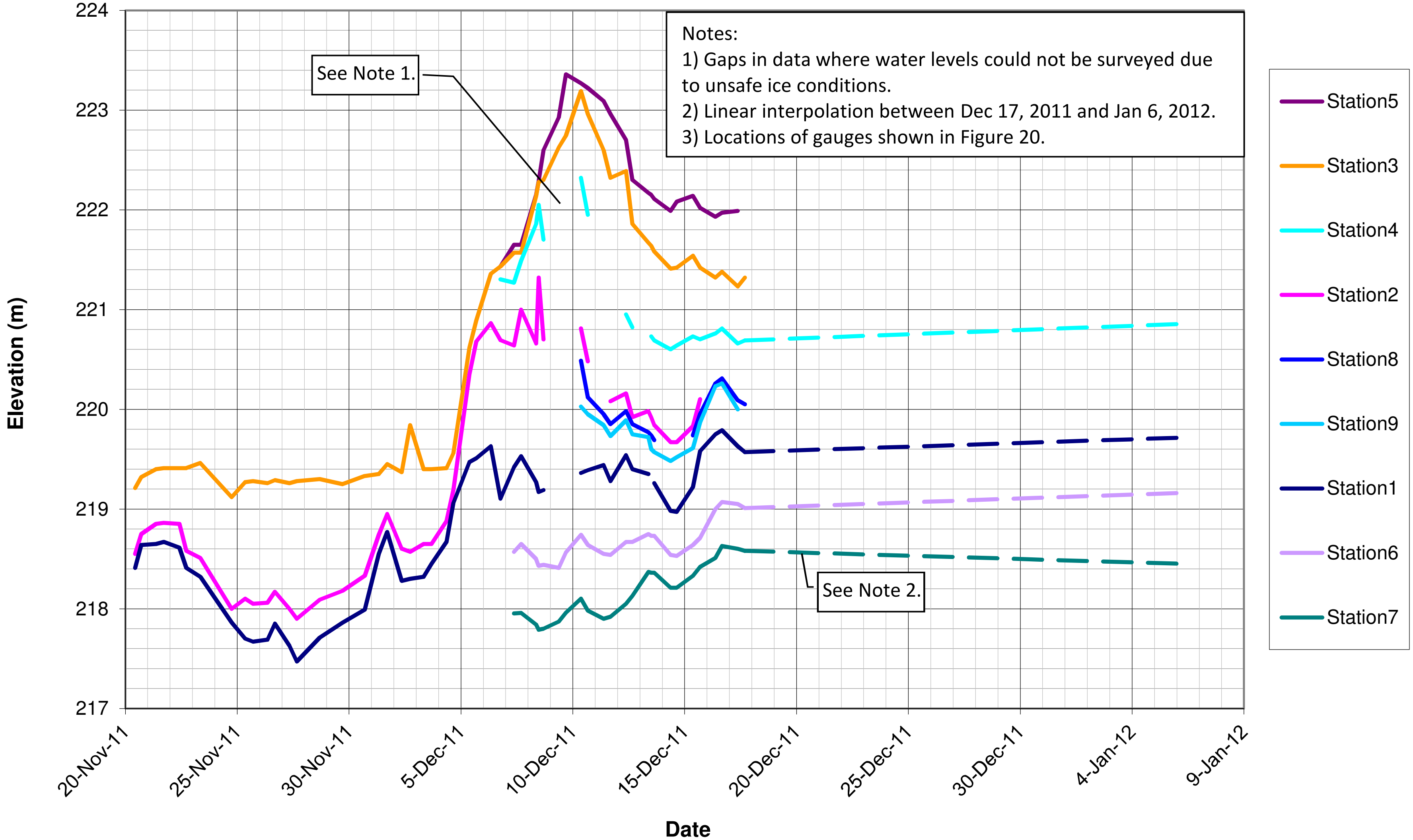


**FIGURE 20**
**Maximum Water Surface Profile for Lower Dauphin River**
***November and December 2011***

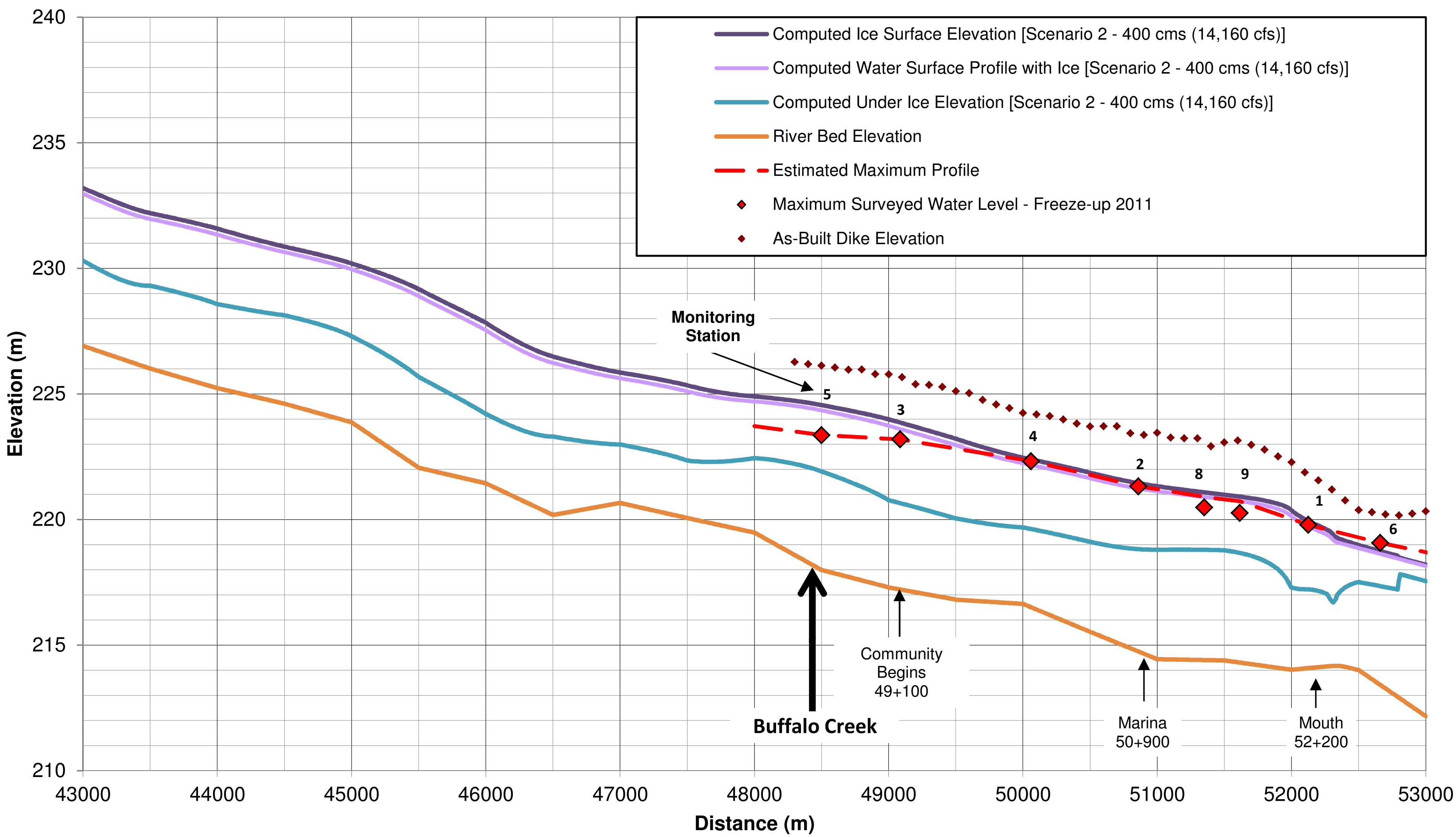


**FIGURE 21**
**Estimated Stage Discharge Relationship on Dauphin River during Winter of 2011-2012**

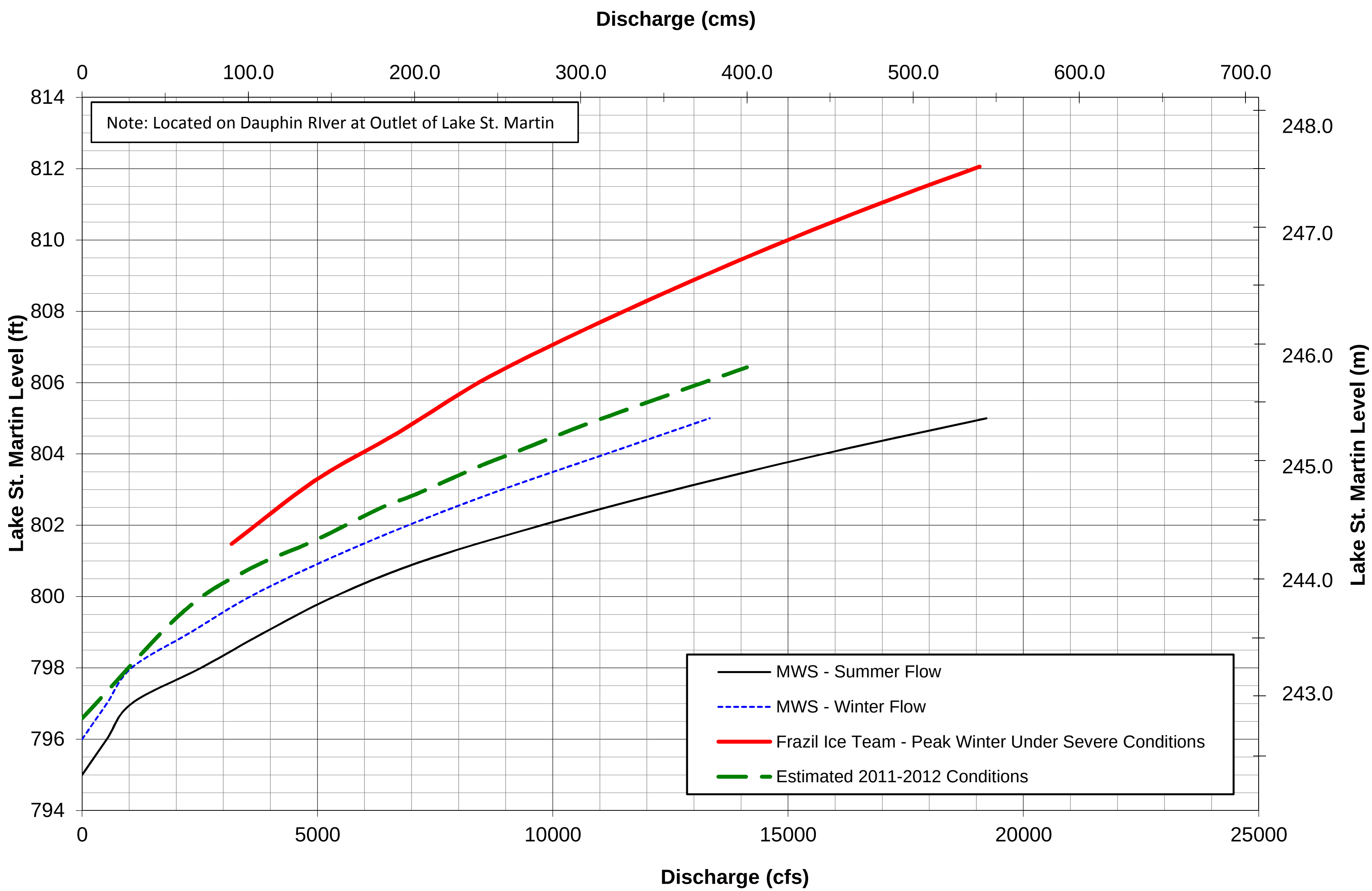


**FIGURE 22**
**Computed Lake St. Martin Level**
**With and Without Operation of the Lake St. Martin Emergency Outlet Channel**

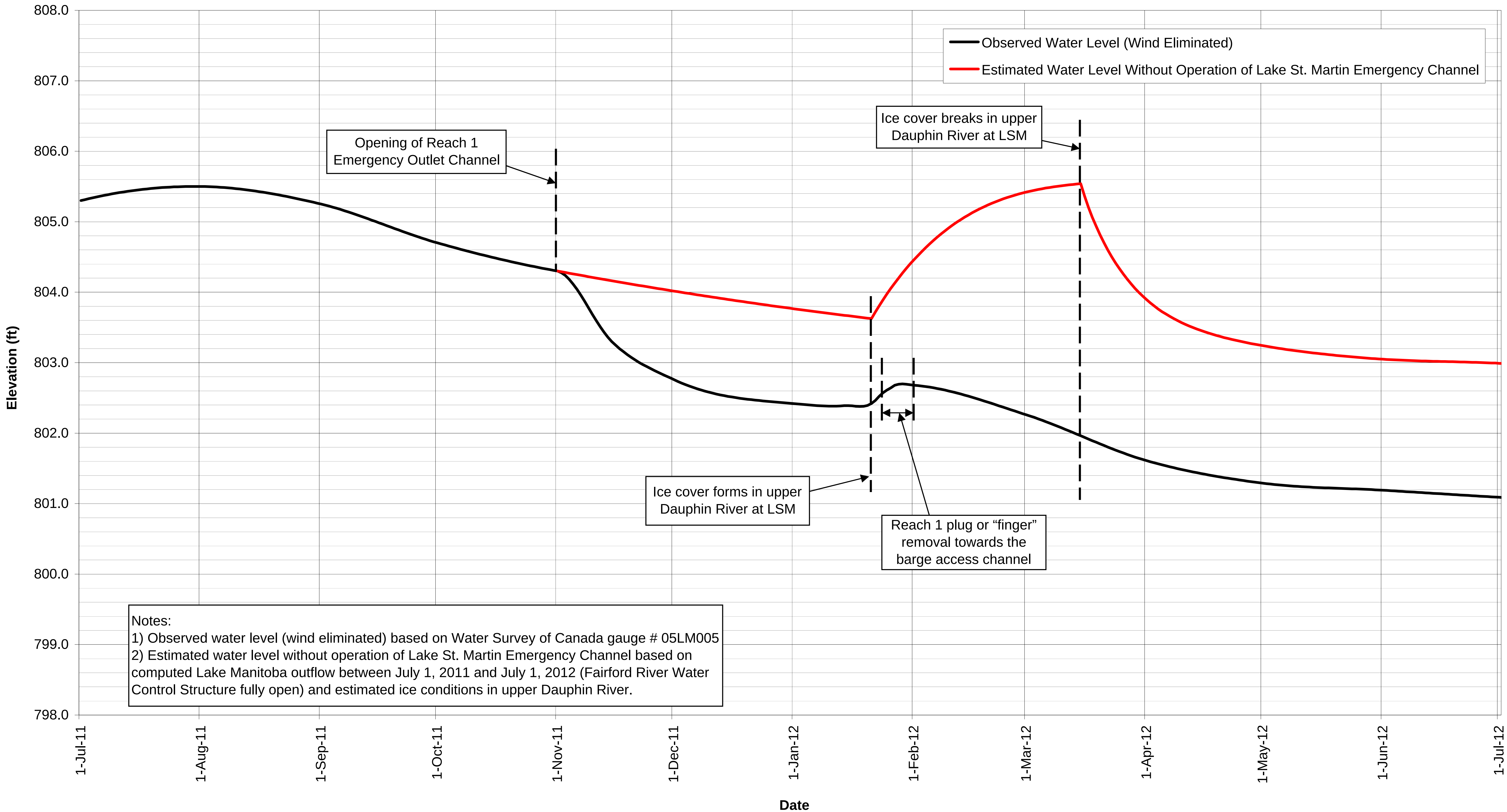


**Figure 23**
**Reach 1 Stage Discharge Relationships**

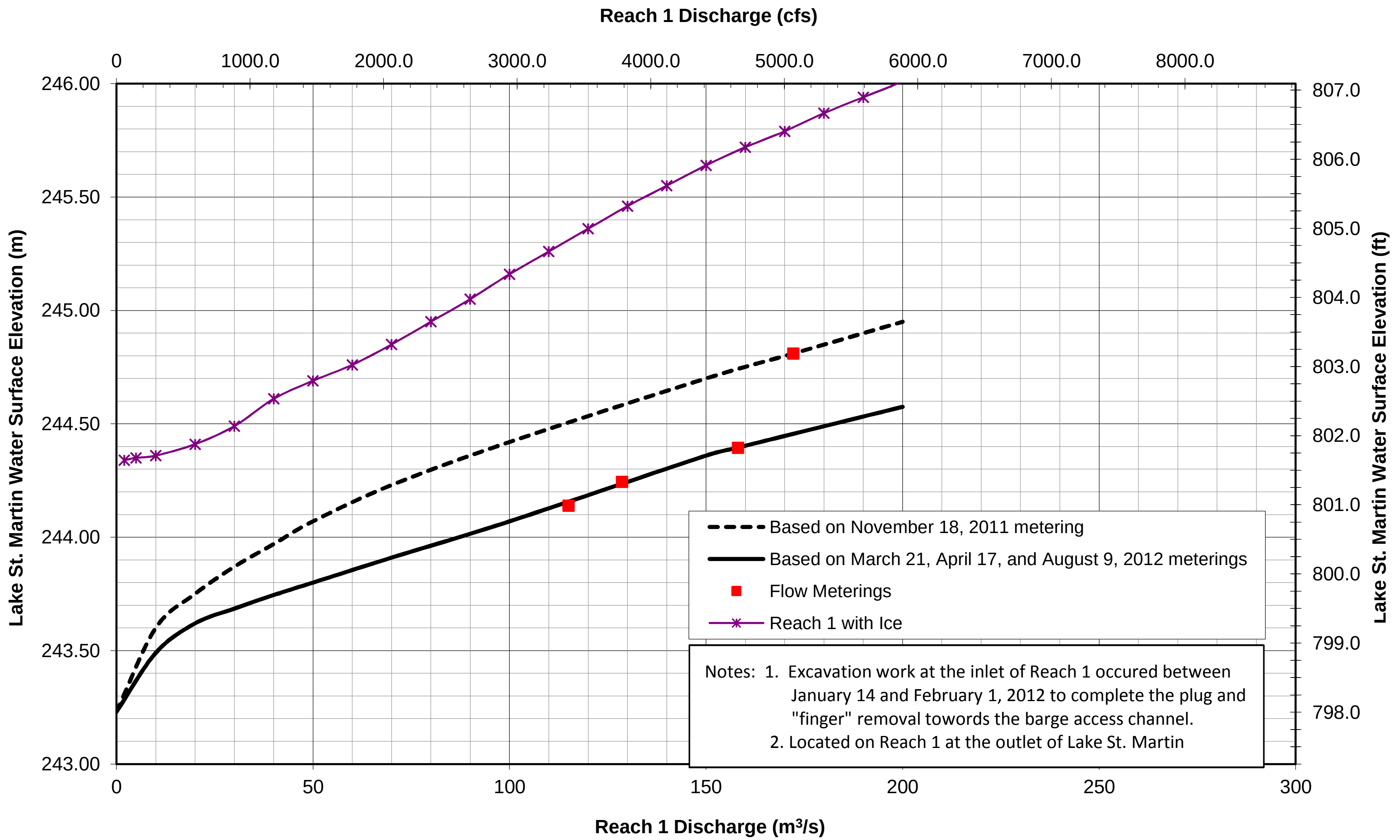


**FIGURE 24**
**Estimated Maximum Water Surface Profile with Ice for Buffalo Creek**
***80 cms (2,825 cfs)***

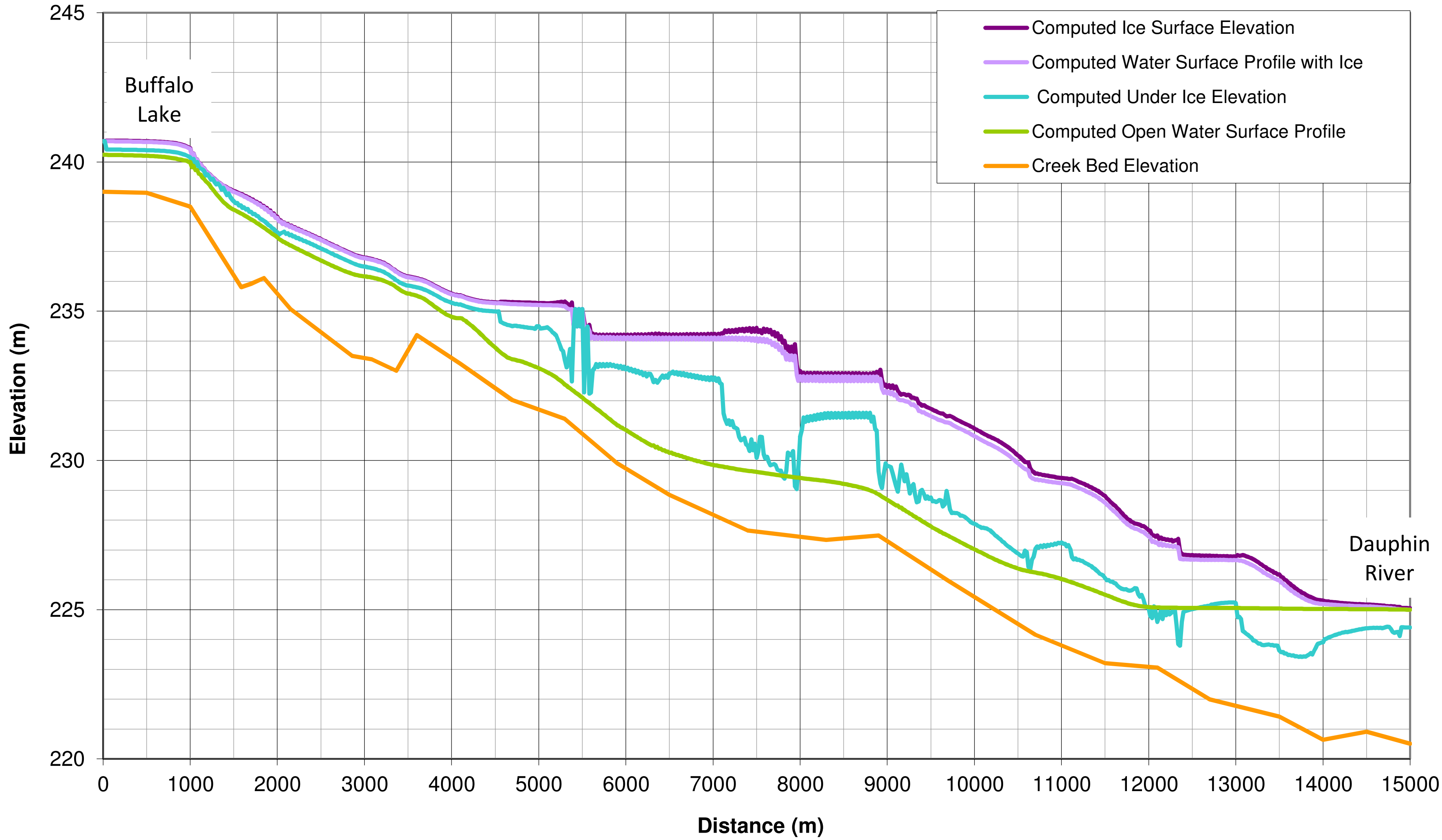
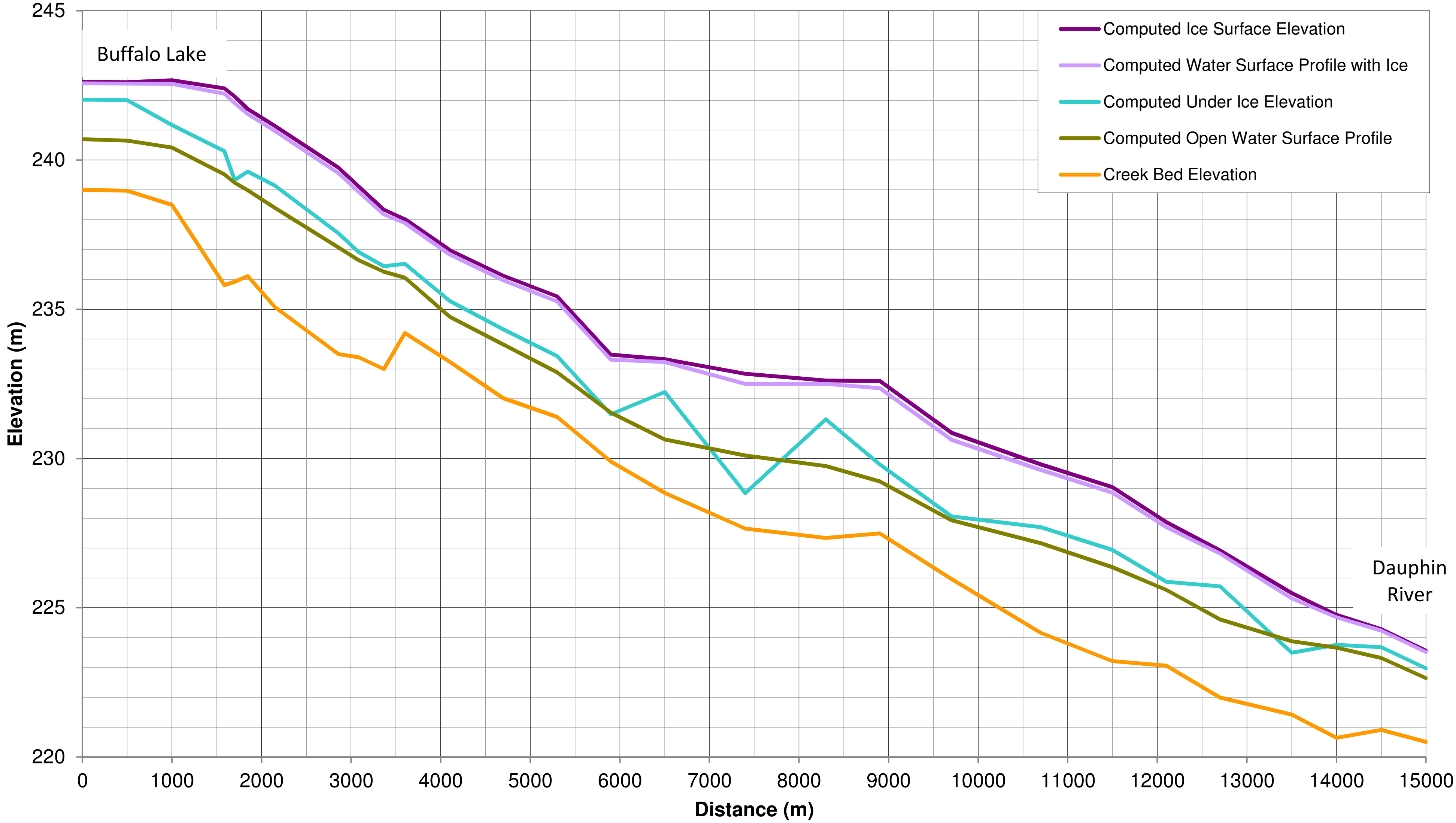


**FIGURE 25**
**Estimated Maximum Water Surface Profile with Ice in Buffalo Creek**
**140 cms *(4,900 cfs)***



# APPENDICES

# APPENDIX A

## LAKE MANITOBA AND LAKE ST. MARTIN FORECAST FIGURES AND DATA

**Comprised of 2 Separate Appendices:**

**Annex 1: Lake Manitoba Inflow Forecast**
**Annex 2: Lake Manitoba and Lake St. Martin Forecast Figures and Emails**

# APPENDIX A – ANNEX 1

# LAKE MANITOBA INFLOW FORECAST

**Lake Manitoba Inflow Forecast**

**June 27, 2011**

| Lake Manitoba<br>June 27, 2011<br>Inflow Forecast | |
|---|---|
| Date | Total Inflow (cfs) |
| 27-Jun-11 | 43300 |
| 28-Jun-11 | 42747 |
| 29-Jun-11 | 42229 |
| 30-Jun-11 | 41740 |
| 1-Jul-11 | 41377 |
| 2-Jul-11 | 41118 |
| 3-Jul-11 | 40924 |
| 4-Jul-11 | 40735 |
| 5-Jul-11 | 40909 |
| 6-Jul-11 | 41599 |
| 7-Jul-11 | 42681 |
| 8-Jul-11 | 44641 |
| 9-Jul-11 | 45980 |
| 10-Jul-11 | 46471 |
| 11-Jul-11 | 46011 |
| 12-Jul-11 | 44971 |
| 13-Jul-11 | 43752 |
| 14-Jul-11 | 41631 |
| 15-Jul-11 | 39385 |
| 16-Jul-11 | 36888 |
| 17-Jul-11 | 34225 |
| 18-Jul-11 | 31703 |
| 19-Jul-11 | 29632 |
| 20-Jul-11 | 27813 |
| 21-Jul-11 | 26313 |
| 22-Jul-11 | 25194 |
| 23-Jul-11 | 23760 |
| 24-Jul-11 | 22801 |
| 25-Jul-11 | 22054 |
| 26-Jul-11 | 21433 |
| 27-Jul-11 | 20644 |
| 28-Jul-11 | 19641 |
| 29-Jul-11 | 18897 |
| 30-Jul-11 | 18165 |
| 31-Jul-11 | 17547 |
| 1-Aug-11 | 16985 |
| 2-Aug-11 | 16330 |
| 3-Aug-11 | 15674 |
| 4-Aug-11 | 15234 |
| 5-Aug-11 | 14921 |
| 6-Aug-11 | 14373 |
| 7-Aug-11 | 13934 |
| 8-Aug-11 | 12807 |
| 9-Aug-11 | 12051 |
| 10-Aug-11 | 11399 |
| 11-Aug-11 | 10744 |
| 12-Aug-11 | 10263 |
| 13-Aug-11 | 9863 |
| 14-Aug-11 | 10423 |
| 15-Aug-11 | 9926 |
| 16-Aug-11 | 9738 |
| 17-Aug-11 | 9868 |
| 18-Aug-11 | 10126 |
| 19-Aug-11 | 10224 |
| 20-Aug-11 | 10199 |
| 21-Aug-11 | 9575 |
| 22-Aug-11 | 7514 |
| 23-Aug-11 | 6568 |
| 24-Aug-11 | 6453 |
| 25-Aug-11 | 6501 |
| 26-Aug-11 | 6765 |
| 27-Aug-11 | 6767 |
| 28-Aug-11 | 6754 |
| 29-Aug-11 | 6797 |
| 30-Aug-11 | 6809 |
| 31-Aug-11 | 6571 |
| 1-Sep-11 | 6341 |
| 2-Sep-11 | 6090 |

| Date | Total Inflow |
|---|---|
| 3-Sep-11 | 6012 |
| 4-Sep-11 | 6091 |
| 5-Sep-11 | 6148 |
| 6-Sep-11 | 6369 |
| 7-Sep-11 | 6628 |
| 8-Sep-11 | 6783 |
| 9-Sep-11 | 7121 |
| 10-Sep-11 | 7281 |
| 11-Sep-11 | 7675 |
| 12-Sep-11 | 7770 |
| 13-Sep-11 | 7708 |
| 14-Sep-11 | 7670 |
| 15-Sep-11 | 7443 |
| 16-Sep-11 | 6928 |
| 17-Sep-11 | 6445 |
| 18-Sep-11 | 6021 |
| 19-Sep-11 | 5738 |
| 20-Sep-11 | 5669 |
| 21-Sep-11 | 5659 |
| 22-Sep-11 | 5675 |
| 23-Sep-11 | 5802 |
| 24-Sep-11 | 6014 |
| 25-Sep-11 | 6227 |
| 26-Sep-11 | 6239 |
| 27-Sep-11 | 6226 |
| 28-Sep-11 | 6129 |
| 29-Sep-11 | 5672 |
| 30-Sep-11 | 5338 |
| 1-Oct-11 | 4837 |
| 2-Oct-11 | 4424 |
| 3-Oct-11 | 4153 |
| 4-Oct-11 | 4176 |
| 5-Oct-11 | 3980 |
| 6-Oct-11 | 3850 |
| 7-Oct-11 | 3881 |
| 8-Oct-11 | 3679 |
| 9-Oct-11 | 3606 |
| 10-Oct-11 | 3682 |
| 11-Oct-11 | 4034 |
| 12-Oct-11 | 4188 |
| 13-Oct-11 | 4194 |
| 14-Oct-11 | 4017 |
| 15-Oct-11 | 4146 |
| 16-Oct-11 | 4107 |
| 17-Oct-11 | 4422 |
| 18-Oct-11 | 4942 |
| 19-Oct-11 | 5080 |
| 20-Oct-11 | 5087 |
| 21-Oct-11 | 4970 |
| 22-Oct-11 | 5147 |
| 23-Oct-11 | 5299 |
| 24-Oct-11 | 5126 |
| 25-Oct-11 | 5105 |
| 26-Oct-11 | 5090 |
| 27-Oct-11 | 4794 |
| 28-Oct-11 | 4598 |
| 29-Oct-11 | 4659 |
| 30-Oct-11 | 4282 |
| 31-Oct-11 | 4398 |
| 1-Nov-11 | 4497 |
| 2-Nov-11 | 4221 |
| 3-Nov-11 | 4617 |
| 4-Nov-11 | 5253 |
| 5-Nov-11 | 5747 |
| 6-Nov-11 | 6351 |
| 7-Nov-11 | 6932 |
| 8-Nov-11 | 7267 |
| 9-Nov-11 | 7879 |
| 10-Nov-11 | 8117 |
| 11-Nov-11 | 8206 |
| 12-Nov-11 | 8026 |
| 13-Nov-11 | 7990 |
| 14-Nov-11 | 8193 |

| Date | Total Inflow |
|---|---|
| 15-Nov-11 | 8202 |
| 16-Nov-11 | 8192 |
| 17-Nov-11 | 8664 |
| 18-Nov-11 | 9006 |
| 19-Nov-11 | 9504 |
| 20-Nov-11 | 10276 |
| 21-Nov-11 | 10554 |
| 22-Nov-11 | 10656 |
| 23-Nov-11 | 10741 |
| 24-Nov-11 | 10173 |
| 25-Nov-11 | 9887 |
| 26-Nov-11 | 9603 |
| 27-Nov-11 | 9464 |
| 28-Nov-11 | 9221 |
| 29-Nov-11 | 8826 |
| 30-Nov-11 | 8681 |
| 1-Dec-11 | 8716 |
| 2-Dec-11 | 8688 |
| 3-Dec-11 | 8732 |
| 4-Dec-11 | 8667 |
| 5-Dec-11 | 8555 |
| 6-Dec-11 | 8502 |
| 7-Dec-11 | 8498 |
| 8-Dec-11 | 8486 |
| 9-Dec-11 | 8687 |
| 10-Dec-11 | 8760 |
| 11-Dec-11 | 8782 |
| 12-Dec-11 | 8776 |
| 13-Dec-11 | 8704 |
| 14-Dec-11 | 8639 |
| 15-Dec-11 | 8434 |
| 16-Dec-11 | 8363 |
| 17-Dec-11 | 8357 |
| 18-Dec-11 | 8336 |
| 19-Dec-11 | 8242 |
| 20-Dec-11 | 8106 |
| 21-Dec-11 | 7988 |
| 22-Dec-11 | 7917 |
| 23-Dec-11 | 7869 |
| 24-Dec-11 | 7822 |
| 25-Dec-11 | 7763 |
| 26-Dec-11 | 7696 |
| 27-Dec-11 | 7603 |
| 28-Dec-11 | 7522 |
| 29-Dec-11 | 7470 |
| 30-Dec-11 | 7412 |
| 31-Dec-11 | 7344 |
| 1-Jan-12 | 4514 |
| 2-Jan-12 | 4505 |
| 3-Jan-12 | 4498 |
| 4-Jan-12 | 4491 |
| 5-Jan-12 | 4486 |
| 6-Jan-12 | 4481 |
| 7-Jan-12 | 4476 |
| 8-Jan-12 | 4472 |
| 9-Jan-12 | 4467 |
| 10-Jan-12 | 4460 |
| 11-Jan-12 | 4454 |
| 12-Jan-12 | 4447 |
| 13-Jan-12 | 4441 |
| 14-Jan-12 | 4437 |
| 15-Jan-12 | 4434 |
| 16-Jan-12 | 4432 |
| 17-Jan-12 | 4430 |
| 18-Jan-12 | 4427 |
| 19-Jan-12 | 4422 |
| 20-Jan-12 | 4417 |
| 21-Jan-12 | 4413 |
| 22-Jan-12 | 4410 |
| 23-Jan-12 | 4409 |
| 24-Jan-12 | 4409 |
| 25-Jan-12 | 4409 |
| 26-Jan-12 | 4409 |

| Date | Total Inflow |
|---|---|
| 27-Jan-12 | 4401 |
| 28-Jan-12 | 4394 |
| 29-Jan-12 | 4385 |
| 30-Jan-12 | 4374 |
| 31-Jan-12 | 4363 |
| 1-Feb-12 | 4351 |
| 2-Feb-12 | 4338 |
| 3-Feb-12 | 4323 |
| 4-Feb-12 | 4310 |
| 5-Feb-12 | 4297 |
| 6-Feb-12 | 4286 |
| 7-Feb-12 | 4278 |
| 8-Feb-12 | 4272 |
| 9-Feb-12 | 4269 |
| 10-Feb-12 | 4267 |
| 11-Feb-12 | 4266 |
| 12-Feb-12 | 4267 |
| 13-Feb-12 | 4268 |
| 14-Feb-12 | 4268 |
| 15-Feb-12 | 4268 |
| 16-Feb-12 | 4269 |
| 17-Feb-12 | 4271 |
| 18-Feb-12 | 4275 |
| 19-Feb-12 | 4282 |
| 20-Feb-12 | 4291 |
| 21-Feb-12 | 4302 |
| 22-Feb-12 | 4316 |
| 23-Feb-12 | 4335 |
| 24-Feb-12 | 4355 |
| 25-Feb-12 | 4379 |
| 26-Feb-12 | 4406 |
| 27-Feb-12 | 4436 |
| 28-Feb-12 | 4472 |
| 29-Feb-12 | 4513 |
| 1-Mar-12 | 4561 |
| 2-Mar-12 | 4613 |
| 3-Mar-12 | 4670 |
| 4-Mar-12 | 4731 |
| 5-Mar-12 | 4795 |
| 6-Mar-12 | 4864 |
| 7-Mar-12 | 4938 |
| 8-Mar-12 | 5019 |
| 9-Mar-12 | 5105 |
| 10-Mar-12 | 5192 |
| 11-Mar-12 | 5276 |
| 12-Mar-12 | 5356 |
| 13-Mar-12 | 5434 |
| 14-Mar-12 | 5509 |
| 15-Mar-12 | 5589 |
| 16-Mar-12 | 5674 |
| 17-Mar-12 | 5766 |
| 18-Mar-12 | 5864 |
| 19-Mar-12 | 5969 |
| 20-Mar-12 | 6075 |
| 21-Mar-12 | 6187 |
| 22-Mar-12 | 6310 |
| 23-Mar-12 | 6454 |
| 24-Mar-12 | 6601 |
| 25-Mar-12 | 6789 |
| 26-Mar-12 | 6976 |
| 27-Mar-12 | 7163 |
| 28-Mar-12 | 7353 |
| 29-Mar-12 | 7555 |
| 30-Mar-12 | 7795 |
| 31-Mar-12 | 8073 |
| 1-Apr-12 | 8382 |
| 2-Apr-12 | 8698 |
| 3-Apr-12 | 9125 |
| 4-Apr-12 | 9646 |
| 5-Apr-12 | 10158 |
| 6-Apr-12 | 10736 |
| 7-Apr-12 | 11519 |
| 8-Apr-12 | 12596 |

| Date | Total Inflow |
|---|---|
| 9-Apr-12 | 13770 |
| 10-Apr-12 | 14868 |
| 11-Apr-12 | 15878 |
| 12-Apr-12 | 16836 |
| 13-Apr-12 | 17719 |
| 14-Apr-12 | 18475 |
| 15-Apr-12 | 19339 |
| 16-Apr-12 | 20167 |
| 17-Apr-12 | 20726 |
| 18-Apr-12 | 20883 |
| 19-Apr-12 | 20857 |
| 20-Apr-12 | 20813 |
| 21-Apr-12 | 20798 |
| 22-Apr-12 | 20772 |
| 23-Apr-12 | 20662 |
| 24-Apr-12 | 20526 |
| 25-Apr-12 | 20248 |
| 26-Apr-12 | 19910 |
| 27-Apr-12 | 19597 |
| 28-Apr-12 | 19333 |
| 29-Apr-12 | 19081 |
| 30-Apr-12 | 18837 |
| 1-May-12 | 18567 |
| 2-May-12 | 18313 |
| 3-May-12 | 18087 |
| 4-May-12 | 17840 |
| 5-May-12 | 17603 |
| 6-May-12 | 17355 |
| 7-May-12 | 17122 |
| 8-May-12 | 16911 |
| 9-May-12 | 16734 |
| 10-May-12 | 16564 |
| 11-May-12 | 16422 |
| 12-May-12 | 16275 |
| 13-May-12 | 16151 |
| 14-May-12 | 16066 |
| 15-May-12 | 16010 |
| 16-May-12 | 15958 |
| 17-May-12 | 15878 |
| 18-May-12 | 15788 |
| 19-May-12 | 15637 |
| 20-May-12 | 15464 |
| 21-May-12 | 15270 |
| 22-May-12 | 15064 |
| 23-May-12 | 14811 |
| 24-May-12 | 14516 |
| 25-May-12 | 14172 |
| 26-May-12 | 13801 |
| 27-May-12 | 13413 |
| 28-May-12 | 12982 |
| 29-May-12 | 12577 |
| 30-May-12 | 12181 |
| 31-May-12 | 11796 |
| 1-Jun-12 | 11418 |
| 2-Jun-12 | 11078 |
| 3-Jun-12 | 10752 |
| 4-Jun-12 | 10457 |
| 5-Jun-12 | 10192 |
| 6-Jun-12 | 9971 |
| 7-Jun-12 | 9792 |
| 8-Jun-12 | 9639 |
| 9-Jun-12 | 9515 |
| 10-Jun-12 | 9395 |
| 11-Jun-12 | 9263 |
| 12-Jun-12 | 9113 |
| 13-Jun-12 | 8955 |
| 14-Jun-12 | 8790 |
| 15-Jun-12 | 8624 |
| 16-Jun-12 | 8458 |
| 17-Jun-12 | 8292 |
| 18-Jun-12 | 8104 |
| 19-Jun-12 | 7911 |
| 20-Jun-12 | 7717 |

| Date | Total Inflow |
|---|---|
| 21-Jun-12 | 7528 |
| 22-Jun-12 | 7337 |
| 23-Jun-12 | 7151 |
| 24-Jun-12 | 6956 |
| 25-Jun-12 | 6755 |
| 26-Jun-12 | 6542 |
| 27-Jun-12 | 6334 |
| 28-Jun-12 | 6141 |
| 29-Jun-12 | 5968 |
| 30-Jun-12 | 5810 |
| 1-Jul-12 | 5656 |
| 2-Jul-12 | 5500 |
| 3-Jul-12 | 5334 |
| 4-Jul-12 | 5159 |
| 5-Jul-12 | 4979 |
| 6-Jul-12 | 4797 |
| 7-Jul-12 | 4622 |
| 8-Jul-12 | 4460 |
| 9-Jul-12 | 4301 |
| 10-Jul-12 | 4139 |
| 11-Jul-12 | 3985 |
| 12-Jul-12 | 3837 |
| 13-Jul-12 | 3694 |
| 14-Jul-12 | 3558 |
| 15-Jul-12 | 3439 |
| 16-Jul-12 | 3327 |
| 17-Jul-12 | 3214 |
| 18-Jul-12 | 3097 |
| 19-Jul-12 | 2985 |
| 20-Jul-12 | 2875 |
| 21-Jul-12 | 2772 |
| 22-Jul-12 | 2671 |
| 23-Jul-12 | 2573 |
| 24-Jul-12 | 2488 |
| 25-Jul-12 | 2420 |
| 26-Jul-12 | 2355 |
| 27-Jul-12 | 2295 |
| 28-Jul-12 | 2244 |
| 29-Jul-12 | 2195 |
| 30-Jul-12 | 2142 |
| 31-Jul-12 | 2097 |
| 1-Aug-12 | 2064 |
| 2-Aug-12 | 2044 |
| 3-Aug-12 | 2022 |
| 4-Aug-12 | 2001 |
| 5-Aug-12 | 1985 |
| 6-Aug-12 | 1968 |
| 7-Aug-12 | 1948 |
| 8-Aug-12 | 1921 |
| 9-Aug-12 | 1891 |
| 10-Aug-12 | 1852 |
| 11-Aug-12 | 1803 |
| 12-Aug-12 | 1757 |
| 13-Aug-12 | 1723 |
| 14-Aug-12 | 1702 |
| 15-Aug-12 | 1690 |
| 16-Aug-12 | 1682 |
| 17-Aug-12 | 1665 |
| 18-Aug-12 | 1635 |
| 19-Aug-12 | 1596 |
| 20-Aug-12 | 1552 |
| 21-Aug-12 | 1515 |
| 22-Aug-12 | 1480 |
| 23-Aug-12 | 1454 |
| 24-Aug-12 | 1428 |
| 25-Aug-12 | 1400 |
| 26-Aug-12 | 1370 |
| 27-Aug-12 | 1342 |
| 28-Aug-12 | 1330 |
| 29-Aug-12 | 1330 |
| 30-Aug-12 | 1341 |
| 31-Aug-12 | 1349 |
| 1-Sep-12 | 1352 |

| Date | Total Inflow |
|---|---|
| 2-Sep-12 | 1343 |
| 3-Sep-12 | 1323 |
| 4-Sep-12 | 1307 |
| 5-Sep-12 | 1299 |
| 6-Sep-12 | 1300 |
| 7-Sep-12 | 1302 |
| 8-Sep-12 | 1303 |
| 9-Sep-12 | 1301 |
| 10-Sep-12 | 1304 |
| 11-Sep-12 | 1327 |
| 12-Sep-12 | 1346 |
| 13-Sep-12 | 1357 |
| 14-Sep-12 | 1354 |
| 15-Sep-12 | 1330 |
| 16-Sep-12 | 1278 |
| 17-Sep-12 | 1220 |
| 18-Sep-12 | 1168 |
| 19-Sep-12 | 1127 |
| 20-Sep-12 | 1092 |
| 21-Sep-12 | 1053 |
| 22-Sep-12 | 1028 |
| 23-Sep-12 | 1009 |
| 24-Sep-12 | 989 |
| 25-Sep-12 | 974 |
| 26-Sep-12 | 982 |
| 27-Sep-12 | 1004 |
| 28-Sep-12 | 1039 |
| 29-Sep-12 | 1090 |
| 30-Sep-12 | 1158 |
| 1-Oct-12 | 1230 |
| 2-Oct-12 | 1298 |
| 3-Oct-12 | 1359 |
| 4-Oct-12 | 1417 |
| 5-Oct-12 | 1477 |
| 6-Oct-12 | 1539 |
| 7-Oct-12 | 1607 |
| 8-Oct-12 | 1683 |
| 9-Oct-12 | 1765 |
| 10-Oct-12 | 1846 |
| 11-Oct-12 | 1931 |
| 12-Oct-12 | 2017 |
| 13-Oct-12 | 2105 |
| 14-Oct-12 | 2194 |
| 15-Oct-12 | 2282 |
| 16-Oct-12 | 2364 |
| 17-Oct-12 | 2429 |
| 18-Oct-12 | 2485 |
| 19-Oct-12 | 2533 |
| 20-Oct-12 | 2585 |
| 21-Oct-12 | 2646 |
| 22-Oct-12 | 2721 |
| 23-Oct-12 | 2798 |
| 24-Oct-12 | 2869 |
| 25-Oct-12 | 2933 |
| 26-Oct-12 | 2989 |
| 27-Oct-12 | 3042 |
| 28-Oct-12 | 3097 |
| 29-Oct-12 | 3154 |
| 30-Oct-12 | 3204 |
| 31-Oct-12 | 3243 |
| 1-Nov-12 | 3290 |
| 2-Nov-12 | 3343 |
| 3-Nov-12 | 3412 |
| 4-Nov-12 | 3503 |
| 5-Nov-12 | 3619 |
| 6-Nov-12 | 3736 |
| 7-Nov-12 | 3855 |
| 8-Nov-12 | 3963 |
| 9-Nov-12 | 4062 |
| 10-Nov-12 | 4158 |
| 11-Nov-12 | 4242 |
| 12-Nov-12 | 4318 |
| 13-Nov-12 | 4395 |

| Date | Total Inflow |
|---|---|
| 14-Nov-12 | 4467 |
| 15-Nov-12 | 4522 |
| 16-Nov-12 | 4566 |
| 17-Nov-12 | 4595 |
| 18-Nov-12 | 4607 |
| 19-Nov-12 | 4608 |
| 20-Nov-12 | 4603 |
| 21-Nov-12 | 4598 |
| 22-Nov-12 | 4591 |
| 23-Nov-12 | 4590 |
| 24-Nov-12 | 4584 |
| 25-Nov-12 | 4575 |
| 26-Nov-12 | 4568 |
| 27-Nov-12 | 4562 |
| 28-Nov-12 | 4552 |
| 29-Nov-12 | 4542 |
| 30-Nov-12 | 4531 |
| 1-Dec-12 | 4517 |
| 2-Dec-12 | 4505 |
| 3-Dec-12 | 4496 |
| 4-Dec-12 | 4490 |
| 5-Dec-12 | 4488 |
| 6-Dec-12 | 4490 |
| 7-Dec-12 | 4499 |
| 8-Dec-12 | 4509 |
| 9-Dec-12 | 4516 |
| 10-Dec-12 | 4519 |
| 11-Dec-12 | 4516 |
| 12-Dec-12 | 4513 |
| 13-Dec-12 | 4512 |
| 14-Dec-12 | 4512 |
| 15-Dec-12 | 4515 |
| 16-Dec-12 | 4521 |
| 17-Dec-12 | 4526 |
| 18-Dec-12 | 4532 |
| 19-Dec-12 | 4543 |
| 20-Dec-12 | 4554 |
| 21-Dec-12 | 4555 |
| 22-Dec-12 | 4551 |
| 23-Dec-12 | 4536 |
| 24-Dec-12 | 4504 |
| 25-Dec-12 | 4459 |
| 26-Dec-12 | 4413 |
| 27-Dec-12 | 4358 |
| 28-Dec-12 | 4305 |
| 29-Dec-12 | 4255 |
| 30-Dec-12 | 4205 |
| 31-Dec-12 | 4200 |

**Lake Manitoba Inflow Forecast**

**July 8, 2011**

| Lake Manitoba<br>July 8, 2011<br>Inflow Forecast | |
|---|---|
| Date | Total Inflow (cfs) |
| 8-Jul-11 | 36714 |
| 9-Jul-11 | 36246 |
| 10-Jul-11 | 35303 |
| 11-Jul-11 | 34375 |
| 12-Jul-11 | 33668 |
| 13-Jul-11 | 32409 |
| 14-Jul-11 | 30610 |
| 15-Jul-11 | 28855 |
| 16-Jul-11 | 26922 |
| 17-Jul-11 | 24832 |
| 18-Jul-11 | 22796 |
| 19-Jul-11 | 21021 |
| 20-Jul-11 | 19268 |
| 21-Jul-11 | 17632 |
| 22-Jul-11 | 16292 |
| 23-Jul-11 | 14683 |
| 24-Jul-11 | 13653 |
| 25-Jul-11 | 12937 |
| 26-Jul-11 | 12415 |
| 27-Jul-11 | 11764 |
| 28-Jul-11 | 10927 |
| 29-Jul-11 | 10367 |
| 30-Jul-11 | 9827 |
| 31-Jul-11 | 9405 |
| 1-Aug-11 | 9028 |
| 2-Aug-11 | 8513 |
| 3-Aug-11 | 7996 |
| 4-Aug-11 | 7700 |
| 5-Aug-11 | 7531 |
| 6-Aug-11 | 7121 |
| 7-Aug-11 | 6812 |
| 8-Aug-11 | 6074 |
| 9-Aug-11 | 5582 |
| 10-Aug-11 | 5166 |
| 11-Aug-11 | 4708 |
| 12-Aug-11 | 4380 |
| 13-Aug-11 | 4097 |
| 14-Aug-11 | 3924 |
| 15-Aug-11 | 3753 |
| 16-Aug-11 | 3869 |
| 17-Aug-11 | 4285 |
| 18-Aug-11 | 4813 |
| 19-Aug-11 | 5169 |
| 20-Aug-11 | 5394 |
| 21-Aug-11 | 5682 |
| 22-Aug-11 | 5786 |
| 23-Aug-11 | 6119 |
| 24-Aug-11 | 6453 |
| 25-Aug-11 | 6501 |
| 26-Aug-11 | 6765 |
| 27-Aug-11 | 6767 |
| 28-Aug-11 | 6754 |
| 29-Aug-11 | 6797 |
| 30-Aug-11 | 6809 |
| 31-Aug-11 | 6571 |
| 1-Sep-11 | 6341 |
| 2-Sep-11 | 6090 |
| 3-Sep-11 | 6012 |
| 4-Sep-11 | 6091 |
| 5-Sep-11 | 6148 |
| 6-Sep-11 | 6369 |
| 7-Sep-11 | 6628 |
| 8-Sep-11 | 6783 |
| 9-Sep-11 | 7121 |
| 10-Sep-11 | 7281 |
| 11-Sep-11 | 7675 |
| 12-Sep-11 | 7770 |
| 13-Sep-11 | 7708 |

| Date | Total Inflow |
|---|---|
| 14-Sep-11 | 7670 |
| 15-Sep-11 | 7443 |
| 16-Sep-11 | 6928 |
| 17-Sep-11 | 6445 |
| 18-Sep-11 | 6021 |
| 19-Sep-11 | 5738 |
| 20-Sep-11 | 5669 |
| 21-Sep-11 | 5659 |
| 22-Sep-11 | 5675 |
| 23-Sep-11 | 5802 |
| 24-Sep-11 | 6014 |
| 25-Sep-11 | 6227 |
| 26-Sep-11 | 6239 |
| 27-Sep-11 | 6226 |
| 28-Sep-11 | 6129 |
| 29-Sep-11 | 5672 |
| 30-Sep-11 | 5338 |
| 1-Oct-11 | 4837 |
| 2-Oct-11 | 4424 |
| 3-Oct-11 | 4153 |
| 4-Oct-11 | 4176 |
| 5-Oct-11 | 3980 |
| 6-Oct-11 | 3850 |
| 7-Oct-11 | 3881 |
| 8-Oct-11 | 3679 |
| 9-Oct-11 | 3606 |
| 10-Oct-11 | 3682 |
| 11-Oct-11 | 4034 |
| 12-Oct-11 | 4188 |
| 13-Oct-11 | 4194 |
| 14-Oct-11 | 4017 |
| 15-Oct-11 | 4146 |
| 16-Oct-11 | 4107 |
| 17-Oct-11 | 4422 |
| 18-Oct-11 | 4942 |
| 19-Oct-11 | 5080 |
| 20-Oct-11 | 5087 |
| 21-Oct-11 | 4970 |
| 22-Oct-11 | 5147 |
| 23-Oct-11 | 5299 |
| 24-Oct-11 | 5126 |
| 25-Oct-11 | 5105 |
| 26-Oct-11 | 5090 |
| 27-Oct-11 | 4794 |
| 28-Oct-11 | 4598 |
| 29-Oct-11 | 4659 |
| 30-Oct-11 | 4282 |
| 31-Oct-11 | 4398 |
| 1-Nov-11 | 4497 |
| 2-Nov-11 | 4221 |
| 3-Nov-11 | 4617 |
| 4-Nov-11 | 4500 |
| 5-Nov-11 | 4958 |
| 6-Nov-11 | 5526 |
| 7-Nov-11 | 6070 |
| 8-Nov-11 | 6369 |
| 9-Nov-11 | 6945 |
| 10-Nov-11 | 7146 |
| 11-Nov-11 | 7199 |
| 12-Nov-11 | 6982 |
| 13-Nov-11 | 6910 |
| 14-Nov-11 | 7077 |
| 15-Nov-11 | 7049 |
| 16-Nov-11 | 7003 |
| 17-Nov-11 | 7439 |
| 18-Nov-11 | 7745 |
| 19-Nov-11 | 8207 |
| 20-Nov-11 | 8942 |
| 21-Nov-11 | 9184 |
| 22-Nov-11 | 9249 |
| 23-Nov-11 | 9298 |
| 24-Nov-11 | 8694 |
| 25-Nov-11 | 8371 |

| Date | Total Inflow |
|---|---|
| 26-Nov-11 | 8051 |
| 27-Nov-11 | 7876 |
| 28-Nov-11 | 7597 |
| 29-Nov-11 | 7165 |
| 30-Nov-11 | 6984 |
| 1-Dec-11 | 6982 |
| 2-Dec-11 | 6918 |
| 3-Dec-11 | 6925 |
| 4-Dec-11 | 6824 |
| 5-Dec-11 | 6675 |
| 6-Dec-11 | 6586 |
| 7-Dec-11 | 6546 |
| 8-Dec-11 | 6498 |
| 9-Dec-11 | 6663 |
| 10-Dec-11 | 6700 |
| 11-Dec-11 | 6685 |
| 12-Dec-11 | 6642 |
| 13-Dec-11 | 6534 |
| 14-Dec-11 | 6433 |
| 15-Dec-11 | 6191 |
| 16-Dec-11 | 6085 |
| 17-Dec-11 | 6042 |
| 18-Dec-11 | 5984 |
| 19-Dec-11 | 5854 |
| 20-Dec-11 | 5682 |
| 21-Dec-11 | 5528 |
| 22-Dec-11 | 5421 |
| 23-Dec-11 | 5336 |
| 24-Dec-11 | 5252 |
| 25-Dec-11 | 5158 |
| 26-Dec-11 | 5054 |
| 27-Dec-11 | 4925 |
| 28-Dec-11 | 4807 |
| 29-Dec-11 | 4719 |
| 30-Dec-11 | 4625 |
| 31-Dec-11 | 4520 |
| 1-Jan-12 | 4514 |
| 2-Jan-12 | 4505 |
| 3-Jan-12 | 4498 |
| 4-Jan-12 | 4491 |
| 5-Jan-12 | 4486 |
| 6-Jan-12 | 4481 |
| 7-Jan-12 | 4476 |
| 8-Jan-12 | 4472 |
| 9-Jan-12 | 4467 |
| 10-Jan-12 | 4460 |
| 11-Jan-12 | 4454 |
| 12-Jan-12 | 4447 |
| 13-Jan-12 | 4441 |
| 14-Jan-12 | 4437 |
| 15-Jan-12 | 4434 |
| 16-Jan-12 | 4432 |
| 17-Jan-12 | 4430 |
| 18-Jan-12 | 4427 |
| 19-Jan-12 | 4422 |
| 20-Jan-12 | 4417 |
| 21-Jan-12 | 4413 |
| 22-Jan-12 | 4410 |
| 23-Jan-12 | 4409 |
| 24-Jan-12 | 4409 |
| 25-Jan-12 | 4409 |
| 26-Jan-12 | 4409 |
| 27-Jan-12 | 4401 |
| 28-Jan-12 | 4394 |
| 29-Jan-12 | 4385 |
| 30-Jan-12 | 4374 |
| 31-Jan-12 | 4363 |
| 1-Feb-12 | 4351 |
| 2-Feb-12 | 4338 |
| 3-Feb-12 | 4323 |
| 4-Feb-12 | 4310 |
| 5-Feb-12 | 4297 |
| 6-Feb-12 | 4286 |

| Date | Total Inflow |
|---|---|
| 7-Feb-12 | 4278 |
| 8-Feb-12 | 4272 |
| 9-Feb-12 | 4269 |
| 10-Feb-12 | 4267 |
| 11-Feb-12 | 4266 |
| 12-Feb-12 | 4267 |
| 13-Feb-12 | 4268 |
| 14-Feb-12 | 4268 |
| 15-Feb-12 | 4268 |
| 16-Feb-12 | 4269 |
| 17-Feb-12 | 4271 |
| 18-Feb-12 | 4275 |
| 19-Feb-12 | 4282 |
| 20-Feb-12 | 4291 |
| 21-Feb-12 | 4302 |
| 22-Feb-12 | 4316 |
| 23-Feb-12 | 4335 |
| 24-Feb-12 | 4355 |
| 25-Feb-12 | 4379 |
| 26-Feb-12 | 4406 |
| 27-Feb-12 | 4436 |
| 28-Feb-12 | 4472 |
| 29-Feb-12 | 4513 |
| 1-Mar-12 | 4561 |
| 2-Mar-12 | 4613 |
| 3-Mar-12 | 4670 |
| 4-Mar-12 | 4731 |
| 5-Mar-12 | 4795 |
| 6-Mar-12 | 4864 |
| 7-Mar-12 | 4938 |
| 8-Mar-12 | 5019 |
| 9-Mar-12 | 5105 |
| 10-Mar-12 | 5192 |
| 11-Mar-12 | 5276 |
| 12-Mar-12 | 5356 |
| 13-Mar-12 | 5434 |
| 14-Mar-12 | 5509 |
| 15-Mar-12 | 5589 |
| 16-Mar-12 | 5674 |
| 17-Mar-12 | 5766 |
| 18-Mar-12 | 5864 |
| 19-Mar-12 | 5969 |
| 20-Mar-12 | 6075 |
| 21-Mar-12 | 6187 |
| 22-Mar-12 | 6310 |
| 23-Mar-12 | 6454 |
| 24-Mar-12 | 6601 |
| 25-Mar-12 | 6789 |
| 26-Mar-12 | 6976 |
| 27-Mar-12 | 7163 |
| 28-Mar-12 | 7353 |
| 29-Mar-12 | 7555 |
| 30-Mar-12 | 7795 |
| 31-Mar-12 | 8073 |
| 1-Apr-12 | 8382 |
| 2-Apr-12 | 8698 |
| 3-Apr-12 | 9125 |
| 4-Apr-12 | 9646 |
| 5-Apr-12 | 10158 |
| 6-Apr-12 | 10736 |
| 7-Apr-12 | 11519 |
| 8-Apr-12 | 12596 |
| 9-Apr-12 | 13770 |
| 10-Apr-12 | 14868 |
| 11-Apr-12 | 15878 |
| 12-Apr-12 | 16836 |
| 13-Apr-12 | 17719 |
| 14-Apr-12 | 18475 |
| 15-Apr-12 | 19339 |
| 16-Apr-12 | 20167 |
| 17-Apr-12 | 20726 |
| 18-Apr-12 | 20883 |
| 19-Apr-12 | 20857 |

| Date | Total Inflow |
|---|---|
| 20-Apr-12 | 20813 |
| 21-Apr-12 | 20798 |
| 22-Apr-12 | 20772 |
| 23-Apr-12 | 20662 |
| 24-Apr-12 | 20526 |
| 25-Apr-12 | 20248 |
| 26-Apr-12 | 19910 |
| 27-Apr-12 | 19597 |
| 28-Apr-12 | 19333 |
| 29-Apr-12 | 19081 |
| 30-Apr-12 | 18837 |
| 1-May-12 | 18567 |
| 2-May-12 | 18313 |
| 3-May-12 | 18087 |
| 4-May-12 | 17840 |
| 5-May-12 | 17603 |
| 6-May-12 | 17355 |
| 7-May-12 | 17122 |
| 8-May-12 | 16911 |
| 9-May-12 | 16734 |
| 10-May-12 | 16564 |
| 11-May-12 | 16422 |
| 12-May-12 | 16275 |
| 13-May-12 | 16151 |
| 14-May-12 | 16066 |
| 15-May-12 | 16010 |
| 16-May-12 | 15958 |
| 17-May-12 | 15878 |
| 18-May-12 | 15788 |
| 19-May-12 | 15637 |
| 20-May-12 | 15464 |
| 21-May-12 | 15270 |
| 22-May-12 | 15064 |
| 23-May-12 | 14811 |
| 24-May-12 | 14516 |
| 25-May-12 | 14172 |
| 26-May-12 | 13801 |
| 27-May-12 | 13413 |
| 28-May-12 | 12982 |
| 29-May-12 | 12577 |
| 30-May-12 | 12181 |
| 31-May-12 | 11796 |
| 1-Jun-12 | 11418 |
| 2-Jun-12 | 11078 |
| 3-Jun-12 | 10752 |
| 4-Jun-12 | 10457 |
| 5-Jun-12 | 10192 |
| 6-Jun-12 | 9971 |
| 7-Jun-12 | 9792 |
| 8-Jun-12 | 9639 |
| 9-Jun-12 | 9515 |
| 10-Jun-12 | 9395 |
| 11-Jun-12 | 9263 |
| 12-Jun-12 | 9113 |
| 13-Jun-12 | 8955 |
| 14-Jun-12 | 8790 |
| 15-Jun-12 | 8624 |
| 16-Jun-12 | 8458 |
| 17-Jun-12 | 8292 |
| 18-Jun-12 | 8104 |
| 19-Jun-12 | 7911 |
| 20-Jun-12 | 7717 |
| 21-Jun-12 | 7528 |
| 22-Jun-12 | 7337 |
| 23-Jun-12 | 7151 |
| 24-Jun-12 | 6956 |
| 25-Jun-12 | 6755 |
| 26-Jun-12 | 6542 |
| 27-Jun-12 | 6334 |
| 28-Jun-12 | 6141 |
| 29-Jun-12 | 5968 |
| 30-Jun-12 | 5810 |
| 1-Jul-12 | 5656 |

| Date | Total Inflow |
|---|---|
| 2-Jul-12 | 5500 |
| 3-Jul-12 | 5334 |
| 4-Jul-12 | 5159 |
| 5-Jul-12 | 4979 |
| 6-Jul-12 | 4797 |
| 7-Jul-12 | 4622 |
| 8-Jul-12 | 4460 |
| 9-Jul-12 | 4301 |
| 10-Jul-12 | 4139 |
| 11-Jul-12 | 3985 |
| 12-Jul-12 | 3837 |
| 13-Jul-12 | 3694 |
| 14-Jul-12 | 3558 |
| 15-Jul-12 | 3439 |
| 16-Jul-12 | 3327 |
| 17-Jul-12 | 3214 |
| 18-Jul-12 | 3097 |
| 19-Jul-12 | 2985 |
| 20-Jul-12 | 2875 |
| 21-Jul-12 | 2772 |
| 22-Jul-12 | 2671 |
| 23-Jul-12 | 2573 |
| 24-Jul-12 | 2488 |
| 25-Jul-12 | 2420 |
| 26-Jul-12 | 2355 |
| 27-Jul-12 | 2295 |
| 28-Jul-12 | 2244 |
| 29-Jul-12 | 2195 |
| 30-Jul-12 | 2142 |
| 31-Jul-12 | 2097 |
| 1-Aug-12 | 2064 |
| 2-Aug-12 | 2044 |
| 3-Aug-12 | 2022 |
| 4-Aug-12 | 2001 |
| 5-Aug-12 | 1985 |
| 6-Aug-12 | 1968 |
| 7-Aug-12 | 1948 |
| 8-Aug-12 | 1921 |
| 9-Aug-12 | 1891 |
| 10-Aug-12 | 1852 |
| 11-Aug-12 | 1803 |
| 12-Aug-12 | 1757 |
| 13-Aug-12 | 1723 |
| 14-Aug-12 | 1702 |
| 15-Aug-12 | 1690 |
| 16-Aug-12 | 1682 |
| 17-Aug-12 | 1665 |
| 18-Aug-12 | 1635 |
| 19-Aug-12 | 1596 |
| 20-Aug-12 | 1552 |
| 21-Aug-12 | 1515 |
| 22-Aug-12 | 1480 |
| 23-Aug-12 | 1454 |
| 24-Aug-12 | 1428 |
| 25-Aug-12 | 1400 |
| 26-Aug-12 | 1370 |
| 27-Aug-12 | 1342 |
| 28-Aug-12 | 1330 |
| 29-Aug-12 | 1330 |
| 30-Aug-12 | 1341 |
| 31-Aug-12 | 1349 |
| 1-Sep-12 | 1352 |
| 2-Sep-12 | 1343 |
| 3-Sep-12 | 1323 |
| 4-Sep-12 | 1307 |
| 5-Sep-12 | 1299 |
| 6-Sep-12 | 1300 |
| 7-Sep-12 | 1302 |
| 8-Sep-12 | 1303 |
| 9-Sep-12 | 1301 |
| 10-Sep-12 | 1304 |
| 11-Sep-12 | 1327 |
| 12-Sep-12 | 1346 |

| Date | Total Inflow |
|---|---|
| 13-Sep-12 | 1357 |
| 14-Sep-12 | 1354 |
| 15-Sep-12 | 1330 |
| 16-Sep-12 | 1278 |
| 17-Sep-12 | 1220 |
| 18-Sep-12 | 1168 |
| 19-Sep-12 | 1127 |
| 20-Sep-12 | 1092 |
| 21-Sep-12 | 1053 |
| 22-Sep-12 | 1028 |
| 23-Sep-12 | 1009 |
| 24-Sep-12 | 989 |
| 25-Sep-12 | 974 |
| 26-Sep-12 | 982 |
| 27-Sep-12 | 1004 |
| 28-Sep-12 | 1039 |
| 29-Sep-12 | 1090 |
| 30-Sep-12 | 1158 |
| 1-Oct-12 | 1230 |
| 2-Oct-12 | 1298 |
| 3-Oct-12 | 1359 |
| 4-Oct-12 | 1417 |
| 5-Oct-12 | 1477 |
| 6-Oct-12 | 1539 |
| 7-Oct-12 | 1607 |
| 8-Oct-12 | 1683 |
| 9-Oct-12 | 1765 |
| 10-Oct-12 | 1846 |
| 11-Oct-12 | 1931 |
| 12-Oct-12 | 2017 |
| 13-Oct-12 | 2105 |
| 14-Oct-12 | 2194 |
| 15-Oct-12 | 2282 |
| 16-Oct-12 | 2364 |
| 17-Oct-12 | 2429 |
| 18-Oct-12 | 2485 |
| 19-Oct-12 | 2533 |
| 20-Oct-12 | 2585 |
| 21-Oct-12 | 2646 |
| 22-Oct-12 | 2721 |
| 23-Oct-12 | 2798 |
| 24-Oct-12 | 2869 |
| 25-Oct-12 | 2933 |
| 26-Oct-12 | 2989 |
| 27-Oct-12 | 3042 |
| 28-Oct-12 | 3097 |
| 29-Oct-12 | 3154 |
| 30-Oct-12 | 3204 |
| 31-Oct-12 | 3243 |
| 1-Nov-12 | 3290 |
| 2-Nov-12 | 3343 |
| 3-Nov-12 | 3412 |
| 4-Nov-12 | 3503 |
| 5-Nov-12 | 3619 |
| 6-Nov-12 | 3736 |
| 7-Nov-12 | 3855 |
| 8-Nov-12 | 3963 |
| 9-Nov-12 | 4062 |
| 10-Nov-12 | 4158 |
| 11-Nov-12 | 4242 |
| 12-Nov-12 | 4318 |
| 13-Nov-12 | 4395 |
| 14-Nov-12 | 4467 |
| 15-Nov-12 | 4522 |
| 16-Nov-12 | 4566 |
| 17-Nov-12 | 4595 |
| 18-Nov-12 | 4607 |
| 19-Nov-12 | 4608 |
| 20-Nov-12 | 4603 |
| 21-Nov-12 | 4598 |
| 22-Nov-12 | 4591 |
| 23-Nov-12 | 4590 |
| 24-Nov-12 | 4584 |

| Date | Total Inflow |
|---|---|
| 25-Nov-12 | 4575 |
| 26-Nov-12 | 4568 |
| 27-Nov-12 | 4562 |
| 28-Nov-12 | 4552 |
| 29-Nov-12 | 4542 |
| 30-Nov-12 | 4531 |
| 1-Dec-12 | 4517 |
| 2-Dec-12 | 4505 |
| 3-Dec-12 | 4496 |
| 4-Dec-12 | 4490 |
| 5-Dec-12 | 4488 |
| 6-Dec-12 | 4490 |
| 7-Dec-12 | 4499 |
| 8-Dec-12 | 4509 |
| 9-Dec-12 | 4516 |
| 10-Dec-12 | 4519 |
| 11-Dec-12 | 4516 |
| 12-Dec-12 | 4513 |
| 13-Dec-12 | 4512 |
| 14-Dec-12 | 4512 |
| 15-Dec-12 | 4515 |
| 16-Dec-12 | 4521 |
| 17-Dec-12 | 4526 |
| 18-Dec-12 | 4532 |
| 19-Dec-12 | 4543 |
| 20-Dec-12 | 4554 |
| 21-Dec-12 | 4555 |
| 22-Dec-12 | 4551 |
| 23-Dec-12 | 4536 |
| 24-Dec-12 | 4504 |
| 25-Dec-12 | 4459 |
| 26-Dec-12 | 4413 |
| 27-Dec-12 | 4358 |
| 28-Dec-12 | 4305 |
| 29-Dec-12 | 4255 |
| 30-Dec-12 | 4205 |
| 31-Dec-12 | 4200 |

**Lake Manitoba Inflow Forecast**

**July22, 2011**

| Lake Manitoba<br>July 22, 2011<br>Inflow Forecast | |
|---|---|
| Date | Total Inflow (cfs) |
| 22-Jul-11 | 15978 |
| 23-Jul-11 | 14953 |
| 24-Jul-11 | 14202 |
| 25-Jul-11 | 13667 |
| 26-Jul-11 | 13263 |
| 27-Jul-11 | 12931 |
| 28-Jul-11 | 12639 |
| 29-Jul-11 | 12381 |
| 30-Jul-11 | 12149 |
| 31-Jul-11 | 11954 |
| 1-Aug-11 | 11790 |
| 2-Aug-11 | 11628 |
| 3-Aug-11 | 11477 |
| 4-Aug-11 | 11315 |
| 5-Aug-11 | 11138 |
| 6-Aug-11 | 10938 |
| 7-Aug-11 | 10747 |
| 8-Aug-11 | 10459 |
| 9-Aug-11 | 10167 |
| 10-Aug-11 | 9885 |
| 11-Aug-11 | 9586 |
| 12-Aug-11 | 9287 |
| 13-Aug-11 | 8990 |
| 14-Aug-11 | 8869 |
| 15-Aug-11 | 8833 |
| 16-Aug-11 | 8800 |
| 17-Aug-11 | 8775 |
| 18-Aug-11 | 8757 |
| 19-Aug-11 | 8748 |
| 20-Aug-11 | 8744 |
| 21-Aug-11 | 8736 |
| 22-Aug-11 | 8721 |
| 23-Aug-11 | 8697 |
| 24-Aug-11 | 8664 |
| 25-Aug-11 | 8623 |
| 26-Aug-11 | 8582 |
| 27-Aug-11 | 8540 |
| 28-Aug-11 | 8499 |
| 29-Aug-11 | 8457 |
| 30-Aug-11 | 8417 |
| 31-Aug-11 | 8380 |
| 1-Sep-11 | 8347 |
| 2-Sep-11 | 8318 |
| 3-Sep-11 | 8292 |
| 4-Sep-11 | 8269 |
| 5-Sep-11 | 8247 |
| 6-Sep-11 | 8225 |
| 7-Sep-11 | 8201 |
| 8-Sep-11 | 8174 |
| 9-Sep-11 | 8146 |
| 10-Sep-11 | 8118 |
| 11-Sep-11 | 8088 |
| 12-Sep-11 | 8055 |
| 13-Sep-11 | 8018 |
| 14-Sep-11 | 7975 |
| 15-Sep-11 | 7926 |
| 16-Sep-11 | 7873 |
| 17-Sep-11 | 7818 |
| 18-Sep-11 | 7761 |
| 19-Sep-11 | 7702 |
| 20-Sep-11 | 7641 |
| 21-Sep-11 | 7578 |
| 22-Sep-11 | 7515 |
| 23-Sep-11 | 7453 |
| 24-Sep-11 | 7394 |
| 25-Sep-11 | 7339 |
| 26-Sep-11 | 7288 |
| 27-Sep-11 | 7241 |

| Date | Total Inflow |
|---|---|
| 28-Sep-11 | 7197 |
| 29-Sep-11 | 7157 |
| 30-Sep-11 | 7118 |
| 1-Oct-11 | 7080 |
| 2-Oct-11 | 7040 |
| 3-Oct-11 | 6998 |
| 4-Oct-11 | 6952 |
| 5-Oct-11 | 6903 |
| 6-Oct-11 | 6851 |
| 7-Oct-11 | 6796 |
| 8-Oct-11 | 6737 |
| 9-Oct-11 | 6675 |
| 10-Oct-11 | 6614 |
| 11-Oct-11 | 6556 |
| 12-Oct-11 | 6502 |
| 13-Oct-11 | 6456 |
| 14-Oct-11 | 6418 |
| 15-Oct-11 | 6390 |
| 16-Oct-11 | 6371 |
| 17-Oct-11 | 6359 |
| 18-Oct-11 | 6351 |
| 19-Oct-11 | 6344 |
| 20-Oct-11 | 6336 |
| 21-Oct-11 | 6326 |
| 22-Oct-11 | 6314 |
| 23-Oct-11 | 6302 |
| 24-Oct-11 | 6295 |
| 25-Oct-11 | 6294 |
| 26-Oct-11 | 6305 |
| 27-Oct-11 | 6329 |
| 28-Oct-11 | 6365 |
| 29-Oct-11 | 6411 |
| 30-Oct-11 | 6463 |
| 31-Oct-11 | 6516 |
| 1-Nov-11 | 6566 |
| 2-Nov-11 | 6612 |
| 3-Nov-11 | 6654 |
| 4-Nov-11 | 6692 |
| 5-Nov-11 | 6725 |
| 6-Nov-11 | 6755 |
| 7-Nov-11 | 6780 |
| 8-Nov-11 | 6803 |
| 9-Nov-11 | 6825 |
| 10-Nov-11 | 6845 |
| 11-Nov-11 | 6865 |
| 12-Nov-11 | 6881 |
| 13-Nov-11 | 6892 |
| 14-Nov-11 | 6901 |
| 15-Nov-11 | 6909 |
| 16-Nov-11 | 6915 |
| 17-Nov-11 | 6920 |
| 18-Nov-11 | 6926 |
| 19-Nov-11 | 6932 |
| 20-Nov-11 | 6935 |
| 21-Nov-11 | 6937 |
| 22-Nov-11 | 6939 |
| 23-Nov-11 | 6939 |
| 24-Nov-11 | 6940 |
| 25-Nov-11 | 6940 |
| 26-Nov-11 | 6939 |
| 27-Nov-11 | 6939 |
| 28-Nov-11 | 6938 |
| 29-Nov-11 | 6934 |
| 30-Nov-11 | 6926 |
| 1-Dec-11 | 6916 |
| 2-Dec-11 | 6899 |
| 3-Dec-11 | 6877 |
| 4-Dec-11 | 6847 |
| 5-Dec-11 | 6809 |
| 6-Dec-11 | 6861 |
| 7-Dec-11 | 6820 |
| 8-Dec-11 | 6814 |
| 9-Dec-11 | 6808 |

| Date | Total Inflow |
|---|---|
| 10-Dec-11 | 6802 |
| 11-Dec-11 | 6797 |
| 12-Dec-11 | 6791 |
| 13-Dec-11 | 6780 |
| 14-Dec-11 | 6765 |
| 15-Dec-11 | 6739 |
| 16-Dec-11 | 6702 |
| 17-Dec-11 | 6654 |
| 18-Dec-11 | 6595 |
| 19-Dec-11 | 6530 |
| 20-Dec-11 | 6466 |
| 21-Dec-11 | 6403 |
| 22-Dec-11 | 6346 |
| 23-Dec-11 | 6294 |
| 24-Dec-11 | 6249 |
| 25-Dec-11 | 6210 |
| 26-Dec-11 | 6176 |
| 27-Dec-11 | 6145 |
| 28-Dec-11 | 6117 |
| 29-Dec-11 | 6089 |
| 30-Dec-11 | 6062 |
| 31-Dec-11 | 6036 |
| 1-Jan-12 | 4514 |
| 2-Jan-12 | 4505 |
| 3-Jan-12 | 4498 |
| 4-Jan-12 | 4491 |
| 5-Jan-12 | 4486 |
| 6-Jan-12 | 4481 |
| 7-Jan-12 | 4476 |
| 8-Jan-12 | 4472 |
| 9-Jan-12 | 4467 |
| 10-Jan-12 | 4460 |
| 11-Jan-12 | 4454 |
| 12-Jan-12 | 4447 |
| 13-Jan-12 | 4441 |
| 14-Jan-12 | 4437 |
| 15-Jan-12 | 4434 |
| 16-Jan-12 | 4432 |
| 17-Jan-12 | 4430 |
| 18-Jan-12 | 4427 |
| 19-Jan-12 | 4422 |
| 20-Jan-12 | 4417 |
| 21-Jan-12 | 4413 |
| 22-Jan-12 | 4410 |
| 23-Jan-12 | 4409 |
| 24-Jan-12 | 4409 |
| 25-Jan-12 | 4409 |
| 26-Jan-12 | 4409 |
| 27-Jan-12 | 4401 |
| 28-Jan-12 | 4394 |
| 29-Jan-12 | 4385 |
| 30-Jan-12 | 4374 |
| 31-Jan-12 | 4363 |
| 1-Feb-12 | 4351 |
| 2-Feb-12 | 4338 |
| 3-Feb-12 | 4323 |
| 4-Feb-12 | 4310 |
| 5-Feb-12 | 4297 |
| 6-Feb-12 | 4286 |
| 7-Feb-12 | 4278 |
| 8-Feb-12 | 4272 |
| 9-Feb-12 | 4269 |
| 10-Feb-12 | 4267 |
| 11-Feb-12 | 4266 |
| 12-Feb-12 | 4267 |
| 13-Feb-12 | 4268 |
| 14-Feb-12 | 4268 |
| 15-Feb-12 | 4268 |
| 16-Feb-12 | 4269 |
| 17-Feb-12 | 4271 |
| 18-Feb-12 | 4275 |
| 19-Feb-12 | 4282 |
| 20-Feb-12 | 4291 |

| Date | Total Inflow |
|---|---|
| 21-Feb-12 | 4302 |
| 22-Feb-12 | 4316 |
| 23-Feb-12 | 4335 |
| 24-Feb-12 | 4355 |
| 25-Feb-12 | 4379 |
| 26-Feb-12 | 4406 |
| 27-Feb-12 | 4436 |
| 28-Feb-12 | 4472 |
| 29-Feb-12 | 4513 |
| 1-Mar-12 | 4561 |
| 2-Mar-12 | 4613 |
| 3-Mar-12 | 4670 |
| 4-Mar-12 | 4731 |
| 5-Mar-12 | 4795 |
| 6-Mar-12 | 4864 |
| 7-Mar-12 | 4938 |
| 8-Mar-12 | 5019 |
| 9-Mar-12 | 5105 |
| 10-Mar-12 | 5192 |
| 11-Mar-12 | 5276 |
| 12-Mar-12 | 5356 |
| 13-Mar-12 | 5434 |
| 14-Mar-12 | 5509 |
| 15-Mar-12 | 5589 |
| 16-Mar-12 | 5674 |
| 17-Mar-12 | 5766 |
| 18-Mar-12 | 5864 |
| 19-Mar-12 | 5969 |
| 20-Mar-12 | 6075 |
| 21-Mar-12 | 6187 |
| 22-Mar-12 | 6310 |
| 23-Mar-12 | 6454 |
| 24-Mar-12 | 6601 |
| 25-Mar-12 | 6789 |
| 26-Mar-12 | 6976 |
| 27-Mar-12 | 7163 |
| 28-Mar-12 | 7353 |
| 29-Mar-12 | 7555 |
| 30-Mar-12 | 7795 |
| 31-Mar-12 | 8073 |
| 1-Apr-12 | 8382 |
| 2-Apr-12 | 8698 |
| 3-Apr-12 | 9125 |
| 4-Apr-12 | 9646 |
| 5-Apr-12 | 10158 |
| 6-Apr-12 | 10736 |
| 7-Apr-12 | 11519 |
| 8-Apr-12 | 12596 |
| 9-Apr-12 | 13770 |
| 10-Apr-12 | 14868 |
| 11-Apr-12 | 15878 |
| 12-Apr-12 | 16836 |
| 13-Apr-12 | 17719 |
| 14-Apr-12 | 18475 |
| 15-Apr-12 | 19339 |
| 16-Apr-12 | 20167 |
| 17-Apr-12 | 20726 |
| 18-Apr-12 | 20883 |
| 19-Apr-12 | 20857 |
| 20-Apr-12 | 20813 |
| 21-Apr-12 | 20798 |
| 22-Apr-12 | 20772 |
| 23-Apr-12 | 20662 |
| 24-Apr-12 | 20526 |
| 25-Apr-12 | 20248 |
| 26-Apr-12 | 19910 |
| 27-Apr-12 | 19597 |
| 28-Apr-12 | 19333 |
| 29-Apr-12 | 19081 |
| 30-Apr-12 | 18837 |
| 1-May-12 | 18567 |
| 2-May-12 | 18313 |
| 3-May-12 | 18087 |

| Date | Total Inflow |
|---|---|
| 4-May-12 | 17840 |
| 5-May-12 | 17603 |
| 6-May-12 | 17355 |
| 7-May-12 | 17122 |
| 8-May-12 | 16911 |
| 9-May-12 | 16734 |
| 10-May-12 | 16564 |
| 11-May-12 | 16422 |
| 12-May-12 | 16275 |
| 13-May-12 | 16151 |
| 14-May-12 | 16066 |
| 15-May-12 | 16010 |
| 16-May-12 | 15958 |
| 17-May-12 | 15878 |
| 18-May-12 | 15788 |
| 19-May-12 | 15637 |
| 20-May-12 | 15464 |
| 21-May-12 | 15270 |
| 22-May-12 | 15064 |
| 23-May-12 | 14811 |
| 24-May-12 | 14516 |
| 25-May-12 | 14172 |
| 26-May-12 | 13801 |
| 27-May-12 | 13413 |
| 28-May-12 | 12982 |
| 29-May-12 | 12577 |
| 30-May-12 | 12181 |
| 31-May-12 | 11796 |
| 1-Jun-12 | 11418 |
| 2-Jun-12 | 11078 |
| 3-Jun-12 | 10752 |
| 4-Jun-12 | 10457 |
| 5-Jun-12 | 10192 |
| 6-Jun-12 | 9971 |
| 7-Jun-12 | 9792 |
| 8-Jun-12 | 9639 |
| 9-Jun-12 | 9515 |
| 10-Jun-12 | 9395 |
| 11-Jun-12 | 9263 |
| 12-Jun-12 | 9113 |
| 13-Jun-12 | 8955 |
| 14-Jun-12 | 8790 |
| 15-Jun-12 | 8624 |
| 16-Jun-12 | 8458 |
| 17-Jun-12 | 8292 |
| 18-Jun-12 | 8104 |
| 19-Jun-12 | 7911 |
| 20-Jun-12 | 7717 |
| 21-Jun-12 | 7528 |
| 22-Jun-12 | 7337 |
| 23-Jun-12 | 7151 |
| 24-Jun-12 | 6956 |
| 25-Jun-12 | 6755 |
| 26-Jun-12 | 6542 |
| 27-Jun-12 | 6334 |
| 28-Jun-12 | 6141 |
| 29-Jun-12 | 5968 |
| 30-Jun-12 | 5810 |
| 1-Jul-12 | 5656 |
| 2-Jul-12 | 5500 |
| 3-Jul-12 | 5334 |
| 4-Jul-12 | 5159 |
| 5-Jul-12 | 4979 |
| 6-Jul-12 | 4797 |
| 7-Jul-12 | 4622 |
| 8-Jul-12 | 4460 |
| 9-Jul-12 | 4301 |
| 10-Jul-12 | 4139 |
| 11-Jul-12 | 3985 |
| 12-Jul-12 | 3837 |
| 13-Jul-12 | 3694 |
| 14-Jul-12 | 3558 |
| 15-Jul-12 | 3439 |

| Date | Total Inflow |
|---|---|
| 16-Jul-12 | 3327 |
| 17-Jul-12 | 3214 |
| 18-Jul-12 | 3097 |
| 19-Jul-12 | 2985 |
| 20-Jul-12 | 2875 |
| 21-Jul-12 | 2772 |
| 22-Jul-12 | 2671 |
| 23-Jul-12 | 2573 |
| 24-Jul-12 | 2488 |
| 25-Jul-12 | 2420 |
| 26-Jul-12 | 2355 |
| 27-Jul-12 | 2295 |
| 28-Jul-12 | 2244 |
| 29-Jul-12 | 2195 |
| 30-Jul-12 | 2142 |
| 31-Jul-12 | 2097 |
| 1-Aug-12 | 2064 |
| 2-Aug-12 | 2044 |
| 3-Aug-12 | 2022 |
| 4-Aug-12 | 2001 |
| 5-Aug-12 | 1985 |
| 6-Aug-12 | 1968 |
| 7-Aug-12 | 1948 |
| 8-Aug-12 | 1921 |
| 9-Aug-12 | 1891 |
| 10-Aug-12 | 1852 |
| 11-Aug-12 | 1803 |
| 12-Aug-12 | 1757 |
| 13-Aug-12 | 1723 |
| 14-Aug-12 | 1702 |
| 15-Aug-12 | 1690 |
| 16-Aug-12 | 1682 |
| 17-Aug-12 | 1665 |
| 18-Aug-12 | 1635 |
| 19-Aug-12 | 1596 |
| 20-Aug-12 | 1552 |
| 21-Aug-12 | 1515 |
| 22-Aug-12 | 1480 |
| 23-Aug-12 | 1454 |
| 24-Aug-12 | 1428 |
| 25-Aug-12 | 1400 |
| 26-Aug-12 | 1370 |
| 27-Aug-12 | 1342 |
| 28-Aug-12 | 1330 |
| 29-Aug-12 | 1330 |
| 30-Aug-12 | 1341 |
| 31-Aug-12 | 1349 |
| 1-Sep-12 | 1352 |
| 2-Sep-12 | 1343 |
| 3-Sep-12 | 1323 |
| 4-Sep-12 | 1307 |
| 5-Sep-12 | 1299 |
| 6-Sep-12 | 1300 |
| 7-Sep-12 | 1302 |
| 8-Sep-12 | 1303 |
| 9-Sep-12 | 1301 |
| 10-Sep-12 | 1304 |
| 11-Sep-12 | 1327 |
| 12-Sep-12 | 1346 |
| 13-Sep-12 | 1357 |
| 14-Sep-12 | 1354 |
| 15-Sep-12 | 1330 |
| 16-Sep-12 | 1278 |
| 17-Sep-12 | 1220 |
| 18-Sep-12 | 1168 |
| 19-Sep-12 | 1127 |
| 20-Sep-12 | 1092 |
| 21-Sep-12 | 1053 |
| 22-Sep-12 | 1028 |
| 23-Sep-12 | 1009 |
| 24-Sep-12 | 989 |
| 25-Sep-12 | 974 |
| 26-Sep-12 | 982 |

| Date | Total Inflow |
|---|---|
| 27-Sep-12 | 1004 |
| 28-Sep-12 | 1039 |
| 29-Sep-12 | 1090 |
| 30-Sep-12 | 1158 |
| 1-Oct-12 | 1230 |
| 2-Oct-12 | 1298 |
| 3-Oct-12 | 1359 |
| 4-Oct-12 | 1417 |
| 5-Oct-12 | 1477 |
| 6-Oct-12 | 1539 |
| 7-Oct-12 | 1607 |
| 8-Oct-12 | 1683 |
| 9-Oct-12 | 1765 |
| 10-Oct-12 | 1846 |
| 11-Oct-12 | 1931 |
| 12-Oct-12 | 2017 |
| 13-Oct-12 | 2105 |
| 14-Oct-12 | 2194 |
| 15-Oct-12 | 2282 |
| 16-Oct-12 | 2364 |
| 17-Oct-12 | 2429 |
| 18-Oct-12 | 2485 |
| 19-Oct-12 | 2533 |
| 20-Oct-12 | 2585 |
| 21-Oct-12 | 2646 |
| 22-Oct-12 | 2721 |
| 23-Oct-12 | 2798 |
| 24-Oct-12 | 2869 |
| 25-Oct-12 | 2933 |
| 26-Oct-12 | 2989 |
| 27-Oct-12 | 3042 |
| 28-Oct-12 | 3097 |
| 29-Oct-12 | 3154 |
| 30-Oct-12 | 3204 |
| 31-Oct-12 | 3243 |
| 1-Nov-12 | 3290 |
| 2-Nov-12 | 3343 |
| 3-Nov-12 | 3412 |
| 4-Nov-12 | 3503 |
| 5-Nov-12 | 3619 |
| 6-Nov-12 | 3736 |
| 7-Nov-12 | 3855 |
| 8-Nov-12 | 3963 |
| 9-Nov-12 | 4062 |
| 10-Nov-12 | 4158 |
| 11-Nov-12 | 4242 |
| 12-Nov-12 | 4318 |
| 13-Nov-12 | 4395 |
| 14-Nov-12 | 4467 |
| 15-Nov-12 | 4522 |
| 16-Nov-12 | 4566 |
| 17-Nov-12 | 4595 |
| 18-Nov-12 | 4607 |
| 19-Nov-12 | 4608 |
| 20-Nov-12 | 4603 |
| 21-Nov-12 | 4598 |
| 22-Nov-12 | 4591 |
| 23-Nov-12 | 4590 |
| 24-Nov-12 | 4584 |
| 25-Nov-12 | 4575 |
| 26-Nov-12 | 4568 |
| 27-Nov-12 | 4562 |
| 28-Nov-12 | 4552 |
| 29-Nov-12 | 4542 |
| 30-Nov-12 | 4531 |
| 1-Dec-12 | 4517 |
| 2-Dec-12 | 4505 |
| 3-Dec-12 | 4496 |
| 4-Dec-12 | 4490 |
| 5-Dec-12 | 4488 |
| 6-Dec-12 | 4490 |
| 7-Dec-12 | 4499 |
| 8-Dec-12 | 4509 |

| Date | Total Inflow |
|---|---|
| 9-Dec-12 | 4516 |
| 10-Dec-12 | 4519 |
| 11-Dec-12 | 4516 |
| 12-Dec-12 | 4513 |
| 13-Dec-12 | 4512 |
| 14-Dec-12 | 4512 |
| 15-Dec-12 | 4515 |
| 16-Dec-12 | 4521 |
| 17-Dec-12 | 4526 |
| 18-Dec-12 | 4532 |
| 19-Dec-12 | 4543 |
| 20-Dec-12 | 4554 |
| 21-Dec-12 | 4555 |
| 22-Dec-12 | 4551 |
| 23-Dec-12 | 4536 |
| 24-Dec-12 | 4504 |
| 25-Dec-12 | 4459 |
| 26-Dec-12 | 4413 |
| 27-Dec-12 | 4358 |
| 28-Dec-12 | 4305 |
| 29-Dec-12 | 4255 |
| 30-Dec-12 | 4205 |
| 31-Dec-12 | 4200 |

**Lake Manitoba Inflow Forecast**

**November 12, 2011**

| Lake Manitoba<br>Nov. 12, 2011<br>Inflow Forecast | |
|---|---|
| Date | Total Inflow (cfs) |
| 12-Nov-11 | 6693 |
| 13-Nov-11 | 6125 |
| 14-Nov-11 | 5482 |
| 15-Nov-11 | 5648 |
| 16-Nov-11 | 5111 |
| 17-Nov-11 | 4904 |
| 18-Nov-11 | 5353 |
| 19-Nov-11 | 5012 |
| 20-Nov-11 | 5329 |
| 21-Nov-11 | 5933 |
| 22-Nov-11 | 5669 |
| 23-Nov-11 | 5955 |
| 24-Nov-11 | 6215 |
| 25-Nov-11 | 6126 |
| 26-Nov-11 | 6454 |
| 27-Nov-11 | 6489 |
| 28-Nov-11 | 7056 |
| 29-Nov-11 | 8306 |
| 30-Nov-11 | 9321 |
| 1-Dec-11 | 10306 |
| 2-Dec-11 | 10977 |
| 3-Dec-11 | 10947 |
| 4-Dec-11 | 10331 |
| 5-Dec-11 | 9387 |
| 6-Dec-11 | 8248 |
| 7-Dec-11 | 7940 |
| 8-Dec-11 | 7861 |
| 9-Dec-11 | 8193 |
| 10-Dec-11 | 8865 |
| 11-Dec-11 | 8915 |
| 12-Dec-11 | 8586 |
| 13-Dec-11 | 8466 |
| 14-Dec-11 | 7773 |
| 15-Dec-11 | 7325 |
| 16-Dec-11 | 7360 |
| 17-Dec-11 | 7478 |
| 18-Dec-11 | 7362 |
| 19-Dec-11 | 7216 |
| 20-Dec-11 | 7310 |
| 21-Dec-11 | 7422 |
| 22-Dec-11 | 7395 |
| 23-Dec-11 | 7410 |
| 24-Dec-11 | 7264 |
| 25-Dec-11 | 7092 |
| 26-Dec-11 | 6977 |
| 27-Dec-11 | 6945 |
| 28-Dec-11 | 6910 |
| 29-Dec-11 | 6946 |
| 30-Dec-11 | 6861 |
| 31-Dec-11 | 6826 |
| 1-Jan-12 | 9749 |
| 2-Jan-12 | 9723 |
| 3-Jan-12 | 9813 |
| 4-Jan-12 | 9629 |
| 5-Jan-12 | 9535 |
| 6-Jan-12 | 9460 |
| 7-Jan-12 | 9401 |
| 8-Jan-12 | 9307 |
| 9-Jan-12 | 9246 |
| 10-Jan-12 | 9190 |
| 11-Jan-12 | 9285 |
| 12-Jan-12 | 9094 |
| 13-Jan-12 | 9182 |
| 14-Jan-12 | 9157 |
| 15-Jan-12 | 9171 |
| 16-Jan-12 | 9081 |
| 17-Jan-12 | 9184 |
| 18-Jan-12 | 9053 |

| Date | Total Inflow |
|---|---|
| 19-Jan-12 | 9027 |
| 20-Jan-12 | 8871 |
| 21-Jan-12 | 8680 |
| 22-Jan-12 | 8611 |
| 23-Jan-12 | 8699 |
| 24-Jan-12 | 8545 |
| 25-Jan-12 | 8523 |
| 26-Jan-12 | 8605 |
| 27-Jan-12 | 8636 |
| 28-Jan-12 | 8423 |
| 29-Jan-12 | 8273 |
| 30-Jan-12 | 8289 |
| 31-Jan-12 | 8265 |
| 1-Feb-12 | 8294 |
| 2-Feb-12 | 8342 |
| 3-Feb-12 | 8397 |
| 4-Feb-12 | 8440 |
| 5-Feb-12 | 8496 |
| 6-Feb-12 | 8489 |
| 7-Feb-12 | 8469 |
| 8-Feb-12 | 8403 |
| 9-Feb-12 | 8336 |
| 10-Feb-12 | 8257 |
| 11-Feb-12 | 8169 |
| 12-Feb-12 | 8123 |
| 13-Feb-12 | 8099 |
| 14-Feb-12 | 8117 |
| 15-Feb-12 | 8133 |
| 16-Feb-12 | 8101 |
| 17-Feb-12 | 8059 |
| 18-Feb-12 | 8033 |
| 19-Feb-12 | 7912 |
| 20-Feb-12 | 8065 |
| 21-Feb-12 | 8060 |
| 22-Feb-12 | 8035 |
| 23-Feb-12 | 8023 |
| 24-Feb-12 | 7849 |
| 25-Feb-12 | 8013 |
| 26-Feb-12 | 8020 |
| 27-Feb-12 | 8028 |
| 28-Feb-12 | 8159 |
| 29-Feb-12 | 8187 |
| 1-Mar-12 | 8152 |
| 2-Mar-12 | 8278 |
| 3-Mar-12 | 8289 |
| 4-Mar-12 | 8453 |
| 5-Mar-12 | 8441 |
| 6-Mar-12 | 8584 |
| 7-Mar-12 | 8549 |
| 8-Mar-12 | 8515 |
| 9-Mar-12 | 8453 |
| 10-Mar-12 | 8406 |
| 11-Mar-12 | 8578 |
| 12-Mar-12 | 8503 |
| 13-Mar-12 | 8505 |
| 14-Mar-12 | 8516 |
| 15-Mar-12 | 8528 |
| 16-Mar-12 | 8605 |
| 17-Mar-12 | 8699 |
| 18-Mar-12 | 8831 |
| 19-Mar-12 | 9077 |
| 20-Mar-12 | 9367 |
| 21-Mar-12 | 9564 |
| 22-Mar-12 | 9679 |
| 23-Mar-12 | 9808 |
| 24-Mar-12 | 9940 |
| 25-Mar-12 | 10098 |
| 26-Mar-12 | 10301 |
| 27-Mar-12 | 10550 |
| 28-Mar-12 | 10762 |
| 29-Mar-12 | 10838 |
| 30-Mar-12 | 10871 |
| 31-Mar-12 | 10991 |

| Date | Total Inflow |
|---|---|
| 1-Apr-12 | 11101 |
| 2-Apr-12 | 11251 |
| 3-Apr-12 | 11238 |
| 4-Apr-12 | 11108 |
| 5-Apr-12 | 11217 |
| 6-Apr-12 | 11380 |
| 7-Apr-12 | 11467 |
| 8-Apr-12 | 11592 |
| 9-Apr-12 | 11658 |
| 10-Apr-12 | 11608 |
| 11-Apr-12 | 11566 |
| 12-Apr-12 | 11105 |
| 13-Apr-12 | 11186 |
| 14-Apr-12 | 11077 |
| 15-Apr-12 | 10901 |
| 16-Apr-12 | 10827 |
| 17-Apr-12 | 10756 |
| 18-Apr-12 | 10511 |
| 19-Apr-12 | 10374 |
| 20-Apr-12 | 10390 |
| 21-Apr-12 | 9868 |
| 22-Apr-12 | 9808 |
| 23-Apr-12 | 9485 |
| 24-Apr-12 | 9437 |
| 25-Apr-12 | 9323 |
| 26-Apr-12 | 9398 |
| 27-Apr-12 | 9667 |
| 28-Apr-12 | 9742 |
| 29-Apr-12 | 9606 |
| 30-Apr-12 | 9638 |
| 1-May-12 | 9835 |
| 2-May-12 | 9809 |
| 3-May-12 | 10089 |
| 4-May-12 | 10683 |
| 5-May-12 | 10679 |
| 6-May-12 | 10508 |
| 7-May-12 | 10105 |
| 8-May-12 | 10095 |
| 9-May-12 | 9910 |
| 10-May-12 | 9185 |
| 11-May-12 | 9141 |
| 12-May-12 | 8599 |
| 13-May-12 | 7320 |
| 14-May-12 | 7201 |
| 15-May-12 | 8804 |
| 16-May-12 | 7970 |
| 17-May-12 | 8001 |
| 18-May-12 | 9068 |
| 19-May-12 | 9100 |
| 20-May-12 | 9290 |
| 21-May-12 | 9352 |
| 22-May-12 | 9687 |
| 23-May-12 | 10891 |
| 24-May-12 | 11358 |
| 25-May-12 | 10935 |
| 26-May-12 | 10634 |
| 27-May-12 | 11339 |
| 28-May-12 | 10478 |
| 29-May-12 | 10203 |
| 30-May-12 | 10458 |
| 31-May-12 | 10164 |
| 1-Jun-12 | 9830 |
| 2-Jun-12 | 9774 |
| 3-Jun-12 | 8981 |
| 4-Jun-12 | 8478 |
| 5-Jun-12 | 8647 |
| 6-Jun-12 | 9415 |
| 7-Jun-12 | 6968 |
| 8-Jun-12 | 7790 |
| 9-Jun-12 | 7097 |
| 10-Jun-12 | 8758 |
| 11-Jun-12 | 8592 |
| 12-Jun-12 | 8286 |

| Date | Total Inflow |
|---|---|
| 13-Jun-12 | 7856 |
| 14-Jun-12 | 8095 |
| 15-Jun-12 | 8060 |
| 16-Jun-12 | 8183 |
| 17-Jun-12 | 8939 |
| 18-Jun-12 | 9640 |
| 19-Jun-12 | 11304 |
| 20-Jun-12 | 9866 |
| 21-Jun-12 | 7254 |
| 22-Jun-12 | 7413 |
| 23-Jun-12 | 6669 |
| 24-Jun-12 | 6226 |
| 25-Jun-12 | 6785 |
| 26-Jun-12 | 9011 |
| 27-Jun-12 | 8317 |
| 28-Jun-12 | 8436 |
| 29-Jun-12 | 8602 |
| 30-Jun-12 | 8749 |
| 1-Jul-12 | 7927 |
| 2-Jul-12 | 6362 |
| 3-Jul-12 | 9152 |
| 4-Jul-12 | 7631 |
| 5-Jul-12 | 6277 |
| 6-Jul-12 | 6207 |
| 7-Jul-12 | 6337 |
| 8-Jul-12 | 5895 |
| 9-Jul-12 | 6159 |
| 10-Jul-12 | 5437 |
| 11-Jul-12 | 4176 |
| 12-Jul-12 | 3305 |
| 13-Jul-12 | 4861 |
| 14-Jul-12 | 4518 |
| 15-Jul-12 | 2694 |
| 16-Jul-12 | 4096 |
| 17-Jul-12 | 4990 |
| 18-Jul-12 | 6399 |
| 19-Jul-12 | 5887 |
| 20-Jul-12 | 5061 |
| 21-Jul-12 | 4721 |
| 22-Jul-12 | 5273 |
| 23-Jul-12 | 5661 |
| 24-Jul-12 | 6368 |
| 25-Jul-12 | 8055 |
| 26-Jul-12 | 8969 |
| 27-Jul-12 | 8056 |
| 28-Jul-12 | 7171 |
| 29-Jul-12 | 7509 |
| 30-Jul-12 | 7071 |
| 31-Jul-12 | 6792 |
| 1-Aug-12 | 7341 |
| 2-Aug-12 | 7954 |
| 3-Aug-12 | 7185 |
| 4-Aug-12 | 7305 |
| 5-Aug-12 | 5655 |
| 6-Aug-12 | 5234 |
| 7-Aug-12 | 5332 |
| 8-Aug-12 | 5713 |
| 9-Aug-12 | 7394 |
| 10-Aug-12 | 7117 |
| 11-Aug-12 | 7608 |
| 12-Aug-12 | 7440 |
| 13-Aug-12 | 6862 |
| 14-Aug-12 | 6851 |
| 15-Aug-12 | 7575 |
| 16-Aug-12 | 6446 |
| 17-Aug-12 | 5137 |
| 18-Aug-12 | 5520 |
| 19-Aug-12 | 6815 |
| 20-Aug-12 | 5501 |
| 21-Aug-12 | 5589 |
| 22-Aug-12 | 6319 |
| 23-Aug-12 | 5561 |
| 24-Aug-12 | 5740 |

| Date | Total Inflow |
|---|---|
| 25-Aug-12 | 5449 |
| 26-Aug-12 | 6344 |
| 27-Aug-12 | 6470 |
| 28-Aug-12 | 6460 |
| 29-Aug-12 | 6373 |
| 30-Aug-12 | 5493 |
| 31-Aug-12 | 6413 |
| 1-Sep-12 | 8181 |
| 2-Sep-12 | 5623 |
| 3-Sep-12 | 4346 |
| 4-Sep-12 | 5461 |
| 5-Sep-12 | 5292 |
| 6-Sep-12 | 2638 |
| 7-Sep-12 | 1591 |
| 8-Sep-12 | 1824 |
| 9-Sep-12 | 2725 |
| 10-Sep-12 | 4596 |
| 11-Sep-12 | 4393 |
| 12-Sep-12 | 3480 |
| 13-Sep-12 | 3127 |
| 14-Sep-12 | 5768 |
| 15-Sep-12 | 2870 |
| 16-Sep-12 | 1459 |
| 17-Sep-12 | 1638 |
| 18-Sep-12 | 1476 |
| 19-Sep-12 | 1496 |
| 20-Sep-12 | 1152 |
| 21-Sep-12 | 1215 |
| 22-Sep-12 | 2551 |
| 23-Sep-12 | 1563 |
| 24-Sep-12 | 2326 |
| 25-Sep-12 | 3652 |
| 26-Sep-12 | 4104 |
| 27-Sep-12 | 4299 |
| 28-Sep-12 | 4534 |
| 29-Sep-12 | 3209 |
| 30-Sep-12 | 4089 |
| 1-Oct-12 | 4018 |
| 2-Oct-12 | 3278 |
| 3-Oct-12 | 3767 |
| 4-Oct-12 | 2352 |
| 5-Oct-12 | 1780 |
| 6-Oct-12 | 1923 |
| 7-Oct-12 | 1912 |
| 8-Oct-12 | 2475 |
| 9-Oct-12 | 3966 |
| 10-Oct-12 | 3113 |
| 11-Oct-12 | 1465 |
| 12-Oct-12 | 1345 |
| 13-Oct-12 | 1018 |
| 14-Oct-12 | 792 |
| 15-Oct-12 | 2643 |
| 16-Oct-12 | 2388 |
| 17-Oct-12 | 2569 |
| 18-Oct-12 | 2028 |
| 19-Oct-12 | 2764 |
| 20-Oct-12 | 2686 |
| 21-Oct-12 | 3705 |
| 22-Oct-12 | 4168 |
| 23-Oct-12 | 4467 |
| 24-Oct-12 | 5149 |
| 25-Oct-12 | 6081 |
| 26-Oct-12 | 5470 |
| 27-Oct-12 | 5923 |
| 28-Oct-12 | 3594 |
| 29-Oct-12 | 4196 |
| 30-Oct-12 | 4222 |
| 31-Oct-12 | 4458 |
| 1-Nov-12 | 5532 |
| 2-Nov-12 | 5200 |
| 3-Nov-12 | 5702 |
| 4-Nov-12 | 5778 |
| 5-Nov-12 | 6208 |

| Date | Total Inflow |
|---|---|
| 6-Nov-12 | 5653 |
| 7-Nov-12 | 5351 |
| 8-Nov-12 | 6050 |
| 9-Nov-12 | 4729 |
| 10-Nov-12 | 4155 |
| 11-Nov-12 | 4069 |
| 12-Nov-12 | 3934 |
| 13-Nov-12 | 3787 |
| 14-Nov-12 | 3532 |
| 15-Nov-12 | 3234 |
| 16-Nov-12 | 2945 |
| 17-Nov-12 | 2626 |
| 18-Nov-12 | 2591 |
| 19-Nov-12 | 2494 |
| 20-Nov-12 | 2769 |
| 21-Nov-12 | 3425 |
| 22-Nov-12 | 3384 |
| 23-Nov-12 | 3592 |
| 24-Nov-12 | 3963 |
| 25-Nov-12 | 4110 |
| 26-Nov-12 | 4613 |
| 27-Nov-12 | 4699 |
| 28-Nov-12 | 4887 |
| 29-Nov-12 | 5248 |
| 30-Nov-12 | 5862 |
| 1-Dec-12 | 6222 |
| 2-Dec-12 | 6742 |
| 3-Dec-12 | 6496 |
| 4-Dec-12 | 5988 |
| 5-Dec-12 | 5023 |
| 6-Dec-12 | 4424 |
| 7-Dec-12 | 4302 |
| 8-Dec-12 | 4221 |
| 9-Dec-12 | 4424 |
| 10-Dec-12 | 4535 |
| 11-Dec-12 | 4693 |
| 12-Dec-12 | 4452 |
| 13-Dec-12 | 4165 |
| 14-Dec-12 | 3958 |
| 15-Dec-12 | 3627 |
| 16-Dec-12 | 3602 |
| 17-Dec-12 | 3676 |
| 18-Dec-12 | 3709 |
| 19-Dec-12 | 3856 |
| 20-Dec-12 | 4132 |
| 21-Dec-12 | 4458 |
| 22-Dec-12 | 4635 |
| 23-Dec-12 | 4630 |
| 24-Dec-12 | 4591 |
| 25-Dec-12 | 4628 |
| 26-Dec-12 | 4778 |
| 27-Dec-12 | 4962 |
| 28-Dec-12 | 5122 |
| 29-Dec-12 | 5262 |
| 30-Dec-12 | 5310 |
| 31-Dec-12 | 5305 |

**Lake Manitoba Inflow Forecast**

**March 11, 2012**

| Lake Manitoba Mar. 11, 2012 Inflow Forecast | | |
|---|---|---|
| Date | Total Inflow - Median (cfs) | Total Inflow - Wet (cfs) |
| 12-Mar-12 | 6377 | 7495 |
| 13-Mar-12 | 6688 | 7217 |
| 14-Mar-12 | 6842 | 7089 |
| 15-Mar-12 | 6784 | 6833 |
| 16-Mar-12 | 6881 | 6881 |
| 17-Mar-12 | 6906 | 6905 |
| 18-Mar-12 | 6912 | 6909 |
| 19-Mar-12 | 7126 | 7121 |
| 20-Mar-12 | 7197 | 7188 |
| 21-Mar-12 | 7046 | 7034 |
| 22-Mar-12 | 6820 | 6805 |
| 23-Mar-12 | 6591 | 6571 |
| 24-Mar-12 | 6284 | 6260 |
| 25-Mar-12 | 6438 | 6408 |
| 26-Mar-12 | 6675 | 6634 |
| 27-Mar-12 | 6980 | 6928 |
| 28-Mar-12 | 7283 | 7222 |
| 29-Mar-12 | 7513 | 7546 |
| 30-Mar-12 | 7742 | 7862 |
| 31-Mar-12 | 8044 | 8031 |
| 1-Apr-12 | 11868 | 11831 |
| 2-Apr-12 | 11921 | 11784 |
| 3-Apr-12 | 12046 | 11901 |
| 4-Apr-12 | 12151 | 11998 |
| 5-Apr-12 | 12108 | 11946 |
| 6-Apr-12 | 12288 | 12115 |
| 7-Apr-12 | 12431 | 12245 |
| 8-Apr-12 | 12802 | 12604 |
| 9-Apr-12 | 13014 | 12810 |
| 10-Apr-12 | 13218 | 13009 |
| 11-Apr-12 | 13671 | 13459 |
| 12-Apr-12 | 14112 | 13896 |
| 13-Apr-12 | 14027 | 13809 |
| 14-Apr-12 | 13814 | 13595 |
| 15-Apr-12 | 13443 | 13221 |
| 16-Apr-12 | 13048 | 12822 |
| 17-Apr-12 | 12782 | 12552 |
| 18-Apr-12 | 12679 | 12446 |
| 19-Apr-12 | 12820 | 13343 |
| 20-Apr-12 | 13035 | 14284 |
| 21-Apr-12 | 13032 | 14995 |
| 22-Apr-12 | 13201 | 15881 |
| 23-Apr-12 | 13143 | 16791 |
| 24-Apr-12 | 12799 | 18288 |
| 25-Apr-12 | 12622 | 19956 |
| 26-Apr-12 | 12027 | 21295 |
| 27-Apr-12 | 11437 | 22070 |
| 28-Apr-12 | 11888 | 22132 |
| 29-Apr-12 | 12142 | 21359 |
| 30-Apr-12 | 11763 | 20185 |
| 1-May-12 | 12179 | 18932 |
| 2-May-12 | 11907 | 17847 |
| 3-May-12 | 11494 | 16939 |
| 4-May-12 | 11686 | 16444 |
| 5-May-12 | 12306 | 16353 |
| 6-May-12 | 10750 | 16317 |
| 7-May-12 | 9543 | 16205 |
| 8-May-12 | 8074 | 16383 |
| 9-May-12 | 6033 | 16373 |
| 10-May-12 | 4844 | 16511 |
| 11-May-12 | 6047 | 16534 |
| 12-May-12 | 6465 | 16162 |
| 13-May-12 | 5100 | 15508 |
| 14-May-12 | 4890 | 15531 |
| 15-May-12 | 5209 | 15701 |
| 16-May-12 | 5090 | 16198 |
| 17-May-12 | 7025 | 16623 |
| 18-May-12 | 9767 | 16945 |

| Date | Total Inflow | |
|---|---|---|
| 19-May-12 | 10050 | 16842 |
| 20-May-12 | 9249 | 16968 |
| 21-May-12 | 10117 | 17328 |
| 22-May-12 | 9801 | 17930 |
| 23-May-12 | 9536 | 17473 |
| 24-May-12 | 11229 | 15923 |
| 25-May-12 | 12403 | 14507 |
| 26-May-12 | 10570 | 13214 |
| 27-May-12 | 8663 | 12711 |
| 28-May-12 | 9213 | 14134 |
| 29-May-12 | 9597 | 16975 |
| 30-May-12 | 11497 | 19384 |
| 31-May-12 | 13725 | 20912 |
| 1-Jun-12 | 14371 | 21601 |
| 2-Jun-12 | 13121 | 21380 |
| 3-Jun-12 | 12801 | 20403 |
| 4-Jun-12 | 12102 | 18523 |
| 5-Jun-12 | 12503 | 16725 |
| 6-Jun-12 | 14420 | 14258 |
| 7-Jun-12 | 16218 | 13065 |
| 8-Jun-12 | 16262 | 13941 |
| 9-Jun-12 | 15419 | 15840 |
| 10-Jun-12 | 15535 | 18286 |
| 11-Jun-12 | 16245 | 20052 |
| 12-Jun-12 | 15211 | 18179 |
| 13-Jun-12 | 13978 | 14201 |
| 14-Jun-12 | 12055 | 9665 |
| 15-Jun-12 | 9271 | 4784 |
| 16-Jun-12 | 6684 | 2254 |
| 17-Jun-12 | 6059 | 3093 |
| 18-Jun-12 | 6017 | 4640 |
| 19-Jun-12 | 5847 | 6656 |
| 20-Jun-12 | 5341 | 8588 |
| 21-Jun-12 | 4577 | 10011 |
| 22-Jun-12 | 4404 | 10728 |
| 23-Jun-12 | 6096 | 10895 |
| 24-Jun-12 | 8788 | 10288 |
| 25-Jun-12 | 9090 | 8180 |
| 26-Jun-12 | 9712 | 7752 |
| 27-Jun-12 | 11782 | 8893 |
| 28-Jun-12 | 10879 | 8630 |
| 29-Jun-12 | 9298 | 9085 |
| 30-Jun-12 | 9875 | 11941 |
| 1-Jul-12 | 10589 | 13121 |
| 2-Jul-12 | 9287 | 11440 |
| 3-Jul-12 | 9536 | 11499 |
| 4-Jul-12 | 10678 | 11412 |
| 5-Jul-12 | 10405 | 10571 |
| 6-Jul-12 | 8941 | 10089 |
| 7-Jul-12 | 7469 | 10993 |
| 8-Jul-12 | 4801 | 10601 |
| 9-Jul-12 | 2487 | 9985 |
| 10-Jul-12 | 2847 | 11234 |
| 11-Jul-12 | 2658 | 11717 |
| 12-Jul-12 | 1465 | 12056 |
| 13-Jul-12 | 3101 | 13696 |
| 14-Jul-12 | 3104 | 14270 |
| 15-Jul-12 | 2450 | 12374 |
| 16-Jul-12 | 1377 | 10422 |
| 17-Jul-12 | 196 | 9669 |
| 18-Jul-12 | -2543 | 9078 |
| 19-Jul-12 | -2699 | 9864 |
| 20-Jul-12 | -2743 | 10961 |
| 21-Jul-12 | -2857 | 12272 |
| 22-Jul-12 | -2189 | 12399 |
| 23-Jul-12 | -859 | 14110 |
| 24-Jul-12 | -622 | 15733 |
| 25-Jul-12 | 512 | 16472 |
| 26-Jul-12 | 3736 | 16424 |
| 27-Jul-12 | 7360 | 17064 |
| 28-Jul-12 | 10056 | 16670 |
| 29-Jul-12 | 13447 | 15971 |
| 30-Jul-12 | 13961 | 15438 |

| Date | Total Inflow | |
|---|---|---|
| 31-Jul-12 | 13816 | 15669 |
| 1-Aug-12 | 13943 | 14603 |
| 2-Aug-12 | 13849 | 11853 |
| 3-Aug-12 | 11742 | 9111 |
| 4-Aug-12 | 12736 | 7502 |
| 5-Aug-12 | 14149 | 5879 |
| 6-Aug-12 | 14983 | 4347 |
| 7-Aug-12 | 15809 | 1835 |
| 8-Aug-12 | 16783 | 455 |
| 9-Aug-12 | 14853 | -1028 |
| 10-Aug-12 | 11800 | -2424 |
| 11-Aug-12 | 7919 | -3746 |
| 12-Aug-12 | 5394 | -2764 |
| 13-Aug-12 | 4444 | -1435 |
| 14-Aug-12 | 4938 | 803 |
| 15-Aug-12 | 5949 | 1483 |
| 16-Aug-12 | 8775 | 2790 |
| 17-Aug-12 | 10138 | 4873 |
| 18-Aug-12 | 10088 | 5564 |
| 19-Aug-12 | 8275 | 5121 |
| 20-Aug-12 | 7308 | 6442 |
| 21-Aug-12 | 6019 | 7653 |
| 22-Aug-12 | 4876 | 8932 |
| 23-Aug-12 | 3248 | 9373 |
| 24-Aug-12 | 2031 | 9576 |
| 25-Aug-12 | -195 | 8316 |
| 26-Aug-12 | -1641 | 5799 |
| 27-Aug-12 | -3517 | 3579 |
| 28-Aug-12 | -4372 | 2475 |
| 29-Aug-12 | -2990 | 2011 |
| 30-Aug-12 | -1577 | 3221 |
| 31-Aug-12 | -1775 | 5044 |
| 1-Sep-12 | -162 | 3380 |
| 2-Sep-12 | 1669 | 1847 |
| 3-Sep-12 | 2812 | 798 |
| 4-Sep-12 | 3273 | -607 |
| 5-Sep-12 | 2054 | -1216 |
| 6-Sep-12 | -740 | -284 |
| 7-Sep-12 | -1430 | 437 |
| 8-Sep-12 | -729 | 1362 |
| 9-Sep-12 | -137 | 3420 |
| 10-Sep-12 | 1300 | 6116 |
| 11-Sep-12 | 3326 | 7519 |
| 12-Sep-12 | 2562 | 8876 |
| 13-Sep-12 | 147 | 9561 |
| 14-Sep-12 | -288 | 8791 |
| 15-Sep-12 | 1047 | 6924 |
| 16-Sep-12 | 2690 | 7135 |
| 17-Sep-12 | 4837 | 6856 |
| 18-Sep-12 | 6327 | 5512 |
| 19-Sep-12 | 6853 | 3566 |
| 20-Sep-12 | 7819 | 1374 |
| 21-Sep-12 | 6916 | -2062 |
| 22-Sep-12 | 5235 | -4903 |
| 23-Sep-12 | 4327 | -6951 |
| 24-Sep-12 | 4889 | -7950 |
| 25-Sep-12 | 4942 | -7737 |
| 26-Sep-12 | 6535 | -6915 |
| 27-Sep-12 | 7864 | -5491 |
| 28-Sep-12 | 8465 | -4654 |
| 29-Sep-12 | 6996 | -4107 |
| 30-Sep-12 | 3112 | -2957 |
| 1-Oct-12 | -640 | -667 |
| 2-Oct-12 | -2433 | 1481 |
| 3-Oct-12 | -3267 | 4404 |
| 4-Oct-12 | -3202 | 6985 |
| 5-Oct-12 | -1694 | 9085 |
| 6-Oct-12 | 1871 | 11268 |
| 7-Oct-12 | 4612 | 11342 |
| 8-Oct-12 | 8581 | 10573 |
| 9-Oct-12 | 12345 | 9794 |
| 10-Oct-12 | 15683 | 6205 |
| 11-Oct-12 | 15767 | 2249 |

| Date | Total Inflow | |
|---|---|---|
| 12-Oct-12 | 17177 | -193 |
| 13-Oct-12 | 17636 | -1372 |
| 14-Oct-12 | 18392 | -1130 |
| 15-Oct-12 | 20659 | 715 |
| 16-Oct-12 | 21884 | 1783 |
| 17-Oct-12 | 20722 | 3333 |
| 18-Oct-12 | 18205 | 4547 |
| 19-Oct-12 | 15114 | 4469 |
| 20-Oct-12 | 11986 | 4634 |
| 21-Oct-12 | 11051 | 3482 |
| 22-Oct-12 | 10769 | 2498 |
| 23-Oct-12 | 8490 | 2155 |
| 24-Oct-12 | 6643 | 2121 |
| 25-Oct-12 | 4257 | 4022 |
| 26-Oct-12 | 637 | 7588 |
| 27-Oct-12 | -2906 | 10479 |
| 28-Oct-12 | -4156 | 12039 |
| 29-Oct-12 | -5444 | 12293 |
| 30-Oct-12 | -6530 | 9674 |
| 31-Oct-12 | -5533 | 7081 |
| 1-Nov-12 | -3933 | 5030 |
| 2-Nov-12 | -1018 | 3664 |
| 3-Nov-12 | 2677 | 4648 |
| 4-Nov-12 | 6254 | 6171 |
| 5-Nov-12 | 7995 | 8797 |
| 6-Nov-12 | 9276 | 12074 |
| 7-Nov-12 | 10157 | 14150 |
| 8-Nov-12 | 9756 | 14893 |
| 9-Nov-12 | 9110 | 15906 |
| 10-Nov-12 | 10302 | 15371 |
| 11-Nov-12 | 11970 | 13736 |
| 12-Nov-12 | 12761 | 13146 |
| 13-Nov-12 | 13381 | 13614 |
| 14-Nov-12 | 13966 | 14804 |
| 15-Nov-12 | 13094 | 15864 |
| 16-Nov-12 | 12054 | 16377 |
| 17-Nov-12 | 11135 | 16534 |
| 18-Nov-12 | 10421 | 15610 |
| 19-Nov-12 | 9598 | 13772 |
| 20-Nov-12 | 9136 | 11987 |
| 21-Nov-12 | 8517 | 10563 |
| 22-Nov-12 | 8116 | 9746 |
| 23-Nov-12 | 7873 | 9433 |
| 24-Nov-12 | 8175 | 9400 |
| 25-Nov-12 | 8373 | 9408 |
| 26-Nov-12 | 7814 | 9343 |
| 27-Nov-12 | 7145 | 8899 |
| 28-Nov-12 | 7127 | 8189 |
| 29-Nov-12 | 6936 | 7678 |
| 30-Nov-12 | 6925 | 7466 |
| 1-Dec-12 | 7397 | 7692 |
| 2-Dec-12 | 7716 | 8151 |
| 3-Dec-12 | 7595 | 8557 |
| 4-Dec-12 | 7253 | 8968 |
| 5-Dec-12 | 6752 | 9430 |
| 6-Dec-12 | 6310 | 9789 |
| 7-Dec-12 | 6001 | 9847 |
| 8-Dec-12 | 5766 | 9733 |
| 9-Dec-12 | 5541 | 9538 |
| 10-Dec-12 | 5469 | 9388 |
| 11-Dec-12 | 5705 | 9156 |
| 12-Dec-12 | 5864 | 9124 |
| 13-Dec-12 | 5799 | 9345 |
| 14-Dec-12 | 5552 | 9465 |
| 15-Dec-12 | 5237 | 9430 |
| 16-Dec-12 | 5056 | 9416 |
| 17-Dec-12 | 5188 | 9123 |
| 18-Dec-12 | 5314 | 8754 |
| 19-Dec-12 | 5669 | 8635 |
| 20-Dec-12 | 6092 | 8411 |
| 21-Dec-12 | 6221 | 8237 |
| 22-Dec-12 | 5985 | 8466 |
| 23-Dec-12 | 5862 | 8944 |

| Date | Total Inflow | |
|---|---|---|
| 24-Dec-12 | 5812 | 9070 |
| 25-Dec-12 | 5933 | 9159 |
| 26-Dec-12 | 5983 | 9263 |
| 27-Dec-12 | 6252 | 9131 |
| 28-Dec-12 | 6468 | 8807 |
| 29-Dec-12 | 6737 | 8569 |
| 30-Dec-12 | 6938 | 8405 |
| 31-Dec-12 | 6861 | 8016 |

**Lake Manitoba Inflow Forecast**

**March 16, 2012**

Lake Manitoba Mar. 16, 2012 Inflow Forecast

| Date | Total Inflow (cfs) | Total Inflow - Wet (cfs) |
|---|---|---|
| 16-Mar-12 | 4689 | 5765 |
| 17-Mar-12 | 4697 | 5779 |
| 18-Mar-12 | 4709 | 5797 |
| 19-Mar-12 | 4714 | 5807 |
| 20-Mar-12 | 4740 | 5842 |
| 21-Mar-12 | 4733 | 5837 |
| 22-Mar-12 | 4746 | 5857 |
| 23-Mar-12 | 4780 | 5902 |
| 24-Mar-12 | 4822 | 5957 |
| 25-Mar-12 | 4856 | 6003 |
| 26-Mar-12 | 4924 | 6089 |
| 27-Mar-12 | 5002 | 6188 |
| 28-Mar-12 | 5064 | 6267 |
| 29-Mar-12 | 5120 | 6339 |
| 30-Mar-12 | 5198 | 6439 |
| 31-Mar-12 | 5291 | 6555 |
| 1-Apr-12 | 9055 | 10348 |
| 2-Apr-12 | 9125 | 10442 |
| 3-Apr-12 | 9208 | 10551 |
| 4-Apr-12 | 9269 | 10633 |
| 5-Apr-12 | 9341 | 10729 |
| 6-Apr-12 | 9381 | 10784 |
| 7-Apr-12 | 9424 | 10845 |
| 8-Apr-12 | 9499 | 10944 |
| 9-Apr-12 | 9618 | 11097 |
| 10-Apr-12 | 9714 | 11222 |
| 11-Apr-12 | 9837 | 11380 |
| 12-Apr-12 | 9926 | 11495 |
| 13-Apr-12 | 9908 | 11481 |
| 14-Apr-12 | 9812 | 11369 |
| 15-Apr-12 | 9794 | 11354 |
| 16-Apr-12 | 9789 | 11355 |
| 17-Apr-12 | 9806 | 11382 |
| 18-Apr-12 | 9874 | 11473 |
| 19-Apr-12 | 10013 | 11649 |
| 20-Apr-12 | 10031 | 11678 |
| 21-Apr-12 | 10066 | 11727 |
| 22-Apr-12 | 10074 | 11743 |
| 23-Apr-12 | 10017 | 11680 |
| 24-Apr-12 | 9998 | 11663 |
| 25-Apr-12 | 9924 | 11579 |
| 26-Apr-12 | 9750 | 11371 |
| 27-Apr-12 | 9578 | 11168 |
| 28-Apr-12 | 9422 | 10982 |
| 29-Apr-12 | 9222 | 10744 |
| 30-Apr-12 | 9199 | 10721 |
| 1-May-12 | 9234 | 10770 |
| 2-May-12 | 9196 | 10730 |
| 3-May-12 | 9261 | 10815 |
| 4-May-12 | 9387 | 10976 |
| 5-May-12 | 9407 | 11006 |
| 6-May-12 | 9325 | 10912 |
| 7-May-12 | 9334 | 10928 |
| 8-May-12 | 9305 | 10898 |
| 9-May-12 | 9230 | 10812 |
| 10-May-12 | 9042 | 10589 |
| 11-May-12 | 8978 | 10515 |
| 12-May-12 | 8680 | 10156 |
| 13-May-12 | 8541 | 9992 |
| 14-May-12 | 8479 | 9922 |
| 15-May-12 | 8450 | 9892 |
| 16-May-12 | 8400 | 9836 |
| 17-May-12 | 8316 | 9739 |
| 18-May-12 | 8254 | 9669 |
| 19-May-12 | 8198 | 9606 |
| 20-May-12 | 8159 | 9564 |
| 21-May-12 | 8138 | 9543 |
| 22-May-12 | 8097 | 9499 |

| Date | Total Inflow | |
|---|---|---|
| 23-May-12 | 8091 | 9497 |
| 24-May-12 | 8041 | 9442 |
| 25-May-12 | 7936 | 9319 |
| 26-May-12 | 7872 | 9245 |
| 27-May-12 | 7812 | 9178 |
| 28-May-12 | 7709 | 9057 |
| 29-May-12 | 7629 | 8964 |
| 30-May-12 | 7544 | 8866 |
| 31-May-12 | 7716 | 8742 |
| 1-Jun-12 | 7660 | 8693 |
| 2-Jun-12 | 7632 | 8674 |
| 3-Jun-12 | 7609 | 8662 |
| 4-Jun-12 | 7574 | 8635 |
| 5-Jun-12 | 7480 | 8540 |
| 6-Jun-12 | 7360 | 8416 |
| 7-Jun-12 | 7293 | 8351 |
| 8-Jun-12 | 7174 | 8226 |
| 9-Jun-12 | 7085 | 8135 |
| 10-Jun-12 | 7047 | 8105 |
| 11-Jun-12 | 6990 | 8052 |
| 12-Jun-12 | 6853 | 7905 |
| 13-Jun-12 | 6745 | 7791 |
| 14-Jun-12 | 6650 | 7692 |
| 15-Jun-12 | 6584 | 7627 |
| 16-Jun-12 | 6527 | 7573 |
| 17-Jun-12 | 6481 | 7532 |
| 18-Jun-12 | 6400 | 7449 |
| 19-Jun-12 | 6297 | 7339 |
| 20-Jun-12 | 6145 | 7171 |
| 21-Jun-12 | 6001 | 7012 |
| 22-Jun-12 | 5895 | 6898 |
| 23-Jun-12 | 5840 | 6845 |
| 24-Jun-12 | 5846 | 6864 |
| 25-Jun-12 | 5885 | 6924 |
| 26-Jun-12 | 5857 | 6903 |
| 27-Jun-12 | 5720 | 6750 |
| 28-Jun-12 | 5541 | 6547 |
| 29-Jun-12 | 5371 | 6352 |
| 30-Jun-12 | 5218 | 6179 |
| 1-Jul-12 | 5114 | 6065 |
| 2-Jul-12 | 5071 | 6024 |
| 3-Jul-12 | 5063 | 6026 |
| 4-Jul-12 | 4930 | 5875 |
| 5-Jul-12 | 4737 | 5651 |
| 6-Jul-12 | 4647 | 5551 |
| 7-Jul-12 | 4582 | 5483 |
| 8-Jul-12 | 4543 | 5445 |
| 9-Jul-12 | 4543 | 5455 |
| 10-Jul-12 | 4569 | 5498 |
| 11-Jul-12 | 4562 | 5499 |
| 12-Jul-12 | 4496 | 5428 |
| 13-Jul-12 | 4431 | 5359 |
| 14-Jul-12 | 4398 | 5327 |
| 15-Jul-12 | 4375 | 5309 |
| 16-Jul-12 | 4353 | 5292 |
| 17-Jul-12 | 4316 | 5255 |
| 18-Jul-12 | 4268 | 5206 |
| 19-Jul-12 | 4167 | 5090 |
| 20-Jul-12 | 4048 | 4951 |
| 21-Jul-12 | 3955 | 4845 |
| 22-Jul-12 | 3899 | 4784 |
| 23-Jul-12 | 3817 | 4691 |
| 24-Jul-12 | 3740 | 4603 |
| 25-Jul-12 | 3657 | 4507 |
| 26-Jul-12 | 3540 | 4370 |
| 27-Jul-12 | 3413 | 4218 |
| 28-Jul-12 | 3288 | 4069 |
| 29-Jul-12 | 3207 | 3975 |
| 30-Jul-12 | 3142 | 3901 |
| 31-Jul-12 | 3070 | 3818 |
| 1-Aug-12 | 2991 | 3726 |
| 2-Aug-12 | 2951 | 3683 |
| 3-Aug-12 | 2911 | 3640 |

| Date | Total Inflow | |
|---|---|---|
| 4-Aug-12 | 2900 | 3634 |
| 5-Aug-12 | 2929 | 3679 |
| 6-Aug-12 | 2936 | 3696 |
| 7-Aug-12 | 2898 | 3655 |
| 8-Aug-12 | 2843 | 3594 |
| 9-Aug-12 | 2761 | 3497 |
| 10-Aug-12 | 2652 | 3364 |
| 11-Aug-12 | 2589 | 3292 |
| 12-Aug-12 | 2526 | 3220 |
| 13-Aug-12 | 2466 | 3150 |
| 14-Aug-12 | 2398 | 3070 |
| 15-Aug-12 | 2345 | 3009 |
| 16-Aug-12 | 2320 | 2985 |
| 17-Aug-12 | 2319 | 2990 |
| 18-Aug-12 | 2296 | 2968 |
| 19-Aug-12 | 2279 | 2953 |
| 20-Aug-12 | 2250 | 2923 |
| 21-Aug-12 | 2184 | 2845 |
| 22-Aug-12 | 2126 | 2776 |
| 23-Aug-12 | 2067 | 2706 |
| 24-Aug-12 | 2013 | 2644 |
| 25-Aug-12 | 1996 | 2629 |
| 26-Aug-12 | 1968 | 2600 |
| 27-Aug-12 | 1989 | 2633 |
| 28-Aug-12 | 2027 | 2691 |
| 29-Aug-12 | 2017 | 2685 |
| 30-Aug-12 | 1966 | 2624 |
| 31-Aug-12 | 1950 | 2611 |
| 1-Sep-12 | 1930 | 2592 |
| 2-Sep-12 | 1914 | 2436 |
| 3-Sep-12 | 1981 | 2514 |
| 4-Sep-12 | 2064 | 2611 |
| 5-Sep-12 | 2136 | 2694 |
| 6-Sep-12 | 2186 | 2753 |
| 7-Sep-12 | 2228 | 2802 |
| 8-Sep-12 | 2289 | 2873 |
| 9-Sep-12 | 2370 | 2967 |
| 10-Sep-12 | 2453 | 3062 |
| 11-Sep-12 | 2498 | 3114 |
| 12-Sep-12 | 2566 | 3193 |
| 13-Sep-12 | 2607 | 3242 |
| 14-Sep-12 | 2602 | 3237 |
| 15-Sep-12 | 2596 | 3232 |
| 16-Sep-12 | 2628 | 3269 |
| 17-Sep-12 | 2656 | 3304 |
| 18-Sep-12 | 2653 | 3302 |
| 19-Sep-12 | 2642 | 3291 |
| 20-Sep-12 | 2608 | 3254 |
| 21-Sep-12 | 2547 | 3187 |
| 22-Sep-12 | 2498 | 3133 |
| 23-Sep-12 | 2526 | 3167 |
| 24-Sep-12 | 2589 | 3241 |
| 25-Sep-12 | 2626 | 3285 |
| 26-Sep-12 | 2630 | 3292 |
| 27-Sep-12 | 2642 | 3308 |
| 28-Sep-12 | 2615 | 3279 |
| 29-Sep-12 | 2584 | 3245 |
| 30-Sep-12 | 2583 | 3247 |
| 1-Oct-12 | 2613 | 3283 |
| 2-Oct-12 | 2611 | 3282 |
| 3-Oct-12 | 2610 | 3284 |
| 4-Oct-12 | 2642 | 3322 |
| 5-Oct-12 | 2686 | 3375 |
| 6-Oct-12 | 2739 | 3438 |
| 7-Oct-12 | 2831 | 3545 |
| 8-Oct-12 | 2881 | 3605 |
| 9-Oct-12 | 2892 | 3620 |
| 10-Oct-12 | 2910 | 3643 |
| 11-Oct-12 | 2941 | 3681 |
| 12-Oct-12 | 2970 | 3716 |
| 13-Oct-12 | 3045 | 3804 |
| 14-Oct-12 | 3149 | 3926 |
| 15-Oct-12 | 3244 | 4037 |

| Date | Total Inflow | |
|---|---|---|
| 16-Oct-12 | 3345 | 4155 |
| 17-Oct-12 | 3429 | 4252 |
| 18-Oct-12 | 3485 | 4319 |
| 19-Oct-12 | 3546 | 4389 |
| 20-Oct-12 | 3615 | 4470 |
| 21-Oct-12 | 3675 | 4542 |
| 22-Oct-12 | 3731 | 4607 |
| 23-Oct-12 | 3775 | 4659 |
| 24-Oct-12 | 3783 | 4670 |
| 25-Oct-12 | 3780 | 4669 |
| 26-Oct-12 | 3795 | 4689 |
| 27-Oct-12 | 3846 | 4748 |
| 28-Oct-12 | 3908 | 4821 |
| 29-Oct-12 | 4008 | 4937 |
| 30-Oct-12 | 4114 | 5059 |
| 31-Oct-12 | 4174 | 5130 |
| 1-Nov-12 | 4220 | 5184 |
| 2-Nov-12 | 4277 | 5252 |
| 3-Nov-12 | 4324 | 5308 |
| 4-Nov-12 | 4368 | 5360 |
| 5-Nov-12 | 4408 | 5407 |
| 6-Nov-12 | 4436 | 5442 |
| 7-Nov-12 | 4467 | 5480 |
| 8-Nov-12 | 4490 | 5507 |
| 9-Nov-12 | 4521 | 5545 |
| 10-Nov-12 | 4579 | 5613 |
| 11-Nov-12 | 4632 | 5677 |
| 12-Nov-12 | 4711 | 5768 |
| 13-Nov-12 | 4796 | 5867 |
| 14-Nov-12 | 4855 | 5937 |
| 15-Nov-12 | 4916 | 6009 |
| 16-Nov-12 | 4937 | 6035 |
| 17-Nov-12 | 4933 | 6033 |
| 18-Nov-12 | 4945 | 6049 |
| 19-Nov-12 | 4965 | 6074 |
| 20-Nov-12 | 4974 | 6087 |
| 21-Nov-12 | 4889 | 5992 |
| 22-Nov-12 | 4843 | 5943 |
| 23-Nov-12 | 4872 | 5979 |
| 24-Nov-12 | 4946 | 6067 |
| 25-Nov-12 | 5071 | 6213 |
| 26-Nov-12 | 5218 | 6384 |
| 27-Nov-12 | 5372 | 6563 |
| 28-Nov-12 | 5450 | 6656 |
| 29-Nov-12 | 5505 | 6722 |
| 30-Nov-12 | 5543 | 6769 |
| 1-Dec-12 | 5592 | 6829 |
| 2-Dec-12 | 5634 | 6880 |
| 3-Dec-12 | 5680 | 6936 |
| 4-Dec-12 | 5672 | 6930 |
| 5-Dec-12 | 5638 | 6895 |
| 6-Dec-12 | 5595 | 6848 |
| 7-Dec-12 | 5573 | 6826 |
| 8-Dec-12 | 5554 | 6807 |
| 9-Dec-12 | 5535 | 6788 |
| 10-Dec-12 | 5538 | 6794 |
| 11-Dec-12 | 5549 | 6809 |
| 12-Dec-12 | 5531 | 6792 |
| 13-Dec-12 | 5560 | 6828 |
| 14-Dec-12 | 5640 | 6923 |
| 15-Dec-12 | 5700 | 6994 |
| 16-Dec-12 | 5714 | 7013 |
| 17-Dec-12 | 5769 | 7079 |
| 18-Dec-12 | 5771 | 7084 |
| 19-Dec-12 | 5731 | 7041 |
| 20-Dec-12 | 5707 | 7017 |
| 21-Dec-12 | 5695 | 7006 |
| 22-Dec-12 | 5636 | 6942 |
| 23-Dec-12 | 5578 | 6880 |
| 24-Dec-12 | 5523 | 6820 |
| 25-Dec-12 | 5466 | 6758 |
| 26-Dec-12 | 5419 | 6707 |
| 27-Dec-12 | 5397 | 6685 |

| Date | Total Inflow | |
|---|---|---|
| 28-Dec-12 | 5396 | 6688 |
| 29-Dec-12 | 5388 | 6682 |
| 30-Dec-12 | 5391 | 6689 |
| 31-Dec-12 | 5391 | 6692 |

**Lake Manitoba Inflow Forecast**

**August 28, 2012**

Lake Manitoba Aug. 28, 2012 Inflow Forecast

| Date | Total Inflow - Median (cfs) | Total Inflow - Upper (cfs) | Total Inflow - Lower (cfs) |
|---|---|---|---|
| 1-Sep-12 | 2876 | 2972 | 2845 |
| 2-Sep-12 | 2890 | 3021 | 2841 |
| 3-Sep-12 | 2904 | 3070 | 2836 |
| 4-Sep-12 | 2919 | 3119 | 2832 |
| 5-Sep-12 | 2933 | 3169 | 2827 |
| 6-Sep-12 | 2948 | 3218 | 2823 |
| 7-Sep-12 | 2962 | 3267 | 2818 |
| 8-Sep-12 | 2976 | 3316 | 2814 |
| 9-Sep-12 | 2991 | 3365 | 2809 |
| 10-Sep-12 | 3005 | 3414 | 2805 |
| 11-Sep-12 | 3020 | 3463 | 2800 |
| 12-Sep-12 | 3034 | 3513 | 2795 |
| 13-Sep-12 | 3048 | 3562 | 2791 |
| 14-Sep-12 | 3063 | 3611 | 2786 |
| 15-Sep-12 | 3077 | 3660 | 2782 |
| 16-Sep-12 | 3092 | 3709 | 2777 |
| 17-Sep-12 | 3106 | 3758 | 2773 |
| 18-Sep-12 | 3121 | 3808 | 2768 |
| 19-Sep-12 | 3135 | 3857 | 2764 |
| 20-Sep-12 | 3149 | 3906 | 2759 |
| 21-Sep-12 | 3164 | 3955 | 2755 |
| 22-Sep-12 | 3178 | 4004 | 2750 |
| 23-Sep-12 | 3193 | 4053 | 2745 |
| 24-Sep-12 | 3207 | 4102 | 2741 |
| 25-Sep-12 | 3221 | 4152 | 2736 |
| 26-Sep-12 | 3236 | 4201 | 2732 |
| 27-Sep-12 | 3250 | 4250 | 2727 |
| 28-Sep-12 | 3286 | 4339 | 2723 |
| 29-Sep-12 | 3321 | 4429 | 2718 |
| 30-Sep-12 | 3357 | 4518 | 2714 |
| 1-Oct-12 | 3393 | 4607 | 2709 |
| 2-Oct-12 | 3429 | 4696 | 2705 |
| 3-Oct-12 | 3464 | 4786 | 2700 |
| 4-Oct-12 | 3500 | 4875 | 2695 |
| 5-Oct-12 | 3536 | 4964 | 2691 |
| 6-Oct-12 | 3571 | 5054 | 2686 |
| 7-Oct-12 | 3607 | 5143 | 2682 |
| 8-Oct-12 | 3643 | 5232 | 2677 |
| 9-Oct-12 | 3679 | 5321 | 2673 |
| 10-Oct-12 | 3714 | 5411 | 2668 |
| 11-Oct-12 | 3750 | 5500 | 2664 |
| 12-Oct-12 | 3786 | 5589 | 2659 |
| 13-Oct-12 | 3821 | 5679 | 2655 |
| 14-Oct-12 | 3857 | 5768 | 2650 |
| 15-Oct-12 | 3893 | 5857 | 2645 |
| 16-Oct-12 | 3929 | 5946 | 2641 |
| 17-Oct-12 | 3964 | 6036 | 2636 |
| 18-Oct-12 | 4000 | 6125 | 2632 |
| 19-Oct-12 | 4036 | 6214 | 2627 |
| 20-Oct-12 | 4071 | 6304 | 2623 |
| 21-Oct-12 | 4107 | 6393 | 2618 |
| 22-Oct-12 | 4143 | 6482 | 2614 |
| 23-Oct-12 | 4179 | 6571 | 2609 |
| 24-Oct-12 | 4214 | 6661 | 2605 |
| 25-Oct-12 | 4250 | 6750 | 2600 |
| 26-Oct-12 | 4286 | 6821 | 2607 |
| 27-Oct-12 | 4321 | 6893 | 2613 |
| 28-Oct-12 | 4357 | 6964 | 2620 |
| 29-Oct-12 | 4393 | 7036 | 2627 |
| 30-Oct-12 | 4429 | 7107 | 2634 |
| 31-Oct-12 | 4464 | 7179 | 2640 |
| 1-Nov-12 | 4500 | 7250 | 2647 |
| 2-Nov-12 | 4536 | 7321 | 2654 |
| 3-Nov-12 | 4571 | 7393 | 2660 |
| 4-Nov-12 | 4607 | 7464 | 2667 |
| 5-Nov-12 | 4643 | 7536 | 2680 |
| 6-Nov-12 | 4679 | 7607 | 2700 |
| 7-Nov-12 | 4714 | 7679 | 2730 |

| Date | Total Inflow | | |
|---|---|---|---|
| 8-Nov-12 | 4750 | 7750 | 2761 |
| 9-Nov-12 | 4804 | 7768 | 2831 |
| 10-Nov-12 | 4857 | 7786 | 2901 |
| 11-Nov-12 | 4911 | 7804 | 2972 |
| 12-Nov-12 | 4964 | 7821 | 3042 |
| 13-Nov-12 | 5018 | 7839 | 3112 |
| 14-Nov-12 | 5071 | 7857 | 3182 |
| 15-Nov-12 | 5125 | 7875 | 3253 |
| 16-Nov-12 | 5179 | 7893 | 3323 |
| 17-Nov-12 | 5232 | 7911 | 3393 |
| 18-Nov-12 | 5286 | 7929 | 3463 |
| 19-Nov-12 | 5339 | 7946 | 3534 |
| 20-Nov-12 | 5393 | 7964 | 3604 |
| 21-Nov-12 | 5446 | 7982 | 3674 |
| 22-Nov-12 | 5500 | 7990 | 3744 |
| 23-Nov-12 | 5554 | 7982 | 3814 |
| 24-Nov-12 | 5607 | 7964 | 3885 |
| 25-Nov-12 | 5661 | 7946 | 3955 |
| 26-Nov-12 | 5714 | 7929 | 4025 |
| 27-Nov-12 | 5768 | 7911 | 4095 |
| 28-Nov-12 | 5821 | 7893 | 4166 |
| 29-Nov-12 | 5875 | 7875 | 4236 |
| 30-Nov-12 | 5929 | 7857 | 4306 |
| 1-Dec-12 | 5982 | 7839 | 4376 |
| 2-Dec-12 | 6036 | 7821 | 4447 |
| 3-Dec-12 | 6089 | 7804 | 4517 |
| 4-Dec-12 | 6143 | 7786 | 4587 |
| 5-Dec-12 | 6196 | 7768 | 4657 |
| 6-Dec-12 | 6230 | 7750 | 4728 |
| 7-Dec-12 | 6252 | 7746 | 4798 |
| 8-Dec-12 | 6253 | 7741 | 4868 |
| 9-Dec-12 | 6255 | 7737 | 4938 |
| 10-Dec-12 | 6257 | 7733 | 5009 |
| 11-Dec-12 | 6259 | 7728 | 5079 |
| 12-Dec-12 | 6260 | 7724 | 5149 |
| 13-Dec-12 | 6262 | 7720 | 5219 |
| 14-Dec-12 | 6264 | 7715 | 5250 |
| 15-Dec-12 | 6266 | 7711 | 5270 |
| 16-Dec-12 | 6267 | 7707 | 5297 |
| 17-Dec-12 | 6269 | 7702 | 5300 |
| 18-Dec-12 | 6271 | 7698 | 5303 |
| 19-Dec-12 | 6273 | 7693 | 5307 |
| 20-Dec-12 | 6274 | 7689 | 5310 |
| 21-Dec-12 | 6276 | 7685 | 5314 |
| 22-Dec-12 | 6278 | 7680 | 5317 |
| 23-Dec-12 | 6280 | 7676 | 5320 |
| 24-Dec-12 | 6281 | 7672 | 5324 |
| 25-Dec-12 | 6283 | 7667 | 5327 |
| 26-Dec-12 | 6285 | 7663 | 5330 |
| 27-Dec-12 | 6287 | 7659 | 5334 |
| 28-Dec-12 | 6288 | 7654 | 5337 |
| 29-Dec-12 | 6290 | 7650 | 5340 |
| 30-Dec-12 | 6292 | 7646 | 5344 |
| 31-Dec-12 | 6293 | 7641 | 5347 |
| 1-Jan-13 | 6295 | 7637 | 5351 |
| 2-Jan-13 | 6297 | 7633 | 5354 |
| 3-Jan-13 | 6299 | 7628 | 5357 |
| 4-Jan-13 | 6300 | 7624 | 5361 |
| 5-Jan-13 | 6302 | 7620 | 5364 |
| 6-Jan-13 | 6304 | 7615 | 5367 |
| 7-Jan-13 | 6306 | 7611 | 5371 |
| 8-Jan-13 | 6307 | 7607 | 5374 |
| 9-Jan-13 | 6309 | 7602 | 5377 |
| 10-Jan-13 | 6311 | 7598 | 5381 |
| 11-Jan-13 | 6313 | 7593 | 5384 |
| 12-Jan-13 | 6314 | 7589 | 5388 |
| 13-Jan-13 | 6316 | 7585 | 5391 |
| 14-Jan-13 | 6318 | 7580 | 5394 |
| 15-Jan-13 | 6320 | 7576 | 5398 |
| 16-Jan-13 | 6321 | 7572 | 5401 |
| 17-Jan-13 | 6323 | 7567 | 5404 |
| 18-Jan-13 | 6325 | 7563 | 5408 |
| 19-Jan-13 | 6327 | 7559 | 5411 |

| Date | Total Inflow | | |
|---|---|---|---|
| 20-Jan-13 | 6328 | 7554 | 5414 |
| 21-Jan-13 | 6330 | 7550 | 5418 |
| 22-Jan-13 | 6332 | 7546 | 5421 |
| 23-Jan-13 | 6333 | 7541 | 5425 |
| 24-Jan-13 | 6335 | 7537 | 5428 |
| 25-Jan-13 | 6337 | 7533 | 5431 |
| 26-Jan-13 | 6339 | 7528 | 5435 |
| 27-Jan-13 | 6340 | 7524 | 5438 |
| 28-Jan-13 | 6342 | 7520 | 5441 |
| 29-Jan-13 | 6344 | 7515 | 5445 |
| 30-Jan-13 | 6346 | 7511 | 5448 |
| 31-Jan-13 | 6347 | 7507 | 5451 |
| 1-Feb-13 | 6349 | 7502 | 5455 |
| 2-Feb-13 | 6351 | 7498 | 5458 |
| 3-Feb-13 | 6353 | 7493 | 5462 |
| 4-Feb-13 | 6354 | 7489 | 5465 |
| 5-Feb-13 | 6356 | 7485 | 5468 |
| 6-Feb-13 | 6358 | 7480 | 5472 |
| 7-Feb-13 | 6360 | 7476 | 5475 |
| 8-Feb-13 | 6361 | 7472 | 5478 |
| 9-Feb-13 | 6363 | 7467 | 5482 |
| 10-Feb-13 | 6365 | 7463 | 5485 |
| 11-Feb-13 | 6367 | 7459 | 5489 |
| 12-Feb-13 | 6368 | 7454 | 5492 |
| 13-Feb-13 | 6370 | 7450 | 5495 |
| 14-Feb-13 | 6372 | 7446 | 5499 |
| 15-Feb-13 | 6373 | 7441 | 5502 |
| 16-Feb-13 | 6375 | 7437 | 5505 |
| 17-Feb-13 | 6377 | 7433 | 5509 |
| 18-Feb-13 | 6379 | 7428 | 5512 |
| 19-Feb-13 | 6380 | 7424 | 5515 |
| 20-Feb-13 | 6382 | 7420 | 5519 |
| 21-Feb-13 | 6384 | 7415 | 5522 |
| 22-Feb-13 | 6386 | 7411 | 5526 |
| 23-Feb-13 | 6387 | 7407 | 5529 |
| 24-Feb-13 | 6389 | 7402 | 5532 |
| 25-Feb-13 | 6391 | 7398 | 5536 |
| 26-Feb-13 | 6393 | 7393 | 5539 |
| 27-Feb-13 | 6394 | 7389 | 5542 |
| 28-Feb-13 | 6396 | 7385 | 5546 |
| 1-Mar-13 | 6398 | 7380 | 5549 |
| 2-Mar-13 | 6400 | 7376 | 5552 |
| 3-Mar-13 | 6401 | 7372 | 5556 |
| 4-Mar-13 | 6403 | 7367 | 5559 |
| 5-Mar-13 | 6405 | 7363 | 5563 |
| 6-Mar-13 | 6407 | 7359 | 5566 |
| 7-Mar-13 | 6408 | 7354 | 5569 |
| 8-Mar-13 | 6410 | 7350 | 5573 |
| 9-Mar-13 | 6412 | 7346 | 5576 |
| 10-Mar-13 | 6413 | 7341 | 5579 |
| 11-Mar-13 | 6415 | 7337 | 5583 |
| 12-Mar-13 | 6417 | 7333 | 5586 |
| 13-Mar-13 | 6419 | 7328 | 5589 |
| 14-Mar-13 | 6420 | 7324 | 5593 |
| 15-Mar-13 | 6422 | 7320 | 5596 |
| 16-Mar-13 | 6424 | 7315 | 5600 |
| 17-Mar-13 | 6426 | 7311 | 5603 |
| 18-Mar-13 | 6427 | 7307 | 5606 |
| 19-Mar-13 | 6429 | 7302 | 5610 |
| 20-Mar-13 | 6431 | 7298 | 5613 |
| 21-Mar-13 | 6433 | 7293 | 5616 |
| 22-Mar-13 | 6434 | 7289 | 5620 |
| 23-Mar-13 | 6436 | 7285 | 5623 |
| 24-Mar-13 | 6438 | 7280 | 5626 |
| 25-Mar-13 | 6440 | 7276 | 5630 |
| 26-Mar-13 | 6441 | 7272 | 5633 |
| 27-Mar-13 | 6443 | 7267 | 5637 |
| 28-Mar-13 | 6445 | 7263 | 5640 |
| 29-Mar-13 | 6447 | 7259 | 5643 |
| 30-Mar-13 | 6448 | 7254 | 5647 |
| 31-Mar-13 | 6450 | 7250 | 5650 |

**Lake Manitoba Inflow Forecast**

**October 4, 2012**

Lake Manitoba Oct. 4, 2012 Inflow Forecast

| Date | Total Inflow - Median (cfs) | Total Inflow - Upper (cfs) | Total Inflow - Lower (cfs) |
|---|---|---|---|
| 4-Oct-12 | 1078 | 4075 | -464 |
| 5-Oct-12 | 1104 | 4100 | -452 |
| 6-Oct-12 | 1130 | 4125 | -440 |
| 7-Oct-12 | 1156 | 4150 | -429 |
| 8-Oct-12 | 1182 | 4175 | -417 |
| 9-Oct-12 | 1208 | 4200 | -405 |
| 10-Oct-12 | 1234 | 4225 | -393 |
| 11-Oct-12 | 1260 | 4250 | -381 |
| 12-Oct-12 | 1286 | 4275 | -369 |
| 13-Oct-12 | 1312 | 4300 | -357 |
| 14-Oct-12 | 1338 | 4325 | -345 |
| 15-Oct-12 | 1364 | 4350 | -333 |
| 16-Oct-12 | 1390 | 4375 | -321 |
| 17-Oct-12 | 1416 | 4400 | -310 |
| 18-Oct-12 | 1442 | 4425 | -298 |
| 19-Oct-12 | 1468 | 4450 | -286 |
| 20-Oct-12 | 1494 | 4475 | -274 |
| 21-Oct-12 | 1519 | 4500 | -262 |
| 22-Oct-12 | 1545 | 4525 | -250 |
| 23-Oct-12 | 1571 | 4550 | -238 |
| 24-Oct-12 | 1597 | 4575 | -226 |
| 25-Oct-12 | 1623 | 4600 | -214 |
| 26-Oct-12 | 1649 | 4625 | -202 |
| 27-Oct-12 | 1675 | 4650 | -190 |
| 28-Oct-12 | 1701 | 4675 | -179 |
| 29-Oct-12 | 1727 | 4700 | -167 |
| 30-Oct-12 | 1753 | 4725 | -155 |
| 31-Oct-12 | 1779 | 4750 | -143 |
| 1-Nov-12 | 1805 | 4775 | -131 |
| 2-Nov-12 | 1831 | 4800 | -119 |
| 3-Nov-12 | 1857 | 4825 | -107 |
| 4-Nov-12 | 1883 | 4850 | -95 |
| 5-Nov-12 | 1909 | 4875 | -83 |
| 6-Nov-12 | 1935 | 4900 | -71 |
| 7-Nov-12 | 1961 | 4925 | -60 |
| 8-Nov-12 | 1987 | 4950 | -48 |
| 9-Nov-12 | 2013 | 4975 | -36 |
| 10-Nov-12 | 2039 | 5000 | -24 |
| 11-Nov-12 | 2065 | 5025 | -12 |
| 12-Nov-12 | 2091 | 5050 | 0 |
| 13-Nov-12 | 2117 | 5075 | 39 |
| 14-Nov-12 | 2143 | 5100 | 79 |
| 15-Nov-12 | 2169 | 5125 | 118 |
| 16-Nov-12 | 2195 | 5150 | 158 |
| 17-Nov-12 | 2221 | 5175 | 197 |
| 18-Nov-12 | 2247 | 5200 | 237 |
| 19-Nov-12 | 2273 | 5225 | 276 |
| 20-Nov-12 | 2299 | 5250 | 316 |
| 21-Nov-12 | 2325 | 5275 | 355 |
| 22-Nov-12 | 2351 | 5300 | 395 |
| 23-Nov-12 | 2377 | 5325 | 434 |
| 24-Nov-12 | 2403 | 5350 | 474 |
| 25-Nov-12 | 2429 | 5375 | 513 |
| 26-Nov-12 | 2455 | 5400 | 553 |
| 27-Nov-12 | 2481 | 5425 | 592 |
| 28-Nov-12 | 2506 | 5450 | 632 |
| 29-Nov-12 | 2532 | 5475 | 671 |
| 30-Nov-12 | 2558 | 5500 | 711 |
| 1-Dec-12 | 2584 | 5466 | 750 |
| 2-Dec-12 | 2610 | 5418 | 789 |
| 3-Dec-12 | 2636 | 5370 | 829 |
| 4-Dec-12 | 2662 | 5319 | 868 |
| 5-Dec-12 | 2688 | 5278 | 908 |
| 6-Dec-12 | 2714 | 5236 | 947 |
| 7-Dec-12 | 2740 | 5171 | 987 |
| 8-Dec-12 | 2766 | 5133 | 1026 |
| 9-Dec-12 | 2792 | 5081 | 1066 |
| 10-Dec-12 | 2818 | 5075 | 1105 |

| Date | Total Inflow | | |
|---|---|---|---|
| 11-Dec-12 | 2844 | 5039 | 1145 |
| 12-Dec-12 | 2870 | 5001 | 1184 |
| 13-Dec-12 | 2896 | 4957 | 1224 |
| 14-Dec-12 | 2922 | 4915 | 1263 |
| 15-Dec-12 | 2948 | 4875 | 1303 |
| 16-Dec-12 | 2974 | 4840 | 1342 |
| 17-Dec-12 | 3000 | 4823 | 1382 |
| 18-Dec-12 | 2947 | 4810 | 1421 |
| 19-Dec-12 | 2899 | 4770 | 1461 |
| 20-Dec-12 | 2866 | 4746 | 1500 |
| 21-Dec-12 | 2843 | 4731 | 1512 |
| 22-Dec-12 | 2798 | 4694 | 1460 |
| 23-Dec-12 | 2769 | 4674 | 1424 |
| 24-Dec-12 | 2740 | 4653 | 1389 |
| 25-Dec-12 | 2704 | 4625 | 1345 |
| 26-Dec-12 | 2668 | 4597 | 1302 |
| 27-Dec-12 | 2635 | 4572 | 1262 |
| 28-Dec-12 | 2604 | 4549 | 1224 |
| 29-Dec-12 | 2571 | 4525 | 1185 |
| 30-Dec-12 | 2540 | 4502 | 1147 |
| 31-Dec-12 | 2510 | 4481 | 1111 |
| 1-Jan-13 | 2491 | 4460 | 1384 |
| 2-Jan-13 | 2477 | 4444 | 1370 |
| 3-Jan-13 | 2473 | 4438 | 1349 |
| 4-Jan-13 | 2466 | 4430 | 1319 |
| 5-Jan-13 | 2457 | 4419 | 1310 |
| 6-Jan-13 | 2451 | 4411 | 1283 |
| 7-Jan-13 | 2443 | 4401 | 1261 |
| 8-Jan-13 | 2436 | 4392 | 1238 |
| 9-Jan-13 | 2429 | 4384 | 1206 |
| 10-Jan-13 | 2421 | 4374 | 1185 |
| 11-Jan-13 | 2411 | 4362 | 1167 |
| 12-Jan-13 | 2396 | 4345 | 1172 |
| 13-Jan-13 | 2382 | 4330 | 1165 |
| 14-Jan-13 | 2379 | 4326 | 1139 |
| 15-Jan-13 | 2374 | 4318 | 1124 |
| 16-Jan-13 | 2369 | 4311 | 1107 |
| 17-Jan-13 | 2362 | 4303 | 1089 |
| 18-Jan-13 | 2359 | 4298 | 1084 |
| 19-Jan-13 | 2354 | 4291 | 1075 |
| 20-Jan-13 | 2348 | 4284 | 1056 |
| 21-Jan-13 | 2344 | 4278 | 1036 |
| 22-Jan-13 | 2265 | 4197 | 1019 |
| 23-Jan-13 | 2252 | 4182 | 994 |
| 24-Jan-13 | 2232 | 4161 | 980 |
| 25-Jan-13 | 2202 | 4130 | 981 |
| 26-Jan-13 | 2180 | 4107 | 996 |
| 27-Jan-13 | 2178 | 4103 | 999 |
| 28-Jan-13 | 2165 | 4089 | 976 |
| 29-Jan-13 | 2155 | 4078 | 948 |
| 30-Jan-13 | 2165 | 4087 | 920 |
| 31-Jan-13 | 2189 | 4110 | 905 |
| 1-Feb-13 | 2257 | 4054 | 932 |
| 2-Feb-13 | 2239 | 4035 | 928 |
| 3-Feb-13 | 2211 | 4006 | 930 |
| 4-Feb-13 | 2209 | 4002 | 932 |
| 5-Feb-13 | 2210 | 4003 | 921 |
| 6-Feb-13 | 2214 | 4005 | 895 |
| 7-Feb-13 | 2220 | 4010 | 875 |
| 8-Feb-13 | 2201 | 3990 | 859 |
| 9-Feb-13 | 2191 | 3979 | 842 |
| 10-Feb-13 | 2199 | 3985 | 821 |
| 11-Feb-13 | 2189 | 3975 | 799 |
| 12-Feb-13 | 2187 | 3972 | 782 |
| 13-Feb-13 | 2199 | 3982 | 769 |
| 14-Feb-13 | 2187 | 3969 | 771 |
| 15-Feb-13 | 2161 | 3943 | 762 |
| 16-Feb-13 | 2158 | 3938 | 757 |
| 17-Feb-13 | 2164 | 3943 | 754 |
| 18-Feb-13 | 2166 | 3944 | 748 |
| 19-Feb-13 | 2150 | 3927 | 745 |
| 20-Feb-13 | 2137 | 3912 | 743 |
| 21-Feb-13 | 2126 | 3901 | 740 |

| Date | Total Inflow | | |
|---|---|---|---|
| 22-Feb-13 | 2110 | 3883 | 739 |
| 23-Feb-13 | 2113 | 3885 | 732 |
| 24-Feb-13 | 2096 | 3867 | 730 |
| 25-Feb-13 | 2114 | 3885 | 725 |
| 26-Feb-13 | 2105 | 3876 | 727 |
| 27-Feb-13 | 2091 | 3862 | 727 |
| 28-Feb-13 | 2095 | 3866 | 729 |
| 1-Mar-13 | 2371 | 4442 | 852 |
| 2-Mar-13 | 2382 | 4452 | 859 |
| 3-Mar-13 | 2385 | 4456 | 857 |
| 4-Mar-13 | 2389 | 4460 | 859 |
| 5-Mar-13 | 2402 | 4473 | 855 |
| 6-Mar-13 | 2408 | 4479 | 852 |
| 7-Mar-13 | 2420 | 4491 | 845 |
| 8-Mar-13 | 2427 | 4497 | 843 |
| 9-Mar-13 | 2418 | 4489 | 843 |
| 10-Mar-13 | 2405 | 4475 | 843 |
| 11-Mar-13 | 2428 | 4499 | 855 |
| 12-Mar-13 | 2435 | 4506 | 857 |
| 13-Mar-13 | 2427 | 4497 | 854 |
| 14-Mar-13 | 2423 | 4493 | 852 |
| 15-Mar-13 | 2451 | 4522 | 853 |
| 16-Mar-13 | 2448 | 4518 | 854 |
| 17-Mar-13 | 2449 | 4520 | 856 |
| 18-Mar-13 | 2425 | 4495 | 857 |
| 19-Mar-13 | 2456 | 4527 | 855 |
| 20-Mar-13 | 2546 | 4616 | 868 |
| 21-Mar-13 | 2647 | 4718 | 859 |
| 22-Mar-13 | 2802 | 4873 | 850 |
| 23-Mar-13 | 2865 | 4935 | 868 |
| 24-Mar-13 | 2902 | 4972 | 873 |
| 25-Mar-13 | 2959 | 5030 | 882 |
| 26-Mar-13 | 2981 | 5051 | 908 |
| 27-Mar-13 | 2997 | 5067 | 914 |
| 28-Mar-13 | 3037 | 5107 | 930 |
| 29-Mar-13 | 3044 | 5114 | 965 |

# APPENDIX A – ANNEX 2

# LAKE MANITOBA AND LAKE ST. MARTIN FORECAST FIGURES AND EMAILS

**Table A2-1**
**Summary of Lake Manitoba and Lake St. Martin Water Level and Discharge Forecasts Issued to MIT**

| | Figure Number | | | Type | Description | 30-Aug-11 | 20-Sep-11 | 11-Oct-11 | 8-Nov-11 | 1-Dec-11 | 5-Jan-12 | 19-Jan-12 | 31-Jan-12 | 10-Feb-12 | 14-Feb-12 | 22-Feb-12 | 24-Feb-12 | 13-Mar-12 | 5-Apr-12 | 10-Apr-12 | 12-Apr-12 | 30-Jun-12 | 31-Jul-12 | 15-Aug-12 | 31-Aug-12 | 30-Sep-12 | 12-Oct-12 | 31-Oct-12 | 30-Nov-12 | 31-Dec-12 | 31-Jan-13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Date of Forecast / Revision Number | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lake Manitoba | 1 | .1 | .1 | Water Level | Fairford Fully Open | RevA | | RevB | RevC | RevD | | RevE | | RevF | | RevG | | RevH | RevI | | | RevJ | RevK | RevL | RevM | RevN | RevO | RevP | RevQ | RevR | RevS |
| | | | .2 | Discharge | Fairford Fully Open | | | RevB | | | | RevE | | | | | | | | | | | | | | RevF | RevG | RevH | RevI | RevJ | RevK |
| Lake St. Martin | 2 | .1 | .1 | Water Level | 5000 cfs channel on Nov 1 - Early Ice Formation | RevA | RevB | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | .2 | Discharge | 5000 cfs channel on Nov 1 - Early Ice Formation | RevA | RevB | | | | | | | | | | | | | | | | | | | | | | | | |
| | | .2 | .1 | Water Level | 5000 cfs channel on Nov 1 - Normal Ice Formation | RevA | RevB | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | .2 | Discharge | 5000 cfs channel on Nov 1 - Normal Ice Formation | RevA | RevB | | | | | | | | | | | | | | | | | | | | | | | | |
| | | .3 | .1 | Water Level | 5000 cfs channel on Nov 1 - Late Ice Formation | RevA | RevB | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | .2 | Discharge | 5000 cfs channel on Nov 1 - Late Ice Formation | RevA | RevB | | | | | | | | | | | | | | | | | | | | | | | | |
| | | .4 | .1 | Water Level | 3/4 channel on Nov 1 - Early Ice Formation | | RevA | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | .2 | Discharge | 3/4 channel on Nov 1 - Early Ice Formation | | RevA | | | | | | | | | | | | | | | | | | | | | | | | |
| | | .5 | .1 | Water Level | 3/4 channel on Nov 1 - Normal Ice Formation | | RevA | | RevB | | | | | | | | | | | | | | | | | | | | | | |
| | | | .2 | Discharge | 3/4 channel on Nov 1 - Normal Ice Formation | | RevA | | RevB | | | | | | | | | | | | | | | | | | | | | | |
| | | .6 | .1 | Water Level | 3/4 channel on Nov 1 - Late Ice Formation | | RevA | | | RevB | | | | | | | | | | | | | | | | | | | | | |
| | | | .2 | Discharge | 3/4 channel on Nov 1 - Late Ice Formation | | RevA | | | RevB | | | | | | | | | | | | | | | | | | | | | |
| | | .7 | .1 | Water Level | 1/2 channel on Nov 1 - Early Ice Formation | | RevA | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | .2 | Discharge | 1/2 channel on Nov 1 - Early Ice Formation | | RevA | | | | | | | | | | | | | | | | | | | | | | | | |
| | | .8 | .1 | Water Level | 1/2 channel on Nov 1 - Normal Ice Formation | | RevA | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | .2 | Discharge | 1/2 channel on Nov 1 - Normal Ice Formation | | RevA | | | | | | | | | | | | | | | | | | | | | | | | |
| | | .9 | .1 | Water Level | 1/2 channel on Nov 1 - Late Ice Formation | | RevA | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | .2 | Discharge | 1/2 channel on Nov 1 - Late Ice Formation | | RevA | | | | | | | | | | | | | | | | | | | | | | | | |
| | | .10 | .1 | Water Level | Full channel on Dec 1 - Early Ice Formation | | RevA | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | .2 | Discharge | Full channel on Dec 1 - Early Ice Formation | | RevA | | | | | | | | | | | | | | | | | | | | | | | | |
| | | .11 | .1 | Water Level | Full channel on Dec 1 - Normal Ice Formation | | RevA | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | .2 | Discharge | Full channel on Dec 1 - Normal Ice Formation | | RevA | | | | | | | | | | | | | | | | | | | | | | | | |
| | | .12 | .1 | Water Level | Full channel on Dec 1 - Late Ice Formation | | RevA | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | .2 | Discharge | Full channel on Dec 1 - Late Ice Formation | | RevA | | | | | | | | | | | | | | | | | | | | | | | | |
| | | .13 | .1 | Water Level | Reach 1 channel in operation | | | | | | RevA | | RevB | RevC | RevD | RevE | | RevF | | RevG | RevH | RevI | RevJ | RevK | RevL | RevM | RevN | RevO | RevP | RevQ | RevR |
| | | | .2 | Discharge | Reach 1 channel in operation | | | | | | RevA | | RevB | RevC | RevD | RevE | | RevF | | RevG | RevH | RevI | RevJ | RevK | RevL | RevM | RevN | RevO | RevP | RevQ | RevR |
| | | | .2b | Discharge | Reach 1 channel in operation (Buffalo Creek) | | | | | | RevA | | RevB | RevC | | RevD | | | | | | | | | | | | | | | |
| | | .14 | .1 | Water Level | Temporarly closure of channel during ice breakup | | | | | | RevA | | | | | | | | | | | | | | | | | | | | |
| | | | .2 | Discharge | Temporarly closure of channel during ice breakup | | | | | | RevA | | | | | | | | | | | | | | | | | | | | |
| | | .15 | .1 | Water Level | Raising Reach 1 Sill Elevation | | | | | | | | | | | | RevA | | | | | | | | | | | | | | |
| | | | .2 | Discharge | Raising Reach 1 Sill Elevation | | | | | | | | | | | | RevA | | | | | | | | | | | | | | |
| | | | .2b | Discharge | Raising Reach 1 Sill Elevation (Buffalo Creek) | | | | | | | | | | | | RevA | | | | | | | | | | | | | | |

**Lake Manitoba Forecast**
**Correspondence and Figures**

**August 30, 2011**

## Garrett Wellwood

---

**From:** Patrice Leclercq [PLeclercq@kgsgroup.com]
**Sent:** Thursday, February 28, 2013 3:47 PM
**To:** 'Patrice Leclercq'
**Subject:** Copy of Dauphin River Discharges below Buffalo Creek Confluence

**From**: Brian Bodnaruk <BBodnaruk@kgsgroup.com>
**To**: RCarson@kgsgroup.com <RCarson@kgsgroup.com>
**Cc**: CSiepman@kgsgroup.com <CSiepman@kgsgroup.com>; Richardson, Ron (MIT); BSmith@kgsgroup.com <BSmith@kgsgroup.com>
**Sent**: Tue Aug 30 16:18:19 2011
**Subject**: Dauphin River Discharges below Buffalo Creek Confluence

The three ice freeze-up scenarios with ice jam formation at the DRFN shown below were routed through Lake Manitoba and Lake St Martin. The 3 scenarios included:

| CONDITION | DATE | TOTAL DISCHARGE | DAUPHIN RIVER | BUFFALO CREEK |
|---|---|---|---|---|
| • Early Freeze-up | Nov 10 | 17,620 cfs | 14,720 cfs | 2,900 CFS |
| • Normal Freeze-up | Nov 25 | 14,160 cfs | 11,790 cfs | 2,370 cfs |
| • Late Freeze-up | Dec 10 | 12,900 cfs | 10,750 cfs | 2,150 cfs |

For each scenario, freeze-up of the diversion channel was assumed to occur one week prior to the date of the ice jam formation date at the DRFN and the ice jam was assumed to reach LSM three weeks after freeze-up at the DRFN. i.e. for early freeze-up case the diversion channel was assumed to be ice covered on Nov 3 and the ice cover on the Dauphin R was assumed to reach LSM on Dec 1.

Complete charts showing daily water levels and discharges for each scenario will be sent shortly.

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bbodnaruk@kgsgroup.com

## Garrett Wellwood

**From:** Patrice Leclercq [PLeclercq@kgsgroup.com]
**Sent:** Thursday, February 28, 2013 3:47 PM
**To:** 'Patrice Leclercq'
**Subject:** Copy of FW: Dauphin River Discharges below Buffalo Creek Confluence
**Attachments:** Figure 1.1.1_RevA.pdf; Figure 2.1.1_RevA.pdf; Figure 2.1.2_RevA.pdf; Figure 2.2.1_RevA.pdf; Figure 2.2.2_RevA.pdf; Figure 2.3.1_RevA.pdf; Figure 2.3.2_RevA.pdf

**From:** Brian Bodnaruk [mailto:BBodnaruk@kgsgroup.com]
**Sent:** Tuesday, August 30, 2011 6:53 PM
**To:** 'Rick Carson'
**Cc:** 'Richardson, Ron (MIT)'; CSiepman@kgsgroup.com; BSmith@kgsgroup.com; PLeclercq@kgsgroup.com
**Subject:** RE: Dauphin River Discharges below Buffalo Creek Confluence

The declining flows are related to the water level on Lake St Martin. Delaying the date of the freeze-up allows the level on LSM to fall with high outflows under open water conditions. It also is affected by the assumption of an ice cover on the Diversion channel when the ice cover forms at the DRFN.

The attached Figures show water levels and flows on Lake Manitoba and LSM as well as discharge from LSM for the “Early”, “Normal” and “Late” freeze-up date scenarios

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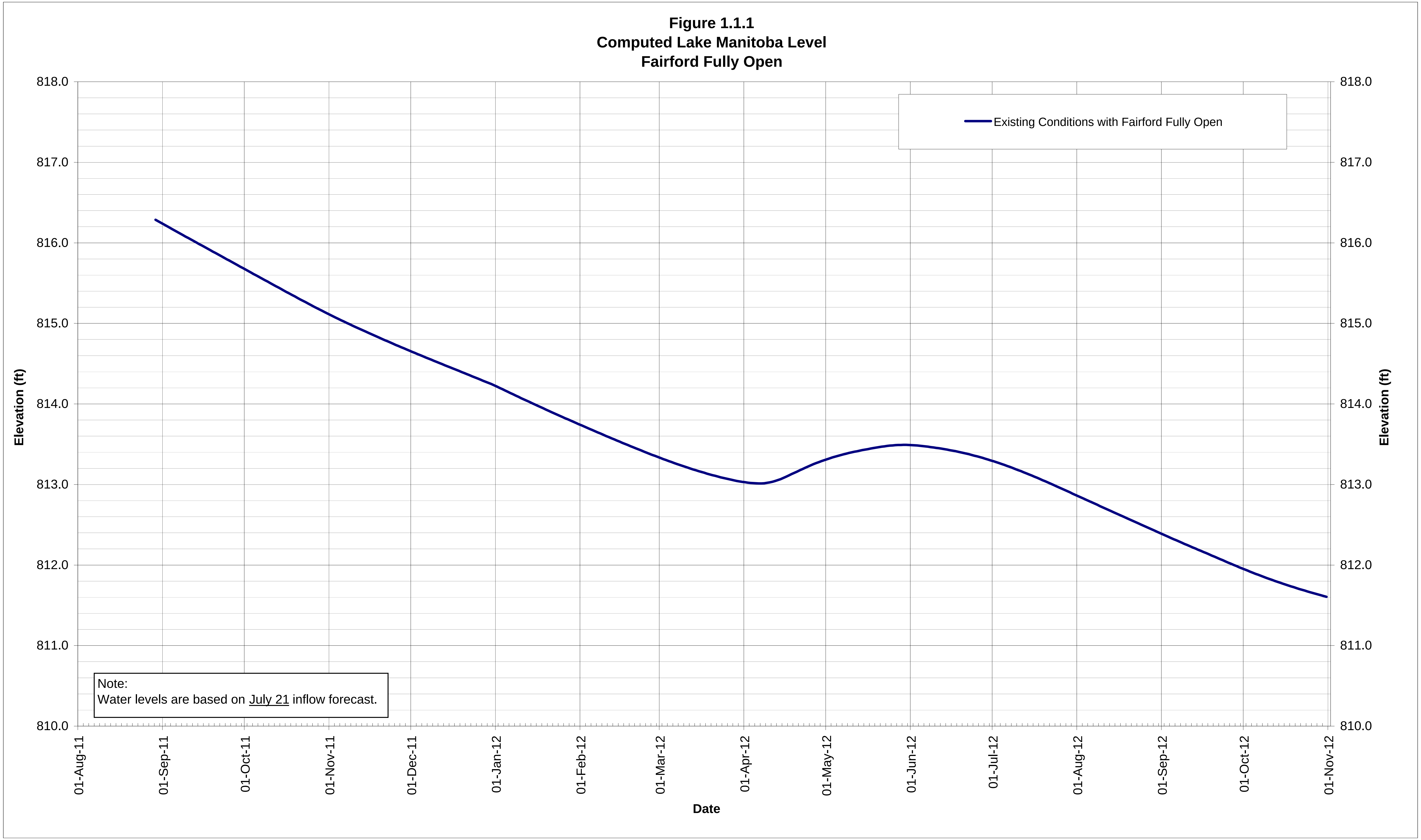


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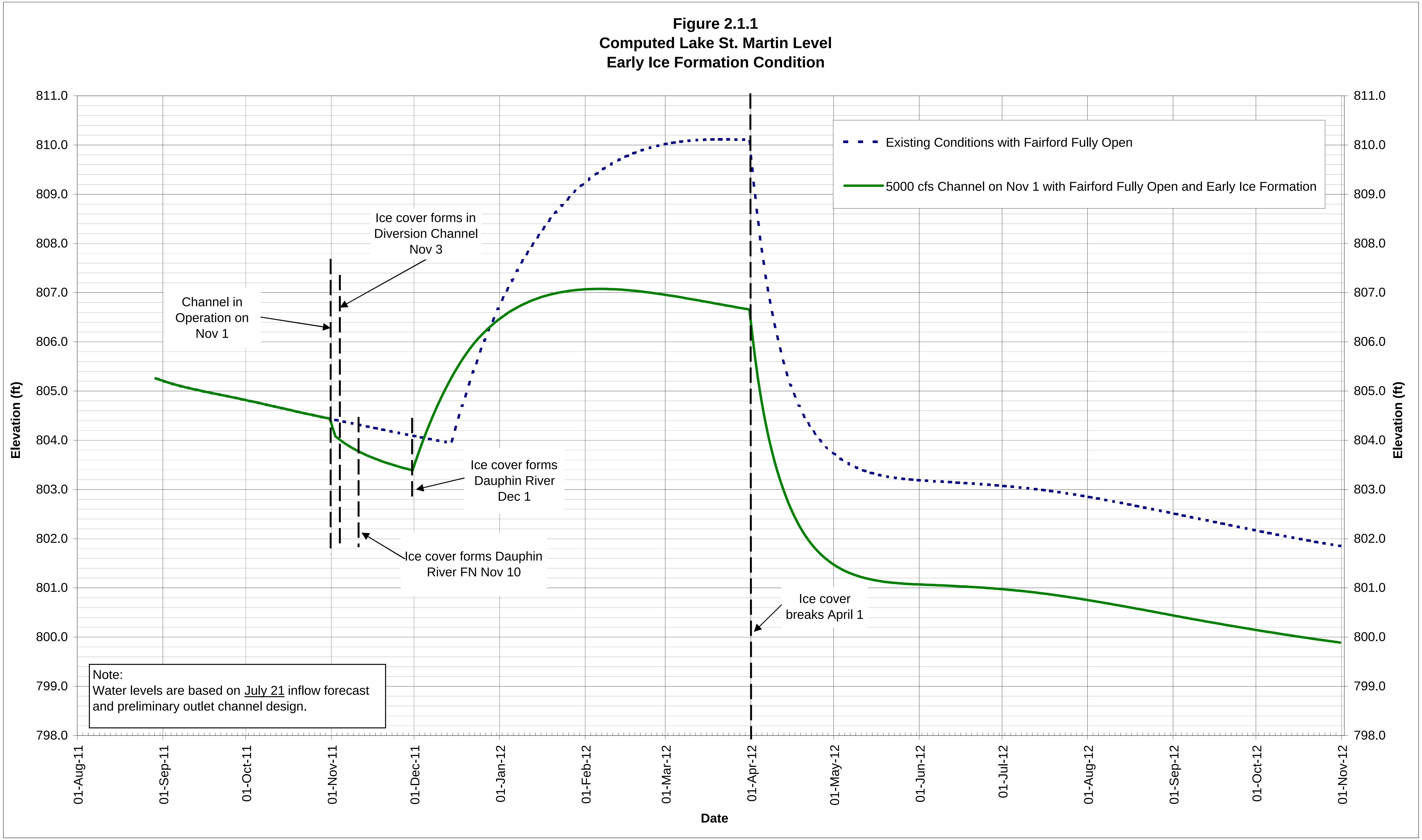


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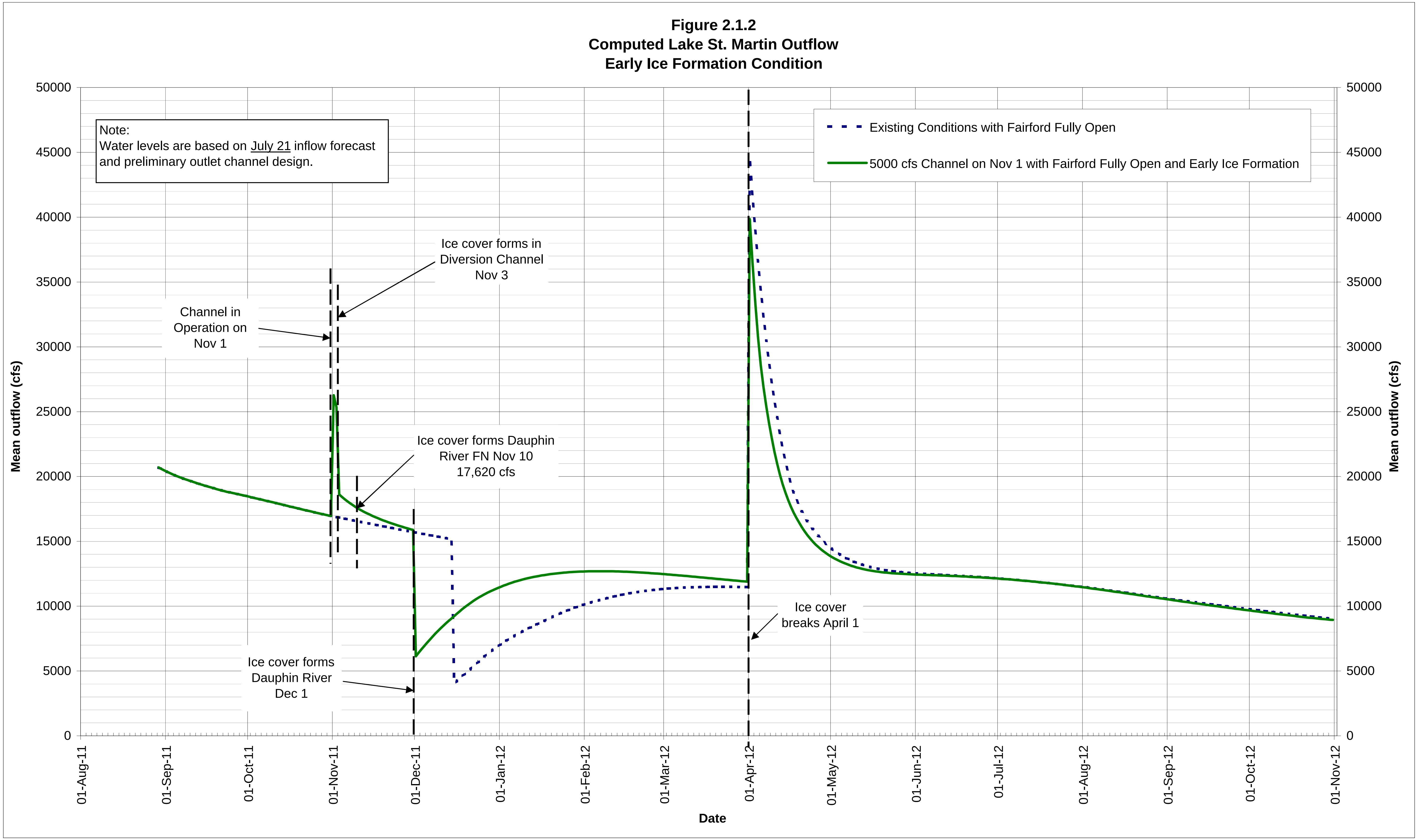


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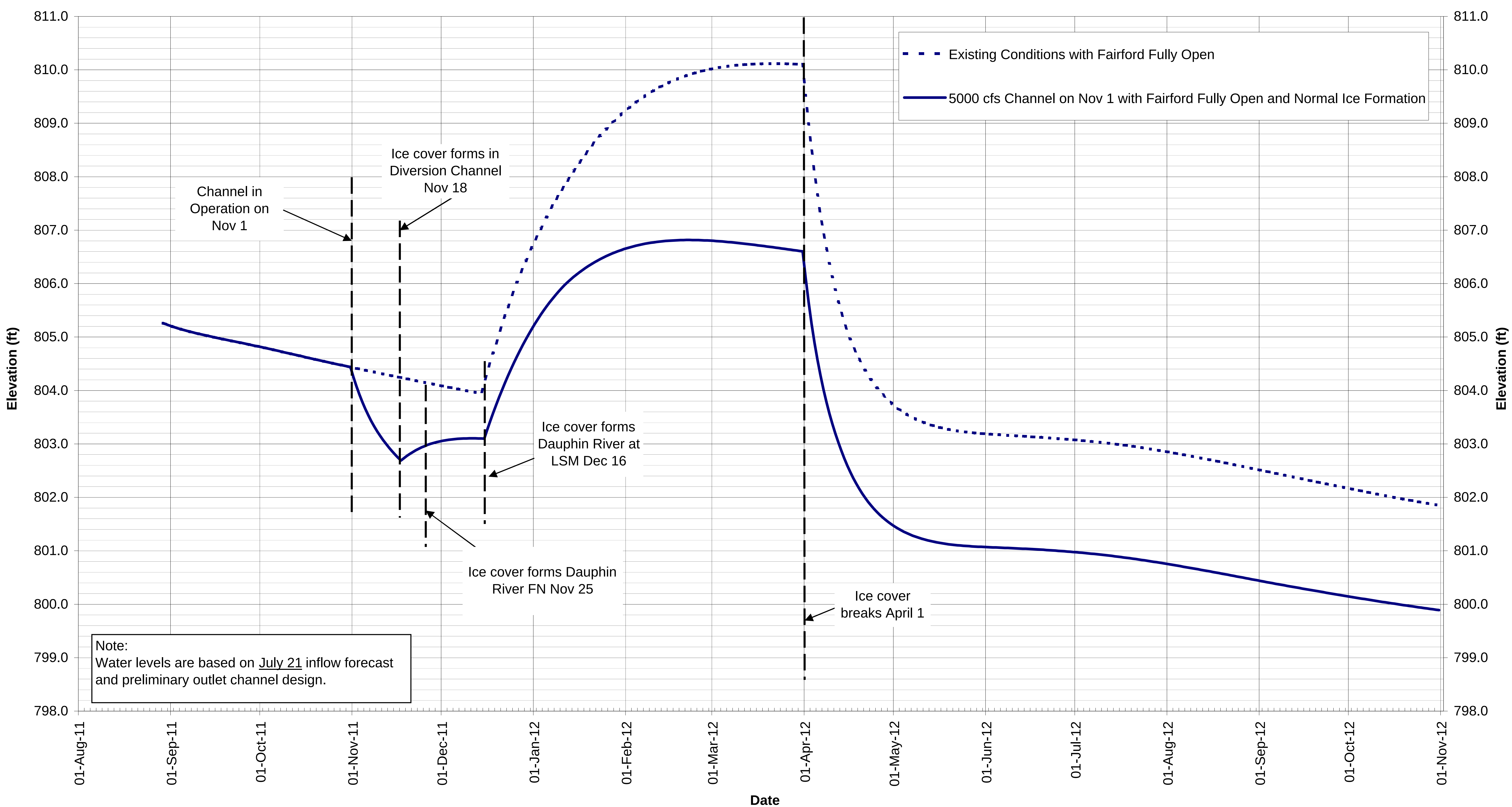
**Figure 2.2.1**
**Computed Lake St. Martin Level**
**Normal Ice Formation Condition**

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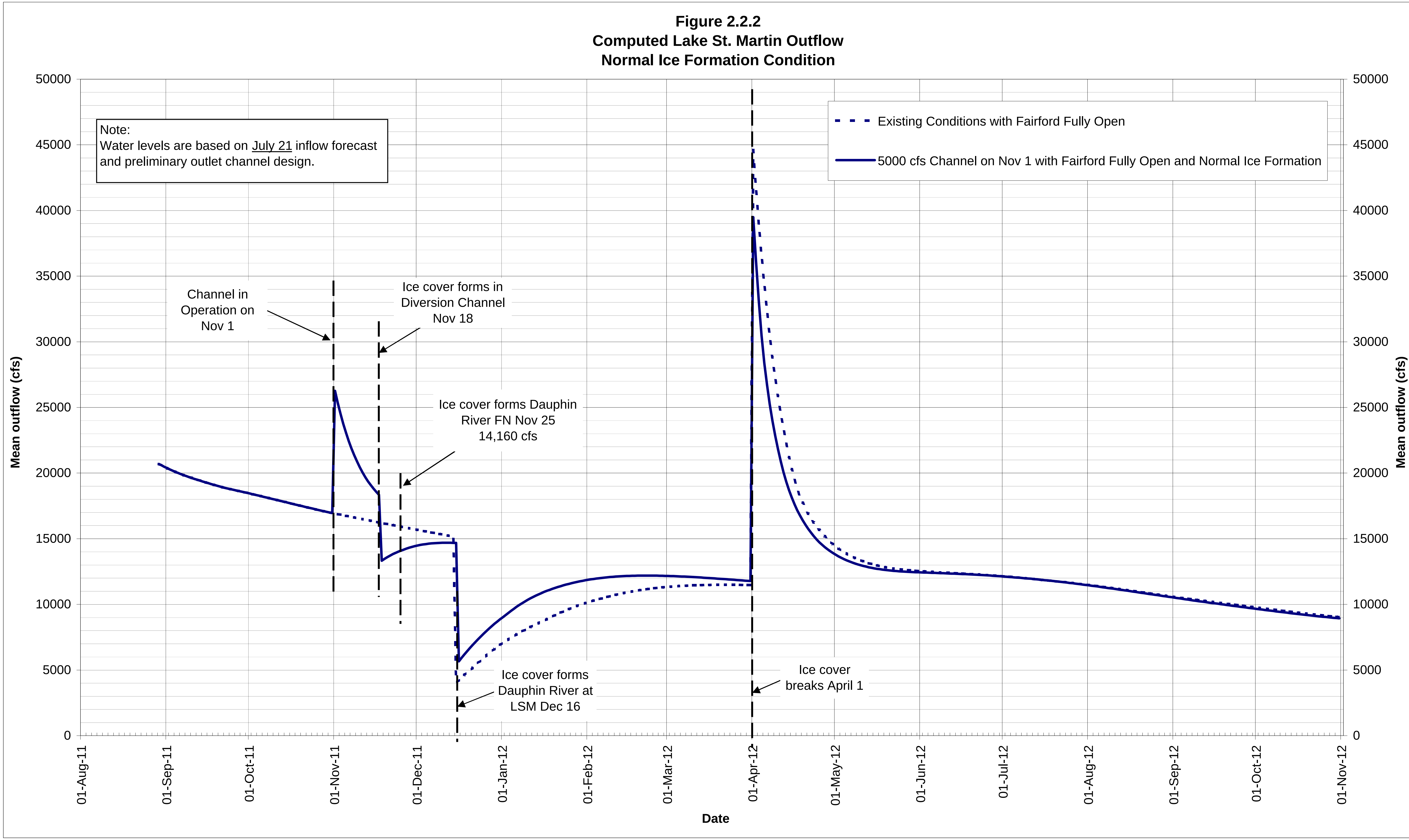


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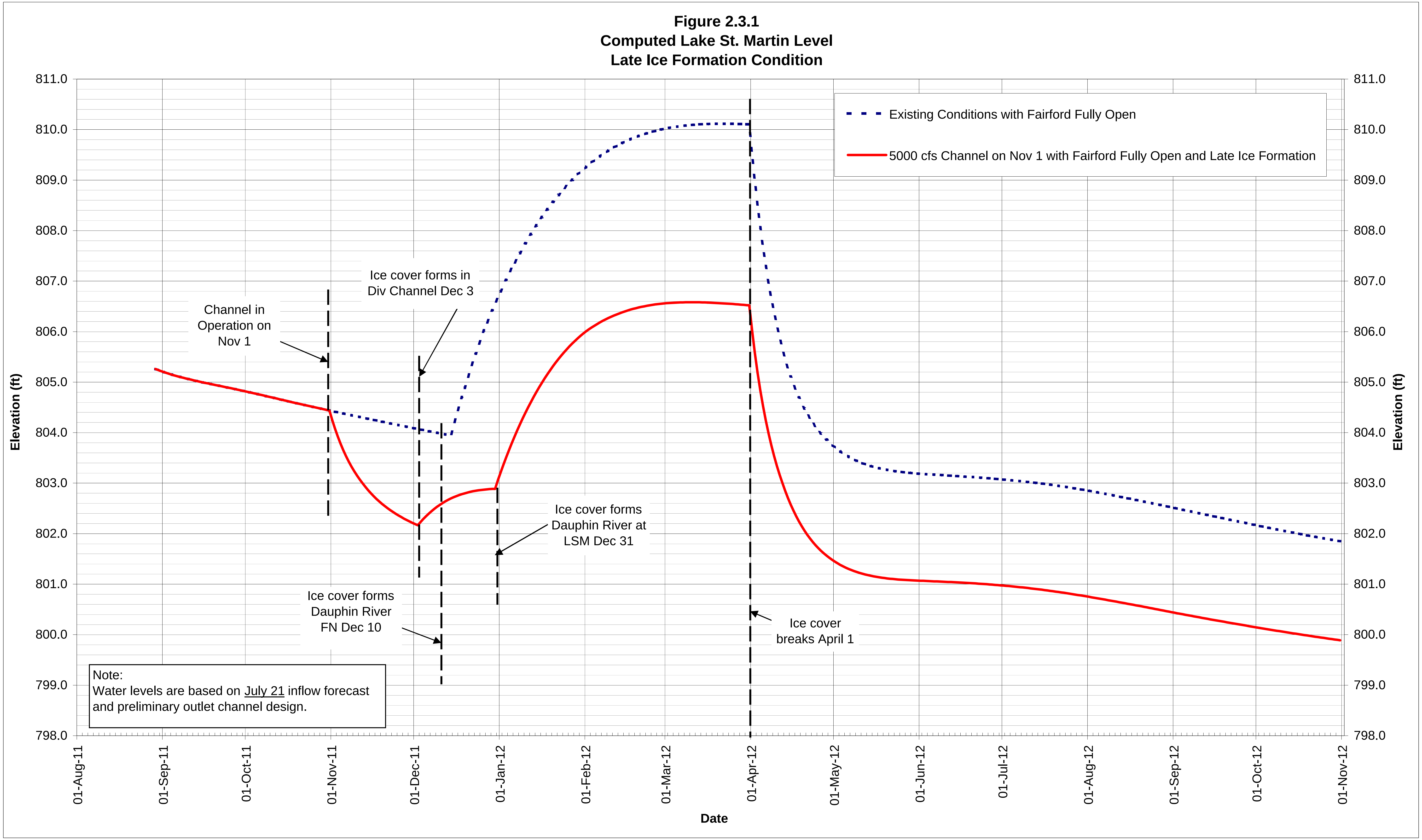


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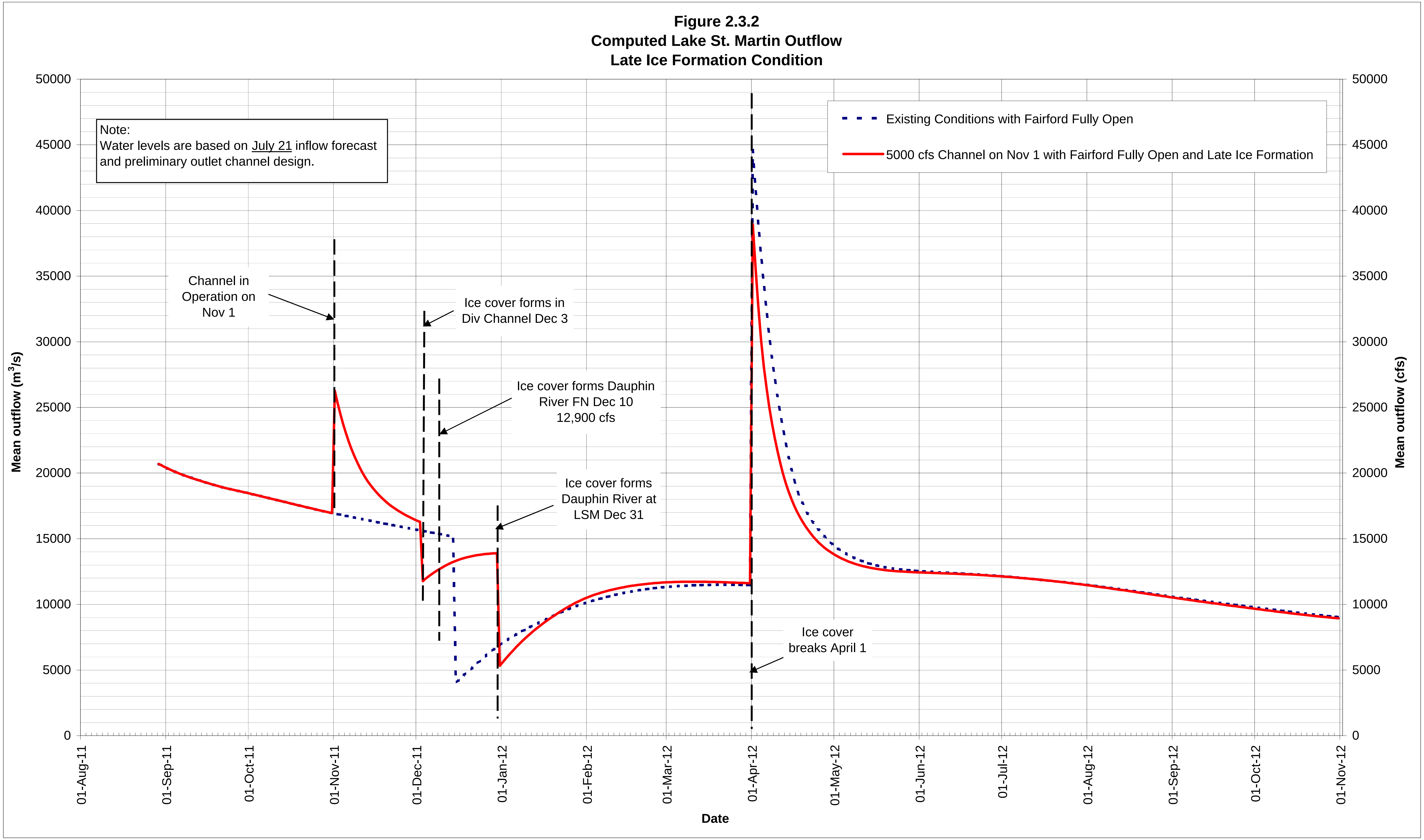


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**Lake Manitoba Forecast**
**Correspondence and Figures**

**September 20, 2011**

## Garrett Wellwood

**From:** Brian Bodnaruk [BBodnaruk@kgsgroup.com]
**Sent:** Tuesday, September 20, 2011 5:05 PM
**To:** 'Richardson, Ron (MIT)'; RCarson@kgsgroup.com
**Cc:** CSiepman@kgsgroup.com; 'Kaatz, Ron G (MIT)'; PLeclercq@kgsgroup.com
**Subject:** RE: DRFN Discharges for Channel Completion Scenarios

Rick,
For the early ice formation scenario with the diversion channel in-service date on Nov 1, the date of the ice formation at the DRFN was assumed as Nov 10 and Nov 8 on Buffalo Creek. The two dates practically coincide. In the interest of conservatism, the open water flow on Buffalo Creek was assumed in defining the flow at the DRFN in the previous flow Table.

An assumption used in the simulations was that the transition from open water condition to ice covered flow conditions would occur instantaneously. If a more gradual transition were to occur, it is possible that open water conditions on Buffalo Creek would prevail when the ice jam was forming at the DRFN. Another point to consider is that an early ice date for ice formation on Lake Winnipeg is not typical.

Nevertheless, I have revised the flow Table to show flows on the dates assumed in the simulations rather than adjusting for coincident conditions if the dates of occurrence were close. The revised flows are shown in BOLD.

Please review and comment on the appropriate flow condition to use.

Revised Flow Table

| Channel Capacity | Ice Formation Condition | Diversion Channel In-Service Date | Dauphin River Discharge (cfs) | Buffalo Creek Discharge (cfs) | DRFN Discharge (cfs) |
|---|---|---|---|---|---|
| Full Channel | Early | 1-Dec | 16,220 | 0 | 16,220 |
| | Normal | | 15,610 | 0 | 15,610 |
| | Late | | **12,090** | **2,430** | **14,520** |
| Full Channel | Early | 1-Nov | **13,090** | **2,600** | **15,690** |
| | Normal | | 11,500 | 2,320 | 13,820 |
| | Late | | 10,450 | 2,090 | 12,540 |
| 3/4 Channel | Early | 1-Nov | **13,845** | **2,965** | **16,810** |
| | Normal | | 12,210 | 2,730 | 14,940 |
| | Late | | 11,205 | 2,575 | 13,780 |
| 1/2 Channel | Early | 1-Nov | **14,485** | **2,215** | **16,700** |
| | Normal | | 13,095 | 2,065 | 15,160 |
| | Late | | 12,170 | 1,960 | 14,130 |

Comments from Ron Richardson

1. The dates corresponding to the flows in the Right Hand column for the DRFN vary depending on the Early, Normal or Late date for ice formation on the DRFN. The corresponding dates are November 10, November 25 and December 10 (approximately 2 weeks between each)
2. The Lake Manitoba chart does not change from the one previous sent.
3. The assumptions used in the simulations were that the ice cover would form on the diversion channel 7 days before the ice formed at the DRFN. For the early date for ice formation on Nov 10, the ice cover was assumed to form on the diversion channel on Nov 3. This was 2 days after the channel was assumed to be commissioned. Applying these dates strictly according to the assumed rule, meant that the ice cover would fully develop on the diversion channel in 2 days after the start of flow. This is considered to be too soon. The simulations were therefore subsequently revised to

delay the ice formation on the channel to 7 days from the 2 days.

4. The revised Table shows that the flow would increase for the ½ channel capacity compared to the full channel case. This is contrary to that presented previously. The reason was that the early flow case used approximate flows corresponding to open water conditions on Buffalo Creek.

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---

**From:** Richardson, Ron (MIT) [mailto:Ron.Richardson@gov.mb.ca]
**Sent:** Tuesday, September 20, 2011 1:15 PM
**To:** Brian Bodnaruk; RCarson@kgsgroup.com
**Cc:** CSiepman@kgsgroup.com; Kaatz, Ron G (MIT); PLeclercq@kgsgroup.com
**Subject:** RE: DRFN Discharges for Channel Completion Scenarios

Hi Brian

Four things:

1. Could you please confirm that the right hand column in the table below "DRFN Discharge cfs" is for the "Nov 10 Ice cover forms DRFN".

2. Can you supply the Lake Manitoba Levels graph for each or does it remain the same (Lk MB outflow governed only by Fairford Dam) with the only change being the level of LSM.

3. I do not think I have the revised 5000 cfs channel (Nov 1 opening) for early, normal , late ice formations. I think I am still using the one we discussed Sept 2 where it has a vertical spike (up and down ~ 9000 cfs) based on Ice Cover forms in the Diversion Channel Nov 3.

4. The frazil impacts at DRFN would seem to be lower with the smaller (1/2) size channel with a DR flow of 19,070 cfs as opposed to the full (5000 cfs) diversion which would yield a DR flow of 21510 cfs. Viewing this it would seem that we should construct the ½ size channel and address the extra LSM level increase, but I may be missing something.

Thanks,

*Ron Richardson, P.Eng.*
*Director, Water Control Operations Branch*
*Manitoba Infrastructure and Transportation*
*600-215 Garry Street*

*Phone: (204) 945-6494*
*Fax: (204) 948-4503*

---

**From:** Brian Bodnaruk [mailto:BBodnaruk@kgsgroup.com]

**Sent:** September-20-11 11:24 AM
**To:** RCarson@kgsgroup.com
**Cc:** CSiepman@kgsgroup.com; Richardson, Ron (MIT); Kaatz, Ron G (MIT); PLeclercq@kgsgroup.com
**Subject:** DRFN Discharges for Channel Completion Scenarios

The following Table summarizes flows on the Dauphin River and Buffalo Creek for full, ½, and ¾ partial completion of the LSM to Buffalo Creek Diversion channel for early, normal and late dates for ice formation and for channel In-Service dates of Nov 1 and Dec 1. I have also attached corresponding Figures showing the LSM water levels and Dauphin River and Buffalo Creek during the ice formation period.

| Channel Capacity | Ice Formation Condition | Diversion Channel In-Service Date | Dauphin River Discharge (cfs) | Buffalo Creek Discharge (cfs) | DRFN Discharge (cfs) |
|---|---|---|---|---|---|
| Full Channel | Early | 1-Dec | 16,220 | 0 | 16,220 |
| | Normal | | 15,610 | 0 | 15,610 |
| | Late | | 12,270 | 7,800 | 20,070 |
| Full Channel | Early | 1-Nov | 13,280 | 8,230 | 21,510 |
| | Normal | | 11,500 | 2,320 | 13,820 |
| | Late | | 10,450 | 2,090 | 12,540 |
| 3/4 Channel | Early | 1-Nov | 14,195 | 5,895 | 20,090 |
| | Normal | | 12,210 | 2,730 | 14,940 |
| | Late | | 11,205 | 2,575 | 13,780 |
| 1/2 Channel | Early | 1-Nov | 4,270 | 14,800 | 19,070 |
| | Normal | | 2,065 | 13,095 | 15,160 |
| | Late | | 1,960 | 12,170 | 14,130 |

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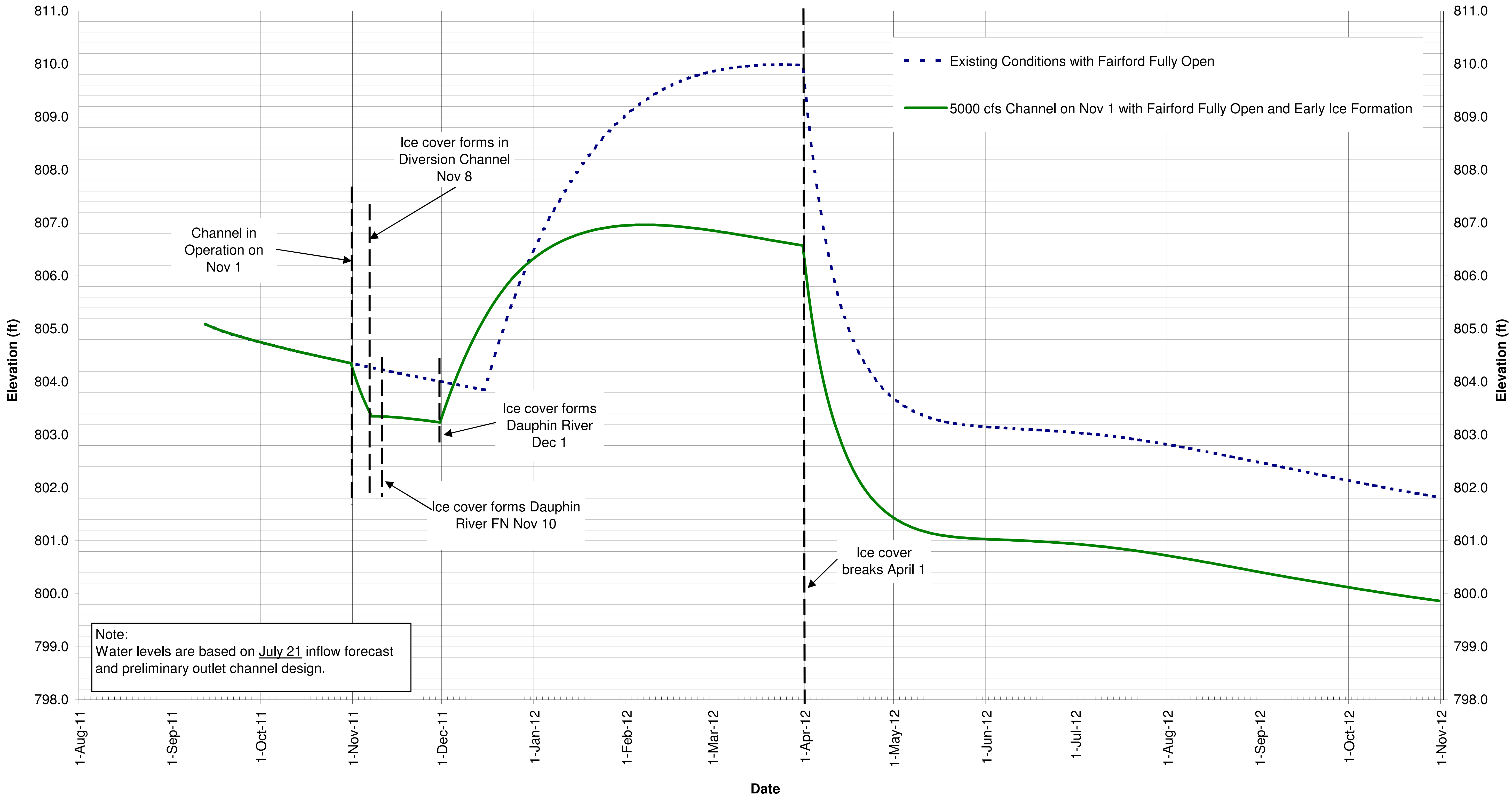
**Figure 2.1.1 RevB**
**Computed Lake St. Martin Level**
**Full Channel in Operation Nov 1 - Early Ice Formation Condition**

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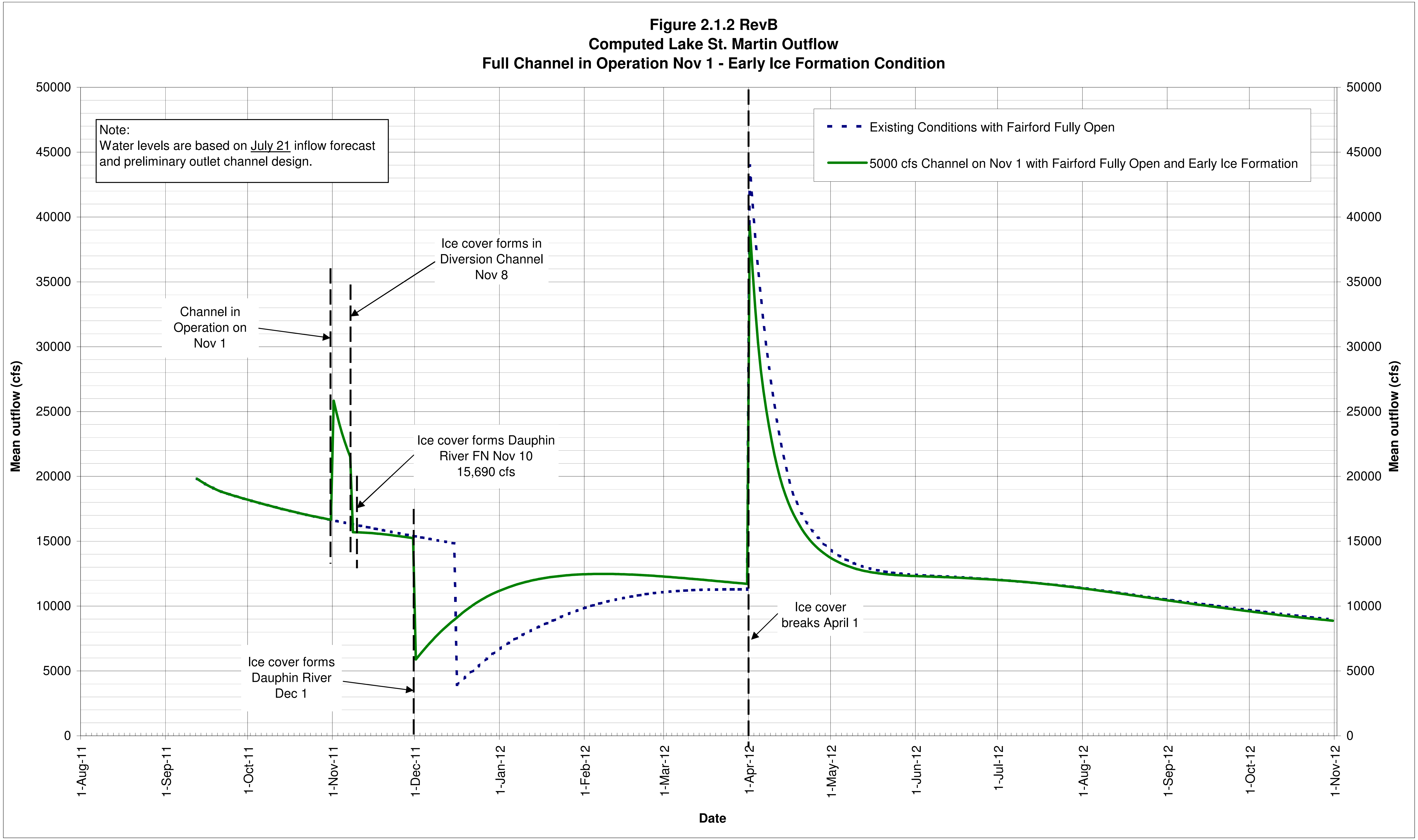


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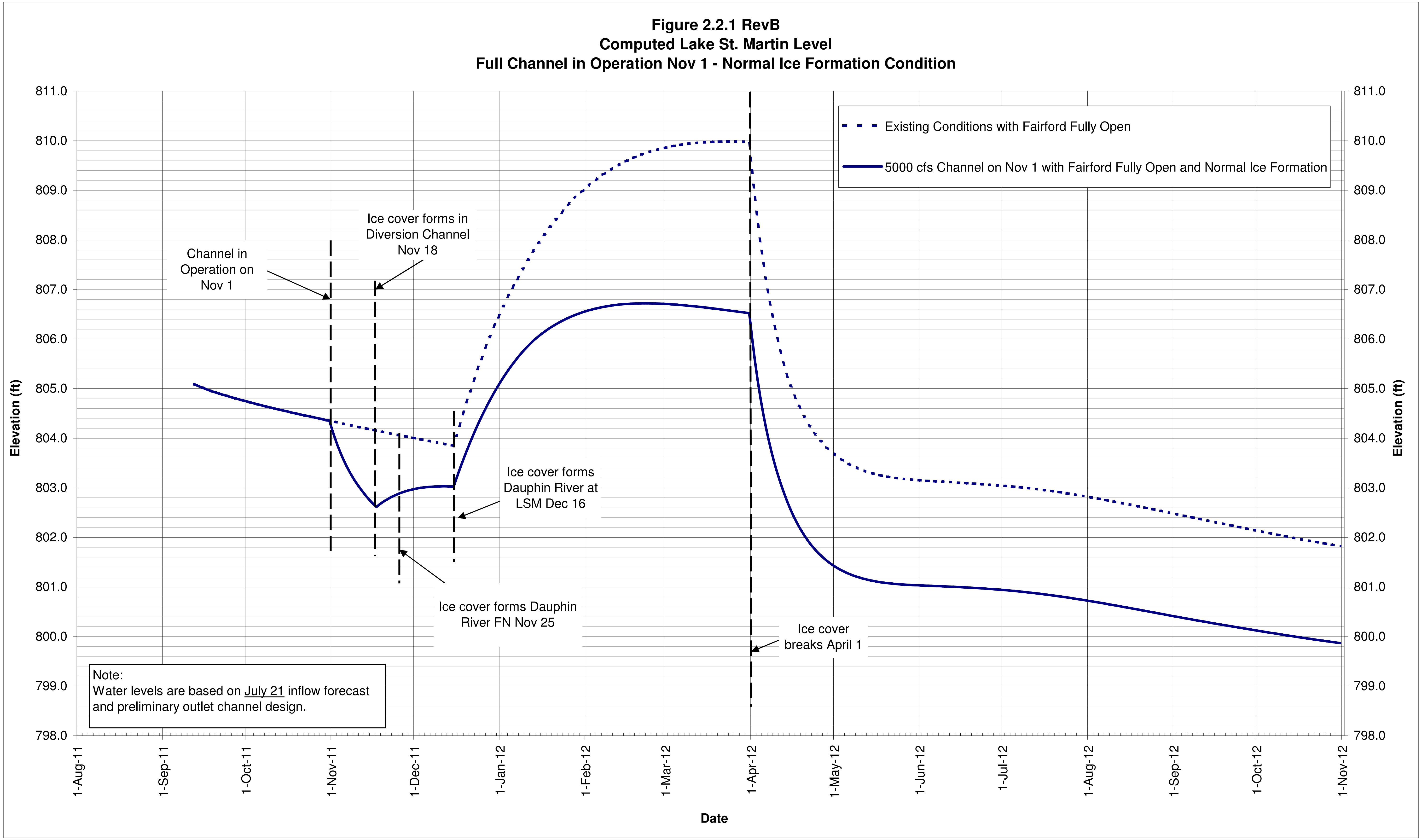


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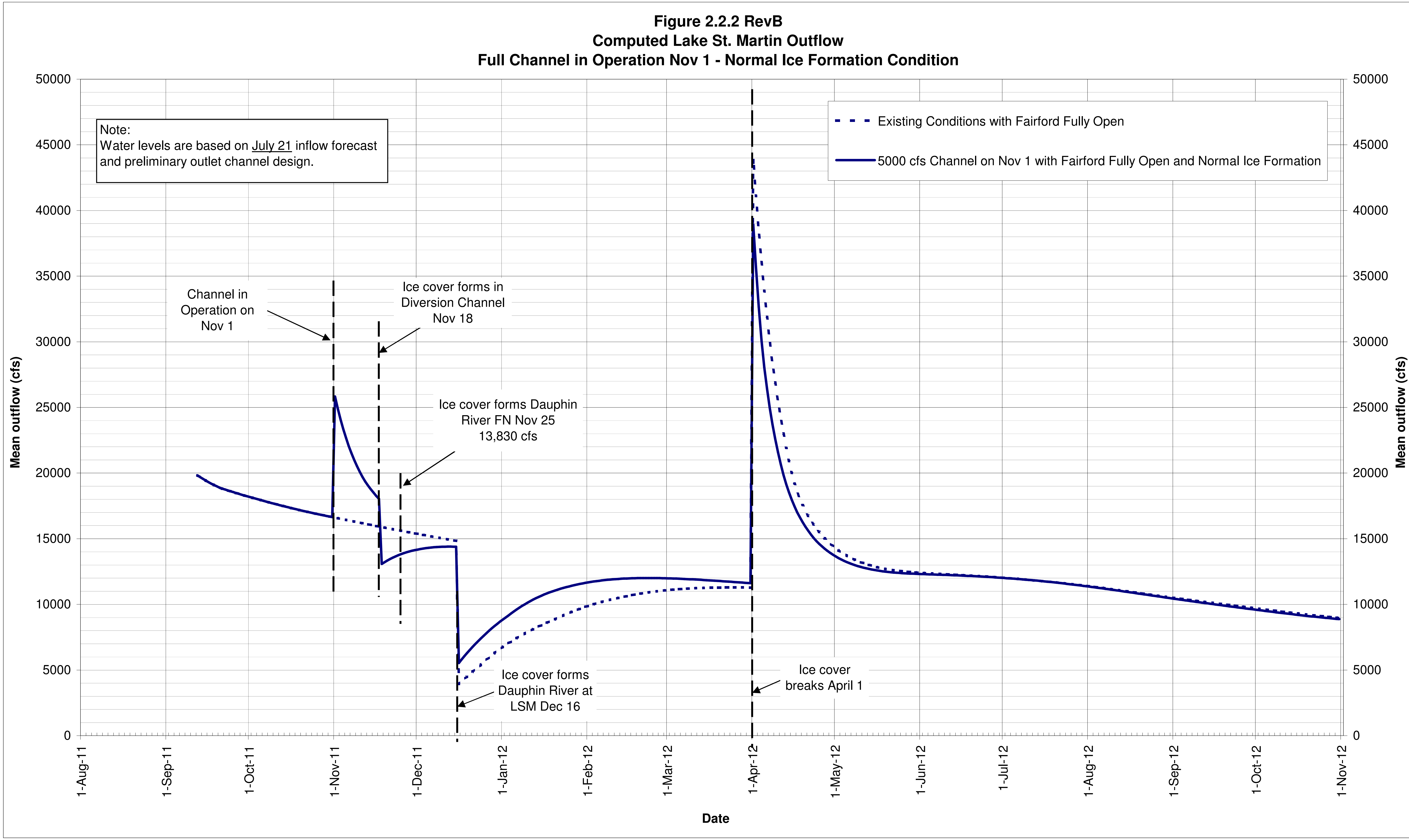


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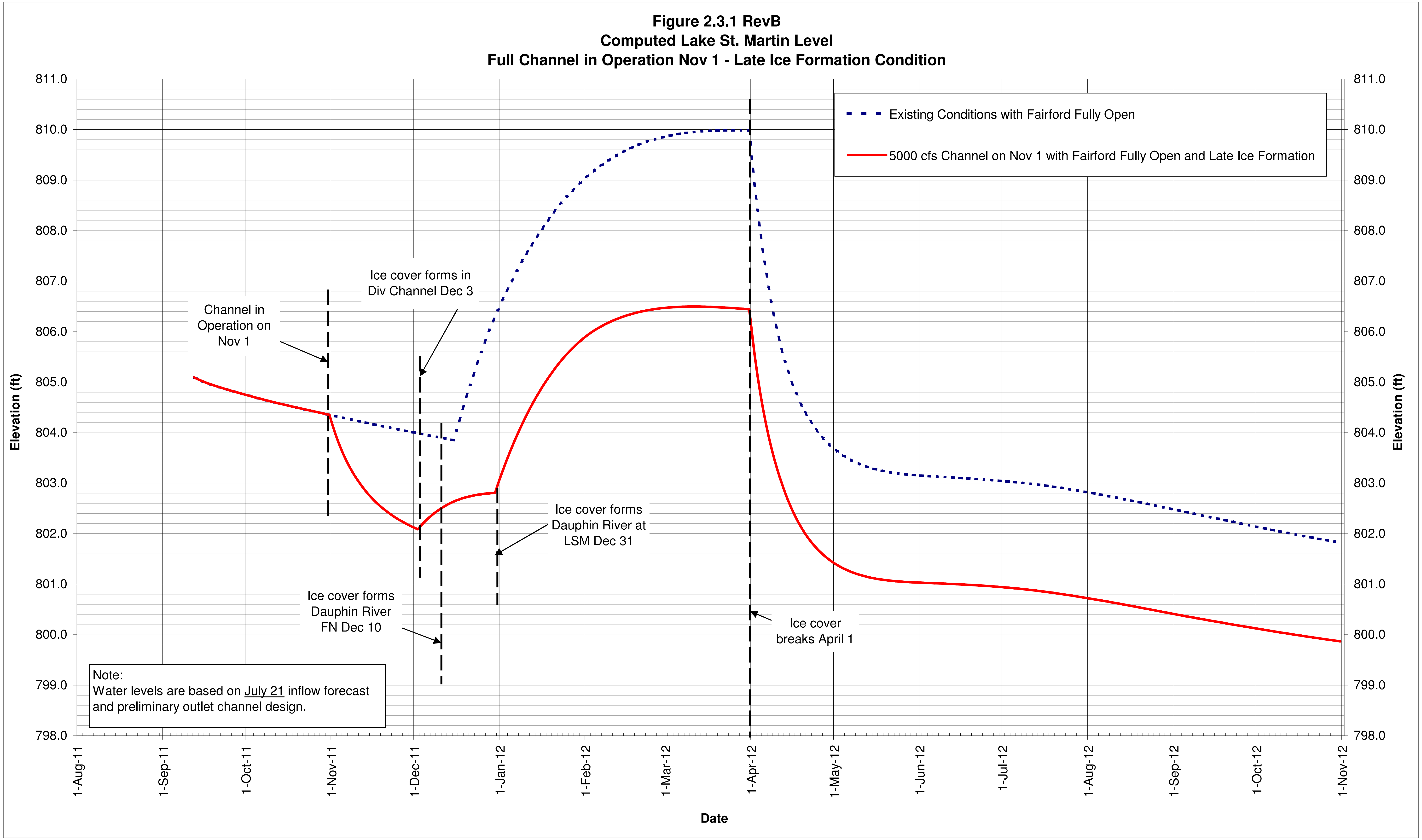


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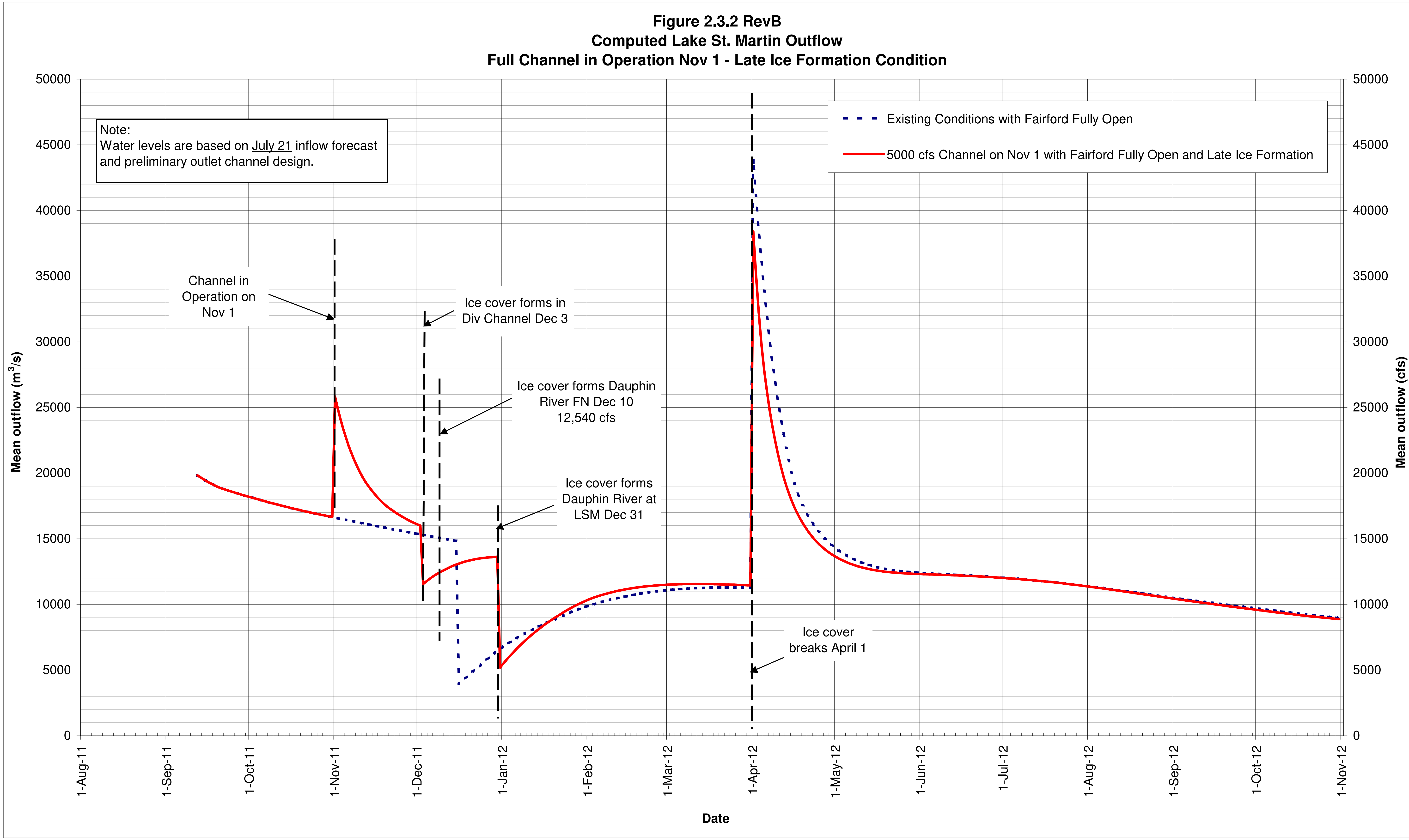


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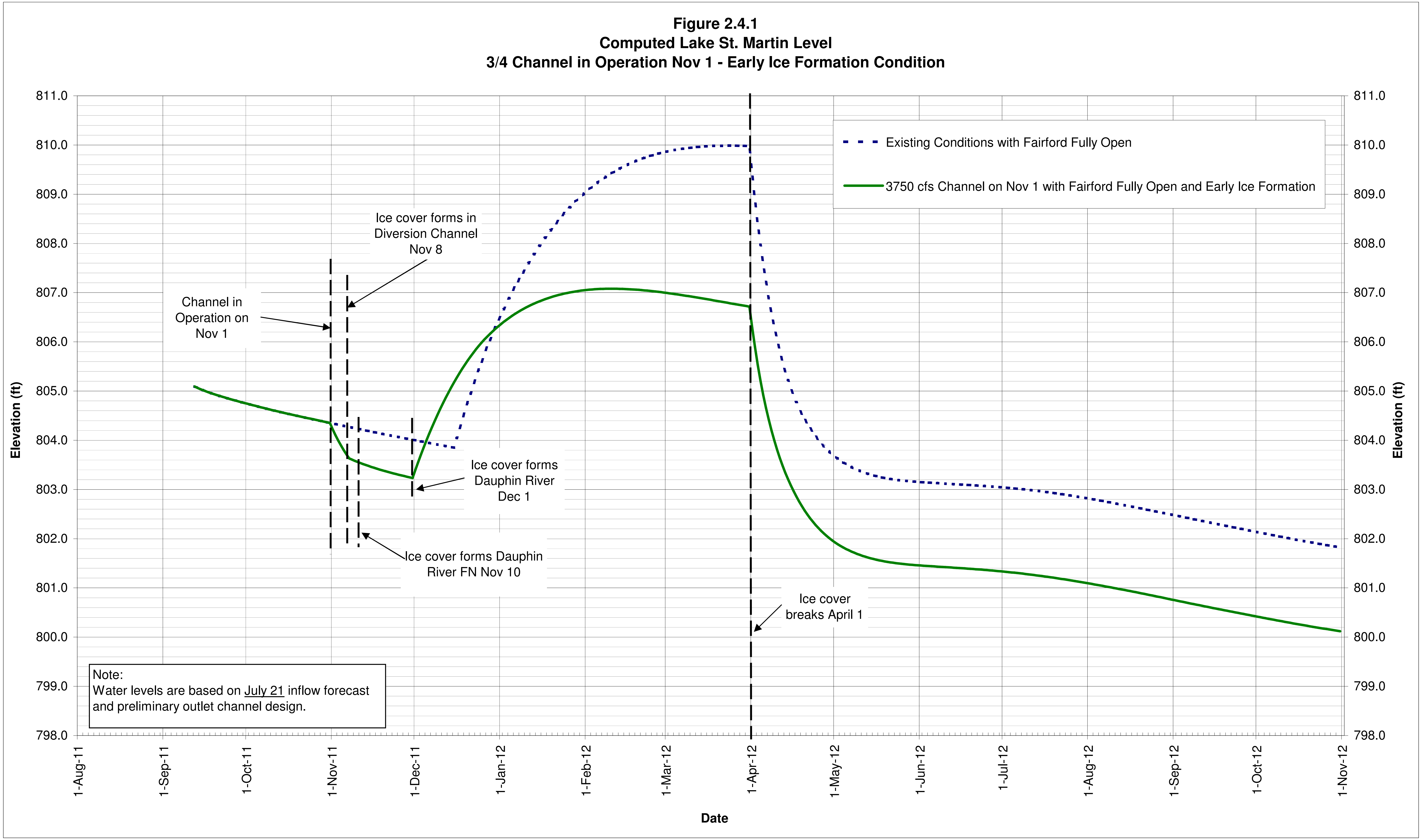


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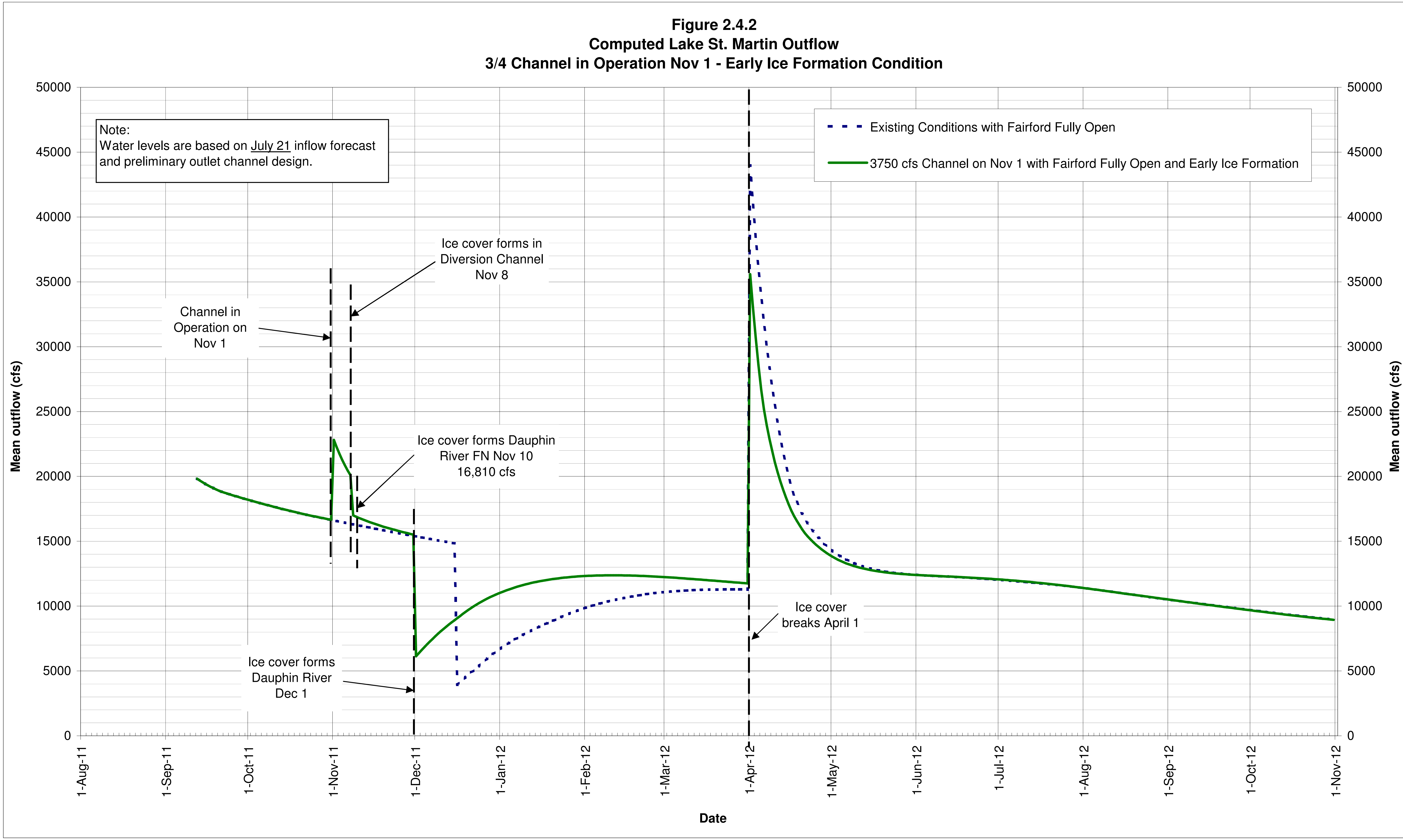


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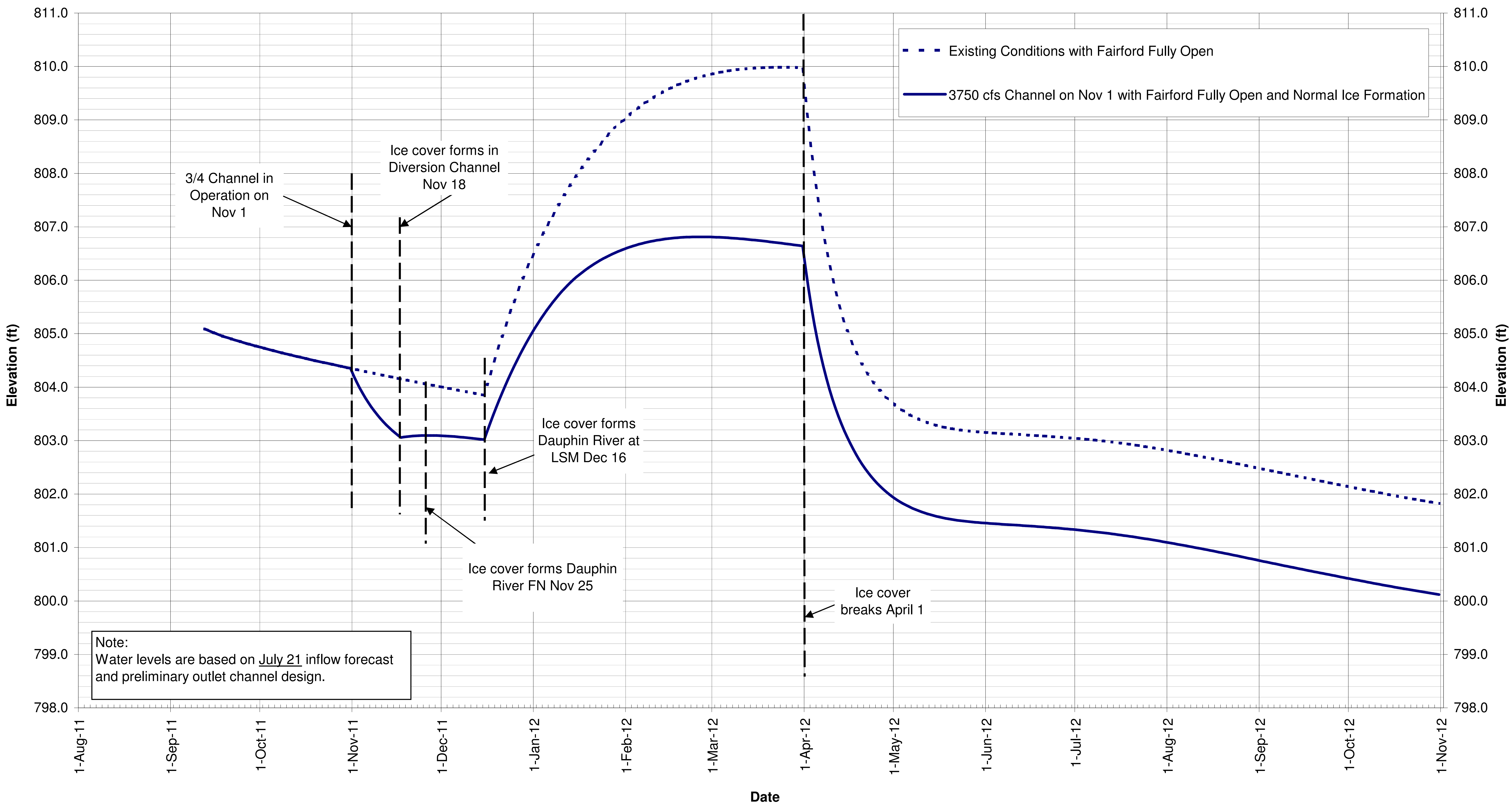
**Figure 2.5.1**
**Computed Lake St. Martin Level**
**3/4 Channel in Operation Nov 1 - Normal Ice Formation Condition**

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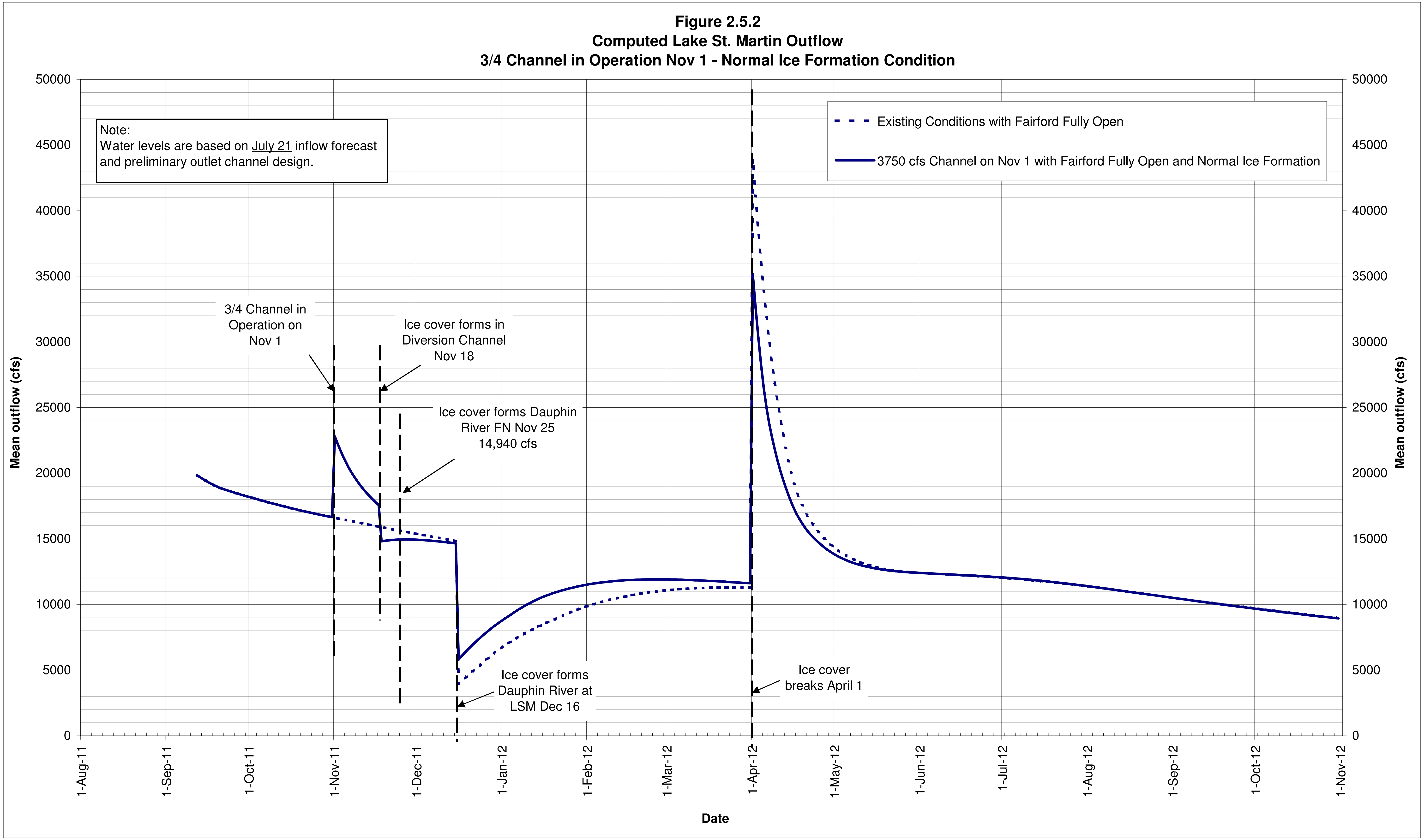


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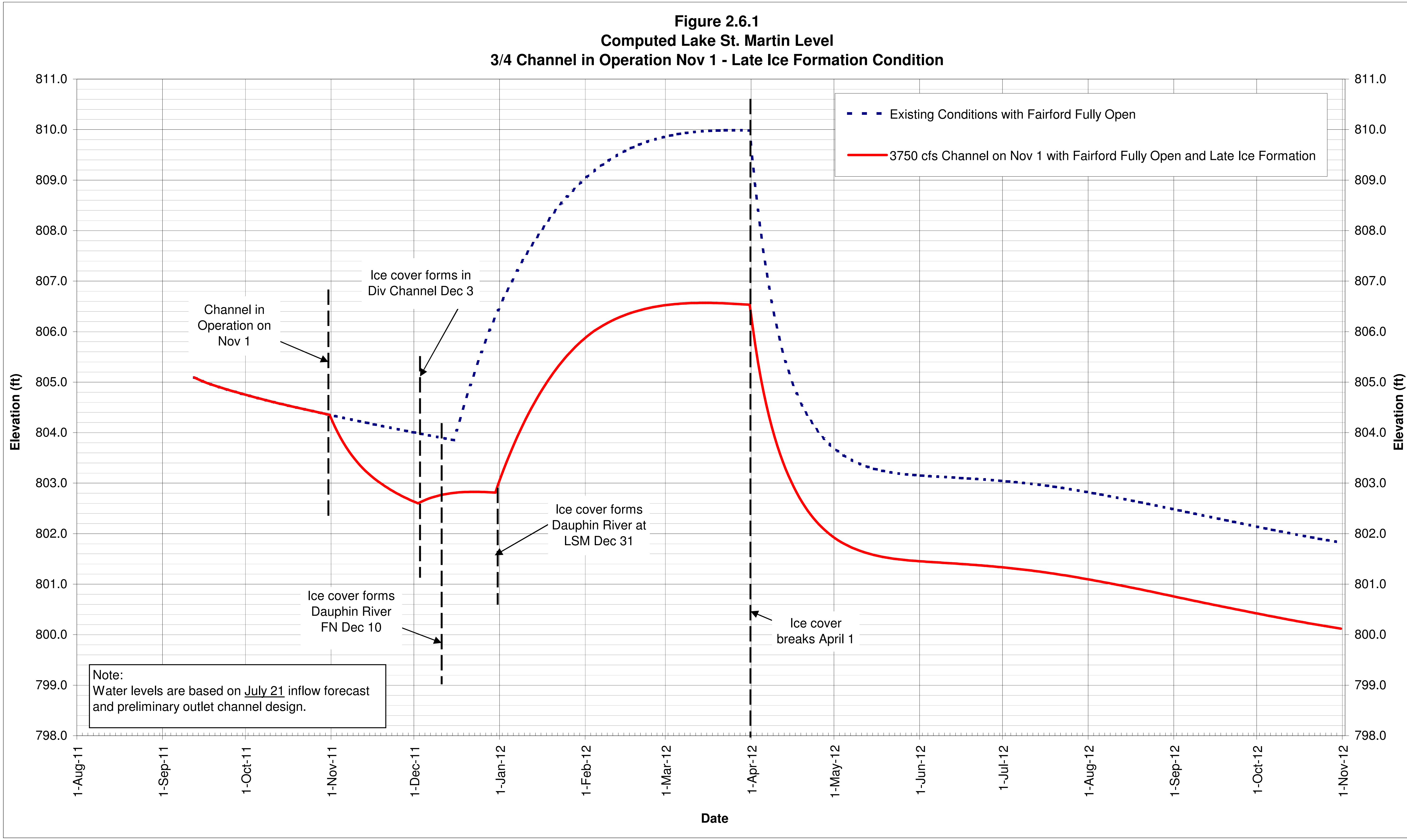


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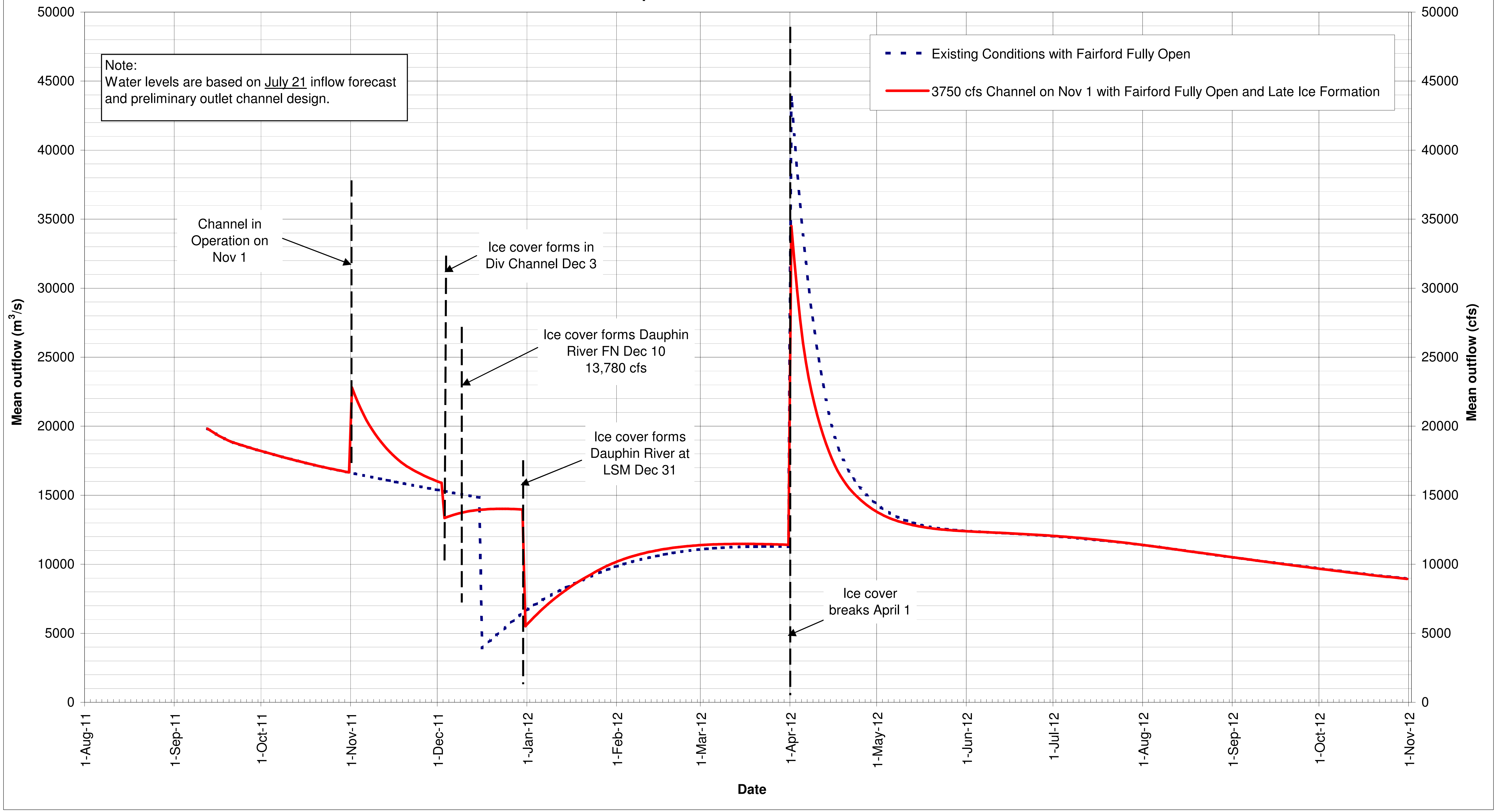
## Figure 2.6.2
## Computed Lake St. Martin Outflow
## 3/4 Channel in Operation Nov 1 - Late Ice Formation Condition

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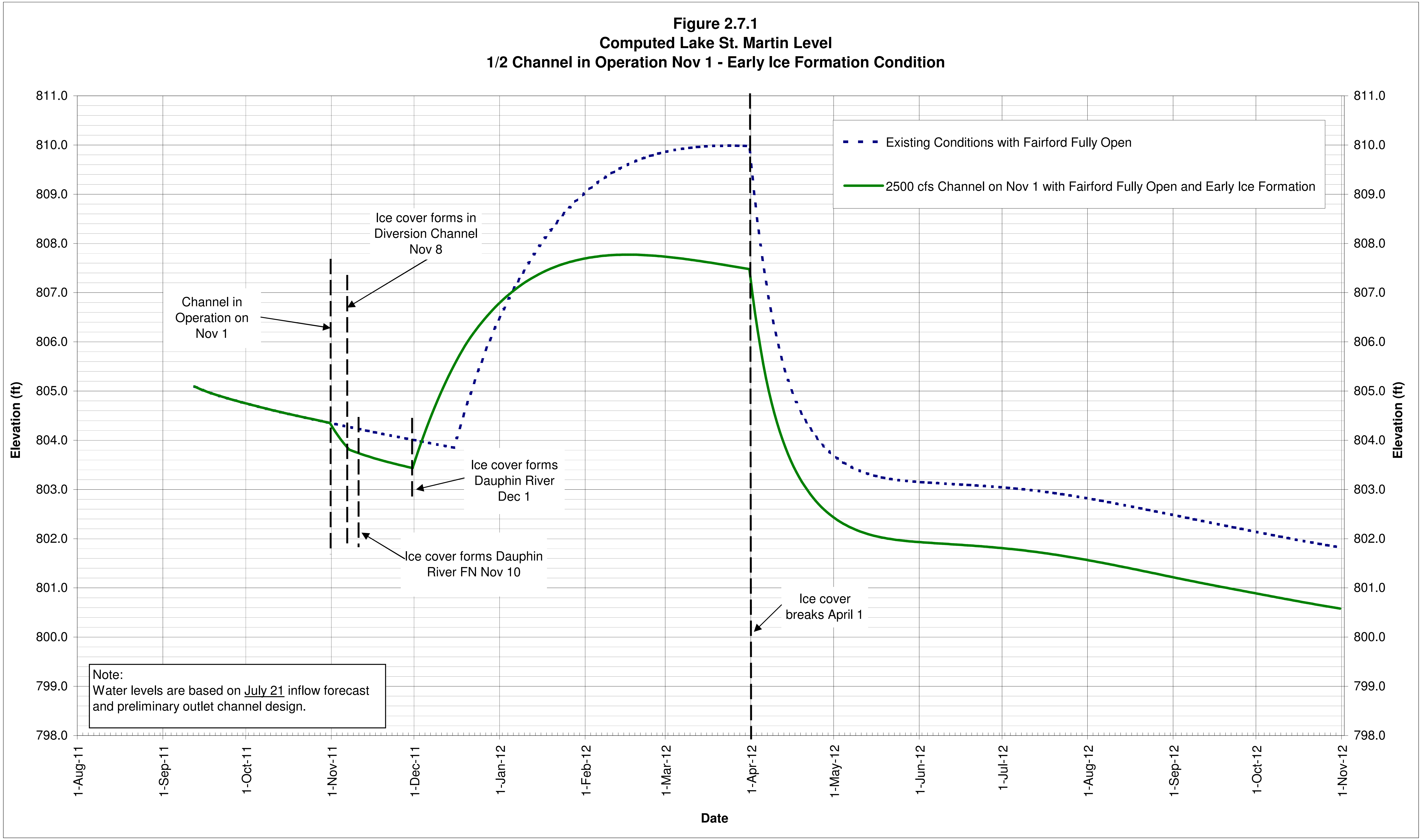


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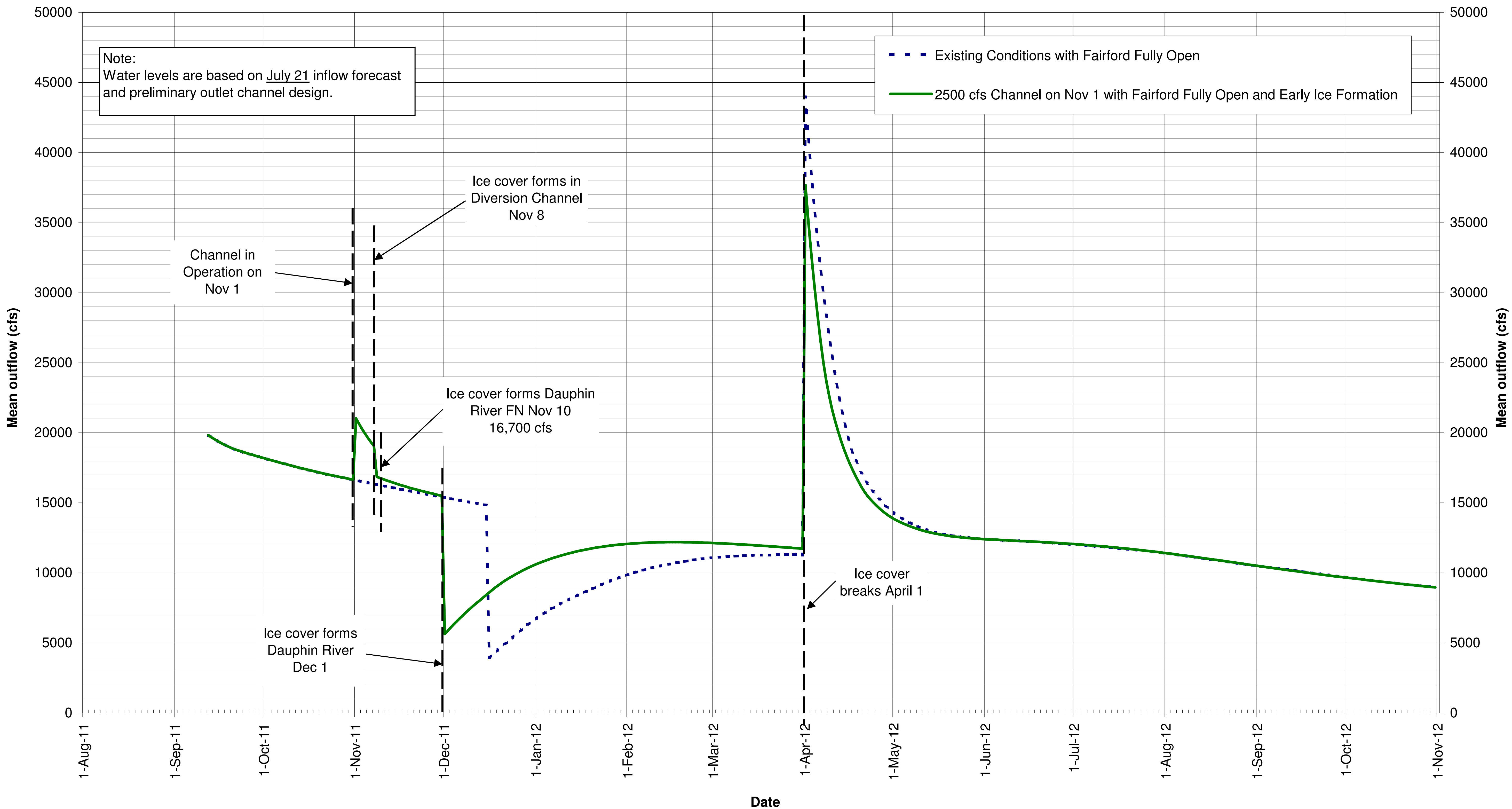
# Figure 2.7.2
## Computed Lake St. Martin Outflow
## 1/2 Channel in Operation Nov 1 - Early Ice Formation Condition

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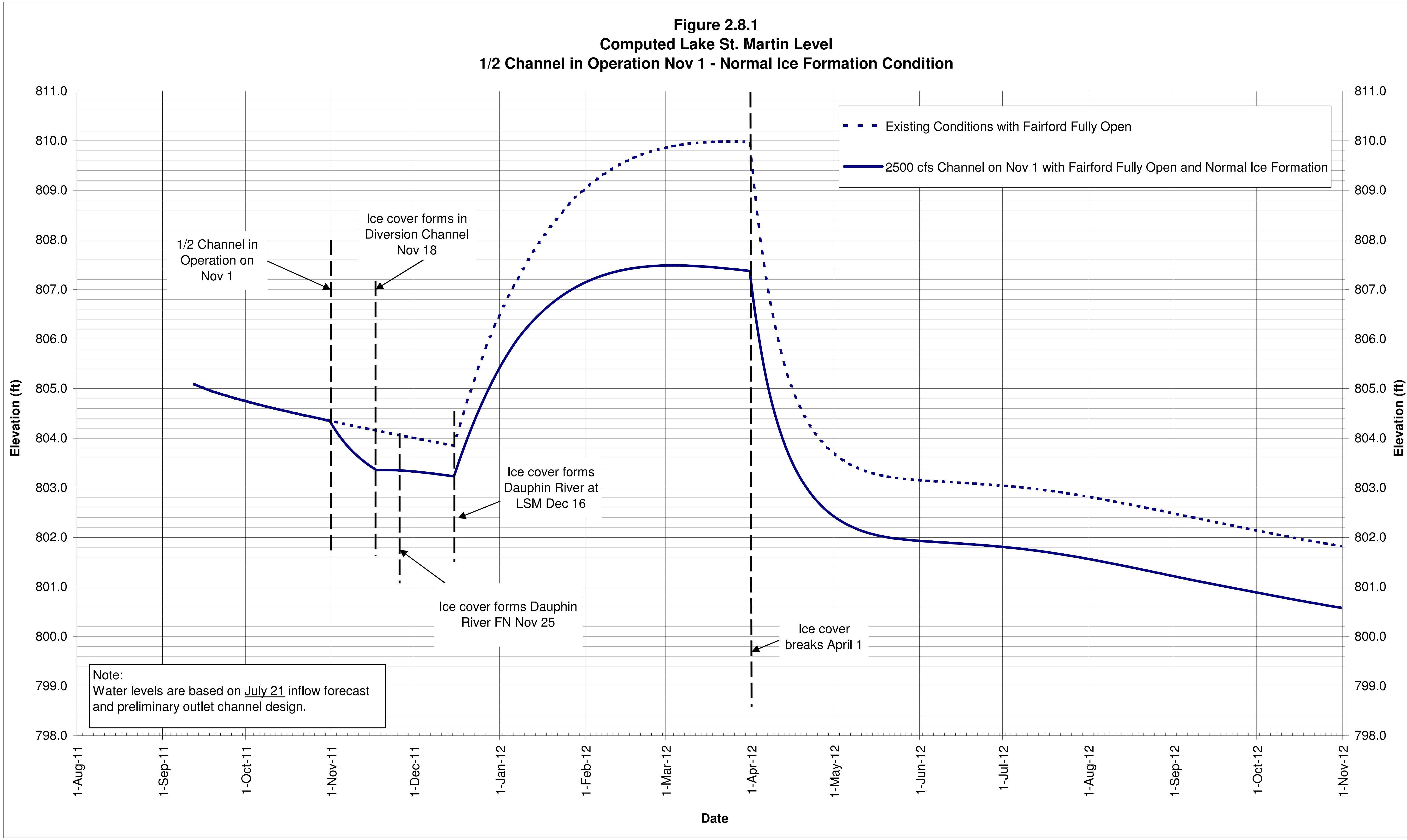


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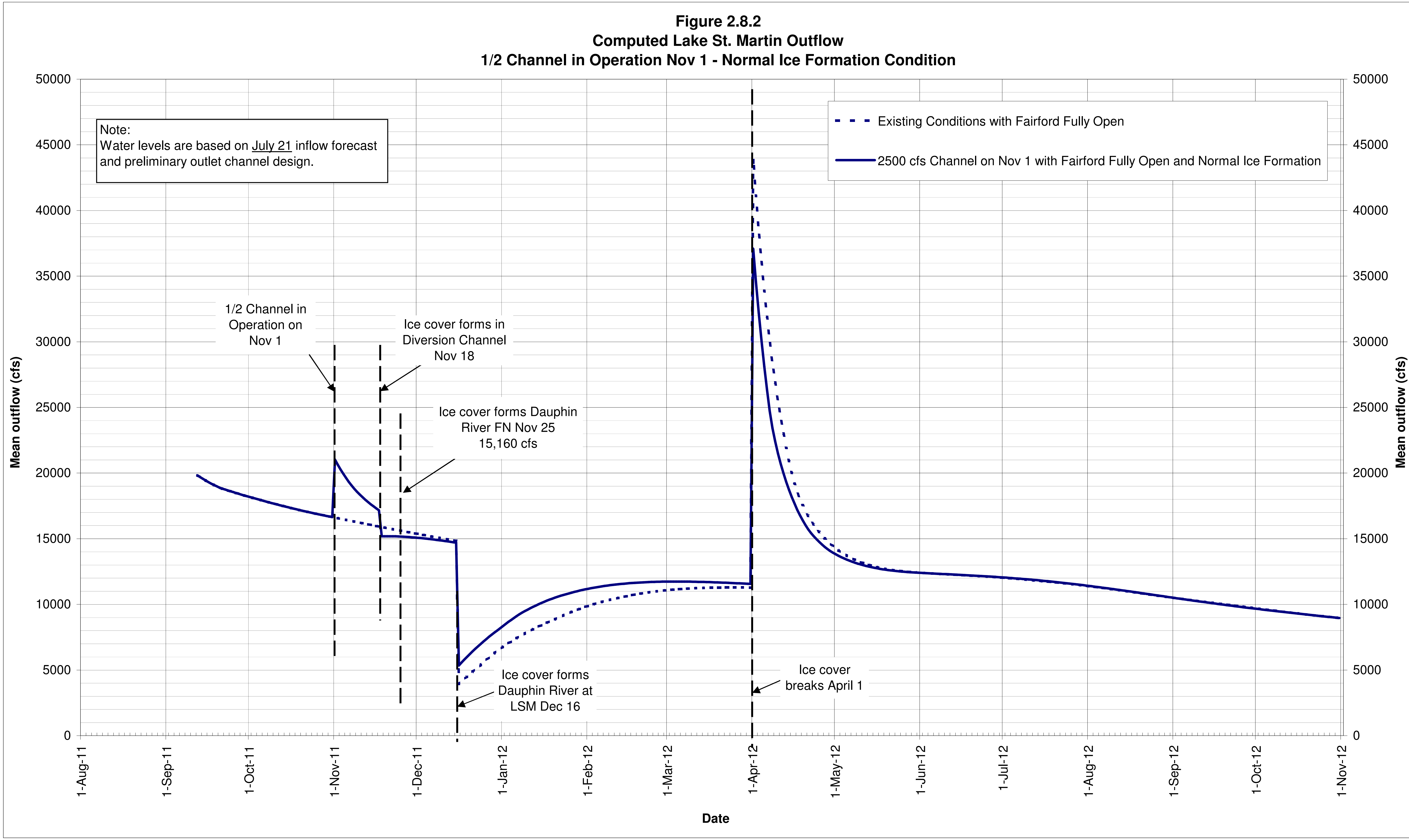


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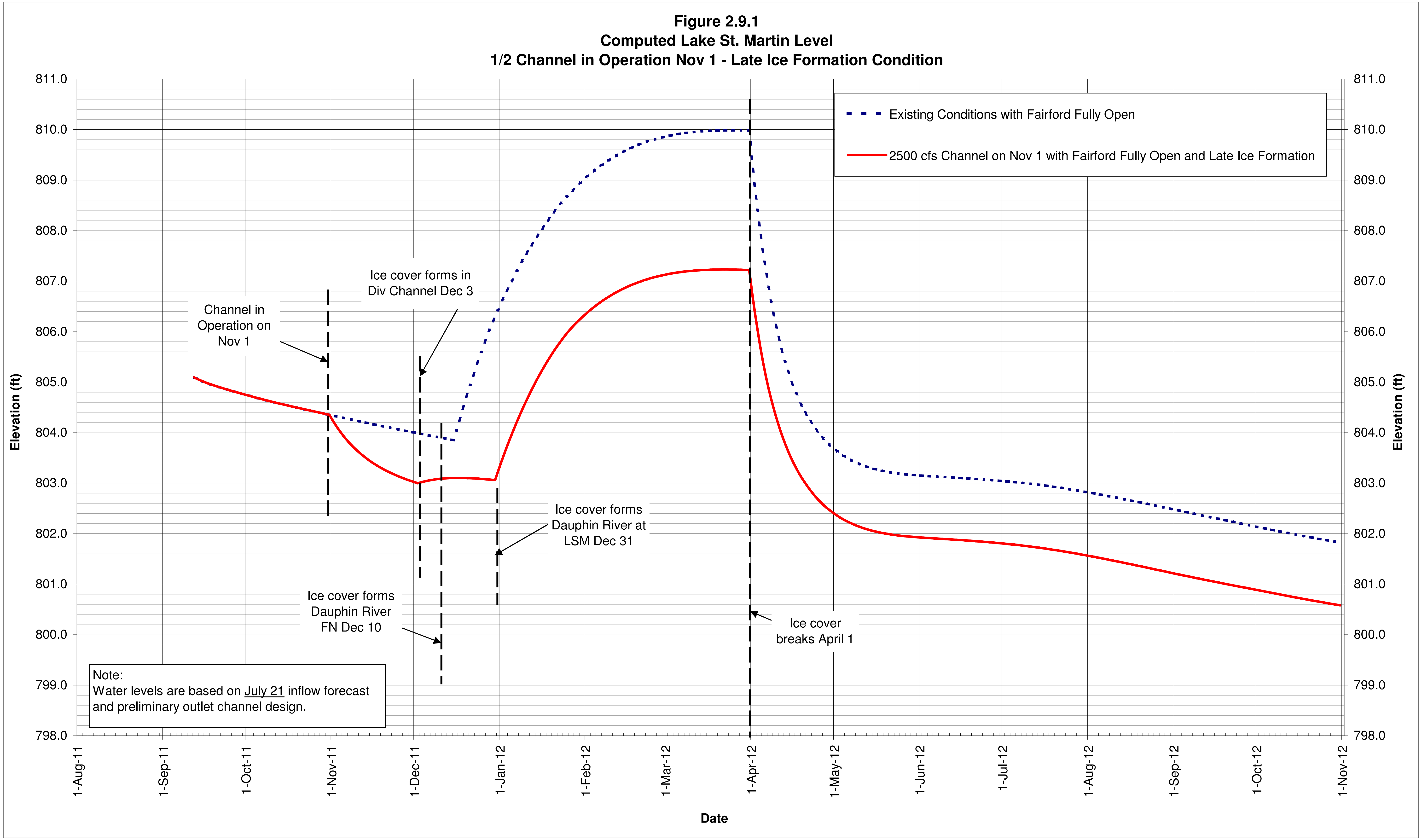


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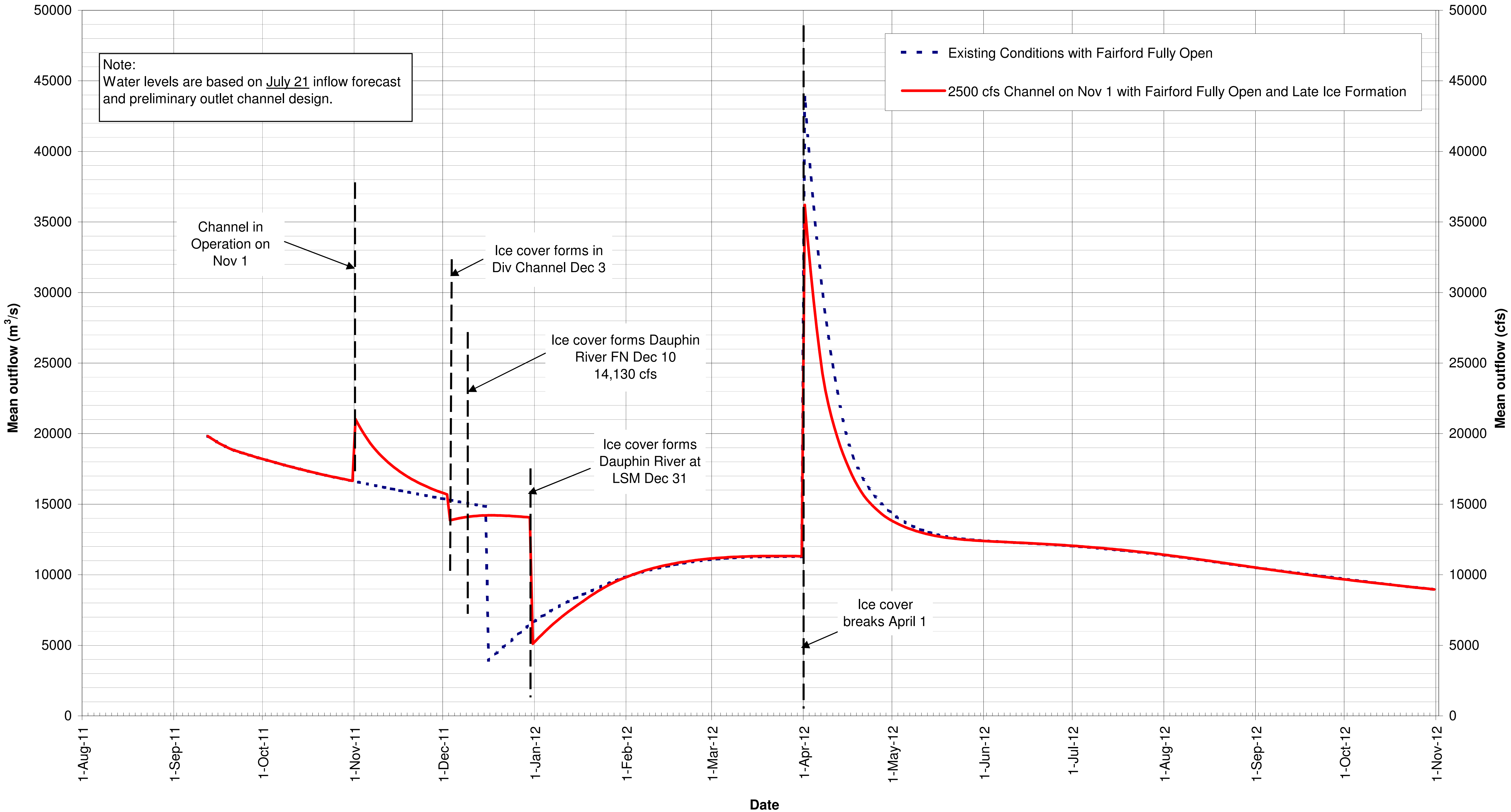
**Figure 2.9.2**
**Computed Lake St. Martin Outflow**
**1/2 Channel in Operation Nov 1 - Late Ice Formation Condition**

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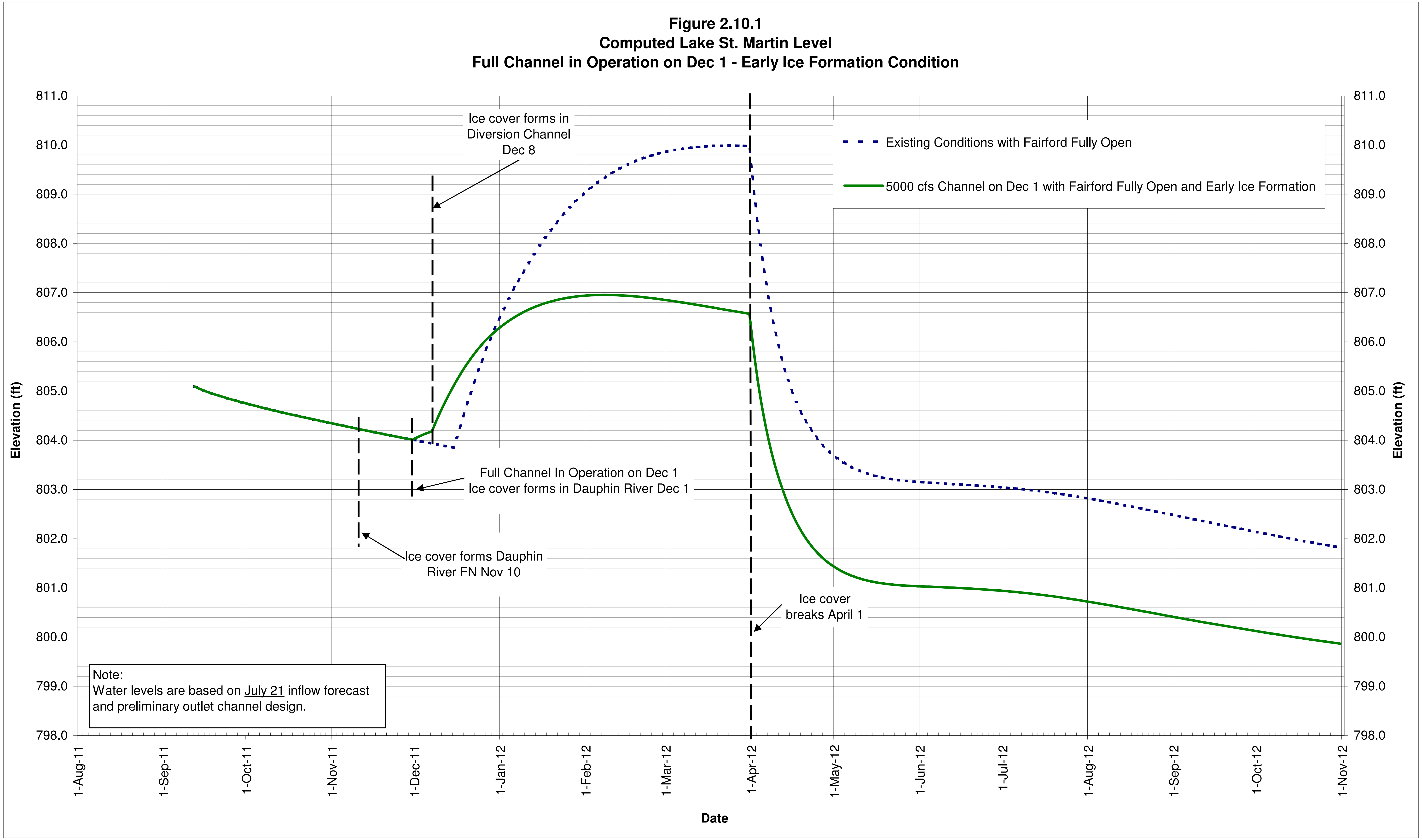


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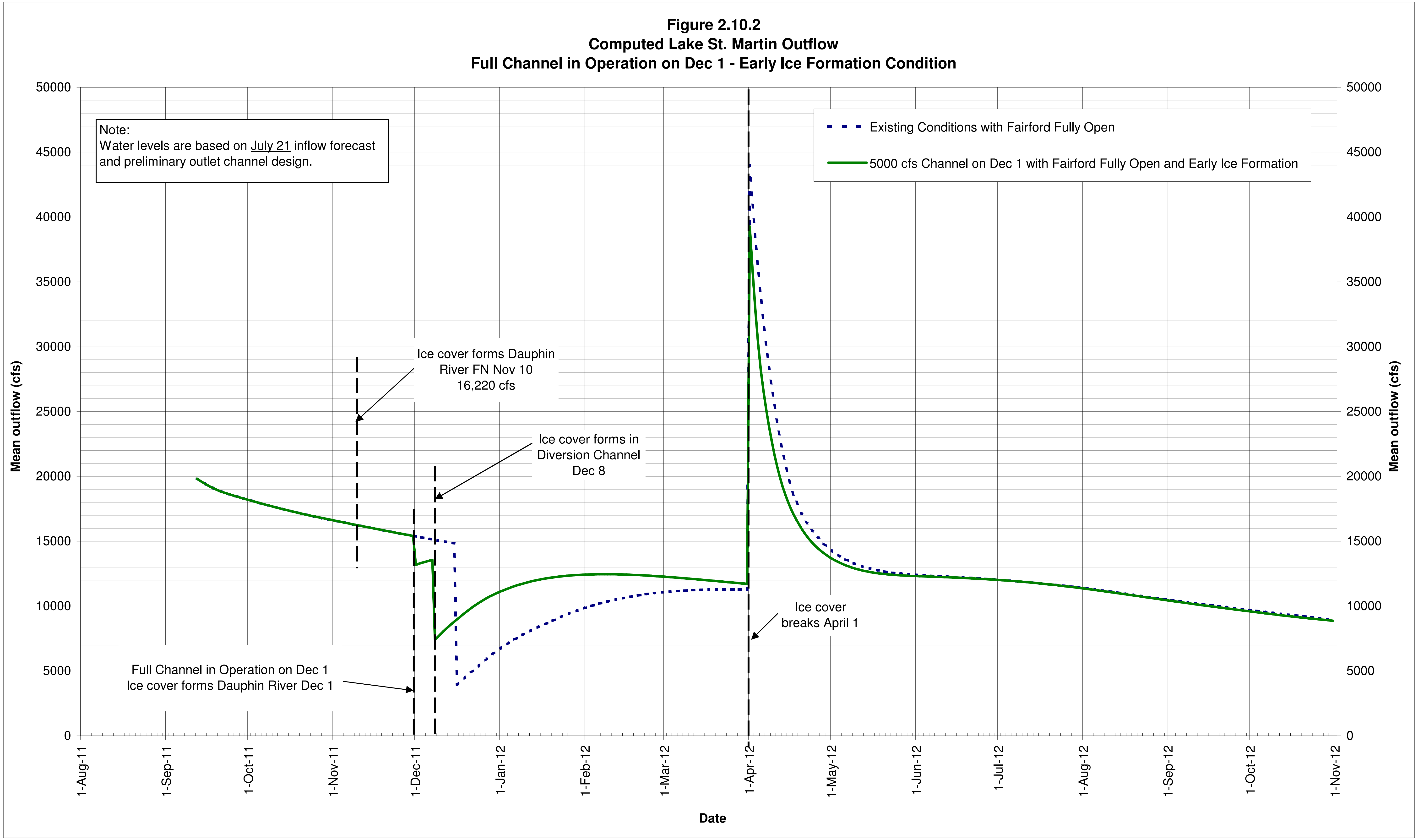


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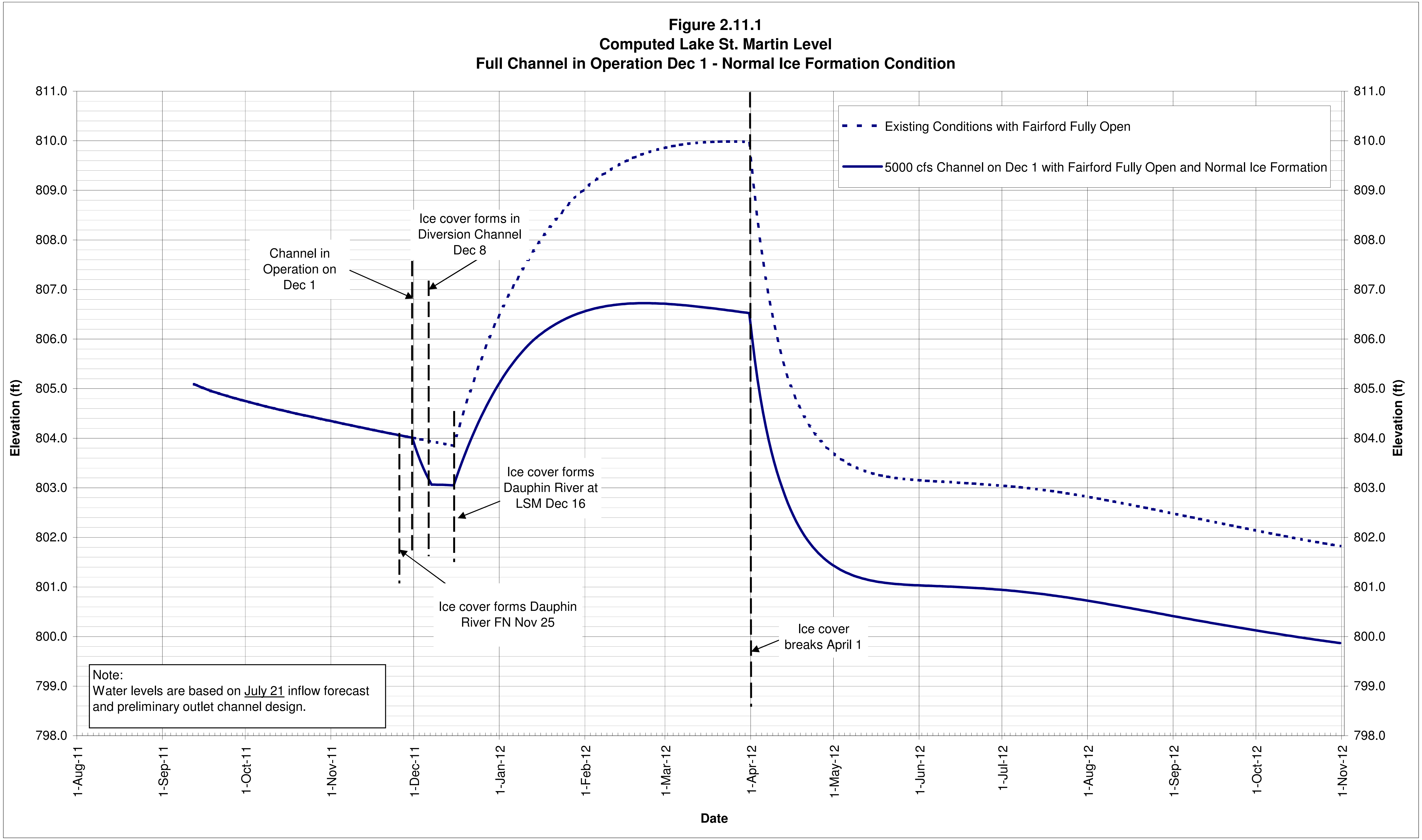


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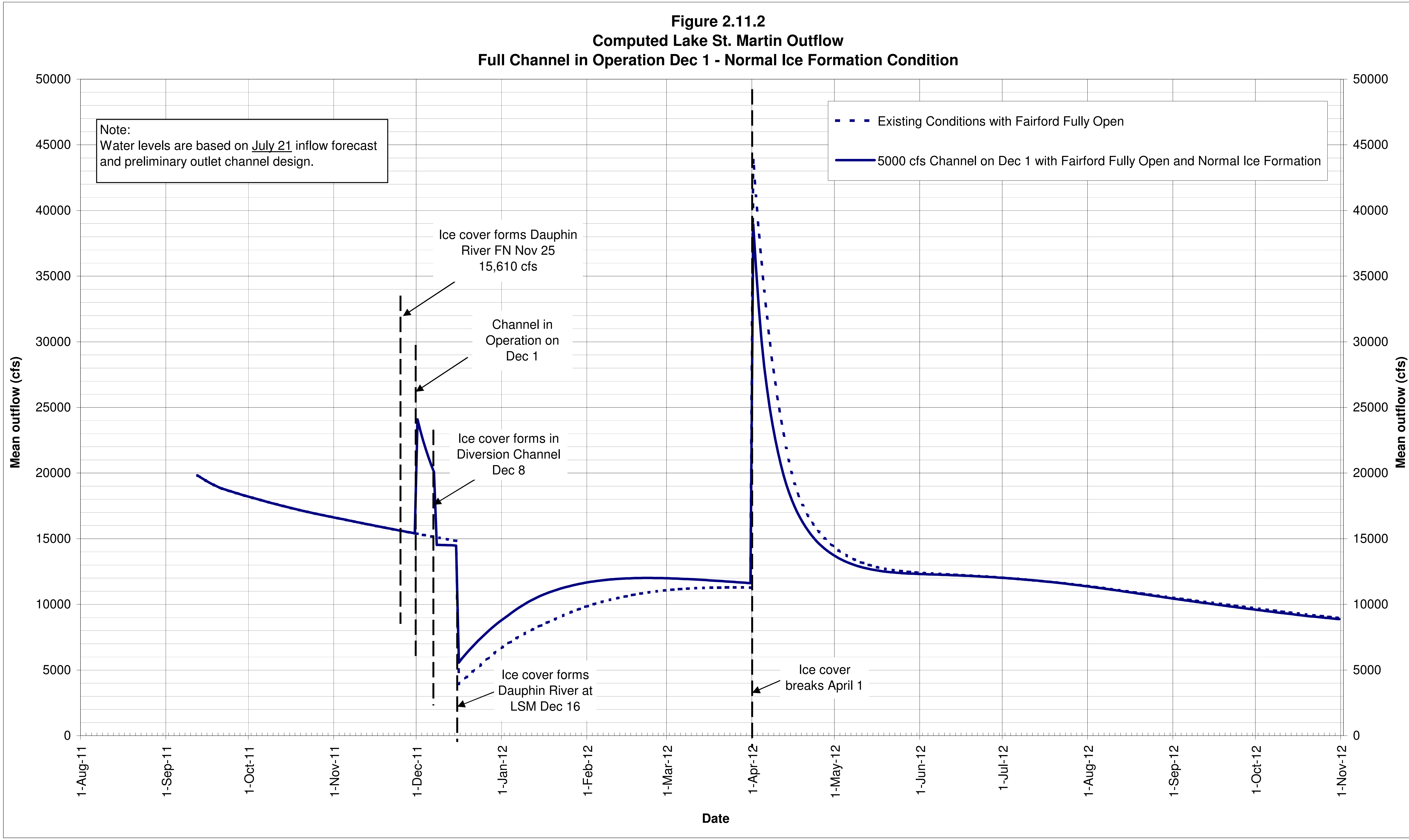


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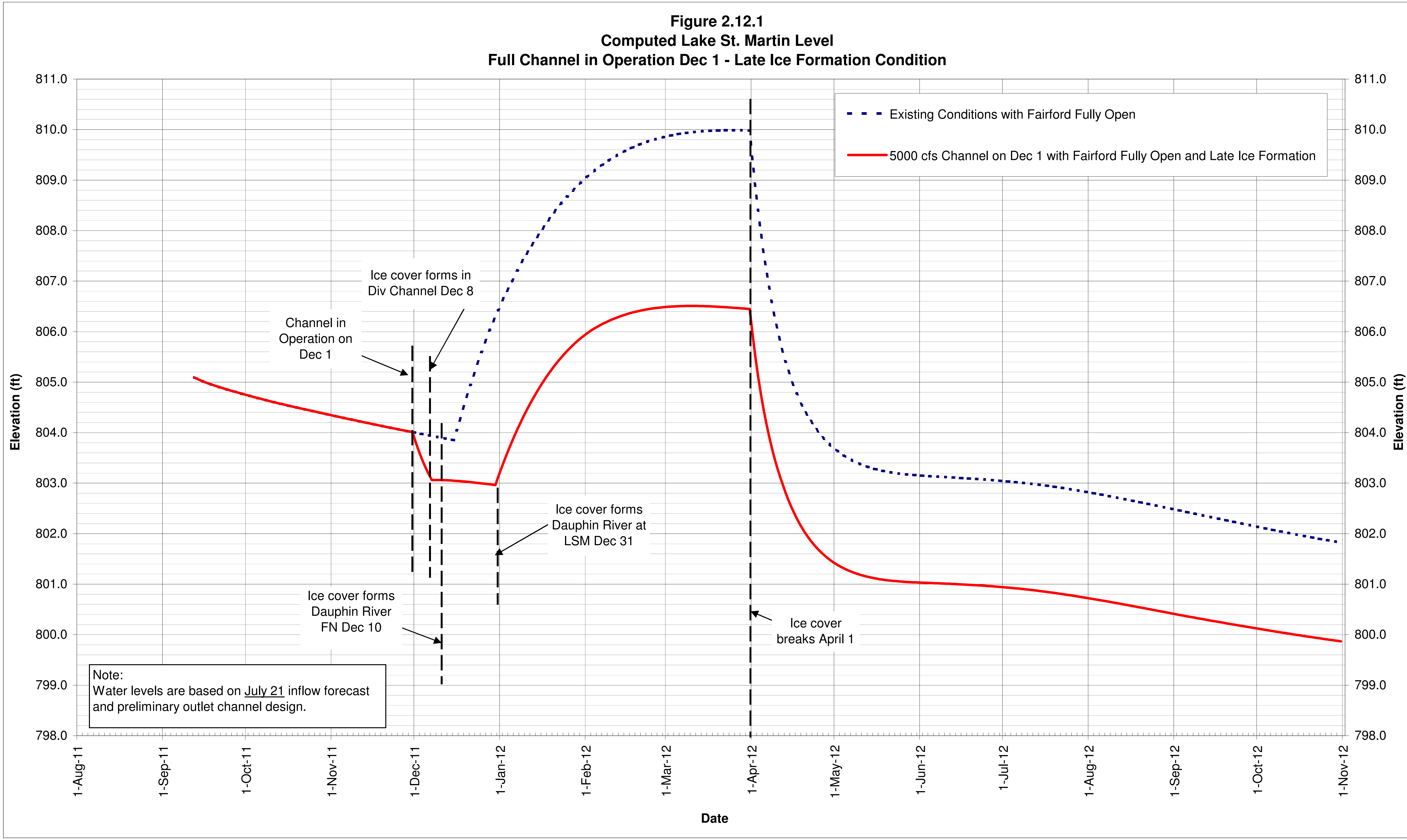


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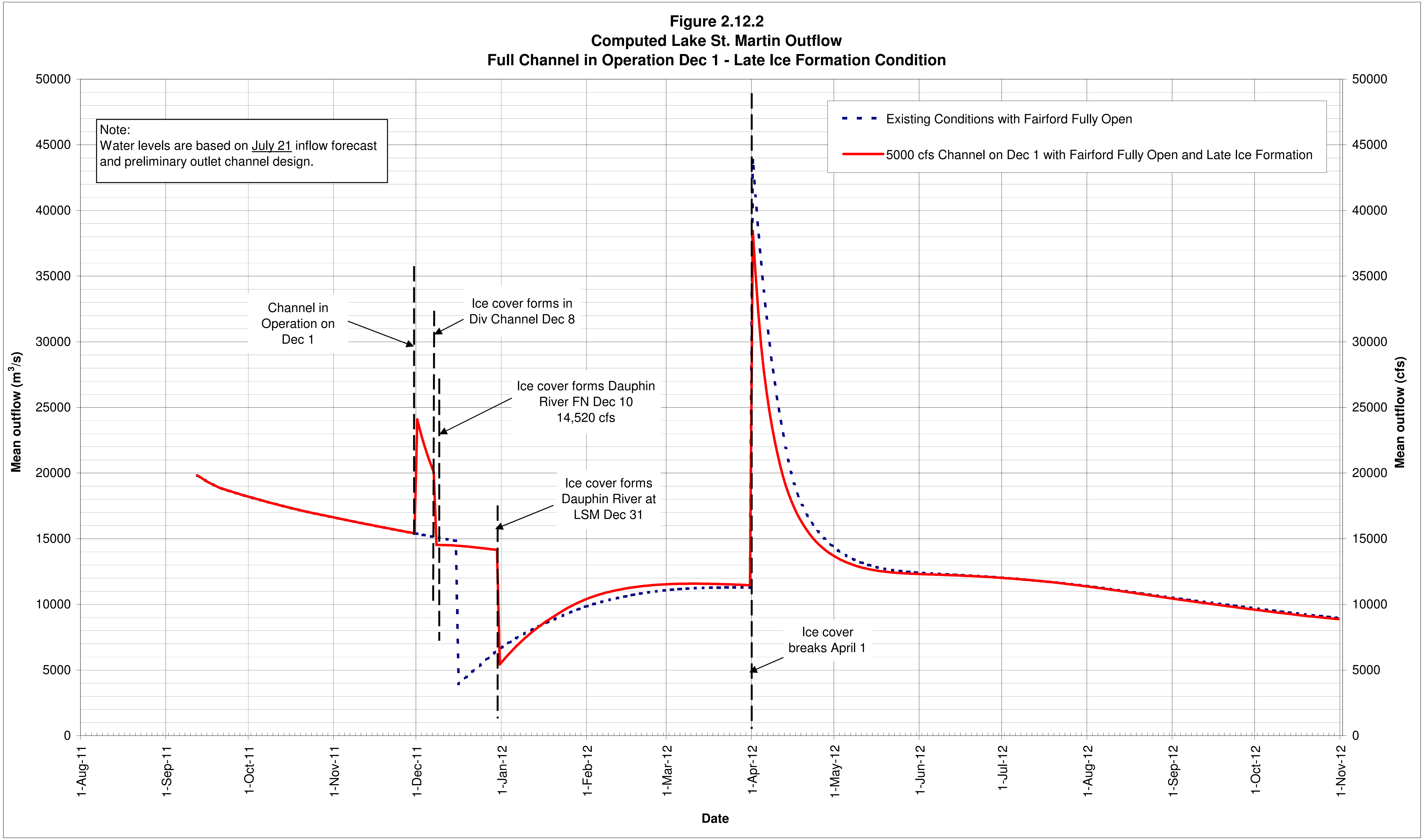


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**Lake Manitoba Forecast**
**Correspondence and Figures**

**October 11, 2011**

## Garrett Wellwood

**From:** Patrice Leclercq [PLeclercq@kgsgroup.com]
**Sent:** Friday, March 01, 2013 8:01 AM
**To:** 'Patrice Leclercq'
**Subject:** FW: URGENT - Lake Manitoba Forecast
**Attachments:** 0.75 Channel Nov 1 Late Q.pdf; 0.75 Channel Nov 1 Late WL.pdf; 0.75 Channel Nov 1 Normal Q.pdf; 0.75 Channel Nov 1 Normal WL.pdf; 0.75 Channel Nov 1 Early Q.pdf; 0.75 Channel Nov 1 Early WL.pdf; Figure 1.1.2_RevB.PDF; Figure 1.1.1_RevA.PDF

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**From:** Colin Siepman [mailto:CSiepman@kgsgroup.com]
**Sent:** October-19-11 3:48 PM
**To:** Steve Topping
**Cc:** Rick Carson; Brian Bodnaruk; Karl-Erich Lindenschmidt; Ron Richardson
**Subject:** RE: URGENT - Lake Manitoba Forecast

Steve,

I believe these are the graphs that you requested for a 75% LSM Channel in service on Nov 1st. They are the same as the ones that I forwarded to you a few weeks ago.

Note that these graphs assume:

1. The Fairford River remains fully open and unrestricted by ice (this is still under review).
2. The LSM channel inlet is dredged successfully (this is currently not on schedule for Nov 1st)

Regards,

Colin Siepman, B.Sc. CE, M.Eng, P.Eng
Senior Project Manager
KGS Group

---

**From:** Rick Carson [mailto:rcarson@kgsgroup.com]
**Sent:** October 17, 2011 10:06 PM
**To:** Colin Siepman; bbodnaruk@kgsgroup.com
**Cc:** steve.topping@gov.mb.ca
**Subject:** Fwd: URGENT - Lake Manitoba Forecast

See request from Steve Topping below.

Begin forwarded message:

> **From:** "Topping, Steve (MWS)" <Steve.Topping@gov.mb.ca>
> **Date:** October 17, 2011 2:41:42 PM MST
> **To:** "Rcarson@kgsgroup.com" <Rcarson@kgsgroup.com>
> **Subject: FW: URGENT - Lake Manitoba Forecast**
>
> Rick, as per Deputy Minister Norquay's request could you have Brian forward the long range projections for Lake Manitoba and Lake St Martin.
>
> Thank you

Steven D. Topping, P. Eng.
Executive Director
Regulatory and Operational Services Division
Manitoba Water Stewardship
Phone: (204) 945-7488
Fax: (204) 945-7419
e-mail: steve.topping@gov.mb.ca

-----Original Message-----
From: Norquay, Don [mailto:Don.Norquay@leg.gov.mb.ca]
Sent: October-17-11 4:34 PM
To: Topping, Steve (MWS)
Cc: Williamson, Dwight (MWS); Beattie, Shannon (LEG); Wereta, Grace (LEG)
Subject: URGENT - Lake Manitoba Forecast
Importance: High

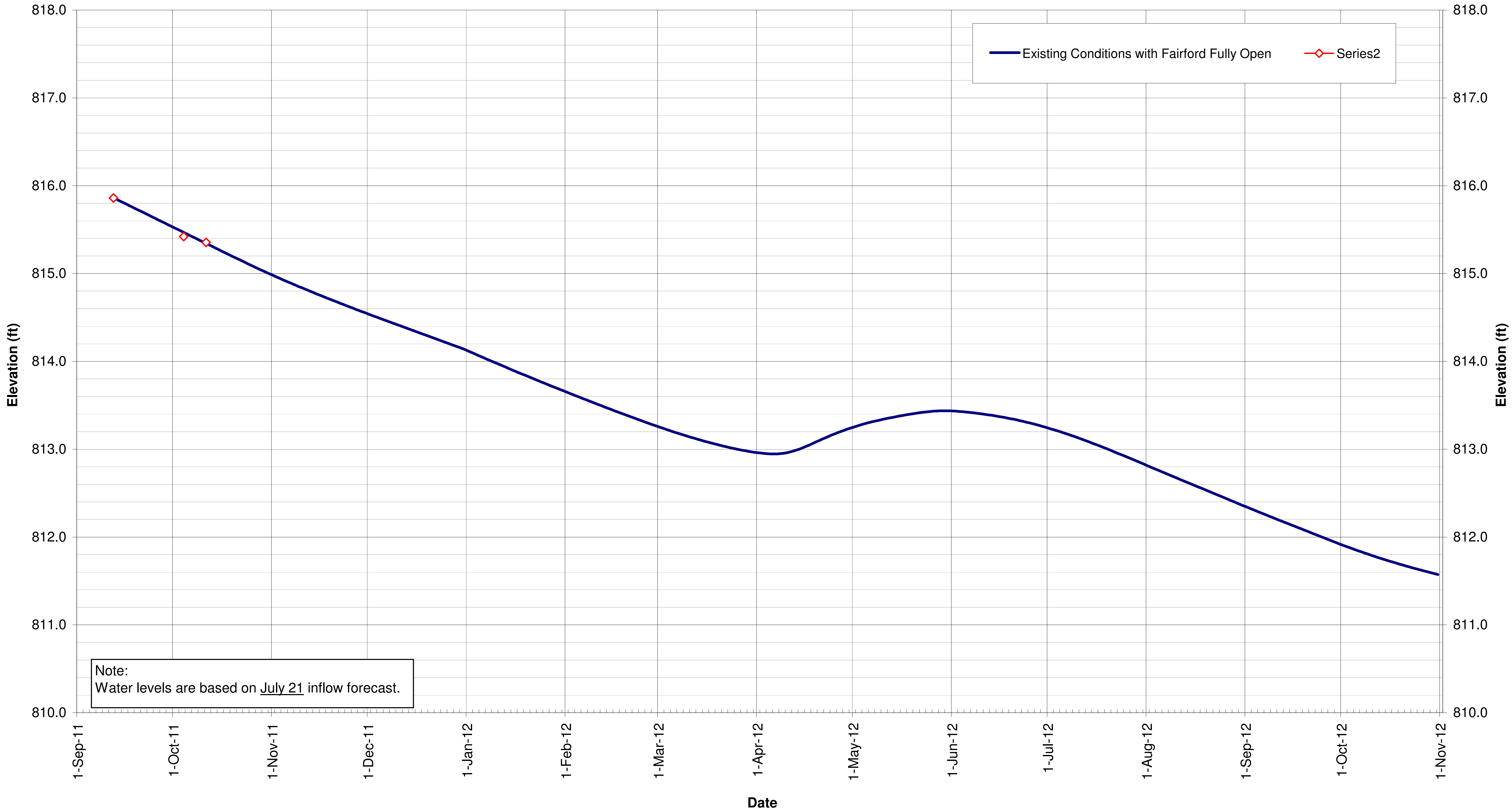
We need a revised long-range forecast on Thursday this week for Lake Manitoba and Lake St. Martin, assuming LSM emergency channel operation commencing November 1st at 75% of its original design capacity and Fairford dam flows at full capacity.

I assume that updating the hydrographs prepared by the consultants with our input around the time of the announcement of the emergency channel project is doable and will meet this need.

Please advise how you will be proceeding and call me to clarify direction as necessary.

Thanks.

# Figure 1.1.1 RevB
## Computed Lake Manitoba Level
## Fairford Fully Open

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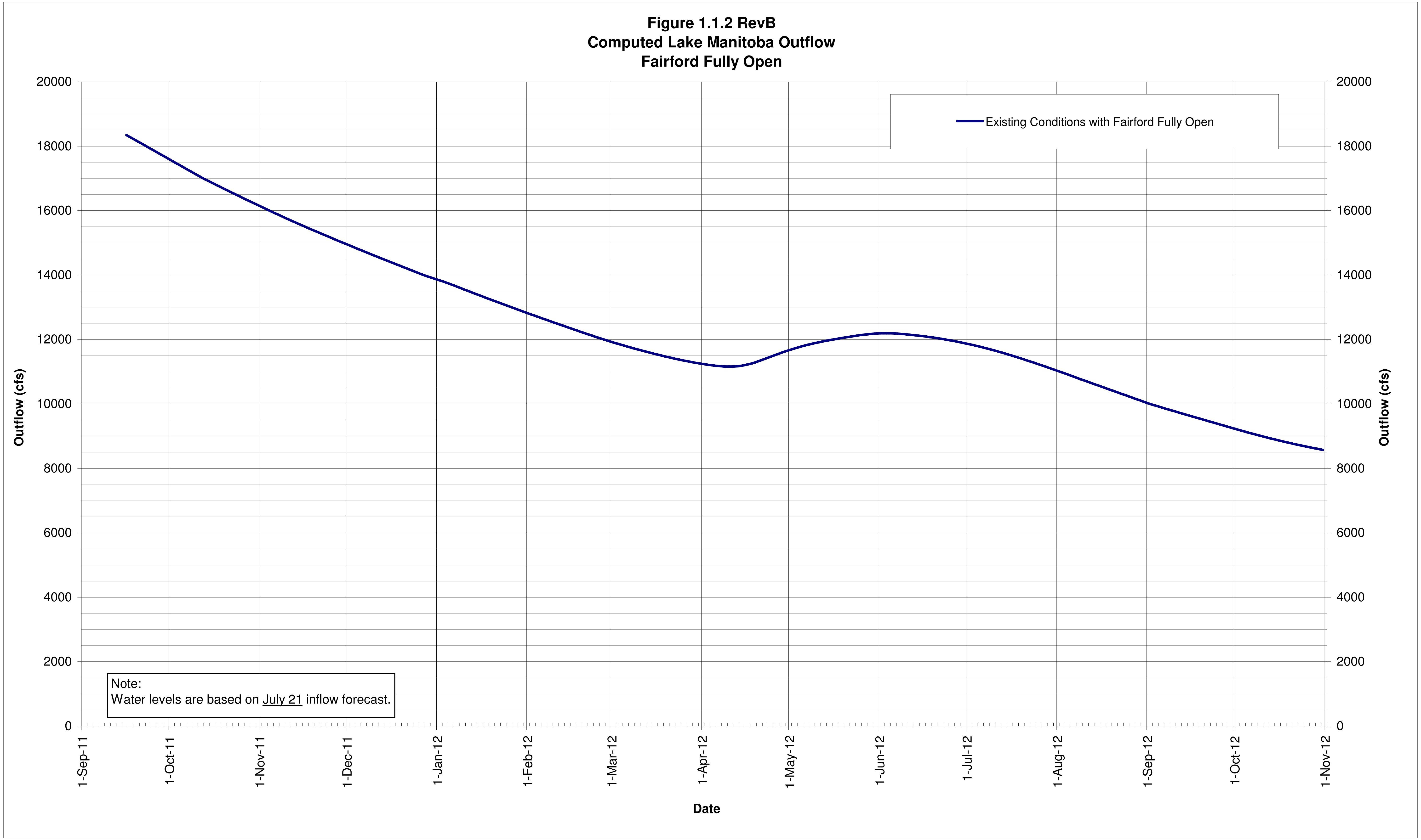
11-0300-18
10/11/2011

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11-0300-18
10/3/2011

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**Lake Manitoba Forecast**
**Correspondence and Figures**

**November 8, 2011**

**Garrett Wellwood**

---

**From:** Patrice Leclercq [PLeclercq@kgsgroup.com]
**Sent:** Friday, March 01, 2013 8:02 AM
**To:** 'Patrice Leclercq'
**Subject:** FW: Computed Discharges on Diversion Channel, Dauphin River and LSM Water Levels
**Attachments:** Lake St Martin Outflow Summary Inlet 50% Removed.xls

---

**From:** Brian Bodnaruk [mailto:BBodnaruk@kgsgroup.com]
**Sent:** November-08-11 12:49 PM
**To:** 'Colin Siepman'; Richardson, Ron (MIT)
**Cc:** Kaatz, Ron G (MIT)
**Subject:** Computed Discharges on Diversion Channel, Dauphin River and LSM Water Levels

As requested, I have attached a file listing the computed discharges on the Diversion Channel and the Dauphin River and water levels on Lake St Martin from today until March 31. For the Diversion channel, the entrance plug has been assumed to be opened 50 percent. Also, it has been assumed that the Diversion Channel would be ice covered by November 20 and that the Dauphin River outlet at Lake St Martin would be ice covered on December 15.

Brian Bodnaruk, P. Eng.

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Winnipeg, Manitoba
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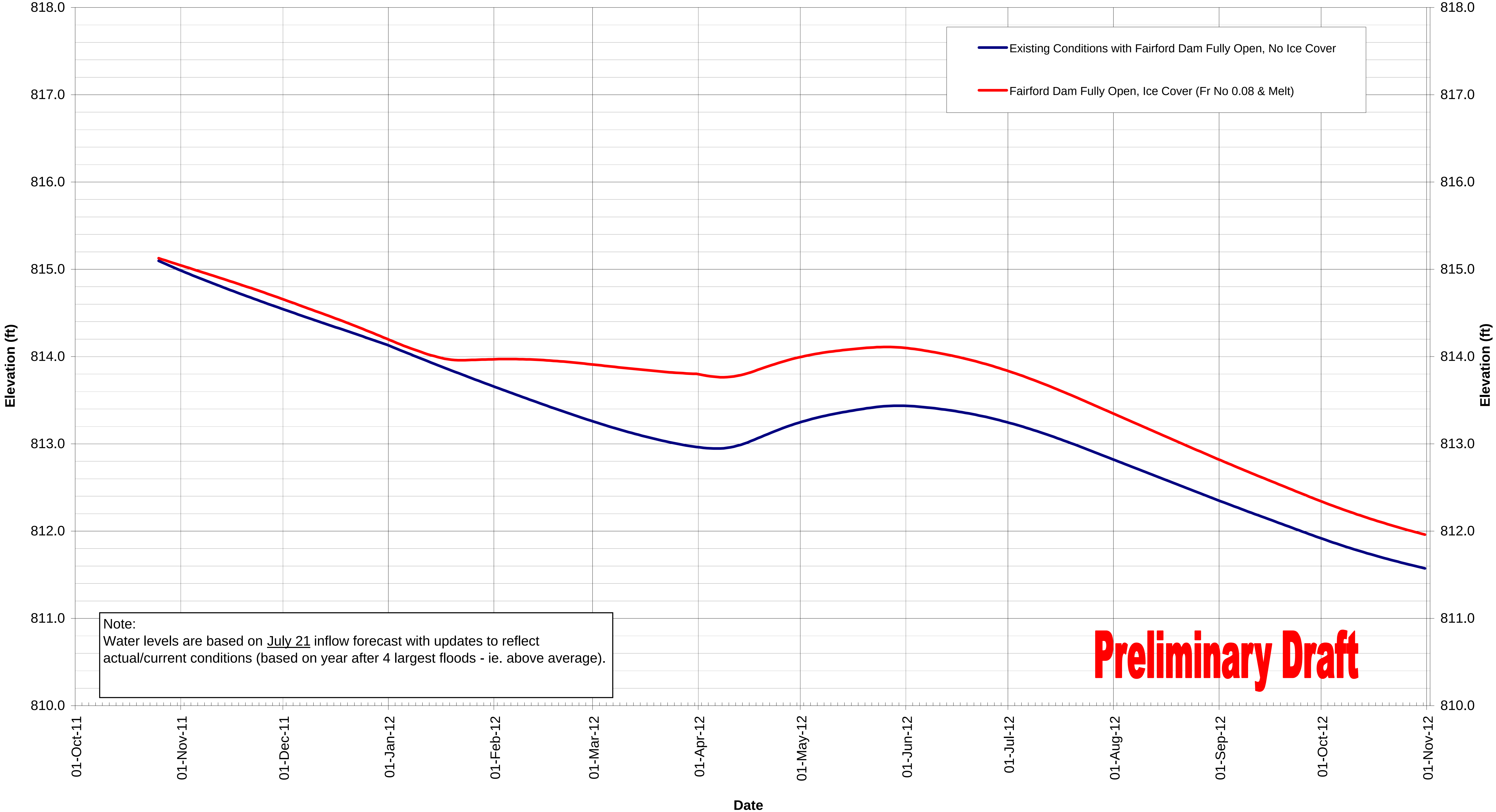
Switch Board - 204.896.1209
Fax - 204.896.0754
bbodnaruk@kgsgroup.com

**Figure 1.1.1 RevC**
**Computed Lake Manitoba Level**
**Fairford Fully Open**

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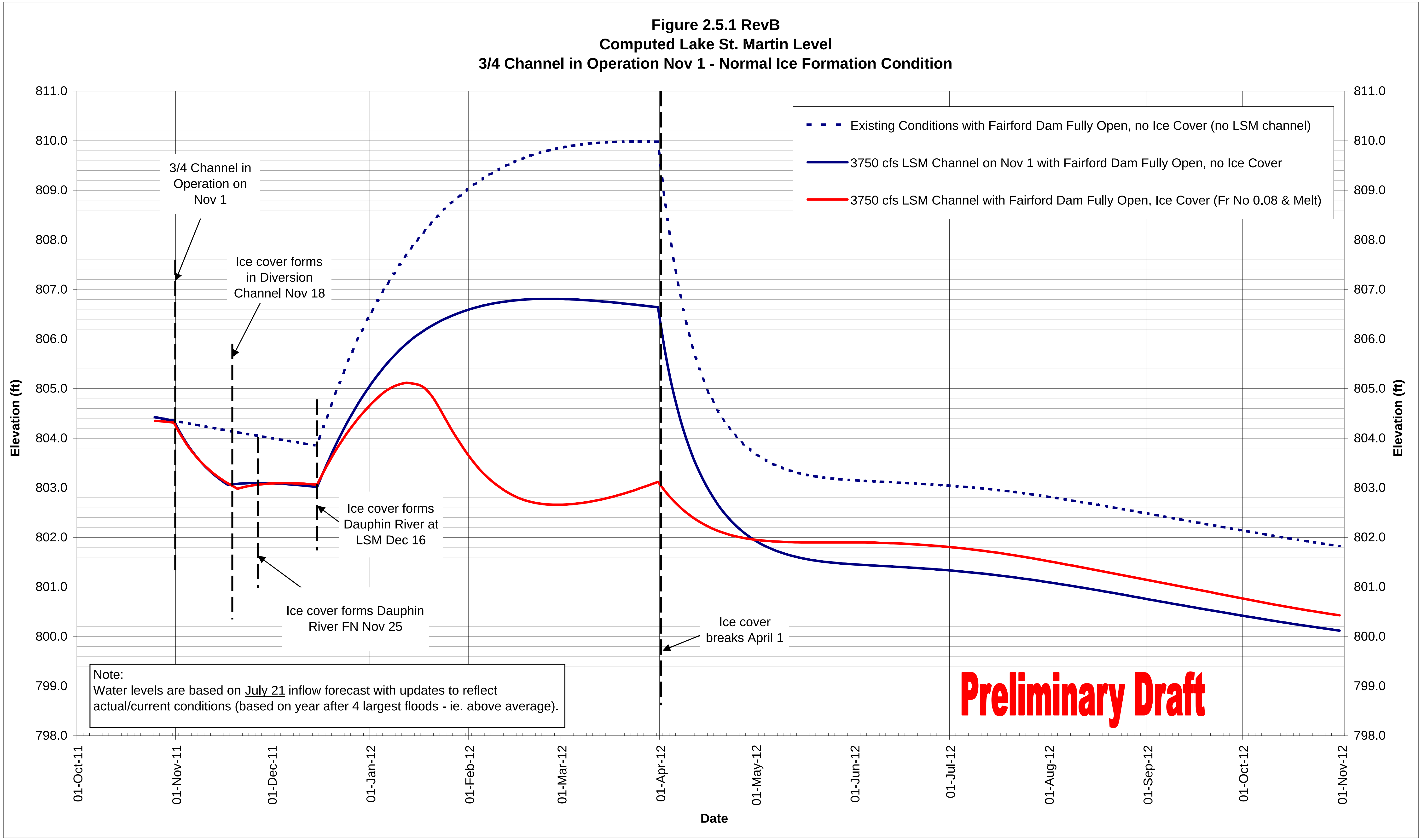
11-0300-18
08/11/2011




Note:
Water levels are based on July 21 inflow forecast with updates to reflect actual/current conditions (based on year after 4 largest floods - ie. above average).

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08/11/2011

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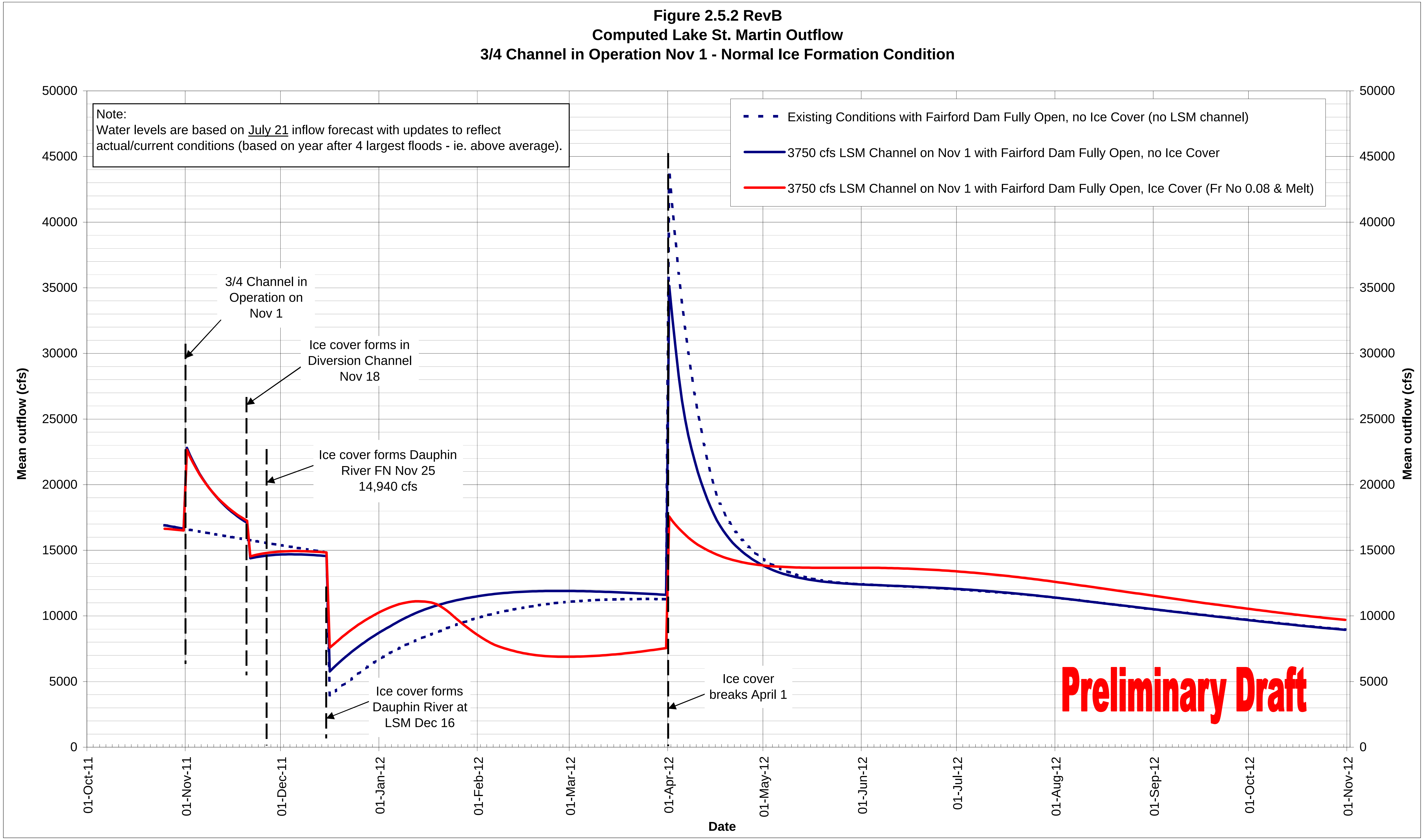


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08/11/2011

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**Lake Manitoba Forecast**
**Correspondence and Figures**

**December 1, 2011**

## Garrett Wellwood

**From:** Patrice Leclercq [PLeclercq@kgsgroup.com]
**Sent:** Friday, March 01, 2013 8:02 AM
**To:** 'Patrice Leclercq'
**Subject:** FW: Performance of the LSM emergency outlet
**Attachments:** Lake Manitoba WL Forecast.pdf; LSM Water Level Forecast.pdf; LSM Outflow Forecast.pdf

---

**From:** Brian Bodnaruk [mailto:BBodnaruk@kgsgroup.com]
**Sent:** December-01-11 11:36 AM
**To:** 'Topping, Steve (MWS)'; Eric.Blais@aecom.com; 'McNeil, Doug (LEG)'; 'Weatherburn, Ron (MIT)'; 'McMahon, Doug (MIT)'; 'Halayko, Larry (MIT)'; 'Richardson, Ron (MIT)'; 'Kaatz, Ron G (MIT)'; mark.allard@govmb.ca; 'Smyrski, Tim (MIT)'; 'Lovie, Mark (MIT)'; Rcarson@kgsgroup.com; csiepman@kgsgroup.com; 'Lindenschmidt, Karl-Erich (MWS)'
**Cc:** Jim.Friesen@aecom.com; Geoff.Hutchinson@aecom.com
**Subject:** RE: Performance of the LSM emergency outlet

The forecasted water level on Lake Manitoba and Lake St Martin water level and total outflow are attached based mild temperature conditions persisting for the next 10 days. The LSM charts have been revised from those submitted yesterday to correct an error in the Dauphin R outflow. The correct discharge on the Dauphin River on Nov 30 should have read 11,300 cfs not 14,100 cfs. A linear interpolation function of the Lake St Martin outflow rating curve was used rather than the correct curvilinear interpolation. The forecast for Lake Manitoba was not affected by the error.

Brian Bodnaruk, P. Eng.

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Switch Board - 204.896.1209
Fax - 204.896.0754
bbodnaruk@kgsgroup.com

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**From:** Topping, Steve (MWS) [mailto:Steve.Topping@gov.mb.ca]
**Sent:** Thursday, December 01, 2011 10:06 AM
**To:** 'Eric.Blais@aecom.com'; 'BBodnaruk@kgsgroup.com'; McNeil, Doug (LEG); Weatherburn, Ron (MIT); McMahon, Doug (MIT); Halayko, Larry (MIT); Richardson, Ron (MIT); Kaatz, Ron G (MIT); 'mark.allard@govmb.ca'; Smyrski, Tim (MIT); Lovie, Mark (MIT); 'Rcarson@kgsgroup.com'; 'csiepman@kgsgroup.com'; Lindenschmidt, Karl-Erich (MWS)
**Cc:** 'Jim.Friesen@aecom.com'; 'Geoff.Hutchinson@aecom.com'
**Subject:** Re: Performance of the LSM emergency outlet

Would either firm have graphs of projected levels of Lake St Martin and Lake Manitoba given the better understanding of the LSM channel and the prolonged open water season?
--------------------------
Sent from my BlackBerry Wireless Handheld

---

**From**: Blais, Eric <Eric.Blais@aecom.com>
**To**: Brian Bodnaruk <BBodnaruk@kgsgroup.com>; McNeil, Doug (LEG); Weatherburn, Ron (MIT); McMahon, Doug (MIT); Halayko, Larry (MIT); Richardson, Ron (MIT); Kaatz, Ron G (MIT); mark.allard@govmb.ca <mark.allard@govmb.ca>; Smyrski, Tim (MIT); Lovie, Mark (MIT);

RCarson@kgsgroup.com <RCarson@kgsgroup.com>; csiepman@kgsgroup.com <csiepman@kgsgroup.com>; Topping, Steve (MWS); Lindenschmidt, Karl-Erich (MWS); CSiepman@kgsgroup.com <CSiepman@kgsgroup.com>
**Cc**: Friesen, Jim <Jim.Friesen@aecom.com>; Hutchinson, Geoff <Geoff.Hutchinson@aecom.com>
**Sent**: Thu Dec 01 09:32:23 2011
**Subject**: RE: Performance of the LSM emergency outlet

Brian,
Not to quibble over the numbers but the data doesn't support the degree of precision that you have presented.
The values I quoted were based on the observed trends as shown on the data below.
Dauphin river flows have been dropping steadily since the channel has been opened as have the Fairford flows (with minor wind generated fluctuations).
I would suggest that the recent jumps in flow rates on the Dauphin have more to do with a problem with the measuring device than any fluctuation in flow, as we commonly see these problems at this time of year.
At the end of the day the drop in Lake St. Martin is the best indication of the relative difference between inflow and outflow.
Eric

# DAUPHIN RIVER NEAR DAUPHIN RIVER [MB] (05LM006)

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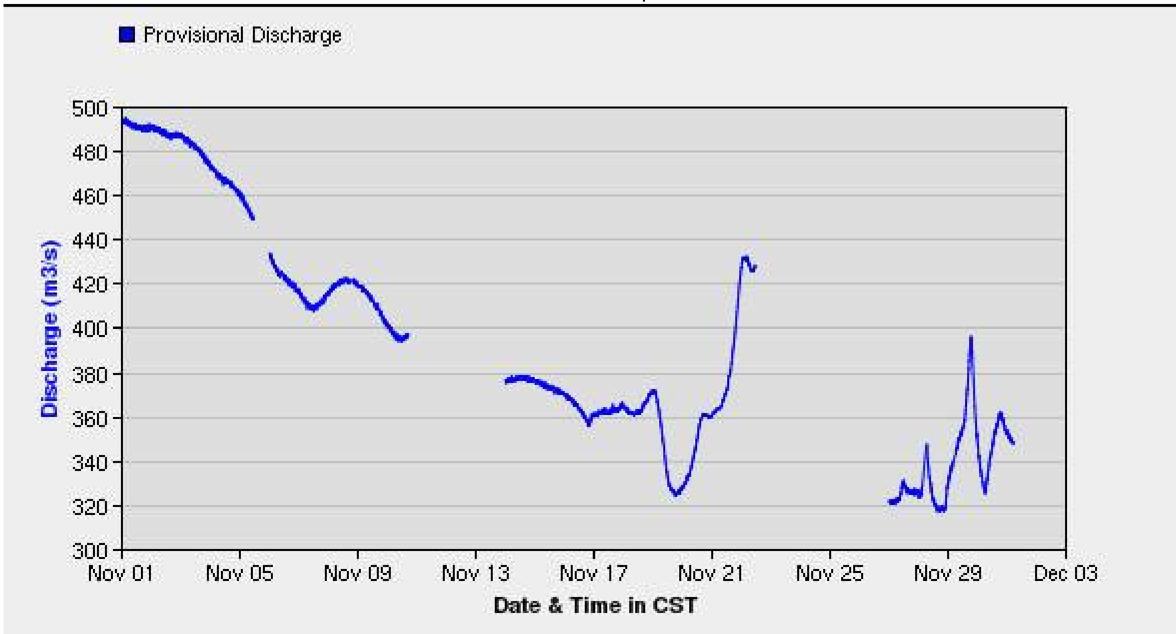


# FAIRFORD RIVER NEAR FAIRFORD [MB] (05LM001)

Top of Form


Bottom of Form
Bottom of Form

**Eric-L. Blais B.Sc., M.A.**
Manager, Water Resources
D 204 928 7405
C 204 223 3140
eric.blais@aecom.com

**AECOM**
99 Commerce Drive
Winnipeg, MB R3P 0Y7
T 204 477 5381
www.aecom.com



---

**From:** Brian Bodnaruk [mailto:BBodnaruk@kgsgroup.com]
**Sent:** November 30, 2011 5:56 PM
**To:** 'McNeil, Doug'; Blais, Eric; 'Weatherburn, Ron (MIT)'; 'McMahon, Doug (MIT)'; 'Halayko, Larry (MIT)'; 'Richardson, Ron (MIT)'; 'Kaatz, Ron G (MIT)'; mark.allard@govmb.ca; 'Smyrski, Tim (MIT)'; 'Lovie, Mark (MIT)'; RCarson@kgsgroup.com; csiepman@kgsgroup.com; 'Topping, Steve (MWS)'; 'Lindenschmidt, Karl-Erich (MWS)'; CSiepman@kgsgroup.com
**Subject:** RE: Performance of the LSM emergency outlet

We have adjusted the inflow to Lake Manitoba based on observed Lake Winnipegosis outflows and Lake Manitoba water levels. The inflow to Lake Manitoba was routed through the Fairford Control Structure and LSM. The following discharges have been computed for November 30.

| | |
|---|---|
| Inflow to Lake Manitoba | 9,165 cfs |
| Lake Manitoba Outflow (Fairford CS) | 15,447 cfs |

| | |
|---|---|
| Lake St Martin Inflow | 15,447 cfs |
| Diversion Channel Flow | 5,447 cfs |
| Dauphin R Discharge | 14,100 cfs |
| Total LSM outflow | 19,582 cfs |

The routed flows through L Manitoba and LSM are shown on the attached Charts

The chart for LSM shows freeze-up of the Diversion Channel to occur on December 10 and freeze-up of the Dauphin River at the outlet of LSM to occur on January 7. Based on these freeze-up date assumptions, the level on LSM is calculated to fall by another 0.5 ft by December 10.

Looking at forecasted temperatures at Gypsumville for the next 2 week period, the temperatures appear to be too mild to have freeze-up to occur by Dec 10. If the date of freeze-up of the Diversion Channel occurs later than Dec 10, the water level on LSM will fall even further.

Brian Bodnaruk, P. Eng.

KGS Group - Consulting Engineers
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865 Waverley Street
Direct Line - 204.478.3235
Switch Board - 204.896.1209
Fax - 204.896.0754
bbodnaruk@kgsgroup.com

---

**From:** McNeil, Doug [mailto:Doug.McNeil@leg.gov.mb.ca]
**Sent:** Wednesday, November 30, 2011 2:59 PM
**To:** 'Blais, Eric'; Weatherburn, Ron (MIT); McMahon, Doug (MIT); Halayko, Larry (MIT); Richardson, Ron (MIT); Kaatz, Ron G (MIT); mark.allard@govmb.ca; Smyrski, Tim (MIT); Lovie, Mark (MIT); BBodnaruk@kgsgroup.com; RCarson@kgsgroup.com; csiepman@kgsgroup.com; Topping, Steve (MWS); Lindenschmidt, Karl-Erich (MWS)
**Subject:** RE: Performance of the LSM emergency outlet

Thanks for this – it will be helpful when I meet with the Lake Manitoba groups, and I have one meeting coming up within two weeks.

*Doug*

Doug McNeil, M.Eng., P.Eng.
Deputy Minister, Manitoba Infrastructure and Transportation
Room 209 Legislative Building
Winnipeg MB R3C 0V8
Legislative Building Phone: 945-3768 FAX: 945-4766

---

**From:** Blais, Eric [mailto:Eric.Blais@aecom.com]
**Sent:** Wednesday, November 30, 2011 2:20 PM
**To:** Weatherburn, Ron (MIT); McMahon, Doug (MIT); Halayko, Larry (MIT); Richardson, Ron (MIT); Kaatz, Ron G (MIT); mark.allard@govmb.ca; Smyrski, Tim (MIT); Lovie, Mark (MIT); BBodnaruk@kgsgroup.com; RCarson@kgsgroup.com; csiepman@kgsgroup.com; Topping, Steve (MWS); Lindenschmidt, Karl-Erich (MWS); McNeil, Doug
**Subject:** Performance of the LSM emergency outlet

We have done some calculations based on data from Water Survey of Canada to gauge the performance of the emergency works up until November 28th.

As of November 1 Lake Manitoba had dropped approximately 2.2' from the peak water level. It dropped an additional 0 .15' from November 1 to the 28th to a level of approximately 814.95' or a total of 2.35'.

Lake St. Martin had only dropped 1.2' from peak to November 1 and has dropped an additional 1.6' between November 1 and 28th, for a total of 2.8' and a water level of approximately 802.8'.

Based on the area of Lake St. Martin the 1.6' drop over 28 days (approximately 0.7"/day) would mean that the outflow rates have (on average) exceeded inflow rates by approximately 2300cfs over the 28 day period.

Since we are still dealing with open water conditions it was possible to use the open water rating curves to support this estimate.

Based on Monday's water levels the Fairford flow should have been approximately 15,000 cfs, Dauphin River approximately 12,000 cfs and the emergency outlet channel (based on design conditions) approximately 6,000 cfs. This would give a difference of 3,000 cfs,

Since we know that the channel is performing at slightly less than the design, these numbers would support the value computed from water levels.

Regards

**Eric-L. Blais B.Sc., M.A.**

Manager, Water Resources

D 204 928 7405

C 204 223 3140

eric.blais@aecom.com

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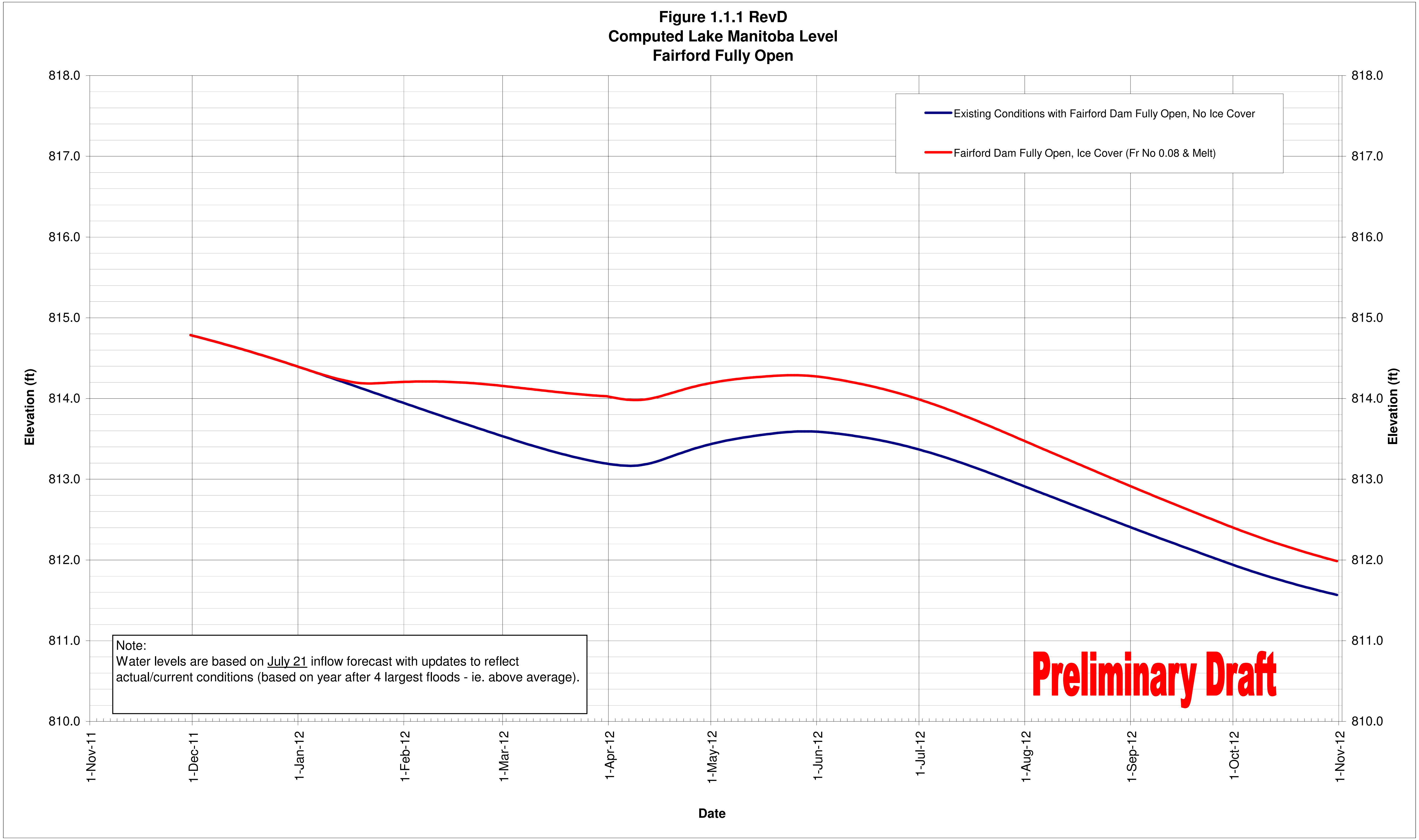


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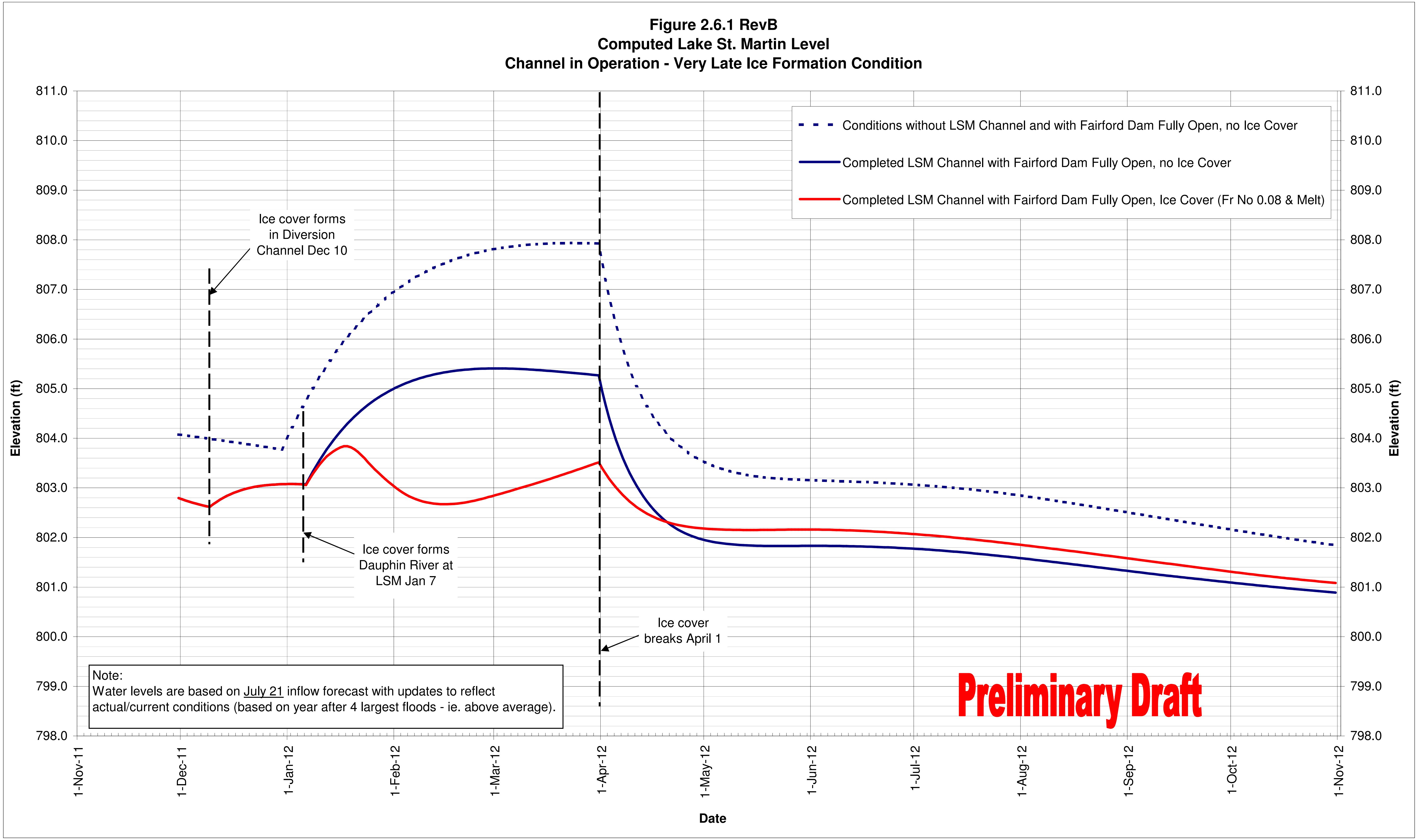


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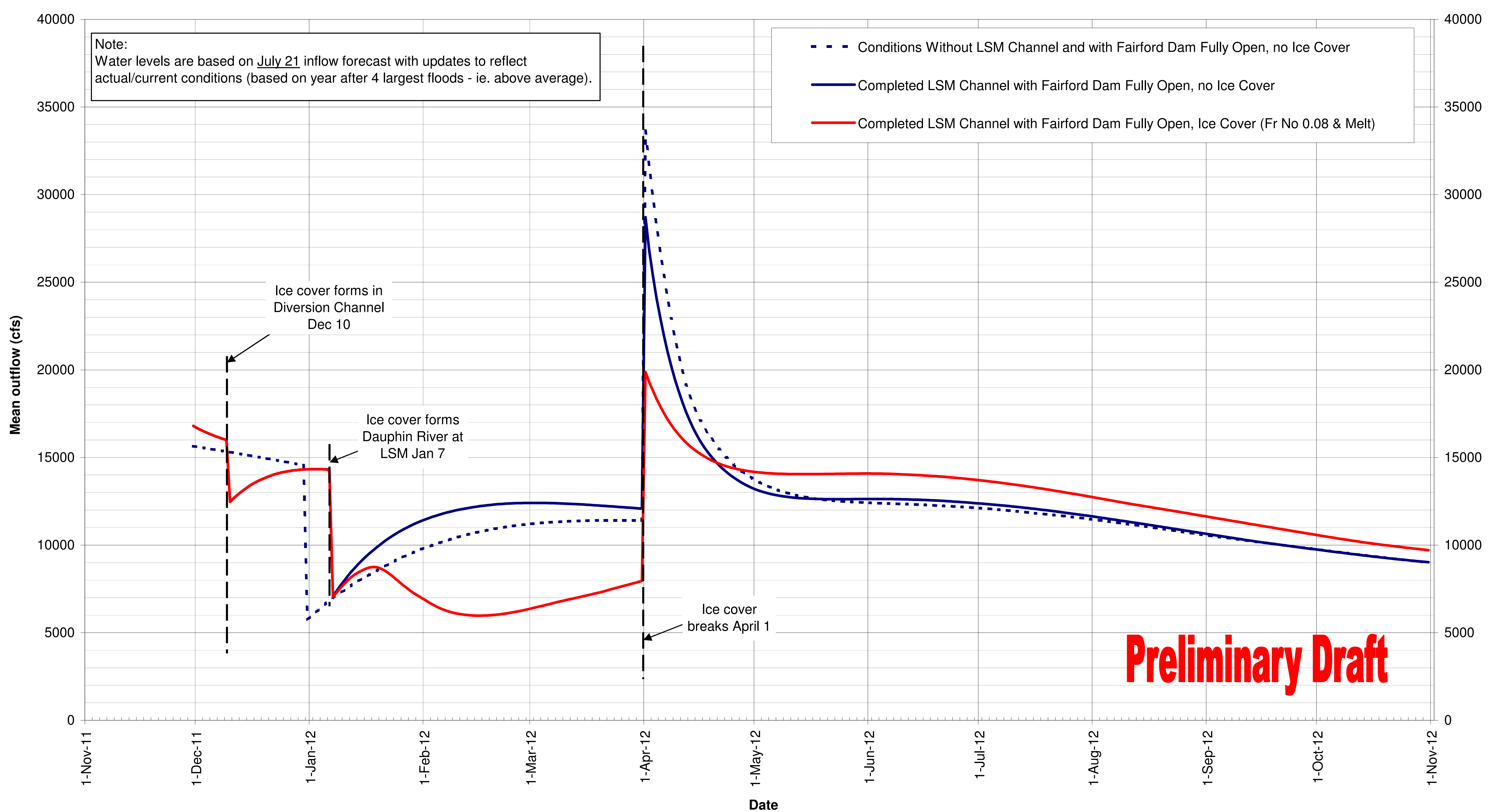
## Figure 2.6.2 RevB
## Computed Lake St. Martin Outflow
## Channel in Operation - Very Late Ice Formation Condition

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**Lake Manitoba Forecast**
**Correspondence and Figures**

**January 5, 2012**

## Garrett Wellwood

**From:** Colin Siepman [CSiepman@kgsgroup.com]

**Sent:** Thursday, January 05, 2012 7:14 PM

**To:** Mark Allard

**Cc:** Bert Smith; Rob Kenyon; Tony Ng; Brian Bodnaruk; Steve Offman; Patrice Leclercq

**Subject:** RE: Reach 3 - Design Update Meeting - Jan 3

**Follow Up Flag:** Follow up

**Flag Status:** Red

**Attachments:** Figure 2.13.1.pdf; Figure 2.13.2.pdf; Figure 2.13.2b.pdf; Figure 2.14.1.pdf; Figure 2.14.2.pdf

Mark,

As discussed at our Jan 3 meeting, projected future water levels on LSM near the end of this winter are decreasing more than originally forecast due to extended open water conditions. Therefore additional alternatives may now be possible.

The original justification for Reach 3 was to reduce river staging during the spring 2012 ice breakup and correspondingly reduce the risk of overtopping the dikes recently constructed at the Dauphin River Communities. The Dauphin River dikes were constructed to accommodate a spring breakup flow of roughly 24,000 cfs with the assumption that any flows above this value would be passed through Reach 3.

Considering that we are still experiencing mild weather and open water conditions we have updated our forecasts based on three new ice formation dates of Jan 25, Feb 1 & Feb 22 (Figures are attached). Based on current long range weather forecasts an ice formation date of Feb 1 is probable, therefore a date of Jan 25 could be considered conservative.

**Alternative 1 - Reduce Reach 3 Capacity**

For the Jan 25 case the peak Reach 1 flow would be 8500 cfs and the combined Dauphin River flow would be 27,000 cfs if Reach 3 is not constructed (Fig 2.13.2 & 2.13.2b). Since the limit for the DR dikes is 24,000 cfs a minimum capacity of 3000 cfs is required for Reach 3. To be conservative we have considered an alternate Reach 3 channel that has a capacity of 4250 cfs which is 50% of the peak capacity of the tendered channel. This means that the Reach 1 peak spring flow of 8500 cfs would be shared equally between Buffalo Creek and Reach 3. After about 1 month the Reach 1 flow will subside to roughly 4000 cfs and could be handled entirely by Buffalo Creek or by Reach 3 for the remainder of the summer, whichever is considered more advantageous from an environmental perspective.

The base width of the 50% capacity channel would be reduced from 47 m to 21 m and the excavation volume would decrease from 915,000 to roughly 500,000 cu. m. (to be confirmed). A long-term analysis has not been performed but the 4250 cfs channel should be capable of handling the entire Reach 1 peak flow in the future if it were made permanent (may be necessary since DR dikes will be removed).

**Alternative 2 – Temporary Closure of Reach 1 in Spring**

For the Jan 25 case the peak combined Dauphin River flow would be 24,300 cfs (Fig 2.14.2). This is essentially equal to the 24,000 cfs limit for the DR dikes. For the current analysis it has been conservatively assumed that the Reach 1 channel would be closed for 0.5 months prior and 0.5 months after the spring ice breakup since the exact timing of the closure may be difficult to predict. Closing the Reach 1 channel for this 1 month period would increase the peak spring level on Lake St. Martin from 805 ft to about 806 ft but would have a negligible effect shortly thereafter.

Note that, unless a permanent road were constructed, there would be no access to bring in assistance if something went awry during installation & removal of the closure and any equipment used would be temporarily stranded until it could be removed by barge. Since a long-term analysis has not been performed it is not clear if Reach 1 could be operated in this manner in the future if made permanent (since the DR dikes will be removed).

**Reach 3 - Sediment Transport Models**

We completed the sediment transport model for the following Reach 3E options:

1) November 25 Tender without Rock Checks
2) November 25 Tender with Rock Checks
3) Drop Structure Option without Rock Checks
4) Drop Structure Option with extension to Willow Point

A 6 month simulation time window (April 1st to October 1st) was selected for the analysis at a constant flow of 115 $m^3/s$ (4000 cfs). The model starts at the Reach 3E inlet and ends in Lake Winnipeg. The model did not allow erosion to occur in the inundated area between the outlet of the channel and Lake Winnipeg but did allow for deposition of the sediments to occur within this area. This inundated area is still being analyzed using a 2D model.

The total cumulative volume of sediments that exit the system is provided below:

1) November 25 Tender without Rock Checks: 190,000 $m^3$
2) November 25 Tender with Rock Checks: 190,000 $m^3$
3) Drop Structure Option without Rock Checks: 95,000 $m^3$
4) Drop Structure Option with extension to Willow Point: 180,000 $m^3$

As a basis for comparison, a total cumulative volume of 190,000 $m^3$ was obtained in our Buffalo Creek sediment model using a 5 month simulation window at 180 cfs, and 231,000 $m^3$ at a flow of 4100 cfs.

From these results, we can make the following conclusions:

- The use of Rock Checks in the inundated area is not an effective way of reducing the total volume of sediments that exit the system.
- The Drop Structure Option significantly reduces the amount of erosion occurring in the channel.
- The extension of the channel to Willow Point increases the potential for erosion within the channel.

Results from this analysis are approximate and should be used qualitatively due to the limitations of the HEC RAS Sediment Transport program to model cohesive sediments.

**Reach 3 Outlet - Impact on Fish & Fish Habitat**

We are still awaiting a summary memo from North/South Consultants comparing the proposed outlet locations east & west of Willow Point.

Regards,

Colin Siepman, B.Sc. CE, M.Eng, P.Eng
Senior Project Manager
KGS Group

---

**From:** Colin Siepman [mailto:CSiepman@kgsgroup.com]
**Sent:** January 2, 2012 10:35 PM
**To:** Mark Allard ; Ron Kaatz; Michael Foth; Paul Graveline; Tony Ng; Brian Bodnaruk; Steve Offman; Patrice Leclercq; Don MacDonell; Warren Bernhardt
**Cc:** Bert Smith; Rob Kenyon; Eric Christiansen; Ron Richardson; Rick Postlethwaite
**Subject:** Reach 3 - Design Update Meeting - Jan 3

The following items have been attached for discussion at the meeting.

1. Buffalo Creek sediment transport model.
2. Updated design summary sheet including Option 3 - Willow Point Channel. Note that the quantity estimate

for Option 2 - Stepped Invert Channel was refined using Civil 3D and has decreased significantly.
3. Willow Point Channel plan and profile
4. Willow Point Channel hydraulic profile

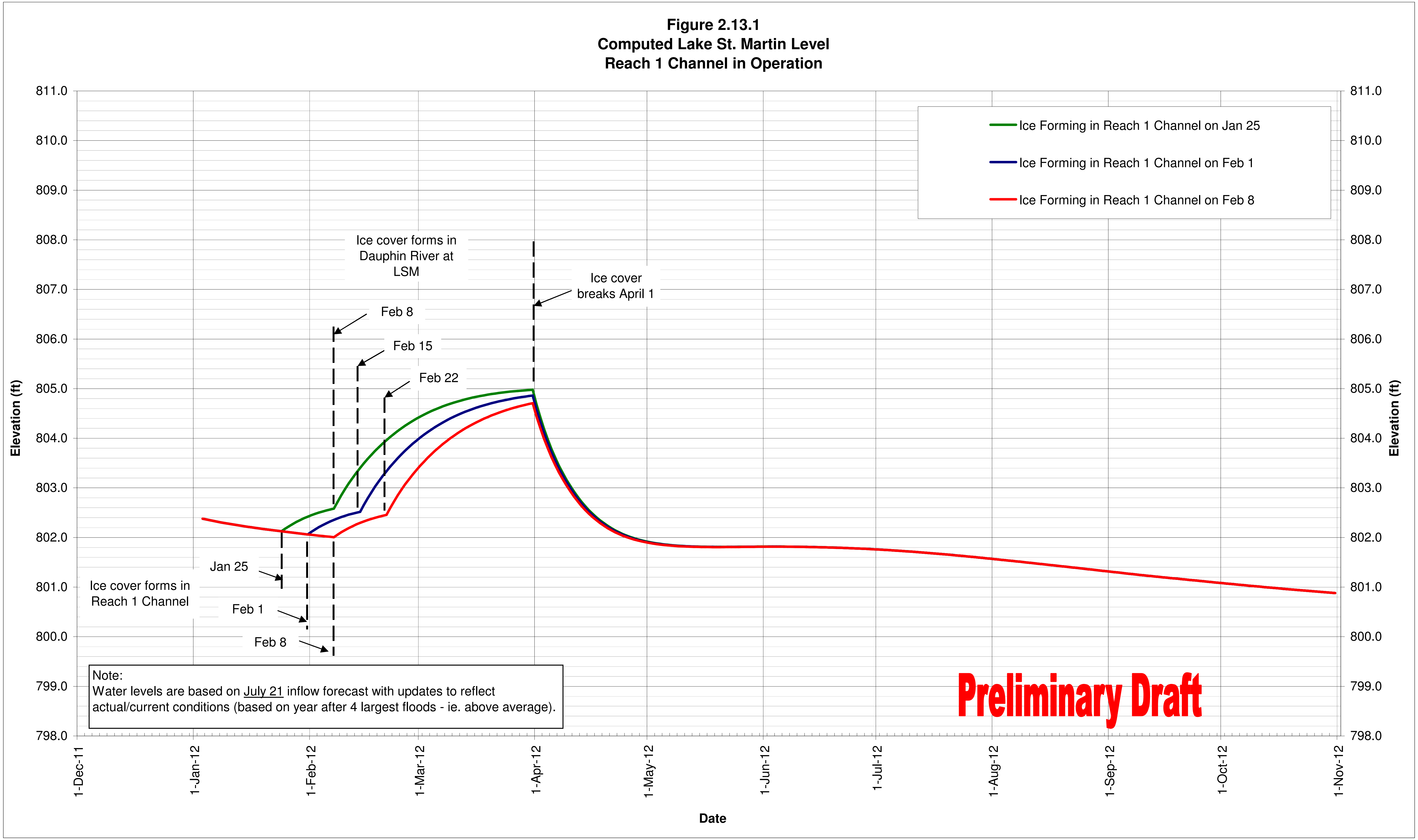
The Willow Point Channel route follows Route 3E to Station 22+300 and then turns East to Station 26+000 and then NE to Lake Winnipeg. The majority of the route must be excavated, as opposed to overland flow, to ensure the flow is directed east of Willow Point. Seven 1-metre high drop structures are required to control erosion similar to the upstream reach.

We will also have some preliminary sediment transport model results for the various Reach 3 channel configurations at the meeting.

Regards,

Colin Siepman, B.Sc. CE, M.Eng, P.Eng
Senior Project Manager
KGS Group

KGS Place
3rd Flr - 865 Waverley St.
Winnipeg, MB, R3T 5P4
Phone : (204) 896-1209
Fax : (204) 896-0754
CSiepman@kgsgroup.com

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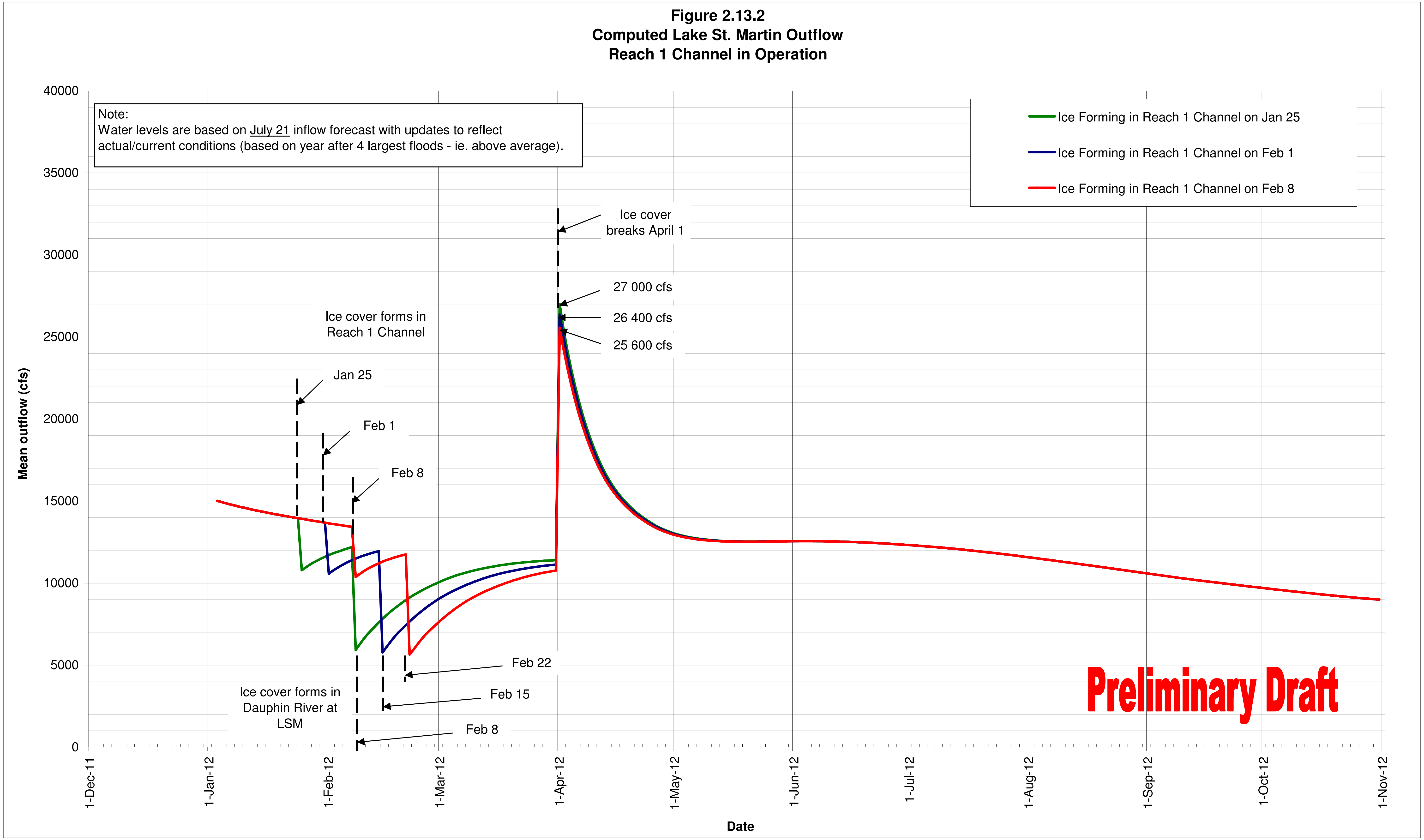


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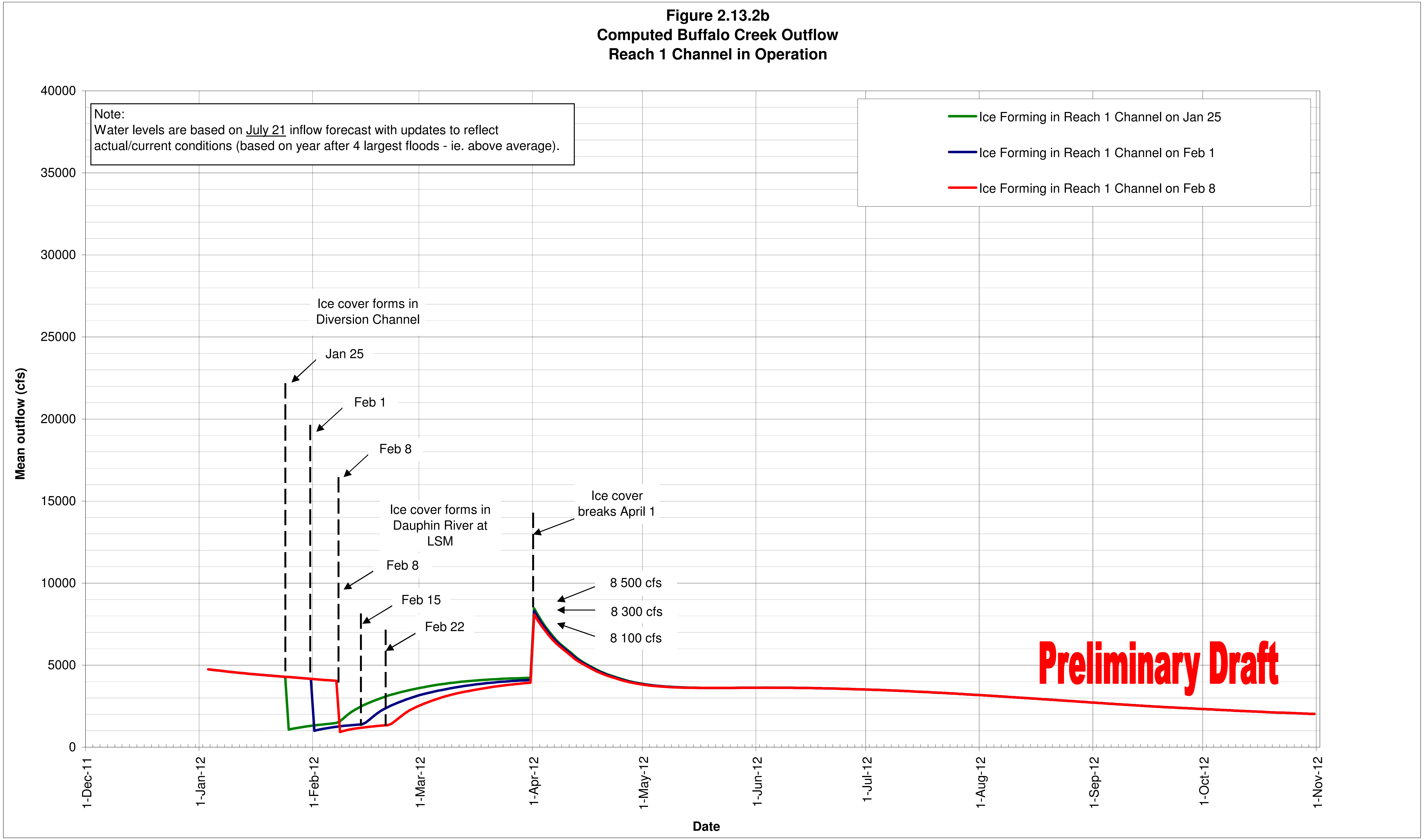


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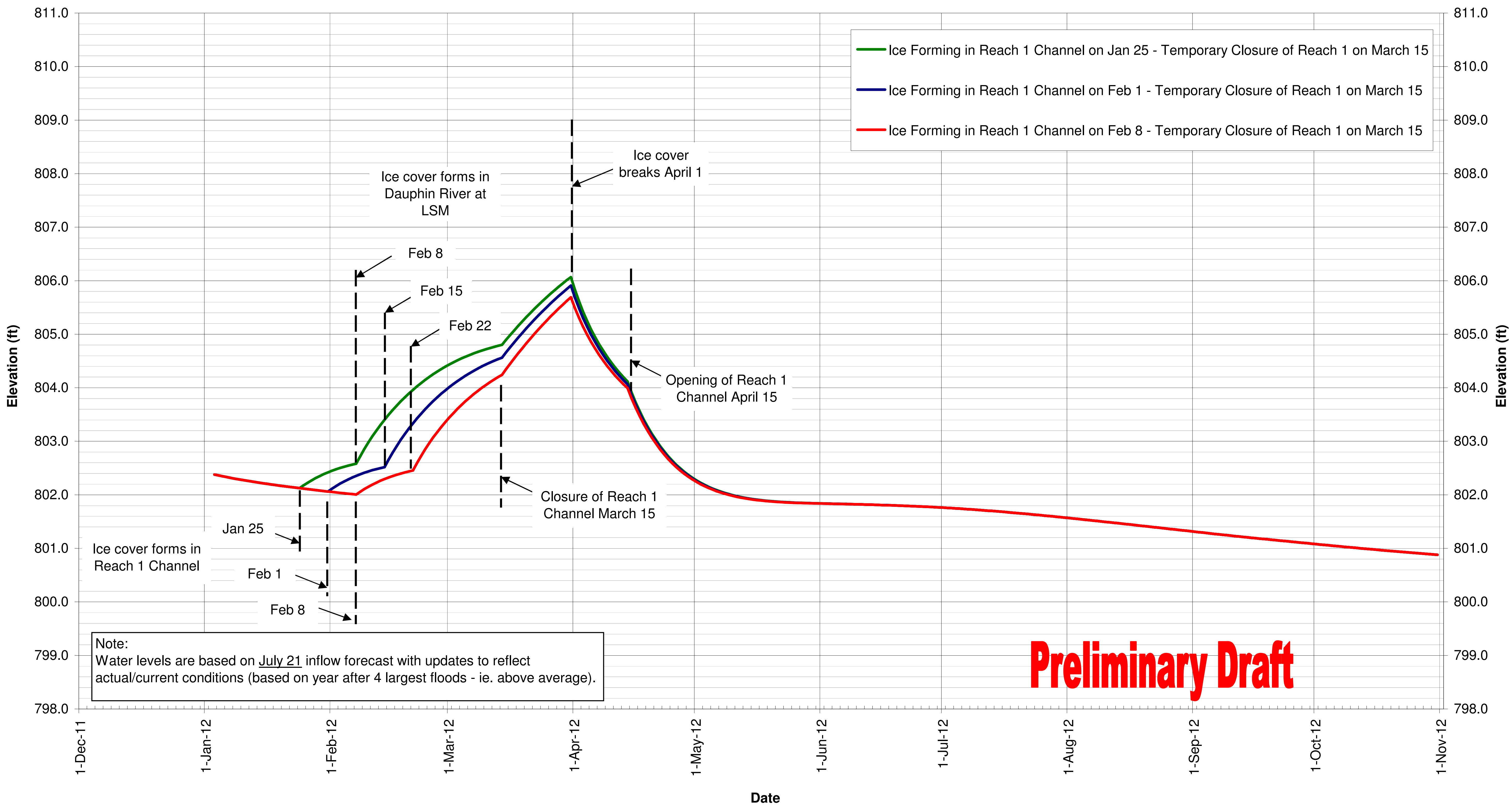
**Figure 2.14.1**
**Computed Lake St. Martin Level**
**Temporary Closure of Reach 1 Channel During Ice Breakup**

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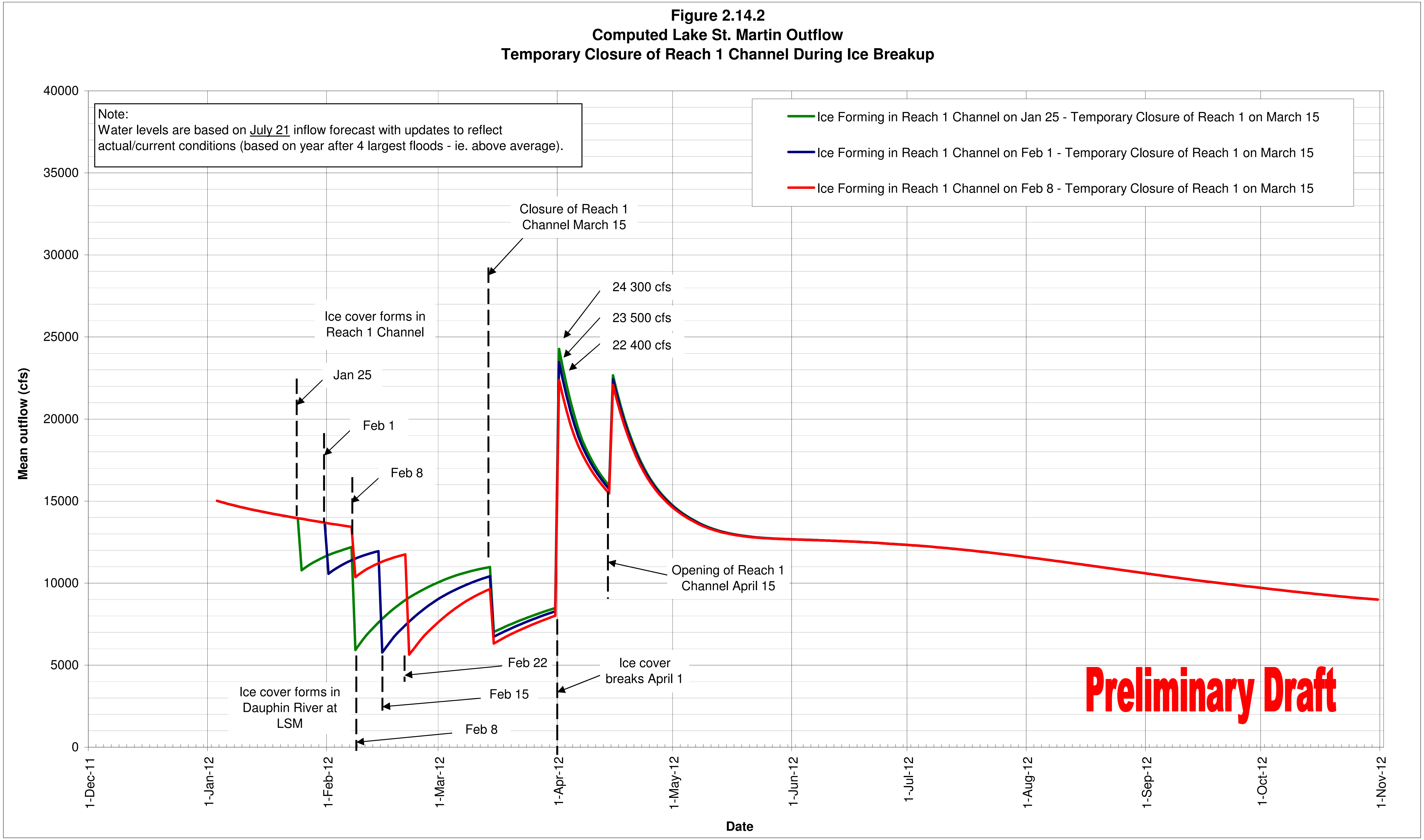


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1/5/2012

**Lake Manitoba Forecast**
**Correspondence and Figures**

**January 19, 2012**

## Garrett Wellwood

**From:** Brian Bodnaruk [BBodnaruk@kgsgroup.com]
**Sent:** Thursday, January 19, 2012 3:44 PM
**To:** 'Loukili, Youssef (MWS)'; 'Westmacott, Jason'
**Cc:** 'Mutulu, Phillip (MWS)'; 'Magura, Christopher'; 'Gawne, Kevin'; CSiepman@kgsgroup.com; PLeclercq@kgsgroup.com
**Subject:** RE: Lake Outflows Forecast Request
**Attachments:** Figure 1.1.1 RevE.pdf; Figure 1.1.2 RevE.pdf; Figure 2.13.1.pdf

The attached charts show the projected water level (Figure 1.1.1 Rev E) and outflow (Figure 1.1.2 Rev E) from Lake Manitoba and the water level on Lake St. Martin (Figure 2.13.1) for the period to the end of summer 2012. The charts are based on inflow forecasts to Lake Manitoba during this period. The inflow to Lake Manitoba is based on the inflow forecast provided by Rick Bowering in July 2011 and modified for winter flows from Lake Winnipegosis to the end of March due to ice on the Waterhen River.

The forecasted inflow to Lake Manitoba to the end of March is based on recession flows from this summer's flood. Inflows after April 1 are assumed values and are subject to change based on the potential from runoff in the spring from snowmelt and from rainfall in the spring and summer. The inflow has for this period has been estimated only from statistical means and can change depending on future snowfall and rainfall.

The outflow from Lake Manitoba (Figure 1.1.2 Rev E) is based on fully opened conditions at the Fairford Control Structure without backwater from ice jams downstream from the control structure to Lake Pinemuta.

Inflow to Lake St. Martin is equal to the computed outflow from Lake Manitoba shown on Figure 1.1.2 Rev E. The computed water level on Lake St. Martin (Figure 2.13.1 Rev E) is affected by ice conditions on the Dauphin River Channel at outlet of Lake St. Martin and on the constructed Reach 1 diversion channel from Lake St. Martin to Buffalo Creek. As shown on the Lake St Martin water level chart we have assumed three dates for the formation of the ice cover on the outlet channel. Corresponding outflows are based on rating curves developed for open water and for ice conditions on the diversion channel and the Dauphin River.

Brian Bodnaruk, P. Eng.

KGS Group - Consulting Engineers
Winnipeg, Manitoba
865 Waverley Street
Direct Line - 204.478.3235
Switch Board - 204.896.1209
Fax - 204.896.0754
bbodnaruk@kgsgroup.com

---

**From:** Loukili, Youssef (MWS) [mailto:Youssef.Loukili@gov.mb.ca]
**Sent:** Tuesday, January 17, 2012 2:38 PM
**To:** Westmacott, Jason
**Cc:** Mutulu, Phillip (MWS); Brian Bodnaruk; Magura, Christopher; Gawne, Kevin
**Subject:** RE: Lake Outflows Forecast Request

Hi Jason,

Thank you for the reminder, and yeah we need an updated forecast of levels and flows through Lake Manitoba/Lake St Martin in connection with the emergency channel. Personally, I don't know and wasn't involved in this subcontracted forecasting work.

Thanks,

Youssef

---

**From:** Westmacott, Jason [mailto:jwestmacott@hydro.mb.ca]
**Sent:** January-17-12 1:47 PM
**To:** Loukili, Youssef (MWS)
**Cc:** Mutulu, Phillip (MWS); Brian Bodnaruk; Magura, Christopher; Gawne, Kevin
**Subject:** RE: Lake Outflows Forecast Request

Hi Youssef,
Any luck on getting a forecast for Fairford? It would be greatly appreciated.
Thanks,
Jason

---

**From:** Loukili, Youssef (MWS) [mailto:Youssef.Loukili@gov.mb.ca]
**Sent:** Monday, December 19, 2011 2:28 PM
**To:** Brian Bodnaruk
**Cc:** Mutulu, Phillip (MWS); Westmacott, Jason; Magura, Christopher
**Subject:** Lake Outflows Forecast Request

Hi Brian,

We need Lake Manitoba daily outflows forecast as well as those going from Lake St Martin to Lake Winnipeg, as soon as you can, for the next three months.

I noticed Lake St Martin levels drop curbed down since last week, and would like you confirm this stemming mainly from ice cover over the channel or not.

Thank you in advance,

**------------------------------------------------------------------**
**Youssef Loukili, PhD**
**Hydrologic Forecaster**
Flood Forecasting & Coordination
Regulatory and Operational Services Division
Manitoba Water Stewardship
200 Saulteaux Crescent
Winnipeg, Manitoba R3J 3W3
Tel: 1-204-945-7676, Fax: 1-204-945-7419
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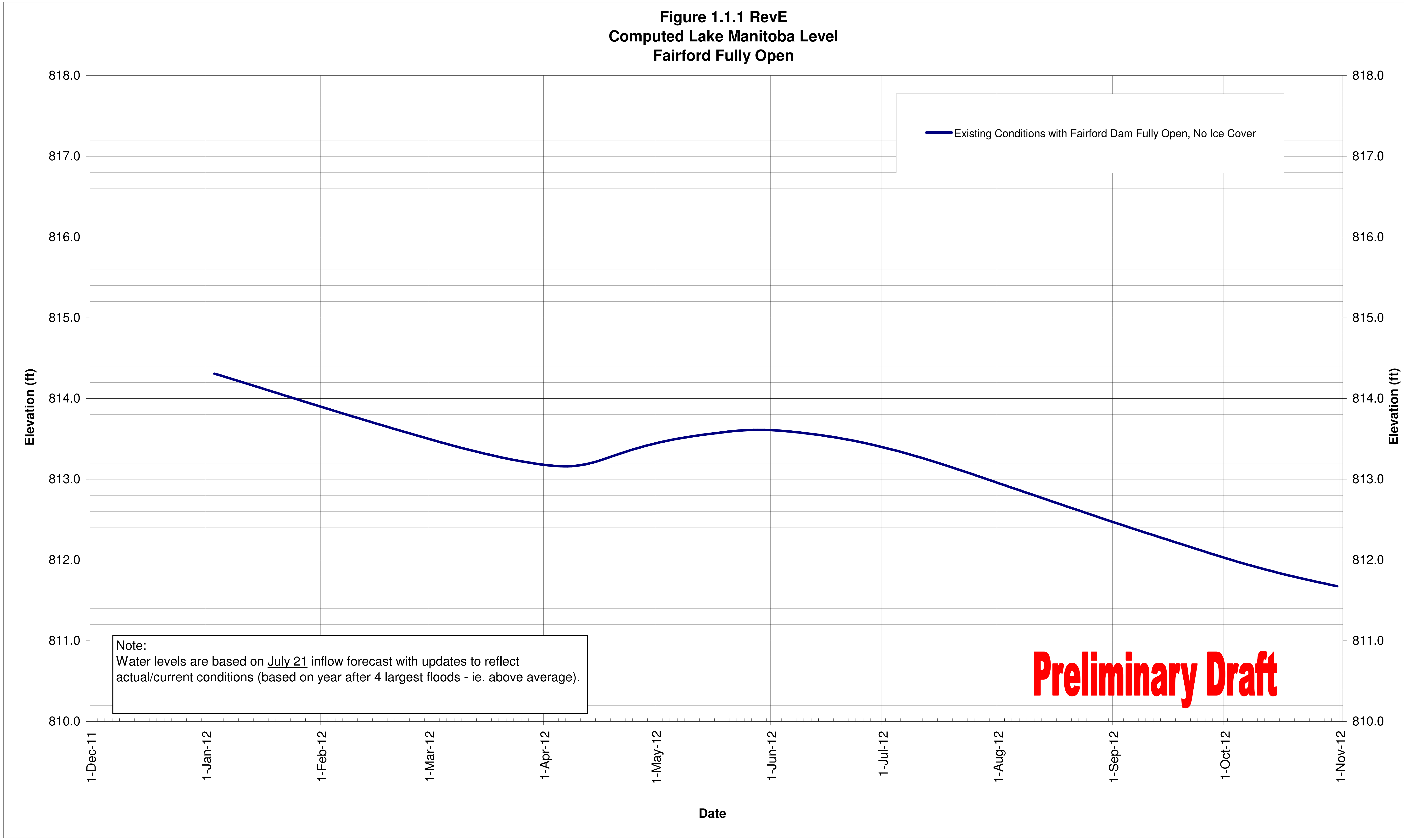


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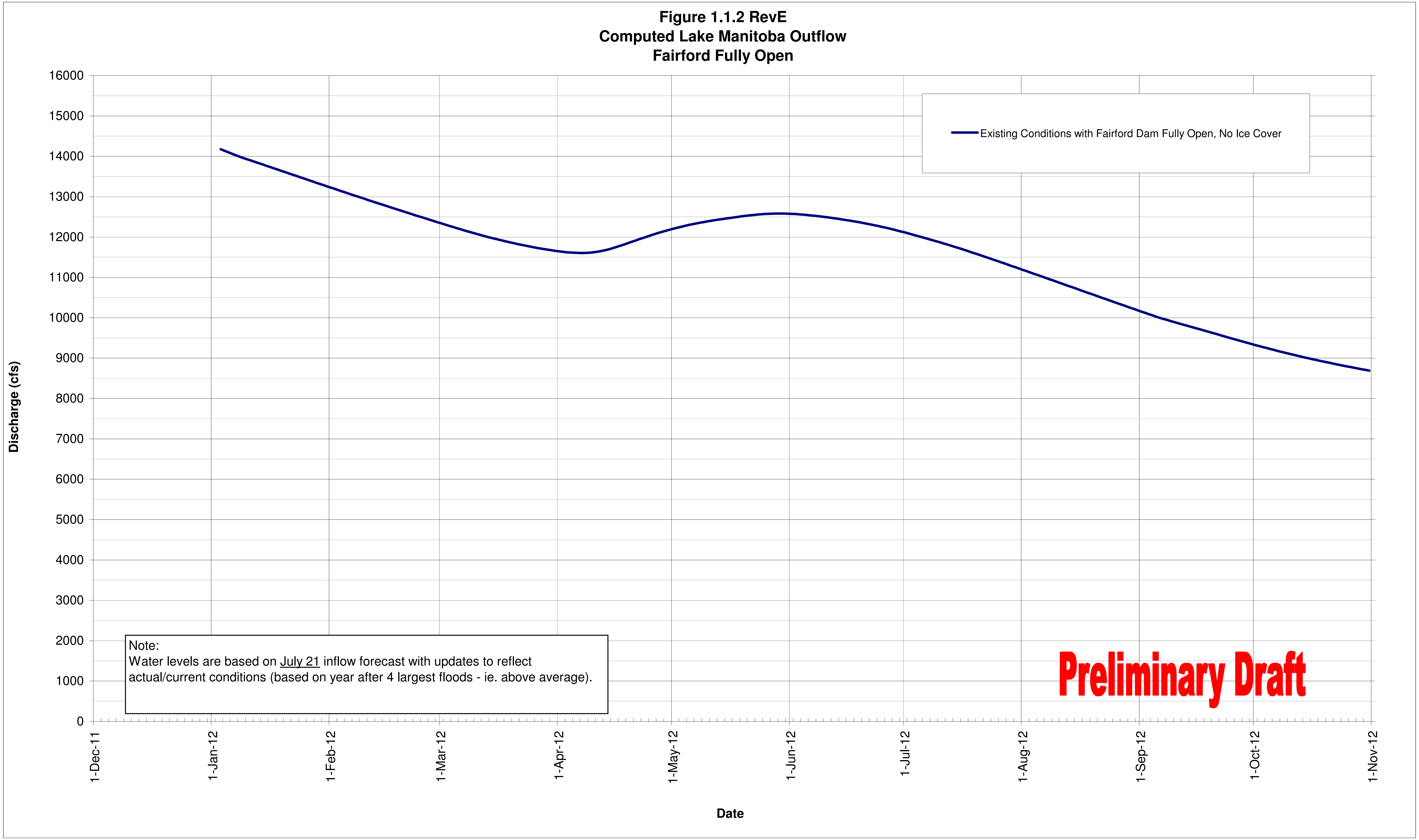


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11-0300-18
1/19/2012

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**Lake Manitoba Forecast**
**Correspondence and Figures**

**January 31, 2012**

## Garrett Wellwood

**From:** Colin Siepman [CSiepman@kgsgroup.com]
**Sent:** Tuesday, January 31, 2012 10:39 PM
**To:** Mark Allard ; Doug McMahon; Ron Richardson; Ron Kaatz; Eric Christiansen; Rick Postlethwaite; Paul Graveline; Michael Foth
**Cc:** Bert Smith; Dave MacMillan; Rick Carson; Rob Kenyon; Tony Ng; Brian Bodnaruk; Patrice Leclercq; Steve Offman
**Subject:** Forecast for the Operation of Reach 3 - Jan31 Update - Confidential
**Attachments:** Figure 2.13.2b RevB.pdf; Figure 2.13.1 RevB.pdf; Figure 2.13.2 RevB.pdf; Reach 1 Outlet - Jan 30.jpg; Buffalo Creek at Reach3 - Jan 30.jpg; Buffalo Creek Inlet - Jan 30.jpg; Buffalo Creek Outlet - Jan 30.jpg; Dauphin River Inlet - Jan 30.jpg; Reach 1 Inlet - Jan 30.jpg

Due to the rise of Lake St. Martin levels observed starting February 21, and an ice cover forming in the upper reaches of the Dauphin River, we have updated our Lake St. Martin water level and outflow forecasts (attached). Our routing model was calibrated by adjusting the Dauphin River and Reach 1 Channel outflow rating curves to represent actual conditions observed on Lake St. Martin.

Our revised forecasts consider three new ice formation dates at 2 week intervals of Feb 10, Feb 24 and Mar 9. The ice formation dates represent “worst case” conditions where an ice cover forms in the Reach 1 Channel and the ice cover in the upper Dauphin River thickens. The figures also consider a “best case” scenario where ice conditions as observed today would remain unchanged until ice breakup, where an ice cover does not form in Reach 1 Channel and the ice cover in the upper Dauphin River does not thicken.

Depending on weather conditions until ice breakup and how the Dauphin River and Reach 1 Channel respond to the possible thickening or formation of an ice cover, expected conditions at ice breakup will likely fall within the upper and lower bounds provided in our forecasts. Based on current long range weather forecasts, an ice formation date earlier than Feb 10 is unlikely; therefore this date could be considered conservative.

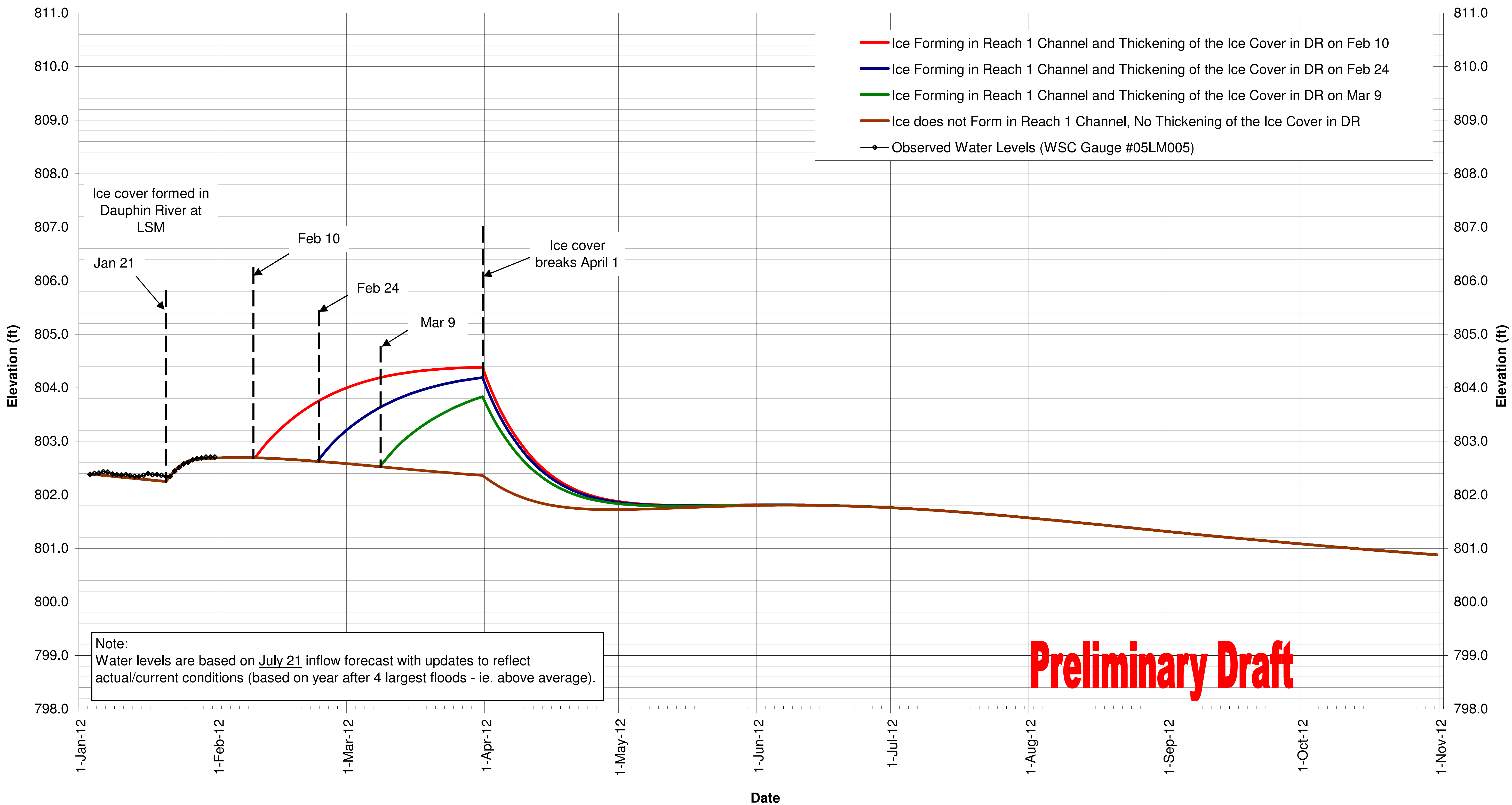
For the February 10 scenario, the water level in Lake St. Martin would reach 804.4 at spring ice breakup (Fig 2.13.1 RevB). Peak Reach 1 flow would be 7,600 cfs and the combined Dauphin River flow would be 24,000 cfs if Reach 3 is not operated (Fig 2.13.2 RevB & 2.13.2b RevB). As noted previously, the current Dauphin River Community dikes can accommodate a peak spring flow of 24,000 cfs.

**Therefore, due to an extremely mild winter, we have reached the point where Reach 3 will not have to be operated to its full capacity of 4250 cfs and are close to the point where the Operation of Reach 3 will not be required.**

Regards,

Colin Siepman, B.Sc. CE, M.Eng, P.Eng
Senior Project Manager
KGS Group

Figure 2.13.2 RevB
Computed Lake St. Martin Level
Reach 1 Channel in Operation

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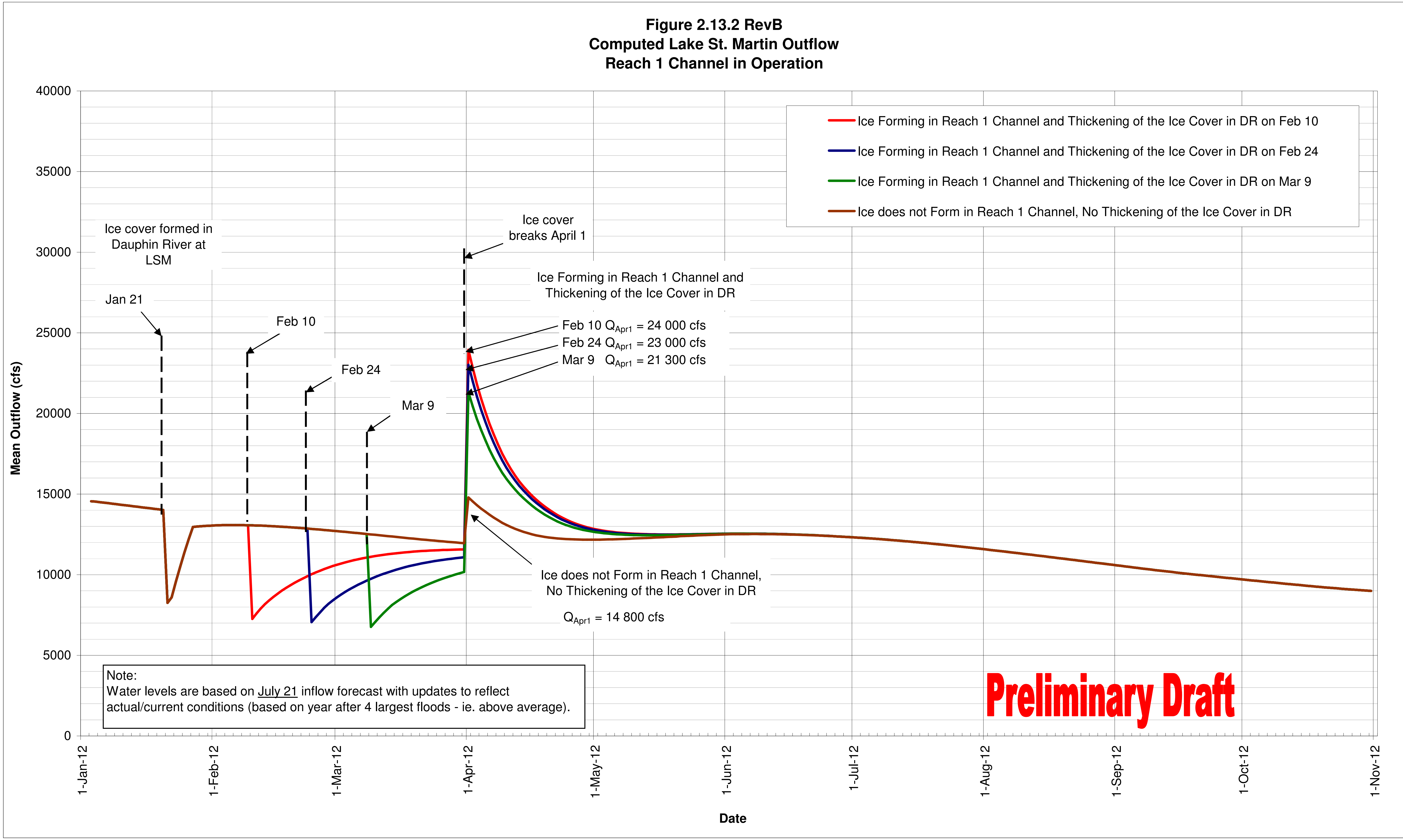


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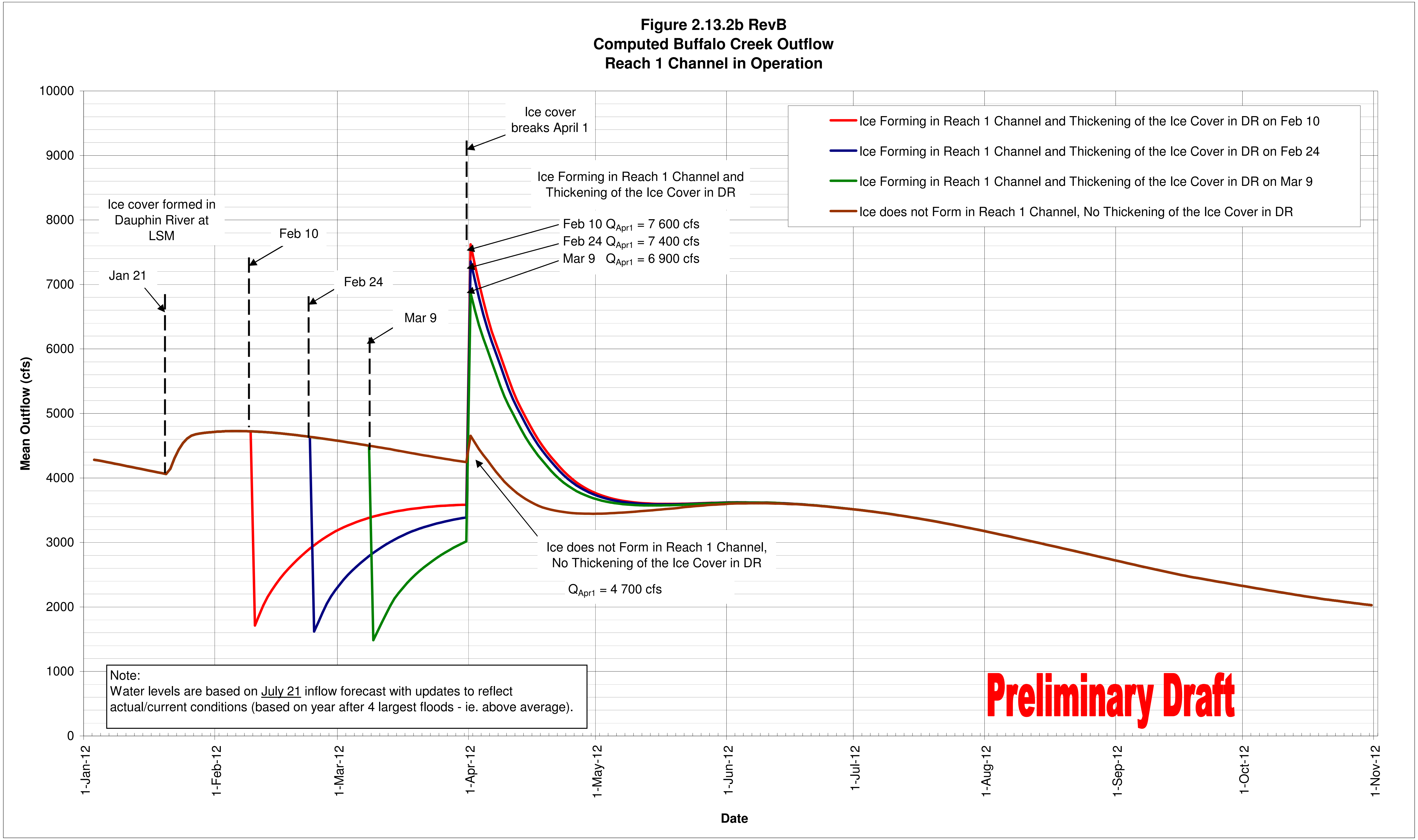


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**Lake Manitoba Forecast**
**Correspondence and Figures**

**February 10, 2012**

## Garrett Wellwood

**From:** Colin Siepman [CSiepman@kgsgroup.com]
**Sent:** Saturday, February 11, 2012 11:31 AM
**To:** Mark Allard ; Doug McMahon; Ron Richardson; Ron Kaatz; Eric Christiansen; Rick Postlethwaite; Paul Graveline; Michael Foth
**Cc:** Bert Smith; Dave MacMillan; Rick Carson; Rob Kenyon; Tony Ng; Brian Bodnaruk; Patrice Leclercq; Steve Offman
**Subject:** Forecast for the Operation of Reach 3 - Feb10 Update
**Attachments:** Figure 2.13.2b RevC.PDF; Figure 1.1.1 RevF.PDF; Figure 2.13.1 RevC.PDF; Figure 2.13.2 RevC.PDF

Find attached our updated Lake Manitoba and Lake St. Martin water level and outflow forecasts.

The Lake Manitoba water level forecast (Figure 1.1.1 RevF) was updated based on a revised inflow forecast to reflect current and expected conditions in Lake Winnipegosis and the Waterhen River. The water level in Lake Manitoba is expected to reach 813.4 ft by April 1st, and continue to drop thereafter.

The Lake St. Martin water level and outflow forecast was updated based on the revised Lake Manitoba outflow forecast, and calibrated by adjusting the Dauphin River and Reach 1 Channel outflow rating curves to represent actual conditions observed in the system.

Our revised forecast considers a “worst case” condition where the ice cover in the upper Dauphin River thickens beginning February 21, in conjunction with a restriction in flow in the Reach 1 Channel due to backwater effects from Buffalo Lake. The figures also consider a “best case” scenario where ice conditions as observed today would remain unchanged until ice breakup, where an ice cover does not form in Reach 1 Channel and the ice cover in the upper Dauphin River does not thicken.

Depending on weather conditions until ice breakup and how the Dauphin River and Reach 1 Channel respond to the possible thickening or formation of an ice cover, expected conditions at ice breakup will likely fall within the upper and lower bounds provided in our forecasts.

For the “worst case” scenario, the water level in Lake St. Martin would reach 803.7 ft at spring ice breakup (Fig 2.13.1 RevC). Peak Reach 1 flow would be 7,000 cfs and the combined Dauphin River flow would be 20,800 cfs if Reach 3 is not operated (Fig 2.13.2 RevC & 2.13.2b RevC). As noted previously, the current Dauphin River Community dikes can accommodate a peak spring flow of 24,000 cfs.

Regards,

Colin Siepman, B.Sc. CE, M.Eng, P.Eng
Senior Project Manager
KGS Group

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**From:** Colin Siepman [mailto:CSiepman@kgsgroup.com]
**Sent:** January 31, 2012 10:39 PM
**To:** Mark Allard ; Doug McMahon; Ron Richardson; Ron Kaatz; Eric Christiansen; Rick Postlethwaite; Paul Graveline; Michael Foth
**Cc:** Bert Smith; Dave MacMillan; Rick Carson; Rob Kenyon; Tony Ng; Brian Bodnaruk; Patrice Leclercq; Steve Offman
**Subject:** Forecast for the Operation of Reach 3 - Jan31 Update - Confidential

Due to the rise of Lake St. Martin levels observed starting January 21, and an ice cover forming in the upper reaches of the Dauphin River, we have updated our Lake St. Martin water level and outflow forecasts (attached). Our routing model was calibrated by adjusting the Dauphin River and Reach 1 Channel outflow rating curves to represent actual conditions observed on Lake St. Martin.

Our revised forecasts consider three new ice formation dates at 2 week intervals of Feb 10, Feb 24 and

Mar 9. The ice formation dates represent “worst case” conditions where an ice cover forms in the Reach 1 Channel and the ice cover in the upper Dauphin River thickens. The figures also consider a “best case” scenario where ice conditions as observed today would remain unchanged until ice breakup, where an ice cover does not form in Reach 1 Channel and the ice cover in the upper Dauphin River does not thicken.

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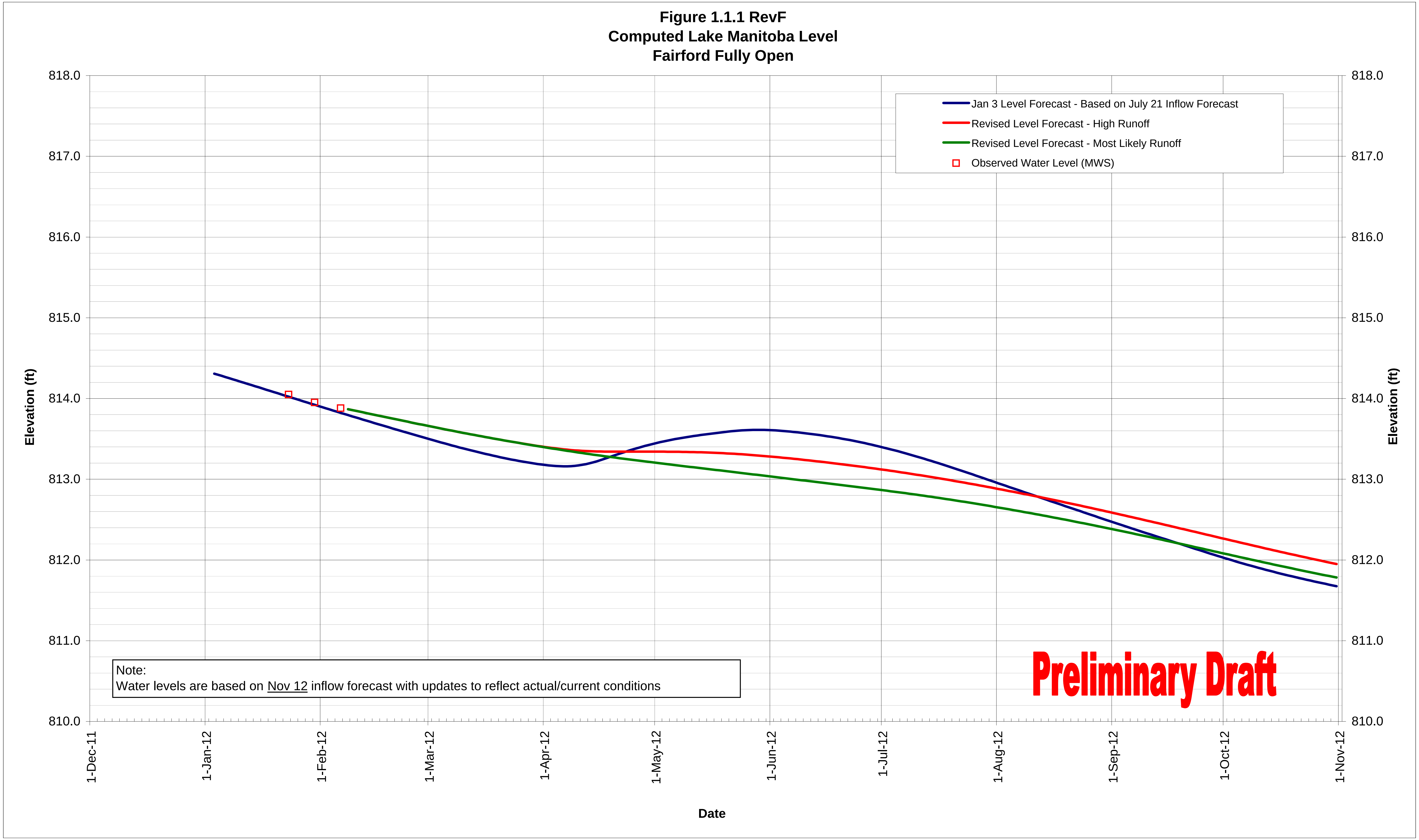
For the February 10 scenario, the water level in Lake St. Martin would reach 804.4 at spring ice breakup (Fig 2.13.1 RevB). Peak Reach 1 flow would be 7,600 cfs and the combined Dauphin River flow would be 24,000 cfs if Reach 3 is not operated (Fig 2.13.2 RevB & 2.13.2b RevB). As noted previously, the current Dauphin River Community dikes can accommodate a peak spring flow of 24,000 cfs.

**Therefore, due to an extremely mild winter, we have reached the point where Reach 3 will not have to be operated to its full capacity of 4250 cfs and are close to the point where the Operation of Reach 3 will not be required.**

Regards,

Colin Siepman, B.Sc. CE, M.Eng, P.Eng
Senior Project Manager
KGS Group

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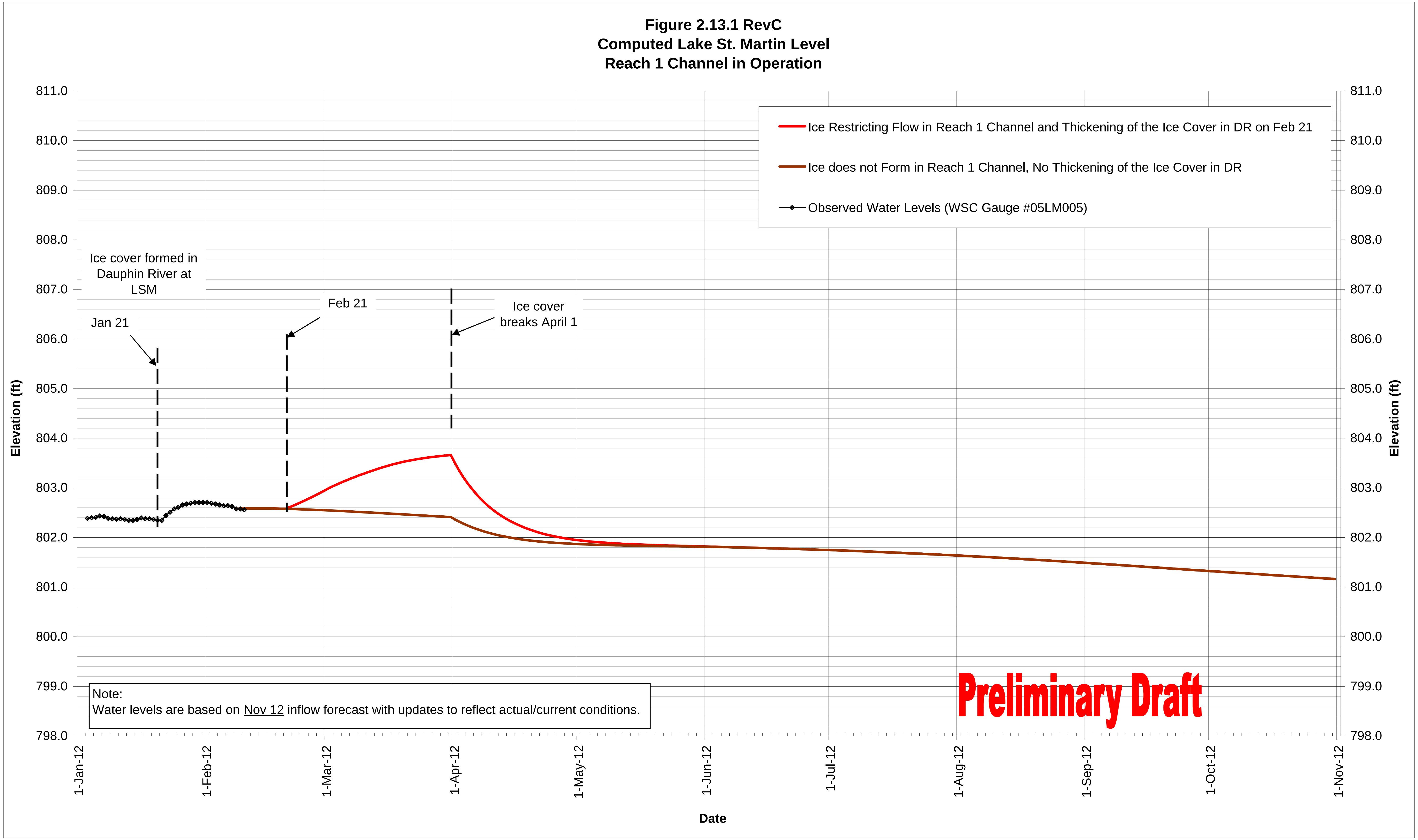


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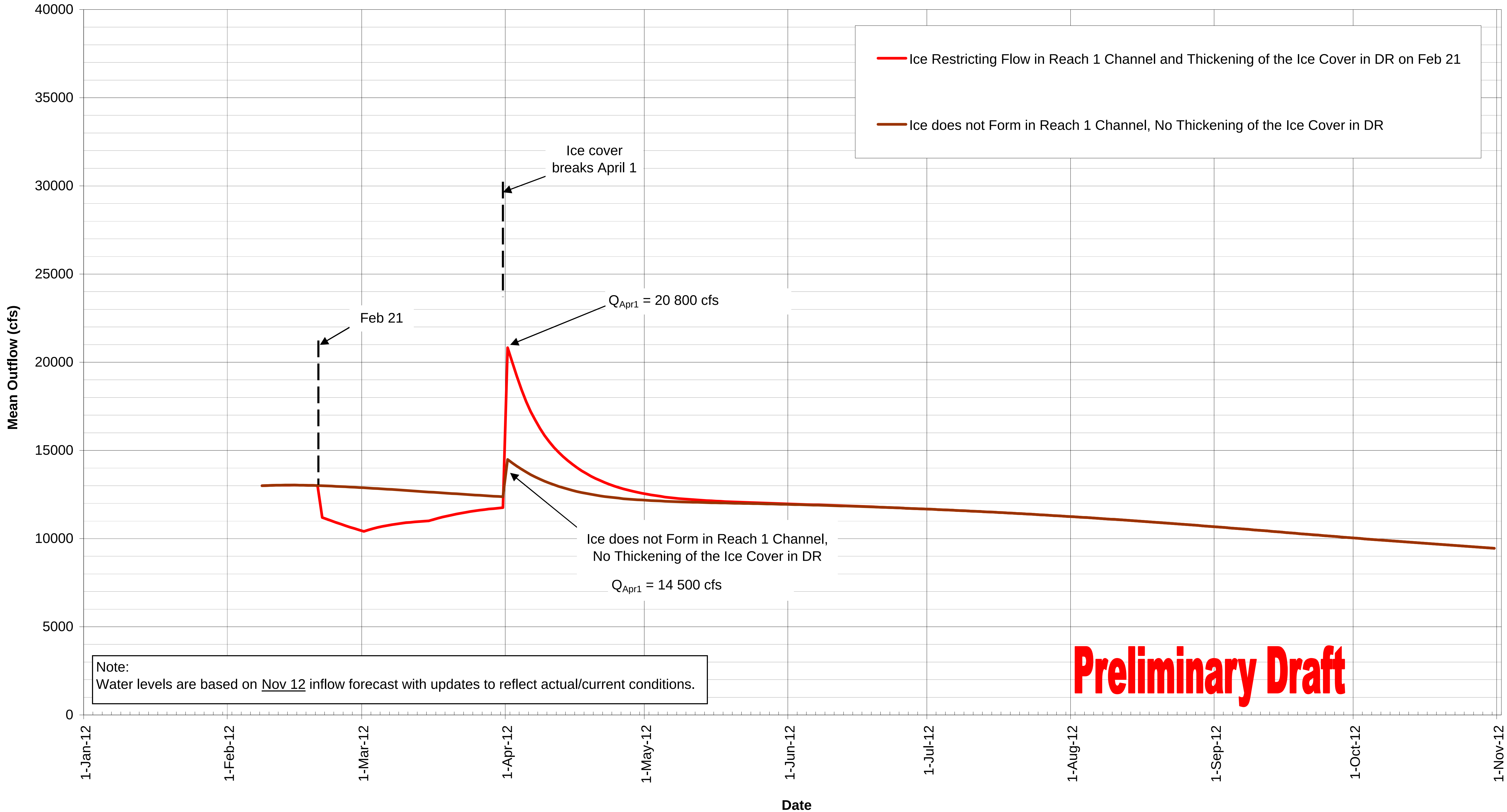
# Figure 2.13.2 RevC
## Computed Lake St. Martin Outflow
## Reach 1 Channel in Operation

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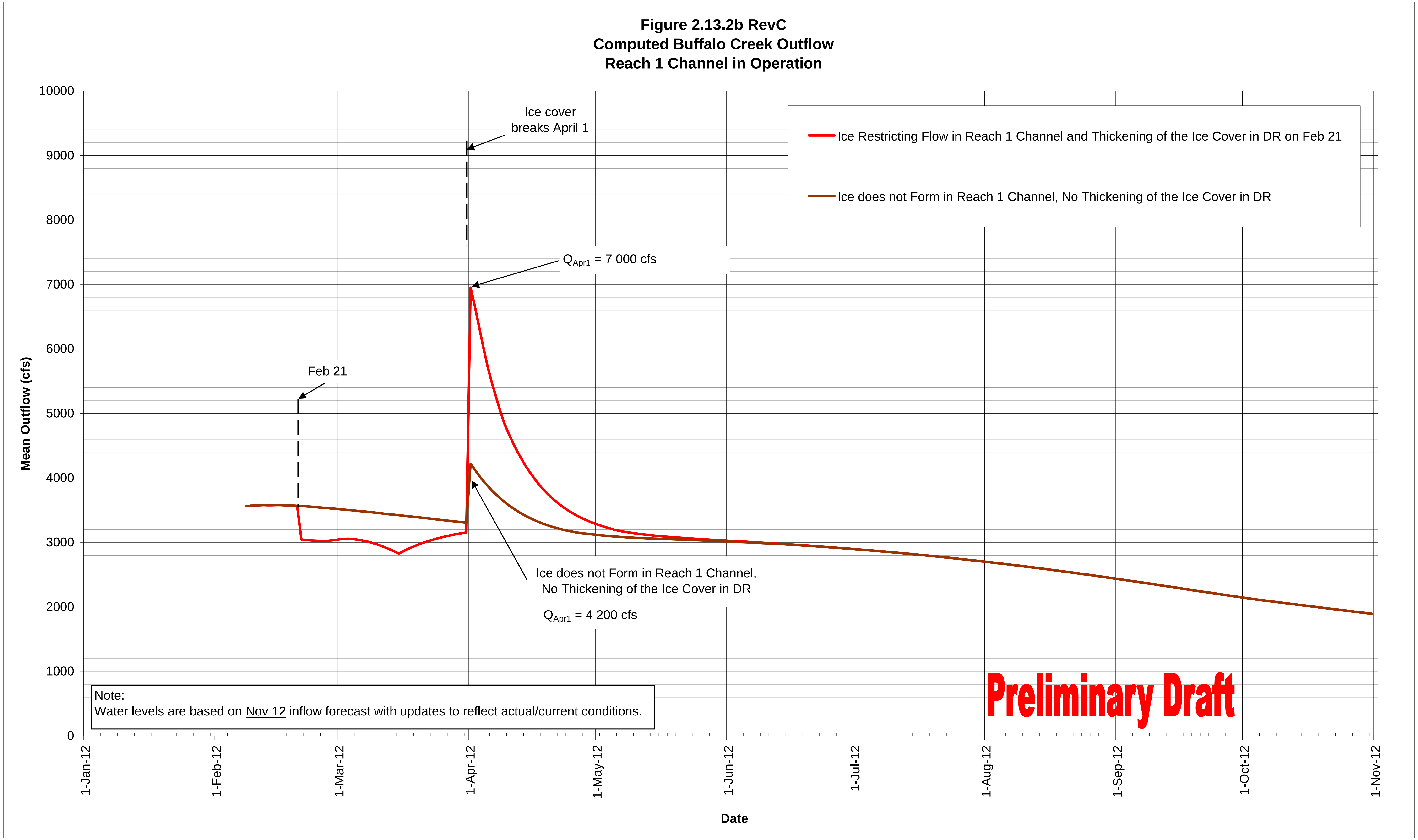


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**Lake Manitoba Forecast**
**Correspondence and Figures**

**February 14, 2012**

## Garrett Wellwood

**From:** Colin Siepman [CSiepman@kgsgroup.com]
**Sent:** Tuesday, February 14, 2012 5:52 PM
**To:** Mark Allard ; Doug McMahon; Ron Richardson; Ron Kaatz; Eric Christiansen; Rick Postlethwaite; Paul Graveline; Michael Foth; Doug McNeil
**Cc:** Bert Smith; Dave MacMillan; Rick Carson; Rob Kenyon; Tony Ng; Brian Bodnaruk; Patrice Leclercq; Steve Offman
**Subject:** RE: Forecast for the Operation of Reach 3 - Feb10 Update
**Attachments:** Figure 2.13.1 RevD.PDF; Figure 2.13.2 RevD.PDF

To help put things in perspective we have updated our Feb 10, 2012 graphs to include the original Sept 20, 2011 forecast, which was issued just prior to the decision to proceed with Reach 3.

The following is a summary of the previous "worst case" flow forecasts for the Dauphin River downstream of Buffalo Creek as we progressed through the winter and adapted to the above average weather conditions:

Sept 20 – 35,000 cfs
Dec 1 – 29,000 cfs
Jan 3 – 27,000 cfs
Jan 31 – 24,000 cfs
Feb 10 – 20,800 cfs

Regards,

Colin Siepman, B.Sc. CE, M.Eng, P.Eng
Senior Project Manager
KGS Group

---

**From:** Colin Siepman [mailto:CSiepman@kgsgroup.com]
**Sent:** February 11, 2012 11:31 AM
**To:** Mark Allard ; Doug McMahon; Ron Richardson; Ron Kaatz; Eric Christiansen; Rick Postlethwaite; Paul Graveline; Michael Foth
**Cc:** Bert Smith; Dave MacMillan; Rick Carson; Rob Kenyon; Tony Ng; Brian Bodnaruk; Patrice Leclercq; Steve Offman
**Subject:** Forecast for the Operation of Reach 3 - Feb10 Update

Find attached our updated Lake Manitoba and Lake St. Martin water level and outflow forecasts.

The Lake Manitoba water level forecast (Figure 1.1.1 RevF) was updated based on a revised inflow forecast to reflect current and expected conditions in Lake Winnipegosis and the Waterhen River. The water level in Lake Manitoba is expected to reach 813.4 ft by April 1st, and continue to drop thereafter.

The Lake St. Martin water level and outflow forecast was updated based on the revised Lake Manitoba outflow forecast, and calibrated by adjusting the Dauphin River and Reach 1 Channel outflow rating curves to represent actual conditions observed in the system.

Our revised forecast considers a "worst case" condition where the ice cover in the upper Dauphin River thickens beginning February 21, in conjunction with a restriction in flow in the Reach 1 Channel due to backwater effects from Buffalo Lake. The figures also consider a "best case" scenario where ice conditions as observed today would remain unchanged until ice breakup, where an ice cover does not form in Reach 1 Channel and the ice cover in the upper Dauphin River does not thicken.

Depending on weather conditions until ice breakup and how the Dauphin River and Reach 1 Channel respond to the possible thickening or formation of an ice cover, expected conditions at ice breakup will likely fall within the upper and lower bounds provided in our forecasts.

For the “worst case” scenario, the water level in Lake St. Martin would reach 803.7 ft at spring ice breakup (Fig 2.13.1 RevC). Peak Reach 1 flow would be 7,000 cfs and the combined Dauphin River flow would be 20,800 cfs if Reach 3 is not operated (Fig 2.13.2 RevC & 2.13.2b RevC). As noted previously, the current Dauphin River Community dikes can accommodate a peak spring flow of 24,000 cfs.

Regards,

Colin Siepman, B.Sc. CE, M.Eng, P.Eng
Senior Project Manager
KGS Group

---

**From:** Colin Siepman [mailto:CSiepman@kgsgroup.com]
**Sent:** January 31, 2012 10:39 PM
**To:** Mark Allard ; Doug McMahon; Ron Richardson; Ron Kaatz; Eric Christiansen; Rick Postlethwaite; Paul Graveline; Michael Foth
**Cc:** Bert Smith; Dave MacMillan; Rick Carson; Rob Kenyon; Tony Ng; Brian Bodnaruk; Patrice Leclercq; Steve Offman
**Subject:** Forecast for the Operation of Reach 3 - Jan31 Update - Confidential

Due to the rise of Lake St. Martin levels observed starting January 21, and an ice cover forming in the upper reaches of the Dauphin River, we have updated our Lake St. Martin water level and outflow forecasts (attached). Our routing model was calibrated by adjusting the Dauphin River and Reach 1 Channel outflow rating curves to represent actual conditions observed on Lake St. Martin.

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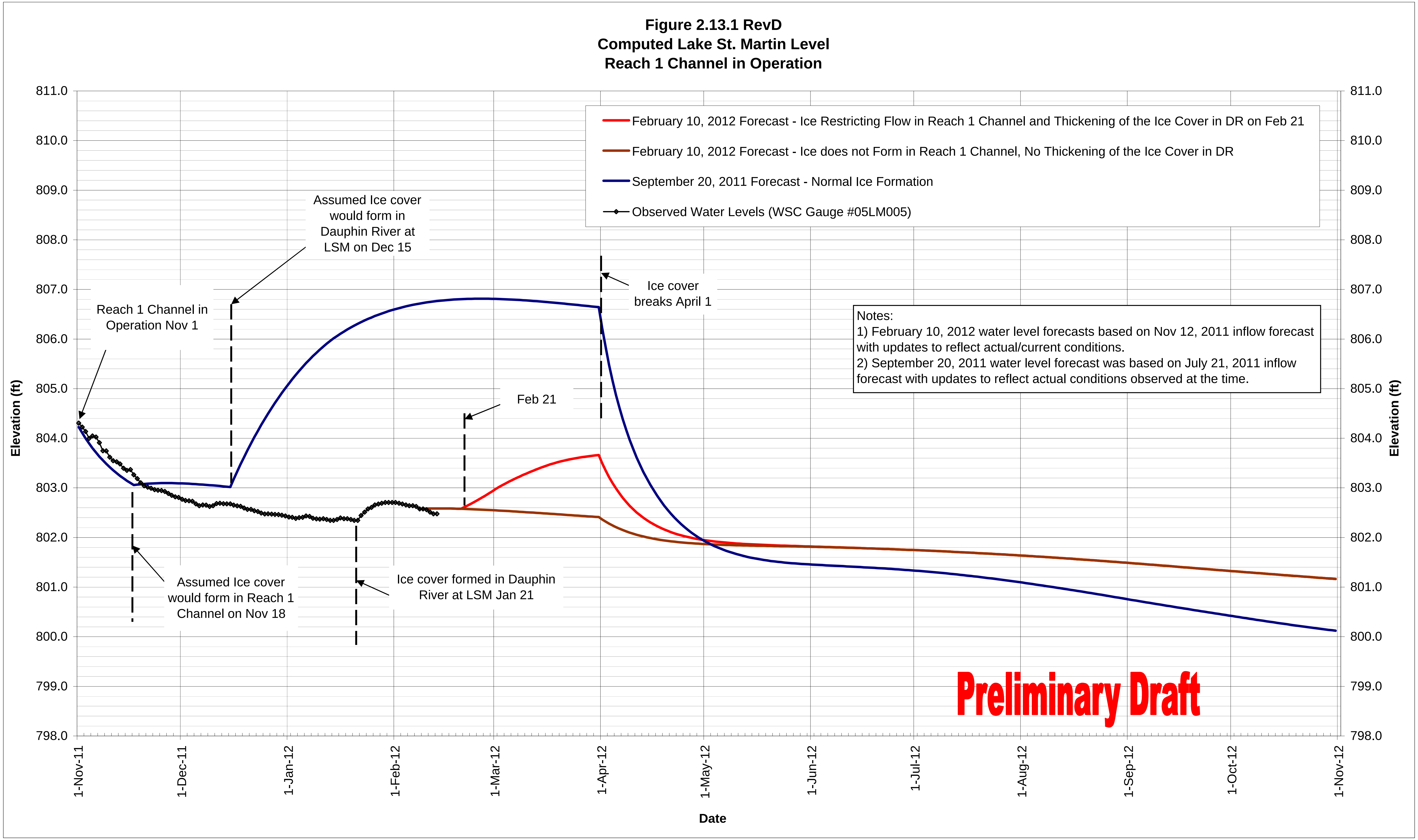
Depending on weather conditions until ice breakup and how the Dauphin River and Reach 1 Channel respond to the possible thickening or formation of an ice cover, expected conditions at ice breakup will likely fall within the upper and lower bounds provided in our forecasts. Based on current long range weather forecasts, an ice formation date earlier than Feb 10 is unlikely; therefore this date could be considered conservative.

For the February 10 scenario, the water level in Lake St. Martin would reach 804.4 at spring ice breakup (Fig 2.13.1 RevB). Peak Reach 1 flow would be 7,600 cfs and the combined Dauphin River flow would be 24,000 cfs if Reach 3 is not operated (Fig 2.13.2 RevB & 2.13.2b RevB). As noted previously, the current Dauphin River Community dikes can accommodate a peak spring flow of 24,000 cfs.

**Therefore, due to an extremely mild winter, we have reached the point where Reach 3 will not have to be operated to its full capacity of 4250 cfs and are close to the point where the Operation of Reach 3 will not be required.**

Regards,

Colin Siepman, B.Sc. CE, M.Eng, P.Eng
Senior Project Manager
KGS Group

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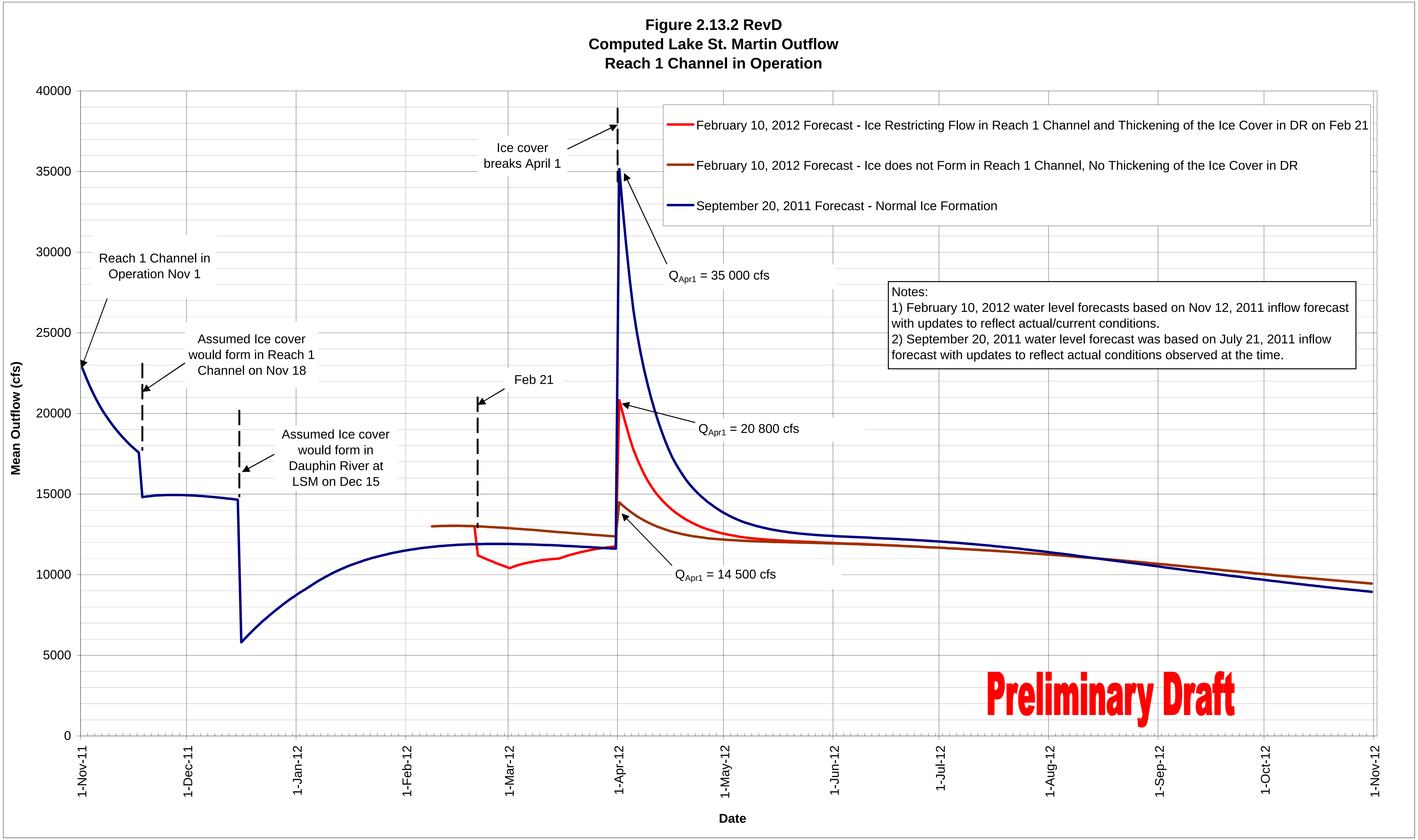


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**Lake Manitoba Forecast**
**Correspondence and Figures**

**February 22, 2012**

## Garrett Wellwood

**From:** Patrice Leclercq [PLeclercq@kgsgroup.com]
**Sent:** Friday, March 01, 2013 8:03 AM
**To:** 'Patrice Leclercq'
**Subject:** FW: Ministers briefing - Reach 3E questions
**Attachments:** AccumulatedFreezingDegreeDays_FisherBranch.pdf; Figure 1.1.1 RevG.PDF; Figure 2.13.1 RevE.PDF; Figure 2.13.2 RevE.PDF; Figure 2.13.2b RevD.PDF; Discharge Summary - 2012-02-22.xls

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**From:** Colin Siepman [mailto:CSiepman@kgsgroup.com]
**Sent:** February-22-12 5:16 PM
**To:** 'Kaatz, Ron G (MIT)'
**Cc:** 'bsmith@kgsgroup.com'; 'Brian Bodnaruk'; 'Richardson, Ron (MIT)'; Mark Allard ; Rob Kenyon; Dave MacMillan; Rick Carson; Eric Christiansen
**Subject:** RE: Ministers briefing - Reach 3E questions

Ron,

Please see responses below in blue text.

In addition, to illustrate the above average temperature conditions during the 2011-2012 winter, we have included a graph of the Accumulated Degree-Days of Freezing based on temperature data from Fisher Branch. The graph indicates that, as of mid February, this has been the warmest winter in the Fisher Branch area in the last 30 years.

Regards,

Colin Siepman, B.Sc. CE, M.Eng, P.Eng
Senior Project Manager
KGS Group

---

**From:** Kaatz, Ron G (MIT) [mailto:Ron.Kaatz@gov.mb.ca]
**Sent:** February 22, 2012 8:27 AM
**To:** 'CSiepman@kgsgroup.com'
**Cc:** bsmith@kgsgroup.com; Brian Bodnaruk; Richardson, Ron (MIT)
**Subject:** Ministers briefing - Reach 3E questions
**Importance:** High

Hi Colin
There is a ministers briefing taking place tomorrow and there are a number of questions that must be confirmed by KGS, please. These questions are the following:

1) Status of Reach 3 Construction (Mark A to respond to)
2) Final result of KGS' analysis and decision on use of Reach 3; (KGS to provide analysis and make recommendation if Reach 3E should or should not be in use); The following is an updated summary of the "worst case" flow forecasts for the Dauphin River downstream of Buffalo Creek, assuming Reach 3 is not operated, as we progressed through the winter and adapted to the above average temperature conditions:

   Sept 20 – 35,000 cfs
   Dec 1 – 29,000 cfs
   Jan 3 – 27,000 cfs
   Jan 31 – 24,000 cfs
   Feb 10 – 20,800 cfs

Feb 22 - 16,800 cfs

The current Dauphin River Community dikes can accommodate a peak spring flow of approximately 24,000 cfs with a freeboard of 2 ft. The Feb 22 “worst case” forecast of 16,800 cfs is now significantly less than this limit and therefore provides additional contingency to allow for minor variations in the forecasts and/or the Dauphin River spring ice jam models.

3) First Nation involvement on Reach 3 (do we have stats?); (Mark A to respond to)
4) Current Lake Manitoba and Lake St. Martin Lake levels; (KGS to provide current graphs and projected tabled sheets of results- elevations forecast to August); We have updated our Lake Manitoba and Lake St. Martin water level and outflow forecasts as of Feb 22 (see attached).

5) Current flows through Fairford River control structure and flows on Dauphin River and Reach 1; (KGS to provide current graphs and projected tabled sheets of results- elevations); We have provided current and projected flows in the attached table.

6) Ice conditions on the above three channels;(KGS to provide current and projected ice conditions on all channels)
   - Fairford River is ice free from Lake Pineimuta to the Fairford Control Structure. No ice in this reach is expected this winter.
   - Dauphin River at Lake St Martin developed a weak cover on January 21, 2012 but it has gradually reduced in its effect (smoothening and thinning). The ice effects are unlikely to get worse.
   - Reach 1 is ice free and unlikely to form a cover.
   - Buffalo Creek has an ice jam that formed downstream of the inlet to Reach 3 but the jam has not progressed and has not affected flow forecasts. The ice effects are unlikely to get worse.

7) Freeboard on Dauphin River dikes; (KGS to provide freeboard on Dauphin River dikes for current conditions and peak spring flow conditions); Current water levels in the Dauphin River communities have not been measured due to restricted access. However, the highest water levels likely occurred in December, at which time the minimum freeboard was approximately 6 ft.

   The Dauphin River Community dikes can accommodate a peak spring flow of approximately 24,000 cfs with a minimum freeboard of 2 ft. The Feb 22 “worst case” forecast of 16,800 cfs is less than this limit and therefore will have a freeboard greater than 2 ft. Since the predicted water levels due to a spring ice jam are based on a detailed RIVICE model by the Frazil Ice Team we are not able to provide the exact freeboard for the 16,800 cfs scenario at this time but could pursue this further if requested by MIT.

8) Approximate total expected costs of construction of Reach 1 ($40M?) , Reach 3 ($9M?) and Dauphin River dikes ($10M?). Mark A to address

Please address the above question, and have the result sent directly to Ron R and Ron R, by 4:00 pm today, February 22, 2012, please?
Some of these questions are and have been touched upon in the past but we require current conditions or evaluations.
Thanks

**Ron G. Kaatz, P. Eng.**
Senior Hydraulic Engineer

Manitoba Infrastructure and Transportation
Engineering & Operations,
Water Control and Structures
Operations & Maintenance Branch
7th floor, 215 Garry St.
Winnipeg, Manitoba R3C 3P3
Ph: (204) 945-0322
Cell: <Personal information removed>
Fax: (204) 948-4503
e-mail: Ron.Kaatz@gov.mb.ca

## Garrett Wellwood

**From:** Patrice Leclercq [PLeclercq@kgsgroup.com]
**Sent:** Friday, March 01, 2013 8:03 AM
**To:** 'Patrice Leclercq'
**Subject:** FW: Lake Manitoba testing
**Attachments:** Discharge Summary.xls; Figure 2.13.1 RevE.pdf; Figure 2.13.2 RevE.pdf; Figure 2.13.2b RevD.pdf

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**From:** Brian Bodnaruk [mailto:BBodnaruk@kgsgroup.com]
**Sent:** February-22-12 6:05 PM
**To:** 'Mutulu, Phillip (MWS)'
**Cc:** 'Colin Siepman'; Richardson, Ron (MIT); Kaatz, Ron G (MIT)
**Subject:** RE: Lake Manitoba testing

Phillip, the information on Lake Manitoba outflows and Lake St Martin outflows was prepared for MIT for the review of the emergency flood channels from Lake St Martin to Lake Winnipeg. The flow estimates were prepared specifically for this project. A number of assumptions and qualifiers were assumed for these projections and were deemed to be suitable for the intended purpose. If this data is used for flow forecasting purposes, the assumptions and parameters used in preparing the flow estimates should be understood.

A complete set of water level charts on Lake Manitoba and Lake St Martin have been sent to Ron Richardson and R. Kaatz at MIT. I have provided a copy to you of these charts for your information, as you requested.

Brian Bodnaruk, P. Eng.

KGS Group - Consulting Engineers
Winnipeg, Manitoba
865 Waverley Street
Direct Line - 204.478.3235
Switch Board - 204.896.1209
Fax - 204.896.0754
bbodnaruk@kgsgroup.com

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**From:** Mutulu, Phillip (MWS) [mailto:Phillip.Mutulu@gov.mb.ca]
**Sent:** Wednesday, February 22, 2012 5:41 PM
**To:** Brian Bodnaruk
**Subject:** RE: Lake Manitoba testing

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**From:** Brian Bodnaruk [mailto:BBodnaruk@kgsgroup.com]
**Sent:** December-13-11 4:03 PM
**To:** Mutulu, Phillip (MWS)
**Subject:** RE: Lake Manitoba

I have attached a chart showing forecasted Lake Manitoba water levels for 2 flow conditions at Fairford Control structure as listed on the chart. Please call me if you require further information.

Brian Bodnaruk, P. Eng.

KGS Group - Consulting Engineers
Winnipeg, Manitoba
865 Waverley Street
Direct Line - 204.478.3235
Switch Board - 204.896.1209
Fax - 204.896.0754
bbodnaruk@kgsgroup.com

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**From:** Mutulu, Phillip (MWS) [mailto:Phillip.Mutulu@gov.mb.ca]
**Sent:** Monday, December 12, 2011 3:35 PM
**To:** Brian Bodnaruk
**Cc:** Loukili, Youssef (MWS)
**Subject:** RE: Lake Manitoba

Is there any chance I could get this information today as you promised ?

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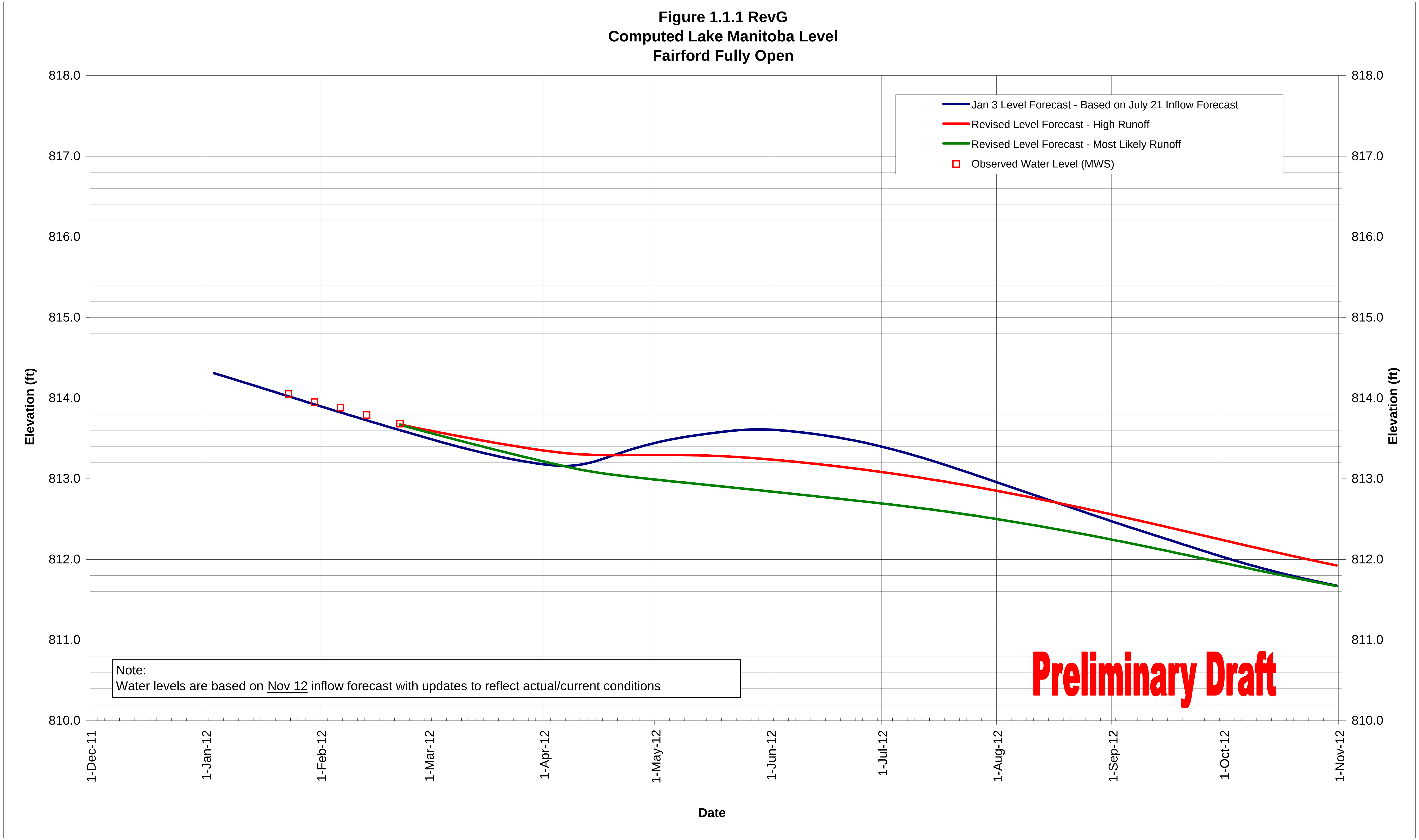
**From:** Mutulu, Phillip (MWS)
**Sent:** December-09-11 1:43 PM
**To:** Brian Bodnaruk
**Cc:** Loukili, Youssef (MWS)
**Subject:** Lake Manitoba

Hi Brian:

I have had a number enquiries about L. Manitoba level projections. Do you have any updated forecasts. ?
Please send me the update if it is ready.

--------------------------------------------------------

**Phillip M. Mutulu, PhD**
**Director,**
**Flood Forecasting & Coordination**
Regulatory and Operational Services Division
Manitoba Water Stewardship
200 Saulteaux Crescent
Winnipeg, Manitoba R3J 3W3
Tel: 1-204-945-6698, Fax: 1-204-945-7419

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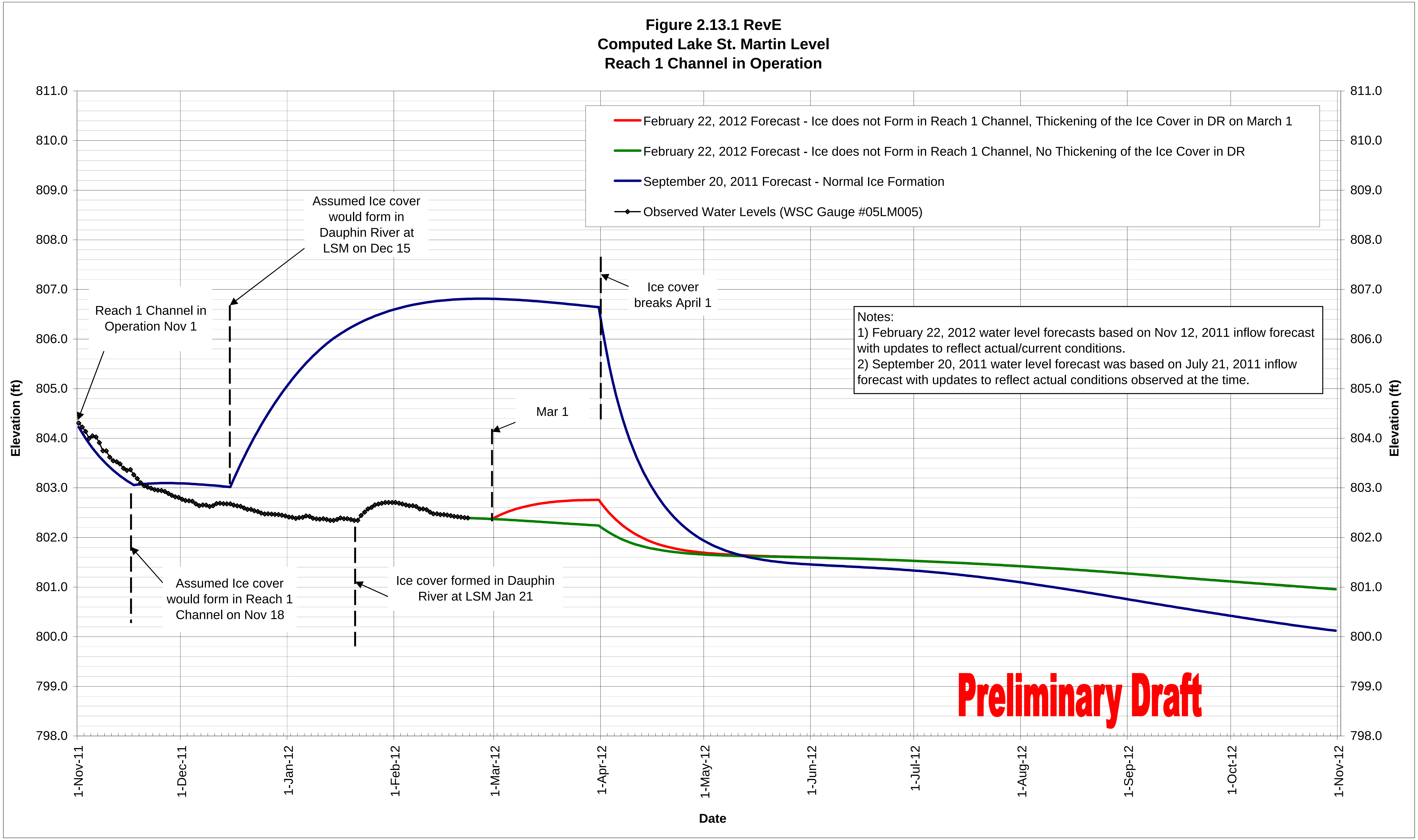


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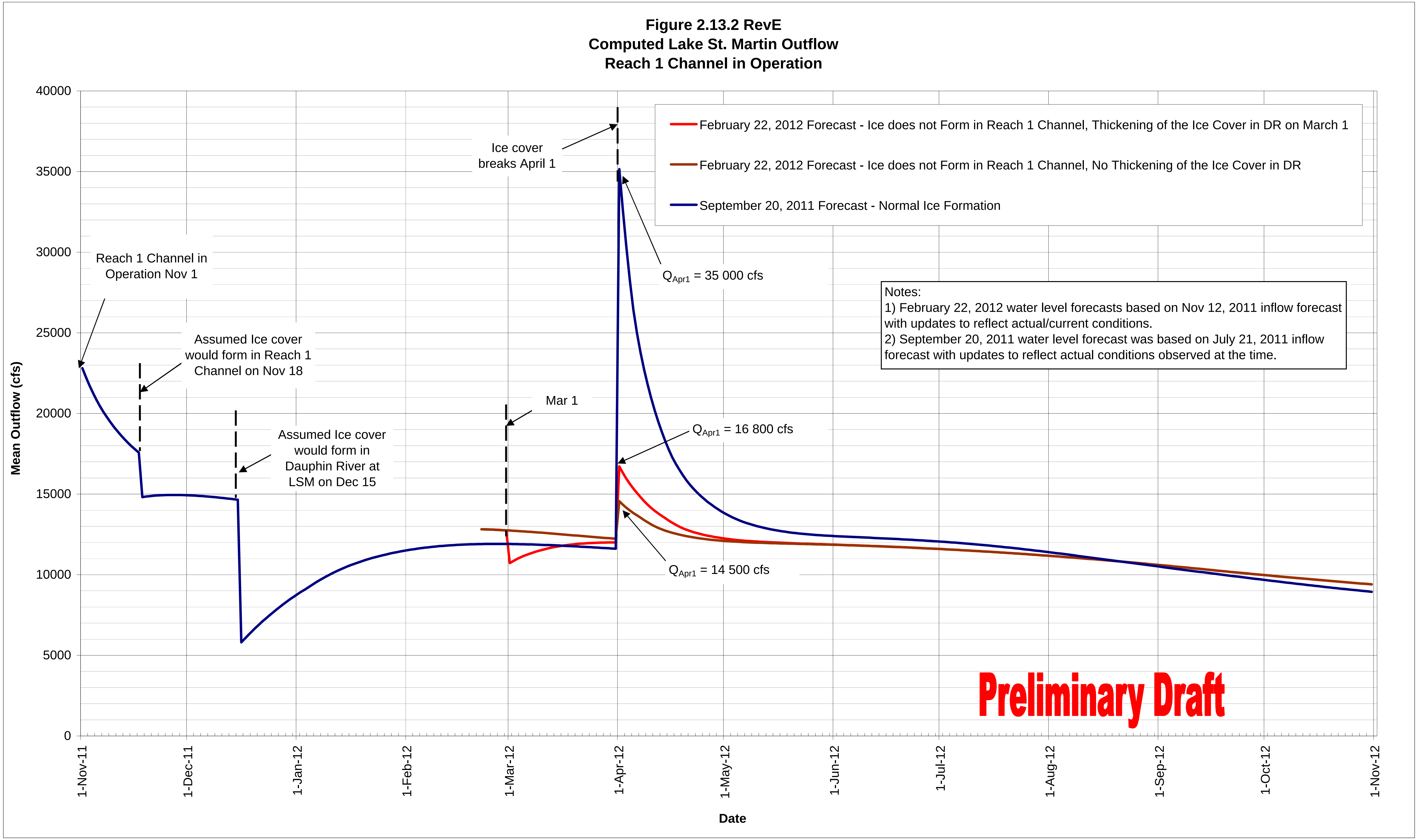


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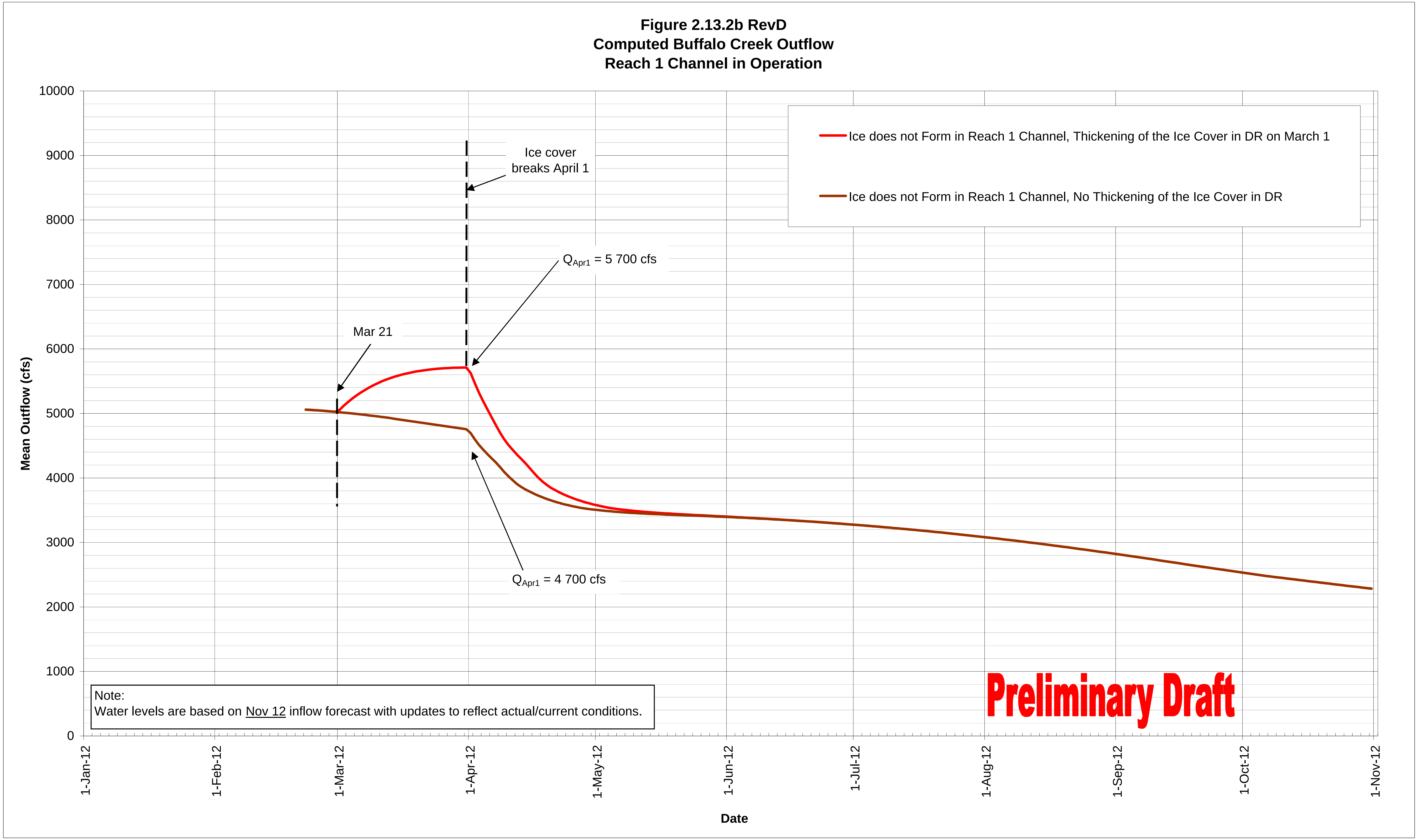


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2/22/2012

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## Garrett Wellwood

**From:** Colin Siepman [CSiepman@kgsgroup.com]
**Sent:** Friday, February 24, 2012 5:55 PM
**To:** 'Allard, Mark (MIT)'
**Cc:** Patrice Leclercq; Brian Bodnaruk; Tony Ng; Steve Offman; Ron Kaatz; Ron Richardson; Rick Carson
**Subject:** RE: Closure of Reach 1
**Attachments:** Figure 2.15.2b.pdf; Figure 2.15.1.pdf; Figure 2.15.2.pdf

Mark,

Attached are figures for the Feb 22 LSM routing with options to raise the sill elevation at the Reach 1 inlet to 800 and 801 on March 15, 2012. Here is a brief summary of the results:

1. The forecast peak spring flow at the Dauphin River communities would not increase
2. LSM levels on April 1st would be 0.4 to 0.8 ft higher than the current forecast
3. LSM levels from May 1st to Sept 1st would be 0.5 to 0.9 ft higher than the current forecast
4. LSM level on Sept 1st would still be greater than the sill elevation, which means the flow would not naturally stop. Therefore equipment will still be required to complete the closure (unless the emergency operating exemption is extended).
5. The desirable operating range for Lake St. Martin is 797 to 800 ft and flood stage is 801.7 ft. Constructing the Reach 1 inlet sill on March 15 will increase LSM levels and could keep it above flood stage all summer.

Note that our LSM graphs to date only extend to Nov 1st, 2012 and do not yet account for the closure of Reach 1 on September 1st, as required by the current emergency operating license. If we close Reach 1 on Sept 1st, and keep Fairford fully open, Lake St. Martin would rise and cause Dauphin River flows to increase during the fall ice jam formation period.

Therefore we soon may have to start looking at scenarios for next fall as I suspect we may want to request an operating extension of a month or two. This may also impact how we remove the DRFN dikes, upgrade PR513, etc.

Regards,

Colin Siepman, B.Sc. CE, M.Eng, P.Eng
Senior Project Manager
KGS Group

---

**From:** Allard, Mark (MIT) [mailto:Mark.Allard@gov.mb.ca]
**Sent:** February 21, 2012 9:06 AM
**To:** Colin Siepman; Brian Bodnaruk
**Subject:** Closure of Reach 1

Gentlemen,

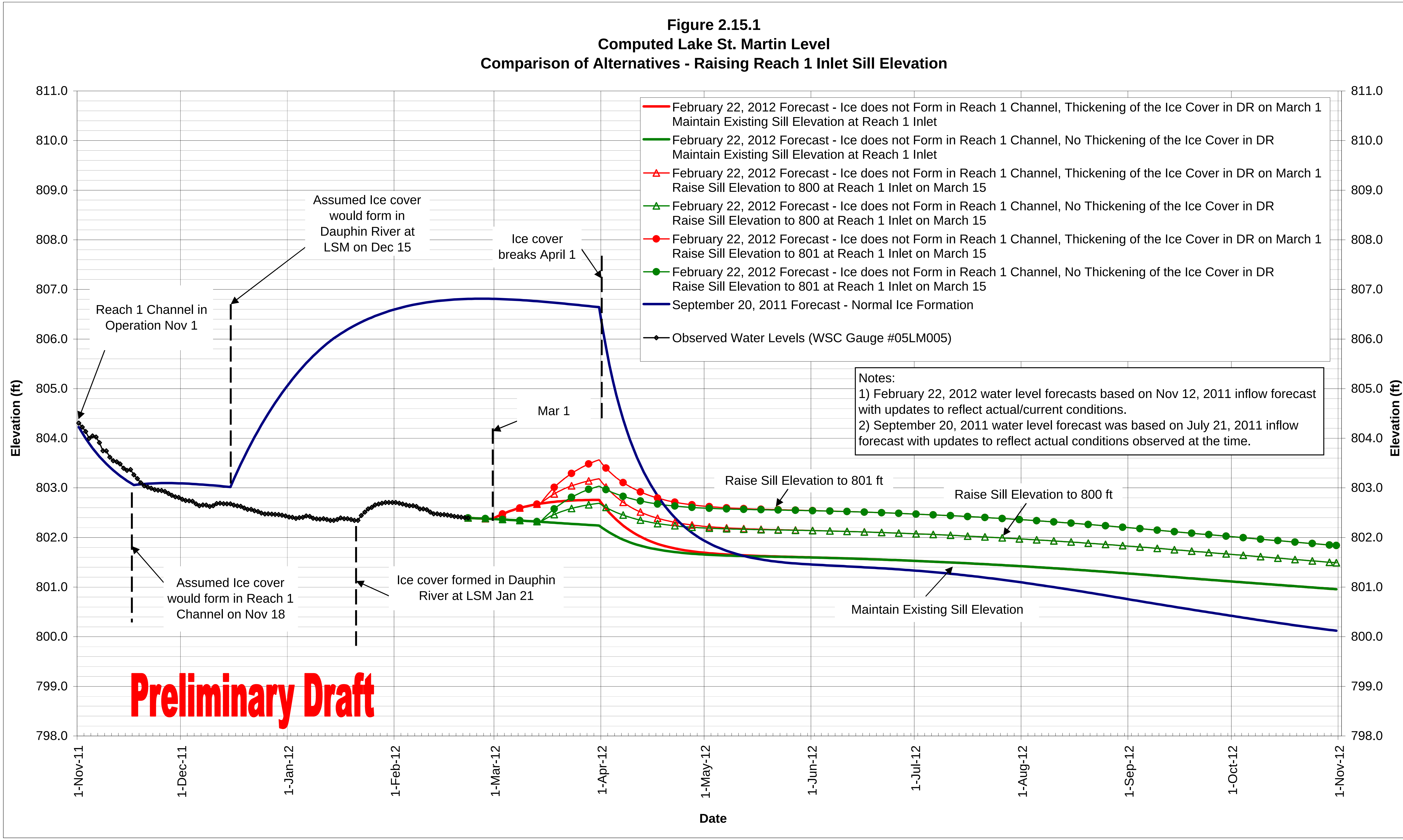
We are throwing around ideas for the closure of Reach 1 and had the thought of raising the inlet in early March to 800 or 801 and allowing the water to naturally stop when it hit that elevation.

If this was to be accomplished, what would this do to the LSM and Dauphin River forecast from March 1 to Sept 1? Can you run both scenarios?

**Mark G. Allard, P. Eng.**
Director of Regional Operations
Engineering and Operations, MIT
West Central Region (04)
Dauphin, MB
(204) 622-2261(w)
(204) 638-1887(c)

**Lake Manitoba Forecast**
**Correspondence and Figures**

**February 24, 2012**

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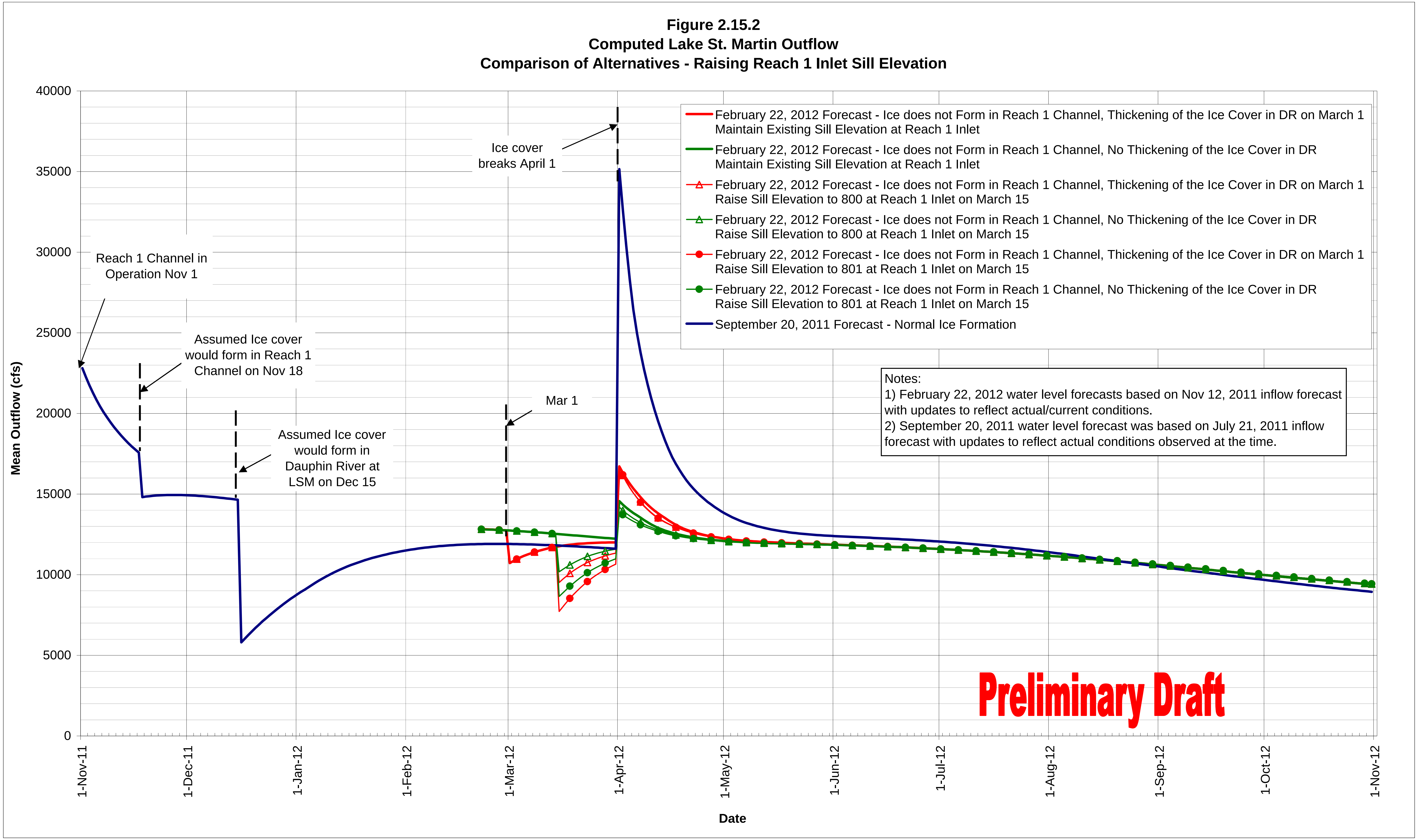


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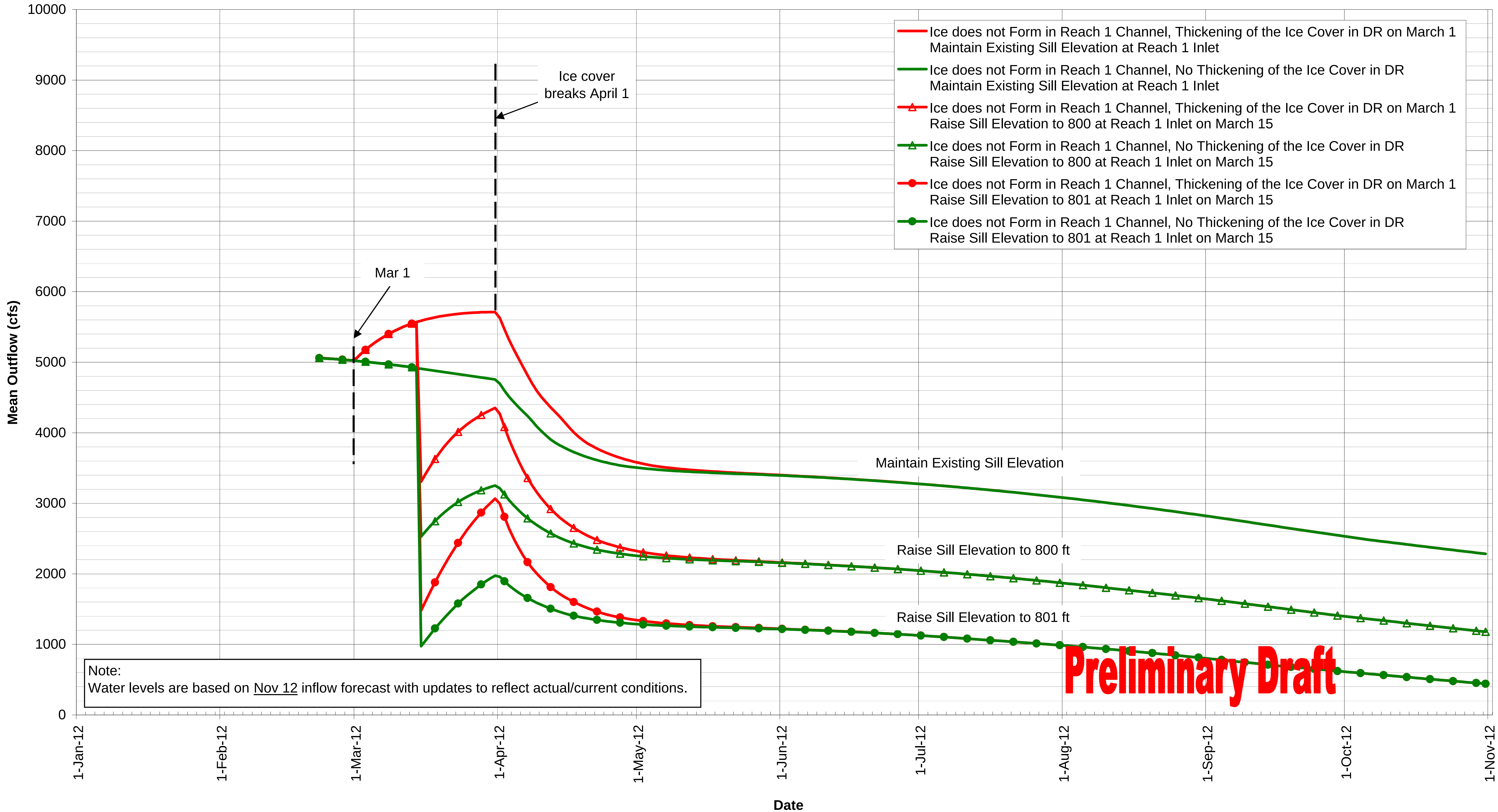
# Figure 2.15.2b
## Computed Buffalo Creek Outflow
## Comparison of Alternatives - Raising Reach 1 Inlet Sill Elevation

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**Lake Manitoba Forecast**
**Correspondence and Figures**

**March 31, 2012**

## Garrett Wellwood

**From:** Patrice Leclercq [PLeclercq@kgsgroup.com]
**Sent:** Friday, March 01, 2013 8:03 AM
**To:** 'Patrice Leclercq'
**Subject:** FW: New Lake Manitoba Inflow Forecast & March 13, 2012 Hydrographs
**Attachments:** Figure 1.1.1 RevH.PDF; Figure 2.13.1 RevF.PDF; Figure 2.13.2 RevF.PDF

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**From:** Colin Siepman [mailto:CSiepman@kgsgroup.com]
**Sent:** March-13-12 4:32 PM
**To:** Mark Allard ; Ron Kaatz; Ron Richardson
**Cc:** Brian Bodnaruk; Rob Kenyon; Bert Smith; Rick Carson; Dave MacMillan
**Subject:** New Lake Manitoba Inflow Forecast & March 13, 2012 Hydrographs

All,

Updated hydrographs are attached with discussion below as requested.

**Impact on Lake Manitoba**

The current hydrographs are based on a March 12, 2012 inflow forecast. These hydrographs indicate that the Fairford Water Control Structure must remain fully open throughout the 2012/2013 winter to reduce Lake Manitoba levels to roughly 811.5 by March 31$^{st}$, 2013.

**Impact on Lake St. Martin**

The original hydrographs prior to the emergency exemption were based on a July 21, 2011 inflow forecast. These hydrographs indicated that Lake St. Martin levels would drop below elevation 801 by August 31, 2012.

The current hydrographs are based on a March 12, 2012 inflow forecast. These hydrographs indicate Lake St. Martin levels will not drop to 801 ft until the end of October 2012 assuming median inflow conditions. If the Reach 1 channel is closed on August 31 it would cause Lake St. Martin to quickly stage to approximately 802 ft, which is above the flood stage of 801.7 and well above the desirable operating range of 797 to 800 ft.

Further, depending on the timing of ice formation in the upper Dauphin River and the processes by which it happens, Lake St. Martin levels may begin to increase significantly in December 2012. If the Reach 1 channel is closed on August 31, 2012 and assuming an extreme ice jam forming on the Dauphin River at the outlet of the lake, the staging of Lake St. Martin could reach 805.5 during the 2012/2013 winter.

**Impact on Dauphin River**

Based on the current hydrographs, Lake St. Martin levels will drop to approximately 801 ft by the end of October if Reach 1 remains open. Assuming an early ice formation of Nov 10 in the Dauphin River Community, the total flow in the river in the community on that date would be approximately 9500 cfs.

Alternatively, if the Reach 1 channel is closed on August 31 it would cause Lake St. Martin to stage to approximately 802 ft by the end of October. Assuming the same early ice formation of Nov 10 in the Dauphin River Community, the total flow in the river in the community would also be approximately 9500 cfs

Therefore the closure of the Reach 1 channel does not impact the expected flows in the community, provided that Lake St. Martin has enough time to stage back to a level where the outflow is equal to inflow.

In 2010 the Dauphin River flow during the fall ice formation period was approximately 7000 cfs, which did not result in flooding of the Communities, but came very close. KGS is currently evaluating the potential ice staging in the fall of 2012 due to a flow of 9500 cfs.

**Recommendation**

It is recommended to extend the operation of the Reach 1 channel from August 31 until the winter of 2012/13 to reduce Lake St. Martin levels. This may possibly extend until March 31 of 2013 if the Fairford Control Structure must remain fully open all winter to reduce Lake Manitoba Levels.

Regards,

Colin Siepman, B.Sc. CE, M.Eng, P.Eng
Senior Project Manager
KGS Group

---

**From:** Kaatz, Ron G (MIT) [mailto:Ron.Kaatz@gov.mb.ca]
**Sent:** March 12, 2012 3:47 PM
**To:** Colin Siepman; Brian Bodnaruk
**Cc:** Richardson, Ron (MIT); Allard, Mark (MIT)
**Subject:** FW: New Lake Manitoba Forecast

Hi Colin and Brian
Attached WSD numerical forecast to 31-Dec-12.

Do you know when your projections will be ready for viewing?
Thanks

**Ron G. Kaatz, P. Eng.**
Senior Hydraulic Engineer

Manitoba Infrastructure and Transportation
Engineering & Operations,
Water Control and Structures
Operations & Maintenance Branch
7th floor, 215 Garry St.
Winnipeg, Manitoba R3C 3P3
Ph: (204) 945-0322
Cell <Personal information removed>
Fax: (204) 948-4503
e-mail: Ron.Kaatz@gov.mb.ca

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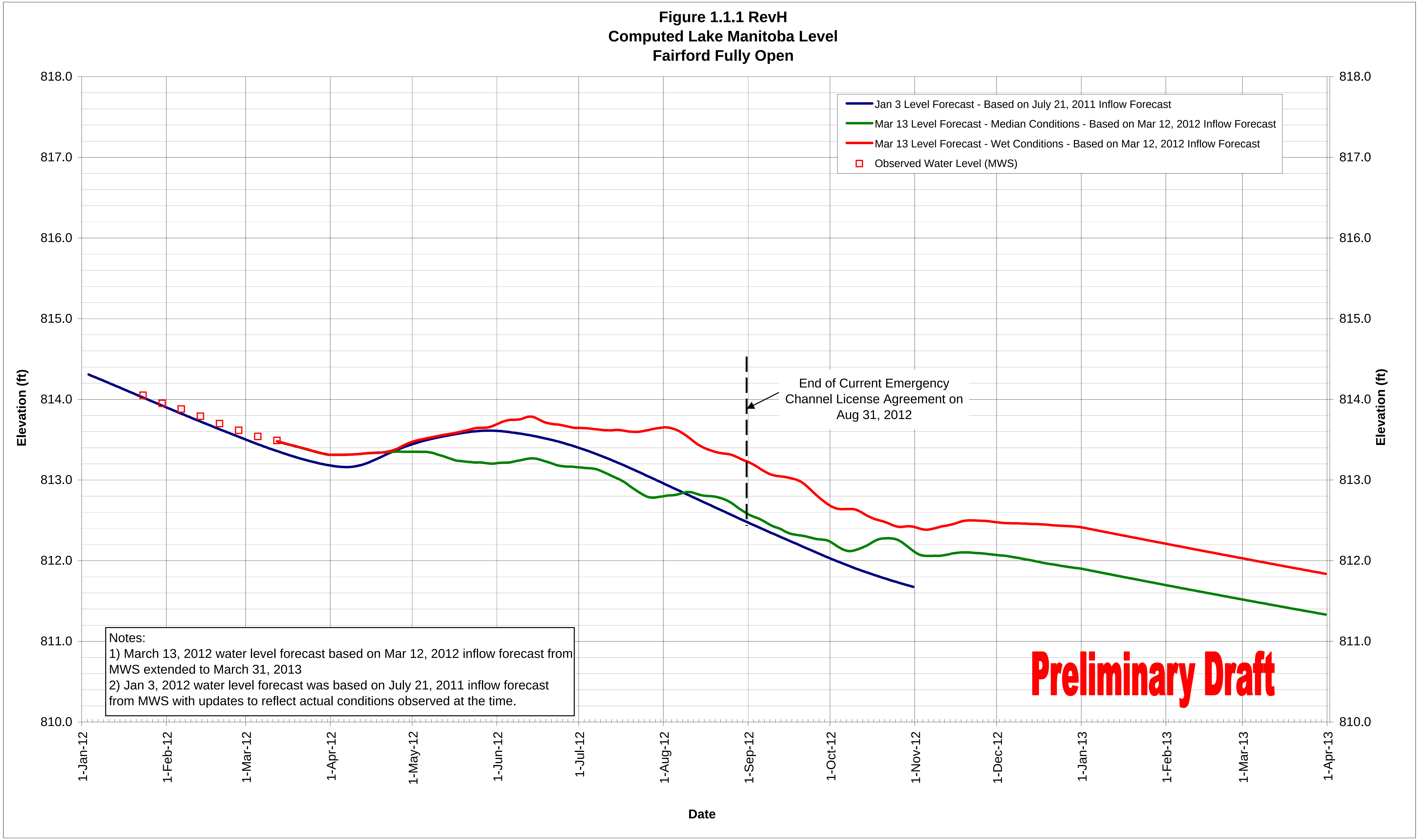
**From:** Mutulu, Phillip (MWS)
**Sent:** March-12-12 1:32 PM
**To:** Kaatz, Ron G (MIT)
**Subject:** FW: New Lake Manitoba Forecast

Ron;

AS requested the graphics with their associated numerics are attached.

Thanks,

Phill

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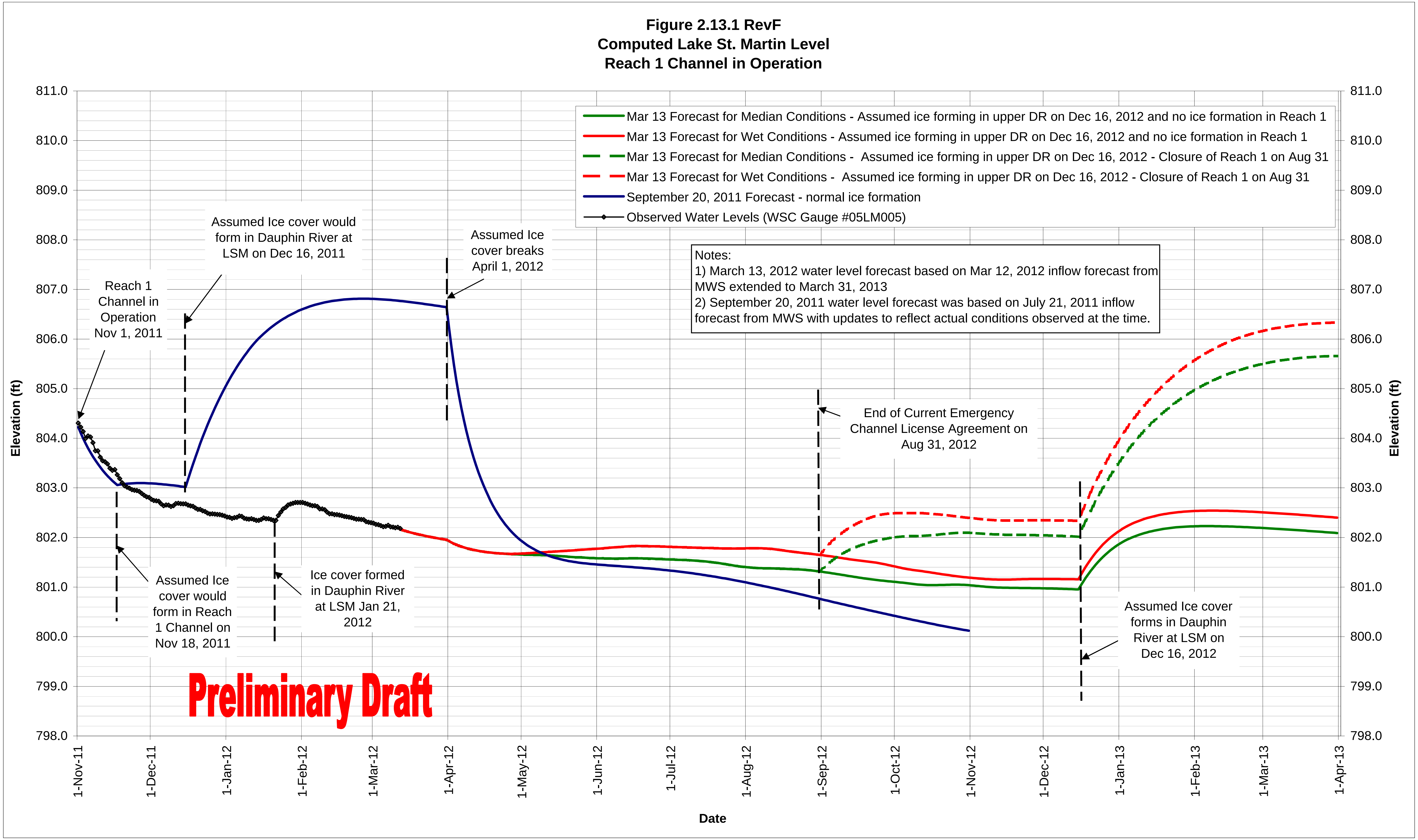


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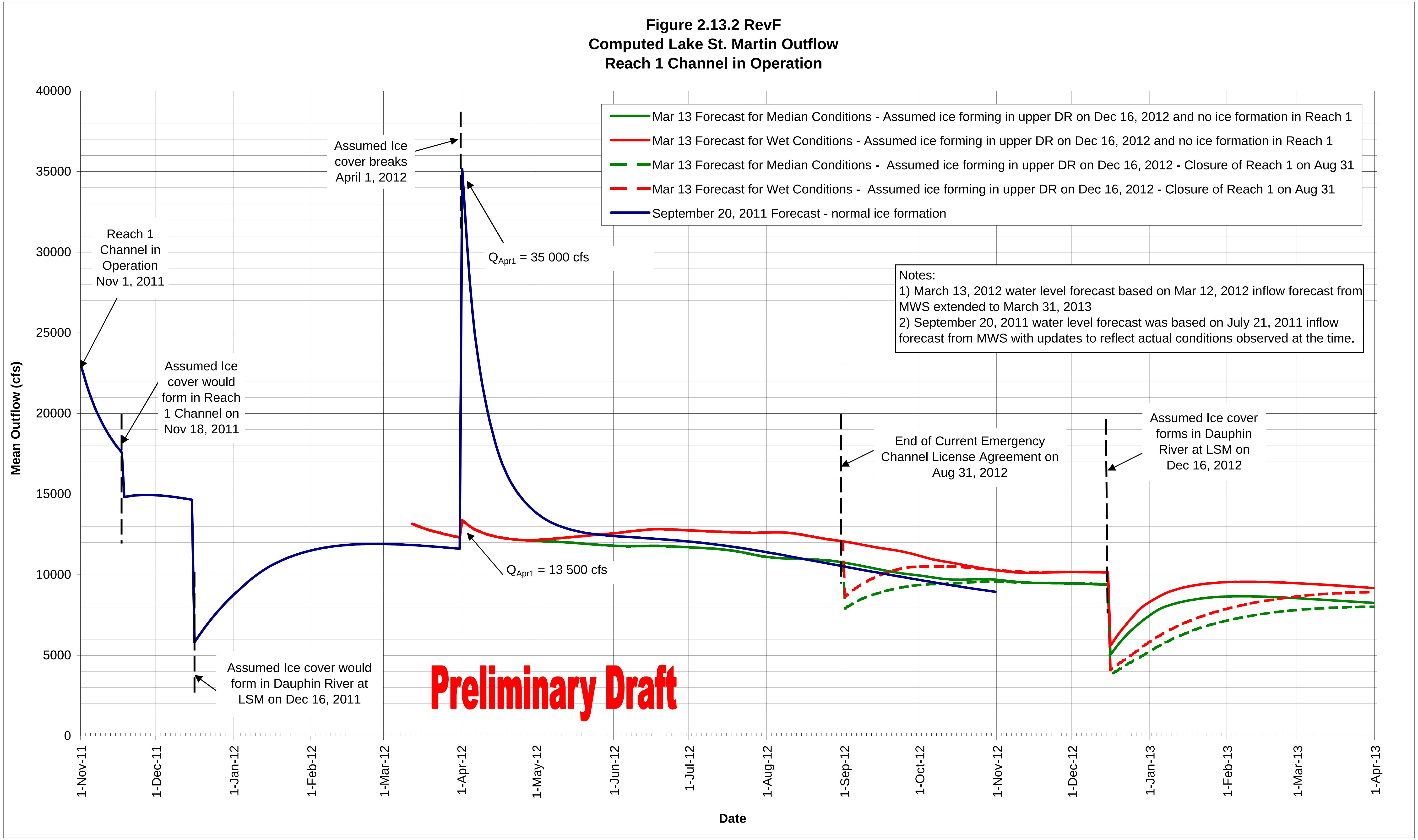


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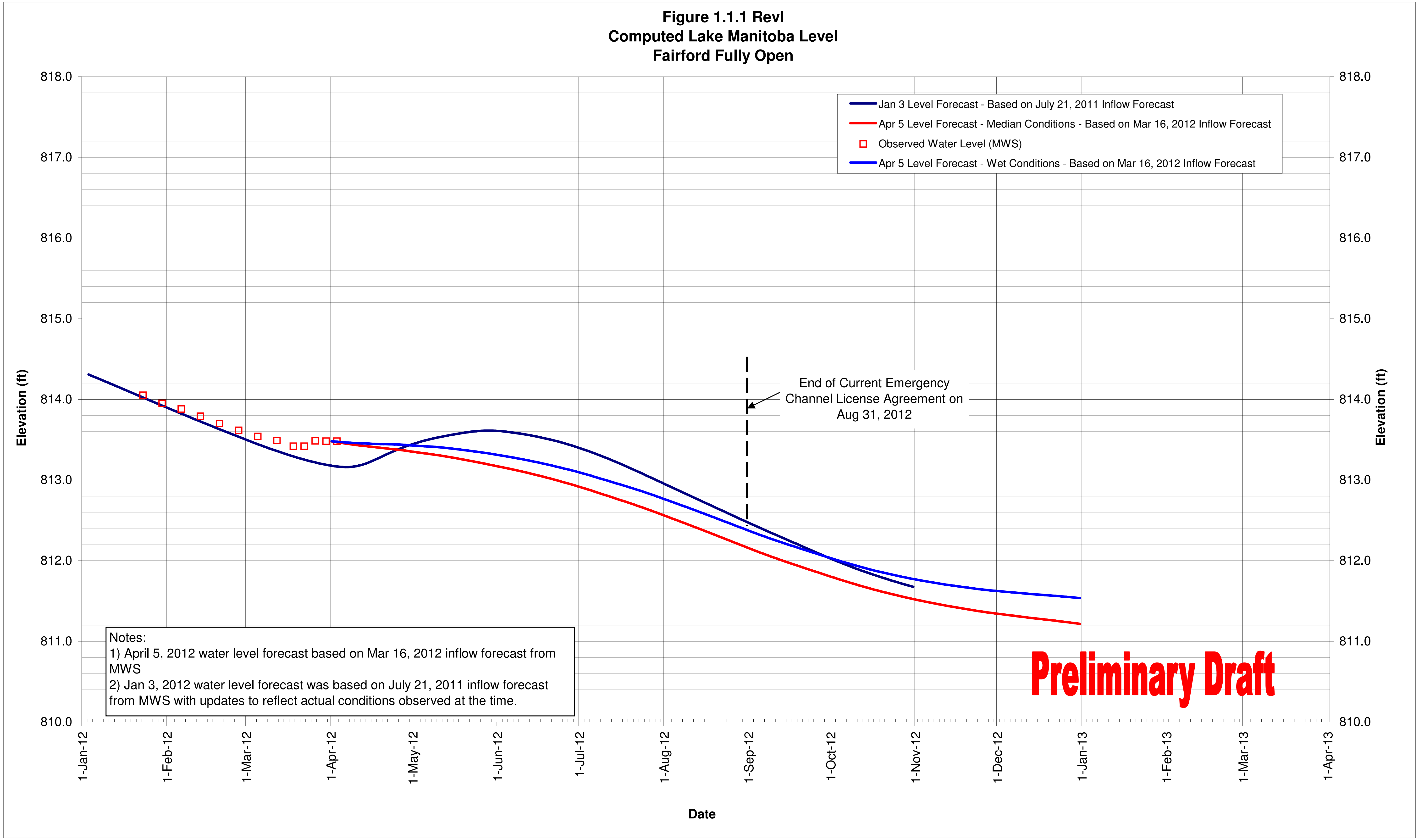
**Lake Manitoba Forecast**
**Correspondence and Figures**

**April 5, 2012**

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4/5/2012

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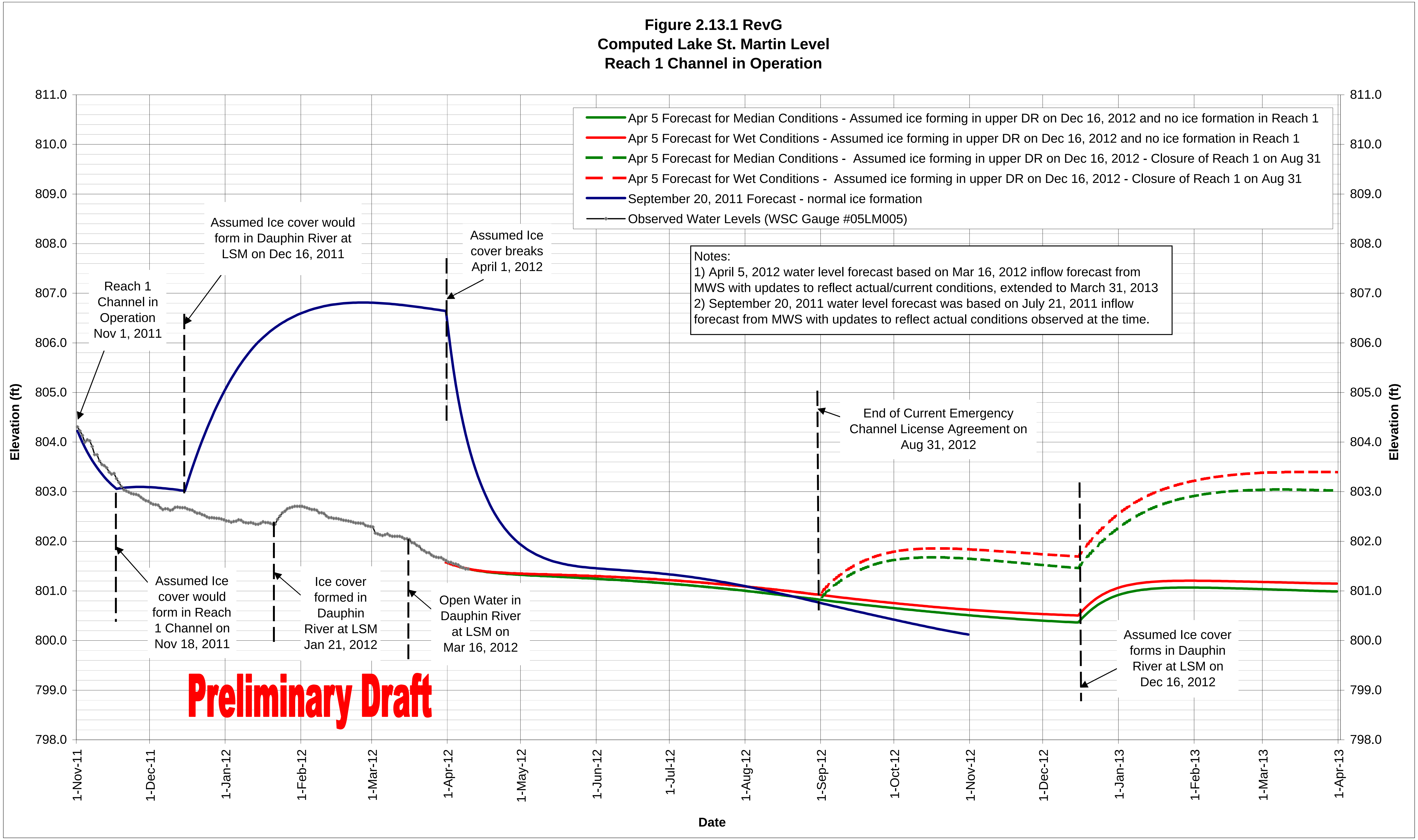
**Lake Manitoba Forecast**
**Correspondence and Figures**

**April 10, 2012**

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4/10/2012

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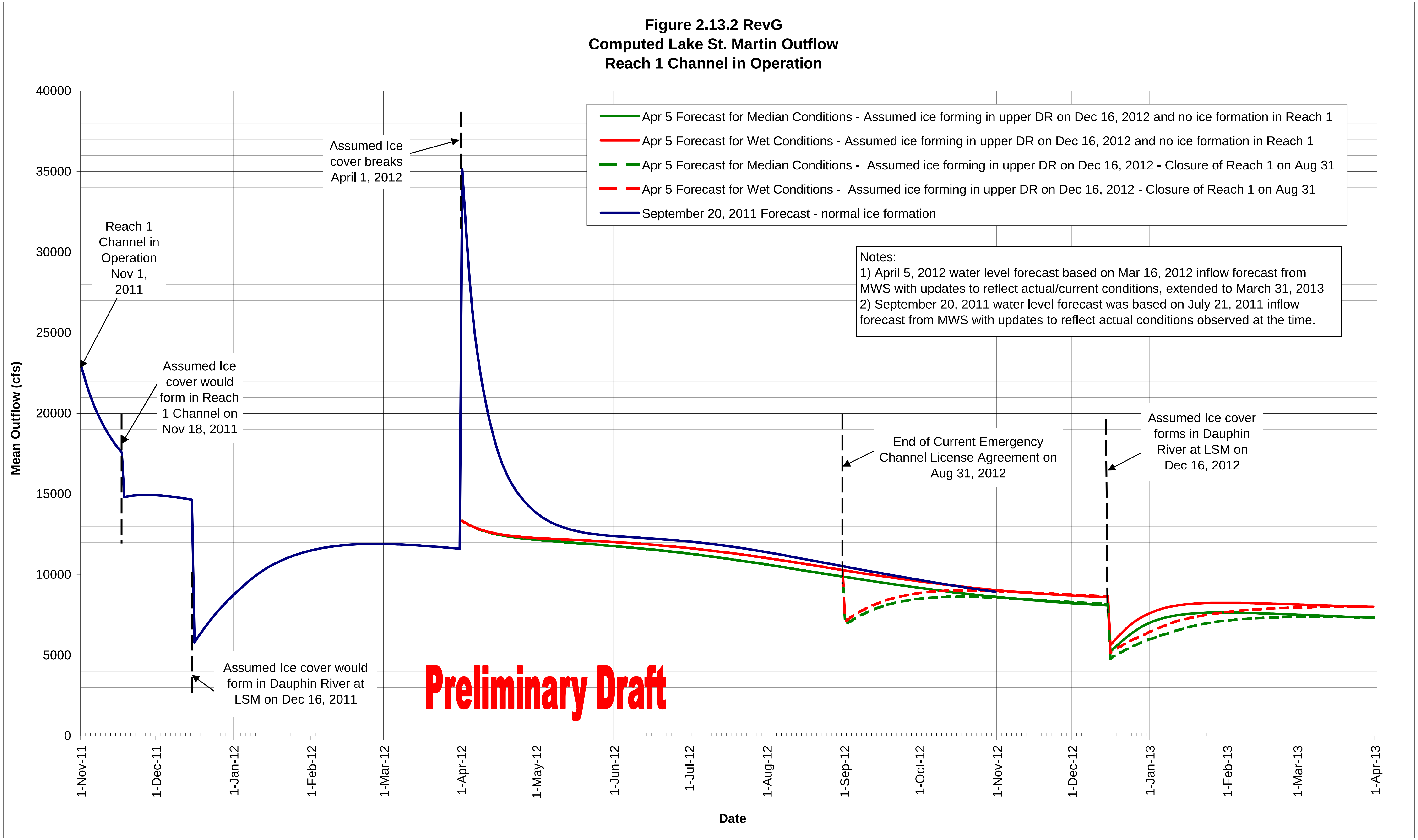


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4/10/2012

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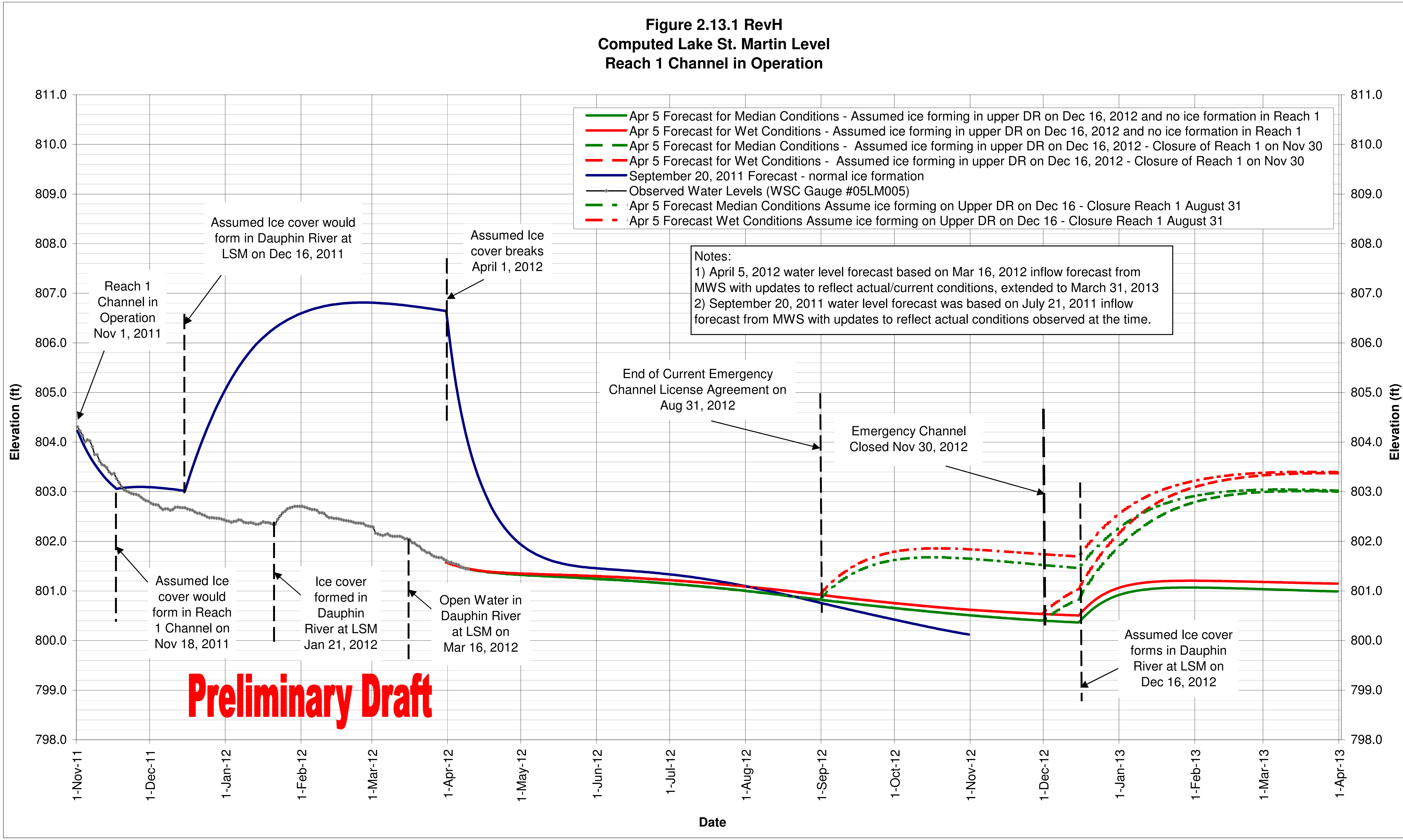
**Lake Manitoba Forecast**
**Correspondence and Figures**

**April 12, 2012**

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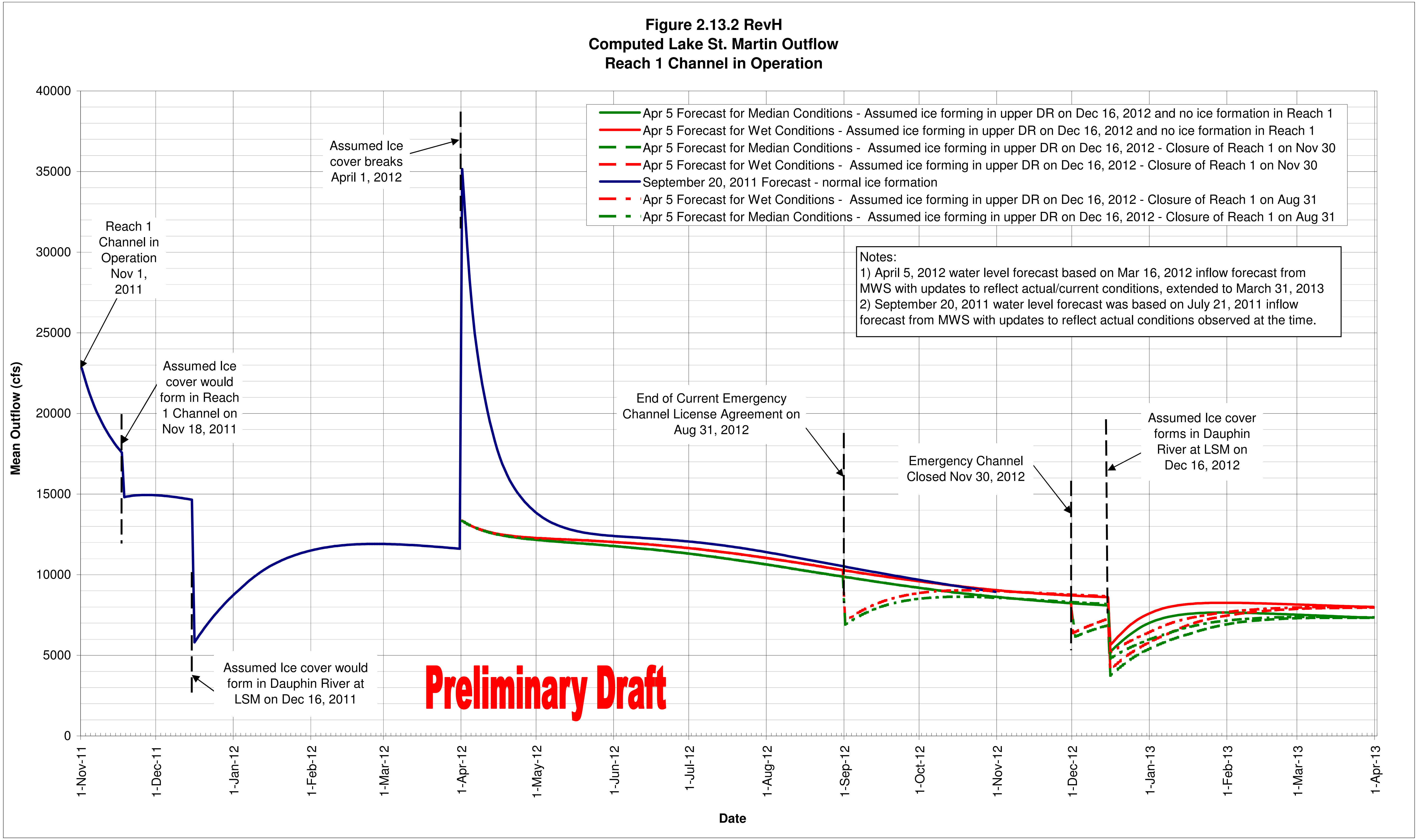


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4/12/2012

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**Lake Manitoba Forecast**
**Correspondence and Figures**

**June 30, 2012**

## Garrett Wellwood

**From:** Colin Siepman [CSiepman@kgsgroup.com]
**Sent:** Wednesday, July 04, 2012 4:15 PM
**To:** Ron Kaatz
**Cc:** Ron Richardson; Mark Allard ; Phillip Mutulu; Steve Topping; Brian Bodnaruk; Rick Carson; Bert Smith; Dave MacMillan; Rob Kenyon
**Subject:** End of June LMB and LSM Forecast
**Attachments:** Figure 2.13.2 RevI.pdf; Figure 1.1.1 RevJ.pdf; Figure 2.13.1 RevI.pdf

Ron,

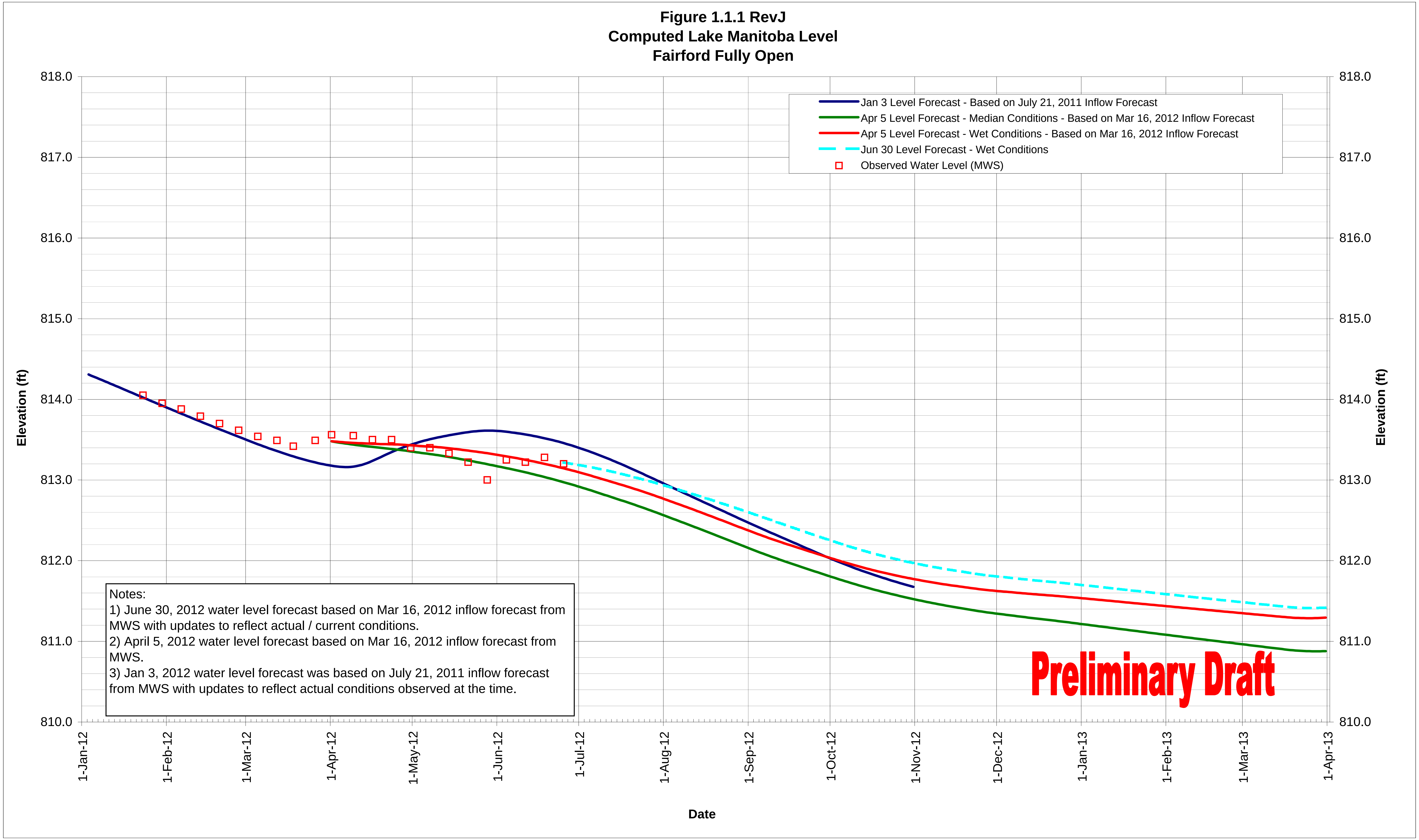
Please find attached the revised Lake Manitoba and Lake St. Martin forecast for the end of June as requested. The water level forecast is based on the March 16 MWS inflow forecast updated to reflect actual / current conditions. As shown on the figures, we are currently tracking slightly above the wet forecast that was issued in April. This is due to the large amount of precipitation that occurred in May and June.

Note that, as per previous forecasts, the Lake St. Martin levels in the coming fall/winter are based on Fairford being fully open and are therefore subject to change pending a decision to operate the Fairford Control Structure.

Let us know if you have any questions or comments.

Regards,

Colin Siepman, B.Sc. CE, M.Eng, P.Eng
Senior Project Manager
KGS Group

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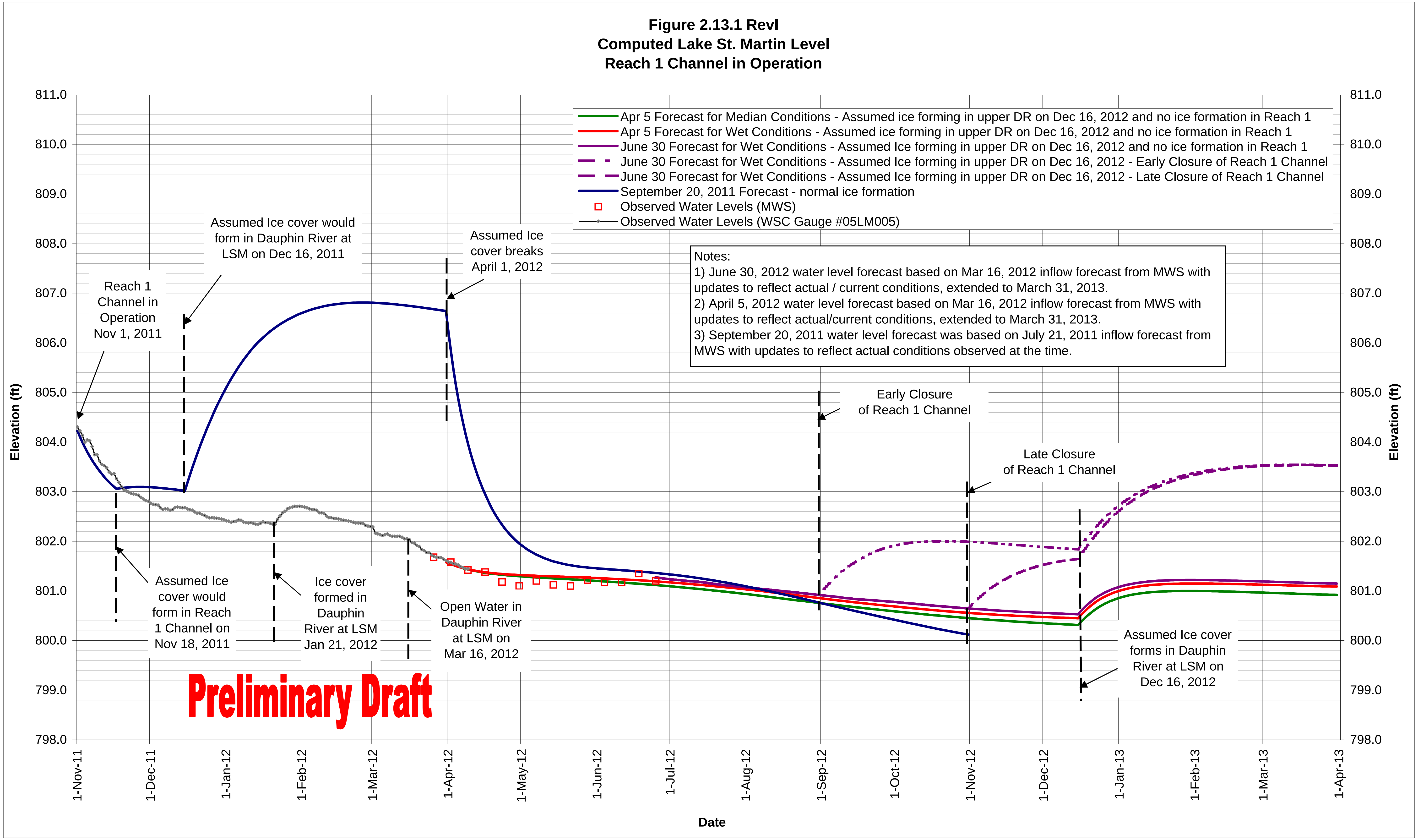


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7/3/2012

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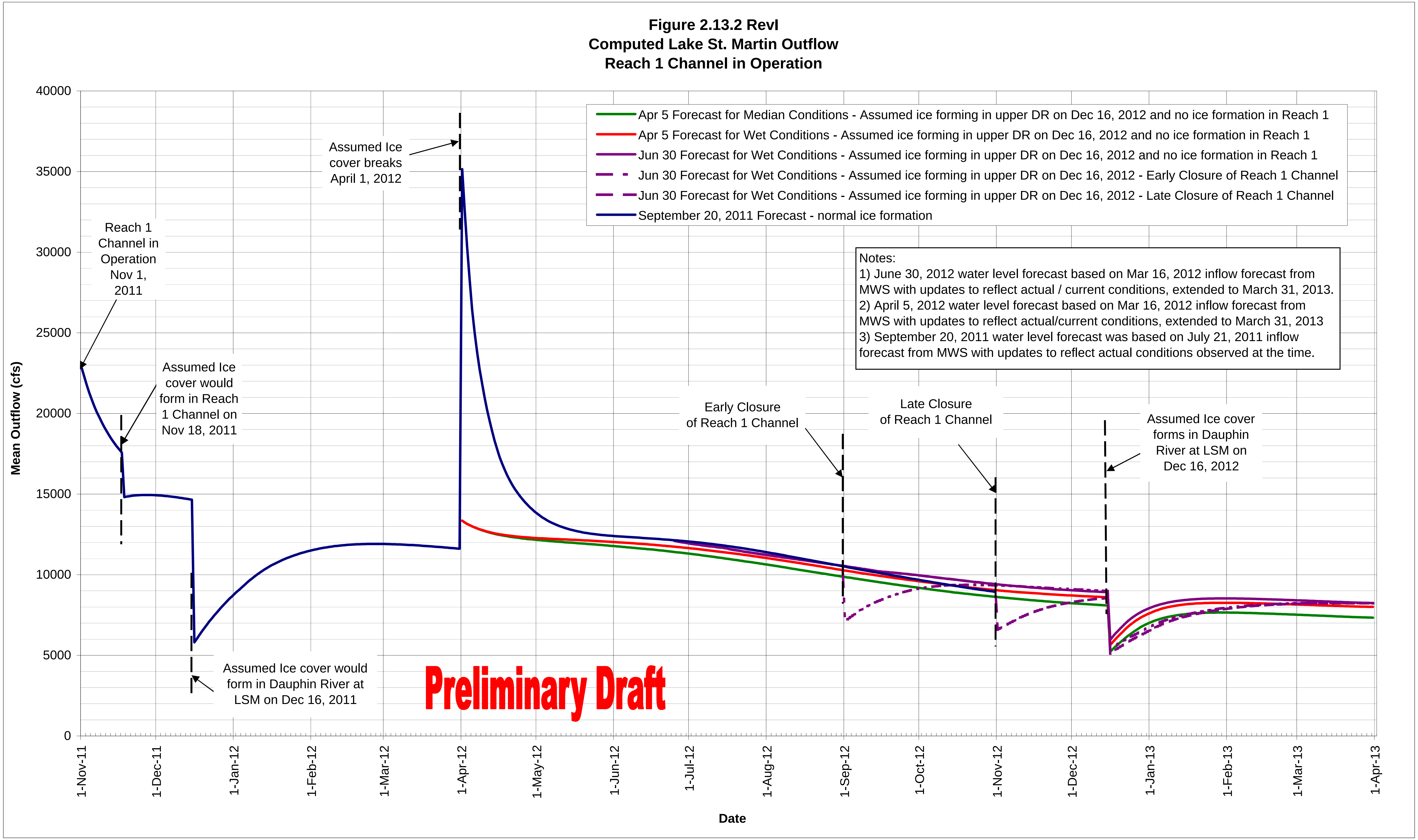


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7/3/2012

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**Lake Manitoba Forecast**
**Correspondence and Figures**

**July 31, 2012**

## Garrett Wellwood

**From:** Colin Siepman [CSiepman@kgsgroup.com]
**Sent:** Thursday, August 02, 2012 3:14 PM
**To:** Ron Kaatz
**Cc:** Ron Richardson; Mark Allard ; Phillip Mutulu; Steve Topping; Brian Bodnaruk; Rick Carson; Bert Smith; Dave MacMillan; Rob Kenyon
**Subject:** End of July LMB and LSM Forecast & Figure for Flood Mailer
**Attachments:** LMB_With&Without LSMEOC.PDF; Figure 1.1.1 RevK.PDF; Figure 2.13.1 RevJ.PDF; Figure 2.13.2 RevJ.PDF

Ron,

Please find attached the updated Lake Manitoba and Lake St. Martin forecast for the end of July. The water level forecast is based on the March 16 MWS inflow forecast updated to reflect actual / current conditions. The end of July forecast has not changed significantly since our previous issue at the end of June. We are still tracking slightly above the wet forecast that was issued in April due to the large amount of precipitation that occurred in May and June.

Note that, as per previous forecasts, the lake levels in the coming fall/winter are based on Fairford being fully open and are therefore subject to change pending a decision to operate the Fairford River Water Control Structure.

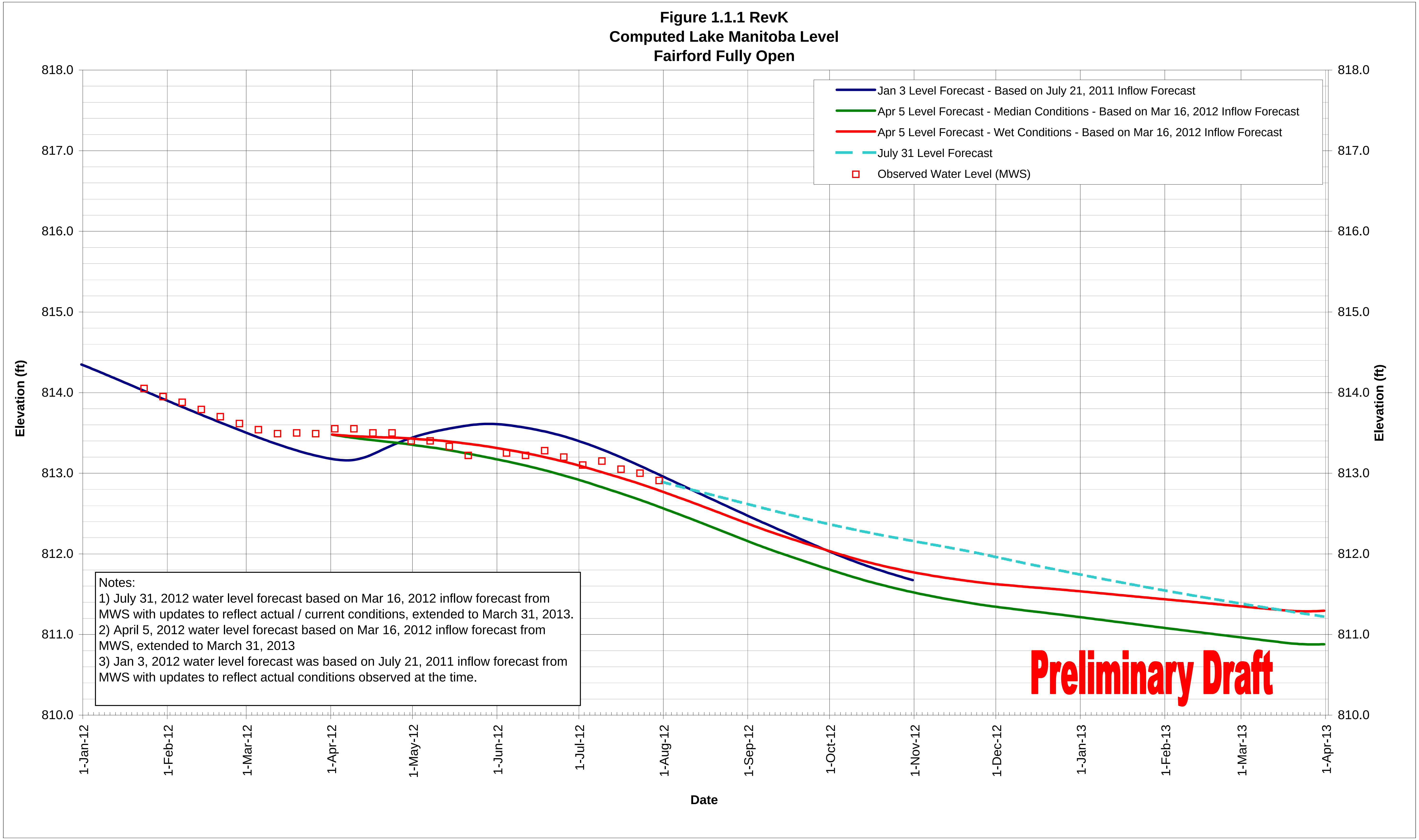
Also attached is the figure requested by Steve Topping, which shows the benefits of operating the Lake St.Martin Emergency Channel to Lake Manitoba. The figure shows observed, estimated and forecasted water levels on Lake Manitoba between Aug. 1, 2011 and Nov, 1, 2012 with and without operation of the Lake St. Martin Emergency Channel.

Let us know if you have any questions or comments.

Regards,

Colin Siepman, B.Sc. CE, M.Eng, P.Eng
Senior Project Manager
KGS Group

KGS Place
3rd Flr - 865 Waverley St.
Winnipeg, MB, R3T 5P4
Phone : (204) 896-1209
Fax : (204) 896-0754
CSiepman@kgsgroup.com

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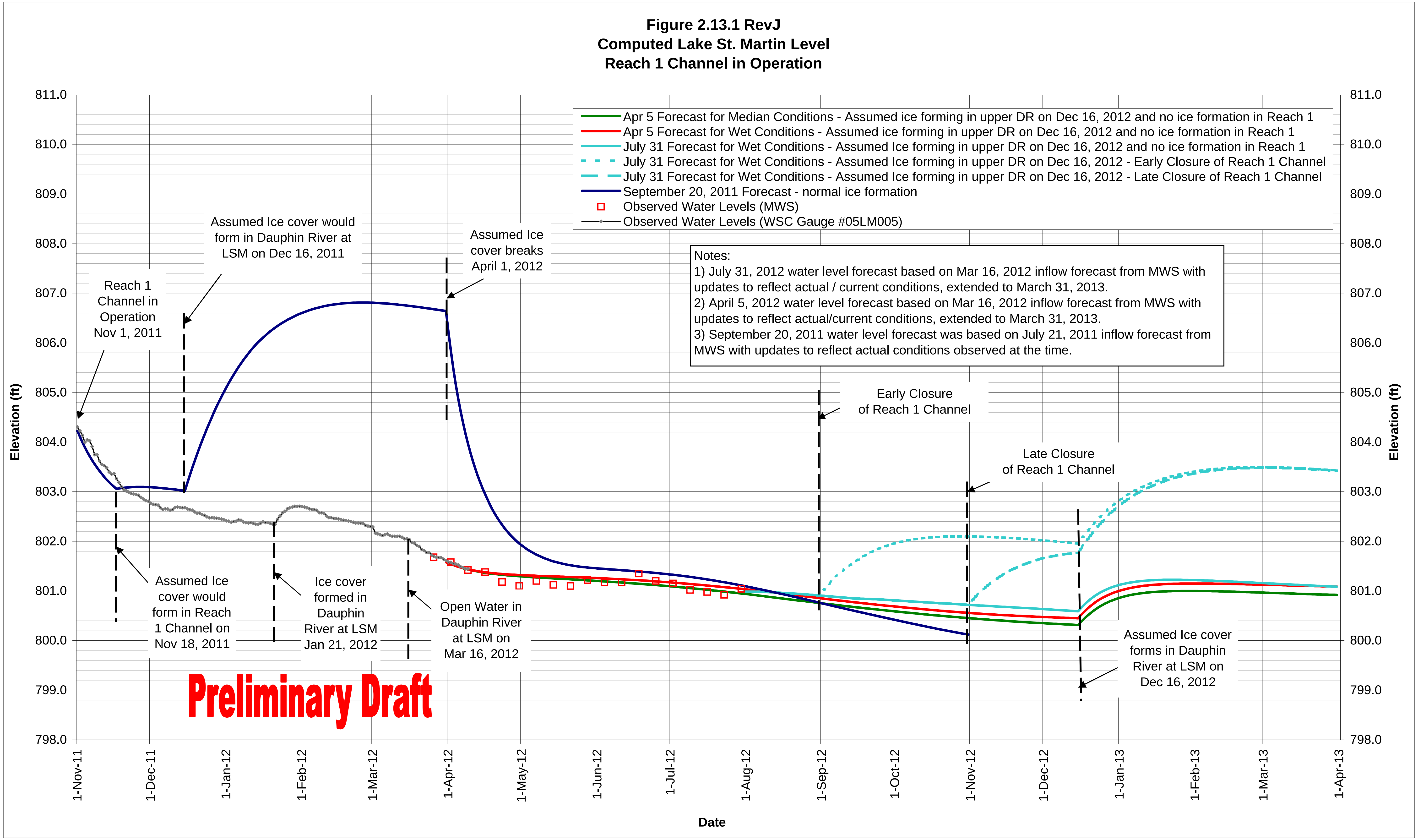


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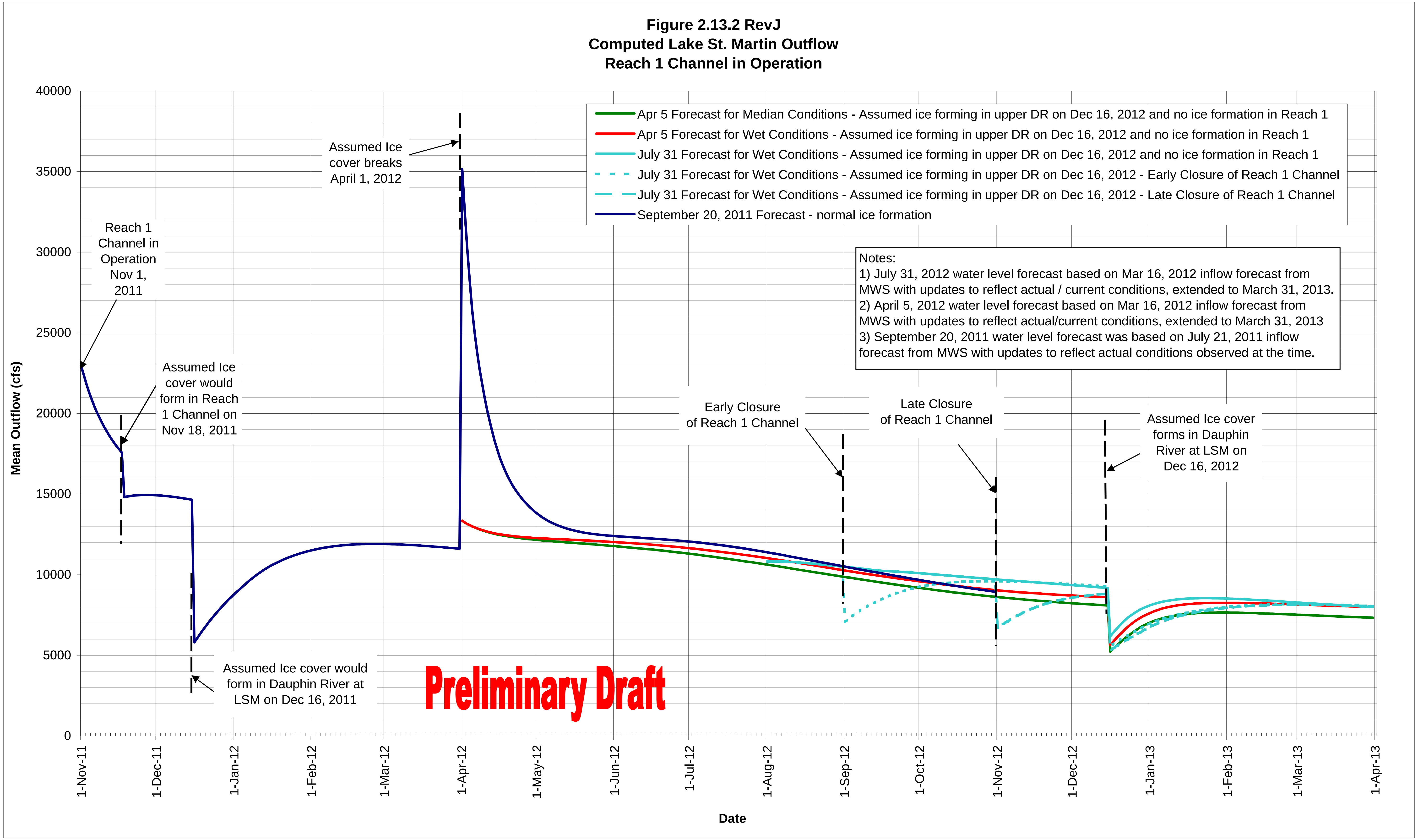


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**Lake Manitoba Forecast**
**Correspondence and Figures**

**August 15, 2012**

## Garrett Wellwood

**From:** Colin Siepman [CSiepman@kgsgroup.com]
**Sent:** Wednesday, August 15, 2012 3:14 PM
**To:** Steve Topping; Ron Kaatz
**Cc:** 'Richardson, Ron (MIT)'; Mark Allard ; 'Mutulu, Phillip (MWS)'; 'Brian Bodnaruk'; 'Rick Carson'; 'Bert Smith'; 'Dave MacMillan'; 'Rob Kenyon'
**Subject:** RE: End of July LMB and LSM Forecast - Updated with Fairford Winter Flow Restriction
**Attachments:** Figure 1.1.1 RevL.PDF; Figure 2.13.1 RevK.PDF; Figure 2.13.2 RevK.PDF

Steve & Ron,

As per your request a new water level forecast was added to the July 31 forecast, which assumes a late closure of the Reach 1 Emergency Channel (November 1, 2012) and winter flows restricted by the Fairford Control Structure to 5000 cfs from November 1, 2012 to February 14, 2013, and then increased to 8800 cfs from February 15, 2013 to March 31, 2013. The 5000 cfs & 8800 cfs flows were based on operating conditions during the winter of 2010-2011.

The water level forecast shows that Lake Manitoba levels would remain near 812.2 ft for the most part of the winter and decrease to 811.9 ft by March 31, 2013. Forecasted water levels in Lake St. Martin show similar levels to those observed in the winter of 2010-2011. Forecasted LSM levels on February 14 would be 801.4 ft compared to 801.2 ft in 2011 and 803.3 ft on March 31 compared to 802.8 ft in 2011.

If flows are held at 5000 cfs for the entire winter, levels on Lake St. Martin would be approximately 801.6 ft on March 31 instead of 803.3 ft. Levels on Lake Manitoba would remain at approximately 812.2 ft.

Note that the above values are still based on the March 16, 2012 inflow forecast from MWS with updates to reflect actual conditions. It is our understanding that MWS is currently generating an updated inflow forecast, which will be incorporated in our upcoming “End of August LMB and LSM Forecast”.

Regards,

Colin Siepman, B.Sc. CE, M.Eng, P.Eng
Senior Project Manager
KGS Group

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**From:** Colin Siepman [mailto:CSiepman@kgsgroup.com]
**Sent:** August 8, 2012 6:13 PM
**To:** 'Allard, Mark (MIT)'; 'Kaatz, Ron G (MIT)'
**Cc:** 'Richardson, Ron (MIT)'; 'Mutulu, Phillip (MWS)'; 'Topping, Steve (MWS)'; 'Brian Bodnaruk'; 'Rick Carson'; 'Bert Smith'; 'Dave MacMillan'; 'Rob Kenyon'
**Subject:** RE: End of July LMB and LSM Forecast & Figure for Flood Mailer

Mark,

Based on the July 31, 2012 water level forecast (Figure 2.13.1 RevJ attached), the projected water level on Lake St. Martin this upcoming winter, assuming closure of the Reach 1 channel, is 803.5 ft.

Based on the April 5, 2012 water level forecast (Figure 2.13.1 RevH attached), the projected water level on Lake St. Martin this upcoming winter, assuming closure of the Reach 1 channel and “median” conditions, was 803.0 ft.

Therefore the difference between the median forecast of April 5, 2012 and the recent forecast of July 31, 2012 is 0.5 ft.

Regards,

Colin Siepman, B.Sc. CE, M.Eng, P.Eng
Senior Project Manager
KGS Group

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**From:** Allard, Mark (MIT) [mailto:Mark.Allard@gov.mb.ca]
**Sent:** August 8, 2012 1:11 PM
**To:** Colin Siepman; Kaatz, Ron G (MIT)
**Cc:** Richardson, Ron (MIT); Mutulu, Phillip (MWS); Topping, Steve (MWS); Brian Bodnaruk; Rick Carson; Bert Smith; Dave MacMillan; Rob Kenyon
**Subject:** RE: End of July LMB and LSM Forecast & Figure for Flood Mailer

Colin, would there be much of a difference in the projected water level on Lake St. Martin using the median forecast and the closure of Reach 1.

**Mark G. Allard, P. Eng.**
Director of Regional Operations
Engineering and Operations, MIT
West Central Region (04)
Dauphin, MB
(204) 622-2261(w)
(204) 638-1887(c)

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**From:** Colin Siepman [mailto:CSiepman@kgsgroup.com]
**Sent:** August-02-12 3:14 PM
**To:** Kaatz, Ron G (MIT)
**Cc:** Richardson, Ron (MIT); Allard, Mark (MIT); Mutulu, Phillip (MWS); Topping, Steve (MWS); Brian Bodnaruk; Rick Carson; Bert Smith; Dave MacMillan; Rob Kenyon
**Subject:** End of July LMB and LSM Forecast & Figure for Flood Mailer

Ron,

Please find attached the updated Lake Manitoba and Lake St. Martin forecast for the end of July. The water level forecast is based on the March 16 MWS inflow forecast updated to reflect actual / current conditions. The end of July forecast has not changed significantly since our previous issue at the end of June. We are still tracking slightly above the wet forecast that was issued in April due to the large amount of precipitation that occurred in May and June.

Note that, as per previous forecasts, the lake levels in the coming fall/winter are based on Fairford being fully open and are therefore subject to change pending a decision to operate the Fairford River Water Control Structure.

Also attached is the figure requested by Steve Topping, which shows the benefits of operating the Lake St.Martin Emergency Channel to Lake Manitoba. The figure shows observed, estimated and forecasted water levels on Lake Manitoba between Aug. 1, 2011 and Nov, 1, 2012 with and without operation of the Lake St. Martin Emergency Channel.

Let us know if you have any questions or comments.

Regards,

Colin Siepman, B.Sc. CE, M.Eng, P.Eng
Senior Project Manager
KGS Group

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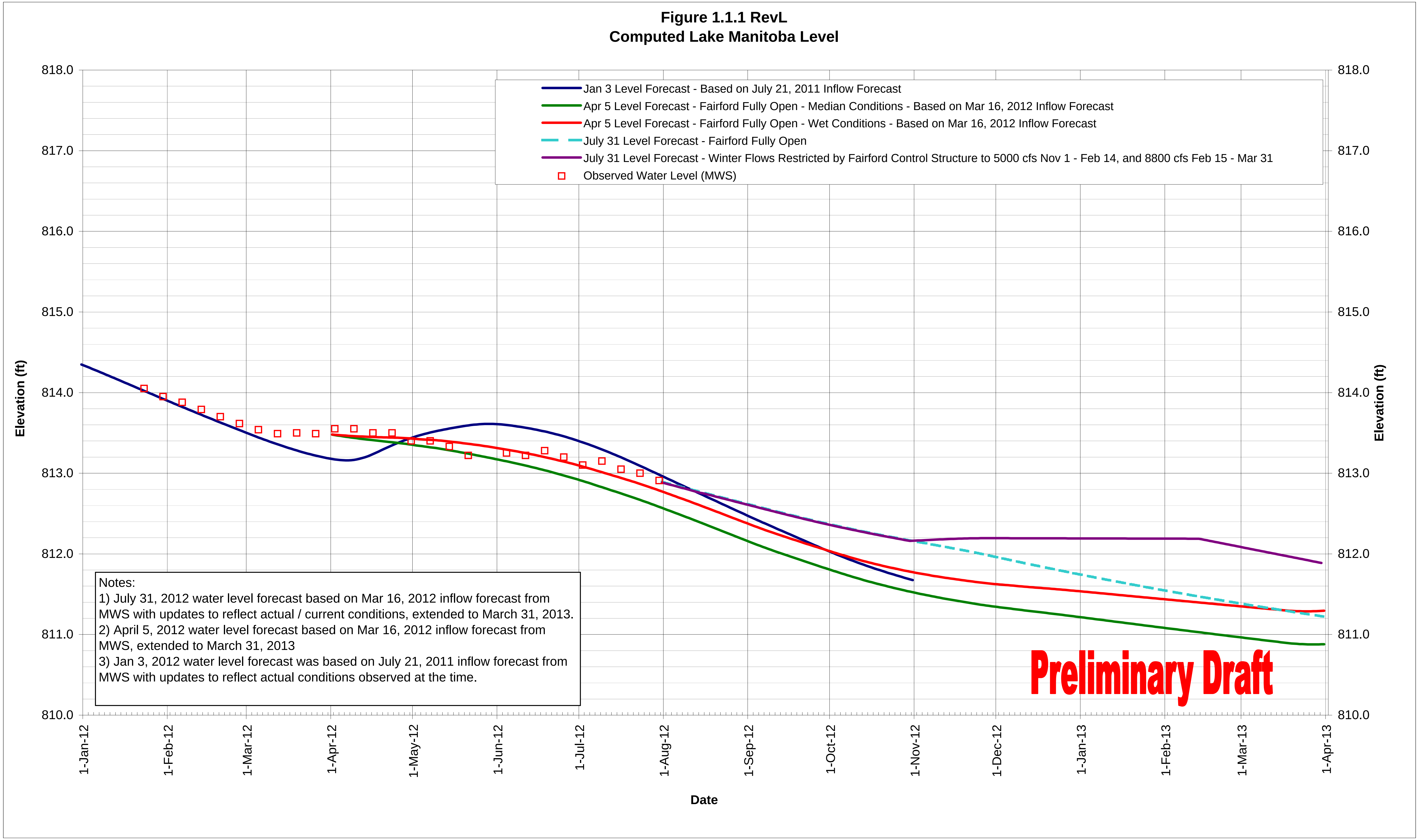


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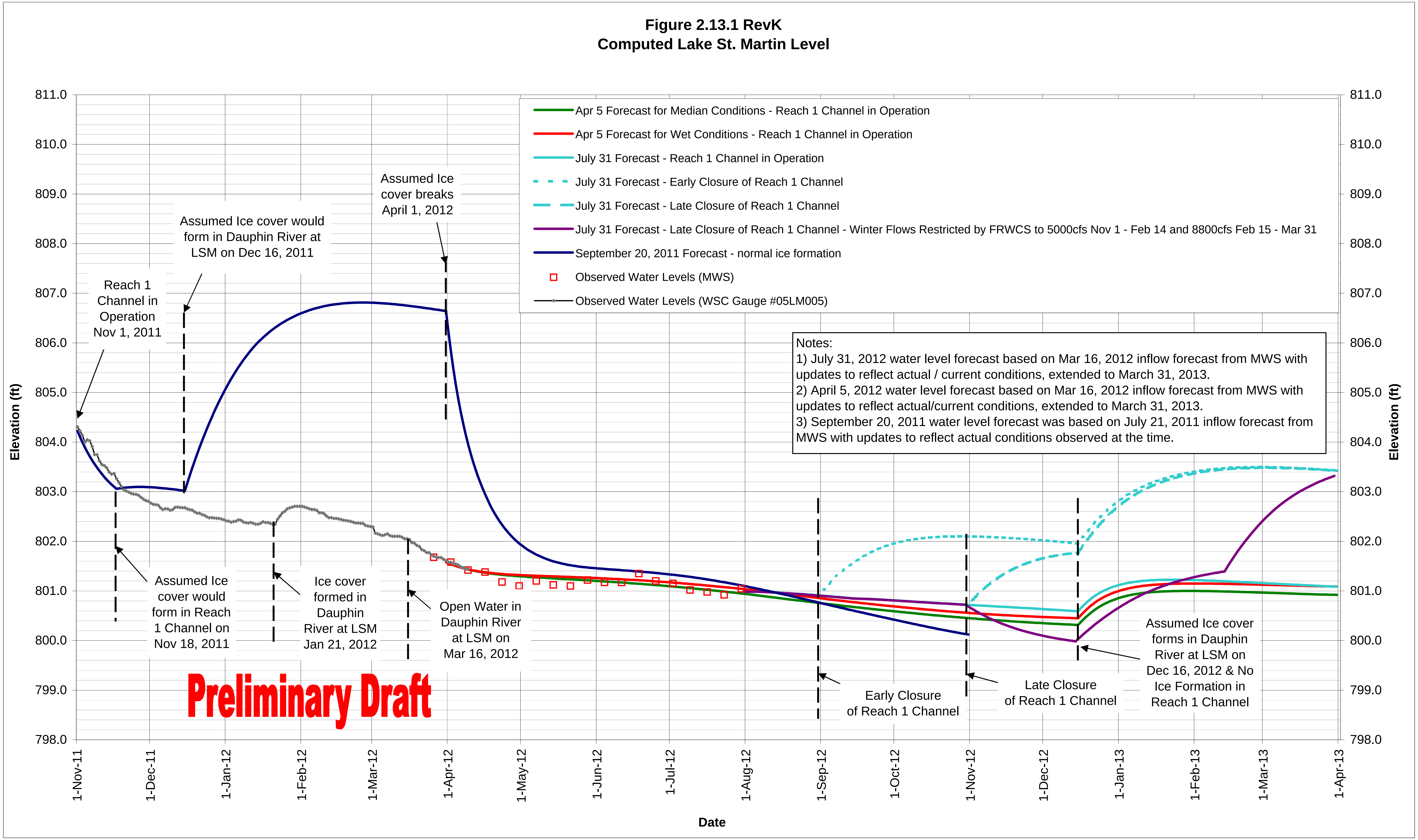


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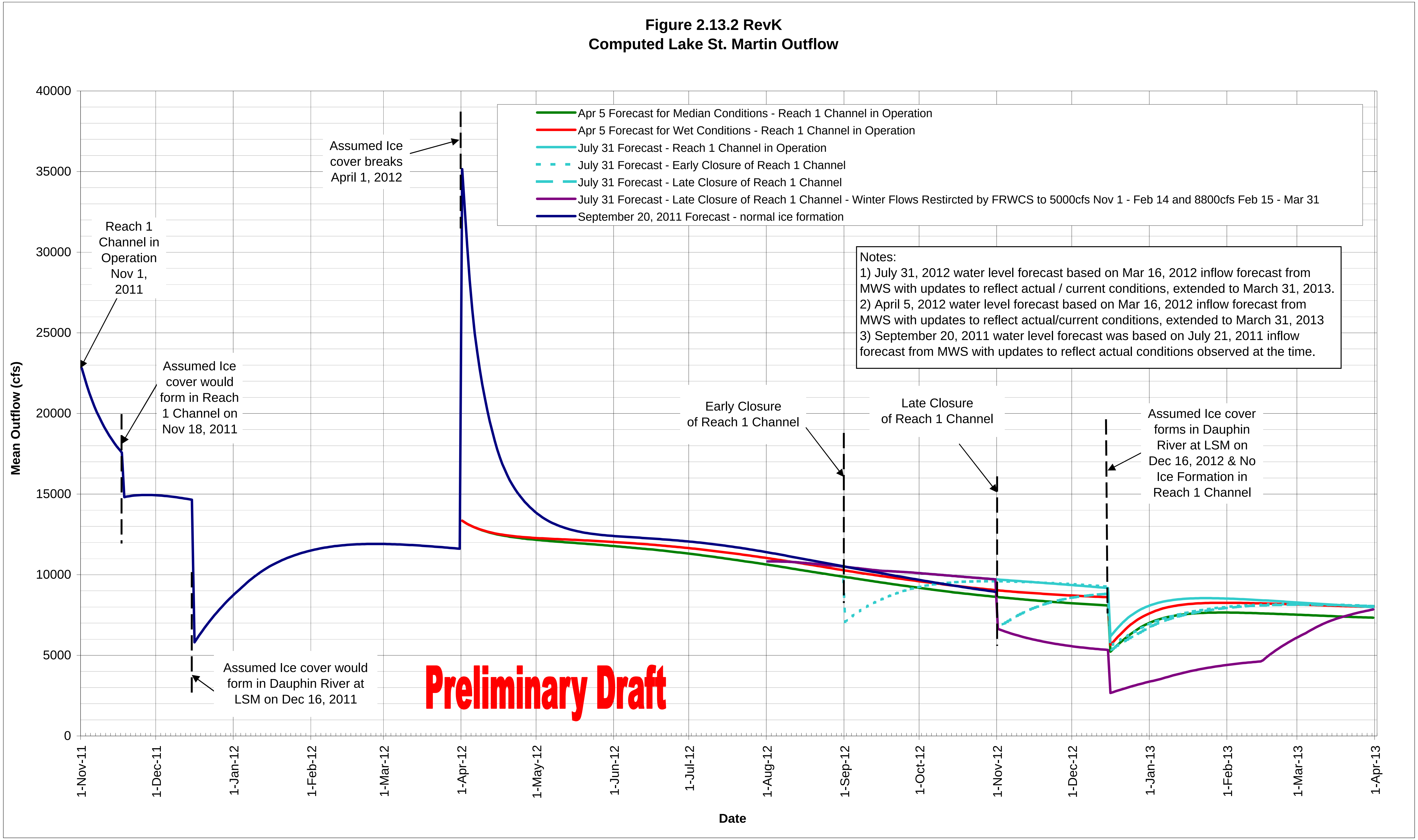


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**Lake Manitoba Forecast**
**Correspondence and Figures**

**August 31, 2012**

## Garrett Wellwood

**From:** Colin Siepman [CSiepman@kgsgroup.com]
**Sent:** Thursday, September 06, 2012 10:06 AM
**To:** 'Topping, Steve (MIT)'; Ron Kaatz
**Cc:** 'Mutulu, Phillip (MIT)'; 'McMahon, Doug (MIT)'; 'Richardson, Ron (MIT)'; Mark Allard ; Brian Bodnaruk; Rick Carson; Bert Smith; Dave MacMillan; Rob Kenyon
**Subject:** End of August LMB and LSM Forecast
**Attachments:** Figure 1.1.1 RevM.PDF; Figure 2.13.1 RevL.PDF; Figure 2.13.2 RevL.PDF

Please find attached the updated Lake Manitoba and Lake St. Martin forecast for the end of August. The water level forecast is based on the Lake Manitoba inflow forecast that was provided by the Hydrologic Forecast Centre, Manitoba Infrastructure and Transportation on August 28, 2012.

As requested, a forecast was prepared for the following three operating scenarios:

- Lake St. Martin Emergency Channel (LSMEC) in operation with Fairford River Water Control Structure (FRWCS) fully open
- Closure of LSMEC on November 1 with FRWCS fully open
- Closure of LSMEC on November 1 with flows restricted by FRWCS to 5000 cfs Nov 1 to Feb 14 and 8000 cfs Feb 15 to Mar 31

Each scenario considered lower decile, median and upper decile weather conditions and flows. A summary of the forecast for the median weather conditions and flows is provided below.

**Lake Manitoba**

The Lake Manitoba water level at the end of August was 812.5 ft. The median water level is expected to recede to approximately 811.9 ft by November 1, 2012. After November 1, the Lake would continue to recede to approximately 811.3 ft by March 31, 2013 with the FRWCS fully open. However, if flows are restricted by the FRWCS during the winter the median water level is expected to rise to approximately 812.1 ft by February 14, 2013 and then recede back to approximately 811.9 ft by March 31, 2013.

**Lake St. Martin**

The Lake St. Martin water level at the end of August was 800.7 ft. The median water level is forecasted to recede to approximately 800.5 ft by November 1, 2012. After November 1, the Lake is expected to rise during the winter due to ice formation in the upper Dauphin River and the median water level on March 31, 2013 is forecasted to be approximately 801.0 ft with the LSMEC in operation. With the closure of LSMEC on November 1 and with FRWCS fully open, the forecasted median Lake level on March 31 is expected to rise to approximately 803.4 ft. With the closure of LSMEC on November 1, and flows restricted by the FRWCS during the winter, the Lake St. Martin water level on March 31 is forecasted to be approximately 803.0 ft. Note that with closure of the LSMEC, the forecasted median Lake St. Martin water level on March 31, 2013 with FRWCS fully open is only 0.4 ft higher than the forecasted water level with flows restricted by the FRWCS.

**Dauphin River**

Median flows in the Dauphin River during an early ice formation in the DRFN Community on November 10, 2012, are forecasted to be approximately 9,000 cfs with the LSMEC in operation. Flows are expected to be less on November 10 with closure of the LSMEC or with the winter flows being restricted by the FRWCS. A review of the potential maximum ice staging in the DRFN community for a flow of 9500 cfs was previously completed by the Frazil Ice Team to assess the potential inundation in the DRFN community without the dikes in place (e-mail sent April 2, 2012). This review indicated that the freeboard above the water surface profile was greater than 0.5 m for all buildings.

At ice breakup on April 1, 2013, median flows in the DRFN Community are forecasted to peak at approximately 13,500 cfs with closure of the LSMEC and with FRWCS fully open. Peak flows at ice breakup on April 1 would be less with LSMEC in operation or with winter flows restricted by the FRWCS due to a lower Lake St. Martin level at ice breakup. The median forecasted peak flow of 13,500 cfs is substantially less than the forecasted 24,710 cfs peak flow that we prepared for in the spring of 2012. However, a detailed review of the potential inundation in the community without the dikes in place for a flow of 13,500 cfs at ice breakup has not been completed.

Let us know if you have any questions or comments. We are also available for a meeting to further discuss the forecast and the potential impacts of the different operating scenarios to Lake Manitoba, Lake St. Martin and the Dauphin River.

Regards,

Colin Siepman, B.Sc. CE, M.Eng, P.Eng
Senior Project Manager
KGS Group

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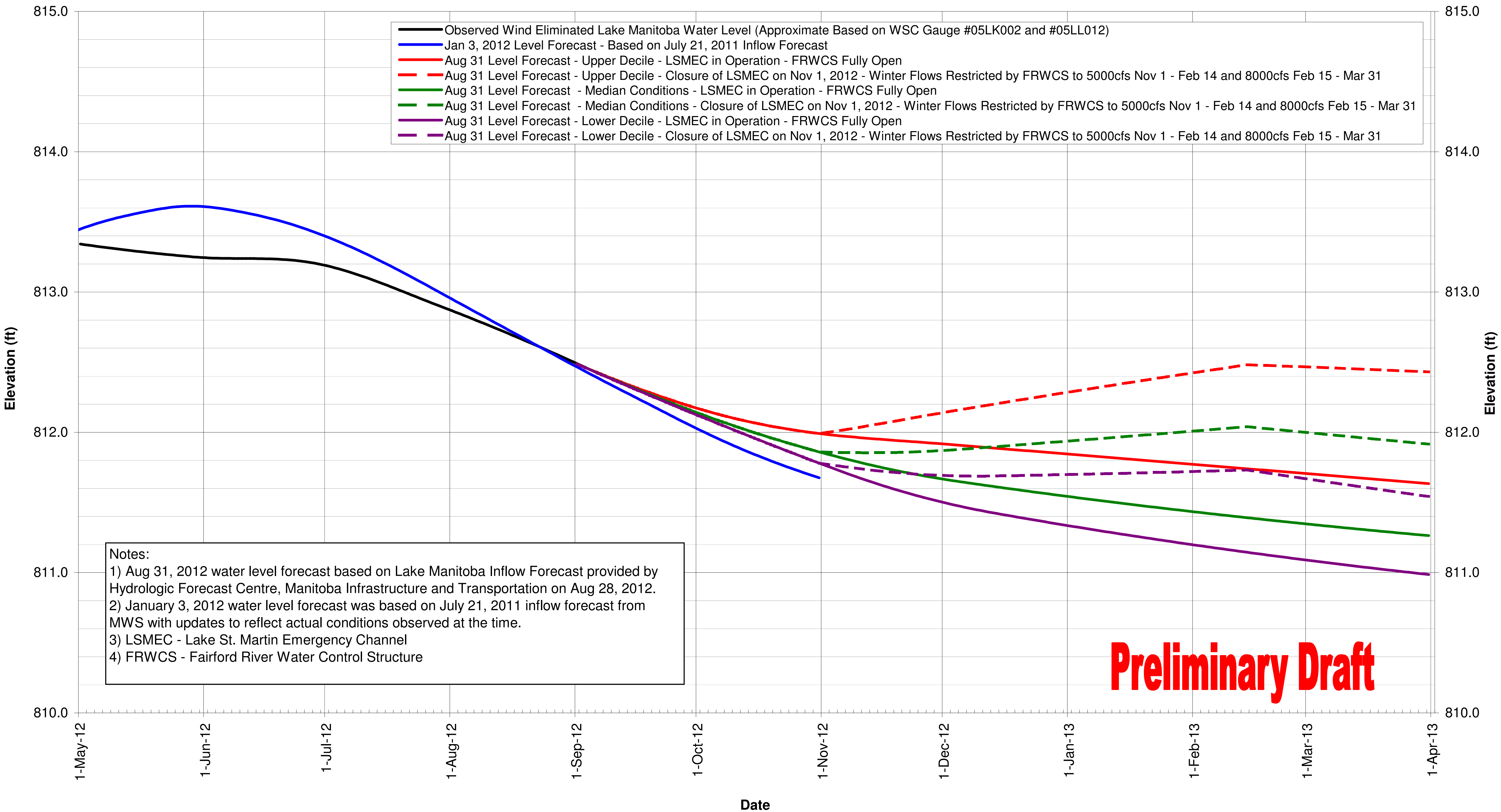
**From:** Topping, Steve (MIT) [mailto:Steve.Topping@gov.mb.ca]
**Sent:** August 22, 2012 10:34 AM
**To:** Colin Siepman
**Cc:** Kaatz, Ron G (MIT); Mutulu, Phillip (MIT); McMahon, Doug (MIT); Richardson, Ron (MIT)
**Subject:** FW: Lake Manitoba Forecast - Aug 21, 2012

The Hydrologic Forecast Center has prepared a new forecast for Lake Manitoba. Could you prepare forecasts for the three scenarios once again. The three scenarios are closing the LSMEO November 1st, operating the LSMEO at full capacity thru the winter and finally cutting back Fairford flows to 5000cfs from Nov 1st- Feb 15 and 8000 cfs from Feb 15th to March 31st. If you have any questions please feel free to contact Philip.

Thank you

***Steven D. Topping, P. Eng.***
***Executive Director***
***Hydrologic Forecasting and Water Management***
***Manitoba Infrastructure and Transportation***
***Phone: (204) 945-7488***
***Fax: (204) 945-7419***
***e-mail: steve.topping@gov.mb.ca***

**Figure 1.1.1 RevM**
**Computed Lake Manitoba Level**

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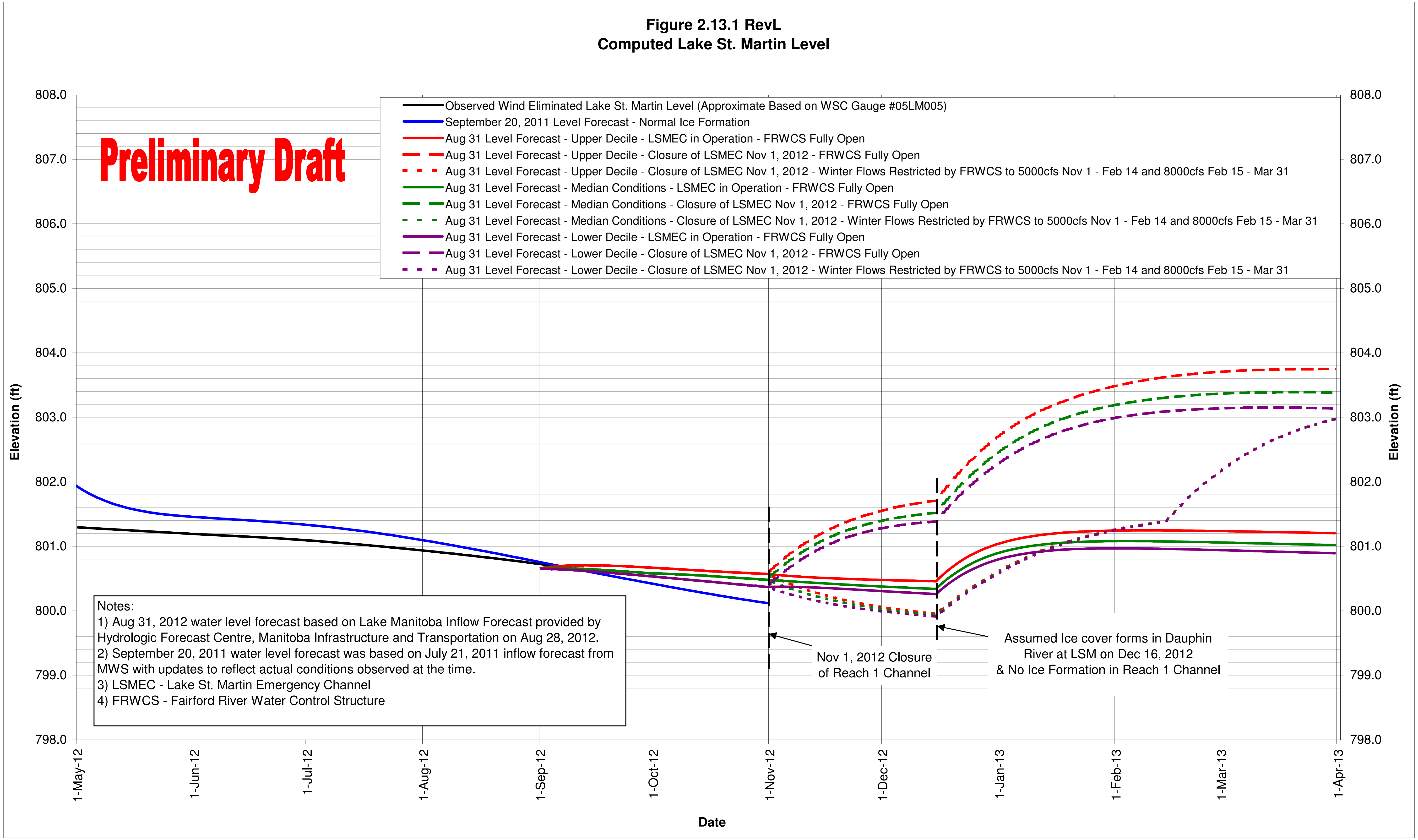


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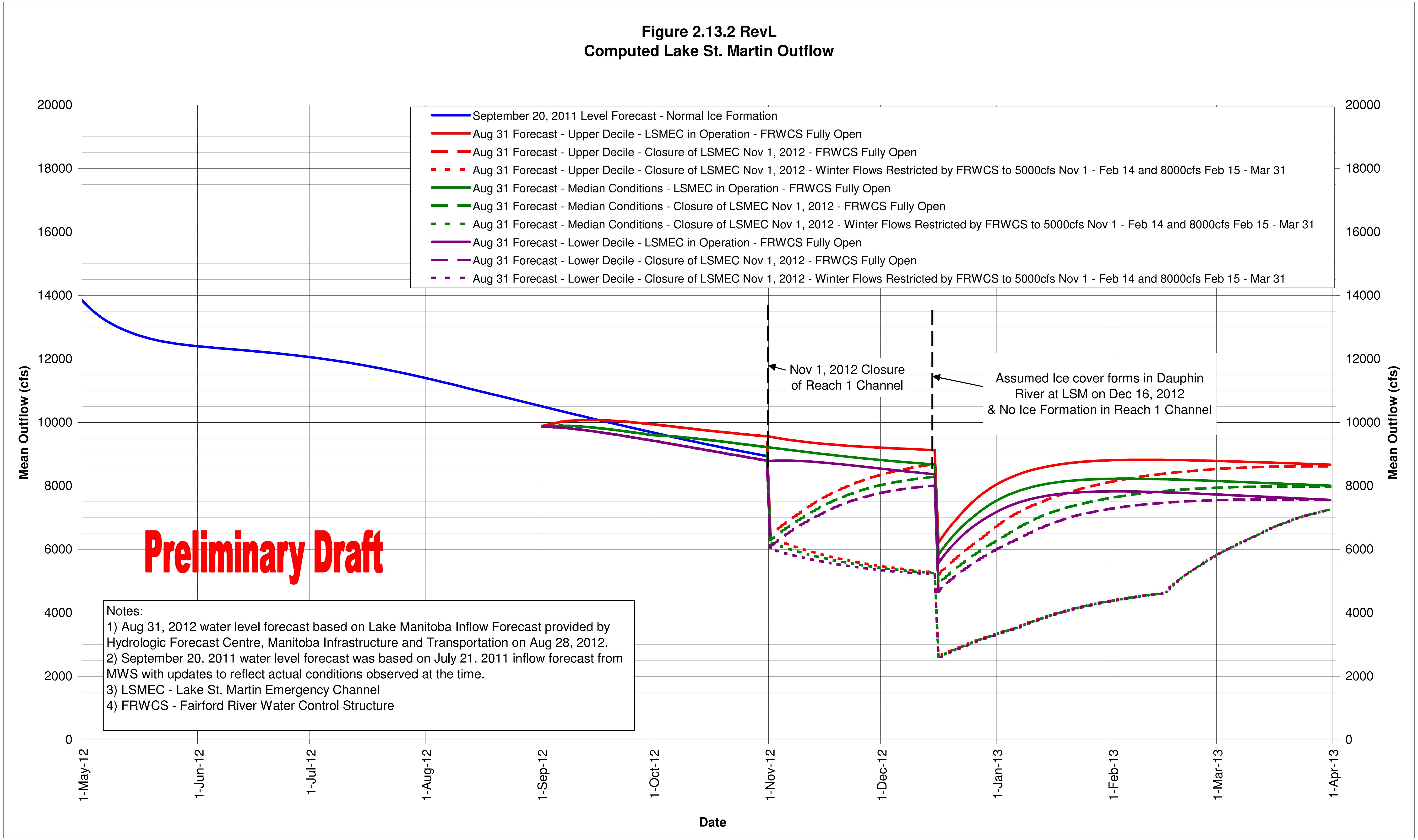


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**Lake Manitoba Forecast**
**Correspondence and Figures**

**September 30, 2012**

## Garrett Wellwood

**From:** Colin Siepman [CSiepman@kgsgroup.com]
**Sent:** Sunday, September 30, 2012 9:25 PM
**To:** 'Topping, Steve (MIT)'; Ron Kaatz
**Cc:** 'Mutulu, Phillip (MIT)'; 'McMahon, Doug (MIT)'; 'Richardson, Ron (MIT)'; Mark Allard ; Bob Harrison; Brian Bodnaruk; Rick Carson; Bert Smith; Dave MacMillan; Rob Kenyon
**Subject:** End of September LMB and LSM Forecast
**Attachments:** Figure 1.1.1 RevN.PDF; Figure 1.1.2 RevF.PDF; Figure 2.13.1 RevM.PDF; Figure 2.13.2 RevM.PDF

Please find attached the updated Lake Manitoba and Lake St. Martin forecast for the end of September. Two forecasts are provided on the figures:

- A revised August 31 Forecast, based on the Lake Manitoba inflow forecast that was provided by the Hydrologic Forecast Centre, MIT on August 28, 2012, with updates to reflect actual conditions.
- The September 28 Forecast, prepared by KGS Group based on recent observations of current inflow conditions.

The September 28 Forecast accounts for a higher evaporation rate on Lake Manitoba than what was originally anticipated in the August 31 Forecast and are based on the current “dry” conditions in the system. This was discussed between Brian Bodnaruk and Philip Mutulu last week and is to be confirmed by the Hydrologic Forecast Centre.

Additionally, the forecast model was updated for Lake Manitoba water level conditions of approximately 812.5 ft and lower. The Lake Manitoba outflow rating curve in the model was adjusted to reflect the current stage-discharge relationship observed between Lake Manitoba and the Fairford River.

As before, the forecast was prepared for the following three operating scenarios:

- Lake St. Martin Emergency Outlet Channel (LSMEOC) in operation with Fairford River Water Control Structure (FRWCS) fully open
- Closure of LSMEOC on November 1 with FRWCS fully open
- Closure of LSMEOC on November 1 with flows restricted by FRWCS to 5000 cfs Nov 1 to Feb 14 and 8000 cfs Feb 15 to Mar 31

Depending on the forecast, and at lower Lake Manitoba water levels, the Lake Manitoba outflow after November 1 was at times forecasted to be less than the proposed 5000 cfs or 8000 cfs restriction. In this case, the actual outflow for the “winter flows restricted by FRWCS” scenario was based on the actual outflow capacity of the Fairford River.

The current water level in Lake Manitoba and Lake St. Martin is lower than what was originally anticipated in the August 31 Forecast and is trending below the lower decile forecast prepared by the Hydrologic Forecast Centre on August 28. A summary of conditions is provided below.

**Lake Manitoba**

The September 28, 2012 water level on Lake Manitoba was approximately 812.0 ft. Based on the September 28 Forecast, the water level is forecasted to recede to approximately 811.7 ft by November 1, 2012 and continue to recede to approximately 811.5 ft by March 31, 2013 with the FRWCS fully open. The exact same water levels are forecasted for the “winter flows restricted by the FRWCS” scenario since the natural Lake Manitoba outflow after November 1, 2012 is forecasted to be lower than the proposed 5000 cfs restriction.

**Lake St. Martin**

The September 28, 2012 water level on Lake St. Martin was approximately 799.8 ft. Based on the September 28 Forecast, the water level is forecasted to recede to approximately 799.4 ft by November 1,

2012. After November 1, the Lake is forecasted to rise during the winter due to ice formation in the upper Dauphin River and the water level on March 31, 2013 (based on the September 28 Forecast) is forecasted to be approximately 799.8 ft with the LSMEOC in operation. With the closure of LSMEOC on November 1 and with FRWCS fully open, the forecasted Lake level on March 31 (based on the September 28 Forecast) is expected to rise to approximately 801.0 ft. Since the natural Lake Manitoba outflow after November 1, 2012 is expected to be lower than the proposed 5000 cfs restriction, the Lake St. Martin water level on March 31 for the “winter flow restricted by FRWCS” scenario does not change and is also forecasted to be approximately 801.0 ft.

**Dauphin River**

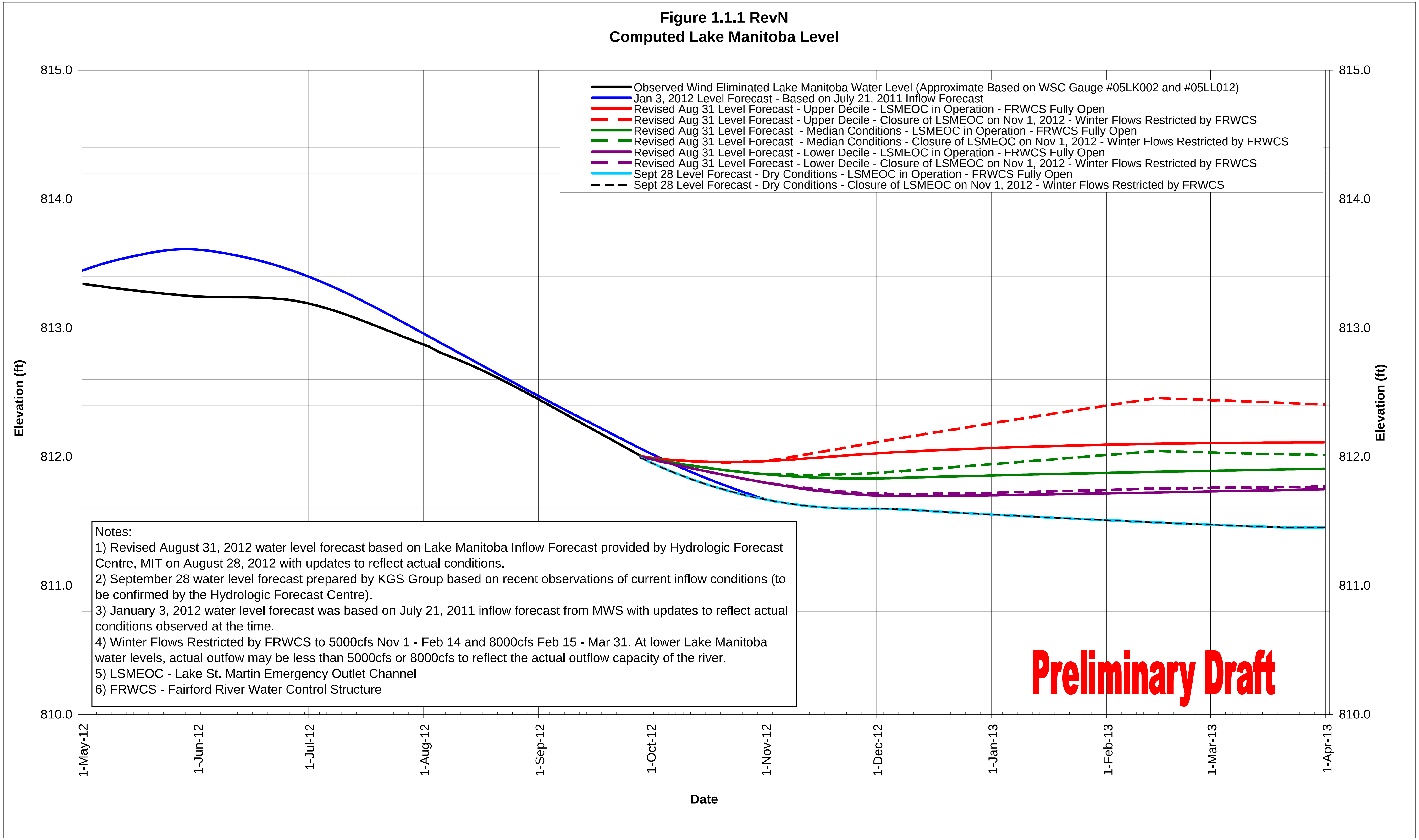
Based on the September 28 Forecast, flows in the Dauphin River during an early ice formation in the DRFN Community on November 10, 2012, are forecasted to be approximately 5,000 cfs with the LSMEOC in operation. Flows are expected to be slightly less on November 10 with closure of the LSMEOC or with the winter flows being restricted by the FRWCS. A review of the potential maximum ice staging in the DRFN community for a flow of 9500 cfs was previously completed by the Frazil Ice Team to assess the potential inundation in the DRFN community without the dikes in place (e-mail sent April 2, 2012). This review indicated that the freeboard above the water surface profile was greater than 0.5 m for all buildings.

At ice breakup on April 1, 2013, flows in the DRFN Community (based on the September 28 Forecast) are forecasted to peak at approximately 7,500 cfs with closure of the LSMEOC and with FRWCS fully open. Peak flows at ice breakup on April 1 would be less with LSMEOC in operation or with winter flows restricted by the FRWCS due to a lower Lake St. Martin level at ice breakup. The forecasted peak flow of 7,500 cfs is substantially less than the forecasted 24,710 cfs peak flow that we prepared for in the spring of 2012.

Brian & I both plan to attend the review meeting October 1st at 2 pm if you have any questions or comments.

Regards,

Colin Siepman, B.Sc. CE, M.Eng, P.Eng
Senior Project Manager
KGS Group

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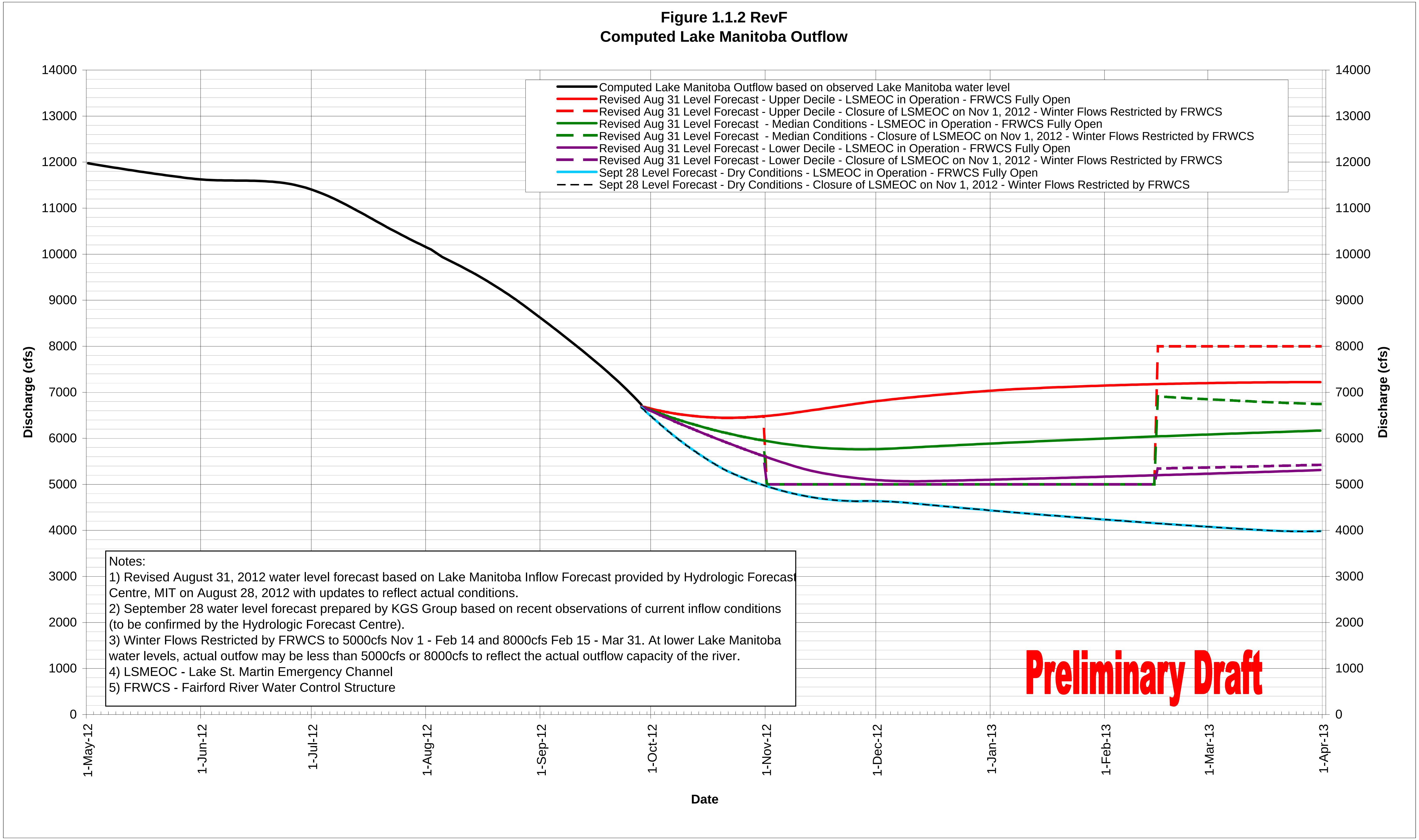


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9/30/2012

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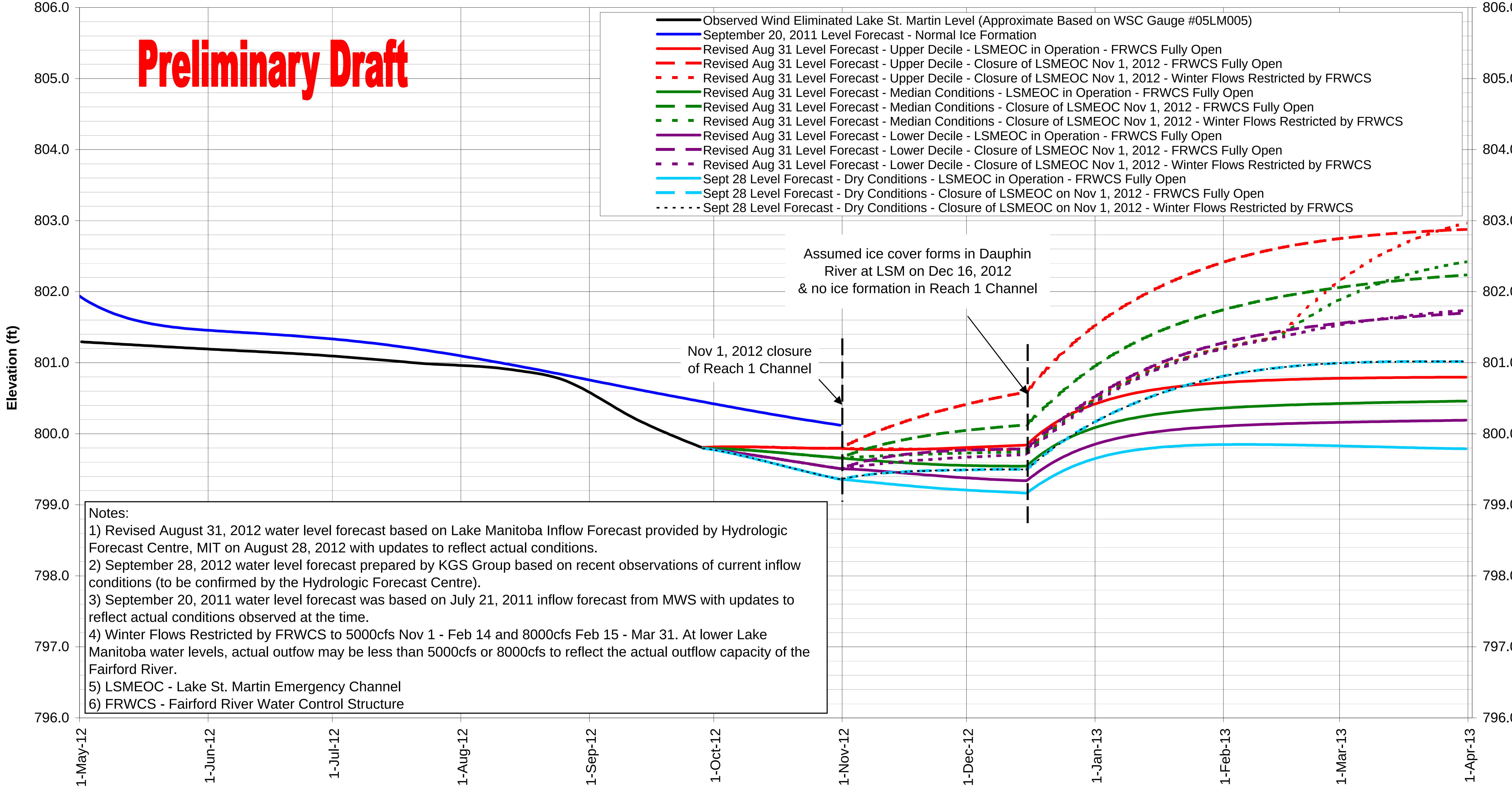
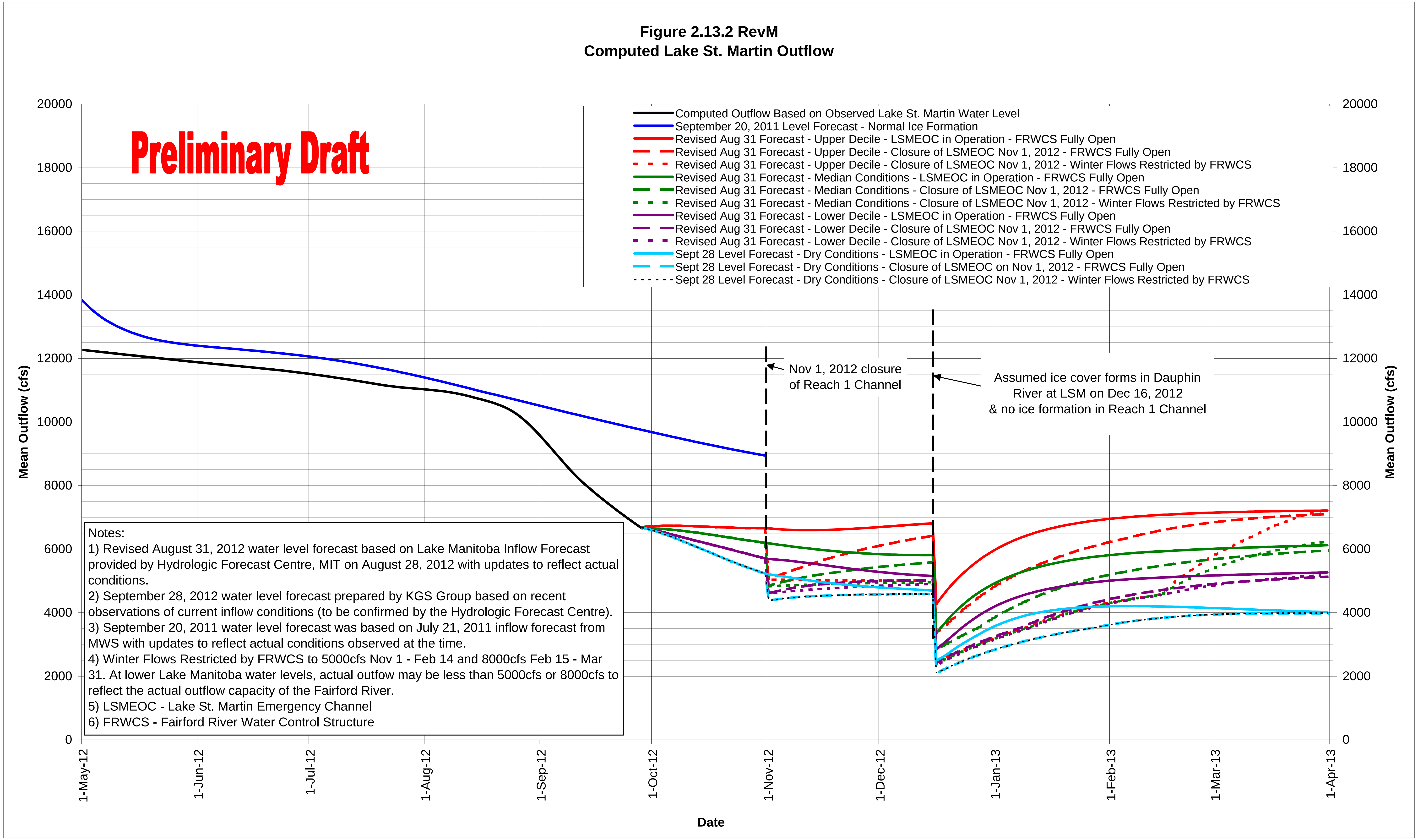
## Figure 2.13.1 RevM
## Computed Lake St. Martin Level




Notes:
1) Revised August 31, 2012 water level forecast based on Lake Manitoba Inflow Forecast provided by Hydrologic Forecast Centre, MIT on August 28, 2012 with updates to reflect actual conditions.
2) September 28, 2012 water level forecast prepared by KGS Group based on recent observations of current inflow conditions (to be confirmed by the Hydrologic Forecast Centre).
3) September 20, 2011 water level forecast was based on July 21, 2011 inflow forecast from MWS with updates to reflect actual conditions observed at the time.
4) Winter Flows Restricted by FRWCS to 5000cfs Nov 1 - Feb 14 and 8000cfs Feb 15 - Mar 31. At lower Lake Manitoba water levels, actual outfow may be less than 5000cfs or 8000cfs to reflect the actual outflow capacity of the Fairford River.
5) LSMEOC - Lake St. Martin Emergency Channel
6) FRWCS - Fairford River Water Control Structure

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11-0300-18
9/30/2012

**Lake Manitoba Forecast**
**Correspondence and Figures**

**October 12, 2012**

## Garrett Wellwood

**From:** Colin Siepman [CSiepman@kgsgroup.com]

**Sent:** Friday, October 12, 2012 3:33 PM

**To:** 'Topping, Steve (MIT)'; Ron Kaatz

**Cc:** 'McMahon, Doug (MIT)'; Don Norquay; 'Richardson, Ron (MIT)'; Mark Allard ; Eric Christiansen; 'Mutulu, Phillip (MIT)'; Bob Harrison; Jason Senyk; Brian Bodnaruk; Rick Carson; Bert Smith; Dave MacMillan; Rob Kenyon; Hannon, Gord (JUS)

**Subject:** Early October LMB and LSM Forecast

**Attachments:** Figure 1.1.1 RevO.PDF; Figure 1.1.2 RevG.PDF; Figure 2.13.1 RevN.PDF; Figure 2.13.2 RevN.PDF

Please find attached the most recent Lake Manitoba (LMB) and Lake St. Martin (LSM) forecast (October 10, 2012) based on the LMB inflow forecast that was provided by the Hydrologic Forecast Centre, MIT on October 4, 2012.

As before, the forecast considered lower decile, median and upper decile weather conditions and flows. The following four operating scenarios were included in the forecast:

- Lake St. Martin Emergency Outlet Channel (LSMEOC) in operation with Fairford River Water Control Structure (FRWCS) fully open
- Closure of LSMEOC on November 15 with FRWCS fully open
- Closure of LSMEOC on November 15 with flows restricted by FRWCS to 5000 cfs Nov 1 to Feb 14 and 8000 cfs Feb 15 to Mar 31
- Closure of LSMEOC on November 15 with flows restricted by FRWCS using 41 logs Nov 1, based on a proposed operating scenario provided by the Hydrologic Forecast Centre, MIT on October 4, 2012.

An assumed LSMEOC closure date of November 15, 2012 was selected for the forecast as the emergency exemption expires Nov 30 (the initial LSMEOC closure would stop flows in 2 or 3 days but the permanent closure activities could take two weeks to complete). The impact of closing LSMEOC later or earlier is discussed under the Lake St. Martin section below.

Depending on the forecast, and at lower LMB water levels, the LMB outflow after November 1 was at times forecasted to be less than the proposed 5000 cfs or 8000 cfs restriction. In this case, the actual outflow for the “winter flows restricted by FRWCS (5000-8000 cfs scenario)” was based on the actual outflow capacity of the Fairford River. This is evident for the lower decile and median conditions forecast as both the 5000-8000 cfs restriction scenario and the FRWCS fully open scenario forecast appear the same on the figures.

The “winter flows restricted by FRWCS (41 logs scenario)” was proposed by the Hydrologic Forecast Centre to reduce the risk of having a shortage of water in LMB and LSM in the event that the spring brings normal to below normal runoff to the lake. The Hydrologic Forecast Centre noted that the FRWCS was operated using 41 logs from April 7, 2009 to November 1, 2010 and that our current end of March 2013 median water level forecast on LMB is similar to the observed water levels on LMB that occurred at the end of March in 2009 and 2010. The impact of having winter flows restricted by FRWCS using 41 logs is discussed below.

The LMB inflow forecast that was provided by the Hydrologic Forecast Centre, MIT on October 4, 2012 is lower than the forecast that was provided on August 28, 2012. As such, the lower decile, median and upper decile October 10, 2012 LMB and LSM water level and outflow forecasts are lower than the revised August 31, 2012 forecasts provided at the end of September.

The current water level and outflow on LMB and LSM follows closely the September 28, 2012 “dry conditions” forecast provided at the end of September, and the October 10, 2012 median forecast is now slightly lower than the September 28, 2012 “dry conditions” forecast. A summary of median conditions is provided below.

**Lake Manitoba**

The October 10, 2012 water level on LMB was approximately 811.9 ft. Based on the median conditions forecast, the water level is forecasted to recede to approximately 811.3 ft by March 31, 2013 with the FRWCS fully open. The exact same water levels are forecasted for the “winter flows restricted by the FRWCS (5000-8000 cfs scenario)” since the median conditions natural LMB outflow after November 1, 2012 is forecasted to be lower than the proposed 5000 cfs restriction. The forecasted median water level on March 31, 2013 for the “winter flows restricted by the FRWCS (41 logs scenario)” is approximately 811.4 ft, which is approximately 0.1ft higher than the FRWCS fully open scenario.

**Lake St. Martin**

The October 10, 2012 water level on LSM was approximately 799.6 ft. Based on the median conditions forecast, the water level is forecasted to recede to approximately 799.3 ft by November 15, 2012. After November 15, the Lake is forecasted to rise during the winter due to ice formation in the upper Dauphin River and the median conditions water level on March 31, 2013 is forecasted to be approximately 799.6 ft with the LSMEOC in operation. With the closure of LSMEOC on November 15 and with FRWCS fully open, the forecasted median conditions water level on March 31 is expected to rise to approximately 800.7 ft. Since the natural LMB outflow after November 1, 2012 is expected to be lower than the proposed 5000 cfs restriction, the LSM median conditions water level on March 31 for the “winter flow restricted by FRWCS (5000-8000 cfs scenario)” does not change and is also forecasted to be approximately 800.7 ft. The forecasted median water level on March 31, 2013 for the “winter flows restricted by the FRWCS (41 logs scenario)” is approximately 800.5 ft, which is approximately 0.2 ft lower than the FRWCS fully open scenario.

The impact to the LSM water level of closing the LSMEOC on November 1 or November 30 instead of November 15, 2012 is virtually negligible on March 31, 2013 (less than 0.1 ft). The short term impact (i.e the difference in LSM water level on November 30, 2012) between a November 1 closure date compared to a November 30 closure date is approximately 0.4 ft (or 0.2 ft per half month).

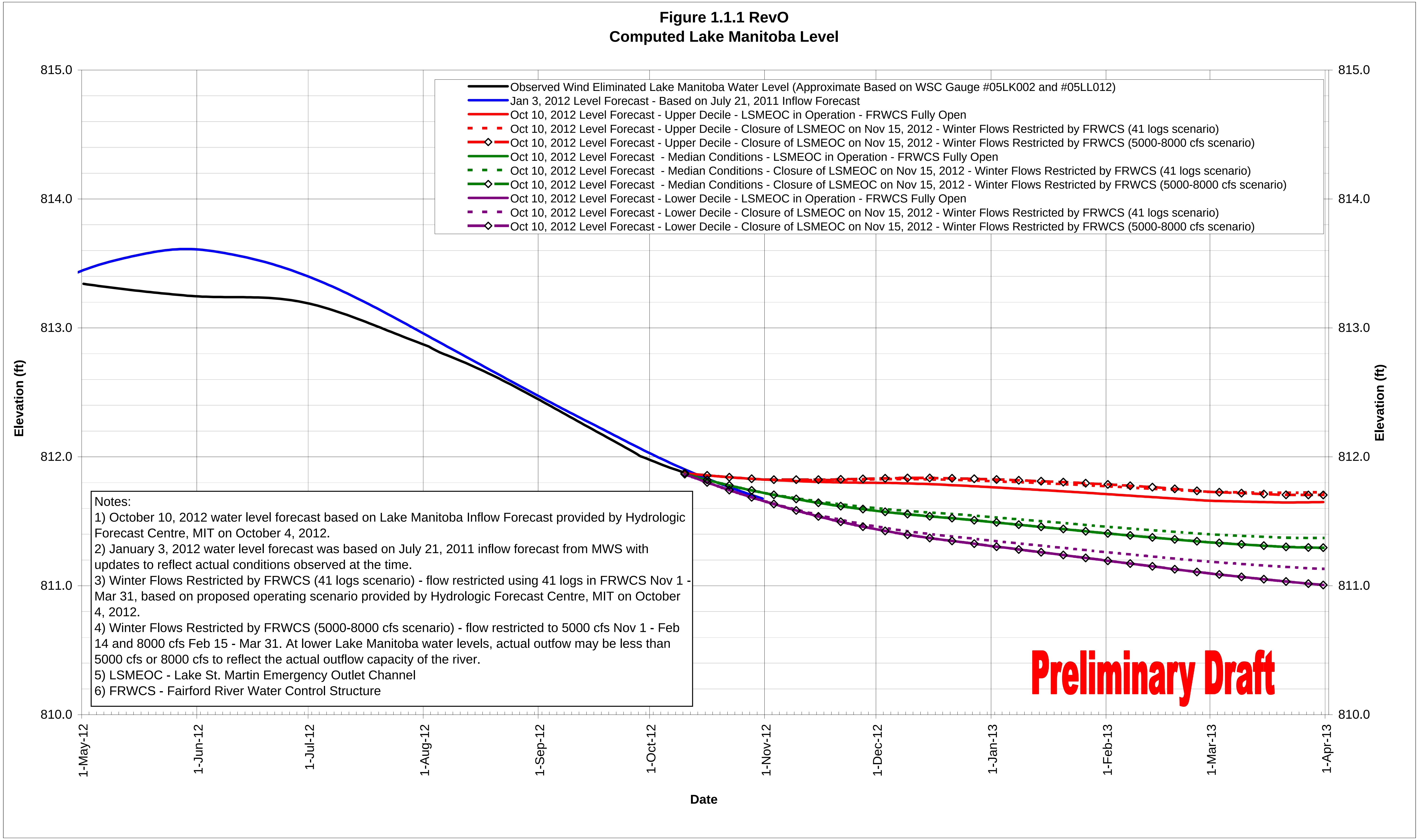
**Dauphin River**

Based on the median October 10, 2012 Forecast, flows in the Dauphin River during an early ice formation in the DRFN Community on November 10, 2012, are forecasted to be approximately 5,000 cfs with the LSMEOC in operation. Flows are expected to be slightly less on November 10 with winter flows being restricted by the FRWCS. A review of the potential maximum ice staging in the DRFN community for a flow of 9500 cfs was previously completed by the Frazil Ice Team to assess the potential inundation in the DRFN community without the dikes in place (e-mail sent April 2, 2012). This review indicated that the freeboard above the water surface profile was greater than 0.5 m for all buildings.

At ice breakup on April 1, 2013, median conditions flows in the DRFN Community are forecasted to peak at approximately 6,600 cfs with closure of the LSMEOC and with FRWCS fully open. Peak flows at ice breakup on April 1 would be less with LSMEOC in operation or with winter flows restricted by the FRWCS due to a lower LSM level at ice breakup. The forecasted peak flow of 6,600 cfs is substantially less than the forecasted 24,710 cfs peak flow that we prepared for in the spring of 2012.

Regards,

Colin Siepman, B.Sc. CE, M.Eng, P.Eng
Senior Project Manager
KGS Group

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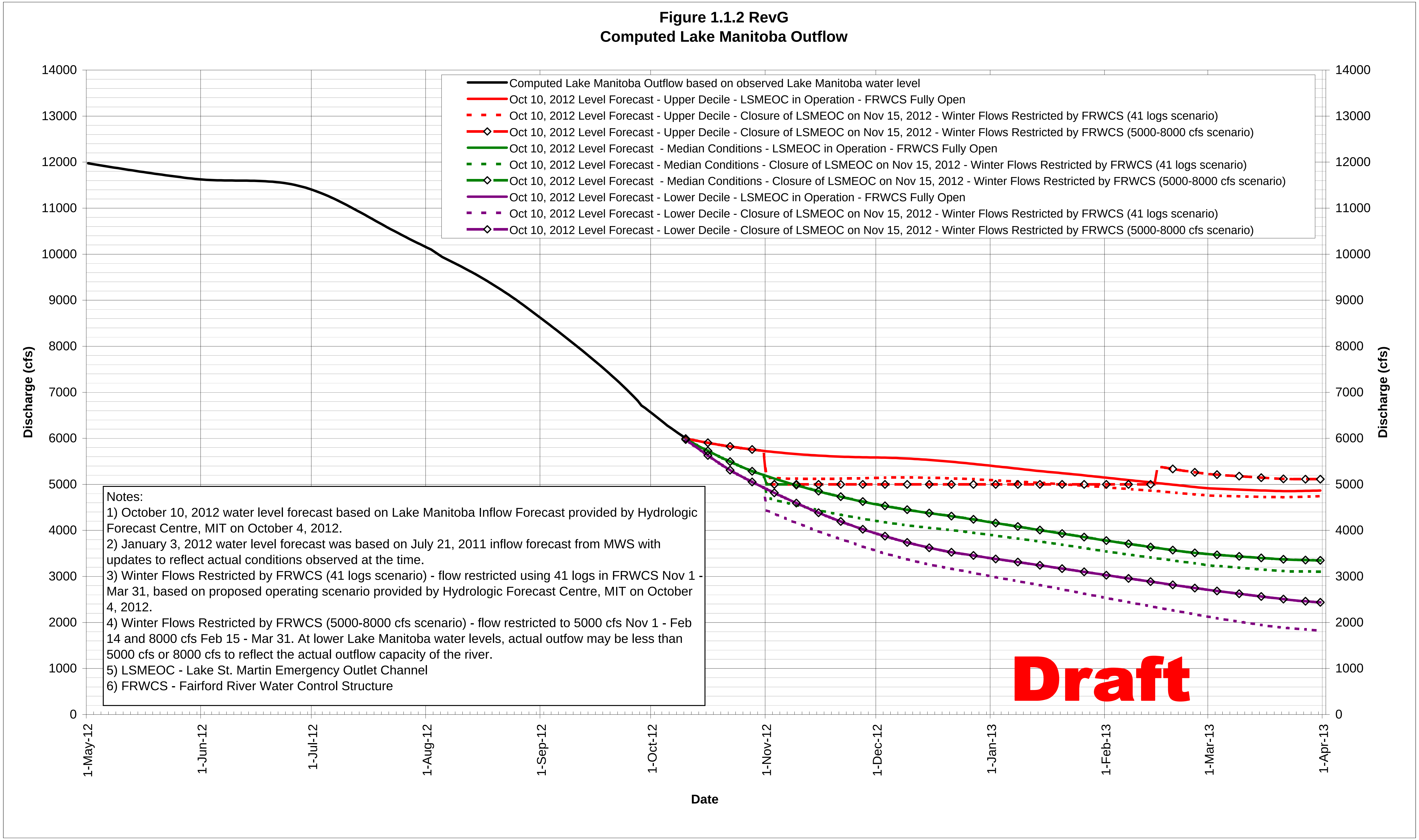


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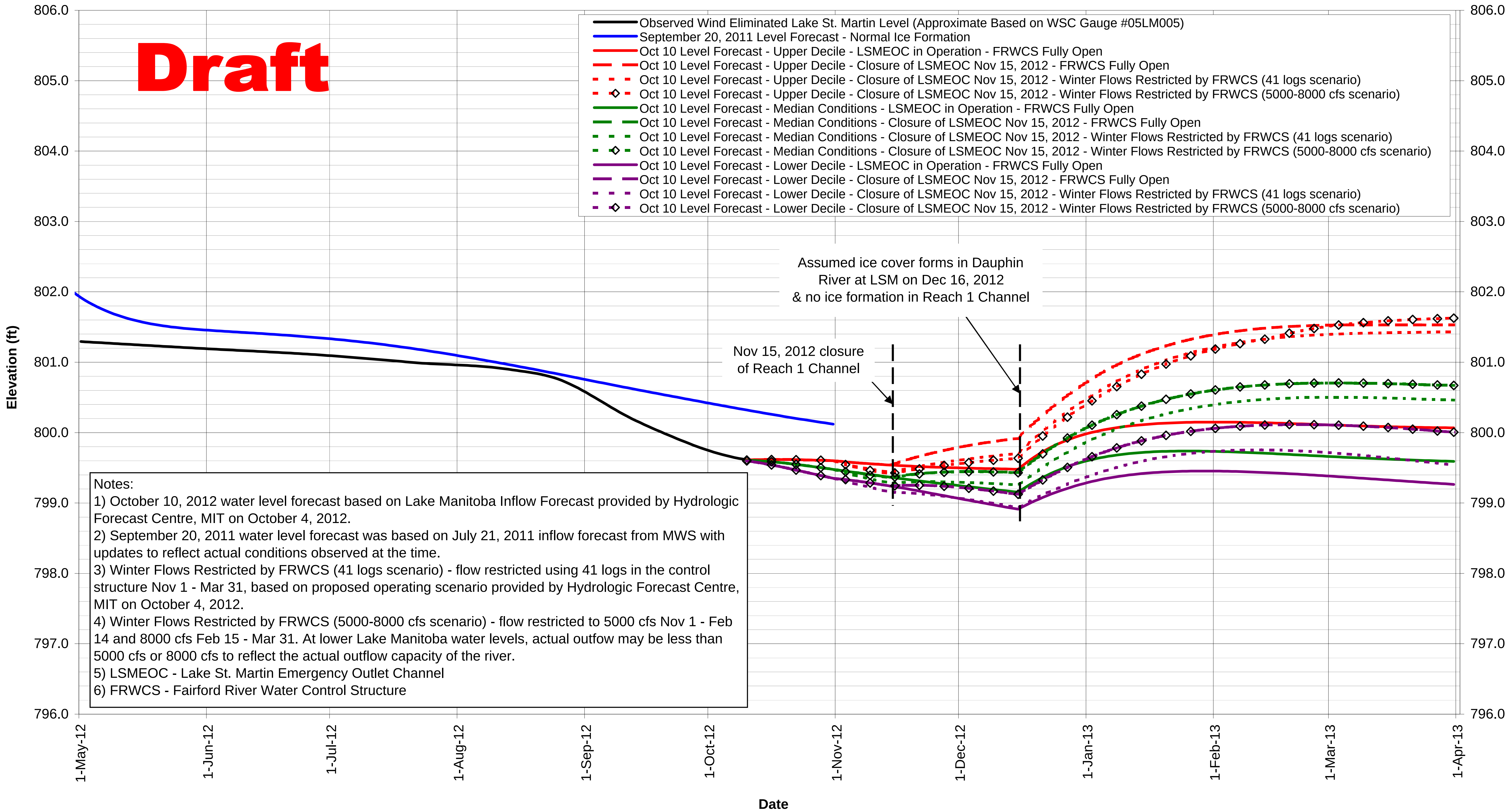
## Figure 2.13.1 RevN
## Computed Lake St. Martin Level




Notes:
1) October 10, 2012 water level forecast based on Lake Manitoba Inflow Forecast provided by Hydrologic Forecast Centre, MIT on October 4, 2012.
2) September 20, 2011 water level forecast was based on July 21, 2011 inflow forecast from MWS with updates to reflect actual conditions observed at the time.
3) Winter Flows Restricted by FRWCS (41 logs scenario) - flow restricted using 41 logs in the control structure Nov 1 - Mar 31, based on proposed operating scenario provided by Hydrologic Forecast Centre, MIT on October 4, 2012.
4) Winter Flows Restricted by FRWCS (5000-8000 cfs scenario) - flow restricted to 5000 cfs Nov 1 - Feb 14 and 8000 cfs Feb 15 - Mar 31. At lower Lake Manitoba water levels, actual outfow may be less than 5000 cfs or 8000 cfs to reflect the actual outflow capacity of the river.
5) LSMEOC - Lake St. Martin Emergency Outlet Channel
6) FRWCS - Fairford River Water Control Structure

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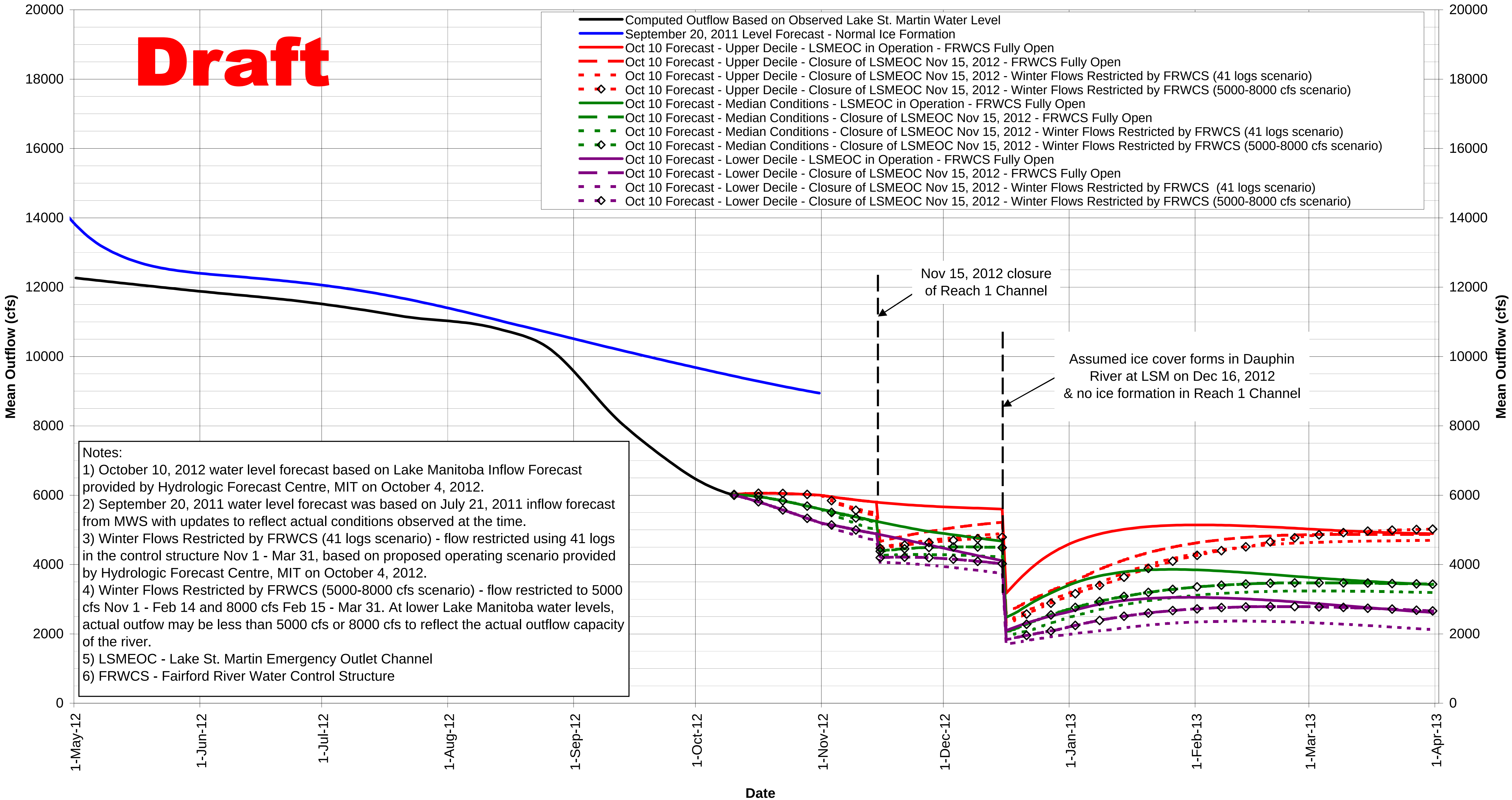
**Figure 2.13.2 RevN**
**Computed Lake St. Martin Outflow**

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10/12/2012

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**Lake Manitoba Forecast**
**Correspondence and Figures**

**October 31, 2012**

## Garrett Wellwood

**From:** Colin Siepman [CSiepman@kgsgroup.com]
**Sent:** Thursday, November 01, 2012 3:05 PM
**To:** 'Topping, Steve (MIT)'; Ron Kaatz
**Cc:** 'McMahon, Doug (MIT)'; Don Norquay; 'Richardson, Ron (MIT)'; Mark Allard ; Eric Christiansen; 'Mutulu, Phillip (MIT)'; Bob Harrison; Jason Senyk; Brian Bodnaruk; Rick Carson; Bert Smith; Dave MacMillan; Rob Kenyon; Hannon, Gord (JUS)
**Subject:** End of October LMB and LSM Forecast
**Attachments:** Figure 1.1.1 RevP.PDF; Figure 1.1.2 RevH.PDF; Figure 2.13.1 RevO.PDF; Figure 2.13.2 RevO.PDF

Please find attached the most recent Lake Manitoba (LMB) and Lake St. Martin (LSM) forecast (October 31, 2012) based on the LMB inflow forecast that was provided by the Hydrologic Forecast Centre, MIT on October 4, 2012, updated to reflect current conditions.

As before, the forecast considered lower decile, median and upper decile weather conditions and flows. The following three operating scenarios were included in the forecast:

- Lake St. Martin Emergency Outlet Channel (LSMEOC) in operation with Fairford River Water Control Structure (FRWCS) fully open
- Closure of LSMEOC on November 15 with FRWCS fully open
- Closure of LSMEOC on November 15 with flows restricted by FRWCS to 5000 cfs Nov 15 to Feb 14 and 8000 cfs Feb 15 to Mar 31

Note that the current MIT operational plan is to leave FRWCS at maximum discharge (i.e. no change in stoplogs). For the scenario where flows are restricted by the FRWCS, the November 1 date of operation was moved to November 15 as this was deemed to be a more likely scenario if a decision was made to operate the control structure. Additionally, at lower LMB water levels, the LMB outflow after November 15 was at times forecasted to be less than the potential 5000 cfs or 8000 cfs restriction. In this case, the actual outflow for the “winter flows restricted by FRWCS (5000-8000 cfs scenario)” was based on the actual outflow capacity of the Fairford River.

All LMB scenarios now consider a potential natural restriction due to ice effects upstream of the FRWCS. For the analysis, it was assumed that the effects of the ice would begin on January 1, 2013 and remain until ice breakup on April 1, 2013. The potential ice effects were based on historic records of discharges and water levels in the Fairford River and Lake Manitoba during winter months, and were assumed to be representative of “normal” ice conditions in the river with FRWCS fully open.

The current water level and outflow on LMB and LSM are slightly above the October 10, 2012 forecast due to higher inflow from precipitation that occurred in October than originally anticipated and a lower evaporation rate on the lakes. A summary of the October 31, 2012 median conditions forecast is provided below.

**Lake Manitoba**

The October 31, 2012 water level on LMB was approximately 812.0 ft. Based on median conditions, the water level is forecasted to recede to approximately 811.5 ft by March 31, 2013 with the FRWCS fully open. A water level of 811.5ft is also forecasted for the median conditions “winter flows restricted by the FRWCS (5000-8000 cfs scenario)” since natural LMB outflow is forecasted to be similar to the potential 5000 cfs restriction for the most part of the winter.

The October 31, 2012 LMB outflow was approximately 6800 cfs and under median conditions, the outflow is expected to recede to approximately 5000 cfs by December 31, 2012.

**Lake St. Martin**

The October 31, 2012 water level on LSM was approximately 799.7 ft. Based on median conditions, the water level is forecasted to rise during the winter due to ice formation in the upper Dauphin River to approximately 799.9 ft with the LSMEOC in operation and then recede to approximately 799.5 ft by March 31, 2013. With the closure of LSMEOC on November 15 and with FRWCS fully open, the forecasted median conditions water level is expected to rise to approximately 800.8 ft and then recede to approximately 800.5 ft by March 31, 2013. Since the natural LMB outflow during the winter is expected to be similar to the potential 5000 cfs restriction, the LSM median conditions water level for the “winter flow restricted by FRWCS (5000-8000 cfs scenario)” is also expected to rise to 800.8 ft and then recede to approximately 800.5 ft by March 31.

The October 31, 2012 LSM total ouflow was approximately 6400 cfs, with approximately 1500 cfs through LSMEOC and 4900 cfs through the upper Dauphin River.

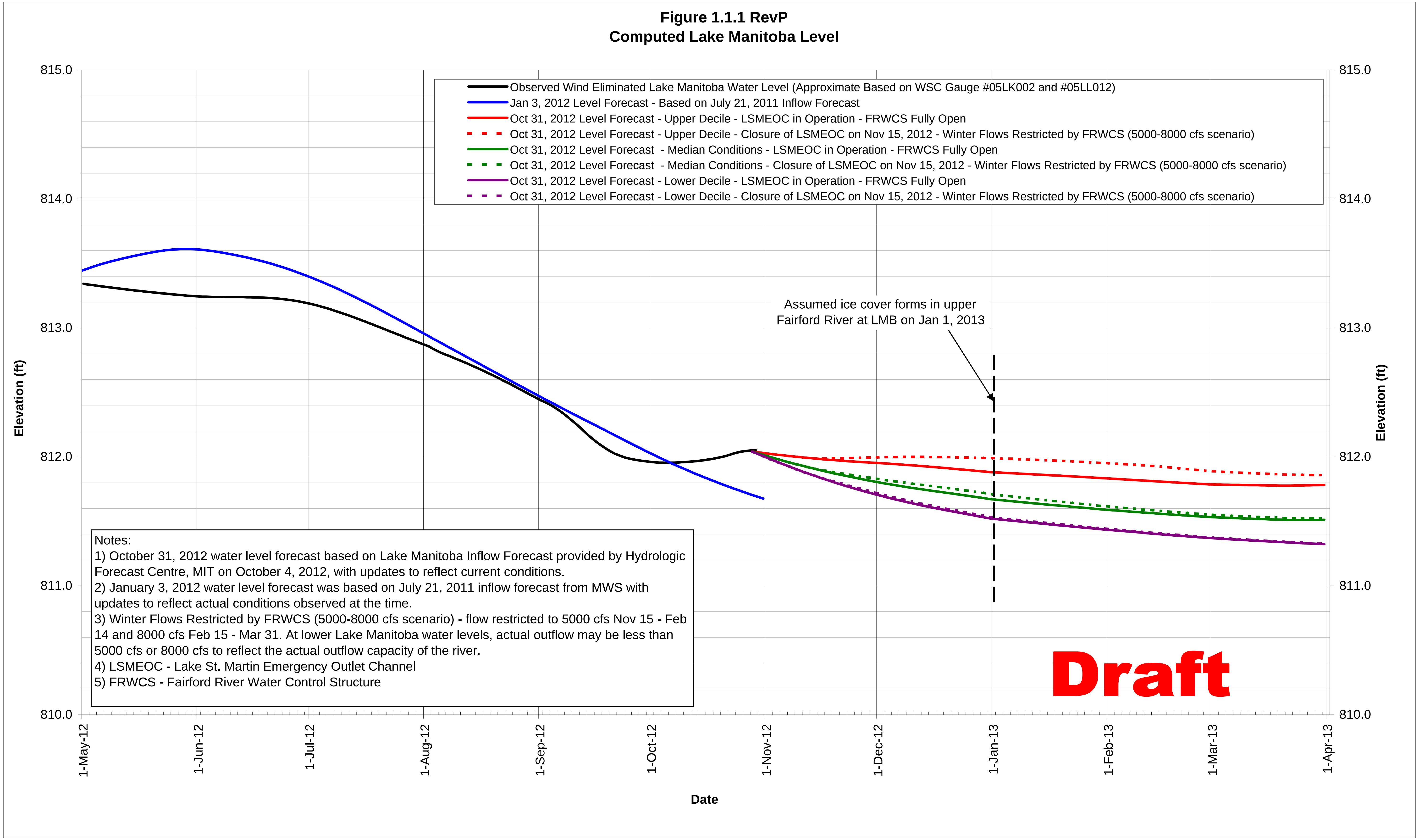
**Dauphin River**

Based on the median October 31, 2012 Forecast, flows in the Dauphin River during an early ice formation in the DRFN Community on November 10, 2012, are forecasted to be approximately 6,500 cfs with the LSMEOC in operation. A review of the potential maximum ice staging in the DRFN community for a flow of 9500 cfs was previously completed by the Frazil Ice Team to assess the potential inundation in the DRFN community without the dikes in place (e-mail sent April 2, 2012). This review indicated that the freeboard above the water surface profile was greater than 0.5 m for all buildings.

At ice breakup on April 1, 2013, median condition flows in the DRFN Community are forecasted to peak at approximately 6,400 cfs with closure of the LSMEOC and with flows restricted by the FRWCS. Peak flows at ice breakup on April 1 would be less with LSMEOC in operation or with FRWCS fully open. Note that for the upper decile forecast, with flows restricted by FRWCS, flows in the DRFN Community at ice breakup on April 1, 2013 are forecasted to peak at approximately 8,400 cfs, which is substantially less than the forecasted 24,710 cfs peak flow that we prepared for in the spring of 2012.

Regards,

Colin Siepman, B.Sc. CE, M.Eng, P.Eng
Senior Project Manager
KGS Group

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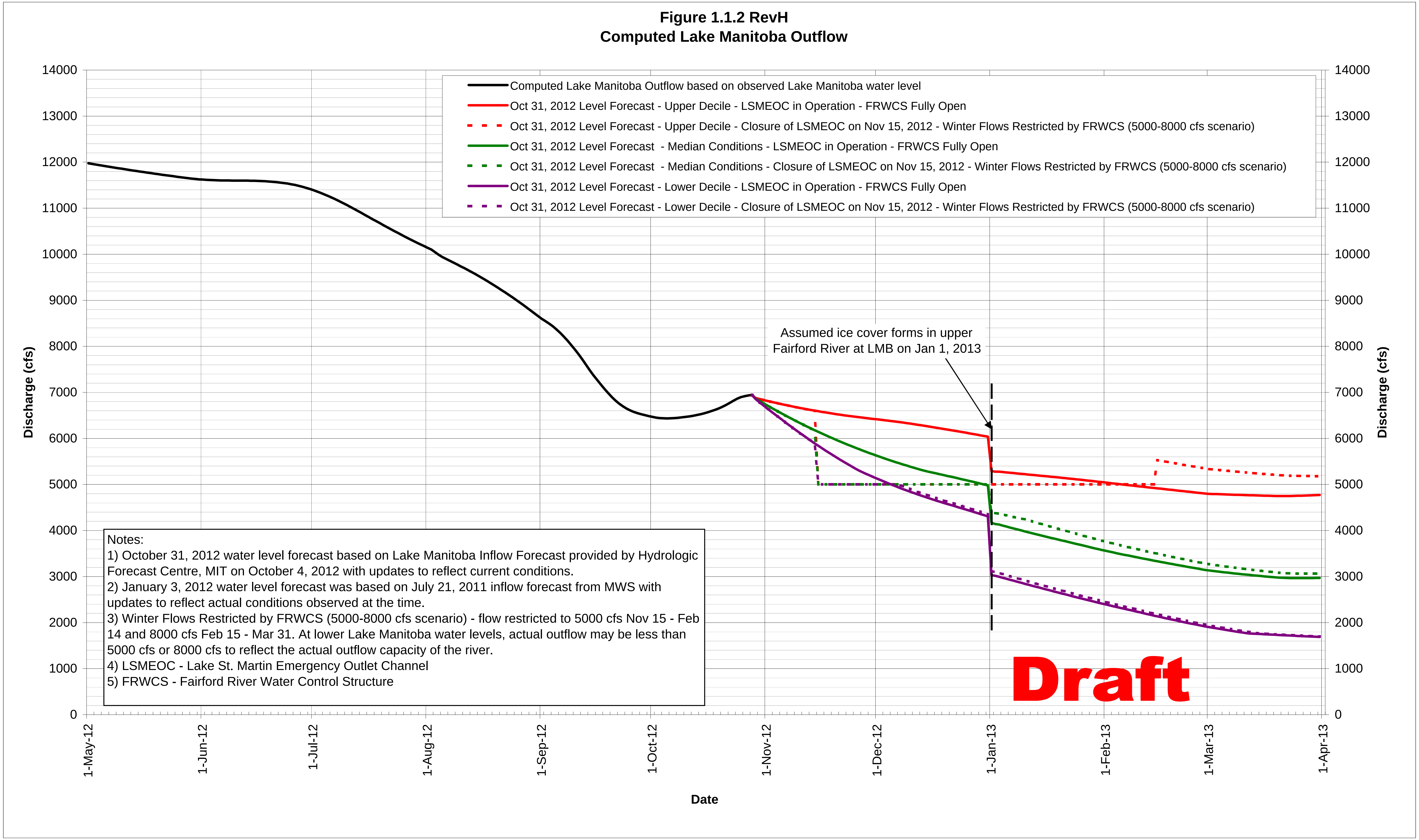


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10/31/2012

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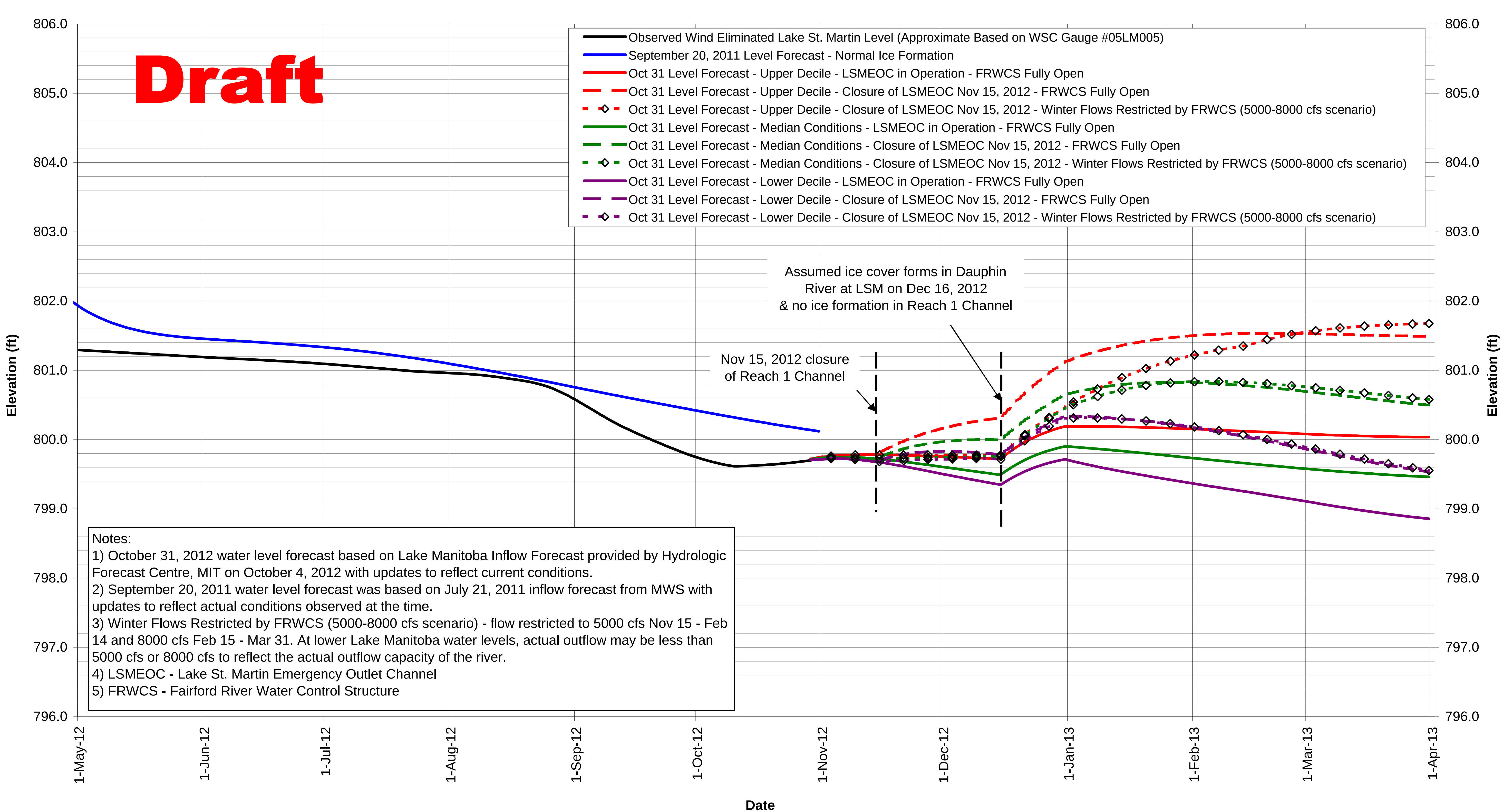
**Figure 2.13.1 RevO**
**Computed Lake St. Martin Level**

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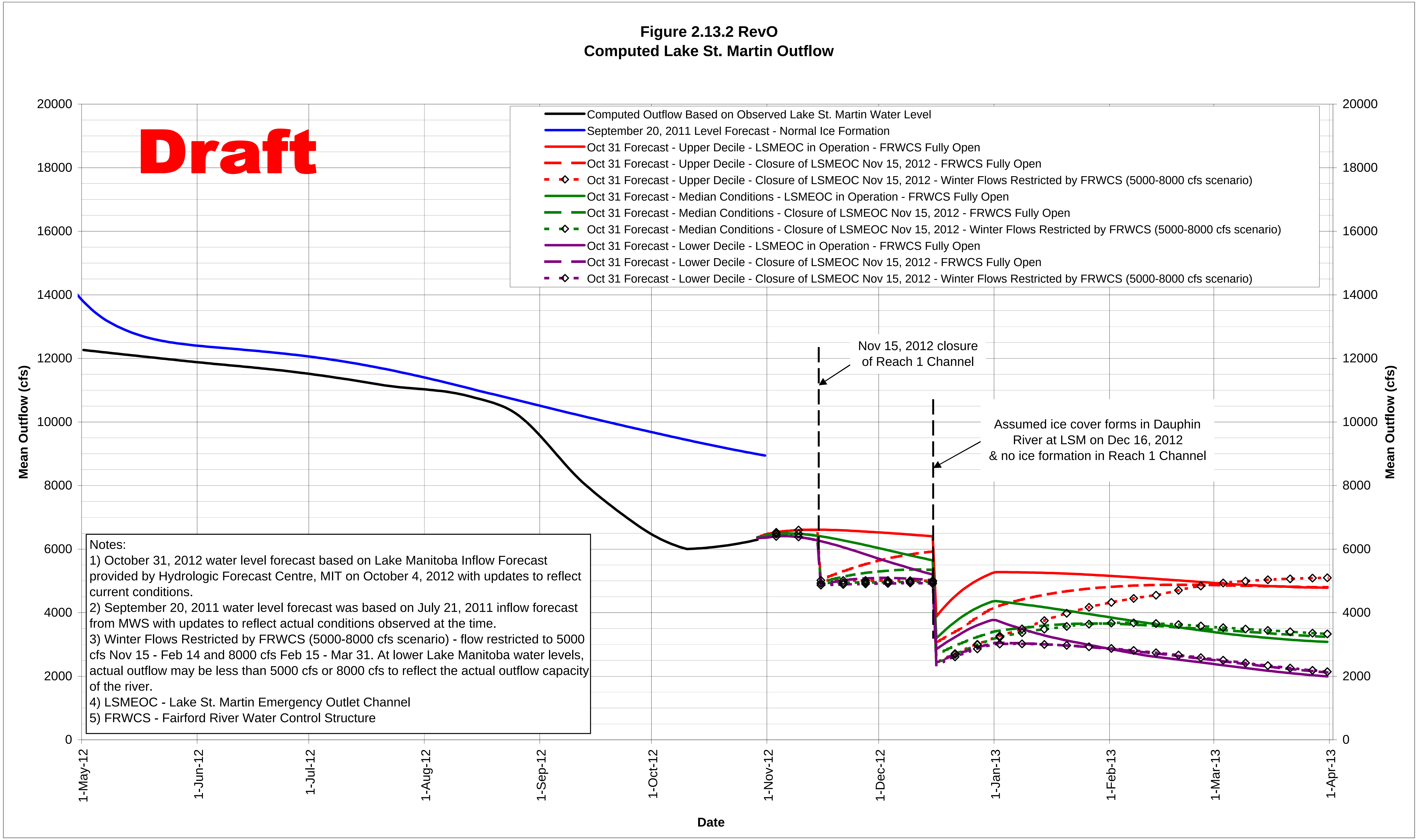


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**Lake Manitoba Forecast**
**Correspondence and Figures**

**November 30, 2012**

## Garrett Wellwood

**From:** Colin Siepman [CSiepman@kgsgroup.com]
**Sent:** Thursday, November 29, 2012 4:53 PM
**To:** 'Topping, Steve (MIT)'; Ron Kaatz
**Cc:** 'McMahon, Doug (MIT)'; Don Norquay; 'Richardson, Ron (MIT)'; Mark Allard ; Eric Christiansen; 'Mutulu, Phillip (MIT)'; Jason Senyk; Brian Bodnaruk; Rick Carson; Bert Smith; Dave MacMillan; Rob Kenyon; Hannon, Gord (JUS)
**Subject:** End of November LMB and LSM Forecast
**Attachments:** Figure 1.1.1 RevQ.PDF; Figure 1.1.2 RevI.PDF; Figure 2.13.1 RevP.PDF; Figure 2.13.2 RevP.PDF; Reach 1 Closure Nov 28.JPG; Reach 1 at Buffalo Lake.JPG; Buffalo Creek at Reach 3 - Nov 28.JPG; Partial Ice Cover in Upper Dauphin River Nov 28.JPG

Please find attached the end of November Lake Manitoba (LMB) and Lake St. Martin (LSM) forecast figures based on the LMB inflow forecast that was provided by the Hydrologic Forecast Centre, MIT on October 4, 2012, updated to reflect current conditions. Note that the current LMB inflow forecast does not extend beyond April 1st 2013. When the Hydrologic Forecast Centre is able to provide an extended LMB inflow forecast and spring 2013 operating scenarios for the FRWCS we will extend the figures accordingly.

As before, the forecast considered lower decile, median and upper decile weather conditions and flows. The following two operating scenarios were included in the forecast:

- Lake St. Martin Emergency Outlet Channel (LSMEOC) closed with Fairford River Water Control Structure (FRWCS) fully open
- LSMEOC closed with flows restricted by FRWCS to 5000 cfs Dec 15 to Feb 14 and 8000 cfs Feb 15 to Mar 31

Note that the current MIT operational plan is to leave FRWCS at maximum discharge (i.e. no change in stoplogs). For the hypothetical scenario where flows are restricted by the FRWCS, the November 15 date of operation was moved to December 15. Additionally, at lower LMB water levels, the LMB outflow after December 15 was at times forecasted to be less than the potential 5000 cfs or 8000 cfs restriction. In this case, the actual outflow for the “winter flows restricted by FRWCS (5000-8000 cfs scenario)” was based on the actual outflow capacity of the Fairford River.

All LMB scenarios once again consider a potential natural restriction due to ice effects upstream of the FRWCS. For the analysis, it was assumed that the effects of the ice would begin on January 1, 2013 and remain until ice breakup on April 1, 2013. The potential ice effects were based on historic records of discharges and water levels in the Fairford River and Lake Manitoba during winter months, and were assumed to be representative of “normal” ice conditions in the river with FRWCS fully open.

The current water level and outflow on LMB and LSM are slightly above the October 31, 2012 forecast due to higher inflow than originally anticipated in the October 4 inflow forecast. A summary of the November 29, 2012 median conditions forecast is provided below.

**Lake Manitoba**

The November 29, 2012 water level on LMB was approximately 812.1 ft. Based on median conditions, the water level is forecasted to recede to approximately 811.6 ft by March 31, 2013 with the FRWCS fully open. A water level of 811.6 ft is also forecasted for the median conditions “winter flows restricted by the FRWCS (5000-8000 cfs scenario)” since natural LMB outflow is forecasted to be similar to the potential restriction scenario for the most part of the winter.

The November 29, 2012 LMB outflow was approximately 7100 cfs under median conditions, the outflow is expected to recede to approximately 5000 cfs by early January 2013 with “normal” ice conditions in the river.

**Lake St. Martin**

The November 29, 2012 water level on LSM was approximately 800.2 ft. Based on median conditions, the water level is forecasted to rise during the winter due to ice formation in the upper Dauphin River to approximately 801.5 ft and then recede to approximately 801.0 ft by March 31, 2013. For the hypothetical “winter flow restricted by FRWCS (5000-8000 cfs scenario)” the median conditions water level is expected to rise to approximately 801.4 ft and then recede to approximately 801.0 ft by March 31. As indicated on the figures, a partial ice cover was observed in the Dauphin River at LSM on November 28, 2012. Depending on the extents of the current partial ice cover in the upper Dauphin River, and the timing at which a full ice cover forms, the rate and speed at which the LSM water level actually rises may differ then what is shown on the forecast. However, when only considering the forecasted peak water level on the lake, ice forming in the upper Dauphin River two to three weeks earlier or later than assumed has negligible effects to the forecast peak water level provided on the figure.

Due to current ice conditions in the upper Dauphin River, the November 29, 2012 LSM outflow is difficult to predict. However based on our forecast and assumed effects of the partial ice cover, the LSM outflow into the upper Dauphin River was estimated to be approximately 4000 cfs. Under open water conditions, the LSM outflow would be approximately 5700 cfs. The LSMEOC is now closed and therefore no longer contributes to the LSM outflow (with the exception of minor seepage through the closure dike).

**Dauphin River**

Based on observed Lake St. Martin water levels, the peak flow in the lower Dauphin River during ice formation in the DRFN was approximately 6,500 cfs (with the LSMEOC in operation). The current discharge in the community is much less due to the closure of the LSMEOC and ice effects in the upper Dauphin River, and are expected to remain below the 6,500 cfs peak for the rest of the winter. A review of the potential maximum ice staging in the DRFN community for a flow of 9500 cfs was previously completed by the Frazil Ice Team to assess the potential inundation in the DRFN community without the dikes in place (e-mail sent April 2, 2012). This review indicated that the freeboard above the water surface profile was greater than 0.5 m for all buildings.

At ice breakup on April 1, 2013, median condition flows in the DRFN Community are forecasted to peak at approximately 7,100 cfs. Peak flows at ice breakup on April 1 would be slightly more (approximately 7,200 cfs) for the median “winter flow restricted by FRWCS (5000-8000 cfs scenario)”. For the upper decile forecast, flows in the DRFN Community at ice breakup on April 1, 2013 are forecasted to peak at approximately 8,600 cfs, which is substantially less than the forecasted 24,710 cfs peak flow that we prepared for in the spring of 2012. Note that the forecasted peak does not consider local runoff from Buffalo Creek.

Regards,

Colin Siepman, B.Sc. CE, M.Eng, P.Eng
Senior Project Manager
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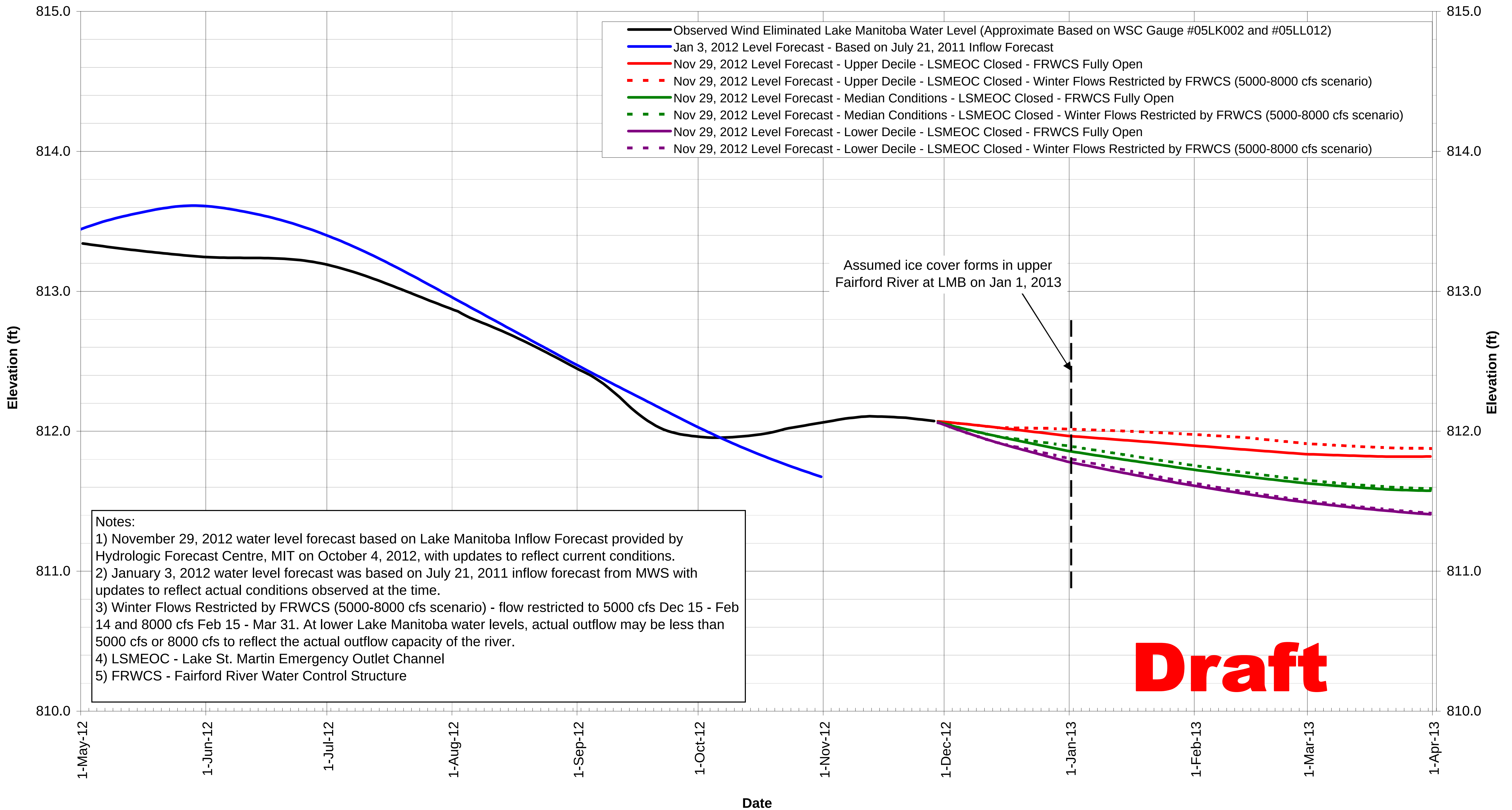
**Figure 1.1.1 RevQ**
**Computed Lake Manitoba Level**

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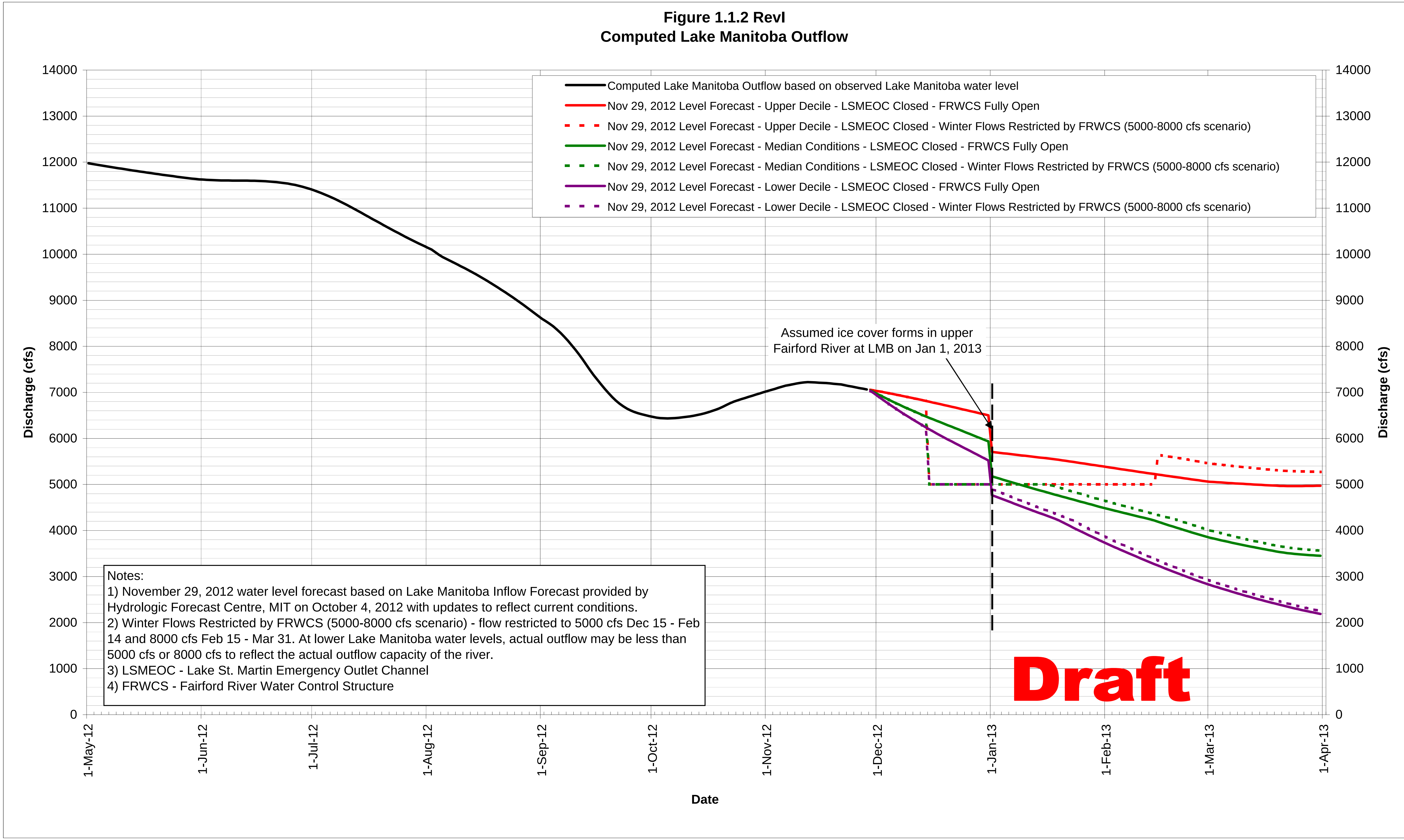


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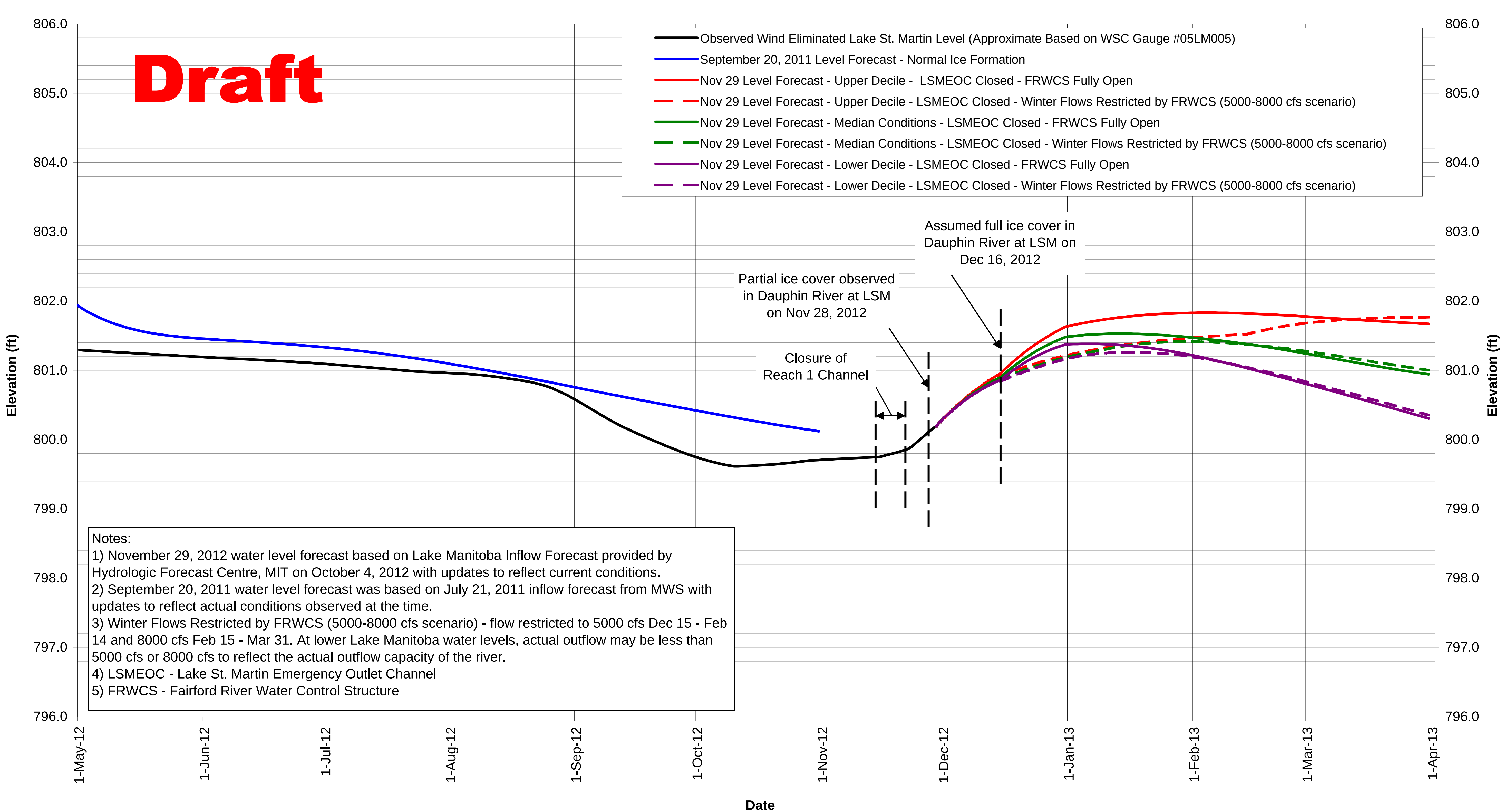
**Figure 2.13.1 RevP**
**Computed Lake St. Martin Level**

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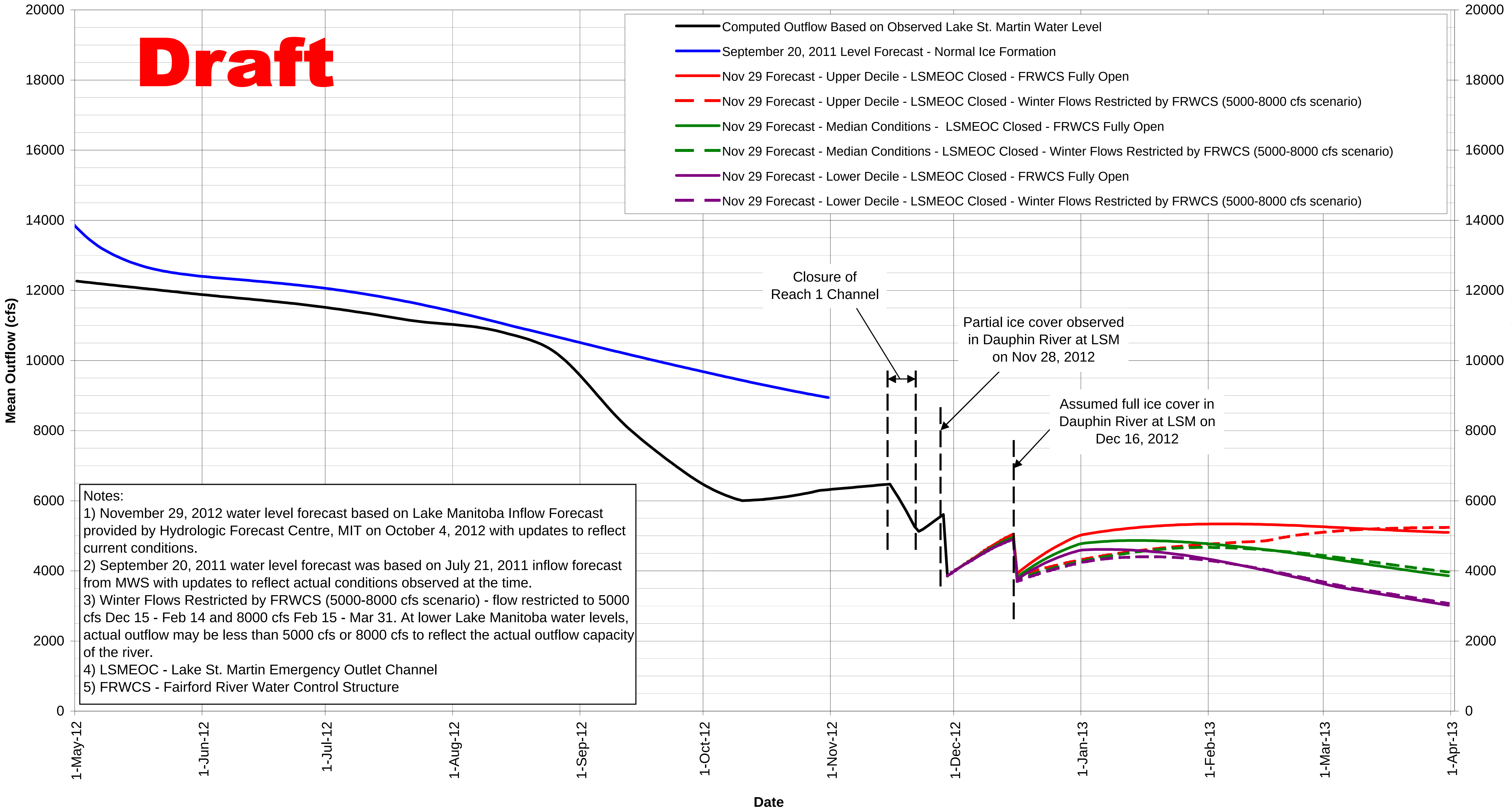
11/29/2012

**Figure 2.13.2 RevP**
**Computed Lake St. Martin Outflow**



**Lake Manitoba Forecast**
**Correspondence and Figures**

**December 31, 2012**

## Garrett Wellwood

**From:** Colin Siepman [CSiepman@kgsgroup.com]
**Sent:** Tuesday, January 08, 2013 2:19 PM
**To:** 'Topping, Steve (MIT)'; Ron Kaatz
**Cc:** 'McMahon, Doug (MIT)'; Don Norquay; 'Richardson, Ron (MIT)'; Mark Allard ; Eric Christiansen; 'Mutulu, Phillip (MIT)'; Jason Senyk; Brian Bodnaruk; Rick Carson; Bert Smith; Dave MacMillan; Rob Kenyon; Hannon, Gord (JUS)
**Subject:** End of December LMB and LSM Forecast
**Attachments:** Figure 1.1.1 RevR.PDF; Figure 1.1.2 RevJ.PDF; Figure 2.13.1 RevQ.PDF; Figure 2.13.2 RevQ.PDF; Dauphin River Inlet at LSM.JPG; Fairford River at HWY 6.jpg; Dauphin River at Frenchman's Rapids.jpg; R1 Closure Seepage - 1.JPG

Please find attached the end of December Lake Manitoba (LMB) and Lake St. Martin (LSM) forecast figures based on the LMB inflow forecast that was provided by the Hydrologic Forecast Centre, MIT on October 4, 2012, updated to reflect current conditions. Note that the current LMB inflow forecast does not extend beyond April 1st 2013. When the Hydrologic Forecast Centre is able to provide an extended LMB inflow forecast and spring 2013 operating scenarios for the FRWCS we will extend the figures accordingly.

As before, the forecast considered lower decile, median and upper decile weather conditions and flows. The forecast also considered that the Lake St. Martin Emergency Outlet Channel (LSMEOC) is closed and that the Fairford River Water Control Structure (FRWCS) is fully open.

Since the current MIT operational plan is to leave FRWCS at maximum discharge (i.e. no change in stoplogs), and the current LMB outflows are near 5000 cfs, the hypothetical scenario where flows are restricted by the FRWCS to 5000 cfs until February 15 was not considered in this forecast.

The forecast once again considered a potential natural restriction due to ice effects upstream of the FRWCS. For the analysis, it was assumed that the effects of the ice would begin on January 20, 2013 and remain until ice breakup on April 1, 2013. The potential ice effects were based on historic records of discharges and water levels in the Fairford River and Lake Manitoba during winter months, and were assumed to be representative of “normal” ice conditions in the river with FRWCS fully open. During a flyover of the Fairford River conducted on December 20, 2012, open water conditions were observed upstream of the FRWCS (see photos attached).

The end of December forecast remains similar to the November 29, 2012 forecast and the current water levels and outflows are trending near median conditions. A summary of the median conditions forecast is provided below.

**Lake Manitoba**

The January 7, 2013 water level on LMB was approximately 811.8 ft and the outflow was approximately 5600 cfs. Based on median conditions, the water level is forecasted to recede to approximately 811.6 ft by March 31, 2013 with the FRWCS fully open.

**Lake St. Martin**

The January 7, 2013 water level on LSM was approximately 801.2 ft. Based on median conditions and current ice conditions in the upper Dauphin River, the water level is forecasted to rise to approximately 801.3 ft within the next few weeks. The water level is then forecasted to recede to approximately 800.8 ft by March 31, 2013. As indicated on the figures, a partial ice cover was observed in the Dauphin River at LSM on November 28, 2012. Similar conditions were observed during a flyover of the Dauphin River conducted on December 20, 2012 (see photos attached). Depending on the extents of the current partial ice cover in the upper Dauphin River, and the timing at which a full ice cover forms, the rate at which the LSM water levels continue to rise or begin to fall may differ then what is shown on the forecast. However, when only considering the forecasted peak water level on the lake, ice forming in the upper Dauphin River earlier or later than assumed has negligible effects to the forecasted peak water level provided on the figure.

Due to current ice conditions in the upper Dauphin River, the Jan 7, 2013 LSM outflow is difficult to predict. However based on our forecast and assumed effects of the ice cover, the LSM outflow into the upper Dauphin River was estimated to be approximately 5500 cfs. The LSMEOC is now closed and therefore no longer contributes to the LSM outflow (with the exception of minor seepage through the closure dike).

**Dauphin River**

Based on observed Lake St. Martin water levels, the peak flow in the lower Dauphin River during ice formation in the DRFN was approximately 6,500 cfs (with the LSMEOC in operation). The current discharge in the community is much less due to the closure of the LSMEOC and ice effects in the upper Dauphin River, and are expected to remain below the 6,500 cfs peak for the rest of the winter. A review of the potential maximum ice staging in the DRFN community for a flow of 9500 cfs was previously completed by the Frazil Ice Team to assess the potential inundation in the DRFN community without the dikes in place (e-mail sent April 2, 2012). This review indicated that the freeboard above the water surface profile was greater than 0.5 m for all buildings.

At ice breakup on April 1, 2013, median condition flows in the DRFN Community are forecasted to peak at approximately 6,800 cfs. For the upper decile forecast, flows in the DRFN Community at ice breakup on April 1, 2013 are forecasted to peak at approximately 7,900 cfs, which is substantially less than the forecasted 24,710 cfs peak flow that we prepared for in the spring of 2012. Note that the forecasted peak does not consider local runoff from Buffalo Creek.

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**From:** Colin Siepman [mailto:CSiepman@kgsgroup.com]
**Sent:** November-29-12 4:53 PM
**To:** 'Topping, Steve (MIT)'; Ron Kaatz
**Cc:** 'McMahon, Doug (MIT)'; Don Norquay; 'Richardson, Ron (MIT)'; Mark Allard ; Eric Christiansen; 'Mutulu, Phillip (MIT)'; Jason Senyk; Brian Bodnaruk; Rick Carson; Bert Smith; Dave MacMillan; Rob Kenyon; Hannon, Gord (JUS)
**Subject:** End of November LMB and LSM Forecast

Please find attached the end of November Lake Manitoba (LMB) and Lake St. Martin (LSM) forecast figures based on the LMB inflow forecast that was provided by the Hydrologic Forecast Centre, MIT on October 4, 2012, updated to reflect current conditions. Note that the current LMB inflow forecast does not extend beyond April 1st 2013. When the Hydrologic Forecast Centre is able to provide an extended LMB inflow forecast and spring 2013 operating scenarios for the FRWCS we will extend the figures accordingly.

As before, the forecast considered lower decile, median and upper decile weather conditions and flows. The following two operating scenarios were included in the forecast:

- Lake St. Martin Emergency Outlet Channel (LSMEOC) closed with Fairford River Water Control Structure (FRWCS) fully open
- LSMEOC closed with flows restricted by FRWCS to 5000 cfs Dec 15 to Feb 14 and 8000 cfs Feb 15 to Mar 31

Note that the current MIT operational plan is to leave FRWCS at maximum discharge (i.e. no change in stoplogs). For the hypothetical scenario where flows are restricted by the FRWCS, the November 15 date of operation was moved to December 15. Additionally, at lower LMB water levels, the LMB outflow after December 15 was at times forecasted to be less than the potential 5000 cfs or 8000 cfs restriction. In this case, the actual outflow for the "winter flows restricted by FRWCS (5000-8000 cfs scenario)" was based on the actual outflow capacity of the Fairford River.

All LMB scenarios once again consider a potential natural restriction due to ice effects upstream of the FRWCS. For the analysis, it was assumed that the effects of the ice would begin on January 1, 2013 and remain until ice breakup on April 1, 2013. The potential ice effects were based on historic records of discharges and water levels in the Fairford River and Lake Manitoba during winter months, and were assumed to be representative of "normal" ice conditions in the river with FRWCS fully open.

The current water level and outflow on LMB and LSM are slightly above the October 31, 2012 forecast due to higher inflow than originally anticipated in the October 4 inflow forecast. A summary of the November 29, 2012 median conditions forecast is provided below.

**Lake Manitoba**

The November 29, 2012 water level on LMB was approximately 812.1 ft. Based on median conditions, the water level is forecasted to recede to approximately 811.6 ft by March 31, 2013 with the FRWCS fully open. A water level of 811.6 ft is also forecasted for the median conditions “winter flows restricted by the FRWCS (5000-8000 cfs scenario)” since natural LMB outflow is forecasted to be similar to the potential restriction scenario for the most part of the winter.

The November 29, 2012 LMB outflow was approximately 7100 cfs under median conditions, the outflow is expected to recede to approximately 5000 cfs by early January 2013 with “normal” ice conditions in the river.

**Lake St. Martin**

The November 29, 2012 water level on LSM was approximately 800.2 ft. Based on median conditions, the water level is forecasted to rise during the winter due to ice formation in the upper Dauphin River to approximately 801.5 ft and then recede to approximately 801.0 ft by March 31, 2013. For the hypothetical “winter flow restricted by FRWCS (5000-8000 cfs scenario)” the median conditions water level is expected to rise to approximately 801.4 ft and then recede to approximately 801.0 ft by March 31. As indicated on the figures, a partial ice cover was observed in the Dauphin River at LSM on November 28, 2012. Depending on the extents of the current partial ice cover in the upper Dauphin River, and the timing at which a full ice cover forms, the rate and speed at which the LSM water level actually rises may differ then what is shown on the forecast. However, when only considering the forecasted peak water level on the lake, ice forming in the upper Dauphin River two to three weeks earlier or later than assumed has negligible effects to the forecast peak water level provided on the figure.

Due to current ice conditions in the upper Dauphin River, the November 29, 2012 LSM outflow is difficult to predict. However based on our forecast and assumed effects of the partial ice cover, the LSM outflow into the upper Dauphin River was estimated to be approximately 4000 cfs. Under open water conditions, the LSM outflow would be approximately 5700 cfs. The LSMEOC is now closed and therefore no longer contributes to the LSM outflow (with the exception of minor seepage through the closure dike).

**Dauphin River**

Based on observed Lake St. Martin water levels, the peak flow in the lower Dauphin River during ice formation in the DRFN was approximately 6,500 cfs (with the LSMEOC in operation). The current discharge in the community is much less due to the closure of the LSMEOC and ice effects in the upper Dauphin River, and are expected to remain below the 6,500 cfs peak for the rest of the winter. A review of the potential maximum ice staging in the DRFN community for a flow of 9500 cfs was previously completed by the Frazil Ice Team to assess the potential inundation in the DRFN community without the dikes in place (e-mail sent April 2, 2012). This review indicated that the freeboard above the water surface profile was greater than 0.5 m for all buildings.

At ice breakup on April 1, 2013, median condition flows in the DRFN Community are forecasted to peak at approximately 7,100 cfs. Peak flows at ice breakup on April 1 would be slightly more (approximately 7,200 cfs) for the median “winter flow restricted by FRWCS (5000-8000 cfs scenario)”. For the upper decile forecast, flows in the DRFN Community at ice breakup on April 1, 2013 are forecasted to peak at approximately 8,600 cfs, which is substantially less than the forecasted 24,710 cfs peak flow that we prepared for in the spring of 2012. Note that the forecasted peak does not consider local runoff from Buffalo Creek.

Regards,

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**Figure 1.1.1 RevR**
**Computed Lake Manitoba Level**

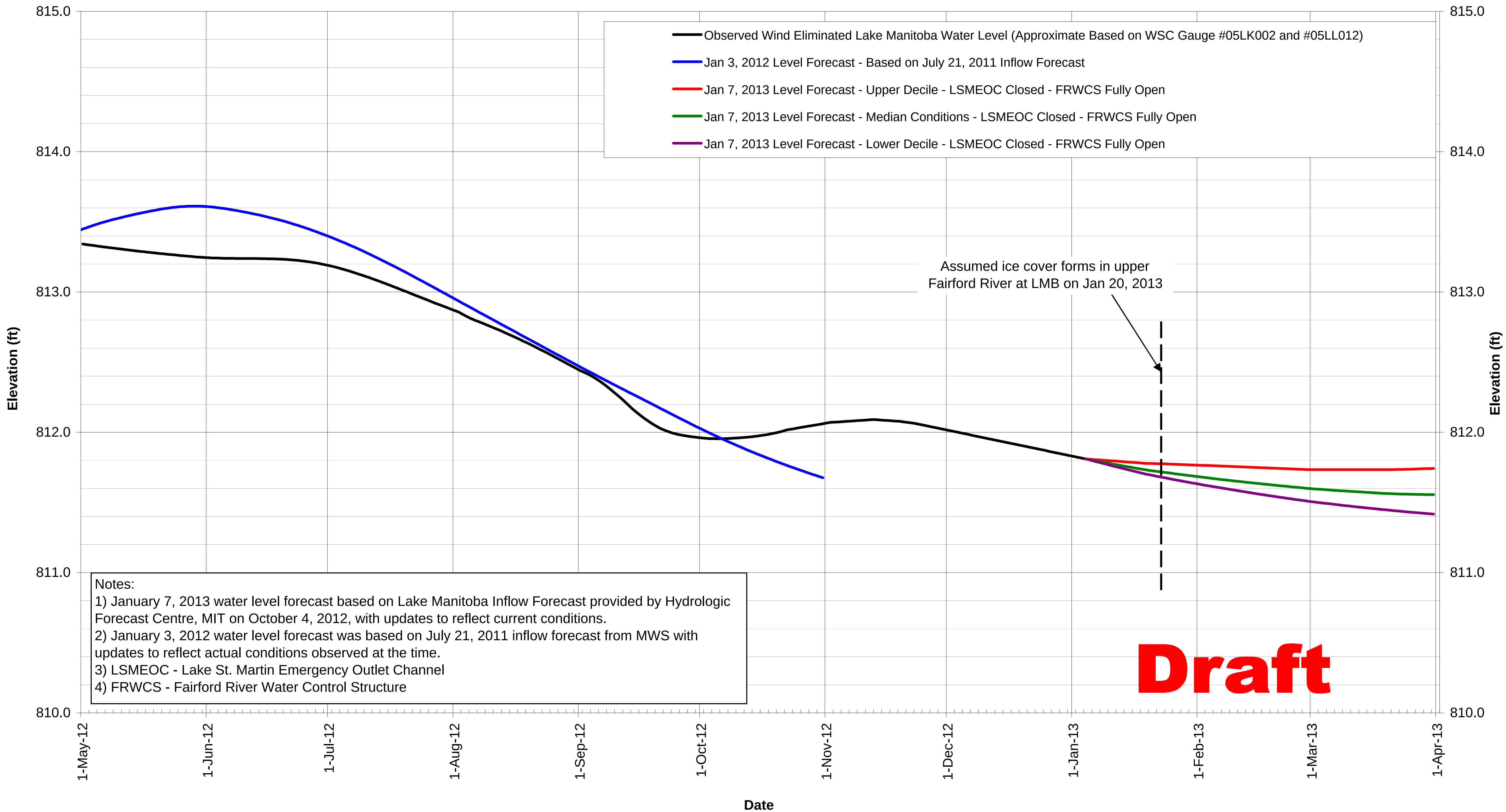
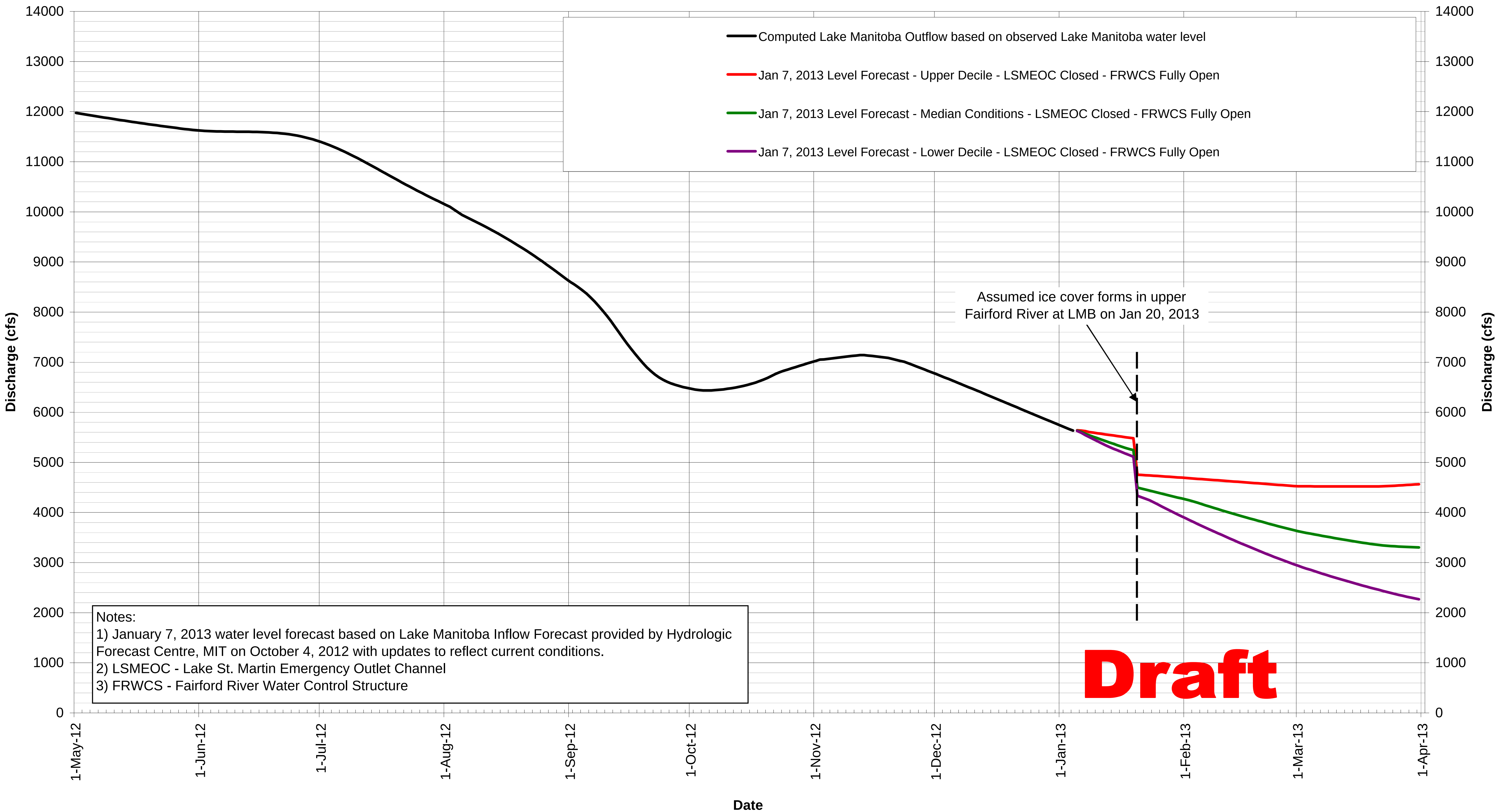


**Figure 1.1.2 RevJ**
**Computed Lake Manitoba Outflow**

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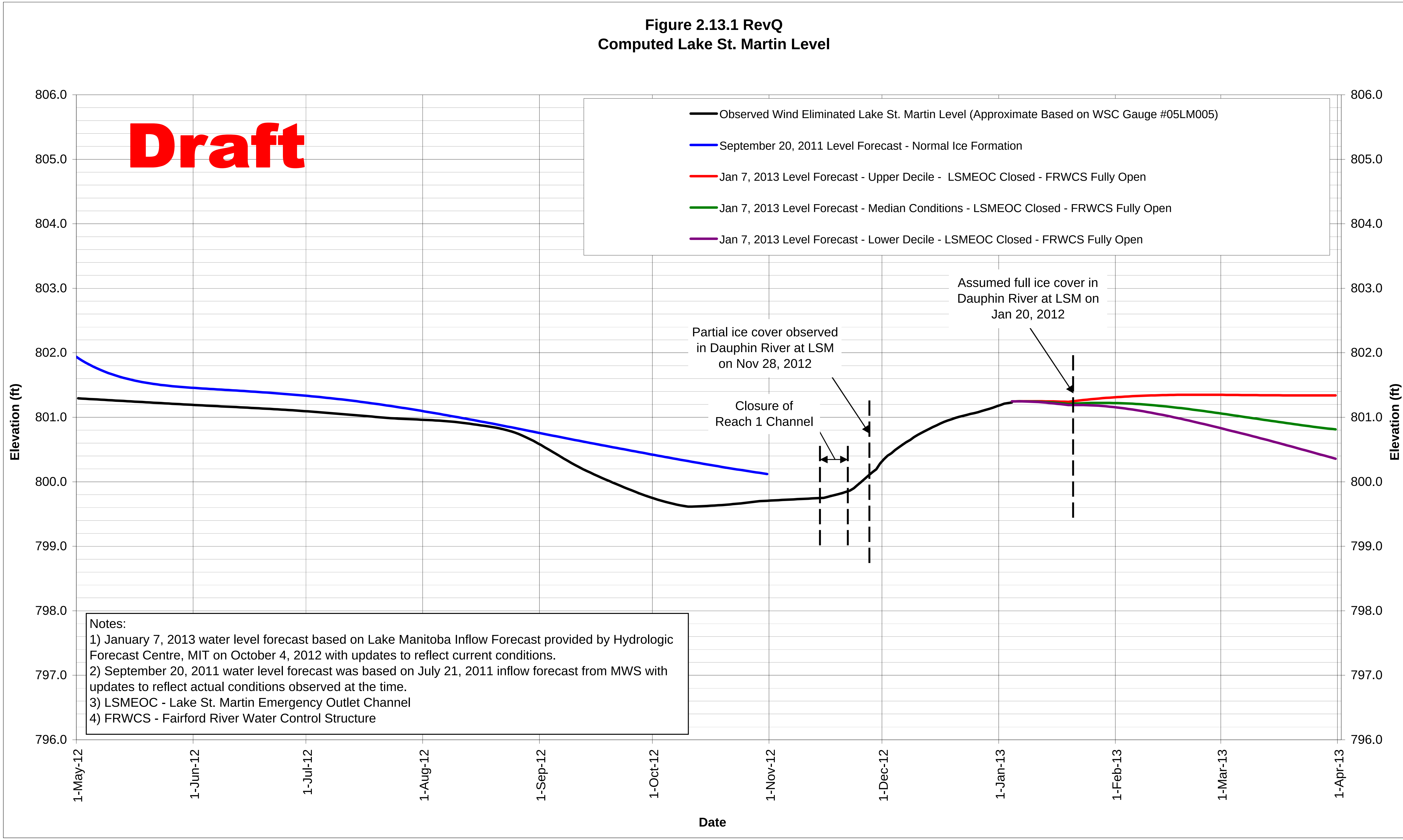


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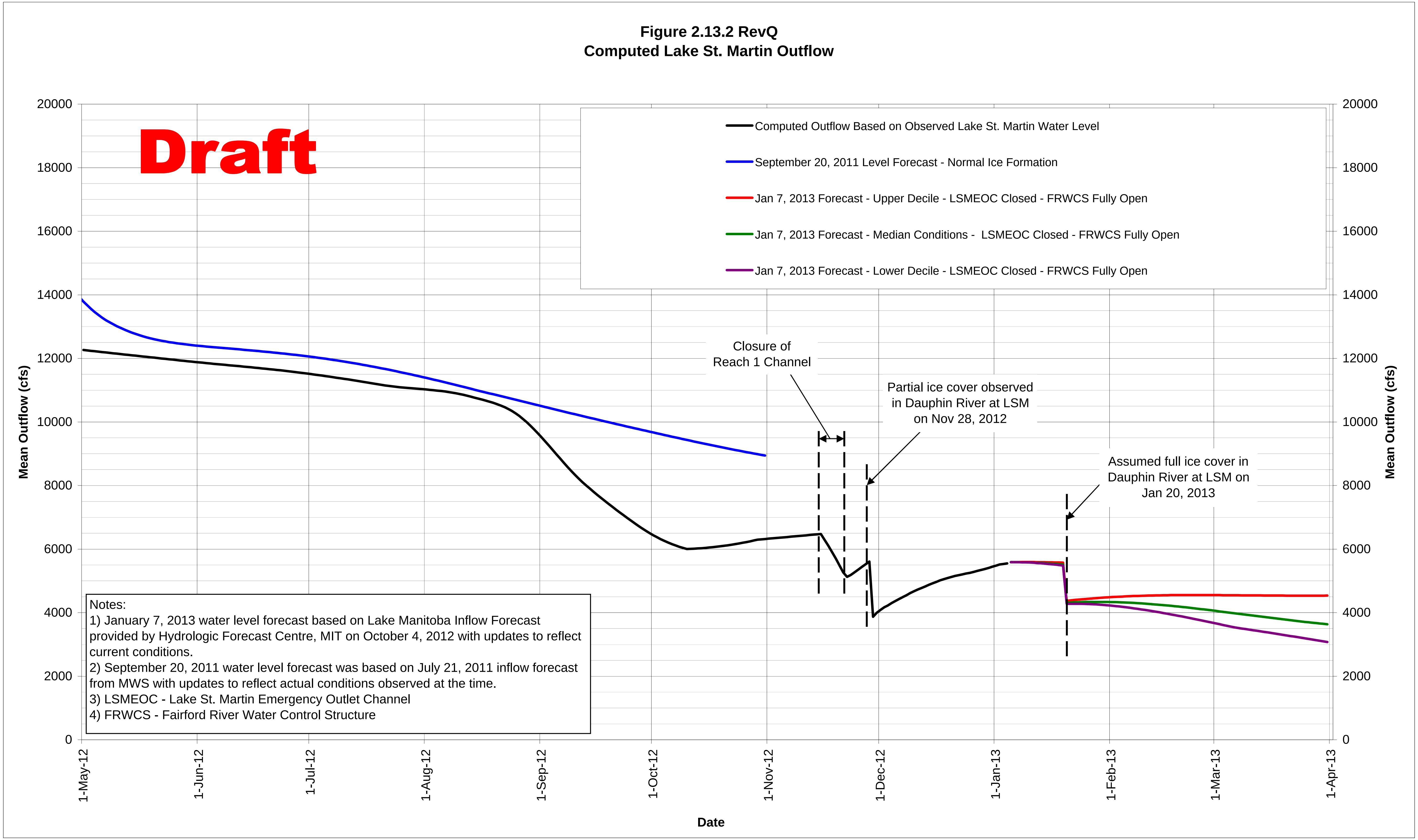


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1/7/2013

**Lake Manitoba Forecast**
**Correspondence and Figures**

**January 31, 2013**

## Garrett Wellwood

**From:** Colin Siepman [CSiepman@kgsgroup.com]
**Sent:** Friday, February 08, 2013 4:47 PM
**To:** 'Topping, Steve (MIT)'; Ron Kaatz
**Cc:** 'McMahon, Doug (MIT)'; Don Norquay; 'Richardson, Ron (MIT)'; Mark Allard ; Eric Christiansen; 'Mutulu, Phillip (MIT)'; Jason Senyk; Brian Bodnaruk; Rick Carson; Bert Smith; Dave MacMillan; Rob Kenyon; Hannon, Gord (JUS)
**Subject:** End of January LMB and LSM Forecast
**Attachments:** Figure 1.1.1 RevS.PDF; Figure 1.1.2 Revk.pdf; Figure 2.13.1 RevR.PDF; Figure 2.13.2 RevR.PDF

Please find attached the end of January Lake Manitoba (LMB) and Lake St. Martin (LSM) forecast figures based on the LMB inflow forecast that was provided by the Hydrologic Forecast Centre, MIT on October 4, 2012, updated to reflect current conditions. Note that the current LMB inflow forecast does not extend beyond April 1st 2013. When the Hydrologic Forecast Centre is able to provide an extended LMB inflow forecast and spring 2013 operating scenarios for the FRWCS we will extend the figures accordingly (we anticipate this will be provided in late February).

As before, the forecast considered lower decile, median and upper decile weather conditions and flows. The forecast also considered that the Lake St. Martin Emergency Outlet Channel (LSMEOC) is closed and that the Fairford River Water Control Structure (FRWCS) is fully open.

Ice effects upstream of the FRWCS were once again considered for this forecast. However, based on current conditions in the Fairford River and water levels in Lake Manitoba, the ice effects were determined to be negligible, and were assumed to remain unchanged for the remainder of the winter. During a flyover of the Fairford River conducted on December 20, 2012, open water conditions were observed upstream of the FRWCS.

This forecast remains similar to the January 7, 2012 forecast, however the current water levels and outflows are trending near upper decile conditions due to higher inflows to Lake Manitoba than the inflow forecast provided by MIT on October 4, 2012. A summary of the upper decile forecast is provided below.

**Lake Manitoba**

The February 7, 2013 water level on LMB was approximately 811.8 ft and the outflow was approximately 5700 cfs. Based on upper decile conditions, the water level is forecasted to recede to approximately 811.7 ft by March 31, 2013 with the FRWCS fully open.

**Lake St. Martin**

The February 7, 2013 water level on LSM was approximately 801.4 ft. Based on upper decile conditions and current ice conditions in the upper Dauphin River, the water level is forecasted to rise to approximately 801.5 ft by March 31, 2013.

Due to current ice conditions in the upper Dauphin River, the Feb 7, 2013 LSM outflow is difficult to predict. However based on our forecast and assumed effects of the ice cover, the LSM outflow into the upper Dauphin River was estimated to be approximately 5300 cfs. The LSMEOC is now closed and therefore no longer contributes to the LSM outflow (with the exception of minor seepage through the closure dike).

**Dauphin River**

Based on observed Lake St. Martin water levels, the peak flow in the lower Dauphin River during ice formation in the DRFN was approximately 6,500 cfs (with the LSMEOC in operation). To our knowledge there was no impact on infrastructure within the community or access, with the exception of a localized area where inundation approached the centerline of PR513. The current discharge in the community is now less due to the closure of the LSMEOC and ice effects in the upper Dauphin River, and is expected to remain below the 6,500 cfs peak for the rest of the winter. A review of the potential maximum ice staging in the DRFN community for a flow of 9500 cfs was previously completed by the Frazil Ice Team to assess the potential inundation in the DRFN community without the dikes in place (e-mail sent April 2, 2012). This review indicated that the freeboard above the water surface profile was greater than 0.5 m for all buildings.

At ice breakup on April 1, 2013, flows in the DRFN Community are forecasted to peak at approximately 8,100 cfs, which is substantially less than the forecasted 24,710 cfs peak flow that we prepared for in the spring of 2012. Note that the forecasted peak does not consider local runoff from Buffalo Creek.

Regards,

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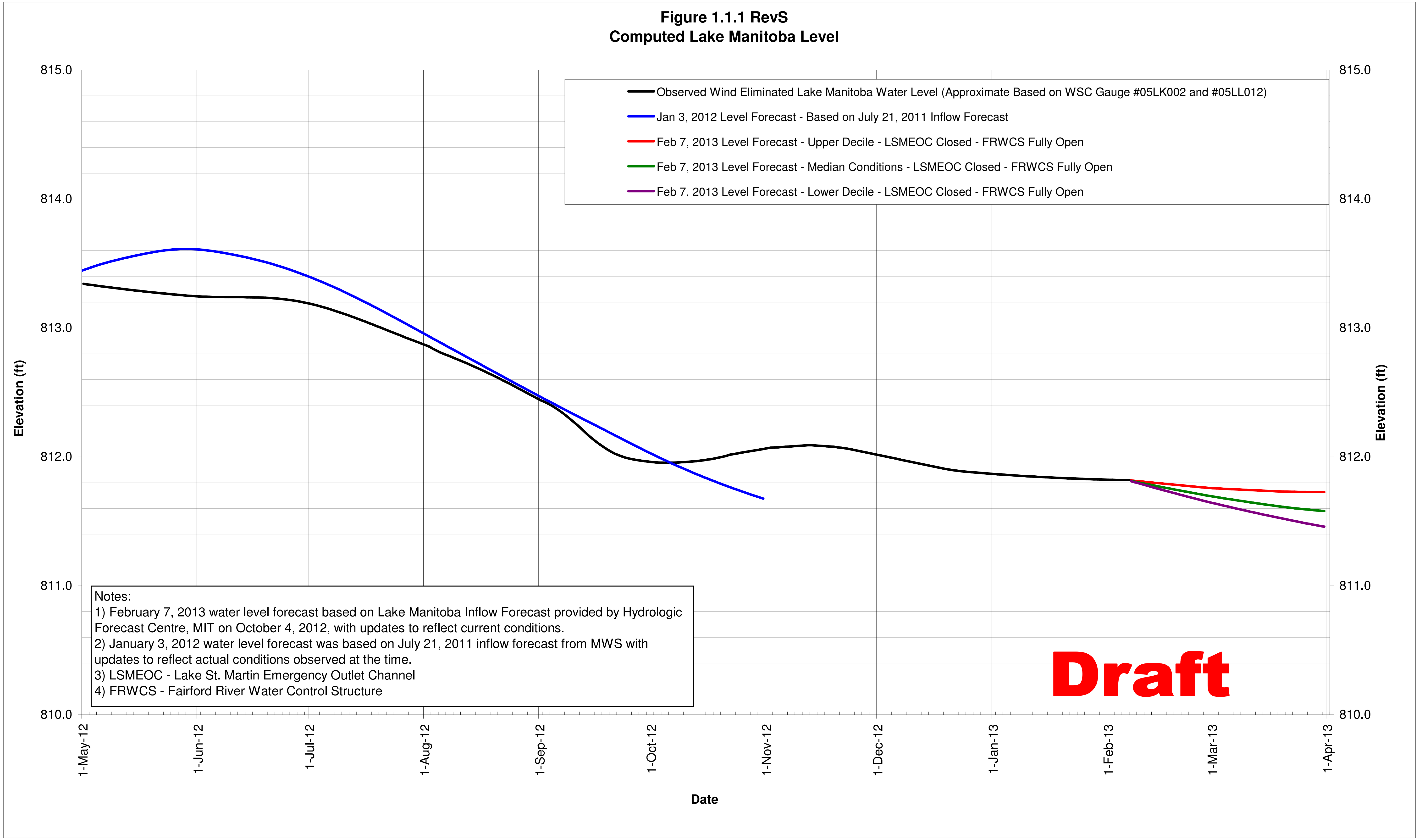


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**Figure 1.1.2 RevK**
**Computed Lake Manitoba Outflow**

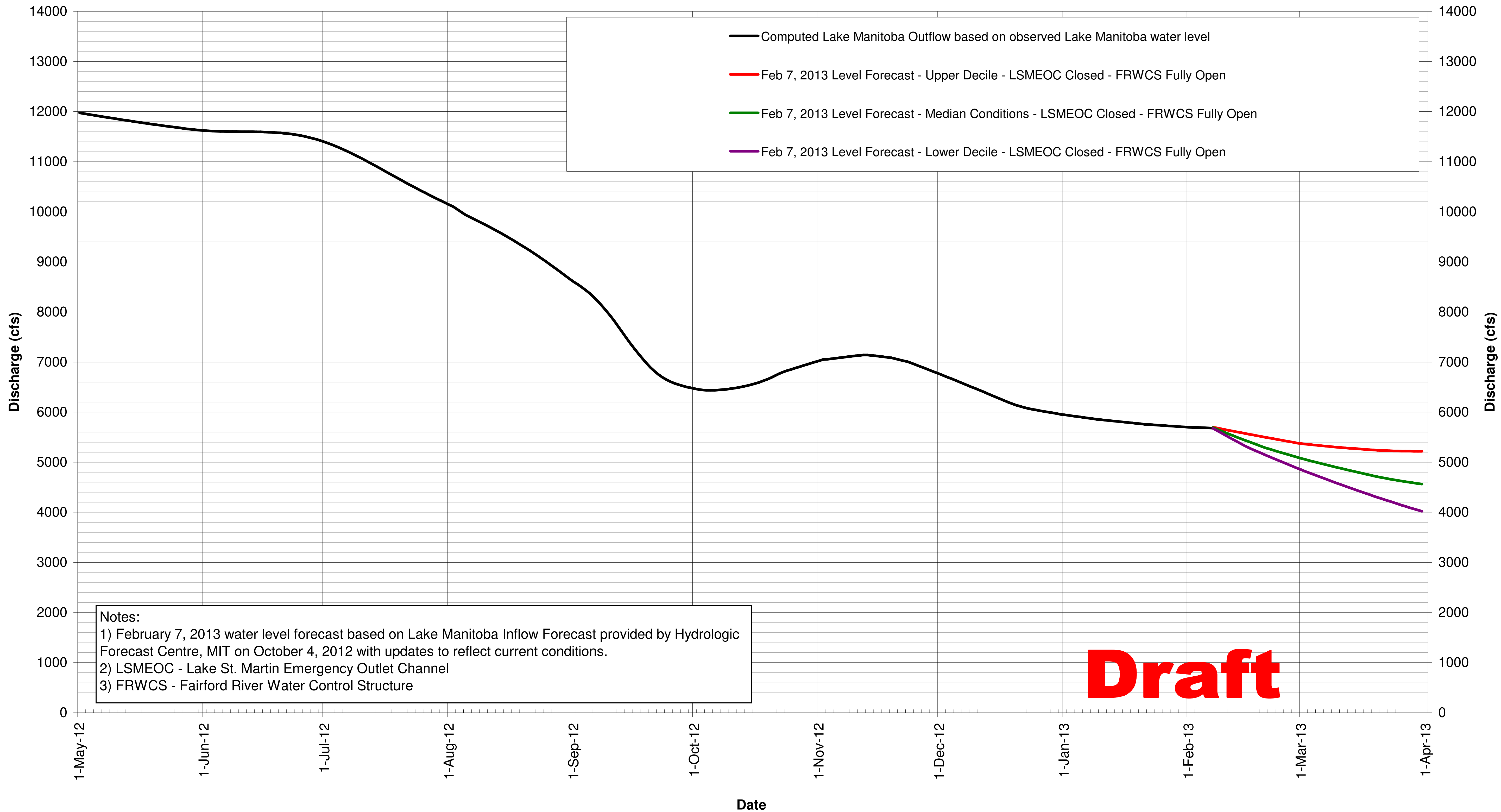


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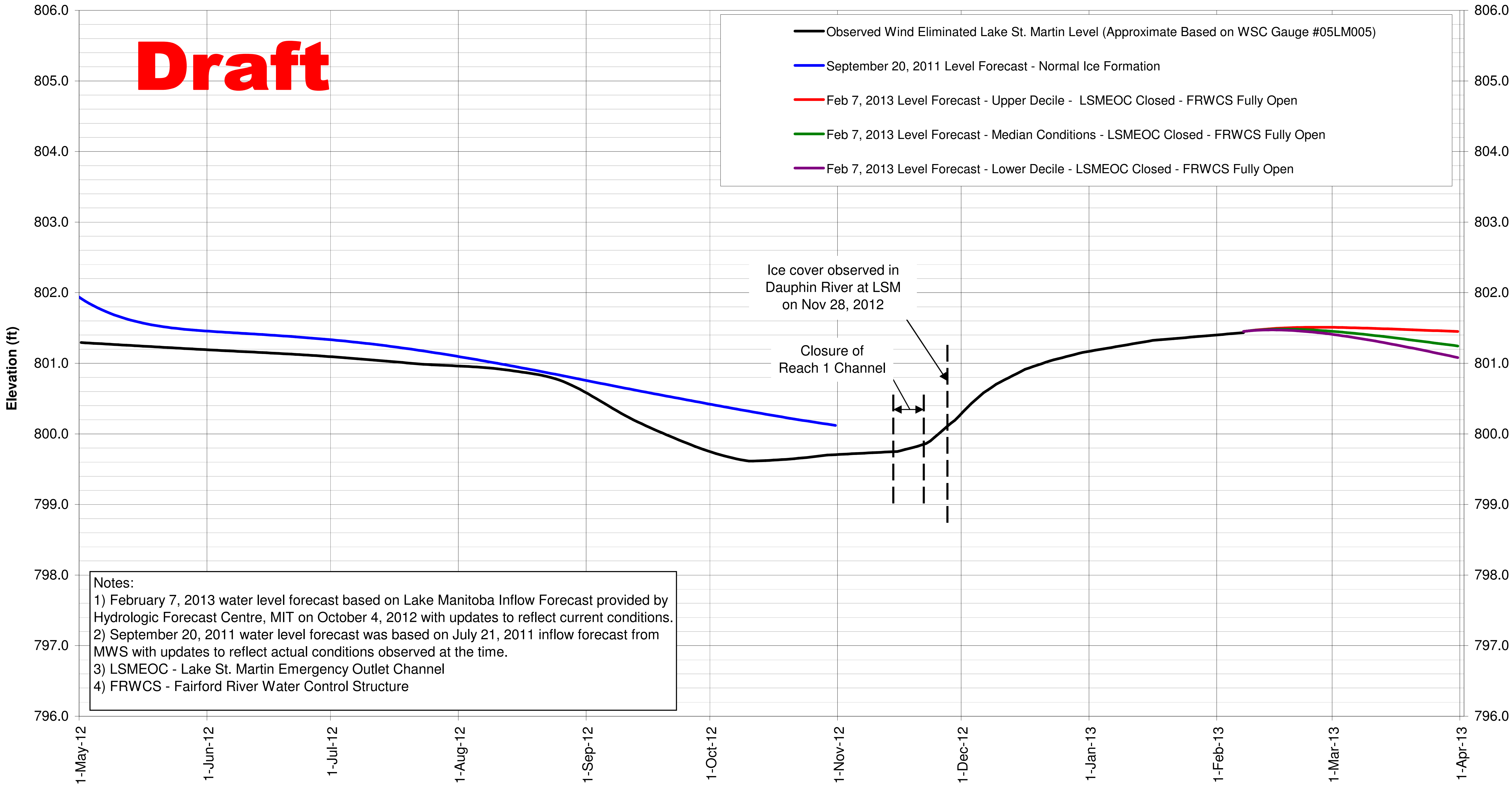
Figure 2.13.1 RevR
Computed Lake St. Martin Level




Notes:
1) February 7, 2013 water level forecast based on Lake Manitoba Inflow Forecast provided by Hydrologic Forecast Centre, MIT on October 4, 2012 with updates to reflect current conditions.
2) September 20, 2011 water level forecast was based on July 21, 2011 inflow forecast from MWS with updates to reflect actual conditions observed at the time.
3) LSMEOC - Lake St. Martin Emergency Outlet Channel
4) FRWCS - Fairford River Water Control Structure

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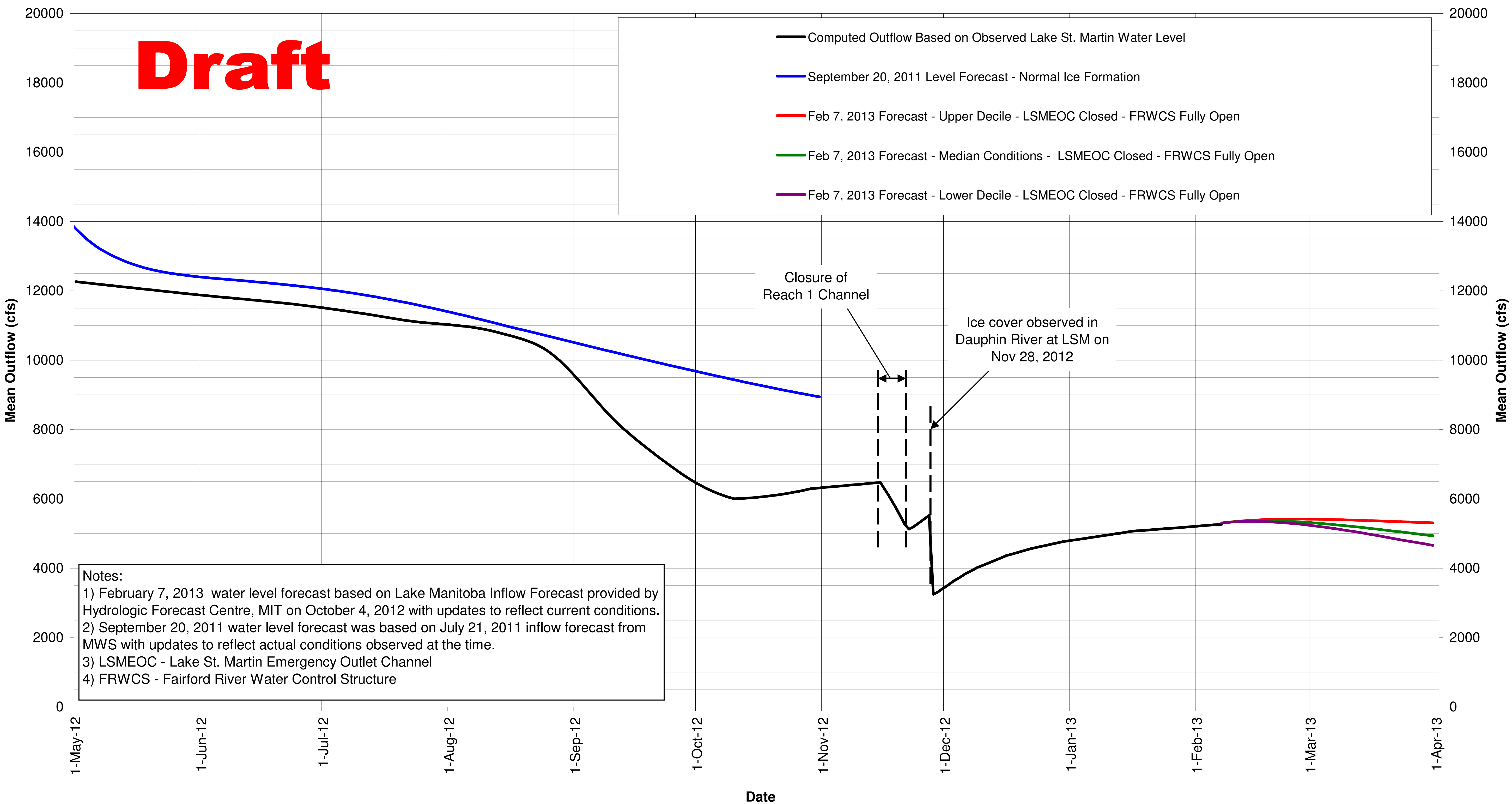
**Figure 2.13.2 RevR**
**Computed Lake St. Martin Outflow**

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2/7/2013

# APPENDIX B

## FLOW METERING AND WATER LEVEL MEASUREMENT OF THE LAKE ST. MARTIN EMERGENCY CHANNEL SYSTEM

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March 6, 2014

File No: 11-0300-18

Manitoba Infrastructure and Transportation
7th Floor, 215 Garry Street
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R3C 3P3

ATTENTION: Mr. Ron Kaatz
Senior Hydraulic Engineer

RE: Emergency Reduction of Lake St. Martin and Lake Manitoba Water Levels Flow Metering and Water Level Measurement of the Lake St. Martin Emergency Channel System

Dear Mr. Kaatz:

## 1.0 INTRODUCTION

As part of the hydraulic studies for the Emergency Reduction of Lake St Martin and Lake Manitoba Water Levels project, KGS Group completed flow meterings and water level measurements along the Lake St. Martin Emergency Channel System. The flow meterings were conducted in the Reach 1 Emergency Channel on November 18, 2011, March 21, 2012, April 17, 2012 and August 9, 2012. Water levels were surveyed at various stations along the Reach 1 channel and on Buffalo Creek on the days of the meterings and also on five more occasions between February 7 and 28, 2012.

The purpose of this program was to obtain instantaneous measurements of flow in the Reach 1 Emergency Channel during its operation to calibrate flood routing and backwater models, and confirm the true capacity of Reach 1 under open water conditions.

The channel was initially put into operation on November 1, 2011, with a partial opening of the inlet plug which took multiple days to complete. After a short delay to create a new barge access channel to the east, the remainder of the plug was removed starting on November 16, 2011. Additional work was completed at the inlet between January 24 and February 1 to complete the plug or "finger" removal towards the barge access channel and cleanup the inlet area.

A description of the equipment and procedures used for data collection during this program is included in Section 2.0. Section 3.0 provides the procedure for data processing and review and also presents a summary of results.

## 2.0 EQUIPMENT AND PROCEDURES

## 2.1 FLOW METERING INSTRUMENTATION

Flows were recorded using an Acoustic Doppler Current Profiler (ADCP). KGS Group used the Teledyne RDI RiverRay – 600 kHZ for this metering, coupled with the Hemisphere A100 Differential Global Positioning System (DGPS) on November 18, 2011 and March 21, 2012. The ADCP was mounted on a tethered miniature boat and was either operated while crossing the channel anchored on the side of a power boat or manually pulled across the watercourse from a cableway.

The ADCP technology relies on the transmission of acoustic energy and the analysis of the sound echoes reflected back from particles in the water columns. By analyzing the change in frequency of the sound echoes, the ADCP makes continuous measurements of the speed and direction of water currents through the water column and depth. This technology provides real-time flow velocities and a bathymetric representation of the river bottom.

The data recorded by the ADCP is continuously transmitted via a Bluetooth connection to a field computer, which integrates the information and provides flow velocity, water depth and cumulative discharge on a real time basis. With the RDI RiverRay unit, the Teledyne RDI's software WinRiver II (version 2.07) was used for this purpose. The DGPS records real time positioning information which is continuously transmitted directly to the ADCP.

## 2.2 FLOW METERING PROCEDURE

The flow metering followed the widely accepted Water Survey of Canada (WSC) [Ref 1] and United States Geological Survey (USGS) [Ref 2] Guidelines for the operation of the ADCP as well as for the post processing [Ref 3 and 4] of the collected information.

The November 18, 2011 flow metering was completed by anchoring the tethered ADCP boat to the side of a power boat while crossing the channel at approximately station 5+500. The March 21, April 17 and August 9, 2012 flow meterings were conducted by manually pulling the tethered ADCP boat across the watercourse from a cableway installed at approximately station 2+000. A description of the cableway installation is included in Section 3.0. A plan showing the location of both metering sites is provided on Figure 1.

The ADCP parameters were set according to the conditions observed at this site by the operator. These parameters included:

- ***Compass Calibration –*** The calibration of the built-in compass of the RiverRay ADCP was carried out on site away from any local source of magnetic fields or potential interferences according to RDI's recommendations.

- ***Cell or Bin Sizes and Maximum Water Depth of Transect –*** The RDI RiverRay software does not require the specification of bin sizes since these are automatically selected on a real time basis as the depth is recorded.

- ***Edge Distances and Shape of Section –*** The location of the starting and ending points of each transect was determined by the operator according to the conditions observed on site and when a minimum depth, at a minimum equal to 2 valid cells, was achieved. The edge distances were measured and the shape parameters for the calculation of the edge discharges were input by the operator.

Each measurement was comprised of four valid transects (i.e. two reciprocal pairs) in which the total exposure time on the channel lasted a minimum of 12 minutes. The computed discharges were targeted to be within 5% of each other. While operating the ADCP from the power boat, the path across the watercourse taken during each of the ADCP transects was maintained identical as much as possible by the boat operator. For measurements taken from the cableway, the path across the watercourse was essentially fixed by the orientation of the cableway setup.

The bottom tracking feature was selected to measure the positioning of the ADCP for discharge calculations. The DGPS coupled with the ADCP was used as an alternative means to measure positioning.

## 2.3 WATER LEVEL MEASUREMENTS

KGS Group surveyed water levels at various stations along the Reach 1 Emergency Channel and on Buffalo Creek on the days of the flow meterings and on five more occasions between February 7, and 28, 2012. The location of the water level surveys are shown on Figure 1. A list of all water levels obtained during the surveys is provided in Table 1. Water surface profiles in Reach 1 generated from the measurements provided in Table 1 are provided on Figure 2.

Water levels were either measured on the east side of Reach 1 using Global Positioning System (GPS) survey equipment or surveyed from temporary benchmarks using a rod and level. Temporary benchmarks were first established on February 10, 2012 at the water level measurement sites along Reach 1 and Buffalo Creek by driving 1-foot nails into the ground or on a nearby tree stump. On March 21, 2012, five temporary benchmarks were re-established on Reach 1 by driving 3-foot rebar into the ground. An additional temporary benchmark was also installed at the cableway site. The coordinates and elevation of the most recent temporary benchmark installed at each water level measurement site is provided on Table 2.

During the November 18, 2011 flow metering, a water level measurement was taken from the gauge board installed at station 5+200 (Gauge 3). The water level was measured relative to the zero of the gauge and is included on Table 1. Survey information for the gauge was obtained from the Lake St. Martin Emergency Channel Outlet Drawings Issued for Record by AECOM on May 8, 2012. Water level measurements were not taken at any of the gauge boards installed on Reach 1 during the subsequent water level surveys and flow meterings in 2012 as the gauges were damaged due to the formation of border ice along Reach 1.

In addition to surveyed water levels discussed above, Water Survey of Canada maintains a continuous water level recorder on Lake St. Martin near Hilbre at gauge no. 05LM005. These levels were included with the rest of the water level measurements discussed above to extend the Reach 1 water surface profiles to Lake St. Martin.

## 3.0 CABLEWAY INSTALLATION

A cableway system was installed at approximately station 2+000 for the purpose of safely operating an ADCP on a straight line to obtain measurements of flow in the Reach 1 Emergency Channel during its operation. The cableway setup took place between March 12 and 21, 2012.

Photos illustrating the installation of the cableway are included in Appendix B. A drawing showing the as-built configuration of the cableway and the materials utilized is also included in Appendix B.

The cableway installation began on March 12 with Maple Leaf Drilling providing drilling services under the direction of KGS Group. The cableway configuration included a steel post, tie-back anchor, pulley platform and pulley installed on both sides of Reach 1, as well as a hand operated winch on the East bank. Maple Leaf drilled two holes on both the East and West banks of the Reach 1 Emergency Channel. A 9” diameter vertical hole was drilled to install a 4” diameter X16 ft long galvanized pipe to support the cableway pulley system. A second 9” diameter hole was drilled at a 45 degree angle to approximately 5 ft depth, and an 8’ groundhog anchor with a “screw” end was installed to give additional support to the 4” diameter pipe when the cable is strung and tensioned. Both holes for the 4” diameter pipe and ground hog anchor were filled with readycrete. Each groundhog anchor was attached to its corresponding post with the use of a tensioned steel cable and a turnbuckle for future adjustment (see Photos in Appendix B). The turnbuckle connects to a pulley platform with a D-ring. The pulley platform is connected to the galvanized post with U-bolts. The pulley platform is comprised of a steel tee welded to a steel plate. The steel tee connects the anchor cable and the turnbuckle with the post, while the steel plate support carries the bolted-on pulley.

On March 21, after the readycrete had cured, the cable and pulley system was installed to allow for flow monitoring. During installation of the 4” diameter pipe on the East bank, the bottom 3 ft of the drill hole was not vertical and would have affected the vertical alignment of the pipe if it was installed to full depth. Therefore, the pipe was raised 3 ft so the pipe could be set vertically. Before installation of the pulley system the pipe was cut down the 3 ft it had been raised during initial installation. During the initial installation, a tag line (fishing line) was launched over the channel from East bank to West bank. Bailer twine was attached to the fishing line and then the ¼” diameter steel cable attached to the bailer twine. When the steel cable was pulled across another tag line was attached to the steel cable to repeat the steps to get the steel cable around the pulley and back to the East bank. The steel cable was then tensioned to manufacturer specifications using a winch and then connected to the spanmaster travelling block with turnbuckles.

## 4.0 MEASUREMENTS AND RESULTS

### 4.1 DATA PROCESSING AND REVIEW

Post processing and quality review of the data with the ADCP was done according to the WSC Procedure for the Review and Approval of ADCP Discharge Measurement [Ref 3]. The quality review of the collected data included, but was not limited to, a detailed review of each transect and of the combination of the valid transects.

Individual quality control and review of each transect recorded with the ADCP consisted of the independent check of the following components:

- Bottom track and ship track
- Ambiguity velocities
- Ratio of bad vertical profiles
- Ratio of lost vertical profiles
- Bad bins

- Top and bottom discharge estimates
- Shore discharge estimates
- Ratio of measured discharge relative to the total discharge
- Extrapolation techniques

The final unadjusted discharge measurement was calculated as an average of a minimum of four transects constituted of two reciprocal pairs. The overall quality of the measurement was reviewed by combining the valid transects (corrected if necessary) together.

During a metering, it is possible for the site to exhibit signs of a moving riverbed. This phenomenon generates a systematic bias in discharge measurements made with an ADCP that is attributed to the movement of sediment near the streambed. This leads to an underestimation of the measured velocity and discharge.

Standard WSC and USGS procedures to test for a moving bed (loop test) were applied during the metering. Results from the loop test showed that there were no signs of a moving bed at this site for any of the flow measurements.

## 4.2 SUMMARY OF RESULTS

The flows measured during the four meterings were 172 $m^3/s$ (6070 cfs), 158 $m^3/s$ (5580 cfs), 129 $m^3/s$ (4560 cfs) and 115 $m^3/s$ (4060 cfs), respectively. The standard deviation between individual transects for each metering ranged between 0.9% and 1.3%, which are well within the recommended target value of 5%.

Results from the metering are included on Table 1. A summary of the results for each flow measurement are provided in Appendix A, which contains the following information, in order:

- A summary sheet with general site identification details, date, equipment used, and final discharge value. As well, the summary sheet also contains details of the measured discharge values and the final discharge calculation and deviation from the average.
- A computer screen shot of the results obtained from the WinRiver II software, showing typical velocity profile, ship track, and discharge summary.
- A computer screen shot of the loop test from the WinRiver II software.
- Results from the loop test.
- Site photos taken on the measurement day.

During the November 18, 2011 metering, some border ice was present along the shore of the Reach 1 Emergency Channel. Additionally, an ice cover was present on Lake St. Martin and portions of Buffalo Lake Bog. However, ice conditions during the metering did not appear sufficiently advanced to have a significant impact on the capacity of the channel. During the March 21, 2012 metering, some ice was present on Lake St. Martin and in Buffalo Lake Bog. However, the ice cover had significantly decayed due to the spring thaw, and therefore did not have an impact on the capacity of the channel. The results obtained during all meterings were therefore assured to be representative of open water conditions.
A rating curve for Reach 1 is provided in Figure 3, and was developed based on the metering data presented in this report and the WSC water levels on Lake St. Martin. As shown on the Figure, there was a shift in the rating curve between the November 18, 2011 measurement and the March 21, 2012 measurement. This shift was attributed to additional excavation work that occurred at the inlet between January 24, and February 1, 2012 to complete the plug and

"finger" removal towards the barge access channel, which increased the capacity of the channel inlet.

## 5.0 REFERENCES

1. Hydrometric Technician, Career Development Program, Water Survey of Canada, Environment Canada, 1999.

2. Measuring Discharge with Acoustic Doppler Current Profilers from a Moving Boat, Chapter 22 of Book 3, Section A, USGS, 2009.

3. Procedures for the Review and Approval of ADCP Discharge Measurements, Water Survey of Canada, Environment Canada, 2004.

4. Application of the Loop Method for Correcting Acoustic Doppler Current Profiler Discharge Measurements Biased by Sediment Transport, USGS, 2006.

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# TABLES

**TABLE 1**
**LAKE ST. MARTIN EMERGENCY CHANNEL SYSTEM – 2011 TO 2012 SURVEYED WATER LEVELS**

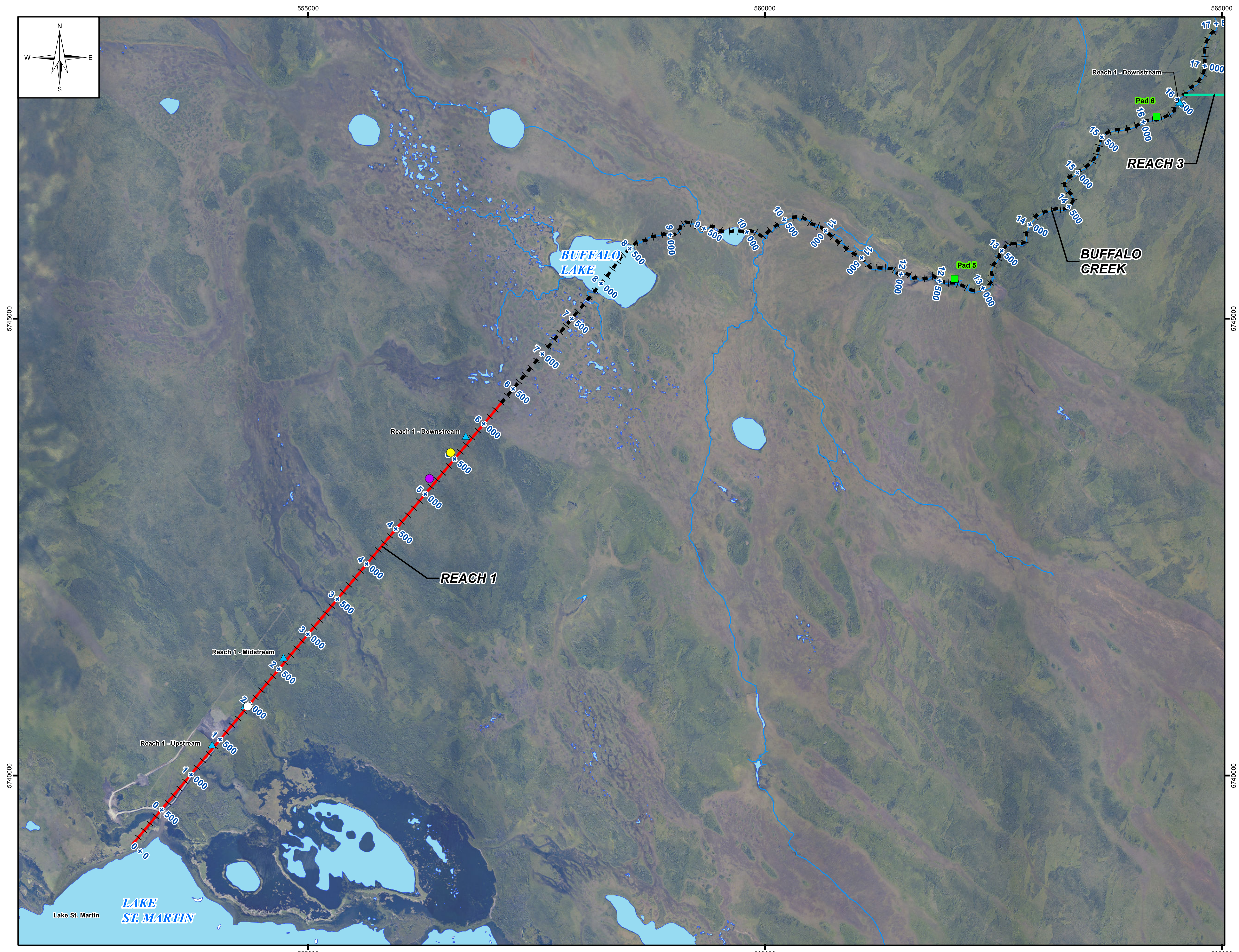
| Station Metric | Point Description | Northing | Easting | November 18, 2011 WSE | February 7, 2012 WSE | February 10, 2012 WSE | February 14, 2012 WSE | February 21, 2012 WSE | February 28, 2012 WSE | March 21, 2012 WSE | April 17, 2012 WSE | August 9, 2012 WSE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N/A | Lake St. Martin Near Hilbre WSC Gauge # 05LM005 | 5706523 | 532695.0 | 244.810 | 244.630 | 244.610 | 244.595 | 244.572 | 244.543 | 244.395 | 244.245 | 244.140 |
| 0+000 | Reach 1 Inlet from Lake St. Martin | 5738450 | 552111.8 | N/R | N/R | N/R | 244.490 | N/R | N/R | N/R | N/R | N/R |
| 1+430 | Reach 1 Upstream | 5740338 | 553947.0 | N/R | N/A | 244.073 | 243.903 | 243.865 | 243.815 | 243.668 | 243.400 | 243.280 |
| 2+000 | Reach 1 Cableway | 5740768 | 554317.7 | N/R | N/R | N/R | N/R | N/R | N/R | N/R | 243.307 | 243.231 |
| 2+670 | Reach 1 Midstream | 5741297 | 554732.1 | N/R | N/R | N/R | 243.563 | 243.579 | 243.541 | 243.365 | 243.130 | 243.070 |
| 5+200 | AECOM Gauge 3 | 5743252 | 556329.3 | 243.052 | N/R | N/R | N/R | N/R | N/R | N/R | N/R | N/R |
| 5+800 | Reach 1 Downstream | 5743731 | 556737.0 | N/R | N/A | 243.181 | 243.016 | 242.909 | 243.002 | 242.635 | 242.530 | 242.520 |
| 16+450 | Buffalo Creek at Reach 3 | 5747371 | 564538.4 | N/R | N/R | 235.643 | 235.484 | 235.338 | 235.436 | N/R | 234.580 | 234.580 |
| | Metered Discharge $m^3/s$ (cfs) | | | 172 (6070 cfs) | N/R | N/R | N/R | N/R | N/R | 158 (5560 cfs) | 129 (4560 cfs) | 115 (4060 cfs) |

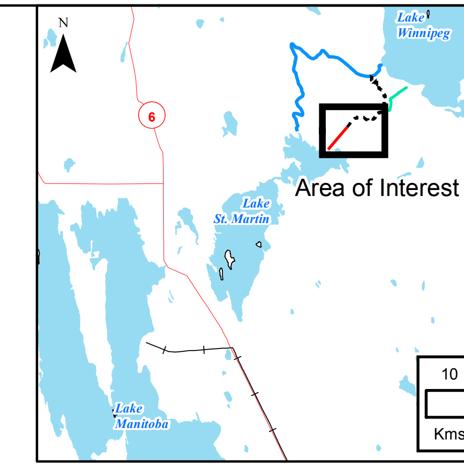
**Notes:** N/A: Not Applicable / Data considered invalid during post processing
N/R: Data was not recorded
WSC: Water Survey of Canada
WSE: Water Surface Elevation (m)

**TABLE 2**
**LAKE ST. MARTIN EMERGENCY CHANNEL SYSTEM – SUMMARY OF BENCHMARKS**

| Station | Benchmark ID | Location Description | Type | Northing (m) | Easting (m) | Elevation (m) |
|---|---|---|---|---|---|---|
| 1+428 | R1_1_TBM1 | Reach 1 Upstream | Rebar | 5740319.795 | 553962.785 | 247.068 |
| 1+431 | R1_1_TBM2 | Reach 1 Upstream | Rebar | 5740304.253 | 553985.531 | 248.109 |
| 2+000 | R1_CWY_TBM1 | Reach 1 Cableway | Rebar | 5740767.598 | 554317.703 | 247.094 |
| 2+670 | R1_2_TBM1 | Reach 1 Midstream | Rebar | 5741289.95 | 554739.82 | 246.384 |
| 2+670 | R1_2_TBM2 | Reach 1 Midstream | Rebar | 5741264.56 | 554771.178 | 247.726 |
| 5+816 | R1_3_TBM1 | Reach 1 Downstream | Rebar | 5743710.771 | 556748.337 | 243.409 |
| 16+453 | R3_1_TBM1 | Buffalo Creek at Reach 3 | Nail | 5747351.594 | 564547.786 | 236.393 |
| 16+446 | R3_1_TBM2 | Buffalo Creek at Reach 3 | Nail | 5747342.955 | 564556.59 | 236.621 |
| 16+538 | R3_1_TBM3 | Buffalo Creek at Reach 3 | Nail | 5747373.237 | 564583.161 | 237.765 |

# FIGURES




LEGEND:

- Water Levels
- AECOM Gauge 3
- Nov 18, 2011 Flow Metering Location
- Cableway – 2012 Flow Mertering Location
- Constructed Helicopter Landing Pad
- Buffalo Creek Channel
- Reach 1 Emergency Channel
- Reach 3 Emergency Channel
- Watercourse
- Waterbody
- Island

NOTES:

1. Aerial Imagery: July 2011.

500 0 500 1,000 1,500

Metres

SCALE: 1:40,000 METRIC 11"x17"

All units are metric and in metres unless otherwise specified.
Transverse Mercator Projection, NAD 1983, Zone 14
Elevations are in metres above sea level (MSL)

| NO. | YY/MM/DD | DESCRIPTION | BY |
|---|---|---|---|
| 0 | 14/03/05 | ISSUED WITH FLOW METERING REPORT | PAL |

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba INFRASTRUCTURE AND TRANSPORTATION

EMERGENCY REDUCTION OF LAKE MANITOBA & LAKE ST. MARTIN WATER LEVELS

FLOW METERING AND WATER LEVEL MONITORING LOCATIONS

MARCH 2014 | FIGURE 1 | REV: 0

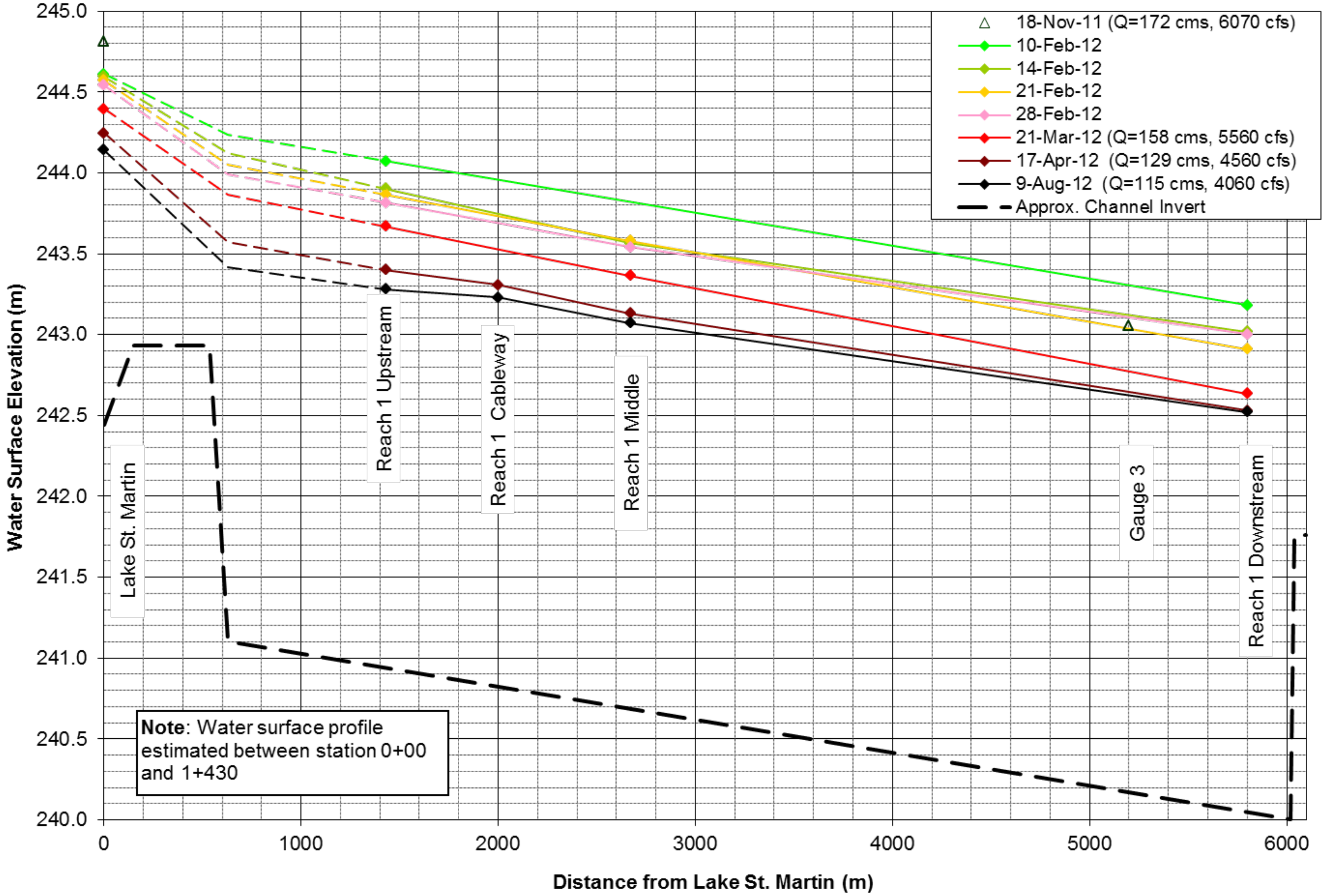



**Figure 2 - Reach 1 Water Surface Profiles**

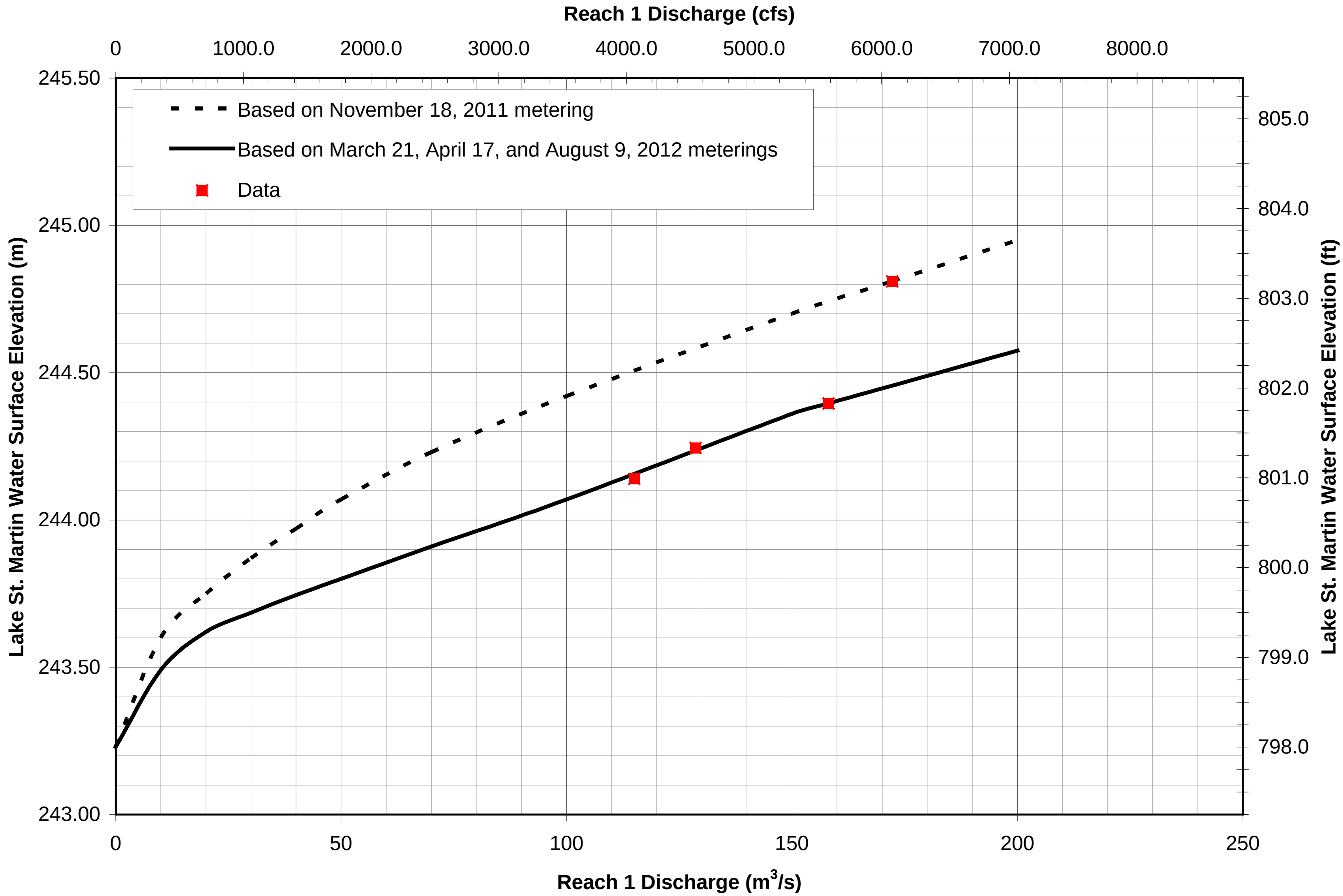



**Figure 3 - Estimated Reach 1 Rating Curve**

# APPENDICES

# APPENDIX A

# FLOW METERING RESULTS

| | |
|---|---|
| **Station:** | **5+500** |
| **Description:** | **Lake St-Martin Emergency Channel System Reach 1** |
| **Date:** | **November 18, 2011** |
| **Time:** | **12:00 PM to 1:00 PM** |

KGS GROUP
CONSULTING ENGINEERS

| | |
|---|---|
| **Client:** | **MIT** |
| **File No:** | **11-0300-18 - 1000.4** |
| **Project:** | **Emergency Reduction of LMB and LSM Water Levels - Flow Metering** |
| **Sheet:** | **1 of 1** |
| **Date:** | **21-Nov-11** **By:** **PAL** |
| **Checked:** | **22-Nov-11** **By:** **APP** |

**Measurement**

| | |
|---|---|
| Info: | Lake St-Martin Emergency Channel System Reach 1 |
| Date: | 18-Nov-11 |
| Time: | 12:00:00 PM to 13:00:00 PM |
| Station | 5+500 |

**Crew** Patrice Leclercq
Ambroise Percheron

**Discharge Summary for Flow in Channel**

Equipment: ADCP - RDI River Ray 600 with Hemisphere A100 DGPS
Metering Location: Station 5+500

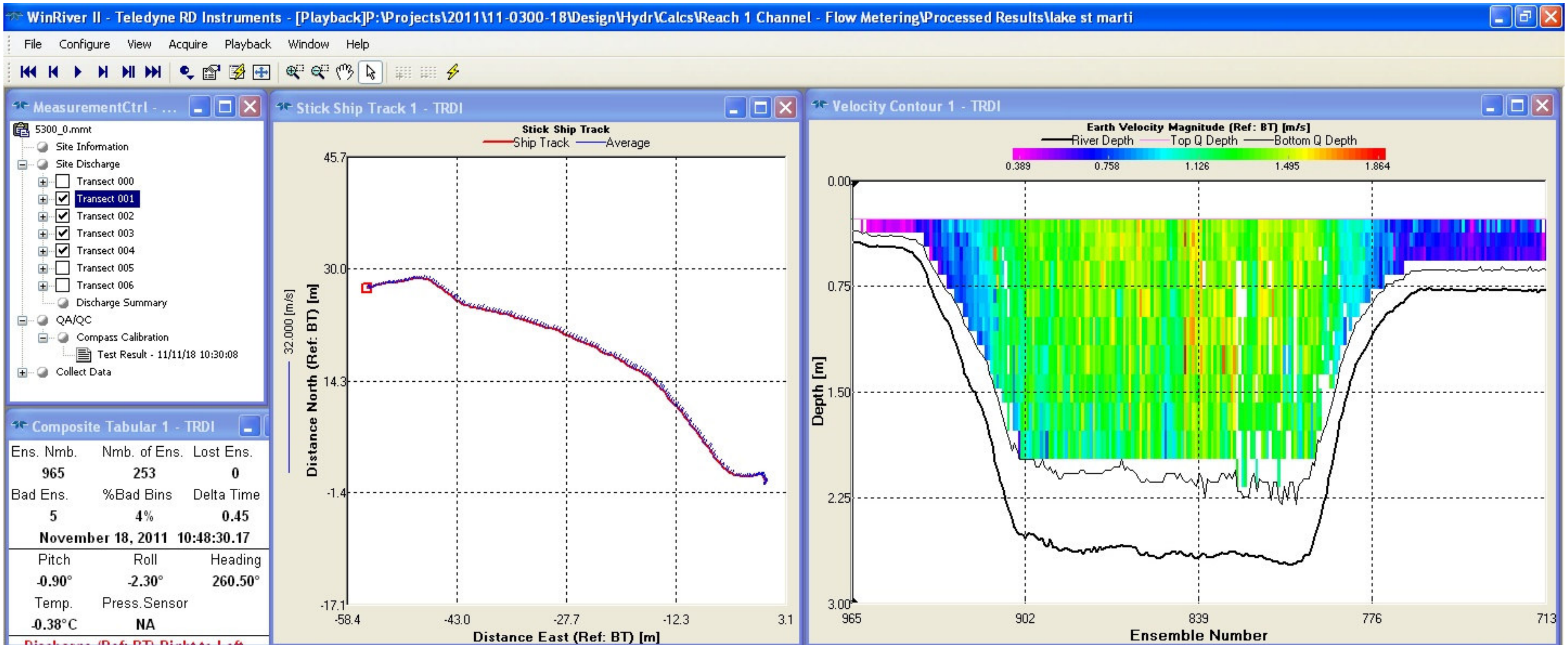
| Transect | Start Bank | Total Q ($m^3/s$) | Delta Q % | Corrected Q for Bed Movement ($m^3/s$) |
|---|---|---|---|---|
| 001 | Right | 175.1 | 1.7 | - |
| 002 | Left | 171.9 | -0.2 | - |
| 003 | Right | 172.2 | 0.0 | - |
| 004 | Left | 169.7 | -1.5 | - |

| | | |
|---|---|---|
| Average ($m^3/s$): | 172.2 | - |
| St. Dev. ($m^3/s$): | 2.2 | - |
| St. Dev. / avg: | 0.013 | - |

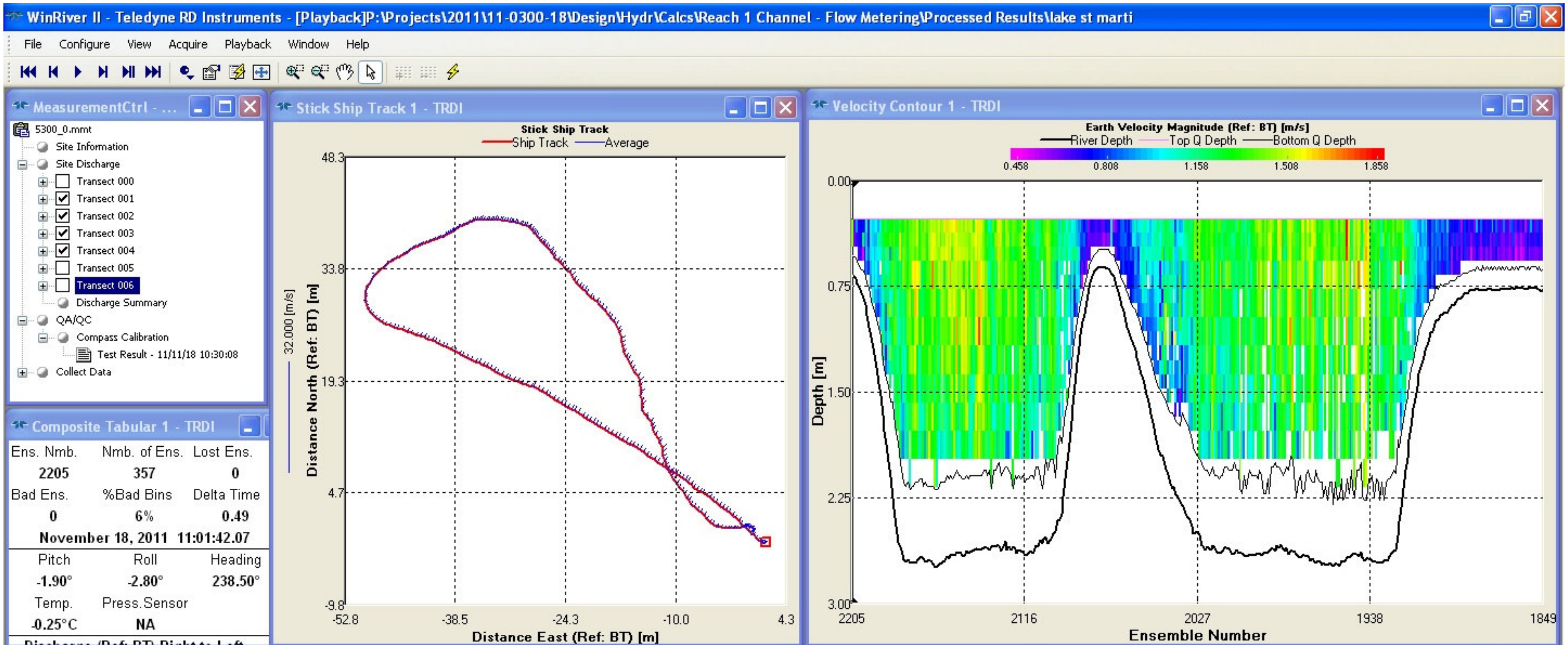
Gauge: 0.25 m

Notes: Gauge board located approximately 300m U/S (AECOM Gauge 3)
Some border ice along banks
No bed movement observed

**Final Discharge:** 172 $m^3/s$
6080 $ft^3/s$




| Transect | Start Bank | # Ens. | Start Time | Total Q $m^3/s$ | Delta Q % | Top Q $m^3/s$ | Meas. Q $m^3/s$ | Bottom Q $m^3/s$ | Left Q $m^3/s$ | Left Dist. m | Right Q $m^3/s$ | Right Dist. m | Width m | Total Area $m^2$ | Q/Area m/s | Boat Speed m/s | Flow Speed m/s | Flow Dir ° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5300001 | Right | 253 | 10:45:46 | 175.060 | 1.65 | 22.493 | 116.245 | 35.813 | 0.071 | 1.00 | 0.438 | 2.50 | 65.23 | 145.57 | 1.203 | 0.417 | 1.166 | 31.27 |
| 5300002 | Left | 233 | 10:48:39 | 171.938 | -0.16 | 22.069 | 114.544 | 34.853 | 0.074 | 1.00 | 0.398 | 2.50 | 65.20 | 145.25 | 1.184 | 0.447 | 1.212 | 29.06 |
| 5300003 | Right | 240 | 10:51:18 | 172.176 | -0.03 | 22.049 | 112.375 | 37.222 | 0.081 | 1.00 | 0.449 | 2.50 | 64.05 | 144.97 | 1.188 | 0.464 | 1.145 | 31.00 |
| 5300004 | Left | 246 | 10:54:02 | 169.714 | -1.46 | 21.657 | 108.843 | 38.654 | 0.140 | 1.00 | 0.420 | 2.50 | 63.69 | 144.10 | 1.178 | 0.430 | 1.160 | 29.03 |
| Average | | 243 | | 172.222 | -0.00 | 22.067 | 113.002 | 36.636 | 0.092 | 1.00 | 0.426 | 2.50 | 64.54 | 144.97 | 1.188 | 0.440 | 1.171 | |
| Std Dev. | | 9 | | 2.193 | 1.27 | 0.341 | 3.193 | 1.660 | 0.033 | 0.00 | 0.022 | 0.00 | 0.79 | 0.63 | 0.011 | 0.020 | 0.029 | |
| Std./\|Avg.\| | | 0.04 | | 0.01 | 0.00 | 0.02 | 0.03 | 0.05 | 0.36 | 0.00 | 0.05 | 0.00 | 0.01 | 0.00 | 0.01 | 0.05 | 0.02 | |




**Discharge Summary - TRDI**

| Transect | Start Bank | # Ens. | Start Time | Total Q m³/s | Delta Q % | Top Q m³/s | Meas. Q m³/s | Bottom Q m³/s | Left Q m³/s | Left Dist. m | Right Q m³/s | Right Dist. m | Width m | Total Area m² | Q/Area m/s | Boat Speed m/s | Flow Speed m/s | Flow Dir ° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5300001 | Right | 253 | 10:45:46 | 175.060 | 1.65 | 22.493 | 116.245 | 35.813 | 0.071 | 1.00 | 0.438 | 2.50 | 65.23 | 145.57 | 1.203 | 0.417 | 1.166 | 31.27 |
| 5300002 | Left | 233 | 10:48:39 | 171.938 | -0.16 | 22.069 | 114.544 | 34.853 | 0.074 | 1.00 | 0.398 | 2.50 | 65.20 | 145.25 | 1.184 | 0.447 | 1.212 | 29.06 |
| 5300003 | Right | 240 | 10:51:18 | 172.176 | -0.03 | 22.049 | 112.375 | 37.222 | 0.081 | 1.00 | 0.449 | 2.50 | 64.05 | 144.97 | 1.188 | 0.464 | 1.145 | 31.00 |
| 5300004 | Left | 246 | 10:54:02 | 169.714 | -1.46 | 21.657 | 108.843 | 38.654 | 0.140 | 1.00 | 0.420 | 2.50 | 63.69 | 144.10 | 1.178 | 0.430 | 1.160 | 29.03 |
| Average | | 243 | | 172.222 | -0.00 | 22.067 | 113.002 | 36.636 | 0.092 | 1.00 | 0.426 | 2.50 | 64.54 | 144.97 | 1.188 | 0.440 | 1.171 | |
| Std Dev. | | 9 | | 2.193 | 1.27 | 0.341 | 3.193 | 1.660 | 0.033 | 0.00 | 0.022 | 0.00 | 0.79 | 0.63 | 0.011 | 0.020 | 0.029 | |
| Std./\| Avg.\| | | 0.04 | | 0.01 | 0.00 | 0.02 | 0.03 | 0.05 | 0.36 | 0.00 | 0.05 | 0.00 | 0.01 | 0.00 | 0.01 | 0.05 | 0.02 | |

LC Version 3.20, July 8, 2010

Processed on: 21-Nov-2011

Loop File: 5300_0_006_11-11-18_ASC.TXT

| Distance Made Good (m) | Loop Time (sec) | Moving Bed Velocity (m/s) | Moving Bed Direction (degrees) | Flow Direction (degrees) | Estimated Percent Correction (percent) |
|---|---|---|---|---|---|
| 2.32 | 236.43 | 0.01 | 133.60 | 30.70 | 0.94 |

Percent Bad Bottom Track: 0.0

Difference in flow direction between out and back sections: 1.7 deg

*********************************************************************

Loop Closure Error not in Upstream Direction -- No Correction Recommended

*********************************************************************

# Photo Summary – November 18, 2011

**Photo 1**
**Reach 1 Emergency Channel Looking Downstream of Metering Location**

**Photo 2**
**Reach 1 Emergency Channel Looking Upstream of Metering Location**

# Photo Summary – November 18, 2011


**Photo 3**
**Reach 1 Emergency Channel Inlet**

**Photo 4**
**Reach 1 Emergency Channel Outlet**

# Photo Summary – November 18, 2011


**Photo 5**
**AECOM 3 Gauge**

| | |
|---|---|
| **Station:** | **2+000** |
| **Description:** | **Lake St-Martin Emergency Channel System Reach 1** |
| **Date:** | **March 21, 2012** |
| **Time:** | **3:30 PM to 4:30 PM** |

KGS GROUP CONSULTING ENGINEERS

| | |
|---|---|
| Client: | MIT |
| File No: | 11-0300-18 - 1000.4 |
| Project: | Emergency Reduction of LMB and LSM Water Levels - Flow Metering |
| Sheet: | 1 of 1 |
| Date: | 22-Mar-12 By: PAL |
| Checked: | 6-Jun-12 By: DPH |

**Measurement**

Info: Lake St-Martin Emergency Channel System Reach 1
Date: 21-Mar-12
Time: 3:30 PM to 4:30 PM
Station 2+000

**Crew** Patrice Leclercq
Ambroise Percheron

**Discharge Summary for Flow in Channel**

Equipment: ADCP - RDI River Ray 600 with Hemisphere A100 DGPS
Metering Location: Measurement taken at cableway location

| Transect | Start Bank | Total Q ($m^3/s$) | Delta Q % | Corrected Q for Bed Movement ($m^3/s$) |
|---|---|---|---|---|
| 002 | Right | 160.0 | 1.2 | - |
| 005 | Left | 156.2 | -1.2 | - |
| 006 | Right | 158.4 | 0.2 | - |
| 007 | Left | 157.7 | -0.2 | - |

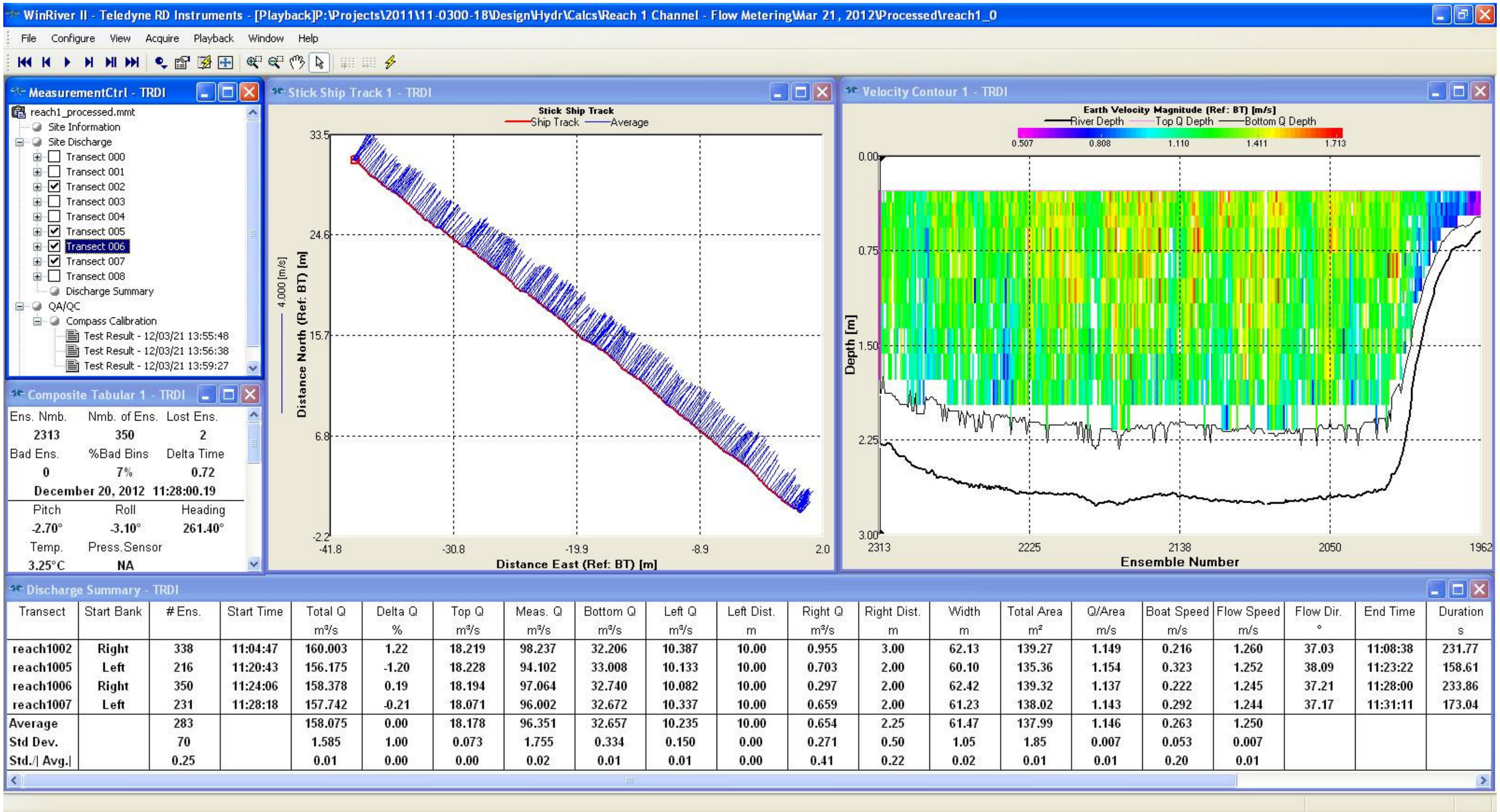
| | | |
|---|---|---|
| Average ($m^3/s$): | 158.1 | - |
| St. Dev. ($m^3/s$): | 1.6 | - |
| St. Dev. / avg: | 0.010 | - |

Gauge: n/a

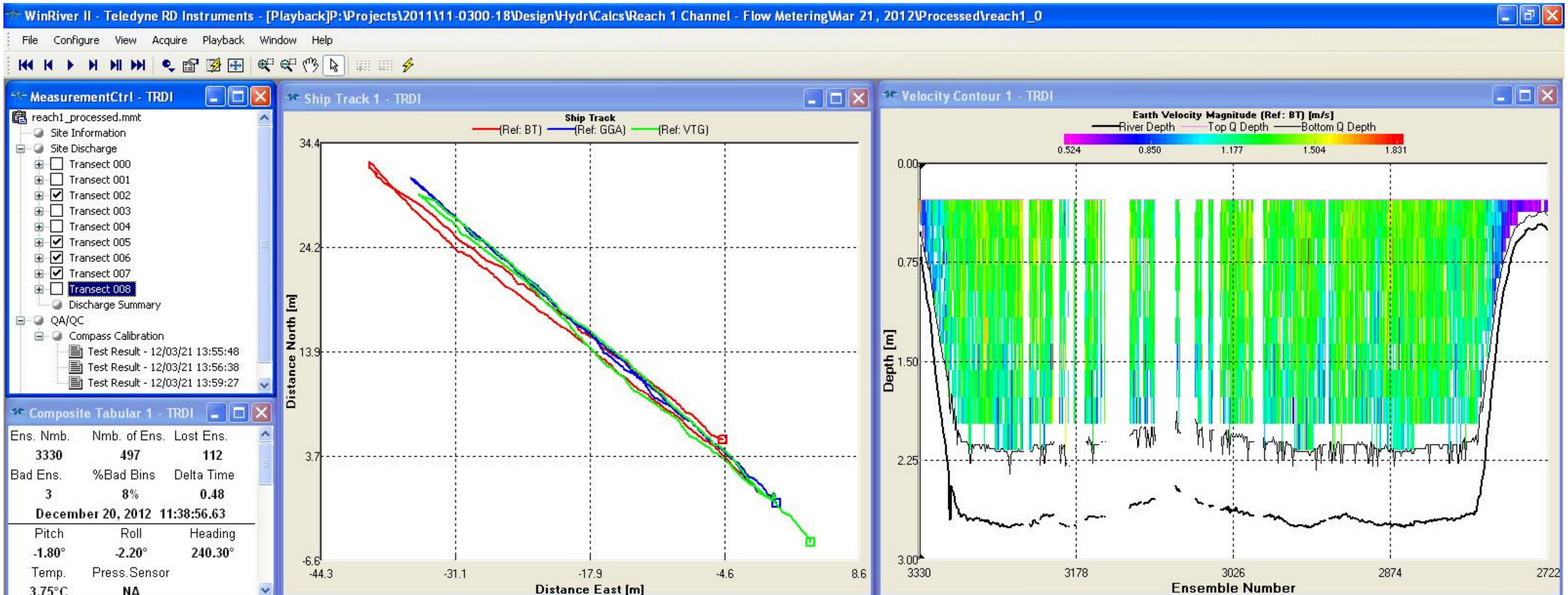
Notes: No bed movement observed

Gauge Boards Damaged

**Final Discharge:** 158 $m^3/s$
5,580 $ft^3/s$




| Transect | Start Bank | # Ens. | Start Time | Total Q m³/s | Delta Q % | Top Q m³/s | Meas. Q m³/s | Bottom Q m³/s | Left Q m³/s | Left Dist. m | Right Q m³/s | Right Dist. m | Width m | Total Area m² | Q/Area m/s | Boat Speed m/s | Flow Speed m/s | Flow Dir. ° | End Time | Duration s |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| reach1002 | Right | 338 | 11:04:47 | 160.003 | 1.22 | 18.219 | 98.237 | 32.206 | 10.387 | 10.00 | 0.955 | 3.00 | 62.13 | 139.27 | 1.149 | 0.216 | 1.260 | 37.03 | 11:08:38 | 231.77 |
| reach1005 | Left | 216 | 11:20:43 | 156.175 | -1.20 | 18.228 | 94.102 | 33.008 | 10.133 | 10.00 | 0.703 | 2.00 | 60.10 | 135.36 | 1.154 | 0.323 | 1.252 | 38.09 | 11:23:22 | 158.61 |
| reach1006 | Right | 350 | 11:24:06 | 158.378 | 0.19 | 18.194 | 97.064 | 32.740 | 10.082 | 10.00 | 0.297 | 2.00 | 62.42 | 139.32 | 1.137 | 0.222 | 1.245 | 37.21 | 11:28:00 | 233.86 |
| reach1007 | Left | 231 | 11:28:18 | 157.742 | -0.21 | 18.071 | 96.002 | 32.672 | 10.337 | 10.00 | 0.659 | 2.00 | 61.23 | 138.02 | 1.143 | 0.292 | 1.244 | 37.17 | 11:31:11 | 173.04 |
| Average | | 283 | | 158.075 | 0.00 | 18.178 | 96.351 | 32.657 | 10.235 | 10.00 | 0.654 | 2.25 | 61.47 | 137.99 | 1.146 | 0.263 | 1.250 | | | |
| Std Dev. | | 70 | | 1.585 | 1.00 | 0.073 | 1.755 | 0.334 | 0.150 | 0.00 | 0.271 | 0.50 | 1.05 | 1.85 | 0.007 | 0.053 | 0.007 | | | |
| Std./\|Avg.\| | | 0.25 | | 0.01 | 0.00 | 0.00 | 0.02 | 0.01 | 0.01 | 0.00 | 0.41 | 0.22 | 0.02 | 0.01 | 0.01 | 0.20 | 0.01 | | | |




Discharge Summary - TRDI

| Transect | Start Bank | # Ens. | Start Time | Total Q m³/s | Delta Q % | Top Q m³/s | Meas. Q m³/s | Bottom Q m³/s | Left Q m³/s | Left Dist. m | Right Q m³/s | Right Dist. m | Width m | Total Area m² | Q/Area m/s | Boat Speed m/s | Flow Speed m/s | Flow Dir. ° | End Time | Duration s |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| reach1002 | Right | 338 | 11:04:47 | 160.003 | 1.22 | 18.219 | 98.237 | 32.206 | 10.387 | 10.00 | 0.955 | 3.00 | 62.13 | 139.27 | 1.149 | 0.216 | 1.260 | 37.03 | 11:08:38 | 231.77 |
| reach1005 | Left | 216 | 11:20:43 | 156.175 | -1.20 | 18.228 | 94.102 | 33.008 | 10.133 | 10.00 | 0.703 | 2.00 | 60.10 | 135.36 | 1.154 | 0.323 | 1.252 | 38.09 | 11:23:22 | 158.61 |
| reach1006 | Right | 350 | 11:24:06 | 158.378 | 0.19 | 18.194 | 97.064 | 32.740 | 10.082 | 10.00 | 0.297 | 2.00 | 62.42 | 139.32 | 1.137 | 0.222 | 1.245 | 37.21 | 11:28:00 | 233.86 |
| reach1007 | Left | 231 | 11:28:18 | 157.742 | -0.21 | 18.071 | 96.002 | 32.672 | 10.337 | 10.00 | 0.659 | 2.00 | 61.23 | 138.02 | 1.143 | 0.292 | 1.244 | 37.17 | 11:31:11 | 173.04 |
| Average | | 283 | | 158.075 | 0.00 | 18.178 | 96.351 | 32.657 | 10.235 | 10.00 | 0.654 | 2.25 | 61.47 | 137.99 | 1.146 | 0.263 | 1.250 | | | |
| Std Dev. | | 70 | | 1.585 | 1.00 | 0.073 | 1.755 | 0.334 | 0.150 | 0.00 | 0.271 | 0.50 | 1.05 | 1.85 | 0.007 | 0.053 | 0.007 | | | |
| Std./\| Avg.\| | | 0.25 | | 0.01 | 0.00 | 0.00 | 0.02 | 0.01 | 0.01 | 0.00 | 0.41 | 0.22 | 0.02 | 0.01 | 0.01 | 0.20 | 0.01 | | | |

LC Version 3.20, July 8, 2010

Processed on: 06-Jun-2012

Loop File: reach1_0_008_12-03-21_ASC.TXT

| Distance Made Good (m) | Loop Time (sec) | Moving Bed Velocity (m/s) | Moving Bed Direction (degrees) | Flow Direction (degrees) | Estimated Percent Correction (percent) |
|---|---|---|---|---|---|
| 7.15 | 402.75 | 0.02 | 317.49 | 36.83 | 1.71 |

Percent Bad Bottom Track: 18.4

WARNING: Percentage of bad bottom track values exceeds 5.
Loop may not be accurate. Please review data.

Difference in flow direction between out and back sections: 0.7 deg

**********************************************************************

Loop Closure Error not in Upstream Direction -- No Correction Recommended

**********************************************************************

# Photo Summary – March 21, 2012

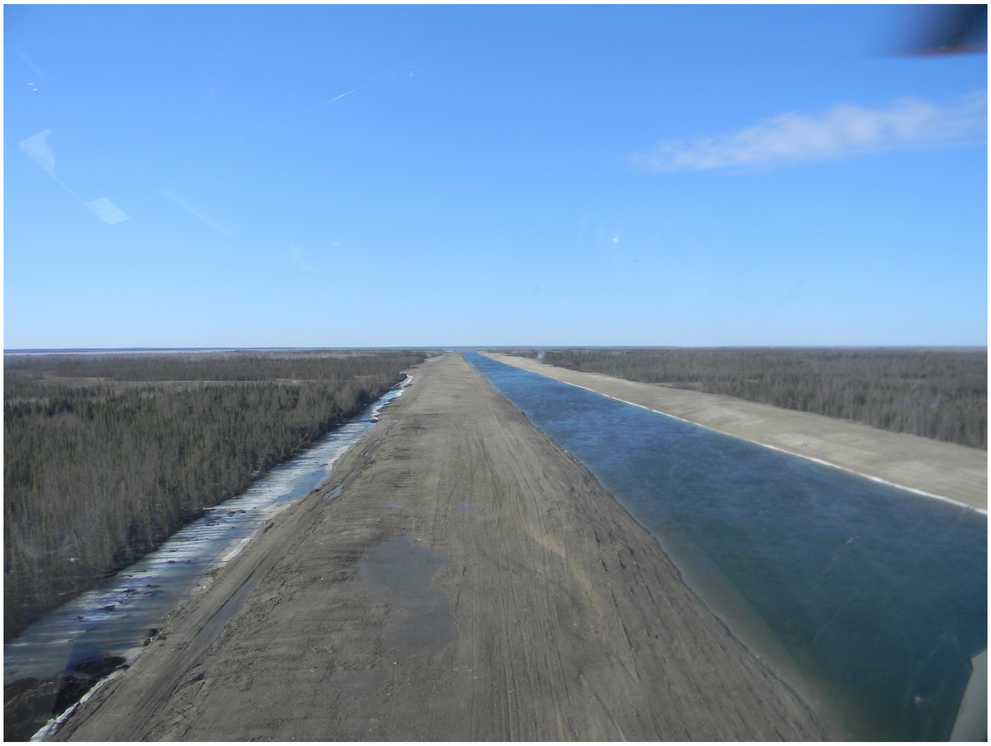


**Photo 1**
**Reach 1 Emergency Channel Looking Upstream**

**Photo 2**
**Reach 1 Emergency Channel Looking Downstream**

## Photo Summary – March 21, 2012

**Photo 3**
**Reach 1 Emergency Channel Inlet**

**Photo 4**
**Reach 1 Emergency Channel Outlet**

| | |
|---|---|
| **Station:** | **2+000** |
| **Description:** | **Lake St-Martin Emergency Channel System** |
| | **Reach 1** |
| **Date:** | **April 17, 2012** |
| **Time:** | **1:00 PM to 1:30 PM** |

KGS GROUP
CONSULTING ENGINEERS

| | |
|---|---|
| **Client:** | **MIT** |
| **File No:** | **11-0300-18 - 1000.4** |
| **Project:** | **Emergency Reduction of LMB and LSM Water Levels - Flow Metering** |
| **Sheet:** | **1 of 1** |
| **Date:** | **6-Jun-12** By: **DPH** |
| **Checked:** | **7-Jun-12** By: **PAL** |

**Measurement**

Info: Lake St-Martin Emergency Channel System Reach 1
Date: 17-Apr-12
Time: 1:00 PM to 1:30 PM
Station 2+000

**Crew** Patrice Leclercq
Ambroise Percheron

**Discharge Summary for Flow in Channel**

Equipment: ADCP - RDI River Ray 600
Metering Location: Measurement taken at cableway location

| Transect | Start Bank | Total Q ($m^3/s$) | Delta Q % | Corrected Q for Bed Movement ($m^3/s$) |
|---|---|---|---|---|
| 001 | Right | 128.9 | 0.2 | - |
| 002 | Left | 128.3 | -0.3 | - |
| 003 | Right | 127.3 | -1.0 | - |
| 004 | Left | 129.9 | 1.0 | - |

| | | |
|---|---|---|
| Average ($m^3/s$): | 128.6 | - |
| St. Dev. ($m^3/s$): | 1.1 | - |
| St. Dev. / avg: | 0.009 | - |

Gauge: n/a

Notes: No bed movement observed

Gauge Boards Damaged

**Final Discharge:** 129 $m^3/s$
4,540 $ft^3/s$

WinRiver II - Teledyne RD Instruments - [Playback]P:\Projects\2011\11-0300-18\Design\Hydr\Calcs\Reach 1 Channel - Flow Metering\Apr 17, 2012\reach1\Reach 1_2\R

File Configure View Acquire Playback Window Help

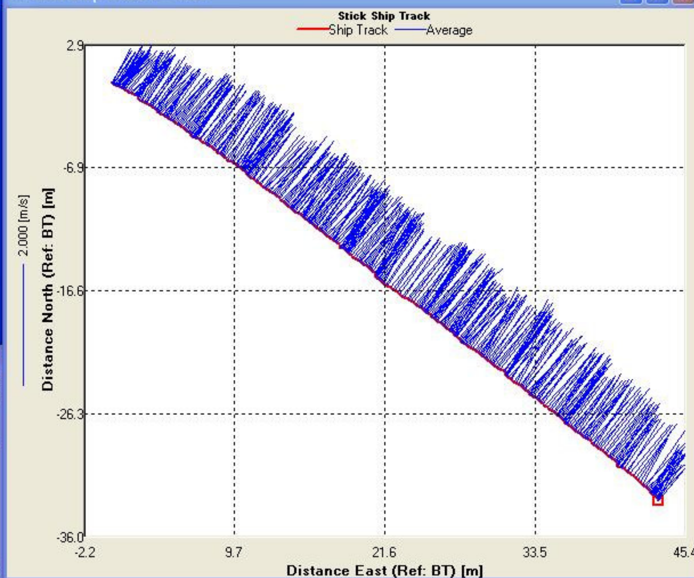
**MeasurementCtrl - TRDI**

- Reach 1_2.mmt
  - Site Information
  - Site Discharge
    - Transcect 000
    - Transect 001
    - Transect 002
    - Transect 003
    - Transect 004
    - Discharge Summary
  - QA/QC
    - Compass Calibration
  - Collect Data

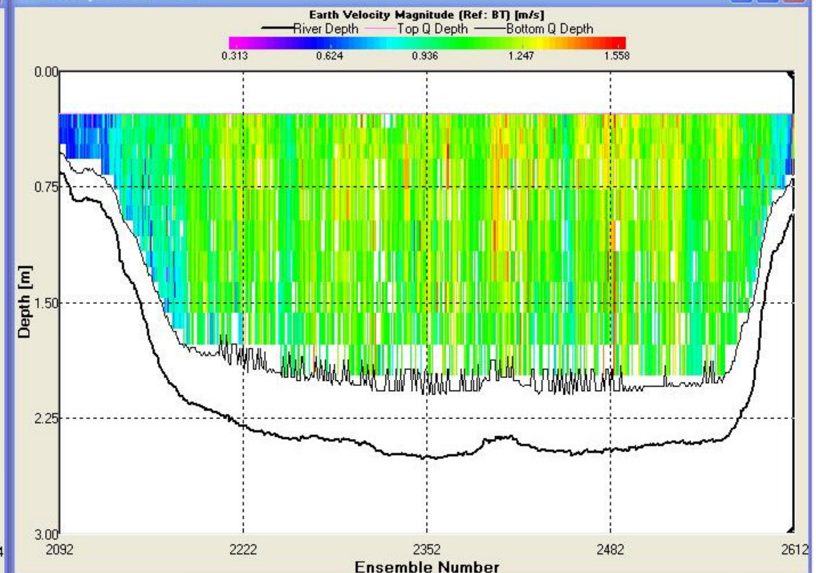
**Composite Tabular 1 - TRDI**

| Ens. Nmb. | Nmb. of Ens. | Lost Ens. |
|---|---|---|
| 2612 | 521 | 0 |
| Bad Ens. | %Bad Bins | Delta Time |
| 0 | 8% | 0.65 |
| February 08, 2013 05:47:32.69 | | |
| Pitch | Roll | Heading |
| -1.40° | -2.00° | 262.10° |
| Temp. | Press.Sensor | |
| 2.88°C | NA | |

**Stick Ship Track 1 - TRDI**

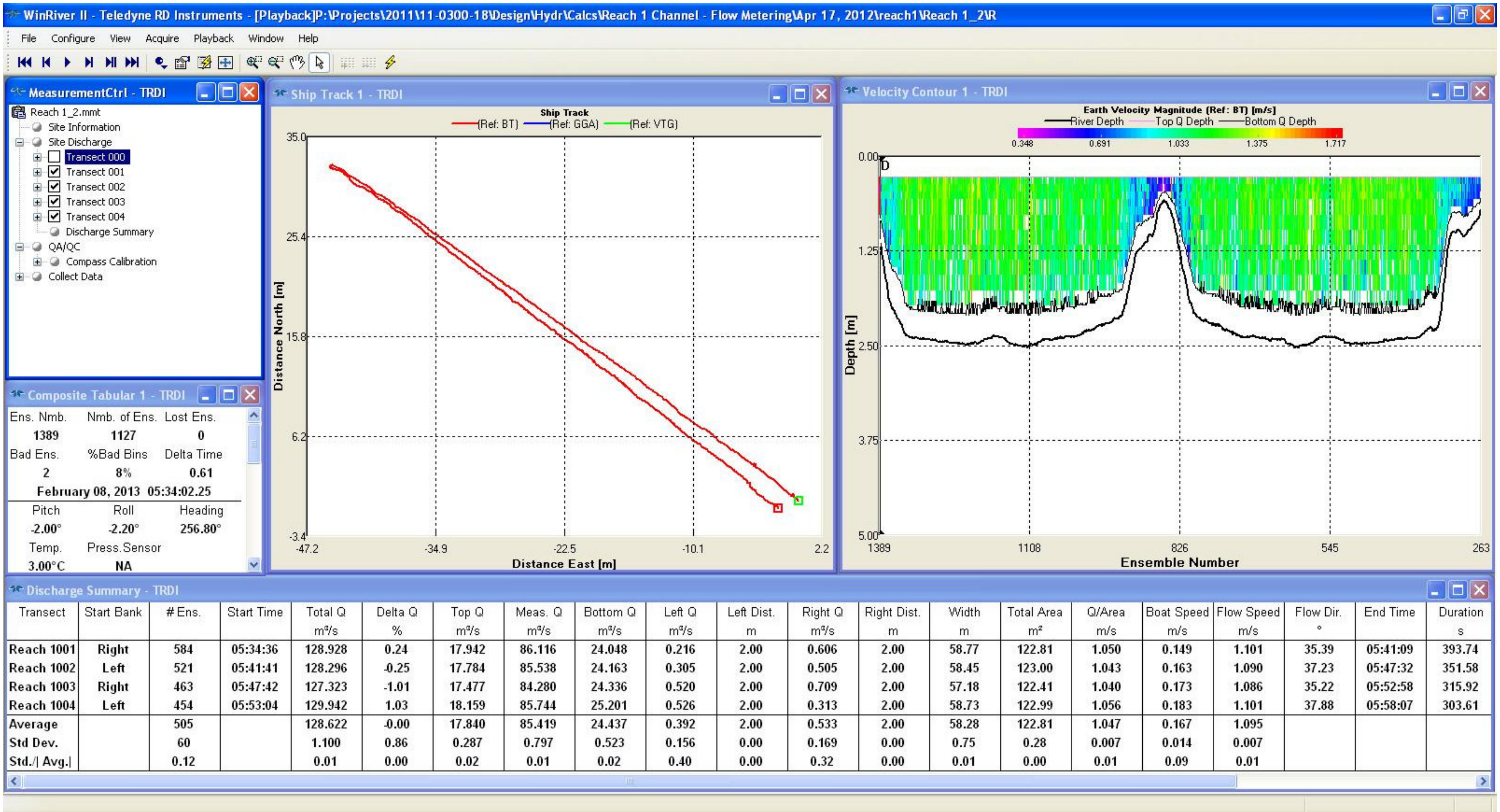



**Velocity Contour 1 - TRDI**




**Discharge Summary - TRDI**

| Transect | Start Bank | # Ens. | Start Time | Total Q m³/s | Delta Q % | Top Q m³/s | Meas. Q m³/s | Bottom Q m³/s | Left Q m³/s | Left Dist. m | Right Q m³/s | Right Dist. m | Width m | Total Area m² | Q/Area m/s | Boat Speed m/s | Flow Speed m/s | Flow Dir. ° | End Time | Duration s |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reach 1001 | Right | 584 | 05:34:36 | 128.928 | 0.24 | 17.942 | 86.116 | 24.048 | 0.216 | 2.00 | 0.606 | 2.00 | 58.77 | 122.81 | 1.050 | 0.149 | 1.101 | 35.39 | 05:41:09 | 393.74 |
| Reach 1002 | Left | 521 | 05:41:41 | 128.296 | -0.25 | 17.784 | 85.538 | 24.163 | 0.305 | 2.00 | 0.505 | 2.00 | 58.45 | 123.00 | 1.043 | 0.163 | 1.090 | 37.23 | 05:47:32 | 351.58 |
| Reach 1003 | Right | 463 | 05:47:42 | 127.323 | -1.01 | 17.477 | 84.280 | 24.336 | 0.520 | 2.00 | 0.709 | 2.00 | 57.18 | 122.41 | 1.040 | 0.173 | 1.086 | 35.22 | 05:52:58 | 315.92 |
| Reach 1004 | Left | 454 | 05:53:04 | 129.942 | 1.03 | 18.159 | 85.744 | 25.201 | 0.526 | 2.00 | 0.313 | 2.00 | 58.73 | 122.99 | 1.056 | 0.183 | 1.101 | 37.88 | 05:58:07 | 303.61 |
| Average | | 505 | | 128.622 | -0.00 | 17.840 | 85.419 | 24.437 | 0.392 | 2.00 | 0.533 | 2.00 | 58.28 | 122.81 | 1.047 | 0.167 | 1.095 | | | |
| Std Dev. | | 60 | | 1.100 | 0.86 | 0.287 | 0.797 | 0.523 | 0.156 | 0.00 | 0.169 | 0.00 | 0.75 | 0.28 | 0.007 | 0.014 | 0.007 | | | |
| Std./\| Avg.\| | | 0.12 | | 0.01 | 0.00 | 0.02 | 0.01 | 0.02 | 0.40 | 0.00 | 0.32 | 0.00 | 0.01 | 0.00 | 0.01 | 0.09 | 0.01 | | | |




| Transect | Start Bank | # Ens. | Start Time | Total Q m³/s | Delta Q % | Top Q m³/s | Meas. Q m³/s | Bottom Q m³/s | Left Q m³/s | Left Dist. m | Right Q m³/s | Right Dist. m | Width m | Total Area m² | Q/Area m/s | Boat Speed m/s | Flow Speed m/s | Flow Dir. ° | End Time | Duration s |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reach 1001 | Right | 584 | 05:34:36 | 128.928 | 0.24 | 17.942 | 86.116 | 24.048 | 0.216 | 2.00 | 0.606 | 2.00 | 58.77 | 122.81 | 1.050 | 0.149 | 1.101 | 35.39 | 05:41:09 | 393.74 |
| Reach 1002 | Left | 521 | 05:41:41 | 128.296 | -0.25 | 17.784 | 85.538 | 24.163 | 0.305 | 2.00 | 0.505 | 2.00 | 58.45 | 123.00 | 1.043 | 0.163 | 1.090 | 37.23 | 05:47:32 | 351.58 |
| Reach 1003 | Right | 463 | 05:47:42 | 127.323 | -1.01 | 17.477 | 84.280 | 24.336 | 0.520 | 2.00 | 0.709 | 2.00 | 57.18 | 122.41 | 1.040 | 0.173 | 1.086 | 35.22 | 05:52:58 | 315.92 |
| Reach 1004 | Left | 454 | 05:53:04 | 129.942 | 1.03 | 18.159 | 85.744 | 25.201 | 0.526 | 2.00 | 0.313 | 2.00 | 58.73 | 122.99 | 1.056 | 0.183 | 1.101 | 37.88 | 05:58:07 | 303.61 |
| Average | | 505 | | 128.622 | -0.00 | 17.840 | 85.419 | 24.437 | 0.392 | 2.00 | 0.533 | 2.00 | 58.28 | 122.81 | 1.047 | 0.167 | 1.095 | | | |
| Std Dev. | | 60 | | 1.100 | 0.86 | 0.287 | 0.797 | 0.523 | 0.156 | 0.00 | 0.169 | 0.00 | 0.75 | 0.28 | 0.007 | 0.014 | 0.007 | | | |
| Std./\|Avg.\| | | 0.12 | | 0.01 | 0.00 | 0.02 | 0.01 | 0.02 | 0.40 | 0.00 | 0.32 | 0.00 | 0.01 | 0.00 | 0.01 | 0.09 | 0.01 | | | |

LC Version 3.20, July 8, 2010

Processed on:  06-Jun-2012

Loop File: Reach 1_2_000_12-04-17_ASC.TXT

| Distance Made Good (m) | Loop Time (sec) | Moving Bed Velocity (m/s) | Moving Bed Direction (degrees) | Flow Direction (degrees) | Estimated Percent Correction (percent) |
|---|---|---|---|---|---|
| 2.05 | 759.44 | 0.00 | 251.48 | 36.36 | 0.27 |

Percent Bad Bottom Track:  0.0

Difference in flow direction between out and back sections:  1.6 deg

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Moving Bed Vel. (MBV) < Minimum MBV Criteria -- No Correction
Recommended

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# Photo Summary – April 17, 2012


**Photo 1**
**Reach 1 Emergency Channel Looking Upstream of Metering Location**


**Photo 2**
**Reach 1 Emergency Channel Looking Downstream of Metering Location**