

WORK PLAN FOR

**THE IDENTIFICATION OF MEASURES TO MITIGATE
FLOODING AND THE IMPACTS OF FLOODING OF THE
LAKE CHAMPLAIN AND RICHELIEU RIVER**

**Submitted by the
International Lake Champlain and Richelieu River Study Board
to the International Joint Commission**

May 31, 2017

Executive summary

The record setting floods of 2011 in Lake Champlain Vermont/New York U.S. and the Richelieu River in the province of Quebec Canada spurred the U.S. and Canadian governments to work together to identify how flood forecasting, preparedness and mitigation can be improved in the Lake Champlain-Richelieu River (LCRR) basin. In July 2013, the International Joint Commission (IJC) submitted the LCRR Plan of Study (PoS) to the Governments of Canada and the United States. The 2013 PoS outlined the work required in the LCRR basin in order to explore potential floodplain management solutions and to provide a range of structural and non-structural flood prevention and mitigation measures. In 2015, the IJC LCRR Technical Work Group completed some initial tasks identified in the PoS. In 2016 the U.S. and Canadian governments decided to pursue Option B as described in the PoS; this decision led to a reference to the IJC to conduct Option B activities, and for IJC to create the International LCRR Study Board to oversee and conduct studies and work related to Option B. This Work Plan describes how these activities would be done, when and their costs.

LCRR Study Board was created in 2017 and is comprised of an equal number of members from the U.S. and Canada. In addition, a full study governance structure has been developed to include study co-chairs, technical work advisory groups, public outreach and communications groups, study co-managers, and information technology and management support. The Study Board will be responsible for overseeing and managing the study and ensuring that the government mandates are met.

The work outlined in Option B of the 2013 PoS and the associated 2016 governments' references to perform the work include seven objectives:

1. Evaluating the causes and impacts of past floods, especially the event of 2011.
2. Assessing the possibilities offered by the floodplain best management practices.
3. Evaluating possible adaptation strategies to the expected future variability in the water supplies.
4. Developing and making recommendations for implementing, as appropriate, an operational, real-time flood forecasting and flood inundation mapping system for the Lake Champlain-Richelieu River watershed.
5. Conducting an in-depth study of current social and political perception on structural and other mitigation measures to support and confirm the desirability of potential structural mitigation solutions.
6. Performing a quantitative and qualitative assessment of potential flood management and mitigation measures (non-structural and/or moderate structural works) and their impacts on important resources of the system: the wetland and fauna, recreational, domestic, industrial and municipal uses of water, shoreline and floodplain built environment and agriculture.
7. Developing resource response models that include basic indicators for water resources response to water levels fluctuations, with special attention on the data inventory and identification of thresholds. Climatic projections, wind wave and ice models, additional new data for the evolution of watershed physiographic characteristics over time and a complete digital terrain model should also be

produced to allow the planning, evaluation and ranking of potential flood mitigation solutions, using a shared-vision approach.

The study would be 5 years in length and cost approximately \$7 million CD and \$5.5 million US.

The seven major objectives of the study will require a multi-disciplinary and interactive strategy for completing study goals and this approach is emphasized in the work tasks. A unique feature of this study is the important emphasis placed on understanding social, political and economic drivers for flood mitigation and forecasting.

The development of new **hydraulic models** for forecasting LC and RR water levels is an important product proposed in the study. These new models will be 2-dimensional (2D) in nature and will be integrated so they perform in a seamless manner. The option of U.S. using a 3D model is being reviewed by experts. The models will be used to forecast future lake and river water levels, evaluate potential flood management and mitigation measures, and evaluate how varying water levels influence important response indicators. These indicators could include critical aquatic habitat or species, recreational uses, water intake and discharge points, economic values, and social perceptions.

A broad **social, political and economic analysis of flood management** will be pursued in this study. Studies on social, political and economic values – whether actual or perceived – will be conducted so that final options and solutions will receive the broadest public support for implementation. Frequent interactions with various sectors of society and feedback and input from them will be gathered as part of the social, political and economic analysis.

An **analysis of various non-structural and structural flood mitigation measures** will be undertaken in the study. A review will be performed of existing practices, methods and structures, both locally in the LCRR basin as well as elsewhere by consulting the existing literature. In addition, how these various measures would be effective in managing water levels will be tested with the new hydraulic and hydrologic models being developed, so actual LCRR responses can be determined and evaluated.

The study is likely to produce recommendations for the implementation of not one, but a set of mitigation measures.

An **analysis of various non-structural and structural flood mitigation measures** will be undertaken in the study. A review will be performed of existing practices, methods and structures, both locally in the LCRR basin as well as elsewhere by consulting the existing literature. In addition, how these various measures would be effective in managing water levels will be tested with the new hydraulic and hydrologic models being developed, so actual LCRR responses can be determined and evaluated.

The hydraulic and hydrologic models will also be used to evaluate various water management scenarios using the response of important **physical, ecological and societal resource indicators**. These indicators will be identified in the study, computed on the basis of how they would have been impacted or reacted during the 2011 and past floods, and then compared with their response under the different flood mitigation measures considered. This will ensure that the ecological and societal concerns are taken into account when deciding on preferred management options for flooding.

Collectively these activities will lead to **decision support tools** in the LCRR basin with regard to flooding. All important ecological, societal, and hydrologic systems information will be integrated into these tools so managers can make the best determinations of the appropriate actions to take.

This complements the development of **flood forecasting tools and systems** so that the public has the best available information from a scientific and social perspective.

The LCRR study will also rely on strong and on-going communications and an effective public outreach effort. Throughout the entire study, resources will be devoted to sharing the work plans, new information and data, and possible ways to move forward, with a wide range of interested publics.

During the course of the study, the Study Board will produce several reports, products and tools that will be made available for the benefit of basin communities and stakeholders. In 2021, the Board will deliver its final report to the International Joint Commission. In that report a set of recommendations for structural and non-structural flood mitigation measures will be provided and prioritized. Because the Board will have sought and considered stakeholders views on the acceptability and feasibility of the proposed measures, the expectations is that the measures will be viable and stand a better chance of being implemented by governments than previous IJC flood studies that recommended specific courses of action.

DRAFT

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1 Preamble

This Draft International Lake Champlain and Richelieu River (LCRR) Study Work Plan, dated May 31, 2017, is respectfully submitted by the International Lake Champlain and Richelieu River Study Board to the International Joint Commission (IJC) who will in turn submit it to the Canadian and United States governments in response to the September 16 and 22, 2016 References by governments to the IJC.

This report will then undergo public consultations in summer 2017, in Canada and the United States, as well as an Independent Review. Following these revisions, a final Work Plan and communication plan will be provided to the IJC on October 2nd 2017.

2 Acknowledgements

This Work Plan could not have been developed without the assistance of the members of the Study's Analysis and Technical Work Groups (AG and TWGs), the Public Advisory Group (PAG), the Study Managers and other members of the study. These individuals, appointed by the Study Board or the IJC, are listed in *Annex 1*.

The members of the Study Board were appointed by the IJC to provide the expertise needed to orient and direct this study. Although they are employed by government agencies in both countries, they serve the IJC in their personal and professional capacities and not as representatives of their agencies. The proposals presented in this Work Plan were developed by the members of the advisory, analysis and technical working groups and should not be considered as official opinions, positions, or commitments of any organizations, agencies or departments named in this report.

3 Introduction to the International Lake Champlain Richelieu River Study

3.1 Flooding of 2011

The Lake Champlain and Richelieu River basin (LCRR) experienced historically high flood levels in late April and May of 2011. Lake Champlain was above the National Weather Service flood stage of 100 ft. for a 68-day period that spanned from April 13 to June 19, 2011 (Kiah and others, 2013, <http://pubs.usgs.gov/of/2013/1135/>).

Flood damages incurred as a result of the 2011 flood events had a severe impact on area residents (table 3.1), commercial enterprises, and policymakers at all levels within the affected region. Throughout the entire LCRR region, about 4,000 homes were damaged, about \$90M (in 2011 US and Canadian currency) in damages incurred and more than 30 municipalities were directly affected. 79% of the economic damages were recorded in Quebec (QC), 10% in Vermont (VT), and 11% in New York (NY). Impacts estimates for the U.S. were obtained from the Federal Emergency Management Agency (FEMA) and from the Ministère de la Sécurité Publique (MSP) for Quebec (http://ijc.org/files/publications/Final_PoS_LakeChamplain-RichelieuRiver.pdf).

Table 3.1 Impact estimates from the 2011 Lake Champlain and Richelieu River Flood

Impact Estimates from 2011 Flood Event (as of January 2013)			
	VT	NY	QC
# People Evacuated	75 <i>(+426 from associated flash floods in tributaries)</i>	124	1 651
# Houses Affected	500	929	2375
# Municipalities Affected	8	5	27
Individual Claims	800	900	3000
Estimated Damages Reported	8 600 000	9 900 000	72 000 000

Note: these estimates are expressed in 2011 US and Canadian currencies.

Policymakers immediately directed resources to mitigate damages, alleviate suffering and reconstruct the flood-affected areas. Scientists and engineers worked together to assess the degree of impact the flooding had on the region (environmental, financial, tourism, and recreation). Finally, residents and governments continue to express the need for improved flood forecasting and to evaluate proper and relevant flood mitigation measures so that future flooding and subsequent flood damages are controlled or minimized.

Over 100 years of water level and river discharge data have been collected in the study area with lake levels recorded at the United States Geological Survey (USGS) Lake Champlain at Burlington, VT lake gage 04294500 from 1907 to present and at the USGS Richelieu River (Lake Champlain) at Rouses Point, N.Y. lake gage 04295000 from 1871 to present; and discharge flows recorded at Saint-Jean-sur-Richelieu, Quebec, Canada stream gage 02OJ016 from 1972 to present. Four major high water events of the 1900s are highlighted in Figure 3.1 with the highest lake levels recorded on May 6, 2011. The USGS reported that the lake level of 103.2 ft. NGVD29 (National Geodetic Vertical Datum 1929) at the USGS Richelieu River (Lake Champlain) at Rouses Point, N.Y. stream gage 04295000 had exceeded its record flood level of 31.1 meters (102.1 feet, NGVD29) set in 1869.

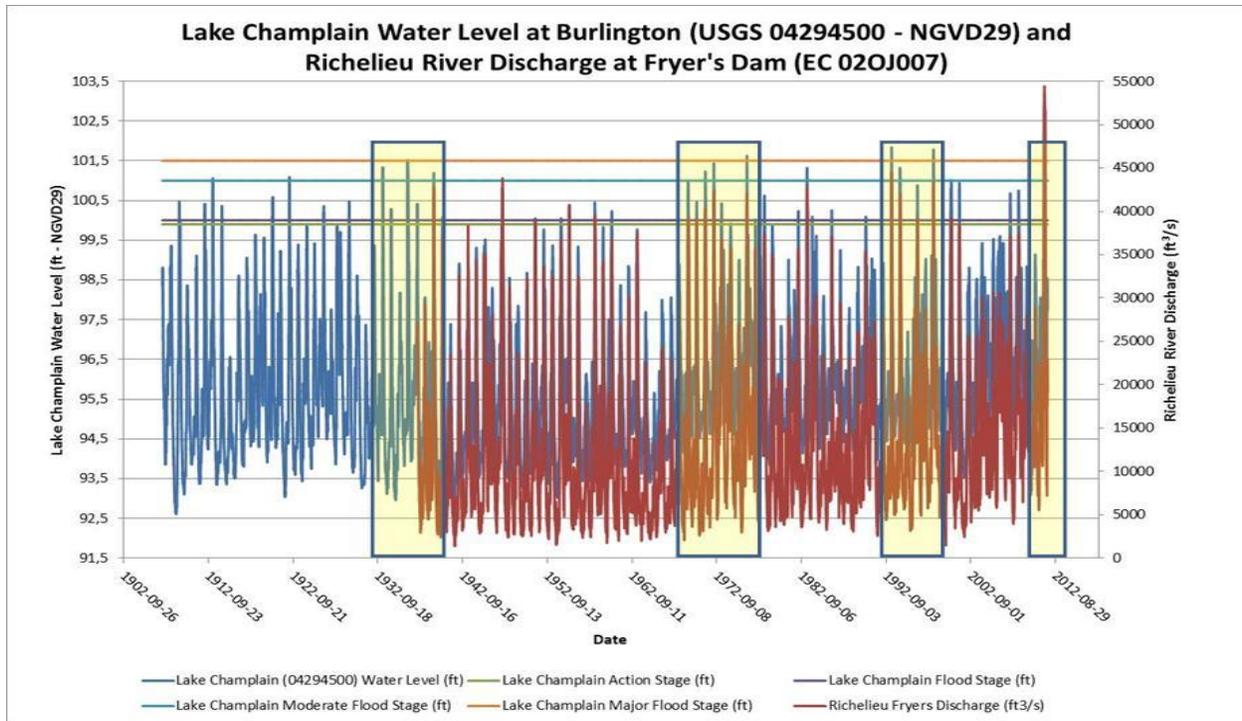


Figure 3.1 Historical Variation of Lake Champlain Water Levels and Richelieu River Discharge

3.2 Scope of Study: the governments' joint reference

In response to these devastating floods the Governments of Canada and the United States requested that the International Joint Commission (IJC) review and make recommendations regarding a comprehensive study of measures to mitigate flooding and the impacts of flooding in the LCRR watershed. To answer this request, the IJC established in May 2012 the International LCRR Study and tasked it to respond to the governments' request through a Plan of Study (PoS) (2013): "The Identification of Measures to Mitigate Flooding and the Impacts of Flooding of Lake Champlain and the Richelieu River".

In July 2013, the International Joint Commission (IJC) submitted the LCRR Plan of Study (PoS) to the Governments of Canada and the United States. The 2013 PoS outlined the work required in the LCRR basin in order to explore potential floodplain management solutions and to provide a range of structural and non-structural flood prevention and mitigation measures.

In July 2014, the Governments provided the IJC with a joint reference, under Article IX of the Boundary Waters Treaty of 1909 to complete portions of the 2013 PoS. The IJC issued its final report to governments in accordance with this reference in December 2015. (http://ijc.org/files/tiny_mce/uploaded/LCRRTWG/Final_Report_LCRRTWG_2015-11-30_EN.pdf)

In September 2016, the United States and Canadian governments followed up on the 2013 PoS and the July 2014 reference by providing the IJC with a further reference on September 16 and 22, 2016 (<http://ijc.org/en/LCRR/Reference>), to "complete the work outlined in Option B of the 2013 PoS to more fully explore the causes, impacts, risks, and solutions to flooding in the LCRR

basin. The LCRR Study Board has been created (http://ijc.org/files/tiny_mce/uploaded/LCRR/LCRR_Directive.pdf) to direct, oversee and assist in managing the IJC work associated with the 2016 joint reference.

The work outlined in Option B of the 2013 PoS and the associated 2016 references include seven elements that represent the essential backbone of the present study.

1. Evaluating the causes and impacts of past floods, especially the event of 2011.
2. Assessing the possibilities offered by the floodplain best management practices.
3. Evaluating possible adaptation strategies to the expected future variability in the water supplies.
4. Developing and making recommendations for implementing, as appropriate, an operational, real-time flood forecasting and flood inundation mapping system for the Lake Champlain-Richelieu River watershed.
5. Conducting an in-depth study of current social and political perception on structural and other mitigation measures to support and confirm the desirability of potential structural mitigation solutions.
6. Performing a quantitative and qualitative assessment of potential flood management and mitigation measures (non-structural and/or moderate structural works) and their impacts on important resources of the system: the wetland and fauna, recreational, domestic, industrial and municipal uses of water, shoreline and floodplain built environment and agriculture.
7. Developing resource response models that include basic indicators for water resources response to water levels fluctuations, with special attention on the data inventory and identification of thresholds. Climatic projections, wind wave and ice models, additional new data for the evolution of watershed physiographic characteristics over time and a complete digital terrain model should also be produced to allow the planning, evaluation and ranking of potential flood mitigation solutions, using a shared-vision approach.

This Work Plan presents overall approaches, goals and activities needed to complete the tasks identified in Option B. Initial tasks to be done in the first 1-2 years of the study are defined in greater detail than subsequent tasks later in the course of the study. As a result, this Work Plan will be updated on an annual basis to reflect progress made, results of work done and the development of the latest science and techniques that may not be available at the start of the study.

Prior to collecting additional information and conducting reviews, a Brief History of the IJC implications on the LCRR was composed (<http://ijc.maps.arcgis.com/apps/MapJournal/index.html?appid=369677f6abbf4d82b34bc7c744cb3c26>). The 1973 last IJC study and the resulting limited implementation of flood mitigation measures illustrate the need to assess the current likelihood for implementation before investing in conducting further studies.

The geographical scope of the study area addressed by this study is the entire LCRR watershed with the downstream limit controlled by the Saint-Lawrence River regime, although the study tasks will focus directly on the Lake and River and their adjoining shorelines and flood areas.

4 Organization of the study – Governance Structure

The detailed description of the study's governance structure is provided in *Annex 1*.

- **Study Board:** The Study Board is responsible for providing oversight to study activities and ensuring that study activities will meet the goals of the references and directives of the IJC International LCRR Study. The IJC has appointed an equal number of members from Canada and the United States to the Study Board and named a member from both Canada and the United States to be the Co-chairs of the Study Board. The Co-chairs are jointly taking a leadership role in planning and implementing the Study Board's mandate. On behalf of the Board, the Co-chairs shall have authority and responsibility for the study.
- **Study Managers:** Two study managers, one Canadian and one from the United States, are responsible for the effective management of the study as overseen by the Study Board. The Study Managers shall keep fully abreast of the work of the different groups and function as an active liaison between the Study Board and those groups. The Study Managers will facilitate and support the collaborations and the relationship among partner and government organizations associated with the study. The Study Managers are responsible for communicating to the different groups the direction of the Study Board, assisting in general administrative and financial/contractual tasks, including providing briefings to the Study Board on these as identified by the Co-chairs.
- **Public Advisory Group (PAG):** to be appointed by the IJC after consultation with the Study Board. The two Co-Leads of the PAG, one Canadian and one from the United States, will be Study Board members. The PAG is a means of engaging the public in the study on an ongoing basis.
- **Independent Review Group (IRG):** will be established by the IJC to ensure that independent technical reviews are carried out as required during the Study process.
- **Information Management function:** the IM/IT Support Group, under Study Managers' supervision, will consolidate the data and information needs, develop data acquisition plans, organise and oversee the acquisitions, and make available all data produced by the study, whether the data is new data collected from sources to results of models and other assessments.
- **Technical Working Groups (TWGs) and Analysis Group (AG)** are responsible of the planning and the implementation of the activities to achieve the goals of the References' Elements. Members of such working groups will be appointed by the Study Board. Each TWG or AG are composed of two Co-Leads, one Canadian and one from the United States, and strive to have an equal number of U.S. and Canadian members.
 - **TWG or AG Co-Leads:** with the assistance of the Study Board Co-Chairs, Study Managers and other TWG or AG members, the Co-Leads are responsible for the development of work plans for their respective TWG or AG, including resources requirements, and its execution, in accordance with the time timetable and budgetary constraints set by the Study Board.
 - **TWG or AG members:** are responsible for the execution of projects or can provide advice or critical input to the successful delivery of the Work Plan.

The different tasks identified in the 2013 PoS can be separated amongst 3 TWGs and one Analysis Group:

- A Social, Political, Economic (SPE) AG,

- An Hydrology, Hydraulics and Mapping (HHM) TWG,
- A Flood Management and Mitigation Measures (FMMM) TWG and
- A Resource Response (RR) TWG.

The resulting LCRR governance structure is shown on figure 4.1.

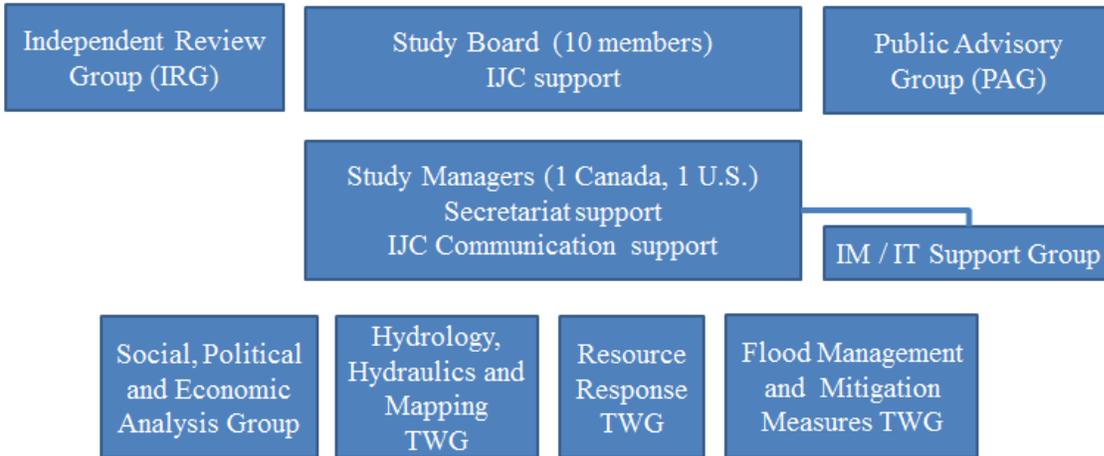


Figure 4.1 LCRR Governance Structure

5 Plan to achieve the objectives of the study

Each element of the governments joint reference will be addressed by updating needed data, and refining and combining scientific concepts, models and tools to generate new knowledge taking into account public, government agencies and stakeholder perspectives by fostering communication and participation at all levels on both sides of the border.

Study objectives will be met by experts from the technical and analysis groups that will combine their respective strengths to execute tasks and report on each objective.

The ensemble of modelling work, tools and knowledge-based assessments are the building blocks of the study and will be integral in its objectives to address the governments' joint reference. Recommendations for a state-of-the-art flood prediction and real-time flood plain mapping system will also be developed and submitted to the governments by the Study Board.

Early in the study, the modelling work will provide a thorough understanding of how the Lake Champlain – Richelieu River responds hydrologically and hydraulically to various climatic forcing. This understanding will support an analysis of the causes and impacts of large floods in the LCRR basin help document best practices and possible adaptation strategies and allow for the simulation of structural and non-structural flood mitigation measures.

An in-depth study of current social and political perceptions on structural and other mitigation measures and the development of economic and environmental performance indicators integrated in a collaborative decision support tool will help in assessing and communicating the relative value of flood mitigation measures, with the aim of converging toward technically and economically feasible measures, that are also socially and politically acceptable.

Recommendations for a state-of-the-art flood prediction and real-time flood plain mapping system will also be developed and submitted to the governments by the Study Board.

The public will be involved at strategic milestones of this study, notably through the PAG, to obtain input and concerns regarding flooding and potential management and mitigation measures.

Information management and technology will be required throughout the study and adapted to achieve its different goals and support the different TWGs and AG in accomplishing their objectives and to support the communication of study findings and recommendations.

The study work plan will be submitted to an IRG initially to gather additional review. The IRG will also be called-upon to assess the quality of key developments throughout the study and to ensure scientific soundness.

The following sections provide information on each of the study objectives. Each objective will state which Reference item it addresses, provide a description of the study objective, identify the lead and responsible TWG and describe the scope of work under the objective. The scope of work entails a description of work tasks, which TWG will be performing that task and timeline. Each task is numbered and can be cross referenced in the summary table for that objective.

5.1 Numerical modelling of the LCRR system in the context of past and future flooding events

This objective consists of the development of hydrologic and hydrodynamic models of the LCRR basin that will be used to analyze and evaluate the capacity and impacts of flood mitigation measures in the basin. This includes the 2011 event, the historical Net Basin Supply (NBS), and extreme hydroclimate scenarios. These models will also serve as the foundation on which will be built a decision support tool and a flood forecasting and real-time mapping system for operational use.

Lead: HHM TWG

Scope of Work:

Task HHM1: **Hydrometeorological data collection:** This task involves the collection of hydrometeorological data and the creation a data and model warehouse for flood modeling and analysis in the basin: This includes the development of a data elevation model (DEM) in the basin (including collection of new topographic and bathymetric data to fill gaps or update old erroneous data), gridded datasets for model input (such as land use and cover as well as vegetation), and collection of meteorological and hydrologic datasets for model calibration and validation (including deployment of meteorological stations, water level stations, and wave buoys).

Task HHM4: **Hydrological modeling:** For this task, both U.S. and Canadian distributed hydrologic models will be calibrated using the new data in the warehouse, will include a five year historical time series that includes the 2011 event. These models will be used to calibrate inflows to the lake for forecasting as well as analysis of the 2011 event. The hydrologic models will be subject to high resolution meteorological forcing to create hourly records of inflow to the basin.

Task HHM3: 2D Hydrodynamic model development: This task comprises the development of a 2D high resolution, unstructured hydrodynamic model to simulate water levels in the basin as driven by hydrologic inflows and wind data. Based upon the new data and model warehouse previously established, a modeling suite will be developed that covers the lake and upper river as well as a lower river model set-up. These models will be calibrated with historical data and used to recreate the 2011 event time series. They will then be used to analyze the LCRR basin under the effect of proposed flood mitigation solutions. This task includes the development of the hydraulic baseline condition representing the current LCRR hydraulics. It also includes the updated flood plain delineation and its mapping based on the return period evaluated in HHM1.

Task HHM5: Development of extreme hydroclimate scenarios: This entails the development a suite of extreme hydroclimate scenarios: A coarse scale hydroclimate model will be driven by global and regional climate modeling methods and will be analyzed to produce scenarios which will generate daily records of NBS for extreme hydroclimate conditions in the LCRR basin. These scenarios will be used to analyze flood mitigation solutions and the response of the ecosystem to these measures.

Timeline is reflected in table 5.1 for Canada and the U.S. Figure 5.1 illustrates the Canadian and U.S. budget for this objective.

Table 5.1 Timeline for numerical modelling of the LCRR system in the context of past and future flooding events

Physics of the system - Canadian Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
HHM1	Hydrometeorological data collection	X				
HHM3	2D hydrodynamic model development (including baseline)	X	X	X		
HHM4	Hydrological modeling	X	X	X		
HHM5	Development of extreme hydroclimate scenarios	X	X	X	X	

Physics of the system - US Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
HHM1	Hydrometeorological data collection	X	X	X		
HHM3	2D hydrodynamic model development (including baseline)	X	X			
HHM4	Hydrological modeling	X	X	X		
HHM5	Development of extreme hydroclimate scenarios	X	X			

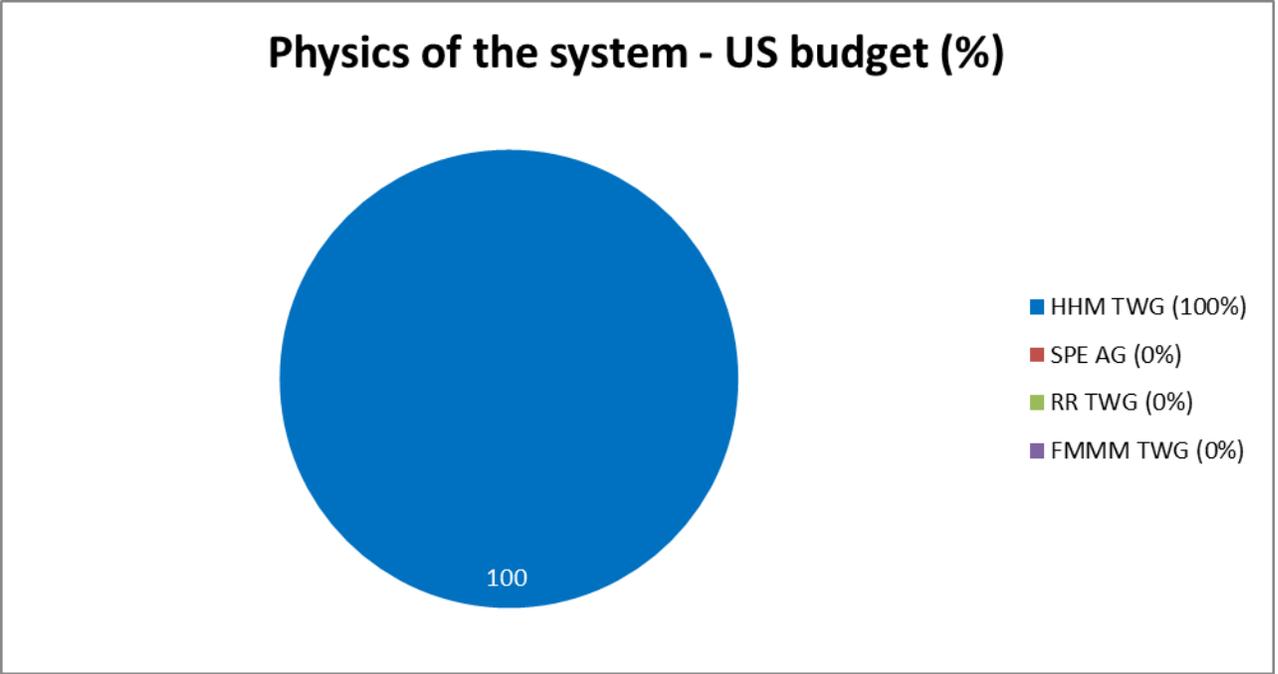
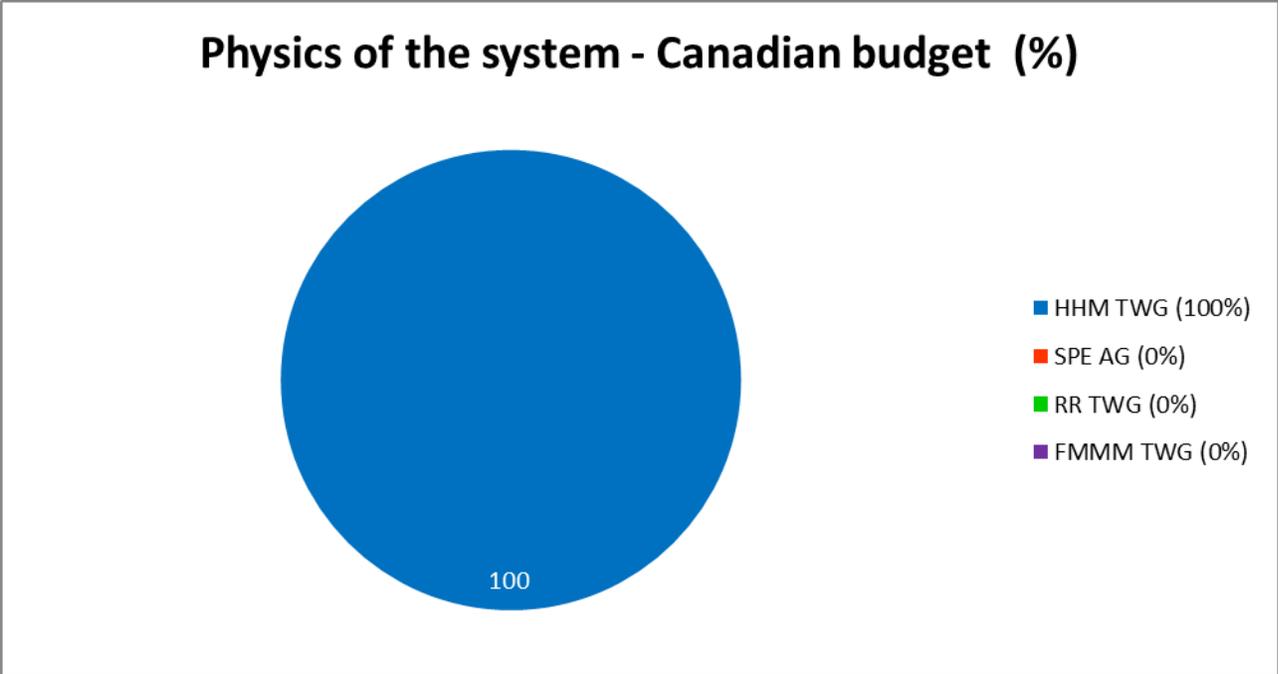


Figure 5.1 Budget for numerical modelling of the LCRR system in the context of past and future flooding events

5.2 Evaluating the causes and impacts of past floods, especially the event of 2011

This study objective directly addresses the governments’ reference item 1: *Evaluating the causes and impacts of past floods, especially the event of 2011.*

While the RR TWG will lead the effort, this objective will draw heavily on the numerical modelling of the 2011 event produced by the HHM TWG, and on the work from the SPE AG to document flooding impacts from the social, political and economic perspectives (see below), including water use, land use, and related policies and practices amongst other topics.

The resulting report will describe the basin conditions that led to the 2011 event, the physical processes that took place, and the ensuing wide ranging consequences of the flooding. The report will also pay attention to the relationship between basin communities and their environment in the context of flooding and include recognized benefits of flooding for the natural environment, together with shorelines and floodplains in areas where the environment has undergone extensive human alterations.

Lead: RR TWG

Scope of work:

Task HHM2: Hydrometeorological analysis of past floods: This will be an analysis of the causes and impacts of past floods, especially the event of 2011: The analysis of hydrological conditions and factors will be done to describe natural flood vulnerability in the basin, variables that led to flooding, and how the basin has been altered by anthropogenic development. HHM will conduct a hydrometeorological analysis of past events by examining physical data records from these events, including a flood frequency analysis based on inflow data.

Task SPE 1: Historical analysis of flooding from a social, political and economic perspective: This will build a historical perspective on flooding from social, political and economic perspectives, including water use, land use, and related policies and practices amongst other topics, focussing on the 2011 flooding.

Task SPE3: Assessment of 2011 flood impacts on public health: This task is an exploration of public and individual health impacts of the 2011 flood, including major casualties, emotional and psychological stress, impacts to vulnerable community members (*e.g.*, children, elderly, poor, those with disabilities).

Task RR1: Review of impacts of past floods on resources: The RR TWG will conduct a review of the impacts of past floods, especially the event of 2011, on ecological and societal resources in the system. Included will be a consideration of the cumulative impacts of select past flood control and flow conveyance activities and flood management practices on important resources of the system. Also included will be a review of the past adaptive behaviors of resource managers, communities in riparian corridors, and ecological indicators themselves.

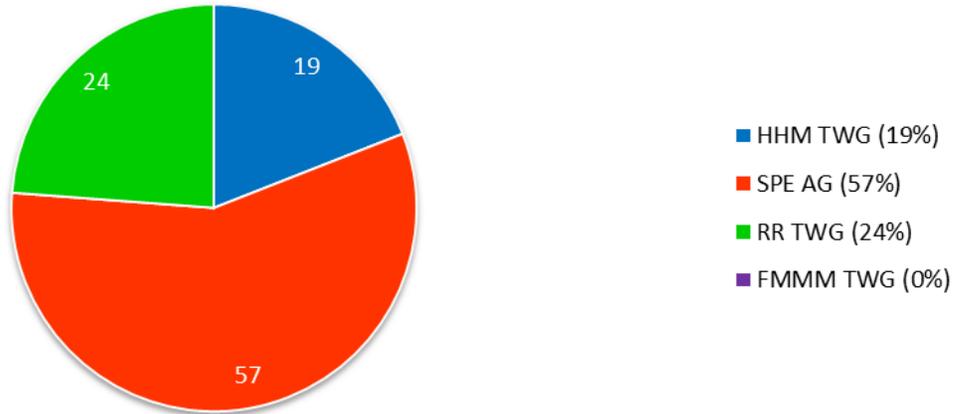
Timeline is reflected in table 5.2 for Canada and the U.S. Figure 5.2 illustrates the Canadian and U.S. budget for this objective.

Table 5.2 Timeline for evaluating the causes and impacts of past floods, especially the event of 2011

Evaluating the causes and impacts of past floods, especially the event of 2011 - Canadian Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
HHM2	Hydrometeorological analysis of past floods	X				
SPE1	Historical analysis of flooding from a social, political and economic perspective	X	X			
SPE3	2011 flood health impacts assessment	X	X			
RR1	Review of impacts of past floods on resources	X				

Evaluating the causes and impacts of past floods, especially the event of 2011 - US Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
HHM2	Hydrometeorological analysis of past floods	X				
SPE1	Historical analysis of flooding from a social, political and economic perspective	X	X			
SPE3	2011 flood health impacts assessment	X	X			
RR1	Review of impacts of past floods on resources	X				

Evaluating the causes and impacts of past floods - Canadian budget (%)



Evaluating the causes and impacts of past floods - US budget (%)

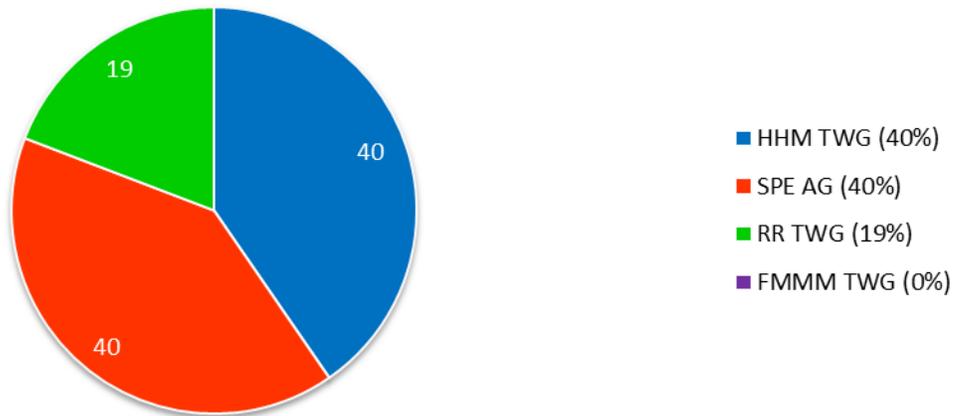


Figure 5.2 Budget for evaluating the causes and impacts of past floods, especially the event of 2011

5.3 Evaluating possible adaptation strategies to the expected future variability in water supplies

This study objective directly addresses the governments' reference item 3: *Evaluating possible adaptation strategies to the expected future variability in water supplies.*

This component of the study consists of an economic and social analysis of current and future water uses and ecological functions that support the socioeconomic development of the LCRR region, taking into account the effect of climate change, Other socio-economic factors, to assess adaptation strategies and the vulnerability of watershed communities.

Several groups of stakeholders and organizations affected by flooding and potential mitigation measures and benefiting directly from the lake or river will be required to contribute to the study to identify Main vulnerabilities and adaptive capacities for flooding within these communities.

By improving the understanding of LCRR communities' vulnerability and adaptive capacities, a better assessment of how the proposed management and mitigation measures may have on water use, socially and economically, will be possible.

Lead: SPE AG

Scope of work:

Task SPE4: Socio-economic assessment of water uses and ecological functions: Based on documentation provided by RR and other TWGs, the work will consist of conducting an economic and social analysis of the LCRR water uses and ecological functions that support the socio-economic development of the region (ecological services), their evolution under climate change and other socio-economic factors (population growth, habits, etc.), and explore adaptation strategies as needed. The inquiry should include an assessment of supporting, regulating, provisioning, and cultural services and uses.

Task SPE5: Advisory group and workshop for discussion on adaptation strategies: Using the Delphi method (a structured communication technique/method, originally developed as a systematic, interactive forecasting method which relies on a panel of experts), this work will form an advisory group and design workshops to discuss plausible adaptation to the current water uses, with the main stakeholder groups and institutions and populations or groups that benefit directly from the lake or river.

This task is a potent example of the general need to specifically interact with local elected officials, public servants and technical experts such as municipal planners and public works professionals. To interact and gain feedback from these professionals in a coordinated manner, the SPE AG suggests developing a list of stakeholder groups that hold expertise in the study topics and inviting all professionals in the LCRR region within these groups to join the effort. As volunteers show interest in participating, local groups can be created for surveys and participating in focus groups, among other activities related to this task and others.

Task SPE8: Vulnerability and resilience of local communities assessment: This task will map the LCRR population and critical infrastructures related to flooding in order to develop a better understanding of the vulnerability and resilience of local communities: This task will shed light on the diversity within and among local communities (including households) located in flood prone areas. This analysis should point out the main sensitivities and adaptive capacities related to flooding that exist within communities.

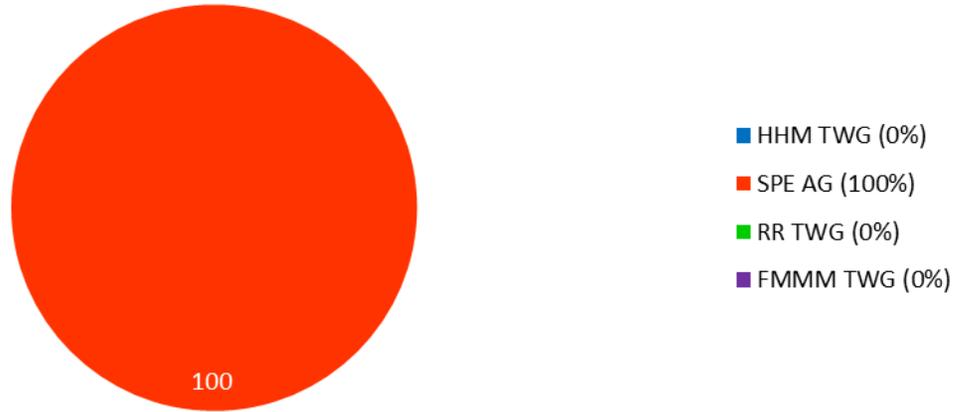
Timeline are reflected in table 5.3 for Canada and the U.S. Figure 5.3 illustrates the Canadian and U.S. budget for this objective.

Table 5.3 Timeline for evaluating possible adaptation strategies to the expected future variability in water supplies

Evaluating possible adaptation strategies to the expected future variability in water supplies - Canadian Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
SPE4	Economic and social assessment of water uses and ecological functions	X	X	X	X	
SPE5	Advisory group and workshop for discussion on adaptation strategies			X	X	
SPE8	Vulnerability and resilience of local communities assessment		X			

Evaluating possible adaptation strategies to the expected future variability in water supplies - US Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
SPE4	Economic and social assessment of water uses and ecological functions	X	X	X	X	
SPE5	Advisory group and workshop for discussion on adaptation strategies			X	X	
SPE8	Vulnerability and resilience of local communities assessment		X			

Evaluating adaptation strategies to future variability in water supplies - Canadian budget (%)



Evaluating adaptation strategies to future variability in water supplies - US budget (%)

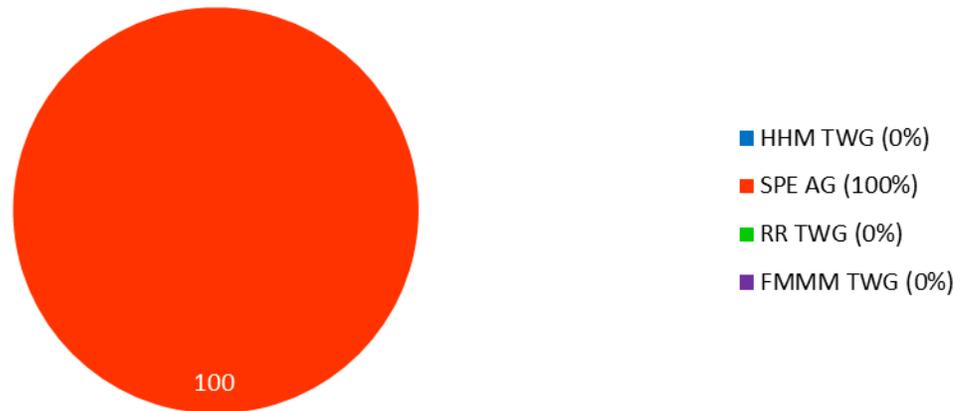


Figure 5.3 Budget for evaluating possible adaptation strategies to the expected future variability in water supplies

5.4 Conducting an in-depth study of current social and political perception on flood mitigation measures

This study objective directly addresses the governments' reference item 5: *Conducting an in-depth study of current social and political perception on structural and other mitigation measures to support and confirm the desirability of potential structural mitigation solutions.*

Lead: SPE AG

This component of the study will produce a social, political and economic analysis of current perceptions on mitigation measures and environmental considerations by documenting residents' and stakeholders' current perceptions and relationships to flooding and the potential mitigation solutions. It will also document the current multilevel and bilateral water governance related to flooding and explore alternative arrangements.

This component is essential to maximise the likelihood of converging toward acceptable flood mitigation measures as the study progresses.

The study will largely involve social, political, and economic analyses that will rely on various surveys and focus groups. These activities go beyond the general public meetings that will be coordinated by the Public Advisory Group (PAG) and by open meetings organized by the International LCRR Study Board.

There is a need to specifically reach-out to local elected officials, public servants and technical experts such as municipal planners and public works professionals to interact and gain feedback from these professionals in a coordinated manner. It is suggested that lists of stakeholder groups that hold expertise in the study topics and inviting these professionals in the LCRR region within these groups to join the effort. As volunteers show interest in participating, local groups can be created for surveys and participating in focus groups, among other activities.

Scope of work:

Task SPE6: **Press review of past floods:** Commencing with the 2011 floods, this task will identify and locate: (A) the ways in which floods and risks are presented and represented in the media and other community conversations; (B) the various flood-related issues reported therein; (C) the actors who appear to be concerned by these problems; (D) the concerns, demands, proposals, and actions; and (E) any other information relevant to the understanding of the local and regional situations.

Task SPE7: **Inventory of existing studies with relevant social, political and economic information:** This will establish, with the help of designated interlocutors, an inventory of all existing studies on the watershed from which the group can extract valuable social, political, and economic information and data: This information will be aggregated into an annotated bibliography.

Task SPE9: **Risk perception analysis:** Mixed-methods research will be conducted to characterize the representations and concerns of local communities in regard to their living environment, as well as their concerns about flooding and land planning. The view is that with proper survey data and analysis (from the RR TWG), it is possible to better understand how citizens, emergency responders, decision makers, and other actors recognize and react to disaster risk and thus how risk awareness can impact long term resilience. The SPE will also explore the relationships and gaps between perceived risk and actual risk. This information will shed light as

to how residents rebuild and adapt their houses post-disaster as well as inform themselves in regards to adaptation methods.

Task SPE10: Water governance analysis: A survey and network analysis will be conducted to identify and understand the sum of mechanisms, processes, relationships, and institutions that the population has put in place to assert their interests, rights, and obligations in regard to flooding: All LCRR institutions and organizations will be invited to participate in the survey. Results will be obtained through interviews of selected participants and synthesized into a report.

Task SPE11: Development of multi-agent governance model: This tasks involves the development of a multi-agent (agent viewed as a stakeholder) decision-making model for flood management: The model aims at simulating the decision processes within the watershed, each agent representing an institution or a group. The model will make use of the sociologic, economic and political information gathered during the study and allow the evaluation of possible alternative institutional arrangements.

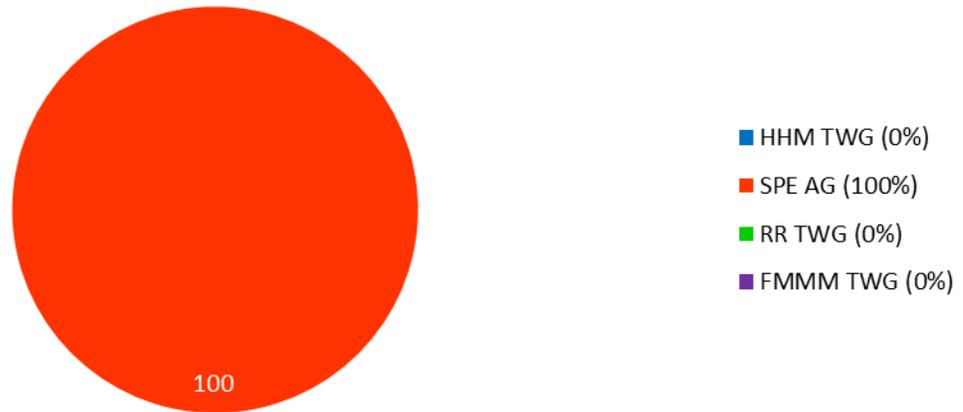
Timeline is reflected in table 5.4 for Canada and the U.S. Figure 5.4 illustrates the Canadian and U.S. budget for this objective.

Table 5.4 Timeline for conducting an in-depth study of current social and political perception on flood mitigation measures

In-depth study of current social and political perception on flood mitigation measures - Canadian Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
SPE6	Press review of past floods	X				
SPE7	Inventory of existing studies with relevant social, political and economic information	X				
SPE9	Risk management analysis		X	X	X	
SPE10	Population network analysis	X	X	X		
SPE11	Multi-agent decision-making model development		X	X	X	

In-depth study of current social and political perception on flood mitigation measures - US Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
SPE6	Press review of past floods	X				
SPE7	Inventory of existing studies with relevant social, political and economic information	X				
SPE9	Risk management analysis		X	X	X	
SPE10	Population network analysis	X	X	X		
SPE11	Multi-agent decision-making model development		X	X	X	

Evaluating social and political perception on flood mitigation measures - Canadian budget (%)



Evaluating social and political perception on flood mitigation measures - US budget (%)

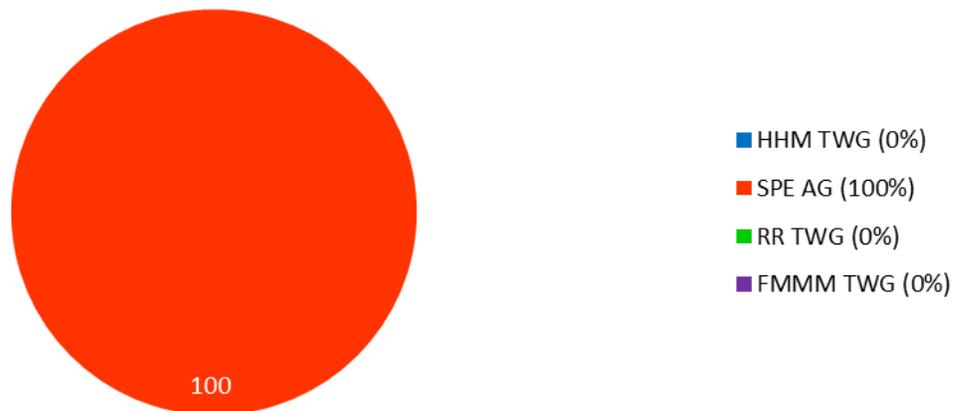


Figure 5.4 Budget for conducting an in-depth study of current social and political perception on flood mitigation measures

5.5 Development of a collaborative decision support tool (CDST)

This study objective directly addresses the governments' reference item 7: *Developing resource response models that include basic indicators for water resources response to water levels fluctuations, with special attention on the data inventory and identification of thresholds.*

Climatic projections, wind wave and ice models, additional new data for the evolution of watershed physiographic characteristics over time and a complete digital terrain model should also be produced to allow the planning, evaluation and ranking of potential flood mitigation solutions, using a shared-vision approach.

Lead: FMMM TWG

A *collaborative decision support tool* (CDST) and associated tools will utilize information and data derived from a variety of models: These include hydrological, hydraulic, environmental and economic models the results of which will be used to conduct an evaluation of flood mitigation measures. Associated tools (simplified models) will be built to help visualize and explain the impacts of various measures detailed in the CDST.

To support this modelling, extensive data will be required. Some pertinent data sets and maps may include: flood maps, local zoning ordinances, high water mark data, Plat maps, building floor elevation, floodplain delineations, wetland mapping, percolation testing and groundwater zones, geological profiles and maps, water quality and extensive socio-economic data. These sources of data and maps will be discussed and refined with the other TWGs in the context of the metrics/performance indicators (PIs) that will be utilized to evaluate the various alternatives.

Baseline

The PIs for the LCRR basin in its present state, *i.e.* without any new flood mitigation measure, will be computed on a temporal series of water level and flows to form the “baseline” to which will be compared the PIs computed in simulating the various flood mitigation measures. In first approximation, two different time series will be used: the short “2011 event” (hourly to daily averaged data), and the historical NBS (Net Basin Supply) series of levels and discharge from 1950 to 2017 (daily mean to quarter-monthly mean). Climate Change NBS series could be added to the baseline series that would be used to assess the effect of climate change on flood mitigation measures.

Scope of work:

Task RR3: Review of Indicators: A review of potential PIs for water resources responses that can reflect impacts of water level fluctuations on wetlands and fauna, water quality, recreational, domestic, industrial and municipal uses, shoreline and floodplain built environment, and agriculture will be done. Indicators will be selected and a presentation of findings will be provided in a Study Board report and as input to resource response models.

Task RR2: Development of Integrated Resource Response Models (IERM): A review of the suitability of a range of response models including integrated ecosystem response models (IERM) will be done for the assessment of flood impacts and water level regulation on resources in the basin. Models selected for the evaluation of measures will be customized according the defined resource responses and integrated with the decision support tool.

Task RR5: Indicators for the natural environment evaluation: The RR TWG will (a) Develop an IERM for the LCRR system that links the data produced by the hydraulic/hydrological models with models for wetlands and fauna, thereby quantifying impacts of hydraulic regimes on biota. (b) Use the models as PIs to quantify the effects of changes in water level regimes on targeted species and wetlands classes and in the context of climate, land use and other changes in hydrology and hydraulics, as well as the 2011 flood.

Task RR6: Analysis of water uses: The RR TWG will (a) Complete an inventory of existing functionally dependent uses. (b) Identify the degree of impact (*e.g.*, physical, operational, and economic) as a function of water level, along with associated costs. (c) Identify impacts associated with water level ranges and timing through the use of hydrographs and response models.

Task RR7: Analysis of shoreline and floodplain built environment: Working closely with the SPE AG, the RR TWG will (a) Establish stage-damage relationships for buildings and response models and real estate property, aggregated to homogeneous types of land uses and areas. (b) Compile an inventory of historical sites that are vulnerable to water level fluctuations. (c) Quantitatively assess the impacts, specifically costs, of erosion of shorelines and impacts on real estate and public infrastructure.

Task RR8: Analysis of impacts on agriculture: The RR TWG will (a) Evaluate the effects of changes in water level regime on agricultural land in the LCRR basin through the use of response models. (b) Assess existing agriculturally-developed land within the watershed; assess its value in consultation with SPE AG, and determine how it has been, is, and will be affected by flooding. (c) Identify potential areas for floodplain reclamation, land protection (agricultural dikes), and other flood risk mitigation measures. (d) Recommend optimal water levels needed to maintain agricultural lands and communities in LCRR.

Task RR10: Resource baseline impact assessment: In the absence of any potential flood mitigation and management measures, impacts on resources in the system need to be characterized according to a set of baseline scenarios (*i.e.* the “status quo” according to current water supply conditions under stable and modified climate regimes and forecast socioeconomic changes). Measures proposed should improve upon one or more of the baseline scenarios according to performance indicators that represent the resources of the system. Taking the full spectrum of hydraulic and hydrological variation into account, performance indicators will be expected to respond to periods of drought as well.

Task SPE14: Development of social, political and economic indicators: The SPE AG will develop social, political, and economic indicators for assessing the many possible non-structural and structural measures to prevent, manage and respond to flooding: These indicators will contribute, along with the materials produced by other TWGs, to construction of a Decision Support Tool to help prioritize and eventually recommend flooding solutions.

Task FMMM9: Development of a Collaborative Decision Support Tool (CDST): The TWG will develop the CDST. That is, develop the framework and document the approach that the study will use to evaluate the various measures (non-structural) and options (structural) that factor in social (human), political, economic and environmental perspectives.

Task FMMM10: Development of metrics/performance indicators to evaluate the proposed measures and options: Working closely with the TWGs and other groups, the TWG will develop the evaluation models for each practical alternative, including the metrics/performance indicators covering the broad range of perspectives that will be used to evaluate the proposed measures and options. Although 2011 is the reference event, indicators must also account for potential changes in climate. The FMMM TWG will hold workshops on an annual basis with all the TWGs and other groups in planning and implementation of the CDST and keep close tabs on the metrics/performance indicators collection that will be needed for evaluation purposes.

Task FMMM11: Finalization of metrics/performance indicators and familiarization with CDST’s capabilities: Working with TWGs, project developers, etc.: the FMMM TWG will interact with the various groups to evaluate the utility of the broader set of metrics /performance indicators and finalize the suite of metrics/performance that that will be used to analyze the proposed mitigation measures. The evaluation will assess the sensitivity of the various metrics/performance indicators against changing water levels and help assess whether they will provide meaningful results for prioritizing/ranking of options. Presentations of the collaborative decision support tool at various stages of development will demonstrate how the metrics and indicators will be used to evaluate and rank plans.

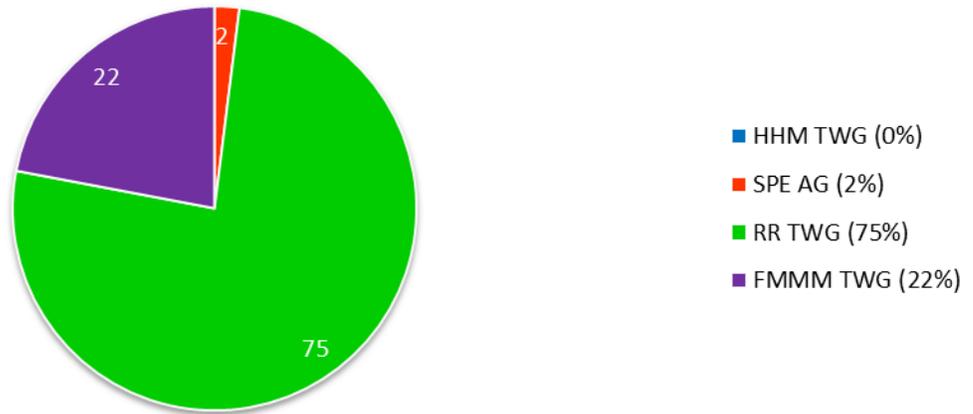
Timeline is reflected in table 5.5 for Canada and the U.S. Figure 5.5 illustrates the Canadian and U.S. budget for this objective.

Table 5.5 Timeline for the development of a collaborative decision support tool (CDST)

Development of a collaborative decision support tool (CDST) - Canadian Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
RR3	Review of indicators	X				
RR2	Development of IERM	X	X			
RR5	Indicators for the natural environment evaluation	X	X	X	X	X
RR6	Uses of water analysis		X	X	X	X
RR7	Shoreline and Floodplain built environment analysis	X	X	X	X	X
RR8	Agriculture impacts analysis	X	X	X	X	X
RR10	Resource Baseline impacts assessment				X	X
SPE14	SPE indicators development			X		
FMMM9	Develop collaborative decision support tool		X			
FMMM10	Develop metrics/performance indicators to evaluate the proposed measures and options		X	X	X	
FMMM11	Finalize metrics/performance indicators and familiarize with model capabilities			X	X	

Development of a collaborative decision support tool (CDST) - US Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
RR3	Review of indicators	X				
RR2	Development of IERM	X	X			
RR5	Indicators for the natural environment evaluation	X	X	X	X	X
RR6	Uses of water analysis	X	X	X	X	
RR7	Shoreline and Floodplain built environment analysis	X	X	X	X	X
RR8	Agriculture impacts analysis	X	X	X	X	X
RR10	Resource Baseline impacts assessment			X	X	X
SPE14	SPE indicators development			X		
FMMM9	Develop collaborative decision support tool		X			
FMMM10	Develop metrics/performance indicators to evaluate the proposed measures and options		X	X	X	
FMMM11	Finalize metrics/performance indicators and familiarize with model capabilities			X	X	

Development of a collaborative decision support tool (CDST) - Canadian budget (%)



Development of a collaborative decision support tool (CDST) - US budget (%)

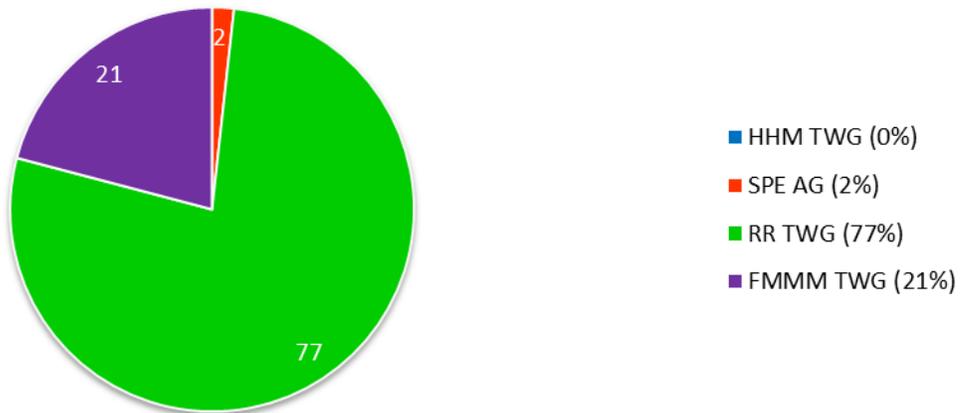


Figure 5.5 Budget for the development of a collaborative decision support tool (CDST)

5.6 Performing a quantitative and qualitative assessment of structural and non-structural potential flood management and mitigation measures

This study objective addresses the governments' reference item 2: *Assessing the possibilities offered by floodplain best management practices. Best floodplain management practices are a form of mitigation measures*, and the governments' reference item 6: *Performing a quantitative*

and qualitative assessment of potential flood management and mitigation measures (non-structural and/or moderate structural works) and their impacts on important resources of the system: the wetland and fauna, recreational, domestic, industrial and municipal uses of water, shoreline and floodplain built environment and agriculture.

Lead: FMMM TWG

This component of the study will identify and document the possible non-structural and moderate structural flood management and mitigation measures, in collaboration with the HHM TWG, the RR TWG and with the SPE AG, and the PAG. The evaluation and ranking of the potential candidate measures for flood management and mitigation will be supported by a collaborative decision support tool (CDST) to be developed as an integral part of the study (objective 6).

Scope of work:

Task FMMM1: Survey of basin jurisdictions' approaches to flooding: This task will conduct a survey of the jurisdictions in the basin to identify a comprehensive list of the various strategies and approaches currently being employed for flood management practices and their perceived effectiveness. This will be based on what is currently considered the flood elevation on a floodplain for a prescribed flood event. This work will be done in close collaboration with the SPE group to identify practical alternatives. Work Groups (SPE AG and RR TWG) will also combine their efforts to develop impact functions and performance indicators.

Task FMMM2: Literature review on structural options: A literature review of previous LCRR studies will be done and a comprehensive list of practical structural options that could be applied in the basin will be compiled.

Task FMMM3: Literature review of non-structural options: A literature review focusing on knowledge and lessons learned by North American jurisdictions (*i.e.*, provinces, conservation authorities, states, etc.) on flood management and mitigation measures will be done. A comprehensive list of the different strategies and approaches that have been employed by the various agencies will be gathered.

Task SPE2: Governance analysis on flood preparedness and response: This consist of an analysis of governance, networks, communication, collaboration, inter-relationship related to preparedness and response, including forecasting and communications, logistics, emergency and medical responders, disaster declarations, media, clean-up and post-flood management.

Task FMMM4: Expert workshop on options for LCRR basin: A workshop of external experts, TWG representatives and decision makers will be held to develop the list of the more promising options (structural and non-structural) for consideration in the LCRR basin. They will work will involve prioritizing the list of options that will be compiled from the basin survey, literature review and discussions with other jurisdictions that have developed strategies for reducing the impacts of flooding in other basins.

Task FMMM6: Initial assessment and prioritization of proposed metrics/performance indicators to use to evaluate options: A list of planning objectives and metrics will be developed. Metrics and indicators will be proposed that will be used to quantify progress towards those objectives. Flood damage reduction is clearly a prime objective, but there are others, such as the protection or improvement of environmental health. This work will be coordinated with input from all the groups.

Task FMMM7: Shortlist the options (non- structural and structural): A list of possible flood damage reduction measures has already been assembled based on information from within and outside the basin. This task will identify those specific measures that decision makers in the basin support for further analysis and that will require detailed analyses. The focus will be on identifying those specific options that have a good chance of being implemented.

Task FMMM8: Engineering feasibility assessment: An engineering feasibility assessment of the promising measures and options will be conducted. This will be accompanied with an approximate cost of implementation and a description of the expected benefits. It will also identify any potential issues or limitations related to that specific option being implemented.

Task HHM6: Hydraulic modeling of potential mitigation measures: The 2D hydraulic modeling suite developed by HHM TWG will be used to analyze the flood mitigation measures identified by the FMMM TWG. The NBS to the LCRR will be varied in a number of realistic ways, and the model will be adjusted to incorporate the proposed measure. The effectiveness of mitigation measures will be considered under a number of scenarios, including: the previously identified flood levels used to generate flood inundation maps; the 2011 flood event; historical NBS; and climate-driven NBS scenarios. Furthermore, the ecosystem response under these conditions will be evaluated based upon the model outputs generated here.

Task SPE12: Vulnerability and impacts analysis of potential mitigation measures: Analysis of the social, political and economic consequences of different strategies for preparing, planning and preventing flood damages, as well as management of resources and hazards during floods and responses and adaptation post-flood will be conducted: Results will be presented directly to impacted stakeholders. Consequences of specific prevention, management and adaptation strategies will be discussed to aid in the decision making process.

Task SPE13: Cost-benefit analysis of potential mitigation measures: An economic analysis of possible adaptation measures including the cost of non-adaptation will be realized: This task consists of conducting cost-benefit analysis of the adaptation measures retained and identified by the FMMM Work group. The economic analysis will compare the discounted costs and benefits of each adaptation measures to the costs of the reference scenario (without adaptation).

Task RR9: Indicator Calibration: Indicators will be calibrated and responses will be forecasted based on historical flood events, including the event of 2011, using existing data to the extent possible.

Task RR11: Assessment of Cumulative impacts of anthropogenic modifications to the system: Over the decades, the system has undergone substantial change due to successive anthropogenic modifications. These modifications range from the establishment of eel cribs and rail and road transportation piers to widening of piles and the Chambly Canal, among others. This task involves quantifying the relative impacts of these alterations of the system, thereby enabling a common understanding of what anthropogenic factors have led to the current hydraulic regime.

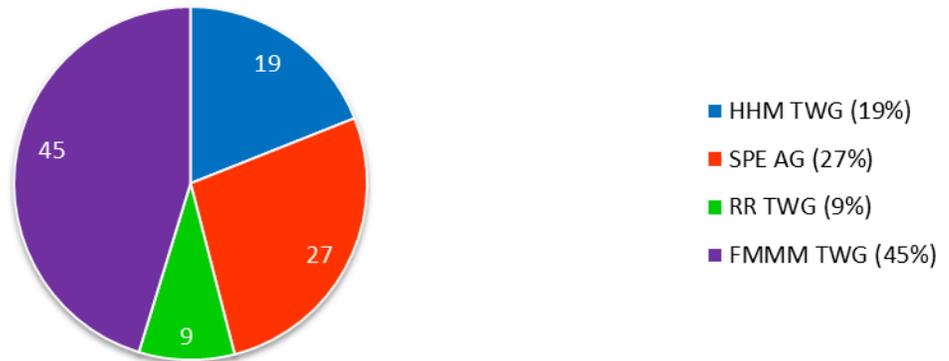
Timeline is reflected in table 5.6 for Canada and the U.S. Figure 5.6 illustrates the Canadian and U.S. budget for this objective.

Table 5.6 Timeline for performing a quantitative and qualitative assessment of structural and non-structural potential flood management and mitigation measures

Performing a quantitative and qualitative assessment of structural and non-structural potential flood management and mitigation measures - Canadian Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
FMMM1	Survey of basin jurisdictions' approaches to flooding	X				
FMMM2	Literature review on structural options	X				
FMMM3	Literature review of non-structural options	X				
SPE2	Governance analysis related to preparedness and response	X	X			
FMMM4	Expert workshop on options for LCRR basin	X				
FMMM6	Initial assessment and prioritization of proposed metrics/performance indicators		X			
FMMM7	Shortlist the options (non- structural and structural)	X	X			
FMMM8	Engineering assessment of structural and non-structural options		X	X		
HHM6	Modeling of the potential flood mitigation and management measures			X	X	X
SPE12	FMMM impacts analysis			X	X	X
SPE13	Cost-benefit analysis of FMMM			X	X	X
RR9	Indicator calibration				X	X
RR11	Assessment of Cumulative impacts of anthropogenic modifications to the system			X	X	

Performing a quantitative and qualitative assessment of structural and non-structural potential flood management and mitigation measures - US Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
FMMM1	Survey of basin jurisdictions' approaches to flooding	X				
FMMM2	Literature review on structural options	X				
FMMM3	Literature review of non-structural options	X				
SPE2	Governance analysis related to preparedness and response	X	X			
FMMM4	Expert workshop on options for LCRR basin	X				
FMMM6	Initial assessment and prioritization of proposed metrics/performance indicators		X			
FMMM7	Shortlist the options (non- structural and structural)	X	X			
FMMM8	Engineering assessment of structural and non-structural options		X	X		
HHM6	Modeling of the potential flood mitigation and management measures			X	X	
SPE12	FMMM impacts analysis			X	X	X
SPE13	Cost-benefit analysis of FMMM			X	X	X
RR9	Indicator calibration				X	X
RR11	Assessment of Cumulative impacts of anthropogenic modifications to the system			X	X	

Assessment of structural and non-structural potential flood management and mitigation measures - Canadian budget (%)



Assessment of structural and non-structural potential flood management and mitigation measures - US budget (%)

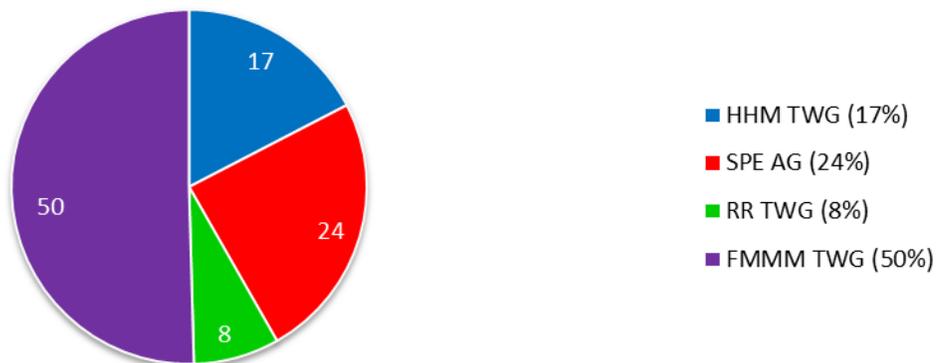


Figure 5.6 Budget for performing a quantitative and qualitative assessment of structural and non-structural potential flood management and mitigation measures

5.7 Development of a binational flood forecasting and real-time flood plain mapping system for operational implementation

This study objective directly addresses the governments' reference item 4: *Developing and making recommendations for implementing, as appropriate, an operational. real-time flood forecasting and flood inundation mapping system for the Lake Champlain-Richelieu River watershed.*

Leads: FMMM TWG and HHM TWG

This component of the study will define the components of the forecasting system to be implemented operationally, including the modeling of wind set-up and wave action. It will also define the governance of the system and address the delivery of forecasts and real-time maps to the end users.

Scope of work:

Task FMMM14: **Recommend a governance mechanism for the operation of the forecasting system.** The FMMM team will develop a proposal for addressing operation of the binational flood forecasting and real-time flood plain mapping system for operational implementation, its coordination, and dissemination of commonly agreed predictive products to end users.

Task HHM7: **Development of a real-time flood forecasting system:** The HHM team will assemble all components of a predictive flood forecasting and real-time flood plain mapping system that uses ensemble predictive meteorology-hydrology (HHM4) and 2D hydrodynamic model (HHM3). Also, U.S. will develop, test, and implement a hydrodynamic model for Lake Champlain and the upper Richelieu River which will be driven by hydrologic predictions and meteorological forecast models. The nature of the final U.S. lake forecasting model – whether it is a 2D or three-dimensional (3D) model - is under review. US will also develop wind wave for the lake to be used in this predictive system. The predictive system will combine US and Canadian meteorology and three hydrological models (ECCC, NCRR and MDDELCC) that will be transferred to a single US-Canada 2D hydrodynamic model to map expected flooding extent. An ensemble approach for determining lake and river levels and flooding potential will provide probabilistic forecasts. This system will assimilate recent observations to produce reliable solutions.

Timeline is reflected in table 5.7 for Canada and the U.S. Figure 5.7 illustrates the Canadian and U.S. budget for this objective.

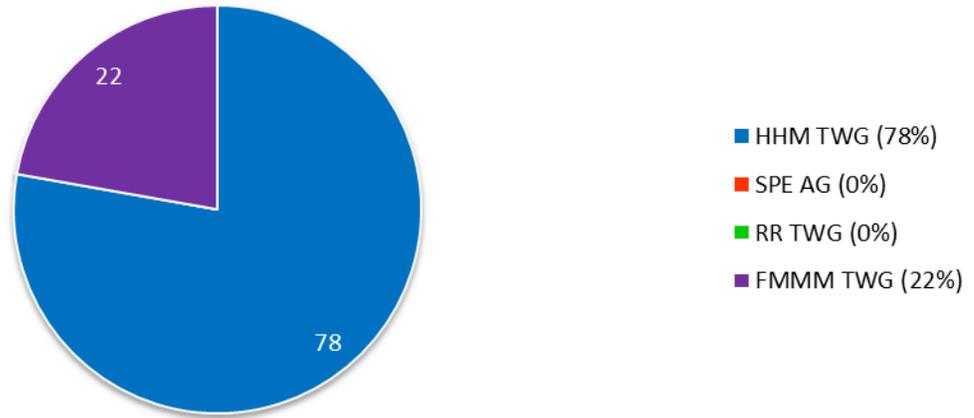
Table 5.7 Timeline for the development of a flood forecasting and real-time flood plain mapping system for operational implementation

Development of flood forecasting and real-time floodplain mapping system for operational implementation - Canadian Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
FMMM14	Recommend a governance mechanism for the operation of the forecasting system			X	X	
HHM7	Development of real-time flood forecasting system		X	X	X	X

Development of flood forecasting and real-time floodplain mapping system for operational implementation - US Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
FMMM14	Recommend a governance mechanism for the operation of the forecasting system					
HHM7	Development of real-time flood forecasting system	X	X	X	X	X

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Development of flood forecasting and real-time floodplain mapping system - Canadian budget (%)



Development of flood forecasting and real-time floodplain mapping system - US budget (%)

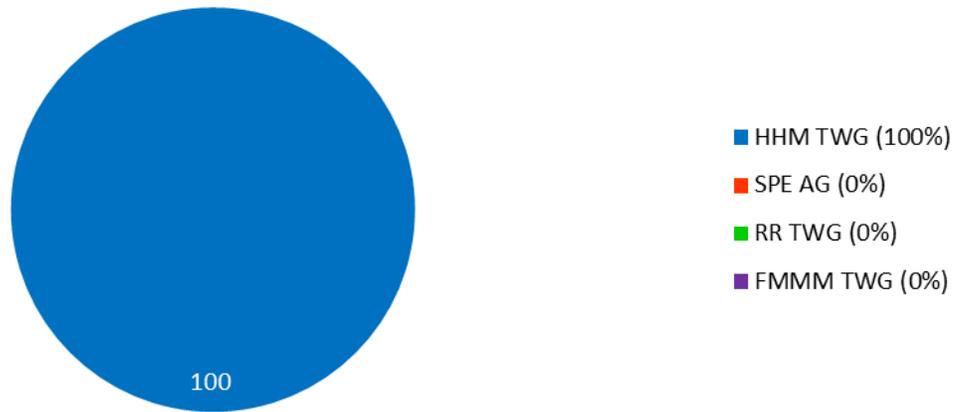


Figure 5.7 Budget for the development of a flood forecasting and real-time flood plain mapping system for operational implementation

6 Public Participation and Outreach

6.1 Introduction

The IJC is committed to the requirement in the Boundary Water Treaty that all interested parties shall be given convenient opportunity to be heard. Therefore, the IJC promotes policies and programs that enable community input in the decision making process. The IJC emphasizes the importance of public outreach, consultation and participation. In the conduct of its activities, the Study Board will carry out its public participation and outreach activities in accordance with the principles contained in the Directive and in the *Guidance to the Study Board on Communication and Public Participation - November 2016* document.

The IJC and LCRR Study Board will strive to collaborate with existing regional organizations in developing and carrying out its communication and public outreach activities.

6.2 Objectives

Public participation in the study will be objectives-driven. The principal objectives are to:

- Ensure that the study process is open, inclusive and fair;
- Make the public aware of the study and provide opportunities to participate;
- Explain the decision-making process of the study;
- Identify and utilize local expertise and information;
- Identify and consider the public's views of the principal issues and questions of the Study;
- Identify and consider the public's priorities and preferences;
- Enhance public understanding of the causes and effects of flooding and potential solutions;
- Broadly disseminate study findings as they become available; and
- Encourage the public to assist in disseminating study findings.

The public refers to any person, association, organization or group that is affected, likely to be affected by, or has an interest in the study and any decisions that may ultimately be taken by the IJC in response to the findings or recommendations of the study. The public includes, but is not limited to, the following individuals and organizations from the following: Environmental work, Navigation including recreational boating, Industry, Agriculture, Water supply and stormwater/sewage treatment, Riparian interests and Municipalities.

6.3 Communication plan

A Communication plan is an important tool for any complex study and it is being developed for the LCRR study. The main elements of the Communication Plan will be:

- Identification of key contacts;
- Development of a stakeholder list (municipalities, elected officials, First Nations/Tribes, local media, interest groups, riparian associations, etc.);
- Determination of key deliverables from the Study Board and work group work plans (public meetings, workshops, reports, comment periods, public outreach products, etc.);

- Development of a specific communication plan for each key deliverable. It will include details such as notice time, translation needs and time, production time, costs, approvals or room bookings; and
- Development of key messaging for both the overall study and each key deliverable or announcement.

A proposed short-term communication plan to address the summer 2017 is provided in **Annex 3**. The final communication plan will be part of the final study work plan (October 2017). It will be updated regularly thereafter.

The Study Board will use three important means for public participation and outreach: public meetings, the LCRR website for public outreach products and the PAG.

6.4 Public meetings

The Study Board will conduct public participation meetings, as appropriate, holding at least one in each country for any specific topic or periodic update. During these meetings, the Study Board Co-Chairs will invite comments from the public on specific or general issues associated with the study as well as provide opportunities for the public to express its views.

In order to inform and provide context for the technical investigations associated with the study, the public will be consulted at the beginning of the Study to identify the public's views on the principal issues, questions and study objectives, any available knowledge in the form of historical data, anecdotal information indigenous knowledge as well as existing or future plans, activities and initiatives (Summer 2017).

Other public participation activities or meetings will be conducted at strategic junctures throughout the study.

6.5 Public Advisory Group

The IJC is committed to engage the public in the study on an ongoing basis through the Public Advisory Group (PAG). The PAG will be binational and members should represent various areas of interest and various locations in the LCRR basin. PAG members will have the opportunity to provide advice on the Study Board's public participation activities set out in its directive. More specifically, the PAG will be asked to:

- Advise the Study Board on public consultation, involvement and information exchange;
- Serve as a conduit for public input to the study process, and for public dissemination of study outcomes;
- Review and provide feedback on Study Board approaches, reports, products, findings and conclusions as requested; and
- Advise the Study Board on the responsiveness of the study process to public concerns.

As such, PAG members will be asked to draw on their knowledge, contacts and experience to provide informed input to the study.

6.6 LCRR Web site

The web is an important communication tool. It is one of the primary means of providing information to a large public. As such, the Study Board has developed, will maintain and promote a website content presence (*i.e.*, Study Board LCRR Webpage, <http://ijc.org/en/LCRR>) on the IJC website regarding the progress and achievements of the Study under the IJC's Rules of Procedure, and public comments and other information will be made available. The Study Board will also use the website to encourage public discussion of information.

The Study Board will also encourage public discussion by inviting comments from the public on specific or general issues associated with the study, and providing opportunities for the public to express its views by, among other means: publicizing a mailing address in each country for correspondence and submissions; establishing and promoting the use of a dedicated e-mail address; and hosting a web-based dialogue.

The Study Board will develop the necessary communication tools and materials to educate the public on flooding and a flood mitigation aspect considered in the study, for use during and after the study is complete. Other IJC Control Boards or studies have developed a variety of interesting communication tools ranging from posters to videos to interactive maps that the Study Board can look at.

Timeline is reflected in table 6.1 for Canada and the U.S.

Table 6.1 Timeline for Public participation and outreach

Public participation and outreach - Canadian Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
-	Public meetings	X	X	X	X	X
-	PAG	X	X	X	X	X
-	PP&O products	X	X	X	X	X
-	Translation/Edition	X	X	X	X	X
-	Communication officer	X	X	X	X	X

Public participation and outreach - US Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
-	Public meetings	X	X	X	X	X
-	PAG	X	X	X	X	X
-	PP&O products	X	X	X	X	X
-	Translation/Edition	X	X	X	X	X
-	Communication officer	X	X	X	X	X

7 Independent Review

The Independent Review Group (IRG) is an independent group that will comment and review study activities and products for the IJC, and provide advice to the Study Board with objectivity on the direction and work to be produced throughout this study. Anticipated involvement of the

IRG will occur at strategic milestones such as review of selected products, like the work plan, and the final review of the study.

Selected reviewers that can provide advice on the study as a whole, as well as in regard to their respective subject-matter expertise, to reflect the study’s different areas of work to be performed will be participating to this independent review.

Timeline is reflected in table 7.1 for Canada and the U.S.

Table 7.1 Timeline for the independent review

Independent Review - Canadian Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
-	4 Reviewers	X	X	X	X	X

Independent Review - US Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
-	4 Reviewers	X	X	X	X	X

8 Information and Data Management

Implementing an information management (IM) framework is critical to ensuring the transparency of the study progress and process, and to protect the investments made by the LCRR SB, the IJC as well as both governments and participating agencies.

The role of the IM/IT Support Group will be to provide support to the LCRR Study Board and TWGs activities with respect to:

- Data management;
- Content management and sharing;
- Cataloguing modeling software needs
- Providing IT support
- Generation of visualization and other data products;
- Communication and collaboration;
- Coordination with IJC IM/IT staff and management on all aspects of IM/IT requirements.

Scope of Work

Task IMIT1: Survey of IM/IT Requirements:

- A register of data and model requirements will be developed and use as basis for building inventory of existing and proposed datasets. The output of the first phase of this activity will be a comprehensive list of data and model required for the LCRR Study. Survey from each TWG on how datasets will flow from various sources (organizations) to the various study components and contributors and, further, how the data are then used and/or modified for use within the individual projects that together constitute the study.

- A detailed documentation of the software and hardware requirements for the study data management framework and infrastructure that will support modeling, data analysis and other science-based investigative activities will be developed.
- Efforts will be made to raise awareness of existing IJC policies so that the modeling activities take into consideration the IJC’s model selection criteria.

Task IMIT2: Metadata protocols for the LCRR study: This task will be accomplished while taking into account the different the metadata specifications of contributing agencies such as the USGS, ECCC, NOAA, USACE, States of Vermont and New York and the Province of Québec. The output of this activity will be metadata specifications that will facilitate data sharing between study contributors and will enable discovery of and access to study data through public portals.

Task IMIT3: Data management system: A data management system based will be developed, implemented and operated. The output from this activity will be a turnkey database management system that will help optimize data flow within and across study projects and will lessen potential risks to data integrity that could result from improper processing (system) or transactions (individuals).

Task IMIT4: Communication and collaboration tools: The output will be online applications deployed for access to designated TWG and Study Board members, supported by documentation of acceptable usage rules and protocols. For the sake of minimizing complexity of use and administration, preferred solutions will be part of Microsoft Office and Office 365 suites of products.

Task IMIT5: Support to the Collaborative Decision Support Tool development: in collaboration with all the TWGs and AG, the IM/IT support team will work with the FMMM for the development of the Collaboration Decision Tool to provide the necessary tools and data to support the assessment of the benefits and impacts of the proposed flood mitigation and management measures.

Timeline is reflected in table 8.1 for Canada and the U.S.

Table 8.1 Timeline for information and data management (IM/IT)

IM/IT - Canadian Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
IMIT1	Survey of IM/IT requirements	X				
IMIT2	Metadata protocols for the LCRR Study	X				
IMIT3	Data management system	X	X	X	X	X
IMIT4	Communication and collaboration tools	X	X	X	X	X
IMIT5	Support to the CDST development	X	X	X	X	X
IM/IT - US Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
IMIT1	Survey of IM/IT requirements	X				
IMIT2	Metadata protocols for the LCRR Study	X				
IMIT3	Data management system	X	X	X	X	X
IMIT4	Communication and collaboration tools	X	X	X	X	X
IMIT5	Support to the CDST development	X	X	X	X	X

9 Secretariat

Watershed organisations have been contracted by the study to provide support to the study as secretariat, to take advantage of already established networks of interested and competent participants. In Canada, Organisme de bassin versant de la baie Missisquoi (<http://obvbm.org/>) have been selected, and the Lake Champlain Basin Program (<http://www.lcbp.org/>) has been selected in Vermont.

Timeline is reflected in table 9.1 for Canada and the U.S.

Table 9.1 Timeline for the Secretariat

Secretariat - Canadian Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
-	Secretary	X	X	X	X	X

Secretariat - US Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
-	Secretary	X	X	X	X	X

10 Study Management

Different fees will need to be covered by the study: the Study Manager salary, travel fees of the different contributors, the salary of other IJC support staff and fees related to the different workshop required for the study realisation, etc. The first workshop involving all the TWGs will be held in September 2017 to discuss all the models required to attain the study's objectives, the PIs determination and the baselines definition.

Timeline is reflected in table 10.1 for Canada and the U.S.

Table 10.1 Timeline for study management

Study management - Canadian Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
-	Study manager	X	X	X	X	X
-	Workshops	X	X	X	X	X
-	IJC support staff	X	X	X	X	X
-	Travel fees	X	X	X	X	X

Study management - US Timeline						
Id	Tasks	YR1	YR2	YR3	YR4	YR5
		17-18	18-19	19-20	20-21	21-22
-	Study manager	X	X	X	X	X
-	Study co-chair	X	X	X	X	X
-	Workshops	X	X	X	X	X
-	IJC support staff	X	X	X	X	X
-	Travel fees	X	X	X	X	X

11 Timeline Summary

Table 11.1 presents the study's main objectives timeline to be addressed by the three technical working groups and the analysis group, the PAG, IM/IT, IRG, secretariat and study management. Figures 11.1 and 11.2 illustrate the Canadian and U.S. budget for the LCRR study.

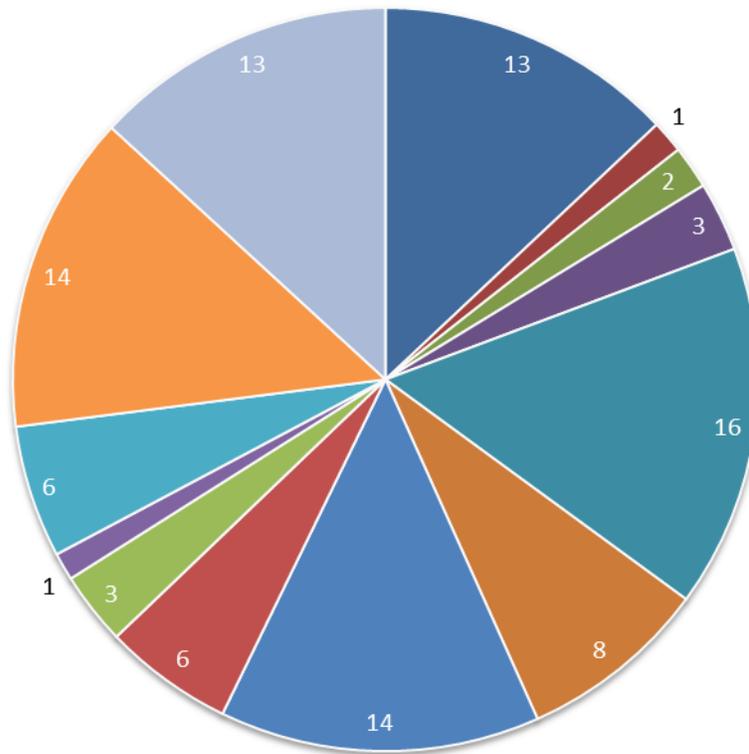
This Work Plan will be revised over the summer of 2017 after receiving input from the public, stakeholders and decisions-makers, the IRG and the IJC. Refinements are still required and discussions with all TWGs and AG will be also held to produce an optimized work plan and to resolve pending issues. A final version of the workplan will be submitted to IJC by October 2, 2017. All study material will be finalized by April 2021.

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Table 11.1 LCRR Study’s timeline

LCRR Study - Canadian Timeline					
Sections	YR1	YR2	YR3	YR4	YR5
	17-18	18-19	19-20	20-21	21-22
Physics of the system	X	X	X	X	
Evaluating the causes and impacts of past floods, especially the event of 2011	X	X			
Evaluating possible adaptation strategies to the expected future variability in water supplies	X	X	X	X	
In-depth study of current social and political perception on flood mitigation measures	X	X	X	X	
Development of a collaborative decision support tool (CDST)	X	X	X	X	X
Performing a quantitative and qualitative assessment of structural and non-structural potential flood management and mitigation measures	X	X	X	X	X
Development of flood forecasting and real-time floodplain mapping system for operational implementation		X	X	X	X
Public participation and outreach	X	X	X	X	X
IM/IT	X	X	X	X	X
Independent Review	X	X	X	X	X
Secretariat	X	X	X	X	X
Study Management	X	X	X	X	X
LCRR Study - US Timeline					
Sections	YR1	YR2	YR3	YR4	YR5
	17-18	18-19	19-20	20-21	21-22
Physics of the system	X	X	X		
Evaluating the causes and impacts of past floods, especially the event of 2011	X	X			
Evaluating possible adaptation strategies to the expected future variability in water supplies	X	X	X	X	
In-depth study of current social and political perception on flood mitigation measures	X	X	X	X	
Development of a collaborative decision support tool (CDST)	X	X	X	X	X
Performing a quantitative and qualitative assessment of structural and non-structural potential flood management and mitigation measures	X	X	X	X	X
Development of flood forecasting and real-time floodplain mapping system for operational implementation	X	X	X	X	X
Public participation and outreach	X	X	X	X	X
IM/IT	X	X	X	X	X
Independent Review	X	X	X	X	X
Secretariat	X	X	X	X	X
Study Management	X	X	X	X	X

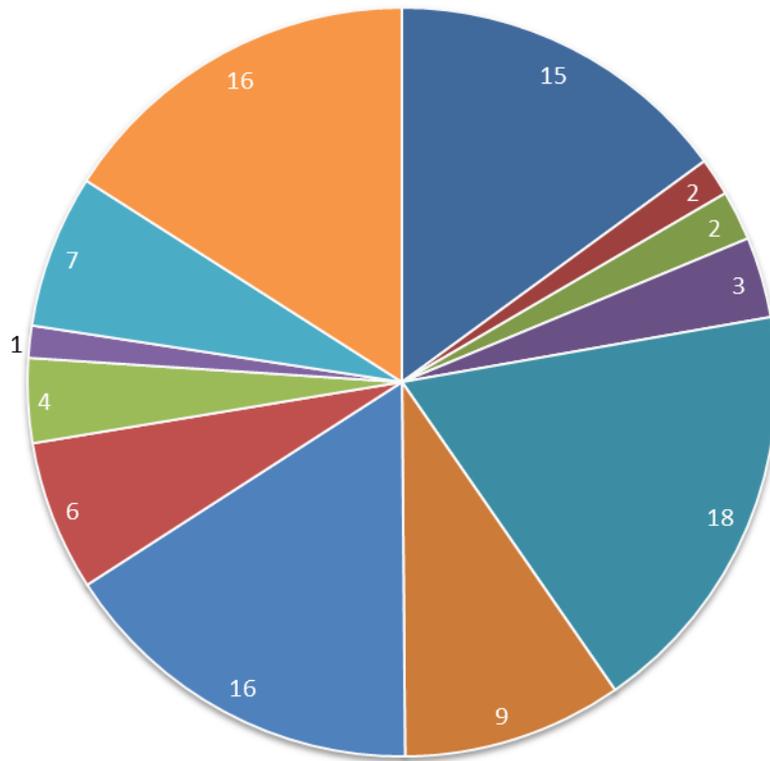
LCRR Study - Canadian budget (%)



- Physics of the system (13%)
- Evaluating the causes and impacts of past floods (1%)
- Evaluating adaptation strategies to variability in water supplies (2%)
- Evaluating social and political perception on flood mitigation measures (3%)
- Development of a collaborative decision support tool (CDST) (16%)
- Assessment of structural and non-structural potential flood management and mitigation measures (8%)
- Development of flood forecasting and real-time floodplain mapping system (14%)
- Public participation and outreach (6%)
- IM/IT (3%)
- Independent Review (1%)
- Secretariat (6%)
- Study Management (14%)
- Contingency (13%)

Figure 11.1 LCRR Study - Canadian budget

LCRR Study - US budget (%)



- Physics of the system (15%)
- Evaluating the causes and impacts of past floods (2%)
- Evaluating adaptation strategies to variability in water supplies (2%)
- Evaluating social and political perception on flood mitigation measures (3%)
- Development of a collaborative decision support tool (CDST) (18%)
- Assessment of structural and non-structural potential flood management and mitigation measures (9%)
- Development of flood forecasting and real-time floodplain mapping system (16%)
- Public participation and outreach (6%)
- IM/IT (4%)
- Independent Review (1%)
- Secretariat (7%)
- Study Management (16%)

Figure 11.2 LCRR Study - U.S. budget

Table 11.2 outlines the key reports that are currently envisioned to answer the joint References' objectives. Reports will be jointly written with all TWGs and AG, reviewed by the IRG, approved by the Study Board and presented to public.

The writing of the report addressing the development of the collaboration decision support tool will be led by the FMMM TWG with the contribution of all TWGs and AG. This report will contain the definition of the performance indicators and different baselines as well as the methodologies used to identify those.

The writing of the report addressing the assessment of the potential mitigation measures will be led by the FMMM with the contribution of all TWGs and AG. It will present the methodology used for the development of the CDST. It will also summarize the main results and conclusions of other key objectives of this study, like evaluating the possible adaptation strategies and the in-depth study of the social, political and economic perceptions of the proposed flood mitigation and management measures.

Table 11.2 Key reports from the LCRR Study Board

Study's main reports	Leader	Due date (estimated)
Numerical modelling of the LCRR system in the context of past and future flooding events	HHM TWG	2019-03-01
Evaluating the causes and impacts of past floods, especially the event of 2011	RR TWG	2019-03-01
Evaluating possible adaptation strategies to the expected future variability in water supplies	SPE AG	2019-03-01
Development of a collaborative decision support tool (CDST)	FMMM TWG	2019-03-01
Conducting an in-depth study of current social and political perception on flood mitigation measures	SPE AG	2021-04-01
Performing a quantitative and qualitative assessment of structural and non-structural potential flood management and mitigation measures	FMMM TWG	2021-04-01
Development of a binational flood forecasting and real-time flood plain mapping system for operational implementation	FMMM TWG	2021-04-01

ANNEXES

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ANNEX 1 Governance of the study

IJC International Lake Champlain Richelieu River (LCRR)

Study Board Governance Structure

Social Political and Economic Analysis Group (AG)

Mandate:

This group will be responsible for the execution of an in-depth study of current social and political perception on structural and other flood mitigation measures to support and confirm the desirability of potential mitigation measures, including consultations with the publics, stakeholders and decision-makers of relevant political jurisdictions and in collaboration with the Public Advisory Group (PAG). Initially, this group will be responsible to address the social dimension of causes and impacts of flooding in the LCRR basin, and adaptations to future climates once hydrological water supplies and associated water levels under selected climate change scenarios will be available (perhaps with climatological science and NGOs collaboration). This analysis group (AG) will be active throughout the Study. The group will also assist the Study on assessments of economic aspects related to the impacts of flooding, and benefit/costs analysis related to the potential flood management and mitigation measures.

In addressing Socio-political considerations, the AG will seek the input of elected officials and decision-makers to obtain their perspective on the proposed flood mitigation measures. Mechanisms/structures and processes to obtain this information will be decided by the AG. All other communications with elected or governmental officials pertaining to the overall Study should be directed/referred to the Commission. The Co-chairs of this group, with the assistance of the Study Board and the PAG will determine the required approach.

Composition:

<i>Social Political Economic Analysis Group</i>				
<i>Canada</i>			<i>U.S.</i>	
Co-Chairs	François Anctil	U. Laval	Curt Gervich	SUNY Plattsburgh
Members	Dominique Morin	U. Laval	Christopher Koliba	University of VT (UVM)
	Isabelle Thomas	U. Montréal	Heather Darby	VT extension
	Laurent Da Silva	Ouranos	Caitlin Lecker	NY Empire State Development
		Qc government	Robert Paquin	Retired, USDA Farm Service Agency (VT) Director

Hydrology, Hydraulics and Mapping TWG

Mandate:

This will be responsible for the execution of the required work, including application of the hydrological models, identification of data needs (historical, near-future and climatic weather scenarios), the hydraulic models, real-time floodplain mapping and the governance of a real-time operational flood forecasting and flood mapping system. Once calibrated, the models will serve in analysis mode as the basis to test the various flood management and mitigation measures that will be developed by the Flood Management and Mitigation Measures TWG. This TWG will be active throughout the Study. Because of the complexities of the work associated with this TWG, sub groups, or committees may be formed to address specific topics that may need additional expertise. This would be determined and recommended by the TWG once it forms.

Composition:

<i>Hydrology, Hydraulics and Mapping TWG</i>				
<i>Canada</i>			<i>U.S.</i>	
Co-Chairs	Jean Morin	ECCC	Jesse Feyen	NOAA
Members	Vincent Fortin	ECCC	Bill Saunders	NOAA, NWS NERFC
	Olivier Champoux	ECCC	Bill Coon	USGS
	Simon Ricard	MDDELCC	Tim Calappi	USACE
	Dominic Roussel	MDDELCC	Blaine Hastings	VT ANR DEC, Watershed Management Division

Flood Management and Mitigation Measures TWG

Mandate:

This TWG will be responsible for the design and assessment of the possible flood management and mitigation measures (non-structural and moderate structural) and to work throughout the study to plan, evaluate and rank the potential candidate measures for flood management and mitigation.

Composition:

<i>Flood Management and Mitigation Measures TWG</i>				
<i>Canada</i>			<i>U.S.</i>	
Co-Chairs	Ted Yuzyk	IJC	Bill Werick	Retired from US Army Corps of Engineers
Members	Jan Adamowski	U. McGill	Ben Rose	VT Division of Emergency Management and Homeland Security
	Syed Moin	IJC	Michael Kline	VT DEC, Watershed Management Division
	Brian Morse	U. Laval	Fletcher Potter	Natural Resources Conservation Service
	Pascal Marceau	Ministère de la Sécurité publique – Qc government	Jason Shea	US Army Corps of Engineers

Resource Response TWG**Mandate:**

This TWG will be responsible for the development of the indicators required for the assessment of the various flood management and mitigation measures on wetland and fauna, recreational, domestic, industrial and municipal uses, shoreline and floodplain built environment and agriculture.

Composition:

<i>Resource Response TWG</i>				
<i>Canada</i>			<i>U.S.</i>	
Co-Chairs	Glenn Benoy	IJC	Perry Thomas	Vermont Agency of Natural Resources
Members	Marianne Bachand	ECCC	Rose Paul	The Nature Conservancy (TNC) of Vermont
	Marc Mingelbier	MFFP - Qc Government	Phil Von Bargaen	Town of Plattsburgh, NY Planning Department
	Alain Rousseau	INRS-ETE	Tim Mihuc	State University of NY (SUNY) Plattsburgh
	Bernard Doyon	Canadian Coast Guard	Donna Parrish	United States Geological Survey (USGS/University of Vermont)

Public Advisory Group (PAG)

Mandate:

The PAG will serve as a conduit for public input to the study process, and for public dissemination of study outcomes, assist in developing the communications plan, provide comment on Study Board reports and products as requested, advise the Study Board on the responsiveness of the study process to public concerns, and advise the Study Board on public consultation, involvement and information exchange. This group will work with all TWGs throughout the study and will have a direct voice on the Study Board through its co-chairs. The PAG will help the Study Board to develop and propose the best possible flood management and mitigation measures, likely to be considered acceptable from the concerned publics and from the political and administrative organization responsible for the execution of the measures.

Composition:

<i>PAG</i>		
<i>Canada</i>		<i>U.S.</i>
Co-Chairs	Madeleine Papineau	Lesley-Ann Dupigny-Giroux
Members		

Independent Review Group (IRG)

The IRG is an independent group that will comment and review on study activities and products for the IJC, and provide advice to the Study Board with objectivity on the directions and work produced in this study. Anticipated involvement of the IRG will occur at strategic milestones such as the definition of the work plan, review of selected products, and final review of Study.

Composition:

Selected senior reviewers that can provide advice on the Study as a whole, as well as regarding their respective subject-matter expertise, to reflect the Study's different areas of work to be performed.

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ANNEX 2 Acronyms

AG	Analysis Group
AHPS	Advanced Hydrologic Prediction System
CD	Canada
CDSA	Collaborative Decision Support Approach
CDST	Collaborative Decision Support Tool
CGVD2013	Canadian Vertical Datum of 2013
DBM	Database Management
ECCC	Environment and Climate Change Canada
ECCC-HES	ECCC Hydrology and Ecohydraulic section
ECCC-CMC	ECCC Canadian Meteorological Center
Eng	English
Fr	French
DEM	Digital Elevation Model
FEMA	Federal Emergency Management Agency
FMMM	Flood Management and Mitigation Measures
FVCOM	Finite Volume Community Ocean Model (Hydrodynamic model)
HHM	Hydrology, Hydraulics and Mapping
IERM	Integrated Ecosystem Response Model
ILCRRSB	International Lake Champlain Richelieu River Study Board
IJC	International Joint Commission
IM/IT	Information Management / Information Technology
INRS	Institut national de la Recherche Scientifique
IRG	Independent Review Group
LCBP	Lake Champlain Basin Program
LCRR	Lake Champlain-Richelieu River
LiDAR	Light Detection And Ranging (Laser Altimetry Remote Sensing Data)
NAVD88	North American Vertical Datum of 1988
NGVD29	National Geodetic Vertical Datum of 1929

MDDELCC	Ministry of Sustainable Development, Environment, and Action against Climate Change
MSP	Ministère de la Sécurité Publique
NBS	Net Basin Supply
NOAA	National Oceanic and Atmospheric Administration
NY	New York
PAG	Public Advisory Group
Pi	Performance Indicator
PoS	Plan of Study
PPO	Public Participation and Outreach
RR	Resource Response
SPE	Social, Political, Economic
SUNY	State University of New York
TNC	The Nature Conservancy
TWG	Technical Work Group
US	United States
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UVM	University of Vermont
VMC	Vermont Monitoring Cooperative
VT	Vermont
VT DEC	Vermont Department of Environmental Conservation
QC	Quebec
USACE	United States Army Corps of Engineers
2D	Two-Dimensional
2011 event	Major flood event in LCRR basin that occurred in Spring and Summer of 2011
3D	Three-Dimensional

ANNEX 3 Proposed communication plan

LCRR Summer 2017 Communications Plan approved by the Study Board

Consultation on Work Plan: 30 day public comment period – from June 27 to July 28 2017

- ParticipateIJC.org to be used to collect comments Fr/Eng
- 12 Banners 6 Eng / 6 Fr 32” by 72” – Mandate of Study – Flood Maps of 2016 – History of Floods – 2011 Flood extra
- Executive Summary document of Study Work Plan, map, historical flood photos, PAG –get involved form, 4 pager - drive people to the website for more information
- Video (animated powerpoint) study mandate Fr/Eng for meetings, website, open houses (5 mins)
- Press release – announce 30 day consultation on work plan and public meetings
- Need to book translation services 30 days in advance.
- Website update
- Video (animated powerpoint) work plan Fr/Eng for meetings, website, open houses (5mins)

Public Meetings

July 11-13 - Three town hall style meetings: Plattsburg NY (ENG) Burlington VT (ENG) Saint-Jean-sur-Richelieu (FR/ENG – simultaneous translation) (Map of locations below)

Scenario

- | | |
|--------|---|
| 6:00pm | Open House - six stations with 1 banner at each station (fr/eng for QC) – Technical staff at each station set up around the room – take questions one on one. |
| 7:00pm | Introduction - 15 min presentation – 2 five min videos fr/eng
Focus on the mandate of the Study and the Work Plan |
| 7:15pm | Q&A from Public |
| 8:45pm | Summary of next steps/ closing of meeting |

Open Houses

July/August A number of open houses (8) from the following smaller communities affected by flooding

Saint Paul-de l'Île aux Noix QC, Richileu QC, Venise-en-Quebec, Henryville QC, Rouses Point NY, Point Au Roche, Chazy Landing, NY, North Hero VT, Alburg VT, Shelburne, VT (Map of locations below)

Scenario

One rep from the relevant Basin organization and at least one Study board member would go to each location, the six banners would be set up – around the room – so people can review at their own pace. Large screen tv should be in a far corner playing the presentation on loop –need to purchase if one of the Basin Organizations do not have.

Promotion

Newspaper ads – local papers in all flood prone areas in Study

Radio ads – local stations in all flood prone areas

Editorial Boards – major local papers TBD

Posters – Public Meeting locations / Open house locations

Facebook - \$1000k targeted at shoreline communities near each meeting/open house site

Postal Drop \$5k targeted at shoreline communities near each meeting site

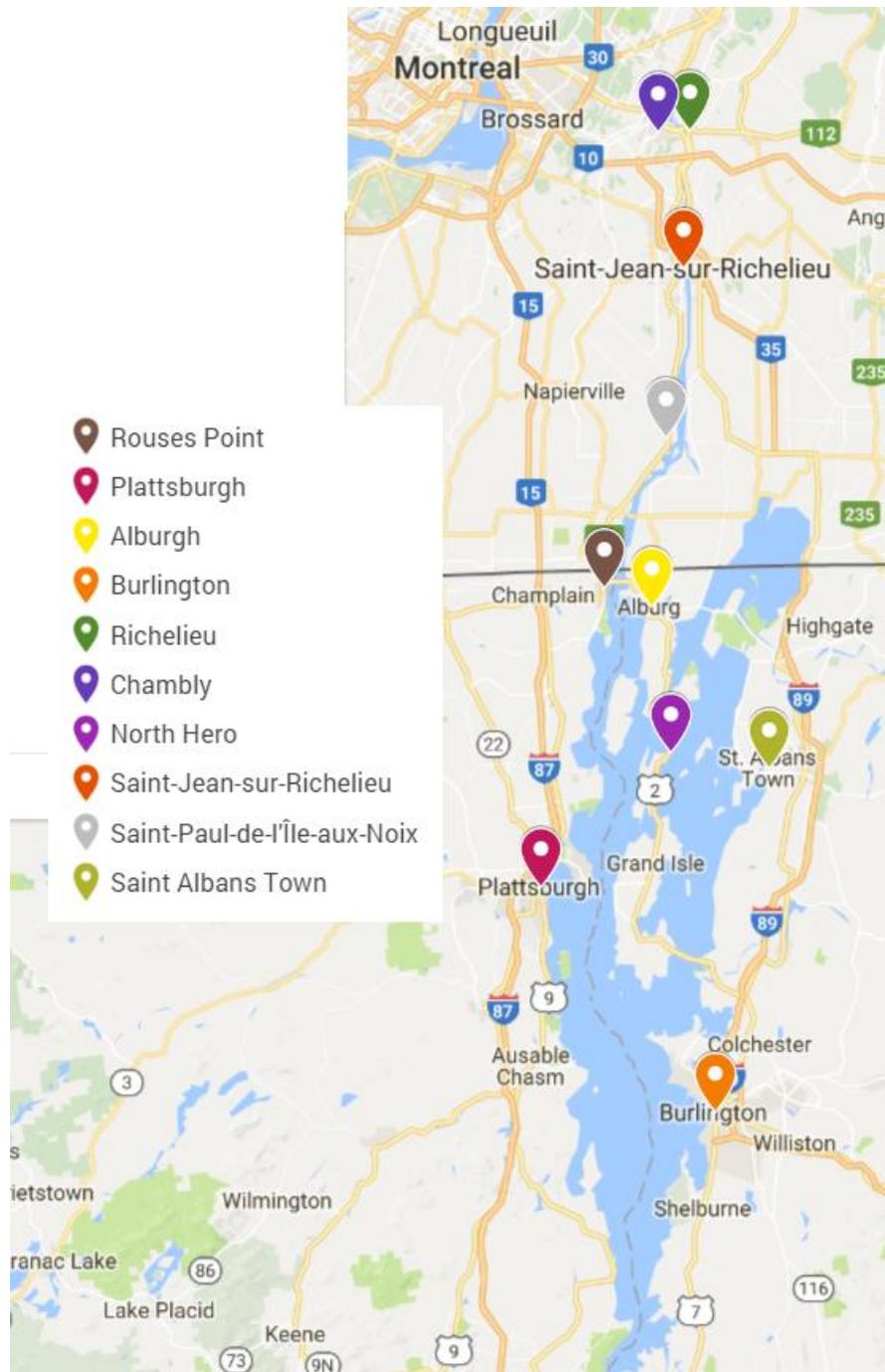
Other Activities

Database

- Develop an Access Data base to have all study contacts, in one place, accessible to all study board members, twgs etc – on the share point site. Need to track contact, and networks, etc. not just a flat list. – coordinate with IT group
- Populate data base.
-

1st Quarterly Newsletter

To be developed and circulated to those who attend the meetings ect.



ANNEX 4 References

International Joint Commission, 2013. The Identification of Measures to Mitigate Flooding and the Impacts of Flooding of Lake Champlain and the Richelieu River. 144p. (http://ijc.org/files/publications/Final_PoS_LakeChamplain-RichelieuRiver.pdf)

International Joint Commission, 2015, Progress towards an operational real-time flood forecasting and flood inundation mapping system for the Lake Champlain and Richelieu River, 91p. (http://ijc.org/files/tinymce/uploaded/LCRRTWG/Final_Report_LCRRTWG_2015-11-30_EN.pdf)

Kiah, R.G., Jarvis, J.D., Hegemann, R.F., Hilgendorf, G.S., and Ward, S.L., 2013, Hydrologic conditions in New Hampshire and Vermont, water year 2011: U.S. Geological Survey Open-File Report 2013–1135, 36 p., <http://pubs.usgs.gov/of/2013/1135/>.

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