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*Lake Champlain – Richelieu River  
International Study Board  
Semi-Annual Report  
April 2021*

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**INTERNATIONAL LAKE CHAMPLAIN – RICHELIEU RIVER STUDY BOARD**

Commissioners:

The International Lake Champlain-Richelieu River Study Board submits herein its Semi-annual Progress Report, covering activities from October 1, 2020 to March 31, 2021.

**1 SUMMARY**

Despite the ongoing challenges posed by the COVID-19 pandemic and the limitations of virtual engagements, the Lake Champlain – Richelieu River Study continued to make steady progress towards fulfilling the Study mandate. As per the mandate, the Study is refining binational models and guidance for coordinated flood forecasts and warnings. During this reporting period, significant progress on the evaluation of moderate structural and non-structural measures was made. Development and refinement of social, economic, and environmental performance indicators continues. Considerable effort and evaluation towards assessing the impacts of climate change on future water supplies, and towards incorporating this information across Study investigations, is ongoing. Throughout all this work, the social, political, and economic acceptability of mitigations strategies that the Study is considering continue to be assessed.

A particularly notable achievement during this reporting period was the execution of eight technical webinars, offered in French and English. These webinars provided an opportunity for interested members of the public, representing a variety of stakeholder groups, to gain a greater understanding of the specialized work the Study is undertaking. During these webinars, TWG (Technical Working Group) members delivered short presentations on the technical aspects of their work, and then engaged in question-and-answer sessions with attendees. Over 250 individuals attended these webinars, and many of those individuals tuned in for more than one. Recordings of the webinars are available on the Study website for continued outreach. The SPE team developed a survey that was distributed to webinar participants, to learn more about their preferences around flood mitigation measures.

Additional highlights from the work completed over this reporting period include:

- The completion of a full draft and initiation of independent review of the “Flood water storage using active and passive approaches - Assessing flood control attributes of wetlands and riparian agricultural land in the Lake Champlain-Richelieu River watershed” report.

- Engagements with municipalities in Québec and emergency responders/municipal planners in the US around flood hazard response planning. In Québec, a series of virtual workshops were held to engage emergency responders with Study products, including improved forecasts and flood inundation maps. In the US, interviews were held with responders and planners from Vermont and New York, and a binational workshop is being explored in the upcoming months.
- Continued collaboration with Grand Conseil de la Nation Waban-Aki and the Mohawks of Kahnawa:ke on the development of performance indicators covering important indigenous considerations, including archeological sites and black ash.
- Improvements in Lake Champlain and Richelieu River hydrodynamic models and forecasting, including tests of wind forcing and coupling between the hydrodynamic and wave models on the lake, and incorporation of the influence of St. Lawrence River water levels on Chambly Basin flooding.
- The initiation of white papers exploring flood risk mapping, communicating flood risk, floodplain management, and flood insurance possibilities.
- Progress towards investigating a potential structural solution involving the removal of man-made artifacts and the reconstruction of a pre-existing shoal around Saint-Jean-sur-Richelieu to reduce water levels during flood events.
- Refinement of the Integrated Socio-Economic and Environmental (ISEE) modeling tool.
- Publication of three issues of the Study newsletter, [\*the Current\*](#).

## 2 **BOARD and WORKING GROUP ACTIVITIES**

### 2.1 **Hydrology, Hydraulics and Mapping Technical Working Group (HHM TWG)**

#### 2.1.1 Summary of Activities:

- NOAA Great Lakes Environmental Research Lab (GLERL) has maintained an experimental real-time nowcast/forecast modeling system that has provided daily predictions of Lake Champlain water levels and wave conditions. The NOAA demonstration website, <https://www.glerl.noaa.gov/res/champlain/>, provides interactive time series plots of observations and forecasts of lake levels and wave height at four key points around the lake. Spatial plots of wind conditions, water level changes, surface currents, and wave conditions across the lake are also provided. Model predictions from the FVCOM hydrodynamic model and the WAVEWATCH III wave model of the lake developed for the study are run autonomously every day to provide these graphics.
- NOAA GLERL and its in-house partner, the Cooperative Institute for Great Lakes Research (CIGLR), have continued to conduct sensitivity analyses of the FVCOM hydrodynamic model and the WAVEWATCH III wave model of Lake Champlain. These tests of wind forcing and model coupling are critical to determining the robustness and skill of the Lake Champlain flood forecasting system. Furthermore, skill assessment of water level predictions from November 2019 to January 2021 were conducted. At Rouses Point, RMS errors increase from approximately 2 to 6 cm over the models 120 hour forecast horizon; bias is minimal, extending from roughly -1 to -2 cm.
- NOAA GLERL and CIGLR evaluated water level data from both sides of the South Hero Causeway. In order to investigate potential water level gradients between sides of the causeway in Lake Champlain (which are caused by the narrow openings in the causeway) the University of Vermont's Forest Ecosystem Monitoring Cooperative collected 10-minute water level data from both north and south sides of the causeway from June 7 to November 4, 2019. The data, after cleaning and processing, indicate that the water levels on both sides of the causeway typically respond similarly with only small, short term differences that are typically less than 1 foot.
- US HHM coordinated with the local National Weather Service (NWS) Weather Forecasting Office (WFO) in Burlington, VT to assess the availability of ice cover data to inform wave predictions on the lake. It was determined the WFO tracks ice cover via satellite imagery and generates a coarse map of ice cover.
- US and Canadian HHM members have continued developing the binational flood forecasting report, which is being expanded to address the plans for the binational flood forecasting and real-time floodplain mapping system for operational implementation. Contributions were received from the NWS Northeast River Forecast Center.
- High resolution 2D hydrodynamic models of the lake/upper river: Lower Richelieu river hydrodynamic models were adapted to account for the considerable influence of the St. Lawrence River level on Chambly Basin flooding. Many hydrodynamic conditions (120) were implemented in the Integrated Socio-Economic and Environmental (ISEE) system and the interpolation functions of ISEE were validated.
- Numerous mitigation solutions to mitigate in-river flows (Theme 1) were tested with specialized hydrodynamic simulations on the St-Jean Shoal model. This work is related to a

1) low-cost diversion, 2) Artifact removal from the shoal and 3) shoal reduction and creation of a new shoal upstream.

- Significant effort was invested in the final calibration and validation of the Canadian National Surface and River Prediction (NSRPS) system for forecasting the hydrology of the Lake Champlain-Richelieu River basin. The present system provides an ensemble of forecasts of tributary flows into Lake Champlain. Both the deterministic (DHPS) and ensemble (EHPS) hydrologic prediction systems are being piloted by NSRPS.

### 2.1.2 Project Task Status:

- **Task HHM1: Hydrometeorological & basic modelling & data collection. Status: *Nearly completed***

This task is complete in Canada. The Water Balance Model (WBM) has been updated for specialized uses. Documentation of the latest version of the WBM must be done. In the US, the collection of wave observations in Lake Champlain was delayed by the cancellation of field work last season due to COVID-19. This work will commence shortly as the buoy will be deployed for the 2021 season. NOAA is developing a report on the model configuration and skill of the Lake Champlain hydrodynamic model and will continue the calibration of the Lake Champlain wave model-based wave observations collected this season.
- **Task HHM2: Hydrologic model development: testing and calibration. Status: *Completed***

The Canadian hydrological forecast system (NSRPS) is calibrated & validated.
- **Task HHM3: 2D hydrodynamic (flood mitigation) model development. Status: *Nearly completed, progressing as planned***

2D Hydrodynamic models for the lower Richelieu River have been calibrated and validated. Many static scenarios were produced and implemented in the ISEE system. The transient mode (dynamic) model needs to be finalized for it to be used in a forecast mode. Documentation will be done during FY2021-22 (April to March).
- **Task HHM 4: Hydroclimatology scenarios. Status: *Completed***

Climate change hydrologic series are finished and available. Hydroclimatic NBS (Net Basin Supply) series are available for numerous climate change scenarios.
- **Task HHM5: Hydrometeorological analysis of past floods. Status: *Completed***
- **Task HHM6: Analysis of mitigation plans. Status: *Progressing as planned***

Numerous structural mitigation measures in the Richelieu River (Theme 1 Mitigation solutions) were elaborated, modeled with 2D hydrodynamics, and tested using the WBM. New solutions are being tested and refined. Approved solutions will be implemented in ISEE for assessment.
- **Task HHM7: Development of real-time flood forecasting system. Status: *Progressing as planned***

A report on a binational forecast and real-time flood inundation mapping system and its governance is currently being finalized. A forecast system (Environment and Climate Change Canada) that is integrating hydrological forecast and hydrodynamic simulations (wind set-ups on river's discharge & mapping) will be brought to a "near operational" status, i.e., proof of concept. Static inundation map products produced in the Study are tested by Quebec government to be included into official Quebec forecasts within INFO-

Crue/Vigilance framework. NOAA GLERL has completed the development and experimental implementation of a hydrodynamic model for real-time predictions of lake levels for Lake Champlain.

### *2.1.3 Work Anticipated Over Next Three Months:*

- NOAA GLERL will maintain the experimental hydrodynamic and wave modeling system and website to provide daily real-time predictions of water levels, currents, and wave conditions in Lake Champlain.
- NOAA GLERL will work with University of Vermont to deploy a WaveRider wave buoy in Lake Champlain to collect critical wave observations for validation of the Lake Champlain WAVEWATCH III model. The buoy will be deployed in the deep basin of the lake between Burlington and Port Douglass. This buoy will be deployed throughout the 2021 boating season after a delay in 2020 due to the COVID-19 pandemic.
- U.S. and Canadian members of HHM will work together to address study objective 5.6: development of a binational flood forecasting and real-time flood plain mapping system for operational implementation.
- NOAA will continue to work on transition of the WAVEWATCH III wave model for Lake Champlain to operations. When complete this will result in a new forecast capacity of wave conditions in the lake.
- NOAA will continue its work in skill assessing the Lake Champlain hydrodynamic model. This skill assessment procedure is critical to documenting the validity of the model prior to its operational installation within NOAA's weather forecasting supercomputing environment.
- HHM Canada:
  - Development and analysis of mitigation solutions and production of 2D hydrodynamic modelling for ISEE.
  - Documentation of 2D hydrodynamic models: lake and river.
  - Documentation of mitigation solutions modelling.
  - Documentation of the latest version of the Water Balance Model.
  - Bring the Canadian hydrology-hydrodynamic forecasting model closer to a “real time” model.
  - Finalization of the report on flood forecasting and mapping.

## **2.2 Flood Management and Mitigation Measures Technical Working Group (FMMM TWG)**

### *2.2.1 Summary of Activities*

- FMMM worked closely with HMM and Parks Canada on an optimized canal diversion under Theme 1. This alternative was determined to cost in the order of \$83 million (USD). Based on benefit-cost analyses, this will not be a viable solution. Due to this, FMMM has turned its attention on the removing man-made artifacts in the shoal combined with a much less costly diversion scheme to find a potentially viable structural solution.
- The Theme 2 report that looks at wetland development and temporary flooding of agricultural land to mitigate flooding has been completed by the contractor, Dr. Alain Rousseau (INRS). It has been sent to the Independent Review Group (IRG). FMMM is

working with the Study Board to determine the policy implications related to the scientific findings from this report.

- Under Theme 3, FMMM is leading an effort that involves all the other TWGs (Technical Working Groups) to assess emergency responders needs in the Quebec portion of study area. This work is being conducted through a series of virtual workshops involving emergency responders from many Canadian communities along the Richelieu River. The study team presented key study products to the responders including a mock five day forecast of water levels and flows, maps of the inundated areas, and analysis of the forecasted impacts as calculated in ISEE and presented in a collaborative decision support tool (CDST) for this purpose. Planning is underway with U.S. responders to determine what Theme 3 exercise would be most valuable on the US side.
- FMMM is leading on the preparation of White Papers that address four topics under Theme 4: flood risk mapping, communicating flood risk, floodplain management and flood insurance. Contracts were put in place for the specialists to develop the White Papers for those four topics by April 2021. The specialists include a team of Ouranos experts, Dr. Daniel Henstra and Dr. Len Shabman, in addition to SPE experts.
- FMMM continued to develop the Collaborative Decision Support Tool (CDST) that integrates the results from the Integrated Socio Economic and Environmental (ISEE) system. This was used to present and highlight information for Theme 3 virtual workshops.
- FMMM has been working with its binational team of experts and has prepared a Climate Decision Scaling Strategy Report. The experts are proceeding well with their respective analyses and there have been many exchanges as results have come forward.

### 2.2.2 Project Task Status

- *Task FMMM1 (was FMMM9): Development of a Collaborative Decision Support Tool (CDST). Status: Progressing as planned.*

Development of the CDST continues with the integration of modelling results. The current effort has been on integrating, interpreting, and validating the results from ISEE. Considerable attention has been on socio- economic PIs and in particular the application of the stage-damage curve. Functionality will continue to evolve as more PIs and knowledge are incorporated into the tool. The CDST was used to highlight flood impacts as part of a series of virtual workshops with emergency responders.
- *Task FMMM2 (was FMMM10): Development of metrics/performance indicators to evaluate the proposed measures and options. Status: Complete.*

Considerable collaboration has been ongoing with HHM, RR and SPE in the development of PIs and convergence on a suite of PIs that will be used for evaluation purposes.
- *Task FMMM3 (was FMMM11): Working with TWGs, project developers, etc.; finalize metrics/performance indicators and familiarize with model capabilities. Status: Progressing as planned.*

Much of this work is complete. Environmental PIs will require additional time for refining and collecting the appropriate environmental data. Efforts are currently focusing

on key economic and social PIs. Climate change robustness is another aspect that FMMM is now focusing on.

- *Task FMMM4: Preliminary assessment of probable in stream structural or channel modification solutions. Status: Progressing as planned.*  
FMMM worked with HHM and Parks Canada in designing an optimized canal diversion. Based on benefit-cost analyses this option was determined not to be viable. The focus is now on exploring the removal of man-made artifacts in the shoal combined with a much more modest diversion scheme, to find a much less costly solution.
- *Task FMMM5: Engagement of decision makers/stakeholders in mitigation solutions. Status: Progressing as planned.*  
FMMM has focused its attention on the decision-makers/stakeholders related to Theme 3, emergency response. FMMM has been working closely with HHM, RR and SPE to assess emergency responders needs in Quebec with regards to flow forecasting, mapping of flood damages, and vulnerability of residents
- *Task FMMM6 (was FMMM1): Survey of basin jurisdictions' approaches to flooding. Status: Completed.*
- *Task FMMM7 (was FMMM2): Literature review on structural options. Status: Completed*  
The report has been reviewed by the IRG and has been revised based on this input. The Study Board revised the final report, and this was considered in the production of the final report that is now available to the public.
- *Task FMMM8 (was FMMM3): Literature review of nonstructural options. Status: Completed.*
- *Task FMMM9: Expert workshop on options for LCRR basin: now FMMM 16 and 19.*
- *Task FMMM10: Initial assessment and prioritization of proposed metrics/ performance indicators to use to evaluate mitigation measures. Status: Progressing as planned.*  
FMMM began this task, working with RR in meetings and teleconferences to develop methods for calculating damages and social impacts. FMMM and RR are considering which environmental PIs need to be used in the evaluation of all Themes.
- *Task FMMM11 (was FMMM7): Shortlist the options (non- structural and structural). Status: Progressing as planned.*  
This is a shared effort between all the TWGs. FMMM has provided input on questions to be addressed by surveys and interviews. FMMM is applying the results of these surveys/interviews to determine potential support for specific options.
- *Task FMMM12 (was FMMM8): Engineering feasibility assessment. Status: Proceeding as clarified. No longer applicable.*  
This task was originally conceived as a separate review by a structural engineer. As the study progressed, it became clear that this study would not produce a single structural alternative, such as the gated structure proposed by previous IJC study teams, so the nature of the task was clarified. Structural flood risk reduction projects generally go through a long, iterative feasibility assessment. The LCRR study has performed the initial formulation and evaluation of a few Theme 1 projects; any that look promising will need much more extensive assessments, including more detailed assessment of engineering feasibility. The engineering feasibility of each structural alternative formulated in the study (such as the diversion, weirs, and dredging) have been reviewed collaboratively

with federal and provincial partners, including preliminary review by hydraulic engineers, to assure effectiveness and robustness. If any study alternative is selected for consideration by governments, there will be more thorough analysis of every aspect, including engineering feasibility.

- *Task FMMM13 (was FMMM14): Recommend a governance mechanism for the operation of the forecasting system. Status: Initiating.*

Progress is ongoing on this specific task. The Study has developed a plan that has seven specific projects to address the development of the binational flood forecasting system. FMMM is the lead on reaching out to emergency responders on their forecasting requirements. FMMM will be working with HHM on a proposed governance mechanism going forward.
- *Task FMMM14 (new). Assess potential of upland storage. Status: Completed, pending IRG review of report.*

Dr. Alain Rousseau (INRS) has completed this report. It is undergoing peer review. FMMM is working with the Study Board to determine the policy implications related the scientific findings from this report.
- *Task FMMM15 (new). Conduct decision scaling to produce Probable maximum Floods (PMF), Climate Change and stochastic Net Basin Supply (CC NBS) Sets. Status: Progressing as planned.*

FMMM has assembled a team of experts and put contracts in place to undertake the defined work. The team of experts have met through videoconferencing to discuss linkages with the projects, data exchange, and to plot a path forward. Work is progressing on these contracts. A Climate Decision Scaling Strategy report has been produced.
- *Task FMMM 16 (was FMMM9). Prepare for and conduct the Forecasting and Flood preparedness Response (Theme 3) workshop. Status: Partially Completed.*

A series of virtual workshops have been held with emergency responders from numerous communities on the Richelieu River and Missisquoi Bay. Efforts are underway to undertake comparable virtual workshops on Lake Champlain.
- *Task FMMM17 (new). Survey responders to ask how they use forecasts. Status: Partially Completed.*

FMMM is working with SPE to analyze the results of the surveys/interviews and assess the feedback from emergency responders that was received during the Theme 3 workshops. This issue is being further explored in the series of virtual workshops in Quebec and may be continued in U.S. workshops.
- *Task FMMM18 (new). Conduct U.S. and Canadian pilot flood response project. Status: Partially completed.*

This was addressed in the series of virtual workshops in Canada and options are being explored in the US.
- *Task FMMM 19 (was FMMM9). Theme 4 workshop. Status: Completed.*

FMMM contracted with two experts and held a two-day floodplain management solution workshop (Theme 4) in Montreal in February 2020 with both American and Canadian flood plan managers and experts. A report was produced by the experts that has provided direction for the Study going forward.

### 2.2.3 Work Anticipated Over Next Year

- Explore in more detail the removal of man-made artifacts in the shoal and a less costly canal diversion solution (Theme 1).
- Draft report for Study Board that includes a comprehensive evaluation of Alternative 1-3 (Theme 1).
- Work with contractor to respond to peer review comments on *Assessing Flood Control Attributes of Wetlands and Riparian Agricultural Land in the Lake Champlain-Richelieu River Watershed* (Theme 2).
- Analyze with SPE the feedback from emergency responders from virtual workshops and provide an assessment on the utility of the study products and 5-day forecast (Theme 3).
- Finalize White Papers for four topic areas for Theme 4 workshop and draft recommendations for Study Board consideration.
- Review and improve GIS data supporting the estimation of damages in the U.S.
- Develop stage-damage tables for each U.S. building in the study area.
- Assess products from the climate research and incorporate into the decision scaling exercise to assess implications for each of the Themes. Draft report to capture the results.
- Contribute to and provide input on the development of a proposed governance mechanism for the binational flood forecasting to be put in place after the study has been completed, and an inundation mapping system.
- Continue the development of the CDST and analysis of outputs from ISEE.

## 2.3 **Resource Response Technical Working Group (RR TWG)**

### 2.3.1 Summary of Activities

- Iterative review of performance indicators (PIs)
  - Production of sets of PI-derived flood damage and social vulnerability online maps targeted for emergency measures.
  - Organization of the Theme 3 workshops in Canada and review of PI mapping products through a virtual flood exercise with eight Quebec municipalities.
  - Continued drafting of a report on the selection and development of social, economic, and environmental performance indicators.
  - Improvement and implementation of a set of PIs on the built environment, agriculture, and the environment.
  - Collaboration towards the development, improvement, and implementation of various economic and social performance indicators with the SPE AG in Canada and the US, such as population vulnerability, damages to commercial, industrial, and recreational buildings, public infrastructures, and socio-sanitary impacts.
  - Consultation with indigenous groups for the development of performance indicators addressing indigenous concerns, such as land occupation and habitat suitability of various plant and wildlife species of interest.
  - Acquisition of information of fish passage operation for PI development.
- Continued development of PIs:

- Continued development of economic PIs in the U.S., including structural damage using FEMA’s Hazus model. GIS processing for economic PIs and collaboration on the integration of the economic analysis in the overall workflow.
- Development and coding of environmental PIs such as wetlands succession, copper redhorse, least bittern, waterfowl, and northern pike.
- Data processing for the development of an archeological site vulnerability PI.
- Development of a water intake PI in Canada.
- Continued development of an integrated modeling platform (ISEE):
  - Integration of the Chambly canal diversion in the model and running water level and performance indicators available in a best-case approach to inform a Study Board decision.
  - Enhancement of the ISEE system by integrating the effect of the St. Lawrence River on the downstream reach, the management of the St. Ours dam, a daily water supply time steps and a slope correction in the upstream reach to account for seasonal variations in channel roughness.
  - Restructuration of the ISEE model (ISEE V2) for improved speed and memory allocation.
  - ISEE structure and code external review.

### 2.3.2 Project Task Status

- *Task RR1: Review of impacts of past floods on resources (and coordination of the Causes and Impacts report). **Status: Completed.***
- *Task RR-2: Iterative review and selection of indicators. **Status: Proceeding as planned,*** Report release was delayed due to important reallocation of resources to online mapping and Theme 3 workshops.
- *Task RR-3: Analysis of water uses and water intakes. **Status: Delayed*** Delayed in the U.S. due to very long delays in obtaining data. Slightly delayed in Canada due to important reallocation of resources to online mapping and Theme 3 workshops.
- *Task RR-4: Analysis of shoreline and floodplain-built environment. **Status: Proceeding as planned.***
- *Task RR-5: Analysis of impacts on agriculture. **Status: Proceeding as planned.***
- *Task RR-6: Analysis of the natural environment. **Status: Proceeding as planned.***
- *Task RR-7: Integrative tool for the assessment of impacts on resources (ISEE). **Status: Proceeding as planned.***  
New Theme 1 alternative required for the Study Board requires additional work.
- *Task RR-8: Resource baseline assessment. **Status: Proceeding as planned***
- *Task RR-10: Assessment of cumulative impacts of anthropogenic modifications to the system. **Status: Completed***

### 2.3.3 Work Anticipated Over Next Three Months

- Complete drafting of a report on the selection and development of social, economic, and environmental performance indicators.

- Integration of a new Theme 1 alternative (St. Jean shoal restoration to natural state) in the ISEE model and run performance indicators to inform a Study Board decision. Relay economic performance indicators to economists for cost-benefit analysis.
- Complete coding of environmental performance indicators, including a wetland succession model in the U.S.
- Complete coding of indigenous archeological sites and indigenous concerns PIs.
- Improve accessibility to road network PI.
- Drafting of report on the evaluation of the baseline and mitigation measures using performance indicators.
- Continued production of flood impacts online maps for dissemination to Study members and Study Board.
- Initiate drafting of report on the ISEE model mechanics and metadata.

## ***2.4 Social, Political and Economic Analysis Group (SPE AG)***

### ***2.4.1 Summary of Activities***

- Data for the CA-Household Risk Perception Survey was collected and analysis is ongoing.
- A public technical webinar was organized to present the integrated results of SPE.
- Another technical webinar was organized to present the methodology and results from the economic team.
- A survey was distributed following the technical webinars and a summary of the results was provided to the Study Board.
- A presentation of SPE tasks 4 and 5 results was organized for the Study Board.
- SPE contributed to the planning of the Municipal needs assessment workshop sequence on Theme 3 (CA) and planned interviews with first responders and municipal/regional planners and other decision makers (US).
- SPE is contributing to the four white papers on Theme 4.
- A final version of the Social Network Analysis (SPE 8 and 9) and answers to comments from the Study Board members were submitted on October 15<sup>th</sup>, 2020.
- Preparation of a note on the changes to the normative framework in Quebec is ongoing (SPE 8).
- The Canadian part of the economic team of SPE was mandated last summer by the Study Board to produce a report covering the economic analysis for the LCRR study of the IJC. As of now, preliminary results with regards to the Chambly Canal diversion have been shared with the Study Board.
- As part of the cost-benefit analysis, SPE-Economists worked jointly with HHM and RR to develop a framework to compute the distribution of flood probabilities for each house and building in the floodplain. This provides a robust overview of the distribution of damages for a typical year as well as for extreme and minimal flood events.
- To evaluate the economic feasibility of the insurance scheme as part of Theme 4, the economic team is developing a model that estimates the risk aversion of households from the data of the Risk Perception Survey. Risk aversion measures how much households will pay for insurance premiums.

- Preliminary recommendations from SPE were provided to the Study Board;
- Planning continued to produce a final integrative SPE report.

#### 2.4.2 Project Task Status

- *Task SPE 1: Historical analysis of flooding from a social, political, economic, and public health perspective. Status: Completed.*
- *Task SPE 2: Press review of past floods. Status: Completed*
- *Task SPE 3: Inventory of existing studies with relevant social, political, and economic information. Status: Completed*
- *Task SPE 4: Vulnerability and resilience of local community assessment. Status: Completed*
- *Task SPE 5: Risk Perception analysis. Status: In progress*  
 In order to complement the household risk perception survey and analysis carried out in the US, the Canadian Household Risk Perception Survey was distributed in Quebec and the data collection was completed. The results are currently being analyzed by several teams in the SPE group and are used to develop an insurance scheme based on risk aversion.
- *Task SPE 6: Development of social, political, economic, and public health indicators. Status: Completed*
- *Task SPE 7: Develop an IJC LRCC Outreach plan. Status: Completed*
- *Task SPE 8: Governance analysis on flood preparedness and response. Status: In progress*  
 Final edits are being compiled and will be submitted in the coming months. In Canada, SPE participated in the planning of the Municipal needs assessment workshops. Semi-directed interviews with municipalities and agencies participating in the workshops are planned for spring 2021. SPE is planning interviews with first responders, planners, and decision makers for the week of March 15<sup>th</sup>, 2021. A note on changes to the normative framework and the new legislation regarding floodplain in Quebec is being prepared by SPE.
- *Task SPE 9: Assessment of Political Acceptability. Status: Progressing as planned*  
 SPE attended each of the technical webinars and produced observation notes with reactions of the public. SPE distributed a survey following the technical webinars, analyzed the results and produced a summary for the members of the Study. Results will be integrated in SPE's integrative report. SPE Canada helped with the planning of the Municipal Needs Assessment workshop, produced observation notes, and is planning interviews with the municipalities regarding the tools provided to them. Interviews with other organizations, elected officials and agencies are also being planned for the spring. SPE Canada produced a final version of its report on *Social Network Analysis and Political feasibility* (SPE 8 and 9) (transmitted to the Study Board on October 15<sup>th</sup>, 2020). SPE Canada attended LCRR – Parks Canada – PSPC Technical meetings on the Chambly Canal Diversion.
- *Task SPE 10: Cost-Benefit Analysis of Potential Mitigation Measures. Status: Progressing as planned*  
 The economic team of SPE has completed the development and integration of economic performance indicators as part of the cost-benefit analysis of the LCRR study. We do not plan to develop additional indicators that contribute to the analysis of Theme 1 related

alternatives. A preliminary cost-benefit analysis of the Chambly Canal diversion measure for Theme 1 was presented to the Study Board.

- *Task SPE 11: Coordination and Integration (social political economics). **Status:** **Progressing as planned***

There are monthly meetings between SPE Canada and USA. SPE Canada and USA are in the process of adopting a work plan and table of contents for the integrative SPE final report.

#### 2.4.3 Work Anticipated over the next year

- Complete a final round of interviews on political feasibility and Theme 3 (SPE Canada).
- Complete a round of interviews on Theme 3 and assess whether to hold a more robust workshop or some similar process (SPE US).
- Complete a note on changes to the normative framework in Quebec.
- Analyze results from the Municipal Needs Assessment Workshop on Theme 3.
- Collaborate with RR to analyze available mitigation measures using performance indicators (as appropriate).
- Review the white papers on Theme 4.
- A first draft of the economic analysis final report is soon to be distributed internally for review and comments by TWGs and Study Board members. This document contains most of the analysis for Chambly Canal diversion measure for Theme 1. Several sections in the report are still a work in progress or prone to revisions due to developments related to hydrological components of ISEE and ongoing discussions between TWGs.
- Revision of the results presented in the economic analysis report based on the revision to the output of ISEE from RR. Furthermore, a supplemental alternative for Theme 1 will be evaluated as part of the economic analysis. This measure is currently being integrated into ISEE by RR and consists of using excavation to restore water levels to a more natural state.
- SPE US is analyzing the transboundary results of the household risk perception survey and will produce a report outlining the key takeaways of how the public in Quebec, Vermont, and New York perceive flood risk, their support for various flood mitigation measures, and their preferences regarding flood mitigation decision criteria.
- SPE plans to investigate the premise of using extreme flood events for cost-benefit analysis with decision scaling.
- SPE US is planning to investigate the potential for an intergovernmental management protocol to mediate the heterogenous governance structures across the basin regarding flood management and mitigation.
- The analysis of an insurance scheme for Theme 4 is currently being worked on and the economic team plans to integrate the results into its final report.
- The economic team also plans to revise and iterate on the economic analysis report with new results from various work in the study such as the excavation alternative of Theme 1 and the optimal insurance scheme.
- Collaborative structuration and writing of the integrated SPE final report (with US-Canada integration).
- Formulation of recommendations to the Study Board.

## 2.5 *Public Advisory Group (PAG), Communications Working Group (CWG), and Outreach Coordinators*

### 2.5.1 *Summary of PAG, CWG and Outreach Activities*

Study members have adapted their outreach and communications during the pandemic, with its related restrictions, relying upon electronic communications and virtual meetings to ensure the work accomplished during the study is relayed to the key constituencies and the general public and that feedback and comments are obtained.

The Communications Working Group (CWG) is comprised of the PAG Co-Chairs, the two study outreach coordinators, the Study Managers, SPE and the IJC Communications Liaison.

- Work with Indigenous people and IP engagement sub-group  
The Indigenous Peoples Engagement Sub-group, under the PAG, continues to work with the Grand Conseil de la Nation Waban-Aki and the Mohawks of Kahnawa:ke to gather information on archeological sites near a proposed structural mitigation measure and, through a pilot project, to develop performance indicators that are of interest, such as Black Ash (a species used for basket weaving), and an archeological site erosion caused by flooding index. A meeting was held with the RR TWG on November 4<sup>th</sup> to discuss performance indicators and on February 23, a meeting was held with the Ndakina office to discuss progress and the path forward. An article on the black ash performance indicator appeared in the February issue of *The Current*.
- Technical webinar series  
Over eight weeks, the Study Board held a series of weekly technical webinars that were intended to communicate key study research to the public and interested parties. The webinars were provided in English and French and allowed opportunities for participants to ask questions directly to study experts. The CWG assisted with the coordination and promotion of these webinars and along with members from other technical working groups were part of the technical webinar planning committee that met regularly from November to January. Both Outreach coordinators were also members of the planning committee and served as the moderators for the webinars throughout the series.  
  
The webinars were attended by over 250 unique individuals across the entire series, with approximately 530 participants in total (meaning that on average, participants joined a couple of the webinars). Each of the webinars was recorded and posted to the LCRR website within 48 hours so that participants could review them, and so that those who could not attend had the opportunity to view them. There have been over 150 views of these videos since being posted. A lessons learned document was developed to assist the Board in preparing future virtual outreach events.
- Communications Plan  
The CWG worked with the PAG and Study Co-chairs to develop a plan of the major communications activities and products (including major study milestones, such as the release of technical reports and the final public meetings) up until the completion of the study. The plan was presented to the Study Board in December 2020. All major communications products that are planned will be available in French and English.

- Theme 3 (Emergency Flood response) with municipal officials

The Canadian Outreach Coordinator was a member of the workshop planning committee that met weekly from December to March. This workshop (comprised of 4 monthly webinars) brought together local and regional emergency responders from communities along the Richelieu River and Missisquoi Bay to discuss tools and models developed by study experts as they relate to user needs before a flood. The Outreach coordinator and the PAG Co-Chair served as moderators for the webinars.

In the United States, the Outreach coordinator is working with SPE on Theme 3, which currently involves SPE interviews with key planning officials in both Vermont and New York, to gauge interest in a larger workshop with other officials.

- Other activities and meetings

The CWG met monthly to discuss and plan various communications and outreach activities. Members also attended Study Board and inter TWG meetings as required.

Here are some recent products the group is working on or have completed recently:

- Fact sheets are being developed to be released alongside major study reports that present key findings in a quick and easily-digestible manner. The first fact sheet was produced for the Potential Structural Solutions report. Several more will be developed in April and May 2021 as the Study Board approves and releases each report.
- Planning has started to produce three videos to continue to explain key study concepts to the public. The first of these will be focused on Theme 3: emergency response to flooding. It is currently being scripted. A second video focusing on Theme 4: floodplain management, will be produced later in the year. A final video outlining study recommendation will be produced toward the end of the study.
- Public and community outreach regarding the study has continued via the bimonthly newsletter, *The Current* with issues in October, December, and February. Recent editions of *The Current* have highlighted study experts, specific performance indicators and members of the PAG. Future editions will also promote upcoming major study reports.
- The CWG reviewed and enhanced elements of the LCRR's website, such as the landing page and library, and continues to keep the site up to date with relevant content and events. Additional Q&As were posted to reflect the questions asked during the September public meetings.
- The Outreach Coordinators and PAG Co-Chairs worked closely with the CWG on other communications products such as news releases, and articles for the IJC's transboundary waters newsletter, *Water Matters*.

### 2.5.2 Work Anticipated Over the Next Year

- The Public Advisory Group will meet twice this year (next meeting April 28) and act as a sounding board for draft Study Board recommendations. They will also provide advice on the dissemination of study results.

- Outreach Coordinators will assist the Study Board in contacting state, regional and local political leaders to discuss draft Study Board recommendations. The IJC will continue to coordinate outreach to federal elected officials.
- A series of public meetings will be planned and take place when the draft LCRR final report is available.
- The CWG will promote the release of upcoming major reports through various communications products such as fact sheets, news releases, newsletter articles, and the IJC’s social media platforms.
- The CWG will continue to keep the public and interested groups apprised of the study’s work and progress through regular updates through the study newsletter and on the LCRR website.
- The CWG has initiated communications with Vermont’s Regional Planning Commissions that are willing and interested to collaborate with the CWG to host meetings or share information to help reach stakeholders at the municipal and local levels.
- The CWG will assist the Study Board and the Technical writers with the production of the final report and the proposed highlight booklet.

## 2.6 LCRR Study Products

**Table 1. Timeline of Major Study Reports**

<b>Product name</b>	<b>Current Status</b>	<b>Date for IRG Review</b>	<b>Projected Completion Date</b>	<b>Report Lead</b>
Hydroclimatology of the LCRR system	Published in peer reviewed journal	N/A	Fall 2019	HHM (CA)
Causes and Impacts of past floods in the LCRR	Completed	Completed	Feb 2020	RR
Potential Structural Solutions to Mitigate Flooding in the LCRR	Finalizing translation and layout for publication	Completed	Spring 2021	FMMM
Flood water storage using active and passive approaches - Assessing flood control attributes of wetlands and riparian agricultural land in the LCRR watershed	Undergoing IRG Review	Ongoing	Spring 2021	FMMM
200 Years of Anthropogenic	A complete draft was delivered in early March. The authors are	N/A	Spring 2021	RR

Changes in the Upper Richelieu River	integrating comments from the Study Board			
A Strategy for Addressing Climate Uncertainty Affecting LCRR Flooding	A complete draft was delivered and is under review by the Board	April 2021	Late Spring 2021	FMMM - HHM
Water Supply Scenarios (description and analysis of different approaches: historic, stochastic, GCM, PMF, future climate, etc.)	In draft	April 2021	Early Summer 2021	FMMM-HHM
U.S. and Canadian Flood Forecasting in the Lake Champlain-Richelieu River Basin: Institutions, Products, and Services	In draft	May 2021	Summer 2021	HHM
Integrated socio-economic-environmental (ISEE) description methodology	In draft	May 2021	Summer 2021	RR
Social and Political Acceptability of proposed mitigation measures	Initiated	August 2021	Fall 2021	SPE
Addendum to the Structural Solutions Report	To be initiated spring 2021	August 2021	Fall 2021	FMMM
PI factsheets	Initiated Fall 2019	October 2021	Early Winter 2021	RR
PI Modeling Results	to be initiated April 2021	October 2021	Early Winter 2021	SPE
Final LCRR Study report to the IJC	to be initiated Spring 2021	December 2021	March 2022	Study Board

**Table 2. Major Study Products to be submitted for technical review**

<b>Product name</b>	<b>Current Status</b>	<b>Date for technical Review</b>	<b>Projected Completion Date</b>	<b>Report Lead</b>
Water Balance Model	initiated Fall 2019	April 2021	May 2021	HHM (CA)

Hydrodynamics of the LCRR system	Draft	Oct 2020	Nov 2020	HHM
Social Network Analysis and Governance	initiated Fall 2019	Fall 2020	Fall 2020	SPE
Report on Lake Champlain hydrodynamic model configuration and skill	to be written	March 2021	March 2021	HHM (US)
Report on Lake Champlain wave model (addendum to LC model report)	to be written	March 2021	Sept 2021	HHM (US)
Collaborative Decision Support Tool Manual	initiated Spring 2020	Fall 2021	Fall 2021	FMMM
WRF-Hydro & GEM - Hydro/Watroute hydrological modelling	to be written	Fall 2021	Fall 2021	HHM

## 2.7 Study Board

### 2.7.1 Summary of Activities

- The Study Board convened monthly virtual meetings during the current reporting period. The items that came back periodically to the meetings include: approval of the minutes of the last meeting, a summary of the activities of the various study groups, a summary of the significant events (workshops, meetings) of the last month or those to come, the governance of the study, the review of the main timelines, as well as any notable item representing an issue for the Study. In addition, during this reporting period, the Study Board dedicated considerable time and energy towards beginning to outline the Study’s final report, and initiating discussions about possible final recommendations.
- Below is a summary of the topics and decisions that were taken during these meetings:

#### **Major Study Board decisions**

- Approval for the publication of the Structural Solutions Report, pending the incorporation of minor edits and completion of the graphic design/layout by the technical writer.
- Approval of an MOU between IJC and the Communauté métropolitaine de Montréal.
- Agreement that new Study findings about structural measures will be added as an addendum to the existing Structural Solutions report.

## 2.8 *Study Management*

### 2.8.1 *Summary of Activities*

- The Study Managers contributed to the planning and execution of the technical webinar series
- The management team (Study Co-Chairs, Co-Managers, IJC liaisons, and the Communication Advisor) met weekly to ensure the proper conduct of the study and discuss the key issues. These meetings were used to guide and advise the Board on the main events and timelines of the study.
- The study managers:
  - Responsible for the overall coordination of the study in partnership with the IJC liaisons and the Study Co-Chairs.
  - Responsible for monitoring contracts and budgets.
  - Lead coordination between Study report authors and the Technical Writers.
  - Coordinate the review of Study reports by the IRG.
  - Participate in the organization of meetings or workshops.
  - Draft the agenda and participate in the Study Board meetings and calls. They lead the monthly Co-Lead calls. Whenever possible they attend and assist with TWG workshops and calls, PAG meetings, Special planning committee calls, CWG calls, and Indigenous People's engagement sub-group conference calls.

**Table 3. Meetings attended by Study members**

	Oct'20	Nov'20	Dec'20	Jan'21	Feb'21	Mar'21
Study Board	10/27	11/24	12/18	1/15, 1/26	2/23	3/23, 3/31
Co-leads	10/23	11/18	12/16	1/20	2/17	3/17
TWGs	10/20		Meeting with the US National Weather Service: 12/9		Theme 2: 2/28 US Theme 3 planning: 2/5, 2/17	US Theme 3 interviews: 3/16 (x4)
Special Planning Committee (SPC)	10/07		Theme 4 analysis: 12/14	Municipal needs assessment preparation: 1/18, 1/25	Municipal needs assessment preparation: 2/1, 2/8, 2/15, 2/22	Municipal needs assessment preparation: 3/1, 3/8, 3/15, 3/16, 3/22, 3/29
PAG		Indigenous collaboration: 11/4			Indigenous collaboration: 2/23	
Communications WG	10/5	11/2	12/7	1/11	2/1	3/1
Outreach Coordinator						
Stakeholder meeting	10/1, 10/6, 10/15	Technical webinars: 11/4, 11/5, 11/12, 11/18, 11/24,	12/10 Workshop: 12/15 Technical webinar: 12/2, 12/9, 12/16	1/11 Workshop: 1/27 Technical webinar: 1/13	Workshop: 2/25	Workshop: 3/18

### 3 BUDGET / EXPENDITURES

Funding allocations are provided for each study group for the duration of the Study, including the granted extension (2021-2022).

#### 3.1 CA and US Budgets

**Table 4: Canadian Summary Funding**

	YR1: 2016-17	YR2: 2017-18	YR2: 2018- 19	YR3: 2019- 20	YR4: 2020-21	YR5: 2021-22	Total Canada
	Actual – March 31	Actual – March 31	Actual – March 31	Actual – March 31	Actual – Oct 31	Planned	
Management	\$47,128	\$249,000	\$281,261	\$243,630	\$108,560	\$356,436	\$1,451,239
HHM	\$25,000	\$205,400	\$367,718	\$391,835	-	\$270,000	\$1,527,453
FMMM	-	\$70,484	\$107,538	\$141,710	\$175,250	\$131,000	\$742,732
RR	-	\$80,000	\$333,709	\$392,384	\$56,190	\$343,000	\$1,472,442
SPE	-	\$24,823	\$185,615	\$494,652	\$93,109	\$135,982	\$1,240,137
PPO	\$6,100	\$74,332	\$160,923	\$156,803	\$77,155	\$137,829	\$680,834
<b>TOTAL</b>	<b>\$78,228</b>	<b>\$704,039</b>	<b>\$1,436,763</b>	<b>\$1,821,013</b>	<b>\$510,264</b>	<b>\$1,374,246</b>	<b>\$7,114,836</b>

#### US

Expenses incurred in this reporting period are in line with the planned annual budget. FY21 funds are in the process of being obligated. A detailed spend plan through the end of the Study has been developed.

**Table 5: US Summary Funding**

US Summary Funding (x US \$1,000)								Total
Planning as per Work Plan	2015- 2016	2016- 2017	2017- 2018	2018- 2019	2019- 2020	2020- 2021	2021- 2022	
FMMM			\$272	\$72	\$181	\$208	\$136	<b>\$869</b>
HHM		\$340	\$511	\$245	\$282	\$25	\$150	<b>\$1,553</b>
IRG/ Publication Costs/ Technical Writing				\$5	\$53	\$180	\$415	<b>\$653</b>
PAG Co-Lead		\$37	\$38	\$19	\$29	\$38	\$28	<b>\$189</b>
Outreach			\$47	\$60	\$66	\$65	\$57	<b>\$295</b>
RR			\$90	\$132	\$63	\$160	\$19	<b>\$464</b>
Study Board				\$5	\$1	\$5	\$5	<b>\$16</b>
Secretariat		\$104	\$100		\$78	\$50	\$13	<b>\$345</b>
SPE			\$143	\$184	\$308	\$90	\$327	<b>\$1,052</b>
Study Management	\$500	\$19	\$344	\$296	\$189	\$180	\$100	<b>\$1,628</b>
<b>Total</b>	<b>\$500</b>	<b>\$500</b>	<b>\$1,545</b>	<b>\$1,018</b>	<b>\$1,250</b>	<b>\$1,001</b>	<b>\$1,250</b>	<b>\$7,064</b>

Respectfully submitted,

<hr/> <p>Deborah H. Lee US Co-Chair</p>	<hr/> <p>Jean-François Cantin Canadian Co-Chair</p>
<p><i>Mae Kate Campbell</i></p> <hr/> <p>Mae Kate Campbell US Study Manager</p>	<hr/> <p>Serge Villeneuve Canadian Study Manager</p>