Performance Indicator Summary

Performance Indicator(s): Volume of sediment eroded

Technical Workgroup: Coastal TWG – Lower River

Research by: Pacific International Engineering Corp. (Michael Davies and Neil MacDonald)

Modeled by: Neil MacDonald (in the CPE and RRM models) and also Bill Werick (in the STELLA Shared Vision Model)

Activity represented by this indicator: Amount of fine sediment input into the river due to the erosion of the banks.

Link to water levels: The relationship between the volume of fine sediments and water level varies considerably depending on location and time of year, although there is a general trend towards increased sediment input with higher water levels.

Importance: In the St. Lawrence River downstream of Montreal, erosion of clay from the riverbanks creates turbidity in the river and results in seasonal deposition of fine materials in Lake St. Pierre. Turbidity due to erosion and the resulting deposition of fine materials in the waterway can be detrimental to water quality and habitats downstream of erosional areas.

Performance Indicator metric(s): Volume (in cubic meters)

Temporal validity: This performance indicator will remain valid until certain rapidly eroding islands are lost, or until shore protection is constructed on currently unprotected areas or removed from currently protected areas.

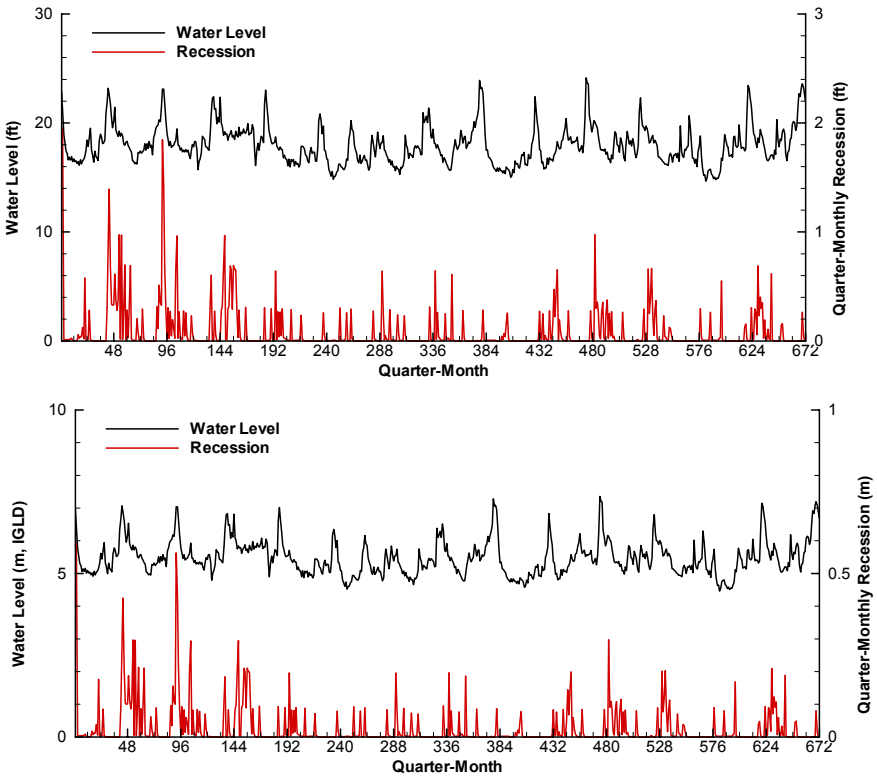
Spatial validity: Detailed modeling has been performed at 27 recession indicator sites along the river where significant erosion exists. Based on this exercise, unique relationships have been developed for the erosion at each site. These relationships are therefore based on the local wind wave, river flow and level, and shipping climate and on the specific soil conditions and morphology of the site. They are not interchangeable.

Links with hydrology used to create the PI algorithm: This performance indicator is determined from a set of 27 broad-scale erosion equations. The form of the equations and their coefficients vary from site to site and from month to month to account for local and

seasonal variability. The dependent variable in each equation is the local quarter-monthly average water level.

The algorithm: The volume of fine sediment entering the system due to bank erosion is computed from the product of the recession at a site and the length of eroding shoreline. The recession is computed from a power function of the total cross-sectional area of the profile eroded. The total cross-sectional area of the profile eroded is determined from a set of polynomial equations with coefficients that vary according to the month. It is assumed that 80% of the sediment eroded from the banks becomes suspended sediments, while the remaining 20% are sands and gravels that do not contribute to turbidity problems.

Validation: The detailed numerical modeling for erosion (CPE model) was calibrated and validated at each site using recession data obtained from air photos over a 14-year period. The broad-scale performance indicator equations (RRM model) used in the SVM model were validated by comparison with the results of the detailed modeling. The predictions given by the broad-scale model equations compare well with the more detailed modeling.



Documentation and references:

Davies, M.H. and MacDonald, N.J. (2002). *Erosion Processes in the Lower St. Lawrence River: Data Needs and Physical Processes Final Report*. Report prepared by Pacific International Engineering Corp. under contract to Environment Canada, MSC-QR.

Davies, M.H., MacDonald, N.J., Timpano, M.E., and Boisvert, A. (2003). *Shoreline Response – Data and Models.* Report prepared by Pacific International Engineering Corp. under contract to Environment Canada, MSC-QR.

Davies, M.H. and MacDonald, N.J. (2004). *Shoreline Response Lower St. Lawrence River*. Report prepared by Pacific International Engineering Corp. under contract to Environment Canada, MSC-QR, 2 volumes.

Risk and uncertainty assessment: The detailed modeling performed to generate the equations used in the SVM has been calibrated and validated only over a 14-year period and only under the conditions experienced during that period (1983-1997). Much of the banks of the lower St. Lawrence River are composed of Champlain Sea blue clay overlain by a grey lacustrine silty-clay. It has been assumed that 80% of the material eroded from each site goes directly into suspension in the river as fine sediments. This likely varies from site to site. Areas with shore protection were assumed to be fully protected from erosion, regardless of the quality of the shore protection. Only those areas that are eroding at a rate greater than 0.2 m/year (7.87 inches/year) under the present operating conditions were studied. This rate limit is derived from the accuracy of the air photo analysis from which the calibration data is derived. Therefore, the influence of areas with erosion rates less than 0.2 m/year (7.87 inches/year) is not directly included in this performance indicator.