Slobodan P. SIMONOVIĆ
Consulting Ltd.

May 5, 2005

Steven D. Topping, P.Eng.
Executive Director
Infrastructure and Operations
Manitoba Water Stewardship
200 Salteaux Crescent
Winnipeg, MB
R3J 3W3

Dear Mr. Topping;

Enclosed you will find (a) the final report and (b) the final invoice related to the contract #WS-026-05/06. With this report our services related to this contract are completed.

Thank you for the opportunity to be of assistance. It was my pleasure seeing you in Winnipeg and participating in the SPLASH model peer review process.

Sincerely yours,

Slobodan P. Simonovic, Ph.D., P.Eng
Director

Encl.

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SPLASH Model Documentation Review

The Final Report

Prepared for Manitoba Water Stewardship
Contract #WS-026-05/05

London, Ontario
May 5, 2005

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INTRODUCTION

The SPLASH model is developed by Manitoba Hydro as the long term planning tool. It is a deterministic simulation model with imbedded optimization capability. The primary role of the model is to determine the long term operation plan of the Manitoba Hydro system under various system configurations and under a range of flow conditions. The SPLASH model structure captures the mandate of the utility – to supply electrical power adequate for the needs of the Province of Manitoba in the most economical way. The Manitoba Hydro electrical power system is interconnected with neighboring Canadian and United States utilities. That expands the role of the system operation to take advantage of power export and import opportunities in order to maximize utility revenues.

IS THE SPLASH MODEL ADEQUATE TOOL TO REPRESENT WATER REGIME IN THE MANITOBA HYDRO SYSTEM?

The primary purpose of the SPLASH model is to support economic evaluations of long term system expansion decisions. Decisions on how much energy to add and when, are usually based on a detailed business case analysis for which the SPLASH model is an excellent tool.

The SPLASH model is a complex simulation-optimization tool that allows alternative system descriptions and various future flow scenarios to be investigated. Utilization of the model flexibility requires skilled user. Various model use modes offer an easy way for planning problem modifications. Therefore, the same model can adapt to different analysis tasks.

The SPLASH model provides the expected water regime resulting from the operation of hydro electric system by Manitoba Hydro. Current version of the model contains a number of limitations: (a) use of monthly time step; (b) use of perfect forecast of flow for the optimization window analysis - 12 moths; (c) use of historical flow sequence of 86 years as representative of future inflow regime; (d) use of linear programming

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algorithm for the solution of a non-linear problem through piece-wise linearization of the objective function; and (e) limited representation of the actual operations principles.

In conclusion, the SPLASH model can be used for prediction of the expected water regime. The accuracy of water regime calculation is directly related to change in the amount of energy added to the Manitoba Hydro system by an alternative future power plant. In other words the larger future power plant addition will result in more dramatic change of the flow regime. The smaller future power plant addition will result in a very small change of the flow regime.

Current version of the model is sufficiently accurate to represent the change of the water regime caused by addition of the Wuskwatim power plant to the Manitoba Hydro system.

However, it is important to point that the SPLASH model can be modified to represent with higher accuracy the change of water regime resulting from the consideration of adding a larger power plant to the system in the future.

DETAILED COMMENTS ON THE MODEL DOCUMENTATION

Document provided to the reviewer can be improved. Following suggestions are provided to assist in that process:

1. Throughout the document terms - simulation and optimization - are used in order to describe the SPLASH model. Clear presentation of the model as a deterministic simulation model with imbedded optimization very early in the document would help the reader considerably.
2. Manitoba Hydro system operation mandate should be part of this document. Multiple objectives of the mandate are dealt in the model through the formulation of an economic objective function and a set of constraints representing environmental, social and regulatory requirements. Including this in the

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documentation may provide for better understanding of model capabilities for the analyses of impacts that future system modifications (addition of new power plants) may have on the flow regime within the system.

3. Document can benefit from the clarification of the distinction between long term planning and system operations. Due to the lack of this clarification, presentation of the graph in Figure 5 adds considerable confusion to the understanding of the model accuracy.
4. The document can benefit from a simple flow diagram illustrating the simulation process with imbedded optimization.
5. Addition of the mathematical formulation of the optimization process (specifying the objective function; constraints and the linearization of the energy term) would increase the technical value of the model documentation.
6. An example of the basic model run formulation (input data set; model parameters; etc.) and its most important outputs could be a valuable addition to the document. I would suggest use of appendix for this presentation.

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