Southwest Nova Scotia Resource Assessment:

Final Report

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Executive Summary

This report summarizes the results from a 2-year investigation into the tidal energy resource potential of tidal passages in Southwest Nova Scotia. The effort was both ambitious and comprehensive, including: a) month-long deployments of Acoustic Doppler Current Profilers (ADCPs) in 5-element spatially-distributed arrays; b) bathymetric surveys using multi-beam sonar; c) high-resolution numerical modelling of the tidal circulation; d) a reconnaissance study of the flow in channels without detailed bathymetry using an innovative kayak-based surface drifter programme; e) multiple meetings with the local communities aimed at engaging the public in the tidal power development process; f) integration of the numerical model output and field measurements into a data base accessible via a Geographic Information System (GIS). The project was a collaboration among 3 academic institutions, Dalhousie University, Acadia University, the Nova Scotia Community College, and a private sector company, Fundy Tidal Inc.

The primary focus of the project was on the tidal currents in three channels in the Digby Neck area (Digby Gut, Petit Passage, and Grand Passage) for which we had some prior current and bathymetric information, and model grids already in place from earlier work. The results from the field measurements, i.e. mainly the ADCP measurements but also the new bathymetry data, were used for comparison to, and to help validate, the numerical model predictions. With the exception of Digby Gut, the agreement between measured and model-predicted currents are generally quite good at tidal frequencies. The comparisons at higher frequencies, i.e. the macroscale eddy motions, unsurprisingly indicate differences in detail but also rather promising agreement in the time-averaged second order statistics (i.e. eddy kinetic energy). The measured velocity profiles are also used to determine bottom drag coefficients, and maximum power densities. The drag coefficients are spatially variable, due in part to variations in bottom roughness, but also in more than 25% of cases the values differ between flood and ebb by a factor of 2 to 3. The tidal energy potential of the different deployment locations is also spatially variable. Mean observed power densities were exceeded 2 kW/m^2 for at least one ADCP site in each of the three channels, with the highest value, 6.0 kW/ m^2, observed in Petit Passage.

In terms of the numerical modelling, the primary goal of the project was to validate new high-resolution models, taking advantage of the newly gathered bathymetric data in the three Digby Neck passages. Due to time and resource constraints, only 2-dimensional simulations were completed. Overall, the numerical model results agreed remarkably well with the ADCP data, especially in regions of strong tidal flow. The model was also successful in predicting the location of regions with highly-variable flow caused by bathymetric features. The improvements in the numerical model allowed the temporal variability seen in the ADCP data to be connected to spatial flow features seen in the model, for example, the eddies shed by Peter's Island in Grand Passage. Furthermore, the high-resolution numerical model allows us to produce a detailed map of the power density for each passage with values ranging from 2 kW/m^2 in Digby Gut to over 10 kW/m^2 in Petit Passage. These maps show that the power density varies considerably over small distances and highlight the necessity of detailed investigation of regions of high power density to better characterize the turbulent flow that produces the flow speed fluctuations. The numerical model was also used to calculate a theoretical extractable power from each passage. The main result of this calculation is that Digby Gut has a much greater potential (60 MW) than Petit Passage (10 to 20 MW) or Grand Passage (5 to 10 MW). Digby

Gut has such a high potential because the volume flow through the Gut is the source of water for the high tides in the closed Annapolis Basin. As turbines are added to the Gut and the flow through it is reduced, the tidal head across the Gut increases in a manner similar to how a tidal barrage creates a higher tidal head. As a result, the potential power is proportional to the potential energy of the tides of the Annapolis Basin, a value much larger than the initial tidal head would suggest. On the other hand, Petit and Grand Passage can only tap the much smaller, existing tidal head across the passages because the flow through these passages does not have a large affect on the tides at either end of the passages. However, economical extraction of large amounts of power from the relatively slow flow through Digby Gut presents a challenge.

For the reconnaissance component, a method was developed for assessing tidal currents using surface flow measurements. The method allows for low-cost assessment of the spatial and temporal variability in tidal flows, and was applied to evaluate several in-stream tidal energy development opportunities in Shelburne, Yarmouth and Digby counties. Initial equipment testing and method development occurred in Grand Passage, followed by high-flow testing in Petit Passage. The drifters performed well in both environments, and the effect of windage was minimal. Tidal energy potential reconnaissance was conducted at 9 sites. Flow speeds were measured with maximum site values ranging from 1.26 m/s (Port L'Hebert) to 4.16 m/s (The Gap), and flow speeds of 3 m/s or higher were observed at 6 of the 9 sites assessed for tidal energy potential. The potential for small-scale tidal energy development is notable at Indian Sluice near the Indian Sluice Bridge (between Sluice Point and Surettes Island) due to flow speed, accessibility, and presence of bridge infrastructure. A single ADCP was deployed at Indian Sluice as part of the project based on the reconnaissance results. In addition to recording maximum flow speeds, the surface flow data was used to generate stage of tide velocity charts for each site. The charts show temporal and spatial variation in tidal flows, and asymmetry is shown at sites where flood and ebb measurements were collected.

The GIS component acts as a repository for much of the input data used within the project. The critical datasets include various bathymetric information from different sources at different resolutions and referenced to different vertical and horizontal datums. These bathymetric datasets have been reconciled to a common datum, the Canadian Geodetic Vertical Datum of 1928, where land is positive and bathymetry is negative values. Other datasets included in the GIS database consist of standard GIS base layers of the coastline, roads, streams, wharf and ferry routes. The locations of ACDP instruments deployed for the project are shown. As well surface drifters have been deployed and are within the database and plotted to show the derived surface current speed. The model outputs of current velocities have not been incorporated into the GIS database as a result of some incompatibility issues. However the GIS database has been organized in a way to allow the user to easily navigate through the datasets and to visualize and interrogate them.

The project included community engagement meetings held in Digby, Yarmouth, and Shelburne counties including the 5 municipal governments in the project area as well as the villages of Tiverton, Freeport and Westport on Long Island and Brier Island. Individual and small group meetings were also conducted with port authorities, local fisherman, whale watching interests and representatives from local boards of trade. First Nations engagement activities were achieved through the completion of a parallel but separate Mi'kmaq Ecological Knowledge Study (MEKS). The objective of meetings was to engage users of the marine environment, to provide information and to seek input by identifying potential tidal power locations and stakeholders who should be consulted. The majority of meetings included presentations by NS Department of Energy, OERA and Fundy Tidal. The project activities were well received and participants were genuinely interested in potential tidal power developments. Municipal stakeholders were aware of the COMFIT program and shared common concerns with regards to the challenge of integrating community energy projects on the distribution system in the region. Digby and Clare Municipalities, being in the region of ongoing community-based tidal power developments, were most aware of tidal power opportunities. Those in Shelburne and Yarmouth Counties were less focused on tidal power as a potential source of community energy, but offered locations for reconnaissance study. Continued community engagement should include follow-up meetings to discuss the project findings.

The report is organized in Volumes, Volume 1 being the reconnaissance study, Volume 2 modelling, Volume 3 the ADCP results, Volume 4 GIS, and Volume 5 community engagement.

Volume Titles and Authors

Volume 1: Tidal Energy Potential Reconnaissance,
Greg Trowse, Richard Cheel and Alex Hay……………………………..153 pp.

Volume 2: Numerical Modelling of Digby Neck Tidal Currents
Mitchell O'Flaherty-Sproul and Richard Karsten…………… ………….41 pp.

Volume 3: Acoustic Doppler Current Profiler Results
Justine McMillan, Doug Schillinger and Alex Hay……………………...119 pp.

Volume 4: GIS
Tim Webster, Erin Marshall, Nathan Crowell, and Kate Collins………….41 pp.

Volume 5: Community Engagement
Dana Morin and Greg Trowse………………………………………………7 pp.