PREPARED FOR

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Nova Scotia Tidal Energy Atlas: An Enabling Initiative for the Emerging Tidal Energy Industry

Final Report to OERA

Submitted by Acadia University
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http://tidalenergyatlas.acadiau.ca

EXECUTIVE SUMMARY

The Nova Scotia Tidal Energy Atlas is an interactive web mapping application that allows all stakeholders access to Bay of Fundy tidal energy related spatial information. The Atlas is a freely available tool built using open source software - GeoServer and the Heron Mapping Client. It includes online features to assist users in both interacting with and manipulating the data. The Atlas can be accessed here: http://tidalenergyatlas.acadiau.ca/.

This Atlas was developed to assist tidal energy stakeholders and decision makers. To date, it provides:

- Over 60 public tidal energy relevant data layers and connections to external databases
- 35 tools and features to manipulate and view data
- Help videos and document tutorials on how to use the website and its features
- User login for project partners to access private data

Building on the previously OERA funded Phase I project "*A Scalable, on-line Geographic Information System (GIS) of potential turbine sites in Nova Scotia*", activities undertaken in Phase II included:

- Software development and troubleshooting of needed features and tools for data manipulation
- Identification, collection, formatting and incorporation of data into the platform
- Relationship building with data providers and organizations involved in projects with similar interests
- Development of supplemental materials: Developer Guide for platform administration, instructional videos and documents, a wiki page with educational resources and links to relevant government policies and regulations
- Dissemination and promotion of the project through conference presentations, industry newsletters and events
- Testing of the website and training with participants from academia, government, industry, the general public and non-profit organizations
- Preparation of a long term sustainability plan for the NS Tidal Energy Atlas

User feedback has indicated stakeholders would use the website for planning, decision-making, determining areas of marine user overlap, engaging stakeholders and project partners, informing the public, education and map making. From March to May 2016, website and server statistics have tracked close to 400 unique visitors to the website from numerous countries around the world.

In further expand the capabilities of the Atlas, potential partnerships and opportunities have been identified for growth and development. Continued investment in the Atlas will further build and refine the features available, and thus increase its capabilities and use by tidal energy stakeholders, educators and the general public.

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ACKNOWLEDGEMENTS

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Funding Agencies:

1 INTRODUCTION

Tidal energy-related spatial data collected to date represents work conducted in various projects and regions within the Bay of Fundy. These studies support the developing industry through risk reduction and informed decision making. Much of the data available for the tidal energy industry in Nova Scotia is in the form of lengthy technical reports and large data sets housed by numerous institutions. Accessing information for technical analysis, business development and community engagement requires extensive exploration. To overcome this challenge, these otherwise disparate sets can be combined, displayed and manipulated in an interactive web mapping application.

This project builds on the previously OERA funded project "A scalable, on-line geographic information system (GIS) of potential turbine sites in Nova Scotia". As part of the initial project, a proof-of-concept Geographic Information System (GIS) platform was developed in the spring of 2014. The platform was built on open source software utilizing industry standards for communicating spatial data.

The Acadia Tidal Energy Institute, in partnership with Atlantic Canada Opportunities Agency, Nova Scotia Department of Energy, Offshore Energy Research Association, Fundy Ocean Research Center for Energy and Tekmap Consulting, have further developed the proof-of-concept into **The Nova Scotia Tidal Energy Atlas**, an interactive web mapping application that makes tidal energy related spatial information readily accessible to the public and provides online tools to allow users to interact with the data. The Nova Scotia Tidal Energy Atlas can be found at: http://tidalenergyatlas.acadiau.ca/.

2 OBJECTIVE

The aim of the project was to develop a *Nova Scotia Tidal Energy Atlas*, an enabling initiative for the emerging tidal energy industry. It requires consolidating, displaying and providing tools to view and manipulate tidal energy related spatial data from existing, ongoing and future research projects on a publically accessible web mapping application. The Nova Scotia Tidal Energy Atlas provides a platform accessible over the internet to transfer knowledge, support economic development, build capacity, inform planning, avoid duplication, and highlight gaps in data collection. The primary objectives of the Nova Scotia Tidal Energy Atlas were to provide a tool for high level decision making for tidal energy project development and stakeholder engagement and become the go-to resource for tidal energy stakeholders to explore available tidal energy information. To achieve this objective, the following five project components were undertaken:

1. Develop a fully functional interactive web mapping application with relevant tidal energy data and needed features for data manipulation.
2. Build relationships with data providers and gather and format the data.
3. Develop supplemental materials.
4. Promote the Atlas, disseminate information and provide workshops and training.
5. Prepare a long term sustainability plan (3-10 years post project completion).

3 METHODOLOGY

3.1 PROJECT CHRONOLOGY: SELECTED ACTIVITIES AND MILESTONES

28 Oct 2014	Project Proposal submitted to OERA
28 Nov 2014	Project Proposal submitted to ACOA
12 Feb 2015	OERA funding approved
4 March 2015	ACOA funding approved
25 March 2015	OERA contract start date
16 April 2015	Project Management Team Meeting #1
16 April 2015	Platform software and data installed and running on Acadia server
12 May 2015	Discussion with FORCE staff on needed features for platform
15 May 2015	1st Steering Committee Meeting
19 May 2015	Discussion with FORCE Facilities Manager about displaying web map in FORCE Visitor Centre
2 June 2015	Project presented at the 34th International Conference on Ocean, Offshore and Arctic Engineering (OMAE2015) in St. John's, Newfoundland
29 June 2015	Project Management Team Meeting #2
3 July 2015	Project Announcement at Acadia with speakers Peter MacKay, Ray Ivany, Keith Irving, Stephen Dempsey, Tony Wright and David Mackinnon.
15 July 2015	Google Analytics set up to track traffic on developing site
7 August 2015	Project Management Team Meeting #3
8 Sept 2015	Co-op student began four-month work term on project
16 Sept 2015	Project presented at the ACZISC Meeting #76 in Halifax
22 Sept 2015	2nd Steering Committee Meeting
24 Sept 2015	Atlas on display at Cumberland Energy Symposium in Springhill
5 Oct 2015	Atlas on display at the Cape Sharp Tidal Open House in Wolfville

9 Oct 2015	Project presented at the 9th Symposium of the International Society for Digital Earth in Halifax
23 Oct 2015	Atlas presented in a lesson plan at the Association of Nova Scotia Science Teachers Annual Conference
23 Oct 2015	Project information sheets distributed at the Marine Renewables Canada (MRC) annual conference in Montreal
4 Nov 2015	Project Management Team Meeting #4
19 Nov 2015	Discussion with MRC about mapping organizations offering tidal energy services from their database
30 Nov 2015	OERA Interim Report Submitted
Dec 2015	Project featured in the International Coastal Atlas Network December 2015 Newsletter
9 Dec 2015	Project Management Team Meeting #5
22 Jan 2016	Project Management Team Meeting #6
27 Jan 2016	3rd Steering Committee Meeting
Feb 2016	Usability testing on website commences
Mar 2016	Project featured in the Fundy Energy Research Network (FERN) Annual Newsletter
2 Mar 2016	Website publically available at: http://tidalenergyatlas.acadiau.ca/
6 Mar 2016	AWSTATS began tracking Server Statistics on live website
22 Mar 2016	Google Analytics began tracking Statistics on live website
23 Mar 2016	Project Management Team Meeting #7
15 April 2016	4th and Final Steering Committee Meeting
31 May 2016	Final ACOA Report and Sustainability Plan submitted
9 June 2016	Project presented at the 11th Annual Bay of Fundy Ecosystem Partnership Workshop in Fredericton, NB
6 July 2016	OERA Final Report completion and submission

3.2 PROOF OF CONCEPT

The Nova Scotia Tidal Energy Atlas was built on a proof-of-concept platform developed in the spring of 2014 with seed funding from OERA. The aim was to build a decision-making tool that integrated complex spatial information of importance to the tidal energy industry while also being scalable, flexible and accessible — prudent features of a rapidly evolving industry. Open source software was chosen for the design and offers many benefits including: access to the software source code, no licensing fees, and software being actively developed by a large worldwide community. Several physical and environmental layers were displayed on the beta website with the ability to query and highlight regions of particular interest (e.g. high tidal power density). The beta tool was presented and well-received in the Data Room at the Nova Scotia Energy Research & Development Forum in May 2014. Figure 1 below is a screen shoot from the beta version displaying several layers of interest to the tidal energy community.

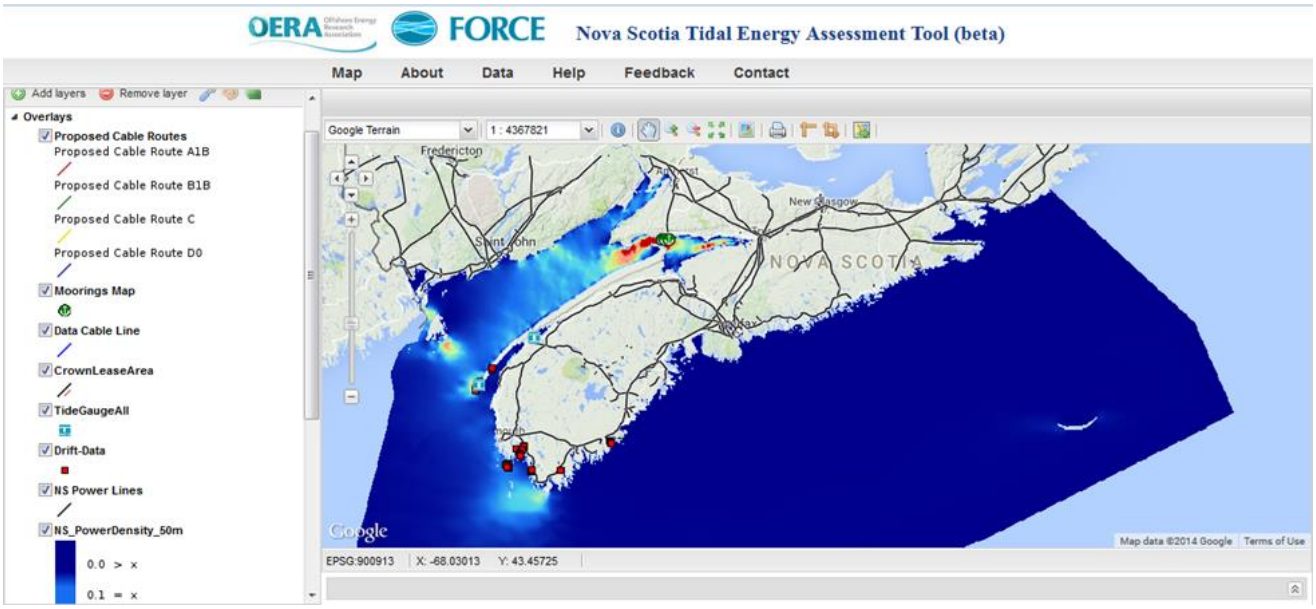

Figure 1: Beta version of platform developed in spring 2014

3.3 SERVER AND SOFTWARE SETUP

3.3.1 Acadia Servers and the Compute Canada Cloud

The beta platform, data and supporting software were transferred from the FORCE server and set up on several Acadia University servers with the assistance of Acadia Technology Services and the project team. Platform development continued on the Acadia servers and in the winter of 2015/2016, the project team pursued an opportunity to move the platform and data to Compute Canada, a not-for-profit organization funded by CFI and supported by regional partnerships to provide essential digital infrastructure for Canadian industry and researchers. Compute Canada recently launched a cloud service that offers greater configurability, availability, durability and portability through virtual machines (VMs)

configured through a cloud account. The computing environment can be customized and carry out both data and computationally intensive work easily. It was desired to move the platform to the Cloud to increase flexibility, tap into robust computing resources and be established in an environment where relevant projects may be able to be integrated on a national level. The Nova Scotia Tidal Energy Atlas and supporting data and software are now housed on the East Cloud of the Compute Canada cloud service with technical and hardware support provided by ACENET.

3.3.2 GeoServer

The robust open source software, GeoServer, provides complete Web Mapping Services (WMS) to store, edit, query, style, and deliver geospatial data to the Nova Scotia Tidal Energy Atlas. GeoServer is written in the Java programming language and is platform independent (runs on numerous operating systems such as Windows and Mac). The GeoServer software is fully compliant with the Open Geospatial Consortium (OGC), an organization that develops international standards and supporting services that promote geospatial interoperability.

3.3.1 PostgreSQL and PostGIS extension

PostgreSQL is a powerful, object-relational database system when combined with the PostGIS extension supports geographic objects, allowing the PostgreSQL server to be used as a backend spatial database for geographic information systems (GIS), like the Nova Scotia Tidal Energy Atlas. Several datasets for the Atlas are held within this server and fed through GeoServer for display on the Atlas. The use of PostgreSQL and PostGIS provides faster delivery of large files and increases the functionality of the custom Time/Depth Navigator tool by allowing temporal data to be displayed in minutes and hours, where shapefiles only supported temporal variance by day.

3.3.2 Heron

The Heron Mapping Client provides the map display and processing tools for this project. The Heron client is written in JavaScript and is built upon existing open source technologies including: OpenLayers and the GeoExt JavaScript toolkit. The flexibility of these open source programs allows for the development of custom features for the Nova Scotia Tidal Energy Atlas including the Tidal Scoring Interface, Vector Buffer and Time/Depth Navigator. The Tidal Scoring Interface provides a powerful geospatial query tool, allowing users to extract and display tidal power model data.

3.3.3 Data Flow

A diagram showing the typical flow of geospatial data through GeoServer to the Heron mapping client on the Compute Canada Cloud is shown in Figure 1. The GeoServer data can also be accessed by other Geographic Information Systems (GIS) including: ArcGIS, GoogleEarth, NASA World Wind, GRASS, and QGIS. The Heron client also provides access to other available Web Mapping Services accessed through the external maps feature of the Nova Scotia Tidal Energy Atlas.

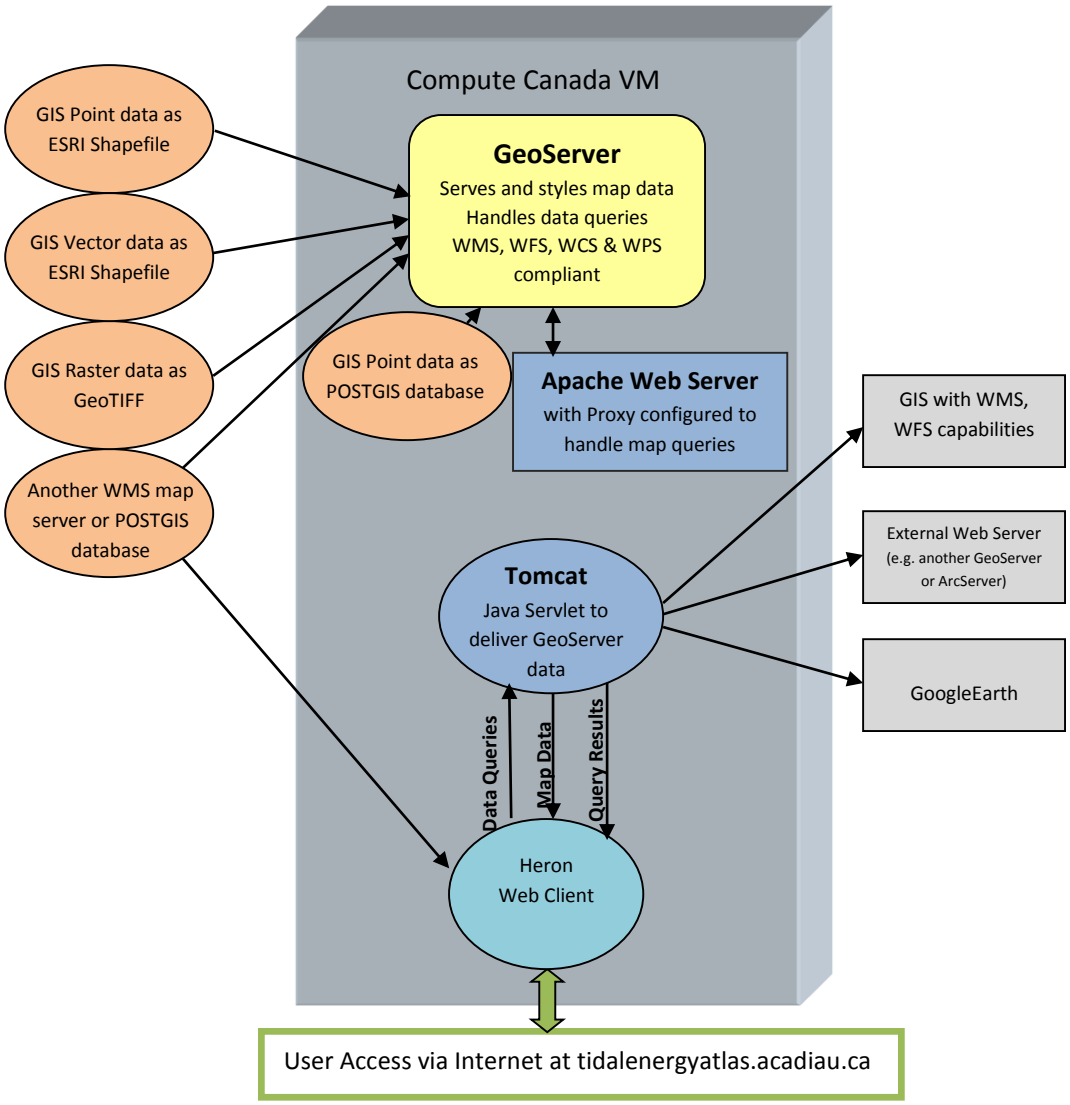

Figure 2: Flow Diagram showing data flow routes.

The specific technical information to setup, maintain and administer the platform on the Compute Canada Cloud has been recorded in an administration guide (Developer Guide for the Nova Scotia Tidal Energy Atlas).

3.4 DEVELOPED FEATURES

A total of 35 unique features and tools have been developed for the Nova Scotia Tidal Energy Atlas and are accessible through a series of toolbars available on the website. Tutorials and videos describing how to use the tools are available under the help tab of the Atlas. The interactive tools available on each toolbar are listed below:

3.4.1 Legend Toolbar

The legend toolbar is located in the Legend tab in the left panel of the Atlas and has several options for displaying active data layers. Each option is also available through a right-click, context menu for each layer item in the legend.

Item	Action
	Zoom to selected layer.
	Remove selected layer from display.
	Change the selected layer opacity from transparent (0) to opaque (100).
	Edit the selected layer style. This feature is only active for WMS layers.
	Display layer information.
	Download selected layer to desktop. Supported formats include: GML, GPS, KML, ESRI Shapefile, and OGC GeoPackage. Only vector layers can be downloaded.

3.4.2 Map Toolbar

The toolbar is located at the top of the map display panel. It provides buttons that allow standard interactive map navigation and manipulation, as well as several custom tools developed for the Atlas.

Item	Action
	Pan - Drag map to desired location.
	Zoom in - Zoom in on map by one level, or drag to define a zoom area.
	Zoom out - Zoom out of map by one level, or drag to zoom out.
	Full extent - Zoom out to full extent of the map.
	Previous view - Return to the previous view.
	Next view - Return to the next view.
	Feature information - Provide information on active layers when selecting a point on the map. The attributes table appears in the Feature Info panel at the bottom of the screen. Each layer displays as a separate tab. Each selection returns a maximum of 10 attributes per layer.
	Measure distance - Click 2 or more locations on map to measure distance in kilometers. Double-click to stop measuring.

	Measure area - Click 2 or more locations on map to measure area in square kilometers. Double-click to stop measuring.
	Coordinate search - Enter latitude and longitude coordinates in decimal degrees to mark a location on the map.
	Draw features - Draw points, lines, polygons, and labels on the map for printing and downloading. See the toolbar below.
	Upload local vector - Upload a local file to display on the web map. Files are only viewed on the user's computer/device and are not saved by the application.
	Save map context - Save your current map session as an xml file.
	Load map context - Load your xml file from a saved map session.
	Score model data - Allows the user to select the model of interest and specify which hydrodynamic model metrics and values to query. Query results for the selected model appear as a new map layer which can be styled and named.
	Time/ depth navigator - Visualize time and depth enabled layers. Useful for tidal flows, marine life detection, etc.
	Vector buffer - Create buffers around user selected layers. Useful for visualizing detection ranges for acoustic monitoring devices, determining proximity to marine protected areas, ports, substations and other important features.
	Print map- Print the current map view with user defined settings. New in the current web map version, this print tool now prints large formats for display as posters/architectural prints.
Login	Located in the heading tab above the map toolbar, the login feature allows users with accounts access to private data.

3.4.3 Draw Features Toolbar

The Draw Features toolbar appears as an extension of the Map Toolbar when the icon is selected.

Item	Action
	Draw point - Click to add a new point to the map
	Draw path - Click two or more points to add a new line to the map, double click to end the line.
	Draw polygon - Click three or more points to add a new polygon to the map. Double click to finish the polygon.
	Draw shape - Select from triangle, square, pentagon, hexagon, and circle. Click and drag to add the new polygon.
	Draw text label - Click any location on the map to add a text label.

 Modify geometry - Select a polygon on the map to modify the vertices.

 Draw hole - Click three or more points within a polygon to draw a hole, double click to finish.

 Select geometry - Select a polygon.

 Drag geometry - Click and drag a polygon to change its position.

 Delete selected geometry - Deletes the polygon that is currently selected.

 Delete all geometries - Remove all custom drawn features (including text labels) from the map. Cannot be undone.

 Navigation - Drag map to desired location.

 Download geometries - Download custom geometries in several formats (GML, GPX, KML, ESRI shapefile, OGC GeoPackage).

 Upload geometries - Upload local geometries (supported formats are WKT, GML, GPX, KML, CSV, ESRI shapefile and OGC GeoPackage).

3.5 PARTNERSHIPS AND DATA

Steering Committee

A steering committee was established for the project to provide guidance, expertise and insight into platform development. Steering committee members have provided valuable advice and connections to those working in the marine spatial planning sector and on projects of relevance at the national level. These connections have enabled awareness of the project across multiple sectors and regions. Steering committee members include representatives from non-governmental organizations, the geomatics industry and government.

Project Management Team

The project management team was formed to oversee the development and maintenance of the Nova Scotia Tidal Energy Atlas. This team included leads from ATEI, FORCE and Tekmap Consulting. The team was involved in day-to-day decision making and activities such as gathering and uploading data to the Atlas.

Related Projects

The Atlantic Coastal Zone Information Steering Committee Secretariat established an Atlantic Marine Biological Data Partnership, an initiative to increase the availability of data on marine species in Atlantic Canada to support ecosystem based management. The outputs of their project will be of relevance to the Tidal Energy Atlas and the biological data collected at tidal energy sites will be of value to the Atlantic Marine Biological Data Partnership. It is anticipated that over the next few years this partnership will strengthen and grow.

ATEI is represented on the Industry/Stakeholders Advisory Committee for the BC Marine Energy National Research Council (NRC) project. The NRC has a long term goal to develop a marine renewable energy (waves, tides, river currents) GIS database /resource atlas /analysis and decision making system for all of Canada. There is great opportunity to collaborate and benefit from combined efforts and

converge GIS databases for tidal resources to accelerate the creation of a Canada-wide marine energy resource atlas/system.

A geo-referenced map of organizations offering tidal energy related services in the Atlantic region has been developed following discussions with Marine Renewables Canada which was looking to create a spatial element to their growing database of organizations.

Data

The project team has had conversations on available layers produced within the group and how to best present the modeling work of Richard Karsten, Thomas Roc and Joel Culina. In addition to OERA and FORCE, numerous data providers have been contacted to request data and/or metadata information for identified layers of interest. Several of these providers include DFO, student researchers, geomatics organizations and Fundy Tidal Inc. A list of available layers on the Nova Scotia Tidal Energy Atlas can be found in the section Appendix: Data.

3.6 SUPPLEMENTAL MATERIALS

Supplemental materials were developed to enhance the user experience and document important project processes. The wiki page provides an overview of the project and links to relevant information such as government policies and regulations. Educational presentations and associated lesson plans developed to explore the emerging tidal energy industry are hosted on the wiki page.

To assist web map users, tutorials have been developed for common tasks such as adding Atlas layers and using custom tools. These tutorials can be found under the Atlas 'help' tab. Several instructional videos based on these tutorials have been created and uploaded to the new ATEI YouTube account and linked to the web map. A developer guide has been generated for the Atlas which documents how the application was built using open source software as well as how to complete administrative tasks and maintenance.

3.7 PROMOTION, TRAINING AND ENGAGEMENT

The main objective of this project was to disseminate information gained by tidal energy research projects through an interactive interface easily accessed by the general public. Promotion, training and engagement activities were essential for awareness and use of the website.

The project announcement at Acadia University on July 3rd, 2015 was well attended and received media attention in local and international news (Tidal Today, South African Tribune). Project information sheets were distributed at numerous events including the Marine Renewables Canada conference in Montreal, outreach events in local communities and in Ottawa, and the International Conference on Ocean Energy in Edinburgh. An article on the project appeared in the International Coastal Atlas Network (ICAN) December 2015 Newsletter and featured in the Fundy Energy Research Network (FERN) 2015 and 2016 Annual Newsletters. Atlas presentations were delivered at several conferences:

1. International Conference on Ocean, Offshore and Arctic Engineering (OMAE 2015)
2. 9th Symposium of the International Society for Digital Earth (ISDE 2015)
3. 11th Bay of Fundy Science Workshop (BoFEP 2016)

In an effort to make the mapping interface easy to use, user feedback on the Atlas was solicited via a survey available on the website, a series of usability tests, one-on-one demonstrations and small group training. Participants included members of academia, government, industry, high school teachers and students, the general public and non-profit organizations. The website either met or exceeded user expectations, with the most common uses being accessing, viewing, sharing, and interpreting tidal energy information. The tool liked most by users was the buffer tool, which allows buffers to be created around features on the map to determine distances and ranges. Improvements to understanding how to use the website and faster response times were the main recommendations from new users. Users indicated they would use the website for planning, decision-making, determining areas of marine user overlap, engaging stakeholders and project partners, informing the public, education and map making. In response to usability testing, instructional videos and tutorials were developed.

Website and server statistics have tracked close to 400 unique visitors to the website in three months (March - May), prior to public promotion of the Tidal Energy Atlas.

3.8 PREPARATION OF A LONG TERM SUSTAINABILITY PLAN

The Atlas will be maintained by Acadia University and FORCE, the co-owners of the Atlas. The Atlas is currently housed on the Compute Canada Cloud with technical support provided by their regional partner ACENET. Use of Compute Canada's services and resources are provided at no cost to academic researchers. Potential future partnerships and funding opportunities have been identified for future Atlas developments.

4 CONCLUDING REMARKS AND RECOMMENDATIONS

The Nova Scotia Tidal Energy Atlas currently serves as the go-to resource for tidal energy stakeholders in the Bay of Fundy to explore available tidal energy information and support high-level decision making. This is evidenced by user feedback, and its use by project developers and other stakeholders. User feedback has indicated stakeholders would use the website for planning, decision-making, determining areas of marine user overlap, engaging stakeholders and project partners, informing the public, education and map making.

The Atlas is currently housed on the Compute Canada Cloud with technical support provided by ACENET and is being maintained by Acadia University and FORCE, the co-owners of the Atlas. General maintenance of the Atlas will include keeping data housed on the Atlas current, responding to Atlas inquiries, promoting the Atlas when opportunities arise and identifying partnerships and funding opportunities.

There is growing interest from a variety of groups in expanding the capabilities of the Atlas and developing resources for educational purposes, as well as training members of the tidal energy industry. Further funding will be sought for future growth and development of the Atlas. The following table lists recommendations for future opportunities with the Atlas:

RECOMMENDATIONS

1	Expand platform to a 3D Viewer and visualize data using the World Wind JavaScript library.
2	Continue to incorporate critical datasets, including new data from FORCE's Environmental Effects Monitoring Program (EEMP).
3	Create a landing page to sit in front of the web map to increase Search Engine Optimization (SEO) and incorporate more materials.
4	Apply for further computing resources in fall 2016 to increase website response time.
5	Work with funding agencies to create data management clauses for agreements.
6	Incorporate a scripting feature to allow users to seamlessly interact with the GIS via a common scripting language (e.g. Python).
7	Actively promote the Atlas website to identified stakeholders and provide in-person training.
8	Ensure new metadata follows the ISO North American Profile.
9	Create New Atlas Tools: • User controlled contouring of selected data/features. • Simple interface for working with model data (FVCOM) via PySeidon. • Added option to share and/or embed the user's current atlas view (similar to Google maps). • Added context menu options in the Layers browser. For example, simply selecting a layer and building a buffer around it (as opposed to going through the Vector Buffer dialog). Currently, only Layer Information is available from the context menu. • Expanded options to display time and elevation indexed data, allowing multiple time or elevation layers to be displayed simultaneously.
10	Enhanced data browser for examining the data that is currently available. This could include download options as suggested by the Steering Committee. A simple dynamic version can be seen here: http://tidalenergyatlas.acadiau.ca/layer_list/layer_grid.html

APPENDIX: DATA

The following Data Use Disclaimer is displayed to users of the web map when they first access the site:

The information contained in this website is for general information purposes only. The data provided is an overview of tidal energy modeling and research in Nova Scotia and currently should not be used for detailed site assessment or navigation. We make no representations or warranties of any kind, express or implied, about the completeness, accuracy, reliability, suitability or availability with respect to the website or the information, products, services, or related graphics contained on the website for any purpose. Any reliance you place on such information is therefore strictly at your own risk.

Below is a list of available layers on the Atlas and identified layers to be updated as part of the Atlas maintenance in the coming months.

Layer Name	Source	Metadata Stage+	Last updated*	Recommended update schedule*
Regional Maps				
Aboriginal Land - New Brunswick	Geogratis	3	2016/06	2016/12
Aboriginal Land- Nova Scotia	Geogratis	3	2016/06	2016/12
Acoustic Receiver Locations 2010 - 2013 - Minas Passage	Acadia Centre for Estuarine Research	2	2016/06	As required
Ambient Noise Hydrophone Locations - Outer Bay of Fundy	Eastern Charlotte Waterways	2	2016/06	As required
Aquaculture Lease Boundaries - Nova Scotia	ArcGIS: Matthew King	2	2015/11	2016/05
Aquaculture Sites - Nova Scotia	ArcGIS: Matthew king	2	2015/11	2016/05
Bathymetry - Nova Scotia	ATEI	2	2016/06	2016/12
Breakwaters - Nova Scotia	GeoNOVA	2	2016/01	2016/07
Eco-Regions - Nova Scotia	Nova Scotia DNR	2	2016/01	2016/07
Ecologically and Biologically Significant Areas - Bay of Fundy	Fisheries and Oceans Canada	2	2016/01	2016/07
First Nation / Première Nation Canada	Government of Canada	3	2016/06	2016/12
FORCE Power Substation - Minas Passage	FORCE	2	2015/09	As required
LiDAR Sediment Stations - Minas Basin	DFO	2	2015/09	2016/03
Lobster Fishing Areas - Atlantic	Bedford Institute of Oceanography	3	2015/11	2016/05
Ocean Tracking Network, Animals - Canada	OTN	3	2015/12	2016/06
Organizations Providing Relevant Services - Atlantic Canada	ATEI	2	2016/01	2016/07
Port Index - World	National Geospatial Intelligence Agency	2	2015/09	2016/03

Power Substations - Nova Scotia	CanVec	2	2015/09	2016/03
Power Transmission Lines - Nova Scotia	CanVec, NRCan	2	2015/09	2016/03
Proposed COMFIT - Nova Scotia	ArcGIS: Nova Scotia Power Inc.	2	2015/09	2016/03
Protected Areas (CARTS) - Maritimes	Canadian Council on Ecological Areas (CCEA)	3	2015/10	2016/04
Provincial Parks - New Brunswick	GeoNB	2	2016/06	2016/12
Provincial Parks- Nova Scotia	GeoNOVA	2	2016/06	2016/12
Reference Site - Minas Passage	FORCE	2	2016/06	As required
Right Whale Critical Habitat - Nova Scotia	DFO	3	2016/06	2016/12
Sediment Grab Samples - Minas Passage	DFO	2	2015/09	2016/03
Significant Habitat - Nova Scotia	Nova Scotia DNR	2	2016/06	2016/12
Substation Locations	CanVec, NRCAN	2	2015/09	2016/03
Tidal Energy Resource Characterization Study Area - Minas Passage	OERA	2	2016/06	As required
Tidal Model Data - Nova Scotia	ATEI	2	2015/09	As model is updated
Tidal Power Density - Nova Scotia	ATEI	2	2016/06	As model is updated
Tide Gauges - Digby	ATEI, FTI, NSCC, OERA	2	2016/06	As required
Tide Height -Nova Scotia	BIO (WebTide)	2	2016/06	As required
Tide Range, 24hr - Nova Scotia	BIO (WebTide)	2	2016/06	As required
Wharves and Slipways - Nova Scotia	GeoNOVA	2	2016/01	2016/07
Minas Passage/ Basin				
ADCP - Minas Passage	ATEI, DAL, FORCE, FTI, OERA	2	2015/09	As required
Crown Lease Area - Minas Passage	FORCE	2	2015/09	As required
FORCE Moorings Map - Minas Passage	FORCE	2	2015/09	As required
FORCE Visitor Centre - Minas Passage	FORCE	2	2015/09	As required
General Substrate Type - Upper BoF	Acadia	2	2015/09	2016/03
Radar Image - Minas Passage	FORCE	2	2015/09	As required
Shaded Bathymetry, 0.5m - Minas Passage	FORCE	2	2015/09	As required
Shaded Bathymetry, 5m - Minas Passage	FORCE	2	2015/09	As required
Shaded Elevation Model - Minas Passage	FORCE	2	2015/09	As required
Striped Bass Detections, 2011 to 2013 - Minas Passage	ATEI	2	2015/09	As required
Tidal Model Output - Minas Passage	ATEI	2	2015/09	As model is updated
Digby Neck/ SW Nova Scotia				

ADCP - Digby Neck	FORCE	2	2015/09	As required
Heatmap of Atlantic White-sided Dolphin Sightings	Fundy Tidal Inc.	3	2016-06	As required
Heatmap of Fin Whale Sightings	Fundy Tidal Inc.	3	2016-06	As required
Heatmap of Grey Seal Sightings	Fundy Tidal Inc.	3	2016-06	As required
Heatmap of Harbour Porpoise Sightings	Fundy Tidal Inc.	3	2016-06	As required
Heatmap of Harbour Seal Sightings	Fundy Tidal Inc.	3	2016-06	As required
Heatmap of Humpback Whale Sightings	Fundy Tidal Inc.	3	2016-06	As required
Heatmap of Minke Whale Sightings	Fundy Tidal Inc.	3	2016-06	As required
Heatmap of North Atlantic Right Whale Sightings	Fundy Tidal Inc.	3	2016-06	As required
Shaded Bathymetry — Digby Gut	ATEI, DAL, FTI, NSCC, OERA	2	2015/09	As required
Shaded Bathymetry - Grand Passage	ATEI, DAL, FTI, NSCC, OERA	2	2015/09	As required
Shaded Bathymetry - Petite Passage	ATEI, DAL, FTI, NSCC, OERA	2	2015/09	As required
Shaded Bathymetry, Site 1 - Digby Gut	ATEI, DAL, FTI, NSCC, OERA	2	2015/09	As required
Shaded Bathymetry, Site 2 - Digby Gut	ATEI, DAL, FTI, NSCC, OERA	2	2015/09	As required
Shaded Bathymetry, Site 3 - Digby Gut	ATEI, DAL, FTI, NSCC, OERA	2	2015/09	As required
Shaded Bathymetry, Site 4 - Digby Gut	ATEI, DAL, FTI, NSCC, OERA	2	2015/09	As required
Surface Drifter Data - Digby Neck	ATEI, FTI, NSCC, OERA	2	2015/09	As required
Tidal Model Output - Digby Gut	ATEI	2	2015/09	As model is updated
Tidal Model Output - Grand Passage	ATEI	2	2015/09	As model is updated
Tidal Model Output - Petite Passage	ATEI	2	2015/09	As model is updated
Tidal Model Statistics				
Minas Basin Sept 2011 Directional Deviation Ebb	ATEI, FORCE, OERA	2	2015/09	As model is updated
Tidal Power Density Over Time - Petite Passage	ATEI	2	2015/09	As model is updated

[+] The metadata stage column indicates the level of available metadata on the Atlas.

Stage 1 No metadata provided
Stage 2 Minimum abstract and source provided
Stage 3 Complete FGDC Nova Scotia Profile or ISO19115 provided

*The last two columns refer to when the data was last accessed by the Atlas data administrator, and the recommended update schedule for when the data administrator should check the source for updates. "As required" is recommended for layers that are assumed to be rarely updated if at all.