BRITISH COLUMBIA
The Best Place on Earth

November 13, 2009

Luisa Fernanda Neira
Via electronic mail

Re: Submission to the Third Request for Proposals for the Development of Value-Added Tools for Decision-Makers

Dear Ms. Neira,

Attached is our submission to your recent RFP. It is a joint response from GeoBC (an agency of the government of British Columbia, Canada), the Nature Conservancy of Canada, and Refractions Research, Inc. I can attest that all three organizations are in agreement with what is stated in this proposal.

If you have any further questions on the submission, please do not hesitate to contact me or the individuals named in Sections C and D on the first page.

Thank you for your consideration of our proposal.

Sincerely,

Director,
GeoBC Information Services
Integrated Land Management Bureau
Tel: 250-387-9806
Email: Elaine.Dawson@gov.bc.ca

A. Title of Proposed Project

GeoAnalytic Grid Engine

B. Cover letter signed by the authorized representative of the firm.

C. Contact Information of the Firm

- Name of Firm: Nature Conservancy of Canada
- Name of Contact Person(s): Pierre Iachetti
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D. (In case of association) Contact information of Associated Firm(s)

- Name of Firm: GeoBC, Government of British Columbia
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E. Project Summary

English

In order to achieve efficient and effective environmental management, decision makers at all levels need to have access to decision support tools that allow for the integration of ecological and social science data. The GeoAnalytic Grid Engine (G^2E) project's goal is to provide decision makers at the local, regional and national levels with a user-friendly, web-based tool that will enable them to consider ecosystems as a whole rather than attempting to manage one issue or resource in isolation of each other. The G^2E application will allow users to visualize and analyze the interaction between different datasets to better understand the interplay between socio-economic and ecosystem data. The tool will be designed to be independent of geographic location, but will be initially populated with Pacific Northwest data as a test. Technically, G^2E will be a derivative of *Hectares BC*, one of the principal ecosystem evaluation tools in British Columbia, Canada. Beneficiaries of this tool will range from local community groups able to see how their data interacts with regional datasets to national managers attempting to understand larger scale concerns. The expected products include the open source software, its associated documentation and related training materials.

Español

A fin de lograr una gestión ambiental eficiente y eficaz, aquellos encargados de tomar decisiones en todos los niveles necesitan tener acceso a herramientas de soporte de toma de decisiones que permitan la integración de informacion científica ecológica y social. El objetivo del proyecto GeoAnalytic Grid Engine (G^2E) es proveer a aquellos encargados de tomar decisiones en el ámbito local, regional y nacional con una herramienta fácil de usar y basada en la Internet que les permita considerar ecosistemas completos en vez de manejar problemas o recursos por separado. G^2E permitirá a los usuarios visualizar y analizar las interacciones entre diferentes conjuntos de datos para entender mejor las relaciones entre información socio-económica y de ecosistemas. La herramienta podrá ser usada en cualquier región geográfica, pero inicialmente contendrá datos de la región del Noroeste Pacífico como prueba. Técnicamente, G^2E será una derivativa de Hectares BC, una de las principales herramientas de evaluación de ecosistemas en Columbia Británica, Canadá. Los beneficiarios de esta herramienta incluirán comunidades locales queriendo relacionar su información con conjuntos de datos regionales y directores nacionales tratando de entender problemas a mayor escala. Los productos esperados incluyen el software de código abierto, su documentación y materiales de entrenamiento.

F. Project Description

1 Rationale

The protection of biodiversity throughout the Americas has become increasingly important. In striving to protect this natural heritage there has been a growing demand for decision support tools that will assist in making informed decisions about the environment and impacts that socio-economic pressures might have. The ability to see far reaching effects of decisions is becoming more and more critical as our economic and societal growth bumps up against our desire to protect biodiversity. The GeoAnalytic Grid Engine (G^2E) project will produce an application that will address this issue. The G^2E tool will provide decision makers with the ability to ask "what if" questions, and base decisions on probable outcomes of these differing scenarios.

The GeoAnalytic Grid Engine (G^2E) is an open source, web based application designed to display and analyze large volumes of spatial or spatiotemporal data. The architecture makes it suitable for both terrestrial and coastal/marine applications. Of particular interest is the short learning curve required to master it. The development of G^2E will leverage heavily the work done to date on Hectares BC (HaBC), an open source project built on geospatial and business intelligence constructs.

HaBC was developed in response to the difficulties in evaluating the comparative importance of ecosystems across the 95 million hectares of British Columbia. A tool was needed that could be used to quickly build and contrast assessments and scenarios covering both small and large areas, including the entire province. It had to be easy to learn and use, and had to be accessible over the web. An examination of the commercial and open source options available concluded that such a tool did not currently exist. As a consequence, a decision was reached to build such a tool. The current version of HaBC is the result. Although it is still in a pilot stage, it has begun to see significant use.

HaBC was funded by government agencies and a biodiversity consortium of environmental NGOs. It is becoming one of the principal tools in British Columbia, Canada for those involved in ecosystem evaluation and management and the development of species conservation frameworks. Like HaBC, G^2E will be an open source project targeting a broad range of users, and like HaBC, G^2E will provide strong collaborative capabilities. For British Columbia, G^2E will power the next version of HaBC (and the name Hectares BC will continue to be used for the tool in British Columbia). For the Americas in general, G^2E will be a tool in its own right, directly applicable to a broad range of biodiversity and socioeconomic assessment needs. (In the remainder of this proposal, G^2E in a BC context is synonymous with the next version of HaBC.)

HaBC as defined currently is designed specifically to work in British Columbia. Those using it typically have access to an array of sophisticated, commercial and open source GIS tools. Nevertheless, HaBC is the tool of choice where visualization and analysis needs to be done quickly and especially when the work involves assessment and prioritization. The success of HaBC so far has led to support for increasing its capabilities, to make it suitable for a broader range of use cases of interest to the Nature Conservancy of Canada and the government of British Columbia.

The significance for IABIN is that G^2E could be deployed for projects both large and small throughout the hemisphere. Unlike most existing GIS applications, especially when used for analysis, G^2E will be very straightforward to use. Another benefit pertains to the role of G^2E as a central repository for diverse datasets. What separates G^2E (and the current version of HaBC) from typical geospatial data warehouse applications, is the ability by the user (i) to easily see what datasets and metadata are available, (ii) to view the datasets in a catalog fashion with search capability, (iii) to view the data through a map interface, and (iv) to carry out serious analysis, including map and report generation, all using the same tool.

2 Project Goals and Objectives

The goal of this project is to provide decision makers at the local, regional and national levels with a web-based tool that will enable them to consider ecosystems as a whole rather than attempting to manage one issue or resource in isolation of each other.

The objectives include:

1. To create a tool that can handle large amounts of data, both in the context of geographic extent and the number of layers or themes of description of the area of interest. In particular the tool must allow for the input and management of diverse environmental and socio-economic datasets.

2. To create a tool that will enable the user to visualize and analyze these datasets. The tool must be designed to support the construction and comparison of an arbitrary number of scenarios, as applicable to assessment and decision making.

3. To create a tool that that can be implemented anywhere and that makes effective use of web technologies.

4. To create a tool that is user friendly. The tool must be able to be used with a minimum of user training.

Further details on the objectives are found in the next section of this document.

3 Project Activities and Methodologies

3.1 High-level understanding of the role of G²E

G²E is a software tool designed to support the integration, visualization and analysis of geospatial datasets and models over the web. The datasets and models are represented as layers (also known as themes), using a geospatial grid paradigm. The objectives of this project are fourfold:

1. G²E will support the integration of data from biodiversity and socioeconomic databases
   The datasets may be ecologic in nature, such as those pertaining to topography (or bathymetry), biology, surficial geology, watershed, climate, Marxan model outputs, etc. They may also be socioeconomic, such as political boundaries, census areas, parks, zoning, cadastral boundaries, and the like. The tool provides procedures that allow the user to import one or more layers of such data. Depending upon the area of interest, the input data can cover a very broad geographic area, or alternatively, a much smaller area. The fundamental resolution (the grid cell size) of the data can be set by the user on input.

2. G²E will provide visualization and analysis capability of data and information
   The user interface includes a map, a query formation utility, a layer list, and a metadata display. The map supports standard operations such as zooming and panning. Queries can be constructed from the layer list using simple drag and drop operations. Categorical and numeric data used in the layers (e.g. elevation values) can be used directly in the query. Query results can be displayed in map form. They can also be represented in tabular (and cross-tabulation) form. Comparisons of two or more queries can be made both visually and in tabular form. Queries can be stored and shared with others. Query results can be output as KML to provide visualization in Google Earth.

3. G²E will support utilization of data with models to develop scenarios (options and consequences) for decision makers
   Much modeling work in both terrestrial and marine environments is based on gridded data structures. The user can create models as virtual layers using the query capabilities in the application. Any number of models can be created. Comparisons of the results of two or more models can then be made, with the results viewable in both map and tabular form. Thus visualization of the outcomes from the different models can be seen as contrasted in a straightforward fashion. Note that the models can be defined directly in the tool. Additionally, the results of complex models produced by other applications (such as Marxan analysis) can be input into the tool, with the results visualized and analyzed further using the tool's capabilities.

4. G²E will be easy to use
   The tool is straightforward to deploy, with the basic set up taking on the order of one to two hours. Procedures to load data are quite practical, with the time required dependent on the number of layers, the grid resolution, and the area to be covered. In contrast to traditional GIS systems, use of the tool for simple visualization purposes can be learned quickly (< 20 minutes); to learn how to carry out more sophisticated analysis requires two to four hours. Use of the tool on specific projects can be comparatively extensive, depending upon the level of sophistication of the analysis, the number of scenarios to be built and related factors. The tool provides strong support for various forms of collaboration, all of which are well documented. Instructions and menus are multilingual.

These objectives allow HaBC and G²E to be directly relevant in addressing the biodiversity goals and their associated indicators put forward in Canada's 4th National Report to the United Nations Convention on Biological Diversity. The primary goals that G²E would help address are as follows: CBD Goal 1: Promote the Conservation of the Biological Diversity of Ecosystems, Habitats; CBD Goal 2: Promote the Conservation of Species Diversity; CBD Goal 5: Pressures from Habitat Loss, Land use Change and Degradation and Unsustainable Water Use Are Reduced; CBD Goal 7b: Address Challenges to Biodiversity from Climate

Change. As well within Chapter 2, HaBC is listed as an example of a successful tool that is being used to provide biodiversity data to decision makers.

The objectives of G^2E will also help integrate information all 5 IABIN thematic networks, but will most closely address key issues from 3 of the 5 Thematic Networks identified by IABIN: Ecosystems, Protected Areas and Invasive Species.

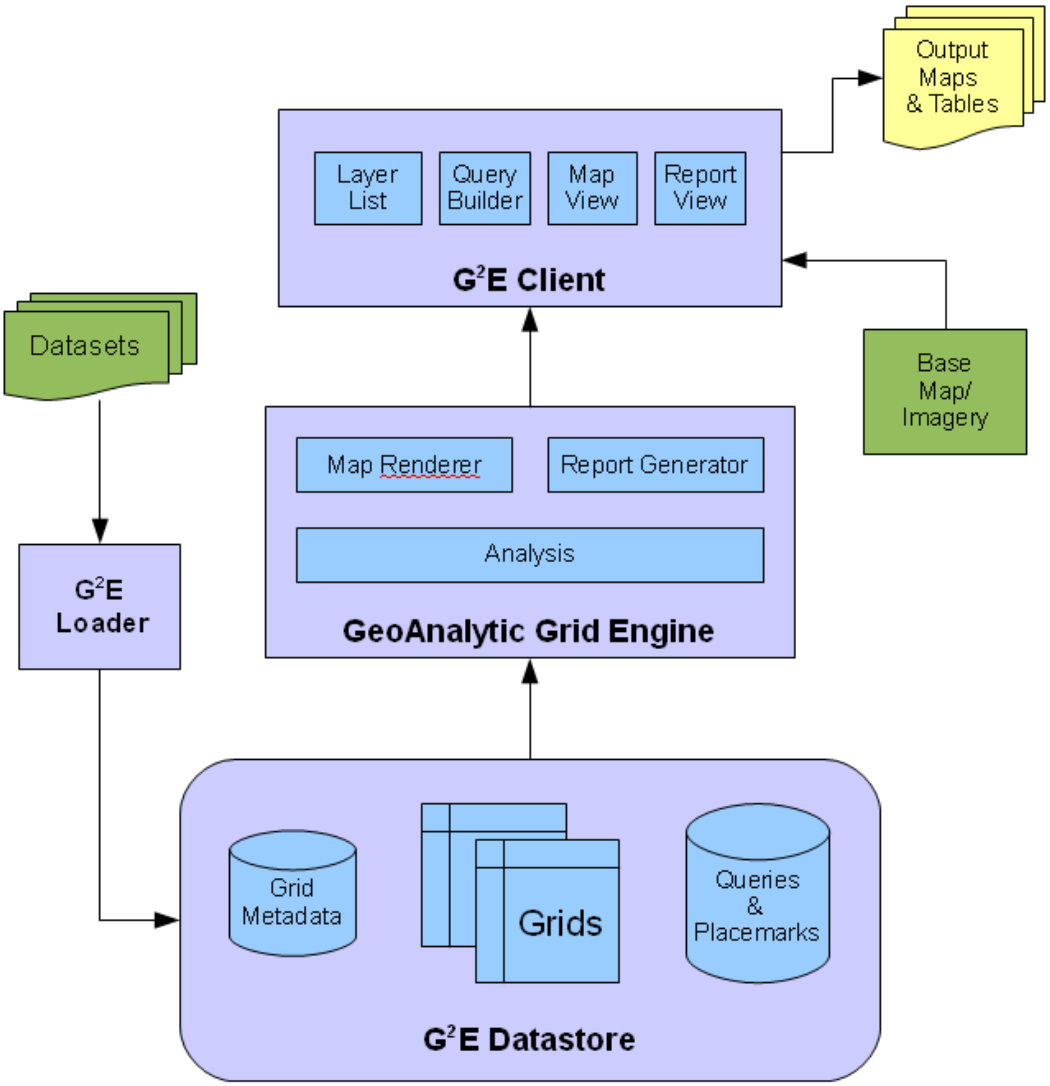
Within the Ecosystem TN, G^2E will specifically address two key issues previously identified: (i) ecosystem information exists at multiple scales and resolutions, and (ii), few tools currently are available that support analysis and interpretation of ecosystem data for decision-making. G^2E will allow users and decision makers to interpret, analyze and display data ranging from species data through to ecosystem data over several spatial scales. This will also help address the stated objective of the Ecosystem TN: Enhance the usefulness of ecosystem information for decision makers in government and civil society.

One of the key needs noted in the Invasive Species TN was the need for the ability to exchange information across national borders to assist in the detection and management of invasive species. G^2E would provide a vehicle that would allow national and sub-national datasets to be exchanged and analyzed.

On a similar note, a prioritize need by the Protected Area TN was to improved access to data to provide assistance to countries with overall protected areas system planning and analyzing protected areas management functionality. G^2E is very well suited to addressing the needs of decision makers working with protected areas. Data store here could easily be analyzed on a variety of levels from region to country to cross boundary areas such as biological corridors, helping to better define and address issues such as connectivity within Protected Areas.

3.2 Technical context of G²E

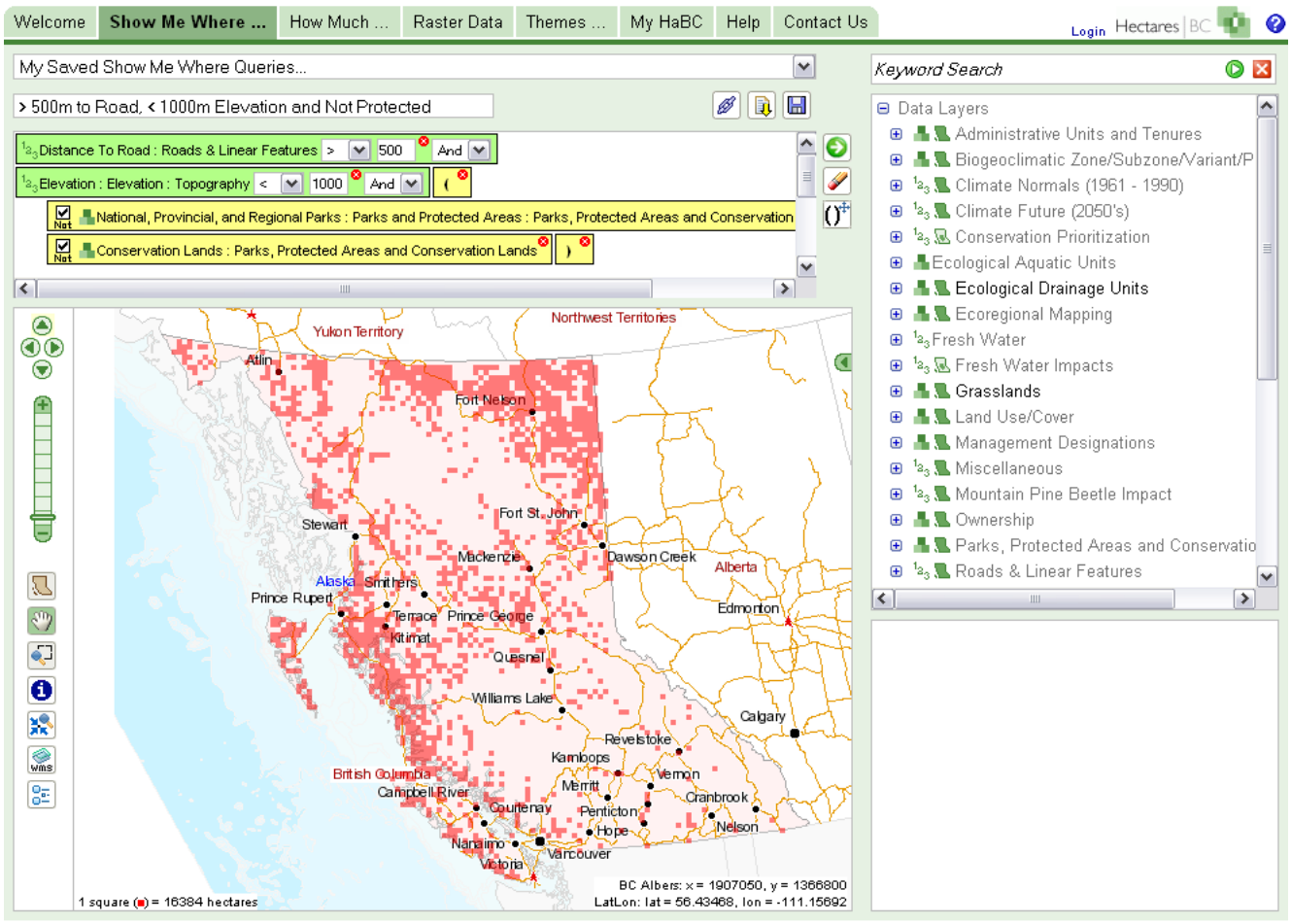
The objective of this proposal is to build the GeoAnalytic Grid Engine as a general purpose tool. In a technical context, G²E can be represented as shown in the following diagram.



G2E Logical Architecture

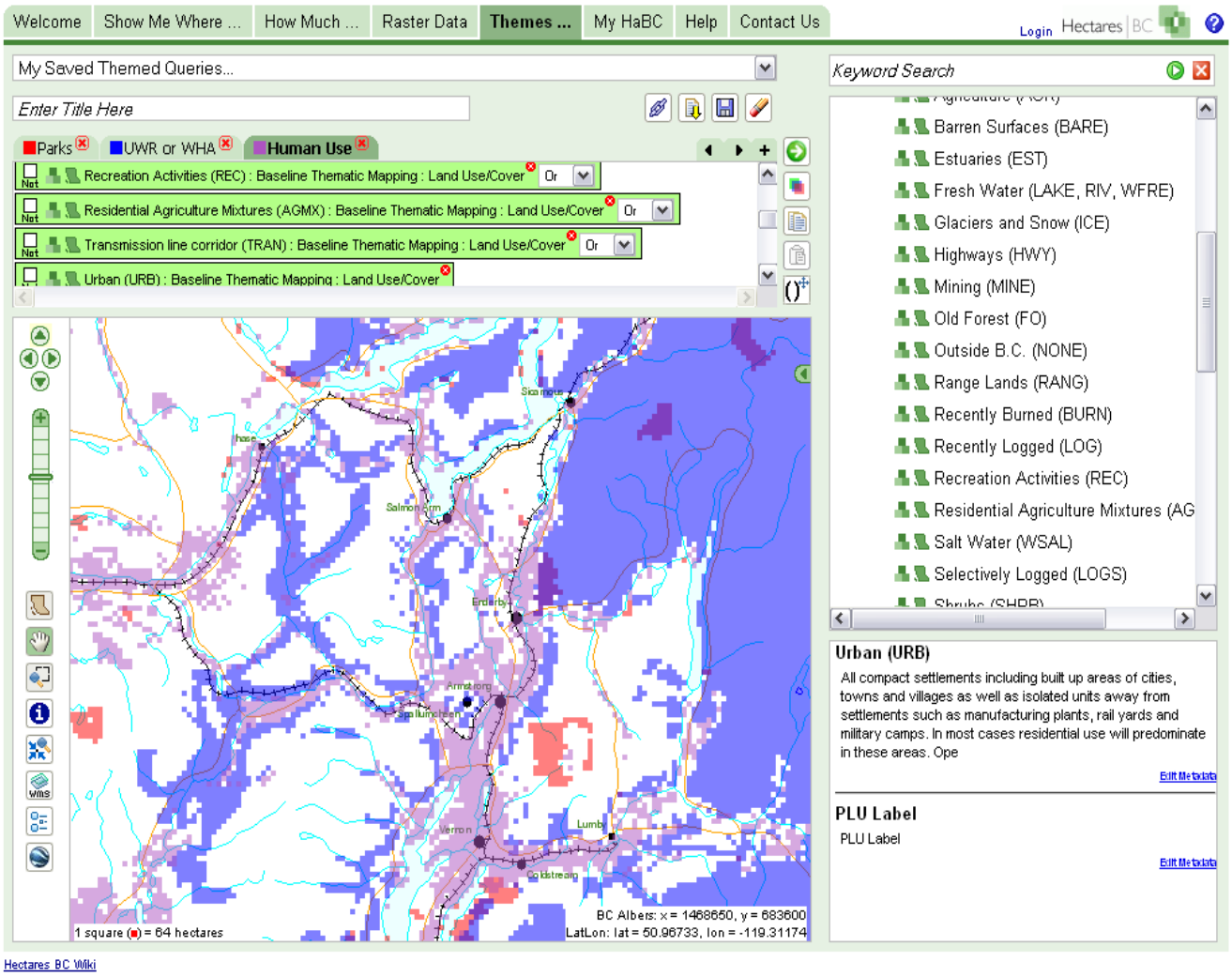
The core of the G²E architecture is the **Grid Engine**. It accepts queries defined by the user, reads the required gridded datasets from the Datastore and computes the query results for presentation. The **Datastore** also records metadata about loaded datasets, and stores user-defined queries to allow them to be reused and shared. User defined placemarks are managed in the datastore as well. The **Client** is a web browser-based component that allows the user to construct queries from layers and to view query results as a map or as tabular reports. The map display is presented over a base map or imagery hosted externally to the system. The **Loader** converts external datasets into the grid format used by G²E, and submits them to the system to make them available to users. Export of maps and tabular results can be made to allow for use of the data in other applications.

An example of the current Hectares BC user interface is shown below. G²E would have a similar appearance. The query is created by drag and drop operations using the layer tree on the right. This allows for fairly sophisticated queries to be made easily, using categorical and/or numeric data. In this case the query is named and has been saved for further use or for sharing with others.



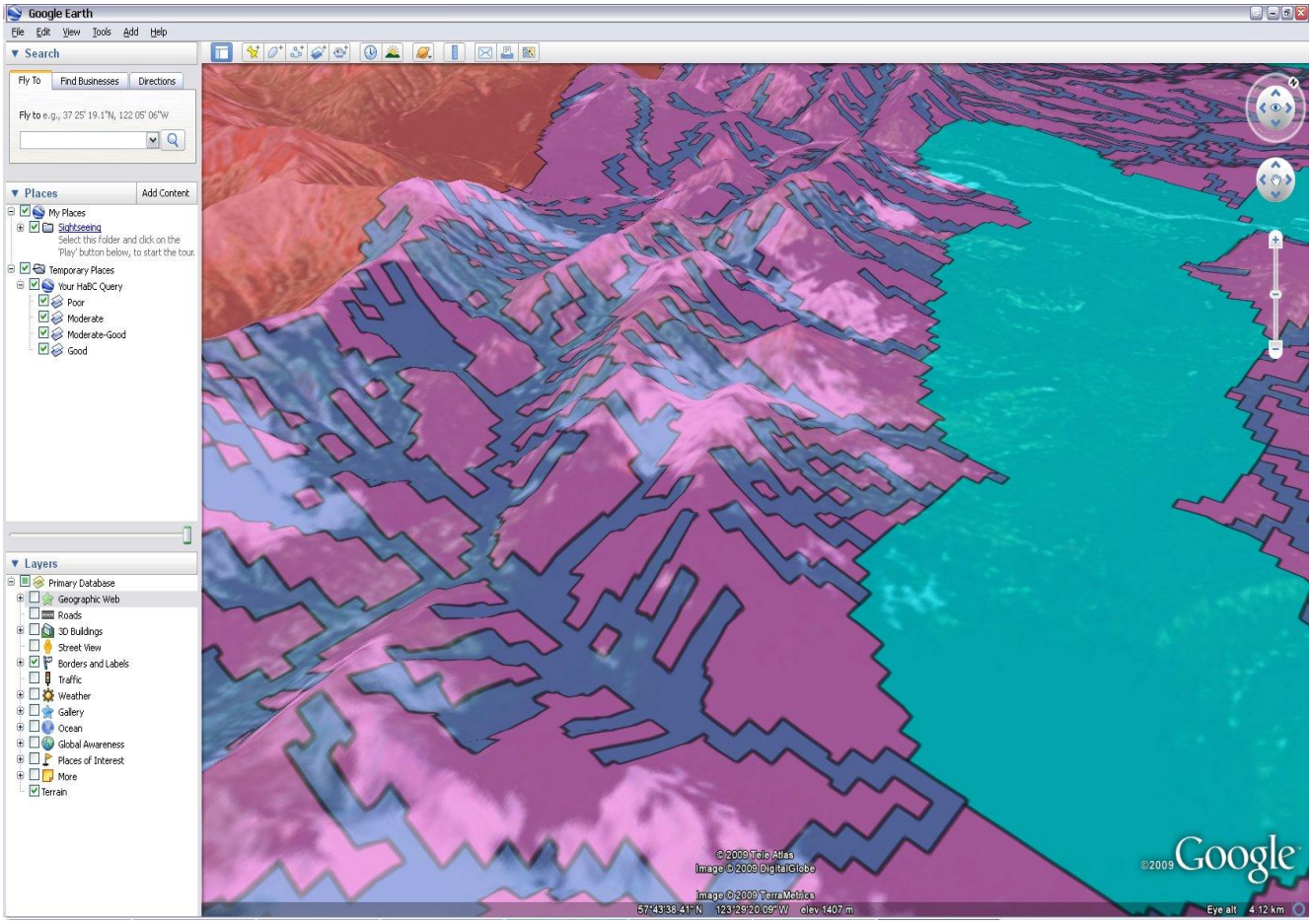
Example of current HaBC user interface. G²E would have a similar appearance.

Another example, zoomed in further, is show below. In this case three colors (and some of their combinations) are shown, corresponding to three different queries as defined in the three live tabs (*Parks*, *UWR or WHA*, and *Human Use*). Names of queries, colors and transparency settings are all controlled by the user. Note the metadata content in the lower right. Scenario comparisons can be made directly using this approach, where each tab and color would correspond to a given query representing a particular scenario.



More detailed example from the current version of HaBC. G²E would be similar.

Finally, it is often of interest to show results on Google Earth, to allow for a three-dimensional perspective. This is shown below. On the right side of the screen the color correspondence is given, pertaining to the query results.



Current HaBC map output in Google Earth. G²E output in Google Earth would be similar.

3.3 Characteristics of G²E and comparison to current version of HaBC

G²E can be conceptualized as a general purpose version of Hectares BC (http://hectaresbc.org/). It is a software application that supports display and analysis of gridded geospatial datasets. The primary distinctions between the current version of Hectares BC (HaBC) and G²E are shown in the table below. Note that the next version of HaBC, as implemented by the government of British Columbia in their information infrastructure, will be based directly on G²E. The technical objectives of this submission are to extend the current version of HaBC as indicated in the table below.

Characteristic	HaBC (current version)	G²E
Maintainability*	Some maintenance is required.	Less maintenance will be required because of design decisions regarding the data management strategy. For typical users no maintenance will be necessary.
Data loading*	Data loading is a significant bottleneck, both in time required to load new datasets and in the specialized resources needed to carry out the work. Currently the	A facility will be provided that will allow new datasets to be uploaded without requiring reloading of existing data. The effect will be faster and simpler data loading. Uploaded data will go through an automated quality assurance process; the user will also be requested to fill

	addition of new attributes requires a redefinition of the database and a re-population of the primary database tables.	out basic metadata about the new data. Data uploaded by a user will be available to others according to access policies defined by the system administrator. A future development, beyond the current scope, would be to establish direct interfaces with other systems; the work outlined here however will set the stage for this as a subsequent step.
Scalability*	The number of hectares could be easily increased, but the number of attributes will reach a practical upper limit of 1000 or so. Because of interest in including large numbers of species models, this is seen as a problem.	The number of cells and the number of attributes will both be highly scalable with the new G^2E architecture.
Performance*	HaBC performs well for most applications today, but will not perform well if the number of attributes increases significantly. Performance problems are also anticipated if the geographic area expands significantly.	G^2E will perform well with large data volumes, including large numbers of cells and large numbers of attributes. This will be true in a traditional Linux server environment and well as commercial environments, with significantly more capability available through cloud computing if desired.
Geographic scope	British Columbia	The geographic scope is arbitrary. It is defined by the user and the datasets of interest.
Conceptual model of geography	A single grid of 1-ha square cells covering British Columbia	Grid resolution and extent is user-defined. Grids of differing resolutions can be used as long as they are aligned with the base tile system.
Coordinate system	NAD83, BC Albers projection	Any reasonable projection can be used.
Grid size	All grid cells are exactly one hectare (100m by 100m) in size	The size of the grid cell area is set by the user, based on grid extent and the projection. If a projection is used that is not equal-area, then the cells will be of varying area.
Multi-scale	The data is stored internally at the resolution of one hectare. More generalized versions are generated automatically by the system. This allows for nearly instantaneous results to be generated for display and approximate tabular estimates. Zooming in will show the most detailed results, as will data exports.	This is similar to HaBC, but the most detailed resolution is based on what is specified by the user.
Basemap	Basemap data is supplied by the government of British Columbia. Use of basemaps from external providers such as Google Maps is not practical.	Google Map basemap and imagery may be used as backdrop. Alternatively, appropriate background data can be sourced from elsewhere.
Area of interest	The area of interest may be all of British Columbia or specific areas as defined through queries.	The area of interest may be the entire area of the project, specific areas defined through queries, or areas defined by the user by digitizing on the screen.

(Access control)	HaBC does not provide any access control mechanisms.	Layers are not necessarily visible to all users. Visibility can be controlled by the system administrator according to desired access policies. This function is outside the scope of the current submission. It will be added to the government's HaBC implementation of G^2E subsequently.
Temporal support*	HaBC has no explicit support for temporal functions or representation of temporal datasets.	Temporal support will be provided, making the application directly applicable to monitoring applications.
Computational support*	Computation is currently restricted to boolean operations based on: and, or, =, ≠, <, ≤, >, ≥, and brackets: (and).	Same as current version of HaBC; additionally, support for algebraic expressions will be added.
3D support*	Three dimensional support is provided through bringing up a Google Earth view of the query results from within the HaBC application. This is experimental at this point.	Same as current version of HaBC, but will be fully operational.
Collaboration*	Queries may be developed and stored, and links to them can be included in email.	As with the current version of HaBC. Additionally, commentary about specific queries will be able to be added. Place marks will be supported such that users can define a point location with a brief description of what is of interest; the description can include links to multimedia files managed elsewhere.
Interoperability	HaBC does a good job of exporting spatial and tabular data following recognized standards. It also allows for use of WMS for background display. It would be realistic to extend it to support KML export.	Interoperability will be expanded to support Google Maps and Google Earth (with the appropriate choice of projection). Support will include allowing URI referencing of the data arrays, such that other web applications can directly access G^2E data.
Language	English only	English, Spanish and Portuguese
Architecture	Web based application operating on a Linux server hosted at the Nature Conservancy of Canada in Victoria, British Columbia	Web based application that could be implemented either on a local server or alternatively in the cloud. An example of the latter is Amazon's Elastic Compute Cloud (EC2) coupled with Amazon's Simple Storage Service (S3).
Application front end	Web mapping interface, with strong query and reporting capabilities	Same as current version of HaBC, with some enhancements to support the full range of requirements.
Application back end	Relational database	Specialized G^2E grid data structures coupled to a simple database for metadata storage
Number of instances of application	A single operational instance of HaBC exists.	The tool can be implemented multiple times without restriction. Thus, specific instances can be set up for particular projects. Instances may be established for a country, a given ecoregion, or any arbitrary area.

License	Open source licensing throughout.	Open source licensing throughout. (See below for further discussion on this point.) If cloud computing is employed, then charges for storage and processing will ensue, based on actual use. If Google Maps basemap or imagery data is used and if the site is not public facing, charges based on use will apply.

* Those properties with an asterisk are of high interest to the Nature Conservancy of Canada or the government of British Columbia. Those without an asterisk are deemed necessary to make the tool applicable elsewhere.

3.4 Intellectual Property

The intellectual property in HaBC is currently being transferred to the government of British Columbia from an environmental NGO to help ensure the long term stability of the application. The Nature Conservancy of Canada, as well as other interested parties, is in favor of this transfer because of their interest in using the tool over the long term.

To ensure that IABIN has unfettered access to the tools in which it invests, the Government of British Columbia will release the source code under an open source license, allowing for free use and modification in perpetuity, to both the initial version of G^2E as well as any subsequent versions.

We believe this is in line with the intent behind IABIN's policies, as IABIN can use, modify, and distribute the tool as it sees fit. Gridded data used by the tool is not considered as part of the tool. Should this require further discussion, please feel free to raise the issue with us.

3.5 Development Methodology

The methodology for G^2E development will follow an agile process using the Scrum agile software development framework. This involves very short daily meetings with the software development, the continual measurement of progress on specific technical objectives, daily assessment of any difficulties, and ongoing interaction with the clients.

Agile development is an iterative process that involves prototyping and incremental progress that can be demonstrated to the client on a regular basis. Particularly uncertain areas of development may involve a highly focused spike of activity to ascertain whether the technology option in question is viable and worth pursuing. Between spiking and prototyping, a project with some technical uncertainties can still proceed quite effectively.

The project manager typically uses specialized project tracking software with the team. Refractions Research, the software developers of HaBC and the proposed G^2E tool, will make use of Scrumworks (http://www.danube.com/scrumworks) for this purpose, as they do on most of their medium to large projects.

As part of the standard process of development, a series documents will be created. These will cover tool requirements, design, build, test, and deployment. Marine and coastal data provided by the Nature Conservancy of Canada will be used for test purposes. Some terrestrial data from the government of British Columbia is also likely to be employed similarly. However, data will only be used as required for testing and will not be part of any deliverables.

As noted above, the development process involves extensive and ongoing interaction with the clients. In this case Refractions Research will make us of professional staff in the Nature Conservancy of Canada and the government of British Columbia. If there are individuals associated with IABIN who would like to take part in such interaction, it would be quite practical to engage them.

What is commonly done and what would be done here is to make regular use of web conferencing as well as a wiki. Web conferences can be held to discuss specific issues and current status. The wiki will house all tool development documents, regular status reports, and a critical issues list, and a general whiteboard for ongoing discussion and commentary. The wiki plays a significant role as a communications device.

Organizationally, the overall development process will be managed by the Project Manager. Oversight will be carried out by GS/OAS (administrative and technical), the Nature Conservancy of Canada (domain expertise), and the government of British Columbia (information infrastructure and domain expertise).

4 Time Frame / Work Plan

The time frame for the project is 25 weeks, or just under six months. It will be broken into the following Work Breakdown Structure (WBS).

1 Requirements: The emphasis is very much on defining succinctly requirements that can be discussed and understood by both the users and the software engineers.

  1.1 Define initial set of requirements, based in part on what is provided in section 3.

  1.2 Assemble use cases: consider both marine/coastal and terrestrial requirements, as well as requirements related to the interface between the two environments

  1.3 Document functional and non-functional requirements: Functional requirements describe what kinds of functions the tool is expected to provide. Non-functional requirements pertain to the technical environment, performance characteristics, aspects of the user interface, and the like.

2 Design: This phase includes the following

  2.1 Design of the lower tier – the data management mechanisms. Effort will be spent here to develop a more scalable, easier to manage alternative to what is used in the the current HaBC implementation.

  2.2 Design of the middle tier – computation and server functions. Part of this can be taken from the current HaBC implementation, but some of it is net new because of changes to the lower tier.

  2.3 Design of the upper tier – the web browser-based client. This is largely done because it will be based on the current HaBC front end. Some enhancement will be required.

3 Build: The build phase will be structured in the same was as the design phase. Note that testing is integral part of the build process.

  3.1 Build and test the lower tier, as described in 2.1 above.

  3.2 Build and test the middle tier, as described in 2.2 above.

  3.3 Build and test the upper tier. Menus, labels and other language constructs in the user interface must be translated into Spanish and Portuguese.

4 Deployment: Deployment as used here involves running the entire application in the environments to be supported and producing the appropriate documentation.

  4.1 Deploy in and package for Linux environment (with Firefox, Safari and Google Chrome browsers)

  4.2 Similar to above but for other environments (e.g., cloud computing)

  4.3 Translate documentation on use and implementation in Spanish and Portuguese

As the Gantt chart in section 8 of this submission shows, these WBS tasks overlap. Not shown but of great importance on the development are spiking and prototyping activities, as described in the section 3.5 above; these will be used in the Design and Build phases as necessary.

5 Team Composition and Task Assignment

The team consists of personnel from the Nature Conservancy of Canada (NCC), the government of British Columbia (GeoBC, the arm of the government involved in this work) and Refractions Research. The software development is being undertaken by Refractions. The individuals, their roles, their affiliations, and their time commitment are listed in the table below.

Resource	Role	Organization	Days
Greg Lawrance	Project Oversight	GeoBC	10
Matt Austin*	Decision Support Expert	GeoBC	30
Pierre Iachetti	Biodiversity Expert	NCC	3
Tanya Bryan	Quantitative Ecologist	NCC	16
Mark Sondheim	Project Manager	Refractions	35
Martin Davis	Technical Architect	Refractions	30
Amr Alam	Senior Software Engineer	Refractions	30
Emily Gouge	Software Engineer	Refractions	90
Darrin Charmley	Quality Assurance Specialist	Refractions	16
TOTAL			**260**

* This resource includes other professionals in addition to Matt Austin. The bulk of the time is allocated to Matt, but Michael Ross (geoweb architect), Peter Friesen (data warehouse specialist), and Charlie Short (ecologist) will also be contributing time.

Greg Lawrance with GeoBC is an information technology specialist with particular knowledge of technical infrastructure and resource data warehousing. Matt Austin serves in the government as an ecologist and decision support expert as related to environmental issues. Pierre Iachetti has a broad background in biodiversity analysis and geographic information systems. He is currently for Director of Conservation & Planning for NCC – BC Chapter. Tanya Bryan, also with NCC, is an ecologist with extensive experience with analysis and assessment.

Mark Sondheim from Refractions has a deep background in both systems and the earth sciences; he has served as a project manager on many projects within both the government and the private sector. Martin Davis acts as the technical architect for most medium to large geospatial developments at Refractions. Amr Allam and Emily Gouge are experienced software developers at Refractions. They were also responsible for most of the software development on HaBC.

Of interest here is the success of Refractions in developing open source tools. In addition to the current version of HaBC, three other projects are as follows:

1. PostGIS: An extension to PostgreSQL, it is considered the premier open source geospatial database in the world. It provides high performance and enterprise reliability.
2. JTS: This is another highly successful open source project undertaken by Refractions personnel (specifically Martin Davis, who is on the proposed team). It is a library of spatial and topological functions, some of which are directly relevant here. JTS and its derivative, GEOS, have been incorporated into many other open source developments.
3. uDig: An Eclipse "rich client" desktop geospatial development environment designed from the ground up as a web application.

6 CVs of Proposed Staff

Mark Sondheim

Education

- Ph.D. Soil Science, University of British Columbia, 1982
- M.A. Geography, University of Toronto, 1975
- B.A. Geology, Antioch College (Ohio), 1973

Employment History

- 2008 – present: Project Manager, Refractions Research Inc.
- 2005 – 2008: Manager, Provincial Baseline Atlas Service, BC Ministry of Agriculture and Lands, Victoria BC
- 1984 – 2005: Head, Corporate Projects Unit, Geographic Data BC, Victoria BC

Career Summary

Mark Sondheim has worked at Refractions Research since April 2008. His principal role is that of a project manager; however he also has responsibilities associated with market development and strategic direction. From January 1980 to March 2008, Mark worked for GeoBC and its predecessors in the British Columbia government. For most of that time he was responsible for establishing and managing a series of province wide programs, including the Digital Road Atlas, the Freshwater Atlas, and Digital Image Services. While in the government, Mark managed a section of 18 people with an annual budget ranging from $1.5m to $2.8m, with much of it obtained from external partners.

Emily Gouge

Education

- B.Sc. (Computer Science), University of Victoria, 2002

Employment History

- 2003 – present: Software Developer, Refractions Research Inc.
- 2002 – 2003: Developer / Analyst, BC Hydro, Victoria BC

Career Summary

Emily Gouge joined Refractions Research in 2003. She is one of the principal developers of the Hectares BC application. Emily has performed as a developer and database manager on many projects. She has past experience with web applications and software development. She also has extensive experience with spatial data modeling and management.

Martin Davis

Education

- B.Sc. with Honours (Mathematics & Computer Science), Queen's University, 1984

Employment History

- 2006 – present: Senior Architect, Refractions Research Inc.
- 1998 – 2006: Senior Developer / Software Architect, Vivid Solutions Inc., Victoria BC
- 1994 – 1998: Programmer / Analyst, BC Ministry of Forests, Victoria BC

- 1988 – 1994: Network Manager, BC Ministry of Finance, Victoria BC

Career Summary
Martin Davis is Refractions' most senior systems architect. He has extensive experience in the areas of systems design and development. Martin's principal areas of expertise are Java development, geomatics, spatial algorithms and spatial data processing. Martin has worked as the Technical Architect on numerous challenging spatial projects for many different clients.
Martin has well over 15 years of experience architecting, designing and developing complex enterprise database systems. He has senior level experience with many database management systems, including Oracle, PostGIS and ArcSDE.

Amr Abou Alam

Education
- B.Sc. (Computer Science – Software Engineering), University of Victoria, 2003

Employment History
- 2003 – present: Software Developer, Refractions Research Inc.

Career Summary
Amr Abou Alam has been with Refractions Research for over six years. During this time, Amr has worked as a Developer on many projects. Amr has over six years of experience with web development, web mapping and its related technologies and use cases. All of Amr's project work has additionally provided him with valuable client-facing experience, such as requirements gathering, system design and process adjustments based on iterative feedback from clients and end-users. Amr is one of the principal developers of the Hectares BC application.

Darrin Charmley

Education
- B.Sc. with Distinction, (Geography), University of Victoria, 2001

Employment History
- 2005 – present: GIS Analyst, Refractions Research Inc.
- 2003 – 2005: Community Forestry and GIS Consultant, CUSO, Indonesia
- 2000 – 2002: GIS Analyst, Pacific Geotech Systems Inc., Victoria BC
- 2000: GIS Training Consultant, Foundation Chol-Chol, Chile
- 1999: GIS Analyst, Ministry of Environment, Lands and Parks, Smithers, BC
- 1997 – 1998: Research Assistant, Geological Survey of Canada, Sidney, BC

Career Summary
Darrin Charmley started with Refractions Research in February 2005 and has been responsible for data transformation, analysis, integration, management and quality assurance on many projects.
Darrin's career as a GIS Analyst began as a coop student working for British Columbia's Ministry of Environment in 1996. Since then, Darrin has worked for other provincial ministries, British Columbia Assessment and Lands, Geological Survey of Canada, private sector consulting companies, and local and international NGOs. Darrin's experience has seen him perform as the technical lead for spatial data management projects, consult non-governmental organizations in the setup and management of a GIS and coordinate multi-stakeholder spatial data integration projects.

Gregory Lawrance

Education

- Bachelor of Science in Forestry, Faculty of Forestry, University of Toronto, 1989
- Diploma, Geographic Information Systems Applications Specialist, School of Natural Resources, Sir Sandford Fleming College, Ontario, 1992

Employment History

- April 2007 to Present: Team Leader, GeoBC Information Services Branch, Integrated Land Mangement Bureau, BC
- November 1994 to April 2007: Timber Supply Forester, Forest Analysis and Inventory Branch, B.C. Ministry of Forests
- November 1992 to November 1994: Senior Environmental Economist, Social & Economic Research & Analysis Section, Statistics Canada, Ottawa
- March 1990 to November 1992: Development Planner, Natural Resource Inventories Section, O.M.N.R., Sault Ste. Marie

Career Summary

Greg leads a multi-agency, multi-year project to improve industry access to spatial information, responsible for provincial metadata repository and services and standards, application manager for HectaresBC. He manages a small team of technical and professional staff to assist with project delivery and operational maintenance of application services.

Matthew Austin

Education

- Master of Environmental Design (Environmental Science), The University of Calgary, thesis entitled: "Wolverine Winter Travel Routes and Response to Transportation Corridors in Kicking Horse Pass Between Yoho and Banff National Parks"
- Honours Bachelor of Science in Zoology, The University of Western Ontario

Employment History

- September 2008 to Present: Lead, Hectares BC, GeoBC Information Services Branch, Victoria BC (work week split with Ministry of Environment)
- April 2006 to Present: Ecosystem Specialist, Ecosystems Branch, Ministry of Environment, Victoria BC
- August 2005 to March 2006: Manager, Project Coordination – Species at Risk, Ecosystems Branch, Ministry of Environment, Victoria BC
- May 2005 to July 2005: Manager, Terrestrial Ecosystems Science Section, Biodiversity Branch, Ministry of Water, Land and Air Protection, Victoria BC

Career Summary

In his current position at GeoBC, Matthew prepares business cases for integrating Hectares BC – a web application allowing users to analyze geospatial information without the need for a GIS – into GeoBC's suite of services. He liaises with senior managers across the natural resource sector, establishing contacts in the social sector and industry. He led geospatial analysis projects for the Forestry Round Table Secretariat including identifying potential areas for designation as Commercial Forest Reserve. And he added functionality to

Hectares BC to allow users to determine which of 1,012 species and 535 ecological communities occur in an area – linked to the Conservation Framework.

Pierre Iachetti

Education

- M.Sc., Royal Roads University, Victoria BC

Career Summary

Pierre Iachetti is currently the Director of Conservation Science and Planning, Nature Conservancy of Canada, BC Region. He is a registered Professional Agrologist with the BC Institute of Agrologists and a Registered Planner with the Planning Institute of BC and the Canadian Institute of Planners. Pierre received his undergraduate degree in Geography from McMaster University, diploma in Restoration of Natural Systems from the University of Victoria, and masters degree in Environment & Management from Royal Roads University. He has previously held a Social Sciences & Humanities Research Council fellowship at the Sustainable Development Research Institute, University of British Columbia and an Alcoa Foundation Conservation and Sustainability fellowship at the International Union for Conservation of Nature (IUCN), Gland, Switzerland. Pierre is currently a member of the World Commission on Protected Areas and the Commission on Ecosystem Management – both with the IUCN. Pierre has served as a project lead or team member on several trans-boundary conservation planning projects spanning BC, Alberta, Washington state, Alaska, Montana, and Idaho.

Tanya Bryan

Education

- MSc, (Biological Oceanography), Dalhousie University
- BSc, University of Guelph

Career Summary

Tanya Bryan has been actively involved with conservation work since 2000. Her experience ranges from academic research on programs relating to the planning and management of protected Areas, including effective sizes and designs of protected areas networks, to teaching public education at a research centre. Through her academic and professional work, she has become familiar with habitat management issues on both the east and west coasts of Canada and has worked with First Nations groups, academics, community groups, private industry and all levels of government.

7 Staffing Schedule

Staffing levels for each of the six months of the project are shown in the chart below. The chart shows the estimated numbers of days in each month that will be spent by personnel on the project. Darker shading indicates higher levels of involvement.

		Allocated Days for Each Month					
#	Resource	1	2	3	4	5	6
1	Greg Lawrance	2.5	1.5	1.5	1.5	1.5	1.5
2	Matt Austin*	7.0	6.0	4.0	4.0	4.0	5.0
3	Pierre Iachetti	0.5	0.5	0.5	0.5	0.5	0.5
4	Tanya Bryan	4.0	3.0	1.0	1.0	4.0	3.0
5	Mark Sondheim	9.0	6.0	5.0	5.0	5.0	5.0
6	Martin Davis	8.0	7.0	6.0	3.0	4.0	2.0
7	Amr Alam	6.0	6.0	6.0	5.0	3.0	4.0
8	Emily Gouge	10.0	16.0	16.0	16.0	16.0	16.0
9	Darrin Charmley	0.0	0.0	0.0	4.0	6.0	6.0
	TOTAL	47.0	46.0	40.0	40.0	44.0	43.0

8 Work Schedule

The tasks defined in the Work Breakdown Structure described in section 4 of this submission are scheduled as per the Gantt chart below.

		Month					
WBS	**Tasks**	1	2	3	4	5	6
1	**Requirements**						
1.1	Initial set						
1.2	Use cases						
1.3	Detailed						
2	**Design**						
2.1	Lower tier						
2.2	Middle tier						
2.3	Upper tier						
3	**Build & Test**						
3.1	Lower tier						
3.2	Middle tier						
3.3	Upper tier						
3	**Deployment**						
3.1	Linux environment						
3.2	Other environments						
3.3	Docs						

The following reports will be generated.

1. Requirements
2. Design
3. Implementation Instructions (multilingual)
4. G^2E User Guide (multilingual)
5. Status Reports (months 1 through 5, plus a final report)

Demonstrations will also be made beginning no later than the third month. These will be to solicit feedback and demonstrate progress. The demonstrations will be run through web conferencing and are expected to occur at the end of months 3, 4, and 5, as well as at project completion.

A project wiki will be established during the first month. All reports and issues will be available on the wiki.

The status reports as well as the other documentation will be discussed with GS/OAS personnel and changes will be made as requested. They and others will be asked to participate in the demonstrations described above.

G. Summary of Costs

In the material that follows, the day rates for Refractions are as used for recent contracts with the government of Canada and the government of British Columbia, and as registered on the government of Canada's web site, Professional Services Online. The rates for government of British Columbia and Nature Conservancy of Canada personnel are as defined by their respective policies.

The cost of carrying out the work is indicated in the table below. Software development is being carried by Refractions. The Nature Conservancy of Canada is providing domain expertise. The government of British Columbia is also providing expertise, but as an in-kind contribution.

Resource	Rate	Days	Value
Nature Conservancy of Canada		19	$9,800
Pierre Iachetti	$600	3	$1,800
Tanya Bryan	$500	16	$8,000
Refractions Research		170	$148,480
Mark Sondheim	$1,000	30	$30,000
Martin Davis	$1,000	24	$24,000
Amr Allam	$920	24	$22,080
Emily Gauge	$800	80	$64,000
Darrin Charmley	$700	12	$8,400
Translation into Spanish and Portuguese			$5,500
TOTAL		**189**	**$158,280**

In kind contributions are being made by the government of British Columbia and Refractions Research. Staff from the Nature Conservancy of Canada will be involved, but their time will not be considered as in-kind.

Resource	Rate	Days	Value
Government of British Columbia		40	$20,000
Greg Lawrance	$500	10	$5,000
Matt Austin and others	$500	30	$15,000
Refractions Research		31	$27,320
Mark Sondheim	$1,000	5	$5,000
Martin Davis	$1,000	6	$6,000
Amr Allam	$920	6	$5,520
Emily Gauge	$800	10	$8,000
Darrin Charmley	$700	4	$2,800
TOTAL		**71**	**$47,320**

The cash contributions and the in-kind contributions are included in the following table. Note that the government of British Columbia cash contribution is $50,000. Half of this can be provided now, and the other half is expected in the new fiscal year beginning April 1, 2010. The budget for next fiscal year has not yet been released.

Organization	Cash Contribution	In-kind Contribution	Total	
Government of British Columbia	$50,000.00	$20,000.00	$70,000.00	Canadian $
Nature Conservancy of Canada	$40,000.00		$40,000.00	
Refractions Research		$27,320.00	$27,320.00	
Subtotal	**$90,000.00**	**$47,320.00**	**$137,320.00**	
IABIN	$68,280.00		$68,280.00	
TOTAL	**$158,280.00**	**$94,640.00**	**$205,600.00**	

Multiplier to convert to US dollars =	0.96
IABIN contribution in US dollars =	$65,548.80
Overall % covered by GS/OAS =	33.21%

As can be seen from the table above, the overall percentage to be covered by GS/OAS is $65,548.80 (USD), which is just under one-third of the total cost.

Legal Status

British Columbia is one of the ten provinces in Canada. Its existence is underwritten in the Canadian constitution.

The Nature Conservancy of Canada is registered with the government of Canada as a charitable organization. Its notification of registration is included with this submission.

Research Research, Inc. was incorporated as a company in the province of British Columbia in 1998. A copy of the legal papers is not attached, but can be provided if required.

Revenue Canada Revenu Canada

The Nature Conservancy
of Canada
110 Eglinton Avenue West
Toronto, Ontario
M4R 2G5

Our file Notre référence
0253617
Tel. (613) 954-0945
Toll Free 1-800-267-2384

November 16, 1994

Re: Notification of Registration

We are writing to confirm that "The Nature Conservancy of Canada" is registered with the Department of National Revenue as a Charitable Organization.

Registration Number: 0253617-52

Effective Date of Registration: January 1, 1967

We hope the foregoing is satisfactory.

Please address all correspondence to the Charities Division, 400 Cumberland Street, 5th floor, Ottawa, Ontario, K1A 0L8.

Yours sincerely,

Suzie Da Costa
Charities Division

Canada

Revenue Canada Revenu Canada

OTTAWA ON K1A 0L5

036716

June 1997

RECEIVED
JUN 18 1997
Ans'd .....

THE NATURE CONSERVANCY OF
CANADA - LA SOCIÉTÉ CANADIENNE
EXECUTIVE DIRECTOR
110 EGLINTON AVENUE WEST
TORONTO ON M4R 2G5

SUBJECT: CONVERSION OF REGISTRATION NUMBER TO THE BUSINESS NUMBER

Registration Number	New Business Number (BN)
0253617-52	11924 6544 RR0001

RECEIVED 1997

We are writing to advise you that your registration number has now been converted to the Business Number (BN), as indicated above.

To ease the changeover, there is a transition period for registered charity, registered Canadian Amateur Athletic Association (RCAAA), and registered National Arts Service Organization (RNASO) accounts, ending September 30, 1998. This period will give you time to notify donors of the new number and to use up tax receipts and other documents with the old charitable registration number. The conversion to the BN will not affect any of the rules or procedures that charities currently follow.

If you require information about your charity account, you can call the Charities Division toll-free at 1-800-267-2384. If you have questions concerning any of your other Revenue Canada BN accounts, please contact your local Tax Services Office at the number listed under Government of Canada in the blue pages of your telephone directory. Please provide your BN when you contact Revenue Canada.

Rob Wright
Deputy Minister of National Revenue

Canada