ADVANCE CONTRACT AWARD NOTICE (ACAN)

1. Definition

An Advance Contract Award Notice (ACAN) allows departments and agencies to post a notice, for no less than fifteen (15) calendar days, indicating to the supplier community that it intends to award a good, service or construction contract to a pre-identified contractor. If no other supplier submits, on or before the closing date, a Statement of Capabilities that meets the requirements set out in the ACAN, the competitive requirements of the government's contracting policy have been met. Following notification to suppliers not successful in demonstrating that their Statement of Capabilities meets the requirements set out in the ACAN, the contract may then be awarded using the Treasury Board's electronic bidding authorities.

If other potential suppliers submit Statement of Capabilities during the fifteen calendar day posting period, and meet the requirements set out in the ACAN, the department or agency must proceed to a full tendering process on either the government's electronic tendering service or through traditional means, in order to award the contract.

2. Definition of Requirements

Background and Project Description:

The Northwest Territories (NWT) is approximately 128 million ha in size of which 33 million ha, or 25% is considered forested (Natural Resources Canada 2006). Attempting to complete a forest inventory over such a large area for use at local, regional and territorial scales is challenging given the relative lack of access and small amounts of detailed inventory data that presently exist (Smith 2002). In response, the federal (Natural Resources Canada, Canadian Space Agency) and territorial (Government of NWT) governments recently completed a satellite-based land cover map of the NWT. This map comprised a component of the Earth Observation for the Sustainable Development of Forests (EOSD) project that was completed for the forested areas of Canada, and this was undertaken across the NWT with Landsat Thematic Mapper (TM) data (Wulder et al. 2003). To improve the informational value of these land cover maps for reporting on the state of NWT forests, generating additional knowledge about forest structure, volume and aboveground biomass is necessary.

The use of satellite remote sensing for inventory mapping from medium spatial resolution imagery has been widely explored with variable results being reported (Jakubauskas and Price 1997; Hall et al. 2006; Sivanpillai et al. 2006; Lutz et al. 2008). Remote regions such as the NWT raise additional challenges because: 1) collection of field information is costly, 2) physical access is difficult, 3) the forested landscape is diverse with increasing multiple use concerns, and 4) relatively few remote sensing inventory-based studies have previously been conducted (Gerylo et al. 2002; Franklin et al. 2003). As a result, there is particular difficulty associated with scaling field measurements to medium spatial resolution satellite imagery such as Landsat, in remote northern regions.

One of the technologies that may supplement the information provided from field data collection is that collected from LiDAR sensors. Of particular interest is a NASA spaceborne sensor called ICESat/GLAS, a satellite platform that carries the Geoscience Laser Altimeter System (GLAS) which is in essence, a large footprint LiDAR (Schutz *et al.* 2005). One of the products of the ICESat mission is a network of height data on Earth's land topography along with canopy height profiles of vegetation cover. Our interest in ICESat/GLAS data, particularly for the Northwest Territories (NWT), lies in retrieving vegetation canopy profiles by analysing the waveform of the returned infrared laser pulse signals. The geographic coverage of ICESat/GLAS results in an extensive network of monitoring plots across NWT that could serve as surrogates to plots traditionally measured from the field. The potential of ICESat/GLAS for deriving structure-related forest attributes has recently been demonstrated by Harding et al. (2005) and Lefsky et al. (2005), but its utility in northern forests are largely unknown other than at very coarse scales (Simard et al. 2011). To support the assessment of the utility of spaceborne ICESat/GLAS for deriving estimates of stand structure, volume and biomass, a corresponding comparison with airborne LiDAR and field measurements would provide insights as to the degree to which stand attributes can be derived. It is hoped that the technology may also be applied successfully in NWT with the ultimate objective of deriving stand structure attributes of height and vegetation cover density. ICESat/GLAS would provide additional stand structure information to better calibrate these models across a larger geographic extent spanning multiple ecozones. Mapping of volume and biomass could then be performed across the NWT land base using models that rely on these two specific structural attributes.

Previous collaborative work with the Alberta Terrestrial Imaging Centre has resulted in processing the ICESat data in preparation for analysis over an area defined as Phase 1 (Figure 1). Of interest is to investigate the influence of ICESat data quality flags on estimation of stand attributes, development of models from ICESat data for estimating stand height and crown closure, and a comparison of two spatial imputation algorithms, k-Nearest Neighbour (kNN) and Random Forest (RF). The means of optimally determining the input parameters and algorithms to drive these spatial imputation algorithms would provide a relevant component of this work as well as to draft a manuscript for journal publication.

Following this work is the development of a workplan to undertake ICESat processing over a Phase 2 area in the NWT where there is a notable lack of field information for calibration and validation of stand structural attributes estimated from ICESat (Phase 2). In order to achieve this task, available airborne LiDAR and forest resource inventory (FRI) plot data throughout Phase 2 need to be quantified. Furthermore, as the Phase 2 work extends even further north (beyond 60° N), where a decay in data quality has been noted (Nelson 2010) the quality of ICESat data at such latitudinal extremes needs to be assessed for model reliability purposes.

Scope of Work:
The Project encompasses the following studies, objectives and deliverables:

Year 1: Contract Award - March 2016

1. Data Inventory Assessment over Phase 2 and Assessing ALS/GLAS Coincidence at Northern Latitudes

In order to calibrate/validate ICESat GLAS models that are expected to be developed (given sufficient ALS data availability) or applied (from Phase 1 in lieu of ALS data), the distribution of existing ALS and FRI field plots need to be quantified throughput phase 2. Furthermore, as ICESat GLAS data being used to model forest attributes, the quality of the data needs assessment this far north, as quality is known to deteriorate at extreme latitudes.

Objective: Assess the quantity, spatial distribution, and access restrictions of ALS and FRI plot data throughout Phase 2 area, and identify ALS/GLAS coincidence in preparation for Task 3

Methods:
1. Gather all existing ALS and FRI plot data between 55° and 70° N
2. Quantify the area of Phase 2 covered by existing ALS data, and assess its distribution as a function of landcover
3. Quantify the number of FRI plots within Phase 2, and assess their distribution as a function of landcover
4. Identify the coincidence of ALS and ICESat GLAS data for all gathered ALS data, for possible use in assessing the quality of ICESat GLAS height data as a function of latitude (Task 3)

Deliverables:
1. Report outlining the current condition, data access permission requirements or restrictions, and recommendations of ALS and FRI plot data in Phase 2 area; existing data will be spatially mapped
2. Report identifying locations of coincidence between ALS and ICESat GLAS data between 55° and 70° N, and possible implications on Task 3

2. PREDICTION AND MAPPING OF STAND HEIGHT AND CROWN CLOSURE OVER PHASE 1 (FIGURE 1)

ICESat GLAS footprints provide the only systematic measurement of forest structure over northern boreal regions where field access is limited. Based on samples of field and airborne LiDAR data from which to calibrate metrics from ICESat GLAS, of interest was to generate point estimates of stand height and crown closure which could subsequently be spatialized using a kNN or Random Forest algorithm.

Objective: Prediction and mapping of stand height and crown closure over Phase 1 area

Methods:

1. Ingest processed airborne LiDAR from Fusion processed raster cells with model coefficients provided by CFS
2. For ICESat, assess quality flags and select those for implementation to identify ICESat footprints suitable for analysis
3. Develop ICESat models to estimate stand height and crown closure as a function of waveform metric
4. Apply ICESat models to kNN and Random Forest algorithms with CFS provided spatial variables that include EOSD circa 2007 land cover, Landsat Thematic Mapper bands 3, 4, 5, digital elevation, Climate Moisture Index, Soil Moisture Index, and Compound Topographic Index. Develop procedures to optimize input parameters in the implementation of these spatial imputation algorithms and validate model outputs

Deliverables:

1. Models for stand height and crown closure
2. Output rasters from kNN and Random Forest algorithms to estimate and map stand height and crown closure, and associated uncertainties, over Phase 1.
3. Manuscript for publication describing effects of quality flags and differences between kNN and Random Forest spatial imputation for rasterizing stand height and crown closure.

Year 2: April 2016 – March 2017

3. Applicability of ICESat in Northern Latitudes & Predictions of Stand Height and Crown Closure over Phase 2

Making predictions of stand height and crown closure in the Phase 2 extent follows the completion of work over Phase 1. In making predictions further north we will need to utilize the models built in phase 1, between the latitudes of 59° and 63°, provided no supplementary airborne laser scanning (ALS) data are available for use to build new models. If ALS data are available, we can investigate ICESat's ability to measure height in even more extreme latitudes; this would follow up on the work of Nelson (2010), who briefly noted a decay in the quality of ICESat measurements between 46° and 60°. Furthermore, such results would justify the use of the Phase 1 ICESat models with the directly measured ICESat heights.

Objective: Prediction and mapping of stand height and crown closure over Phase 2 area

Methods:

1. Gather ALS data from northern Alberta to as far north in the NWT as possible
2. Do quality checks on ICESat estimates of height with respect to ALS data
3. Present a measure of the expected quality of ICESat heights at high latitudes, which can be amassed in model uncertainties when phase 2 area-wide models are calculated
4. Create new stand height and crown closure models from ALS data if we have high coincidence, otherwise apply the Phase 1 models
5. Apply and evaluate application of ICESat models of stand height and crown closure over Phase 2 to generate rasterized outputs of stand height and crown closure
6. Document results, implementation issues and draft results for publication

Deliverables:

1. Models and uncertainty analysis for estimating and validating stand height and crown closure at ICESat footprints over Phase 2.
2. Rasterized outputs of stand height, crown closure and associated uncertainty from kNN and RF over Phase 2.
3. Report and evaluation of results with assessment for publication over more northerly geographic extent of the northern Boreal.

4. Development of an Active Sensor Gap Fraction (GF) Model as a Predictor of Crown Closure

The estimation and mapping of tree crown closure is a challenging attribute in northern boreal forest environments. Alternative approaches based on LiDAR data Gap fraction from ICESat data require a scaling factor to be applied to the ground portion of the waveform. With access to Airborne Laser Scanner (ALS) data a physically based model can be applied to derive scaling factors based on a number of supplementary parameters. Using these parameters we can model the scaling factors to individual GLAS footprints and up-scale to the phase 2 extent via kNN or Random Forest. The ability of this GF product as a predictor of an improved crown closure product can be explored. As GF is a fundamental parameter for estimation of Leaf Area Index (LAI), future projects could explore this possibility.

Objective: To develop a new method for estimation of crown closure from inverse of gap fraction estimated from GLAS data

Methods:

1. Obtain GF from airborne LiDAR and GLAS (unscaled)
2. Calculate scaling factor between coincident airborne LiDAR and GLAS footprints by noting the differences in each data sources calculation of GF, then model this relationship
3. Apply this model to GLAS data based on optimal predictor variables
4. Use kNN or RF to spatialize the model to the Phase 2 extent
5. As a publishable component to this project, evaluate methods of inverting GLAS estimates of GF as a predictor of crown closure (100 x [1-GF]) in the kNN or RF algorithm for spatializing crown closure to the phase 2 extent. If results suggest improved CC, revised CC models over Phase 1 will be developed with GF as a predictor of CC. The same method will be applied over Phase 2.
6. Conduct statistical analyses of model performance and uncertainties for estimation of CC from GLAS data with and without GF as a predictor.

Deliverables:

1. Statistical results describing models of GF based on available field ALS and GLAS data.
2. Updated rasterized product of CC for Phase 1 and Phase 2 (if CC is improved with addition of GF as predictor), and associated uncertainty rasters from RF and kNN
3. Draft paper/report describing the estimation and validation of gap fraction and its potential for estimating/mapping CC over the Phase 1 area

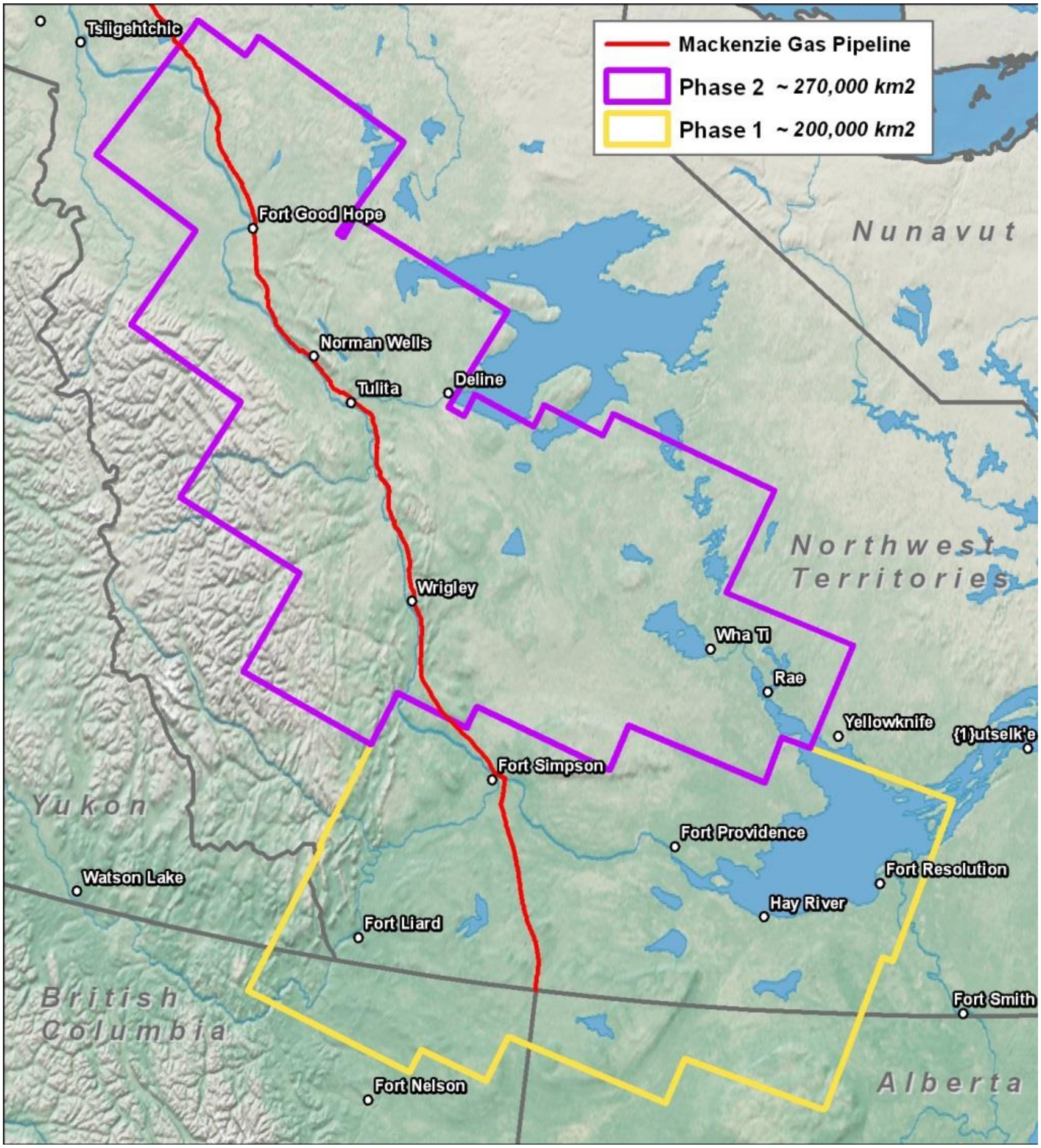

Figure 1. Location of Phase 1 and Phase 2 study areas

3. Trade Agreements

There is no trade agreement impacted with this contract.

4. **Title to Intellectual property**

Natural Resources Canada has determined that any intellectual property rights arising from the performance of the Work under the resulting contract will belong to Canada, on the following grounds:

To generate knowledge and information for public dissemination

NRCan reserves the right to grant, upon written request, a license to exercise the required Intellectual
Property Rights in such Canada-owned information to the successful Contractor.
For reference, the Treasury Board Site is: http://www.tbs-sct.gc.ca/pubs_pol/dcgpubs/contracting/tipaucpca1-eng.asp#_Toc490365246

5. **Contract Period**

The contract period will be from Contract Award to March 31, 2017.

6. **Estimated Cost**

The estimated maximum value for this contract is $50,000.00.

7. **Exception to the Government Contracts Regulations and applicable trade agreements**

(d) Only one person or firm is capable of performing this contract.

The Consultant has led multiple Airborne Laser Scanner (ALS) campaigns in the area of the phase 1 GNWT project and as such, he held unique access to ALS hardware and software which was essential to the project. The research expertise of the Consultant and his HQP (eg., graduate students and post doctoral fellows) were directly aligned with the research objectives of the projects. Access to hardware, lab personal and Consultant’s in-kind contributions constitutes a significant cost component that cannot be replicated using private sector contractors

8. **Name and Address of the Proposed Contractor**

Department of Geography,
University of Lethbridge,
4401 University Drive Est,
Lethbridge, AB.
T1K 3M4

9. **Inquiries on Submission of Statement of Capabilities**

"Suppliers who consider themselves fully qualified and available to provide the services/goods described herein, may submit a Statement of Capabilities in writing, preferably by e-mail, to the contact person identified in this Notice on or before the closing date and time of this Notice. The Statement of Capabilities must clearly demonstrate how the supplier meets the advertised requirements."

10. Closing Date

The closing date for a submission of a Statement of Capabilities is December 04, 2015 at 14:00 Mountain Standard Time.

11. Contract Authority

Contracting Authority
Kingsley Okosun
5320 122nd Street, Edmonton AB. T6H 3S5
Telephone: 780-435-7208
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