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THE SURVEYOR GENERAL BRANCH

Annual Report 2019–2020



Canada 

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MESSAGE FROM THE SURVEYOR GENERAL

I am pleased to present the Surveyor General Branch's (SGB) annual report for the 2019–2020 fiscal year, the tenth in a series detailing our achievements, projects and publications.

The annual report:

- ◆ presents the SGB's progress in addressing the recommendations of the 2019 audit of the Canada Lands Survey System
- ◆ showcases the volume of work undertaken by our staff in 2019–2020
- ◆ illustrates the progress made in our four strategic priorities:
 - ◇ Indigenous peoples' control of their lands
 - ◇ spatially enabling Canada for the digital economy
 - ◇ northern property rights
 - ◇ protection of Canada's oceans

The SGB continues to play an integral part of Natural Resources Canada's (NRCan) Lands and Minerals sector. As a science and technology (S&T) organization within NRCan, the SGB responds to NRCan's S&T priority issues through innovation in services to enhance competitiveness and contributions to sound stewardship, both onshore and offshore.

Although the SGB enjoyed many accomplishments and successes throughout 2019–2020, undeniably, the past several months have provided significant challenges. The COVID-19 pandemic affected the delivery of many government initiatives, including our three programs:

- ◆ Canada Lands Survey System
- ◆ Canadian Geodetic Survey
- ◆ Canadian Section of the International Boundary Commission

Predictably, the SGB rose to the challenge. We will continue to deliver on our responsibilities and serve the many Canadians and industries that rely on our work. As well, the SGB will continue to collaborate with others across the department to overcome the challenges presented by COVID-19.

As always, I invite you to review and provide comments on the report, and I look forward to your continued engagement.

Jean Gagnon

Surveyor General of Canada Lands

Canadian Commissioner, International Boundary Commission

Director General, Surveyor General Branch

THE SURVEYOR GENERAL BRANCH: WHO WE ARE

The SGB will be 150 years old in 2021. Our mission has always been to ensure that Canadians have access to secure and reliable land survey systems, clearly defined boundaries, and accurate positioning information to meet Canada's economic, social, and environmental needs. The SGB also contributes to the science and infrastructure that Canada needs to succeed in the global economy.

In 2019–2020, the SGB had a:

◆ budget of
\$21,995,813

◆ dynamic workforce of
168 employees,
including survey engineers,
geodetic engineers, survey
technicians and support staff

◆ head office in Ottawa and
10 regional offices
across Canada

OUR PROGRAMS

The SGB's three programs align with several federal government priorities and commitments. Our work contributes to NRCan's core responsibilities related to natural resource science and risk mitigation by providing important information about Canada's lands and supporting vital land management tools and practices.

- ◆ The **Canada Lands Survey System** (CLSS) helps to define, demarcate, and describe property boundaries and the extent of property rights for Canada Lands — the North, First Nations reserve lands, national parks, and offshore. With boundary certainty and a well-maintained property rights system, stakeholders can focus on community well-being and economic growth. A strong land survey system is especially important to support Indigenous self-governance.
- ◆ The **Canadian Geodetic Survey** (CGS) provides foundational positioning infrastructure, i.e. a framework that facilitates the accurate measurement of latitude, longitude, elevation, and gravity in Canada. Such measurements are important not only for boundaries, but for anything for which the location matters, including all economic activities in Canada and a wide array of scientific studies and applications.
- ◆ The **Canadian Section of the International Boundary Commission** (IBC), in co-operation with its United States counterpart, preserves and maintains a clear and visible boundary between Canada and the United States. This work includes maintaining the boundary monuments and open vistas through forested areas, as well as regulating construction and work within 3 metres of the 8,891-kilometre boundary. Having a clear Canada-United States boundary is essential to support law enforcement agencies in ensuring the security of Canadians and preserving our sovereignty. The Canadian Section of the IBC operates under a separate reporting structure, tracking its accomplishments and year-end metrics in its own annual report. Its report is submitted to the United States Secretary of State and the Canadian Minister of Foreign Affairs and is available on the [IBC website](#).

Program evaluation

To ensure that we are delivering on our commitments effectively and are providing high quality products and services to our clients, the SGB regularly reports on and assesses the performance of its programs. For example, we track the progress and results of key projects that support our strategic priorities, as well projects that help improve our daily operations. These projects are monitored through an evergreen dashboard that is updated every two months and shared with SGB management (see Annex 1).

In addition to the internal reporting, the SGB undergoes audits at the departmental level. The most recent audit of the Canada Lands Survey System (CLSS) program was in 2019. We are currently working to address the recommendations of the audit.

The following list includes three of the recommendations and the steps taken for each in 2019–2020.

Recommendations

- ◆ **Track the percentage of service standards met and publish this information on the SGB webpage and on the MyCLSS online portal to help clarify expectations for external stakeholders** – The audit found that the CLSS program has effective processes to develop and maintain the National Standards for Survey of Canada Lands and to ensure that surveys undertaken on Canada Lands are conducted in accordance with these standards. Furthermore, the CLSS program is implementing service standards to support efficient and effective service delivery. Future annual reports will track these standards to guarantee consistent quality of service for all clients.
- ◆ **Reinforce the relationship between the CLS program and its Indigenous stakeholders** – The SGB created a database to track in-person Indigenous engagement across Canada, allowing the SGB to better document its communication efforts. Approximately 300 Indigenous engagements were recorded in the database for 2019–2020.
- ◆ **Update the memorandum of understanding (MOU) between the CLSS program and the Association of Canada Lands Surveyors (ACLS)** – The CLSS program updated this expired MOU in 2019–2020. The MOU establishes a working relationship in the field of cadastral surveying and land administration with clearly defined roles and responsibilities.



STRATEGIC PRIORITIES AND HIGHLIGHTS

STRATEGIC PRIORITY 1: Indigenous peoples’ control of their lands

One priority that has continuously been at the centre of the SGB’s work is supporting reconciliation initiatives with Indigenous communities.

Survey Capacity Development program


One way the SGB contributes to Indigenous reconciliation is through the Survey Capacity Development program, whose purpose is to:


- ◆ increase awareness and understanding of land surveying
- ◆ provide mentoring and tools to enable better participation in surveys
- ◆ encourage land surveying as a career option by providing in-community training for Indigenous Canadians


This 2018 program builds on the success of a survey capacity pilot project led by the Wiikwemkoong First Nation in Ontario.

The SGB made significant progress on this initiative from 2019 through 2020. Our staff helped to deliver 42 weeks of in-community training to 8 First Nation communities across Canada. Furthermore, 6 new First Nations communities entered the program in March 2020 and will begin work when conditions allow.

In 2019–2020, the SGB also consulted externally with a variety of groups to ensure that the program structure and training materials were developed in a way that was practical and responded to the needs of the First Nations participants. This consultation included:

**36** engagement sessions
with First Nations or First Nation organizations

**8** engagement sessions
with surveyors or surveying associations

**14** engagement sessions
within NRCan or other government departments

The discussions that took place during these sessions helped determine if the program’s training was useful and how its delivery could be improved to better support effective capacity development within the community.

Boundary Dispute Resolution Unit

Across the country, SGB staff also continues to engage with Indigenous peoples to research and develop cost-effective and culturally inclusive ways to resolve boundary disputes on First Nations lands. The Boundary Dispute Resolution Unit (BDRU) is leading these efforts.

Formed in October 2018, the BDRU works with Indigenous organizations and communities to identify existing boundary issues as well as effective dispute resolution practices. In 2019–2020, the SGB conducted engagement sessions through the BDRU, including 14 face-to-face sessions with First Nations, 3 with Indigenous organizations, and 7 with non-Indigenous organizations.

Throughout these engagements, the BDRU learned several important lessons:

- ◆ Awareness and creation of an “ethical space” is crucial to all intercultural dialogues, but it is of even more importance when conflict is involved.

- ◆ Any third-party dispute resolution professionals working in Indigenous communities must possess good cultural awareness, so they should ideally have experience working in or with Indigenous communities.
- ◆ Disputes are best resolved by using the accepted tradition in the community where dispute resolution is taking place. An openness to—and understanding of—different Indigenous legal traditions and methods for resolving land disputes is therefore crucial. Additionally, it is important to recognize that western alternative dispute resolution methods (such as mediation and arbitration) may not blend with Indigenous legal traditions.

First Nations Land Management Framework Agreement

The SGB also supports Canada's efforts to reinforce Indigenous peoples' authority over the land through the First Nations Land Management Framework Agreement (FNLMA), which recognizes First Nations' right to self-govern their lands.

In 2019–2020, the SGB completed comprehensive research reports on the survey history of 39 reserves. The SGB also completed 84 legal land descriptions for lands covered by a First Nation land code, of which 43 were approved and recorded in the Canada Lands Survey Registry (CLSR). The SGB also completed parcel renewal for 3 reserves in Quebec. This work is important because it helps provide certainty over the extent of the lands a First Nation administers through the FNLMA.

As part of our commitment to support Indigenous communities' control over their lands, the SGB continues to implement a settlement agreement for flooding damages on reserve lands. The settlement agreement is intended to help resolve a specific long-standing claim by Indigenous peoples. In 2019–2020, the settlement agreement involved 12 First Nations and flooding easements on 35 reserves, covered by 35 survey plans in northwestern Ontario and southeastern Manitoba.

STRATEGIC PRIORITY 2:

Spatially enabling Canada for the digital economy

Canadian Geodetic Survey

One of the SGB programs, the CGS, is working to improve several important systems and services that Canadians rely on. 2019–2020 performance indicators related to these can be found in Annex 2.

The CGS supports the Canadian Spatial Reference System (CSRS), which is the foundation of positioning in Canada. In 2019–2020, there were a variety of service improvements in the area of geodesy, including to the CSRS.

Specifically, **CSRS Version 7** was released, providing enhanced position information as well as a new velocity model for epoch transformations that is sufficiently accurate for use in northern Canada.

This velocity model is significant because it describes the deformation of the Earth's surface, which, over time, affects the coordinates of positions surveyed. The CSRS Version 7 also includes a new error model that enables clients and government agencies to better understand the accuracy of coordinates that have been transformed between epochs.

The CGS also provides clients with essential positioning information through the **CSRS Precise Point Positioning** (CSRS-PPP) service. This service has important applications across a wide range of fields, including professional surveying and engineering, construction, glaciology, geodynamics, and marine science.

In 2019–2020, the CSRS-PPP service was modernized with a new software architecture. This service will be further enhanced in the future, incorporating a new capability to resolve global navigation satellite system (GNSS) signal ambiguities. Many clients will be able to obtain the required position accuracy with less data collection in the field, leading to increased efficiency and reduced costs. The SGB-CGS have developed processes to routinely generate the necessary data products to enable this capability for the new Canadian Spatial Reference System Precise Point Positioning with ambiguity resolution (CSRS-PPP-AR) service, expected to be introduced in late 2020.

The delivery and improvement of these products and services align with the United Nations General Assembly Resolution 69/266 (2015). The resolution emphasizes the importance of implementing “open geodetic data-sharing mechanisms for the benefit of realizing, improving and accessing the global geodetic reference frame at the national, regional and global levels.” This resolution applies to nearly all of what the SGB-CGS accomplished in 2019–2020.

2019–2020 initiatives

In the last year, the SGB-CGS has been involved in:

- ◆ Creating a new coordinate transformation webpage from which clients can download grid shift files generated by the member agencies of the Canadian Geodetic Reference System Committee.
- ◆ Contributing to gravity maps from the Gravity Recovery and Climate Experiment satellites, which have been processed with the SGB-CGS’s novel de-stripping methodology and are also now available online.
- ◆ Supplying important GNSS-derived ionospheric products as part of the Canadian contribution to an international consortium of Australia, Canada, France and Japan. This consortium provides space weather information to a new space weather service for civil aviation launched by the United Nations International Civil Aviation Organization.
- ◆ Providing robust GNSS station coordinate streams to a new Earthquake Early Warning system being developed for Canada’s west coast. The warning system combines GNSS position information with seismic data and will soon enter its commissioning phase. This effort is a collaboration among the SGB-CGS, Ocean Networks Canada and other organizations.

Stakeholder communications

The SGB-CGS works with numerous academic and scientific partners to improve and circulate its products and services. For instance, in 2019–2020, the SGB-CGS engaged in the following stakeholder communications:

- ◆ The SGB-CGS entered into collaboration agreements with Calgary and Montréal that allow the SGB-CGS to monitor and report on the quality of the cities’ RTK networks (private GPS/GNSS reference networks).
- ◆ The SGB-CGS met regularly with Canadian academia in geodesy and related application areas. The Canadian Geodetic Science and Applications Committee enables important information sharing between the SGB-CGS and its research colleagues in Canada.
- ◆ In addition to establishing academic partnerships, the SGB-CGS has worked extensively with federal partners. The SGB-CGS provided presentations on the North American Terrestrial Reference Frame 2022 (NATRF2022) to both the federal Positioning, Navigation and Timing Board and the Canada Council on Geomatics to keep the national stakeholder communities up to date. The SGB-CGS also worked with the Lands and Minerals sector and Transport Canada to communicate issues about positioning to non-traditional stakeholders. Notably, the SGB-CGS coordinated a workshop at the Canadian Institute of Mining, Metallurgy and Petroleum. Also, along with Transport Canada, the SGB-CGS presented at the Transportation Association of Canada and ITS Canada joint conference. See Annex 3 for a list of other events SGB participated in throughout 2019–2020.
- ◆ The SGB-CGS has also participated in exciting projects with international partners. In 2019–2020, the SGB-CGS developed a partnership with the United States’ National Geodetic Survey (NGS) and helped prepare new reference frames for North America. The SGB-CGS is working with the NGS on developing a new North American geoid model that involves extensive data exchange, knowledge transfer and regular communications. Experimental geoid models produced are now in a higher resolution than previously in Canada, i.e. one arcminute by one arcminute.

Future services

The SGB-CGS strategy to spatially enable Canada involves assessing the benefits of the services we currently provide and also considering future services that could be delivered.

In March 2020, NRCan received the final report from an assessment conducted by an independent contractor on the value of precision GNSS services in Canada. The study considered the benefit of a proposed free-to-user national broadcast of a GNSS augmentation signal. It also considered the incremental benefits of the federal government providing another service in addition to what is currently available from all providers (governments, academia, private sector).

The analysis indicates that investing in such services is estimated to generate economic value of \$3.3 billion (present value over 20 years) in certain economic sectors. Furthermore, the report indicates that this investment will also result in a number of scientific and social benefits. This study is important for SGB-CGS because it will provide a basis for discussions and planning of future geodetic infrastructure and services.

STRATEGIC PRIORITY 3: Northern property rights

Through the CLS program, the SGB provides the system of land surveys for Yukon, Nunavut and the Northwest Territories (N.W.T.). This system is the foundation and an essential component of property rights in the North and is mandated through both federal and territorial legislation.

In 2019–2020, the SGB worked with the territorial governments on surveying territorial parks:

- ◆ Tu'eyeta Protected Area (N.W.T.)
- ◆ Thaidene Nene National Wildlife (N.W.T.)
- ◆ Kinngaaluk Territorial Park (Nunavut)
- ◆ Dàadzàii Vàn Territorial Park (Yukon)
- ◆ Ch'ihilii Chik Habitat Protection Area (Yukon)

Furthermore, the SGB has collaborated with the Parks Canada Agency (PCA) on the Tallurutiup Imanga National Marine Conservation Area, a 108,000-square kilometre marine conservation area north of Baffin Island, Nunavut.

All these parks, protected areas, and marine protected areas provide ecological and culturally significant protection of land for northern citizens and for all Canadians. In addition to advancing Canada's environmental commitment to protect land and marine space, these efforts help further support reconciliation initiatives for co-management of protection areas.

The SGB's territorial regional offices provide continued support to territorial municipalities through partnerships that have resulted in numerous accomplishments, including, in 2019–2020:

- ◆ collaborating on contract wording for land survey projects
- ◆ working with private land survey firms on legal survey projects
- ◆ advising on project management
- ◆ open communication of plan recording, registering and ratification

These efforts will help municipalities obtain the survey products they need and help private land surveyors bid and complete the work successfully. These ongoing projects have supported the SGB Northern Canada division in building relationships with key stakeholders (including territorial municipalities and private surveyors) and will help minimize the destruction of legal survey infrastructure in the North.

Another ongoing project that made significant advancements in the last year is the modernization of the Yukon's land titles. Accomplishments related to this project include:

- ◆ developing requirements to move to a digital registry
- ◆ creating a digital interface between the SGB and Yukon Land Title Office databases
- ◆ creating training tools in preparation for implementing this new system

This work has helped the SGB's Yukon regional office to integrate its functions with the Yukon Land Title Office, thereby reducing duplication of efforts and allowing for greater efficiency.

In 2019–2020, the SGB's N.W.T. and Nunavut regional offices also continued their important work on collaborating with Indigenous and government partners to advance active land claim agreements. The past year saw significant progress in implementing an existing comprehensive land claim agreement, for which a five-year survey program was developed. For another land claim agreement, SGB staff actively contributed to a technical table by helping to create land descriptions and mapping products.

Working with comprehensive land claim projects is tremendously important for the SGB because it facilitates building relationships with Indigenous groups, territorial governments, and other government departments such as Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC). It is also essential for northern Canadians because the work ensures boundary certainty for Indigenous groups and territorial governments and helps prevent future conflict regarding boundaries on federal lands.

STRATEGIC PRIORITY 4: Protection of Canada's oceans

This strategic priority is increasingly important as our federal, provincial, and territorial partners seek clarity around jurisdiction and natural resource ownership in Canada's offshore regions. It is in this context that the SGB plays an important role by providing foundational tools and services to support marine spatial management.

Marine cadastre

The SGB collaborated with various organizations on joint efforts in the area of marine spatial management throughout 2019–2020, including with the Canadian Hydrographic Service (CHS). The CHS is currently developing a marine spatial data infrastructure (MSDI) to provide information on particular maritime routes. For this, the SGB needs to create synergies within the MSDI related to a register (marine cadastre) that lists the rights, responsibilities, and restrictions in the marine field.

The main purpose of the marine cadastre is to provide a level of certainty that ensures investment and economic development. The marine cadastre and the MSDI have the overall strategic objective of enabling Canada to better take advantage of the economic potential of its oceans.

International marine boundaries

The SGB has been involved in creating a standard for international boundaries with government partners, including Fisheries and Oceans Canada, Geoscience Australia, and the United Kingdom Hydrographic Office. This new international hydrographic organization (IHO) standard, IHO S-121, defines maritime limits and boundaries for nations around the world and was finalized in September 2019.

The Open Geospatial Consortium (OGC) is an international voluntary consensus standards organization committed to improving access to geospatial, or location, information. The OGC established a pilot project for maritime limits and boundaries (MLB). Within that project, the SGB participated in developing a pilot project to operationalize the IHO S-121 standard and assess its potential in the creation of a marine cadastre. This OGC pilot project, completed in March 2020, will help to advance the architecture, implementation model, and prototypes for sharing MLBs, while adhering to the requirements of the United Nations Convention on the Law of the Sea.

The SGB is also involved in planning a standard for marine cadastres from the International Organization for Standardization (ISO). The SGB is a Canadian representative in the review process for the Land Administration Domain Model standard, which is in progress. In addition, the SGB is participating in developing a type of Canadian marine cadastre based on IHO and ISO standards.

PEI-NB Interconnection Cable project

In 2019–2020, the SGB was an active member of a multidisciplinary team involved in constructing the PEI-NB interconnection cable. Since 2015, the SGB Atlantic regional office has managed survey projects related to the creation of licence footprints and easements for this upgrade to the interconnection cable. This upgrade connected Prince Edward Island and New Brunswick via underground and underwater electric transmission lines that allow the provision of power between the provinces. The cables crossed through three jurisdictions (federal and two provincial) and involved licensing by multiple regulators.

SGB staff in the SGB Atlantic regional office led the Federal/Provincial Survey Working Group and collaborated with a variety of stakeholders. The resulting plans and licence agreement were completed in the fall of 2019. These plans and agreement supported the federal government in exercising due diligence by protecting the ocean while also enabling an energy conduit between the two provinces without prejudice to the provincial jurisdictional rights. This project will serve as a model for future multi-jurisdictional offshore projects, as well as for the Strait of Belle Isle Cable Crossing (Labrador to Newfoundland) and the Cabot Strait Cable Crossing (Newfoundland to Nova Scotia), both currently underway.



RESPONDING TO FUTURE CHALLENGES

In addition to delivering on its commitments and providing access to reliable survey systems, the SGB works to identify current and future challenges and their solutions. These include operational challenges such as rapidly evolving technology, which requires vigilant monitoring of our systems, processes and standards. The SGB prioritizes this in its everyday operations to stay aligned with the continuously evolving demands of industry and clients.

First Nations self-government

Another change to which the SGB must adapt is that many First Nations are moving toward self-government and regaining management and control of their lands. The SGB supports this change through initiatives such as the First Nations Land Management program and by contributing to the implementation of self-government agreements. We recognize that increasingly, First Nations communities need effective land management options and tools.

One of the SGB's overarching goals is to support reconciliation with Indigenous peoples and make the CLSS the system of choice for First Nations. The CLSS is a reliable and robust survey system that has the flexibility to accommodate various registries and adapt to Indigenous governance requirements. The SGB must ensure that this system continues to support the needs and self-government capacity of First Nations communities across Canada.

COVID-19 adjustments

One particular challenge the SGB faced toward the end of 2019–2020 was the threat of COVID-19 on our operations and employee well-being. The SGB is now tasked with creating a plan for post-COVID-19 recovery and finding ways to support economic activity across Canada while adhering to health and safety measures.

Despite these challenges, the SGB has adapted quickly to the changes brought about by the pandemic. Our staff has migrated to a remote work environment with little loss of productivity and have adopted new ways of communicating and collaborating from a distance. The main change in the way we work as a result of COVID-19 is a renewed emphasis on the need for clear and ongoing communications with the Indigenous communities we serve.

The future

Moving forward, the SGB will continue to support the development of Canada's economy and do its part to contribute positively to society, especially during these difficult times. In addition to advancing reconciliation with Indigenous peoples, the SGB's priorities will include supporting partners such as CIRNAC, the Government of Nunavut and the Government of the N.W.T. through the transfer of responsibilities to territorial governments.

The SGB will also engage with partners in a unified vision of a Canadian marine cadastre to support the administration of the full sovereign extent of Canada's offshore regions. On the geodetic front, the SGB plans to pursue new strategic alliances and provide national leadership on PPP services. The CGS will also continue to improve the CSRS-PPP service and precise GNSS product generation and further explore opportunities related to the upcoming reference frame modernization in the United States.

Building capacity

SGB staff are spread across Canada, operating out of 10 regional offices and a main office in Ottawa. By working in close proximity to our clients and stakeholders, we are able to strengthen collaboration and remain cognizant of regional needs and priorities.

Current staff

The SGB's work requires a high level of professional and technical expertise. In 2019–2020, our employees were distributed across the following occupational groups:

◆ **102** engineers or
land surveyors (ENSUR)

◆ **25** technical or
scientific support (EG)

◆ **148** indeterminate
SGB staff

◆ **6** seasonal (typically general labourers who
SGB staff support the IBC)

The nature of the surveying industry is that many staff join in mid-career. Consequently, approximately 54 employees are eligible to retire within the next 5 years. More employees retired in this fiscal year than the last one (2019–2020: 9, 2018–2019: 8).

Strategic Human Resources Plan

In response to the increasing number of upcoming retirements and as per the recommendation of the recent audit of the CLS program, the SGB has developed a Strategic Human Resources Plan to staff 34 positions from 2018 to 2022. This plan outlines various employment considerations, risks, strategies and actions that can be taken to fill important positions that may become vacant. Between 2018 and 2020, more than half of these 34 positions were filled, and the remainder will be filled in the next two years.

The CLSS team developed the Land Surveyor Development program in 2017 to help with succession planning and recruiting by hiring and training new graduates in land surveying. This program also helps these graduates obtain the work experience needed to become certified surveyors, with a focus on providing opportunities to Indigenous participants. Although the program is not fully implemented, the SGB is helping staff acquire their commission and licence to practise. Seven of the 14 participants who were supported through this initiative have obtained their Canada Lands Surveyor certification.



ANNEX 1: SGB PROJECTS

The following table lists the completed and ongoing projects related to SGB's strategic priorities and operations. Although much progress has been made on these projects, some will require more time than initially planned. These projects were delayed for various reasons, including the COVID-19 pandemic, and will continue beyond the end of the 2019–2020 fiscal year. The projects will be tracked in the SGB dashboard for 2020–2021, and new projects will also be managed through the SGB's upcoming 2020–2023 Integrated Business Plan.

Project	Project description
Modernization of the <i>Canada Lands Surveyors Act</i>	Initiate amendments to the <i>Canada Lands Surveyors Act</i> (the Act) to respond to the request submitted by the ACLS and to modernize the legislative framework supporting the Canada Lands Surveyors profession. The Act has not been revised since it came into force in 1999.
Government to government agreement on surveys for self-governing and FNLM nations	Investigate the need and feasibility for nation to nation survey protocol agreements with First Nations, similar to interdepartmental agreements with INAC, through discussion with Indigenous organizations and leaders. The aim is to have five agreements with high-capacity communities, in varied regions, in place within two years.
Improve tracking of FNLM lands and excluded lands on the map browser	Develop a process for tracking the lands described and excluded under FNLM. Work with the Self-governing First Nations Land Registry to develop a process for receiving updates to intergovernmental agreements with FNLM First Nations that add lands to the First Nation's land code.
Improve the knowledge of the SGB staff regarding Indigenous cultures	Raise SGB staff awareness regarding Indigenous issues through training and education.
Co-develop the North American 4D spatial reference system	Contribute to the development and implementation of a North American 4D spatial reference system in collaboration with the United States' National Geodetic Survey and the Mexico's <i>Instituto Nacional de Estadística y Geografía</i> .
Improve modelling of crustal velocities for Canada	Improve the NAD83 (CSRS) crustal velocity model by using improved glacial isostatic adjustment models, block modelling methods in British Columbia and Yukon, and new public and commercial RTK stations in weak areas of the velocity model.
Develop rapid multi-GNSS Precise Orbit Determination and DCM products	Current precise orbit determination packages operated by the CGS are limited to GPS and GLONASS constellations and have reached their efficiency limits. A new modern package that allows processing of data from emerging GNSS constellations (Galileo, Beidou) and allows gains in computation efficiency is required to support CGS clients acquiring data with receivers to track signals from multiple constellations.

Project	Project description
Incorporation of additional GNSS constellations into current ionospheric products for enhanced geodetic positioning and space weather monitoring	In addition to the current GPS and GLONASS ionosphere mapping service developed in the CGS, GNSS signals received from satellites of other emerging constellations (Galileo) tracked by regional (ACS) and global (IGS) networks are processed. The signals are incorporated into current ionospheric maps at varying temporal scales to improve the performance of precise positioning applications and to support space weather research.
Develop a real-time GNSS precise positioning service for an earthquake early warning system (complete)	Implement a real-time, high availability, GNSS precise positioning service for natural hazards applications (e.g. earthquakes). Liaise with the natural hazard community to facilitate utilization.
Support northern land titles modernization and integration	Nunavut, Yukon and the Northwest Territories are each at various stages of modernizing their land titles systems and how they operate with the Canada Lands Survey system. This project will participate in the modernization and integration of each territorial land titles system.
Support the modernization of Nunavut and N.W.T. mining regulations	Support Nunavut and the Northwest Territories as they move toward a map selection process for their mining regulations.
Expanded use of digital plans in the North	Work with territorial land registries to allow for the adoption of digital plans.
Regional office document scanning and transfer	To develop a thorough inventory of the non-CSLR records stored in the SGB regional offices and develop a proposed plan of action for each regional office to address these records.
Respond to the recommendations identified in the cost of land survey study	The Surveyor General will do a detailed analysis of the Study of Survey Costs to identify where the SGB could improve its processes to reduce the cost of surveying and how to support initiatives with First Nations.
Facilitate the exchange of knowledge within the International Boundary Commission	Improve access to the International Border Commission data from the commission's portal (internal and external) and to the methods used for field data capture and integration into IBC files.
Collaborate with Parks Canada to finalize the agreement (complete)	Finalize the agreement in the area of surveys and specifications for the description of land for transactions on Parks Canada Lands. This agreement will supersede the 1955 Interdepartmental Agreement that is currently the basis for surveys in national parks.

Project	Project description
Develop a system to manage imagery that was uniquely captured for the SGB	The remainder of this project will focus on integrating aerial imagery created by the SGB (e.g. Quebec & Atlantic Orthophotography program) into the Earth Observation Data Management System. This system is expected to move into production during the 2018–2019 fiscal year. Relevant digital imagery will be added either to the NAPL collection or to a sub-collection with the same attributes.
Implement the Canadian Geodetic Survey IT Architecture Plan	A two-year project to transform CGS' current IT state from one that is unreliable and unsustainable to a stable, managed environment. The work will be guided by recommendations contained in the Cistel and Teramach reports and will be consistent with the Canadian Active Control System (CACS) evergreening and network segmentations projects that are part of the department's IT plan.
Implement a trusted digital repository	Implement a trusted digital repository to support the eRegistry within GCDocs in collaboration with CIOSB and PWGSC to ensure the long-term preservation of the Canada Land Survey System registry.
Migrate the SQL Server from version 2008R2 to version 2016	Modernize the database management software to the latest version to support software updates for SGB line of business activities (ESRI ArcGIS 10.5/6 desktop and Server) and to remain current with security best practices.
Road map and implementation of CLSS IT strategies	Migrate the SGB LOB IT architecture to the best suited long term, scalable, modernized and secure environment.

ANNEX 2: PROGRAM METRICS

SGB metrics – Canada Lands Survey System

General metrics

To maintain the Canada Lands Survey System and the land registries across Canada, the SGB conducts various important daily operations represented by the metrics in the following table. This work provides the foundation for all the projects and programs that support the SGB's four strategic priorities.

Measured output	2019–2020
New parcels created in cadastral datasets	5,842
Parcels maintained	311,874
Survey instructions issued	774
Documents registered in the CLSR	1,697

Saskatchewan Treaty Land Entitlement

Treaty Land Entitlement claims can be submitted by First Nations that did not receive all the land they were entitled to under treaties signed by the Crown. In Saskatchewan, much of this land has already been surveyed in the province's township system. The SGB is responsible for reviewing these parcels to identify and resolve any ambiguities or related issues.

Measured output	2019–2020
Area of parcels described	5,358 hectares
Progress (proportion of the total shortfall of 859,000 hectares that has been described by the SGB)	62.5%

Manitoba Treaty Land Entitlement

In Manitoba, a significant proportion of the treaty land to which First Nations are entitled has yet to be surveyed. The SGB is responsible for surveying this Crown land to define land selections and ensure that Canada adheres to its treaty obligations. The progress of this work is measured by the metrics in the following table.

Measured output	2019–2020
Area surveyed	2,666.5 hectares
Progress (proportion of the total obligation of 577,000 hectares that has been described by the SGB)	50%

FNLM Metrics

These metrics represent the work carried out to help provide certainty over the extent of lands a First Nation administers through the FNLMA.

Measured output	2019–2020
Land descriptions	84 completed 43 approved and recorded in the CLSR
Research reports completed	39

Interdepartmental letters of agreement and survey contracts to the private sector

To support the mandate and obligations of our partners in other government departments, certain SGB activities are carried out at cost recovery. The figures in the following table are indicators of the work accomplished in this context. The majority of survey contracts issued to the private industry are a result of these letters.

Measured output	2019–2020
Interdepartmental letters of agreement	
Letters of agreement	20
Value	\$3,200,000
Survey contracts to the private sector	
Contracts	122
Value	\$1,677,000

SGB metrics – Canadian Geodetic Survey

The following metrics are derived from the CGS Performance Indicator Profile and will serve as a key reference point for future evaluations. These indicators are used to monitor the CGS' accomplishments and results from year to year. They are aligned with the division's expected immediate outcomes (providing accessible, accurate and timely geodetic information) and intermediate outcomes (georeferencing to a common Canadian reference system consistent with international standards).

Measured output	Target	2019–2020
Accessible, accurate and timely geodetic information		
GNSS stations for which data are distributed	≥112	124
Accuracy of GNSS orbits with respect to international standards	<2 cm	1.3 cm

Measured output	Target	2019–2020
Horizontal accuracy of real-time GNSS products	<10 cm 95% of the time	7.5 cm
GNSS stations used for reference frame and velocity computations	>330	332
Accuracy of the Canadian Gravity Standardization Network	<10 micro Gals	4 micro Gals
Availability of CACS daily data files (within 30 minutes after the end of the day)	>95%	98.89%
Availability of rapid orbit and clock products (within 12 hours after the end of the day)	≥95%	98.11%
Georeferencing to a common Canadian reference system consistent with international standards		
Direct users of CGS data products	≥7,000	8,225
Requests for CGS products and services	300,000	344,606
Commercial GNSS reference stations monitored by the CGS as part of the RTK compliance program	>500	685

ANNEX 3: EVENTS AND AWARDS

Events

The SGB participated in following events and conferences in 2019–2020:

- ◆ European Geosciences Union General Assembly – Vienna, Austria, April 2019
- ◆ National Surveyors' Conference – Halifax, Canada, May 2019
- ◆ Canadian Water Resources Association Conference – Collingwood, Canada, May 2019
- ◆ International Association of Great Lakes Research Conference – Brockport, United States, June 2019
- ◆ Workshop on the Applications of Global Navigation Satellite Systems – Suva, Fiji, June 2019
- ◆ General Assembly of the International Union of Geodesy and Geophysics – Montréal, Canada, July 2019
- ◆ Space Climate 7 Meeting – Canton Orford, Canada, July 2019
- ◆ 20th International Beacon Satellite Symposium - Olsztyn, Poland, August 2019
- ◆ 7th International Colloquium on Scientific and Fundamental Aspects of GNSS – Zurich, Switzerland, September 2019
- ◆ ION GNSS+ - Miami, United States, September 2019
- ◆ Fall for Geomatics – Truro, Canada, October 2019
- ◆ American Geophysical Union Meeting – San Francisco, United States, December 2019
- ◆ Canadian Hydrographic Conference – Québec, Canada, February 2020

Awards

SGB staff received the following awards in 2019–2020:

- ◆ 2019 PNT Leadership Award for Services

In conjunction with the ION GNSS+ conference in September 2019, GPS World hosted its annual Leadership Awards dinner, at which CGS' Simon Banville co-won this award for his work on instantaneous, centimetre-level, multi-frequency precise point positioning.

- ◆ 2019–2020 Lands and Minerals Sector Merit Award

James Banks received this merit award for Outstanding Leadership on the NB-PEI Cable Crossing project, which involved significant collaboration with a variety of stakeholders, as well as a willingness to work on innovative solutions.

ANNEX 4: PUBLICATIONS

Erickson C., Banham G., Berg R., Chessie J., Craymer M., Donahue B., Tardif R., Theriault S., Veronneau M. “The U.S. is replacing NAD83 with NATRF2022: what this means for Canada.” *Geomatica*, vol. 73, issue 3, 2019, p. 74–80. (This NATRF2022 paper was selected as an “Editor’s Choice” paper by *Geomatica*)

Ghoddousi-Fard, R. “On the estimation of regional covariance functions of TEC variations over Canada.” *Advances in Space Research* vol. 65, issue 3, 2019, p. 943–958.

ISO 19161-1:2020 Geographic information – Geodetic references – Part 1: International terrestrial reference system (ITRS). International Standards Organization, 2020.

Banville, S.; Collins, P.; Donahue, B.; Elson, S.; Ghoddousi-Fard, R.; Goudarzi, M. A.; Mireault, Y.; Lahaye, F. (2019), NRCan Analysis Center, *International GNSS Service Technical Report 2018*, 2019, p. 47–53.

Crowley, J., Huang, J. “A least-squares method for estimating the correlated error of GRACE models.” *Geophysical Journal International*, 2020.

Castellazzi, P., Burgess, D., Rivera, A., Huang, J., Longuevergne, L., and Demuth, M. “Glacier Melt and Potential Impacts on Water Resources in the Canadian Rocky Mountains.” *Water Resources Research*, vol. 55, issue 12, 2019.).

ANNEX 5: ABBREVIATIONS

ACLS	Association of Canada Lands Surveyors
BDRU	Boundary Dispute Resolution Unit
CGS	Canadian Geodetic Survey
CHS	Canadian Hydrographic Service
CIRNAC	Crown-Indigenous Relations and Northern Affairs Canada
CLS	Canada Lands Survey
CLSR	Canada Lands Survey Records
CLSS	Canada Lands Survey System
CSRS	Canadian Spatial Reference System
FNLM	First Nations Land Management
FNLMFA	First Nations Land Management Framework Agreement
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
IBC	International Boundary Commission
IHO	International Hydrographic Organization
ILA	Interdepartmental Letter of Agreement
ISO	International Organization for Standardization
MSDI	Marine Spatial Data Infrastructure
NRCan	Natural Resources Canada
PPP	Precise Point Positioning
SGB	Surveyor General Branch

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