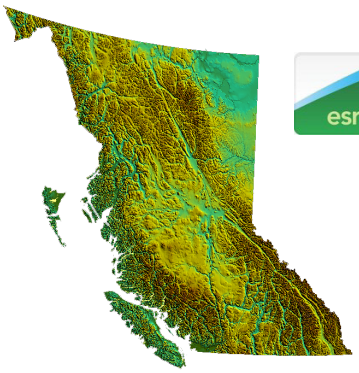
mnc

The Cadastral and Parcel Mapping Experts

2017: ParcelMap BC



esri Special Achievement in GIS 2017 Award Winner

bc Land Title & Survey

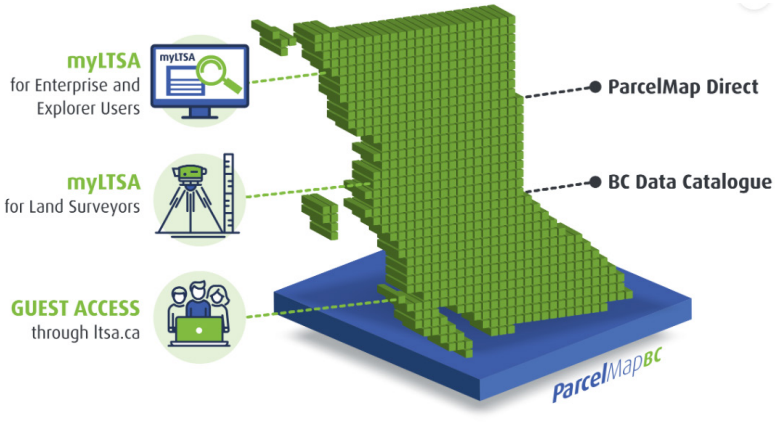
Overview

MNC created a single, complete, trusted, and sustainable spatial GIS representation of the over 2 million active titled parcels and surveyed provincial Crown land parcels for the Land Title and Survey Authority of British Columbia (LTSA). The project's success was shared at the Esri User Conference in San Diego in 2017, where LTSA received the Special Achievement in GIS (SAG) award for ParcelMap BC.

Parcel Map BC Creating the Foundation for Land Administrative Service Excellence

5 primary channels for customers to access ParcelMap BC:

- Lawyers, notaries, realtors, and government staff use ParcelMap BC via myLTSA for land records research
- Land surveyors access ParcelMap BC for research, planning, and to submit survey plan datasets
- Property owners search ParcelMap BC through the LTSA's website
- Stakeholders integrate ParcelMap BC with their systems using ParcelMap Direct
- GIS professionals use an Open Government view via the BC Data Catalogue



Read more at: https://resources.esri.ca/customer-stories/mapping-british-columbia-s-parcel-fabric

The LTSA was one of 180 organizations in areas such as agriculture, defense, transportation, nonprofit work, telecommunications, and local and state government to receive a SAG Award. Esri staff annually nominate hundreds of candidates from around the world for consideration, and Dangermond selects the finalists.

Testimonials

”The SAG Awards provide a great opportunity to showcase all the outstanding achievements of our users,”

Jack Dangermond, Esri founder and president.

“The Special Achievement in GIS Award recognizes exemplary organizations implementing spatial analytics technology to change the world. Highlighting the good work of users—in industries ranging from commerce to government—benefits the entire GIS community, and that’s very valuable.”

Alex Miller and Myron Doherty of Esri Canada; Jack Dangermond, Esri Founder and President; Mike Thomson and Brian Greening of the LTSAParcelMap BC

“We gratefully acknowledge the contributions of our various partners to complete this ambitious project. The initial build of ParcelMap BC now offers a sustainable mapping infrastructure that unifies and standardizes parcel information, enabling everyone to access and benefit from land information in British Columbia.”

Connie Fair, President and CEO of the LTSA.

“MNC compilation work, assisted by ArcGIS desktop and mobile solutions, proved to be of excellent quality even under very aggressive deadlines and within the budget envelope.”

Mike Thomson, British Columbia Land Survey, Surveyor General of British Columbia

Strategic Objectives

Primary goal for the ParcelMap BC (PMBC) project is to create and develop an operational model for a ***single, complete, trusted*** and ***sustainable*** visual representation of lands within a given parcel and its relationship to adjacent parcels.

Single	• Includes parcel fabrics for all local government areas including municipalities, the rural areas of all Regional Districts, and all surveyed parcels of provincial Crown lands.
Complete	• Includes all active parcels in the provincial Crown Land Registry and all parcels with active titles in the LTSA's Land Title Register.
Trusted	• The parcel fabric will adhere to standards for parcel attribution, topology, currency, auditability and spatial accuracy. New surveys are to adhere to spatial accuracy standards, and as a result, the quality of the entire parcel fabric will improve over time.
Sustainable	• PMBC parcel fabric and operational framework is financially sustainable and will be maintained and enhanced over time by LTSA with guidance from our stakeholders.

Solution

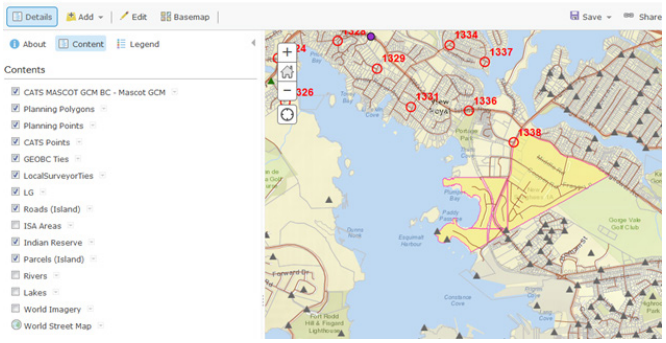
LTSA conducted a procurement process and subsequently contracted MNC (as part of the winning bid team including Esri and MDA) to compile and complete their parcel fabric. Esri's parcel fabric data model was selected as the preferred data model and maintenance tool set for the LTSA operations team because it is a widely adopted Commercial Off-The-Shelf (COTS) solution and secondly, it supports the use of Least Squares Adjustments (LSA) to improve the fabric's spatial accuracy.

MNC's major project components:

- **Field CAD Tie Collection:** MNC developed an online and mobile solution for Cadastral Tie Survey (CATS) field data collection of approximately 2,600 cadastral field ties. FME workspaces were built to support the data migration and conversion from XLS to GIS features. 4,500 more ties were collected from registered survey plans. All ties were then integrated into the parcel fabric and used for spatial accuracy assessments and LSA.
- **Esri's Parcel Fabric:** Created an Esri parcel fabric of every active titled parcel and surveyed provincial Crown land parcel within the Province of BC (approximately 2 million parcels). This fabric was compiled from disparate source datasets and completed with the precision input of over 10,000 missing parcels from survey plans and legal metes and bounds descriptions. 54 unique FME workspaces were developed for acceptance testing.
- **Survey Plan Submissions (SPS) Website (released in 2016):** Created a CAD specification and a web-based digital plan submission and checking system through which BC Land Surveyors submit their survey plan datasets. The CAD files and survey plan images are checked against LTSA business rules before submission and approval. MNC designed and built FME workspaces that are used to check and ensure data quality.

Background

Cadastral (CAD) tie collection was a key part of the PMBC project since Control (known locations on the ground) is the fundamental layer that supports:



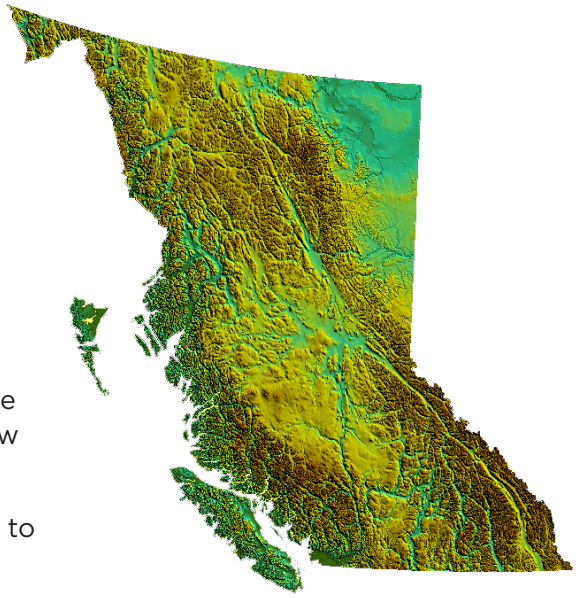
- The fabric data model
- Future spatial adjustments
- Assessing spatial quality of the data (a core program requirement)

Problems with Collecting Cadastral Ties using Traditional Survey Methods:

Handling large volumes of paper prints in the field makes it hard to find the relationship between plans and proposed tie locations to the survey fabric.

Field CAD Tie Challenge

Here were some of the challenges we faced:



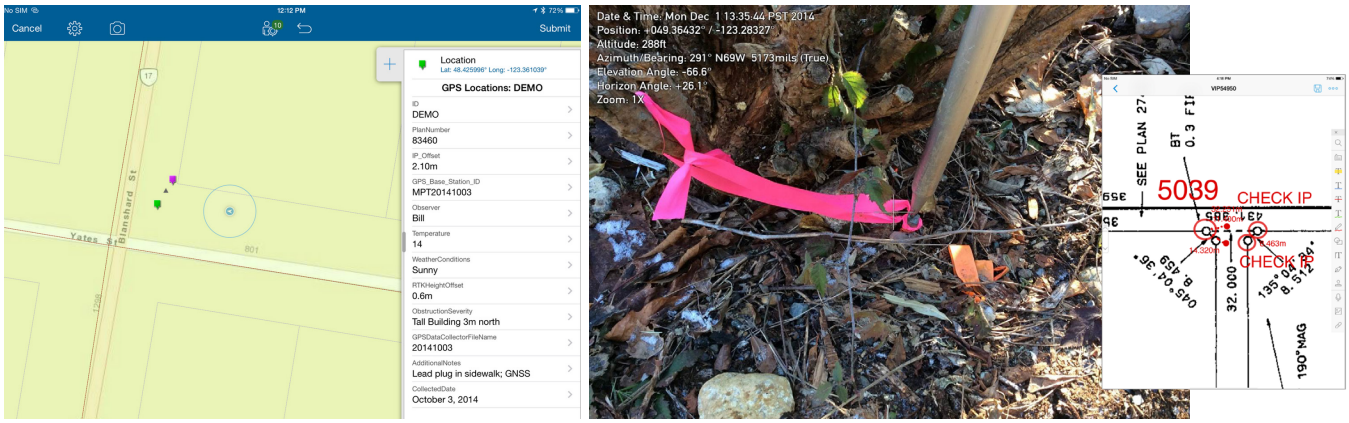
- 94% of BC is Crown Land, covered by either Mountains or forests.
- A tight timeline. Over 2,600 field ties had to be collected throughout the province in less than a year in order to stay ahead of the fabric compilation work.
- We started in September so the scheduling had to consider collecting ties only on Vancouver Island or near Vancouver from November to February due to weather restrictions. The remainder of the province had to be collected after the snow melt.
- Parcel density of approximately one tie per 100 parcels had to be factored in.
- Ties had to be equally distributed across the geographic extent of the Province.

Creating a Customized ArcGIS Online Solution

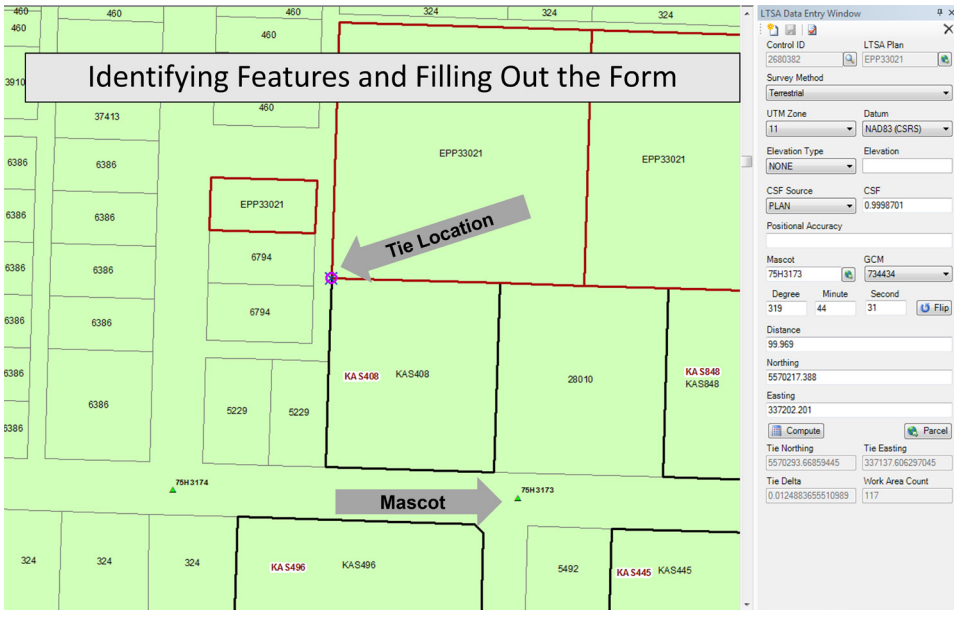
An efficient, affordable way was needed to collect, check, and manage the survey data. Therefore, we chose ArcGIS Online to manage the CAD tie planning and collection process. We leveraged the ArcGIS Collector tool to create an application we refer to as CATS (Cadastral Tie Survey) to augment traditional survey field methods. The application was built to collect survey-grade coordinates of field ties and images, in addition to using traditional GPS equipment.

The tool also allowed for red-lining to input details about a field tie. This tool had the ability to collect data for ArcGIS offline in remote areas and then upload the data when the field crews could re-establish a web connection.

Surveyor and field crews could collaborate in real time using ArcGIS Online to optimize the collection of over 2,600 field ties in a short timeline through the Province of BC.



4500 Plan Ties and metadata were collected from survey plans in integrated areas in BC which was more cost effective than picking up ties in the field. All the ties were used in building the parcel fabric making it more accurate.



Field Work

In the field, surveyors did the following:

- Download planned points and work areas to iPad collectors
- Identify the point in the fabric
- Spatially locate the tie in the field and associate metadata to the point in the fabric
- Collect and associate images (registered plan and photo of the survey plan)
- Use coordinates from photos and coordinates captured in the app to validate the tie location
- Verify that coordinates picked up with the CATS application match within a tolerance to the accurate coordinates collected by surveyor GPS data collectors

Tolerance requirements were to have 5 cm positional accuracy in Integrated Survey Areas (ISAs), and 20 cm positional accuracy in all other areas.

Planning CAD Points to Collect

To be efficient our Surveyor pre-planned the points to be collected in the field using ArcGIS Online. If this same project were to be done again today, we could use Esri's Navigator app instead.

Some considerations in planning the points were:

- Use "readily available" survey posts wherever possible
- Select block corners; there is a greater likelihood that a post will be found at one of the corners
- Ties will be collected only in areas with direct vehicle access
- Careful consideration was given for "open sky" to enable the use of GPS
- Imagery was used to identify clearings and to stay away from heavily treed areas
- Imagery also displays local improvements such as fences and roads which greatly assist in locating survey posts in the field

Field crew routes were pre-planned each day and MNC worked with LTSA to get approval on proposed field CAD tie locations.

Office Work

4,500 plan ties and metadata were collected from survey plans in Integrated Survey Areas (ISAs). This was more effective than picking up ties in the field. All the ties were used in building the ParcelMap BC parcel fabric, making it more accurate.

Office workers harvested monument points (MASCOTs) and tied them to parcel corners. All this was done within a customized interface created for ArcMap.

Becoming a Fan of ArcGIS Online

Our Surveyor was not familiar with GIS and had reservations about using ArcGIS Online. However, after planning the first collection area, he quickly realized the benefits:

- All reference maps and data were available on one map at his fingertips
- Ease of sharing data with field crews, interactively via the web
- Easily managed the field tie progress
- Data was uploaded, analyzed by the surveyor and backed up daily to prevent any loss of data

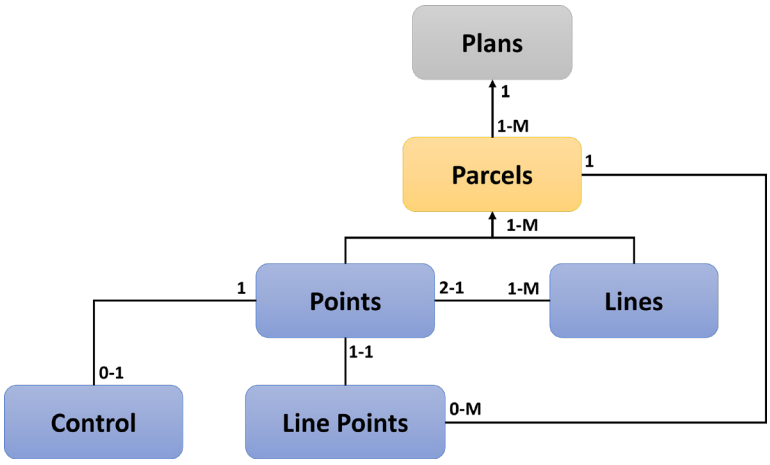
Esri's Parcel Fabric

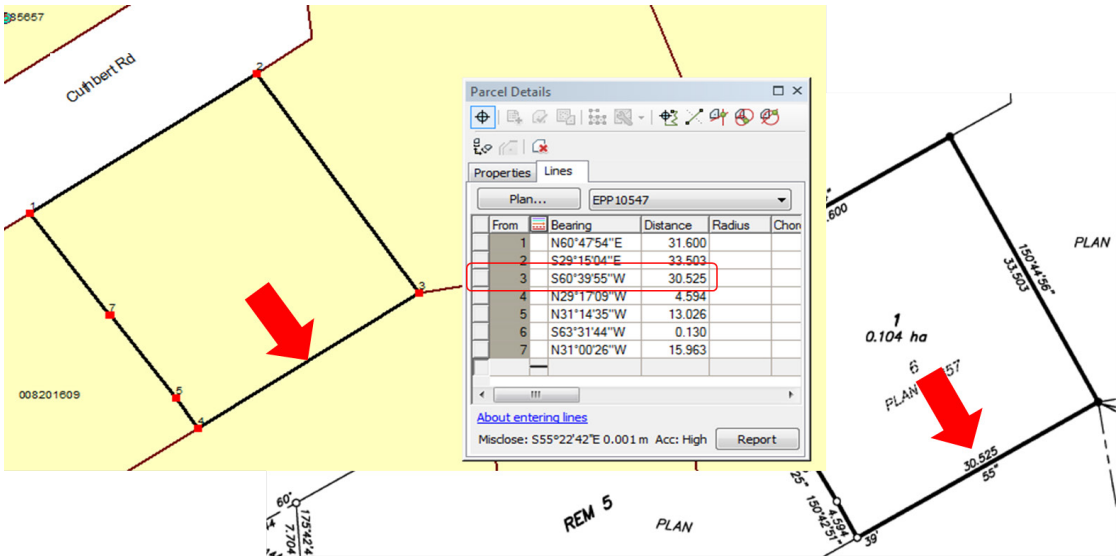
As Cadastral ties were being collected, the build of the parcel fabric began which would account for more than 2 Million active Titles in the province.

Elements of a Parcel Fabric

A parcel fabric maintains data integrity with relationships that persist between points, lines, and polygons. The "best" parcel fabric is one built from survey plans, whereby all observations (i.e., bearings and distances) are captured and retained.

The foundation of a parcel fabric is control (i.e., Cadastral ties) which represents known locations on the ground. Between points are boundary lines whose data structure allows the original surveyed observations to forever be retained on the geometry, no matter how the geometry is modified over time. These values are also used on adjustment algorithms for the fabric.

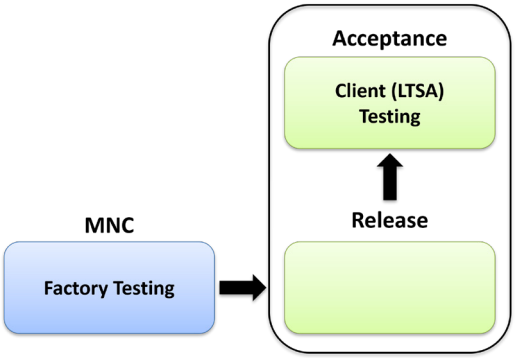




Precision Input from Survey Plans - Capturing Bearings and Distances in the Parcel Fabric

Acceptance Process

A Test Plan was developed to organize the testing and acceptance process for the ParcelMap BC parcel fabric. There were a total of 54 tests to ensure completeness and correctness. These included:



- Comprehensive tests either on an incremental delivery or on the whole provincial dataset, and
- Random samples for visual inspection.
- The test plan ended up being more than 100 pages long. Structured test plans are common to software development and less common in data projects such as this. The benefit of having a test plan for the ParcelMap BC project was that it allowed for a rigorous, repeatable, and focused approach to consistently delivering high-quality data deliverables.
- Data was delivered in several incremental deliveries throughout the project. Each increment contained approximately 150,000 parcels. The acceptance process involved each incremental delivery going through 3 sets of tests between 3 different groups:
  - MNC: 2 weeks per incremental delivery - performing comprehensive and random sample tests
  - MDA: 1 week per incremental delivery - testing the File Geodatabase to Postgres process
  - LTSA: 3 weeks per incremental delivery - performing comprehensive and random samples tests

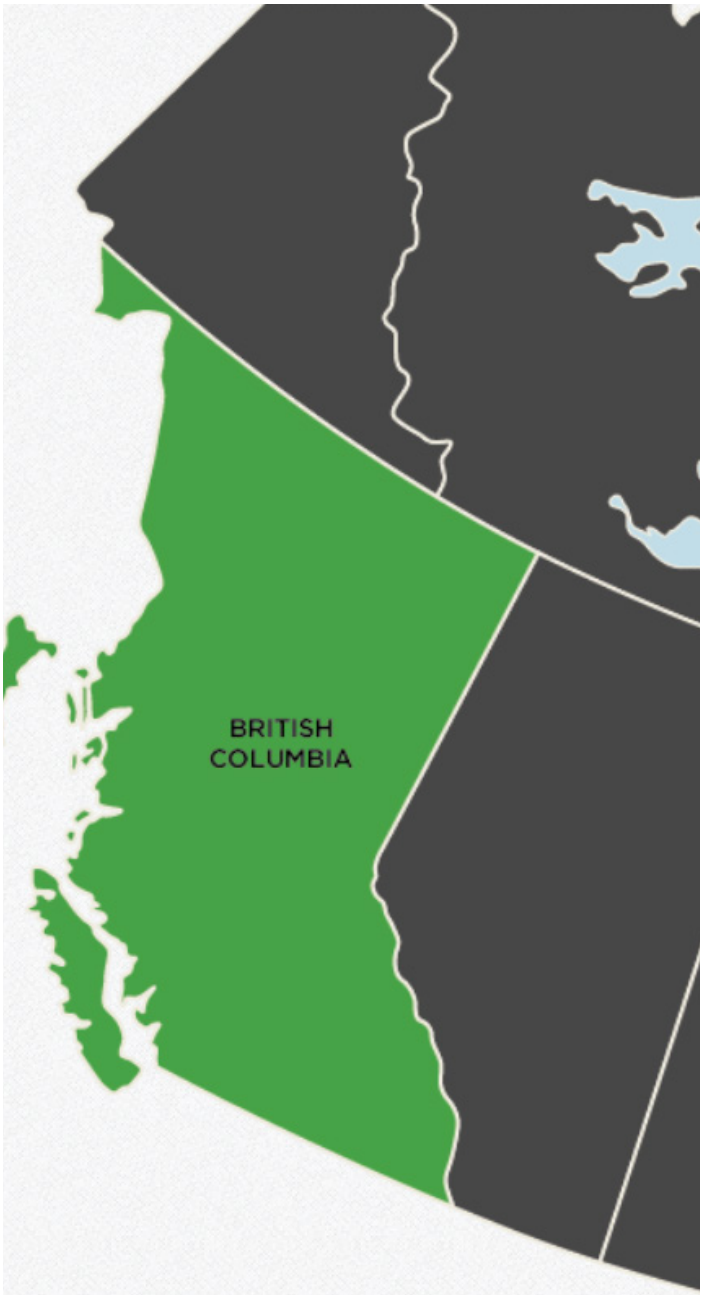
FME was integrated into the solution to perform the many tasks of loading, transforming, extracting, and checking that were required for the ParcelMap BC project. Parcel data was first loaded and modified into staging feature classes, which were then cleaned up and prepped for transformation into Esri's Canadian Parcel Data Model (CPDM). The newly-created parcel fabric was then checked with a variety of quality-assurance tests.

To Create Fabric-Ready Data

- Aggregate polygons.
- Generate staging polygons and staging lines to be used in the parcel fabric creation process.
- Replace stroked curves in polygons with true curves.
- Check topology.
- Calculate the Combined Scale Factor (CSF) for each staging line using a Digital Elevation Model (DEM).
- Assign attributes to polygons and lines.
- Generate parcel fabric connection lines to support Least Squares Adjustment (LSA) functionality.

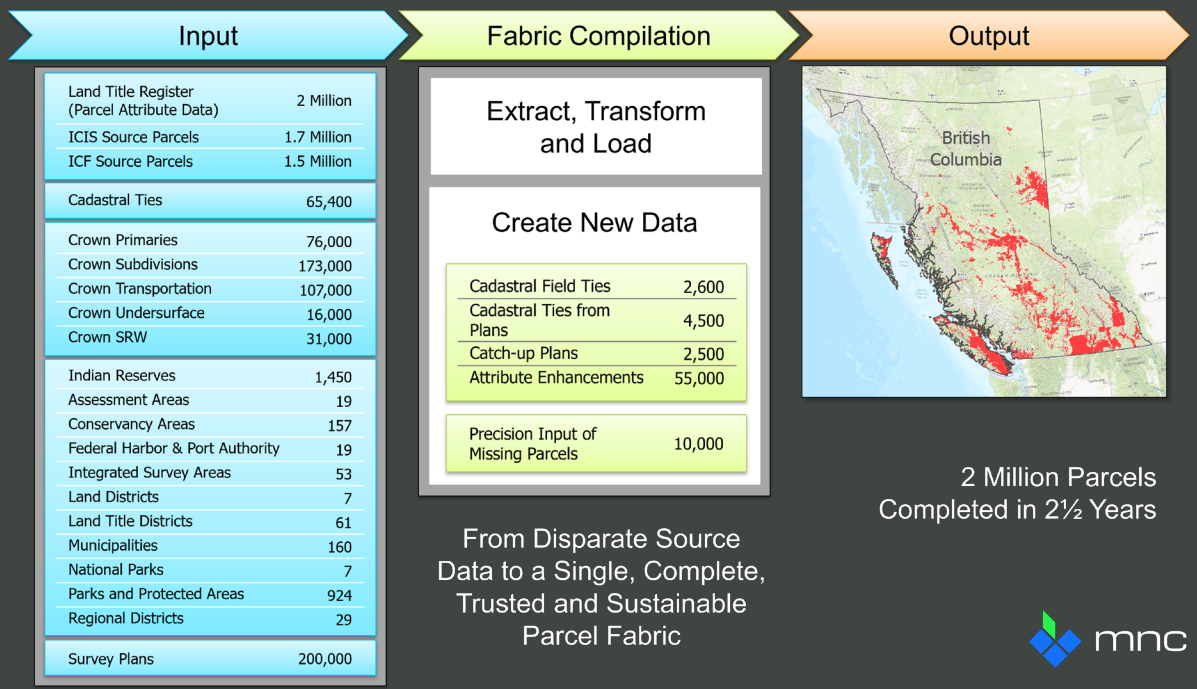
For Acceptance and Testing

- Extract random samples.
- Verify completeness.
- Ensure the correctness of attributes.
- Guarantee accuracy through data load and transformation.



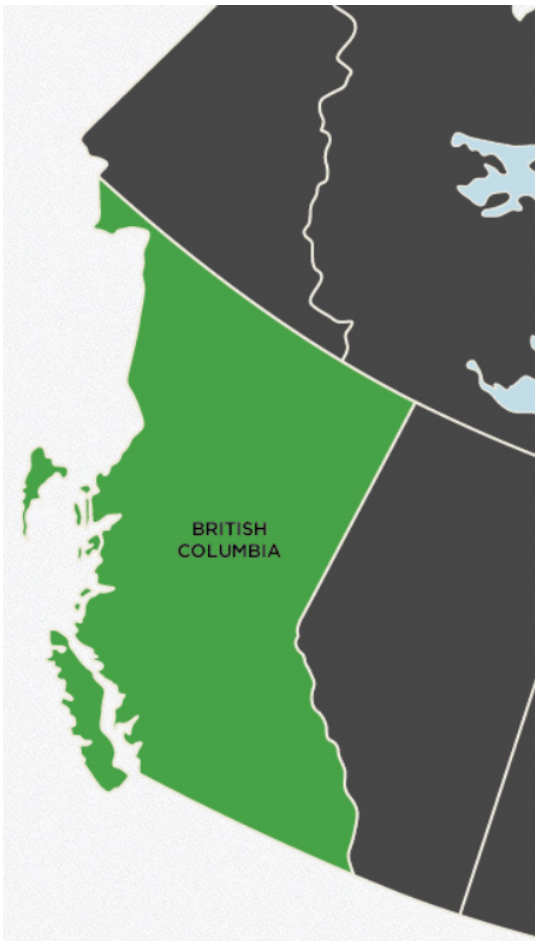
Why FME Was Used

- FME® is stable and reliable for handling very large datasets.
- Scripts are easy to re-configure leading to faster update cycles.
  - In this multi-year project, data needed to be continually enhanced to keep up with current technology (i.e. data model updates).
- Ability to set up complicated data joins on multiple fields.
  - Assigning attributes in FME® is much more time-efficient than performing individual field calculations.
- FME® has specific transformations for issues encountered in PMBC.
  - Checking for spikes, gaps, and overlaps in the parcel fabric is easier in FME®.
- Easy to de-bug scripts
  - Log files are produced each time a script is run and are easy to investigate.
  - Outputs from each transformation can be analyzed directly within the FME® script canvas.
  - The Inspector Transformer allows users to easily locate and de-bug issues; saving time and money.
- Testing is straightforward and repeatable, and it is easy to prompt and run scripts.
- Data discrepancy outputs from tests can be formatted to simplify analysis.
- Scripts are scalable and can be run in multiple different environments.
  - Users in different locations can run scripts on different systems (Postgres or file geodatabase).



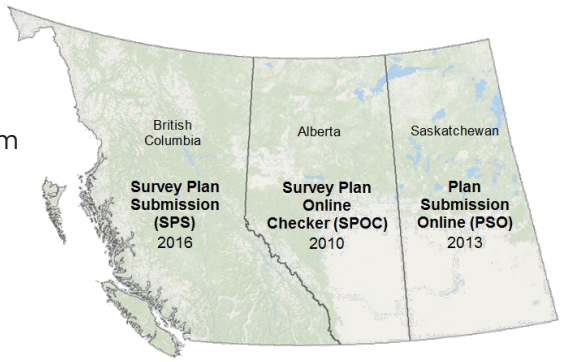
Result

- Improve speed and efficiency of land-related research, planning, and business decisions through a visual representation of the parcels in the land title register and Crown land registry.
- Minimize possible data discrepancies and confusion by reducing the need to consult separate spatial systems in BC.
- Supports faster and more accurate real estate dealings by using the visual representation of the parcels in the land title register.
- Reduces routine data maintenance tasks and overlapping parcel fabric efforts.
- Best Practices Compliant: completely adheres to the fundamental principles of a survey-aware fabric where all survey dimensions, and accuracies associated with the dimensions, are preserved and not altered.
- Comprehensive Integration: parcels are linked to their corresponding records in the Land Title Register and/or Crown Land Registry.
    - This will allow users to conveniently access related parcel information such as titles, plans, documents, and tenure information.
- Survey-Aware Parcel Fabric: parcels are dynamically geo-referenced to the underlying provincial survey control network.
    - This enables the overall parcel fabric accuracy to be continually improved as new geo-referenced survey plans are integrated into the fabric.
    - New survey plans retain original survey observations, even after successive “best fit” adjustments have been made.
- Transparent Quality: each parcel within the parcel fabric has a known level of spatial quality.
    - This will provide parcel fabric consumers with the information necessary to make informed business decisions.
    - This will help target future spatial accuracy improvement programs by identifying areas of the fabric where spatial accuracy is poor.



Survey Plan Submissions (SPS) Website

- Survey Plan Submissions (SPS) is a web-based application designed to support operational maintenance of the ParcelMap BC parcel fabric. It leverages Esri's ArcGIS for Server technology and Safe Software's FME.
- To support sustainability, BC land surveyors are required to submit their survey plan datasets to LTSA as part of the mandatory process for plan package submissions. Surveyors submit their datasets through SPS; an innovative web map application that runs custom geoprocessing services to perform various business rule checks that validate their digital survey plan quality online.



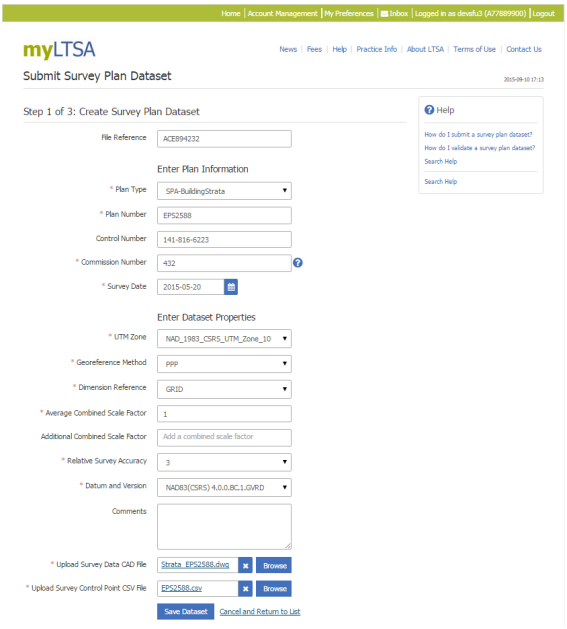
- Surveyors use AutoCAD (or other CAD programs) to create the registered survey plan image, which is an official plan of record for plans in BC. Traditionally, digital parcel fabrics could be maintained by having technicians re-draw the survey plan using various coordinate geometry (COGO) techniques. SPS eliminates the need for redundant redrawing (i.e., CAD --> paper --> GIS).
- The ParcelMap BC Operations Team can now integrate newly surveyed digital and geo-referenced parcels and control points from the survey plan (i.e., CAD file) directly into the parcel fabric. Because these plans are geo-referenced, the overall spatial accuracy of the ParcelMap BC fabric can be improved.

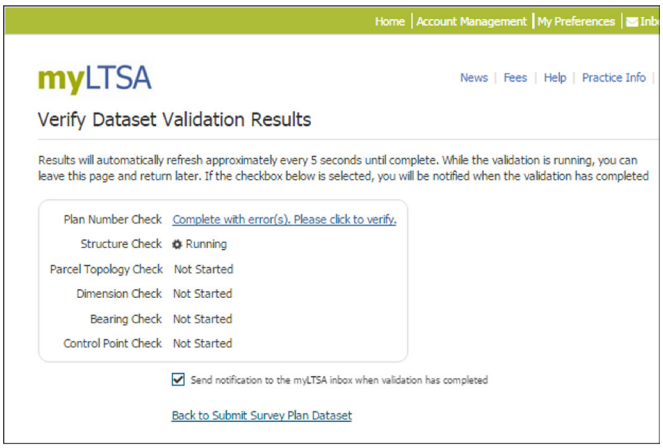
SPS was built on the success of the SPOC application built for Alberta in 2010 and the Plan Submission Online (PSO) application built for Saskatchewan in 2013.

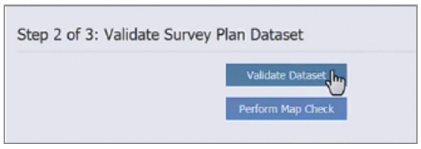
Step 1: Create a New Dataset

To submit their survey plan datasets in SPS, surveyors must first create a new dataset and enter/upload the following information into the application:

- Metadata (e.g., Survey Date, UTM Zone, etc.)
- Survey data in the form of a CAD file (.dwg format)
- Control point data in the form of a CSV file







Step 2: Validate the Dataset

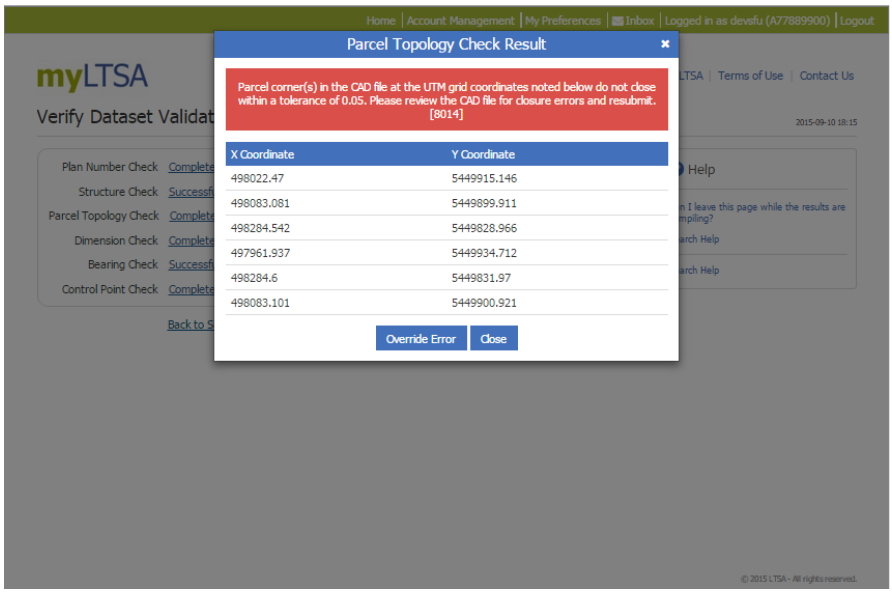
A number of business rules are checked to validate the integrity of data provided and report any errors, including:

- Plan Number Check
  - A plan number which is not assigned for the entered commission number
  - A plan number which is already in use or not assigned
- Structure Check
  - Missing Layer, Invalid CAD file, 3-D CAD, CAD not in Model Space
- Parcel Topology Check
  - Parcel corner(s) do not close within a tolerance of 0.05
- Control Point Check
  - Missing or wrong Record Separator
  - Missing Description
  - Not Enough Control Points

Plan Type controls the list of tests performed and the parameters

Parcel Topology Check Result

Example of messaging back to user – problem with topology – the line work on a specific layer does not created closed shape as expected – coordinates for the user to review CAD file easily.

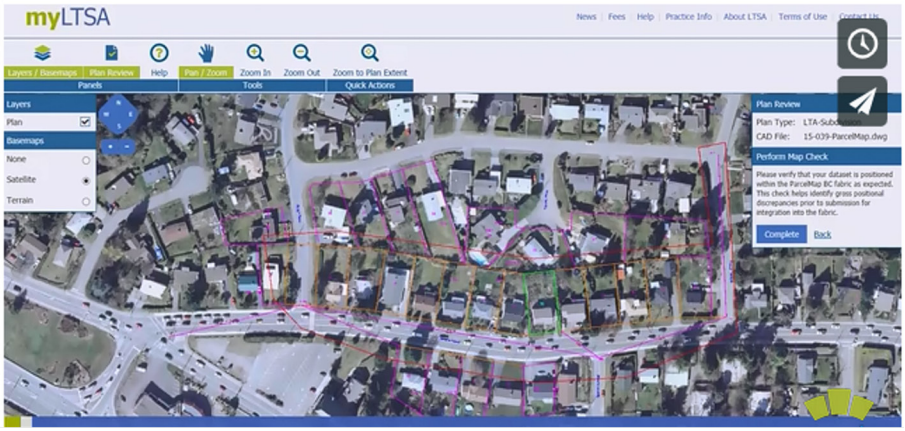


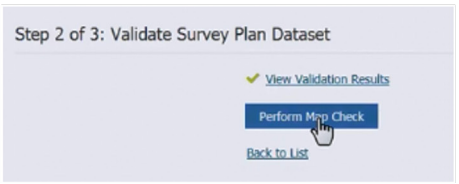
Perform a Map Check

Surveyors perform a visual check to ensure the plan is correctly positioned within the ParcelMap BC fabric.

Visual confirmation of geo-referencing and surround of their area of interest

Esri JavaScript API is used to create the map user interface (basic functions– pan, zoom, display the map). Esri ArcGIS Enterprise map services are used to display the map data, such as the parcel fabric under the CAD file.





Step 3: Submit the Dataset

Only registered land surveyors may submit survey plan datasets.

Result

- **Reduced Errors & Costs:** By identifying survey plan errors prior to plan registration, costs are reduced through automated checks and any associated costs for resubmission or corrections
- **Improved Quality:** All processed files are verified to ensure compliance with geo-reference requirements parcel closures or other survey elements are included
- **User Friendly:** The system alerts surveyors if any necessary plan information is missing or appears to be incorrect, guiding the process before final submission
- **Visual Checks for Users:** Users can view their plan relative to the cadastral(parcel) fabric and identify any plan anomalies or conflicts prior to submission
- **Faster Approvals and Improved Quality:** Digital workflows help streamline the approval process and improves the overall quality of the registration documents through automated business rule checks and validation
- **Reduced Effort:** Registry staff can focus their efforts on registering documents instead of verifying that files match submission requirements
- **More Secure:** The system compresses and encrypts the surveyor's digital plan package, ensuring only authorized staff can extract the information in this package for plan registration purposes
- **More Information:** Metadata is verified by users and assists in automating subsequent approval and mapping workflows such as unit counts and location information

About MNC

MNC is the expert in the compilation and maintenance of cadastral and parcel mapping. Providing clients with practical and innovative data collection, mapping and geomatics solutions related to surveyed land information.

esri Partner Network Silver

FME by Safe Software

www.mncl.ca

mnc@mncl.ca