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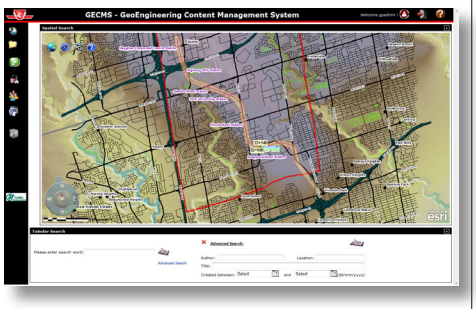

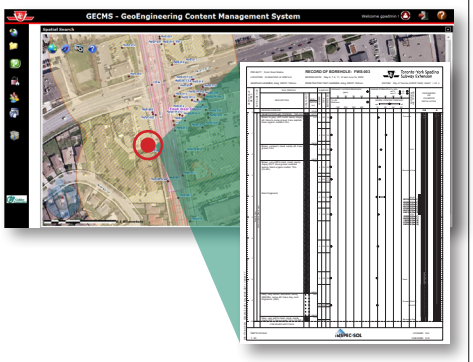

Canadian Consulting Engineering Awards 2012

GECMS: Geo-Engineering Content Management System

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Project Client

N/A

Consultants

N/A

Contractors

N/A

Project Highlights

In 2008, Golder Associates Ltd. (Golder) was appointed by the Toronto Transit Commission (TTC)—Canada's largest public transit system—as Principal Geo-Engineering Consultant (PGEC) for the $2.6 billion Toronto-York Spadina Subway Extension (TYSSE) project. With an estimated completion date of 2015, the TYSSE project will increase the current subway line by 8.6 km, adding six new subway stations and 2,900 new commuter parking spaces. The large scope of this project, in relation to a tight construction schedule, posed several challenges for project stakeholders.

Drawing on experience from previous subway construction projects, the TTC Project Managers Joint Venture Team—consisting of multiple consulting engineering firms including Hatch Mott MacDonald, Delcan and MMM Group—foresaw considerable information management challenges. Multiple geo-engineering investigations performed for the tunnels and six stations would need to be accessible, organized and kept up-to-date.

The team felt this challenge could compromise the timely completion of the project. Also, TTC project managers identified the inefficiencies of the paper-based document and data management and retrieval system used during construction of the TTC's Sheppard subway. For TTC project managers, a paperless system providing quick, intuitive access to information suited their needs more effectively.

To address these challenges and needs, the TTC conceptualized a spatially-based document management solution. Golder and the TTC worked closely together to develop a secure, easy-to-access, one-stop portal used by project participants of the TYSSE project. The first system of its kind adopted by the TTC, and, to Golder's knowledge, applied to a large-scale engineering project, the Geo-Engineering Content Management System (GECMS) serves three primary functions: 1) document management and viewing; 2) spatial data management and viewing; and 3) instrumentation data management, monitoring and reporting.

When a User logs in to the GECMS via Internet connection, they are presented with a map of the TYSSE project area and spatial search tools to assist with data location. For example, a User may select a subway station and use a 'Document Search' feature to locate all documents belonging to that particular station. Or, a borehole drilling site may be selected and associated data logs will appear for review. Also, by reading instrumentation devices installed prior to construction, the GECMS instrumentation component monitors fluctuating conditions, such as deformation, vibration and groundwater

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Project Highlights

levels during the construction phase. The instrumentation component has also been used to monitor progress of the four TYSSE Tunnel Boring Machines—Holey, Moley, Yorkie and Torkie—in near-real time. To manage subsurface risk during the tunneling phase, the instrumentation component has been developed to send auto-generated email messages to TTC project managers if pre-determined thresholds are exceeded.

Using the GECMS web application, documents may be shared easily between project stakeholders in a central information hub. For example, tunnel and station designers can upload designs to the document management component for easy access to authorized Users, such as engineers, TTC managers, construction firms and municipal and federal politicians. This feature improves project collaboration by opening up the lines of communication between key stakeholders, and also decreases file searching time and instances of file duplication.

By making information digitally accessible, the GECMS helps to keep the TYSSE project on time and on budget by providing a reliable, centralized portal approach to managing critical information for a large and multi-discipli-nary project team. The GECMS is currently used by approximately 184 authorized Users, and manages 13,775 documents, 11.9GB of information and 4,000 monitored instruments.

Keeping the TYSSE project on track ultimately means commuters can travel more freely in the GTA, spending less time stuck in gridlock and more time with their families and friends. And the sooner potentially fewer cars are travelling on GTA roads, the earlier we can hope to achieve lower carbon emissions to improve air quality and contribute to Canada's role in addressing global warming.

Furthermore, transit expansion projects such as the TYSSE help to ease traffic congestion in the GTA, which will in turn reduce fuel consumption (due to lessened idling on roadways), and also increase productivity for freight and commercial vehicle operators (improved delivery times for goods and services).

Project Description

Objectives

Based on lessons learned from the TTC Sheppard subway project, the Project Managers Joint Venture Team quickly realized the challenges of managing large volumes of documents generated from geo-engineering investigations, and the challenges this could pose for the timely completion of the TYSSE project.

One of the PGEC's deliverables was to develop and maintain the GECMS. This web-based application manages geo-engineering documentation, spatial and instrumentation data. By making this information readily accessible to assist participants in making timely and informed decisions, the GECMS assists the project team in mitigating subsurface risk through all stages of design and construction of the TYSSE project.

Solutions

To accommodate the TTC's unique requirements, Golder developed the GECMS—a one-stop portal web application that leverages ESRI's ArcGIS Server technology, Microsoft's SharePoint and the Golder Instrument Data Interpretation and Evaluation (GIDIE) system to manage geo-engineering documentation and data.

The GECMS is comprised of three functional components:

1) Spatial Data Manager and Viewer – ESRI ArcGIS Server and Microsoft Silverlight

- Pan/Zoom viewing capabilities
- Quick Map production and Map Feature identification
- Allows documents to be linked to and searched with spatial data
- Spatial Data Manager and Viewer

2) Document Manager – Microsoft SharePoint Document Libraries

- Working (draft) documents
- Published (final) documents
- Enables documents to be linked to and searched with spatial data

3) Instrument Data Monitoring Manager – GIDIE

- Instrument and senior definition administration
- Near real-time monitoring of instrumentation readings
- Tunnel Boring Machine (TBM) progress is viewable through spatial map
- Instrument locations viewable through spatial map

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Project Description

- Instrument readings viewable in report or graph formats

Once a User is logged into the portal, they are presented with a map of the project area and can refer to spatial search tools to find the information of interest. For example, the User can select a subway station from the station layer and use the 'Document Search' feature to uncover all documents related to that particular station.

Project team members can also 'click' on a document management icon to upload and manage documents. The document version control feature allows users to maintain a historical legacy of records, to help ensure they are accessing the most up-to-date information.

GIDIE allows project team members to leverage the map viewer to connect with instrumentation systems installed prior to and during construction. This allows users to monitor engineering parameters such as vibration, groundwater levels, ground movements, and building settlement in near real-time. This component also allows users to see the near real-time progress of the TBM at a quick glance.

Achievements

The GECMS has enabled the project team to share, upload, view and edit relevant geo-engineering and geo-environmental documentation with other participants, engineers, TYSSE staff and consultants. This has greatly improved collaboration and facilitated greater communication amongst key project team members. It has also promoted quicker and more effective design execution through easy access to critical information. Version control has helped to ensure that all referenced spatial data is up-to-date and accurate, assisting in minimizing risk during this complex, large-scale project.

TECHNICAL EXCELLENCE & INNOVATION

The high level architecture approach adopted by Golder's GECMS development team resulted in the design of a one-stop web portal that presents the User with a list of information management tools. Building the GECMS with integrating technologies streamlined the development process in order to create highly interactive and interoperable suite of software tools. By developing the GECMS in a modularized fashion, each User can select the appropriate information management component, such as Spatial Data Manager and Viewer, Document Manager or GIDIE. The end-goal is to provide a one-stop portal that will allow multiple information management tools to be

integrated together into one location.

Innovative features include:

- Project information accessible to all team members via the internet
- Replaces the need to send large attachments via email
- Controls editing and versioning
- One Editor at a time per document
- Single copy of the document
- Version comments are tracked
- Access to spatial data, documents and tools is restricted by User permissions
- Users can search and access documents through online mapping tools
- Integrated instrumentation and reporting
- Automated email alert to users when new documents are uploaded, or existing documents are updated
- Scheduled batch reporting based on individual monitoring needs

CONTRIBUTION TO ECONOMIC, SOCIAL AND/OR ENVIRONMENTAL QUALITY OF LIFE

Like many major cities around the world, traffic conditions in the Greater Toronto Area (GTA) are worsening. Commuters are spending more time in their cars away from their families, their jobs and their personal interests. Commercial transport of goods is also being delayed. In a study commissioned by Transport Canada in 2002, the estimated congestion cost of traffic for the city of Toronto totalled $1.6 billion. More than 90 per cent of this cost represents the value of the time lost to auto travellers (drivers and their passengers) in congestion. The study also estimated an increase of 1.2 to 1.4 megatonnes of greenhouse gas due to congestion every year. [1]

One of the goals of the TYSSE project is to help address this growing problem. Once completed, the TTC's subway line will be the first to extend into the Regional Municipality of York, connecting travellers such as suburban commuters and York University students with underground transit. In effect, the TYSSE project aims to encourage people to get out of their cars and onto public transit to promote a healthier, more sustainable environment for one of Ontario's fastest growing regions. Potentially fewer cars on GTA highways and roads means less traffic congestion, which should lead to a rise in productivity for freight and commercial vehicle operators (improved delivery times for goods and services).

1 "The Cost of Urban Congestion in Canada," Transport Canada, Mar. 22, 2006

Project Description

The role the GECMS plays in the TYSSE project is to provide faster access to information, resulting in expedited decision-making amongst key stakeholders. With access to information such as near real-time instrumentation reporting, time spent waiting to receive necessary information to make an informed decision has been lessened. Placed in context of the large scope of information the GECMS manages, project management efficiencies continue to be realized.

As a result, the role the GECMS plays to make information digitally accessible helps to keep the TYSSE project on time and on budget; although the degree to which this can be measured is difficult to quantify in isolation given the complexity of the project and myriad of variables affecting its targeted completion date.

In this way, the GECMS is a contributing factor in assisting the TYSSE project team and their efforts to extend the TTC's subway system, and in turn help to improve the economic, environmental and social quality of life in the GTA.

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Sketches/Drawings

GECMS Database Model

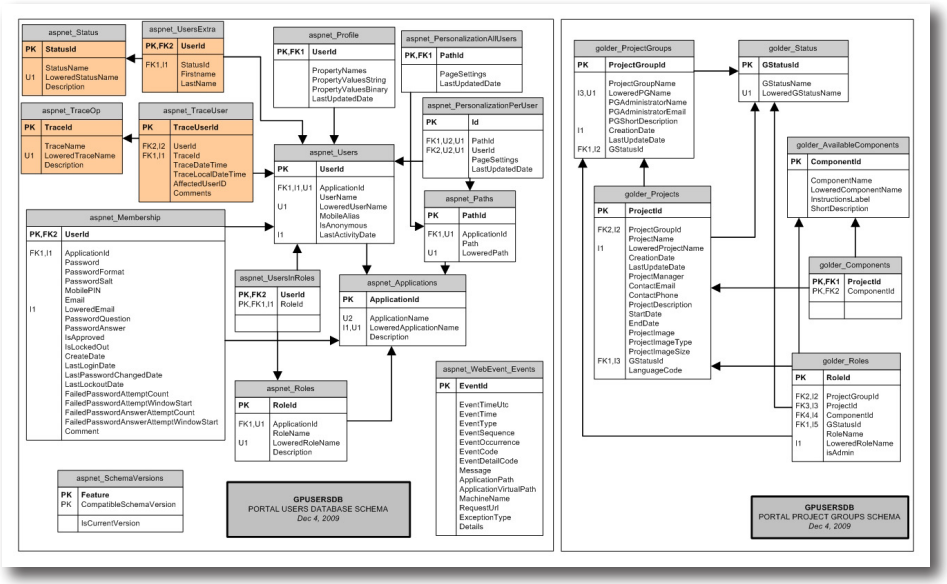
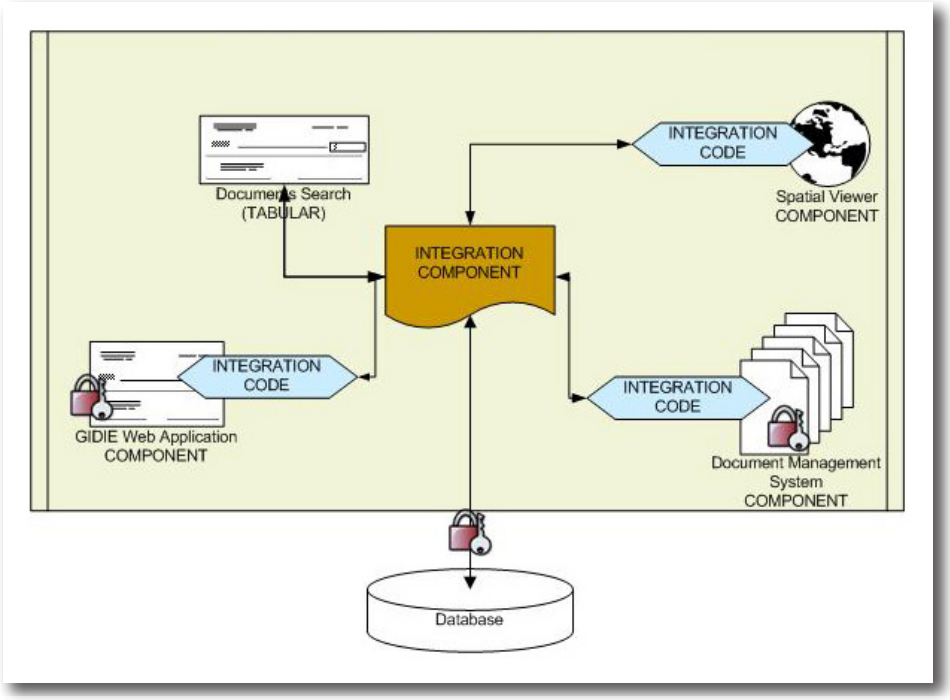


Image: Golder Associates

GECMS Software Architecture



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Graphics Representations

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Landing Page View

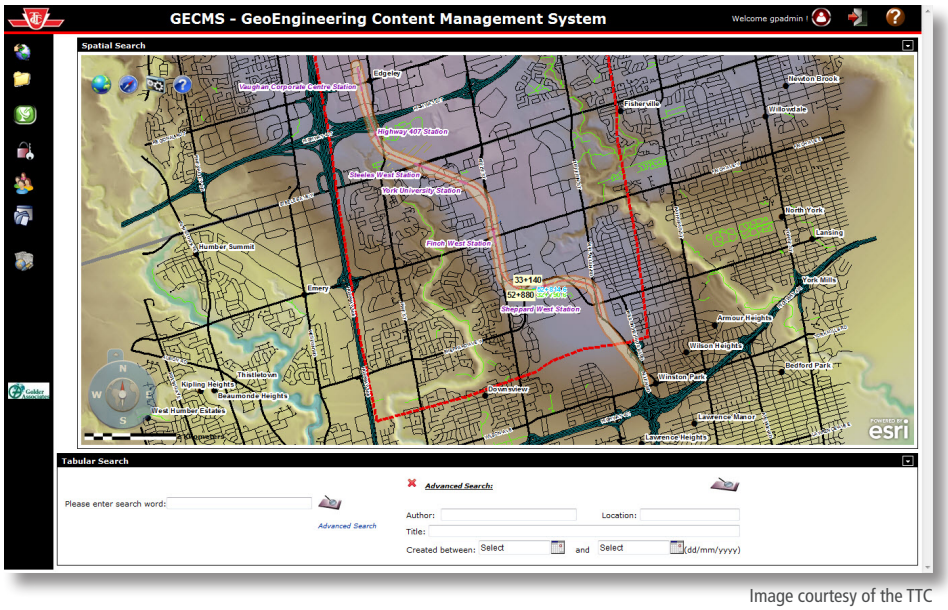
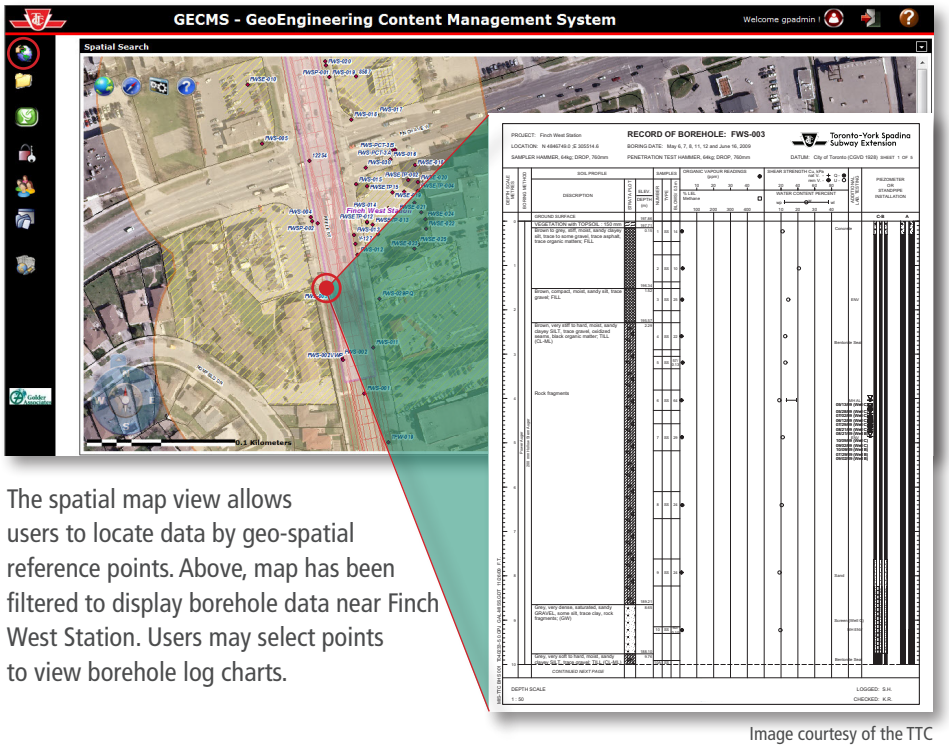


Image courtesy of the TTC

The GECMS landing page in spatial map view showing the TYSSE project area. Users may choose how they wish to retrieve information.

Spatial Map View



The spatial map view allows users to locate data by geo-spatial reference points. Above, map has been filtered to display borehole data near Finch West Station. Users may select points to view borehole log charts.

Image courtesy of the TTC

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Graphics Representations

Document Management View

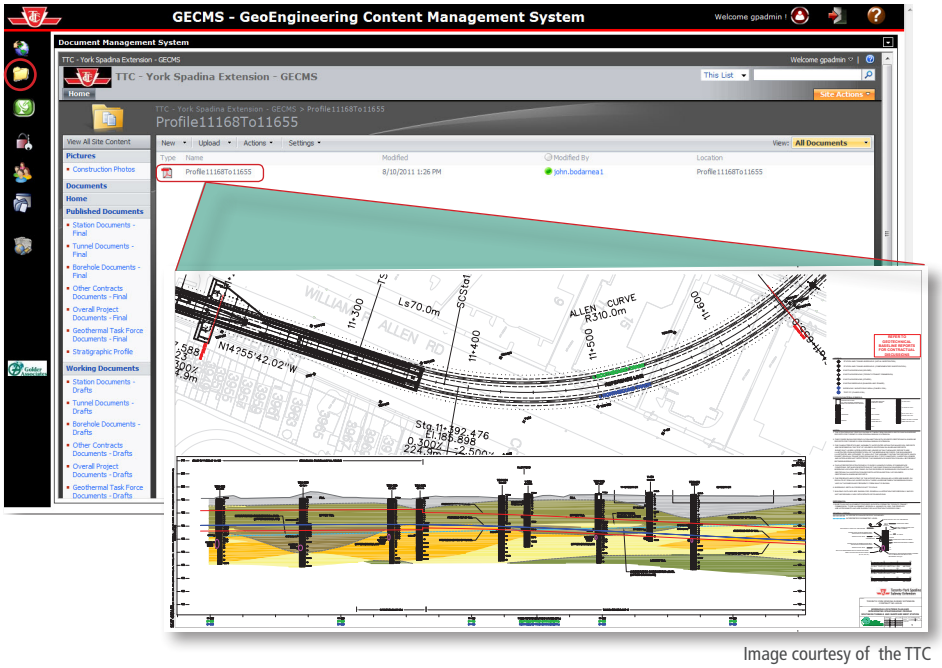

Image courtesy of the TTC

Based on User access security level assigned by the TTC, the Document Management component allows users to centrally view and manage all documents and published spatial data.

Instrumentation Page View

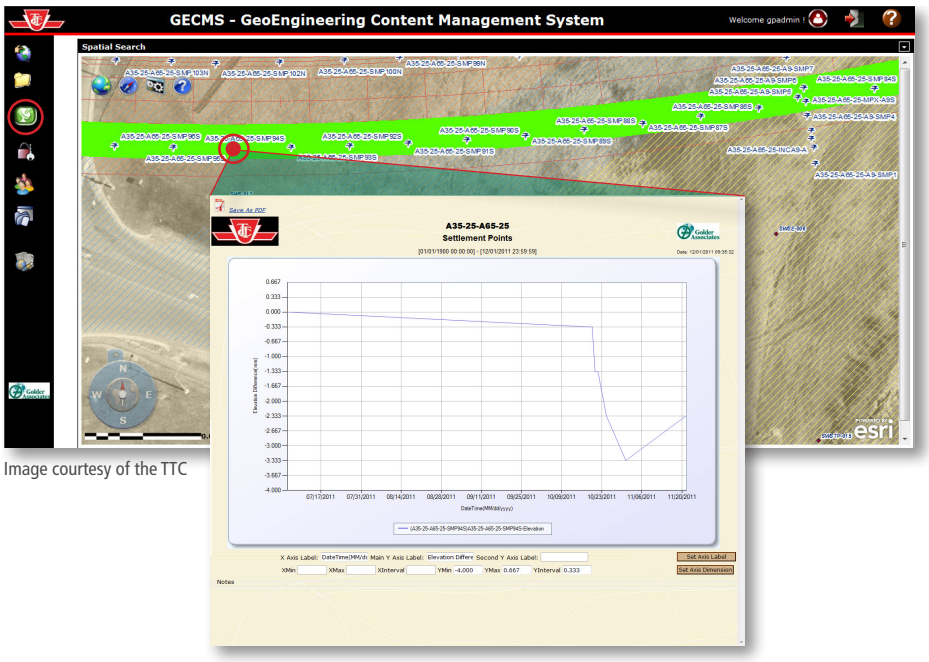

Image courtesy of the TTC

In near-real time, the GECMS monitors data from the 4,000 instruments deployed on the project, facilitating rapid decision-making for the TYSSE project team. Above, a ground settlement graph is generated from an instrument selected as part of the tunnel boring machine advancement (show in green).

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Graphics Representations

Photograph: Golder Associates

Ahmad Mian, project engineer for Golder's TYSSE team, onsite at the future Vaughan Corporate Centre station accessing the GECMS using a tablet with Wi-Fi connection.

Photograph: Golder Associates

The GECMS manages approximately 180 users, 13,570 documents, 11.1GB of information and 4,000 monitored instruments.*

*Based on statistics generated on Dec. 12, 2011.

Graphics Representations

Photograph: Golder Associates

Dave Walters, project manager for Golder's TYSSE team, leads a multi-disciplinary working group reviewing various design options and geo-engineering challenges aided by the GECMS portal.

Photograph: Golder Associates

Golder TYSSE project team assesses tunnel boring machine progress viewed in near real-time within the GECMS.

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