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GEOTECHNICAL news

A closed tailings storage facility at the El Indio Mine in Chile

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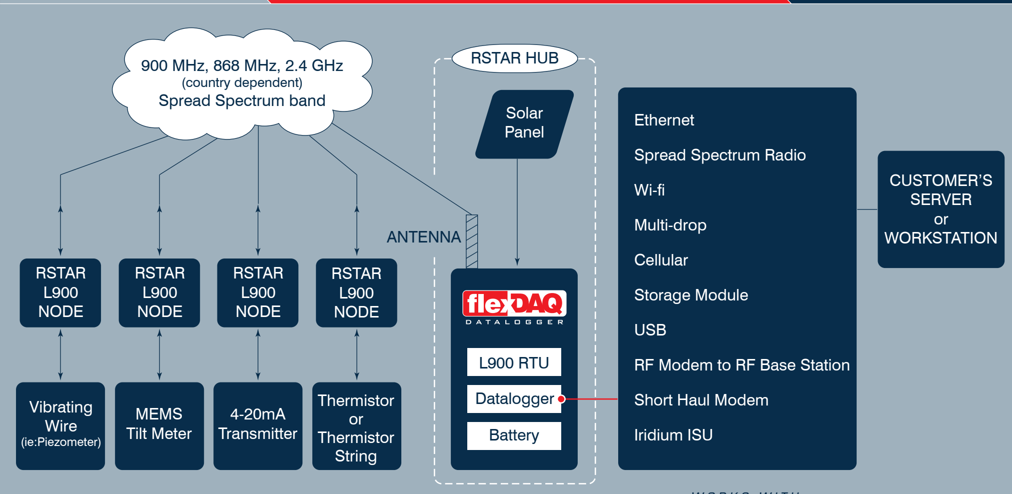
DIAGRAM

Typical RSTAR configuration for the RSTAR L900 System.



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FEATURES

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GEOTECHNICAL NEWS

PUBLISHER John W. Gadsby

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BiTech Publishers Ltd.
103 - 11951 Hammersmith Way
Richmond, British Columbia
Canada V7A 5H9
tel 604-277-4250 • fax 604-277-8125
email *gn@geotechnicalnews.com*
web *www.geotechnicalnews.com*

GEOTECHNICAL NEWS is published quarterly.

Paper subscription rates:

- within North America: $51.00 CDN per year
- overseas: $85.00 US per year through BiTech Publishers Ltd.

Electronic version:
GEOTECHNICAL NEWS is also available in electronic version. For details,visit *www.geotechnicalnews.com*

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Printed in Canada

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Cover *A closed tailings storage facility at the El Indio Mine in Chile.*

(Björn Weeks photo)

Message from the President

Doug VanDine, President of Canadian Geotechnical Society

This is my first President's message to the CGS membership in the CGS News. I briefly thanked my predecessor, **Richard Bathurst** and his administration in my "few words" in the January 2015 issue of the CGS e-Newsletter, but here I would more formally like to recognize the legacy of his administration. Among other things under Richard's leadership, the French version of the 4th edition of the *Canadian Foundation Engineering Manual* was completed and published. Planning was also initiated for the proposed online 5th edition of this important document. **Michel Aubertin** was retained as CGS Executive Director to replace **Victor Sowa;** and the CGS annual conference Memorandum of Understanding (MOU) was updated.

For those of you who didn't attend the very successful GeoRegina 2014, I introduced the 2015 Executive Committee. Joining me will be VP Technical **Angela Küpper** (Senior Geotechnical Engineer, BGC Engineering); VP Finance **Dharma Wijewickreme** (Professor, Civil Engineering, University of British Columbia); VP Communications **Catherine Mulligan** (Professor, Building, Civil and Environmental and Associate Dean Research and Graduate Studies, Concordia University); Technical Division Rep **Richard Brachman** (Professor, Civil Engineering, Queen's University) and Section Rep **Seán Mac Eoin** (Senior Geotechnical Engineer, AECOM). Angela, Dharma and Catherine served very well in the same capacities in the previous administration. In addition, the Executive Committee will be supported by CGS Headquarters staff, **Michel Aubertin**, **Wayne Gibson**, **Lisa McJunkin** and, for a portion of the year, **Victor Sowa**.

In addition to the above, the CGS depends on a myriad of other volunteers: Section Directors, Division Chairs and Committee Chairs and all their respective executive members and members. The Directors and Chairs are listed elsewhere in this issue. Thanks to all who spend a bit of their "free time" helping to make the CGS a dynamic technical society.

Some credit an engineer, Robert Johnson, with the quote "The world is run by those who show up". The same is true about the geotechnical profession. If you want to make a difference in the geotechnical field, get involved. I would like to remind you that besides the 20 CGS local sections across Canada, there are seven technical divisions: **Soil Mechanics and Foundations**, **Engineering Geology**, **Rock Mechanics**, **Groundwater**, **Cold Regions**, **Geosynthetics and Geoenvironmental** and there are 7 committees: **Landslides**, **Mining Geotechnique**, **Transportation**, **Professional Practice**, **Education**, **Heritage** and a newly minted committee, **Sustainable Geotechnique**. There is literally something for all Canadian geotechnical professionals in the CGS and I encourage you to get involved. For more information on all CGS activities visit *http://www.cgs.ca/*.

For me, an important aspect of any organization is communication. Hopefully by now you have received the first few issues of the CGS monthly e-Newsletter. We hope that along with the quarterly CGS News, the monthly e-Newsletter and the soon-to-be-updated website and social media outlets, will keep you better informed as what's going on in the CGS and the Canadian geotechnical profession in general.

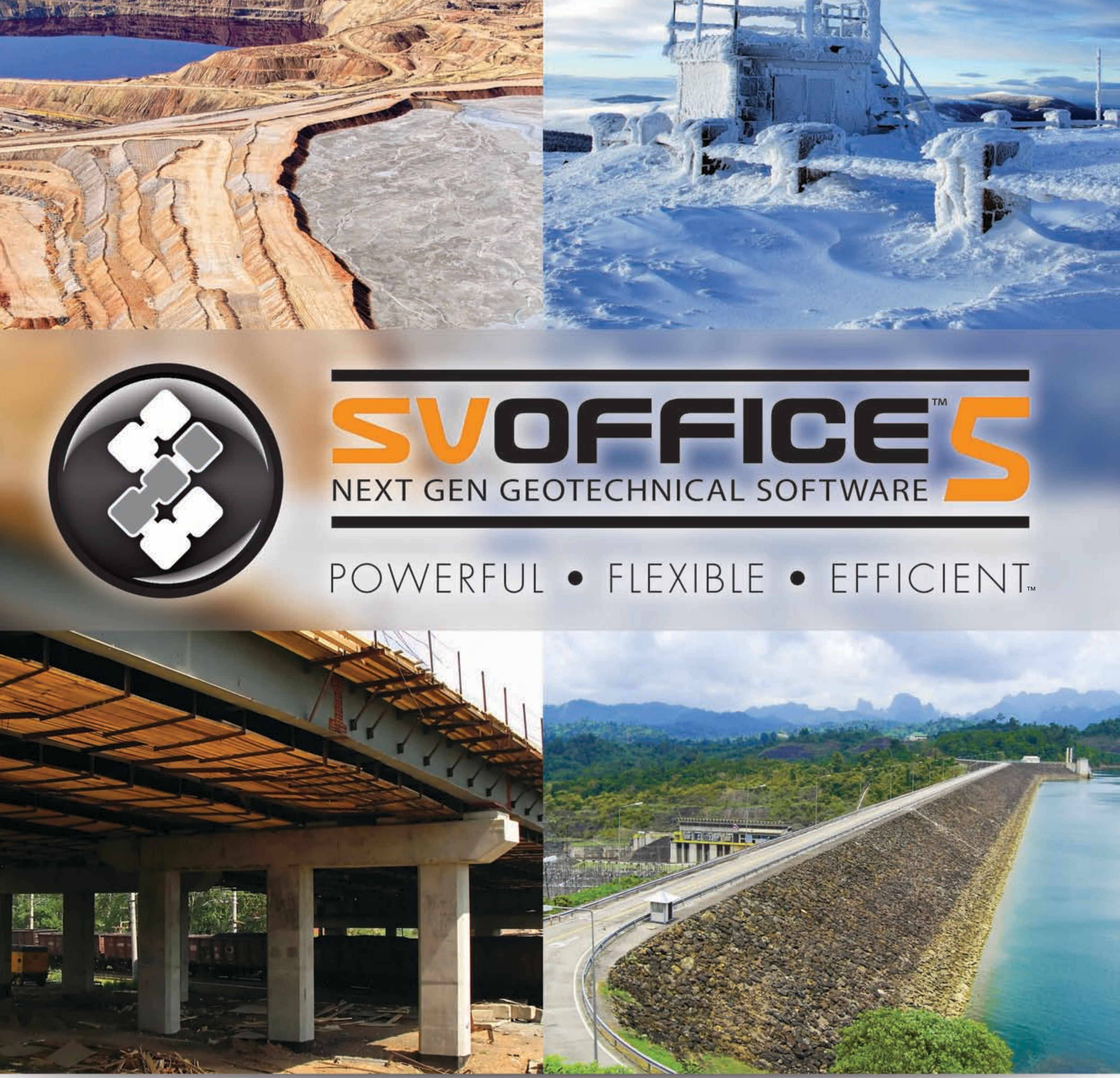
I would be remiss in not reminding you of the **68th CGS Annual Conference and the 7th Canadian Permafrost Conference (GEOQuébec 2015)** *http://www.geoquebec2015.ca/EN/* that will be held in beautiful Quebec City September 20 to 23. Thanks to the organizing committee under the leadership of **Jean Côté**, this conference promises to be one of the best. Make your plans to attend now, participate and get involved.

And for those who like to plan ahead, prepare to attend **GeoVancouver 2016** in September 2016. More about that conference later.

Provided by Doug VanDine
President 2015 - 2016

Message du président

Il s'agit de mon premier message aux membres de la SCG à titre de président dans *CGS News*. J'ai remercié brièvement mon prédécesseur, **Richard Bathurst,** et son équipe administrative, dans mes "quelques mots" du numéro de janvier 2015 du Bulletin d'information électronique de la SCG, mais j'aimerais maintenant reconnaître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plus officiellement l'héritage de cette administration. Entre autres réalisations, sous la direction de M. Bathurst, la version française de la 4e édition du *Manuel canadien d'ingénierie des fondations* a été terminée et publiée. La planification de la 5e édition de cet important document a été amorcée; une version en ligne est proposée. **Michel Aubertin** a été retenu comme directeur général de la SCG pour remplacer **Victor Sowa**, et le protocole d'entente (PE) de la conférence annuelle de la SCG a été actualisé.

Pour ceux qui n'ont pas assisté à la conférence très réussie GéoRegina 2014, j'y ai présenté les membres du Comité exécutif 2015. La vice-présidente technique, **Angela Küpper** (géotechnicienne principale, BGC Engineering), le vice-président des finances, **Dharma Wijewickreme** (professeur, génie civil, Université de la Colombie-Britannique), la vice-présidente aux communications, **Catherine Mulligan** (professeure, génie civil, environnemental et du bâtiment, et doyenne associée, recherche et études de cycles supérieurs, Université Concordia), le représentant de division technique, **Richard Brachman** (professeur, génie civil, Université Queen's) et le représentant de section **Seán Mac Eoin** (géotechnicien principal, AECOM) se joindront à moi. Angela, Dharma et Catherine ont très bien servi dans les mêmes rôles dans le cadre de l'administration précédente. Le Comité exécutif sera soutenu par le personnel du siège social de la SCG, **Michel Aubertin**, **Wayne Gibson**, **Lisa McJunkin**, et pendant une partie de l'année, **Victor Sowa**.

En plus des personnes susmentionnées, la SCG dépend d'une myriade d'autres bénévoles: les directeurs des sections, les présidents des divisions et des comités, et tous les membres de leur direction respective, ainsi que des membres. Les directeurs et les présidents sont nommés plus loin dans ce numéro. Merci à tous ceux qui passent une partie de leur "temps libre" à aider à faire de la SCG une société technique dynamique.

Certains attribuent la citation "Le monde est dirigé par ceux qui sont présents" à l'ingénieur Robert Johnson. Il en va de même de la professionnels de la géotechnique. Si vous souhaitez faire une différence dans le domaine de la géotechnique, impliquez-vous. J'aimerais vous rappeler qu'outre les 20 sections locales de la SCG au Canada, il y a sept divisions techniques: **mécanique des sols et fondations**, **géologie de l'ingénieur**, **mécanique des roches**, **eaux souterraines**, **géotechnique des régions froides**, **géosynthétique et géoenvironnement**, ainsi que sept comités : **glissements de terrain**, **géotechnique minière**, **transports**, **pratiques professionnelles**, **éducation**, **patrimoine**, et un tout nouveau comité, **géotechnique durable**. Il y a vraiment quelque chose pour tous les professionnels en géotechnique canadiens à la SCG, et je vous encourage à contribuer. Pour obtenir de plus amples renseignements sur toutes les activités de la SCG, consultez le site *http://www.cgs.ca/*.

Pour moi, un aspect important de toute organisation est la communication. Vous devriez avoir maintenant reçu les premiers numéros du Bulletin d'information électronique mensuel de la SCG. Nous espérons qu'avec le *CGS News* trimestriel, ce Bulletin d'information électronique mensuel, le site Web qui sera bientôt actualisé et les médias sociaux vous serez mieux informé sur ce qui se passe à la SCG et dans la profession géotechnique canadienne en général.

Je m'en voudrais de ne pas vous rappeler la **68e conférence annuelle de la SCG et la 7e conférence canadienne sur le pergélisol (GéoQuébec 2015)** *http://www.geoquebec2015.ca/* qui se tiendront dans la magnifique ville de Québec du 20 au 23 septembre. Grâce au comité organisateur dirigé par **Jean Côté**, cette conférence promet d'être l'une des meilleures. Prévoyez y assister dès maintenant, participez et impliquez-vous.

Pour ceux qui aiment planifier à long terme, prévoyez aussi participer à **GéoVancouver 2016**, en septembre 2016. De plus amples renseignements au sujet de cette conférence vous seront fournis ultérieurement.

Fourni par Doug VanDine
Président 2015-2016

From the Society

Call for Nominations CGS President Elect

The next President-Elect for the Canadian Geotechnical Society will be appointed January 1, 2016 and this individual will become President for 2017 and 2018. The process leading to this appointment, which will be confirmed at the 68th Canadian Geotechnical Conference (GeoQuébec 2015) in Quebec City on September 20-23, 2015, has now begun.

In accordance with the CGS By-Law, a Nominating Committee was formed in 2014 to propose a suitable candidate. It consisted of then President **Richard Bathurst** as chair, **Bryan Watts** (then Past-President), **Lee Barbour** and **Heinrich Heinz** (general members of CGS).

That committee has put forward the name of **Dr. Dharma Wijewickreme**. Dr. Wijewickreme has agreed to be a candidate, and his statement of qualifications and objectives for the Society follows. Other candidates, however, are also welcomed. Any general member of the CGS may nominate a candidate for the position of President-Elect. Nominations must be received in writing by CGS Headquarters by **June 15, 2015**. They must include the printed names, signatures and CGS member numbers of at least 18 general members, and a statement by the candidate expressing a willingness to serve as President-Elect and then

President, if elected. For further information contact CGS Headquarters.

If there are no additional candidates, Dr. Wijewickreme will be acclaimed at the Board of Directors Meeting in Quebec City this fall. If additional candidates are nominated, the selection of the President-Elect will be by a general members' ballot during the summer of 2015.

Appel de Candidatures Président Désigné de la SCG

Le prochain président désigné de la Société canadienne de géotechnique sera nommé le 1er janvier 2016, et cette personne deviendra président pour 2017 et 2018. Le processus menant à cette nomination, qui sera confirmée lors de la 68e conférence canadienne de géotechnique (GéoQuébec 2015) dans la ville de Québec, du 20 au 23 septembre, est maintenant commencé.

Conformément aux règlements de la SCG, un Comité de candidatures a été mis sur pied en 2014 pour proposer un candidat approprié. Il est composé de l'ancien président **Richard Bathurst**, à titre de président, de **Bryan Watts** (qui était l'ancien président au moment de sa nomination), de **Lee Barbour** et de **Heinrich Heinz** (membres de la SCG).

Ce comité a proposé le nom du **Dr Dharma Wijewickreme**. Le Dr Wijewickreme a accepté d'être candidat, et son énoncé de qualifications ainsi que ses objectifs pour la Société vous seront transmis plus bas. D'autres candidats sont toutefois les bienvenus. Tout membre de la SCG peut poposer un candidat au poste de président désigné. Les candidatures doivent être reçues par écrit au siège social de la SCG d'ici le **15 juin 2015**. Elles doivent comprendre les noms en lettres moulées, les signatures et les numéros de membre d'au moins 18 membres de la SCG, et une déclaration du candidat exprimant sa volonté d'agir à titre de président désigné, puis de président s'il est élu. Communiquez avec le siège social de la SCG pour obtenir de plus amples renseignements.

S'il n'y a pas d'autres candidats, le Dr Wijewickreme sera élu par acclamation lors de la réunion du conseil d'administration dans la ville de Québec, cet automne. Si d'autres candidats sont mis en candidature, le président désigné sera élu à la suite d'un vote des membres pendant l'été 2015.

President-Elect Objectives: Nomination Statement of Dr. Dharma Wijewickreme

I am honoured to have been chosen by the Nominating Committee of the Canadian Geotechnical Society (CGS) as the Society's President-Elect

Dharma Wijewickreme

in 2016 and it is with pleasure that I accept this nomination. If elected, I look forward to serving the CGS as President for a two-year term commencing January 2017.

I have actively participated in a wide range of CGS activities in various roles. The latest is the start of a second two-year term as your Vice President Finance. My other contributions to the CGS have included being the Technical Co-Chair of the 59th Canadian Geotechnical Conference in Vancouver (2006); Regional Director for B.C. (2004-2005); a founding member of the Technical Committee on Mining Geotechnique (2012-2014); a member (2004 to 2010) and then Chair of the National Education Committee (2007-2010); Member of the Geotechnical Research Board (2011-2012) and the Membership Task Force Committee (2010). My contributions to the CGS at local and international levels through the Vancouver Geotechnical Society (VGS) and International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE), include being the Co-chair of the 14th VGS Symposium (2000); Program Director for the VGS (2000-2001); Conference Co-Chair of the 3rd International Conference on the Performance Based Design in Geotechnical Earthquake Engineering under the auspices of the Technical Committee ISSMGE-TC-203 on Geotechnical Earthquake Engineering and Associated Problems (2017); and Member of the TC-203 (since 2011) and Technical Committee ISSMGE-TC-29 on Laboratory Stress Strain Strength Testing of Geomaterials (2003-2010). I'm also a member the American Society of Civil Engineers, the Canadian Society for Civil Engineering and the Earthquake Engineering Research Institute.

My professional activities over the last 25 years comprise 11 years in industry and 14 years in academia. At present, I am a Professor of Civil Engineering at the University of British Columbia (UBC). Before joining UBC in 2001, I worked in geotechnical consulting practice with Golder Associates, where I became an Associate (Partner) of the firm in 1997. At UBC, I conduct research which focuses on pipeline and earthquake geotechnical engineering. With industry funding, I have contributed to establishing a new Pipeline Integrity Institute (PII) at UBC, created to champion pipeline practice and innovation through research and training. My research on soil liquefaction contributed to the seismic design guidelines in the Canadian Foundation Engineering Manual CFEM (2007) and the Task Force Report on Geotechnical Earthquake Engineering Design in Greater Vancouver, with application in major earthquake engineering projects. I have served on the Editorial Boards of the Canadian Geotechnical Journal since 2008 and the ASTM Geotechnical Testing Journal since 2005. In 2013 I was the recipient of the Canadian Society for Civil Engineering Horst Leipholz Medal for outstanding contributions to Engineering Mechanics and Practice in Canada. I was also elected a Fellow of both the Canadian Academy of Engineering and the Canadian Society for Civil Engineering in 2013.

Through its leadership and the tremendous efforts of past and current volunteers, the CGS can proudly state with pride that our learned Society's membership is both growing and that its finances are strong. The annual CGS conference, local section involvement, Cross Canada Lecture tours, the addressing of technical issues through our Divisions, the publication of the CFEM, along with the linkage with the Canadian Geotechnical Journal, all form the basis of the CGS' deliverables to the profession as a learned society.

Our membership has been the key to the Society's success, but we need to better involve young professionals. The importance for collaboration between academics and practitioners, and the need for increased involvement in policy and regulatory deliberations in relation to the geotechnical profession has also been identified. Continuing these important issues involve activities that extend well beyond the time spans of the recent and current CGS administrations. The challenge is to find the most effective ways of implementing the tasks identified on an ongoing basis. I believe that there is a need to increase the involvement of our membership in the implementation of identified tasks. In other words, we need to find ways get the Society's action items into the routine "things-to-do list" of our general membership. This will likely involve new ways of recognizing and rewarding our members for their efforts at the grass-roots level.

As we move forward, there is an increased need to be mindful of the rapidly changing value systems in the world. It is my opinion that further effort should be placed to convey our learned Society's contributions to society-at-large, especially to the school-age population. We will need to develop outreach activities extending beyond the traditional professional realms that are often used, while capitalizing on the readily available forms of modern communication tools. Of course, our approaches in this regard must be developed to be compatible with our volunteer-based frameworks and resources.

I believe that the experience gained through my voluntary contributions to the CGS, VGS, and ISSMGE, combined with my professional activities in both industry and academia, positions me well to provide leadership to our Society in 2017-2018. In addition, my intimate familiarity of the CGS' finances, operations, and protocols provides me the opportunity to directly focus on action-oriented tasks.

The Canadian Geotechnical Society, now nearly 70 years since its formation, is founded on "solid and competent ground." We have established an international reputation that is second to none. If elected as your President commencing in 2017, it would be my honour to lead and contribute to the profession and the society-at-large.

Provided by Dharma Wijewickreme, P.Eng., Ph.D., FCSCE, FCAE

Call for Nominations for CGS Awards

Look around. We all know at least one deserving geotechnical professional deserving of recognition!

The CGS wishes to again recognize the considerable contributions and achievements by geotechnical professionals in Canada and abroad in a family of awards, many of which will be presented during the Awards Ceremony at the CGS Annual Conference in Quebec City – GeoQuébec 2015 (September 20-23, 2015). Funding for many of these awards is provided by the Canadian Foundation Geotechnique, so remember to also support your Foundation! The various awards are summarized below. You can also go to *www.cgs.ca/awards.php?lang=en* for more information and the list of past recipients, or contact CGS Headquarters.

If you know of someone deserving of any of the CGS Awards, nominate them by **June 1, 2015**. If you wish to make a submission for a Student Award, it must be received by **April 21, 2015**. Send your nominations to CGS Headquarters at:

The Canadian Geotechnical Society
8828 Pigott Road
Richmond, BC
V7A 2C4, Canada,
Fax: (604) 277-7529
email: *cgs@cgs.ca*

Nominations should include the name and contact information of the nominator, a resume or curriculum vita of the nominee, and a letter highlighting the contributions and achievements that make the nominee a worthy candidate for that specific award. Letters of support from others, CGS members and non-members, are encouraged. If possible, nominations should include an appropriate head and shoulders photo of the nominee.

Appel de mise en candidatures pour les prix de la SCG

Regardez autour de vous. Nous connaissons tous au moins un professionnel en géotechnique méritant d'être reconnu!

La SCG souhaite de nouveau reconnaître les importantes contributions et réalisations des professionnels en géotechnique au Canada et à l'étranger, à l'aide d'un ensemble de prix qui seront pour la plupart présentés durant

Award	Brief Description/Comments
CGS Society Awards	
Legget Medal	For significant lifelong contribution to the geotechnical field in Canada. The most senior and prestigious CGS award.
R.M. Quigley Award	For the best paper published in Canadian Geotechnical Journal in the preceding year. Two runners-up are also recognized. CGS membership is not required. Nominations are by CGJ Associate Editors, but suggestions are welcome.
CGS Division Awards	
G. Geoffrey Meyerhof Award	**Soil Mechanics & Foundation Division.** For outstanding contribution to soil mechanics and foundation engineering.
Thomas Roy Award	**Engineering Geology Division**. For outstanding contribution (publication or otherwise) to engineering geology.
Roger J.E. Brown Award	**Cold Regions Geotechnology Division**. For outstanding contribution (publication or otherwise) to permafrost science or engineering. Awarded biannually, in even numbered years (not to be awarded in 2015).
John A. Franklin Award	**Rock Mechanics Division**. For outstanding publication in rock mechanics and/or rock engineering. Awarded biannually, in odd numbered years.
Geosynthetics Award	**Geosynthetics Division**. For outstanding publication in the application of geosynthetics to civil, geotechnical or geoenvironmental engineering. Awarded biannually, in even numbered years (not to be awarded in 2015).
Geoenvironmental Award	**Geoenvironmental Division**. For outstanding contribution (publication or otherwise) in geoenvironmental engineering. Awarded biannually, in even numbered years (not to be awarded in 2015).
Joint Awards	
Robert N. Farvolden Award	Joint award of the CGS **Groundwater Division** and the **Canadian National Committee of the International Association of Hydrologists**. For outstanding contribution to groundwater science or engineering, by an individual or group, that emphasizes the role or importance of groundwater.
Schuster Medal	Joint award of the CGS **Landslide Committee** and **Engineering Geology Division** and the **Association of Environmental and Engineering Geologists.** For outstanding contribution to geohazards research in North America. Awarded biannually to a CGS member, in odd numbered years. Nominations closed February 1, 2015.
CGS Student Awards	
Graduate Presentation	For best 15-minute technical presentation on video submitted by a graduate student at a Canadian university. One runner-up is also recognized. CGS membership is not required.
Undergraduate Individual Report	For best undergraduate student report by an individual in Canada. One runner-up is also recognized. CGS membership is not required.
Undergraduate Group Report	For best undergraduate student report by a group in Canada. One runner-up is also recognized. CGS membership is not required.
CGS Service Awards	
A.G. Stermac Award	For outstanding service over a period of time to the CGS by a member at the local, national or international level. More than one award can be presented each year.
Appreciation Certificate	For deserving CGS members recognized by the President or others as having contributed noteworthy service to the CGS.

la cérémonie de remise de prix lors de la conférence annuelle de la SCG dans la ville de Québec, GéoQuébec 2015 (20 au 23 septembre 2015). La Fondation canadienne de géotechnique finance un grand nombre de ces prix, n'oubliez donc pas de soutenir également votre Fondation! Vous pouvez également consulter la page *www.cgs.ca/awards.php?lang=fr* pour obtenir de plus amples renseignements et la liste des précédents lauréats, ou communiquer avec le siège social de la SCG.

Si vous connaissez quelqu'un méritant l'un des prix de la SCG, posez sa candidature d'ici le **1er juin 2015**. Si vous souhaitez soumettre la candidature d'une personne pour un prix étudiant, elle doit être reçue d'ici le **21 avril 2015**. Envoyez vos candidatures au siège social de la SCG, à :

La Société canadienne de géotechnique
8828 Pigott Road
Richmond, C.B.
V7A 2C4, Canada
Télécopieur : 604-277-7529
Courriel: *cgs@cgs.ca*

Les candidatures doivent comprendre le nom et les coordonnées de la personne qui les soumettent, un curriculum vitæ du candidat et une lettre soulignant les contributions et les réalisations qui font en sorte que le candidat mérite ce prix. Des lettres de recommandation d'autres personnes, qu'elles soient membres ou non de la SCG, sont encouragées. Si possible, les candidatures doivent inclure une photo en buste appropriée du candidat.

Call for Nominations for 2015 Awards and Fellowships Engineering Institute of Canada (EIC)

As a constituent Society of the **Engineering Institute of Canada** (EIC), CGS members are eligible for awards and fellowships of the EIC which are summarized below. CGS members are encouraged to submit EIC nominations of fellow members to CGS Headquarters by **July 15, 2015**.

Nominations must include:

1. A completed EIC Nomination Form which is available from *http://eic-ici.ca/honours_awards/*)
2. A nomination letter
3. The nominee's CV, and
4. Supporting letters from colleagues, preferably Fellows of the EIC (FEIC).

Past CGS member recipients of EIC Awards and Fellowships can be found on the CGS website *www.cgs.ca/awards.php?lang=en.* It is recommended that nominators review the awards details and criteria prior to preparing nominations. For more information, contact CGS Headquarters at:

The Canadian Geotechnical Society
8828 Pigott Road
Richmond, BC
V7A 2C4, Canada,
Fax: (604) 277-7529
email: *cgs@cgs.ca*

Appel de candidatures pour les prix et bourses de recherche 2015 Institut canadien d'ingénierie (ICI)

À titre de société membre de l'**Institut canadien des ingénieurs** (ICI), les membres de la SCG sont admissibles aux prix et aux bourses de recherche. Les membres de la SCG sont encouragés à soumettre des candidatures de collègues membres pour l'ICI au siège social de la SCG d'ici le **15 juillet 2015**.

Les candidatures doivent inclure :

5. un formulaire de candidature de l'ICI dûment rempli qui est disponible sur le site http://eic-ici.ca/honours_awards/);
6. une lettre de candidature;
7. le curriculum vitæ du candidat;
8. des lettres de recommandation de collègues, préférablement des fellows de l'ICI.

Il est recommandé que les personnes qui soumettent des candidatures examinent les détails et les critères des prix avant de les préparer. Pour obtenir

Award of Honour	Brief Description/Comments
Sir John Kennedy Medal	For outstanding service to the profession or for noteworthy contributions to the science of engineering, or to the benefit of the EIC. EIC's most distinguished award.
Julian Smith Medal	For achievement in the development of Canada.
John B. Stirling Medal	For leadership and distinguished service at the national level within the EIC and/or its member societies.
CP Rail Engineering Medal	For leadership and service at the regional, branch and section levels by members of EIC member societies.
K.Y. Lo Medal	For significant engineering contributions at the international level, such as promotion of Canadian expertise overseas; training of foreign engineers; significant service to international engineering organizations; and advancement of engineering technology recognized internationally.
Fellowship of the EIC	For excellence in engineering and services to the profession and to society.
Honorary Member	For non-members of the EIC and its member societies, and on occasion non-engineers, who have achieved outstanding distinction through service to engineering and the profession of engineering in Canada.

de plus amples renseignements, communiquez avec le siège social de la SCG à :

La Société canadienne de géotechnique
8828 Pigott Road
Richmond, C.-B.
V7A 2C4, Canada
Télécopieur : 604-277-7529
Courriel: *cgs@cgs.ca*

Les noms des membres de la SCG qui ont déjà reçu des prix et des bourses de recherche de l'ICI sont affichés sur le site Web de la SCG à *www.cgs.ca/awards.php?lang=fr*.

Canadian Foundation for Geotechnique 2015 Michael Bozozuk National Graduate Scholarship

Dr. Dennis Becker, President of the **Canadian Foundation for Geotechnique** is pleased to announce the call for nominations for the 8th annual *Michael Bozozuk National Graduate Scholarship*.

The scholarship, valued at $5,000, was established by the Canadian Foundation for Geotechnique in 2007, on the occasion of the 60th Canadian Geotechnical Conference in Ottawa. The 2015 scholarship will be presented at the Canadian Geotechnical Conference, in Quebec City, QC this fall.

Any Canadian or permanent resident, entering or registered in a Canadian university Masters or PhD program that is directly related to an identified field of geotechnique, is eligible. Programs include geotechnical engineering, geological engineering, mining engineering, geoenvironmental engineering or geoenvironmental geoscience, engineering geology and hydrogeology. Nominees must have high academic standing and preference will be given to those who have some practical experience and are active, or show leadership, in the geotechnical community.

Nominations are limited to **one per academic department** and require a letter, accompanied by rationale, written **and signed** by the graduate supervisor. Rationale should include evidence of academic standing, research output, contributions to practice, and leadership/activity in the geotechnical community. A nomination package is limited to **five pages**. For award ceremony purposes, the nomination package should also include a digital image (300 dpi) of the nominee.

Nominations for the 2015 Scholarship will be accepted by the Canadian Geotechnical Society's Scholarship Selection Committee Chair, **Dr. Paul Simms** (c/o Carleton University, Department of Civil and Environmental Engineering, 1125 Colonel By Drive, Ottawa ON. K1S 5B6, telephone (613) 520 2600 ext. 2079, *paul_simms@carleton.ca*) up until **May 1, 2015**. If submitted by email, nominations **must be signed** by the supervisor and include the words "Canadian Foundation for Geotechnique National Graduate Scholarship" in the subject line.

For further information, refer to the Foundation's website *www.cfg-fcg.ca* or contact Dr. Dennis Becker, (403) 260 2253, *dennis_becker@golder.com*

Provided by Dennis Becker
President of the Canadian Foundation for Geotechnique

Bourse nationale pour études supérieures Michael Bozozuk 2015 de la Fondation canadienne de géotechnique

Le **Dr Dennis Becker**, président de la **Fondation canadienne de géotechnique**, est heureux de lancer un appel de candidatures pour la 8e édition de la *Bourse nationale pour études supérieures* qui est décernée annuellement.

D'une valeur de 5 000 $, la bourse a été établie par la Fondation canadienne de géotechnique en 2007, lors de la 60e conférence canadienne de géotechnique qui a eu lieu à Ottawa. La bourse de 2015 sera décernée lors de la prochaine conférence canadienne de géotechnique, qui aura lieu dans la ville de Québec, au Québec, cet automne.

Toute personne détenant la citoyenneté canadienne ou la résidence permanente au Canada, qui s'inscrira ou est inscrite dans un programme d'une université canadienne de maîtrise ou de doctorat directement lié à un domaine des géotechniques est admissible. Au nombre de ces programmes, mentionnons les géotechniques, le génie géologique, le génie minier, le génie géoenvironnemental ou la géoscience géoenvironnementale, la géologie de l'ingénieur et l'hydrogéologie. Les candidats doivent avoir des notes élevées. La préférence sera accordée à ceux qui ont de l'expérience pratique et sont actifs ou font preuve de leadership dans la communauté géotechnique.

Les candidatures sont limitées à **une par département**. Elles doivent être accompagnées d'une lettre et d'un exposé raisonné, rédigés **et signés** par le directeur de thèse. L'exposé raisonné devrait inclure des données sur les bonnes notes du candidat, ainsi qu'une description de ses résultats de recherche, de ses contributions à la pratique et de son leadership ou de ses activités dans la communauté géotechnique. Un dossier de candidature se limite à **cinq pages**. Aux fins de la cérémonie de remise, le dossier de candidature devrait aussi comprendre une image numérique (300 ppp) du candidat.

Les candidatures présentées pour la bourse de 2015 seront acceptées par le président du Comité de sélection de la bourse de la Société canadienne de géotechnique, le Dr Paul Simms (a.s. de : Université Carleton, Département de génie civil et environnemental, 1125, chemin Colonel By, Ottawa, ON K1S 5B6, téléphone 613-520-2600, poste 2079, *paul_simms@carleton.ca*) **jusqu'au 1er mai 2015**. Les dossiers de candidature envoyés par courriel **doivent être signés** par le directeur de thèse et comprendre la mention "Bourse nationale pour études supérieures de la Fondation canadienne de géotechnique" dans la ligne objet.

Pour plus de renseignements, consultez le site Web de la Fondation, à *www.cfg-fcg.ca*, ou communiquez avec le Dr Dennis Becker, au 403-260-2253 ou à *dennis_becker@golder.com*

Fourni par Dennis Becker, Président de la Fondation canadienne de géotechnique

Upcoming Conferences and Seminars

68th Canadian Geotechnical Conference
7th Canadian Permafrost Conference
September 20 – September 23, 2015, Québec City, Québec

The **Eastern Quebec Section** of the **Canadian Geotechnical Society and the Canadian National Committee for the International Permafrost Association (CNC-IPA)**, invite you to **GéoQuébec 2015**, for the joint

68th Canadian Geotechnical and 7th Canadian Permafrost Conference. The conference will be held from September 20 - 23, 2015 in the Convention Centre in Québec City, Québec. It will cover a wide range of topics, including speciality sessions that are of local and national relevance to the fields of geo-engineering, permafrost and engineering geology. In addition to the technical program and plenary sessions, the conference will include a complement of workshops, short courses, technical excursions and local tours.

The official languages for the conference will be English and French. The Convention Centre is located in the historic downtown area of Québec City, a UNESCO World Heritage Site, facing onto Québec's Parliament Hill. Old Québec City, which is the cradle of French civilization in North America, is best explored on foot and September is the best time of the year with a typically warm, dry weather and the maple trees just beginning to take on their colourful fall foliage.

The conference theme **Challenges from North to South**, reflects the diverse and complex challenges that the geotechnical, cold regions engineering and permafrost communities will need to address in order to support sustainable economic development. The Local Organizing Committee invites members from the Canadian and international communities to contribute papers on their recent research and advancements in geotechnical, geo-environmental and cold regions engineering, as well as permafrost science.

For more information regarding sessions, topics and the technical program, please visit the web site www.geoquebec2015.ca or contact **Jean Côté** (Conference Co-Chair - geotechnical) at jean.cote@geoquebec2015.ca or **Michel Allard** (Conference co-Chair - permafrost at michel.allard@geoquebec2015.ca. For geotechnical contributions, please contact **Didier Perret** (Technical Program co-Chair) at comtec_geot@geoquebec2015.ca and for permafrost and cold region engineering contributions, **Richard Fortier** (Technical Program co-Chair) at comtec_perg@geoquebec2015.ca.

68e conférence canadienne de géotechnique
7ième conférence canadienne sur le pergélisol
20 - 23 septembre 2015, Québec, Québec, Canada,

La Société canadienne de géotechnique (SCG), la Section régionale de l'Est-du-Québec de la Société canadienne de géotechnique et le Comité national canadien de l'Association internationale du pergélisol (CNC-AIP) vous invitent à participer à GéoQuébec 2015; il s'agit de la 68e conférence canadienne de géotechnique et de la 2e conférence conjointe SCG/CNC-AIP sur le pergélisol. Cet événement se déroulera au Centre des congrès à Québec (Québec), Canada, du 20 au 23 septembre 2015. Le thème de GéoQuébec 2015 – Des défis du Nord au Sud - reflète la diversité des défis complexes auxquels font face les spécialistes en géotechnique, en géotechnique des régions froides et en pergélisol pour assurer le développement durable des communautés canadiennes. Les langues officielles de la conférence sont le français et l'anglais. Le Centre des congrès se trouve à quelques pas du quartier historique de la ville de Québec, un joyau du patrimoine mondial de l'UNESCO, et fait face à la colline parlementaire de Québec. Le mois de septembre à Québec est le meilleur moment de l'année, avec une température clémente et des érables qui se parent de leur feuillage coloré.

Le Comité local d'organisation de la conférence invite les membres des communautés canadiennes et internationales en géotechnique, en géotechnique des régions froides et en pergélisol à contribuer à la conférence en soumettant les résultats de leurs travaux et découvertes dans ces domaines. La conférence couvrira un large spectre de thèmes incluant des séances spéciales d'intérêt local et national dans les domaines de spécialisation de la géo-ingénierie, du pergélisol et du génie géologique. En plus du programme technique et des séances plénières, la conférence comprendra des ateliers, des cours intensifs, des excursions techniques et des visites guidées.

Pour plus d'information sur les sessions, les sujets et le programme technique, visitez le site web *www.geoquebec2015.ca* ou contacter **Jean Côté,** Coprésident de la conférence (géotechnique) *jean.cote@geoquebec2015.ca*, **Michel Allard**, Coprésident de la conférence (pergélisol) *michel.allard@geoquebec2015.ca*. Pour les contributions en géotechnique, **Didier Perret**, Coprésident du programme technique *comtec_geot@geoquebec2015.ca.* Pour les contributions en géotechnique des régions froides et sur le pergélisol, **Richard Fortier,** Coprésident du programme technique *comtec_perg@geoquebec2015.ca*.

13th International Symposium on Rock Mechanics (ISRM Congress 2015) May 10 – 13, 2015, Montreal, Québec

The 13th International Congress on Rock Mechanics (ISRM Congress 2015) will be held in conjunction with the CIM Convention 2015 from May 10 to 13, 2015 in Montréal, QC. Over 1,000 international researchers, engineers and practitioners will explore **Innovations in Applied and Theoretical Rock Mechanics**. Ground-breaking information on topics from geophysics in rock mechanics to reservoir geomechanics will pepper the technical program.

Keynote speakers will include:

Dr. Erik Eberhardt, P.Eng. - *Transitioning from Open Pit to Underground Mining: Meeting the Rock Engineering Challenges of Going Deeper*

Yossef H. Hatzor, Ph.D. - *Discontinuous Deformation Analysis in Rock Mechanics Practice*

Jean Sulem - *Multiphysics Couplings and Stability of Fault Zones in the Area of Constitutive Modelling and Deformation Processes of Rocks*

Chris Massey - *The Performance of Rock Slopes During the 2010/11 Canterbury (New Zealand) Earthquake Sequence, and Beyond?*

Dr. Francois Malan - *Hard Rock Tabular Excavations: Historic Solutions and Future Challenges*

Dr. Alejo Oscar Sfriso - *Selecting Material Parameters for Advanced Constitutive Modelling, An Overview*

Professor Chungsik Yoo - *Use of Geosynthetics in Underground Works, Fundamentals*

MIT's **Hebert Einstein** will also chair a one-day **Shale Symposium** that is subdivided into four plenary sessions, one on *Shale in Hydrocarbon Extraction*, one on *Shale in Slopes*, one on *Shale in Tunnels and Mines* and finally a debate on *Shale is a Soft Rock and not a Hard Soil*.

A 450+ booth trade exhibition will be the first of its kind in Canada. This prestigious gathering of top business managers, engineers, consultants, procurement agents, researchers, academics and industry practitioners - in all specialty areas related to the mining industry - will also include the participation of renowned experts in the field of rock mechanics. Mining industry suppliers can seize this unique opportunity to stand face to face with thousands of International buyers and stakeholders.

The CIM Expo! is Canada's premier mining show, featuring the latest in mining equipment, tools, technologies and services. To make it even easier to find the partners and opportunities, a number of exhibitors will be grouped into regional and international pavilions.

This event is being organized by CARMA, CIM, ARMA, McGill University, Queen's University, and the University of Toronto. Registration is now open with early registration closing April 3, 2015. For more information please go to www.isrm2015.com.

Provided by Sam Proskin
Rock Mechanics Division Chair

Membership Registration for 2015

If you haven't already renewed, your Canadian Geotechnical Society membership is expiring! You are encouraged to visit the Canadian Geotechnical Society website at www.cgs.ca, to renew your membership for 2015 as soon as possible.

Membership benefits include:

- Online access to the electronic version of *the Canadian Geotechnical Journal* (published monthly) including all past issues;
- Member pricing for print subscriptions to the *Canadian Geotechnical Journal*;
- A complementary print subscription to *Geotechnical News* (four issues annually);
- Online member access only to past CGS conference electronic proceedings;
- Member pricing for the CGS-sponsored professional development opportunities, including the Society's popular Annual Conference, to be held in Quebec City in 2015;
- Preferred member information on CGS's spring and fall Cross Country Lecture Tour featuring recognized National and International speakers;
- Membership in one of CGS's technical divisions – Soil Mechanics and Foundations, Engineering Geology, Geoenvironmental, Rock Mechanics, Geosynthetics, Groundwater and Cold Regions;
- Complementary membership in the International Society related to your Division of choice, i.e., ISSMGE, IAEG, ISRM, IGS or IPA. Additional memberships at preferred second society member pricing (CSCE, IAH, NAGS, etc.);
- Access to information from CGS's technical committees – Professional Practice, Education, Landslides, Transportation Geotechnique, Heritage, Sustainability Geotechnics and Mining Geotechnique.

We welcome all new and renewing members and look forward to your participation in 2015. We are planning several new programs this year and encourage you to recommend a friend or colleague to join the Canadian Geotechnical Society so that we can continue to improve upon the benefits the Society offers our profession.

Members in the News

Michel Aubertin, PhD, ing, FCSCE, FEIC, FCAE CGS Executive Director/ Directeur général de la SCG

Michel Aubertin.

On January 1, 2015, **Dr. Michel Aubertin** became the Canadian Geotechnical Society's Executive Director, succeeding previous Secretary Generals **Dr. Victor Sowa** (2007-2014), **Dr. Jim Graham** (1998-2006) and **Mr. Tony Stermac** (1987-1997).

Dr Aubertin obtained his BSc in Civil Engineering from the Université de Sherbrooke (1979), a MScA in Geotechnique (1982) and a PhD in Geomechanics (1989) from École Polytechnique de Montréal. After a few years of consulting, he joined the Department of Applied Sciences at the Université du Québec en Abitibi-Témiscamingue (UQAT) in 1984; he then became the first Director of the Unité de recherche et de service en technologie minérale (URSTM.com). Dr. Aubertin joined École Polytechnique de Montréal in 1989 and became a full Professor in 1996. From 1994 to 1999, he was responsible for the undergraduate program in mining engineering - a bilingual co-operative program, jointly offered with McGill University.

Throughout his academic career, Dr. Aubertin has maintained an extensive research program in a wide variety of geotechnical topics including the geomechanical behaviour of rock and rock masses, analysis of underground backfilled slopes, unsaturated water flow in and around waste disposal sites, design of covers to control acid mine drainage, environmental management of mining wastes and reclamation of mine sites. He has supervised or co-supervised, more than 100 graduate students, including 28 PhD candidates and 12 post-doctoral fellows. He has authored approximately 230 refereed papers and 100 technical reports and articles and held the Industrial NSERC Polytechnique-UQAT Chair on Environment and Mine Wastes Management (2001 - 2012). Since 2013, he has been the Scientific Director of the Research Institute on Mines and the Environment (RIME UQAT-Polytechnique) at École Polytechnique.

Dr. Aubertin has been involved with the Canadian Geotechnical Society since becoming a member in 1980. He co-edited with his colleague **R.P. Chapuis**, the Proceedings of the 1st Canadian Conference on Environmental Geotechnics in 1991. He served on the Executive and as Chair of the Rock Mechanics Division from 1992 to1995, VP Finance from 1997 to 1998, Chair of the Geotechnical Research Board from 2004 to 2008, and President of CGS from 2009 to 2010. Most recently, he was a founding member and the first Chair of the CGS Mining Geotechnique Technical Committee from 2012 to 2014. In every instance, Dr. Aubertin's leadership has moved the CGS forward in many ways.

Dr. Aubertin has also been involved with many other professional organizations and technical, review and editorial boards, including five years as Associate Editor of the Canadian Geotechnical Journal. In 2013, he was invited by the Canadian Council of Academies to join the Expert Panel on "The Potential for New and Emerging Technologies to Reduce the Environmental Impacts of Oil Sands Development".

Dr. Aubertin is the recipient of nine teaching awards, numerous research and professional service awards and three CGS awards. He has presented many invited lectures including the 2008 CGS Cross Canada Lecture Tour and the RM Hardy Address in 2013. Dr. Aubertin is a Fellow of the Canadian Society for Civil Engineers(1999), Engineering Institute of Canada (2003) and Canadian Academy of Engineering (2003).

Michel Aubertin, PhD, ing, FCSCE, FEIC, FCAE CGS Executive Director/ Directeur général de la SCG

Le 1er janvier 2015, **Dr Michel Aubertin** est devenu le Directeur général de la Société canadienne de geotechnique (SCG); il succède ainsi à ceux qui ont précédemment occupé le poste de Secrétaire ou Directeur général, **Dr Victor Sowa** (2007-2014), **Dr Jim Graham** (1998-2006) et **M. Tony Stermac** (1987-1997).

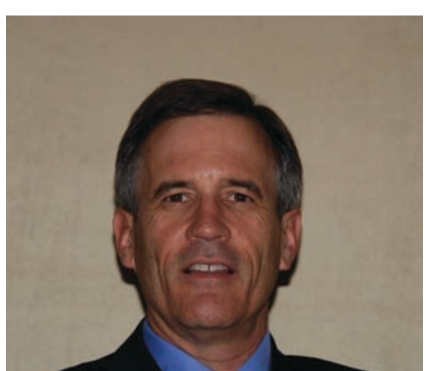
Michel Aubertin au obtenu un B.Sc.A. en génie civil de l'Université de Sherbrooke (1979), ainsi qu'une maîtrise en géotechnique (1982) et un doctorat en géomécanique (1989) de l'École Polytechnique de Montréal. Après quelques années dans une firme de consultants, il a joint en 1984 le Département des sciences appliquées de l'Université du Québec en Abitibi-Témiscamingue (UQAT); il a aussi été directeur de l'Unité de recherche et de service en technologie minérale (URSTM.com). Dr Aubertin a débuté à l'École Polytechnique en 1989 et il est devenu professeur titulaire en 1996. De 1994 à 1999, il a été responsable du programme coopératif et bilingue en génie des mines, offert conjointement avec l'université McGill.

Tout au long de sa carrière académique, Dr Aubertin a mené un programme de recherche diversifié touchant plusieurs sujets liés à la geotechnique, incluant des travaux sur le comportement géomécanique des roches et des massifs rocheux, l'analyse des chantiers miniers remblayés, les écoulements d'eau en conditions non saturées autour des sites de stockage, la conception des couvertures pour le contrôle du drainage minier acide, la gestion environnementale des rejets produits par les mines et la restauration des sites miniers. Il a supervisé ou co-supervisé plus de 100 étudiants gradués, dont 28 candidats au doctorat et 12 chercheurs postdoctoraux. Il est l'auteur d'environ 230 papiers de revue et de conférence, et d'une centaine d'articles et rapports techniques. Il a été titulaire de la Chaire industrielle CRSNG Polytechnique-UQAT en Environnement et gestion des rejets miniers (2001-2012); depuis 2013, il est le Directeur scientifique de l'Institut de recherche sur les mines et l'environnement (IRME UQAT-Polytechnique) à l'École Polytechnique.

Michel Aubertin participe aux activités de la Société canadienne de geotechnique depuis qu'il en est devenu membre en 1980. Par exemple, il été coéditeur (avec son collègue **R.P. Chapuis**) des Comptes rendus de la première conférence canadienne de géotechnique environnementale (1991). Il a été membre de l'exécutif puis directeur de la division de mécanique des roches (1992-1995), VP Finance de la SCG (1997-1998), Directeur du Conseil de recherche en geotechnique (2004-2008) et Président de la Société (2009-2010); plus récemment, il a été l'un des membres fondateurs et le premier directeur du comité technique sur la géotechnique minière (2012-2014). Les initiatives du Dr Aubertin ont permis à la SCG de progresser de diverses façons.

En parallèle, Dr Aubertin collabore également avec plusieurs autres organisations professionnelles et comités techniques, incluant un mandat de cinq ans comme Éditeur associé pour la Revue canadienne de géotechnique. En 2013, il a été invité par le Conseil des académies canadiennes à participer à un panel d'expert qui se penche sur les technologies visant à réduire les impacts environnementaux liés au développement des sables bitumineux.

Au cours de sa carrière, le Prof. Aubertin a reçu neuf prix pour son enseignement et plusieurs distinctions pour ses travaux de recherche et services professionnels, incluant 3 prix de la SCG. Il a été invité à présenter plusieurs allocutions tel la Tournée pancanadienne de la Société canadienne de geotechnique (CCLT, 2008) et le RM Hardy Address (2013). Michel Aubertin a reçu le titre de Fellow de la Société canadienne de génie civil (1999), de l'Institut canadien des ingénieurs (2003), et de l'Académie canadienne du génie (2003).



Dr. Paulo Branco.

Dr. Paulo Branco 2014 Southern Ontario Section Award Recipient

Dr. Paulo Branco, P.Eng., Senior Principal of Thurber Engineering Ltd. Oakville office, was presented the Canadian Geotechnical Society - Southern Ontario Section Award at their holiday season meeting on December 3, 2014 at the Pearson Centre in Mississauga, Ontario. The award recognizes CGS-SOS members for significant contributions to the local group and to the advancement of geotechnical engineering. Paulo's award is well-deserved. Amongst his many other contributions, he has served as Secretary, then Chair of the CGS-SOS and then the local section's Regional Director on the National CGS committee. Paulo has also made many contributions to the development of the Foundations Section of the Canadian Highway Bridge Design Code during his many years service as a committee member. He has also served as Secretary, Program Chairman and Chairman of the Tunnelling Association of Canada, Alberta Chapter between 1991 and 1996.

Over his 35 years career in geotechnical practice in Brazil and Canada, Paulo has specialized in geotechnical design of tunnels in both transportation and municipal applications and is recognized as an expert in this field. As part of this work for transit and utility tunnels, he has worked extensively in assessment and mitigation of potential damage to structures and utilities in the vicinity of tunnels. Other areas of his expertise encompass design of embankments and structures constructed on soft clay foundations including the design of mitigation measures to maintain stability and to limit settlement to acceptable levels and the use of numerical models and their validation with field monitoring.

Provided by David Home, Southern Ontario Section (SOS)

Heritage Committee

Canadian Geotechnical Society Virtual Archives

There are rich but rarely used resources in Canada that consist of files containing historical information on geotechnical laboratory and field research, geotechnical investigations, work of committees and geotechnical expertise. Ways to identify and use these resources have been developed by the Heritage Committee of the Canadian Geotechnical Society in the form of virtual archives on the CGS web site, where the location and content of accessible historical geotechnical material are given.

CGS members and others are invited to submit candidate material for consideration. The submission should give the location of the material, a description of its nature and content, its historical significance and the conditions under which it can be accessed. Do not submit physical archival material as the Society has no space to store it, however electronic copies of photographs or materials are welcome.

Your contribution to the CGS Virtual Archives web page should be sent to the Chair of the Heritage Committee, **J. Suzanne Powell**, P.Eng. at *spowell@thurber.ca*

History of Local Sections of the Canadian Geotechnical Society

The Heritage Committee believes that the history of the local sections of the Canadian Geotechnical Society to be valuable part of the Society and its members. The CGS Heritage Committee would like to assemble if at all possible, a collection of historical summaries of all the sections. Hopefully every local section of the CGS will take the time to gather their archives and write their own history.

Please contact the Chair of the CGS Heritage Committee, **J. Suzanne Powell**, at *spowell@thurber.ca* if you have any questions.

Archives in Geotechnical Engineering Practice

Archives are important to geotechnical engineering undertakings, beginning with design, construction, post-construction performance and as-built records. Also included may be technical literature on geology, hydrogeology, seismicity, climate, environment, scientific research and relevant case histories. The data which are to be consolidated into reports often originates with a diverse group of consultants, with the information required by the owner, designer, contractor, regulatory authorities, insurers, financial organizations and review boards. So the effective cataloguing and storage of archival data for ready access in usable forms is now a significant concern along with the increasing reliance on digital media for this purpose. The merits of maintaining good archives is discussed in a paper prepared by **M.A.B. Shelbourn** and **M.A.J. (Fred) Matich** for the CGS 2013 Conference in Montreal which CGS members can view at *http://members.cgs.ca/documents/conference2013/cgs2013/pdfs/GeoMon2013Paper661.pdf*

Submitted by Dr. Mustapha Zergon
Past Chair of CGS Heritage Committee

2015 Board of Directors, Committee Chairs, other Positions and Headquarters / Membres du Conseil D'administration et du Personnel du Siège Social, Présidents des Comités et Personnes Occupant d'autres Postes En 2015

(Additional information for the various positions shown below is located on the CGS website at **www.cgs.ca**).

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Introduction by John Dunnicliff, Editor

This is the 81st episode of GIN.

The importance of Step 2 in the Systematic Approach to Planning Monitoring Programs

Those of you who are familiar with my frequent sermons on planning (e.g. red book Chapter 4) will be aware of my Step 2: "Predict Mechanisms that Control Behavior".

The article by Francesca Bozzano elaborates on and extends the importance of this by showing, with two case history examples, that:

> "A general inverse relationship exists between the level of understanding about the ongoing geological/geotechnical process and the complexity (and cost) of an efficient monitoring system. Said another way – the more we understand the process, the less is the complexity and cost of the monitoring system."

A very important message – we should do intensive homework at the beginning of the planning process!

More on fully-grouted piezometers

The article by D'Hollander et al adds to our confidence level for using the fully-grouted method. Site specific solutions were developed to address the challenges of installing the piezometers in a flowing stream with continuous readings obtained in all weather and stream conditions.

Having published several articles in GIN on this subject during the past 13 years (see the next section), I'll now go on hold, and encourage you to transfer your attention to interacting with Gord McKenna, as in the next section.

Fully-grouted piezometers. We need your stories and insights.

Fully-grouted piezometers appeared briefly on the stage in 1969 with Peter Vaughan's paper in Geotechnique, but didn't gain traction until much later. Since then, the method of installing diaphragm-type piezometer tips by simply grouting them in (with no sand pack) seems to have gained fairly widespread popularity. The technique has been supported by the following key publications:

- McKenna, G.T., 1995, "Grouted-in installation of piezometers in boreholes". Canadian Geotechnical Journal, Volume 32, pp.355-363.
- Mikkelsen, P.E., 2002, "Cement-bentonite grout backfill for borehole installations". Geotechnical News, December.
- Contreras, I.A., Grosser, A.T., Ver Strate, R.H., 2008, "The use of the fully-grouted method for piezometer installation". Geotechnical News, June.
- Durham Geo Slope Indicator (DGSI), 2009. "Grout Mixes for Piezometers". http://www.slopeindicator.com/support/piezometers/technote-groutmix-piezometers.php
- Contreras, I.A., Grosser, A.T., Ver-Strate, R.H., 2012, "Update of the fully-grouted method for piezometer installation". Geotechnical News, June.

and again in this episode of GIN (D'Hollander et al), but with a few warnings. Some practitioners enjoy the ease and speed of installation of fully-grouted piezometers while others choose conventional techniques every time.

You now have a chance to share war stories on how the method has been working for YOU: your successes and failures. There's major evidence of success in some parts of the world (for example, in the West Coast of USA, where it has become accepted practice) but concerns remain. There is field evidence of poor sealing, e.g.

- For those who have poor cement-bentonite grout mixes, who add bentonite to the water first instead of cement, or who use a pre-determined quantity of bentonite rather than adding enough to achieve a consistency of thick cream or pancake batter (details of how to do this are in Mikkelsen (2002).
- The few who forget to add the bentonite.

<u>So, please send us your fully-grouted piezometer stories:</u>

- Your anecdotes, improvements, failures, fears and insights.
- Vaughan made calculations to show that the grout could be 2 orders of magnitude **more** permeable than the formation for a good seal. Contreras et al (2008) did numerical analysis to prove that the grout could indeed be 3 orders of magnitude **more** permeable to seal effectively. Do you accept this latter recommendation and use it in your practice? Or do you favor different permeability criteria?
- Are you using this method? If yes, why? If not, why not?
- Do you place the filter up or down? Proponents of "up" claim that this prevents de-saturation during installation.
- Do you surround the tip with a tiny sand sock? Proponents claim that this prevents grout from plugging the filter.
- Are we ready to declare the fully-grouted method as mainstream?
- And if so, subject to what provisions?

Gord McKenna of BGC Engineering Inc., Vancouver has volunteered to assemble your contributions for a future GIN. Please drop him a line as soon as possible by e-mail (GMcKenna@bgcengineering.ca), cc to me (john@dunnicliff.eclipse.co.uk), and let him know if you have anything to contribute. If yes, please follow that up with **brief and crisp** information by **June 30, 2015**. If there is enough information, perhaps a journal article afterwards.

Second International Course on Geotechnical and Structural Monitoring in Italy, June 4-6, 2015

Tenth century Poppi Castle.

We've now confirmed that the course will be held at the same location as last time – in Poppi castle. Poppi is considered one of the most beautiful towns in Tuscany with the spectacular tenth-century castle of the Guidi Counts situated on the hilltop that dominates the surrounding countryside. There will be a much larger exhibition area than last time.

Details are on *www.geotechnicalmonitoring.com*, together with the course schedule and registration information. The list of 14 speakers includes **John Burland** of Imperial College London, **Michele Jamiolkowski** of Technical University of Turin (both of whom were leaders on the International Committee for the Safeguard of the Leaning Tower of Pisa), and **Elmo DiBiagio** of Norwegian Geotechnical Institute.

Several pre- and post-course leisure activities are being planned, and during the course various activities will also be available for accompanying persons. See www.geotechnicalmonitoring.com/en/leisure for details.

Corporate updates

Several manufacturers of geotechnical instruments are now owned by Nova Metrix LLC, Woburn, MA (www.nova-metrix.com). These include Durham Geo Slope Indicator (USA, www.slopeindicator.com), Roctest (Canada, www.roctest.com), Telemac (France, www.telemac.fr), Interfels (Germany, www.interfels.com), Smartec (Switzerland, www.smartec.ch) and Soil Instruments (England, www.soil.co.uk).

Sherborne (England, www.sherbornesensors.com) manufactures sensors that are used in geotechnical and structural applications, is also owned by Nova Metrix.

Both Interfels and Soil Instruments had been part of itmsoil (England), which remains in business as ITM Monitoring Ltd (www.itmmonitoring.com) to provide monitoring services but not manufacturing. ITM Monitoring Ltd is owned by Rcapital, a private investment business in London (www.rcapital.co.uk).

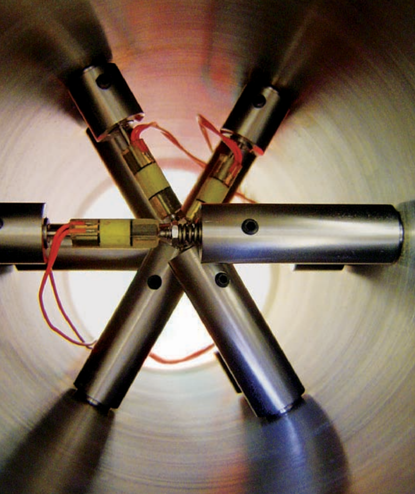
The USA arm of itmsoil is now Specto Technology (www.spectotechnology.com), an independent company providing hardware and software from a variety of manufacturers, with a focus on delivering wireless monitoring solutions.

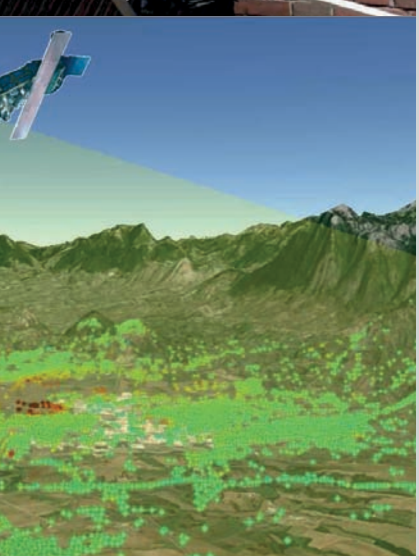
U.S. mid-market private equity firm Hammond Kennedy Whitney & Co, Indianapolis (www.hkwinc.com) has recently bought a majority interest in RST Instruments Ltd. (www.rstinstruments.com). RST management remain substantial shareholders.

Closure

Please send an abstract of an article for GIN to *john@dunnicliff.eclipse.co.uk* —see the guidelines on *www.geotechnicalnews.com/instrumentation_news.php*

Apki Lambi Umar Ke Liye! (Hindi)






Lesson learned from two case histories about the planning of integrated monitoring systems

Francesca Bozzano

The primary lesson

During the past eight years as an engineering geologist on a research team studying geological risks, I have made use of integrated systems to monitor and manage ongoing instability processes. These have included landslides and ground subsidence. In our monitoring systems, contact instruments and remote techniques have been used for monitoring.

This article presents the primary lesson learned from two case histories: that a general inverse relationship exists between the level of understanding about the ongoing geological/geotechnical process and the complexity (and cost) of an efficient monitoring system. Said another way – the more we understand the process, the less is the complexity and cost of the monitoring system. In Figure 1, our understanding of ongoing process is shown at the left, in which the scale indicates low-level (L), medium-level (M) and high-level (H) of understanding. The complexity (and cost) of the corresponding planned monitoring system is shown at the right.

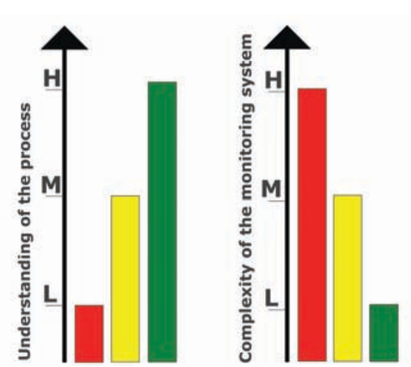


Figure 1. Sketch of the relationships between the level of understanding for an ongoing process and the complexity (and cost) of the monitoring system.

The red bars represent case histories characterised by an *a priori* low-level understanding, for which a highly complex and integrated monitoring system must be planned and executed to close the information gap. The green bars represent case histories characterised by an *a priori* high-level understanding, for which a simple and integrated monitoring system can perform well.

Based on the lesson summarised in Figure 1, efforts should be placed on acquiring and organising qualitative and quantitative information about a specific process in firm reconstructions using an approach that is largely used in engineering geology. This approach, which is known as the geological model, is a very good planning tool for efficient monitoring systems.

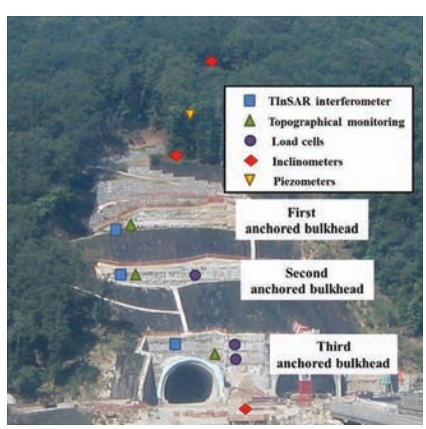


Figure 2. Photograph of the slope, which shows the three anchored bulkheads and the location of the monitoring instrumentation. The symbols for TInSAR monitoring and topographical monitoring indicate that they specifically observe the bulkheads.

In the next section, two opposite case histories are described: the first case history is representative of a low-level *a priori* understanding of an ongoing process; the second case history is representative of a high-level *a priori* understanding of an ongoing process.

Case history 1

The first case concerns an unstable slope that delayed the construction of tunnels along a highway in southern Italy. In February 2007, the tunnel entrances were destroyed by an unexpected translational landslide when the length of the excavated tunnel was approximately 12m. The volume of the landslide was approximately 10,000m^3, which included metamorphic rock debris from the adjacent steep slope. At that time, the tunnel alignment could not be changed and stabilisation of the landslide was imperative.

Geological and geomorphological surveys enabled us to discover that the landslide was embedded in an older and larger and deeper quiescent/inactive rotational landslide with a volume of approximately 1,000,000m^3. The 2007 shallow landslide was located at the toe of the older and larger landslide, and was triggered by the tunnel excavation.

In the following months, three bulkheads (Figure 2) anchored using 30m long tiebacks were placed along the slope to stabilise the shallow part of it. An integrated monitoring system was planned by considering uncertainties in the volume of the ongoing instability process, i.e., small instabilities in the shallow section of a quiescent

Figure 3. Photograph of the valley in which the landslide occurred. The slope involved in the instability (right); the location of the terrestrial interferometer (left). A sketch of the area covered by the TInSAR monitoring is superimposed.

large landslide body or its deep remobilisation? What is the range of the expected displacement velocity? The object to be monitored was not clearly defined, and the monitoring system was multi-purpose and complex.

The monitoring system consisted of:

- Probe inclinometers, for which readings were collected either every week or fifteen days.
- Observation wells and open standpipe piezometers, for which readings were collected every week or fifteen days.
- Electrical resistance load cells installed at the head of some of the tiebacks.
- Topographical monitoring of the three bulkheads by a total station (Figure 2).
- In addition, the slope was monitored by a terrestrial interferometer (TInSAR) located in front of the landslide slope on the opposite side of the valley at a distance of approximately 900m (Figure 3). Interferometric images were acquired every five minutes.
- Hourly rainfall data and daily photographs were also recorded.

TInSAR monitoring was performed by our research team, whereas other companies were responsible for the remaining instrumentation. Our task was to collect all available data and assist with managing the ongoing stabilisation projects and tunnel excavation.

During the six-year monitoring period, many secondary instability events were recorded, such as the occurrence of shallow and small landslides in different sections of the slope, the movement of excavation debris along the slope (triggered by rainfall), the failure of a metallic wall on short piles (installed to protect the downslope trail from excavation debris), and the gravitational settling of gabions located in the upper portion of the slope.

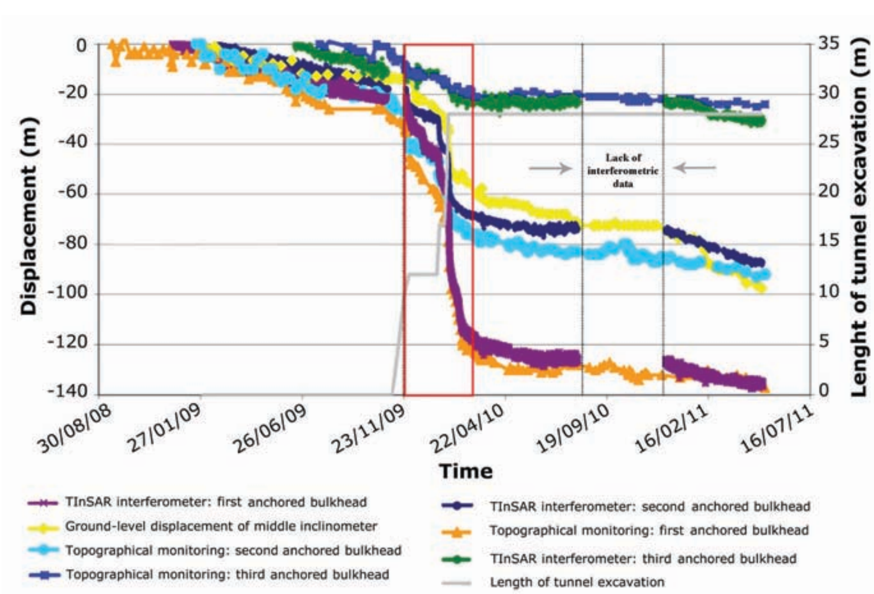


Figure 4. Displacement (left y-axis) and the tunnel excavation length (right y-axis) vs. time monitored using different techniques.

The main recorded event was the reactivation of the larger landslide from late 2009 to early 2010, when the tunnel excavation restarted after completing the remedial projects. All instrumentation recorded the crisis (red rectangle in Figure 4) triggered by the excavation. However, only by the continuous monitoring using terrestrial interferometry the tunnel projects was stopped when a displacement velocity of approximately 1 mm per hour was determined for the first anchored bulkhead.

This complex, redundant and expensive integrated monitoring platform, which was planned due to uncertainties experienced by the *a priori* geological model, performed well, which is indicated by the red bars in Figure 1.

If a well-constrained and calibrated numerical stress-strain model of the slope had been done in order to simulate the effects of the excavation of the tunnel on the stability of the quiescent large landslide, attention would have been concentrated on it. In that case the monitoring would have consisted mainly of continuously recording in-place inclinometers.

Case history 2

This case concerns another category of geological risks: subsidence. The involved area (30 km^2) is located in central Italy, about 30km east of downtown Rome. This area has become intensively urbanised over the decades. In certain small sections, subsidence has caused extensive damage to buildings and infrastuctures. A large quarry basin containing travertine (a sedimentary rock, formed by the precipitation of carbonate minerals from solution in ground and surface waters, and/or geothermally heated hot-springs. It is used as building material) is located within this area;

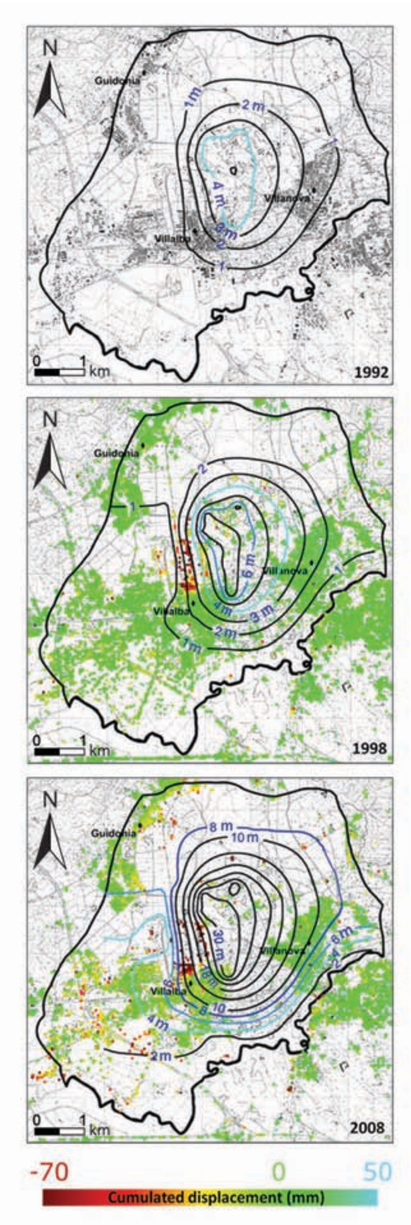


Figure 5. Groundwater depression cone in 1992, 1998 and 2008 reconstructed using a numerical model calibrated on a large piezometric dataset. The black lines represent iso-lowering lines with respect to the groundwater level in 1954. The estimated total displacement (coloured symbols) since 1992 based on the A-DInSAR technique is superimposed on the 1998 and 2008 maps.

the volume of extracted travertine has substantially increased over the last thirty years. The travertine hosts an aquifer; therefore, the consequent mining of travertine includes groundwater drainage. In 2008, the flow rate of this drainage system was approximately $4m^3$/sec.

In certain parts of the area travertine is outcropping, whereas highly compressible soils (fine-grained deposits with organic matter and soil-travertine mixed deposits) overlay travertine in other areas. The thickness of the compressible deposits range between tens of centimetres to tens of metres. These deposits are hydraulically connected to the travertine-hosted aquifer.

In designing a distributed monitoring system to monitor the evolution of subsidence in this region, we first attempted to develop a comprehensive understanding of the ongoing geological/geotechnical process. A large database of existing geological, geotechnical and hydrogeological information was created. The temporal evolution of the ground displacement from 1992 to 2010 was determined using SAR satellite images (ERS and ENVISAT satellites provided by the ESA (European Space Agency)) with the advanced-differential interferometric synthetic aperture radar (A-DInSAR) technique. A hydrogeological model that was calibrated and validated using long-term piezometric data was utilised to reproduce the groundwater drawdown in the studied area.

All collected information was processed and combined (see Figures 5 and 6). Groundwater drawdown was the primary cause of the recorded subsidence, in which the thicknesses of the compressible deposits primarily controlled the extent of subsidence. Throughout the investigated area, the onset of subsidence was strictly related to the groundwater cone depression, whereas the amount of ground displacement was related to the thicknesses of the compressible deposits (Figure 6).

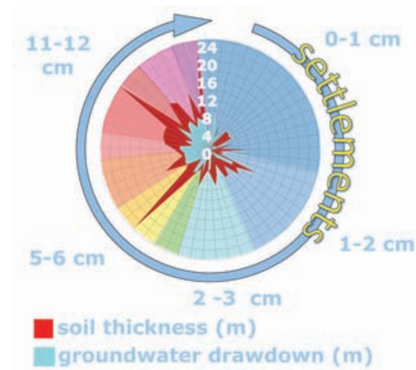


Figure 6. Plot showing the interpretation of the subsidence process. 97 small areas ($50m^2$) are selected as geologically representative. Each one is represented by a circular sector in the graph and ordered clockwise with respect to the settlement measured from 1992 to 2008. The over layered red and blue rose diagrams (the labels in m are along the NS radius) respectively indicate the thickness and ground water lowering for each areal parcel. In this plot it is possible to directly compare the intensity of the predisposing (thickness) and triggering (water lowering) factors with the induced effect (settlement).

Additional useful information was obtained from a monitoring test that spanned one year and was performed in a representative area. For this purpose, an open standpipe piezometer monitored the groundwater in the travertine, a multipoint electrical resistance piezometer recorded pore water pressure in the overlaying compressible deposits and in the travertine and a borehole equipped with a probe magnetic extensometer was used to monitor settlements. A significant relationship was inferred from the collected data, i.e., subsidence occurs when the groundwater level decreases, whereas uplift occurs when the groundwater level increases. A negligible time-delay between the decreased groundwater level and subsidence was observed.

All information provided here constitutes a robust geological model of the area and the ongoing subsidence. To control the evolution of subsidence where vulnerable buildings or lifelines are in the vicinity of susceptible soils, monitoring the subsoil pore water pressure is sufficient (green bars in Figure 1).

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The use of fully-grouted piezometers in a streambed

Raymond D'Hollander, Paul Roth, Shane Blauvelt, James O'Loughlin

The site is a stream located in the northeastern United States with contaminated sediments in the channel bed. Data regarding both vertical hydraulic gradients and absolute piezometric pressures were required during remedial design to evaluate stability of the bed and banks for an excavation scenario and for use in modeling a potential chemical isolation cap.

Selection of fully-grouted method of piezometer installation

Available data during the pre-design planning indicated that the stream water surface and adjacent groundwater elevations are variable with a typical annual range of about 1 m. The groundwater data indicated the potential for significant upward gradients and for some of the groundwater to be saline. The water depth above the proposed piezometer locations was typically about 1 to 3 m. Shearing by ice, debris, and high flows as well as the potential for artesian groundwater made an open standpipe piezometer impracticable for measurements performed over an extended period.

Vibrating wire piezometers with onshore data acquisition systems were selected for measuring the groundwater pressures in the streambed. It was desirable to position the top piezometer in the creek at about the expected post-remediation sediment surface to evaluate the piezometric pressure and gradient likely at that point. This position ranged from 0.6 m to 1.8 m below the sediment surface. The shallow depth of these piezometer raised concerns with the effectiveness of conventional bentonite seals, particularly given the potential for erosion in the stream bed. Also, access to the locations was difficult and the ability to install the two piezometers quickly in the same borehole was desirable. Based on these considerations, the fully-grouted method was selected for installing the piezometers in the creek, as described in McKenna (1995) and Contreras et al. (2008).

Stream cross-section instrumentation

Instrumentation cross-sections were installed at six locations along the stream. Each instrumentation cross-section included two vibrating wire piezometers in the channel, a stilling well, and two open standpipe piezometers installed at the top of the bank, as shown on Figure 1. The fully-grouted piezometers in the channel were installed in vertical pairs with the bottom piezometer approximately 2.1 m to 3.3 m below the top piezometer. The on-shore standpipe piezometers were installed so that the top piezometer was located near the groundwater surface and the deeper piezometer at about the elevation of the bottom piezometer in the channel pair. Due to the potential for saline groundwater, bentonite seals for the standpipe piezometers were installed using bentonite pre-hydrated with fresh water and then tremied into the borehole.

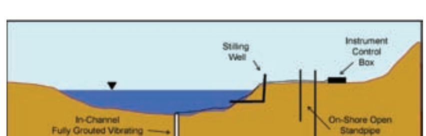

Figure 1. Typical instrumentation cross-section.

Fully-grouted piezometer installation

Drilling

The fully-grouted piezometers were installed in the center of the channel using a CME 45C drill rig on a segmented barge, as shown in Figure 2. The barge was disassembled and reassembled between some of the cross-sections due to the presence of low bridges. The borings were advanced using mud rotary and casing.

Piezometer and tremie pipe assembly

Unvented vibrating wire piezometers with a range of 0.2 MPa were used. They were taped to the Schedule 40, 19-mm diameter PVC threaded pipe used to tremie the grout, as shown in Figure 3. Depending on the water depth, the top pipe length was 1.5 m or 3 m to allow for a convenient stick up out of the water for grouting; this top length was unscrewed after grouting so that the finished top of the pipe was below the sediment surface. The total pipe length was measured to fit the finished depth of the borehole, so that the pipe would rest on the borehole

Figure 2. Drill rig on barge.

bottom to prevent vertical movement of the piezometers before the grout set. The top of the tremie pipe was surveyed after grouting to provide an accurate location and elevation.

Grouting

Portland cement, water, and sodium bentonite powder were blended with a cement to water ratio by weight of 1:2.5, per DGSI (2009). The cement and water were mixed first, with bentonite blended in afterwards as required to achieve a consistency suitable for tremie pumping. A hose was connected to the tremie pipe and the grout pumped in as the drill casing was slowly removed.

Figure 3. Installation of vibrating wire piezometer and tremie pipe.

Cabling and data collection

The cables from the vibrating wire piezometers were threaded through galvanized steel pipes for protection and weight and then laid on the channel bottom to the bank as shown in Figure 4. A data acquisition system was installed in a steel job box as shown in Figure 5. The job box was weighted with concrete blocks and padlocked to discourage theft. The data acquisition system was programmed to take readings at 15-minute intervals to provide adequate data during storm events, which typically cause the creek elevation to peak in 3 to 6 hours. The stilling wells and on-shore standpipe piezometers were monitored using vented water level loggers, also programmed to collect readings every 15 minutes.

Evaluation of in situ hydraulic conductivity

The on-shore open standpipe piezometers in each cross-section were tested using falling and rising head tests. These tests showed that the soils around these piezometers have hydraulic conductivities that range from 3 x 10^{-5} cm/s to 2 x 10^{-2} cm/s, with most between 5x10^{-4} cm/s to 2x10^{-3} cm/s. Grain-size analyses of the materials obtained during the drilling of the in-stream piezometers indicated that the creek sediments in which the fully-grouted piezometers were bedded would also likely be in this range. Since we expected that the grout mix permeability would be about 1x10^{-6} cm/s, we determined that the fully-grouted piezometers should provide accurate readings with good response times. The research of Contreras et al (2102) confirms that this assumption was appropriate.

Figure 4. Stilling well and pipe protection of cables.

Data analysis

Barometric pressure measurements were obtained from a local meteorological station and used in the calculation of the piezometric pressures measured by the unvented vibrating wire piezometers. This permitted direct comparison of the piezometric data between the fully-grouted piezometers and the vented water level loggers in the standpipe piezometers and stilling wells. Contreras et al. (2012) provide a good discussion on the importance of incorporating barometric measurements into vibrating wire piezometer measurements.

Only one fully-grouted piezometer of the 12 installed showed anomalous results. A bottom piezometer had significantly higher piezometric pressures than the on-shore piezometer at about the same elevation, and it showed an upward hydraulic gradient greater than 1. The boring log for the vibrating wire piezometer installation indicated a 0.1 m layer of running sand, and water inflow was observed during drilling at the installed elevation. We were unable to determine if the anomalous readings were a real local phenomenon, or simply an instrumentation error. During design of the stream remedy, neither interpretation created a challenge so the issue could remain unresolved.

Figure 5. On-shore monitoring location and on-shore open standpipe piezometers.

Summary and conclusion

An accurate picture of the seasonal hydrogeologic interactions between stream sediments, stream water surface, and bank groundwater was developed using fully-grouted piezometers in conjunction with conventional on-shore standpipe piezometers and stilling wells. The fully-grouted piezometers provided valuable, reliable data at relatively low cost and installation time compared to traditional piezometer installation methods. The ability to do on-shore data acquisition of continuous readings allowed for inexpensive monitoring. Upward vertical gradients ranging from 0.05 to 0.6 were measured within the stream bottom, with one exception as discussed above. Site specific solutions were developed to address the specific challenges of installing the piezometers in a flowing stream with continuous readings obtained in all weather and stream conditions.

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Paolo Gazzarrinni

Overture

38th episode of the Grout Line and for this issue the annual reminder, for anyone interested, that the Grouting Fundamentals Course at the Colorado School of Mines in Golden, this year will be held June 22-26, 2015.

For this issue a couple of articles; first, hot off the presses, from Kathleen Bensko, P.G., Geologist, Risk Management Center, Institute for Water Resources, U.S. Army Corps of Engineers Pittsburgh, PA (Kathleen.Bensko@usace.army.mil), and second a short note/reminder about jet grouting spoil, from me.

Kathleen sent me the following article related to the new publication of the revised Grouting Technology Engineering and Design Manual. As explained in Kathleen's presentation/article, the manual, at the time of preparing this issue for its publication (January), is in its final review, but, probably in March, when Geotechnical News is published the manual will be available on line at the address below. Stay tuned to the USACE's webpage!

I didn't have the possibility to read in detail the manual (only.... more than 500 pages!) and I will comment on it in the future. Of course I will have something to say! If you have any comments, for discussion, please send me your thoughts.

The U. S. Army Corps of Engineers prepares to roll out the Revised EM 1110-2-3506 Grouting Technology Engineering and Design Manual

The U. S. Army Corps of Engineers (USACE) is proud to announce the soon-to-be released version of the revised *Grouting Technology* Engineering and Design Manual. The document is currently in the final draft form and is undergoing circulation at Headquarters (HQUSACE) for signature by the Colonel, Corps of Engineers, Chief of Staff. Once signed the publication process will be completed and the official document will be posted in the downloadable pdf format as Publication Number EM 1110-2-3506 entitled *Grouting Technology* at the following site: *http://www.publications.usace.army.mil/USACEPublications/EngineerManuals.aspx.*

The current version of the *Engineering and Design Manual EM 1110-2-3506 Grouting Technology* is dated 20 January 1984 and supersedes EM 1110-2-3501 dated 01 July 1966 and EM 1110-2-3503 dated 19 August 1963. It is comprised of 15 chapters, 4 appendices, and is 159 pages. The intent of the manual was to provide technical criteria and guidance for civil works projects and included information on procedures, materials, and equipment used in grouting applications that were considered to be state of the art and standard practice at the time of its publication. The manual primarily addresses neat cementitious suspension grouts and additives describing their uses as an increment of permanent construction such as pre-treating foundations, as post-construction remedial repair, or as an increment of expedient construction (examples being groundwater control during construction or repair of a cofferdam). The 1984 version covered the purposes, geologic considerations for civil works applications and provided information on the grout materials typically used to include cement types, admixtures, chemical grouts, asphalt grouts, and clay or bentonite grouts and the equipment used in a grouting program. The manual described the various applications in which grouting was performed and included water retention structures, tunnels, shafts and chambers, navigation structures, building foundations and precision and specialty grouting. Field procedures were recommended for the drilling, grouting, and pressure testing activities and the recommended pressures to be used and methods for calculating safe grouting pressures. The means for administering the grouting work as part of the general contract or as a separate contract, methods of estimating, and suggested methods of record keeping and reporting was also included in the document.

The USACE investigated computer aided monitoring for grouting at a project in the Buffalo District in 1975 and at the Nashville District's Center Hill Dam in 1984. The capabilities of these attempts were rather limited and lacked the ability to produce graphical outputs. In 1997-1999 efforts led by the Jacksonville District to utilize the most current technology and standards of practice to investigate the site of the Portuguese Dam in Ponce, Puerto Rico also resulted in the development of project-specific computer programs to track the micro-fine grouting data from the foundation grouting program. Around this time in 1998, the private sector was implementing the use of real-time automated data collection and display technology at the Penn Forest Dam in Pennsylvania along with the use of balanced stable grouts, and held a USACE Grouting Workshop at the site. Since 1998, USACE has actively supported and embraced the latest developments in grouting, including: (1) design of grouting as an engineered feature, (2) use of balanced stable grout mixes, (3) advanced computer monitoring, control, and analysis for controlling grout injection, production of project records, and performance verification, and (4) Best Value Selection for grouting projects. These efforts were led by the Louisville District and Headquarters through use of these approaches in projects and by organizing on-site USACE workshops for dissemination of the information. In 2000, the Patoka Lake Project, where a grouted cutoff was constructed in karstic limestone between the dam and the emergency spillway, was the first USACE project to successfully incorporate and integrate all of these elements. Following the success at Patoka Lake Dam, the same general approach with substantially more advanced and more powerful computer technology was used effectively in the Chicago McCook Reservoir test grouting program (Chicago District), the Mississinewa Dam cutoff wall pre-grouting program (Louisville District), the sinkhole remediation project and cutoff wall pre-grouting project at Clearwater Dam (Little Rock District), and the cutoff wall pre-grouting project in karstic geology at Wolf Creek Dam (Nashville District). Many of the specific approaches and techniques for best application of the new technology were developed and refined on these USACE projects.

Headquarters determined that an update of the *Grouting Technology Manual* was required and should include all of the advances in equipment, methodology, materials, and technology that had been accomplished on these exemplary projects. As a result, Gannett-Fleming was contracted by the USACE to perform this work. Two reviews were conducted, each comprised of experienced individuals from numerous USACE Districts, and their comments were incorporated into the draft copy dated 30 March 2009 and was submitted to the HQUSACE. The task for completion and publication of the document was then transferred to the USACE Risk Management Center in June 2011 and was reviewed by Senior Geotechnical Engineers and evaluated based on a Dam Safety perspective. In December of 2011 a meeting was conducted with RMC and the original reviewers to assess all comments, to include experience gained from more recent projects and to form a consensus on the required revisions. The draft was submitted to a Technical Editor in January of 2012. The document was provided to the HQUSACE Proponent and it was decided that the document was in need of further editing to prepare it for compliance and submission for HQUSACE review, and subsequent approval and publication. The Director of the RMC determined that after the document received a second Technical Review followed by an RMC final review, the final draft would again be submitted to the HQUSACE. This occurred in August 2014 and the document is currently being processed through HQUSACE and is awaiting signature.

The newly revised *EM 1110-2-3506 Grouting Technology* Engineering

Manual has been designed to provide guidance in all aspects of grouting and to include the best practices and most current technology that is being utilized on USACE civil works grouting projects. The revised manual is comprised of 31 chapters, 2 appendices and is 536 pages. The new Engineering Manual provides updated information on equipment and methods used in current grouting practice, information on available grout materials, mix designs, and the benefits of the use of balanced stable mixes for foundation grouting. Guidance is provided in geohydrology and flow modeling, hydraulic barrier design and QA/QC, vibration controls near grouting operations, and grouting under high head and high flow conditions. Grouting considerations are discussed for pre-grouting prior to cutoff wall installations, grouting in karst geology, blanket and consolidation grouting, conduits, void filling, prestressed rock anchors, tunnels, concrete structures, and compaction and hydrofracture grouting. Safe grouting pressures are emphasized especially when grouting foundations through earthen embankments and an appendix is provided with examples of pressure calculations for use under various circumstances. The manual also includes guidance for source selection, the different contract types, measurement and payment methods and quantity estimates for preparing grouting contracts.

The purpose of the revised *EM 1110-2-3506 Grouting Technology* Engineering Manual remains consistent with that of the versions which have preceded it. As stated in the Purpose statement in the Introduction in Chapter 1, "This manual provides technical criteria and guidance for civil works grouting applications. Information on procedures, materials, and equipment for use in planning and executing a grouting project is included, and types of problems that might be solved by grouting are discussed. Methods of grouting that have proven to be effective are described, and various types of grout and their proportions are listed. The manual discusses grouts composed primarily of cementitious suspensions and additives, although other types are mentioned." The grouting industry has made remarkable technological advances and the need for the USACE *EM 1110-2-3506 Grouting Technology* to reflect the most current state-of-the-art methodologies and provide guidance for best practices for civil works projects has resulted in this comprehensive Engineering Manual.

Some considerations about the Jet Grouting Reflow/Spoil and its management

Last fall I had the good fortune to participate in a couple of geotechnical/tunneling conferences in which some papers about jet grouting were published and presented.

At the first conference one of the papers was related to jet grouting. Despite the overall success of the project, there was mention of an accident that caused the uplift of a spillway, with cracking and damage to the structure. The cause of the accident was an incorrect procedure used by the contractor (I don't want to know its name!); "it was believed that insufficient annulus space around the jet grout monitor was likely the major contributor to the problem by hindering the free flow of jet grout spoil cutting to the surface".

A few days later, at another conference, I came across another paper about a jet grouting project where: "Frac-outs and up to 75 mm heaves in the road and surrounding features had begun to occur in the immediate jet grouting vicinity". Also in this case the overall result of the jet grouting was positive, but:

WHOA! WHOA! What is happening to the jet grouting industry?

Why so many accidents?

Let's stop a moment and regroup. How can this happen? How is it that the Contractor (I address them first,

later the design engineers) can ruin the jet grouting name and cause damages, in the first case, or potential damages (less problematic episode) in the second case?

For discussion, hoping I will have some reactions and comments from you, here are some of my thoughts.

- Everybody who has heard the name of jet grouting knows that this powerful soil improvement technique uses very high energy created by high velocity fluids and high pressures.

Question: what does high mean? In the jet grouting industry today high velocity means 700 to 900 km/hr, using pressures of 400 to 500 bars.

And the fluid flows? The flows are not often taken into account, as for example, in the specifications. It is the Contractor who decides what flows will be used to do the work. As an example, the ASCE-G-I guidelines mention superficially these important variables (we are working on that!).

What do these considerations have to do with the spoil/reflow? It is well known that using high pressures, high flows and high volumes of grout mix to create the necessary energy to construct the jet grouted element, the process produces high volumes of reflow composed of soil in situ and grout mix at the ground surface.

"Spoil/Reflow is created considering that the soil is not able to receive the excess volume of grout necessary to create the energy required to build the geometrical elements designed. Reflow is a "must" in the jet grouting process, with exceptions in some special cases and applications. Without a continuous return of the reflow to the ground surface, significant grout pressure can build up in the ground with consequent hydro-fracturing or hydro-jacking of the soil." Ref 1.

So another question: what does high flow mean? More than thirty years ago, on my first jet grouting job, I was using a grout mix flow of 70 liters per minute. The limitation, obviously, was due to the pump and accessories available at that time. Contractors and Manufacturers evolved, and today there are pumps on the market that can achieve 500 to 600 liters/minute, at 400 to 500 bars, even though some jet grouting projects are still carried out using much smaller flows.

It is clear, and I am referring to the conclusions of the accident at the spillway of the first paper mentioned above, that the annulus space between the drilled hole and the monitor/jet grouting rods, can play a fundamental role, **depending on the flows used**. Using 70 liters/minute can provide different results in the spoil compared to using 500 liters/minute!

We cannot use a Ferrari engine with a FIAT 500 (FCA Group) brake and chassis! Or, we can, but with adequate precaution.

- Apart from the annular space, what keeps me up at night, and this may be the most important point, is that in both cases the Contractor/s-Engineers didn't have a trigger point defined to stop the jet grouting once the spoil/reflow was lost. For how much time should the jetting continue without having the spoil/reflow returning to surface? 0 seconds? 30 seconds? 1 minute? 5 minutes?

Here again the *fluid flows*, decided by the Contractors, can play an important role.

I believe it is a good practice, or better it should be mandatory, that in each jet grouting project (and here I am speaking to the Engineer/Designer) there should be, in the Specification, a clause asking the Contractor to define a time limit in which the jetting can continue without spoil/reflow returning to surface before stopping jetting and starting to ream the hole. This time can be dependant on the risk that can be managed in a specific project (jet grouting done in the desert vs. below a building) and from the flow used for the jetting (70 or 200 or 400 or 600 liters/minute). In any case it is something that should be discussed, for each specific jet grouting project, between the Engineer and the Contractor to mitigate the risk of uplifting, before the start of the works, and after the field test.

- Other factors that can influence the spoil/return are, of course, the grout mix composition (thinner or thicker depending on the type of soil) and the type of jet grouting whether it will be single, double or triple. And definitely the soil conditions.
- Last but not least, and probably the most important aspect is the attention and care of the operator at the drill rig. The operator is the "key" person in avoiding heave and other damages.

Related to the operator, I am reminded of a short episode that happened a few months ago. On a jet grouting project, the operator was jetting, sitting inside the cabin of an excavator located behind the jet grouting mast without a direct view of the hole and consequently of the reflow.

A third person was obliged to control the spoil/reflow return and inform the operator (by shouting?) about potential spoil/reflow problems.

Definitely not an ideal situation in jet grouting considering that the operator should "feel" the spoil/reflow and ream the hole if needed.

I leave it to you to decide who needs to take care of these important details and I welcome discussion about these observations!

Ref 1. Siu, Gazzarrini, and al. "John Hart Dam - Back-up Jet Grouted seepage cut off wall construction". ICOLD 2013 International Symposium - Seattle USA

And, as usual, the same request, asking you to send me your grouting comments or grouting stories or case histories. My coordinates are:

Paolo Gazzarrini, paolo@paologaz.com, paologaz@shaw.ca or paolo@groutline.com.

Ciao! Cheers!

Mine closure in Chile – challenges and changes

Björn Weeks

Chile is one of the world's most important mining countries – leading the world by far in copper production, while being also the second largest producer of gold, and home to nearly a third of the world's lithium reserves. The economy of the nation rises and falls with copper prices, and Chile is home to dozens of international mining companies, with large projects owned in whole or in part by companies such as Barrick, BHP, Teck, Glencore, Kinross, Anglo American, and many others. The coastal nation hosts some of the largest mines in the world, including the emblematic copper mines of the state-owned miner Codelco. These include mines with over 100 years of continuous operation, such as "El Teniente", one of the world's largest underground mines with over 2400 kilometers of underground tunnels, and the massive open pit mine "Chuquicamata", which boasts an open pit that is arguably the largest excavation on the planet (with plans well underway to extend the mine with further underground excavation below the pit).

In this context, it is perhaps surprising how little practical experience there is within the country in mine closure. While there are hundreds of abandoned sites throughout Chile (some of which present significant environmental and health & safety concerns), sites that have been closed in accordance with modern standards are few and far between. This is likely to change in the coming years, with many large mines nearing the end of their productive life, combined with the rapid evolution of the legal landscape for mine closure, an evolution that has focused on eliminating the generation of more abandoned sites in the future.

This article provides a brief overview of mine closure in Chile, including some of the technical and social chal-

Photo 1. Uncontrolled and abandoned tailings, dried by evaporation and coexisting with dwellings in the surrounding area.

lenges, and the ongoing developments of the regulatory context for closure.

The legal context

In order to understand the focus of current closure laws in Chile, it helps to understand the national importance of abandoned sites. While mining generally has a wide social acceptance in the country, thanks to its role in the economy and as a provider of well-paying jobs, its long history has left marks across the nation. The national mining service (Sernageomin) has a catalog of at least 1400 abandoned sites. These include sites that are located near to communities, and are generating on-going impacts in the absence of state funds earmarked for their remediation (see Photo 1). While programs have been developed to identify, catalog and better rank these sites by risk, funding for their remediation and reclamation still seems remote.

One of the first steps in the development of Chilean closure law was in 1994, with the establishment of an Environmental Impact Assessment (EIA) system. While closure was not directly addressed by the system, the EIA for new mining projects was expected to include the closure phase. The next major step forward for mine closure regulation came in 2002, with the introduction of a new mining security regulation. This regulation established for the first time a requirement that all mines to present to Sernageomin a closure plan by 2009. The focus of the closure plan under this law was on physical stability and health and safety issues. Notably, environmental issues were not covered, as they were considered to be outside of the jurisdiction of Sernageomin. By international standards, the requirements were decidedly light.

This changed in 2012 with the publication of a new closure law and associated regulation, which dramatically increased the role of the state. Responding in part to public pressure and increased attention to the large number of abandoned sites in the country, the new law explicitly laid out a mission to prevent the future generation of more abandoned sites. This would be done by the by means of financial guarantees provided by the mining companies for each operation, provisioning amounts sufficient to execute the site closure should the owner default on their closure obligation – provisioning that is a relatively common practice internationally, and already applied in neighboring Peru. The new law also makes one of the first nods to the social aspects of closure, obligating that closure plans prepared under the new law indicate when and how the closure will be communicated to stakeholders.

The new law included a phasing-in process. In the first phase, every mine (over a minimum size threshold), that at the time had an approved closure plan, needed to provide by November of 2014 a cost estimate for the execution of both the approved plan, and to comply with any other closure-related commitments that had been acquired along the way through the EIA system. Once the estimate has been approved by Sernageomin, the mining company would be required to provide a guarantee for the amount, using one of the approved financial instruments. Using a formula that takes into account remaining mine life and a discount rate based on an independent state-provided index, the present value of the closure to be guaranteed is calculated. Initially, only 20% of the present value needs to guaranteed, with the amount gradually ramping up to the full present value over two thirds of the remaining mine life, or 15 years (whichever is shorter). There are various provisions for partial reductions of the guarantee to promote progressive closure, although it remains to be seen how these will be applied in the practice.

2015 promises to be an interesting year for closure in Chile. As plans are approved, mining companies will begin to pay for the guarantees. The total amount to be guaranteed is estimated to be well over $30 billion dollars, with the first year requiring guarantees of 20% of that total. More interestingly from a technical point of view, the phase-in of the closure law is now completed, and all new closure plans, or updates to existing plans, will be required to comply with the full closure law, with adequate measures included for promoting (or "guaranteeing" in the concerning phraseology of the law) physical and chemical stability.

Most notably, this will mean that all closure plans must include a risk evaluation for the principal installations, with closure measures defined to mitigate the risks. Sernageomin has provided a guide for conducting this risk evaluation, which, while not legally binding, is likely to be treated as the rule. This risk evaluation guide indicates that in the absence of specific studies, the evaluation must consider "worst case" scenarios. For example, in the absence of geochemical characterization, all waste rock should be considered acid generating. As there has been relatively little legal motivation for such characterizations in the past, this could either mean a dramatic upswing in characterization work in the next few years in preparation for the next updates, or significantly more complex and expensive closure plans as past assumptions of relatively benign conditions are replaced by more conservative assumptions.

A third possibility of course is that it will be possible to "game" the risk evaluation to give the desired outcome, without providing the engineering fundamentals. It will largely sit with the regulator to determine if this happens or not. While a possibility, the evolving sophistication of the authorities makes this outcome less likely.

Technical challenges

Climate is a key driver in the selection of closure measures, and there are few countries where that axiom is more evident than in Chile. While mines located in the southern part of the country may be subject to annual rainfalls of over two meters, a large portion of mines are concentrated in the north, which is extremely arid. In the Atacama Desert, which occupies much of the northern territory, average annual precipitation can be less than 2 mm, while potential evaporation soars. Sites of such extreme aridity can bring unexpected benefits for closure design. At least in theory, small quantities of contact water can potentially eliminate or dramatically reduce acid rock drainage (ARD), by the reduction or elimination of one of the three elements needed for its generation (the others being oxygen and a waste with the potential to generate ARD).

At some sites, contact water quantities are so small in comparison with evaporation rates, that a strong case can be made to eliminate many common control measures. Unfortunately for the engineer, the closure design is rarely so simple. Many of the arid sites are subject to occasional, but significant, rainfall or snowmelt events. Due to limited data, it can be difficult or impossible to characterize to an adequate confidence level what is the "real" 1-in-100 year or 1-in-1000 year event. To dimension the difficulty, consider that having 90% confidence in just a 25 year storm requires 59 years of precipitation data – a quantity of data that would be considered excellent for many sites in Chile. The difficulty in correctly estimating the intensity of the low frequency storm events results in a number of design challenges. Water diversion structures that have been sized based on conventional precipitation estimates can result in the construction of immense structures in the desert that will remain dry for years or decades – or possibly even in perpetuity, given the uncertainties in the estimation of the design storms. On the other hand, there is little expectation that more innovative (and potentially more realistic) estimates will be accepted by the approving authorities.

In theory, potentially acid generating waste rock could sit with oxidation products developing on the surface of the rock for years, and these products would then be flushed by the storm event. Adequately characterizing the risks associated with such events ideally requires consideration of a range of issues, including statistically defined water balances, reaction rates, and dilution potentials. Receptors must also be figured in the equation. Many sites benefit from their extreme remoteness from inhabited areas. Groundwater resources are often isolated as well, with water table depths below ground surface of 90 meters or more, protected in varying degrees by bedrock, dense desert soils, and a powerful evaporative regime. On the other hand, unique and sometimes fragile desert environments may come into play. A common and particularly sensitive case is the salar environment, where all discharges from a watershed drain to an isolated internal evaporation point, the salar. These discharge points are delicate ecosystems, home to a variety of species including the famous flamingos, or the deer-like vicuñas (see Photo 2).

Even where ARD issues are not a concern, the aridity can create other issues, particularly the generation of dust. Waste rock dumps tend to be relatively immune to this problem, at least in the long term. The range of grain sizes present in a waste rock dump can be expected to provide considerable protection form the ongoing generation of dust through the formation of a "desert pavement", a process in which finer particles are scoured away by the wind, leaving a resistant surface of the particles too large to be moved.

On the other hand, the closure of any tailings facility requires a site-specific evaluation of dust generation post-closure. Due to the relatively fine and uniform size of many tailings, they may generate nuisance dust for decades or even hundreds of years after closure. While to a foreigner the concern of Chilean regulators over dust generation may seem exaggerated, a quick visit to Chañaral, a coastal town located approximately 800 km north of Santiago can provide some rapid context. Historic marine disposal of tailings in the bay just north of this community has resulted

Photo 2. A typical salar environment. (https://creativecomons.org/licenses/by-sa/3.0/deed.en).

in the accumulation of some 300 million tons of tailings, creating an immense beach deposit along the coast. While active deposition of tailings ended decades ago, and various remediation projects have come and gone, square kilometers of exposed tailings remain, and one can easily see the accumulation of tailings dust throughout the community of Chañaral to the south. Traveling across the tailings on the public road, even on mildly windy days blowing tailings reduce visibility.

Given the vast cumulative extent of tailings deposits in the country, dust control is not a trivial matter. The typical methodology proposed for closure is the placement of a granular cover. However, taking the example of one of the larger deposits in the country which at closure will cover roughly 6000 hectares, a 15 cm cover would translate into a need for over 9 million cubic meters of fill material – a significant mine in its own right if obtained from a borrow source, and with practically any source of cover material, a significant closure cost.

Photo 3. The closed and covered tailings at El Indio, Barrick's pioneering work that set the national reference point for mine closure practice in Chile. Photo shows the closed and covered tailings deposit in the valley, with channel restoration along the axis of the deposit.

Alternatives to granular covers abound. Anecdotal evidence and laboratory work conducted by Golder Associates suggests that when waters with high salt content are used to transport the tailings (either seawater or desalinated seawater – both increasingly being evaluated for mining use), subsequent drying of the tailings results in the formation of a resistant salt crust on the tailings, that effectively eliminate dust generation. Some researchers have shown the benefits of windrows on the tailings surface to reduce wind erosion, with a lower material cost than a complete cover. But with the example of Chañaral never far from the mind, solid studies will be needed to convince the authorities that such alternatives, as yet undemonstrated in Chile, will meet long term needs.

Closures to date

Few sites have been closed in Chile. The closure of the coal mine at Lota in the south in 1997 continues to resonate as a cautionary tale, not for technical challenges, but for the dramatic community impacts that resulted from the closure. Even 10 years after closure, the community was marked by high levels of poverty, unemployment, and demonstrations by the ex-miners.

A much more positive example is the locally owned Lo Aguirre site, located just west of Santiago. In 2000, the site presented a voluntary closure plan, which was largely implemented by 2008. Lacking the resources of international mining companies, the closure works were resourcefully self-financed, largely through the sale of scrap generated in closure activities, and sale of copper obtained through reprocessing of select wastes. Social impacts were virtually non-existent, thanks to the proximity of the mine to the larger, diversified economy, and closure in a time of high economic growth.

Perhaps the most emblematic closure to date has been the El Indio site (see Photo 3), located at over 4000 meters above sea level in the arid Andes, close to the border with Argentina. When mining operations terminated in 2002, the owner of the site (Barrick) implemented a closure program that was nationally unprecedented. In the absence of clear closure regulations at the time, Barrick undertook a voluntary agreement with the authorities, presenting a complete and detailed closure plan, developed in accordance with current international practices. Application of this plan resulted in completion of the majority of closure works in 2005, prior to the obligation to present any sort of closure plan under the first closure law. Workers relocated rapidly thanks to the high national demand for mining experience at the time of closure.

Closure in the future

The coming years promise to redefine mine closure in Chile. Large, aging mines that are nearing closure, relatively little practical experience with mine closure at a national level, and a new legal framework create both uncertainty and considerable opportunity. While the new closure law is arguably flawed, it represents an important leap forward. The timely imposition of financial guarantees for closure should go a long way towards the stated goal of avoiding abandoned mine sites in the future, and motivate serious consideration and study of adequate closure measures earlier in the mine life cycle.

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An unexpected short-duration warm-up and rainfall event during winter: ice-clogged drains and damage to a building

Robert P. Chapuis

Context

This is the fourth historical case study on “groundwater” problems that I have presented in Geotechnical News. This unusual case concerns a drainage system for an industrial building with distinct sewers for sanitary sewage water and stormwater. The building had a nearly flat roof, which is quite common in industrial areas, probably because it is cost efficient, requires less material and provides more room space than a sloped roof. Also, it is easier to walk on and inspect.

The large roof had several sections, each with a small slope towards a central collector, a simple gravity drainage system which avoids water ponding. Each drainage column was located within the heated building, which avoided the risk of water freezing and damaging the pipes and building structure. Each drainage column discharged rain water and snowmelt to a sewer pipe, leading the water towards a ditch about 2 m deep (Figure 1).

Prior to the event recounted in this paper, the flat roof was in excellent condition. There was no water penetration into the underlying decking and insulation. Each central collector was protected with a metal screen to avoid entrance of gravel, airborne debris, leaves, and wildlife. In addition, the end of the drain pipe, in the ditch, was screened to prevent entry and nesting of wildlife, which could cause clogging. Therefore, clear precautions had been taken to have a rodent-free and snake-free building, to avoid pipe clogging and rodent damage within the building.

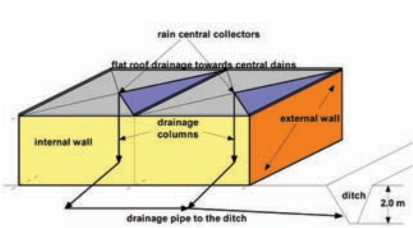


Figure 1. Sketch of the building and its stormwater drainage system.

The event

The event which caused damage occurred in the middle of winter, when one day, the air temperature rapidly increased from -15ºC to a few degrees above freezing, and stayed above 0ºC for only 2-3 days. This rapid but short warm-up also brought a few centimetres of rain, which caused some additional snow to melt, clearly visible in the parking lot. However, nobody paid attention to what was happening on the flat roof, which had to drain several cubic meters of rain and melting snow.

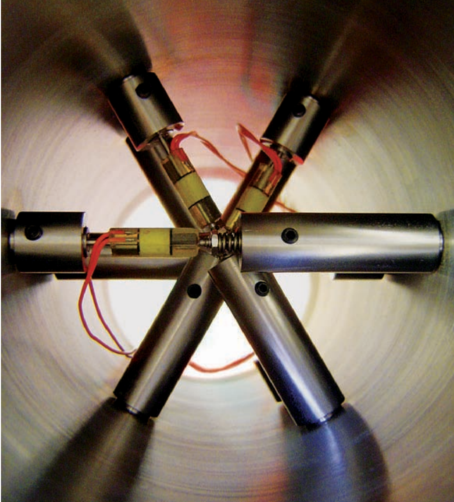
Inside the building, some time has passed before it was realized that water had started spurting from the joints of the vertical drainage columns, damaging the building and some stored goods. The spurting water was clear, cold and under pressure. An employee climbed onto the roof and saw standing water in each flat division. The vertical drainage columns were made with plastic pipe sections simply fitting together (no glue, no welding): this system was quite frequently used for vertical drainage pipes, but it cannot resist water under pressure.

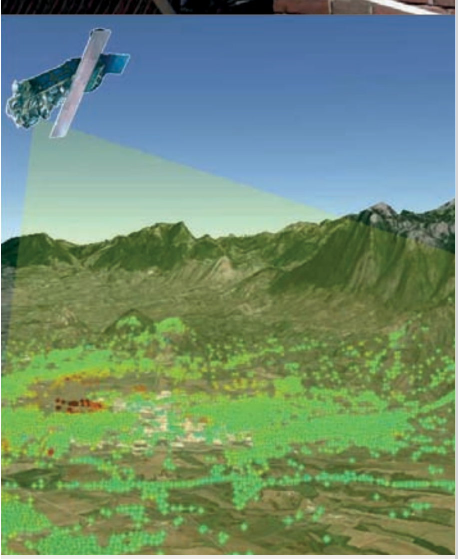
Investigation and repair

The investigation for this case was quite simple. There were pools of standing water on the roof. Water was supposed to fall freely through the vertical drainage columns but this was not the case. Water could flow from the roof into the vertical drainage columns where it was under pressure, but it was squirting out by the pipe joints inside the building. Therefore, there must have been some clogging in the underground drainage system.

An inspection of the drain pipe outlet in the ditch revealed that the pipe was blocked by a long cylinder of ice. During winter, a small amount of water had started to freeze close to the pipe outlet, and additional water reaching this ice became gradually frozen, due to cold air entering the drain pipe. As a result, an ice “dam”, made with a long ice plug, was formed which blocked water behind it. In previous winters, there has been no sudden warm-up, and slow melting of the ice plug allowed water to reach the ditch. Unfortunately, during the rapid but short warm-up in this case, the underground ice plug, insulated from the warm outside air, did not melt, which caused damage inside the building.

In order to counteract the possibly dangerous consequences of a fast warm-up, a few meters of electric de-icing (heating) cable were subsequently installed in the end part of the drain pipe, near its outlet. The cable was similar to those used for keeping rain gutters free of ice during cold weather. The heating cable operation was controlled by a device which checked the temperature around the cable, in order to prevent future freezing of water within the drain pipe.





SECOND INTERNATIONAL COURSE ON GEOTECHNICAL AND STRUCTURAL MONITORING

June 4-6, 2015 | Poppi, Tuscany (Italy)

Course Director: John Dunnicliff, Consulting Engineer

Organizer: Paolo Mazzanti, NHAZCA S.r.l.

THE COURSE: attendance at the course is a great opportunity **to establish a valuable network** with colleagues from all over the world, **to meet manufacturers** and **see the most recent and innovative instrumentation**, thanks to a large exhibition area.

COURSE EMPHASIS: is on **why and how to monitor field** performance. The course will include planning monitoring programs, hardware and and software, web-based and wireless monitoring, remote methods for monitoring deformation, vibration monitoring and offshore monitoring. Case histories presented by prominent international experts and discussion during the open forum will be an additional source of knowledge.

WHO: engineers, geologists and technicians who are involved with performance monitoring of geotechnical features of civil engineering, mining and oil and gas projects. Project managers and other decision-makers who are concerned with **management of RISK during construction**.

OBJECTIVE: to learn the who, why and how of successful geotechnical and structural monitoring while networking and sharing best practices with others in the geotechnical and structural monitoring community.

INSTRUCTION: provided by leaders of the geotechnical and structural monitoring community, representing users, manufacturers, designers and people from academia from all over the world.

LOCATION: the 3-day course will be held in Tuscany (Italy). In addition to providing an opportunity to increase your own expertise about geotechnical and structural monitoring, attendance at the course will give you a beautiful cultural, historical and taste experience in one of the most attractive places in the world.

As **John Gadsby** (publisher of this magazine) wrote in the September 2014 issue, *"The 2014 edition of this course was a great success. Anyone in the monitoring community should add this course to his/her list of 'to dos'"*

Course Partners: Marmota Engineering, Geokon, Measurand, RST Instruments, Geosense, Canary Systems, Soldata, Mine Design Technologies, Sylex, CSG, Shanghai Zhichuan Electronic Tech, Ace Instrument, 3d Laser Mapping, Smartec, Vista Data Vision, Gkm Consultants, Worldsensing, IDS Ingegneria dei Sistemi, Trimble navigation, Sisgeo.

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Jonathan Fannin, Editor

Professor of Civil Engineering, University of British Columbia

Geofilters Part 2

Jonathan Fannin & Kelvin Legge

Jonathan Fannin

In the Geofilters Part 1 article that was published in the GN: December 2014 issue, I sought to contrast the path-of-discovery through which practice in granular filters has evolved, with that for the origins of practice in specifying a geotextile filter. The intent was to discriminate between what we really know, and what we merely believed, about the merits of using a geotextile filter.

This companion Geofilters: Part 2 now reviews select guidance that is currently used for granular filters, as well as that for geotextile filters, placing emphasis on applications in embankment dam engineering and matters pertaining to base soil-filter layer compatibility. Thereafter, consideration is given to the content of a new draft bulletin from the South African National Committee on Large Dams (SANCOLD) – a substantial work-in-progress to revise and update the 1985 ICOLD Bulletin 55 on "Geotextile Filters in Dams"- for which I am grateful to my co-author Kelvin Legge. But first, let us commence with some very general reflections on dam engineering, both past and present.

Dam engineering: 3500 BC to the present day

Throughout the ages the lives of people and water have been inextricably linked (Fig. 1). For several thousand years, societies have diverted and dammed rivers to meet their increasing water needs, with the earliest evidence of canal irrigation in Neolithic civilisations dating back to c. 6500 BC, in the southern regions of modern-day Iraq (Viollet, 2007). On a planet that is mostly covered in water, but where less than 2.5% of it is freshwater, the ability of societies to regulate and manipulate the water that is

Kelvin Legge

available to them has not only proven key to their progress and development, but to their very survival. Writing on the subject of early dams, Fahlbusch (2009) notes what is often regarded as the oldest known dam in the world, at Jawa in modern-day Jordan, which dates to c. 3500BC, comprised a basalt stone shell with a core of "clay, ash and soil that had been tamped". The Sadd el Kafara dam in modern-day Egypt dates to c. 2650 BC, and comprised a core of "silty sand and gravel" that was supported on either side by layers of rockfill and revetment stone, yielding a structure that was approximately 110m long and 14 m high. "The examples at Jawa and Sadd el Kafara show the Bronze Age engineers were able to construct high, long and obviously expensive dams" (Fahlbusch, 2009).

The International Commission on Large Dams (ICOLD), using the most recent publication of the World Register of Dams, recognises that for single-purpose dams "48% are for irrigation, 17% for hydropower, 13% for water supply, 10% for flood control, 5% for recreation, and less than 1% for navigation and fish farming". A growing appreciation for dam safety and dam risk management, has contributed to advances in technology across a wide range of subject areas, including the role of seepage-control in civil, mining and environmental structures. ICOLD, founded in 1928, provides guidance to dam engineering practitioners in pertinent aspects of these advances. The use of geotextiles as filters and transitions in dams was first addressed its Bulletin 55 of 1986. It provided guidance to the designer on applications and limitations for consideration as understood at that time. The approach was conservative, in keeping with conventional dam engineering philosophy and, it could be argued, reasonably so given the somewhat limited knowledge of polymers and geotextile performance within the profession. Although a number of dam engineers had incorporated the use of geotextiles, most notably the Valcross Dam in France, the long-term performance in these applications was neither widely-disseminated nor fully understood at that time. Thus the use of geotextiles as filters and transitions was largely limited to applications that offer easy access for repair in the event of unsatisfactory performance, such as under upstream riprap and beneath downstream toe drains.

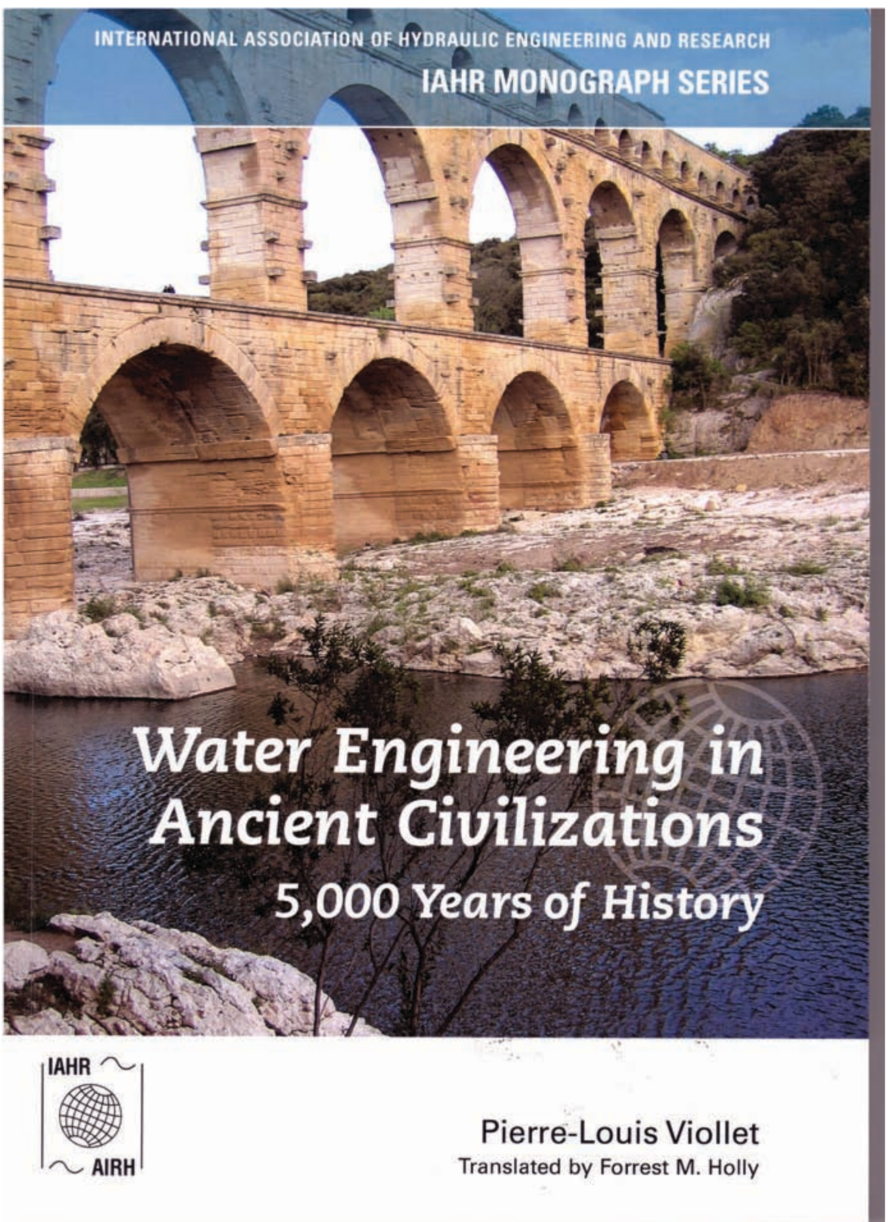

Figure 1. The beginning of the Bronze Age witnessed the oldest known embankment dams.

Timblin (1988) reports on 7 categories for the location of a geotextile filter in an embankment dam (Table 1), making reference to the purpose of the filter, the type of flow, the significance of failure, and the ease of access for repair. Following a short yet succinct review of geosynthetics in dam construction, he ventured that "with proper selection of materials, good design procedures, and a strong testing program, geosynthetics offer a valuable set of new materials for the advanced dam engineer".

Current regulatory guidance in North America

The United Sates Society on Dams (USSD, 2011) considered the use of geosynthetics as a construction material for embankment dams, including specific reference to geotextiles as filters in fill dams. Also in that year, the US Federal Emergency Management Agency (FEMA, 2011) published on the subject of filters for embankment dams, with the objective of reporting on best practices for design and construction, and with commentary on the use of geotextile in filter/drainage systems for dams (Fig. 1). In a third contribution of that same year, the US Bureau of Reclamation (USBR, 2011) issued a ninth revision to Design

Table 1. Geotextiles as filters in embankment dams (after Timblin, 1988)				
Filter Location	Purpose of Filter	Type of Flow	Significance of Failure	Access for Repair
A. Downstream slope protection.	Control of erosion by rainfall.	Occasional surface flow.	Noncritical.	Easy.
B. Downstream surface drains.	Removal or surface seepage.	Continuous local seepage.	Noncritical. Local wet areas may reappear.	Easy.
C. Upstream slope protection.	Control of erosion by wave action and by outward flow during drawdown.	Cyclic flow during wave action. Small flow during drawdown.	Usually noncatastrophic.	Possible.
D. Temporary internal drainage.	Dissipation of excess pore pressure during construction of wet fills.	Temporary flow, limited quantity. some migration of fines allowable if drains not blocked.	Noncatastrophic. Failure may lead to instability during construction or delays.	None.
E. Upstream internal fill boundary.	Prevention of unacceptable migration of fines in upstream direction.	Transient and small flows during drawdown.	Noncatastrophic. Only significant if migration is large and continuous.	None.
F. Downstream internal interface-no continuous flow from reservoir.	Prevention of unacceptable migration of fines.	Flow only due to infiltration of rainfall.	Limited and non-catastrophic.	May be possible to excavate with reservoir drawn down for safety.
G. Downstream internal interface-no continous flow from reservoir.	Prevention of internal erosion including effects of concentrated flow in cracks, etc.	Continuous flow from reservoir, potentially large and increasing.	Potentially catastrophic and rapid. General seepage may involve slow deterioration.	Generaly none. Downstream weight block/ inverted filter may be removed and repair accomplished only with reservoir drawn down for safety.

Standard No.13, Embankment Dams, Chapter 5: Protective Filters. It too offered a commentary on the use of geotextiles. In many aspects the three publications share a similar perspective.

The USSD (2011) White Paper on Materials for Embankment Dams provides an outline of important points that need to be recognised and understood when selecting materials for use in embankment dams and, in Chapter 7, addresses geosynthetic materials. Section 7.6 reports on geotextiles as filters in fill dams, giving consideration to:

- possible applications of geotextiles as filters in earth dams
- principles of filtration
- differences between geotextile filters and granular filters
- opening sizes of geotextiles
- filter design criteria for geotextiles
- geotextiles as possible shear surfaces
- consolidation and seismic activity

It relies predominantly on the ICOLD Bulletin 55 of 1986, and appears to offer limited additional insight. Importantly, care is urged to ensure "case histories of satisfactory performance of geotextiles in non-critical applications are not used to justify uses in critical applications. For example, successful use of geotextiles at interfaces where hydraulic stresses are low or the interface may have been stable without the geotextile do not demonstrate suitability for interfaces subjected to severe flow. Generally, the performance of the geotextile cannot be monitored in situ directly and evidence of deterioration may not be visible until considerable damage has occurred. Considerable caution is required in the design of transitions that are subject to continuous seepage."

The FEMA (2011) publication represents "an effort to collect and disseminate current information and experience having a technical consensus". Chapter 3 addresses additional applications, with Section 3.3 reporting on geotextiles in embankment dams. It includes the following statement explaining current practice for using geotextiles in U.S. dams:

"In a limited number of cases, geotextiles have been used as deeply buried filters in France, Germany, South Africa and a few other nations. Most notable, is a geotextile installed as a filter for Valcross Dam which has been successfully performing for over 35 years. These applications remain controversial and are not considered to be consistent with accepted engineering practice within the United States. Because geotextiles are prone to installation damage and have potential for clogging, their reliability remains uncertain. …. It is the policy of the National Dam Safety Review Board that geotextiles should not be used in locations that are both critical to safety and inaccessible for replacement."

The specific concern of FEMA (2011) arises from the successful outcome of research studies, on sand and gravel filters, and their usage over many years in dams (Fig. 2). In contrast, the usage of geotextiles in embankment dams is deemed to be very limited. Further, a concern is raised that materials on the downstream side of a geotextile will not provide adequate support to the discharge face, causing the geotextile to bulge and thereby encourage detachment of base soil particles that contribute to (i) the formation of "filtered layer cake with a very low permeability" and result in clogging of the geotextile, else (ii) piping if the opening size distribution of the geotextile is overly large. Experience is cited from geotextiles used under riprap, and in highway drainage work, in support of the concern. It leads to the recommendation that "due to issues with clogging, geotextiles should only be used in non-critical areas of embankment dams".

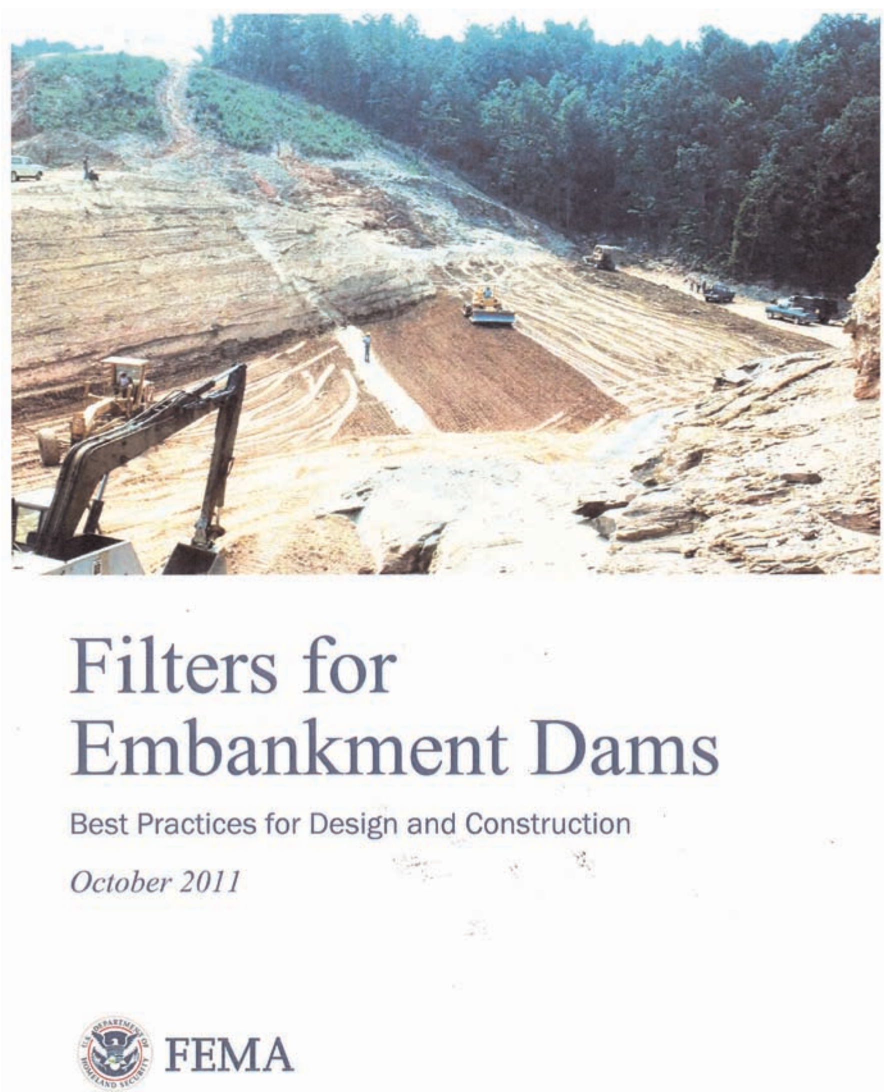

Figure 2. Current regulatory guidance includes commentary on both granular and geotextile filters.

The scope of the USBR (2011) chapter of the design standard applies to "naturally occurring earth materials or to filters manufactured from such natural earth materials by grading, screening, washing, and crushing. … Filters of woven or nonwoven fabrics are generally not recommended for use as protective filters and are excluded from this chapter." Reference is made to Appendix B of the Chapter 5, in which the content of the FEMA (2011) publication is largely reproduced verbatim in which discussion of the shortcomings related to the use of geotextiles.

SANCOLD (2014) revision of ICOLD Bulletin 55 (1986)

The history of dam engineering from ancient through to modern times reveals the use of an engineered filter layer is a relatively recent development that was formalised by Karl Terzaghi less than 100 years ago. In the time since then, and more particularly in the last 25 years, it is reasonable to claim that considerable advances have been made in our understanding of both granular and geotextile filters. Likewise, there is a more informed appreciation for the challenging issues that exist in the sourcing, manufacturing, placement, performance and durability of both granular and geotextile filters. Indeed, there are many similarities to be found in case histories that report on deficient performance.

In reporting on geotextile filters in dams, the SANCOLD draft revision of ICOLD Bulletin 55 seeks to address, amongst other factors:

- the importance of competent filters in avoiding dam failures
- granular materials as filters in dams
- geotextile uses and applications
- principles of geotextile filtration
- differences between geotextile filter materials and granular filter materials
- filter design criteria for geotextiles
- the effects of time and permeating fluids on service life
- composite (granular and geotextile) filters
- quality assurance (materials and construction)
- durability of geotextiles

In giving recognition to the importance of competent filters, the prevalence of failures arising from internal erosion of the body of the dam is noted. What is perhaps the most novel intended contribution of the current version (2.0) of the SANCOLD draft revision is the concept of a composite filter, where proven compatibility allows for use of a geotextile as an adjunct to a granular filter, for example in a chimney drain where the application is primarily intended to protect against contamination of the filter by core material during construction, as well as protect against unacceptable internal erosion during first filling.

The compilation of experience, both in South Africa and elsewhere in the technical literature, pertaining to dam engineering and related construction applications, is leading to the proposition that "geotextiles can thus be used in non-critical applications as primary filters and can be used as adjuncts to granular filters in critical applications to form a composite filter material". As noted at the beginning of this Geofilters: Part 2 article, the SANCOLD activity is a substantial work-in-progress to revise and update the 1985 ICOLD Bulletin 55. The approach advances beyond that of the USBR (2011) and FEMA (2011) publications, and is herefore deserving of considered deliberation. It is the changing nature of water quality and availability of ideal granular filter materials, informed by laboratory and field investigations, which has led to advocating the use of composite granular and geotextile filters in critical applications in dam engineering. The approach is proposed so as to embrace the benefits offered by geotextile and by granular filters under suboptimal conditions, while recognising that limitations of one material type may be complemented by the relative advantages of the other material type.

Accordingly, and in closing on this Geofilters: Part 2, my co-author Kelvin Legge would be delighted to receive correspondence from those with any experience using composite geotextile-granular filters in dams, with a view to compiling case studies on the subject to inform the SANCOLD revisions and updates to the 1985 ICOLD Bulletin 55 on "Geotextile Filters in Dams".

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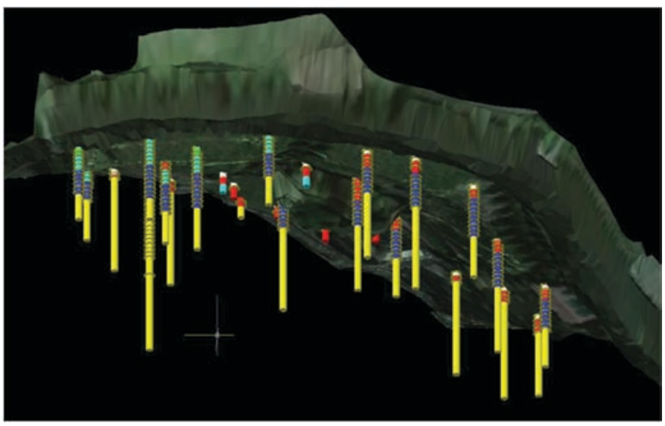
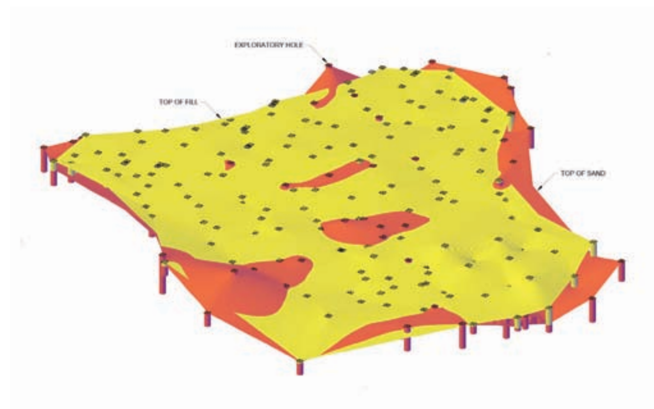
Share and share alike

Gary Morin



The HoleBASE SI Extension for AutoCAD® Civil 3D enables rapid visualisation of borehole data, allowing creation of 3D layouts and sub-surfaces.



Incorporating geotechnical data in BIM aids design optioneering and refinement at the outset of a project.

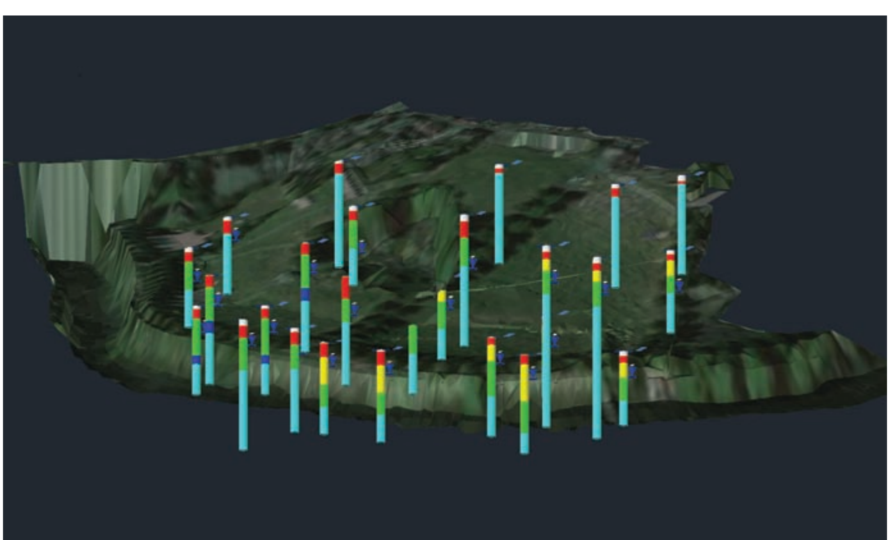
Sharing of geotechnical data for use in Building Information Modelling should result in more informed decision-making, improved collaboration and emphasise the importance of geotechnics.

It has been well-documented that Building Information Modelling (BIM) enables better decision making during the planning and design stages of a project, throughout the construction process and into the operational and maintenance phases.

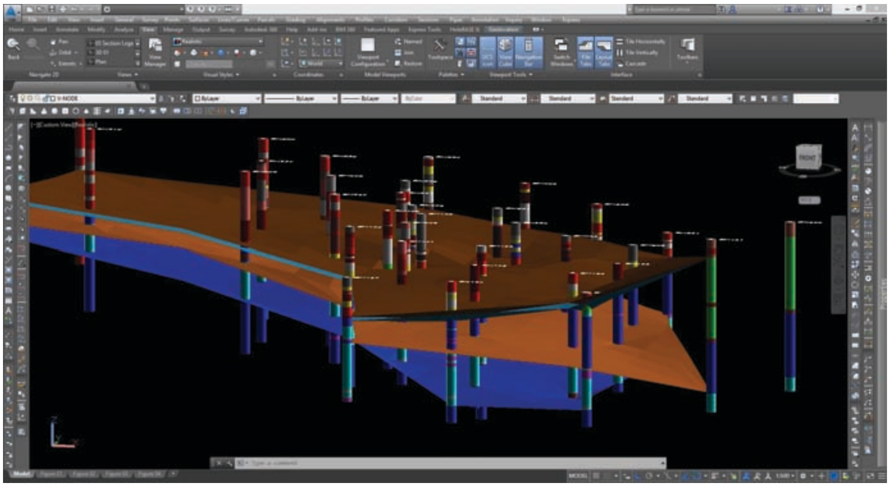
However models sometimes appear to neglect geotechnical aspects. BIM often appears to start from the ground up, with the subsurface considered as an homogenous substance. This implies there is no risk in the ground, which is clearly untrue.

In fact, there is a host of benefits to applying BIM principles to geotechnical data management and including geotechnical data in BIM: it allows considered design optioneering and refinement at the outset of a project; minimises geotechnical risk in construction and enables cost-effective repairs and maintenance of assets throughout the project's lifetime.

Using BIM means geotechnical contractors and consultants can collaborate easily. Data sharing and central data management results in big improvements in efficiency and quality.



Geotechnical modelling in BIM can lead to a more complete understanding of project elements.



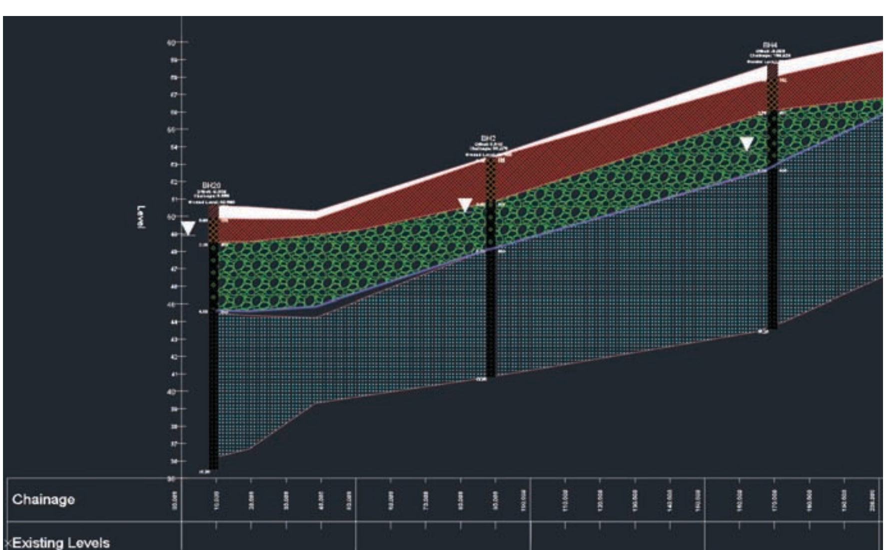
BIM allows access to data in real time, giving the opportunity to refocus sampling and testing mid-investigation.

Of course, sharing of geotechnical data digitally is nothing new. Geotechnical data management systems such as Keynetix's HoleBASE SI, for example, manages all of a project's geotechnical factual and interpreted data. The extension for AutoCAD Civil 3D also allows visualisation of information, such as geological surfaces, for use in both BIM models and the AutoCAD environment.

However the sharing of interpreted data appears to be a big sticking point for incorporating geotechnical information in BIM. While data is commonly shared between geotechnical companies, it is rarely shared with the rest of the team.

It appears many geotechnical teams are reluctant to supply digital data as they cannot separate factual from interpreted information. This means they are concerned by the possibility of interpretative data being misused.

In fact, better data sharing should actually lead to a more complete understanding of the project – resulting in informed decision-making – and improved collaboration should reduce the risk of interpreted data being misused.



Incorporating geotechnical data in BIM gives the ability to create sections in seconds.

Having a clear image of the proposed design and access to full project information will also enable optimisatiion of the site investigation.

Furthermore, having access to field data in real time and incorporating it into BIM almost immediately gives the opportunity to refocus sampling and testing mid-investigation. This should deliver more useful data, reducing risk and saving money in the long term.

One of BIM's biggest benefits, as far as geotechnical teams are concerned, is the opportunity to share the vision and concerns for the ground conditions.

More significantly, recognition by other project team members of the critical importance of high quality geotechnical information in creating an accurate BIM model will reinforce the messages that thorough site investigation can reduce risk and the geotechnics is an integral part of the entire project.

HoleBASE SI Extension for AutoCAD® Civil 3D

The HoleBASE SI Extension for AutoCAD® Civil 3D allows quick and easy inclusion of geotechnical and site investigation data in BIM models and CAD drawings. It provides:

- Geotechnical models for BIM
- Dynamic Integration of geotechnical data in the AutoCAD Civil 3D environment
- Visualisation of geotechnical boring data, allowing creation of 3D borehole layouts and sub-surfaces
- Dynamic geotechnical profiles and sections in seconds
- Civil point groups and surfaces from any data stored in HoleBASE SI
- The facility to use standard Autodesk Civil 3D commands.

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