Insurance Advisory Tips for Members

Managing Insurance Risk for Topographic Earthwork Survey Assignments

Part 3 - As-Built Surveys

By Douglas S. McGill

Mr. Douglas McGill is currently self employed (McGill Development Services Limited) and takes a special interest in earthworks science. His firm offers development management services, contract dispute resolution and approval process expertise to a variety of clients in the Greater Toronto Area. This is the third of a series of three articles to outline how the civil engineering earthworks process works and how survey data we collect fits into that process. This article looks at how the engineer relies on the original ground survey to complete earthworks balancing calculations and sources of errors that can lead to claims. Overall, earthworks related assignments are an area of work fraught with service issues and insurance claims so having a basic understanding of sources/causes of errors from all parties involved in the process can help you to manage your liability and reputation.

In this third and final instalment, we will look at the pièce de résistance of all this effort, namely the as-built survey. The outcome of this work can be fame, shame or the start of the blame game. Understanding the purpose of your work and how it fits into the development earthworks process will help you manage liability. For the purposes of this article I am going to break as-built surveys down into the following categories:

1. Topsoil stripping verification
2. Rough grading/pre servicing pre-grade verification
3. Post servicing lots and blocks pre-grade verification
4. Post servicing SWM blocks pre-grade verification
5. Stockpile quantities

The location of the first three survey efforts in a typical earthwork calculation cell is shown on **Figure 1.** Note that items 2 and 3 are targeted on the same surface but at different times. Items 4 and 5 are special conditions. Points on each of these items are expanded on under the headings below.

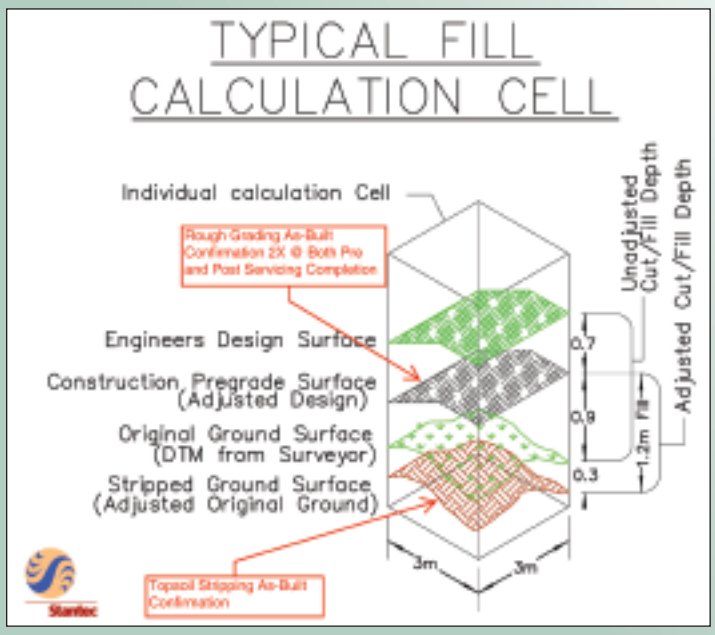

Figure 1.

Topsoil Stripping

The purpose of this survey is to provide a Digital Terrain Model (DTM) which, when subtracted from the original ground surface DTM, provides the in situ volume of topsoil stripped by the contractor from the site in the first phase of earthworks operations. This information has two uses:

- Confirming payment to the contractor; and
- Confirming that the engineers estimate of the topsoil quantity to be stripped is in reasonable alignment with actual quantity. If the engineers grading design was "balanced" (i.e. cut = fill) then a higher volume of topsoil will leave the site in deficit. Conversely less stripping will result in a surplus.

It should be noted that if the topsoil stripping data is to be useful in managing the site balance it needs to be delivered in a timely fashion. If a discrepancy is discovered early enough the results can be used to either adjust the site design or develop some other ameliorating strategy. Many aspects of completing this as-built survey are similar to the considerations already reviewed in the first article on original ground surveys and I will not repeat them here but I will add a few suggestions specific to their completion.

- When collecting the stripping data it is often collected in more than one session or day. If this is the case it is helpful to organize each collection date into a separate layer and to clearly define the stripping boundary of that day.
- If points need to be taken for a sub excavation or house demolition or any other "non-stripping" condition, delineate the boundary and annotate appropriately.
- The same consideration applies to stockpiles; identify the limits of the stockpile base even if there is no interest in the actual stockpile volume.

While the foregoing points might seem obvious, in the course of my projects, I have received original ground shots blended with stripping shots, shots on stockpiles, shots in demolished house basements and no shots in areas within the site limits that turned out to be under stockpile locations. You have to keep in mind that the recipient of these files will typically be an AutoCAD operator with the Engineering firm that has never even seen the site. He/she will take your points, build a surface and compare to original ground. Anything that is not a typical stripping shot must be clearly identified as such.

Rough Grading/Pre Servicing

Once the site grading has been completed, that is the mineral soils cut and placed in the fill areas, the site is said to be "rough graded". This will show the success of the first stage in the engineer's site balancing strategy. If the original ground topo was accurate, the topsoil stripping quantity well estimated and the quantity calculations of the design surface adjusted for pre-grades successful; then the site will be balanced (i.e. no appreciable surplus or deficit). As per the second article, the successful completion of this phase of the earthworks ends concerns with the accuracy of the original topographic survey, however the engineer is still not out of the woods yet as it will not be until after the road and house construction is completed that the validity of the pre-grades will be verified by actual results.

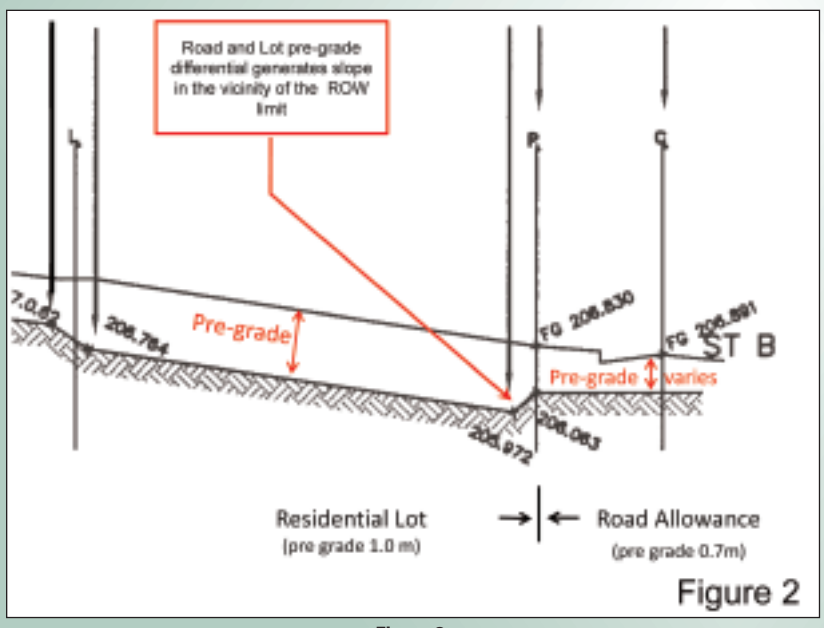

Figure 2.

The as-built survey at this point should verify that the rough grade surface is below the design surface by the designated pre-grade amounts (i.e. design grade – surveyed grade = pre-grade). As identified previously, various blocks and roads within the project have the design grade adjusted by different pre-grade values for a variety of reasons. Thus a road may be 0.7m but the lot immediately fronting on it may be 1.0m. This results in a rough grade differential in the vicinity of the ROW limit of 0.3m. You would be wise to request from the engineer the drawings issued for rough grading or even the DTM surface that was used to complete the earth balance calculations. If the site is perfectly graded, every shot when compared to the rough grade DTM (which equals design DTM adjusted for pre-grades) will match grade (i.e. have a differential of 0) or if compared to the design surface equal the pre-grade adjustment. While these statements are true for most areas of the sites, if you followed the second article closely, you will know that for some conditions (i.e. roads) this will be only approximately true (the rough grade for roads is flat whereas the design surface has asphalt crossfall, curbs and boulevard slopes). This is all clearly illustrated in **Figure 2** (a detail taken from **Figure 3**).

As always the objective of the survey is to correctly represent the surfaces involved. This in principle should be easier than an original topographic survey as the rough grade surface will typically be built out a series of flat angular surfaces. With the engineers rough grading drawings in hand you also know the dividing boundaries between them. **Figure 3** is a guideline for selecting elevation locations.

Post Servicing Lots and Blocks

Once the rough grading is completed, the municipal services and asphalt roadway are constructed within the road allowance. Grades are controlled such that the road ends up within close tolerances of its design elevation. Now if the engineer estimated the road pre-grades correctly, the pipe displacement, pipe granular bedding, road base granular and a variety of other minor factors will have displaced sufficient earth fill such that the boulevards adjacent to the roads are about 0.30m below finished/design grade. If the pre-grade value was too high the road/boulevards will be short of material and this material will be pulled from the lot areas into the road allowance. If the pre-grade value was to low there is too much material and it will be pushed out of the road allowance and into the lots. Either action will alter the previously confirmed rough grade.

Of course, as part of the road building program, the servicing trench work involved the casting of excavated earth onto the lot areas. This will trash the previous rough grade condition in the vicinity of the roads even if all is well with the road pre-grade values. At this point there will typically be a program to stake the site lots with pre-grades and complete a clean–up grading program to re-establish rough grade. It is after this clean-up by the contractor that the as-built is done.

One of the main purposes of the as-built survey is to confirm to the customer (the builder) that he/she is getting what was ordered. There will typically be a purchase and sale agreement between the developer and builder that stipulates a pre-grade value for the lot and permissible accuracy tolerances. With prices running at $6,000 or more per foot of frontage, in the GTA, the builder expects to get pretty much exactly what was ordered.

Similar to the rough grading surface survey, the post serv-

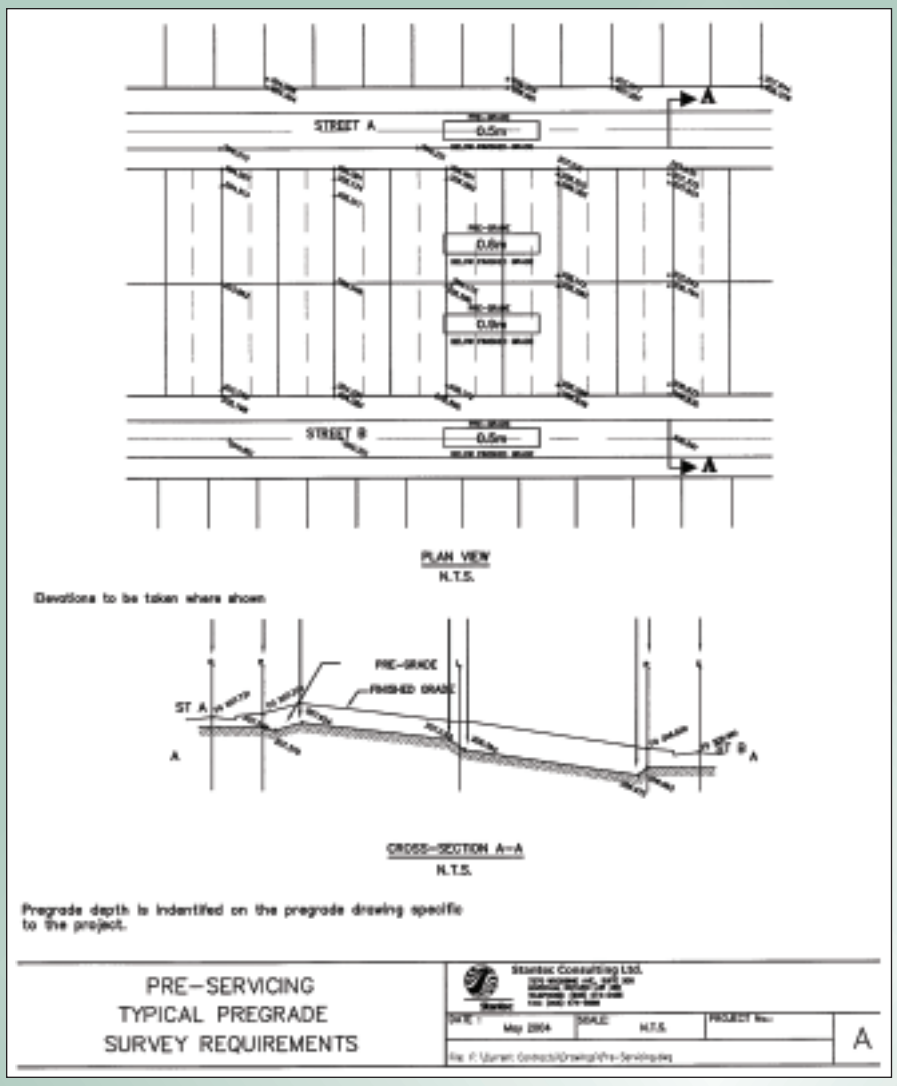

Figure 3.

icing as-built is composed of a series of flat surfaces. If the lots have a split point then this will need to be picked up as part of the surface definition. **Figure 4** shows a diagram which attempts to show a suitable patterning of point collection for this type of survey. In a number of cases I have received surveys where the points were picked up at the lot corners to allow direct comparison with the design values. These were worthless as the lot corner is typically on a slope transition between the boulevard and lot plane. The surface of interest is what correctly represents the lot condition.

Post Servicing Storm Water Management/Channel Blocks

Storm Water Management (SWM) and channel blocks are a special condition, a variety of features including access roads, sediment forebays, overland flow paths, etc. often make for some complex contour conditions that need to be accurately met. Accordingly, the surveyor collecting the as-built data needs to have some idea of what should be there so data collection can reflect the accuracy/deficiency of the existing grading. This is best achieved by providing the party chief with the engineer's design drawings so that he/she can see the location of the design features and collect point elevations on a corresponding basis. The survey should include elevation points that section the slopes at sufficient detail/density to produce a contoured plan at intervals specified on the original engineering drawings. The as-built pond/channel slope survey points should be of sufficient density to define the shape of the pond contouring with higher densities required in areas of contour curvature. My practice was to provide descriptive specifications for this work. **Figure 5** illustrates the same considerations outlined above.

Ponds should always be surveyed at the pre-grade condition (prior to topsoil placement) to ensure that they meet design volume specifications. Most SWM ponds and channels have expensive landscape programs and the time to find problems is before they go in.

Stockpiles

Point coverage as always is a function of the complexity of the shape. Irregular slopes and profile conditions require correspondingly more shots to define. Of course to define the volume of the pile you must also define a bottom to it. Preferably the bottom is a survey of the actual ground conditions before the pile is put up. If it goes onto original ground the original topo will serve the purpose. It is more frequently the case however that the area will be stripped and rough-graded, in which case this surface should be surveyed before the pile is built up. If timing does not permit this information to be collected, a poor second choice is using the points around the toe of slope to create a surface under the pile.

As-Built Summary

If you have completed an as-built survey, ensure that the results are sent out to the requesting party promptly to limit your liability. If there is a delay in getting it out and the next component of work proceeds without the check, it will typically greatly increase corrective costs. If there is any reason for delay at your end, call the client to advise and gain an understanding of the timing need.

Of course technology is changing the way this work is being done. Instead of laying out grade stakes it makes more sense to work with the DTM. When the DTM is coupled with the use of GPS, it allows for a check of site grading elevation at any point in the plan in real time. For example, if you upload the original ground topo DTM with a global lowering adjustment of the expected topsoil stripping (typically 0.3m - a DTM that the engineer has already created), a point elevation collected in the field following stripping will ideally match that elevation, if the topsoil stripping amount actually matches the estimate. Similarly, at the rough grading stage, the DTM design surface adjusted for pre-grades is a model of the desired surface and

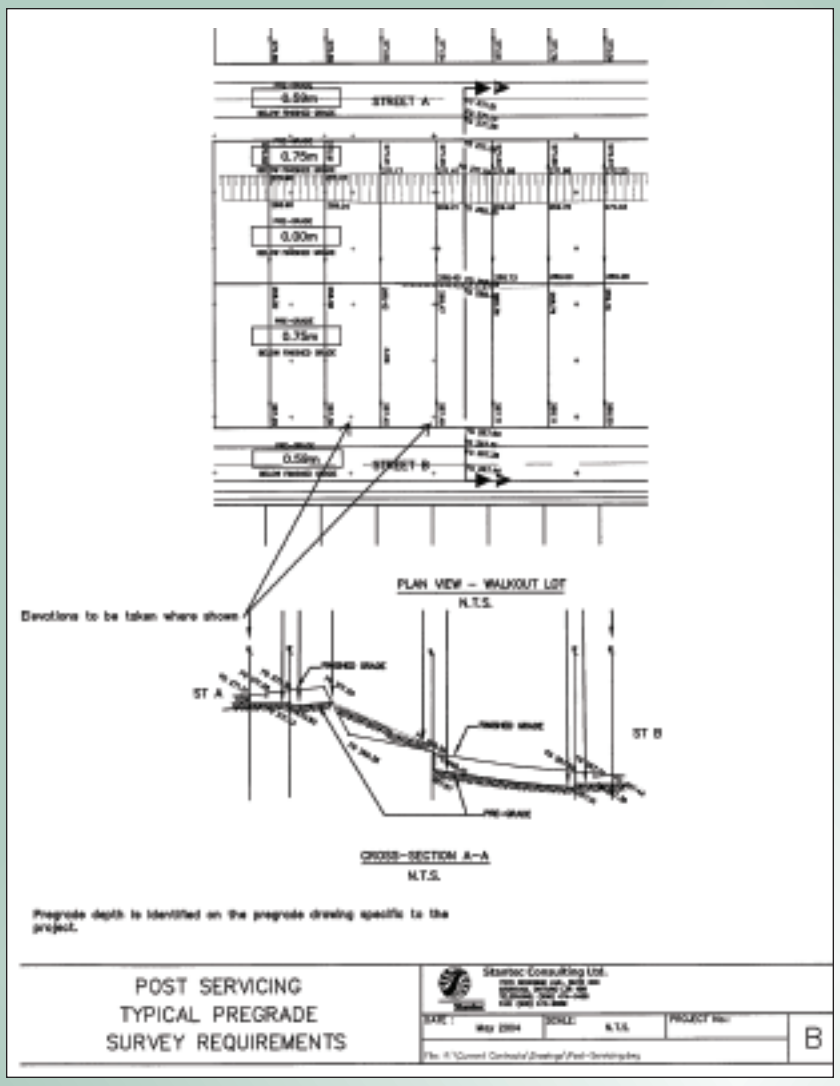

Figure 4.

this same surface serves again for the post servicing survey check.

In this day and age it would also be a nice touch to see embedded digital photos in the survey file to illustrate any unusual conditions (a picture can be worth a thousand points). With today's technology and a little imagination, your office can be creating a superior product with minimal additional costs.

Overall Summary

I hope you have found this series of articles informative in relation to your role in the development earthworks process. The major focus of my effort has been to explain how your input relates to the civil engineer's work (of necessity as I am not a qualified surveyor). I have also attempted to identify some means and insights on how you can manage your liability. Your liability is not defined by the successful outcome of a site's earthworks program but by the provision of accurate surface models of the site's topography at selected points in time to support the engineer's earthworks management effort. The most frequent causes of survey issues in this process are not typically technical. They are communication issues and a failure of one party or another to understand the task at hand. In my own experience it was very unusual to have an issue with the actual elevation accuracy of points. The problem was most often that they were not in the correct locations or were at insufficient densities to make them accurate/useful for the required as-built check.

A little research frequently showed that the survey crew was sent out with vague instructions to do a "survey" with insufficient comprehension of its use. If your office is in the regular practice of collecting as-built data, the best liability control measure is having the crew that deals with this work understand what the survey is used for and what the objectives of its use are. Armed with this knowledge and some training they can use their skills to work efficiently, provide good results and identify limiting conditions to the accuracy of the collected data.

In short insurance is for errors. It is not a cure for lack of training or lack of care.

Hopefully you have found something of value in the foregoing series. Should you have any feedback please e-mail your thoughts to **mcgill_dev_services@rogers.com.**

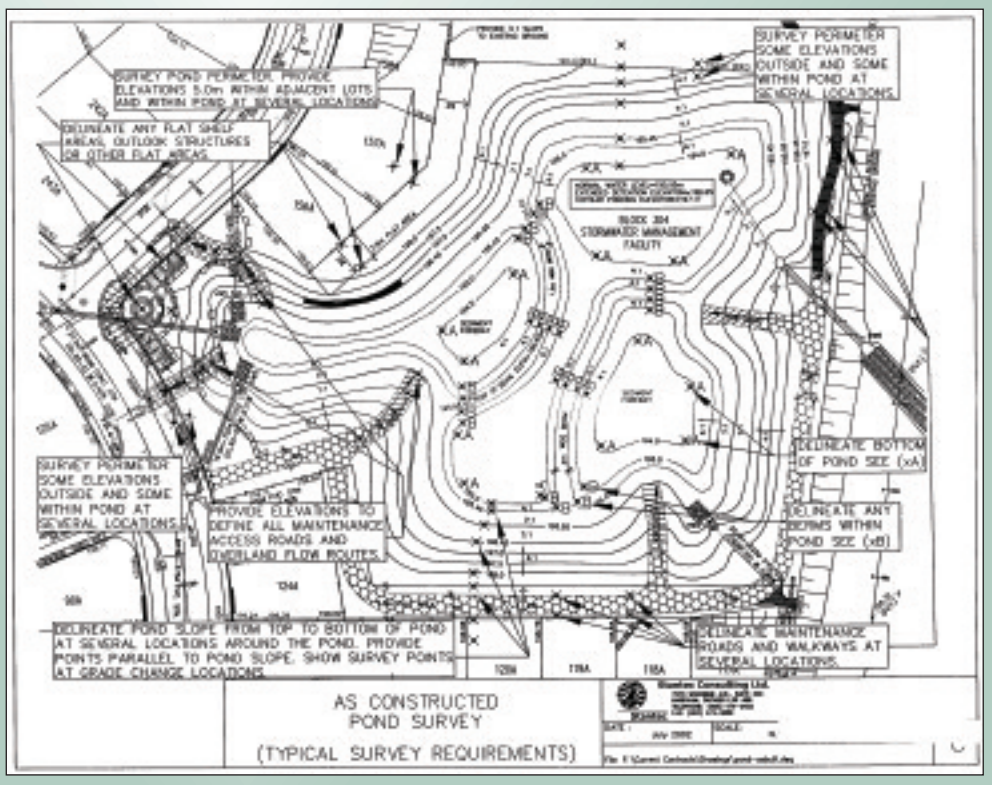

Figure 5.

NEWS FROM 1043

Changes to the Register

Members Deceased

Meldrum, Hazen Bronson	959	July 23, 2010
Robinson, Wallace Franklin	952	August 7, 2010
Seawright, Thomas	974	Sept. 13, 2010

CofA's Issued

Rouse Surveyors Inc., Toronto, September 7, 2010
NA Geomatics Inc., Stratford, September 7, 2010

CofA's Relinquished

Coyne and Whale Surveying Limited

Surveyors in Transit

Two New Appointments

Susan MacGregor has been appointed as the Surveyor General of Ontario. The Surveyor General is the Minister of Natural Resources' representative on the Council of the Association of Ontario Land Surveyors, and on the Ontario Geographic Names Board, which is responsible for recommending names of geographic features to the Minister. Susan will replace **Brian Maloney** who will be continuing his role as the Director Geographic Information Branch on a full time basis.

ServiceOntario and the Ministry of Government Services have announced that **Bill Snell** has been appointed as the Examiner of Surveys. The Examiner is the provincial authority on cadastral surveying and patented lands, acts as a tribunal chair for hearings under the Boundaries Act and is the provincial resource on all matters pertaining to surveys, plans and descriptions on patented lands. Bill can be reached by phone at 416-314-4886.

Halliday Surveying Inc. has relocated to 449 Second Avenue, Espanola, Ontario, P5E 1L2. Phone and fax numbers remain the same.

McMorran Geomatics Services (MGS) has recently moved to 332 Eckerson Ave., Stittsville, ON, K2S 0K8.

J.H. Gelbloom Surveying Limited has moved to 476 Morden Road, Unit 102, Oakville, ON, L6K 3W4. Phone, fax, and e-mail information remains the same.

J.D. Barnes Ltd., Ottawa office has relocated to 2430 Don Reid Drive, Suite 204, Ottawa, ON, K1H 1E1.

Gifford Harris Surveying Ltd. new address in Trenton is Box 5294, R.R. 5, Trenton, ON, K8V 5P8. Phone number remains the same.

As of July 1, 2010, **Hewett & Milne Ltd.** will be maintaining the records of **Coyne & Whale Surveying Limited** and **Harry R. Whale Inc.**

Kirkup & Ure Surveying Ltd. has relocated to 96 Church Street St. Catharines, ON, L2R 3C8. Phone, fax and e-mail information remains the same.

Angela Jeffray has left **Trow Geomatics** in Timmins and is now with **Kerry Boehme OLS - (A Division of Ivan B. Wallace Ontario Land Surveyors Ltd.)** in Trenton.

Tracy Rouse is the OLS in charge at **Rouse Surveyors Inc.,** located at 25 Oxley Street, Suite TH7, Toronto, ON. Phone number is 416-598-3933 and fax is 647-347-2929.

Peter Moreton is the OLS in charge of **NA Geomatics Inc.** located at 107 Erie St. Suite 2, Stratford, ON. Phone number is 519-273-3205 and fax is 519-273-7133. Consultation offices will be located in London and Kincardine.

The notes and records of **David Horwood Limited** are now owned by **Krcmar Surveyors Ltd.**

David Horwood Sr. is now consulting for **Krcmar Surveyors Ltd.**

THE AOLS IS PLEASED TO ANNOUNCE THAT THE FOLLOWING WERE SWORN IN AS ONTARIO LAND SURVEYORS:

Daniel Robinson	1931	Aug. 18, 2010	Annis O'Sullivan Vollebekk Ltd.
Peter Feren	1932	Sept. 08, 2010	Kirkup and Ure Surveying Ltd.
Yordanka Zaharieva	1933	Sept. 08, 2010	D.J. Cullen Limited
Michael Fisher	1934	Sept. 08, 2010	City of St. Catharines
Blake van der Veen	1935	Sept. 08, 2010	
Christopher Oyler	1936	Sept. 08, 2010	Coote, Hiley, Jemmett Limited