# Ontario Professional Surveyor

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*on the cover ...*

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**Engineering Gender Balance**
**Notes on Survey of a Lake Huron Shore**
**Improved Dual Frequency GPS/GNSS Precise Point Positioning**

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Volume 59, No. 1
Winter 2016

# ONTARIO PROFESSIONAL SURVEYOR

VOLUME 59, No. 1 Winter 2016

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## ON THE COVER ...

The Walter J. Blackburn Memorial Fountain, modeled after the world famous Jet d'Eau in Geneva, Switzerland, sprays over the Thames River with the cityscape of London, Ontario in the background. (Photo credit – Tourism London) Walter Juxton Blackburn was at one time the publisher of the London Free Press newspaper. The Walter J. Blackburn Foundation, a private charity in London, funds capital needs for charitable organizations in several fields including health care, social services and education.

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# President's Page

## By Travis Hartwick, O.L.S.

Well folks, this is it; the final President's Page for 2015. When I took on the position of President I thought I had a good grasp on what the membership wanted from its Council: namely, be cost effective, enforce the rules and work with the members and other organizations to position the Association for a successful future. This final page is usually the place where I highlight all the successes of the year, paint a rosy picture and bid you all farewell. But, I thought I would take a different tack this year and highlight the items that kept Council up at night and diverted our resources away from completing all of our planned goals.

The Constitutional Challenge continues to be on Council's mind and consumes resources and funds on a weekly basis. The membership is seeking answers as to merit, cost and positioning but our legal advisors are cautious in what is divulged in order that the proceedings go forward in a fair and just manner. So what do you do? There is no right answer for how to address concerns of the membership and we have come under scrutiny for avoiding the questions put to us. In the end, it is important that process and procedure be adhered to and unfortunately a certain amount of transparency must be sacrificed. While the proceeding is moving forward, it is doing so at the pace of the courts and we expect it to continue well into 2016 and possibly beyond. It is unfortunate that we are named in this proceeding as it has caused projects slated to be completed this year to be put on hold and expedited a request for additional funds from the membership.

Sketches continue to consume the time and effort of Council, Committee's and AOLS Staff. I personally have a hard time digesting the problem with this topic. It seems to me that the legislation and AOLS guidelines are clear and that some of the members are choosing not to follow the rules. I can certainly understand the frustration we feel when other disciplines such as, Planners, Architects, and Engineers create products that compete with us when we are forced to follow the rules created by our legislation. If OLS firms are not following the rules and creating an uneven playing field for other OLS firms then evidence should be gathered and a formal complaint should be lodged.

CPD is a hot topic of late. It is hard to believe that with all the communications between the AOLS office and the membership that we have had people call the AOLS office in November and say "I hear there is some CPD thing that I have to do before the end of the year. Can you tell me what that is about?" Really? How can this be possible? We have spoken about CPD in every venue for the last 3 years. This is not new folks. As of December 2015 we have 73 members (14%) not participating in the program and 43 members (8%) who are not on track to complete the CPD requirements by the end of the month. It is clearly written in our regulations that CDP is mandatory and Council has taken a hard stance on this. We intend on enforcing compliance to the best of our abilities. There was/is no intention for Council to use CPD as a "sword"; we want CPD to be a "shield" for our members; something that ensures they are current on the affairs of the AOLS, best practices for their business, and the case law and technical advancements in our field of practice.

Along with the few items that challenged Council, there were many items that were addressed that will move the Association in a positive direction. The Professional Standards Committee has completed the update of their manual and it is now a current, sound reference resource. AERC, PAC, UCSLC and GRLC continue to do great work and we are seeing the highest number of Articling Students in years. The Complaints and Discipline Committees continue to provide essential services to ensure public confidence and integrity of our members. The AOLS book is well on its way and is shaping up to be a fantastic synopsis of the Association. CEC continues to be a strong committee and is providing many quality educational opportunities for our members. The AOLS AGM in London Ontario is coming together nicely and will provide great debate and "out of the box" learning opportunities for our members. We were able to address all of the motions out of the 2015 AGM. We have been instrumental in furthering the collaboration between sister Associations and Professional Surveyors Canada. The list goes on.

With your help on Council and Committees, I believe we can continue to accomplish our goals and I am confident that the future leaders of the Association will continue to point us in a positive direction. It was truly a pleasure to serve as your President. I would like to take this opportunity to thank our Executive Director Blain Martin and the AOLS staff for their support and hard work. I will leave you with one final thought. In our business we find that the best calculators and drafts people are those who have worked in the field and similarly, the best field people are those that have spent time in the office. I think the same is true for our membership. The strongest Association that we can have will be made of people who have experienced both the Association side of our profession and the practical side of our profession. Please take an active and positive role in moving our profession forward.

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# Notes on Survey of a Lake Huron Shore

By R.J. Stewart, B.Sc., O.L.S., C.L.S.

Lake Huron is an inland water body; being non-tidal, the normal ambulatory water's edge is the limit of the bed of the lake for Ontario cadastral survey purposes.

Many Ontario townships were laid out with shore road allowances adjoining Lake Huron. Retracement of the inner (or, upper) limits of shore road allowances is always a challenge due to the uncertainty of the natural physical features from which they are measured—an uncertainty that is exacerbated where shores are subject to geomorphological change. The inner limit of a shore road allowance is a boundary fixed in position, generally 66 feet from the position of the natural boundary at the time of the survey.[1] But water lines—and some other natural features found at lake shores—are not fixed in position, and often ambulate due to changing water levels or physical erosion and accretion.

Where lakes have been artificially flooded—such as the many reservoir lakes that feed the Trent-Severn system—surveyors have generally found ways to determine underwater contours that reasonably represent pre-flooding lake conditions. Geomorphological effects are not usually significant on relatively small lakes, whether flooded or not, due to factors such as short fetches and, in many cases, bedrock shores. However, many Lake Huron shores—especially in southern Ontario—are composed of sand or gravel beaches, which are particularly vulnerable to the effects of factors such as changing water levels[2], longshore drift, and virtually unlimited fetch resulting in significant wave action during high wind events. As a result, determining the position of the fixed-in-position inner limit of a shore road allowance that was laid out over 150 years ago can be a challenge.

## Saugeen Township: A Specific Example

Saugeen Township is bounded on the northwest by Lake Huron, with dynamic sand and gravel beaches throughout. The township was surveyed for settlement in 1847 and 1851. In a recent survey of a portion of Lot 26 in the Lake Range of Saugeen Township, the question of the position on the ground of the lakeward limit of the Lake Range lots was raised due to inconsistencies in survey retracements over several decades.

The original plan of Saugeen Township (see Figure 1) appears to show a shore road allowance, but most of the Lake Range lot lines are drawn through what appears to be the shore road allowance. The ambiguity leads to questions that can only be answered by researching underlying sources of information. Was a shore road allowance in fact laid out? If so, how does a surveyor today retrace the inner limit of the shore road allowance?

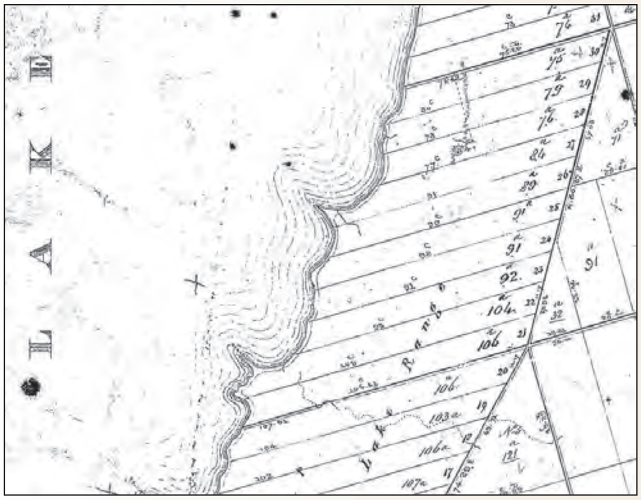

Figure 1. Portion of Original Saugeen Township Plan (SR 2047).

## 1847 PLS Wilkinson Survey[3]

Pursuant to Specific Instructions dated 21 September 1847, Provincial Land Surveyor (PLS) Alexander Wilkinson laid out lots fronting on Lake Huron for Huron Township (70 lots), Kincardine Township (70 lots), Bruce Township (70 lots), and Saugeen Township (60 lots). In the course of the survey, PLS Wilkinson ran a shore traverse and placed posts on the shore to mark the positions of all lot lines.

PLS Wilkinson was not instructed to lay out a shore road allowance along Lake Huron; and on the plan, the various lot lines extend to the edge of Lake Huron. Notwithstanding, the plan includes a note along the portion of the shore that subsequently became the Township of Huron, which states, "*There is a road allowance along the shore 1 chain in width — the lot posts are placed on the east side of the road*" (see Figure 2).

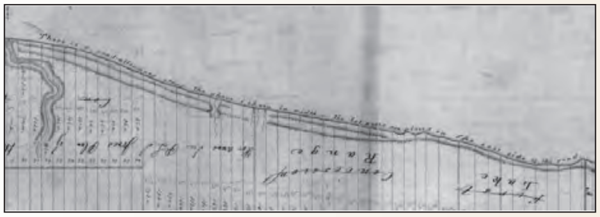

Figure 2. Portion of PLS Wilkinson's 1847 plan (P19-8, SR 6663).

In addition, the field notes demonstrate that a shore road allowance was laid out; each of Wilkinson's posts was marked with an "R" on the side facing the lake, indicating that the posts were placed on the boundary of a road allowance. As of 1847, then, it is clear that a shore road allowance was intended for each of the four townships. The question remains: can the positions of PLS Wilkinson's posts be reasonably retraced today?

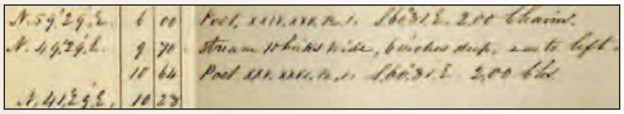

**Figure 3. From page 84 of PLS Wilkinson's 1847 field notes (FNB 1323).**

Of concern in the recent survey, PLS Wilkinson placed a post to mark the north corner of Lot 25, which is also the west corner of Lot 26, Lake Range. The post was marked "*XXV, XXVI, R, 1*" (for "Lot 25, Lot 26, Road, Concession 1". (See Figure 3). The post is no longer extant. The stream ("*10 links wide, 6 inches deep*") crossed by PLS Wilkinson in Lot 25 is likely the same stream that exists today; but, because of the sandy soil of the upper part of the beach, and the effect of several intervening periods of very high water levels, the current location of the creek cannot be relied upon to retrace PLS Wilkinson's traverse. There are no other physical features that would lead to a precise retracement of PLS Wilkinson's traverse and posting.

However, PLS Wilkinson's traverse must have been located on the beach where he would have had clear sights for significant distances—for example, 10.64 chains across Lot 25 and 10.23 chains along the first leg through Lot 26 (see Figure 3). The water level of Lake Huron was about 176.5 metres at the time of PLS Wilkinson's survey, which is very close to the all-time (since 1918) mean level of 176.44.[4] The sand and gravel beach at the subject location is relatively flat; and, at that water level, there was a significantly wide beach available for PLS Wilkinson to make a clear traverse along the shore.

PLS Wilkinson did not run any of the side lines of the lots that he laid out. In addition, the rear corners of the lots were not marked or surveyed; in fact, when the Township of Saugeen was surveyed in 1851 (reviewed below), the rear line of the Lake Range was run for the first time in a different location than that anticipated by Wilkinson's plan.

## 1851 PLS Vidal Survey[5]

Following Specific Instructions dated 13 January 1851, PLS Alexander Vidal surveyed the Township of Saugeen pursuant to the 1,000-acre sectional system, modified to fit particular idiosyncrasies of the territory; specifically, the irregular lake shore and the fact that the Township was substantially a gore bounded on the northeast by the Saugeen Road. PLS Vidal's Instructions did not direct him to provide for a shore road allowance along the lake; however, shore road allowances were introduced (although not consistently applied throughout the province) as a standard feature of the 1,000-acre system in 1850. As noted above, the plan drawn by PLS Vidal, dated 8 September 1851, indicates that a shore road allowance along the lake was created as part of the township subdivision; but most of the side lot lines of the various adjoining lots were drawn through the shore road allowance to the lake.

PLS Vidal did not run a shore traverse.[6] Instead, he accepted the posts placed by PLS Wilkinson in 1847 as marking the inner limit of the shore road allowance (Vidal report, FNB 1711, page 204). With the exception of Wilkinson's side roads, PLS Vidal did not measure to the lake or to any of Wilkinson's posts. The Wilkinson posts were simply adopted as marking the respective Lake Range lot corners. Because PLS Vidal accepted PLS Wilkinson's posts (a) as lot corners and, by extension, (b) as defining the inner limit of a shore road allowance, the shore road allowance was recognized by PLS Vidal in his survey of the entire township. The challenge is to retrace the positions of those posts today.

PLS Vidal used PLS Wilkinson's side road posts to govern the positions of the corresponding concession lines. For example, the posts placed by Wilkinson to mark the location of the side road between Lots 10 and 11 were used to commence Vidal's survey of the line between Concessions 2 and 3 (FNB 1711, page 50); the posts placed for the side road between Lots 20 and 21 were used to commence the survey of the line between Concessions 4 and 5 (FNB 1711, page 60); and the posts placed for the side road between Lots 30 and 31 were used to commence the survey of the line between Concessions 6 and 7 (FNB 1711, page 69).

PLS Vidal's field notes are inconsistent in describing the edge of the lake; notwithstanding, where mentioned at all, the notes indicate that PLS Vidal found the posts to be at least 1 chain (66 feet) away from the waters of Lake Huron:

- At the "*Town line between Saugeen and Bruce … Post N$^{o}$ 1. Saugeen on the left, and N$^{o}$ 70 Bruce on the right … Posts on East side of Lake Shore Road 1$^{c}$.50$^{l}$ East from High water mark Lake Huron*" (FNB 1711, page 41)
- At the "*Road between 2$^{nd}$ and 3$^{rd}$ Concessions … between Lots N$^{os}$ 10 & 11 of the Lake Range – Posts being 1$^{c}$.08$^{l}$ from High water – Lake Huron*" (FNB 1711, page 50)
- At the "*Road between 4$^{th}$ and 5$^{th}$ Concessions … between Lots N$^{os}$ 20 & 21 of the Lake Range: Centre Post being 2$^{c}$.65$^{l}$ from High water – Lake Huron*" (FNB 1711, page 60)
- At the "*Road between 6$^{th}$ and 7$^{th}$ Concessions … between Lots N$^{os}$ 30 & 31 of the Lake Range – Posts 3 ch from water – sandy Beach*" (FNB 1711, page 69)
- At the "*Road between the 8$^{th}$ and 9$^{th}$ Concessions, & 40 & 41 Lake Range … Posts on the East side of the Lake Shore Road"* (FNB 1711, page 72)
- At the "*Road between 10$^{th}$ and 11$^{th}$ Concessions … at the Side Road between the Lake Range and N$^{o}$ 9*" (FNB 1711, page 78)

***cont'd on page 6***

PLS Vidal included a sketch at only one of the above notes, specifically at page 60 (see Figure 4), which demonstrates that the 4/5 Concession line (20/21 side road) intersected the shore at a sharp angle resulting in a measurement of 2.65 chains to "*High water*", taken in the direction of the concession line. This configuration results in a perpendicular calculation of 1.0 chain separating the posts from "*High water*".[7]

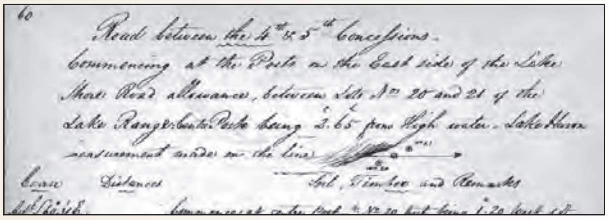
60
Road between the 4th & 5th Concessions
commencing at the Posts on the East side of the Lake
Shore Road allowance, between Lots No 20 and 21 of the
Lake Range, both Posts being 2.65 from High water. Lake Huron
measurement made on the line
Course Distances Soil, Timber and Remarks

Figure 4. Portion of page 60 of PLS Vidal's field notes.

It is not certain as to what PLS Vidal meant by "*High water*". However, the water level of Lake Huron at the time of his survey work in 1851 was about 177.2 metres—which is a very high level. PLS Vidal may have measured from the water's edge, which was at a high level, or he may have measured from a physical "mark" somewhere above the water. It was more likely the latter: it would be an unlikely coincidence for the 1851 water's edge to precisely match the dry physical feature that Wilkinson (arbitrarily) chose to measure from in 1847. Such a "*high water mark*"—the specific words were used once, on page 41—could well have been a physical indication left on the shore by the all-time high water level of 178.0 metres which occurred in the summer of 1838, 13 years before PLS Vidal was on the ground and only 9 years before PLS Wilkinson's attendance.

As noted above, PLS Vidal did not run a shore traverse, did not measure to PLS Wilkinson's post at the line between Lots 25 and 26, and did not survey the line between Lots 25 and 26. Consequently, nothing in the field notes of PLS Vidal provides any direct evidence in positioning the shore road allowance at the subject site. However, the notes are useful to the extent that, as shown above, PLS Vidal found PLS Wilkinson's posts to be about 1 chain from "*High water*".

## Resolution

Lake Huron is non-tidal; consequently, whenever the term "high water mark" is used, the meaning must be drawn from (and will vary with) context. In the above-described circumstances, PLS Vidal used the term once, in the same context as the words "*High water*". In each instance, PLS Vidal was measuring from a mark on the ground, whether it was the water's edge at a very high water level or a literal "mark" on the ground (again, probably the latter).

In this particular case, the topography of the shore was of assistance. A small acclivity was observed in the vicinity of the landward edge of the beach, the bottom of which was approximately at elevation 177.5 metres, close to the 178.0-metre all-time high level (Figure 5).

Figure 5. Illustration of Acclivity.

While it is impossible to show that today's "acclivity" is the same physical feature that PLS Vidal or PLS Wilkinson observed over 160 years ago, this determination fit well with the "high water mark" shown on a nearby subdivision plan that was surveyed in 1947. In addition, that positioning put the location of the 1847 PLS Wilkinson shore traverse on the beach, which was compatible with the long traverse segments recorded in the 1847 field notes. Consequently, in the absence of any evidence to the contrary, the acclivity was accepted as the best evidence of the edge of Lake Huron from which PLS Wilkinson set out the one-chain distance to place his scribed posts.

The above-described solution will not be the answer in every case. Other parts of the same shore may not have the same type of "mark" on the shore. In every case, it is the best available evidence that will guide retracement. The challenge is to be thorough enough to find the best evidence, and also to be flexible enough to follow the evidence wherever that path leads.

[1] *Monashee Enterprises Ltd. v. Minister for Recreation and Conservation for B.C.*, Re (1981), 28 B.C.L.R. 260, 21 R.P.R. 184, 124 D.L.R. (3d) 372, 23 L.C.R. 19 (C.A.); *White v. Rosseau (Village)* (1995), 24 O.R. (3d) 826 (Gen. Div.).

[2] The water level of Lake Huron varies naturally through a range of over six feet.

[3] PLS Wilkinson's plan is dated 21 October 1847 and is archived with the OSG as P19-8 (SR 6663). When he drew the plan, PLS Wilkinson had more information about the shoreline than he set out in his field notes. The field notes, archived in FNB 1323, do not contain any ties to the lake, but the plan includes points of land that are still there today. PLS Wilkinson did not indicate the source of the shore detail; perhaps he had records of the c.1820 hydrographic surveys by Lt. H.W. Bayfield, R.N.

[4] IGLD1985 is the datum for all water levels in this article. Historical IGLD1985 monthly mean water levels from 1918 to 2013 for the Great Lakes can be obtained from the Canadian Hydrographic Service at http://www.tides.gc.ca/C&A/network_means-eng.html.

Pre-1860 water level information has been taken from Quinn, Frank H. and Cynthia E. Sellinger, *Lake Michigan Record Levels of 1838, a Present Perspective*, J. Great Lakes Res. 16(1):133-138, Internat. Assoc. Great Lakes Res., 1990, p. 137. Lake Michigan and Lake Huron are considered to be a single water body for water level purposes. The methodology of determining water levels in the Quinn and Sellinger paper does not result in precise levels, due to the paucity of controlled data. However, the data, which is provided to the nearest tenth of a metre, is relevant as a guideline, especially in the absence of any better data.

[5] PLS Vidal's plan is dated 8 September 1851 and is archived with the OSG as C21 (SR 2047).

[6] PLS Vidal's field notes, diary and report are archived at the OSG as FBN 1711.

[7] PLS Vidal measured chainages along the centerline of the concession road allowance. From his centerline post he measured chainages of 1.2 chains to each of the lot posts, resulting in a centerline chainage of 2.4 chains between the two lot posts. This is in conflict with that which PLS Wilkinson reported in his field notes. While Wilkinson did not run the side lines, his posts were planted such that the chainage between the posts calculates to be only 0.72 chain. This would lead to a conclusion that Vidal planted his own posts, but the Vidal report states explicitly that he "*ran the Concession Roads lines from Mr Wilkinsons* [sic] *posts on the Lake shore fronts*". The discrepancy—which is insignificant to this study—can only be attributed to blunder.

# Improved Dual Frequency GPS/Galileo Precise Point Positioning

By Akram Afifi, Ph.D. and Ahmed El-Rabbany, Ph.D., P.Eng., Department of Civil Engineering, Ryerson University

The use of the Precise Point Positioning (PPP) technique proved to be capable of providing positioning solutions at the sub-decimeter-level accuracy. PPP accuracy and convergence time are controlled by the ability to mitigate all potential errors and biases. A number of un-differenced and between-satellite single-difference (BSSD) GPS PPP models have been developed since early 2000 (see for example, Kouba and Héroux, 2001; Elsobeiey and El-Rabbany, 2014). For a single Global Navigation Satellite System (GNSS) constellation, BSSD linear combination cancels out all receiver-related biases, assuming that multipath does not exist. Elsobeiey and El-Rabbany (2014) showed that, as a result of eliminating the receiver-related biases, a faster PPP convergence time is obtained through the BSSD GPS PPP model. More recently, Afifi and El-Rabbany (2014) showed that combining the un-differenced GPS and Galileo observations in a PPP model improves the solution convergence time by about 25%, in comparison with the GPS-only counterpart.

In this article, a new PPP model, which combines GPS and Galileo observations in a BSSD mode, is presented. Two scenarios are considered when forming a BSSD. In the first scenario, either a GPS or a Galileo satellite is selected as a reference for both GPS and Galileo observations. The second scenario, on the other hand, considers two reference satellites: a GPS reference satellite for the GPS observables and a Galileo satellite for the Galileo observables. The first scenario is commonly referred to as tight combination, while the latter is commonly referred to as per-constellation or loose combination (Odijk and Teunissen, 2013). Precise orbits and clock corrections from the International GNSS Service multi-GNSS experiment (IGS-MEGX) network are used to account for the GPS and Galileo satellite orbit and clock errors (Montenbruck et al., 2014). As these products are presently referenced to the GPS time and since we use mixed GNSS receivers that also use GPS time as a reference, the GPS to Galileo time offset is cancelled out in our model. The inter-system bias is either cancelled out through differencing of the observations or is treated as an additional unknown parameter. The hydrostatic component of the tropospheric zenith path delay is modelled through the Hopfield model, while the wet component is considered as an additional unknown parameter (Hopfield, 1972; Hofmann-Wellenhof et al., 2008). All remaining errors and biases are accounted for using existing models as shown in Kouba (2009). It is shown that the newly developed GPS/Galileo PPP model improves the precision of the estimated parameters by about 50% and 25%, in comparison with the un-differenced GPS-only model, when the loose and the tight combinations are used, respectively. In addition, the solution convergence time is reduced to 10 minutes for both BSSD scenarios, which represents about 50% improvement in comparison with the GPS-only PPP solution.

## GPS and Galileo BSSD PPP Model

To verify the developed GPS/Galileo PPP model, GPS and Galileo measurements at six globally-distributed stations (Figure 1) were selected from the IGS tracking network (Dow et al., 2009). Those stations were occupied by GNSS receivers, which are capable of simultaneously tracking the GPS and Galileo constellations. A total of 12 datasets representing the GPS/Galileo measurements over two different days, namely January 1, 2014 and July 8, 2014, were processed. A one-hour data span with four visible Galileo satellites for each dataset was considered in our analysis. All datasets had a sampling rate of 30 seconds.

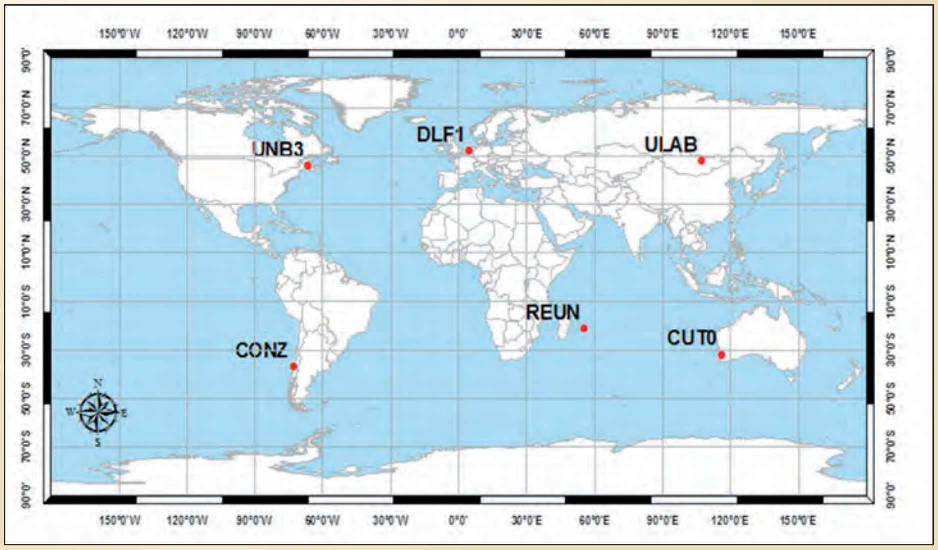


Figure 1. Analysis stations

The positioning results for stations DLF1, and UNB3 are presented below. Similar results are obtained for the other stations. However, a summary of the convergence times and the three-dimensional PPP solution standard deviations are presented below for all stations.

Natural Resources Canada's GPSPace PPP software was modified to handle data from both the GPS and Galileo systems, which enabled a combined GPS/Galileo PPP solution as detailed above. The PPP solutions for the proposed GPS/Galileo BSSD model as well as the traditional un-differenced ionosphere-free GPS/Galileo and GPS-only PPP models were obtained. The latter results were used to assess the performance of our newly developed PPP model.

Figures 2 to 4 summarize the positioning results in the East, North, and Up directions, respectively, for all analysis modes. As can be seen, the un-differenced GPS-only PPP solution indicates that the model is capable of obtaining a sub-decimetre level accuracy. However the solution takes about 20 minutes to converge to decimetre level accuracy. On the other hand, the addition of Galileo observations reduces the convergence of the un-differenced PPP solution to about 15 minutes.

Considering the first scenario (i.e., tight combination) of the newly developed ionosphere-free BSSD GPS/Galileo PPP model, we processed all datasets twice: the first considers a GPS satellite as a reference for both GPS and Galileo observables, while the second considers a Galileo satellite as a reference. As can be seen in Figures 2 to 4, almost identical positioning results are obtained with an average convergence time equal to 10 minutes. We also processed the datasets through the loose combination PPP model and obtained a comparable convergence time to the first scenario. However, the performance of the loose combination model was better than that of the tight combination model within the convergence interval. In comparison with the GPS-only PPP model, the newly developed BSSD model improved the PPP solution convergence by about 50%. Figure 5 summarizes the convergence times for all analysis cases, which confirm the PPP solution consistency at all stations.

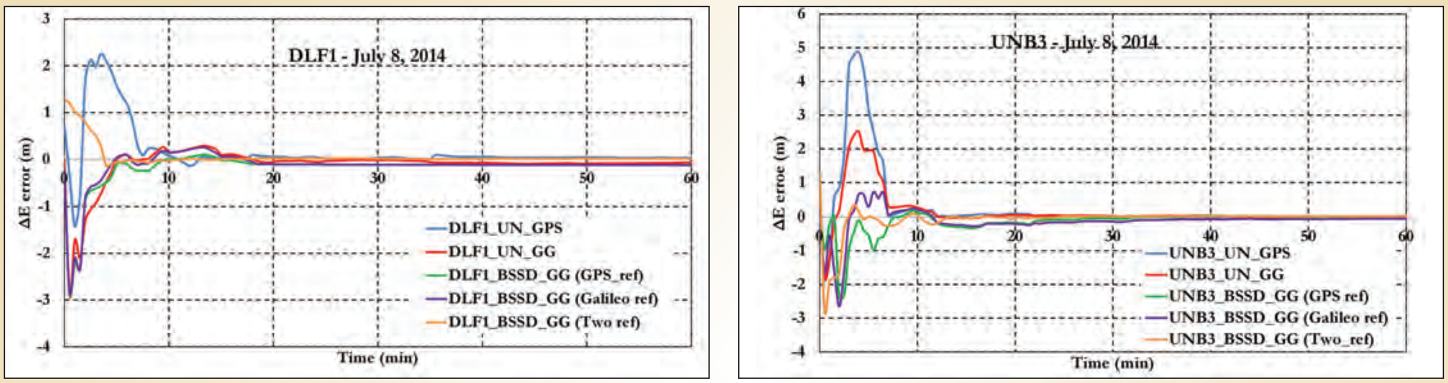


**Figure 2. Positioning errors in East direction**

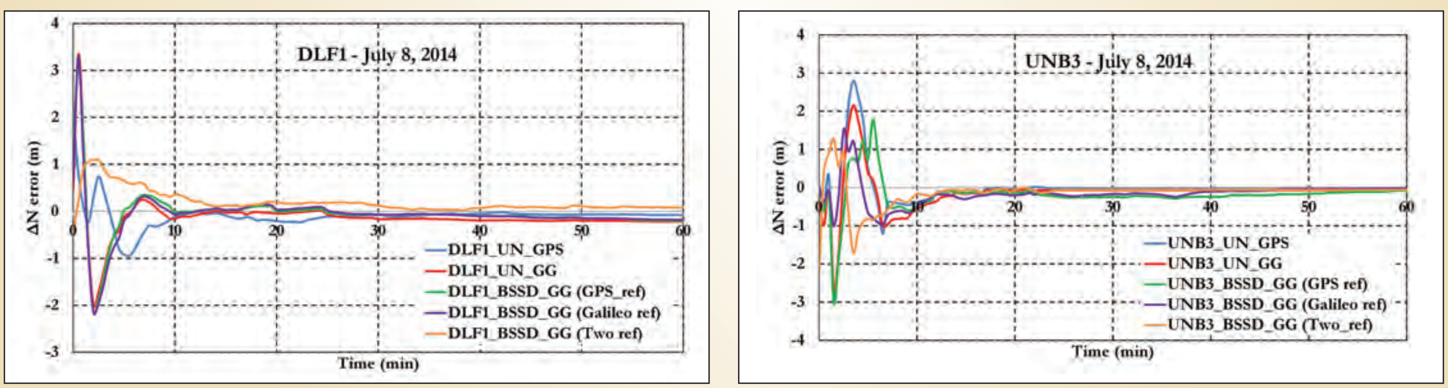


**Figure 3. Positioning errors in North direction**

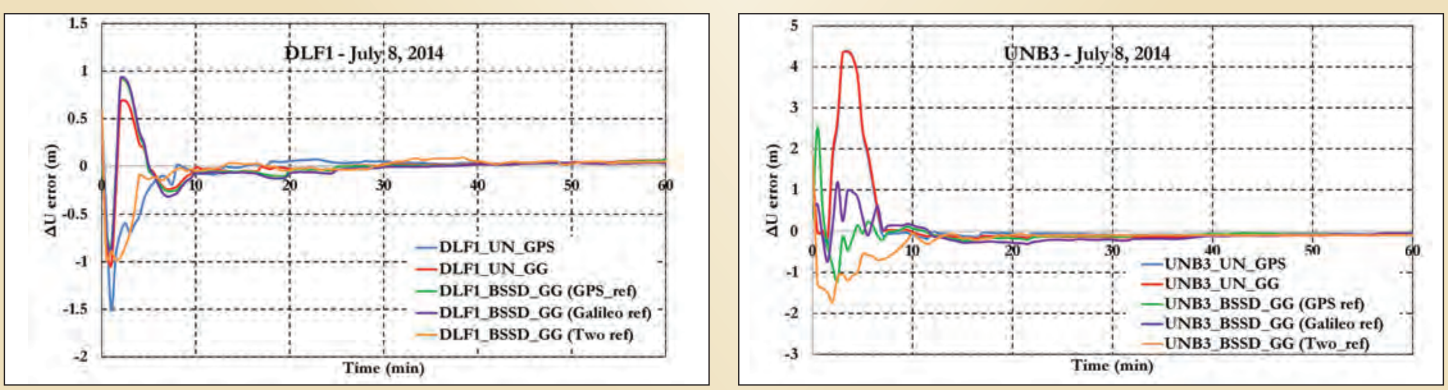


**Figure 4. Positioning errors in Up direction**

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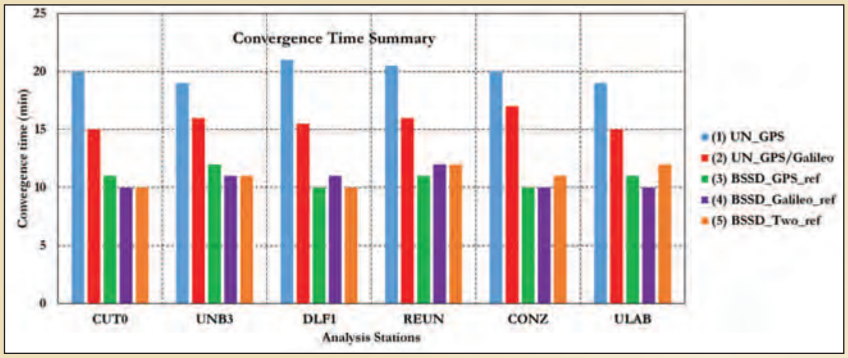


**Figure 5. Summary of convergence times of all stations and analysis cases. (1) Un-differenced GPS model; (2) Un-differenced GPS/Galileo model; (3) BSSD model with a GPS satellite as a reference; (4) BSSD model with a Galileo satellite as a reference; (5) BSSD model with both a GPS and a Galileo satellite as reference satellites**

To further assess the performance of the various PPP models, the solution output was sampled every 10 minutes and the standard deviation of the computed station coordinates was calculated for each sample as shown in Figure 6.

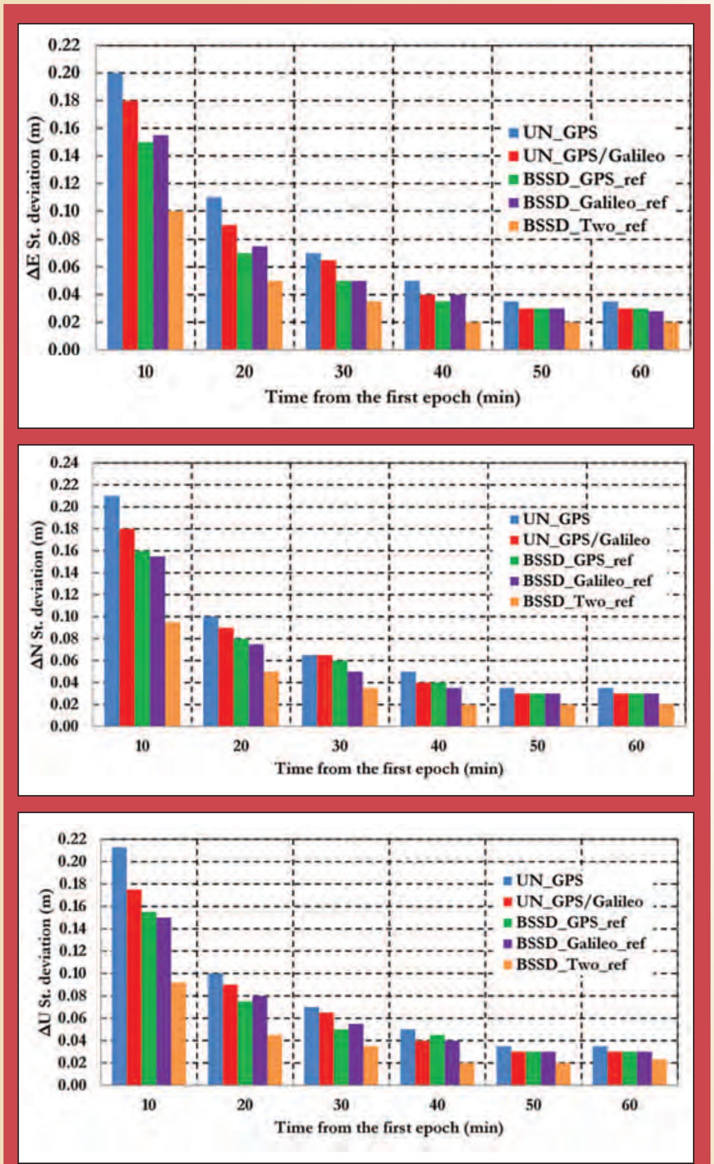


**Figure 6. Positioning standard deviations in East, North, and Up directions**

Examining the standard deviations after 10 minutes, it can be seen that the newly developed GPS/Galileo PPP model improves the precision of the estimated parameters by about 50% and 25%, in comparison with the un-differenced GPS-only model, when the loose and the tight combinations are used, respectively. As the number of epochs, and consequently the number of measurements, increases, the performance of the various models tends to be comparable. An exception, however, is the loose combination model, which is found to be superior to all other PPP models.

## Conclusions

Two scenarios have been considered when forming BSSD, namely loose and tight combinations. It has been shown that the newly developed PPP model improves the solution convergence time by about 50%, in comparison with the un-differenced GPS PPP model, regardless of the type of BSSD combination used. In addition, the newly developed model improves the precision of the estimated parameters by about 50% and 25%, in comparison with the un-differenced GPS-only model, when the loose and the tight combinations are used, respectively. As the number of epochs increases, the performance of the various models tends to be comparable. An exception, however, is the loose combination model, which is found to be superior to all other PPP models. Almost identical results are obtained through the tight combination when either a GPS or a Galileo satellite is selected as a reference.

## Acknowledgments

This research was partially supported by the Natural Sciences and Engineering Research Council (NSERC) of Canada, the Government of Ontario, and Ryerson University. The GNSS data and the satellite precise products used in our analysis were downloaded from the International GNSS service (IGS) website.

Please contact **Dr. Akram Afifi** by email at **akram.afifi@ryerson.ca** and **Dr. Ahmed El-Rabbany** at **rabbany@ryerson.ca** for further information.

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# Third Annual Boundary Law Conference

## *Enhancing Parcel Title by Re-Thinking Parcel Boundaries*

By Izaak de Rijcke

Four Point Learning hosted the Third Annual Boundary Law Conference, a full day of Continuing Professional Development for Lawyers and Surveyors alike, in Guelph on November 16, 2015. Unlike last year, the weather did not pose any challenge. This event began on Sunday evening with a short meet and greet and then dove into the substance of papers and presentations early the next morning. The conference involved presentations from land surveyors as well as speakers from private practice, government, law school and one judge. Topics were generally grouped around the theme, "*Enhancing Parcel Title by Re-Thinking Parcel Boundaries,*" and this worked well in keeping a common thread for all of the separate presentations. Mr. Ken Wilkinson, Examiner of Surveys, opened the day and set the tone for the many presentations which followed.


Craig Carter

This year featured a contribution by the Honourable Justice R. Raikes who kindly agreed to be interviewed by me on the topic, "*Thinking Like a Court: What does* Quasi-judicial *actually mean?*" It was the decision of Justice Cooley of the Michigan Supreme Court in *Diehl v. Zanger* which saw this expression used in describing the function of a land surveyor. The interview with Justice Raikes was insightful for those in attendance because it gave everyone an opportunity to reflect on the work of the surveyor in a retracement in which evidence was evaluated and filtered in reaching an opinion on a boundary's location.

A conference which explores this theme cannot do it justice without also taking into account increasing expectations from the public to deliver boundary line, property corner establishment, and retracement services in a virtual environment. This challenge was addressed in a topical presentation with the title, "*A Legal Framework for Embracing Boundary Location Using Only Coordinates*." Increasing capacity to model boundary location using digital mapping is challenging our traditional views of how evidence based on co-ordinates is treated. In my presentation I addressed these changes with a view to describing a framework for understanding the changes needed in the legal framework for determining boundary location.

Anne Cole delivered an excellent paper titled, "*Beyond a Code of Ethics: Integrity and Fairness as Defining Qualities of the Professional's Mindset.*" The idea of what constitutes the profile of the professional person in today's society is broader than what might be seen as enumerated in a *Code of Ethics*. Her paper was especially helpful in giving extensive insight on this subject. This presentation was followed with an update of the law of evidence – especially as it relates to

## Sites to See

### GeoAlliance Canada

**http://geoalliance.ca/en**

GeoAlliance Canada is a new umbrella organization that will provide leadership to fuse together the energy and resources of existing geospatial business, non-profit, education and government organizations. It will create a neutral platform for members of the geo community to network and collaborate on projects of mutual interest. The AOLS is a founding member.

expert evidence and the new treatment of expert evidence by the courts. Speaking on the topic, "*Technical Evidence in the Courtroom: An Update on the Presentation of Scientific and Complex Evidence in Boundary Disputes*", Megan Mills delivered a synopsis of what to expect when appearing in court as an expert witness.

The presentations in the afternoon started with a workshop-styled approach to solving especially difficult title and boundary problems in the land registration context. Both Ron Mak and I focused on four practical examples which spoke to the implementation of a solution when it involved working with the description for a PIN and, through collaboration of lawyers and surveyors with professionals working in the land registration system, to obtain a court order to settle and quiet outstanding title interests and title uncertainty. Practical examples and redacted forms from actual court proceedings were made available to illustrate what an application for a court order or judgment looks like.

We were especially fortunate to have real estate lawyer Craig Carter find time in his busy schedule to speak about the implications of a recent court case involving an encroachment of a structure into an easement. His presentation was titled, "*New Thinking about Easements: What has* Weidelich v de Koning *done to the Relevance of Easement Boundaries?*" and it prompted all of us to think differently about what may be emerging as new law in Ontario. This was followed by my presentation on behalf of Robert Fenn called, "Adverse Possession and the Inconsistent Use Test: *Does this Apply in Ontario?*" We know that in a post-*LTCQ* environment, there is no longer room for adverse possession. However, in addition to the many *Registry* non-converts which remain vulnerable to adverse possession, occupation on the ground often continues as misaligned with the legal boundary location. The uncertainty which flows from this all too common situation deserves careful assessment. Managing this risk and avoiding litigation was the focus of this presentation.

Collectively, this year's presentations again explored a wide range of thought-provoking issues and questions around the central themes of title and boundary certainty. In doing so, conference attendees also received a binder with copies of the several papers and resources that offered ideas for best practices and future solutions in the ever evolving world of boundary law. The event qualified for CPD credits for both Ontario Land Surveyors and Lawyers in Ontario. Conference materials for this and the last two years' events are available through Four Point Learning at http://fourpointlearning.ca . Given the popularity and success of this year's conference, plans are indeed underway for the fourth annual event.

# Advertiser's News

## Data Integration of Geospatial Technologies

### Submitted by Cansel Professional Services

### Introduction

The field of surveying is a profession based on the fundamentals of geometry and the use of specialized tools to collect and lay out the angles and distances that are necessary for the design and construction of the physical infrastructure in the world around us. Surveying tools and techniques have continued to evolve over time leading to the development of new technologies which allow modern surveyors to capture more information more quickly than previously possible. The benefit of these advancements is further accentuated by the high level of accuracy of the data captured when compared to that of survey data in a traditional survey. In order to meet the advancement of hardware, processing software and techniques have also evolved to allow surveyors the ease of processing the large amount of data collected. This article will discuss three technology tools and software used by modern surveyors to capture and process a complete data set to be used in design and construction.

### New Technology Tools

#### • Scanning

Phase-based scanning has taken the place of the selective data collection practices used in the past. At one time, it was necessary for a surveyor to collect attributes of specific points that would allow a draftsperson to complete a dimensional rendering of what was observed. Extensive field notes were required to accurately portray field observations to allow an accurate rendering to be produced, on which future plans and designs could be based. Often detail and accuracy were lost in the relay of information and created inaccuracy in the rendering from the item being observed. Phase-based scanning tools use a wave of light to capture a return of large groups of points which together can be referenced to a single point of origin allowing their placement on a plane or map. The groups of points that are captured are easily identifiable to the human eye and allow a comprehension of detail not possible with traditional survey techniques. The accuracy of the detail captured helps eliminate error in use of the point clouds when used for reference, measurement or design.

#### • UAV

While phase-based scanning offers exceptional detail and accuracy, its practical application becomes limited when a large area needs to be observed and lesser accuracy is acceptable. Unmanned aerial vehicles (UAVs) offer the ability to observe large areas at moderate altitudes in a very efficient manner. Like the stereoscopic images of the past, UAVs use high definition cameras to capture images that are used to create a three dimensional rendering of the area below their flight path. The data captured by UAVs is coupled with powerful software that allows the production of three dimensional surface data accurate to centimetre level. From the modelled surface, it is possible to make accurate measurements, comparisons, design decisions and observations as well as have a permanent record of the site observed.

#### • V10 Imaging Rover

The use of UAVs is extremely efficient at gathering large amounts of data that are easily manipulated to create surface data, however, there are situations where more information is required. Challenges such as large vertical surfaces or features shielded from the view of the UAV's camera can inhibit total product quality by compromising the totality of the data set. A ground-based deployment of the same photogrammetric technology is the solution to such a challenge, enabling a user to first capture the overhead data by means of a UAV, quickly create a surface and analyze any gaps in the data. The same user can then deploy ground-based photogrammetric techniques to fill the gaps before leaving the site.

### Data Fusion to Current Tools

Large areas can be observed quickly and accurately using UAV technologies. Ground-based photogrammetric techniques can then be applied to fill any void in the data captured by the UAV. Any area of great importance is then collected using phase-based scanning technology which promises the most accurate record possible. Finally, it is possible to merge all three data sets into one, allowing a complete picture in one convenient format for future use.

### Data Workflow

This section explains some of the technical aspects of the three new technologies and illustrates their basic workflows and deliverables.

#### • Scanning

A scanning project goes through a detailed process from the data collection until the first level of deliverables which is point cloud data. The process starts by creating survey plans prior to conducting the scans to define rough locations for the scanner and the reference points that will be used to tie the scans together. This step is essential to insure the completeness of the point cloud and reduce the back end time required to stitch the scans together. Then, the data

*cont'd on page 16*

collection starts by physically setting up the scanner at the drafted location and placing markers in their appropriate places. The markers are used to tie scans together and if needed, they can be used to reference the scans to a known coordinate system. The individual scans need to be correctly aligned through processing software in order to make up a complete point cloud. The final deliverables from scanning depend on the application and can be BIM (Building Information Modeling), DSM (Digital Surface Model), or volume calculations, etc. Figure 1 illustrates the scanning workflow from data collection to point cloud generation.

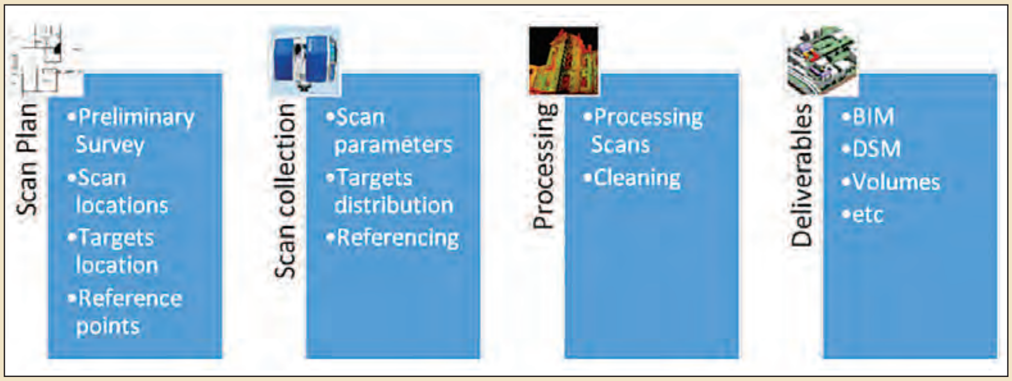


Figure 1: Scanning workflow diagram

In this article, the FARO Laser Scanner Focus3D X 330 is used to demonstrate the data delivered from the scanning workflow. The Focus3D X 330 is a high-speed 3D scanner with extra-long range measurement capabilities that can scan objects up to 330 metres away with an accuracy of ±2 mm and scan speed of up to 976,000 points per second by means of an interface with an easy to use touch screen. These advances in performance do not come at the expense of safety as the model has a Class 1 'eye safe' laser. It has a high measurement speed and delivers extraordinary scan data quality at extended range with very low noise. The left side of Figure 2 below shows the Focus3D X 330. This scanner was used for the purpose of this article to scan a house and create a point cloud. The house, shown in the right side of Figure 2, was scanned with five scanning setups and three spheres/targets per scan. The FARO SCENE 5 software was used to stitch the individual scans together to generate the point cloud. The expected accuracy using this surveying tool is in the range of 2 mm.

## • UAV

Figure 3 shows the workflow when using a UAV. The first step of the process, project planning, is flight design and preparation, which includes creating a mission that defines the flight area. The takeoff and landing locations are also defined at this stage along with total area parameters, such as the image overlaps (between 70-90%) and flight elevation. The next step of the process requires ground targets to be distributed in the flight area and surveyed to relate target coordinates to the flight data captured. The camera parameters are then adjusted according to the weather conditions before flying the UAV. The flight can take a few minutes up to a few hours depending on the battery life and the system design. Once the flight is complete and a safe landing is made the user can download the information for processing. Different deliverables can then be generated at the final step of the process based on the application.


Figure 3: UAV workflow diagram


Figure 2: FARO Focus3D X 330 and scanning point cloud

In this article, the Trimble UX-5 system shown in Figure 4 is used for UAV data capturing. The UX-5 system includes a hand-held Trimble Tablet Rugged PC which controls all flight planning as well as flying the aircraft. The UX-5 cruises at an 80 Km/hr air speed and can fly for ~50 minutes.

Figure 4: The UX-5 System, with launcher

The Trimble UX-5 aerial image data can be processed into final deliverables with the Trimble Business Center (TBC) Photogrammetry Module. TBC will follow multiple steps of processing before generating the deliverables; these steps are interior orientation, tie point generation, bundle block adjustment and image matching. TBC does not need a large degree of user interaction after the import of the images and log files, along with definitions of the ground targets with observed coordinates. TBC will then extract the tie points and do the adjustment using a powerful processing engine to create the deliverables (orthomosaic, point cloud, and raster DSM). Figure 5 shows the deliverables, point cloud and orthomosaic of a flight made using an UX5 system above the house that was shown in Figure 2.

Figure 5: Point cloud (right) and orthomosaic (left) for the same area scanned in the earlier section

## • Imaging Rover - V10

The Trimble V10 Imaging Rover is an integrated camera system that precisely captures 360 degree digital panoramas which are used to visually document and measure the surrounding environment. A total of 12 calibrated cameras provide complete site documentation that can be used to make photogrammetric measurements.

The workflow for the Trimble V10 Imaging Rover is shown in Figure 6. The collection strategy is designed in the first step of the process based on the target that needs to be surveyed in accordance with the accuracy requirement of the project. It may be necessary to identify the tie points or in some cases to place artificial distinguishable targets in the project planning step in order to improve the results of the data processing. The images are captured in the second step of the workflow. If a position sensor is integrated in the setup (such as a GNSS receiver or a prism), the position information is collected simultaneously in this step. The field procedure of the V10 Imaging Rover is as simple as using GNSS or traditional total station surveying because the image data is captured simultaneous to their use. The acquired data is then processed using the TBC Photogrammetry Module included in the advanced version of the software. The final step of the workflow is to generate the required deliverables defined by the application of the data. The most common deliverable produced using this technology is a 3D model of the area captured where you can measure any point you see in the pictures. A Google Street View or a point cloud can also be generated from the processed images.

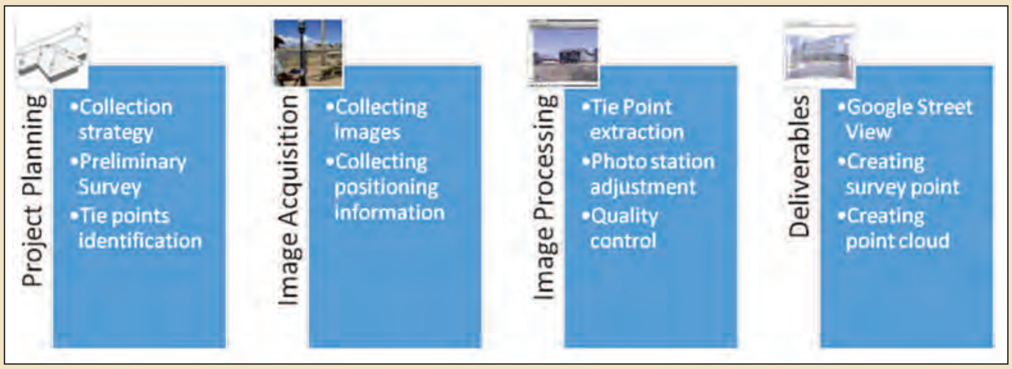


Figure 6: V10 workflow diagram

In this article, the Trimble V10 Imaging Rover with GNSS was used for the collection of geospatial information of the target object. The V10 images were captured in six points for 3D modeling. Figure 7 shows the V10 Imaging Rover integrated with a Trimble R8 GNSS receiver.

Figure 7: V10 Imaging Rover

cont'd on page 18

## Sample Scenarios: House

The house shown in Figure 2 was surveyed with the three different technologies explained in the previous section. This test was performed with the goal to show how the outputs of these technologies are matched.

The V10 measurements around the house were compared to the results of the phase-based scanning. It was seen that the differences between the V10 results and those from the scanning cloud matched with a maximum difference of 3 cm. The same behaviour was observed in the comparison of the UX-5 results and the scanning results as the difference between them reached up to a maximum of 3 cm. Figure 8 shows the integration of the deliverables from the three technologies. Figure 9 shows the difference between the density of the point clouds obtained from scanning and using a UAV.

Figure 8: Deliverables from UX5, V10 and scanning integrated together

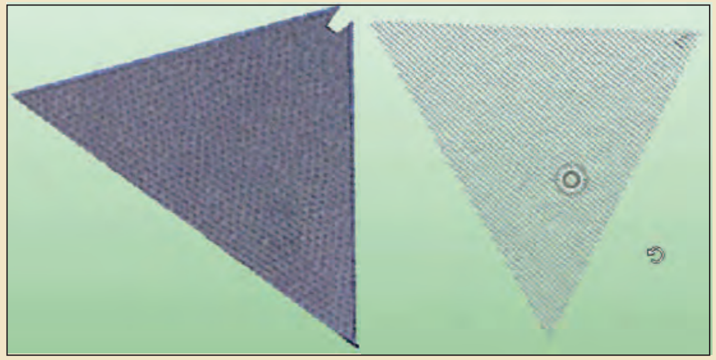

Figure 9: Scanning point cloud on the left and UX5 point cloud on the right for the same part of the roof

As was mentioned before, the scanning and photogrammetry accuracies are expected to be in millimetre and centimetre levels, respectively. It was also demonstrated that the deliverables of all three technologies are matched together very well within the accuracy of each technology. Therefore, the surveyors' decision and the project requirements will define which technology is better to efficiently complete the deliverables.

## Cansel Professional Services

Cansel offers state-of-the-art technologies for a wide variety of industries. We offer specialized workflows and training services to help you maximize your business opportunities using these technologies. Examples of the use of new technologies in various industries will follow in future articles. Cansel offers the tools and expertise to help your business from field to finish. For further information contact **Ahmed El-Ghazouly,** P.Eng., Ph.D., M.Sc., Professional Services Manager by email at **Ahmed.El-Ghazouly@cansel.ca**

# Esri Canada GIS Ambassador Program

By Jean Tong, OCT, Manager, K-12 Teaching and Learning

Are you a passionate professional who recognizes the ways in which geography matters to all of us and are you interested in supporting young people? If so, consider becoming a GIS Ambassador. We strongly encourage Geographic information system (GIS) users in industry and higher education, who are keen on supporting the use of GIS in K-12 education, to join with us, become a GIS Ambassador, and get involved in promoting critical spatial thinking among young Canadians. By becoming a GIS Ambassador, you and the organization you work for can engage Canadian youth and help them to develop a deeper understanding of the world around them.

There are a number of ways that a GIS Ambassador can support K-12 educators and youth group leaders. For example, you can:

- Open your doors and invite students to your workplace so that they can experience how GIS software is actually used in a production environment,
- Present a lesson to a K-12 class on the use of GIS in your area of work,
- Provide local data for K-12 teachers and students to use in projects,
- Facilitate a hands-on workshop for teachers in the use of GIS, or
- Work on a community project in conjunction with K-12 student participation.

The Education and Research group at Esri Canada supports GIS Ambassadors in the community in a number of ways. Specifically, we:

- Connect GIS Ambassadors with local educators, schools or youth groups,
- Provide activities that are age-specific and connected to provincial/territorial curricula,
- Provide presentation materials for teachers to use in the classroom, and
- Promote the individuals/organizations who are directly involved in the Canadian K-12 GIS education community.

Visit **esri.ca/ambassador** for more information or contact **k12@esri.ca**

# Calendar of Events

**February 9 to 11, 2016**

**13th Annual ORCGA DIG SAFE Symposium**
*Blue Mountain, Ontario*
**www.orcga.com**

**February 10 to 12, 2016**

**GIM International Summit 2016**
*Amsterdam, The Netherlands*
**www.gimsummit.com**

**February 24 to 26, 2016**

**124th AOLS Annual General Meeting**
*London, Ontario*
**www.aols.org**

**May 4 to 6, 2016**

**National Surveyors Conference 2016**
*Edmonton, Alberta*
**www.acls-aatc.ca**

**July 12 to 16, 2016**

**ISPRS XXIII Congress**
*Prague, Czech Republic*
**www.isprs2016-prague.com**

**October 31 to November 3, 2016**

**GIS-Pro 2016 – URISA's 54th Annual Conference**
*Toronto, Ontario*
**www.urisa.org**

# Engineering Gender Balance

## *The Lassonde School of Engineering at York University is Canada's first engineering school to set a goal of 50:50 gender balance*

By Marisa Sterling, P.Eng.

"By twelve years old, most girls can't do math."

"If they study science, they will have to give-up arts or sports."

"High school physics is too hard for girls anyways."

It is not uncommon to hear these statements from parents, teachers, friends, relatives, classmates and girls themselves. Possibly without realizing it, an unconscious bias has been established in Canadian society dissuading girls from the fields of math and science.

It's no wonder that so few girls and women become engineers. In 2015, women held only 12 per cent of licenses to work in the engineering profession across Canada.

Almost 25 years ago, I was part of a speaker's panel that discussed how to encourage more women into professions. I spoke about engineering, and recent female graduates of law and medicine spoke about their respective professions.

Today, the professions of medicine and law are leaders in inviting and encouraging women into their fields, but engineering has barely made a dent. From 1991 to 2013, the undergraduate enrolment of women in engineering programs across Canada went from 16.1 per cent to 19.0 per cent, an increase of just 2.9 per cent over a 22 year period.

A tremendous amount of outreach and effort by numerous organizations over these years has been focused on drawing girls into engineering with programs like science camps, coding sessions and robotics clubs. As valuable as these activities are, the profession has seen little change in its gender split.

> **"By twelve years old, most girls can't do math."**
>
> **"If they study science, they will have to give-up arts or sports."**
>
> **"High school physics is too hard for girls anyways."**

Canada needs more women in engineering. Research has shown that if a group includes more women, its collective performance rises. Gender diversity also shows a positive effect on team innovation in ground-breaking research. With Canada ranking just 26th globally for business innovation, this is clearly an opportunity to drive economic growth with a diverse set of contributions.

It is predicted that Canada is facing major impending labour shortages in fields like engineering. By excluding women from the engineering profession, a highly competent and productive segment of the labour market is currently underutilized. Thus, promoting women's advancement in engineering would diversify this field that is expected to power much of Canada's economic engine, meet projected labour demands, and boost innovation and productivity.

The Lassonde School of Engineering at York University has taken a leadership role to address this complex problem of women's underrepresentation in engineering. On March 3, 2015, it made a bold announcement during National Engineering Month and ahead of International Women's Day.

The School launched the Lassonde 50:50 Challenge to become the first engineering school in Canada to reach a 50:50 gender balance.

"Achieving a 50:50 gender balance should be a necessity for every engineering school. It is the single most significant change we can make to improve engineering education in Canada," said Janusz Kozinski, founding Dean of the Lassonde School of Engineering at the time of the launch.

The Lassonde 50:50 Challenge is the first of its kind in Canada. I was selected as the School's first Assistant Dean, Inclusivity and Diversity to lead this project. Alongside me are two honourary co-chairs, Silicon Valley entrepreneur and philanthropist Sandra Bergeron, and Katty Kay, journalist and co-author of The Confidence Code and Womenomics. It is a real honour to be a part of this team affecting change on an issue so close to my heart.

I believe achieving this goal calls for a comprehensive approach including changing cultural biases and beliefs about what men and women do best throughout their education, training and professionalization.

At the public and high school level, we will support initiatives that help girls view themselves as competent in math and science, and help girls associate their desire to help people and society with being an engineer. For example, girls are interested in solving climate change, ending poverty and designing tools that help people – all outcomes that an engineer can contribute to. So we will focus on programming that helps girls find a fit between their own values and what they perceive engineers do.

The Lassonde School has been created to be the home of Rennaissance Engineering: a place where students are free

Krystel Reyes (left) and Amelia Kishlyansky are the very first recipients of The AOLS Educational Foundation Women in Geomatics Engineering Entrance Awards

to explore their passions and gain different perspectives from the world around them. Our Renaissance undergraduate curriculum will give students a truly multi-disciplinary education. With the opportunity to take courses in law, business and international development alongside engineering, students can explore ideas such as social entrepreneurship.

We will experiment with the teaching environment to support female students' full participation. The "flipped classroom" model at Lassonde encourages students to discover answers in small groups working collaboratively with professors and classmates. This marks a shift away from traditional lectures and textbook learning, toward a focus on problem-solving and hands-on learning. In addition, inclusivity training for professors and students will create an "identity safe" climate to allow for the full participation of everyone regardless of their gender identity.

Our co-op and internship programs will provide specialized training to help students prepare, before entering the workplace, how to confront gender bias and encourage gender inclusive policies at the companies where they work. Our goal is to create allies in men and women within the engineering profession to reduce stereotype threats that can discourage women from staying in engineering, as their profession of choice, after their education.

Lastly, we will review the pathways for women into post-graduate studies and professorships to increase the role models for female students and the research outcomes for the School.

The Lassonde School of Engineering is grateful for the leadership of the Association of Ontario Land Surveyors (AOLS) in helping us reach the goal of gender balance. In addition to the eleven financial awards that the AOLS currently provides for Lassonde students, this fall the AOLS introduced two new Women in Geomatics Engineering Entrance awards designed specifically for female high school graduates. The inaugural winners are Amelia Kishlyansky and Krystel Reyes.

Now is the time for all of us to embrace this challenge. I look forward to working with the many experts and engineering schools that are also committed to this long overdue social change. Reaching 50:50 is a bold ambition and one that I am confident we will achieve, together.

**Marisa Sterling,** P.Eng, serves as founding Assistant Dean, Inclusivity and Diversity, of the Lassonde School of Engineering at York University. She leads the strategy and implementation of the $1.5 million initiative to achieve 50:50 gender balance at the school. Marisa speaks regularly on topics affecting women in engineering. If you would like to partner with Lassonde towards the 50:50 Challenge, please contact Marisa at **marisa.sterling@lassonde.yorku.ca**

# UAV aerial surveys for validation of RADARSAT-2 imagery

By Julien Li-Chee-Ming, Dennis Sherman and Costas Armenakis

## Introduction

Water is an important resource and information about surface water conditions can help a wide variety of applications including hydrology, meteorology, ecology, and agronomy. Wetlands have several functions including water storage and retention, which can reduce flooding and provide continuous flow for hydroelectric generation and irrigation for agriculture. Synthetic Aperture Radar is well suited as a tool for monitoring surface water by supplying acquisitions irrespective of cloud cover or time of day. The Remote Sensing Science program of the Canada Centre for Mapping and Earth Observation for the RADARSAT Constellation Mission (RCM) is using Satellite Interferometric Synthetic Aperture Radar (InSAR) for water level estimation, polarimetry for flooded vegetation, and image thresholding for surface water delineation. A small Unmanned Aerial System (sUAS) is used to provide low altitude aerial surveys in support of the InSAR water level project where ground validation is required.

## Test site

The study site is the Peace Athabasca Delta (PAD). It is located partially within the southeast corner of Wood Buffalo National Park, Canada's largest national park, and also spreads into the Regional Municipality of Wood Buffalo, west and south of the historical community of Fort Chipewyan. The study area consists of four unique locations within Wood Buffalo National Park, selected in order to coincide with RADARSAT-2 image acquisition locations and dates. The locations of the four sites are shown in Figure 1.


**Figure 1. Locations of the study sites within Wood Buffalo National Park.**

RADARSAT-2 passed over the area on June 27, 2015 (Figure 2). The image is projected in NAD83 UTM Zone 12N. The test site chosen to run the validation process was a segment of the Quatre Fourches River. The extent was about 1 km by 2 km, delineated by the red rectangle in Figure 2.

The UAV aerial survey was performed on the same day by Julien Li-Chee-Ming and Dennis Sherman, members of York University's GeoICT Lab.

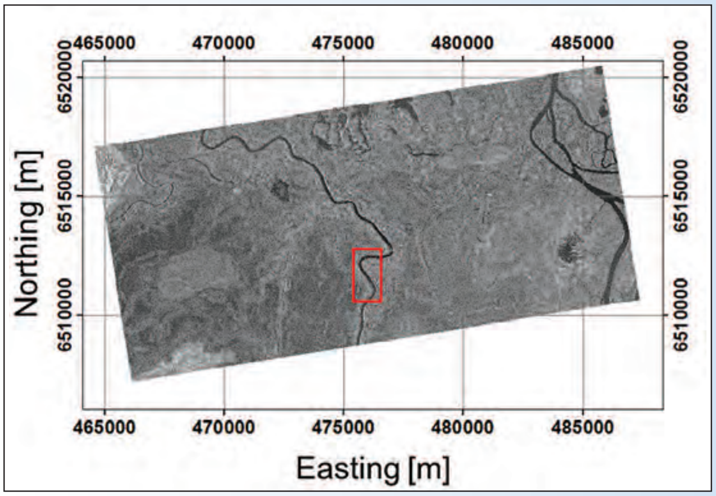


**Figure 2. Validation site for the RADARSAT-2 image.**

## UAV aerial survey

The DJI Phantom 2 Vision Plus UAV quadcopter was used for the aerial survey (Figure 3). It was equipped with a 14MP camera, with 110 degree FOV, on a 3-axis gyro stabilizing gimbal. There was a Naza-M V2 autopilot onboard, which consisted of a single frequency GPS receiver, a MEMS IMU, and a digital compass. The time of each flight was about 15 to 20 minutes depending on wind and flight patterns.

Flights were conducted using both manual remote control and pre-planned flight grids. While the pre-planned grids were useful for systematic coverage of a given study area, it was found to be inefficient due to the large scale homogeneous ground coverage features without water (e.g. large mud flats, large grass land regions). Surveying these areas resulted in blocks of images without information useful to the study. As a result, the UAV was flown in manual mode to follow the river. This required a two person crew. One person piloted the Phantom and maintained line of sight. The second person used the real-time video feed and telemetry provided by the app to instruct the pilot. A third person was present in case of emergency. A sample of the images collected by the UAV is shown in Figure 4.

**Figure 3. Dennis Sherman preparing for takeoff.**

**Figure 4. Sample image from the DJI Phantom 2 Vision+ wide-angle camera, flying 90 metres above ground level (detail: the two operators are next to the boat).**

Using the Pix4D Capture App (Figure 5), the quadcopter was able to automatically fly gridded waypoints, remain at an altitude of 90 m above ground level throughout the flight,


**Figure 5. Pix4Dmapper Capture – Android app (source: play.google.com)**

and keep 80% front overlap and 40% side overlap. The ground coverage per image was approximately 100 $m^2$ with a ground resolution of 3-4 cm. In manual control, the Phantom's autopilot provided flight stabilization, and the Pix4D Capture App automatically triggered the camera every 20m.

## Data processing

The photogrammetric processing software Agisoft

*cont'd on page 24*

Photoscan (www.agisoft.com) was used to generate ortho-mosaics from the images collected by the UAV (Figure 6).

The work flow is as follows:

1. Laboratory camera calibration.
2. Photogrammetric triangulation of UAV captured aerial images using image feature matching.
3. 3D point cloud generation using dense image matching.
4. Surface modelling of 3D point cloud using a triangular surface mesh cloud.
5. Ortho-mosaic generation.
6. Fine georeferencing of the ortho-mosaic using ground control points (GCPs) surveyed with Trimble R9 GPS units.

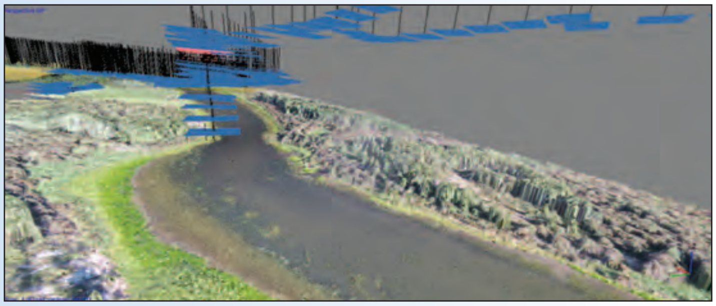

**Figure 6. Generation of ortho-mosaics from UAV imagery in Agisoft Photoscan. (Blue areas and black vectors represent the images and their perspective centres.)**

Figure 7 shows the workflow to validate land/water delineation from RADARSAT-2's Synthetic Aperture Radar (SAR) imagery. The top left image shows the area of interest in the SAR image (2 m resolution). The bottom left image is the corresponding UAV ortho-mosaic (5 cm resolution). Four GCPs, indicated in the images with green circles, were used for the fine georeferencing. Supervised classification was used to classify each image into water and non-water (vegetation) pixels. A median filter removed the salt and pepper noise, the edges were then extracted using a spatial Laplacian filter.

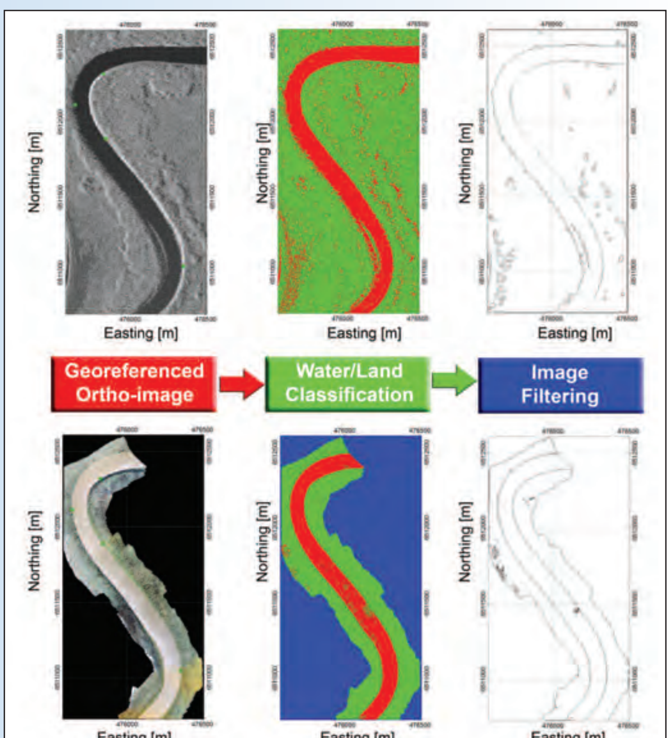


**Figure 7. Workflow to validate extracted land-water boundary from SAR imagery (top row) and UAV ortho-mosaics (bottom row).**

## Results and Analysis

The red edge in Figure 8 (top left) is the land-water boundary extracted from the SAR image in Figure 7 (top right), the green edge is the boundary, extracted from the UAV ortho-mosaic in Figure 7 (bottom right). CloudCompare (http://www.danielgm.net/cc/), an open source point cloud processing software tool, was used to quantify the difference between the extracted edges. The Cloud to Cloud (C2C) comparison tool was used to measure the distances between the two boundaries, shown in Figure 8 (top right). The C2C function takes in a "reference" point cloud and a "compared" point cloud. A distance is calculated from every point in the reference cloud, along its normal vector to intersection of the compared cloud. In this case, the reference point cloud consisted of the edge pixels derived from the SAR data. The compared point cloud consisted of the edge pixels extracted from the UAV ortho-mosaic.

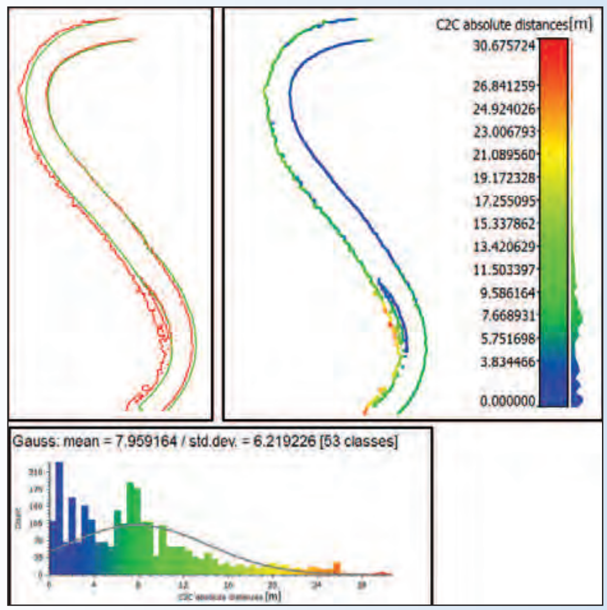


**Figure 8. Left: Visual comparison between the land-water boundary extracted from the SAR image (red) and UAV ortho-mosaic (green). Right: CloudCompare's Cloud to Cloud (C2C) comparison. Every edge pixel of the land-water boundary from the SAR image is shown, the colour represents the closest distance from that point to a point in the UAV dataset. Bottom: Statistics for the calculated distances.**

The eastern bank aligned well between the two datasets (within 4 m, or 2 pixels). However, the western bank extracted from the SAR image was much noisier. Also, the western bank did not align as accurately between the two datasets (up to 30m, or 15 pixels). The SAR image was captured while the satellite was ascending and looking right. This suggests the western boundary was not captured in the SAR image because RADARSAT-2's line of sight was blocked by the vegetation just west of the bank.

## Conclusions and Future Work

Aerial surveys using small unmanned mapping systems continue to gain popularity as low altitude remote sensing tools. This article presented a process for using imagery collected by a small UAV to validate wetland mapping products derived from SAR satellite imagery. Future work includes using data collected from the UAV to validate other SAR thematic products, namely, water level estimations and classifying other land cover types, such as flooded vegetation and uplands.

**Julien Li-Chee-Ming** is a Ph.D. candidate at York University. He obtained his B.Eng and M.Sc in Geomatics Engineering at York University. His research interests include low-cost navigation systems, urban 3D modelling, and rapid mapping with unmanned vehicle systems. He can be reached at **julienli@yorku.ca**

**Dennis Sherman** earned his Bachelor of Engineering from the Lassonde School of Engineering at York University. He is currently completing his Master of Science in Earth and Space Science focusing on photogrammetry and remote sensing techniques to estimate sea ice thickness and volume. He can be reached at **dsherman@yorku.ca**

**Costas Armenakis,** Ph.D., P.Eng., is an Associate Professor and Undergraduate Program Director of the Geomatics Engineering program, York University. His research interests focus on unmanned mobile sensing and mapping systems and applications. He can be reached at **armenc@yorku.ca**

# Update of an appeal of the decision in "Case No. 883"

By J. Chester Stanton, MBA, B.Sc., O.L.S., C.L.S., O.L.I.P.

*The Municipal Resurvey: The Resurrection*, written by John Barzo and me, was published in the Ontario Professional Surveyor, Volume 57, No.1, Winter 2014. The article was based on Surveyor General of Ontario, Susan F. MacGregor's decision in "Case No. 883" in which she confirmed the location on the ground of a road allowance. The Surveyor General's decision was appealed to the Ontario Divisional Court in the form of: Lawrence Dale and Betty Dale v The Corporation of the Township of Tiny, 2015 ONSC 7340. On December 3, 2015 the court's decision was released; the Surveyor General's decision was upheld and the appeal was dismissed. Details of the case can be found at:

http://www.canlii.org/en/on/onscdc/doc/2015/2015onsc7340/2015onsc7340.html?resultIndex=1

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# NEWS FROM 1043

## Changes to the Register

### Members Deceased

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| Douglas H. Black | 729 | Sept. 29, 2015 |
| James K. White | 1180 | Oct. 18, 2015 |

### Retirements/Resignations

| | | |
|---|---|---|
| Robert J. Mann | 1668 | Oct. 31, 2015 |
| Russell W. R. Jones | 1282 | Dec. 31, 2015 |
| Daniel J. Lymer | 1597 | Dec. 31, 2015 |
| Lindsay Reiach | CR123 | Dec. 31, 2015 |
| Charles T. Strongman | 1428 | Dec. 31, 2015 |
| W. Bryan Tamblyn | 1426 | Dec. 31, 2015 |
| Gordon D. McElravy | CR101 | Dec. 31, 2015 |
| Ali J.M. Bair | CR17 | Dec. 31, 2015 |
| Alfonso Roccaforte | 1587 | Dec. 31, 2015 |
| R. Desmond Rasch | 1321 | Dec. 31, 2015 |
| William D. Snell | 1601 | Dec. 31, 2015 |
| Wayne T. Pearce | 1669 | Dec. 31, 2015 |
| Dan J. Cormier | 1801 | Dec. 31, 2015 |
| John H. Michael | CR110 | Dec. 31, 2015 |

### CofA's Issued

RS Geomatics, Toronto, Ontario - August 12, 2015

### CofA's Relinquished

Pearce Surveying Inc.
Burlington, Ontario, June 30, 2015

Wayne D. Turpel Surveying Limited
Elmira, Ontario, October 15, 2015

Guido Papa Surveying Ltd.
Woodbridge, Ontario, October 19, 2015

Precision Ontario Land Surveying
Port Stanley, Ontario, November 17, 2015

Michael Clancy Surveying Ltd.
Scarborough, Ontario, November 30, 2015

## Surveyors in Transit

**Hugh S. Coutts** is now the Managing OLS at **RS Geomatics** located at 41 Crittenden Square, Toronto, ON, M1B 1V2. Phone: 416-708-0545.

**Jamie Leslie** is now with **McIntosh Perry Surveying Inc.** in Carp, Ontario.

**Steven P. Davidson** and the office of **J.L. Richards & Associates Limited** have moved to 314 Countryside Dr., Sudbury, ON, P3E 6G2. Phone: 705-522-8174.

**Blake van der Veen** is now with **Kim Husted Surveying Ltd.** in Tilsonburg, Ontario.

**Paul Kidd Surveying Ltd**. is now located at 907 Carlaw Ave., Toronto, ON, M4K 3L4.

**Ministry of Transportation of Ontario, Geomatics Section** is now located at 159 Sir William Hearst Ave. (3rd Floor), Toronto, ON, M3M 0B7.

**NRCan (International Boundary Commission - Canada Section)** is now located at 588 Booth Street, 2nd Floor, Ottawa, ON, K1A 0Y7.

**Van Harten Surveying Inc.** has acquired **Wayne D. Turpel Surveying Limited** and it will operate as a branch office of Van Harten Surveying Inc. with **Wayne D. Turpel** as the managing OLS.

**J.D. Barnes Limited** has acquired **Guido Papa Surveying Ltd.** and it is now a division of J.D. Barnes Limited with **Valerio Papa** as the managing OLS.

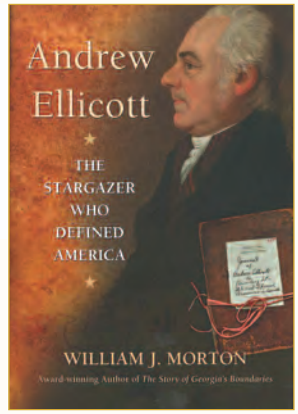
**Greg Ford** is no longer with **P.A. Blackburn Limited.**

**Krcmar Surveyors Ltd.** has purchased **Michael Clancy Surveying Ltd**. The records purchased include: (1) A. E. Reuben; (2) Michael J. Clancy Surveying Limited; (3) Wicken, J. E.; (4) McBain & Wicken (West of Yonge Street); (5) Barber Wynne Roberts & Seymour; (6) Barber, Frank & Associates.

**David J. Wylie** is no longer with **Stantec Geomatics Ltd.** in Ottawa.

# BOOK REVIEW

## Andrew Ellicott - The Star Gazer Who Defined America




**By William J. Morton**

William J. (Bill) Morton attended college at Emory University in Atlanta, Georgia and graduated from the University of Miami Medical School in Miami, Florida in 1962. He served in the U.S. Air Force Medical Corps in Germany for three years and returned to Atlanta for his Urological Surgery training in the Emory University/Grady Memorial Hospital program. He opened his Urology office in Atlanta in 1970.

In 1985, Morton graduated from Woodrow Wilson College of Law in Atlanta and became a member of the State Bar of Georgia with interests in medical malpractice and healthcare law. He closed his Urology office in 2000 and after serving as a Georgia magistrate court judge for two years, he fully retired.

Morton is a licensed U.S. Coast Guard captain and has over 5500 hours as a private pilot with commercial, instrument and instructor ratings. His other hobbies include amateur ornithology, photography, astronomy, classical piano and fly fishing. All of his professional background is detailed on his personal website www.wjmortonmdjd.com

Now retired, but always infatuated with history, his 2010 award-winning book, *The Story of Georgia's Boundaries: A Meeting of History and Geography,* introduced him to Andrew Ellicott, the most famous astronomer-surveyor in the young United States during his lifetime.

As Morton learned more about Ellicott, he became perplexed as to why Ellicott was not celebrated for his major contributions to the United States and Canada. Ellicott had no formal education and was self-taught in astronomy, the earth sciences, mechanics and mathematics but he would eventually survey the boundaries of fourteen

*cont'd on page 30*

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states, more than anyone in the history of the United States before or since. Ellicott was chosen by President George Washington and Secretary of State Thomas Jefferson to survey the ten-square-mile District of Columbia as well as many of the boulevards and squares in the new federal capital. He was also appointed by President James Monroe in 1817 to be a surveyor for the United States to establish the new boundary between Canada and the United States as part of the proceedings of the Treaty of Ghent concluding the War of 1812. Ellicott was now in his seventh decade of life and in declining health and his only contribution to the boundary survey was to find and mark the 45th latitude where it crossed the St. Lawrence River. Ellicott placed a stone monument "on the south bank of the river, bearing south 74° 45' west, 1840 yards distant from the stone church in the Indian village of St. Regis." This monument has not been found, but the area is known as Ellicott Point. Perhaps his greatest achievement was his survey of the first international boundary line of the United States dividing the thirteen states from the property owned by His Catholic Majesty, Charles V of Spain.

Morton's research has unearthed hundreds of letters and documents in The Library of Congress in Washington, D.C., the National Archives in College Park, Maryland and the Papeles Procedentes de Cuba in many Special Collections libraries.

Morton's book is a compelling portrait of Ellicott and the never-before-told story of his four year excursion to locate, measure and mark the first international boundary between the United States and Spain. This story, which was ignored by historians for two hundred years, is about the measuring and marking of the first southern boundary of the United States as provided for in a treaty with Spain. The new nation, exhausted after her break-away war with Great Britain, now faced another powerful adversary with Spain, whose ambition was to control the people and property in North America as she had done in South America.

After the Revolutionary War, Spain controlled more property on the North American Continent than any other nation which included the old British colonies of East and West Florida, the lower Mississippi River and New Orleans, the huge territory known as Louisiana on the west side of the Mississippi, all the rivers draining into the Gulf of Mexico, and most of what would be California, Arizona, Texas and New Mexico. Spain? How did Spain get so powerful? Here's how.

With the war over in 1783, the thirteen British colonies, now established as a confederation of states, occupied only that small part of the North American continent south of the Saint Lawrence River down to Georgia and as far west as the Mississippi River. Exhausted by the war, heavily in debt and still working to design a viable federal government, the young United States paid little attention to Spain as she quietly grew her hegemony. The biggest problem: Spain was stopping all U.S. commerce coming down the Mississippi River and passing through New Orleans to the Gulf of Mexico. Spain was a power to be reckoned with.

For a dozen years Spanish emissaries and U.S. diplomats sparred over the use of the Mississippi River and the exact boundary line between the two nations. Finally, in 1795, both issues were resolved in great detail by the Treaty of Friendship, Limits and Navigation between Spain and the United States – the so-called Pinckney Treaty, aptly named for its chief U.S. negotiator, Thomas Pinckney. The two major provisions of the treaty opened up the Mississippi River for free trade and delineated the boundary line between the six-year-old United States and the Spanish-held territory of East and West Florida. After the new Congress ratified the Pinckney Treaty, President Washington appointed Andrew Ellicott as commissioner for the survey and directed him to organize a team to meet the Spanish survey team in Natchez, a small village with a Spanish fort on the banks of the Mississippi River, and perform the survey of the new boundary.

Washington chose Andrew Ellicott, a second-generation Pennsylvanian and the most famous astronomer-surveyor in America. The book is not a biography of Ellicott, but is a close study of what is unquestionably a major achievement. His exploits in this monumental United States/Spanish survey of the boundary line provide a stunning record of a critical moment in American history. The dramatic stories of his four-year-long efforts are the stuff of fiction. Here are adventures into unknown territory fraught with physical hazard and personal danger, including encounters with hostile Indians, Spanish spies, and a cast of remarkable characters. Revealed in his letters home, there is also a warm tale of spousal devotion (he addressed his wife as "Dearest of All Earthly Beings") despite his having a washerwoman as a mistress. The stories of Ellicott's extraordinary work are peopled with men such as William Dunbar (a brilliant scientist and surveyor who lived in Natchez), Manuel Gayoso (the Spanish governor in Natchez and later New Orleans), Anthony Hutchins (plantation owner, obstructionist and English loyalist), Benjamin Hawkins (a former U.S. senator and agent to the Cherokee Indians), and Thomas Freeman (a rival surveyor who would make life miserable for Ellicott). Appearing in this story as well are officials at the highest level of the U.S. government who oversaw and financed his work.

After Ellicott finished the survey and returned to his home in Philadelphia, the capital of the United States, he spent two years writing his manuscript and creating maps of all the rivers and important places in the unknown

***cont'd on page 32***


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southwest territory. In 1803 he published the 450-page *Journal of Andrew Ellicott* about his experience, which included a 300-page diary, 150 pages of astronomical observations and mathematical calculations, and the maps he drew of his travels. This book is based on the *Journal* and hundreds of his letters to and from contemporaries.

Elliott's perseverance to successfully complete his assignment in spite of the dilatory Spanish, hostile Indians and dealing with terrible living conditions, can arguably be said to have stopped Spain's hegemony on the North American Continent.

**Bill Morton**'s book is featured in the Book Reviews on page 35. Copies can be purchased from POB online at **www.pobonline.com** or from Amazon.com, Inc. at **www.amazon.com**

# The Surveying Instruments of John James Haslett, P.L.S.

By Peter von Bitter, Ph.D., *Senior Curator Emeritus, Natural History, R.O.M. & Professor Emeritus, Earth Sciences, U. of T.*

The three instruments in question constitute a very rare and early working compendium owned, in part signed and used by a known pioneering Canadian surveyor at a time when Canada was very much in its infancy and still at the exploration stage.

The English style theodolite is an instrument that was favoured by early Ontario surveyors, before the transit (an American invention) was introduced in the 1850s and 1860s north of the Canadian/U.S. border, particularly by those with direct or indirect roots in the U.K.; the instrument in question appears to date from the 1840s and is signed by its English maker [A. Abraham]; it is also signed on the telescope tube of the theodolite by its owner John Haslett, an owners' signature being most unusual on Canadian made or Canadian used instruments.

*On October 22, 2015, John van Nostrand, grandson of John (Jack) van Nostrand, OLS #417 and great-great-nephew of Arthur J. van Nostrand, OLS #192, donated three surveying instruments which belonged to John James Haslett, P.L.S., his great-great-grandfather (on his mother's side) to the Glanmore National Historic Site, a museum in Belleville, Ontario. J.J. Haslett played an important role in the surveying history of the County of Hastings, Belleville and the Quinte region between 1848 and 1878. On the table, along with a photo of J.J. Haslett, is the telescope in front, the octant on the back left and the theodolite on the back right. (Editor)*

The telescope is signed Dollond, a famous name in early to mid 19th Century English (London) instrument makers; although it is not, *per se* a surveying instrument. John Haslett likely carried & used this instrument on his surveys of the Canadian Shield; the octant falls into the same category, i.e., it is strictly speaking, a mid 19th century nautical instrument, by a well known and prolific British maker of moderately priced octants.

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# EDUCATIONAL FOUNDATION NEWS

## Congratulations to the Fall 2015 Educational Foundation Award Winners

On November 5, 2015, Keith Watson presented the Eastern Regional Group Award to **Cole Barrett** for his scholastic achievement in the Survey Technician Program at Loyalist College.

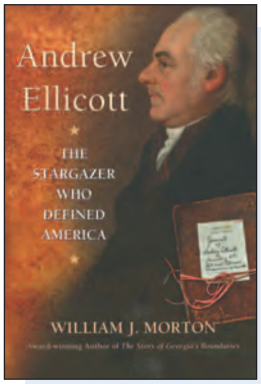
Maureen Mountjoy (centre) and the Geomatics Engineering award winners at Ryerson University.

On the evening of Thursday, November 12, Maureen Mountjoy attended the Department of Civil Engineering Awards Ceremony at Ryerson University to present the following eight Educational Foundation awards to: **Braeden Hurley** and **Peter Umukoro** who received awards for students entering the third year of the Civil Engineering program who have demonstrated academic excellence and an interest in pursuing Geomatics Engineering, and to the following third-year students entering fourth year of the Geomatics Engineering option whose fourth year Capstone Project incorporates Global Navigation Satellite Systems, Surveying, Digital Mapping, Geographic Information Systems and Remote Sensing; **Lindsey Hau, Aleta Mawuenyegah, Pedro Sena, Lahini Senthil-Kumaran, Sahand Shaghaghi and Ragavan Shanmugarajah.**

## Mark Your Calendars

The Educational Foundation Annual Meeting of Members will be held on Thursday, February 25, 2016 at the London Convention Centre in London, Ontario from 7:30 a.m. to 8:30 a.m.

# BOOK REVIEWS




Published by Georgia History Press

ISBN 978-0-9841596-3-5

## Andrew Ellicott
### The Stargazer Who Defined America

By William J. Morton

This never-before-told story is an important piece of American history and tells of a four year adventure that fell on the shoulders of one man. His success would make a huge difference in the security and commerce of the struggling United States. The story involves the complex details of diplomacy in dealing with the dilatory Spanish, the technical and physical problems of measuring and marking a 530 mile line through dense woods and swamps and interacting with angry Indians through whose property they were trespassing.

Andrew Ellicott was a second generation Pennsylvanian who served as a major in the Maryland Militia during the Revolutionary War. Without much of a formal education, he became the most famous astronomer-surveyor in America. Ellicott surveyed all of Pennsylvania's boundaries and would eventually survey the boundaries of thirteen states, more than anyone before or since. President George Washington and Secretary of State Thomas Jefferson asked Ellicott to survey the ten square mile District of Columbia and he worked with Pierre L'Enfant, the architect of the City of Washington, to survey many of the boulevards and squares in the new federal capital. However, Ellicott's most ambitious task was in surveying the first international boundary line of the United States.

*Information taken from inside the front cover.*

## Revolution
### Mapping the Road to American Independence 1755-1783

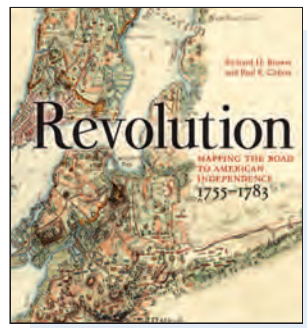
By Richard H. Brown and Paul E. Cohen

Historians of the Revolutionary War in America have been fortunate in their resources: few wars in history have such a rich literary and cartographic heritage. The high skills of the surveyors, artists, and engravers who delineated the topography and fields of battle allow us to observe the unfolding of events that ultimately defined the United States.

When warfare erupted between Britain and her colonists in 1775, maps provided graphic news about military matters. A number of the best examples are reproduced here, including some from the personal collections of King George III, the Duke of Northumberland, and the Marquis de Lafayette. Other maps from institutional and private collections are being published for the first time. In all, sixty significant and beautiful cartographic works from 1755 to 1783 illustrate this intriguing era.

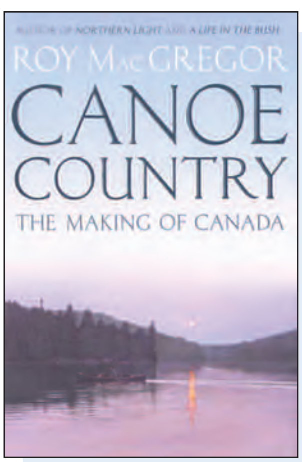
At the Treaty of Paris, the French and Indian War (1755-1763) ended, and King George III gained clear title to more territory than has ever been exchanged in any other war before or since. The British military employed its best-trained artists and engineers to map the richest prize in its Empire. They would need those maps for the fratricidal war that would begin twelve years later. Their maps and many others make up the contents of this fascinating and beautiful book.

*Information taken from inside the front cover.*




Published by W.W. Norton & Company

ISBN 978-0-393-06032-4




Published by Random House Canada

ISBN 978-0-307-36141-7

## Canoe Country
### The Making of Canada

By Roy MacGregor

Famous paddlers have been so enchanted with canoes that one swore God made Canada to suit them – which explains why today over one million are owned by Canadians. Drawing on his family's roots in Algonquin Park and decades spent whenever possible with a paddle in his hand, this is Roy MacGregor's story of high adventure on white water and the sweetest peace in nature's quietest corners – the canoe and Canada.

David Thompson, the great nineteenth-century explorer, travelled more than eighty thousand kilometres while mapping nearly four million square kilometres of North America; he believed he had seen but a small percentage of the land mass that would soon become Canada, and he saw it mostly from his canoe. Prime Minister Pierre Trudeau and filmmaker Bill Mason struck up a curious friendship over their shared love of paddling, one that carefully skirted the treacherous shoals of politics – until the matter of the new Canadian flag raised itself on the shores of the Picanoc River. Aboriginal Canadians were Canada's original canoeists, and so if anyone could improve on the perfect means of transport it would be them. MacGregor takes us for an unforgettable ride in the innovative and potentially lifesaving Cree-Yamaha freighter canoe, which nearly meets its match on the waves of James Bay. During the siege of Khartoum, an English general is overwhelmed by the odds facing his command and sends for help; it comes by a most unexpected means – vessels guided by Canadian voyageurs, in what is surely the strangest tale history has to offer about the canoe.

*Information taken from inside the front cover.*

# The Last Word

## London, Ontario and the “other” Thames, a Canadian Heritage River

In 1793 Lieutenant-Governor John Graves Simcoe selected a town site, which he named London, at the forks of the Thames River to be the future capital of Upper Canada. Simcoe’s selection was overruled and York (renamed Toronto in 1834) was chosen instead. By 1825 however, Simcoe’s site became the centre of a large administrative area called the London District. In 1826 Thomas Ridout, the Surveyor-General of Upper Canada, approved the area northeast of the Forks, even though the land was dotted with swamps and bogs, as a site for the District town. He directed Colonel Mahlon Burwell, overseen by Colonel Thomas Talbot, to undertake the initial survey and plan for the town and its courthouse. Stores and hotels were erected and by 1834 population had grown to over 1100. A British Garrison stationed there in 1838 brought in military spending and increased population and by 1840 London was large enough to be incorporated as a town and officially declared as a city in 1855.


London (Ontario), from the River Thames, ca 1846, James Hamilton (1810-1896), Public Domain


Portrait of Colonel John Graves Simcoe, [ca. 1881] by George Theodore Berthon (1806-1892). Credit: Government of Ontario Art Collection, 694156.

Flowing through the heart of London, the Thames River, once called Askunesippi (Antlered River) by the Natives and later La Tranche (The Ditch) by the French, was renamed in 1792 by Simcoe after its namesake in England. The river originates in Perth and Oxford counties and its upper and lower branches merge at “the Forks” in London. The Thames was one of the major theatres of the War of 1812, in particular the Battle of the Thames on October 5, 1813 near Moraviantown. The Americans attacked and won a victory over the British and Native Americans. It was in this battle that Shawnee Chief Tecumseh was killed. During the American Civil War, as part of the vast network called the Underground Railroad, the river provided a route to freedom for slaves fleeing from Detroit. Because of its outstanding contribution to the country’s cultural heritage, natural heritage and recreational opportunities, the Thames River was formally designated as a Canadian Heritage River on August 14, 2000.


**Published by:**
The Association of Ontario Land Surveyors
(Established 1892)
1043 McNicoll Avenue
Toronto, Ontario, Canada M1W 3W6
Phone:416-491-9020 FAX:416-491-2576
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Unless otherwise stated, material which originates from our membership may be re-printed with acknowledgment.

Printed by Colour Systems Incorporated
Original graphics design by Uniq Graphics and Design, Toronto, Ontario
Computer implementation by nu Vision Images Inc., Toronto, Ontario

**Views and opinions in editorials and articles are not official expressions of the Association’s policies unless so stated. The *Ontario Professional Surveyor* Magazine and its publisher accept no responsibility for these views and opinions.**

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The *Ontario Professional Surveyor* Magazine is published quarterly as a medium of communication between the Association and its members. Readers are invited to comment and express their opinions on relevant subjects.

The *Ontario Professional Surveyor* Magazine is distributed to all members of the Association.

Subscription Rates to others: $40.00 per year or $10.00 per copy. All rates to us - no provision for commissions or discounts.

Canadian Publication Sales Agreement
# 40064685
Postage paid Mississauga / Gateway

**Published Quarterly:**
**next publication deadline:**
**February 15, 2016**

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