Well Record Improvement Project

Phase Two

2007 Summary

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Acknowledgement

The Well Record Improvement Project, an initiative of the Ausable Bayfield and Maitland Valley Source Protection Region, would not have been possible without the support and assistance of various organizations. We would like to extend a special thanks to Conservation Ontario for their support throughout this endeavour. As well, we would like to thank the Ministry of Environment and its continued support to us through the use of the Drinking Water Information System and Water Well Information System, which proved to be invaluable for this project.

Introduction

Water Well Records (WWR) for domestic wells, as part of the Well Water Information System (WWIS), are identified as being critical data for Drinking Water Source Protection (DWSP). The location and number of domestic (private) wells provide an idea as to the number of individuals who use this source of water and rates of consumption for groundwater sources. In addition, well water records can include information on soils and aquifers to facilitate knowledge of the area as a whole.

As part of a provincial initiative to verify the WWIS and as part of the data collection phase of the proposed Drinking Water Source Protection project, the Ausable Bayfield and Maitland Valley Conservation Authorities undertook a review of the Water Well Information System: specifically, the Water Well Records with respect to spatial accuracy and well record completeness. From the assessment of the WWR, the Ausable Bayfield Conservation Authority (ABCA) and Maitland Valley Conservation Authority (MVCA) found the dataset to be of questionable use. Given the lack of confidence in the accuracy of the well records, a two phase project was proposed. Phase One (2005) refined the WWR based on existing data and Phase Two (2006/2007) field verified these records with the ultimate goal of updating provincial records.

The first season of Phase Two was completed from June to December 2006. This time period was 25 weeks: field work accounted for 21 weeks, initial training accounted for two weeks, and an additional two weeks were used for weather related issues. It is estimated that during this period 30-40% of the domestic wells in the 25-year municipal wellhead protection areas and 15% of the wells total in the Ausable Bayfield and Maitland Valley Region were recorded.

The second season of Phase Two was completed from April to November 2007. This time period was 33 weeks, with field work accounting for 31 weeks, and two weeks for weather related issues. It is estimated that by the end of the field season, approximately 65% of the properties in the region of study were visited, and over 50% of the wells on those properties were recorded.

Phase Two Methodology

Field verification uses Global Positioning System (GPS) technology to capture the position of the well. This location was used to compare against Water Well Records in order to verify their accuracy.

To capture the well location, a team of two individuals visited properties within the 25-year time-of-travel wellhead protection area (WHPA) for municipal wells within the Ausable Bayfield Maitland Valley (ABMV) region. In 2007, visits were extended to every rural property within the Ausable Bayfield and Maitland Valley Region. This area, however, did not include the southern parts of the region that are currently on piped water. Each site visit included meeting the owner of the

property, explaining the project, and requesting permission to GPS their well. Predominantly, permission was granted and a GPS coordinate was taken. The coordinate accuracy was sub meter except in areas where buildings interfered with satellite connection. In these areas, a coordinate was taken at a minimum distance from the well where satellites could communicate with the GPS unit. Upon completion of the GPS coordinate reading, a photograph was taken of the well in context to surrounding buildings. Photographs will aid for future work, particularly if the landscaping on a property changes dramatically.

In 2006, the team used a mobile office in which they were able to input coordinate data and assemble information for the property owner immediately following a site visit. In addition, an aerial photograph with the well location(s) was printed on site for the property owner. A package, prepared in collaboration with the local County Health Units and the two Conservation Authorities, was also provided to the landowner. This package contained best management practices, grant projects information, water sampling procedures, and ongoing CA stewardship information. Distribution of the package and aerial photograph helped to build a relationship with the landowner and familiarize them with Source Protection materials. However, as the season progressed, it was noticed that most property owners did not care for the aerial photograph. Thus, in the 2007 season, aerial photographs were only distributed to landowners who expressed interest in one. This saved approximately 5-10 minutes for each visit. If no one was home at a residence, a package was left as mail with an additional letter requesting they contact the Ausable Bayfield Conservation Authority if they have a well on-site. No GPS was taken where a land owner was not home, which accounts for the variance between visits and recorded data.

In order to manage the progress of the project, visited properties also had a GPS reading taken indicating if data had been collected. Collected status data contained information regarding the necessity to return (if no one was home) and whether the permission was granted or denied to the survey crew. This information allowed efficient tracking of properties which required return visits.

Results

Visitation

Initially, it was the goal of the team to visit and record all domestic wells in the region. However, because of the large number of domestic wells, it was determined that the focus for season one would be the 25-year municipal wellhead protection areas (WHPAs).

The team visited 2220 rural and older urban properties within the 25-year municipal WHPAs to capture their domestic well location(s). Due to the decision to obtain the consent of the property owner to GPS the well, re-visits were required for 537 (24%) of the properties. In all, 2,839 separate visits to

properties were completed to capture their well status. Listed below in Table 1 are the results for visitation at properties during the 2006 field season.

In the second season, the initial goal of visiting all domestic wells on rural properties was reinstated. The team visited 4156 rural properties, 692 (17%) of which required return visits. Thus, 4880 separate visits were made in the second field season. In total, Phase Two saw 6376 properties visited, with 1229 revisits needed to capture their well status. As a result, 7719 visits were made over the two field seasons. The results for property visits in 2007 are also listed in Table 1. Total results for Phase Two are listed in Table 2.

Table 1: Visits to properties in the 25-year WHPA to survey well status for the 2006 field season

Visit Type	#Properties 2006	Total Visits 2006	#Properties 2007	Total Visits 2007
Single Visit	1683	1683	3464	3464
1 Return Visit:	487	974	675	1350
2 Return Visit:	31	93	15	45
3 Return Visit:	12	48	-2*	-8*
4 Return Visit:	3	15	0	0
5 Return Visit:	2	12	1	6
6 Return Visit:	2	14	1	7
7 Return Visit:	0	0	2	16
TOTAL	**2220**	**2839**	**4156**	**4880**

* Two 2006 properties were revisited in 2007, and consequently were moved into a different category. This results in the apparent negative numbers.

Table 2: Total visits to properties for Phase Two

Visit Type	# Properties	Total Visits
Single Visit	5147	5147
1 Return Visit:	1162	2324
2 Return Visit:	46	138
3 Return Visit:	10	40
4 Return Visit:	3	15
5 Return Visit:	3	18
6 Return Visit:	3	21
7 Return Visit:	2	16
TOTAL	**6376**	**7719**

There are 37 municipal well systems providing residential drinking water in the study area. Within 8 of these communities, a systematic surveying method was developed to target properties in urban areas with a greater likelihood of having a well. In the first field season, information packages were provided to selected older homes in the towns based on the apparent age of the property and likelihood of pre-existing before municipal supply. For these homes, the number of properties and visits are included in Table 1. In addition, newer homes and

"infill" homes, not likely to have a well, were also visited once. An information package was not provided to these newer homes; however, an information sheet was left with contact information and a project outline, in case the property did have a well. If property did have a well, than the GPS location was taken. These properties are shown in the 'Newer Homes' column of Table 3.

Table 3: Number of old and new homes of urban communities within a WHPA

Community	Total	Older homes	Newer homes
Auburn	130	30	100
Bayfield	450	150	300
Belgrave	200	50	150
Blyth	500	50	450
Brucefield	82	7	75
Brussels	93	43	50
Hensall	400	25	375
Zurich	400	50	350
TOTAL			**1850**

For example, Hensall has a total of 400 properties. Of the 400 properties, 25 'older' properties had a visitation status captured and an information package provided (they are included in the visiting numbers for Table 1). The remaining 375 properties were visited but did not have a visitation status captured. Therefore, considering all visits, 2,839 visits had a status taken, 1850 did not, for a total of 4,689 separate visits. Towns and villages were not visited in the 2007 season, as it was too time consuming and emphasis was placed on rural properties.

Survey Status

In 2006, a GPS survey was deemed necessary at 2220 properties. Table 4 shows the final status of the 2220 properties as of January 8th, 2007. Uptake on this program was very high and only 35 (2%) of properties owners denied access to the property.

Table 4: Final survey status for the 2006 and 2007 field seasons for the properties needing a GPS survey

Final survey status for properties	Number 2006	% of total 2006	Number 2007	% of total 2007
Person home, survey completed	1289	58%	2129	51%
Person home, denied access	35	2%	48	1%
Person home, but come back later	142	6%	261	6%
No one home	754	34%	1718	42%
TOTAL	**2220**	**100%**	**4156**	**100%**

Table 4 also shows the status results for the 2007 season. While the results are quite similar, there were more properties visited during this season. As in the first season, there were 48 (1%) property owners who chose not to participate. Overall, 54% of the properties visited over the two seasons had the GPS survey completed with, again, only 1% who denied access to the property. The total results can be seen in Table 5.

Table 5: Final survey status for Phase Two for the properties needing a GPS survey

Final survey status for properties	Number	% of total
Person home, survey completed	3418	54%
Person home, denied access	83	1%
Person home, but come back later	403	6%
No one home	2472	39%
TOTAL	**6376**	**100%**

Table 6 lists the different types of wells surveyed for both field seasons, while Table 7 shows the final numbers to date for Phase Two. Domestic wells included wells in use, as well as abandoned and decommissioned wells. A suspected well is an area where it is unknown if a well exists, but there may something to indicate the presence of a well, such as a depression in the ground. Municipal wells included the main wells of the municipal water supplies and other wells maintained by the municipality, such as those at community centres or parks. Additionally, municipal monitoring wells were also included in this category.

Take note that the number of wells does not match the number of properties. Many properties had more that one well on the property, and so all that were known were surveyed. Also, some properties where the owner was found at home did not have a well, but instead may have used a spring or, in most cases, shared a well with a close neighbour. In addition, properties were not assessed when no one was found at home.

Table 6: Type of well surveyed by GPS for the 2006 and 2007 field seasons

Type of well surveyed	Number 2006	% of total 2006	Number 2007	% of total 2007
Domestic Well	1401	91%	2526	98.5%
Municipal Well/Suspected Municipal Well	90	6%	11	0.5%
Suspected well (can't find owner, windmill)	43	3%	21	1%
TOTAL	**1534**	**100%**	**2558**	**100%**

Table 7: Type of well surveyed by GPS for Phase Two

Type of well surveyed	Number	% of total
Domestic Well	3927	96%
Municipal Well/Suspected Municipal Well	101	3%
Suspected well (can't find owner, windmill)	64	1%
TOTAL	**4092**	**100%**

Discussion

There were 21 weeks of field work completed by the two-member team during the 2006 season. The estimate of productivity was to visit 50 properties per day. Therefore, 21 weeks of work represented a target of 5,250 site visits in the 2006 season. With revisits and visiting properties in small centers, the crew performed 4,689 site visits at 4,070 properties.

Within each of the 37 municipal well systems, there can be multiple wells (see Table 6). An additional 133 recordings were taken for municipal wells, suspected municipal wells (90), and suspected wells (43). While this work was not specific to the project, it is useful information for Source Water Protection. Overall, 4,689 site visits occurred with an expectation of 5,250. This represents an 89% visitation rate as per budgeting and achieves an actual reading of a well in the order of 30%, or 1401 wells.

The same team complete 31 weeks of field work in the 2007 season. With the same estimate of productivity at 50 visits per day, the work target was to visit 7750 properties in 2007. A portion of the area covered in 2007 also included revisits. In total, 4880 site visits were made to 4156 different properties. Thus, the 2007 season saw a 63% visitation rate as per budgeting and achieved an actual reading of a well in the order of 52%, or 2526 wells.

For Phase Two as a whole, 7719 site visits occurred with an expectation of 10270. This represents a 75% visitation rate, and an actual reading of a well at 51%, or 3927 domestic wells.

While the visitation rate dropped in the second season, the actual success rate for reading a well did increase. The drop in site visits can be partially attributed to the increase in the amount of driving time for the team, as all properties visited were rural in comparison to the visits in towns from the 2006 season. In addition, the field season did not begin as early as planned due to inclement weather in April 2007. Therefore, the season dropped to 31 weeks from the original target of 36 weeks. However, the team did improve in promoting the positive aspects of this project, as can be seen in the improvement in the number of wells that were recorded.

Positional Comparisons:
The following comparisons serve to identify the accuracy of the WWR records with respect to field verification.

GPS location within a buffer of the Well Water Record
The purpose of the following comparison is to show how close the field surveyed wells are with respect to an existing WWR. By reviewing these results, we will have an idea of the accuracy of the records. Each existing WWIS record has circular buffers drawn around it, and the number of surveyed wells which fall into various buffers are recorded in Table 9. Table 8 lists the results for the 2006 field season for comparison.

The '# of wells in buffer zone' represents the number of wells in that particular buffer zone, but excludes the previous buffer zones. For instance, in Table 9 at the 5 meter buffer there are 18 newly surveyed wells with 5 meters of an existing WWIS record. However, 15 of those wells are between 2 and 5 meters, two wells are between 1 and 2 meters, and one well is less than a meter. The greatest percentage of surveyed wells was located in the 200 to 500 meter buffer zone from the well water record (27.09%).

Table 8: The number of GPS (new) wells within the buffers and buffer zones of a WWIS record for the 2006 season

Buffer Distance (m)	#of wells within buffer	# of wells within buffer zone	% of wells within buffer zone
1	1	1	0.07%
2	2	1	0.07%
5	10	8	0.57%
10	46	36	2.57%
20	126	80	5.71%
50	431	305	21.77%
100	751	320	22.84%
200	1027	276	19.70%
500	1320	293	20.91%
1000	1397	77	5.50%
2000	1401	2	0.14%

Total number of surveyed wells is 1,401.

Table 9: The number of GPS (new) wells within the buffers and buffer zones of a WWIS record as of November 30, 2007

Buffer Distance (m)	#of wells within buffer	# of wells within buffer zone	% of wells within buffer zone
1	1	1	0%
2	3	2	0.05%
5	18	15	0.38%
10	92	74	1.88%
20	279	187	4.76%
50	1002	723	18.41%
100	1790	788	20.07%
200	2441	651	16.58%
500	3505	1064	27.09%
1000	3896	391	9.96%
2000	3927	31	0.79%

Total number of surveyed wells is 3927.

While the new numbers for Phase Two do differ somewhat from the 2006 results, it still remains that the majority of newly surveyed wells fall between 50 and 500 meters away from the exiting Water Well Records.

Well Water Record within a buffer of a GPS location:
The purpose of this comparison is to show how many existing WWIS wells are in proximity to the field surveyed wells. Each new well has circular buffers drawn around it and the number of existing WWIS wells which fall into the various buffers are recorded in Table 11. Table 10 shows the results for the 2006 season for comparison. By reviewing these results, we get an idea as to how many existing WWIS wells could be represented by the newly surveyed wells.

Table 10: The number of WWR within the buffers and buffer zones of a GPS (new) record for the 2006 season

Buffer Distance(m)	#of wells within buffer	#of wells within buffer zone
1	1	1
2	2	1
5	7	5
10	44	37
20	119	75
50	448	329
100	777	329
200	1074	297
500	1612	538
1000	2130	518
2000	3196	1066
5000	5852	2656

Total number of original WWIS records is 11136 (from WRIP August 2006).

Table 11: The number of WWR within the buffers and buffer zones of a GPS (new) record as of November 30, 2007

Buffer Distance(m)	#of wells within buffer	#of wells within buffer zone
1	1	1
2	3	2
5	16	13
10	89	73
20	253	164
50	941	688
100	1659	718
200	2325	666
500	3834	1509
1000	4976	1142
2000	6104	1128
5000	8696	2592

Total number of original WWIS records is 11161 (new boundary, records from Wrip August 2006).

The '# wells within the buffer zone' represents the number of wells in that buffer zone but excludes the previous zone. For instance, using a 10 meter buffer, there are 89 existing WWIS wells within 10 meters of a surveyed well, however, 73 of those wells are between 5 and 10 meters, 13 wells are between 2 and 5 meters, two wells are between 1 and 2 meters, and one well is less than a meter.

There are 3927 domestic wells that were surveyed. The buffer has to be extended out to almost 1000 meters in order to account for the new field surveyed wells with respect to the existing well water records. In other words, for there to be one WWR for every GPS location, the buffer has to be extended to somewhere between 500 and 1000 metres. At 500 metres, there are only 3840 records; at 1000 metres, there are 4977 records – more than one per new GPS location. It is important to remember, however, that only approximately 60% of the study region was covered, and of that area only 50% of the wells recorded.

Phase Two Field Verification comparison with Phase One Desktop Exercise

In Phase One of this project, a desktop exercise in a GIS environment was performed to relate each well record with a parcel. Because wells are typically found adjacent to a house or a homestead, WWR locations that were in the middle of a field were 'dragged' to the nearest structure. After this exercise, it was found that a number of properties did not have wells. Therefore, 6,669 wells were arbitrarily placed in parcels where common sense indicated a well should exist. In our region, there exists approximately 11,000 well records in total.

The Ministry of the Environment (MOE) database classifies well records with a UTM (Universal Transverse Mercator) reliability code. Because well records were recorded using a variety of methods (e.g., some recent well records have GPS coordinates taken, older wells had only lot and concession recorded, and others had distances from major records recorded) there is variability between

the accuracy of the locations of well records. The MOE reliability code is listed below in Table 12. Only Well Records with a reliability code from 1-5 inclusive (0 to 300 metres) are considered useful for modelling purposes.

Table 12: MOE UTM reliability code for WWIS records

Reliability code	Distance
1	> 3m
2	3m-10m
3	10m-30m
4	30m-100m
5	100m-300m
6	300m-1km
7	1km-3km
8	3km-10km
9	unknown

It was determined to use this same value (within 300 metres) when considering if the desktop exercise was meaningful. Because the two sets of buffers use different distances, 200 metres was considered as a maximum meaningful distance. Therefore, if a well record is within 200 metres of a surveyed well, then it is assumed that the two perhaps represent the same well and that the well record is reliable.

From Table 13 below, it was determined that 57.17% of dragged well records were within 200 metres of a surveyed well. Including wells up to a 500 metre buffer, 81.47% of dragged WWR records were within this area. To calculate these percentages, the number of wells in the each buffer zone was divided by the number of dragged wells in the 25-year municipal WHPA. The quotient was not the total number of dragged records because only 15% of the total area was surveyed. These percentages would likely improve if the other 60-70% of the 25-year municipal WHPAs were surveyed.

Table 14 lists the number of dragged wells within the buffer for the newly surveyed wells as of November 30, 2007. Just over 20% of the dragged well records were within 200 meters of a surveyed well. While this percentage does seem to be much lower than the 2006 season's results, one must take into consideration that only 60% of the study area was covered, and the study area itself only constituted approximately 60% of the entire Ausable Bayfield and Maitland Valley Region. If the number of dragged wells was reduced to correspond with the actual size of the study are (area not on piped water), the number of wells within 200 meters of a surveyed well would be closer to 40%, rather than 20%. Again, were more of the area covered, it is likely that these percentages would improve.

Table 13: Dragged WWIS record from the desktop exercise in the buffer and buffer zones of a surveyed well for the 2006 season

Buffer Distance(m)	#of wells within buffer	#of wells within buffer zone
1	2	2
2	7	5
5	19	12
10	78	59
20	230	152
50	529	299
100	791	262
200	981	190
500	1398	417
1000	1820	422
2000	2742	922
5000	5055	2313

Total number of original records that were dragged is 9700.
The number of dragged well within the 25-year WHPAs is 1716.

Table 14: Dragged WWIS record from the desktop exercise in the buffer and buffer zones of a surveyed well as of November 30, 2007

Buffer Distance(m)	#of wells within buffer	#of wells within buffer zone
1	4	4
2	9	5
5	49	40
10	172	123
20	544	372
50	1319	775
100	1866	547
200	2268	402
500	3347	1079
1000	4152	805
2000	4947	795
5000	6389	1442

Total number of original records that were dragged is 9769 (new boundary).

The desktop exercise does not necessarily account for parcels with multiple wells, especially when a well record was arbitrarily placed. Some properties may have several wells adjacent to the house and only one well water record to associate with the property. The desktop exercise should not be a substitute for field verification.

Conclusions

As mentioned, the purpose of this study was to determine the reliability of the Water Well Records found in the Water Well Information System. By comparing the newly surveyed wells to the positions of the existing records it can be seen that only 25% of the new records are within 50 meters of the existing records. Conversely, to account for all of the newly surveyed wells a buffer would have to be extended out from these locations to approximately 1000 meters.

Additionally, the desktop exercise tends to show similar results. While some of the records might be closer to the actual position of the wells when dragged on the map, there is still a low percentage of records within the maximum meaningful distance of 200 metres.

Thus, it can be seen that the ABCA and MVCA's lack of confidence in the records found in the Water Well Information System is justified. In addition, a desktop exercise does not make these records any more reliable. Any updates made to the WWIS by way of new field surveys, such as this project, would result in a more accurate and reliable set of Water Well Records. However, while the location of the field surveyed wells are highly accurate, it is difficult to associate a field surveyed well with the WWIS record. Wells that have a Well Registration tag ID can readily be associated, but this is not so for most other wells.

Initially, this project set out to locate and verify 16 000 wells, municipal wells or suspected wells. However, during the course of two field seasons only 4092 wells or 26% were actually verified. While twice this many properties were visited, approximately half the owners were not home. In order to build trust in the community, these properties were not accessed. In the first field season, a high emphasis was placed on completing the records within well head protection zones, so an aggressive call back approach was employed. While there was in increase in data collection, this method proved to be highly time consuming. The cost for the two phases over three years was $150,000. It is estimated that it would require an additional $150,000 over three more years to complete the initial target. Beyond this target, there are numerous wells and sand points along the Lake Huron Shoreline and within the towns and townships now on municipal water systems.

In conclusion, the project was successful, but underestimated the impact of owners not being available. Therefore, while additional efforts to capture this data are desirable, it is not practical to do so as a separate project. Instead, the Conservation Authority will work with local drillers to improve the accuracy of the WWIS.