Blind River

Town of Blind River

Automated Drinking Water Well Waste Reduction System

Project Final Report

The project overview

The Town of Blind River constructed a direct filtration water treatment plant in 2007. The source of raw water supply to the treatment plant continued to be ground water drawn from a series of wells classified as being ground water under the direct influence of surface water (GUDI). It is thought that the wells are recharged by the adjacent Blind River which has an elevated and seasonally variant concentration of organics (TOC/DOC), turbidity and colour. The wells operate on a demand basis as controlled by the treatment plant SCADA system which results in variable down-times from 6 to 8 hours. This residence time allows for the build-up and/or surging in the wells of organics and other compounds as well as colour and turbidity which is most noticeable on initial well pumping and reduces as the well is pumped. Although concentrations reduce as pumping progresses, the initial high concentrations on start-up are problematic for consistently effective operation of the treatment plant.

On well pump start-up, raw water is drawn from the wells and enters the treatment plant resulting in an initial loading on the dual media filters that is elevated in certain parameters and reduced the filtration effectiveness. This reduction in treatment effectiveness, results from the suspected carry-over of natural organic material (NOM) which is a trihalomethanes (THM) formation precursor. The treatment process has been optimized over the past few years and the THM concentrations, which exceeded the Drinking Water Quality Standard of 100 ug/l (calculated on an annual running average basis), have been reduced to within compliance limits. Optimization included modifying well operations (e.g. longer run times to reduce the number of start-up events) has also reduced the backwashing requirements. The dosing of coagulant and flocculant has been adjusted, however the treatment plant does not perform optimally during well start up when the water quality is degraded for a short period. This results in a significant loading on the treatment process shortening the backwash cycle and increasing the duration. At one point up to 30% of production water was consumed to backwash the filters. In addition to reducing water treatment plant efficiency, this elevated backwashing requirement increased loading on the sewage treatment plant.

Project Objective

The intent of the project was to design a system which would initially divert well water to pump to waste. The diverted waste water quality would be monitored and when it had improved and stabilized, as determined using an in-line monitor, an automated valving system would direct the raw water flow to the treatment plant. The approach would be to use the existing discharge piping in the well pump house to direct the initial pumping to waste and install equipment to monitor raw water quality and control the operation of valves to redirect the raw water to the treatment plant. This automated system for flushing initial well water on start-up would prevent poor quality water from entering the treatment plant. Real time monitoring and automatic controls would have the following benefits and cost savings:

- Reduction in the loading on the treatment plant;
- Reduction in the quantity of treatment chemicals consumed;
- Reduced loading on the filters and increased run time /reduction in frequency of backwashes;
- Reduction in the duration of back wash cycles;
- Reduced pumping/power costs; and,
- Reduction in DBP formation.

Project Approach

The first step in the project was to determine the appropriate water quality parameter to monitor and to select the well which would be used for testing the equipment. The specifications for the equipment were developed simultaneously. Water quality sampling was conducted in the summer and fall of 2012 on the 4 service wells to determine which well displayed the poorest initial water quality on start-up. Sampling was conducted by starting each well following shut-down periods established by the drinking water system operator, (dictated by the drinking water demand and available system storage for treated water). Each well was started and a sample aliquot immediately directed from a small diameter hose connected to the well discharge into a series of 5 gallon pails. The second sample was directed to second pail 15 seconds after the first, etc. Following the filling of each pail, tests for turbidity, UVT and conductivity were conducted using hand held water quality analyzers. These results were recorded in the field, (the photos below show the sampling and field testing procedures).

Interval sampling of raw water from well #6

Technician conducting water quality field analyses

Samples were drawn into laboratory supplied bottles from each of the sample pails from each well series and were packaged and shipped by bus to ALS laboratories in Thunder Bay, ON for further analyses.

Prepared sample ready for shipment to the laboratory for testing

The sampling periods and analytical results are included in the Tables that follow.

It was determined that the initial quality of the raw well water varied with subsequent sampling runs. Sampling results confirm a marked improvement in water quality, after approximately 4 minutes on average, and that there was little further improvement after this pumping time. From review of the initial data set, iron, TSS and colour were identified as preliminarily preferred candidates for monitoring to control the automated valve system.

Since colour can be readily monitored it was decided to use this parameter for monitor and control of the valve actuators. This was supported by a review of available and affordable on-line monitoring equipment. The plots below display the sample period and the corresponding analytical results.

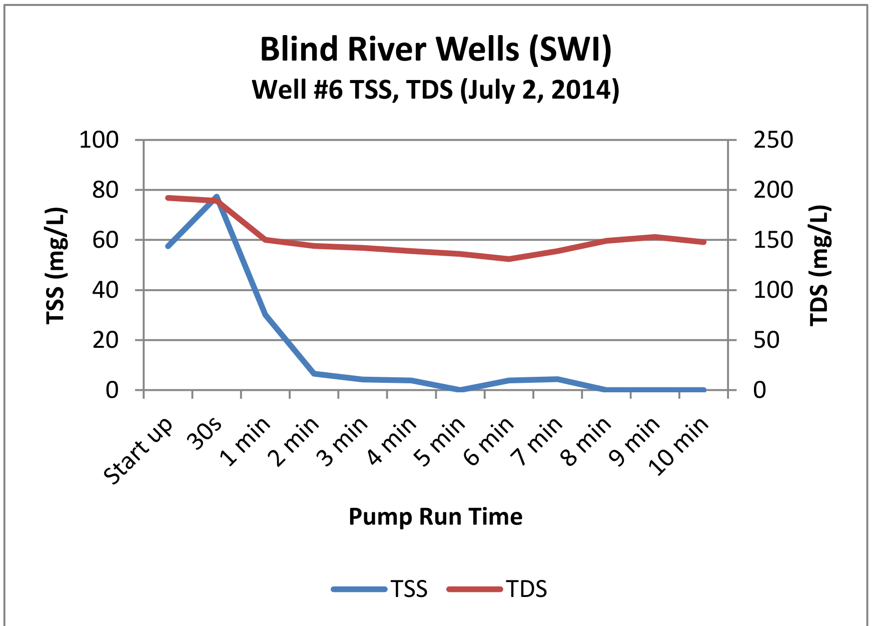
Additional monitoring was conducted in the summer of 2014 to determine if there had been a change in the water quality and characteristics of the production wells. Based on a review of water quality data from all of the production wells, well #6 was identified as the test well. Following review, of the water quality data and a review of available and affordable on-line monitoring equipment, colour was selected as the best parameter to use for the automated system. The results of the analyses conducted in 2014 are also included in the Tables below.

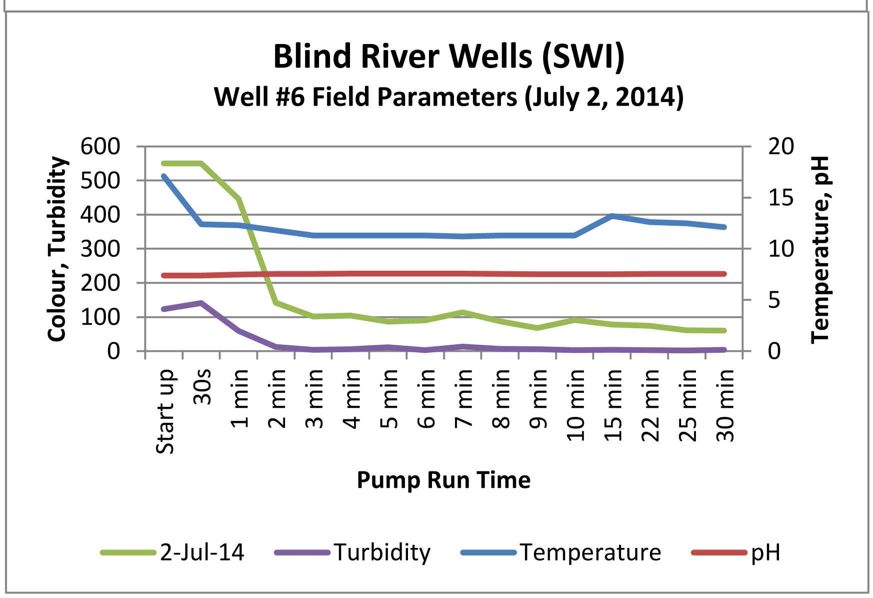
Detailed review of available in line water quality analysers revealed the preferred solution was to source equipment manufactured in Sweden and apparently not used in the North American drinking water industry. The in line colour analyzer was supplied by Can Am Instruments and is manufactured by Kemtrak. Similarly, in order to source automated butterfly valves that incorporated fail-close or fail-open status, equipment was special ordered from the United States. Though the actuators bear a CSA certification, the colour analyzer was not CSA certified. Accordingly, once the equipment arrived at the Canadian supplier (in Oakville, ON), it was subjected to the required testing and evaluation for CSA certification.

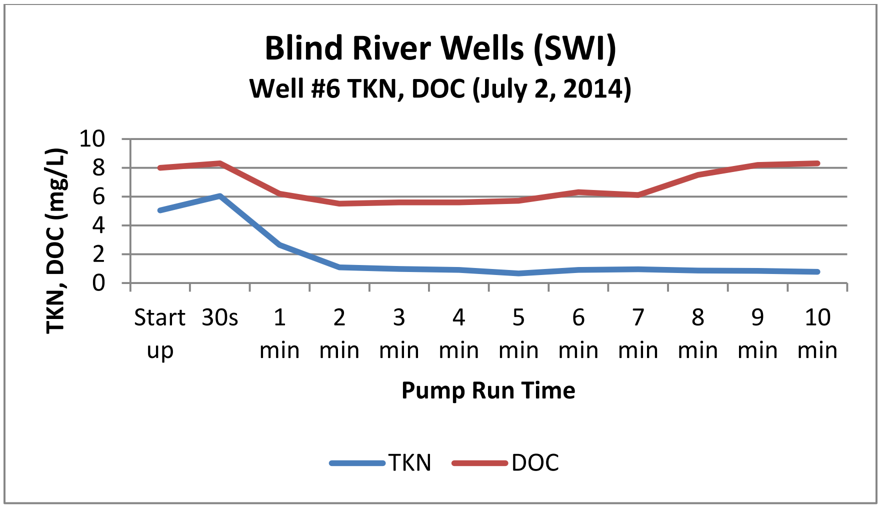
			Colour		
Time	Temp	pH	2-07-14	8-11-12	28-06-12
Start up	17.1	7.38	550	38	61
30s	12.4	7.39	550	19	20
1 m	12.3	7.48	446	72	71
2 m	11.8	7.54	142	48	121
3 m	11.3	7.55	101	6	32
4 m	11.3	7.57	104		18
5 m	11.3	7.58	86		44
6 m	11.3	7.58	90		8
7 m	11.2	7.57	114		41
8 m	11.3	7.54	87		4
9 m	11.3	7.51	68		2
10 m	11.3	7.52	91		31
15 m	13.2	7.51	78		
22 m	12.6	7.53	74		
25 m	12.5	7.53	61		
30 m	12.1	7.53	60		

	2-Jul-14									
Time	EC	UVT	TKN	TSS	total iron	total manganese	DOC	TDS	dissolved iron	dissolved manganese
Start up	326	NT	5.05	57.5	15.5	0.282	8	192	0.055	0.171
30s	331	NT	6.05	77.3	18.7	0.295	8.3	189	0.093	0.167
1 m	245	NT	2.65	30.1	7.2	0.92	6.2	150	0.177	0.636
2 m	223	NT	1.1	6.5	2.43	1.03	5.5	144	0.162	0.814
3 m	220	NT	0.974	4.2	2.3	0.858	5.6	142	0.106	0.739
4 m	216	NT	0.921	3.8	1.82	0.818	5.6	139	0.198	0.696
5 m	215	NT	0.658	<2.0	1.46	0.683	5.7	136	0.287	0.6
6 m	215	NT	0.91	3.8	1.26	0.569	6.3	131	0.306	0.486
7 m	217	NT	0.966	4.4	0.95	0.365	6.1	139	0.456	0.319
8 m	231	NT	0.872	<2.0	0.804	0.349	7.5	149	0.341	0.272
9 m	246	NT	0.855	<2.0	0.788	0.279	8.2	153	0.411	0.242
10 m	243	NT	0.777	<2.0	0.761	0.256	8.3	148	0.379	0.198
15 m	236	NT								
22 m	235	NT								
25 m	234	NT								
30 m	234	NT								

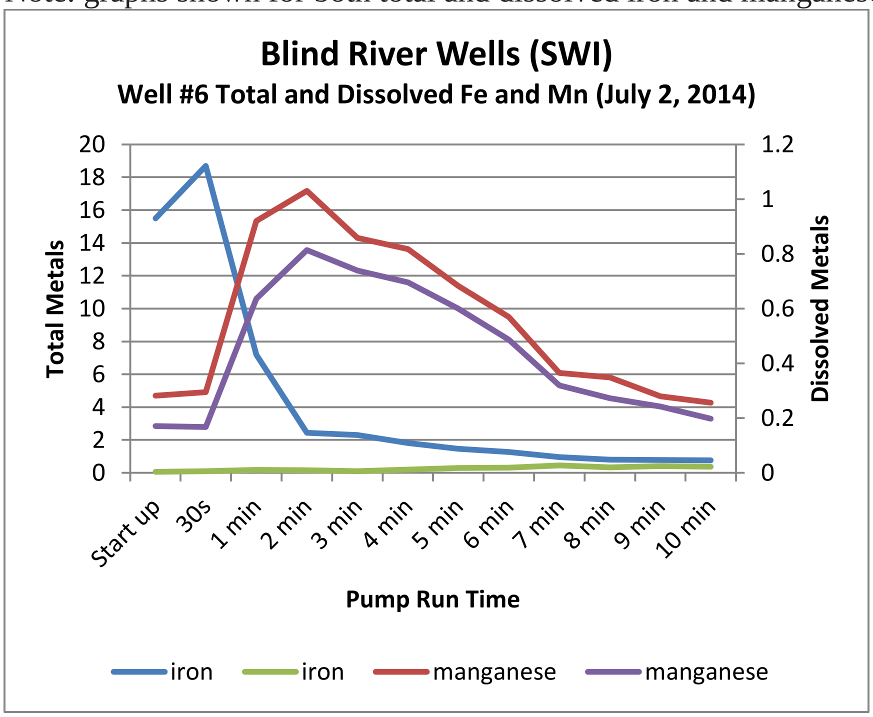
Plots of result of samples following varying time intervals

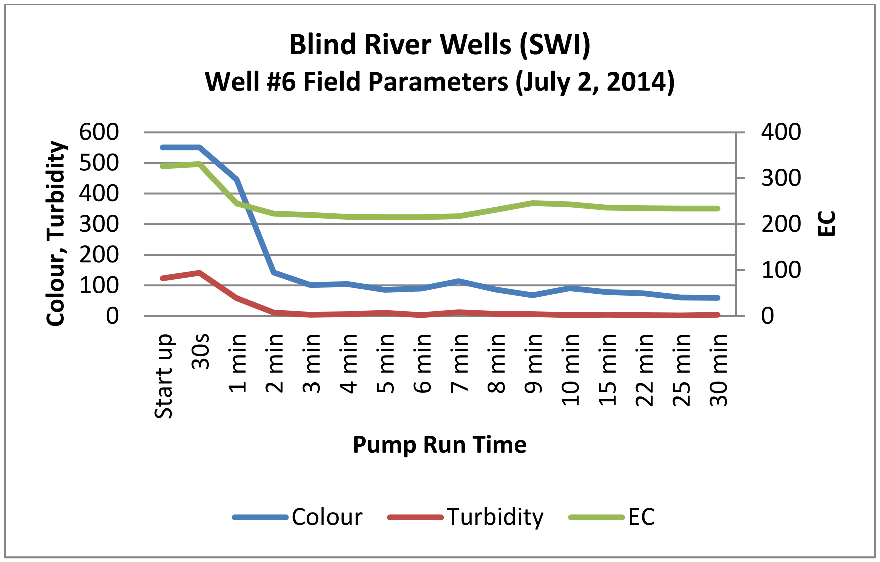






Note: graphs shown for both total and dissolved iron and manganese





The equipment was installed in December 2014 at which time it was determined that one of the two actuators was not functioning which required the procurement of a replacement actuator. This delayed the completion of the equipment installation and commissioning until early 2015. On February 24, 2015, the system was commissioned and tested at which time the following observations were made;

1. The colour analyzer is powered on and off with well pump operation (i.e. when the well pump is off so is the analyzer).
2. When the well pump is off, the pump to waste valve is open and the valve to the raw water watermain is closed.
3. When the pump switches on, the analyzer also switches on and initializes.
4. For testing purposes a colour set point of 14.5 PCU was used. Once the analyzer initializes and begins to analyze colour and once the raw water colour was consistently below 14.5 PCU for a period of 10 seconds (“Delay”), the unit sent the appropriate signals to close the waste valve and open the main valve to direct raw water to the treatment plant.
5. To test the operational sensitivity of the equipment and ensure accurate performance, the colour set point was then lowered to below 14.5 PCU. This verified that equipment performed as expected when the water exceeds a lower set point. Similar to item 4, once a colour value was consistently above the set point for a period of 10 seconds (“Hold”), the unit sent signals to open the waste valve and close the main valve.

A time period of 10 seconds was used for the “Delay” and “Hold” parameters only for testing purposes and these values were changed to 30s (Delay) and 300s (Hold) once testing was complete. This was done to avoid frequent diversion of pumping to waste while at the same time maintain water quality at a level that the treatment plant can effectively accommodate.

A set point of 14.5 PCU was also only used for testing purposes and this value is felt to be too low as a working set point. Accordingly, the set point was set at 30 PCU once testing was complete. This value may also prove to be too low and can be refined after the system has been used for a longer period of time. The equipment, as installed, is depicted in the following photos.

Kemtrak controller display

Photo showing the equipment included in Well #6 pump house. The red valves control the by-pass of raw water and the redirection to the treatment plant.

The in-line colour sensor flow cell

PUC, the Accredited Water Works Operating Authority, added a timer to override the system in the event that the system starts-up and pumps to waste for an extended period of time (perhaps 10 or 15 minutes) which may happen if water colour does not improve to below the set point or if the system fails.

Further testing was conducted to verify equipment performance through the conduct of a number of on-off cycles of the well to verify such things as the default position of the valves to ensure that on start-up the well discharges to waste, that the water quality analyzer is performing as required, adjusting the set points if/as necessary and that the valves cycle to allow the well water to be directed to the treatment plant based on the colour set points. The operation of the water treatment plant was discussed with PUC and it was verified that there was no impact of the test on the treatment plant operation. It is speculated that this may be due to the modified operating scenario as well as since the by-pass discharge equipment was installed on only one of the production wells in operation.

Results and challenges

The equipment operated as intended. The initial raw water flow was diverted to waste and when water quality improvements were noted by the in-line colour monitor, the raw water flow was redirected to the treatment plant. The volume of the wasted raw water was insignificant in terms of the total volume of raw water supply to the treatment plant. It was therefore not possible to determine the impact of the operation of the unit on the quality of raw water directed to the plant and its expected improvement on the operation of the treatment plant, its efficiency and reduction in DBP formation. Based on the results of the project, it is apparent that if all wells had been equipped with the automated control system, there may be a measurable impact by the reduction in the initial loading on the treatment plant.

Since the initial raw water quality is so poor it became apparent that the sensitivity of in-line monitor sensors was being reduced with time due to the deposition of fines in the raw water and that the glass lenses were becoming occluded. Due to budget constraints and time remaining to complete the project it was not possible to order, install and test the cleaning kits supplied by the manufacturer. This would be an area for future testing of the monitoring unit.

Next steps

The Town will consider the results of the test and determine if it would like to proceed with the purchase, installation and testing of the cleaning unit. If the Town does proceed and following monitoring of the effectiveness of the cleaning unit, the Town may consider installing the Automated Drinking Water Well Waste Reduction System on the other raw water supply wells.

This device would be of interest to other municipalities in the Province using GUDI wells as a source of raw water supply which are subject to initial poor water quality on start-up. The impact of the diversion of poor raw well water for well #6 on the anticipated improvement of performance of the treatment plant was not observed. This is due to the small percentage of raw water diverted, (relative to the volume produced by all 4 operating service wells. If all of the wells had been equipped with the automated raw water diversion to waste equipment, it is speculated that the impact on improvement in treatment plant operations may be observable based on the reduction in initial loading determined during the project.

Appreciation

The assistance provided by staff of the PUC was invaluable in the installation and calibration of the equipment. Staff also assisted in sampling and monitoring as well as the evaluation of the need for a cleaning unit for the in-line monitor.

Appreciation is also expressed to the Town of Blind River for hosting the project and assistance provided in the administration.

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