Cameco

April 26, 2016

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VIA EMAIL and REGULAR MAIL

Mr. John Thelen
Senior Project Officer
Nuclear Processing Facilities Division
Canadian Nuclear Safety Commission
280 Slater Street
Ottawa, ON K1P 5S9

Dear Mr. Thelen,

Groundwater Pump and Treat System Performance Overview for the Port Hope Conversion Facility

With this correspondence, Cameco Corporation (Cameco) is pleased to provide Canadian Nuclear Safety Commission (CNSC) staff with an overview of the performance of the groundwater pump and treat system since its initial installation in 2008. This information is being provided in support of the licence renewal application submitted to CNSC staff on November 20, 2015 [Ref. 1].

If you have any questions or concerns regarding this submission, please do not hesitate to contact me.

Sincerely,

Rebecca Peters
Superintendent, Special Projects

c. CNSC: B.Prieur, N. Howden, K. Murthy
PHCF: S. Frankcom-Wright, T. Smith, D. Ingalls

References:

1. Cameco Letter, D. Clark (Cameco) to M. Leblanc (CNSC Secretariat). Cameco Corporation – Port Hope Conversion Facility renewal of Licence FFOL-3631.0/2017 for a 10-year term. November 20, 2015.

Attachments:

1. 1. Groundwater Pump and Treat System Performance Overview for the Port Hope Conversion Facility

Groundwater Pump and Treat System Performance Overview
For The
Port Hope Conversion Facility

April 26, 2016

1.0 BACKGROUND

Following the identification of uranium contamination in soils below the footprint of the uranium hexafluoride (UF_6) plant in July 2007, two groundwater contaminant plumes were identified as originating from the plant – subsequently referred to as the east and south plumes. The Subsurface Investigation, Building 50 (UF_6 plant) report, dated August 2008, details the UF_6 plant investigations that followed the July 2007 discovery.

The south plume was identified as extending south from the UF_6 plant and into the parking lot, where it deviated east towards the harbour. The east plume was characterized as extending east from the UF_6 plant to the harbour, migrating through areas of historic contamination in the vicinity of building 2. Soil and groundwater impacts were also been identified at the uranium dioxide (UO_2) plant, and other portions of the site. The Subsurface Investigation – Building 24 (UO_2 Plant) report, dated November 2008, details investigations and remedial actions completed at the UO_2 plant while the Site-Wide Environmental Investigation Report (SWEIR), dated December 2008, provides a comprehensive summary of soil and groundwater conditions across the site.

After the site characterization that formed the basis of the above-noted investigations was completed, a groundwater pump-and-treat system for the UF_6 plant was designed by third party experts and implemented in 2008 and has been further enhanced over time. Initially, TW1, TW4, TW5 and TW7 were installed to provide capture and control of the south plume while TW3 and TW6 were installed to provide capture and control of the east plume. TW8A and TW9 were installed downgradient of TW3 and TW6. TW2A/TW2B/TW2C were installed to provide capture and control of groundwater downgradient of the UO_2 plant, while TW27A/TW27B were installed to provide capture and control of groundwater downgradient of the former UF_6 plant.

The SWEIR identified potential contaminants across the facility and the identification of contaminants of potential concern (COPCs) was refined in the Site-Wide Risk Assessment, dated June 2009. Primary COPCs targeted by the pump-and-treat system operations at the PHCF include uranium, arsenic, ammonia and ammonium, nitrate, fluoride, and radium-226, trichloroethylene (TCE), cis-1,2-dichloroethylene (cis-1,2-DCE) and vinyl chloride (VC). Distribution of the COPCs vary across the site and by pumping well location.

2.0 PUMPING WELL INSTALLATION DETAILS

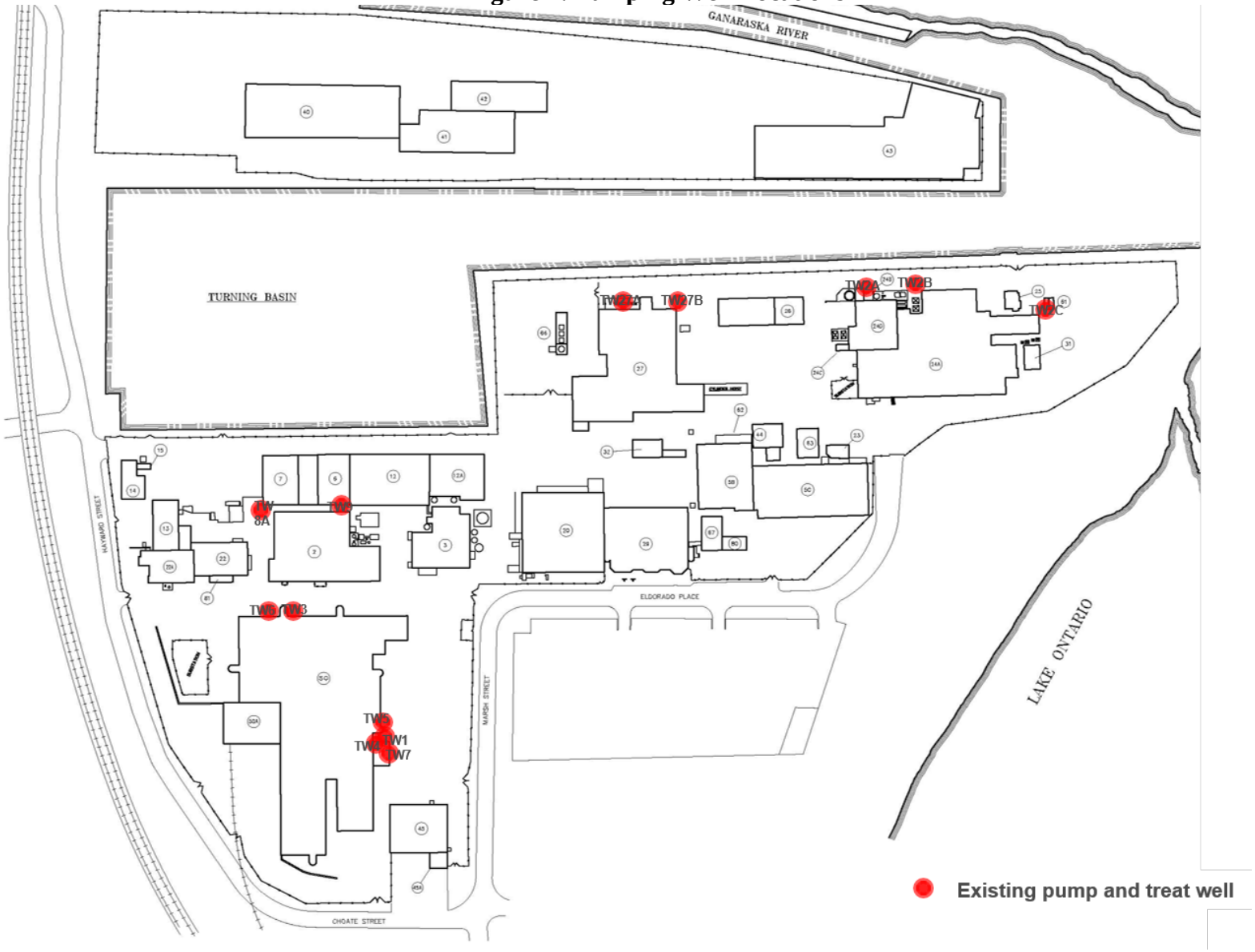
Pumping wells were targeted for installation within recognized COPC plumes and downgradient of known and/or suspected COPC sources defined in the Building 50 Report and the SWEIR, among other site investigations. As a general approach, well screens were installed within preferential zones of groundwater flow and contaminant transport.

Table 1 describes general pumping well installation details, including well depths, screen lengths and overburden units screened. Figure 1 shows the locations of these wells.

Table 1: Pumping Well Installation Details

Pumping Well	Depth (below grade)	Screen Length	Unit Screened
TW1	7.3 m (24 ft)	1.2 m (4 ft)	Deep overburden (coarse sand and gravel)
TW2A	6.1 m (20 ft)	1.2 m (4 ft)	Deep overburden (sand)
TW2B	6.1 m (20 ft)	1.5 m (5 ft)	Deep overburden (silty sand)
TW2C	7.0 m (23 ft)	1.5 m (5 ft)	Deep overburden (silty sand)
TW3	7.0 m (23 ft)	1.2 m (4 ft)	Deep overburden (sand and gravel)
TW4	6.9 m (22.5 ft)	1.5 m (5 ft)	Deep overburden (coarse sand and gravel)
TW5	7.3 m (24 ft)	1.5 m (5 ft)	Deep overburden (silty sand till)
TW6	8.5 m (28 ft)	1.5 m (5 ft)	Deep overburden (sand and gravel)
TW7	6.9 m (22.5 ft)	1.5 m (5 ft)	Deep overburden (silty sand till)
TW8A	7.9 m (26 ft)	3.0 m (10 ft)	Deep overburden (sand and gravel)
TW9	4.1 m (13.5 ft)	1.4 m (4.5 ft)	Shallow overburden (silty sand till)
TW27A	10.1 m (33 ft)	1.5 m (5 ft)	Deep overburden (sand and gravel)
TW27B	4.9 m (16 ft)	1.2 m (4 ft)	Overburden (sand and gravel)

Figure 1: Pumping Well Locations



3.0 PUMPING WELL TIMELINE

Table 2 summarizes the onset of recovery operations from the current pumping well installations. Pump-and-treat well operations commenced at the east and south perimeters of the UF_6 plant in the first quarter of 2008 and all UF_6 plant pumping wells were in operation by the second quarter of 2008. Pumping well operations expanded in the fourth quarter of 2008 between the UF_6 plant and the harbour (TW8A, TW9) and to the east of the UO_2 plant (TW2A).

Despite mass discharges to the harbour being much less than derived risk-based performance targets when taking into consideration the operation of the UF_6 plant east and south plume pumping wells and the single pumping well installation between the UO_2 plant and the harbour, Cameco installed four new pumping wells in association with the implementation of the Site-Wide Environmental Management Plan (SWEMP). The four additional pumping wells commenced operation during the fourth quarter of 2011. These most recent installations are located to the east of the former UF_6 plant (TW27A and TW27B) and to the east/southeast of the UO_2 plant (TW2B and TW2C).

Table 2: Pumping Well Commissioning Timeline

Pumping Well	Location	Operations Initiated
TW1	South of the UF_6 plant	Q1 2008
TW4		Q2 2008
TW5		
TW7		
TW3	East of the UF_6 plant	Q1 2008
TW6		Q2 2008
TW8A	Between the UF_6 plant and the harbour	Q4 2008
TW9		
TW2A	East of the UO_2 plant	Q4 2008
TW2B		Q4 2011
TW2C	Southeast of the UO_2 plant	
TW27A	East of the former UF_6 plant	Q4 2011
TW27B		

At present, twelve pumping wells are in operation under baseline conditions. TW7 to the south of the UF_6 plant has not been operated since June 2014. TW1, TW4 and TW5 in the immediate vicinity satisfy pumping well production targets for the south portion of the UF_6 plant.

4.0 PUMPING TARGETS

Initial pumping targets established in 2008 were based on groundwater modelling structured specifically to the PHCF. Pumping targets have been amended since 2008, taking into consideration the implementation of the SWEMP and the revised 2012 model approach (summarized in Section 8.0), among other items.

Pump-and-treat system recovery targets are validated and/or updated as part of the annual third party groundwater and surface water review reporting. Table 3 summarizes current recovery targets, including both individual pumping well targets and well grouping targets.

Table 3: Current Recovery Targets

Well	Average Daily Volume (m^3/day)
TW1	10.0
TW4	
TW5	
TW7	
TW2A	1.0
TW2B	1.0
TW2C	1.0
TW3	17
TW6	
TW8A	
TW9	
TW27A	3.5
TW27B	3.5
Total	37.0

5.0 MAINTENANCE

The presence of carbonate scale and/or biosolids in well screens, pumps and piping infrastructure at select pumping well locations necessitate an extensive maintenance program. Maintenance approaches have been modified and improved since 2008 and continue to evolve as required to maintain reliable and consistent pump-and-treat system operations. Cameco continues to allocate significant resources to the ongoing maintenance efforts in support of continual improvement.

Routine maintenance activities at the pumping wells include the cleaning of orifice plates, pump components (including intake screens) and discharge line fittings, the verification/adjustment of

pump rates, the replacement of pumps and associated inlet/outlet lines, as well as acid dosing activities (TW3 and TW6). Scheduled well rehabilitation work is also typically carried out on semi-annual and annual frequencies at select wells at buildings 27, 24 and 50. In support of the planned well rehabilitation work, downhole camera inspections are also completed at select pumping wells.

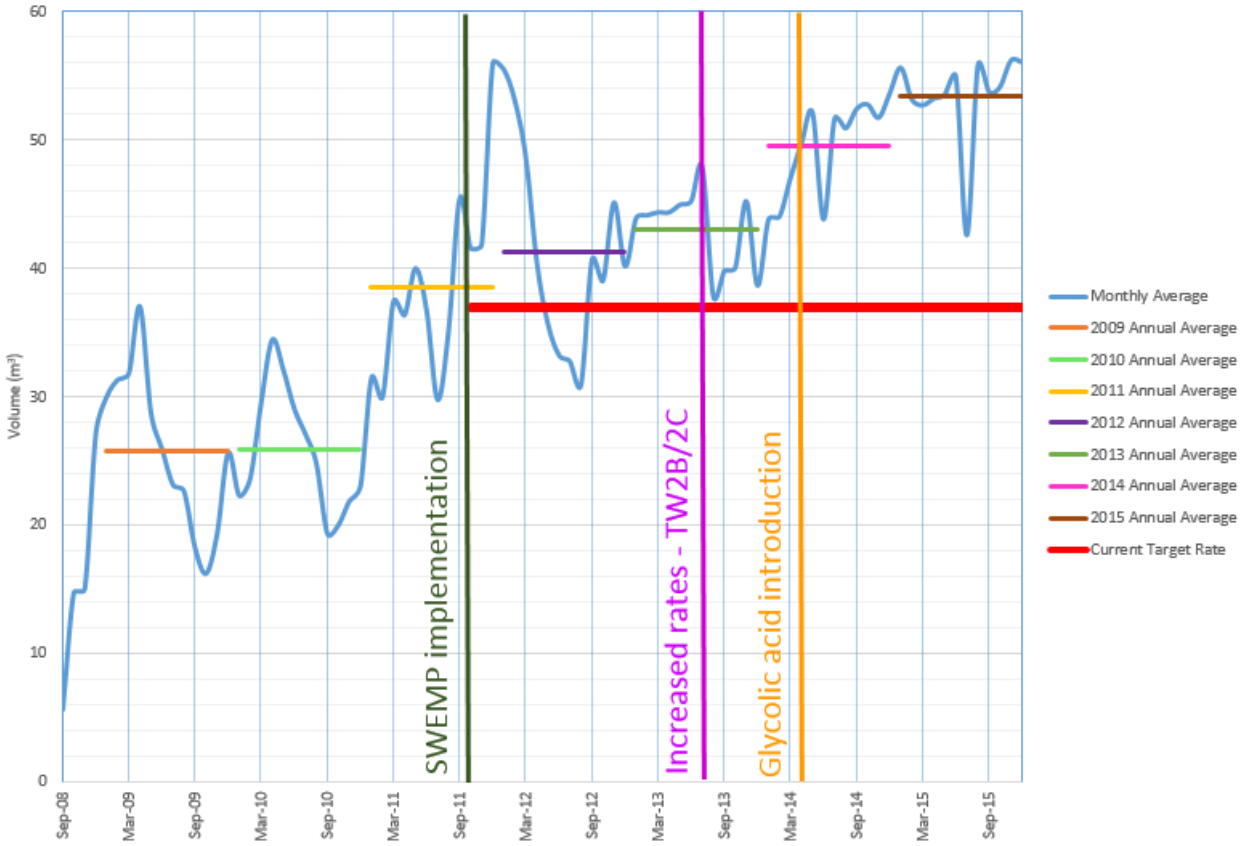
Maintenance program improvements to note since the initiation of the pump and treat program include the expansion of well rehabilitation program in 2014 (inclusion of TW3 and TW6) and the introduction of an alternate acid for carbonate scale removal in 2014. Improvements to maintenance and operational approaches have undeniably resulted in significant improvements to overall system recovery rates as evidenced in Figure 2.

6.0 PUMPING WELL PRODUCTION

Mean pumping well recovery rates significantly and steadily increased from 2009, the first full year of system operations. The 2015 mean recovery rate was approximately 53.4 m^3/day, a 107% increase from 2009.

Improvements in production volumes have resulted from continual improvements to the above-noted well maintenance program, targeted increases in recovery rates at the UO_2 plant, improved reliability of wastewater treatment plant operations, and a 2011 pumping well expansion. Figure 2 illustrates the average monthly and annual total system recovery volumes observed since 2008 with reference to the current target cumulative rate.

Figure 2: Pump-and-Treat System Recovery Rates



7.0 MASS REMOVALS

Estimated mass removals of primary COPCs are summarized in Table 4.

The effectiveness of the pump-and-treat system operations are demonstrated through both increases and decreases in COPC mass removals. Decreases in observed 2015 mass removals primarily resulted from decreases in concentrations of COPCs in recovered groundwater as the source material is removed from the subsurface. Alternately, increases in mass removals resulted from increases in pumping rates and/or COPCs in groundwater as a result of increased areas of influence/capture. It is expected that there will be variability year over year in the COPC mass removed as material is pulled into the zone of capture.

Table 4: Mass Removal of COPCs

Contaminant of Potential Concern	Mass Removed (kg)						
	2009	2010	2011	2012	2013	2014	2015
Ammonia	51	26	21	35	53	75	64
Arsenic	4.1	3.5	2.6	3.1	2.8	2.5	2.6
Fluoride	66	44	39	60	51	53	48
Nitrate	72	28	41	38	41	53	44
Uranium	17	14	20	28	29	31	25
Trichloroethylene	NC	NC	NC	0.41	0.38	0.44	0.64
cis-1,2-Dichloroethylene	NC	NC	NC	0.08	0.12	0.14	0.16
Vinyl Chloride	NC	NC	NC	0.23	0.20	0.20	0.10
Notes: NC= Not Calculated							

8.0 MASS DISCHARGE

Groundwater mass discharge estimates are re-evaluated on a periodic basis and compared to the overall risk-based performance objectives presented in the SWRA Update, dated December 2009 and the SWRA Follow-Up, dated December 2010. Since 2012, Cameco has completed the re-evaluation on a two year cycle.

Mass discharge estimates are summarized in Table 5. All mass discharge values are well below their respective performance objectives and mass discharges of all primary COPCs decreased from 2008 to 2014. The notable increase in mass discharges of ammonia between 2012 and 2014 is attributable to decreases in well production from TW8A and TW9 over the noted time period. Pump depth settings have been adjusted to place pump intakes above well screens as negative side effects have been realized when operating with pump intakes within the well screens.

Table 5: Mass Discharges of COPCs

Contaminant of Potential Concern	Groundwater Mass Discharges to Harbour (kg/yr) [1,2]		
	2008	2012	2014
Uranium	20	6.5	5.1
Arsenic	2.9	1.7	2.0
Fluoride	58	13	15
Ammonia	149	85	95
Nitrate	58	3.3	3.8
cis-1,2-DCE	0.3	0.06	0.02
TCE	0.4	0.04	0.01
VC	0.2	0.06	0.03
Notes:	1. Based on average pumping condition 2. Harbour discharges = discharges from Areas 1 though 8		

It is important to note that the groundwater model has evolved since 2008 and the mass discharge modelling approach used for the 2012 and 2014 estimates differs from that used for the 2008 estimates. In 2008, the mass discharge was calculated using estimates of simulated groundwater discharge rates to the harbour and the average concentration of COPCs in harbour-proximal areas across seven designated zones of discharge, excluding data from monitoring wells within interpreted areas of capture. The number of discharge zones has since increased to nine and the mass discharge is now estimated using the summation of mass discharges from individual harbour-proximal monitoring wells belonging to the separate harbour discharge zones.

The harbour discharge zones are illustrated as Areas 1 through 8 in Figure 3 and the simulated capture from the 2015 average operating condition is illustrated in Figure 34 Pump-and-treat system operations have negligible influence on discharges through Area 1 (upgradient flow-through) and mass discharges to Lake Ontario from Area 9 are considered negligible.

Figure 3: Zones of Groundwater Discharge

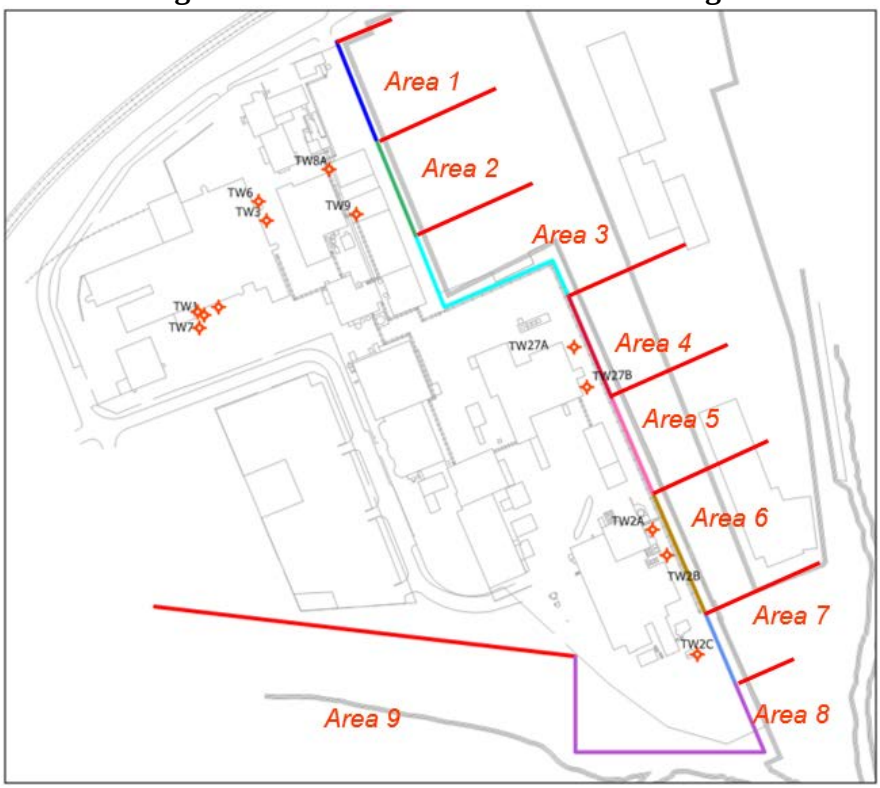
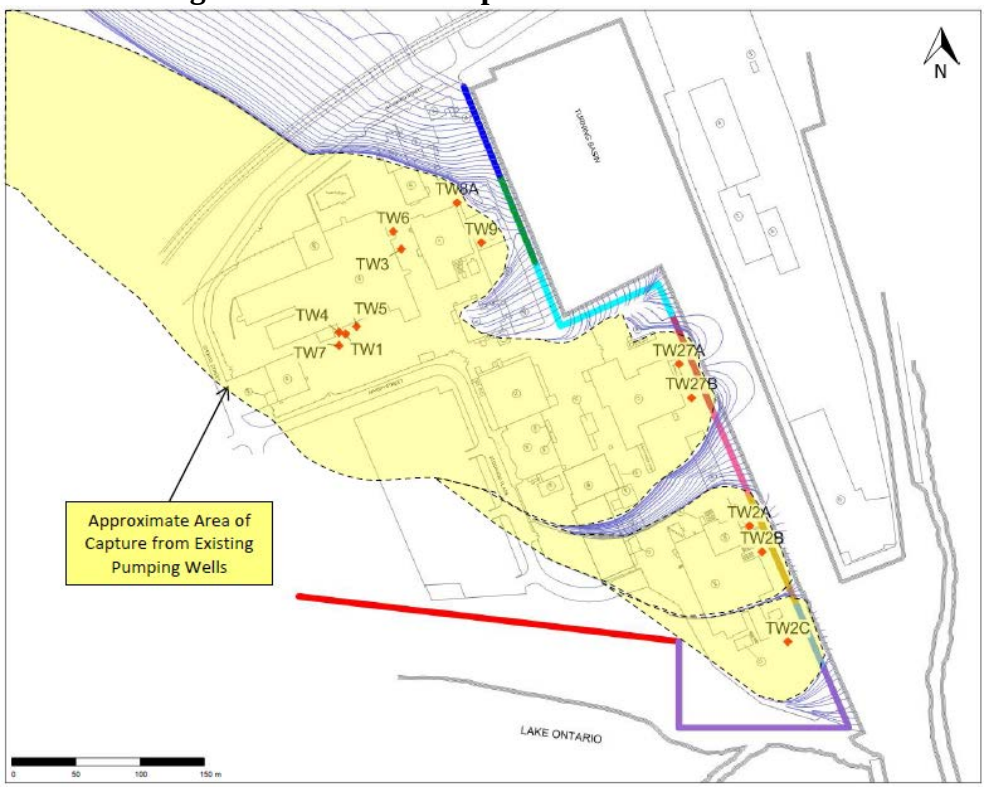


Figure 4: Simulated Capture – 2015 Mean Rates



9.0 PUMPING WELL EFFLUENT QUALITY

Positive trends of decreasing concentrations of COPCs have been observed at a number of locations, including:

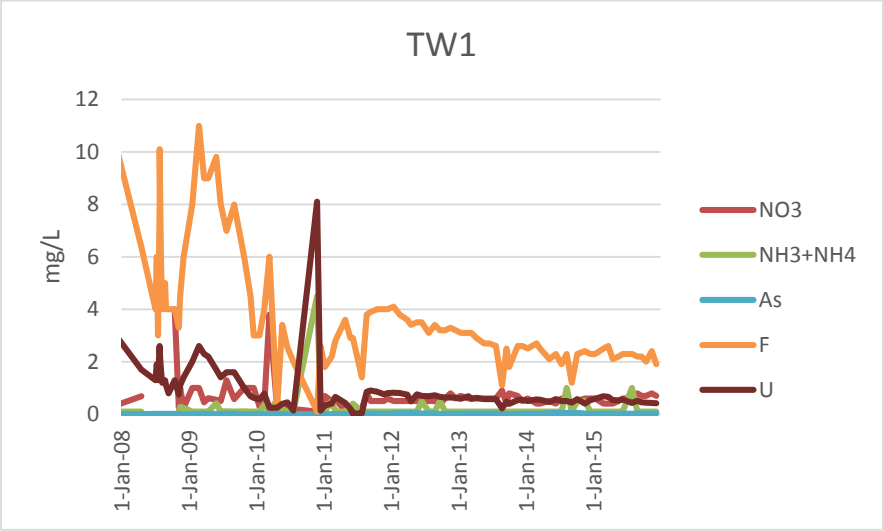
- Fluoride in the south plume, east plume, building 27
- Arsenic and uranium in the east plume
- Uranium in the south plume, TW2A
- Nitrate at TW2A, TW27A and TW9
- Ammonia at TW2A
- TCE in the east plume, TW27B
- cis-1,2-DCE at building 27
- VC at the UO_2 plant, TW27A

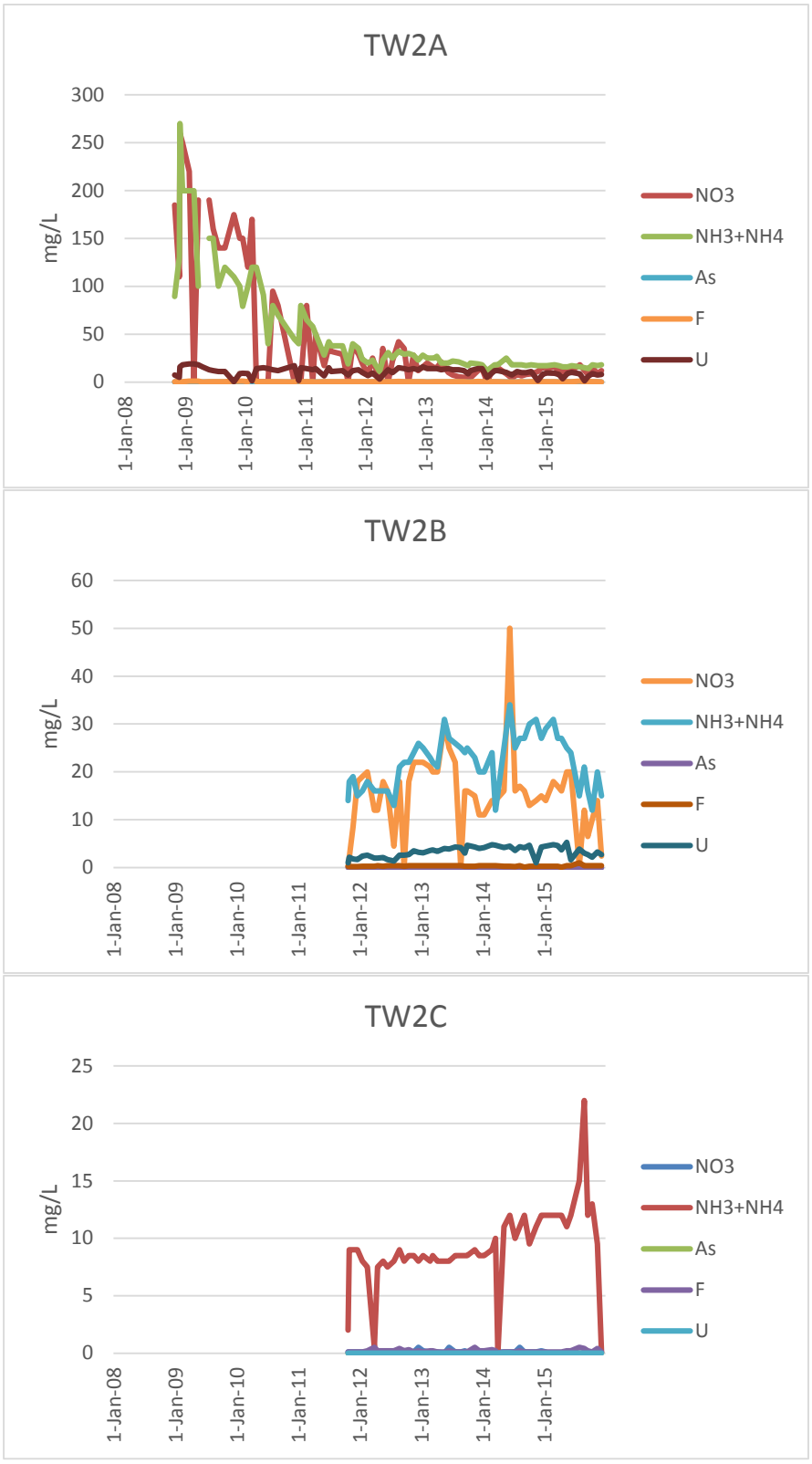
In areas where increases in concentrations of COPCs are observed, the trends are interpreted as being related to increased pumping rates and associated expanded zones of groundwater capture. Variations in pumping well effluent quality over time are illustrated in Appendix A for select primary COPCs.

10.0 CONCLUSIONS

The performance of the groundwater pump and treat system is discussed in the annual groundwater and surface water review report submitted to CNSC staff. As summarized in the current document, since initial implementation, the pump-and-treat system has been enhanced and currently achieves its operational objectives. This has resulted in capture of COPC plumes in the areas of the UF_6 plant, UO_2 plant and the original UF_6 plant and a corresponding decrease in the loadings to the harbour. On an annual basis, Cameco uses data collected during the monitoring program, maintenance activities and annual modelling review to determine appropriate target pumping rates, maintenance requirements and other activities to ensure that the operational objectives are met in the following year.

APPENDIX A: PUMPING WELL WATER QUALITY TRENDS

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1-Jan-14
1-Jan-15
NO3
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F
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TW2B
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mg/L
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1-Jan-14
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NO3
NH3+NH4
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TW2C
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NO3
NH3+NH4
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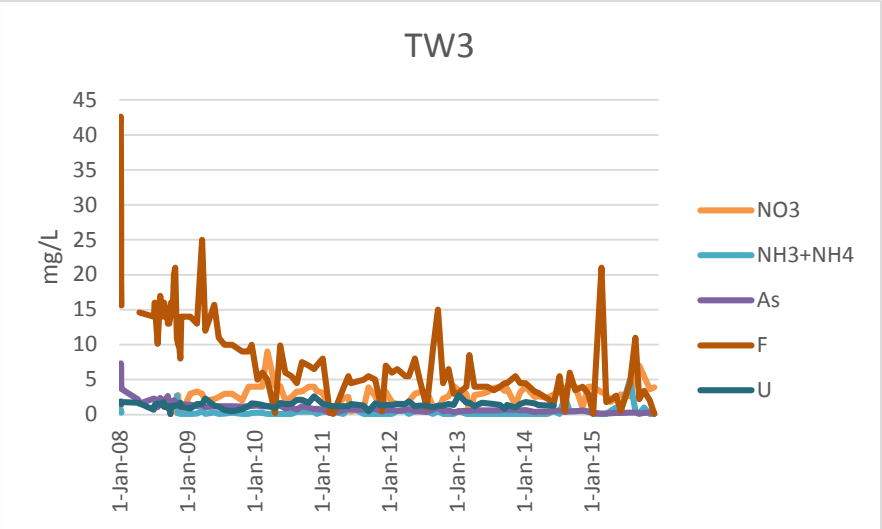
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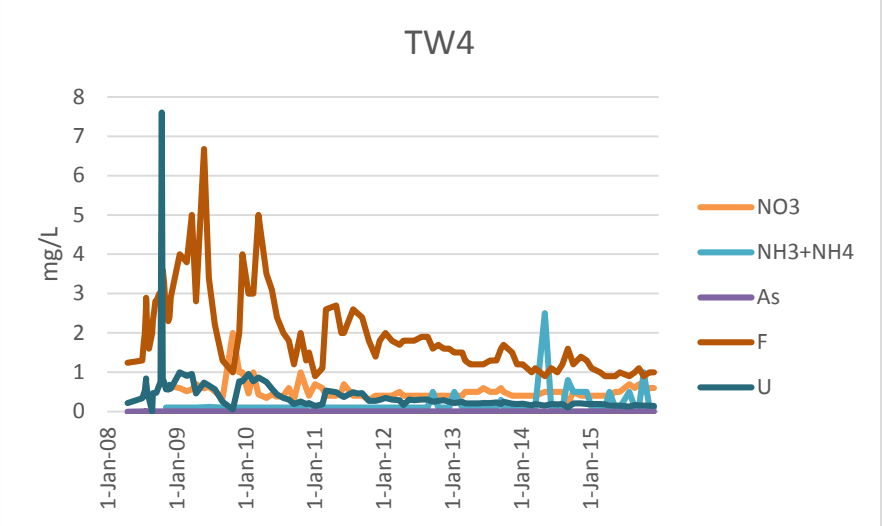
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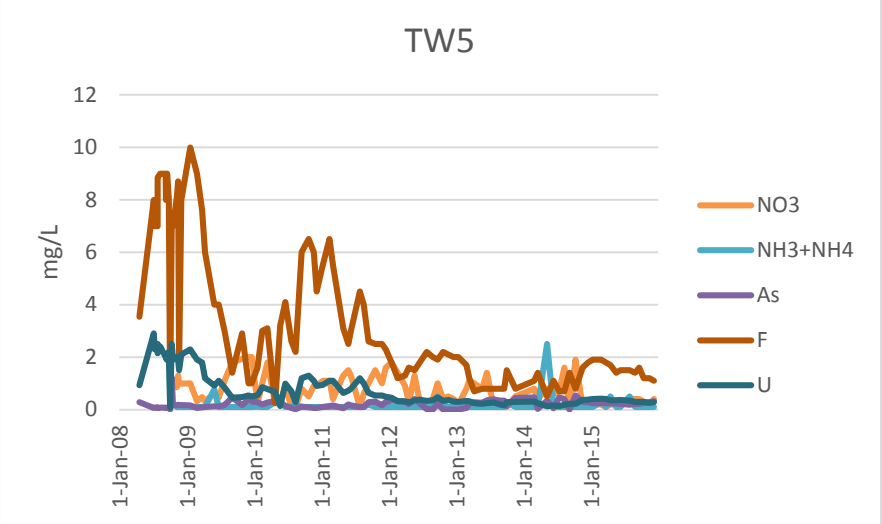
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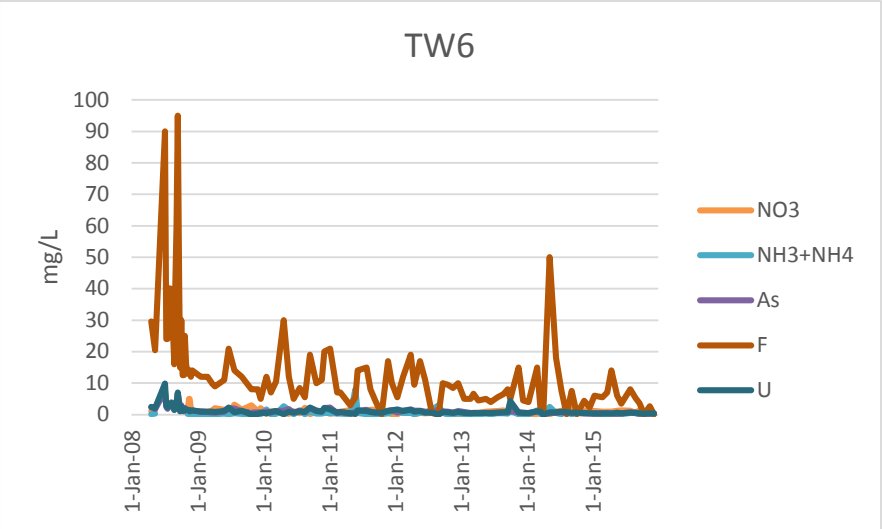
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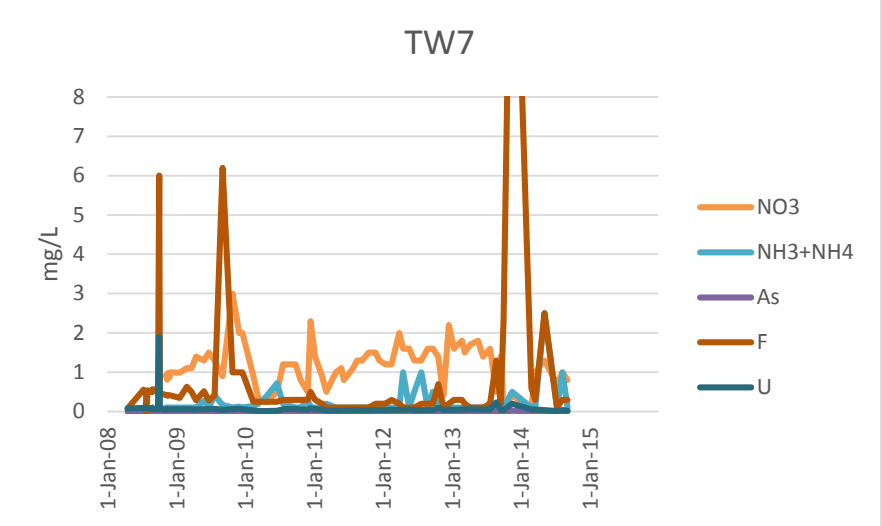
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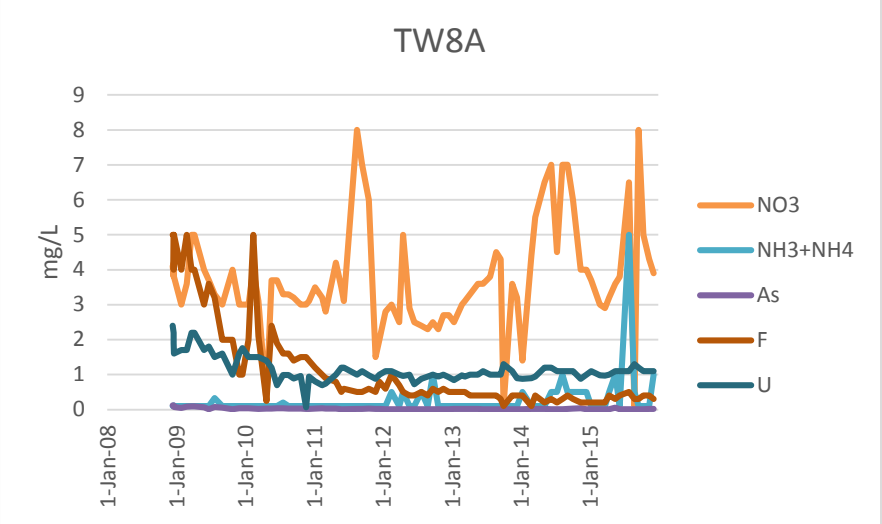
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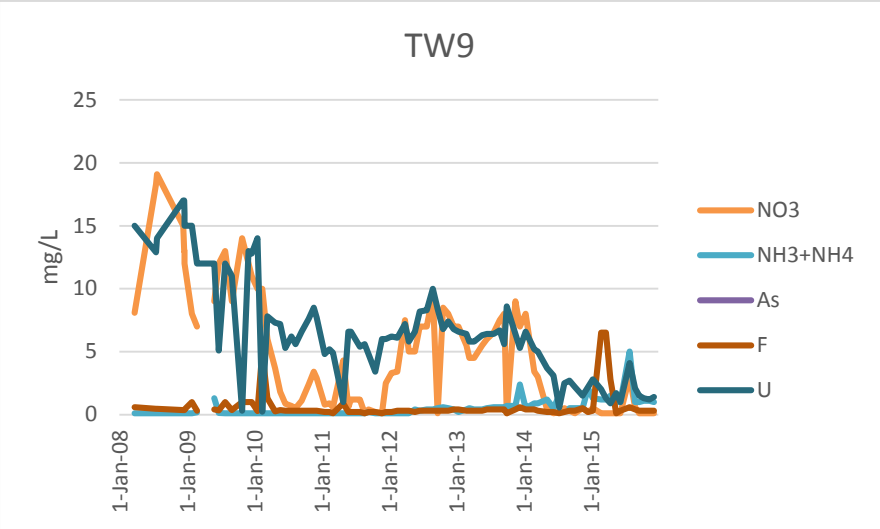
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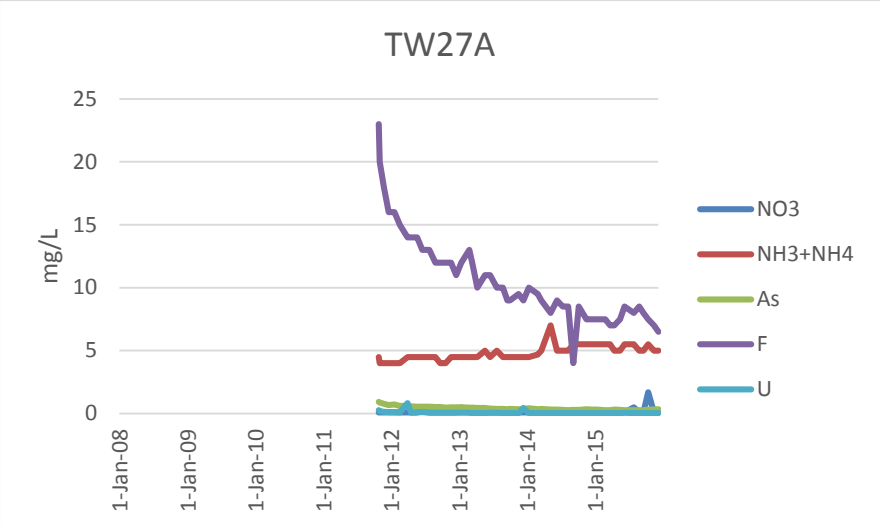
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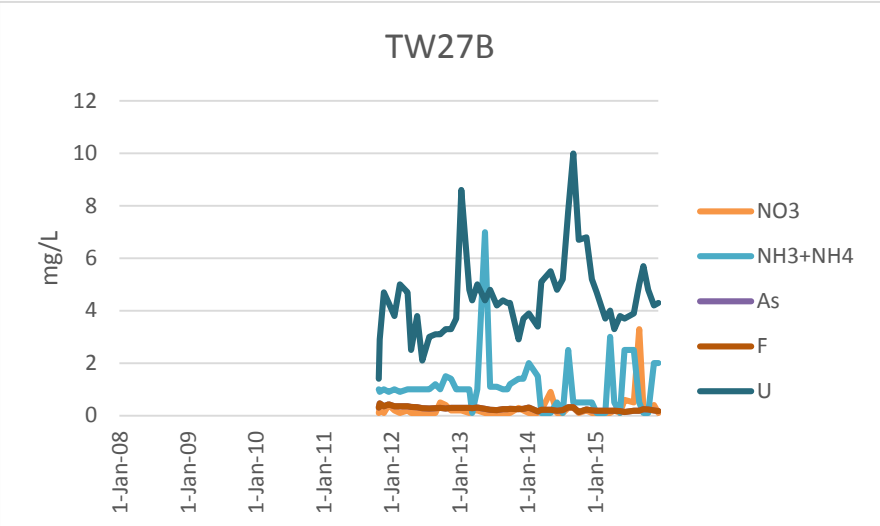
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NH3+NH4
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