

Memo

To:	John Roberts, PEng	Client:	TMAC Resources
From:	Sarah Portelance, PEng	Project No:	1CT022.002
Reviewed By:	Maritz Rykaart, PhD, PEng	Date:	January 22, 2016
Subject:	Document P6-10b, Water and Load Balance Model – Results of Sensitivity Analysis		

1 Context

A series of Technical Review comments requested additional scenarios to be evaluated through the water and load balance model. These include:

- ECCC 4, KIA 11A and KIA 11C: Requested inclusion of free cyanide, mercury and selenium from process water be included in water quality predictions.
- KIA 11A: Requested a description of the site specific variable hydrology and requested that it be included into the load balance of the water quality predictions.
- KIA 5, KIA 11B and AANDC TC4: Requested that the water and load balance evaluate the 75th percentile input values for background water quality, pollution control and sediment control pond concentrations, ore and waste rock source terms and the tailings beach source term.

TMAC reviewed available data from geochemical testing and identified alternative test results for cyanide, selenium and mercury. The maximum concentrations from the process water aging tests as listed in Table 1 was subsequently used for the Base Case and the Sensitivity Analysis. The Base Case is as presented in Document P6-10 of the Application. The Sensitivity Analysis results and input values are presented in this memo and addresses the additions proposed by interveners as described above.

Table 1: Maximum process water concentration for free cyanide, mercury and selenium from process water ageing tests

Parameter	Concentrations (mg/L)
WAD Cyanide	0.27
Mercury	0.000079
Selenium	0.0075

This memo includes the results of the water and load balance Sensitivity Analysis which includes free cyanide, mercury and selenium process water concentrations as described in Table 1, variable hydrology implemented as a Monte Carlo simulation based on historical precipitation and temperature data, and 75th percentile input values for background water quality, Sedimentation Control and Pollution Control Pond concentrations, ore and waste rock source terms and the tailings beach source term.

2 Results

Table 2 summarizes the results of the Base Case and Sensitivity analysis within the TIA post closure when the North Dam has been breached. Results are presented in each case for two conditions; the open water period when discharge from the TIA to Doris Lake would occur (Open Water Mean), and the period when the ice cover is at its maximum and no discharge occurs (Max. Cryoconcentration). This 100% cryoconcentration assumption is unrealistically conservative but is added to bracket the results recognizing that some degree of cryoconcentration does occur.

Highlighted cells in Table 2 indicate values that exceed CCME guideline values for freshwater aquatic life.

- For the Base Case four elements exceed these guideline values during the open water season within the TIA; aluminum, chromium, copper and iron. These metals exceed the guideline value by 1.7, 1.3, 1.7 and 1.1 times respectively, which are likely well below the factors of safety built into these guideline values.
- For the Sensitivity Analysis six elements exceed CCME guideline values for freshwater aquatic life during the open water season in the TIA; aluminium, arsenic, chromium, copper, iron and selenium. These metals exceed the guideline values by 2.3, 2.0, 2.7, 2.6, 1.6 and 1.3 respectively. Once again, these exceedances are likely well below the factors of safety built into these guideline values.
- None of the base case or sensitivity analysis results exceeded the CCME guidelines for livestock watering, which are indicative of potential effects on terrestrial wildlife.

It is important to note that the 75th percentile background concentrations for aluminum, chromium, iron and mercury were higher than the CCME guideline values for freshwater aquatic life.

Finally, the compliance point at closure is not within the designated TIA, but in Doris Creek downstream of the TIA. At that point there are no exceedances of CCME guideline values for freshwater aquatic life.

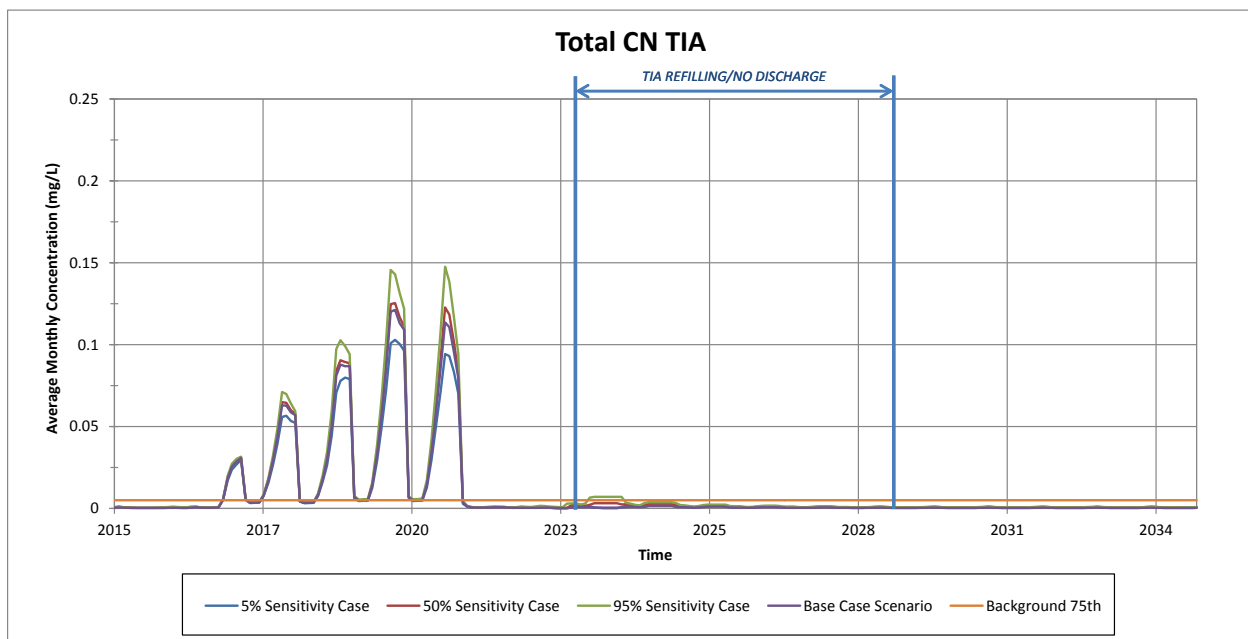
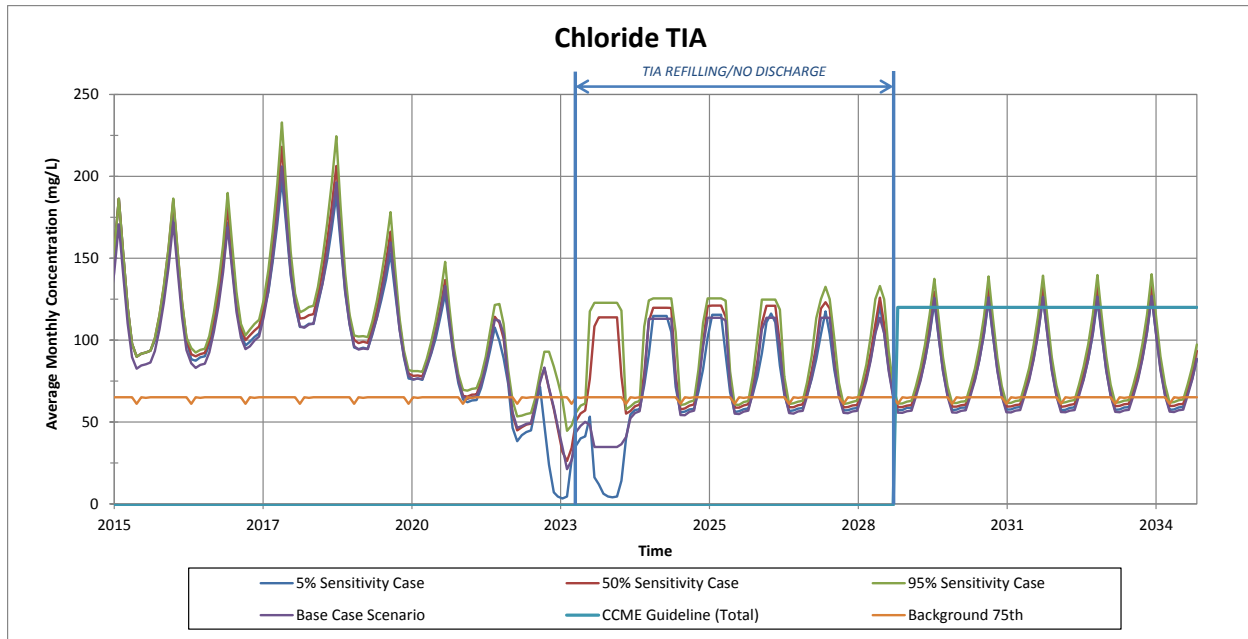
Following Table 1 is a series of graphs illustrating the results of the modeling showing both the Base Case and Sensitivity Analysis results for all parameters listed in Table 2.

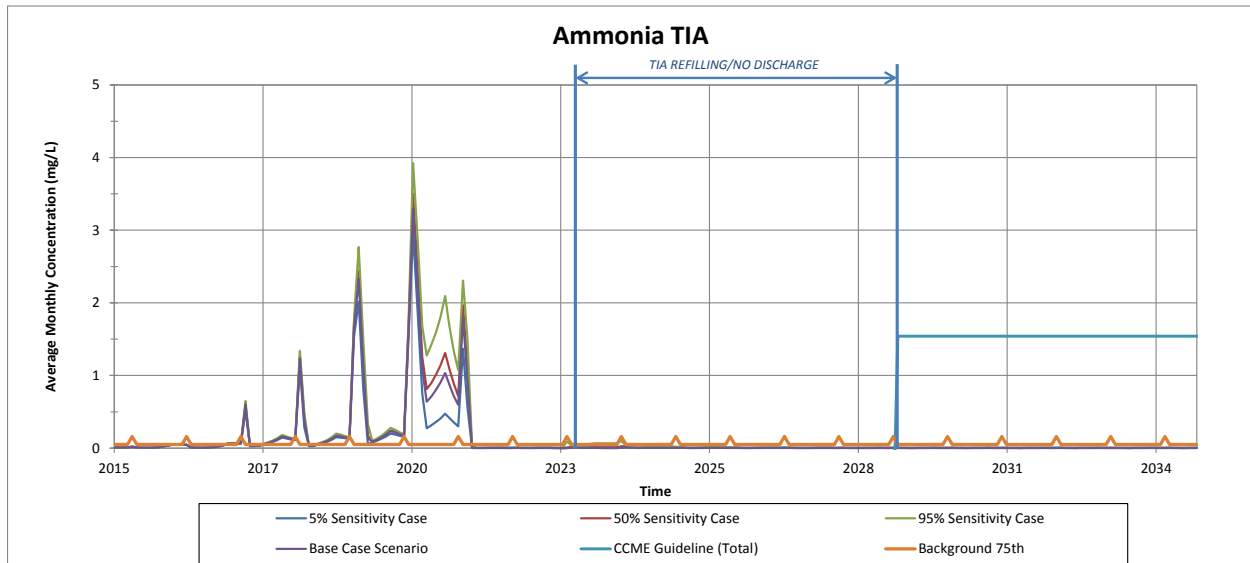
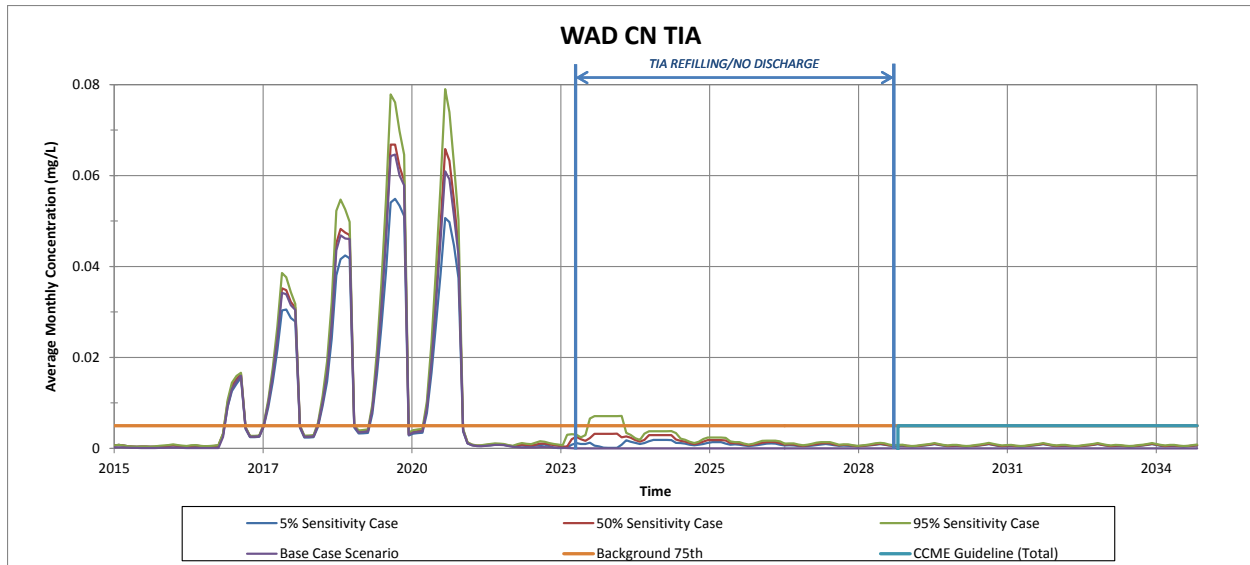
Table 2: Sensitivity analysis results for TIA pond water quality

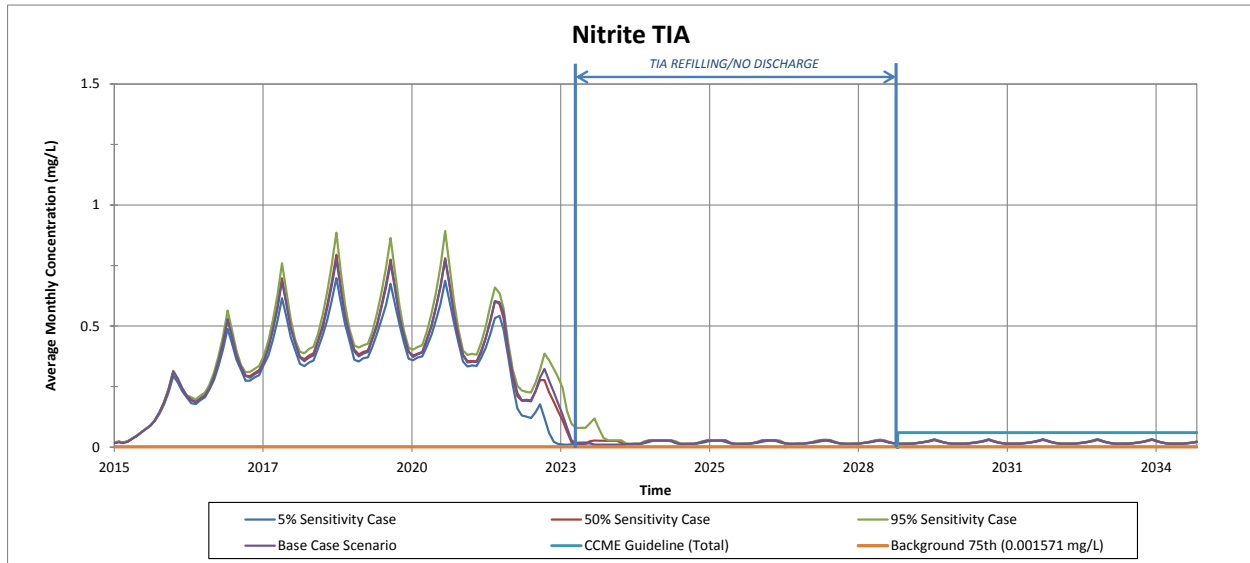
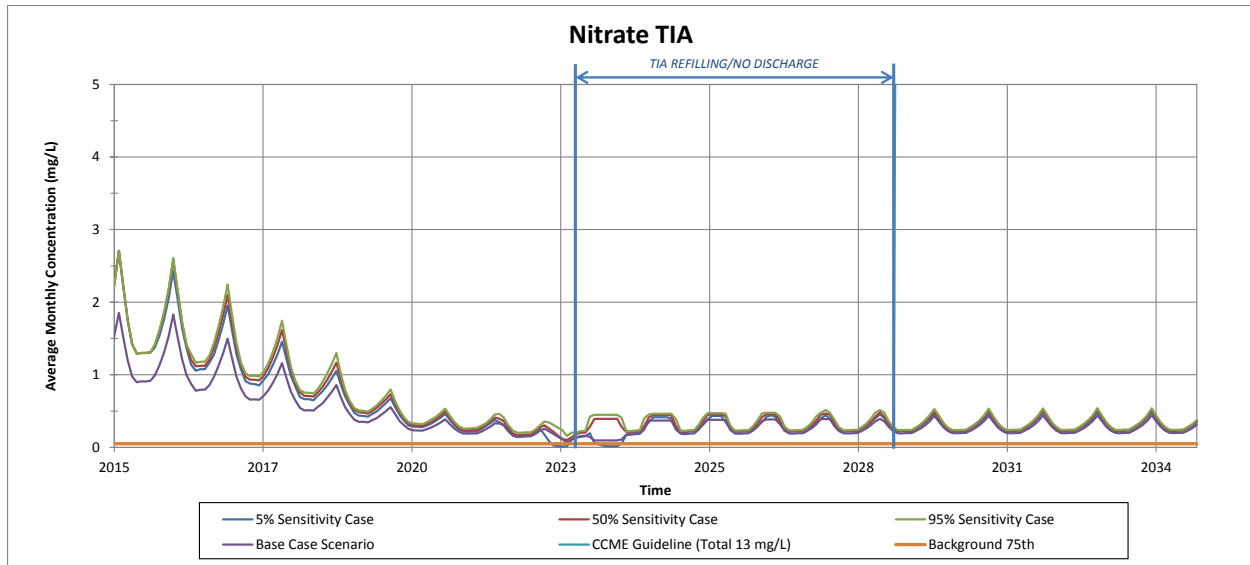
Parameter	Post Closure				Background Concentration		CCME Guideline (Fresh Water Aquatic Life)	CCME Guideline (Livestock Watering)
	Base Case		Sensitivity Analysis (75th Percentile Input Values)					
	Open Water Mean	Max. Cryo-concentration	Open Water Mean	Max. Cryo-concentration	50th	75th		
Chloride	58.42	126.90	64.39	140.30	63.80	65.15	120	
Total CN	0.00029	0.00057	0.00064	0.00118	0.005	0.005		
WAD CN	0.00000001	0.00000003	0.00064128	0.00117800	0.005	0.005	0.005	
Ammonia	0.0013	0.0019	0.0028	0.0065	0.16	0.16	1.54	
Nitrate	0.204	0.443	0.249	0.540	0.050	0.050	13.00	
Nitrite	0.0147	0.0320	0.0153	0.0332	0.0016	0.0016	0.060	
Aluminum	0.17	0.27	0.23	0.39	0.05	0.16	0.10	5
Arsenic	0.003	0.007	0.010	0.022	0.001	0.001	0.005	0.025
Barium	0.005	0.009	0.011	0.024	0.02	0.02		
Beryllium	0.0000	0.0001	0.0009	0.0021	0.001	0.001		0.1
Boron	0.03	0.06	0.07	0.15	0.1	0.1	1.5	5
Cadmium	0.00001	0.00003	0.00003	0.00007	0.00001	0.00005	0.00007	0.08
Chromium	0.0013	0.0018	0.0027	0.0050	0.001	0.005	0.001	0.05
Cobalt	0.00019	0.00033	0.00223	0.00477	0.002	0.002		1
Copper	0.0035	0.0073	0.0051	0.0109	0.0015	0.0016	0.002	0.5
Iron	0.34	0.48	0.48	0.77	0.17	0.31	0.3	
Lead	0.00013	0.00024	0.00055	0.00115	0.00011	0.00050	0.001	0.1
Manganese	0.037	0.069	0.055	0.112	0.058	0.058		
Mercury	0.000005	0.000009	0.000034	0.000074	0.00002	0.00010	0.000026	0.003
Molybdenum	0.0008	0.0018	0.0063	0.0136	0.005	0.005	0.07	0.5
Nickel	0.0010	0.0020	0.0024	0.0050	0.002	0.002	0.025	1
Selenium	0.0005	0.0011	0.0006	0.0013	0.0004	0.0004	0.001	0.05
Silver	0.00002	0.00004	0.00004	0.00007	0.00002	0.00002	0.00010	
Strontium	0.04689	0.09558	0.01177	0.02537				
Thallium	0.00004	0.00009	0.00013	0.00027	0.0002	0.0002	0.0008	
Uranium	0.00008	0.00017	0.00017	0.00038	0.0002	0.0002	0.015	0.2
Vanadium	0.00081	0.00143	0.00136	0.00270	0.0016	0.0016		0.1
Zinc	0.0041	0.0084	0.0057	0.0119	0.0052	0.0052	0.03	50

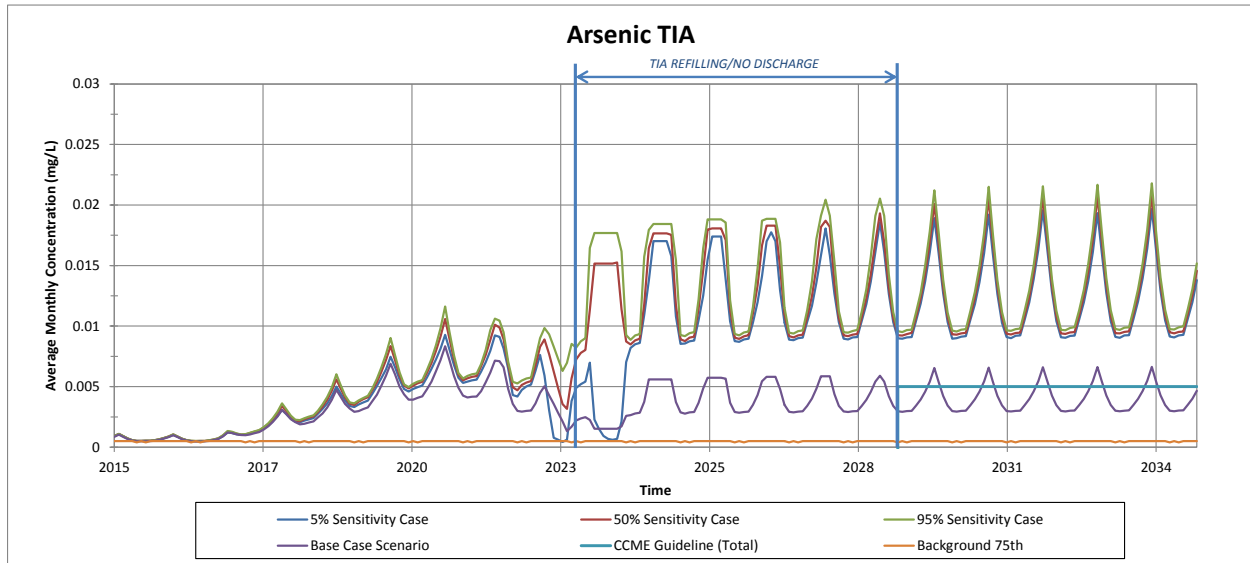
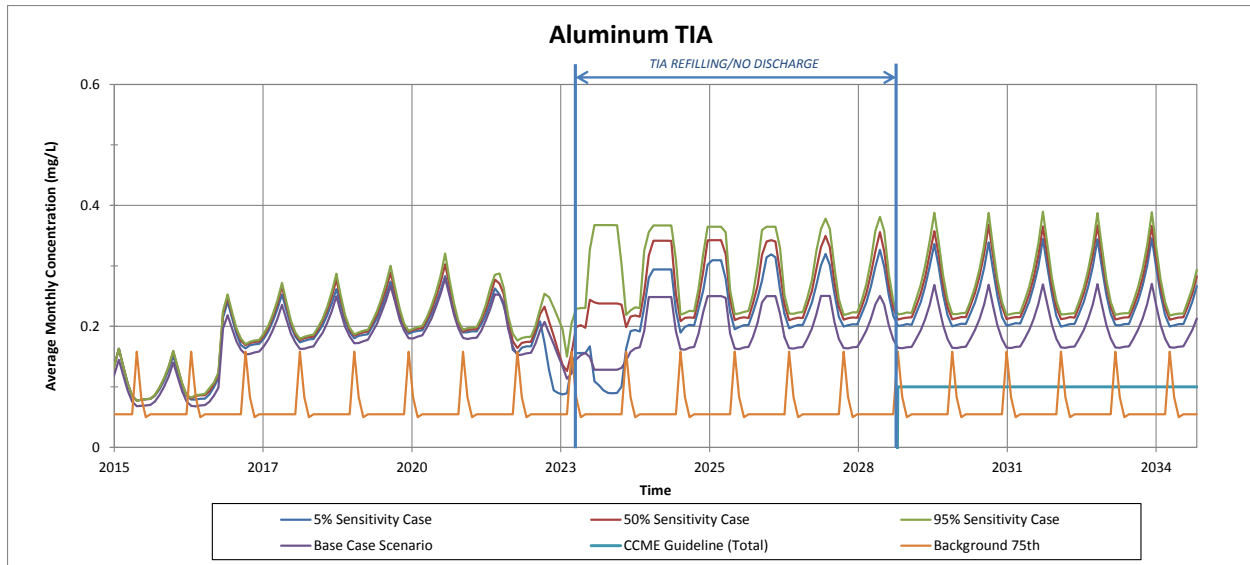
Note: Highlighted cells with red text indicate parameters that exceed CCME guideline values for freshwater aquatic life.

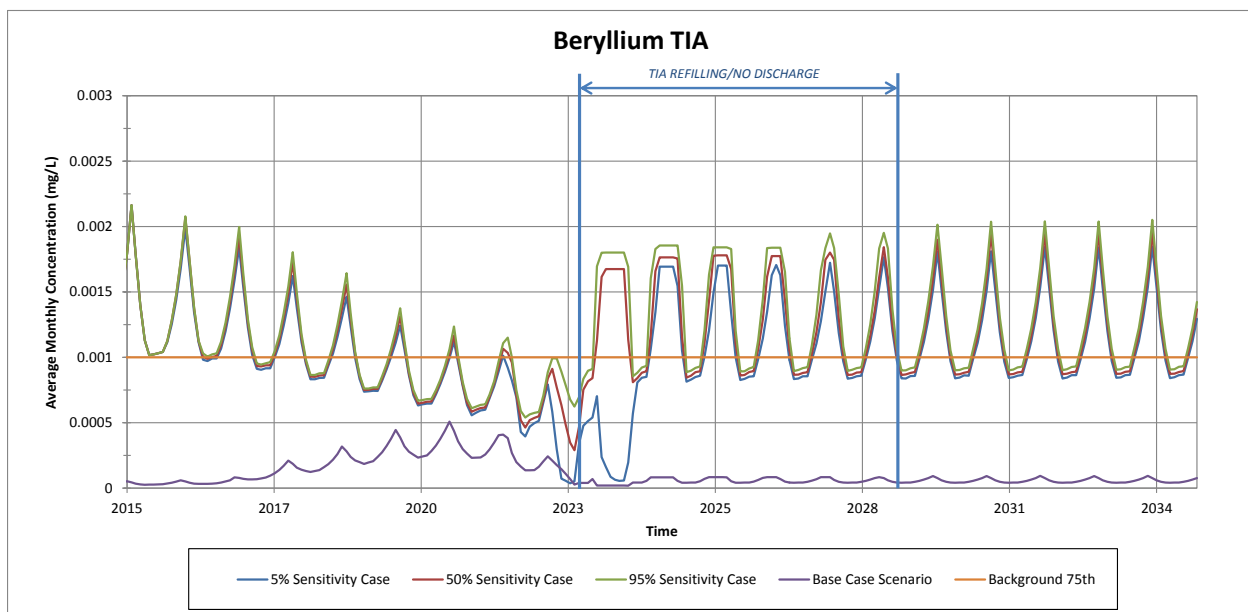
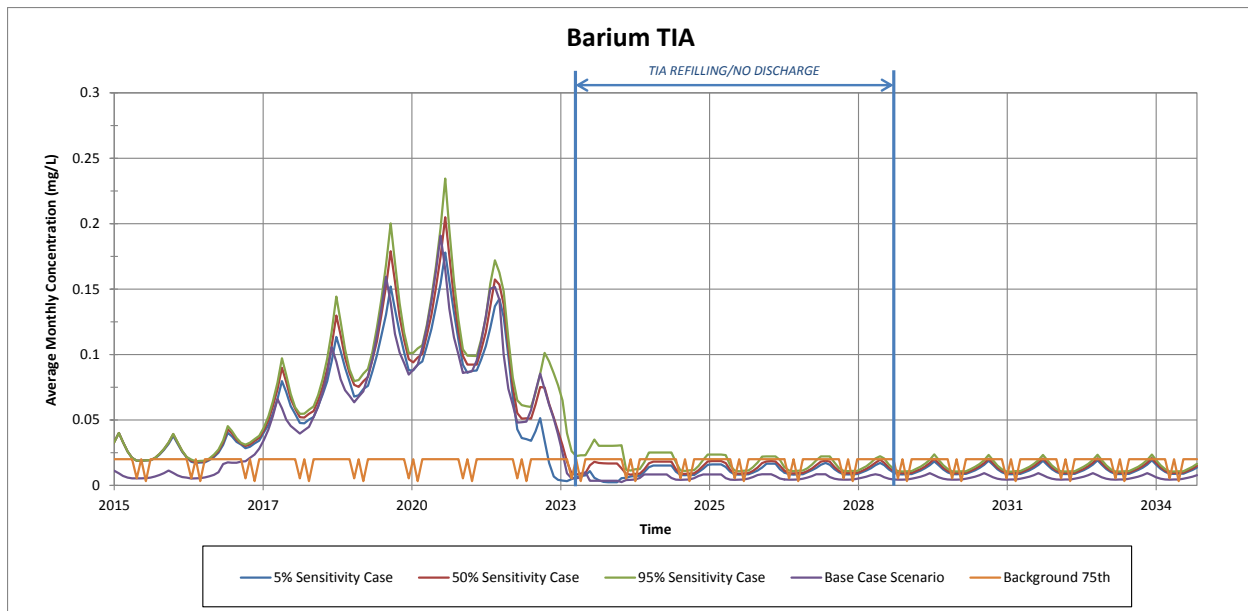
There were no exceedances of CCME guidelines for livestock watering.

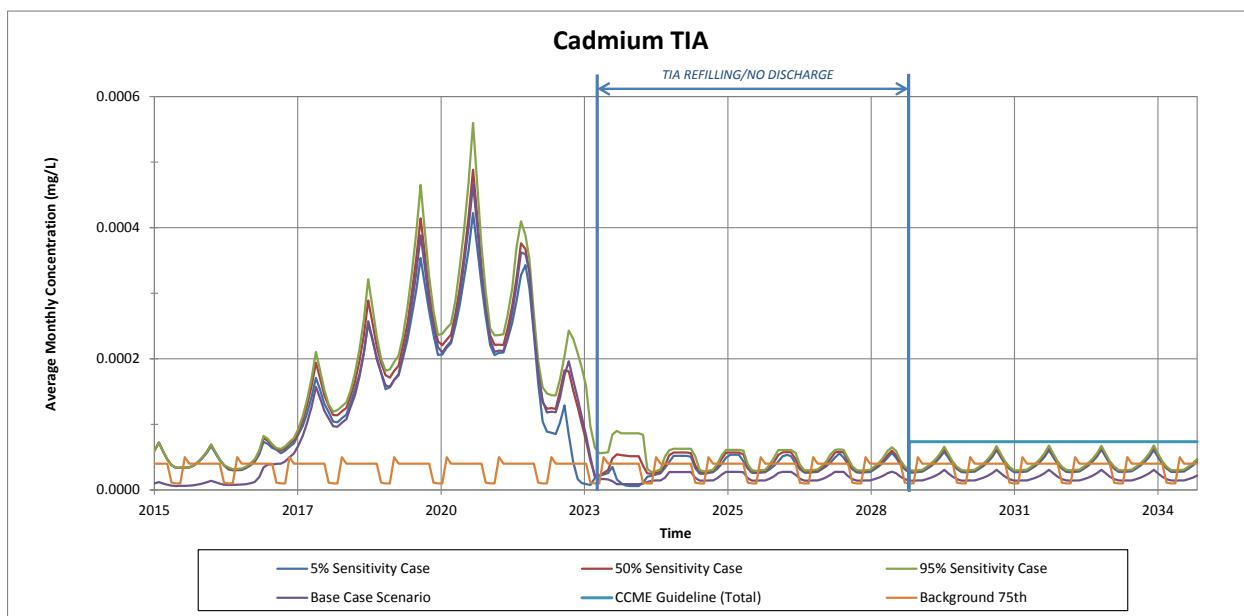
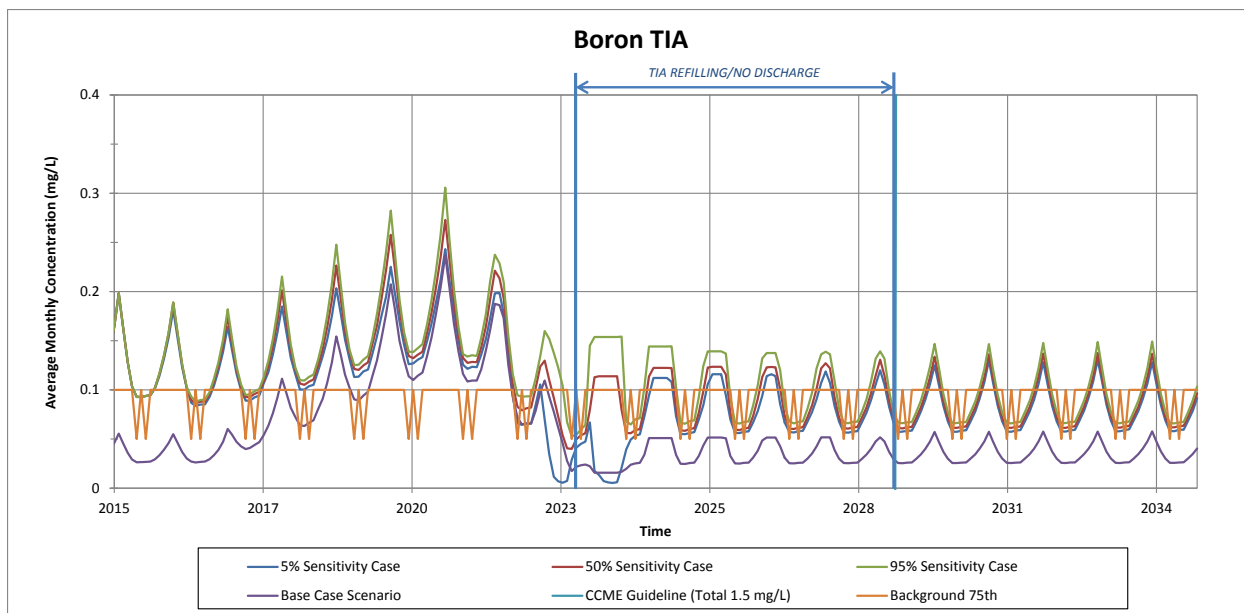


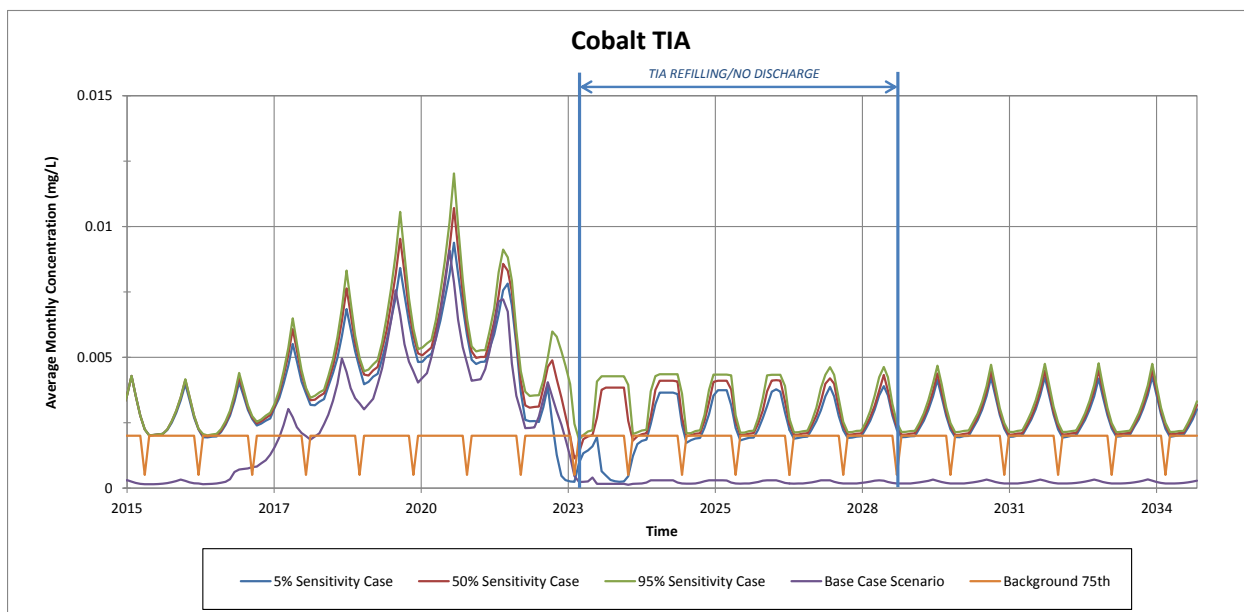
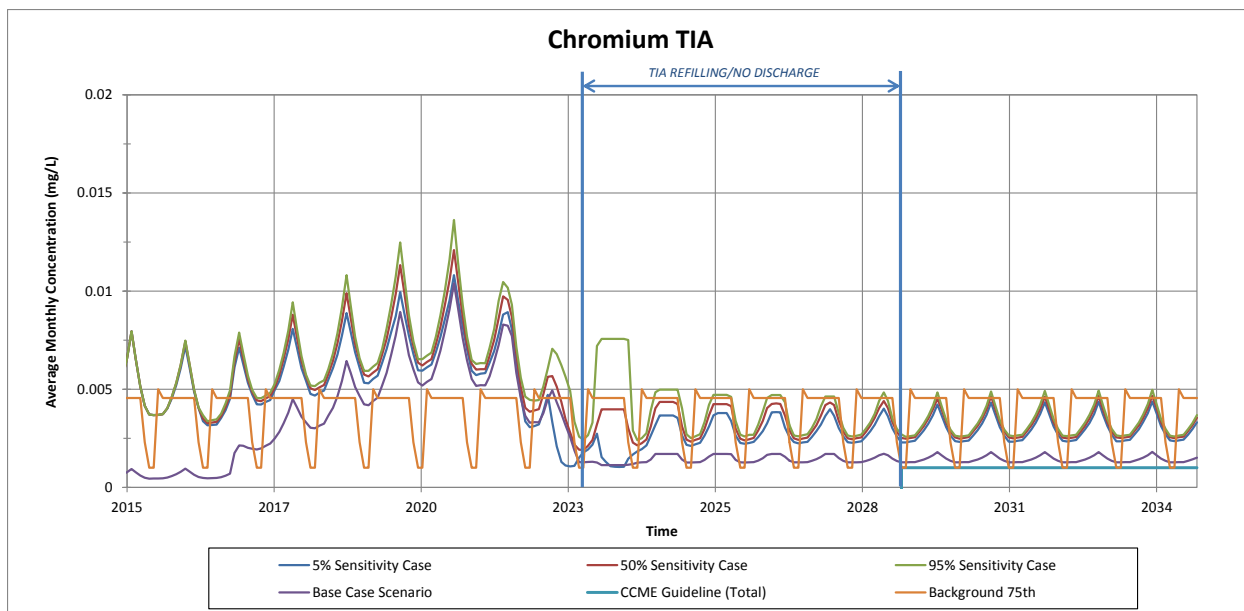


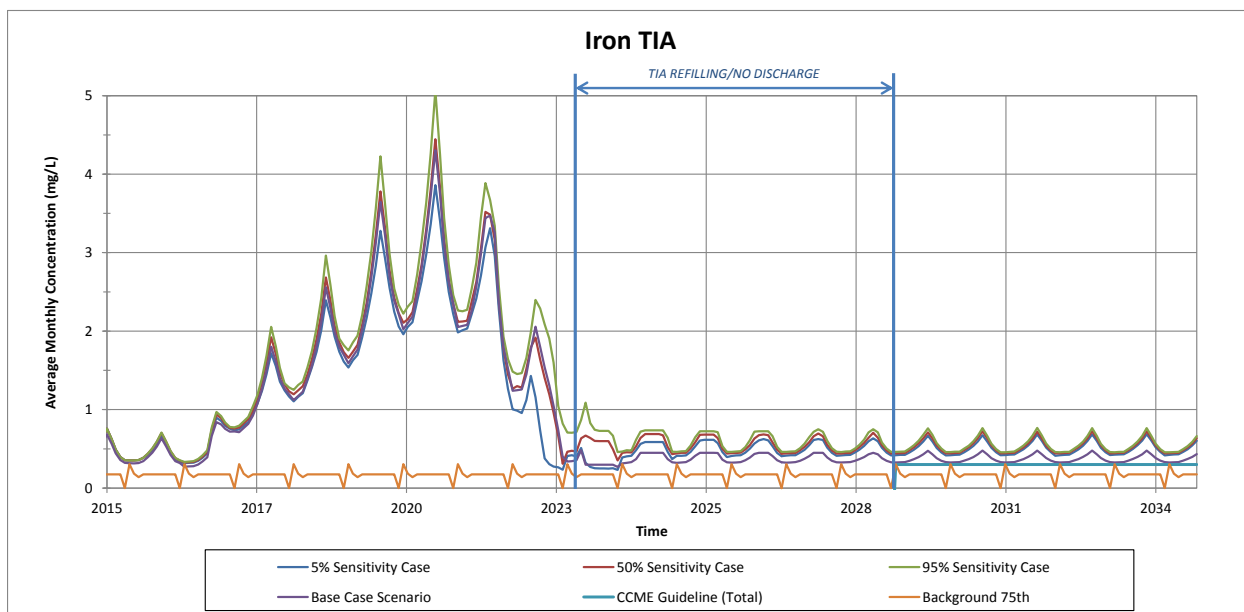
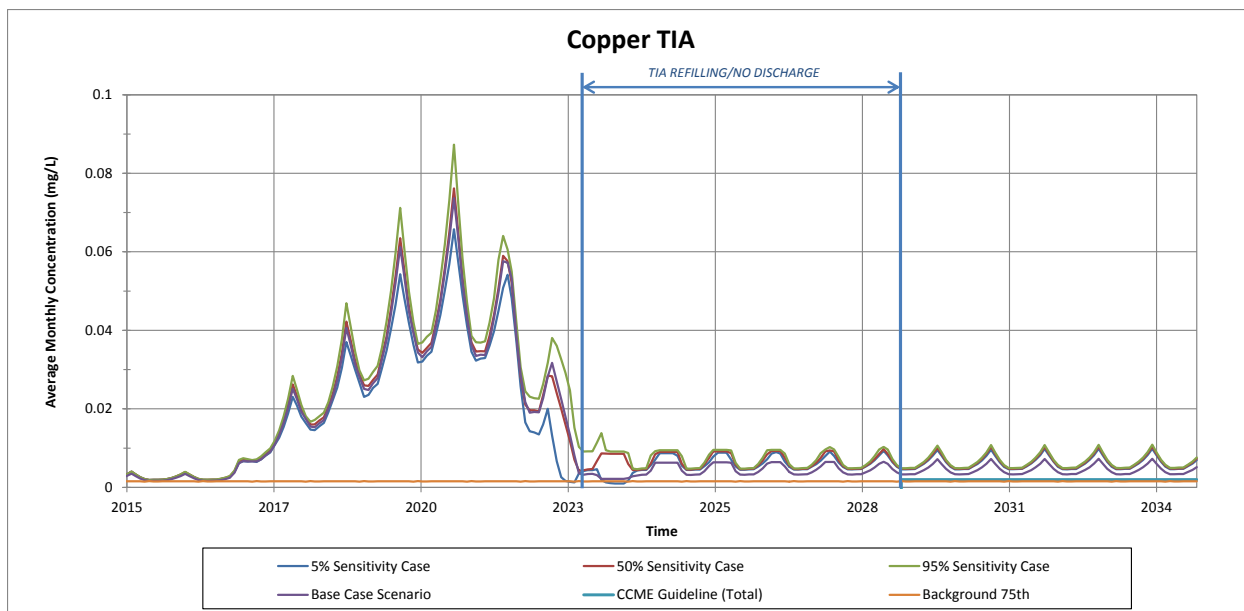


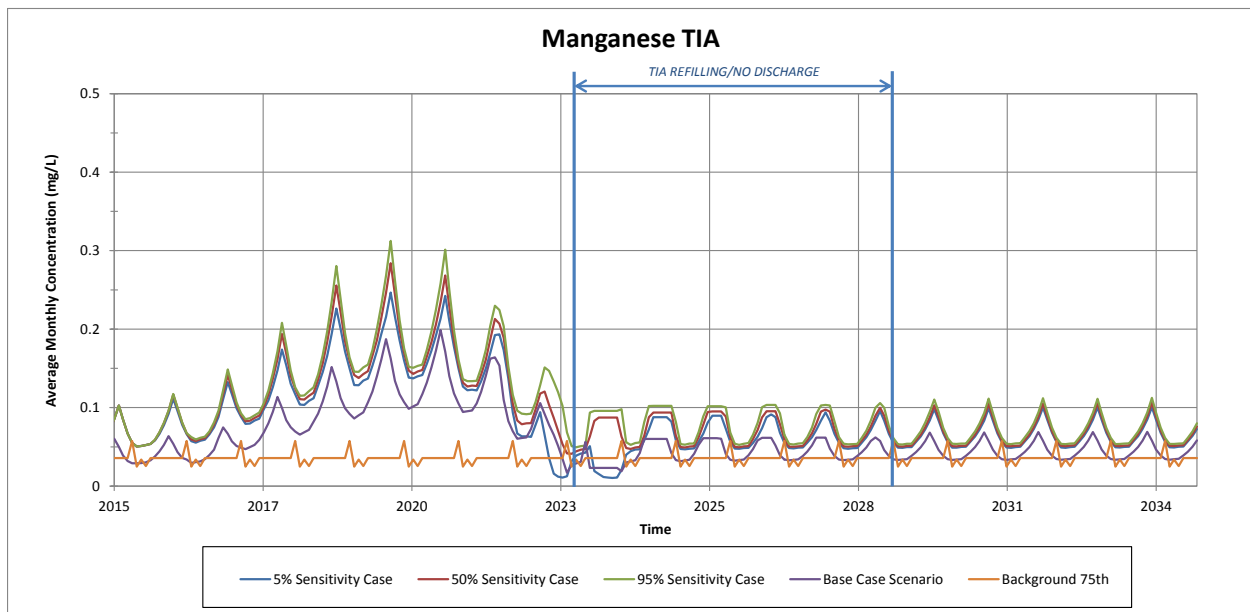
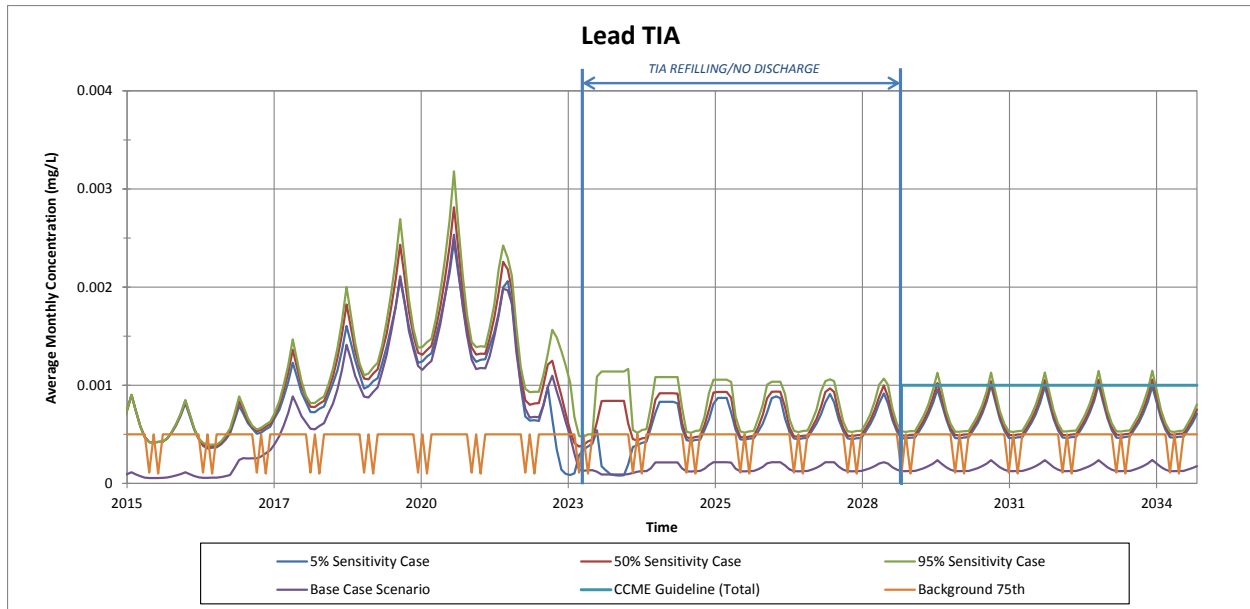


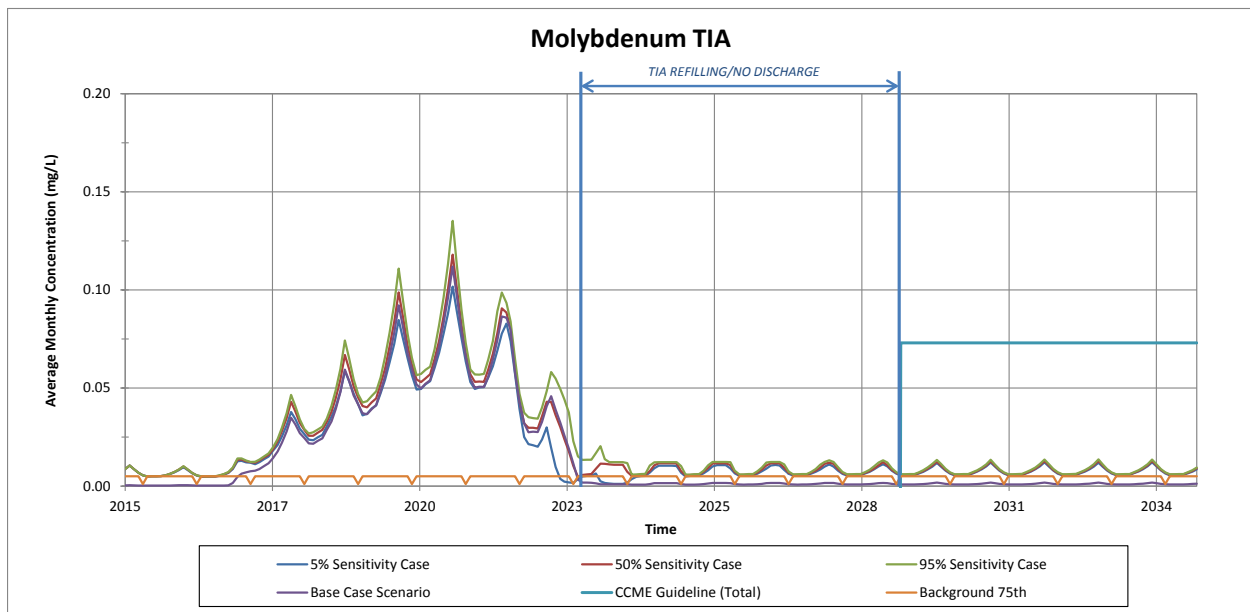
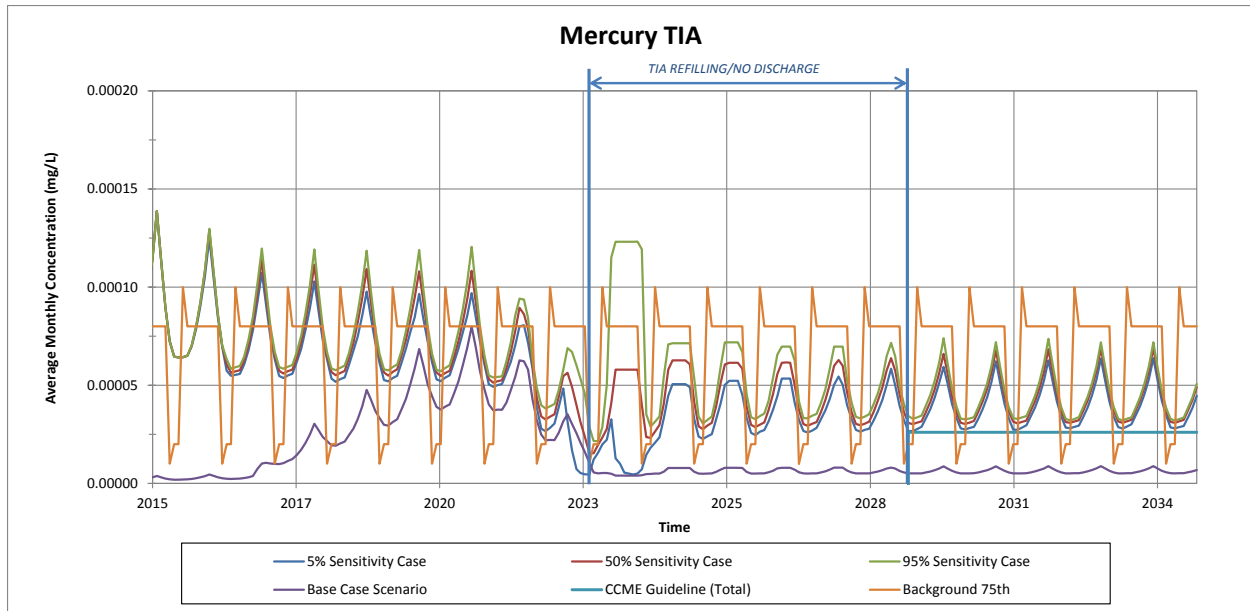


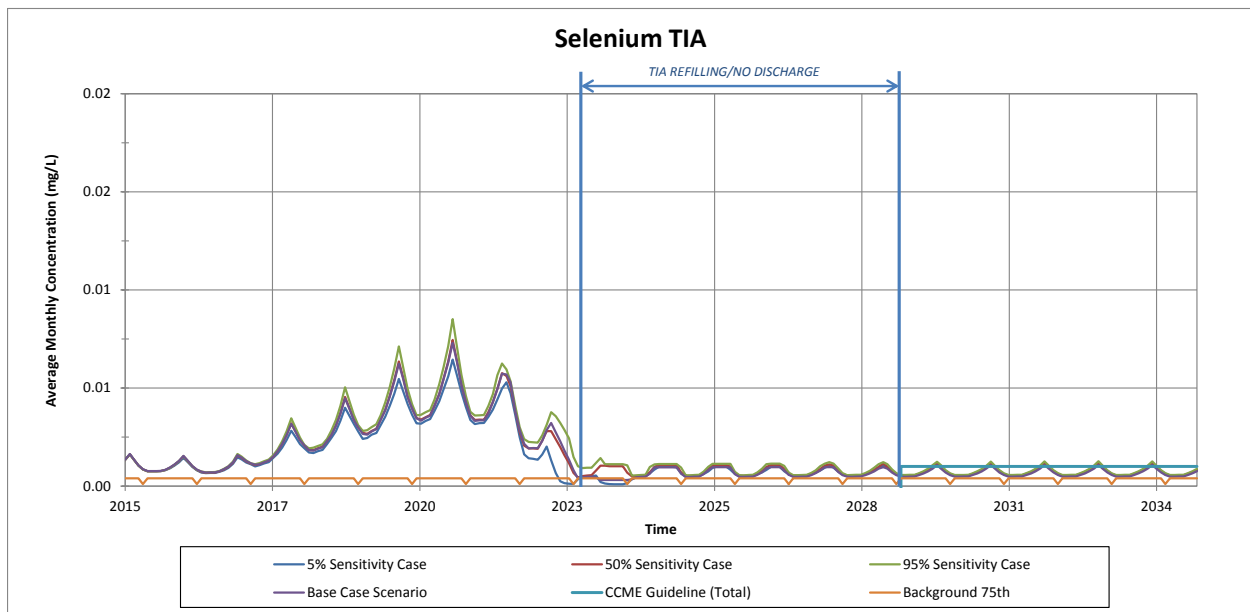
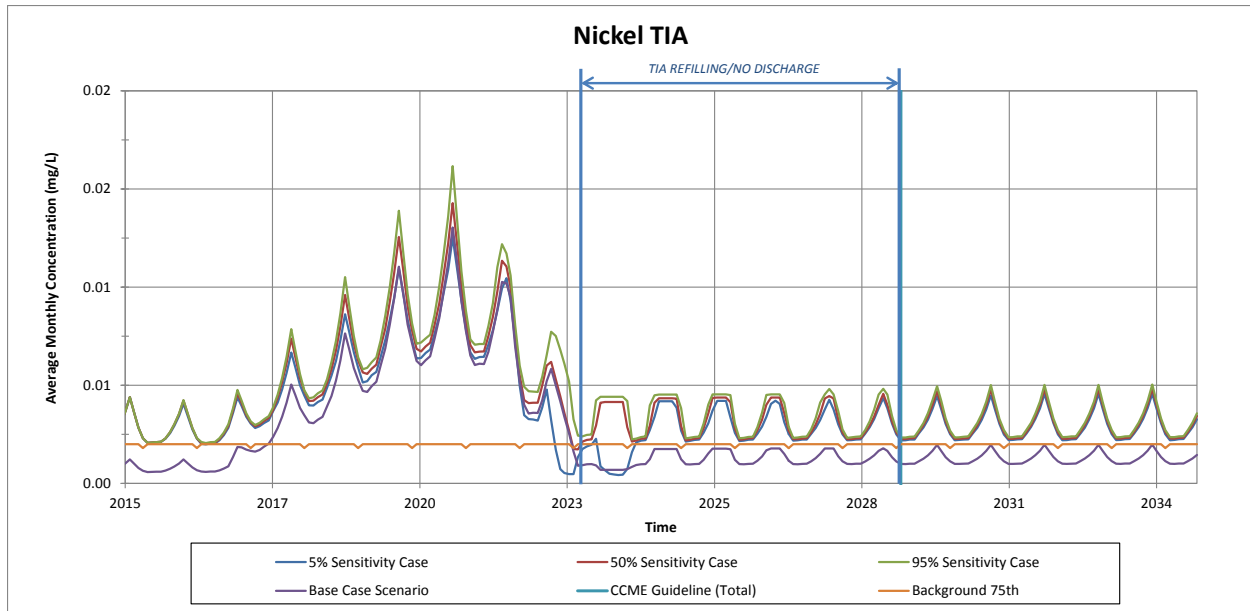


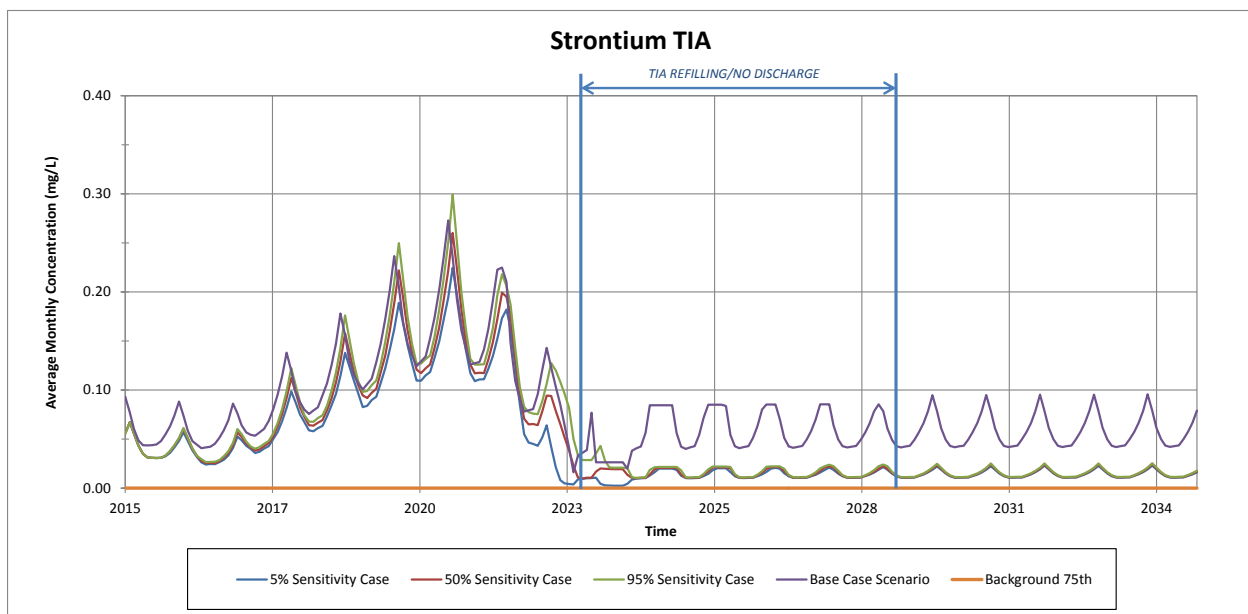
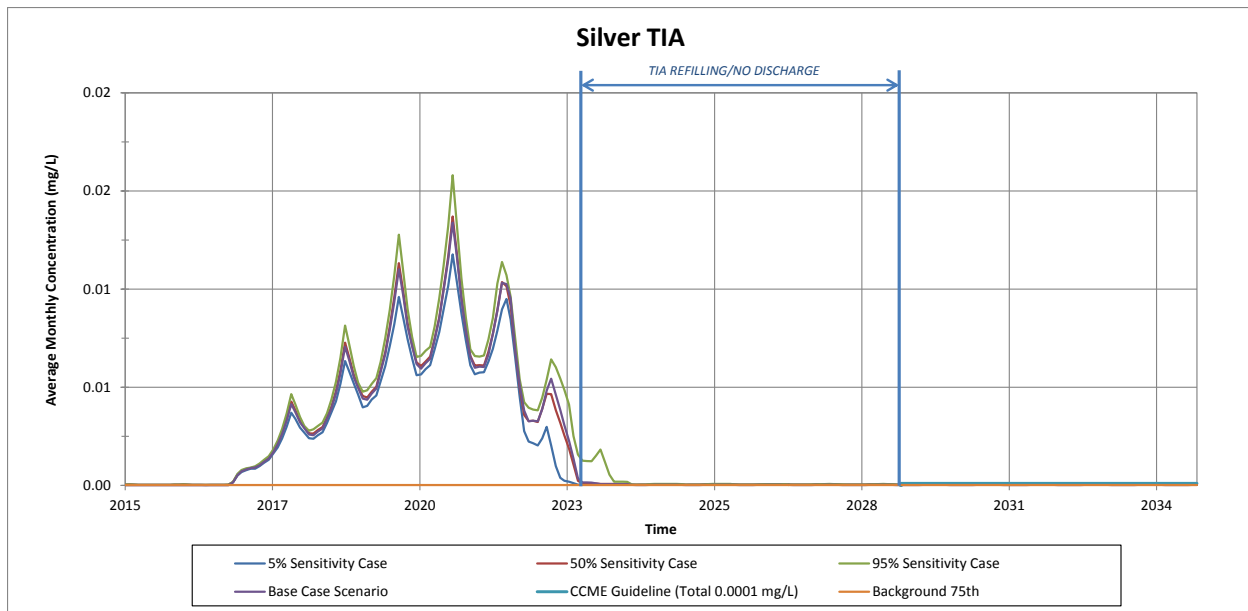


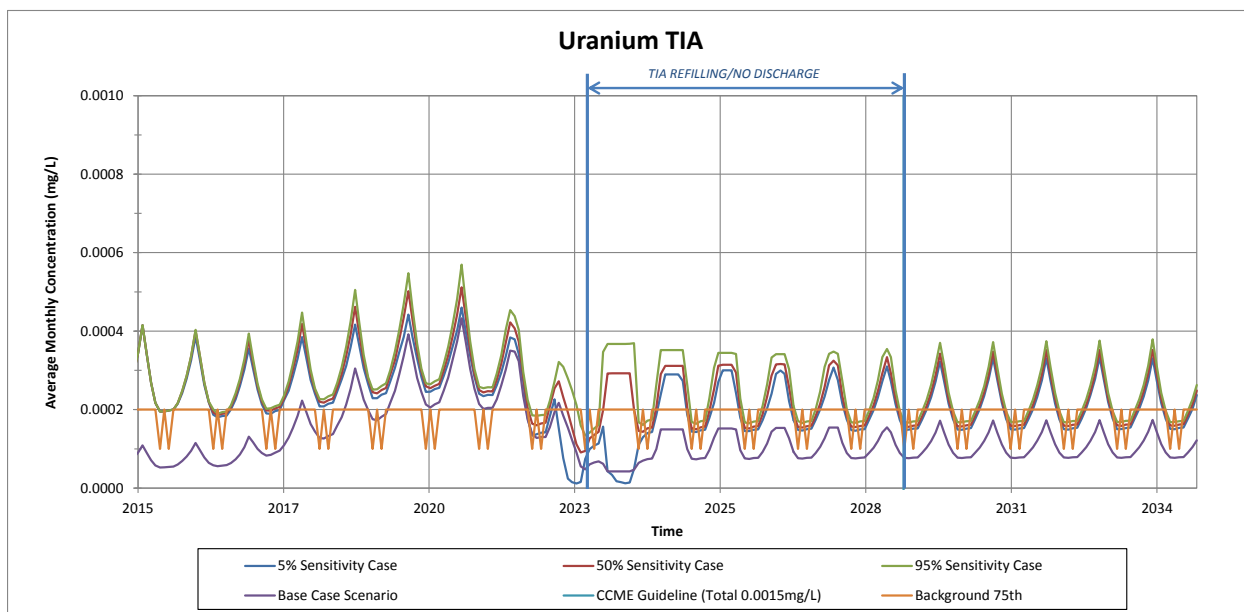
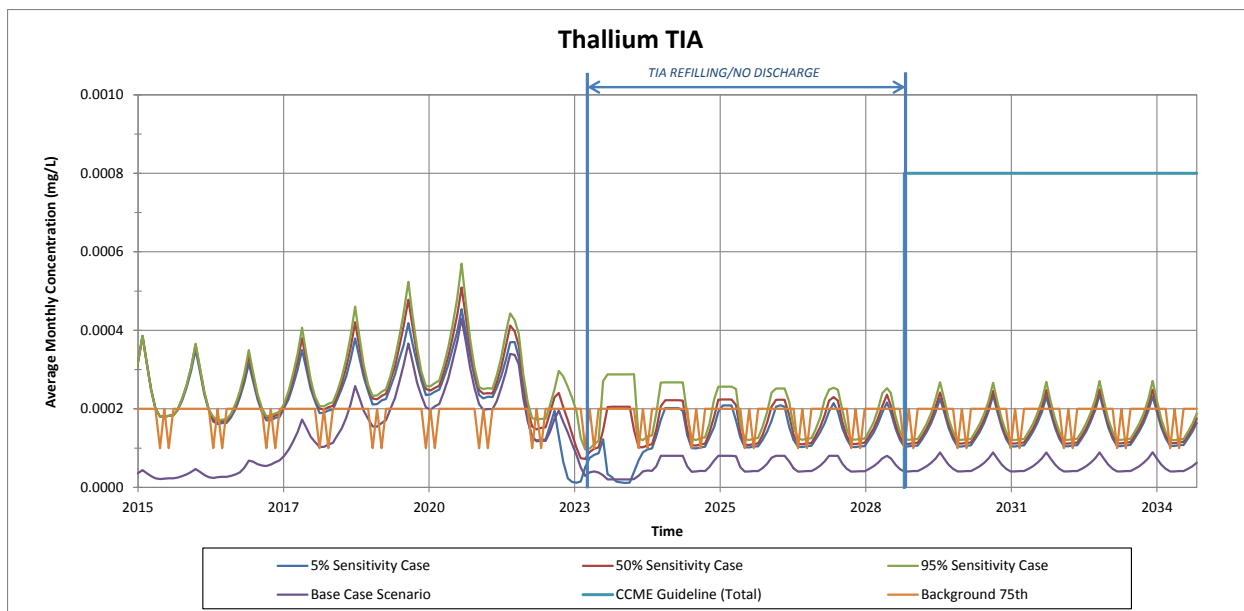


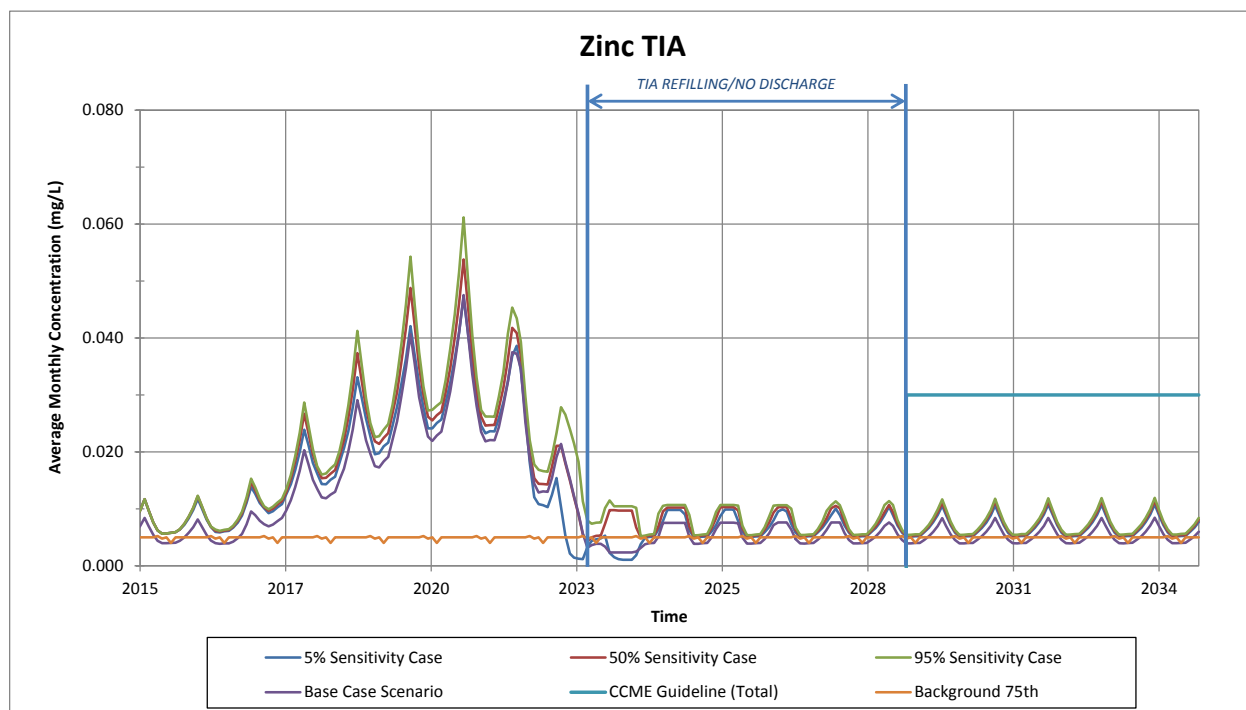
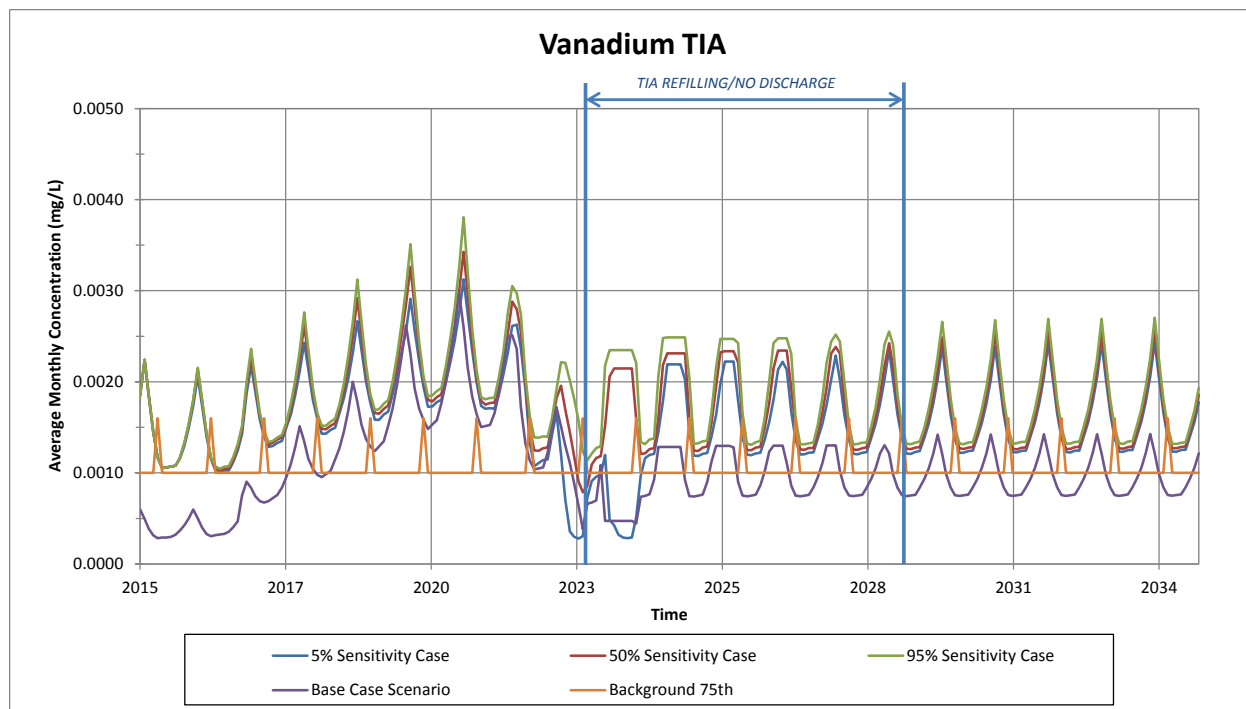












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