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TECHNICAL MEMORANDUM

July 2, 2021

To: Steve Grace, CEMEX

Cc: Yasha Saber, Compass Land Group
Pat Mitchell, Mitchell Chadwick

From: Andy Kopania

Subject: Quarry Lake Water Quality and Aquatic Life Criteria
CEMEX CLAYTON QUARRY

On March 1, 2021, EMKO Environmental, Inc. completed the Technical Memorandum "Adaptive Management Program to evaluate water quality conditions after reclamation of the CEMEX Clayton Quarry" (EMKO, 2021) (referred to herein as the AMP Tech Memo). The AMP Tech Memo used laboratory analytical data from DI-WET leaching results on 14 rock samples collected from the Clayton Quarry to identify equilibrium water quality conditions in the future quarry lake once the mining excavation fills with water. The AMP Tech Memo was prepared to address specific peer review comments received from Contra Costa County's Environmental Impact Report (EIR) consultant team on the Hydrology and Water Quality Evaluation Report, May 2020, CEMEX Clayton Quarry, Clayton, Contra Costa County, California (EMKO, 2020a) (referred to herein as the May 2020 Hydrology Report). The basis for the AMP Tech Memo is described in the Technical Memorandum "Initial Sampling to Support Adaptive Management Plan, Clayton Quarry" (EMKO, 2020b) (referred to herein as the Initial Sampling Memo).

Based on the AMP Tech Memo (EMKO, 2021), the County's EIR consultant provided additional comments regarding the Quarry Lake water quality and potential effects on aquatic receptors. This technical memorandum has been prepared to evaluate how the water quality in the quarry lake will change after mining is completed and the excavation fills with water, in response to the comments from the County's EIR consultant. Concentrations of parameters detected in the DI-WET leachability testing described in the AMP Tech Memo (EMKO, 2021) are used in this evaluation as the basis for assessing the potential accumulation or dilution of each parameter in the quarry lake over time. As stated above, the DI-WET leaching procedure was used to represent equilibrium conditions in the water that comes in contact with the different geological formations and rock types in the reclaimed quarry.

Approach

The timeframes considered and water budget inputs and outputs used in this evaluation are based on those listed in Table 10 and depicted on Figure 3 of the May 2020 Hydrology Report (EMKO, 2020a). The standards used to evaluate whether or not water quality objectives may be exceeded include drinking water maximum contaminant levels (MCLs) (SWRCB, 2018a and 2018b), the water quality objectives listed in Chapter 3 of the San Francisco Bay Regional Water Quality Control Board's (RWQCB's) Basin Plan (RWQCB, 2017), and the U.S. EPA's Aquatic Life Criteria Table (U.S. EPA, 2021).

Attachment A contains summary tables presenting the results from the DI-WET laboratory analyses for the constituents listed in the EIR consultant's comments. Results are presented for the Knoxville Formation, altered diabase, and unaltered diabase, as discussed in the Initial Sampling Memo (EMKO, 2020b) and the AMP Tech Memo (EMKO, 2021).

As noted in the tables in Attachment A, there were no detections of barium or zinc in any of the DI-WET leachate samples. In cases where the laboratory results include both samples with detectable values of a specific analyte and samples in which the laboratory did not detect that analyte (referred to as a non-detect or ND result), the results for the non-detect samples are often presumed to be one-half of the laboratory detection limit so that statistical analyses can be performed on the entire sample set (U.S. EPA, 1991). However, in cases where an analyte is not detected in any of the samples collected for that study, the analyte is presumed to not be present in the samples. Thus, for barium and zinc no further evaluation is presented in this Tech Memo as they would not be expected to be present in the water that accumulates in the quarry lake since they were not detected in any of the 14 samples from the quarry.

In addition, pH and conductivity are water quality properties that are not directly related to a mass per volume concentration of a single analyte. The pH concentration will vary based not only on the nature of the rainfall running off the exposed geologic formations around the quarry but will also vary based on the amount of dissolved carbon dioxide and oxygen in the water. These latter two factors are dependent on the amount of carbon dioxide in the atmosphere, the extent of aquatic plant growth in the quarry lake, and the amount of decaying organic matter that accumulates in the quarry lake. As discussed in the May 2020 Hydrology Report (EMKO, 2020a), due to the steep sides of the quarry, it is not anticipated that appreciable aquatic plant growth would occur in the quarry lake. Thus, there would be little or no decaying organic matter in the lake that could affect pH. Furthermore, as discussed in the AMP Tech Memo (EMKO, 2021), the Knoxville Formation and the diabase both have a net acid neutralization potential, so acid rock drainage will not occur within the reclaimed quarry and pH levels will not fall below applicable water quality standards. Thus, pH is not evaluated further in this Tech Memo.

The conductivity is a function of the amount of Total Dissolved Solids (TDS) in the water.

Thus, if the TDS remains below applicable water quality standards, the conductivity will also typically remain below applicable standards. Since TDS concentrations would range from only 35% to 55% of the TDS regulatory threshold (see Tables 1 and 2 below), conductivity is not expected to be an issue and no separate evaluation of conductivity is necessary.

Findings

Based on the above discussion, the parameters that are evaluated in this Tech Memo are:

- TDS;
- Sulfate;
- Arsenic;
- Iron;
- Manganese;
- Selenium; and
- Vanadium.

Table 1 presents a summary of applicable water quality objectives based on the regulatory sources cited above. The water quality standards for TDS and sulfate are secondary drinking water standards based on aesthetic qualities (i.e. taste and odor), also referred to as "consumer acceptance levels" (SWRCB, 2018b). The Basin Plan (RWQCB, 2017) includes some MCLs as being applicable to certain beneficial uses that may apply to the quarry lake or to discharges from the quarry lake. Therefore, when the Basin Plan (RWQCB, 2017) does not include a specific freshwater criterion for a listed constituent, the secondary MCL is shown in Table 1 and is considered to be protective of aquatic life in the context of this analysis.

TABLE 1. Water Quality Standards

Constituent	MCL (mg/L)	Basin Plan (mg/L) (c)	EPA Aquatic (mg/L)
TDS	500-1,000 (a)	500-1,000 (a)	NA
Sulfate	250-500 (a)	250-500 (a)	NA
Arsenic	0.01	0.15/0.34 (b)	0.15/0.34 (b)
Iron	0.3 (a)	0.3 (a)	1.0
Manganese	0.05 (a)	0.05 (a)	NA
Selenium	0.05	0.005/0.02 (b)	0.0015 (d)
Vanadium	NA	NA	NA

NA = not available or not applicable
(a) secondary MCL
(b) 4-day average/1-hour average, also referred to as chronic and acute
(c) Table 3.5 of the Basin Plan includes MCLs for certain beneficial uses
(d) 30-day average based on U.S. EPA 2016

As requested by the County's EIR consultant and to maintain consistency with the hydrologic evaluations already conducted, the quarry lake hydrologic parameters used to develop Table 10 and Figure 3 in the May 2020 Hydrology Report (EMKO, 2020a) were used to calculate the concentration of each of the constituents listed in Table 1 over time in the quarry lake. For each constituent, the average concentration from the DI-WET leaching results were calculated for the Knoxville Formation, the altered diabase, and the unaltered diabase. As discussed above and described further in the AMP Tech Memo (EMKO, 2021), in cases where the laboratory results for a specific analyte include both samples with detectable values and samples in which the laboratory did not detect that analyte (referred to as a non-detect or ND result), the results for the non-detect samples were presumed to be one-half of the laboratory detection limit for this evaluation. To develop a useable input for the diabase highwall and the upper watershed areas, it was assumed based on field observations in the quarry that the altered diabase constitutes 10 percent of the diabase rock mass and the unaltered diabase constitutes 90 percent of the diabase rock mass.

Calculation sheets for each constituent are provided in Attachment B. The results from the calculation sheets are summarized in Table 2. Charts showing the incremental increase for each constituent over time, compared with the applicable water quality standards, are provided in Attachment C. The individual quarry lake water surface elevations shown in Table 2, in the calculation sheets in Attachment B, and on the charts in Attachment C are consistent with those used for Table 10 and Figure 3 of the May 2020 Hydrology Report (EMKO, 2020a).

As described above, the results from the DI-WET leaching procedure represent equilibrium conditions in the water that comes in contact with the different geological formations and rock types in the reclaimed quarry. Thus, the concentrations shown in Table 2 are the equilibrium concentrations that are predicted to occur at each quarry lake water elevation shown. Once the water level reaches an elevation of 735 feet, then any excess water would be discharged from the quarry lake. At that point, the volume of water entering the lake and the volume of water leaving the lake would be the same so that the constituent concentrations would remain constant from that time forward.

Comparing the information in Tables 1 and 2, all concentrations would remain well below the MCLs, the Basin Plan water quality objectives, and the U.S. EPA's Aquatic Life Criteria (U.S. EPA, 2021).

TABLE 2. Incremental Constituent Concentrations as Quarry Lake Fills				
Quarry Lake Water Elevation (feet above mean sea level)	410	530	630	735
Incremental Years to Fill	21	20	30	87
Cumulative Water Volume (acre-feet)	2184	3828	5679	8515
Constituent Concentrations (mg/L)				
TDS	174	186	206	274
Sulfate	95	102	113	150
Arsenic	0.0009	0.001	0.0012	0.0016
Iron	0.1195	0.1281	0.1421	0.1899
Manganese	0.0138	0.0148	0.0164	0.0218
Selenium	0.0005	0.0005	0.0006	0.0009
Vanadium	0.0129	0.014	0.0157	0.0215

Formal published and enforceable water quality standards have not been developed for vanadium at the time this evaluation was conducted. Certain reclamation activities and any discharge from the quarry lake will require that CEMEX apply for and receive Waste Discharge Requirements (WDRs) from the RWQCB. The WDRs will include a Monitoring and Reporting Program that will verify the concentrations of the constituents of concern listed in Tables 1 and 2 within the quarry lake remain below applicable water quality standards. If any water quality standards are modified, or a standard is developed for vanadium, then the WDR Monitoring and Reporting Program would continue to confirm that future standards are met.

Summary and Conclusions

The AMP Tech Memo (EMKO, 2021) describes the process that was developed to identify which constituents may leach into the quarry lake from the diabase, the altered diabase, and the Knoxville Formation. That information was then applied to a U.S. EPA procedure to determine how many samples would be appropriate to collect as part of a future monitoring program to assess whether or not water quality standards would be exceeded in the quarry lake, once it begins filling with water. However, the AMP evaluation process did not consider the volume of water entering and accumulating within the quarry lake and the resulting concentrations in the lake itself.

In contrast, the more detailed evaluations presented in this Technical Memorandum requested by the County's EIR consultant specifically address the concentrations of the identified constituents over time in the water within the quarry lake. The water volumes over time, and thus the mixing ratios for the leachate from the geologic formations, are based on the data and assessments presented in the May 2020 Hydrology Report (EMKO, 2020a), as specifically requested by the County's EIR consultant. Thus, the findings of this assessment provide substantial evidence from which conclusions regarding potential impacts can be made.

The findings of this Quarry Lake Water Quality and Aquatic Life Criteria evaluation indicate that applicable and enforceable water quality standards would not be exceeded in the quarry lake after mining ceases and the quarry fills with water. The WDRs that would be issued by the RWQCB include monitoring and reporting requirements that would verify that standards continue to be met in the future, including any new or revised standards. Thus, any potential impacts related to the CEQA Appendix G criterion for water quality[1] would be less than significant. These findings indicate that the AMP (EMKO, 2021) is unnecessary and there would be no benefit implementing that program. This analysis also demonstrates that U.S. EPA aquatic life criteria would not be exceeded so biological resources that may access the quarry lake would not be affected.

References Cited

California State Water Resources Control Board (SWRCB), 2018a, Maximum Contaminant Levels and Regulatory Dates for Drinking Water, U.S. EPA vs California, Last Updated October 2018, https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/ccr/mcls_epa_vs_dwp.pdf (accessed July 1, 2021).

SWRCB, 2018b, Secondary Drinking Water Standards, https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/ddw_secondary_standards.pdf (accessed July 1, 2021).

EMKO Environmental, Inc. (EMKO), 2020a, Hydrology and Water Quality Evaluation Report, May 2020, CEMEX Clayton Quarry, Clayton, Contra Costa County, California.

EMKO, 2020b, Technical Memorandum: Initial Sampling to Support Adaptive Management Plan, Clayton Quarry, August 13, 2020.

EMKO, 2021, Adaptive Management Program to evaluate water quality conditions after reclamation of the CEMEX Clayton Quarry, March 1, 2021

San Francisco Bay Regional Water Quality Control Board (RWQCB), 2017, Water Quality Control Plan (Basin Plan) for the San Francisco Bay Basin, Chapter 3, Water Quality Objectives, https://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/planningtmdls/basinplan/web/bp_ch3.html (accessed June 29, 2021).

U.S. EPA, 1991, Regional Guidance on Handling Chemical Concentration Data Near the Detection Limit in Risk Assessments, Regional Guidance on Handling Chemical

1 The CEQA Appendix G criterion for water quality specifically refers to whether a project would violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface or ground water quality.

Concentration Data Near the Detection Limit in Risk Assessments | Risk Assessment | US EPA (accessed July 2, 2021).

U.S. EPA, 2016, Aquatic Life Ambient Water Quality Criterion for Selenium in Freshwater 2016 – Fact Sheet, https://www.epa.gov/sites/production/files/2016-06/documents/se_2016_fact_sheet_final.pdf (accessed July 2, 2021).

U.S EPA, 2021, National Recommended Water Quality Criteria – Aquatic Life Criteria Table, https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table (accessed July 1, 2021).

ATTACHMENT A

DI-WET LABORATORY RESULTS

SUMMARY TABLES

Metals Results from DI-WET Extraction
Wall Rock Samples Collected on October 14, 2020
CEMEX Clayton Quarry

KNOXVILLE FORMATION SAMPLES														
ANALYTE	UNITS	KXF1		KXF2		KXF3		KXF4		KXF5		MDL	PQL	RT
Arsenic (WET DI)	mg/L	0.0031		0.00307		0.00507		0.00181		0.02		0.0002	0.001	0.01
Barium (WET DI)	mg/L	ND		ND		ND		ND		ND		0.007	0.035	1
Iron (WET DI)	mg/L	ND		0.105	B	0.101	B	ND		0.29		0.06	0.15	0.3
Manganese (WET DI)	mg/L	ND		ND		ND		ND		ND		0.01	0.05	0.05
Selenium (WET DI)	mg/L	0.00271		0.00195		0.00123		0.00471		0.0068		0.0001	0.00025	0.05
Vanadium (WET DI)	mg/L	0.015	B	0.017	B	0.029		ND		0.132		0.01	0.025	
Zinc (WET DI)	mg/L	ND		ND		ND		ND		ND		0.02	0.05	5
ALTERED DIABASE SAMPLES														
ANALYTE	UNITS	BENCH 1 A1		BENCH 1 A2		BENCH 2 A1		BENCH 2 A2		BENCH 3 A1		MDL	PQL	RT
Arsenic (WET DI)	mg/L	ND		ND		ND		ND		ND		0.0002	0.001	0.01
Barium (WET DI)	mg/L	ND		ND		ND		ND		ND		0.007	0.035	1
Iron (WET DI)	mg/L	ND		ND		ND		0.062	B	ND		0.06	0.15	0.3
Manganese (WET DI)	mg/L	0.028	B	0.015	B	0.334		0.011	B	0.019	B	0.01	0.05	0.05
Selenium (WET DI)	mg/L	0.00199		0.00016	B	0.0003		0.00011	B	0.00014	B	0.0001	0.00025	0.05
Vanadium (WET DI)	mg/L	ND		ND		ND		ND		ND		0.01	0.025	
Zinc (WET DI)	mg/L	ND		ND		ND		ND		ND		0.02	0.05	5
UNALTERED DIABASE SAMPLES														
ANALYTE	UNITS	BENCH 1 U1		BENCH 1 U2		BENCH 2 U1		BENCH 2 U2				MDL	PQL	RT
Arsenic (WET DI)	mg/L	0.0004	B	ND		0.00035	B	0.00073	B			0.0002	0.001	0.01
Barium (WET DI)	mg/L	ND		ND		ND		ND				0.007	0.035	1
Iron (WET DI)	mg/L	0.124	B	ND		0.134	B	0.156				0.06	0.15	0.3
Manganese (WET DI)	mg/L	ND		ND		ND		ND				0.01	0.05	0.05
Selenium (WET DI)	mg/L	0.00027		0.00028		ND		ND				0.0001	0.00025	0.05
Vanadium (WET DI)	mg/L	0.018	B	0.012	B	ND		ND				0.01	0.025	
Zinc (WET DI)	mg/L	ND		ND		ND		ND				0.02	0.05	5

MDL = Method Detection Limit
PQL = Practical Quantitation Limit
ND = Not detected above the PQL
B = Concentration detected at a value between the MDL and PQL. Reported value is an estimated quantity.
RT = Regulatory Threshold, equivalent to primary or secondary maximum contaminant level, based on:
SWRCB, 2021, A Compilation of Water Quality Goals, accessed January 13, 2021
https://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/#db_instructions

General Mineral Constituent Results from DI-WET Extraction

Wall Rock Samples Collected on October 14, 2020

CEMEX Clayton Quarry

KNOXVILLE FORMATION SAMPLES														
ANALYTE	UNITS	KXF1		KXF2		KXF3		KXF4		KXF5		MDL	PQL	RT
Conductivity @25C (WET-DI)	umhos/cm	108		86		76		177		202		1	10	900
Residue, Filterable (TDS) @180C (WET DI)	mg/L	66		52		52		104		120		20	40	500
Sulfate (WET DI)	mg/L	22	B	ND		ND		50		ND		20	50	250
pH, Saturated Paste	units	7.6		7.8		7.9		7.8		8.4		0.1	0.1	6.5 - 8.5
ALTERED DIABASE SAMPLES														
ANALYTE	UNITS	BENCH 1 A1		BENCH 1 A2		BENCH 2 A1		BENCH 2 A2		BENCH 3 A1		MDL	PQL	RT
Conductivity @25C (WET-DI)	umhos/cm	1770		522		650		177		1810		1	10	900
Residue, Filterable (TDS) @180C (WET DI)	mg/L	1910		390		528		102		2020		20	40	500
Sulfate (WET DI)	mg/L	1170		238		351		65		1300		20	50	250
pH, Saturated Paste	units	6.9		7.8		6.8		7.9		7.3		0.1	0.1	6.5 - 8.5
UNALTERED DIABASE SAMPLES														
ANALYTE	UNITS	BENCH 1 U1		BENCH 1 U2		BENCH 2 U1		BENCH 2 U2				MDL	PQL	RT
Conductivity @25C (WET-DI)	umhos/cm	90		121		95		105				1	10	900
Residue, Filterable (TDS) @180C (WET DI)	mg/L	54		78		60		66				20	40	500
Sulfate (WET DI)	mg/L	22	B	35	B	29	B	27	B			20	50	250
pH, Saturated Paste	units	8.9		9		8.8		8.9				0.1	0.1	6.5 - 8.5

MDL = Method Detection Limit

PQL = Practical Quantitation Limit

ND = Not detected above the PQL

B = Concentration detected at a value between the MDL and PQL. Reported value is an estimated quantity.

H = Hold time exceeded

RT = Regulatory Threshold, equivalent to primary or secondary maximum contaminant level, based on:

SWRCB, 2021, A Compilation of Water Quality Goals, accessed January 13, 2021

https://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/#db_instructions

ATTACHMENT B

CALCULATIION SHEETS FOR CONSTITUENT ACCUMULATION OVER TIME

IN THE QUARRY LAKE

TDS Accumulation Over Time											
Reclaimed Quarry Lake											
Period	Elevation Range	Duration	Inflow (AF/yr)				Inflow Volume	Evaporation (AF)		Net Volume (AF)	
	(ft msl)	(years)	Pond Surface	Diabase Highwall	Knoxville Formation	Upper Watershed	(AF)	Per Year	Total	Incremental	Total
1	110 - 410	21	11.5	100.2	8.5	10.7	2748.9	26.9	564.9	2184	2184
	Liters		14,184,049	123,586,239	10,483,863	13,197,333	3,390,481,159	33,178,342	696,745,173	2,693,735,986	2,693,735,986
	TDS	mg/L	0	157	79	157	Total mg TDS				
		mg	0	19,403,039,507	828,225,144	2,071,981,265	468,368,164,237			174	174
2	410 - 530	20	21	90.9	8.5	10.7	2622	48.9	978	1644	3828
	Liters		25,901,308	112,115,660	10,483,863	13,197,333	3,233,963,257	60,313,045	1,206,260,895	2,027,702,363	4,721,438,348
	TDS	mg/L	0	157	79	157	Total mg TDS				
		mg	0	17,602,158,595	828,225,144	2,071,981,265	410,047,300,074			202	186
3	530 - 630	30	29.9	82.2	8.5	10.7	3939	69.6	2088	1851	5679
	Liters		36,878,528	101,385,118	10,483,863	13,197,333	4,858,345,260	85,844,334	2,575,330,008	2,283,015,252	7,004,453,600
	TDS	mg/L	0	157	79	157	Total mg TDS				
		mg	0	15,917,463,548	828,225,144	2,071,981,265	564,530,098,699			247	206
4	630 - 735	87	42.7	70.5	8.1	10.7	11484	99.4	8648	2836	8515
	Liters		52,665,992	86,954,390	9,990,504	13,197,333	14,164,315,045	122,599,522	10,666,158,451	3,498,156,595	10,502,610,194
	TDS	mg/L	0	157	79	157	Total mg TDS				
		mg	0	13,651,839,174	789,249,843	2,071,981,265	1,436,637,114,546			411	274

Sulfate Accumulation Over Time											
Reclaimed Quarry Lake											
Period	Elevation Range	Duration	Inflow (AF/yr)				Inflow Volume	Evaporation (AF)		Net Volume (AF)	
	(ft msl)	(years)	Pond Surface	Diabase Highwall	Knoxville Formation	Upper Watershed	(AF)	Per Year	Total	Incremental	Total
1	110 - 410	21	11.5	100.2	8.5	10.7	2748.9	26.9	564.9	2184	2184
	Liters		14,184,049	123,586,239	10,483,863	13,197,333	3,390,481,159	33,178,342	696,745,173	2,693,735,986	2,693,735,986
	Sulfate	mg/L	0	88	20	88	Total mg Sulfate				
		mg	0	10,863,230,399	213,870,797	1,160,045,562	256,980,081,910			95	95
2	410 - 530	20	21	90.9	8.5	10.7	2622	48.9	978	1644	3828
	Liters		25,901,308	112,115,660	10,483,863	13,197,333	3,233,963,257	60,313,045	1,206,260,895	2,027,702,363	4,721,438,348
	Sulfate	mg/L	0	88	20	88	Total mg Sulfate				
		mg	0	9,854,966,500	213,870,797	1,160,045,562	224,577,657,165			111	102
3	530 - 630	30	29.9	82.2	8.5	10.7	3939	69.6	2088	1851	5679
	Liters		36,878,528	101,385,118	10,483,863	13,197,333	4,858,345,260	85,844,334	2,575,330,008	2,283,015,252	7,004,453,600
	Sulfate	mg/L	0	88	20	88	Total mg Sulfate				
		mg	0	8,911,751,884	213,870,797	1,160,045,562	308,570,047,283			135	113
4	630 - 735	87	42.7	70.5	8.1	10.7	11484	99.4	8648	2836	8515
	Liters		52,665,992	86,954,390	9,990,504	13,197,333	14,164,315,045	122,599,522	10,666,158,451	3,498,156,595	10,502,610,194
	Sulfate	mg/L	0	88	20	88	Total mg Sulfate				
		mg	0	7,643,290,850	203,806,289	1,160,045,562	783,621,414,902			224	150

Arsenic Accumulation Over Time Reclaimed Quarry Lake											
Period	Elevation Range	Duration	Inflow (AF/yr)				Inflow Volume	Evaporation (AF)		Net Volume (AF)	
	(ft msl)	(years)	Pond Surface	Diabase Highwall	Knoxville Formation	Upper Watershed	(AF)	Per Year	Total	Incremental	Total
1	110 - 410	21	11.5	100.2	8.5	10.7	2748.9	26.9	564.9	2184	2184
	Liters		14,184,049	123,586,239	10,483,863	13,197,333	3,390,481,159	33,178,342	696,745,173	2,693,735,986	2,693,735,986
	Arsenic	mg/L	0	0.0004	0.00661	0.0004	Total mg Arsenic				
		mg	0	45,727	69,298	4,883	2,518,073			0.0009	0.0009
2	410 - 530	20	21	90.9	8.5	10.7	2622	48.9	978	1644	3828
	Liters		25,901,308	112,115,660	10,483,863	13,197,333	3,233,963,257	60,313,045	1,206,260,895	2,027,702,363	4,721,438,348
	Arsenic	mg/L	0	0.0004	0.00661	0.0004	Total mg Arsenic				
		mg	0	41,483	69,298	4,883	2,313,283			0.0011	0.0010
3	530 - 630	30	29.9	82.2	8.5	10.7	3939	69.6	2088	1851	5679
	Liters		36,878,528	101,385,118	10,483,863	13,197,333	4,858,345,260	85,844,334	2,575,330,008	2,283,015,252	7,004,453,600
	Arsenic	mg/L	0	0.0004	0.00661	0.0004	Total mg Arsenic				
		mg	0	37,512	69,298	4,883	3,350,815			0.0015	0.0012
4	630 - 735	87	42.7	70.5	8.1	10.7	11484	99.4	8648	2836	8515
	Liters		52,665,992	86,954,390	9,990,504	13,197,333	14,164,315,045	122,599,522	10,666,158,451	3,498,156,595	10,502,610,194
	Arsenic	mg/L	0	0.0004	0.00661	0.0004	Total mg Arsenic				
		mg	0	32,173	66,037	4,883	8,969,123			0.0026	0.0016

Iron Accumulation Over Time

Reclaimed Quarry Lake

Period	Elevation Range	Duration	Inflow (AF/yr)				Inflow Volume	Evaporation (AF)		Net Volume (AF)	
	(ft msl)	(years)	Pond Surface	Diabase Highwall	Knoxville Formation	Upper Watershed	(AF)	Per Year	Total	Incremental	Total
1	110 - 410	21	11.5	100.2	8.5	10.7	2748.9	26.9	564.9	2184	2184
	Liters		14,184,049	123,586,239	10,483,863	13,197,333	3,390,481,159	33,178,342	696,745,173	2,693,735,986	2,693,735,986
	Iron	mg/L	0	0.1035	0.1112	0.1035	Total mg Iron				
		mg	0	12,796,119	1,165,806	1,366,452	321,895,907			0.1195	0.1195
2	410 - 530	20	21	90.9	8.5	10.7	2622	48.9	978	1644	3828
	Liters		25,901,308	112,115,660	10,483,863	13,197,333	3,233,963,257	60,313,045	1,206,260,895	2,027,702,363	4,721,438,348
	Iron	mg/L	0	0.1035	0.1112	0.1035	Total mg Iron				
		mg	0	11,608,455	1,165,806	1,366,452	282,814,256			0.1395	0.1281
3	530 - 630	30	29.9	82.2	8.5	10.7	3939	69.6	2088	1851	5679
	Liters		36,878,528	101,385,118	10,483,863	13,197,333	4,858,345,260	85,844,334	2,575,330,008	2,283,015,252	7,004,453,600
	Iron	mg/L	0	0.1035	0.1112	0.1035	Total mg Iron				
		mg	0	10,497,415	1,165,806	1,366,452	390,890,175			0.1712	0.1421
4	630 - 735	87	42.7	70.5	8.1	10.7	11484	99.4	8648	2836	8515
	Liters		52,665,992	86,954,390	9,990,504	13,197,333	14,164,315,045	122,599,522	10,666,158,451	3,498,156,595	10,502,610,194
	Iron	mg/L	0	0.1035	0.1112	0.1035	Total mg Iron				
		mg	0	9,003,258	1,110,944	1,366,452	998,816,849			0.2855	0.1899

Manganese Accumulation Over Time

Reclaimed Quarry Lake

Period	Elevation Range	Duration	Inflow (AF/yr)				Inflow Volume	Evaporation (AF)		Net Volume (AF)	
	(ft msl)	(years)	Pond Surface	Diabase Highwall	Knoxville Formation	Upper Watershed	(AF)	Per Year	Total	Incremental	Total
1	110 - 410	21	11.5	100.2	8.5	10.7	2748.9	26.9	564.9	2184	2184
	Liters		14,184,049	123,586,239	10,483,863	13,197,333	3,390,481,159	33,178,342	696,745,173	2,693,735,986	2,693,735,986
	Manganese	mg/L	0	0.0126	0.0050	0.0126	Total mg Manganese				
		mg	0	1,557,187	52,419	166,286	37,293,739			0.0138	0.0138
2	410 - 530	20	21	90.9	8.5	10.7	2622	48.9	978	1644	3828
	Liters		25,901,308	112,115,660	10,483,863	13,197,333	3,233,963,257	60,313,045	1,206,260,895	2,027,702,363	4,721,438,348
	Manganese	mg/L	0	0.0126	0.0050	0.0126	Total mg Manganese				
		mg	0	1,412,657	52,419	166,286	32,627,260			0.0161	0.0148
3	530 - 630	30	29.9	82.2	8.5	10.7	3939	69.6	2088	1851	5679
	Liters		36,878,528	101,385,118	10,483,863	13,197,333	4,858,345,260	85,844,334	2,575,330,008	2,283,015,252	7,004,453,600
	Manganese	mg/L	0	0.0126	0.0050	0.0126	Total mg Manganese				
		mg	0	1,277,452	52,419	166,286	44,884,746			0.0197	0.0164
4	630 - 735	87	42.7	70.5	8.1	10.7	11484	99.4	8648	2836	8515
	Liters		52,665,992	86,954,390	9,990,504	13,197,333	14,164,315,045	122,599,522	10,666,158,451	3,498,156,595	10,502,610,194
	Manganese	mg/L	0	0.0126	0.0050	0.0126	Total mg Manganese				
		mg	0	1,095,625	49,953	166,286	114,132,188			0.0326	0.0218

Selenium Accumulation Over Time

Reclaimed Quarry Lake

Period	Elevation Range (ft msl)	Duration (years)	Inflow (AF/yr) Pond Surface	Diabase Highwall	Knoxville Formation	Upper Watershed	Inflow Volume (AF)	Evaporation (AF) Per Year	Total	Net Volume (AF) Incremental	Total
1	110 - 410	21	11.5	100.2	8.5	10.7	2748.9	26.9	564.9	2184	2184
	Liters		14,184,049	123,586,239	10,483,863	13,197,333	3,390,481,159	33,178,342	696,745,173	2,693,735,986	2,693,735,986
	Selenium	mg/L	0	0.0002	0.00348	0.0002	Total mg Selenium				
		mg	0	24,717	36,484	2,639	1,340,652			0.0005	0.0005
2	410 - 530	20	21	90.9	8.5	10.7	2622	48.9	978	1644	3828
	Liters		25,901,308	112,115,660	10,483,863	13,197,333	3,233,963,257	60,313,045	1,206,260,895	2,027,702,363	4,721,438,348
	Selenium	mg/L	0	0.0002	0.00348	0.0002	Total mg Selenium				
		mg	0	22,423	36,484	2,639	1,230,929			0.0006	0.0005
3	530 - 630	30	29.9	82.2	8.5	10.7	3939	69.6	2088	1851	5679
	Liters		36,878,528	101,385,118	10,483,863	13,197,333	4,858,345,260	85,844,334	2,575,330,008	2,283,015,252	7,004,453,600
	Selenium	mg/L	0	0.0002	0.00348	0.0002	Total mg Selenium				
		mg	0	20,277	36,484	2,639	1,782,010			0.0008	0.0006
4	630 - 735	87	42.7	70.5	8.1	10.7	11484	99.4	8648	2836	8515
	Liters		52,665,992	86,954,390	9,990,504	13,197,333	14,164,315,045	122,599,522	10,666,158,451	3,498,156,595	10,502,610,194
	Selenium	mg/L	0	0.0002	0.00348	0.0002	Total mg Selenium				
		mg	0	17,391	34,767	2,639	4,767,365			0.0014	0.0009

Vanadium Accumulation Over Time

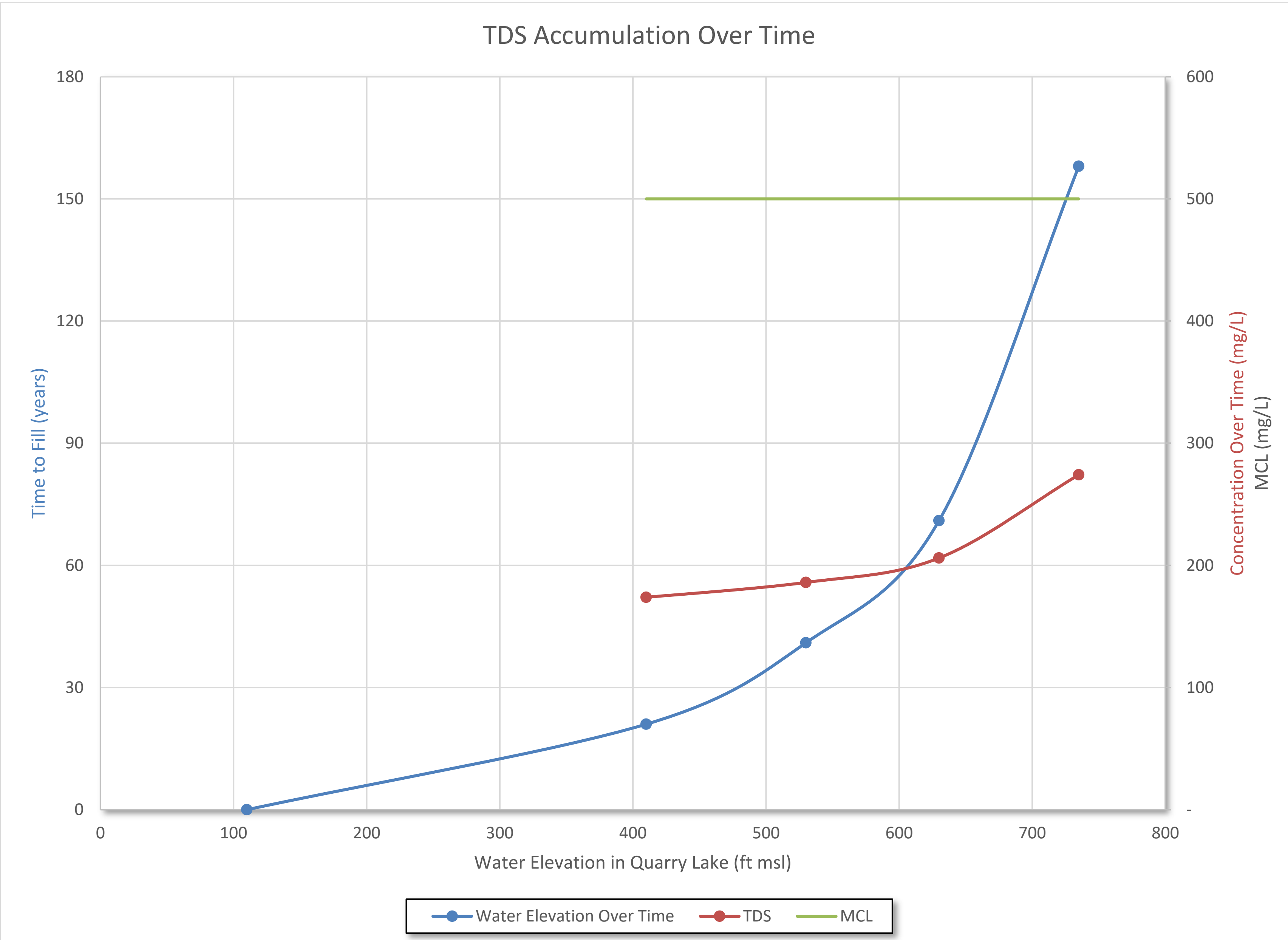
Reclaimed Quarry Lake

Period	Elevation Range	Duration	Inflow (AF/yr)				Inflow Volume	Evaporation (AF)		Net Volume (AF)	
	(ft msl)	(years)	Pond Surface	Diabase Highwall	Knoxville Formation	Upper Watershed	(AF)	Per Year	Total	Incremental	Total
1	110 - 410	21	11.5	100.2	8.5	10.7	2748.9	26.9	564.9	2184	2184
	Liters		14,184,049	123,586,239	10,483,863	13,197,333	3,390,481,159	33,178,342	696,745,173	2,693,735,986	2,693,735,986
	Vanadium	mg/L	0	0.0084	0.0486	0.0084	Total mg Vanadium				
		mg	0	1,038,124	509,516	110,858	34,828,452			0.0129	0.0129
2	410 - 530	20	21	90.9	8.5	10.7	2622	48.9	978	1644	3828
	Liters		25,901,308	112,115,660	10,483,863	13,197,333	3,233,963,257	60,313,045	1,206,260,895	2,027,702,363	4,721,438,348
	Vanadium	mg/L	0	0.0084	0.0486	0.0084	Total mg Vanadium				
		mg	0	941,772	509,516	110,858	31,242,897			0.0154	0.0140
3	530 - 630	30	29.9	82.2	8.5	10.7	3939	69.6	2088	1851	5679
	Liters		36,878,528	101,385,118	10,483,863	13,197,333	4,858,345,260	85,844,334	2,575,330,008	2,283,015,252	7,004,453,600
	Vanadium	mg/L	0	0.0084	0.0486	0.0084	Total mg Vanadium				
		mg	0	851,635	509,516	110,858	44,160,249			0.0193	0.0157
4	630 - 735	87	42.7	70.5	8.1	10.7	11484	99.4	8648	2836	8515
	Liters		52,665,992	86,954,390	9,990,504	13,197,333	14,164,315,045	122,599,522	10,666,158,451	3,498,156,595	10,502,610,194
	Vanadium	mg/L	0	0.0084	0.0486	0.0084	Total mg Vanadium				
		mg	0	730,417	485,539	110,858	115,432,729			0.0330	0.0215

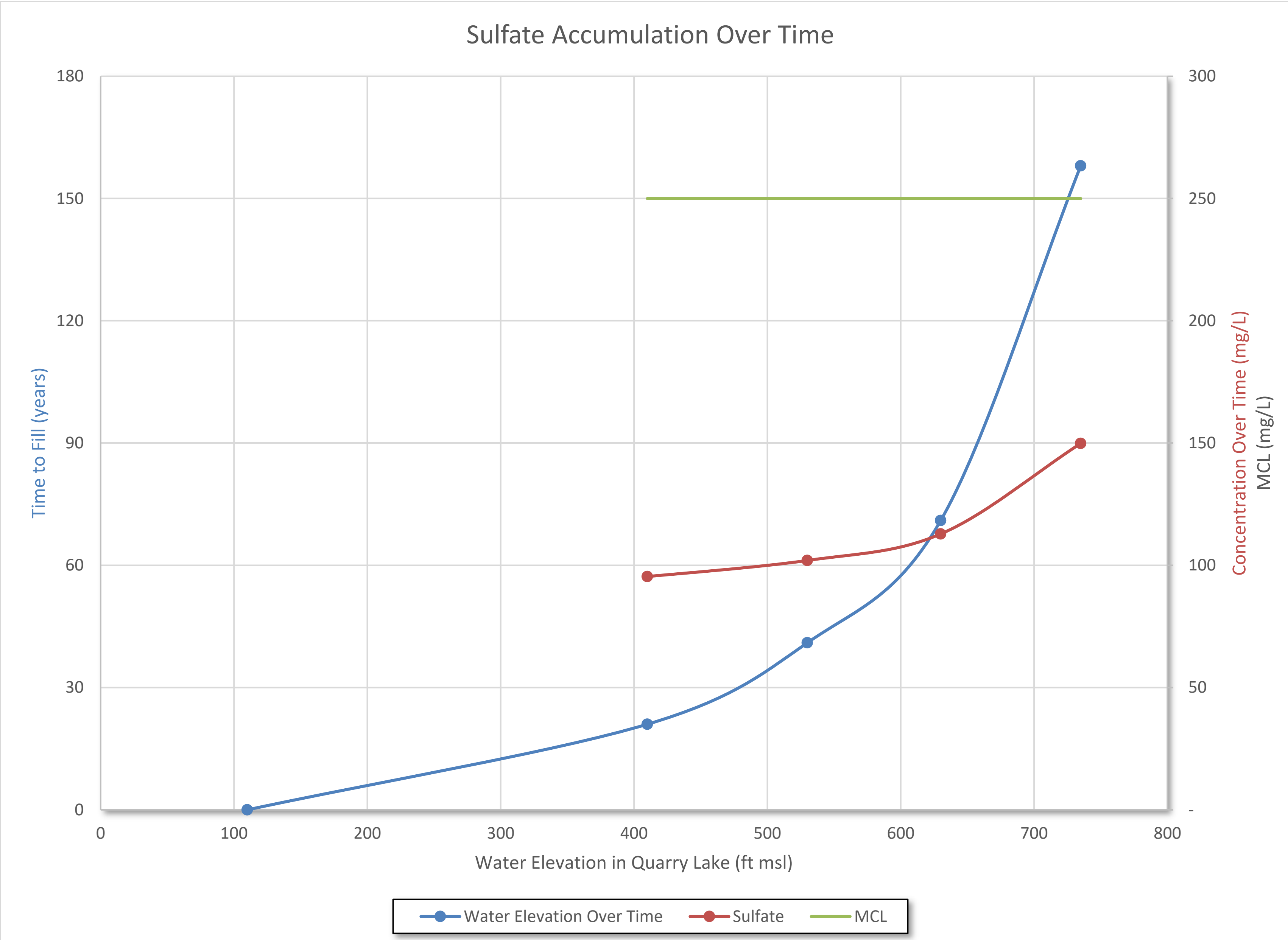
ATTACHMENT C

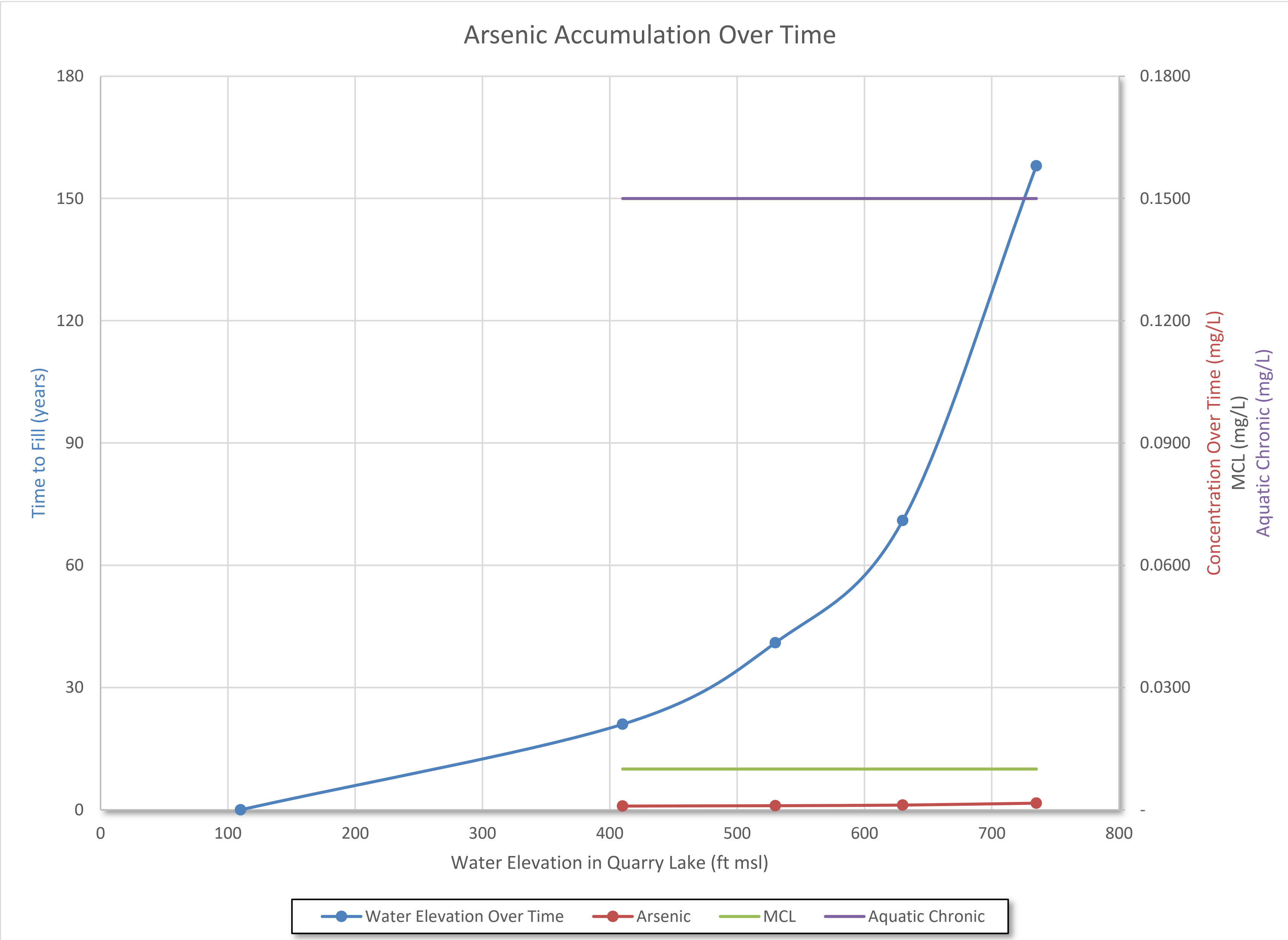
CHARTS SHOWING THE INCREMENTAL INCREASE

FOR EACH CONSTITUENT OVER TIME

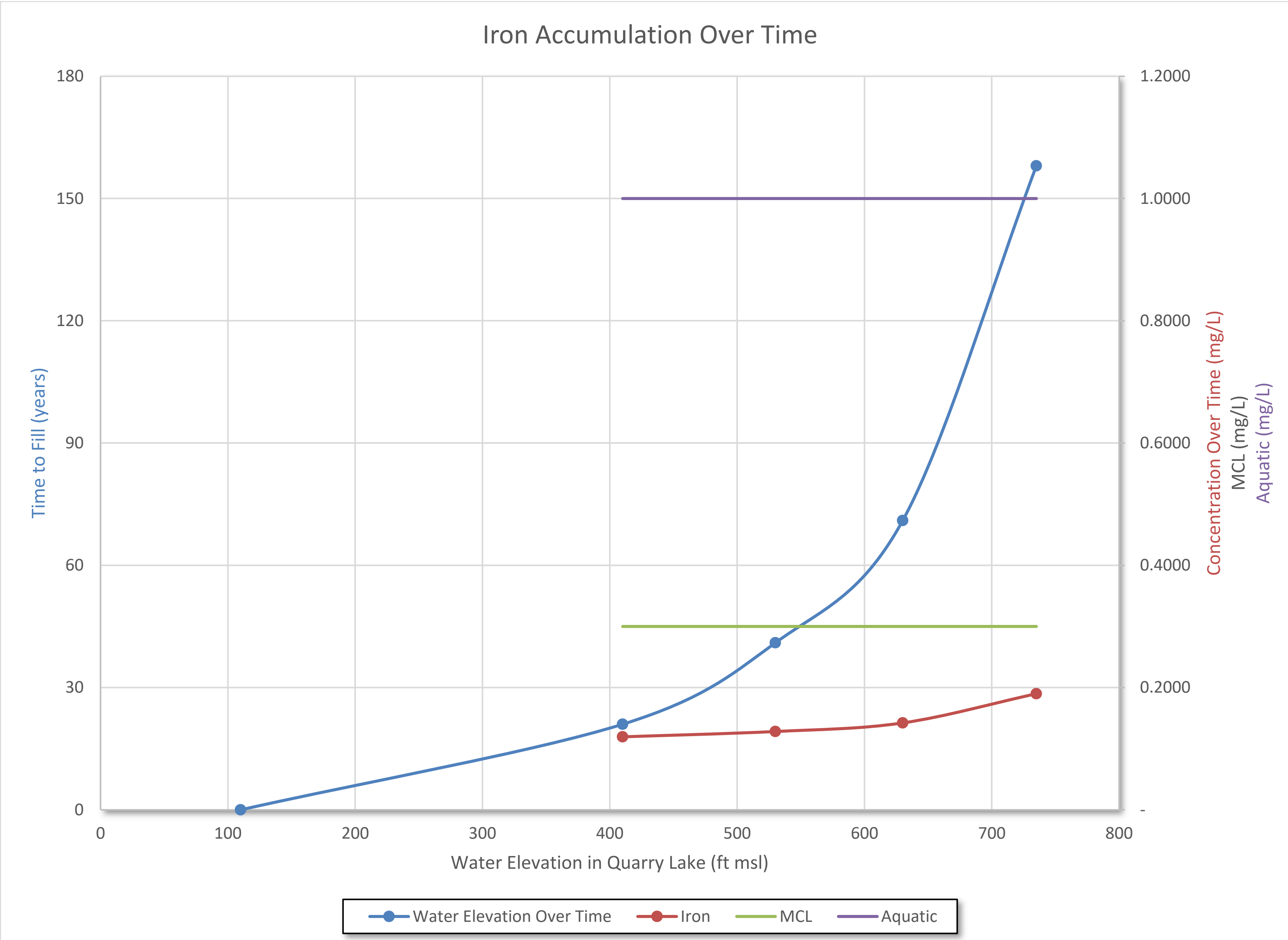


TDS Accumulation Over Time
Time to Fill (years)
180
150
120
90
60
30
0
600
500
400
300
200
100
-
Concentration Over Time (mg/L)
MCL (mg/L)
0
100
200
300
400
500
600
700
800
Water Elevation in Quarry Lake (ft msl)
Water Elevation Over Time
TDS
MCL

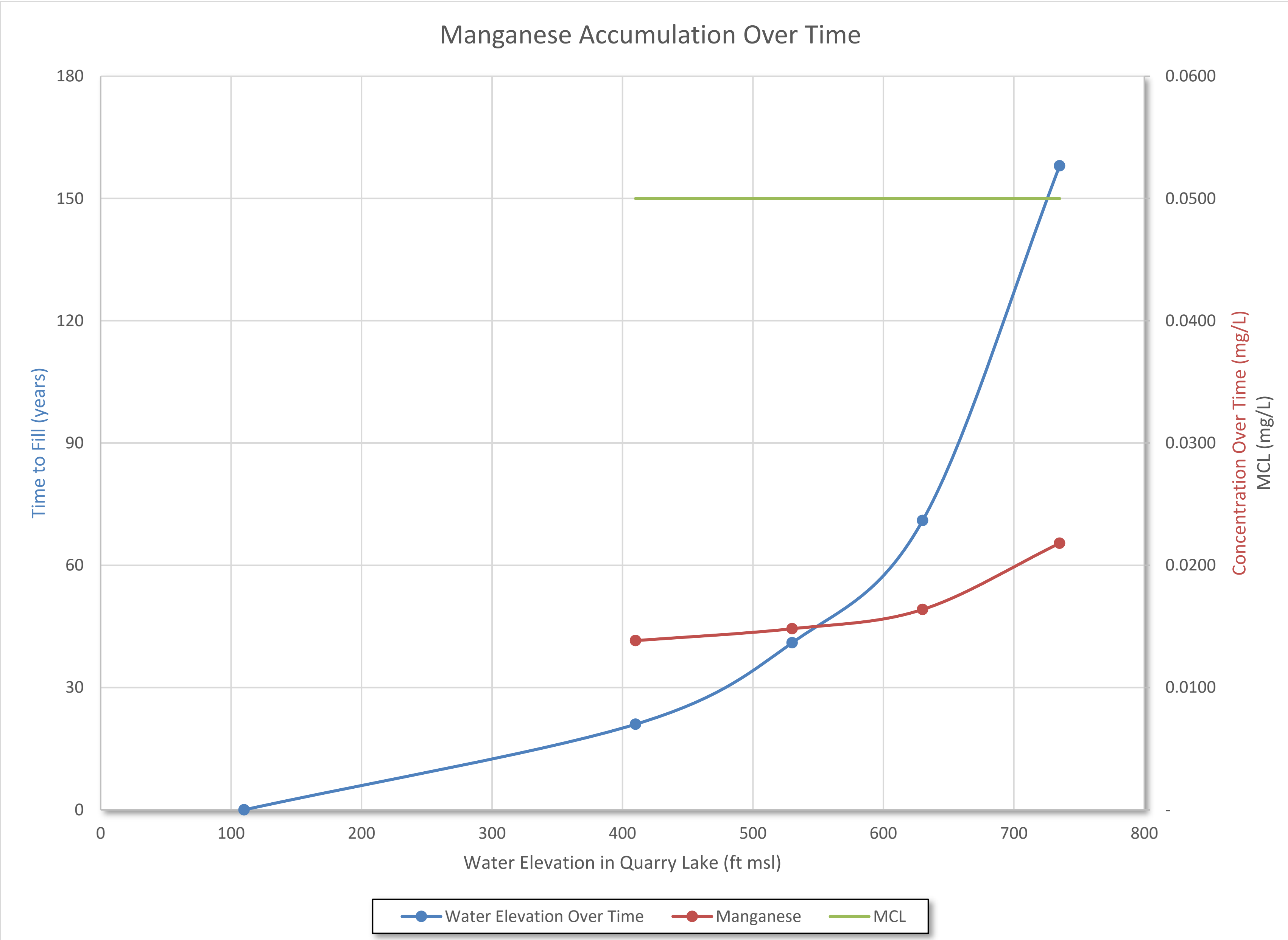

Sulfate Accumulation Over Time
Time to Fill (years)
0
30
60
90
120
150
180
Concentration Over Time (mg/L)
MCL (mg/L)
-
50
100
150
200
250
300
0
100
200
300
400
500
600
700
800
Water Elevation in Quarry Lake (ft msl)
Water Elevation Over Time
Sulfate
MCL

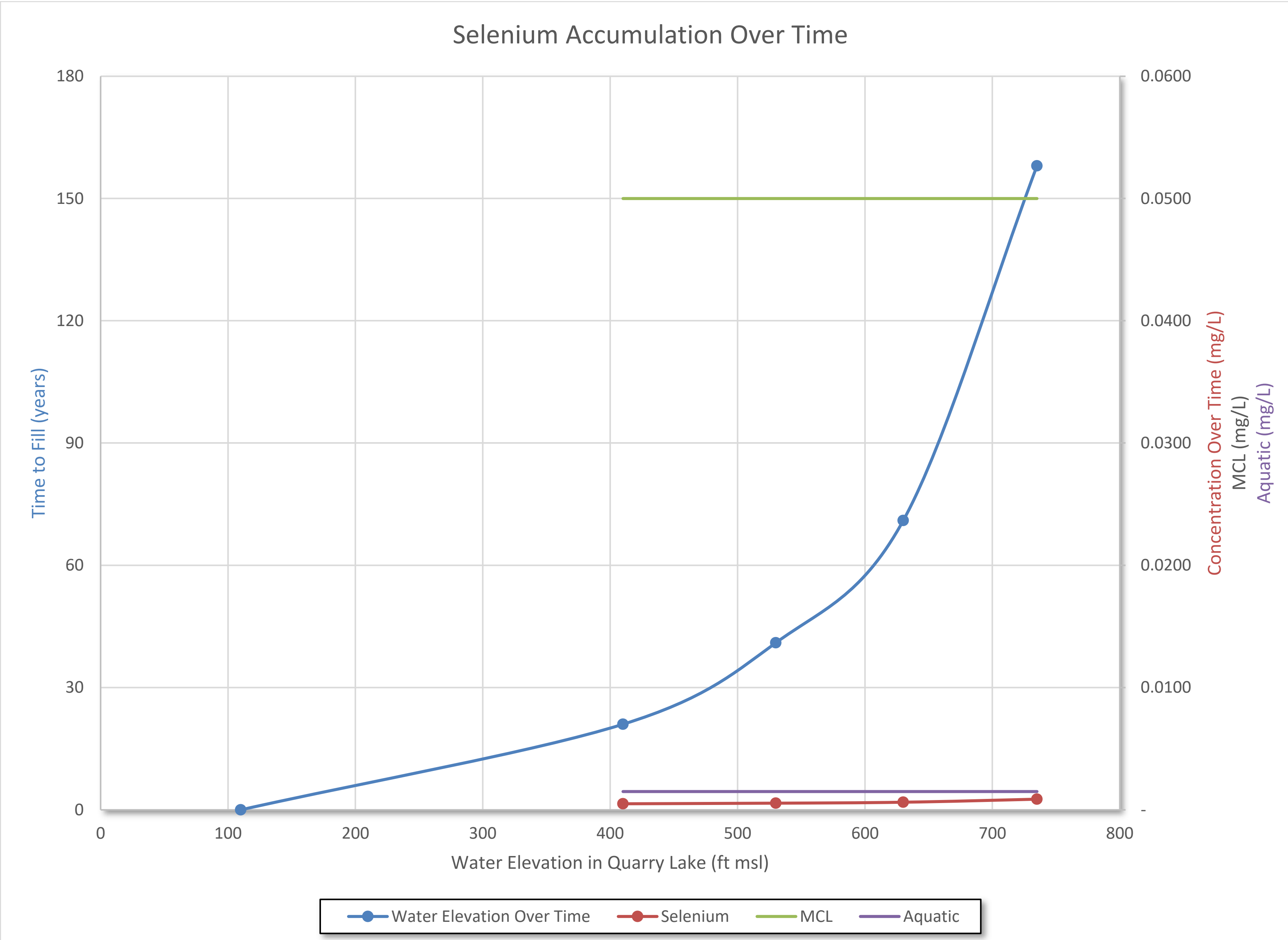


Arsenic Accumulation Over Time
Time to Fill (years)
180
150
120
90
60
30
0
0.1800
0.1500
0.1200
0.0900
0.0600
0.0300
-
Concentration Over Time (mg/L)
MCL (mg/L)
Aquatic Chronic (mg/L)
0
100
200
300
400
500
600
700
800
Water Elevation in Quarry Lake (ft msl)
Water Elevation Over Time
Arsenic
MCL
Aquatic Chronic

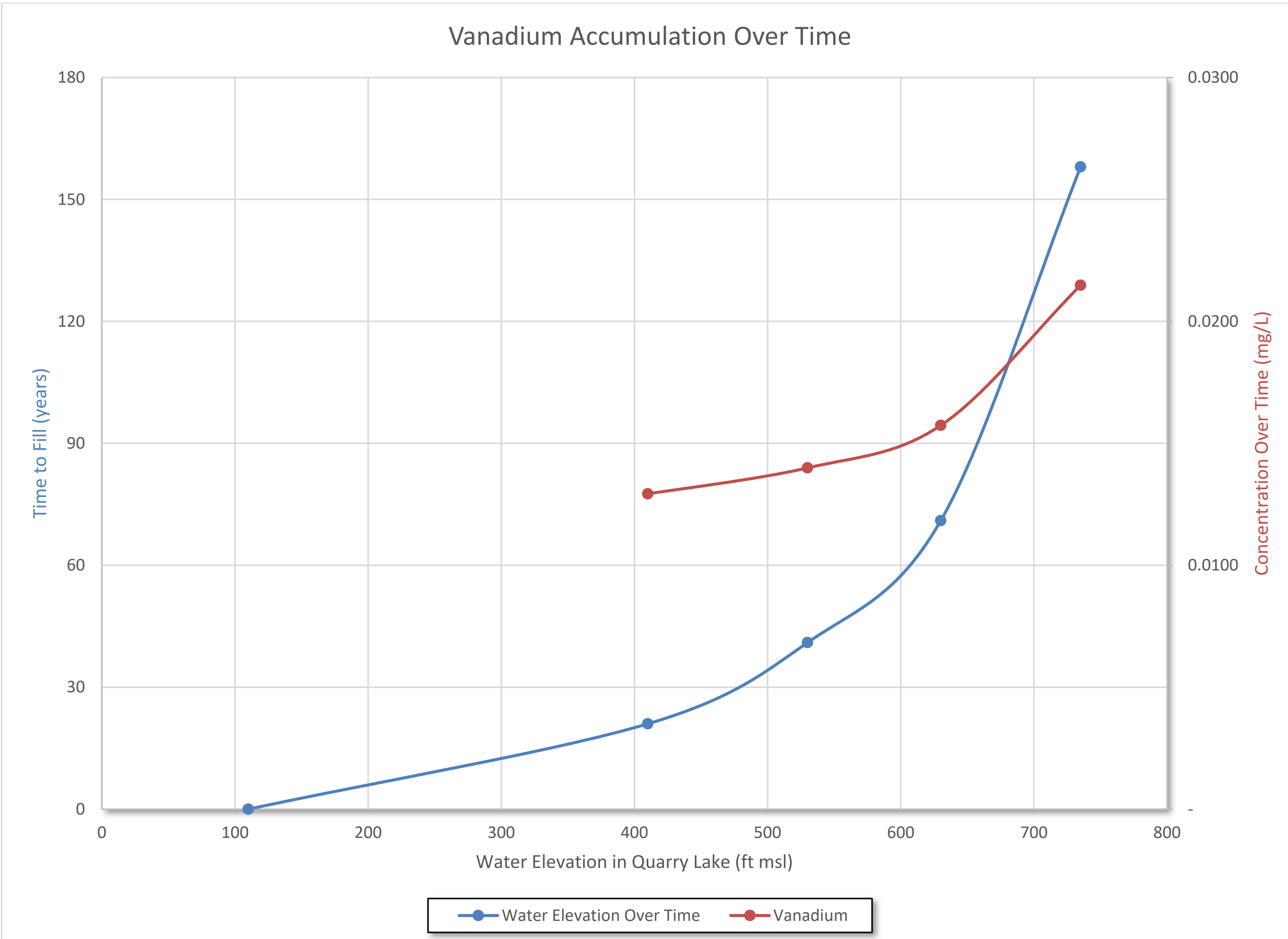


Iron Accumulation Over Time
180
150
120
90
60
30
0
Time to Fill (years)
1.2000
1.0000
0.8000
0.6000
0.4000
0.2000
-
Concentration Over Time (mg/L)
MCL (mg/L)
Aquatic (mg/L)
0
100
200
300
400
500
600
700
800
Water Elevation in Quarry Lake (ft msl)
Water Elevation Over Time
Iron
MCL
Aquatic


Manganese Accumulation Over Time
180
150
120
90
60
30
0
Time to Fill (years)
0.0600
0.0500
0.0400
0.0300
0.0200
0.0100
-
Concentration Over Time (mg/L)
MCL (mg/L)
0
100
200
300
400
500
600
700
800
Water Elevation in Quarry Lake (ft msl)
Water Elevation Over Time
Manganese
MCL



Selenium Accumulation Over Time
180
150
120
90
60
30
0
Time to Fill (years)
0.0600
0.0500
0.0400
0.0300
0.0200
0.0100
-
Concentration Over Time (mg/L)
MCL (mg/L)
Aquatic (mg/L)
0
100
200
300
400
500
600
700
800
Water Elevation in Quarry Lake (ft msl)
Water Elevation Over Time
Selenium
MCL
Aquatic



Vanadium Accumulation Over Time
Time to Fill (years)
180
150
120
90
60
30
0
0.0300
0.0200
0.0100
-
Concentration Over Time (mg/L)
0
100
200
300
400
500
600
700
800
Water Elevation in Quarry Lake (ft msl)
Water Elevation Over Time
Vanadium