March 8, 2024 Project No. GL12393309-07.960

Kevin O'Hara, Site Coordinator
Ohio Environmental Protection Agency
Division of Environmental Response and Revitalization
Southeast District Office
2195 Front Street
Logan, Ohio 43138

RE: FORMER SATRALLOY SITE
CHARACTERIZATION OF POTENTIAL BORROW SOIL

Dear Mr. O'Hara:

1.0 INTRODUCTION

Amendment 11 to the Interim Action Workplan (Borrow Soil Sampling and Analysis Workplan) was submitted to the Ohio Environmental Protection Agency (Ohio EPA) by Cyprus Amax Minerals Company (CAMC) on August 1, 2023. Ohio EPA approved Amendment 11 on August 10,2023. This letter presents the results of the sampling and analysis, as well as a discussion of the implications of these results.

CAMC intends to place slag from the Former Satralloy Site (Site, Figure 1) in the Former Mine Area and cap the resultant repository with two feet of soil. The intended borrow source is soil, which will be removed from the Former Mine Area, much of which is spoil from former coal mining. In addition, in order to provide sufficient volume for slag deposition in the repository, mine spoils in excess of that required for the cap will be moved to suitable areas of the Site (i.e., incorporated into regrading after slag removal).

The potential concerns for use of coal mine spoils as fill are:

- Acid generation (i.e., acidic stormwater runoff)
- Leaching of sulfate into stormwater runoff.

To address these potential concerns, it was decided to analyze these soils for acid generating potential and sulfate leaching potential, as described below. Thirty-six (36) samples were collected from nine locations (Figure 2). Three test pits were constructed in each of the three borrow areas labeled A-C on Figure 2. Four samples were collected to vertically profile the borrow soils encountered at each test pit.

WSP USA Inc.
18300 NE Union Hill Road Suite 200 Redmond
Washington 98052
T: 425-883-0777 425-882-5498

2.0 CHARACTERIZATION PROGRAM

The samples were analyzed by SGS Canada Inc. in Burnaby, BC, Canada for the following parameters:

- Paste pH
- Bulk neutralization potential (NP) by the Modified Sobek method (MEND 2009)[1]
- Total sulfur, sulfate sulfur, sulfide sulfur and residual sulfur by a combination of methods CSA06V, CSA07V and CSA08C1
- Total carbon and inorganic carbon by methods CSA06V and CSB02V, respectively.

The analytical results were used to calculate the acid potential (AP) as well as the metric used for classification of the ARD potential (i.e., the net potential ratio [NPR = NP/AP]). NPR values were interpreted per the classification presented in Table 1.

Table 2 presents the analytical results and associated calculated values (i.e., AP and NPR). The acid potential was calculated using sulfide sulfur according to the approach described in MEND (2009). Also included are the classifications of ARD potential for the individual samples using the criteria from Table 1 as well as the amount of limestone needed to achieve an NPR value ≥ 2 (i.e., the limestone requirement column).

The sulfate and sulfide concentrations were sufficiently high that a sulfate leaching concern could not be ruled out from these results alone. Therefore, it was decided that determination of sulfate leaching potential was needed. Five (5) samples were selected for analysis of sulfate leaching potential (refer to Table 3 for sample IDs). They were selected representing the 10^{th}, 25^{th}, 50^{th}, 75^{th} and 95^{th} percentiles of the sulfide sulfur contents. The samples were subjected to short-term leach testing using the Synthetic Precipitation Leaching Procedure (SPLP) and the Net Acid Generation (NAG) test. The SPLP is meant to simulate interaction between a solid and meteoric water and accounts for release of readily soluble constituents. The NAG test oxidizes all reactive sulfides using hydrogen peroxide, thereby representing a “worst-case” scenario in terms of sulfide reactivity. The leachates generated by both tests were analyzed for sulfate and the results are presented in Table 3.

3.0 RESULTS AND DISCUSSION

The analytical results on the soil samples presented on Table 2 can be summarized as follows:

- The total sulfur content and sulfide sulfur content range from 0.04 to 2.83 wt% and < 0.01 to 2.17 wt%, respectively, with average total sulfur and total sulfur contents of 0.48 and 0.26 wt%, respectively. On average, sulfide sulfur represents 54% of total sulfur, with 35% and 11% of total sulfur represented by sulfate sulfur and residual sulfur, respectively. In the case of these samples, residual sulfur likely is represented by sulfur associated with organic matter.
- The bulk NP ranges from -9 to 13.3 kg $CaCO_3$/ton, with an average value of -1.3 kg $CaCO_3$/ton. Negative values for NP indicate acidity being generated by processes other than sulfide oxidation (e.g., oxidation of organic carbon).

[1] MEND, 2009. Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials. MEND Report 1.20.1.

- The general absence of neutralizing potential is confirmed by the values for total inorganic carbon (TIC), which are non-detect in the majority of samples and do not exceed 0.19 wt%. TIC is generally understood to be indicative of the presence of carbonate minerals with potential buffering capabilities.
- Total carbon (TC) ranges from non-detect to 15.6 wt%, with an average value of 4.82 wt%. The difference between TC and TIC is likely indicative of the presence of coal residue (i.e., organic carbon).
- Paste pH values ranges from 3.1 to 7.7, with an average value of 4.9, indicating acidic conditions in the majority of samples (i.e., of the 36 samples analyzed, 31 samples have a paste pH < 6.5).Calculated values for AP (based on sulfide sulfur) range from < 0.3 to 68 kg $CaCO_3$/ton, with an average value of 8 kg $CaCO_3$/ton.
- Resulting NPR values range from -5.7 to 9.5, with an average value of approximately zero.

3.1 Acid Rock Drainage Potential

When applying the criteria in Table 1 to the calculated NPR values, four samples are considered non-potentially acid generating (NPAG), two samples Uncertain, and the remaining 30 samples potentially acid generating (PAG). This classification is in good agreement with the observed paste pH values. The PAG nature of the majority of the samples is primarily due to a general absence of neutralizing potential, resulting in even small amounts of sulfide sulfur being capable of generating acidic conditions. The coal component of the borrow soil may be contributing acidity as well.

3.2 Limestone Requirement

The limestone requirement was calculated from the acid potential, assuming that limestone is 100% effective. The calculation also accounts for the acidity generated by processes other than sulfide oxidation in the case of samples for which the measured NP was less than zero.

Calculated limestone requirements for individual samples to achieve an NPR ≥ 2 as presented on Table 2 range from 0 to 14.5 wt%, with an average requirement of approximately 2 wt%.

3.3 Sulfate Leaching Potential

The results of the sulfate leaching tests (Table 3) indicate the following:

- Sulfate concentrations in SPLP leachates are approximately proportional to the sulfate sulfur content of the samples, with sample BA-2-(6-8) being a notable exception.
- The average sulfate concentration in the five SPLP leachates is 193 mg/L.
- Sulfate concentrations in NAG leachates are approximately proportional to the sulfide sulfur content of the samples.
- The average sulfate concentration in the five NAG leachates is 103 mg/L.

It is important to note that the sulfate concentration in surface water originating from areas with this borrow soil would be much lower than the concentrations measured in the laboratory leachates. Any sulfate in contact water from sulfidic borrow soil would be diluted in two ways: first, leachate flow would be diluted by the stormwater not infiltrating into the borrow soil that does not contain sulfidic material (i.e., unimpacted runoff); and second, the stormwater from the area with borrow soil would be further diluted by unimpacted stormwater from surrounding areas.

To consider potential impact to Cross Creek, these results are compared to existing sulfate concentrations in Cross Creek (Table 4). The most relevant Cross Creek data are for CCW-4 through -10, which are downstream of McIntyre Creek. CCW-1, -2, and -3 are upstream of McIntyre Creek and would be unaffected by fill soil placed in the lowlands of the Site. The potential sulfate concentrations in surface water from borrow soil placed in the lowlands would be much lower than the existing sulfate concentrations in Cross Creek.

4.0 PROPOSED MITIGATION APPROACH

The specifications for the slag consolidation project have been revised to require addition of limestone to borrow soil with acid-generating potential used for the stockpile cover, backfill, and other purposes. These requirements are specified in Section 02200 (Earthworks) and include the following key elements:

- Clean soil fill with acid-generating potential shall be amended with a minimum of 5% limestone by dry weight. No more than 15% limestone by dry weight shall be used.
- Limestone amendment shall be angular to sub-angular crushed stone having 100% finer than 1.5 inches and no more than 5% by dry weight passing the US #4 sieve.
- Amending methods shall ensure that the limestone is uniformly mixed throughout the lift, both vertically and laterally, to achieve a uniform, homogeneous material free of any pockets of limestone or zones without limestone.

The minimum requirement for 5% limestone addition is slightly more than twice the average limestone requirement from Table 2. This is considered appropriate to ensure neutralization, particularly considering that the borrow soil will be extensively mixed during excavation and placement, so that any “hot spots” will tend to be eliminated. The upper limit of 15% was included to maintain workability of the amended soil and reduce particle-to-particle contact which could interfere with compaction, although it is unlikely in any case that the contractor would significantly exceed the minimum requirement due to the expense of the limestone.

The limestone amendment is specified as predominantly fine gravel to facilitate uniform mixing with the borrow soil and allow use of the likely range of commercially available materials.

The limestone amendment will not change the other requirements for fill soil placement such as lift thickness and compaction.

Because the potential sulfate concentrations in surface water that has contacted borrow soil placed in the lowlands would be much lower than the existing sulfate concentrations in Cross Creek, no mitigation is necessary for sulfate.

5.0 CLOSING

If you have any questions, please call Barb Nielsen at (480) 313-2892.

Very truly yours,

WSP USA Inc.

Rens Verburg
Technical Fellow - Geochemistry

Frank S. Shuri, LG, LEG
Vice President, Civil Engineering

RV/FSS/mtd

CC: B. Nielsen (Cyprus)
J. Sisson (Cyprus)
S. Anderson (WSP)
L. Holder (WSP)

Attachments: Table 1 – Screening Criteria for Evaluating ARD Potential (from INAP; MEND 2009)
Table 2 – Analytical Results for Potential Borrow Soil
Table 3 – Sulfate Results for SPLP and NAG Tests on Potential Borrow Soil
Table 4 – Cross Creek Sulfate Results
Figure 1 – Site Map
Figure 2 – Sampling Locations

c:\users\usmd701094\golder associates\12393309x07, satralloy - report\ard results letter 2024-003-08.docx

Table 1
Screening Criteria for Evaluating ARD Potential (from INAP; MEND 2009)

Classification	Criterion	Description
Potentially Acid Generating (PAG)	Net Potential Ratio (NPR) < 1	Likely to generate acidity, unless sulfide minerals are non-reactive, or the net potential (NP) is preferentially exposed on surfaces
Uncertain	1 ≤ NPR < 2	Neither clearly acid-generating nor acid- consuming. Possibly acid generating potential if NP is not reactive enough or depleted more rapidly than sulfides
Non-Potentially Acid Generating (NPAG)	NPR ≥ 2	Acid consuming, low acid generating potential, unless: the NP is not sufficiently reactive, extremely reactive sulfides are present, or there is preferential exposure of sulfides in the material

Table 2
Analytical Results for Potential Borrow Soil

	Total Sulfur	Sulfate Sulfur	Sulfide Sulfur	Insoluble S	Bulk NP	Total Inorganic Carbon (TIC)	Total Carbon (TC)	Paste pH	Acid Potential (AP)	Net Potential Ratio (NPR)	ARD Classification (see Table 1)	Limestone Requirement
Units	wt% *	wt%	wt%	wt%	kg $CaCO_3$/t	wt%	wt%		kg $CaCO_3$/t			wt%
Sample ID (depth-feet)												
BB-1-(2-4)	0.46	0.27	0.14	0.054	-6.4	ND	7.779	4.20	4.4	-1.47	PAG	1.5
BB-1-(4-6)	1.38	0.12	1.15	0.110	-2.2	0.03	5.052	4.19	35.9	-0.06	PAG	7.4
BB-1-(6-8)	1.13	0.15	0.92	0.057	-3.2	0.02	7.157	4.16	28.8	-0.11	PAG	6.1
BB-1-(8-10)	0.89	0.18	0.73	-0.024	-3.6	ND	5.954	4.10	22.8	-0.16	PAG	4.9
BB-3-(1-3)	0.04	0.02	0.01	0.005	3.0	ND	0.388	7.45	0.3	9.54	NPAG	0.0
BB-3-(3-5)	0.17	0.09	0.08	-0.002	0.2	ND	1.466	5.12	2.5	0.07	PAG	0.5
BB-3-(5-7)	0.18	0.12	0.05	0.011	-0.5	ND	2.106	4.90	1.6	-0.31	PAG	0.4
BB-3-(7-9)	0.17	0.13	0.04	0.003	-0.9	ND	1.808	4.77	1.3	-0.70	PAG	0.3
BA-1-(0-2)	0.35	0.23	0.08	0.040	-1.9	ND	6.613	4.64	2.5	-0.75	PAG	0.7
BA-1-(2-4)	0.50	0.26	0.12	0.122	-2.5	ND	10.596	4.36	3.8	-0.66	PAG	1.0
BA-1-(6-8)	0.48	0.34	0.06	0.079	-3.4	ND	7.809	4.17	1.9	-1.84	PAG	0.7
BA-1-(8-10)	0.66	0.26	0.25	0.146	-1.7	ND	14.798	4.45	7.8	-0.21	PAG	1.7
BA-2-(1-3)	0.20	0.10	0.04	0.057	-1.5	ND	5.047	4.83	1.3	-1.21	PAG	0.4
BA-2-(4-6)	0.58	0.19	0.24	0.148	-2.6	ND	15.623	4.34	7.5	-0.35	PAG	1.8
BA-2-(6-8)	0.21	0.14	0.03	0.042	-1.9	ND	3.59	4.48	0.9	-2.01	PAG	0.4
BA-2-(8-10)	0.21	0.10	0.07	0.036	-1.3	ND	2.933	4.65	2.2	-0.59	PAG	0.6
BA-3-(1-3)	0.17	0.07	0.05	0.054	-2.7	ND	4.817	4.66	1.6	-1.72	PAG	0.6
BA-3-(3-6)	0.27	0.08	0.08	0.111	-3.2	ND	9.436	4.52	2.5	-1.26	PAG	0.8
BA-3-(6-9)	0.18	0.04	0.04	0.100	-2.8	ND	6.271	4.57	1.3	-2.21	PAG	0.5
BA-3-(9-12)	0.18	0.05	0.03	0.104	-3.5	ND	7.185	4.64	0.9	-3.78	PAG	0.5
BC-1-(1-3)	0.46	0.32	0.07	0.071	-5.4	ND	6.789	3.55	2.2	-2.45	PAG	1.0
BC-1-(3-6)	0.22	0.13	0.06	0.030	-3.1	ND	3.32	3.97	1.9	-1.65	PAG	0.7
BC-1-(6-8)	0.09	0.07	0.01	0.009	-1.5	ND	1.267	3.90	0.3	-4.82	PAG	0.2
BC-1-(8-11)	0.11	0.08	0.01	0.019	-1.8	ND	1.541	4.89	0.3	-5.70	PAG	0.2
BC-2-(2-4)	0.10	0.06	0.03	0.011	2.6	0.02	0.752	7.49	0.9	2.81	NPAG	0.0
BC-2-(7-9)	0.10	0.03	0.08	-0.009	3.7	0.05	0.151	7.68	2.5	1.49	UNCERTAIN	0.1
BC-2-(10-12)	0.20	0.16	0.05	-0.010	13.4	0.19	0.772	6.26	1.6	8.56	NPAG	0.0
BC-2-(12-15)	0.44	0.40	0.08	-0.036	0.8	0.02	0.424	5.55	2.5	0.31	PAG	0.4
BC-3-(2-4)	0.09	0.04	0.04	0.006	-0.1	ND	0.549	5.29	1.3	-0.06	PAG	0.3
BC-3-(5-7)	0.23	0.08	0.13	0.017	0.0	ND	1.296	5.77	4.1	0.00	PAG	0.8
BC-3-(9-11)	0.34	0.27	0.08	-0.008	7.5	0.09	0.84	6.55	2.5	3.00	NPAG	0.0
BC-3-(12-15)	0.44	0.27	0.21	-0.042	6.7	0.06	0.254	7.31	6.6	1.02	UNCERTAIN	0.6
BB-2-(1-4)	1.24	0.27	0.92	0.045	-5.9	ND	6.472	3.56	28.8	-0.20	PAG	6.3
BB-2-(5-7)	0.79	0.33	0.39	0.067	-6.0	ND	5.947	3.65	12.2	-0.49	PAG	3.0
BB-2-(8-10)	1.19	0.37	0.65	0.171	-7.7	ND	8.464	3.13	20.3	-0.38	PAG	4.8
BB-2-(10-12)	2.83	0.42	2.17	0.239	-9.0	0.02	8.314	3.75	67.8	-0.13	PAG	14.5
MIN	0.04	0.02	< 0.01	-0.042	-9.0	0.02	0.15	3.13	< 0.3	-5.7		0.0
MAX	2.83	0.42	2.17	0.239	13.4	0.19	15.62	7.68	67.8	9.5		14.5
AVERAGE	0.48	0.17	0.26	0.05	-1.3	0.06	4.82	4.88	8.0	-0.2		1.8

ND = Not detected of the 0.01% Level of Detection
** wt.% = percentage by weight*

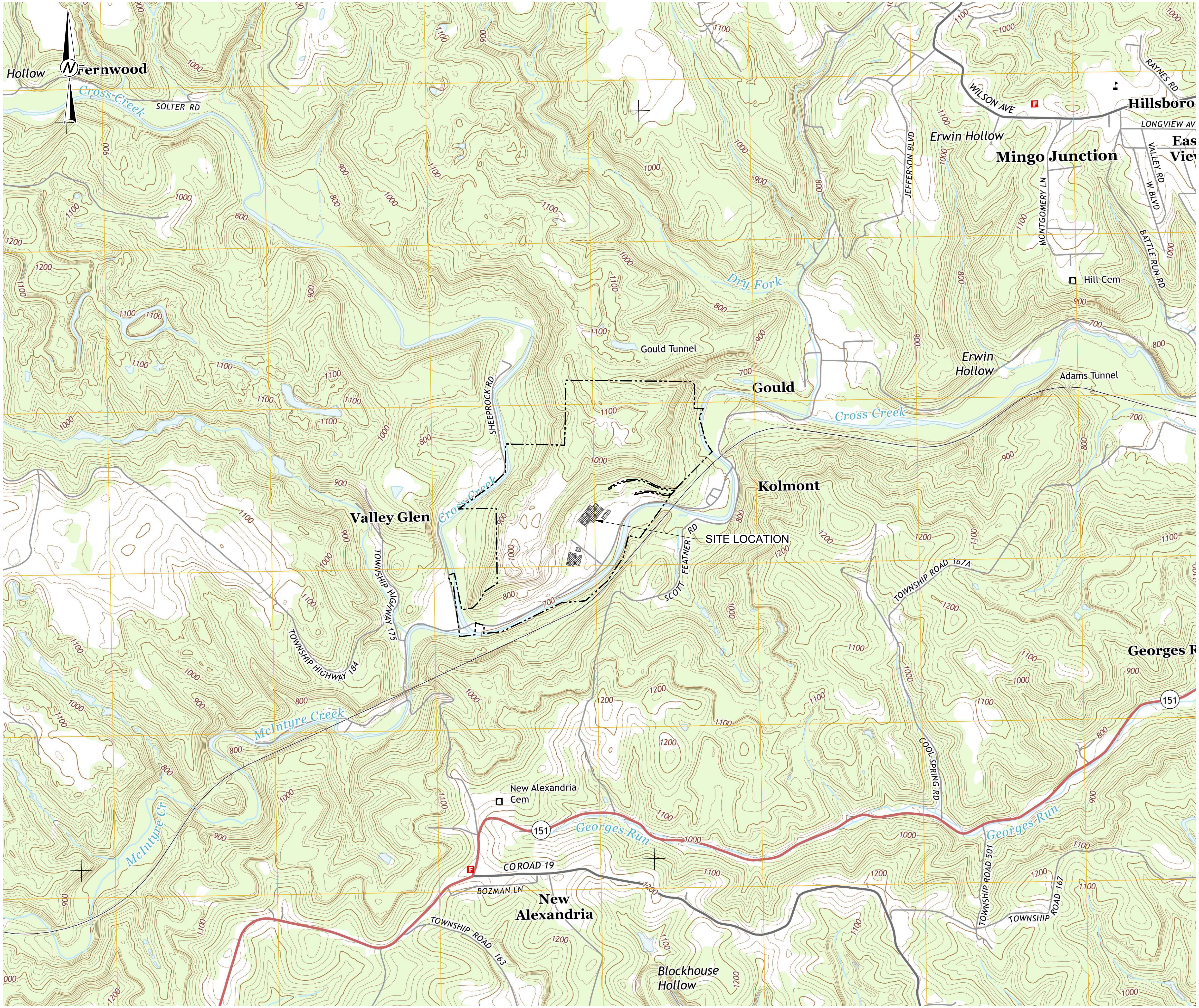
Table 3
Sulfate Results for SPLP and NAG Tests on Potential Borrow Soil

	Total Sulfur	Sulfate Sulfur	Sulfide Sulfur	Insoluble S	SPLP Sulfate	NAG Sulfate
Units	**wt% ***	**wt%**	**wt%**	**wt%**	**mg/L**	**mg/L**
Sample ID (Depth - feet)						
BB-1-(4-6)	1.38	0.12	1.15	0.110	302.8	260
BA-2-(6-8)	0.21	0.14	0.03	0.042	18.0	55
BA-3-(6-9)	0.18	0.04	0.04	0.100	10.1	22
BC-2-(12-15)	0.44	0.40	0.08	-0.036	303.0	84
BC-3-(12-15)	0.44	0.27	0.21	-0.042	331.9	95
Average					193	103

** wt% = percentage by weight*

Table 4
Cross Creek Sulfate Results
November 2006 through September 2014

	Sulfate (mg/L)			
Location	**Num. Samples**	**Min**	**Max**	**Mean**
CCW-01	16	157	320	226
CCW-02	15	180	310	232
CCW-03	9	180	310	240
CCW-04	15	700	1100	958
CCW-05	8	290	660	486
CCW-06	14	280	650	460
CCW-07	15	300	670	479
CCW-08	15	300	670	477
CCW-09	15	300	690	475
CCW-09A	2	330	420	380
CCW-10	9	330	630	454



OHIO

REFERENCE(S)

1.) MAP TAKEN FROM U.S.G.S. 7.5 MINUTE QUADRANGLE OF STEUBENVILLE WEST, OHIO, DATED 2013.

0 1000 2000
1" = 1000' FEET

CLIENT
CYPRUS AMAX MINERALS COMPANY

PROJECT
FORMER SATRALLOY SITE
JEFFERSON COUNTY, OHIO

TITLE
SITE MAP

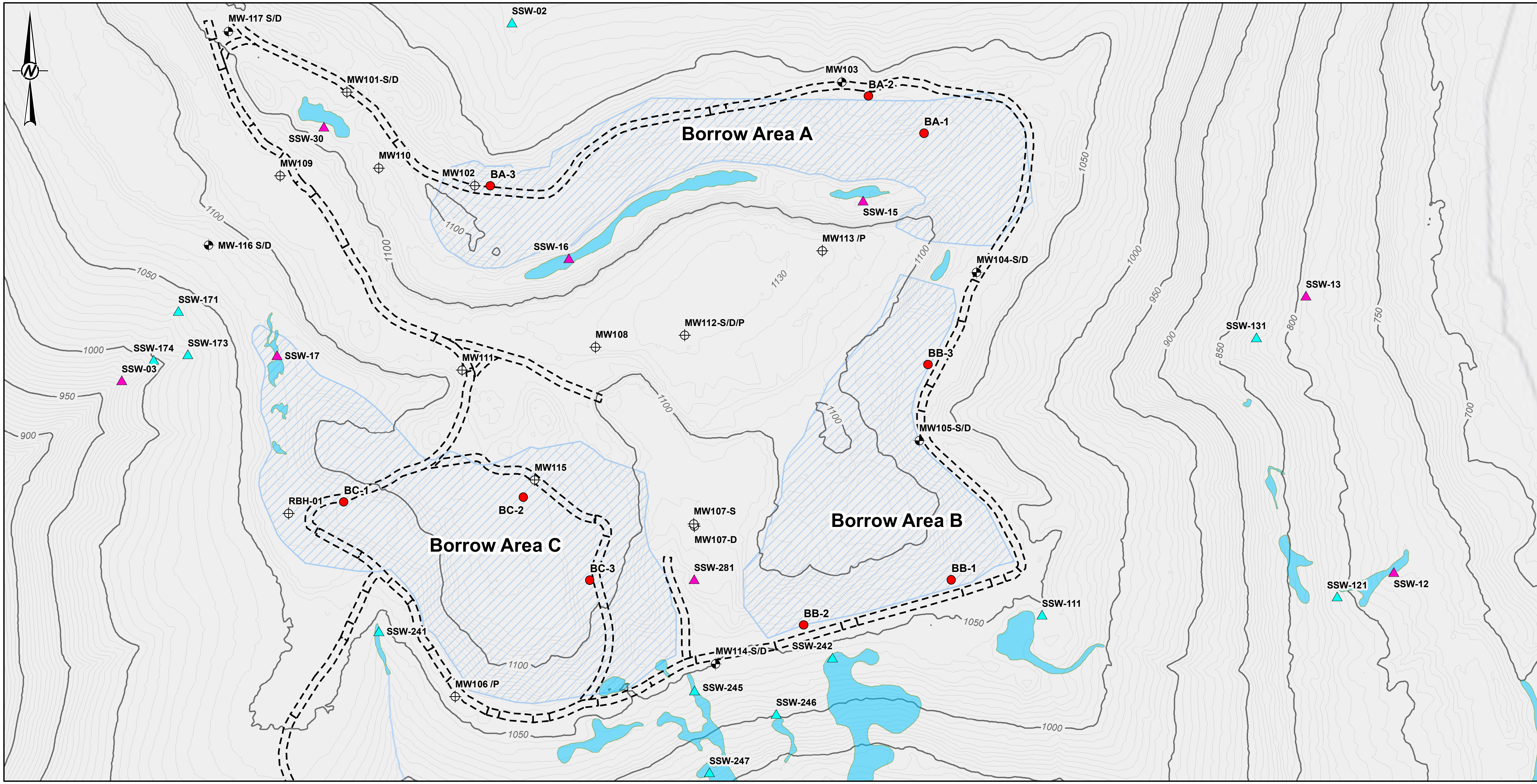
CONSULTANT

wsp

YYYY-MM-DD	2023-05-09
DESIGNED	DRI
PREPARED	REDMOND
REVIEWED	DRI
APPROVED	DRI

PROJECT NO.	CONTROL	REV.	FIGURE
GL1239330907	-	0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D



LEGEND

- Borrow Soil Test Pit
- Monitoring Well - Active
- Monitoring Well - Decommissioned
- Seep Location
- Surface Water Location
- 50 ft Interval
- 5 ft Interval
- Railroad
- Roads
- Tributary (Aug 2021)
- Wetland (Aug 2021)
- Borrow Soil Area

DRAFT

0 100 200 400 Feet

1 inch = 200 feet

NOTE(S)
1. BORROW SOIL TEST PIT LOCATIONS WERE DETERMINED BY HANDHELD GPS.

REFERENCE(S)
1. SERVICE LAYER CREDITS: ESRI, HERE, GARMIN, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

CLIENT
CYPRUS AMAX MINERALS COMPANY

PROJECT
FORMER SATRALLOY SITE
JEFFERSON COUNTY, OHIO

CONSULTANT

wsp

YYYY-MM-DD	2/21/2024
DESIGNED	DRI
PREPARED	DTD
REVIEWED	DRI
APPROVED	DRI

TITLE
SAMPLING LOCATIONS
BORROW SOIL SAMPLING AND ANALYSIS

PROJECT NO.	CONTROL	REV.	FIGURE
GL1239330907	-	-	2