TECHNICAL MEMORANDUM

DATE January 29, 2021 **Project No.** 152030402

TO Mr. Alan Noell
Washington State Department of Ecology (Ecology)

FROM Gary Zimmerman and Tom Haskins, LG

RESERVE SILICA RECLAMATION SITE – 2020 REMEDIAL INVESTIGATION ACTIVITIES
FACILITY ID NO.: 2041; CLEANUP SITE NO.: 4728

1.0 INTRODUCTION

A Remedial Investigation (RI) and Feasibility Study (FS) Work Plan (Work Plan) is being prepared for the Reserve Silica Reclamation Site (Site) under Agreed Order No. DE 16052. The draft Work Plan was submitted to Ecology in June 2020. The draft Work Plan is being revised to address comments provided by Ecology in the letter regarding *Draft Remedial Investigation/Feasibility Study Work Plan (Golder Associates, June 30, 2020) comments for the following Site: Reserve Silica Reclamation*, dated September 30, 2020. The draft Work Plan included a description for completing preliminary RI tasks during 2020 to support the overall RI/FS and to provide additional data in support of finalizing the RI/FS Work Plan. Ecology's letter provided comments on the proposed scope of work and approval to complete the preliminary RI task during 2020. The following preliminary RI tasks were completed in 2020:

- Conduct a frequency domain electromagnetic (EM) geophysical survey across the Lower Disposal Area (LDA) to map areas where alkaline groundwater (i.e., high pH) is present within the LDA.
- Install a new groundwater monitoring well (identified as P-14) within an area of the LDA where the indicated conductivity readings from the EM survey were the highest.
- Collect a groundwater sample from new well P-14 and analyze the sample for the chemicals of potential concern (COPCs) approved by Ecology in the comment letter.
- Collect a groundwater sample from an existing monitoring well (P-11) located on the west side of the Lower Haul Road, which is hydrologically downgradient of the LDA, and analyze the sample for the list of COPCs approved by Ecology in the comment letter.

This technical memorandum presents the results of the above preliminary RI tasks completed in 2020. The work was completed in accordance with the draft Sampling and Analysis Plan and draft Quality Assurance Project Plan, included as Appendices D and E, respectively, to the draft Work Plan, as modified where appropriate based on Ecology's comments on the draft Work Plan.

2.0 EM GEOPHYSICAL SURVEY AND INSTALLATION OF P-14

Prior to drilling and construction of well P-14, the EM geophysical survey of the LDA was completed in October 2020. Results of the EM survey and the proposed location for drilling and installing well P-14 were provided to

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Ecology in a previous Technical Memorandum[1]. The attached Figure 1 shows the results of the EM survey and the location of well P-14. The proposed location for well P-14 was near the center of the LDA in a location where the highest EM readings were recorded. Installing the well in this highest EM area location would provide representative data on the chemical composition of highly alkaline groundwater in direct contact with the cement kiln dust (CKD) within the LDA and prior to the groundwater migrating through native soils and other fill material located outside of the LDA. Ecology verbally approved the proposed location of well P-14 and the proposed drilling and well construction specifications during a conference call on November 9, 2020.

Borehole drilling and installation of well P-14 were completed on November 20, 2020 by Cascade Drilling, Inc., a Washington State-licensed driller, using roto-sonic drilling methods. The roto-sonic drilling method collected continuous cores, which permitted detailed evaluation of the soils and materials encountered during drilling. Soils were logged by a qualified Golder geologist in accordance with Unified Soil Classification System (USCS) standards and Golder technical guidelines. The P-14 borehole was advanced to a maximum depth of 70 feet below ground surface (bgs). The following general lithologies were encountered and are shown in the P-14 well log, which is included in Attachment 1:

- 0 to 2 feet bgs: Vegetated topsoil and low permeability clay cap
- 2 to 14 feet bgs: Clay waste mine soils; light gray clay, stiff, dry to moist
- 14 to 36 feet bgs: CKD material: light gray powder, dry to wet, (field testing indicated high pH around 13 when mixed with water)
- 36 to 51 feet bgs: CKD mixed with mine waste soils and gravels; CKD with gravel, some pockets of sand, intermittent mottled red/brown color. Groundwater was observed within this interval at the time of drilling, at a depth of 40 feet bgs.
- 51 to 61 feet bgs: Clayey Silt CKD mixed with mine waste soils and gravels: Clayey silt (possible saturated compacted CKD) and sand and gravel some mottling, glass fragments and paper debris, high pH around 13 when mixed with water.
- 61 to 70+ feet bgs: Weathered to competent sandstone bedrock; highly weathered, orange, thinly laminated sandstone, oxidized, dry to moist, neutral pH when mixed with water, an indicated confining unit upon which water in the LDA is perched.

After bedrock was encountered, the P-14 borehole was backfilled with hydrated bentonite to a depth of 52 feet bgs, and two feet of silica sand was placed above the bentonite seal. The P-14 monitoring well was constructed with 10 feet of 2-inch diameter, 0.010-inch slot size, schedule 40 poly vinyl chloride (PVC) screen placed from approximately 40 to 50 feet bgs. The well completion schematic is shown in Attachment 1. P-14 well development was completed on December 4, 2020 through surging and pumping to remove any materials introduced during drilling and to produce groundwater representative of the formation.

3.0 GROUNDWATER SAMPLING

On December 11, 2020, groundwater samples were collected from both wells P-14 and P-11. Groundwater sampling and analyses were performed following the procedures described in the draft Work Plan. As detailed in

[1] Golder Associates Inc. (Golder). 2020. Reserve Silica Reclamation Site – 2020 Geophysical Survey and Proposed Location of Groundwater Monitoring Well P-14.

the draft Work Plan and in the Technical Memorandum (Golder, November 2020) approved by Ecology, this initial sampling round from well P-14 included the expanded list of COPCs, including the following: antimony, arsenic, beryllium, chromium, lead, mercury, nickel, selenium, silver, thallium, vanadium, and 2,3,7,8-substituted dioxins & furans. The purpose of analyzing for this expanded list of COPCs in well P-14 was to evaluate the presence and concentrations of these compounds in groundwater located within the LDA in an area where saturated CKD is present and some of the highest conductivity readings were measured during the geophysical survey. If these COPCs are leaching to groundwater from the CKD and other material disposed in the LDA, samples collected from well P-14 would be expected, based on the EM survey, to contain the highest concentrations generally detected within the LDA.

Well P-11 is located west of the Lower Haul Road and appears to monitor the shallow groundwater migrating from the LDA, after the high pH groundwater has migrated through the fill material beneath the Lower Haul Road. Previous investigations completed by others identified ASARCO slag in the near surface soils that comprise the Lower Haul Road and other, deeper fill soil, coal pieces, woody debris, with occasional occurrences of CKD[2]. The groundwater samples collected from wells P-11 and P-14 were analyzed for the same COPCs, except Ecology requested that copper also be analyzed for in the well P-11 sample, because ASARCO slag is known to contain copper, in addition to its primary contaminants of arsenic and lead. The P-11 sample was not analyzed for 2,3,7,8-substituted dioxins & furans, as these compounds were only analyzed in well P-14 to evaluate if these compounds are leaching from the CKD. Analyzing groundwater samples from wells P-14 and P-11 for a similar list of COPCs allows for a preliminary evaluation of groundwater quality within and downgradient of the LDA.

4.0 GROUNDWATER ANALYTICAL RESULTS

Table 1 presents a summary of the laboratory metals analytical results for the groundwater samples collected from wells P-14 and P-11. Table 2 presents the dioxins and furans analytical results. The analytical results indicate the following:

- Antimony, arsenic, and lead were detected in groundwater samples collected from both wells P-11 and P-14 at concentrations exceeding Model Toxics Control Act (MTCA) cleanup levels.
- Vanadium was detected in P-11 at a reported concentration that exceeded MTCA cleanup level. Vanadium was also detected in P-14 but at a reported concentration that was below the MTCA cleanup level.
- The estimated concentration of thallium reported in P-11 was slightly above the MTCA cleanup level, but the reported concentration was below the laboratory reporting limit, so the concentration is considered estimated.
- Beryllium, chromium, mercury, silver, and thallium were not detected in P-14.
- The concentrations of arsenic, chromium, lead, nickel, and vanadium reported in the groundwater samples collected from well P-11 were significantly higher (more than 200% higher) than the concentrations reported in the groundwater samples collected from well P-14.
- There were no dioxins or furans compounds detected above the laboratory reporting limits.

[2] Aspect Consulting, LLC (Aspect). 2017. Remedial Investigation Report, Reserve Silica Site. November.
Aspect. 2019. Lot 6 Historical Review, Reserve Silica, Ravensdale Site, Washington. August 19.

Data obtained during these 2020 remedial investigation activities will be evaluated in conjunction with the extensive amount of existing Site environmental data during the development of the Final RI/FS Work Plan.

Golder Associates Inc.

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Senior Project Engineer

Tom Haskins, LG
Staff Hydrogeologist

Gary Zimmerman
Principal

GZ/TH/JX/sb

Attachments
Tables 1 and 2
Figure 1
Attachment 1: P-11 and P-14 Well Log

152030402-tm-rev0-2020-ri- 4728-012921

Tables

Table 1: Summary of Field Parameters and Laboratory Analytical Results for Metals

				Results				
				P-14		P-11		
Analyte	**CAS Number**	**Units**	**MTCA Applicable GW CUL[1]**	**12/11/2020**		**12/11/2020**		**Percent Difference P-11:P-14**
Water Levels and Elevations								
Depth to Water	-	feet BTOC	-	31.09		14.02		-
Groundwater Elevation	-	feet AMSL	-	742.23		725.00		-
Screened Interval	-	feet BGS	-	40 - 50		14 - 19		-
Field Parameter								
pH	-	pH	-	13.30		12.67		-
Conductivity	-	µS/cm	-	18697		6113		-
Temperature	-	°C	-	11.6		11.6		-
Dissolved Oxygen	-	mg/L	-	0.12		1.25		-
Oxidation Reduction Potential	-	mV	-	-61.2		15.9		-
Turbidity	-	NTU	-	17.9		34.3		-
Total Metals								
Antimony	7440-36-0	µg/L	6.4	147		201		37%
Arsenic	7440-38-2	µg/L	5	270		1670		519%
Beryllium	7440-41-7	µg/L	32	2	U	0.76	J	-
Chromium	7440-47-3	µg/L	50	5	U	45.1		802%
Copper	7440-50-8	µg/L	640	NA		75.5		-
Mercury	7439-97-6	µg/L	2	0.1	U	0.11		-
Lead	7439-92-1	µg/L	15	18.8		138		634%
Nickel	7440-02-0	µg/L	320	36.8		112		204%
Selenium	7782-49-2	µg/L	80	11.9		6.41		-46%
Silver	7440-22-4	µg/L	80	2	U	0.35	J	-
Thallium	7440-28-0	µg/L	0.32	1	U	0.54	J	-
Vanadium	7440-62-2	µg/L	80	23.4		116		396%

Notes:

1 - Applicable MTCA CUL is either the MTCA Method A CUL or the lower of either the MTCA Method B Cancer or Non-Cancer CULs.

"U" qualifier - indicates analyte was not detected above reporting limit.

"J" qualifier - indicates analyte was not detected above reporting limit, but was estimated between method detection limit and reporting limit.

BTOC - Below Top of Casing | AMSL - Above Mean Sea Level | BGS - Below Ground Surface | MTCA - Model Toxics Control Act | GW - Groundwater | CUL - Cleanup Level | µS/cm - microsiemens per centimeter | mV - millivolts | NA - Not Analyzed | NTU - Nephelometric Turbidity Units

Table 2: Summary of Laboratory Analytical Results for Dioxins and Furans

				Results (µg/L)	
				P-14	
Analyte	**CAS Number**	**MTCA Applicable GW CUL (µg/L)[1]**	**Toxicity Equivalency Factor[2]**	**12/11/2020**	
Dioxins/Furans					
2,3,7,8-TCDF	51207-31-9	-	0.1	9.92E-06	U
2,3,7,8-TCDD	1746-01-6	6.70E-07	1	9.92E-06	U
1,2,3,7,8-PeCDF	57117-41-6	-	0.03	9.92E-06	U
2,3,4,7,8-PeCDF	57117-31-4	-	0.3	9.92E-06	U
1,2,3,7,8-PeCDD	40321-76-4	-	1	9.92E-06	U
1,2,3,4,7,8-HxCDF	70648-26-9	-	0.1	4.90E-07	J
1,2,3,6,7,8-HxCDF	57117-44-9	-	0.1	9.92E-06	U
2,3,4,6,7,8-HxCDF	60851-34-5	-	0.1	4.90E-07	J
1,2,3,7,8,9-HxCDF	72918-21-9	-	0.1	9.92E-06	U
1,2,3,4,7,8-HxCDD	39227-28-6	-	0.1	6.80E-07	J
1,2,3,6,7,8-HxCDD	57653-85-7	-	0.1	9.92E-06	U
1,2,3,7,8,9-HxCDD	19408-74-3	-	0.1	9.92E-06	U
1,2,3,4,6,7,8-HpCDF	67562-39-4	-	0.01	9.92E-06	U
1,2,3,4,7,8,9-HpCDF	55673-89-7	-	0.01	9.92E-06	U
1,2,3,4,6,7,8-HpCDD	35822-46-9	-	0.01	9.92E-06	U
OCDF	39001-02-0	-	0.0003	1.98E-05	U
OCDD	3268-87-9	-	0.0003	4.96E-05	U
TEF Sum of Dioxins/Furan Concentrations[2]	-	6.70E-07	-	1.66E-07	-

Notes:

1 - Applicable MTCA CUL is either the MTCA Method A CUL or the lower of either the MTCA Method B Cancer or Non-Cancer CULs.

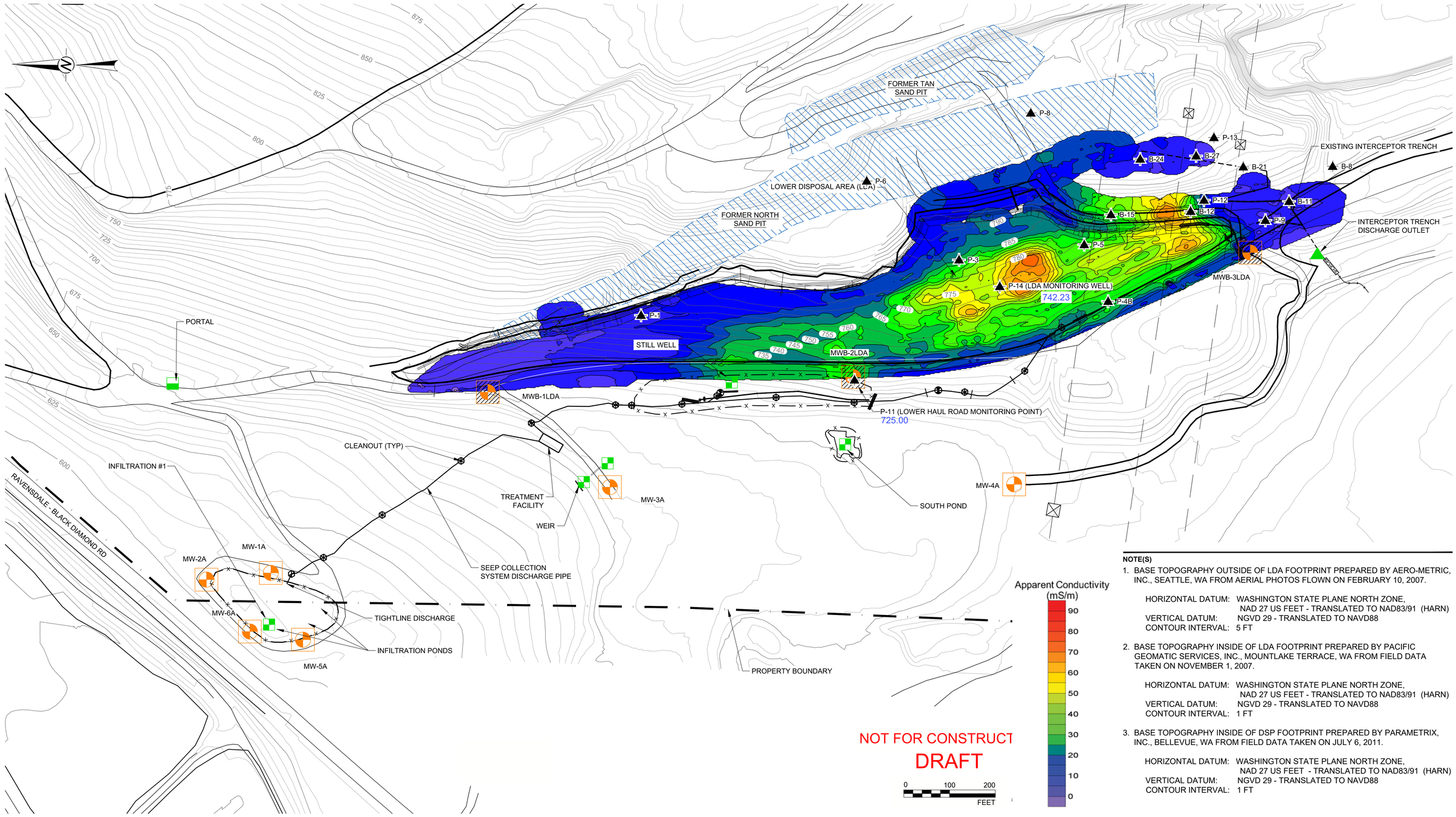
2 - Dioxin/Furan cleanup levels will be calculated using Ecology's Toxicity Equivalent Factors calculation methodology and guidance. *Evaluating the Toxicity and Assessing the Carcinogenic Risk of Environmental Mixtures Using Toxicity Equivalency Factors* (Ecology 2007).

"U" qualifier - indicates analyte was not detected above reporting limit.

"J" qualifier - indicates analyte was not detected above reporting limit, but was estimated between method detection limit and reporting limit.

MTCA - Model Toxics Control Act | GW - Groundwater | CUL - Cleanup Level

Figure



NOTE(S)

1. BASE TOPOGRAPHY OUTSIDE OF LDA FOOTPRINT PREPARED BY AERO-METRIC, INC., SEATTLE, WA FROM AERIAL PHOTOS FLOWN ON FEBRUARY 10, 2007.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET - TRANSLATED TO NAD83/91 (HARN)
   VERTICAL DATUM: NGVD 29 - TRANSLATED TO NAVD88
   CONTOUR INTERVAL: 5 FT

2. BASE TOPOGRAPHY INSIDE OF LDA FOOTPRINT PREPARED BY PACIFIC GEOMATIC SERVICES, INC., MOUNTLAKE TERRACE, WA FROM FIELD DATA TAKEN ON NOVEMBER 1, 2007.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET - TRANSLATED TO NAD83/91 (HARN)
   VERTICAL DATUM: NGVD 29 - TRANSLATED TO NAVD88
   CONTOUR INTERVAL: 1 FT

3. BASE TOPOGRAPHY INSIDE OF DSP FOOTPRINT PREPARED BY PARAMETRIX, INC., BELLEVUE, WA FROM FIELD DATA TAKEN ON JULY 6, 2011.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET - TRANSLATED TO NAD83/91 (HARN)
   VERTICAL DATUM: NGVD 29 - TRANSLATED TO NAVD88
   CONTOUR INTERVAL: 1 FT

LEGEND

MW-1A	ALLUVIAL MONITORING WELL	▲	INTERCEPTOR TRENCH SAMPLING LOCATION
MWB-1DDSP	BEDROCK MONITORING WELL	— x — x —	FENCE LINE
MWB-2DSP	BEDROCK MONITORING WELL	▲ P-1	GOLDER PIEZOMETER - NO PROPOSED SAMPLING UNLESS OTHERWISE SPECIFIED
	LDA SURFACE WATER SAMPLING LOCATION	742.23	GROUNDWATER ELEVATION (12/11/2020), FEET ABOVE MEAN SEA LEVEL
	DSP BEDROCK SAMPLING LOCATION (PORTAL)		

CLIENT
HOLCIM

CONSULTANT
GOLDER

YYYY-MM-DD	2021-01-15
DESIGNED	JX
PREPARED	REDMOND
REVIEWED	JX
APPROVED	GZ

PROJECT
RI WORK PLAN 2020
RAVENSDALE, WA

TITLE
2020 GEOPHYSICAL SURVEY AND P-14 WELL LOCATION

PROJECT NO.	PHASE	REV.	FIGURE
152030402	002	A	1

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

0 1 in

ATTACHMENT 1

P-11 and P-14 Well Logs

RECORD OF BOREHOLE P-11 HSA

SHEET 1 of 2

PROJECT: Resrve Silica LDA Field Invest
PROJECT NUMBER: 073-93074-02.013
LOCATION: Adjacent to MWB-2LDA
DRILLING METHOD: Hollow Stem Auger
DRILLING DATE: 11/15/10
DRILL RIG: CME 65 Limited Access
DATUM: Local
AZIMUTH: N/A
COORDINATES: N: 1,712,741.18 E: 127,159.00
ELEVATION: 735
INCLINATION: -90

DEPTH (ft)	BORING METHOD	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ■ (10 20 30 40) / WATER CONTENT (PERCENT) W_p W W_l (20 40 60 80)	NOTES WATER LEVELS / GRAPHIC
0	Hollow Stem Auger 8-inch Casing Diameter	0.0 - 20.5 Compact to very dense, mottled, olive brown to medium gray, heterogeneous, mix of silty fine to medium SAND and SILT, some fine to coarse subrounded to subangular gravel, scattered cobble/boulder fragments, scattered pockets of fine-grained coal fragments, damp to wet (SM) (FILL-MINE SPOILS)	SM									Flush-mount monument set in concrete with locked well cap 2 in nominal diameter solid schedule 40 PVC pipe set in cement
5						S-1	CA	18-18-14	32	1.0 / 1.5	■	
												2 in nominal diameter solid schedule 40 PVC pipe set in bentonite chips
10						S-2	CA	10-10-18	28	1.5 / 1.5	■	
												2 in nominal diameter solid schedule 40 PVC pipe set in #2/12 silica sand backfill Groundwater measured at 13.21 ft BGS ATD (borehole depth 20 ft)
15		15.0 Slightly cohesive silt and fine to medium sand observed				S-3	CA	8-10-50/6"	>50	1.3 / 1.5	>> ■	2 in nominal diameter 0.010-inch slotted schedule 40 PVC pipe set in #2/12 silica sand backfill
20		20.0 Debris (metal wire) observed Log continued on next page										#2/12 silica sand backfill

1 in to 3 ft
DRILLING CONTRACTOR: Cascade Drilling Inc.
DRILLER: S. Stivers

LOGGED: S. Morgan
CHECKED: D. Findley
DATE: 1/12/2011

Golder Associates

BOREHOLE RECORD 073-93074-02.013 RESERVE SILICA LDA.GPJ GLDR_WA.GDT 6/10/13

RECORD OF BOREHOLE P-11 HSA

PROJECT: Resrve Silica LDA Field Invest
PROJECT NUMBER: 073-93074-02.013
LOCATION: Adjacent to MWB-2LDA
DRILLING METHOD: Hollow Stem Auger
DRILLING DATE: 11/15/10
DRILL RIG: CME 65 Limited Access
DATUM: Local
AZIMUTH: N/A
COORDINATES: N: 1,712,741.18 E: 127,159.00
ELEVATION: 735
INCLINATION: -90

DEPTH (ft)	BORING METHOD	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ■ (10 20 30 40) / WATER CONTENT (PERCENT) W_p W W_l (20 40 60 80)	NOTES WATER LEVELS / GRAPHIC
20			SM		714.5	S-4	CA	50/6"	>50	0.5 / 0.5	>>■	
		Boring completed at 20.5 ft.			20.5							
25												
30												
35												
40												

1 in to 3 ft
DRILLING CONTRACTOR: Cascade Drilling Inc.
DRILLER: S. Stivers

LOGGED: S. Morgan
CHECKED: D. Findley
DATE: 1/12/2011

Golder Associates

WELL NUMBER P-14

GOLDER

CLIENT Holcim
PROJECT NAME Reserve Silica Reclamation Site
PROJECT NUMBER 152030402
PROJECT LOCATION Ravensdale, WA
DATE STARTED 11/20/20 **COMPLETED** 11/20/20
GROUND ELEVATION Not Surveyed **HOLE SIZE** 6-inch
DRILLING CONTRACTOR Cascade Drilling
GROUND WATER LEVELS:
DRILLING METHOD Sonic
▽ **DURING DRILLING** 40.0 feet bgs
LOGGED BY T. Haskins, LG **CHECKED BY** G. Zimmerman
▼ **AFTER DRILLING** 31.09 feet bgs
NOTES Ecology Well ID: BLZ447

DEPTH (ft)	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0			Topsoil and Clay Cap	Flush-mount monument and concrete surface seal
2			Light gray CLAY, stiff, high plasticity, moist [MINE WASTE SOIL]	
5			Dry	
10				
14			Light gray powder/SILT, dry [Cement Kiln Dust (CKD)]	
15			Moist	3/8" hydrated bentonite chips
20			Wet, perched groundwater	
25				
30			▼ Clayey SILT/CKD, moist	
35	pH 13 when soil mixed with water			
36			CKD with gravel, moist	
40			▽ Gray SILT with gravel, moist [CKD]	12/20 Colorado silica sand filter pack around 0.010" slotted PVC screen from 40 to 50 ft bgs
42			Mottled brown and gray, GRAVEL with silt and sand, dry to moist [MINE WASTE GRAVEL]	
45	pH 13 when soil mixed with water		Red and brown, SILT and gravel, oxidized, moist to wet [MINE WASTE SILT and CKD]	
50			Dry to moist	End cap
51			Mottled gray, SILT and clay, with sand and gravel, moist [MINE WASTE SILT and CKD]	
55			Glass fragments/paper present	
60	pH 13 when soil mixed with water		Color changes to dull gray, cobbles present	
61			Highly weathered SANDSTONE, white, grades to orange at 61.5ft, oxidized, thinly laminated, dry to moist [SANDSTONE BEDROCK]	3/8" hydrated bentonite chips
65	pH neutral when soil mixed with water			
70				
70			Bottom of borehole at 70.0 feet.	