Rec'd by
D. Shuman
Hand delivered

TECHNICAL MEMORANDUM

Date:	July 29, 2016	**Project No.:**	1520304.350
To:	Washington State Department of Ecology	**Company:**	Reserve Silica Corporation and LafargeHolcim
From:	Sarah Morgan, PE, Gary Zimmerman (Golder Associates Inc.)		
RE:	**RESPONSE TO NOTICE OF VIOLATION NO. 13465 ISSUED TO RESERVE SILICA CORPORATION RAVENSDALE SITE, WASHINGTON**		

Washington State Department of Ecology (Ecology) issued Notice of Violation (NOV) No. 13465 on June 29, 2016 concerning the Ravensdale Site (Site). This Technical Memorandum (Report) is intended to comply with Part 1 and Part 2 of Ecology's request for additional information regarding the Site (What Steps Have Been Taken and What Steps Are Being Taken). Historical agreements, investigation, remediation, and monitoring activities have occurred at the Site since the mid-1980s. This Report focuses most on those activities at the Site since approximately 2002 concerning the cement kiln dust (CKD) landfills located on portions of the Site. Part 2 of this Report provides a general description of the steps that will be taken to address the high pH water discharging to the infiltration ponds at the Site.

1.0 SITE HISTORY

Sand and coal mining operations occurred at the site during portions of the 20th century. In the late 1970s and early 1980s, two open pit areas were authorized by Ecology for landfilling of CKD from the Ideal Basic Cement Co plant in Seattle [now Lafarge Holcim Company (Holcim)]. These areas are known as the Dale Strip Pit ("DSP") (approximately 6 acres) and the Lower Disposal Area (LDA) (approximately 7 acres).

The DSP was created to mine the Dale No. 4 coal seam from the surface in 1946. Prior to 1946, the coal seam was worked from an underground mine. The underground mining chutes were driven upward to the surface to provide ventilation and allow the transportation of timbers into the mine. Construction of the mine allowed groundwater to drain by gravity to the mine portal (Portal). The Portal has since collapsed, and now a pipe in the collapsed Portal allows water to continuously drain from the mine under an Ecology Sand and Gravel General Permit (Ecology 2005). The portal, identified on the attached Figure 1, is located north of the LDA.

The LDA is a former open pit sand mine that was reclaimed by placing CKD and other material into the mine excavation from June 1979 to October 1982. The LDA was filled with approximately 175,000 tons of CKD. Records indicate that a cap consisting of clay and up to 7 feet of overburden material from sand mining operations was placed over the CKD.

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Historically, high pH seepage has surfaced along the slope west of the LDA. The outbreaks are primarily located along the northern half of the western boundary of the LDA. The leachate drains through low-lying, marshy areas and commingles with stormwater before flowing to three infiltration ponds. (ARCADIS 2004, 2009).

Reserve Silica Corporation (Reserve) purchased the Site in 1986, and is the present owner. Reserve is backfiling the remaining historical excavation areas under an inert waste landfill permit (Permit #PR0082027). In January 2011, an Easement Agreement involving Site Environmental Activities (Easement) was filed on record between Reserve and Holcim (Reserve 2010). The areas covered by the Easement include both the DSP and LDA, access roads, monitoring wells, and the LDA leachate seepage areas and infiltrations ponds as shown in Exhibit A.

Seattle-King County Department of Public Health (Public Health), issued Reserve an annual Permit (PR0015708) for a Closed Landfill, Post Closure Limited Purpose Facility (Permit). The current Permit was issued on January 5, 2016 (Public Health 2016) and covers the LDA and DSP. These areas are illustrated in Figure 1.

Groundwater monitoring has demonstrated that there have been no environmental conditions detected from the Dale Strip Pit (DSP) (Golder 2016).

2.0 INVESTIGATION, REMEDIATION, AND MONITORING ACTIVITIES

Holcim has conducted activities relating to the CKD landfills under contractual agreements with Reserve since approximately 2002.

On August 3, 2006 the Interagency Group consisting of Ecology and Public Health approved the Bedrock Well Installation Work Plan and the Sampling and Analysis and Quality Assurance Project Plan (SAP/QAPP) submitted by Arcadis on behalf of Holcim (Arcadis 2006). In March 2014, Golder on behalf of Holcim submitted an Inspection and Maintenance Plan for CKD Reclamation Area Covers (Golder 2014a). All work conducted by Holcim has proceeded pursuant to the SAP/QAPP following approvals by the Interagency Group.

Various locations of groundwater and surface water monitoring have been conducted at the Site since 2002. Figure 1 shows well locations and groundwater and surface water sampling locations. ARCADIS performed monthly and quarterly monitoring activities through the second quarter of 2009. Golder assumed responsibility for monitoring activities in August 2009 and conducted groundwater and surface water monitoring until April 2014. GeoEngineers performed groundwater and surface monitoring from May to December 2014. Golder resumed the groundwater and surface monitoring in February 2015.

Groundwater monitoring of the shallow/alluvial monitoring wells generally occurred on a quarterly schedule from July 2005 to September 2008. After the seep collection test trenches were installed, groundwater monitoring frequency for the four wells around the infiltration ponds was increased to monthly through September 2009. At the end of the formal test trench monitoring program in October 2009, the sampling frequency for these four wells returned to quarterly.

Surface water monitoring of Infiltration Ponds #1, Weir (or the constructed wetlands located upstream if the Weir was dry), South Pond, and Still Well generally occurred on a monthly schedule from February 2005 to June 2008 and then was reduced to the current quarterly schedule.

Groundwater monitoring of wells MWB-1SDSP and MWB-1DDSP generally occurred on a quarterly schedule starting in December 2002. Monitoring of well MWB-5DSP generally occurred on a monthly schedule from December 2006 to June 2008 and then monitoring was reduced to quarterly. Groundwater monitoring of well MWB-6DSP generally occurred on a quarterly schedule starting in December 2006. Groundwater levels and field parameters are being measured in wells MWB-2DSP and MWB-4SDSP on a quarterly schedule. Surface water monitoring of the Portal discharge generally occurred on a quarterly schedule starting in March 2002.

A variance for monitoring frequency of the DSP was granted by Public Health on March 15, 2012 and renewed on April 17, 2016 under requests by Holcim pursuant to its obligations under the SAP/QAPP directives (Public Health 2012, 2016). While requested under the SAP/QAPP by Holcim, the variance was issued to Reserve under its Permit. The current groundwater and surface water monitoring scope of work being conducted includes the following:

- Quarterly collection of groundwater samples from six on-site shallow/alluvial groundwater monitoring wells (MW-1A, MW-2A, MW-3A, MW-4A, MW-5A, and MW-6A) as part of the LDA monitoring program.
- Annual collection of groundwater samples from three on-site bedrock groundwater monitoring wells (MWB-1LDA, MWB-2LDA, and MWB-3LDA) as part of the LDA monitoring program.
- Annual collection of groundwater samples from four on-site bedrock groundwater-monitoring wells (MWB-1SDSP, MWB-1DDSP, MWB-5DSP, MWB-6DSP) as part of the DSP monitoring program.
- Semi-annual measurement of water levels and field parameters in monitoring wells MWB-2DSP and MWB-4SDSP.
- Quarterly collection of surface water samples from Infiltration Ponds #1, Weir (or the constructed wetlands located upstream if the Weir is dry), South Pond, and Still Well as part of the LDA surface water sampling program.
- Annual collection of water samples from the culvert that discharges from the former mine Portal (the Portal) as part of the DSP sampling program.
- Measurement of field parameters in water purged from the groundwater monitoring wells, and sampled directly from the surface water areas. Field parameters include: groundwater

level readings (in wells only), pH, conductivity, temperature, dissolved oxygen (DO), oxidation-reduction potential (ORP), and turbidity.

- Analysis of the groundwater, surface water, and quality control samples for dissolved arsenic, lead, iron, manganese, potassium, and total dissolved solids (TDS).
- Analysis of duplicate samples for quality control.
- Quarterly Interceptor Trench monitoring for instantaneous flow volume and sampling for pH, TDS, and turbidity.

In September and October 2007, the soil cover on the LDA was upgraded. Specific activities included regrading the cover to provide positive surface water runoff at all locations, increasing the thickness of the low-permeability cover soil layer to a minimum of two feet at all locations, and constructing a surface water diversion ditch around the upslope boundary of the cover (Golder 2008a).

In September 2008, two test trenches were installed to intercept and collect high-pH seepage from the LDA (Golder 2009). One trench was located on the bench immediately to the west of the LDA, where several seeps (and resulting carbonate deposits) had been observed over the course of several years. The second trench was located at the toe of the cover slope near the south end of the LDA. The trenches themselves were backfilled with gravel and each included a perforated drain pipe and a standpipe system to measure flow rate. Collected seepage was discharged through a 4-inch tightline installed from the trenches to the infiltration ponds.

During 2010 to 2012, a comprehensive program of test pit excavations, borehole drilling, piezometer measurements, tracer tests, and geophysical investigations was performed (Golder 2013a). The results of this program strongly suggested that groundwater is entering the LDA from the southern end and flowing to the north, producing the observed high-pH seeps and shallow groundwater impacts.

A groundwater interceptor trench was constructed at the south end of the LDA during August through October of 2013 (Golder 2014b). The trench is approximately 220 feet long and up to 20 feet deep. It is filled with gravel with a perforated drainage pipe in the bottom that discharges from the hillside to the south of the LDA. Flow from this trench are clean (non-impacted) groundwater and generally range between about 0.5 and 1 gallon per minute. Since construction of this trench, seepage along the western side of the LDA has continued, although any volume changes have not been measured, and shallow groundwater impacts continue.

In February 2013, a collection ditch was excavated along the bench below the western seepage zone to intercept and collect seepage, and a drop inlet structure was installed to direct seepage into the tightline and convey it directly to the infiltration ponds, thereby reducing the volume that commingles with surface water (Golder 2013b). In 2015, the 4-inch tightline downstream of the drop inlet was replaced with a 10-inch pipe to reduce the required frequency of cleaning resulting from carbonate precipitation in the pipe.

The attached Figure 2 shows the location of the interceptor trench, seepage trenches, and seepage collection discharge pipe system.

Since the installation of the seep collection ditch and inlet structure that convey seepage directly to the infiltration ponds, the monitoring results show that the pH of the infiltration ponds has increased.

A summary of previous site activities is provided in Table 2-1:

Table 2-1: Summary of Selected CKD Landfill Actions at the Ravensdale Site

Date	Activity
2002 - present	Groundwater and Surface Water Monitoring
2007	Upgrade LDA Cover
2008	Install Seep Collection Test Trenches
2008 - 2011	Monitor Seep Collection Test Trenches
2008, 2009, 2013	Cover Inspections and Maintenance
2010 - 2011	Upgrade DSP Cover
2010 - 2012	LDA Hydrogeological Investigations
2011	Establish Easements for Monitoring and Remedial Activities
2013	Install Drop Inlet on Bench West of LDA
2013	Construct Phase 1 Groundwater Interceptor Trench and install leachate collection trench with tightline to infiltration ponds
2013 - present	Monitor Interceptor Trench Discharge
2015	Replace Drop Inlet Discharge Pipe

A summary of reports and requests for variances is provided in Table 2-2:

Table 2-2: Summary of Selected Reports and Requests for Variances

Date	Description
2002 – present; 4 Quarterly Reports Issued Per Year	Groundwater and Surface Water Monitoring
March 2, 2006 (approved August 3, 2006)	Sampling and Analysis and Quality Assurance Project Plan, Reserve Silica Site, Ravensdale, Washington
July 25, 2008	Construction Summary Report, Lower Disposal Area Cover Upgrade, Reserve Silica Site, Ravensdale, Washington
August 4, 2008	Workplan for Seep Collection Test Trenches, Reserve Silica Site, Ravensdale, Washington
March 6, 2009	Construction Summary Report, Seep Collection System Test Trenches, Reserve Silica Site, Ravensdale
October 2010 (January 27, 2011 King County Record)	Environmental Easement Between Holcim and Reserve Silica Corporation
February 8, 2011 (granted May 16, 2012)	Request for Reduction in Groundwater Monitoring Frequency, DSP Monitoring Wells
March 20, 2013	Ravensdale Site, LDA Seepage Collection Ditch, February 2013
June 11, 2013	Lower Disposal Area Hydrogeological Investigations, Ravensdale Site
January 3, 2014	Technical Memorandum: *Ravensdale Site Groundwater and Surface Water Statistical Characterization: Arsenic Background Level Evaluation*
January 8, 2014	Lower Disposal Area – Interceptor Trench Project, Construction Summary Report, Ravensdale Site
April 9, 2015 (granted April 7, 2016)	Request for Reduction in Groundwater Monitoring Frequency, DSP Monitoring Wells, DSP Portal, and LDA Bedrock Wells

3.0 STEPS BEING TAKEN TO CONTROL RELEASE OF HIGH PH WATER TO THE ENVIRONMENT

As described above, various measures have been conducted to prevent the seepage of high pH water from the LDA. It is recognized that additional measures are required to further reduce the seepage, control the release to the environment, and to prevent potential exposure to the high pH surface water. These additional measures will include:

- To address the potential for accidental exposure of humans to high pH surface water, fencing will be installed around the perimeter of the infiltration ponds, around the seepage collection ditch, and around the seepage along the south western edge of the LDA. If repairs can be made to the landfill cover along the south western edge of the LDA that prevent the seepage from reaching the surface, fencing will not be needed in that area. The attached Figure 3 depicts the proposed locations of the fencing.
- Golder is providing LafargeHolcim with several remedial action alternatives to address the high pH seepage emanating from the LDA and prevent release of the high pH water to the environment. These actions may be implemented as interim actions.
- Submittal of additional reports and data to support the implementation of remedial action alternatives.
- Continued quarterly surface and groundwater monitoring in accordance with the procedures established in the *Sampling and Analysis and Quality Assurance Project Plan* (Arcadis 2006).

4.0 REFERENCES

ARCADIS (U.S.) Inc. (ARCADIS). 2004. Lower Disposal Area and Dale Strip Pit Conceptual Design Plan, Reserve Silica Property, 28131 Black Diamond-Ravensdale Road, Ravensdale, Washington. April 28.

ARCADIS. 2006. Sampling and Analysis and Quality Assurance Project Plan, Reserve Silica Site, Ravensdale, Washington. March 2.

ARCADIS. 2009. Quarterly Monitoring Report, Second Quarter 2009, Reserve Silica Site, Ravensdale, Washington. September 16.

Golder Associates Inc. (Golder) 2008a. *Construction Summary Report, Lower Disposal Area Cover Upgrade, Reserve Silica Site, Ravensdale, Washington*. Prepared for Holcim (US) Inc. July 25.

Golder 2008b. *Workplan for Seep Collection Test Trenches, Reserve Silica Site, Ravensdale, Washington*. Prepared for Holcim (US) Inc. August 4.

Golder 2009. *Construction Summary Report, Seep Collection System Test Trenches, Reserve Silica Site, Ravensdale, Washington*. Prepared for Holcim (US) Inc. March 6.

Golder 2013a. *Lower Disposal Area Hydrogeological Investigations, Ravensdale Site*. Prepared for Holcim (US) Inc. June 11.

Golder 2013b. *Ravensdale Site, LDA Seepage Collection Ditch, February 2013*. Letter Report Prepared for Holcim (US) Inc. March 20.

Golder 2014a. *Inspection and Maintenance Plan for CKD Reclamation Area Covers, Ravensdale Site*. Report Prepared for Holcim (US) Inc. March 27.

Golder 2014b. *Lower Disposal Area – Interceptor Trench Project, Construction Summary Report, Ravensdale Site*. Prepared for Holcim (US) Inc. January 8.

Golder 2016. *Quarterly Monitoring Report First Quarter 2016, Ravensdale Site*. Prepared for Holcim (US) Inc. Submitted to Washington State Department of Ecology. March 15.

Reserve Silica Corporation, 2010. Easement Agreement Involving Site Environmental Activities. Grantor: Reserve Silica Corporation. Grantee: Holcim (US) Inc. King County Recording Date January 27, 2011.

Seattle-King County Department of Public Health. 2012. *2012 Annual Permit PR0015708 Reserve Silica Closed Landfill Post Closure Limited Purpose Landfill Facility*. Issued to Reserve Silica Corporation. Issued July 26, 2012.

Seattle-King County Department of Public Health. 2016. *2016 Annual Permit PR0015708 Reserve Silica Closed Landfill Post Closure Limited Purpose Landfill Facility*. Issued to Reserve Silica Corporation. Issued January 5, 2016.

Washington State Department of Ecology (Ecology). 2005. Sand and Gravel General Permit. Limit for Discharge to Ground Water. January 5.

FIGURES

NOTES

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
   VERTICAL DATUM: NGVD 29
   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
   VERTICAL DATUM: NGVD 29
   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
   VERTICAL DATUM: NGVD 29
   CONTOUR INTERVAL: 1 FT

4. MONITORING INCLUDES ONLY WATER LEVELS AND FIELD PARAMETERS.

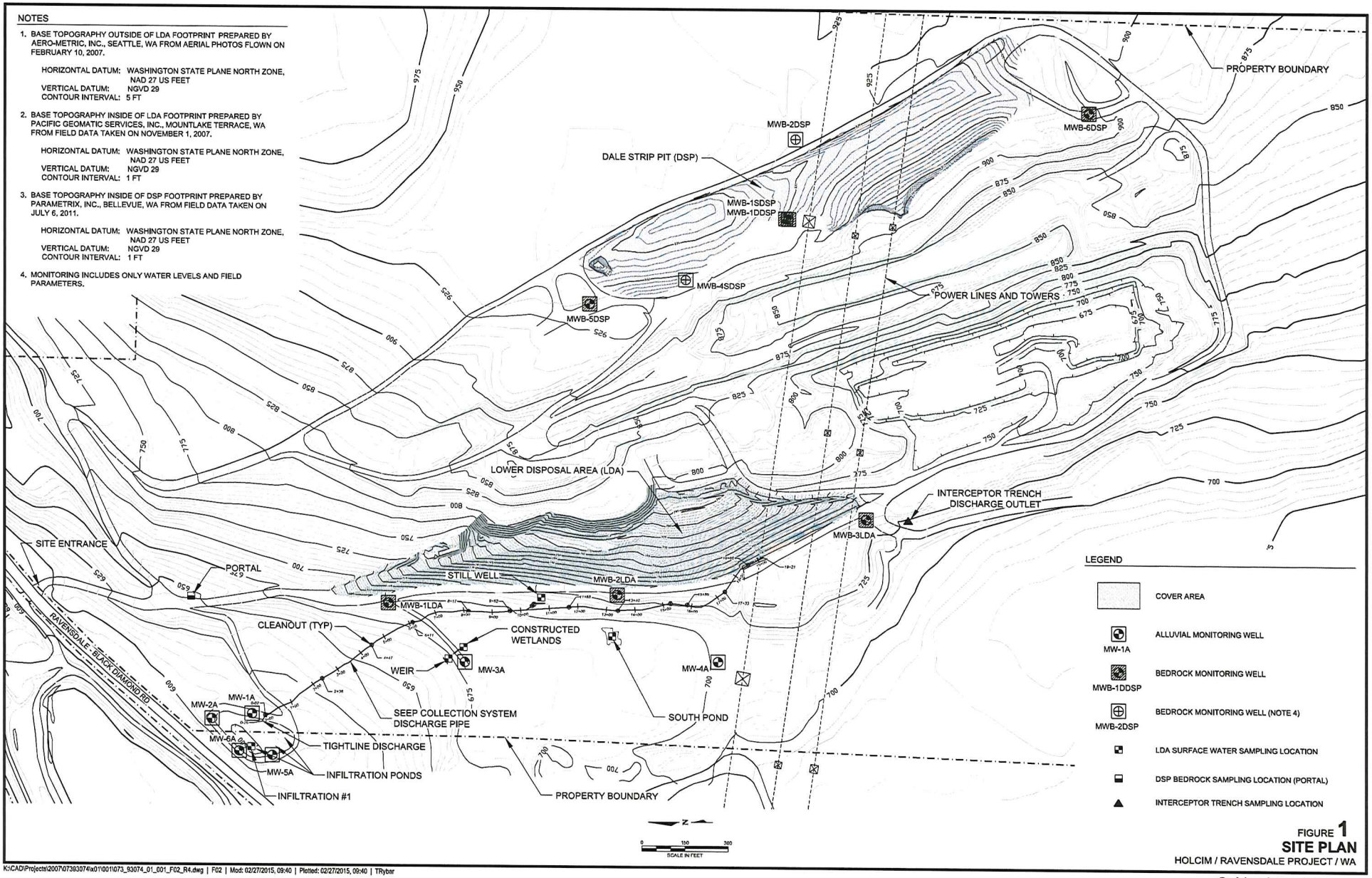
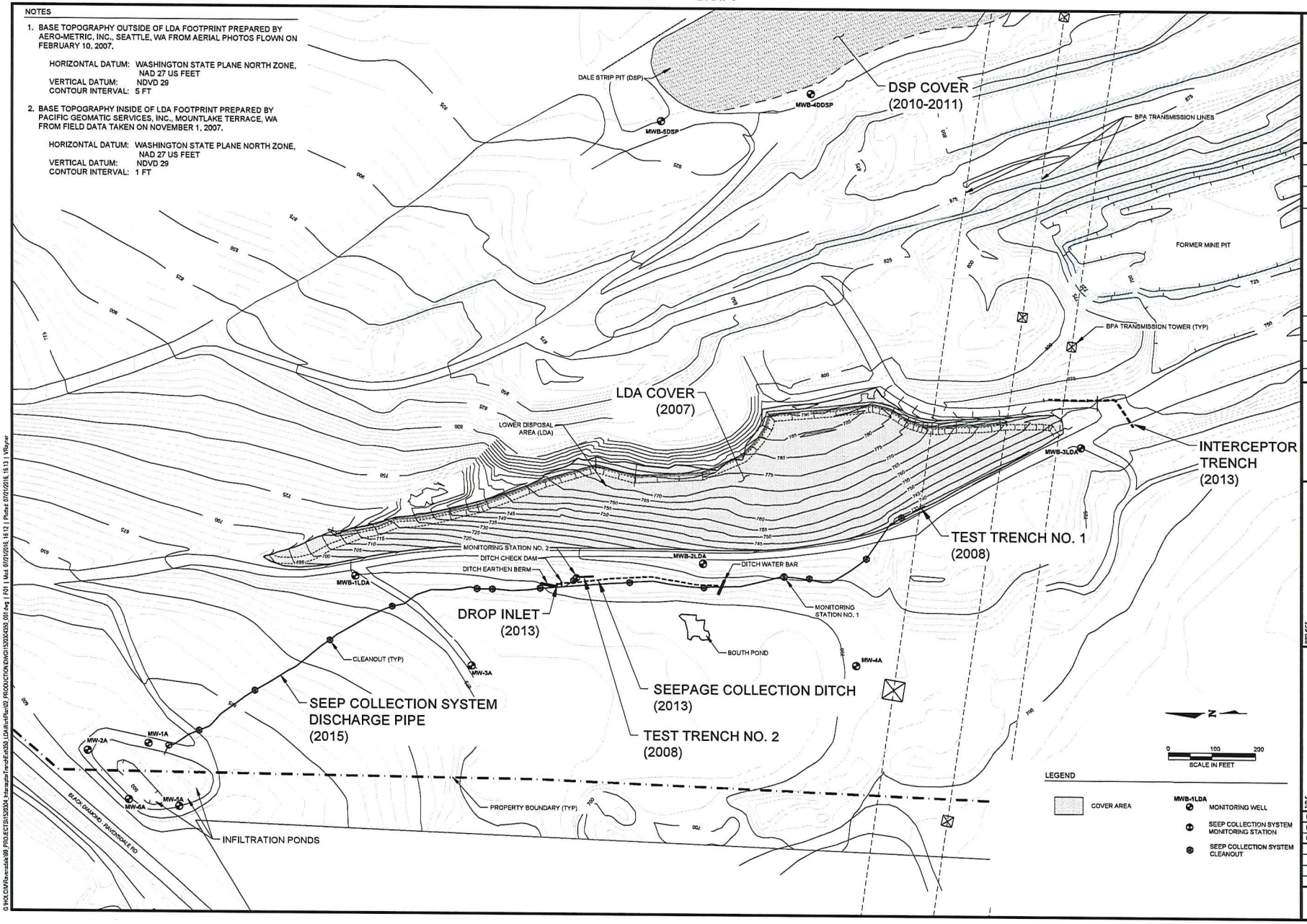


FIGURE 1
SITE PLAN
HOLCIM / RAVENSDALE PROJECT / WA

K:\CAD\Projects\2007\07393074\a01\001\073_93074_01_001_F02_R4.dwg | F02 | Mod: 02/27/2015, 09:40 | Plotted: 02/27/2015, 09:40 | TRybar

Golder Associates

DRAFT



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REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT: RAVENSDALE SITE

TITLE: LDA FACILITIES LAYOUT

PROJECT No.		1520304.350
FILE No.		AS SHOWN
REV. A	SCALE	AS SHOWN
DESIGN	SJM	07-21-16
CADD	VMN	07-21-16
CHECK	VMN	07-21-16
REVIEW	FSS	07-21-16

FIGURE 2

G:\NOL\CAD\Ravensdale\99 PROJECTS\1520304 Interceptor Trench\Fig350 LDA Facilities.dwg | F2I | Mod: 07/21/2016, 16:12 | Plotted: 07/21/2016, 16:13 | VDwyer

DRAFT

NOTES

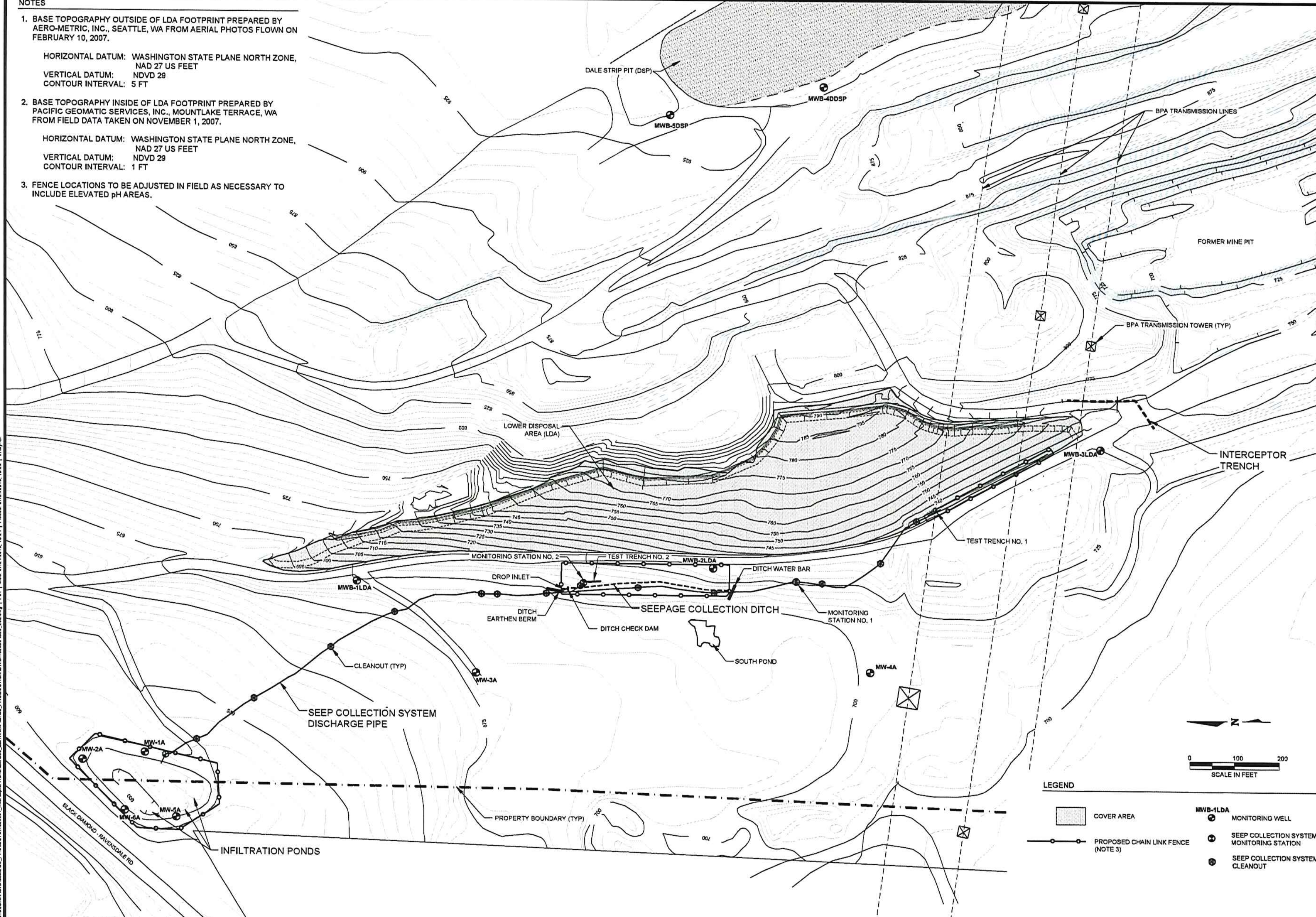
1. BASE TOPOGRAPHY OUTSIDE OF LDA FOOTPRINT PREPARED BY AERO-METRIC, INC., SEATTLE, WA FROM AERIAL PHOTOS FLOWN ON FEBRUARY 10, 2007.

   HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 27 US FEET
   VERTICAL DATUM: NDVD 29
   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
   VERTICAL DATUM: NDVD 29
   CONTOUR INTERVAL: 1 FT

3. FENCE LOCATIONS TO BE ADJUSTED IN FIELD AS NECESSARY TO INCLUDE ELEVATED pH AREAS.


DALE STRIP PIT (DSP)
MWB-4DDSP
MWB-5DSP
BPA TRANSMISSION LINES
FORMER MINE PIT
BPA TRANSMISSION TOWER (TYP)
LOWER DISPOSAL AREA (LDA)
MWB-3LDA
INTERCEPTOR TRENCH
TEST TRENCH NO. 1
MONITORING STATION NO. 2
TEST TRENCH NO. 2
MWB-2LDA
DITCH WATER BAR
DROP INLET
MWB-1LDA
SEEPAGE COLLECTION DITCH
DITCH EARTHEN BERM
DITCH CHECK DAM
MONITORING STATION NO. 1
SOUTH POND
CLEANOUT (TYP)
MW-3A
MW-4A
SEEP COLLECTION SYSTEM DISCHARGE PIPE
MW-1A
MW-2A
MW-5A
MW-6A
BLACK DIAMOND - RAVENSDALE RD
INFILTRATION PONDS
PROPERTY BOUNDARY (TYP)
N
0 100 200
SCALE IN FEET

LEGEND

COVER AREA

PROPOSED CHAIN LINK FENCE (NOTE 3)

MWB-1LDA MONITORING WELL

SEEP COLLECTION SYSTEM MONITORING STATION

SEEP COLLECTION SYSTEM CLEANOUT

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REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

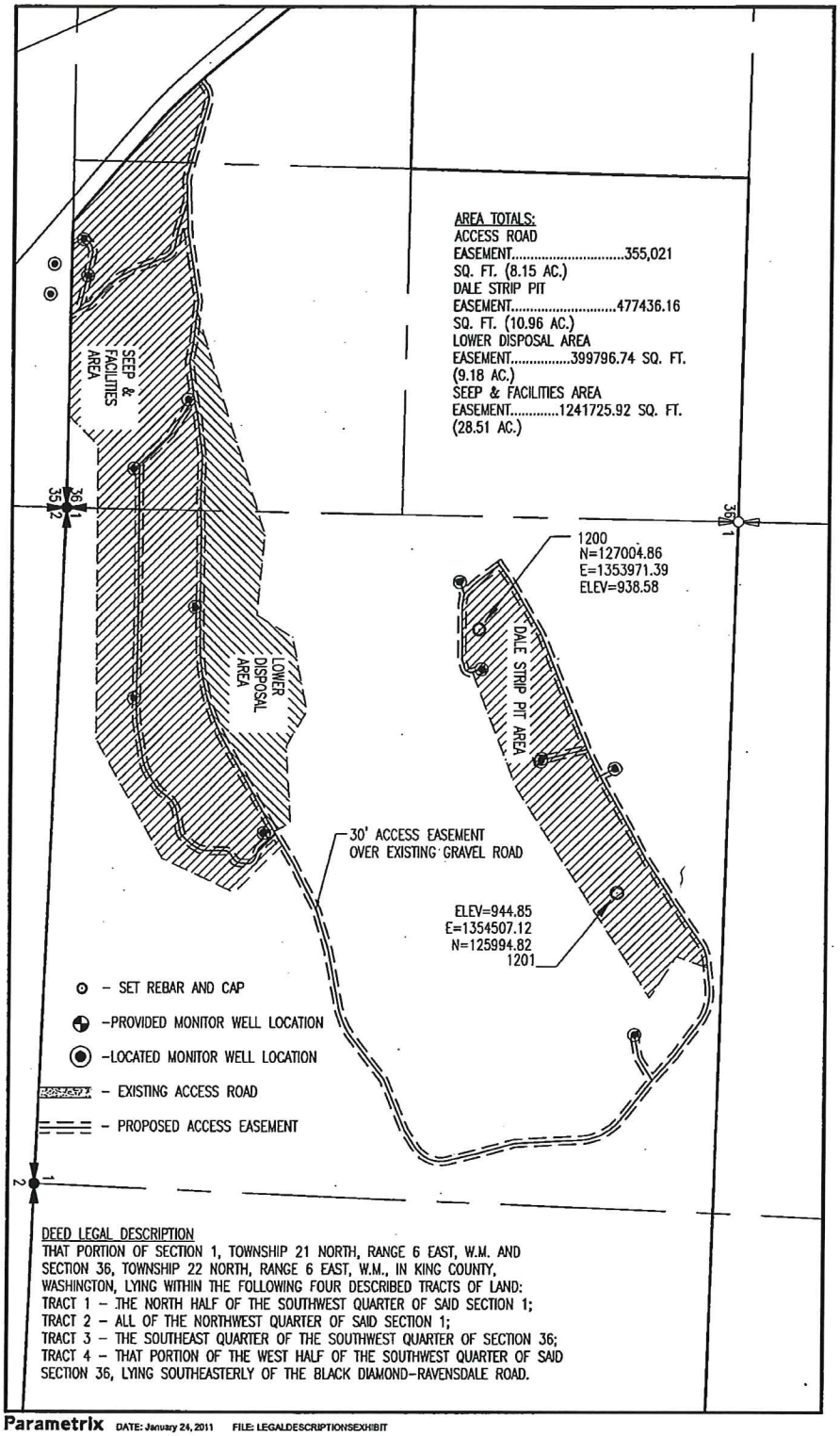
PROJECT
RAVENSDALE SITE

TITLE
PROPOSED FENCING LOCATIONS

PROJECT No.		1520304.350
FILE No.		AS SHOWN
REV. A	SCALE	AS SHOWN
DESIGN	SJM	07-21-16
CADD	VMN	07-21-16
CHECK	VMN	07-21-16
REVIEW	FSS	07-21-16

FIGURE 3

EXHIBIT A
ENVIRONMENTAL EASEMENT BOUNDARIES



DEED LEGAL DESCRIPTION

THAT PORTION OF SECTION 1, TOWNSHIP 21 NORTH, RANGE 6 EAST, W.M. AND SECTION 36, TOWNSHIP 22 NORTH, RANGE 6 EAST, W.M., IN KING COUNTY, WASHINGTON, LYING WITHIN THE FOLLOWING FOUR DESCRIBED TRACTS OF LAND:
TRACT 1 – THE NORTH HALF OF THE SOUTHWEST QUARTER OF SAID SECTION 1;
TRACT 2 – ALL OF THE NORTHWEST QUARTER OF SAID SECTION 1;
TRACT 3 – THE SOUTHEAST QUARTER OF THE SOUTHWEST QUARTER OF SECTION 36;
TRACT 4 – THAT PORTION OF THE WEST HALF OF THE SOUTHWEST QUARTER OF SAID SECTION 36, LYING SOUTHEASTERLY OF THE BLACK DIAMOND–RAVENSDALE ROAD.

Parametrix DATE: January 24, 2011 FILE: LEGALDESCRIPTIONEXHIBIT

N

0 500

1"=500'

NOTE

EASEMENT BOUNDARIES OF THE DALE STRIP PIT AREA, LOWER DISPOSAL AREA, AND SEEP & FACILITIES AREA RUN ALONG THE ROAD CENTERLINE WHEN THEY ARE COINCIDENT WITH THE ACCESS ROAD EASEMENT.

LEGAL DESCRIPTION EXHIBIT

EXHIBIT A: ENVIRONMENTAL EASEMENT BOUNDARIES