
PILOT TEST WORK PLAN



Property:

Plastic Sales and Service Site
6870 Woodlawn Avenue Northeast
Seattle, Washington

Report Date:

September 11, 2023

Prepared for:

Washington State Department of Ecology
Toxics Cleanup Program
Northwest Regional Office
15700 Dayton Avenue North
Shoreline, Washington

Pilot Test Work Plan

Washington State Department of Ecology

Toxics Cleanup Program, Northwest Regional Office
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Plastic Sales and Service Site
6870 Woodlawn Avenue Northeast
Seattle, Washington 98115

Project No.: 0651-002

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1.0 INTRODUCTION

On behalf of the Lutheran Retirement Home of Greater Seattle (The Hearthstone), SoundEarth Strategies, Inc. (SoundEarth) has prepared this Pilot Test Work Plan to describe the groundwater remediation pilot test to be conducted at the Plastic Sales and Service Site (the Site).

The Site is defined in the Washington State Department of Ecology (Ecology) Agreed Order No. DE 7084 (Agreed Order), dated September 14, 2009, as the extent of contamination caused by the releases of hazardous substances at the property located at 6870 Woodlawn Avenue Northeast (the Dry Cleaner Building Property). The Site includes the Dry Cleaner Building Property and both the north-adjointing property, located at 6869 Woodlawn Avenue Northeast (Janke Property) and the west-adjointing property, located at 6860 Woodlawn Avenue Northeast (the Hearthstone Property), along with portions of the western alley (the alley) and the Woodlawn Avenue Northeast and 4th Avenue Northeast rights-of-way (ROWS). The Site is collectively referred to as the Plastic Sales and Service Site (PSS Site).

The purpose of this Pilot Test Work Plan is to describe the design and implementation of groundwater remediation pilot test to be conducted at the PSS Site. The Work Plan identifies specific protocols, treatment locations, equipment, field documentation reporting requirements, and other procedures SoundEarth will use during the 18-month duration of the pilot test.

1.1 BACKGROUND

An initial groundwater remedy was implemented at the Site in 2019 to treat chlorinated volatile organic compounds (CVOCs) released into groundwater from the former industrial dry cleaning operation at the Hearthstone Property, which predated the Plastic Sales and Service facility. The initial groundwater remedy consisted of installing 34 pairs of injection wells in the shallow and deep water-bearing zones beneath the PSS Site and injecting carbon into the injection wells to promote the biological degradation of CVOCs in groundwater and bring CVOC concentrations into compliance with regulatory cleanup standards. The initial groundwater treatment remedy successfully degraded CVOCs in groundwater to concentrations below regulatory cleanup standards on a portion of the PSS Site, but in some areas of the PSS Site, residual CVOC concentrations in groundwater remain well above regulatory cleanup standards. In addition, the CVOC groundwater plume has moved beyond the injection well network installed in 2019 into the 4th Avenue Northeast ROW east of the Janke Property. CVOCs were detected at concentrations well above regulatory cleanup levels in groundwater samples collected from the new groundwater monitoring well installed in the 4th Avenue Northeast ROW in early 2023. Ecology has requested that the groundwater cleanup remedy for the PSS Site be expanded to treat contaminated groundwater in the 4th Avenue Northeast ROW.

1.2 OBJECTIVES

The pilot study will be performed to satisfy the following objectives:

- Evaluate the reduction in tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), and vinyl chloride (VC) concentrations in shallow and deep water-bearing zones in the pilot test study area.
- Assess the potential for generation and degradation of CVOC daughter products cis-1,2-DCE and VC.

- Estimate injection design parameters, including but not limited to injection pressure, flow rate, and volume; injection radius of influence and distribution; and remediation product dosing and loading in support of full-scale design.

2.0 PILOT STUDY DESIGN

This section presents the selected in situ groundwater treatment technology, pilot study treatment area and layout, and design.

2.1 IN SITU GROUNDWATER TREATMENT TECHNOLOGY

The selected in situ groundwater treatment approach includes combining in situ biological enhanced reductive dechlorination (ERD) with abiotic degradation simulated by zero valent iron (ZVI). Anaerobic conditions will be created in groundwater by injecting carbon into groundwater. Carbon functions as an energy source for microbes under anaerobic conditions to degrade CVOCs to harmless end products (e.g., carbon dioxide, ethene). ZVI serves as the reductant and CVOCs serve as the oxidants. The two major relevant dechlorination pathways are hydrogenolysis and reductive β -elimination. In hydrogenolysis (also known as reductive dehalogenation), a chlorine or other halogen atom in the molecule is replaced with a hydrogen atom. In reductive β -elimination (also known as vicinal dehalogenation), two chlorine atoms or other halogens bonded to adjacent carbon atoms are removed, leaving behind two electrons. ZVI also reduces the potential for formation of daughter products (i.e., cis-1,2-DCE and VC).

2.2 PILOT STUDY TREATMENT AREA AND LAYOUT

The pilot test injections will consist of a mixture of powdered ZVI and Electron Donor Solution, Extended Release (EDS-ER), which is a self-emulsifying vegetable oil produced by Tersus Environmental. The mixture will be injected into three new injection wells and eight existing injection wells in the shallow water-bearing zone at the Site. Pilot test injections will also be performed at two existing injection wells and one new injection well in the deep water-bearing zone at the Site. These 14 total injection wells would provide the data needed to evaluate the effectiveness of the ZVI additive to increase the degradation of CVOCs in groundwater. Based on the results of performance groundwater monitoring across the 18 months after implementing the pilot test, SoundEarth will determine whether pilot test results warrant full-scale implementation. The locations of new and existing injection wells for the pilot test are presented on Figures 1 and 2.

2.3 DESIGN PARAMETERS

The product loading and injection volumes for EDS-ER and powdered ZVI are based on the original injection program implemented at the Site. In general, the product loading is as follows:

- **EDS-ER:** The injection concentrations for this project will be the same as previous injections completed in 2019: a dosing of 13 percent (%) of EDS-ER. This concentration is higher than normal injection concentrations to compensate for the limited total volume that can be injected to avoid daylighting of the injectate. The increased concentrations allow for longer treatment times and migration of the product from the injection point.
- **Powdered ZVI:** A dosing of 1.6% by mass for powdered ZVI was selected based on its use as a secondary treatment mechanism, such as by reducing the potential for generation of cis-1,2-DCE and VC. Given this dosing, the total mass of ZVI concentrate is estimated at 400 pounds.

Based on the dosing, the total volume of prepared EDS-ER and powdered ZVI solution is estimated at 2,000 gallons, equating to an approximately 3% pore volume replacement in the treatment area. The total EDS-ER and powdered ZVI application volume equates to a delivery volume of approximately 100 gallons per shallow injection well and 350 gallons per deep injection well. The pilot study design specifics for the Site are summarized in Table 1.

3.0 PILOT STUDY ACTIVITIES

3.1 PRELIMINARY ACTIVITIES

3.1.1 Underground Injection Control Registration

An application for an Underground Injection Control (UIC) registration will be completed through Ecology.

3.1.2 Health and Safety Plan

A Site-specific Health and Safety Plan (HASP) will be prepared under separate cover for the injection activities that meets the minimum requirements for such a plan identified in federal regulations (Parts 1910.120 and 1926 of Title 29 of the Code of Federal Regulations) and state regulations (Chapter 296 of the Washington Administrative Code). The HASP will identify the known physical, chemical, and biological hazards; hazard monitoring protocols; and administrative and engineering controls required to mitigate the identified hazards. The Safety Data Sheets for EDS-ER and powdered ZVI are provided in Appendix A.

3.1.3 Street Use Permits

Access to the 4th Avenue Northeast ROW requires a street use permit from the City of Seattle for installation of the new injections wells.

3.1.4 Utility Locating

A utility survey will be performed before advancement of the new soil boring/injection wells. The survey will include a public one-call and private utility locate to clear the new soil boring/injection well locations of subsurface utilities prior to drilling.

3.2 SOIL BORING AND INJECTION WELL INSTALLATION

Soil borings will be completed for lithologic description, field screening, and collection of soil samples for potential chemical analysis. The soil borings will be converted to injection wells INJ-1 through INJ-5 as shown on Figure 1.

3.2.1 Soil Borings

Soil borings will be advanced using a sonic or hollow-stem-auger drill rig to a depth of approximately 65 feet below ground surface (bgs). Soil samples will be collected from each boring for lithologic description. Soil will be logged in accordance with the Unified Soil Classification System. Soil samples will be field screened for potential evidence of contamination by using visual observations and notations of odor and by conducting headspace analysis using a photoionization detector to detect the presence of volatile organic vapors. Soil samples will not be collected for laboratory analysis of CVOCs.

3.2.2 Injection Well Installation

After completion of each soil boring, an injection well will be installed and screened at a depth interval to be determined based on field observations of the depth at which groundwater is encountered. Groundwater is expected to be encountered at depths between 45 and 55 feet bgs, based on groundwater-level measurements performed at groundwater monitoring wells MW5R, MW10R, and MW16R.

Each injection well will be constructed of 2-inch-diameter blank PVC casing that is flush threaded to 0.020-inch slot well screen. The bottom of the injection well will be fitted with a threaded PVC bottom cap, and the top of the well casing will be fitted with a locking compression-fit well cap. The annulus of the injection well will be filled with #10/20 silica sand to a minimum height of 1 foot above the top of the screened interval, and a bentonite seal with a minimum thickness will be installed above the sand pack. The injection well will be completed with a flush-mounted, traffic-rated well box set in concrete.

Following installation, the injection well will be developed with the use of a submersible pump. Well development will consist of surging and purging until groundwater no longer appears turbid and the measured total depth in the well is equivalent to the overall length of the well. Turbidity will be measured visually during injection well development activities.

3.3 INJECTION ACTIVITIES

SoundEarth will mobilize an injection trailer to perform and monitor the injections of EDS-ER and ZVI. The injection design is based on past injections and the physical limitations of the injection wells in the lower and upper aquifer zones. Injections will be performed at 11 injection wells in the shallow water-bearing zone (depths of 5 to 25 feet bgs) and at 3 injection wells in the deep water-bearing zone (35 to 50 feet bgs).

A total of 270 gallons of EDS-ER will be used to make 2,200 gallons of injectate. Approximately 400 pounds of ZVI will be added to the injectate for final injection. The goal will be to inject 100 gallons into each of the shallow wells and 350 gallons into each of the deep wells.

3.3.1 Injection Equipment

The mobile injection trailer will include a 150-gallon batch tank, centrifugal mixing pump, centrifugal injection pump, and generator. The injection manifold will include gate and check valves, pressure gauges, and a recycle line.

3.3.2 Injection Solution Preparation

The EDS-ER concentrate will be provided in 55-gallon drums and the powdered ZVI will be provided in 25 kilogram pails. The EDS-ER and ZVI solution will be prepared in approximately 150-gallon batches by mixing 15 gallons of EDS-ER concentrate with 140 gallons of potable water followed by 30 pounds of powdered ZVI.

3.3.3 Injections and Monitoring

The prepared solution will be delivered to the 11 shallow injection wells and system pressures, flow rates, and total flow will be recorded; changes in groundwater elevation will also be monitored by measuring water levels in adjacent injection and monitoring wells to assess the saturated zone response. The injection process will continue by injecting the prepared solution into the three deep wells while monitoring system injection parameters and groundwater-level

changes in adjacent wells. The targeted injection volume per injection well is estimated at 100 gallons for shallow wells and 350 gallons for deep wells. The solution volume is based on injection well performance; therefore, the solution may be distributed unevenly to the injection wells, but a total injection volume of 2,200 gallons will be maintained.

4.0 GROUNDWATER MONITORING PROGRAM

The groundwater monitoring program will consist of a baseline event and two post-injection groundwater monitoring events. The groundwater monitoring program is summarized in Table 2.

4.1 GROUNDWATER MONITORING

Groundwater performance monitoring for the pilot test will occur over a period of 18 months after the pilot test injections are performed. To monitor the pilot test performance, groundwater samples will be collected from the shallow and deep water-bearing zone injection/monitoring wells listed in Table 2. Groundwater sample collection will be performed in general accordance with the *Groundwater Performance Monitoring Plan, Plastic Sales and Service Site, 6870 Woodlawn Avenue Northeast, Seattle, Washington, Agreed Order No. DE 7084* prepared by SoundEarth dated March 4, 2020.

Groundwater monitoring wells used to monitor the performance of the pilot test will be sampled using low-flow sampling techniques or passive diffusive samplers if injectate is present in the water column. SoundEarth will collect field parameter measurements (pH, temperature, electrical conductivity, dissolved oxygen, and oxidation-reduction potential) during groundwater sampling events and submit the samples for laboratory analysis of the following analytes:

- CVOCs by EPA Method 8260D
- Total organic carbon by Method SM 5310C
- Volatile fatty acids by EPA Methods 300.0 and 300.0 Modified
- Nitrate by EPA Method 353.2
- Sulfate by EPA Method 300.0
- Total and dissolved iron and manganese by EPA Method 200.8
 - Groundwater samples will be field filtered using a 0.45-micron filter for dissolved metals analysis.
- Methane, ethene, and ethane by Method RSK-175.

4.2 POST-INJECTION GROUNDWATER MONITORING

Six groundwater monitoring events will be performed over a period of 18 months following the completion of the pilot test injections. Performance groundwater sampling will take place 30, 90, 120, 150, 180, and 210 days after the injection event. The duration of groundwater performance monitoring was designed in consideration of the contamination velocity in the shallow and deep water-bearing zones, seasonal fluctuations in groundwater elevations, the anticipated degradation rate of CVOCs over time, and the need to gather sufficient data to have certainty in the efficacy of the pilot test results. The performance groundwater monitoring events will consist of measuring water levels and collecting groundwater samples from injection/monitoring wells for field parameter measurements, where applicable, and laboratory analyses as specified in Table 2.

5.0 INVESTIGATION-DERIVED WASTE

Investigation-derived waste (IDW) will consist of soil cuttings and decontamination, development, and purge water. The IDW will be temporarily stored in 55-gallons drums for waste characterization and profiling.

6.0 SCHEDULE

The injection and groundwater monitoring schedule are predicated on Ecology's designation of a Site Manager for the Site under the Voluntary Cleanup Program. The preliminary schedule for the full injection and monitoring plan is as follows:

Injection and Monitoring Item	Schedule or Condition
Approval of the Pilot Test Work Plan	Following Ecology's designation of a Site Manager for the Site
UIC registration	Following approval of the Pilot Test Work Plan
Injections	1 month following UIC registration update
Performance of groundwater monitoring events	18 months following injections

7.0 REPORTING

A Pilot Study Report will be prepared following post-injection groundwater monitoring activities. The Pilot Study Report will include the following:

- A description of soil boring/injection well installation, injections, and baseline and post-injection groundwater monitoring activities
- Summary tables of soil and groundwater monitoring analytical results
- Summary tables of injection parameters (pressures, injection flow rates, and volumes)
- A figure depicting the injection and monitoring well network
- Documentation of waste disposal tracking for IDW
- Findings of the pilot study and recommendations for full-scale application































8.0 LIMITATIONS

The services described in this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with SoundEarth's agreement with the client. This report is solely for the use and information of the client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

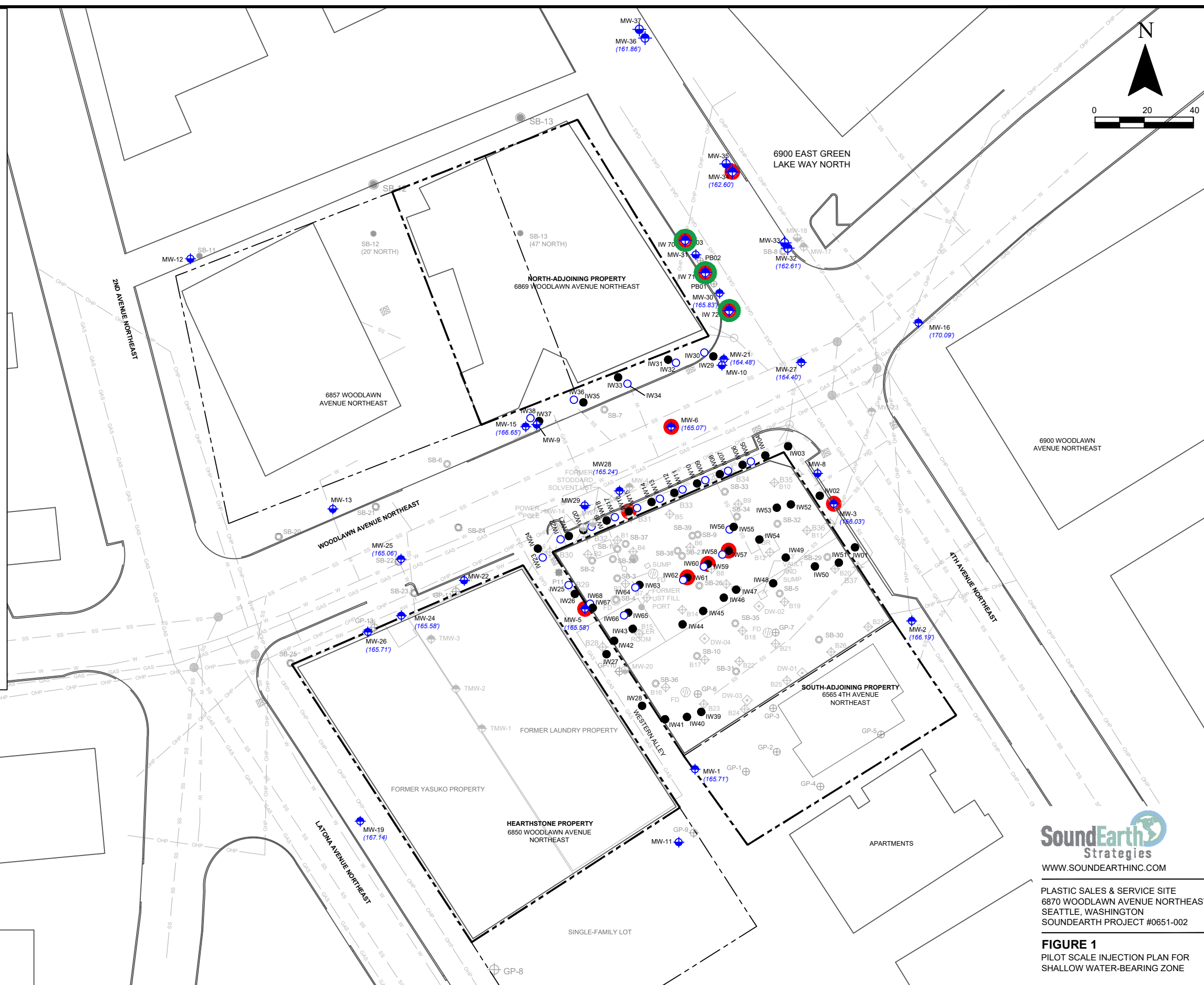
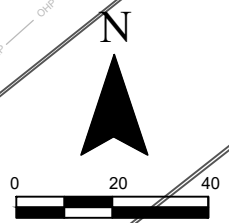
Opinions and recommendations contained in this report are derived, in part, from data gathered by others, and from conditions evaluated when services were performed, and are intended only for the client, purposes, locations, time frames, and project parameters indicated. SoundEarth does not warrant and is not responsible for the accuracy or validity of work performed by others, nor from the impacts of changes in environmental standards, practices, or regulations subsequent to performance of services. SoundEarth does not warrant the use of segregated portions of this report.

FIGURES

LEGEND

-  CATCH BASIN
-  MANHOLE
-  SHALLOW-ZONE MONITORING WELL
-  DEEP-ZONE MONITORING WELL
-  DEEP DEWATERING WELL
-  SHALLOW INJECTION WELL
-  DEEP INJECTION WELL
-  APPROXIMATE DIRECTION OF GROUNDWATER FLOW (SHALLOW ZONE)
-  SHALLOW ZONE POTENTIOMETRIC SURFACE CONTOUR (APRIL 25, 2022)
DASHED WHERE INFERRED
-  (165.71) GROUNDWATER ELEVATION
-  DECOMMISSIONED WELL
-  DIRECT-PUSH BORING (GEOENGINEERS 2004)
-  DIRECT-PUSH BORING (GEOENGINEERS 2002/2003)
-  DIRECT-PUSH BORING (FARALLON 2004)
-  DIRECT-PUSH BORING (FARALLON 2006/2007)
-  DIRECT-PUSH BORING (FARALLON 2010)
-  DIRECT-PUSH BORING (SOUNDEARTH 2008)
-  HOLLOW-STEM AUGER (SOUNDEARTH 2009)
-  POST-ELECTRICAL RESISTANCE HEATING BORING LOCATION
-  SW STORMWATER LINE
-  GAS GAS LINE
-  SS SANITARY SEWER LINE
-  W WATER LINE
-  OHP OVERHEAD POWER LINE
-  PROPERTY BOUNDARY LINE
-  PARCEL BOUNDARY
-  FD FLOOR DRAIN
-  UST UNDERGROUND STORAGE TANK
-  RED DENOTES INJECTION WELL FOR PILOT SCALE
-  GREEN DENOTES NEW INJECTION WELL

NOTES:
1. FIGURE DERIVED FROM BASEMAP BY FARALLON CONSULTING, 2010.



PLASTIC SALES & SERVICE SITE
6870 WOODLAWN AVENUE NORTHEAST
SEATTLE, WASHINGTON
SOUNDEARTH PROJECT #0651-002

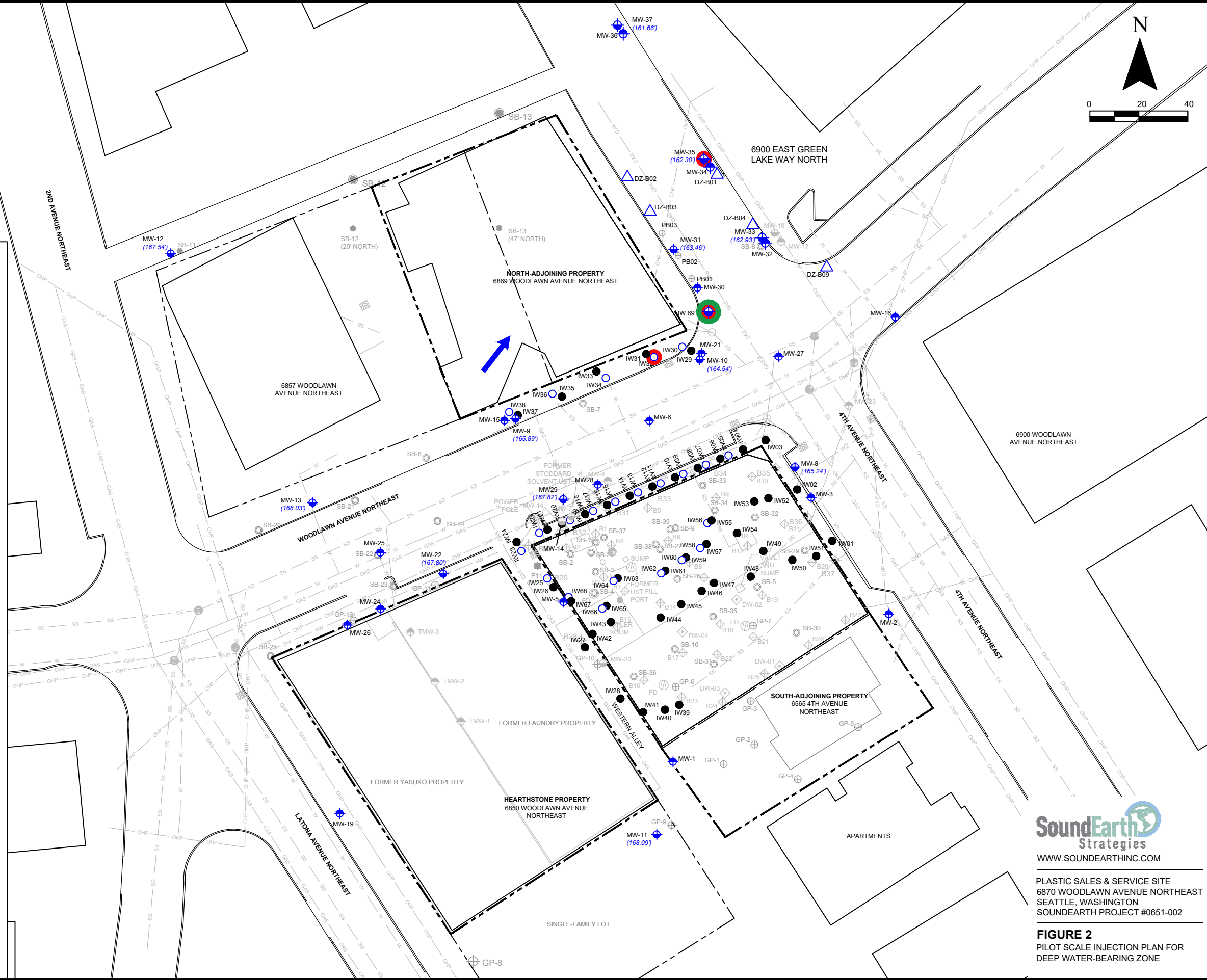
FIGURE 1
PILOT SCALE INJECTION PLAN FOR
SHALLOW WATER-BEARING ZONE



LEGEND

- CATCH BASIN
- MANHOLE
- SHALLOW-ZONE MONITORING WELL
- DEEP-ZONE MONITORING WELL
- DEEP DEWATERING WELL
- DEEP WATER-BEARING ZONE BORINGS (2022)
- SHALLOW INJECTION WELL
- DEEP INJECTION WELL
- APPROXIMATE DIRECTION OF GROUNDWATER FLOW (DEEP ZONE)
- DEEP ZONE POTENTIOMETRIC SURFACE CONTOUR (APRIL 25, 2022)
- (168.03') GROUNDWATER ELEVATION
- DECOMMISSIONED WELL
- DIRECT-PUSH BORING (GEOENGINEERS 2002/2003)
- DIRECT-PUSH BORING (GEOENGINEERS 2004)
- DIRECT-PUSH BORING (FARALLON 2004)
- DIRECT-PUSH BORING (FARALLON 2006/2007)
- DIRECT-PUSH BORING (FARALLON 2010)
- DIRECT-PUSH BORING (SOUNDEARTH 2008)
- HOLLOW-STEM AUGER (SOUNDEARTH 2009)
- POST-ELECTRICAL RESISTANCE HEATING BORING LOCATION
- STORMWATER LINE
- GAS LINE
- SANITARY SEWER LINE
- WATER LINE
- OVERHEAD POWER LINE
- PROPERTY BOUNDARY LINE
- PARCEL BOUNDARY
- FLOOR DRAIN
- UNDERGROUND STORAGE TANK
- DENOTES INJECTION POINTS FOR PILOT SCALE
- DENOTES NEW INJECTION WELL

NOTES:
 1. FIGURE DERIVED FROM BASEMAP BY FARALLON CONSULTING, 2010.



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PLASTIC SALES & SERVICE SITE
 6870 WOODLAWN AVENUE NORTHEAST
 SEATTLE, WASHINGTON
 SOUNDEARTH PROJECT #0651-002

FIGURE 2
 PILOT SCALE INJECTION PLAN FOR
 DEEP WATER-BEARING ZONE

TABLES



Table 1
Pilot Test Injection Design
Plastic Sales and Service Site
6870 Woodlawn Avenue Northeast
Seattle, Washington

Parameter	Value	Units	Notes
Treatment Area Layout			
Treatment Length (perpendicular to groundwater flow direction) in Shallow Water-Bearing Zone	40	feet	Treatment in the 4th Avenue Northeast ROW
Treatment Length (perpendicular to groundwater flow direction) in Deep Water-Bearing Zone	10	feet	Treatment in the 4th Avenue Northeast ROW
Treatment Width (with groundwater flow direction) in Shallow Water-Bearing Zone	40	feet	Treatment in the 4th Avenue Northeast ROW
Treatment Width (with groundwater flow direction) in Deep Water-Bearing Zone	40	feet	Treatment in the 4th Avenue Northeast ROW
Treatment Area in Shallow Water-Bearing Zone	2,200	square feet	Treatment in the 4th Avenue Northeast ROW
Treatment Area in Deep Water-Bearing Zone	800	square feet	Treatment in the 4th Avenue Northeast ROW
Total Injection Wells in Shallow Water-Bearing Zone	10	injection wells	Three new injection wells and seven existing injection wells
Total Injection Wells in Deep Water-Bearing Zone	3	injection wells	One new injection well and two existing injection wells
Radius of Influence	5	feet	Estimated based on previous work
Treatment Interval	10 to 45	feet bgs	Shallow and deep water-bearing zones
Treatment Interval Thickness in Shallow Water-Bearing Zone	10	feet	
Treatment Interval Thickness in Deep Water-Bearing Zone	20	feet	
Injection Well Hydraulics			
Hydraulic Conductivity in Shallow Water-Bearing Zone	0.0385	feet per day	
Hydraulic Conductivity in Deep Water-Bearing Zone	9.6	feet per day	
Hydraulic Gradient in Shallow Water-Bearing Zone	0.046	feet per foot	
Hydraulic Gradient in Deep Water-Bearing Zone	0.028	feet per foot	
Effective Porosity in Shallow Water-Bearing Zone	25	percent	
Effective Porosity in Deep Water-Bearing Zone	30	percent	
Groundwater Seepage Velocity in Shallow Water-Bearing Zone	0.01	feet per day	
Groundwater Seepage Velocity in Deep Water-Bearing Zone	0.90	feet per day	
Travel Distance over 1 Month in Shallow Water-Bearing Zone	0.21	feet	
Travel Distance over 1 Month in Deep Water-Bearing Zone	26.88	feet	
Total Pore Volume in Shallow Water-Bearing Zone	41,140	gallons	
Total Pore Volume in Deep Water-Bearing Zone	35,904	gallons	



Table 1
Pilot Test Injection Design
Plastic Sales and Service Site
6870 Woodlawn Avenue Northeast
Seattle, Washington

Parameter	Value	Units	Notes
Reagent Dosing			
EDS-ER	2,250	pounds	
EDS-ER Concentrate Volume	270	gallons	Density of 8.33 pounds per gallon
EDS-ER Mix Ratio	13	percent	
Volume of Water	1,808	gallons	
EDS-ER Mix Volume	2,078	gallons	
EDS-ER Mix Volume to Total Pore Volume Ratio - Shallow	3	percent	
EDS-ER Mix Volume to Total Pore Volume Ratio - Deep	3	percent	
Powdered ZVI Mass	400	pounds	
EDS-ER Concentrate per Well - Shallow	13	gallons	Density of 15 pounds per gallon
EDS-ER Concentrate per Well - Deep	46	gallons	
Water Mix per Well - Shallow	100	gallons	
Water Mix per Well - Deep	350	gallons	
Powdered ZVI per Well - Shallow	19	pounds	
Powdered ZVI per Well - Deep	67	pounds	
Total Application Volume	2,078	gallons	

NOTES:

bgs = below ground surface

EDS-ER = Electron Donor Solution, Extended Release by Tersus Environmental

powdered ZVI = powdered zero valent iron (micron size)

ROW = right-of-way



Table 2
Pilot Test Groundwater Monitoring Schedule
Plastic Sales and Service Site
6870 Woodlawn Avenue Northeast
Seattle, Washington

Injection or Monitoring Well	Water-Bearing Zone
IW100 (IW69)	Deep
IW101 (IW70)	Shallow
IW103 (IW71)	Shallow
IW104 (IW72)	Shallow
IW16	Shallow
IW32	Deep
IW57	Shallow
IW59	Shallow
IW61	Shallow
MW05	Shallow
MW06	Shallow
MW34	Shallow
MW35	Deep
Monitoring Well Only	Water-Bearing Zone
MW30	Shallow
MW9	Deep
MW33	Deep
IW22	Deep

NOTES:

Chlorinated volatile organic compounds (CVOCs) will be analyzed by US Environmental Protection Agency (EPA) Method 8260D.

Groundwater samples will be analyzed for one or more of the following analytes:

- Total organic carbon by SM 5310C.
 - Volatile fatty acids by EPA Methods 300.0 and 300.0 Modified.
 - Sulfate by EPA Method 300.0.
 - Total iron and manganese by EPA Method 200.8.
 - Dissolved iron and manganese by EPA Method 200.8.
- (The samples will be field filtered using a 0.45-micron filter for dissolved metals analysis.)
- Methane, ethene, and ethane by RSK-175.

APPENDIX A
Materials Safety Data Sheets

SAFETY DATA SHEET

EDS-ER™



Creation Date: 2/1/2019
Revision Date: 5/29/2023
Version 1.2
SDS # 01A

1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product Identifier

Product Name: EDS-ER™

Synonyms: Electron Donor Solution – Extended Release

Product Form: Mixture

1.2 Recommended use of the chemical and restrictions on use

Recommended Use: Remediation of contaminated groundwater and soils.

Restrictions on Use: Use as recommended by the label.

1.3 Details of the supplier and of the safety data sheet

Supplier: Tersus Environmental, LLC
1116 Colonial Club Rd
Wake Forest, NC 27587
Phone: +1-919-453-5577
Email: info@tersusenv.com

1.4 Emergency telephone number

For leak, fire, spill or accident emergencies, call:

+1-919-453-5577 (Tersus Office Hours, 8:00 AM to 5:00 PM Eastern)

+1-800-424-9300 (Chemtrec 24 Hour Service – Emergency Only)

2. HAZARD IDENTIFICATION

2.1 Relevant identified uses of the substance or mixture

No applicable GHS categories. This product is not considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Other hazards None known.

2.2 Label element The product does not require a hazard warning label in accordance with GHS. The normal safety precautions for the handling of chemicals must be observed.

Hazard statement Non-Regulated Material

Precautionary statement

Prevention	No GHS prevention statements
Response	No GHS response statements
Storage	No GHS storage statements
Disposal	No GHS disposal statements

2.3 Classification system

NFPA Ratings (scale 0-4)

Health = 0

Fire = 1

Reactivity = 0

HMIS Ratings (scale 0-4)

Health = 0 Flammability = 1 Reactivity = 0

3. COMPOSITION/INFORMATION ON INGREDIENTS**3.1 Chemical Formula**

Mixture

3.2 Hazardous components

Chemical Name	Concentration (%)	CAS Number
None	None	None

3.3 Nonhazardous components

Chemical Name	Concentration (%)	CAS Number
Soybean Oil	90 to 93	8001-22-7
Emulsifiers	7 to 10	Proprietary

In accordance with paragraph (i) of §1910.1200, the specific chemical identity and/or exact percentage (concentration) of composition has been withheld as a trade secret.

Synonyms are provided in Section 1.

Occupational exposure limits, if available, are listed in Section 8.

4. FIRST AID MEASURES**4.1 General Information**

Check the vital functions. If unconscious place in recovery position and seek medical advice. In case of respiratory arrest, administer artificial respiration. Cardiac arrest, perform resuscitation. Victim conscious with labored breathing: half-seated. Victim in shock: on his back with legs slightly raised. Vomiting: prevent asphyxia/aspiration pneumonia. Prevent cooling by covering the victim (no warming up). Keep watching the victim. Give psychological aid. Keep the victim calm, avoid physical strain. Take the victim to a doctor if irritation persists.

Remove affected person from source of contamination.

Eye Contact

Promptly wash eye with plenty of water while lifting the eye lids. Continue to rinse for at least 15 minutes and get medical attention. Do not apply (chemical) neutralizing agents. In case of eye irritation consult an ophthalmologist. Remove any contact lenses and open eyelids wide apart.

Skin Contact

Wash off promptly and flush contaminated skin with water. Promptly remove clothing of soaked through and flush skin with water. Get medical attention if irritation persists after washing. Do not apply (chemical) neutralizing agents.

Inhalation

Move the exposed person to fresh air at once. When breathing is difficult, properly trained personnel may assist affected person by administering oxygen. Perform artificial respiration if breathing has stopped. Keep the affected person warm and at rest. Get prompt medical attention.

Ingestion Drink plenty of water. DO NOT induce vomiting. Get medical attention immediately. Never give anything by mouth to an unconscious person. Keep the affected person warm and at rest.

4.2 Important symptoms and effects (acute and delayed) Symptoms/injuries after skin contact: Causes skin irritation.
Symptoms/injuries after eye contact: Eye damage / irritation.

5. FIRE-FIGHTING MEASURES

5.1 Suitable Extinguishing Media Alcohol resistant foam. Carbon dioxide (CO₂). Dry chemicals, sand, dolomite, etc. Water spray

5.2 Specific Hazards Arising from the chemical or mixture Fire hazard: high.
Explosion hazard: Not known.
Oxides of the following substances: Carbon, Sulfurous gases (SO_x)

5.3 Special Fire Fighting Procedures Cool containers exposed to flames with water until well after the fire is out. Use water spray to reduce vapors. If the risk of water pollution occurs, notify appropriate authorities. Avoid water in straight hose stream; will scatter and spread fire. Keep upwind. Do not inhale explosions and combustion gases. Collect contaminated fire extinguishing water separately. This must not be discharged into drains. Cool containers exposed to flames with water until well after the fire is out. Use water spray to reduce vapor. If the risk of water pollution occurs, notify appropriate authorities. Avoid water in straight hose stream; will scatter and spread fire. Wear positive-pressure, self-contained breathing apparatus (SCBA) and chemical protective clothing.

5.4 Unusual Fire and Explosion Hazards Rags containing this material may heat and burn spontaneously. If a material with a large surface area, like rags, filters etc., is saturated with vegetable oils spontaneous combustion has been known to happen

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal Precautions Wear protective clothing as described in Section 8 of this safety data sheet. Do not smoke or use open fire or other sources of ignition. Contact with walking surface may result in formation of slippery film/falling hazard.

6.2 First Aid In case of contact with skin, wash with soap and water. If symptoms occur, seek medical attention. In case of contact with eyes, rinse with plenty of water for at least 15 minutes and see an eye specialist if irritation persists. In case of inhalation, remove to fresh air. In case of ingestion, drink water. If symptoms occur, seek medical assistance. Do not discharge into drains, sewers, or watercourses or onto the ground. Inform the relevant authorities if this occurs.

6.3 Environmental Precautions

6.4 Methods for Containment and Clean Up Spilled product should be removed immediately. Provide enough ventilation. Recover product for reuse if possible. Avoid contamination of waterways and (if large quantity) vegetation. Absorb in non-

combustible material, vermiculite, dry sand or earth and place into containers. If in mist form and levels are above 12mg/m³(total), an air purifying respirator (APR) and goggles are recommended. Avoid runoff into storm sewers and ditches which lead to waterway.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling

Contain with applicable regulations. Avoid contact with eyes. Avoid inhalation of vapors and spray/mist. Remove contaminated clothing immediately. Clean contaminated objects and areas thoroughly observing environmental regulations. Keep away from sources of ignition – No smoking. Handle in accordance with good industrial hygiene and safety procedures. Discharge into the environment must be avoided. Keep container tightly closed. Either local exhaust or general room ventilation is usually required.

7.2 Hygiene measures

Handle in accordance with good industrial hygiene and safety procedures. Use good personal hygiene practices.

7.3 Conditions for safe storage (with incompatibilities)

Technical measures: Clean bulk tanks periodically to prevent accumulation of bacteria

Storage conditions: Store in tightly closed, original container in a well-ventilated place. Protect against frost. Protect against direct sunlight.

Storage temperature: See technical datasheet. Above 10°C (50°F) and away from heat or flame.

Storage area: Store in a dry area. Comply with applicable regulations. Collect spillage.

Packaging materials: Stainless steel. Plastic.

8. EXPOSURE CONTROL / PERSONAL PROTECTION

8.1 Control parameters

Exposure guidelines, ingredients with workplace control parameters.

Components with occupational exposure limits

Soybean Oil (8001-22-7)

TWA Short-term value: 5 mg/m³

Long-term value: 15 mg/m³

8.2 Exposure Control



Appropriate engineering controls

Provide adequate general and local exhaust ventilation. Observe any occupational exposure limits for the product or ingredients. Do not allow uncontrolled discharge of product into the environment.

Eye/face protection

The following protection should be worn: Chemical splash goggles.

Respiratory protection	An approved NIOSH respirator must be worn if exposed to excessive oil vapors
Hand protection	Neoprene. Vinyl, Rubber (natural, latex), Butyl rubber. Wear protective gloves made of the following material: Chemical-resistant, impervious gloves complying with an approved standard should be worn if a risk assessment indicates skin contact is possible. Polyvinyl chloride (PVC). Manufactured/tested in accordance with EN 374, Avoid the following conditions: Polyvinyl alcohol (PVA).
Other skin and body protection	Wear appropriate clothing to prevent any possibility of skin contact. If using hot oil, insulated gloves may be required
Hygiene measures	Wash promptly if skin becomes contaminated. Wash hands at the end of each work shift and before eating, smoking, and using the toilet. When using do not eat, drink, or smoke.
Environmental Exposure Controls	Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	Clear yellow to clear brown, amber
Odor	Light Vegetable Oil
Odor threshold	Not determined.
pH	Not determined. Natural when diluted with water.
Melting point /Freezing Point	-2°C
Initial Boiling point and boiling point range	Not determined.
Flash Point	282°C (540°F)
Evaporation rate	Not determined.
Flammability (solid; gas)	Not determined.
Upper/lower flammability or explosive limits	Not determined.
Vapor pressure	Not determined.
Vapor density	Not determined.
Relative density	0.925 g/cm ³ (7.719 lbs/gal)
Solubility (ies)	Dispersible
Partition coefficient: n-octanol/water	Not determined.
Initial Boiling point and boiling point range	Not determined.
Auto-ignition temperature	Unknown
Decomposition temperature	Unknown
Viscosity	80 cP at 24°C; 35 cSt at 40°C

10. STABILITY AND REACTIVITY

10.1 Reactivity No further relevant information available.

<u>10.2 Chemical stability</u>	Stable under normal conditions and use.
<u>10.3 Possibility of hazardous reactions</u>	No dangerous reactions known.
<u>10.4 Conditions to avoid</u>	No further relevant information available.
<u>10.5 Incompatible materials</u>	No further relevant information available.
<u>10.6 Hazardous decomposition products</u>	Oxides of carbon (CO _x).
<u>10.7 Hazardous Polymerization</u>	Hazardous polymerization will not occur.

11. TOXICOLOGICAL INFORMATION

11.1 Acute Toxicity

Acute toxicity (oral)	LD50 Species: Rat (male/female) Dose: >2.000 mg/kg Method: OECD 423
Skin	Acute toxicity estimate: 3,571 mg/kg Method: Calculation method
Serious Eye Damage/Irritation	Not classified
Respiratory or Skin Sensitization	Not classified
Ingestion	Not classified
Germ Cell Mutagenicity	Not classified
Carcinogenicity	Not classified
Reproductive Toxicity	Not classified
Specific Target Organ Toxicity (Single Exposure)	Not classified
Specific Organ Toxicity (Repeated Exposure)	Not classified
Aspiration Hazard	Not classified
General Remarks	Not classified
Repeated does toxicity	> 5000 mg/Kg bw/day [OECD 422, CAS# 8001-30-7]
Reproductive toxicity	> 2000 mg/Kg bw/day [OECD 422, CAS# 8001-30-7]

11.2 Additional Toxicological Information

When used and handled according to specifications, the product does not have any harmful effects according to our experience and the information provided to us. The substance is not subject to classification.

11.3 Carcinogenic Categories

11.3.1 IRAC (International Agency for Research on Cancer): No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible, or confirmed human carcinogen by IARC.

11.3.2 ACGIH (American Conference of Governmental Industrial Hygienists): No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible, or confirmed human carcinogen by ACGIH.

11.3.3 NTP (National Toxicology Program): No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible, or confirmed human carcinogen by NTP.

11.3.4 OSHA (Occupational Safety & Health Administration): No component of this product present at levels greater than or equal to 0.1% is on OSHA's list of regulated carcinogens.

12. ECOLOGICAL INFORMATION

12.1 Chemical Fate Information

Product is readily biodegradable in wastewater treatment systems.

12.2 Biodegradability

Slow, not readily degradable Method: OECD 301 D

Chemical Oxygen Demand: 2.324 mg/g DIN 38409 T.31

12.3 Toxicity

Acute toxicity to fish- LC0: >100 mg/L 96h (no data, OCED 203, s-s)

Acute toxicity to aquatic invertebrates: No data

Toxicity to aquatic algae: No data

Toxicity to microorganisms- EC50: >100 mg/L 3 h (a.s. bacteria, OCED 209, s)

12.4 Bioaccumulative potential

No data available

12.5 Aquatotoxicity, invertebrates

Species: *Daphnia magna*

Exposure duration: 48 h

EC50: > 100 mg/l

Method: OECD 202

12.6 Aquatotoxicity, algae / aquatic plants

Species: *Scenedesmus subspicatus*

Exposure duration: 72 h

EbC50: 341 mg/l

Method: OECD 201

12.7 Mobility in soil

Adsorption coefficient in soil (log Koc): no data

12.8 Results of PBT and vPvB assessment

The substance is not PBT or vPvB

12.9 Other adverse effects

No information available

13. DISPOSAL CONSIDERATIONS

13.1 Waste Disposal Methods

Dispose according to federal, state, and local laws. Dispose of waste to licensed waste disposal site in accordance with the requirements of the local Waste Authority. Waste is suitable for incineration.

14. TRANSPORTATION INFORMATION**14.1 U.S. (D.O.T.)**

Proper Shipping Name: Chemicals not otherwise indexed (NOI) nonhazardous.
Hazard Class: N/A
UN/NA: N/A
Labels: N/A

14.2 Canada (T.D.G.)

Proper Shipping Name: Chemicals not otherwise indexed (NOI) nonhazardous.
Hazard Class: N/A
UN/NA: N/A
Labels: N/A

14.3 IMDG

Proper Shipping Name: Chemicals not otherwise indexed (NOI) nonhazardous.
Hazard Class: N/A
UN/NA: N/A
Labels: N/A

14.4 IATA

Proper Shipping Name: Chemicals not otherwise indexed (NOI) nonhazardous.
Hazard Class: N/A
UN/NA: N/A
Labels: N/A

14.5 Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

N/A for product as supplied.

15. REGULATORY INFORMATION**15.1 EPCRA - Emergency Planning and Community Right-to-Know Act****CERCLA Reportable Quantity**

This material does not contain any components with a CERCLA RQ.

15.2 SARA 311/312 Hazards No SARA Hazards

SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

This product does not contain any hazardous air pollutants (HAP), as defined by the U.S. Clean Air Act Section 112 (40 CFR 61).

15.3 California Prop. 65

This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

15.4 The components of this product are reported in the following inventories

CH INV: On the inventory, or in compliance with the inventory
DSL: All components of this product are on the Canadian DSL
AICS: On the inventory, or in compliance with the inventory

NZIoC:	On the inventory, or in compliance with the inventory
ENCS:	On the inventory, or in compliance with the inventory
KECI:	Not in compliance with the inventory
PICCS:	On the inventory, or in compliance with the inventory
IECSC:	On the inventory, or in compliance with the inventory
TCSI:	On the inventory, or in compliance with the inventory
TSCA:	On the inventory, or in compliance with the inventory

16. OTHER INFORMATION

16.1 Abbreviation/acronyms used

UVCB (substance)- Chemical substances of Unknown or Variable Composition, complex reaction products and biological materials

CAS (number)- Chemical Abstracts Service

EC (number)- Ref. EINECS/ELINCS number

R.E.A.Ch.- Registration, Evaluation, Authorisation and Restriction of Chemicals

TARIC - Tariffa Integrata della Comunità (Integrated Community Tariff code)

GHS - Globally Harmonised System of Classification and Labelling of Chemicals

CLP - Classification, Labelling and Packaging regulation

n/a - not applicable

PPE - Personal Protection Equipment

(Q)SAR - (Quantitative) Structure-Activity Relationship

bw – body weight

NOAEL - No Observed Adverse Effect Levels

STOT - Specific Target Organ Toxicity

BCF - Bioconcentration Factor

PBT (substance) - Persistent Bioaccumulative Toxic

vPvB (substance) - very Persistent, Very Bioaccumulative

SVHC (substance) - Substances of Very High Concern

Components not precisely identified are proprietary or non-hazardous.

Mixture classified as not dangerous according to Regulation (EC) 1272/2008.

Observe employment restrictions for people.

Product is not listed with IARC, NTP, ACGIH or OSHA as a carcinogen.

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All recommendations for the use of our products, whether given by us, orally or to be implied from data or lab tests results by us, are based on the current state of our knowledge at the time those recommendations are made. When additional information is obtained, these recommendations may be

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End of Safety Data Sheet

SAFETY DATA SHEET
Zero Valent Iron (ZVI) Powder D50 = 7-8 um



Revision Date: 4/19/2022
Version: 1.1

1. PRODUCT AND COMPANY IDENTIFICATION

Product identifier

Product Name Zero Valent Iron (ZVI) Powder D50 = 7-8 um

Relevant identified uses of the substance or mixture and uses advised against

Recommended Use: Professional use, Industrial use. Remediation of Groundwater and Soil.
Restrictions on Use: Use as recommended by the label

Details of the supplier and of the safety data sheet

Supplier Tersus Environmental, LLC
 1116 Colonial Club Rd
 Wake Forest, NC 27587
 Phone: +1-919-453-5577
 Email: info@tersusenv.com

Emergency telephone number

For leak, fire, spill or accident emergencies, call:

- +1-919-453-5577 (Tersus Office Hours, 8:00 AM to 5:00 PM Eastern)
- +1-919-638-7892 (Tersus Outside office hours)
- +1-800-424-9300 (Chemtrec 24 Hour Service – Emergency Only)
- +1-703-527-3887 (Chemtrec Outside United States 24 Hour Service – Emergency Only)

2. HAZARD IDENTIFICATION

Classification of the substance or mixture

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)
Combustible dust Classified

Label Elements

Signal Word

Warning

Hazard Statements

May form combustible dust concentrations in air

Precautionary Statements

Not applicable

Hazards not otherwise classified (HNOC)

Not applicable

Other hazards

Not classified as PBT or vPvB

Emergency Overview

The product contains no substances which at their given concentration, are considered hazardous to health.		
Appearance	Physical State	Odor
Light grey metal Powder	Powder	Odorless

3. COMPOSITION/INFORMATION ON INGREDIENTS

Substances/Mixtures

Chemical Name	CAS-No.	Content (%)	Trade Secret
Iron	7439-89-6	>99%	-

Synonyms are provided in Section 1.

Occupational exposure limits, if available, are listed in Section 8.

4. FIRST AID MEASURES

4.1 Description of first-aid measures

Inhalation	Move to fresh air. If symptoms persist, call a physician.
Skin contact	Take off contaminated clothing. Wash skin with soap and water.
Eye contact	Rinse thoroughly with plenty of water, also under the eyelids. Get medical attention if irritation persists.
Ingestion	Drink 1 or 2 glasses of water. If possible, drink milk afterwards. Get medical attention.

4.2 Most important symptoms and effects, both acute and delayed

Inhalation	Main symptoms: Cough and shortness of breath. May cause irritation of respiratory tract.
Skin contact	Long term contact can cause irritation.
Eye contact	May cause mechanical irritation.
Ingestion	Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhea.

4.3 Indication of any immediate medical attention and special treatment needed

Treat symptomatically.

5. FIRE-FIGHTING MEASURES

5.1 Extinguishing media

Suitable Extinguishing Media

Use extinguishing measures that are appropriate to local circumstances and the surrounding environment. Keep containers and surroundings cool with water spray. Confining and smothering metal fires is preferable rather than applying water. Use: Dry powder, dry chemical.

Extinguishing media which shall not be used for safety reasons

Do not use a solid water stream as it may scatter and spread fire.

5.2 Special hazards arising from the substance or mixture

Special Hazard

Avoid generating dust; fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source is a potential dust explosion hazard.

5.3 Advice for firefighters

As in any fire, wear self-contained breathing apparatus and full protective gear.

6. FIRE-FIGHTING MEASURES

6.1 Personal precautions, protective equipment and emergency procedures

Avoid dust formation. Remove all sources of ignition. For personal protection equipment see section 8.

6.2 Environmental precautions

Try to prevent the material from entering drains or water sources.

6.3 Methods and material for containment and cleaning up

Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13).

6.4 Reference to other sections

Refer to protective measures listed in section 8 and 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling

Protective measures

Use sufficient dust extraction. Keep workplace clean from dust. Accumulated dust dispersed in air may cause dust explosion if ignited.

Advice on general occupational hygiene

Avoid inhalation, ingestion and contact with skin and eyes. General occupational hygiene measures are required to ensure safe handling of the substance. The measures involve good personal and housekeeping practices (i.e., regular cleaning with suitable cleaning devices), no drinking, eating, and smoking at the workplace. Shower and change clothes at end of work shift.

7.2 Conditions for safe storage, including any incompatibilities

Keep container tightly closed in dry place to avoid oxidation of material. Make sure the product does not come in contact with acids or strong oxidizers.

7.3 Specific end uses

No information available.

8. EXPOSURE CONTROL / PERSONAL PROTECTION

8.1 Control parameters

Exposure limits	ACGIH TLV	OSHA PEL	NIOSH IDLH
Iron 7439-89-6	Nuisance dust: 15 mg/m ³	Nuisance Dust: 15 mg/m ³	-

8.2 Exposure controls

Engineering Measures Ensure adequate ventilation, especially in confined areas

Protective measures

Eye/Face Protection ANSI approved safety glasses or protective goggles
 Skin protection Long sleeved clothing.
 Hand Protection Use of canvass gloves is advisable.
 Respiratory protection If exposure limits are exceeded or irritation is experienced, NIOSH/MSHA approved respiratory protection should be worn. Respiratory protection must be provided in accordance with current local regulations minimum N95

Thermal hazards The substance does not represent a thermal hazard, thus special consideration is not required.

Environmental Exposure Controls

Dust from exhaust ventilation should be separated out in order to avoid release to the natural environment.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Physical state Powder
 Appearance Light grey metal Powder.
 Odor Odorless
 Odor Threshold Not applicable
 Particle size D50 = 7-8 um (micron)

Property	Values	Note
pH	Not applicable	Insoluble in water.
Melting/freezing point	1538°C @ 1013hPa	
Boiling point/boiling range	2861°C @ 1013hPa	
Flash Point	Not Applicable	Not relevant for inorganic substance
Evaporation rate	Solid with a melting point >300°C	
Flammability (solid, gas)	Not flammable.	According to Method A10, EU-Regulation 440/2008
Flammability Limits in Air		
• Upper flammability or explosive limit	No information available	
• Lower flammability or explosive limit	No information available	

Property	Values	Note
Vapor pressure	No information available	Solid with a melting point >300°C
Vapor density	No information available	Solid with a melting point >300°C
Relative density	7.87g/cm ³ @ 20°C	
Water Solubility	0.015 mg/l @ 22°C	
Solubility in other solvents	No information available	
Partition coefficient: n-octanol/water	Not determined	Not relevant for inorganic substances
Autoignition temperature	Not classified.	UN test N.4
Decomposition temperature	Will not decompose	Not relevant for inorganic substances
Viscosity	No information available	Solid with a melting point >300°C
Explosive properties	Not explosive	The substance contains no chemical groups associated with explosive properties.
Oxidizing Properties	Not oxidizing	The substance is incapable of reacting exothermically with combustible materials based on the chemical structure.

9.2 Other information

VOC Content (%)	Not applicable
Bulk Density	1.0-3.0 g/cm ³
Dust explosion class	St 1

10. STABILITY AND REACTIVITY

10.1 Reactivity

Stable under normal conditions.

10.2 Chemical stability

Stable under normal handling and storage conditions.

10.3 Possibility of hazardous reactions

None under normal processing.

10.4 Conditions to Avoid

Avoid generating dust; fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source is a potential dust explosion hazard.

10.5 Incompatible Materials

Strong oxidizing agents and strong acids.

10.6 Hazardous decomposition products

None under normal use

11. TOXICOLOGICAL INFORMATION**11.1 Information on toxicological effects****Information on likely routes of exposure**

General	The principal risk to human health presented by "iron" dust is related to the concentration of dust in the air acting as a nuisance dust. The higher the concentration of dust the greater the risk of irritation to the respiratory system and mechanical irritation to the eyes
Acute Toxicity	The substance is not toxic for skin, inhalation or ingestion
Skin corrosion/irritation	Not irritating.
Serious Eye Damage/Eye Irritation	OECD 405: Not irritating
Respiratory or skin sensitization	Not sensitizing.
Germ Cell Mutagenicity	Ames test OECD 471 negative
Reproductive Toxicity	Testing of metallic iron for reproductive toxicity is not appropriate due to a lack of systemic exposure.
STOT-single exposure	Not classified according to the criteria of the Globally Harmonized System (GHS)
STOT-repeated exposure	Not classified according to the criteria of the Globally Harmonized System (GHS)
Aspiration hazard	Not classified according to the criteria of the Globally Harmonized System (GHS)

Chemical Name	LD50 Oral	LD50 Dermal	LC50 Inhalation
Iron 7439-89-6	7500 mg/kg bw (Rat)	-	-

Carcinogenicity Not classified according to the criteria of the Globally Harmonized System (GHS)

Legend:**ACGIH: (American Conference of Governmental Industrial Hygienists)**

A1 - Known Human Carcinogen

A2 - Suspected Human Carcinogen

A3 - Animal Carcinogen

A4 - Not Classifiable as a Human Carcinogen

IARC: (International Agency for**Research on Cancer) Group 1 -**

Carcinogenic to Humans

Group 2A - Probably

Carcinogenic to Humans Group

2B - Possibly Carcinogenic to

Humans Group 3 - Not Classifiable

as to Carcinogenicity in Humans

NTP: (National Toxicity Program)

Known - Known Carcinogen

Reasonably Anticipated - Reasonably Anticipated to be a Human Carcinogen

OSHA: (Occupational Safety & Health Administration)

X - Present

12. ECOLOGICAL INFORMATION

12.1 Toxicity

Ecotoxicity effects

Contains forms of iron which are highly insoluble and non-hazardous.

Chemical Name	Toxicity to algae	Toxicity to fish	Toxicity to microorganisms	Toxicity to daphnia and
Iron	-	LC50 96 h = 13.6 mg/L (Morone saxatilis - static) LC50 96 h = 0.56 mg/L (Cyprinus carpio -	-	-

12.2 Persistence and degradability

The methods for determining the biological degradability are not applicable to inorganic substances.

12.3 Bioaccumulative potential

Iron and its compounds are essential compounds. Iron is an essential trace element, well regulated in all living organisms. The available evidence shows the absence of iron biomagnification across the trophic chain both in the aquatic and terrestrial food chains. The existing information suggests not only that iron does not biomagnify, but rather that it tends to exhibit biodelution.

12.4 Mobility in soil

Iron and its compounds are found in the form of hydroxides in the environment. They are stabilized in the form of oxides in the long term.

12.5 Results of PBT and vPvB assessment

As iron is not bio-available, owing to its extreme insolubility in water, it is not systematically available or bio-accumulative, and hence it does not fulfil either of the PBT or vPvB criteria for classification.

12.6 Other adverse effects

None anticipated.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product disposal

Dispose of in accordance with local regulations.

Packaging disposal

Packaging that cannot be cleaned should be disposed as special waste in compliance with local and national regulations.

14. TRANSPORTATION INFORMATION

DOT

UN/ID No	Not applicable
Proper shipping name	Not applicable
Transport hazard class(es)	Not applicable
Packaging group	Not applicable

IATA

UN/ID No	Not applicable
Proper shipping name	Not applicable
Transport hazard class(es)	Not applicable
Packing Group	Not applicable

IMDG

UN/ID No	Not applicable
Proper shipping name	Not applicable
Transport hazard class(es)	Not applicable
Packing Group	Not applicable
Marine pollutant	Not applicable

15. REGULATORY INFORMATION**15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture****International Inventories**

All of the components in the product are on the following Inventory lists:

TSCA	Complies
EINECS/ELINCS	Complies
DSL/NDSL	Complies
ENCS	-
IECSC	Complies
KECL	Complies
PICCS	Complies
AICS	Complies

Legend:

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List

EINECS/ELINCS - European Inventory of Existing Commercial Chemical Substances/EU List of Notified Chemical Substances

ENCS - Japan Existing and New Chemical Substances
IECSC - China Inventory of Existing Chemical Substances

KECL - Korean Existing and Evaluated Chemical Substances

PICCS - Philippines Inventory of Chemicals and Chemical Substances
AICS - Australian Inventory of Chemical Substances

U.S. Federal Regulations**SARA 313**

Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372.

SARA 311/312 Hazard Categories

Acute Health Hazard

No

Chronic Health Hazard	No
Fire Hazard	No
Sudden Release of Pressure Hazard	No
Reactive Hazard	No

Clean Water Act

This product does not contain any substances regulated as pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42).

CERCLA

This material, as supplied, does not contain any substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355). There may be specific reporting requirements at the local, regional, or state level pertaining to releases of this material.

U.S. State Regulations**California Proposition 65**

This product does not contain any Proposition 65 chemicals.

16. OTHER INFORMATION

Components not precisely identified are proprietary or non-hazardous.

<u>NFPA</u>	Health Hazard 0	Flammability 1	Instability 0	Physical and chemical hazards -
<u>HMIS</u>	Health Hazard 0	Flammability 1	Physical Hazard 0	Personal protection E

Abbreviations

EC50: median effective concentration

LC50: median lethal concentration.

LD50: median lethal dose.

NIOSH: The National Institute for Occupational Safety and Health
NOEC: no observable effect concentration

OEL: occupational exposure limit

OSHA Occupational Safety & Health Administration

PBT: Persistent, bioaccumulative, and toxic chemicals
PNEC: Predicted no effect concentration (PNEC)

STEL: short-term exposure limit

TLV: Substance with TLV-values

TWA: Time weighted average

vPvB: very persistent, very bioaccumulative chemical

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End of Safety Data Sheet