

June 30, 2023

Ms. Jennifer Meyer
Environmental Program Associate
Remediation and Redevelopment Program
Wisconsin Department of Natural Resources
1027 W. St. Paul Avenue
Milwaukee, WI 53233

Via WDNR RR Program Submittal Portal

Subject: Remedial Action Options and Design Report
Milwaukee Die Casting Company Site
4132 North Holton Street, Milwaukee, Wisconsin
WDNR BRRTS # 02-41-000023
WDNR FID # 241228240

Dear Ms. Meyer,

We are providing this *Remedial Action Options and Design Report* (“Report”) to the Wisconsin Department of Natural Resources (WDNR) for the Milwaukee Die Casting Company Site (“Site”). This Report is being submitted on behalf of Pharmacia LLC (“Pharmacia”), which is acting on behalf of Fisher Controls International, Inc. (“Fisher”) in this matter.¹

This Report was prepared in general accordance with Wisconsin Administrative Code NR 722.13 and NR 724.09 and presents a focused evaluation of viable remedial action options and the design of the selected remedial option for MW-1 area shallow groundwater. This Report follows the May 19, 2023 *Pre-Design Investigation Report*. The NR 712.09 submittal certification is provided as **Attachment 1**.

1. BACKGROUND

1.1 Basis and Objectives for MW-1 Shallow Groundwater Remedial Action

Additional investigation has been conducted at the Site in response to a WDNR August 10, 2018 letter to Pharmacia and Fisher. The results of the additional investigation have been reported to WDNR in various documents and demonstrate, among others, that: (1) the nature and extent of

¹ By submitting this Report, neither Pharmacia nor Fisher is waiving any of its rights under federal or state law. Additionally, nothing in this Report should be deemed an admission of fact or law, or a waiver of any defense or right to contest Pharmacia’s or Fisher’s liability under any state or federal law.

groundwater impacts have been defined, (2) there are no potentially complete migration or exposure pathways associated with the residual chlorinated volatile organic compounds (CVOCs) in groundwater, (3) residual CVOC concentrations in groundwater are stable and (4) reduced (anaerobic) conditions and active natural anaerobic biodegradation have been documented in the residual source area [i.e., MW-1 area and adjacent 2015 CVOC-impacted unsaturated soil removal area; refer to attached **Figures 1 and 2 (Attachment 2)**].

During a discussion of the additional investigation results,² the WDNR communicated its position to Pharmacia that although groundwater trend data demonstrate stable concentrations for the residual source area (i.e., MW-1 area), some MW-1 area data do not demonstrate decreasing concentration trends for tetrachloroethene (PCE)/trichloroethene (TCE) (parent chlorinated ethenes). As such, the WDNR communicated a concern that natural attenuation may not achieve compliance with NR 140 groundwater quality standards in a “reasonable period of time” per NR 726.05(6)(b).

The MW-1 area shallow groundwater remedial action has been designed in response to NR 726.05(6)(b). The objectives of the remedial action are to reduce CVOC mass, reduce the period of groundwater monitoring, and allow a determination that NR 140 groundwater quality standards can be met in a “reasonable period of time.”

1.2 Pre-Design Investigation

MW-1 area pre-design investigation, consisting of saturated soil and groundwater sampling and field and laboratory testing, was conducted in February 2023. The pre-design investigation was conducted pursuant to the February 10, 2023 *Pre-Design Investigation Work Plan* and documented in the May 19, 2023 *Pre-Design Investigation Report*. The following is a summary of the MW-1 area pre-design investigation findings:

- Subsurface conditions generally consist of heterogeneous clay fill (i.e., re-worked clay with varying amounts of silt, sand and gravel) to depths of approximately 8 to 10 feet below ground surface (bgs), overlying a silty sand to depths of approximately 15 to 17 feet bgs, which overlies a very dense silt [refer to **Figure 3 (Attachment 2)**]. Site shallow groundwater monitoring wells are screened within the clay fill and underlying silty sand unit. The depth to groundwater at MW-1 has averaged 4.1 feet bgs over the past nine (9) groundwater sampling events.
- The highest photoionization detector (PID) readings were measured within the silty sand unit proximate to MW-1.

² October 25, 2022 conference call with WDNR Project Manager Greg Moll to discuss September 20, 2022 *Groundwater Monitoring Progress Report*.

- The highest total CVOC³ saturated soil concentrations were detected at GP-01-2023 within the silty sand unit. GP-01-2023 was advanced adjacent to MW-1 on the east margin of the 2015 CVOC-impacted unsaturated soil removal area. Total CVOC saturated soil concentrations detected at GP-01-2023 were 236,641 micrograms per kilogram (µg/kg) (9 to 10 feet bgs) and 787,545 µg/kg (11 to 12 feet bgs). Elevated CVOC concentrations (greater than 1,000 µg/kg) were also detected at GP-02-2023, GP-03-2023, GP-11-2023, GP-12-2023 and GP-13-2023 (refer to **Figure 2**).
- Groundwater analytical data [refer to **Figure 4 (Attachment 2)**] indicate that parent CVOCs (PCE and TCE) and PCE/TCE degradation product concentrations are consistent with previous sampling events.
- Groundwater geochemical data [oxidation-reduction potential (ORP), dissolved oxygen (DO), nitrate, dissolved iron, sulfate, sulfide and methane] indicate variable reduction-oxidation (redox) conditions with more reduced (anaerobic) conditions in the area of MW-1 than at downgradient monitoring well locations MW-7 and MW-6 (refer to **Figure 4**).
- Groundwater ethene/ethane, microbial enumeration [*Dehalococcoides* (Dhc)] and total organic carbon (TOC) data (refer to **Figure 4**) indicate that active natural anaerobic biodegradation is occurring in the area of MW-1 but that this natural biodegradation activity is likely limited by low TOC (as well as the variable redox conditions indicated above).

2. REMEDIAL ACTION OPTIONS EVALUATION

2.1 Remedial Action Options Development and Evaluation

MW-1 area shallow groundwater remedial action options were developed and evaluated in a streamlined manner in general accordance with NR 722. The range of viable remedial action options was established based on the remedial action objectives (Section 1.1), the pre-design investigation results (Section 1.2) and the significant past investigation data and removal action activities conducted at the Site. The following Site-specific conditions were also considered during the evaluation of the MW-1 area shallow groundwater remedial action options:

- The Site is currently a vacant, grass-covered parcel; however, the Site owner, the Redevelopment Authority of the City of Milwaukee (RACM), plans to redevelop the Site and conceptual redevelopment plans have been initiated.
- The Site currently has a Site-wide cap. The cap was constructed as part of the 2015 removal action and is subject to “continuing obligations.” The cap includes three (3) cap types (clay cap, soil cover, and topsoil cover).

³ The total CVOC concentration is the sum of tetrachloroethene (PCE), trichloroethene (TCE), 1,1-dichloroethane, 1,1-dichloroethene (DCE), cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride concentrations; a concentration of one-half the detection limit was assumed for non-detect results.

Table 1 (Attachment 3) summarizes the identified viable remedial action options for MW-1 area shallow groundwater [NR 722.13(2)(d)] and an evaluation of the remedial action options pursuant to NR 722.07(4), including effectiveness [NR 722.07(4)(a)1 and 2], implementability [NR 722.07(4)(a)3], restoration time frame [NR 722.07(4)(a)4] and economic feasibility [NR 722.07(4)(b)].

2.2 Selected Remedial Action Option

As indicated in **Table 1**, the following remedial action option components have been selected for MW-1 area shallow groundwater:

- Enhanced In-Situ Bioremediation (EISB). Electron donor (carbon source) with a microbial culture additive will be injected into MW-1 area shallow groundwater. EISB is expected to reduce CVOC mass and mobility in MW-1 area shallow groundwater while maintaining treatment zone and downgradient geochemistry. EISB is readily implementable based on current Site conditions and would result in minor Site cap disturbance. Implementation of EISB is expected to reduce the period of groundwater monitoring and allow a determination that groundwater quality standards can be met in a “reasonable period of time” per NR 726.05(6)(b).
- Post-EISB Groundwater Monitoring. Performance groundwater monitoring will be conducted to evaluate and document the effectiveness of EISB in meeting the remedial action objectives.
- WDNR Continuing Obligations. The Site was placed on the Wisconsin Remediation and Redevelopment Database (WRRD) in 2018 for continuing obligation at the Site, including continuing obligations and Site-specific requirements associated with residual groundwater impacts. WDNR continuing obligations will be maintained for the Site.

3. DESIGN

3.1 Description

EISB will consist of direct amendment of the MW-1 area shallow groundwater zone with an electron donor (carbon source) and a dechlorinating microbial culture to stimulate biodegradation of the CVOCs. Emulsified vegetable oil [EVO] and KB-1[®] (amendments) have been selected as the electron donor and microbial culture, respectively. The amendments will be delivered to the target EISB amendment zone via a grid of direct-push technology (DPT) points.

Post-EISB performance monitoring will be conducted to allow a determination that groundwater quality standards can be met in a “reasonable period of time” per NR 726.05(6)(b). Performance monitoring will include the installation of two (2) performance monitoring wells.

3.2 Design Criteria, Concepts and Assumptions

This section summarizes the EISB design criteria, concepts and assumptions including the EISB target amendment zone, number of injection points, amendment quantity estimates and injection procedure.

Target Amendment Zone

The MW-1 area shallow groundwater target EISB amendment zone (horizontal extent and depth interval) was established based on the pre-design investigation data. The approximate target zone area and depth interval are approximately 8,100 square feet (sf) and 8 to 18 feet bgs (silty sand layer), respectively, as depicted on **Figure 2** and **Figure 3**.

Number of Injection Points

The number of injection points for the target EISB amendment zone was determined based on previous experience considering the Site-specific target zone soil composition (silty sand with varying density), depth and thickness; the overlying soil conditions (clay fill); and underlying soil conditions (very dense silt). Based on these Site conditions, the anticipated effective radius of influence (ROI) of each extraction well is assumed to be 7.5 feet (i.e., injection points advanced on an approximately 15-foot grid). Based on this ROI, approximately 46 injection points are planned to uniformly amend the target zone (refer to **Figure 2**). However, the final number and spacing of injection points may be modified in the field based on achieved amendment quantity delivery variability.

Amendment Quantity Estimates

Commercially available EVO will be diluted with anaerobic water. The anaerobic water will be generated by adding KB-1[®] Primer to municipal water. Anaerobic water is used to disperse the electron donor and protect anaerobic bioaugmentation cultures during injection.

The estimated total EVO injection quantity for the target EISB amendment zone was established based on the estimated electron donor demand in Site groundwater (based on the February 2023 MW-1 groundwater data). The estimated electron donor demand is based on the stoichiometry of a redox process in which the added electron donor (i.e., EVO) is used by microbes to consume electron acceptors (i.e., CVOCs, DO, nitrate, sulfate and iron).

Based on the evaluation presented on the worksheet provided in **Attachment 4**, approximately 38,000 gallons of EVO emulsion will be injected (approximately 825 gallons per injection point). The EVO concentration of the EVO emulsion will be approximately 4,800 milligrams per liter

(mg/L). Approximately 23 liters of KB-1[®] (approximately 0.5 liters per injection point) will be added to the EVO emulsion during injection.

Injection Procedure

Initial injection locations will be staked by Geosyntec's survey subcontractor. The EISB amendment injections will be performed in a top-down manner using a retractable DPT injection tool. The tool will be attached to hollow steel DPT drive rods and then driven into the top of the target EISB amendment zone. The rods will then be retracted to expose the 2-foot long section containing injection ports. The upper and lower halves of the tool will seal off the zones above and below the injection ports, allowing the injection solution to be injected into the desired zone. The discrete injections will be performed every 2 feet within the target zone. This will result in 4 to 5 EVO delivery "lifts" in each injection point.

Based on the Site conditions and previous experience, an EISB amendment injection rate of approximately 5 gallons per minute (gpm) at pressures of approximately 15 to 25 pounds per square inch (psi) above hydrostatic pressure is anticipated. Injection rates and pressures will likely be modified in the field based on injection observation.

The KB-1[®] culture will be added in three (3) of the EVO emulsion delivery lifts (i.e., top, middle and bottom). Approximately one third of the EVO delivery lift volume will be injected first, followed by KB-1[®] injection using compressed gas. Following injection of KB-1[®], the EVO delivery lift injection will be completed. By resuming EVO injection immediately after the introduction of KB-1[®], the KB-1[®] culture will be introduced into the groundwater within a "protective ring" of anaerobic water amended with EVO.

The injection process duration (start and stop times), amendment quantities, and the injection rate and pressure for each injection point will be recorded on an Injection Tracking Sheet.

Following injection, the injection points will be abandoned in accordance with NR 140.

4. PERFORMANCE MONITORING

Post-EISB performance monitoring will be conducted to evaluate and document the effectiveness of EISB in meeting the remedial action objectives, including collecting sufficient data to allow a determination that groundwater quality standards can be met in a "reasonable period of time" per NR 726.05(6)(b).

4.1 Monitoring Well Installation

Groundwater monitoring well MW-1 will be abandoned in accordance with NR 141 prior to EISB

implementation due to the proximity of planned amendment injection points. This will prevent injection short-circuiting in the vicinity of MW-1. In addition, it is anticipated that proximate amendment injection would foul MW-1, making it unusable for further groundwater monitoring. MW-1 will be replaced (MW-1R) following EISB implementation.

Two (2) EISB performance monitoring wells (PMW-1 and PMW-2) will be installed solely for the purpose of post-EISB implementation performance monitoring. PMW-1 and PMW-2 will be installed at the approximate locations of pre-design investigation soil boring locations GP-13-2023 and GP-15-2023, respectively (refer to **Figures 2 and 3**).

MW-1R and performance monitoring wells PMW-1 and PMW-2 will be installed with 10-foot screens with the bottom of the screens installed at the base of the silty sand unit.

MW-1R and performance monitoring wells PMW-1 and PMW-2 will be installed and developed in accordance with NR 141. The location and elevation (ground surface and top of casing) of the wells will be surveyed. A soil boring log (WDNR Form 4400-122), a Well Construction Form (WDNR Form 4400-113A) and a Monitoring Well Development Form (WDNR Form 4400-113B) will be completed for each monitoring well.

4.2 Monitoring Frequency

The frequency of post-EISB performance monitoring is based on previous experience in evaluating the effectiveness of EISB in meeting the remedial action objectives. The following table summarizes the post-EISB performance monitoring plan:

Well ID	Post-EISB Performance Monitoring		
	3 months	6 months	12 months
MW-1R (planned)	✓	✓	✓
PMW-1, PWM-2 (planned)	✓	✓	✓
MW-6, MW-7, MW-13, MW-14	✓	✓	
groundwater monitoring well network ⁴			✓

4.3 Sampling and Analysis

Water levels will be measured in the Site monitoring wells and performance monitoring wells prior to sampling.

⁴ pursuant to the WDNR-approved June 15, 2021 *Additional Groundwater Investigation Work Plan and Groundwater Monitoring Plan*

Post-EISB performance monitoring samples will be collected using low-flow purging and sampling. During low-flow purging, field parameters [pH, temperature, conductivity, dissolved oxygen (DO), turbidity and oxidation-reduction potential (ORP)] will be monitored using a portable water quality meter.

Collected groundwater samples will be immediately placed in laboratory supplied containers and placed in a cooler with ice for submittal to the laboratory. The groundwater samples will be submitted to a NR 149 accredited laboratory under standard chain-of-custody protocols.

The following table summarizes the post-EISB performance monitoring parameters, laboratory methods and planned laboratory:

Groundwater Parameter	Laboratory Method	Planned Laboratory
VOCs	EPA 8260	Pace Analytical
Dhc	Gene-Trac [®]	SiREM
functional gene assay (FGA) ⁵	Gene-Trac [®]	SiREM
TOC	SM 5310C	Pace Analytical
chloride, nitrate, nitrite, sulfate	EPA 300.1	Pace Analytical
alkalinity	SM 2320B	Pace Analytical
total and dissolved iron	EPA 6010D	Pace Analytical
ethene, ethane and methane	EPA 8015B Modified	Pace Analytical

4.4 Data Quality Plan

Post-EISB performance monitoring sampling and analysis quality assurance and quality control (QA/QC) procedures will be conducted in general accordance with NR 716.13(6) and include the following:

- One duplicate sample for every 10 or less samples;
- One equipment blank for every 10 or less samples, unless dedicated sampling equipment is used;
- One trip blank for each shipping container containing samples for VOC analysis;
- Decontamination of sampling equipment between each sampling location, unless dedicated or disposable sampling equipment are used; and
- Checking and calibrating field instruments in accordance with manufacturer's instructions.

The quality of the post-EISB performance monitoring laboratory analytical data will be validated by reviewing the chain-of-custody forms, holding times, analytical detection limits, field QA/QC sample results (duplicate samples and field blanks), and laboratory QA/QC results (method blanks,

⁵ Vinyl Chloride Reductase (vcrA), BAV1 Reductase (bvcA) and TCE Reductase (tceA)

surrogates, and laboratory control samples). Data validation qualifiers will be added to groundwater analytical summary tables. Data validation reports will be provided in the performance monitoring progress reports.

4.5 Data Evaluation

Performance monitoring data evaluation will include post-EISB geochemical (redox) conditions, electron donor (carbon source) consumption, and residual CVOC mass reduction. These data will also be used to evaluate residual CVOC degradation (decay) rates. Decay rates will be calculated using the procedures documented in WDNR guidance *Understanding Chlorinated Hydrocarbon Behavior in Groundwater: Investigation, Assessment and Limitations of Monitored Natural Attenuation* (RR-699).

5. PERMITS, LICENSES AND APPROVALS

An Infiltration/Injection (I/I) Request will be prepared and submitted to the WDNR for review and approval to implement the MW-1 area shallow groundwater EISB. The I/I Request will be prepared pursuant to NR 140.28 and in accordance with WDNR guidance Infiltration and Injection Requests (PUB-RR-935). The I/I Request will include an associated Wisconsin Pollutant Discharge Elimination System (WPDES) Notice of Intent.

6. PUBLIC HEALTH AND ENVIRONMENTALS LAWS AND STANDARDS

6.1 Health and Safety

EISB implementation will comply with the Project Health and Safety Plan and the injection contractor's Work-specific health and safety plan and be conducted in accordance with applicable requirements of the Project Health and Safety Plan 29 CFR 1910 Occupational Safety and Health Standards and 29 CFR 1926 Safety and Health Regulations for Construction.

Storage, handling and mixing of EVO, KB-1[®] and KB-1[®] Primer will be conducted in accordance with the Safety Data Sheets (SDSs) provided in **Attachment 5**.

EISB injection equipment decontamination will be conducted, as necessary. A temporary decontamination pad may be used to facilitate the collection and removal of decontamination solids and liquids.

6.2 Wisconsin Administrative Code

MW-1 area shallow groundwater remedial action implementation will be conducted in accordance with the WDNR I/I Request Approval conditions pursuant to Wisconsin Administrative Code NR 140.28.

The MW-1 area shallow groundwater remedial action is being implemented in response to WDNR’s communicated concern that natural attenuation of source area parent CVOCs (PCE and TCE) concentrations may not achieve compliance with NR 140 groundwater quality standards in a “reasonable period of time” per NR 726.05(6)(b). WDNR RR-699 Section 5.2.1.3 (“Meeting standards within a reasonable period of time”) documents that “Reasonable period of time is determined in relation to the criteria of NR 722.07(4).” A preliminary evaluation of these criteria is presented in the following table:

NR 722.07(4)(a)4 Criteria	Preliminary Evaluation
a. Proximity of contamination to receptors.	<ul style="list-style-type: none"> ▪ As reported in previous documents, there are no potentially complete exposure pathways associated with the residual CVOCs in groundwater.
b. Presence of sensitive receptors.	<ul style="list-style-type: none"> ▪ There are no known sensitive receptor pathways associated with residual CVOCs in groundwater. CVOCs have not been detected in groundwater at off-Site downgradient sentinel monitoring well MW-9 or at off-Site downgradient sentinel piezometer PZ-10.
c. Presence of threatened or endangered species or habitats, as defined by state and federal law.	<ul style="list-style-type: none"> ▪ There are no known threatened or endangered species or habitat receptors associated with residual CVOCs in groundwater. CVOCs have not been detected in groundwater at off-Site downgradient sentinel monitoring well MW-9 or at off-Site downgradient sentinel piezometer PZ-10.
d. Current and potential use of the aquifer, including proximity to private and public water supplies and surface water bodies.	<ul style="list-style-type: none"> ▪ Existing continuing obligations include a requirement for WDNR approval for construction of a water supply well on the Site and two adjacent properties to the east. ▪ CVOCs have not been detected in groundwater at off-Site downgradient sentinel monitoring well MW-9 or at off-Site downgradient sentinel piezometer PZ-10. ▪ CVOCs have not been detected in source area piezometer PZ-1A.
e. Magnitude, mobility and toxicity of the contamination.	<ul style="list-style-type: none"> ▪ Significant previous removal action activities have decreased the magnitude, mobility and toxicity of CVOCs at the Site. The planned EISB will provide additional magnitude, mobility and toxicity reduction.
f. Geologic and hydrogeologic conditions.	<ul style="list-style-type: none"> ▪ The highest residual CVOC concentrations in groundwater are present in MW-1 area shallow groundwater within the silty sand unit (between overlying clay fill and underlain very dense silt). There are no significant preferential geologic or hydrogeologic migration pathways associated with the residual CVOCs in groundwater.

NR 722.07(4)(a)4 Criteria	Preliminary Evaluation
g. Effectiveness, reliability, and enforceability of continuing obligations.	<ul style="list-style-type: none"> ▪ Continuing obligations were established for the Site in 2018, including continuing obligations and Site-specific requirements associated with residual groundwater impacts. The current Site owner and adjacent property owners have been notified of these continuing obligations in accordance with s. 292.12(2), Wis. Stats. and RR-819 (<i>Continuing Obligations for Environmental Protection Responsibilities of Wisconsin Property Owners Wis. Stat. § 292.12</i>).
h. Naturally occurring biodegradation processes at the site or facility which are expected to reduce the total mass of contamination in an effective and timely manner	<ul style="list-style-type: none"> ▪ Reduced (anaerobic) conditions and active natural anaerobic biodegradation have been documented for MW-1 area shallow groundwater. Implementation of EISB will enhance these conditions. Substantially greater degradation rates (i.e., lower half-lives) have been reported for chlorinated ethenes (PCE, TCE and their daughter products) following EISB [post-EISB half-lives for chlorinated ethenes are at least one (1) order of magnitude lower than for MNA].
i. The degradation potential of the compounds.	<ul style="list-style-type: none"> ▪ Reduced (anaerobic) conditions and active natural anaerobic biodegradation have been documented for MW-1 area shallow groundwater. Implementation of EISB will enhance these conditions.

6.3 Waste Management

Soil generated during injection point installation; soil and groundwater generated during groundwater monitoring well installation, development and groundwater sampling; and accumulated decontamination solids and liquids (if generated) will be contained in labeled 55-gallon drums. The drums will be staged in the northwest portion of the Site pending disposal. The water drums will be staged in secondary containment. Weekly drum inspections will be conducted pending disposal. The drums will be transported by a licensed hauler, in accordance with Federal, State, and local marking, labeling, placarding, and manifesting requirements, to appropriately licensed disposal facilities.

7. REPORTING

EISB implementation will be documented in a NR 724.15 *Construction Documentation Report*. Performance monitoring will be documented in semi-annual NR 724.13(3) *Progress Reports*.

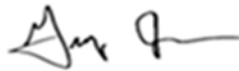
Ms. Jennifer Meyer
Wisconsin Department of Natural Resources
June 30, 2023
Page 12

Please contact us if you have any questions regarding this *Remedial Action Options and Design Report*.

Sincerely,



Jeremiah Johnson, P.G.
Senior Geologist
(Licensed P.G. in WI)



Greg Johnson, P.H., P.G., P.E.
Senior Engineer
(Licensed P.E. in WI, P.H. in WI, P.G. in IL, WI)

Attachment 1 - NR 712.09 Submittal Certification

Attachment 2 - Figures

Attachment 3 - Tables

Attachment 4 - EVO Injection Worksheet

Attachment 5 - EISB Amendment Safety Data Sheets

cc: Mr. Christopher Clark, Pharmacia LLC
Ms. Mary Jo Anzia, BSI

ATTACHMENT 1

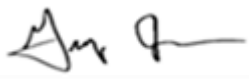

NR 712.09 Submittal Certification

Remedial Action Options and Design Report
Milwaukee Die Casting Company Site
4132 North Holton Street
Milwaukee, Wisconsin
WDNR BRRTS # 02-41-00023
WDNR FID # 241228240

NR 712.09 Submittal certification.

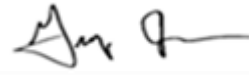
Document Name	REMEDIAL ACTION OPTIONS AND DESIGN REPORT
Document Date	June 30, 2023
Site Name	Milwaukee Die Casting Company Site
WDNR BRRTS #	02-41-000023

"I, Greg Johnson, hereby certify that I am a registered professional engineer in the State of Wisconsin, registered in accordance with the requirements of ch. A-E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A-E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code."

 Greg Johnson, P.H., P.G., P.E. Senior Engineer P.E. #: 29898-006	 6/30/2023
---	---

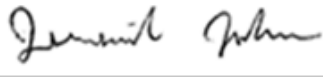
Signature, title and P.E. number	P.E. stamp
----------------------------------	------------

"I, Greg Johnson, hereby certify that I am a hydrogeologist as that term is defined in s. NR 712.03 (1), Wis. Adm. Code, am registered in accordance with the requirements of ch. GHSS 2, Wis. Adm. Code, or licensed in accordance with the requirements of ch. GHSS 3, Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code."

 Senior Engineer	6/30/2023
--	-----------

Signature and title	Date
---------------------	------

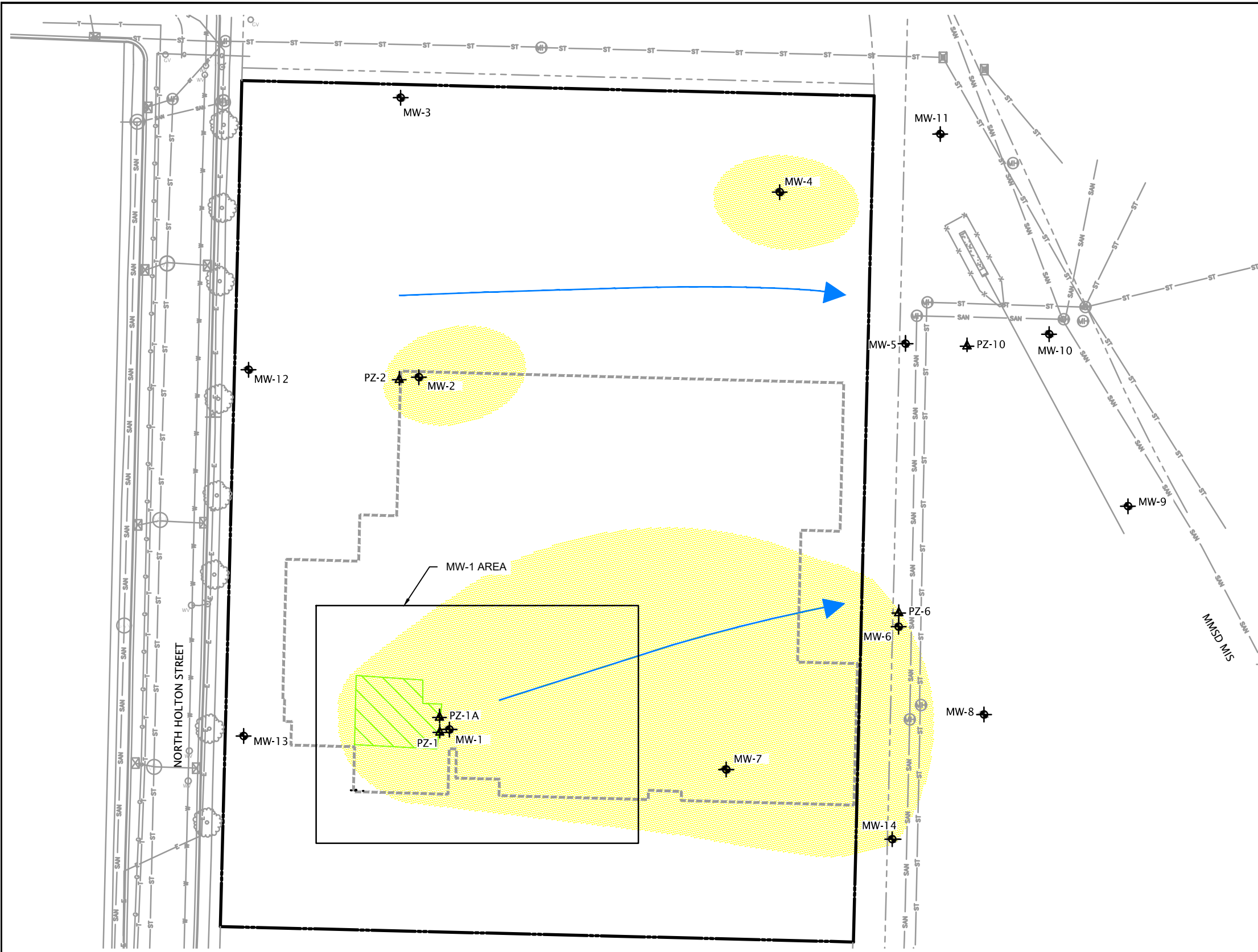
"I, Jeremiah Johnson, hereby certify that I am a scientist as that term is defined in s. NR 712.03 (3), Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code."

 Senior Geologist	6/30/2023
---	-----------








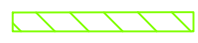
Signature and title	Date
---------------------	------

ATTACHMENT 2

Figures



LEGEND

-  APPROXIMATE SITE PROPERTY LINE
-  APPROXIMATE ADJACENT PROPERTY LINES
-  APPROXIMATE FORMER BUILDING FOOTPRINT
-  MW-7 MONITORING WELL LOCATION
-  PZ-2 PIEZOMETER LOCATION
-  ESTIMATED SHALLOW GROUNDWATER FLOW DIRECTION (SEE NOTE 1)
-  ESTIMATED EXTENT OF CVOCs > NR 140 ES (SEE NOTE 1)
-  2015 CVOC-IMPACTED UNSATURATED SOIL REMOVAL AREA

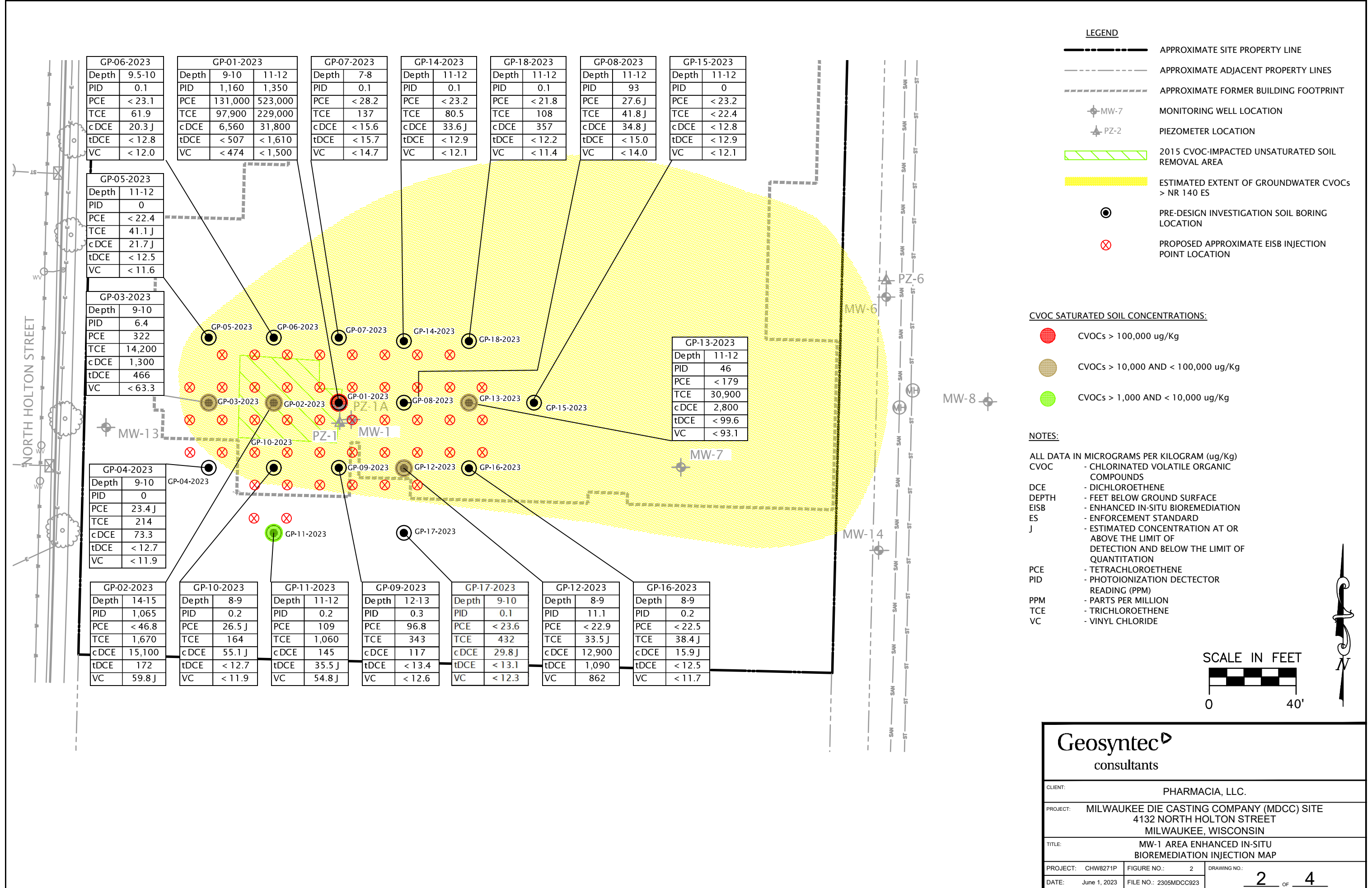
NOTES:

- CVOC - CHLORINATED VOLATILE ORGANIC COMPOUNDS
- ES - ENFORCEMENT STANDARD
- (1) - BASED ON JULY 27, 2022 GROUNDWATER DATA

SCALE IN FEET



Geosyntec consultants		
CLIENT:	PHARMACIA, LLC.	
PROJECT:	MILWAUKEE DIE CASTING COMPANY (MDCC) SITE 4132 NORTH HOLTON STREET MILWAUKEE, WISCONSIN	
TITLE:	SITE LAYOUT	
PROJECT: CHW8271P	FIGURE NO.: 1	DRAWING NO.:
DATE: June 1, 2023	FILE NO.: 23-05MDCC923	1 OF 4



LEGEND

- APPROXIMATE SITE PROPERTY LINE
- APPROXIMATE ADJACENT PROPERTY LINES
- APPROXIMATE FORMER BUILDING FOOTPRINT
- MONITORING WELL LOCATION
- PIEZOMETER LOCATION
- 2015 CVOC-IMPACTED UNSATURATED SOIL REMOVAL AREA
- ESTIMATED EXTENT OF GROUNDWATER CVOCs > NR 140 ES
- PRE-DESIGN INVESTIGATION SOIL BORING LOCATION
- PROPOSED APPROXIMATE EISB INJECTION POINT LOCATION

CVOC SATURATED SOIL CONCENTRATIONS:

- CVOCs > 100,000 ug/Kg
- CVOCs > 10,000 AND < 100,000 ug/Kg
- CVOCs > 1,000 AND < 10,000 ug/Kg

NOTES:

ALL DATA IN MICROGRAMS PER KILOGRAM (ug/Kg)

CVOC - CHLORINATED VOLATILE ORGANIC COMPOUNDS

DCE - DICHLOROETHENE

DEPTH - FEET BELOW GROUND SURFACE

EISB - ENHANCED IN-SITU BIOREMEDIATION

ES - ENFORCEMENT STANDARD

J - ESTIMATED CONCENTRATION AT OR ABOVE THE LIMIT OF DETECTION AND BELOW THE LIMIT OF QUANTITATION

PCE - TETRACHLOROETHENE

PID - PHOTOIONIZATION DETECTOR READING (PPM)

PPM - PARTS PER MILLION

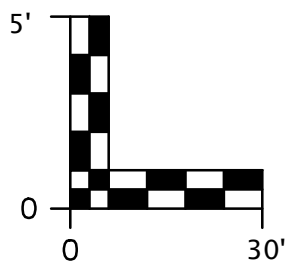
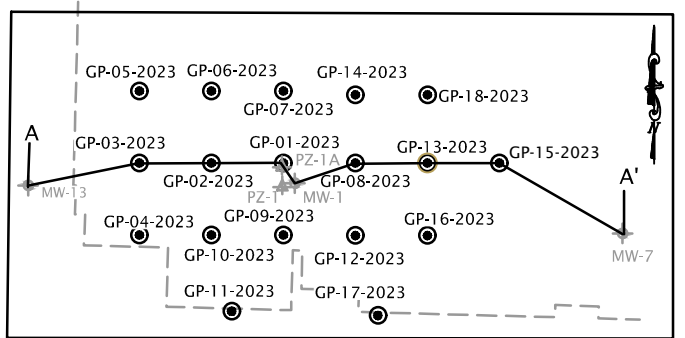
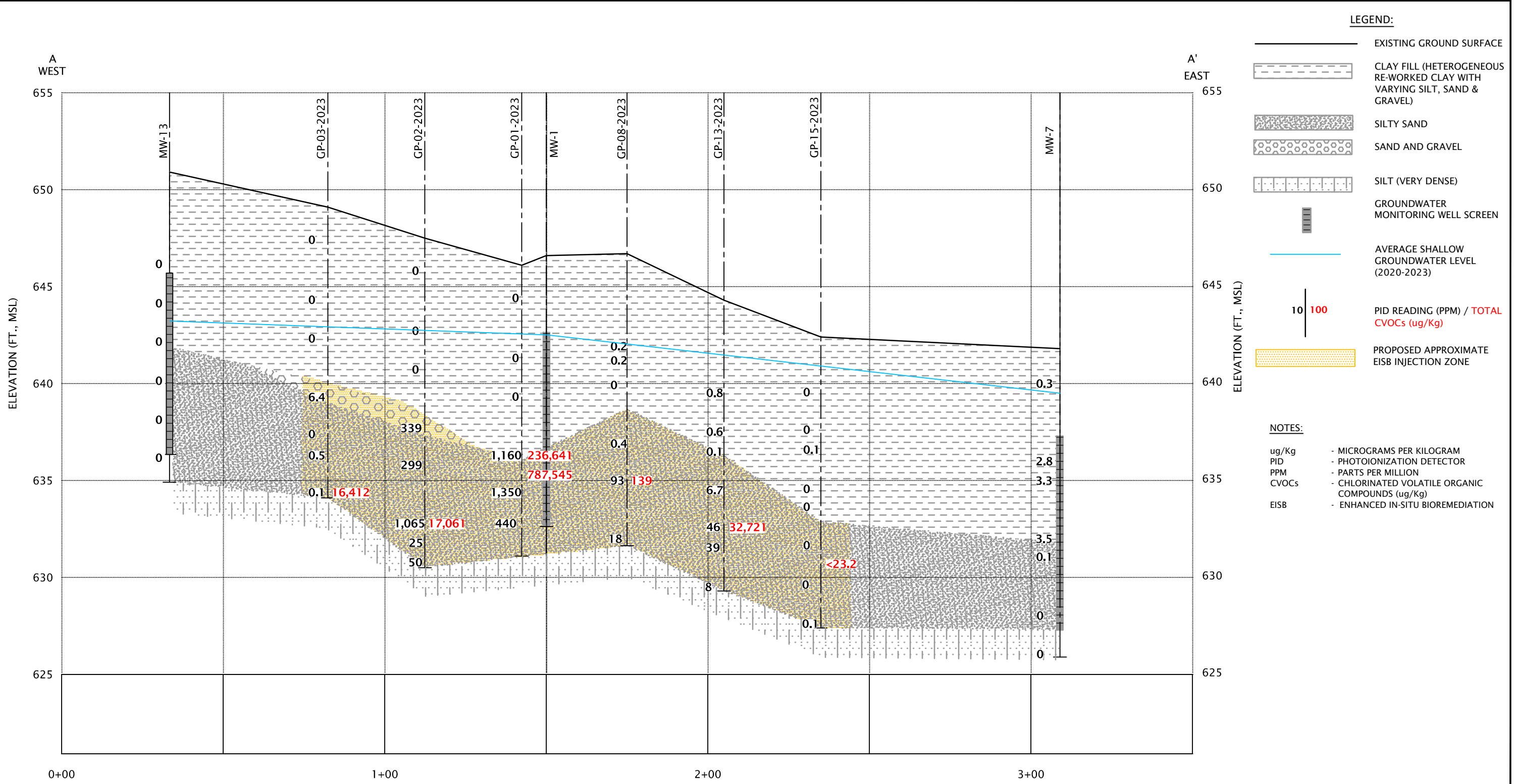
TCE - TRICHLOROETHENE

VC - VINYL CHLORIDE

SCALE IN FEET











Geosyntec consultants		
CLIENT:	PHARMACIA, LLC.	
PROJECT:	MILWAUKEE DIE CASTING COMPANY (MDCC) SITE 4132 NORTH HOLTON STREET MILWAUKEE, WISCONSIN	
TITLE:	MW-1 AREA ENHANCED IN-SITU BIOREMEDIATION INJECTION MAP	
PROJECT: CHW8271P	FIGURE NO.: 2	DRAWING NO.: 2 OF 4
DATE: June 1, 2023	FILE NO.: 2305MDCC923	



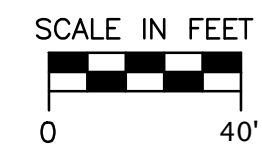
Geosyntec consultants		
CLIENT:	PHARMACIA, LLC.	
PROJECT:	MILWAUKEE DIE CASTING COMPANY (MDCC) SITE 4132 NORTH HOLTON STREET MILWAUKEE, WISCONSIN	
TITLE:	MW-1 AREA ENHANCED IN-SITU BIOREMEDIATION INJECTION ZONE MAP	
PROJECT:	CHW8271P	FIGURE NO.: 3
DATE:	June 1, 2023	FILE NO23-05 MDCC 923
DRAWING NO.:	3 OF 4	

LEGEND

-  APPROXIMATE SITE PROPERTY LINE
-  APPROXIMATE ADJACENT PROPERTY LINES
-  APPROXIMATE FORMER BUILDING FOOTPRINT
-  MW-7 MONITORING WELL LOCATION
-  PZ-6 PIEZOMETER LOCATION
-  ESTIMATED GROUNDWATER FLOW DIRECTION (SEE NOTE 1)
-  ESTIMATED EXTENT OF CVOCs > NR 140 ES (SEE NOTE 1)
-  2015 CVOC-IMPACTED UNSATURATED SOIL REMOVAL AREA

NOTES:

- ALL DATA IN MICROGRAMS PER LITER (µg/L) UNLESS NOTED
 BOX + BOLD - CONCENTRATION GREATER THAN NR 140 ES
 CVOC - CHLORINATED VOLATILE ORGANIC COMPOUNDS
 DCE - DICHLOROETHENE
 DEPTH - FEET BELOW GROUND SURFACE
 Dhc - DEHALOCOCCOIDES (e/L)
 DO - DISSOLVED OXYGEN (mg/L)
 e/L - ENUMERATION PER LITER
 ES - ENFORCEMENT STANDARD
 J - ESTIMATED CONCENTRATION AT OR ABOVE THE LIMIT OF DETECTION AND BELOW THE LIMIT OF QUANTITATION
 mg/l - MILLIGRAMS PER LITER
 mV - MILLIVOLTS
 ORP - OXIDATION-REDUCTION POTENTIAL (mV)
 PCE - TETRACHLOROETHENE
 TCE - TRICHLOROETHENE
 VC - VINYL CHLORIDE
 (1) BASED ON JULY 27, 2022 GROUNDWATER DATA

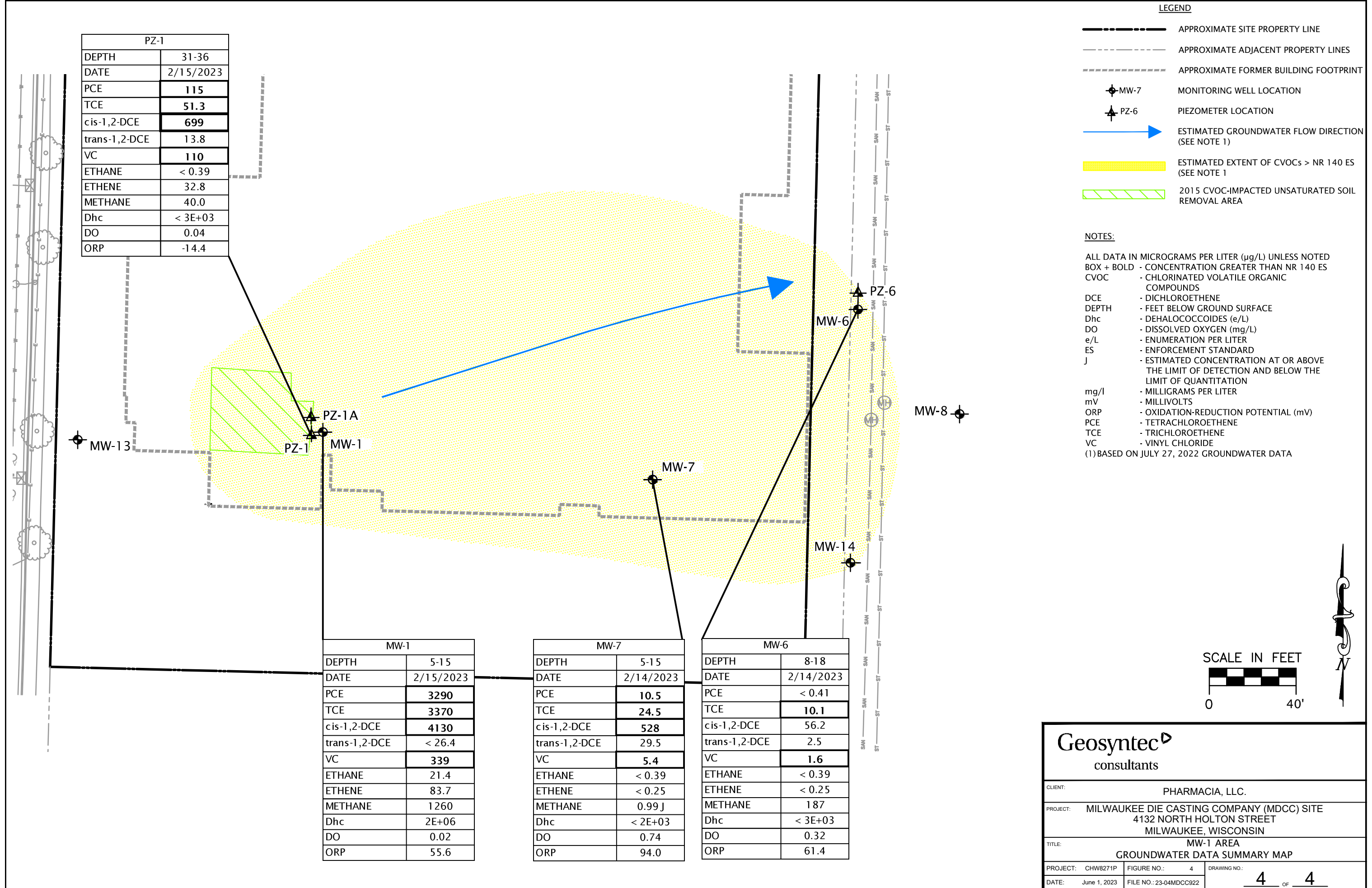


PZ-1	
DEPTH	31-36
DATE	2/15/2023
PCE	115
TCE	51.3
cis-1,2-DCE	699
trans-1,2-DCE	13.8
VC	110
ETHANE	< 0.39
ETHENE	32.8
METHANE	40.0
Dhc	< 3E+03
DO	0.04
ORP	-14.4

MW-1	
DEPTH	5-15
DATE	2/15/2023
PCE	3290
TCE	3370
cis-1,2-DCE	4130
trans-1,2-DCE	< 26.4
VC	339
ETHANE	21.4
ETHENE	83.7
METHANE	1260
Dhc	2E+06
DO	0.02
ORP	55.6

MW-7	
DEPTH	5-15
DATE	2/14/2023
PCE	10.5
TCE	24.5
cis-1,2-DCE	528
trans-1,2-DCE	29.5
VC	5.4
ETHANE	< 0.39
ETHENE	< 0.25
METHANE	0.99 J
Dhc	< 2E+03
DO	0.74
ORP	94.0

MW-6	
DEPTH	8-18
DATE	2/14/2023
PCE	< 0.41
TCE	10.1
cis-1,2-DCE	56.2
trans-1,2-DCE	2.5
VC	1.6
ETHANE	< 0.39
ETHENE	< 0.25
METHANE	187
Dhc	< 3E+03
DO	0.32
ORP	61.4



Geosyntec
consultants

CLIENT: PHARMACIA, LLC.

PROJECT: MILWAUKEE DIE CASTING COMPANY (MDCC) SITE
4132 NORTH HOLTON STREET
MILWAUKEE, WISCONSIN

TITLE: MW-1 AREA
GROUNDWATER DATA SUMMARY MAP

PROJECT: CHW8271P FIGURE NO.: 4 DRAWING NO.: 4 OF 4
 DATE: June 1, 2023 FILE NO.: 23-04MDCC922

ATTACHMENT 3

Tables

TABLE 1
Remedial Action Options Evaluation Summary - MW-1 Area Shallow Groundwater
Milwaukee Die Casting Company Site
4132 North Holton Street
Milwaukee, Wisconsin

Remedial Action Options	NR 722.13(2)(d) Description	NR 722.07(4)(a)1 and 2 Effectiveness	NR 722.07(4)(a)3 Implementability	NR 722.07(4)(a)4 Restoration Time Frame	NR 722.07(4)(b) Economic Feasibility	NR 722.09 RAO Evaluation Result
WDNR Continuing Obligations	<ul style="list-style-type: none"> placement of the Site on Wisconsin Remediation and Redevelopment Database (WRRD) for groundwater [due to the presence of residual chlorinated volatile organic compound (CVOC) groundwater concentrations greater than NR 140 enforcement standards (ESs)] water supply well prohibition 	<ul style="list-style-type: none"> considered effective as there are no potentially complete exposure pathways associated with residual CVOC groundwater concentrations at the Site 	<ul style="list-style-type: none"> already implemented at the Site 	<ul style="list-style-type: none"> not applicable 	<ul style="list-style-type: none"> low comparative implementation cost low comparative operation, maintenance and/or monitoring (OMM) cost low comparative cost uncertainty 	<p style="text-align: center;">selected</p> <p>already implemented; will be maintained</p>
Monitored Natural Attenuation (MNA)	<ul style="list-style-type: none"> groundwater monitoring data collection and evaluation to confirm that natural processes are resulting in stable or decreasing CVOC groundwater concentrations 	<ul style="list-style-type: none"> a common remedy for dissolved concentrations of CVOCs in groundwater; CVOCs are susceptible to natural processes that can attenuate concentrations in groundwater including biological degradation, abiotic degradation, sorption, dispersion, and volatilization as documented in the September 20, 2022 <i>Groundwater Monitoring Progress Report</i>, the groundwater data collected to date (8 quarterly sampling events over 2 years) demonstrate that natural anaerobic de-chlorination (degradation) processes are occurring at the Site based on observed PCE/TCE daughter products (including end product ethene) and methane and oxidation-reduction potential (ORP) data; these data also suggest that the natural degradation processes, which may include both microbial and abiotic reactions, may be limited in the MW-1 area due to low concentrations of total organic carbon (TOC) 	<ul style="list-style-type: none"> groundwater monitoring well network currently in place; 8 quarterly sampling events have been completed over the past 2 years not considered implementable as a stand alone RAO at this time based on WDNR's current position that although current groundwater trend data demonstrate relatively stable concentrations for the MW-1 area, some MW-1 area data do not demonstrate decreasing concentration trends for PCE/TCE (parent chlorinated ethenes); as such, the WDNR has communicated a concern that natural attenuation may not achieve compliance with NR 140 groundwater quality standards in a "reasonable period of time" per NR 726.05(6)(b) 	<ul style="list-style-type: none"> EPA documents median natural degradation (decay) rates for TCE of 0.11 to 0.15 per year (or half-lives of 4.6 to 6.3 years); based on this TCE half-life range and the current TCE concentration in groundwater at MW-1 [approximately 3,400 micrograms per liter (ug/L)], the theoretical calculated time to achieve the NR 140 TCE ES (5 ug/L) would theoretically be 43 to 59 years by natural attenuation 	<ul style="list-style-type: none"> low comparative implementation cost (monitoring well network in place) moderate comparative OMM cost moderate to high OMM cost uncertainty (if stand alone RAO) 	<p>limited post-EISB performance groundwater monitoring</p>
Removal and Disposal	<ul style="list-style-type: none"> excavation of MW-1 area residual saturated soil impacts from shallow groundwater target zone and disposal in licensed landfill 	<ul style="list-style-type: none"> highly effective in reducing residual MW-1 area shallow groundwater contaminant mass and mobility 	<ul style="list-style-type: none"> implementable based on current Site conditions pre-treatment of soil would likely be required to achieve the PCE and TCE land disposal restriction (LDR) concentrations, WDNR TCE "contained-out" concentrations and Toxicity Characteristic Leaching Procedure (TCLP) regulatory levels likely to require excavation dewatering and water management and potential excavated soil bulking/solidification amendment (to meet landfill paint filter test criteria) significant Site cap disturbance and repair 	<ul style="list-style-type: none"> likely to be highly effective in decreasing restoration time frame 	<ul style="list-style-type: none"> high comparative implementation cost moderate to high comparative implementation cost uncertainty low comparative OMM cost (comparative shorter period of post-remedial action groundwater monitoring) 	<p>not selected</p>
In-Situ Chemical Oxidation (ISCO)	<ul style="list-style-type: none"> vertical injection or direct mixing of reactive chemical oxidants into MW-1 area shallow groundwater target zone common oxidants for CVOCs include hydrogen peroxide (Fenton's reagent), potassium and sodium permanganate, and sodium persulfate 	<ul style="list-style-type: none"> proven successful in treating CVOCs in groundwater likely to be effective in reducing residual MW-1 area shallow groundwater contaminant mass and mobility ISCO provides rapid in situ destruction, but rebound is common (reactants are short-lived and thus may not reach contaminants in lower permeability zones, sorbed contaminants may be released following oxidation of natural organic matter and delivery challenges in which reagent fails to come in contact with a substantial fraction of the mass) variable density of target zone silty sand will likely require closely spaced injection locations and multiple injection events may be required direct mixing of reagent into the target saturated zone (following removal of unsaturated soil) would reduce delivery challenges and likely be more effective in reducing source area groundwater contaminant mass and mobility; however, direct mixing zone may require solidification amendments to maintain geotechnical stability of the treatment area ISCO changes target zone geochemistry which may have adverse impact to downgradient MNA 	<ul style="list-style-type: none"> readily implementable based on current Site conditions health and safety issues with handling and injection of oxidants and reagents WDNR NR 140 exemption for infiltration/injection required minor Site cap disturbance and repair for vertical injection; significant Site cap disturbance and repair for direct mixing 	<ul style="list-style-type: none"> likely to be effective in decreasing restoration time frame 	<ul style="list-style-type: none"> moderate comparative implementation cost for vertical injection; high comparative implementation cost for direct mixing low to moderate comparative OMM cost (post-remedial action confirmation groundwater monitoring) moderate comparative cost uncertainty (potential for multiple injection events based on delivery challenges; potential for rebound) 	<p>not selected</p>

TABLE 1
Remedial Action Options Evaluation Summary - MW-1 Area Shallow Groundwater
 Milwaukee Die Casting Company Site
 4132 North Holton Street
 Milwaukee, Wisconsin

Remedial Action Options	NR 722.13(2)(d)	NR 722.07(4)(a)1 and 2	NR 722.07(4)(a)3	NR 722.07(4)(a)4	NR 722.07(4)(b)	NR 722.09
	Description	Effectiveness	Implementability	Restoration Time Frame	Economic Feasibility	RAO Evaluation Result
Enhanced In-Situ Bioremediation (EISB)	<ul style="list-style-type: none"> in-situ treatment by direct anaerobic reductive dechlorination (primary) and abiotic reductive dechlorination (secondary) vertical injection of electron donor (carbon source) such as emulsified vegetable oil (EVO) with microbial culture additive through a series of injection points in the MW-1 area 	<ul style="list-style-type: none"> proven successful in treating CVOCs in groundwater likely to be effective in reducing residual MW-1 area shallow groundwater contaminant mass and mobility while maintaining treatment zone geochemistry allowing downgradient MNA as documented in the May 2023 Pre-Design Investigation Report, the groundwater data indicate existing reduced (anaerobic) conditions and active natural anaerobic biodegradation in the area of MW-1; however, this natural biodegradation activity is likely limited by low TOC; EISB would introduce an electron donor (carbon source) into shallow groundwater to stimulate microbial growth; this process depletes the groundwater zone of dissolved oxygen (DO) and other electron accepters including nitrate, sulfate, and ferric iron, which lowers the ORP, thereby creating the conditions for anaerobic reductive dechlorination to occur variable density of target zone silty sand will likely require closely spaced injection locations and multiple injection events may be required potential for rebound following depletion of carbon source: however, rebound potential is typically comparatively less than ISCO 	<ul style="list-style-type: none"> readily implementable based on current Site conditions WDNR NR 140 exemption for infiltration/injection required minor Site cap disturbance and repair for vertical injection 	<ul style="list-style-type: none"> likely to be effective in decreasing restoration time frame substantially greater degradation rates (i.e., lower half-lives) have been reported for chlorinated ethenes (PCE, TCE and their daughter products) following EISB; literature information indicate post-EISB half-lives for chlorinated ethenes are at least one (1) order of magnitude lower than for MNA 	<ul style="list-style-type: none"> moderate comparative implementation cost low to moderate comparative OMM cost (post-remedial action confirmation groundwater monitoring) moderate comparative cost uncertainty (potential for multiple injection events based on delivery challenges; potential for rebound) 	<p style="text-align: center;"><u>selected</u></p> <p style="text-align: center;">selected over ISCO based on MW-1 area treatment zone geochemistry and comparatively less potential for rebound</p>
Air Sparging	<ul style="list-style-type: none"> injection of air into target groundwater zone to transfer CVOCs from aqueous phase to the vapor phase (conducted in conjunction with soil vapor extraction) air sparging volatilizes contaminants and enhances aerobic biodegradation 	<ul style="list-style-type: none"> likely to be effective in reducing residual MW-1 area shallow groundwater contaminant mass and mobility variable density of target treatment zone may cause air to not flow uniformly through this zone air injection changes target zone geochemistry which may have adverse impact to downgradient MNA 	<ul style="list-style-type: none"> air injection, vapor extraction and potentially vapor-phase treatment infrastructure needed; therefore, would require integration with redevelopment reducing practical implementability at the Site significant Site cap disturbance and repair significant OMM duration uncertainty 	<ul style="list-style-type: none"> likely to be effective in decreasing restoration time frame 	<ul style="list-style-type: none"> high comparative implementation cost high comparative OMM cost high OMM cost uncertainty (comparatively high OMM duration uncertainty) 	not selected
Pump and Treat	<ul style="list-style-type: none"> vertical extraction wells or downgradient permeable collection trench to collect impacted groundwater on-site pretreatment and permitted sewer discharge 	<ul style="list-style-type: none"> likely to be effective in reducing residual MW-1 area shallow groundwater contaminant mass and mobility variable density of target treatment zone may limit effectiveness of extraction 	<ul style="list-style-type: none"> extraction and treatment infrastructure needed; therefore, would require integration with redevelopment reducing practical implementability at the Site significant Site cap disturbance and repair 	<ul style="list-style-type: none"> likely to be effective in decreasing restoration time frame 	<ul style="list-style-type: none"> high comparative implementation cost high comparative OMM cost high OMM cost uncertainty (comparatively high OMM duration uncertainty) 	not selected
Permeable Reactive Barrier (PRB)	<ul style="list-style-type: none"> passive method of treatment in-situ chemical reduction using PRB constructed using a trenched or emplaced zero-valent iron (ZVI) barrier downgradient of MW-1 area chemical reaction occurs on the surface of ZVI particles as impacted groundwater flows through the wall degrading CVOCs via abiotic reductive dehalogenation 	<ul style="list-style-type: none"> proven successful in treating CVOCs in groundwater less comparative short-term effectiveness in reducing residual MW-1 area shallow groundwater contaminant mass and mobility 	<ul style="list-style-type: none"> readily implementable based on current Site conditions WDNR NR 140 exemption for placement of reactive material in groundwater required presence of long-term barrier may restrict property redevelopment potential that barrier would require re-placement of reactive materials significant Site cap disturbance and repair 	<ul style="list-style-type: none"> comparatively less effectiveness in decreasing restoration time as this RAO does not actively treat residual source area groundwater 	<ul style="list-style-type: none"> high comparative implementation cost moderate comparative OMM cost high OMM cost uncertainty (comparatively high OMM duration uncertainty) 	not selected

ATTACHMENT 4

Enhanced In-Situ Bioremediation (EISB) - Emulsified Vegetable Oil (EVO) Injection Worksheet

ATTACHMENT 4

Enhanced In-Situ Bioremediation (EISB) - Emulsified Vegetable Oil (EVO) Injection Worksheet

MW-1 Area Shallow Groundwater
Milwaukee Die Casting Company (MDCC) Site

EISB Injection Components	Assumed Value	Calculated Value
EISB Target Amendment Zone		
Injection Point (IP) Radius of Influence (ROI) (ft)	7.5	
IP Influence Area (ft ²)		177
Target Zone Area/Footprint (ft ²)		8,129
Number Injection Points (refer to Figure 2)	46	
Top of Target Zone Depth (ft bgs) (refer to Figure 3)	8	
Bottom of Target Zone Depth (ft bgs) (refer to Figure 3)	18	
Porosity	25%	
Target Zone Pore Volume (ft ³)		20,322
Emulsified EVO Injection Quantity		
Fraction of pore volume displaced by EVO emulsion (%)	25%	
Total volume of EVO emulsion injection (gal)		38,002
Volume of EVO emulsion injection per IP (gal)		826
EVO Concentration and Quantity		
EVO Target Concentration (mg/L)		600
Target pore volumes to be amended	2	
Total volume to be amended (ft ³)		40,644
EVO concentration in pore volume (mg/L)		1,200
EVO concentration in injectate (mg/L)		4800
EVO amount (lb)		3,044
Commercial EVO product purity (Newman zone)	46%	
Newman zone amount (lb)		6,616
KB-1		
Initial DHC concentration (DHC/L)	1.00E+11	
Final concentration DHC after dilution in aquifer (DHC/L)	3.00E+06	
Volume of KB-1 required (L)		17
Volume of KB-1 per IP (L)		0.38

Electron Demand (e- equiv basis) for Site-Specific Electron Acceptors (based on Pre-Design Investigation data for MW-1; refer to Figure 4)						
Compound	MW-1 GW Concentration	Molecular Mass	Concentration	Electrons Accepted	Electron Demand	
	(µg/L)	(g/mol)	(µM)	(/mol)	(µe ⁻ /L)	(me ⁻ /L)
<i>Chlorinated Ethenes</i>						
Tetrachloroethene (PCE)	3290	165	19.94	8	159.52	0.16
Trichloroethene (TCE)	3370	131	25.73	6	154.35	0.15
Dichloroethene (DCE)	4130	97	42.58	4	170.31	0.17
Vinyl Chloride (VC)	339	62.5	5.42	2	10.85	0.01
<i>Misc Organic Species</i>						
Oxygen (O ₂) DO	1000	32	31.25	4	125.00	0.13
Nitrate (NO ₃ ⁻)	0	62	0.00	10	0.00	0.00
Sulphate (SO ₄ ²⁻)	228000	96	2375.00	8	19000.00	19.00
<i>Inorganic Solids</i>						
Iron [FeO(OH)]	1910	56	34.11	1	34.11	0.03
Total Electron Demand						19.65

bgs - below ground surface
DHC - *Dehalococcoides*
ft - feet
ft² - square feet
ft³ - cubic feet
g/L - grams per liter
g/mol - grams per mol
gal - gallons
lb - pounds
L - liters
mg/L - milligrams per liter
µg/L - micrograms per liter

Required EVO (Electron Donor) Concentration (e- equiv basis) (based on Total Electron Demand for Site-Specific Acceptors)							
Names of Typical EVO Electron Donors	Formula	Molecular Mass (g/mol)	Chemical Reactions	Electron Equivalents		Required EVO Concentration ⁽¹⁾ (mg/L)	Concentration with SF=10 ⁽²⁾ (mg/L)
				(e ⁻ /mol)	(e ⁻ /g or me ⁻ /mg)		
Oleic acid (Soybean Oil)	C ₁₈ H ₃₄ O ₂	282	C ₁₈ H ₃₄ O ₂ + 43H ₂ O = 9CO ₂ + 9HCO ₃ ⁻ + 111H ⁺ + 102e ⁻	102	0.36	54.43	544
Gamma-linolenic (Soybean Oil)	C ₁₈ H ₃₀ O ₂	278	C ₁₈ H ₃₀ O ₂ + 43H ₂ O = 9CO ₂ + 9HCO ₃ ⁻ + 107H ⁺ + 98e ⁻	98	0.35	55.84	558
Linoleic acid (Soybean Oil)	C ₁₈ H ₃₂ O ₂	280	C ₁₈ H ₃₂ O ₂ + 43H ₂ O = 9CO ₂ + 9HCO ₃ ⁻ + 109H ⁺ + 100e ⁻	100	0.36	55.12	551
Palmitic acid (Soybean Oil)	C ₁₆ H ₃₂ O ₂	256	C ₁₆ H ₃₂ O ₂ + 38H ₂ O = 8CO ₂ + 8HCO ₃ ⁻ + 100H ⁺ + 92e ⁻	92	0.36	54.78	548
Stearic acid (Soybean Oil)	C ₁₈ H ₃₆ O ₂	284	C ₁₈ H ₃₆ O ₂ + 43H ₂ O = 9CO ₂ + 9HCO ₃ ⁻ + 113H ⁺ + 104e ⁻	104	0.37	53.76	538
Assumed EVO Concentration							600

Notes:
⁽¹⁾ Required EVO concentration = total electron demand / EVO electron equivalent
⁽²⁾ a safety factor (SF) of 10 is applied to account for variability in groundwater chemistry, demand from the metal oxides (e.g., iron and manganese) and potential non-uniform amendment mixing within target zone.

ATTACHMENT 5

Enhanced In-Situ Bioremediation (EISB) Amendment Safety Data Sheets

1. PRODUCT IDENTIFICATION

TRADE NAME (AS LABELED):	Newman Zone EVO
SYNONYMS:	None known
CAS#:	Mixture
PRODUCT USE:	This product is used for soil and ground water remediation. It is formulated and processed using food grade additives, following packaging, sanitation and storage as required by Best Practices used for Food products.
CHEMICAL SHIPPING NAME/CLASS:	Non-Regulated Material
U.N. NUMBER:	None
MANUFACTURER'S NAME:	RNAS Remediation Products
ADDRESS:	6712 West River Road, Brooklyn Center, MN 55430
BUSINESS PHONE:	1-763-585-6191
EMERGENCY PHONE:	1-800-424-9300 (Chemtrec 24 Hr Service – Emergency Only)
DATE OF CURRENT REVISION:	January 16, 2016
DATE OF LAST REVISION:	July 16, 2015

2. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW: This product is a white liquid with a vegetable oil odor.

Health Hazards: Not expected to cause adverse health effects when used as intended. Prolonged or repeated exposure may cause irritation to skin. May cause irritation to eyes upon contact. Inhalation of vapors/sprays or mist may cause respiratory irritation. Ingestion of large amounts of this product may cause gastrointestinal irritation.

Flammability Hazards: This product is a Non-Flammable liquid with a flash point of >540°F (>282°C).

Reactivity Hazards: None known

Environmental Hazards: The Environmental effects of this product have not been investigated. Release of this product is not anticipated to have significant adverse effects in the aquatic environment.

US DOT SYMBOLS

CANADA (WHMIS) SYMBOLS

EUROPEAN and (GHS) Hazard Symbols

None

Non-Regulated Material

Complies with WHMIS 2015

Signal Word: **None**

GHS LABELING AND CLASSIFICATION:

This product does not meet the definition of a hazardous substance or preparation as defined by 29CFR 1910.1200 or the European Union Council Directives 67/548/EEC, 1999/45/EC, 1272/2008/EC and subsequent Directives.

EU HAZARD CLASSIFICATION OF INGREDIENTS PER DIRECTIVE 1272/2008/EC:

None of the ingredients are listed in Annex VI

Substances not listed either individually or in group entries must be self classified.

Component(s) Contributing to Classification(s):

All Ingredients

GHS Hazard Classification(s):

None known

Hazard Statement(s):

None known

Precautionary Statement(s):

None known

HEALTH HAZARDS OR RISKS FROM EXPOSURE:

SYMPTOMS OF OVEREXPOSURE BY ROUTE OF EXPOSURE: The most significant routes of overexposure for this product are by contact with skin or eyes, inhalation of vapors and ingestion. The symptoms of overexposure are described below.

ACUTE:

INHALATION: Not expected to cause adverse health effects when used as intended. Inhalation of vapors/mist/spray may cause respiratory irritation.

CONTACT WITH SKIN: Not expected to cause adverse health effects when used as intended. Prolonged and repeated contact may cause irritation to skin.

EYE CONTACT: Direct eye contact can cause irritation with redness, tearing and blurred vision.

INGESTION: Under normal conditions of intended use, this material is not expected to be an ingestion hazard. Ingestion of large quantities may cause gastrointestinal irritation, nausea and vomiting.

CHRONIC: None known

TARGET ORGANS: **Acute:** Skin, Respiratory System and Eyes **Chronic:** None known

3. COMPOSITION AND INFORMATION ON INGREDIENTS

Hazardous Ingredients:	WT%	CAS#	EINECS #	GHS Hazard Classification(s)
Food Grade Soybean Oil	45 - 55%	8001-22-7	232-274-4	None
Water	35 - 45%	7732-18-5	231-791-2	None
Food Grade Sodium-L-lactate	0 - 4%	867-56-1	212-762-3	None
Proprietary Food Grade Surfactant Blend	4 - 6%	Proprietary	Not Listed in ESIS	None
Sodium Bicarbonate	0 - 1%	144-55-8	205-633-8	None
Balance of other ingredients is less than 1% in concentration (or 0.1% for carcinogens, reproductive toxins, or respiratory sensitizers).				

NOTE: This product has been classified in accordance with the hazard criteria of 29CFR1910.1200 and the SDS contains all the information required by the CPR, EU Directives and the Japanese Industrial Standard JIS Z 7250: 2000.

4. FIRST-AID MEASURES

EYE CONTACT: If product enters the eyes, open eyes while under gentle running water for at least 15 minutes. Seek medical attention if irritation persists.

SKIN CONTACT: Wash skin thoroughly with soap and water after handling. Seek medical attention if irritation develops and persists.

INHALATION: If breathing becomes difficult, remove victim to fresh air. If necessary, use artificial respiration to support vital functions. Seek medical attention.

INGESTION: If product is swallowed, call physician or poison control center for most current information. If professional advice is not available, do not induce vomiting. Never induce vomiting or give diluents (milk or water) to someone who is unconscious, having convulsions, or who cannot swallow. Seek medical advice. Take a copy of the label and/or SDS with the victim to the health professional.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: None known

RECOMMENDATIONS TO PHYSICIANS: Treat symptoms and eliminate overexposure.

5. FIRE-FIGHTING MEASURES

FLASH POINT: Non-Flammable with flash point >540°F (>282°C)

AUTOIGNITION TEMPERATURE: Not Available

FLAMMABLE LIMITS (in air by volume, %): Lower NA Upper NA

FIRE EXTINGUISHING MATERIALS: Use fire extinguishing methods below:

Water Spray: Yes

Carbon Dioxide: Yes

Foam: Yes

Dry Chemical: Yes

Halon: Yes

Other: Any "C" Class

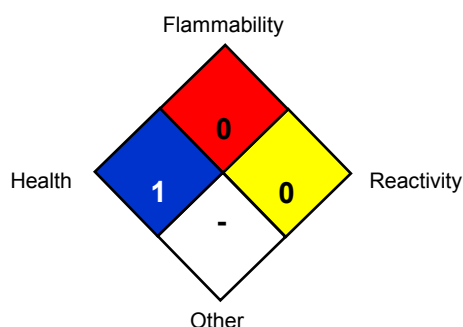
UNUSUAL FIRE AND EXPLOSION HAZARDS: Not considered a fire or explosion hazard.

Explosion Sensitivity to Mechanical Impact: No

Explosion Sensitivity to Static Discharge: No

SPECIAL FIRE-FIGHTING PROCEDURES: Incipient fire responders should wear eye protection. Structural firefighters must wear Self-Contained Breathing Apparatus and full protective equipment. Isolate materials not yet involved in the fire and protect personnel. Move containers from fire area if this can be done without risk; otherwise, cool with carefully applied water spray. If possible, prevent runoff water from entering storm drains, bodies of water, or other environmentally sensitive areas.

NFPA RATING SYSTEM



HMIS RATING SYSTEM

HAZARDOUS MATERIAL IDENTIFICATION SYSTEM			
HEALTH HAZARD (BLUE)	1		
FLAMMABILITY HAZARD (RED)	0		
PHYSICAL HAZARD (YELLOW)	0		
PROTECTIVE EQUIPMENT			
EYES	RESPIRATORY	HANDS	BODY
	See Sect 8		See Sect 8
For Routine Industrial Use and Handling Applications			

Hazard Scale: 0 = Minimal 1 = Slight 2 = Moderate 3 = Serious 4 = Severe * = Chronic hazard

6. ACCIDENTAL RELEASE MEASURES

SPILL AND LEAK RESPONSE: Stop the flow of material, if this can be done safely. Contain discharged material. Absorb spill using an absorbent, non-combustible material such as earth, sand, or vermiculite. Place in a proper container for disposal. Dispose of in accordance with U.S. Federal, State, and local hazardous waste disposal regulations and those of Canada and its Provinces, those of Australia, Japan and EU Member States (see Section 13, Disposal Considerations).

7. HANDLING and STORAGE

WORK PRACTICES AND HYGIENE PRACTICES: As with all chemicals, avoid getting this product ON YOU or IN YOU. Wash thoroughly after handling this product. Use good hygiene practices.

STORAGE AND HANDLING PRACTICES: Store in original container. Keep container closed when not in use. Store in a cool, dry location. Avoid freezing or extended storage in high temperatures and away from incompatible materials.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION

Chemical Name	CAS#	ACGIH TLV	OSHA TWA
Blend of Food Grade Soybean Oil	8001-22-7	10 mg/m ³ Oil Mists	15 mg/m ³ Oil Mists
Food Grade Sodium-L-lactate	867-56-1	Not Listed	Not Listed
Proprietary Food Grade Surfactant Blend	Proprietary	Not Listed	Not Listed
Sodium Bicarbonate	144-55-8	Not Listed	Not Listed

VENTILATION AND ENGINEERING CONTROLS: Use with adequate ventilation to ensure exposure levels are maintained below the limits provided above.

The following information on appropriate Personal Protective Equipment is provided to assist employers in complying with OSHA regulations found in 29 CFR Subpart I (beginning at 1910.132) or equivalent standard of Canada, or standards of EU member states (including EN 149 for respiratory PPE, and EN 166 for face/eye protection), and those of Japan. Please reference applicable regulations and standards for relevant details.

RESPIRATORY PROTECTION: Not required when using this product. Maintain airborne contaminant concentrations below guidelines listed above, if applicable. If necessary, use only respiratory protection authorized in the U.S. Federal OSHA Respiratory Protection Standard (29 CFR 1910.134), equivalent U.S. State standards, Canadian CSA Standard Z94.4-93, the European Standard EN149, or EU member states.

EYE PROTECTION: Safety glasses or goggles are recommended to avoid eye contact. If necessary, refer to U.S. OSHA 29 CFR 1910.133, Canadian Standards, and the European Standard EN166, Australian Standards, or relevant Japanese Standards.

SKIN PROTECTION: Wear impervious gloves for prolonged or repeated exposure as appropriate to task when using this product. If necessary, refer to U.S. OSHA 29 CFR 1910.138, the European Standard DIN EN 374, the appropriate Standards of Canada, Australian Standards, or relevant Japanese Standards.

BODY PROTECTION: Use body protection appropriate to task being performed. If necessary, refer to appropriate Standards of Canada, or appropriate Standards of the EU, Australian Standards, or relevant Japanese Standards.

9. PHYSICAL and CHEMICAL PROPERTIES

APPEARANCE (Physical State) and COLOR: This product is a white liquid with a vegetable oil odor.

ODOR: Slight

ODOR THRESHOLD: Not Applicable

pH: 7.0 – 9.0

MELTING/FREEZING POINT: Not Available

BOILING POINT: Not Available

FLASH POINT: >540°F / >282°C (For pure soybean oil)

EVAPORATION RATE (n-BuAc=1): Not Available

FLAMMABILITY (SOLID, GAS): Not Applicable

UPPER/LOWER FLAMMABILITY OR EXPLOSION LIMITS: Not Available

VAPOR PRESSURE (mm Hg @ 20°C (68°F)): Not Available

VAPOR DENSITY: Not Available

SPECIFIC GRAVITY: 0.98 – 0.99 @ 25°C

SOLUBILITY IN WATER: Dispersible in water

WEIGHT PER GALLON: 8.15 – 8.25 lb/gal

PARTITION COEFFICIENT (n-octanol/water): Not Available

AUTO-IGNITION TEMPERATURE: Not Available

DECOMPOSITION TEMPERATURE: Not Available

VISCOSITY: 24 - 200 cPs @ 20°C

10. STABILITY and REACTIVITY

STABILITY: Stable under conditions of normal storage and use.

HAZARDOUS DECOMPOSITION PRODUCTS: Thermal decomposition products include oxides of carbon.

MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE: Strong oxidizing materials.

POSSIBILITY OF HAZARDOUS REACTIONS: Will not occur.

CONDITIONS TO AVOID: Incompatible materials

11. TOXICOLOGICAL INFORMATION

TOXICITY DATA:

No LD50 Data available for this product.

SUSPECTED CANCER AGENT: Ingredients within this product are not found on the following lists: FEDERAL OSHA Z LIST, NTP, IARC, or CAL/OSHA and therefore are not considered to be, nor suspected to be, cancer-causing agents by these agencies.

IRRITANCY OF PRODUCT: No specific data available

SENSITIZATION TO THE PRODUCT: This product is not a skin and respiratory sensitizer

REPRODUCTIVE TOXICITY INFORMATION: No information concerning the effects of this product and its components on the human reproductive system.

12. ECOLOGICAL INFORMATION

ALL WORK PRACTICES MUST BE AIMED AT ELIMINATING ENVIRONMENTAL CONTAMINATION.

ENVIRONMENTAL STABILITY: No specific data available on this product.

CHEMICAL EFFECT ON PLANTS, ANIMALS AND AQUATIC LIFE: This product is not expected to cause significant harm to plants, animals or aquatic life.

WATER ENDANGERMENT CLASS: Water endangering in accordance with EU Guideline 91/155-EWG – Not Determined.

SPECIFIC AVAILABLE COMPONENT INFORMATION: No additional data available at this time.

13. DISPOSAL CONSIDERATIONS

PREPARING WASTES FOR DISPOSAL: Waste disposal must be in accordance with appropriate U.S. Federal, State, and local regulations, those of Canada, Australia, EU Member States and Japan.

EU Waste Code: Not determined

14. TRANSPORTATION INFORMATION

US DOT, IATA, IMO, ADR:

U.S. DEPARTMENT OF TRANSPORTATION (DOT) SHIPPING REGULATIONS: This product is classified (per 49 CFR 172.101) by the U.S. Department of Transportation, as follows.

PROPER SHIPPING NAME: Non-Regulated Material

HAZARD CLASS NUMBER and DESCRIPTION: None

UN IDENTIFICATION NUMBER: None

PACKING GROUP: NA

DOT LABEL(S) REQUIRED: None

NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER: None

RQ QUANTITY: None

MARINE POLLUTANT: The components of this product are not designated by the Department of Transportation to be Marine Pollutants (49 CFR 172.101, Appendix B).

INTERNATIONAL AIR TRANSPORT ASSOCIATION SHIPPING INFORMATION (IATA): This product is not considered as dangerous goods.

INTERNATIONAL MARITIME ORGANIZATION SHIPPING INFORMATION (IMO): This product is not considered as dangerous goods.

EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD (ADR): This product is not considered by the United Nations Economic Commission for Europe to be dangerous goods.

15. REGULATORY INFORMATION

UNITED STATES REGULATIONS:

U.S. SARA REPORTING REQUIREMENTS: The components of this product are subject to the reporting requirements of Sections 302, 304, and 313 of Title III of the Superfund Amendments and Reauthorization Act as follows: None

U.S. SARA THRESHOLD PLANNING QUANTITY: There are no specific Threshold Planning Quantities for the components of this product. The default Federal SDS submission and inventory requirement filing threshold of 10,000 lbs (4,540 kg) therefore applies, per 40 CFR 370.20.

U.S. CERCLA REPORTABLE QUANTITY (RQ): None

U.S. TSCA INVENTORY STATUS: The components of this product are listed on the TSCA Inventory or are exempted from listing.

OTHER U.S. FEDERAL REGULATIONS: None

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): Ingredients within this product are not on the Proposition 65 Lists.

CANADIAN REGULATIONS:

CANADIAN DSL/NDSL INVENTORY STATUS: The components of this product are on the DSL Inventory, or are exempted from listing.

OTHER CANADIAN REGULATIONS: Not applicable.

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA) PRIORITIES SUBSTANCES LISTS:

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the SDS contains all of the information required by those regulations.

CANADIAN WHMIS CLASSIFICATION and SYMBOLS: Complies with WHMIS 2015

EUROPEAN ECONOMIC COMMUNITY INFORMATION:

This product does not meet the definition of a hazardous substance or preparation as defined by the European Union Council Directives 67/548/EEC, 1999/45/EC, 1272/2008/EC and subsequent Directives.

See Section 2 for Details

AUSTRALIAN INFORMATION FOR PRODUCT: The components of this product are listed on the International Chemical Inventory list.

JAPANESE INFORMATION FOR PRODUCT:

JAPANESE MINISTER OF INTERNATIONAL TRADE AND INDUSTRY (MITI) STATUS: The components of this product are not listed as Class I Specified Chemical Substances, Class II Specified Chemical Substances, or Designated Chemical Substances by the Japanese MITI.

JAPANESE ENCS INVENTORY: The components of this product are on the ENCS Inventory as indicated in the section on International Chemical Inventories, below.

POISONOUS AND DELETERIOUS SUBSTANCES CONTROL LAW: No component of this product is a listed Specified Poisonous Substance under the Poisonous and Deleterious Substances Control Law.

INTERNATIONAL CHEMICAL INVENTORIES:

Listing of the components on individual country Chemical Inventories is as follows:

Asia-Pac: Listed or Exempt from listing

Australian Inventory of Chemical Substances (AICS): Listed or Exempt from listing

Korean Existing Chemicals List (ECL): Listed or Exempt from listing

Japanese Existing National Inventory of Chemical Substances (ENCS): Listed or Exempt from listing

Philippines Inventory of Chemicals and Chemical Substances (PICCS): Listed or Exempt from listing

Swiss Giftlist List of Toxic Substances: Listed or Exempt from listing

U.S. TSCA: Listed

16. OTHER INFORMATION

ABBREVIATIONS AND ACRONYMS:

EPA: United States Environmental Protection Agency

ARD: European Agreement concerning the International Carriage of Dangerous Goods by Road

IMDG: International Maritime Code for Dangerous Goods

DOT: US Department of Transportation

IATA: International Air Transport Association

ACGIH: American Conference of Governmental Industrial Hygienists

NFPA: National Fire Protection Association (USA)

HMIS: Hazardous Materials Identification System (USA)

PREPARED BY: Paul Eigbrett – **(GHS MSDS Compliance PLUS)**

DATE OF PRINTING: January 16, 2016

The information contained herein is believed to be accurate but is not warranted to be so. Data and calculations are based on information furnished by the manufacturer of the product and manufacturers of the components of the product. Users are advised to confirm in advance of the need that information is current, applicable and suited to the circumstances of use. RNAS Remediation Products assumes no responsibility for injury to vendee or third party person proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Furthermore, RNAS Remediation Products assumes no responsibility for injury caused by abnormal use of this material even if reasonable safety procedures are followed.

END OF SDS SHEET

SAFETY DATA SHEET

1. CHEMICAL IDENTIFICATION AND COMPANY INFORMATION

Product Name: KB-1®
Company Info: SiREM
 130 Stone Rd. W., Guelph, Ontario, Canada, N1G 3Z2
 Phone: 519-822-2265
 Toll Free, North America: 1-866-251-1747
 Fax: 888-635-3470
www.siremlab.com

Emergency Phone Number: 519-822-2265 (for 24/7 assistance, contact poison center hotline in your jurisdiction).

Description: Microbial inoculum (non-pathogenic, non-hazardous) in growth media consisting of a dilute aqueous solution of mineral salts and nutrients.

Recommended Use: Bioremediation of contaminated groundwater.

Restrictions on Use: KB-1® product intended for laboratory research and field applications for cleanup of contaminated groundwater. Products are not intended to be used as human or animal therapeutics, cosmetics, agricultural or pesticide products, food additives, or as household chemicals.

2. HAZARDS IDENTIFICATION

GHS Classification: Not classified as “hazardous” per OSHA 29 CFR 1910.1200, “Hazard Communication”.

GHS Label elements, including hazard and precautionary statements: Not Applicable.

HMIS Rating:	Health	Flammability	Physical Hazard	Personal Protection
	1	0	0	B*
NFPA Rating:	Health	Flammability	Reactivity	Special Hazard
	1	0	0	N/A

* B = Safety Glasses, Gloves.

A review of available data indicates minimal potential for health effects related to normal use of this product. Microbial components are non-pathogenic. The product is not expected to be a health hazard as a result of inhalation of mists, ingestion or skin contact. Eye contact may result in mild irritation/redness. Normal hygiene precautions should be observed, including eye protection, skin protection, and hand washing. The potential exists for individuals with hypersensitivity to biological materials to exhibit allergic sensitivity to biological components of this product (see Section 4, “First Aid Measures”).

3. COMPOSITION/INFORMATION ON INGREDIENTS

KB-1® is a microbial culture grown in an aqueous dilute solution of mineral salts and nutrients classified as non-hazardous in accordance with provisions of OSHA 29 CFR 1910.1200, "Hazard Communication."

The microbial composition of KB-1®, as determined by phylogenetic analysis, includes:

- Dehalococcoides sp.*
- Geobacter sp.*
- Methanomethylovorans sp.*

Identification of organisms was obtained by matching 16S rRNA gene sequence of organisms in KB-1® to other known organisms. The characteristics of related organisms can be used to identify potential or likely characteristics of organisms in KB-1®.

4. FIRST AID MEASURES

Avoid direct contact with skin and eyes. In any case of any exposure which elicits a response, a physician should be consulted immediately.

Route of Entry	Symptoms	First Aid Procedures
Ingestion	Upset stomach, irritation of digestive tract.	Do not induce vomiting. Drink several cups of water. Seek medical attention.
Skin contact	Skin irritation – reddening, itching or inflammation.	Remove contaminated clothes. Wash skin with plenty of water and soap. Seek medical attention if irritation develops or open wounds are present.
Eye contact	Eye irritation – redness, tearing, blurred vision.	Rinse immediately with plenty of water for 15 – 20 minutes, lifting lower and upper eyelids occasionally (remove contact lenses if easily possible). Seek medical attention if undue irritation or redness occurs.
Inhalation of mist	Respiratory irritation, coughing, breathing difficulty.	Remove victim to fresh air. Administer first aid as appropriate for symptoms. Seek medical attention if serious symptoms occur.

5. FIRE FIGHTING MEASURES

- General: This material is non-flammable, consisting primarily of water, and poses no special hazards if involved in a fire situation.
- Suitable extinguishing media: If material is involved in fire situation, use extinguishing media suitable for surrounding fire.
- Special protective equipment and precautions for firefighters: No special equipment necessary; use equipment appropriate for surrounding fire.
- Hazardous combustion products: Not applicable.
- Toxic gases produced: Not applicable.
- Shock/impact sensitivity: Not shock sensitive.

6. ACCIDENTAL RELEASE MEASURES

Method of containment and cleanup:

Spilled KB-1[®] should be soaked up with sorbent and saturated with a 10% bleach solution (prepared by making a one in ten dilution of diluted standard bleach [normally sold at a strength of 5.25% sodium hypochlorite] to disinfect affected surfaces. Sorbent should be double bagged and disposed of as indicated in Section 13. After removal of sorbent, area should be washed with 10% bleach solution to disinfect. If liquid from the culture vessel is present on the fittings, non-designated tubing or exterior of the stainless steel pressure vessel liquid should be wiped off and the area washed with 10% bleach solution.

Ventilation:

No special ventilation is required in the event of the spill, as the material consists of water and non-volatile constituents. If the potential for generation of mist exists, open windows and provide adequate ventilation. If high levels of mist are encountered, use personal protective equipment indicated below.

Eye/skin protection:

Have eye-washing facilities readily available where eye contact can occur. Wash skin with soap and water. Use appropriate protective gloves when handling. Showering and changing into street clothes after work is recommended.

Protective equipment for airborne mist:

A NIOSH/MSHA approved dust mask or air purifying respirator with dust/mist filter is recommended where elevated concentrations of airborne mist are expected.

7. HANDLING AND STORAGE

Handling and storage precautions:

Use personal protective equipment (eye & skin protection) and hygiene measures (hand washing) to minimize contact with the material.

KB-1[®] is shipped in stainless steel pressure vessels and connected to injection lines and inert gas is used to pressurize the vessel to displace the contents. KB-1[®] should be handled with care to avoid any spillage. Vessels are shipped with 1 to 5 pound per square inch (psi) pressure; valves should not be opened until connections to appropriate lines for subsurface injection are in place.

During storage, avoid exposing stainless steel pressure vessels to undue temperature extremes (i.e., temperatures less than 0°C or greater than 30°C may result in harm to the microbial cultures and damage to the vessels). All valves should be in the closed position when the vessel is not pressurized to prevent the escape of gases and to maintain anaerobic conditions in the vessel.

Incompatibilities:

Avoid exposure of the culture to air as the presence of oxygen will kill the microbes.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

OSHA Permissible Exposure Limits (PELs):	No occupational exposure limits are established for microbial constituents. Mixture is not classified as “hazardous” in accordance with 29 CFR 1910.1200 “Hazard Communication,” exceedance of exposure limits is not anticipated either under normal conditions of use, or as the result of an accidental release.
ACHIH Threshold Limit Values (TLVs):	
Engineering controls:	Generally not required under normal conditions of use. If method of use will result in significant mist generation, use under conditions of adequate ventilation.
Work practices:	Use good hygiene practices, avoid mist generation, and minimize contact with the material as a general precautionary measure.
Personal protective equipment:	Under normal conditions of use, wear safety glasses, protective gloves (latex, vinyl or nitrile) and steel toed footwear as general precautionary measures, particularly when opening pressure vessel valves or when pressurizing vessels to inject contents into the subsurface environment. For laboratory use, also wear lab coat. For higher risk of eye contact, wear safety goggles or face shield, as appropriate. Respiratory protection is not required under normal conditions of use (see Section 6, “Accidental Release Measures.”

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance, physical state:	Aqueous liquid, dark grey, slightly turbid under anaerobic conditions, pink if exposed to air (oxygen).
Odor:	Pungent (“skunky”) odor.
Solubility:	Soluble in water.
pH:	6.5 – 7.5
Melting range	Not determined, approximately equivalent to water.
Vapor density:	Not determined, approximately equivalent to water.
Vapor pressure:	Not determined, approximately equivalent to water.
Relative density:	Not determined, approximately equivalent to water.
Evaporation rate:	Not determined, approximately equivalent to water.
Initial Boiling point, boiling range	Not determined, approximately equivalent to water.
Flammability	Not flammable.
Partition coefficient	Not applicable
Auto-ignition temperature	Not applicable
Decomposition temperature:	No data, bacterial contents will decompose by heating.
Flash point	N/A

10. STABILITY AND REACTIVITY

Chemical stability and reactivity:	Stable and non-reactive.
Possibility of hazardous reactions:	Stable. Spontaneous hazardous chemical reactions / decomposition will not occur.
Conditions to avoid:	Maintain under anaerobic conditions to preserve product integrity (exposure to air/oxygen will kill microbes).
Incompatible materials:	Strong oxidizers, acids, water reactive materials.
Hazardous decomposition products:	Not applicable.
Shock sensitivity:	Not shock sensitive; will not decompose and form shock sensitive compounds.

11. TOXICOLOGICAL INFORMATION

Potential for pathogenicity: KB-1® has tested **negative** (i.e., the organisms are not present) for a variety of pathogenic organisms indicated below:

Pathogenic Organisms	Disease(s) Caused	Test Results
<i>Salmonella sp.</i>	<i>Typhoid fever, gastroenteritis</i>	Not Detected
<i>Listeria monocytogenes</i>	<i>Listerioses</i>	“
<i>Vibrio sp.,</i>	<i>Cholera, gastroenteritis</i>	“
<i>Campylobacter sp.,</i>	<i>Bacterial diarrhea</i>	“
<i>Clostridia sp.,</i>	<i>Food poisoning, botulism, tetanus, gas gangrene</i>	“
<i>Bacillus anthracis</i>	<i>Anthrax</i>	“
<i>Pseudomonas aeruginosa</i>	<i>Wound infection</i>	“
<i>Yersinia sp.,</i>	<i>Bubonic plague, intestinal infection</i>	“
<i>Yeast and Mold</i>	<i>Candidiasis, yeast infection etc.</i>	“
<i>Fecal coliforms</i>	<i>Indicator organisms for many human pathogens diarrhea, urinary tract infections</i>	“
<i>Enterococci</i>	<i>Various opportunistic infections</i>	“

While there is no evidence that virulent pathogenic organisms are present in KB-1®, there is potential that certain organisms in KB-1® may have the potential to act as opportunistic (mild) pathogens, particularly in individuals with open wounds and/or compromised immune systems. For this reason standard hygienic procedures such as hand washing after use should be observed.

12. ECOLOGICAL INFORMATION

This product is not rated as “hazardous” as either an acute or chronic ecological hazard, in accordance with the OSHA Hazard Communication standard, 29 CFR 1910.1200.

13. DISPOSAL CONSIDERATION

Material must be disinfected or sterilized prior to disposal. Consult local regulations prior to disposal.

14. TRANSPORT INFORMATION

U.S. (D.O.T.):	Proper Shipping Name:	Culture of Micro-organisms
	Hazard Class:	Not applicable
	UN/NA:	Not applicable
	Labels:	Not applicable

Canada (T.D.G.)	Proper Shipping Name:	Culture of Micro-organisms
	Hazard Class:	Not applicable
	UN/NA:	Not applicable
	Labels:	Not applicable

International: IMDG:	Proper Shipping Name:	Culture of Micro-organisms
	Hazard Class:	Not applicable
	UN/NA:	Not applicable
	Labels:	Not applicable

IATA:	Proper Shipping Name:	Culture of Micro-organisms
	Hazard Class:	Not applicable
	UN/NA:	Not applicable
	Labels:	Not applicable

15. REGULATORY INFORMATION

TSCA:	No
-------	----

SARA TITLE III

Section 302 (EHS) Ingredients:	No
--------------------------------	----

Section 313 Ingredients:	No
--------------------------	----

Section 304 (EHS/CERCLA) Ingredients:	No
---------------------------------------	----

SARA TITLE III NOTIFICATION INFORMATION

Acute Health Hazard:	No
----------------------	----

Chronic Health Hazard:	No
------------------------	----

Fire Hazard:	No
--------------	----

Sudden Release of Pressure Hazard:	No
------------------------------------	----

16. OTHER INFORMATION

SiREM provides the information contained herein for hazard communication and safety planning purposes, based on existing information on each of the product components available in the literature; no independent testing was conducted on the final product. The above information is intended to be used only as a guide to the appropriate precautionary handling of this material by a properly trained person.

SECTION 1 - PRODUCT AND COMPANY IDENTIFICATION

1.1 PRODUCT NAME:	KB-1[®] Primer
PRODUCT CODE:	N/A
CHEMICAL FAMILY NAME:	Mixture
U.N. NUMBER:	None
U.N. DANGEROUS GOODS CLASS:	Not Regulated
1.2 PRODUCT USE:	For preparation of anaerobic water for use in groundwater remediation. KB-1 [®] products are intended for laboratory research and field applications for groundwater remediation, and are not intended to be used as human or animal therapeutics, cosmetics, agricultural or pesticidal products, food additives, or as household chemicals.
1.3 SUPPLIER/MANUFACTURER'S NAME:	SiREM
ADDRESS:	130 Stone Road, West, Guelph, Ontario Canada N1G 3Z2
1.4 EMERGENCY PHONE:	519-515-0840
BUSINESS PHONE:	519-515-0840 (Product Information)
WEB SITE:	www.siremlab.com
1.5 DATE OF PREPARATION:	December 05, 2018
DATE OF LAST REVISION:	New

SECTION 2 - HAZARDS IDENTIFICATION

2.1 Classification of the mixture:

This product does meet the definition of a hazardous substance or preparation as defined by 29 CFR 1910. 1200 AND the European Union Council Directives 67/548/EEC, 1999/45/EC, 1272/2008/EC, 2015/830/EU and subsequent Directives.

Component(s) Contributing to Classification(s)

L-Cysteine

2.2 GHS Label elements, including precautionary statements:

Pictogram(s):

None applicable.

Signal Word:

Warning!

GHS Hazard Classification(s):

Acute Toxicity Category 5 (Oral)

Hazard Statement(s):

H303: May be harmful if swallowed

Prevention Statement(s):

None Applicable

Response Statement(s):

P312: Call a POISON CENTER/doctor if you feel unwell.

Storage Statement(s):

None Applicable

Disposal Statement(s):

None Applicable.

2.3 Other Hazards:

This mixture does not meet the criteria for PBT or vPvB in accordance with Annex VII.

SECTION 3 - COMPOSITION and INFORMATION ON INGREDIENTS

3.1 Substances: Not applicable

3.2 Mixtures:

HAZARDOUS INGREDIENTS:	CAS #	EINECS #	Index #	WT %	GHS CLASSIFICATION
L-Cysteine	52-90-4	200-158-2	Not Listed	1-10%	ACUTE TOX. CAT 4 (ORAL)
Balance of other ingredients are non-hazardous or hazardous below the applicable cut-off level.					

Additional Information: See SECTION 16 for full classification phrases.

SECTION 4 - FIRST-AID MEASURES

4.1 Description of first aid measures:

Contaminated individuals of chemical exposure must be taken for medical attention if any adverse effect occurs. Rescuers should be taken for medical attention, if necessary. Take copy of label and SDS to health professional with contaminated individual.

EYE CONTACT: If product enters the eyes, open eyes while under gentle running water for at least 15 minutes. Seek medical attention if irritation persists.

SKIN CONTACT: Wash skin thoroughly after handling. Seek medical attention if irritation develops and persists. Remove contaminated clothing. Launder before re-use.

INHALATION: If breathing becomes difficult, remove victim to fresh air. If necessary, use artificial respiration to support vital functions. Seek medical attention.

INGESTION: If product is swallowed, call physician or poison control center for most current information. If professional advice is not available, do not induce vomiting. Never induce vomiting or give diluents (milk or water) to someone who is unconscious, having convulsions, or who cannot swallow. Seek medical advice. Take a copy of the label and/or SDS with the victim to the health professional.

4.2 Most important symptoms and effects, both acute and delayed:

May be harmful if swallowed. See section 11 for additional information.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Pre-existing skin problems may be aggravated by prolonged or repeated contact.

4.3 Indication of immediate medical attention and special treatment needed:

Treat symptoms and reduce over-exposure.

SECTION 5 - FIRE-FIGHTING MEASURES

5.1 Extinguishing media:

Use media suitable for surrounding area. Carbon dioxide, foam, dry chemical, halon, water spray.

5.2 Specific hazards arising from the chemical:

No data available for this product.

<u>Explosion Sensitivity to Mechanical Impact:</u>	Not Sensitive.
<u>Explosion Sensitivity to Static Discharge:</u>	Not Sensitive
<u>Minimum Ignition Energy (M.I.E.)</u>	No Data at this time

5.3 Special firefighting Procedure:

Incipient fire responders should wear eye protection. Structural firefighters must wear Self-Contained Breathing Apparatus and full protective equipment. Isolate materials not yet involved in the fire and protect personnel. Move containers from fire area if this can be done without risk; otherwise, cool with carefully applied water spray. If possible, prevent runoff water from entering storm drains, bodies of water, or other environmentally sensitive areas.

SECTION 6 - ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures:

No action shall be taken involving any personal risk or without suitable training. Do not touch or walk through spilled material. Avoid breathing dust. Provide adequate ventilation. Use appropriate respirator when ventilation is inadequate and use personal protective clothing as described in Section 8 of this safety data sheet. See section 11 for additional information on health hazards.

6.2 Environmental precautions:

No specific data available for this product.

6.3 Methods and material for containment and cleaning up:

Wear suitable protective clothing. Avoid dust formation. Avoid breathing dust. Carefully sweep up and remove. Place material in a dry container and cover. Remove from the area. Flush spill area with water. Do not let products enter drains. Dispose of in accordance with applicable Federal, State, and local procedures (see Section 13, Disposal Considerations).

SECTION 7 - HANDLING and STORAGE

7.1 Precautions for safe handling:

As with all chemicals, avoid getting this product ON YOU or IN YOU. Wash thoroughly after handling this product. Do not eat, drink, smoke, or apply cosmetics while handling this product. Use in a well-ventilated location. Remove contaminated clothing immediately

7.2 Conditions for safe storage, including any incompatibilities:

Store in a tightly sealed container in a cool, dry and well-ventilated place. Store away from direct light. Avoid generation of dust. Do not breathe dust. Wash thoroughly after handling. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. Wear suitable protective clothing. Segregate from strong oxidizing agents, acids, bases.

7.3 Specific end uses:

See section 1.2.

SECTION 8 - EXPOSURE CONTROLS - PERSONAL PROTECTION

8.1. Control parameters:

EXPOSURE LIMITS/GUIDELINES: None established for this product.

8.2 Exposure Controls:

Currently, International exposure limits are not established for the components of this product. Please check with competent authority in each country for the most recent limits in place.

VENTILATION AND ENGINEERING CONTROLS: Generally not required under normal conditions of use. If method of use will result in significant dust generation, use in lab hood or under conditions of adequate ventilation.

The following information on appropriate Personal Protective Equipment is provided to assist employers in complying with OSHA regulations found in 29 CFR Subpart I (beginning at 1910.132) or equivalent standard of Canada, or standards of EU member states (including EN 149 for respiratory PPE, and EN 166 for face/eye protection), and those of Japan. Please reference applicable regulations and standards for relevant details.

RESPIRATORY PROTECTION: Maintain airborne contaminant concentrations below guidelines listed above, if applicable.

If necessary, use only respiratory protection authorized in the U.S. Federal OSHA Respiratory Protection Standard (29 CFR 1910.134), equivalent U.S. State standards, Canadian CSA Standard Z94.4-93, the European Standard EN149, or EU member states.

EYE PROTECTION: Safety glasses or chemical goggles as appropriate to prevent eye contact. If necessary, refer to U.S. OSHA 29 CFR 1910.133 or appropriate Canadian Standards.

HAND PROTECTION: Use chemical resistant gloves to prevent skin contact. If necessary, refer to U.S. OSHA 29 CFR 1910.138 or appropriate Standards of Canada.

BODY PROTECTION: Use body protection appropriate to prevent contact (e.g. lab coat, overalls). If necessary, refer to appropriate Standards of Canada, or appropriate Standards of the EU, Australian Standards, or relevant Japanese Standards.

SECTION 9 - PHYSICAL and CHEMICAL PROPERTIES**9.1 Information on basic physical and chemical properties:**

PHYSICAL STATE:	Solid (Granules)
APPEARANCE:	White to off-white powder or granules
ODOR:	Odorless
ODOR THRESHOLD (PPM):	Not Available
pH:	6-8 (aqueous solution)
MELTING / FREEZING POINT (C°):	Not Available
BOILING POINT (C°):	Not Available
FLASH POINT:	Not Available
EVAPORATION RATE (nBuAc = 1):	Not Available
FLAMMABILITY (solid, gas):	Not Available
FLAMMABLE LIMITS (in air by volume, %):	Not Available
VAPOR PRESSURE (mmHg):	Not Available
VAPOR DENSITY (AIR=1):	Not Available
RELATIVE DENSITY	2.4 to 2.6 g/cm ³ , depending on formulation
SOLUBILITY IN WATER (%)	Soluble
PARTITION COEFFICIENT: N-OCTANOL/WATER:	Not Available
AUTOIGNITION TEMPERATURE:	Not Available
DECOMPOSITION TEMPERATURE:	Not Available
VISCOSITY:	Not Available
EXPLOSIVE PROPERTIES:	Not Available
OXIDISING PROPERTIES:	Not Available
9.2 Other Information:	
PACKING DENSITY:	Not Available
VOC:	Not Available

SECTION 10 - STABILITY and REACTIVITY

10.1 Reactivity: See section 10.5.

10.2 Chemical Stability: Product is stable.

10.3 Possibility of Hazardous Reactions: Under normal conditions of storage and use, hazardous reactions will not occur.

10.4 Conditions to avoid: Contact with incompatibles, exposure to light, and moist air.

10.5 Incompatible materials: Strong oxidizing agents, bases.

10.6 Hazardous Decomposition Products: Carbon monoxide, carbon dioxide, nitrogen oxides, sulfur oxides, potassium oxides.

SECTION 11 - TOXICOLOGICAL INFORMATION**11.1 Information on Toxicological Effects:****TOXICITY DATA:**

L-Cysteine CAS# 52-90-4

Oral LD50 1890 mg/kg Rat

Oral LD50 660 mg/kg Mouse

11.1.2 Mixtures:

Acute toxicity	Acute Toxicity Category 5 (Oral)
Skin corrosion / irritation	Based on available data, the classification criteria are not met
Serious eye damage / irritation	Based on available data, the classification criteria are not met
Respiratory or skin sensitization	Based on available data, the classification criteria are not met
Germ cell mutagenicity	Based on available data, the classification criteria are not met
Carcinogenicity	Based on available data, the classification criteria are not met
Reproductive toxicity	Based on available data, the classification criteria are not met
STOT-single exposure	Based on available data, the classification criteria are not met
STOT-repeated exposure	Based on available data, the classification criteria are not met
Aspiration hazard	Based on available data, the classification criteria are not met

Other Information

POTENTIAL HEALTH HAZARDS OR RISKS FROM EXPOSURE:

ACUTE:

EYE CONTACT: Eye exposure may produce irritation.

SKIN CONTACT: Prolonged or repeated skin exposure may cause irritation.

INHALATION HAZARDS: Inhalation of dusts may cause irritation.

INGESTION HAZARDS: May be harmful if swallowed. May cause gastrointestinal tract irritation.

CHRONIC: None Known

TARGET ORGANS: ACUTE: Organs CHRONIC: None Known

CARCINOGENICITY: None of the ingredients are found on the following lists: FEDERAL OSHA Z LIST, NTP, CAL/OSHA, IARC and therefore are not considered to be, nor suspected to be a cancer-causing agent by these agencies.

IRRITANCY OF PRODUCT: Contact with this product can be irritating to skin and eyes.

SENSITIZATION OF PRODUCT: This product is not considered a skin sensitizer.

REPRODUCTIVE TOXICITY INFORMATION: No information concerning the effects of this product and its components on the human reproductive system.

MUTAGENICITY INFORMATION: This product does not contain a component that is suspected to be a mutagenicity hazard.

SPECIFIC TARGET ORGAN TOXICITY – SINGLE EXPOSURE: Data not sufficient for classification.

SPECIFIC TARGET ORGAN TOXICITY – REPEATED EXPOSURE: Data not sufficient for classification.

ASPIRATION HAZARD: Not applicable

SECTION 12 - ECOLOGICAL INFORMATION

ALL WORK PRACTICES MUST BE AIMED AT ELIMINATING ENVIRONMENTAL CONTAMINATION.

12.1 Toxicity:

No specific data available on this product.

12.2 Persistence and Degradability:

No specific data available on this product.

12.3 Bioaccumulative Potential:

No specific data available on this product.

12.4 Mobility in Soil:

No specific data available on this product.

12.5 Results of PBT and vPvB Assessment:

No specific data available on this product.

12.6 Other Adverse Effects:

No specific data available on this product.

12.7 Water Endangerment Class:

Not believed to be water endangering in accordance with EU Guideline 91/155-EWG. At present there are no ecotoxicological assessments for this product.

SECTION 13 - DISPOSAL CONSIDERATIONS

13.1 Waste Treatment Methods:

Waste disposal must be in accordance with appropriate Federal, State, and local regulations, those of Canada, Australia, EU Member States and Japan.

SECTION 14 - TRANSPORTATION INFORMATION

14.1 Transport Information:

US DOT; IATA; IMO; ADR:

THIS PRODUCT IS NOT CLASSIFIED AS DANGEROUS GOODS AS DEFINED BY 49 CFR 172.101 BY THE U.S. DEPARTMENT OF TRANSPORTATION.

PROPER SHIPPING NAME: None

HAZARD CLASS NUMBER and DESCRIPTION: Not Regulated

UN IDENTIFICATION NUMBER: None

PACKING GROUP: None

DOT LABEL(S) REQUIRED: None

NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (2016): None

MARINE POLLUTANT: This product does not contain ingredients that are classified by the DOT as a Marine Pollutant (as defined by 49 CFR 172.101, Appendix B)

TRANSPORT CANADA, TRANSPORTATION OF DANGEROUS GOODS REGULATIONS:

This product is not classified as Dangerous Goods, per regulations of Transport Canada

INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA):

This product is not classified as Dangerous Goods, by rules of IATA:

INTERNATIONAL MARITIME ORGANIZATION SHIPPING and MARITIME DANGEROUS GOODS CODE SHIPPING INFORMATION (IMO / IMDG):

This product is not classified as Dangerous Goods.

EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD (ADR):

This product is not classified by the United Nations Economic Commission for Europe to be dangerous goods.

SECTION 15 - REGULATORY INFORMATION

15.1 Safety, Health and Environmental Regulations/Legislation Specific for the Substance or Mixture:

UNITED STATES REGULATIONS

SARA REPORTING REQUIREMENTS: This product is not subject to the reporting requirements of Sections 302, 304 and 313 of Title III of the Superfund Amendments and Reauthorization Act., as follows: None

TSCA: All components in this product are listed on the US Toxic Substances Control Act (TSCA) inventory of chemicals.

SARA 311/312:

Acute Health: No Chronic Health: No Fire: No Reactivity: No

U.S. SARA THRESHOLD PLANNING QUANTITY: There are no specific Threshold Planning Quantities for this product. The default Federal SDS submission and inventory requirement filing threshold of 10,000 lb (4,540 kg) may apply, per 40 CFR 370.20.

U.S. CERCLA REPORTABLE QUANTITY (RQ): None

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): None of the ingredients are on the California Proposition 65 lists.

CANADIAN REGULATIONS:

CANADIAN DSL/NDSL INVENTORY STATUS: All of the components of this product are on the DSL Inventory

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA) PRIORITIES SUBSTANCES LISTS: No component of this product is on the CEPA First Priorities Substance Lists.

CANADIAN WHMIS CLASSIFICATION and SYMBOLS: This product is categorized as per WHMIS 2015 Hazardous Product Regulations.

EUROPEAN ECONOMIC COMMUNITY INFORMATION:

EU LABELING AND CLASSIFICATION:

Classification of the mixture according to Regulation (EC) No1272/2008. See section 2 for details.

AUSTRALIAN INFORMATION FOR PRODUCT:

AUSTRALIAN INVENTORY OF CHEMICAL SUBSTANCES (AICS) STATUS: Components of this product are listed on the AICS.

STANDARD FOR THE UNIFORM SCHEDULING OF DRUGS AND POISONS: Not applicable.

JAPANESE INFORMATION FOR PRODUCT:

JAPAN INDUSTRIAL SAFETY AND HEALTH LAW: This product has been classified per the Japan Industrial Safety and Health Law. See Section 2 for the GHS Classification.

KOREA ACT ON REGISTRATION AND EVALUATION OF CHEMICAL SUBSTANCES (K-REACH): This product has been classified per K-REACH. See Section 2 for the GHS Classification.

INTERNATIONAL CHEMICAL INVENTORIES:

Listing of the components on individual country Chemical Inventories is as follows:

Asia-Pac:	Listed
Australian Inventory of Chemical Substances (AICS):	Listed
Korean Existing Chemicals List (ECL):	Listed
Japanese Existing National Inventory of Chemical Substances (ENCS):	Listed
Philippines Inventory of Chemicals and Chemical Substances (PICCS):	Listed
Swiss Giftliste List of Toxic Substances:	Listed
U.S. TSCA:	Listed

15.2 Chemical Safety Assessment:

A chemical safety assessment has not been performed on this product.

SECTION 16 - OTHER INFORMATION

HMIS Rating (Scale 0-4)

Health hazard: 1
Flammability: 0
Physical Hazard: 0

NFPA Rating (Scale 0-4)

Health hazard: 1
Flammability: 0
Physical Hazard: 0

Caution: HMIS and NFPA ratings are based on a 0-4 rating scale

0= Minimal Hazard

1= Slight

2= Moderate

3= High

4= Extreme

Abbreviations and acronyms

ACGIH	American Conference of Governmental Industrial Hygienists
CFR	Code of Federal Regulations
DOT	Federal Department of Transportation
GHS	The Globally Harmonized System of Classification and Labelling of Chemicals
HMIS	Hazardous Material Identification System
HCS	Hazard Communication Standard
IARC	International Agency for Research on Cancer
IATA	The International Air Transport Association
ICAO	The International Civil Aviation Organization
IMDG	International Maritime Dangerous Goods
IMO	International Maritime Organization
LD50/LC50	Lethal Concentration/Dose, 50 percent
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health

NTP	<i>National Toxicology Program</i>
OSHA	<i>Occupational Safety and Health</i>
PEL	<i>OSHA Permissible Exposure Limit</i>
SARA	<i>Superfund Amendments and Reauthorization Act</i>
TLV	<i>ACGIH Threshold Limit Value</i>
TWA	<i>Time-Weighted Average</i>
Acute Tox	<i>Acute Toxicity</i>
Skin Corr	<i>Skin Corrosion</i>

PREPARED BY: Chris Eigbrett

MSDS to GHS Compliance

History Log:
December 05, 2018 - Document creation

End of SDS Sheet