Focused Remedial Investigation Report

Freeway Landfill and Freeway Dump

Prepared for

Minnesota Pollution Control Agency

August 2019

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Certifications

|  |
| --- |
| I hereby certify that this plan, document, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Geologist under the laws of the state of Minnesota. |
|  |  | date |
| John C. GreerPG #: 30347 |  | Date |

Acronyms

**Acronym Description**

µg/L Micrograms per Liter

ASTM American Society for Testing and Materials

B(a)P Benzo(a)pyrene

Bgs Below Ground Surface

BTU/lb British Thermal Units per Pound

CD Construction Debris

CDM Camp Dresser & McKee

CERCLA Comprehensive Environmental Response, Compensation, and Liability Act

CLP Closed Landfill Program

CRA Conestoga-Rovers & Associates

DDT Dichlorodiphenyltrichloroethane

DRO Diesel Range Organics

FEMA Federal Emergency Management Agency

FES Fuller Engineering Services

FFS Focused Feasibility Study

ft/d Feet per Day

ft/ft Feet per Feet

GPS Global Positioning System

GRO Gasoline Range Organics

HERC Hennepin Energy Recovery Center

HIG Historic Information Gatherers

IDW Investigation Derived Waste

ISV Intrusion Screening Values

LIDAR Light Detection and Ranging

MCL Maximum Contaminant Limit

MDH Minnesota Department of Health

MDNR Minnesota Department of Natural Resources

mg/L Milligrams per Liter

MGS Minnesota Geologic Survey

MnDOT Minnesota Department of Transportation

MPCA Minnesota Pollution Control Agency

MSL Mean Sea Level

Acronyms (cont.)

**Acronym Description**

MSW Municipal Solid Waste

MVTL Minnesota Valley Testing Laboratories, Inc.

NAD North American Datum

NAVD North American Vertical Datum

NWS National Weather Service

PA Preliminary Assessment

PAH Polycyclic Aromatic Hydrocarbon

PCB Polychlorinated Biphenyl

PCE Tetrachloroethane

PE Professional Engineer

PFAS Per- and Polyfluoroalkyl Substances

PFHxS Perfluorohexane Sulfonate

PFOA Perfluorooctanoic Acid

PFOS Perfluorooctanesulfonate

PID Photoionization Detector

PLP Permanent List of Priorities

PVC Polyvinyl Chloride

QAPP Quality Assurance Project Plan

RQD Rock Quality Designation

RI Remedial Investigation

SLV Soil Leaching Value

SRV Soil Reference Value

SVOC Semi-volatile Organic Compound

TCE Trichloroethylene

US EPA United States Environmental Protection Agency

USACE United States Army Corps of Engineers

USFWS United States Fish and Wildlife Service

UTM Universal Transverse Mercator

VC Vinyl Chloride

VOC Volatile Organic Compound

# Introduction

## Purpose

This focused remedial investigation (RI) report has been prepared by Barr Engineering Co. (Barr) on behalf of the Minnesota Pollution Control Agency’s (MPCA) Closed Landfill Program (CLP). This report provides a summary of investigation findings and results at the Freeway Dump and Freeway Landfill (the Site) located in Burnsville, Dakota County, Minnesota (Figure 1).

The purpose of the investigation is to characterize Site conditions in support of future remedial design. Improved waste containment or removal of the waste from the Site will be an important component of the future remedial design. Therefore, the focus of this RI report is the condition of waste material at the Site and associated potential receptors and risk pathways. In addition to the evaluation of the waste material, cover soil and groundwater investigation activities were conducted and are summarized and discussed in this report. Potential risks associated with current or future groundwater conditions is beyond the scope of the focused RI. If it is determined that it is necessary to conduct additional groundwater investigation, the results would be summarized in a follow-up supplemental RI report.

The initial phase (Phase A) of the investigation was conducted in the spring of 2018 and generally followed the conceptual *Investigation & Sampling Plan*, written by MPCA (MPCA, 2017). The MPCA plan was informed by findings from previous investigations at both the Freeway Landfill and Freeway Dump and outlined a work scope that included sampling of soil, waste material, and groundwater, as well as screening of landfill gas. The results of Phase A were summarized in *Phase A Investigation Report* (Barr, 2018) and several data gaps were identified in the report. Focused RI activities were conducted in the spring of 2019 (Phase B) to address these data gaps and included evaluations of waste extent, cover soil, and groundwater.

## Organization of Report

The report is organized as follows:

1. **Introduction**: describes the content and objectives of this report.
2. **Site Background**: provides general Site background information including a description of the setting, topography, geology, and brief operating history of each project area.
3. **Regulatory History and Previous Investigation**: provides historical background of the Site from a regulatory perspective through brief summaries of previous investigations.
4. **Waste Material Investigations**: includes a discussion of the activities completed to evaluate the extent of waste material as well as solid media quality. Describes the results of the investigation, including a description subsurface conditions as well as solid media analytical results.
5. **Cover Soil Investigation:** includes a discussion of the activities conducted to further characterize the cover soil present at the Site for potential reuse as part of a remedial action. Describes analytical results.
6. **Groundwater Investigation:** includes a discussion of the activities completed to evaluate the groundwater conditions at the Site. Describes the results of the investigation, including groundwater sampling analytical results.
7. **Conceptual Site Model:** provides a summary of the current understanding of the Site subsurface conditions.
8. **Potential Receptors / Risk Assessment:** identifies potential receptors and evaluates the risk to human health and the environment.
9. **Conclusions:** provides a recommendation for additional action based on the findings of the investigations.
10. **References:** includes a summary of references cited in the report.

# Site Background

The Site comprises two project areas (Figure 1), referred to in this report as the Freeway Dump (Dump) and the Freeway Landfill (Landfill). Multiple parcels are associated with the Site and are controlled by various ownership entities, including the R.B. McGowan Company, Inc., Freeway Transfer, Inc., Quarry Property, LLC, Michael B. McGowan, and Trustees of the Richard B. McGowan Family Irrevocable Trust Agreement dated October 22, 1997. For the remainder of this report, those various entities will be referred to as the Site Owner. Property boundaries and ownership in the vicinity of the Site are shown on Figures 1 to 5.

The limits of waste associated with both the Dump and Landfill extend beyond parcels owned by the Site Owner and onto adjacent properties, as shown on Figures 2 and 3. The following sections describe the two project areas.

## Site Location and Setting

**Freeway Dump**

The Dump is an unpermitted, inactive waste disposal area located at 11937 Interstate 35W (Parcel ID: 02-03410-38-010), just north of the east service road for Interstate 35W and the Cliff Road interchange. The Dump is unlined, with a vegetated soil-cover, encompasses approximately 28 acres, and is currently being used as a golf driving range. Two office trailers and one small building are located on the Property.

Based on review of historical aerial photographs and the recent investigation, the extent of waste at the Dump is believed to extend onto several adjacent properties as shown on Figure 1, including:

* Allstate Self Storage facility owned by Burnsville Storage Company (Burnsville Storage) – MN LP, located south of the Dump. A Subaru auto dealership is located south of Burnsville Storage.
* Interstate 35W (I-35W) right of way, located west of the Dump. Edward Kraemer and Sons quarry (Kraemer Quarry) is located west of I-35W.
* Vacant land/wetlands owned by Northern States Power Company (Xcel Energy) and US Fish and Wildlife Service (USFWS), located north and east of the Dump.

The area of waste associated with the Dump (including waste present on neighboring properties) is approximately 34 acres and the estimated volume of waste is approximately 760,000 cubic yards. The inferred waste extent of the Dump is presented on in Figure 4.

**Freeway Landfill**

The Landfill is an MPCA-permitted unlined, soil-covered, inactive waste disposal area **located just south of the Minnesota River (Figure 1).**

**The Landfill consists of several parcels, totaling approximately 189 acres, 131 of which were used for placement of waste during landfill operation and approximately 58 of which include a quarry and undeveloped land (Liesch, 1993). The Landfill is located primarily on the following property parcels: 037-02-15600-00-010; 037-02-15600-00-060; 037-02-15600-00-020, 037-02-15600-02-010; 037-02-15600-00-030; 037-02-15600-00-040; and 037-02-15600-00-050.**

**Within the Landfill area is the Freeway Transfer Station which is located at 11501 Embassy Road** (parcel ID: 02-15600-01010)**. The Transfer Station is located on the east side of the Landfill property, approximately 1,500 feet south of the Minnesota River, and currently operates as a waste processing, recycling, and hauling facility. A quarry to the west is also owned by the Site Owner and the western edge of the Landfill extends into this parcel. Other commercial activities on the Landfill properties appear to be a gravel crushing operation in the quarry located to the west of the Landfill and a dumpster storage operation that is present on top of the Landfill.**

The surrounding properties include Kraemer Quarry, located to the south, I-35W to the east, and a salt storage and barge unloading facility (U.S. Salt) owned by Port Marilyn LLC, located north of the Landfill. Based on review of historical aerial photographs and recent investigations, the extent of waste at the north end of the Landfill extends onto the U.S. Salt property.

The area of waste associated with the Landfill (including waste present on neighboring properties) is approximately 141 acres and the estimated volume of waste is approximately 5,310,000 cubic yards. The inferred waste extent of the Landfill is presented on Figure 5.

**Minnesota River**

**The average water level for the Minnesota River located north of the Landfill is approximately 692 feet** above mean sea level (**feet MSL; calculated from 2015-present elevation data obtained from the US Army Corps of Engineers). The 100-year flood elevation is 715 feet MSL (FEMA, 2016), and the recorded historical river level extremes at the nearby Savage river gage are 719.40 feet on April 15, 1965 and 687.05 feet on October 29, 1976 (NWS, 2018). It is recognized that river elevation sources are based on different vertical datum (i.e., 1912 Mean Sea Level Datum, North American Vertical Datum (NAVD) 1929, and NAVD 1988). The difference between those data for the Minnesota River elevation is 0.54 feet.**

**Kraemer Quarry**

The Kraemer Mining and Materials quarry is located approximately 1,000 feet west of the Dump and immediately south and southwest of the Landfill. The resource being mined in the quarry is the Prairie du Chien Group dolostone. Dewatering in the quarry captures groundwater in the Prairie du Chien aquifer beneath the Site, significantly depressing the water table from what it would be under natural conditions. Except for near the northern edge, waste is generally not currently in contact with groundwater at the Landfill, but groundwater models completed for the Landfill predict that condition will change when Kraemer Quarry operations and pumping end (Barr, 2015).

## ****Topography****

**Freeway Dump**

The majority of the Dump is a generally flat-top mound that sits above the surrounding wetland at elevations ranging from approximately 720 feet to 725 feet MSL. The tee-box area of the driving range sits a little higher at approximately 730 feet MSL. The raised elevation of the Dump extends beyond the north and east boundaries of the Dump property. The surrounding wetland is located at an elevation ranging from approximately 700 feet MSL along the north perimeter to about 710 feet MSL to the southeast of the Dump.

**Freeway Landfill**

**Prior to waste disposal operations commencing, the topography of the Landfill area likely varied from 696 to 705 feet MSL (Liesch, 1991). According to current LIDAR survey data (**Fugro and MDNR**, 2011), the maximum elevation of the Landfill is approximately 750 feet MSL at its peak near the center of the property. The ground surface slopes downward in all directions to an elevation of approximately 700 feet MSL at the property limits. This slope is relatively gentle, generally ranging from 2% to 4%, with the exception of the east and south edges where steeper 20-30-foot-long slopes up to approximately 30% are present. The ridge on the east side of the Landfill is adjacent to an intermittent surface water channel that runs north to the river, between the Landfill and Highway 35W.**

**The Transfer Station is located in a topographically depressed area at approximately 710 feet MSL. Surrounding the Transfer Station to the north, south, and east is a berm feature that rises to approximately 745 feet MSL, and to the west is the access road that rises out from the station to Landfill grade of approximately 735 feet MSL.**

## ****Geology****

The surficial geology of the area is generally characterized by glaciofluvial sediments associated with the Minnesota River Valley. Peat and organic silts and clays are found in adjacent bottomland areas (MPCA, 1992). The Landfill and Dump areas consist of waste material (municipal solid waste/construction debris/ash) dumped on former wetlands and overlain by cover soil fill (Liesch, 1991).

The uppermost bedrock unit is the dolostone of the Prairie du Chien group. The surface of the Prairie du Chien is typically weathered and friable and slopes north toward the Minnesota River. The Jordan Sandstone underlies the Prairie du Chien. The St. Lawrence Formation, a dolomitic shale and siltstone unit, underlies the Jordan Sandstone (MPCA, 1992).

## Site Ownership and Operating History

A review was conducted of historical landfill records, files, and historical aerial imagery. The MPCA provided Barr with a list of archived project files for the Dump and Landfill, which included files dating back to the early 1960’s. Historical aerial imagery was obtained from Historic Information Gathers (HIG). These aerial images were used to evaluate historical disturbance limits and approximate operational dates for the Landfill (aerial photos are found in Appendix A of the *Phase A Investigation Report*, Barr, 2018). The disturbance limits shown on the aerial photography were evaluated to identify historical dumping as well as current waste limits. Based on historical landfill records, files provided by the MPCA, and historical aerial imagery the following approximate chronology of significant milestones has been developed for the Site (Barr, 2018).



**Pre-Operations History**

**From the** **Black Dog Preserve 1984 Resource Inventory (MDNR, 1984)**

***Up until the year 1853 the area around Black Dog Lake was inhabited by about 250 Dakota native people and their chief, Black Dog. The Dakota were hunter gatherers and left no discernible impact upon the land. Following European settlement of the area in the mid-1800’s, ownership of the land began and bottomland meadows were used to provide hay for domesticated animals. Row crops were planted in the area and north-south drainage ditches were placed on the far southern portion of Site. Agricultural use in the general area continued until the early 1960’s when light industrial and commercial development of the area commenced.***

**Freeway Dump**

The Dump property was purchased by Richard McGowan and his business partner sometime around 1960. It is uncertain exactly when the Dump became active and started receiving waste, with some reports indicating that dumping began as early as 1960. A review of historical aerial photographs indicate that the Dump was active between 1960 and 1969. The Dump initially accepted ash from a nearby power plant and later accepted other refuse including municipal solid waste and construction waste (MPCA, 2017). After the Dump ceased operating in 1969, the property remained unused until 1993, when the driving range operations began. An irrigation system is present at the driving range. Based on a review of aerial photographs, the storage facility buildings south of the dump were constructed between 1970 and 1979, and the storage facility buildings at the southeast corner of the dump were constructed between 1984 and 1990.

**Freeway Landfill**

The Landfill property is comprised of multiple parcels that were purchased from several different owners in the 1960s by Richard McGowan. Prior to the Landfill operating, the area was mostly wetland and undeveloped, with the exception of farming activities visible in the 1937 aerial photo and a few small structures located north of the frontage road on the south bank of the Minnesota River, visible in the 1966 aerial photo.

The Landfill began accepting waste in July 1969 under a conditional use permit issued by the City of Burnsville. In October 1971, the MPCA issued the Landfill a solid waste permit (No. SW 57). From a review of historical aerial photos, it appears that Landfill operations began in the northeast corner of the property and then expanded to the south. In the late 1970s and 1980s, environmental regulations were significantly updated in response to evolving knowledge about environmental contaminants and associated risks to human health and the environment. Landfill regulations were updated to require engineered liners and caps for new landfills. Based on concerns at the Site, the Landfill was added to the Superfund National Priorities List in 1986 (MPCA, 2015). Under the new regulations, landfill owners were requested to either make necessary upgrades to their facilities or to stop accepting waste. In 1990, Freeway Landfill stopped accepting waste.

The Transfer Station was constructed in the late 1980s and operates on a 12-acre parcel bounded by the Freeway Landfill to the north, south, and west. The Transfer Station is currently in operation and has been since 1991 (Liesch, 1993).

# Regulatory History and Previous Investigations

Previous investigations have been conducted at the Freeway Dump and Freeway Landfill properties. The following section provides a brief summary of previous investigations limited to details that are pertinent to this report.

## Freeway Dump

Relevant previous investigation activities at the Dump are briefly summarized below. Previous investigations at the Dump were generally limited in scope and were conducted at the edges of the Dump. Therefore, prior to the recent investigation little was known of the conditions of waste material within the Dump.

### 1987 Preliminary Assessment

A Preliminary Assessment (PA) was conducted in 1987 by the MPCA (MPCA, 1987). The PA was prompted by concerns from the USFWS, whose property abuts the Dump to the east. USFWS had observed stressed vegetation, erosion, and waste materials at the eastern edge of the landfill. MPCA identified dichlorodiphenyltrichloroethane (DDT) and polycyclic aromatic hydrocarbons (PAHs) in soil samples collected from the perimeter of the Dump and concluded there were exposure risks from the Dump, including the groundwater and surface water migration pathways. Following the Preliminary Assessment, the Dump was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) inventory of potentially hazardous waste sites.

### 1992 Screening Site Inspection Report

A subsequent investigation was conducted in early 1992, as documented in the Screening Site Inspection Report (MPCA, 1992), to evaluate the Freeway Dump as a potential candidate for the National Priorities List. The investigation included completion of four soil borings, installation of two monitoring wells (including existing well OFMW-1), and analysis of soil, surface water, and groundwater samples. Tetrachloroethane (PCE), acetone, and phthalates were detected in soil samples and metals such as arsenic, cadmium, chromium, and selenium were detected in soil, surface water, and groundwater samples. Additional investigation was recommended.

### 1997 Groundwater Investigation

An additional investigation was conducted in 1997 and 1998 by the MPCA. Nine monitoring wells were installed around the perimeter of the Dump (existing wells MW-97-1 to MW-97-9). Groundwater sample results indicated the presence of arsenic, boron, manganese and low levels of volatile organic compounds (VOC) and polychlorinated biphenyls (PCB). In the fall of 2003, response actions including grading and drainage improvements were completed as noted in a correspondence between the MPCA and the Site Owner (MPCA, 2004).

## Freeway Landfill

Previous investigations have been conducted at the Landfill, including remedial investigations conducted on behalf of the Site Owner and environmental assessments conducted on behalf of the MPCA. Relevant investigation activities at the Landfill are briefly summarized below.

### 1978 Impact of Seepage Study

In 1978, Barr prepared a report in response to a request from the MPCA to assess the impact of the Landfill on the water quality in the Minnesota River and to evaluate whether a new groundwater monitoring network was needed. Five new monitoring wells were constructed for the investigation. Sampling activities included soil sampling of the monitoring well borings, three groundwater sampling events, and five surface water sampling events. The report recommended continued monitoring program for the landfill included quarterly groundwater and surface water sampling (Barr, 1978).

### 1988 Remedial Investigation

Conestoga-Rovers & Associates (CRA) was retained by R.B. McGowan Company in 1988 to conduct an RI of the Site for the MPCA in accordance with a Request for Response Action. Four new monitoring wells were constructed as part of the investigation. Investigation activities included well installation, water level measurement, slug testing, and water quality sampling. Sampling activities included two sampling events at seven groundwater locations and one surface water location for metals and VOCs. Additional wells and surface water locations were identified in the plan but could not be sampled due to insufficient water volume due to dewatering activities at the adjacent quarry. CRA recommended that no remedial action was warranted and the Site be delisted from the National Priorities List (CRA, 1988).

### 1991 Supplemental RI

A Supplemental RI was conducted in 1991. Bruce A. Liesch Associates (Liesch) was retained by R.B. McGowan Company to complete additional RI activities required by MPCA after review of the initial 1988 RI Report. The purpose of Supplemental RI investigation was to further define the extent and magnitude of landfill impacts and hydrogeological conditions. Four new monitoring wells were constructed as part of the investigation. Investigation activities included well installation, water level measurement, slug testing, and water quality sampling. Sampling activities included two sampling events at ten groundwater locations and three surface water locations for metals and VOCs. One sampling round was conducted while the quarry well was in operation and the second was conducted when the well was not in use. A post-RI monitoring plan was outlined, which included three sampling events per year and annual reporting (Leisch, 1991).

### 1993 Closure Report

In 1993, a closure report was prepared by Leisch on behalf of R.B. McGowan Company to provide documentation of landfill closure activities for certification of overall final closure by the MPCA. The landfill closure was required by a Court Order issued by the Dakota County District Court. Final closure activities included completion of additional final cover soil permeability testing, final cover modeling, installation of eight landfill gas monitoring probes, maintenance of the final cover, and surveying (Leisch, 1993). Additionally, Camp Dresser & McKee (CDM) submitted a Final Human Health and Ecological Risk Assessment (Risk Assessment) to the MPCA. The Risk Assessment found landfill gas exposure risks to workers and nearby residents below threshold risks and the ecological risk of leachate contact was considered unlikely (CDM, 1993).

### 1998 Gas extraction system conceptual design

Woodward-Clyde Consultants were retained by the MCPA to prepare cover system and gas extraction system conceptual design in 1998. A pre-design field investigation was conducted in 1997 that included a topographic survey, an existing cover evaluation, a waste thickness evaluation, and landfill gas monitoring. Twenty-four soil borings were advanced through the landfill cover, five of which were further advanced to refusal to determine the vertical extent of waste. Four landfill gas monitoring probes were installed in the borings that were advanced through the waste column with measured methane concentrations between 25.7% and 64.2% (Woodward-Clyde, 1998).

### 2005 Subsurface Investigation

In 2005, a subsurface investigation was conducted by Fuller Engineering Services (FES) on behalf of the MPCA throughout the Landfill to evaluate the extent of cover soil and waste. The investigation included 74 soil borings, landfill gas monitoring, and detailed surveying to assess the topography and subsurface conditions (FES, 2005). The results of the Fuller study are the primary basis for volume calculations utilized in the Focused Feasibility Study (Barr, 2019).

### 2015 Groundwater Investigation

More recently, in 2015, the MPCA conducted groundwater investigations and Barr conducted groundwater modeling to estimate future groundwater conditions that are anticipated when the Kraemer Quarry ceases operation and discontinues dewatering pumping. MCPA installed eight monitoring wells into the waste and two monitoring wells into the bedrock. Groundwater samples were collected at these new monitoring wells. Barr used the analytical results and predictive modeling for the groundwater conditions and contaminant transport (Barr, 2015b). The findings of the modeling effort are summarized as part of the risk evaluation in Section 8.5.

# Waste Material Investigation

Waste material investigation activities were conducted in 2018 and 2019 to evaluate the extent and nature of waste material and to further characterize the Site geology. The results of the investigations have improved the understanding of Site risks and will inform the evaluation of potential Site remedies.

## Summary of Investigation Activities

Several previous investigations, most significantly the Fuller study (FES, 2005), provided data with respect to the presence of waste material at the Landfill; however, there were data gaps related to the extent of waste, including the presence of waste along the north edge of the Landfill property and in the vicinity of the Transfer Station area. Additionally, there were limited data available regarding the extent and nature of the waste material present at the Dump. These data gaps were the focus of Phase A of the investigation, which occurred during the spring of 2018 and included:

* Thirty-five soil borings completed at the Dump
* Eight soil borings completed at the Transfer Station
* Fourteen test excavations completed at the Dump
* Nine test excavations completed at the Landfill

Following the Phase A investigation, data gaps concerning the extent of waste material to the north of the Landfill and to the south of the Dump remained. In order to address these data gaps, the following additional investigation activities were conducted as part of Phase B during the spring of 2019:

* Eight soil borings completed at the Burnsville Storage property (south of the Dump)
* Two test excavations completed at the U.S. Salt property (north of the Landfill)

### Soil borings

Soil borings were advanced with a direct-push, tracked drill rig and soil samples were collected with a dual-tube or macro-core sampler. Continuous sampling was conducted at all soil boring locations. These samples were described in the field by a Barr geologist or environmental scientist in accordance with the Unified Soil Classification System. Samples were screened in the field for volatile organic vapors using an MPCA-provided photoionization detector (PID) fitted with a 10.6 eV lamp. Additionally, the samples were inspected by Barr for other evidence of contamination such as staining, odors, discoloration, and/or sheen and the observations were documented on the geologic log of each boring. Borings were sealed in accordance with Minnesota Department of Health rules. A soil boring matrix is provided as Table 2. Boring logs are included in Appendix A. There were no major deviations from the planned work. Soil borings completed at the Site are described below:

**Phase A**

*Dump –* Thirty-five soil borings were completed at the Dump. The Dump soil borings were generally spaced over an approximate 180-foot by 180-foot grid. Locations of the soil borings at the Dump are shown on Figure 2.

*Landfill –* Eight soil borings were completed at the Transfer Station located in the Landfill property. The purpose of the borings at the Transfer Station was to assess the subsurface material directly under and adjacent to the operations building. For this purpose, two of the borings were completed within the building footprint and the remaining six borings were located surrounding the building. Locations of the soil borings at the Transfer Station are shown on Figure 3.

**Phase B**

*Dump –* Eight soil borings were completed at the Burnsville Storage property located south of the Dump. The borings were generally spaced across the Burnsville Storage property for the purpose of identifying the extent of waste material south of the Dump. Two of the boring locations were placed near buildings that are used as residences, and soil-gas samples were collected for laboratory analysis from these locations. Locations of the soil borings at the Burnsville Storage property are shown on Figure 2.

**Soil Gas Screening**

Soil gas was measured by Barr at most boring locations using a multi-gas meter capable of measuring methane, carbon dioxide, and oxygen. Upon completion of a soil boring, soil gas was screened at a depth of approximately three feet below ground surface (bgs). A tube was fitted to the multi-gas meter and lowered down the hole. The hole around the tube was then backfilled, the meter allowed to equilibrate, and the readings were logged.

### Test Excavations

Test excavations were completed at several locations at both the Dump and Landfill. The purpose of the majority of test excavations was to identify the edge of the waste boundary or to determine if waste appeared to extend beyond the property boundaries. Therefore, most of these test excavations were completed just inside the property boundary. In addition to identifying the extent of waste, the added benefit of exposing larger areas of the subsurface was to further classify the types of waste material present.

Test excavations were completed with an excavator in 1 to 2 foot lifts to depths of up to 15 feet bgs or to groundwater, whichever was encountered first. As the excavation proceeded, the operator segregated the soil and/or waste material by depth so that upon completion the leftover soil and/or waste material could be replaced back in the excavation in the order and approximate position from which it was removed. As the soil was replaced the excavator bucket was used to tamp in approximate one-foot lifts to re-compact the soil.

A test excavation matrix is provided as Table 3. Excavation field logs are included in Appendix B. Test excavations completed at the Site are described below:

**Phase A**

*Dump* – Fourteen test excavations were completed at the Dump. Ten of the test excavations were completed along the property boundaries and four excavations were completed in the interior of the Dump. The interior borings were completed adjacent to previously completed boring locations to better classify the waste material overserved during the soil boring investigation. Locations of the test excavations are shown on Figure 2. There were no major deviations from the planned work.

*Landfill* – Nine test excavations were completed at the Landfill. Eight of the test excavations were completed along the northeast property boundary and one was completed at the southeast corner of the property. Locations of the test excavations are shown on Figure 3.

**Phase B**

*Landfill* – Two test excavations were completed at the U.S. Salt property located north of the Landfill.

### Sample Analysis

Selected samples collected during this RI were submitted to laboratories for analysis. The sample analytical parameter lists are provided in Table 1. Laboratories were selected by the MPCA from a list of state-contract laboratories or other state agency laboratories. A summary of samples collected is provided in Tables 2 and 3. Samples were analyzed at Pace Analytical Services, Inc. (Pace) of Minneapolis, Minnesota for all of the parameters listed, with the following exceptions:

* Groundwater analysis of volatile organic compounds (VOCs), Per- and Polyfluoroalkyl Substances (PFAS), and 1,4-dioxane was performed by Minnesota Department of Health (MDH) laboratories.
* A select group of waste sample parameters were analyzed at Minnesota Valley Testing Laboratories, Inc. (MVTL) of New Ulm, Minnesota and Beta Analytical Testing Laboratory (Beta) of Miami, Florida.
* PFAS analysis of crushed bedrock samples was performed by SGS AXYS Analytical Services Ltd. in Sidney, British Columbia.

**Phase A**

During the Phase A investigation, soil, waste, and groundwater samples from borings and test pits were collected for laboratory analysis by a field representative of the MPCA laboratory contractor, Pace. A detailed summary of sample collection activities is presented in Section 3.2.3 of the *Phase A Investigation Report* (Barr, 2018).

**Phase B**

Sample collection was conducted as part of the Phase B Waste Investigation as follows:

* Soil Gas – Soil gas samples were collected from two of the boring locations on the Burnsville Storage property. Barr and MPCA collaborated to inform the Pace representative at what intervals samples would be collected. Pace collected the samples in accordance with the Quality Assurance Project Plan (QAPP) (Barr, 2019).
* Waste – Samples of waste material were also collected from the cover soil boring locations (Section 5.0) and the monitoring well borings (Section 6.0).
* Bedrock – Samples of bedrock were collected from the borings advanced for construction of monitoring wells MW-9D and MW-10D. These samples were crushed by the laboratory as part of sample preparation prior to analysis.

Laboratory analytical reports from the RI are included in Appendix C. Upon receipt of the laboratory analytical data, Barr performed a data quality review. A summary of the data quality review is included in Appendix D. The review concluded that all data met the data quality objectives of the project and are deemed acceptable for the purposes of this project, as qualified in the tables.

### Surveying

Final locations of all soil borings and test excavations were surveyed by Barr using a hand-held global positioning system (GPS) device. Elevations were approximated based off of existing topographic information (LIDAR; Fugro and MDNR, 2011).

## Summary of Subsurface Conditions

This section describes the subsurface conditions observed during the Phase A and Phase B investigations, including descriptions of the different solid media encountered and their distributions across the Site. Unconsolidated materials (including waste material, fill, and native sediments) and bedrock were described in the field by Barr. Materials were described using methods included in American Society for Testing and Materials (ASTM) D-2488, Standard Practice for Description and Identification of Soils.

A discussion of the extent and thickness of the waste material across the Dump and Landfill is included in Section 4.3.

### Solid Media Definitions

General descriptions of the primary unconsolidated materials and bedrock encountered at the Site are provided below.

**Cover Soil Fill**

Fill material used as cover soil was observed at nearly all investigation locations during both phases of the investigation. Fill material generally consisted of a few inches of root zone material (topsoil with a fine sandy loam texture) underlain by sand to silty sand with varying percentages of coarse-grained sediment. Layers of finer grained sediments (clays and silts) were also observed in some locations.

**Waste Material**

For the purposes of this investigation, waste material was divided into two classifications: (1) municipal solid waste/construction debris (MSW/CD) and (2) ash, as described in the following paragraphs.

**Municipal Solid Waste/Construction Debris –** MSW/CD was encountered across most of the Site during both phases of the Investigation. Municipal solid waste consisted of paper, plastics, glass, wood, metal, and rubber and was sometimes mixed with fill material. Construction debris varied, typically including bricks, concrete, wood, shingles, pipes, and insulation. The level of decomposition varied as well, with some areas appearing relatively dry and containing readable lines of newspaper, whereas other pockets of waste material were well-degraded and had a noticeable odor of decomposition.

**Ash –** Ash was observed only at investigation locations at the Dump, and was observed during both phases of the Investigation. Ash is generally described as gray, or black, non-plastic, silt to fine grained sand-size material and was differentiated from native sediments by strength and texture comparisons. The ash encountered at the Dump was mostly fine-grained and non-cemented, making it appear as a possible native gray silt except that it often was intermixed with waste material. The ash was generally observed either above and/or below the waste material.

**Native Material Beneath Waste**

Native sediments encountered during the investigation included alluvial or glacial sediment deposits. In general, native sediments were encountered below the waste material. The most commonly observed native sediment was a dark brown fibrous peat, but lean to fat clays, organic clays, silts, and sandy soils were also present in some locations.

**Bedrock**

The uppermost bedrock encountered during the Investigation is a sandy dolostone of the Prairie du Chien Group. The upper unit of the bedrock observed at the Site was generally described as brown, tan, and/or gray, very weak, and moderately weathered. The Prairie du Chien is heavily fractured near the surface with fracture density generally decreasing with depth. Discrete intervals with greater fracture density, vuggy porosity, and dissolution voids are present at depth and were observed during rock coring conducted in advance of installation of wells MW-9D and MW-10D (Section 6.2).

### Freeway Dump

The summary of subsurface conditions at the Dump is primarily based on the soil borings and test excavations that were completed during Phase A of the Investigation, and the soil borings and monitoring well installations that were completed during Phase B of the Investigation. Boring logs and monitoring well logs are provided in Appendix A. Test excavation logs are provided in Appendix B. Subsurface conditions at the Freeway Dump generally consist of non-native fill material overlaying waste material (MSW/CD and ash), which overlay native sediments and/or bedrock. Cross section locations are displayed on Figure 6, and four cross sections of the Dump are included as Figure 6A, Figure 6B, Figure 6C, and Figure 6D. Observations from both phases of the Investigation are summarized below.

**Cover Soil Fill**

Cover soil fill was observed at all 61 Investigation locations, at thicknesses ranging from 0.5 to 12.5 feet. Typically, the observed thickness of cover soil ranged from 2 to 5 feet. In general, the greatest cover soil fill thicknesses were observed along the west side of the Dump, where soil borings were positioned along a landscaped Berm.

Field screening of the cover soil did not identify evidence of contamination such as staining, odors, discoloration, or sheen. Soil headspace readings ranged between 0.0 and 6.9 parts per million (ppm). Field screening results are included in the boring logs.

**Waste Material**

Waste material encountered at the Dump consisted of a combination of MSW/CD and ash. MSW/CD thicknesses vary throughout the Dump, but generally range from 10 to 20 feet thick. The greatest thickness of MSW/CD was approximately 30 feet at boring FD-SB-A3 in the north-central portion of the Dump. The thinnest intervals of MSW/CD were identified at the westernmost borings (FD-SB-A1 through FD-SB-G1), where thicknesses averaged less than 2.5 feet.

Inferred waste extents and waste thicknesses for the Dump are presented on Figure 4. A more detailed discussion of waste extent is provided in Section 4.3.

Decomposition, chemical-like, and/or petroleum odors were encountered in varying degrees in the MSW/CD. Sheens were also observed, ranging from trace to heavy rainbow sheen. Soil headspace readings were generally elevated (above 10 ppm), and ranged from 0.0 to 343 ppm. Headspace readings above 100 ppm were observed at seven borings and two test excavations, all of which were generally located in the eastern portion of the Dump. Field screening results are presented in the boring logs (Appendix A).

Ash was observed both above and below the MSW/CD in the Dump ranging in thickness from 0 to 13 feet. In general, ash is more commonly observed above the MSW/CD on the east half of the property and below the MSW/CD on the west half of the property. Ash was occasionally encountered mixed with a minor amount of debris/plastic sheeting.

Field screening of the ash did not identify evidence of contamination such as staining, discoloration, odor, or sheen. Headspace readings ranged between 0.0 and 4.5 ppm. Field screening results are presented in the boring logs (Appendix A).

**Native Sediment**

Native soil was observed at 31 (of 47) soil boring locations. Native soil generally consists of peat overlaying a thin layer of organic silt/fat clay. Peat was widespread throughout the main portion of the Dump, but was not observed in borings completed near the southern limit and at Burnsville Storage. Peat thickness ranged from 1 to 10 feet. Generally, peat layers were observed to be between two and five feet thick. The silts and clays underlying the peat were generally no thicker than one foot. Poorly graded sand and clayey sand is present beneath the waste material only at locations in the northeast portion of the Dump.

**Bedrock**

Borings were generally advanced to the top of the Prairie du Chien bedrock. The depth to bedrock encountered during the investigations varied from 9.5 to 40 feet bgs. Bedrock was encountered at higher elevation (approximately 705 feet MSL) in the southern portion of the Dump, and generally slopes downward to the north edge of the property (approximately 690 feet MSL) towards the wetland.

### Freeway Landfill

The subsurface conditions at the Landfill discussed below are based on historical investigation data as well as the recent investigations, which include test excavations, soil borings, and monitoring well installations. Boring logs and monitoring well logs are provided in Appendix A. Test excavation logs are provided in Appendix B. Subsurface conditions at the Landfill generally consist of non-native fill material overlaying waste material (MSW/CD), which overlay native sediments and/or bedrock. Cross section locations are displayed on Figure 6, and four cross sections of the Landfill are included as Figure 6E and Figure 6F.

**Cover Soil Fill**

Fill soil covering the waste material was encountered at all monitoring well, soil boring, and test trench locations. Fill soil ranged in thickness from approximately 0.5 feet to 25 feet, with an average thickness of approximately 10 feet. In general, fill soil was observed at greater thicknesses near the center of the Landfill, with thinner cover soil intervals around the perimeter of the Landfill. The fill soil typically included a topsoil cover overlaying brown or gray silty sand and/or sandy lean clay. These observations are consistent with those from previous investigations completed by others. Cover soil thickness contours are presented in Figure 7.

Field screening in the fill material did not identify evidence of contamination such as staining, odors, discoloration, and/or sheen, with the exception of trace sheen and moderate odor being observed in borings TS-SB-02 and TS-SB-05 (Phase A, Transfer Station). PID soil headspace readings ranged from 0.1 to 5.4 ppm.

**Waste Material**

Waste material consisted of MSW/CD and observations made during the investigation were consistent with those from historical investigations. Where observed, waste material ranged in thickness from approximately 6 to 25 feet. A more detailed discussion of waste material thickness and extent is provided in Section 4.3.

Light to moderate decomposition and waste odors were observed throughout the waste material at the Landfill. Sheens were also encountered, ranging from trace to heavy rainbow. PID headspace readings in the waste material varied greatly, ranging from 1.0 ppm to 203 ppm. The highest PID reading was observed in a sample from 19 feet bgs in well MW-10. Field screening results are presented in the soil boring and test excavation logs.

**Native Sediment**

Native sediment was observed beneath the waste material throughout the Landfill. Native sediments were observed in 46 of the 78 boring locations completed in 2005 (FES, 2005). At the remaining borings, either waste was observed directly on top of bedrock or the borings were located outside of the footprint of the waste. Native sediment consisted of poorly graded sand, silty sand, clayey silt, and sandy lean clay.

Field screening of native sediment in soil borings completed at the Transfer Station did not identify evidence of contamination such as staining, odors, discoloration, or sheen. PID headspace readings for samples from these borings were below 1.9 ppm. At the borings completed on the north side of the property, field screening identified a moderate rainbow sheen in soil during construction of well MW-13 and a light sheen in soil during construction of well MW-12, which occurred in native sediments directly beneath waste materials. No odor or discoloration was noted in this layer and PID headspace readings were below 1.2 ppm.

**Bedrock**

The sandy dolostone of the Prairie du Chien Group was observed at both deep monitoring well locations (MW-9D and MW-10D). The Prairie du Chien Group was encountered between 22 and 24 feet bgs. Field screening did not identify evidence of contamination in the bedrock. The thickness of the Prairie du Chien ranges from 134 to 165 feet below the Landfill (Liesch, 1991). The bedrock surface was observed at a higher elevation (approximately 700 feet MSL) in the southern portion of the Landfill, and generally slopes downward to the north.

### Landfill Gas Monitoring

Landfill gas monitoring was conducted with a multi-gas meter during Phase A of the investigation at the Dump and during the 2005 Fuller investigation at the Landfill. Landfill gas concentrations are presented in Table 4.

Dump – Measurements indicated methane concentrations ranged from 0.0% to 36.9% across the Dump. Carbon dioxide concentrations ranged from 0.0% to 28.6% and oxygen concentrations ranged from 0.0% to 22.3%. As would be expected, the concentrations of methane and carbon dioxide generally had an inverse relationship compared with the concentration of oxygen.

Landfill – Measurements indicated methane concentrations ranged from 0.0% to 70.0% across the Landfill, with an average concentration of 36.2%. Carbon dioxide concentrations ranged from 0.0% to 42.0% and oxygen concentrations ranged from 0.0% to 20.3%.

## Waste Extent

The extent of waste present at the Dump and Landfill was determined based on several methods including review of historical investigation results, review of historical aerial photography, and completion of investigation activities. The waste extent is shown on Figures 4 and 5 and the following sections describe the extent of waste and the information utilized to determine the extent at both the Dump and Landfill.

### Freeway Dump

The extent of waste material at the Dump appears to extend beyond the property boundaries in nearly all directions. Test excavations were completed along the edges of the property during Phase A of the investigation; however, waste material and/or ash were encountered at each of these locations extending to the property line, as described in the following paragraphs.

**West** – Interstate 35W is located west of the Dump. Three test excavations were placed along the west edge of the property and although no MSW/CD was present, ash was observed at all three locations. The Minnesota Department of Transportation (MnDOT) conducted a Phase II investigation in 2014 (MnDOT, 2015) and a supplemental investigation in 2018 (MnDOT, 2018) along the right-of-way corridor adjacent to the property. The logs from borings placed between the Dump and the Interstate indicated the presence of a greyish silt with fine-grained sand, which is similar to the description of the ash encountered during this investigation. Additionally, historical aerial photographs from 1964 and 1967 indicate that waste disposal operations were occurring close to the edge of the highway. Although MSW/CD do not seem to extend beyond the Dump property boundary, it is assumed that ash may extend into the Interstate 35W right-of-way.

**North** – Along the north and east edges of the property, it was anticipated that waste material was present beyond the property boundary as the elevated ground surface of the Dump above the adjacent wetland can be observed. The elevated ground surface extends approximately 100 feet north of the property boundary and waste was observed during construction of wells MW-19-02 and MW-19-03 located above 70 feet north of the property boundary. Boring logs from three monitoring wells (MW-97-7, MW-97-8, and MW-97-9) indicate no waste present; therefore, the northern extent of the waste is assumed to be located near the toe of the slope.

**East** – Along the east edge of the elevated Dump surface, the slope is typically more gradual, and where it contacts the wetland is less easily identified. At one test excavation (FD-TT-06) completed along the east edge of the property near what appeared to be the bottom of the slope, waste material was observed extending below the groundwater surface. Additionally, the boring log for OFMW-1, located farther to the east, indicates ash was encountered in the boring. The extent of waste is inferred to continue along the toe of the slope to the edge of the Burnsville Storage property to the south (see below for discussion of conditions for that property).

**Southeast** – The Burnsville Storage property adjoins the Dump property to the south and southeast. It is assumed that the extent of waste is to the property boundary in the southeast corner of the property. Although the area to the southeast of the property corner appears disturbed in historical photos and waste material was encountered in a nearby test excavation (FD-TT-08), no waste material was observed in the five borings in this area during the Phase B waste extent investigation (see Figure 2).

**South** – Test excavations along the south property boundary encountered waste material. Additionally, the boring log for monitoring well MW-97-6, located just south of the property boundary indicates the presence of waste material. During the Phase B waste extent investigation, waste was observed in three borings (FD-SB-01, FD-SB-04, and FD-SB-08) on the west side of the Burnsville Storage property. Visual evidence of this waste was mainly the presence of demolition debris or ash.

A historical dump site referred to as the “Astleford Dump” was located south of the Freeway Dump along the east side of the frontage road. The exact limits of dumping associated with the Astleford Dump are not well documented. The limits shown on Figure 12 are based ona 1986 property description diagram by the USFWS that was included in the MPCA historical files for the Dump and ground disturbance evident on historical aerial photographs. Similarly, while the exact operational dates of the Astleford Dump are unknown, based on aerial photos it appears the dump was potentially active in the 1950s and 1960s (Figure 12). Waste was observed in investigation locations south of the Site as part of the RI. Based on the location of those observations, combined with historical photograph review of the Freeway Dump operations, the delineation of the extent of waste between the two dumps is not determined.

### Freeway Landfill

**An assumed waste footprint was presented in the** Investigation & Sampling Plan (MPCA, 2017) based on data from previous investigations. Along the west edge of the Landfill, the 2005 soil boring investigation (FES, 2005) delineated the extent of waste material with a line of borings (No. 1 – 8) where no waste was observed. Along the south edge of the Landfill, the extent of waste material is defined by the bottom of the slope running along the property boundary. The extent of waste is also defined by the bottom of the slope along the east edge of the Landfill. This is supported in historical aerial imagery which does not show any disturbance beyond current landfill slopes.

During the RI, test excavations were completed along the north edge of the Landfill and in the southeast corner to gain a better understanding of the extent of waste in these areas (Figure 5). In the southeast corner, waste material was observed in FL-TT-08. This excavation was located on the slope due to soft ground conditions beyond the toe of the slope. No waste material was identified in borings WT-7 or DP-8, located beyond the toe of the slope. Historical aerial photos do not show any disturbance in this corner of the Landfill, with the exception of an access road in the 1990s. It is anticipated that the waste material extends no further than the bottom of the slope, but the exact location of the extent of waste has not been determined in this area.

During Phase A of the RI, waste material was observed in test excavations completed along the northern property boundary of the Landfill. The waste included both MSW and CD, and field screening noted chemical and petroleum odors within the waste material. Two additional test excavations were completed on the U.S. Salt property north of the Landfill in 2019. Waste was observed in the eastern excavation (FL-TT-09) and was described as inert construction debris (asphalt, concrete, rebar). No waste was observed in the western excavation (FL-TT-10). The result indicate that waste extends onto the U.S. Salt property in some areas as shown on Figure 5, but it is anticipated that the waste at the this property is primarily comprised of CD mixed with fill.

At the Transfer Station, no waste material was observed at locations TS-SB-02 and TS-SB-07, which were completed inside the operations building. Waste material was observed at every other boring location surrounding the operations building that was completed during the 2018 investigation. Based on that information, waste materials are anticipated to extend throughout the Transfer Station area, with the exception of directly under the buildings and, possibly, the weighing stations.

## Summary of Analytical Results

The majority of the laboratory analysis of samples was conducted during Phase A of the RI in the spring of 2018. One sample of solid media was collected from nearly all the soil boring and test excavation locations for laboratory analysis during the Phase A investigation. This included 48 MSW/CD samples, 7 ash samples, 6 native sediment samples, and 3 cover soil fill samples.

For the purpose of providing context to the data, solid media results were compared to the MPCA’s soil reference values (SRVs) and soil leaching values (SLVs). The SRVs are conservative, risk-based criteria that are dependent on land use scenarios. Concentrations from solid media samples were compared to both Recreational and Industrial SRVs. The SLVs provide a conservative estimate of the potential for contaminants detected in soil to leach to the groundwater, and it is also recognized that site specific groundwater data can be useful to further assess this potential migration pathway. For the purpose of results discussion in the subsequent sections, diesel range organics (DRO) and gasoline range organics (GRO) concentrations were compared to the criteria (100 mg/kg) included in the MPCA’s *Best Management Practice for Off-Site Reuse of Unregulated Fill* (Unregulated Fill: MPCA, 2012). It is acknowledged that comparison of waste samples to these criteria is likely overly conservative; however, it is useful in developing an understanding of the overall nature and magnitude of contaminant concentrations associated with the waste material.

As discussed in Section 4.2.2 of the *Phase A Investigation Report* (Barr, 2018), previous investigations in the surrounding area have concluded that the background concentrations of arsenic, iron, manganese, and vanadium often exceed SRVs and SLVs. Therefore, the range of background concentrations will be taken into account when discussing exceedances in the following sections. A comparison of criteria to background concentrations is provided in the following table:

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Criteria (mg/kg)** | **Dakota County Background Range\*** |
| **SLV** | **Industrial SRV** | **Recreational SRV** | **Soil****(0.2 – 0.5 m)** | **Soil Parent Material****(1 – 2 m)** |
| Arsenic | 5.8 | 20 | 11 | 7 | 12 | 12 | 17 |
| Iron | NA | 75,000 | 12,000 | 17,000 | 30,000 | 34,000 | 90,000 |
| Manganese | 130 | 8,100 | 5,000 | 498 | 1,284 | NA | NA |
| Vanadium | 4 | 250 | 40 | 72 | 93 | 93 | 115 |
| \*Data range from summary maps: OFR09-02, Minnesota Soil, Till, and Ground-Water Geochemical Data. Lively, R.S.; Thorleifson, L.Harvey (Minnesota Geological Survey, 2009) http://conservancy.umn.edu/handle/11299/117364  |

Tables 5a to 5c provide a summary of exceedances of the above-referenced criteria and all data is included in Appendix E. An abbreviated summary of the analytical results from the Phase A solid media sampling is provided below. For a more detailed discussion, please refer to the *Phase A Investigation Report* (Barr, 2018).

MSW/CD – Concentrations of metals, semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), PCBs, and total petroleum hydrocarbons (TPHs) that exceeded the comparison criteria listed above were detected in samples of MSW/CD throughout the Landfill and Dump.

| **Parameter** | **Samples Analyzed** | **Number of Phase A Sample Locations with SRV Exceedances** |
| --- | --- | --- |
| **MPCA Unregulated Fill\*** | **MPCA Tier 2 Recreational SRV** | **MPCA Tier 2 Industrial SRV** | **MPCA Screening SLV** |
| Metals | 48 | - | 42 | 13 | 47 |
| VOCs | 48 | - | 2 | 1 | 24 |
| PCBs | 48 | - | 20 | 8 | 35 |
| B(a)P equivalent | 48 | - | 15 | 12 | 19 |
| Other SVOCs | 48 | - | 2 | 2 | 15 |
| DRO | 48 | 41 | - | - | - |
| GRO | 48 | 8 | - | - | - |
| \*MPCA unregulated fill criteria regarding only DRO and GRO |

Ash – Ash was observed only in the Dump but not in the Landfill. Concentrations of vanadium were detected above the recreational SRV at all locations and above the industrial SRV at one sample location. Concentrations of vanadium were detected above background concentrations in five of the seven samples. In five of seven samples, arsenic was detected at a concentration above the Industrial SRV (and above background concentrations). Manganese was detected at all locations at concentrations above the SLV but below or within the background range. Note that manganese was also detected in groundwater samples collected from temporary wells installed during Phase A in the vicinity of the sample locations where the SLV was exceeded. Iron was also detected at all locations at a concentration above the Recreational SRV but below or within the background range. DRO was detected at a concentration of 33.7 mg/kg in one sample. The benzo(a)pyrene (B(a)P-equivalent) concentration exceeded the Industrial SRV at one location.

Native Sediment – Six samples of native sediment were collected during Phase A for laboratory analysis – two from the Landfill and four from the Dump (Table 5c). Arsenic, iron, manganese, and vanadium were detected above SLVs or SRVs at most locations, but the concentrations were below or within their background ranges.

Boron was detected above the SLV at four locations, benzene was detected above the SLV at three locations, while Bis(2-ethylhexyl)phthalate, B(a)P-equivalent, and PCBs were each detected above their SLV in one location. Boron and benzene were also detected above drinking water and/or surface water standards in groundwater samples collected from temporary wells installed at the Dump during Phase A. The B(a)P-equivalent concentration was also above the Recreational SRV at one location. DRO was detected at a concentration above 100 mg/kg at two locations.

The locations where parameters exceeded SLVs or SRVs and were above the background range were all located at the Dump, from native soils sitting below waste material. At the Landfill, where native sediment samples were collected from locations outside of the waste footprint, all results were below SLVs and SRVs or were within background ranges.

### Analytical Results – Waste to Energy

Three composite waste samples were collected during Phase B of the investigation for laboratory analysis of parameters associated with evaluating waste-to-energy potential. A composite sample from the entire waste interval was collected from each of the borings at MW-9D and MW-10D. The third sample was composited from material collected at eight of the cover soil evaluation boring locations (Table 2). The waste samples caloric value ranged from 580 to 1265 British thermal units per pound (BTUs/lb), significantly lower than typical garbage being accepted for incineration. For example, typical “fresh” garbage caloric values for MSW recently processed at the Hennepin Energy Recovery Center (HERC) range from 5,860 to 6,646 (BTU/lb) (see Barr Focused Feasibility Study).

### Analytical Results – Crushed Bedrock

Bedrock samples were collected for laboratory analysis from wells MW-9D and MW-10D. The sample intervals were generally within 10 feet of the bedrock surface. Samples were delivered to the laboratory and crushed for the purpose of analysis.

Analytical results for the bedrock samples are shown on Table 6. The appropriate criteria to use for comparison of crushed rock sample results would be dependent on uncertain future uses and exposure scenarios. In a mining scenario, a potential exposure scenario is direct contact during crushing operations, but end uses of an aggregate product may result in other exposure scenarios. In light of those uncertainties, the results on Table 6 are compared to SRVs and SLVs for the purpose of providing context to the results. Exceedances of those criteria do not, by themselves, indicate an exposure risk issue that warrants being addressed.

The reported manganese concentration of 1,500 mg/kg at location MW-10D exceeds the SLV and is slightly higher than the upper background range value of 1,284 mg/kg. The reported concentrations of manganese from location MW-9D and vanadium at both locations exceed their SLV criteria but are within the background range. It should be noted that at locations MW-9D and MW-10D the bedrock is overlain by waste materials. For context, the concentration of manganese in groundwater samples collected from the same monitoring wells exceeded drinking water criteria, whereas vanadium did not exceed either drinking water or surface water criteria.

### Analytical Results – Soil Gas

Two soil gas samples were collected from boring locations near occupied buildings at the Burnsville Storage property south of the Dump. The soil gas samples were submitted for laboratory analysis of VOCs. As shown on Table 7, several VOCs were detected, including benzene, ethylbenzene, perchloroethylene (PCE), and trichloroethylene (TCE). However, following MPCA guidance (MPCA, 2017), the concentrations were less than the MPCA’s 33x Residential Intrusion Screening Values (ISVs). ISVs are conservative, risk-based values for assessing the potential inhalation exposure concern related to intrusion of soil gas contaminants into occupied buildings.

Methane is a landfill gas constituent that does not have a risk-based ISV. However, it poses other risks for intrusion into buildings and the related potential for explosion in the presence of oxygen and an ignition source. Methane had been detected at high levels across much of the dump in 2018, including values of 9% to 30.8% in the four locations closest to the adjoining Burnsville Storage Property (borings FS-SB-G1 through G4, Figure 2).

Soil gas sample results from the two borings conducted in 2019 adjacent to the occupied buildings at the Burnsville Storage property (FD-SB-07 and FD-SB-08) showed non-detectable or low levels of methane. The concentration of 45.3 ppm (0.00453%) methane at FD-SB-07 is well below the lower explosive limit for methane of 5%. Based on the preliminary soil gas results at these two borings, the potential risk for landfill gas intrusion concerns at the occupied buildings at this property are relatively low, but this risk should continue to be assessed as part of future efforts.

# Cover Soil Investigation

Investigation activities were completed to evaluate the substantial volume of cover soils that are present over waste at the Site. The primary objective in collecting cover soil samples was to evaluate their potential for reuse as part of a remedial action.

## Summary of Investigation Activities

Cover soil investigation boring locations were selected based on previous investigation activities. The borings were completed near previous boring locations in order to (a) verify the observations from previous borings and (b) target locations with adequate thickness. The locations were chosen to be spread across both the Landfill and Dump and to represent a range of cover soil thicknesses.

### Soil Borings

Cover soil investigation borings were advanced with a direct-push, tracked drill rig. Soil samples were collected with a dual-tube or macro-core sampler. Soil borings were advanced to, or in some cases below, the top of waste. The soil samples were described in the field by a Barr geologist or environmental scientist in accordance with the Unified Soil Classification System. The samples were inspected by Barr staff for evidence of contamination such as staining, odors, discoloration, or sheen and the observations were documented on the geologic log of each boring. Borings were sealed in accordance with Minnesota Department of Health rules. Locations of the borings are shown on Figure 7 and boring logs are presented in Appendix A. A summary of the cover soil borings is provided below:

Dump – Five soil borings were completed at the Dump. The borings were drilled near the locations of Phase A investigation locations FD-SB-A4, FD-SB-B1, FD-SB-C3, FD-SB-F2, FD-SB-G5 and were similarly named.

Landfill – Fourteen soil borings were completed at the Landfill. The borings were drilled near 2005 investigation (FES, 2005) locations so the approximate depth to waste was known. The borings at eight of the fourteen locations were advanced five to ten feet beyond the top of waste to facilitate collection of waste material samples (See Section 4.1.3).

### Sample Collection

Soil samples from cover soil borings were collected and analyzed by Pace for the parameters listed in Table 1. Upon receipt of the laboratory analytical data, Barr performed a data quality review. A summary of the data quality review is included in Appendix D. The review concluded that all data met the data quality objectives of the project and are deemed acceptable for the purposes of this project, as qualified in the tables.

## Summary of Investigation Results

The following subsections detail the results of the cover soil investigation conducted in the spring of 2019. A description of the cover soil fill material observed at the Dump and Landfill is included in Section 4.2.1.1. Soil boring details are presented in the Soil Boring Matrix (Table 2). The four cover soil samples (FD-SB-G1, TS-SB-02, TS-SB-03, TS-SB-07) collected during Phase A are also included in this discussion of results.

### Field Screening Results

As discussed above in Sections 4.2.2 and 4.2.3, field screening of the cover soil did not identify evidence such as staining, odors, discoloration, or sheen, with the exception of trace sheen and moderate odor observed in borings TS-SB-02 and TS-SB-05 (Transfer Station). Headspace readings for all the soil samples were below 10.0 ppm.

### Potential Reuse Criteria

The primary purpose of the cover soil investigation was to evaluate the cover soil’s potential for reuse within the proposed remedial design. The appropriate criteria for comparison with analytical results will be dependent on the design alternatives and details. For the purpose of providing context and a potential initial set of criteria for comparison, the results of the soil cover investigation were compared to the MPCA *Best Management Practices for the Off-Site Reuse of Unregulated Fill* (Unregulated Fill: MPCA, 2012) and Dakota County Ordinance 110, Solid Waste Management. These criteria, which are likely more conservative than would be required based on likely future land use scenarios (e.g., soil cover at a restricted access landfill or soil that will be covered by a future commercial redevelopment, etc.), are listed below:

* free from solid waste, debris, asbestos-containing material, visual staining, and chemical odor
* organic vapors less than 10 parts per million, as measured by a PID
* for petroleum-impacted soil, less than 100 mg/kg DRO/ GRO
* for contaminants detected in soil, less than the MPCA’s SRVs and Tier 1 SLVs
	+ Dakota County Ordinance 110 modifies the Lead criteria to less than 100 mg/kg

In addition to the Unregulated Fill and Dakota County criteria, analytical results are also compared to the MPCA Industrial and Recreational SRVs, which represent other conservative criteria for potential future land use scenarios.

### Analytical Results

Soil quality results are presented with comparison to the above-described criteria in Table 8. Generally, concentrations did not exceed any of the criteria with the following exceptions:

* The arsenic concentration of 75.1 mg/kg exceeded the Residential and Industrial SRVs (11 mg/kg and 20 mg/kg, respectively) at location FD-SB-C3. Arsenic concentrations also exceeded SLV at three locations (FD-SB-G5; FL-SB-02; FL-SB-08); however, these detections were below or within their background range as discussed in Section 4.3. Arsenic was also detected at concentrations in groundwater samples collected in the vicinity of these samples; however it is important to note that the waste material underlying the cover soils may be a contributor to the arsenic detections in groundwater.
* The BaP-equivalent concentration exceeded the SLVs in samples collected from three locations (TS-SB-03, FD-SB-C3; FL-SB-07).
* The benzene SLV was exceeded at one location (FL-SB-13). Benezene was also detected at concentrations above drinking water standards in locations at both the Dump and Landfill; however, it is important to note that the waste material underlying the cover soils may be a contributor to the arsenic detections in groundwater.
* DRO was detected at every location; however, DRO concentrations exceeded 100 mg/kg (the Unregulated Fill guidance concentration) at only 4 of the 23 locations (TS-SB-03, FD-SB-F2; FL-SB-03; FL-SB-13). DRO concentrations ranged from 3 to 458 mg/kg and the mean concentration was 72 mg/kg.
* Lead was detected above 100 mg/kg at one location (TS-SB-03).

One or more potential reuse criteria were exceeded at 6 of the 23 sample locations. These sample locations were not grouped within a particular area of the Site, but, rather, appeared to be randomly distributed.

The alternatives for landfill closure under consideration include excavation, staging, and reuse of the cover soil. In light of the planned large-scale soil handling, the average concentrations in cover soil are anticipated to be a suitable measure for assessing risks. The average contaminant concentrations for the cover soil do not exceed any of the conservative criteria.

Given the relatively low concentrations of contaminants present in the cover soil and the expected future land uses, it is believed that the cover soil is suitable for reuse as part of the remedial alternatives under consideration for the Site.

# Groundwater Investigation

Groundwater monitoring has been periodically conducted at the Site dating back to the 1970s. Over that time, the monitoring well network, sampling details, and sample parameters have evolved. The purpose of this section is to summarize the current monitoring well network (which consists of wells constructed as part of this investigation as well as those installed historically), discuss the recent investigation activities, and summarize the results of the recent investigation activities. Previous groundwater monitoring results help inform the understanding of the Site, but the results are not included in the discussion in this section.

## Monitoring Well Network

The current monitoring well network consists of 40 wells (including the wells installed during the Phase B investigation). The Monitoring Well Network Matrix (Table 9) provides construction details for the well network. The monitoring well locations are shown on Figure 8. For the purpose of discussion and interpretation, the wells are organized into the following three groupings:

Perched – These wells are screened at depths where water or leachate was encountered above the regional groundwater table. The bottoms of the well screens are either on the bedrock surface or at the bottom of waste and generally low well volumes and recharge capacity have been observed during sampling events.

Water Table – These wells within the monitoring well network are screened across the regional groundwater table, with the exception of wells WT-9 and WT-10. Typically, the regional water table at the Site is in fractured Prairie du Chien bedrock and, therefore, most of the water table wells were constructed as open borehole bedrock monitoring wells (some were constructed with screen and sandpack due to hole collapse). The newly installed wells (MW-11, MW-12, and MW-13) located in the northern portion of the Landfill were constructed with a screen and sandpack as the water table is present in unconsolidated material in this area.

Jordan – There are three wells at the Landfill that are constructed as open borehole bedrock monitoring wells in the Jordan Sandstone which underlies the Prairie du Chien. The open-hole sections of these wells are in the Jordan and generally at depths of approximately 160 to 220 feet below ground surface.

Although the monitoring wells are separated into three different groups for the purpose of discussion and comparison of results, it is important to note that these are not separate aquifer units.

### Existing Monitoring Wells

Thirty of the forty monitoring wells that comprise the network were installed prior to Phase B, as summarized below. While the following paragraphs reference wells that are no longer present, only the wells that remain at the Site are included in the total count of wells and in the well construction summary (Table 9).

This well is screened across the regional diameter screen due to borehole collapse.

Landfill – From 1977 to 1983, eight regional water table monitoring wells (WT-1 through WT-8) and one Jordan Sandstone monitoring well (J-1) were installed at the Landfill. Of these wells, only wells WT-6 and J-1 remain. WT-6 was modified when the Transfer Station was built (the riser pipe was raised approximately 10 feet). Around 1986 it was observed that wells WT-7 and WT-8 (located on the southern property edge) were dry. An additional four wells (WT-9 to WT-12B) were subsequently installed in 1987 and then in 1990 four additional wells (WT-13 and WT-14, J-13 and J-14) were installed. In 1993, eight landfill gas wells were installed. One of these wells (MP-8) is located near the nested pair WT-13 and J-13. Although this well was constructed dry and for the purpose of landfill gas monitoring, it has since been observed to accumulate perched groundwater. Because the log indicates its construction is the same as a typical monitoring well would be, it is included here as part of the monitoring well network.

In 2015 the MPCA installed an additional 10 monitoring wells at the Landfill. Eight of these wells (MW-1 to MW-8) are screened in the perched groundwater/leachate, while the other two (MW-4D and MW-8D) are screened across the regional water table in the Prairie du Chien.

## Summary of Investigation Activities

Previous investigations at the Landfill and Dump provided data with respect to the groundwater characterization; however, most of these investigations were conducted over twenty years ago and were somewhat limited in scope. Additional monitoring wells were installed as part of the RI to add to the monitoring well network and gain a more complete understanding of the current groundwater conditions. Recent groundwater investigation activities occurred during the spring of 2019 and included:

* Installation of four shallow monitoring wells at the Dump
* Installation of four shallow monitoring wells at the Landfill (one as a nested pair with a bedrock monitoring well)
* Installation of two bedrock monitoring wells at the Landfill
* Collection of one round of groundwater samples from the monitoring well network
* Completion of two synoptic groundwater elevation measurement events
* Collection of other physical and geophysical data, as described in Section 6.2.2 and 6.2.3

### Monitoring Well Installation

Monitoring wells were installed using several different methods, depending on the geologic materials in which the well was to be constructed. The following paragraphs provide the well installation details for each method.

#### Direct-Push / Hollow Stem Auger

Soil borings were initially advanced with a direct-push, tracked drill rig. Soil samples were collected with a dual-tube or macro-core sampler to log the lithology prior to the installation of shallow monitoring wells. Soil samples were collected from continuous vertical intervals and were logged in the field by a Barr geologist or environmental scientist as described in Section 4.1.1. Boring logs are provided in Appendix A.

Monitoring wells were then installed via hollow-stem auger drilling and were constructed using 2-inch diameter, Schedule 40 polyvinyl chloride (PVC) well screens (No. 10 slot) and risers. Wells were constructed in accordance with Minnesota well code. Well construction details are provided in Table 9. Shallow monitoring wells installed at the Site are described below:

Dump – Four monitoring wells were installed as perched wells via direct push/hollow stem auger on the north side of the Dump (Figure 2). Two of the locations are on the property owned by the Site Owner, while the other two are located on a neighboring property owned by Northern States Power Company (Xcel Energy). Because of flood conditions occurring during installation and associated higher groundwater levels, two of the wells (MW-19-03 and MW-19-04) were completed with 20-foot long well screens rather than the planned 10-foot long well screens. The 20-foot screens were installed to comply with MDH monitoring well installation requirements that do not allow for threaded riser pipe connections below the observed groundwater level.

Landfill - Three monitoring wells (MW-11 to MW-13) were installed as water table wells via hollow-stem auger on the north side of the Landfill (Figure 3).

One other shallow monitoring well (MW-9) was installed as a perched well via direct push/hollow stem auger on the south side of the Landfill as a nested pair with a bedrock monitoring well (MW-9D, discussed below). Another shallow monitoring well was planned as a nested pair with bedrock monitoring well MW-10D; however, this well was not installed because there was no evidence of perched water during the drilling of MW-10D.

#### Rotasonic and Diamond Core

Two soil/rock borings were advanced and monitoring wells (MW-9D and MW-10D) were installed at the Landfill. Borings were advanced using rotasonic (sonic) drilling technology to provide continuous soil samples for the planned bedrock monitoring wells. Sonic drilling uses dual line threaded drill pipe with an inner core barrel and an outer sonic drill casing. The sample is extruded from the core barrel into plastic sleeves so that it can be logged, field screened, and sampled. From ground surface to the top of competent bedrock, continuous soil core samples were collected in accordance with ASTM D-6914-04e1 *Standard Practice for Sonic Drilling for Site Characterization*.

From the top of competent bedrock to the bottom of the borehole, diamond core drilling was conducted with 2.5-inch inner diameter (HQ) core barrels. The rock cores were continuously recovered and logged for geologic classification and fracture density assessment using rock quality designation (RQD) (ASTM D6032 - 08). Core recovery and RQD were calculated as described in ASTM D6032-08. The rock type, field strength, color, texture, structure, decomposition, disintegration, fracture density, and stratigraphic contacts were described for the core. Fractures were described noting the depth, type, apparent dip angle, aperture, healing, infilling, unevenness, and moisture. Drillers provided any observations related to rod drops, water loss, and relative coring rate to enhance the field geologist’s notes as related to the potential presence of fractures. Boring logs are included as Appendix A. All cores were photographed with depth and boring location identification.

MW-9D – The borehole was advanced to 31 feet bgs by rotasonic drilling with diamond core drilling from 31 to 78 feet bgs. RQD ranged from very poor to good within the diamond cored interval, though generally the RQD was fair. The casing is set to a depth of 45 feet bgs. The open borehole portion of the well extends to a depth of 83 feet bgs (the borehole was advanced by rotasonic from 78 to 83 feet bgs because it was decided to extend the depth of the well an additional 5 feet after the diamond core tooling had been removed from the hole).

MW-10D – The borehole was advanced to 31 feet bgs by rotasonic drilling with diamond core drilling from 31 to 88 feet bgs. RQD ranged from poor to excellent within the diamond cored interval, though generally the RQD was fair to good. The casing is set to a depth of 66.5 feet bgs and the open borehole extends to a depth of 88 feet bgs.

#### Well Development

The new monitoring wells were developed after a minimum of 24 hours following grout installation in accordance with the Minnesota Well Code. Well development was conducted by surging and over-pumping. For the bedrock monitoring wells and some of the shallow wells, the development process continued until discharge water was visibly free of sediment. Monitoring well MW-9 was observed to have very little water (less than 1 foot) and was not developed.

### Physical Site Data Collection

The following section includes descriptions of the surveying data, groundwater level measurements, and river level measurements.

#### Surveying

Final locations of all soil borings, test excavations, monitoring wells, and any other important features noted during the field investigation were surveyed using a hand-held GPS device. The horizontal coordinates of each investigation location were surveyed by GPS to the nearest 1 foot, and referenced to the Universal Transverse Mercator (UTM) coordinate grid system North American Datum (NAD)-83.

Due to the complications with persistent flooded river conditions during the RI, an elevation survey has not yet been completed. The elevations of newly installed and some existing monitoring wells will be surveyed to an accuracy of 0.1 feet and will be referenced to the North American Vertical Datum (NAVD) of 1988. The elevation survey of the monitoring well network will be conducted by a licensed surveyor contracted by the MPCA.

For the purpose of this report, the ground surface elevations of well locations that have not yet been surveyed are approximated based off existing LIDAR (Light Detection and Ranging) topographic information and the riser elevations are approximated based on LIDAR and well construction log detail. The ground surface elevation of soil boring and test excavation locations will not be surveyed but are approximated based off LIDAR.

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#### Groundwater Level Measurements

Groundwater levels were measured in monitoring wells during the spring of 2019. A summary of groundwater level measurements is provided in Tables 10a and 10b. Synoptic rounds of groundwater level measurements were obtained on April 9, 2019 and June 17, 2019. The Minnesota River stage (at Savage MN, approximately 1 mile upstream) was approximately 708 feet MSL, which is between the minor flood stage (702 feet MSL) and moderate flood stage (710 feet MSL), on April 9 and, therefore, several wells were inaccessible. During the June 17 measurement event, the Minnesota River Stage at Savage, MN was approximately 699 feet MSL, which is between the action stage (697 feet MSL) and the minor flood stage. Only one well (J-1) was inaccessible (due to flooding) on June 17. Groundwater levels were also recorded by Pace when groundwater samples were collected for laboratory analysis. Groundwater levels from the synoptic measurements are presented on the groundwater contour figures (Figures 9 to 11)

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### Borehole Geophysical Logging

The Minnesota Geologic Survey (MGS) conducted borehole geophysical logging in several wells at the Landfill. The logging generally consisted of video, gamma, caliper, and multi-tool (fluid resistivity, fluid temperature, spontaneous potential (SP), normal resistivity (16N and 64N), single point resistance, lateral resistivity, and specific conductance) logging. MGS performed the downhole surveys at monitoring wells WT-11B, WT-13, J-13, WT-14, and J-14 as part of their on-going regional assessment program. Barr reviewed the logs (Appendix G) to assess if discrete, hydraulically active fractures or fracture zones could be easily identified that might warrant discrete interval sampling in the open borehole wells. During Phase B, it was determined that discrete interval sampling would not be pursued; however, further analysis of the geophysical logging data will be conducted as part of the ongoing groundwater investigation.

### Sample Collection

Groundwater samples were collected for laboratory analysis by Pace. The sample parameter lists are included in Table 1. Samples were analyzed at Pace for all of the parameters listed, with the exception of a select group of groundwater sample parameters that were analyzed at MDH’s laboratory. Laboratories were selected by MPCA from a list of state-contract laboratories or other state agency laboratories.

Upon receipt of the laboratory analytical data, Barr performed a data quality review. A summary of the data quality review is included in Appendix D. The review concluded that all data met the data quality objectives of the project and are deemed acceptable for the purposes of this project, as qualified in the tables.

**Phase A** – During Phase A of the investigation (2018) groundwater samples were collect from temporary wells in select borings and also from test excavations where groundwater was observed. Groundwater samples were collected from the borings using 1–inch diameter PVC screen and riser. New screens and risers were used at each sample location. A peristaltic pump was used to recover the sample from the temporary wells. Purging was not conducted prior to sample collection due to the limited volume and recharge observed. Samples were generally turbid due to this lack of purging. If water was encountered in a test excavation, a sample was collected using surface water sampling techniques, which generally included filling a laboratory-cleaned container by lowering it into the water that had accumulated in the excavation. The sample was then transferred into the appropriate laboratory-provided sample container.

**Phase B** – During Phase B (2019) of the investigation, groundwater samples were collected from the existing and newly installed monitoring wells at the Site. Due to flood conditions, sampling was not conducted at three locations (J-1, WT-9, and WT-10), and at multiple locations sampling was delayed to allow for flood waters to recede sufficiently. No sample was collected from well WT-12B because the sampling crew was unable to locate the well (the well was eventually located during the water level measuring event on June 17). Wells were sampled in accordance with procedures detailed in the QAPP.

In addition to samples collected from the monitoring wells, a groundwater sample was collected on
May 29, 2019 from a seep located downgradient of the Landfill at Kraemer Quarry. A sample
of the discharge water from the quarry’s pumping operations was also collected. The discharge water sample was collected from an outfall flowing into settling ponds in the northwest corner of the quarry. The sample was collected at this point because due to flooded conditions the normal effluent point for the pumping operations was not in use and sampling could not be conducted safely at the interim effluent point. Sample locations are shown on Figure 3.

### Investigation Derived Waste

Investigation derived waste (IDW), including soil cuttings from well construction activities and purge water from well development and sampling, was containerized in 55-gallon steel drums. Solid and liquid waste streams were containerized separately. The waste was profiled as similar to the IDW disposed of during the 2015 well installation at the Landfill. Clean Harbors collected IDW generated as part of the Phase B investigation and hauled it offsite for disposal on June 24, 2019. The HQ rock cores were boxed and stored offsite.

## Summary of Analytical Results

Groundwater samples were compared to drinking water and surface water standards as there is potential risk for migration to both well receptors and surface water receptors. MPCA surface water standards for both chronic and acute exposure were used for comparison. These standards are dependent on the hardness of the receiving surface water body. A hardness value of 360 mg/L was estimated for the Minnesota River (MPCA, 2006). Drinking water criteria used for comparison were the EPA’s maximum contaminant levels (MCLs) and the MDH health risk limits (HRLs). The following discussion of analytical results is separated into three groups; perched, water table, and Jordan, similar to the monitoring well network (Table 9).

During Phase A of the investigation, the analytical parameter list covered a large range and, as would be expected from groundwater in contact with waste material, concentrations of a number of parameters were above drinking water and surface water criteria. The parameter list selected for Phase B of the investigation was reduced to include only parameters that exceeded relevant criteria during Phase A. Results from Phase A of the investigation are summarized in the *Phase A Investigation Report* (Barr, 2018) and exceedances are presented in Table 11 of this report for reference. Because data collected from permanent monitoring wells is typically more reliable than data collected from temporary wells or test excavations, the majority of this section is focused on the results from Phase B of the investigation. The exceedances of drinking water and surface water criteria for groundwater samples collected from the monitoring well network are presented in Table 12. While Tables 11 and 12 only include exceedances of criteria, all groundwater data is tabulated in Appendix E.

**Perched Groundwater** – Sample locations and monitoring wells included in the perched groundwater group include the Phase A temporary well locations at the Dump and Landfill, test excavation locations at the Dump, 2015 MPCA-installed monitoring wells (MW-1 to MW-8), former landfill gas monitoring well MP-8 at the Landfill, and the newly installed monitoring wells (MW-19-01 to MW-19-04) at the Dump.

Generally, the results for samples from perched wells installed during Phase B were similar to the results collected during Phase A. Analytical results from the perched groundwater samples collected during Phase B are summarized below:

General Parameters – Concentrations of nitrogen (ammonia, as N) were observed in 6 of 7 perched wells (MW-3 and MW-9 were not sampled for ammonia due to insufficient sample volume) at the Landfill ranging from 0.47 to 621 milligrams per liter (mg/l) and at all four perched wells at the Dump ranging from 0.4 to 20.2 mg/l, exceeding the chronic surface water standard of 0.04 mg/l. Concentrations of chloride exceeding the chronic surface water standard of 230 mg/l were not detected in wells at the Dump, but were detected in four of eight wells (MW-9 was not sampled for chloride due to insufficient sample volume) at the Landfill at concentrations ranging from 1,070 to 1,240 mg/l. Cyanide concentrations exceeded the chronic surface water standard of 5.2 µg/l at one Landfill well and two Dump wells.

Metals –More than ten metals exceeded drinking water and/or surface water criteria in the 2019 sample collected from well MW-1. At the remaining wells, concentrations of metals above criteria were widespread, but the specific metals generally varied. Boron and manganese were most commonly detected at concentrations above drinking water standards. Cobalt concentrations were detected above surface water standards at four wells at the Landfill but none at the Dump. Hexavalent chromium concentrations were also detected above surface water standards at one Dump and five Landfill locations, with two locations at the Landfill exceeding drinking water standards.

VOCs –Multiple VOC analyte concentrations above drinking water and/or surface water standards were reported at wells MW-1 (fourteen) and MW-3 (six) at the Landfill. In addition, benzene concentrations above surface water and/or drinking water standards were reported at two Dump and five other Landfill locations. A vinyl chloride (VC) concentration above both drinking water and chronic surface water standards was reported at one well at the Dump. A TCE concentration above the HRL was reported at one location at the Dump.

1,4-dioxane - Concentrations of 1,4-dioxane were reported in 7 of 9 perched wells at the Landfill ranging from 4.2 to 220 µg/l and 3 of the 4 perched wells at the Dump ranging from 3.4 to 13 µg/l. The chronic surface water standard for 1,4-dioxane is 1.0 µg/l.

PFAS- Per- and polyfluoroalkyl substances (PFAS) concentrations were reported at all perched well locations at the Dump and Landfill, with the exception of MP-8. There are no MCLs for PFAS compounds. The MDH has developed HRLs for some PFAS compounds. Compounds whose reported concentrations most often exceeded their HRL were perfluorohexane sulfonate (PFHxS), perfluorooctanesulfonate (PFOS), and perfluorooctanoic acid (PFOA). The reported concentrations of these compounds were one to two orders of magnitude higher than their HRLs.

**Water Table** – Sample locations and monitoring wells included in the water table group include the Phase A test excavation locations at the Landfill, newly installed bedrock wells (MW-9D and 10D), 2015 MPCA installed monitoring wells (MW-4D and MW-8D), and existing wells WT-6 to WT-14 at the Landfill, the seep sample collected from Kraemer Quarry, and the existing monitoring wells (MW-97-1 to MW-97-9; OFMW-1) at the Dump. Analytical results from the water table groundwater samples collected during Phase B are summarized below:

General Parameters – Concentrations of nitrogen (ammonia, as N) were observed in all 11 water table wells at the Landfill ranging from 0.14 to 84.9 mg/l and at 7 of 9 water table wells at the Dump ranging from 0.12 to 5.3 mg/l. The chronic surface water standard for nitrogen (ammonia, as N) is 0.04 mg/l. Concentrations of chloride exceeding the chronic surface water standard of 230 mg/l were detected in 3 of 11 wells at the Landfill ranging from 240 to 501 mg/l and at 3 of 9 wells at the Dump ranging from 272 to 291 mg/l. Cyanide concentrations exceeded the chronic surface water standard of 5.2 µg/l at two Landfill wells.

Metals – Reported metals concentrations in excess of criteria in samples collected from water table wells were widespread but the specific metals varied by location. Boron and manganese were most commonly detected at concentrations above drinking water standards. Cobalt concentrations were detected above surface water standards at eight wells at the Landfill, and five wells at the Dump.

VOCs – No reported VOC concentrations for samples collected from the water table wells exceeded drinking water or surface water standards, with the exception of vinyl chloride which exceeded the MCL at well MW-8D.

1,4-dioxane - Concentrations of 1,4-dioxane exceeding the chronic surface water standard of 1.0 µg/l were reported for 8 of 11 water table wells at the Landfill ranging from 1.2 to 40 µg/l. The concentration of 1,4-dioxane reported in the seep sample was 19 µg/l. 1-4-dioxane was not reported in any of the samples from the Dump wells at a concentration that exceeds the criteria.

PFAS - PFAS compounds were reported at nearly all water table well locations at the Dump and Landfill, as well as in the seep sample, with the exception of wells MW-97-2, MW-97-3, and MW-97-4. PFOS and PFOA were the compounds most commonly reported at concentrations exceeding their HRLs. Generally, the concentrations of these compounds were one order of magnitude or less higher than their HRLs.

**Jordan** – There are three monitoring wells located at the Landfill that are open in the Jordan Sandstone. Due to flood conditions, it was not possible to sample well J-1 in the spring of 2019. Reported concentrations of nitrogen (ammonia, as N) in samples from wells J-13 and J-14 exceed surface water and/or drinking water criteria were limited to nitrogen (ammonia, as N), ranging from 0.21 to 0.30 mg/l at both locations and 1,4-dioxane at J-14 (3.3 µg/l).

# Conceptual Site Model and Potential Pathways/Receptors

A generalized conceptual site model is presented in the following paragraphs. Because the investigations completed to date have been focused, the conceptual site model that has been developed is similarly focused. Also included in the following paragraphs is an assessment of the potential pathways and receptors associated with the presence of waste in unlined facilities.

## Waste Materials and Subsurface Conditions

At both the Dump and the Landfill, a thin layer of top soil is generally present that covers non-native fill material overlying waste material, which rests on native sediments and/or bedrock. A liner below the waste is not present at either location. At the Dump, bedrock generally slopes downward to the north edge of the property towards the Minnesota River, as shown on Figures 6A and 6D. At the Landfill, the bedrock elevation is generally higher in the south and slopes down to the north towards the Minnesota River, as displayed on Figures 6E and 6F. Descriptions of the subsurface materials and detailed investigation observations are included in Section 4.2.

At the Dump, waste appears to extend beyond the property boundaries in all directions, as detailed in Section 4.3. Waste material at the Dump, which includes MSW/CD and ash, was observed to be between 10 and 30 feet thick within the Dump boundary and between 5 and 10 feet thick in locations where waste material was identified south of the perimeter of the Dump in Phase B of the Investigation (Figure 4).

At the Landfill, waste appears to be generally contained on property owned by the Site Owner, except for some waste material that extends offsite to the north adjacent to the Minnesota River. Generally, waste material encountered at the Landfill consisted of MSW/CD, with a slightly higher percentage of construction debris compared to the Dump. Waste material that extends offsite to the north appears more similar to construction debris than MSW. The thickness of waste material encountered during Phase B of this investigation ranged from 6 to 15 feet, with an average waste thickness of about 13 feet. Data from a 2005 investigation indicate that waste material was commonly observed to be between 15 and 25 feet thick in the center portion of the landfill, with a maximum thickness of 49 feet (FES, 2005). Waste material is present throughout the Transfer Station area, with the exception of directly under the buildings and, possibly, the weighing stations.

### Direct Contact Pathway

Under current conditions, there is a limited risk of direct contact with waste. There is a vegetated soil cover present at both the Landfill and Dump that is being maintained by the Site Owner. Access is controlled at the Landfill and land use is commercial for both areas.

TheAlong the east, north, and west edges the vegetation includes shrubs and the south edge is wooded. Cover soil is present over the waste material. However, the investigation results indicate that the cover soil thickness is less than one foot in some locations.

The Landfill is similarly vegetated with grasses over the majority of the land surface and the edges of the property having shrubs or wooded vegetative cover. The Landfill is no longer operational; however, the Transfer Station is operational and access roads through the Landfill are utilized as well as lay-down areas in the northern portion of the Landfill. Cover soil is present over the waste material. Investigation results indicate the soil cover thickness is two feet or greater. The Landfill is also accessible to pedestrian and vehicular traffic; however, access is controlled by fencing and gates.

There are also limited areas of waste that extend onto adjacent commercial properties as follows:

* The U.S. Salt property located north of Freeway Landfill - a gravel driving surface and support structures are present over the underlying debris, limiting direct contact risk for this commercial property.
* The wetland complex (Xcel Energy and US Fish and Wildlife) located north and east of Freeway Dump - a vegetated cover over the waste is present in these areas, reducing direct contract risks for these areas that are rarely accessed by people.
* The Burnsville Storage Company facility located south of Freeway Dump - a paved surface and slab-on-grade storage building limit direct contact concerns for this property.

### Vapor Pathway

Decomposition of MSW creates landfill gas, including high levels of methane. The majority of the waste area is vacant land, and minimal monitoring is currently conducted. There are a few existing buildings near the waste that may pose a risk of landfill gas intrusion (all believed to be slab-on-grade construction), including:

* Freeway Transfer Station at Freeway Landfill
* Commercial building at driving range at Freeway Dump (operated seasonally)
* Storage units and two residentially-occupied spaces at the Burnsville Storage Company at south end of Freeway Dump (Soil gas samples near the occupied units did not identify soil vapor intrusion risks)

At the Dump, a limited set of soil gas samples was collected beyond the waste extent boundary on the Burnsville Storage property. These samples were collected within 20 feet of buried waste material. The methane concentration was several orders of magnitude below the lower explosive limit and the VOC concentrations did not exceed 33x ISVs. Additional sampling may be required for future buildings constructed near the waste boundaries.

## Hydrogeology

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The uppermost bedrock beneath the Site is dolostone of the Prairie du Chien Group. Immediately below the Prairie du Chien is the Jordan Sandstone. The Prairie du Chien and Jordan are hydraulically interconnected and are the two most utilized and productive aquifers in the Twin Cities metropolitan area. Groundwater flow in the Prairie du Chien Group is dominated by secondary porosity features (fractures and dissolution voids). Previous investigations indicate that hydraulic conductivities range from approximately 16 feet per day (ft/d) to 1,530 ft/d within the upper Prairie du Chien (Leisch, 1991). Higher conductivity zones are expected to be representative of higher fracture density and lower conductivity zones are expected to be representative of lower fracture density. Preliminary assessment of rock coring and downhole geophysical logging results did not identify discrete fracture zones that dominate groundwater flow. Although groundwater flow at the Site is through secondary porosity features, based on available information it appears that at the scale of tens of feet or greater, the equivalent porous media approximation can be applied to the Prairie du Chien at the Site.

Under natural conditions, groundwater in the unconsolidated material, the Prairie du Chien, and the Jordan would discharge to the Minnesota River (or into associated lakes and wetlands that discharge to the river). However, the groundwater flow patterns near the Site are currently influenced by the long-term dewatering operations at the Kraemer Quarry located approximately 1,000 feet west of the Dump and immediately south and southwest of the Landfill, which has a significant impact on current and future risks. The Site is also periodically influenced by flooding on the adjacent Minnesota River. The following sections summarize the conceptual site model and associated potential pathways and receptors for three scenarios: (1) current conditions with dewatering at Kraemer Quarry, (2) periodic flood conditions, and (3) predicted future conditions after dewatering at Kraemer Quarry ceases. Ultimately, the primary receptor for groundwater at the Site is the Minnesota River, but the pathway to the river varies for each scenario as discussed below.

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The water table in the vicinity of the Site is generally present below the unlined waste, either in unconsolidated materials above the bedrock or in the uppermost bedrock. In some areas of the Site, the waste is in contact with the bedrock and at times there is perched water within the waste. Wetlands are adjacent to the north and east sides of the Dump, which drain to Black Dog Lake and the river

Groundwater pumping at the adjacent quarry produces a cone of depression causing the groundwater at most (if not all) of the Site to generally be captured by the quarry sump rather than river. The water collected by the Kraemer Quarry dewatering is discharged to the river at an outfall west of the Landfill (see Figure 3). The effect of the dewatering is most apparent at the Landfill where the groundwater flow direction in the water table aquifer in the Prairie du Chien under the Landfill is directly southwest toward the quarry sump with an approximate hydraulic gradient of 0.25 feet per foot (ft/ft). At the Dump, the groundwater flow may be less influenced by the quarry dewatering. The flow direction at the Dump appears to be to the northwest based on the June 2019 groundwater level measurements with an approximate hydraulic gradient of 0.01 ft/ft. However, it is anticipated that groundwater in the water table aquifer under the Dump is ultimately captured by the Kraemer Quarry pumping (i.e., it does not continue flowing toward the river).

In summary, nearly all of the groundwater at the Site is currently believed to be captured by the Kraemer Quarry pumping and discharged to the river via the quarry outfall. Additional data collection is planned to further assess the groundwater movement at the Site during various seasons and river stages.

#### Groundwater Pathway

Because there is no liner beneath the waste in either facility, waste is directly in contact with perched groundwater in portions of both the Dump and Landfill. Perched groundwater samples collected during the 2018 and 2019 investigations exhibited concentrations of various constituents that exceed drinking water and surface water criteria (as discussed in Section 6.3).

The newly installed wells at the Dump, which were screened in what is assumed to be perched groundwater, have been monitored only during flood conditions. Therefore, their connection to the water table is still being evaluated; however, it is assumed that there would be a downward gradient between the two based on the water levels measured to date.

At the Landfill, an apparent connection between the perched and water table wells exists, based on the analytical results for groundwater samples which indicated the presence of similar constituents, such as PFAS, metals, and 1,4-dioxane in both groups of wells at concentrations exceeding comparison criteria.

In groundwater samples collected from monitoring wells MW-9, MW-9D, and MW-10D, which are located in the southwestern portion of the Landfill and upgradient of the Kraemer Quarry, several parameters were detected in concentrations in excess of drinking water and/or surface water quality standards. Those parameters include several metals, VOCs, 1,4-dioxane, and PFAS.

Several of those same parameters were also detected at similar concentrations in the sample collected from the seep. Fewer of the parameters, and at generally lower concentrations, were detected in the discharge sample. Based on these results, it appears that impacted groundwater from beneath the Landfill is expressed through seeps into Kraemer Quarry. It also appears that the impacted groundwater/leachate is mixed with clean groundwater that is also captured by the Quarry (i.e., groundwater that does not pass beneath or contact waste in the Dump or Landfill) thereby diluting the observed contaminants in the discharge from the quarry to the river.

The City of Burnsville utilizes a surface water feature in the southern portion of the Kraemer Quarry as a drinking water supply. The City also operates water supply wells that are open to the Jordan Sandstone and are located approximately one-third of a mile to the southeast of the Dump. Based on the current pumping rates at the quarry, and their influence on the groundwater flow direction, the current risk of contaminant migration to these receptors is low.

#### Surface Water Pathway

Several surface water features are present in the vicinity of, and immediately adjacent to, the Site, including the following:

* Freeway Dump is bounded to the north and east by a wetland which lies between the Dump and the Minnesota River.

There is potential risk of seepage of leachate from the Dump to the north into the wetland and from the Landfill to the north into the Minnesota River. The newly installed monitoring wells on the north side of the Landfill are defined as water table wells and show groundwater in direct contact with waste. Because the new wells were installed and sampled during a flood event (similar to the new wells at the Dump), it is too early to make conclusions about the hydrogeological conditions and connection with surface water in this area.

### Periodic Flood Conditions

The periodic flooding of the Minnesota River temporarily changes the groundwater flow directions described above, especially for areas of the Site in close proximity to the river and areas inundated by the flood. The river experienced a significant flood event lasting from March through June 2019 during the Phase B groundwater investigation, which provided insights into flooded conditions.

During the flood conditions, the groundwater elevation was above the top of the bedrock and in contact with waste throughout a large portion of the landfill (see Figure 6E). Groundwater levels measured in newly installed monitoring wells MW-11, MW-12, and MW-13 were higher than the river elevation in June 2019. Based on the groundwater elevations measured relative to the river stage elevation, it appears that north of the Landfill near the river there is a groundwater divide and that some of the groundwater at the Landfill was discharging to the River as flood waters receded. The water quality in those wells exhibited concentrations of parameters such as metals, VOCs, PCBs, 1,4-dioxane, and PFAS in excess of drinking water and/or surface water quality standards.

Additional monitoring is warranted to verify whether this observed flow pattern exists during normal (non-flooded) conditions.

### Modeled Future Conditions

In 2015, Barr conducted groundwater model simulations to estimate future groundwater conditions near the Landfill under a future scenario when the quarry ceases operation and discontinues dewatering pumping.

The initial groundwater model (Barr, 2015a) evaluated the percent of waste in the Landfill (by area) that would come into contact with the regional water table level based on varying the surface water level in the future quarry pit lake that would form when Kraemer ceases dewatering. The future surface water elevation in the lake will be controlled by the elevation chosen for the controlled lake outlet. In those simulations, the water table rises above the bottom of the waste within the footprint of waste at the Landfill, with the predicted percentage of saturated waste dependent on the elevation of the future pit lake. At the lowest simulated pit lake stage (672.6 feet MSL) the water table rises into 9 to 12 percent of the waste (by area). At the highest simulated pit lake stage (698.8 feet MSL) the water table rises into 75 to 85 percent of the waste (by area).

The model was then used to evaluate contaminant transport associated with contaminants leaching from waste to shallow groundwater and migrating towards both the Minnesota River and the future pit lake under future conditions (Barr, 2015b). The MPCA installed and sampled groundwater wells that were screened in the perched zone within the waste at the Landfill (MW-1 to MW-8). The analytical results from groundwater samples in contact with waste were used to define source concentrations of contaminants in groundwater used in this modeling.

Contaminants of concern evaluated in the future transport simulations included selected metals and PFOA during the average condition with the pit-lake stage at an elevation of 690 feet MSL and during a 100-year flood. The results of the model showed that, in the future scenario where dewatering is discontinued, groundwater discharging to either the pit-lake or river exceeds water quality standards for chromium, cobalt, chloride, antimony, arsenic, cadmium, iron, lead, manganese, mercury, nickel, zinc, and PFOA. The modeling has not been updated to incorporate the most recent investigations results from Phase A and B, but as noted above, there are currently parameters in excess of surface water quality standards in monitoring wells located adjacent to the river and at the currently downgradient wells located in the southwestern area of the landfill adjacent to the quarry.

# Conclusions and Recommendations

The focused RI was completed to characterize the waste material at the Site and to evaluate potential risk related to the waste to current or likely future receptors. The focused RI was completed in support of potential future remedial design. The focused RI includes a review of Site background information and the results of the recent investigation on the Site and its surrounding properties.

Based on the existing and anticipated conditionsThe following paragraphs summarize additional investigation activities that are recommended.

## Waste Material Investigation

The delineation of the extent of waste material present at the Site has been refined through the recent investigation activities. Neither the Dump nor Landfill were constructed as lined facilities and the waste material directly overlays native sediments or bedrock. The waste was observed to be in direct contact with perched groundwater. Concentrations of several contaminants, notably PFAS, 1,4-dioxane, and metals were detected above drinking water or surface water standards in perched groundwater samples.

At this time no future waste material investigation tasks are recommended.

## Groundwater Investigation

The evaluation of potential wider concerns for current or future groundwater conditions are beyond the scope of the focused RI, but it is recognized that improved waste containment or removal from the Site will be an important source control/removal component when wider risk pathways are evaluated and addressed. Limited groundwater investigation activities were conducted during this focused RI. The following additional tasks are recommended to complete the groundwater investigation undertaken during the focused RI:

* Survey the elevations of newly installed monitoring wells (and select existing monitoring wells to corroborate elevations)
* Collect at least one additional round of groundwater samples from the entire monitoring well network during a non-flood river stage.
* Conduct at least two additional synoptic rounds of groundwater level measurements from the entire monitoring well network.

Following the completion of the recommended tasks, a supplemental RI report will be prepared to further evaluate the current and future groundwater conditions at the Site.

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Tables

Table 1 Laboratory Analytical Parameter List

Table 2 Soil Boring Matrix

Table 3 Test Excavation Matrix

Table 4 Landfill Gas Screening Results (Phase A & B)

Table 5

Table 5a Summary of Exceedances – Municipal Solid Waste / Construction Debris (Phase A)

Table 5b Summary of Exceedances – Ash (Phase A)

Table 5c Summary of Exceedances – Native Sediment (Phase A)

Table 6 Summary of Analytical Results – Crushed Bedrock (Phase B)

Table 7 Summary of Analytical Results – Soil Gas (Phase B)

Table 8 Summary of Analytical Results – Cover Soil Investigation (Phase A & B)

Table 9 Monitoring Well Network Matrix

Table 10

Table 10a Water Level Measurements – Dump

Table 10b Water Level Measurements – Landfill

Table 11 Summary of Exceedances – Water (Phase A)

Table 12 Summary of Exceedances – Groundwater (Phase B)

Figures

Figure 1 Site Overview

Figure 2 Investigation Locations – Dump

Figure 3 Investigation Locations – Landfill

Figure 4 Waste Extent – Dump

Figure 5 Waste Extent – Landfill

Figure 6 Cross Section Locations

Figure 7 Cover Soil Investigation Locations

Figure 8 Monitoring Well Network

Figure 9 Groundwater Contour Map – Landfill, April 9 2019

Figure 10 Groundwater Contour Map – Dump, June 17 2019

Figure 11 Groundwater Contour Map – Landfill, June 17 2019

Figure 12 Historical Aerial Photographs – Astleford Dump

Appendices

Appendix A-1

Waste Investigation Boring Logs

Appendix A Boring Logs

Appendix A-1 Waste Investigation Boring Logs

Appendix A-2

Cover Soil Investigation Boring Logs

Appendix A-2 Cover Soil Investigation Boring Logs

Appendix A-3

Monitoring Well Boring Logs

Appendix A-3 Monitoring Well Boring Logs

Appendix B

Test Excavation Field Logs

Appendix B Test Excavation Field Logs

Appendix C-1

*Included in Separate File*

Laboratory Analytical Reports

Solid Media – Phase A (2018)

Appendix C Laboratory Analytical Reports

Appendix C-1 Solid Media - Phase A (2018)

Appendix C-2

*Included in Separate File*

Laboratory Analytical Reports

Water – Phase A (2018)

Appendix C-2 Water - Phase A (2018)

Appendix C-3

*Included in Separate File*

Laboratory Analytical Reports

Solid Media – Phase B (2019)

Appendix C-3 Solid Media - Phase B (2019)

Appendix C-4

*Included in Separate File*

Laboratory Analytical Reports

Water – Phase B (2019)

Appendix C-4 Water - Phase B (2019)

Appendix C-5

*Included in Separate File*

Laboratory Analytical Report

Soil Gas – Phase B (2019)

Appendix C-5 Soil Gas - Phase B (2019)

Appendix D

Appendix D Data Quality Review

Laboratory Analytical Data Tables

Appendix E Laboratory Analytical Data Tables

Appendix F

Minnesota River Elevations and Monthly Precipitation

Appendix F Minnesota River Elevations and Monthly Precipitation

Appendix G

Downhole Geophysical Survey Field Logs

Appendix G Downhole Geophysical Survey Field Logs