

Executive Summary

This Remedial Investigation and Focused Feasibility Study (RI/FFS) report was prepared on behalf of Northern States Power Co. (NSP) to document the findings of the multi-media environmental site investigations, human health risk assessment, and focused feasibility analysis of remediation alternatives conducted for the former manufactured gas plant (MGP) in Fargo, North Dakota (Site), and in its vicinity. The former MGP operated on the north side of Northern Pacific (NP) Avenue between 11th Street North and North University Drive.¹ Between July 2015 and September 2016, investigations were performed on the following properties in accordance with work plans submitted to and accepted by the North Dakota Department of Health (NDDH):

- The Heartland Apartments property (Heartland);
- The United Refrigeration, Inc. property (URI);
- Various city streets, alleys, and sidewalks (Rights of Way [ROWs]) between and around these properties;²
- The former Union Storage and Transfer Facility property (Historic Union);
- The Culligan Water Conditioning of Fargo property (Culligan); and
- The 1213 NP Avenue property.

The Heartland and URI properties comprise the former MGP Site; the remaining properties are in its vicinity.

ES.1 Objectives and Scope

This report provides a holistic summary and interpretation of the environmental investigations conducted at the Site to-date and evaluates the results with the following overall objectives:

1. Characterize the source(s) of constituents associated with the former MGP Site;
2. Delineate the extent of potential MGP constituents in soil, groundwater, and soil gas at the former MGP Site and in its vicinity;
3. Characterize hydrogeology at the former MGP Site and its vicinity;
4. Develop a conceptual site model (CSM) to explain the sources and environmental fate and transport of MGP constituents;
5. Evaluate whether other, non-MGP sources are impacting Site environmental conditions;
6. Determine whether there are unacceptable risks to human health posed by exposure to potential MGP constituents, based on current and reasonably foreseeable future conditions at the Site and its vicinity; and

¹ The Fargo MGP Site was located at 1150 NP Avenue, Fargo, Cass County, North Dakota, and encompassed two parcels (01-2382-04070-000 and 01-2382-04120-000), which are separated by 12th Street North.

² Including 11th Street North, 12th Street North, NP Avenue, and alleys north of the Heartland property, north of the URI property, and south of the URI property.

7. Develop a remedial approach for the Site and its vicinity based on an FFS of viable remediation alternatives.

To meet these objectives, NSP performed the following work:

- Implemented a comprehensive, multi-media sampling program that included the collection of more than 265 soil, 115 water, and 125 vapor samples from nearly 300 locations to characterize environmental conditions throughout the Site and in its vicinity.
- Performed a geophysical survey, consisting of a ground penetrating radar (GPR) and electromagnetic survey (EM survey), over portions of the Site to locate underground structures and features.
- Excavated and properly disposed of more than 2,378 tons of soil from the City ROWs adjacent to the Site where former impacts were encountered and removed.
- Established a permanent monitoring network of 34 sub-slab soil gas monitoring points and 22 groundwater monitoring wells.
- Performed extensive historical research to understand former MGP operations as well as other industrial operations in the area that may be potential sources.
- Performed a quantitative human health risk assessment to determine whether there are unacceptable risks posed by current conditions or based on reasonably anticipated future land use conditions.
- Performed an FFS of remediation alternatives for the properties that comprise the Site and its vicinity.
- Conducted public outreach activities, including hosting a public meeting, outreach to affected property owners and interested members of the public, and hosting an informational website.

The main conclusions from this work are summarized as follows.

ES.2 MGP Sources and Impacts

MGP impacts consist primarily of non-aqueous phase liquid (NAPL) and its associated impacts to soil, groundwater, and soil gas. The NAPLs, which consisted of oily and/or tarry material that is consistent with historic releases of MGP drip oil, petroleum feedstock, and tar, were encountered as "blebs,"³ sheens, and free product. The distribution of NAPL relative to the location of former MGP structures shows that there are four main source areas at the MGP Site:

1. **Tar production and storage operations** located in the southern parking lot area at the Heartland property, where NAPL impacts were observed during the field investigations. NAPL was encountered in 13 of 36 locations in the southern parking lot area, most frequently at depths from 2-7 ft below ground surface (bgs), with NAPL "stringers"⁴ encountered at depths of up to 32 ft bgs.
2. **Tar transfer areas**, including former rail lines, pipes, and wooden tanks in portions of the NP Avenue ROW and at the Heartland property that were likely used to convey tar for off-Site sale. NAPL was found in, beneath, and around these tar transfer areas. NAPL-related impacts were

³ Trace spheres of residual NAPL present in the pores of the surrounding soil matrix.

⁴ Thin seams of residual NAPL present in the surrounding soil matrix.

shallow (2-8 ft bgs) in this area and encountered in borings along the north-south rail spur, and inside and around pipes leading to the southern rail spur and in a former tank in the NP Avenue ROW.

3. **MGP petroleum storage and conveyances**, used for carbureted water gas (CWG) production and located in the northern parking lot area at the Heartland property, where petroleum impacts were observed. A light sheen was observed at depths up to 8 ft bgs at four locations in the northern parking lot area, and small blebs of NAPL were observed at 9 ft bgs over a 1- to 2-in depth interval.
4. **Drip oil sheens**, encountered near the former gas distribution holder at the URI property. A shallow sheen was observed at depths up to 8 ft bgs at borings in the alley south of the URI property and the southeastern corner of the URI property.

Former MGP piping in close proximity to the former MGP Site may have also acted as preferential pathways for limited historical NAPL migration based on the presence of sheen in/adjacent to those pipes.

These MGP NAPLs are comprised primarily of organic hydrocarbons (in various proportions) that, over time, transfer to the environmental media that they contact. Consistent with the presence of these NAPLs, a range of organic hydrocarbons that are potential MGP constituents were detected in soil and groundwater, both on- and off-Site, including:⁵

- Polycyclic aromatic hydrocarbons (PAHs), including naphthalene, 2-methylnaphthalene, pyrene, and fluoranthene.
- Monocyclic aromatic hydrocarbons (MAHs), including benzene, toluene, ethylbenzene, and xylenes (BTEX) and their alkylated homologs.
- Total petroleum hydrocarbons (TPH), including diesel range organics (DRO) and gasoline range organics (GRO) fractions.

The potential MGP constituents detected in soil gas samples included BTEX compounds and naphthalene.

The highest concentrations of these potential MGP constituents in soil were located in proximity with NAPL and concentrations decreased with distance from the identified NAPL, confirming that the NAPL acts as a source of contamination and its impacts are sufficiently delineated by the analytical data collected in the investigation. In turn, groundwater and soil gas impacts were co-located with the elevated soil impacts and have also been sufficiently delineated.

In addition to NAPL and its related impacts, inorganic potential MGP constituents, including cyanide (total and free) and ammonia, were detected in soil and groundwater. The presence of cyanide is consistent with historical manufactured gas purification operations (iron oxide media was used to remove sulfide from manufactured gas; strongly complexed cyanides were often bound to the oxide media), although no purifier box waste (*i.e.*, a current source) was encountered at the MGP Site during the investigations. Notably, the concentrations of free cyanide, which is more physiologically relevant from a human health perspective, were significantly lower than total cyanide concentrations. The presence of ammonia is consistent with ammonia recovery operations at the Site; ammonia was historically recovered as a byproduct of coal gas production for sale. Metals concentrations were generally within the range of naturally occurring background concentrations for North Dakota soils.

⁵ As described in ES.2, these constituents are not unique to MGPs, and there is some evidence of contribution from other sources.

Surface soils on the MGP Site showed no evidence of source material or significant MGP-related contamination (*i.e.*, showed low to non-detectable levels of MAHs, PAHs, DRO, GRO, and free cyanide).

Consistent with the hydrogeological setting of the Site, the analytical data that has been collected, and the observations during the field investigations, the bulk transport of MGP-related constituents in the subsurface is limited except along preferential pathways. The Site is underlain by low-permeability silts/clays (measured horizontal hydraulic conductivity on the order of 10^{-8} to 10^{-7} cm/s) to a depth of at least 100 ft bgs, and the limited subsurface migration potential of the contamination was evident from the rapid attenuation of potential MGP constituents in groundwater and soil gas with distance from the source material. Further, sub-slab soil gas sampling results for the Heartland, URI, Historic Union, Culligan, and 1213 NP Avenue properties showed low concentrations in sub-slab soil gas samples underneath the buildings. At the Heartland, URI, and Historic Union properties, where MGP-related impacts were identified, constituent concentrations in sub-slab samples were lower than at soil gas sampling locations in the surrounding areas, which provided evidence of vapor attenuation with distance from the source(s).

The lateral extent of MGP-related impacts to soil and groundwater has been sufficiently delineated in all directions as part of the investigation activities. Vertical delineation was not completed in all areas of the Site, but is not warranted because: (1) the low-conductivity native silts/clays extend to a depth of at least 100 ft bgs; (2) groundwater monitoring wells screened below the source areas in the clay at 60 ft bgs, with the exception of ammonia and cyanide, had no detections of MGP impacts; and (3) there is no identified use of shallow groundwater within the vicinity of the MGP Site. Overall, the extent of the impacts are well-defined and located only in the low-conductivity subsurface silt/clays sequestered above the deep groundwater aquifer.

ES.3 Non-MGP Impacts

The Fargo MGP Site is located in an urban area with many other known or potential sources of contamination, including petroleum storage and transfer facilities, dry cleaning operations, and railroad operations, contributing to both the suite of potential MGP constituents (DRO, GRO, PAH, MAH), as well as distinct constituents, such as dichlorodifluoromethane (CFC-12). In addition, there are elevated concentrations of naturally occurring metals in soil and groundwater. In delineating the nature and extent of MGP contamination, and in evaluating human health risks, it is important to recognize these non-MGP contributions. For example:

- DRO was detected in soil and groundwater at locations absent of other potential MGP constituents near the periphery of the investigations, indicating that the background level of DRO in the vicinity of the Site may be elevated by other sources.
- Chemical fingerprinting analyses identified several locations in the City ROWs that showed evidence of petroleum contributions from off-Site sources and/or more recent sources than those associated with the former MGP.
- Multiple properties, including the URI, Historic Union, and Culligan properties, had detections of compounds that are not potential MGP constituents (*e.g.*, chloroform, isopropyl alcohol, CFC-12) at magnitudes exceeding risk-based screening levels in sub-slab soil gas.
- Multiple metals were detected in surface soil, subsurface soil, and groundwater, some at concentrations exceeding United States Environmental Protection Agency (US EPA) screening levels (*e.g.*, aluminum, arsenic, chromium, lead, and manganese). However, these are generally consistent with naturally occurring concentrations of these metals found in Fargo and

Cass County, based on a comparison to metals data collected by the United States Geological Survey (USGS).

ES.4 Human Health Risk Evaluation

A human health risk evaluation was performed as part of the Site investigation.⁶ The risk evaluation characterized priority⁷ exposure pathways to evaluate whether these pathways present a risk to human health under current conditions. Priority pathways include:

- Exposure to surface soil for a current Resident at the Heartland property.
- Exposure to soil vapors potentially infiltrating residential and commercial buildings at the Heartland, URI, Historic Union, and Culligan properties.
- Exposure to shallow groundwater infiltrating basements at the Heartland property for a Resident and Historic Union for a Maintenance Worker.

In addition, the risk evaluation characterized non-priority⁸ exposure pathways for which data were collected during the Site investigation. These pathways include:

- Potential exposure to shallow soil (0-15 ft bgs) for a future Utility Worker and Construction Worker at the Heartland, URI, City ROWs, Historic Union, and Culligan properties.
- Potential exposure to groundwater (0-15 ft bgs) during future subsurface excavation for a future Utility Worker and Construction Worker at the Heartland, URI, City ROWs, Historic Union, and Culligan properties.

Based on the results of this risk evaluation, there are no unacceptable risks to human health based on current conditions as determined by the current dataset. There are, however, elevated risks associated with future potential exposures for a Utility Worker at the Heartland property and a Construction Worker at the Heartland, URI, City ROWs, and Historic Union properties. There are seven compounds contributing to elevated risk at these properties: DRO, GRO, benzo[a]pyrene, 2-methylnaphthalene, naphthalene, dibenzofuran, and benzene. While these are potential MGP constituents, they are also commonly associated with petroleum hydrocarbons; as described above, there are multiple non-MGP sources of petroleum hydrocarbons in the area.

ES.5 Focused Feasibility Study

An FFS was conducted to identify and evaluate viable remediation alternatives to address MGP-related impacts throughout the MGP Site and its vicinity.⁹ In order to guide the remedy evaluation and selection process to specific endpoints that ensure protectiveness, risk reduction- and mass reduction-based Remedial Action Objectives (RAOs) were developed for the impacted media at the Site and its vicinity. Further, Site-specific risk-based cleanup goals (CUGs) and Not to Exceed values (NTE) were established

⁶ The scope of the risk evaluation included all properties that were investigated except for the 1213 NP Avenue property, because MGP-related impacts were not identified at this property.

⁷ Priority exposure pathways were defined as potentially complete exposure pathways for current property occupants.

⁸ Non-priority exposure pathways consisted of potentially complete exposure pathways under reasonably foreseeable future use of the properties.

⁹ Similar to the risk evaluation, the scope of the FFS included all properties that were investigated except for the 1213 NP Avenue property, because MGP-related impacts were not identified at this property.

for each of the properties that have been investigated and used in concert with other criteria defined by the RAOs (*i.e.*, the presence of NAPL and heavily impacted soil) to define remediation target areas for each property.

A preliminary screening of a robust set of remedial technologies and process options was performed to identify remedial technologies for each of the media of concern at the Site and properties in the vicinity. Using these selected remedial technologies, remediation alternatives were developed for each of the five evaluated properties. The range of remediation alternatives for each property generally included:

- A baseline option of no further action;
- Source removal options for source material and surface soil (as applicable) remediation;
- Piping removal/grouting to eliminate preferential pathways;
- Monitored natural attenuation (MNA) or no further action for groundwater impacts;
- Vapor mitigation, MNA, or no further action for soil gas impacts; and
- Engineering and institutional controls to limit exposures and manage residual risks.

Due to the relative abundance of NAPL and heavily impacted media on the Heartland property in comparison to other properties, additional source remediation options including NAPL extraction and *in situ* solidification and stabilization (ISS) were included in the range of alternatives for the Heartland property.

A detailed assessment of the remediation alternatives was performed based on the Comprehensive Environmental Response, Compensation, and Liability Act's (CERCLA) remedy evaluation criteria.¹⁰ The results of the comparative analysis demonstrate that the Targeted Source Removal alternative is the preferred remedial approach for all five of the properties evaluated, assuming regulatory approval and cooperation from the property owners, because it provides long-term effectiveness and protectiveness with a higher level of certainty in comparison to the other alternatives, while also being cost-effective, implementable, and more likely to receive regulatory approval. Through the removal of source material and elimination of preferential pathways (pipes), the Targeted Source Removal alternative limits direct exposure to impacted media, while also promoting the long-term stability and attenuation of associated groundwater and soil gas impacts. This alternative is readily implementable and cost-effective, and any short-term impacts and logistical challenges associated with implementation can be managed through the use of safety measures and engineering controls. The use of institutional and engineering controls, a critical component of this alternative, will allow for the long-term management of any residual risks, such as those associated with source material and/or impacted media left in place outside the remediation zones. Further, a monitoring program will be implemented at permanent groundwater and soil gas monitoring points at the Site and properties in the vicinity to evaluate MNA of impacts to both media.

¹⁰ Overall protection of human health and the environment; long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; cost; regulatory approval; and community acceptance. The 9th CERCLA criterion, compliance with Applicable or Relevant and Appropriate Requirements (ARARs), was not used as a separate evaluation criterion for this FFS because it is assumed that the NDDH will evaluate the remediation alternatives in the context of State regulations and highlight the need for compliance with additional requirements, if any.

ES.6 Next Steps

Pending approval of the RI/FFS by the agencies, the provision of access by the relevant property owners, and public outreach to interested parties, NSP is planning to perform the following next steps:

- Prepare and submit a work plan for each property that specifies how the selected remedy may be implemented in order to achieve RAOs.
- Work with individual property owners, the City, and NDDH to develop and implement appropriate institutional controls to ensure long-term protectiveness.
- Consistent with US EPA guidance, collect two additional rounds of sub-slab soil gas samples from the existing vapor pins at the Culligan and 1213 NP Avenue properties.
- Develop a monitoring plan for groundwater and soil gas to evaluate the temporal stability of the MGP impacts.