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**Addendum to Lowry Landfill Superfund Site  
Five Year Review Report, dated September 28, 2017**

A Five-Year Review (FYR) addendum is generally completed for remedies where the protectiveness determination is deferred until further information is obtained. When deferring protectiveness in the Five-Year Review report, EPA typically provides a timeframe for when the information will be obtained, and a protectiveness statement can be made. This document sets forth additional information received since the protectiveness statements for Sitewide, Operable Unit 1 (OU1), Shallow Groundwater and Subsurface Liquids, and Operable Unit 6 (OU6), Deep Groundwater, were deferred in the fourth Five-Year Review (2017 FYR) for the Lowry Landfill Superfund Site, Arapahoe County, Colorado, which was signed by Betsy Smidinger, Director of the Superfund and Emergency Management Division, on September 28, 2017.

The protectiveness statement(s) outlined in the 2017 FYR are as follows:

**Operable Unit 1 (OU1) Shallow Groundwater and Subsurface Liquids**

**Protectiveness Determination:** Protectiveness Deferred

**Protectiveness Statement:** A protectiveness determination of the OU1 remedy cannot be made at this time until further information is obtained. Further information will be obtained by sampling and analyzing the wells located within the footprint of the plume for 1,4-dioxane. Based on the results, appropriate measures will be taken to prevent exposure to contaminated groundwater. It is expected these actions will take approximately one year to complete, at which time a protectiveness determination will be made.

**Operable Unit 2 (OU2) Landfill Solids**

**Protectiveness Determination:** Protective

**Protectiveness Statement:** The remedy at OU2 is protective of human health and the environment because there are no completed exposure pathways to landfill solids.

**Operable Unit 3 (OU3) Landfill Gas (LFG)**

**Protectiveness Determination:** Short-term Protective

**Protectiveness Statement:** The remedy at OU3 currently protects human health and the environment because there is no exposure to hazardous waste due to a functioning landfill gas treatment system that prevents the release of landfill gases into ambient air. The LFG subsurface performance standards were provided in the 2002 minor modification to the ROD and then updated in 2007 and 2012 using EPA's Vapor Intrusion Model (VIAM). This model is undergoing updates to reflect EPA's June 2015 final vapor intrusion guidance. For the remedy to be protective in the long-term, the Landfill Gas (LFG) performance standards should be revised utilizing EPA's updated toxicity values and Site-specific input data.

**Operable Unit 4 (OU4) Soils****Protectiveness Determination:** Protective**Protectiveness Statement:** The remedy at OU4 is protective of human health and the environment because the ongoing maintenance of the cover areas prevents direct contact, ingestion and inhalation of soil contaminants as well as minimizes the migration of soil by wind or water erosion.**Operable Unit 5 (OU5) Surface Water and Sediments****Protectiveness Determination:** Protective**Protectiveness Statement:** The remedy at OU5 is protective of human health and the environment because the operation and maintenance of the Surface Water Removal Action (SWRA) effectively prevents contamination from migrating to on-site surface water and sediments.**Operable Unit 6 (OU6) Deep Groundwater****Protectiveness Determination:** Protectiveness Deferred**Protectiveness Statement:** A protectiveness determination of the OU6 remedy cannot be made at this time until further information is obtained. Further information will be obtained by installing additional vertical migration wells north of the Site within the 1,4-dioxane plume to assess if this contaminant, as well as any others, is confined to the shallow units. It is expected these actions will take approximately one year to complete, at which time a protectiveness determination will be made.**Sitewide****Protectiveness Determination:** Protectiveness Deferred**Protectiveness Statement:** Because a protectiveness determination cannot be made for the OU1 and OU6 remedies at this time until further information is obtained, a protectiveness determination cannot be made for the Site. Further information for OU1 will be obtained by sampling and analyzing the wells located within the footprint of the plume for 1,4-dioxane. Based on the results, appropriate measures will be taken to prevent exposure to contaminated groundwater. For OU6, further information will be obtained by installing additional vertical migration wells north of the Site within the 1,4-dioxane plume. It is expected these actions will take approximately one year to complete, at which time a protectiveness determination will be made**Progress Since the Five-Year Review Completion Date**

The fourth FYR included nine issues and recommendations. This section is divided into two parts. The first section discusses two issues and recommendations that were the basis for deferring protectiveness of OU1 and OU6; and the resolution of the issue for OU3 that changes the protectiveness determination from Short-Term Protective to Protective. The second section will discuss other issues that were identified in the FYR and that have been addressed or are ongoing to help inform the updated OU1 and Sitewide protectiveness statement.

## Resolution of Five-Year Review Issues that Resulted in Deferred Protectiveness

### OUI

*Issue #4: Private or municipal wells are located within the Murphy Drainage downgradient of the Site. Four of these wells are located within the footprint of the 1,4-dioxane plume and one well is located immediately adjacent to the plume*

*Recommendation: Sample these wells and analyze for 1,4-dioxane. Based on the results, implement appropriate remedial actions.*

*Completion Date: June 3, 2020*

### *Activities Completed:*

To address the issue and recommendation, the Work Settling Defendants (WSD) conducted a well survey in 2017 that extended five miles downgradient of the Site along the Murphy Creek Drainage. Several private or municipal wells were identified within the drainage. Four of these wells are located within the footprint of the 1,4-dioxane plume, and one well is located immediately adjacent to the plume. In addition to the wells located within the drainage, domestic wells are located approximately 1,000 feet east of the leading edge of the plume, just outside the Murphy Creek Drainage and within the Gun Club Estates.

The WSDs and Tri-County Health Department (TCHD) investigated the four subject wells, among others, and concluded that two private wells were the only active private or municipal supply wells within or immediately adjacent to the footprint of the off-Site 1,4-dioxane plume. All other private or municipal wells within or adjacent to the plume have been abandoned and cannot be sampled. The two active private wells are north of the Site and in unincorporated Arapahoe County. These two wells have been sampled annually since 2006, and 1,4-dioxane has never been detected in either well.

The TCHD will continue to perform community outreach and public education regarding protection of private wells. In addition, the WSDs and TCHD will continue to monitor the two private wells identified, conduct surveys every five years to identify any newly placed wells that might have been installed, evaluate potential contamination, determine if an unacceptable risk is present within and immediately adjacent to the off-Site plume, and assure residents that their water supply is not affected by the North End plume.

Two documents provide a more detailed summary of the well survey and sampling results:

- *Technical Memorandum Identification and Sampling of Water Supply Wells Within and Immediately Adjacent to Off-Site 1,4-Dioxane Plume, June 3, 2020; SEMS #100008216.*
- *Evaluation of Private Wells Identified as an Issue in the 2017 Five Year Review, rev June 1, 2020, SEMS #100008217.*

Institutional controls for the Site are outlined in the 2005 Institutional Control Plan. In addition, if the properties are annexed into the City of Aurora, Aurora Code Section 138-154 will restrict the usage of these independent water supplies.

## OU6

*Issue #9: There are no vertical migration wells located north of the Site within the 1,4-dioxane plume area to assess if 1,4-dioxane contamination is confined to shallow aquifer units.*

*Recommendation: Review the vertical migration compliance well network and evaluate the need for an additional migration compliance well in the 1,4-dioxane plume area.*

*Completion Date:* October 16, 2020

### *Activities Completed:*

Additional wells were installed and sampled to assess the vertical extent of the 1,4-dioxane plume north of the Site, in accordance with the *Work Plan to Further Assess the North End 1,4-Dioxane Plume, dated November 8, 2018 (SEMS #100005847)*. No 1,4-dioxane has been detected in any deep unweathered bedrock well in the Study Area, nor within Section 31 north of the Site boundary. Based on these results, the deep plume is sufficiently characterized and monitored.

The extent of the 1,4-dioxane plume north of the Site has been delineated and is described in the following documents:

- *Memorandum Progress Report, Assessment of Northern Extent of 1,4-Dioxane in Groundwater North of Well MW114-WD, September 22, 2017, SEMS #100003594*
- *Technical Memorandum: Updated 1,4-Dioxane Plume Map and North End Conceptual Model, 2017 Five-Year Review Issue #7 and 9, SEMS #100008576, dated September 2, 2020 (the “North End Investigation Report”), which includes an evaluation of the risks to potential site receptors (1,4-Dioxane Risk Summary - North End Sampling Results, Lowry Landfill Superfund Site, September 2, 2020 SEMS #100008571).*

## Resolution of Five-Year Review Issues that Changes the Protectiveness from Short-Term to Protective OU3

*Issue # 8: Several LFG performance standards may not be stringent enough based on current toxicity values.*

*Recommendation: Reevaluate the LFG performance standards utilizing updated toxicity values and Site-specific input data (as opposed to default values) in the Johnson-Ettinger model.*

*Completion Date:* July 27, 2018

### *Activities Completed:*

In 2018, performance standards for subsurface gas compounds were updated using the most recent version of EPA’s vapor intrusion model (VIAM), site-specific input variables, and current toxicity values from the November 2017 EPA Regional Screening Levels, in *Revision 3, Updated Compliance Monitoring Plan, Landfill Gas Remedy, Remedial Action/Operations & Maintenance, July 27, 2018*

**Status of Other FYR Issues**

*In the 2017 FYR, the issues below for OUs 1 and 6 did not affect current protectiveness; OU3 was found to be Short-term Protective. A Short-term Protective determination for OU1 and a Protective determination for OU6 are appropriate now that Issues Nos. 4 and 9 have been resolved.*

OU #	Issue	Recommendations	Current Status	In the 2017 FYR, Affect Current Protectiveness?	Current Implementation Status Description	Completion Date (if applicable)
1	#1 The potable water injections are not part of the remedy for the NBBW and the effectiveness or potential impact to the water balance and contaminant transport north of the NBBW has not been evaluated by EPA.	Discontinue potable water injections and conduct an optimization study of the groundwater containment remedy to assess changes in water levels, capture zones and water chemistry	Ongoing	No	Potable water injection terminated in October 2018. The data collected during the subsequent synoptic sampling was reported in the Cessation Summary Report - dated 5/15/2020. A Numerical Model was developed to study the water levels and capture zones upgradient and immediately downgradient of the NBBW. The Numerical Model is documented in the Revised Calibration/Methodology Report 12/9/2019. To study the water quality, a 3-dimensional data visualization and analysis (3DVA) was completed 6/1/2020. These reports and models were created to support the final analysis of water balance and contaminant transport at the NBBW. The NBBW Containment System Evaluation (CSE) Plan was finalized 10/16/2020. <b>NBBW Containment System Evaluation under agency review and are projected to be completed in the Spring 2021.</b>	N/A

OU #	Issue	Recommendations	Current Status	In the 2017 FYR, Affect Current Protectiveness?	Current Implementation Status Description	Completion Date (if applicable)
1	#2 The capacity of the WTP was limited during times of high precipitation in 2015 and early 2016.	Evaluate and upgrade the WTP capacity	Completed	No	The effluent pipe from the water treatment plant was upgraded from a 2-inch line to a 4-inch line, which increased the capacity of the plant to treat more water per day as described in the <i>Memorandum RE: Work Plan to Increase Capacity of Water Treatment Plant, June 27, 2018</i> ; <i>Letter EMSI RE: Notification of Additional Action to Extract Groundwater from NBBW-IW-3 in B-326/MW113 Area, May 8, 2020</i> .	2/1/2019
1	#3 Numerous compliance wells continue to exceed the performance standards for 1,4-dioxane, chloroform, iron and nitrate in the northern, eastern, western and southern portions of the Site.	Conduct a Capture Zone Analysis in accordance with EPA's 2008 guidance. Based on the results of the Capture Zone Analysis, optimize the remedial extraction systems on-Site and off-Site to ensure the remedy is meeting remedial action objectives.	Ongoing	No	A Numerical Model to evaluate the effectiveness of the NBBW was developed, which is documented in the Revised Calibration/Methodology Report 12/9/2019. In addition, 3DVA of the hydrogeology and groundwater plumes was completed 6/1/2020. These reports and models support the analysis of the effectiveness of the remedial extraction systems in meeting remedial action objectives. The effectiveness evaluation for the Perimeter Slurry Wall; and the effectiveness evaluation for the North End extraction features, North Toe Extraction System, and MW38 Extraction Systems were completed on January 28, 2021. <b>The NBBW containment system evaluation is projected to be completed in Spring 2021.</b>	N/A

OU #	Issue	Recommendations	Current Status	In the 2017 FYR, Affect Current Protectiveness?	Current Implementation Status Description	Completion Date (if applicable)
1	#5 The containment effectiveness monitoring at the perimeter slurry wall does not monitor for 1,4-dioxane.	Add 1,4-dioxane to the monitoring plan for the perimeter wells.	Completed	No	1,4-Dioxane was added as an indicator chemical for demonstration of the effectiveness of the perimeter slurry wall in the <i>Groundwater Monitoring Plan, Revision 2, August 16, 2018</i> (listed on Lowry Landfill website under September 6, 2018)	8/16/2018
1	#6 The performance standard for iron is based on background concentrations in the weathered Dawson. Several wells that are screened in the unweathered Dawson are out of compliance for iron.	Reevaluate the performance standard for iron.	Completed	No	Based on the reevaluation of the performance standard, iron was removed as an indicator chemical in the <i>Groundwater Monitoring Plan, Revision 2, August 16, 2018</i> (listed website under September 6, 2018)	8/16/2018

OU #	Issue	Recommendations	Current Status	In the 2017 FYR, Affect Current Protectiveness?	Current Implementation Status Description	Completion Date (if applicable)
1	<p>#7 The 1,4-dioxane plume extends off-Site to the north. No institutional controls are in place in this area and there are private wells located within the footprint and the vicinity of the plume. In addition, there are domestic drinking water wells located approximately 1,000 feet east of the leading edge of the plume, just outside the Murphy Creek Drainage in the Gun Club Estates.</p>	<p>Develop an updated plume map and conceptual site model to ensure there is no potential for future exposure in this area. Based on the results, evaluate the need for a monitoring plan for wells located within the vicinity of the plume edge. Also, assess the need for additional institutional controls for the 1,4-dioxane plume area.</p>	Ongoing	No	<p>The North End Monitoring Plan Update 2 was completed on October 16, 2020. The September 2, 2020, North End Investigation report includes an updated plume map, focused conceptual site model, and a Risk Assessment for the North End.</p> <p>There is no need for additional ICs; Aurora Code Section 138-154 was not listed in the 2017 FYR but is considered an IC.</p> <p><b>A draft conceptual site model for the Site is under agency review. The projected completion date is Spring 2021.</b></p>	N/A



## New Issues and Recommendations

There are no new issues and recommendations since the 2017 FYR.

## Protectiveness Statements

Based on new information and actions taken since the Fourth Five-Year Review completion date, the protectiveness statements for the Site and OU1 and OU6 are revised as follows:

### **Operable Unit 1 (OU1) Shallow Groundwater and Subsurface Liquids**

**Protectiveness Determination:** Short-term Protective

**Protectiveness Statement:** The remedy at OU1 is short-term protective of human health and the environment because there are no completed exposure pathways for 1,4-dioxane in shallow groundwater. In order to be determined protective in the long term, the conceptual site model and the containment system evaluation for the North Boundary Barrier Wall will need to be completed.

### **Operable Unit 3 (OU3) Landfill Gas (LFG)**

**Protectiveness Determination:** Protective

**Protectiveness Statement:** The remedy at OU3 currently protects human health and the environment because there is no exposure to hazardous waste due to a functioning landfill gas treatment system that prevents the release of landfill gases at unacceptable levels into ambient air.

### **Operable Unit 6 (OU6) Deep Groundwater**

**Protectiveness Determination:** Protective

**Protectiveness Statement:** The remedy at OU6 is protective of human health and the environment because there are no completed exposure pathways, and the 1,4-dioxane plume is confined to the shallow units.

### **Sitewide**

**Protectiveness Determination:** Short-term Protective

**Protectiveness Statement:** The remedy is short-term protective of human health and the environment because there are no completed exposure pathways for 1,4-dioxane in shallow groundwater and the deep groundwater plume is delineated. In order to be determined protective in the long term, the conceptual site model and the containment system evaluation for the North Boundary Barrier Wall, will need to be completed.

## Next Five-Year Review

The next five-year review will be completed by September 28, 2022, five years after the signature of the last five-year review report.

**BETSY  
SMIDINGER**

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Betsy Smidinger, Director  
Superfund and Emergency Management Division

## References

- 1,4-Dioxane Risk Summary, North End Sampling Results, Lowry Landfill Superfund Site, EPA Region 8. September 2, 2020. SEMS #100008571.
- Aurora Code Section 138-154. - Use of independent water system; cross connection; use of Dawson Aquifer. Aurora Code. SEMS #100008837.
- Compliance Monitoring Plan Updated Revision 3, Landfill Gas Remedy, Remedial Action/Operations & Maintenance, Engineering Management Support, Inc. (EMSI). July 27, 2018. SEMS #100005273.
- Development of Calibrated Numerical Three-Dimensional, Finite-Element Groundwater Simulation Model (Calibration/Methodology Report), Lowry Landfill Superfund Site, CDM Smith. December 9, 2019. SEMS #1931041.
- Final Institutional Controls Plan, Lowry Landfill Superfund Site, Parsons, February 28, 2005. SEMS #10008992.
- Fourth Five-Year Review Report for Lowry Landfill Superfund Site, Arapahoe County, Colorado, EPA Region 8. September 28, 2017. SEMS #100001702.
- Groundwater Monitoring Plan, Lowry Landfill Superfund Site Revision 2, EMSI/Parsons. August 16, 2018. SEMS #100007654.
- Memorandum RE: Evaluation of Private Wells Identified as an Issue in the 2017 Five Year Review, rev June 1, 2020. SEMS #100008217.
- Memorandum RE: North End Groundwater Monitoring Plan – Update No. 2, EMSI and Parsons. October 16, 2020. SEMS #100008836.
- Memorandum, Progress Report, Assessment of Northern Extent of 1,4-Dioxane in Groundwater North of Well MW 144-WD, EMSI/CDM Smith. September 22, 2017. SEMS #100003594
- Memorandum RE: Work Plan to Increase Capacity of Water Treatment Plant, June 27, 2018; Letter EMSI RE: Notification of Additional Action to Extract Groundwater from NBBW-IW-3 in B-326/MW113 Area, EMSI. May 8, 2020. SEMS #100008214.
- North Boundary Barrier Wall Containment System Evaluation Plan, Lowry Landfill Superfund Site, EMSI, Parsons, and CDM Smith. October 16, 2020. SEMS #1953708.
- Pilot Test for Cessation of Potable Water Injection (Cessation Summary Report), Revised Final Report, EMSI and CDM Smith. May 15, 2020. SEMS #100008220.

Technical Memorandum Documentation of Three-Dimensional Data Visualization and Analysis, Revision 3, dated June 2020. SEMS #1953692.

Technical Memorandum Identification and Sampling of Water Supply Wells Within and Immediately Adjacent to Off-Site 1,4-Dioxane Plume, June 3, 2020. SEMS #100008216.

Technical Memorandum Updated 1,4-Dioxane Plume Map and North End Conceptual Model, 2017 Five-Year Review Issues #7 and #9 (North End Investigation Report), Lowry Landfill Superfund Site, EMSI/CDM Smith. October 16, 2019, revised September 2, 2020. SEMS #100008576.

Work Plan to Further Assess the North End 1,4-Dioxane Plume, dated November 8, 2018. SEMS #100005847.