UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
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DEC 12 2019

**MEMORANDUM**

REPLY TO THE ATTENTION OF

**SUBJECT:** Procedures for Addressing Potential 1,4-Dioxane Contamination at Region 5 Superfund Remedial Sites

**FROM:** Douglas Ballotti, Director
Superfund & Emergency Management Division

**TO:** Remedial Project Managers (RPMs)

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## Background

1,4-Dioxane, or simply dioxane,[1] is a widely-used, synthetic industrial chemical that EPA has classified as likely to be carcinogenic to humans. The critical effect systems are: heptic, nervous, respiratory and urinary. Adverse health effects on the gastric and reproductive systems also have been documented. 1,4-Dioxane is being found in the groundwater at sites throughout the United States, but in the past it was not reliably analyzed for using Superfund's Contract Lab Program (CLP) routine analytical services methods. Due to advancements made in the CLP statements of work, 1,4-dioxane is now analyzed reliably and routinely down to 2 micrograms per liter (ug/L). Low-level 1,4-dioxane analysis can also be scheduled at our regional lab that has a reporting limit of 0.20 ug/L. The current tap-water regional screening level is 0.46 ug/L. A federal drinking water standard for 1,4-dioxane has not been established, although in 2012 it was introduced as a contaminant under the third unregulated contaminant monitoring rule (UCMR 3) of the Safe Drinking Water Act.

The physical and chemical properties and behavior of 1,4-dioxane create challenges for its characterization and treatment. It is completely miscible in water, flammable, highly mobile in both soil and groundwater, and has not been shown to readily biodegrade in the environment. It may migrate rapidly in groundwater ahead of other contaminants and does not volatilize rapidly from surface water bodies. 1,4-Dioxane is also difficult to clean up, as air stripping and granular activated carbon adsorption are ineffective treatment methods. Thus, if you have a site that is already in the cleanup stage for other volatile organic compounds, the selected remediation may be ineffective in cleaning up 1,4-dioxane contamination. Pump and treatment remediation is the primary method used when remediating sites contaminated with 1,4-dioxane. Advanced oxidation processes involving hydrogen peroxide with ultraviolet light or ozone and photocatalysis may also be used.

1,4-Dioxane is a likely contaminant at many Superfund remedial sites contaminated with chlorinated solvents, particularly 1,1,1-trichloroethane (TCA), because of its widespread use as a

[1] Also known as dioxan, p-dioxane, diethylene dioxide, diethylene oxide, diethylene ether and glycol ethylene ether.

stabilizing agent. Additionally, recent studies demonstrate that 1,4-dioxane is a relatively common co-contaminant of trichloroethane (TCE) in groundwater plumes independent of 1,1,1-TCA contamination. 1,4-Dioxane is frequently found at federal facility sites and is found as an impurity in antifreeze and aircraft deicing fluids. It may also be found at sites that included the following operations: printing inks and painting; flame retardant production; rubber, plastic, and adhesives manufacturing; solvent-based cleaning; surfactant manufacturing; textile, polishes, waxes and resin manufacturing; and membrane filter production. It is also an impurity in personal consumer products such as deodorants, shampoos, and cosmetics[2]. 1,4-Dioxane is frequently detected in wastewater and landfill leachate.

**Toxicity**

EPA's Integrated Risk Information System (IRIS) database provides detailed toxicological information such as the chronic oral reference dose (RfD) and reference concentration for inhalation exposure (RfC) for 1,4-dioxane. Additionally, the Agency for Toxic Substances and Disease Registry (ATSDR) has established minimal risk levels (MRLs) for inhalation exposure. EPA risk assessments indicate that the drinking water concentration representing a $1x10^{-6}$ excess lifetime cancer risk level for 1,4-dioxane is 0.35 µg/L (EPA IRIS 2013).

The IRIS chemical assessment summary can be found online at www.epa.gov/iris by typing 1,4-dioxane into the "Search IRIS" field.

**Assessing 1,4-Dioxane at Region 5 Superfund Remedial Sites**

It is critical to evaluate the site history when determining if sampling for 1,4-dioxane is necessary. When identified, 1,4-dioxane is frequently found within previously delineated chlorinated solvent plumes and existing monitoring networks. Before sampling for 1,4-dioxane, Region 5 Superfund RPMs should consult with the Region 5 quality assurance chemists. Not only will they help you determine if 1,4-dioxane sampling is necessary, they will also ensure that a suitable analytical method is used for 1,4-dioxane analysis. 1,4-Dioxane can be reliably analyzed by CLP and non-CLP methods (e.g. SW-846-8260, 8270, method 522 etc.). The important thing to consider is if the laboratories' reporting limits for 1,4-dioxane are low enough to meet your screening levels. Additionally, RPMs will need to evaluate the reliability of past 1,4-dioxane analyses at potentially-responsible-party-lead sites on a site-specific basis. Sampling and analysis of 1,4-dioxane needs to be within the scope of an approved quality assurance project plan.

Ideally, sampling and analysis of groundwater for 1,4-dioxane is recommended at Region 5 Superfund remedial sites during the investigative stage, although it may be necessary during post-Record of Decision (post-ROD) and post-remediation phases. The following types of sites should be sampled for 1,4-dioxane in order to address the data gap regarding its presence:

- 1,1,1-TCA, TCE, and/or other chlorinated organic solvents are present or were historically used;
- aircraft manufacturing/maintenance took place; or

[2] Traces of 1,4-dioxane may be present in some food supplements, food containing residues from packaging adhesives or on food crops treated with pesticides that contain 1,4-dioxane as a solvent or inert ingredient (ATSDR 2012; DHHS 2011).

- disposal (e.g. landfills) of the following wastes or products may have taken place: chlorinated solvents, greases, dyes, varnishes, paint strippers, waxes, antifreeze, de-icing chemicals, cosmetics, shampoos, deodorants, pharmaceuticals, polyethylene terephthalate (PET) plastic, pesticides.

Depending on the stage of the site in the Superfund remedial pipeline, RPMs should take the following actions:

During Remedial Investigation/Feasibility Study (RI/FS)

RPMs should evaluate if additional groundwater sampling is needed to analyze for 1,4-dioxane at Superfund remedial sites in the RI/FS stage where groundwater sampling efforts are concluded. RPMs should plan for additional sampling and risk analysis as appropriate before the final groundwater remedial action is selected. If 1,4-dioxane is found to present an unacceptable risk, appropriate cleanup levels and cleanup actions will need to be selected in the site decision document.

Post-ROD

RPMs should evaluate if additional groundwater sampling is needed to analyze for 1,4-dioxane at Superfund remedial sites where the final groundwater remedy has been selected but has not yet been implemented. RPMs should also plan for additional sampling and risk analysis as appropriate before the final groundwater remedial action is determined to be construction complete. Additional response action should be recommended if 1,4-dioxane yields an unacceptable risk not addressed by the selected remedial action. The need for additional response action should be documented in an appropriate site decision document.

Post-Remedial Implementation

RPMs should assess the need for additional groundwater sampling to analyze for 1,4-dioxane to ensure protectiveness at Superfund remedial sites where the final groundwater remedy has been implemented and/or is in long-term remedial action or operation and maintenance. RPMs should plan for additional sampling and risk analysis as appropriate. Additional response action should be recommended if 1,4-dioxane yields an unacceptable risk not addressed by the implemented remedial action. The need for additional response action should be documented in an appropriate site decision document. This evaluation and sampling should be conducted before the next five-year review (FYR) is completed, which will require a field-sampling event well before the FYR is due. The results of any 1,4-dioxane evaluation should be documented in the FYR report. If there is concern that there may be unacceptable human exposures to 1,4-dioxane, the RPM should conduct evaluation and sampling as soon as possible.