Sources of 1,4-Dioxane in the Tidal Delaware River

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Introduction

From the 1950's through the 1990's a common industrial chemical called 1,4-dioxane was used as a stabilizer for chlorinated solvents like 1,1,1-Trichloroethane (1,1,1-TCA) (1,4-dioxane, 2019). It was not until 2013 that the U.S. Environmental Protection Agency (EPA) classified this chemical as a likely carcinogen (1,4-dioxane, 2019). Though 1,4-dioxane is no longer used as a stabilizer, it remains in soil and groundwater at many contaminated sites. Until recently, the chemical was used in industrial products and is still used in pharmaceuticals, food additives, and crop pesticides (Broughton, A, et al, 2019).

The purpose of this research is to compile and assess data on locations in the Delaware River Basin that may be contributing 1,4-dioxane to the tidal Delaware River.

Methodology

This research, which has been directed by the DRBC, aims to study the association between source areas of 1,4-dioxane in the Delaware River Basin and 1,4-dioxane found in high concentration in the Delaware River.

- Literature was reviewed to determine knowledge gaps surrounding the interaction of 1,4-dioxane between groundwater and surface water.
- EPA, US Geological Survey (USGS), and state level environmental agency databases were searched to locate sites within a 4-mile vicinity of the Delaware River which had known concentrations of 1,4-dioxane and 1,1,1-TCA. 1,1,1-TCA was used as a proxy for undiscovered 1,4-dioxane sites since the two chemicals frequently occur together at contaminated sites.
- GIS analysis was done on 1,4-dioxane and 1,1,1-TCA sites to create heat maps showing areas of high contaminant occurrences. When viewing heat maps, dark colors represent a high density of sampling sites, while lighter areas represent a low density of sites. Separate maps were made for groundwater, surface water, soil, and industrial wastewater effluent samples for both contaminants.

Work Cited

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- The opinions expressed in this poser are of the author and do not necessarily reflect the views of the DRBC or the Water Center at Penn.

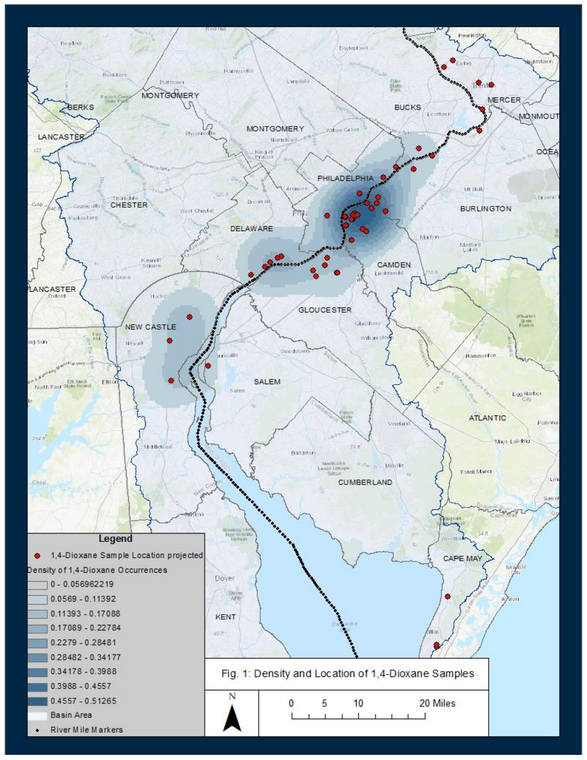

Fig. 1: Density and Location of 1,4-Dioxane Samples

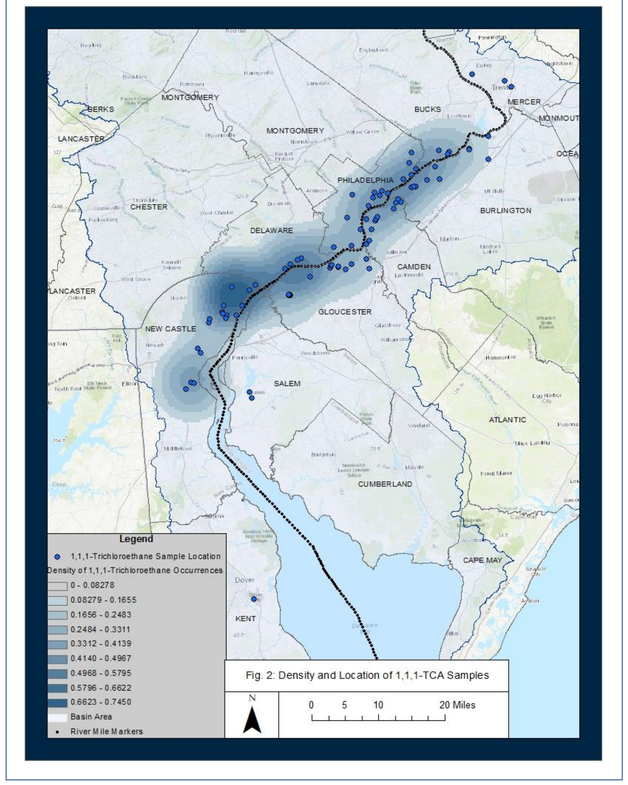

Fig. 2: Density and Location of 1,1,1-TCA Samples

Discussion

Heat maps were created to show the relative density of 1,4-dioxane and 1,1,1-TCA occurrences. The numeric ranges associated with each color band present in the heat maps can be interpreted as the likelihood of another contaminated site occurring within the same color band. Based on available data, analysis shows the occurrence of 1,4-dioxane sites is greatest on the New Jersey side of the Delaware River, in Camden County (Fig. 1). Although most occurrences are in New Jersey, Philadelphia County, PA, also contains a high density of sites.

The density of 1,1,1-TCA sites are more evenly distributed on both sides of the Delaware River (Fig. 2). The highest density of 1,1,1-TCA sites occurs in northern New Castle County, DE, and in southern Delaware County, PA. It is likely that additional 1,4-dioxane sites exist along the river in this region but were not located using the tools available in this research.

Individual maps were created for groundwater, surface water, soil, and effluent samples for both 1,4-dioxane and 1,1,1-TCA sites, since sample media represents the various pathways through which the contaminant may enter the river.

A cluster of 1,4-dioxane groundwater occurrences appear to contribute to river concentrations in Camden and Gloucester Counties, NJ. Several groundwater occurrences may contribute 1,4-dioxane in Salem County, NJ and in New Castle County, DE. Surface waters containing 1,4-dioxane may contribute the chemical to the Delaware River through tributaries in Delaware and Philadelphia Counties, PA.

1,1,1-TCA surface water occurrences clustered in Delaware and Philadelphia Counties, PA, may be serving as unknown sources of 1,4-dioxane in the river, while groundwater contamination, located in northern New Castle County, DE, Philadelphia County, PA, and Camden and Gloucester Counties, NJ, may also be contributing 1,4-dioxane to the river. Sites containing 1,1,1-TCA soil contamination may be contributing 1,4-dioxane to the river near northern New Castle County, DE.

Conclusion

The results of mapping various contaminant pathways revealed the importance of analyzing all available sample media types to develop a complete understanding of various potential sources of 1,4-dioxane. Groundwater, surface water, and soil contamination all contribute to river contamination differently in certain stretches of the river. Wastewater should be further evaluated as a potential source.