



Evaluation of the Potential Sources of Perfluorocarbon Contamination Observed in Private Water Supply Wells

Trace Line Analysis of Ambient Wells Sampled For PFCs in Relation to Sources of Suspected PFC Contamination

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Introduction

During the past several years, sampling and analysis of environmental media, including ground water, soil, and municipal waste water sludge components for the presence of perfluorochemicals (PFCs) have been conducted in Dakota County by the Minnesota Department of Health (MDH), the Minnesota Pollution Control Agency (MPCA) and the Dakota County Water Resources Department. These surveys included the collection of environmental media at both selected sites, including landfills, dumps and wastewater treatment facilities, as well as private water supply wells. This work was completed in an effort to better understand the concentrations and distribution of PFCs in the environment and to identify potential sources of PFC contamination associated with the production and use of PFCs and the disposal of consumer products treated or containing these chemicals.

These surveys identified perfluorobutanoic acid (PFBA), a four carbon PFC, manufactured at the 3M Cottage Grove Facility (3M Facility). This chemical is widely distributed in environmental media. Detections in drinking water samples were below the Health Risk Limits (HRLs) established for PFBA by the Minnesota Department of Health (MDH). However, the apparent wide-spread distribution of these industrial chemicals in areas not associated with industrial facilities or suspected sources is a concern and suggest that the problem may extend well beyond the four disposal sites investigated and remediated in Washington County.

The purpose of this project is to evaluate the proximity of wells found to be contaminated with low levels of PFBA with sites potentially contaminated with PFCs. Three sources are looked at as possible vehicles for the distribution of PFBA. Each vehicle is not the sole reason for widespread distribution, but can be considered a major contributor to elevated levels of PFCs found throughout Dakota County.

Methods

Dakota County staff have created multiple geographic datasets useful in conducting a preliminary exposure assessment, including: an inventory of water supply wells, Dakota County licensed solid and hazardous waste facilities, unlicensed disposal sites, hazardous waste generators, reported spills, and municipal sewage sludge and biosolid land application sites.

Groundwater path lines to the sampled water wells were estimated using a single layer Analytic Element groundwater model created for this purpose. Path lines were traced backward in time from the well screens using several starting elevations, and terminated at the point of recharge, or after 100 years. The model was based on the Metropolitan Area Groundwater Model, South Province model (Hansen and Seaberg, 2001).

Dumps

Dakota County staff have mapped more than 1,700 solid waste disposal sites in Dakota County. Several dozen of these sites are candidates for having received PFC production wastes due to their size, proximity to the 3M Facility, and dates of operation or association with known haulers. Four of these potential sites were sampled by MPCA or Dakota County Water Resources staff. Low levels of PFBA were identified at all the sites sampled.

Land application of biosolids derived from WWTP servicing industrialized Areas

Land application of sewage sludge to agricultural lands has long been a management solution for sludge derived from domestic wastewater treatment plants (WWTP). PFCs have been identified in sewage sludges produced from metropolitan wastewater treatment plants. In the past, Dakota County farm fields have been the primary destination of land applied sewage sludge.

Atmospheric Deposition from the 3M Facility

The offsite deposition of airborne PFC emissions originating from the 3M Facility has been proposed as an explanation of the low-level PFC contamination observed in groundwater resources in communities adjacent to the 3M Facility. However, information needed to test this conceptual release model, including air dispersion modeling and the sampling of soils and waters proximate and downwind of the 3M Facility was not gathered for this study. For the purposes of the study we have conducted a simple proximity analysis consisting of concentric five-mile buffered areas centered on the 3M Facility. We predict the highest off-site concentrations will be closest to the 3M Facility.

Results

The results of the analysis indicate a positive spatial relationship between the potential sources of PFC contamination evaluated and the detection of low levels of PFBA in groundwater. However, uncertainty regarding the completeness and accuracy of the data prevents us from definitively concluding that any of the observed relationships are causal. A clear spatial relationship between solid waste disposal sites and detected PFBA is observed, suggesting that waste disposal sites are a likely source of PFC contamination in local groundwater resources. Additionally, a spatial relationship between sewage sludge land application sites and elevated PFBA levels in groundwater is suggested in central and eastern regions of the County. However, there exist a number of examples where this relationship is not observed. In these cases elevated levels of PFBA may have been the result of unknown sources. Finally, a positive spatial relationship between proximity to the 3M Facility and elevated PFBA concentrations in groundwater is suggested, in particular a majority (95%) of the drinking water wells with elevated PFBA occurred within 15 miles of the 3M Facility. However, without additional data, no plausible single mechanism explaining the dispersal of PFCs can be advanced.

Discussion

The results of this analysis suggest that there are multiple sources of PFCs that may have contributed to the contamination of private water supply and municipal wells observed in Dakota County. This analysis did not produce indisputable evidence of a single or primary source of PFBA in Dakota County groundwater. However, it does support explanations based on proximity to the 3M Facility. Our ability to draw more definitive conclusions regarding the potential sources of PFC contamination is currently limited by the insufficiency of the reviewed data sets and the absence of adequate environmental data.

Recommendations

The lack of representative data identifying the sources, areal extent and magnitude of environmental PFCs is the greatest obstacle to understanding the mechanisms of PFC distribution in Dakota County. Additional sampling of environmental media including soils, surface and ground waters is needed to further define the extent of PFC contamination proximate to the 3M Facility. Future investigations should be expanded to include a complete accounting of sewage sludge application sites, the locations of industrial and commercial operations that used PFCs, broader sampling of licensed and unlicensed solid waste disposal sites, and the identification of the location of fire fighting events where foams were used.

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