



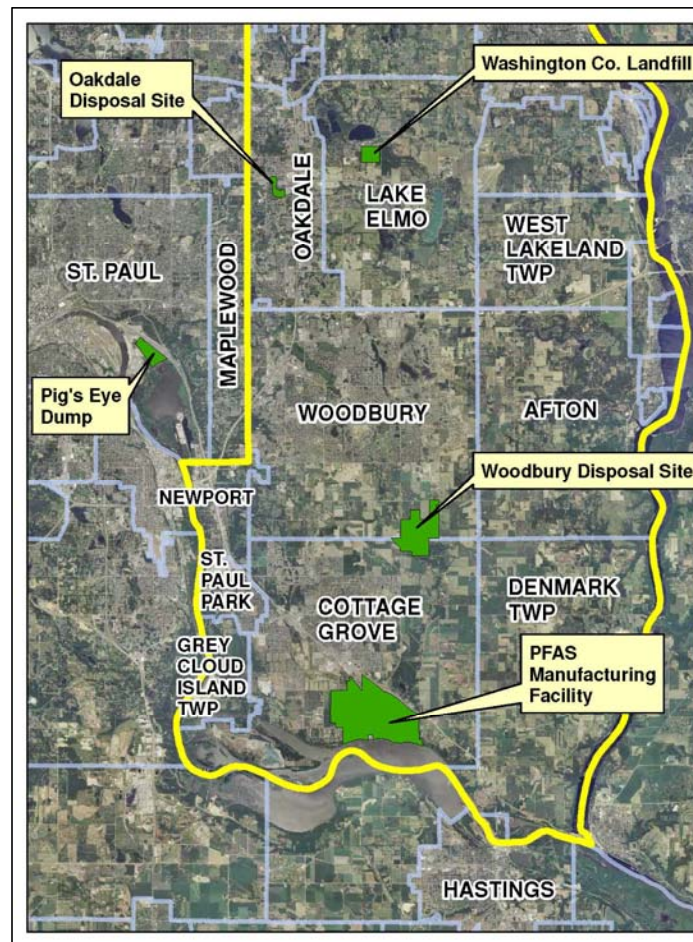
The Role of Surface Water and Stormwater Transport of Perfluoroalkyl Substances (PFAS) in the Creation of a Groundwater “Mega-Plume”, Washington County, Minnesota

Ginny Yingling | Hydrogeologist

April 12, 2018

PFAS in Washington County, MN

- Since 2003, the state has been investigating PFAS contamination in Washington Co.
- Sources:
 - Chemical plant (on-site disposal)
 - 3 associated legacy waste disposal sites
 - Dumpsite that accepted WWTP biosolids / sludges



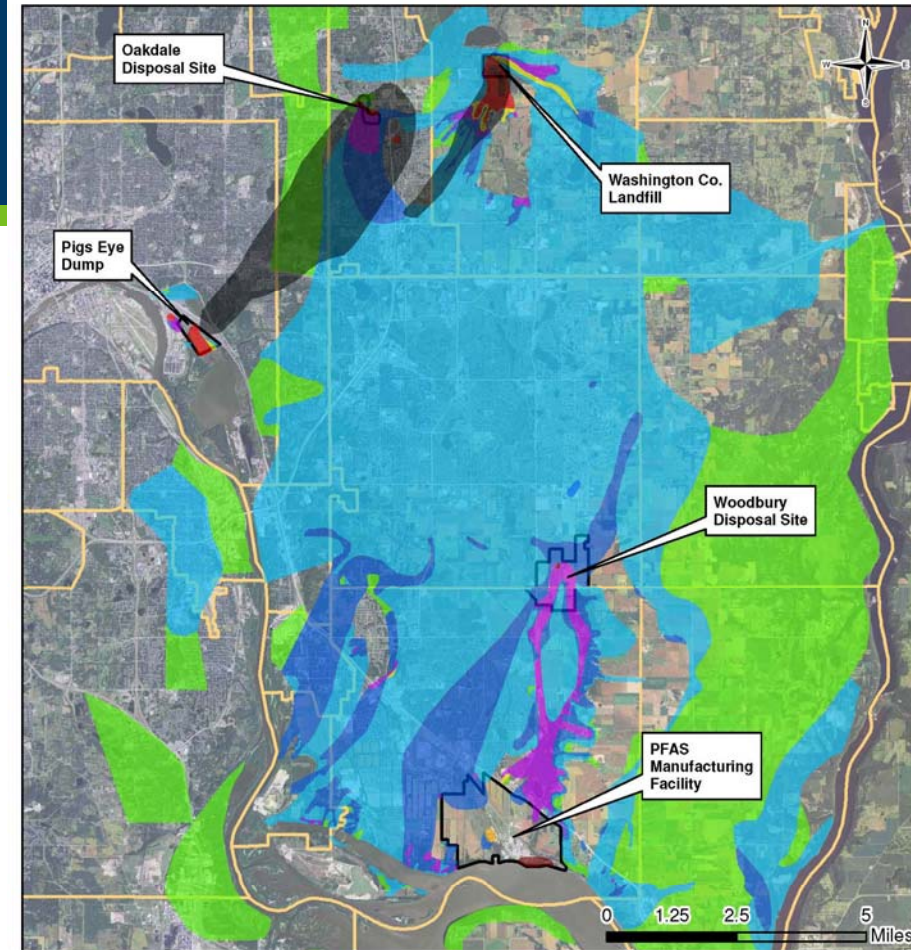
Location of PFAS Sites in Washington Co., Minnesota



Co-Mingled “Mega-Plume”

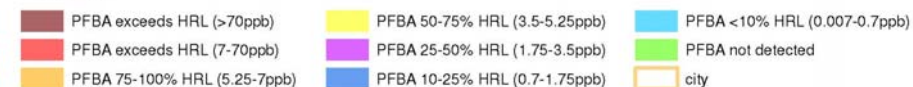
- **Over 130 sq. mi.**
 - 4 major aquifers
 - 8 municipal systems
 - >2,000 private wells (600+ drinking advisories)
 - Much larger than predicted by modeling
- **PFBA most widespread**
 - More PFBA in source areas
 - More mobile
- **Distribution controlled by:**
 - Bedrock features
 - PFAS chemical properties
 - Groundwater pumping
 - **Groundwater - Surface water interactions**

4/12/2018



DEPARTMENT OF HEALTH

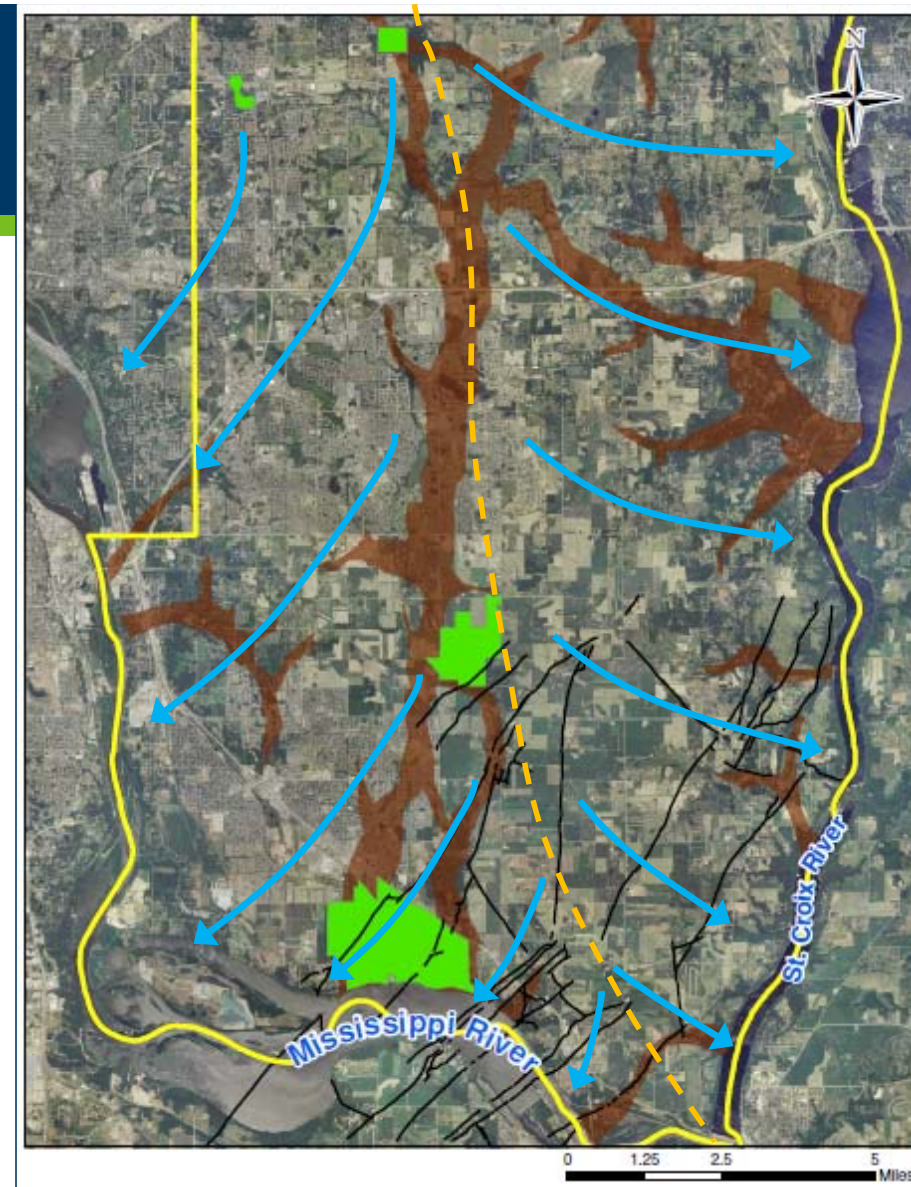
PFBA - All Aquifers



NOTES: Map combines data from all aquifers, actual concentrations in any area may vary; blank spaces indicate no sample data; PFBA HRL = 7 ppb 3/26/2018

Groundwater Flow

- A groundwater divide extends from north to south beneath the county
 - West of the divide - flows to Mississippi River
 - East of the divide - flows to St. Croix River
 - Flow “fans out” near confluence of rivers
- Buried bedrock valleys exert significant control over local flow directions



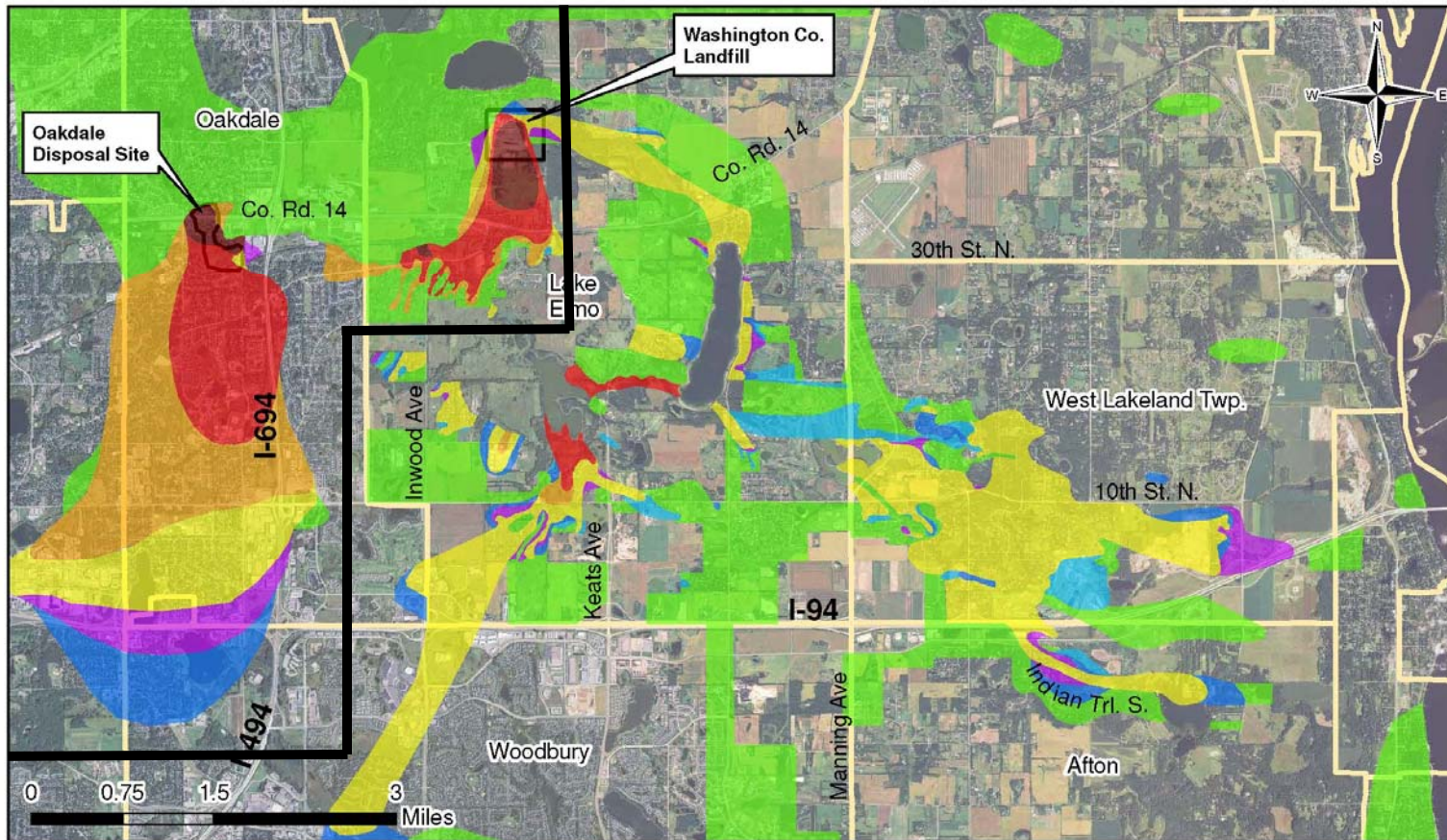
MDH Drinking Water Guidelines











- PFOS: 0.027 ppb
- PFOA: 0.035 ppb
- PFBA: 7.0 ppb
- PFBS: 2.0 – 3.0 ppb

MDH issued new Health Based Values (HBVs) in May 2017

- Protective for both long-term/lifetime and fetal exposures
- Based on animal studies which showed slight liver and thyroid effects in adults; studies showed immune system and developmental effect in infants and children
- Currently use PFOS value (0.027 ppb) as surrogate for PFHxS
- PFCs usually occur as mixtures
 - MDH evaluates the additive effects – called a Hazard Index (HI)
 - Accounts for differing levels of toxicity in similar chemicals



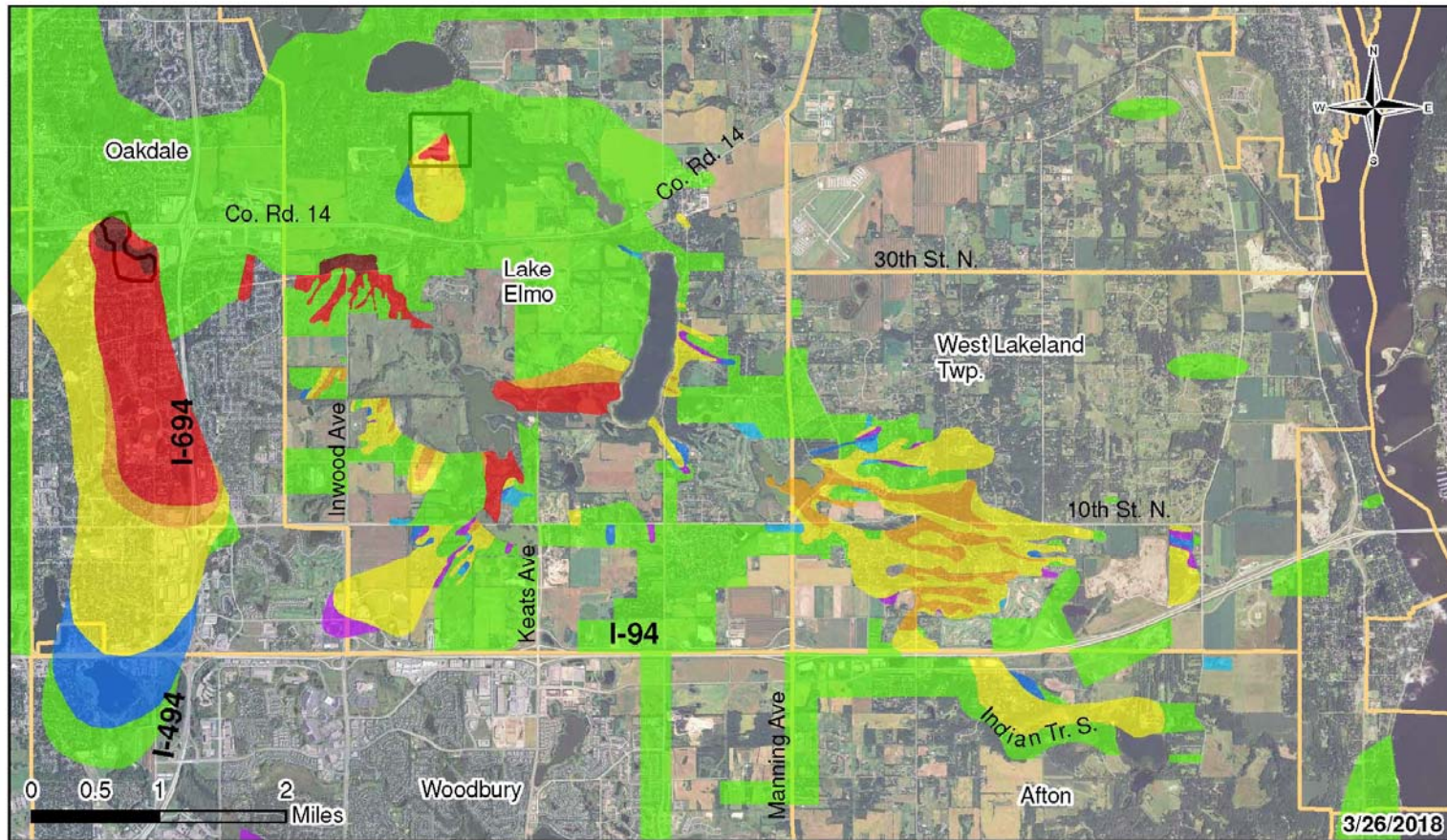
PFOA - All Aquifers

- | | |
|--|--|
|  PFOA greater than 1.75ppb (>50x HBV) |  PFOA 0.027-0.035ppb (75-100% HBV) |
|  PFOA 0.35-1.75ppb (10-50x HBV) |  PFOA 0.0175-0.026ppb (50-75% HBV) |
|  PFOA 0.175-0.35 ppb (5-10x HBV) |  PFOA 0.004-0.0174ppb (<50% HBV) |
|  PFOA 0.035-0.175ppb (1-5x HBV) |  PFOA not detected |









MDH Health Based Value (HBV) for PFOA is 0.035 parts per billion (ppb; or 35 parts per trillion)

Map combines data from all aquifers, actual concentrations in any area may vary depending on well depth; blank spaces indicate no sample data

3/26/2018

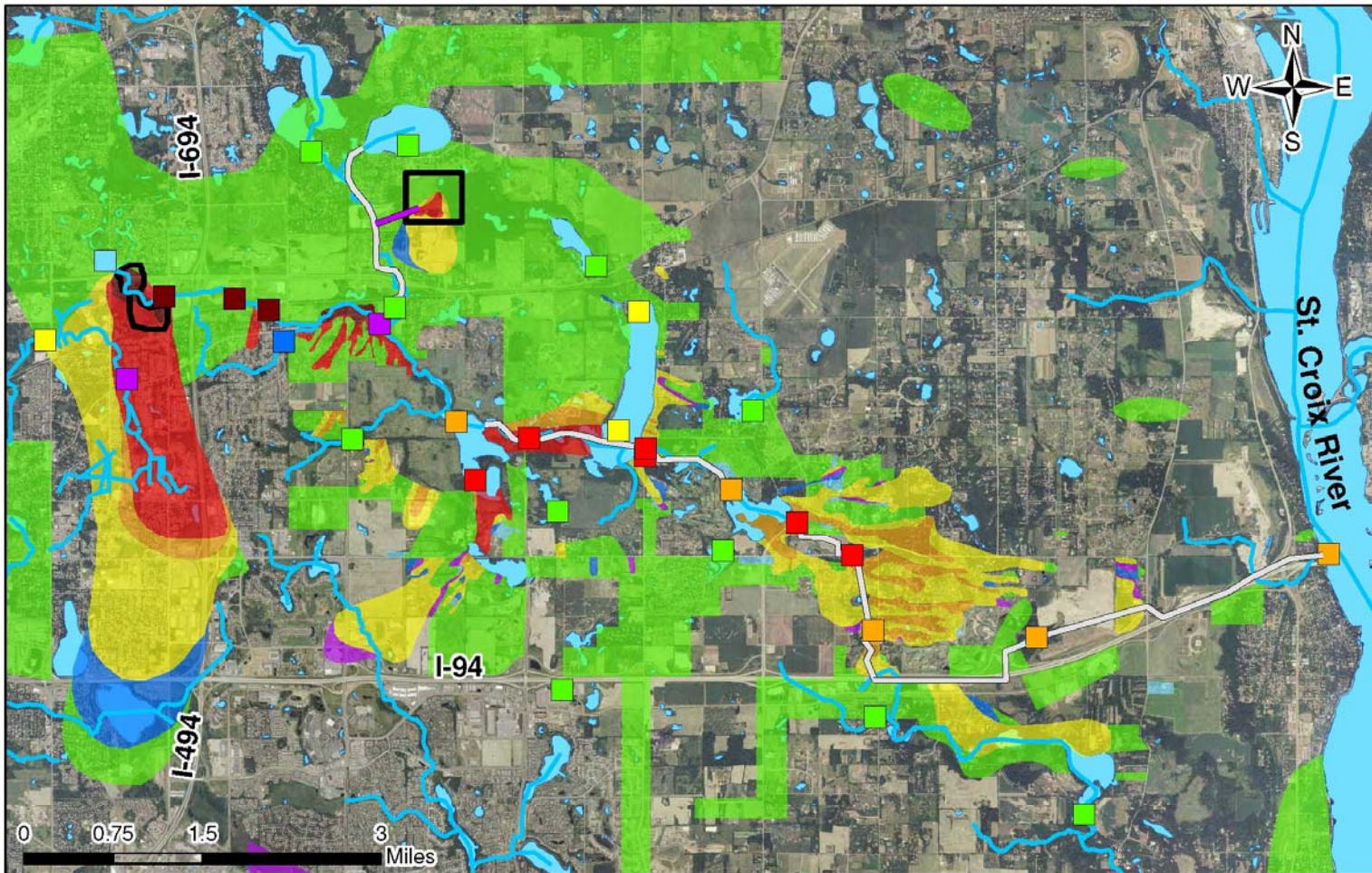


PFOS - All Aquifers

- | | |
|--|--|
|  PFOS greater than 1.35ppb (>50x HBV) |  PFOS 0.021-0.027ppb (75-100% HBV) |
|  PFOS 0.271-1.35ppb (10-50x HBV) |  PFOS 0.0136-0.02ppb (50-75% HBV) |
|  PFOS 0.136-0.27ppb (5-10x HBV) |  PFOS 0.004-0.0135ppb (<50% HBV) |
|  PFOS 0.028-0.135ppb (1-5x HBV) |  PFOS not detected |

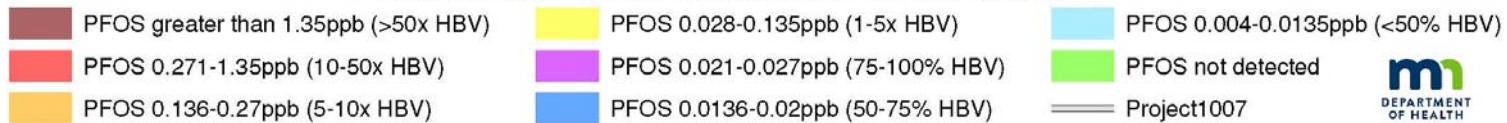
MDH Health Based Value (HBV) for PFOS is 0.027 parts per billion (ppb; or 27 parts per trillion)

NOTES: Map combines data from all aquifers, actual concentrations in any area may vary; blank spaces indicate no sample data

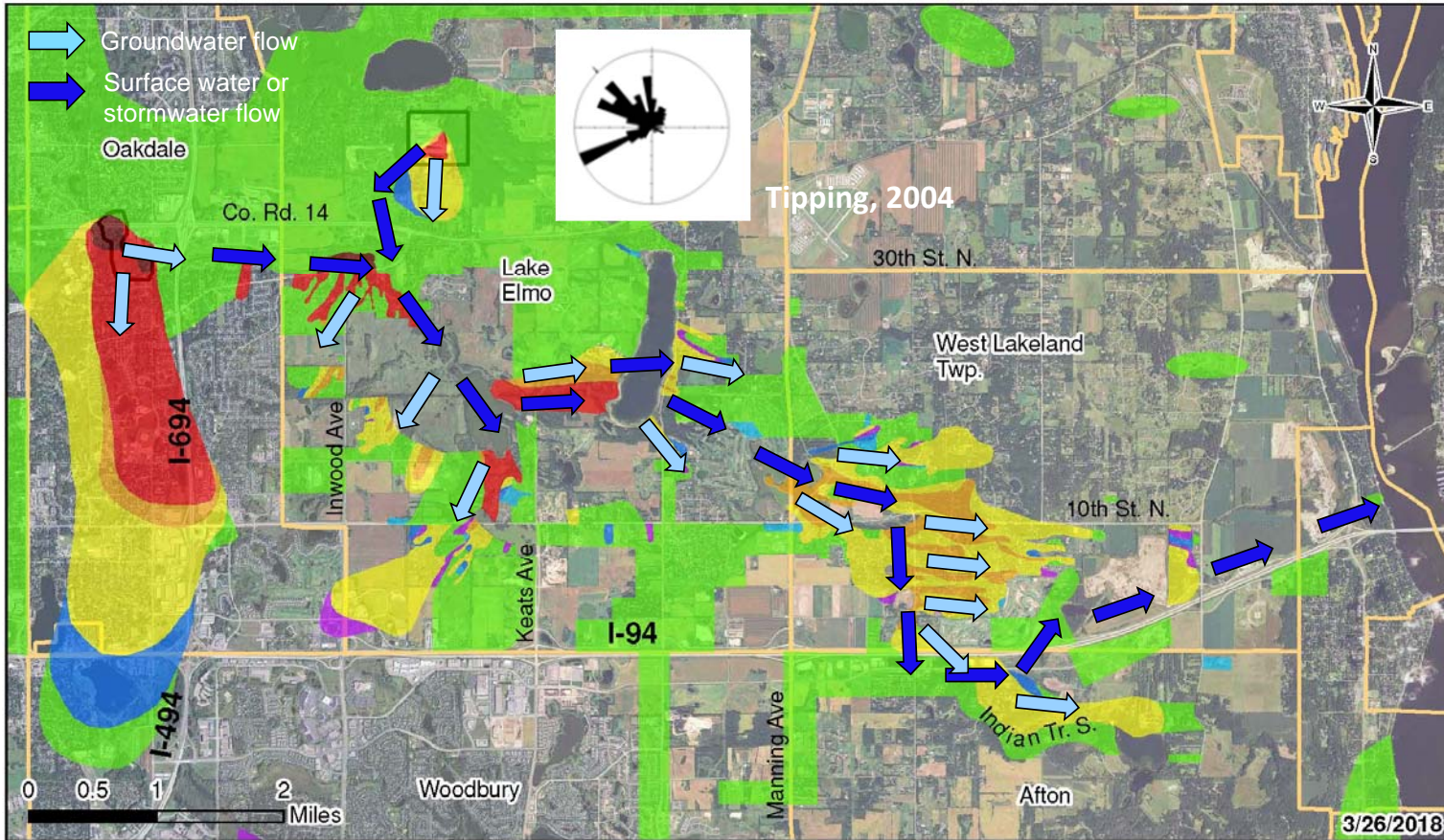


4/2/2018









PFOS in Surface Water and Groundwater



Note: map combines groundwater data from all aquifers, actual concentrations in a given well may vary; blank spaces indicate no sample data



PFOS - All Aquifers

 PFOS greater than 1.35ppb (>50x HBV)	 PFOS 0.021-0.027ppb (75-100% HBV)
 PFOS 0.271-1.35ppb (10-50x HBV)	 PFOS 0.0136-0.02ppb (50-75% HBV)
 PFOS 0.136-0.27ppb (5-10x HBV)	 PFOS 0.004-0.0135ppb (<50% HBV)
 PFOS 0.028-0.135ppb (1-5x HBV)	 PFOS not detected

MDH Health Based Value (HBV) for PFOS is 0.027 parts per billion (ppb; or 27 parts per trillion)

NOTES: Map combines data from all aquifers, actual concentrations in any area may vary; blank spaces indicate no sample data

Conclusions

- The persistence and mobility of PFAS in the environment means groundwater–surface water interactions may represent a critical element of PFAS transport and plume development, especially in areas with shallow groundwater
- Surface water transport of PFAS may move the contamination many miles away from source areas
 - See also: Awad et al., 2011 and Kwadijk et al., 2014
- Infiltration along a surface water pathway may create one or more discrete groundwater plumes isolated from their source
 - Groundwater discharge to surface water may contaminant water bodies distant from the source
- CAUTION: PFAS in groundwater or surface water that appears to be unrelated to a source MAY NOT be background.

Acknowledgements

- MDH – Environmental Health Division
- MPCA – Closed Landfill & Superfund
- Minnesota Public Health Laboratory
- Minnesota Geological Survey
- Valley Branch Watershed District
- West Central Environmental Consultants
- Washington County
- Interpoll Laboratories
- Barr Engineering
- 3M Company
- Weston Solutions
- Antea Group
- Agency for Toxic Substances and Disease Registry (ATSDR)
- U.S. Geological Survey
- Cities of Oakdale, Lake Elmo, Woodbury, Cottage Grove, Afton, Maplewood, Newport, Saint Paul Park
- Grey Cloud Island, West Lakeland, and Denmark Townships

Thank You and Disclaimer

This work was partially funded through a cooperative agreement grant from the Agency for Toxic Substances and Disease Registry (ATSDR) and the Center for Disease Control (CDC).

The opinions expressed are those of the author and do not necessarily reflect the official views of ATSDR, the CDC, the Department of Health and Human Services, or the Minnesota Department of Health.

Questions?



More Information and References

MDH general PFAS Information:

<http://www.health.state.mn.us/divs/eh/hazardous/topics/pfcs/index.html>

MDH Health Risk Limits:

<http://www.health.state.mn.us/divs/eh/risk/guidance/gw/table.html>

MPCA PFAS Investigations:

<http://www.pca.state.mn.us/index.php/waste/waste-and-cleanup/cleanup-programs-and-topics/topics/perfluorochemicals-pfc/perfluorochemicals-pfcs.html?menuid=&redirect=1>

Awad, E., X. Zhang, S.P. Bhavsar, S. Petro, P.W. Crozier, E.J. Reiner, R. Fletcher, S.A. Tittlemier, E. Braekevelt, 2011. *Env. Sci. & Tech.*, 45:8081-8089.

Kwadijk, C.J.A.F., M. Kotterman, and A.A. Koelmans, 2014. *Env. Tox. and Chem.*, 33(8):1761-1765.

Tipping, R., 2004. Southern Washington County Lineament Study. Report by the Minnesota Geological Survey, St. Paul, Minnesota. May 21, 2004.

Thank you!