BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	**)**	
	)	
PROPOSED AMENDMENTS TO GROUNDWATER QUALITY (35 ILL. ADM. CODE 620)	**)**	**R 2022-018 (Rulemaking - Public Water Supply)**
	)	

NOTICE OF FILING

To: ALL PARTIES ON THE ATTACHED SERVICE LIST

PLEASE TAKE NOTICE that I have today electronically filed with the Office of the Clerk of the Illinois Pollution Control Board the attached **Pre-filed Testimony of Melinda Hahn**, **Pre-filed Testimony of Lisa Yost**, and a **Certificate of Services**, copies of which are hereby served upon you.

/s/ Sarah L. Lode
Sarah L. Lode

Dated: September 15, 2022

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CERTIFICATE OF SERVICE

I, the undersigned, certify that on this 15th day of September, 2022, I have electronically served the attached **Pre-filed Testimony of Melinda Hahn** and **Pre-filed Testimony of Lisa Yost** upon the individuals on the attached service list. I further certify that my email address is Sarah.Lode@afslaw.com; the number of pages in the email transmission is 59; and the email transmission took place before 5:00 p.m.

/s/ Sarah L. Lode
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Prepared By:
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Date:
September 15, 2022

Case Number:
R22-18

Project Number:
1690015671 – 001

PRE-FILED TESTIMONY OF MELINDA HAHN:

IN THE MATTER OF: PROPOSED AMENDMENTS TO GROUNDWATER QUALITY (35 ILL. ADM. CODE 620)

RAMBOLL

CONTENTS

ATTACHMENT

ACRONYMS AND ABBREVIATIONS

BTV	Background Threshold Value
CERCLA	Comprehensive Environmental response, Compensation, and Liability Act
ESA	Environmental Site Assessment
HTTAC	Human Threshold Toxicant Advisory Concentration
IEPA	Illinois Environmental Protection Agency
LCMRL	Lowest Concentration Minimum Reporting Level
LLOQ	Lower Limit of Quantitation
MCL	Maximum Containment Level
MDL	Method Detection Limits
mg/L	milligrams/liter
NFR	No Further Remediation
NTU	Nephelometric Turbidity Unit
NWQAP	National Water Quality Assessment Program
RCRA	Resource Conservation and Recovery Act
SRP	Site Remediation Program
TACO	*Tiered Approach to Corrective Action Objectives*
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
µg/L	Micrograms per Liter

TESTIMONY OF MELINDA HAHN

At the request of counsel, this document provides testimony regarding the Illinois Environmental Protection Agency's (IEPA) December 7, 2021, Proposed Amendments to Groundwater Quality (35 Ill. Adm. Code 620) rulemaking for public water supplies. The focus here is on the proposed Class I and Class II standards for cobalt and vanadium. Because these metals are naturally occurring in soil and to some extent in groundwater, the proposed standards should be considered relative to background concentrations in water. The proposed standards should also be considered relative to the practical quantitation limits available for detecting cobalt and vanadium in typical, unfiltered Illinois groundwater samples. A CV for Dr. Hahn is provided as Attachment 1.

Qualifications

Dr. Hahn is a senior managing consultant at Ramboll. She holds a Ph.D. in Environmental Engineering from the Johns Hopkins University, as well as a B.S. in Mathematics and a B.S. in Physics from the University of Texas at Austin. She has more than 25 years of experience in environmental engineering, with particular emphasis on site investigation, remediation, contaminant fate and transport modeling, and statistics of environmental data.

Dr. Hahn has provided strategic support for many remediation projects under state voluntary remediation programs, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Resource Conservation and Recovery Act (RCRA), and landfill regulations. In support of these projects, she has performed many statistical data evaluations, including Monte Carlo analyses, multivariate analyses, and multiple regression analyses; utilized 3-D geo-statistical interpolation; and modeled contaminant fate and transport (for both groundwater and air).

1. INORGANIC ANALYTES

The proposed Class I standard for cobalt of 0.0012 milligrams per liter (mg/L) is approximately three orders of magnitude lower than its current value of 1 mg/L, and the proposed Class I standard for vanadium of 0.00027 mg/L is approximately two orders of magnitude lower than its current value of 0.049 mg/L. Data summarized here demonstrate that these proposed standards would be lower than background concentrations in many Illinois groundwaters and would not be readily detectable in typical unfiltered groundwater samples due to matrix interference caused by naturally occurring solids and dissolved phase constituents. Class I water quality standards are often used as remedial objectives or remedial goals for contaminated sites. Site remedial objectives are generally based on risk to human health and the environment. However, remedial programs including CERCLA (typically the most stringent), do not require clean up to concentrations below natural or anthropogenic background levels.[1] Therefore, remedial goals are set based on risk, or, when the risk-based concentration is below background levels, at an upper percentile estimate, or background threshold value (BTV) for background concentrations. Accordingly, the Illinois Pollution Control Board (the "Board") should take state-specific background concentrations into account and use the BTV as a minimum value when proposing groundwater quality standards.

1.1 The Illinois Pollution Control Board Should Not Set Groundwater Standards Below Background Levels

The Board should consider the existing, natural background concentrations of cobalt and vanadium in state groundwater before setting new groundwater quality standards, and, if necessary, the economic reasonableness of setting groundwater standards below background levels. IEPA admitted that it had not taken naturally occurring background conditions into consideration prior to proposing to dramatically reduce the Class I groundwater standards for many inorganic analytes.[2] IEPA also admitted that soil background concentrations for inorganic analytes were taken into consideration in the Board promulgated rules governing remedial objectives for soils in Part 742 (*Tiered Approach to Corrective Action Objectives*, or TACO).[3] The Board should act consistently and take background into consideration for the Part 620 regulations.

Setting a standard close to or below background levels or practical quantitation limits can be impractical for many reasons, including for purposes of defining contamination, assigning responsibility for contamination, and conducting remediation. Phase I and Phase II Environmental Site Assessments (ESAs) are often conducted prior to or during real estate transactions. A Phase II ESA can involve collecting site groundwater samples and comparing the resulting concentrations to Part 620 groundwater standards. A Class I groundwater standard below background would lead to some properties incorrectly being identified as "impacted" or "contaminated" above IEPA Class I groundwater standards, when, in fact, the condition is actually natural and not caused by anthropogenic sources. These incorrectly categorized properties could lead to value diminution and unnecessary economic losses for the property owners (individuals or businesses). Knowingly and incorrectly choosing to define a proportion of groundwater in the state as environmentally impacted is

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[1] USEPA, Office of Solid Waste and Emergency Response, Role of Background in the CERCLA Cleanup Program, April 12, 2002, p. 3.

[2] Hearing Transcript at 121 (Mar. 9, 2022), *In the Matter of: Proposed Amendments to Groundwater Quality (35 Ill. Adm. Code 620)*, R2022-018.

[3] Hearing Transcript at 125 (Mar. 9, 2022), *In the Matter of: Proposed Amendments to Groundwater Quality (35 Ill. Adm. Code 620)*, R2022-018.

not economically reasonable. This could also lead to unnecessary litigation as “impacted” property owners may look to blame upgradient property owners as the source of the incorrectly identified environmental impact.

Improper identification of environmental impact in groundwater could also lead to unnecessary remediation or, at least, a requirement of the property owner to prove to IEPA that groundwater sample results are consistent with local background conditions. This determination requires the installation of monitoring wells, the collection and analysis of samples, the preparation of a report to document the determination, possible participation in the voluntary Site Remediation Program (SRP) to receive a No Further Remediation (NFR) letter, etc. Depending on depth of aquifer and formation type, this process could easily cost property owners tens of thousands of dollars. Alternatively, property owners could accept deed restrictions on their properties that prohibit the use of the groundwater. This would unnecessarily deny property owners the use and enjoyment of their property and also diminish the value of the property. When asked about the remedy for the incorrect identification of groundwater as impacted, IEPA recognized that a property owner would need to make the necessary background demonstration investigation, accept a deed restriction, or rely on a municipal ordinance, if any, that prevents use of groundwater for consumption.[4] IEPA, however, did not attempt to assess the number of potentially affected property owners or the costs of compliance/valuation losses. Again, groundwater standards set below existing background concentrations would cause unnecessary economic losses, and IEPA has failed to determine whether these losses are economically reasonable.

1.2 Many Groundwaters in Illinois Have Natural Cobalt and Vanadium Concentrations Higher Than the Proposed Class I Standards

IEPA proposed the Class I standard for cobalt of 0.0012 mg/L solely on the basis of potential human health effects. If IEPA had considered existing water quality, it would have discovered that a natural cobalt concentration above 0.001 mg/L in groundwater is common in Illinois. The United States Geological Survey (USGS) monitors concentrations of inorganic constituents in groundwater as part of its National Water Quality Assessment Program (NWQAP)[5] and publishes its findings.[6] Most of the groundwater samples collected under this program are passed through a 0.45 μm filter prior to chemical analysis. Filtered samples generally have lower metals concentrations compared to unfiltered, or “total,” samples required by Part 620 to determine compliance with groundwater quality standards. Filtration removes some of the solids present in groundwater samples that contribute to observed metals concentrations. Illinois is considered a “humid” area in this study, and USGS reports that 10% of collected groundwater samples in humid areas exceed 0.0013 mg/L for cobalt.[7,8] In the same USGS report of NWQAP data, a map of spatial distribution of cobalt concentration in groundwater (reproduced below) shows that approximately one-third of the Illinois samples exceed 0.001 mg/L.[9]

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[4] Hearing Transcript at 122 (Mar. 9, 2022), *In the Matter of: Proposed Amendments to Groundwater Quality (35 Ill. Adm. Code 620)*, R2022-018.

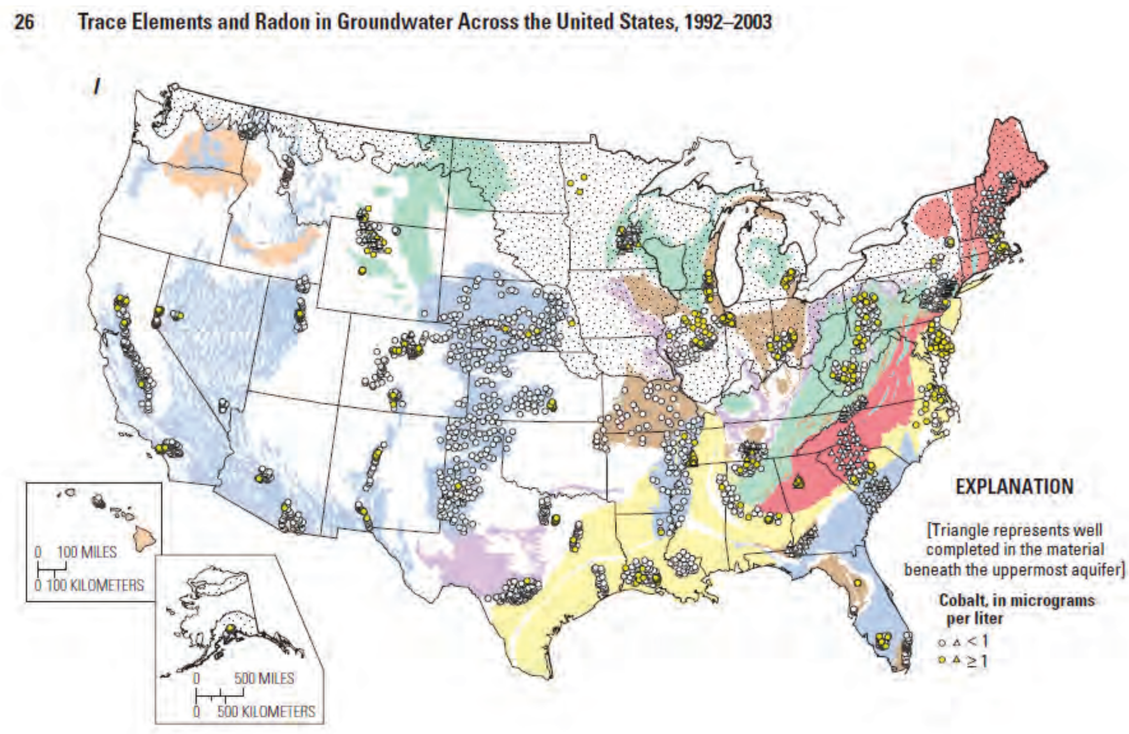
[5] Note that all of the NWQAP groundwater samples discussed in this report were passed through a 0.45 μm filter.

[6] USGS, Trace Elements and Radon in Groundwater Across the United States, 1992-2003, 2011.

[7] USGS, Trace Elements and Radon in Groundwater Across the United States, 1992-2003, 2011, p. 20

[8] Note that the metals concentrations in this report are expressed in units of micrograms per liter (μg/L) rather than milligrams per liter (mg/L). One microgram per liter is equivalent to 0.001 milligram per liter.

[9] USGS, Trace Elements and Radon in Groundwater Across the United States, 1992-2003, 2011, p. 26.



Similarly, IEPA proposed the Class I standard for vanadium of 0.00027 mg/L solely on the basis of potential human health effects using the Human Threshold Toxicant Advisory Concentration (HTTAC) formula from proposed Appendix A. If IEPA had considered existing water quality, it would have discovered that a natural vanadium concentration above its proposed value of 0.00027 mg/L in groundwater is common in Illinois. The USGS reports that more than 50% of collected groundwater samples in humid areas exceed 0.00027 mg/L for vanadium.[10] In the same USGS report of NWQAP data, a map of spatial distribution of vanadium concentration in groundwater (reproduced below) shows that the majority of groundwater samples collected in the Midwest, including Illinois, exceeded the higher value 0.0014 mg/L.[11,12]

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[10] USGS, Trace Elements and Radon in Groundwater Across the United States, 1992-2003, 2011, p. 20

[11] USGS, Trace Elements and Radon in Groundwater Across the United States, 1992-2003, 2011, p. 33.

[12] Note that the metals concentrations in this report are expressed in units of micrograms per liter (µg/L) rather than milligrams per liter (mg/L). One microgram per liter is equivalent to 0.001 milligram per liter.

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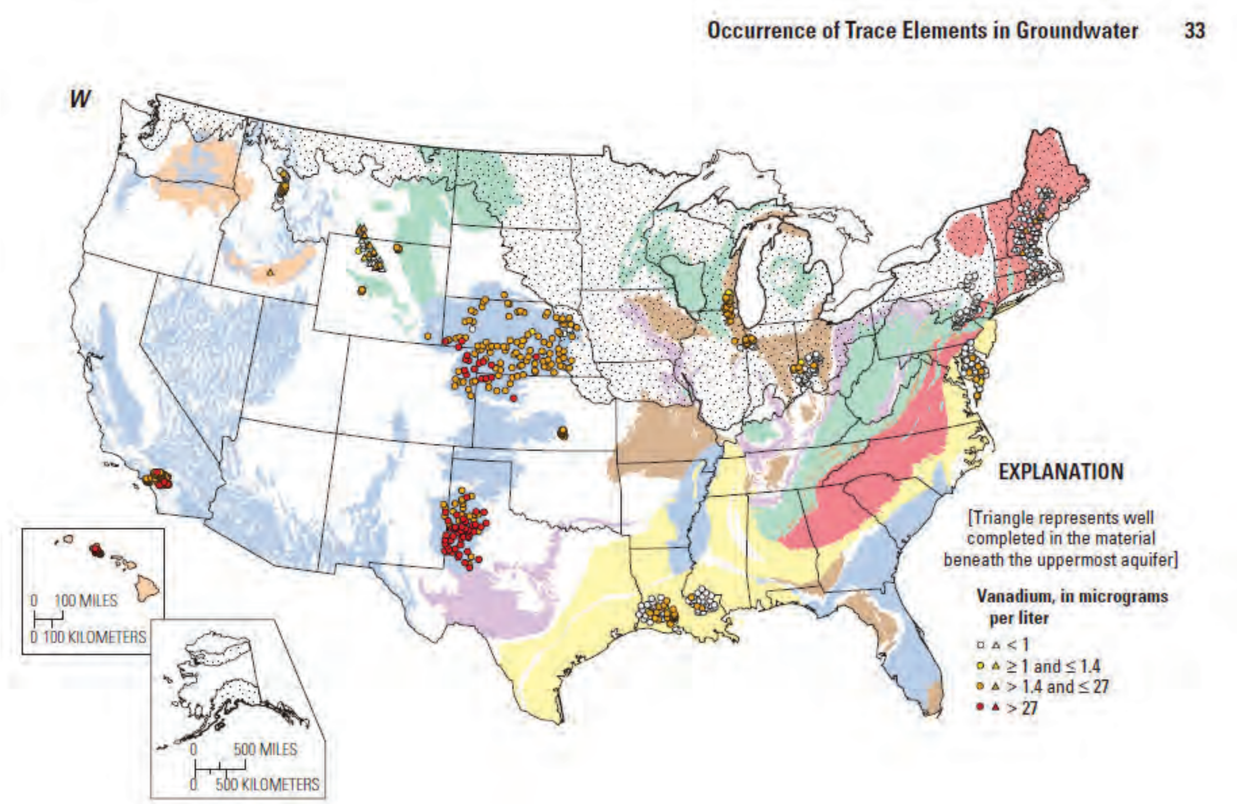

Because the USGS continues to add samples in its NWQAP program over time, Ramboll downloaded the current version of the NWQAP groundwater data[13] for Illinois to verify the statistics above are still accurate and found that, among detected filtered sample results,[14] 24% exceeded the IEPA's proposed Class I standard of 0.0012 mg/L for cobalt, and 55% exceeded the IEPA's proposed Class I standard of 0.00027 mg/L for vanadium. As discussed below, the unfiltered groundwater samples had reporting limits consistently above the proposed standards. However, these data sets were used to estimate an approximate BTV of 0.02 to 0.03 mg/L for both cobalt and vanadium. These BTVs are more appropriate numbers for proposed standards when estimated health-based levels fall below background concentrations.

1.3 The Proposed Class I Standards for Cobalt and Vanadium Are Not Detectable in Typical Laboratory Reporting for Unfiltered Samples

IEPA requires compliance with groundwater standards for metals to be determined based on unfiltered (total) samples. Unfiltered groundwater samples have greater turbidity and potential for interference from solids, and other metals and ions that increase the effective reporting limit due to sample dilutions required by matrix interference, compared to filtered samples. IEPA reports that the "LLOQ/LCMRL" or Lower Limit of Quantitation/Lowest Concentration Minimum Reporting Level for

[13] USGS Groundwater Data for the Nation, available at https://waterdata.usgs.gov/nwis/gw, accessed on 9/10/2022.

[14] Even among the filtered sample results, many samples had reporting limits that exceeded the proposed Class I standard, so the calculation was limited to detected (enumerated) values. The true proportion exceeding would be higher.

cobalt is 0.0001 mg/L using the United States Environmental Protection Agency (USEPA) Method 200.8,[15] but does not provide a reference or context for this number. The LLOQ is defined in the proposal as the minimum concentration that can be measured or reported pursuant to USEPA's Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods (SW-846). The LLOQ is verified by spiking clean control water (e.g., reagent water or method blanks) that does not have issues with matrix interference. The LCRML is used by USEPA to support drinking water analysis to ensure compliance with regulation.[16] The Technical Basis for the LCMRL describes the calculation of this value as a statistic generated from multiple laboratories estimating the minimum detectable spiking concentration of an analyte within certain statistical confidence[17] using laboratory reagents, rather than actual field groundwater samples with significant turbidity. Drinking water sources generally have low turbidity as USEPA has promulgated an maximum contaminant level (MCL) for turbidity of 1 Nephelometric turbidity unit (NTU).[18] A rule of thumb goal for investigative groundwater samples, in contrast, is to collect a sample after field stabilization of turbidity to less than 10 NTU (10 times more turbid than the MCL for drinking water).[19] The LLOQ/LCMRLs are simply not relevant to or achievable in real world groundwater samples with turbidity greater than 1 NTU. IEPA admitted that commercial laboratories may not be capable of achieving reporting limits below its proposed Class I groundwater quality standards, which is necessary to demonstrate compliance.[20] Further, IEPA appears to be unconcerned regarding the technical feasibility or the potential increased cost of compliance, stating that "the Agency recognizes that not all commercial labs may be able to achieve the appropriate levels of quantitation at this time. Nonetheless, to remain viable, commercial labs should expect to keep up with analytical techniques and new methodologies".[21] In fact, laboratories currently operating in Illinois and laboratories certified by IEPA to analyze samples collected in Illinois may be unable to achieve reporting limits needed to show compliance with the very low proposed standards for cobalt and vanadium in unfiltered groundwater samples.[22]

USEPA documentation for Method 200.8,[23] the analytical method typically used to analyze metals in water, includes estimated instrument detection limits for inorganic elements but notes that actual method detection limits (MDLs) will vary based on the sample matrix, instrumentation, and selected

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[15] IEPA's Motion for Acceptance, Statement of Reasons, and Proposed Amendments at 4850 (Dec. 7, 2021), *In the Matter of: Proposed Amendments to Groundwater Quality (35 Ill. Adm. Code 620)*, R2022-018.

[16] USEPA, Lowest Concentration Minimum Reporting Level (LCMRL) Calculator, available at https://www.epa.gov/dwanalyticalmethods/lowest-concentration-minimum-reporting-level-lcmrl-calculator, accessed July 27, 2022.

[17] USEPA, Technical Basis for the Lowest Concentration Minimum Reporting Level (LCMRL) Calculator, Office of Water, USEPA 815-R-11-001, December 2010.

[18] USEPA, National Primary Drinking Water Regulations, available at https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations, accessed July 27, 2022.

[19] USEPA, Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, Ground Water Forum Issue Paper, Office of Solid Waste and Emergency Response, USEPA 542-S-02-001, May 2002.

[20] IEPA's Prefiled Answers to Follow-Up Questions at 36 (May 6, 2022), *In the Matter of: Proposed Amendments to Groundwater Quality (35 Ill. Adm. Code 620)*, R2022-018.

[21] IEPA's Prefiled Answers to Follow-Up Questions at 36 (May 6, 2022), *In the Matter of: Proposed Amendments to Groundwater Quality (35 Ill. Adm. Code 620)*, R2022-018.

[22] Communications with commercial laboratory staff confirm that labs would have difficulty achieving reporting limits below the Class I standards proposed by IEPA for cobalt and vanadium.

[23] Method 200.8: Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma - Mass Spectrometry, available at https://www.epa.gov/sites/default/files/2015-06/documents/epa-200.8.pdf, accessed July 27, 2022.

operating conditions. It also provides a table of "typical MDLs" for total recoverable determinations (i.e., unfiltered samples), which indicates a value of 0.004 mg/L for cobalt in aqueous samples.[24]

Illinois groundwater data from the USGS National Water Information System[25] demonstrate that none of the more than 3,000 samples from the database tested for "total" cobalt (unfiltered) achieved a reporting limit of less than 0.0012 mg/L. The majority (84%) of unfiltered samples were undetected for cobalt at a reporting limit of 0.005 mg/L. The lowest reporting limit for cobalt in the database was 0.003 mg/L, approximately three times higher than the proposed Class I standard.

Similarly, 92% of the more than 3,000 unfiltered groundwater samples analyzed for vanadium were undetected at a reporting limit of 0.005 mg/L. This value, at more than 18 times the currently proposed Class I standard for vanadium, was the lowest reporting limit in the database for vanadium.

IEPA failed to consider the technical feasibility of achieving an actual laboratory reporting limit of less than its proposed Class I standards for cobalt and vanadium in real world, unfiltered groundwater samples. IEPA's very low LLOQ/LMCRLs are based on clean, idealized laboratory samples rather than actual unfiltered groundwater samples. Demonstration of compliance with these proposed standards is not achievable even with reasonable efforts at well stabilization and collection of low-flow samples for many Illinois groundwaters that have naturally elevated levels of turbidity.

1.4 Conclusions Regarding Proposed Cobalt and Vanadium Standards

The IEPA failed to consider the existing, natural concentrations of cobalt and vanadium in the groundwater it is seeking to regulate. Consequently, it has proposed Class I standards for these metals below their natural background concentrations that will cause unnecessary economic losses to property owners due to false assessments of their property as environmentally impaired. Further, demonstration of compliance with IEPA's low proposed Class I standards for cobalt and vanadium is not technically feasible for real world unfiltered groundwater samples due to matrix interference and practical reporting limits falling above the proposed Class I standards. BTVs, which here I have estimated at 0.02 to 0.03 mg/L[26] for both cobalt and vanadium based on available data, are more appropriate numbers for the Board to use in setting standards for these constituents given the calculated health-based levels fall below background concentrations.

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[24] Method 200.8: Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma - Mass Spectrometry, available at https://www.epa.gov/sites/default/files/2015-06/documents/epa-200.8.pdf, accessed July 27, 2022.

[25] USGS Groundwater Data for the Nation, available at https://waterdata.usgs.gov/nwis/gw, accessed on 9/10/2022.

[26] At the very least, the Board should not set the cobalt standard below the 0.006 mg/L standard applicable under other Illinois regulatory programs. *See* 35 Ill. Adm. Code §845.600.

2. REFERENCES

415 ILCS 5/1 *et seq.* the Illinois Environmental Protection Act.

USEPA, Technical Basis for the Lowest Concentration Minimum Reporting Level (LCMRL) Calculator, Office of Water, USEPA 815-R-11-001, December 2010

USEPA, Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, Ground Water Forum Issue Paper, Office of Solid Waste and Emergency Response, USEPA 542-S-02-001, May 2002.

US EPA, Office of Solid Waste and Emergency Response, Role of Background in the CERCLA Cleanup Program, April 12, 2002

IEPA's Prefiled Answers to Follow-Up Questions (May 6, 2022), *In the Matter of: Proposed Amendments to Groundwater Quality (35 Ill. Adm. Code 620)*, R2022-018.

IEPA's Motion for Acceptance, Statement of Reasons, and Proposed Amendments (Dec. 7, 2021), *In the Matter of: Proposed Amendments to Groundwater Quality (35 Ill. Adm. Code 620)*, R2022-018

Hearing Transcript (Mar. 9, 2022), *In the Matter of: Proposed Amendments to Groundwater Quality (35 Ill. Adm. Code 620)*, R2022-018

USGS, National Water-Quality Assessment Program, Trace Elements and Radon in Groundwater Across the United States, 1992-2003, 2011.

USGS Groundwater Data for the Nation, available at https://waterdata.usgs.gov/nwis/gw.

USEPA, Lowest Concentration Minimum Reporting Level (LCMRL) Calculator, available at https://www.epa.gov/dwanalyticalmethods/lowest-concentration-minimum-reporting-level-lcmrl-calculator

USEPA, National Primary Drinking Water Regulations, available at https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations

Method 200.8: Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma - Mass Spectrometry, available at https://www.epa.gov/sites/default/files/2015-06/documents/epa-200.8.pdf

CERTIFICATION PAGE

Melinda W Hahn

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Melinda Hahn, PhD

ATTACHMENT 1
MELINDA HAHN, PHD CV

MELINDA W. HAHN, PH.D.

Senior Managing Consultant

Dr. Hahn's practice areas include site investigation and remediation, contaminant fate and transport modelling, statistics of environmental data, forensic analysis, litigation support, and due diligence. Regulatory areas include RCRA, CERCLA, TSCA, and Voluntary Cleanup/Risk-Based Corrective Action. Dr. Hahn has experience in the following industry categories: energy (electric utilities, petroleum dispensing, pipeline operations, former manufactured gas plant sites), industrial equipment manufacturing, metal working and metal recycling, automobile manufacturing, ink and chemical manufacturing, wood treating, mining, cement manufacturing, milling and smelting operations, secondary aluminum production, and dry cleaning.

EDUCATION

1995
PhD, Environmental Engineering
The Johns Hopkins University

1990
BS, Physics
The University of Texas at Austin

1990
BS, Mathematics
The University of Texas at Austin

ACADEMIC HONORS

1992-1995
Graduate Fellow, National Science Foundation

1995
Most Distinguished Environmental Engineering Dissertation, Association of Environmental Engineering Professors

CAREER

1998-Present
Senior Manager, Ramboll Environ

1997-1998
Consultant, Roy Ball, PC

1995-1997
Senior Project Engineer, Environmental Resources Management-North Central, Inc.

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PROJECTS

- Provided technical litigation support for over 50 matters regarding extent, severity, timing, and source of soil and ground water contamination and vapor intrusion, necessity for and costs of remediation, human health risk assessment, toxic tort liability, Superfund cost allocation (including consistency with the NCP), insurance cost recovery, and the siting and monitoring of a hazardous waste landfill. The regulatory frameworks included Illinois Voluntary Cleanup Program, Illinois Leaking Underground Storage Tank Program, RCRA, CERCLA, TSCA, NCP, and California Proposition 65.
- Provided expert testimony in matters involving Superfund cost allocation, statistics of environmental data, and contaminant fate and transport.
- Conducted environmental forensic evaluations to determine sources of observed environmental contamination in soil, groundwater, sediment and sub-slab/indoor air for sites in litigation and pre-litigation phases.
- Performed multivariate statistical analyses of data for forensic analysis, for contaminant ecological impact analysis, and as part of human health and ecological risk assessments.
- Provided litigation support for a real estate transaction dispute at a site with groundwater and indoor air contamination.
- Provided litigation support for environmental liability estimation for a Potentially Responsible Party at a large site with sediments contaminated with PCBs. Evaluated historical information on industrial processes and wastewater treatment, along with recent facility data to estimate the contribution of PCB mass to the river from the facility.
- Directed RCRA closure activities at a site with soil, groundwater and indoor air contamination.
- Conducted chemical isotope dating analysis of PCB contamination of river sediments to identify the likely potentially responsible party. This project included preparation of sampling plan, implementation of sediment core sampling, and interpretation of sample results.
- Retained as an expert witness to evaluate a claim of chemical crop damage from herbicide use along a utility right-of-way. Developed opinions based on chemical analysis and theories of fate and transport.
- Retained as an expert witness and provided technical support for litigation involving the sources of chlorinated solvent contamination at dry cleaning facilities. Developed opinions based on chemical analysis and theories of fate and transport.
- Retained as an expert witness and provided opinions regarding timing of releases and groundwater contaminant fate and transport.
- Evaluated claims of residents living near a scrap metal facility of transport and deposition of lead-containing particles in their homes using statistical analysis of plaintiffs' chemical data. Provided expert testimony based on this analysis.
- Evaluated the hydrogeological setting of a proposed petroleum pipeline pumping station and estimated the likelihood of a release and groundwater contamination. Provided expert testimony based on this analysis.
- Directed and assisted in the closure of a number of sites in the Illinois Voluntary Cleanup Program and the Illinois Leaking Underground Storage Tank Program.
- In several cases, evaluated the potential contribution of urban industrial sources of heavy metals to residential soil using simple data comparisons and statistical techniques.

- Performed ground water and contaminant fate and transport modeling using MODFLOW and MT3D for use as a Superfund cost allocation tool in support of expert testimony. Relative mass of TCE entering the Superfund Site from sources on two PRP's properties was used as a basis for cost allocation. A Monte Carlo analysis was also performed to evaluate the sensitivity of the proposed allocation to changes in key variables.
- Performed Monte Carlo analysis of risk to ground water posed by a proposed petroleum pipeline in support of expert testimony. The analysis examined the likelihood of the exceedance of the Illinois Class I ground water standard for benzene per mile of proposed pipeline.
- Conducted Monte Carlo statistical risk assessment for residential exposure to benzo(a)pyrene in soil for an Illinois Site Remediation Program closure of a former industrial facility. The calculations resulted in a distribution of cleanup objectives that correspond to an excess cancer risk of 10^{-6}. A Tier 3 (Risk-Based Corrective Action) site-specific remediation objective was selected from the calculated distribution.
- Performed Monte Carlo cost allocation among four PRPs for a Superfund Site in support of expert testimony. Total volume, volume of hazardous substances, and volume of drummed materials were considered.
- Utilized 3-D geostatistical interpolation techniques to visualize environmental data, to estimate excavation volumes for remediation, and to identify and distinguish source areas and potential preferential pathways of migration for a number of contaminated sites.
- Provided litigation support for a number of insurance cost recovery projects, including a former wood treating facility and a jewelry manufacturer. Tasks included the identification of likely sources and timing of contamination.
- Provided consulting services for several aluminum companies regarding new Land Disposal Restriction (LDR) treatment standards. ENVIRON assisted these companies with a DC circuit court challenge to improper LDR treatment standards.
- Performed research and analysis of remedial activities and associated costs to determine compliance with the NCP for cost recovery matters for a number of sites.
- Performed a number of due diligence environmental site assessments for commercial and industrial properties for prospective buyers and lenders.

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On Behalf of: Dynegy Midwest Generation, LLC, Electric Energy Inc., Illinois Power Generating Company, Illinois Power Resources Generating, LLC, and Kincaid Generation, LLC

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Date:
September 15, 2022

Case Number:
R22-018

Project Number:
1690015671 – 001

PRE-FILED TESTIMONY OF LISA YOST:

IN THE MATTER OF: PROPOSED AMENDMENTS TO GROUNDWATER QUALITY (35 ILL. ADM. CODE 620)

SIGNATURE:

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Lisa Yost

____

Lisa Yost, MPH, DABT
Principal Consultant

CONTENTS

TABLES

APPENDICES

ACRONYMS AND ABBREVIATIONS

ATSDR	Agency for Toxic Substances and Disease Registry
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DNEL	Derived No Effect Level
ECHA	European Chemicals Agency
ESAADI	Estimated Safe and Adequate Daily Intake
EU	European Union
HTTAC	Human Toxicant Threshold Advisory Concentration
IEPA	Illinois Environmental Protection Agency
IRIS	Integrated Risk Information System
kg	Kilogram
LOAEL	Lowest-observed-adverse-effect Level
MCLGs	Maximum Contaminant Level Goals
MCLs	Maximum Contaminant Levels
MF	Modifying Factor
mg/Kg	Milligrams per kilogram
mg/Kg/day	Milligram per kilogram per day
mg/L	Milligrams per liter
MRL	Minimal Risk Level
NAS	National Academy of Sciences
NOAEL	No-observed-adverse-effect Level
NTP	National Toxicology Program
PCBs	Polychlorinated Biphenyls
PCDD/Fs	Dibenzo-P-Dioxins And Furans
PPRTV	Provisional Peer Reviewed Toxicity Value
RCRA	Resource Conservation and Recovery Act
RfD	Oral Reference Dose
RSC	Royal Society of Chemistry
RSL	Regional Screening Level
TCE	Trichloroethylene
UF	Uncertainty Factors
µg	Micrograms

ug/L	Micrograms per liter
US	United States
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

TESTIMONY OF LISA YOST

1.1 Qualifications

Ms. Lisa Yost is a board-certified toxicologist with more than 30 years of experience assisting clients assessing human health risks related to exposure to a variety of chemical substances in environmental media (soil, water, and in fish, shellfish, game, and home-grown foods) in the workplace or within consumer products. She has conducted or supervised risk assessments under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Resource Conservation and Recovery Act (RCRA), and state-led regulatory contexts, assisting clients in negotiations with regulatory staff to develop and apply sound technical approaches that realistically characterize potential risk and meet environmental and business objectives. She has directed project teams comprised of colleagues, consultants, regulatory staff, and academic researchers working to develop coordinated strategies addressing human health concerns.

Ms. Yost conducted detailed toxicological evaluations of numerous chemicals and chemical classes, including polychlorinated dibenzo-p-dioxins and furans (PCDD/Fs), polychlorinated biphenyls (PCBs), pesticides, trichloroethylene (TCE) and other solvents, mercury, arsenic, and selenium. Ms. Yost serves as the volunteer chair of the Minnesota Department of Health Environmental Health Tracking and Biomonitoring Advisory Panel with responsibilities for providing input to the Department of Health on biomonitoring priorities and strategies including planned design of monitoring for pesticide exposures. A full resume is provided as Attachment A.

1.2 Background and Summary of Opinions

This document discusses the Illinois Environmental Protection Agency (IEPA) December 7, 2021, Proposed Amendments to Groundwater Quality (35 Ill. Adm. Code 620) rulemaking for public water supplies, which identifies proposed revised values for Class I and Class II groundwater quality standards. My report focuses on the Class I and Class II standards for selenium, fluoride, and molybdenum. The proposed IEPA standards are considered relative to the United States Environmental Protection Agency's (USEPA) and regional states' regulatory standards, and with consideration of the underlying scientific basis. The proposed standards are also considered in relation to their beneficial effects, given that selenium and molybdenum are essential nutrients and fluoride has established benefits in limiting tooth decay.

The IEPA-proposed Class I standards considered here are based on human health (molybdenum), protection of livestock foraging on plants irrigated by groundwater (selenium), and livestock watering (fluoride). The Class II standards are based on protection of livestock foraging on plants irrigated by groundwater (molybdenum, selenium) and livestock watering (fluoride). None of the metals under consideration are carcinogens, so all discussion here is related to analyses appropriate for consideration of effects other than cancer.

More specifically, the IEPA proposed Class I standard for molybdenum is based on a human health toxicity threshold advisory concentration (HHTAC), determined using a formula included in Appendix A of IEPA's Proposed Amendments to 35 Ill. Adm. Code 620, Groundwater Quality Standards.[1] The IEPA

[1] IEPA's Motion for Acceptance, Statement of Reasons, and Proposed Amendments at 65–70 (Dec. 7, 2021), *In the Matter of: Proposed Amendments to Groundwater Quality (35 Ill. Adm. Code 620)*, R2022-018.

HHTAC values for noncarcinogenic chemicals are derived from oral reference doses (RfDs) using the following equation:[2]

$$HHTAC = RSC\, x \frac{ADE}{W}$$

Where:

HHTAC=	Human Threshold Toxicant Advisory Concentration (mg/L)
RSC =	Relative contribution of the amount of the exposure to a chemical via drinking water when compared to the total exposure to that chemical from our source. If valid chemical specific data are not available a value of 20% (0.2) shall be used
ADE =	Acceptable daily exposure of a substance in mg per day (mg/d). To derive an ADE, the RfD is multiplied by the body weight of the receptor under consideration – in this case a 15 kg child.
W =	Per capital daily water consumption for a child (0-6 years of age) equal to 0.78 liters per day.

The IEPA proposed Class II standard for molybdenum is based on irrigation to protect livestock foraging and is intended to be protective of "short-term use on soils that react with this element". The Class I and Class II standard for selenium is also based on an irrigation standard to protect foraging livestock and is based on “continuous [irrigation] use on all soils” and/or use on “neutral and alkaline fine textured soils.” The Class I and Class II value for fluoride is derived from an aesthetic-based value proposed to prevent dental mottling in livestock watered with groundwater. All of the proposed Class II standards are based on the 1972 Water Quality Criteria Document prepared by the National Academy of the Science for the USEPA (USEPA (1972)).[3]

Based on my review I offer the following opinions regarding the IEPA proposed standards:

- **Selenium**: The proposed Class I and Class II standard for selenium of 0.02 mg/L based on USEPA (1972) is unreasonable for Illinois agriculture, and a Class I and II standard of 0.05 mg/L is more appropriate for the following reasons:

    - IEPA previously used the same underlying document and technical analysis to support the current 0.05 mg/L standard for selenium, stating that continuous irrigation was not used in Illinois, and IEPA has indicated in this proceeding that continuous irrigation is still not used in Illinois agriculture.

    - The USEPA (1972) document also identified the 0.02 mg/L irrigation standard as appropriate for fine textured neutral or alkaline soils, but data reviewed indicates that soils in Illinois are typically acidic, suggesting that is not an appropriate to use this standard in Illinois. The USEPA (1972) also expresses considerable uncertainty around the appropriateness of the 0.02 mg/L standard for fine textured neutral or alkaline soils.

[2] *Id.* at 5047–5058.

[3] USEPA 1972. Water Quality Criteria 1972. Prepared by the National Academy of Sciences for the USEPA. Washington, DC. 1972. Hereafter (USEPA 1972)

  - Selenium is an essential nutrient. Available data indicate that elevated selenium, through consumption of plants irrigated by groundwater or otherwise, is not an issue for Illinois livestock and that, in fact, recommendations have been made that Illinois livestock be provided selenium supplements to avoid deficiencies.

  - A Class I and Class II standard of 0.05 mg/L for selenium is more appropriate: it is consistent with the selenium maximum contaminant level (MCL) of 0.05 mg/L, is consistent with the livestock watering standard for selenium provided in USEPA (1972) and provides a limit on the amount of selenium introduced into agricultural fields that may be used for storage.

- **Fluoride**: The proposed standard of 2 mg/L to protect livestock that consume groundwater from developing tooth mottling, which are changes in the appearance of tooth enamel, and does not provide a clear public health or agricultural benefit. The current standard of 4 mg/L is appropriate to protect against injurious health effects to humans and animals.

  - The federal MCL for fluoride of 4 mg/L.

  - Surrounding states have adopted the MCL and do not have a lower standard to protect livestock watering.

  - The 2 mg/L livestock standard for fluoride in USEPA (1972) is based on aesthetic impacts to livestock and acknowledges that injurious effects from fluoride would only be expected if fluoride levels were several-fold higher than 2 mg/L.

- **Molybdenum**: The proposed Class I standard for molybdenum of 0.0019 mg/L should be updated with a more scientifically robust basis for the toxicity value. The available evidence does not support the need for the proposed Class II standard of 0.05 mg/L for the protection of livestock consuming forage irrigated with groundwater.

  - The proposed molybdenum standard is based on a 1991 USEPA Integrated Risk Information System (IRIS) value derived from a 1961 study that has significant limitations identified by the Agency for Toxic Substances and Disease Registry (ATSDR) 2020 Toxicological Profile for Molybdenum (ATSDR (2020)) and by the Wisconsin Department of Health.

  - The ATSDR (2020) intermediate minimum risk level (MRL) of 0.06 milligram per kilogram per day (mg/kg/day) is a much more current analysis and ultimately relies on the same study that was also relied on by the recent European Chemicals Agency (ECHA) for a chronic derived no observed effect level (DNEL) value of 3.4 mg/kg/day. The ECHA analysis determined that no further adjustment was needed to use a subchronic study as the basis of evaluating chronic exposures because there were no further effects observed following additional exposure.

  - The use of an updated and more scientifically robust toxicity value for molybdenum is not inconsistent with the tiered approach for toxicity sources used by IEPA and is appropriate in this limited instance. The discussion in USEPA's 2003 Human Health Toxicity Values in Superfund Risk Assessment (USEPA (2003) regarding selection of toxicity values, upon which IEPA relies, notes that "IRIS is not the only source of toxicology information, and in some cases more recent, credible and relevant data may come to the Agency's attention."

- The updated data and analyses, together with the essential nutrient status of molybdenum, suggest that the standard proposed by IEPA is unnecessarily stringent. It would be appropriate for the Illinois Pollution Control Board (the "Board") to apply the ATSDR intermediate oral MRL of 0.06 mg/kg-day as the basis for the Class I criteria. A Class I standard based on the ATSDR intermediate duration MRL of 0.06 mg/kg/day results in a value of 0.2 mg/L, which is protective of public health.
- Available evidence does not support adding a Class II standard for molybdenum at 0.05 mg/L to protect against effects on livestock related to molybdenum in forage. There is no evidence of a need to protect livestock against molybdenum in forage and without this evidence of potential harm, the regulation creates a burden without a clear benefit.

For background and context, below I provide a table comparing the proposed IEPA Class I standards for molybdenum, selenium, and fluoride with enforceable standards and MCLs for these constituents established by USEPA and in states surrounding Illinois. In most instances, the standards proposed by IEPA are significantly lower than those derived by USEPA and in effect in the other states. Table 1 summarizes the following numeric values: the proposed IEPA standards; the USEPA MCLs and maximum contaminant level goals (MCLGs); and the standard and guidelines for drinking water identified for neighboring states.

Table 1: Summary of Illinois Proposed Class 1 Water Standards for Protection of Human Health in Comparison with Other Relevant Regulatory Guidelines

	Proposed IEPA Class I Standard		USEPA and MCL/ MCLGs	Neighboring States (mg/L)[d]						
Chemical	mg/L	Basis	MCL /MCLG[a]	IN	IO	KY	MI	MO	OH	WI
Fluoride	2	Livestock	4	4	4	4	4	4	4	4
Molybdenum	0.019	HTTAC	NA	NA	NA	NA	0.073	NA	NA	NA
Selenium	0.02	Irrigation	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

HTTAC – Human Toxicant Threshold Advisory Concentration
Livestock – Standard is based on livestock consumption of groundwater
Irrigation – Standard is based on livestock consuming forage irrigated by groundwater.
[a] USEPA 2022a. Groundwater and Drinking Water. National Primary Drinking Water Regulations. Last updated January 26, 2022. Available at: https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations
[b]USEPA 2018. Drinking Water Standards and Health Advisories. Available at: https://www.epa.gov/system/files/documents/2022-01/dwtable2018.pdf
[c] USEPA 2022. Regional Screening Levels. Values in Table 1 represent risk-based concentrations for water protective of risks associated with use as residential drinking water. All of the chemicals here are regulated based on a hazard index for effects other than cancer. Last updated May 18, 2022. Tables available at https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables
[d] Values represent enforceable standards for protection of human health .
IN – Indiana Article 2 Water Quality Standards available at. Standards for protection of human health for groundwater used as drinking water. http://iac.iga.in.gov/iac/T03270/A00020.PDF
IO - Iowa uses MCLs where available and also defers to USEPA lifetime health advisories: www.iowadnr.gov/Portals/idnr/uploads/consites/statewidegwstandards.pdf
KY – Kentucky Title 401 | Chapter 010 | Regulation 031 https://apps.legislature.ky.gov/law/kar/titles/401/010/031/. Drinking water resources must comply with the federal MCL of 0.05 mg/L.
MI – Michigan Table 1. Groundwater: Residential and nonresidential Part 201 generic cleanup criteria and screening available at: https://www.michigan.gov/egle/about/organization/remediation-and-redevelopment/remediation-and-investigation/cleanup-criteria. The drinking water standard for fluoride in Michigan is 4 mg/L based on the MCL. Mich. Admin. Code R 325.10604c. Michigan also has generic groundwater cleanup criteria that identifies a value of 2 mg/L for fluorine based on aesthetic considerations.
MO - Missouri drinking water standards apply MCLs where available and health advisories where no MCL. No value is listed for molybdenum. Missouri Department of Natural Resources. 2022. 10 CSR 20-7—DEPARTMENT OF NATURAL RESOURCE. https://www.sos.mo.gov/CMSImages/AdRules/csr/current/10csr/10c20-7.pdf
OH - Ohio Environmental Protection Agency 2018 Drinking Water Standards for Ohio Public Water Systems September 2018. https://epa.ohio.gov/static/Portals/28/documents/pws/DWStandardsList.pdf
WI Wisconsin Department of Natural Resources Drinking Water & Groundwater Quality Standards/Advisory Levels at: https://dnr.wisconsin.gov/sites/default/files/topic/DrinkingWater/HALtable.pdf includes the non-enforceable USEPA Drinking Water advisory of 0.04 mg/L. Drinking water advisory level of 0.06 mg/L was recently recommended in the Wisconsin Department of Health Recommended Public Health Groundwater Quality Standards WDPH 2022 at: https://www.dhs.wisconsin.gov/publications/p02434v-2.pdf

2. SELENIUM

The proposed Class I and II standard for selenium is 0.02 mg/L based on protection of livestock foraging crops irrigated by groundwater and would replace the current standard of 0.05 mg/L, which the Board previously established based on livestock watering.[4] The current standard of 0.05 mg/L is also consistent with the USEPA MCL and MCLG [5] for selenium and the standards in effect in surrounding states with similar agricultural economies. For the reasons provided below, the Board should maintain the current 0.05 mg/L Class I and Class II standard for selenium.

2.1 Draft Standard in Comparison with Other Federal and State Regulatory Standards

All neighboring states apply the MCL of 0.05 mg/L for selenium. Other states in the region were also evaluated to identify whether any had standards for the protection of livestock foraging on crops irrigated by groundwater. No other neighboring states were found with selenium standards for the protection of livestock consuming forage.

2.2 The Draft Threshold for Selenium of 0.02 mg/L for Protection of Irrigation of Crops Is Unnecessary

Selenium, which occurs naturally in the earth's crust, is an essential nutrient for humans and animals. Essential nutrients are necessary for healthy function and cannot be produced by the body. While selenium may have toxicity at higher concentrations, the proposed standard of 0.02 mg/L for selenium, based on foraging of irrigated crops by livestock, is unnecessary.

The reference provided by IEPA for the proposed selenium standard of 0.02 mg/L is page 345 of USEPA (1972), which relies on studies from the 1960s and 1970s[6] that reported elevations of selenium in forage crops irrigated with water containing selenium[7]. USEPA (1972) notes that forage needs to have selenium concentrations between 0.3 and 0.1 mg/kg to avoid deficiencies in cattle, but concentrations greater than 3 or 4 mg/kg were considered toxic.[8] Estimation of forage concentrations from irrigation water concentrations is complex, is dependent on soil conditions, plant types, and the amount of irrigation over time, and was not estimated by USEPA (1972). The USEPA (1972) irrigation water standard for selenium contains the following assumptions and conclusions:

> "With the low levels of selenium required to produce toxic levels in forages, the recommended maximum concentration in irrigation waters is 0.02 mg/l for continuous use on all soils. At a rate

[4] IEPA Comments at 11 (July 8, 1991), *In the Matter of: Groundwater Quality Standards: 35 Ill. Adm. Code* 620, R1989-014(B).

[5] USEPA 2022. Groundwater and Drinking Water. National Primary Drinking Water Regulations. Last updated January 26, 2022. Available at: https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations

[6] Allaway, W. H., P. D. Moore, J. E. Oldfield, .md 0. H. Mut (1966), Movement of physiological levels of selenium from soil through plants to animals. J. Kutr. 88:411·-4l8.

Hamilton, J. W. and 0. A. Beath (1963), Uptake of available selenium by certain range plants.]. Range Manage. 16(5):261-264.
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Gissel-Nielson, G. and B. Bisbjerg (1970), The uptake of applied selenium by agricultural plants. II. Utilization of various selenium compounds. Plant Sozl 32(2) :382-396.

[7] The studies relied on by USEPA (1972) do not appear to be representative of irrigation of agricultural forage in Illinois. Studies were conducted in Oregon, Wyoming, New Zealand and Denmark. The amount of irrigation applied was not described by the authors, but irrigation would be expected to be much higher in arid locations like eastern Oregon and Wyoming than in Illinois.

[8] Allaway, W. H., E. E. Cary, and C. F. Ehlig (1967), The cycling of low levels of selenium in soils. plants and animals, in Sym/10s111n selenium zn b10med1cwt, 0. H :Muth, J. E. Oldfield, and P. I· Weswig, eds. (AVI Publishing Co., Westport, Connecticut pp. 273-276.

of 3 acre feet of water per acre per year this concentration represents 3.2 pounds per acre in 20 years."

USEPA (1972) also recommends the 0.02 mg/L selenium irrigation standard based on forage of irrigated crops for certain soil conditions stating:

> "The same recommended maximum concentration should be used on neutral and alkaline fine textured soils until greater information is obtained on soil reactions."

Illinois agricultural land is not irrigated continuously, and IEPA has acknowledged that in prior standard setting and in statements regarding the proposed regulation. Moreover, the standard based on soil characteristics also does not appear to apply in Illinois. Specifically, while much of Illinois agricultural land is fine grained it is not predominantly neutral or alkaline. These issues are discussed further here.

2.2.1 Continuous Irrigation Is Not Used in Illinois

Continuous irrigation is not used in Illinois and, accordingly, it is not appropriate to base Illinois groundwater quality standards on this use. The level of irrigation assumed by USEPA (1972) to form the basis for the 0.02 mg/L selenium standard is 3-acre feet water use per acre per year. This irrigation level is higher than the 1.5 average acre foot of water reported by the United States Department of Agriculture in 2018 (USDA (2018))[9] used on cropland in the entire United States (US), including the West which is much more arid and highly irrigated. Irrigation levels in Illinois are typically even lower. USDA (2018)[10] indicates that in Illinois 332,220 total acre-feet of water was applied to 564,575 acres in Illinois in 2018 for irrigation, or a resulting 0.5 acre-foot of water per acre for that year, far lower than 3-acre-feet per acre per year.

IEPA has acknowledged that irrigation is not continuous in Illinois as part of both a prior (1991) rulemaking and in the current rulemaking. IEPA also relied on the same USEPA (1972) document to support the current selenium standard of 0.05 mg/L. Specifically, in the 1991 groundwater rulemaking[11], IEPA indicated that the USEPA (1972) selenium standard for irrigation was based on continuous watering and for that reason was not an appropriate basis for standard setting in Illinois[12]. In making this argument, IEPA first explained its decision to propose a standard of 0.5 mg/L for copper, based on the USEPA (1972) recommended livestock watering standard, rather than propose the USEPA (1972) irrigation-based standard of 0.2 mg/L stating:

> This standard was chosen rather than the irrigation number of 0.2 mg/L because the latter is based on continuous irrigation <u>*which is not utilized in Illinois, either within a year or from year-to-year.*</u> [Emphasis added]

Continuing the discussion in the context of selenium, IEPA stated:

> The Agency has performed a similar evaluation of the Class II: General Resource Standard established for selenium and has determined that the standard, as proposed, was also based on

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[9] USDA 2018. Irrigation and Water Management data now available https://www.nass.usda.gov/Newsroom/archive/2019/11-13-2019.php

[10] USDA 2018. Census of Agriculture. 2018 Irrigation and Water Management Survey. Table 7 Irrigation by Estimated Quantity of Water Applied: 2018 and 2013. Available at: https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/Farm_and_Ranch_Irrigation_Survey/fris_1_0007_0007.pdf

[11] IEPA Comments at 9–11 (July 9, 1991), *In the Matter of: Groundwater Quality Standards: 35 Ill. Adm. Code* 620, R1989-014(B).

[12] IEPA Comments at 9–11 (July 9, 1991), *In the Matter of: Groundwater Quality Standards: 35 Ill. Adm. Code* 620, R1989-014(B).

> continuous irrigation. Thus, the Agency recommends that the Class II standard for selenium should be amended to 0.05 mg/1 which is the number established for livestock watering.

Thus, IEPA explicitly rejected guidelines based on continuous watering in the 1991 rulemaking, but now relies on the same reference to propose a 0.02 mg/L guideline for selenium.

In the current rulemaking, IEPA has similarly acknowledged that irrigation in Illinois is intermittent in nature, stating: "We have, yeah, I would say intermittent irrigation here."[13] IEPA further stated that:

> I do not believe continuous irrigation is a practice that is used in Illinois simply because that we do not have a necessity for it. We do get regular rainfall.[14]

Thus, irrigation levels in Illinois are below the 3 acres per feet per year that USEPA (1972) identified as sufficient to result in elevated concentrations of selenium in forage consumed by livestock.

2.2.2 Illinois Soil Types Are Not Consistent with the USEPA (1972) Selenium Irrigation Standard Basis

The USEPA (1972) reference relied on by IEPA states that the 0.02 mg/L irrigation standard for selenium is appropriate for "use on *neutral and alkaline* fine textured soils *until greater information is obtained* on soil reactions" [emphasis added]. In March 9, 2022[15] IEPA indicated that the draft selenium irrigation standard is based on:

> "the use up to 20 years on fine texture soils, not for water used continuously on all soils."

Thus IEPA acknowledged again that continuous irrigation is not practiced in Illinois and focused on fine textured soils but failed to discuss whether those soils were neutral or alkaline. The pH of soils is a factor influencing uptake of selenium by plants (ATSDR 2003[16]) with higher uptake by plants in soils that are alkaline due to the presence of soluble selenium forms.

Exhaustive analysis of soils in Illinois is beyond the scope of this expert report. However, data reviewed indicate that many agricultural soils in Illinois have particle sizes that are relatively fine textured,[17] but that soils are not predominantly neutral or alkaline. The Illinois State Water Survey (2021)[18] provides maps of soil types in Illinois indicating much of the agricultural land is silty and states the following regarding Illinois soils:

> Agricultural soils of Illinois tend to acidify to pH values more acidic than 6.5. This acidity is managed by adding lime (carbonates of calcium and magnesium). Average soil pH values vary from mildly alkaline (7.0-7.5) to strongly acid (5.2-5.5) in extreme southern Illinois.

The ATSDR notes that selenium is more likely to be taken up by plants in alkaline soils. Thus, while many soils are fine textured in Illinois, most soils are not neutral or alkaline. IEPA has not established the applicability of the USEPA (1972) irrigation standard for selenium for Illinois soil.

USEPA (1972) also notes that the 0.02 mg/L irrigation value is recommended "until greater information is obtained," reflecting general uncertainty in this approach. As noted above, the studies

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[13] Hearing Transcript at 148:13–148:14 (Mar. 9, 2022), *In the Matter of: Proposed Amendments to Groundwater Quality (35 Ill. Adm. Code 620)*, R2022-018.

[14] *Id.* at 154.

[15] *Id.* at 150:13–150:15.

[16] Agency for Toxic Substances and Disease Registry (ATSDR) 2003. Toxicological Profile for Selenium. Available at: https://www.atsdr.cdc.gov/ToxProfiles/tp92.pdf .

[17] The Illinois state soil is Drummer silty clay loam which is a fine silty soil and is found in 1/3 of the counties in Illinois. This soil type was identified as the state soil because it is the most extensive soil type in Illinois. See: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/office/ssr12/tr/?cid=nrcs141p2_030689

[18] Illinois State Water Survey Alternative Crop Suitability Maps. https://www.isws.illinois.edu/data/altcrops/gisoils.asp

cited by USEPA (1972) to support the proposed 0.02 mg/L standard were conducted in Oregon, Wyoming, New Zealand, and Denmark with a focus on “range plants” and thus do not reflect Illinois agriculture. While the level of irrigation in these areas was not identified in the studies, irrigation in arid areas of eastern Oregon and in Wyoming would be expected to be much higher than in Illinois. Given the lack of support for using the 0.02 mg/L in an area with soil and irrigation practices like Illinois, it is more appropriate for the Board to continue to use the livestock watering value of 0.05 mg/L for selenium rather than change its basis now. While IEPA has indicated that irrigation has increased over time, the 2018 data indicate that irrigation is far below levels that the 0.02 mg/L standard is based on, i.e., 3 acres per foot per year for 20 years. The Class I and Class II irrigation standard is not needed to protect livestock consuming forage in Illinois agriculture.

Available data do not suggest that that selenium is elevated in forage consumed by livestock in Illinois[19]. Instead, data indicates the need for supplementation to reach adequate selenium in animal feed in Illinois. A United States Department of Agriculture (USDA) Illinois Grazing Management Fact Sheet[20] discusses minerals in forage needed for cattle health and identifies the need to supplement cattle feed because selenium is often deficient in Midwestern soils, and as a result in the forage consumed by livestock, stating:

> Other minerals, needed in much smaller amounts, are called “trace” minerals. The trace minerals selenium and iodine are deficient in many Midwestern soils and may need to be added to the diet. Selenium deficiency can lead to lowered fertility, white muscle disease, retained placenta, stillbirths, and weak calves that are susceptible to diarrhea and pneumonia. Generally, trace mineral supplementation is cheap and good insurance for preventing problems. Supplementing the cattle diet with a mineral mix that includes all the trace minerals is probably best.

Similarly, agricultural extension office publications in Illinois[21] focus on the lack of selenium in forage rather than any issues with elevated selenium. In this article entitled “Preparing for calving season” the agricultural extension officer notes the following:

> In many areas of the Midwest, Selenium is deficient in the soil. As a result, pasture, hay, and grains that are grown from Midwestern soils will share the deficiency. As a herd manager, one option to consider is providing higher levels of Selenium in your mineral supplementation program to alleviate deficiency problems. Injectable products, such as Mu-Se, provide supplemental Selenium along with vitamin E. It is recommended that Selenium and vitamin E both be supplemented to guard against Selenium deficiency.

A second article by the same author[22] states:

> Selenium deficiency is a problem in Illinois. Selenium and Vitamin E are generally used in conjunction to supplement against Se deficiency.

[19] In contrast, in the western US, selenium accumulation into plants consumed by livestock has long been a concern (USGS 2018). Selenium can become elevated in forage within areas where there is relatively high selenium in soil and there are plants that are highly effective in accumulating selenium. The main areas with elevated selenium in the West can be found in North and South Dakota, Montana, Wyoming, Colorado, and Utah (USDA 2018). USDA 2018. Irrigation and Water Management data now available https://www.nass.usda.gov/Newsroom/archive/2019/11-13-2019.php

[20] https://www.nrcs.usda.gov/wps/portal/nrcs/il/technical/landuse/pasture/nrcs141p2_030620/

[21] Meteer 2017. Orr Agricultural R&D Center. University of Illinois at Urbana-Champaign. College of ACES. Preparing for Calving Season. Available at: https://extension.illinois.edu/blogs/cattle-connection/2017-01-23-preparing-calving-season

[22] Meteer 2016. Orr Agricultural R&D Center. University of Illinois at Urbana-Champaign. College of ACES Minding Your Minerals. Available at: https://extension.illinois.edu/blogs/cattle-connection/2016-03-22-minding-your-minerals

Selenium is often added to livestock feed as a nutritional supplement in many locations in the US and is subject to Food and Drug Administration regulations.[23] Without indications that selenium is elevated in forage crops in Illinois, and/or indications that there is continuous irrigation that could result in elevations, setting the Class I and Class II standard for selenium at 0.02 mg/l, lower than the MCL, lower than the previously established 0.05 mg/l standard derived based on livestock watering, and lower than the standard in effect in all neighboring states with similar agricultural economies, is inappropriate.

2.3 Conclusions Regarding Proposed Selenium Standards

Use of a standard based on protection of livestock consuming forage does not seem reasonable given the lack of evidence of an issue or concern regarding selenium in forage in Illinois and the identified need for selenium as a supplement in livestock feed. Further, IEPA previously used the same technical basis to support the current 0.05 mg/L standard for selenium, stating that continuous irrigation was not used in Illinois. The USEPA (1972) also identified the 0.02 mg/L irrigation standard as appropriate for fine textured neutral or alkaline soils, but data reviewed indicates that soils in Illinois are typically acidic. That recommendation was also one that was provided "until greater information is obtained," and significantly, the studies conducted to support the 0.02mg/L value are based on areas with soils and irrigation practices that are very different than Illinois. A Class I and Class II standard of 0.05 mg/L for selenium is more appropriate. It is consistent with the selenium MCL of 0.05 mg/L used in other states and the livestock watering based-limit previously established by the Board.

[23] https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm?fr=573.920

3. FLUORIDE

IEPA proposes Class I and Class II values of 2 mg/l for fluoride with a stated basis of protecting tooth mottling in livestock through drinking groundwater. For the reasons provided below, the Board should keep the current fluoride standard of 4 mg/L.

3.1 Proposed Standards in Comparison with Other Federal and State Regulatory Standards

USEPA has an MCL and MCLG[24] of 4 mg/L for fluoride. States neighboring Illinois have all applied the MCL of 4 mg/L as their enforceable standard for fluoride. The neighboring states all have significant agriculture, but none were identified with standards for fluoride based on protection of livestock watering.

3.2 The Proposed Fluoride Threshold of 2 mg/L for Protection of Livestock Is Unsupported

The reference provided by IEPA for the fluoride threshold of 2 mg/L for protection of livestock is USEPA (1972). USEPA (1972) indicates that the standard for fluoride of 2 mg/L is based on protection of livestock *consuming groundwater as drinking water* and is intended to be protective against tooth mottling, a cosmetic dental effect in livestock. USEPA (1972) indicates that some fluorosis (tooth mottling) may occur in livestock teeth at this level but that other adverse effects would not be expected. USEPA (1972) notes that where adverse health effects had been noted in livestock the concentration of fluoride in the water was much higher than the 4 mg/L MCL stating:

> Chronic fluoride poisoning of livestock has, on the other hand, been observed in several areas of the world, resulting in some cases from the consumption of waters of high fluoride content. These waters come from wells in rock from which the element has been leached, and they often contain 10-15 mg/L.

In suggesting a standard of 2 mg/L to protect against tooth mottling in livestock, USEPA (1972) notes that much higher concentrations can be ingested without adverse effects:

> It appears, however, that as little as 2 mg/L may cause tooth mottling under some circumstances. *At least a several-fold increase in its concentration seems, however, required to produce other injurious effect*. [emphasis added].

Thus, both the USEPA (1972) document relied on by IEPA and more recent documentation indicate that adverse effects on livestock occur at concentrations greater than even the MCL and current Board-promulgated Class I and Class II standard of 4 mg/L. While fluoride has not been identified as an essential nutrient, the benefits of fluoride in promoting strong teeth are well established (NIH 2022).[25]

3.3 Conclusions Regarding Proposed Standards for Fluoride

The federal MCL of 4 mg/L is the enforceable national standard drinking water standard for fluoride. Surrounding states have adopted the MCL and do not have a lower standard to protect livestock that consume drinking water. The 2 mg/L proposed standard does not appear to provide a clear public

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[24] USEPA 2022. National Primary Drinking Water Regulations. Available at: https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations

[25] National Institutes of Health NIH 2022. Fluoride Fact Sheet for Health Professionals. https://ods.od.nih.gov/factsheets/Fluoride-HealthProfessional/

health or agricultural benefit beyond that of the MCL of 4 mg/L. Specifically, while it may provide aesthetic benefit to livestock, it does not otherwise provide further protection to their health or wellbeing. Accordingly, the Board should keep the current Class I and Class II standard of 4 mg/L for fluoride.

4. MOLYBDENUM

The proposed Class I value for molybdenum of 0.019 mg/L is new (i.e. there it is no current standards for molybdenum in 35 Ill Admin. Code Part 620). While there is no MCL for molybdenum, the proposed standard is much lower than the regional screening level value for molybdenum of 0.1 mg/L. The proposed Class I value was derived using the updated HTTAC equation in IEPA's proposed Appendix A and a relative source contribution (RSC) factor of 0.2. For the reasons provided below, the Board should adopt a Class I standard of no lower than 0.1 mg/L for molybdenum. The proposed Class II value for molybdenum, also new, is 0.05 mg/L and is intended to protect livestock that may consume forage from land irrigated with groundwater containing molybdenum. For the reasons provided below, a Class II standard for molybdenum is not necessary.

4.1 Proposed Standards in Comparison with Federal and State Regulatory Standards

There is no federal MCL for molybdenum, and no neighboring states have been identified with an enforceable molybdenum standard.

4.2 The Proposed Class I Value for Molybdenum Is Inappropriate

The toxicity value used to derive IEPA's proposed molybdenum standard is based on a 1992 review of an older (1961) flawed epidemiologic study. As IEPA has acknowledged, more current and reliable toxicity information regarding molybdenum is available through the ATSDR. As further explained below, while the USEPA-derived hierarchy used by IEPA to determine toxicity values for constituents where proposed Appendix A of Part 620 is used gives preference to IRIS values over ATSDR values, USEPA has also explained that the most current, credible, and relevant peer reviewed studies should not be ignored.

IEPA's proposal does not rely upon the most current and reliable toxicity values. Using the more current and reliable values would result in a standard of 0.2 mg/L under the HTTAC formula in proposed Appendix A. Nonetheless, recognizing that IEPA has already set a molybdenum standard of 0.1 mg/L in other programs that apply to a large amount of groundwater in Illinois (*see* 35 Ill. Adm. Part 845.600), I would recommend setting a similar standard here.

4.2.1 IEPA Selection of Toxicity Values

IEPA uses the following USEPA (2003)[26] hierarchy in selecting toxicity values when utilizing proposed Appendix A to derive a Class I standard: 1) RfDs from the USEPA IRIS files; 2) RfDs derived by USEPA as Provisional Peer Reviewed Toxicity Values (PPRTV); and 3) Other toxicity values. The USEPA (2003) hierarchy also identifies the objective of relying on the best available science rather than a rote reliance on the hierarchy stating:

> "This revised hierarchy recognizes that EPA should use the best science available on which to base risk assessments."

The USEPA (2003) document that lays out the hierarchy also notes that:

[26] USEPA (2003) Human Health Toxicity Values in Superfund Risk Assessment. Available at https://semspub.epa.gov/work/HQ/163525.pdf

> "EPA recognizes that there may be other sources of toxicological information. As noted in the December 1993 memorandum entitled "Use of IRIS Values in Superfund Risk Assessment" (OSWER Directive 9285.7-16, December 21, 1993):
>
> "…IRIS is not the only source of toxicology information, and in some cases more recent, credible and relevant data may come to the Agency's attention. In particular, toxicological information other than that in IRIS may be brought to the agency by outside parties. Such information should be considered along with the data in IRIS in selecting toxicological values; ultimately the Agency should evaluate risk upon its best scientific judgement and consider all credible and relevant information available to it."

Thus, while IRIS is the Tier 1 source for toxicity values, USEPA acknowledges that it is not the only source, and that other more recent data may represent the best available science and should be considered when selecting a toxicity value.

4.2.2 The RfD for Molybdenum Is Not Representative of Toxicity and More Representative Values Are Available

The Class 1 groundwater standard for molybdenum was derived using the USEPA IRIS file chronic RfD of 0.005 mg/kg-day. The USEPA 1992[27] IRIS RfD is based on a study of people in an Armenian village where molybdenum concentrations in water and food were elevated (Koval'skiy *et al*. 1961).[28] A lowest-observed-adverse-effect level (LOAEL) of 0.14 mg/kg-day was identified as associated with elevated uric acid levels in urine in comparison with people in the control group. USEPA derived the chronic RfD of 0.005 mg/kg-day through application of a total uncertainty factor of 30 including: a UF of 3 used for protection of sensitive human populations; and a factor of 10 for the use of a LOAEL, rather than a no-observed-adverse-effect level (NOAEL). USEPA notes that the RfD is "only slightly above the ESAADI [Estimated Safe and Adequate Daily Intake] which was derived from the molybdenum content of the average U.S. diet."

More recent and well-founded toxicity values derived to be protective of human health following oral exposure are available for molybdenum, which should be considered in setting the Class 1 groundwater values. These include the 2020[29] intermediate duration oral MRL of 0.06 mg/kg-day and the ECHA DNEL of 3.4 mg/kg-day[30].

ATSDR (2020)[31] reviewed the available data including the study relied upon by USEPA for the IRIS RfD and derived an intermediate duration oral MRL of 0.06 mg/kg/day based on a NOAEL of 17 mg/kg/day identified in a 13-week study in Sprague-Dawley rats (Murray *et al.* 2014).[32] This study also identified a LOAEL, including reduced body weights and kidney effects in rats treated, at 60 mg/kg-day. ATSDR derived the MRL by dividing the NOAEL of 17 mg/kg-day by an UF of 100 and a modifying factor (MF)

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[27] USEPA 1992. Integrated Risk Information System (IRIS) file on Molybdenum CASRN 7439-98-7 | DTXSID1024207 https://iris.epa.gov/ChemicalLanding/&substance_nmbr=425

[28] Koval'skiy, V.V., G.A. Yarovaya and D.M. Shmavonyan. 1961. Changes of purine metabolism in man and animals under conditions of molybdenum biogeochemical provinces. Zh. Obshch. Biol. 22:179-191. (Russian trans.) Not seen as reported in USEPA

[29] Agency for Toxic Substances and Disease Registry (ATSDR) 2020. Toxicological Profile for Molybdenum Available at www.atsdr.cdc.gov/toxprofiles/tp212.pdf

[30] European Chemicals Agency (ECHA) Molybdenum EC number: 231-107-2 | CAS number: 7439-98-7 https://echa.europa.eu/registration-dossier/-/registered-dossier/15524/7/1

[31] Agency for Toxic Substances and Disease Registry (ATSDR) 2020. Toxicological Profile for Molybdenum. Available at www.atsdr.cdc.gov/toxprofiles/tp212.pdf

[32] Murray FJ, Sullivan FM, Tiwary AK, et al. 2014a. 90-Day subchronic toxicity study of sodium molybdate dihydrate in rats. Regul Toxicol Pharmacol 79:579-588. https://europepmc.org/article/med/24041747

of 3 including the following: an UF of 10 for extrapolation from animals to humans; a UF of 10 for human variability; and a MF of 3 for concern that reproductive and/or developmental effects may be a more sensitive endpoint than kidney effects in populations with marginal copper intakes. ATSDR (2020) indicates that the MRL has already accounted for dietary intake stating that the MRL was derived assuming "healthy dietary levels of molybdenum and copper and represents the level of exposure above and beyond the normal diet".

ATSDR (2020) evaluated the available data and concluded data were inadequate to derive a chronic MRL. Specifically, ATSDR commented on the Koval'sky *et al.* (1961) used by USEPA to derive the chronic RfD. ATSDR stated:

> The study has a number of deficiencies that limit the interpretation of the results: (1) the control group consisted of 5 individuals compared to 52 subjects in the exposed group; (2) no information was provided on the controls to assess whether they were matched to the exposed group; (3) it does not appear that the study controlled for potential confounders, such as diet and alcohol, which can increase uric acid levels; and (4) NAS (2001) noted that there were potential analytical problems with the measurement of serum and urine copper levels (ATSDR 2020).

Thus, the recent review by ATSDR (2020) incorporates additional studies beyond those available to USEPA in deriving the IRIS RfD. Consequently, the MRL derived by ATSDR (2020) represents an updated and reliable source to derive a health-based standard for molybdenum.

The ECHA derived a chronic oral DNEL of 3.4 milligram per kilogram of body weight per day based on the same study used by ATSDR to derive the MRL (Murray *et al.* 2014; Hoffman 2011)[33]. ECHA derived this DNEL by dividing the NOAEL of 17 mg/kg/day by an assessment factor of 5 to account for variability within human populations. No adjustment factors were applied for sub-chronic to chronic exposure in the study because other investigations (National Toxicology Program (NTP) 1997 inhalation study[34]) demonstrated no increase in systemic toxicity for 13 weeks or two years. No adjustment factor was applied for interspecies (rodent to human) because absorption is demonstrated to be nearly complete in both rodents and people.[35] Thus the 57-fold difference between the ATSDR intermediate oral MRL of 0.06 mg/kg-day and the ECHA chronic oral DNEL is due to the use of different uncertainty factors in deriving the toxicity value from the NOAEL. The ECHA file also determined that no further adjustments would be needed to account for the use of a sub-chronic study based on the findings from the NTP inhalation study.

ECHA toxicity values consist of comprehensive and up-to-date analyses that can inform the selection of toxicity data. At the time that the USEPA (2003) memo was written, European resources were not nearly as well developed as they are now. After a tremendous effort to develop appropriate andrepresentative toxicity values for use in the European Union's (EU) REACH regulations. ECHA can serve as "more recent, credible and relevant data" in the case of molybdenum.

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[33] Hoffman, 2011 Study No. 10-2225 Sodium molybdate dihydrate: A 90-day Oral Dietary Administration study in Rats (GLP) Final Report. Available at: https://www.molybdenumconsortium.org/assets/files/Pennsylvania/Exhibit%20E%20to%20Comments%20-%2090-Day%20Oral%20Dietary%20Study.pdf

[34] NTP. 1997. Toxicology and carcinogenesis studies of molybdenum trioxide in F344/N rats and B6C3F1 mice (inhalation studies). Research Triangle Park, NC: National Toxicology Program. TR263. https://ntp.niehs.nih.gov/ntp/htdocs/lt_rpts/tr462.pdf

[35] European Chemicals Agency (ECHA) Molybdenum EC number: 231-107-2 | CAS number: 7439-98-7 available at: https://echa.europa.eu/registration-dossier/-/registered-dossier/15524/7/1

Finally, the Wisconsin Department of Public Health used the ATSDR intermediate oral MRL of 0.06 mg/kg/day to derive a recommended water guideline of 0.06 mg/L based on consumption of 1 liter of water a day by a 10 kg child and a RSC of 10.[36] Although it is not stated in the recommended guideline, the Wisconsin Statutes identify use of a 10-fold uncertainty factor to adjust from a sub-chronic study in evaluating chronic effects.[37] The Wisconsin Department of Public Health noted that the ATSDR MRL was a more appropriate basis for their recommendation due to flaws in the Koval'sky *et al.* (1961) study used to derive the IRIS RfD.

Accordingly, in the case of molybdenum, it is more appropriate to use the ATSDR MRL as the toxicological value. It consists of more current and reliable data than used for the IRIS RfD. ECHA and Wisconsin both relied on the same underlying data as ATSDR to derive health-based standards for molybdenum and the Board should do the same.

4.2.3 Essential Nutrient Status of Molybdenum

Molybdenum is an essential nutrient required for growth in most plants and animals and has a recommended daily intake of 17 ug/day for children ages 1-3 and 22 ug/day for children ages 4-8 years (ATSDR 2020)[38]. The proposed threshold value for molybdenum would be equivalent to 15 ug/day for a child under the age of 6 consuming 0.78 liters of water a day (i.e., 19 ug/L x 0.78 L consumed), which is less than the essential nutrient level. The fact that the water standard would result in an intake lower than the level required as an essential nutrient points to the conservatism of the approach and indicates it more conservative than needed to protect public health.

4.2.4 Conclusions Regarding Class I Standard for Molybdenum

Data reviewed for molybdenum including information on toxicity, dietary intake, and essential nutrient status all indicate that that the proposed Class I standard is lower than needed to be protective of public health. The Class I standard for molybdenum of 0.0019 mg/L is based on an IRIS value developed in 1992 that was derived from a 1961 study that has significant limitations as identified by ATSDR (2020) and by the Wisconsin Department of Health. The ATSDR (2020) intermediate MRL of 0.06 mg/kg/day is a much more current analysis that incorporates studies conducted since the 1991 USEPA IRIS data review and ultimately relies on the same study in rats (Murray *et al.* 2014) that was also relied on by the European Union's Reach program to derive a chronic DNEL value of 3.4 mg/kg/day. The ECHA analysis determined that no further adjustment was needed to use a subchronic study as the basis of evaluating chronic exposures because there were no further effects observed following additional exposure.

Although there is no stated plan for USEPA to update the IRIS RfD for molybdenum, such updates do periodically occur and if an update were conducted, the Murry *et al.* (2014) study would be expected to be a key study used to derive an updated RfD as it provides valuable updated information that was not available for the 1991 review.

The updated data and analyses together with the essential nutrient status of molybdenum suggest that the proposed standard is unnecessarily stringent. It would be appropriate for the Board to apply the ATSDR intermediate oral MRL of 0.06 mg/kg-day as the basis for the Class I criteria. As noted by the ECHA review, no adjustment to the intermediate MRL is needed to account for long term exposure

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[36] Wisconsin Department of Health Recommended Public Health Groundwater Quality Standards WDPH 2022 at: https://www.dhs.wisconsin.gov/publications/p02434v-2.pdf

[37] Wisconsin Legislature: NR 105.07

[38] ATSDR 2020 Toxicological Profile for Molybdenum available at; https://www.atsdr.cdc.gov/ToxProfiles/tp212.pdf

due to the fact that no further adverse effects were seen in other long-term exposure studies. A Class I standard based on the ATSDR intermediate duration MRL of 0.06 mg/kg/day, when used in IEPA's proposed new HTTAC formula in Appendix A results in a molybdenum value of 0.2 mg/L as being protective of public health. Accordingly, IEPA's proposed Class I standard of 0.019 mg/L is unnecessarily stringent and a higher standard is more appropriate. While a health-based Class I standard of 0.2 mg/L is appropriate for molybdenum, I understand a groundwater molybdenum standard of 0.1 mg/L exists in Illinois in other regulatory contexts. For consistency between programs, the Board may wish to set a similar Class I standard for molybdenum in Part 620; however, there is no demonstrated need for a health-based standard to be any lower.

4.3 The Class II Standard for Molybdenum of 0.050 mg/L Based on Irrigation Is Unnecessary for Illinois Agriculture

This review has determined that a Class II standard for molybdenum is not needed to protect grazing livestock in Illinois. But if the Board believes a Class II standard is necessary, there is no need to set it at a level lower than the Class I standard I have recommended of 0.1 mg/L.

IEPA has proposed a Class II standard of 0.05 mg/L for molybdenum, identified as protective of livestock that forage on irrigated crops, as proposed in USEPA (1972), which relies on earlier studies.[39] USEPA (1972) identifies the 0.05 mg/L irrigation advisory as recommended for "short-term use on soils that react with this element." IEPA did not provide further information regarding the applicability of this standard for Illinois agriculture, e.g., whether soils would be expected to react to molybdenum and review of studies relied on by USEPA (1972) and other data reviewed here indicate that molybdenum is unlikely to be an issue for Illinois agriculture.

Kubata (1975),[40] one of the authors cited by USEPA (1972 [Kubuta *et al.* 1963]), identifies the geographic distribution of areas where molybdenum concentrations are toxic for grazing animals in five western states[41]. Kubota (1975) did not include Illinois or other Midwestern states with soils similar to Illinois. Bingham *et al.* (1970), cited by USEPA (1972), describes high molybdenum in forage occurring in a county in California where soils have unusually high salinity and also high metals including molybdenum.

Similarly, Jensen and Lesperance (1971), cited by USEPA (1972), indicate that molybdenum toxicity to grazing animals is a problem "of economic importance in the US and in various other parts of the world" and further indicates that: "In the United States the problem is severe in parts of Nevada and California and in isolated valleys of Colorado." These authors also state that: "Forages that contain high levels of· Mo are found in areas (a) where soils are alkaline, (b) adjoining rivers, lakes, and sinks, and where drainage is poor and water tables are high, and (c) where drainage usually covers granite rather than volcanic mountain areas." Molybdenum toxicity occurs primarily in the Western US, due to naturally occurring levels in soil and soil characteristics. Molybdenum is

[39] Lesperance, A. L. and V. R. Bohman (1963), Effect of inorganic molybdenum and type of roughage on the bovine.]. Amm. Scz. 22(3):686-694
Dye, W. B. and J. L O'Hara (1959), Molybdosis. Nevada Agr. Exp. Sta. Bull. 208, 32 pp.
Jensen, E. H. and A. L. Lesperance (1971), Molybdenum accumulation by forage plants. Agron. J. 63(2)·201-204.
Kubota, J., E. R. Lemon, and W. H. Allaway (1963), The effect of soil moisture content upon the uptake of molybdenum, copper, and cobalt by alsike clover. Sozl Scz. Soc. Amer. Proc. 27(6) :679-683.
Bingham, F. T., R. J. Arklcy, N. T. Coleman, and G. R. Bradforcd (1970), Characteristics of 1'igl1 boron soils in western Ken County. Hilgardza 40(7):193-204.

[40] Kubota, J. Areas of molybdenum toxicity to grazing animals in the western states. United States: N. p., 1975. Web. doi:10.2307/3897768

[41] Kubota 1975 identifies Washington, Idaho, Montana, Wyoming, and Colorado as states with "relatively extensive areas producing forage plants with 10 to 20 ppm or more of Mo, levels well within the toxic range for grazing animals" This article goes on to state that these areas represented "all of the areas of high MO presently recognized in this country with the exception of the Florida Everglades".

more readily absorbed in alkaline soils (Kaiser *et al.* (2005))[42] and as described above for selenium, Illinois soils tend to be mildly acidic or neutral, while high salinity soils, mineralized soils and soils with a higher pH are more common in the Western US.

Ultimately, the studies used as a basis for the proposed Class II molybdenum standard are not based on areas representative of Illinois agriculture. Given the differences in soil conditions in Illinois in comparison with locations where molybdenum has been identified as a problem in irrigated forage consumed by livestock, molybdenum would not be expected to be a problem in Illinois livestock.

Review of Illinois agricultural extension publications did not identify any articles describing elevated molybdenum in forage crops and resulting toxic effects in livestock in Illinois. In contrast, some indications were found regarding molybdenum deficiencies in plants in certain Illinois settings. The Illinois Agronomy Handbook notes that molybdenum deficiencies can be an issue for soybeans grown in acidic strongly weathered soils,[43] and an article from the University of Illinois extension indicates molybdenum deficiencies can occur in fruit trees on acidic soils[44]. However, another article from the University of Illinois notes that molybdenum deficiencies are extremely rare in Illinois[45]. No indications were found of issues with livestock and molybdenum toxicity in Illinois and as described above molybdenum is an essential nutrient for livestock with a role in metabolism and growth[46]. Given these considerations, no Class II standard has previously been set for molybdenum, and, given the lack of impact reasons noted above, there appears to be no evidence suggesting a need for one now.

4.3.1 Conclusions Regarding Proposed Class II Standard for Molybdenum

Considering the Class II standard for molybdenum of 0.05 mg/L to protect against effects on livestock related to molybdenum in forage, available evidence does not suggest the need for a standard to protect against this endpoint in Illinois. Without this evidence of potential harm, the regulation creates a burden without a clear benefit. If the Board insists on setting a Class II standard for molybdenum, it should be set no lower than 0.1 mg/L. This is the limit is consistent with the molybdenum standard in other groundwater regulatory contexts in Illinois (see 35 Ill. Adm. Code § 845.600).

[42] MKaiser BN, Gridley KL, Ngaire Brady J, Phillips T, Tyerman SD. The role of molybdenum in agricultural plant production. Ann Bot. 2005 Oct;96(5):745-54. doi: 10.1093/aob/mci226. Epub 2005 Jul 20. PMID: 16033776; PMCID: PMC4247040.

[43] Fernandez and Hoeft Managing Soil pH and Crop Nutrients. Chapter 8 in Illinois Agronomy Handbook http://extension.cropsciences.illinois.edu/handbook/pdfs/chapter08.pdf

[44] University of Illinois Extension 2016. Fruit and Vegetable News. Available at: http://ipm.illinois.edu/ifvn/contents.php?id=6

[45] University of Illinois Urbana-Champaign. College of Agricultural, Consumer & Environmental Sciences. A short course in secondary macronutrients and micronutrients. Available at: https://aces.illinois.edu/news/short-course-secondary-macronutrients-and-micronutrients

[46] MSD Manual Veterinary Manual. Etiology of Molybdenum Toxicity in Animals. Available at: Molybdenum Toxicity in Animals - Toxicology - MSD Veterinary Manual (msdvetmanual.com)

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Principal Consultant

Ms. Lisa Yost is a board-certified toxicologist with more than 30 years of experience assisting clients assessing human health risks related to exposure to a variety of chemical substances in environmental media (soil, water, and in fish, shellfish, game, and home-grown foods) in the workplace or within consumer products. She has conducted or supervised risk assessments under CERCLA, RCRA or state-led regulatory contexts, assisting clients in negotiations with regulatory staff to develop and apply sound technical approaches that realistically characterize potential risk and meet environmental and business objectives. She has directed project teams comprised of colleagues, consultants, regulatory staff and academic researchers working to develop coordinated strategies addressing human health concerns.

Ms. Yost has extensive experience crafting culturally relevant public health messages directed to diverse technical and non- technical audiences. She has provided technical support for litigation and detailed toxicological evaluations of numerous chemicals and chemical classes, including polychlorinated dibenzo- p-dioxins and furans (PCDD/Fs), polychlorinated biphenyls (PCBs), pesticides, trichloroethylene (TCE) and other solvents, mercury, arsenic, selenium and other metals. Ms. Yost serves as the volunteer chair of the Minnesota Department of Health Environmental Health Tracking and Biomonitoring Advisory Panel with responsibilities for providing input to the Department of Health on biomonitoring priorities and strategies including planned design of monitoring for pesticide exposures.

CONTACT INFORMATION

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PROFESSIONAL AFFILIATIONS AND ACTIVITIES

Society of Toxicology

Northland Society of Toxicology

Invited Member and Chair, Advisory Counsel to the Minnesota Department of Health Environmental Tracking and Biomonitoring

CREDENTIALS AND EDUCATION

Diplomate, American Board of Toxicology (DABT)

(certified in 1990; recertified in 1995, 2000, 2005, 2010, and 2015)

1980
Master of Public Health, Environmental and Industrial Health
University of Michigan, Ann Arbor, MI, United States

1977
BS, Botany
Miami University, Oxford, OH, United States

PROJECTS

Metals

- Providing ongoing human health risk assessment support for the Elk Valley Water Quality Plan (EVWQP) conducted under an order from the British Columbia Ministry of Environment. The EVWQP is an area-based management plan to address current water quality trends for selenium, cadmium, nitrate, and sulphate and calcite formation. Conducted analyses of the amount of background selenium intake in the diet and assisted in developing the site exposure assessment in WebEx presentations with oversight from advisory groups including Provincial, Federal and First Nations representatives [2018-present, Canada-BC]
- Conducted a human health risk assessment for Herrington Lake in Kentucky to evaluate the need for cleanup of coal ash in a popular recreational lake. Fish consumption and contact with sediments were evaluated for metals including selenium and arsenic [2018 to 2021, USA KY].
- Evaluated human health risks associated with exposure to cadmium and thallium in home-grown vegetables within communities with varying levels of metal deposition from former smelting releases. [2013-2014, Canada-BC]
- Assisted investigation of arsenic intake in the diets of people within the area of Taiwan studied by EPA in deriving the cancer slope factor for arsenic. Dietary intake of inorganic arsenic was substantially higher than assumed by EPA, indicating the toxicity values overestimate arsenic toxicity. [USA-Wash. DC]
- Assisted in a comprehensive study to estimate exposure to inorganic arsenic in the diet. Used findings to establish the relative importance of the dietary sources in comparison with environmental exposures. This work was published in a peer reviewed journal. [USA-TX]
- Human health risk assessment in support of a permit application for reopening the A-J Gold Mine near Juneau, Alaska. [USA-AK]
- Human health risk assessment for Superfund site in Montana contaminated with arsenic, cadmium, and lead. Evaluated uncertainties associated with EPA's carcinogenic slope factor for arsenic. [USA-MT]
- Conducted an evaluation of the potential for arsenic in terrestrial plants to be detoxified by methylation to better characterize the risks associated with consumption of garden vegetables. [USA-MT]
- Assessed risks associated with arsenic in soil at the National Zinc Superfund site in Bartlesville, Oklahoma. Dietary intake estimates for arsenic suggested that the EPA carcinogenic slope factor may substantially overestimate risk. Considered bioavailability of arsenic in soil. [1996; USA-OK]
- Collaborated on design of a pilot-scale study to evaluate revegetation potential for severely disturbed and naturally unvegetated portions of a former asbestos mine. [1991, USA-CA]
- Collaborated on hazard assessment and exposure assessment for a lead-contaminated waste site in California. Prepared a case study of remediation options taken for similar sites in the state. [USA-C A]
- Acted as task manager in a review of the scientific basis for the EPA Office of Drinking Water standard for lead conducted for the American Association of Water Works. Critiqued the evidence used by EPA in supporting the target blood lead level of 10–15 mg/dL. [USA-Wash. DC]

1,4-Dioxane, Trichloroethylene, Other Solvents and Petroleum Products

- Conducted a human health risk assessment for indoor air in an operating facility in Minnesota with oversight by USEPA Region 5 and the Minnesota Pollution Control Agency [2016-2020, Fridley, MN]
- Worked with a Ramboll Environ group in analysis of 1,4-dioxane, which includes identification of the most technically supportable toxicity values for risk assessment of 1,4-dioxane at sites in the US, Canada and the EU. In this context, provided detailed comments

to the New Jersey Department of Environmental Protection on draft 1,4-dioxane drinking water standards. [2014 to 2015, Midland, MI].

- Worked with an ENVIRON group to comment on the 2012 EPA TSCA Workplan Chemical Risk Assessment for Trichloroethylene (TCE): Degreaser and Arts/Crafts Uses. Evaluated appropriateness of EPA's selected endpoints and points of departure (reproductive, developmental and kidney). [2012; USA-Wash. DC]
- Worked with a project team to conduct a hazard assessment of TCE under the EPA Voluntary
- Children's Chemical Evaluation Program (VCCEP) for an industry alliance. Conducted a weight of evidence evaluation of all cancer and noncancer endpoints for TCE. [2007-2009, USA Wash. DC]
- Provided toxicological, risk assessment and risk communication support for a client that detected TCE in workplace drinking water. Assisted in developing medical monitoring for children of workers. Addressed health questions at more than 60 meetings with former workers. [1999- 2008, USA-OR]
- Managed a project team that prepared a weight-of-evidence analysis of the carcinogenicity data for TCE. Derived appropriate target concentrations for TCE in indoor air and presented the approach in meetings with EPA Region 9 project managers and toxicologists. [2006-2008, USA- CA]
- Managed a project team of toxicologists and epidemiologists providing detailed comments on the EPA Risk Characterization Document for TCE issued in 2000. [2000, USA-Wash. DC]
- Managed a project to develop risk-based cleanup levels for a former bulk fuel terminal in Seattle, Washington. Presented the approach to risk assessment for the site at meetings with the Washington State Department of Ecology. [USA-WA]

Pesticides, PCBs, and Mercury

- Leading a human health risk assessment regarding PCBs in soils and sediments at a site in Minnesota [2019 to present, USA-MN].
- Working with a team deriving cleanup levels for PCBs, mercury and other metals in sediments resulting from historic reclamation activities at a large lake in Michigan [2019 to present, USA-MI].
- Conducted detailed toxicology evaluations of, 1,3-dichloropropene and 1,2-dichloropropane, for cases involving alleged exposures to fumigants from drift off of fields and from groundwater contamination. [2001-2003, USA-HI]
- Human health risk assessment of sites including a former gas-manufacturing plant with petroleum hydrocarbons in soil and groundwater; a former flower bulb treating facility with residual pesticides in soil and a manufacturing facility with solvents in groundwater and soil. [USA-OR]
- Assisted counsel for two separate school districts in addressing concerns regarding residual PCBs in dust or air related to use of caulk containing PCBs. Provided input on human health risk and safe exposure levels as well as providing talking points regarding PCB toxicity and risk communication presentations to concerned teachers and staff. [2013-to 2017, NYC and CA.]
- Identified protective concentrations for PCBs in indoor air in schools with PCBs in lighting ballasts and in caulk. Estimated a PCB air concentration representative of 'substantial endangerment' and identified ballasts as key source to indoor air. [2012-2015, USA-NY]
- Assisted in sampling approach and evaluation of EPA's public health levels for PCBs in indoor school air to ensure these values were protective of cancer and non-cancer endpoints for adults and children. Described risks of PCBs and protectiveness of approach to concerned stakeholders. [2013-Present, USA-CA]

- Worked with a team to assist counsel regarding likely current PCB concentrations in serum for individuals in various demographics that had no other known PCB exposures [2013-USA]
- Prepared an analysis of the representativeness of the current and a draft proposed reference dose for PCBs for PCB congener 209. Evaluation determined that PCB 209 was many-fold less toxic than the current or the proposed RfD. [2011; USA-Wash. DC]
- Assisted in design of analyses conducted in a flux-chamber a contract laboratory to measure mercury volatilization from synthetic or natural gypsum wallboard. Assisted in risk calculations conducted with mercury findings from flux chamber. [2006-2009, USA-GA]
- Assessed human health risks for worker exposure to PCBs in concrete joint compound in a flightline area for commercial aircraft, including inhalation and contact with surfaces. Findings indicated phased removal of PCB-containing material was both health-protective and practical. [2002-2008; USA-WA]
- Estimated human health risks for workers' and residents' potential exposure to PCBs present in the natural gas pipeline system on behalf of a trade association preparing comments to EPA regarding the Advance Notice of Proposed Rulemaking to modify the EPA Mega Rule for PCBs.[2010; USA, Wash. DC]
- Assisted EPA Region 2 on a risk assessment related to placement of lake sediments within an onsite sediment containment area. Prepared a hypothetical accident scenario and airborne exposure scenarios. Provided risk communication support at two public meetings. [2009-2010; USA, NY]
- Provided toxicological support in a sensitivity analysis of PCB risk assessments. These analyses identified components of the risk assessment method that have the greatest influence on PCB cleanup levels. [USA]

Human Health Risk Assessment – Dioxin in the Environment

- Assess human health risks related to exposure to dioxins and furans through soil or house dust including consideration of outdoor play frequency and location. Develop appropriate cleanup levels for residential and floodplain soils in Midland, Michigan and in the Tittabawassee River. [2006 –2020; USA-MI]
- Evaluated potential human health risks associated with dioxins and furans in fish and game collected from the Tittabawassee River floodplain area using intake estimated from UMDES. Considered findings relative to UMDES biomonitoring data and to fish and game consumption advisories. [2006 – 2020; USA-MI]
- Provided litigation support regarding dioxins and furans in soil and the food chain including fish and game. Prepared detailed analyses of underlying toxicological and epidemiological data and interpretation of biomonitoring data. The evaluation included the full suite of chemicals, including pesticides, other organic compounds, and metals, such as arsenic, mercury, and selenium. [2008-2011; USA-MI]
- Conducted technical review of human health risk assessment for dioxins and furans for the St. Elizabeth's West Campus. [2007, USA-Washington DC]
- Conducted supplemental Risk Calculations for dioxins and furans in soil at the Former Alaska Pulp Company Mill Facility were conducted to evaluate a potential land use change to partial residential use. [2004-2005; USA, AK]
- Lead a human health risk assessment dioxins and furans in soil and sediments for the former municipal solid waste incinerator in Sitka, Alaska. Issues included protecting sensitive Native American cultural resources and identifying representative risk estimates for fish consumption. [2002-2004; USA, AK]
- Lead toxicologist on a sediment investigation of former pulp and paper mill. Developed a protective and reasonable means to evaluate risks associated with exposure to dioxins

and furans in sediments, fish, and shellfish. Presented findings at several public meetings and availability sessions. [1996-2000; USA-AK]

- Human health risk assessment for upland of a former pulp and paper mill. Developed detailed uncertainty assessment for dioxins and furan toxicity values including consideration of relative exposure through background diet. Considered bioavailability in risk estimates for soil. [1996- 2001; USA-AK]
- Lead toxicologist on former wood- treatment facility that used PCP, creosote, and arsenical fungicides. Uncertainties in the dioxin slope factor and comparative risks associated with consumption of fish and crayfish from reference locations were key issues. [1990-1992; USA OR]
- Human health risk assessment for a hazardous waste site in a unique desert environment. Past releases included process sludge from pesticide (2,4-D) manufacturing with potential dioxin and furan contamination and other contaminants (2,4,5-T, TCE, and benzene). [1989-1990; USA OR]
- Developed educational materials, including seminars on PCBs, dioxin, and PCP; chronologies of the development of scientific knowledge on PCP, aromatic amines, and the dermal and cardiovascular effects of tetrachlorodibenzo-p-dioxin (TCDD); and exhibits. [1986-1989, USA- TX and MO]
- Reviewed toxicological and epidemiologic literature that investigated an association between exposure to TCDD and adverse effects on the cardiovascular system. Abstracted epidemiologic studies on dioxins and chlorinated phenoxy herbicides. [1986-1989, USA]

Litigation Support

- Provided expert opinions regarding PCB exposures in a school. Bard et al. v. Monsanto et al. Case No. 18-2-00001-7. Superior Court of Washington for King County [2018, 2021, USA-WA]
- Served as an expert for a power company in Ohio and prepared an expert report regarding human health impacts of thermal discharges to Ohio River (The Dayton Power and Light Company et al.v. Scott Nally Case Nos.13-296712; 13-256713; 13-576714; 13-316715; 13-776716; 13-256717; 13-666718). Presented the report at an ORSANCO meeting and was deposed regarding the report. [2014, USA-OH].
- Served as an expert on human health risk assessment of TCE in a litigation matter (Lawrence O'Connor, et al., Plaintiffs, v. Boeing North American, Inc., et al., Defendants Case No. CV 97-1554 DT (RCx)) involving cancer risks associated with downwind exposures to chemicals at a rocket testing facility. Prepared an expert report and was deposed regarding the potential TCE risks for downwind residents. [2005, USA-CA].
- Provided technical support to private clients in litigation regarding exposure in occupational and environmental settings. Conducted detailed reviews of experts' publications and depositions provided for plaintiffs in litigation regarding TCE and perchloroethylene in groundwater. [USA]
- Directed literature searches on 30 chemicals found in Love Canal, and prepared profiles on the health effects of several of these substances, including TCE, 1,1-dichloroethene, and perchloroethylene, in support of litigation. [USA, Wash, DC]
- Helped develop scientific testimony regarding scientific literature on the carcinogenic, respiratory, immunologic, and irritant effects of formaldehyde associated with exposure to levels similar to those measured in a plaintiff's home, in litigation involving exposure to formaldehyde in a new mobile home [1988, USA]

Air Toxics

- Lead development of a white paper to evaluate the state of the knowledge on elongate mineral particles (EMPs) including the fraction that are countable by NIOSH standards. This work was published in a peer reviewed journal [2014-2017, USA-MN]

- Conducted a risk assessment to consider risks associated with crysodolite asbestos focusing on the relative potency of various mineralogical types [2014-2016, USA]
- Assisted with identification of appropriate cleanup levels for lead in outdoor dust related to a lead refinery in Southern California. Key issues included protective means to estimate exposure and consideration of urban background concentrations. [2013-2014, USA-CA]
- Lead human health risk assessment and risk communication within environmental impact statement for release of PAHs, SO2 and fluoride from a planned aluminum refinery in Fjardaal, Iceland. With project team, presented findings to the Icelandic regulatory board [2006-2009, Iceland]
- Reviewed toxicological basis for Israeli proposed air quality criteria for methylene chloride and 12 additional chemicals including comparison with guidelines developed by other agencies worldwide. Made recommendations for modifications. [2006-2007, Israel]
- Managed an investigation and risk communication at a wood pulp processing facility in southwest Washington, where an accidental release of hydrogen sulfide, methyl mercaptan, and other mercaptans had resulted in temporary illness in a group of children [2001, USA-WA]
- Risk evaluation and characterization of formaldehyde in FEMA trailers used following a hurricane. [2006, USA-LA]
- Reviewed scientific literature on 26 respiratory toxins, conducted risk assessments on selected carcinogens, and maintained a database on more than 200 chemicals regulated under OSHA's Air Contaminant Rule. [1987, USA, WDC]
- Collaborated in the development of a unique system to rank more than 200 toxic chemicals carried by railroad for the risk of acute lethality and serious permanent health effects related to short-term airborne releases. Assisted in comments on DOT regulations. [1983-1987; USA-WDC]
- Reviewed and evaluated risks associated with airborne exposure to toxic chemicals, including lead, PCBs, and PCDDs and PCDFs expected from a municipal garbage incinerator that was planned for Essex County, New Jersey. [1982; USA-NJ]
- Reviewed the toxicological and epidemiologic data that investigated cardiopulmonary effects of carbon black. Prepared a report that was submitted to OSHA. [1986, USA WDC]
- Evaluated human health risks of asbestos inhalation from native serpentine rock within the Clear Creek Management Area, a popular dirt bike riding area. Quantified uncertainties in EPA's unit risk factor for asbestos and identified representative exposure variables. [1990-1992; USA-CA]
- Reviewed a risk assessment associated with a former asbestos mine. A key issue was relevance of increased incidence of benign tumors in experimental animals to predict excess cancer risks in human populations. [1991; USA-CA]
- Evaluated the epidemiologic and toxicological literature on the health risks of ingested asbestos for a public water utility. Evaluated effects of weathering in water as a mechanism for the reduction in the carcinogenic potency of ingested versus inhaled asbestos. [1987, USA-CA]
- Prepared a chronology of the state-of-the-art industrial hygiene approaches for asbestos from 1900-1988. Directed review of epidemiologic literature on asbestos and mesothelioma and lung cancer, and prepared an evaluation of potential alternative causes of mesothelioma. [1988; USA- WDC]
- Prepared a case study on the health issues and the legislative and regulatory history of the use of asbestos insulation in school buildings nationwide as part of standard setting for a utilities cooperative in Minnesota. [1982, USA-MN]

Product Safety

- Worked with a project team to draft a manuscripts regarding the effectiveness of a quaternary ammonium product in inactivating SARS-CoV-2. [2021 to present, Saint Paul, MN.]
- Worked with project team to assess data on the frequency of hand-washing among restaurant workers. Analyses will be helpful in evaluation of exposure to antimicrobial agents in hand washing. [2018-2021, Saint Paul, MN.]
- Worked with project team to assess data on the frequency of hand-washing among health care workers. Analyses will be helpful in evaluation of exposure to antimicrobial agents in hand washing. Work was published in 2018. [2016-2018, Saint Paul, MN.]
- Assessed human health risks associated with exposure to chloroxylenol as an active ingredient in dishwashing soap and liquid hand soaps as used by consumers and health care professionals. Attended strategy meetings with client and discussed approach at FDA. Presented findings of this work at SETAC and published the work in 2016. Worked with team on designing additional research to address FDA data needs [2014 to 2017; USA, Wash. DC]
- Evaluated potential human health exposure pathways related to trace metals in residential wallboard made of either natural (mined) or synthetic gypsum generated via flue-gas desulfurization (FGD) within coal-fired power plants (FGD gypsum). Published these findings [2006-2009, USA-GA]
- Managed and directed two risk assessment reports on human consumer uses and ecological risks under the Registration, Evaluation, Authorization and Restriction of Chemical substances (REACH) system. In this context, coordinated preparation of Chemical Safety Reports [2009-2011, USA, MI]
- Assessed arsenic in rock products with higher than typical background concentrations. Estimated potential exposure during mining or use including consideration of bioavailability of arsenopyrite. Summarized regulatory standards [2009, USA-NY, NJ, GA, FL, SC and Canada New Brunswick]
- Assessed the potential for use of a consumer product to result in allergic contact dermatitis. Product chemical constituents were reviewed and where indications of irritation or photosensitization were identified, the context and relevance of these findings was evaluated. [2008, USA]
- Assessed potential exposures to lead from a toy with a small surface area containing paint exceeding the Consumer Product Safety Commission (CPSC) levels for lead. Estimated lead exposures resulting from handling and from unintended uses by young children, e.g. mouthing. [USA]
- Served on a project team providing detailed comments to EPA regarding the use of copper chromated arsenical (CCA) pesticides as wood preservatives. Participated in strategy meetings, drafted comments, and coordinated research into exposure aspects of the assessment. [2001; USA, Wash. DC]
- Assessed exposure and health risks of leaching of metals (e.g., nickel, chromium, cobalt, iron, neodymium, tungsten) from alloys used in an implanted medical device. Considered potential device failures and conducted assessments in support of FDA submissions. [2008-2009, USA-MN]
- Human health risk assessment of the use of formaldehyde to sterilize storage areas in the production of sugar beets. Evaluated all potential exposure pathways related to this use including potential concentrations in the final product and in residual biomass used in feeding cattle. [USA]
- Reviewed the technical merits of claimed asbestos exposure in workers who had handled asbestos-containing gaskets during fabrication, installation, removal (scraping and wire brushing), and replacement activities. [2006, USA]

Human Health Risk Assessment and Fish Consumption Advisories

- Evaluated human health risks associated with PCBs and mercury in sediments, fish, shellfish, and clapper rail for former LCP facility in Brunswick, Georgia as part of feasibility study and site remedial planning. [2005-2015; USA-GA]
- Provided technical support for Michigan client regarding fish consumption advisories and their relationship with risks associated with fish consumption as represented in a population based consumption survey. Worked with project team to develop sampling strategy to monitor fish contaminants in consumed species. [2006 to 2019, USA-MI].
- Assessed human health risks associated with exposure to Triclosan in the aquatic environment. Key issues include identification of an appropriate toxicity value for Triclosan and representative fish consumption rates. Published this work in a peer reviewed journal. [2014-2016, USA-MN]
- Evaluated potential health risks related to lead, arsenic and other metals (including selenium) in fugitive dust released along an ore haul road and port facility. Evaluated risks related to subsistence consumption of local foods including fish, game, and berries. Presented approach at a public meeting in a remote Inuit village and addressed questions. [2002-2006, USA-AK]
- Evaluated the potential for arsenic to accumulate into seafood for a client considering redevelopment of property on the Duwamish River in Washington. Lack of typically consumed shellfish and the methylation status of arsenic in popularly consumed finfish were key issues. [2000-2001, USA-WA]
- Conducted a human health risk assessment to evaluate potential effects of mercury and PCBs in sediments and in fish within an urban lake in New York State. Detailed analysis of toxicity data for methylmercury and PCBs and selection of a representative fish consumption rate were critical issues. [2000-2004; USA, NY]
- Provided technical review of human health risk aspects of the RI/FS for the Lower Duwamish Waterway Superfund site focusing largely on identification of appropriate and representative fish consumption rates for recreational anglers and for Native American anglers. Participated in meetings with representatives from a group of potentially responsible parties and assisted in negotiations with the regulatory agencies. [2001-2003, USA-WA]

Regulatory Evaluation and Detailed Exposure Assessment

- Worked with a project team in the US and Israel to provide detailed analysis of the regulatory process in Michigan as regulated by Michigan law and regulations from the State of Michigan Environment, Great Lakes and Energy Department. [2021 USA, MI]
- Was selected to serve on a Technical Advisory Group providing input on selection of toxicity values as part of the Michigan: *Part 201: Stakeholder Recommendations for Updating Michigan's Generic Cleanup Criteria* [2013-2014, USA, MI]
- Providing input to the Navajo EPA regarding exposure analysis and the overall approach to risk assessment at sites in New Mexico. [2021 to present USA, NM]
- Collaborated on a preliminary risk assessment that evaluated the human health risks for workers and residents associated with exposure to TCE, arsenic, and PCBs in material used as fill in construction of a roadway in Anchorage, Alaska. [1990; USA-AK]
- Managed a program providing technical enforcement support to EPA Region 10 on a wide range of sites regulated under CERCLA or RCRA. Managed multidisciplinary technical reviews of RI/FS project documents, including risk assessments, site inspections, sampling and analysis plans, quality assurance project plans, and work plans. [1989-1991; USA-WA, OR, CA]
- Collaborated on a review to determine how gastrointestinal absorption of contaminants is reduced when the contaminants are adsorbed to soil including evaluation of lead, arsenic, chromium, PCP, and benzo[a]pyrene. [1993; USA-WA]

- Collaborated on devising a system to rank contaminated sediments in Puget Sound, Washington, based on the toxicological properties of contaminants and the potential for exposure. Ranking intended to be used to develop priorities for sediment remediation. [1990; USA-WA]
- Reviewed and evaluated studies on the carcinogenicity and mutagenicity of toxic agents to be categorized for regulation by OSHA. Audited toxicology and mutagenicity studies submitted to EPA in support of pesticide registration. [1982; USA, Wash. DC]
- Conducted a review to determine the meaning of significant risk of cancer to workers under OSHA's revised generic cancer policy and as interpreted by health directorates in other countries. [1983; USA, Wash. DC]
- Coordinated with authors in the publication of a document on research needs in the area of transport and fate of organic pollutants in the environment in a document used to develop a federal EPA budget for research projects on transport and fate. [1979; USA, Wash. DC]
- Represented the National Women's Health Network before the FDA at a public hearing on toxic shock. Maintained national speaker's bureau and spoke at the College of William and Mary and the University of Toronto on occupational health issues. [1980; USA, Wash. DC]
- Advised National Women's Health Network members and public on toxicological questions, most of which focused on reproductive health and maternal and child health. [1980-1981; USA, Wash. DC]

CAREER

2011-present
Principal Consultant
Ramboll US Corp./ENVIRON US Corp., Minneapolis, MN USA

1989-2011
Public Health Specialist, Toxicologist, Managing Toxicologist
Exponent Environmental Health Sciences, Saint Paul, MN USA

1984-1989
Senior Scientist
Karch & Associates, Washington DC USA
1981-1983
Staff Scientist
Clement Associates, Washington DC USA

1980-1981
Internship Coordinator
National Women's Health Network, Washington DC USA

1979-1989
Intern
U.S. Environmental Protection Agency, Washington DC USA

PUBLICATIONS

Dell, L.D., Gallagher, A.E., Yost, L.J., Mundt, K.A. 2021. Integration of Evidence on Community Cancer Risks from Elongate Mineral Particles in Silver Bay, Minnesota. Risk Analysis, Vol. 0, No. 0, 2021 DOI: 10.1111/risa.13673 https://onlinelibrary.wiley.com/doi/epdf/10.1111/risa.13673

Albright, J.; White, B., Pedersen D., Carlson P., Yost L., Littau C 2018. Use patterns and frequency of hand hygiene in healthcare facilities: Analysis of electronic surveillance data American Journal of

Infection Control: Volume 46, Issue 10, Pages 1104–1109 (2018). Available at: https://www.ajicjournal.org/issue/S0196-6553(17)X0011-4.

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Kirman C, Budinsky R, Yost L, Baker B, Zabik J, Rowlands C, Long T, Simon T. Derivation of soil clean-up levels for 2,3,7,8-tetrachloro-dibenzo-p-dioxin (TCDD) toxicity equivalence (TEQD/F) in soil through deterministic and probabilistic risk assessment of exposure and toxicity, Hum Ecol Risk Assess 2011; 17(1):125–158.

Yost LJ, Shock SS, Holm SE, Lowney YW, Noggle JJ. Lack of complete exposure pathways for metals in natural and FGD gypsum. Hum Ecol Risk Assess 2010; 16(2):317–339.

Menzie CA, Ziccardi LM, Lowney YW, Fairbrother A, Shock SS, Tsuji JS, Hamai D, Proctor D, Henry E, Su SH, Kierski MW, McArdle ME, Yost LJ. Importance of considering the framework principles in risk assessment for metals. Environ Sci Technol 2009; 43(22):8478–8482.

Kaetzel RS, Yost LJ, O'Boyle RA, Booth PN. Assessment as a decision-making tool for treatment of emissions at a new aluminum smelter in Iceland: 2. Human health risk assessment. J Hum Ecol Risk Assess 2009; 15(3):442–468.

Booth PN, Salatas, JH, Kaetzel RS, Gard NW, Yost LJ, O'Boyle RA, Mackay CE. Risk assessment as a decision-making tool for treatment of emissions at a new aluminum smelter in Iceland: 1. Background and introduction. J Hum Ecol Risk Assess 2009; 15:423–441.

Shock SS, Noggle JJ, Bloom N, Yost LJ. Evaluation of potential for mercury volatilization from natural and FGD gypsum products using flux-chamber tests. Environ Sci Technol 2009; 43(7):2282–2287.

Tsuji JS, Yost LJ, Barraj LM, Scrafford CG, Mink PJ. Use of background inorganic arsenic exposures to provide perspective on risk assessment results. Regul Toxicol Pharmacol 2007; 48:59–68.

Mandel JH, Kelsh MA, Mink PJ, Alexander DD, Kalmes RM, Weingart M, Yost L, Goodman M. Occupational trichloroethylene exposure and non-Hodgkin's lymphoma: A meta-analysis and review. Occup Environ Med 2006; 63:597–607; originally published online 27 Apr 2006.

Yost LJ, Tao S-H, Egan SK, Barraj LM, Smith KM, Tsuji JS, Lowney YW, Schoof RA, Rachman NJ. Estimation of dietary intake of inorganic arsenic in U.S. children. Hum Ecol Risk Assess 2004; 10:473☐483.

Yost LJ, Shock S, Garry M, Garson YN, Sugino AK, Shields WJ. Health risk evaluation of PCBs from joint compound measured on surfaces and in air. Organohal Comp 2003; 63:413-416.

Meacher DM, Menzel DB, Dillencourt, MD, et al. Estimation of multimedia inorganic arsenic intake in the U.S. population. Hum Ecol Risk Assess 2002; 8(7):1697-721

Peek DC, Butcher MK, Shields WJ, Yost LJ, Maloy JA. Discrimination of aerial deposition sources of polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran downwind from a pulp mill near Ketchikan, Alaska. Environ Sci Technol 2002; 36(8):1671☐1675

Yost LJ, Shields WJ, Peek DC, Schoof RA, Ruby MV, Maloy JA. Identification and hazard evaluation of crushed rock as an unexpected source of elevated arsenic in soil. Poster presented at the Society for Environmental Geochemistry and Health's Fourth International Conference on Arsenic Exposure and Health Effects, San Diego, CA, July 2000.

Moore M, Maloy J, Yost LJ, Shields W, Petito Boyce C. Exposure to PCDDs/Fs: Relative importance of the diet and of soil. TAPPI International Environmental Conference, Volume 3, pp. 1103–1112, TAPPI Press, Atlanta, GA, 1999.

Schoof RA, Yost LJ, Eickhoff J, Crecelius EA, Cragin DW, Meacher DM, Menzel DB. A market basket survey of inorganic arsenic in food. Food Chem Toxicol 1999; 37(8):839–846.

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