

Webinar Dictionary

insane in the membrane

/in-sān en the mem-brān/ *adj* something beyond crazy.

insane in the geomembrane

/in-sān en the geō-mem-brān/ *adj* 1 something beyond crazy relating to surface impoundment liner systems. 2 creating standards for surface impoundment liner systems with limited regard for accepted engineering practices and known scientific principles.

JR Register, P.E.

Consumers Energy

Andrew Bittner, P.E.

 GRADIENT

Regulatory Framework Hierarchy



Laws

- Legislature – enact laws, defined by court rulings, appropriation
- Example: Resource Conservation and Recovery Act (RCRA)

Rules

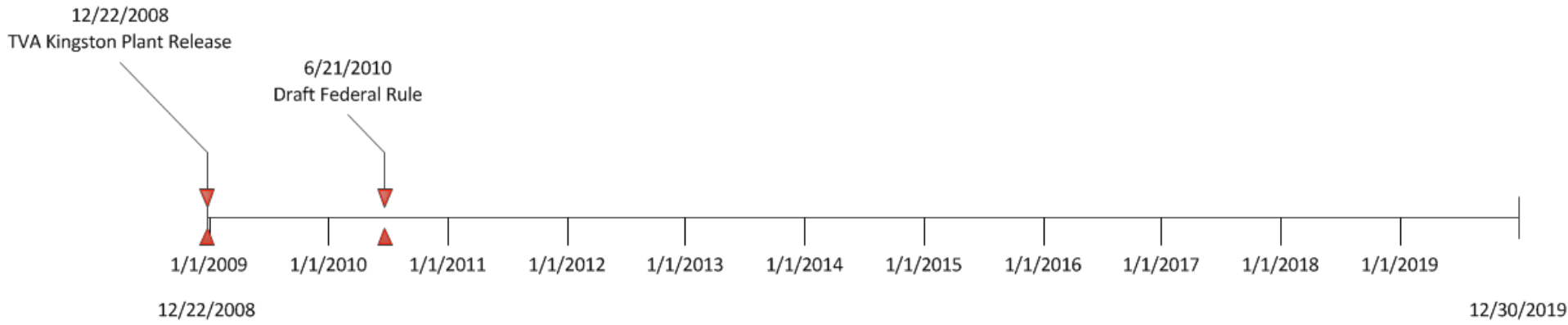
- Regulatory Agency – establishes standards through legal process
- Example: Title 40 Code of Federal Regulations

Policy

- Designed on the basis or rules and gives vision and direction
- Example: Groundwater Monitoring Milestones (April 30, 2018)

Procedures

- Series of steps for a repetitive function to achieve consistency
- Example: Process for a Permit Application



Hazardous and Solid Waste Management System; Identification and Listing of Special Wastes; Disposal of Coal Combustion Residuals From Electric Utilities

(75 FR 35128, June 21, 2010)

Proposes three potential regulatory frameworks:

- Subtitle C – Special Waste (S001)
- Subtitle D – Self Implementing
- “D Prime” – Maintain Operation of Surface Impoundments

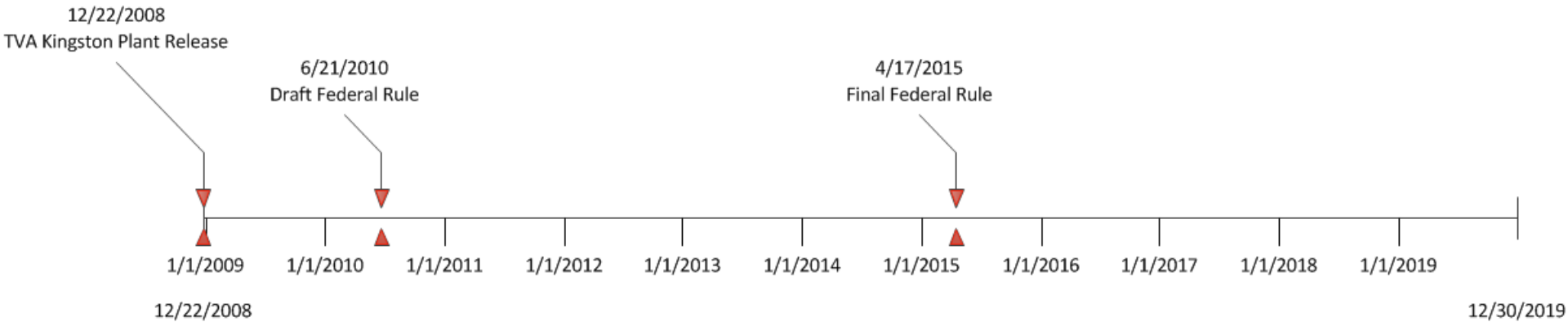
Draft Rule - Liner Requirements

New Landfill, Existing Surface Impoundment

- Composite Liner System, 2 Components
 - Upper component must consist of a minimum 30-mil flexible membrane liner (FML);
 - FML (Polymeric) materials most commonly used are PVC, CSPE, CPE, and HDPE.
 - HDPE has specific requirement of 60-mil thickness to ensure proper seaming welding
 - Lower component must consist of at least 2 feet of compacted soil meeting hydraulic conductivity of 1×10^{-7} cm/sec.

New Surface Impoundment

- Composite Bottom Liner System
- Leachate Collection System installed between upper and lower component of Composite Liner System



Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities

(80 FR 21301, April 17, 2015)

- Minimum Requirements Codified under 40 CFR 257
- Schedule of Compliance Milestones
- Self-Implementing
 - Certifications by Owners or Operators
 - Certifications by Qualified Professional Engineers
- Performance and Standards justified by Risk Analysis

Statutory Performance Standard

"no reasonable probability of adverse effects on health or the environment from the disposal of solid waste ..."

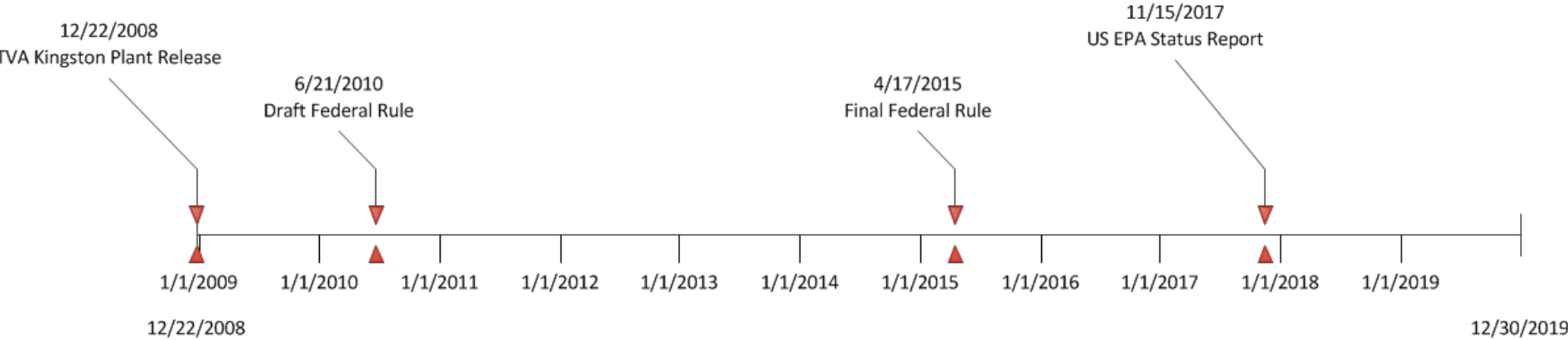
Final Liner Standards

Landfill Standards – Remain the same

- Add Definition of Alternative Composite Bottom Liner System

Surface Impoundment Standards

- Existing Units – Add Compacted Clay Liner
- Additional Conditions for Forced Closure



US EPA Settlement Agreement (June 14, 2016)

- Remand Rule – Published as Direct Final Rule August 5, 2016

Water Infrastructure Investment for the Nation (WIIN) Act (December 16, 2016)

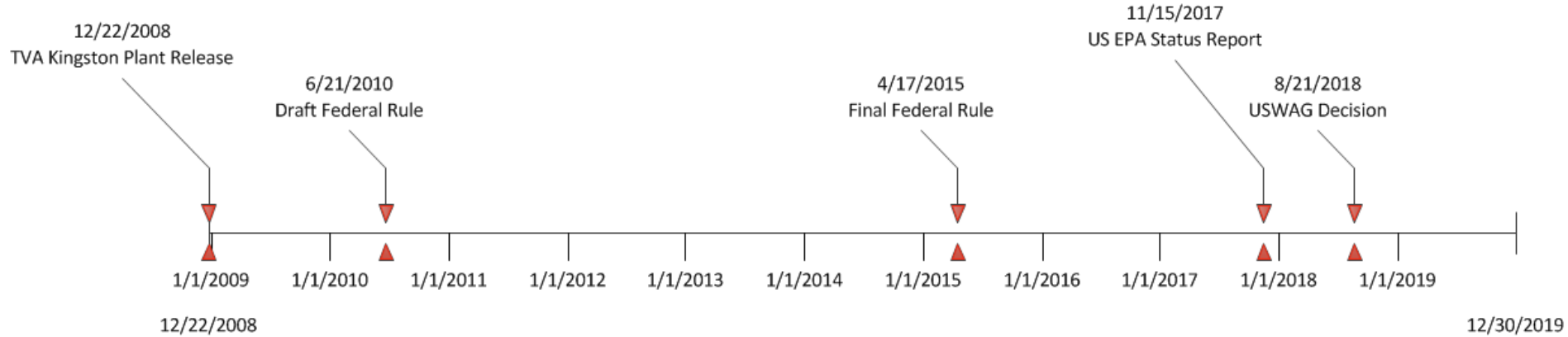
- Establishes Framework for State Permit Program/Flexibility

US EPA granted USWAG Petition (September 13, 2017)

- Signals Initiation of Rulemaking from US EPA

US EPA Status Report

- Briefing and Direction on Rulemaking Schedule



DC Circuit Denies EPA's Motion to Hold Case in Abeyance

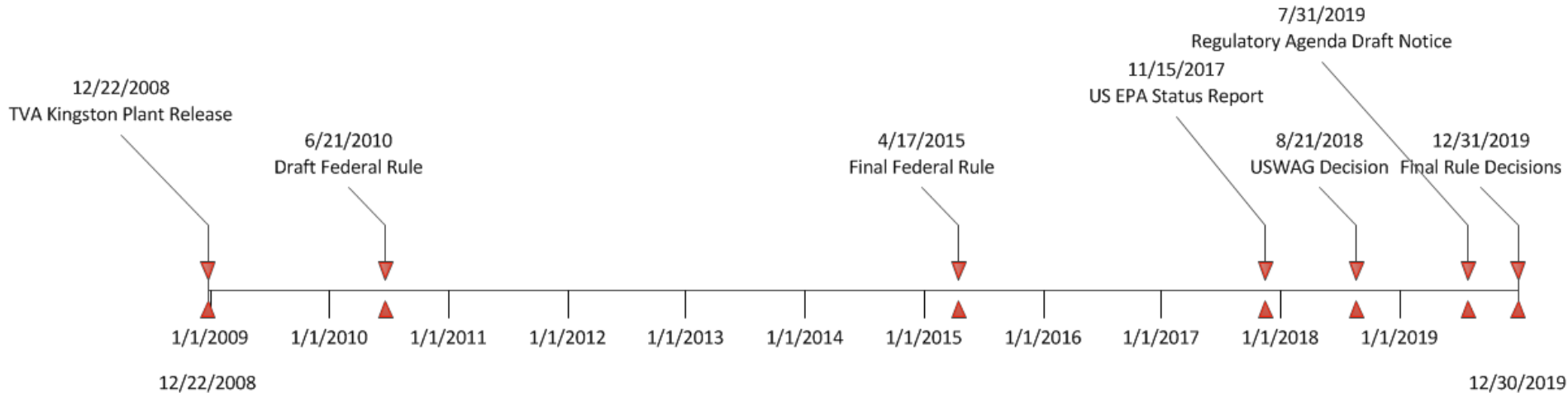
DC Circuit Renders Decision on Remaining Points of Litigation

- Forced Closure of Unlined Impoundments
- “Clay” as an Acceptable Liner Construction

Record Evidence

- Natural Damage Cases
- US EPA Risk Assessment

[Court Opinion on WIIN Act Relief \(Page 38 of Opinion\)](#)



US EPA Implementation of Circuit Court Decision

- Motion for Voluntary Remand without Vacatur (December 17, 2018)
- Affidavit from Barnes Johnson, US EPA Administrator

US District Court Grants Motion (March 13, 2019)

US EPA Spring 2019 Regulatory Agenda

- Liner System Equivalency Demonstration

Background

2015

- New "CCR Rule" by the US EPA
- Lined CCR units required to have either:
 - >2 ft. of compacted soil with $K < 10^{-7}$ cm/s
 - Composite liner system
 - min. 30-mil geomembrane liner
 - >2 ft. of compacted soil with $K < 10^{-7}$ cm/s
 - Alternative composite liner system
 - min. 30-mil geomembrane liner
 - lower component with lower liquid flow rate than >2 ft. of compacted soil with $K < 10^{-7}$ cm/s

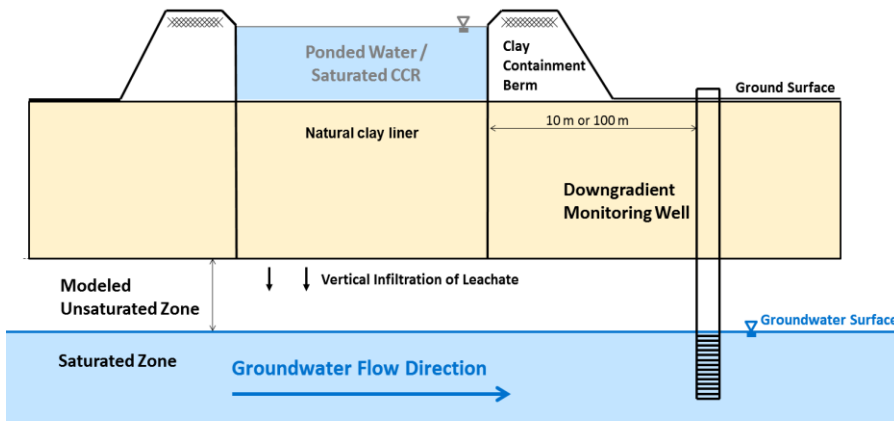
2018

- DC Circuit Court vacated portions of CCR Rule
- Determined that only composite liner systems could meet the RCRA HHE protection standard



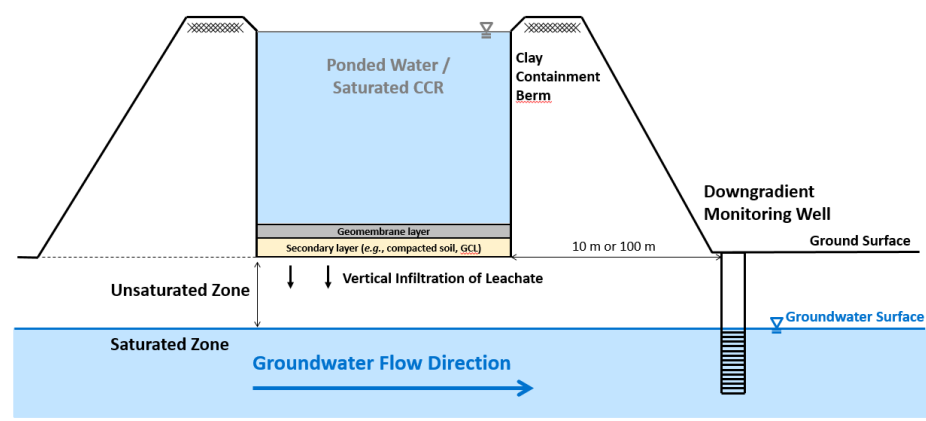
- Evaluate the **relative** performance of alternative liners
 - Compare performance of alternative liners to composite liners
 - Project funded by Electric Power Research Institute (EPRI)
- Approach: model evaluation
 - Mimic US EPA's 2014 CCR Risk Assessment using EPACMTP
 - Conservative, probabilistic evaluation
 - Modeled lithium (conservative tracer) and arsenic(III)
 - Calculate and compare maximum downgradient groundwater concentrations over 10,000 years

Natural Clay (Alternative) Liner



Not to scale

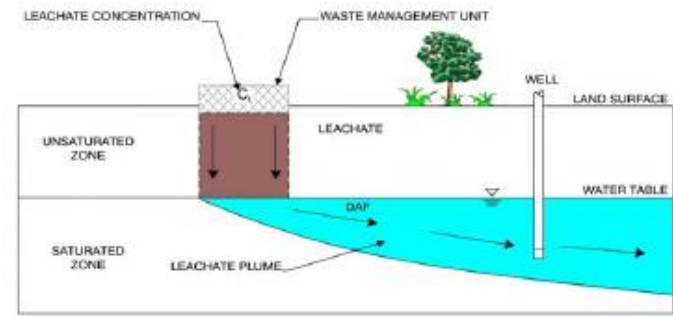
Composite Liner





Not to scale

Approach

- EPA Composite Model for Leachate Migration and Transformation Products
 - Fate and transport modeling of constituents leaching from WMU through underlying unsaturated and saturated zones



- Infiltration Rate Calculations

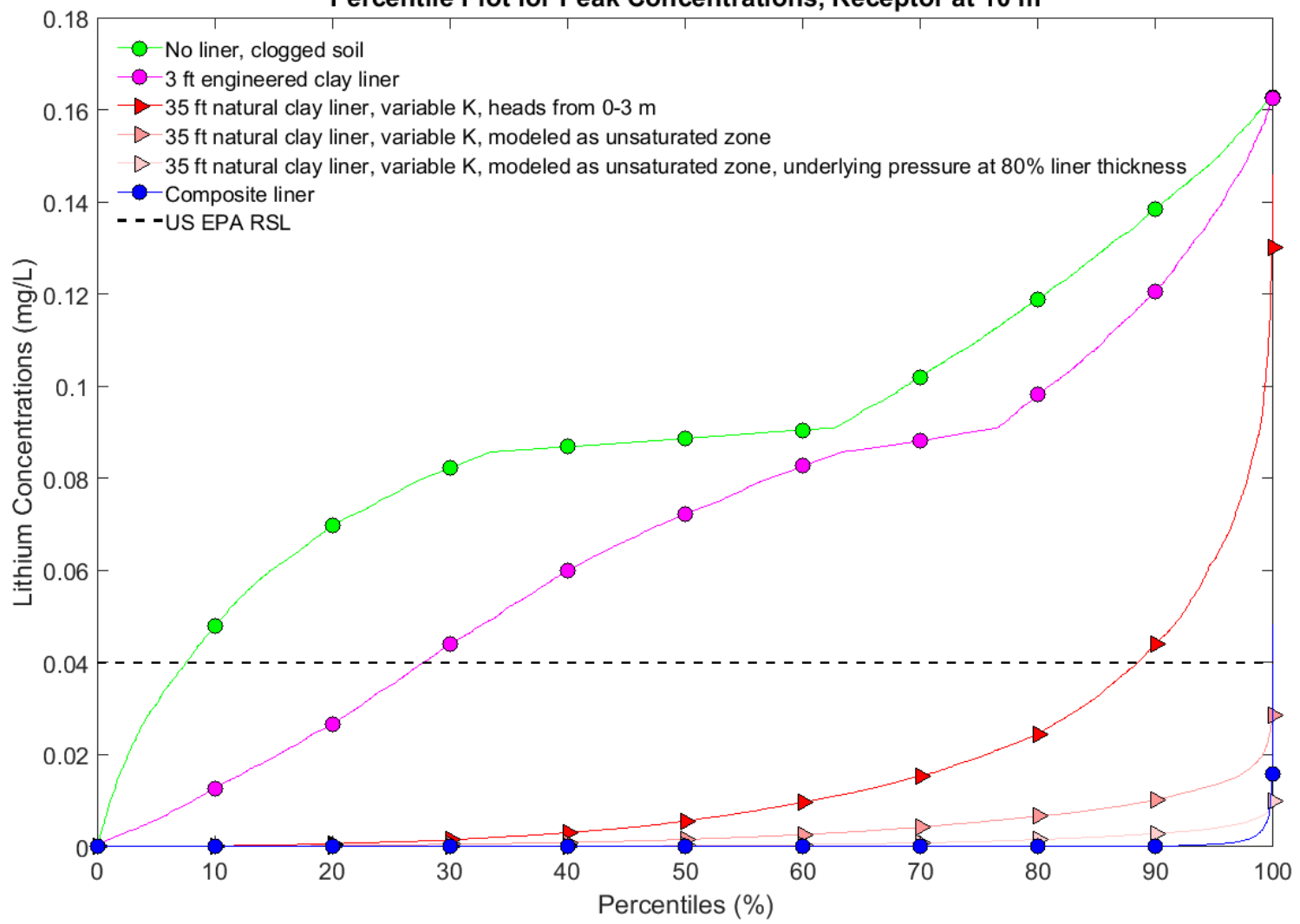
- Engineered clay liner  Darcy's Law
- Natural clay liner  Giroud's Empirical Formula

Liner Scenario	Calculated Infiltration Rate (m/year)		
	25 th Percentile	50 th Percentile	75 th Percentile
Engineered Clay Liner	0.06	0.08	0.1
Natural Clay Liner: 35 ft., $K = 5.5 \times 10^{-9}$ to 2.2×10^{-8} cm/s	0.003	0.005	0.006
Geomembrane Composite Liner	0	6E-5	2E-4
Composite Liner – Double Defect Frequency	0	7E-5	3E-4
Geomembrane Composite Liner with GCL	0	1E-5	7E-5

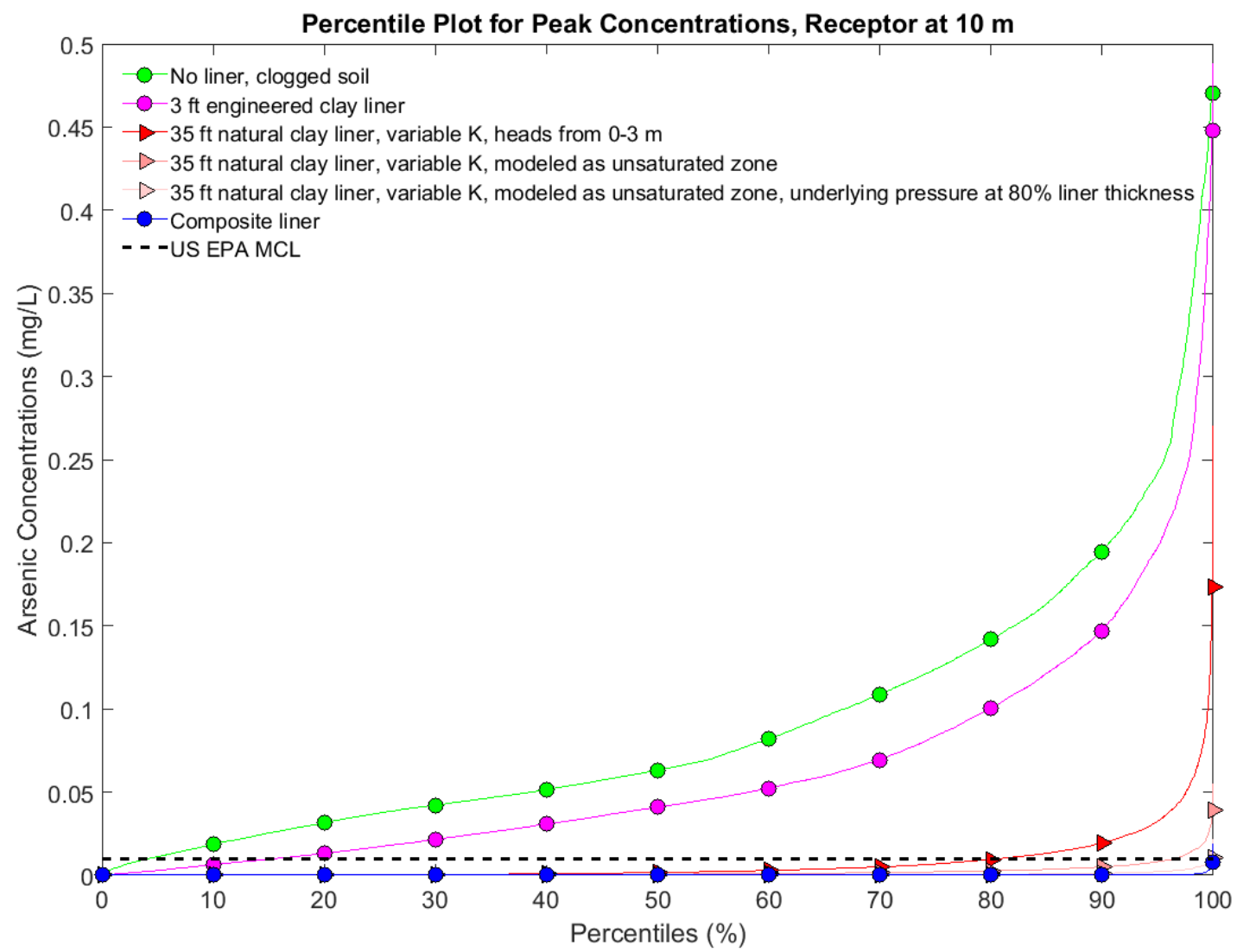
Parameter	Distribution type	Value			
SI operations duration	Constant	75 years			
Source concentration	Statistical distribution		25 th %	50 th %	75 th %
		Lithium	86 µg/L	91 µg/L	163 µg/L
		Arsenic	40 µg/L	70 µg/L	160 µg/L
SI size	Constant	100 acres			
Ponding depth	Uniform	0 to 3 m			
Monitoring well locations	Constant	10 m and 100 m downgradient			
Aquifer hydraulic conductivities	EPACMTP database	3E-07 cm/s to 2 cm/s			
Hydraulic gradient	EPACMTP database	1E-05 to 1E-01			
Aquifer thickness	EPACMTP database	3 m to 915 m			

Model Results – Lithium, 10 m Downgradient

Percentile Plot for Peak Concentrations, Receptor at 10 m



Model Results – Arsenic, 10 m Downgradient



Model Limitations (Conservative)

- Constant hydraulic head and infiltration rate
 - Model does not account for time of migration through thick, natural clay liners
 - Evaluated in sensitivity analysis
 - 10,000 years exposure period much longer than typical human health risk assessment exposure periods
 - Model does not consider contaminants sorbed to thick clay liners
 - Evaluated in sensitivity analysis
 - Assumption of constant hydrogeological conditions and liner characteristics over 10,000 years is uncertain
 - Reactive transport not simulated: $\text{As(III)} \leftrightarrow \text{As(V)}$; complexation, redox reactions
- ➔ **Potential overestimation of maximum-predicted concentrations**

Modeling Conclusions

- Composite bottom liner systems all perform similarly, even with high-defect density
- Performance of engineered clay liner is more similar to performance of the unlined scenarios than to composite liner systems
- Performance of low-conductivity natural clay liners can perform similar to composite liner systems
 - Natural clay hydraulic conductivity is a sensitive parameter in these evaluations
 - Thickness of clay is a sensitive parameter affecting the duration of transport through the liner
- **Certain alternative liner systems can perform similarly to the composite liners: by extension these can be equally protective of human health and the environment**

Contact Information

Harold D. Register, Jr., P.E.

Senior Engineer

Consumers Energy

HAROLD.REGISTERJR@cmsenergy.com

Andrew Bittner, P.E.

Principal

Gradient

abittner@gradientcorp.com

John M. Allen, P.E.

IGS-NA President - Elect

Technical Services Manager

CETCO Environmental Products

john.allen@mineralstech.com

Timothy D. Stark Ph.D., P.E.

Professor of Civil & Environmental Engineering

University of Illinois at Urbana-Champaign

Technical Director

Fabricated Geomembrane Institute

tstark@Illinois.edu

Jen Miller, M.S.

Coordinator

Fabricated Geomembrane Institute

University of Illinois at Urbana-Champaign

fabricatedgeomembrane@gmail.com

FGI's Next Webinar

Temporary Landfill Covers: Design and Construction

Tuesday, September 10, 2019 at Noon CDT

Free to Industry Professionals

1.0 PDH

Presenter:

Elliot Pugh (Wind Defender)

Check out the FGI's Website:

- Latest Specifications and Guidelines
- Installation Detail Drawings (PDF and DWG)
- Technical Papers and Journal Articles
- Webinar Library (available to view and download)
- ASTM Field and Laboratory Test Method Videos
- Pond Leakage Calculator
- Industry Events Calendar
- Photo Gallery
- Member Directory
- Material and Equipment Guides
- Industry News
- Women in Geosynthetics

www.fabricatedgeomembrane.com

Thank You For Attending!

JR Register, P.E.

harold.registerjr@cmsenergy.com



Consumers Energy

Andrew Bittner, P.E.

abittner@gradientcorp.com

