REINHOLD ENVIRONMENTAL Ltd.

2017 NOx-Combustion-CCR Round Table Presentation

February 27 & 28, 2017, in Cleveland, OH / Hosted by FirstEnergy

CCR Groundwater Program Management & Risk Mitigation Strategies

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February 27th, 2017

BURNS McDONNELL

Introduction

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Agenda

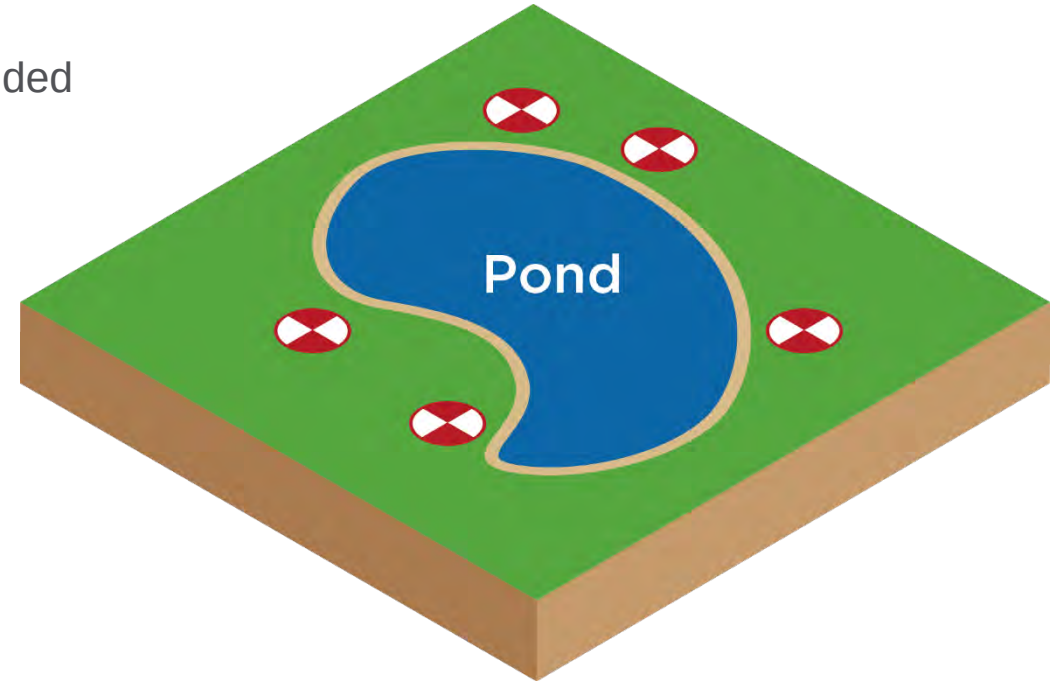
- CCR Rule Overview: Groundwater Requirements
- Timeline for Action
- Case Studies
- Conclusions

CCR Overview: Groundwater

Rule Requirements

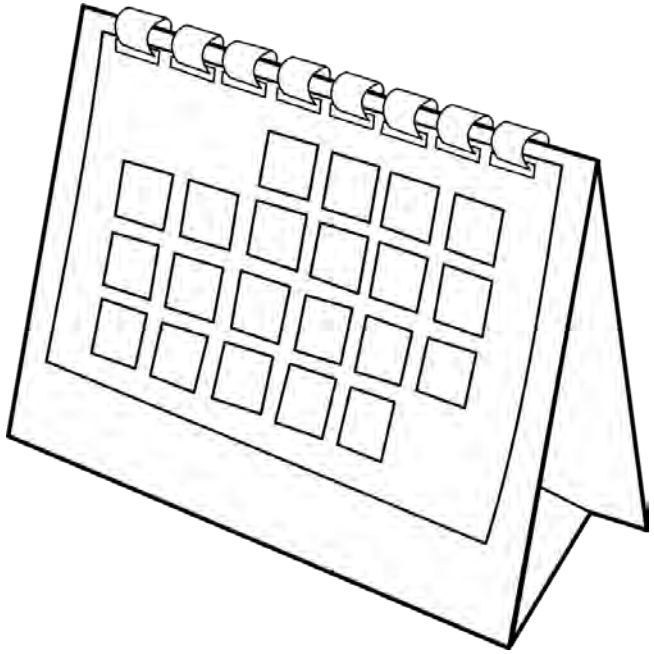
DESIGNING YOUR NETWORK

- Minimum of one upgradient and three downgradient wells
  - Typically more wells are recommended to accurately characterize site
- Downgradient wells at the waste boundary
- Monitoring of uppermost aquifer
- Multiunit networks are allowable



CCR Compliance Schedule for Groundwater

- First report by January 31, 2018
- Rule provides detailed path for detection monitoring, assessment monitoring, and corrective action planning
- **Corrective action may begin as soon as first quarter of 2019**
  - Corrective Action strategy must go through public vetting process
  - Also requires risk assessment



CCR Compliance Schedule for Groundwater

- Initiation of **Corrective Action Assessment** required within 90 days of Statistically Significant Increase (SSI); must be complete within 90 days of initiation
- 60-day extension is an option
- Requires PE certification of accuracy
- CA demonstration must be included in Annual Groundwater Monitoring Report (public posting via internet)
- **CA considered complete following 3 consecutive years of compliance with groundwater protection standard**

Planning Ahead

HOW LIKELY ARE GROUNDWATER IMPACTS?

- Review of EPA Findings:
  - 16 of 17 proven damage cases involved unlined facilities
  - 63% of operating landfills & impoundments are unlined
  - Data shows unlined impoundments typically operate up to 20 years before they begin to leak
  - Most currently operating impoundments are 20-40 years old

Recent Developments

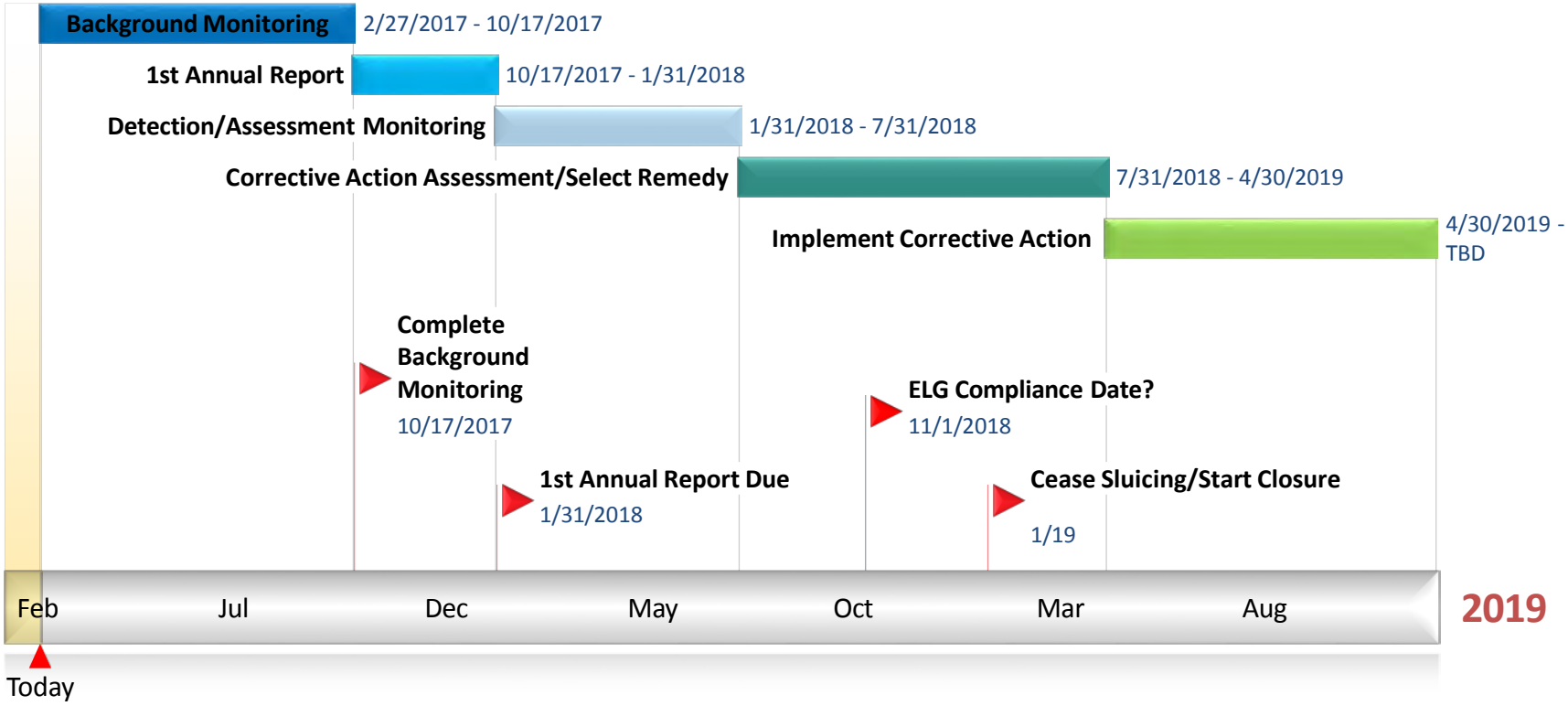
- Pending: June 14, 2016 Court approval of remand and remand/vacate motion
  - Add Boron to Appendix IV? – Remand Rule in 2019 TBD
  - Remove exemptions for Inactive CCR Surface Impoundments
    - Federal Register notice on August 5, 2016
    - Same requirements as for active CCR Surface Impoundments
    - Different Compliance Dates
      - April 17, 2019 Groundwater Monitoring System Requirements
      - August 1, 2019 Initial Groundwater Monitoring and Corrective Action Report

Recent Developments

- "Water Infrastructure Improvements for the Nation Act" or the "WIIN Act" (Public Law No. 114–322)
- 42 USC § 6945 Upgrading of open dumps
  - (d) State programs for control of coal combustion residuals
    - 40 CFR § 257 or State permit program
    - 180 days for USEPA to approve State permit program
    - ***"at least as protective as"***
    - technical standards that differ from the criteria under part 257 based on site-specific conditions are allowed if…
    - **IF** congress appropriates funds, USEPA shall implement permit program in a nonparticipating States
    - USEPA shall implement permit program for Native American Tribal Land.

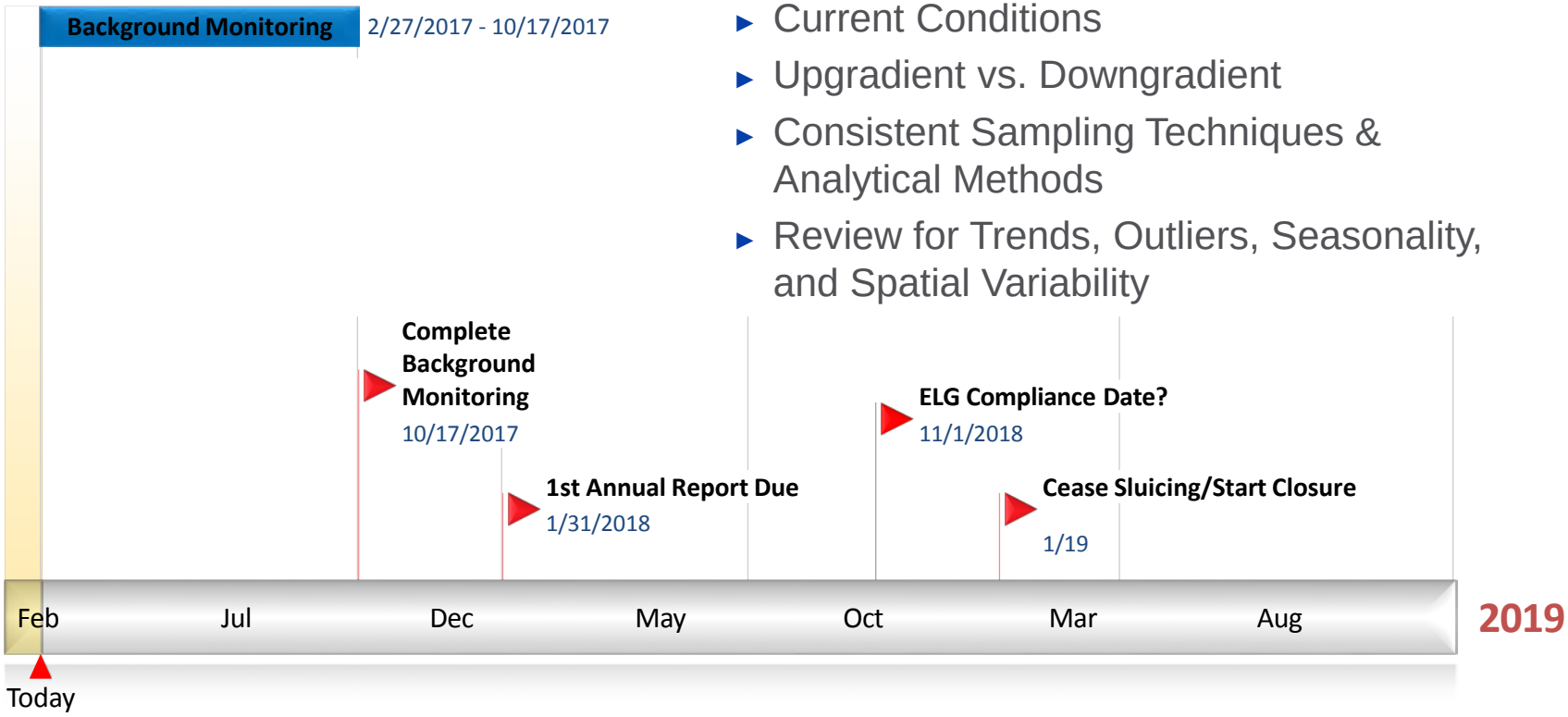
CCR Groundwater Management: Timeline

Groundwater Management Timeline



Background Monitoring

- Established With 8 Independent Baseline Samples
- Use Appropriate Data
  - Current Conditions
  - Upgradient vs. Downgradient
  - Consistent Sampling Techniques & Analytical Methods
  - Review for Trends, Outliers, Seasonality, and Spatial Variability



Background Data

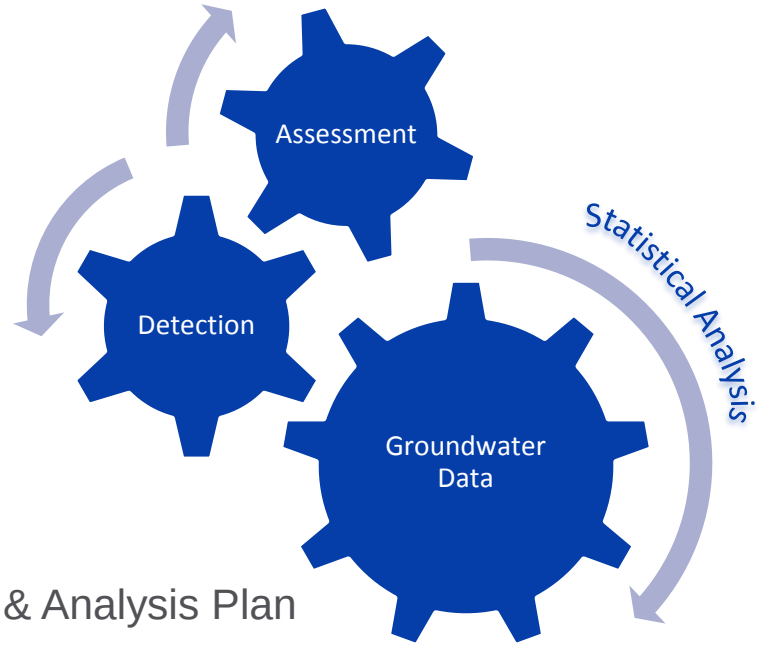
Represents Historical Conditions Unaffected by Site Activities

- Update Background Every 2 years
  - Higher “Statistical Power”
  - Increased Ability To Detect Changes In Concentration And/Or Releases

Background Monitoring

RISK FACTORS

- Field Work – collection of data/samples
- Sample Handling, Packaging, Shipping
- Laboratory
- Data Review and Management
- Statistical Analysis
- Reporting



MITIGATE RISK

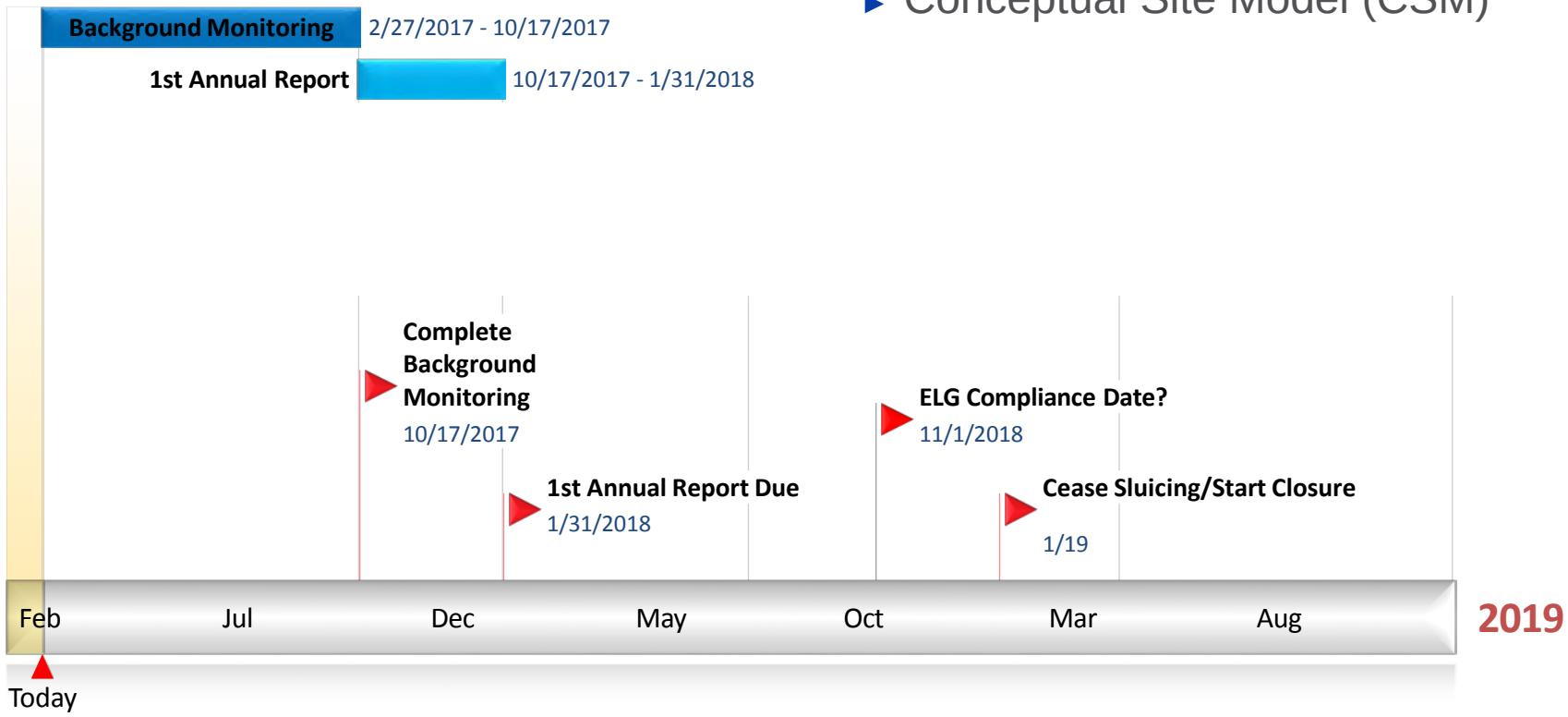
- Personnel Trained, Understand, and Follow Sampling & Analysis Plan
- Use Properly Working Field/Lab Equipment and Instruments
- Field/Lab Documentation and QA/QC
- Data Validation and Statistical Software/Method
- Groundwater Monitoring System Properly Designed, Constructed, and Developed

Groundwater Data Accessible to Public - quality and defensible data

First Annual Report

Site Characterization

- Robust statistical analysis
- Conceptual Site Model (CSM)



Statistical Analysis

METHODS

- Time Series
- Trend Tests (Sen's Slope/Mann Kendall)
- Outlier Tests
- T-Test (Mann-Whitney)
- Box & Whisker Plots
- Prediction Interval (background)
- Confidence Interval (GWPS)

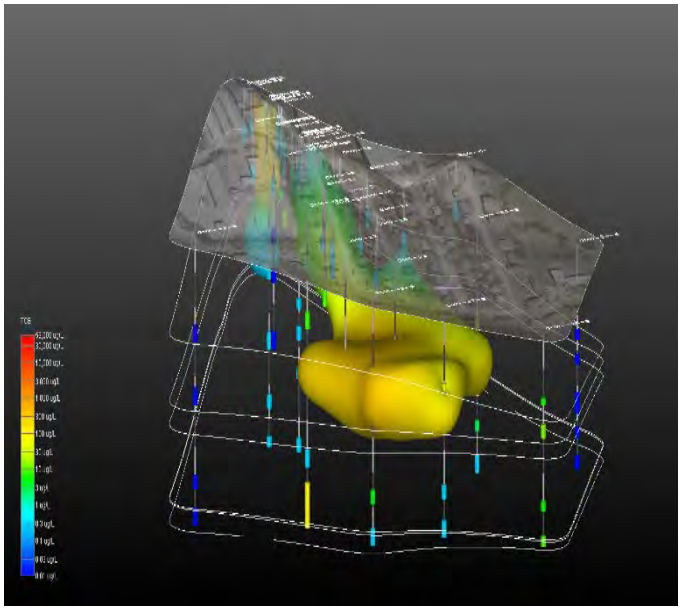
SELECTION

- Groundwater Results and Distribution of Data (normality and %NDs)
- Site Hydrogeological Conditions
  - Groundwater Flow
  - Spatial Variability

Conceptual Site Model

WHAT IS A CONCEPTUAL SITE MODEL?

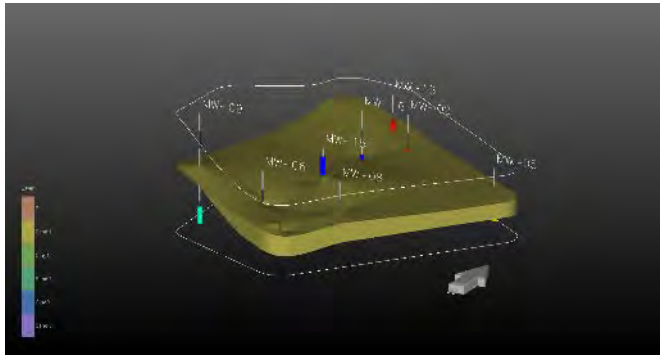
- A ‘living representation’ of a site.
- Supports effective evaluation of site conditions and compliance strategies
- May consist of:
  - Maps and cross-sections
  - Risk exposure/pathway diagrams
  - Computer models

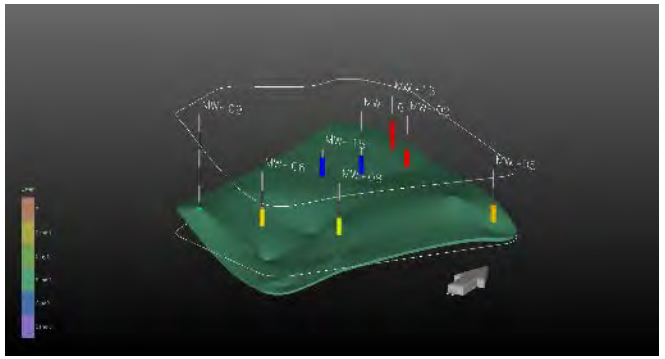


Conceptual Site Model

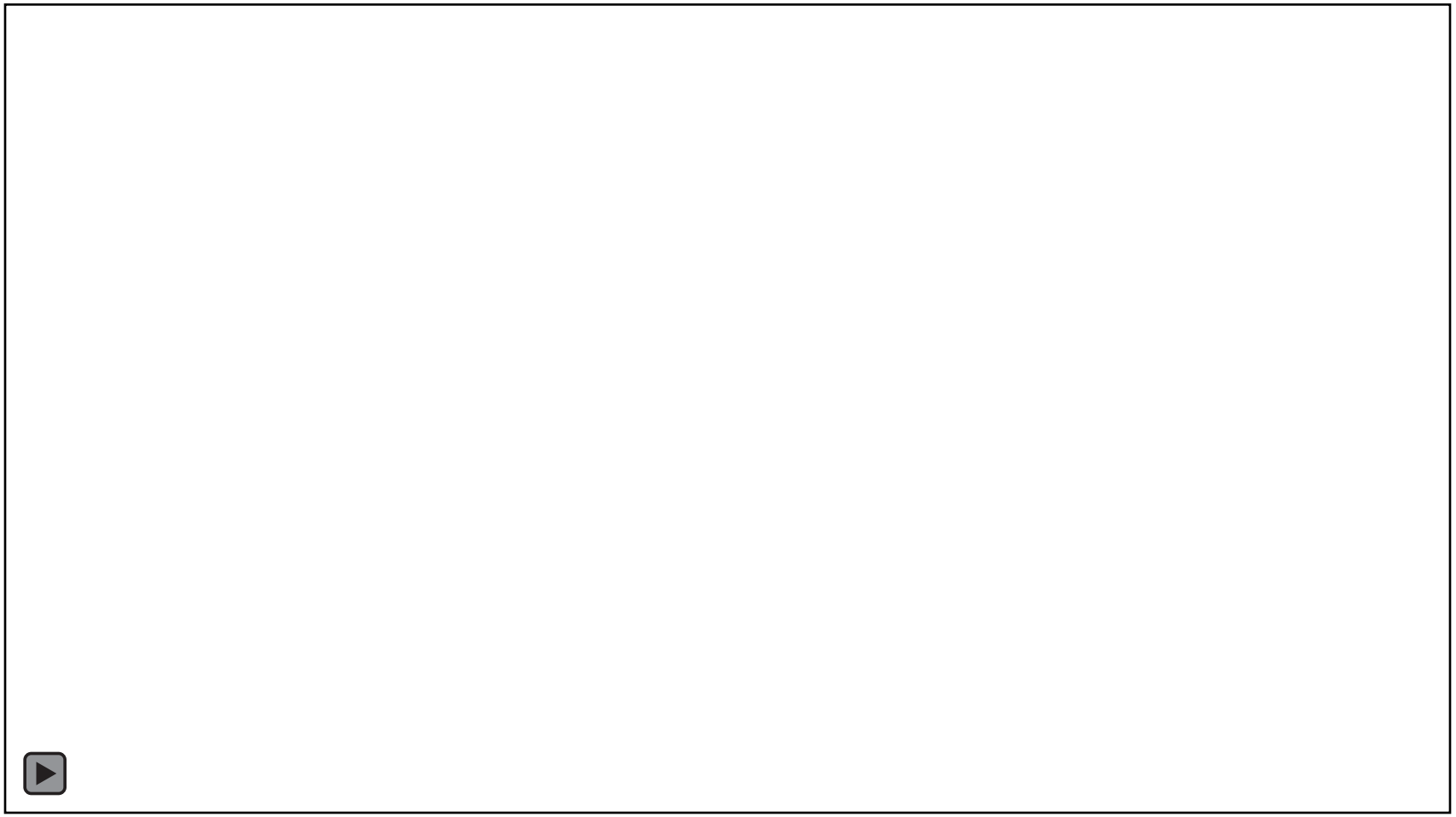
WHY IS A CSM IMPORTANT?

- Defines the problem
- Critical to the assessment/selection and design of cost-effective Corrective Measures
- Simulate “what if” scenarios
- Aids communication among team members, decision makers, stakeholders and field personnel.

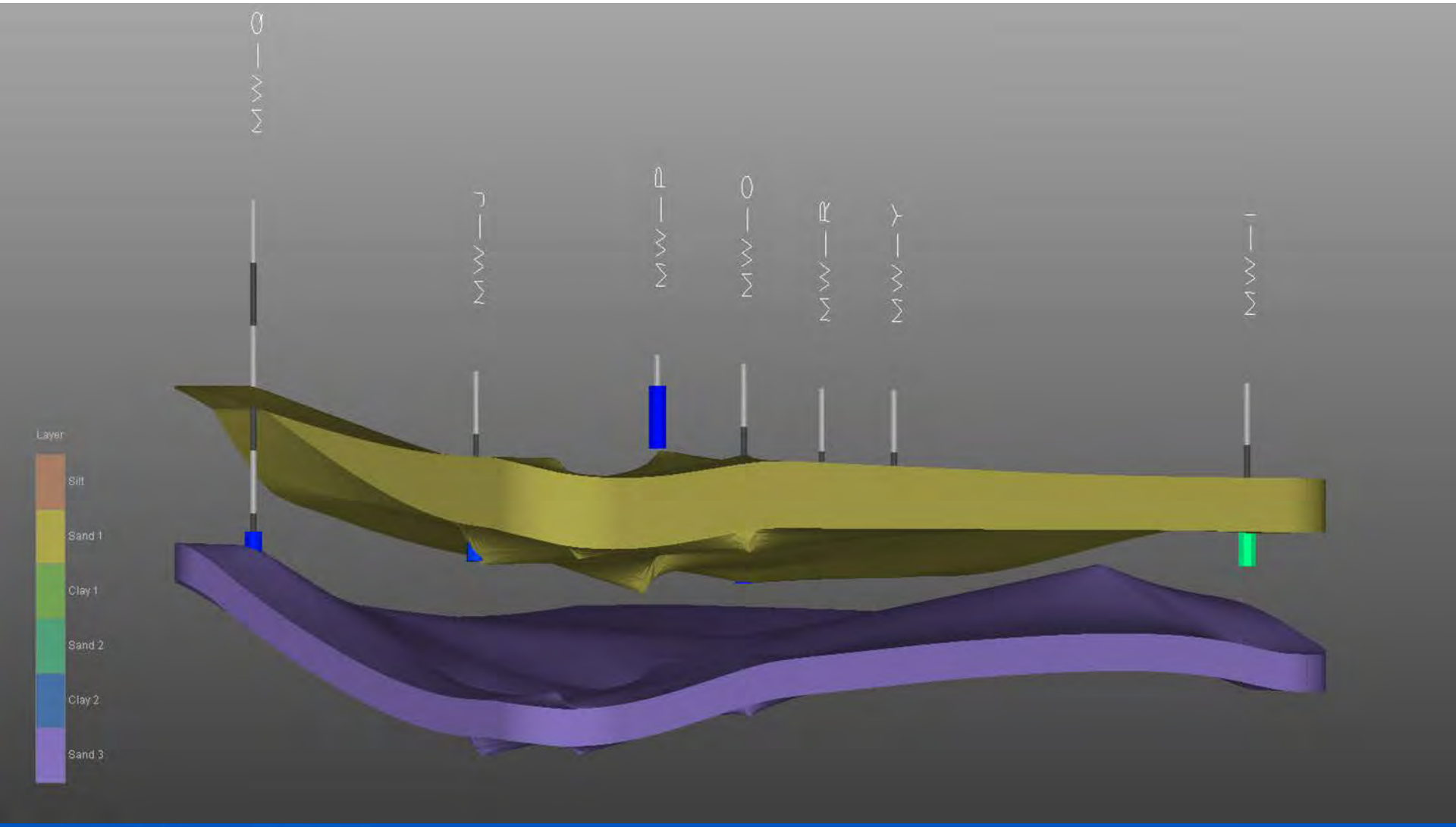




Conceptual Site Model



Conceptual Site Model



Conceptual Site Model

WHAT DOES A GOOD CSM LOOK LIKE?

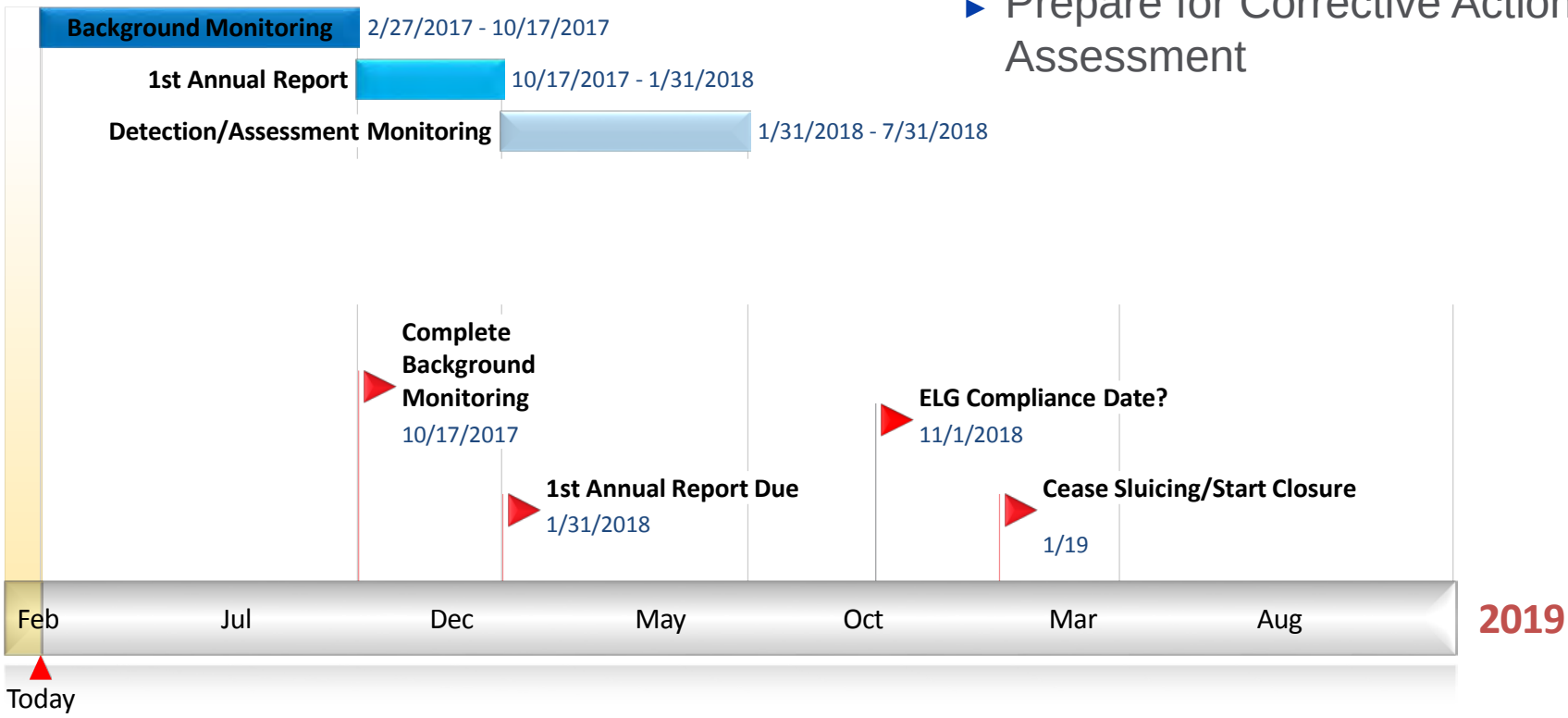
- Represents accurate interpretation of site data
- Confirmed or modified based on new data
- Holistic

WHAT DOES A GOOD CSM DO?

- Defines the problem / risk
- Basis for confident, cost-effective decisions
- Basis for communication among team members, decision makers, and stakeholders

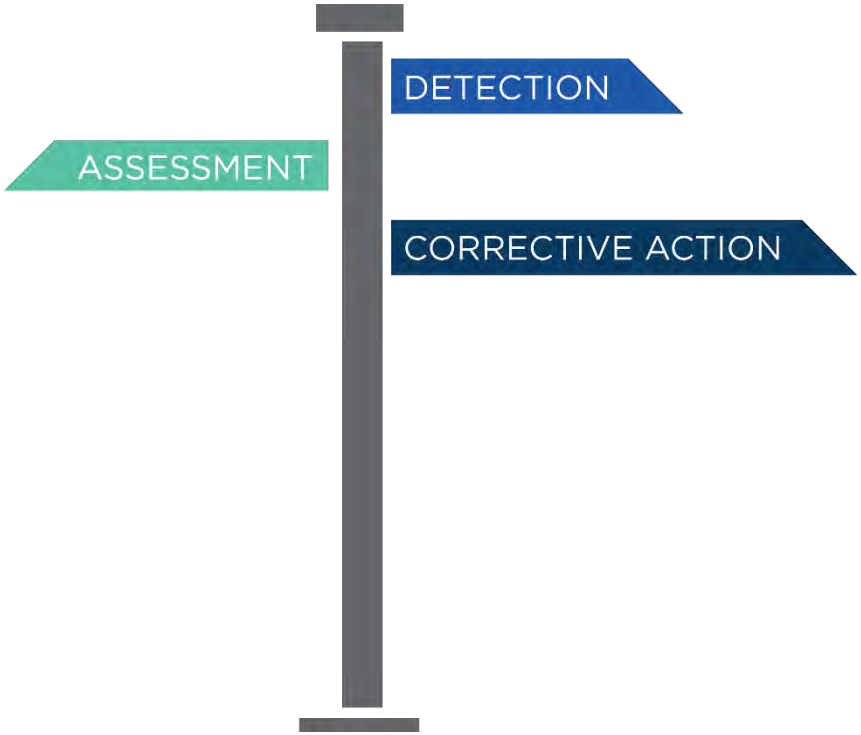
Compliance Monitoring

- Detection Monitoring
- Assessment Monitoring
- Prepare for Corrective Action Assessment



Compliance Monitoring

- Implement Detection vs. Assessment Monitoring?



- Dependent upon:
  - Groundwater Data
    - Background and Compliance
  - Statistical Analysis
    - SSI Verification Resampling
    - Alternate Source Demonstration

Compliance Monitoring

DETECTION MONITORING

- Sampling shall be done semiannually; unless there is inadequate groundwater flow, in which case sampling is done annually
- Purpose is to identify potential groundwater impacts with selected indicator parameters
- Establish assessment monitoring program within 90 days of an SSI found during detection monitoring

APPENDIX III CONSTITUENTS
Boron
Calcium
Chloride
Fluoride
pH
Sulfate
Total Dissolved Solids (TDS)

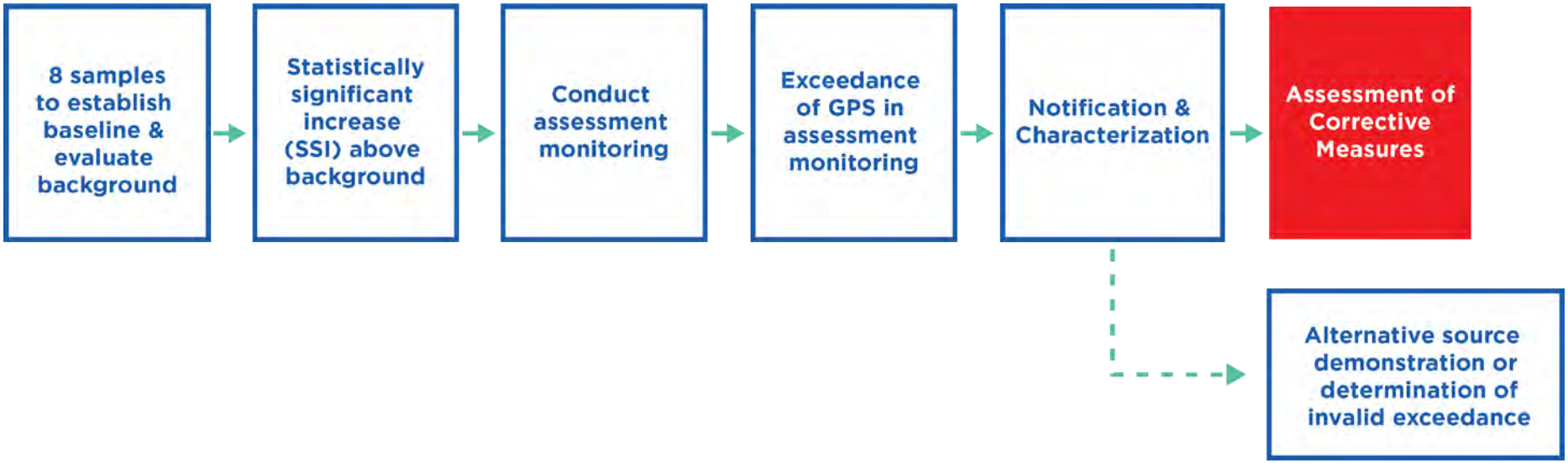
Compliance Monitoring

ASSESSMENT MONITORING

- Sample for Appendix IV constituents 90 days after triggering assessment monitoring, and annually thereafter
- Resample 90 days after obtaining results
- Establish groundwater protection standards during assessment monitoring for any constituents found to be SSIs
- If all constituents are at or below background for 2 consecutive events then return to detection monitoring
- Otherwise, move towards Corrective Action

APPENDIX IV CONSTITUENTS	
Antimony	Fluoride
Arsenic	Lead
Barium	Lithium
Beryllium	Mercury
Cadmium	Molybdenum
Chromium	Selenium
Cobalt	Thallium
Radium 226 & 228 Combined	
Boron?	

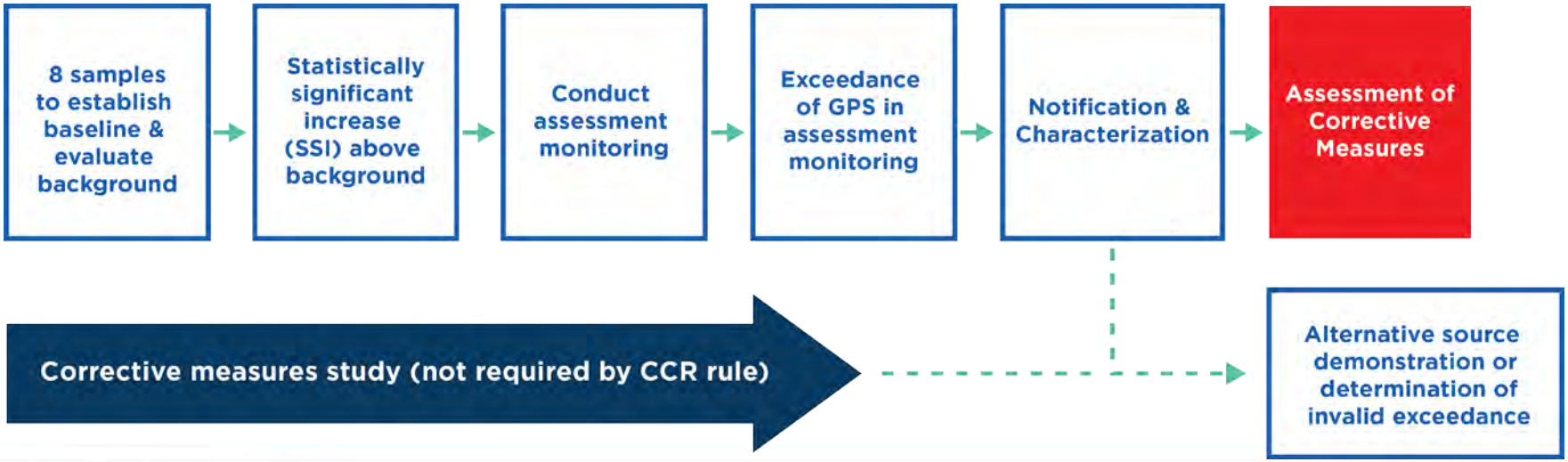
Compliance Monitoring



Groundwater Corrective Measures Study

Preliminary assessment of site conditions, potential impacts, risk, and cost

- Conducted **prior to** *Assessment of Corrective Measures* mandated in 40 CFR § 257.96



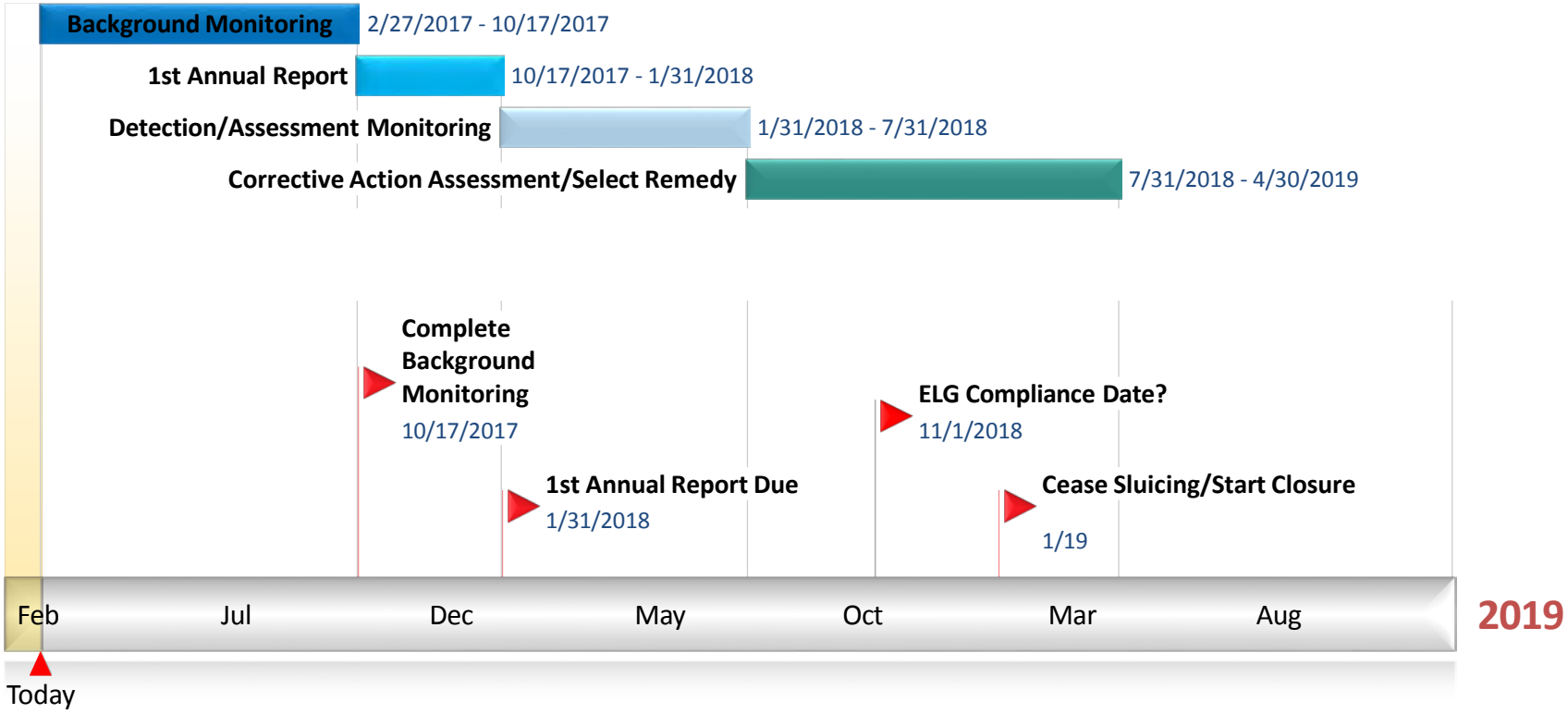
Groundwater Corrective Measures Study

- Reduced Uncertainty
  - Advanced Knowledge of Risk and Cost Drivers
- Early Identification & Screening of Compliance Strategies
- Identification of Cost-Saving Approaches
  - Alternative Source Evaluation
  - Monitored Natural Attenuation
- Integration with other CCR/ELG Compliance Strategies
- Reduced Schedule Pressure
- Improved Decision Making

Groundwater Corrective Measures Study

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Description	No Corrective Measures	Monitored Natural Attenuation and Supporting Investigation	Small Scale Pump & Treat	Hydraulic Containment with Pump & Treat
30 Year NPV	**$1,300,000**	**$2,800,000**	**$7,700,000**	**$25,800,000**

Corrective Action Assessment



Assessment of Corrective Measures

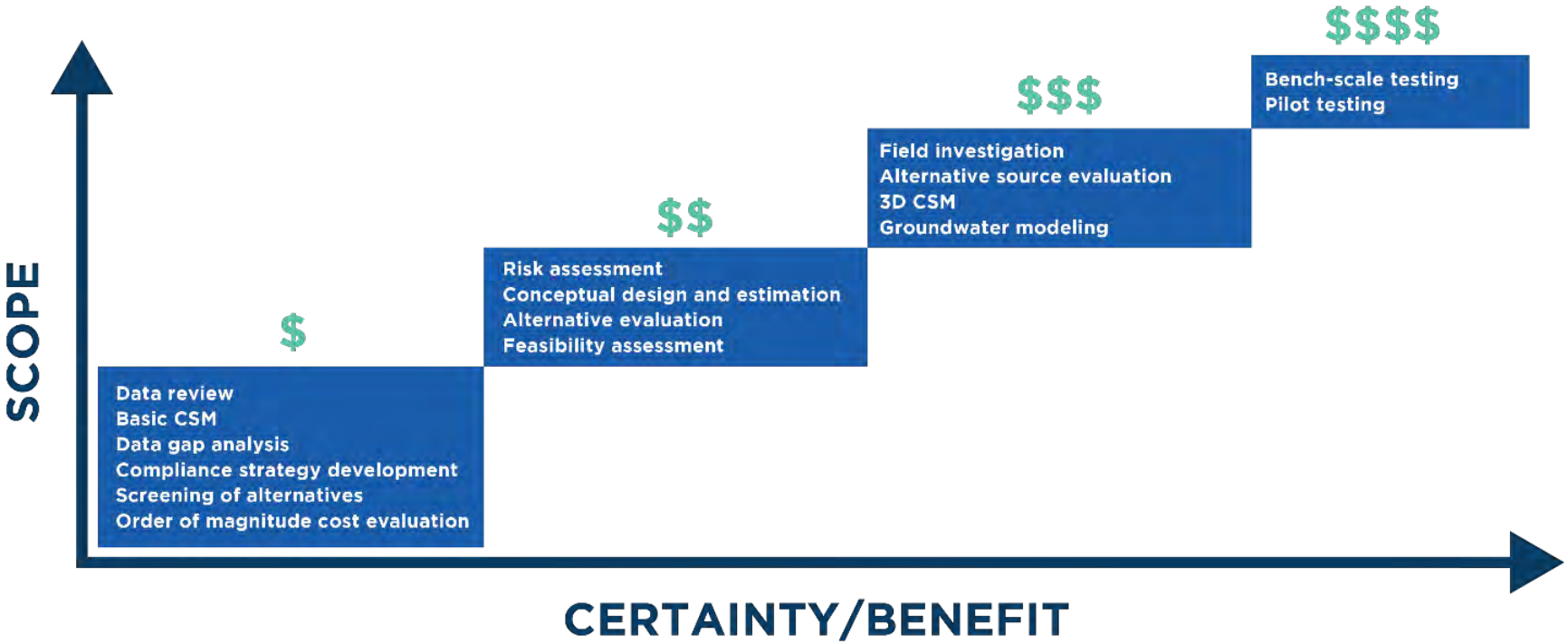
Rule Requirements

- Public Notification
  - Notification of GPS Exceedance
  - Notification of Impacted Property Owners
- Release Characterization
  - Must install and sample at least one additional monitoring well (per Rule)
- If alternative source or invalid exceedance cannot be demonstrated, begin Assessment of Corrective Measures
  - 90 days to complete
  - 60-day extension possible (Requires PE certification)
  - Public meeting 30 days before selecting remedy
  - 90 days after to selection to begin corrective action

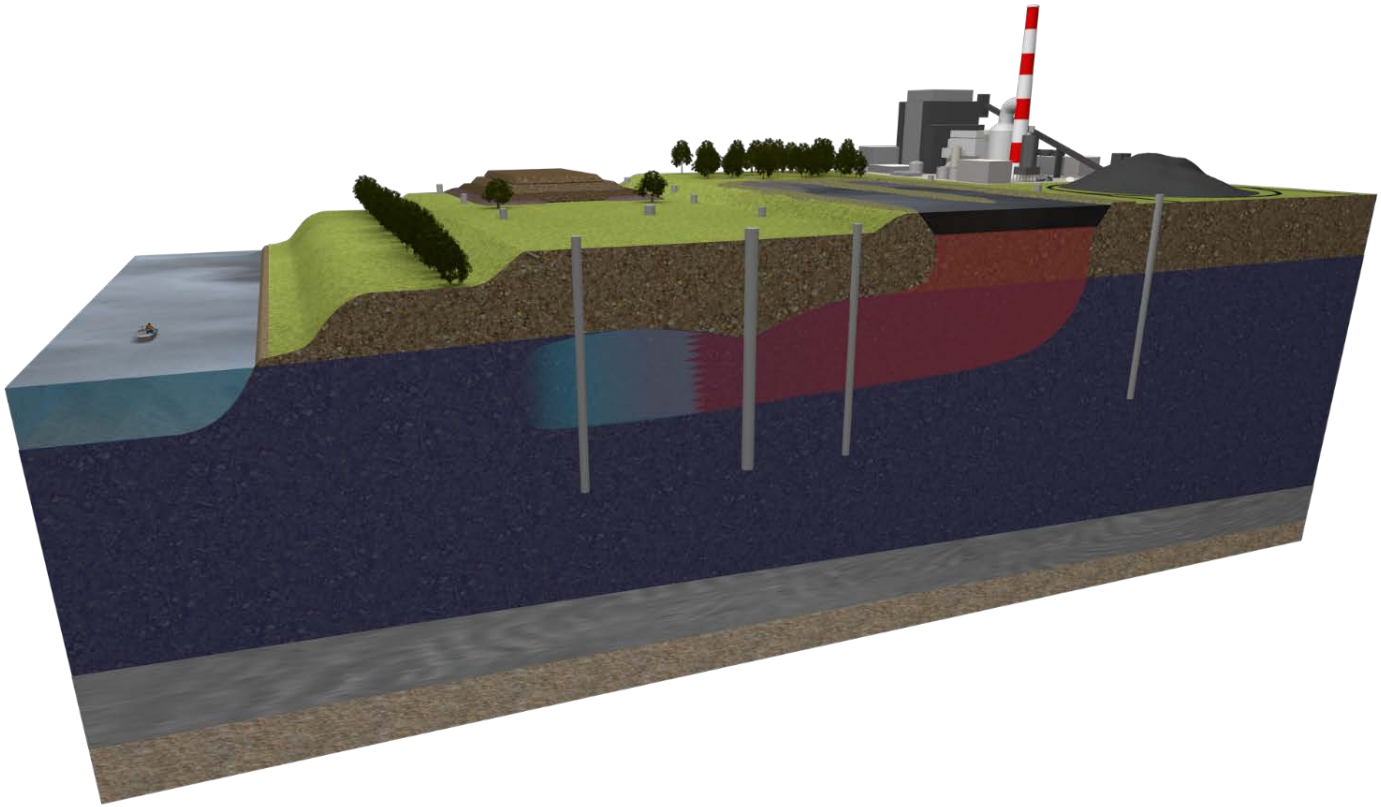
Assessment of Corrective Measures

- (a) Timing
  - (a) …as soon as feasible…
- (b) Requirements
  - Be protective of human health and the environment
  - Attain the groundwater protection standard
  - Control the source(s) of Appendix IV constituents
  - Remove contaminated material
  - Comply with all applicable RCRA requirements
- (c) Evaluation factors
  - …magnitude of reduction of existing risks…
  - …magnitude of residual risk…
  - …risk due to implementation…
  - …potential for exposure…to remaining waste…
- (d) Schedule factors
  - Nature and extent
  - Potential risk
  - Resource value of the aquifer

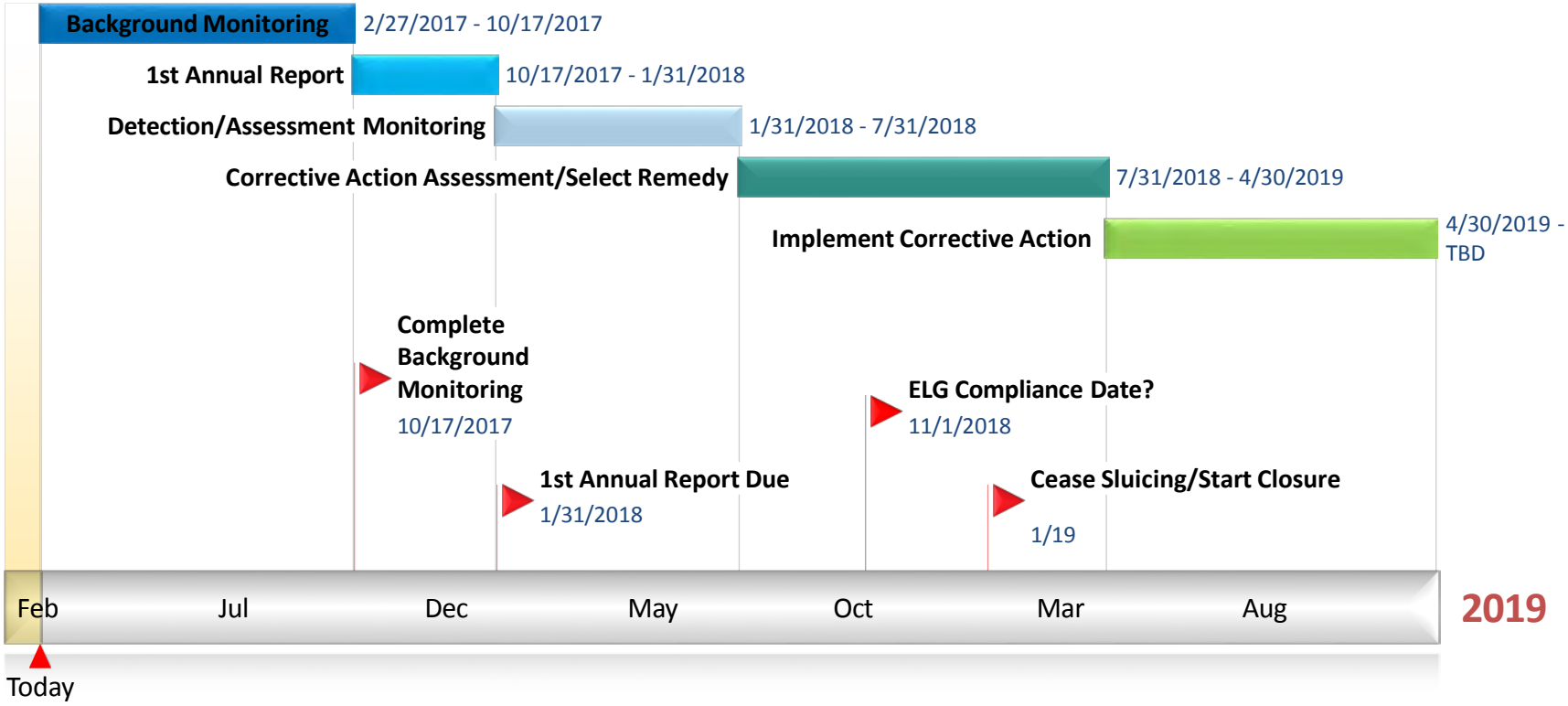
Assessment of Corrective Measures



Assessment of Corrective Measures



Implement Corrective Action



Corrective Action Timeline

Groundwater Monitoring and Closure

- Consider Corrective Action costs/operation as part of your closure determination
- Monitoring well network design
- Statistical analysis
- Data validation

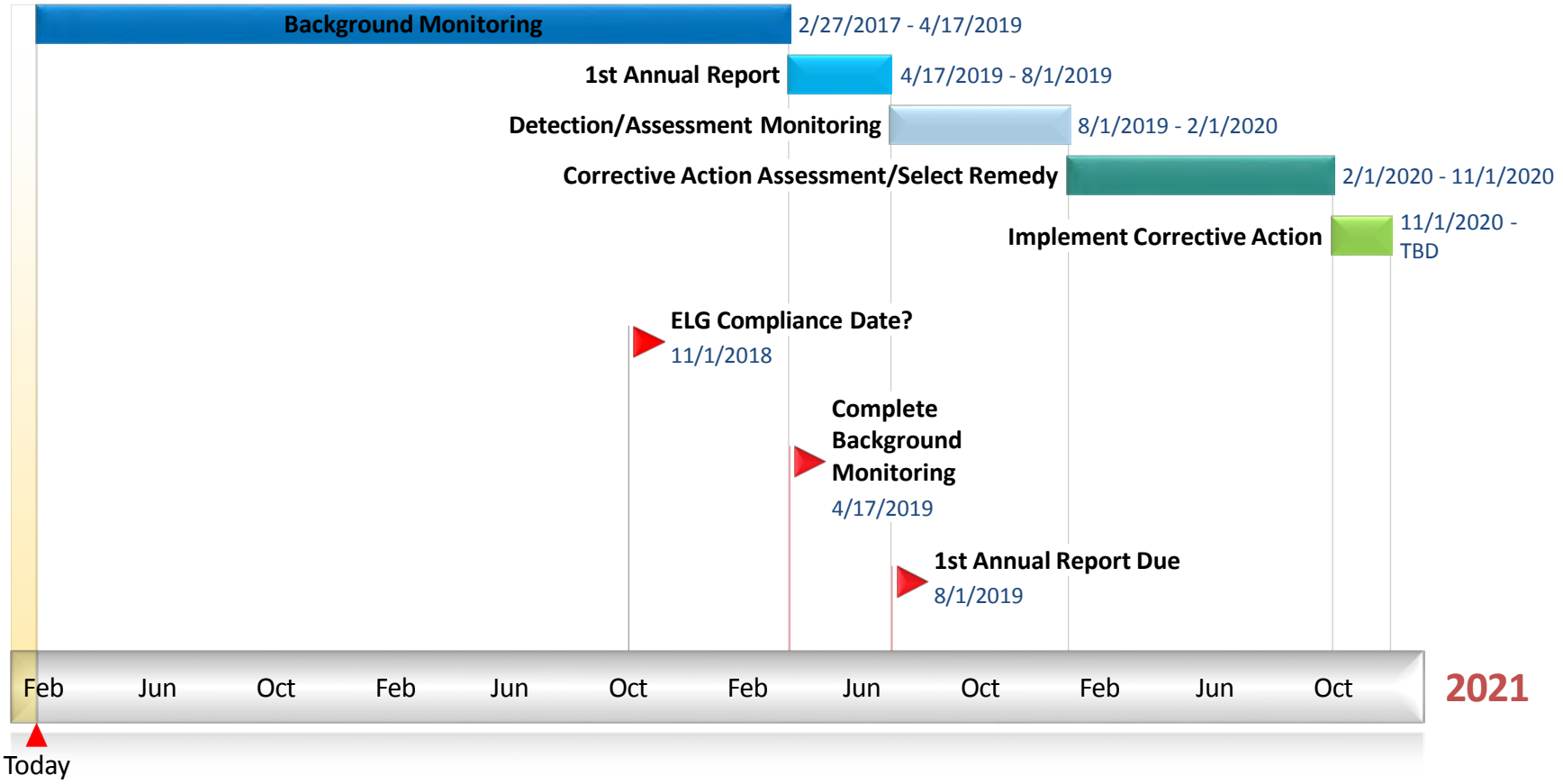
Corrective Action

- #1 Objective – minimize or eliminate remediation
- Corrective Action Studies
- Risk Assessments
- Cost Modeling

Corrective Action Compliance Strategies

- Monitored natural attenuation
- Institutional controls
- Hydraulic capture/containment
- In-situ treatment
- Ex-situ treatment
- Excavation/disposal
- Capping
- Combined remedies
- Solidification/Stabilization
- Phytoremediation
- Passive/reactive treatment barriers

Implement Corrective Action – Inactives

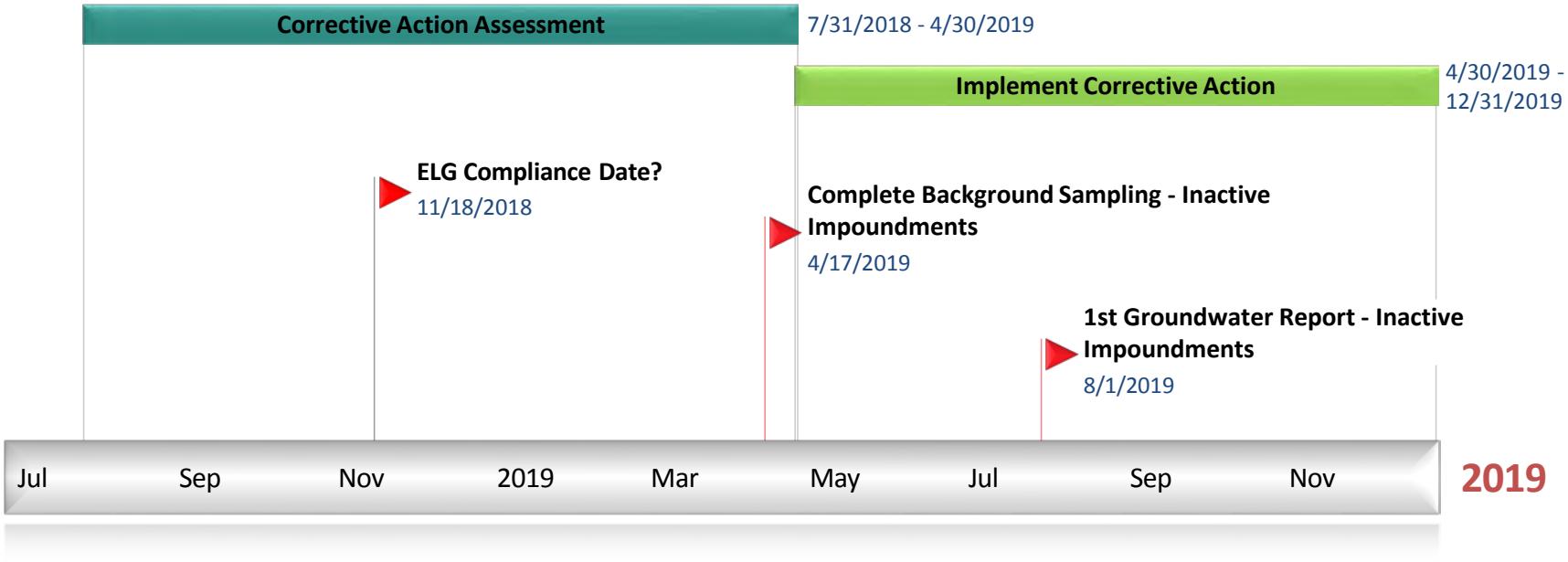


Case Studies

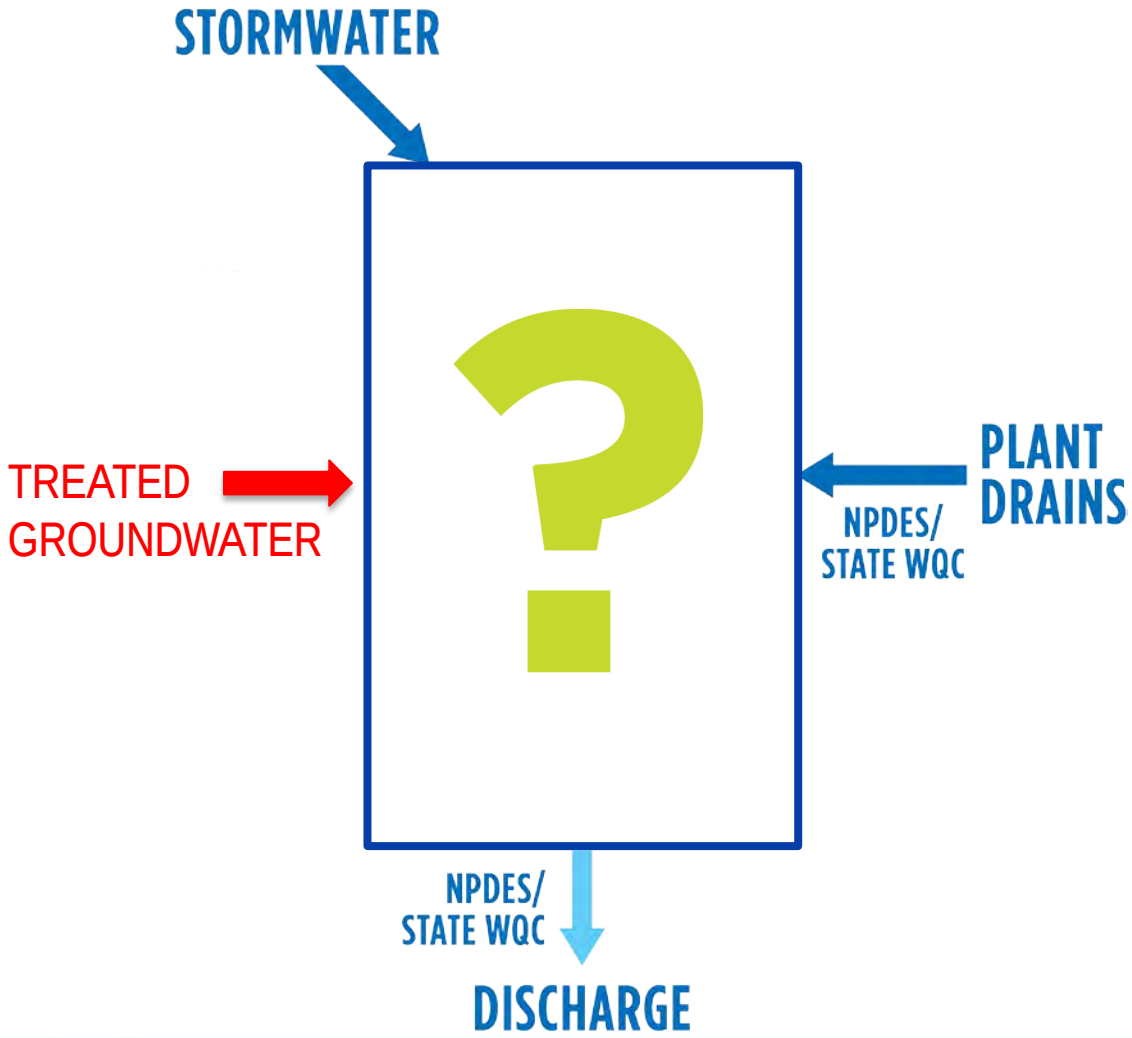
Case Study 1: Impoundments in Series

- One impoundment is classified as active
- Two impoundments are classified as inactive and have begun the process for closure
- ELG compliance date is November 1, 2018

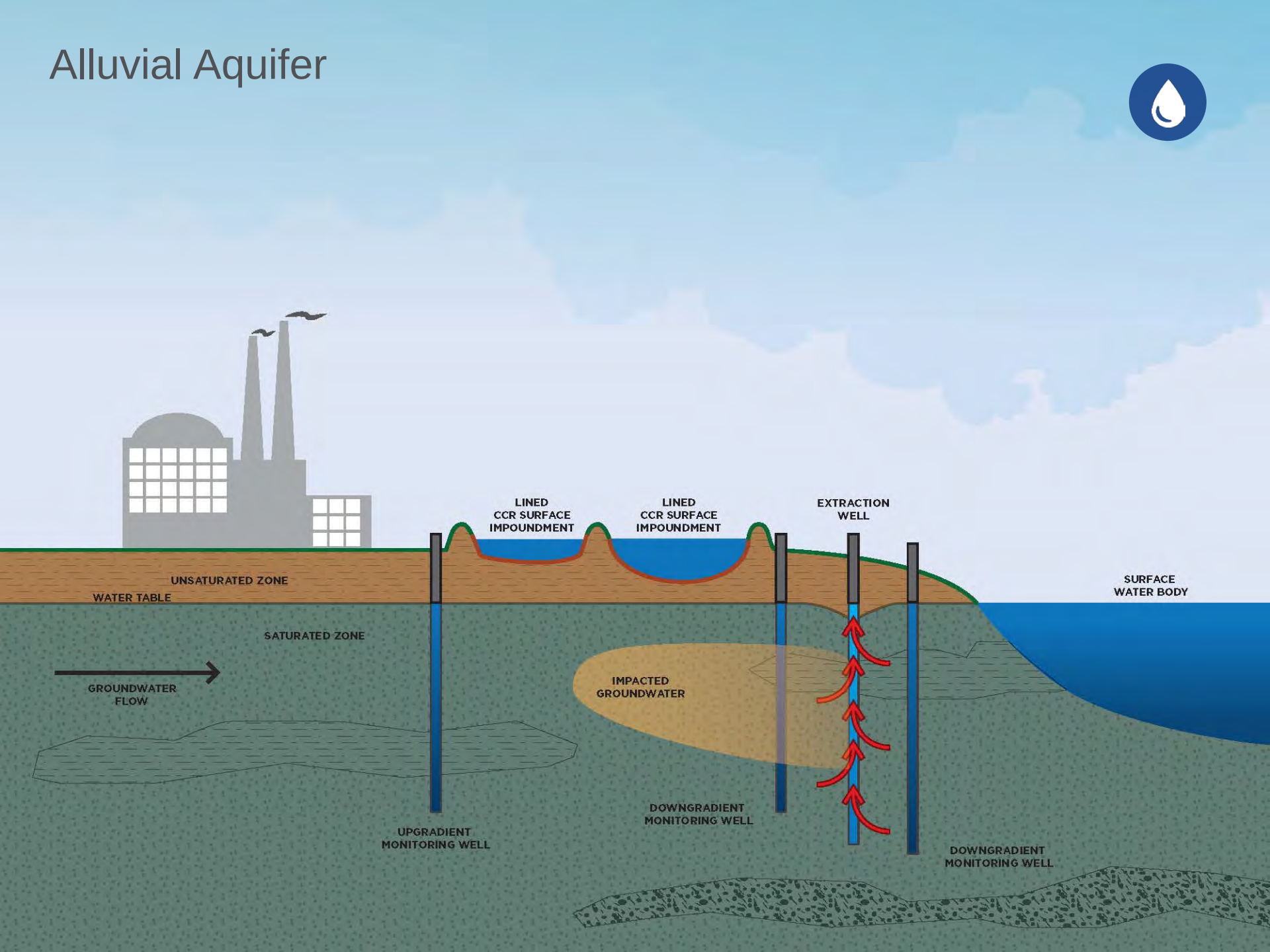
Case Study 1: Impoundments in Series



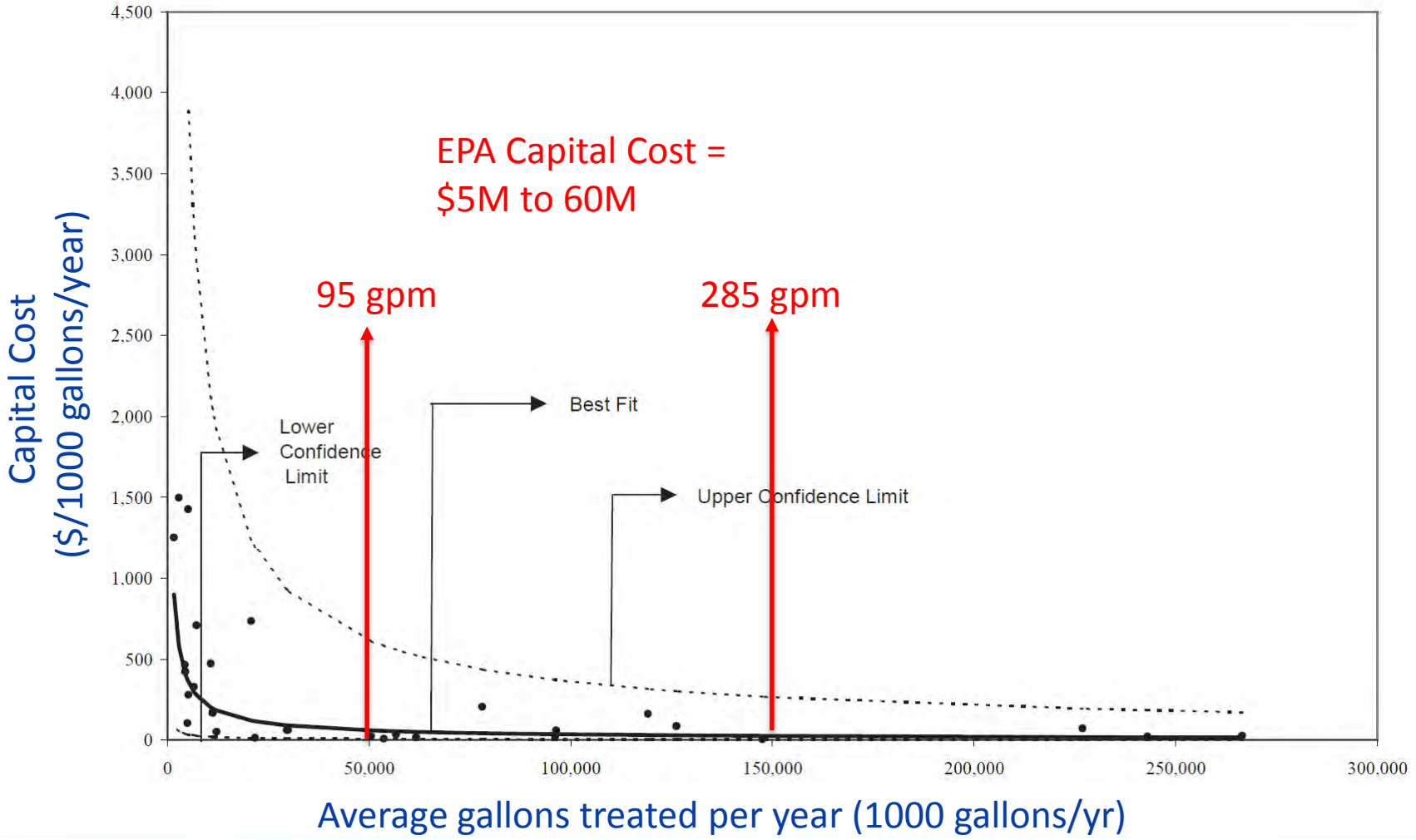
Case Study 2: Water Balance Management



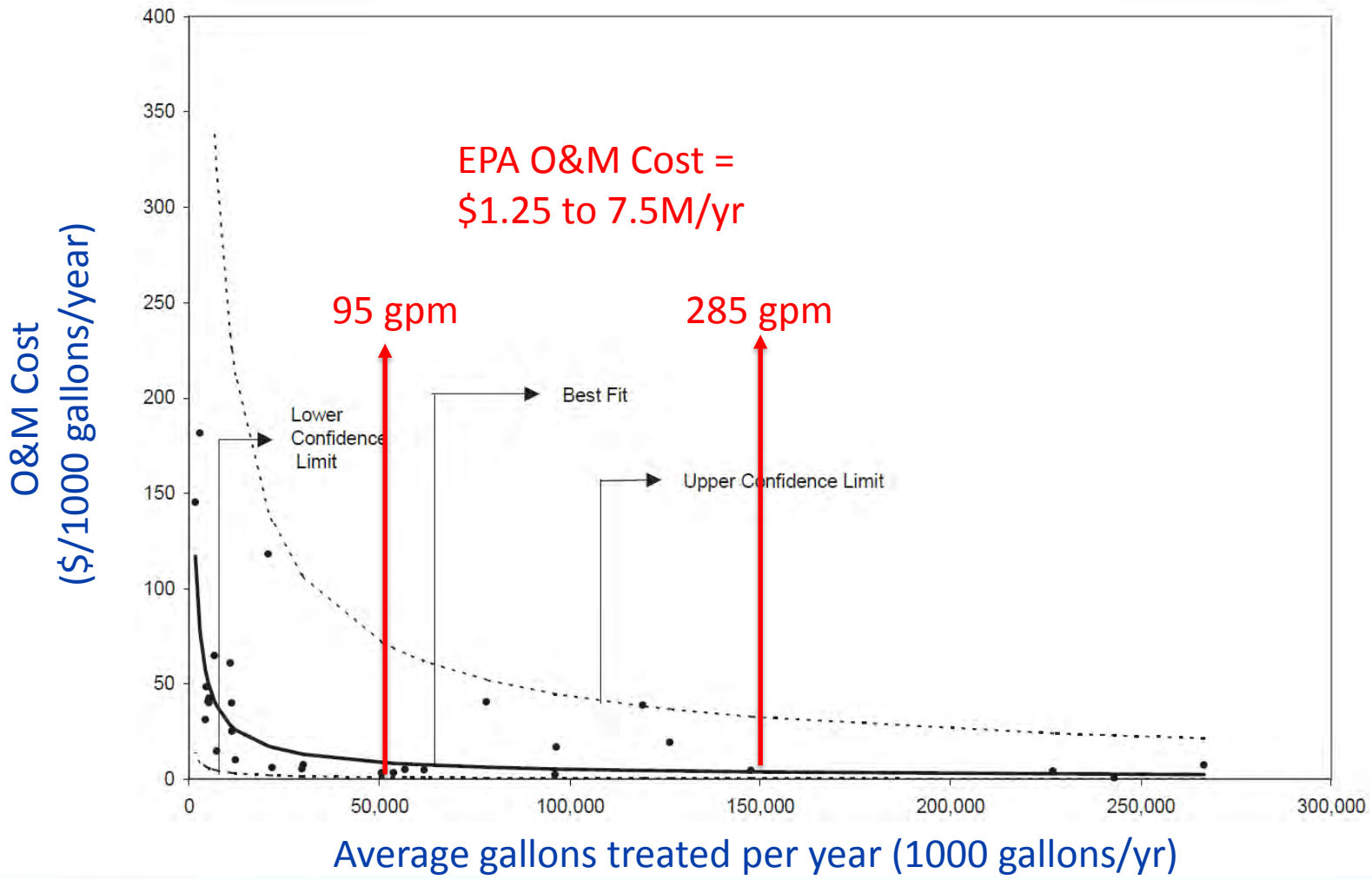
Alluvial Aquifer



Treated Groundwater – Capital Cost



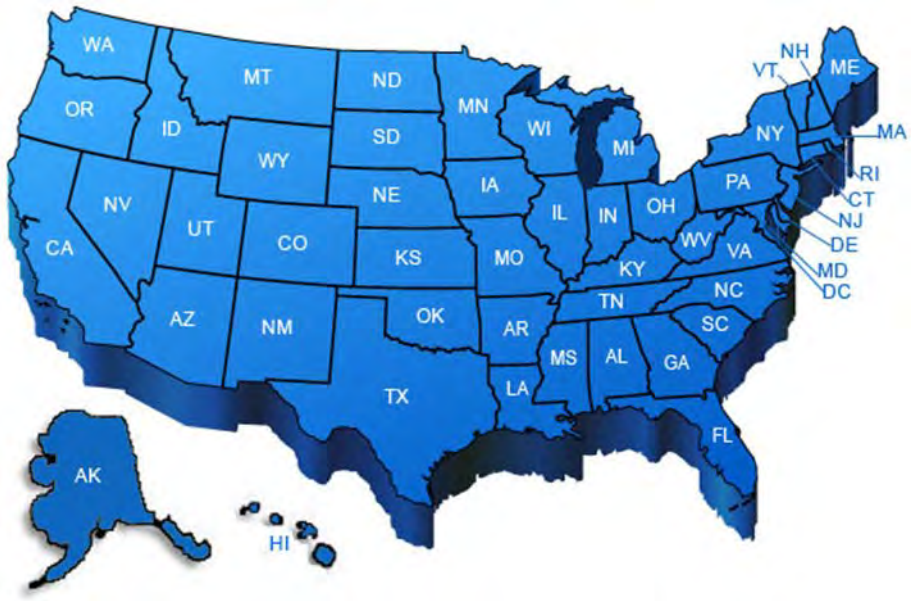
Treated Groundwater – O&M Cost



Groundwater Management: Holistic Strategies

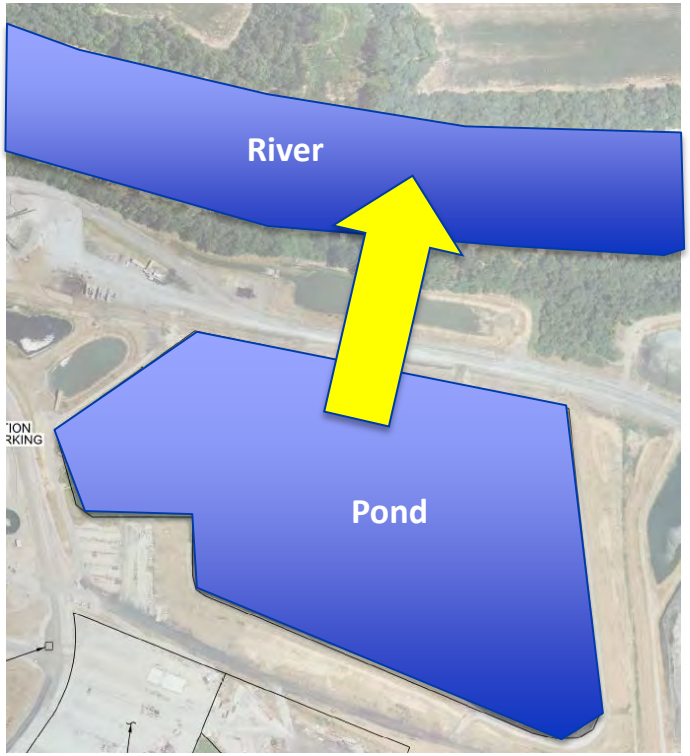
A Complex Problem Requires Planning

- Impoundment Closure Methods
  - Clean Closure vs. Cap In Place
- Corrective Action Strategies
  - Water treatment capacity
  - Plant water balance
  - Capital vs O&M
  - Risk Profile
- Permitting
  - Discharge options will be state specific
  - NPDES permit modifications?
  - Temporary discharges?



Case Study 3: New Process Water Ponds?

- 2 Units at 250 MW – Midwest Location
- Project began in 2016
- Current ash pond receives flow from:
  - Coal Runoff Pond
  - Landfill Runoff Ponds
  - Rainfall runoff
  - Various process streams
    - Bottom ash sluice, pyrites, and economizer ash
    - Boiler area sumps
    - RO Reject
  - Outage flows:
    - Metal cleaning wastewater



Pond Sizing Considerations

- TSS– Coal Pile Runoff
- Water Quality – Past Sampling Data
- Residence time – Target ELG Limit of 30 ppm TSS
- Footprint available – 26 acres
- Rainfall – Plant Runoff

Stream Name	S.G.	Daily Capacity %	TSS (mg/L)	Volumetric Flow (GPM)	Volumetric Flow (L/min) Avg
Process Drains	2	100%	150	322	1,220
Stormwater	2	5%	136	16,112	3,050
Coal Pile Runoff	1.4	5%	240	3,444	652

25-Year Storm Rainfall (in):	5.5
Average Annual Rainfall (in):	46
Equivalent Number of 25-Year Storms:	8.36

Process Streams

Stream Description	Average Flow, GPM	Adjusted Flow, GPM
Misc. Drains	200	200
Metal Cleaning Wastes	15	15
Bottom Ash Sluice System	4,500	-
Bottom Ash Hopper Seal Water	1,700	-
Unit 1 Boiler Sump	2	2
Unit 2 Boiler Sump	2	2
Clarifiers A+B	104	104
Total	6,522	322

Process Streams

Stream Description	Average Flow, GPM	Adjusted Flow, GPM
Misc. Drains	200	200
Metal Cleaning Wastes	15	15
Bottom Ash Sluice System	4,500	-
Bottom Ash Hopper Seal Water	1,700	-
Unit 1 Boiler Sump	2	2
Unit 2 Boiler Sump	2	2
Clarifiers A+B	104	104
Total	6,522	322

TSS Loading– Settling in Pond

- Coal Pile Runoff is design

Stream Type	Average TSS, ppm	Max TSS, ppm
Coal Pile Runoff	60	240
Storm Water	75	140
WWT Effluent	5	5
CTBD	50	50

Rainfall

- 25 Year, 24-Hour Storm Event

Runoff Streams	Flow, GPM
Coal Pile Runoff	3,444
Plant Area Runoff	2,462
Runoff Pond A	884
Runoff Pond B	3,726
Runoff Pond C	6,348
Rainfall	2,124

	Coal Pile Runoff Pond	Plant Island area runoff	Misc. Drains	Runoff Pond A	Runoff Pond B	Runoff Pond C	Combined Flow to Ash Pond	ELG Limit	Current NPDES Limits
	3444	2462	200	884	3726	6348	19171		
Water Analysis									
pH	4.2	8.1	6.50	9.10	7.7	7.7	7.32		6-9
Acidity	3298.85	--	--	--	--	--	592.63		
Arsenic	.0019	.0014	0.01	0.138	.0499	.0499	0.06	0.01	
Chromium	.0017	.0007	0.00	ND	.0017	.0017	0.02	0.20	0.2 mg/L
Copper	.021	.006	0.01	ND	ND	ND	0.03	1.00	1.0 mg/L
Iron	67.3	.545	14.06	0.035	.727	.727	16.13		1.0 mg/L
Mercury	ND	ND	0.00	ND	.0002	.0002	0.00	0.001	
Selenium	.020	ND	0.01	0.019	.004	.004	0.01	0.02	
Zinc	.49	ND	0.03	0.02	.02	.02	0.10	1.00	1.0 mg/L
Oil and Grease	ND	ND	5.07	ND	ND	ND	0.52	20.00	17 mg/L
Total Dissolved Solids	3730	244	101.75	2560	4050	4050	3,128.48	50 (BAT)	
Total Suspended Solids	28.8	43	113.00	6.6	31.2	31.2	168.00	30	30 mg/L
Chloride	576	12.6	9.46	187	975	975	646.89		1200 mg/L
Nitrate as N	1	.8	--	ND	1.4	1.4	1.03	17.00	
Nitrite as N	ND	ND	--	ND	ND	ND	--	17	

	Coal Pile Runoff Pond	Plant Island area runoff	Misc. Drains	Runoff Pond A	Runoff Pond B	Runoff Pond C	Combined Flow to Ash Pond	ELG Limit	Current NPDES Limits
	3444	2462	200	884	3726	6348	19171		
Water Analysis									
pH	4.2	8.1	6.50	9.10	7.7	7.7	7.32		6-9
Acidity	3298.85	--	--	--	--	--	592.63		
Arsenic	.0019	.0014	0.01	0.138	.0499	.0499	0.06	0.01	
Chromium	.0017	.0007	0.00	ND	.0017	.0017	0.02	0.20	0.2 mg/L
Copper	.021	.006	0.01	ND	ND	ND	0.03	1.00	1.0 mg/L
Iron	67.3	.545	14.06	0.035	.727	.727	16.13		1.0 mg/L
Mercury	ND	ND	0.00	ND	.0002	.0002	0.00	0.001	
Selenium	.020	ND	0.01	0.019	.004	.004	0.01	0.02	
Zinc	.49	ND	0.03	0.02	.02	.02	0.10	1.00	1.0 mg/L
Oil and Grease	ND	ND	5.07	ND	ND	ND	0.52	20.00	17 mg/L
Total Dissolved Solids	3730	244	101.75	2560	4050	4050	3,128.48	50 (BAT)	
Total Suspended Solids	28.8	43	113.00	6.6	31.2	31.2	Settling In Pond 168.00	30	30 mg/L
Chloride	576	12.6	9.46	187	975	975	646.89		1200 mg/L
Nitrate as N	1	.8	--	ND	1.4	1.4	1.03	17.00	
Nitrite as N	ND	ND	--	ND	ND	ND	--	17	

	Coal Pile Runoff Pond	Plant Island area runoff	Misc. Drains	Runoff Pond A	Runoff Pond B	Runoff Pond C	Com Flo		urrent PDES its
	3444	2462	200	884	3726	6348	171		
Water Analysis									
pH	4.2	8.1	6.50	9.10	7.7	7.7	32		9
Acidity	3298.85	--	--	--	--	--	63		
Arsenic	.0019	.0014	0.01	0.138	.0499	.0499	0.06	0.01	
Chromium	.0017	.0007	0.00	ND	.0017	.0017	0.02	0.20	0. mg/L
Copper	.021	.006	0.01	ND	ND	ND	0.03	1.00	1. mg/L
Iron	67.3	.545	14.06	0.035	.727	.727	16.13		1.0 mg/L
Mercury	ND	ND	0.00	ND	.0002	.0002	0.00	0.001	
Selenium	.020	ND	0.01	0.019	.004	.004	0.01	0.02	
Zinc	.49	ND	0.03	0.02	.02	.02	0.10	1.00	1.0 mg/L
Oil and Grease	ND	ND	5.07	ND	ND	ND	0.52	20.00	17 mg/L
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Chloride	576	12.6	9.46	187	975	975	646.89		1200 mg/L
Nitrate as N	1	.8	--	ND	1.4	1.4	1.03	17.00	
Nitrite as N	ND	ND	--	ND	ND	ND	--	17	

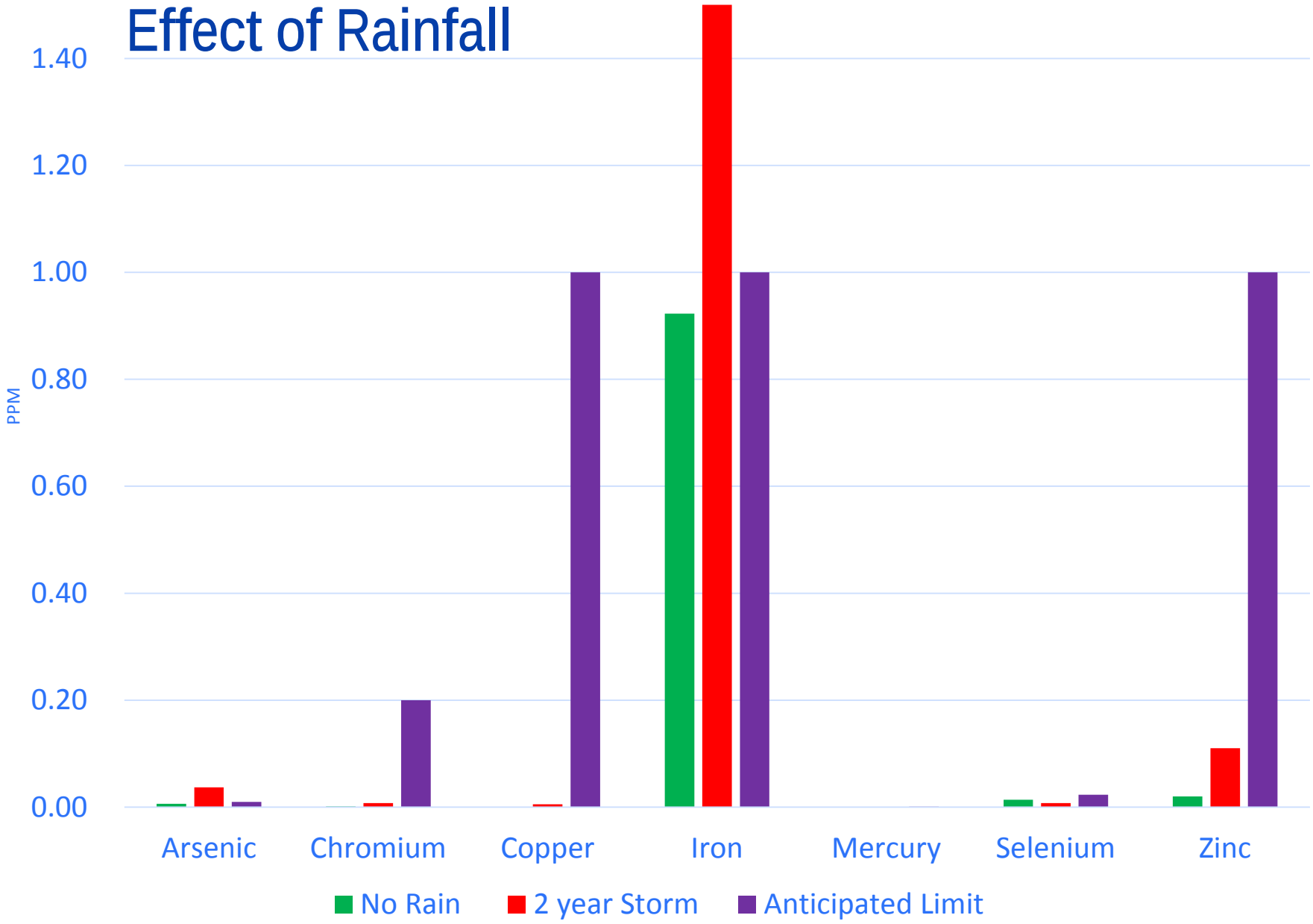
Additional Chemical Feed Needed

Settling In Pond

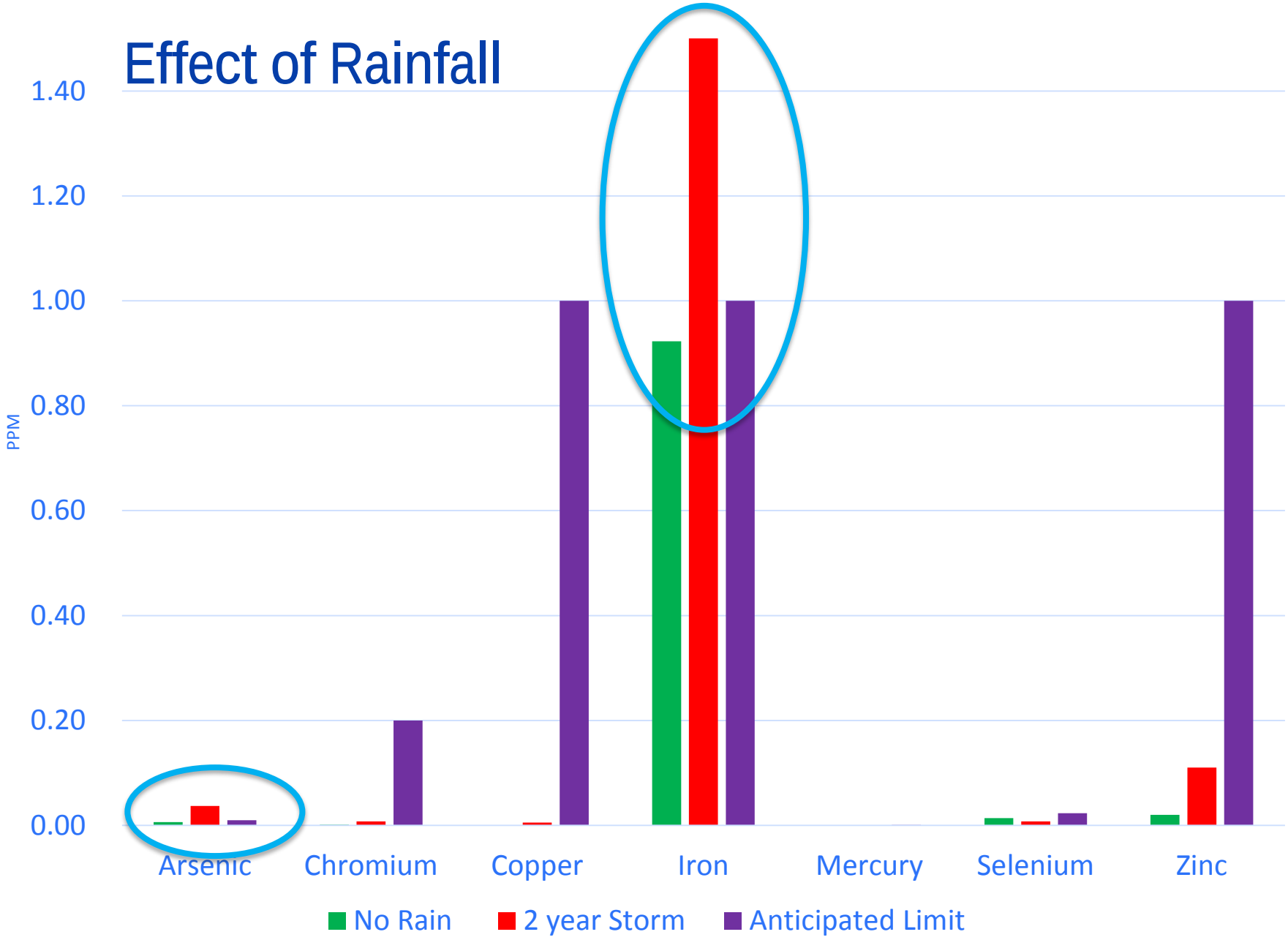
Water Mass Balance Pond - Chemical Feed

- Minimal Sampling Data Available
  - Future sampling plan developed to gather more complete data
- Chemical Feed System to account for Iron and Arsenic
  - Caustic – to regulate pH
  - Polymer – to promote metals settling
  - Acid – to regulate pH in event of algae blooms

Effect of Rainfall



Effect of Rainfall



Final Design – New Water Mass Balance Pond

- Required Acreage – 10 acres
- Available Acreage –
  - 20 acres (partial closure)
  - 26 acres with full removal
- Time to accumulate 1 ft of sludge – 4 years

Costs For Closure of Ash Pond

- Mobilization/Demobilization
- Dewatering
- General Site Prep
- Pond Solids Cut to Fill
- Pond Solids Excavate to Landfill
- Pipe Demolition
- Subgrade Compaction
- Composite Liner
- Protective Cover
- Slope Protection
- QA/QC
- Water Treatment Rental

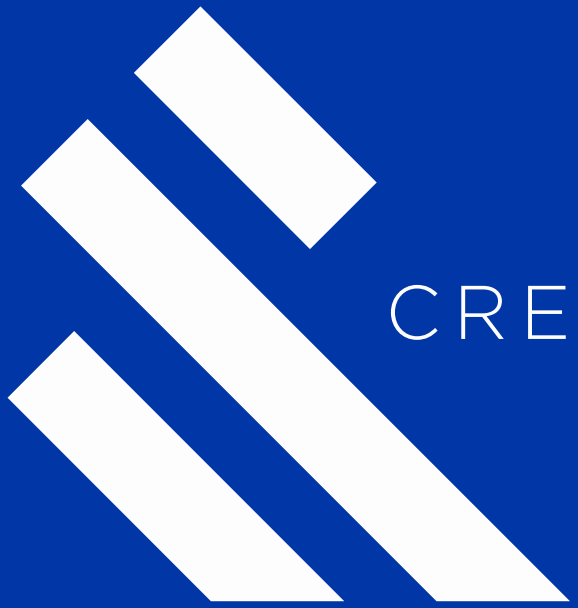
Total Costs (Direct, Indirect, Contingency) for Closure by Removal of CCR Material - $40 million

Conclusions

Conclusions

Start Planning Now

- Start evaluating groundwater data to determine whether or not groundwater impacts are probable
- Consider a Conceptual Site Model to get a detailed understanding of subsurface conditions on your site
- Corrective Action Assessment – do this now and get an appropriate range of costs in the budget
- Evaluate your current plant water balance; it is up to date? Need seasonal flow and constituent data
- Begin evaluation of an added water source; could this replace or decrease your current fresh water use?



CREATE AMAZING.

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