Green and Sustainable Remediation Analysis: Coal Ash Surface Impoundment Closure

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Fourth International Symposium on Bioremediation and Sustainable Environmental Technologies (Battelle)

May 24, 2017

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Background on Federal CCR Rule

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 257 and 261

[EPA–HQ–RCRA–2009–0640; FRL–9919–44–OSWER]

RIN–2050–AE81

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

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final rule.

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Background on Federal CCR Rule

Regulation

- April 2015: US EPA issued final rule covering the disposal of coal combustion residuals (CCR) from electric utilities

Requirements

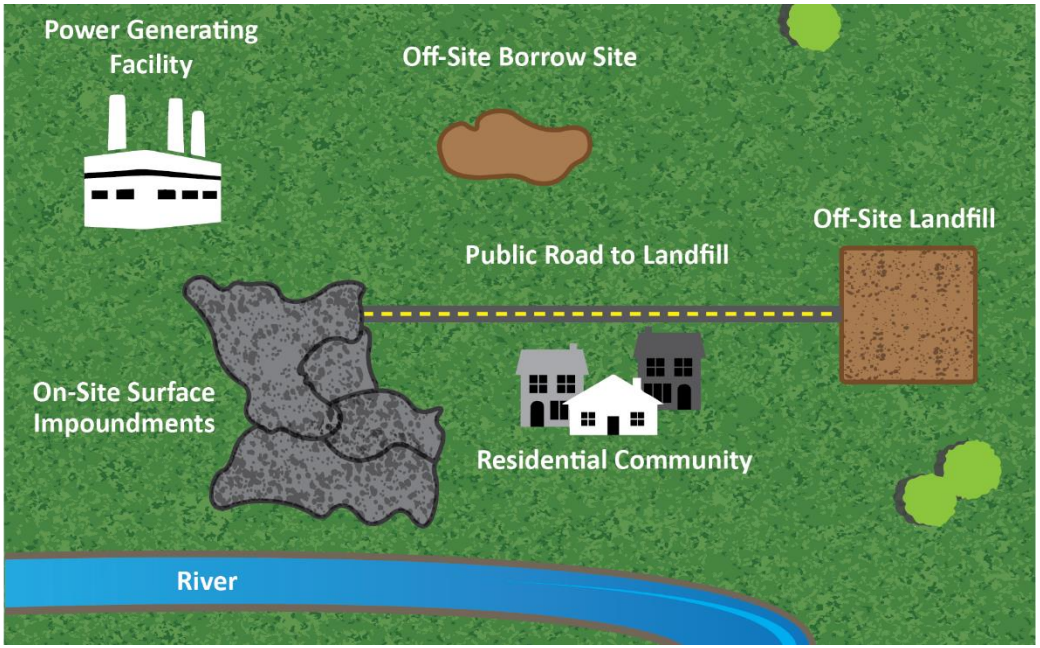
- Sets technical criteria for disposal unit location and structural integrity
- Sets groundwater protection requirements, including groundwater assessment and corrective action
- Requires closure for unlined CCR SIs that cause statistically significant groundwater concentration exceedances above relevant standards
- Active and Inactive SIs are subject to requirements of the rule

Results

- **Many SIs will be closed** due to failure to meet structural integrity, location, and/or groundwater monitoring requirements

Closure by Removal or Closure in Place?

- Safety and environmental sustainability can be scientifically evaluated for each alternative
- This is part of the EPRI Framework* to holistically evaluate closure options



*Electric Power Research Institute (EPRI), *Relative Impact Framework for Evaluating Coal Combustion Residual Surface Impoundment Closure Options*, 3002007543, 2016.

Environmental Impact Assessment

40 CFR 1502.14 Alternatives including the proposed action

This section is the heart of the environmental impact statement…it should **present the environmental impacts of the proposal and the alternatives in comparative form**, thus sharply defining the issues and providing a **clear basis for choice among options by the decisionmaker and the public**.

Estimated costs for SIs ranging from 10 to 250 acres:

- Closure in Place ($) - $3.5M to $150M per SI
- Closure by Removal ($$$) - $15M to $2,700M per SI

Framework for Comparing Closure Alternatives

Complexity

Pathway	Contaminant Release	Contaminant Concentrations	Regulatory Benchmark Analysis	Risk Assessment
Groundwater (GW) CCR Leaching to GW	Total flux	Time-weighted average	Time above maximum contaminant level (MCL) State Criteria	Drinking water
Surface Water (SW) CCR Leaching to GW & Discharge to SW	Total flux	Time-weighted average	Time above MCL Time above aquatic benchmark	Drinking water Recreator Fish ingestion Aquatic organisms
Air Fugitive Particulate Matter (PM) & Diesel	Total emissions	PM_{10} and $PM_{2.5}$	Time above National Ambient Air Quality Standard (NAAQS)	Inhalation risks
CCR Direct Contact	N/A	N/A	N/A	Dermal Incidental ingestion

Data needs and level of analysis

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Framework for Comparing Closure Alternatives

Topic of This Presentation

Complexity

Pathway	Case study methodology	Other possible metrics
Sustainability	Greenhouse gas emissions NO_x, SO_x, PM_{10} air emissions Energy consumption Water usage Resource consumption	Land use/value Monetization Noise/vibration Environmental Justice
Safety	Worker injuries and fatalities Truck accidents leading to: -Truck driver injuries and fatalities -Community injuries and fatalities	Years of Potential Lost Life

Data needs and level of analysis

Evaluated Metrics

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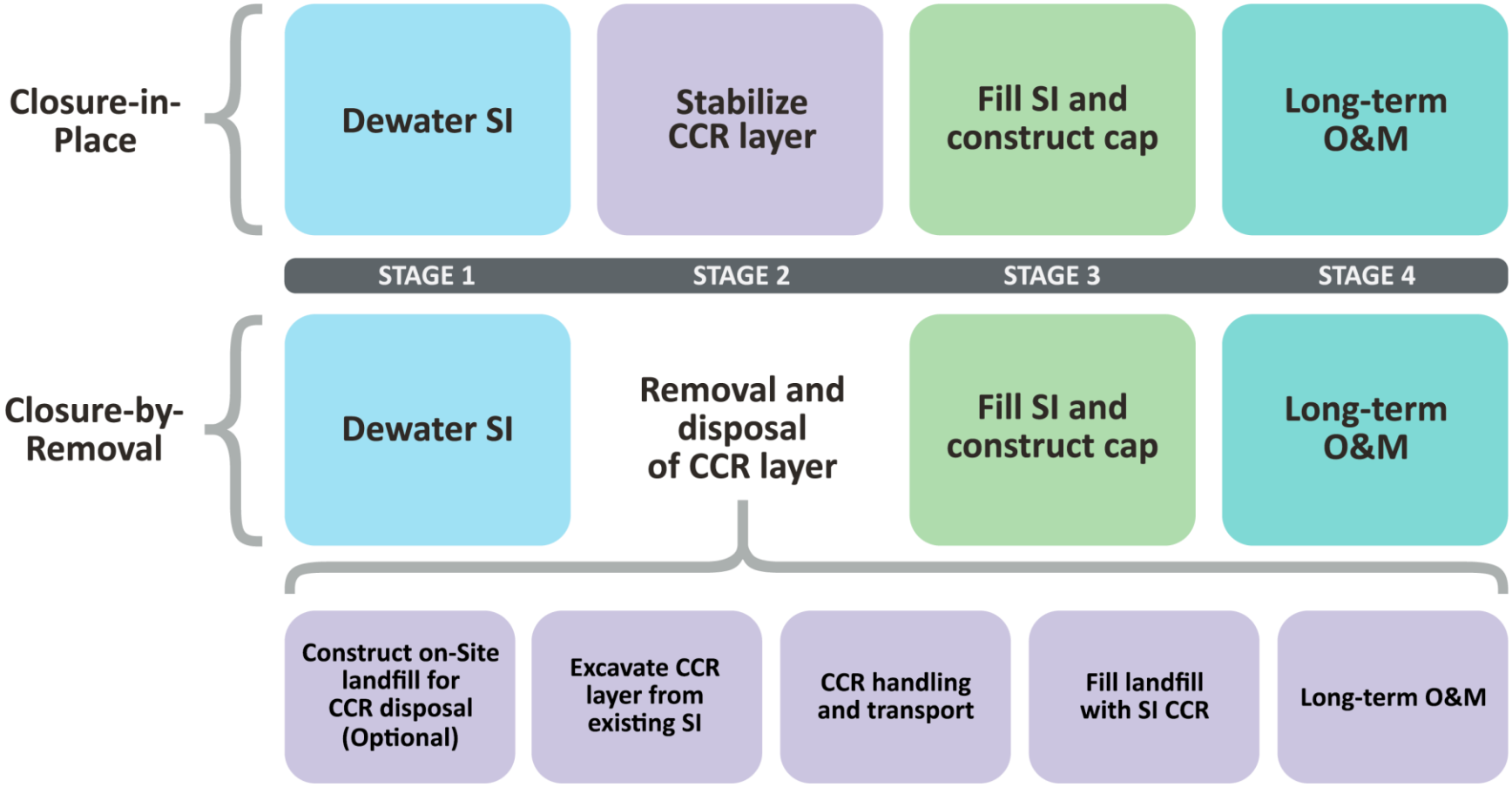
Outline

- Methodology
- Results from Case Studies
- Conclusions

Define work elements for each closure option



Estimate Sustainability Impacts

SiteWise™ provides calculation sheets and default lookup tables for estimating the environmental footprint of remedy alternative components.

Key Inputs
Material usage
Water and electricity usage
Equipment use
Personnel, materials, and equipment Transportation

Key Outputs
Total energy consumption
Greenhouse gas emission
On-site and total SO_X
On-site and total NO_X
On-site and total PM_{10}

Estimate Sustainability Impacts

Example: Environmental Impacts of a hypothetical work element evaluated using SiteWise™

Earthwork Equipment

Equipment Type	Power	Hours
Excavator	150 HP	5,000
Dozer	335 HP	4,500

Personnel hours and Transport

Type	Hours	Distance traveled (mile)
Construction laborers	13,000	15,000
Site supervisors	2,000	2,000
Engineers	400	500

Material Use and Transport

Equipment Type	Weight (ton)	Distance from Source (mile)
HDPE Liner	700	50
Geocomposite	380	50
Top Soil	12,000	10

	GHG Emissions (ton)	Energy Used (MMBTU)	NOx Emission (ton)	SOx Emission (ton)	PM10 Emission (ton)
Consumables	2,741	92,686	7	11	2
Transportation-Personnel	7	84	0	8.69E-05	5.01E-04
Transportation-Equipment	0	0	0	0	0
Equipment Use and Misc.	208,206	11,560	1	5	1

Estimate Worker Risks

Analysis of fatality/injury rates ("Incidence Rates") published by US Bureau of Labor Statistics

- Incidence Rate = (N/EH) x 20,000,000

Notes: (N/EH) = Injuries/hour worked. 20,000,000 = 10,000 FTEs (40 hrs/wk x 50 wks/yr).

Example – 2013 Nonfatal Occupational Injuries

Occupation	Incidence Rate (per 10,000 workers)	Number of Injuries (N)	Total Hours (EH)
Overall	109.4	1,162,210	2.1E+11
Police	490.9	28,170	1.2E+09
Construction Laborers	302	20,710	1.4E+09
Engineering	17	3,510	4.18E+09

Estimate Community and Worker Risks from Truck Crashes

Output Parameters	Remedy Parameter Required	Data Source
Number of large truck crashes	Truck mileage driven	US Department of Transportation; Large Truck and Bus Crash Facts
Number of large truck crashes with fatalities		
Number of large truck crashes with injuries		
Occupant (truck driver) fatalities/injuries	Truck mileage driven	US Department of Transportation; Large Truck and Bus Crash Facts
Non-occupant (community) fatalities/injuries		

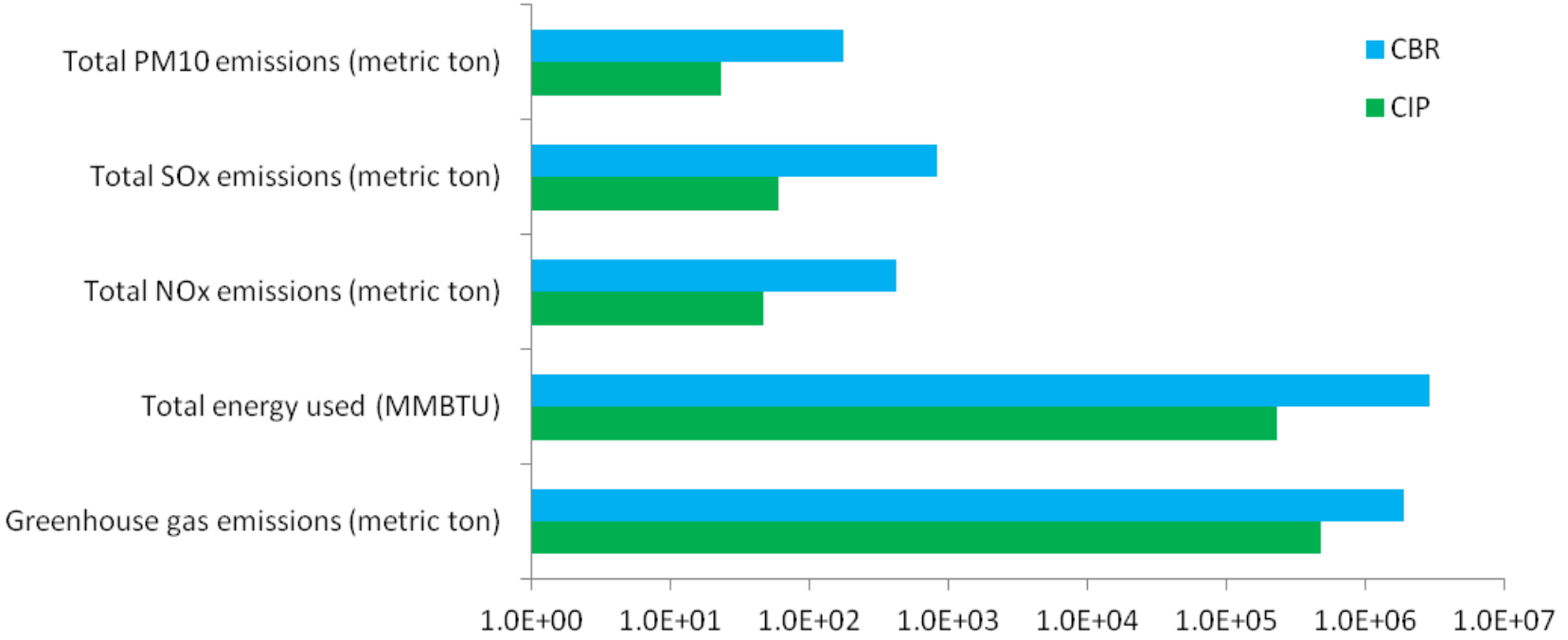
Outline

- Methodology
- Results from Case Studies
- Conclusions

Case Study Sites

Site	Site A	Site B
SI Area (acres)	90	371
CCR Volume (yd^3)	3.6M	10.4M
Distance to Landfill (miles)	20	37
Distance to Closest Community (miles)	2	0.1
Average CCR Thickness (feet)	25	20
Distance to Soil Depot (miles)	10	10
Dump Truck Capacity (yd^3)	15	15

Results - Sustainability Metrics (Site A)

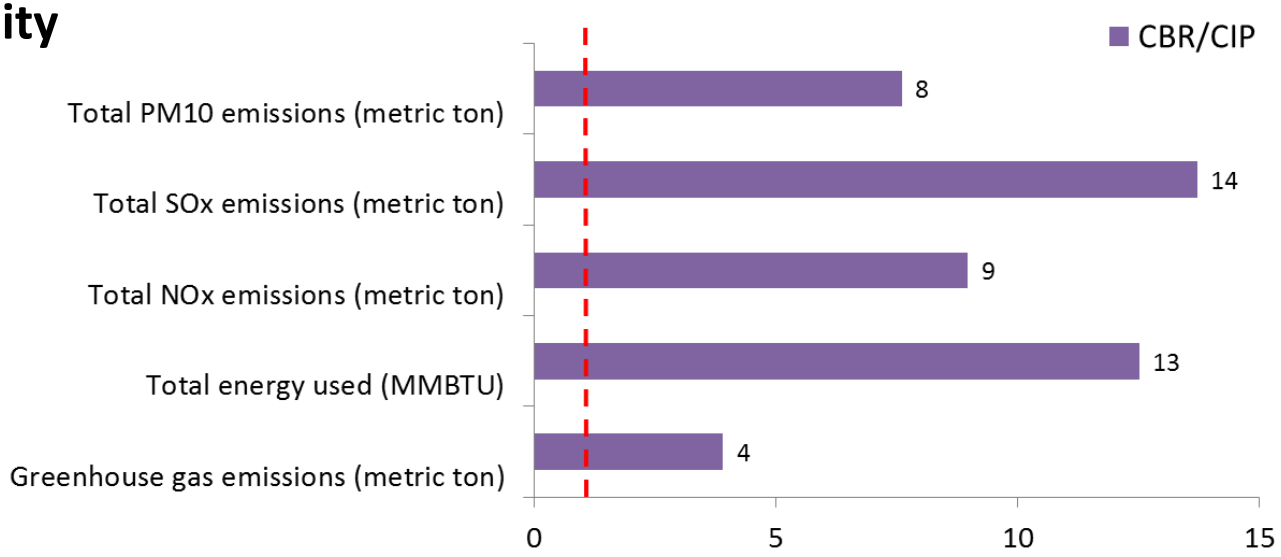


Outcome Metric	CIP	CBR
Greenhouse gas emissions (metric ton)	481,052	1,884,452
Total energy used (MMBTU)	229,001	2,868,140
Total NO_x emissions (metric ton)	47	422
Total SO_x emissions (metric ton)	60	823
Total PM_{10} emissions (metric ton)	23	175

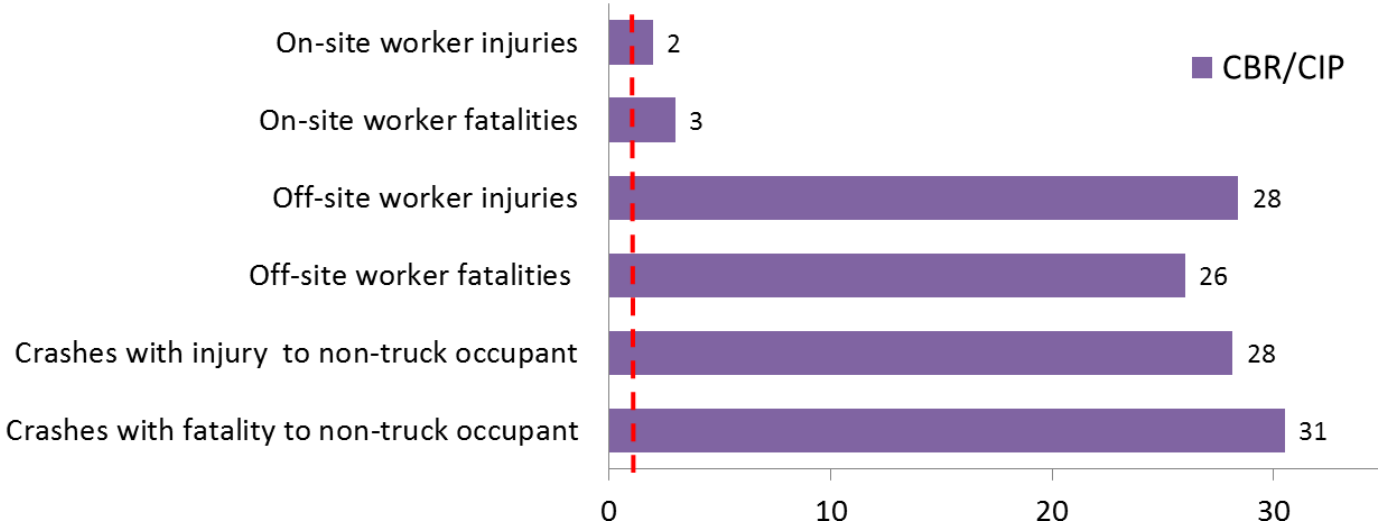
CBR = Closure by Removal; CIP = Closure in Place

Impacts – Sustainability and Safety (Site A)

Sustainability



Safety



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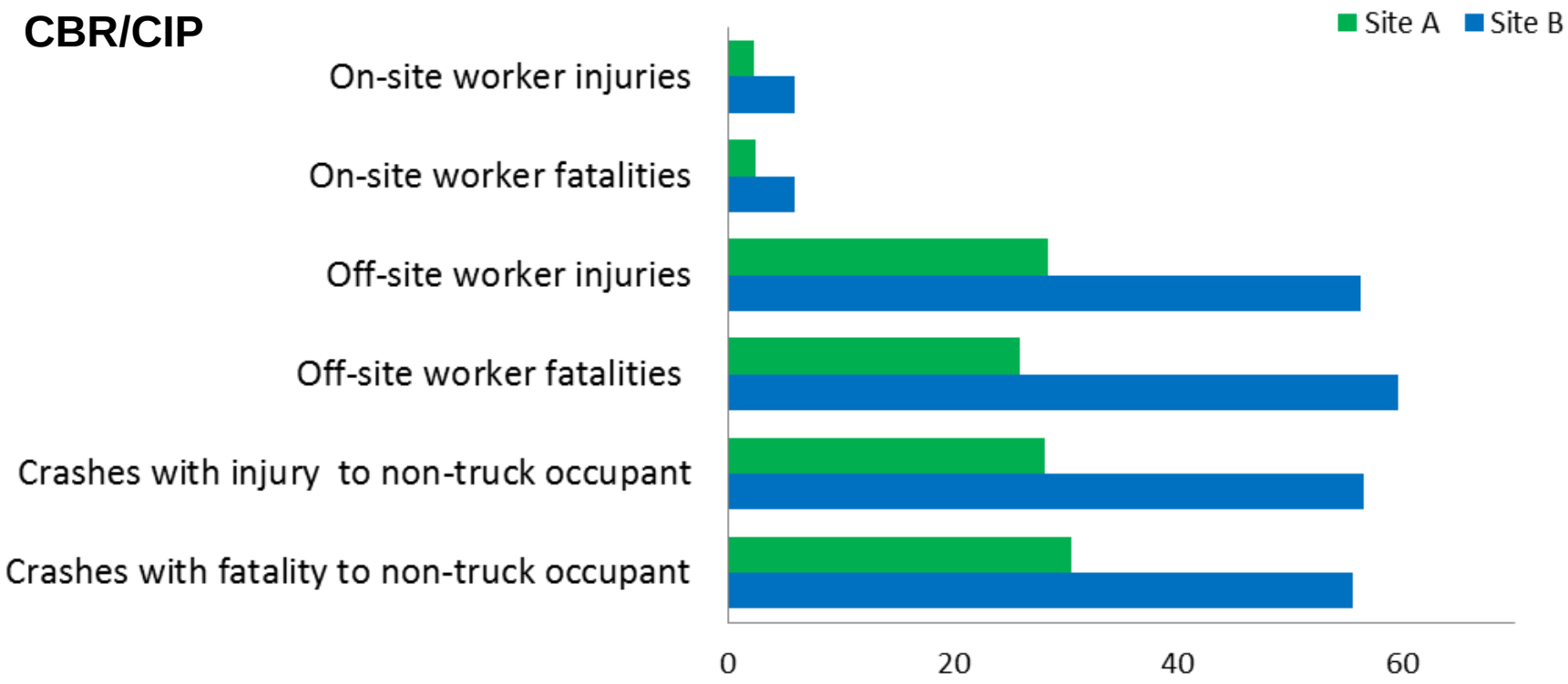
Similar Method, Different Site

CBR/CIP



Site	CCR Volume	Distance to Landfill
A	3.6M cys	20 miles
B	10.4M cys	37 miles

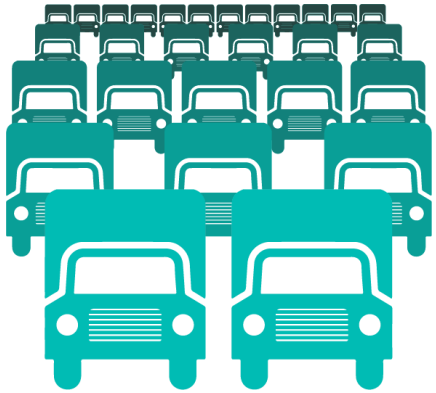
CBR = Closure by Removal; CIP = Closure in Place

The Impact of Trucks (Site A)

	Parameter	Value
SI Parameters	SI Area	90 acres
	Average CCR Thickness	25 feet
	CCR Volume	3,630,000 yd^3
Assumptions	Truck Capacity	15 yd^3
	Truck Trip/day	100 roundtrips
	Work hours	5 days/week, 8 hours/day
Calculations	Total Truck Trips	240,000 round trips
	CCR Removal Time	9 years
	Interval between trucks seen on roads	5 minutes each trip leg

Summary of Outcome Metrics (Site A)

Truck Activity & Community Risks



CBR is 28x CIP

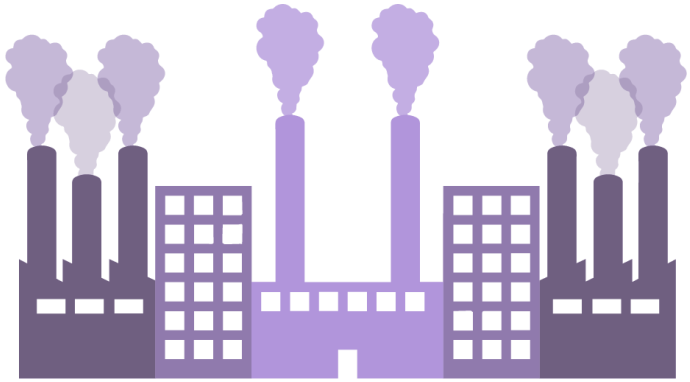
Worker Risks

CBR is 3x CIP

Energy Consumption

CBR is 12x CIP

Air Emissions

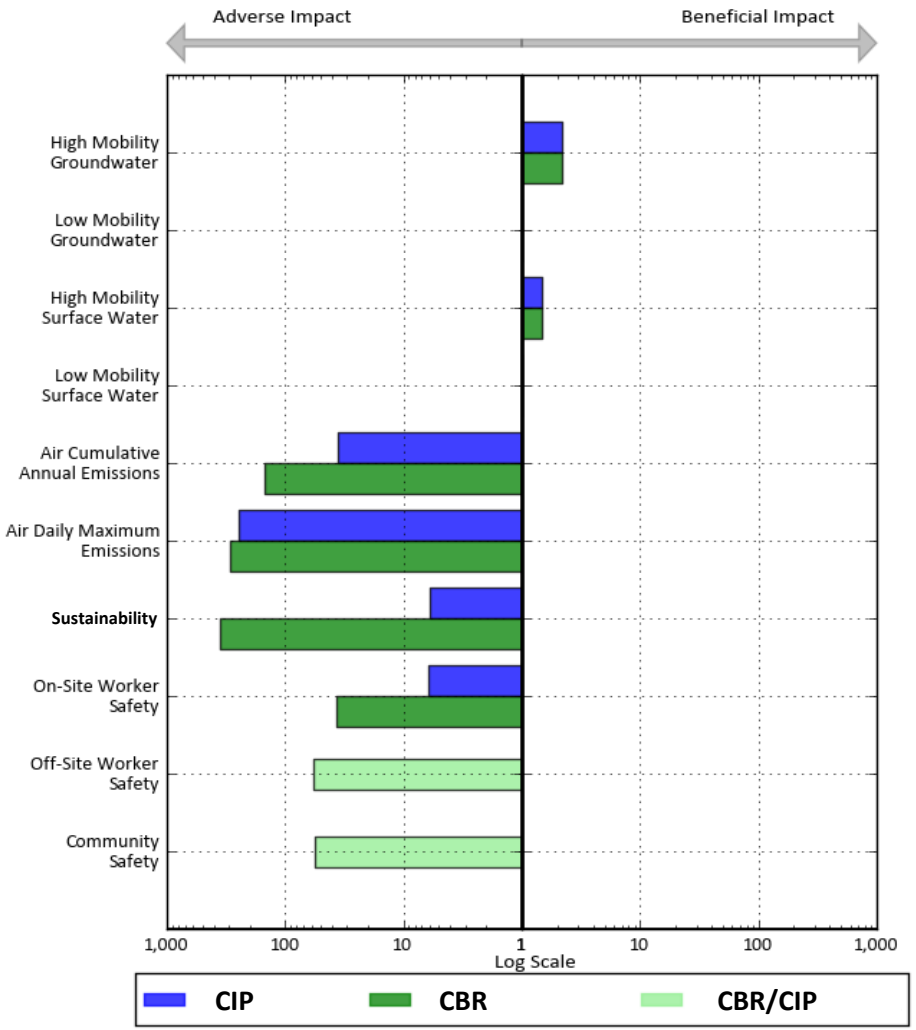


CBR is 8x CIP

CBR = Closure by Removal; CIP = Closure in Place

How does this relate to the Framework?

- High mobility constituents in groundwater and surface water:
  - Both CIP and CBR have beneficial impacts compared to baseline
  - CIP and CBR have similar results
- Air:
  - Both CIP and CBR have adverse impacts compared to baseline
  - CBR has more adverse impacts than CIP, especially when considering cumulative emissions over the time period of closure
- Sustainability and safety:
  - Both CIP and CBR have adverse impacts compared to baseline
  - CBR impact is more adverse



CBR = Closure by Removal; CIP = Closure in Place

Conclusions

- Provides a well-precedented, scientifically-defensible method to evaluate closure adverse impacts (and benefits)
- Adverse impacts of CBR were always greater than CIP, up to 20-fold, depending on the outcome metric
- Promotes selection of a more protective & sustainable closure alternative

CBR = Closure by Removal; CIP = Closure in Place

Questions?

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Further Information: Electric Power Research Institute (EPRI), *Relative Impact Framework for Evaluating Coal Combustion Residual Surface Impoundment Closure Options*, 3002007543, 2016.

Electric Power Research Institute (EPRI), *Relative Impact Framework Application for a Hypothetical Coal Combustion Residual Surface Impoundment*, 3002007544, 2016.

Herman, K. 2014. "Actuarial risk analysis to promote National Contingency Plan (NCP)-consistent remediation." *Remediation* 24 (3):11-19.