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A Step-by-Step Approach to Decarbonization through Performance-Based Remedial Design

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Motivation and Context

- Decarbonization and sustainability
- Design Phase for regulator to bid

Steps and Agenda:

1. Understand Scope
2. Understand Performance
3. Create Design Specifications
4. Expected Benefits & Costs
5. Support Stakeholders and Regulatory Agency During Bidding

1. Understand Scope

1. Understand Scope → 2. Understand Performance → 3. Create Design Specifications → 4. Expected Benefits & Costs → 5. Support Stakeholders and Regulatory Agency During Bidding

- Which scope elements can be considered: **equipment, materials, transportation, energy source, water use, or waste management?**






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- Understand relevant policy and client requirements and preferences
- Identify potential best management practices and ideas

ASTM INTERNATIONAL

Designation: E2893 – 16$^{\varepsilon 1}$

Standard Guide for Greener Cleanups[1]

E2893 – 16$^{\varepsilon 1}$

TABLE X3.1 Greener Cleanup BMP Table

Category	Best Management Practice	Core Element Addressed (at Site Level)					Remediation Technology											
		Energy	Air	Water	Materials and Waste	Land and Ecosystems	Soil Vapor Extraction	Air Sparging	Pump and Treat	In-situ Chemical Oxidation	Bioremediation/MNA	In-situ Thermal Treatment	Phytotechnology	Subsurface Containment & Treatment Barriers	Excavation and Surface Restoration	Ex-situ Bio/Chemical Oxidation	Landfill Covers and Caps	Vapor Intrusion Mitigation
Buildings	Capture roof runoff for on-site use, as appropriate based on the water quality			X			X	X	X			X				X		
Buildings	Choose water efficient plumbing fixtures (for example, low flow fixtures, tankless water heaters)			X			X	X	X									
	Install a green roof on buildings to																	

EPA United States Environmental Protection Agency

Green Remediation

Best Management Practices (BMPs) for...

- Excavation and Surface Restoration (PDF) (5 pp, 286K) *Update*
- Site Investigation and Environmental Monitoring (PDF) (4 pp, 179K) *Update*
- Pump and Treat Systems (PDF) (6 pp, 673K) *Update*
- Bioremediation (PDF) (4 pp, 493K) *Update*
- Soil Vapor Extraction & Other Air-Driven Systems (PDF) (4 pp, 457K) *Update*
- Cleaner Fuels & Air Emissions for Site Cleanups (PDF) (5 pp, 425K) *Update*
- Integrating Renewable Energy (PDF) (6 pp, 840K) *Update*
- Sites with Leaking Underground Storage Tanks (PDF) (4 pp, 216K) *Update*
- Waste Cover Systems and Integrated Site Reuse Planning (PDF) (5 pp, 641K) *Update*
- Mining Sites (PDF) (6 pp, 535K)
- Implementing In Situ Thermal Technologies (PDF) (6 pp, 249K)
- Materials and Waste Management (PDF)

2. Understand Performance

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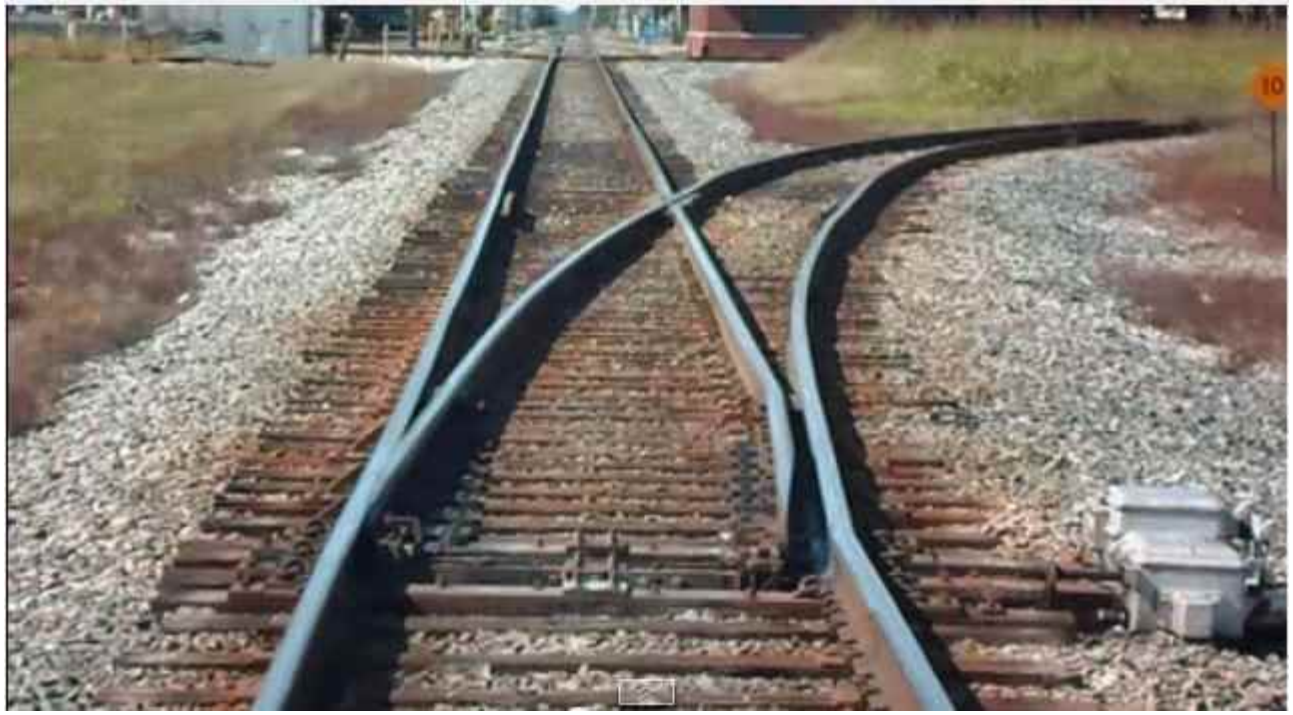
How do you ensure biddability of modifications?

Evaluate feasibility of potential modifications

- Research market availability
- Understand costs and benefits of specific modifications
- **Is it appropriate to include in the RD?**



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Hard

DPT drilling only

3.3 IDLE REDUCTION

Ensure compliance with the three-minute idling limit, pursuant to N.J.A.C. 7:27-14 and N.J.A.C. 7:27-15 for all on-road vehicles and non-road construction equipment operating at, or visiting, the construction site.

Target (Performance-Based)

- XX% reduction in carbon emissions (vs baseline)
- XX% of materials must have recycled content
- XX% of equipment should be electric (pending availability)

Soft

- “To the extent feasible…” – with an option for feedback

Document in the Sustainability Action Plan, a designated collection point for recycling uncontaminated single-use items such as metal, plastic and glass containers; paper and cardboard; and other consumable items. If this is not possible, provide an explanation in the Sustainability Action Plan.

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Table 01 33 29 – 1 Comparison of Carbon Intensities of Fuels

Fuel	Carbon Intensity (gCO2e/MJ)
20% Biodiesel from Grease Residues, 80% ULSD	89.36
20% Biodiesel from Plant Oils (excluding palm oil), 80% ULSD	93.36
15% Ethanol from Corn, 85% ULSD	98.88
15% Ethanol from any Cellulosic Biomass, 85% ULSD	92.88
100% ULSD	100.45
100% Renewable Diesel	37.93
100% Compressed Natural Gas (CNG)	79.21
100% Propane	83.19
100% Renewable Propane from Grease Residues	45
100% Renewable Propane from Plant Oils (excluding palm oil) Residues	65
100% Biomethane CNG from Landfill Gas	70
100% Biomethane CNG from Municipal Wastewater sludge, food scraps, or Other Organic Waste	45
100% Biomethane Liquified Natural Gas (LNG) from Landfill Gas	85
100% Biomethane LNG from Municipal Wastewater sludge, food scraps, or Other Organic Waste	60
Electricity – RFC East eGrid 2021	85.17
Electricity – 100% Renewable Energy	0.00
100% California reformulated gasoline blendstock for oxygenate blending	100.82

Reference: California Air Resources Board 2018, Lookup Table Pathways (7-1) and Temporary Pathways Table (Table 8). EPA eGRID 2021, RFC East.

Requirement examples:

Hard (Specific Requirement)

- Regulatory mandate of 100% renewable diesel

Target (Performance-Based)

- Achieve 20% reduction in carbon intensity compared to baseline (100% ULSD) across all equipment and transportation of materials using any combination of fuels.

Soft (Not Required; Potential Differentiator)

- Use fuel sources of a lower intensity than Ultra Low Sulfur Diesel (ULSD), to the extent possible.

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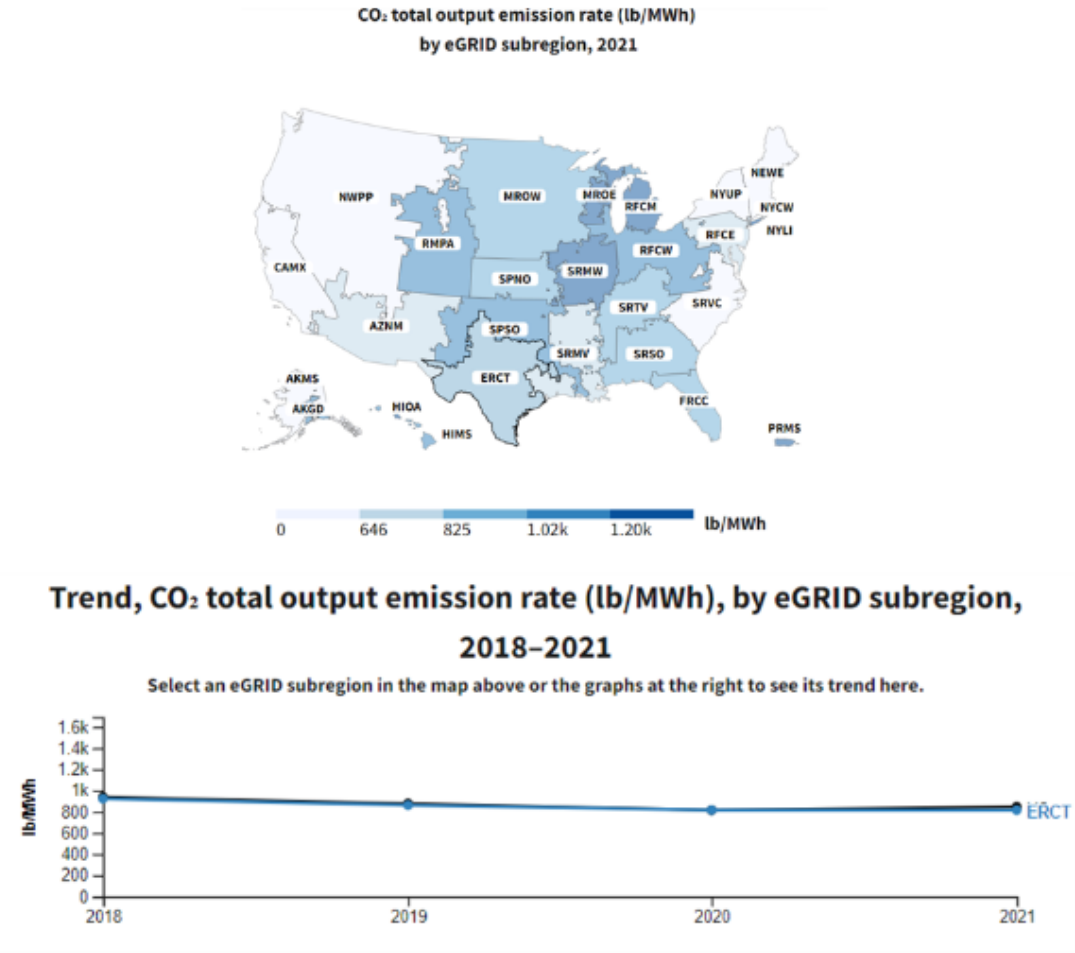

Electric Generation Mixes from GREET 2022 Model for Texas

TRE Mix: Stationary Use

5-year period	Residual Oil	Natural Gas	Coal	Nuclear	Biomass	Others
1990	0.2%	41.6%	50.6%	6.8%	0.0%	0.9%
1995	0.1%	38.8%	46.7%	13.8%	0.0%	0.7%
2000	0.4%	40.3%	46.4%	12.6%	0.0%	0.3%
2005	0.1%	34.0%	51.4%	13.0%	0.0%	1.6%
2010	0.2%	40.8%	37.7%	13.3%	0.0%	8.1%
2015	0.0%	49.6%	28.4%	11.3%	0.0%	10.6%
2020	0.1%	50.8%	12.5%	11.0%	0.0%	25.6%
2025	0.1%	35.5%	13.1%	10.1%	0.0%	41.3%
2030	0.1%	33.6%	12.9%	9.8%	0.0%	43.6%
2035	0.1%	32.6%	12.8%	9.4%	0.0%	45.1%
2040	0.0%	30.7%	9.0%	9.0%	0.0%	51.2%
2045	0.0%	33.0%	6.5%	8.7%	0.0%	51.7%
2050	0.0%	35.2%	6.4%	8.4%	0.0%	50.0%

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- Moves EPA and Sitewise are additional resources for emission factors
- Quantify metrics (i.e., carbon footprint, % recycled content) for modeling of baseline and performance at target scenario
  - Carbon footprint associated with hauling materials
  - Example: hauling clay and soil for a levee

Levee

Consumables Modeled	Assumed Hauling Length	Assumed Hauling Vehicle	Vehicle Capacity Limit	Unit	Number of One-Way Trips Assumed	Total Mileage	Hours of Operation	Fuel Consumption Rate	Unit	CO_2e EF	Unit	CO_2e Emissions	Unit	Notes
Clay	On-site	Dump Truck	80,000	LB	112	1,125	56	34.1	gal/hr	10.5	kg CO2e/gal	20.2	MT	Assumes the dump truck operates at 20 miles per hour and carries clay from an "on-site" source (< 5 miles). Dump truck with 510 horsepower used.
Soil	On-site	Dump Truck	80,000	LB	113	1,125	56	34.1	gal/hr	10.5	kg CO2e/gal	20.2	MT	Assumes the dump truck operates at 20 miles per hour and carries soil from an "on-site" source (< 5 miles). Dump truck with 510 horsepower used.

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Carbon Footprint - Equipment

- Equipment type
- Fuel type
- Fuel consumption rate
- Operating hours

Equipment Modeled	Activity	Piece of Equipment	Operating Duration	Unit	Fuel Consumption Rate	Unit	CO_2e EF	Unit	CO_2e Emissions	Unit	
Dozer (135-180 HP; U-Blade)	Earthwork - Embankment Fill	2	1,221.5	hr	7.40	gal/hr	10.5	kgCO2e/gal	**94.9**	MT	Dozer with 140 HP and U-Blade used as proxy.
Roller	Earthwork - Embankment Fill	2	1,196.2	hr	16.4	gal/hr	10.5	kgCO2e/gal	**206**	MT	Roller with 300 HP used as proxy.
Grader	Earthwork - Embankment Fill	1	656.7	hr	9.59	gal/hr	10.5	kgCO2e/gal	**66.1**	MT	Roller with 175 HP used as proxy.
Excavator (1 CY)	Inspection Trench Excavation	2	1,294.1	hr	6.63	gal/hr	10.5	kgCO2e/gal	**90.1**	MT	Excavator with 1.25 CY used as more conservative va
	Concrete Pipe &										Combines 25 T and 23.5 T crane cost estimate items

Carbon Footprint – Materials

- Materials used (example: clay and soil for levee)
- Also for embodied carbon in manufacturing / lifecycle
- Emissions factors are available in Environmental Product Declarations (EPDs) or SimaPro

Materials Modeled	Activity	Volume Quantity	Unit	Consumable Characteristic	Unit	Source	Mass Quantity	Unit	CO_2e EF	Unit	CO_2e Emissions	Unit	Notes
Clay	Earthwork (General Fill)	3,333	LCY	2,700	LB/LCY	a	8,999,100	LB	0.01	kgCO2e/kg	**39.0**	MT	Clay EF includes clay pit operation and transport.
Soil	Earthwork (General Fill)						4,500	TON	0.01	kgCO2e/kg	**39.0**	MT	Clay EF includes clay pit operation and transport. Clay EF is used as proxy for soil.

3. Create Design Specifications

Example Design Specification Structure

1.4 SUSTAINABILITY ACTION PLAN

Submit a plan to reduce emissions, energy, and water usage, and promote material reduction, reuse and recycling to the extent practicable. Include in the Sustainability Action Plan methods to implement the requirements of Paragraphs RENEWABLE ENERGY, FUEL, MATERIALS, WASTE REDUCTION, REUSE, AND RECYCLING, and BEST MANAGEMENT PRACTICES (BMP).

3.6 BEST MANAGEMENT PRACTICES

3.6.3 Technology Specific Requirements

Consider the feasibility of implementing the following BMPs. These BMPs are specific to bioremediation treatment using ammendment injection:

(1) Deploying portable gas chromatography/mass spectrometry equipment for analyzing petroleum compounds and volatile organic compounds

Recent examples:

- On a 90% Design, sustainability modifications began to threaten the bid schedule
- On a 95% Design, soft and hard requirements only

Lessons learned:

- Better to start early in the RD process
- Assess bidder ability to meet requirements
- Incentives in addition to requirements
- Sustainability Action Plan is the contract-required deliverable

> installed meet USEPA's Tier 4 clean diesel standards. NJDEP's Bureau of Mobile Sources provides funding for non-road equipment options such as hybrid electric or fully electric. The feasibility of purchasing such equipment through NJDEP's program should be investigated as part of the Sustainability Action Plan. Emission control devices include diesel

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What type of requirement?

The plan should indicate that where low carbon alternatives cannot be used, ULSD should be used. Ensure that all diesel construction equipment and generators that do not have an aftermarket emission control device installed meet USEPA's Tier 4 clean diesel standards. NJDEP's Bureau of

that are emitted to the atmosphere. The plan should indicate which emission control devices will be used or demonstrate that such retrofits are not needed (based on existing equipment meeting Tier 4 standards or proposed fuels). In the Sustainability Action Plan, outline the planned fuel providers, types of fuel including sulfur content, and submit the purchased fuel receipts.

4. Expected Benefits & Cost

Importance of calculating benefits and costs

- Creates incentive for stakeholders and regulatory agency
- Communicates remedy sustainability performance to stakeholders

Example benefits

- Social cost of emissions [$/MT CO2e] avoided
- Alignment with stakeholder decarbonization and carbon reduction policies

Example costs

- Potential increase based on modifications
- More sustainable materials often have equivalent price, but may not be as readily available

5. Support Stakeholders and Regulatory Agency During Bidding

Done throughout!

Provide bidders with methods to reach target scenario

- Availability of low carbon fuels (biodiesel, renewable diesel) or recycled materials near the site
- Applicability of low carbon fuels or electric to different heavy-duty equipment used
- Cost implications of low carbon fuels

Target requirements

- Standard and accessible spreadsheet tools
- % of fuel from a certain source, % of electric equipment, % of materials from low carbon vendors, % of recycled content, or local vendors
- Revise targets if needed based on bid review

Resources

- ASTM International (ASTM) ASTM E2893 Standard Guide for Greener Cleanups
- EPA Green Remediation Best Management Practices Guides https://www.clu-in.org/greenremediation/
- California Air Resources Board 2018, Lookup Table Pathways (7-1) and Temporary Pathways Table (Table 8). EPA eGRID 2021, RFC East.
- EPA MOVES: EFs for mobile (transportation and equipment) source emissions
- EPA Spreadsheets for Environmental Footprint Analysis (SEFA) (Version 3.0, 2019)
- Sitewise (Version 3.1, 2013)

Thank you!

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