REMEDIATION ROUNDTABLE

December 8, 2015

Connecticut Department of Energy and Environmental Protection

www.ct.gov/deep/remediationroundtable

Agenda

- Wave 2 RSRs 90% Draft and Public Information Meeting Schedule
- Common Verification Issues and Revised Verification Forms
- A Case Study in Green Remediation

Announcements

- APS
  - Posting this week
  - Public Information Session December 21, 2015 from 1:30-3:30 pm in the McCarthy Auditorium
  - Derivation, Use, and Request Process

- No more Roundtable Q&A spreadsheet updates

Website Updates

- Interim and Final BRRP Verification forms and instructions
- GW Factsheet
- Green Remediation

Updates

Significant Environmental Hazard STATS

- 12 since July 1, 2015
  - 1 supply well
  - 6 plumes threatening wells
  - 4 surface soil – As, BaP, and PCB
  - 1 volatilization

- NONE due to statutory amendments
- Lower than average

Roundtable 2016

2016 Scheduled Dates:

March 15, 2016 at 1:30-3:30pm

June 21, 2016 at 1:30-3:30pm

October 25, 2016 at 1:30-3:30pm

(not 2nd Tuesdays)

…In the Gina McCarthy Auditorium

Questions / Comments

Please speak loudly.

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Wave 2 RSR Amendments
90% Draft

Robert Bell, Remediation Division Assistant Director
Maurice Hamel, Remediation Division Environmental Analyst 3
Kevin Neary, Remediation Division Environmental Analyst 3

Connecticut Department of Energy and Environmental Protection


Transformation Components
Wave I RSR Amend-ments
Municipal Liability Relief
Expanded Institutional Control Authority
SEHN
Wave 2 RSR Amendments
Risk Evaluation
State-Wide GW ReClass
Information Mgmt
Release Reporting Regulations
Soil Reuse Regulations
Historical Releases
Unified Program Elements

Schedule Going Forward

- “90%” Roll out of Wave 2 language - descriptive text of intent of amendments anticipated in January/February
- Multiple informal outreach sessions anticipated in February/March
- Formal Public Hearing Draft and Comment Period anticipated in March/April

Proposed Wave 2 Language Update

Definitions / Soil

- Background
- Pesticides
- 80% rule
- Wide Spread Polluted Fill
- Public notice
- Residential activity

Groundwater

- Additional Polluting Substances
- Diminishing State Groundwater Plume
- Alternative GWPC
- Monitored Natural Attenuation
- Upgradient policy
- Volatilization Criteria

Background Definitions

- Proposed changes to the background definitions
  - Based on Background Workgroup recommendations
  - Addresses gaps in current language
  - Incorporates the concept of anthropogenic sources
  - Implementation language to be added to soil and groundwater sections

Background Concentration

The site-specific concentration of a substance in soil, groundwater, or other environmental media that would be expected to exist in the absence of any release that is due to current or historical site-related or nearby activities, and such concentration may be a combination of a naturally-occurring condition and anthropogenic influences.

Naturally-Occurring Condition

The presence of a substance that is found in soil, groundwater, or other environmental media as a result of natural processes without any influence from human activities.

Anthropogenic Influence

The presence of a substance due to an offsite non-point source in environmental media, as a result of human activities not related to the current or historical activities at the site.

- Contemplating excluding certain nearby activities

Pesticides as Incidental Sources

Pesticides applied in accordance with accepted practices at the time of use are exempt from compliance with:

Direct Exposure Criteria, as long as:

- An AUL is placed on the property
  - indicating the nature and extent of pesticides in soil
  - activity, land use, and soil reuse limitations
  - notice is provided to the local Director of Health and abutters, and
  - Measures acceptable to the Commissioner are taken to limit human exposure on residential properties
    - e.g. minimum caps

Pesticides as Incidental Sources

Pesticides applied in accordance with accepted practices at the time of use are exempt from compliance with:

Groundwater Protection Criteria, as long as:

- The nature of pesticides in the groundwater has been characterized either
  - On-site
  - Downgradient of the site, or
  - Downgradient potable wells have been sampled
- A sensitive receptor survey identifying existing groundwater uses has been submitted to the Commissioner, the local Director of Health, and abutters

Pesticides as Incidental Sources

Pesticides applied in accordance with accepted practices at the time of use are exempt from compliance with:

Pollutant Mobility Criteria, as long as:

- Requirements of the incidental pesticide sections for DEC and Groundwater are met

80% Rule - PMC Exemption

2(c)(4)(C) The pollutant mobility criteria do not apply ... provided:

(i) Such release area

(aa) Is located in an area in which at least eighty percent of the release area and the majority of the contaminant mass has been subject to infiltration ...

Widespread Polluted Fill

Pollutant mobility criteria do not apply to WSPF

- New self-implementing option
- No longer needs to extend onto multiple parcels
- ELUR to restrict reuse of the fill
- Clarifies that it also applies to non-coastal sites

Widespread Polluted Fill (cont.)

For all WSPF Variances

- Current or future potable wells are not at risk
- VOCs have been address to PMC
- Other releases have been addressed
- Groundwater compliance can be achieved
- DEC issues are addressed
- Placement of the fill was legal

Widespread Polluted Fill (cont.)

For self-implementing WSPF

- Abuts SA, SB or SC surface water bodies
- GB groundwater classification
- Extends over an area of 10 acres
- The fill was not a landfill
- Owner of the parcel did not do the filling
  - municipal exemption

Widespread Polluted Fill (cont.)

Commissioner's approval for

- Coastal sites not meeting self-implementing conditions
- Non-coastal sites

Factors to consider

- Extent of the polluted fill
- Proportion of fill on the parcel
- Affect on surface water quality
- Degree PMC exceedances
- Proportion of fill below the watertable

Public Notice

- Consolidate PN requirements from RSRs and statutes
- Clarify information needed in various types of notice
- Create consistency in the duration - 30 days
- Add posting on internet when available
- "Abutters" means within 200 feet of property line
- Clarify that PN is for releases covered by a RAP
  rather than for the entire site
- Require re-noticing
  - During additional periods of active remediation

Residential Activity

"Residential activity" means any activity related to (A) a residence or dwelling, including but not limited to a house, apartment, condominium, dormitory, or (B) pre-school, primary and secondary school, child or adult day care center, playground, or outdoor recreational area

Questions / Comments

Please speak loudly.

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Additional Polluting Substance

- APS for SWPC and VolC
- Language will mimic other APS provisions currently in RSRs
- Calculations will be provided
- Will be part of current APS request improvement

Diminishing State Groundwater Plume

"Diminishing State Groundwater Plume" means a plume in which, the concentrations decrease over time allowing for seasonal variation and the breakdown components are not expected to exceed applicable criteria; and there is no migration or expansion in any direction at concentrations exceeding applicable criteria, as determined by the three-dimensional and seasonal characterization

- Diminishing State Groundwater Plume to replace the Steady State Groundwater Plume term except for TI Variance

Alternative GWPC

- Self-Implementing Option
  - Plume is located within Alternative GWPC Map area
  - Source area soil addressed
  - No existing use of groundwater
  - Diminishing State Plume Groundwater Compliance - plume will not migrate outside Alternative GWPC area
  - Monitoring conducted
    - meeting Alternative GWPC
    - SWPC or Alternative SWPC
    - VoIC or Alternative VoIC
- Commissioner Approval Option
  - Plume is outside Alternative GWPC Map area but public water available to surrounding area

MNA Provision

- Evaluation of concept
  - May not fit into Wave 2 RSR changes
  - MNA in RSRs would not be an end-point
  - May be more appropriate as a Guidance Document
  - Guidance would follow content of discussion document
  - MNA concept in guidance rather than Regulations would provide better flexibility and scientific changes

Upgradient Policy

2(g)(2) Compliance with Criteria for Ground Water

A down gradient property owner is not responsible for remediating dissolved groundwater contamination flowing onto his or her property from another site, as long as the contamination is present solely as a result of the off-site source(s).

- NOT NAPL
- In Applicability Section

Volatilization Criteria

- Proposed changes to the criteria applicability:
  - Increase applicability distance from 15’ to 30’
  - Clarify that the applicability distance applies both horizontally and vertically from buildings
  - Changes proposed based on updated understanding of the vapor intrusion pathway

Volatilization Criteria

- Proposed change to mitigation implementation:
  - Require the recording of a Deed Notice (AUL)
  - Deed Notice would require annual status update letter be sent to DEEP (confirming system is still on)

Questions / Comments

Please speak loudly.

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Common Verification Form Issues and Revised Verification Forms

Claire Foster
Environmental Analyst III
Audit Program Coordinator
Remediation Division

Connecticut Department of Energy and Environmental Protection

Overview

- Current status of verification submissions
- Purpose and outline of verification forms
- Common verification form issues
- Upcoming revisions to forms

Current Status of Verification Submissions

Connecticut Department of Energy and Environmental Protection

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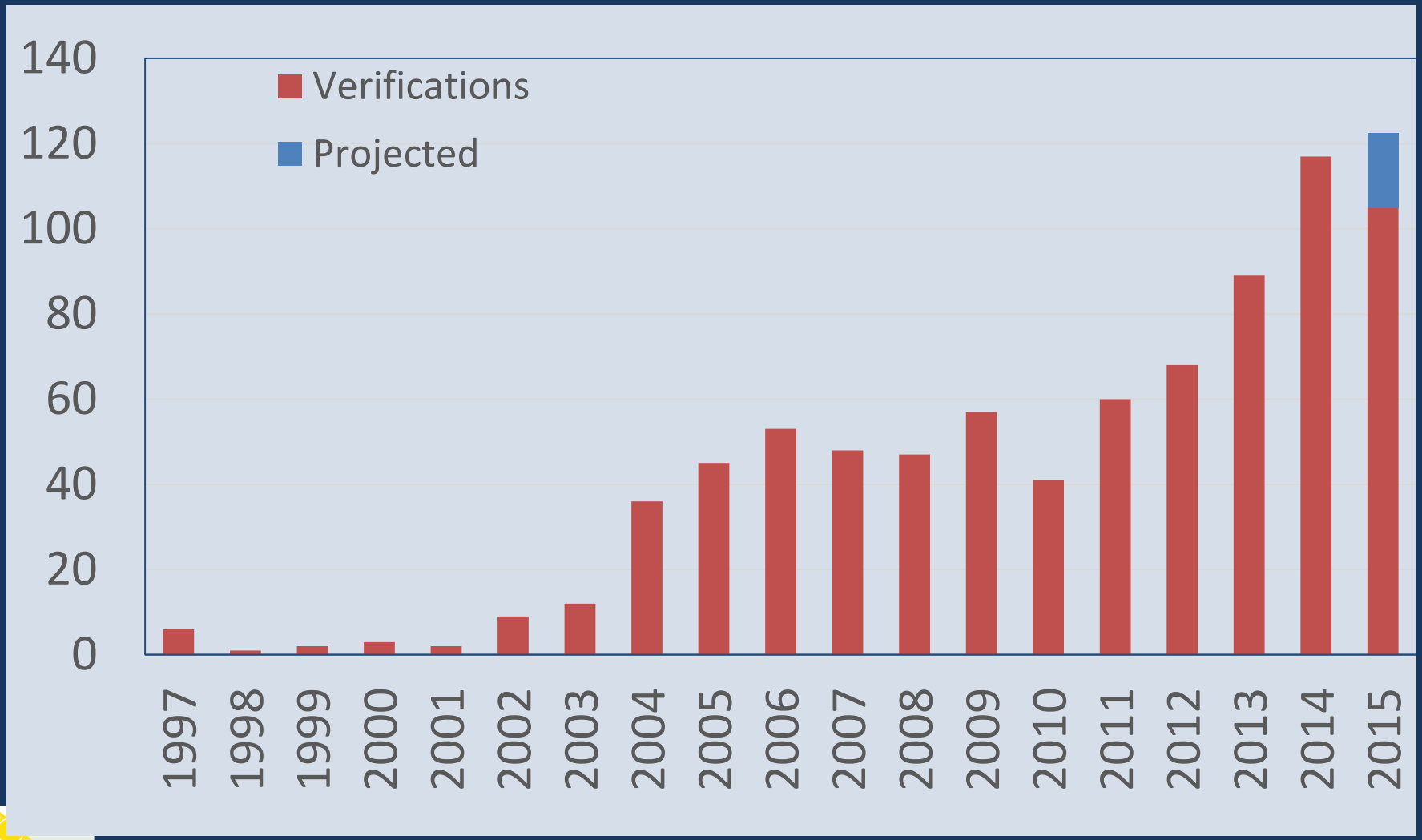
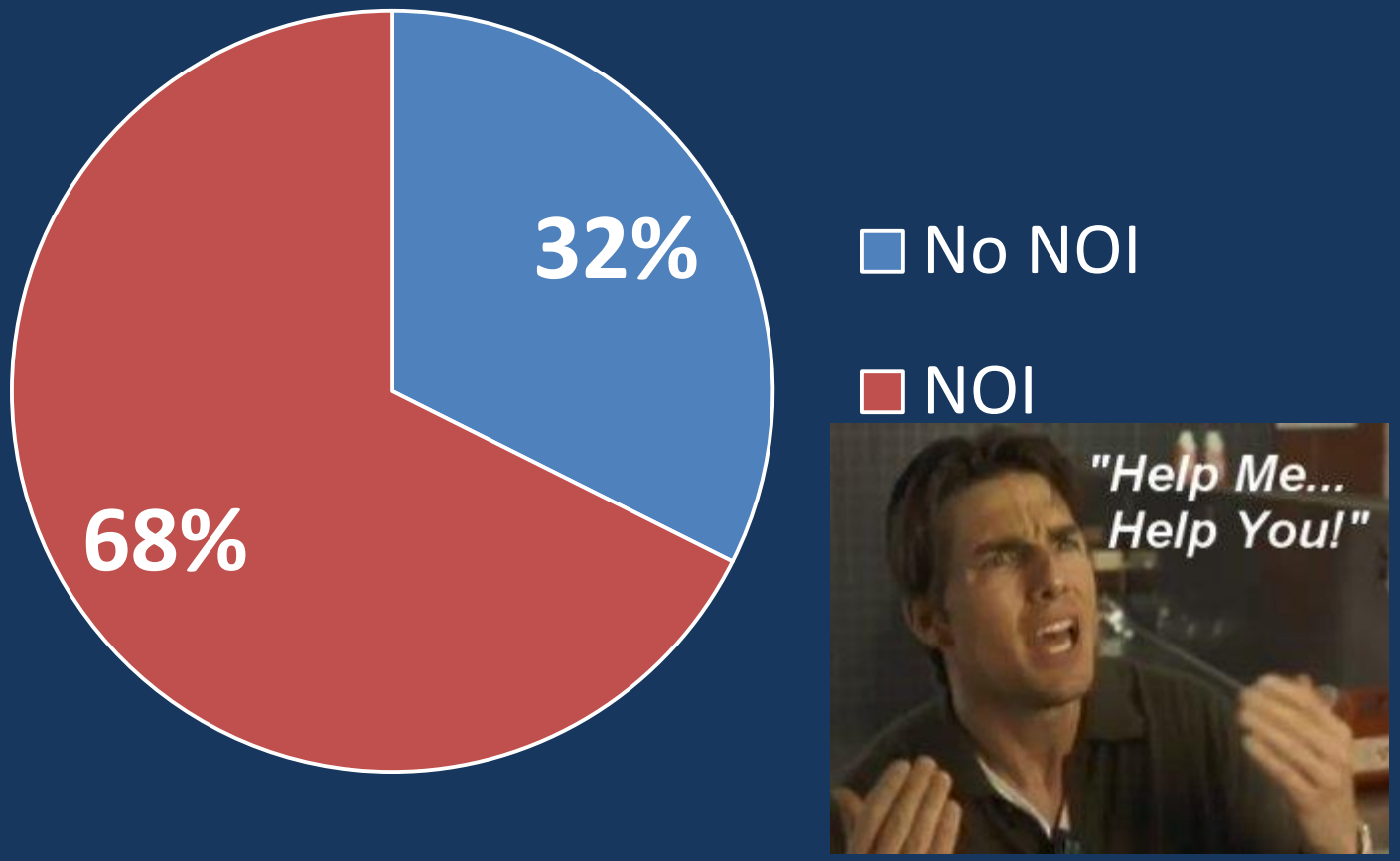
Verification Statistics



Notices of Insufficiency (NOI)



Purpose and Outline of Verification Forms

Connecticut Department of Energy and Environmental Protection

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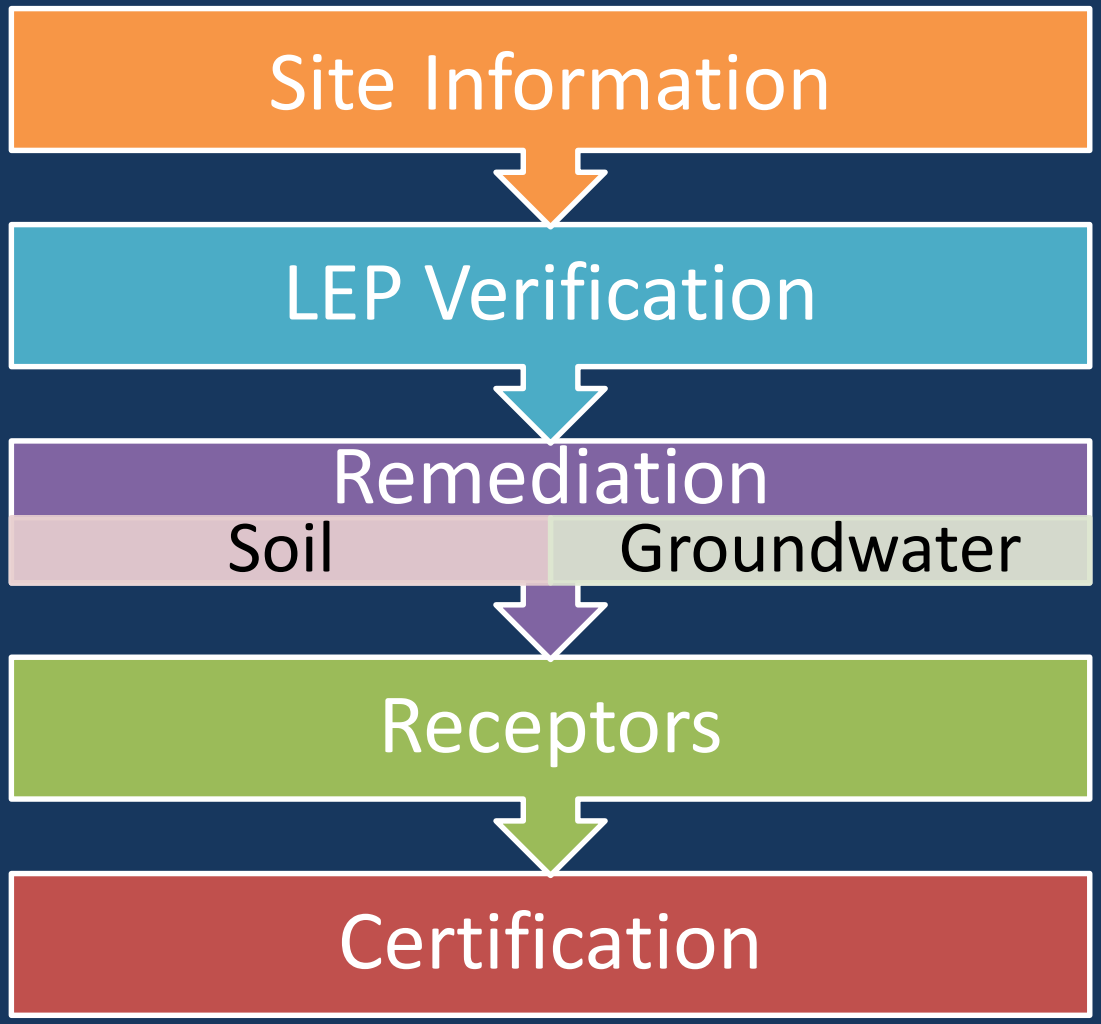
Purpose of the forms

Twofold purpose:

1. To provide a summary of site conditions
2. To ensure compliance with all required provisions of the RSRs at the site

Verification Form Outline



Verification Form Outline

Remediation

Soil

- Summary
- Application
- Background
- Direct Exposure Criteria
- Pollutant Mobility Criteria
- Other Provisions

Verification Form Outline

Remediation

Groundwater

- Summary
- Incidental Sources
- Application
- General Compliance
- Background
- Groundwater Protection Criteria
- Surface Water Protection Criteria
- Volatilization Criteria
- Other Provisions

Common Verification Form Issues

Connecticut Department of Energy and Environmental Protection

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Common Issues – 1st page

Part II: Verification

This verification pertains to the Form III filed with the Department on 1/15/99 and assigned **Rem#**12345 .

In accordance with CGS §22a-134a(n), the certifying party of a Form III is not required to investigate or remediate any release or potential release of pollution at the parcel that occurs after the completion of Phase II Investigation, as defined in the Site Characterization Guidance Document, or from and after the date the Form III was filed, whichever is later. **Below, enter the date the Form III was filed, completion date of the Phase II, and the date this verification is rendered. Check the date to which this verification applies**:

☐ Date Form III was filed: 1/15/99 ☒ Date of this verification: 12/08/15

☐ Date of complete Phase II Investigation: 9/15/05

"I verify in accordance with Section 22a-134(19) of the Connecticut General Statutes and Section 22a-133v-1(z) of the Regulations of Connecticut State Agencies (RCSA), that an investigation has been performed at the parcel in accordance with prevailing standards and guidelines, and that...

(check one of the following)

☐ **The establishment was in compliance with the remediation standards** (RCSA Sections 22a-133k-1 through 22a-133k-3) **at the time the Form III was filed or the completion of the Phase II Investigation, or at the time of this verification, as indicated above, without requiring remediation**."

☒ **All releases existing at the establishment at the time the Form III was filed or the completion of the Phase II Investigation, or at the time of this verification, as indicated above, have been remediated in accordance with the remediation standards** (RCSA Sections 22a-133k-1 through 22a-133k-3)."

John Doe

Signature of Licensed Environmental Professional License #: 99999

John Doe

Name of Licensed Environmental Professional (print or type)

Phone Number: 860-424-3000

LEP Seal

Common Issues – 1st page

Before you send, double-check:

- ✓Are all three dates filled out mm/dd/yy?
- ✓Do both Form III filing dates match?
- ✓Is only one date checked for the date you are verifying to?
- ✓Is the form signed and stamped?

Common Issues

The following sections refer to RSR subdivisions required for all sites:

III. A. Soil -

4. Application of Standards for Soil Remediation

III. B. Groundwater –

6. Application of Groundwater Remediation Standards

7. Compliance with Criteria for Groundwater

Common Issues – Required Sections

6. Application of Groundwater Remediation Standards			RCSA 22a-133k-3
☒	All plumes have been investigated in accordance with prevailing standards and guidelines, including the SCGD or equal alternative approach.		
☒	A sufficient quantity and quality of groundwater data has been collected to understand seasonal and dimensional groundwater conditions.		
☒	Groundwater monitoring has been completed in accordance with 22a-133k-3(g)		
☒	Groundwater monitoring was completed to determine the following: (mark all appropriate boxes below)		
	☒	The effectiveness of any soil remediation to prevent the pollution of groundwater from RA	3(g) (A)
		☐ Not applicable. Remediation of soil was not necessary	
	☐	The effectiveness of any measures to render soil environmentally isolated	3(g) (B)
		☒ Not applicable.	
	☒	The effectiveness of any remediation taken to eliminate or minimize risks associated with release, or risks identified in a risk assessment	3(g) (C)
		☐ Not applicable. No remediation of environmental media was conducted	
	☐	That all substances in groundwater in a GA or aquifer protection area meet Background or GWPC, as applicable	3(g) (D)
		☒ Not applicable. Groundwater in a GB area and not in aquifer protection area	
	☒	That all substances in groundwater meet SWPC and applicable VolC	3(g) (E)
	☒	If a plume in GB area interferes with any existing uses of groundwater for a drinking water supply or any other existing uses, including but not limited to industrial, commercial or agricultural uses	3(g) (F)
		☐ Not applicable. Groundwater is in a GA area	
☒	The Verification Report documents and explains how the Groundwater Remediation Standards were achieved for each plume.		

Common Issues

Other sections require at least one option is selected:

- DEC, PMC, and compliance for both
- SWPC and compliance
- Volatilization if VOCs detected in groundwater

Common Issues – Selecting at least one option

8. Pollutant Mobility Criteria (PMC)	22a-133k-2(a)1(B) and k-2(c)	Applicable Release Area (RA) ID #'s
☐ **PMC not applicable** due to environmentally isolated soils	22a-133k-2(c)(4)(A)	
Date Certificate of Title for recordation of ELUR submitted to Commissioner:		
→Copy of Certificate of Title page (w/ volume, page, and date recorded) must be attached		
☐ **PMC not applicable** - polluted fill (*All the following must apply*)	22a-133k-2(c)(4)(B)	
☐ Such fill is polluted only with coal ash, wood ash, coal fragments, asphalt fragments, or any combination thereof;		
☐ Such fill is not polluted with any VOCs >applicable PMC;		
☐ The concentrations of each substance in any such fill is consistent with DEC requirements;		
☐ Such substance is not affecting and will not affect the quality of an existing or potential public water supply resource or an existing private drinking water supply;		
☐ A public water supply distribution system is available within 200 feet of such parcel and all parcels adjacent thereof; **and**		
☐ The placement of the fill was not prohibited by law at the time of placement.		
☐ **PMC not applicable** to substances other than VOCs (*The following must apply*)	22a-133k-2(c)(4)(C)	
☐ 80% of RA subject to infiltration for at least 5 years, or (I)		
☐ Concentration of substance and extent of plume will not increase if anthropogenic feature removed, (Commissioner approval) (II)		
Approval date(s):	→Copy(s) of Approval(s) must be attached	
AND one or more of the following apply (4)(C)(II):		
☐ GA: The concentration of all substances in groundwater ≤ GWPC and the SWPC for 4 consecutive quarters		
☐ GB with GA concerns: The concentration of all substances in groundwater in an Aquifer Protection Area or used as a source of public drinking supply ≤ GWPC and SWPC for 4 consecutive quarters		
☐ GB: The concentration of all substances in groundwater in a GB area are ≤ SWPC for 4 consecutive quarters		
AND all of the following must apply:		
☐ The groundwater sampling locations are representative of the plume and the areal extent of the plume that exceeds applicable criteria is not increasing over time		
☐ The concentration of substances is not increasing over time, and		
☐ The groundwater samples are collected from locations most likely to have been impacted by release		
☐ **PMC not applicable** – "Incidental Sources"	22a-133k-2(c)(5)	
☐ Incidental release due to normal operation of motor vehicles		
☐ A result of normal paving and maintenance of pavement		

8. PMC (continued)	22a-133k-2(a)1(B) and k-2(c)	Applicable Release Area (RA) ID #'s
☐ Mass analyses of COCs other than inorganic or PCBs ≤ PMC	22a-133k-2(c)(1)(A)	
☐ TCLP/SPLP analyses of inorganic COCs or PCBs ≤ PMC	22a-133k-2(c)(1)(B)	
☐ TCLP/SPLP analyses of COCs in polluted soil at or above seasonal low water table ≤ GWPC.	22a-133k-2(c)(2)(A)	
☐ TCLP/SPLP analysis of VOCs in polluted soil at or above seasonal low water table < 10x GWPC, or	22a-133k-2(c)(2)(B) (GA Area)	
☐ Mass analysis of soils polluted with VOCs in polluted soil at or above seasonal low water table < GA PMC x10 or alternative dilution factor (*All the following must apply*↓)		
☐ No NAPL present in RA, as determined pursuant to 22a-133k-2(c)(E)(3)		
☐ Water table is ≥ 15' above bedrock surface, and		
☐ Downward vertical flow velocity ≤ horizontal flow velocity.		
AND either subset (B)(i) or (B)(ii) or (B)(iii) below (in their entirety)		
B)(i) ☐ Public water within 200' of subject and adjacent parcels and any parcel within the areal extent of the RA plume (aa)		
B)(i) ☐ Groundwater within plume not used for drinking (bb)		
B)(i) ☐ No supply wells exists within 500' of RA, and (cc)		
B)(i) ☐ Not a potential public water supply resource (dd)		
B)(ii) ☐ Concentration of VOCs < GWPC within 75' of nearest downgradient property boundary (aa)		
B)(ii) ☐ Areal extent of plume and concentrations of VOCs not increasing over any point in time, except for seasonal variations and natural attenuation (bb)		
B)(ii) ☐ Notice has been provided to Commissioner that requirements have been met (cc) →This Verification Form may be considered the Notice. Details must be documented and explained in the VR.		
(B)(iii) ☐ Concentrations of VOCs< GWPC within 25' downgradient of RA, and (aa)		
(B)(iii) ☐ Notice of such condition has been provided to Commissioner (bb) →This Verification Form may be considered the Notice. Details must be documented and explained in the VR.		
☐ TCLP/SPLP analysis of inorganic, semi-volatile, PCBs, or pesticides in polluted soil at or above seasonal low water table < GWPC x10 (or x dilution factor)	22a-133k-2(c)(2)(C) (GA Area)	
☐ Mass analysis of inorganic, semi-volatile, PCBs, or pesticide < GA PMC x 10 (*All the following must apply*)		
☐ Release area is ≥25' from downgradient property line (ii) (aa)		
☐ NAPL is not present, and (ii) (bb)		
☐ Water table is ≥15' above the bedrock surface (ii) (cc)		

Common Issues – Selecting at least one option

8. PMC (continued)	22a-133k-2(a)1(B) and k-2(c)	Applic Area
☒	Mass analyses of COCs other than inorganic or PCBs ≤ PMC	22a-133k-2(c)(1)(A)	
☐	TCLP/SPLP analyses of inorganic COCs or PCBs ≤ PMC	22a-133k-2(c)(1)(B)	
☐	TCLP/SPLP analyses of COCs in polluted soil at or above seasonal low water table ≤ GWPC.	22a-133k-2(c)(2)(A)	
☐	TCLP/SPLP analysis of VOCs in polluted soil at or above seasonal low water table < 10x GWPC, or	22a-133k-2(c)(2)(B) (GA Area)	
	Mass analysis of soils polluted with VOCs in polluted soil		

Common Issues

Certification Page:

- ✓ Make sure applicable date selected matches 1st page

"I understand that this verification is being applied to the remediation of releases at the establishment as of:

Check applicable box

- ☐ The Date the Form III was filed
- ☐ The Date the Phase II Investigation was completed
- ☐ The Date the LEP rendered this verification

and that this Verification does not attest to any release that may have occurred subsequent to the applicable date of the verification indicated above."

Check if applicable

- ☐ This verification incorporates a "portion of an establishment" verification rendered on:
- ☐ This verification incorporates an "Interim" verification rendered on:

Common Issues

Certification Page:

- ✓ Fill out Certifying Party contact information entirely, including email

Authorized Signature for Certifying Party Date

Certifying Party:

Address:

City/Town: State: Zip Code:

Phone:

e-mail:

Upcoming Revisions to Forms

Connecticut Department of Energy and Environmental Protection

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Proposed Revisions to Forms

Major changes:

- 1st page formatting
- Beginning of Soil and GW sections
- Compliance measures
- New format for Significant Environmental Hazard section

Draft Consideration for VF

Part II: Verification Information

This verification pertains to the Form III filed with the Department on _____ and assigned **Rem#** _____.

If this Final Verification is being used to also close any previous Form III filing(s), list the applicable Rem #s:

_____ _____ _____ _____ **Note -> erroneous entries will target this verification for rejection**

In accordance with §22a-134a(n), this verification may be applied to all releases existing at the parcel at the date the Form III was filed, or to all releases existing at the parcel at the time of a Phase II Investigation (as defined in the Site Characterization Guidance Document), , whichever is later. This verification may also be applied to the environmental conditions of the property establishment as of the date this verification is being rendered.

Enter all of the following dates, and then mark the box of the date this verification applies to.

	Date of Form III Filing:	Date of complete Phase II:	Date of this verification:
	_____	_____	_____
This verification applies to this date: (check only one)	☐	☐	☐

"I verify in accordance with Section 22a-134(19) of the Connecticut General Statutes and Section 22a-133v-1(z) of the Regulations of Connecticut State Agencies (RCSA), that an investigation has been performed at the parcel in accordance with prevailing standards and guidelines, and that...

(check one of the following)

☐ **The establishment was in compliance with the remediation standards** (RCSA Sections 22a-133k-1 through 22a-133k-3) **at the date indicated above, without requiring remediation**."

☐ **All releases existing at the establishment at the date indicated above, have been remediated in accordance with the remediation standards** (RCSA Sections 22a-133k-1 through 22a-133k-3)."

Signature of Licensed Environmental Professional License #: _____

LEP Seal

Draft Consideration for VF

Primary Rem#:

Part III: Standards for Soil Remediation

Check either #1, #2, or #3 below to indicate the final assessment of release determination and investigation completed at the subject property for all potential releases applicable to the pertinent date of this verification.

A. Release Determination and Investigation

1. ☐ **No Releases to Soil**.

   All potential releases to soil – applicable to the pertinent date of this verification - have been investigated in accordance with prevailing standards and guidelines, including the SCGD (Phase II ESA) or other equal alternative approach, and there were no detected concentrations of a substance in soil before remediation.

   If #1 checked, skip to ****

2. ☐ **Releases to Soil – No Remediation or other Compliance Measure Required**.

   Substances, applicable to the pertinent date of this verification, were detected in soil, but all detected concentrations of substances in soil were less than criteria before remediation or initiation of other compliance measure.

   ☐ The nature and distribution of all releases applicable to the pertinent date of this verification have been characterized in accordance with prevailing standards and guidelines, including the SCGD (Phase III Investigation) or equal alternative approach.

   If #2, in its entirety, is checked, skip to #** below.

3. ☐ **Releases to Soil –Remediation or other Compliance Measure Required**

   Substances in soil at the site and associated with a release applicable to the pertinent date of this verification exceeded criteria at any time,

   ☐ The nature and distribution of all releases applicable to the pertinent date of this verification have been characterized in accordance with prevailing standards and guidelines, including the SCGD (Phase III Investigation) or equal alternative approach.

   If #3 is checked, complete the information in the box below.

Draft Considerations for VF

- Draft Considerations in effort to provide clarity for completion by LEP, and more expeditious screen by DEEP
- These considerations are boilerplate. Specific changes will be targeted for unique type of verifications (ie: Interim, IV-s, IV-F)
- Draft forms will be posted for review
- DEEP anticipates discussion of draft considerations with EPOC Technical Committee.

Questions / Comments

Please speak loudly.

www.ct.gov/deep/remediationroundtable

Green Remediation

Camille Fontanella
Technical Outreach Coordinator
Remediation Division

Connecticut Department of Energy and Environmental Protection

Greener Cleanups

1. Are you familiar with Green Remediation?

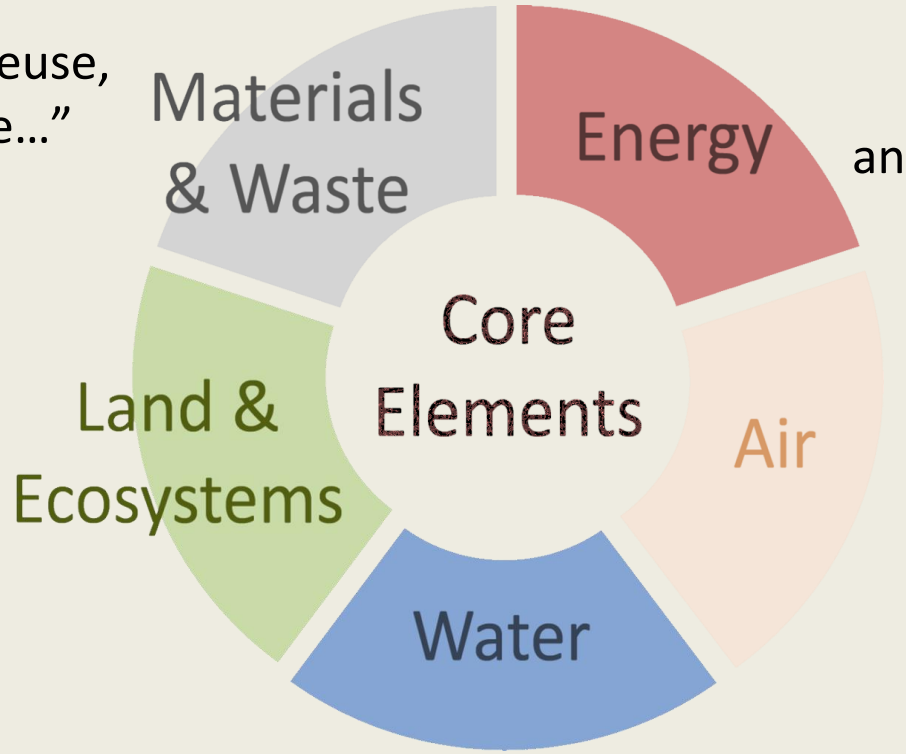
2. Are you familiar with EPA's Core Elements for Greener Cleanups?

3. Are you familiar with the ASTM Standard Guide for Greener Cleanups?

EPA's Policy on Greener Cleanups

- August 2009 - OSWER Policy on Greener Cleanup
  - OSWER's goal is to evaluate cleanup actions comprehensively to ensure protection of human health and the environment and to reduce the environmental footprint of cleanup activities, to the maximum extent possible.
- December 2013 – Asst. Administrator memo encouraging Greener Cleanup Practices through use of ASTM
- Greening the remediation process is part of the 2014-2018 Strategic Plan in line with Administrator McCarthy's key themes for the future

EPA's Core Elements



"Minimize, Reuse, and Recycle…"

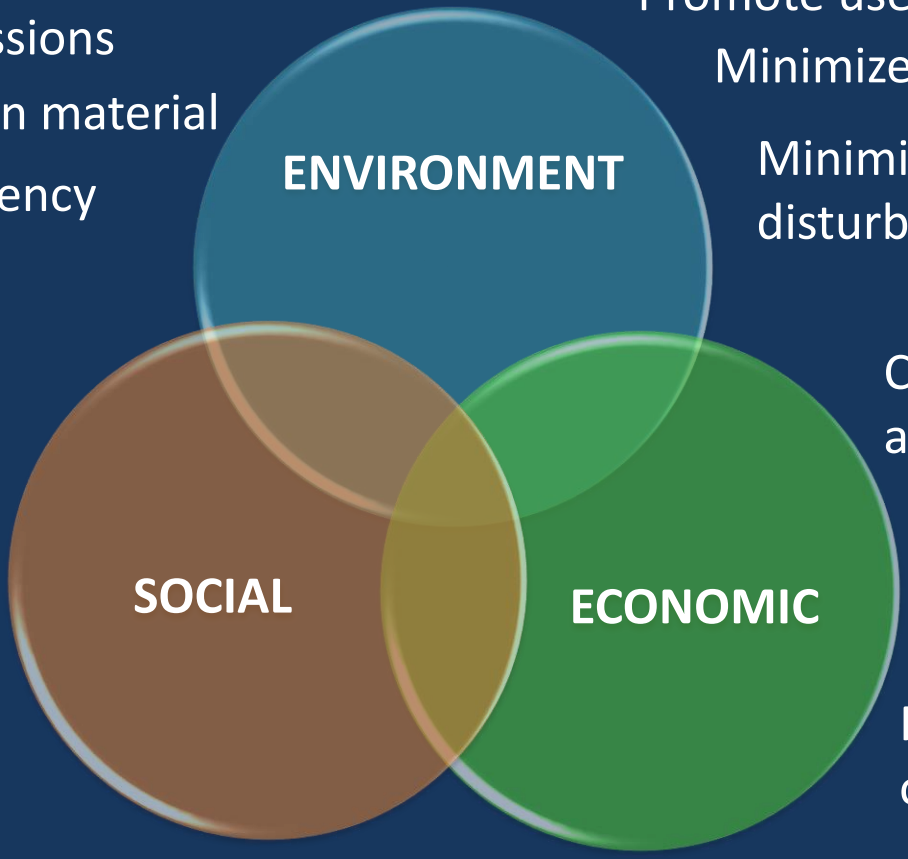
"Reduction, Efficiency, and Renewables…"

"Conserve, Protect, and Restore…"

"Protect Air Quality, Reduce Greenhouse Gases…"

"Improve Quality, Decrease Quantity of Use…"

Sustainability Principles



Minimize diesel emissions

Minimize use of virgin material

Promote water efficiency

Promote use of renewable energy

Minimize waste generation

Minimize habitat disturbance

Preserve greenspace through reuse

Engage communities

Monitor institutional and engineering controls

Cleanup to reasonably anticipated land use

Facilitate land reuse

Provide employment opportunities

ASTM Standard Guide for Greener Cleanups

- Supports EPA's Greener Cleanup Principles
- Applicable to individual or multiple phases of a cleanup
- Identifies best management practices ("BMPs")
- Offers an option for a quantitative footprint evaluation
- Promotes transparency through a robust reporting structure

Green Remediation in Connecticut

- No state regulatory or statutory requirements for regulated community
- Encourage use of EPA's Greener Cleanup Principles
  - economic benefit to our state and business/industry – cost savings, job growth
  - better environmental practices
  - energy efficiency and conservation = best use of natural resources

Green Remediation Resources

DEEP:

- New Green Remediation Webpage

http://www.ct.gov/deep/cwp/view.asp?a=2715&q=570838&deepNav_GID=1626

  - Existing Guidance
  - Highlight CT site examples

- Siting Clean Energy on Brownfields Webpage

http://www.ct.gov/deep/cwp/view.asp?a=2715&q=552764&deepNav_GID=1626

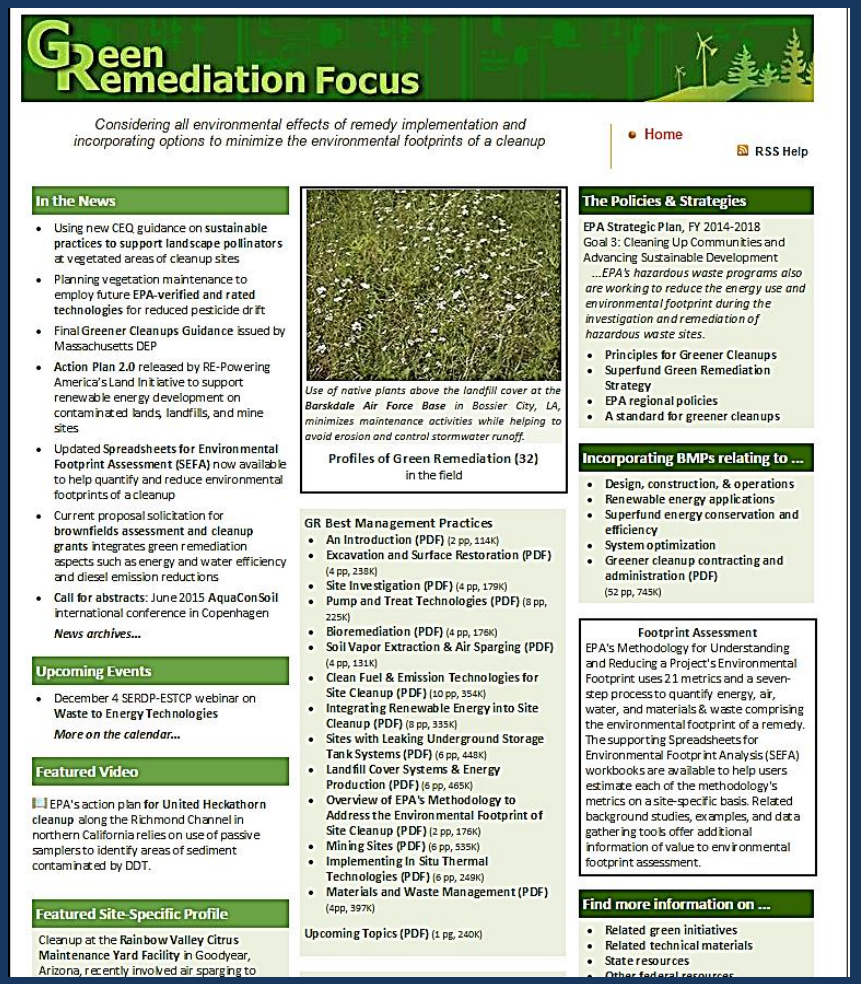
  - Financing and Incentives
  - State and Federal Resources

Green Remediation in Connecticut

EPA:

www.cluin.org/greenremediation

- Site Profiles
- BMP Fact Sheets
- Policies
- Quantitative Evaluation



Green Remediation Focus

Considering all environmental effects of remedy implementation and incorporating options to minimize the environmental footprints of a cleanup

Home RSS Help

In the News

- Using new CEQ guidance on **sustainable practices to support landscape pollinators** at vegetated areas of cleanup sites
- Planning vegetation maintenance to employ future **EPA-verified and rated technologies** for reduced pesticide drift
- Final **Greener Cleanups Guidance** issued by Massachusetts DEP
- **Action Plan 2.0** released by RE-Powering America's Land Initiative to support renewable energy development on contaminated lands, landfills, and mine sites
- Updated **Spreadsheets for Environmental Footprint Assessment (SEFA)** now available to help quantify and reduce environmental footprints of a cleanup
- Current proposal solicitation for **brownfields assessment and cleanup grants** integrates green remediation aspects such as energy and water efficiency and diesel emission reductions
- **Call for abstracts**: June 2015 **AquaConSoil** international conference in Copenhagen

News archives...

Upcoming Events

- December 4 SERDP-ESTCP webinar on **Waste to Energy Technologies**

More on the calendar...

Featured Video

EPA's action plan **for United Heckathorn cleanup** along the Richmond Channel in northern California relies on use of passive samplers to identify areas of sediment contaminated by DDT.

Featured Site-Specific Profile

Cleanup at the **Rainbow Valley Citrus Maintenance Yard Facility** in Goodyear, Arizona, recently involved air sparging to

*Use of native plants above the landfill cover at the **Barskdale Air Force Base** in Bossier City, LA, minimizes maintenance activities while helping to avoid erosion and control stormwater runoff.*

Profiles of Green Remediation (32) in the field

GR Best Management Practices

- **An Introduction (PDF)** (2 pp, 114K)
- **Excavation and Surface Restoration (PDF)** (4 pp, 238K)
- **Site Investigation (PDF)** (4 pp, 179K)
- **Pump and Treat Technologies (PDF)** (8 pp, 225K)
- **Bioremediation (PDF)** (4 pp, 176K)
- **Soil Vapor Extraction & Air Sparging (PDF)** (4 pp, 131K)
- **Clean Fuel & Emission Technologies for Site Cleanup (PDF)** (10 pp, 354K)
- **Integrating Renewable Energy into Site Cleanup (PDF)** (8 pp, 335K)
- **Sites with Leaking Underground Storage Tank Systems (PDF)** (6 pp, 448K)
- **Landfill Cover Systems & Energy Production (PDF)** (6 pp, 465K)
- **Overview of EPA's Methodology to Address the Environmental Footprint of Site Cleanup (PDF)** (2 pp, 176K)
- **Mining Sites (PDF)** (6 pp, 535K)
- **Implementing In Situ Thermal Technologies (PDF)** (6 pp, 249K)
- **Materials and Waste Management (PDF)** (4pp, 397K)

Upcoming Topics (PDF) (1 pg, 240K)

The Policies & Strategies

EPA Strategic Plan, FY 2014-2018
Goal 3: Cleaning Up Communities and Advancing Sustainable Development
...EPA's hazardous waste programs also are working to reduce the energy use and environmental footprint during the investigation and remediation of hazardous waste sites.

- **Principles for Greener Cleanups**
- **Superfund Green Remediation Strategy**
- **EPA regional policies**
- **A standard for greener cleanups**

Incorporating BMPs relating to ...

- **Design, construction, & operations**
- **Renewable energy applications**
- **Superfund energy conservation and efficiency**
- **System optimization**
- **Greener cleanup contracting and administration (PDF)** (52 pp, 745K)

Footprint Assessment

EPA's Methodology for Understanding and Reducing a Project's Environmental Footprint uses 21 metrics and a seven-step process to quantify energy, air, water, and materials & waste comprising the environmental footprint of a remedy. The supporting Spreadsheets for Environmental Footprint Analysis (SEFA) workbooks are available to help users estimate each of the methodology's metrics on a site-specific basis. Related background studies, examples, and data gathering tools offer additional information of value to environmental footprint assessment.

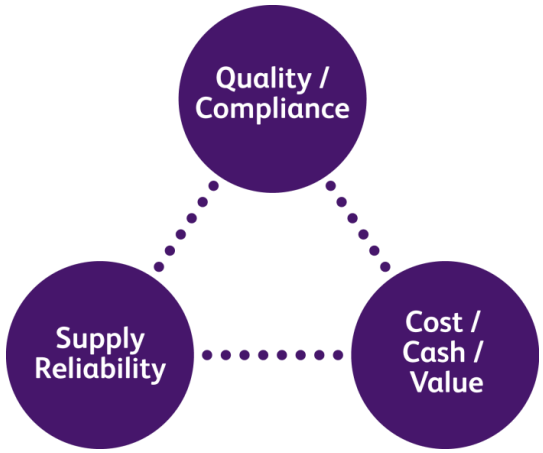
Find more information on ...

- **Related green initiatives**
- **Related technical materials**
- **State resources**
- **Other federal resources**

Pfizer GLOBAL SUPPLY

PHARMACIA & UPJOHN GREENER CLEANUP CASE STUDY

CTDEEP Remediation Roundtable
8 December 2015



Compromise to quality and compliance is not an option

Presentation Outline

- Pfizer's Approach to Sustainability: Choosing Greener Cleanup
- Pharmacia & Upjohn Company Site Background
- Evaluation of BMPs, including selection for thermal remedy and why it is green option
- Remedial Action Components
- Regulatory Acceptance by USEPA and CTDEEP
- Community Impact and Acceptance: Stakeholder Interaction
- Relative Cost/Benefit over Project Life-Cycle
- Greener Cleanups can be applied on simplest terms to smaller, less-complex projects

Pfizer GLOBAL SUPPLY

PHARMACIA & UPJOHN GREENER CLEANUP CASE STUDY

PFIZER'S APPROACH TO SUSTAINABILITY: CHOOSING GREENER CLEANUP

Why consider greener cleanup and sustainability?

- Protect human-health and the environment while maximizing the environmental, social and economic benefits through the life-cycle (SURF, 2013)
- A Pfizer core value is “Respect for Society”. Community input indicates a significant desire to return impacted properties to beneficial reuse within reasonable timeframe through cleanup that maximizes safe and sustainable means and methods, including greener cleanup approaches during remedy execution
- Value Proposition:
  - Reduce environmental footprint
  - Increase social responsibility and public outreach
  - Reduce remediation costs and long-term liabilities

General Principles

- Plan with the end in mind
- Identify and engage appropriate Stakeholders early in the process
- ***Consider environmental footprint and sustainability in technology screening and remedy selection***
- To the extent possible preserve and enhance the assets of the property and create opportunities for beneficial reuse
- ***Seek opportunities to incorporate green remediation techniques in the design and implementation phase***
- Where appropriate, ensure future use is consistent with the site's location in the community and in nature

Sustainability & Greener Remediation Strategies

Pfizer GLOBAL SUPPLY

- Through life-cycle analysis, conserve resources and reduce total pollutant and waste burdens on the environment
  - Reduce air emissions and GHG emissions
  - Minimize waste generation that results in diminished onsite EHS benefit and displaces offsite treatment and disposal facility capacity
  - Find opportunities to use treated water and replenish aquifer and onsite wetlands while minimizing net flood risk to watershed
  - Seek to conserve energy through OM&M optimization
  - Consider remedy component substitutions to lower carbon footprint
  - Enhance onsite natural resources (or prevent further degradation)

Sustainability & Greener Remediation Strategies

- Through green remediation design/build, accomplish long-term return on investment to achieve cleanup goals
  - Increase operational efficiencies of the remediation activity
  - Consider in-situ remedies over ex-situ remedies that consume less energy and pose less exposure to contaminants

- ASTM Greener Cleanup Core Elements
  1. **Energy:** Reduction, Efficiency and Renewables;
  2. **Air:** Protect Air Quality, Reduce Greenhouse Gases;
  3. **Water:** Improve Quality, Decrease Quantity of Use;
  4. **Land & Ecosystems:** Conserve, Protect and Restore;
  5. **Materials & Waste:** Minimize, Reuse and Recycle;

PHARMACIA & UPJOHN GREENER CLEANUP CASE STUDY

PHARMACIA & UPJOHN COMPANY SITE BACKGROUND

Pharmacia & Upjohn Company LLC Site

Pfizer GLOBAL SUPPLY

Pharmacia & Upjohn Company LLC Site

Pfizer GLOBAL SUPPLY

North Haven, CT

- 140 years of industrial uses
- Located adjacent to a river
- Onsite stockpiling of wastewater sludges
- Soil & groundwater are impacted by VOCs, SVOCs, PCB, metals
- RCRA 3008(h) Corrective Action Order

Site Conditions

- Primary Causes
  - Releases from aboveground / underground tank operations
  - Use of lagoons (former clay borrow pits) for wastewater treatment
  - Onsite stockpiling of wastewater treatment residuals/sludge
- Resulting Site Conditions
  - Broad range of chemical contamination in soil, groundwater and adjacent title flat sediments
  - Free phase organics (DNAPL) below groundwater in former production area
  - Impacted sludge and soil
  - Shallow groundwater impacts across the Site
  - Limited impacts below aquitard

PHARMACIA & UPJOHN
GREENER CLEANUP CASE STUDY

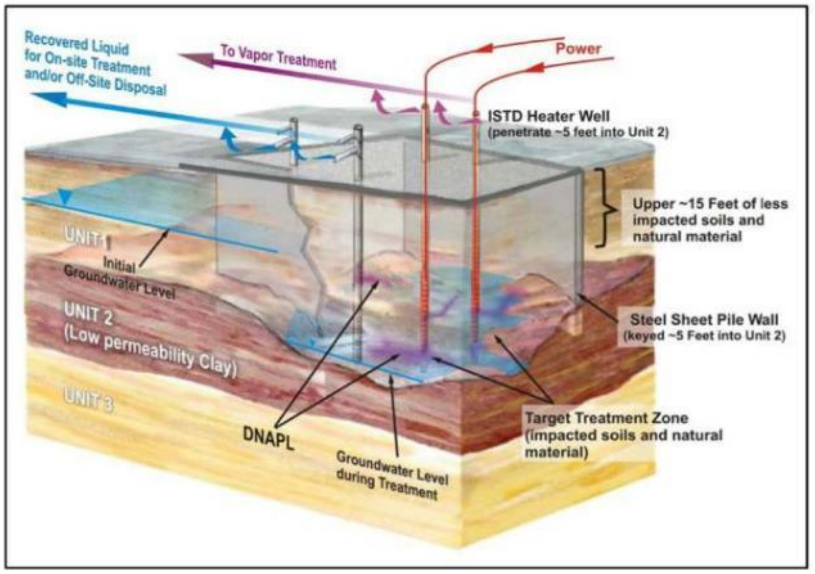
EVALUATION OF BMPS, INCLUDING SELECTION FOR THERMAL REMEDY AND WHY IT IS GREEN OPTION

Sustainability in the Feasibility Study Phase

Pfizer GLOBAL SUPPLY

Considered sustainability in the feasibility study and remedy selection process

- Overall chemical mass removal
- Nuisances to community
- Remediation worker safety
- Compare carbon footprint of technologies and long-term O&M
- Use resources efficiently with focus on sustainability
- Beneficial reuse of Site
- Public support for remedy



CMS Carbon Footprint Analysis

CMS considered Carbon Footprint of alternatives

Analysis quantified equivalent CO_2 emissions associated with

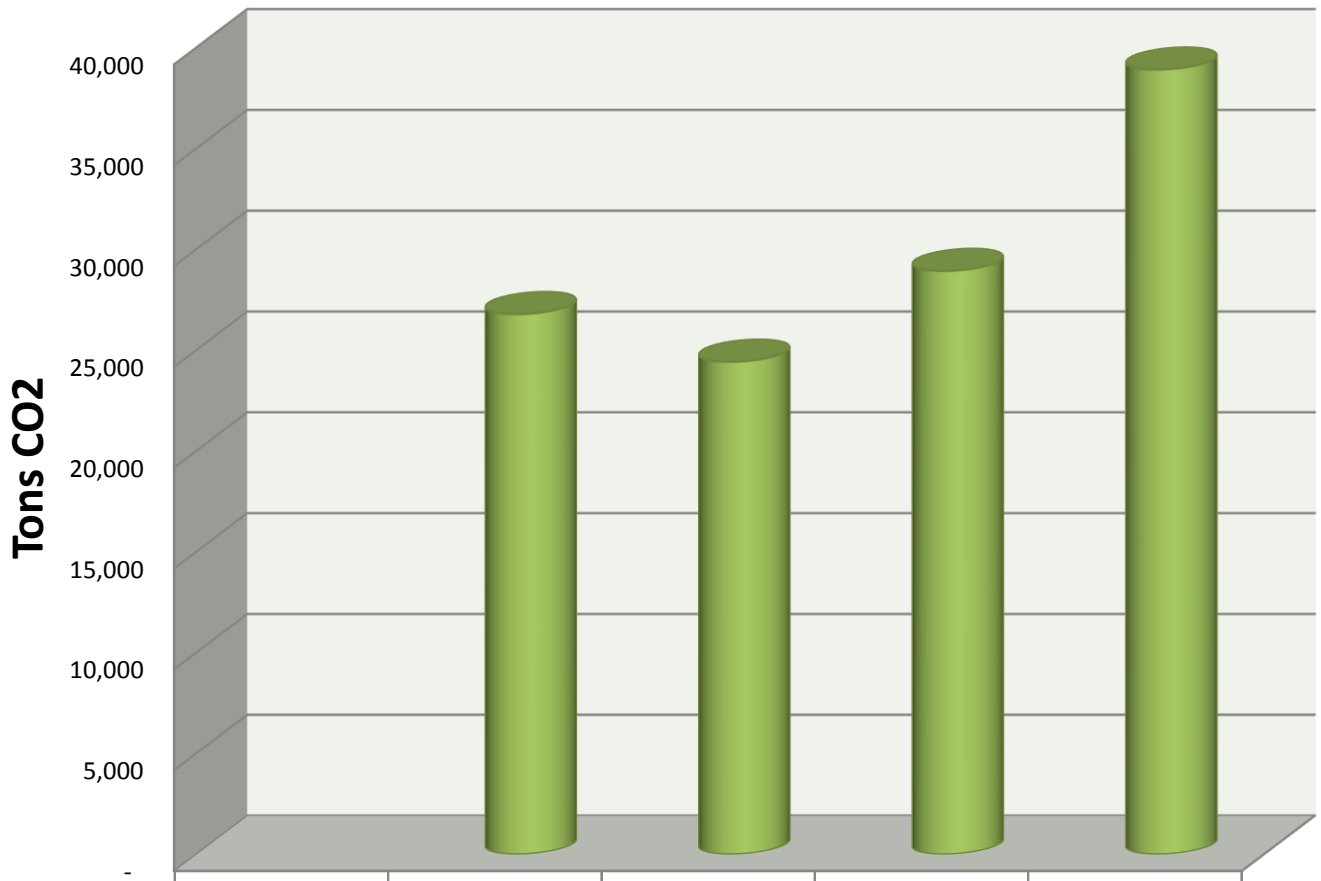
- major on-site/off-site transportation components;
- major energy use requirements from treatment/ disposal activities associated with construction of each Site-wide CMS Alternative; and
- long-term O&M trade-offs vs. upfront capital investment

Stakeholder input and carbon foot print evaluated as part of Short-Term Effectiveness criteria

CMS Carbon Footprint Comparison

Energy, Air, Water, Materials & Waste, Land Reuse

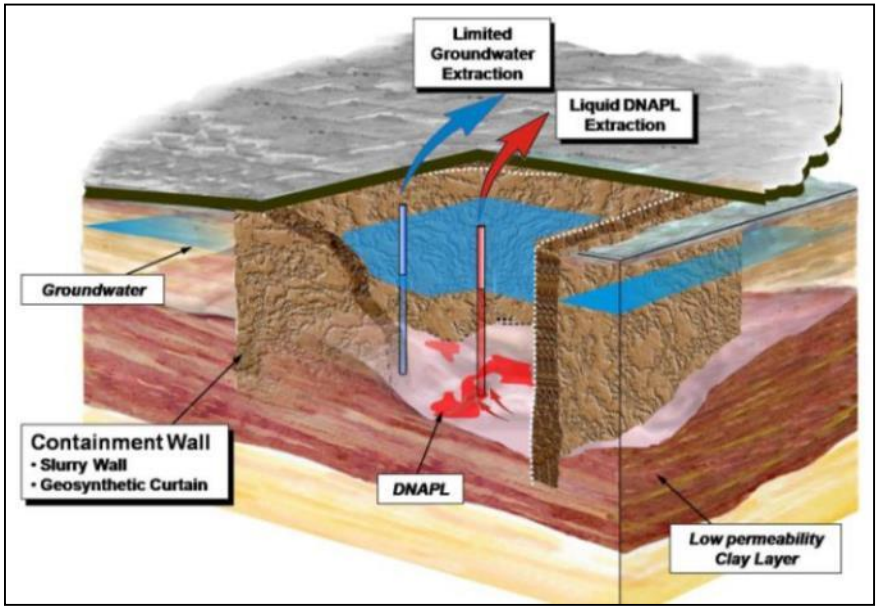
Pfizer GLOBAL SUPPLY



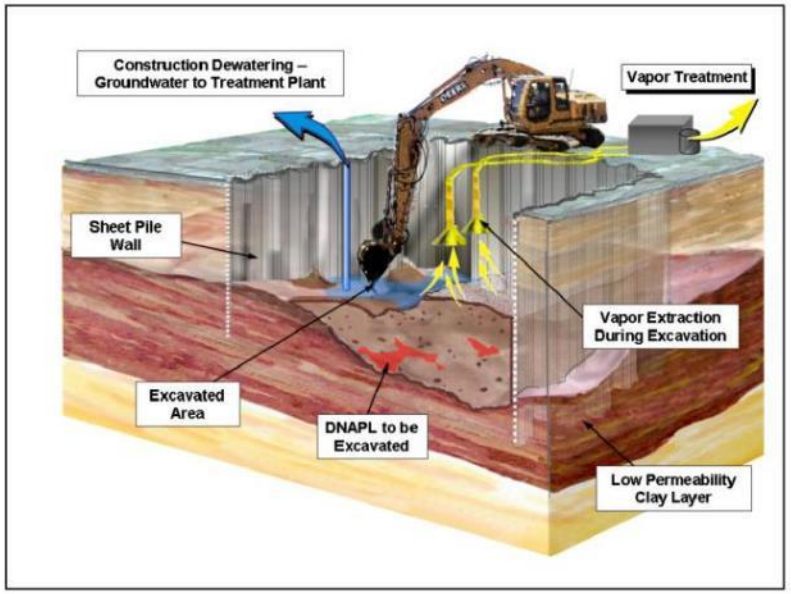
		Long-Term O&M	Caps and Covers	ISTT	Soil & GW Treatment
		CMA #2	CMA #3	CMA #4	CMA #5
Mass of CO2 Emissions (tons)		26,790	24,428	28,933	38,918

Three Alternatives to Treating DNAPL

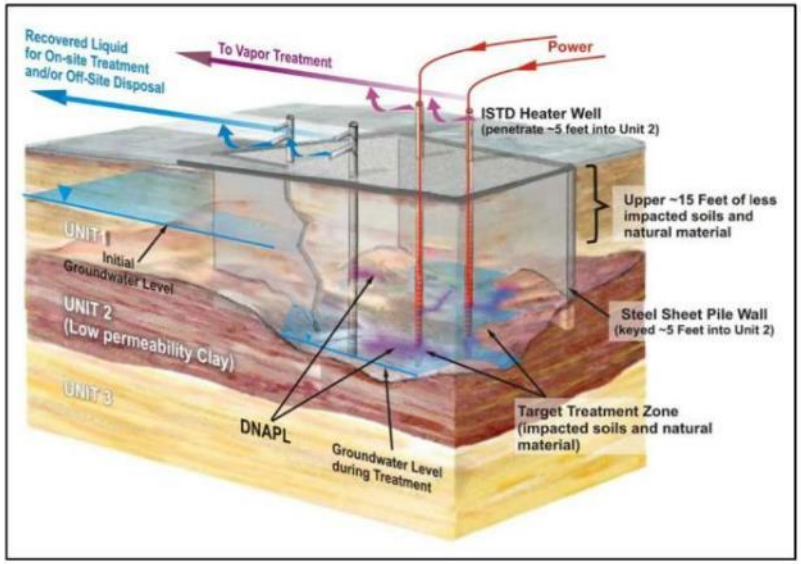
Pfizer GLOBAL SUPPLY



CMA 3: Liquid Extraction



CMA 5: Excavation and Disposal



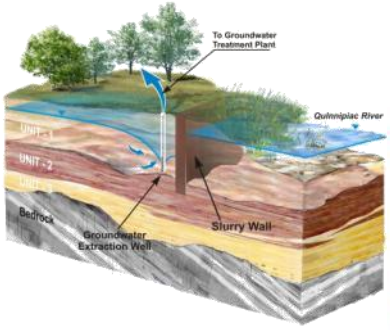
CMA 4: In-Situ Thermal Remediation

CMS Alt 4 Selected Remedy

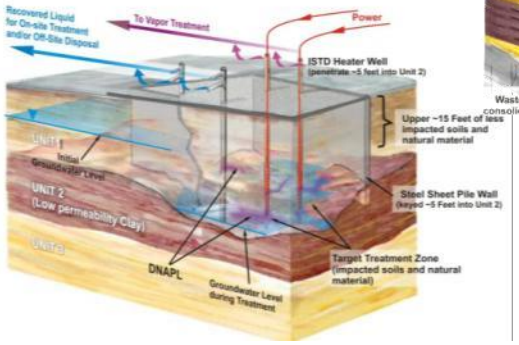
Air: Protect Air Quality, Reduce Greenhouse Gases

- CMS Alt 3 had the lowest total CO_2 emissions
- CMS Alt 4 had slightly higher total CO_2 emissions than CMS Alt 3, but achieved a greater reduction of toxicity, mobility and volume
- CMS Alt 5 had significantly higher total CO_2 emissions without any substantial benefits and more worker risks

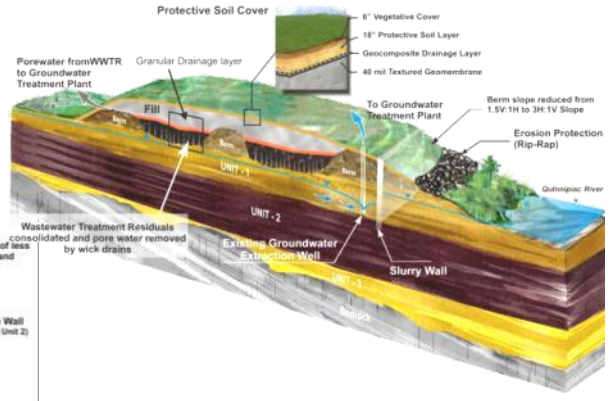
Hydraulic Barrier Wall



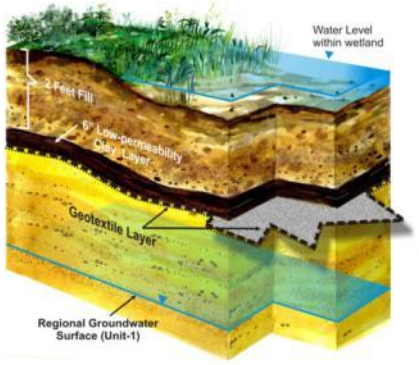
In-Situ Thermal



Consolidation and Capping



Constructed Wetlands



Corrective Measures Study (CMS) Alternative Evaluation

Pfizer GLOBAL SUPPLY

Followed EPA guidance on remedy selection

- Evaluated technologies and Site-wide alternatives per RCRA Order
- Balancing criteria considered green remediation, ecological revitalization, minimizing community impacts and future reuse
- Stakeholder input and carbon foot print evaluated as part of Short-Term Effectiveness criteria

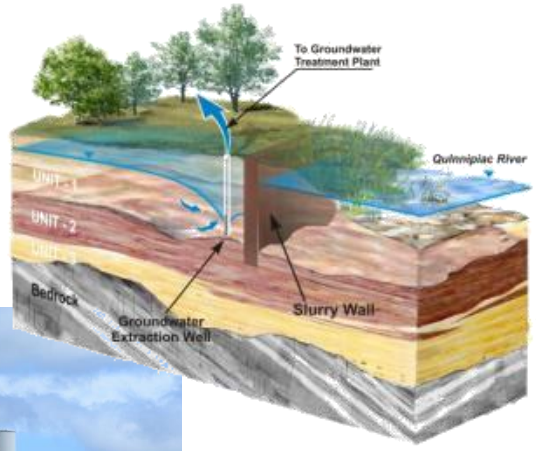
CMS Alternative 4 Selected

- High chemical mass removal
- Less impacts to community
- Greater beneficial reuse of Site
- Lower carbon footprint compared to alternatives with similar mass removal
- Reduced long-term groundwater pumping (and carbon footprint)
- Strong public support for Site-wide remedy

Green Best Management Practices

Materials & Waste: Minimize, Reuse, Recycle

Pfizer GLOBAL SUPPLY



- Additional BMPs during remedy implementation
  - Managed drill cutting, sediment, and excess soil under on-site caps, rather than off-site disposal
- Used ground granulated blast furnace slag – a repurposed manufacturing byproduct - for hydraulic barrier wall construction; avoiding the use of bentonite, a natural resource
- The subsurface cut-off wall component reduced long-term groundwater extraction rates by more than 50% (Energy, Water)

CMI Implementation

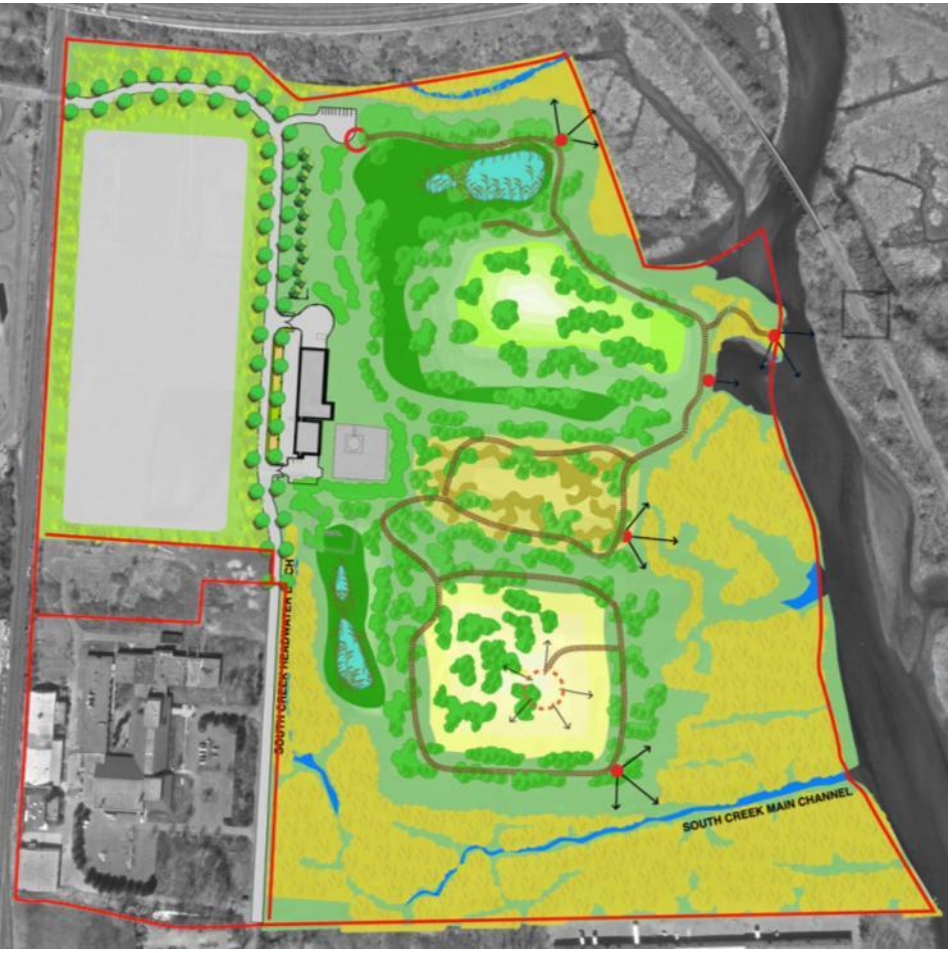
Water: Improve Quality, Decrease Quantity of Use

Pfizer GLOBAL SUPPLY

- Additional implementation efforts, supported by RCRA Order, potentially reduced environmental footprint below estimate, examples include:
  - Reducing groundwater extraction rates by 50% via use of subsurface cutoff wall and covers (Energy, Water)
  - Managing drill cutting, sediment dredge spoils, and excess soil and debris from grading under on-site caps, rather than off-site disposal (Materials & Waste)
  - Using local labor and labs when possible to reduce daily transportation (Energy)
  - Utilizing ground granulated blast furnace slag (mfg byproduct) for HBW construction with better results (Materials & Waste)
  - Avoided use of bentonite (natural resource – Materials & Waste)

Economic Green BMPs

Energy: Reduction, Efficiency and Renewables



Economic BMPs

- Local buying commitment
- Local job creation
- Market based and stakeholder driven re-use planning process
- Redevelopment opportunities

Sustainability in Reuse Plan

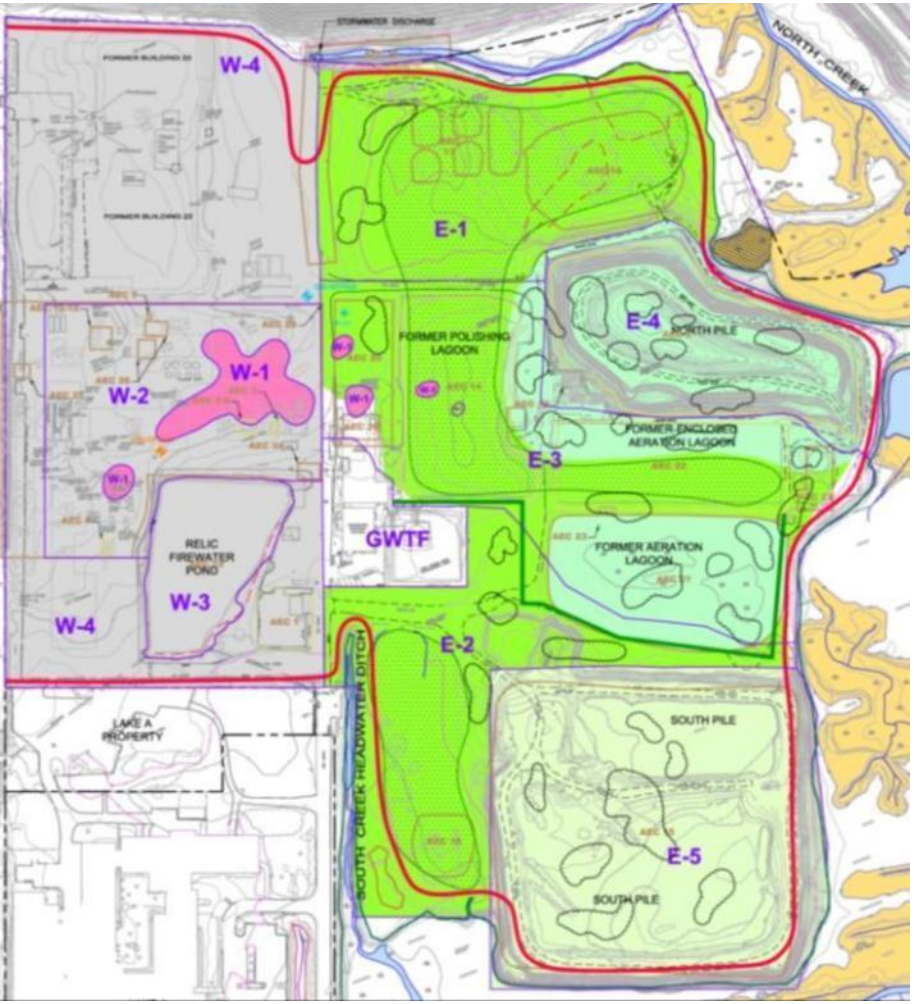
Land & Ecosystems: Conserve, Protect & Restore

- 60 acre ecological restoration
  - Re-established lost habitat
  - Creation of on-site wetlands
  - Selected re-vegetation requires minimal mowing
- 17-acres designated for economic development

PHARMACIA & UPJOHN GREENER CLEANUP CASE STUDY

REMEDIAL ACTION COMPONENTS

Key Components of EPA Approved Remedy



- Groundwater control and treatment, long-term operations

East Side Components

- Sediment removals, tidal wetlands mitigation
- Eastern side consolidation, protective barriers, ecological enhancements

West Side Components

- Thermal desorption to treat the most impacted area
- Western side protective barrier

Groundwater Control

Water: Improve Quality, Decrease Quantity of Use

Initial upgrades to existing Groundwater Treatment Facility

- COMPLETE (2012-2013)

Perimeter Hydraulic Barrier Wall

- COMPLETE (2013)

Expansion of Groundwater Extraction System

- COMPLETE

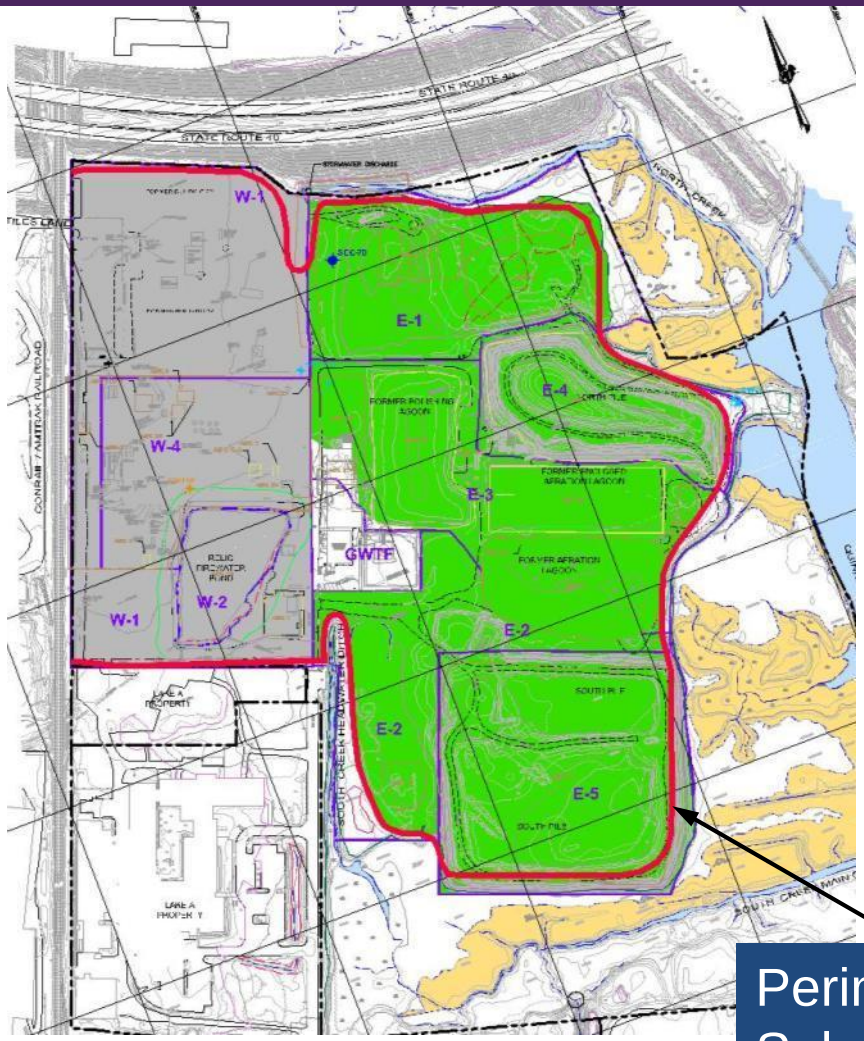
Final retrofit of existing GWT Facility

- 2016

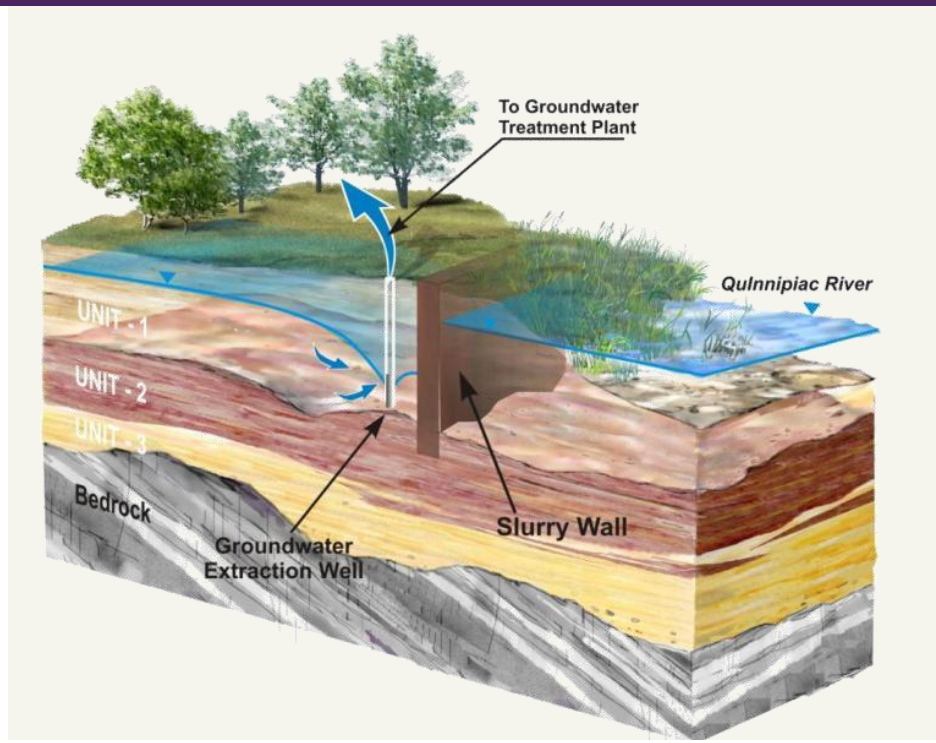
Groundwater Control and Treatment

Materials & Waste: Minimize, Reuse, Recycle

Pfizer GLOBAL SUPPLY



Perimeter Subsurface Hydraulic Barrier Wall



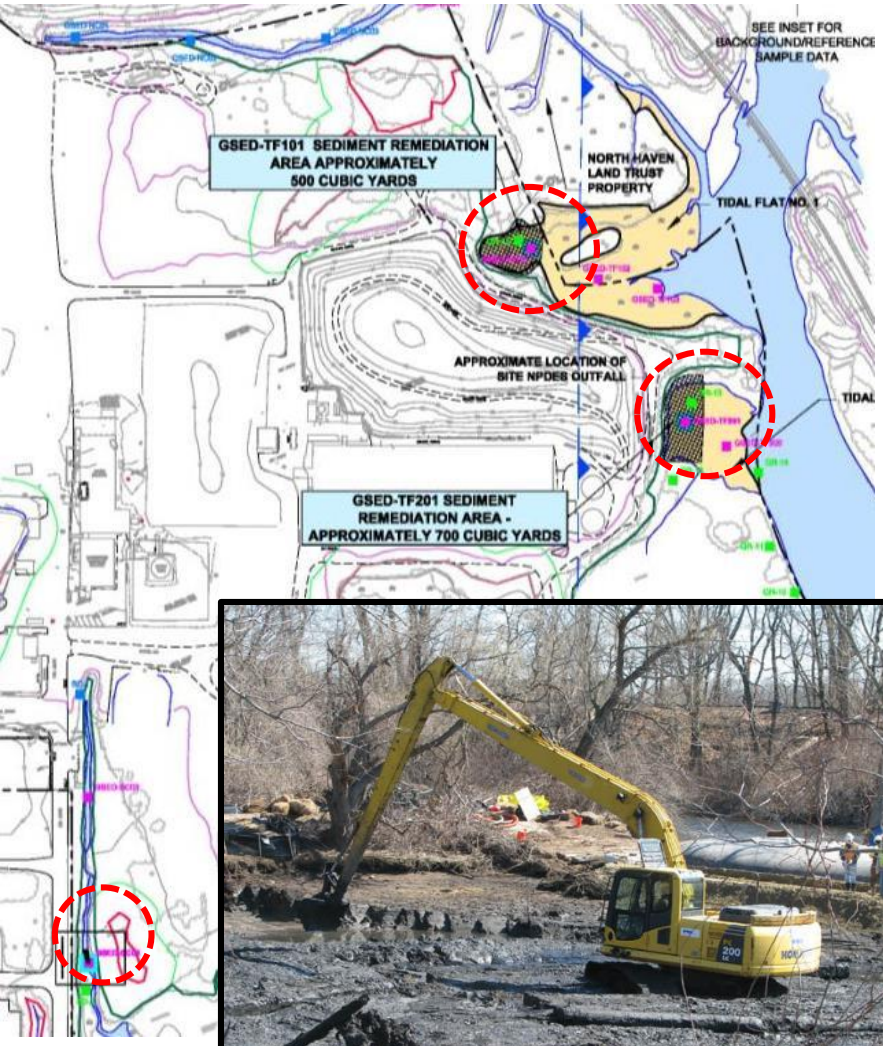
Perimeter Hydraulic Barrier Wall

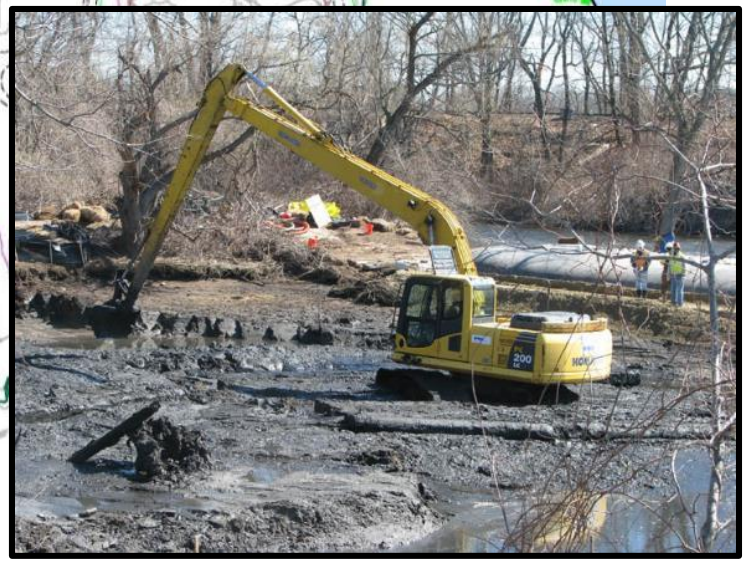
- 825 tons of Portland cement
- 2,465 tons of furnace slag

Sediment Removals

Land & Ecosystems: Conserve, Protect & Restore

Pfizer GLOBAL SUPPLY





Sediment Removals

- COMPLETE (2013-2014)

Tidal Wetland Mitigation

- 2014 - 2015

East Side Consolidation, Stabilization, Covers

Materials & Waste: Minimize, Reuse, Recycle

North Pile

2013

- Reuse of onsite soil for grading below caps thus avoiding unnecessary import of offsite clean fill (COMPLETE)

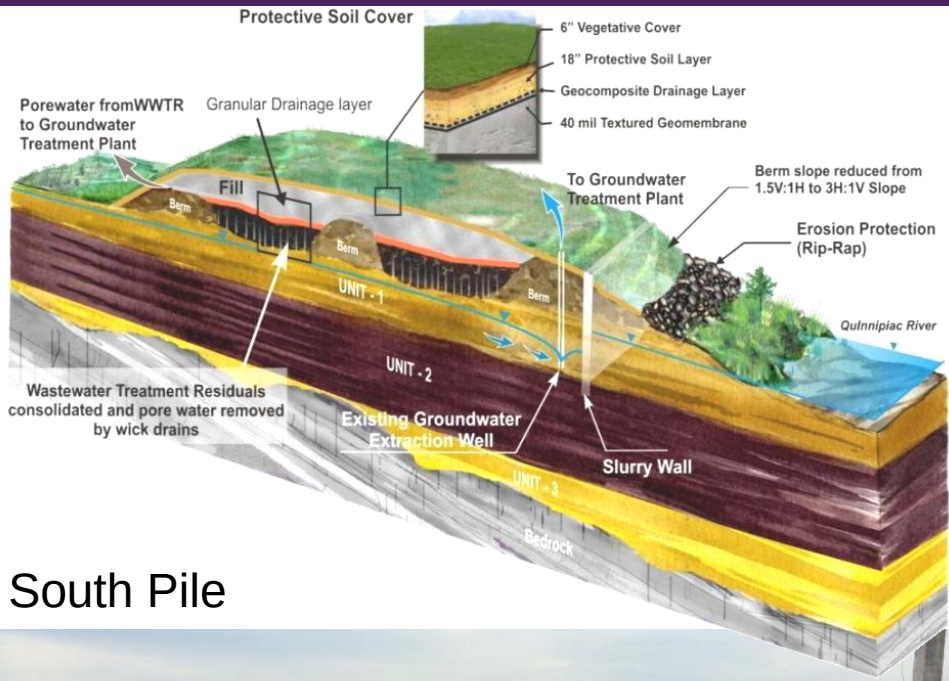
2014

- New cover system completed
- Final cover and planting

East Side Consolidation, Stabilization, Covers

Materials & Waste: Minimize, Reuse, Recycle

- Consolidation of residuals
- Low permeability cover system
- Ecological enhancements (native upland meadow and shrubs)
  - COMPLETE



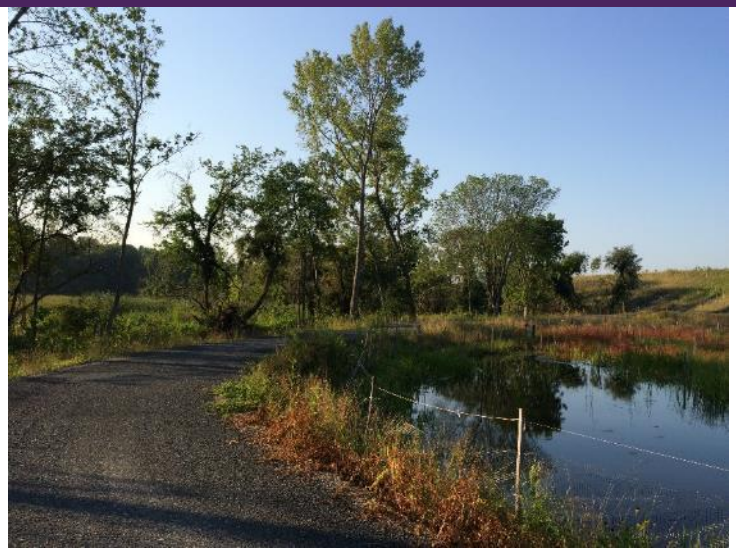
South Pile

Eastern FAL

East Side Ecological Restoration

Land & Ecosystems: Conserve, Protect & Restore

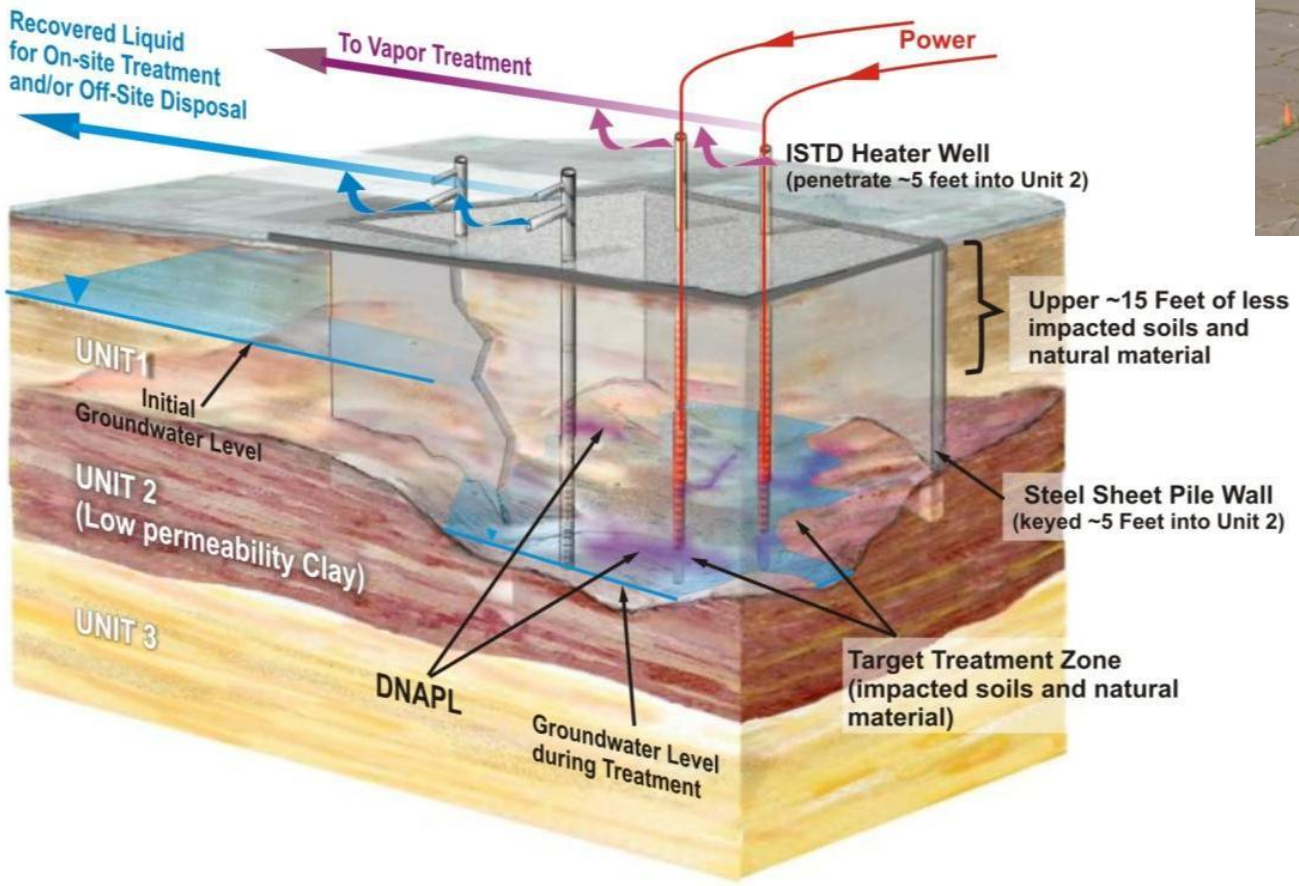
Pfizer GLOBAL SUPPLY



- Ecological restoration and Tidal Wetland Mitigation
- Creation of 6+ acres of new freshwater wetland habitat
- 2014/2015 - planting and subsequent monitoring / maintenance

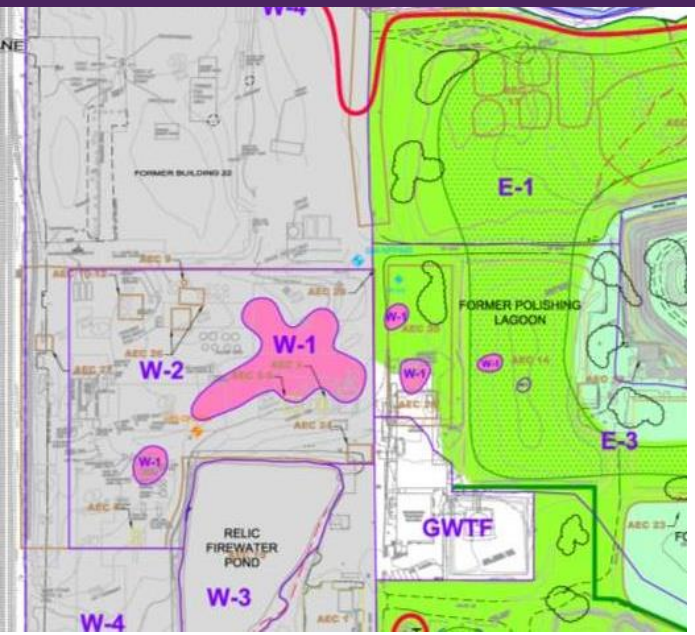
DNAPL Remediation

Air: Protect Air Quality, Reduce Greenhouse Gases



- In-Situ thermal desorption
- High energy use balanced by high mass removal

In-Situ Thermal Remediation of DNAPL



- Pilot system
  - COMPLETE (2012)
- Full-scale system design
  - COMPLETED (2015)
- Full-scale construction, operation, decommissioning
  - 2014 through 2016

2013 In-Situ Thermal Pilot Study

Energy: Reduction, Efficiency and Renewables

Pfizer GLOBAL SUPPLY

- Study showed that most chemical mass was removed at 100 degrees Celsius
- Increase in temperature above 100 C required large expenditure of energy for diminishing returns in reductions

Full-Scale ISTR (June 2015)

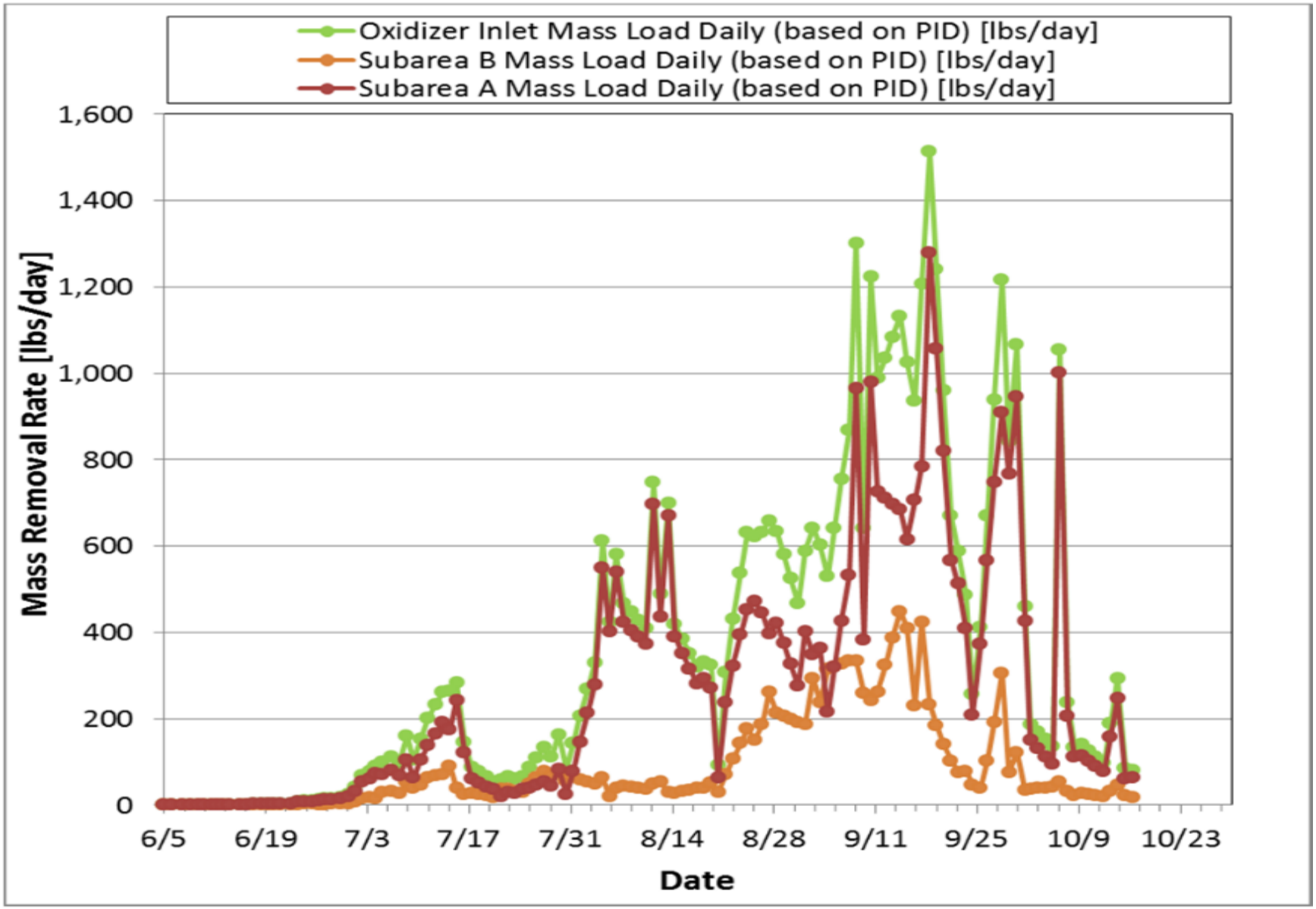
In-Situ Thermal Remediation (Benefits/Considerations) Safety

- Benefits of In-Situ Thermal
  - Minimize worker/community exposure of sub-surface soil and groundwater impacts
  - Aggressive remediation of NAPL impacts within in a reasonable timeframe (6 months of treatment operation)
  - Ability to remediate a wide range of Chemicals of Concern at high concentrations (VOC, SVOC, chlorinated compounds, PCB)
  - Ability to confidently meet EPA Region 1 RCRA 3008(h) Order performance objectives, and CTDEEP NAPL requirements
- Other Considerations
  - Type of COCs impact design and operation of system
  - Significant cost for equipment and operation
  - Complex above-ground treatment system

ISTR Mass Removal Rates

Energy: Reduction, Efficiency and Renewables

Pfizer GLOBAL SUPPLY



PHARMACIA & UPJOHN GREENER CLEANUP CASE STUDY

REGULATORY ACCEPTANCE BY USEPA AND CTDEEP

RCRA 3008(h) Order on Consent (Updated 31 March 2011 – Greener Cleanup)

- Groundwater extraction flow reduction realized through low permeability caps, subsurface barrier walls and Site grading reducing energy usage by half

- Encourage beneficial use of manufacturing byproduct (ground granulated blast furnace slag) as a component of low permeability barrier wall mix

RCRA 3008(h) Order on Consent (Updated 31 March 2011 – Greener Cleanup)

- Flexibility to optimize ISTR temperature balanced on energy input/CO2 emissions vs mass removal considerations (i.e. avoid diminishing rate reductions for ever increasing energy inputs)

- Allows on-site reuse of soil, sediment and debris as grading fill as part of the Site-wide Area of Contamination designation

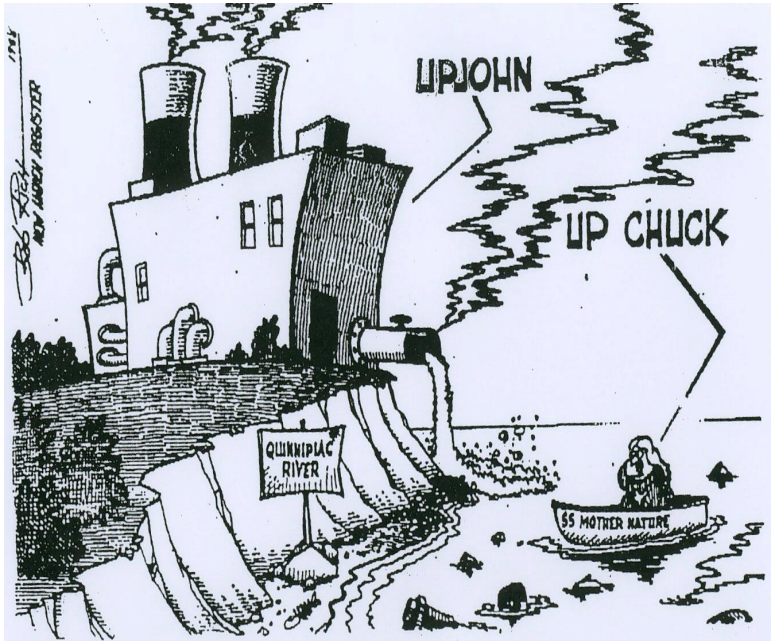
PHARMACIA & UPJOHN GREENER CLEANUP CASE STUDY

COMMUNITY IMPACT AND ACCEPTANCE: STAKEHOLDER INTERACTION

Headlines – Then

Lieberman targets Upjohn for continued violations

April 6, 1988 · THE NORTH HAVEN POST



New Haven Register, 1988

Upjohn cleanup vowed but many are skeptical

New Haven Register AUGUST 25, 1988

Documents pile up against sludge heap at Upjohn Co.

New Haven Register, Monday, December 5, 1988

Community Participation With and Without Stakeholders Engaged

Pfizer GLOBAL SUPPLY

- Pre-1995
  - No future vision for property beyond remedy
  - Remedy and reuse designs are decoupled
  - Engagement between responsible party and agencies
  - Little local participation
  - Result: Negative Press, Adversarial Relationships and Little Progress
- Post-1995
  - Vision for property considers eco-transition zone between river & commercial zone
  - 17-acres near rail / road access for development
  - Engagement inclusive of Town, Citizen Advisory Panel, local commissions
  - Sought reuse ideas from economic/enviro groups
  - Result: Full support of remedy and Much Progress

Community Outreach Approach

- 2003 - Pfizer Inc acquired Pharmacia Corporation, parent company of Pharmacia & Upjohn Company LLC
- Share Future Vision Alternatives with Stakeholders (business, recreational, educational, environmental, regulatory & local government) – “Begin with the End in Mind”
- Demonstrate that the preferred remedy is compatible with future land use
- Creation of video for consistent presentation
- Promote Interactive Meetings, Fact Sheets, Newspaper Articles, Open Houses, and Website (www.upjohnnorthhaven.com)

Media Attention – Now

Old Upjohn site gets attenion; Pfizer speaks

The North Haven Citizen Friday, July 7, 2006

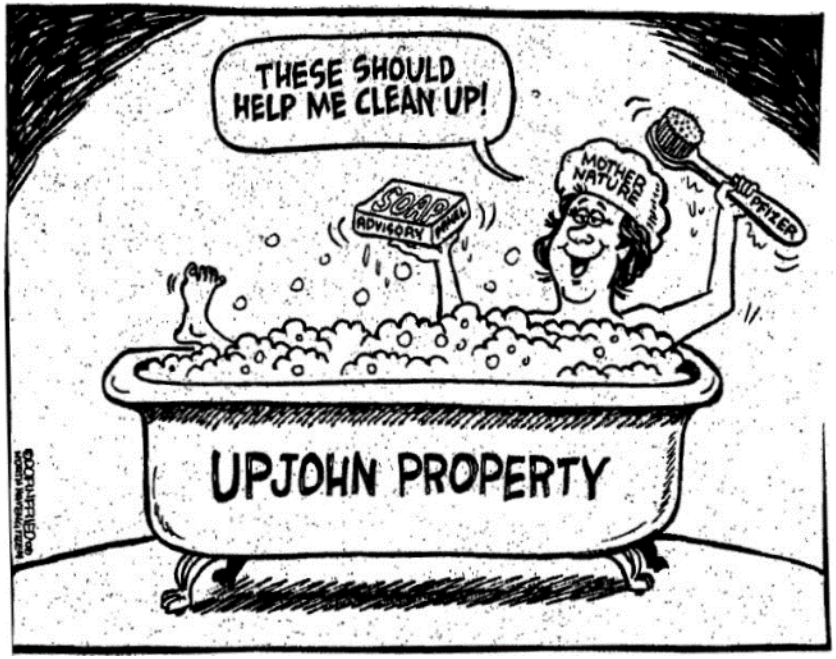
Pfizer Steps Up

Residents will Soon Have Say on Cleanup

North Haven Courier, July 6, 2006

Pfizer updates residents on cleanup

New Haven Register, June 30, 2006



North Haven Citizen, July 7, 2006

EPA Recognition of Achievements

Pfizer GLOBAL SUPPLY

CLU-IN

EPA United States Environmental Protection Agency

Technology Innovation and Field Services Division

Search

Contaminated Site Clean-Up Information

Technologies | Contaminants | Issues | Strategies & Initiatives | Vendors & Developers | Training & Events | Additional Resources

CLU-IN | Strategies & Initiatives | Green Remediation Focus | Profiles of Green Remediation | Pharmacia & Upjohn Company LLC Site

Green Remediation Focus

Pharmacia & Upjohn Company LLC Site, North Haven, Connecticut

RCRA Corrective Action

- View Menu of 32 Profiles

Cleanup Objectives: Provide long-term protection of human health and the environment by remediating soil, sediment, and groundwater impacted by past releases of manufacturing wastes, wastewater, and wastewater treatment residuals, including contaminants such as volatile organic compounds, polychlorinated biphenyls, and lead. The remedy for this 78-acre site, located along the Quinnipiac River in south central Connecticut, involves upgrade of the existing groundwater extraction system (GWES), installation of a perimeter groundwater hydraulic barrier wall, excavation and onsite consolidation of impacted soils and sediments, construction of low permeability and protective soil barrier cover systems, in situ thermal remediation (ISTR) for dense non-aqueous phase liquids (DNAPL) removal, extensive ecological restoration, and preparation of a portion of the site for future commercial/light industrial redevelopment opportunities.

Green Remediation Strategy: The strategy focuses on: (1) conducting a quantitative analysis of the carbon footprint of remedial activities, and identifying opportunities to reduce the footprint, (2) incorporating green remediation best management practices such as re-using onsite soil, sediment, and debris generated during remedy construction, (3) revitalizing the site's ecological systems in a manner that complements the Quinnipiac River ecosystem, and (4) integrating the community's vision for future use. Key studies and findings affecting the strategy include:

IMAGE GALLERY

Click on images below for details

Aerial View of Site

Results of Carbon Footprint Analysis

Staying Connected

Podcasts

NEWS Room

Live Events

TechDirect

USEPA Citizen Award

Citizens' Advisory Panel

- David Monz, Chairman
- Annette Gattilia*
- Rico Gattilia
- Miriam Brody
- Hugh Davis
- Joelle Innocenti
- Tom Roberts

- Annette worked tirelessly from late 1970's until her recent death (April 28, 2014) to effect the Site remedy.

6-Oct-2014 Ecological Milestone Planting Event

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PHARMACIA & UPJOHN GREENER CLEANUP CASE STUDY

RELATIVE COST/BENEFIT OVER PROJECT LIFE-CYCLE

Greener Cleanup Value-Added: Not Just Money Saved

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- ***The cost of Greener Cleanup is not only measured in dollars but also the comparative environmental footprint over the project life-cycle as well as the timeframe for return of the property to future beneficial reuse***

- ***The currency of added value or reduced costs must be viewed by resources consumed and pollutants released to the environment as well as dollars spent***

Review of Green Remediation Cost Impacts for North Haven

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Green Remediation Aspects	Cost Impacts
Use of local labor resources (where feasible)	Cost neutral since this was included in contract terms at the beginning of the contract
Use of recycled material in hydraulic barrier wall mix design	Unit cost comparable to other reagents – Change in mix design resulted in project cost change
Hydraulic barrier wall at toe of slope	Resulted in reduction of HBW mix and elimination of a MSE wall
Low permeability cover system with storm water directed to BMP/wetland restoration area	Results in 40% reduction in groundwater treatment flows due to reduced storm water infiltration (treatment plant operational savings)
In-Situ Thermal Remediation (ISTR)	ISTR costs offset by cost avoidance (savings) for need of DNAPL waste incineration at Port Arthur, TX
Consolidation of on-site material for cover system sub-grade	Reduced amount of clean fill import that was needed by 40,000 cu yds

Green Remediation Cost Considerations

- North Haven lessons learned on green remediation cost impacts:
  - Incorporating green remediation concepts early in the design process minimizes any cost impacts
  - Include green remediation aspects in contract terms/scope upfront
  - Most companies/contractors/vendors have green/sustainable goals that align with green remediation aspects

PHARMACIA & UPJOHN GREENER CLEANUP CASE STUDY

GREENER CLEANUPS CAN BE APPLIED ON SIMPLEST TERMS TO SMALLER, LESS-COMPLEX PROJECTS

QUESTIONS?

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Questions / Comments

Please speak loudly.

www.ct.gov/deep/remediationroundtable

Remediation Roundtable

E-mail: DEEP.remediationroundtable@ct.gov

Web: www.ct.gov/deep/remediationroundtable

REMEDIATION ROUNDTABLE

Next meeting: March 15, 2016

Connecticut Department of Energy and Environmental Protection

www.ct.gov/deep/remediationroundtable