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Greener Cleanup Technical Summary Form, including Social and Economic Aspects Pharmacia and Upjohn Company LLC, North Haven, Connecticut Prepared by Gnarus Advisors LLC, Arlington, Virginia

INTRODUCTION

This Technical Summary form identifies green best management practices (BMPs) incorporated into the design and implementation of the corrective action performed at the Pharmacia and Upjohn Company Site LLC in North Haven, Connecticut. The environmental aspects of the evaluation followed ASTM E 2893-13 *Standard Guide for Greener Cleanups*. The evaluation included social and economic BMPs incorporated into the cleanup.

X2.1 | General Information

X2.1.1 User's name and organization:
John A. Simon, Gnarus Advisors LLC

X2.1.2 Date:

July 6*, 2015*

X2.1.3 Property name:
Pharmacia and Upjohn Company LLC

X2.1.4 Site location (address, city, state, zip code):
41 Stiles Lane
North Haven, CT
06473

X2.1.5 Tax parcel ID # or EPA, state, project ID #:
EPA ID No. CTD001168533

X2.1.6 Cleanup program (for example, RCRA, state voluntary cleanup program):
RCRA Corrective Action

X2.1.7 Lead oversight agency (for example, EPA, state, other):
US EPA, Region 1, in coordination with Connecticut Department of Energy and Environmental Protection (CTDEEP)

X2.2 | Site Status Information

X2.2.1 Current cleanup phase:
RCRA Corrective Measures Implementation

X2.2.2 Contaminants at the site:
DNAPL Area - Volatile organic compounds (VOCs; predominately benzene, chlorobenzene, toluene, and tetrachloroethene [PCE]); semivolatile organic compounds (SVOCs; predominately, dichlorobenzenes, azobenzene, 2-chloroaniline, and 3,3'-dichlorobenzidine); and polychlorinated biphenyls (PCBs)

Soil/wastewater treatment residuals - VOCs, SVOCs, PCBs, and metals

Groundwater - VOCs, SVOCs, PCBs, and metals (lead)

Sediment - Highest concentrations of key chemicals with bioaccumulation potential are 3,3-dichlorobenzidine, benzidine, and PCBs

X2.2.3 Current, historical, and reasonably anticipated future use(s) for the site, if known:
Historical - The site was used for industrial manufacturing beginning in the mid-1800s, when I.L. Stiles & Sons operated a clay mine and brick yard. I.L. Stiles continued its operations into the 1930s. The site was then used by Carwin Chemical Company for chemical manufacturing from the mid-1940s to 1962 and by the Burndy Corporation for electrical component manufacturing from circa 1963 to 1975. Beginning in 1962, the Upjohn Company produced specialty and industrial chemicals, including pharmaceutical, dye, pigment, and photographic intermediates, agricultural treatment chemicals, ultraviolet curing initiators, coating and adhesive additives, and flavor and fragrance components.

Pfizer assumed responsibility for the Site in April 2003 as a result of its acquisition of the Pharmacia Corporation. Pharmacia & Upjohn Company LLC, is a subsidiary of Pharmacia LLC, and both are indirect wholly-owned subsidiaries of Pfizer Inc.

Current - The buildings had been demolished when Pfizer assumed responsibility for the site and the site is currently vacant, except for the groundwater treatment building. The only site activities are operation of the groundwater treatment system, groundwater monitoring, and routine site maintenance.

Future - The west side of the site will be available for as yet to be determined commercial or industrial purposes and the east side of the site will be a nature conservatory with walking trails.

X2.2.4 Potential human or ecological receptors of contamination:
Potential Human receptors - Site workers, trespassers, site visitors, and Quinnipiac River users; The pathway to all of these receptors are eliminated through the various remedial measures being implemented at the site. There are no drinking water exposures because groundwater is classified as GB (not suitable for potable uses) and groundwater use will be limited by an Environmental Land Use Restriction.

Potential Ecological receptors - Terrestial and estuarine receptors. The pathway to these receptors have been addressed through the various remedial measures being implemented at the site.

X2.2.5 Uses of adjacent properties:
Adjacent properties are primarily used for commercial and industrial purposes with the Quinnipac River to the east.

X2.2.6 Stakeholder involvement in the site:
In addition to Pfizer, EPA, and CTDEEP, the site has had active stakeholder participation by the following organizations: North Haven Citizens' Advisory Panel (CAP), Quinnipiac River Watershed Association, North Haven Land Trust, Regional Growth Partnership, North Haven Trail Association, and North Haven Board of Selectmen.

X2.2.7 Past or on-going cleanup activities:
See attachment for supplementary materials.

X2.2.8 Technologies or engineering controls implemented:
As described in X2.2.7, technologies and engineering controls include site cover systems, perimeter below grade hydraulic barrier walls, groundwater containment through pumping and treating, in-situ thermal desorption, site security, and site perimeter fencing.

X2.2.9 Interim or final cleanup goals, if established, and the status in achieving those goals:
Soil Cleanup Goals - The soil cleanup goals are based on the CTDEEP Remediation Standard Regulations (RSR) criteria for potential human health risks from direct contact with contaminated soils (i.e., institutional controls) and ecological risk assessment for terrestrial receptors. As described in the CMS, the Unit 1 hydraulic control system addresses the RSR soil criteria based on protection of GB groundwater.

Groundwater Cleanup Goals - The RSR criteria for groundwater are based on the potential degradation of adjacent surface water for protection of ecological risk and the potential risks to human health in future occupied buildings from volatilization of VOCs in groundwater.

Sediment Cleanup Goals - The ecological PMPS for sediment are based on potential ecological risks to estuarine wildlife.

X2.2.10 Activity and use limitations:
Plan to implement institutional controls, including Environmental Land Use Restrictions to prohibit residential use, restrict groundwater use, and prevent disturbance to or demolition of engineered controls constructed on-site.

X2.3 | Application
See Table X2.1

TABLE X2.1 Application of Guide (check all that apply)

Cleaning Phase	BMP Evaluation Process	Quantitative Evaulation Process with BMPs		Results Document	
		Footprint Analysis	LCA	Evaluation	Implementation
Site Assessment	✓			✓	✓
Remedy Selection		✓		✓	
Remedy Design/ Implementation	✓			✓	
Operation, Maintencance and Monitoring	✓			✓	
Remedy Optimization					

X2.4 | Environmental Footprint Reduction
Gnarus identified 87 green BMPs, 9 social BMPs, and 8 economic BMPs designed and/or implemented at the Pharmacia & Upjohn Company LLC site, as listed in Tables 1 through 5. The tables include the core elements that apply to each green BMP and the priority (with a ranking of 1 through 3, with 3 being the most significant). The tables also provide comments about actual or anticipated cost savings for selected BMPs.

X2.5 | BMP Process Summary

X2.5.2 BMP summary table
See attachment for supplementary materials, including BMP Tables.

X2.5.2 List all BMPs that were required by local, state, or federal environmental laws or regulations:
Two BMPs were required by environmental laws and regulations:

1. Install and maintain silt fences and storm water management basins to capture sediment-laden runoff along sloped areas (part of consolidation/cover system remedy)

2. Prepared and are implementing community relations plan to ensure the social BMPs were implemented in a coordinated manner

X2.6 | Quantitative Evaluation Summary

See Final Revised Corrective Measures Study for the Pharmacia and Upjohn Company LLC Site, Appendix W (June 2010) for carbon footprint analysis that quantifies equivalent carbon dioxide emissions associated with: (1) major on-site/off-site transportation components; (2) major energy use requirements from treatment/disposal activities associated with the construction of each site-wide Corrective Measures Alternative; and (3) long-term O&M. Specific activities include the transportation of primary construction materials to the site, transportation of primary wastes from the site to disposal facilities, on-site treatment and off-site treatment, and operation of the groundwater treatment facility. The purpose of the partial quantitative evaluation performed was to compare CO2-equivalent emissions across various remedial alternatives. Due to its focused nature, this evaluation did not follow the quantitative evaluation steps in Section 7.

8.3.2 | SELF-DECLARATION

A greener cleanup project was implemented in conformance with the ASTM E2893 Standard Guide for Greener Cleanups for the Pharmacia and Upjohn Company Site located at 41 Stiles Lane, New Haven, CT by John A. Simon of Gnarus Advisors LLC.

John A. Simon

July 6, 2015
Date

GNARUS ADVISORS LLC
WWW.GNARUSLLC.COM

Supplementary Materials

Greener Cleanup Technical Summary Form, including Social and Economic Aspects
Pharmacia & Upjohn Company LLC Site

41 Stiles Lane
North Haven, Connecticut

July 6, 2015

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Attachment for X2.2.7 - Past or On-going Cleanup Activities

Interim Corrective Actions and RCRA Closures Completed

- Manufacturing building and storage tank decommissioning and demolition/deconstruction

- Fencing and security

- Construction of a hydraulic control system for shallow groundwater (Hydrogeologic Unit 1) consisting of a perimeter sub-grade, low-permeability vertical barrier along three sides of the site that will intercept and treat contaminated groundwater
- Groundwater treatment facility for extracted groundwater
  - Biological treatment
  - Chemical coagulation
  - Suspended solids removal
  - UV light oxidation with hydrogen peroxide

- Relic Firewater Pond Interim Measure - compressing loose sediment at the bottom of the pond and then isolating sediments below a geosynthetic membrane and soil cover

- Former Polishing Lagoon Interim Closure – excavating wastewater treatment residuals, backfilling, and installing compacted soil and vegetated cover

- North Pile Interim Closure – installing a geosynthetic membrane cover over the crown of the pile and collecting and treating surface water runoff

- Former Enclosed Aeration Lagoon Interim Closure – compressing wastewater treatment residuals to reduce permeability and isolating material below a geosynthetic membrane and soil covers

- Removal and off-site disposal of recovered DNAPL

- Removal of soil from the site perimeter and other areas containing elevated concentrations of PCBs and disposing of these soils off-site

- Removal of wastes from the Former Burndy Lagoons, Former Northern Lagoon, and Former Laboratory Bottle Area and disposing of these materials off-site

- Stabilization and installation of low-permeability cover systems for both the North Pile, South Pile, and Former Aeration Lagoons on the east side of the Site to safely contain contaminated materials, prevent future contact with the materials, and minimize infiltration

- Management of surface water accumulation and infiltration at the South Pile, including treatment of accumulated storm water in the wastewater treatment plant until cover system installation completed

- Construction of protective barrier and low-permeability (nearly impermeable) cover systems over the east side of the Site to allow it to be safely used by maintenance workers and visitors

Corrective Measures as Defined in 2011 Administrative Order

- Enhancement of the east side ecological habitat, including creation of higher value uplands and wetlands habitat on the northern portion of the site

- Focused remediation of Quinnipiac River sediment in two areas of the tidal mud flats and in a small stretch of South Creek

- Pilot-scale in-situ thermal remediation system to treat DNAPL and full-scale design

- Monitoring deep groundwater (in hydrogeologic Unit 3) to confirm continued compliance with comparative criteria along the site perimeter

- Treatment of an area on the Site using in-situ thermal remediation to address DNAPL (pilot test completed; full-scale system operating)

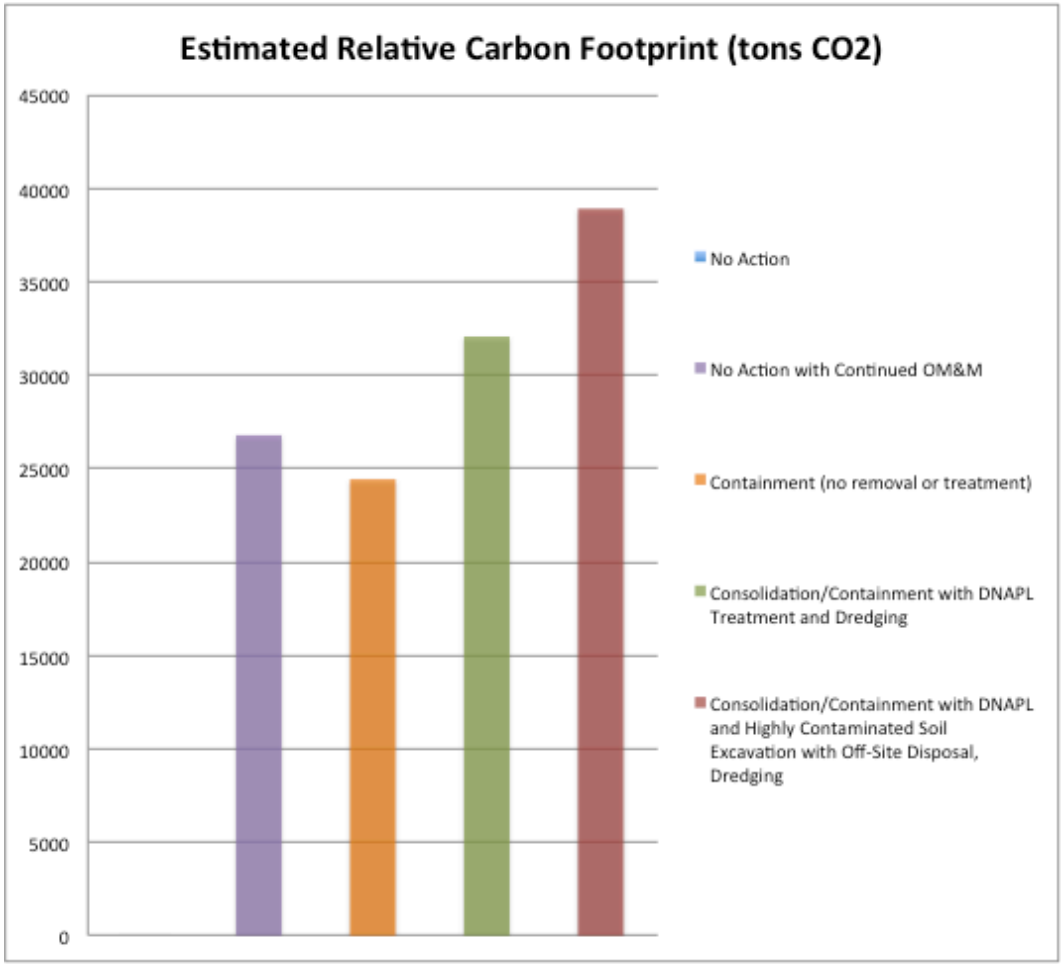
- Construction of caps or barrier covers over the west side of the Site to allow safe commercial/light industrial redevelopment

- Enhancement of the east side ecological habitat, including creation of higher value uplands and wetlands habitat on the southern portion of the site. Walking trails for interpretative environmental education will be constructed for guided viewing of the enhanced habitats, which will be maintained as an ecological area

- Long-term operation, monitoring, and maintenance (OM&M) of installed remediation systems

Note: the following summary table is a partial quantitative evaluation performed to compare CO2-equivalent emissions across various remedial alternatives. This evaluation did not follow the quantitative evaluation steps in Section 7.

Figure X2.4 – Estimated Relative Carbon Footprint for Various Remedies Considered for DNAPL Area



Remedial Alternative #1 – No Action (not shown because zero)
Remedial Alternative #2 – No Action with Continued OM&M
Remedial Alternative #3 – Containment (no removal or treatment)
Remedial Alternative #4 – Consolidation/Containment with DNAPL Treatment and Dredging
Remedial Alternative #5 – Consolidation/Containment with DNAPL and Highly Contaminated Soil Excavation with Off-Site Disposal, Dredging

Note: Remedial alternatives 2 through 5 all include groundwater extraction and treatment, groundwater monitoring, cover inspections, site security, and site-wide management; however, alternatives 3 through 5 have less groundwater extraction because of more extensive covers and subgrade barriers.

Note: the above data were published in: 1) US EPA (2010). Statement of Basis for Pharmacia & Upjohn Company LLC Site, North Haven, Connecticut. June 14. Table 7. 2) Golder Associates (2010). Final Revised Corrective Measures Study. June. Appendix W.

Other Relevant Material/Information

The remedial planning process for the Pharmacia & Upjohn Company LLC Site included selecting and implementing social and economic BMPs. The BMP evaluation process followed the same process as set forth in Section 6, as applicable, including the evaluation of social and economic BMPs. The BMPs considered and selected are shown in Table 1 through 6.

Pfizer's management supported the use of sustainable remediation concepts as part of its Green Journey to integrate environmental sustainability into its business (see http://www.pfizer.com/responsibility/protecting_environment/green_journey). This included instructing Pfizer's consultants to promote green and sustainable remediation concepts during the implementation of the project and Pfizer's retention of a specialty consultant to provide expertise in community relations pertaining to environmental issues and identifying ecological enhancements to incorporate into the project.

Table 1
Pharmacia and Upjohn Site
North Haven, Connecticut
Green BMP Table - Site Assessment
(Remedy Implementation Phase)

Category		Core Element Addressed (at Site Level)					Site Assessment	Priority	Retained?	Comments
		Energy	Air	Water	Materials and Waste	Land and Ecosystems				
Sampling and Analysis	Use local laboratory to minimize impacts from transportation	X	X				X	3	✔	
Project Planning and Team Management	Use local staff (including subcontractors) when possible to minimize resource consumption	X	X		X		X	2	✔	Local contractors used when appropriately qualified
Sampling and Analysis	Use on-site mobile lab or other field analysis (e.g., portable gas chromatography/mass spectrometry for fuel-related compounds and VOCs) to minimize the need for offsite laboratory analysis and associated sample packing and shipping	X	X		X		X	2	✔	On-site lab used with membrane interface probe
Wastewater Management	Treat potentially contaminated purge water with an on-site treatment technique prior to, or discharge to a waterway, as permissible	X	X		X		X	2	✔	Used GWTS for purge water
Materials	Prepare, store, and distribute documents electronically using an environmental management information system				X		X	1	✔	
Sampling and Analysis	Use field test kits for screening analysis of soil for VOC DNAPLs and polychlorinated biphenyls to minimize the need for offsite laboratory analysis and associated sample packing and shipping	X	X		X		X	1	✔	
Vehicle and Equipment Management	Use equipment to increase automation such as electronic pressure transducers, thermo-couples and water quality monitoring devices coupled with an automatic data logger	X	X	X			X	1	✔	
Sampling and Analysis	Use direct sensing non-invasive, technology such as a membrane interface probe, X-ray fluorescence, laser-induced fluorescence (LIF) sensor, cone penetrometer testing (CPT), electrical resistivity tomography, rapid optical screening tool (ROST), fuel fluorescence detector (FFD), membrane interface probe (MIP) and/or seismic refraction/reflection	X			X	X	X	1	✔	
Sampling and Analysis	Use biodegradable nitrile gloves during sampling activities. Information on the gloves is provided at: http://www.showabestglove.com/site/content/pdf/productsheets/US_EN/6105PF.pdf				X		X	1	No	
Sampling and Analysis	Use reconditioned 55-gallon steel drums to manage waste and wastewater				X		X	1	No	May apply to other technologies that generate drummed waste
Buildings	Reuse existing structures for treatment system, storage, sample management, etc.	X	X		X	X	X	2	No	Not considered at time of investigation
Materials	Recycle as much non-usable/spent equipment/materials as possible following completion of project				X		X	1	No	Not sufficient to consider for investigation stage
Sampling and Analysis	Use passive/no purge groundwater sampling system			X	X		X	2	No	Not possible at this stage of project; however, will consider in the future
Vehicle and Equipment Management	Implement an idle reduction plan	X	X			X	X	2	No	Limited opportunity for idle reduction during investigation
Vehicle and Equipment Management	Minimize diesel emissions through the use of retrofitted engines, use of ultra-low or low sulfur diesel or alternative fuels, or filter/treatment devices to achieve BACT or MACT		X				X	2	No	Not considered at time of investigation
Vehicle and Equipment Management	Replace conventional vehicles with electric, hybrid, ethanol or compressed natural gas vehicles	X	X				X	2	No	Not considered at time of investigation
Project Planning and Team Management	Select facilities with green policies for worker accommodations and periodic meetings	X	X	X	X		X	1	No	Not available in North Haven

Table 1
Pharmacia and Upjohn Site
North Haven, Connecticut
Green BMP Table - Site Assessment
(Remedy Implementation Phase)

		Core Element Addressed (at Site Level)								
Category		**Energy**	**Air**	**Water**	**Materials and Waste**	**Land and Ecosystems**	**Site Assessment**	**Priority**	**Retained?**	**Comments**
Sampling and Analysis	Use multi-port sampling system in monitoring wells to minimize the number of wells needing to be installed				X	X	X	1	No	Not technically practicable for this investigation
Vehicle and Equipment Management	Use biodegradable hydraulic fluids on hydraulic equipment such as drill rigs				X		X	1	No	Not available at time of investigation
Wastewater Management	Employ closed-loop graywater washing system for decontamination of trucks			X	X		X	1	No	Not available at time of investigation
Sampling and Analysis	Contract a laboratory that uses green practices and/or chemicals	X	X	X	X	X	X	1	No	Not practicable given methods used

Table 2
Pharmacia and Upjohn Site
North Haven, Connecticut
Green BMP Table - Containment Cover System (Remedy Design/Implementation)

		Core Element Addressed (at Site Level)								
Category		Energy	Air	Water	Materials and Waste	Land and Ecosystems	Subsurface containment & Treatment Barriers	Priority	Retained?	Comments
Site Preparation/Land Restoration	Enhance existing natural resources, manage surface drainage, prevent soil/sediment runoff and promote carbon sequestration by incorporating wetlands, bioswales and other types of vegetation into overall remedial approach		X	X		X	X	3	✔	
Materials	Designed barrier wall using a mixture of Portland cement and recycled ground granulated blast furnace slag				X		X	3	✔	
Site Preparation/Land Restoration	Use onsite or nearby sources of capping and backfill material for excavated area	X	X		X		X	3	✔	Total volume of material brought on-site is approximately 100,000 cy
Surface/Storm Water Management	Use excavated areas to serve as retention basins in final storm water control plans			X	X	X	X	3	✔	
Materials	For non-reactive component of permeable treatment/containment barriers, use locally derived materials (e.g., sand/gravel)	X	X		X		X	3	✔	Used on-site fill where possible and local sources of off-site fill
Site Preparation/Land Restoration	Adjust pile heights to accommodate a net balance of cuts and fills being performed throughout the Site to avoid the need to dispose of any materials off-site as well as the need to import clean fill to establish the subgrade of the cover system; also moved the hydraulic barrier wall to the toe of the slope of the South Pile	X				X	X	3	✔	Nominal materials from project disposed of off-site
Site Preparation/Land Restoration	For South Pile hydraulic barrier wall, the stability evaluation of the South Pile indicated that the hydraulic barrier wall could be installed via soil mixing in-place instead of removing soil and mixing the reagent above grade	X			X	X	X	3	✔	Total barrier wall cost savings of $928,000
Site Preparation/Land Restoration	Transfer soil removed from the top of the wall alignment to either the Former Aeration Lagoon or the South Pile and used as fill to facilitate the wastewater treatment residuals consolidation process	X			X	X	X	3	✔	
Site Preparation/Land Restoration	Evaluated biodiversity of flora, fauna, and wildlife to optimize habitat enhancement, minimize exotic invasive species, and support biodiversity (e.g., created protected open water zones, in-creek structures to create habitat complexity, such as pools and riffles, and the addition of structural diversity and shading)			X		X	X	3	✔	Utilized services of specialized biologists and ecologist to conduct studies to support BMP
Site Preparation/Land Restoration	Designed cover systems using a water balance to be upland meadows, constructed with seeding, wetland plant plugs and shrubs that should be essentially self-sustaining and, thus, would not require maintenance such as watering and/or mowing	X	X	X	X	X	X	2	✔	
Power and Fuel	Use biodiesel for the east side remedial components construction.	X					X	2	✔	
Site Preparation/Land Restoration	Visually screening the gas ventilation wells using vegetation/shrubbery as part of the proposed ecological enhancements to be established on the North Pile					X	X	2	✔	
Site Preparation/Land Restoration	Considered predicted climate change increases in water levels along the river when designing North Pile and South Pile cover systems					X	X	2	✔	
Site Preparation/Land Restoration	Revegetate excavated areas and/or areas disrupted by equipment or vehicles as quickly as possible using native vegetation, if possible, and restore as close as possible to original conditions			X		X	X	2	✔	
Site Preparation/Land Restoration	Maximize use of native, non-invasive and/or drought resistant vegetative cover across the site during restoration using a suitable mix of shrubs, grasses, and forbs to preserve biodiversity and related ecosystem services			X		X	X	2	✔	

Table 2
Pharmacia and Upjohn Site
North Haven, Connecticut
Green BMP Table - Containment Cover System (Remedy Design/Implementation)

		Core Element Addressed (at Site Level)								
Category		Energy	Air	Water	Materials and Waste	Land and Ecosystems	Subsurface containment & Treatment Barriers	Priority	Retained?	Comments
Surface/Storm Water Management	Use gravel roads, porous pavement and separated pervious surfaces rather than impermeable materials to maximize infiltration			X		X	X	2	✔	Access roads on east side of site are earthen materials
Materials	Use on-site/local materials, when possible (e.g., rocks for drainage control)	X	X		X		X	2	✔	
Site Preparation/Land Restoration	Minimize clearing of trees throughout investigation and cleanup	X		X	X	X	X	2	✔	
Site Preparation/Land Restoration	Reclaim uncontaminated soil for use as fill or other purposes such as frost prevention and erosion control layers in cover systems				X	X	X	2	✔	
Site Preparation/Land Restoration	Placed cut vegetation under cover systems instead of transporting off-site for disposal				X	X	X	2	✔	Estimated savings of $20,000
Surface/Storm Water Management	Install and maintain silt fences and basins to capture sediment-laden runoff along sloped areas			X		X	X	2	✔	Regulatory requirement
Project Planning and Team Management	Use local staff (including subcontractors) when possible to minimize resource consumption	X	X		X		X	1	✔	Local contractors used when appropriately qualified
Wastewater Management	Redirect influx of upgradient groundwater into the treatment area by adding engineering controls (e.g., installation of subsurface barriers to divert groundwater)	X		X			X	3	No	Considered, but not implemented because would cause flooding
Materials	Use recycled content (e.g., steel made from recycled metals, concrete and/or asphalt from recycled crushed concrete and/or asphalt, respectively, and plastic made from recycled plastic).; tarps made with recycled or biobased contents instead of virgin petroleum-based contents)				X		X	1	No	Not considered during design
Materials	Use biobased products (e.g., erosion control fabrics containing agricultural byproducts)				X		X	1	No	Not considered during design

Table 3
Pharmacia and Upjohn Site
North Haven, Connecticut
Green BMP Table - In-Situ Thermal Treatment (Remedy Design/Implementation)

		Core Element Addressed (at Site Level)								
Category		Energy	Air	Water	Materials and Waste	Land and Ecosystems	In-situ Thermal Treatment	Priority	Retained?	Comments
Materials	Maximize the reuse of existing wells for sampling, injections or extractions, where appropriate, and/or design wells for future reuse	X	X		X	X	X	3	✔	
Materials	Reuse well liners and heating rods during project and plan to use for other projects in the future				X		X	3	✔	
Power and Fuel	Install a thermal oxidizer equipped with a heat exchanger that uses some of the energy in the vapor discharge from the oxidizer to pre-heat the combustion air of the oxidizer; this results in a savings of approximately 40% of the fuel requirements for the oxidizer	X					X	3	✔	
Power and Fuel	Install amp meters to evaluate consumption rates on a real-time basis to evaluate options for off-peak energy usage	X					X	3	✔	
Power and Fuel	Operate remediation system during off-peak hours of electrical demand, without compromising cleanup progress	X					X	3	✔	
Power and Fuel	Insulate all applicable pipes and equipment to improve energy efficiency	X					X	2	✔	
Project Planning and Team Management	Use local staff (including subcontractors) when possible to minimize resource consumption	X	X		X		X	2	✔	
Vehicle and Equipment Management	Use variable frequency drive motors to automatically adjust energy use to meet system demand on blowers, vacuum pumps, etc. that accommodate changes in operating requirements as treatment progresses	X					X	2	✔	
Wastewater Management	Treat condensate in onsite systems where contaminant types and concentrations permit rather than have shipped offsite for treatment	X	X				X	2	✔	Condensate conveyed to on-site treatment system, unless it contains NAPL
Wastewater Management	Treat potentially contaminated purge water in on-site wastewater treatment system	X	X		X		X	2	✔	
Residual Solid and Liquid Waste	Use alternative drilling methods including direct-push technology (DPT) or sonic for well drilling to minimize drill cuttings that require disposal	X	X		X	X	X	2	✔	Plan to use roto-sonic drilling methods to reduce cuttings
Power and Fuel	Use solar panels for air monitoring stations	X						2	✔	
Project Planning and Team Management	Perform a heat and energy balance calculation to optimize heating and extraction rates which requires an adequate characterization of site hydraulics / hydrogeology. Maintain the energy balance on a daily basis during operation and adjust extraction strategy accordingly and minimize unnecessary operation period	X					X	2	✔	
Materials	Recycle as much non-usable/spent equipment/materials as possible following completion of project				X		X	2	✔	
Power and Fuel	Insulate the surface of the target treatment zone to reduce energy losses and use greener insulation alternatives, such as light weight expanded clay aggregate (LECA) beads rather than polyurethane foam.	X			X		X	1	✔	

Table 3
Pharmacia and Upjohn Site
North Haven, Connecticut
Green BMP Table - In-Situ Thermal Treatment (Remedy Design/Implementation)

		Core Element Addressed (at Site Level)								
Category		Energy	Air	Water	Materials and Waste	Land and Ecosystems	In-situ Thermal Treatment	Priority	Retained?	Comments
Project Planning and Team Management	Surgically target treatment zone and select appropriate performance standards to minimize volume requiring treatment relative to remedial goals	X	X	X	X	X	X	1	✔	Yes, used Triad approach and field dye testing for DNAPL delineation
Sampling and Analysis	Use local laboratory to minimize impacts from transportation	X	X				X	1	✔	
Vehicle and Equipment Management	Implement a telemetry system to reduce frequency of site visits	X	X				X	1	✔	
Materials	Co-locate heater elements and recovery wells in the same borehole, particularly in the saturated zone, to minimize the total number of wells and land disturbance	X	X	X	X	X	X	3	No	Not practicable
Power and Fuel	Purchase renewable energy via local utility and Green Energy Programs or renewable energy credits/certificates (RECs or Green Tags) to power cleanup activities	X	X				X	3	No	Economics
Site Preparation/Land Restoration	Revegetate excavated areas and/or areas disrupted by equipment or vehicles as quickly as possible using native vegetation, if possible, and restore as close as possible to original conditions			X		X	X	2	No	Plan to pave and use area commercially
Sampling and Analysis	Use passive/no purge groundwater sampling system			X	X		X	1	No	Not practicable
Surface/Storm Water Management	Use gravel roads, porous pavement and separated pervious surfaces rather than impermeable materials to maximize infiltration			X		X	X	1	No	Not in this area
Wastewater Management	Use uncontaminated wastewater or treated water for tasks such as wash water, irrigation, dust control, constructed wetlands or other uses			X	X		X	1	No	Not practicable
Residual Solid and Liquid Waste	Segregate drilling waste and, if possible, treat waste liquids in on-site wastewater treatment plant	X					X	1	No	Initially considered placing waste under engineered cap; but, timing prohibited implementation

Table 4A
Pharmacia and Upjohn Site
North Haven, Connecticut
Green BMP Table - Groundwater Extraction and Treatment (Remedy Design/Implementation)

		Core Element Addressed (at Site Level)								
Category		Energy	Air	Water	Materials and Waste	Land and Ecosystems	Pump and Treat	Priority	Retained?	Comments
Power and Fuel	Install subsurface, low permeability barrier wall to limit volume of groundwater to be extracted and treated	X						3	✔	
Project Planning and Team Management	Surgically target treatment zone and select appropriate performance standards to minimize volume requiring treatment relative to remedial goals.	X	X	X	X	X	X	3	✔	
Vehicle and Equipment Management	Use variable frequency drive motors to automatically adjust energy use to meet system demand on blowers, vacuum pumps, etc. that accommodate changes in operating requirements as treatment progresses	X					X	3	✔	Some motors have VFD
Residual Solid and Liquid Waste	Segregate drilling waste based on location/composition to reduce the volume of drilling waste disposed off-site; collect needed analytical data to make on-site reuse decisions	X	X		X	X	X	3	✔	Drilling waste placed under site cap
Wastewater Management	Place extraction wells in locations that will minimize volume of water requiring extraction	X	X	X	X		X	3	✔	
Wastewater Management	Subsurface barrier wall and low permeability covers in waste areas minimizes water requiring extraction	X	X	X	X		X	3	✔	Anticipate a 40% reduction from pre CMI levels
Residual Solid and Liquid Waste	Minimize off-site disposal of solid waste by improving solids dewatering with a filter press or other technologies	X	X		X		X	2	✔	Plan to improve dewatering efficiency as part of system redesign
Power and Fuel	Use gravity flow where feasible to reduce the number of pumps for water transfer after subsurface extraction	X			X		X	2	✔	System designed based on gravity flow, where
Materials	Reuse the existing 8-inch diameter force main (1,000 feet) located within the Main Utility Corridor as part of the new system				X		X	2	✔	
Materials	Minimize material use by using a single-wall conveyance system piping as the need for the use of double-wall piping was dismissed as the presence of the hydraulic barrier wall provides a second layer of containment				X		X	2	✔	
Buildings	Properly insulate/reinsulate buildings and use environmentally friendly insulation materials, e.g. spray-on cellulose (recycled newspaper)	X					X	2	✔	
Materials	Maximize the reuse of existing wells for sampling, injections or extractions, where appropriate, and/or design wells for future reuse	X	X		X	X	X	2	✔	
Power and Fuel	Insulate all applicable pipes and equipment to improve energy efficiency	X					X	2	✔	Aboveground pipes are insulated
Power and Fuel	Purchase renewable energy via local utility and Green Energy Programs or renewable energy credits/certificates (RECs or Green Tags) to power cleanup activities	X	X				X	3	No	Not economical
Buildings	Install energy recovery ventilators in buildings to allow incoming fresh air while capturing energy from outgoing, conditioned air and/or destratification fans to better circulate warmer air indoors during colder months	X	X				X	1	No	Not economical
Vehicle and Equipment Management	Use biodegradable hydraulic fluids on hydraulic equipment such as drill rigs				X		X	1	No	Not practicable for location
Wastewater Management	Employ closed-loop graywater washing system for decontamination of trucks			X	X		X	1	No	Not enough decontamination to make practicable

Table 4B
Pharmacia and Upjohn Site
North Haven, Connecticut
Green BMP Table - Groundwater Extraction and Treatment (Remedy Design/Implementation)

		Core Element Addressed (at Site Level)								
Category		Energy	Air	Water	Materials and Waste	Land and Ecosystems	Pump and Treat	Priority	Retained?	Comments
Power and Fuel	Operate pumping equipment in pulsed mode to adjust pumping as needed due to tidal changes; system designed to operate to maintain minimum water levels to prevent flow into the river	X					X	3	✔	
Sampling and Analysis	Use local laboratory to minimize impacts from transportation	X	X				X	3	✔	
Vehicle and Equipment Management	Implement a telemetry system to reduce frequency of site visits	X	X				X	2	✔	Remote monitoring, but not system operation
Materials	Use dedicated materials (i.e., reuse sampling equipment and nonuse of disposable materials/equipment) when performing multiple rounds of sampling of all matrices				X		X	2	✔	Use dedicated bladder pumps and tubing
Project Planning and Team Management	Use local staff (including subcontractors) when possible to minimize resource consumption	X	X		X		X	2	✔	Use local staff when possible
Residual Solid and Liquid Waste	Use filters (e.g., bag/cartridge filters) that can be backwashed to avoid frequent disposal of filters				X		X	2	✔	Use sand filters that can be backwashed
Wastewater Management	Treat potentially contaminated purge water using the on-site treatment system	X	X		X		X	2	✔	
Power and Fuel	Optimized flow rate to UV-oxidation treatment unit to maximize efficiency	X					X	2	✔	
Power and Fuel	UV-oxidation system is optimized by adjusting the number of lamps used based on the groundwater flow rate	X					X	2	✔	
Power and Fuel	Install amp meters to evaluate consumption rates on a real-time basis to evaluate options for off-peak energy usage	X					X	1	✔	UV treatment system equipped with amp meters
Materials	Prepare, store, and distribute documents electronically using an environmental management information system				X		X	1	✔	
Surface/Storm Water Management	Use gravel roads, porous pavement and separated pervious surfaces rather than impermeable materials to maximize infiltration			X		X	X	1	✔	Access roads on east side of site are earthen materials
Vehicle and Equipment Management	Minimize diesel emissions through the use of retrofitted engines, use of ultra-low or low sulfur diesel or alternative fuels, or filter/treatment devices to achieve BACT or MACT		X				X	1	✔	Use low sulfur fuel for emergency generators
Power and fuel	Switch to a less energy-intensive technology for remediation polishing when possible (e.g., supplement groundwater extraction systems with plant based groundwater extraction system) when overall energy balance supports the concept	X		X	X	X	X	3	No	Not applicable at cleanup phase being implemented
Power and Fuel	Purchase renewable energy via local utility and Green Energy Programs or renewable energy credits/certificates (RECs or Green Tags) to power cleanup activities	X	X				X	3	No	Not economical
Wastewater Management	Reinject treated groundwater to the subsurface to recharge an aquifer			X			X	3	No	Difficult given regulatory requirements
Wastewater Management	Consider discharging wastewater to a POTW or other regional water treatment plant rather than building and operating an on-site treatment plant, when feasible and environmentally beneficial based on additional analysis	X			X		X	3	No	Not economical to discharge to POTW
Sampling and Analysis	Use passive/no purge groundwater sampling system			X	X		X	2	No	Not possible at this time; however, consider in the future
Wastewater Management	Use uncontaminated wastewater or treated water for tasks such as wash water, irrigation, dust control, constructed wetlands or other uses			X	X		X	2	No	Difficult given regulatory requirements

Table 4B
Pharmacia and Upjohn Site
North Haven, Connecticut
Green BMP Table - Groundwater Extraction and Treatment (Remedy Design/Implementation)

		Core Element Addressed (at Site Level)								
Category		Energy	Air	Water	Materials and Waste	Land and Ecosystems	Pump and Treat	Priority	Retained?	Comments
Power and Fuel	Operate remediation system during off-peak hours of electrical demand, without compromising cleanup progress	X					X	2	No	Could compromise system efficiency at this cleanup phase
Materials	Use regenerated GAC for use in carbon beds				X		X	2	No	No need to replenish carbon b/c only used for polishing
Sampling and Analysis	Contract a laboratory that uses green practices and/or chemicals	X	X	X	X	X	X	1	No	Not practicable given methods used

Table 5
Pharmacia and Upjohn Site
North Haven, Connecticut
Green BMP Table - Sediment Dredging (Remedy Design/Implementation)

		Core Element Addressed (at Site Level)								
Category		Energy	Air	Water	Materials and Waste	Land and Ecosystems	Excavation and Surface Restoration	Priority	Retained?	Comments
Residual Solid and Liquid Waste	Minimize off-site disposal of solid waste	X	X		X		X	3	✔	Dredged sediment placed in South Pile; no off-site disposal
Project Planning and Team Management	Use local staff (including subcontractors) when possible to minimize resource consumption	X	X		X		X	2	✔	Local contractors used when appropriately qualified
Residual Solid and Liquid Waste	Use geotextile bags or nets to contain excavated sediment, facilitate sediment drying, and increase ease of sediment placement or transport, when appropriate			X		X	X	2	✔	Either used recyclable Aqua-Barriers or sand bags that were later used for on-site fill
Sampling and Analysis	Use local laboratory to minimize impacts from transportation	X	X				X	2	✔	
Site Preparation/Land Restoration	Use onsite or nearby sources of backfill material for excavated areas, if shown to be free of contaminants	X	X		X		X	2	✔	Used sand from sand bags for fill material
Site Preparation/Land Restoration	Minimize clearing of trees throughout investigation and cleanup	X		X	X	X	X	1	✔	Trees only removed if absolutely necessary
Site Preparation/Land Restoration	Salvage uncontaminated and pest- or disease-free organic debris, including trees downed during site clearing, for use as fill, mulch, compost, or habitat creation				X	X	X	1	✔	Compost removed vegetation
Surface/Storm Water Management	Install and maintain silt fences and basins to capture sediment runoff along sloped areas			X		X	X	1	✔	Regulatory requirement
Wastewater Management	Use dewatering processes that maximize water reuse			X	X		X	3	✔	All water drained back
Power and Fuel	Purchase renewable energy via local utility and Green Energy Programs or renewable energy credits/certificates (RECs or Green Tags) to power cleanup activities	X	X				X	3	No	Not economical.
Sampling and Analysis	Use on-site mobile lab or other field analysis (e.g., portable gas chromatography/mass spectrometry for fuel-related compounds and VOCs) to minimize the need for offsite laboratory analysis and associated sample packing and shipping	X	X		X		X	2	No	Not feasible given data quality objectives
Vehicle and Equipment Management	Implement an idle reduction plan	X	X			X	X	2	No	Not considered when dredging conducted
Power and Fuel	Employ auxiliary power units to power cab heating and air conditioning when a machine is not operating (such as smartway generator or plug in outlet)	X	X				X	1	No	Not necessary given climate
Power and Fuel	Use biodiesel produced from waste or cellulose based products, preferring local sources wherever readily available to reduce transportation impacts				X		X	1	No	Not considered during design
Project Planning and Team Management	Select facilities with green policies for worker accommodations and periodic meetings	X	X	X	X		X	1	No	Not available in North Haven
Sampling and Analysis	Contract a laboratory that uses green practices and/or chemicals	X	X	X	X	X	X	1	No	Not practicable given methods used
Vehicle and Equipment Management	Use biodegradable hydraulic fluids on hydraulic equipment such as drill rigs				X		X	1	No	Not considered during design
Vehicle and Equipment Management	Minimize diesel emissions through the use of retrofitted engines, use of ultra-low or low sulfur diesel or alternative fuels, or filter/treatment devices to achieve BACT or MACT		X				X	1	No	Not considered during design
Wastewater Management	Employ closed-loop graywater washing system for decontamination of trucks			X	X		X	1	No	Not considered during design

Table 6
Pharmacia and Upjohn Site
North Haven, Connecticut
Sustainability BMP Table - Social and Economic BMPs
(Remedy Design/Implementation)

Category		Priority	Retained?	Comments
Social	Implement strategies to develop a more collaborative relationship with stakeholders beyond existing regulatory requirements to the extent possible, for example by engaging the stakeholders and increasing the transparency of operations at the site. This included conducting community workshops and interviews to solicit and incorporate input into remedial decision process; with community input and support selected and are implementing remedy incorporating in situ thermal treatment for source control and utilizing on-site containment cells to limit transport of waste throughout community.	3	✔	
Social	Conducted community workshops and interviews to solicit and incorporate input into future land use selection process	3	✔	
Social	Restore site surroundings so that they are visually attractive. Constructed ecological preserve on the east side of the property consisting of nature trails and wetlands; allow community access on a guided basis for interpretative environmental education and guided viewing of the enhanced habitats	3	✔	
Social	Provided the public with adequate and timely information concerning forthcoming actions or decisions by developing North Haven Informational website that ensures the community is fully informed about corrective action plans and progress	3	✔	
Social	Implement a local education program about site impacts and remediation impacts	3	✔	
Social	Conduct on-site citizen training sessions for the local community that directly relate to site assessment and cleanup efforts	3	✔	
Social	Retain third party to provide assistance with management of communications with community	3	✔	
Social	Prepared community relations plan to ensure the above measures were implemented in a coordinated manner	3	✔	Regulatory requirement
Social	Developed videos that assisted stakeholders visualize the remedy and restoration	3	✔	
Economic	Conducted market analysis to evaluate optimum future land use, plan to refresh the analysis after the source area treatment is completed	3	✔	
Economic	Integrated redevelopment plans into the cleanup which enabled appropriate infrastructure design to be incorporated into remedial design	3	✔	
Economic	Outreach to real estate market and community stakeholders to ensure reuse potential is integrated with the remedy	3	✔	
Economic	Local buying commitment, including web-based form on website that local businesses can use to provide information on local services and products to Pfizer	3	✔	
Economic	Created local jobs during the remediation. In addition, the anticipated commercial/industrial developmentfuture land use integrated into the remedy should create additional jobs	3	✔	
Social	Involved town Selectmen in the remedial decision process to ensure local government supported proposed remedy	2	✔	

Table 6
Pharmacia and Upjohn Site
North Haven, Connecticut
Sustainability BMP Table - Social and Economic BMPs
(Remedy Design/Implementation)

Category		Priority	Retained?	Comments
Social	Communicate site activities to stakeholders in a non-technical fashion if needed so that stakeholders understand the issues at hand and the process of estimating public health risk	2	✔	
Social	Identify organizations with common environmental, social and/or economic concerns	2	✔	
Social	Develop a contact list and add to the list those members of the public who request they be added. Update the list regularly and subdivide the list by category of interest of geographic area. Use the list to send announcements, reports and other communication with the public.	2	✔	
Social	Ensure that the site is secure. Employ a full-time security guard and/or install physical barriers such as a fence will prevent unauthorized entry to the site and protect remediation equipment from vandalism or theft. A full-time security guard and/or physical barriers may protect trespassers from risks associated with site activities, from tripping hazards to exposure to hazardous materials.	2	✔	