EPA/ROD/R01-95/109
1995

EPA Superfund
Record of Decision:

PEASE AIR FORCE BASE
EPA ID: NH7570024847
OU 04
PORTSMOUTH/NEWINGTON, NH
09/26/1995

<IMG SRC 0195109>

Record of Decision
Site 32/36
Pease Air Force Base, New Hampshire

September 1995

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DECLARATION

SITE NAME AND LOCATION

Site 32/36, Pease Air Force Base (Pease AFB), Rockingham County, New Hampshire

STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) presents a selected source control remedial action designed to protect human and ecological receptors from contaminants in the Site 32/36 source areas at Pease AFB, New Hampshire. This ROD was developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986, and the National Contingency Plan (NCP) (40 CFR Part 300). Through this document the Air Force plans to remedy the threat to human health, welfare, or the environment posed by contaminants associated with Site 32/36 source areas. The Site 32 source area is defined as the region where dense nonaqueous phase liquids (DNAPLs) and residual DNAPL are present, including areas of inferred DNAPL, as suggested by the presence of substantially elevated levels of dissolved volatile organic compounds (VOCs). The Site 32 source area consists of an irregularly shaped three-dimensional volume defined by VOC-contaminated soils, and overburden and shallow bedrock groundwater. The Site 36 source area is defined as VOC-and metals-contaminated soils that, based on an evaluation of leaching potential, are believed to be causing groundwater quality standards to be exceeded.

Contaminants associated with the Site 32/36 source areas that have migrated to surface water and sediment, and dissolved-phase contaminants that have migrated to groundwater outside the defined Site 32 Technical Impracticability (TI) zone are addressed in the Zone 3 Draft Final Feasibility Study (FS) Report (G-628) and Proposed Plan (G-728), and will be addressed in the Zone 3 ROD.

The decision presented in this document is based on the Administrative Record for the site. The Administrative Record for the site is located at 61 International Drive, Building 43, at Pease AFB. The Administrative Record Index as it applies to Site 32/36 is presented in Appendix D.

The State of New Hampshire Department of Environmental Services (NHDES) concurs with the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from Site 32/36 source areas, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, public welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

The selected remedy for Site 32/36 will protect human health, welfare, and the environment through containment of the Site 32 source area within the Technical Impracticability (TI) Zone and removal of the Site 36 contaminant source.

The selected remedy includes the installation of a vertical barrier to facilitate containment of the Site 32 source area; extraction and treatment of groundwater from within and below the vertical barrier to prevent migration of contaminants in the source area overburden; and excavation and off-site disposal of Site 36 metals- and VOC-contaminated soil. Extracted groundwater will be treated in the modified Site 32/36 treatment plant and will be discharged via off-site (on-base) subsurface recharge trenches or surface application.

Because the Site 32 source area is unlikely to be successfully remediated because of its relatively complex hydrogeology and the suspected existence of DNAPL, the selected remedy will also require the establishment of a Technical Impracticability (TI) zone. The TI zone proposed for Site 32 is restricted to the source area (DNAPL zone) and that portion of the dissolved-phase contaminant plume which does not meet Applicable or Relevant and Appropriate Requirements (ARARs) and which can be hydraulically contained by the vertical barrier and groundwater extraction system. Waivers for several of the federal and state chemical-specific ARARs for source area groundwater will be required within the TI zone. Contaminants present in the groundwater at concentrations in excess of chemical-specific ARARs outside of the TI zone will be addressed by the remedial alternative selected for Zone 3. Additional measures in the source area will be required to prevent human receptor exposure to contamination. Land Use restrictions regarding groundwater use and excavation activities in Zone 3 are already in place at the base. Future restrictions on activities in the source area at Site 32 will be implemented as part of any deeded property transfer action.

STATUTORY DETERMINATION

The selected remedy is protective of human health and the environment complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost effective. The remedy uses permanent solutions and alternative treatment technologies to the maximum extent practicable. Because of the technical impracticability associated with remediating the Site 32 source area, contaminant rather than treatment is the principal element of this selected remedy. However, the selected remedy will involve treatment of extracted groundwater from Site 32 and off-site disposal of Site 36 metals- and VOC-contaminated soil. Because this remedy will result in hazardous substances remaining on-site, a periodic review will be conducted by the Air Force, U.S. Environmental Protection Agency (EPA), and NHDES to ensure that the remedy is providing adequate protection of human health and the environment. This review will be conducted at least once every 5 years as long as hazardous substances remain on-site above health-based cleanup levels.

The foregoing represents the selection of a remedial action by the Air Force and EPA New England, with the concurrence of NHDES.

Concur and recommend for immediate implementation:

U.S. Air Force

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By: ______________________________ Date: ____________________

Alan K. Olsen
Director Air Force Base Conversion Agency

U.S. Environmental Protection Agency

By: _______________________________ Date: _____________________

Linda M. Murphy
Director, Waste Management Division

RECORD OF DECISION SUMMARY

I. SITE NAME, LOCATION, AND DESCRIPTION

Pease Air Force Base (AFB) is a National Priorities List (NPL) site consisting of numerous areas of contamination. This Record of Decision (ROD) addresses the control of source area contamination at Site 32/36 (Buildings 113/119) located in the area of Pease AFB designated as Zone 3. The Site 32 source area is define as the region where dense, nonaqueous phase liquid (DNAPL) and residual DNAPL are present, including areas of inferred DNAPL, as suggested by the presence of substantially elevated levels of dissolved volatile organic compounds (VOCs) in soft and groundwater. The Site 32 source area consists of an irregularly shaped, three-dimensional volume defined by VOC-contaminated soil and overburden and bedrock groundwater. The Site 36 source area consists of VOC-and metals-contaminated soil that are believed to be causing groundwater quality standards to be exceeded. The management of contaminants that have migrated to groundwater, surface water, and sediment beyond the defined Site 32/36 source areas are being addressed in the Zone 3 Proposed Plan and ROD.

Site 32/36 occupies approximately 10.5 acres near the center of Pease AFB. Building 113 was used for aircraft equipment maintenance, including degreasing operations, between 1956 and 1968. Building 119 was used for jet engine and engine accessory maintenance from 1956 to 1990. Site 32/36 has been investigated under the Air Force Installation Restoration Program (IRP), and the results of the field investigations to confirm and to determine the nature and extent of contamination at Site 32/36 have indicated that sediment, surface water, soil, and groundwater have been impacted by past activities at Site 32/36.

The 4,365-acre former base is located in the City of Portsmouth and the Town of Newington, both of which are in Rockingham County, New Hampshire. As shown in Figure 1, Pease AFB is located on a peninsula bounded on the west and southwest by Great Bay; on the northwest by Little Bay; and on the north and northeast by the Piscataqua River. The base is situated in the approximate center of the peninsula.

At the beginning of World War II, an airport at the current Pease AFB location was used by the U.S. Navy. The Air Force assumed control of the site in 1951, and construction of the present facility was completed in 1956. During its history, Pease AFB has been the home of the 100th Bombardment Wing and the 509th Bombardment Wing whose mission was to maintain a combat-ready force capable of long-range bombardment operations. Over time, various quantities of fuels, oils, solvents, lubricants, and protective coatings were used at the base, and releases of contaminants into the environment occurred.

In December 1988, Pease AFB was selected as one of 86 military installations to be closed by the Secretary of Defense's Commission on Base Realignment and Closure. The base was close as an active military retaken on 31 March 1991. The New Hampshire Air National Guard remains at the base and uses some of the existing facilities. The remainder of the reservation has been divided between the Department of the Interior (DOI) through an intergovernmental conveyance, the State of New Hampshire's Pease Development Authority (PDA) in the form of a long-term lease (in anticipation of a deeded transfer in the future), and the Air Force. Site 32/36 is located near the center of the base within the area known as the Industrial Shop/ Parking Apron (IS/PA). The site is bounded by Lee Street to the north, Rochester Avenue to the east, Somersworth Street to the south, and Dover Avenue to the west.

The IS/PA area contains most of the flightline shops, aircraft repair shops and hangars, aircraft parking apron, and refueling areas. One of the main base water supply wells (Haven well) is located in this area. Several IRP and Underground Storage Tank (UST) Management Program sites and points of interest (POI) are located in the IS/PA area near Buildings 113 and 119 (see Figure 1). Sites 31, 33, 35, and 38 (Buildings 244, 229, 226, and 120, respectively) are located north of Site 32/36. Site 34 (Building 222) is located west of site 32/36.

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The area surrounding Buildings 113 and 119 is flat (5% slope), except for a relatively steep slope (40% slope) behind Building 119 and along Dover Avenue. Much of the area is paved or occupied by buildings. Wetlands occupy the majority of the area between Building 113 and Building 119 and between Building 222 and Dover Avenue. Toward the east, across Portsmouth Avenue, the area is occupied by recreational fields and additional wetlands. Newfields Ditch originates approximately 500 feet west of Building 113, north of Building 222 (Site 34), and flows northeast, eventually discharge to the Piscataqua River. A general land use map for Pease AFB, including Site 32/36, is shown in Figure 2.

There are approximately 3,700 dwellings within a 1-mile radius of Pease AFB. Based on water usage surveys conducted in 1988 and 1992 and on available U.S. Geological Survey (USGS) and New Hampshire Department of Environmental Services (NHDES) information, it was determined that a number of these dwellings have wells and/or springs located on their associated properties. The Town of Newington in particular has a large number of private wells. Privately owned wells are use for potable, sanitary, and agricultural purposes. There are also wells for which use is undocumented. The vast majority of Portsmouth residences surveyed are serviced by town water only. A complete compilation of area springs and wells for Pease AFB, based on information available to date, is presented in the Pease AFB Off-Base Well Inventory Letter Report (G-599).

Pease AFB is located on a peninsula within the Piscataqua River drainage basin. Drainage is radially away from the peninsula, into Great Bay toward the west, Little Bay to the northwest and north, and the Piscataqua River to the east. Little Bay flows into the Piscataqua River at the northern end of the peninsula Great Bay, Little Bay, and the Piscataqua River are all tidally influenced. Consequently, these bodies of water are subject to semidiurnal water-level variations.

Surface water runoff in the Site 32/36 area is controlled by a network of stormwater drainage ditches and storm sewers. The local drainage ditches and storm sewers converge, channeling all the site stormwater into Newfields Ditch. The surface water in Newfields Ditch flows generally toward the east through a series of ditches and culverts and empties into the Piscataqua River at Portsmouth via Hodgsons Brook and North Mill Pond.

A wetlands area, ranging from 3 to 4 feet below the grade of Buildings 113 and 119, receives most of the runoff from the two sites. The area of delineated wetlands associated with Site 32/36 is shown in Figure 3. Runoff not collected in the wetland area is collected in the surrounding storm sewers.

Two drainage ditches drain the wetlands area in the vicinity of Site 32/36. The first ditch, which runs next to Building 119, is a portion of Newfields Ditch. The course of Newfields Ditch starts at the Parking Apron near the Jet Engine Test Cell (JETC) (Site 34) and crosses beneath Dover Avenue. The reach of Newfields Ditch running from its headwaters to Site 32 was referred to as the Northern Ditch in the Site 34 Draft Final RI Report(G-579). The second drainage ditch originates near Building 113 and joins Newfields Ditch halfway between Buildings 113 and 119. From there, surface water flows into a large-diameter pipe (culvert) that runs underground along Newfields Street between Rochester and Portsmouth Avenues. Several other drainage lines carrying surface runoff from portions of the Industrial Shop area empty into the culvert before it reaches Portsmouth Avenue. Because Pease AFB was a U.S. military installation, the Federal Emergency Management Agency (FEM) did not delineate floodplains at the base. Therefore, it is not known whether Site 32/36 is within a 100-year floodplain. There are no records indicating that flooding has occurred near Site 32/36.

A more complete description of the site is presented in the Site 32/36 Draft Final Remedial Investigation (RI) Report (G-583).

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II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

A. Site Use and Response History

Buildings 113 and 119 (Site 32/36) are located within Zone 3 in the center of the base in the IS/PA as shown in Figure 4. Buildings 113 and 119 have been grouped together for evaluation since 1987 because of similar stratigraphy, geographic proximity, and similar contaminant profiles. Building 113 was used between 1955 and 1991 for aircraft maintenance including vapor degreasing operations. The principal area of environmental concern at Building 113 as a result of previous activities is a former 1,200-gallon concrete UST located next to the building as shown in Figure 5. The UST received waste trichloroethene (TCE) generated from the degreasing of aircraft parts inside Building 113 between 1956 and 1968. The UST was filled with sand at some time after 1977 and was removed in 1988. Upon removal of the UST, an overflow pipe was discovered, indicating a potential pathway from the waste TCE UST to the subsurface environment.

Jet engine and engine accessory maintenance was performed in Building 119 between 1956 and 1990. Prior to 1971, waste from the building including fuel and TCE, was disposed of at a fire training area. During 1971 to 1990, wastes were either drummed and stored in a designated drum storage area on-site for contractor removal, or were piped via an underground sewer line to Building 226 [industrial waste treatment plant (IWTP)] located along Dover Avenue, north of Building 119 for treatment. A line break between the two buildings may have resulted in a release of contaminants. During the early stages of the IRP, it was observed that the soil surrounding the drum storage area and off rack behind the building was visibly stained, apparently from former waste spills (see Figure 6). Stained soil and stressed vegetation have also been observed next to the southeasternmost rear door of the building.

In 1983, an IRP Phase I Problem Identification/Records Search was conducted at Pease AFB (G-84). The study identified Sites 32 and 36 as potential sources for the release of contaminants into the environment. In response to this finding, a Phase II presurvey was conducted to obtain sufficient information for use in planning a more detailed study. The Phase II presurvey was completed in 1984 (G-524). Based on the conclusions of the Phase I Report and the Phase II Presurvey Report, Buildings 113 and 119, and 17 other IRP sites at Pease AFB, were recommended by WESTON for confirmation investigations. In September 1984, WESTON initiated the Stage 1 study for 19 IRP sites (including Buildings 113 and 119) at Pease AFB. A summary of site investigations conducted at Site 32/36 is presented in Table 1 in Appendix A. (All tables for this report are presented in Appendix A.)

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Stage 1 field work at Site 32/36 was performed from September 1984 through September 1985. Field activities performed during Stage 1 were designed to provide data to evaluate aquifer characteristics and to assess the presence or absence of contamination in groundwater, soil, surface water, and sediment. Field investigations and the results of those investigations are described in detail in the report entitled IRP Phase II-Confirmation/Quantification, Stage 1 Final Report for Pease AFB (G-525); issued in June 1986.

In October 1987, WESTON began the Stage 2 study at Pease AFB. Stage 2 field activities were designed to supplement the work performed during Stage 1 and to focus on individual IRP sites. This effort included additional investigation at Buildings 113 and 119. Field work for the Stage 2 study was performed between October 1987 and May 1989. The field investigations are described in detail in four Interim Technical Reports (ITR Nos. 1 through 4) (G-530, G-531, G-536, and G-537, respectively) and the IRP Stage 2 Draft Final Report for Pease Air Force Base (G-533). Based on the findings of the Stage 2 investigation, it was determined that conditions at Site 32/36 posed a potential threat to human health and the environment. Consequently, fast-track remedial action was initiated at Site 32/36 and four other sites at the base.

Based on the results of the Stage 2 investigation, Stage 3B was initiated in May 1990. The objectives of the Stage 3B effort were to assess the areal extent of contamination, to evaluate the potential for contaminant migration, and to provide additional data necessary to support the risk assessment (RA) and detailed analysis of remedial alternatives.

Additionally, Stage 3B included design, construction, and operation of a pilot groundwater extraction and treatment system to recover and treat contaminated groundwater from the Lower Sand (LS), and excavation of the overflow pipe and contaminated soft near the waste TCE UST and overflow pipe. These actions were performed as interim remedial measures (IRMs). Field work was performed between May and October 1990. The field investigation and results are presented in the report entitled Site Characterization Summary (SCS) for Site 32/36 (G-560). During excavation of the TCE UST overflow pipe, approximately 315 cubic yards (yd3) of soil was removed along with the overflow pipe. Of the soil removed, approximately 45 yd3 was contaminated with TCE and its degradation products and was transported to an off-base incineration facility. The intent of the SCS was to provide a detailed assessment of Site 32/36, with emphasis on the presence of contamination in various environmental media, the migration of contaminants away from the site, and the adequacy of data to complete both a baseline RA and a detailed analysis of remedial alternatives. Included in the SCS were recommendations for additional investigations at Site 32/36. Following review by the NHDES and EPA, the field work as recommended in the SCS to support the RI was initiated in April 1991 under Stage 3C.

The scope of work for the Stage 3C field work included the following:

- Control grid survey.
- Seismic refraction survey.
- Drilling and sampling of 76 soil borings.
- Installation and surveying of seven overburden monitor wells and five bedrock monitor wells.
- Installation and surveying of 19 piezometers.
- Surface water and sediment sampling at five locations.
- Monthly water level measurements.

Results of the Stage 3C field work and the results of previous site investigations were incorporated into the IRP Site 32/36 Draft Final RI issued in June 1992 (G-583). The RI presented available data from the site and included an RA, which identified potential human health and ecological risk associated with the Site 32/36 source area. A more detailed description of Site 32/36 history through 1991 is presented in the Site 32/36 RI Report.

The Site 32/36 Draft Final Feasibility Study (FS) Report (G-581) was issued in December 1992. The Draft Final FS developed and evaluated remedial alternatives to address the Site 32/36 source area. This document identified cleanup goals for the site based on the findings of the RA and evaluated several remedial alternatives to address contamination in Site 32/36 source area soil. Based on the evaluation presented in the FS, a preferred remedial alternative was identified for Site 32/36. The preferred remedial alternative was presented in the Site 32/36 Draft Final Proposed Plan, which was originally issued in April 1993.

Subsequent to the issuance of the Site 32/36 Draft Final FS and Draft Final Proposed Plan, concern arose about dewatering the Marine Clay and Silt (MCS) unit at the site, which could result in land subsidence and building settlement. A geotechnical evaluation was performed to estimate the maximum depth to which the groundwater may be lowered during pumping at Site 32/36 so that structural distress of the existing buildings is minimized (Site 32/36 and Vicinity Building Settlement Letter Report) (G-612). It was recommended at that time that pumping at Site 32/36 be restricted so that maximum allowable drawdowns, estimated from the geotechnical analysis are not exceeded.

A public hearing was held to present the selected remedy for Site 32/36 as described in the April 1993 Draft Final Proposed Plan. However, based on the comments received during the public hearing and the results of the geotechnical evaluation, it was determined that several of the alternatives presented in the December 1992 FS Report were not feasible. The Draft Final Proposed Plan was retracted by the Air Force, and the FS Report was rewritten and re-released in October 1993 as the Revised Draft Final Site 32/36 FS Report (RDFFS)(G-662).

A modified pumping program was implemented at Site 32/36 between 26 July and 16 September 1993 (Site 32/36 Pilot GWTP IRM at Pease AFB Letter Report) (G-654) and consisted of pumping from shallow bedrock (SBR) wells at the site. Low groundwater elevations forced the termination of pumping in September 1993. Reevaluation of geotechnical data (G-654) resulted in a revision of the predicted minimum allowable groundwater elevations for buildings in the Site 32/36 vicinity that allowed greater total groundwater extraction rates.

The Site 32/36 Proposed Plan was reissued in January 1994 and presented the Air Force's preferred alternative for Site 32/36, which combined the no-action alternative for Site 32 with excavation and off-site disposal of Site 36 soil. The recommendation of no action for Site 32 was based on the conclusions of the Site 32 TI Evaluation Report prepared in accordance with Office of Solid Waste and Emergency Response (OSWER) Directive 9234.2-25, Guidance for Evaluating the Technical Impracticability of Groundwater Restoration (G-655).

The first draft of the Site 32 TI Evaluation Report was completed in March 1994. The objective of that report was to provide the technical basis for the TI determination at Site 32/36. The TI Evaluation Report concluded that complete groundwater restoration to applicable or relevant and appropriate standards (ARARs) at Site 32 in a reasonable time frame is not feasible under any remedial scenario. It recommended isolation of the Site 32 source area to prevent continued migration of contaminated groundwater. In addition, it defined the TI Zone as the spatial extent of groundwater to be captured by the hydraulic containment system at Site 32. A conceptual layout of the TI Zone is included in the Site 32 TI Evaluation Report. The limits of the TI Zone will be refined from that presented in the Site 32 TI Evaluation Report during the design process, based on remedial design investigation and modeling results.

After submission of the TI Evaluation Report, several investigations were performed that resulted in a revised conceptual model of the source area and pumping performance. During March 1994, the University of Waterloo used a drivepoint groundwater sampling device to collect discrete samples for chemical analysis over several vertical profiles at Site 32. The results indicated that high concentrations of TCE are present throughout most of the saturated water column, including the MCS unit.

Also in March 1994, groundwater pumping was implemented at Site 32/36 and it was shown that groundwater extraction could be seasonably sustainable at a greater rate than previously attained. It was thus concluded that source area groundwater extraction may be a more viable option than previously considered for the control of contaminant migration at Site 32.

Based on the site data obtained after the TI Evaluation Report was issued, and subsequent discussions with EPA and NHDES, the Air Force developed an additional alternative for the site that incorporated the findings and recommendations of the TI Evaluation Report into remediation of the site. Because this alternative was not evaluated in the RDFFS Report, it was presented and evaluated in a separate document entitled Revised Site 32/36 FS Addendum 1, issued in March 1995 and revised in May 1995 (G-730). Based on the additional data and comments from EPA and NHDES, the Air Force also revised and reissued the Site 32 TI Evaluation Report in March 1995 and again in May 1995 (G-719).

The Revised Final Proposed Plan for Site 32/36 (June 1995) identified the selected remedy for Site 32/36 as the remedial alternative presented in the Site 32/36 FS Addendum 1.

B. Enforcement History

The enforcement history at Site 32/36 is summarized as follows:

- In 1976, the Department of Defense (DOD) devised a comprehensive IRP to assess and control environmental contamination that may have resulted from past operations and disposal practices at DOD facilities.

- In June 1980, DOD issued a Defense Environmental Quality program Policy Memorandum (DEQPPM) requiring identification of past hazardous waste disposal sites on DOD agency installations. The DEQPPM was issued in response to the Resource Conservation and Recovery Act (RCRA) of 1976, and in anticipation of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

- On 14 July 1989, Pease AFB was proposed for addition to the NPL. The effective date of addition was 21 February 1990.

- On 24 April 1991, the Air Force, EPA, and NHDES signed a Federal Facilities Agreement (FFA) establishing the protocol and timetable for conducting the Remedial Investigation/Feasibility Study (RI/FS) and Remedial Design/Remedial Action (RD/RA) processes a Pease AFB. Modification to this FFA was issued on 18 March 1993.

As part of the timetable established in the FFA, the Air Force, in an effort to streamline activities, designed a basewide strategy plan for conducting an RI/FS investigation. This strategy plan grouped the numerous sites into seven zones. The zones were delineated based on hydrogeological similarities, analytical results, geographic location, surface features, and types of source areas contained within the zones. RI/FS reports have been prepared for each zone. Prior to inclusion of Pease AFB on the NPL, five sites, including Site 32/36, were on an accelerated RI/FS approach because of the potential threat they posed to human health and the environment. The Air Force, EPA, and NHDES agreed that the source area RI/FS reports, as well as the remedial actions at these sites, would continue on an accelerate track toward source area cleanup, independent of the zones in which they were contained.

III. COMMUNITY PARTICIPATION

Throughout the site's history, the community has been actively involved. EPA, NHDES, and the Air Force have kept the community and other interested parties apprised of site activities through informational meetings, fact sheets, press releases, and public meetings.

In January 1991, the Air Force released a community relations plan, which outlined a program to address community concerns and keep citizens informed about and involved in remedial activities at the base. This plan was updated and reissued in November 1994.

Numerous fact sheets have been released by the Air Force throughout the IRP program at Pease AFB. These fact sheets are intended to keep the public and other concerned parties apprised of developments and milestones in the Pease AFB IRP. The fact sheets released to date that concern Site 32/36 are summarized as follows:

Fact Sheet	Release Date
Original Site 32/36 Proposed Plan Fact Sheet	April 1993
Pease AFB Installation Restoration Program Update	December 1992
Pease AFB Installation Restoration Program Update	October 1994
Summary of Site 32/36 Proposed Plan	June 1995

In addition to the fact sheets, a number of public meetings have been held concerning the remediation of Site 32/36. On 14 November 1991 an IRP update public meeting was held and on 12 January 1993 an IRP public workshop and meeting was conducted to provide the public with information on the status of the IRP at Pease AFB.

On 3 August 1995, the Air Force will conduct a public hearing and information session for the Site 32/36 Revised Proposed Plan, during which oral comments on the Proposed Plan will be received. A transcript of oral comments received during this meeting and the Air Force's response to comments is provided in the attached Responsiveness Summary (Appendix C). In addition, a public comment period for the Proposed Plan will be conducted from 12 July to 11 August 1995. Responses to written comments received during this period are also included in Appendix C.

A complete information repository, containing documents relating to the Pease AFB IRP, is maintained at Pease AFB in Building 43. The Administrative Record, containing all documents that support the remedies for Pease Air Force Base, also is located in Building 43 of Pease AFB. An index of the administrative record is maintained at the EPA Region I office in Boston, Massachusetts.

IV. SCOPE AND ROLE OF OPERABLE UNIT OR RESPONSE ACTION

This ROD addresses only source control at Site 32/36. The actions being taken at Site 32/36 are compatible with other actions being taken or planned at other zones or areas at Pease AFB.

Source material at Site 32 is defined as the region where DNAPL and residual DNAPL are present, including areas of inferred DNAPL as suggested by the presence of substantially elevated levels of dissolved VOCs in soil and groundwater. The Site 32 source area consists of an irregularly shaped three-dimensional volume defined by VOC-contaminated soil and overburden and bedrock groundwater. The Site 36 source area is defined as contaminated soil that is believed to be causing groundwater quality standards to be exceeded. Management of contaminants that have migrated away from the designated Site 32/36 source areas via surface water and groundwater pathways are addressed in a separate ROD for Zone 3.

The results of the Risk Assessment (RA), which are presented in the Site 32/36 RI Report, and are summarized in Section VI of this ROD, form the basis for the Air Force to conclude that contaminants in soil associated with activities at Site 32/36 do not pose unacceptable health risk to current or potential future receptors. However, because the soil is highly contaminated at depth, it represents a continuing source of contamination to the groundwater through leaching. Therefore, in the RDFFS, cleanup goals were established for contaminants in soil that would protect against continued leaching of source area contaminants to groundwater at concentrations exceeding health-based regulatory criteria. As previously indicated, cleanup goals were not established for groundwater in the RDFS groundwater is not considered a source. However, treatment goals for groundwater were developed in the RDFFS to ensure that groundwater extracted from the source area as part of the selected source control alternative would be treated to levels that would be protective to human health and the environment given the selected disposal option.

Recognizing that it would be technically impracticable to remediate the Site 32 source area because of the suspected existence of residual DNAPL, and complex site hydrogeology, the Air Force prepared and submitted the Site 32 TI Evaluation Report in March 1994. This document, which was prepared in accordance with OSWER Directive 9234.2-25, was subsequently revised and reissued in March 1995 and again in May 1995. The TI Evaluation provided the basis for concluding that it is technically impracticable to remove residual DNAPL from the subsurface in the Site 32 source area; however, physical/hydraulic containment of the source area may be achieved.

The basis for the determination of TI at Site 32 is as follows:

- Complex overburden stratigraphy exists at the site with an Upper Sand (US) unit, an MCS unit with sand layers and lenses, and a highly heterogeneous LS/GT unit, which may or may not include a basal gravel layer. Shallow bedrock exists at the site and is also heterogeneous in degree of fracturing and yield. These geologic constraints critically limit the ability to locate the DNAPL and to restore the aquifer.

- DNAPL product or residual is highly suspected to exist in the LS, GT, and shallow fractured bedrock at Site 32 because of the high concentrations of soluble halogenated compounds (near the solubility limit) detected in the groundwater in these water-bearing units. Multiple attempts to locate DNAPL pools in the overburden or bedrock have been unsuccessful. Removal of DNAPL pools would be very difficult because their locations are not known. Residual DNAPL, being an immiscible liquid held in soil pores or rock fractures by capillary forces, is particularly difficult to remediate because it does not migrate through the aquifer in response to hydraulic forces.

- Much of the contamination at Site 32/36 is in relatively low-permeability overburden materials (LS/GT). Groundwater extraction has been shown by the GWTP IRM implemented in February 1991 to be difficult and impractical in the LS/GT flow unit because of the low yield of the extraction wells in this water-bearing unit.

- Groundwater extraction rates in the relatively high-permeability shallow bedrock would be limited due to the potential for settlement of the buildings in the vicinity of Site 32.

Shallow fractured bedrock groundwater extraction rates within the source area are typically low (< 1 gpm). While sufficient for hydraulic containment into the shallow fractured bedrock, pumping at these rates in the shallow fractured bedrock alone will not contain LS source area groundwater.

- Excavation and removal of contaminated soil would not likely provide complete removal of the DNAPL because it appears to be present in the shallow fractured bedrock as well as in the soil.

Based on evaluation of the available, relevant data, it was concluded that it is technically impracticable to remove residual DNAPL from the subsurface in the Site 32 source area and that complete groundwater restoration to ARARs at Site 32 is not feasible under any remedial scenario. However, containment of source area groundwater may be achieved by installing a vertical barrier in the overburden surrounding the source area and extracting groundwater from the LS and shallow bedrock. The source containment alternative will effectively contain the area of residual DNAPL and prevent continued migration of contaminated groundwater from the source area. The TI Evaluation Report defined the TI Zone as the spatial extent of groundwater to be captured by the hydraulic containment system at Site 32.

Based on the findings of the TI Evaluation presented previously and subsequent discussions with EPA and NHDES, the Air Force developed an additional remedial alternative for Site 32/36 that was not evaluated in the RDFFS. This alternative, which incorporates the finding of the TI Evaluation, was presented and evaluated in an addendum to the Site 32/36 RDFFS. This alternative is the selected remedy for Site 32/36, which will be presented in the Final Proposed Plan.

The selected source control remedy for Site 32/36, as described in the Proposed Plan provides for the following tasks:

- Installation of a vertical barrier around the Site 32 source area for the purposes of isolating overburden source materials and highly contaminated groundwater from adjacent areas.

- Extraction of groundwater from within and beneath the source area at Site 32 for the purpose of hydraulically containing the DNAPL Zone at Site 32. Extracted groundwater would be treated at the modified Site 32/36 treatment plant and discharged to off-site (on-base) subsurface recharge trenches or applied surficially on base.

- Establishment of a TI Zone at the Site 32 source area within which ARARs [e.g., Safe Drinking Water Act (SDWA) requirements, State of New Hampshire Primary Drinking Water Standards (Env-Ws 315 through 318), and State of New Hampshire Groundwater Quality Criteria and Ambient Groundwater Quality Standards (Env-Ws 410.03, 410.04, and 410.05)] would not likely be attained. Establishment of the TI Zone will require a TI determination and ARAR waivers. The TI Zone includes the DNAPL Zone and the areas that will be contained by the source area containment.

- Long-term monitoring to evaluate the performance of the source control remedial actions taken at Sites 32 and 36 and to ensure that the contaminated groundwater containment system is operating as intended.

- Excavation and off-site disposal of Site 36 metals- and VOC-contaminated soil.

- Placement of land use restrictions to regulate use of groundwater and excavation activities at the Site 32 source area.

Management of migration of the dissolved-phase groundwater containment plume outside the TI Zone will be addressed in the Zone 3 Proposed Plan.

V. SUMMARY OF SITE CHARACTERISTICS

Section 1 of the RDFS contains an overview of the Draft Final Site 32/36 RI Report. Based on the results of the RI, a working conceptual model was developed that incorporated all data concerning Site 32/36 and vicinity, including geologic, hydrologic, analytical field measurements, and visual observations. Additional geologic, hydrologic, and analytical field measurement data have been obtained for the Site 32 source area since the RI Report was issued. These data have been incorporated into the summary of site characteristics presented herein. The salient points of the site conceptual model are summarized as follows:

- Potential sources identified at Site 32/36 are the former waste TCE UST and overflow pipe at Building 113, the drum storage/oil rack area at Building 119, the area of stained soil and stressed vegetation at the eastern corner of Building 119, the wastewater pipeline break adjacent to the northwest corner of Building 119, and an area at the northwestern corner of Building 113 (see Figure 7).

- The source with the highest concentrations and the greatest potential for release of contaminants in the subsurface is the former waste TCE UST and overflow pipe source area associated with Building 113.

- TCE and four of its degradation products are the predominant compounds detected in soil at the location of the former waste TCE UST and at the end of the overflow pipe, near the delineated wetlands.

- Aromatic hydrocarbons (AHCs) and polynuclear aromatic hydrocarbons (PAHs) are the predominant compounds detected in the soil near the drum storage area and oil rack at Building 119, along with lower concentrations of TCE and its degradation products.

- The highest concentrations of halogenated hydrocarbons (HHCs) at Building 113 generally occur in depressions of the MCS surface below the former location of the overflow pipe. The greatest lateral extent of contamination in unsaturated soil was found at the 6- to 10-foot depth, generally where the top of the MCS unit occurs.

- Data suggest that halogenated solvents have migrated through the MCS to the LS below the source area at Building 113.

- Soft sampling data from Building 119 suggest that the vertical extent of AHCs is limited to the US unit and the top of the MCS unit. The highest level of AHCs were encountered along the top of the MCS unit at the groundwater table.

- The extent of PAH migration at Building 119 appears to be limited because of these compounds' strong sorptive properties. The highest PAH concentrations were detected near the ground surface (0 to 2 feet), with concentration decreasing quickly with depth. The probable transport mechanism of PAHs is erosion with surface runoff carrying PAH-contaminated soil particles downslope and into Newfields Ditch.

- HHCs were detected in groundwater and primarily consist of TCE and its degradation products. The highest concentration of TCE occupied in the LS and SBR aquifers near the location of the former waste TCE UST at Building 113.

- HHCs persist in the LS aquifer for at least 1,500 feet in the downgradient direction and at least 2,000 feet downgradient in the SBR aquifer.

- The presence in groundwater of relatively high concentrations of HHCs such as TCE and 1,2-DCE, which have densities greater than that of water, suggests that these compounds may exist as DNAPL. To date, free-phase DNAPL has not been observed in any of the Site 32/36 borings or monitor wells. It is likely that DNAPL exists only as a residual in soil pore spaces and bedrock fractures rather than as pools as a result of the relatively complex stratigraphy that occurs in the site area.

- The ratios of TCE to its breakdown products in the soil and groundwater correspond to the ratios expected during the anaerobic biodegradation of TCE.

- At present, based on observed data, it is hypothesized that the shallow fractured bedrock and gravel lenses (ablation till) provide preferential pathways for the migration of dissolved phase HHCs.

The results of the RI as conceptualized are discussed in more detail in the subsections that follow. As stated in the introduction, this ROD describes the selected alternatives for the Site 32/36 source areas. By definition, the Site 32/36 source areas do not include contaminants that have migrated to surface water and sediment from the source areas; however, a summary of surface water and sediment data is presented for reference. Contaminants that have migrated from the Site 32/36 source areas to surface water, sediment, and groundwater outside the Site 32 TI Zone are addressed in the Zone 3 Draft Final RI Report (G-628) and FS Report (G-662).

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A. Soil Quality

Source characterization at Site 32/36 included the collection of analysis of soil samples. All samples were collected from Site 32/36 over a period of 7 years. Samples were obtained from approximately 84 borings and verification soil sampling was conducted following the removal of the overflow pipe and surrounding soil. The results of the laboratory analyses for each potential source area at Site 32/36 are summarized below.

<u>Site 32 (Building 113) -- Former Waste TCE UST and Associated Overflow Pipe</u>

This area is the source with the highest concentrations and the greatest potential for release of contaminants in the subsurface. TCE and four of its degradation products, cis- and trans-1,2-dichloroethene(DCE), 1,1-dichloroethene, and vinyl chloride, are the predominant compounds detected in soil at the location of the former waste TCE UST and at the end of the overflow pipe, near the delineated wetlands. As seen on Figure 8, verification samples collected after the removal of the TCE UST and overflow pipe indicate that a significant concentration (up to 190 mg/kg) of TCE remains in the soil at the end of the overflow pipe area in the vicinity of the wetlands. Additionally, AHCs and base/neutral/acid extractable (BNA) compounds consisting primarily of PAHs were detected in surface and subsurface soil samples collected in the area surrounding the source. Maximum total AHCs and maximum total PAHs in Site 32 soil are shown in Figures 9 and 10, respectively.

In general, the lateral distribution of HHCs in US soil at Site 32 (Building 113) appears to be principally controlled by the slope of the surface of the MCS unit. As shown in Figure 11, the highest concentrations of HHCs in unsaturated soil generally were detected in depressions of the MCS surface below the former location of the overflow pipe. The greatest lateral extent of contamination was found at the 6- to 10-foot depth, generally where the top of the MCS unit occurs. Maximum total HHCs in soil by depth at Site 32 are presented in Figure 12. Limited soil samples were collected in and below the MCS unit. However, as evidenced by soil contaminant concentrations within the first 5 feet of the MCS and by high HHC concentrations detected in the LS/GT (910,000 µg/L at well location 5024), these compounds have migrated through the MCS to the LS/GT below the source area at Building 113. Recent sampling has confirmed the presence of HHC contamination in the LS/GT soil.

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One soil sample was collected from the boring for well 6122, which was drilled, constructed, and sampled specifically to confirm the presence or absence of free-phase DNAPL (G-651). Well 6122 is located near the former waste TCE UST. Soil analytical results showed 16 mg/kg of TCE at a depth of 25 to 26 ft below ground surface (ft BGS), 1 foot above bedrock. The corresponding pore water fraction of TCE was estimated at 37 mg/L, using the method of Feenstra et al. (G-653). For comparison, the solubility of pure TCE in water is 1,100 mg/L (G-653). Free-phase DNAPL was not observed in the soil or groundwater at location 6122. A conceptual illustration of HHC movement from the TCE UST and overflow pipe source is shown in Figure 13.

A potential secondary source area exists west of Building 113 around the location of boring 7092 (see Figure 12). This area consists of a maintained lawn with no visible soil staining or stressed vegetation; however, field instrument readings for organic vapors in the soil were measurably above background levels during drilling of boring 7092. Analytical results of soil samples collected from this boring showed both HHCs and AHCs. Soft sample results from nearby borings did not indicate any contamination; therefore, this potential source appears to be confined to a limited area.

<u>Site 36 (Building 119) -- Drum Storage/Oil Rack Area</u>

AHCs and PAHs are the predominant compounds detected in the soil near the drum storage area and oil rack, along with lower concentrations of TCE and its degradation products. As shown in Figure 9, the highest levels of AHCs were encountered along the top of the MCS unit generally coincident with the average water table elevation. The lateral distribution of AHCs in the soil follows the direction of groundwater flow in the US unit to the southeast toward Newfields Ditch. With the exception of the chlorobenzenes, the densities of the AHCs detected are less than water, and movement downgradient with the groundwater is likely the primary mechanism for their migration. The highest concentrations of chlorobenzene compounds were detected at 3 to 4 ft BGS in the US unit soil. Deeper in the US unit, the chlorobenzene concentrations decrease, and none were detected in the MCS unit below the drum storage/oil rack source area, suggesting that most of the chlorobenzene soil contamination is restricted to the US unit soil. No floating product has been observed at this site, and the detected concentrations of AHCs in the soil from the unsaturated zone suggest that none exists at Building 119.

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The extent of PAH migration at Building 119 appears to be limited because of these compounds' strong sorptive properties. As shown in Figure 10, the highest PAH concentrations were detected near the ground surface (0 to 2 feet BGS), with concentrations decreasing quickly with depth. The only migration appears to be downslope along the ground surface toward the southeast. The probable transport mechanism is erosion, with surface runoff carrying PAH-contaminated soil particles downslope and into Newfields Ditch.

In addition to HHCs detected in the drum storage/oil rack area, HHCs were also detected in an area of stressed vegetation and stained soil noted close to a rear door at the southeasternmost corner of Building 119 (see Figure 14). The area, covering approximately 60 ft2, is relatively flat and consists of grass lawn bordered by the buildings concrete sidewalk. Conversations with personnel at the building indicated that some waste solvent products from Building 119 may have been discharged to the ground in this area. Based on historical information on waste handling practices and because soil sampled at several locations between this area and the drum storage and oil rack area was free of contamination, the two potential sources at Building 119 do not appear to be connected. Maximum total HHCs in soil by depth at Site 36 are shown in Figure 14.

The location of the wastewater pipeline break was investigated and only low levels of contaminants were detected. The nature and extent of soil contamination, believed to be caused by a break in the wastewater pipeline adjacent to the northwest corner of Building 119, was evaluated based on analyses of 11 soil boring samples. The primary organic contamination detected at the site was AHCs and PAHs; all compounds exceeding background were detected at depths from 0 to 8 feet BGS. Eight samples were analyzed for metals, and the concentrations of four metals were detected above base background values: arsenic, cadmium, sodium, and thallium.

Nine of the metals detected in Site 32/36 soil exceeded the established background soil concentrations: antimony, cadmium, chromium, copper, lead, potassium, selenium, sodium, and thallium. With the exception of antimony at location 32-778, all of the samples exceeding background are located at Site 36 near the drum storage/oil rack source area. Sample 36-763-B001 (1 to 2 ft BGS), located in the identified source area has the most metals exceeding background and the highest concentrations. The elevated metals concentrations likely represent the presence of these metals in the waste solvents handled at the site. When solvents were disposed of or spilled on the ground at the drum storage area/oil rack the metals accumulated in the soil below. The decrease in metals detection and concentrations away from the identified source suggests that the extent of the elevated metals concentrations is limited to the area immediately surrounding the source.

B. Groundwater Quality

The groundwater at Site 32/36 has been affected by the sources identified during the investigation, mainly the oil rack and drum storage area at Building 119 and the former TCE UST and overflow pipe at Building 113. Of the 42 target organic compounds identified in the soil analyses at Site 32/36, 21 were identified in groundwater samples. Sixteen other compounds (predominantly AHCs and phenols) were identified in groundwater but not in soil; however, all were at low concentrations or J values. A J value indicates the results are considered approximate because of limitations identified during data validation or that the compound(s) were detected at concentrations below detection limits.

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HHCs were detected in US, LS, shallow, and deep bedrock groundwater and primarily consist of TCE and its degradation products. Samples collected from the US groundwater show primarily HHCs at Building 113 with minor amounts of AHCs and PAHs, and AHCs and HHCs at Buildings 119. Metals were also detected at concentrations above background concentrations at Site 32. However, it is believed that metals were most likely mobilized from the soil as a result of the organic contamination at the site. The highest concentrations of TCE occurred in the LS and shallow bedrock water-bearing units (910,000 and 940,000 μg/L in wells 5024 and 6074, respectively) near the location of the former waste TCE UST at Building 113 (see Figure 15). TCE concentrations at these levels strongly suggest the presence of nonaqueous-phase TCE nearby. In fact, concentrations of TCE greater than 10,000 μg/L (1% of solubility) indicate the potential presence of DNAPL (G-732). Residual TCE, rather than pooled TCE, is thought to be the primary contaminant source at the site because, even at these relatively high concentrations, no product has been recovered or observed.

A conceptual model of TCE distribution in groundwater at Site 32/36 is shown in Figure 16. HHCs were detected in overburden and bedrock water-bearing units in the downgradient groundwater flow direction as shown in Figures 17 and 18, respectively, HHCs at levels above Maximum Contaminant Levels (MCLs) persist for at least 1,600 feet in the downgradient direction in the LS/GT water-bearing unit and 2,000 feet in the shallow fractured bedrock water-bearing unit.

Efforts to locate free-phase DNAPL at Site 32 consisted of drilling and sampling in the US and MCS, followed by well installation in the LS/GT where the unit was underlain by bedrock troughs and depressions near the source. The wells were screened at the bottom of the unit, just above the bedrock. Organic vapor meters were used to screen soil samples to optimize collection of samples for laboratory analysis. Bottom-filling bailers were used to collect samples from the bottom of the monitor wells, and oil/water probes were used to detect the DNAPL-groundwater interface.

Well 6122 (as discussed previously), was drilled, constructed, and sampled specifically to confirm the presence or absence of free-phase DNAPL (O-651). The well was placed as close to existing well 6074 as possible because well 6074 contained the highest historical concentrations of TCE in groundwater at Site 32. Rotasonic drilling techniques were used to drill well 6122 because this technique does not require the addition of drilling fluids (which make DNAPL detection difficult). Both hydrophobic dye an fluorescence techniques (G-658) were used to visually detect the presence of free-phase DNAPL in soil and groundwater samples from well 6122. The well was not developed and groundwater was not purged prior to sampling to ensure optimal conditions for collection of free-phase DNAPL.

Screening with fluorescence and hydrophobic dye did not indicate the presence of DNAPLs in the overburden soil or the shallow fractured bedrock groundwater at the location of well 6122. The results of soil analysis for VOCs, in conjunction with calculation of the corresponding TCE pore water concentration (37 mg/L), confirmed the field screening results that free-phase DNAPL is not present in the overburden soil or groundwater. While the DNAPL was not encountered in shallow bedrock well 6122, subsequent sampling has shown the highest concentration of TCE in groundwater in well 6122 to be 420 mg/L, approximately 40% of the solubility of pure TCE in water. This TCE concentration suggests that residual DNAPL saturation may be present nearby. Repeated attempts to locate DNAPL at Site 32 have not been successful and at best have only suggested that residual DNAPL, rather than more mobile, pooled DNAPL, exists at the site.

C. Groundwater Flow

The following summary of hydrogeology in the Site 32/36 area is based on data summarized in the Site 32/36 RI Report and the Site 32/36 Exploratory Well Letter Report (G-602). Additionally, three shallow fractured bedrock wells were installed in the Site 32 area during July and August 1992, after the Draft Final Site 32/36 RI Report was submitted. Boring logs, well construction summaries, and the results of step-down tests were presented in the Site 32/36 Remedial Alternatives Re-evaluation and Continued Operation of the Pilot GWTP Letter Report, dated 15 March 1993 (G-613). These data were incorporated into the hydrogeology summary presented below.

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The data presented in the Draft Final Site 32/36 Source Area RI Report indicate that beneath Site 32/36, groundwater exists in both the overburden and the bedrock. Drilling logs indicate that two overburden flow units (US flow unit and LS/GT flowunit) exist across Site 32/36. The saturated thickness of the US ranges from 0 to 4 feet. The average hydraulic conductivity of the US at Site 32/36 is 0.10 ft/day. Based on water elevation data, it appears that US groundwater discharges to Newfields Ditch during seasonally high groundwater conditions. US groundwater flows beneath the ditch during seasonally low groundwater conditions. US and LS/GT flow units are separated by the low-permeability MCS unit that essentially acts as an aquitard, and thus separates groundwater flow between the US and LS/GT. In both of these units, groundwater flows predominantly eastward.

The LS and GT units are treated as a single hydrogeologic unit because of their textural and hydrological similarities. The LS/GT flow unit is generally of relatively low permeability. The hydraulic conductivity of the LS/GT is generally in the range of 0.04 to 0.54 ft/day, based on slug testing of wells that are screened across both the LS and GT. Basal sand or gravel lenses (ablation till) may act as preferential flow zones in the overburden. These cases were observed overlying shallow fractured bedrock during drilling at Building 119, particularly in the boring for well 6013. The vertical hydraulic gradient between the US and LS units was downward at Building 113 and upward at Building 119. The upward gradient at Building 119 reflects discharges to Newfields Ditch.

The top 20 feet of bedrock at Site 32/36 is generally relatively highly fractured. Hydraulic testing results presented in the Site 32/36 Exploratory Well Letter Report (G-602) revealed that the shallow fractured bedrock is the most permeable flow unit at Site 32/36. The permeability of the deep competent bedrock is typically approximately two orders of magnitude less than the permeability of the shallow fractured bedrock. The average groundwater flow velocity of the shallow fractured bedrock flow zone was calculated to be approximately 2.04 ft/day. The average groundwater flow velocity for the deep competent bedrock system was calculated to be approximately 0.03 ft/day. Groundwater flow in both the deep competent bedrock and shallow fractured bedrock is eastward. The shallow fractured bedrock receives recharge from the LS/GT flow unit near Site 32/36 and discharges to the LS/GT flow unit toward the east-northeast, near Portsmouth Avenue, downgradient of Site 32/36. Site data indicate that shallow fractured bedrock receives groundwater from deep competent bedrock at Site 32/36 between Building 113 and Portsmouth Avenue.

A conceptual model of dissolved contaminant migration pathways in groundwater at Site 32 is shown in Figure 19.

D. Surface Water and Sediment

Surface water and sediment are not considered sources of contamination at Site 32/36. Background information is presented in this subsection to complete the conceptual model of the site. Surface water and sediment samples were collected from four locations within Newfields Ditch and associated drainage. Each of these locations may receive runoff from Site 32/36, but may also receive runoff from other source areas within Zone 3, namely Site 34 and Site 39 (Building 227).

Analytical results revealed the presence of pesticides, PAHs, and VOCs in the sediment samples collected near Site 36. Surface water near Site 36 contained trace amounts of TCE and 1,2-DCE. Surface water and sediment samples collected near Site 32 did not contain concentrations of organic contaminants above the quantitation limits.

Based on the chemical characterization of soil contamination at Site 36, the levels of PAHs and VOCs detected in sediments appear to be associated with the soil contamination from the drum storage/oil rack source area at Building 119. The compounds, locations, and concentrations correspond with the Site 36 soil boring analytical data. Pesticides were present in the sediments at levels indicative of background concentrations.

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Surface water and sediment inorganic quality in the area of Site 32/36 were compared to concentrations of inorganics collected from several locations upgradient from Site 32/36. None of the sediment samples for Site 32/36 exceeded upgradient inorganic levels by more than one order of magnitude. Inorganics that exceeded upgradient levels by three or more times in sediments were aluminum, barium, calcium, copper, potassium, magnesium, silicon, sodium, and vanadium. Inorganics that exceeded upgradient levels by two to three times (but not by more than three times at any point) were chromium, nickel, and zinc.

VI. SUMMARY OF SITE RISKS

An RA was performed to estimate the probability and magnitude of potential adverse human health and environmental effects from exposure to source area contaminants associated with Site 32/36. Source area soil and groundwater were evaluated in the risk assessment for Site 32/36 and Zone 3, respectively. The public health risk assessment followed a four-step process:

1. Contaminant identification that identified those hazardous substances which, given the specifics of the site, were of significant concern.

2. Exposure assessment, which identified actual or potential exposure pathways, characterized the potentially exposed populations, and determined the extent of possible exposure.

3. Toxicity assessment, which considered the types and magnitude of adverse health effects associated with exposure to hazardous substances.

4. Risk characterization, which integrated the three earlier steps to sure the potential and actual risks posed by cancer risks.

The results of the baseline human health and ecological risk assessments for Site 32/36 are discussed in the subsections that follow.

A. Human Health Risk Assessment

A total of 39 contaminants of concern identified for the soil were selected for evaluation in the human health risk assessment. These contaminants constitute a representative subset of the more than 65 contaminants identified at the site during the RI. The data for soil samples at depths of 0 to 2 feet and 0 to 15 feet were evaluated separately. The 0- to 2-foot-deep soil data are used to evaluate risk under both current and future use conditions. Contaminants of concern in 0- to 2-foot-deep soil are presented in Table 2. The contaminants of concern were selected to represent potential site-related hazards based on toxicity, concentration, frequency of detection, mobility, and persistence in the environment.

A summary of the health effects of each of the contaminants of concern can be found in Subsection 632 and Appendix L.4 of the Site 32/36 Draft Final RI (G-583).

In addition, the 0- to 15-foot-deep soil data are used to evaluate risk under a future scenario in which building construction may occur at the site. If building construction were to occur, subsurface soil could become mixed with the surficial soil, making subsurface contaminants available for contact with potential receptors. Contaminants of concern in 0- to 15-foot-deep soil are presented in Table 3. For the 0- to 2-foot-deep interval, there were approximately 24 contaminants of concern of the total of 48 contaminants detected in this depth interval. For the 0- to 15-foot-deep interval, there were approximately 33 contaminants of concern of the total of 65 contaminants detected in this depth interval.

The overburden and shallow fractured bedrock groundwater, and the deep bedrock groundwater in the Site 32/36 source area were evaluated as hot spots during the Zone 3 RI. The source area includes the area of highly contaminated groundwater, which is indicative of the presence of DNAPL. A total of 40 contaminants of concern identified for the Site 32/36 groundwater were selected for evaluation in the human health risk assessment and are presented in Table 4. A summary of the health effects of each of the contaminants of concern can be found in Section 6 of the Zone 3 Draft Final RI (G-629).

The potential human health effects associated with exposure to the contaminants of concern were estimated quantitatively through the development of several hypothetical exposure pathways based on the present uses and potential future uses of the site. Site 32/36 is not currently used. The future use of Site 32/36 is assumed to be industrial. The following is a Summary of the exposure pathways evaluated. A more thorough description is presented in Subsection 6.3.1 of the Site 32/36 RI Report and the Zone 3 RI Report.

Maintenance workers and trespassers were selected as potential current receptors. The maintenance worker was chosen as the current reasonable maximally exposed individual(RME) for the soil pathway. Potential exposure to a maintenance worker is expected to be greater than that to a trespasser because of a greater frequency of contact. The current maintenance worker was assumed to be on the site for 2 hours/day, 1 day/week, 50 weeks/year, for 25 years. Current maintenance activities at the site were assumed to be minimal.

Because future use for Site 32/36 is assumed to continue as industrial, building workers, maintenance workers, and trespassers were selected as the potential future receptors. The maintenance worker was also selected as the future RME for the soil pathway. The future maintenance worker is expected to contact soil with a greater frequency than a trespasser. Soil contact by a building worker (i.e., an individual working inside of a building) is expected to be negligible. The future maintenance worker was projected to be on-site for 2 hours/day, 250 days/year, for 25 years. The exposure frequency of the future maintenance worker was assumed to be greater than that of the current maintenance worker because the site may be more active in the future. It is unlikely, however, that the site would support a full-time (i.e., 40 hours/week) maintenance worker.

The exposure routes that were evaluated for the soil pathway consist of incidental ingestion of soil and dermal contact with soil. In accordance with guidance from EPA Region I, exposure to chemicals through the inhalation of fugitive dust and vapors originating from contaminated soil was not addressed. Dermal absorption was not evaluated for metals because absorption of metals through the skin is considered to be negligible.

The exposure doses are expressed as intakes or absorbed doses in mg/kg day. Two sets of doses were calculated. One set, which is averaged over the exposure duration, is used in the risk characterization to evaluate the potential for noncancer health effects. The other set, which is averaged over a 70-year lifetime, is used to evaluate potential cancer risk. Life-time averaged doses are calculated only for those chemicals that have been categorized by EPA as carcinogens.

It was assumed in determining the soil ingestion route for the current and future maintenance workers that the amount of soil ingested from on-site soil is proportional to the length of time that the worker spends on-site.

An off-base resident was selected as the future RME for the groundwater pathway. The off-base resident is considered to be exposed for 350 days/year for 30 years.

Potential risks were assessed based on three exposure concentrations: the mean, the upper 95% confidence limit of the mean, and the maximum. EPA Region I guidance recommends that the mean and maximum concentrations be used in calculating risk, while national EPA guidance indicates that the upper 95% confidence limit of the mean be used.

Excess lifetime cancer risks were determined for each exposure pathway by multiplying the exposure level with the chemical-specific cancer factor. Cancer potency factors have been developed by EPA from epidemiological or animal studies to reflect a conservative "upper bound" of the risk posed by potentially carcinogenic compounds. That is, the true risk is unlikely to be greater than the risk predicted. The resulting risk estimates are expressed in scientific notation as a probability (e.g., 1.00E-06 for 1/1,000,000) and indicate (using this example), that an average individual is not likely to have greater than a 1-in-1-million chance of developing cancer over 70 years as a result of site-related exposure, as defined to the compound at the stated concentration. Current EPA practice considers cancer risks to be additive when assessing exposure to a mixture of hazardous substances.

The hazard index (HI) was also calculated for each pathway as EPA's measure of the potential for noncancer health effects. A hazard quotient is calculated by dividing the exposure level by the reference doses (RfD) or other suitable benchmark for noncancer health effects for an individual compound. Reference doses have been developed by EPA to protect sensitive individuals over the course of a lifetime and they reflect a daily exposure level that is likely to be without an appreciable risk of an adverse health effect. RfDs are derived from epidemiological or animal studies and incorporate uncertainty factors to help ensure that adverse health effects will not occur. The hazard quotient is often expressed as a single value (e.g., 0.3), indicating the ratio of the stated exposure as defined to the reference dose value (in this example, the exposure as characterized is approximately one-third of an acceptable exposure level for the given compound). The hazard quotient is only considered additive for compounds that have the same or similar toxic endpoint and the sum is referred to as the HI.

Calculated risks for each individual contaminant of concern for each exposure pathway evaluated are presented in Appendix L of the Site 32/36 RI and the Zone 3 RI Reports. A summary of additive chemical risks for each soil pathway evaluated is presented in Table 5 and in Table 6 for groundwater. The conclusions of the human health risk assessment are summarized in the paragraphs that follow.

The total lifeline cancer risk posed by exposure to 0- to 2-foot-deep soil was calculated to range from approximately 4-in-10-million (4.10E-07) to 2-in-1-million (1.76E-06) for the current maintenance worker and from 2-in-1-million (2.05E-06) to 9-in-1-million (8.78E-06) for the future maintenance worker. More than 99% of the risk is posed by the PAHs, which were the only carcinogenic chemicals that posed a risk of greater than 1-in-1-million. The cancer risks calibrated for 0- to 2-foot-deep soil are within the EPA range of generally acceptable risk levels of 1-in-1-million to 1-in-10,000 (1.00E-06 to 1.00E.04); however, because of the absence of sensitive receptors, the Air Force believes that these risk levels do not require action. EPA typically requires action for cancer risk levels greater than 1.00E-04.

Base, on the evaluated chemicals, there is no potential for adverse noncancer health effects posed by exposure to 0- to 2-foot-deep soil. The total (nonsegregated) hazard indices ranged from approximately 0.001 (136E-03) to 0.01 (1.13E-02) for the current maintenance worker and from 0.007 (6.80E-03) to 0.06 (5.65E-02) for the future maintenance worker. The segregated hazard indices ranged from approximately 1.41E-08 to 0.05 (5.28E-02).

The total lifetime cancer risk posed by exposure of the future maintenance worker to 0- to 15-foot-deep soil was calculate to range from approximately 2-in-1-million (1.57E-06) to 1-in-100,000 (9.99E-06). More than 99% of the risk is posed by the PAHs. The PAHs and TCE were the only carcinogenic contaminants of concern that posed a risk of greater than 1-in-1-million. The estimated cancer risks calculated for 0- to 15-foot-deep soil are within the EPA range of generally acceptable risk levels of 1.00E-06 to 1.00E-04; however, because of the absence of sensitive receptors, the Air Force believes that these risk levels do not require action. EPA typically requires action for cancer risk levels greater than 1.00E-04.

Based on the evaluated chemicals, there is no potential for adverse noncancer health effects posed by exposure to 0- to 15-foot-deep soil. The total (nonsegregated) hazard indices ranged from approximately 0.03 (2.58E-02) to 0.2 (1.73E-01). The segregated hazard indices ranged from approximately 7.06E-08 to 0.07 (7.00E-02).

The Air Force believes that direct human receptor contact with hazardous substances in source area soil from this site does not present an imminent and substantial endangerment to public health or welfare. However, actual or threatened release of hazardous substances from this site to groundwater may present an imminent and substantial endangerment to public health and welfare if not addressed. Hydraulic and physical containment of the Site 32 source area combined with institutional controls restricting groundwater use will address this groundwater quality issue.

The results of the hot spot exposure scenario for overburden and shallow groundwater revealed that cancer and noncancer risks to human receptors exceeded EPA's range of generally acceptable risk levels of 1.00 E-06 to 1.00 E-04 for cancer risks and a hazard index of greater than 1 for noncancer risk. The cancer risk for the deep bedrock hot spot fell between 1.00 E-06 and 1.00 E-04 and the hazard index exceeded 1.

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

B. Ecological Risk Assessment

A hazard quotient or index greater than 1 indicates that the species may be at risk to an adverse effect through exposure, but does not necessarily indicate that an adverse effect will occur. A hazard index of less than 1 indicates that adverse effects are not likely to occur and no action is required. A hazard index of greater than 10 indicates that risks are at a level of potential concern and may warrant action. A hazard index between 1 and 10 is subject to interpretation based on the toxicity of the chemical and the uncertainty in the calculation. In addition, the frequency of detection and reproducibility of the data should be investigated. Whether a remedial action must be initiated should be examined on a site-by-site basis, after careful consideration of the levels of the hazard indices compared to the possible adverse effects of remedial action on the ecological habitat (e.g., loss of existing wetland communities and other habitats, or increased contaminant migration resulting from resuspension of contaminated fine-grained particles).

The objectives of the ecological risk assessment were to identify and estimated the potential ecological impacts associated with the contaminants of concern at Site 32/36. The assessment focused on the potential impacts of contaminants of concern found in the source area soil to terrestrial wildlife that inhabit or may potentially inhabit the site.

It was assumed that exposure to terrestrial wildlife primarily occurs when animals feed in those areas affected by site contamination. For this assessment, avian and mammalian species with the greatest potential for exposure were selected for evaluation of exposure. Species selected were representative of major foraging guilds and trophic levels that are present at Site 32/36. Although amphibians and reptiles are important components of this ecosystem, sufficient exposure and toxicity data were not available for their evaluation. An ecological inventory of Pease AFB by the New Hampshire Natural Heritage program did not identify any threatened, endangered, or species of special concern at Site 32/36.

The species evaluated and their relevant exposure pathways are listed as fo lows:

- Meadow vole:
  - Incidental ingestion of soil.
  - Ingestion of vegetation.
- American robin:
  - Incidental ingestion of soil.
  - Ingestion of soil invertebrates (earthworms).

Potential risk to the meadow vole and American robin were estimated by comparing the estimated daily doses of contacts of potential concern (average and maximum) with Critical Toxicity Values (CTVs) (i.e., acceptable daily intakes). When toxicity data were not available for a specific substance, toxicity data for related isomers were used. Species-specific toxicity data for target wildlife species often were not available for the contaminants of potential concern. Thus, when possible, toxicity values from the literature were selected using the most closely related species. Toxicity values selected for the assessment were the lowest exposure doses reported to be toxic or the highest doses associated with no adverse effect. Data for chronic toxicity were preferentially used, when available.

The total average hazard index for the meadow vole at Site 32/36 is presented in Table 5. As shown in the table, the cumulative hazard index is 3.08. Lead contributed approximately 90% of the total average hazard index as follows:

- Lead) 82% (HI = 2.53).
- Copper) 8% (HI = 0.25).

The majority of the hazard index attributed to lead was the result of soil ingestion. Much of the average copper hazard index can be attributed to plant ingestion.

The total maximum hazard index for the meadow vole at Site 32/36 is also presented in Table 7. As shown in the table, the cumulative hazard index is 23.4. As with the total average hazard index, lead and copper contributed approximately 93% of the total maximum hazard; however, bis(2-ethylhexyl)phthalate at maximum concentration contributed 5% of the total maximum hazard. The primary chemicals and their contributions to the maximum cumulative hazard index follows:

- Lead) 90% (HI = 21.1).
- Bis(2-ethylhexyl)phthalate) 5% (HI = 1.16).
- Copper) 3% (HI = 0.79).

The pathway contribution to the maximum hazard index for the meadow vole was similar to that observed for the average hazard index with bis(2-ethylhexyl)phthalate contributing primarily through the soil ingestion pathway.

The total average hazard index for the American robin at Site 32/36 is presented in Table 8. As shown in the table, the total average hazard index for the American robin was 0.99, and the maximum total hazard index was 2.96. The only chemical with a hazard quotient greater than 1 was chromium at the maximum concentration.

In summary, contaminants in source area surface soil at Site 32/36 posed risks to the representative species in excess of the EPA benchmark values. For the American robin, the total average hazard index was below benchmark values, and the total maximum hazard index was only slightly above the benchmark value. For the meadow vole, both the total maximum and total average hazard indices were in excess of benchmark values. Lead and copper contributed 90% of the total average and maximum hazard indices for the meadow vole. The highest detected lead and copper concentrations were in soil in the area of the former drum storage area (location 763).

There are several significant uncertainties associated with the estimation of risk to the meadow vole at Site 32/36 as a result of exposure to lead. These uncertainties, which result in a very conservative estimate of potential risk, are listed below:

- Sample Station 36-763-B001, which had the maximum detected lead concentration in soil (417 mg/kg), is located in a mowed lawn directly adjacent to a parking area for Building 119. The habitat conditions at this location are not preferred by the meadow vole and therefore, exposure to lead at this location would probably be limited.

- As discussed in the uncertainty analysis in the Site 32/36 Draft Final RI Report (G-583), if sample 36-763-B001 were excluded from the analysis, lead would not remain as a chemical of concern for this data set. In addition, if sample 36.763-B001 were removed from the 0- to 2-foot soil data set, the resulting mean and maximum lead concentrations would be 13.37 and 26.8 mg/kg, Respectively, concentrations that would not result in a substantial risk of adverse effects to resident meadow voles.

- Finally, subsequent to the completion of the Site 32/36 RI, a preferred toxicity study was identified for determining a mammalian CTV for lead. The mammalian CTV for lead developed using the preferred study was 5.64E+00 mg/kg-day. The original mammalian CTV for lead used in the Site 32/36 RI was 1.00E-01 mg/kg-day. If the new CTV were used, the hazard index resulting from lead exposure, even if sample 36-763-B001 were included, would be less than one.

Considering the aforementioned uncertainties, the potential risks of adverse effects to the meadow vole at Site 32/36 appear to be minimal.

VII. DEVELOPMENT AND SCREENING OF ALTERNATIVES

A. Statutory Requirements/Response Objectives

Section 121 of CERCLA establishes several statutory requirements and preferences, including remedial actions must be protective of human health and the environment; remedial actions, when complete, must comply with all federal and more stringent state environmental standards, requirements, criteria, or limitations, unless a waiver is invoked; the remedial action selected must be cost effective and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and a preference for remedies in which treatment that permanently and significantly reduces the toxicity, mobility, or volume (TMV) of the hazardous substances is a principal element over remedies not involving such treatment. Response alternatives were developed to be consistent with these mandates.

Based on preliminary information relating to types of contaminants, environmental media of concern, and potential exposure pathways, Remedial Action Objectives (RAOs) were developed to aid in the development and screening of alternatives. These RAOs were developed to mitigate existing and future potential threats to human health and the environment via source control. RAOs for Site 32/36, which were presented in detail in the Site 32/36 RDFFS Report (G-662), are discussed briefly in the following paragraph.

The results of the human health and ecological risk assessments revealed that contaminants in Site 32/36 source area soil do not pose unacceptable risks to human or ecological receptors under the current or future exposure pathways selected for the site, except for lead and copper at the former drum storage area at Site 36, which contributed 90% of the total hazard indices that exceeded benchmark values. Due to the uncertainties associated with the ecological risk assessment, especially for the meadow vole lead exposure, as described in the previous subsection, RAOs for ecological risk were not developed. Because some of the contaminants in Site 32/36 source area soil could leach to groundwater at concentration that may present an unacceptable health risk, the following source control RAO was developed:

- To reduce the migration of contaminants from Site 32/36 source area soil and groundwater such that groundwater outside the TI Zone will attain all chemical-specific groundwater standards within the 30-year reasonable time frame for groundwater restoration.

RAOs for the mitigation of contaminants that have migrated to face water and sediment from the Site 32/36 source area and dissolved phase contaminants in groundwater beyond the boundary of the TI Zone are addressed in the Zone 3 FS and ROD.

B. Technology and Alternative Development and Screening

CERCLA and the National Oil and Hazardous Substances Contingency Plan (NCP) set forth the process by which remedial actions are evaluated and selected. In accordance with these requirements, a range of alternatives was developed for the Site 32/36 source area.

The FS developed a range of alternatives, including some in which treatment that reduces the TMV of the hazardous substances is a principal element. This is range included an alternative that attempts to remove or destroy hazardous substances to the maximum extent feasible, eliminating or minimizing the need for long-term management. This range also included alternatives that treat the principal threats posed by the site but vary in the degree of treatment employed and the quantities and characteristics of the treatment residuals and untreated waste that must be managed; alternatives that involve little or no treatment but provide protection via containment through engineering or institutional controls; and a no-action alternative.

In Section 3 of the Site 32/36 RDFFS Report, technologies were identified, assessed, and screened based on implementability, effectiveness, and cost. These technologies were combined into seven source control alternatives and were presented in Section 4 of the Site 32/36 RDFFS Report Each source control alternative was then evaluated in detail and screened in Section 5 of the Site 32/36 RDFFS Report. An additional source control alternative was developed and screened in the Site 32/36 FS Addendum 1.

VIII. DESCRIPTION OF ALTERNATIVES

This section provides a brief narrative summary of each alternative that was evaluated in detail in Section 5 of the RDFFS and in the Site 32/36 FS Addendum 1. A detailed tabular assessment of Alternatives 1 through 7 is presented in Tables 5.2-1 through 5.2-7 of the RDFFS and a detailed tabular assessment of Alternative 8 is presented in Table 1 of the Site 32/36 FS Addendum 1.

A. Source Control Alternatives Analyzed

The source control alternatives analyzed for the site include the following:

- Alternative 1: No action except long-term environmental monitoring (considered as a baseline requirement by CERCLA).

- Alternative 2: Long-term groundwater extraction for hydraulic containment of source area contaminants; on-site treatment and disposal of extracted groundwater; and excavation and off-site disposal of Site 6 VOC- and metals-contaminated soil.

- Alternative 3: Isolation of the Site 32 source control area using horizontal and vertical barriers; extraction/on-site treatment and disposal of groundwater from within the Site 32 source area; and excavation and off-site disposal of Site 36 VOC- and metals-contaminated soil.

- Alternative 4: Excavation and on-site treatment of Sites 32 and 36 VOC-contaminated soil; extraction, on-site treatment, and disposal of groundwater; and excavation and off-site disposal of Site 36 metals-contaminated soil.

- Alternative 5: Passive remediation of the Site 32 source area via in situ absorption, and excavation and off-site disposal of Site 36 VOC- and metals-contaminated soil.

- Alternative 6: Excavation and on-site treatment of Site 36 VOC-contaminated soil and Site 32 MCS unit soil; in situ treatment of the remaining Site 32 VOC-contaminated soil by soil vapor extraction and air sparging; extraction, on-site treatment and disposal of groundwater, and excavation and off-site disposal of Site 36 metals-contaminated soil.

- Alternative 7: Isolation of the Site 32 source area by vertical barriers; excavation and on-site treatment of Site 36 VOC-contaminated soil and Site 32 MCS unit soil; pneumatic fracturing in competent bedrock, dual-phase extraction, and on-site treatment of groundwater and vapor; and excavation and off-site disposal of Site 345 metals-contaminated soil.

- Alternative 8: Isolation of the Site 32 source area by vertical barriers; extraction and treatment of groundwater from within and below the vertical barriers; long-term groundwater and treatment system monitoring; excavation and off-site disposal of Site 36 VOC- and metals-contaminated soil; and placement of land use restrictions.

<u>Alternative 1 -- No Action</u>

Consistent with the requirements of the NCP and subsequent EPA guidance, the no-action alternative for Site 32/36 was evaluated in detail in the FS to serve as a baseline for comparing existing site conditions with those conditions resulting from other alternatives. No cleanup or mitigation measures would be used to remediate contaminant sources or their potential migration pathways. Removal of contaminants from the source areas would be dependent on the dynamics of natural mechanisms, such as dissolution, dispersion, adsorption/desorption, and biodegradation.

The only activity to be performed for this alternative is the Superfund Amendments and Reauthorization Act (SARA) review, which would occur every 5 years. Because the Zone 3 FS includes institutional controls, such as Groundwater Management Zone (GMZ), which would include the Site 32/36 area, no additional institutional controls are necessary for this alternative.

Estimated Time for Design and Construction: 2 months.
Estimated Period of Operation: 30 years.
Estimated Capital Cost: None.
Estimated Operation and Maintenance (O&M) Cost (net present worth): $65,000.
Estimated Total Cost (net present worth): $65,000.

<u>Alternative 2</u> -- Extraction, On-Site Treatment, and Disposal of Groundwater, and Excavation and Off-Site Disposal of Site 36 VOC- and Metals-Contaminated Soil This alternative would consist of the following remedial actions:

- Groundwater extraction from the source and surrounding areas to control contaminant plume migration via hydraulic containment.

- On-site groundwater treatment and disposal by reinjection on-site and/or discharge to the base sanitary sewer or local storm drain.

- Excavation and off-site disposal of VOC- and metals-contaminated soil adjacent to Building 119 (Site 36).

- Long-term groundwater and treatment system monitoring.

Estimated Time for Design and Construction: 9 months.
Estimated Period of Operation: 30 years.
Estimated Capital Cost: $1,137,000.
Estimated O&M Cost (net present worth): $7,215,100.
Estimated Total Cost (net present worth): $8,388,000.

Alternative 3 - Isolation of the Source Area Using Horizontal and Vertical Barriers, On-Site Treatment and Disposal of Groundwater, and Excavation and Off-Site Disposal of Site 36 VOC- and Metals-Contaminated Soil

This alternative consists of the following remedial actions:

- Containment of the Site 32 source area with horizontal and vertical barriers.

- Extraction of groundwater from within and below the source area and on-site treatment and disposal by on-site reinjection and/or discharge to the base sanitary sewer or local storm drain.

- Excavation and off-site disposal of Site 36 VOC- and metals-contaminated soil.

- Long-term groundwater and treatment system monitoring.

Estimated Time for Design and Construction - 1 month.
Estimated Period of Operation: 30 years.
Estimated Capital Cost: $3,359,000.
Estimated O&M Cost (net present worth): $2,190,600.
Estimated Total (net present worth): $5,550,000.

Alternative 4 -- Excavation and On-Site Treatment of Site 32/36 VOC-Contaminated Soil; Extraction, On-Site Treatment, and Disposal of Groundwater; and Excavation and Off-Site Disposal of Site 36 Metals-Contaminated Soil

Alternative 4 consists of the following activities:

- Construction of a vertical barrier wall to facilitate VOC-contaminated soil excavation.

- On-site chemical oxidation treatment and disposal of VOC-contaminated soil.

- Excavation and off-site disposal of metals-contaminated soil adjacent to Building 119 (Site 36).

- On-site treatment of groundwater recovered from excavation dewatering and on-base disposal of treated groundwater via discharge to the base sanitary sewer or local storm drain, or reinjection upgradient in Zone 3.

- Demolition and off-site disposal of part or all of Building 113.

Estimated Time for Design and Construction - 3 months.
Estimated Period of Operation: 1 month.
Estimated Capital Cost: $3,405,100.
Estimated O&M Cost (net present worth): $64,700.
Estimated Total (net present worth): $3,470,000.

Alternative 5 -- Passive Remediation of the Source Area Using In Situ Adsorption, and Excavation and Off-Site Disposal of Site 36 VOC- and Metals-Contaminated Soil Alternative 5 consists of the following remedial actions:

- Placement of adsorption material (Reclaim polymer canisters) in groundwater wells in the source control area.

- Periodic recovery and replacement of polymer canisters, and shipment of used canisters to the vendor for contaminant extraction and polymer regeneration.

- Excavation and off-site disposal of VOC- and metals-contaminant soil at Site 36.

- Installation of additional groundwater wells in the source control area if preliminary application of the technology is successful and if [there is reason to believe additional wells would accelerate the remediation process.

Estimated Time for Design and Construction - 1 month.
Estimated Period of Operation: 30 years.
Estimated Capital Cost: $558,800.
Estimated O&M Cost (net present worth): $1,654,600.
Estimated Total (net present worth): $2,213,000.

<u>Alternative 6</u> -- Excavation and On-Site Treatment of Site 36 VOC-Contaminated Soil and Site 32 MCS Unit Soil; In Situ Treatment of Remaining Site 32 VOC-Contaminated Soil by Soil Vapor Extraction and Air Sparging; Extraction, On-Site Treatment, and Disposal of Groundwater; and Excavation and Of-Site Disposal of Site 36 Metals-Contaminated Soil

Alternative 6 consists of the following activities:

- Excavation within the Site 32 source control area to remove the MCS unit with excavation dewatering, if necessary.

- Backfilling of the excavation with clean granular soil to enhance Soil Vapor Extraction (SVE) efficiency. SVE involves the application of negative pressures within the soil vadose zone to induce chemical constituents to vaporize and be removed as a gas.

- Creation of an enhanced vadose zone in the VOC-contaminated soil area by groundwater extraction, if necessary and feasible to enhance SVE efficiency.

- In situ treatment of contaminated vadose zone soil via SVE, and removal of VOCs in extracted vapor via activated carbon adsorption.

- Air sparging of the saturated zone to enhance contaminant removal via SVE.

- Excavation and off-site disposal of Site 36 metals-contaminated soil.

- On-site treatment via chemical oxidation of recovered groundwater and VOC-contaminated soil excavated from Sites 32 and 36.

- Discharge of treated groundwater to the base sanitary sewer or local storm drain system.

- Off-site disposal of treated soil that could not be used as backfill.

- Treatment system monitoring.

Estimated Time for Design and Construction - 9 months.
Estimated Period of Operation: 5 years.
Estimated Capital Cost: $2,404,000.
Estimated O&M Cost (net present worth): $431,200.
Estimated Total (net present worth): $2,835,000.

<u>Alternative 7</u> -- Isolation of the Site 32 Source Area by Vertical Barriers, Excavation and On-Site Treatment of Site 36 Voc-Contaminated Soil and Site 32 MCS Unit Soil, Pneumatic Fracturing in the Shallow Bedrock, Dual-Phase Extraction and On-Site Treatment of Groundwater and Vapor, and Excavation and Off-Site Disposal of Site 36 Metals-Contaminated Soil

This alternative consists of the following remedial actions:

- Excavation of Site 36 VOC- and metals-contaminated soil with off-site disposal of metals-contaminated soil.

- Installation of vertical barriers (sheet piling) around the Site 32 source area.

- Excavation of the MCS unit from the Site 32 source area (with dewatering if necessary), and on-site treatment of this soil and Site 36 VOC-contaminated soil by chemical oxidation.

- Placement of an impermeable geomembrane over the LS unit in the Site 32 excavation and backfilling with clean granular soil.

- Pneumatic fracturing in bedrock and installation of sumps in competent bedrock.

- Extraction of groundwater from shallow bedrock wells in the source control area.

- Installation of passive air inlet vents and dual-phase extraction vents in the source area.

- Removal of groundwater and vapor from dual-phase action wells.

- On-site treatment of groundwater by chemical oxidation for inorganic compound removal and activated carbon for organic compound removal.

- On-site vapor treatment by vapor-phase activated carbon.

- Off-site disposal of excavated and treated soil.

- Discharge of treated groundwater to the base sanitary sewer or local storm drain system, or reinjection upgradient of Zone 3.

- Treatment system monitoring.

Estimated Time for Design and Construction - 1 month.
Estimated Period of Operation: 5 years.
Estimated Capital Cost: $2,605,900.
Estimated O&M Cost (net present worth): $815,800.
Estimated Total (net present worth): $3,422,000.

Alternative 8 -- Source Control - Containment of DNAPL Area, On-Site Treatment of Groundwater, and Excavation and Off-Site Disposal of Site 36 VOC- and Metals-Contaminated Soil

This alternative consists of the following remedial actions:

- Isolation of the source area at Site 32 using vertical barriers to prevent to the maximum extent possible the movement of groundwater through the source area and to contain the highly contaminated soil and groundwater from horizontal movement.

- Groundwater extraction from within and below the contained area to hydraulically contain groundwater within the source area. The contaminated groundwater would be treated at the existing Site 32/36 treatment plant. The plant will require modifications based on this action as well as additional proposed action within Zone 3. Treated groundwater would be discharged to off-site (on-base) subsurface recharge trenches or surficially applied on base.

- Treatment of extracted groundwater in the modified Site 32/36 treatment plant via chemical oxidation, filtration, and air stripping.

- Excavation and off-site disposal of Site 36 VOC- and metals-contaminated soil.

- Establishment of a TI Zone within which cleanup to identified chemical-specific ARARs is not considered feasible based on a TI determination.

- Placement of restrictions on use of groundwater and regulation of excavation activities at the Site 32 source area.

- Groundwater and treatment system monitoring.

Estimated Time for Design and Construction - 9 months.
Estimated Period of Operation: 30 years.
Estimated Capital Cost: $1,226,900.
Estimated O&M Cost (net present worth): $3,596,180.
Estimated Total (net present worth): $4,823,000.

IX. SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

Section 121(b)(1) of CERCLA presents several factors that must be considered when assessing alternatives. Building on these specific statutory mandates, the NCP articulates nine evaluation criteria to be used in assessing the individual remedial alternatives.

A detailed analysis was performed on the alternatives using the nine evaluation criteria in order to select a site remedy. The following is a summary of the comparison of each alternative's strengths and weaknesses with respect to the nine evaluation criteria. These criteria are summarized in the following paragraphs.

Threshold Criteria

The two threshold criteria described must be met in order for the alternatives to be eligible for selection in accordance with the NCP:

1. Overall protection of human health and the environment addresses whether a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

2. Compliance with ARARs addresses whether a remedy will attain all federal and more stringent state environmental or facility siting laws, or whether there are grounds for invoking a waiver pursuant to the requirements of the NCP.

Primary Balancing Criteria

The following five criteria are utilized to compare and evaluate the elements of one alternative to another once the threshold criteria have been met.

3. Long-term effectiveness and permanence assesses alternatives based on the long-term and permanence they afford, along with the degree of

4. Reduction of TMV through treatment addresses the degree to which alternatives use recycling or treatment that reduces TMV, including how treatment is used to address the principal threats posed by the site.

5. Short-term effectiveness addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period, until cleanup goals are achieved.

6. Implementability addresses the technical and administrative feasibility of a remedy, including the availability of material and services needed to implement a particular option.

7. Cost includes estimated capital and O&M costs, as well as present-worth costs.

Modifying Criteria

The modifying criteria are used in the final evaluation of remedial alternatives, after public comments on the RI and FS Reports and Proposed Plan are received:

8. State acceptance addresses the state's position and key concerns related to the preferred alternative and other alternatives, and the state's comments on ARARs or the proposed use of waivers.

9. Community acceptance addresses the public's general response to the alternatives described in the Proposed Plan and RI and FS Reports. Community acceptance of both the original and the revised Proposed Plans for Site 32/36 was evaluated based on written

comments and verbal comments received in public meetings during the public comment period.

Detailed tabular assessments of each alternative according to the threshold and balancing criteria are presented in Tables 5.2-1 through 5.2-7 of the Site 32/36 RDFFS and in Table 1 of the Site 32/36 FS Addendum 1.

Following the detailed analysis of each individual alternative, a comparative analysis, focusing on the relative performance of each analysis against the threshold and balancing criteria, was conducted. This comparative analysis is presented in Table 9.

The following subsection presents the nine criteria, including the two modifying criteria not discussed in the RDFFS, a brief narrative summary of the alternatives, and the strengths and weaknesses according to the detailed and comparative analysis.

A. Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses how an alternative as a whole will protect human health and the environment. This includes an assessment of how public health and environmental risks are properly eliminated, reduced, or controlled, through treatment, engineering controls, or institutional controls.

All of the alternatives evaluated would be coupled with institutional controls restricting groundwater use that will be in place as part of the overall Zone 3 remedy. These restrictions would be designed to prevent human receptors from contacting contaminated groundwater. Because contamination will remain in place and given the long-term uncertainties of enforcing institutional controls after the property has been transferred, it cannot be said that institutional controls alone render these alternatives equally protective. Those alternatives that would successfully remove and/or contain contaminants would clearly provide a greater level of protection at Site 32/36.

With respect to Site 32, Alternative 1, the no-action alternative, would provide no additional protection over the long-term because contaminants would continue to leach freely from source area soil to groundwater. Alternatives 4, 5, 6, and 7 all involve the removal and treatment of source area contaminants at Site 32. If it were possible to implement these alternatives, they would provide varying but significant protection at Site 32. However, because of the TI conditions at Site 32, successful implementation of these alternatives is unlikely. Alternatives 2, 3, and 8 are designed to contain the Site 32 source area contaminants via groundwater extraction and treatment alone, or in combination with physical barriers. If implemented, these alternatives would also provide significant protection at Site 32. Of these three alternatives, Alternative 8 is expected to adequately contain the source, and as a secondary effect will remove some contaminants through source area pump and treat, which is part of the hydraulic containment component of this alternative. Combined with grater use restrictions in the vicinity of Site 32/36, Alternative 8 will provide the highest level of protection to human health and the environment.

With respect to Site 36 source area soil, Alternatives 2 through 8 would provide an equal level of protection by excavating the soil and disposing of it off base.

B. Compliance with ARARs

Compliance with ARARs addresses whether a remedy complies with all state and federal environmental and public health laws and requirements that apply or are relevant and appropriate to the conditions and cleanup options at a specific site. If an ARAR cannot be met, the reasons must be clearly stated and a waiver (e.g., a TI ARAR waiver) may be required.

Chemical-Specific - Because elimination of DNAPL, the primary source of groundwater contamination at Site 32, has been determined to be infeasible, none of the alternatives evaluated in the FS would be expected to attain chemical-specific groundwater ARARs within the source area within a reasonable time frame (i.e., 30 years). Consequently, in order to implement any of the alternatives, an ARAR waiver would have to be obtained. Such a waiver may be obtained under CERCLA Subsection 121(d)(4)(c) when compliance with ARARs cannot be achieved because it is technically impractical from an engineering perspective. Alternative 8, which is the only alternative developed after the TI Evaluation was conducted, specifically anticipates the granting of a TI ARAR waiver as part of the alternative, and, as a result, MCLs and Maximum Contaminant Level Goals under the SDWA, State Of New Hampshire Primary Drinking Water Criteria, and the State of New Hampshire Groundwater Quality Criteria and Ambient Groundwater Quality Standards would be waived within the TI Zone for specified contaminants.

At Site 36, all of the alternatives are expected to meet chemical-specific groundwater within a reasonable time frame because contaminated soil that poses a risk of leaching will be excavated and disposed of off-site.

Location-Specific -- All the alternatives would be conducted to ensure that no adverse impacts to wetlands will occur, given that wetlands occupy a portion of the site in the vicinity of remedial activities.

Action-Specific -- All of the alternatives would be conducted to meet action-specific ARARs. Extracted groundwater would be treated to meet groundwater cleanup standards prior to discharge. Alternatives 2, 3, 4, 6, and 7, which involve discharges of treated groundwater to the sewer or storm drain, would meet all applicable standards. All of the alternatives would comply with state RCRA standards in handling hazardous wastes. Finally, air emissions from the groundwater treatment facility and soil excavation activities would be monitored to ensure that they do not exceed federal and state emissions standards.

C. Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to the ability of an alternative to maintain reliable protection of human health and the environment over time once the cleanup goals have been met.

The no-action alternative would not effectively reduce leaching of contaminants from source area soil to groundwater. Some reduction in source area contamination would occur through natural attenuation processes, but contaminants would continue to leach into groundwater for decades. Alternative 2 would depend mainly on a hydraulic containment system, consisting of a groundwater extraction and a treatment system. Pilot tests of a pump and treat system at Site 32 have indicated that the ability of Alternative 2 to effectively control contaminant migration away from the source is constrained by the possibility that settling or subsidence will occur as a result of lowering the water table through groundwater traction. If subsidence is significant, the integrity of nearby buildings may be so compromised that demolition or costly repair of the structures would be necessary. However, if groundwater is extracted at a lower rate that is not likely to negatively impact building integrity, effective containment of contaminants is questionable.

Alternative 3 includes, among its other remedial components, the use of horizontal barriers to minimize the movement of contaminated groundwater through the Site 32 source area soil and into the bedrock. A horizontal barrier consists of a grout-filled zone in the shallow fractured bedrock. This would involve directional drilling from the site perimeter and the injection of grout to form the barrier. However, successful installation of horizontal barriers at the Site 32 source area would be difficult to achieve because of the highly irregular and undulating bedrock surface, as well as the other inherent difficulties and unknowns associated with this technology.

Alternative 4 would consist of excavating Site 32 source area soil with on-site chemical oxidation treatment and disposal of VOC-contaminated soil. Excavation activities would be complicated by the proximity of the surrounding buildings to the area requiring excavation, the deep depth of the contaminated soil, and the high water table. The building settlement problems discussed above in connection with Alternative 2 would be likely to occur during dewatering of the soil prior to and during excavation. Because residual DNAPL is believed to be present in the bedrock fractures, much of the contamination may be inaccessible by excavation. Additionally, the nature of DNAPL movement in the subsurface makes successful excavation of the entire DNAPL source highly unlikely, particularly because separate-phase DNAPL has not been located at the site. Consequently, the contamination that is not excavated will continue to leach contaminants into the groundwater.

Alternative 5 would utilize an adsorptive polymer to passively remove contaminant mass from the source area. However, the effectiveness of this technology at DNAPL sites is unproven. Based on the lack of data showing successful implementation of this technology, the effectiveness of Alternative 5 cannot be assessed.

Alternative 6 uses in situ SVE and air sparging to remove VOC contaminants from Site 32 source area soil. Implementing these technologies would require dewatering and removal of the MCS unit and creation of an enhanced vadose zone in the VOC-contaminated soil area by groundwater extraction, if necessary and possible. However, there are site-specific unknowns, such as air permeability of soil, the impact of air sparging on DNAPL mobility, and the potential for subsidence of adjacent buildings resulting from dewatering, that present concerns about the effectiveness of this alternative.

Alternative 7, among its other remedial components, entails pneumatic fracturing in the bedrock and the installation of sumps in the competent bedrock to collect free-phase DNAPL pools. Because DNAPL pools have not yet been located at this site, and the possibility that pneumatic fracturing could result in unfavorable DNAPL mobilization, this method is not likely to be effective.

Alternative 8 consists of a combination of a vertical barrier and a hydraulic containment system. The long-term effectiveness of this alternative is primarily dependent upon successful installation of a vertical barrier. The barrier would have to be keyed into the undulating fractured bedrock surface. The hydraulic containment system consisting of a groundwater extraction and a treatment system, would not be expected to cause building subsidence under this alternative because hydraulic containment, when combined with vertical barriers, could be achieved at a much lower pumping rate. Consequently, Alternative 8 is expected to be effective in isolating source area contaminants.

With respect to site 36 soil, Alternatives 2 through 8 would all be effective in protecting human health and the environment over the long term. Under all of these alternatives, VOC- and metals-contaminated soil would be excavated and transported off-site, thereby eliminating the risks posed by leaching of contaminants from soil into groundwater.

D. Reduction of Toxicity, Mobility, or Volume Through Treatment

Reduction of TMV through treatment are three principal measures of the overall performance of an alternative. The 1986 amendments to the Superfund statute emphasize that, whenever possible, a remedy should be selected that uses a treatment process to permanently reduce the level of toxicity of contaminants at the site, the spread of contaminants away from the source of contamination, and the volume or amount of contamination at the site.

Some reduction in the TMV of contaminants may occur in Alternative 1 as a result of natural attenuation processes. This reduction would probably be slow, and may be considered minimal even over several decades.

Alternatives 2, 3, and 8 would provide some level of volume reduction by pumping and treating extracted groundwater to remove some of the residual contamination at the Site 32 source area as part of the hydraulic containment process. However, these alternatives are specifically designed to reduce the mobility of contaminants because their primary objective is to prevent the further migration of source area contamination.

If it were possible to implement Alternatives 4 through 7 (the treatment alternatives), they would provide varying levels of TMV reduction. However, as discussed above, it is not likely that these alternatives could be successfully implemented at Site 32 in light of the finding of TI.

The TMV of metals- and VOC-contaminated soil from the Site 36 source area would be permanently reduced by Alternatives 2 through 8 through excavation, treatment; and off-site disposal.

E. Short-Term Effectiveness

Short-term effectiveness refers to the likelihood of adverse impacts on human health or the environment that may be posed during the construction and implementation of an alternative until cleanup goals are achieved. It also evaluates how long it will take for an alternative to attain protection. Alternative 1 would not result in adverse impacts on human health or the environment during implementation. However, it may take decades for natural attenuation processes to restore source area groundwater quality to cleanup goals.

Alternatives 2, 3, 4, 6, 7, and 8 would pose some potential risk resulting from an unexpected release of vapors from groundwater extraction and treatment, and spills or leaks of untreated groundwater and treatment chemicals occurring during the remediation period. Engineering precautions would be taken to ensure protection of workers during operation, including vapor detection systems within the treatment building, proper personal protective equipment (PPE) and emissions monitoring. These techniques would be implemented for all alternatives involving long-term groundwater treatment.

Air emissions also may occur from the SVE system in Alternative 6 and the dual-phase extraction system in Alternative 7. Although the system is closed, accidental releases may occur that could pose potential health risks to workers and area residents. Monitoring equipment and PPE would be important engineering controls. Short-term exposure to groundwater from extraction and treatment would be limited for Alternatives 6 and 7 a 5-year operational period is specified for these two alternatives. As previously discussed, successful implementation of these alternatives, however, is highly unlikely.

Excavation of relatively large volumes of VOC-contaminated soil performed for Alternatives 4, 6, and 7 may generate potentially hazardous air emissions. Air monitoring, dust suppression techniques, PPE, and enclosed cabs on construction equipment would be used to protect workers. The short-term exposure associated with groundwater extraction from excavation dewatering would be similar to that for Alternative 2, but for a shorter remedial time frame (several months).

Potential short-term risks to the community and workers during implementation of Alternative 5 would be minimal. Localized risks could result from VOC and dust emissions generated during excavation well installation and replacement of the adsorptive polymer canisters. Engineering controls would be used to minimize these emissions, and on-site air quality monitoring would be conducted to evaluate the level of respiratory and dermal protection required by the workers.

All alternatives, with the exception of Alternatives 1 and 5, may potentially affect the wetlands because of implementation of groundwater extraction or dewatering. Wetlands would be restored with native vegetation after completion of the remedial action.

Minimal potential risk to the environment and the surrounding community would be associated with the installation of the source area containment system, the groundwater extraction and treatment system, or the excavation of Site 36 soil under the selected remedy. Institutional controls would be required for protection because of the potential for human receptor exposure to contaminated groundwater outside of the hydraulically contained area. Protectiveness would be maintained as long as contaminants did not migrate beyond the area where institutional controls are in effect.

Excavation and off-site disposal of Site 36 VOC- and metals-contaminated soil would be completed in approximately 1 week, and therefore protection to potential human receptors would be achieved in the same time frame.

F. Implementability

Implementability refers to the technical and administrative feasibility of an alternative, including the availability of materials and services needed to implement the alternative.

The no-action alternative would not present implementation difficulties.

Alternatives 2, 3, and 8 would use readily available technologies for groundwater extraction and treatment. No technical difficulties would be expected, although the length of time required to achieve cleanup goals is unknown. Alternative 3, which includes both vertical and horizontal barriers, presents some complexity because confirmation of completeness of the horizontal barrier is difficult. Additionally, implementation of horizontal barriers could be problematic and time-consuming. Specialty contractors would be required for drilling horizontal wells and grouting bedrock. The application of this technology to create horizontal barrier is unproven, especially for conditions at this site. The most significant uncertainty would be locating the precise depth of the horizontal barriers into the bedrock that would be required for successful implementation of this alternative. Alternative 8 presents some complexity associated with the installation of vertical barriers (proposed sheet piling) because they will need to be keyed into the uneven bedrock surface. However, use of sheet piling is a well-established construction technique and can generally be implemented with relative ease.

Alternatives 4, 6, and 7 would use relatively innovative technologies to perform the excavation because soil requiring excavation is located at considerable depth and within the saturated zone. Impacts on buildings in the vicinity of the site would need to be evaluated in greater detail. Handling the excavated soil would be difficult because of its moisture content. The on-site treatment process for each alternative would require analytical work to determine proper reagent requirements.

Alternative 5 would be relatively easy to implement and would require no major construction. The most difficult part of this alternative would be the installation of new wells, if needed.

Alternative 6 also would use readily available treatment technologies. Pilot testing of both SVE and air sparging would need to be conducted. The effects of source area dewatering on buildings in the vicinity would need to be evaluated in greater detail.

Alternative 7 would use innovative treatment technologies that may be difficult to implement. Pilot testing of dual-phase extraction would need to be conducted. The potential structural effects of source area dewatering on buildings in the vicinity would need to be evaluated in greater detail. Fracturing of the bedrock to facilitate DNAPL collection would engender potential risk associated with remobilization of DNAPL or dissolved-phase contamination.

With respect to Site 36 soil, Alternatives 2 through 8, which all involve excavation and off-site disposal of VOC- and metals-contaminated soil, would use standard construction practices and equipment. Therefore, these alternatives pose no implementability problems.

G. Cost

Cost includes the capital (up-front) cost of implementing an alternative as well as the cost of operating and maintaining the alternative over the long-term, and net present worth of both capital and O&M costs.

The estimated present worth value of each alternative are as follows:

Remedial Alternative	Capital Cost	Present-Worth O&M Cost at Year 30	Total Present-Worth Cost
1. No action	None	$65,000	$65,000
2. Extraction, on-site treatment, and disposal of groundwater, and excavation and off-site disposal of Site 36 VOC-metals-contaminated soil.	$1,137,000	$7,215,100	$8,388,000
3. Isolation of the source area using horizontal and vertical barriers, on-site treatment and disposal of groundwater, and excavation and off-site disposal of Site 36 VOC- and metals-contaminated soil.	$3,359,000	$2,190,600	$5,550,000
4. Excavation and on-site treatment of Site 32/36 VOC-contaminated soil; extraction, on-site treatment, and disposal of groundwater; and excavation and off-site disposal of Site 36 metals-contaminated soil.	$3,405,100	$64,700	$3,470,000
5. Passive remediation of the source area using in situ adsorption, and excavation and off-site disposal of Site 36 VOC- and metals-contaminated soil.	$558,800	$1,654,600	$2,213,000
6. Excavation and on-site treatment of Site 36 VOC-contaminated soil and Site 32 MCS unit soil; in situ treatment of remaining Site 32 VOC-contaminated soil by soil vapor extraction and air sparging; extraction, on-site treatment, and disposal of groundwater; and excavation and off-site disposal of Site 36 metals-contaminated soil.	$2,404,000	$431,200	$2,835,000
7. Isolation of the Site 32 source area by vertical barriers; excavation and on-site treatment of Site 36 VOC-contaminated soil and Site 32 MCS unit soil; pneumatic fracturing in the shallow bedrock; dual-phase extraction and on-site treatment of groundwater and vapor;, and excavation and off-site disposal of Site 36 metals-contaminated soil.	$2,605,900	$815,800	$3,422,000
8. Source control -- Containment of DNAPL area; on-site treatment of groundwater; and excavation and off-site disposal of Site 36 VOC- and metals-contaminated soil.	$1,226,900	$3,596,180	$4,823,000

Costs for the eight remedial alternatives ranged from $65,000 to $8,388,000. The selected remedy (Alternative 8) is the third most expensive alternative ($4,823,000) in comparison to all the alternatives evaluated.

It should be noted that the costs for Alternatives 4, 5, 6, and 7 presented in the Site 32/36 FS Report assumed that the source area excavation and treatment technologies proposed in each alternative would be successful in accessing and removing DNAPL. Consequently, the O&M costs of these alternatives included groundwater extraction and treatment (for the purpose of minimizing migration of source area contaminants) for durations of less than 30 years. Based on the finding of TI as presented in the TI Evaluation Report issued after the FS, it is not likely that any of the treatment alternatives could successfully access and remediate DNAPL. Therefore, it is likely that Site 32 groundwater would have to be extracted and treated for 30 years or longer. If the O&M costs for Alternatives 4, 5, 6, and 7 were based on 30-year durations, the total costs of these alternatives would be much higher. As a result of the potential need to operate Alternatives 4, 5, 6, and 7 for the longer periods estimated in the Site 32/36 FS Report, Alternative 8 becomes more cost competitive.

H. State Acceptance

NHDES has been involved in the environmental activities at Pease AFB since the mid-1980s, as summarized in Section II of this document. The RI was performed as an Air Force lead, with State and EPA oversight, in accordance with the FFA. NHDES has reviewed this document and concurs with the selected remedy. A copy of the Declaration of Concurrence is attached as Appendix B.

I. Community Acceptance

The comments received during the public comment periods and the public hearings on the Site 32/36 Source Area Proposed Plan are summarized in the attached document entitled The Responsiveness Summary (Appendix C). Public comments were supportive of the proposed remedial action, and, as a result, the selected remedy has not been modified from that presented in the Proposed Plan.

X. THE SELECTED REMEDY

The selected remedy (Alternative 8) is comprehensive in that it provides for source control and reduction of exposure to site contaminants via containment of the Site 32 source area and excavation and off-site disposal of Site 36 VOC- and metals-contaminated soil. The selected remedy also contributes to attainment of overall Zone 3 objectives of migration control for groundwater and surface water.

The selected remedy involves physical and hydraulic containment of the Site 32 source area or DNAPL Zone via installation of a vertical barrier and extraction of groundwater from within and below the vertical barrier. Extracted groundwater would be treated on-site and subsequently discharged to a subsurface recharge system or surface application area. VOC- and metals-contaminated soil at Site 36 would be excavated and disposed of off-site at an off-base facility. Long-term groundwater and treatment system monitoring would be conducted to verify the performance of the containment and treatment systems.

Alternative 8 also involves establishment of a TI Zone within which it has been determined that it is technically impracticable to remediate groundwater to levels consistent with ARARs. Establishment of a Tl Zone would require a TI determination and waivers for certain chemical-specific ARARs that cannot be achieved.

A. Methodology for Cleanup Level Determination

Cleanup levels for source area soil and source area groundwater at Site 32/36 were evaluated and established in the Site 32/36 RDFFS and Zone 3 FS Reports (G-662 and G-628). Because contaminated surface water and sediment are not defined as source materials, cleanup goals for these media are addressed in the Zone 3 FS Report (G-628). Treatment goals for source area groundwater were, however, developed in the Site 32/36 RDFFS for the purpose of providing criteria to guide treatment of groundwater potentially extracted as part of source control activities. These treatment goals should not be confused with cleanup goals for groundwater, which are presented in the Zone 3 FS Report, Proposed Plan, and ROD.

It should be noted that the following discussion describes the methodology used to select cleanup goals for soil at Sites 32 and 36 in the RDFFS Report. The Site 32 TI Evaluation Report, which was prepared and issued after the Site 32/36 RDFFS Report, provided the technical justification concluding that it is technically impracticable to remediate the Site 32 source area soil. For this reason, the soil and source area groundwater cleanup goals presented in the RDFFS no longer apply to the Site 32 source area. Instead, the RAO for the Site 32 source area is to contain the source in place to prevent continued leaching of contaminants from the source area soil and to prevent continued migration of source area groundwater such that groundwater outside the TI Zone will attain all chemical-specific groundwater standards within the 30-year reasonable time frame for groundwater restoration. The soil cleanup goals presented in the RDFFS continue to apply to the Site 36 source area soil.

The results of the human health and environmental risk assessments for Site 32/36 soil form the basis for the Air Force to conclude that no significant adverse health effects on human receptors or significant adverse effects to ecological receptors are anticipated for the exposure scenarios selected for Pease AFB. Therefore, cleanup goals for source area soil were not based on potential risks associated with incidental ingestion of, or dermal contact with, contaminated soil for either human or ecological receptors. It should be noted that the risk assessment did not evaluate air exposure pathway for soil contaminants. If the air pathway were evaluated, in the absence of site-specific air monitoring data, air contaminant concentrations would be modeled based on the analytical results for surface soils. Exposure and, consequently, risk through the air pathway are expected to be substantially less than that associated with other exposure routes for soil. The risk posed by the air pathway is not likely to affect the final risk characterization for soil (i.e. cancer risks and noncancer hazard indices), or the subsequent decisions as to whether remediation of the soil is necessary. Therefore, the potential short-term actual effects of inhalation of volatilized or airborne contaminants on the health of construction workers during excavation of soil on-site have not been evaluated. To establish RAOs and soil cleanup goals, it was assumed that the air exposure pathway would not result in adverse human health effects during construction activities for soil contaminant concentrations at or below the baseline levels.

However, the potential exists for contaminants at Site 32/36 to leach from source area soil into groundwater at concentrations that could present a health risk (exceed maximum contaminant levels) if the groundwater was ingested by or came in direct contact with human receptors. Therefore, the RAO for source control actions at Site 32/36 is to prevent to the maximum extent possible the leaching of contaminants from source area soil into groundwater at levels that would result in a health risk, and to prevent the migration of contaminants in groundwater away from the source areas.

Contaminant fate and transport modeling was performed to provide guidance in the development of potential cleanup goals for contaminated soil at Site 32/36. A detailed description of the application of the model is provided in Appendix A of the Site 32/36 RDFFS Report. The objective of this modeling effort was to estimate maximum soil contaminant concentrations (target cleanup levels) that could exist in unsaturated source area soil without using leaching to groundwater that would result in groundwater contamination exceeding levels protective of human health.

The methodology for selecting cleanup goals for organics was to compare the maximum concentration for organic contaminants detected in site soil samples with target cleanup levels generated by a leaching model. The modified Summers Leaching Model, considered a conservative leaching model, was used per EPA guidance. Cleanup goals were established for contaminants detected at concentrations exceeding the leaching model target levels.

Inorganic contaminant cleanup goals for source area soil were based on a qualitative evaluation of the contaminants' potential to leach to groundwater. Cleanup goals for inorganic contaminants were established if the maximum detected concentration of the contaminant in groundwater exceeds ARARs and the maximum detected concentration of the contaminant in soil exceeds the background concentration. The naturally occurring background levels of metals in the vicinity of the base were determined by evaluating the metals content of soil samples collected throughout the base.

As previously indicated, groundwater treatment goals have been developed for groundwater that will be extracted, treated, and discharged as part of the source control actions at Site 32/36. The treatment goals for on-site groundwater reinjection are based on ARARs, where available, or risk-based concentrations where ARARs were not available. Cleanup goals for groundwater that contains contaminants that have migrated beyond the TI Zone at Site 32/36 are addressed in the Zone 3 FS Report.

B. Soil Cleanup Goals

In the Site 32/36 RDFFS, organic contaminant cleanup goals for both Site 32 and Site 36 source area soil were based on the contaminants' potential to leach to groundwater. Table 10 presents the maximum concentrations for organic contaminants detected in soil samples collected prior to the preparation of the Site 32/36 RDFFS Report, target cleanup levels based on the modified Summers Model, and the selected cleanup goals. Cleanup goals were established for contaminants detected at concentrations exceeding the leaching model target levels.

Inorganic contaminant cleanup goals for Site 32/36 source area soil are presented in Table 11. This table also presents ARARs for metals in groundwater, maximum concentration of metals detected in soil samples from Site 32/36, and background metals concentrations. Cleanup goals for inorganic contaminants were established using the methodology described in the previous subsection. The cleanup goals selected are the background metals concentrations established in the February 1993 letter report (G-609). Cleanup levels were set at the base-wide background because the leaching model indicated cleanup levels to be less than naturally occurring background levels.

As previously indicated in this subsection, cleanup goals for soil presented in the RDFFS Report no longer apply to Site 32 source area soil, which is consistent with the determination of TI for this area.

C. Groundwater Treatment Goals

Groundwater treatment goals have been developed for groundwater that will be extracted, treated, and discharged as part of the source control actions at Site 32/36. The treatment goals for on-site groundwater reinjection are based on RARs, where available, or risk-based concentrations where ARARs were not available.

Table 12 presents the maximum concentrations of all contaminants detected in Site 32/36 groundwater and treatment goals for subsurface discharge (reinjection to groundwater). Extracted groundwater that will be used for land application will be treated by Best Available Technology (BAT) to remove all regulated contaminants exceeding ambient groundwater quality standards (Env-Ws 410.05). The proposed treatment system will meet these requirements. Cleanup goals for contaminants in groundwater that have beyond the Site 32 TI Zone are addressed in the Zone 3 FS Report.

D. Description or Remedial Components

The selected remedy (Alternative 8) for Site 32/36 involves source control at Site 32/36 and involves the following key components:

- Isolation of the overburden source area or DNAPL Zone at Site 32 using a vertical barrier.
- Extraction of groundwater from within and below the vertical barrier and on-site treatment of contaminated groundwater. Discharge of the treated groundwater by off-site (on-base) subsurface reinjection trenches or land application.
- Long-term groundwater and treatment system monitoring.
- Excavation and off-site disposal of Site 36 VOC- and metals-contaminated soil.
- Establishment of a TI Zone within which cleanup to ARARs is not considered technically feasible based on a TI determination.
- Placement of restrictions on use of groundwater and regulation of excavation activities within the Site 32 TI Zone.

Figure 20 presents a remedial process flow sheet for the selected remedy that depicts the elements described. Detailed descriptions of the various components follow.

Source Area Containment

As shown in Figure 21, a vertical barrier is proposed to isolate the source area contamination in the overburden in the vicinity of Building 113. The purpose of the vertical barrier is to prevent to the maximum extent possible the movement of groundwater through the overburden source area that likely contains residual DNAPL within the soil pore spaces and bedrock fractures. The residual DNAPL in the soil pores and shallow bedrock fractures acts as a source of dissolved- phase groundwater contamination. The barrier also allows groundwater extraction on one side of the barrier while minimizing extraction effects on the other side of the barrier. The vertical barriers would not extend beneath Building 113 or into the bedrock, but combined with groundwater extraction, the contaminants within the affected area would be immobilized.

There are two main types of vertical barriers typically used to isolate an area: slurry walls and steel sheet piling. For cost estimation of the preferred remedy, the vertical barrier was assumed to be constructed of steel sheet piling. Sheet piling was selected over slurry walls based on the limited work area, potential contaminant compatibility issues, and the lack of long-term performance data for slurry walls. Approximately 13,650 ft2 of sheet piling were estimated to be required to enclose the selected area. This quantity was estimated using a 420-foot perimeter and average depths rang from 25 to 40 feet. The pilings would extend to the top of shallow fractured bedrock.

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Groundwater Extraction

Groundwater in the LS would be extracted from within the contained area. Based on the modeling performed recently for the source area and presented in the Site 32 Source Area Control Options Letter Report (G-727), two new overburden wells and one existing LS well would be used to extract groundwater from the LS within the vertical barrier. In addition, groundwater would be extracted from three existing and one new shallow fractured bedrock well, each located below the vertical barrier, to minimize the migration of contaminants already present in the bedrock groundwater. The proposed groundwater extraction system is shown in Figure 21. However, the exact number of new wells that will be required, the extraction well configuration, and pumping rates will be finalized during remedial design. The performance monitoring plan will be used to evaluate the performance of the source actions and adjustments in the extraction system will be made, if necessary. Based on numerical groundwater flow modeling, a combined pumping rate of 3 gpm from the LS wells and a combined pumping rate of 1.5 gpm from the shallow fractured bedrock wells are estimated to be required to achieve hydraulic containment (see Figure 22). Additional shallow fractured bedrock extraction wells may be considered (such as well 6122), depending on the performance of the extraction system

TI Zone

The TI Zone defines the horizontal and vertical extent of the area for which the TI determination is sought and includes the DNAPL Zone and the areas that will be contained by the source area containment system.

The numerical groundwater flow modeling estimated that the LS and shallow bedrock extraction system would capture an area somewhat larger than the DNAPL Zone. This area, shown in Figure 21, would establish the horizontal and vertical extent of Site 32 for which the TI determination would be sought. Groundwater flow from the northern, western, and southern directions is toward the containment zone; consequently, the northern, western, and southern TI Zone boundaries would be defined by the extent of the TCE plume that exceeds the MCL (5 µg/L). The eastern TI Zone boundary will be defined by the extent of the shallow fractured bedrock capture zone predicted by source area containment modeling. The vertical extent of the TI Zone will extend from the ground surface to an elevation of -10 ft MSL (which includes all areas of the DNAPL Zone that are 20 feet below the top of bedrock, as shown in Figure 23).

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Groundwater Treatment and Disposal

Groundwater collected at Site 32 would be treated at the existing Site 32/36 groundwater treatment plant (GWTP), which would need to be upgraded based on the expected groundwater influent contaminant concentrations and reconfigured to improve ease of operation and maintenance. Figure 20 presents the proposed GWTP with the representative process options. The conceptual GWTP design developed for costing this alternative is discussed in the paragraphs that follow.

The major treatment processes recommended for the GWTP are chemical oxidation and filtration for iron removal and air stripping for VOC removal. The extracted groundwater would first be pumped into the existing 10,000-gallon holding tank to equalize fluctuations in flow and contaminant concentrations. The optimum flow rate would be based on VOC removal in the air strippers and would be determined following installation of the recovery wells and subsequent tests.

Groundwater from the equalization tank would be pumped into a mixing tank where iron oxidation would occur. Dissolved ferrous iron would be oxidized to ferric iron by aeration and caustic (NaOH) addition to attain an optimum pH range of 7 to 7.5. The reactor tank would be equipped with an air sparging system to provide oxygen in the form of air bubbles in the tank.

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Effluent from the mixing all would be routed through a pressurized multimedia filter for removal of the oxidized iron and suspended solids. Treated plant effluent would be used to backwash the filter when necessary to reduce head loss. Backwash water from the filter would be routed to a solids holding tank for settling. The supernatant from the holding tank would be pumped to the influent holding tank for reprocessing. Periodically, thickened sludge would be pumped from the solids holding tank and dewatered at another treatment plant on base or shipped off base for treatment and disposal.

After filtration, the groundwater would be passed through the existing packed column air stripping system or a new tray system to remove dissolved-phase VOCs. The two existing air strippers and associated blowers (1,000 cfm) would be used. Based on expected influent groundwater concentrations, it is likely that offgas from the air stripping towers would require treatment to meet NHDES Ambient Air Limits. Two vapor-phase adsorption units (each containing 3,000 pounds of carbon or other adsorptive media) operating in series would be capable of treating 1,000 cfm of air. For cost estimation, it was assumed that the vapor-phase carbon adsorbers would be regenerated off-site. However, on-site steam regeneration of spent adsorptive media also could be performed.

An effluent holding tank would be required to provide sufficient water for backwashing the multimedia filter. Treated effluent also would be discharged to a subsurface recharge system located off-site at another area of the base. The proposed recharge system would likely be designed to accept flows from other Zone 3 sites as well as Site 32/36. For the purposes of cost estimation, because Site 32/36 groundwater would constitute a small portion of the total treated groundwater being pumped to the Zone 3 recharge system, only transmission on line costs were included in the alternative cost estimate.

Performance Monitoring Plan

A detailed plan for monitoring the performance and effectiveness of the source control action being taken at Site 32 and the action taken at Site 36 will be developed and submitted to NHDES and EPA for approval during the remedial design phase of the remedial response.

The groundwater monitoring component of the plan will provide the data necessary to monitor: 1) the effectiveness of the removal actions at Site 36, 2) the effectiveness of the containment system at Site 32, and 3) the groundwater quality and flow conditions in the Site 32/36 area. The performance of the groundwater treatment plant will also be evaluated to ensure compliance with regulatory requirements.

Performance and effectiveness data generated for the Performance Monitoring Plan will be evaluated, at a minimum, after startup and during the 5-year reviews. If the Site 32/36 remedy fails to meet the performance standards specified in the Performance Monitoring Plan, remedial system modifications, such as containment system enhancements, will be identified and implemented.

As specified in the Zone 3 Proposed Plan (G-728), a GMZ would be established as part of the Zone 3 selected alternative and would include management of the dissolved-phase contaminated groundwater outside of the TI Zone. Long-term groundwater monitoring required for the GMZ is included in the selected alternative for Zone 3.

Excavation and Off-Site Disposal of Site 36 Metals- and VOC-Contaminated Soil

The metals-contaminated soil that would require remediation is located on the southern side of Building 119, as shown in Figure 23. The estimated volume of the excavation is approximately 120 yd3 based on the cleanup goals stated in Subsection B. The approximate surface area of contaminated soil is 1,000 ft2. The contaminated soil requiring treatment extends to an approximate depth of 3 feet. Because of the small volume of metals-contaminated soil, installation and operation of an on-site treatment process would be neither technically feasible nor cost effective. Therefore, the excavated soil would be transported to an off-site facility for treatment and/or disposal. Excavation would be conducted with standard construction equipment. Soil would be properly secured for transportation to the off-site disposal facility. Manifests for transporting the material would be obtained if necessary.

The VOC-contaminated soil that would require remediation is located on the eastern side of Building 119, as shown in Figure 24. The estimated volume of the excavation is approximately 430 yd3 based on an approximate 40-foot-diameter surface area and a depth limited to the MCS unit. As with the metals-contaminated soil, because of the small volume present, the excavated soil would be transported to an off-site facility for treatment and/or disposal.

Institutional Controls

The current long-term lease between the Air Force and PDA has restrictions on groundwater use and land use at the base and include the area of Site 32/36 in Zone 3. The current restrictions will be included in any future land conveyance documents and adjusted as circumstances may require.

Restrictions on excavation activities in the TI Zone at Site 32 would be implemented as part of this Site 32/36 remedial alternative. All excavation activities would be regulated and would require approval by the Air Force. It should be noted that these land use restrictions have been put in place through the requirements specified in the long-term lease between PDA and the Air Force. Appropriate land use restrictions would be included as part of the deeded transfer when that event occurs.

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XI. STATUTORY DETERMINATIONS

The remedial action selected for implementation at the Site 32/36 source area is consistent with CERCLA and, to the extent practicable, the NCP. The selected remedy is protective of human health and the environment, attains ARARs or invokes appropriate waivers, and is cost-effective. The selected remedy does not satisfy the statutory preference for treatment that permanently and significantly reduces the TMV of hazardous substances as a principal element. The selected remedy uses alternative treatment technologies and resource recovery technologies to the maximum extent practicable.

A. The Selected Remedy is Protective of Human Health and the Environment

The remedy at this site will permanently reduce the risks posed to human health and the environment by eliminating, reducing, or controlling exposures to human and environmental receptors through engineering controls and institutional controls, specifically:

- Isolation of the source area or DNAPL Zone at Site 32 using a vertical barrier.
- Hydraulic containment of the source area through extraction of groundwater from within and below the vertical barrier and on-site treatment of contaminated groundwater. Discharge of the treated groundwater by off-site (on-base) subsurface reinjection trenches or land application.
- Long-term groundwater and treatment system monitoring.
- Excavation and off-site disposal of Site 36 VOC- and metal-contaminated soil.
- Placement of restrictions on use of groundwater and regulation of excavation activities at the Site 32 TI Zone.

The excavation of Site 36 soils will prevent the continued leaching of contaminants to groundwater. The containment and institutional controls components of the selected remedy will prevent human exposure to contaminated groundwater.

B. The Selected Remedy Attains ARARs or Provides Grounds for a Waiver

This alternative would minimize contaminant migration away from the source area, but would not achieve compliance with several state and federal groundwater chemical-specific ARARs inside the TI Zone over the short term. Waivers for these ARARs SDWA MCLs and MCLGs, State of New Hampshire Primary Drinking Water Standards (Env-Ws 315 through 318), and State of New Hampshire Groundwater Quality Criteria and Ambient Groundwater Quality Standards (Env-Ws 410.03, 410.04, and 410.05)] will be required within the TI Zone. Contaminants present in the groundwater at levels in excess of chemical-specific ARARs outside of the TI Zone will be addressed by the remedial alternative selected for Zone 3, which addresses management of migration issues for all of Zone 3.

All activities conducted in connection with the selected remedy (including discharge of treated groundwater, excavation, and air emissions) will meet all chemical- location-, and action-specific ARARs.

The following list summarizes the major federal and state ARARs that will be met or waived by the selected remedy:

- Chemical-specific ARARs:
  - SDWA Maximum Contaminant Levels and Maximum Contaminant Level Goals.
  - RCRA Action Levels.
  - State of New Hampshire Groundwater Quality Criteria and Ambient Groundwater Quality Standards -- Env-Ws 410.03 and 410.05.
  - State of New Hampshire Primary Drinking Water Criteria Env-Ws 315 through 318.
- Location-Specific ARARs:
  - Executive Order 11990 (40 CFR 6, Appendix A), Protection of Wetlands.
  - Fish and Wildlife Coordination Act (FWCA).

- Archaeological and Historic Preservation Act.

- Clean Water Act (CWA), Section 404 (40 CFR 230 and 30 CFR 320 through 330), Prohibition of Wetlands Filling.

- State of New Hampshire Dredging Rules -- Env-Ws 415, Env-Wt 300 through 400, and Env-Wt 600.

• Action-Specific ARARs:

  - RCRA Hazardous Waste Regulations [Subpart C (delegated) and Subpart F (Corrective Action)].

  - SDWA Underground Injection Control Program.

  - Clean Air Act (NESHAPs).

  - RCRA Air Emission Regulations (Subparts AA, BB, and CC).

  - State of New Hampshire Hazardous Waste Management Act and Hazardous Waste Rules, Env-Wm 100-1000 (specified provisions).

  - State of New Hampshire Groundwater Protection Rules, Env-Ws 410.07, 410.10(c), 410.26, 410.30 and 410.31.

  - State of New Hampshire Surface Water Classification Rules, Env-Ws 430-437.

  - State of New Hampshire Air Pollution Control Rules, Env-A 100-1300 (specified provisions).

  - Guidance for Evaluating the Technical Impracticability of Groundwater Restoration (OSWER Directive 9234.2-25).

  - Policy on Control of Air Emissions from Air Strippers at Superfund Groundwater Sites (OSWER Directive 9355.0-28).

  - EPA Region I Memorandum from Louis Gitto to Merrill S. Hohman (12 July 1989) regarding Superfund air strippers.

The base-wide ARARs document (G-614) identifies and describes ARARs for Pease AFB, Table 13 provides a complete list of ARARs and to be considered (TBC) criteria (federal and state criteria considered pertinent but not legally binding) for the selected remedy, including regulatory citations, requirement synopses, actions to be taken to attain the requirements, and determinations as to whether the requirement is applicable, relevant, and appropriate or to be considered.

In addition to meeting ARARs for all on-site activities, the selected remedy will comply with all applicable laws and regulations for off-site activities. For example, regeneration of spent vapor-phase carbon and disposal of metals- and VOC-contaminated soil will comply with RCRA requirements.

<u>C. The Selected Remedy is Cost Effective</u>

The Air Force considers the selected remedy to be cost effective (i.e., the remedy affords overall effectiveness proportional to its costs). Summaries of the costs associated with all of the remedial alternatives were presented in Section IX, Subsection G.

Alternatives 4, 5, 6, and 7 all have lower total present-worth costs than the selected remedy, but these alternatives involve a significant amount of source area treatment at Site 32, the effectiveness of which is uncertain because of the suspected existence of DNAPL and the complex hydrogeologic conditions present at the site. The estimated costs for Alternatives 4 through 7 presented in the RDFFS assumed the treatment technologies would be effective in removing or destroying contaminants from the Site 32 source area, and that long-term extraction and treatment of groundwater could, therefore, be terminated before 30 years. However, based on the findings of the TI Evaluation, which determined that cleanup of the Site 32 source area is not technically feasible, it is likely that the pump and treat components of Alternatives 4 through 7 would have to be conducted indefinitely to provide long-term effectiveness. Therefore, the costs associated with groundwater extraction and treatment for Alternatives 4 through 7, as presented in the RDFFS, are unrealistic. Therefore, the selected remedy is the most cost effective, proportional to its anticipated overall effectiveness.

A summary of the costs for key elements associated with the selected remedy (in present-worth costs) is presented as follows:

Component of Remedy	Present-Worth Cost
TI Waiver Administration	$15,000
Vertical Barriers	$319,194
Groundwater Extraction and Recharging System	$101,960
Groundwater Treatment System	$110,810
Site 36 VOCs/Metals Soil Excavation and Disposal	$254,300
Miscellaneous	$425,556
O&M	$3,596,180
TOTAL (rounded)	$4,823,000

O&M includes groundwater monitoring, maintenance of monitor wells, operation and maintenance of the groundwater treatment system, and 5-year SARA reviews intended to review the status and progress of the remedial action, as discussed in 40 CFR 300.430 (f)(4)(ii). Miscellaneous includes mobilization, demobilization, air quality monitoring, procurement, administrative and legal fees, and contingency costs.

D. The Selected Remedy Uses Permanent Solutions and Alternative Treatment or Resource Recovery Technologies to the Maximum Extent Practicable

The Air Force evaluated the alternatives to determine which provides the most favorable balance of trade-offs among the alternatives in terms of: (1) long-term effectiveness and permanence; (2) reduction of TMV of contaminants through treatment; (3) short-term effectiveness; (4) implementability; and (5) cost. The balancing test emphasized long-term effectiveness and permanence and the reduction of TMV of contaminants through treatment, and considered the preference for treatment as principal element, the bias against off-site land disposal of untreated waste, and community and state acceptance. Of the alternatives evaluated, the selected remedy provides the most favorable balance of the factors considered.

Given the presence of DNAPL at Site 32, the ability of any treatment alternative to provide long-term effectiveness and permanence is questionable. The selected remedy combines containment of the Site 32 source area with some treatment of extracted groundwater to reduce TMV to the maximum extent practicable. The selected remedy will provide a high degree of effectiveness and permanence, given the site conditions, at reasonable cost. Moreover, the selected remedy will be easy to implement and will have few short-term impacts on workers or the community. It has received both public and State acceptance.

E. The Selected Remedy Does Not Satisfy the Preference for Treatment That Permanently and Significantly Reduces the TMV of Hazardous Substances as a Principal Element

The principal element of the selected source control remedy for Site 32/36 is the physical and hydraulic containment of contaminants in Site 32 source area soil and groundwater. Containment of the Site 32 source area is being conducted for the purpose of minimizing the potential for continued migration of source area contaminants away from the site. In addition, removal and off-site disposal of Site 36 VOC- and metals-contaminated soil will eliminate this area as a contaminant source.

Some treatment will be conducted on extracted groundwater at Site 33/36 and may be conducted on soil excavated from Site 36; however, treatment is not the principal element of the selected remedy. When a selected remedy cannot satisfy the preference for treatment, CERCLA § 121 requires that the ROD provide justification for such failure. For Site 32/36, the justification is provided by the results of the TI Evaluation, which concluded that effective removal and treatment of DNAPL at the Site 32 source area is not feasible.

XII. DOCUMENTATION OF SIGNIFICANT CHANGES

No changes to the Site 32/36 selected remedy have occurred since the issuance of the Draft Final Site 32/36 Proposed Plan (G-652).

XIII. STATE ROLE

NHDES reviewed the various alternatives and indicated its support for the selected remedy. NHDES also reviewed the Site 32/36 RI Report, including the risk assessment, and the Site 32/36 RDFFS Report and the Site 32/36 FS Report Addendum 1 to determine whether the selected remedy is in compliance with state ARARs. NHDES understands that the selected remedy will require a TI determination, and establishment of a TI Zone within which ARARS will be waived [e.g., SDWA, State of New Hampshire Primary Drinking Water Standards (Env-Ws 315 through 318), and State of New Hampshire Groundwater Quality Criteria and Ambient Groundwater Quality Standards (Env-Ws 410.03, 410.04, and 410.05)].A copy of the Declaration of Concurrence is provided in Appendix B.

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LIST OF ACRONYMS

AALs	Ambient Air Limits
AFB	Pease Air Force Base
AFCEE/ESB	Air Force Center for Environmental Excellence
AHCs	Aromatic hydrocarbons
ARARs	Applicable or Relevant and Appropriate Requirements
BNA	base/neutral/acid extractable
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COD	chemical oxygen demand
CTVs	Critical Toxicity Values
CWA	Clean Water Act
DEQPPM	Defense Environmental Quality Program Policy Memorandum
DNAPLs	dense nonaqueous phase liquids
DOD	Department of Defense
DOI	Department of the Interior
EO	Executive Order
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FFA	Federal Facility Agreement
FS	Feasibility Study
ft BGS	ft below ground surface
FWCA	Fish and Wildlife Coordination Act
GMZ	Groundwater Management Zone
GRS	Groundwater Recovery System
GWTP	groundwater treatment plant
HAPs	hazardous air pollutants
HHCs	halogenated hydrocarbons
HI	hazard index
HQ AFBCA	Headquarters Air Force Base Conversion Agency
HSWA	Hazardous and Solid Waste Amendments
IRMs	interim remedial measures
IRP	Air Force Installation Restoration Program
IS/PA	Industrial Shop/Parking Apron
ITR	Interim Technical Reports
IWTP	industrial waste treatment plant
JETC	Jet Engine Test Cell
LS	Lower Sand
LS/GT	low-permeability overburden materials
TOX	total organic halogen
MCLGs	Maximum Contaminant Level Goals
MCLs	Maximum Contaminant Levels
MCS	Marine Clay and Silt
NaOH	aeration and caustic
NCP	National Contingency Plan
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHDES	State of New Hampshire Department of Environmental Services
NHPA	National Historic Preservation Act
NPL	National Priorities List
O&G	oil and grease
O&M	Operation and Maintenance
OEHL	Occupational and Environmental Health Lab
OSWER	Office of Solid Waste and Emergency Response
PA	Preliminary Assessment
PAHs	polynuclear aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PDA	Pease Development Authority
PEA	3 letter site code
Pease AFB	Pease Air Force Base
POI	points of interest
PPE	personal protective equipment
ppmw	parts per million by weight
RA	risk assessment
RAOs	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
RD/RA	Remedial Design/Remedial Action

RDFFS	Revised Draft Final Site 32/36 FS Report
RfD	reference doses
RI	remedial investigation
RI/FS	Remedial Investigation/Feasibility Study
RME	reasonable maximally exposed individual
ROD	Record of Decision
ROs	Remedial Objectives
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SBR	shallow bedrock
SCS	Site Characterization Summary
SDWA	Safe Drinking Water Act
SI	Site Investigation
SMCL	Secondary Maximum Contaminant Level
SVOCs	semivolatile organic compounds
TBC	to be considered
TCE	trichloroethene
TDS	total dissolved solids
TI	Technical Impracticability
TMV	volume, toxicity, or mobility
TOC	total organic carbons
TSDFs	treatment, storage, and disposal facilities
US	Upper Sand
USGS	U.S. Geological Survey
UST	Underground Storage Tank
VOCs	volatile organic compounds
yd3	cubic yards

APPENDIX A

TABLES

Table 1

Summary of Site Investigations
Site 32/36, Pease AFB, NH

Date	Activity	Sampling Points	Purpose	Report
Stage 1				
11/84-2/85	Monitor well installation and development	522 (RFW-22) and 523 (RFW-23)	Establish groundwater monitoring points in the IS/PA.	Stage 1 Final Report (G-525)
11/84-12/84	Drilling and sampling of power auger borings; installation of piezometers	15-B-1, 15-B-2, 15-B-3, 15-B-4	Evaluate soil for total organic halogen (TOX), oil and grease (O&G), phenols, metals, and VOCs.	Stage 1 Final Report (G-525)
3/85-4/85	Groundwater sampling (round 1)	522 and 523	Evaluate groundwater for TOX, TOC, O&G, phenols, metals, and VOCs.	Stage 1 Final Report (G-525)
4/85	Drilling and sampling of power auger borings	15-B-19 and 15-B-22	Evaluate soil for TOX, O&G, phenols, metals, and VOCs.	Stage 1 Final Report (G-525)
4/85	Tank sampling	Building 113	Characterize contents of waste TCE UST.	Stage 1 Final Report (G-525)
4/85-5/85	Groundwater sampling (round 2)	522 and 523	Same as round 1.	Stage 1 Final Report (G-525)
5/85	Surveying	Monitor walls and power auger borings	Determine elevations and locations.	Stage 1 Final Report (G-525)
8/85	Resampling of power auger boring	15-B-1	Resampled due to lost sample.	Stage 1 Final Report (G-525)
8/85-9/85	Slug test	522 and 523	Determine hydraulic conductivity.	Stage 1 Final Report (G-525)

Table 1

Summary of Site Investigations
Site 32/36, Pease AFB, NH
(Continued)

Date	Activity	Sampling Points	Purpose	Report
Stage 2				
10/87-12/88	Soil gas survey*	25-ft by 25-ft grid	Assess soil VOC concentrations.	ITR No. 1 (G-530)
Begin 11/87	Water level measurements (quarterly)	Stage 1 wells, Stage 2 wells, piezometers, and gages as installed	Assess hydrologic characteristics.	ITR No. 1 (G-530)
12/87	Resurvey	Monitor wells 522 and 523	Reestablish locations and elevations.	ITR No. 1 (G-530)
4/88	Staff gage installation	804 and 805	Obtain water level measurements; establish surface water and sediment sampling locations.	ITR No. 2 (G-531)
4/88-5/88	Soil boring drilling and sampling	12 borings; 746 to 749, 760 to 767	Investigate soil-gas anomalies; evaluate soil for VOCs, SVOCs, pesticides/PCBs, herbicides, TPHs, metals, and cyanide.	ITR No. 2 (G-531)
4/88-5/88	Piezometer installation	In borings 749, 760, and 761	Obtain water level measurements.	ITR No. 2 (G-531)
4/88-5/88	Survey	Soil borings, gages, and piezometers	Determine elevation and locations.	ITR No. 2 (G-531)
9/88-10/88	Overburden and bedrock well installation and development	548, 554, 616	Evaluate overburden and bedrock water quality.	ITR No. 4 (G-537)

Table 1

Summary of Site Investigations
Site 32/36, Pease AFB, NH
(Continued)

Date	Activity	Sampling Points	Purpose	Report
Stage 2 (continued)				
10/88	Soil boring drilling and sampling	778 and 783	Assess chemical and geotechnical properties of the MCS unit. Evaluate soil for VOCs, SVOCs, pesticides/ polychlorinated biphenyls (PCBs), herbicides, total petroleum hydrocarbons (TPHs), metals, and cyanide.	ITR No. 4 (G-537)
11/88-12/88	Survey	Monitor wells and soil borings.	Determine elevations and locations.	ITR No. 4 (G-537)
11/88	Surface water and sediment sampling.	804 and 805	Evaluate surface water for VOCs, SVOCs, pesticides/PCBs, herbicides, total metals, and cyanide. Evaluate sediment for VOCs, SVOCs, pesticides/PCBs, metals, herbicides, and TPHs.	ITR No. 4 (G-537)
11/88	Slug test	554	Estimate hydraulic conductivity.	ITR No. 4 (G-537)
11/88-12/88	Round 1 groundwater sampling	522, 523, 548, 554, 616	Evaluate groundwater for VOCs, SVOCs, dissolved metals, cyanide, common anions, total hardness, and nitrate/nitrite.	ITR No. 4 (G-537)
5/89	Surface water and sediment sampling	804 and 805	Evaluate surface water for VOCs, pesticides/PCBs, herbicides, total metals, cyanide, chemical oxygen demand (COD), total organic carbons (TOC), and ammonia/nitrogen. Evaluate sediment for cyanide.	ITR No. 4 (G-537)

Table 1

Summary of Site Investigations
Site 32/36, Pease AFB, NH
(Continued)

Date	Activity	Sampling Points	Purpose	Report
Stage 2 (continued)				
5/89	Round 2 groundwater sampling	522, 523, 548, 554, 616	Evaluate groundwater for VOCs, SVOCs, dissolved metals, common anions, total hardness, nitrate/nitrite, and ammonia nitrogen.	Stage 2 Final Report (G-540)
Stage 3B				
5/90-6/90	Seismic refraction survey	Area bounded by New Castle Street and Dover, Durham, and Concord Avenues	Develop interpretive bedrock surface contour map; aid in silting additional monitor/recovery wells.	Geophysical Survey Letter Report, August 1990 (G-539)
6/90	Wetlands delineation	Area between Buildings 113 and 119	Delineate wetlands to fulfill permit requirements for soil removal.	Phase II Wetlands Report For Sites 34 and 32/36, July 1990 (G-546)
7/90	Overburden and bedrock well installation and development	569 through 574; 631 through 633	Evaluate overburden and bedrock water quality; identify potential recovery wells for GWTP.	IRP Site 32/36 SCS, July 1991 (G-560)
7/90	Survey	Monitor and recovery wells	Determine elevations and locations.	IRP Site 32/36 SCS, July 1991 (G-560)
7/90	Hydraulic testing	Monitor wells 569 through 574, 631, 632, and 633	Estimate transmissivity and hydraulic conductivity;, identify potential recovery wells for GWTP.	Recovery Well Selection Letter Report, September 1990 (G-548)

Table 1

Summary of Site Investigations
Site 32/36, Pease AFB, NH
(Continued)

Date	Activity	Sampling Points	Purpose	Report
Stage 3B (continued)				
8/90	Groundwater sampling	522, 523, 548, 554, 569 through 574, 616, 631, 632, 633	Evaluate groundwater for VOCs.	IRP Site 32/36 SCS, July 1991 (G-560)
8/90	Surface water and sediment sampling	804, 805, 831, 832	Evaluate surface water and sediment for VOCs.	NA
8/90-2/91	Monthly water level measurements	Stage 1, 2, and 3B wells	Assess hydrologic characteristics.	IRP Site 32/36 SCS, July 1991 (G-560)
10/90	Recovery well selection	570, 571, and 573	Recover VOC-contaminated groundwater for treatment in GWTP.	Recovery Well Selection Letter Report, September 1990 (G-548)
10/90	Soil removal IRM	Removal of overflow pipe and 440 tom of soil	Source control.	Soil Removal at IRP Site 32/36 ITIR, April 1991 (G-554)
2/91-7/92	Groundwater treatment IRM	Groundwater extraction from three LS wells, GWTP installation, and discharge of treated groundwater.	Recover and treat contaminated groundwater.	GWTP ITIR, October 1992 (G-582)
Stage 3C				
4/91	Control grid survey	Sites 32, 36, and vicinity site.	Establish geophysical survey grid for RI Report, December 1992	IRP Site 32/36 Draft Final (G-583)

Table 1

Summary of Site Investigations
Site 32/36, Pease AFB, NH
(Continued)

Date	Activity	Sampling Points	Purpose	Report
Stage 3C (continued)				
5/91	Seismic refraction survey	Area bounded by Dover and Rochester Avenues, Somersworth and Lee Streets	Refine an interpretive contour map of bedrock surface topography.	IRP Site 32/36 Draft Final RI Report, December 1992 (G-583)
5/91-10/91	Soil boring drilling and sampling	56 borings	To evaluate the extent of contaminated soil and to locate the depth to the top of the MCS unit across the site.	IRP Site 32/36 Draft Final RI Report, December 1992 (G-583)
5/91-10/91	Soil boring drilling and sampling	10 borings	To obtain data concerning average on-site sell conditions for use with the Risk Assessment.	IRP Site 32/36 Draft Final RI Report, December 1992 (G-583)
5/91-10/91	Soil boring drilling and sampling	10 borings	To obtain soil samples for lithologic classification purposes.	IRP Site 32/36 Draft Final RI Report, December 1992 (G-583)
7/91-10/91	Overburden and bedrock well installation and development	7 overburden wells: 5018-5020, 5022, 5024-5026, 5 bedrock wells: 6007, 6008, 6012-6014	To assess the areal extent of groundwater contamination.	IRP Site 32/36 Draft Final RI Report, December 1992 (G-583)
9/91-10/91	Groundwater sampling	5018-5020, 5022, 5024-5026, 554, 569-574	Evaluate groundwater for VOCs, SVOCs, COD, TOC, total dissolved solids (TDS), metals, and BOD.	IRF Site 32/36 Draft Final RI Report, December 1992 (G-583)

Table 1

Summary of Site Investigations
Site 32/36, Pease AFB, NH
(Continued)

Date	Activity	Sampling Points	Purpose	Report
Stage 3C (continued)				
6/91	Surface water and sediment sampling	805, 8044	Evaluate location 805 sediment for pesticides/PCBs and TPH. Evaluate location 8044 surface water and sediment for VOCs, SVOCs, pesticides/PCBs, total metals, TPH, cyanide, TOC, BOD, COD, TDS, dissolved metals, and turbidity.	IRP Site 32/36 Draft Final RI Report, December 1992 (G-583)
9/91	Surface water and sediment sampling	804, 805, 831, 832	Evaluate sediment and surface water for VOCs, SVOCs, pesticides/PCBs, total metals, and TPHs and evaluate surface water for dissolved metals.	IRP Site 32/36 Draft Final RI Report, December 1992 (G-583)
1/92-2/92	Hydraulic testing - Step-drawdown tests	6007, 6008, 6013, 6014	Estimate optimum discharge rates, select wells for long-term pumping tests.	Site 32/36 Exploratory Well Letter Report, 22 May 1992 (G-602)
1/92-2/92	Hydraulic testing - Long-term tests	6008, 6013	Estimate transmissivity, saturated hydraulic conductivity, and storativity of shallow bedrock zone.	Site 32/36 Exploratory Well Letter Report, 22 May 1992 (G-602)
1/92	Groundwater sampling	16 Overburden wells, 14 bedrock wells	Estimate VOC concentrations in overburden and bedrock at Site 32/36.	Site 32/36 Exploratory Well Letter Report, 22 May 1992 (G-602)
10/91-8/92	Well installation	Bedrock wells: 6027, 6029, 6031, 6033, 6042, 6060, 6064	Install potential recovery and monitor wells in shallow bedrock.	Zone 3 Draft Final RI Report, September 1993 (G-629)

Table 1

Summary of Site Investigations
Site 32/36, Pease AFB, NH
(Continued)

Date	Activity	Sampling Points	Purpose	Report
Stage 3C (continued)				
7/92-8/92	Well installation	6073, 6074, 6075	Install shallow bedrock recovery wells for OWTIP IRM.	Site 32/36 Remedial Alternatives Reevaluation and Continued Operation of the Pilot GWTP Letter Report, 15 March 1993 (G-613)
7/92-8/92	Hydraulic testing step -- drawdown tests	6073, 6074, 6075	Optimize pumping rates for new recovery wells.	Site 32/36 Remedial Alternatives Reevaluation and Continued Operation of the Pilot GWTP Letter Report, 15 March 1993 (G-613)
8/92-2/93	Geotechnical evaluation	Buildings 112, 113, 115, 116, 117, 119, 120, 122, 220, 227, 229	Estimate maximum depth to which groundwater may be drawn down during pumping at Site 32/36 so that structural distress of the existing buildings is minimized.	Site 32/36 and Vicinity Building Settlement Analysis Letter Report, 3 March 1993 (G-612)
7/93-10/93	Redesigned Groundwater Recovery System (GRS) operation	Groundwater extraction from six shallow bedrock wells	Recover and treat contaminated groundwater.	Site 32/36 Pilot GWTP IRM at Pease Letter Report, 11 November 1993 (G-654)
6/93-9/93	Groundwater sampling	616, 6008, 6027, 6060, 6064, 6073, 6074	Monitor VOC concentrations before and during pumping in shallow bedrock.	Site 32/36 Pilot GWTP IRM at Pease Letter Report, 11 November 1993 (G-654)

Table 1

Summary of Site Investigations
Site 32/36, Pease AFB, NH
(Continued)

Date	Activity	Sampling Points	Purpose	Report
Stage 3C (continued)				
9/93-11/93	Geotechnical reevaluation	Building 113 and vicinity	Reevaluate maximum allowable drawdown based on actual pumping data.	Site 32/36 Pilot GWTP IRM at Pease Letter Report, 11 November 1993 (G-654)
9/93-12/93	Install and sample DNAPL detection wen	6122	Optimize well location for detection of DNAPL. Sample soil and groundwater for presence of DNAPL.	DNAPL Detection Well Letter Report, 20 December 1993 (G-651)
3/94-Present	Groundwater recovery system operation	Groundwater extraction from six shallow bedrock wells	Recover and treat contaminated groundwater.	Site 32/36 Groundwater Extraction Assessment Letter Report, 1 July 1994 (G-720)
9/94	Seismic refraction survey	North of Building 113. between Dover and Rochester Avenues	Supplement data collected in 5/91 to provide additional detail on depth to bedrock.	Seismic Refraction Results for Site 32/36, 6 October 1994 (G-721)
8/94-9/94	Source area groundwater modeling	Site 32/36	Model source area groundwater extraction scenarios.	Site 32/36 Source Area Modeling Letter Report, 26 September 1994 (G-717)
11/94-12/94	Installation of soil borings and monitor well	6127, 4250, 4251, 4252, 4253, 4254	Confirm bedrock trough north of Building 113. Install and sample shallow bedrock monitor well in trough for VOCs.	Site 32 Source Area Control Options Letter Report, 10 February 1995 (G-727)

Table 1

Summary of Site Investigations
Site 32/36, Pease AFB, NH
(Continued)

Date	Activity	Sampling Points	Purpose	Report
Stage 3C (continued)				
11/94-12/94	Source area containment groundwater modeling	Site 32/36	Model source area groundwater containment scenarios.	Site 32 Source Area Control Options Letter Report, 10 February 1995 (G-727)

*Building 119 only.
NA = Not applicable.
COD = Chemical oxygen demand -- 5 day.
BOD = Biochemical oxygen demand -- 5 day.
O&G = Oil and grease.
PCBs = Polychlorinated biphenyls.
SVOCs = Semivolatile organic compounds.
TOC = Total organic carbon.
TOX = Total organic halogen.
VOCs = Volatile organic compounds.

Table 2

Contaminants of Concern in Soil (0 to 2 feet deep)a
Site 32/32, Pease AFB, NH

Contaminant	Frequency of Detection-b	Range of Sample Quantitation Limits (mg/kg)	Range of Averaged (Detected) Concentrations-c (mg/kg)	Mean Concentrations-d (mg/kg)	Upper 95% Confidence Limit of the Mean (mg/kg)
Organics					
Benzoic acid	2/7	1.7-1.8	0.081-0.13 (0.16)	0.66c	0.94c
Bis(2-ethylhexyl) phthalate	3/12	034-0.43	0.60-4.0	0.62	1.2
2-Butanone	1/14	0.010-0.013	0.007-0.016	0.006	0.008
4.4'-DDD	1/3	0.018-0.038	0.022	0.017	0.028c
4-4'-DDE	1/3	0.018-0.038	0.010	0.013c	0.022c
1,3-Dichlorobenzene	2/14	0.005-0.006	0.055(0.032)-0.14	0.016	0.035
Di-n-butyl phthalate	11/12	0.34	0.052(0.051)-0.29	0.13	0.17
PAHs					
Acenaphthene	1/12	0.34-0.43	0.71	0.23	0.31
Anthracene	2/12	0.34-0.43	0.86-1.5	0.35	0.56
Benzo(a)anthracene	3/12	0.34-0.43	0.53-2.8	0.55	0.97
Benzo(a)pyrene	3/12	0.34-0.43	0.002-1.2	0.30	0.47
Benzo(b)fluoranthene	3/12	0.37-0.43	1.0-1.8	0.50	0.82
Benzo(g,h,i)perylene	1/12	0.36-0.43	2.1	0.33	0.62
Benzo(k) fluoranthene	2/12	0.34-0.43	0.003-0.83	0.22	0.32
Chrysene	4/12	0.34-0.43	0.046-2.8	0.55	1.0
Dibenzo(a,h)anthracene	2/12	0.34-0.43	0.27-0.47	0.21	0.26
Fluoranthene	6/12	0.34-0.37	0.043-6.6	1.1	2.2
Fluorene	2/12	0.34.0.43	0.45-0.66	0.24	0.32
Indeno(1,2,3-c,d)pyrene	2/12	0.34-0.43	0.85-1.6	0.36	0.58
Phenanthrene	5/12	0.34-0.43	0.041-5.1	0.89	1.8
Pyrene	4/12	0.34-0.41	0.043-3.6	0.72	1.4

Table 2

Contaminants of Concern in Soil (0 to 2 feet deep)a
Site 32/32, Pease AFB, NH

Contaminant	Frequency of Detection-b	Range of Sample Quantitation Limits (mg/kg)	Range of Averaged (Detected) Concentrations-c (mg/kg)	Mean Concentrations-d (mg/kg)	Upper 95% Confidence Limit of the Mean (mg/kg)
Inorganics					
Chromium	9/11	3.5-4.5	4.9(43)-58	20	29
Copper	10/11	3.4	4.2-66	23	35
Lead	11/11	20f	2.0-417	50	117

a The listed contaminants were selected as contaminants of concern for both the human health and ecological risk assessments.
b The number of sampling locations at which the chemical was detected compared with the total number of sampling locations.
c If the minimum or maximum detected concentration differed from the respective minimum or maximum averaged concentration, the detected concentration is given in parentheses.
d Arithmetic mean.
e Exceeds the maximum detected concentration.
f Sample quantitation limits were not available. The method detection limit is indicated (G-563).

Table 3

Contaminants of Concern in Soil (0 to 15 feet deep)a
Site 32/36, Pease AFB, NH

Contaminant	Frequency of Detection-b	Range of Sample Quantitation Limits (mg/kg)	Range of Averaged (Detected) Concentrations-c (mg/kg)	Mean Concentration-d (mg/kg)	Upper 95% Confidence Limit of the Mean (mg/kg)
Organics					
Benzoic acid	5/12	1.7-2.0	0.47(0.053)-0.55(0.20)	0.75c	0.86c
Bis(2-ethylhexyl) phthalate	6/21	0.34-0.50	0.12(0.047)-4.0(7.9)	0.65	1.1
Butylbenzyl phthalate	1/10	0.34-0.45	0.13(0.071)	0.19c	0.20c
Carbon disulfide	6/45	0.005-0.70	0.002-0.23	0.017	0.031
Chlorobenzene	4/45	0.005-0.79	0.002-0.45	0.027	0.49
1,2-Dichlorobenzene	4/45	0,005-0.79	0.001-1.4	0.056	0.11
1,3-Dichlorobenzene	4/45	0.005-1.3	0.001-0.83	0.054	0.097
1,4-Dichlorobenzene	2/9	0.34-0.45	0.14(0.049)-0.41(0.64)	0.21	0.26
1,2-Dichloroethene (total)	15/40	0.005-0.70	0.004(0.005)-2.9(4.9)	0.16	0.32
Di-n-butyl phthalate	19/21	0.34-0.40	0.050(0.038)-0.59(1.0)	0.15	0.20
Ethylbenzene	2/45	0.005-0.79	0.19-4.4	0.12	0.29
Naphthalene	1/10	0.34-0.45	0.25	0.20	0.21
PAHs					
Acenaphthene	2/21	0.34-0.45	0.1.3(0.78)-0.71	0.21	0.25
Anthracene	3/21	0.34-0.45	0.18(0.16)-1.5	0.27	0.38
Benzo(a)anthracene	6/21	0.34-0.45	0.12(0.061)-2.8	0.36	0.58
Benzo(a)pyrene	6/21	0.34-0.45	0.023-0.67(1.2)	0.21	0.26
Benzo(b)fluoranthene	6/21	0.34-0.45	0.15(0.10)-1.6(1.8)	0.31	0.44
Benzo(g,h,i)perylene	3/21	0.36-0.45	0.17(0.14)-2.1	0.28	0.44
Benzo(k)fluoranthene	4/21	0.34-0.45	0.0014-0.49(0.83)	0.19	0.22
Chrysene	9/21	0.34-0.45	0.12(0.045)-2.8	0.35	0.58
Dibenzo(a,h)anthracene	4/21	0.34-0.45	0.12(0.039)-0.47	0.20	0.22

Table 3

Contaminants of Concern in Soil (0 to 15 feet deep)a
Site 32/36, Pease AFB, NH
(Continued)

Contaminant	Frequency of Detection-b	Range of Sample Quantitation Limits (mg/kg)	Range of Averaged (Detected) Concentrations-c (mg/kg)	Mean Concentration-d (mg/kg)	Upper 95% Confidence Limit of the Mean (mg/kg)
Fluoranthene	11/21	0.34-0.45	0.043-6.6	0.61	1.2
Fluorene	3/21	0.34-0.45	0.13(0.061)-0.66	0.21	0.25
Indeno(1,2,3-c,d)pyrene	4/21	0.34-0.45	0.16(0.095)-1.6	0.27	0.39
Phenanthrene	9/21	0.34-0.45	0.11(0.041)-5.1	0.51	0.94
Pyrene	9/21	0.34-0.45	0.11(0.043)-3.6	0.44	0.74
Phenol	4/10	0.34-0.40	0.065(0.058)-0.27(0.36)	0.17	0.20
Toluene	8/45	0.005-0.79	0.002(0.001)-0.73	0.037	0.070
Trichlorethene	20/45	0.005-0.032	0.001-160(190)	3.7	9.7
Vinyl chloride	6/45	0.012-1.6	0.0093(0.013)-0.23(0.40)	0.052	0.089
Xylenes (total)	4/45	0.002-0.79	0.001-15	0.52	1.1
Inorganics					
Antimony	4/21	10-30	10(13)-37	11	13
Lead	18/21	0.65-28	16(1.9)-214(417)	24	41
Thallium	5/21	1.6-23	21-36(46)	9.9	14

a The listed contaminants were selected as contaminants of concern for the human health risk assessment only.
b Number of sampling locations at which the chemical was detected compared with the total number of sampling locations.
c If the minimum or maximum detected concentration differed from the respective minimum or maximum averaged concentration, the detected concentration is given in parentheses.
d Arithmetic mean.
e Exceeds the maximum detected concentration.

Table 4

Summary of Highest Concentrations of Organic Compounds
Composite Groundwater Sample Results - Sites 32 & 36
Pease AFB, NH

Organic Compounds	Maximum Detected Concentration (µg/L)	Location-Sample ID
Volatile Organics		
Aromatic Hydrocarbons		
1,2-Dichlorobenzene	4.0	572-M003
1,2-Dichlorobenzene	0.6	554-M004
1,2-Xylene	6.0	554-M004
1,2,4-Trichlorobenzene	0.1	633-M003
1,2,4-Trimethylbenzene	14.0	5025-M002
1,3-Dichlorobenzene	1.0	6012-M001
	1.0	554-M004
1,3,5-Trimethylbenzene	4.0	5025-M002
1,4-Dichlorobenzene	3.0	554-M004
4-Isopropyltoluene	0.2	633-M003
Benzene	19.0	554-M004
Chlorobenzene	1,200.0	5024-M001
Ethyl Benzene	3.0	554-M004
Isopropylbenzene	1.0	5025-M002
2,4-Dimethylphenol	54.0	554-M004
m,p-Xylene (Sum of Isomers)	6.0	554-M004
n-Propylbenzene	2.0	5025-M002
sec-Butylbenzene	3.0	5025-M002
tert-Butylbenzene	0.2	633-M003
Toluene	7.0	554-M004
Halogenated Hydrocarbons		
1,1-Dichloroethene	20.0	548-M003
1,1,1-Trichloroethane	0.9	7531-M008
Chloromethane	300.0	5025-M001
cis-1,2-Dichloroethene	11,000.0	5025-M002
Total-1,2-Dichloroethene	13,000.0	548-M003
trans-1,2-Dichloroethene	230.0	573-M002
Dichlorodifluoromethane	0.6	5077-M001
Tetrachloroethylene (PCE)	50.0	6012-M002
Trichloroethylene (TCE)	680,000.0	5024-M002
Trichlorofluoromethane	6.0	6027-M001
1,1-Dichloroethane	4,600.0	5025-M002
Oxygenated Hydrocarbons		
Benzoic Acid	5.0	5024-M001
Semivolatile Organics		
Polynuclear Aromatic Hydrocarbons		
2-Methylnaphthalene	12.0	5025-M001
Acenaphthene	8.0	6042-M001
Naphthalene	13.0	548-M001
Phenols		
4-Methylphenol	5.0	5024-M001
4-Nitrophenol	3.0	5024-M001
Phthalates		
Bis(2-Ethylhexyl)Phthalate	430.0	554-M102
Dimethyl Phthalate	20.0	6031-M001
Di-N-Butyl Phthalate	32.0	616-M002

Note: Analytical data included in this table have been evaluated according to EPA Region I protocols. Data not evaluated accordingly were not included.

Table 5

Total Lifetime Cancer Risks and Hazard Indices
Site 32/36, Pease AFB, NH

		Total Lifetime Cancer Risk			Total Hazard Index		
Medium	RME	Mean	Upper 95% Confidence Limit	Maximum	Mean	Upper 95% Confidence Limit	Maximum
Soil (0 to 2 feet deep)	Current maintenance worker	4E-07	7E-07	2E-06	1E-03	3E-03	1E-02
	Future maintenance worker	2E-06	3E-06	9E-06	7E-03	2E-02	6E-02
Soil (0 to 15 feet deep)	Future maintenance worker	2E-06	2E-06	1E-05	3E-02	4E-02	2E-01

Table 6
Summary of Total Lifetime Cancer Risks and Hazard Indices
Site 32/36, Pease AFB, NH

Groundwater-d							
Sites 32/36 Overburden and Shallow Bedrock -- Main	Future off-base resident	3E-04 (filtered)	5E-04 (filtered)	1E-03 (filtered)	3E+00 (filtered)	4E+00 (filtered)	1E+01 (filtered)
Sites 32/36 Overburden and Shallow Bedrock -- Hot Spot	Future off-base resident	4E-02 (filtered)	2E-01 (filtered)	2E-01 (filtered)	4E+02 (filtered)	2E+03 (filtered)	2E+03 (filtered)
Sites 32/36 Deep Bedrock - Hot Spot IIc	Future off-base resident	5E-05 (filtered) 5E-05 (total)	NA	NA	1E+00 (filtered) 1E + 00 (total)	NA	NA
Sites 32/36 Deep Bedrock -- Hot Spot IIc	Future off-base resident	7E-05 (filtered) 7E-05 (total)	NA	NA	2E+00 (filtered) 2E+00 (total)	NA	NA

NA = Not applicable. Risk was evaluated based only on one exposure concentration.
NC = Not calculated. A toxicity value was not available for the chemical of concern.

a Values are rounded to one significant figure.
b Maximum cancer risk at hazardous waste sites is regulated in the range of 1E-06 to 1E-04 (10-6 to 10-4). Risks of less than 1E-06 (10-6) are generally not of concern.
c A hazard index of 1 (1E+00) or greater is usually considered the benchmark of potential concern.
d Filtered and total values are based on organics data plus inorganics data for filtered and unfiltered (total) samples, respectively.
e Data were limited to one well. The exposure concentration is the averaged concentration from that well.

Table 7

Summary of Hazard Indices for the Meadow Vole
Site 32/36, Pease AFB, NH

Chemical	Hazard Indices for Soil Ingestion		Hazard Indices for Plant Ingestion		Total Hazard Indices	
	Average	Maximum	Average	Maximum	Average	Maximum
Organics						
Benzoic acid	2.40E-04	2.83E-04	7.70E-03	9.10E-03	7.94E-05	9.38E-03
Bis(2-ethylhexyl)phthalate	1.80E-01	1.16E+00	1.95E-04	1.26E-05	1.80E-01	1.16E+00
2-Butanone	6.05E-07	1.61E-06	NE	NE	6.05E-07	1.61E-06
4,4'-DDD	6.93E-07	8.97E-07	6.93E-08	8.97E-08	7.62E-07	9.86E-07
4,4'-DDE	4.87E-06	5.13E-06	1.69E-07	1.78E-07	5.04E-06	5.31E-06
1,3-Dichlorobenzene	1.48E-05	1.30E-04	4.75E-05	4.16E-04	6.23E-05	5.46E-04
Di-n-butylphthalate	1.81E-05	4.05E-05	3.99E-06	8.90E-06	2.21E-05	4.94E-05
PAHs						
Acenaphthene	2.29E-05	7.08E-05	4.36E-05	1.34E-04	6.65E-05	2.05E-04
Anthracene	6.10E-06	2.62E-05	6.10E-06	2.02E-05	1.22E-05	5.23E-05
Benzo(a)anthmcene	6.40E-03	3.26E-02	1.28E-03	6.51E-03	7.67E-03	3.91E-02
Benzo(a)pyrene	5.23E-02	2.09E-01	5.23E-03	2.09E-02	5.76E-02	2.30E-01
Benzo(b)fluoranthene	NE	NE	NE	NE	NE	NE
Benzo(g,h,i)perylene	NE	NE	NE	NE	NE	NE
Benzo(k)fluoranthene	NE	NE	NE	NE	NE	NE
Chrysene	NE	NE	NE	NE	NE	NE
Dibenzo(a,h)anthracene	NE	NE	NE	NE	NE	NE
Fluoranthene	1.53E-04	9.21E-04	9.21E-05	5.53E-04	2.46E-04	1.47E-03
Fluorene	3.35E-05	9.21E-05	4.69E-05	1.29E-04	8.04E-05	2.21E-04
Indeno(1,2,3-cd)pyrene	NE	NE	NE	NE	NE	NE
Phenanthrene	1.11E-02	6.35E-02	1.11E-02	6.35E-02	2.22E-02	1.27E-01
Pyrene	1.67E-04	8.37E-04	1.00E-04	5.02E-04	2.68E-04	1.34E-03
Inorganics						
Chromium						
Hexavalent	1.77E-02	4.19E-02	1.32E-03	3.14E-03	1.90E-02	4.50E-02
Trivalent	2.60E-04	6.15E-04	1.95E-05	4.62E-05	2.80E-04	6.62E-04
Copper	5.08E-02	1.46E-01	2.03E-01	5.83E-01	2.54E-01	7.29E-01
Lead	1.74E+00	1.45E+01	7.85E-01	6.55E+00	2.53E+00	2.11E+01
		Cumulative Hazard Index:			3.08E+00	2.34E+01

NE - Not evaluated due to lack of dose and/or CTV

Table 8

Summary of Hazard Indices for the American Robin
Site 32/36, Pease AFB, NH

Chemical	Hazard Indices for Soil Ingestion		Hazard Indices for Plant Ingestion		Total Hazard Indices	
	Average	Maximum	Average	Maximum	Average	Maximum
Organics						
Benzoic acid	NE	NE	NE	NE	NE	NE
Bis (2-ethylhexyl)phthalate	NE	NE	NE	NE	NE	NE
2-Butanone	NE	NE	NE	NE	NE	NE
4,4'-DDD	1.47E-04	1.90E-04	3.08E-02	3.98E-02	3.09E-02	4.00E-02
4,4'-DDE	7.68E-04	8.09E-04	1.38E-01	1.48E-01	1.39E-01	1.46E-01
1,3-Dichlorobenzene	NE	NE	NE	NE	NE	NE
Di-n-butylphthalate	NE	NE	NE	NE	NE	NE
PAHs						
Acenphthene	1.83E-05	5.63E-05	NE	NE	1.83E-05	5.63E-05
Anthracene	2.78E-05	1.19E-04	2.78E-05	1.19E-04	5.56E-05	2.38E-04
Benzo(a)anthracene	4.37E-05	2.22E-04	1.31E-04	6.67E-04	1.75E-04	8.89E-04
Benzo(a)pyrene	2.38E-05	9.52E-05	1.90E-04	7.62E-04	2.14E-04	8.57E-04
Benzo(b)fluoranthene	3.97E-05	1.43E-04	3.17E-04	1.14E-03	3.57E-04	1.29E-03
Benzo(g,h,i)perylene	2.62E-05	1.67E-04	1.57E-04	1.00E-03	1.83E-04	1.17E-03
Benzo(k)fluoranthene	1.75E-05	6.59E-05	1.05E-04	3.95E-04	1.22E-04	4.61E-04
Chrysene	4.37E-05	2.22E-04	1.75E-04	8.89E-04	2.18E-04	1.11E-03
Dibenzo(a,h)anthracene	1.67E-05	3.73E-05	NE	NE	1.67E-05	3.73E-05
Fluoranthene	8.73E-05	5.24E-04	1.75E-04	1.05E-03	2.62E-04	1.57E-03
Fluorene	1.90E-05	5.24E-05	NE	NE	1.90E-05	5.24E-05
Indeno(1,2,3-cd)pyrene	2.86E-05	1.27E-04	2.86E-04	1.27E-03	3.14E-04	1.40E-03
Phenanthene	7.06E-05	4.05E-04	2.12E-04	1.21E-03	2.83E-04	1.62E-03
Pyrene	5.71E-05	2.86E-04	1.14E-04	5.71E-04	1.71E-04	8.57E-04
Inorganics						
Chromium	4.12E-02	1.19E-01	4.12E-01	1.19E+00	4.53E-01	1.31E+00
Copper	2.48E-02	7.12E-02	2.73E-01	7.83E-01	2.98E-01	8.54E-01
Lead	6.47E-03	5.39E-02	6.47E-02	5.39E-01	7.12E-02	5.93E-01
			Cumulative Hazard Index:		9.94E-01	5.93E-01

NE - Not evaluated due to lack of dose and/or CTV

Table 9

Summary of Detailed Alternatives Evaluationa
Site 32/36, Pease AFB, NH

Remedial Alternative	Protection of Human Health and the Environment Ranking	Compliance with ARARs Ranking-b	Long-Term Effectiveness and Permanence Ranking	Reduction in TMV of Contaminants Ranking	Short-Term Effectiveness Ranking	Implementability Ranking	Cost Analysis-c (sensitivity analysis)d
1. No action	C	C	C	C	AB	A	$65,000
2. Extraction, on-site treatment, and disposal of groundwater, and excavation and off-site disposal of Site 36 VOC,- and metals-contaminated soil	BC	C	B	BC	AB	AB	$8,388,000 ($7,485,800 to $9,006,200)
3. Isolation of the source area using horizontal and vertical barriers, on-site treatment and disposal of groundwater, and excavation and offsite disposal of Site 36 VOC- and metals-contaminated soil	BC	C	B	BC	B	B	$5,550,000 ($5,072,300 to $7,779,700)
4. Excavation and on-site treatment of Site 32/36 VOC-contaminated soil; extraction, on-site treatment, and disposal of groundwater; and excavation and off-site disposal of Site 36 metals-contaminated soil	BC	C	B	BC	BC	B	$3,470,000 ($3,124,400 to $4,211,600)
5. Passive remediation of the source area using in situ adsorption, and excavation and off-site disposal of Site 36 VOC- and metals-contaminated soil	BC	C	C	BC	AB	AB	$2,213,000 ($2,002,700 to $2,347,300)
6. Excavation and on-site treatment of Site 36 VOC-contaminated soil and Site 32 MCS unit soil; in situ treatment of remaining Site 32 VOC-contaminated soil by SVE and air sparging; extraction, on-site treatment, and disposal of groundwater, and excavation and off-site disposal of Site 36 metals-contaminated soil	BC	C	B	BC	BC	B	$2,835,000 ($2,766,900 to $3,065,100)

Table 9

Summary of Detailed Alternatives Evaluationa
Site 32/36, Pease AFB, NH
(Continued)

Remedial Alternative	Protection of Human Health and the Environment Ranking	Compliance with ARARs Ranking-b	Long-Term Effectiveness and Permanence Ranking	Reduction in TMV of Contaminants Ranking	Short-Term Effectiveness Ranking	Implementability Ranking	Cost Analysis-c (sensitivity analysis)d
7. Isolation of the source area by vertical barriers, excavation and on-site treatment of Site 36 VOC-contaminated soil and Site 32 MCS unit soil, pneumatic fracturing in the shallow bedrock, dual-phase extraction and on-site treatment of groundwater and vapor, and excavation and off-site disposal of Site 36 metals-contaminated soil	BC	C	B	BC	BC	B	$3,422,000 ($3,243,700 to $3,994,300)
8. Source control -- Containment of DNAPL area, on-site treatment of groundwater, and excavation and off-site disposal of Site 36 VOC and metals-contaminated soil	AB	A	AB	BC	B	AB	$4,823,000 ($4,338,000 to $5,164,000)

a The ranking system is defined as follows:

A - The alternative met the intent of the criterion.
B - The alternative partially meets the intent of the criterion.
C - The alternative does not meet the intent of the criterion.
AB - The alternative was ranked between A and B.
BC - The alternative was ranked between B and C.

b None of the alternatives will meet groundwater ARARs. Failure to meet any ARAR means that the alternative fails to satisfy this criterion, unless a waiver is obtained. Only Alternative 8 incorporated an ARAR waiver based on technical impracticability.
c Estimated costs represent present-worth costs. Detailed cost estimates are presented in Table 3 of the Site 32/36 FS Addendum 1.
d The sensitivity analysis costs represent the upper and lower limits of the 50% confidence interval.

Table 10

Selection of Cleanup Goals for Organics in Soil
Site 32/36, Pease AFB, NH

Compound	Soil Target Levels Based on Leaching (mg/kg)	Maximum Soil Concentration Detected (mg/kg)	Potential Soil Cleanup Goal (mg/kg)
VOCs			
Benzene	0.47	0.012	NA
Carbon disulfide	0.49	0.23 J	NA
Chlorobenzene	38	0.455	NA
Chloromethane	0.15	0.001 J	NA
1,2-Dichlorobenzene	1,161	14	NA
1,3-Dichlorobenzene	1,161	2.3	NA
1,4-Dichlorobenzene	145	0.046	NA
Dichlorodifluoromethane	413	0.139	NA
1,1-Dichloroethene	0.5	0.0097	NA
cis-1,2-Dichloroethene	4.7	4.9a	4.7b
trans-1,2-Dichloroethene	7	4.9a	NA
Ethylbenzene	876	4.4	NA
Tetrachloroethene	2.1	0.021	NA
Toluene	284	0.73	NA
1,1,1-Trichloroethane	35	0.024 J	NA
Trichloroethene	0.7	190	0.7
Trichlorofluoromethane	362	0.022 J	NA
Vinyl chloride	0.02	0.4	0.02
Xylenes (total)	3,049	15	NA
Pesticides/PCBs			
4,4'-DDD	97	0.022	NA
4,4'-DDE	284	0.01 J	NA

Table 10

Selection of Cleanup Goals for Organics in Soil
Site 32/36, Pease AFB, NH
(Continued)

Compound	Soil Target Levels Based on Leaching (mg/kg)	Maximum Soil Concentration Detected (mg/kg)	Potential Soil Cleanup Goal (mg/kg)
SVOCs			
Acenaphthene	11,463	0.71	NA
Anthracene	399	1.5	NA
Benzoic acid	8,443	0.094	NA
Benzo(a)anthracene	159	2.8	NA
Benzo(a)pyrene	1,252	2.3	NA
Benzo(b)fluoranthene	125	1.8	NA
Benzo(g,h,i)perylene	1,775	2.1	NA
Benzo(k)fluoranthene	1,001	1.4	NA
Bis(2-ethylhexyl) phthalate	683	7.9	NA
Butyl benzyl phthalate	24	0.54	NA
Chrysene	46	2.8	NA
Dibenzo(a,h)anthracene	1,126	0.47	NA
Fluoranthene	7,178	6.6	NA
Fluorene	8,306	0.66	NA
Indeno(1,2,3-cd)pyrene	728	1.6	NA
Naphthalene	21	0.25 J	NA
Phenanthrene	282	5.1	NA
Phenol	27	0.29 J	NA
Pyrene	12,903	3.6	NA

a Value presented is for total 1,2-dicholorethene.
b There is the potential that cis-1,2-dichloroethene may be present at greater than 4.7 mg/kg in the maximum detected sample for total 1,2-dichloroethene.
NA = Not applicable. Leaching value exceeds maximum detected concentration.
J = Estimated value below quantitation limit.

Table 11

Determination of Potential Cleanup Goals for Metals in Soil
Site 32/36, Pease AFB, NH

Metal	Maximum Groundwater Concentration Detected (µg/L)	Groundwater ARARa (µg/L)	Maximum Soil Concentration Detected (mg/kg)	Soil Background Concentration-d (mg/kg)	Potential Cleanup Goal (mg/kg)
Aluminum	59,700	200b	17,500	24,900	NA
Antimony	ND	10	37.2	NC	NA
Arsenic (total)	118	50	20.1	15.25	15.25
Barium	331	1,000	156	105	NA
Beryllium	4.5	1	1.6	1.8	NA
Boron	149	620b	ND	NC	NA
Cadmium	ND	5	8.7	NC	NA
Calcium	103,000	NA	3,370	3,180	NA
Chromium (total)	171	100	57.6	37.5	37.5
Cobalt	67.3	NA	14.1	19.6	NA
Copper	126	1,300	66.1	42	NA
Iron	125,000	300	34,200	35,300	NA
Lead	37.6	15	417	65.3	65.3
Magnesium	53,600	NA	7,660	8,240	NA
Manganese	2,280	50b	993	623	NA
Mercury	0.31	2	ND	NC	NA
Nickel	169	100	34.5	43.4	NA
Potassium	24,400	35,000b	6,410	6,650	NA
Selenium	33.2	50	1.4	NC	NA
Silicon	74,700	NA	1,510	1,900	NA
Sodium	127,000	NA	315	356	NA
Thallium	ND	2	45.6	NC	NA
Vanadium	153	256c	53.1	49.3	NA
Zinc	569	5,000	104	92.3	NA

a Value presented is an MCL unless otherwise noted.
b New Hampshire Department of Public Health Services - Secondary Maximum Contaminant Level (SMCL)
c Concentration based on cancer risk of 10-6 of hazard index of 1.
d Background levels established in the letter report dated February 1993 (G-609).
ND = Not detected.
NC = Not calculated for the metals that were detected in fewer than 50% of the samples.

Table 12

Target Treatment Goals for Groundwater Extracted as Part of Source Control Remedy Site 32/36, Pease AFB, NH

Compound	Maximum Concentration Detected (µg/L)	Treatment Goal for Discharge to Groundwater-a (µg/L)
VOCs		
Benzene	19	5
sec-Butylbenzene	3 J	NA
tert-Butylbenzene	0.2 J	NA
Chlorobenzene	1,200 J	100
Chloromethane	300 J	3b
1,2-Dichlorobenzene	0.6 J	600
1,3-Dichlorobenzene	1(40)	600
1,4-Dichlorobenzene	3(3.7)	75
p-Dichlorobenzene	2J	NA
dichlorodifuoromethane	34	1,000b
1,1-Dichloroethane	54.4 J	81b
1,1-Dichloroethene	20	7
cis-1,2-dichloroethene	11,000 J	70
trans-1,2-Dichloroethene	13,000	100
Ethylbenzene	3	700
Isopropylbenzene	1 J	89.1c
4-Isopropyltoluene	0.2 J	NA
n-Propylbenzene	2 J	NA
Tetrachloroethene	50	5
Toluene	7(71 J)	1,000
1,2,4-Trichlorobenzene	0.1 J	70
1,1,1-Trichloroethane	1.3	200
Trichloroethene	680,000(4,233,067)	5
Trichlorofluoromethane	6 J	2,000b
1,2,4-Trimethylbenzene	14	70
1,3,5-Trimethylbenzene	4 J	NA
Vinyl chloride	4,600 J	2

Table 12

Target Treatment Goals for Groundwater Extracted as Part of Source Control Remedy Site 32/36, Pease AFB, NH (Continued)

Compound	Maximum Concentration Detected (µg/L)	Treatment Goal for Discharge to Groundwater-a (µg/L)
VOCs (continued)		
Xylenes (total)	12	10,000
SVOCs		
Acenaphthene	7 J	2,190c
Benzoic acid	5 J	28,000b
Bis(2-ethylhexyl) phthalate	430	6
Dimethyl phthalate	20	313,000
Di-n-butyl phthalate	32	3,650c
2,4-Dimethylphenol	54	730c
2-Methylnaphthalene	12	13.4c
4-Methylphenol	5 J	350b
Naphthalene	13	20b
4-Nitrophenol	3 J	60d
Pentachlorophenol	7 J	1
Metals - Total (dissolved)		
Aluminum	59,700 (687)	NA
Arsenic	118f (59.9)	50
Barium	331 (55.8)	2,000
Beryllium	4.5	4
Boron	149 (142)	620b
Calcium	103,000 (94.5)	NA
Chromium III	171f	100f
Chromium VI	171f	100f
Cobalt	67.3	NA
Copper	126 (14.5)	1,300
Iron	125,000 (1,360)	NA
Lead	37.6 (11.4)	15

Table 12

Target Treatment Goals for Groundwater
Extracted as Part of Source Control Remedy
Site 32/36, Pease AFB, NH
(Continued)

Compound	Maximum Concentration Detected (µg/L)	Treatment Goal for Discharge to Groundwater-a (µg/L)
Metals - Total (dissolved) (continued)		
Magnesium	53,600 (27,000)	NA
Manganese	2,280 (500)	1,500c
Mercury	0.31	2
Nickel	169 (63)	100
Potassium	24,400 (12,600)	35,000b
Selenium	33.2	50
Silicon	74,700 (7,760)	NA
Sodium	115,000	NA
Vanadium	153	20d
Zinc	159 (140)	2,000d

NA = Not available.
( ) = Number in parentheses represents the maximum concentration detected in mobile laboratory samples for VOCs and soluble metals for metals.
J = Estimated value below the quantitation limit.

a Value presented is an MCL unless otherwise noted.
b New Hampshire Department of Public Health Services.
c Concentration based on cancer risk of 10-6 or hazard index of 1.
d EPA Lifetime Health Advisory.
e State of New Hampshire AWQC.
f Value presented is total arsenic or total chromium.

Table 13

ARARs for the Selected Remedy - Source Control - Containment of DNAPL Area, On-Site Treatment of Groundwater, and Excavation and Off-Site Disposal of Site 36 VOC- and Metals-Contaminated Soil
Site 32/36, Pease AFB, NH

Medium	Requirement	Requirement Synopsis	Action To Be Taken To Attain Requirements	Status
	CHEMICAL-SPECIFIC			
Groundwater	FEDERAL-SDWA-Maximum Contaminant Levels (MCLs) (40 CFR 141.11-141.16)	MCLs have been promulgated for a number of common organic and inorganic contaminants. These levels regulate the contaminants in public drinking water supplies, but may also be considered relevant and appropriate for groundwater aquifers potentially used for drinking water.	MCIs were used when selecting groundwater cleanup goals. At Site 32, since the requirements will not be attained within the TI Zone, a waiver will be sought. Groundwater extracted from the TI Zone will he treated to meet MCLs before discharge	Relevant and Appropriate
Groundwater	FEDERAL-SDWA-Maximum Contaminant Level Goals (MCLGs) (40 CFR 141.50-141.51)	MCLcs are nonenforceable health-based goals for public water systems. MCLGs are set at levels that would result in no known or expected adverse health effects, with an adequate margin of safety.	Non-zero MCLGs were considered when selecting groundwater cleanup and treatment goals. At Site 32, since the requirements will not be attained within the TI Zone for groundwater restoration, a waiver will he sought. Treatment of groundwater extracted from the TI Zone will be conducted to attain requirements	Relevant and Appropriate
Groundwater, Soil	FEDERAL-RCRA-Examples of Concentrations Meeting Criteria for Action Levels (40 CFR 264.521, Appendix A)	These nonenforceable health-based groundwater and soil protection standards are established for 146 toxic compounds.	RCRA action levels were considered in selection of cleanup levels.	TBC
Groundwater	FEDERAL-EPA Health Advisories (HAs)	HAs are nonenforceable health-based standards established for various exposure durations (i.e, 1 day, 10 days, and lifetime).	HAs were considered when selecting groundwater cleanup goals. Table 12 of the ROD presents treatment goals for groundwater. Extracted groundwater will be treated using oxidation/filtration and air stripping to meet these standards.	TBC

Table 13

ARARs for the Selected Remedy - Source Control - Containment of DNAPL Area, On-Site Treatment of Groundwater, and Excavation and Off-Site Disposal of Site 36 VOC- and Metals-Contaminated Soil Site 32/36, Pease AFB, NH (Continued)

Medium	Requirement	Requirement Synopsis	Action To Be Taken To Attain Requirements	Status
Groundwater, Surface Water, Sediment, Soil	FEDERAL-EPA Risk Reference Doses (RfDs)	RfDs are dose levels developed based on noncarcinogenic effects and are used to develop Hazard Indices. A Hazard Index of less than or equal to 1 is considered acceptable.	EPA RfDs were used to characterize risks due to exposure to contaminants in groundwater, soil, surface water, and sediment.	TBC
Groundwater, Surface Water, Sediment, Soil	FEDERAL-EPA Carcinogen Assessment Group Potency Factors	Potency Factors are developed by the EPA from Health Effects Assessments or evaluation by the Carcinogenic Assessment Group and are used to develop excess cancer risks. A range of 10-4 to 10-7 is considered acceptable.	EPA Carcinogenic Potency Factors have been used to compute the individual incremental cancer risk resulting from exposure to site contamination in groundwater, soil, surface water, and sediment.	TBC
Groundwater	STATE-NH Admin. Code Env-Ws 410.03, 410.04, and 410.05, Groundwater Quality Criteria and Ambient Groundwater Quality Standards	New Hampshire Groundwater Quality Criteria (410.03) require that all groundwater of the state shall be suitable for drinking, shall not contain regulated contaminants in excess of the standards (410.05), and dull not cause discharges to surface water in excess of surface water quality standards. The standards, which are derived from MCLs and other EPA and NH health-based limits, protect quality of ambient groundwater. Exemptions from groundwater quality criteria (410.04) include areas designated as GMZs.	These standards were used to establish groundwater cleanup goals. At Site 32, where cleanup of groundwater to meet the standards is technically impracticable within the TI Zone, a waiver would be required. These standards were also used when selecting treatment levels for extracted groundwater.	Applicable, to the extent more stringent than MCLs and MCLGs.
Groundwater	NH Primary Drinking Water Criteria (MCLs and MCLGs) Under RSA Ch. 485, Promulgated as Env-Ws 315-318	Standards for public drinking water systems. Used as cleanup standards for aquifers and surface water bodies that are potential drinking water sources.	NH MCLs and non-zero MCLGs were used as appropriate to establish groundwater cleanup goals. At Site 32, since requirements will not be attained within the TI Zone, a waiver will be sought. Groundwater extracted from the TI Zone will be treated before discharge to meet these standards.	Relevant and Appropriate, to the extent more stringent than federal MCLs and MCLGs.

Table 13

ARARs for the Selected Remedy - Source Control - Containment of DNAPL Area, On-Site Treatment of Groundwater, and Excavation and Off-Site Disposal of Site 36 VOC- and Metals-Contaminated Soil
Site 32/36, Pease AFB, NH
(Continued)

Medium	Requirement	Requirement Synopsis	Action To Be Taken To Attain Requirements	Status
	LOCATION-SPECIFIC			
Wetlands	Wetlands Executive Order (EO) 11990, 40 CFR 6, Appendix A	Under this order, federal agencies are required to minimize the destruction, loss, or degradation of wetlands or beneficial values or wetlands. 40 CFR 6, Appendix A contains the EPA policy for carrying out the provisions of EO 11990.	Remedial activities will minimize harm to the wetland to the extent possible. Appropriate federal agencies identified (under this act) will be contacted and allowed to review the proposed work plan prior to initiating the remedial activities.	Applicable
Wetlands	FEDERAL-CWA Section 404 (b)(i), Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 CFR 230 and 33 CFR 320-330)	Contains requirement for discharge or dredged or fill material, including that no discharge is permitted if there is a practicable alternative to the proposed discharge that would have a less adverse impact on the aquatic ecosystem, and that no discharge is permitted unless appropriate and practicable steps are taken to minimize potential adverse impacts on the aquatic ecosystem.	No dredging or filling or wetlands will occur under this alternative. Remedial activities will be designed to minimize potential adverse effects on the aquatic ecosystem.	Applicable
Wetlands	FEDERAL-16 USC 661 et seq., Fish and Wildlife Coordination Act	Requires federal agencies to take into consideration the effect that water-related projects will have on fish and wildlife. Requires consultation with the U.S. Fish and Wildlife Service and the state to develop measures to prevent, mitigate, or compensate for project-related losses to fish and wildlife	Actions taken will minimize adverse effects. Relevant federal and state agencies will be contacted to help analyze effects of the remedial action on wildlife in the wetlands in and around the site.	Applicable

Table 13

ARARs for the Selected Remedy - Source Control - Containment of DNAPL Area, On-Site Treatment of Groundwater, and Excavation and Off-Site Disposal of Site 36 VOC- and Metals-Contaminated Soil
Site 32/36, Pease AFB, NH
(Continued)

Medium	Requirement	Requirement Synopsis	Action To Be Taken To Attain Requirements	Status
Wetlands	STATE-RSA 485:A.17, NH Admin. Code Env-Ws 415, Rules Relative to Prevention of Pollution from Dredging, Filling, Mining, Transporting, and Construction	Establish criteria for conducting any activity in or near state surface waters that significantly alters terrain or may otherwise adversely affect water quality, impede natural runoff, or create unnatural runoff. Activities within the scope of these provisions include excavation, dredging, filling, mining, and grading of topsoil in or near wetland areas.	Soil excavation, grading activities, and source containment extraction and treatment systems will meet substantive requirement of these NHDES rules as applicable to wetlands.	Applicable
Wetlands	STATE-RSA 482-A, NH Admin. Code Env-Wt 300, 400, and 600, New Hampshire Criteria and Conditions for Fill and Dredging in Wetlands	Regulate filling and other activities in or adjacent to wetlands, and establish criteria for the protection of wetlands from adverse impacts on fish, wildlife, commerce, and public recreation.	Proposed work adjacent to the wetlands will comply with substantive requirements of the state wetlands protection statute and regulations. Any wetlands damaged during construction will be restored.	Applicable
Historic Places	FEDERAL-16 USC 496A-1, Archaeological and Historic Preservation Act	Provides for the preservation of historical and archaeological data that might be lost because of alteration of terrain. Requires data recovery and preservation.	If articles are encountered during excavation, these measures will be taken.	Applicable
Groundwater	STATE-NH Admin. Code Env-Ws 378, Site Selection of Wells for Community Water Systems	These regulations establish procedures and standards for siting of new wells that will supply community water systems. They establish protective radii around the well in which certain activities are prohibited. In addition, they establish a wellhead protection area within which an inventory of contamination sources must be performed and contamination management program must be developed.	The Haven well is the source of drinking water for the base and is a potential drinking water source for the City of Portsmouth. Effluent and remedial system monitoring efforts will be combined with the selection of the groundwater recharge locations to ensure that the Haven well will not be adversely impacted.	Relevant and Appropriate

Table 13

ARARs for the Selected Remedy - Source Control - Containment of DNAPL Area, On-Site Treatment of Groundwater, and Excavation and Off-Site Disposal of Site 36 VOC- and Metals-Contaminated Soil
Site 32/36, Pease AFB, NH
(Continued)

Medium	Requirement	Requirement Synopsis	Action To Be Taken To Attain Requirements	Status
ACTION-SPECIFIC				
Hazardous Waste/Soil	FEDERAL-RCRA 40 CFR Part 264	RCRA Subtitle C establishes standards applicable to treatment, storage, transport, and disposal of hazardous waste and the closure of hazardous waste facilities.	Management of hazardous waste at part of a CERCLA response must comply with the substantive requirements of Subtitle C regulations.	Relevant and Appropriate. Has effect through state hazardous waste requirements, which operate in lieu of direct federal regulations. See discussion of these requirements below.
Hazardous Waste/Soil	FEDERAL-RCRA 40 CFR 264.90-264.101 (Subpart F), Releases from Solid Waste Management Units	General facility requirements for groundwater monitoring at affected facilities and general requirements for corrective action programs if required at regulated facilities.	Groundwater monitoring and treatment will be conducted in accordance with these requirements.	Relevant and Appropriate
Hazardous Waste/Soil	STATE-RSA Ch. 147-A, NH Hazardous Waste Management Act and Hazardous Waste Rules, Env-Wm, Chapters 100-1000, specific requirements detailed below.	Standards for management of hazardous waste facilities. Operates in lieu of federal RCRA Subtitle C requirements.	Soil and groundwater at the site contain listed hazardous waste from degreasing activities. Actions to be taken are listed separately below.	See following section-by-section analysis.
Hazardous Waste/Soil	STATIE-NH Admin. Code Env-Wm 702.08, Environmental Health Requirements	Requires operator of a hazardous waste facility to meet certain standards for surface water, groundwater, and air.	Treatment of groundwater will be conducted to meet these requirements.	Applicable (Site 32 only)
Hazardous Waste/Soil	STATE-NH Admin. Code Env-Wm 702.09, General Design Requirements	All hazardous waste treatment and transfer facilities are to meet specified design requirements.	The groundwater treatment facility will be designed in accordance with these requirements.	Applicable (Site 32 only)

Table 13

ARARs for the Selected Remedy - Source Control - Containment of DNAPL Area, On-Site Treatment of Groundwater, and Excavation and Off-Site Disposal of Site 36 VOC- and Metals-Contaminated Soil
Site 32/36, Pease AFB, NH
(Continued)

Medium	Requirement	Requirement Synopsis	Action To Be Taken To Attain Requirements	Status
Hazardous Waste/Soil	STATE-NH Admin. Code Env-Wm 702.10-702.14, Monitoring of Hazardous Waste Treatment Facilities	Requirements for installation and operation of one or more of the following monitoring systems: • Groundwater monitoring network. • Air emission monitoring network. • Leachate monitoring network.	Environmental monitoring during remedial operations will be developed and conducted in accordance with these regulations.	Applicable
Hazardous Waste/Soil	STATE-NH Admin. Code Env-Wm 707.03, Waste Pile Requirements	Incorporates by reference the requirements of 40 CFR 264, Subpart L, regarding waste piles.	Any excavated soil stockpiled at the site will comply with these regulations and 40 CFR 264, Subpart L.	Applicable (Site 36 only)
Hazardous Waste/Soil	STATE-NH Admin. Code Env-Wm 400-404, Identification and Listing of Hazardous Waste	Requirements for the identification and listing of hazardous wastes.	Excavated soil and treatment residues will be analyzed to determine whether they are hazardous prior to any action that involves treatment or disposal.	Applicable
Hazardous Waste/Soil	STATE-NH Env-Wm 353.09 and 353.10, Siting Requirements for Hazardous Waste Facilities and Variances	Restrictions on siting of hazardous waste facilities.	The groundwater treatment system will comply with these requirements.	Applicable
Hazardous Waste/Soil	STATE-NH Admin. Code Env-Wm 708.02, Operation Requirements	Establishes requirements that must be met when operating hazardous waste facility. Also specifies closure requirements.	The groundwater treatment facility will operate in accordance with theese requirements.	Applicable (Site 32 only)
Hazardous Waste/Soil	STATE, NH Admin. Code Env. Wm 708.03, Technical Standards	These regulations incorporate federal technical standards.	The design and operation of the groundwater treatment facility will comply with these technical standards.	Applicable (Site 32 only)

Table 13

ARARs for the Selected Remedy - Source Control - Containment of DNAPL Area, On-Site Treatment of Groundwater, and Excavation and Off-Site Disposal of Site 36 VOC- and Metals-Contaminated Soil
Site 32/36, Pease AFB, NH
(Continued)

Medium	Requirement	Requirement Synopsis	Action To Be Taken To Attain Requirements	Status
Hazardous Waste/Soil	STATE-NH Admin. Code Env-Wm 708.03, Additional Technical Standards -- Treatment Standards	General requirements for selection of treatment methods. The treatment method must accomplish one or more of the following objectives: • Render the waste nonhazardous. • Render the waste safe for handling and transport. • Render the waste amenable to recovery or reuse. • Render the waste more amenable to long-term storage. • Reduce the volume off the hazardous waste.	The design and operation of the groundwater treatment plant will be conducted so as to achieve one or more or these objectives.	Application (Site 32 only)
Groundwater	FEDERAL-EPA OSWER Directive 9234.2-25, Guidance for Evaluating the Technical Impracticability of Groundwater Restoration	Provides guidance on how EPA will determine whether groundwater restoration is technically impracticable and what alternative measures or actions must be undertaken.	A TI Zone will be established to encompass the area of known DNAPL contamination where groundwater standards cannot be met. A TI ARAR waiver will be invoked within this zone, however, and the remedial alternative will comply with ARARs outside this zone.	TBC (Site 32 only)
Groundwater	FEDERAL-SDWA, Underground Injection Control Program, 40 CFR 144 and 146	This regulation was established to protect underground sources of drinking water from endangerment by injection of fluids through wells.	As treated groundwater is proposed to be recharged to the subsurface at Pease AFB, these requirements will be followed.	Relevant and Appropriate
Groundwater	FEDERAL -- Methods for Monitoring Pump-and-Treat Performance (EPA/600/R.94/123)	Provides guidance for monitoring the effectiveness and efficiency of pump-and-treat systems.	A pump-and-treat monitoring plan will be developed that describes monitoring objectives, types of measurements to be made, measurement locations, methods, equipment, procedures, schedules, and reporting requirements.	TBC

Table 13

ARARs for the Selected Remedy - Source Control - Containment of DNAPL Area, On-Site Treatment of Groundwater, and Excavation and Off-Site Disposal of Site 36 VOC- and Metals-Contaminated Soil Site 32/36, Pease AFB, NH (Continued)

Medium	Requirement	Requirement Synopsis	Action To Be Taken To Attain Requirements	Status
Groundwater	STATE-NH Admin. Code Env-Ws 410.07 and 410.10(c), Prohibited Discharges	Section 410.07 prohibits discharge of wastewater exceeding the 410.05 standards to groundwater, or any discharge to the ground or groundwater that would result in a violation of surface water quality in adjacent surface waters. Section 410.10(c) requires that such discharges be treated by best available technology.	Treated groundwater discharged on-site will comply with these requirements. Groundwater treatment via oxidation, air stripping, and carbon adsorption will prevent discharge of contaminants to surface water above state standards. Treatment goals are presented in Table 12.	Applicable
Groundwater	STATE-NH Admin. Code-Ws 410.26, Groundwater Management Zone	These regulations require establishment of a GMZ at sites with contaminated groundwater which exceeds Groundwater Quality Criteria.	A GMZ will be established, deed restrictions controlling use of groundwater will be imposed, and monitoring will be conducted within the GMZ.	Applicable
Groundwater	STATE-NH Admin. Code Env-Ws 410.30 and 410.31	These provisions establish the methods for sampling and monitoring groundwater.	Groundwater will be sampled and monitored in accordance with these requirements to ensure that groundwater quality outside the GMZ is not degraded.	Applicable
Groundwater	STATE-NH Admin. Code Env-Ws Parts 430-437, Surface Water Classification RSA 485-A:12	Prohibits the disposal of wastes in any manner that would lower the quality of surface water below the minimum requirements of its surface water classifications.	Treated groundwater discharged on-site will comply with these requirements.	Applicable
Groundwater	STATE-NH Admin. Code Env-We 604, Abandonment of Wells	Imposes requirements for closure of walls.	If groundwater wells are no longer needed, the closure requirements will be met.	Applicable

Table 13

ARARs for the Selected Remedy - Source Control - Containment of DNAPL Area, On-Site Treatment of Groundwater, and Excavation and Off-Site Disposal of Site 36 VOC- and Metals-Contaminated Soil
Site 32/36, Pease AFB, NH
(Continued)

Medium	Requirement	Requirement Synopsis	Action To Be Taken To Attain Requirements	Status
Air	FEDERAL-RCRA 40 CFR 264, Subpart AA	Contains air pollution emission standards for process vents associated with distillation, fractionation, thin film evaporation, and solvent extraction of air or steam stripping operations. Applicable to operations that manage hazardous wastes with organics concentrations of at least 10 parts per million by weight (ppmw).	Equipment used in air stripping activities will meet these requirements and be monitored for compliance.	Applicable (Site 32 only)
Air	FEDERAL-RCRA 40 CFR 264, Subpart BB	Contains air pollutant emission standards for equipment leaks at hazardous waste treatment, storage, and disposal facilities (TSDFs). Contains design specifications and requirements for monitoring for leak detection. It is applicable to equipment that contains or contacts hazardous wastes with organic concentrations of at least 10% by weight.	Equipment used in groundwater treatment and soil and groundwater storage operations will meet the design specifications, and will be monitored for leaks.	Relevant and Appropriate
Air	FEDERAL-RCRA 40 CFR 264, Subpart CC (proposed)	Contains proposed air pollutant emission standards for owners and operators of TSDFs using tanks, surface impoundments, and containers to manage hazardous wastes. Specific organic emissions controls would have to be installed if VOC concentrations equal or are greater than 500 ppmw.	Required emissions controls will be installed.	TBC
Air	FEDERAL-CAA 40 CFR 61, National Emission Standards for Hazardous Air Pollutants (NESHAPs)	Set maximum emission standards for 189 hazardous air pollutants (HAPs).	Several HAPs have been detected at the site. Releases of contaminants to the air during soil excavation and groundwater treatment will not exceed these levels.	Applicable

Table 13

ARARs for the Selected Remedy - Source Control - Containment of DNAPL Area, On-Site Treatment of Groundwater, and Excavation and Off-Site Disposal of Site 36 VOC- and Metals-Contaminated Soil Site 32/36, Pease AFB, NH (Continued)

Medium	Requirement	Requirement Synopsis	Action To Be Taken To Attain Requirements	Status
Air	FEDERAL-EPA OSWER Directive 9M55.0-28, Policy on Control of Air Emissions from Superfund Air Strippers at Superfund Groundwater Sites	Provides guidance on the control of air emissions from air strippers used at Superfund sites for groundwater treatment and distinguishes between requirements for attainment and nonattainment areas for ozone.	Emissions from air strippers will be monitored and controlled, as necessary.	TBC
Air	STATE-RSA Ch. 125C, Air Pollution Control, NH Admin. Rules Env-A 100-1300, as specified below	Air pollution controls as specified below.	See discussion below.	See below
Air	STATB-NH Admin. Code Env-A 800, Testing and Monitoring Procedures	Identifies procedures that must be followed for the testing of air emissions from stationary sources.	During the source containment groundwater treatment operations, air emissions will be monitored and tested to ensure that these sources do not exceed applicable standards.	Applicable (Site 32 only)
Air	STATE-NH Admin. Code Env-A 1002, Fugitive Dust Control	Requires precautions to prevent, abate, and control fugitive dust during specified activities, including excavation, construction, and bulk hauling.	Precautions to control fugitive dust emissions will be required during remedial activities. Monitoring will be conducted to ensure compliance.	Applicable
Air	STATE-NH Admin. Code Env-A 1204, Control of VOC Emissions	Specifies VOC emission control methods and establishes limits on VOC emissions for various process categories.	Precautions will be taken during remedial actions to minimize VOC emissions.	Relevant and Appropriate

Table 13

ARARs for the Selected Remedy - Source Control - Containment of DNAPL Area, On-Site Treatment of Groundwater, and Excavation and Off-Site Disposal of Site 36 VOC- and Metals-Contaminated Soil
Site 32/36, Pease AFB, NH
(Continued)

Medium	Requirement	Requirement Synopsis	Action To Be Taken To Attain Requirements	Status
Air	STATE-NH Admin. Code Env-A 1300, Toxic Air Pollutants	Establishes Ambient Air Limits (AALs) to protect the public from concentrations of pollutants in ambient air that may cause adverse health effects.	Release of contaminants in the air from any on-site remedial activities will not result in exeedance of the respective AAL, if one exists. Emissions from the GWTP are not expected to result in exceedance of these standards. Proposed air emissions will be coordinated with the Air Resources Division of NHDES.	Applicable
Air	STATE-NH Env-A 505.02(a), Emergency Procedures	Imposes obligations on sources of air pollution in case of emergency.	Comply with directions off state in case of "warning" status.	Applicable
Air	FEDERAL-EPA Region I memorandum, 12 July 1969 from Louis Gitto to Merril S. Hohman	States that Superfund air strippers in ozone nonattainment areas generally merit controls on all VOC emissions.	Remedial actions, including air strippers, will include controls to reduce VOC emissions.	TBC (Site 32 only)

APPENDIX B

DECLARATION OF CONCURRENCE

State of New Hampshire
DEPARTMENT OF ENVIRONMENTAL SERVICES
6 Hazen Drive, P.O. Box 95, Concord, NH 03302-0095
603-271-3503 Fax 603-271-2867
TDD Access: Relay NH 1-800-735-2964

September 18, 1995

Mr. Alan K. Olsen
Director, Air Force Base Conversion Agency
1700 North Moore Street, Suite 2300
Arlington, VA 22209-2802

Re: Record of Decision for Site 32/36 Declaration of Concurrence
Pease Air Force Base Superfund Site

Dear Mr. Olsen:

The New Hampshire Department of Environmental Services has reviewed and concurs with the "Record of Decision, Site 32/36" (Site 32/36 ROD) for the Pease Air Force Base Superfund Site, located in Newington and Portsmouth, New Hampshire. The Site 32/36 ROD was drafted by the Air Force in accordance with the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act of 1986 (CERCLA) to document the Site 32/36 remedy selection and all facts, analysis and site specific policy determinations related to the selection of the remedy. The preferred remedy for Site 32/36 has the following components:

- Isolation of the overburden source area or DNAPL Zone at Site 32 using a vertical barrier.
- Extraction of groundwater from within and below the vertical barrier and on-site treatment of contaminated groundwater. Discharge of the treated groundwater by off-site (on-base) subsurface reinjection trenches or land application.
- Long-term groundwater and treatment system monitoring.
- Excavation and off-site disposal of Site 36 VOC and metals contaminated soil.
- Establishment of a TI Zone within which cleanup to ARARs is not considered technically feasible based on a TI determination.
- Placement of restrictions on use of groundwater and regulation of excavation activities within the Site 32 TI Zone.

CONSISTENCY WITH STATE REMEDIATION POLICY

Prior to Pease Air Force Base (PAFB) becoming a Superfund site, and as a party to the "Pease Federal Facility Agreement Under CERCLA Section 120" (Pease FFA), the Department has been actively involved in the oversight of the Air Force's environmental response activities at Site 32/36 and has worked with the Air Force to ensure consistency with State regulations and policies. When the Department reviews RODs it verifies that the RODs are generally consistent with the approach the Department would require for similar sites in the State of New Hampshire, regardless of their Superfund status. The following discussion examines in detail the equivalency of the Site 32/36 remedy with our approach under Env-Ws 410 to groundwater remediation at similar sites.

Site 32/36 ARARs DETERMINATION AND ENV-WS 410 BACKGROUND

As discussed in the Zone 2 ROD Declaration of Concurrence letter, the Department and EPA-New England reached a productive compromise for the implementation of Env-Ws 410 as an ARAR at PAFB. The Department accepted EPA's Env-Ws 410 ARARs determinations for PAFB RODs and EPA-New England agreed that the PAFB RODs would include language that addresses the portions of Env-Ws 410 not designated as ARARs. In particular, criteria to determine the effectiveness of the remedy were to be addressed in the body of the RODs to ensure long-term protection of the groundwater.

The following text discusses the substantive requirements of Env-Ws 410 and then explains the approach utilized in the ROD to implement these requirements. Evaluation of the ROD's implementation of the substantive requirements of Env-Ws 410 is a crucial element of the Department's concurrence analysis because consistency with Env-Ws 410's approach ensures: 1) consistency with the State Remediation Policy and 2) successful implementation of the Env-Ws 410 ARAR compromise.

Env-Ws 410 APPROACH AND THE SITE 32/36 ROD

Env-Ws 410 contains rules that establish statewide groundwater quality standards and provides an exemption from these standards under certain conditions. Env-Ws 410 allows the scope and aggressiveness of remedial actions to be selected based on the resource value and use of the groundwater. Under Env-Ws 410, a GMZ is established to manage the use of contaminated groundwater until ambient groundwater quality standards are met. The relevant requirements of Env-Ws 410 applicable to the Site 32/36 remedy are as follows:

- GMZ Establishment: Env-Ws 410.26 requires the establishment and containment of contaminated groundwater within a Groundwater Management Zone (GMZ) when violations of Groundwater Quality Standards are present.

- Source Area Treatment, Removal or Containment: Env-Ws 410 requires that sources of continuing groundwater contamination must be either treated or removed and, if treatment or removal are not feasible, the source must be contained.

- Groundwater Restoration: The remedial action must restore groundwater quality to meet the groundwater quality criteria contained in Env-Ws 410.03. A high priority is given to source control, high value groundwaters or groundwater that will or is being used as a water supply.

- Establishment of Performance Standards: Final and interim objectives and criteria, including specific performance standards are established for the remedial actions. If the remedial actions do not meet the performance standards, additional action may be required.

- Lone Term Monitoring of the GMZ and Remedy Performance: Env-Ws 410 requires monitoring of the performance of remedial systems and GMZ boundary compliance.

- Groundwater Management Permit: A groundwater management permit is required to establish a GMZ. The Groundwater Permit delineates the GMZ and defines the steps that must be taken to implement source area remedial actions and specifies performance standards for the remedial system, etc.

- Institutional Controls: Env-Ws 410.20 requires notification to all landowners within the Groundwater Management Zone within 30 days of Groundwater Permit approval. Env-Ws 410.21 requires that the permit holder record notice of the permit in the registry of deeds for each lot within the groundwater management zone. Env-Ws 410.26(e) requires that use of groundwater be controlled by either ownership of the overlying land or deeded use to the exclusive right to use the groundwater within the GMZ unless an alternate water supply is available.

The Site 32/36 ROD implements these requirements in the following fashion:

- GMZ Establishment: The Site 32/36 source area is located entirely within Zone 3. The Zone 3 ROD includes Env-Ws 410.26 as an ARAR; this provides for the establishment of a GMZ and containment of groundwater contamination within the GMZ.

- Source Area Treatment, Removal or Containment: The selected remedy will either excavate or physically/hydraulically contain Site 32/36 source areas.

- Remedial Action Plan: The FS/ROD steps of the CERCLA process and the environmental monitoring plan provisions are functionally equivalent to Env-Ws 410's requirements for a Remedial Action Plan.

- Establishment of Remedy Performance Standards: The ROD requires development of performance standards for the remedial actions within the Environmental Monitoring Plan.

- Long Term Monitoring of the GMZ and Remedy Performance: The description of the Environmental Monitoring Plan in the ROD provides for monitoring of the performance and effectiveness of the remedial actions. The Zone 3 ROD requires monitoring of the groundwater quality at the GMZ boundary.

- Eventual Achievement of Groundwater Quality Standards: The ROD waives the requirement to achieve chemical specific standards within a reasonable time frame. The Department has adopted a similar approach (i.e., long term hydraulic containment of the DNAPL source) for complex, highly contaminated non-CERCLA DNAPL sites.

- Groundwater Permit: The Air Force has voluntarily agreed to supply the information necessary to obtain permits to ensure that the substantive requirements of regulations are met. This ensures that substantive portions of Env-Ws 410 permit protocols are met.

- Institutional Controls: The Statutory Determination section of the ROD requires the "Placement of restrictions on use of groundwater."

Based on the successful implementation of the Env-Ws 410 ARAR compromise, the Site 32/36 ROD is consistent with the approach that would be required to meet our groundwater remediation approach at similar sites within the State.

After the remedy is implemented, the long term monitoring plan will ensure future consistency with Env-Ws 410's substantive requirements and other key ARARs. A comprehensive, detailed review of all environmental monitoring data will be conducted on a periodic basis by the Air Force, EPA-New England and the Department in order to ensure that the remedial action provides adequate protection of human health and the environment and complies with applicable regulations.

STATE CONCURRENCE

The Department acting on behalf of the State of New Hampshire, concurs that the selected remedy, described in the ROD, satisfies the requirements of CERCLA.

Very truly yours,

[Signed]
Robert W. Varney
Commissioner

cc: Carl W. Baxter, P.E., DES-WMEB
Gary S. Lynn, P.E., DES-WMEB
Anne Renner, Esq., NHDOJ-AGO
Michael J. Daly, EPA
Arthur L. Ditto, P.E., AFBCA
James Snyder, AFCEE

APPENDIX C

RESPONSIVENESS SUMMARY

OVERVIEW

The Air Force issued the Site 32/36 Proposed Plan to the public in June 1995. In the Site 32/36 Proposed Plan, the Air Force identified its preferred alternative for Site 32/36. The selection of this preferred alternative by the Air Force was coordinated with U.S. Environmental Protection Agency (EPA), New England Region, and the New Hampshire Department of Environmental Services (NHDES).

The following subsections describe the background on community involvement with Site 32/36 activities, and the Air Force's response to comments received during the Site 32/36 Proposed Plan public comment period of 12 July to 11 August 1995.

BACKGROUND ON COMMUNITY INVOLVEMENT

Prior to the start of the public comment period for the site 32/36 Proposed Plan, the Force issued a fact sheet that summarized the content of the Site 32/36 Proposed Plan. Presentations on the status of work being conducted and results of the work at Site 32/36 were made to the Pease Air Force Base Restoration Advisory Board/Technical Review Committee (RAB/TRC). Additionally, the content of the Site 32/36 Proposed Plan was presented to and discussed with the members of the RAB/TRC. Notifications announcing the beginning of the Site 32/36 Proposed Plan comment period were mailed to all individuals on the Pease AFB mailing list in June 1995. A news release was also issued to the media announcing the beginning of the Site 32/36 Proposed Plan comment period. Newspaper announcements (advertisements) were published in two local newspapers the weekend prior to the public hearing date of 3 August 1995. It is noted that the public comment period and public hearing for Site 32/36 ran concurrently with that of Zone 3.

Proposed remedial actions for Site 32/36 and Zone 3 were presented simultaneously to the public.

SUMMARY OF COMMENTS RECEIVED DURING COMMENT PERIOD AND THE AIR FORCE RESPONSES

No written comments were received during the public comment period. Verbal comments were provided by three individuals at the public hearing on 3 August 1995I as follows:

SITE 32/36 COMMENTS/RESPONSES

1. Comment: I'm with EOS Research, Ltd. We are the technical advisor to the SCOPE group. I just want to mention that we (SCOPE) generally concur with the conceptual approach that has been presented by the Air Force for both Zone 3 and Site 32/36. We do feel, however, that probably the most difficult part is yet to come. And that is ensuring that the actual implementation of these new conceptual plans is brought forward in a technically appropriate manner. With that in mind, we would like to continue our involvement on a technical basis with the Air Force, the EPA and the NHDES in working out the details, particularly in regard to Site 32/36, where we are dealing with extraordinarily complex technical issues that cannot really have the questions answered in a forum like this.

We feel that one of the approaches that should be followed during design and monitoring phase is sort of a learn-as-you-go approach. And we feel that by implementing the conceptual actions that are being proposed, you can learn a lot in the process. And you should not have any expectations that all your questions will be answered prior to the actual implementation. So we encourage the Air Force to maintain a certain amount of flexibility in going into this implementation phase. And we also encourage the regulatory agencies involved to keep that in mind, that you may not have all the questions answered before hand.

Response: The Air Force acknowledges SCOPE's concurrence with the conceptual approach for remedial actions at Zone 3 and Site 32/36 presented by the Air Force. The Air Force welcomes SCOPE's continued involvement with the Pease environmental program and believes that SCOPE's input to the Site 32/36 remedial action design development can be very constructive. The Air Force concurs with SCOPE's learn-as-you-go approach for remedial action implementation and will work with EPA and NHDES to use that approach for Zone 3 and Site 32/36.

2. Comment: SCOPE is-again, we concur with the overall proposal in both Zone 3 and Site 32/36.

Response: Concurrence acknowledged.

3. Comment: While I'm on Zone 3, you've got construction of recharge trenches southwest of the runway for discharge of treated groundwater. Could you expand on that, just where are they going to be. Where would the water eventually end up once the contaminated water that has been cleaned to drinking water standards is put back into the earth, in those recharge trenches. (Air Force Note: Site 32/36 treated water will also go to these recharge trenches.)

Response: The recharge trench will be located approximately 2,200 feet north of the south end of the runway and 500 feet west of the centerline of the runway. The treated water that is recharged to these trenches will be absorbed back into the existing water table in the general area of the trenches. Groundwater flow in this area is in a westerly direction.

4. Comment: And a couple of things on Site 32/36. We're in agreement that the vertical barriers are one option that might be undertaken to contain the source contaminants. But we want to make it clear that monitoring of that area within the TI Zone-monitoring is probably going to be really, really crucial.

If the contaminants are not contained in that vertical barrier, within that vertical barrier, it's going to have to be - - they are going to have to be detected as soon as you see that there is no containment within the TI Zone or no decrease in the contaminant levels within the FI Zone. And if that happens, I think we need to go to some type of a more aggressive clean up effort. It may be that the vertical barriers are going to contain the source. For how long? That remains to be seen.

Response: The Air Force agrees that monitoring of the TI Zone is a critical part of the Site 32/36 remedial action. The long-term monitoring plan will be designed to ensure that appropriate data is gathered so that evaluations can be made to determine whether or not the containment system is functioning correctly. If it is found that the containment system is not functioning correctly, the Air Force is obligated to make the necessary adjustments to correct the situation.

5. Comment: On that issue (Long Term Monitoring), I think it's important to those in Washington that pay the bills that an Air Force presence needs to be present here at Pease for a liaison between the City of Portsmouth, the Town of Newington, organizations such as SCOPE, so that the community does not have to go to Washington to say, hey, things aren't going right up at Pease.

It's like when you want money to stay local. I like to spend my money locally because the money stays locally. The same with the Air Force. If you stay here, there is a presence here. We can come to you and say hey, this is not working. You're going to have to use some more aggressive remedial actions in order to clean this thing up. Or, get with your people down there. You're not spending enough money. You're not taking care of the problem.

If there is an Air Force presence here, we can go right to you. We don't have to go to Washington. So that, I think, is as important as monitoring these sites to make sure that the contaminants are not migrating further out than what we already have them contained in.

Response: The Air Force agrees the long-term monitoring and the associate interfacing with the public will be and is a very important part of the remediation process. The current plans are for the Air Force to maintain a physical presence at Pease Air Force Base during the long-term monitoring process.