Record of Decision Amendment for the Technical Support Facility Injection Well (TSF-05) and Surrounding Groundwater Contamination (TSF-23) and Miscellaneous No Action Sites, Final Remedial Action

Part II – Decision Summary

1. INTRODUCTION AND STATEMENT OF PURPOSE

This Record of Decision (ROD) Amendment modifies the original remedy for Operable Unit (OU) 1-07B, at the Idaho National Engineering and Environmental Laboratory (INEEL). The original remedy was documented in the *Record of Decision for the Technical Support Facility (TSF) Injection Well (TSF-05) and Surrounding Groundwater Contamination (TSF-23) and Miscellaneous No Action Sites Final Remedial Action* (DOE-ID 1995 [DOE/ID-10139]) (the 1995 ROD).

- **Site Name and Location:**

  Technical Support Facility Injection Well (TSF-05) and
  Surrounding Groundwater Contamination (TSF-23),
  Operable Unit 1-07B,
  Idaho National Engineering and Environmental
  Laboratory (CERCLIS ID 4890008952),
  Idaho Falls, Idaho.

- **Identification of Lead and Support Agencies:** The U.S. Department of Energy (DOE), Idaho Operations Office (DOE-ID) is the lead agency for the remedy decisions under Executive Order 12580. The U.S. Environmental Protection Agency (EPA) approves the decisions and, along with the Idaho Department of Environmental Quality (IDEQ), has participated in the selection of the remedy. The IDEQ concurs with the amended remedy for the OU 1-07B groundwater cleanup. The DOE, EPA, and IDEQ are collectively referred to as the Agencies in this document.

- **Statutory Requirements Met:** In accordance with Section 117(c) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Section 300.435(c)(2)(ii) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), and pursuant to the 1995 ROD, this ROD Amendment has been prepared to document changes to the 1995 ROD. All public participation and documentation procedures specified in NCP Sections 300.435(c)(2)(ii) and 300.825(a)(2), including issuing a revised proposed plan (the *Proposed Plan for Operable Unit 1-07B, Final Remedial Action at the TSF Injection Well (TSF-05) and Surrounding Groundwater Contamination (TSF-23)* [DOE-ID, EPA, and IDEQ 2000 {DOE/ID-21251}]) that highlighted the proposed changes, were conducted as required.

- **Date of Original ROD Signature:** August 4, 1995.

- **Need for ROD Amendment:** This ROD Amendment documents fundamental changes to certain features of the original remedy selected in the 1995 ROD. The Agencies evaluated several alternative technologies to determine if any might be more cost-effective than the remedy selected in the 1995 ROD. The Agencies determined that two technologies – in situ bioremediation (ISB) and monitored natural attenuation (MNA) – in combination with the pump-and-treat technology originally selected in the 1995 ROD reduce the overall remedial timeframe and significantly reduce the overall cost of remediation as compared to the original remedy of pump-and-treat alone.

Location of Administrative Record and Hours of Availability: The documents that form the basis for the decisions made in this ROD Amendment are contained in the Administrative Record for OU 1-07B. This ROD Amendment will become part of the Administrative Record pursuant to Section 300.825(a)(2) of the NCP. The Administrative Record is available to the public at the following locations:

INEEL Technical Library
DOE Public Reading Room
1776 Science Center Drive
Idaho Falls, ID 83415
(208) 526-1185
Hours: 8 a.m. to 5 p.m. Monday through Friday, except as posted

Albertsons Library
Boise State University
1910 University Drive
Boise, ID 83725
(208) 385-1621
Hours: 7:30 a.m. to 12 midnight Monday through Thursday; 7:30 a.m. to 8 p.m. Friday; 10 a.m. to 8 p.m. Saturday; 10 a.m. to midnight Sunday, except as posted

University of Idaho Library
University of Idaho Campus
434 2nd Street
Moscow, ID 83843
(208) 885-6344
Hours: 8 a.m. to midnight, except as posted

and on the Internet (at http://ar.inel.gov).

2. OU 1-07B HISTORY AND ORIGINAL REMEDY

2.1 History

OU 1-07B is the final remedial action for the TSF-05 Injection Well and the Surrounding Groundwater Contamination (TSF-23) located at the Technical Support Facility (TSF) within Test Area North (TAN), one of nine major facilities at the INEEL (Figures 2-1 and 2-2). Table 2-1 lists the contaminants of concern (COCs) that will be remediated in this action.

TAN consists of several experimental and support facilities used for research and development on reactor performance and nuclear safety. From about 1953 to 1972, liquid wastes generated at TAN were disposed of by pumping them down the TSF-05 Injection Well in the southwest corner of the TSF. This well dispersed the wastes into the Snake River Plain Aquifer, which underlies the INEEL. The wastes consisted mainly of industrial and sanitary wastewater, but also included organic, inorganic, and low-level radioactive wastewaters. Activities generating these wastes included efforts to develop a nuclear-powered aircraft and tests simulating accidental loss of coolant from nuclear reactors.

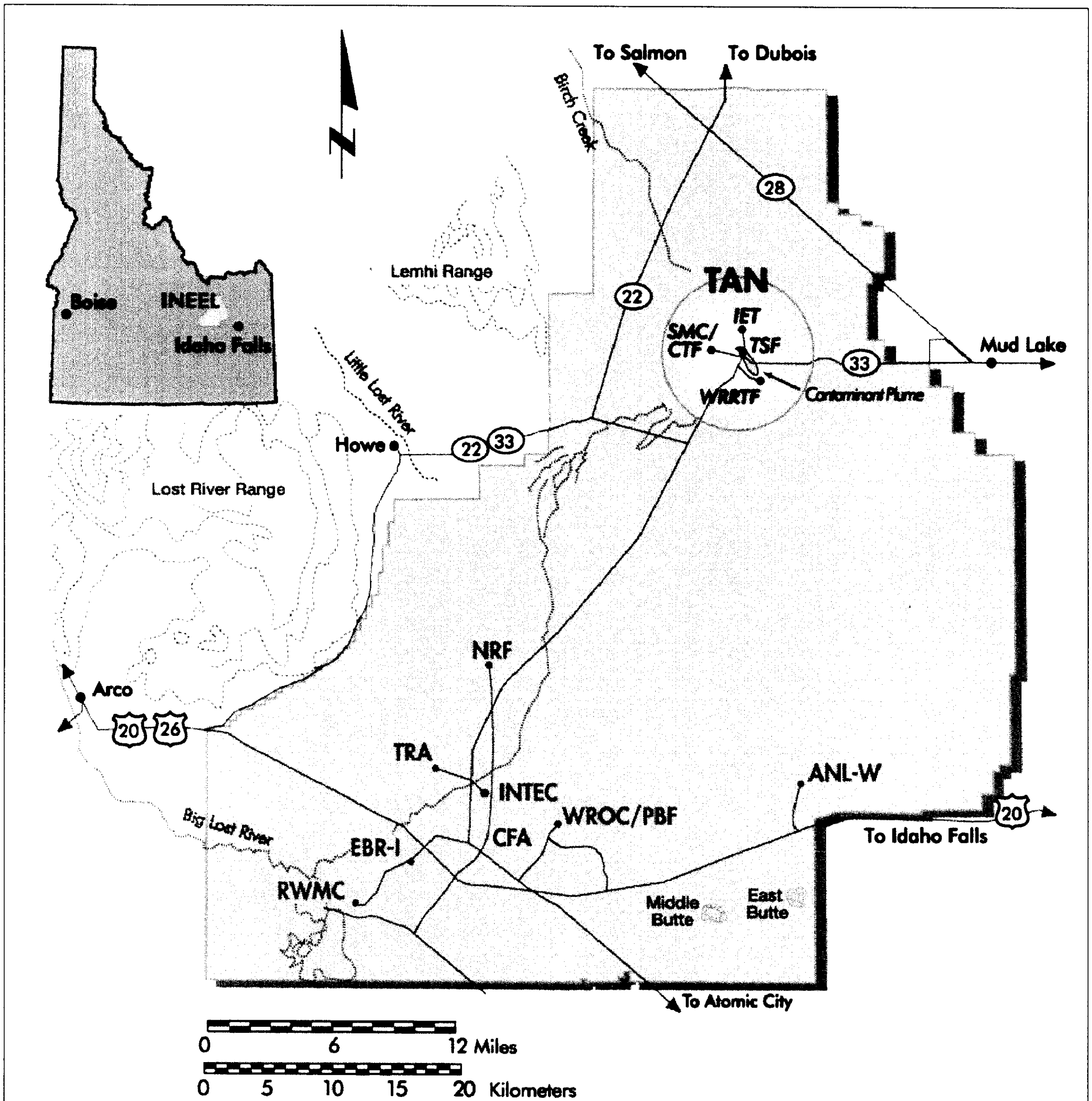
In 1987, low levels of trichloroethene (TCE) and tetrachloroethene (PCE) – two volatile organic compounds (VOCs) that can be harmful to humans – were detected in the wells used to supply drinking water to workers at TAN (Wells TAN-1 and TAN-2). The TSF-05 Injection Well was identified as the source of the groundwater contamination. An air sparging system was installed to treat the drinking water supply at TAN to comply with safe drinking water requirements. Untreated contaminated water is not available to workers at TAN or to the public.

In September 1992, the Agencies began an interim action for OU 1-07A, as documented in the *Record of Decision (ROD) for Technical Support Facility (TSF) Injection Well and Surrounding Groundwater Contamination* (INEL 1992 [INEL-5202]). Activities included constructing and operating the Groundwater Treatment Facility (GWTF) to extract and treat contaminated groundwater in the vicinity of the TSF-05 Injection Well.[1] The Interim Action also initiated measurement of aquifer parameters based on data from groundwater extraction and new monitoring wells.

Sampling from the TSF-05 area confirmed that 1,2-dichloroethene (DCE), tritium, Sr-90, and Cs-137 were also present above acceptable risk-based concentrations. These other COCs are in the groundwater near the injection well but are not found in the drinking water from the production wells. Uranium-234, which is also a COC, and tritium do not exceed maximum contaminant levels (MCLs), but are included as COCs because they exceed the 1×10^{-6} risk-based concentration for groundwater ingestion, as described in the 1995 ROD. The only contaminants consistently detected in the production wells at levels exceeding federal drinking water standards (i.e., MCLs) are TCE and PCE, which are removed by the air sparging system.

The TSF-05 Injection Well is 93 m (310 ft) deep and is perforated from 55 to 74 m (180 to 244 ft) and 82 to 93 m (269 to 305 ft) below ground surface. The depth to groundwater is about 63 m (206 ft). Historical records provide little definitive information on the types and volumes of organic wastes disposed of into the groundwater via the injection well. It is estimated that as little as 1,325 L (350 gal) or as much as 132,489 L (35,000 gal) of TCE may have been disposed of in the well during its period of operation, 1953 to 1972.

[1] GWTF operations will end when the amended remedy is implemented.



ANL-W	Argonne National Laboratory—West	CFA	Central Facilities Area
EBR-I	Experimental Breeder Reactor-I	IET	Initial Engine Test (Facility)
INTEC	Idaho Nuclear Technology and Engineering Center	NRF	Naval Reactors Facility
PBF	Power Burst Facility	RWMC	Radioactive Waste Management Complex
SMC/CTF	Specific Manufacturing Capability/Contained Test Facility	TAN	Test Area North
TRA	Test Reactor Area	TSF	Technical Support Facility
WROC	Waste Reduction Operations Complex	WRRTF	Water Reactor Research Test Facility

Figure 2-1. Location of Test Area North at the Idaho National Environmental and Engineering Laboratory.

Table 2-1. Contaminants of concern in the vicinity of the TSF-05 Injection Well.

Contaminant	Maximum Concentrations[a]	Federal Drinking Water Standard
VOLATILE ORGANIC COMPOUNDS (VOCs)		
Trichloroethene (TCE)	12,000 – 32,000 ppb	5 ppb [b]
Tetrachloroethene (PCE)	110 ppb	5 ppb [b]
cis-1,2-Dichloroethene (DCE)	3,200 – 7,500 ppb	70 ppb [b]
trans-1,2-Dichloroethene (DCE)	1,300 – 3,900 ppb	100 ppb [b]
RADIONUCLIDES		
Tritium	14,900 – 15,300 pCi/L [c]	20,000 pCi/L
Strontium-90	530 – 1,880 pCi/L	8 pCi/L
Cesium-137	1,600 – 2,150 pCi/L	119 pCi/L [d]
Uranium-234	5.2 – 7.7 pCi/L [c]	27 pCi/L [e]

Key: ppb = parts per billion; pCi/L = picocuries per liter.

a. The concentration range is taken from measured concentrations at the TSF-05 Injection Well. Source: *Fiscal Year 1999 Groundwater Monitoring Report, Test Area North, Operable Unit 1-07B (INEEL 2000a [INEEL/EXT-99-01255])*.

b. Parts per billion (ppb) is a weight-to-weight ratio that is equivalent to micrograms per liter (µg/L) in water.

c. Maximum concentrations of tritium and U-234 are below federal drinking water standards and baseline risk calculations indicate cancer risk of 3×10^{-6}. While this risk is smaller than 1×10^{-4}, both tritium and U-234 are included as COCs as a comprehensive plume management strategy.

d. The maximum contaminant level (MCL) for Cs-137 is derived from a limit of 4 millirem per year (mrem/yr) cumulative dose-equivalent to the public, assuming a lifetime intake of 2 liters per day (L/day) of water.

e. The federal drinking water standard for U-234 is for the U-234, -235, and -238 series.

In 1994, a remedial investigation and feasibility study (RI/FS) for OU 1-07B was completed to characterize the extent and nature of the contamination and determine what cleanup was required (EG&G 1994 [EGG-ER-10643]). The primary risk driver was determined to be the ingestion of groundwater contaminated with TCE. However, TCE also can be harmful to human health through dermal contact, inhalation of vapors, or ingestion of crops irrigated with TCE-contaminated water. A proposed plan (the *Proposed Plan for Operable Unit 1-07B, Final Remedial Action at the TSF Injection Well (TSF-05) and Surrounding Groundwater Contamination (TSF-23)* [DOE, EPA, and IDEQ 2000]) based on the RI/FS was published in May 1994 presenting the Agencies' recommendations for cleanup of the groundwater contamination. The Agencies' agreement to clean up the site was documented in a ROD signed in August 1995 (the 1995 ROD) (DOE-ID 1995 [DOE/ID-10139]). The 1995 ROD directed that pump-and-treat technology be used to restore the hot spot and that treatability studies be conducted concurrently to evaluate alternative technologies to clean up this portion of the contaminant plume.

One of the treatability studies conducted was on ISB. The Agencies recognize that during ISB at the hot spot, VOC daughter products (such as vinyl chloride) may be produced as interim, ephemeral breakdown products; however, bioremediation will result in complete dechlorination of VOCs by 2095. The baseline risk assessment leading to the 1995 ROD will not be revised to include daughter products because no new COCs have been identified. Temporary daughter products produced during remediation

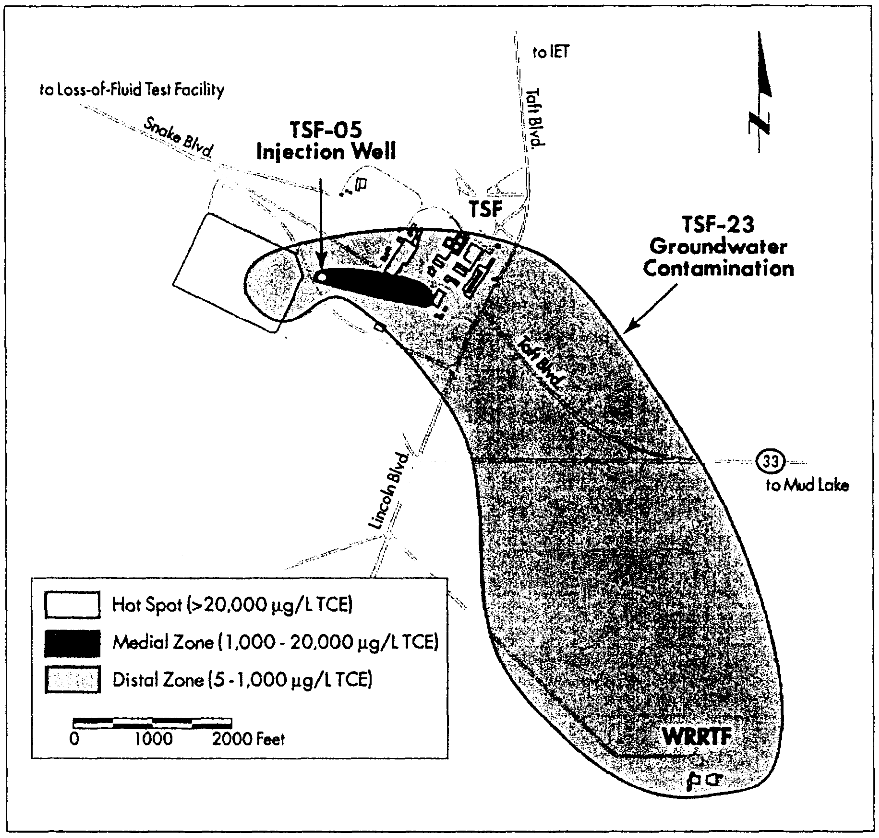


Figure 2-2. Facilities at Test Area North. Operable Unit 1-07B is the TSF-05 Injection Well and the TSF-23 Contaminant Plume underlying TAN.

activities will be short-lived and will not exist at the end of remediation activities. The action taken under this ROD Amendment will meet remedial action objectives (RAOs) and ensure that drinking water standards will be met throughout the contaminant plume by or before 2095.

Because the TCE has migrated more widely from the injection well than the other COCs, the boundaries of the contaminant plume have been defined by the TCE concentrations. Remedial actions that reduce TCE will act to reduce the other VOC COCs as well. Additional information concerning geology, hydrology, and the nature and extent of contamination was provided in the 1995 ROD and can be found in the Administrative Record for OU 1-07B (as described in Section 1).

2.2 Original Remedy

In 1995, the OU 1-07B ROD selected the remedial action (the "original remedy") — "Alternative 4: 25 Micrograms per Liter Trichloroethene Groundwater Contamination Plume Extraction; Hot Spot Containment and/or Removal with Aboveground Treatment." RAOs were developed as part of the 1995 ROD. The purpose of the RAOs was to "reduce the contamination in the groundwater at TAN to ensure that offsite populations are not at risk in the future, and that the future residents would not be at risk from use of TAN groundwater if the TAN area were converted to the public domain at any time in the future."

The 1995 ROD specified that the original remedy would be conducted in three phases, with institutional controls, as described below:

- **Phase A – Transition of OU 1-07A Interim Action to OU 1-07B Final Remedial Action.** Phase A provided for the transition into OU 1-07B activities through the continuation of OU 1-07A surge-and-stress pumping of the TSF-05 Injection Well and operation of the interim action Groundwater Treatment Facility (GWTF) to remove the secondary source, pump and treat contaminated groundwater, and collect data on aquifer parameters. Phase A also tested radionuclide removal technologies.

- **Phase B – Hot Spot Containment and/or Removal with Treatability Studies.** Phase B added implementation of hot spot containment, defined as groundwater extraction at a rate sufficient to create hydraulic containment of TCE and other contaminants within the hot spot. Phase B also included evaluation and testing of five innovative technologies. The 1995 ROD specified that a treatability study report would document the results and assess whether any of the technologies tested could be more effective than the [original] selected pump-and-treat remedy. Finally, Phase B also included groundwater monitoring to track the extent of the contaminant plume, document fluctuations in TCE concentrations, and measure the attenuation rate of the plume.

- **Phase C – Dissolved Phase Groundwater Treatment with Continuation of Hot Spot Containment and/or Removal.** Phase C was defined as (a) the treatment of the 25 to 5,000 μg/L TCE portion of the plume to enhance natural attenuation in the less-than-25 μg/L-portion of the plume, and (b) the continuation of hydraulic containment or removal or both of the hot spot initiated during Phase B. Phase C was to follow completion of Phase B treatability studies and include the continuation of groundwater monitoring.

- **Institutional Controls.** Institutional controls were specified to protect current and future users from health risks associated with groundwater contamination."

Phase A began with the signing of the 1995 ROD and was the transition from the OU 1-07A Interim Action to the OU 1-07B Final Action. Planning for the treatability studies was completed in 1995. Phase A activities transitioned into Phase B in 1996, and pump-and-treat containment of the hot spot began. Hot spot containment will continue until ISB treatment is fully operational. The Phase B treatability studies were completed in 1999 (the treatability studies are described more fully in Section 2.4).

Institutional controls were initiated under the OU 1-07A Interim Action and continued under the 1995 ROD. In October 1999, the *Final Record of Decision for Test Area North, Operable Unit 1-10* (DOE-ID 1999a [DOE/ID-10682]) (OU 1-10 ROD) established an institutional control plan encompassing all sites within Waste Area Group (WAG) 1, including this site. The institutional controls are being implemented in accordance with the OU 1-10 ROD.

The pump-and-treat and natural attenuation components of the original remedy are presented in Table 2-2.

Table 2-2. Components of the original remedy. The zones are as originally defined in the 1995 ROD.

Zone	Implementation Phase	Original Remedy Approach
Hot Spot (greater than 5,000 μg/L TCE)	Phases B and C	Pump-and-Treat
Dissolved Phase (25 to 5,000 μg/L TCE)	Phase C	Pump-and-Treat
Dissolved Phase (5 to 25 μg/L TCE)	Phases B and C	Monitored Natural Attenuation
Entire Plume	Phases B and C	Institutional Controls and Groundwater Monitoring

2.3 Explanation of Significant Differences

In November 1997, the Agencies published an Explanation of Significant Differences (ESD) (INEEL 1997 [INEEL/EXT-97-00931]) documenting changes to the 1995 ROD in several areas, including contaminant area definitions, the treatability studies schedule, and waste management requirements). The changes were based on information gathered during the Phase A and Phase B activities. Changes that are relevant to the final remedial action described in this ROD Amendment are summarized below.

2.3.1 Division of Plume into Three Zones

Initial evaluation of each technology to be tested identified the portion or portions of the contaminant plume in which it could effectively be applied. The 1995 ROD had divided the contaminant plume into a hot spot, in which TCE concentrations were greater than 5,000 μg/L; a dissolved phase with TCE concentrations of 25 to 5,000 μg/L; and a dissolved phase with TCE concentrations of 5 to 25 μg/L. The ESD changed the boundaries of the zones to facilitate the treatability studies, identifying the three zones as follows:

- The "hot spot" is the area immediately around the injection well, where concentrations of TCE exceed 20,000 parts per billion (ppb)

- The "medial zone" is the portion of the plume in which concentrations of TCE are between 1,000 and 20,000 ppb

- The "distal zone," which is the remainder of the plume, has TCE concentrations of between 5 and 1,000 ppb.

Figure 2-2 shows the zones. The divisions identified in the 1995 ROD and the ESD are shown in Table 2-3. This ROD Amendment uses the divisions identified in the ESD.

Table 2-3. Contaminant plume boundaries defined by the 1995 ROD and the ESD.

Original 1995 ROD	ESD
Hot Spot (greater than 5,000 μg/L TCE)	Hot Spot (greater than 20,000 μg/L TCE)
Dissolved Phase (25 to 5,000 μg/L TCE)	Medial Zone (1,000 to 20,000 μg/L TCE)
Dissolved Phase (5 to 25 μg/L TCE)	Distal Zone (5 to 1,000 μg/L TCE)

2.3.2 Extension of Treatability Studies

The time for conducting the treatability studies was extended from 3 years to approximately 5 years from the date of the 1995 ROD signature to facilitate sequential rather than parallel testing of the technologies being studied (as described in Section 2.4).

2.3.3 Waste Management Requirements and Area of Contamination Definition

As described in the ESD, DOE determined that solvents listed by the Resource Conservation and Recovery Act (RCRA) were disposed of at the TAN facility in the TSF-21 Valve Pit, which was interconnected with the TSF-05 Injection Well. Because of this determination, the RCRA-listed waste classification (waste code F001) became applicable to the contaminant plume and to any associated wastes generated from the groundwater remediation activities.

The Area of Contamination (AOC) designation for waste management purposes was not fully covered in the 1995 ROD. The ESD defined the AOC as follows:

> "The AOC for waste management purposes will be defined as the area overlying and within the contaminated groundwater plume (i.e., detectable TCE concentrations greater than 5 μg/L). This AOC definition allows for necessary remediation activities to be performed at prescribed locations within the AOC but will not result in management of wastes outside of established temporary accumulation areas. Any future temporary accumulation areas will be established within the AOC immediately adjacent to the existing or future treatment facilities only to the extent necessary for proper and efficient management of waste streams. The CERCLA site for waste management purposes, as defined in the [Federal Facility Agreement and Consent Order (FFA/CO)], is the entire INEEL site area.... Waste generated during remedial action will be managed within the AOC, ... or offsite. Waste generated during remediation activities and stored in a temporary accumulation area within the AOC will be moved to one or more of the waste management areas within the INEEL site or sent offsite for storage, treatment, and/or disposal."

2.3.4 Clarification of ARARs

With respect to two of the treatability studies (ISB and In Situ Chemical Oxidation [ISCO]), the ESD clarified applicable or relevant and appropriate requirements (ARARs) to specify that secondary MCLs would not be applicable before the end of the restoration period (defined as 2095), because the hot spot and medial zones would not be drinking water sources due to high concentrations of COCs in those zones. Institutional controls, as part of the remedial action, will be maintained to ensure protection of human health and the environment until the remedial action is completed.

2.3.5 Construction of the New Pump-and-Treat Facility

Although remediation of the medial zone was not identified as starting until Phase B treatability studies were completed, modeling suggested that early implementation of extraction and treatment of the portion of the plume in the medial zone would enhance subsequent remediation in the distal zone. Accordingly, the Agencies agreed to begin design and construction of the New Pump and Treat Facility (NPTF) before the Phase B treatability studies were completed. The NPTF will extract and treat contaminated groundwater in the medial zone and reinject the treated water. Construction of the NPTF was completed in January 2001; operations are expected to begin in Fall 2001.

2.4 Summary of Treatability Studies

Treatability studies were conducted for each of the five potential alternative approaches:

- Metal Enhanced Reductive Dehalogenation (MERD)
- Monolithic Confinement (Grouting)
- In Situ Bioremediation (ISB)
- In Situ Chemical Oxidation (ISCO)
- Monitored Natural Attenuation (MNA).

The Technology Evaluation Work Plan (TEWP) (DOE-ID 1997b [DOE/ID-10562]) outlined the process for conducting the treatability studies, including literature surveys, bench-scale laboratory tests, and pilot-scale studies. The objective was to obtain sufficient specific information to determine whether one technology or a combination of several could achieve the RAOs at a lower cost or in less time than that predicted for the original remedy. The TEWP also identified the applicability of each alternative approach for use in each of the three zones.

The treatability studies were concluded in 1999 and the results are summarized in the Field Demonstration Report (FDR) (DOE-ID 2000a [DOE/ID-10718]). Summaries of the studies and the results are provided below. The documents that detail the treatability studies, work plans, and results are listed in Section 2.5 for the reader's use.

2.4.1 Metal Enhanced Reductive Dehalogenation

The MERD technology uses iron to enhance the rate of degradation of a wide range of organic contaminants, including TCE. This technology would only be applicable to remediation of the hot spot. It was evaluated for its ability either to replace or to augment the pump-and-treat technology. Two variations were evaluated: one using zero-valent iron and the other using nickel-plated iron (enhanced iron).

Both a bench-scale feasibility study (FS) and a laboratory treatability study were carried out. Agency review of the results determined that neither variation performed better than the original remedy of pump-and-treat. The MERD evaluation was terminated in April 1997.

2.4.2 Monolithic Confinement

The technical feasibility of monolithic confinement (grouting) is well established. Successful reduction of permeability through grouting could reduce contaminant flux sufficiently to meet RAOs for in situ containment or isolation of the secondary source. The primary consideration for selection of this technology is its cost. However, cost estimates prepared in the initial evaluation indicated that grouting would not be more cost-effective than the original remedy of pump-and-treat. Moreover, the area that would need to be treated by grouting would still require pump-and-treat to control leakage. Based on these results, studies related to monolithic confinement were terminated in October 1996.

2.4.3 In Situ Bioremediation

ISB involves interaction between native microorganisms and amendments that will stimulate the bacteria to dechlorinate TCE and other chlorinated VOCs. Bioremediation through aerobic or anaerobic processes dechlorinates TCE to carbon dioxide, water, chloride, ethene, and ethane. Anaerobic ISB was studied for use at the hot spot; aerobic ISB was evaluated for use in the medial and distal zones.

Initial results indicated that ISB could remediate the same mass of TCE as a pump-and-treat system in roughly half the time. Initial evaluation and laboratory tests suggested enhanced anaerobic ISB had the potential to replace pump-and-treat for remediation of the hot spot. Laboratory studies of aerobic ISB demonstrated significant potential for enhanced bioremediation of the downgradient contaminant plume; however, the addition of amendments on that scale would be cost-prohibitive.

To facilitate ISB field studies, the Air Stripper Treatment Unit (ASTU) was constructed in 1998 and began operation in November of that year. The ASTU extracted water 150 m (500 ft) downgradient from the hot spot, treated it by air stripping, and reinjected it through a well 20 m (60 ft) downgradient from where it was extracted. The ASTU provided containment at the hot spot while the ISB field evaluation was ongoing because the GWTF could not be operated during this treatability study.

A field evaluation of anaerobic ISB conducted at the hot spot from January to September 1999 showed that sodium lactate performed well as an amendment. TCE was completely dechlorinated, with no resulting residual VOC contamination. ISB showed several clear advantages over pump-and-treat for hot spot remediation: (a) ISB destroys chlorinated ethenes rather than transferring them to air, (b) ISB does not bring contaminants aboveground for treatment, and thus eliminates risks to workers from exposure to contaminants, and (c) ISB promises a shorter restoration timeframe, which results in a lower overall cost.

2.4.4 In Situ Chemical Oxidation

ISCO was evaluated for use at the hot spot. ISCO is an innovative technology for remediation of chlorinated solvents in groundwater. Laboratory tests and small-scale experiments at the INEEL have shown that the oxidant potassium permanganate is effective in dechlorinating VOCs to end products such as carbon dioxide, chlorine, chloride, and manganese. Effective operation of this technology depends on a delivery system that can inject the oxidant into the area of highest contaminant concentration, or where undissolved contaminant may be present.

A laboratory evaluation of ISCO was completed and a field evaluation work plan was finalized. However, the oxidant used in ISCO would kill the microorganisms that facilitate ISB. Therefore, the Agencies agreed to conduct the ISCO field evaluation after the ISB field evaluation was completed but only if the ISB field evaluation were unsuccessful. Since the ISB field evaluation was successful, the Agencies agreed not to proceed with ISCO field testing.

2.4.5 Monitored Natural Attenuation

Natural attenuation is defined by the EPA as "the biodegradation, diffusion, dilution, sorption, volatilization, and/or chemical and biochemical stabilization of contaminants to effectively reduce contaminant toxicity, mobility, or volume to levels that are protective of human health and the environment." At this site, MNA would only be applicable to remediation of the distal zone.

Factors important to evaluating the applicability of MNA at this site included site-specific information about the potential for biotic degradation, abiotic degradation, or other geochemical or biochemical processes that could attenuate the specific COCs in this contaminant plume. Evaluation of natural attenuation involved sampling and analysis of groundwater in the distal zone. The evaluation used computer models to predict the potential change over time in contaminant distribution and concentration. It was determined that MNA better meets the balancing criteria than pump-and-treat for remediation of the distal zone.

2.5 Key Documents for Completed Remediation Activities

The goals and results of activities relating to OU 1-07B that have been completed to date are reported in the key documents in Table 2-4. For the reader's convenience, the document number (e.g., DOE/ID-10139) is listed. Either the title or the document number can be used to locate the document in the Administrative Record. The Administrative Record is available online at http://www.inel.gov/publicdocuments/ or at the Information Repositories listed in Section 1.

Table 2-4. Key documents for OU 1-07B completed remediation activities.

Referred to as	Date	Title	Document No.
1995 ROD	Aug 95	*Record of Decision for the Technical Support Facility Injection Well (TSF-05) and Surrounding Groundwater Contamination (TSF-23) and Miscellaneous No Action Sites Final Remedial Action*	DOE/ID-10139
TEWP	Mar 97	*Technology Evaluation Work Plan, Test Area North Final Groundwater Remediation, OU 1-07B*	DOE/ID-10562
RD/RA SOW	Aug 97	*Remedial Design/Remedial Action Scope of Work, Test Area North Final Groundwater Remediation, Operable Unit 1-07B*	DOE/ID-10522
ESD	Nov 97	*Explanation of Significant Differences from the Record of Decision for the Technical Support Facility Injection Well (TSF-05) and Surrounding Groundwater Contamination (TSF-23) and Miscellaneous No Action Sites, Final Remedial Action*	INEEL/EXT-97-00931
OU 1-10 ROD	Oct 99	*Final Record of Decision for Test Area North, Operable Unit 1-10*	DOE/ID-10682
FDR	Mar 00	*Field Demonstration Report, Test Area North Final Groundwater Remediation, Operable Unit 1-07B*	DOE/ID-10718
Proposed Plan	Nov 00	*Proposed Plan for Operable Unit 1-07B, Final Remedial Action at the TSF Injection Well (TSF-05) and Surrounding Groundwater Contamination (TSF-23)*	DOE/ID-21251
	Jan 98	*Well Characterization and Evaluation Report Supporting Functional and Operational Requirements for the New Pump and Treat Facility at Test Area North Operable Unit 1-07B*	INEL/EXT-97-01356
	Feb 98	*Site Conceptual Model: 1996 Activities, Data Analysis, and Interpretation – Test Area North Operable Unit 1-07B*	INEL/EXT-97-00556
	Feb 98	*Natural Attenuation Field Evaluation Work Plan, Test Area North, Operable Unit 1-07B*	DOE/ID-10606
	Sep 98	*In Situ Bioremediation Field Evaluation Work Plan, Test Area North, Operable Unit 1-07B*	DOE/ID-10639
	Jan 99	*Numerical Modeling Support of the Natural Attenuation Field Evaluation for Trichloroethene at the Test Area North, Operable Unit 1-07B*	INEEL/EXT-97-01284
	Apr 99	*Laboratory Evaluation of In Situ Chemical Oxidation for Groundwater Remediation, Test Area North, Operable Unit 1-07B, Idaho National Engineering and Environmental Laboratory*	ORNL/TM-13711
	Oct 99	*Phase C Groundwater Monitoring Plan*	INEEL/EXT-99-00021
	Oct 99	*Phase C Remedial Action Work Plan for Test Area North Final Groundwater Remediation, Operable Unit 1-07B*	DOE/ID-10679
	Nov 99	*In Situ Chemical Oxidation Field Evaluation Work Plan for the TSF-05 Hot Spot, Test Area North Final Groundwater Remediation, Operable Unit 1-07B*	DOE/ID-10698
	Jan 00	*Fiscal Year 1999 Groundwater Monitoring Report, Test Area North, Operable Unit 1-07B*	INEEL/EXT-99-01255
	Mar 00	*New Pump and Treat Facility Remedial Design, Test Area North, Operable Unit 1-07B*	DOE/ID-10661
	Apr 00	*Aerobic Biodegradation Laboratory Studies at Test Area North, Operable Unit 1-07B*	INEEL/EXT-99-00736
	Oct 00	*Sampling and Analysis Plan for the Enhanced In Situ Bioremediation Field Evaluation, Test Area North, Operable Unit 1-07B*	INEEL/EXT-98-00421
	Nov 00	*Microbial Studies Report Supporting Implementation of In Situ Bioremediation at Test Area North*	INEL/EXT-98-00474

3. COMMUNITY PARTICIPATION

Public participation was an important element in the decision-making process for the OU 1-07B Final Remedial Action. In accordance with CERCLA Section 113(k)(2)(b)(i–v) and Section 117, the Agencies provided various opportunities for the public to learn about the activities leading to this ROD Amendment and to provide their opinions and comments for the Agencies' consideration in making the final decision. Between October 1995 and January 2001, a series of publications and face-to-face (or telephone) meetings offered information and comment opportunities. These included: the original Record of Decision in 1995; an Explanation of Significant Differences in 1997; articles in the *INEEL Reporter*; *Citizen's Guide* supplemental updates; *Update Fact Sheets*; the November 2000 Proposed Plan; briefings and presentations to interested groups; tours; and public meetings.

Articles in the *INEEL Reporter* (a publication of the INEEL's Environmental Restoration Program) regularly updated individuals on the mailing lists during the course of the project. Reports also appeared in five issues of *EM Progress* and a *Citizen's Guide to Environmental Restoration at the INEEL* (a supplement to the *INEEL Reporter)* in the first half of 1996, 1997, 1998, 1999, and 2000. In addition, many newspapers and technical journals ran articles on the technology, and several regional television and radio stations aired interviews with project managers and public affairs staff.

In October 1999, December 1999, and November 2000, *Update Fact Sheets* were distributed to approximately 600 individuals on the INEEL Community Relations Plan mailing list. The *Update Fact Sheets* described developments during the OU 1-07B treatability studies and announced the dates of future public meetings. Each fact sheet included information on the availability of technical briefings to those interested in the OU 1-07B Final Remedial Action.

In November 2000, the *Proposed Plan for Operable Unit 1-07B, Final Remedial Action at the TSF Injection Well (TSF-05) and Surrounding Groundwater Contamination (TSF-23)* was published (DOE-ID, EPA, and IDEQ 2000). About 600 copies were mailed out to recipients on the *INEEL Community Relations Plan* mailing list during the week of November 20, 2000. The public comment period for the Proposed Plan began November 27 and was planned to end on December 26, 2000. At the request of the public, the comment period was extended 30 days to January 26, 2001.

During the week of November 20, 2000, the INEEL Community Relations representative for TAN telephoned people in various Idaho communities who are known to have an interest in INEEL environmental restoration activities. The calls were made to inform them and their organizations in advance about the Proposed Plan, to provide the schedule for the public meetings, and to find out whether they wanted a technical briefing.

Also during the week of November 20, 2000, DOE-ID issued a news release to more than 100 media contacts. The news release announced the 30-day public comment period for the Proposed Plan. This information was published in community calendar sections of newspapers and aired in public service announcements on radio stations. The news release also included information that reference documents for the Proposed Plan were available in the Administrative Record section of the INEEL Information Repositories located in the INEEL Technical Library in Idaho Falls, Albertsons Library on the campus of Boise State University, and the University of Idaho Library in Moscow, Idaho. During the following week, display advertisements announcing the availability of the Proposed Plan and the locations of public meetings were published in the *Post Register* (Idaho Falls); the *Arco Advertiser* (Arco); *The Sho-Ban News* (Fort Hall); *The Idaho State Journal* (Pocatello); *The Times-News* (Twin Falls); the *Idaho Statesman* (Boise); and the *Moscow-Pullman Daily News* (Moscow). A follow-up advertisement ran in newspapers approximately four days before the public meetings in Idaho Falls and Twin Falls. Post cards were mailed to approximately 5,400 individuals and organizations on the INEEL mailing list informing them of the availability of the Proposed Plan, the duration of the comment period, and the times and locations of upcoming public meetings. An electronic note with this information was sent to all INEEL employees.

Technical briefings were provided to two groups. A January 12, 2001, technical briefing was held for Coalition 21, an organization of retired INEEL employees and others who are interested in INEEL affairs. A previous briefing had been held with Coalition 21 in April 2000 on the bioremediation technology. Two briefings were provided by DOE-ID for the INEEL Citizen's Advisory Board and its Environmental Restoration Program Subcommittee. The advisory board is a group of 15 individuals, selected to represent the citizens of Idaho, who make recommendations to the Agencies regarding environmental restoration activities at the INEEL. The advisory board submitted their formal recommendations on the Proposed Plan in January 2001.

During the course of the project, members of the Shoshone-Bannock Tribes and an environmental group toured the treatment facility at TAN and were briefed by project managers. Members of the Citizen's Advisory Board toured the area proposed for remediation on September 21, 1999.

Public meetings were held in Idaho Falls on December 5 and in Twin Falls on December 6, 2000. Each public meeting began at 7 p.m. The newspaper advertisements had invited the public to also attend the "availability sessions" scheduled from 6 to 7 p.m. Availability sessions are opportunities for informal discussion of the contaminant plume investigation and proposed alternatives with Agency and project representatives before the formal public meeting began. At each meeting, a court reporter recorded discussions and public comments from which written transcripts were later prepared and placed into the Administrative Record for OU 1-07B.

Those who attended the meeting were invited to have their comments recorded by the court reporter during the formal comment portion of the meeting, or submit them in writing, or both. A postage-paid, pre-addressed form for comments was provided as part of the Proposed Plan. Copies of the form were also provided at the public meeting. The INEEL Community Relations Office also asked those who attended the meeting to evaluate its effectiveness using a form printed on the back of the meeting agenda.

Approximately 30 members of the public or representatives of stakeholder groups (people not associated with the OU 1-07B project) attended the Idaho Falls public meeting and availability session. Twin Falls had been selected for the second meeting location to be convenient for residents of the Snake River Plain from Pocatello to Boise who might have an interest in TAN because of the groundwater issue. It was also expected, since the Idaho Falls meeting took place on the same night as a Jackson, Wyoming, public meeting for a different INEEL project, that members of the public and the media who wished to attend meetings for both projects would be able to do so by attending the Twin Falls meeting. However, no members of the public or the media came to the Twin Falls public meeting or availability session.

During the comment period, ten separate sets of formal comments were received, seven submitted in writing and three delivered as formal comments at the public meetings. Part III of this ROD Amendment, the Responsiveness Summary, consists of a summary of the concerns expressed in the comments received, and the Agencies' responses to them. Transcripts of the formal comments delivered at the public meetings and scanned versions of comments received in writing are provided in Appendix A to this ROD Amendment. The comments are in the Administrative Record for OU 1-07B.

All comments received on the Proposed Plan were considered during the remedy selection process documented in this ROD Amendment. Community acceptance, as one of the EPA's nine criteria used in final evaluation of remedial alternatives, is documented in Sections 7.1 and 7.2 of this ROD Amendment.

4. BASIS FOR THE AMENDMENT

The 1995 ROD was written with a requirement to conduct treatability studies, which focused on specific technologies that offered the potential to be more cost-effective than the original remedy of pump-and-treat technology. Cost-effectiveness considers all the balancing criteria, including cost and time for completion, as well as ability to meet RAOs. Although pump-and-treat technology would meet RAOs, it would require several decades for completion, increasing the cost of remediation. Results of the treatability studies showed that two of the technologies investigated, ISB and MNA, would better meet the balancing criteria than pump-and-treat technology for remediation of the hot spot and the distal zone, respectively. This section presents the key information about these two technologies that supports selection in this ROD Amendment of the amended remedy. The data and information used to reach a final decision on the five technologies was presented in the FDR (DOE-ID 2000a [DOE/ID-10718]).

4.1 New Information from Treatability Studies

Five technologies were identified for evaluation (see Section 2.4). Based on the results of the treatability studies, the Agencies agreed that:

- Monolithic confinement cannot perform more effectively than pump-and-treat technology at the hot spot. Therefore, all work on evaluation of this technology was terminated in October 1996.
- MERD cannot perform more effectively than pump-and-treat technology at the hot spot. Therefore, all work on evaluation of this technology was terminated in April 1997.
- ISB would perform more effectively than pump-and-treat technology at the hot spot.
- MNA would better meet the balancing criteria than pump-and-treat technology in the distal zone.
- ISCO would not be evaluated further due to the success of ISB.

The Agencies agreed that ISB, for remediation of the hot spot, and MNA, for remediation of the distal zone, would be effective components of an amended remedial action in combination with pump-and-treat technology in the medial zone. ISB would result in significant cost savings by achieving hot spot restoration in roughly half the time estimated for a pump-and-treat system. MNA would restore the groundwater within the remediation timeframe and would also result in a significant cost savings by eliminating the need for construction and operation of the facilities (i.e., air stripping units) that would be required under the original pump-and-treat technology.

The following sections summarize aspects of ISB and MNA that supported the reassessment of the original remedy.

4.2 Information Supporting ISB for Hot Spot Restoration

The first laboratory study performed in support of the ISB treatability study focused on evaluation of aerobic dechlorination mechanisms. The study revealed that microorganisms capable of TCE dechlorination were present not only inside the contaminant plume, but also outside. Complete dechlorination of TCE was stimulated with the addition of either phenol or methane. Nitrogen compounds appeared to be the most limiting nutrients for degradation aside from the cometabolic substrate. While this study demonstrated that enhanced aerobic bioremediation of TCE in the medial and distal zones of the contaminant plume is possible, the addition of amendments on that scale is cost-prohibitive.

The anaerobic laboratory study was performed to determine whether enhanced ISB had the potential to replace pump-and-treat technology in the source area, where aquifer conditions were already anaerobic. The study showed that TCE could be completely dechlorinated to carbon dioxide, water, chloride, ethene, and ethane through the addition of sodium lactate as an electron donor. The TCE dechlorination rates were estimated to result in a TCE half-life of less than one month. It was concluded that a field evaluation of enhanced ISB was warranted for the source area.

VOC daughter products (such as vinyl chloride) may be produced as interim, ephemeral breakdown products; however, bioremediation will result in complete dechlorination of VOCs by 2095.

The field evaluation was performed to determine whether the results suggested through the anaerobic laboratory studies could be achieved at field scale. The new information provided by the field evaluation included the following significant points:

- Complete dechlorination of TCE was achieved by enhanced ISB in a very complex hydrogeologic setting.

- Anaerobic reductive dehalogenation of chlorinated solvents can be effectively monitored and interpreted by taking advantage of the following lines of evidence: (1) electron donors, (2) biological activity indicators, (3) oxidation-reduction reactants and products, (4) contaminants and their degradation products, and (5) general water-quality parameters (pH, specific conductivity, oxidation reduction potential, and temperature). The combination of five individual lines of evidence provides compelling data supporting anaerobic dechlorination of chloroethenes.

The FDR (DOE-ID 2000a [DOE/ID-10718]) presented field monitoring data that demonstrated the ISB technology evaluation met or exceeded all objectives and expectations (see FDR Section 2.4). In accordance with the Remedial Design/Remedial Action (RD/RA) Scope of Work (SOW) (DOE-ID 1997a [DOE/ID-10522]), the technical success of the field evaluation combined with the preliminary cost information supports a recommendation to implement ISB for remediation of the hot spot. Figure 4-1 illustrates the effects of ISB on TCE concentrations in the plume.

Other advantages of ISB relative to the pump-and-treat technology include the fact that the chlorinated ethenes are completely destroyed rather than simply transferred to the air or other media, and that ISB does not require pumping contaminated groundwater aboveground where a risk of worker exposure or environmental release would exist.

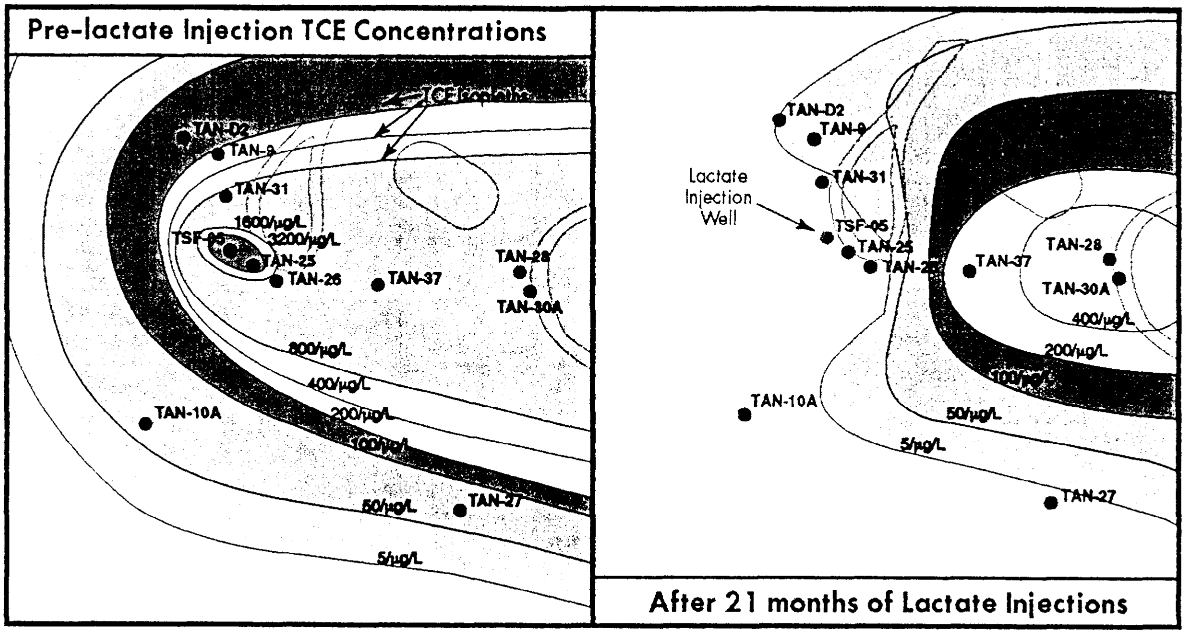


Figure 4-1. Effects of ISB on TCE in the contaminant plume. The diagrams show changes in TCE concentrations within the ISB treatment area after 21 months of sodium lactate injections and ASTU operation.

4.3 Information Supporting MNA for Distal Zone Restoration

The evaluation of MNA for the distal portion of the contaminant plume included the analysis and interpretation of groundwater monitoring data, numerical modeling, and laboratory studies. Initially, the evaluation followed *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites,* OSWER Directive 9200.4-17P (EPA 1999a), and focused on anaerobic reductive dechlorination and dispersion as possible mechanisms. As the data were compiled, however, it became apparent that another mechanism was affecting TCE in the distal zone of the contaminant plume. Therefore, the focus of the evaluation changed to the development of an understanding of the fate and transport of TCE at TAN using monitoring data, numerical modeling, and the results of existing site-specific laboratory studies.

Existing groundwater-monitoring data were used to provide a quantitative analysis of the fate of TCE relative to that of PCE and tritium. PCE is sensitive to attenuation mechanisms such as sorption or volatilization; tritium is conservative except for its radioactive half-life, which can be accounted for assuming some constant groundwater velocity. The disappearance of TCE relative to PCE and tritium indicates that a natural attenuation mechanism other than dispersion, sorption, or volatilization is reducing TCE concentrations over time. Numerical modeling provided a qualitative analysis of the contaminant plume evolution. The ratios of PCE to TCE determined from field data and the observed pattern of chlorine numbers were consistent with an oxidative degradation mechanism and led to an estimate of a 10–20 year degradation half-life. Laboratory studies demonstrated that microorganisms capable of cometabolically oxidizing TCE are present not only inside, but also downgradient of and cross-gradient to the contaminant plume. Numerical modeling using a half-life from the high end of the estimated range predicted that natural attenuation would achieve the RAOs within the remedial timeframe. The numerical modeling also demonstrated that the original pump-and-treat remediation strategy using dissolved-phase treatment units would have to be redesigned to include more extraction well locations and higher pumping rates (resulting in higher implementation and operation costs) to meet RAOs within the remedial timeframe.

Independent studies performed by the U.S. Geological Survey, Pacific Northwest National Laboratory, and DOE Environmental Management Science Program researchers all confirmed the presence of potential energy sources in low concentrations across the INEEL, including at TAN. Given that very little biological activity would be required to achieve the estimated TCE half-life of 10–20 years, the available evidence suggested this mechanism might be responsible for the observed attenuation. The new information identified through this data analysis indicated that natural attenuation of TCE and the other VOC COCs through a mechanism other than dispersion appeared to be occurring at TAN.

EPA provides guidance on evaluating the applicability of monitored natural attenuation for groundwater cleanup (EPA 1999a). Of the 11 points EPA recommends for evaluation of natural attenuation, 10 clearly can be answered in the affirmative. Table 4-1 lists the 11 points summarized from EPA's guidance and evaluates whether they are met at OU 1-07B. Based on conservative modeling, the contaminant plume is not expected to grow more than an additional 30 percent during the entire restoration timeframe (ending in 2095). The plume is well characterized, with 10 years of historical monitoring data available as well as flow and solute transport models. Analysis of these data has demonstrated that VOC dechlorination is taking place. Adequate monitoring wells are in place to continue monitoring the plume. If the plume growth exceeds expectations, the contingency remedy for the distal zone of pump-and-treat (i.e., the default remedy described in the 1995 ROD) will be implemented.

The FDR (DOE-ID 2000a [DOE/ID-10718]) cautioned that implementation of MNA as the distal zone remedy through a ROD Amendment should be subject to two conditions: (1) that pump-and-treat technology be identified as a contingency for MNA; and (2) that performance reviews of MNA be conducted every year for the first 5 years and at least every 5 years thereafter so long as performance criteria are met. In addition, the contingency remedy also will be invoked if the required monitoring necessary for MNA is not performed.

Table 4-1. Evaluation of MNA for remediation of the distal zone using EPA-recommended criteria.[a]

Criterion	Criterion Met?
1. Source-control and long-term monitoring should be fundamental components of any MNA remedy.	Yes
2. MNA should not be considered a default or presumptive remedy.	Yes
3. Decisions to employ MNA as a remedy or a remedy component should be thoroughly and adequately supported with site-specific characterization data and analysis.	Yes
4. Unless EPA or the overseeing regulatory authority determines that historical data are of sufficient quality and duration to support a decision to use MNA, data characterizing the nature and rates of natural attenuation processes should be provided. Where the latter are inconclusive, data for microcosm studies may also be necessary.	Yes
5. EPA expects the MNA will be most appropriate when used in conjunction with other remediation measures or as a follow-up to active remediation measures that have already been implemented.	Yes
6. Sites where the contaminant plumes are no longer increasing in extent, or are shrinking, would be most appropriate candidates for MNA remedies.	Although continued growth of the distal zone of the plume is expected, the plume is well characterized and confined within the INEEL's boundaries, and there are no downgradient receptors that could be impacted. If the plume growth exceeds expectations, the contingency remedy for the distal zone of pump-and-treat (i.e., the default remedy described in the 1995 ROD) will be implemented.
7. Where restoration is technically practicable using either aggressive or passive methods, the longer restoration timeframe required by the passive alternative may be reasonable in comparison with the timeframe needed for more aggressive restoration alternatives.	Yes
8. Adequate performance monitoring and contingency remedies should be utilized because of higher levels of uncertainty associated with implementation of MNA over longer timeframes.	Yes
9. Implementation of MNA should meet regulatory authorities' expectations that contaminated groundwater will be restored to beneficial use within a reasonable timeframe.	The Agencies agreed in the 1995 ROD that a reasonable timeframe of no more than 100 years (i.e., 2095) would be appropriate for restoration of the contaminant plume. Comments received during the public involvement process indicated that this timeframe is acceptable.
10. Source-control measures will be evaluated for all contaminated sites, and source-control measures will be taken at most sites where practicable.	Yes
11. Performance monitoring should continue until remediation objectives have been achieved, and longer, if necessary, to verify that the site no longer poses a threat to human health and the environment.	Yes

a. *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites,* OSWER Directive 9200.4-17P (EPA 1999a).