United States

Department of Agriculture

REMEDIAL INVESTIGATION/FEASIBILITY STUDY

REVISED PHASE 2 WORK PLAN

NEMO WORK CENTER

LAWRENCE COUNTY, SOUTH DAKOTA

March 2010

United States Department of Agriculture

Forest Service

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NEMO WORK CENTER
LAWRENCE COUNTY, SOUTH DAKOTA

March 2010

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List of Acronyms and Abbreviations

ARAR	Applicable or Relevant and Appropriate Requirement(s)
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPC	Compound of Potential Concern
CSM	Conceptual Site Model
DQO	Data Quality Objective
EE/CA	Engineering Evaluation/ Cost Assessment
EI/DQ	Existing Information/Data Quality Report
EDB	Ethylene Dibromide
EPA	Environmental Protection Agency
ERA	Ecological Risk Assessment
FS	Feasibility Studies
ft	Feet
FSP	Field Sampling Plan
GIS	Geographic Information Systems
HAZWOPER	Hazardous Waste Operations and Emergency Response
HHRA	Human Health and Risk Assessment
HSP	Health and Safety Plan
MSE	MSE Inc.
msl	mean sea level
MW	monitoring well
NPL	National Priority List
OSHA	Occupational Safety and Health Administration
PP	Proposed Plan
ppb	parts per billion
QAPP	Quality Analytical Project Plan
QA	Quality Assurance
QC	Quality Control
ROD	Record of Decision
RI	Remedial Investigation
RCRA	Resource Conservation and Recovery Act
RW	water supply well
Site	Nemo, South Dakota
TEC	TEC Inc.
TBC	To-Be-Considered criteria
US	United States
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
URS	URS Corporation
UST	Underground Storage Tank
VOC	Volatile Organic Compound
Weston	Weston Solutions, Inc.
WP	Work Plan

SECTION 1
INTRODUCTION

The United States Department of Agriculture (USDA) Forest Service, hereafter called the US Forest Service, has contracted with Weston Solutions, Inc. (Weston) and TEC Inc. (TEC) to conduct a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigation/Feasibility Study (RI/FS) to assess the impact of Ethylene Dibromide (EDB) found in groundwater beneath the US Forest Service Nemo Work Center Site (the Site), Nemo, South Dakota (see Figure 1-1 and Figure 1-2). This Revised Phase 2 Work Plan (WP) was prepared under Modification 0003 of Contract No. GS-10F-0117J/AG-82X9-D-08-0179.

1.1 PHASE 2 WORK PLAN RATIONALE

This revised Phase 2 WP has been developed to provide project level details on the RI/FS for the assessment of EDB contamination at the Site. Based on a review and analysis of the existing information, including the Existing Information/Data Quality (EI/DQ) Report (Weston and TEC 2009), the US Forest Service has determined a course of action to carry out the RI/FS. The purpose of this RI/FS is to assess site conditions and evaluate alternatives to the extent necessary to select a remedy.

To date, a series of activities have been conducted during this RI/FS effort, including the following activities: field studies, data collection, risk assessment, model development, treatability studies, and analysis of alternatives. However, an additional round of groundwater sampling is required in order to address data gaps and finalize the in-progress RI/FS Reports. In addition to this revised Phase 2 WP, previously prepared documents including the Quality Assurance Project Plan (QAPP), Field Sampling Plan (FSP), site specific Health and Safety Plan (HSP), will be utilized during implementation of the additional round of groundwater sampling.

1.2 SUMMARY OF RI/FS EFFORTS

The RI serves as the mechanism for collecting data to characterize site conditions; determine the nature of the waste; assess risk to human health and the environment; and conduct treatability testing as necessary to evaluate the potential performance, cost, and design of the treatment technologies and selected remedies that are being considered. The FS serves as the mechanism for the development, screening, and detailed evaluation of alternative remedial actions (EPA 1988).

The initial task for the RI/FS was to create an EI/DQ report, which was completed in February 2009, and described previous investigations and regulatory actions, evaluated previous conclusions and recommendations, and provided a comprehensive list of recommendations to complete this CERCLA RI/FS. In March 2009, a focused Phase 1 WP was finalized to conduct seasonal groundwater-surface water interaction studies between Boxelder Creek, the Bedrock Ridge behind the Nemo Work Center, and the alluvial valley north east of the Bedrock Ridge associated with the town of Nemo. A Phase 2 WP was prepared in July 2009 to incorporate additional sampling activities. The Phase 2 field work was completed during August 2009.

This Revised Phase 2 WP has been prepared for an additional round of RI groundwater sampling at the Site.

Project Planning Tasks include the following items.

- Revision of planning documents, including WP, FSP, QAPP, and HSP (as needed).

Field Tasks include the following items.

- During March 2010, a single round of groundwater samples will be collected from monitoring wells and selected domestic wells, shown on Table 1-1. Samples will be analyzed for EDB; natural attenuation parameters; and major ions, see Table 1-1.

Sample analysis and data evaluation tasks include the following.

- Sample analysis will be conducted by Mid-Continent Testing Laboratories in Rapid City, SD
- Data validation will be conducted on all EDB sample delivery groups so that the results will be defensible for risk assessment purposes. Natural attenuation parameters, major ions and field measurements are considered screening level and will not be validated.
- The March 2010 analytical data will be incorporated into the numerical groundwater model developed to model groundwater flow patterns, and include natural attenuation, extraction and other processes to conduct Tier 3 Risk Assessment and assess the remedial alternatives for cleanup in the FS and remedial action design, and 5-year review assessment.
- The March 2010 analytical data will be incorporated into the comprehensive risk assessment, including human health and ecological assessments for groundwater, subsurface soil, seepage to surface water and sediments to determine environmental media and pathways which should be considered in the evaluation of remedial alternatives.

Reporting tasks include the following.

- The RI Report, which will summarize previous investigations and results, describe current study activities, site characteristics, and a Conceptual Site Model (CSM), present the nature and extent of contamination, describe contaminant fate and transport concepts, conduct screening risk assessment using Applicable or Relevant and Appropriate Requirements (ARARs) And To-Be-Considered (TBC) action levels, incorporate the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA), and present conclusions to be utilized in the FS documentation.
- The FS Report, which will include the screening remedial technologies, development of remedial alternatives, and finally a detailed analysis of the remedial alternatives to provide a preferred alternative for remedial action to be presented to the public in the Proposed Plan.
- Although the Proposed Plan (PP) is not part of the current contract, it is a CERCLA document which allows state regulators and the community to evaluate the preferred alternative and provide comment, generally over a 30-day public comment period during which a public meeting is held and comments are received.
- Although the Record of Decision (ROD) is not part of the current contract, it is the CERCLA document that records the chosen Remedial Action alternative in the public record and is the basis of the Remedial Action design, construction, and long-term operations and maintenance.

1.3 PROJECT AND SITE MANAGEMENT

The Weston/TEC Team will be responsible for the management of all tasks to be undertaken for the RI/FS. As the primary contractor for the RI, TEC is responsible for overall RI project management and ensuring that all RI tasks described in project scoping documents are completed in a satisfactory manner.

Weston is responsible for overall FS project management and ensuring that all FS tasks described in project scoping documents are completed in a satisfactory manner.

A Weston employee will be responsible for health and safety supervision of Weston field activities and implementation of groundwater sampling.

Figure 1-1. Regional Location Map

Figure 1-1
Regional Location Map
Nemo Work Center Remedial Investigation

Figure 1-2. Project Area Layout Map

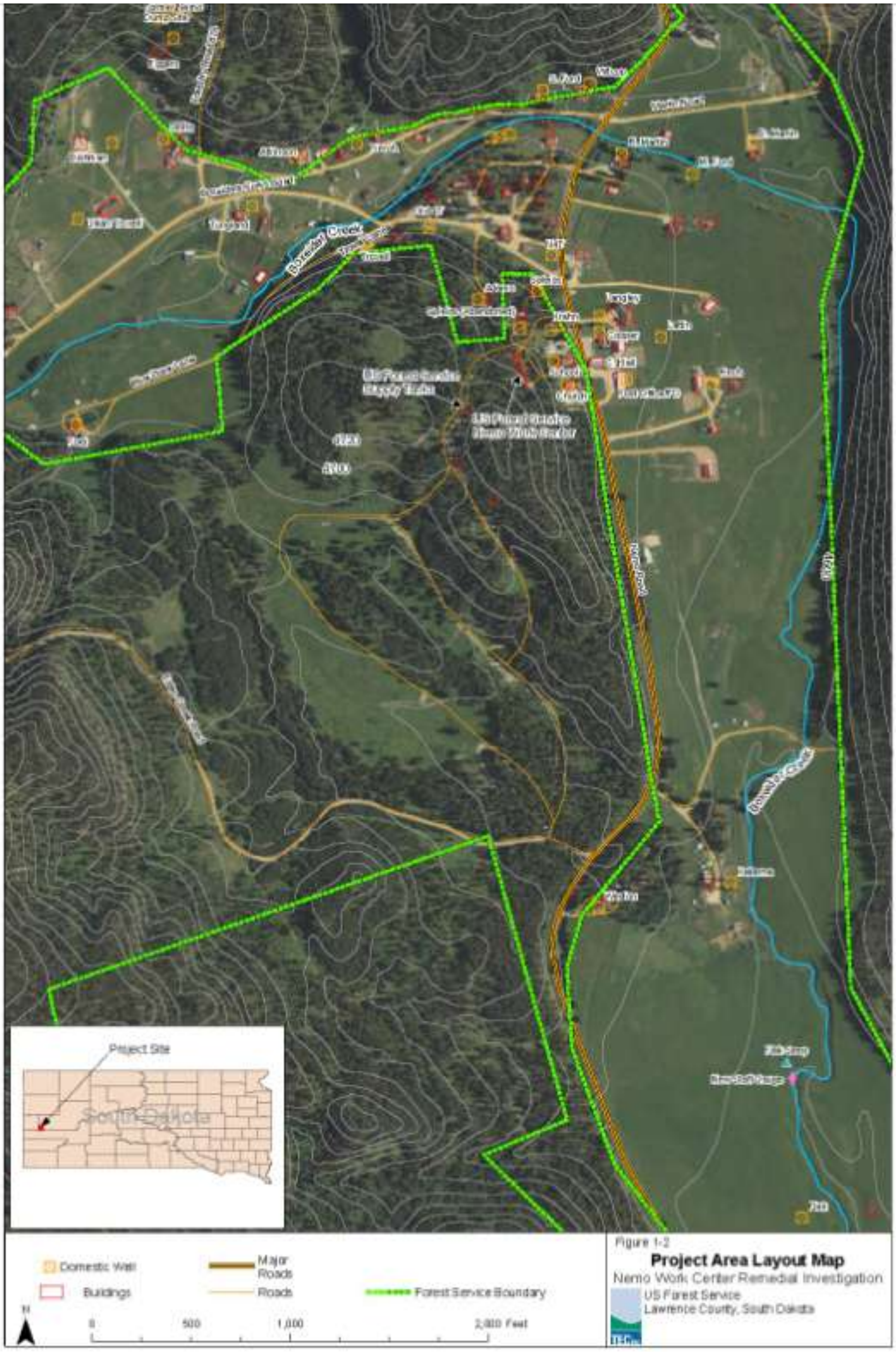


Table 1-1. Sample Locations

Sample Description	Sample Method	EDB 524.2	Dissolved Oxygen HACH	Chloride SM 4500-CL B	Nitrate SM4500-NO2B	Nitrite SM4500-NO3F	Sulfate SM 4500-SO4E	Methane RSK-175	Alkalinity/ Carbonate/ Bicarbonate SM 2320B	Calcium/ Magnesium/ Sodium SM 3111B	Silicon SM 3111D		Comments
MW- 1	N	1	1										
MW- 2	N	1	1	1	1	1	1	1	1	1	1		Matrix Spike(MS)/MS Duplicate(D)
MW- 3	N	1	1										
MW- 4	N	1	1										
RW- 8	N	1	1										
MW- 10	N	1	1										Field Duplicate (FD)
MW- 11	N	1	1										
MW- 12	N	1	1										
RW- 13	N	1	1										
RW- 15	N	1	1										MS/MSD
MW- 16	N	1	1										
MW- 17	N	1	1										
MW- 19	N	1	1										
MW- 20	N	1	1										FD
MW- 21	N	1	1										
MW- 22	N	1	1										
MW- 24	N	1	1	1	1	1	1	1	1	1	1		
MW- 25	N	1	1										
MW- 26	N	1	1	1	1	1	1	1	1	1	1		
MW- 27	N	1	1										
MW- 28	N	1	1	1	1	1	1	1	1	1	1		
MW- 29	N	1	1	1	1	1	1	1	1	1	1		FD
MW- 30	N	1	1	1	1	1	1	1	1	1	1		
MW- 31	N	1	1										
Adams	N	1	1	1	1	1	1	1	1	1	1		
Deverman1	N	1	1										
Krahn	N	1	1	1	1	1	1	1	1	1	1		
N4T	N	1	1	1	1	1	1	1	1	1	1		
Old N4T	N	1	1	1	1	1	1	1	1	1	1		
Church	N	1	1										
Weston	N	1	1										
Post Office	N	1	1										
School	N	1	1	1	1	1	1	1	1	1	1		
Troxell	N	1	1	1	1	1	1	1	1	1	1		
Wick/GR	N	1	1										
Kaberna	N	1	1										
SWP01	N	1	1										MS/MSD
SWP02	N	1	1										
SWP03	N	1	1										FD
SWP04	N	1	1										
SWP05	N	1	1										
SWP06	N	1	1										
Environmental samples		42	42	12	12	12	12	12	12	12	12	0	
Field Duplicates Samples	FD	4		1	1	1	1	1	1	1	1		Selected from contaminated samples if possible
MS/MSD Samples	MS/SD	3		1	1	1	1	1	1	1	1		Selected from clean samples
Trip Blank Samples	TB	6											
Quality control samples		17	0	2	2	2	2	2	2	2	2	0	
Total samples		59	42	14	14	14	14	14	14	14	14	0	

SECTION 2
SUMMARY OF EXISTING INFORMATION

2.1 LOCAL SETTING

Nemo, South Dakota is a small unincorporated rural community (population 508 [2000 census]) along Boxelder Creek in Lawrence County. Nemo is located approximately 20 miles northwest of Rapid City in the northeastern portion of the Black Hills National Forest. The Black Hills region is situated between the Cheyenne and the Belle Fourche Rivers, and contains about one fifth of the State's population. The Black Hills are characterized by an uplifted elongated area, approximately 120 miles long and 60 miles wide, rising above the surrounding plains. The plains lie at about 3,000 ft above mean sea level (msl) and the maximum elevation within the Black Hills is at Harney Peak (7,242 ft above msl). Nemo is at 44 degrees, 111 minutes, 3 seconds north latitude and 103 degrees, 30 minutes, 19 seconds west longitude. The legal description for the Site includes the majority of the western half of Section 27, Township 3 North, Range 5 East. The Site is approximately 4,639 feet above msl.

2.2 REGIONAL CLIMATE

The climate of the Black Hills region is continental, with generally low precipitation influenced by topography, with hot summers and cold winters, and extreme variations in precipitation and temperatures. Annual precipitation ranges from approximately 17 inches in the low-lying plains, to approximately 27 inches in the northern highlands near Lead, South Dakota. Nemo is characterized by an average annual precipitation of about 20 inches per year between 1950 and 1998 (Carter, Driscoll, and Hamade, 2001). The greatest precipitation generally occurs in May and June, and the lowest precipitation is observed in November through February.

2.3 REGIONAL GEOLOGIC SETTING

The geologic structures associated with the Black Hills region are directly related to the geologic history of the Cordilleran Platform, the stable interior of the North American Continent. Precambrian rock forms the basement of the Cordilleran Platform, which has undergone metamorphism in numerous orogenic events, culminating in the Laramide Orogeny that resulted in the current uplift of the Black Hills. Following the Precambrian period, sedimentary deposits of sandstone, shale, limestone and dolomite represent transgressive seas through the Ordovician age, between 550 and 450 million years ago. Rocks of the Silurian age have been removed from the geologic record in the Black Hills by Devonian erosional activities that occurred in a terrestrial environment about 400 to 360 million years ago. The Lower Carboniferous period saw the emplacement of the Madison Limestone, in a warm, calm marine environment between 360 and 325 million years ago. The Madison Limestone is an important groundwater resource aquifer in South Dakota, characterized by Karst hydrogeology, consisting of large contiguous dissolution caverns forming preferential water pathways. The seas receded in the Upper Carboniferous, between 325 and 250 million years ago and a coastal environment deposited sandstones, shales, dolomites and anhydrite deposits of the Minnelusa Formation, another important groundwater resource aquifer that directly overlies the Madison Limestone along the periphery of the Black Hills. Following a period of erosion, the Opeche Shale was deposited atop the Minnelusa formation in the Upper Permian, which acts to confine the upward movement of groundwater in the Minnelusa formation, followed by the Upper Permian deposits of the Minnekhata Limestone, a productive but thin (maximum 60 feet thick) aquifer. The Triassic and Jurassic were periods of deposition of shale, anhydrite, limestone and sandstone, which characterize the Spearfish Formation, Sundance Formation, and Morrison Formation. The Lower Cretaceous was the period of deposition of the last important groundwater aquifer material in the Black Hills area, known as the Inyan Kara Group, consisting of massive to thin-bedded sandstones and conglomerates with clays, siltstone, limestone and coal. Although the Inyan Kara Group is not as permeable as the other aquifers, its thickness and effective porosity makes it a viable water resource.

2.4 Local Geologic Setting

The Site is located along the northeastern edge of the Precambrian outcrop that is the dominant feature in the Central portion of the Black Hills region. These are the oldest rocks in the Black Hills, consisting of igneous and metamorphic material between 1.7 and 2.5 billion years old. They were eroded nearly flat in the early Paleozoic period, and then overlaid by Paleozoic, Mesozoic, and Cenozoic sediments. During the Laramide Orogeny, the Black Hills underwent a period of uplift, followed by erosion of the Post-Precambrian sediments in the central Black Hills; leaving sedimentary layers tilted 15 to 20 degrees in a ring around the central Precambrian core. These sedimentary outcrops became the main recharge points for the Madison, Minnelusa, Minnekhata, and Inyan Kara aquifers.

In Nemo, the bedrock consists of Precambrian meta-sedimentary rocks (Redden, 1981) (Figure 2-1) including:

- Phyllite, a fine-grained metamorphic rock formed by the low grade metamorphism of fine-grained, sedimentary rocks, such as mudstones or shales;
- Quartzite, a compact, granular rock metamorphosed from sandstone in which silica, or quartz, has been deposited between the grains of quartz sand;
- Marble, a non-foliated metamorphic rock resulting from the metamorphism of limestone, composed mostly of calcite;
- Amphibolite, a metamorphosed igneous rock consisting mainly of hornblende amphibole; and
- Taconite, an iron-bearing, high-silica, flint-like rock, referred to as a banded iron formation due to the typical alternating iron-rich layers and shale or chert layers.

The meta-sedimentary rocks at Nemo dip vertically, and strike between 10 and 30 degrees west of north (Rahn and Johnson, 2002). Well-developed foliation in the phyllite trends along the bedding planes, as do the folds, while faults are observed both along the general strike, as well as across bedding planes. Although outcrops of Precambrian rock are observed in the upland areas around Nemo, thin deposits of alluvium and colluvium cover the bedrock in most locations.

Surficial deposits overlie the bedrock and include Quaternary terrace deposits and alluvium under the flood plain of Boxelder Creek and its tributaries. Based on monitoring well drill logs, these Quaternary deposits are range in thickness from 12 to 21 feet.

2.5 Local Geomorphic Features

Nemo is located in a river valley dominated by Boxelder Creek, which delineates the valley floor. North of the Site, Boxelder Creek flows from west to east until it encounters the tilted Cambrian limestone of the Madison Formation, then runs south, parallel to the limestone ridge. Boxelder Creek enters the area at approximately 4,650 ft above msl to the northwest of the Site, near the Ford Well, and drops about 50 ft over its eastern flow stretch (approximately 3,600 ft, or about 1 ft drop to 72 ft of run). Boxelder Creek runs southerly about 2,800 ft along the eastern perimeter of the Site, dropping about 20 ft, or about 1 ft of drop per each 140 ft of run. Boxelder Creek provides an important hydrologic control to the surface water and groundwater systems in proximity to the Site. Regionally, surface water is directed eastward over the Black Hills topography in the Precambrian core until it encounters the uplifted Paleozoic sedimentary aquifer outcrops of the Madison, Minnelusa, and Minnekhata formations. Most of the recharge for these important aquifers occurs at these outcrops. The Boxelder Creek flow is completely lost to the Madison Formation several miles south of the Site, except in periods of peak flow.

In the area, Boxelder Creek and Nemo are surrounded by regional highlands to the west, north, and east, with the valley lowlands extending south from the Site. Locally, the Site is characterized by a bedrock ridge, which extends from 100 to 160 feet above the valley floor at an elevation of about 4,730 ft above msl. The bedrock ridge is generally aligned with local strike of bedding planes and foliation (approximately N35°W).

Local faults passing through and adjacent to the Site have been identified by previous consultants as potentially important to the transport of groundwater and EDB in the local Precambrian aquifer. A near-vertical strike-slip fault has been observed just west of the local ridgeline at the Site, located by inference along the longitudinal axis of the EDB plume, striking at approximately N25°W. This fault is theorized to be both a preferential pathway for contaminated groundwater traveling along the trend, and a relatively impermeable boundary for contaminated water moving westward. Northeast of the Site, east-west trending normal faults have been inferred to pass through the town of Nemo, potentially further minimizing the movement of contaminated groundwater from the Site north of these faults.

2.6 Local Hydrogeologic Setting

At the Site, groundwater appears to be strongly influenced by local recharge from surface precipitation, especially in the vicinity of the local bedrock ridge just west of the Nemo Work Center. Groundwater elevations in monitoring wells installed by previous consultants at the Site have shown mounding following topography, with groundwater elevation maxima generally corresponding to the maximum ground surface elevation on the local bedrock ridge, near MW-20. Results from water level measurements between December 2003 and November 2007 show:

- At the northern perimeter of the Site (Troxell Well) approximately 100 feet south of Boxelder Creek, at an elevation of 4,641 ft above msl, groundwater elevations ranged from 4,614.95 to 4,615.56 ft above msl.
- Approximately 400 ft south of the Troxell Well, at 4,696 ft above msl (MW-1), groundwater elevations ranged from 4,615.44 to 4,619.71 ft above msl.
- Approximately 900 ft south of the Troxell Well, at 4,727 ft above msl (MW-20) near the maximum elevation of the bedrock ridge, groundwater elevations ranged from 4,631.95 to 4,634.82 ft above msl (MW-20 became an extraction well and water levels were not collected after May 2005).
- Approximately 2,500 feet south of the Troxell Well, at 4,630 ft above msl (MW-10), groundwater elevations ranged from 4,590.28 to 4,593.72 ft above msl.
- Approximately 4,600 feet south of the Troxell Well, at 4,568.62 ft above msl (MW-12), groundwater elevations ranged from 4,552.22 to 4,565.50 ft above msl.

2.7 HISTORY OF PAST INVESTIGATIONS

Periodic groundwater sampling and reporting was implemented in 2000 at the Site with at least ten rounds of groundwater sampling completed by February 2008 (MSE Inc. [MSE] from 2000 to 2005; and URS Corp. [URS] from 2007 to 2008). In 2005, a draft Engineering Evaluation/Cost Analysis (EE/CA) was published (MSE, 2005). Most recently, in March of 2008, the results of a passive soil gas survey were published (URS, 2008).

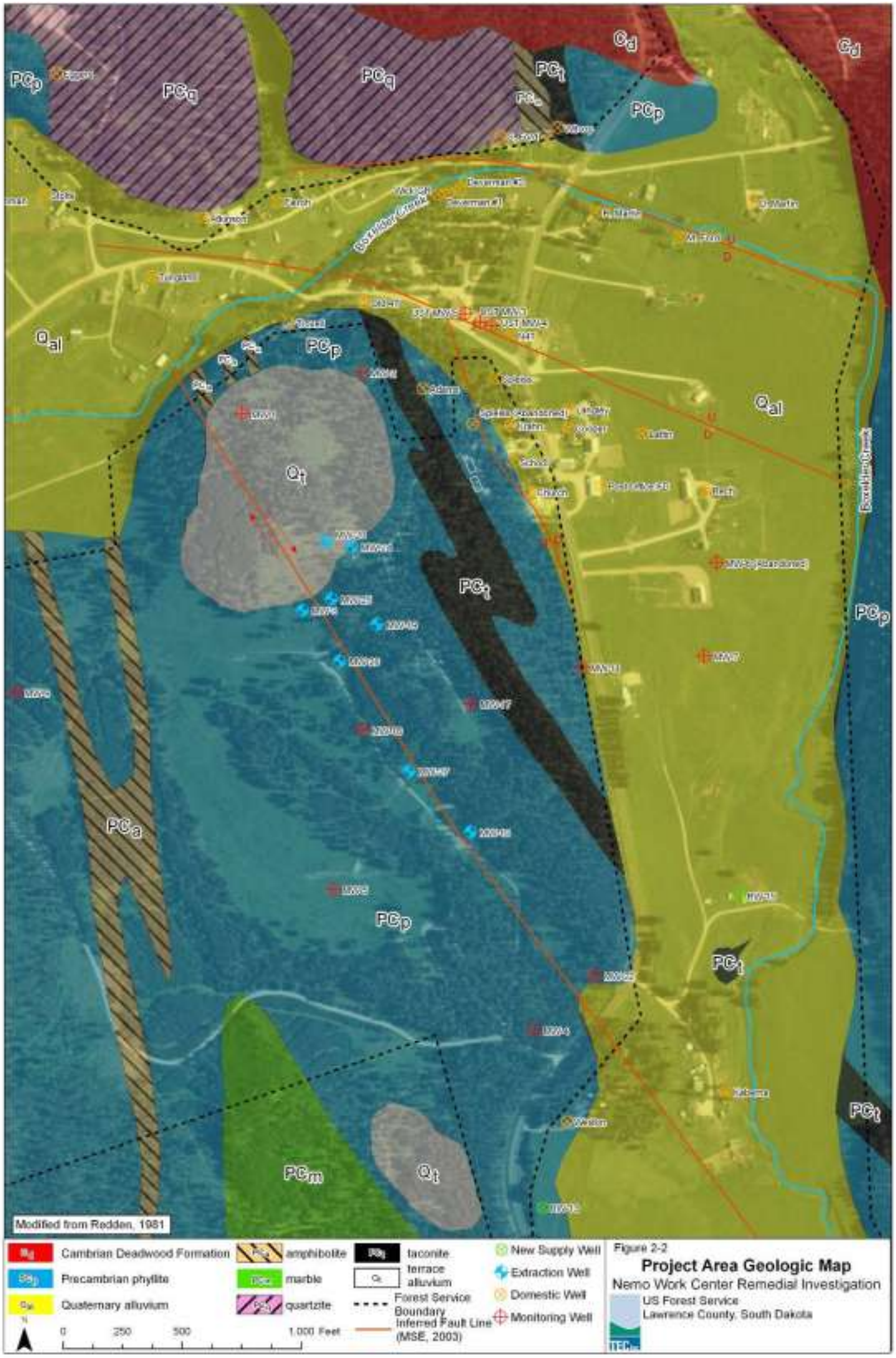
To date, a total of 31 groundwater wells have been installed as part of the environmental investigation conducted by the US Forest Service at the Site (MW-1-4, 8, 10-13, 15-17, 19-22, and 24-31):

- MW-8, MW-13, MW-15, and MW-21 located outside the area of contamination were converted to US Forest Service water supply wells (RW-8, RW-13, RW-15, and RW-21) for Nemo residents whose wells have been affected by EDB from US Forest Service activities;
- MW-3, MW-10, MW-20, MW-24, MW-25, MW-26, and MW-27 were converted to extraction wells in 2006 and 2007. These are plumbed to a granular activated carbon adsorption groundwater treatment system installed by URS Corporation in 2007 to control the migration of the EDB groundwater plume.
- MW-14 was abandoned in April 1998.
- MW-28, 29, 30, and 31 were installed and sampled during August 2009 as part of the Phase 2 WP field effort.
- In addition, seepwater monitoring points SWP-01 through 06 were installed and sampled during August 2009 as part of the Phase 2 WP field effort.

Based on the most recent measurements, the EDB plume(s):

- Extend in length approximately 4,780 ft from the Troxell well in the north to the Kaberna well in the in the south east, trending approximately 150 degrees from north; and
- Extend in width approximately 1,780 ft from the Post Office well in the westerly direction, although there is no well that delineates the western boundary of the plume at this location.

Figure 2-1. (Former Figure 2-2) Project Area Geologic Map



SECTION 3
PROJECT BACKGROUND

3.1 DESCRIPTION OF PROJECT

The project consists of carrying out a comprehensive RI/FS at the Site. This project will be conducted in a phased approach consisting of the following phases in accordance with CERCLA.

- A definitive contaminated media data gathering phase groundwater sampling.
- The analysis and reporting phase of the RI.
- The analysis and reporting phase of the FS.

CERCLA guidance recommends the development of a PP, which allows the public to participate through a public meeting to evaluate the proposed remedy. Public comments on the PP are documented in a Responsiveness Summary, which is part of the ROD. The ROD, which follows the completion of the RI/FS, documents the acceptance of the regulatory community, the public stakeholders, and the Responsible Parties to final CERCLA remedial action, prior to implementation of the remedial action.

3.2 PRELIMINARY CONCEPTUAL SITE MODEL

TEC has evaluated the existing data and developed a simplified CSM to help direct the RI/FS investigation. The current understanding of the environmental impact at the Site indicates that the primary mechanisms which control groundwater movement in the Nemo area include preferential flow paths created by structural and lithologic geologic features, groundwater recharge from precipitation on higher slopes surrounding the site, and Boxelder Creek. Geologic features governing local water bearing zones are described briefly below.

1. The Bedrock Ridge, which consists of a thin sedimentary overburden (1 to 15 feet in thickness) over fractured Precambrian metamorphic bedrock, is believed to be the primary location of the EDB contamination associated with the US Forest Service at the project site (suspected EDB burial pits west of the Site). Previous geologic interpretations indicate bedrock bedding planes are dipping nearly vertical, and striking approximately 150 degrees to the southwest. Previous interpretations of the EDB plume in the Bedrock Ridge indicate that it extends longitudinally in the general direction of bedding strike. Groundwater MWs indicate that groundwater within the ridge is commonly found in a series of confined fractures or bedding planes that are not strongly connected as observed by highly variable static water levels in adjacent wells. Current MWs do not isolate fracture systems, but are believed to be screened over multiple fractures with differing vertical gradients. In order to better define the interconnectivity of the fracture systems, a comprehensive geophysical survey was conducted during August 2009 to map the subsurface groundwater fractures and identify EDB migration pathways through the bedrock.

2. A shallow alluvial system associated with the valley west of the Bedrock Ridge transports water draining off the Bedrock Ridge to the east and a mountain range to the west; and potentially from loosing portions of the Boxelder Creek to the north of the shallow alluvial system. A northwest-southeast trending vertical strike-slip fault is interpreted to lie between the western alluvium and

the Bedrock Ridge, which may limit water movement from east to west and induce water movement to the north and south. Monitoring well MW-3 may be screened in close proximity to the fault, with some evidence that the fault influences water and EDB in the well.

3. A northeastern alluvial system that extends to the southeast associated with the valley east of the Bedrock Ridge, and the town of Nemo. Three underground storage tanks (USTs) removed from the Nemo Guest Ranch are associated with a petroleum release that is suspected from one or more of these USTs and includes EDB within this alluvial area beneath the Nemo Guest Ranch property. There is a strong potential that EDB from this release area may be affecting domestic wells within the eastern alluvium. Groundwater in the area is expected to originate from losing portions of the Boxelder Creek and from run-off and inflow from the surrounding ridges, including the Bedrock Ridge. Results from groundwater samples collected from MW-2, located on the northeast slope of the Bedrock Ridge between the Bedrock Ridge EDB plume and the Nemo Guest Ranch, have not detected EDB as of the last sample round in November 2007. Two additional MWs are proposed south of MW-2 and east of the suspected EDB burial pits to further assess groundwater movement from the Bedrock Ridge to the eastern alluvium. A stream flow survey was completed along the northern extent of Boxelder Creek to estimate where surface water may be gaining or losing and provide additional evidence of groundwater and contaminant flow directions. Previous geological interpretations indicate a series of block faults trending west-northwest to east-southeast that may affect groundwater movement in the Boxelder alluvial valley, including potentially limiting groundwater movement across the fault planes.

4. A series of cross sections have been generated presenting the subsurface conceptual model, including fracture zones, water levels in well screened areas, and fault traces with respect to the site map. Figure 3-1 presents the site map with the location of the cross sectional lines. Figures 3-2 and 3-3 provide example cross sections.

Recharge to the shallow bedrock aquifer west of the iron-rich Bedrock Ridge is provided by precipitation on the higher slopes west of Nemo. Groundwater west of the iron-rich Bedrock Ridge generally flows from the northwest to the southeast following the fault and southeast from MW-3 towards the Kaberna and Weston residences where geologic structures converge and groundwater discharges to Boxelder Creek. In May 1997 groundwater was observed flowing to the surface from a seep at this location (Flak seep).

This water flowed into Boxelder Creek. Analytical results for a water sample collected from the Flak seep showed 0.069 parts per billion (ppb) of EDB. During each monitoring event conducted since 1997, the location of the Flak seep has been checked. No water has been observed flowing from the Flak seep since the initial observation. EDB has not been detected in any other surface water samples.

The aquifer north and east of the bedrock ridge and beneath Nemo, exhibits sufficient permeability to promote infiltration of surface water from Boxelder Creek and transmission of groundwater to the southeast towards the Church well. The groundwater east of the bedrock ridge exhibits limited communication with the groundwater west of the ridge due to the presence of the fault and steeply dipping lower permeability strata which hydraulically separates the two flow regimes.

Boxelder Creek is recognized as a gaining stream as it enters the valley west of Nemo where recharge is largely controlled by local topography and drainage from the more confined valley immediately upstream. Within the town of Nemo, adjacent to the Troxell residence and downstream into the open valley east of Nemo, Boxelder Creek is recognized as a losing stream where surface water discharges into the alluvial aquifer. Flows may also be transmitted southeast through preferential flow paths created by northwest-southeast trending fault and steeply dipping lithologic contacts). Water levels in wells located in the northern portion of Nemo (Troxell, Adams, and Spleiss) appear lower than the elevation of Boxelder Creek throughout this reach and generally follow areas of high conductivity. Further east and south of Nemo, Boxelder Creek again becomes a gaining stream in the valley towards the Kaberna residence. Groundwater conditions and the predominant gradient in the valley would be controlled by recharge from areas of elevated topography to the east and groundwater discharge into Boxelder Creek.

3.3 Applicable Or Relevant And Appropriate Requirements And To-Be-Considered Guidance

Applicable or Relevant and Appropriate Requirements refer to standards and other substantive environmental protection requirements promulgated under US Federal or South Dakota state laws that specifically address a circumstance at a hazardous waste site such as the presence of a hazardous substance, pollutant, contaminant, remedial action, or location. “Applicability” implies that the circumstances at the Facility satisfy all of the jurisdictional prerequisites of a requirement and are legally applicable for the Facility. “Relevant and appropriate requirements” refer to standards and other substantive environmental protection requirements promulgated under US Federal or state law that are not legally applicable to a site but address situations sufficiently similar to be of use in evaluating the Facility. “Relevance” implies that the requirement regulates or addresses situations sufficiently similar to those found at the Site. “Appropriateness” implies that the circumstances of a release or threatened release of chemicals are such that use of the standard is suitable. A requirement may be relevant but not appropriate for a site and therefore would not be an ARAR.

To-Be-Considered (TBC) benchmarks are non-promulgated advisories, guidance or benchmarks that are not generally enforceable, but are guidance documents or advisories that may be considered in determining the necessary cleanup level for the protection of human health or the environment. TBCs may be used as guidance for evaluating chemicals where no ARARs exist or in situations where ARARs are not sufficiently protective of human health and the environment. ARARs and TBCs are used to determine the scope and extent of cleanup for a site. Levels of concern developed during a risk assessment are considered TBCs. They help to formulate remedial action alternatives as well as govern the implementation and operation of a selected action.

3.4 Preliminary ARARs and TBCs for the Site

The focus of the ARARs and TBC are chemical in nature and based primarily on the presence of EDB. Based upon the current knowledge of the Site, the state and Federal ARARs that apply include those relating to groundwater, surface water, soil, air, hazardous and solid wastes, remediation systems water discharge and air emissions, and historic preservation. They are described in the previous Phase 2 WP and listed below:

<u>Water Discharge Systems</u>

Federal:

The Clean Water Act, Section 303: *Water Quality Standards and Implementation Plans*

Title 40 of the Code of Federal Regulations (CFR), Part 131

Title 40 of the CFR, Part 141, ***National Primary Drinking Water (NPDW) Regulations***

Title 40 of the CFR, Part 143, ***National Secondary Drinking Water (NSDW) Regulations***

Title 40 of the CFR, Part 144, ***Underground Injection Control (UIC) Program***

The National Contingency Plan (NCP) (CFR Part 300)

State of South Dakota

South Dakota Administrative Rule (SDAR) 74:51, Surface Water Quality, Section 74:51:01, ***Surface Water Quality Standards***

SDAR 74:51, Surface Water Quality, Section 74:51:03, ***Uses Assigned to Streams***

SDAR 74:54, Groundwater Quality, Section 74:54:01, ***Groundwater Quality Standards***

SDAR 74:54, Groundwater Quality, Section 74:54:02, ***Groundwater Discharge Permits***

SDAR 74:04, Water Hygiene, Section 74:04:09, Capacity ***Requirements for Community and Non-Community Water System***

SDAR 74:55, Underground Injection Control, Section 74:55:02, ***Underground Injection Control—Class I, IV, and V Well***

Pesticides

Federal:

7 USC. 136, ***The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA***

Figure 3-1. (Former Figure 3-4) Cross Section Layout Map

Figure 3-2. (Former Figure 1-2) Cross Section A-A’

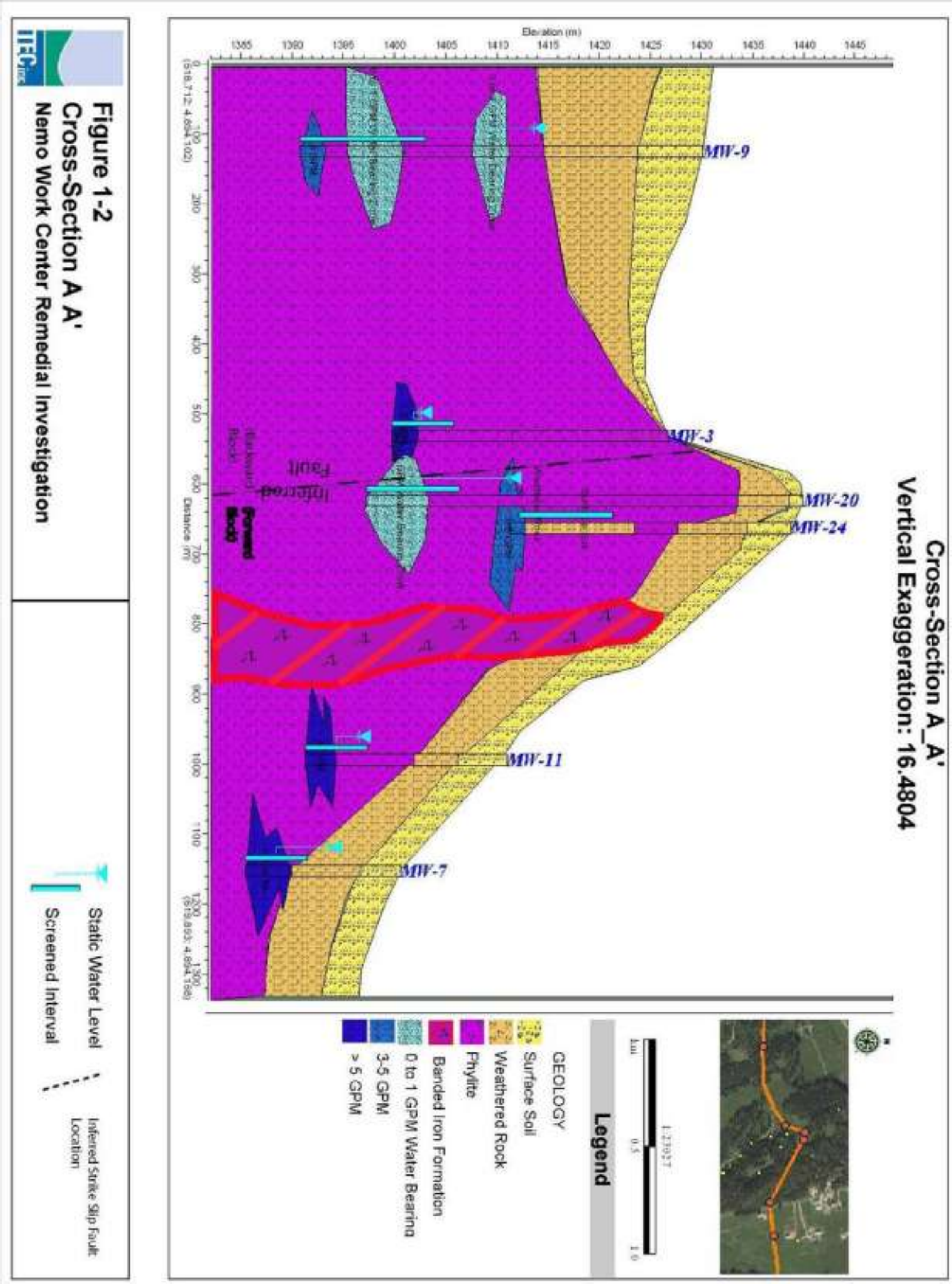
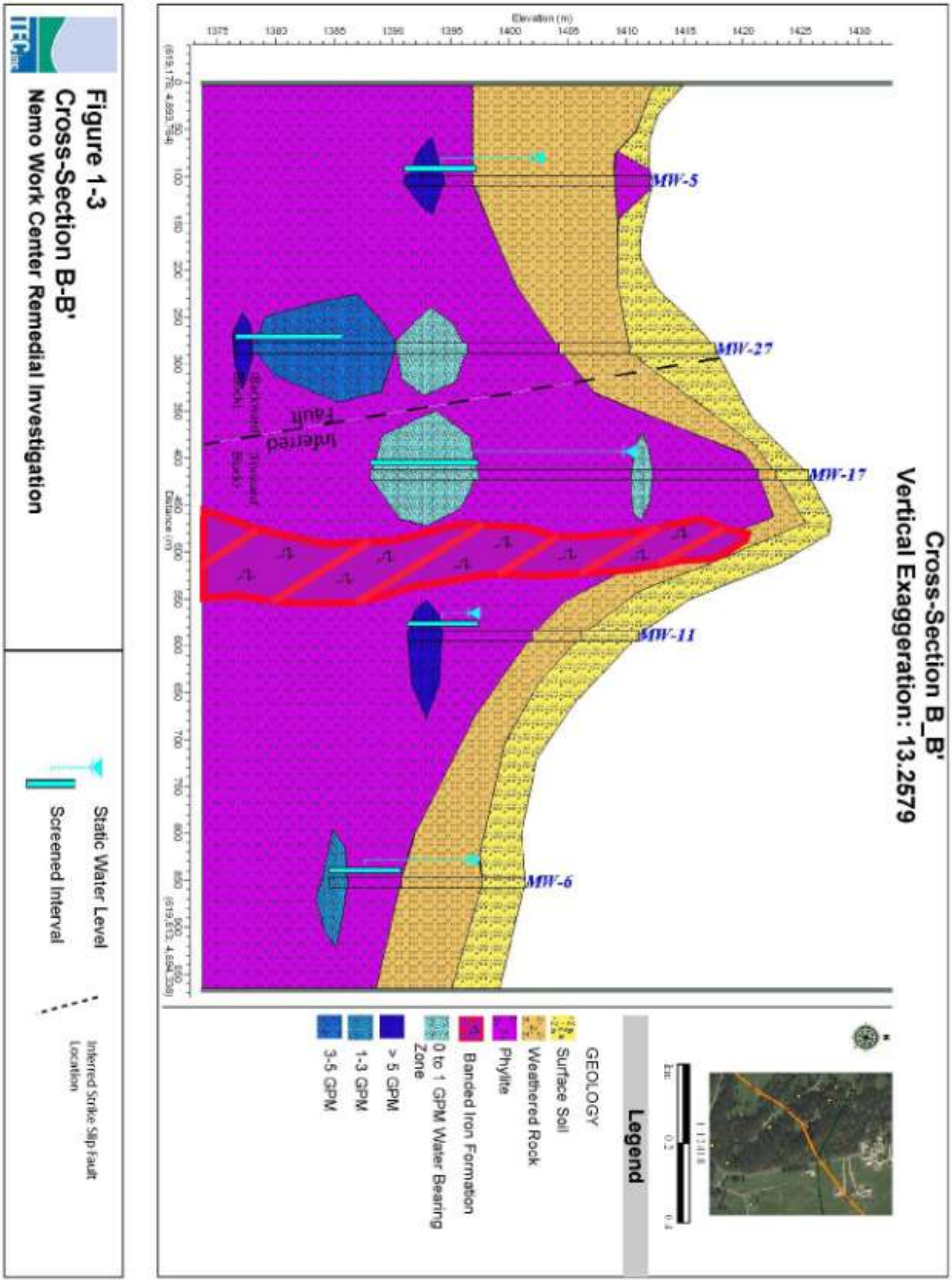


Figure 3-3. (Former Figure 1-3) Cross Section B-B'



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SECTION 4
PROJECT TASKS

4.1 INTRODUCTION

Weston and TEC under Blanket Purchase Agreement NAB08002 prepared these project tasks, in response to the request for proposal from the USFS. The USFS asked the Weston/TEC Team to provide a cost/task proposal to including providing a cost estimate and rationale for field investigation tasks selected to fill the most critical data gaps identified in the Existing Information/Data Quality Report (Weston Solutions/TEC February 2009).

4.2 PLANNING DOCUMENTS

The work plan defines the scope and objectives of RI/FS activities to the extent possible. The scope of the RI site characterization is documented in the work plan, with detailed descriptions provided in the in the FSP. Later project tasks are scoped in less detail, pending the acquisition of more complete data about the site. This Revised Phase 2 work plan has been prepared to incorporate a March 2010 round of groundwater sampling and analytical data into the in-progress RI report. Because the RI/FS process is dynamic and iterative, the work plan or supplemental plans, such as the QAPP and the FSP, can be modified during the RI/FS process to incorporate new information and refined project objectives. The work plan has been revised, for this additional iteration (March 2010) of site characterization activities.

4.3 FIELD SAMPLING PLAN

The FSP consists of the six elements listed below:

- Site Background – This analysis includes a description of the site and surrounding areas and a discussion of known and suspected contaminant sources, probable transport pathways, and other information about the site.

- Sampling/Data Collection Objectives – Specific objectives of a sampling and data collection effort that describe the intended uses of data should be clearly and succinctly stated.

- Sample/Data Collection Location and Frequency – This section of the sampling plan identifies each sample matrix to be collected and the constituents to be analyzed. A table will be used to clearly identify the number of samples to be collected along with the appropriate number of replicates and blanks. A figure will be included to show the locations of existing or proposed sample points.

- Sample Designation – A sample numbering system will be established for each project. The sample designation will include the sample or well number, the sampling round, the sample matrix (e.g., surface soil, ground water, soil boring), and the name of the site.

- Sampling/Data Collection Equipment and Procedures – Sampling and data collection procedures are clearly written step-by-step instructions for each type of sampling or data collection effort and are necessary to enable the field team to gather data that will meet the data quality objectives

(DQOs). A list will include the equipment to be used and the material composition (e.g., Teflon, stainless steel) of the equipment along with decontamination procedures.

- Sample Handling and Analysis – A table is included that identifies sample preservation methods, types of sampling jars, shipping requirements, and holding times.

4.4 QUALITY ASSURANCE PROJECT PLAN

A project-specific RI QAPP has been prepared. It covers any analytical methods and data validation procedures to be used to ensure that data sampled and analyzed will meet the appropriate data quality objectives to be used for its intended purposes. Weston and TEC have developed project-specific DQOs designed to ensure data of adequate quality are collected to support project decisions. DQOs were developed in accordance with US Environmental Protection Agency (EPA) QA/G4 Guidance for the DQO Process (most recent version) and documented in the project QAPP. All laboratory services shall be conducted in accordance with the approved project QAPP, unless written approval of a variance request is obtained from the US Forrest Service. Variance requests shall be submitted to the US Forrest Service in writing and should include adequate justification for the variance. Approved variance requests shall be included in the FSP. Samples shall not be submitted for analysis until the QAPP is approved by the US Forrest Service. Only those aspects of a QAPP that are specific to the site being investigated need to be explicitly described. If site-specific information is already contained in another document (e.g., the FSP) it need only be referenced. Similarly, any information contained in guidance documents such as the *DQO Guidance* should only be referenced and not repeated in the QAPP.

4.5 HEALTH AND SAFETY PLAN

Protecting the health and safety of the investigative team and the public is a major concern during remedial response actions. Workers may be exposed to a variety of hazards including toxic chemicals, biological agents, heat or other physical stresses, equipment-related accidents, and fires or explosions. The surrounding community may be at increased risk from unanticipated chemical releases created by onsite activities.

A site-specific HASP has been prepared to comply with US Forest Service, Occupational Safety and Health Administration (OSHA), EPA, state, and local health and safety regulations regarding the proposed work effort. As applicable, the Weston/TEC Team will use EPA guidelines for designating the appropriate levels of protection needed at the study sites. The project manager will maintain written certification that the approved HSP has been reviewed with all personnel that work at the project site prior to their mobilization.

All on-site workers (Contractor and subcontractor) performing hazardous operations, including working with hazardous materials, will have completed the OSHA 1910.120 Hazardous Waste Operations and Emergency Response (HAZWOPER) training and/or other applicable training, plus annual refresher courses. Weston and TEC will maintain documentation supporting training records and have the site-specific HSP on site available for workers and/or regulatory review.

4.6 FIELD TASKS

Samples will be collected from 36 existing wells for this field effort. Six samples will also be collected at recently installed seep water points. All groundwater samples will be sampled and analyzed for EDB only using drinking water method E524.2 as an added analyte (EDB is normally analyzed as a pesticide). E524.2 is a drinking water method. Because the matrix sampled is groundwater and, generally analyzed by solid waste methods (SW846), additional QC is proposed to ensure that the analyses are not affected by matrix interference. This is consistent with previous sampling events at the site. Data packages will include USEPA level 3 and USEPA level 4 results from the contract laboratory and will be validated for risk assessment purposes.

Selected groundwater samples will also be analyzed for dissolved oxygen, chloride, nitrate, nitrite, sulfate, methane, methane, alkalinity, and major ions (per Table 1-1). These results will provide parameters for evaluating natural degradation of EDB at the site, and will be used in evaluating the fate of the EDB in groundwater. These results will be for screening and will not require data validation. Limited field parameters (listed in the FSP) will also be collected during the sampling event.

Additional QC samples will include four EDB field duplicates, up to six trip blanks, and three matrix spike/spike duplicates.

4.7 Sample Analysis and data Validation

These tasks include laboratory evaluation, organizing delivery of supplies and sample shipment logistics, interface between sampling team and laboratory project manager, organizing procedures for database implementation via the laboratory information management system and laboratory database manager, and general laboratory coordination. The two general categories of data used in RI/FS investigations are defined as: (1) screening data and (2) definitive data.

Screening data are generated by rapid methods of analysis with less rigorous sample preparation, calibration and/or QC requirements than are necessary to produce definitive data. Sample preparation steps may be restricted to simple procedures such as dilution with a solvent, instead of elaborate extraction/digestion and cleanup. Screening data may provide analyte identification and quantitation, although the quantitation may be relatively imprecise. Physical test methods, e.g., dissolved oxygen measurements, temperature and pH measurements, moisture content, turbidity, conductance, etc., have been designated by definition as screening methods.

Definitive data are generated using rigorous analytical methods (see QAPP), such as approved EPA reference methods. The data can be generated in a mobile or off-site laboratory. Data are analyte-specific, and both identification and quantitation are confirmed. These methods have standardized QC and documentation requirements. Definitive data are not restricted in their use unless quality problems require data qualification.

Data will be managed internally by TEC following the receipt of field data, which will be entered into our Master Data worksheet (Excel-based), and then uploaded into our integrated Geographic Information System (GIS)-based Environmental Restoration data management system for generation of cross-sections, borelogs, well construction logs, 3-D fence diagrams, and GIS maps for development of complex CSMs and GIS-based layers for 3-D fate and transport modeling.

The project data management system is based on the premise that all data must flow from single-error free master data sources, in a manner that minimizes conflicting results that occur from multiple data entry. Once the data sets are developed, if errors are found or new data is obtained, revisions are made in the Master Data sets which flow through the remaining deliverables.

4.7.1 Data Validation

The data reduction, review, reporting, and validation procedures described in QAPP will ensure; (1) complete documentation is maintained, (2) transcription and data reduction errors are minimized, (3) the data are reviewed and documented, and (4) the reported results are qualified if necessary. Laboratory data reduction and verification procedures are required to ensure the overall objectives of analysis and reporting meet method and project specifications. The analysts shall perform a 100 percent review of the screening data.

The laboratory QA staff shall issue QA reports to the laboratory management, laboratory supervisors and task leaders. These reports shall describe the results of QC measurements, performance audits, and systems audits, and confirmation sample comparisons performed for each sampling and analysis task. Quality problems associated with performance of methods, completeness of data, comparability of data including field and confirmatory data, and data storage shall be documented with the corrective actions that have been taken to correct the deficiencies identified.

4.7.2 3-D Numerical Groundwater Model

Equations describing ground water flow and contaminant transport are very non-linear and analytical solutions only exist for isotropic and homogeneous aquifers. Numerical models perform transport calculations by approximating the flow equations using very small increments of space and time allow geologic complex sites to be modeled.

The models used to describe ground water flow and contaminant transport at the site are part of the Groundwater Modeling System. This software serves as GIS type graphical user interface allowing complex hydrogeologic CSMs to be mapped to a numerical model grid. The hydrogeologic CSM consists of a simplified description of the site features that are most important in determining how groundwater will migrate through the site under both natural and manmade conditions. These include topographic features, such as surface water locations and topographic relief; and soil and rock characteristics, such as porosity, hydraulic conductivity, anisotropy, thickness.

Ground water modeling will be used to:

- Validate the CSM;
- Increase the understanding of the hydrogeology and contaminant transport dynamics of the Site;
- Optimize the layout and operation of pump and treat remediation system; and
- Predict the progress fate and transport of EDB, which is the contamination of concern at the Site.

SECTION 5
REMEDIAL INVESTIGATION REPORT

The RI will serve as the mechanism for collecting data to characterize site conditions, determine the nature of the contamination, assess risk to human health and the environment; and conduct treatability testing to evaluate the potential performance and cost of the treatment technologies that are being considered. The RI Report will be prepared to document the site background, and the results of previous investigations, describe the field activities and results, present the nature and extent of impacted material, develop a list of ARARs and TBC criteria, screen compounds detected on-site for compounds of potential concern (COPCs), provide a CSM to describe the potential exposure pathways and potential receptors of the COPCs, conduct a baseline risk assessment to quantify the risk associated with the COPCs, and provide recommendations and conclusions for remedial alternatives, if necessary. A baseline risk assessment is developed to identify the existing or potential risks that may be posed to human health and the environment by the site. Because this assessment identifies the primary health and environmental threats at the site, it also provides valuable input to the development and evaluation of alternatives during the FS. The RI Technical Report will be provided in draft format for the US Forest Service to review, then finalized after comments and concerns are resolved. TEC will prepare digital photo documentation, including sites and buildings under investigation, field activities, and sample locations.

5.1 PAST STUDIES

The US Forest Service requested an EI/DQ document to evaluate previous investigation results, identify data gaps, and provide recommendations for additional investigation activities. The purpose of the EI/DQ Report is to summarize the large body of work that has been conducted by the US Forest Service since EDB was first determined to be a potential hazard at the Site by the US Bureau of Reclamation in 1994. The EI/DQ Report provides the basis for the RI/FS Phase 2 Work Plan, and decisions regarding activities to be conducted in the RI/FS will be evaluated based on the conclusions of this report.

5.2 FIELD INVESTIGATION

Field investigation tasks are structured to flow in a general to specific, results-linked, phased investigation, designed to streamline operations and schedules.

This task involves documenting efforts related to fieldwork in conducting the RI. The task begins when any element, as outlined in the work plan, is approved (in whole or in part) and fieldwork is authorized. Field investigation is defined as complete when the contractor and subcontractors are demobilized from the field.

5.3 SITE PHYSICAL CHARACTERISTICS

The analysis of existing data serves to provide a better understanding of the nature and extent of contamination and aids in the design of remedial investigation tasks. Quality assurance information on existing sampling data will be reviewed to assess the level of uncertainty associated with the data. This is important to establish whether sampling will be needed to verify or simply supplement existing data.

Existing data will be used to develop a site description, which should include location, ownership, topography, geology, land use, waste type, estimates of waste volume, and other pertinent details. The site description will also include a chronology of significant events such as chemical storage and disposal practices, previous site visits, sampling events, regulatory violations, legal actions, and changes in ownership. In addition, information concerning previous cleanup actions, such the existing pump and treatment system, is often valuable for determining the characteristics of any wastes or contaminated media remaining at the site. All sources of information or data will be summarized in a technical memorandum or retained for inclusion in the RI report.

5.4 CONCEPTUAL SITE MODEL

Information on the waste sources, pathways, and receptors at a site are used to develop a conceptual understanding of the site to evaluate potential risks to human health and the environment. The conceptual site model will include known and suspected sources of contamination, types of contaminants and affected media, known and potential routes of migration, and known or potential human and environmental receptors. This effort, in addition to assisting in identifying locations where sampling is necessary, will also assist in the identification of potential remedial technologies.

5.5 NATURE AND EXTENT OF EDB CONTAMINATION

The final objective of the field investigations is to characterize the nature and extent of the EDB contamination such that informed decisions can be made as to the level of risk presented by the site and the appropriate type(s) of remedial response. This process involves using the previously gathered information collected during the RI on EDB source location and physical site data (e.g., ground-water flow directions, over land flow patterned) to give an estimate of the locations of contaminants including their migration pathways.

In this case, this approach consists of having taken a large number of samples using screening level techniques and then, based on the results of these samples, taking additional samples - to be analyzed more rigorously - from those locations that showed the highest concentrations in the previous round of sampling. The final step is to document the extent of contamination using an analytical level that yields data quality that is sufficient for the risk assessment and the subsequent analysis and selection of remedial alternatives.

At the Site, the nature and extent of contamination may be of concern in four media: groundwater, soil, surface water, and sediments, all of which will be considered in the analysis.

5.6 FATE AND TRANSPORT INCLUDING GROUNDWATER AND VADOSE ZONE MODELING

The models used to describe groundwater flow and contaminant transport at the Site are part of the Groundwater Modeling System. This software serves as a GIS graphical user interface allowing complex hydrogeologic CSMs to be mapped to a numerical model grid. The hydrogeologic CSM consists of a simplified description of the site features that are most important in determining how groundwater will migrate through the site under both natural and manmade conditions. These include topographic features, such as surface water locations and topographic relief; and soil and rock characteristics, such as porosity, hydraulic conductivity, anisotropy, and thickness.

The model used for groundwater flow will be *MODFLOW 2000*. This model simulates groundwater flow in heterogeneous and anisotropic media in three dimensions. The contaminant transport modeling will be done using the MultiSpecies Transport in Three Dimension solute transport model. This model simulates the movement of dissolved species due to advective and dispersive processes in an aquifer. It can also simulate retardation of the solute due sorption on the aquifer matrix and simulate natural attenuation as a first order decay process.

Groundwater modeling will be used to:

- Validate the CSM;
- Increase the understanding of the hydrogeology and contaminant transport dynamics of the site;
- Optimize the layout and operation of the pump and treat remediation system; and
- Predict the fate and transport of EDB, which is the contaminate of concern at the Site.

5.7 Applicable or Relevant and Appropriate Requirements and To-Be-Considered Screening

The fundamental purpose of ARARs is to define the minimum level of protection that must be provided by a remedy selected and implemented under CERCLA. Section 121 of CERCLA provides that any "standard, requirement, criteria or limitation" under any federal environmental law, or any more stringent state standard, requirement, criteria, or limitation under an environmental or facility siting law, may be an ARAR with respect to a hazardous substances that will remain onsite if such requirement is:

- legally applicable to the substance, site, or action contemplated;
- relevant and appropriate under the circumstances;
- "substantive" in nature.

Remedial action taken under CERCLA must require "a level or standard of control" which at least attains such requirement. ARARs must be determined on a site-by-site basis considering the specific substances that have been released, the location of each release, and the alternative actions for responding to the release under consideration at the site. For the Nemo project EDB is the primary contaminant where the ARARs apply. An initial ARAR was completed under the EI/DQ, and will be reviewed and finalized under as part of this work plan.

TBCs are non-promulgated advisories, criteria, guidance, or proposed standards issued by federal or state government. They do not have the status of ARARs because they are not enforceable or promulgated. TBCs may be consulted to interpret ARARs or to determine remediation goals when ARARs do not exist or are insufficient. Compliance with TBCs is not mandatory unless the TBC is adopted by the ROD. TBCs usually fall into one of three categories,

- Health-effects information with a high degree of credibility (e.g., SDWA Health Advisories, Reference Doses, and Potency Factors).

- Technical information on how to perform or evaluate response actions (e.g., RCRA guidance on designing caps for closure).

- Policy documents (e.g., Groundwater Classification Guidelines). Conduct baseline human health and ecological risk assessments

5.8 BASELINE HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

The baseline risk assessment provides an evaluation of the potential threat to human health and the environment in the absence of any remedial action. It provides the basis for determining whether or not remedial action is necessary and the justification for performing remedial actions. The baseline risk assessment will also be used to support a finding of imminent and substantial endangerment if such a finding is required. Detailed guidance on evaluating potential human health impacts as part of this baseline assessment is provided in the Superfund Public Health Evaluation Manual (U.S. EPA, October 1986).

In general, the objectives of a baseline risk assessment may be attained by identifying and characterizing the following:

- Toxicity and levels of hazardous substances present in relevant media (e.g., air, groundwater, soil, surface water, sediment, and biota);

- Environmental fate and transport mechanisms within specific environmental media such as physical, chemical, and biological degradation processes and hydrogeologic conditions;

- Potential human and environmental receptors;

- Potential exposure routes and extent of actual or expected exposure;

- Extent of expected impact or threat; and the likelihood of such impact or threat occurring (i.e., risk characterization); and

- Level(s) of uncertainty associated with the above items.

The risk assessment process can be divided into four components:

- Contaminant identification;

- Exposure assessment;

- Toxicity assessment; and

- Risk characterization.

5.9 CONCLUSIONS AND RECOMMENDATIONS

This section will summarize the findings from the RI including the nature and extent of contamination, contaminant fate and transport, and the risk assessment. Contaminants of concern are identified and recommendations for further monitoring or remediation are presented. Also data gaps are identified that could lead to additional studies. This section will also identify if a FS is required and what the rationale for the next steps are.

SECTION 6
FEASIBILITY STUDY

Although the Site is not on the National Priority List (NPL), the US Forest Service has chosen to follow the CERCLA process, in an agreement with the State of South Dakota. As such, efforts will be focused on utilizing presumptive remedies defined in EPA guidance documents (Presumptive Remedies: Policies and Procedures, OSWER Directive 9355.0-47FS and others) for contaminated soil and groundwater.

The purpose of the FS is to develop and evaluate remedial alternatives for mitigating risks associated with potential exposure to EDB contaminated media at the Site. The evaluation of alternatives presented in the FS Report will be used to support a PP and ROD in selection of the final remedial actions to be implemented at the Site. The US Forest Service intends to use information gathered during the RI to develop site-specific cleanup levels and evaluate remedial alternatives. The information to be used includes the nature and extent of contamination and estimates of potential risk associated with exposure to COPCs in soil and groundwater at the site, in this case EDB. COPCs will be defined in the RI Report as the major risk-contributing constituents for media and exposure pathways with potentially unacceptable levels of risk. The COPCs served as a basis for identifying the list of affected media requiring remediation, developing cleanup levels, and developing remedial alternatives to mitigate the unacceptable risk.

The FS will be conducted to identify and evaluate available response options, remedial technologies, and process options for remediating affected media at the site, and to determine the most effective overall approach to achieve the desired objectives in a practical and economical way.

The FS will consider the following site-specific factors:

- the contaminants present;
- the affected media;
- the accessibility and location of the affected media;
- the size and volume of affected media;
- the planned future land use for the site; and
- the site sensitivity or the potential receptors of site contaminants.

This will be accomplished by assessing the results of previous investigations and reviewing past and current pilot-scale studies at the sites to identify data gaps, eliminate ineffective technologies, and move forward with effective technologies. In areas where promising technologies have not been fully evaluated, additional pilot-scale tests will be conducted.

Typically, during a FS, the following steps will be conducted:

- identify potential response actions;

- define possible remedial technologies that might be used at this site;
- screen remedial technologies for practical application, effectiveness, and cost;
- determine process options; and
- evaluate costs.

6.1 DEVELOPMENT OF SCREENING ALTERNATIVES

Alternatives for remediation are developed by assembling combinations of technologies, and the media to which they would be applied, into alternatives that address contamination on a site wide basis or for an identified operable unit. This process consists of six general steps:

1. Develop remedial action objectives specifying the contaminants and media of interest, exposure pathways, and preliminary remediation goals that permit a range of treatment and containment alternatives to be developed.
2. Develop general response actions for each medium of interest defining containment, treatment, excavation, pumping, or other actions, singly or in combination that may be taken to satisfy the remedial action objectives for the site.
3. Identify volumes or areas of media to which general response actions might be applied, taking into account the requirements for protectiveness as identified in the remedial action objectives and the chemical and physical characterization of the site.
4. Identify and screen the technologies applicable to each general response action to eliminate those that cannot be implemented technically at the site.
5. Identify and evaluate technology process options to select a representative process for each technology type retained for consideration.
6. Assemble the selected representative technologies into alternatives representing a range of treatment and containment combinations, as appropriate.

6.2 REMEDIAL ALTERNATIVES

Remedial action objectives are currently under development. The goal of the RI is to develop remedial goals that will be protective of human health and the environment under the current and anticipated future land-use scenarios. In addition, multi-media sampling shows that EDB is present at the site above the drinking water standard. As a result, it is probable that one or more treatability studies will be recommended to evaluate potential remedial alternatives.

Remedial alternatives are currently under development for the Site. One remedial alternative that will be evaluated is the pump and treat system currently in place. It is not yet clear that this system will inhibit migration pathways to receptors. The initial CSM indicates that groundwater movement in the bedrock ridge water-bearing zone is constrained by relatively low hydraulic conductivities and shallow gradient, and localized in the area.

In order to provide site-specific information regarding the expected results of various remedial alternatives to be evaluated in the FS, treatability may be evaluated. The next step is to review past and current pilot-scale removal actions to determine data gaps, eliminate ineffective technologies, and to conduct additional tests on those technologies that have shown promise. The following step is to conduct additional treatability studies to eliminate any unresolved factors that were posed by the review of the previous data (this step is not currently part of the work plan).

6.3 DETAILED ANALYSIS OF ALTERNATIVES

The detailed analysis of alternatives consists of the analysis and presentation of the relevant information needed to allow decision makers to select a site remedy, not the decision-making process itself. During the detailed analysis, each alternative is assessed against the evaluation criteria described in this chapter. The results of this assessment are arrayed to compare the alternatives and identify the key tradeoffs among them. This approach to analyzing alternatives is designed to provide decision makers with sufficient information to adequately compare the alternatives, select an appropriate remedy for a site, and demonstrate satisfaction of the CERCLA remedy selection requirements in the ROD.

The specific statutory requirements for remedial actions that must be addressed in the ROD and supported by the FS report are listed below. Remedial actions must:

- Be protective of human health and the environment
- Attain ARARs (or provide grounds for invoking a waiver)
- Be cost-effective
- Utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable
- Satisfy the preference for treatment that reduces toxicity, mobility, or volume as a principal element or provide an explanation in the ROD as to why it does not

Alternatives are defined to match contaminated media with appropriate process options. However, the alternatives selected as the most promising may need to be better defined during the detailed analysis. Each alternative should be reviewed to determine if an additional definition is required to apply the evaluation criteria consistently and to develop order-of-magnitude cost estimates (i.e., having a desired accuracy of +50 percent to -30 percent). The information developed to define alternatives at this stage in the FS process may consist of preliminary design calculations, process flow diagrams, sizing of key process components, preliminary site layouts, and a discussion of limitations, assumptions, and uncertainties concerning each alternative.

Pursuant to CERCLA guidance (USEPA, 1988), the remedial alternatives investigated in this FS will be evaluated according to their ability to meet the following criteria:

1. Overall protection of human health and the environment;

2. Compliance with ARARs;

3. Long-term effectiveness and permanence of the remedial action to minimize risks;

4. Reduction of toxicity, mobility, and volume through treatment;

5. Ability to meet short-term remediation goals, including minimization of adverse health, safety, and environmental impacts during remedial activities;

6. Technical viability, reliability, and implementability; and

7. Cost-effectiveness and economic feasibility.

The alternatives will also be evaluated against two additional criteria after public and regulator comments are received on the FS report and draft PP:

8. State acceptance; and

9. Community acceptance.

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