Multi-Phased Remedial Investigation (RI)
of Surface and Subsurface Contamination of Soldier Creek
at Tinker AFB, Oklahoma
U.S. Air Force Installation Restoration Program

FINAL

FEASIBILITY STUDY INITIAL SCREENING OF ALTERNATIVES REPORT

FEBRUARY 1993

TINKER PROJECT NO: WWYK89-0196B
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WASTE SCIENCE AND TECHNOLOGY CORP.

SOLDIER CREEK RI/FS (NPL Site)
Prepared for: Tinker Air Force Base through
U.S. Army Corps of Engineers
Tulsa District

FINAL
FEASIBILITY STUDY INITIAL SCREENING OF ALTERNATIVES REPORT
TINKER AFB - SOLDIER CREEK RI/FS

Prepared for:
TINKER AIR FORCE BASE
through
TULSA DISTRICT CORPS OF ENGINEERS
CONTRACT NO. DACA56-89-C-0062

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EXECUTIVE SUMMARY

This Feasibility Study (FS) Initial Screening of Alternatives report provides a preliminary examination and discussion of the technologies and alternatives to be included in the FS for the Soldier Creek Site. The report presents the remedial action objectives for the Soldier Creek Site, estimates the extent of contaminated media requiring remediation, presents and evaluates remedial technologies and process options, develops the retained technologies and process options into alternatives, and screens the alternatives for the remediation of the Soldier Creek Site.

Remedial action objectives were developed for the Soldier Creek Site to determine the degree of cleanup required. The objectives for sediment and surface water consist of the following:

- Prevent the ingestion of or direct dermal contact with sediment and surface water containing contaminant concentrations greater than the cleanup goals.

- Prevent the migration of contaminants from sediment to the groundwater that would result in groundwater contamination in excess of the groundwater cleanup goals.

No sediment contaminants were detected above the cleanup goals for the Soldier Creek Site. The following six surface water contaminants were detected above the preliminary cleanup goals (Ambient Water Quality Criteria) for the site.

Contaminant of Concern	Cleanup Goal (ug/L)
Benzene	0.66
1,2-Dichlorobenzene	0.033
Tetrachloroethene	0.8
Cadmium	1.8
Chromium	11
Lead	1.3

Contaminant of Concern	Cleanup Goal (ug/L)
Cadmium	1.8
Chromium	11
Lead	1.3

Six sediment and surface water (SSW) alternatives were developed to address the contamination at the Soldier Creek Site. The alternatives are as follows:

- SSW Alternative 1--No Action: The site would be left as is, and no funds would be expended to remediate the site.

- SSW Alternative 2--Limited Action: Sediment, surface water, and groundwater monitoring would be conducted.

- SSW Alternative 3--Capping: A concrete cap would be constructed over contaminated areas in this alternative. Use restrictions would be placed on the capped areas and a fence would be constructed around the perimeter of the capped areas.

- SSW Alternative 4--Sediment Excavation and Off-base Landfill Disposal: Contaminated sediment would be excavated and dewatered onsite and then transported to an off-base RCRA-permitted hazardous waste landfill for disposal.

- SSW Alterative 5--Sediment Excavation, Stabilization, and Off-base Landfill Disposal: Contaminated sediment would be excavated and transported to an on-base area for stabilization. Stabilized sediment would be transported to an off-base landfill for disposal.

- SSW Alternative 6--Sediment Excavation and Soil Washing: Contaminated sediment would be excavated and transported to an on-base area for soil washing. Soil washing would remove organic and inorganic contaminants from the sediment. Treated sediment would be replaced in the excavated areas. Treatment residuals may require further treatment before disposal.

The FS Initial Screening of Alternatives report was originally prepared concurrently with the Remedial Investigation report (BVWST, 1992a) and the Risk Assessment report (BVWST, 1992b); therefore, technologies and process options were developed into alternatives, and the alternatives screened, based on an assumption that all media (sediment and surface water) would require some degree of remediation.

All of the SSW alternatives were retained to be incorporated into the FS report because the alternatives provide a range in the type of treatment and containment technologies considered for remediation of the Soldier Creek Site. All of the alternatives, except the no action alternative, would adequately achieve the remedial action objectives through treatment or monitoring.

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ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFLC	Air Force Logistics Command
ARAR	Applicable or Relevant and Appropriate Requirement
BVWST	B&V Waste Science and Technology Corp.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
EPA	U.S. Environmental Protection Agency
FFA	Federal Facilities Agreement
FS	Feasibility Study
GWTP	Groundwater Treatment Plant
HI	Hazard Index
HQ	Hazard Quotient
IWTP	Industrial Wastewater Treatment Plant
mg/kg	Milligrams per kilogram
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
NUS	NUS Corporation
O&M	Operation and maintenance
OSDH	Oklahoma State Department of Health
OWRB	Oklahoma Water Resources Board
POTW	Publicly Owned Treatment Works
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
SARA	Superfund Amendments and Reauthorization Act of 1986
SSW	Sediment and surface water
STP	Sanitary Treatment Plant
TCLP	Toxicity Characteristics Leaching Procedure
ug/L	Micrograms per liter

1.0 INTRODUCTION

This report presents the screening of remedial technologies and process options, and the preliminary development and screening of remedial alternatives for the Feasibility Study (FS) of the Soldier Creek Site at Tinker Air Force Base (AFB). A comprehensive discussion of the site history and the nature and extent of the contamination at the Soldier Creek Site is provided in the Remedial Investigation (RI) report (BVWST, 1993a).

1.1 Summary of Soldier Creek Site Location and History

Tinker AFB is southeast of the Oklahoma City metropolitan area, bordering on Del City and Midwest City in central Oklahoma, as illustrated on Figure 1-1 (page 1-2). The main portion of Soldier Creek is to the east of Tinker AFB; however, two tributaries (West and East Soldier Creek) originate on the base. Soldier Creek flows to the north from its headwaters near Southwest 59th Street to its confluence with Crutcho Creek approximately six miles downstream. The Soldier Creek Site includes Soldier Creek, its tributaries, and any area underlying or adjacent to the waterway that may be contaminated by the migration of hazardous substances, pollutants, or contaminants from Tinker AFB (EPA, 1988a).

For purposes of the Tinker AFB - Soldier Creek Study (RI/FS) project, West Soldier Creek is identified as the tributary that originates on the west side of Building 3001 and flows northward to its confluence with Soldier Creek approximately two miles downstream. East Soldier Creek is identified as the tributary that flows northward along the east side of Building 3001 and past the Industrial Wastewater Treatment Plant (IWTP). Its origin is just to the north of Building 3705, and its confluence with Soldier Creek is approximately one mile downstream. The primary study area of the RI consisted of the tributaries that directly receive discharges or runoff from Tinker AFB (West and East Soldier Creek) and the main stem of Soldier Creek from its headwaters downstream to East Reno Avenue, as illustrated on Figure 1-2 (page 1-3). As shown on Figure 1-2, Soldier Creek and its branches are bordered mainly by recreational and residential areas with some areas supporting commercial and

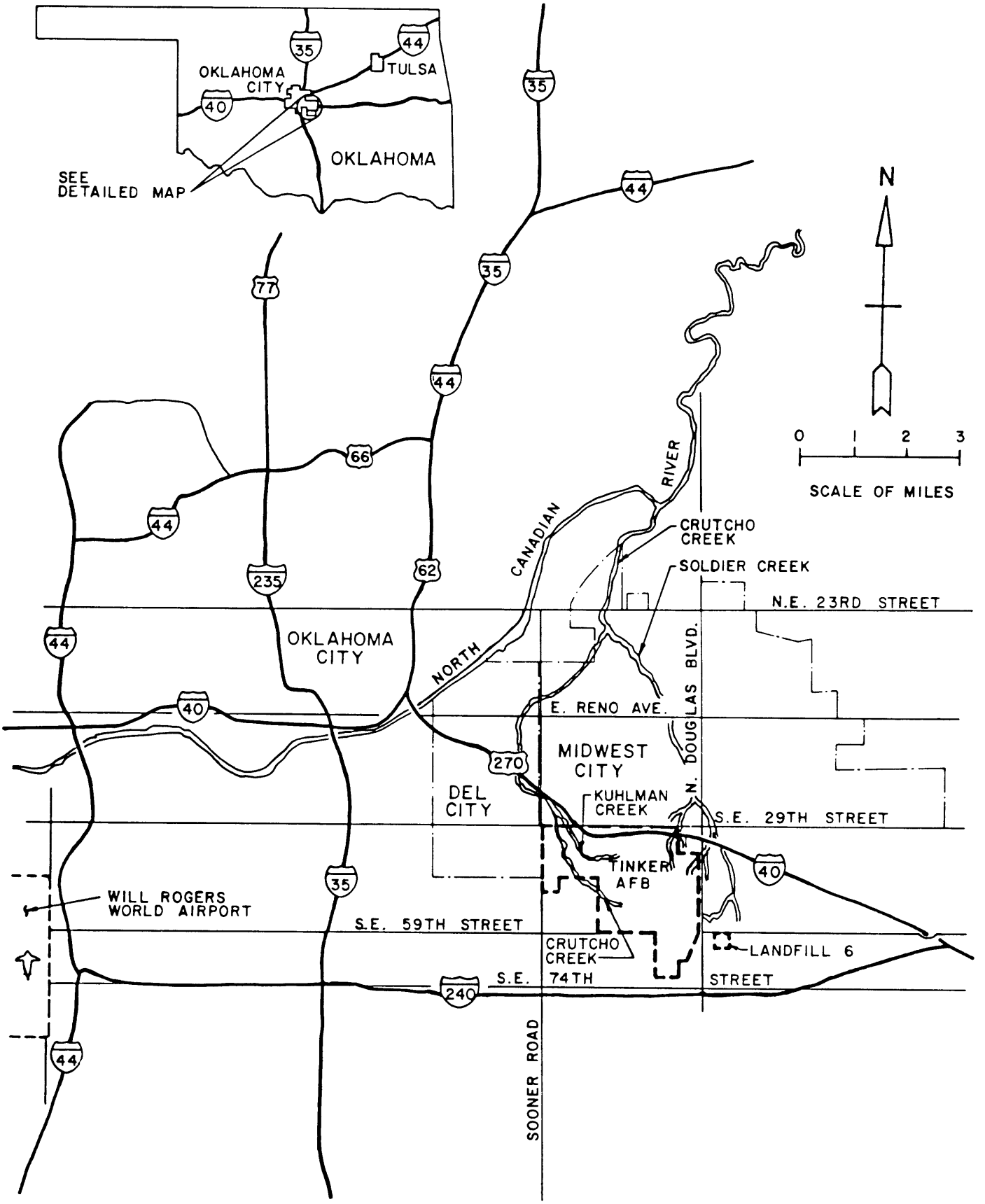

FIGURE 1-1
SITE VICINITY
TINKER AFB - SOLDIER CREEK RI/FS
FS INITIAL SCREENINGS OF ALTERNATIVES REPORT

DATE: 1-22-93 PVT
PLOT SCALE -1

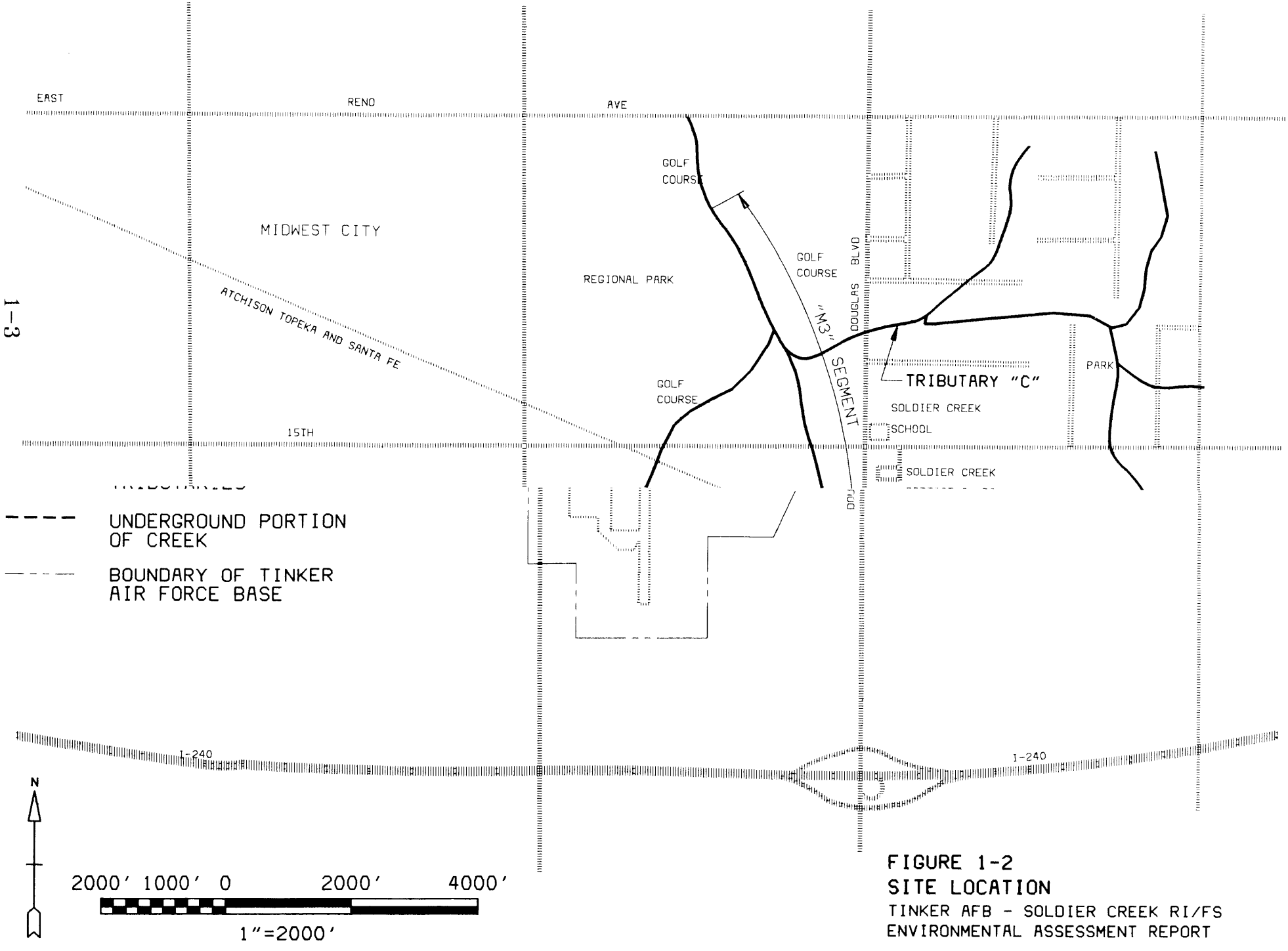

FIGURE 1-2
SITE LOCATION
TINKER AFB - SOLDIER CREEK RI/FS
ENVIRONMENTAL ASSESSMENT REPORT

industrial uses. The recreational and residential areas include a regional park, a public golf course, and a trailer park.

Areas on Tinker AFB that contribute runoff or discharge to Soldier Creek and its tributaries include the eastern-most runway area of the Building 3001 complex and the IWTP. The Building 3001 complex consists of an aircraft overhaul and modification complex to support the mission of the Oklahoma City Air Logistics Center. The IWTP, located in the northeastern portion of the Base, receives industrial process waters discharged from Building 3001 through a series of underground lines. Once received at the plant, these waters are treated and combined with treated sanitary wastewater before discharge to East Soldier Creek under a National Pollutant Discharge Elimination System permit.

Tinker AFB was activated in March 1942 under the name of the Midwest Air Depot. During World War II, the depot was responsible for reconditioning, modifying, and modernizing aircraft, vehicles, and equipment. The primary mission has not changed. Tinker AFB is still a major industrial complex for overhauling, modifying, and repairing military aircraft, aircraft engines, and accessory items.

As part of the overall Air Force Installation Restoration Program, Tinker AFB began investigation of previously used waste disposal sites in 1981 (EPA, 1988a). A basewide sampling program was conducted in 1983. Analytical results from the sampling program indicated that trichloroethene was present in the groundwater. Remedial investigations were conducted from 1986 to 1989 to determine the nature and extent of groundwater contamination in the Building 3001 area. These investigations determined that chromium, in addition to trichloroethene, was a chemical of concern in the groundwater. On July 22, 1987, the Building 3001 Site and the Soldier Creek Site were added to the National Priorities List (NPL).

1.2 Authority for the Work

On December 9, 1988, the U.S. Environmental Protection Agency (EPA) Region VI, the Oklahoma State Department of Health (OSDH), and the U.S. Department of the Air Force, Tinker AFB signed a Federal Facilities Agreement (FFA)(Administrative Docket Number NPL-U3-2-27) under the Comprehensive Environmental Response,

Compensation, and Liability Act of 1980 (CERCLA) Section 120 and the Superfund Amendments and Reauthorization Act of 1986 (SARA) (EPA, 1988a). The intent of this agreement is to ensure that the past and present activities at the Building 3001 and Soldier Creek NPL Sites are thoroughly investigated and appropriately remediated to protect the public health, welfare, and the environment. The FFA establishes requirements for the performance of the RI and the FS at the site in accordance with CERCLA. In addition, the FFA establishes procedures and schedules for developing, implementing, monitoring, documenting, and approving response actions at both the Building 3001 and Soldier Creek Sites, in accordance with CERCLA, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP)(EPA, 1991a), and Superfund guidance and policy. The agreement sets procedures for remedial actions and specifies that Tinker AFB will establish and maintain an administrative record that will include all documents that form the basis for the selection of a response action at both the Building 3001 and Soldier Creek Sites (EPA, 1988a).

1.3 Purpose and Scope of the FS Initial Screening of Alternatives Report

The FS Initial Screening of Alternatives report presents the remedial action objectives for the Soldier Creek Site, preliminarily delineates the extent of contaminated media requiring remediation, presents and evaluates remedial technologies and process options, develops the retained technologies and process options into alternatives, and screens the alternatives for the remediation of the Soldier Creek Site. This document provides a preliminary examination and discussion of the technologies and alternatives to be included in the FS for the Soldier Creek Site. This report is prepared in accordance with the NCP (EPA, 1991a), the "Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (EPA, 1988b), the "Air Force Installation Restoration Program Management Guidance" (AFLC, 1989), and other appropriate guidances (EPA, 1985, 1986, 1988c, 1988d, 1990, and 1991b).

2.0 REMEDIAL ACTION OBJECTIVES

This section presents the preliminary cleanup goals for sediment and surface water and the preliminary remedial action objectives for the Soldier Creek Site. Cleanup goals represent the concentration of contaminants when remedial activities at the site are completed. Cleanup goals are established by either: the adoption of standards or recommendations from regulatory agencies, such as water quality criteria or health advisories, or by the calculation of cleanup goals based on health-related criteria. Regulatory standards that apply to a site are determined by reviewing the applicable or relevant and appropriate requirements (ARARs). Contaminant-specific, location-specific, and action-specific ARARs for the site were agreed to by all parties of the FFA and were incorporated into the Risk Assessment report (BVWST, 1993b). The approach used to develop health-related criteria is derived from the risk assessment process (EPA, 1989a). The risk assessment is essentially a process by which the magnitude of potential carcinogenic risk and noncarcinogenic health hazards is evaluated.

2.1 Preliminary Cleanup Goals for Sediment

Cleanup goals for the sediment were determined using health-related criteria based on direct dermal contact with sediment and incidental ingestion. This approach for calculating cleanup goals is especially useful because regulatory standards generally have not been promulgated for soil and sediment.

The Soldier Creek Site was divided into nine segments based on stream morphology and location and risk calculations were completed for each segment. Soldier Creek was divided into these segments to identify the areas of the stream that exhibit the majority of the risks. Even though most of the segments are nearly one-half mile long, breaking the stream into segments allows problem areas to be addressed, while areas that exhibit no risk can be left alone. The nine segments include two on-base segments (E1 and W1) and seven off-base segments (A, B, E2, M1, M2, M3, and W2) with the following RI sample locations associated with each segment:

- A - Segment: All sampling locations along "A" branch of Main Soldier Creek including A01, A02, A03.

- B - Segment: All sampling locations along "B" branch of Main Soldier Creek including B01, B02, B03.

- E1 - Segment: Sampling locations along East Soldier Creek including E01 through E11 to the confluence of East and "B" Branch of Soldier Creek.

- E2 - Segment: Sampling locations along East Soldier Creek including E12 and E13 to the confluence of East and Main Soldier Creek.

- M1 - Segment: Sampling locations along Main Soldier Creek including M01 through M06.

- M2 - Segment: Sampling locations along Main Soldier Creek including M07 through M09.

- M3 - Segment: Sampling locations along Main Soldier Creek including M10 through M13.

- W1 - Segment: Sampling locations along West Soldier Creek including W01 through W07 to the confluence of West Soldier Creek and the unnamed tributary.

- W2 - Segment: Sampling locations along West Soldier Creek including W08 and W09 to the confluence of West and Main Soldier Creek.

The sediment locations that comprise the nine segments are shown on Figure 1-2 (page 1-3).

Two groups of people (child combined with adult and adult worker) were examined in the following reasonable maximum exposure (RME) current and future scenarios based on Phase I and II of the RI analytical results:

- Child combined with adult.

  -- Exposure of a child, age 1 - 6 years, and an adult, age 6 - 30 years, to sediment in off-base segments A, B, M1, M2, M3, E2, and W2 through incidental ingestion and dermal contact [current risk sediment (0-6 inches)] while swimming and wading in Soldier Creek.

  -- Exposure of a child, age 1 - 6 years, and an adult, age 6 - 30 years, to sediment in off-base segments A, B, M1, M2, M3, E2, and W2 through incidental ingestion and dermal contact [future risk sediment (0-5 feet)] while swimming and wading in Soldier Creek.

- Adult.

  -- Exposure of an adult worker, over a 25 year period, to sediment in on-base segments E1 and W1 through incidental ingestion and dermal contact [current risk sediment (0-6 inches)] during construction work.

  -- Exposure of an adult worker, over a 25 year period, to sediment in on-base segments E1 and W1 through incidental ingestion and dermal contact [future risk sediment (0-5 feet)] during construction work.

These combinations of exposed people were selected based on the rationale, methodology, and assumptions presented in the exposure assessment (Section 3.0) of the Risk Assessment report (BVWST, 1993b).

Risk calculations were completed to determine the excess cancer risk and the hazard index (HI) for noncarcinogenic effects. Acceptable excess cancer risk values range from 1×10^{-4} to 1×10^{-6}, as recommended in the NCP. These values represent the excess chance that a person will develop cancer due to a lifetime exposure to site

contaminants. For example, a value of 1×10^{-4} is interpreted as the probability that one additional person in ten thousand will develop cancer and a value of 1×10^{-6} is interpreted as the probability that one additional person in one million will develop cancer as a result of exposure to site contaminants. The risk of adverse noncarcinogenic effects from chemical exposure is expressed in terms of a hazard quotient (HQ). All of the HQ values for chemicals within each exposure pathway are summed to yield the HI. The HI value is the ratio of the projected daily intake for a contaminant and the maximum amount that may be ingested, inhaled, etc., without the accompaniment of harmful, noncarcinogenic effects. An HI value of less than 1.0 indicates little concern for noncarcinogenic effects, while an HI value greater than or equal to 1.0 indicates an increased level of concern.

For the sediment, a target excess cancer risk of 1×10^{-6} (one person in one million will develop cancer) was established, and a target hazard index of less than 1.0 was selected. This is consistent with EPA guidance presented in the NCP. After the contaminant intake was determined, the allowable contaminant concentration (cleanup goal) was calculated from the target excess cancer risk and HI by back-calculating the equations used in the risk assessment. The back calculations represent the reverse of the process used to calculate potential cancer risk and health indices in the risk assessment process. Cleanup levels were calculated for all contaminants detected and are presented in Table 2-1 (page 2-5). Only two organic compounds, methylene chloride and tetrachloroethene, were detected at concentrations (140 mg/kg and 83 mg/kg, respectively) above the sediment cleanup goals (130 mg/kg and 19mg/kg, respectively). Both compounds were detected above the potential cleanup goals in the sediment sample collected from the 0 to 6" interval at location E03. This location is on-base in Outfall G. The compounds were detected above the cleanup goals only during Phase I of the RI. A sediment sample was not collected during Phase II of the RI because only decayed vegetation was present at the E03 location. Tetrachloroethene was not detected in any other samples from East Soldier Creek during Phase II of the RI. Methylene chloride was detected in other samples collected from East Soldier Creek during Phase II of the RI; however, the concentration of the compound detected in all of these samples was present at one order of magnitude less than the potential cleanup goal of 1×10^{-6}.

TABLE 2-1
POTENTIAL SEDIMENT CLEANUP LEVELS
TINKER AFB – SOLDIER CREEK RI/FS
FS INITIAL SCREENING OF ALTERNATIVES REPORT

Chemical of Concern(a)	Cleanup Level (b) (mg/kg)		
	Carcinogenic		Noncarcinogenic
	1x10-4	1x10-6	
Volatile Organics			
Acetone	--	--	41,000
Benzene	3,300	33	--
Carbon Disulfide	--	--	570,000
Chlorobenzene	--	--	8,300
Chloroethane	--	--	--
Chloroform	16,000	160	--
1,2-Dichloroethene (total)	--	--	57,000
Ethylbenzene	--	--	570,000
Methylene Chloride	13,000	130	--
Tetrachloroethene	1,900	19	--
Toluene	--	--	83,000
Trichloroethene	140,000	1,400	--
Vinyl Acetate	--	--	1,000,000(c)
Xylene (total)	--	--	830,000
Semi-Volatile Organics			
Acenaphthene	--	--	38,000
Anthracene	--	--	190,000
Benzo(a)Anthracene	160	1.6	--
Benzo(a)Pyrene	160	1.6	--
Benzo(b)Fluoranthene	160	1.6	--
Benzo(k)Fluoranthene	160	1.6	--

Chemical of Concern(a)	Cleanup Level (b) (mg/kg)		
	Carcinogenic		Noncarcinogenic
	1x10-4	1x10-6	
Benzo(g,h,i)Perylene	--	--	--
Bis(2-ethylhexyl)Phthalate	10,000	100	--
Butylbenzylphthalate	--	--	130,000
2-Chloronaphthalene	--	--	--
Chrysene	160	1.6	--
Dibenzo(a,h)Anthracene	12,000	120	--
Dibenzofuran	--	--	--
1,3-Dichlorobenzene	--	--	--
1,4-Dichlorobenzene	100,000	1,000	--
1,2-Dichlorobenzene	--	--	790,000
3,3-Dichlorobenzidine	5,500	55	--
2,4-Dimethylphenol	--	--	180,000
Di-n-Butylphthalate	--	--	63,000
Di-n-Octylphthalate	--	--	13,000
Fluoranthene	--	--	25,000
Fluorene	--	--	25,000
Indeno(1,2,3-C,D)pyrene	12,000	120	--
2-Methylnaphthalene	--	--	--
2-Methylphenol	--	--	440,000
4-Methylphenol	--	--	440,000
Naphthalene	--	--	2,500
Phenanthrene	--	--	--

Chemical of Concern(a)	Cleanup Level (b) (mg/kg)		
	Carcinogenic		Noncarcinogenic
	1x10-4	1x10-6	
Pyrene	30,000	300	--
Metals			
Aluminum	--	--	--
Arsenic	--	--	2,100
Barium	--	--	140,000
Cadmium	--	--	1,000
Calcium	--	--	--
Chromium	--	--	10,000
Cobalt	--	--	--
Copper	--	--	--
Cyanide	--	--	670,000
Lead	--	--	--
Magnesium	--	--	--
Manganese	--	--	210,000
Mercury	--	--	620
Nickel	--	--	41,000
Potassium	--	--	--
Selenium	--	--	--
Silver	--	--	6,200
Vanadium	--	--	14,000
Zinc	--	--	410,000

(a) Chemicals of concern include all constituents detected in the sediment.

(b) BVWST, 1993c

(c) Risk calculation indicated maximum concentration of 1,000,000 mg/kg.

-- Indicates that the contaminant was detected in the sediment but a risk-based cleanup level could not be developed because slope factors are not available for these constituents.

No semi-volatile organic compounds or inorganic analytes were detected above the potential sediment cleanup goals. The cancer risk due to the levels of contaminants present at the site is between $1x10^{-4}$ and $1x10^{-6}$ and the noncarcinogenic HI is less than 1. Therefore the carcinogenic and noncarcinogenic risks associated with the sediment at the Soldier Creek Site can be considered insignificant and not a threat to human health or the Soldier Creek environment.

2.2 Preliminary Cleanup Goals for Surface Water

Five potential types of surface water cleanup levels are available for the Soldier Creek Site and are presented in Table 2-2 (page 2-7):

- Risk-based cleanup level.
- Ambient Water Quality Criteria (Toxic and Carcinogenic Protection).
- Ambient Water Quality Criteria for Protection of Freshwater Aquatic Life.
- Oklahoma Raw Water Numerical Criteria.
- Oklahoma Numerical Criteria for Toxic Substances.

Risk-based cleanup levels for surface water were calculated in a manner similar to the sediment cleanup levels described previously. These cleanup levels were developed for the same stream segments as for the sediment and were based on a target cancer risk range of 1×10^{-4} (one person in ten thousand) to 1×10^{-6} (one person in one million will develop cancer) and a target hazard index of less than 1.0.

Two groups of people (child combined with adult and adult worker) were examined in the following separate RME current and future scenarios based on the Phase I and II of the RI analytical results:

- Child combined with adult.

  -- Exposure of a child, age 1 - 6 years, and an adult, age 6 - 30 years, to surface water in off-base segments M2, M3, E2, and W2 through ingestion and dermal contact (current and future risk) while swimming.

TABLE 2-2
POTENTIAL SURFACE WATER CLEANUP LEVELS
TINKER AFB – SOLDIER CREEK RI/FS
FS INITIAL SCREENING OF ALTERNATIVES REPORT

Contaminant of Concern (a)	Potential Cleanup Levels											
	Cleanup Level (b) (mg/kg)			Oklahoma Raw Water Numerical Criteria (OWRB, 1989a) ug/l	Oklahoma Numerical Criteria for Toxic Substances (OWRB, 1989a)		Ambient Water Quality Criteria (EPA, 1986a)					
							For Toxic Protectio		For Carcinogenic Protection		Protection of Freshwater Aquatic Life	
					Acute ug/l	Chronic ug/l	Ingesting Water and Organisms ug/l	Ingesting Organisms Only ug/l	Ingesting Water and Organisms ug/l	Ingesting Organisms Only ug/l	Acute ug/l	Chronic ug/l
	Carcinogenic		Noncarcinogenic									
	1x10-4	1x10-6										
Volatile Organics												
Acetone	--	--	500,000	--	--	--	--	--	--	--	--	--
Benzene	2,000	20	--	--	--	2,200	--	--	0.66(b)	40(b)	5,300(c)	--
Bromodichloromethane	170,000	1,700	--	--	--	--	--	--	--	--	--	--
Bromoform	3,300,000	33,000	--	--	--	--	--	--	--	--	--	--
Carbon Disulfide	--	--	5,300	--	--	--	--	--	--	--	--	--
Chlorobenzene	--	--	13,000	--	--	--	488	15,050	--	--	19,500(c)	--
Chloroform	76,000	760	--	--	--	--	--	--	0.19	15.7	28,900(c)	--
Dibromochloromethane	200,000	2,000	--	--	--	--	--	--	--	--	--	--
Methylene Chloride	89,000	890	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethene (total)	--	--	150,000	--	--	--	--	--	0.033(b)	1.85(b)	11,600(c)	--
1,1,1-Trichloroethane	--	--	100,000	--	--	--	--	--	--	--	--	--
Trichloroethene	28,000	280	--	--	--	--	--	--	2.7(b)	80.7(b)	45,000(c)	21,900(c)
Tetrachloroethene	31,000	310	--	--	--	--	--	--	0.8(b)	8.85(b)	5,280(c)	840(c)
Toluene	--	--	5,600	--	--	875	14,300	424,000	--	--	17,500(c)	--
Xylene (total)	--	--	11,000,000	--	--	--	--	--	--	--	--	--
Semi-Volatile Organics												
Benzo(g,h,i)Perylene	--	--	--	--	--	--	--	--	--	--	--	--
Benzoic Acid	--	--	100,000	--	--	--	--	--	--	--	--	--
Chrysene	120,000	1,200	--	--	--	--	--	--	--	--	3,980(c)	--
Fluoranthene	--	--	22,000	--	--	--	42	54	--	--	--	--
Pyrene	--	--	5,900,000	--	--	--	--	--	--	--	--	--

(a) Contaminants of concern include all constituents detected in the surface water.
(b) Human health criteria for carcinogens reported for three risk levels. The 10E(-6) risk level is presented.
(c) Insufficient data available to develop criteria. Value presented is the lowest observed effect level.
(d) Hardness-dependent criteria (225 mg/l actual Soldier Creek hardness value used to develop).
(e) Hardness-dependent criteria (50mg/l used to develop).

TABLE 2-2 (Continued)
POTENTIAL SURFACE WATER CLEANUP LEVELS
TINKER AFB – SOLDIER CREEK RI/FS
FS INITIAL SCREENING OF ALTERNATIVES REPORT

Contaminant of Concern (a)	Potential Cleanup Levels											
	Cleanup Level (b) (mg/kg)			Oklahoma Raw Water Numerical Criteria (OWRB, 1989a) ug/l	Oklahoma Numerical Criteria for Toxic Substances (OWRB, 1989a		Ambient Water Quality Criteria (EPA, 1986a)					
							For Toxic Protectio		For Carcinogenic Protection		Protection of Freshwater Aquatic Life	
					Acute ug/l	Chronic ug/l	Ingesting Water and Organisms ug/l	Ingesting Organisms Only ug/l	Ingesting Water and Organisms ug/l	Ingesting Organisms Only ug/l	Acute ug/l	Chronic ug/l
	Carcinogenic 1x10-4	Carcinogenic 1x10-6	Noncarcinogenic									
Metals												
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	8,100	100	360	190	--	--	0.0022(b)	0.0175(b)	--	--
Barium	--	--	250,000	1,000	--	--	1,000	--	--	--	--	--
Beryllium	2,000	20	--	--	--	--	--	--	0.0037(b)	0.064(b)	130(c)	5.3(c)
Cadmium	--	--	2,100	20	84.1(d)(e)	2.14(d)(e)	10	--	--	--	1.8(e)	0.66(e)
Calcium	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	--	--	11,000	50	--	--	50	--	--	--	16(c)	11(c)
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	1,000	41.2(d)	25.6(d)	--	--	--	--	9.2(e)	6.5(e)
Cyanide	--	--	49,000	200	45.9	10.7	200	--	--	--	22	5.2
Iron	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	100	229(d)	8.9(d)	50	--	--	--	34(e)	1.3(e)
Magnesium	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	350,000	--	--	--	50	100	--	--	--	--
Nickel	--	--	62,000	--	2800(d)	313(d)	13.4	100	--	--	1,100(e)	56(e)
Selenium	--	--	--	10	20	5	10	--	--	--	260(c)	35(c)
Silver	--	--	350,000	50	16.4(d)	0.49	50	--	--	--	1.2(e)	0.12(e)
Sodium	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	--	--	560,000	--	--	--	--	--	--	--	--	--
Zinc	--	--	13,000,000	5,000	233(d)	211(d)	--	--	--	--	180(e)	47(e)

(a) Contaminants of concern include all constituents detected in the surface water.
(b) Human health criteria for carcinogens reported for three risk levels. The 10E(-6) risk level is presented.
(c) Insufficient data available to develop criteria. Value presented is the lowest observed effect level.
(d) Hardness-dependent criteria (225 mg/l actual Soldier Creek hardness value used to develop).
(e) Hardness-dependent criteria (50mg/l used to develop).

- -- Exposure of a child, age 1 - 6 years, and an adult, age 6 - 30 years, to surface water in off-base segments A, B, and M1 through incidental ingestion and dermal contact (current and future risk) while wading.

- Adult.

  - -- Exposure of an adult worker, for a 25 year period, to surface water in on-base segments E1 and W1 through incidental ingestion and dermal contact (current and future risks) during construction work.

These combinations of exposed people were selected based on the rationale, methodology, and assumptions presented in the exposure assessment (Section 3.0) of the Risk Assessment report (BVWST, 1993b).

The chemicals of concern for the surface water include those contaminants detected in Soldier Creek at concentrations greater than any of the potential cleanup levels. The cleanup goal for each surface water contaminant at the Soldier Creek Site is the lowest value of the potential cleanup levels listed in Table 2-2 (page 2-7).

2.3 Preliminary Remedial Action Objectives

CERCLA, as amended by Section 121(b) of the SARA, requires selection of remedial actions that attain a degree of cleanup that ensures protection of human health and the environment, are cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In conjunction with these requirements, preliminary remedial action objectives were developed for the Soldier Creek Site to determine the degree of cleanup required. Remedial action objectives were developed based on the cleanup levels discussed in Subsections 2.1 and 2.2. The remedial action objectives developed for the contaminated sediment and surface water consist of the following goals:

- Prevent the ingestion of or direct dermal contact with Soldier Creek sediment and surface water with contaminant concentrations greater than those associated with a 1×10^{-6} (one in one million) excess cancer risk level, a noncarcinogenic health hazard, or a state or federal surface water standard,

whichever is lowest. The preliminary cleanup goals for the sediment chemicals of concern at the Soldier Creek Site are listed in Table 2-1 (page 2-5). The preliminary cleanup goals for surface water chemicals of concern at the Soldier Creek Site are summarized in Table 2-3 (page 2-11).

- Prevent the migration of contaminants from Soldier Creek sediment to the groundwater that would result in groundwater contamination. Concentration levels in sediment that should not be exceeded are listed in Table 2-1 (page 2-5).

TABLE 2-3
CLEANUP GOALS FOR SURFACE WATER
TINKER AFB - SOLDIER CREEK RI/FS
FS INITIAL SCREENING OF ALTERNATIVES REPORT

Contaminant of Concern (a)	Cleanup Goal (ug/L)	Source of Cleanup Goal
Benzene	0.66	Ambient Water Quality Criteria
1,2-Dichloroethene	0.033	Ambient Water Quality Criteria
Tetrachloroethene	0.8	Ambient Water Quality Criteria
Cadmium	1.8	Ambient Water Quality Criteria
Chromium	11	Ambient Water Quality Criteria
Lead	1.3	Ambient Water Quality Criteria

(a) These contaminants were detected at concentration levels exceeding at least one of the potential cleanup levels presented in Table 2-2 (page 2-6).

3.0 PRELIMINARY DELINEATION OF AREAS AND VOLUMES OF CONTAMINATED MEDIA

The remedial action objectives defined in Subsection 2.3 were used to develop the areas and volumes of contaminated media. It should be noted that the areas and volumes calculated for this report are only estimates based on the data available at this time. If additional or updated information becomes available, the estimates will be revised.

3.1 Sediment

A comparison of the RI analytical results to the cleanup goals established in Subsection 2.4 for the sediment at the Soldier Creek Site indicates that no contaminants are above levels of concern. These potential sediment cleanup levels are presented in Table 2-1 (page 2-5). The analytical results are presented in the RI report (BVWST, 1993a). A delineation of the area and volume of this medium is not required because the risk associated with the sediment is generally less than 1×10^{-6} (one in one million), as determined in the risk assessment report (BVWST, 1993b) and as discussed in Subsection 2.1 of this report.

3.2 Surface Water

A comparison of the RI analytical results and the cleanup goals for the surface water at the Soldier Creek Site indicates that six contaminants were detected at levels above the cleanup goals. A delineation of the area and volume of contaminated surface water is not presented here because of the dynamic nature of surface water. It is probable that surface water contamination detected during one sampling event at a specific location may not be present during a subsequent sampling event at that same location. The three organic chemicals of concern (benzene, 1,2-dichloroethene, tetrachloroethene) were each detected at separate sampling locations. Each contaminant was detected during Phase I or II of the RI. The other three contaminants, chromium, lead, and cadmium, were detected at several locations along the E1, E2, M2, W1, and W2 segments of Soldier Creek during both Phase I and II of the RI.

4.0 GENERAL RESPONSE ACTIONS AND POTENTIAL TECHNOLOGIES

General response actions are broad classes of actions or remedies that meet remedial action objectives. General response actions have been identified for sediment and surface water contamination at the Soldier Creek Site. The general response actions for all media include the following remedies:

- No action, in which the site is left "as is" and limited provisions are made for monitoring, control, or cleanup of the contamination.

- Institutional controls, which involve the creation and implementation of controls for regulating public and environmental contact with the contaminants.

- Containment, which involves physical restrictions on contaminant mobility.

- Collection or removal, which involves the direct physical removal of the contamination or contaminant sources.

- Disposal, which involves measures to relocate contaminants in a manner that will reduce their interaction with the public and the environment.

- Treatment, which involves on-base and off-base measures to render the contaminated media less hazardous and which decreases the toxicity, mobility, and volume associated with media contaminants.

Remedial technologies and process options were identified for each general response action. Remedial technologies refer to general categories of technology types, and process options refer to specific processes within each technology type. For example, a slurry wall is a process option within the remedial technology of vertical barriers under the containment general response action for sediment and surface water.

Table 4-1 (page 4-3) lists the general response actions, technologies, and process options for sediment and surface water. Sediment and surface water responses are evaluated as one media type. The technologies and process options were identified using technical experience and a variety of technical sources, including EPA documents and professional journals.

TABLE 4-1
POTENTIAL TECHNOLOGIES AND PROCESS OPTIONS FOR SEDIMENT AND SURFACE WATER
TINKER AFB - SOLDIER CREEK RI/FS
FS INITIAL SCREENING OF ALTERNATIVES REPORT

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION
No Action	None	None
Institutional Controls	Land Use	Deed restrictions
	Access Restrictions	Fencing
	Monitoring	Groundwater, sediment, surface water
Containment	Capping	Cover method, concrete cap, clay cap, multilayer cap
	Surface Controls	Stream diversion, retaining structure, dewatering
	Vertical Barriers	Slurry wall, grout curtain, sheet piling, vibrating beam
	Horizontal Barriers	Grout injection, block displacement
Removal	Excavation	Mechanical, hydraulic, pneumatic
Disposal	Off-base	Resource Conservation and Recovery Act (RCRA)-permitted landfill
	On-base	RCRA-compliant landfill
Sediment Treatment	Physical/Chemical	Solvent extraction, soil washing, stabilization
	Thermal	Incineration, low-temperature thermal separation (desorption)
	In Situ	Bioreclamation, stabilization, soil flushing, vitrification, vapor extraction
	Off-base	RCRA-permitted incineration facility
	Biological	Composting, land farming
Surface Water Treatment	On-base	Existing or proposed treatment facility, new treatment facility
	Off-base	RCRA-permitted treatment facility, publicly owned treatment works

5.0 PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

The remedial technologies and process options identified in Section 4.0 were first screened on the basis of technical implementability. This initial screening eliminates technologies that are clearly ineffective or unworkable based on the site and contaminant characteristics. Table 5-1 (page 5-2) summarizes the technology screening for Soldier Creek sediment and surface water. This table presents the general response actions, remedial technologies, process options, and a description of each process option. The process option descriptions were provided to facilitate an understanding of each option and to assist in the evaluation of its technical implementability. The screening comments address the technical feasibility and ability of the process option to serve its intended purpose. The screening comments also include a statement of whether the process option is retained or rejected. Retained process options are further evaluated in Section 6.0 on the basis of effectiveness, implementability, and cost.

TABLE 5-1

INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SEDIMENT AND SURFACE WATER

TINKER AFB - SOLDIER CREEK RI/FS

FS INITIAL SCREENING OF ALTERNATIVES REPORT

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
No Action	None	None	No actions would be taken to meet the remedial action objectives.	RETAINED A no action alternative is required in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan.
Institutional Controls	Land Use	Deed Restrictions	All property that is adjacent to Soldier Creek with sediment that exhibits a risk in excess of the cleanup goals would have restrictions concerning land usage placed on the deeds.	REJECTED Cannot be placed on property not owned by Tinker AFB. Would be difficult to enforce.
	Access Restrictions	Fencing	All property that is adjacent to Soldier Creek with sediment that exhibits a risk in excess of the cleanup goals would be fenced to control access.	RETAINED Effective means of reducing public access to site, therefore limiting contact with wastes. May be used in conjunction with selected remedial alternative.
	Monitoring	Groundwater	Periodic monitoring of groundwater would be conducted to determine the migration of contaminants directly from the sediment or from contaminated areas covered with a cap.	RETAINED Monitoring of groundwater might indicate migration rate of contaminants directly from the sediment or capped areas because Soldier Creek recharges the top of regional aquifer zone. Monitoring could be performed if no remediation was implemented.
		Sediment	Periodic monitoring of sediment would be conducted to determine changes in the concentration of sediment contaminants.	RETAINED Sediment monitoring would be an effective means of determining contaminant migration. Monitoring could be performed if no remediation was implemented or to determine the extent and effectiveness of a remedial action.
		Surface Water	Periodic monitoring of surface water would be conducted to determine the migration of contaminants from the sediment.	RETAINED Would be an effective means of determining contaminant migration in Soldier Creek. Monitoring could be performed if no remediation was implemented or to determine the extent and effectiveness of a remedial action.
Containment	Capping	Cover Methods	Rip-rap would be placed over the contaminated areas to minimize contact between surface water and the contaminated sediment.	RETAINED May be effective in containing sediment contaminants. Contaminants would remain in place and no treatment would be involved.
		Concrete Cap	A concrete cap would be installed over the contaminated areas to minimize contact between surface water and the contaminated sediment.	RETAINED May be effective in containing sediment contaminants. Contaminants would remain in place and no treatment would be involved.

TABLE 5-1 (Continued)
INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SEDIMENT AND SURFACE WATER
TINKER AFB - SOLDIER CREEK RI/FS
FS INITIAL SCREENING OF ALTERNATIVES REPORT

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Containment (Continued)	Capping (Continued)	Clay Cap	The contaminated sediment would be covered with a compacted clay cap to minimize contact between surface water and the contaminated sediment.	RETAINED May be effective in containing sediment contaminants. Contaminants would remain in place and no treatment would be involved. Construction of cap may be difficult to implement.
		Multilayer Cap	Contaminated areas would be covered with a cap conforming to RCRA regulations to minimize contact between surface water and the contaminated sediment. A multilayer cap includes the following layers, from bottom to top, compacted clay, sand, synthetic liner, sand, geotextile fabric, native soil, and topsoil.	RETAINED May be effective in containing sediment contaminants. Contaminants would remain in place and no treatment would be involved. Construction of the cap may be difficult to implement.
	Surface Controls	Stream Diversion	Dikes or berms would be constructed in Soldier Creek to provide temporary dewatering of area and isolation of sediment until it can be removed or contained.	RETAINED Would facilitate cleanup operations. May be used in conjunction with other remedial actions to provide temporary dewatering of contaminant area.
		Retaining Structure	Sheet pile walls or other retaining structures would be used to provide temporary dewatering of area and isolation of sediment until sediment can be removed or effectively contained.	REJECTED Costs for sheet piling would be significantly higher than costs for the construction of dikes and berms, without providing greater effectiveness. Would be less cost-effective than construction of a temporary dike or berm considering the size of the creek.
		Dewatering	Well points could be installed in the creek bed following stream diversion to dewater the sediment before excavation, drying beds could be constructed onsite, or a mechanical dewatering process could be used to dewater the excavated sediment.	RETAINED Dewatering of sediment may be required before treatment or disposal. Either of the dewatering processes would be relatively easy to implement and would reduce treatment and disposal costs.
	Vertical Barriers	Slurry Wall	A soil-cement or soil-bentonite slurry would be pumped into a trench as excavation proceeded and would be used to create a wall of low permeability.	REJECTED A slurry wall could contain horizontal movement of contaminants, but downward migration would not be reduced. Contaminated sediment would remain in place. Not practical due to contaminant locations. Would have to place slurry wall along length of creek.

TABLE 5-1 (Continued)
INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SEDIMENT AND SURFACE WATER
TINKER AFB - SOLDIER CREEK RI/FS
FS INITIAL SCREENING OF ALTERNATIVES REPORT

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Containment (Continued)	Vertical Barriers (Continued)	Grout Curtain	Grout would be injected or mixed into the sediment with auger-like blades to create a wall of low permeability.	REJECTED More costly than a slurry wall to construct. Grout curtain could contain horizontal movement of contaminants, but downward migration would not be reduced. Contaminated sediment would remain in place. Not practical due to contaminant locations. Would have to place grout curtain along length of creek.
		Sheet Piling	Sheet piling would be installed around the contaminated portions of Soldier Creek to prevent the migration of contaminants.	REJECTED Used primarily for temporary dewatering. Wall integrity would be unpredictable. Sheet piling could contain horizontal movement of contaminants, but downward migration would not be reduced. Contaminated sediment would remain in place. Not practical due to contaminant locations. Would have to place sheet piling along length of creek.
		Vibrating Beam	A variation of a grout curtain in which a vibrating force would be used to advance a steel beam into the ground. Grout would be injected as the beam was withdrawn.	REJECTED More costly than a slurry wall to construct. Grout curtain could contain horizontal movement of contaminants, but downward migration would not be reduced. Contaminated sediment would remain in place. Not practical due to contaminant locations. Would have to place grout curtain along length of creek.
	Horizontal Barriers	Grout Injection	Grout would be pressure-injected through holes drilled in a pattern to provide a low-permeable barrier beneath the contaminated sediment.	REJECTED Not a proven technology. Contaminants would remain in sediment untreated. Erosion of surface sediment could still occur. Would be difficult to test continuity of the barrier.
		Block Displacement	After contaminated areas were isolated by a vertical barrier, grout would be injected through holes bored through the sediment. Continued grout pumping would cause upward displacement of the contaminated sediment.	REJECTED Innovative technology that is not proven. Contaminants would remain in sediment untreated. Erosion of surface sediment could still occur.
Removal	Excavation	Mechanical	Sediment would be excavated using conventional equipment and placed on trucks for disposal or transport to a treatment area. Dewatering of excavation area may be required.	RETAINED Effective and well-established technology. Sediment could be excavated using conventional equipment.
		Hydraulic	Centrifugal pumps would be used to remove sediment in a liquid slurry form. A large volume of water would be required for operation. The slurry would be pumped directly to the treatment area or to trucks for disposal.	REJECTED Soldier Creek channel depth and width is not appropriate for hydraulic dredging. Amount of water in Soldier Creek is not sufficient for effective operation.

TABLE 5-1 (Continued)
INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SEDIMENT AND SURFACE WATER
TINKER AFB - SOLDIER CREEK RI/FS
FS INITIAL SCREENING OF ALTERNATIVES REPORT

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Removal (Continued)	Excavation (Continued)	Pneumatic	A process that operates similar to hydraulic dredges but uses compressed air or hydrostatic pressure instead of water to remove sediment.	REJECTED Uncommon technology in United States; therefore, its availability would be limited.
Disposal	Off-base	Resource Conservation and Recovery Act-(RCRA) Permitted Landfill	Sediment would be transported and placed in a RCRA-permitted, commercial hazardous waste landfill. Dewatering or pretreatment may be required.	RETAINED Landfilling is an established technology for the long-term containment of wastes.
	On-base	RCRA-Compliant Landfill	Sediment would be excavated and placed in a landfill constructed on-base that meets the substantive requirements of RCRA. The design and construction of the landfill would include a double liner, a leachate collection system, and a leak detection system. Long-term maintenance of the landfill and groundwater monitoring would be required to ensure the integrity of the system.	REJECTED Landfilling is an established technology for the long-term containment of wastes; however, it is not an Air Force policy to construct an on-base landfill for the containment of RCRA wastes.
Sediment Treatment	Physical/ Chemical	Solvent Extraction	Excavated sediment would be washed with an organic solvent to extract target compounds. Treated sediment would be separated from the solvent, dried, and returned to excavated areas. Spent solvent would be treated by distillation, precipitation, sedimentation, etc., to concentrate contaminants and recycle the solvent. Concentrated residuals would require further treatment or disposal.	REJECTED Technology is generally used to treat polyclorinated biphenyls, and is not effective for treating sediment contaminated with inorganics.
		Soil Washing	Process similar to solvent extraction except that water and the appropriate chemical additives or surfactants would be used to extract target compounds. Treated sediment would be dewatered and replaced in the excavated area. Process water would be treated and reused. Concentrated residuals would require further treatment or disposal.	RETAINED Commercially available, innovative technology effective for the removal of inorganic compounds and some organic compounds from soil and sediment.

TABLE 5-1 (Continued)
INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SEDIMENT AND SURFACE WATER
TINKER AFB - SOLDIER CREEK RI/FS
FS INITIAL SCREENING OF ALTERNATIVES REPORT

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Sediment Treatment (Continued)	Physical/ Chemical (Continued)	Stabilization	Contaminated sediment would be excavated and combined with a pozzolan and water in a pug mill. The wet slurry would be allowed to cure and the stabilized material could be replaced in the excavated areas or disposed of in a landfill. Pozzolanic materials used for stabilization include portland cement, fly as, alumina, and silicates.	RETAINED Process has been proven for inorganic stabilization and certain stabilization processes can stabilize both inorganics and organics.
	Thermal	Incineration	Several types of incineration technologies are available. These include rotary kiln, fluidized bed, liquid injection, and infrared incineration. A rotary kiln incinerator would probably be used because it is the most flexible system and has been in use for a long time. The rotary kiln is also the most water tolerant of all incineration technologies.	REJECTED Technically feasible for the destruction of organic contaminants; however, inorganic contaminants, especially metals, would not be effectively destroyed and might require further treatment before disposal. Very high startup and operational costs would be involved. Air pollution control devices may have to be used. Operational permits would have to be obtained.
		Low-Temperature Thermal Separation (Desorption)	Contaminated sediment would be heated in an indirectly fired rotary dryer to volatilize the organics. The vapors would be carried to a gas handling system with an inert gas and then cooled to condense the organics. The organics would be reclaimed, used as a supplemental fuel, or passed through a combustion after-burner for destruction.	REJECTED Process would be potentially applicable to sediment contaminated with organic compounds; however, the process would not be as effective for inorganic contamination. Requires a feed with less than 20 percent organics and a 10 to 40 percent moisture content. Process may be subject to hazardous waste incineration regulations that require destruction efficiencies of 99.99 or 99.9999 percent.
	In Situ	Bioreclamation	A solution containing microorganisms, nutrients, and oxygen would be injected into the contaminated sediment.	REJECTED Would not be effective for the treatment of inorganic contaminants. Certain metals might inhibit the activity of the microorganisms. Stream diversion and dewatering would be required.
		Stabilization	Pozzolanic ingredients and water would be blended with the sediment in place using proprietary equipment. The treated sediment would form a monolithic, stabilized mass that may remain isolated from the environment.	REJECTED Most work with stabilization techniques has not involved in situ treatment. A thorough mixing of the stabilizing agent and the sediment would be required. Stream diversion, and possibly dewatering, would be required.

TABLE 5-1 (Continued)
INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SEDIMENT AND SURFACE WATER
TINKER AFB - SOLDIER CREEK RI/FS
FS INITIAL SCREENING OF ALTERNATIVES REPORT

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Sediment Treatment (Continued)	In Situ (Continued)	Soil Flushing	The contaminated sediment would be flushed with water, a detergent solution, or a solvent to mobilize contaminants. The elutriate would be intercepted, collected, and pumped to the surface to remove the contaminants.	REJECTED Potential toxins from a solvent soil flushing solution could be introduced into the soil system. Physical and chemical properties of the soil system may be altered because of the flushing solution. Potential exists for solvents to transport contaminants into the groundwater. Stream diversion would be required.
		Vitrification	Electrodes, placed in the sediment, would be used to create a current in the contaminated sediment to vitrify it. Inorganics and some organics would be trapped in the melt, which could form obsidian or a very strong glass as it cooled.	REJECTED The sediment would require extensive dewatering before implementation of this technology. Stream diversion would be required. Process is energy intensive and costly. Off-gas containment and treatment would be required for the possible release of some organic vapors.
		Vapor Extraction	Probes or wells would be installed into the vadose (unsaturated) zone. A vacuum would be applied to the wells to extract volatile organic compounds from the soil pores. The vacuum would continually draw contaminated air from the soil pores while drawing fresh air from the surface into the soil. The extracted air would be treated before being dispersed into the atmosphere.	REJECTED Would not be applicable because no real vadose zone exists beneath Soldier Creek because the creek is recharged by the perched aquifer and the creek recharges the top of regional aquifer zone.
	Off-base	RCRA-Permitted Incineration Facility	Excavated sediment would be transported to a commercially licensed hazardous waste incineration facility where the sediment would be incinerated.	REJECTED Technically feasible for the destruction of organic contaminants; however, inorganic contaminants would not be effectively destroyed and may require further treatment before disposal. Costs for transportation to facility and incineration would be very high. Limited number of permitted incineration facilities would be available. Facility may not accept the sediment if the metal concentration is significant.
	Biological	Composting	Organic compounds in the sediment would undergo aerobic thermophilic decomposition by microorganisms. Bulking agents (sawdust or woodchips) would be added to obtain proper porosity. Heat produced during decomposition would serve to keep temperature in the proper range to promote pathogen inactivation and drying.	REJECTED Experimental process for the decomposition of organics in soils that has not been proven on actual full-scale operation at a hazardous waste site. Would not be effective for the treatment of inorganic contaminants.

TABLE 5-1 (Continued)
INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SEDIMENT AND SURFACE WATER
TINKER AFB - SOLDIER CREEK RI/FS
FS INITIAL SCREENING OF ALTERNATIVES REPORT

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
Sediment Treatment (Continued)	Biological (Continued)	Land Farming	Land treatment area would be constructed for application and treatment of the contaminatd sediment. Additional groundwater monitoring wells would be installed around the treatment area to detect potential migration of contaminants into the groundwater. Sediment would be applied in layers or windrows, and would be mechanically mixed and watered on a periodic basis. Nutrients could be added to enhance biodegradation.	REJECTED Not effective for the treatment of inorganic contaminants. Land farming requires a large land area for implementation and is management intensive. A liner and leachate collection system may have to be installed. Potential for adverse environmental impacts would exist if facility is not properly designed and managed.
Surface Water Treatment	On-base	Existing or Proposed Treatment Facility	Diverted surface water would be treated at an on-base treatment facility such as the Building 3001 Groundwater Treatment Plant (GWTP), Sanitary Treatment Plant, or a treatment system to be constructed at the Base in the future.	RETAINED The on-base treatment facilities would be able to handle the volume of surface water to be treated. The GWTP is designed to treat groundwater with contaminant characteristics similar to that of the surface water.
		New Treatment Facility	A treatment system would be designed and constructed to treat diverted surface water. The use of treatment technologies such as air stripping, ultraviolet oxidation, electrochemical precipitation, and biological treatment would be considered.	RETAINED A properly desinged treatment system would effectively remediate contaminated surface water.
	Off-base	RCRA-Permitted Treatment Facility	Diverted surface water would be transported by truck to an off-base RCRA facility for treatment.	RETAINED May be effective depending on the volume of surface water to be treated. The treatment processes used by the facility should be adequate to remediate the water.
		Publicly Owned Treatment Works (POTW)	Diverted surface water would be treated at a nearby POTW.	REJECTED The Midwest City POTW may not be able to adequately treat site contaminants.

6.0 FURTHER EVALUATION OF PROCESS OPTIONS

The process options for sediment and surface water that were retained during the initial screening (Section 5.0) were evaluated in greater detail for effectiveness, implementability, and cost. The results are presented in this section.

6.1 Final Evaluation of Technologies and Process Options for Sediment and Surface Water

The effectiveness of the process options were evaluated relative to other options within the same technology type. This evaluation focused on three main points:

- Effectiveness in handling the estimated areas or volumes of sediment and surface water while meeting the goals identified in the general response actions.

- Effectiveness in protecting human health and the environment during the construction and implementation phases.

- Reliability and certainty of the process options with respect to the contaminants and conditions at the site.

The implementability of a process option encompasses both the technical and institutional feasibility of implementing a process. Because technical feasibility of the process options was considered during the initial screening, the primary emphasis during this more detailed evaluation was institutional feasibility. Institutional feasibility includes consideration of the ability to obtain necessary permits for offsite actions; the availability of treatment, storage, or disposal facilities; and the availability of the necessary equipment and workers.

The cost evaluation included a qualitative estimation of the capital and operation and maintenance (O&M) costs associated with the process options. Because more detailed cost estimates will be included in the screening evaluation of alternatives, costs are not greatly emphasized at this point. The greatest costs during site

remediation are usually associated with the degree to which the different technology types are used, not the specific process options.

The evaluation of the sediment and surface water process options is summarized in Table 6-1 (page 6-3).

6.2 Retained Technologies and Process Options for Sediment and Surface Water

The sediment and surface water technologies and process options that passed the evaluation procedure in Table 6-1 (pages 6-3 through 6-6) are listed in Table 6-2 (page 6-7). The technologies and process options are described in this section, and represent the pool from which remedial alternatives will be developed in Section 7.0.

6.2.1 No Action

No action is required for consideration in accordance with the NCP. This option will serve as a baseline against which the other technologies will be compared. Under the no action alternative, no land use restrictions would be implemented, and no contaminant treatment would be performed. This option would not provide any protection to the public or environment and would be the least protective of all of the sediment and surface water actions. No action would require no capital expenditures; however, five-year regulatory reviews would be required in accordance with CERCLA.

6.2.2 Fencing

Fencing would be a means of reducing receptor contact with the contaminated sediment and surface water, although it would not protect the environment or prevent further contaminant migration. Periodic monitoring of surface water and sediment would be necessary to determine if the migration of contaminants occurred outside the fenced area. Fencing may be used in conjunction with other remedial actions. Costs for fencing would be relatively low and would depend on the extent of the contaminated area to be fenced.

TABLE 6-1

EVALUATION OF PROCESS OPTIONS FOR SEDIMENT AND SURFACE WATER

TINKER AFB - SOLDIER CREEK RI/FS

FS INITIAL SCREENING OF ALTERNATIVES REPORT

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EVALUATION CRITERIA			STATUS
			EFFECTIVENESS	IMPLEMENTABILITY	COST	
No Action	None	None	Would not meet the remedial action objectives or protect human health and the environment.	Would be easily implemented because no activities would be required.	No capital costs would be associated with this technology.	Retained as a baseline as required by the National Oil and Hazardous Substances Pollution Contingency Plan.
Institutional Controls	Access Restrictions	Fencing	Would limit risk to human health but would not protect the environment.	Would be easy to construct. Periodic monitoring and maintenance may be required. Equipment and workers would be readily available.	Costs would be low in relation to the total cost of remediation.	Retained because it would be a moderately effective means of restricting contact with a cap constructed over contaminated areas. May be used in conjuction with other technologies to increase their effectiveness.
	Monitoring	Sediment	Alone, it would not meet the remedial action objectives or protect human health and the environment. Would be an effective means of determining contaminant migration but would not protect the public or the environment. Monitoring could be performed if no remedial action was implemented or to determine the extent and effectiveness of a remedial action.	Would be easily implemented. Equipment and workers would be readily available.	Costs would be low in relation to the total cost of remediation. O&M costs would depend on the frequency and magnitude of sampling.	Retained because it would be an effective means of determining contaminant migration. Would be used in conjunction with the selected remedial action.
		Surface Water	Alone, it would not meet the remedial action objectives or protect human health and the environment. Would be an effective means of determining contaminant migration in Soldier Creek but would not protect the public or the environment. Surface water monitoring could be performed if no remedial action was implemented or to determine the extent and effectiveness of a remedial action.	Would be easily implemented. Equipment and workers would be readily available.	Costs would be low in relation to the total cost of remediation. O&M costs would depend on the frequency and magnitude of sampling.	Retained because surface water monitoring would be an effective means of determining contaminant migration in Soldier Creek. Would be used in conjunction with the selected remedial action.

TABLE 6-1 (Continued)

EVALUATION OF PROCESS OPTIONS FOR SEDIMENT AND SURFACE WATER

TINKER AFB - SOLDIER CREEK RI/FS

FS INITIAL SCREENING OF ALTERNATIVES REPORT

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EVALUATION CRITERIA			STATUS
			EFFECTIVENESS	IMPLEMENTABILITY	COST	
Institutional Controls (Continued)	Monitoring (Continued)	Groundwater	Alone, it would not meet the remedial action objectives or protect human health and the environment. Would be an effective means of determining contaminant migration from Soldier Creek to the groundwater but would not protect the public or the environment. Groundwater monitoring could be performed if no remedial action was implemented to determine the migration, if any, of contaminants from the sediment to the groundwater.	Would be easily implemented. Equipment and workers would be readily available.	Costs would be low in relation to the total cost of remediation. O&M costs would depend on the frequency and magnitude of sampling.	Retained because groundwater monitoring may be an effective means of determining contaminant migration from Soldier Creek. Would be used in conjunction with the selected remedial action.
Containment	Capping	Cover Methods	May be effective in minimizing ingestion of or contact with sediment contaminants. Rip-rap would not effectively minimize surface water infiltration or contaminant migration. Contaminants would not be treated and would remain in place.	Would not be difficult to implement and would require only readily available materials. Would require restrictions on future land use. Long-term maintenance would be required.	Costs would be low to moderate depending on the maintenance requirements.	Rejected as a capping measure because installation of rip-rap in Soldier Creek would not minimize surface water infiltration and the subsequent migration of sediment contaminants.
		Concrete Cap	Would be effective in minimizing ingestion of or contact with sediment contaminants. Would limit further contamination of groundwater and surface water by limiting infiltration. Contaminants would not be treated and would remain in place.	May be difficult to implement, but would be easier to construct than the other capping technologies. Would require temporary surface water diversion and may require special installation procedures. Would require restrictions on future land use. Long-term maintenance would be required to ensure the integrity of the cap. Concrete-lined drainage channels are commonly used in municipal and industrial applications.	Costs would be the lowest of the capping options.	Retained as a capping measure because a concrete cap would provide protection for the public and the environment at a lower cost than the other capping options. It would also be easier to implement in a small channel with side slopes.
		Clay Cap	Would be effective in minimizing ingestion of or contact with sediment contaminants. Would also minimize surface water infiltration, thereby reducing contaminant migration to the groundwater. Effectiveness of the cover would be reduced by surface water erosion if stream diversion was not implemented. Contaminants would not be treated and would remain in place.	May require special installation procedures and permanent surface water diversion, but would require only readily available materials. Construction of cap in creek channel may be difficult because of the small channel size and side slopes. Would require restrictions on future land use. Long-term maintenance would be required to ensure the integrity of the cap. Burrowing animals or deep-rooted vegetation could harm the cap integrity.	Costs would be lower than cost to construct a multilayer cap.	Rejected because of cost and implementation problems.

TABLE 6-1 (Continued)

EVALUATION OF PROCESS OPTIONS FOR SEDIMENT AND SURFACE WATER

TINKER AFB - SOLDIER CREEK RI/FS

FS INITIAL SCREENING OF ALTERNATIVES REPORT

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EVALUATION CRITERIA			STATUS
			EFFECTIVENESS	IMPLEMENTABILITY	COST	
Containment (Continued)	Capping (Continued)	Multilayer Cap	Would be effective in minimizing ingestion of or contact with sediment contaminants. Would also minimize surface water infiltration, thereby reducing contaminant migration to the groundwater. Effectiveness of the cover would be reduced by surface water erosion if stream diversion was not implemented. Contaminants would not be treated and would remain in place.	May require special installation procedures and permanent surface water diversion, but would require only readily available materials. Construction of cap in creek channel may be difficult because of the small channel size and side slopes. Would require restrictions on future land use. Long-term maintenance would be required to ensure the integrity of the cap. Burrowing animals or deep-rooted vegetation could harm the cap integrity.	Costs would be the highest of all of the capping options.	Rejected because of cost and implementation problems.
	Surface Controls	Stream Diversion	Would effectively isolate contaminated areas from surface water contact until sediment could be treated or contained.	Would be relatively easy to implement. Dikes or berms would be constructed to provide temporary or permanent diversion of stream waters.	Construction costs would not be high but removal of temporary dikes or berms would entail additional costs.	Retained because stream diversion may be required as part of a removal or containment option and would be effective as a means to facilitate cleanup operations.
		Dewatering	Would be effective in reducing the volume and mobility of the contaminated sediment by removing the excess water. Dewatering would facilitate treatment, transport, and disposal of the sediment. Dewatering would also reduce the treatment, transport, and disposal costs by reducing the volume of the sediment.	Would be relatively easy to implement. Well points could be installed in the creek channel, drying beds could be constructed onsite, or a mechanical dewatering process could be used.	Costs for dewatering would depend on the volume of sediment to dewater and the method used. May be cost-effective because of the reduced treatment, transport, and disposal costs associated with dewatered sediment.	Retained because dewatering would reduce treatment, transport, and disposal costs. Dewatering may be required as part of a remedial action alternative.
Removal	Excavation	Mechanical	Would be an effective method to remove contaminated sediment. Contaminant resuspension may be a problem, but Soldier Creek could be diverted to minimize this problem.	Would be easily implemented using conventional construction equipment. A backhoe could be used for excavation because of the narrow creek channel and shallow depth of contamination in Soldier Creek.	Costs would be relatively low for excavation ($5-25 per cubic yard).	Retained because it is an effective and well established technology for removing contaminated sediment and, therefore, would be easily implementable.
Disposal	Off-base	Resource Conservation and Recovery Act-(RCRA-) Permitted Landfill	Would be effective for the long-term containment of sediment or treatment residuals if landfill was properly designed, constructed, and maintained. Transportation to a facility within the State of Oklahoma may be possible. Contaminant volume or toxicity would not be reduced.	Would be easily implementable and would contain contaminants off-base. There may be restrictions on disposal because of Land Disposal Restrictions.	Costs would be dependant on disposal and transportation costs.	Retained as a potential disposal method because landfilling is a well established technology for the containment of hazardous wastes.

TABLE 6-1 (Continued)

EVALUATION OF PROCESS OPTIONS FOR SEDIMENT AND SURFACE WATER

TINKER AFB - SOLDIER CREEK RI/FS

FS INITIAL SCREENING OF ALTERNATIVES REPORT

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EVALUATION CRITERIA			STATUS
			EFFECTIVENESS	IMPLEMENTABILITY	COST	
Sediment Treatment	Physical/ Chemical	Soil Washing	Would be effective for the extraction of inorganics and some organics from the sediment. Toxicity, mobility, and volume of sediment contaminants would be reduced. Process water or solution would have to be treated and treatment residuals may require further treatment or disposal.	Would be relatively easy to implement because several mobile systems are commercially available. May need to use several different washing solutions (eg. water, organic solvents) to effectively extract organics and inorganics. Equipment and workers would be readily available.	Treatment costs would be approximately $200- $400 per cubic yard of sediment treated.	Retained because it is a commercially available, innovative technology that is effective for the removal of inorganic compounds and some organic compounds from soil and sediment.
		Stabilization	Would be effective for stabilizing inorganic compounds and some organics in sediment. Stabilized sediment would require disposal after treatment. Contaminant mobility would be, and toxicity may be, reduced.	Would be relatively easy to implement using conventional methods and materials. Equipment and workers would be readily available.	Costs vary with type of process and stabilizer used.	Retained because it is an effective and well established technology for the containment and stabilization of inorganic and some organic compounds.
Surface Water Treatment	On-base	Existing or Proposed Treatment Facility	Would be effective for treating contaminated surface water because of the low contaminant concentrations in and the small volume of water to be treated. The on-base treatment system used would be able to adsorb the contaminant concentrations or remove the metals and organics from the surface water.	Implementation would be relatively easy because treatment facility would already be constructed at time of implementation. Surface water would have to be piped or trucked to the treatment facility.	Capital costs would be very low if water was trucked to treatment facility. O&M costs would be low and would depend on the volume of water to be treated.	Retained as a treatment option for surface water because of the ease of implementation and because an on-base treatment facility should effectively treat the surface water.
		New Treatment Facility	Would be effective in remediating surface water because the treatment system would be specifically designed to remove the chemicals of concern.	Implementation would be more difficult than using an existing treatment facility. Surface water would have to be piped or trucked to the treatment facility, and a location for the facility would have to be determined.	Capital and O&M costs would be moderate to high depending on the size of treatment system required and the volume of surface water to treat. May not be cost effective if volume is too low.	Rejected as a treatment option for surface water because of the level of difficulty of implementation and because implementation may not be cost effective.
	Off-base	RCRA - Permitted Treatment Facility	Would be effective in remediating contaminated surface water.	Implementation would be easy if volume of water to be treated is small. Surface water would have to be trucked to the off-base facility.	Unit costs would be high depending on the volume of water to treat. Overall costs would be low if volume to treat is small.	Rejected as a treatment option for surface water because the volume of surface water to be treated cannot be determined at this time.

TABLE 6-2
AVAILABLE PROCESS OPTIONS FOR THE DEVELOPMENT OF REMEDIAL ALTERNATIVES
TINKER AFB-SOLDIER CREEK RI/FS
FS INITIAL SCREENING OF ALTERNATIVES REPORT

GENERAL RESPONSE ACTION	SEDIMENT AND SURFACE WATER PROCESS OPTIONS
No Action	None
Institutional Controls	Fencing Sediment Monitoring Surface Water Monitoring Groundwater Monitoring
Containment	Concrete Cap Stream Diversion Dewatering
Collection/Removal	Mechanical Excavation
Disposal	Off-Base RCRA-Permitted Landfill
Sediment Treatment	Soil Washing Stabilization
Surface Water Treatment	Existing or Proposed On-base Treatment Facility

6.2.3 Sediment, Surface Water, and Groundwater Monitoring

Surface water monitoring would be used to evaluate the effectiveness of the remedial action and to provide information on contaminant migration. Sediment monitoring would be used to assess the progress of a remedial action, such as excavation, or the horizontal and vertical migration of contaminants, if no remedial action was implemented. Groundwater monitoring could indicate if contaminants have migrated from the sediment to the groundwater. Periodic sampling and analytical testing would be used to quantify contaminant concentrations.

Monitoring alone would not protect human health or the environment. Monitoring would be used in conjunction with remedial alternatives to evaluate the extent and effectiveness of the remedial action. The costs of sampling and analysis of sediment and surface water would be moderate and would depend on the number of samples collected and the parameters analyzed. Additional groundwater monitoring wells, if necessary, would be easily constructed using conventional techniques, and the cost of installation would be low compared to the overall cost of any alternative. The total cost would depend on the depth and number of wells required and the frequency and magnitude of sampling to be conducted.

6.2.4 Concrete Cap

This process option involves covering the contaminated sediment with a concrete cap to eliminate direct human and animal exposure with contamination and to minimize migration of contaminants by reducing surface water infiltration. The cap would consist of a sand or gravel drainage and a concrete protective layer. Soldier Creek would be temporarily diverted during construction, and the completed cap would remain as a flow route for the creek.

Capping is an accepted engineering practice for reducing direct contact with and the mobility of contaminants; however, the toxicity and volume of the contaminants would not be reduced. Concrete drainage ditches are common and are used for both municipal and industrial applications. Inspection and maintenance of the cap would be necessary because cracks could develop in the concrete or the concrete could erode. The relative cost of constructing a cap over the contaminated areas would depend on the quantity and type of areas requiring a cap.

6.2.5 Stream Diversion

Stream and surface water diversion could be accomplished by constructing temporary dikes or berms in the narrow creek channel of Soldier Creek. Construction of an alternate flow route for Soldier Creek drainage pathways may be required to divert surface water around contaminated areas during excavation or if the creek sediment is capped. Federal and state 404 permits may have to be obtained before the construction of any dikes, berms, or alternative flow routes (EPA, 1988c).

Stream diversion would effectively isolate contaminated areas and would also provide temporary dewatering of the areas until the sediment could be excavated or permanently contained. By diverting surface water in contaminated areas, any future remedial action could be performed more easily and effectively with less chance of contaminant resuspension. Costs for construction of temporary dikes or berms would be very low in comparison to the overall cost of remediation.

6.2.6 Mechanical Excavation

Excavation of contaminated sediment would be accomplished using conventional equipment such as backhoes, bulldozers, and front-end loaders. Because of the small channel width and shallow depth of contamination in Soldier Creek, a backhoe could be effectively used for sediment excavation. Surface water diversion would be implemented with this option to facilitate excavation and to reduce the risk of contaminant resuspension. Federal and state 404 permits may have to be obtained before the implementation of any stream diversion or excavation activities at the site.

Mechanical excavation would result in the physical removal of the contaminated sediment from the site. Once the material was removed, it could be physically or chemically treated, placed in an on-base landfill, or transported to an off-base Resource Conservation and Recovery Act-(RCRA-)permitted landfill for disposal. Relative costs for mechanical excavation would depend on the volume of sediment and would be between $5 and $25 per cubic yard.

6.2.7 Off-Base RCRA-Permitted Landfill

Under this process option, the contaminated sediment would be excavated and loaded onto trucks and transported to an off-base RCRA-permitted hazardous waste landfill for disposal. An offsite RCRA landfill includes a double liner system, a leachate detection and collection system, a multilayer cap, and a groundwater monitoring system to provide secure and long-term containment if the facility is properly maintained. This option would permanently remove contaminated material from the site and is a proven and acceptable practice that reduces the risk posed by hazardous substances by minimizing contact with the public and environment. Permits may be required to transport the contaminated sediment. A RCRA-permitted landfill is available within the State of Oklahoma; however, the chosen landfill must be in compliance with the CERCLA offsite disposal policy at the time of implementation. Costs would depend on the volume of sediment requiring transportation and disposal, and would range between $150 and $300 per ton, not including transportation costs.

6.2.8 Soil Washing

The soil washing process extracts metal and organic contaminants from excavated soil using an aqueous medium as the washing solution. The extracted contaminants are then separated from the washing fluid by conventional wastewater treatment processes suited to the particular contaminants. After the contaminants have been removed from the washing fluid, the fluid is recycled and reused in the soil washing process.

Depending on the contaminants to be removed, washing fluids can be composed of water, or water mixed with chelating agents, surfactants, acids, or bases. Chemical additives would need to be replenished if the wastewater treatment system did not allow the additives to pass through intact. A variability of waste types can make formulation of suitable washing fluids difficult and some contaminants may be removed effectively while others are not. Metals removal would be enhanced by the addition of weak acids or chelating agents with the washing solution. Organics removal would be enhanced by the addition of organic solvents or surfactants to the washing solution.

Soil washing is a volume reduction method and is most applicable for soil and sediment with a particle size distribution between 0.25 and 2 millimeters. Volume reduction is achieved by separating the "washed" coarse material from the highly contaminated fine particles and washing fluid. Soil washing would be relatively easy to implement; however, the technology is innovative and proprietary. Several mobile systems are commercially available that have been proven to remove and concentrate organic and metal contaminants. The extracted contaminants would be concentrated and further treated or transported to an off-base RCRA-permitted hazardous waste landfill for disposal. This would effectively reduce the risk posed by the hazardous residuals by minimizing contact with the public and environment. The cost of the soil washing process option would be in a range between $200 and $400 per cubic yard of material treated.

6.2.9 Stabilization

Contaminated sediment would be excavated and combined with pozzolanic ingredients and water in a pug mill. Pozzolanic materials used for stabilization include portland cement, fly ash, alumina, and silicates. The stabilized sediment would be transported off-base to a RCRA-permitted landfill for disposal or replaced in the excavated areas. Because the Land Disposal Restrictions would apply to the disposal or replacement of treated sediment, the stabilized sediment would be analyzed under the toxicity characteristic leaching procedure (TCLP) to ensure that the sediment did not exceed TCLP requirements. Future monitoring at the site would be required to monitor the integrity of the stabilized material.

Stabilization is a means of minimizing the risks associated with hazardous wastes by limiting the solubility and mobility of the contaminants with or without improvement of the physical characteristics of the waste. Immobilizing the sediment contaminants would minimize the potential for leaching into the groundwater and prevent ingestion of or direct contact with the sediment contaminants.

Stabilization has been shown to be effective in treating and immobilizing inorganic materials such as heavy metals. A silicate-based process, combined with cement or lime, would be the most effective method for stabilizing sediment contaminated with

both inorganics and organics. Bench-scale and pilot testing would be necessary to prove the effectiveness of stabilizing organics to select the specific stabilizing agent.

This process could be implemented relatively easily because commercial cement mixing and handling equipment is readily available. Mobile, trailer-mounted stabilization systems are also available. Costs for this process would depend on the quantity of material to be treated and the materials used in the stabilization process.

6.2.10 Existing or Proposed On-Base Treatment Facility

Diverted surface water would be delivered to an on-base treatment facility for treatment. Potential facilities include the Sanitary Treatment Plant (STP) and the Groundwater Treatment Plant (GWTP). The GWTP is the groundwater treatment system designed to remediate contaminated groundwater associated with the Building 3001 Site at Tinker AFB. The GWTP uses chemical reduction/precipitation and air stripping to remove inorganic and organic contaminants from groundwater which are similar to the contaminants in the surface water, but are at greater concentration than in the surface water. The GWTP would be effective in treating the surface water because of the design of the system, the low volume of water to be treated, and the low concentration of contaminants in the water. The STP, which treats sanitary and municipal-type wastewaters at Tinker AFB, may also be appropriate as a treatment method for the surface water because of the low water volume and contaminant concentrations. The use of one system over the other cannot be determined until the volume of surface water to be removed is known and an estimation of the resultant concentration of the water after removal from Soldier Creek is made.

Implementation of this technology would be relatively easy because the treatment facility would already be constructed. The diverted surface water would have to be piped or trucked to the treatment facility. Transporting the water by a vacuum truck would be easier to implement than by a pipeline, especially if surface water must be diverted off-base. The capital costs would be low for this technology if the surface water was trucked to the treatment facility. The capital costs would be moderate to high if a piping system was constructed to convey the water. The O&M costs would depend on the volume of surface water to be treated.

7.0 PRELIMINARY DEVELOPMENT AND SCREENING OF ALTERNATIVES

The technologies and process options that appear to be the most promising for the site conditions were identified in Section 6.0. Alone, these technologies would not remediate the contamination at the Soldier Creek Site. Combining the individual technologies or process options develops possible solutions, which are referred to as remedial alternatives, to the contamination problem.

This section describes the development of the preliminary remedial alternatives for the sediment and surface water at the site. It also describes the initial screening of these alternatives, based on effectiveness, implementability, and cost, to identify the most promising of the preliminary alternatives that will be further developed and evaluated in the FS report.

7.1 Development of Sediment and Surface Water Remedial Alternatives

The goals in developing the preliminary remedial alternatives are to provide both a range of cleanup options and sufficient detail to adequately compare alternatives with one another. For the contaminated sediment and surface water at the site, retained technologies and processes from Section 6.0 were combined to form a range of remedial alternatives for the initial screening performed in this section.

Alternatives developed for the remediation of sediment and surface water at the Soldier Creek Site will provide protection for human health and the environment, as well as be a source control measure for the groundwater contamination.

The NCP and the EPA "Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (EPA, 1988b) recommends that the following types of alternatives be developed to the extent practicable:

- No action alternative.

- Alternatives that contain contaminated material with little or no treatment, but protect human health and the environment by preventing potential exposure to or by reducing the mobility of the contaminants through engineering or institutional controls.

- Treatment alternatives ranging from those that would eliminate or minimize, to the extent practicable, the need for long-term management (including monitoring at a site) to those that would use treatment as a primary component to address the principle threats at a site.

- One or more innovative treatment technologies that offer the potential for comparable or superior performance or implementability, fewer or lesser adverse impacts, or lower costs.

For the Soldier Creek Site, six sediment and surface water alternatives were developed for these ranges. Table 7-1 (page 7-3) provides a summary of the major components of each alternative.

No action provides either no or limited measures to protect human health and the environment. Institutional controls are implemented to minimize the potential exposure to contaminants. Sediment and Surface Water (SSW) Alternative 1 is the "no action" alternative and would not include any measures to limit potential risks associated with contaminated sediment and surface water. SSW Alternative 2 is the limited action alternative. It would consist of some institutional controls to protect public health. Neither alternative would provide any treatment or containment of sediment or surface water.

Containment would prevent potential exposure to contaminated sediment or reduce the mobility of contaminants to protect human health and the environment. Little or no treatment would be involved with containment. SSW Alternative 3 would provide containment as the primary component. During implementation, diverted surface water would be sent to an existing or proposed on-base treatment facility.

TABLE 7-1

PRELIMINARY DEVELOPMENT OF SEDIMENT AND SURFACE WATER ALTERNATIVES

TINKER AFB - SOLDIER CREEK RI/FS

FS INITIAL SCREENING OF ALTERNATIVES REPORT

COMPONENTS	PRELIMINARY SEDIMENT AND SURFACE WATER ALTERNATIVES					
GENERAL RESPONSE ACTION TECHNOLOGY/PROCESS OPTION	1	2	3	4	5	6
No Action	●					
Institutional Control						
Fencing			●			
Sediment Monitoring		●		●	●	●
Surface Water Monitoring		●	●			
Ground Water Monitoring		●	●			
Containment						
Concrete Cap			●			
Stream Diversion			●	●	●	●
Dewatering				●		
Removal						
Mechanical Excavation				●	●	●
Disposal						
Off-base RCRA-Permitted Landfill				●	●	
Sediment Treatment						
Soil Washing						●
Stabilization					●	
Surface Water Treatment						
Existing or Proposed On-base Treatment Facility			●	●	●	●

NOTES:

1--No Action

2--Limited Action

3--Capping

4--Sediment Excavation and Off-base Landfill Disposal

5--Sediment Excavation, Stabilization, and Off-base Landfill Disposal

6--Sediment Excavation and Soil Washing

Treatment of sediment would either eliminate or minimize, to the extent feasible, the need for long-term management at the site. Treatment would be used as the primary component of two alternatives. Treatment options include stabilization (SSW Alternative 5) and soil washing (SSW Alternative 6). Soil washing is considered an innovative treatment technology. SSW Alternatives 4 and 5 involve excavation, treatment, and disposal of contaminated sediment in an appropriate landfill as the primary component of the remedial action. During implementation, diverted surface water would be sent to an existing or proposed on-base treatment system.

7.2 Discussion and Screening of Sediment and Surface Water Alternatives

The following subsections provide a general description of each of the sediment and surface water alternatives. The descriptions include the components of each alternative; major design and construction considerations that are identifiable at this point in the development process; and effectiveness, implementability, and cost evaluations.

A key aspect of the screening evaluation is the effectiveness of each alternative in protecting human health and the environment. Each alternative is evaluated on its effectiveness in providing protection and reducing contaminant toxicity, mobility, or volume. Both short- and long-term components of effectiveness are evaluated. Short-term refers to the construction period, and long-term refers to the period after all construction has been completed.

Implementability is a measure of both the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative. Technical feasibility refers to the ability to construct, reliably operate, and meet technology-specific regulations for process options until the remedial action objectives are achieved. No time estimates are provided for the alternatives at this stage in the development. Alternatives that would require a "long time" would probably require 30 years or more to meet the remedial action objectives. Technical feasibility also relates to the operation, maintenance, replacement, and monitoring requirements of an alternative in the future after the remedial action objectives are achieved.

Administrative feasibility refers to the ability to obtain approvals from other offices and agencies; the availability of treatment, storage, and disposal services and capacity; and the requirements for, and availability of, specific equipment and technical specialists.

The evaluation focuses on the major components of each alternative. Additional information will be required to better determine both the effectiveness and implementability of the alternatives. Some of this information will be provided during the detailed evaluation of remedial alternatives in the FS report; however, some information may not be available until the design phase. For example, the effectiveness of a treatment process may not be fully defined until bench-scale or pilot testing is conducted. For all of the alternatives, with the exception of the no action and limited action alternatives, there will be short-term environmental damage as a result of construction. The areas where the natural terrain is altered by construction or excavation will be regraded and revegetated to return the area to as close as to its natural state as possible.

The preliminary alternatives are defined in sufficient detail to provide rough comparisons of the capital and O&M costs. However, many uncertainties still exist, so accurate cost estimations are not practicable at this phase in the FS process. Actual costs of the alternatives are not provided. Rather, a qualitative assessment of the expected costs are given.

The preliminary screening of sediment and surface water alternatives with respect to cost is based on each alternative's cost relative to the other remedial options. Because the risk assessment determined that no risk was associated with sediment, and therefore, no sediment needs to be remediated, a volume of 2,000 cubic yards was assumed to develop the range of costs. Alternative capital and O&M costs are assembled into a range of values and assigned a specific cost designation such as low, moderate, or high. The range of costs for the capital expenditures for remediation of the Soldier Creek Site is broken down as follows:

Very low:	$0 to 100,000
Low:	$100,001 to 1,000,000

Moderate:	$1,000,001 to 5,000,000
High:	$5,000,001 to 10,000,000

The range of costs for annual O&M expenditures is broken down as follows:

Very low:	$0 to 1,000
Low:	$1,001 to 10,000
Moderate	$10,001 to 100,000
High:	$100,001 to 500,000

The overall range of costs for the alternatives, based on a 30-year life and a 5 percent discount rate, is broken down as follows:

Very low:	$0 to 50,000
Low:	$50,001 to 500,000
Moderate:	$500,001 to 1,000,000
High:	$1,000,001 to 5,000,000

More accurate cost estimates will be developed for the FS report.

7.2.1 SSW Alternative 1--No Action

Under SSW Alternative 1, no remedial action would be taken and the site would remain in its present condition. This alternative, which is required by the NCP and SARA, is a baseline against which the other sediment and surface water alternatives are judged.

7.2.1.1 Effectiveness. SSW Alternative 1 would not provide any protection to the public or environment and is the least protective of all of the sediment and surface water alternatives. No remedial activities would be implemented under SSW Alternative 1; therefore, any current and future public health and environmental risk determined during the risk assessment process would remain. The toxicity, mobility, and volume of contaminants would remain unchanged. This alternative would not meet any of the preliminary remedial action objectives outlined in Subsection 2.3.

7.2.1.2 Implementability. SSW Alternative 1 would be easily implemented. Coordination with other agencies would be minimal because no remedial activities are involved. Five-year regulatory reviews would be required in accordance with the NCP because contaminated sediment and surface water would remain at the site.

7.2.1.3 Cost. The overall cost for this alternative would be very low. There would be no capital costs associated with SSW Alternative 1 because no remedial actions would be conducted. Very low O&M costs would be associated with performing the five-year regulatory reviews of the Soldier Creek Site.

7.2.2 SSW Alternative 2--Limited Action

SSW Alternative 2 would consist solely of the institutional control of continued sediment, surface water, and groundwater monitoring to minimize potential health risks associated with the contaminated media. A potential source of surface water contamination in Soldier Creek, as determined during an investigation of the storm drainage system at Tinker AFB (NUS, 1989), is drainage from Building 3001 and other point sources (i.e. underground storage tanks) through outfalls to the creek. Recommendations for eliminating the Building 3001 point sources were addressed in the NUS Corporation (NUS) report and will be further investigated and evaluated during remedial design to address the existing surface water contamination in Soldier Creek. A summary of the recommendations made in NUS report is provided in the RI report (BVWST, 1993a).

7.2.2.1 Effectiveness. This alternative would be effective in protecting human health by reducing the potential for contact with sediment. It would not be protective of the environment because contamination would remain in place and could continue to migrate through the surface water and to the groundwater. No treatment or containment would take place; therefore, the toxicity, mobility, and volume of contaminants would remain unchanged. No adverse short-term health or environmental risks would be expected during implementation of this alternative because only limited activities would occur. The effectiveness of SSW Alternative 2 would depend on the quality of the sediment, surface water, and groundwater monitoring. No reduction in the toxicity, mobility, or volume of contaminants would be achieved. This alternative would meet all of the remedial action objectives

concerning sediment because no risk, associated with sediment, was determined to exist at the site, but it may not meet the remedial action objective concerning protection of the environment from surface water.

7.2.2.2 Implementability. SSW Alternative 2 would be easily facilitated because sediment, surface water, and groundwater sampling is commonly performed and many contractors would be available to complete the monitoring.

7.2.2.3 Cost. The overall cost to implement SSW Alternative 2 would be low. There would be no capital costs associated with this alternative, if additional monitoring wells were not constructed. The O&M costs would include periodic sediment, surface water, and groundwater sampling and analysis. These costs are considered to be low.

7.2.3 SSW Alternative 3--Capping

SSW Alternative 3 would involve the construction of a concrete cap over the potentially contaminated portions of Soldier Creek. The cap would be constructed of a sand or gravel drainage layer and a concrete layer. Because the contaminated sediment is primarily in the flow route of the creek, surface water would need to be temporarily diverted during construction. A fence may be installed around the capped areas and use restrictions placed on the cap to protect the integrity of the cap. Contaminated surface water would be collected and treated at an existing or proposed on-base treatment facility. Periodic monitoring of surface and groundwater water would be performed to monitor future release of contaminants after capping was completed.

A potential source of surface water contamination in Soldier Creek, as determined during an investigation of the storm drainage system at Tinker AFB (NUS, 1989), is drainage from Building 3001 and other point sources (i.e. underground storage tanks) through outfalls to the creek. Recommendations for eliminating the Building 3001 point sources were addressed in the NUS report and will be further investigated and evaluated during remedial design to address the existing surface water contamination in Soldier Creek. A summary of the recommendations made in the NUS report is provided in the RI report (BVWST, 1993a).

7.2.3.1 Effectiveness. Only a minimal reduction in the long-term health risk associated with contaminated sediment would be achievable with this alternative. The public health would be protected to some extent by SSW Alternative 3 because potential receptors would not be able to come into contact with the contaminated sediment after capping. However, the future release of contaminants to surface water or groundwater would be possible if the cap was disturbed or failed, and the environment would not be protected because the contaminants would remain untreated. Because the sediment would not be excavated during capping, the short-term risks to workers would be less than for the alternatives that involve excavation. Use restrictions may be placed on and fencing constructed around the capped areas to prevent future activities at the site that may harm the integrity of the cap, and expose potential receptors to contaminants. The remedial action objectives for sediment and surface water, established in Subsection 2.3, would be satisfied by this alternative because the potential exposure to contaminants would be minimized by the cap. With proper maintenance, the cap should provide protection for many years; however, the long term durability and effectiveness of capping is not proven. Contaminant mobility would be indirectly reduced by construction of the cap by reducing infiltration and the rate at which the contaminants could migrate from the sediment to the groundwater. No reduction in the toxicity or volume of the contaminants would be achieved.

7.2.3.2 Implementability. Cap construction may be difficult to implement because the contamination is primarily in the creek beds and drainage areas of Soldier Creek. On flat or gently sloping terrain, the actual construction of a cap can be implemented with little difficulty. However, along creek banks and in stream channels, the implementation would be more difficult because of the bank slopes and uneven terrain. Capping material would have to be transported to the site, but the cap could be constructed using conventional construction equipment. The cap would be inspected to monitor its integrity and groundwater and surface water monitoring would be conducted to determine if migration was occurring from the capped areas. Federal and state 404 permits may have to be obtained before the implementation of this alternative because of the surface water diversion and cap construction activities associated with SSW Alternative 3 (EPA, 1988c).

7.2.3.3 Cost. The overall cost for this alternative would be moderate. The capital cost for this alternative would include costs for stream diversion and construction of the cap. These costs are considered to be low. The O&M costs would be moderate and would include monitoring of groundwater and surface water in addition to periodic inspection and maintenance of the cap.

7.2.4 SSW Alternative 4--Sediment Excavation and Off-Base Landfill Disposal

SSW Alternative 4 would involve the excavation and dewatering of all contaminated sediment and transportation of the contaminated material to an off-base RCRA-permitted hazardous waste landfill for disposal. Surface water would be diverted temporarily during excavation with berms constructed for this purpose. Drying beds could be constructed on-base to provide an air drying dewatering process, or a mechanical dewatering process could be implemented. Well points could also be installed after stream diversion in the contaminated areas to dewater the sediment before excavation. After excavation of all of the sediment exceeding the cleanup goals, clean soil would be used to restore the excavated areas. Contaminated surface water would be collected and treated in an existing or proposed on-base treatment facility. Future land use restrictions would not be required because contaminated sediment would be removed from the site.

A potential source of surface water contamination in Soldier Creek, as determined during an investigation of the storm drainage system at Tinker AFB (NUS, 1989) is drainage from Building 3001 and other point sources (i.e. underground storage tanks) through outfalls to the creek. Recommendations for eliminating the Building 3001 point sources were addressed in the NUS report and will be further investigated and evaluated during remedial design to address the existing surface water contamination in Soldier Creek. A summary of the recommendations made in the NUS report is provided in the RI report (BVWST, 1993a).

7.2.4.1 Effectiveness. Public health and the environment would be protected because the contaminated sediment would be excavated and permanently removed from the site. After removal of the contaminated sediment, the potential for exposure by direct contact or ingestion, or for future release of contaminants to the groundwater would be eliminated. A potential health risk would exist for workers

during excavation of the contaminated sediment from dermal and inhalation exposure to contaminants. This alternative would require the transportation of large volumes of sediment, which would increase the potential for the exposure of the public to contaminants as a result of an accident or fugitive dust emissions. RCRA-permitted landfills are designed to minimize and monitor the migration of contaminants from the landfill; however, the long-term reliability of landfill disposal is uncertain. The remedial action objectives for sediment and surface water, established in Subsection 2.3, would be satisfied by the implementation of this alternative. This alternative would be effective in indirectly reducing the mobility of the contaminants through containment, but would not reduce the volume or the toxicity of the contaminants.

7.2.4.2 Implementability. Excavation and off-base disposal in a RCRA-permitted landfill is a common and proven practice for the remediation of contaminated soil and sediment. To verify the removal of all of the contaminated sediment to acceptable levels, sediment sampling would have to be conducted during the excavation process. In general, the depth of sediment excavation should not be greater than six feet; therefore, excavation could be accomplished using conventional equipment. The services required to implement this alternative would be readily available. Federal and state 404 permits may have to be obtained because this alternative involves sediment excavation in and around Soldier Creek and temporary diversion of surface water (EPA, 1988c). Permits may be required for off-base transportation, and the selected landfill would have to be in conformance and compliance with the CERCLA offsite disposal policy at the time of implementation.

7.2.4.3 Cost. The overall cost to implement this alternative would be moderate. The capital cost of SSW Alternative 4 would be moderate and would include expenditures for the excavation of the contaminated sediment, dewatering of the excavated sediment, transportation to and disposal of the sediment at an off-base RCRA-permitted landfill, and backfilling of the excavated areas with clean soil to restore the creek to its condition before remediation. No O&M costs would be incurred if Soldier Creek was properly restored after excavation.

7.2.5 SSW Alternative 5--Sediment Excavation, Stabilization, and Off-Base Landfill Disposal

This alternative would consist of the excavation and stabilization of contaminated sediment and the transportation of the stabilized material to an off-base landfill for disposal. Temporary diversion of Soldier Creek may be required during sediment excavation. Excavated sediment may also require dewatering before stabilization. This could be accomplished by the same methods described for SSW Alternative 4. After transporting the excavated sediment to an on-base stabilization area, the sediment would be mixed with stabilizing agents (lime, soda ash, or polymers) and allowed to cure. The stabilized material would be transported to an off-base landfill for disposal. Contaminated surface water would be collected and treated in an existing or proposed on-base treatment facility. No future land use restrictions would be required for this alternative because all of the sediment exceeding the cleanup goals would be removed.

A potential source of surface water contamination in Soldier Creek, as determined during an investigation of the storm drainage system at Tinker AFB (NUS, 1989), is drainage from Building 3001 and other point sources (i.e. underground storage tanks) through outfalls to the creek. Recommendations for eliminating the Building 3001 point sources were addressed in the NUS report and will be further investigated and evaluated during remedial design to address the existing surface water contamination in Soldier Creek. A summary of the recommendations made in the NUS report is provided in the RI report (BVWST, 1993a).

7.2.5.1 Effectiveness. SSW Alternative 5 would be effective in protecting public health and the environment and in minimizing the long-term risk associated with contaminated sediment. A potential health risk would exist for workers during the excavation and stabilization of contaminated sediment from dermal and inhalation exposure to contaminants. The stabilization process is proven for the treatment of sediment contaminated with inorganics; however, the long-term reliability of stabilizing material contaminated with organics is uncertain. This alternative would be more effective than SSW Alternative 4 in reducing short- and long-term risk because the contaminated material would be stabilized before off-base transportation, thereby reducing the risk of accidental release of contaminants. In addition, two

remedial methods would be used to minimize contaminant mobility. The remedial objectives for sediment and surface water, established in Subsection 2.3, would be satisfied by this alternative because the risk of future exposure to contaminants would be reduced. Stabilization of contaminated sediment would minimize the mobility and toxicity of the contaminants; however, the overall volume of material would increase. The disposal of stabilized material in an off-base landfill would further minimize the mobility of the contaminants.

7.2.5.2 Implementability. Because of the additional remedial activity of stabilization, this alternative would be more difficult and time consuming to implement than an alternative that requires only excavation and disposal. In general, the depth of excavation would not be greater than six feet, which would make excavation with conventional equipment relatively easy. The services and materials required to implement this alternative would be readily available. To ensure that the contaminated sediment was removed to acceptable levels, sediment samples would be collected during the excavation process. Federal and state 404 permits may have to be obtained because of the excavation and temporary surface water diversion activities associated with this alternative (EPA, 1988c). The total volume of the sediment would increase after stabilization, increasing transportation and disposal costs.

7.2.5.3 Cost. The overall cost to implement this alternative would be high. The capital costs to implement SSW Alternative 5 would include surface water diversion, excavation of contaminated sediment, stabilization of contaminated sediment, transportation of the stabilized material to an off-base landfill for disposal, and restoration of Soldier Creek, and are considered to be moderate. No O&M costs would be associated with this alternative if Soldier Creek was properly restored.

7.2.6 SSW Alternative 6--Sediment Excavation and Soil Washing

This alternative would consist of the excavation and soil washing of contaminated sediment and the replacement of the treated sediment in excavated areas. Treatment residuals may require additional treatment before disposal, and temporary diversion of Soldier Creek may be required during sediment excavation. The excavated sediment would be fed to a washing unit where agitation of the sediment with the

washing solution would remove contaminants from the sediment. Treated sediment could be replaced in the excavated areas or transported to an off-base landfill for disposal and Soldier Creek restored to its original condition. Contaminated surface water and spent washing solution would be collected and treated in an existing or proposed on-base treatment facility. No future land use restrictions would be required because all of the sediment exceeding the cleanup goals would be treated to below cleanup goals.

A potential source of surface water contamination in Soldier Creek, as determined during an investigation of the storm drainage system at Tinker AFB (NUS, 1989), is drainage from Building 3001 and other point sources (i.e. underground storage tanks) through outfalls to the creek. Recommendations for eliminating the Building 3001 point sources were addressed in the NUS report and will be further investigated and evaluated during remedial design to address the existing surface water contamination in Soldier Creek. A summary of the recommendations made in the NUS report is provided in the RI report (BVWST, 1993a).

7.2.6.1 Effectiveness. SSW Alternative 6 would be effective in protecting human health and the environment and in minimizing the long-term risk associated with contaminated sediment. Bench-scale and pilot testing would be required to determine if the soil washing process was capable of reducing contaminant concentrations in the sediment to levels below the cleanup goals.

The toxicity, mobility, and volume of sediment contaminants would be effectively reduced by the soil washing process. Potential short-term human health and environmental risks would exist during the excavation and stabilization of contaminated sediment. If treated sediment was returned to the excavated areas, monitoring of the areas may be required to monitor the potential recontamination of the sediment.

7.2.6.2 Implementability. The excavation of the contaminated sediment would be relatively easy to complete using conventional equipment, and the services and materials to implement this alternative would be available. To ensure that the contaminated sediment was removed to acceptable levels, sediment samples would

be collected during the excavation process. Federal and state 404 permits may have to be obtained because of the excavation and temporary surface water diversion activities associated with this alternative (EPA, 1988c). The treated sediment from the soil washing process would be analyzed by the TCLP to determined if any risk was involved with replacing the treated sediment back into the excavated areas of Soldier Creek. If the treated sediment exhibited concentrations in excess of TCLP requirements, the sediment would require further treatment. Soil washing is an innovative technology and has undergone limited full-scale demonstrations. However, several mobile soil washing processes are commercially available and could be implemented on-base with little difficulty. Different washing solutions may have to be used to effectively extract organic and inorganic contaminants from the sediment. Extracted contaminants could be separated from the washing solution by a conventional wastewater treatment process and the washing solution reused.

7.2.6.3 Cost. The overall cost to implement this alternative would be moderate. Capital costs would be moderate and would include costs for surface water diversion, excavation of contaminated sediment, soil washing, replacement of treated sediment into Soldier Creek, treatment of the washing solution, and disposal of treatment residuals. O&M costs would consist of long-term monitoring of the replaced sediment and are considered to be low.

7.3 Summary of Preliminary Alternative Screening

The NCP requires that the preliminary alternatives be subjected to an initial screening to eliminate those alternatives that have adverse impacts on public health and the environment, are not applicable to the contaminants and media at the site, or are much more expensive to implement than other alternatives that provide essentially the same level of protection. The alternatives that pass this screening will be further developed and evaluated in greater detail in the FS report. The screening results are presented in the following sections. The preliminary screening of the sediment and surface water alternatives is summarized in Table 7-2 (page 7-16).

Six alternatives were developed for the remediation of contaminated sediment and surface water at the Soldier Creek Site. The alternatives were developed to provide

TABLE 7-2
SUMMARY OF PRELIMINARY SCREENING OF SEDIMENT AND SURFACE WATER ALTERNATIVES
TINKER AFB - SOLDIER CREEK RI/FS
INITIAL SCREENING OF ALTERNATIVES REPORT

PRELIMINARY ALTERNATIVE	SCREENING CRITERIA				
	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	STATUS
SSW Alternative 1 No Action	No actions would be taken to remediate the sediment and surface water at the site.	Would not be effective in preventing direct contact with or ingestion of contaminated sediment or surface water. Would not be protective of the environment. Would not provide any reduction in the toxicity, mobility, or volume of sediment and surface water contaminants.	Criterion is not applicable because no remedial actions would be implemented at the site.	No capital costs and very low O&M costs would be associated with this alternative. Overall cost of this alternative would be very low.	Retained as a baseline comparison, as required by the NCP.
SSW Alternative 2 Limited Action	Continued sediment, surface water, and groundwater monitoring would be implemented on periodic basis to monitor contaminant migration.	Would be somewhat effective in reducing potential direct contact with or ingestion of contaminated sediment and surface water; however, no protection of the environment would be provided. Contaminants could continue to migrate and no reduction in toxicity, mobility, or volume of sediment or surface water contaminants would be achieved. Only minimal risks to workers would be encountered during sediment and surface water sampling. Would meet all of the remedial action objectives for sediment and surface water.	Would be very easy to implement.	No capital and low O&M costs would be associated with this alternative, if no additional monitoring wells were installed. Overall cost of this alternative would be low.	Retained because all of the remedial action objectives for sediment can be met without remediation. Surface water monitoring should be sufficient to address the potential risk to the public and the environment associated with the surface water.
SSW Alternative 3 Capping	A concrete cap would be constructed over the contaminated areas. Temporary surface water diversion would be implemented by constructing alternate flow routes around the contaminated areas to facilitate the implementation of this alternative. Contaminated surface water would be collected and treated in an existing or proposed on-base treatment facility. Use restrictions would be placed on the capped areas.	Only minimal reductions in long-term health risks would be possible. The cap would prevent potential receptors from coming into contact with the contaminated sediment. Future release of contaminants to surface water or groundwater would be possible if the cap was disturbed or failed. Short-term risks to workers would be less than with alternatives that include excavation. Long-term durability and effectiveness of capping has not been proven.	Cap construction may be difficult to implement over the contaminated areas because the contaminated sediment is primarily in the creek bed. Soldier Creek is not very wide and it may be difficult to use equipment needed for cap construction effectively. Alternate flow routes could be constructed using conventional construction equipment. The cap would require long-term maintenance. Federal and state 404 permits may be required because of surface water diversion and capping activities involved with this alternative.	Low capital and moderate O&M costs would be associated with this alternative. Overall cost of this alternative would be moderate.	Retained because the alternative would achieve the remedial action objectives for sediment and surface water and would provide a range in the degree of remediation implemented at the site.

TABLE 7-2 (Continued)
SUMMARY OF PRELIMINARY SCREENING OF SEDIMENT AND SURFACE WATER ALTERNATIVES
TINKER AFB - SOLDIER CREEK RI/FS
INITIAL SCREENING OF ALTERNATIVES REPORT

PRELIMINARY ALTERNATIVE	SCREENING CRITERIA				
	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	STATUS
SSW Alternative 4 Sediment Excavation and Off-base Landfill Disposal	Contaminated sediment would be excavated and dewatered onsite and then transported to an off-base Resource Conservation and Recovery Act-(RCRA-)permitted hazardous waste landfill for disposal. Temporary surface water diversion would be implemented at the site to facilitate the sediment excavation process. Contaminated surface water would be collected and treated in an existing or proposed on-base treatment system. Clean soil would be used to replace the excavated sediment and restore Soldier Creek to its original condition.	Would be effective in reducing the long-term health and environmental risks associated with the sediment and surface water contamination. Potential for exposure by direct contact with or ingestion of contaminants, and for future releases of contaminants to the groundwater would be eliminated. Public health and the environment would be protected because contaminants would be removed from the site. Would be effective in indirectly reducing the mobility of the contaminants through containment, but not the volume or toxicity.	Excavation and offsite disposal in a landfill are common and proven practices for the remediation of contaminated soil and sediment. Excavation would be easy to implement with conventional construction equipment. Sediment sampling would have to be conducted during the excavation process to verify the removal of all the contaminated sediment to acceptable levels. Off-base transportation may require permits and disposal of contaminated sediment may have to comply with strict regulations under current EPA policy. Federal and state 404 permits may be required because of the excavation and temporary surface water diversion activities involved with this alternative.	Moderate capital and no O&M costs would be associated with this alternative. Overall cost of this alternative would be moderate.	Retained because the alternative would achieve the remedial action objectives for sediment and surface water and would provide a range in the degree of remediation implemented at the site.
SSW Alternative 5 Sediment Excavation, Stabilization, and Off-base Landfill Disposal	Contaminated sediment would be excavated and transported to an on-base area for stabilization. Sediment may require dewatering before stabilization. The stabilized sediment would be transported to an off-base RCRA landfill for disposal. Temporary surface water diversion would be implemented at the site to facilitate the sediment excavation process. Contaminated surface water would be collected and treated in an existing or proposed on-base treatment facility. Clean soil would be used to replace the excavated sediment and restore Soldier Creek to its original condition.	Would be effective in protecting public health and the environment because contaminated sediment would be removed and stabilized. Worker exposure to contaminants would increase because some handling of the sediment would be required during stabilization. Sediment would be stabilized before transporting off-base, thereby reducing the risk for contaminant contact with the public or environment. Effectiveness of stabilization is difficult to predict because the long-term reliability of stabilizing organic contaminated sediment is uncertain; however, certain stabilization methods have shown applicability to stabilizing both organics and inorganics. Would reduce the mobility of the contaminants, but total volume of material would increase.	Would be more difficult to implement than an alternative that requires only excavation and disposal because of the added stabilization process. Stabilization is a commercially available technology for the treatment of hazardous wastes before landfilling. Excavation would be easy to implement with conventional equipment. Services and materials would be readily available. Sediment sampling would have to be conducted during the excavation process to verify the removal of all of the contaminated sediment above cleanup goals. Federal and state 404 permits may be required because of the excavation and temporary surface water diversion activities involved with this alternative.	Moderate capital and no O&M costs would be associated with this alternative. Overall cost of this alternative would be high.	Retained because the alternative would achieve the remedial action objectives for sediment and surface water and would provide a range in the degree of remediation implemented at the site.

TABLE 7-2 (Continued)
SUMMARY OF PRELIMINARY SCREENING OF SEDIMENT AND SURFACE WATER ALTERNATIVES
TINKER AFB - SOLDIER CREEK RI/FS
INITIAL SCREENING OF ALTERNATIVES REPORT

PRELIMINARY ALTERNATIVE	SCREENING CRITERIA				
	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	STATUS
SSW Alternative 6 Sediment Excavation and Soil Washing	Contaminated sediment would be excavated and transported to an on-base area for soil washing. Soil washing would remove organic and inorganic contaminants from the sediment. Temporary surface water diversion would be implemented at the site to facilitate the sediment excavation process. Treated sediment would be replaced in the excavated areas, or disposed of in an off-base landfill. Treatment residuals may require further treatment before disposal. Contaminated surface water and washing fluids would be collected and treated in an existing or proposed on-base treatment facility.	Would be effective in protecting public health and the environment because contaminated sediment would be treated and removed. Worker exposure to contaminants would increase because some handling of the sediment would be required during the soil washing process. The toxicity, mobility, and volume of sediment contaminants would be reduced by the soil washing process.	Several mobile soil washing systems are commercially available and could be implemented with little difficulty. Excavation of sediment would be relatively easy to implement using conventional construction equipment. Soil washing is a relatively innovative technology with limited full-scale demonstrations. Bench-scale and pilot testing would be required to demonstrate the technical feasibility of this technology in achieving the cleanup goals. Weak acids or chelating agents may need to be added to the washing solution to effectively extract metals, and surfactants may need to be used for the extraction of organics. Sediment sampling would have to be conducted during the excavation process to verify the removal of all of the contaminated sediment above cleanup goals. Federal and state 404 permits may be required because of the excavation and temporary surface water diversion activities involved with this alternative.	Moderate capital costs and no O&M costs would be associated this alternative. Overall cost of this alternative would be moderate.	Retained because the alternative would achieve the remedial action objectives for sediment and surface water and would provide a range in the degree of remediation implemented at the site.

a range in the degree of cleanup, the time and costs to complete the remediation, and the type of treatment employed.

SSW Alternatives 1 and 2 propose that no action and limited action be taken to remediate the sediment and surface water at the Soldier Creek Site. SSW Alternative 1 would not be effective in preventing ingestion of or direct contact with sediment and surface water contaminants. SSW Alternative 2 would protect public health by the continued monitoring of sediment, surface water, and groundwater. Neither alternative would provide additional protection of the environment because no action would be taken to prevent the migration of the contaminants or to reduce the toxicity, mobility, or volume associated with the sediment and surface water contaminants.

The remainder of the sediment and surface water alternatives would reduce any long-term risk associated with contaminated media. SSW Alternative 3 would reduce ingestion of or direct contact with contaminants by capping the contaminated areas and constructing alterative flow routes for Soldier Creek around these areas. Some protection of the environment would occur; however, the sediment contaminants would not be treated or destroyed. Migration of contaminants from the sediment would be minimized because surface water infiltration would be reduced. SSW Alternatives 4, 5, and 6 would be the most effective at protecting public health and the environment because contaminated sediment would be excavated and treated or removed from the site, and contaminated surface water would be collected and treated in an existing or proposed on-base treatment facility. Under SSW Alternative 4, contaminated sediment would be excavated, dewatered, and placed in an off-base RCRA landfill for final disposal. SSW Alternative 5 would also employ the use of an off-base RCRA landfill for final containment of sediment, but the alternative also includes a treatment process, stabilization, to minimize the toxicity, volume, or mobility of the contaminants. SSW Alternative 6 would involve using the soil washing process to treat contaminated sediment, and disposal of the treated sediment in an off-base RCRA landfill or replacement of the sediment in excavated areas.

SSW Alternative 4, while effectively removing and containing the contaminated sediment, would not reduce the toxicity or volume of the contaminants, but would indirectly reduce contaminant mobility through containment. SSW Alternative 5 would use stabilization to reduce the toxicity and mobility of the contaminated sediment; however, the volume of material would be increased after treatment. SSW Alternative 6 would effectively reduce the mobility, toxicity, and volume of the sediment contaminants.

The short-term risks to the public and environment during implementation of all of the sediment and surface water alternatives, with the exception of SSW Alternatives 1 and 2, would be minimal. However, a greater short-term risk to workers would occur during the implementation of SSW Alternatives 5 and 6 because of the stabilization and treatment of the sediment. A greater risk to the public would occur under any alternative that involved off-base transportation of contaminated sediment or treatment residuals. SSW Alternatives 1 and 2 would involve no short-term risk to the public or environment. Workers and the local community could be exposed to contaminants during implementation; however, control measures such as personnel protective equipment and dust suppressants would be used to mitigate any adverse effects.

SSW Alternative 1 would not meet any of the remedial action objectives because sediment and surface water with contaminant concentrations exceeding the cleanup goals would not be addressed. The remedial action objectives would be achieved by the other alternatives; however, only minimal reduction in long-term health risks would be achievable with SSW Alternatives 2 and 3.

The equipment and services needed to implement the sediment and surface water alternatives would be available and most alternatives would be relatively easy to implement. However, the construction of a concrete cap over the contaminated areas, as specified under SSW Alternative 3, may be difficult to implement. A treatability study and bench-scale or pilot testing may have to be completed before implementation of SSW Alternatives 5 and 6 to determine the effectiveness of stabilization and soil washing on the site contaminants.

No capital costs and very low O&M costs would be associated with SSW Alternatives 1 and 2. SSW Alternative 3 would have low capital and moderate O&M costs, and SSW Alternatives 4, 5, and 6 would have moderate capital and no or low O&M costs.

All of the sediment and surface water alternatives were retained for further detailed evaluation in the FS report to provide a range in the treatment and containment technologies considered for remediation of the Soldier Creek Site. The no action alternative, SSW Alternative 1, was retained as the baseline from which to compare the other retained alternatives.

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