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Vol. I

Contract No. DAAK11-83-D-0007
Task Order 0004
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WEST VIRGINIA ORDNANCE WORKS FEASIBILITY STUDY FOR THE TNT MANUFACTURING AREA, THE BURNING GROUNDS, AND THE INDUSTRIAL SEWERLINES
DRAFT FINAL REPORT

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
P.O. Box ESE
Gainesville, FL 32602

July 1986

Prepared for:

U.S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
Installation Restoration Division
Aberdeen Proving Ground, MD 21010-5401

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This report evaluates the feasibility of several alternative measures to remedy endangerment to public health, welfare, and the environment posed by hazardous materials found in specific source areas associated with the former West Virginia Ordnance Works (WVOW) near Pt. Pleasant, WV. The land, now owned by the State of West Virginia, currently comprises the Clifton F. McClintic State Wildlife Station (McClintic Wildlife Station). The land is managed to support migratory game birds, fresh water fish, and uplands game; public hunting and fishing are encouraged at the McClintic Wildlife Station. As a result of previous investigations by the State and the U.S. Environmental Protection Agency (EPA), the site was placed on the National Priorities List (NPL) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

Source areas addressed are the TNT Manufacturing Area, the Burning Grounds Area, and the Industrial Sewerlines. Wastes were disposed in the Burning Grounds Area during and shortly after military operations on the site during World War II (WWII). The report presents the method and results of the development and evaluation of remedial alternatives to

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address the exposure pathways as defined by the Endangerment Assessment (EA) (ESE, 1986b). Remedial technologies were identified and screened for two factors: (1) waste characteristics, and (2) the degree of technology development. Remaining technologies were screened based on site characteristics. Remedial alternatives were developed from the list of remaining technologies. Alternatives were developed for five categories, according the the National Contingency Plan (NCP); (1) Offsite Disposal, (2) Meets Requirements, (3) Exceeds Requirements, (4) CERCLA, and (5) No Action. A detailed analysis was conducted to evaluate each alternative for technical, environmental, public health, institutional, and cost criteria. A recommended alternative was selected based on the results of this analysis. This alternative is the 4A CERCLA Alternative which involves (1) in situ flaming of TNT residue on the surface of the Burning Grounds Area; (2) offsite disposal of asbestos in a sanitary landfill; (3) placement of a 2-foot (ft) soil cover over soil containing greater than 50 micrograms per gram (ug/g) of total nitroaromatics; and (4) excavation, flashing, and backfilling of the reactive Industrial Sewerlines.

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LIST OF ACRONYMS AND ABBREVIATIONS

AAAP	Alabama Army Ammunition Plant
ABL	Allegany Ballistics Laboratory
ANAD	Anniston Army Depot
ASTM	American Society for Testing and Materials
BLM	Bureau of Land Management
BOE	U.S. Bureau of Explosives
CAAP	Cornhusker Army Ammunition Plant
°C	degrees Celsius
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm	centimeters
CWA	Clean Water Act
cy	cubic yards
cy/hr	cubic yards per hour
DDT	deflagration-to-detonation transition
2,4-DNB	2,4-dinitrobenzene
DNR	Department of Natural Resources
2,4-DNT	2,4-dinitrotoluene
2,6-DNT	2,6-dinitrotoluene
DOD	Department of Defense
DOT	Department of Transportation
EA	Endangerment Assessment
EP	Extraction Procedure
EPA	U.S. Environmental Protection Agency

ESE	Environmental Science and Engineering, Inc.
°F	degrees Fahrenheit
fibers/L	fibers per liter
ft	feet
ft^2	square feet
ft-MSL	feet above mean sea level
ft/sec	feet per second
FWQC	Federal Water Quality Criteria
gal	gallons
GW	ground water
HHS	Department of Health and Human Services
HSWA	Hazardous and Solid Waste Amendments
HUD	Department of Housing and Urban Development
km/sec	kilometers per second
LAAP	Louisiana Army Ammunition Plant
lb	pounds
LEAD	Letterkenny Army Depot
MAAP	Milan Army Ammunition Plant
McClintic Wildlife Station	Clifton F. McClintic State Wildlife Station
mi	miles
MOU	Memorandum of Understanding
MSL	mean sea level
NAAQS	National Ambient Air Quality Standards
N&D	noise and dust
NCP	National Contingency Plan
NGVD	National Geodetic Vertical Datum

NIPDWR	National Interim Primary Drinking Water Regulations
NPL	National Priorities List
NSPS	New Source Performance Standards
O&M	operation and maintenance
OMB	Office of Management and Budget
OSHA	Occupational Safety and Health Administration
PAHs	polynuclear aromatic hydrocarbons
PPLV	preliminary pollutant limit value
qt	quarts
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
RMA	Rocky Mountain Arsenal
RMCL	Recommended Maximum Contaminant Level
ROD	Record of Decision
SADA	Savanna Army Depot Activity
SDWA	Safe Drinking Water Act
SHAD	Sharpe Army Depot
sq yd	square yard
SW	surface water
TNB	trinitrobenzene
1,3,5-TNB	1,3,5-trinitrobenzene
TNT	trinitotoluene
2,4,6-TNT	2,4,6-trinitrotoluene
tons/hr	tons per hour
TSDF	treatment, storage, or disposal facility
µg/g	micrograms per gram
µg/L	micrograms per liter

USAMBRDL	U.S. Army Medical Bioengineering Research and Development Laboratory
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WVAPCC	West Virginia Air Pollution Control Commission
WVOW	West Virginia Ordnance Works
WVPDES	West Virginia Pollution Discharge Elimination System
WVWQS	West Virginia Water Quality Standards
WWII	World War II

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D-WVOW-FS.3/EXSUM.1
07/23/86

EXECUTIVE SUMMARY

Environmental Science and Engineering, Inc. (ESE), under contract with the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), is conducting a Remedial Investigation/Feasibility Study (RI/FS) of the former West Virginia Ordnance Works (WVOW). The purpose of the RI/FS is to assess soils, surface water, and ground water contamination resulting from past 2,4,6-trinitrotoluene (2,4,6-TNT) manufacturing operations and to evaluate potential remedial action alternatives.

To expedite implementation of source area remedial actions, WVOW has been divided into two operable units. The first operable unit (source areas) consists of the TNT Manufacturing Area, the Burning Grounds Area, and the Industrial Sewerlines. The second operable unit (ground water areas) consists of the Pond 13, Yellow Water Reservoir, and Red Water Reservoirs. A supplemental Remedial Investigation (RI) was initiated for the second operable unit in March 1986 to complete characterization of ground water flow direction and contamination for these areas. The supplemental RI is scheduled to be completed in August 1986.

This report presents the findings of the Feasibility Study (FS) for the first operable unit. A subsequent FS report will be prepared for the second operable unit. The purpose of the FS is to develop and evaluate, in accordance with the National Contingency Plan (NCP), alternative remedial responses to uncontrolled releases of hazardous substances.

The FS provides information needed to select cost-effective remedial alternatives that effectively abate/mitigate releases of hazardous substances and provide adequate protection for public health, welfare, and the environment.

In the following sections, information related to the site background, nature and extent of the problem, objectives of the remedial action, applicable technologies, and remedial action alternatives are addressed.

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Site Background

The WVOW site covers approximately 8,323 acres in Mason County, WV. It is approximately 58 miles (mi) northwest of Charleston, 41 mi northeast of Huntington, and 6 mi north of Point Pleasant, WV, on the east bank of the Ohio River. Approximately one-third of the area is currently occupied by the Clifton F. McClintic State Wildlife Station (McClintic Wildlife Station), which is 2,788 acres in size and operated by the West Virginia Department of Natural Resources (DNR).

From 1942 to 1945, WVOW operated to produce 2,4,6-TNT explosive. Production of this material during World War II (WWII) resulted in contamination of the soils of the industrial area, process facilities, and industrial wastewater disposal facilities by 2,4,6-TNT and associated byproducts and environmental transformation products. The 2,4,6-TNT was shipped to various Government installations to be loaded into munitions or for otner uses. No loading of munitions or testing of ordnance was conducted at WVOW.

At the close of operations in 1945, the WVOW plant was declared surplus and the facilities were salvaged or disposed of. Because the industrial area was contaminated to the extent that complete decontamination was not feasible, a portion of the land was not released to private ownership but was transferred to the State of West Virginia for wildlife management. If the land were to be used for any other purpose, or in the event of national emergency, the ownership of the land would revert to the Federal Government. The land, now owned by the state, currently comprises the McClintic Wildlife Station and is managed by the West Virginia DNR. West Virginia DNR's management practices are primarily designed to promote wetlands habitats and populations of resident and migratory waterfowl. Consistent with this objective, more than 30 shallow ponds have been constructed since cessation of military activities on the site, and most of the ponds are stocked with bass. The area is open for public hunting and fishing. Smaller portions of the nonindustrial areas of the site were excessed by the Government and are now owned by Mason C[illegible], WV, or by private owners.

Surface water contamination was observed on the site (at Pond 13) in May 1981. Following preliminary investigation by the West Virginia DNR and the U.S. Environmental Protection Agency (EPA), WVOW was listed on the National Priorities List (NPL) of uncontrolled hazardous waste sites under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. In accordance with Executive Order 12316, the NCP, and the Memorandum of Understanding (MOU) between the Department of Defense (DOD) and EPA, USATHAMA is designated the lead agency for the CERCLA response; this report is one element of the CERCLA response.

Nature and Extent of Contamination:

The FS is predicated on the information and data generated during the RI and the identified pathways, receptors, and corresponding criteria developed in the Endangerment Assessment (EA) to protect receptors. The results of the RI and EA identified the following six areas that potentially require remediation:

1. TNT Manufacturing Area,
2. Burning Grounds Area,
3. Industrial Sewerlines,
4. Acids Area/Yellow Water Reservoir,
5. Red Water Reservoirs, and
6. Pond 13/Wet Well Area.

The location of each area is shown in Fig. 1.

The principal sitewide contaminants are nitroaromatic residues, and the predominant compound observed is 2,4,6-TNT. Two other compounds, 1,3,5-trinitrobenzene (1,3,5-TNB) and 2,4-dinitrobenzene (2,4-DNB), are also widely distributed. Table 1 is a summary of the nature and extent of contamination at the WVOW site.

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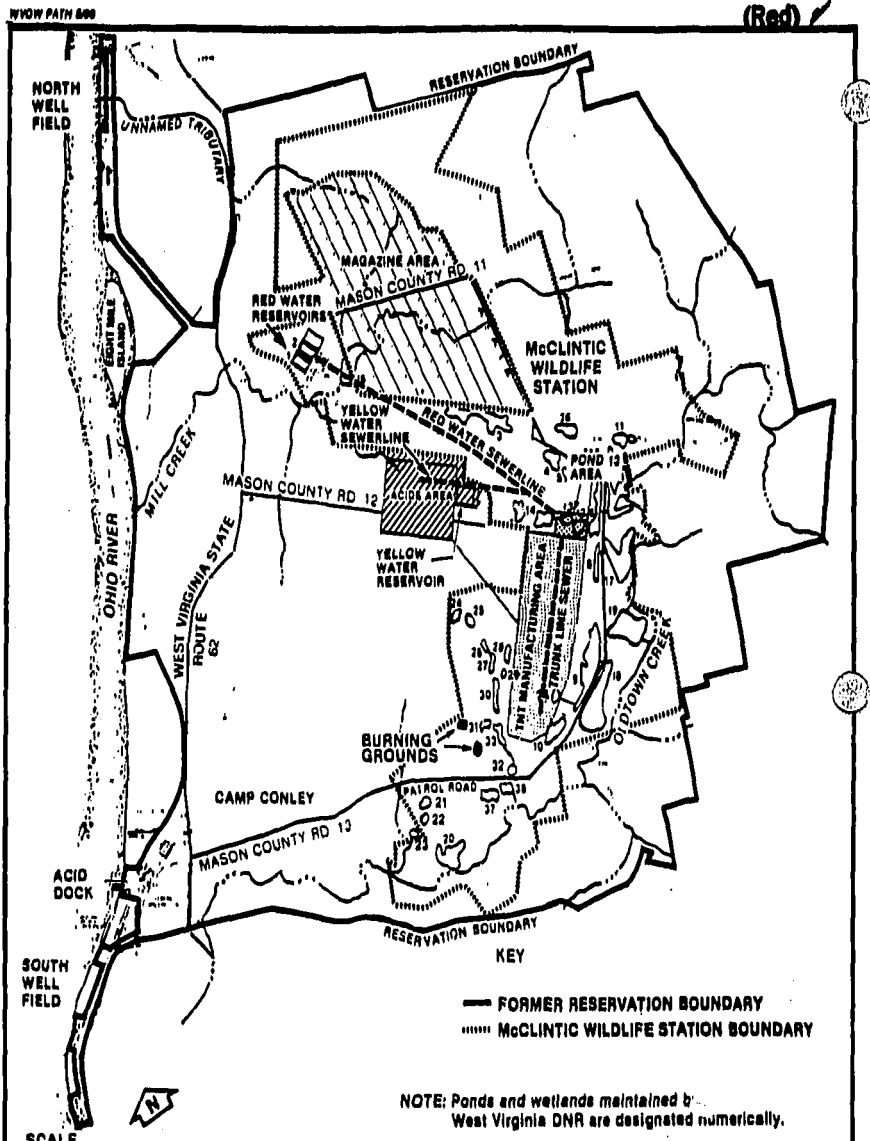

NOTE: Ponds and wetlands maintained by West Virginia DNR are designated numerically.

SOURCES: USATHAMA, 1984.
War Department, O.C.E., Construction Division, 1950.
State of West Virginia, DNR, 1984.
ESE, 1986a.

SOURCE: ESE, 1986c.

Figure 1
WVOW STUDY AREAS

WEST VIRGINIA ORDNANCE WORKS
Feasibility Study

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Table 1. Summary of Contamination Status for WVOW

Environmental Medium	Contaminant	Maximum Concentration Detected*
TNT Manufacturing Area		
Soils	Nitroaromatics	3%
	Lead	320 µg/g
Surface Water	Nitroaromatics	1 µg/L (Pond 34 only)
Sediments	Nitroaromatics	0.4 µg/g
Ground Water	Nitroaromatics	14,000 µg/L
	Lead	20 µg/L†
Burning Grounds Area		
Soils	Nitroaromatics	2%
	Lead	1,400 µg/g
	PAHs	100 µg/g
	Friable asbestos	Observed
Surface Water	Lead	20.5 µg/L†
	Asbestos	2.6×10^6 fibers/L
Sediments	Lead	31 µg/g
Ground Water	Uncontaminated†	--
Industrial Sewerlines		
TNT Manufacturing Area	Nitroaromatics	71%
Acids Area/Yellow Water Reservoir	Nitroaromatics	400 µg/g
Red Water Reservoirs	Nitroaromatics	0.2%
Pond 13/Wet Well Area	Uncontaminated	--

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Table 1. Summary of Contamination Status for WVOW
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Environmental Medium	Contaminant	Maximum Concentration Detected*
Offsite Areas**		
Soils	Uncontaminated	--
Surface Water	Asbestos	480,000 fibers/L††
Sediments	Uncontaminated	--
Ground Water	Uncontaminated†	--

* In each area, sampling strategy was designed to identify and sample the most contaminated areas, so the maximum concentrations are not necessarily representative of the typical concentration in each source area. In virtually all source areas, several samples were collected that were uncontaminated, thus realistically defining the extent of contamination.

† Lead in ground and surface waters did not exceed relevant standards or criteria [e.g., National Interim Primary Drinking Water Regulations (NIPDWR) = 50 µg/L].

** Offsite areas are sampling locations not in the designated source areas. The offsite areas include Oldtown Creek (on McClintic Wildlife Station), Mill Creek potable water supply wells, the former magazine area, and a conventional solid waste landfill on former WVOW property.

†† Recently proposed Recommended Maximum Contaminant Level (RMCL) for asbestos in drinking water is 7,100,000 fibers/L (Federal Register, Vol. 50, No. 219:46936-47021).

NOTE: fibers/L = fibers per liter
PAHs = polynuclear aromatic hydrocarbons
ft^2 = square feet
µg/g = micrograms per gram
µg/L = micrograms per liter

Source: ESE, 1986c.

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According to the 40 CFR261.23, Resource Conservation and Recovery Act (RCRA) definition, 2,4,6-TNT may be classified as hazardous because of the characteristic of reactivity. RCRA regulations preclude landfilling, or capping wastes that are classified as reactive.

To adequately determine if any of the explosive contamination required special treatment, representative samples of WVOW soils were tested for reactivity to verify their nonreactive status. The results of these tests indicate that only one sample of organic crystalline residue from the TNT process sewerline (containing over 40 percent 2,4,6-TNT) was reactive. Four composite soil samples collected from the TNT Manufacturing Area and Burning Grounds Area were determined to be nonreactive. The results of these tests were used in the FS to exclude the reactivity characteristic from those soils which did not react and to further define any materials-handling/safety considerations required in evaluating remedial alternatives. EPA concurred that sewerlines would be considered reactive and that soil would not be considered reactive. This position is further supported by recent work at the Milan Army Ammunition Plant (MAAP), Savanna Army Depot Activity (SADA), and Louisiana Army Ammunition Plant (LAAP) sites.

Objectives of Remedial Action

Remedial action objectives were defined by the EA. The EA summarized and interpreted RI data and assessed actual and/or potential harm to public health, welfare, or the environment from hazardous substances originating on WVOW. Consequently, the EA justified the need for remedial action and served to focus remedial action alternatives. The EA provided a transition from the RI (ESE, 1986a) to the FS, which is in progress.

Criteria were developed in consideration of all realistic exposure pathways by which humans, wildlife, or aquatic life may be exposed to the contaminants. Criteria development was modeled on the Preliminary Pollutant Limit Value (PPLV) methodology developed at the U.S. Army Medical Bioengineering Research and Development Laboratory (USAMBRDL). The PPLV methodology represents an approach to criteria development based on site-specific exposure and risk assessment techniques and is documented by Small (1984). The criteria were developed under the assumption that McClintic Wildlife Station will continue to be managed as a hunting and fishing area with unrestricted access. Recreational users should not be exposed directly or through game and fish to contamination levels that pose a significant risk. In addition, aquatic and terrestrial biota should not be exposed to toxic concentrations.

Several key factors affect the exposure assessment. Hazardous concentrations of contaminants associated with the TNT Manufacturing Area, Burning Grounds Area, and Industrial Sewerlines are restricted to McClintic Wildlife Station, and would, under the No Action alternative, continue to be restricted to McClintic Wildlife Station. No residences will be constructed on McClintic Wildlife Station. Ground water resources that have become contaminated are not now used for potable supply; McClintic Wildlife Station is served by a municipal supply.

Overwhelming institutional constraints militate against the use of ground water on McClintic Wildlife Station as a potable supply. McClintic Wildlife Station is expected to remain a wildlife station in perpetuity. The area is the most popular (i.e., heavily utilized) facility in West Virginia's state wildlife management system because of its proximity to the state's two largest cities, Huntington and Charleston. The State of West Virginia has the incentive, intent, and authority to maintain the land in this use. Very few, if any, sites on the NPL exhibit similar institutional constraints on land use. Because of these constraints, it is clear that residences will not be constructed on McClintic Wildlife Station nor will onsite ground water be used as a drinking water supply.

By comparing actual contaminant levels with these criteria, the actual risks incurred by the exposed population were estimated. The estimated lifetime cancer risk associated with regular use of the site and consumption of harvested game is estimated not to exceed 4×10^{-5}. Because the population exposed at the levels assumed is less than 200, the expected number of excess cancer incidences under the No Action alternative is less than 0.008. In other words, odds are at least 100 to 1 that no excess cancers will occur as a result of contamination in the source areas. Noncarcinogenic contaminants do not exceed the safe levels of residual contamination with the exception of 2,4,6-TNT, which exceeds the derived criterion by a factor of 4 in the Burning Grounds Area. The development of criteria was based on a variety of conservative assumptions and safety factors so that exceedance of the criteria does not imply that adverse health effects are expected. Nonetheless, achievement of the recommended criteria would be a prudent course of action. The acceptable soil sediment and water contamination levels for WVOW source areas are included in Table 2.

Aside from endangerment posed by the toxicity of nitroaromatic contamination to humans and wildlife, additional hazards exist at the site. The sewerlines contain reactive wastes [Allegany Ballistics Laboratory (ABL), 1986]. In addition, discrete pieces of TNT are present at the Burning Grounds Area. These wastes should be removed or rendered nonreactive. Open manholes associated with sewerlines pose a safety hazard which should be remedied. Friable asbestos deposits in the Burning Grounds Area pose an inhalation hazard requiring remediation. Vegetation stress is evident in the Burning Grounds Area, and it appears that vegetation will not grow in soils containing more than 1,000 µg/g of total nitroaromatics.

Table 2. Acceptable Soil, Sediment, and Water Contamination Levels for WVOW Source Areas

Compound	McClintic Soils* [0.5 to 2 feet (ft)] (µg/g)	Pond Waters† (µg/L)	Pond Sediments† (µg/g)	Surficial Soils** (to 0.5 ft) (µg/g)
2,4,6-TNT	7,300	60	4	680
1,3,5-TNB	72,000	80	8	2,800
1,3-DNB	3,400	160	16	190
2,4-DNT				
10^{-6} risk	15	3.4	0.22	1.5
10^{-5} risk	150	34	2.2	15
2,6-DNT				
10^{-6} risk	3.1	0.67	0.53	0.31
10^{-5} risk	31	6.7	5.3	3.1
Total Nitroaromatics				
10^{-6} risk	500			50
10^{-5} risk	NA††			300

*Protects hunters from exposure by the plant-to-game pathway.
†Protects aquatic life and fishermen.
**Protects frequent McClintic Wildlife Station visitors from exposure by direct contact and inhalation of dust.
††Plants do not grow in soils containing total nitroaromatic contamination at concentrations that would result in 10^{-5} cancer risk.

Source: ESE, 1986c.

Considering the findings of the EA, the following remedial objectives were defined to minimize or eliminate the endangerment associated with the source areas:

1. To eliminate safety hazards associated with reactive wastes: remove or render nonreactive all reactive wastes;
2. To achieve less than 10^{-6} individual lifetime excess cancer risk for avid hunters and their families or friends who consume meat from game that feed in contaminated areas: remove or cover the upper 2 ft of soil if total nitroaromatic contamination exceeds 500 µg/g.
3. To achieve less than 10^{-6} individual lifetime excess cancer risk for frequent visitors to McClintic Wildlife Station who come into direct contact with surficial soils: remove or cover the upper 6 inches of soil if total nitroaromatic contamination exceeds 50 µg/g.

Achievement of these criteria will also eliminate endangerment associated with other site contaminants since the other contaminants are found in association with high levels of nitroaromtic contamination. Achievement of Objective 3 will also mitigate potential impacts on aquatic biota associated with erosion and runoff from extreme storm events. All ponds stocked and used for fishing currently achieve the recommended surface water and sediment criteria designed to protect fishermen and aquatic life. It is necessary that any remedial actions taken will not result in exceedance of the acceptable contamination levels presented in Table 2.

To ensure that the individual lifetime excess cancer risk not exceed 10^{-5}, the objectives could be modified as follows:

- No change for Objective 1.
- Delete Objective 2: Plants cannot grow in soils contaminated with nitroaromatics at levels that would lead to a 10^{-5} risk level for game meat consumers nor would exposure to

noncarcinogenic contaminants exceed acceptable levels as a result of plant uptake, regardless of soil contamination.

- For Objective 3, change the criterion for removing or covering the upper 6 inches of soil from 50 µg/g to 300 µg/g total nitroaromatic contamination.

Remedial Technologies

Response actions were identified for contaminated environmental media at the WVOW site. The remedial response actions for soils and sewerlines are generally source control measures which remove or control the contamination to prevent the spread of pollutants from the source. Examples of such remedial actions include containment (i.e., isolation) or disposal of the contaminated media.

Potential remedial technologies associated with each response action were identified. The comprehensive list of potentially applicable technologies did not include auxiliary unit operations that may be necessary for the implementation of a treatment or control technology (e.g., revegetation as part of a multimedia cap).

To select applicable remedial technologies for each area, a 2-phase screening process was conducted. The first phase considered two factors that determine applicability to the three areas of concern: (1) waste characteristics, and (2) the degree of technological development. Technologies which were ineffectual or were otherwise limited due to contaminant characteristics and undeveloped technologies were eliminated from further consideration. Those technologies that passed the initial screening were evaluated based on site-specific characteristics for each area of concern. Technologies remaining after the site characteristics screening were subsequently used for the assembly of alternatives for each area. Table 3 presents the applicable technologies selected for the assembly into remedial alternatives.

Table 3. Applicable Remedial Technologies for the TNT Manufacturing Area and the Burning Grounds Area

Medium	Available Remedial Technologies	Areas for Which Remedial Technologies are Applicable (X = applicable to site)	
		TNT Manufacturing Area	Burning Grounds Area
Soils/Sediments	Multimedia cap	X	X
	Clay cap	X	X
	In situ flaming (applies to TNT pieces only)	X	X
	Flaming (applies to TNT pieces only)	X	X
	Incineration	X	X
	Landfill	X	X
	Limit access	X	X
	No action	X	X
Industrial Sewerlines	Incineration	X	
	Flashing	X	
	Landfill	X	
	Grout in place	X	
	Limit access	X	
	No action	X	

Source: ESE, 1986c.

Alternatives Selection

As specified in EPA policy on compliance with environmental statutes other than CERCLA, remedial action alternatives were assembled into the following categories:

Category	Description
1	Alternatives for treatment or disposal at an off-site facility, as appropriate;
2	Alternatives that attain applicable or relevant and appropriate Federal public health and environmental requirements;
3	As appropriate, alternatives that exceed applicable or relevant and appropriate Federal public health and environmental requirements;
4	As appropriate, alternatives that do not attain applicable or relevant and appropriate Federal public health and environmental requirements but will reduce the likelihood of present or future threat from the hazardous substances and that provide significant protection to public health and welfare and the environment. This must include an alternative that closely approaches the level of protection provided by the applicable or relevant and appropriate requirements; and
5	No Action alternative.

Development of alternatives in these categories ensured that a broad spectrum of remedial alternatives was evaluated.

In accordance with the NCP, the alternatives developed for each area of concern were screened based on environmental, public health, and cost criteria. This screening eliminated those alternatives which could not adequately protect human health and the environment or were an order of magnitude more costly than others in the same category. The alternatives for each area of concern which remained after the initial screening included at least one alternative in each of the five categories except Category 1, offsite disposal for sewerlines, where no offsite option exists based on the assumption that the sewerlines are reactive. The No Action alternative (Category 5), which was determined from the EA to be environmentally inadequate, was still carried forward to the detailed

analysis of alternatives because all categories must be represented in the detailed analysis. Tables 4, 5, and 6 provide descriptions of the remedial alternatives that were carried forward to the detailed analysis.

Detailed Alternatives Analysis

In accordance with Sec. 300.68(i) of the NCP, a detailed analysis of the remedial action alternatives was performed. The detailed analysis included technical, environmental, institutional, public health, and cost evaluations for each alternative.

The elements of the technical analysis included performance, which refers to the degree to which a remedial action will prevent or minimize substantial danger to public health or the environment; reliability, which involves the frequency and complexity of necessary maintenance and the demonstrated reliability at similar sites; and implementability, which is the relative ease of installation and the time to achieve beneficial results. The safety concerns associated with each alternative were also addressed in the technical analysis.

The environmental evaluation of alternatives provided an assessment of the extent to which the alternative is expected to effectively prevent, mitigate, or minimize threats to public health, welfare, and the environment. This included an analysis of any adverse impacts associated with the implementation of the alternative, methods for mitigating these impacts, and costs of mitigation.

The institutional requirements evaluation consisted of evaluating the effects of applicable or relevant and appropriate Federal requirements pertaining to the design, operation, and timing of each alternative. Consideration was given to state and local institutional requirements.

Table 4. Area of Concern—TNT Manufacturing Area

Alternative	Cleanup Level	Excavated Volume (cy)	Treatment Method	Treatment Volume (cy)	Disposal/ Treatment Level (percent)	Disposal Site	Disposal Volume (cy)	Capped Area (sq yd)	Backfill Source	Backfill Volume (cy)	Post-Closure Monitoring	Years Mobilized
1A1*												
1A2	10^{-6}	6,710	Incinerate	6,710	99.99	Ensco, AR	6,710	0	Offsite	6,710	None	1
1B1 Offsite Disposal	<detection	53,000	Landfill	0	—	Cecos, OH	53,000	0	Offsite	53,000	None	2
1B2	10^{-6}	6,710	Landfill	0	—	Cecos, OH	6,710	0	Offsite	6,710	None	1
2A	10^{-6}	6,710	Incinerate	6,710	99.99	Onsite	—	0	Onsite	1,677	—	1
2B Meets Requirements	10^{-6}	6,710	Onsite Landfill	0	—	Onsite	6,710	0	Onsite	2,100	GW	1
2C	10^{-6}	0	Multimedia Cap	0	—	Onsite	—	10,060	—	0	GW	1
3A	<detection	53,000	Onsite Incinerate	53,000	99.99	Onsite	0	0	Onsite	8,555	—	4
3B Exceeds Requirements	<detection	53,000	Onsite Landfill	0	—	Onsite	53,000	0	Onsite	17,500	GW	2
3C	<detection	0	Multimedia Cap	0	—	Onsite	0	51,200	—	0	GW	1
4A CERCLA	10^{-6}	0	Soil Cap	0	—	Onsite	0	10,060	Onsite	0	—	1
5A No Action	—	—	No Action	—	—	—	—	—	—	—	GW SW Seeps	—

* = 1A1 screened out based on excessive cost.
— = Not applicable.
GW = Ground Water.
SW = Surface Water.
cy = cubic yard.
sq yd = square yard.

Source: USAE, 1986c.

Table 5. Area of Concern—Burning Grounds Area

Alternative	Cleanup Level	Excavated Volume (cy)	Treatment Method	Treatment Volume (cy)	Disposal/ Treatment Level (percent)	Disposal Site	Disposal Volume (cy)	Capped Area (sq yd)	Backfill Source	Backfill Volume (cy)	Post-Closure Monitoring	Years Mobilized
1A2	10^{-6}	3,625	Incinerate	3,625	99.99	Ensco, AR	3,625	0	Offsite	3,625	None	1
1B1 Offsite Disposal	<detection	17,000	Landfill	0	—	Cescos, OH	17,000	0	Offsite	17,000	None	1
1B2	10^{-6}	3,625	Landfill	0	—	Cescos, OH	3,625	0	Offsite	3,625	None	1
2A	10^{-6}	3,625	Incinerate	3,425	99.99	Onsite	—	0	Onsite	910	—	1
2B Meets Requirements	10^{-6}	3,625	Onsite Landfill	0	—	Onsite	3,625	0	Onsite	4,370	GW	1
2C	10^{-6}	0	Multimedia Cap	0	—	Onsite	—	5,134	—	0	GW	1
3A	<detection	17,000	Onsite Incinerate	17,000	99.99	Onsite	0	0	Onsite	3,225	—	2
3B Exceeds Requirements	<detection	17,000	Onsite Landfill	0	—	Onsite	17,000	0	Onsite	4,600	GW	2
3C	<detection	0	Multimedia Cap	0	—	Onsite	0	18,556	—	0	GW	1
4A CERCLA	10^{-6}	0	Soil Cap	0	—	Onsite	0	5,134	Onsite	0	—	1
5A No Action	—	—	No Action	—	—	—	—	—	—	—	GW/SW	—

— = Not applicable.
GW = Groundwater.
SW = Surface water.

Source: ESE, 1986c.

Table 6. Area of Concern—Industrial Sewerlines

Alternative	Cleanup Level	Excavated Volume (cy)	Treatment Method	Treatment Volume (cy)	Disposal/ Treatment Level (percent)	Disposal Site	Disposal Volume (cy)	Capped Area (sq yd)	Backfill Source	Backfill Volume (cy)	Post-Closure Monitoring	Years Mobilized
7A	10^{-6} Meets	20,400	Incinerate	680	95/99.99	Onsite	680	0	Onsite	500	—	3
7B	10^{-6} Requirements	20,400	Flaming/ Onsite Landfill	680	—	Onsite	680	0	Onsite	500	GW	3
8A	<detection Exceeds	47,680	Incinerate	29,680	99.99	Onsite	29,680	0	Onsite	8,000	—	3
8B	<detection Requirements	47,680	Flaming/ Onsite Landfill	29,680	—	Onsite	29,680	0	Onsite	9,400	GW	3
4A	CERCLA	10^{-6}	20,400	Flaming/ Backfill	680	—	Onsite	680	0	Onsite	500	—	3

— = Not applicable.
GW = Ground Water.

Source: ESE, 1986c.

The cost analysis was a 4-step process. The initial step was to estimate the capital and operation and maintenance (O&M) costs for each alternative. To achieve this task, quantities of material requiring remediation under each alternative were estimated, and unit costs for the remedial technologies were gathered from standard cost manuals and vendor quotes. The second step was to calculate the present-worth cost of each alternative. Using the estimated costs for each alternative, the present-worth cost of each alternative was calculated using a discount rate of 10 percent. The present-worth costs allowed the comparison of costs, in 1986 dollars, between alternatives with no O&M and alternatives with O&M occurring for 30 years. Next, a sensitivity analysis was performed which examined the sensitivity of cost estimates to changes in key cost assumptions. The final step in the cost analysis was to perform a cost-benefit analysis of the 10^{-5}, 10^{-6}, and Exceeds Criteria levels of cleanup. The cost to implement a remedial alternative for each risk level was compared to the benefits received upon implementation.

The capital, O&M, and present-worth costs for each alternative are presented in Table 7.

Recommendation of the Preferred Alternative

A preferred alternative was selected based on the results of the detailed analysis. The preferred alternative for the WVOW site is to: (1) flame the reactive TNT pieces in place on the surface of the Burning Grounds Area; (2) provide a soil cover over contaminated soils at the TNT Manufacturing Area and Burning Grounds Area; (3) excavate all reactive sewerlines, flash the sewers to destroy the contamination, and replace the unreactive material in the excavated trench; and (4) transport asbestos to an offsite local sanitary landfill for disposal. This alternative (4A) will achieve a 10^{-6} level of risk upon implementation. The alternative is recommended to: (1) meet all the criteria and requirements established in the EA; (2) prevent significant adverse impacts to the environment caused by prolonged onsite incineration; and (3) provide a viable, cost-effective remediation in accordance with Sec. 300.68(i)(5)(ii) of NCP, in an attempt to balance the funds available to the Army for site remediation.

Table 7. Present-Worth Costs for Remedial Alternatives

Alternative	TNT Manufacturing Area			Burning Grounds Area			Industrial Sewerlines		
	Capital ($1,000)	O&M ($1,000)	Present Worth ($1,000)	Capital ($1,000)	O&M ($1,000)	Present Worth ($1,000)	Capital ($1,000)	O&M ($1,000)	Present Worth ($1,000)
Offsite 1A2 Excavation to attain requirements; offsite incineration	22,030	0	22,030	10,722	0	10,722			
Offsite 1B1 Excavation to exceed requirements; offsite landfill	16,287	0	16,287	5,575	0	5,575			
Offsite 1B2 Excavation to attain requirements; offsite incineration	2,582	0	2,582	1,271	0	1,271			
Attains Requirements 2A Excavation; onsite incineration	4,229	0	4,229	2,382	0	2,382	1,310	0	1,310
Attains Requirements 2B Flaming; excavation; onsite landfill	1,066	6	1,123	624	4	662	954	2	973
Attains Requirements 2C Flaming; multimedia cap	1,090	2	1,109	600	1	609			
Exceeds Requirements 3A Excavation; onsite incineration	26,339	0	26,339	8,459	0	8,459	14,332	0	14,332

Table 7. Present-Worth Costs for Remedial Alternatives (Continued, Page 2 of 2)

Alternative	TNT Manufacturing Area			Burning Grounds Area			Industrial Sewerlines		
	Capital ($1,000)	O&M ($1,000)	Present Worth ($1,000)	Capital ($1,000)	O&M ($1,000)	Present Worth ($1,000)	Capital ($1,000)	O&M ($1,000)	Present Worth ($1,000)
Exceeds Requirements 3B Flaming; excavation; onsite landfill	5,678	31	5,970	1,924	11	2,028	3,518	17	3,678
Exceeds Requirements 3C Flaming; multimedia cap	4,798	9	4,883	1,632	4	1,670			
CERCLA 4A (TNT/BG Areas) Flaming; soil cover	594	2	613	327	1	336			
CERCLA 4A (Sewers) Excavate; flashing; backfill							855	0	855
No Action 5A Monitoring	0	8	75	0	5	47	0	2	19

Source: ESE, 1986c.

xxxvi

1.0 INTRODUCTION

The U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) issued Contract No. DAAK11-83-D-0007 to Environmental Science and Engineering, Inc. (ESE) to perform tasks relating to the Multi-Installation Eastern Sites Environmental Contamination Surveys Program. Task Number 0004, Delivery Order Number 0005, comprises a Remedial Investigation/ Feasibility Study (RI/FS) of the former West Virginia Ordnance Works (WVOW). The purpose of the RI/FS is to assess soils, surface water, and ground water contamination resulting from past 2,4,6-trinitrotoluene (2,4,6-TNT) manufacturing operations and to evaluate potential remedial action alternatives.

In order to expedite implementation of source area remedial actions, WVOW has been divided into two operable units. The first operable unit (source areas) consists of the TNT Manufacturing Area, the Burning Grounds Area, and the Industrial Sewerlines. The second operable unit (ground water areas) consists of the Pond 13, Yellow Water Reservoir, and Red Water Reservoirs. A supplemental RI was initiated for the second operable unit in March 1986 in order to complete characterization of ground water flow direction and contamination for these areas. The supplemental RI is scheduled to be completed in August 1986.

This report presents the findings of the source areas FS. A subsequent FS report will be prepared for the ground water areas. The purpose of the FS is to develop and evaluate, in accordance with the National Contingency Plan (NCP), alternate remedial responses to uncontrolled releases of hazardous substances. The FS provides information needed to select cost-effective remedial alternatives that effectively abate/mitigate releases of hazardous substances and provide adequate protection for public health, welfare, and the environment.

The purpose of the FS is to provide the information necessary for selection of a cost-effective remedial action alternative(s) for each of six designated areas of concern at WVOW in accordance with the NCP. The NCP states:

> The appropriate extent of remedy shall be determined by the lead agency's selection of the remedial alternative which the agency determines is cost-effective (i.e., the lowest cost alternative that is technologically feasible and reliable and which effectively mitigates and minimizes damage to and provides adequate protection of public health, welfare, or the environment) [300.68(j)(1)].

1.1 SITE BACKGROUND INFORMATION

The WVOW site covers approximately 8,323 acres in Mason County, WV. It is approximately 58 miles (mi) northwest of Charleston, 41 mi northeast of Huntington, and 6 mi north of Point Pleasant, WV, on the east bank of the Ohio River. Approximately one-third of the area is currently occupied by the Clifton F. McClintic State Wildlife Station (McClintic Wildlife Station), which is 2,788 acres in size and operated by the West Virginia Department of Natural Resources (DNR).

From 1942 to 1945, WVOW operated to produce trinitrotoluene (TNT) explosive. Production of this material during World War II (WWII) resulted in contamination of the soils of the industrial area, process facilities, and industrial wastewater disposal facilities by TNT and associated byproducts and environmental transformation products. TNT was shipped to various Government installations to be loaded into munitions or for other uses. No loading of munitions or testing of ordnance was conducted at WVOW.

At the close of operations in 1945, WVOW was decontaminated to place it in standby status. Later in 1945 the plant was declared surplus and the facilities salvaged or disposed of. No records currently exist regarding the general extent of this decontamination. The industrial portion of the site was deeded to the State of West Virginia, with the stipulation

that the site be used for wildlife management. If the land were to be used for any other purpose, or in the event of national emergency, the ownership of the land would revert to the Federal Government. The land, now owned by the state, currently comprises the McClintic Wildlife Station and is managed by the West Virginia DNR. West Virginia DNR's management practices are primarily designed to promote wetlands habitats and populations of resident and migratory waterfowl. Consistent with this objective, more than 30 shallow ponds have been constructed since cessation of military activities on the site, and most of the ponds are stocked with bass. The area is open for public hunting and fishing. Smaller portions of the nonindustrial areas of the site were excessed by the Government and are now owned by Mason County, WV, or by private owners. The layout of the former industrial facility and the present boundary of the McClintic Wildlife Station are shown in Fig. 1.1-1.

In May 1981, a seepage of red water was observed adjacent to Pond 13 located on the McClintic Wildlife Station. This pond is located near the former TNT wastewater trunk sewerlines and pumping station. This incident was investigated by West Virginia DNR and the U.S. Environmental Protection Agency (EPA). The shallow ground water discharging to Pond 13 was found to be contaminated by 2,4-dinitrotoluene (2,4-DNT) [up to 7,100 micrograms per liter (µg/L)], 2,6-dinitrotoluene (2,6-DNT) (1,300 µg/L), 2,4,6-TNT (166 µg/L in one sample), and phenol (31 µg/L).

Based on these and other studies by West Virginia DNR and EPA contractors in 1981 and 1982, WVOW has been ranked as the 84th site on the National Priorities List (NPL) under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (PL 96-510 amended by PL 97-272).

The WVOW site is located in Mason County, along the western boundary of the state adjacent to the Ohio River. Most of the site is about 1 to 2.5 mi east of the present-day river and is situated on alluvial terrace

ORIGINA
(Red)

WVOW PATH 3/96

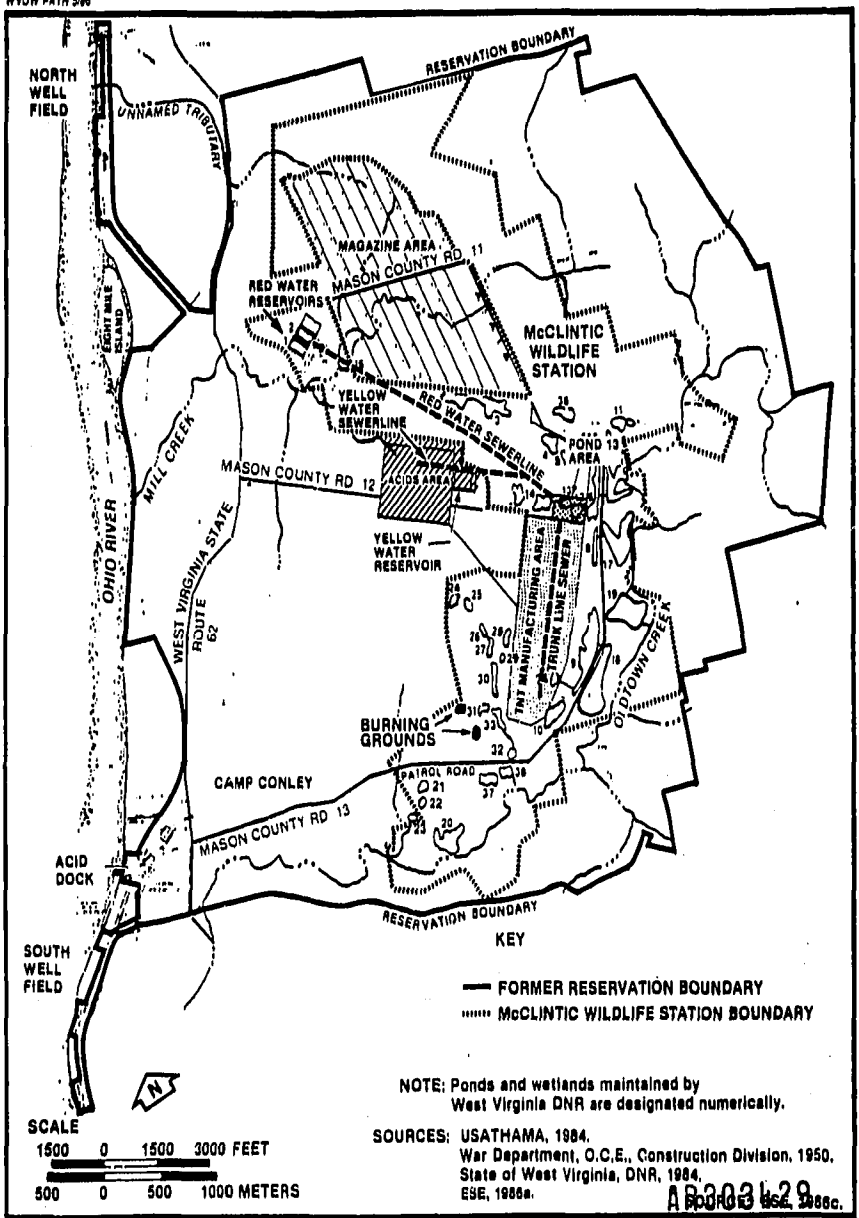

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Figure 1.1-1
WVOW STUDY AREAS

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deposits; the western section lies within the floodplain of the Ohio River. The upland areas in the eastern section of the post are characterized by ridges of narrow to medium width. These ridges are remnants of an old plateau, and their slopes vary due to differential weathering of sandstones and shales. Runoff is fairly high and rapid in the dissected ridge areas. Site elevations range from about 560 feet above mean sea level (ft-MSL) along the Ohio River to about 880 ft-MSL along the northern boundary. The Ohio River has a pool elevation of 538 ft-MSL near WVOW [National Geodetic Vertical Datum (NGVD) of 1929, U.S. Geological Survey (USGS), 1968; 1975 Photorevised]. Bedrock in the area is 60 to 135 feet (ft) below land surface and is covered by consolidated river terrace alluvium. The river terraces along the Ohio River were deposited as glacial outwash and have been reworked by recent river migration and floodplain development.

Several distinct hydrogeologic flow systems have been characterized at WVOW. At the TNT Manufacturing Area, two aquifers are apparent: a shallow aquifer of alluvial origin and a deep aquifer apparently consisting of alluvial sediments underlain by glacial outwash sediments. The two aquifers in the TNT Manufacturing Area are separated by a gray clay confining bed which essentially eliminates any vertical interconnection between the two flow systems.

At the Burning Grounds Area, the near-surface environment is characterized by extensive clay layers. Water-bearing units vary from poorly graded sands to isolated clay or silt lenses and vary in elevation as much as 40 ft. In general, the water-bearing units contain a high percentage of fines (silts and clays) in contrast with the poorly graded aquifers encountered throughout most of the TNT Manufacturing Area. The sediments and aquifer materials in the Burning Grounds Area also exhibit a higher degree of areal lithologic variability.

In general, the hydrogeologic program primarily addressed shallow ground water flow systems at each area of concern. At each area, the sediments encountered are typical of alluvial deposition. The Burning Grounds Area showed a high degree of areal and vertical lithologic variation in aquifer materials and overlying and underlying sediments. This indicates that the aquifers present in these areas are probably discontinuous beyond the immediate area of concern.

In contrast, the shallow aquifer at the TNT Manufacturing Area and the shallow aquifer along the red water sewerline are similar in lithologic and textural characteristics and represent similar depositional environments.

Because of substantial topographic differences in several of the shallow aquifers (e.g., the Burning Grounds Area and red water sewerline monitor wells), the shallow aquifers encountered across the site cannot be correlated and are not part of a single continuous flow system, but represent similar depositional environments.

The majority of the deep monitor wells drilled throughout the site were screened in sediments of alluvial origin. Several deep wells encountered glacial outwash material. According to published information (Wilmoth, 1966), the glacial outwash aquifer represents a single continuous aquifer system. However, given the limited number of monitor wells which penetrated the glacial outwash aquifer throughout the site during this investigation, it was not possible to verify this information.

Given the wide variety of shallow aquifer characteristics, the high variability in lithology encountered both areally and vertically, and the topographic differences encountered within several similar shallow aquifers, it is felt that the shallow aquifer systems encountered, in general, reflect discontinuous conditions which cannot be correlated throughout the site.

Based on the information obtained from interviews during the Archives Search (ESE, 1984), the local public is apparently aware of the contamination at WVOW. Based on these interviews, the public does not appear to be highly concerned about safety while hunting and fishing onsite, or the consumption of fish and wildlife taken at the McClintic Wildlife Station. Immediate public and West Virginia DNR concern may develop if proposed remedial actions include long-term destruction or restriction of significant fishing, hunting, or wildlife habitat.

1.2 NATURE AND EXTENT OF PROBLEMS

The FS is predicated on the information and data generated during the RI, and the identified pathways, receptors, and corresponding criteria developed in the Endangerment Assessment (EA) to protect receptors.

Site investigations were initiated when surface water contamination was observed on the site (at Pond 13) in May 1981. Following preliminary investigation by the West Virginia DNR and EPA, WVOW was listed on the NPL of uncontrolled hazardous waste sites under CERCLA of 1980. Under a Memorandum of Understanding (MOU) between the Department of Defense (DOD) and EPA, USATHAMA was designated the lead agency for the CERCLA response, and this report is one element of the CERCLA response.

As documented in the RI report (ESE,1986a), nitroaromatic contamination of soils, sediments, ground water, and surface waters was found in several areas of the site (Fig. 1.2-1, Table 1.2-1). 2,4,6-TNT and 1,3,5-trinitrobenzene (1,3,5-TNB) are the dominant nitroaromatic constituents, whereas the dinitrotoluenes comprise not more than 2 to 5 percent of the total nitroaromatic contamination. The dinitrotoluenes are probable carcinogens and are believed to be more toxic than either TNT or trinitrobenzene (TNB). Data were determined to be sufficient to assess endangerment and conduct the FS in three areas (TNT Manufacturing Area, Burning Grounds Area, and Industrial Sewerlines) which are designated source areas. In other areas (Pond 13, Yellow Water Reservoir, and Red Water

ORIGINAL
(Red)

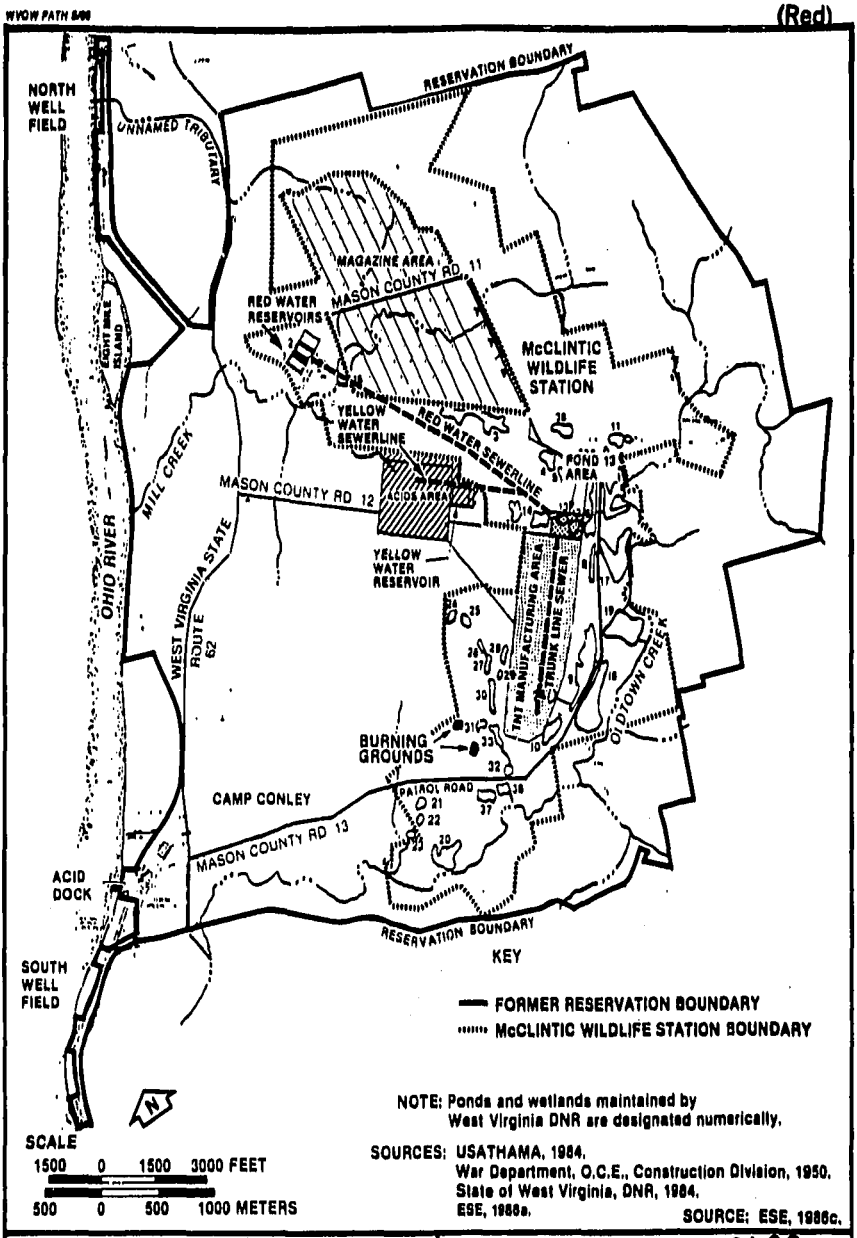

Figure 1.2-1
WVOW STUDY AREAS

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Table 1.2-1. Summary of Contamination Status for WVOW

Environmental Medium	Contaminant	Maximum Concentration Detected*
TNT Manufacturing Area		
Soils	Nitroaromatics	3%
	Lead	320 µg/g
Surface Water	Nitroaromatics	1 µg/L (Pond 34 only)
Sediments	Nitroaromatics	0.4 µg/g
Ground Water	Nitroaromatics	14,000 µg/L
	Lead	20 µg/L†
Burning Grounds Area		
Soils	Nitroaromatics	2%
	Lead	1,400 µg/g
	PAHs	100 µg/g
	Friable asbestos	Observed
Surface Water	Lead	20.5 µg/L†
	Asbestos	2.6×10^6 fibers/L
Sediments	Lead	31 µg/g
Ground Water	Uncontaminated†	--
Industrial Sewerlines		
TNT Manufacturing Area	Nitroaromatics	71%
Acids Area/Yellow Water Reservoir	Nitroaromatics	400 µg/g
Red Water Reservoirs	Nitroaromatics	0.2%
Pond 13/Wet Well Area	Uncontaminated	--

Table 1.2-1. Summary of Contamination Status for WVOW
(Continued, Page 2 of 2)

Environmental Medium	Contaminant	Maximum Concentration Detected*
Offsite Areas**		
Soils	Uncontaminated	--
Surface Water	Asbestos	480,000 fibers/L††
Sediments	Uncontaminated	--
Ground Water	Uncontaminated†	--

* In each area, sampling strategy in the RI was designed to identify and sample the most contaminated areas, so the maximum concentrations are not necessarily representative of the typical concentration in each source area. In virtually all source areas, several samples were collected that were uncontaminated, thus realistically defining the extent of contamination.

† Lead in ground and surface waters did not exceed relevant standards or criteria [e.g., National Interim Primary Drinking Water Regulations (NIPDWR) = 50 µg/L].

** Offsite areas are sampling locations not in the designated source areas. The offsite areas include Oldtown Creek (on McClintic Wildlife Station), Mill Creek potable water supply wells, the former magazine area, and a conventional solid waste landfill on former WVOW property.

†† Recently proposed Recommended Maximum Contaminant Level (RMCL) for asbestos in drinking water is 7,100,000 fibers/L (EPA, 1985b).

NOTE: fibers/L = fibers per liter
PAHs = polynuclear aromatic hydrocarbons
ft^2 = square feet
µg/g = micrograms per gram
µg/L = micrograms per liter

Source: ESE, 1986c.

Reservoirs), the data developed during the RI were inadequate to define either the extent of contamination or the potential for migration to potential receptor populations. In these areas a second phase of RI is being conducted to fill identified data gaps. The supplemental RI is scheduled to be completed in August 1986.

Details of the contaminant distribution in each source area are presented in the RI report (ESE, 1986a).

Each of these areas of concern is located within the McClintic Wildlife Station boundary with the exception of the sewerlines within the Acids Area/Yellow Water Reservoir.

The soils and sediments containing 2,4,6-TNT at WVOW may be considered hazardous waste by virtue of contacting or containing residues of specifically listed hazardous waste categories K044 and K047 [40 Code of Federal Regulations (CFR) 261.32], which are waste treatment sludges from manufacturing explosives and/or red/pink water. These wastes may be classified hazardous because of the characteristic of reactivity. Reactive wastes are defined in 40 CFR 261.23 for Resource Conservation and Recovery Act (RCRA) purposes. Reactive characteristics relevant to 2,4,6-TNT-containing materials are: (1) being capable of detonation or explosive reaction if subjected to a strong initiating source; (2) detonation when heated under confinement; and (3) definition as either a forbidden explosive (49 CFR 173.51), a Class A explosive (49 CFR 173.53), or a Class B explosive (49 CFR 173.88). RCRA regulations preclude landfilling or capping wastes that are classified as reactive.

Based on the results of Army testing of soils containing low concentrations of explosives (i.e., less than approximately 20 percent) at Milan Army Ammunition Plant (MAAP) and Savanna Army Depot Activity (SADA) and the contaminant concentrations observed at WVOW, it was believed that the soils at WVOW would be nonreactive (Roy F. Weston, Inc., [illegible]

1982). The previous studies at MAAP and SADA indicated that TNT concentration in soil or sediment had to exceed 15 to 20 percent for the soil to be reactive. To determine if any of the contaminated soil at WVOW should be considered reactive in the evaluation of remedial alternatives, representative samples of WVOW soils were tested for reactivity. The soil matrices which were demonstrated to be nonreactive are not considered hazardous with respect to reactivity for the purposes of evaluating remedial action alternatives in the FS.

The U.S. Bureau of Mines has tested two protocols for determining RCRA reactivity status--the U.S. Gap Test and the Internal Ignition Test. EPA publication SW846, Test Methods for Evaluating Solid Wastes (EPA, 1982), defines four reactivity tests required under RCRA in Subsec. 6-2 (Definition of Explosive Materials). These tests are thermal stability, detonation, spark, and impact sensitivity. Three other tests are required by USATHAMA to define sensitivity and materials-handling characteristics. These tests are electrostatic sensitivity, friction sensitivity, and fire or open-flame sensitivity. These nine tests and their regulatory/materials-handling relevance are summarized in Table 1.2-2.

The nine tests were performed on composited WVOW soil samples. The samples were collected and composited in a manner to ensure that they were representative of the areas containing the highest degree of soil contamination. Samples were collected from the following areas:

1. TNT Manufacturing Area
2. West Burning Grounds
3. East Burning Grounds

Two additional samples were tested for reactivity. A duplicate sample of TNT Manufacturing Area soils was tested after spiking and mixing with 2,4,6-TNT to provide a sample containing approximately 10 percent (100,000 µg/g) 2,4,6-TNT in addition to the ambient 2,4,6-TNT level.

Table 1.2-2. Reactivity Test Summary

Test	Description	Positive Results	Purpose
Thermal Stability	Heat to 167 degrees Fahrenheit (°F) in oven for 48 hours. Sample in aluminum foil container.	Detonation, deflagration, or exothermic decomposition is a positive test; fuming/ smoldering is nonpositive.	RCRA explosivity and explosive classification.
Detonation (Blasting Cap)	Insert No. 8 blasting cap into sample and observe detonation. Place on lead cylinder. Sample in paper cup. Demonstrates behavior to initiating force produced by cap.	Detonation (as evidenced by ≥1/8-inch compression of lead block).	RCRA explosivity and explosive classification.
Spark	Insert electric igniter into sample, which is in paper cup. Place paper cup on lead block on steel plate.	Deflagration evidenced by burning; detonation causes mushrooming of lead block.	RCRA explosivity, personnel safety (spark/flame events in field), and explosive classification.
Impact	Performed on U.S. Bureau of Explosives (BOE) impact apparatus. Impact hammer drop height 10 inches.	Explosion evidenced by flame or flame/noise; smoke alone not positive. Results can be misleading at low concentrations. Primarily severe test for high explosives; can produce positive results at low concentrations.	RCRA explosivity, explosive classification, field safety, and materials handling.

Table 1.2-2. Reactivity Test Summary (Continued, Page 2 of 3)

Test	Description	Positive Results	Purpose
Friction	Sliding friction machine. Force applied hydraulically through stationary wheel to sample on anvil. Force 1,800 pounds (lb) or as required to ensure ≥1-inch slide for anvil. Pendulum propels anvil at a known velocity, perpendicular to force. Reduce force selectively, then reduce velocity selectively, if positive.	Ignition evidenced by production of flame, smoke, or distinct loud noise; or infrared detection of decomposition products.	RCRA ignitability, personnel safety during field sampling and laboratory handling, and safety during bulk handling.
Electrostatic	Calibrated electrostatic spark jumps from pointed electrode to metal plate (serving as sample holder). Energy input should be set after preliminary testing.	Ignition as evidenced by flames, smoldering, or glowing.	Relevant to electrostatic spark initiation during field sampling and laboratory handling.
Fire	Container of sample subjected to fire; plastic container.	Explosion, as evidenced by a loud noise and projection of fragments.	RCRA ignitability. Relevant to safe handling of flammable materials of questionable sensitivity.

Table 1.2-2. Reactivity Test Summary (Continued, Page 3 of 3)

Test	Description	Positive Results	Purpose
U.S. Gap (U.S. Bureau of Mines)	Sample in 16-inch-long carbon steel tubing (1.44-inch inside diameter). Cylinder bottom closed with two layers of poly sheet. Sample subjected to shock wave generated by detonation of a Pentolite pellet. Steel witness plate, 1/8-inch thick, mounted at upper end of sample tubing and separated by spaces 0.063-inch thick.	Positive detonation if stable propagation velocity >1.5 kilometers per second (km/sec) measured; witness plate punched through; tube fragmented along its entire length. Any two out of three indicates positive.	Likely to be adopted by EPA for RCRA reactivity testing.
U.S. Internal Ignition [Deflagration-to-Detonation Transition (DDT)] (U.S. Bureau of Mines)	Sample contained in 18-inch-long, 3-inch Schedule 80 carbon steel pipe capped at both ends with forged steel pipe caps. Sample subjected to thermal/pressure stimulus from ignitor capsule located at center of sample vessel.	Positive if either the pipe or at least one of the end caps is fragmented into at least two pieces.	Likely to be adopted by EPA for reactivity testing. Assesses thermal explosive hazard.

Source: ESE, 1986c.

Also, a sample of the organic material found in the process sewerline at TNT Process Line 5 was tested. A total of five samples were evaluated. Sampling locations are shown in App. A, Figs. A-1 through A-4. The figures include the locations of individual composite soil subsamples collected in each area of concern.

The test plan matrix is presented in Table 1.2-3.

The technical approach of the testing program included the collection and testing for reactivity of composite soil samples representative of worst-case 2,4,6-TNT concentrations observed during the field RI program.

The 9-test series required a minimum sample size of approximately 40 lb of soil. In order to collect sufficient sample for testing and for chemical analysis and in order to ensure that samples to be tested were representative of the overall worst-case soils in each general location, a 2-stage compositing procedure was employed at each area, except for the organic residue from the process sewerline (TNT Line 5).

The following discussion describes in detail the 2-stage compositing procedure employed in collecting the four soil samples for reactivity testing. The 2-stage compositing procedure was accomplished in accordance with American Society for Testing and Materials (ASTM) Method D346. At each area of concern (e.g., East Burning Grounds), each distinct stage 1 composite sample was collected by spreading shovelfuls on a polyethylene sheet to form a long pile (approximately 5 ft long), then quartering using alternate shovelfuls. These quarters were mixed by respreading alternate shovelfuls. A subsample was removed from this pile by saving every third shovelful on a second polyethylene sheet to produce a sample of approximately 18 to 25 lb. This 18- to 25-lb sample formed the stage 1 composite subsample. After five similar stage 1 subsamples were collected, the second-stage compositing was performed to reduce the soil to a single composite sample of approximately 50 lb. To accomplish

Table 1.2-3. WWW Reactivity/Sensitivity Testing Matrix

Composite Sample Location/ Description	Test Protocols								
	Thermal Stability	Impact Sensitivity	Friction Sensitivity	Detonation Test	Electrostatic Sensitivity	Spark Sensitivity	Fire Sensitivity	U.S. Gap Test	Internal Ignition Test (DDT)
TNT Manufacturing Area	X	X	X	X	X	X	X	X	X
TNT Manufacturing Area spiked with 10 percent 2,4,6-TNT	X	X	X	X	X	X	X	X	X
West Burning Grounds	X	X	X	X	X	X	X	X	X
East Burning Grounds	X	X	X	X	X	X	X	X	X
TNT Process Sewerlines Organic Residue	X	X	X	X	X	X	X	X	X

Source: ESE, 1986c.

this, the five first-stage composites were combined into a single long pile (5 ft long) by spreading alternate shovelfuls. Alternate shovelfuls of this pile were rejected to give a pile of 40 to 60 lb, which formed the reactivity sample. A portion of this sample was retained for chemical analysis at ESE. The composite sample for reactivity testing was placed in clean (new), covered, plastic 5-gallon (gal) paint buckets, sealed, and labeled for delivery to the Allegany Ballistics Laboratory (ABL) for testing. Each sample collected for chemical analysis was placed in a foil-wrapped, 1-quart (qt) mason jar with Teflon® lid liner and stored for chemical analysis at 4 degrees Celsius (°C).

Individual samples for the East Burning Grounds and the West Burning Grounds were collected in this manner. The TNT Manufacturing Area soil sample was collected in the same manner with the exception that a duplicate second-stage composite was collected. Both samples were transported to ABL for testing. The first sample was tested as received. The second sample was tested after spiking to add sufficient 2,4,6-TNT to produce a sample which contained approximately 10 percent 2,4,6-TNT concentration by weight (100,000 µg/g dry weight) after the sample was dried to a moisture content of 1.5-percent water. The 2,4,6-TNT was added by ABL and mixed in a rotary drum until the 2,4,6-TNT/soil mixture was homogeneous.

At TNT Line 5, a section of one of the sewerlines leading from the Washer-Flaker building to the trunk sewerline was approximately two-thirds plugged by crystalline organic residue. This residue contained 71-percent total nitroaromatic residue (field laboratory analysis). Approximately 35 lb of the residue was collected for reactivity testing.

To characterize the 2,4,6-TNT concentration in the composited soil/sediment samples collected for physical testing, chemical analyses were performed on each sample at ESE. No extra dilutions to resolve or quantify other nitroaromatics within the certified range were [illegible]

because the regulatory/materials-handling assessment is based on 2,4-TNT. No other analytes were resolvable at the dilution used to quantify 2,4,6-TNT and, therefore, could not be quantified. Results of the chemical analyses are shown in Table 1.2-4. It should be noted that chemical analysis of the spiked sample indicated that this sample contained 7.3 percent 2,4,6-TNT by weight rather than the target of 10 percent 2,4,6-TNT by weight.

The results of these tests were used to exclude the reactivity characteristic from those soils which did not react and to further define any materials-handling/safety considerations required in evaluating remedial alternatives. A summary of the reactivity tests is presented in Table 1.2-5. The results indicate that only the sample of organic residue from the TNT process sewerline was reactive based on thermal stability, cap test, fire test, DDT test, and U.S. Gap Test. These results were consistent with the previous investigations at MAAP and SADA in demonstrating that soil contaminated with significant quantities of 2,4,6-TNT (up to 7 percent at WVOW) were not reactive. The results of the reactivity testing program were presented to EPA Region III personnel at a January 17, 1986 meeting; at this meeting, EPA personnel concurred that contaminated soil would be treated as nonreactive and sewerlines would be treated as reactive. The complete details of the reactivity testing are presented in App. A. Reactivity sampling locations are also included in App. A.

Direct and indirect exposure pathways to humans and animals exist for the contaminants observed in the TNT Manufacturing Area and the Burning Grounds Area. Simplified schematics of the potential exposure pathways for these areas are presented in Figs. 1.2-2 and 1.2-3. Direct exposure of humans and animals to nitroaromatic contamination can occur via direct contact with nitroaromatic residues in the soils or contaminated ground water seeps in the TNT Manufacturing Area.

Table 1.2-4. Reactivity Sampling Stations--Chemical Analyses

Site Designation	ESE Sample Number	TNT Concentration (µg/g)	Description
EBG	568605	9,300	East Burning Grounds composite sample
WBG	568604	4,750	West Burning Grounds composite sample
TNT-1	568602	1,130	TNT Manufacturing Area composite sample, TNT Lines 6 and 7
TNT-SP	568603	73,400	TNT Manufacturing Area, duplicate sample of TNT-1, spiked to 10% by weight TNT by ABL
TNT-SEW	568606	442,000	TNT Manufacturing Area, discrete sample, sewerline from TNT Line 5 Washer/Flaker house; sample consisted of crystalline material from pipe

Source: ESE, 1986c.

Table 1.2-5. Summary of the Reactivity Test Results

Sample Designation	Thermal Stability	BOE Impact Test	AEL Friction* Test	Electro-static Discharge Test	Cap Test	Spark Test	Fire Test	DDT Test	U.S. Cap Test
568602—TNT Manufacturing Area	No Reaction	No Reaction	320	No Reaction	No Reaction	No Reaction	No Reaction	No Reaction	Plate bulged; container peeled and split.
568603—TNT Manufacturing Area (duplicate)	No Reaction	No Reaction	330	No Reaction	No Reaction	No Reaction	No Reaction	No Reaction	Plate bulged; container in strips.
568604—West Burning Grounds	No Reaction	No Reaction	106	No Reaction	No Reaction	No Reaction	No Reaction	No Reaction	Plate bulged; container in strips.
568605—East Burning Grounds	No Reaction	No Reaction	165	No Reaction	No Reaction	No Reaction	No Reaction	No Reaction	No plate bulge; container in strips.

Table 1.2-5. Summary of the Reactivity Test Results (Continued, Page 2 of 2)

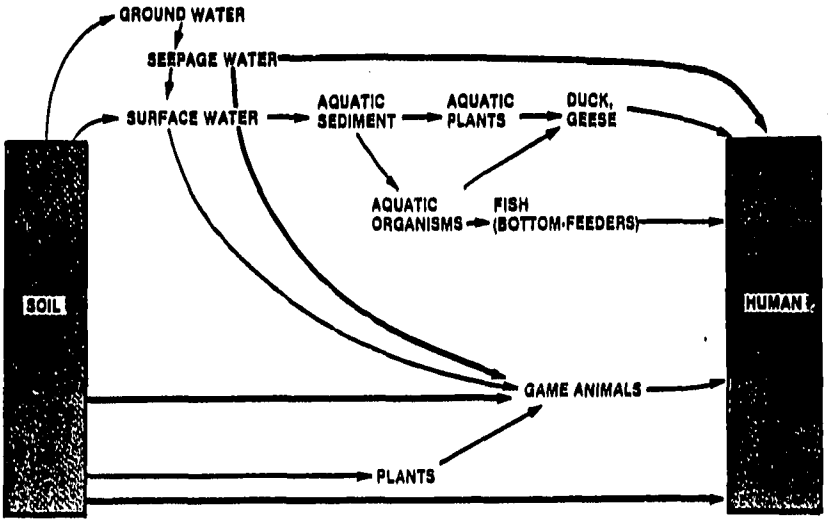
Sample Designation	Thermal Stability	BOE Impact Test	ABL Friction* Test	Electro-static Discharge Test	Cap Test	Spark Test	Fire Test	DOT Test	U.S. Gap Test
568606—Sewerline, TNT Line 5	Reaction	No Reaction	650	No Reaction	Cylinder mush-roomed	No Reaction	Burning	Container† cap fragmented	Plate† perforated; container fragmented.

*Force applied to the friction wheel where five trials with no reactions were obtained at 8 feet per second (ft/sec).
†Test results met the criterion for an explosive or propagating reaction.

Sources: ABL, 1986.
ESE, 1986c.

ORIGINAL
(Red)

WVOW PATH 5/90



SOURCE: ESE, 1986c.

Figure 1.2-2
EXPOSURE PATHWAYS RELATED TO SOIL CONTAMINATION IN THE TNT MANUFACTURING AREA

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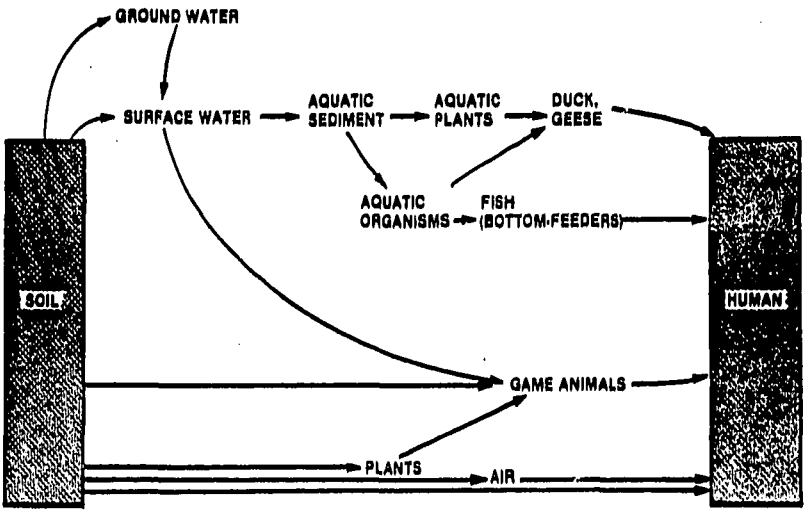

SOURCE: ESE, 1986c.

Figure 1.2-3
EXPOSURE PATHWAYS RELATED TO SOIL CONTAMINATION IN THE BURNING GROUNDS AREA

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Since the ground water in these areas is not currently utilized for drinking water, no direct pathway to humans is shown for ground water. The McClintic Wildlife Station is expected to remain a wildlife station in perpetuity. As a result, residences will not be constructed nor will onsite ground water be used as a drinking water supply.

Direct exposure of humans and animals to observed soil contaminants (nitroaromatics, asbestos, PAHs, and lead) can occur via direct contact and inhalation of suspended soil particulates containing these contaminants. Indirect exposure via aquatic food-chain mechanisms in both areas can occur from uptake by aquatic organisms which are fed upon by fish and/or waterfowl and then by humans. Indirect exposure via terrestrial mechanisms in both areas involves the uptake of soil contaminants by plants which may be eaten by upland game animals which, in turn, may be eaten by humans.

Direct and indirect exposure pathways to humans and animals exist via the safety hazards associated with numerous open manholes and via migration of contaminated ground water to seeps and surface waters in the TNT Manufacturing Area.

Offsite migration of contamination may occur in these areas in two locations. Erosion and surface water runoff from the Burning Grounds Area during the 100-year storm event may cause significant contamination of Ponds 31 and 33 and Oldtown Creek.

1.3 OBJECTIVES OF REMEDIAL ACTION

Remedial action objectives are defined by the EA. The EA summarized and interpreted RI data in order to assess actual and/or potential harm to public health, welfare, or the environment from hazardous substances originating on WVOW. Consequently, the EA justified the need for remedial action and served to focus remedial action alternatives.

Criteria for remediation were developed in consideration of all realistic exposure pathways by which people, wildlife, or aquatic life may be exposed to the contaminants. Criteria development was modeled on the Preliminary Pollutant Limit Value (PPLV) methodology developed at the U.S. Army Medical Bioengineering Research and Development Laboratory (USAMBRDL). The PPLV methodology represents an approach to criteria development based on site-specific exposure and risk assessment techniques and is documented by Small (1984). The criteria were developed under the assumption that McClintic Wildlife Station will continue to be managed as a hunting and fishing area with unrestricted access. Recreational users should not be exposed directly or through game and fish to contamination levels that pose a significant risk. In addition, aquatic and terrestrial biota should not be exposed to toxic concentrations.

Several key factors affect the exposure assessment. Hazardous concentrations of contaminants associated with the TNT Manufacturing Area, Burning Grounds Area, and Industrial Sewerlines are restricted to the McClintic Wildlife Station and would, under the No Action alternative, continue to be restricted. No residences will be constructed on the McClintic Wildlife Station. Ground water resources that have become contaminated are not now used for potable supply; the McClintic Wildlife Station is served by a municipal supply. Overwhelming institutional constraints militate against the use of ground water on the McClintic Wildlife Station as a potable supply. The McClintic Wildlife Station is expected to remain a wildlife station in perpetuity. The area is the most popular (i.e., heavily utilized) facility in West Virginia's state wildlife management system because of its proximity to the state's two largest cities, Huntington and Charleston. The State of West Virginia has the incentive, intent, and authority to maintain the land in this use. Very few, if any, sites on the NPL exhibit similar institutional constraints on land use. Because of these constraints, it is clear that residences will not be constructed on McClintic Wildlife Station, nor will onsite ground water be used as a drinking water supply.

The criteria for residual contaminant levels are summarized in Table 1.3-1.

By comparing actual contaminant levels with these criteria, the actual risks incurred by the exposed population have been estimated. The estimated lifetime cancer risk associated with regular use of the site and consumption of harvested game is estimated not to exceed 4×10^{-5}. Since the population exposed at the assumed levels is less than 200, the expected number of excess cancer incidences under the No Action alternative is less than 0.008. In other words, odds are about 100 to 1 that no excess cancers will occur as a result of contamination in the source areas. Noncarcinogenic health effects are not likely, with the possible exception of effects associated with 2,4,6-TNT which exceeds the derived criterion by a factor of 4.

Aside from endangerment posed by the toxicity of nitroaromatic contamination to humans and wildlife, additional hazards exist at the site. Some sewerlines contain reactive wastes (ABL, 1986). These wastes should be removed or rendered nonreactive. Open manholes associated with sewerlines pose a safety hazard which should be remedied. Friable asbestos deposits in the Burning Grounds Area pose an inhalation hazard requiring remediation. Vegetation stress is evident in the Burning Grounds Area, and it appears that vegetation will not grow in soils containing more than 1,000 µg/g of total nitroaromatics.

Considering the findings of the EA, the following remedial objectives were defined to minimize or eliminate the endangerment associated with the source areas:

1. To eliminate safety hazards associated with reactive wastes: remove or render nonreactive all reactive wastes.
2. To achieve less than 10^{-6} individual lifetime excess cancer risk for avid hunters and their families or friends who consume meat

Table 1.3-1. Acceptable Soil, Sediment, and Water Contamination Levels for WVOW Source Areas

Compound	McClintic Soils* [0.5 to 2 feet (ft)] (µg/g)	Pond Waters† (µg/L)	Pond Sediments† (µg/g)	Surficial Soils** (to 0.5 ft) (µg/g)
2,4,6-TNT	7,300	60	4	680
1,3,5-TNB	72,000	80	8	2,800
1,3-DNB	3,400	160	16	190
2,4-DNT				
10^{-6} risk	15	3.4	0.22	1.5
10^{-5} risk	150	34	2.2	15
2,6-DNT				
10^{-6} risk	3.1	0.67	0.53	0.31
10^{-5} risk	31	6.7	5.3	3.1
Total Nitroaromatics				
10^{-6} risk	500			50
10^{-5} risk	NA††			300

*Protects hunters from exposure by the plant-to-game pathway.
†Protects aquatic life and fishermen.
**Protects frequent McClintic Wildlife Station visitors from exposure by direct contact and inhalation of dust.
††Plants do not grow in soils containing total nitroaromatic contamination at concentrations that would result in 10^{-5} cancer risk.

Source: ESE, 1986c.

from game that feed in contaminated areas: remove or cover the upper 2 ft of soil if total nitroaromatic contamination exceeds 500 µg/g.

3. To achieve less than 10^{-6} individual lifetime excess cancer risk for frequent visitors to the McClintic Wildlife Station who come into direct contact with surficial soils: remove or cover the upper 6 inches of soil if total nitroaromatic contamination exceeds 50 µg/g.

Achievement of these criteria will also eliminate endangerment associated with other site contaminants since the other contaminants are found in association with high levels of nitroaromatic contamination. Achievement of Objective 3 will also mitigate potential impacts on aquatic biota associated with erosion and runoff from extreme storm events. All ponds stocked and used for fishing currently achieve the recommended surface water and sediment criteria designed to protect fishermen and aquatic life. It is necessary that any remedial actions taken will not result in exceedance of the acceptable contamination levels presented in Table 1.3-1.

To ensure that the individual lifetime excess cancer risk not exceed 10^{-5}, the objectives could be modified as follows:

- No change for Objective 1.
- Delete Objective 2: Plants cannot grow in soils contaminated with nitroaromatics at levels that would lead to a 10^{-5} risk level for game meat consumers nor would exposure to noncarcinogenic contaminants exceed acceptable levels as a result of plant uptake, regardless of soil contamination.
- For Objective 3, change the criterion for removing or covering the upper 6 inches of soil from 50 µg/g to 300 µg/g total nitroaromatic contamination.

2.0 SCREENING OF REMEDIAL ACTION TECHNOLOGIES

The methodology used to determine a cost-effective remedial action alternative for each of the three areas of concern was a stepwise evaluation of remedial technologies and assembled remedial alternatives that utilizes a series of screenings and was conducted in accordance with the NCP and EPA's FS Guidance Manual (Fig. 2.0-1) (EPA, 1985a). The purpose of these screenings was to prevent infeasible, unacceptable, or costly technologies and alternatives that do not meet the goals and objectives defined by the EA from being carried forward to the next evaluation step. Specific criteria including waste characteristics, technology development, and site characteristics were utilized for evaluating remedial technologies and to determine the magnitude and importance of any effect resulting from the implementation of a remedial alternative. Upon completion of the various screening processes, a detailed analysis of the alternatives remaining was performed. The resulting range of applicable remedial alternatives was then presented, along with the information necessary to determine the preferred alternative(s).

For this report, cost-effective remedial action alternatives were developed based on the information and data presented in the RI and the identified pathways, receptors, and corresponding criteria developed in the EA for the three source areas of concern:

1. TNT Manufacturing Area,
2. Burning Grounds Area, and
3. Industrial Sewerlines throughout the site.

Because the sewerlines are a significant source of contamination at the site, they are considered a separate area of concern.

Based on the results of the RI and the EA, remedial response actions were identified for WVOW. The response actions are general classes of response (e.g., containment) that address site problems and meet cleanup goals and objectives.

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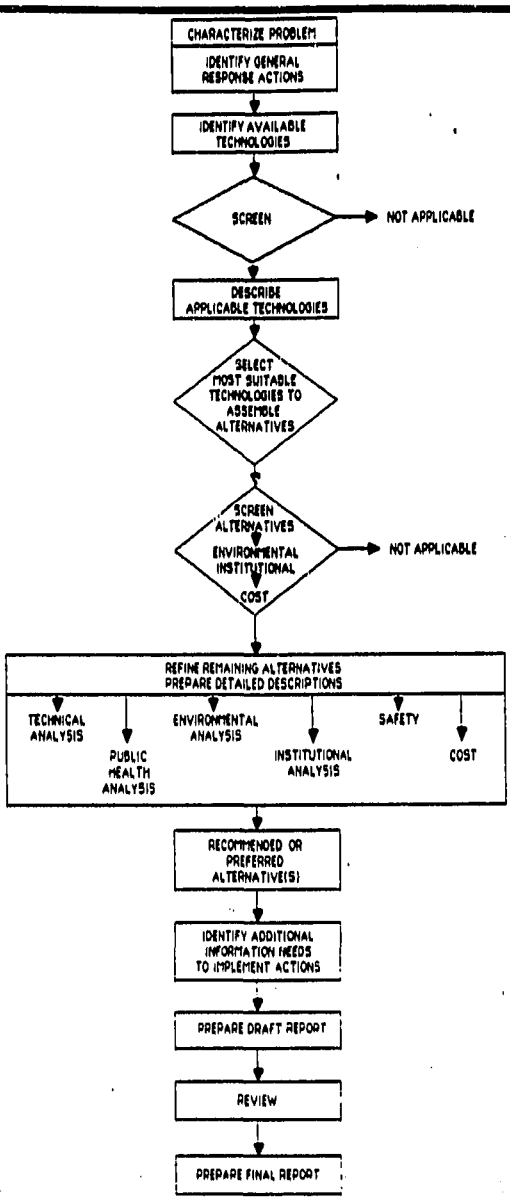
WVOW PATH 6/90



SOURCE: ESE, 1988c.

Figure 2.0-1
FEASIBILITY STUDY PROCESS

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Feasibility Study

Once the response actions were identified, a list of specific remedial technologies was developed for each response action. Each technology was screened to determine its applicability to the WVOW site. Applicability was evaluated based on waste characteristics, the ability of the technology to address the goals and objectives defined by the EA, the status of the technology development, and the specific site characteristics at each area of concern.

Technologies that passed the technology screening were used to form remedial alternatives that address the contaminated media at a particular area of concern.

2.1 IDENTIFICATION OF REMEDIAL RESPONSE ACTIONS

The following media are contaminated to various degrees:

1. Soils,
2. Sediments,
3. Ground water,
4. Surface water, and
5. Industrial sewerlines.

The remedial response actions for soils, sewerlines, and sediments are generally source control measures which remove or control the contamination to prevent the migration of pollutants from the source. The remedial actions for ground water and surface water generally serve to remedy the effects of contaminant migration from the source and to prevent further migration of nitroaromatics. Remedial response actions appropriate to the contaminated media in all areas of concern at WVOW are listed in Table 2.1-1. At the source areas (TNT Manufacturing Area, Burning Grounds Area, and Industrial Sewerlines), only soils and industrial sewerlines are applicable media. Depending on the results of the subsequent RI and EA, the remaining media may be applicable to the other areas of concern at WVOW. The remedial technologies compiled in the following section also address contaminated media on a sitewide basis and are not limited to the source areas.

Table 2.1-1. Remedial Response Actions for the WVOW Site

Remedial Response Action	Applicable Environmental Media				
	Ground Water*	Soils	Surface Water*	Sediments*	Industrial Sewerlines
Containment	X	X		X	
Collection	X		X		
Diversion			X		
In situ Treatment	X	X	X	X	X
Treatment	X	X	X	X	
In situ Decontamination					X
Decontamination					X
Disposal	X	X	X	X	X
Alternative Water Supply	X				
Limited Action	X	X	X	X	X
No Action	X	X	X	X	X

*Not applicable for the WVOW source areas (TNT Manufacturing Area, Burning Grounds Area, Industrial Sewerlines).

Source: ESE, 1986c.

2.2 IDENTIFICATION OF REMEDIAL TECHNOLOGIES

Potential remedial technologies associated with each response action identified in Table 2.1-1 are listed in Table 2.2-1. The list does not include auxiliary unit operations that may be necessary for the implementation of a treatment or control technology. For example, a transportation step may be necessary for conducting an excavation operation; likewise, grading and revegetation are required with capping. Discussion of these auxiliary unit operations is included in the alternatives analysis.

Table 2.2-1. Available Remedial Technologies for the WOW Site

Remedial Response Action	Remedial Technology	Applicable Environmental Medium				
		Ground Water	Soils	Surface Water	Sediments	Industrial Sewerlines
Containment	Capping:					
	Synthetic membrane		X		X	
	Clay		X		X	
	Asphalt		X		X	
	Multimedia		X		X	
	Concrete		X		X	
	Chemical sealant		X		X	
	Barriers:					
	Slurry wall	X				
	Vibrating beam	X				
	Grout curtain	X				
	Sheet piling	X				
	Concrete wall	X				
	Clay wall	X				
Collection	Extraction wells	X				
	Subsurface drains	X				
Diversion	Dikes and berms			X		
	Ditches and trenches			X		
	Culverts			X		
In situ Treatment	Microbial degradation	X	X	X	X	
	Soil aeration		X		X	
	Solution mining		X		X	
	Vitrification		X		X	
	Fixation/Encapsulation		X		X	
	Limestone treatment bed	X		X		
	Activated carbon bed	X		X		
	Chemical treatment	X	X	X	X	
	Surface flashing		X		X	
In situ Decontamination	Hydraulic scour					X
	Burn					X
	Solvent wash					X
	Chemical treatment					X

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Table 2.2-1. Available Remedial Technologies for the WOW Site (Continued, Page 2 of 3)

Remedial Response Action	Remedial Technology	Applicable Environmental Medium				
		Ground Water	Soils	Surface Water	Sediments	Industrial Sewerlines
Treatment	Biological:					
	Activated sludge	X		X		
	Trickling filter	X		X		
	Rotating biological contactor	X		X		
	Aerated lagoon	X		X		
	Composting		X		X	
	Physical/Chemical:					
	Ion exchange	X		X		
	Membrane separation	X		X		
	Oxidation	X		X		
	Reduction	X		X		
	Hydrolysis	X		X		
	Liquid/liquid extraction	X		X		
	Carbon adsorption	X		X		
	Air stripping	X		X		
	Steam stripping	X		X		
	Solar evaporation ponds	X		X		
	Spray evaporation	X		X		
	Wet-air oxidation	X		X		
	Publicly-owned treatment works	X		X		
	Incineration		X		X	X
	Aqueous thermal decomposition		X		X	
	Solvent extraction (leaching)		X		X	
	Sodium fluxing		X		X	
	Electron beam		X		X	
	Plasma treatment		X		X	
	Fixation		X		X	
Decontamination	Mechanical scour					X
	Hydraulic scour					X
	Chemical treatment					X
	Burn					X
	Solvent wash					X

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Table 2.2-1. Available Remedial Technologies for the WVOW Site (Continued, Page 3 of 3)

Remedial Response Action	Remedial Technology	Applicable Environmental Medium				
		Ground Water	Soils	Surface Water	Sediments	Industrial Sewerlines
Disposal	Deep well injection	X		X		
	Direct discharge	X		X		
	Landfill (onsite/offsite)		X		X	X
Alternative Water Supply	Bottled water	X				
	Tie-in to municipal system	X				
	Individual treatment units	X				
Limited Action	Monitor	X	X	X	X	X
	Limit access	X	X	X	X	X
No Action	None	X	X	X	X	X

Source: ESE, 1986c.

2.3 SELECTION OF APPLICABLE REMEDIAL TECHNOLOGIES

To select applicable remedial technologies for each area, a 2-phase screening process was conducted. The first phase considered two factors that determine technology applicability to the three areas of concern: (1) waste characteristics, and (2) the degree of technology development.

The degree of contamination, as well as the cleanup goals and objectives defined by the EA, vary by area of concern. In general, however, the waste characteristics are similar throughout the site. Thus, waste characteristic and technology development screenings were conducted for the WVOW site as a whole by medium. Those technologies that passed the initial screening were evaluated based on site-specific characteristics for each of the three areas of concern. Technologies remaining after the site characteristics screening were subsequently used in the assembly of alternatives for each area.

2.3.1 WASTE CHARACTERISTICS/TECHNOLOGY DEVELOPMENT SCREENING

In the waste characteristics/technology development screening, the characteristics of nitroaromatics were examined to eliminate technologies that are ineffective, unsafe, or otherwise not suitable for meeting the goals and objectives defined by the EA. Waste characteristics evaluated in screening included:

1. Physical properties such as volatility, solubility, and density;
2. Specific chemical constituents (TNT, 2,4-DNT, 2,6-DNT, etc.); and
3. Properties that determine the degree of hazard, such as reactivity or ignitability.

If the technology was not eliminated based on waste characteristics, then the degree of technology development, performance record, and inherent construction, operation, and maintenance problems were considered. Technologies that are unreliable or not fully demonstrated, such that excessive development work would be required prior to implementation,

were eliminated. Table 2.3-1 presents the results of the waste characteristics/technology development screening for the WVOW site. Justification for elimination of a technology is also presented.

2.3.2 SITE CHARACTERISTICS SCREENING

To conduct the site characteristics screening, the technologies were evaluated by medium for the TNT Manufacturing Area and the Burning Grounds Area. For simplification, the Industrial Sewerlines were screened as a medium within the TNT Manufacturing Area. Site data gathered during the RI were used to identify site conditions that would limit or promote the use of any technology. Such site characteristics include site area and configuration, soil texture, topography, depth to a ground water confining layer, and existing land use. EA results, indicating that ground water contamination in the TNT Manufacturing Area is not a significant exposure pathway, were also used as screening criteria for eliminating technologies applicable to ground water remediation.

Tables 2.3-2 and 2.3-3 summarize the site characteristics screening for the TNT Manufacturing Area and the Burning Grounds Area, respectively. Justification for elimination of a technology is also provided.

Table 2.3-1. Screening of Remedial Technologies Based on Waste Characteristics and Technology Development for the WOW Site

Medium	Remedial Response Action	Remedial Technology	Reason for Elimination
Ground Water/ Surface Water	Containment (ground water)	Barriers:	
		Slurry wall	
		Vibrating beam	Difficult to maintain beam alignment and continuity during installation
		Grout curtain	Long-term continuity is questionable
		Sheet piling	Time required for joints to seal may be substantial; requires maintenance to ensure corrosion resistance
		Concrete wall	Limited to installations requiring high degree of strength
		Clay wall	Limited performance experience; requires excessive excavation
	Collection (ground water)	Extraction wells	
		Subsurface drains	
	Diversion (surface water)	Dikes and berms	
		Ditches and trenches	
		Culverts	
	In situ treatment	Microbial degradation	Not demonstrated to be effective on large scale
		Limestone treatment bed	Not applicable to nitroaromatics
		Activated carbon bed	Not demonstrated for long-term remediation
		Chemical treatment	Reaction and reaction products difficult to control
	Treatment	Biological:	
		Activated sludge	Not demonstrated to be effective on large scale
		Trickling filter	
		Rotating biological contactor	
		Aerated lagoon	
		Composting	
		Publicly-owned treatment works	
		Physical Chemical:	
		Ion exchange	Not demonstrated for nitroaromatics
		Oxidation	Excessive development required to implement
		Reduction	Excessive development required to implement
		Liquid/liquid extraction	Excessive development required to implement
		Carbon adsorption	
		Air stripping	Not effective for nitroaromatics
		Steam stripping	Not effective for nitroaromatics
		Evaporation ponds	Poor performance
		Spray evaporation	Potential for contaminant migration
		Wet-air oxidation	Not fully demonstrated for nitroaromatics
		Hydrolysis	Excessive development requirements for nitroaromatic contamination
		Membrane separation	Potential for fouling of membrane; concentrate stream requires treatment

Table 2.3-1. Screening of Remedial Technologies Based on Waste Characteristics and Technology Development for the WWM Site (Continued, Page 2 of 3)

Medium	Remedial Response Action	Remedial Technology	Reason for Elimination
Ground Water/ Surface Water (Continued)	Disposal	Deep well injection Direct discharge Recharge to aquifer	
	Alternative water supply (ground water)	Bottled water Tie-in to municipal system Individual treatment units	No protection provided during bathing
	Limited action	Monitor Limit access	
	No action	None	
Sediments/Soils	Containment	Capping: Synthetic membrane Clay Asphalt Multimedia Concrete Chemical sealant	 Limited field experience Susceptible to weathering Susceptible to freeze/thaw stresses Susceptible to freeze/thaw stresses
	In situ treatment	Microbial degradation Soil aeration Solution mining Vitrification Fixation Chemical treatment Flaming	Not demonstrated full scale Not demonstrated full scale Not demonstrated full scale Not effective for nitroaromatics Not generally compatible with nitroaromatics Reaction and reaction products difficult to control
	Treatment	Biological: Composting Land farming	 Nitroaromatics are generally not biodegradable Not demonstrated on large scale
		Physical/Chemical: Sodium fluxing Electron beam Plasma treatment Fixation/solidification Aqueous thermal decomposition Incineration Burn/flaming	 Innovative technology—excessive development requirements Innovative technology—excessive development requirements Innovative technology—excessive development requirements Not generally compatible with nitroaromatics Innovative technology—excessive development requirements
	Disposal	Landfill	

Table 2.3-1. Screening of Remedial Technologies Based on Waste Characteristics and Technology Development for the WAUM Site (Continued, Page 3 of 3)

Medium	Remedial Response Action	Remedial Technology	Reason for Elimination
Sediments/Soils (Continued)	Limited action	Monitor Limit access	
	No action	None	
Industrial Sewerlines/ Sumps	In situ decontamination	Mechanical scour Hydraulic scour Burn in place Solvent wash Chemical treatment Grout	Safety Poor condition of pipe may lead to exfiltration of contaminants Safety Poor condition of pipe may lead to exfiltration of contaminants Poor condition of pipe may lead to exfiltration of contaminants
	Treatment	Incineration	
	Decontamination	Mechanical scour Hydraulic scour Burn/flaming Chemical treatment Solvent wash	Safety Creates additional waste stream Creates additional waste stream Creates additional waste stream
	Disposal	Landfill	
	Limited action	Monitor Limit access	
	No action	None	
Asbestos/ Rubble	Containment	Capping: Synthetic membrane Clay Asphalt Multimedia Concrete Chemical sealant	 Susceptible to weathering; freeze/thaw stresses Susceptible to freeze/thaw stresses Susceptible to freeze/thaw stresses
	Disposal	Landfill	

Source: ESE, 1986c.

Table 2.3-2. Site Screening of Remaining Remedial Technologies for the TNT Manufacturing Area

Medium	Remedial Response Action	Remedial Technology	Reason for Elimination
Ground Water/ Surface Water	Containment (ground water)	Barriers: Slurry wall	Ground water not a significant exposure pathway
	Collection (ground water)	Extraction wells	Ground water not a significant exposure pathway
		Subsurface drains	Ground water not a significant exposure pathway
	Diversion (surface water)	Dikes and berms	
		Ditches and trenches	
		Culverts	
	Treatment	Carbon adsorption	Ground water not a significant exposure pathway
	Disposal	Deep-well injection	Ground water not a significant exposure pathway
		Direct discharge	
		Recharge to aquifer	
	Alternative water supply (ground water)	Tie-in to municipal system	No receptors
		Individual treatment units	No receptors
	Limited action	Monitor	
		Limit access	
	No action	None	
Soils	Containment	Capping: Clay	
		Multimedia	
	In situ treatment	Flaming	
	Treatment	Incineration	
		Flaming	
	Disposal	Landfill	
	Limited action	Monitor	
		Limit access	
	No action	None	

Table 2.3-2. Site Screening of Remaining Remedial Technologies for the TNT Manufacturing Area (Continued, Page 2 of 2)

Medium	Remedial Response Action	Remedial Technology	Reason for Elimination
Industrial Sewerlines/ Sumps	In situ treatment	Grout Barriers	
	Treatment	Incinerate	
	Decontamination	Burn/Flaming	
	Disposal	Landfill	
	Limited action	Monitor Limit access	
	No action	None	

Source: ESE, 1986c.

Table 2.3-3. Site Screening of Remaining Remedial Technologies for the Burning Grounds Area

Medium	Remedial Response Action	Remedial Technology	Reason for Elimination
Asbestos/Rubble	Containment	Capping: Clay Multimedia	
	Disposal	Landfill	
	Limited action	Monitor Limit access	
	No action	None	
Soils	Containment	Capping: Clay Multimedia	
	In situ treatment	Flaming	
	Treatment	Incineration Burn/flaming	
	Disposal	Landfill	
	Limited action	Monitor Limit access	
	No action	None	

Source: ESE, 1986c.

2.4 RESULTS OF REMEDIAL TECHNOLOGY SCREENING

The technologies which remain after screening for waste characteristics/ technology development and site characteristics are listed in Table 2.4-1 for the TNT Manufacturing Area and the Burning Grounds Area. Each of these technologies is considered applicable for assembly into remedial alternatives presented in Sec. 2.5.

Table 2.4-1. Applicable Remedial Technologies for the TNT Manufacturing Area and the Burning Grounds Area

Medium	Available Remedial Technologies	Areas for Which Remedial Technologies are Applicable (X = applicable to site)	
		TNT Manufacturing Area	Burning Grounds Area
Sediments/Soils	Multimedia cap	X	X
	Clay cap	X	X
	In situ flaming	X	X
	Flaming	X	X
	Incineration	X	X
	Landfill	X	X
	Limit access	X	X
	No action	X	X
Industrial Sewerlines	Incineration	X	
	Flaming	X	
	Landfill	X	
	Grout in place	X	
	Limit access	X	
	No action	X	

Source: ESE, 1986c.

2.5 ASSEMBLY AND SCREENING OF ALTERNATIVES

Applicable remedial technologies identified in Table 2.4-1 were assembled into alternatives that address the contamination in three source areas of concern at WVOW. The assembly of alternatives is based on the information and data generated during the RI and the identified pathways, receptors, and corresponding criteria developed in the EA. These alternatives were screened for public health/environmental impacts and cost. Those alternatives that would not protect public health or the environment or had cost an order of magnitude greater than alternatives providing similar benefits were eliminated. The alternatives remaining after the screening were carried forward to detailed analysis.

2.5.1 CATEGORIZATION OF ASSEMBLED ALTERNATIVES

In an effort to provide a degree of flexibility in the final selection of a remedial action, a set of alternatives covering a range of remedial actions has been developed. As specified in EPA policy on compliance with environmental statutes other than CERCLA, remedial action alternatives were assembled in the following categories:

Category	Description
1	Alternatives for treatment or disposal at an off-site facility, as appropriate;
2	Alternatives that attain applicable or relevant and appropriate Federal public health and environmental requirements;
3	As appropriate, alternatives that exceed applicable or relevant and appropriate Federal public health and environmental requirements;
4	As appropriate, alternatives that do not attain applicable or relevant and appropriate Federal public health and environmental requirements but will reduce the likelihood of present or future threat from the hazardous substances and that provide significant protection to public health and welfare and the environment. This must include an alternative that closely approaches the level of protection provided by the applicable or relevant and appropriate requirements; and
5	No Action alternative.

Development of alternatives in these categories ensured that a broad spectrum of remedial alternatives was evaluated.

Alternatives included in Category 1 must specify the offsite storage, destruction, treatment, or secure disposal of contaminated environmental media, as appropriate, to a facility approved under RCRA. Under this alternative, contaminated environmental media (sewerlines and soils) will be removed to meet or exceed applicable or relevant and appropriate Federal public health and environmental requirements such that levels of chemical contaminants remaining are either below risk levels (10^{-6}) derived in the EA or are below detectable levels (2 µg/g). All contaminated materials must be manifested and transported offsite via a licensed transporter. The facility receiving the contaminated materials must have interim status or be fully permitted and be in compliance with all applicable RCRA regulations. For instance, a landfill facility receiving contaminated materials must have a double liner, as defined by RCRA.

Alternatives in Category 2 are onsite actions which are in compliance with standards and/or criteria set by applicable or relevant and appropriate environmental laws, regulations, and criteria. Applicable laws, regulations, and criteria may include RCRA, Safe Drinking Water Act (SDWA), Clean Air Act (CAA), Clean Water Act (CWA), Department of Transportation (DOT) Hazardous Materials Transport Rules, EPA Ground Water Protection Strategy, and appropriate Federal public health and environmental requirements. Contaminated sewerlines and soils are treated or left in place in accordance with RCRA closure standards, as appropriate, or site-specific criteria developed to conform to EPA's risk assessment or EA guidelines. Onsite remedial activities conducted under CERCLA must meet the technical and regulatory requirements of RCRA, but do not require permits. Closure and post-closure of the site are in accordance with applicable RCRA regulations.

Alternatives in Category 3 are onsite actions which exceed the same standards, criteria, and regulations as Category 2 alternatives. Contaminated sewerlines and soils are removed to below detectable levels, as appropriate.

Alternatives in Category 4 are onsite actions which meet the site-specific criteria established in the EA and CERCLA goals of preventing or minimizing current or future migration of hazardous substances and protecting human health, welfare, and the environment. The alternatives protect potential human and other animal receptors from direct contact and ingestion of pollutants. Onsite actions under this alternative do not require permits.

Assembled alternatives in Category 5 require limited action to minimize any immediate danger to human health, welfare, or the environment or require no remedial action.

2.5.2 ASSEMBLY OF ALTERNATIVES

The applicable remedial technologies identified in Sec. 2.4 were assembled into alternatives, by category, for each area of concern. In assembling the alternatives for each area of concern, the source of the contamination in that area was initially addressed. Selection of the remedial technology for the source was based on the type, concentration, and extent of contamination in the environmental medium; knowledge of previous applications and performance of the remedial technologies; and knowledge gained from pilot-scale or field studies.

The remaining contaminated environmental media in each area of concern were then addressed. The technologies to address the remaining environmental media were selected to be compatible with or enhance the source technology selected. One contaminated medium is present at the

TNT Manufacturing Area, and two media are present at both the Burning Grounds Area and the Industrial Sewerlines.

Twelve alternatives were assembled for the TNT Manufacturing Area. These alternatives are presented in Table 2.5-1.

Twelve alternatives were assembled for the Burning Grounds Area. These alternatives are presented in Table 2.5-2.

Six alternatives were assembled for the Industrial Sewerlines. These alternatives are presented in Table 2.5-3.

2.5.3 SCREENING OF ALTERNATIVES

The alternatives developed for each area of concern were screened based on environmental, public health, and cost criteria. This screening allowed an initial assessment of the applicability of each alternative relative to the others within each category for each area of concern. This screening process eliminated those alternatives which could not adequately protect human health and the environment, or were an order of magnitude more costly than others in the same category but do not provide significantly greater protection of human health, welfare, and the environment. However, the alternatives for each area of concern which remained after the initial screening included at least one alternative in each of the five categories discussed in Sec. 2.5.1 except Category 1, Offsite Disposal for Sewerlines, where no offsite option exists based on the assumption that all sewerlines are reactive. No offsite option exists for the reactive TNT residue in the Burning Grounds Area. This residue will be destroyed by in situ flaming in all cases.

2.5.3.1 Screening Criteria

Alternatives developed for each area of concern were screened on the basis of environmental, public health, and cost criteria.

Table 2.5-1. Assembled Alternatives for the TNT Manufacturing Area

Category/ Alternative	Contaminated Environmental Medium of Concern: Soils	Cleanup Criteria
1/Offsite Disposal		
1A1	Excavation Offsite incineration	Detection limits
1A2	Excavation Offsite incineration	10^{-6} risk levels
1B1	Excavation Offsite landfill	Detection limits
1B2	Excavation Offsite landfill	10^{-6} risk levels
2/Attains Requirements		
2A	Excavation Onsite incineration Backfill	10^{-6} risk levels
2B	Excavation Onsite landfill	10^{-6} risk levels
2C	Multimedia cap	10^{-6} risk levels
3/Exceeds Requirements		
3A	Excavation Onsite incineration Backfill	Detection limits
3B	Excavation Onsite landfill	Detection limits
3C	Multimedia cap	Detection limits
4/CERCLA		
4A	Soil cover	10^{-6} risk levels
5/No Action		
5A	No action	None

Source: ESE, 1986c.

ORIGINAL
(Red)

Table 2.5-2. Assembled Alternatives for the Burning Grounds Area

Category/ Alternative	Contaminated Environmental Medium of Concern: Soils/Sediments	Asbestos/Rubble	Cleanup Criteria
1/Offsite Disposal			
1A1	In situ Flaming of TNT residue Excavation Offsite incineration	Offsite landfill	Detection limits
1A2	In situ Flaming of TNT residue Excavation Offsite incineration	Offsite landfill	10^{-6} risk levels
1B1	In situ Flaming of TNT residue Excavation Offsite landfill	Offsite landfill	Detection limits
1B2	In situ Flaming of TNT residue Excavation Offsite landfill	Offsite landfill	10^{-6} risk levels
2/Attains Requirements			
2A	In situ Flaming of TNT residue Excavation Onsite incineration Backfill	Offsite landfill	10^{-6} risk levels
2B	In situ Flaming of TNT residue Excavation Onsite landfill	Onsite landfill	10^{-6} risk levels
2C	In situ Flaming of TNT residue Multimedia cap	Offsite landfill	10^{-6} risk levels
3/Exceeds Requirements			
3A	In situ Flaming of TNT residue Excavation Onsite incineration Backfill	Offsite landfill	Detection limits
3B	In situ Flaming of TNT residue Excavation Onsite landfill	Onsite landfill	Detection limits
3C	In situ Flaming of TNT residue Multimedia cap	Offsite landfill	Detection limits
4/CERCLA			
4A	In situ Flaming of TNT residue Soil cover	Offsite landfill	10^{-6} risk levels
5/No Action			
5A	No action	No action	None

Source: ESE, 1986c.

Table 2.5-3. Assembled Alternatives for the Industrial Sewerlines

Category/ Alternative	Contaminated Environmental Medium of Concern		Cleanup Criteria
	Sewerlines	Soils	
1/Offsite Disposal			
	No option	No action	
2/Attains Requirements			
2A	Excavation Onsite incineration Backfill	No action	10^{-6} risk levels
2B	Excavation Flashing Onsite landfill	No action	10^{-6} risk levels
3/Exceeds Requirements			
3A	Excavation Onsite incineration Backfill	Excavation Onsite incineration Backfill	Detection limits
3B	Excavation Flashing Onsite landfill	Excavation Onsite landfill	Detection limits
4/CERCLA			
4A	Excavation Flashing Backfill	No action	10^{-6} risk levels
5/No Action			
5A	No action	No action	None

Source: ESE, 1986c.

The environmental and public health screening took into account short-term (construction-related) environmental impacts, long-term environmental impacts, and protection of human health, welfare, and the environment. Those alternatives creating short-term and/or long-term environmental effects that would overshadow any environmental benefit of implementing the alternative were eliminated. Also, those alternatives which did not reduce or minimize harm to human health, welfare, or the environment were also eliminated.

Each of the alternatives was evaluated based upon its present-worth cost. This cost is developed using published capital and operation and maintenance (O&M) costs, assumes a lifetime of 30 years, and is designed to achieve an accuracy within -50 to +100 percent. Alternatives that had costs an order of magnitude greater than those of other alternatives but do not provide greater environmental or public health benefits or greater reliability were eliminated.

A summary of the preliminary screening of the alternatives for the TNT Manufacturing Area is presented in Table 2.5-4.

A summary of the preliminary screening of the alternatives for the Burning Grounds Area is presented in Table 2.5-5.

A summary of the preliminary screening of the alternatives for the Industrial Sewerlines throughout the site is presented in Table 2.5-6.

2.5.4 SUMMARY OF ALTERNATIVES SCREENING

On the basis of the screening criteria, the 1A1 alternatives for the TNT Manufacturing Area and the Burning Grounds Area were eliminated for cost; all other alternatives in each area of concern were carried forward. No 1A offsite alternative is available for reactive sewerlines or TNT residue. No alternatives were technically inadequate or were environmentally detrimental except those in Category 5 (No Action). However, these alternatives were still carried forward to the detailed analysis of alternatives because all categories must be represented in the detailed analysis.

Table 2.5-4. Preliminary Screening of Alternatives for the TNT Manufacturing Area

Category/Alternative	Environmental/Public Health Factors	Present-Worth Cost ($1,000)
1/Offsite Disposal		
1A1/Excavation Offsite incineration	Contamination removed to below detection levels. Contaminants permanently destroyed. Contaminant migration halted. Short-term construction impacts. Long-term public health and environmental impacts eliminated. Aesthetics improved.	81,172
1A2/Excavation Offsite incineration	Contamination removed to 10^{-6} risk levels. Contaminants permanently destroyed. Contaminant migration halted. Short-term construction impacts. Long-term public health and environmental impacts eliminated. Aesthetics improved.	10,275
1B1/Excavation Offsite landfill	Contamination removed to below detection levels. Contaminants not destroyed. Contaminant migration halted. Short-term construction impacts. Long-term public health and environmental impacts eliminated. Aesthetics improved.	9,600
1B2/Excavation Offsite landfill	Contamination removed to 10^{-6} risk levels. Contaminants not destroyed. Contaminant migration halted. Short-term construction impacts. Long-term public health and environmental impacts eliminated. Aesthetics improved.	1,215

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Table 2.5-4. Preliminary Screening of Alternatives for the TNT Manufacturing Area (Continued, Page 2 of 4)

Category/Alternative	Environmental/Public Health Factors	Present-Worth Cost ($1,000)
2/Attains Requirements		
2A/Excavation Onsite incineration	Contamination removed to 10^{-6} risk levels. Contaminants permanently destroyed. Contaminant migration halted. Short-term construction impacts. Long-term public health and environmental impacts eliminated. Aesthetics improved. Temporary onsite facility. Ash backfilled.	4,554
2B/Excavation Onsite landfill	Contamination removed to 10^{-6} risk Contaminants not destroyed. Contaminant migration restricted. Short-term construction impacts. Long-term public health and environmental impacts reduced. Aesthetics improved. Permanent onsite facility. Minimal post-closure land use restrictions.	1,061
2C/Multimedia cap	Contamination isolated to 10^{-6} risk levels. Contaminants not destroyed. Contaminant migration restricted. Short-term construction impacts. Long-term public health and environmental impacts reduced. Aesthetics improved. Permanent onsite facility. Minimal po t-closure land use restrictions.	755

Table 2.5-4. Preliminary Screening of Alternatives for the TNT Manufacturing Area (Continued, Page 3 of 4)

Category/Alternative	Environmental/Public Health Factors	Present-Worth Cost ($1,000)
3/Exceeds Requirements		
3A/Excavation Onsite incineration	Contamination removed to below detection levels. Contaminants permanently destroyed. Contaminant migration halted. Short-term construction impacts. Long-term public health and environmental impacts eliminated. Aesthetics improved. Temporary onsite facility. Ash backfilled.	12,175
3B/Excavation Onsite landfill	Contamination removed to below detection levels. Contaminants not destroyed. Contaminant migration restricted. Short-term construction impacts. Long-term public health and environmental impacts reduced. Aesthetics improved. Permanent onsite facility. Minimal post-closure land use restrictions.	3,513
3C/Multimedia cap	Contamination isolated to below detection levels. Contaminants not destroyed. Contaminant migration restricted. Short-term construction impacts. Long-term public health and environmental impacts reduced. Aesthetics improved. Permanent onsite facility. Minimal post-closure land use restrictions.	3,847

Table 2.5-4. Preliminary Screening of Alternatives for the TNT Manufacturing Area (Continued, Page 4 of 4)

Category/Alternative	Environmental/Public Health Factors	Present-Worth Cost ($1,000)
4/CERCLA		
4A/Soil cover	Contamination isolated to 10^{-6} risk levels. Contaminants not destroyed. Contaminant migration restricted. Short-term construction impacts. Long-term public health and environmental impacts reduced. Aesthetics improved. Permanent onsite facility. Minimal post-closure land use restrictions.	499
5/No Action		
5A/No Action	Contaminants remain. Continued contaminant migration. No isolation of receptors. No short-term impacts. Long-term public health and environmental impacts remain. Permanent land use restrictions.	73

Source: ESE, 1986c.

Table 2.5-5. Preliminary Screening of Alternatives for the Burning Grounds Area

Category/Alternative	Environmental/Public Health Factors	Present-Worth Cost ($1,000)
1/Offsite Disposal		
In situ Flaming 1A1/Excavation Offsite incineration	Contamination removed to below detection levels. Contaminants permanently destroyed. Contaminant migration halted. Short-term construction impacts. Long-term public health and environmental impacts eliminated. Aesthetics improved.	25,840
In situ Flaming 1A2/Excavation Offsite incineration	Contamination removed to 10^{-6} risk levels. Contaminants permanently destroyed. Contaminant migration halted. Short-term construction impacts. Long-term public health and environmental impacts eliminated. Aesthetics improved.	5,206
In situ Flaming 1B1/Excavation Offsite landfill	Contamination removed to below detection levels. Contaminants not destroyed. Contaminant migration halted. Short-term construction impacts. Long-term public health and environmental impacts eliminated. Aesthetics improved.	2,999
In situ Flaming 1B2/Excavation Offsite landfill	Contamination removed to 10^{-6} risk levels. Contaminants not destroyed. Contaminant migration halted. Short-term construction impacts. Long-term public health and environmental impacts eliminated. Aesthetics improved.	604

Table 2.5-5. Preliminary Screening of Alternatives for the Burning Grounds Area (Continued, Page 2 of 4)

Category/Alternative	Environmental/Public Health Factors	Present-Worth Cost ($1,000)
2/Attains Requirements 2A/Excavation Onsite incineration	Contamination removed to 10^{-6} risk levels. Contaminants permanently destroyed. Contaminant migration halted. Short-term construction impacts. Long-term public health and environmental impacts eliminated. Aesthetics improved. Temporary onsite facility. Ash backfilled.	3,631
2B/In situ Flaming Excavation Onsite landfill	Contamination removed to 10^{-6} risk levels. Contaminants not destroyed. Contaminant migration restricted. Short-term construction impacts. Long-term public health and environmental impacts reduced. Aesthetics improved. Permanent onsite facility. Minimal post-closure land use restrictions.	570
2C/In situ Flaming Multimedia cap	Contamination isolated to 10^{-6} risk levels. Contaminants not destroyed. Contaminant migration restricted. Short-term construction impacts. Long-term public health and environmental impacts reduced. Aesthetics improved. Permanent onsite facility. Minimal post-closure land use restrictions.	406

Table 2.5-5. Preliminary Screening of Alternatives for the Burning Grounds Area (Continued, Page 3 of 4)

Category/Alternative	Environmental/Public Health Factors	Present-Worth Cost ($1,000)
3/Exceeds Standards 3A/Excavation Onsite incineration	Contamination removed to below detection levels. Contaminants permanently destroyed. Contaminant migration halted. Short-term construction impacts. Long-term public health and environmental impacts eliminated. Aesthetics improved. Temporary onsite facility. Ash backfilled.	5,828
3B/In situ Flaming Excavation Onsite landfill	Contamination removed to below detection levels. Contaminants not destroyed. Contaminant migration restricted. Short-term construction impacts. Long-term public health and environmental impacts reduced. Aesthetics improved. Permanent onsite facility. Minimal post-closure land use restrictions.	1,441
In situ Flaming 3C/Multimedia cap	Contamination isolated to below detection levels. Contaminants not destroyed. Contaminant migration restricted. Short-term construction impacts. Long-term public health and environmental impacts reduced. Aesthetics improved. Permanent onsite facility. Minimal post-closure land use restrictions.	1,467

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Table 2.5-5. Preliminary Screening of Alternatives for the Burning Grounds Area (Continued, Page 4 of 4)

Category/Alternative	Environmental/Public Health Factors	Present-Worth Cost ($1,000)
4/CERCLA		
4A/In situ Flaming Soil cover	Contamination isolated to 10^{-6} risk levels. Contaminants not destroyed. Contaminant migration restricted. Short-term construction impacts. Long-term public health and environmental impacts reduced. Aesthetics improved. Permanent onsite facility. Minimal post-closure land use restrictions.	327
5/No Action		
5A/No Action	Contaminants remain. Continued contaminant migration. No isolation of receptors. No short-term impacts. Long-term public health and environmental impacts remain. Permanent land use restrictions.	48

Source: ESE, 1986c.

Table 2.5-6. Preliminary Screening of Alternatives for the Industrial Sewerlines

Category/Alternative	Environmental/Public Health Factors	Present-Worth Cost ($1,000)
1/Offsite Disposal	No option.	--
2/Attains Requirements 2A/Excavation Onsite incineration Backfill	Contamination removed to 10^{-6} risk levels. Contaminants permanently destroyed. Contaminant migration halted. Short-term construction impacts. Long-term public health and environmental impacts eliminated. Aesthetics improved. Temporary onsite facility. Ash backfilled.	3,469
2B/Excavation Flashing Onsite landfill residue	Contamination removed to 10^{-6} risk levels. Contaminant levels reduced. Contaminant migration restricted. Short-term construction impacts. Long-term public health and environmental impacts eliminated. Aesthetics improved. Permanent onsite facility. Minimal post-closure land use restrictions.	582
3/Exceeds Requirements 3A/Excavation Onsite incineration Backfill	Contamination removed to below risk levels. Contaminants permanently destroyed. Contaminant migration halted. Short-term construction impacts. Long-term public health and environmental impacts eliminated. Aesthetics improved. Temporary onsite facility. Ash backfilled.	7,840

Table 2.5-6. Preliminary Screening of Alternatives for the Industrial Sewerlines (Continued, Page 2 of 2)

Category/Alternative	Environmental/Public Health Factors	Present-Worth Cost ($1,000)
3B/Excavation Flashing Onsite landfill	Contamination removed to below detection levels. Contaminant levels reduced. Contaminant migration restricted. Short-term construction impacts. Long-term public health and environmental impacts eliminated. Aesthetics improved. Permanent onsite facility. Minimal post-closure land use restrictions.	2,098
4/CERCLA 4A/Excavation Flashing Backfill	Contamination isolated to 10^{-6} risk levels. Contaminant levels reduced. Contaminant migration restricted. Short-term construction impacts. Long-term public health and environmental impacts eliminated. Aesthetics improved. Permanent onsite facility. Minimal post-closure land use restrictions.	338
5/No Action 5A/No Action	Contaminants remain. Contaminant migration unchecked. No short-term impact. Long-term public health and environmental impacts remain. Possible permanent land use restrictions.	--

Source: ESE, 1986c.

3.0 REMEDIAL ACTION ALTERNATIVES

Detailed descriptions of the most promising alternatives identified in Sec. 2.5 are presented in this section.

3.1 TNT MANUFACTURING AREA ALTERNATIVES

3.1.1 OFFSITE DISPOSAL ALTERNATIVES--CATEGORY 1

3.1.1.1 Alternative 1A2

Alternative 1A2 for the TNT Manufacturing Area involves the remediation of contaminated soil surrounding Washer/Flaker building foundations. Soil will be excavated and transported to a RCRA-permitted commercial incinerator that will accept nitroaromatics-contaminated soil in large quantities.

The objective of this alternative is complete removal of all contaminated soil that contains nitroaromatic concentrations above the 10^{-6} risk levels. To achieve a 10^{-6} risk level for soils in the TNT Manufacturing Area, the following remedial objectives are indicated by the EA for the source areas:

1. Remove, or render nonreactive, all reactive wastes;
2. Remove or cover the upper 2 ft of soil if total nitroaromatic contamination exceeds 500 µg/g; and,
3. Remove or cover the upper 6 inches of soil if total nitroaromatic contamination exceeds 50 µg/g.

The worst-case estimate for surficial contamination (>50 µg/g) at the TNT Manufacturing Area is approximately 9,000 ft^2 per TNT line, or 90,000 ft^2 total for the 10 lines. The location of this surficial contamination is shown in Fig. 3.1-1.

The WVOW RI report (ESE, 1986a) indicates contamination was consistently below the 10^{-6} remedial objective of 500 µg/g at a depth of 50 centimeters (cm) (approximately 1.6 ft). Therefore, excavation to

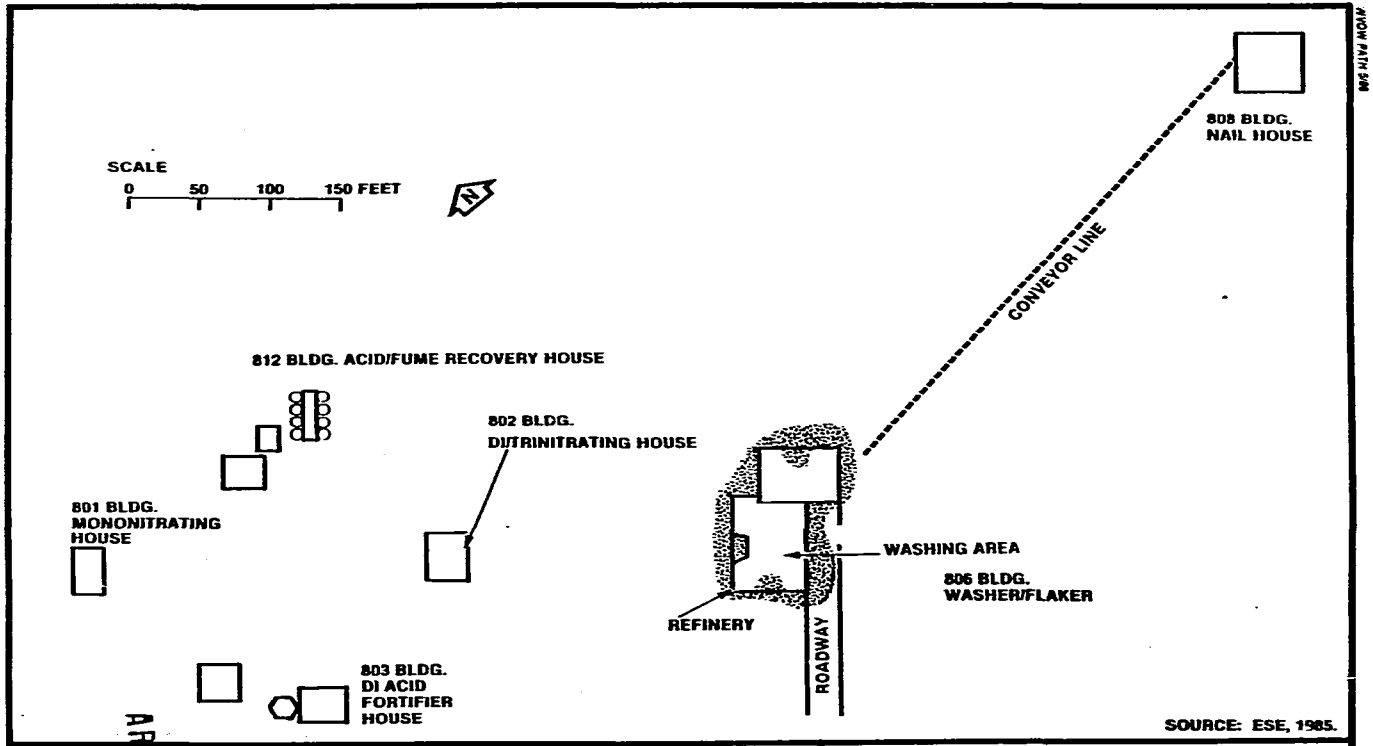

Figure 3.1-1
AREAS TO BE REMEDIATED FOR ALTERNATIVES 1A2, 1B2, 2A, 2B, 2C, AND 4A—TNT MANUFACTURING AREA (LINES 1-10)

WEST VIRGINIA ORDNANCE WORKS
Feasibility Survey

depth of 1.6 ft was assumed sufficient to achieve the 10^{-6} cleanup objective to remove contamination within the upper 2 ft. Assuming a 25-percent swell factor upon excavation, approximately 6,700 cubic yards (cy) of soil will be removed and incinerated offsite. Areas to be excavated are shown in Fig. 3.1-1.

Site Preparation--Mobilization operations associated with this alternative include:

1. Clearing and grubbing of heavy vegetation over an estimated 2.1 acres (0.21 acre per TNT line),
2. Performing a topographic survey of the contaminated area to document original elevations,
3. Installing trailers for decontamination and administration purposes,
4. Constructing access roads capable of supporting heavy equipment,
5. Constructing surface water controls, and
6. Extending utilities to these mobilized areas.

Access roads must be constructed to each building foundation to facilitate the movement of heavy earthmoving equipment. An estimated 3,500 linear ft of berms and/or swales will be constructed around the boundaries of contaminated areas to prevent surface water from entering or leaving the area during removal activities. Uncontaminated runoff will be routed around the area to existing drainageways. Onsite surface water will be channeled to collection points for evaporation and eventual offsite treatment (assuming significant runoff contamination). Ground water is not expected to be encountered during excavation because the uppermost aquifer is generally more than 15 ft below the land surface.

A decontamination station will be constructed to serve personnel, trucks, and equipment entering and leaving the contaminated areas. A concrete pad with a raised curb around the outer edges to collect rinsewaters is usually installed for this purpose. The decontamination sta

equipped with containers for disposal of contaminated personnel protective equipment, tubs and sprayers for personnel decontamination, a pressure washer for equipment and truck decontamination, and a pump to transfer spent washwater from the sump to a holding tank. The decontamination station will be centrally located to minimize the distance contaminated vehicles must travel onsite.

Implementation--Implementation of this alternative requires excavation of soil with a backhoe and/or other earthmoving equipment. Backhoes under normal operating conditions will achieve greater than 100 cubic yards per hour (cy/hr) production rate; however, to avoid overstockpiling contaminated materials, excavation will coincide with loading and offsite transport rates.

The soil will be transported to a staging area where front-end loaders place the soil into containers or load the soil directly into trucks. Trucks will transport the material to a RCRA-permitted commercial incinerator after manifest requirements are met. Contaminated soil will be transported in accordance with DOT regulations covering transport of hazardous materials.

Confirmatory sampling and analysis of soil will be required to provide adequate assurances that soil has been removed to meet soil criteria objectives.

Closure--Closure of the site involves backfilling the excavated areas to original elevations, including compaction, final grading, and revegetation. Temporary facilities will be removed following decontamination. All wastes from the decontamination of equipment and personnel will be collected and transported to a RCRA-permitted disposal facility.

Local soil imported from offsite will be used to backfill the excavated areas. Approximately 6,700 cy of backfill will be placed and compacted to minimize post-closure settlement. The top 1 ft of backfill will consist of topsoil to facilitate the establishment of vegetative cover. The fill will be graded to prevent ponding of surface water, and native grasses will be seeded and mulched to prevent erosion. Periodic post-closure inspection and maintenance of the revegetative areas and short-term land use restrictions will be required until the area is stable.

Special Conditions--The decision to accept this material by a commercial incineration facility is dependent on many factors. First, a waste profile sheet which gives detailed information on waste characteristics must be submitted to the facility. After reviewing this sheet, the commercial facility's management will decide if the waste is to be accepted and under what conditions.

One facility was identified which gave a "prescreening" acceptance of the waste, assuming nonreactivity. The facility, located approximately 750 mi from the WVOW site, is one of a few commercial incinerators capable of accepting the waste. One condition of acceptance is that the waste must be drummed. This condition, coupled with the long distance which vehicles must travel to deliver the waste, makes this alternative undesirable from a cost and safety standpoint.

A second factor to be considered is the availability of commercial incinerators at the time of actual cleanup. With increasing regulatory restrictions placed on the types of materials which can be landfilled, the demand for alternate disposal options will increase. This may result in a shortage of incinerator capacity in the near future, causing the offsite disposal of large volumes of soil to be infeasible.

3.1.1.2 Alternative 1B1

Alternative 1B1 for the TNT Manufacturing Area involves the remediation of soil surrounding the Washer/Flaker building foundations, di/trinitrating houses, acid/fume recovery houses, diacid fortifier houses, and nail houses. Soil will be excavated and transported to a RCRA-permitted offsite landfill for disposal.

The objective of this alternative is the complete removal of all nitroaromatic concentrations above detectable levels (i.e., >2 µg/g, using field analyses). The worst-case estimate for surficial contamination is approximately 46,000 ft^2 per TNT line, or 460,000 ft^2 total for the 10 lines located at the TNT Manufacturing Area. The location of this surficial contamination is shown in Fig. 3.1-2.

The excavation depth to achieve complete removal varies depending on the level of surficial contamination, due to the downward migration of various pollutant concentrations. Approximately 53,000 cy of contaminated soil must be excavated and landfilled offsite, assuming a 25-percent swell factor. Areas to be excavated are shown in Fig. 3.1-2.

The Washer/Flaker building foundations (approximately 27,000 ft^2) will be demolished, loaded into covered trucks, and transported to a sanitary landfill. These foundations must be removed to gain access to underlying soils. If necessary, the Washer/Flaker foundations will be decontaminated prior to offsite disposal using a hand-held flaming device. The contamination surrounding other foundations in the TNT Manufacturing Area, which was generally below 50 µg/g, was not considered high enough to justify foundation removal.

Site Preparation--Site preparation is the same as that described under TNT Manufacturing Area Alternative 1A2 except:

1. The area to be cleared is approximately 11 acres; and
2. An estimated 16,000 linear ft of berms and/or swales will be required to control surface runon/runoff.

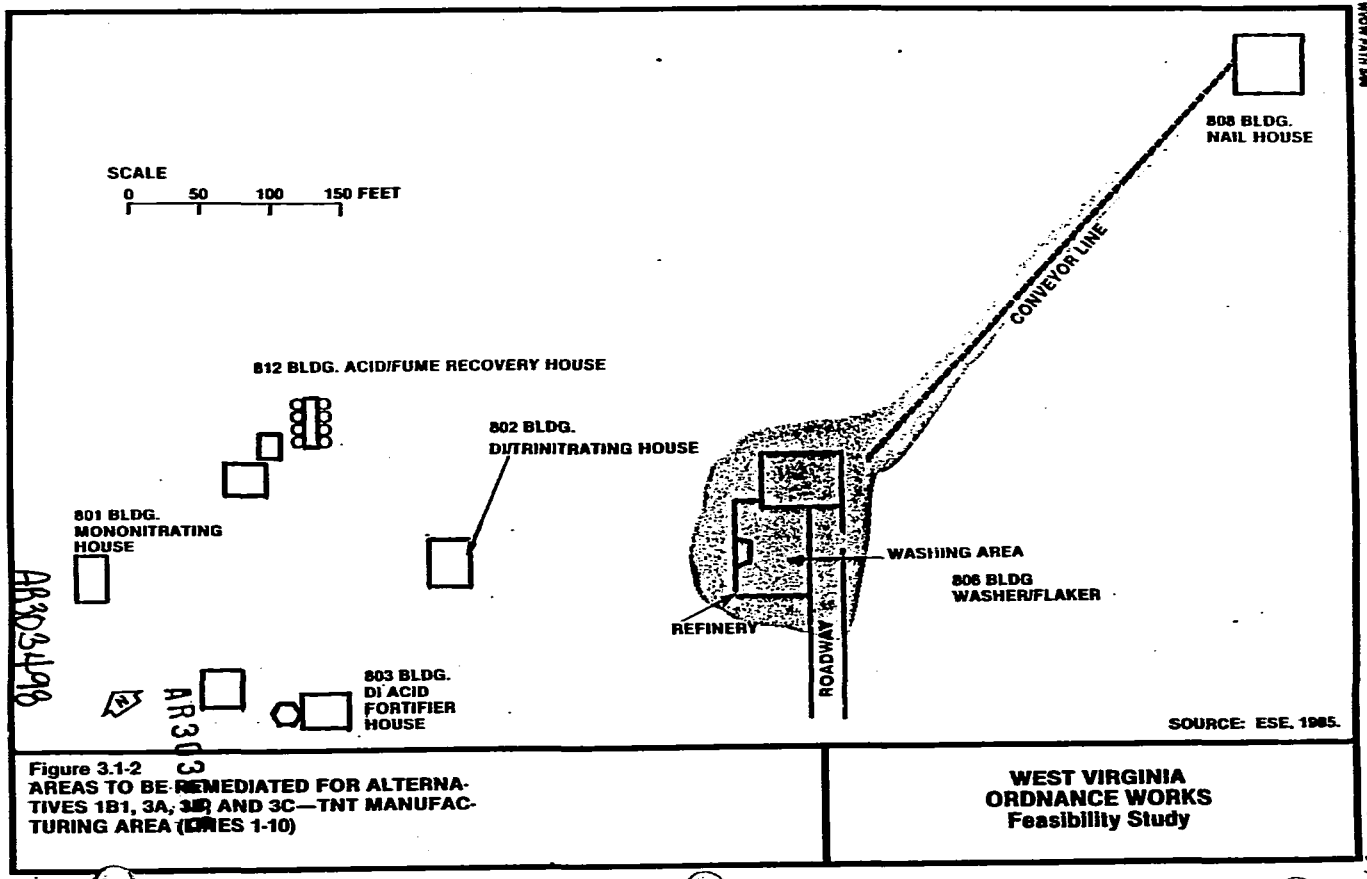

Figure 3.1-2
AREAS TO BE REMEDIATED FOR ALTERNATIVES 1B1, 3A, 3B AND 3C—TNT MANUFACTURING AREA (LINES 1-10)

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Implementation--Contaminated soil and foundations will be loaded from a staging area into covered trucks for offsite transport. Each truck will be decontaminated and its contents manifested before leaving the site. The nonreactive materials will be placed in double-lined, highly impermeable cells meeting the technical construction and operation requirements of RCRA. The landfill will also be EPA-approved for acceptance of CERCLA wastes.

Confirmatory sampling and analysis of soil will be required to provide assurances that soil has been removed to meet criteria objectives.

Closure--Closure and post-closure activities are the same as those described under TNT Manufacturing Area Alternative 1A2, except that 53,000 cy of backfill will be placed and compacted to minimize post-closure settlement.

Special Considerations--Before a commercial landfill will accept any nitroaromatics-contaminated soil, an analysis must be performed and a statement provided certifying that the material is nonreactive. One commercial landfill which gave a preliminary acceptance to the nonreactive soils was identified. The facility is under RCRA interim status and is located approximately 200 mi from the WVOW site. Contaminated soil can be accepted in bulk by this facility.

The disposal of contaminated soils into landfills over the next few years is questionable. Several regulatory "hammers" which may significantly limit the types of materials acceptable for land disposal are upcoming. As evidenced by the Hazardous and Solid Waste Amendments (HSWA) of 1984, the goal of the Federal hazardous waste management program is to reduce dependence on land disposal as a predominant management option.

3.1.1.3 Alternative 1B2

Alternative 1B2 for the TNT Manufacturing Area is the same as Alternative 1B1, except contaminated soil is removed to 10^{-6} risk levels. Approximately 6,700 cy of soil will be excavated and landfilled offsite. The depth of excavation will be approximately 2 ft of the areas shown in Fig. 3.1-1.

Site Preparation--Site preparation is the same as that described under TNT Manufacturing Area Alternative 1A2.

Implementation--Implementation is the same as that described under TNT Manufacturing Area Alternative 1B1.

Closure--Closure and post-closure activities are the same as those described under TNT Manufacturing Area Alternative 1A2.

Special Considerations--Special considerations are the same as those described under TNT Manufacturing Area Alternative 1B1.

3.1.2 ATTAINS REQUIREMENTS ALTERNATIVES

3.1.2.1 Alternative 2A

Alternative 2A for the TNT Manufacturing Area involves the remediation of contaminated soil surrounding Washer/Flaker building foundations. Soil will be excavated and transported to an onsite incinerator. The substantive requirements of RCRA for incineration of hazardous wastes will be achieved. No permits will be required for this onsite CERCLA remedial action as per 40 CFR Part 300, Vol. 50,No. 224, Nov. 20, 1985.

The objective of this alternative is the complete removal of all contaminated soil above 10^{-6} risk levels, as described in Alternative 1A2. The estimated volume of soil requiring remediation is 6,700 cy. Areas to be excavated are shown in Fig. 3.1-1.

Site Preparation--Site preparation is the same as for Alternative 1A2, except additional trailers will be used for incineration operations. Fencing must be constructed around the incinerator site to limit public access.

Implementation--A transportable rotary kiln incinerator will be set up at the TNT Manufacturing Area. The solids incinerator module consists of a trailer-mounted rotary kiln, solids preparation and charging equipment, a burner, an air blower, and an ash discharge system.

Contaminated soil will be trucked to a temporary storage area near the incinerator. From there it will be loaded into the incinerator feed hopper and fed to the incinerator at a rate between 1 and 4 tons per hour (tons/hr). Ash formed during incineration is discharged into the kiln end breeching, where it falls into an ash discharge chute. A water-cooled screw conveyor subsequently carries the ash to a storage bin, where it is sampled for potential contaminants before being used as backfill in excavated areas.

The incinerator will be equipped with an afterburner to ensure complete combustion of kiln off-gases. A constant afterburner temperature will be maintained with auxiliary fuel oil or fuel gas. A baghouse will be necessary to control release of particulate material and acidic gas products of combustion. Periodic sampling of stack gases will be necessary to ensure compliance with air quality restrictions.

Organic destruction efficiencies of greater than 99.99 percent will be maintained as required by RCRA. Extraction procedure (EP) toxicity testing for leachable metals in the ash will be necessary to determine whether or not disposal at a RCRA-permitted landfill will be required.

Closure--Upon completion of incineration operations, the incinerator will be decontaminated and removed. Wastes generated from decontamination activities will be collected and hauled to a RCRA-permitted landfill for disposal.

Ash from the incinerator will be used as backfill in the excavated areas. Fill material and topsoil will be brought in to fill gaps in the excavated areas and to facilitate proper contouring of the area. Native grasses will be seeded and mulched over the fill areas to assist in preventing erosion. Post-closure maintenance and inspection of these areas will be required.

Special Considerations--The characteristics of soils in the TNT Manufacturing Area must be evaluated prior to implementation to determine the operating conditions, including feed rate, for the incinerator. A vendor estimate of 4 cy/hr was used as an estimate for feed rate throughout this FS.

3.1.2.2 Alternative 2B

Alternative 2B is similar to Alternative 2A, except that the contaminated soil is landfilled onsite instead of being incinerated. Contaminated soil will be removed to 10^{-6} risk levels, as described in Alternative 1A2. Approximately 6,700 cy of soil will be excavated and landfilled onsite. Areas to be excavated to approximately a 2-ft depth are shown in Fig. 3.1-1. No permits for this onsite alternative will be required as per the NCP.

Site Preparation--Site preparation is the same as for Alternative 1A2, except an additional 1 to 2 acres must be cleared at the landfill site. The landfill site must be fenced to limit public access.

Implementation--The landfill will be designed and constructed to meet RCRA criteria, including a double-lined bottom and sides, double liners,

collection system, and double-lined cap. The landfill for the 6,700 cy of soil will cover approximately 0.5 acre. The landfill will be graded to minimize standing water and infiltration. Native grasses will be seeded and mulched to prevent erosion. Fencing will be placed around the landfill to limit public access.

Confirmatory sampling and analysis will be performed to provide assurance that contamination remaining in soils is below criteria. As the landfill is constructed, contaminated materials will be placed and compacted in 1-ft layers. Monitor wells will be installed around the landfill and ground water periodically analyzed in accordance with RCRA requirements. Permits are not required for the landfill because it represents an onsite CERCLA response action.

Closure--Closure will include the removal of all temporary facilities, post-closure sampling and analysis of ground water from monitor wells, and post-closure landfill cover maintenance. The site must be registered as a hazardous waste disposal facility with permanent land use restrictions. Soil which was excavated to construct the landfill will be used as backfill in the TNT Manufacturing Area and will be seeded with native grasses for stability.

Special Considerations--There are no special considerations for this alternative description.

3.1.2.3 Alternative 2C

Under Alternative 2C, a multimedia cap will be used to isolate contaminated areas (exceeding 50 ug/g total nitroaromatics) from direct contact. Contaminated foundations remain in place and are capped along with the soil. The estimated area to be capped is approximately 2 acres. No permits will be required for this onsite CERCLA response action as per the NCP.

Site Preparation--Site preparation is similar to that described for Alternative 1A2, except for the references to excavation.

Implementation--The design of multimedia caps at the TNT Manufacturing Area will conform to EPA's guidance under RCRA, which recommends a 3-layer system consisting of an upper vegetative layer underlain by a drainage layer over a low-permeability layer. The cap functions by diverting infiltrating liquids from the vegetative layer through the drainage layer away from underlying waste materials. Local soils will be used to construct the vegetative (topsoil) layer and the low-permeability clay layer. Gravel, crushed stone, or a synthetic material will be utilized for the drainage layer. A synthetic liner will be placed above the clay to ensure the cap's integrity.

The site will be compacted and graded to promote runoff from the finished cap. The top 1 ft of soil will be loosely compacted to promote revegetation. Native grasses will be seeded and mulched to prevent erosion.

Closure--Closure will involve maintaining the existing land use restrictions to protect the capped area, and installing ground water post-closure monitor wells as required under RCRA. Post-closure monitoring of the ground water is required for 30 years under RCRA.

Special Considerations--There are no special considerations for this alternative description.

3.1.3 EXCEEDS REQUIREMENTS ALTERNATIVES

3.1.3.1 Alternative 3A

Alternative 3A, Onsite Incineration, is identical to Alternative 2A except that contaminated soil is removed to below detectable levels. The areas to be excavated are presented in Fig. 3.1-1. Washer/Flaker foundations will be decontaminated if necessary by using a hand-held steam

device and disposed of in an offsite sanitary landfill. The total volume to be excavated and incinerated onsite is approximately 53,000 cy, as described in Alternative 1B1. No permits will be required for this onsite CERCLA response action as per the NCP.

Site Preparation--Site preparation will be the same as for Alternative 1B1. Additional trailers will be used for incineration, and the incinerator site must be fenced to limit public access.

Implementation--Implementation will be the same as for Alternative 2A, except that the time to implement will be much longer due to the increased quantity of soil to be processed.

Closure--Closure will be the same as for Alternative 2A.

Special Considerations--Special considerations will be the same as for Alternative 2A.

3.1.3.2 Alternative 3B

Alternative 3B, Onsite Landfilling, is the same as Alternative 2B except that contaminated soil is removed to below detectable levels. Contaminated foundations will also be removed, decontaminated with a hand-held flaming device if necessary, and disposed of in the onsite landfill. The total volume to be excavated and landfilled onsite is approximately 53,000 cy, as described in Alternative 1B1. No permits are required for this onsite CERCLA response action as per the NCP.

Site Preparation--Site preparation for this alternative is the same as for Alternative 1B1, except an additional 2 to 3 acres will be cleared for the landfill site.

Implementation--Implementation of this alternative will be the same as for Alternative 2B, except that the time to implement will be longer because of increased material volumes to be landfilled.

Closure--Closure will be the same as for Alternative 2B.

Special Considerations--There are no special considerations for this alternative description.

3.1.3.3 Alternative 3C

Alternative 3C, involving the use of a multimedia cap, is the same as Alternative 2C except that all areas with detectable nitroaromatics concentrations will be capped. The area to be capped is 11 acres (1.1 acre per TNT line), as shown in Fig. 3.1-2. No permits will be required for this onsite CERCLA response action as per the NCP.

Site Preparation--Site preparation is similar to that described for Alternative 1B1.

Implementation--The design considerations for the multimedia cap are the same as those described for Alternative 2C. The volume of onsite topsoil and clay required to construct the Exceeds Requirements multimedia cap will be significantly greater (5X) than for the Attains Standards cap.

Closure--Closure requirements are similar to those described under Alternative 2C.

Special Considerations--There are no special considerations for this alternative description.

3.1.4 CERCLA ALTERNATIVE

3.1.4.1 Alternative 4A

Alternative 4A involves soil cover which will be placed over all contaminated areas exceeding 50 ug/g total nitroaromatics to isolate the contaminants from direct contact. Contaminated foundations remain in place and are capped with the soil. The estimated area to be capped is 2.0 acres, as shown in Fig. 3.1-1. No permits are required for this onsite CERCLA response action as per the NCP.

Site Preparation--Site preparation is the same as that described under Alternative 1A2, except for the references to the trailers and utilities required for mobilization.

Implementation--Onsite soils will be used to construct a soil cover over contaminated areas. The thickness of the cover will be a minimum of 2 ft.

The site will be compacted and graded to promote runoff from the finished cover. Native grasses will be seeded and mulched to prevent erosion. Fig. 3.1-3 shows a comparison of the soil cover with the multimedia cap described under TNT Alternatives 2C and 3C.

Closure--Closure will involve maintaining existing wildlife station land use restrictions, post-closure inspection, and maintaining the cover.

Special Considerations--There are no special considerations for this alternative description.

3.1.5 NO ACTION ALTERNATIVE

3.1.5.1 Alternative 5A

Under Alternative 5A, no remedial actions will be implemented at the TNT Manufacturing Area. This alternative will not improve site conditions nor will it mitigate the migration of site contaminants. This alternative has been included to establish a present site condition baseline. Alternative 5A is not classified in the NCP as either a source control or a management of migration remedy. The baseline conditions are as stated in the WVOW RI report (ESE, 1986a) and the WVOW EA (ESE, 1986b).

Alternative 5A includes a long-term monitoring program to provide information on the extent of contamination migration as a function of time. The monitoring program includes sampling and analysis of ground

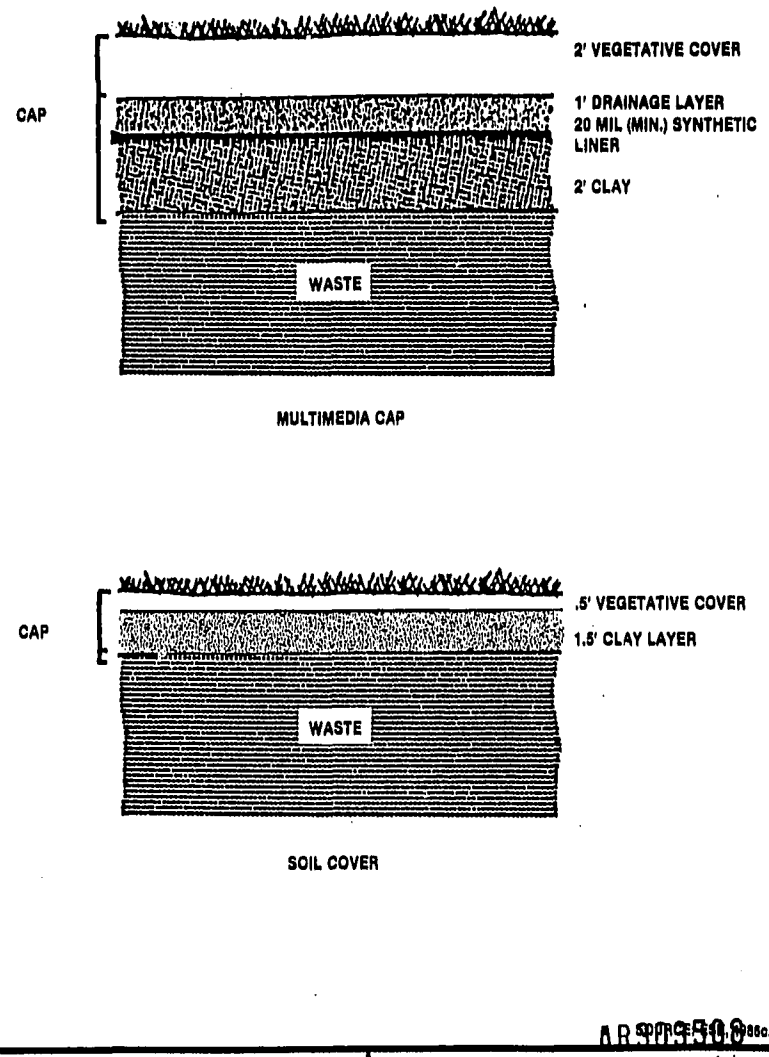

Figure 3.1-3
COMPARISON OF THE MULTIMEDIA CAP (2C, 3C ALTERNATIVES) TO THE SOIL COVER (4A ALTERNATIVES)

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water, surface water, and seeps. Existing onsite monitor wells can continue to be used to monitor any possible future migration of contamination past the installation boundary toward potential human or environmental receptors.

This alternative does not address the public health and environmental considerations, but it does provide a means to identify future problems; it can be implemented easily, and no capital costs and low O&M costs are required.

3.2 BURNING GROUNDS AREA ALTERNATIVES

3.2.1 OFFSITE DISPOSAL ALTERNATIVES

3.2.1.1 Alternative 1A2

Alternative 1A2 for the East and West Burning Grounds Area involves the excavation, transportation, and offsite incineration of contaminated soil. Asbestos and rubble scattered in these areas will be disposed of at an offsite sanitary landfill. TNT residue (chunks) will receive *in situ* flaming prior to offsite disposal.

The objective of this alternative is complete removal of contaminated soil to the 10^{-6} risk levels. To achieve a 10^{-6} risk level for soils in the Burning Grounds Area, the following remedial objectives were established by the WVOW EA (ESE, 1986b) for the source areas:

1. Remove, or render nonreactive, all reactive wastes;
2. Remove or cover the upper 2 ft of soil if total nitroaromatic contamination exceeds 500 µg/g; and
3. Remove or cover the upper 6 inches of soil if total nitroaromatic contamination exceeds 50 µg/g.

The estimated surficial contamination in the East and West Burning Grounds is 15,200 ft^2 and 33,780 ft^2, respectively. The locations of the contaminated soils in each area are shown in Figs. 3.2-1 and 3.2-2, respectively.

In both the East and West Burning Grounds, contaminants were consistently below 500 µg/g in both areas at a depth of 50 cm (approximately 1.6 ft). Therefore, excavation to a depth of approximately 1.6 ft in both areas is assumed sufficient to achieve the 10^{-6} cleanup objective (removal of all soil that exceeds a 500-µg/g nitroaromatics concentration within the upper 2 ft). At these depths of excavation, approximately 900 cy and 2,000 cy, respectively, must be excavated from the East and West Burning Grounds, respectively. Assuming a swell factor of 25 percent, approximately 3,625 cy of contaminated soil will be excavated and offsite incinerated.

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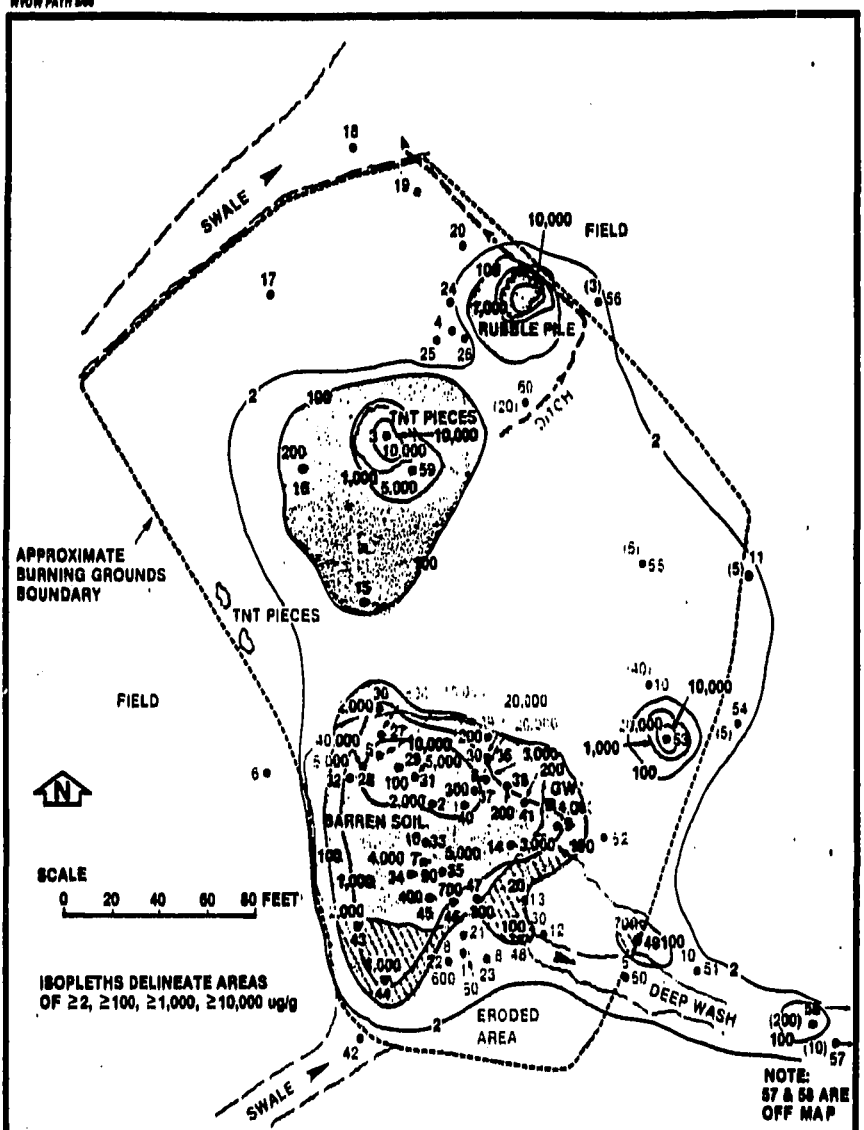
WVOW PATH 5400



ALL CONCENTRATIONS ARE TOTAL NITROAROMATICS IN ug/g DRY WT.

SOURCE: ESE, 1985.

Figure 3.2-1
AREAS TO BE REMEDIATED FOR ALTERNATIVES 1A2, 1B2, 2A, 2B, 2C, AND 4A—EAST BURNING GROUNDS

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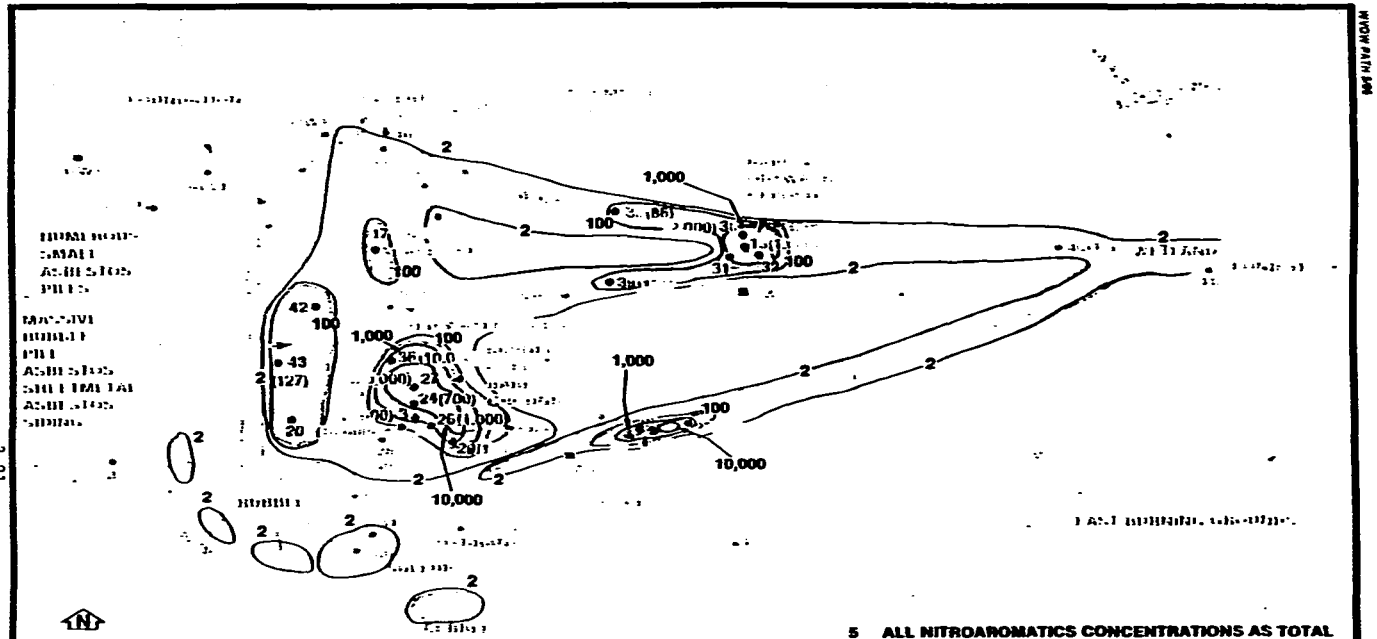

Figure 3.2-2
AREAS TO BE REMEDIATED FOR ALTERNATIVES 1A2, 1B2, 2A, 2B, 2C, AND 4A—WEST BURNING GROUNDS

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ORIGINAL
(Red)

Site Preparation--Mobilization operations associated with this alternative include:

1. Clearing and grubbing an estimated 2 acres,
2. Topographic surveying of the contaminated area,
3. Installation of trailers for decontamination and administrative purposes,
4. Construction of surface water controls, and
5. Extension of utilities to mobilized areas.

Access roads to the Burning Grounds Area will be constructed from a nearby existing gravel roadway.

Approximately 3,500 linear ft of berms and swales will be constructed around the boundaries of contaminated areas to prevent sheet runoff from entering or leaving the site during removal activities. Uncontaminated offsite water will be routed around the site to existing drainageways.

A decontamination station will be constructed to serve personnel, trucks, and equipment entering and leaving the site. The decontamination station will be similar to that described for TNT Manufacturing Area Alternative 1A2.

Implementation--Implementation of contaminated soil removal requires excavation with a backhoe and other earthmoving equipment. Extensive regrading and backfilling of heavily eroded areas will allow the safe movement of heavy equipment throughout the site. Contaminated soil will be loaded into trucks at a central staging area for offsite transport. Trucks will transport the soil to a RCRA-permitted commercial incinerator after manifest requirements are met. Contaminated soil and water (runoff) will be transported in accordance with DOT regulations covering the transport of hazardous materials. Trucks will be decontaminated before leaving the site. Confirmatory sampling and analysis of soil will be required to ensure that soil has been removed to meet the ID-6 action level.

Asbestos and rubble will be loaded into trucks for transportation to a sanitary landfill. Asbestos will be double-bagged to preclude the release of fibers during transport and landfilling. Federal requirements and specific landfill requirements for asbestos packaging, transport, and burial will also be achieved.

In situ flaming will be required for all TNT residue at these sites. Flaming entails the use of a hand-held flamer to thermally decontaminate surface contaminants. It is anticipated that complete decomposition of all potentially reactive residues that are at or near the flame front can be accomplished because of the intensity of the heat. This technique has been used successfully in the decontamination of structures at Frankford Arsenal (EPA, 1985b).

Closure--Closure for this alternative involves backfilling of the excavated areas, compaction, final grading, and revegetation. All wastes from decontamination of equipment and personnel will be collected and transported to a RCRA-permitted disposal facility. Approximately 3,420 cy of local soil imported from offsite will be placed and compacted in 1-ft layers to minimize any post-closure settlement. The top 1 ft of backfill will be loosely compacted topsoil to facilitate the establishment of vegetative cover. Native grasses will be seeded and mulched to prevent erosion.

Special Considerations--The special considerations discussed under TNT Manufacturing Area Alternative 1A2 are also applicable to this alternative. In addition, all reactive materials must be rendered nonreactive before they will be accepted by the offsite incineration facility. In situ flaming will ensure that excavated materials are acceptable for offsite incineration.

3.2.1.2 Alternative 1B1

Alternative 1B1 for the East and West Burning Grounds Area involves the offsite disposal of contaminated soil in a RCRA-permitted offsite landfill. Asbestos and rubble scattered in these areas will be disposed of at an offsite sanitary landfill. TNT residue will receive in situ flaming prior to offsite disposal.

The objective of this alternative is the complete removal of all nitroaromatics concentrations above detectable levels (>2 µg/g). The estimated surficial contamination for the East and West Burning Grounds is 41,250 and 125,300 ft^2, respectively, as shown in Figs. 3.2-3 and 3.2-4, respectively.

The excavation depth to achieve complete removal varies depending on the level of surficial contamination. An estimated 16,900 cy of contaminated soil will be excavated and landfilled offsite, assuming a 25-percent swell factor.

Site Preparation--Site preparation is the same as that described under Alternative 1A2, except approximately 4 acres will be cleared and grubbed.

Implementation--Implementation is the same as that described for TNT Manufacturing Area Alternative 1B1. In addition, in situ flaming of TNT residue will be accomplished prior to excavation of the soils.

Closure--Closure and post-closure activities are the same as those described under Alternative 1A2, except that 16,900 cy of backfill is required.

Special Considerations--The special considerations discussed under TNT Manufacturing Area Alternative 1B1 are also applicable to this alternative.

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(Red)

WVOW PATH 500

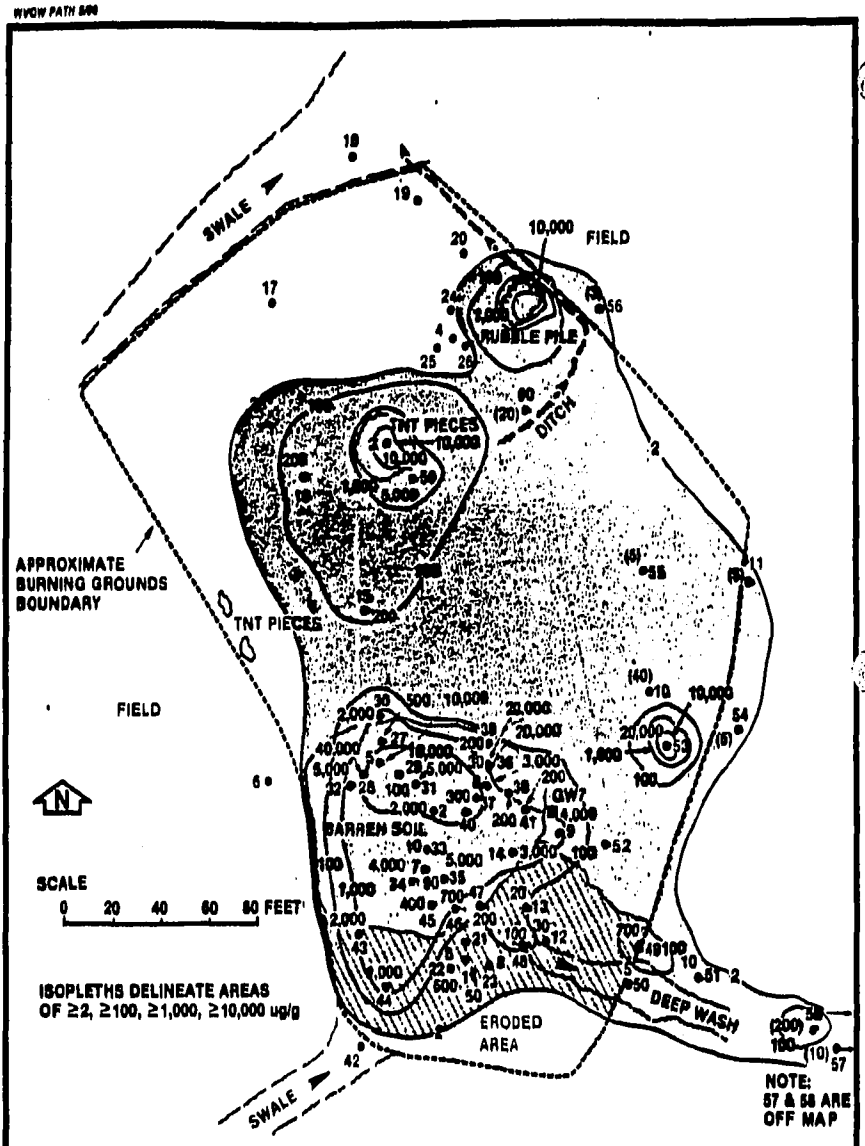

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Figure 3.2-3
AREAS TO BE REMEDIATED FOR ALTERNATIVES 1B1, 3A, 3B, AND 3C—EAST BURNING GROUNDS

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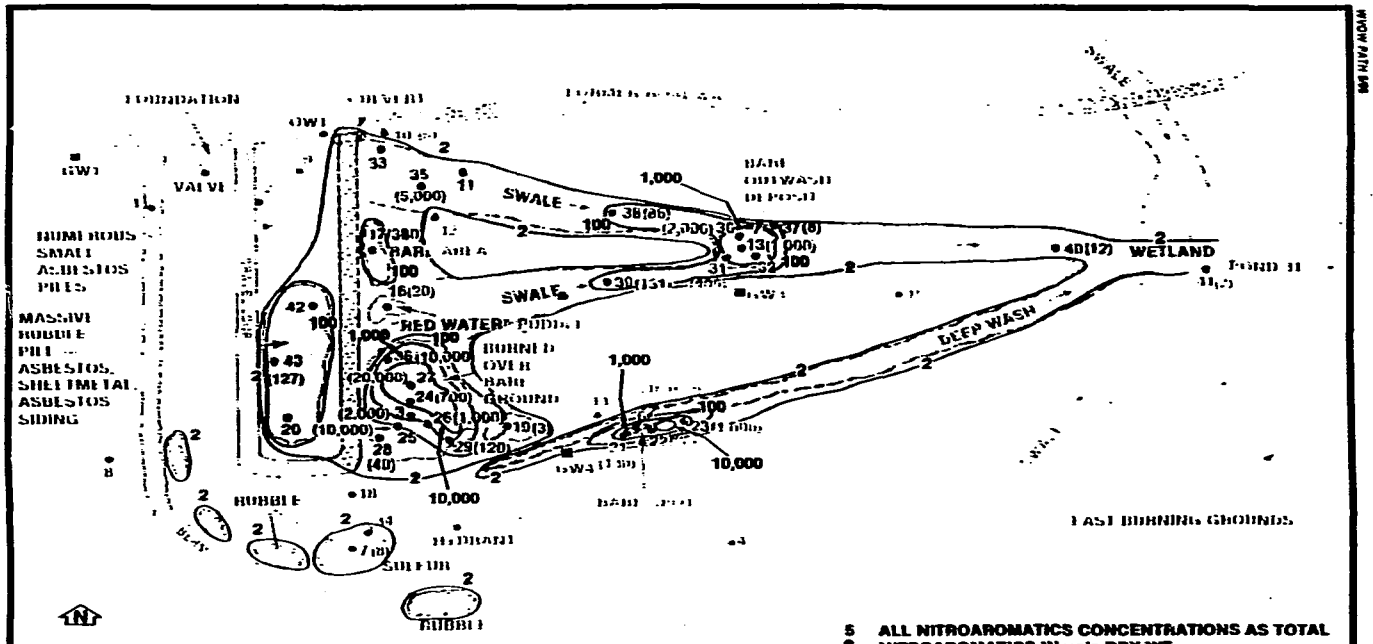

Figure 3.2-4
AREAS TO BE REMEDIATED FOR ALTERNATIVES 1B1, 3A, 3B, AND 3C—WEST BURNING GROUNDS

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Reactive materials cannot be landfilled. TNT residue at the Burning Grounds Area must be thermally treated prior to disposal in a landfill. The use of in situ flaming for the TNT residue will help ensure that all excavated materials can be accepted by the offsite facility.

3.2.1.3 Alternative 1B2

Alternative 1B2 for the East and West Burning Grounds Area is the same as for Alternative 1B1, except contaminated soil is excavated and removed to the 10^{-6} risk level. The locations of the areas to be excavated in each area are shown in Figs. 3.2-1 and 3.2-2, respectively. The depth of excavation is approximately 2 ft in both areas, resulting in a 3,625-cy volume of soil to be disposed of in an offsite landfill.

Site Preparation--Site preparation is the same as that described under Alternative 1A2.

Implementation--Implementation will be the same as that described for TNT Manufacturing Area Alternative 1B1. In situ flaming of TNT residue will be accomplished prior to excavation of the soils.

Closure--Closure and post-closure activities are the same as those described for Alternative 1A2.

Special Considerations--The special considerations are the same as those discussed for TNT Manufacturing Area Alternative 1B1. The treatment and disposal of TNT residue are the same as discussed for Alternative 1B1.

3.2.2 ATTAINS REQUIREMENTS ALTERNATIVES

3.2.2.1 Alternative 2A

Alternative 2A for the Burning Grounds Area involves the excavation and onsite incineration of contaminated soil. Asbestos and rubble will be disposed of in an onsite sanitary landfill. TNT residue will be in situ flamed prior to soil excavation. The substantive requirements of RCRA

for incineration of hazardous wastes will be achieved. However, no permits will be required for this onsite CERCLA response action as per the NCP.

The objective of this alternative is the complete removal of all contaminated soil above 10^{-6} risk levels, as described in Alternative 1A2. To accomplish this objective, approximately 3,625 cy of soil must be excavated and incinerated. Areas to be excavated are shown in Fig. 3.2-1 for the East Burning Grounds and Fig. 3.2-2 for the West Burning Grounds.

Site Preparation--Site preparation under this alternative is the same as for Alternative 1A2.

Implementation--The construction and operation of a transportable rotary kiln incinerator is discussed under TNT Manufacturing Area Alternative 2A. The asbestos and rubble will be loaded into trucks for transportation to a sanitary landfill. Asbestos will be double-bagged to preclude the release of fibers during transport and landfilling. Federal requirements and specific landfill requirements for asbestos packaging, transport, and burial will also be achieved.

TNT residue will be excavated along with the soil and incinerated. It is anticipated that complete destruction of all nitroaromatics contaminants will be accomplished in the incinerator (99.99-percent destruction efficiency).

Closure--Closure of the onsite incinerator is discussed under TNT Manufacturing Area Alternative 2A.

Special Considerations--The special considerations discussed under TNT Manufacturing Area Alternative 2A are applicable to this alternative.

3.2.2.2 Alternative 2B

This alternative consists of excavation and onsite landfilling of contaminated soil. Prior to landfilling, all TNT residue at the site will be thermally treated by in situ flaming. Asbestos and rubble will be disposed of in the onsite landfill along with contaminated soils. To accomplish the alternative objectives, approximately 3,625 cy of soil must be removed and landfilled. Areas to be excavated are shown in Fig. 3.2-1 for the East Burning Grounds and Fig. 3.2-2 for the West Burning Grounds. No permits are required for this onsite CERCLA response action as per the NCP.

Site Preparation--Site preparation under this alternative is the same as for Alternative 1A2. Approximately 1 to 2 additional acres must be cleared and graded for the construction of the onsite landfill.

Implementation--Implementation of the onsite landfill at the Burning Grounds Area is similar to that described under TNT Manufacturing Area Alternative 2B, except for material quantities. The Burning Grounds Area offers an exceptional location for the placement of a landfill because the thick clay layer at the site provides a natural, impermeable barrier to the migration of pollutants.

Closure--Closure of the landfill is the same as for TNT Manufacturing Area Alternative 2B.

Special Considerations--No special considerations are applicable to this alternative.

3.2.2.3 Alternative 2C

This alternative involves the placement of a multimedia cap over all areas where surficial contamination exceeds 50 µg/g total nitroaromatics. Prior to capping, rubble and asbestos will be removed and hauled to offsite sanitary landfill. TNT residue will be in situ flamed prior to

capping. The estimated area to be capped is approximately 2 acres. Areas to be capped are shown in Fig. 3.2-1 for the East Burning Grounds and Fig. 3.2-2 for the West Burning Grounds. Permits are not required for this onsite CERCLA response action as per the NCP.

Site Preparation--Site preparation for this alternative is similar to that described for Alternative 1A2. Extensive backfilling and grading of swales and eroded areas are required to provide a level surface for cap placement.

Implementation--Implementation of the multimedia cap at the Burning Grounds Area is the same as TNT Manufacturing Area Alternative 2C. In addition, *in situ* flaming will be used to decompose TNT residue, and asbestos/rubble will be disposed of offsite in a sanitary landfill prior to the installation of the cap.

Closure--Closure of the cap is the same as for TNT Manufacturing Area Alternative 2C.

Special Considerations--A significant amount of soil erosion can occur during heavy storms. Drainage ditches or berms will be installed upgradient of the capped areas to divert stormwater around the site. Frequent inspection and maintenance of the cap will be required until vegetative growth can provide adequate support against excessive erosion.

3.2.3 EXCEEDS REQUIREMENTS ALTERNATIVES

3.2.3.1 Alternative 3A

Alternative 3A, Onsite Incineration, is identical to Burning Grounds Area Alternative 2A except that the contaminated soil is removed to below detectable levels. Areas to be excavated are presented in Figs. 3.2-3 (East Burning Grounds) and 3.2-4 (West Burning Grounds). The total volume of material to be excavated and incinerated onsite is approximately 16,900 cy, as described in Alternative 1B1. Rubble and

asbestos will be removed and disposed of in an offsite landfill prior to excavation of soils. Permits are not required for this onsite CERCLA response action as per the NCP.

Site Preparation--Site preparation is the same as that described under Alternative 1A2. Additional trailers are required for incineration, and the incinerator site must be fenced to limit public access.

Implementation--The construction and operation of the incinerator is discussed under TNT Manufacturing Area Alternative 2A. TNT residue will be incinerated with the soil. Asbestos and rubble will be transported offsite and disposed of in a sanitary landfill.

Closure--Closure of the onsite incinerator is discussed under TNT Manufacturing Area Alternative 2A.

Special Considerations--Special considerations for the onsite incinerator are discussed under TNT Manufacturing Area Alternative 2A.

3.2.3.2 Alternative 3B

Alternative 3B, Onsite Landfilling, is the same as Alternative 2B, except that contaminated soil is removed to below detectable levels. The total volume to be excavated and disposed of in an onsite landfill is approximately 16,900 cy. Asbestos and rubble are disposed of in an offsite sanitary landfill. TNT residue will be in situ flamed and subsequently disposed of in an onsite landfill with the excavated soils. Permits are not required for this onsite CERCLA response action as per the NCP.

Site Preparation--Site preparation for this alternative is the same as for Alternative 1A2. An additional 1 to 2 acres must be cleared for the construction of the landfill.

Implementation--Implementation of this alternative will be the same as for Alternative 2B except that the time to implement will be longer because a significantly larger amount of material must be landfilled.

Closure--Closure will be the same as for TNT Manufacturing Area Alternative 2B.

Special Considerations--No special considerations are applicable to this alternative.

3.2.3.3 Alternative 3C

Alternative 3C, involving the use of a multimedia cap, is the same as for Alternative 2C except that all areas with detectable nitroaromatics concentrations will be capped. The area to be capped, which is estimated to be 4 acres, is shown in Fig. 3.2-3 for the East Burning Grounds and Fig. 3.2-4 for the West Burning Grounds. TNT residue will receive in situ flaming prior to the installation of the cap. Asbestos and rubble will be disposed of in an offsite sanitary landfill. Permits are not required for this onsite CERCLA response action as per the NCP.

Site Preparation--Site preparation is similar to that described for Alternative 1A2. In addition, extensive backfilling and grading of eroded areas are required to provide a flat surface for capping.

Implementation--Design considerations for the multimedia cap are the same as for TNT Manufacturing Area Alternative 2C. Rubble and asbestos will be removed and TNT residue will be flamed prior to capping.

Closure--Closure requirements are the same as those described under TNT Manufacturing Area Alternative 2C.

Special Considerations--Special considerations are the same for Alternative 2C.

3.2.4 CERCLA ALTERNATIVE

3.2.4.1 Alternative 4A

Under Alternative 4A, soil cover will be placed over all areas where contamination exceeds 50 µg/g total nitroaromatics. The estimated area to be covered, approximately 2 acres, is shown in Fig. 3.2-1 for the East Burning Grounds and Fig. 3.2-2 for the West Burning Grounds. Permits are not required for this onsite CERCLA response action as per the NCP.

Site Preparation--Site preparation for this alternative is similar to that described for Alternative 1A2. Extensive backfilling and grading of eroded areas are required to provide a flat area for the cover.

Implementation--Onsite soils will be used to construct a soil cover over contaminated areas. The thickness of the cover will be a minimum of 2 ft. The cover will consist of two layers--an upper vegetative layer (topsoil) and a low-permeability clay layer (see Fig. 3.1-3).

The site will be compacted and graded to promote runoff from the finished cover. Native grasses will be seeded and mulched to prevent erosion.

Asbestos and rubble will be disposed of at an offsite sanitary landfill. TNT residue will receive in situ flaming prior to capping.

Closure--Closure will involve maintaining existing wildlife station land use restrictions, post-closure inspection, and maintaining the cover.

Special Considerations--Frequent inspection and maintenance of the cover will be required until vegetative growth can provide adequate stability and protection against erosion.

3.2.5 NO ACTION ALTERNATIVE

3.2.5.1 Alternative 5A

Under Alternative 5A, no remedial actions will be implemented at the Burning Grounds Area; however, a long-term monitoring program to provide

information on the extent of contaminant migration as a function of time will be implemented. The monitoring program includes sampling and analysis of ground and surface waters. Existing onsite monitor wells will continue to be used to monitor any increase or decrease in contaminant concentrations, or to indicate a status quo in the contaminant concentrations indicating that conditions have reached steady-state at the site.

This alternative does not address the public health and environmental considerations, but it does provide a means to identify future problems; it can be implemented easily, and no capital cost and low O&M costs are required.

3.3 INDUSTRIAL SEWERLINE ALTERNATIVES

3.3.1 OFFSITE DISPOSAL ALTERNATIVES

No offsite disposal option exists based on the reactive nature of the Industrial Sewerlines. Current Federal regulations ban the landfilling of reactive wastes, and no offsite incinerator facility was located that could accept these wastes.

3.3.2 ATTAINS REQUIREMENTS ALTERNATIVES

3.3.2.1 Alternative 2A

Alternative 2A for the Industrial Sewerlines involves excavation and onsite incineration of all sewerlines. The contaminated soil surrounding the sewerlines will be left in place or immediately backfilled into the trench once the sewerlines are removed, provided that the contaminated soil is more than 2 ft below the land surface. Afterward, clean fill will be placed over the contaminated soils in the trench to effectively isolate the soil from direct contact.

To achieve this remedial objective, approximately 680 cy of contaminated sewerlines will be removed and incinerated. An additional 18,000 cy of uncontaminated soil excavation will be necessary to gain access to the sewerlines.

The substantive requirements of RCRA for incineration of hazardous wastes will be achieved. No permits will be required for this onsite CERCLA remedial action, as per the NCP.

Site Preparation--Mobilization operations associated with this alternative include:

1. Clearing and grubbing of heavy vegetation over an estimated 17 acres, assuming a 30-ft corridor along the sewerlines for equipment workspace;
2. Installation of trailers for decontamination and administrative purposes;

3. Construction of access roads for heavy equipment;
4. Surface water controls; and
5. Extension of utilities to these mobilized areas.

Berms will be constructed to divert oncoming runoff around excavated areas during removal activities. A decontamination station will be constructed to serve personnel, trucks, and equipment entering and leaving the site. The station will be similar to that described under TNT Manufacturing Area Alternative 1A2.

Implementation--Excavation of contaminated sewerlines will be accomplished using two backhoes operating in tandem. The first backhoe will perform nonhazardous excavation to the contaminated sewerlines. The second backhoe will excavate contaminated sewerlines. A bulldozer will backfill the trench immediately ahead of the second backhoe in order to provide a working bench. Additional backfill may be necessary to completely fill the trench. The use of two backhoes in this manner will minimize any cross-contamination between contaminated media and uncontaminated soil which is used as backfill.

For safety purposes, the sewerlines may be wetted to reduce the potential for detonation from impact or confinement. Testwork and material evaluation will be required to establish the percent moisture needed to effect excavation and reliable conveyance of the materials. Blast shields will be employed during excavation.

Contaminated soil removed from the trench will be returned to the trench at locations that are greater than 2 ft below the land surface and covered with clean backfill.

Special precautions will be used in the handling, transport, and loading of reactive materials into the incinerator. If wetting or blending the materials is used to reduce the potential for detonation, these factors

must be accounted for in the rotary kiln design and operating parameters. The water must be evaporated in the kiln, resulting in an additional heat requirement.

The construction and operating requirements for the kiln are described under TNT Manufacturing Area Alternative 2A. The sewerline material will be burned separately from any unreactive contaminated soil in accordance with RCRA requirements [264.34(b)(iv)]. In addition, organic destruction efficiencies of greater than 99.99 percent will be maintained. No permits are required for implementation of this alternative. Nonhazardous ash, as defined by EP toxicity testing for leachable metals, will be used as backfill.

Closure--Closure of the remedial activities for this alternative involves backfilling of the excavated areas, compaction, final regrading, and revegetation. Open manholes will also be backfilled for safety reasons. All wastes from decontamination of equipment and personnel will be collected and transported to a RCRA-permitted disposal facility. The top 1 ft of backfill will be loosely compacted topsoil to facilitate the establishment of vegetative cover. Maintenance of revegetated areas is the only post-closure activity predicted for this alternative. At closure, the incinerator will be decontaminated and removed from the site.

Special Considerations--One company which specializes in transportable, rotary kiln incinerators showed an interest in using its equipment for the incineration of potentially reactive sewerlines. Nevertheless, onsite incineration of this material may prove very difficult and/or costly due to the potential for explosion as reactives are exposed to high temperatures.

3.3.2.2 Alternative 2B

Alternative 2B for the Industrial Sewerlines is similar to Alternative 2A except that sewerlines are landfilled onsite instead of incinerated

onsite. Prior to landfilling, the sewerline material is thermally treated by flashing. Approximately 680 cy of sewerline material will be flashed and subsequently landfilled. No permits will be required for the landfill or flashing device, as per the NCP.

Site Preparation--Site preparation for this alternative is the same as for Alternative 2A.

Implementation--Excavation will be the same as described for Alternative 2A. Contaminated soil removed from the trench will be returned to the trench 2 ft below the land surface and covered with clean backfill.

Flashing involves the use of a controlled, high-temperature flame to thermally degrade all contaminants. Flashing provides complete and rapid destruction of all residues contacted by the flame (Battelle, 1983).

Once the sewerlines are brought to the surface, they will be wetted with water to desensitize explosive residues toward impact. Water containing dissolved and/or suspended explosives will be retained and treated as necessary. After the sewerlines are wetted, the sewerline pipes will be mechanically fractured and the explosive residue will be separated from the pipe. The residue will be placed in a remotely operated flashing device which will expose all residue to the flame front. Because of the high temperature of the flame, there should be rapid decomposition of all explosive residues present. Occasional turning of the materials may be required to expose all reactives to the flame.

After flashing, confirmatory sampling will be used to ensure that destruction of explosive residues is achieved. The ash from the flashing device will be placed in an onsite landfill, along with the contaminated sewerline pipe and small volumes of soil attached to the

Construction and operating requirements for the landfill are described under TNT Manufacturing Area Alternative 2B. Clean backfill placed over trenched areas will be seeded and mulched to promote revegetation and prevent erosion.

Closure--Closure of this alternative is similar to that described under Alternative 2A. The landfill will be registered as a hazardous waste disposal facility with permanent land use restrictions. Post-closure maintenance of the landfill involves landfill cover maintenance and post-closure monitoring of the ground water.

Special Considerations--The design of the flashing device could be modeled after a Rockwell International® flamer used for sewerline decontamination at Alabama Army Ammunition Plant (AAAP) (Rockwell, 1981). The determination of explosive concentrations of the residue is required to optimize the dwell time of the flamer (Battelle, 1983).

3.3.3 EXCEEDS REQUIREMENTS ALTERNATIVES

3.3.3.1 Alternative 3A

Alternative 3A, Onsite Incineration, is identical to Alternative 2A except that soils beneath sewerlines are removed to below detectable contaminant concentrations. To achieve this remedial objective, approximately 680 cy of contaminated sewerlines and 29,000 cy of contaminated soil must be excavated and incinerated. No permits are required for this onsite CERCLA alternative, as per the NCP.

Site Preparation--Site preparation is the same as described for Alternative 2A.

Implementation--The excavation and loading activities under this alternative are similar to those described for Alternative 2A. The operation of the incinerator is described under TNT Manufacturing Area Alternative 2A.

Closure--Closure of this alternative is the same as described for Alternative 2A. At closure, the incinerator will be decontaminated and removed from the site.

Special Considerations--Special considerations of this alternative are the same as described for Alternative 2A.

3.3.3.2 Alternative 3B

Alternative 3B, Onsite Landfilling, is the same as Alternative 2B except that soils beneath sewerlines are removed to below detectable contaminant concentrations. Approximately 680 cy of sewerlines and 29,000 cy of contaminated soil must be landfilled to meet the objectives of this alternative. No permits are required for this onsite CERCLA response action as per the NCP.

Site Preparation--Site preparation is the same as described for Alternative 2A.

Implementation--Excavation and transport of contaminated materials are the same as described for Alternative 2A. The reactive material found in sewerlines will require flashing prior to landfilling; however, soils under the sewerlines are not unreactive and, therefore, will be landfilled directly. The landfill will be constructed and operated according to RCRA requirements, as described under TNT Manufacturing Area Alternative 2B.

Closure--Closure of this alternative is similar to that described for Alternative 2A. The landfill will be registered as a hazardous waste disposal facility with permanent land use restrictions.

Special Considerations--The special considerations for this alternative are the same as described for Alternative 2B.

3.3.4 CERCLA ALTERNATIVE

3.3.4.1 Alternative 4A

CERCLA Alternative 4A involves excavation and flashing of the sewerlines, followed by backfilling the trench with resulting nonreactive burned materials. The products of burning will be placed in the trench a minimum of 2 ft below the land surface. Clean backfill will be placed over the contaminated materials to prevent direct contact. The estimated quantity of sewerlines to be burned is 680 cy. No permits will be required for this CERCLA response action, as per the NCP.

Site Preparation--Site preparation is the same as that described for Alternative 2A.

Implementation--The excavation and loading operations will be the same as those described for Alternative 2A. Sewerlines will be burned by a remotely operated flamer, as described in Alternative 2B. After burning, confirmatory sampling and analysis will ensure that materials have been adequately treated to be returned to the trench.

Closure--Closure of this alternative is the same as that described for Alternative 2A.

Special Considerations--The special considerations for the flamer are the same as those described under Alternative 2B.

3.3.5 NO ACTION ALTERNATIVE

3.3.5.1 Alternative 5A

Under Alternative 5A, no remedial actions will be implemented for the industrial sewerlines and soils beneath the sewerlines at WVOW; however, a long-term monitoring program to provide information on the extent of contaminant migration as a function of time will be implemented. The monitoring program includes sampling and analysis of ground water from existing onsite monitor wells to detect changes in contaminant

concentrations or a status quo in the contaminant concentrations indicating that conditions have reached a steady-state at the site.

This alternative does not address the public health and environmental considerations, but it does provide a means to identify future problems; it can be implemented easily, and no capital cost and low O&M costs are required.

4.0 ANALYSIS OF REMEDIAL ACTION ALTERNATIVES

In accordance with Sec. 300.68(i) of the NCP, a detailed analysis of the remedial action alternatives discussed in Sec. 3.0 was performed and is presented by remedial action category in this section. This detailed evaluation includes technical, environmental, institutional, public health, and cost analyses based on the information presented in Tables 4.0-1 through 4.0-3 for each area of concern. The evaluation was performed using EPA's Guidance Document For Feasibility Studies Under CERCLA (EPA, 1985a).

4.1 TECHNICAL ANALYSIS OF ALTERNATIVES

Each remedial action alternative was evaluated for performance, reliability, implementability, and safety. The resulting technical evaluations of the alternatives are included in the summary of remedial action alternatives at the end of this section. The elements of technical feasibility are as follows:

1. Performance--Two aspects of remedial actions determine their desirability on the basis of performance: effectiveness and useful life. Effectiveness refers to the degree to which a remedial action will prevent or minimize substantial danger to public health, welfare, or the environment. The useful life is the length of time this level of effectiveness can be maintained.
2. Reliability--Two aspects of remedial technologies that provide information about reliability are their O&M requirements and their demonstrated reliability at similar sites. O&M refers to the availability of labor and materials and their costs and the frequency and complexity of necessary O&M. Demonstrated performance refers to the proven effectiveness under similar waste and site conditions, the probability of failure, and the necessity of bench-scale and pilot studies.

Table 4.0-1. Alternatives—TNT Manufacturing Area

Alternative	Cleanup Level	Excavated Volume (cy)*	Treatment		Disposal/ Treatment Level (percent)	Disposal		Capped Area (sq yd)	Backfill		Post-Closure Monitoring	Years Mobilized
			Method	Volume (cy)		Site	Volume (cy)		Source	Volume (cy)		
Offsite 1A2	10^{-6}	6,710	Incinerate	6,710	99.99	Ensco, AR	6,710	0	Offsite	6,710	None	1
Offsite 1B1	<detection	53,000	Landfill	0	—	Cescos, OH	53,000	0	Offsite	53,000	None	2
Offsite 1B2	10^{-6}	6,710	Landfill	0	—	Cescos, OH	6,710	0	Offsite	6,710	None	1
Attains Requirements 2A	10^{-6}	6,710	Incinerate	6,710	99.99	Onsite	—	0	Onsite	1,677	—	1
Attains Requirements 2B	10^{-6}	6,710	Onsite Landfill	0	—	Onsite	6,710	0	Onsite	2,100	GW	1
Attains Requirements 2C	10^{-6}	0	Multimedia Cap	0	—	Onsite	—	10,060	—	0	GW	1
Exceeds Requirements 3A	<detection	53,000	Onsite Incinerate	53,000	99.99	Onsite	0	0	Onsite	8,555	—	4
Exceeds Requirements 3B	<detection	53,000	Onsite Landfill	0	—	Onsite	53,000	0	Onsite	17,500	GW	2
Exceeds Requirements 3C	<detection	0	Multimedia Cap	0	—	Onsite	0	51,200	—	0	GW	1

Table 4.0-1. Alternatives—TNT Manufacturing Area (Continued, Page 2 of 2)

Alternative	Cleanup Level	Excavated Volume (cy)*	Treatment		Disposal/ Treatment Level (percent)	Disposal		Capped Area (sq yd)	Backfill		Post-Closure Monitoring	Years Mobilized
			Method	Volume (cy)		Site	Volume (cy)		Source	Volume (cy)		
CERCLA 4A	10^{-6}	0	Soil Cap	0	—	Onsite	0	10,060	Onsite	0	—	1
No Action 5A	—	—	No Action	—	—	—	—	—	—	—	GW SW Seeps	—

— = Not applicable.
GW = Ground Water.
SW = Surface Water.

*All volumes include a swell factor of 25 percent.

Source: ESE, 1986c.

Table 4.0-2. Alternatives—Burning Grounds Area

Alternative	Cleanup Level	Excavated Volume (cy)*	Treatment		Disposal/ Treatment Level (percent)	Disposal		Capped Area (sq yd)	Backfill		Post-Closure Monitoring	Years Mobilized
			Method	Volume (cy)		Site	Volume (cy)		Source	Volume (cy)		
Offsite 1A2	10^{-6}	3,625	Incinerate	3,625	99.99	Ensco, AR	3,625	0	Offsite	3,625	None	1
Offsite 1B1	<detection	17,000	Landfill	0	—	Cescos, OH	17,000	0	Offsite	17,000	None	1
Offsite 1B2	10^{-6}	3,625	Landfill	0	—	Cescos, OH	3,625	0	Offsite	3,625	None	1
Attains Requirements 2A	10^{-6}	3,625	Incinerate	3,425	99.99	Onsite	—	0	Onsite	910	—	1
Attains Requirements 2B	10^{-6}	3,625	Onsite Landfill	0	—	Onsite	3,625	0	Onsite	4,370	GW	1
Attains Requirements 2C	10^{-6}	0	Multimedia Cap	0	—	Onsite	—	5,134	—	0	GW	1
Exceeds Requirements 3A	<detection	17,000	Onsite Incinerate	17,000	99.99	Onsite	0	0	Onsite	3,225	—	2
Exceeds Requirements 3B	<detection	17,000	Onsite Landfill	0	—	Onsite	17,000	0	Onsite	4,600	GW	2
Exceeds Requirements 3C	<detection	0	Multimedia Cap	0	—	Onsite	0	18,556	--	0	GW	1

Table 4.0-2. Alternatives—Burning Grounds Area (Continued, Page 2 of 2)

Alternative	Cleanup Level	Excavated Volume (cy)*	Treatment		Disposal/ Treatment Level (percent)	Disposal		Capped Area (sq yd)	Backfill		Post-Closure Monitoring	Years Mobilized
			Method	Volume (cy)		Site	Volume (cy)		Source	Volume (cy)		
CERCLA 4A	10^{-6}	0	Soil Cap	0	—	Onsite	0	5,134	Onsite	0	—	1
No Action 5A	—	—	No Action	—	—	—	—	—	—	—	GW/SW	—

— = Not Applicable.
GW = Ground Water.
SW = Surface Water.

*All volumes include a swell factor of 25 percent.

Source: ESE, 1986c.

Table 4.0-3. Alternatives—Industrial Sewerlines

Alternative	Cleanup Level	Excavated Volume (cy)*	Treatment Method	Treatment Volume (cy)	Disposal/ Treatment Level (percent)	Disposal Site	Disposal Volume (cy)	Capped Area (sq yd)	Backfill Source	Backfill Volume (cy)	Post-Closure Monitoring	Years Mobilized
Attains Requirements 2A	10^{-6}	20,400	Incinerate	680	95	Onsite	680	0	Onsite	500	—	3
Attains Requirements 2B	10^{-6}	20,400	Flaming/ Onsite Landfill	680	—	Onsite	680	0	Onsite	500	GW	3
Exceeds Requirements 3A	<detection	47,680	Incinerate	29,680	99.99	Onsite	29,680	0	Onsite	8,000	—	3
Exceeds Requirements 3B	<detection	47,680	Flaming/ Onsite Landfill	29,680	—	Onsite	29,680	0	Onsite	9,400	GW	3
CERCLA 4A	10^{-6}	20,400	Flaming/ Backfill	680	—	Onsite	680	0	Onsite	500	—	3
No Action 5A	—	—	No Action	—	—	—	—	—	—	—	GW	—

— = Not applicable.
GW = Ground Water.

*All volumes include a swell factor of 25 percent.

Source: ESE, 1986

3. Implementability--Another important aspect of remedial alternatives is implementability, i.e., the relative ease of installation and the time required to achieve a given level of response. Ease of installation, also known as constructability, is determined by conditions both internal and external to the site. The time requirements are generally classified as the time required to implement a technology and the time required before results are actually realized.
4. Safety--Each remedial alternative is evaluated with regard to safety. This evaluation includes threats to the safety of nearby communities and environments as well as those to workers during implementation. Major risks considered are fire, explosion, and exposure to hazardous substances.

4.1.1 TECHNICAL ANALYSIS OF OFFSITE ALTERNATIVES

4.1.1.1 Offsite 1A2 Alternatives

The 1A2 Alternatives involve removal and offsite treatment of contaminated soils in an offsite commercial incinerator. For cost purposes, the offsite incinerator selected was Ensco Environmental Services located in Little Rock, AR.

The level of treatment is to achieve applicable (10^{-6}) criteria for the site. This involves the removal and offsite treatment of approximately 6,710 and 3,625 cy of soil from the TNT Manufacturing Area and Burning Grounds Area, respectively. The Industrial Sewerlines are not addressed because no offsite facility was identified which would accept reactive materials for incineration. Washer/Flaker foundations remain in place under this alternative. The asbestos piles of the Burning Grounds Area are removed and disposed of in an offsite sanitary landfill. TNT residue at the Burning Grounds Area receives *in situ* flaming prior to soil excavation.

Performance--Offsite rotary kiln incineration will effectively remove and destroy all nitroaromatics-contaminated soils found at the TNT Manufacturing Area and Burning Grounds Area. The useful life of this alternative is potentially infinite because nitroaromatics contaminants are totally destroyed. In situ flaming of the TNT residue at the Burning Grounds Area provides effective treatment of nitroaromatic residue.

Reliability--Labor and equipment required for removal and disposal of soil and rubble piles are readily available. Excavation and transport are conventional operations that are simple to implement; however, the distance of travel (>500 miles for Alternative 1A2) may hinder the ability to transport the material effectively. Precautions must be taken to limit the spread of contamination during offsite transport.

The reliability and availability of the hand-held flamer are high. Flamers may be obtained as off-the-shelf equipment.

This alternative requires only periodic attention (maintenance of revegetated areas) upon implementation. The effectiveness of flaming, excavation, and offsite incineration has been demonstrated for similar wastes.

Implementability--There are no site conditions which would limit the implementation of this alternative.

The removal and transport of contaminated soils are limited by the rate at which materials can be accepted at the RCRA facility. Acceptance of the material cannot be determined until a waste profile sheet has been thoroughly reviewed by the facility. Wastes must be drummed prior to transport, which significantly increases both the time and expense necessary to implement the alternative. Competition for available incineration capacity will likely increase due to the upcoming regulatory restrictions placed on land disposal facilities.

The time to implement this alternative is not expected to exceed 1 year, assuming that the offsite incinerator can accept at least 40 cy of soil each day. Desired results are achieved immediately upon implementation.

Safety--Onsite safety concerns are associated with the operation of heavy equipment and the potential for worker contact during soil excavation. The TNT residue could potentially detonate when heated directly by flame. Workers must wear proper shielding (e.g., safety glasses) during in situ flaming of the residue.

Offsite safety concerns are primarily related to the transportation of contaminated soil long distance on public highways. Judicious routing of trucks to avoid populated areas must be planned to minimize public exposure.

Summary--The technical feasibility of contaminated soil treatment in offsite commercial incinerators is well established. Acceptance of nitroaromatics-contaminated soils will be determined by the commercial facility after a careful review of the waste characteristics. Competition for available incineration capacity may increase due to potential regulatory restrictions for onsite landfills.

4.1.1.2 *Offsite 1B1 Alternatives*

The 1B1 Alternatives involve the complete removal of contaminated soils in each area to detection limits (i.e., <2 µg/g using field methods). The material will be transported approximately 200 mi to an offsite commercial landfill. The landfill selected for cost purposes was Cecos, International, located in Williamsburg, OH.

The volumes of material to be removed vary considerably between sites. At the TNT Manufacturing Area, the estimated amount of soil to be excavated is 53,000 cy. In addition, the Washer/Flaker (Bldg. 806) foundations will be removed, decontaminated as necessary using a hand-

held flaming device, and disposed of into a sanitary landfill. Burning Grounds Area soils to be removed are estimated to be approximately 17,000 cy. Friable asbestos will be placed in an offsite sanitary landfill. There is no 1B1 Alternative for the Industrial Sewerlines because no commercial landfill was identified which would accept reactive or shock-sensitive materials.

In situ flaming will be used to thermally destroy the TNT residue at the Burning Grounds Area prior to soil excavation.

Performance--Complete removal and offsite disposal of existing contaminated materials in RCRA-licensed facilities effectively prevent substantial danger to public health, welfare, and the environment of the WVOW site. The useful life of this alternative is indefinite because contaminants are removed and no longer pose a threat to the community. Flaming provides complete and rapid destruction of all explosive residues.

Reliability--The reliability of in situ flaming, excavation, and offsite transport is the same as that discussed for the Offsite 1A2 Alternatives. This alternative requires only periodic attention (maintenance of revegetated areas) upon implementation. The effectiveness of offsite landfilling has been demonstrated for similar wastes.

Implementability--The ability to implement the excavation and transport operations is not hindered by site conditions. The backfill requirements of this alternative are substantial due to the large quantity of material removed from the site. The backfill required to replace disposed soil will potentially result in large disturbed areas if onsite soils are used. The use of local, offsite backfill results in a significantly higher cost.

The removal and transport of contaminated soils are limited by the rate at which the materials can be accepted at the RCRA facility. Special arrangements must be made with the facility because of the quantity of material requiring disposal. A waste profile sheet and a statement certifying the material as unreactive must be provided to the landfill facility before the waste can be accepted. Offsite landfilling of hazardous materials is becoming increasingly difficult and more expensive due to the steadily growing regulatory control of this technology. RCRA manifest requirements, under 40 CFR Parts 262 and 263, must be complied with for all wastes shipped offsite.

The time to implement this alternative is estimated to be 4 years. The time to implement is affected by climatic conditions and the rate at which the materials can be accepted at the commercial facility. The beneficial results of this alternative are obtained immediately upon implementation.

Safety--The safety concerns for this alternative are the same as those discussed for the Offsite 1A2 Alternatives.

Summary--The technical feasibility of contaminated soil disposal in offsite RCRA facilities is well established. However, due to uncertainties relating to the current availability of RCRA-permitted facilities and future regulatory prohibitions for this type of technology, its application for the WVOW site is uncertain.

4.1.1.3 Offsite 1B2 Alternatives

The 1B2 Alternatives, involving excavation and offsite disposal in a RCRA-licensed landfill, are similar to 1B1 Alternatives except the removal objective is to meet relevant requirements (instead of complete removal). Therefore, the volume of material from the TNT Manufacturing Area and Burning Grounds Area is approximately 10,300 cy. Washer/Flaker foundations remain in place, and asbestos piles are disposed of in an

offsite sanitary landfill. TNT residue in the Burning Grounds Area receives in situ flaming prior to soil excavation. Industrial Sewerlines are not addressed under this alternative because reactive materials cannot be placed in landfills.

Performance--Performance of this alternative is the same as that described for the Offsite 1B1 Alternatives.

Reliability--The reliability of these alternatives is identical to that described for the 1B1 Alternatives.

Implementability--The ease of implementation for these alternatives is similar to that described for the 1B1 Alternatives. The time to implement these 1B2 Alternatives is estimated to be less than 1 year. Results are obtained immediately upon implementation.

Safety--The safety concerns are identical to those described for the 1B1 Alternatives.

Summary--The technical feasibility of contaminated soil disposal in offsite RCRA facilities is well established. Due to uncertainties relating to the current and future regulatory prohibitions for this technology, its application to the WVOW site is uncertain.

4.1.2 TECHNICAL ANALYSIS OF ATTAINS REQUIREMENTS ALTERNATIVES

4.1.2.1 Attains Requirements 2A Alternatives

Assembled 2A Alternatives involve the removal and onsite treatment of the contaminated soil in an onsite incinerator. The ash from the incinerator, if determined nonhazardous according to EP toxicity characteristics for metals, will be used as backfill in the excavated areas. Permits are not required for the operation of the incinerator.

The level of treatment is to achieve applicable (10^{-6}) criteria for the site. To meet the objectives of this alternative, an estimated 6,710 cy and 3,625 cy of soil will be incinerated from the TNT Manufacturing Area and Burning Grounds Area, respectively. In addition, an estimated 680 cy of contaminated sewerlines will be incinerated, for a total volume of approximately 11,000 cy from the three areas. Washer/Flaker foundations will remain in place, and asbestos from the Burning Grounds Area will be disposed of in an offsite sanitary landfill. TNT residue at the Burning Grounds Area will be incinerated along with contaminated soils.

Performance--Onsite rotary kiln incineration will effectively remove and destroy all nitroaromatics contamination in soils and sewerlines found at the WVOW site. Removal and subsequent destruction of organic contaminants are permanent and irreversible, resulting in an infinite useful life for this alternative.

Reliability--Labor and equipment required for the removal of soils, sewerlines, and asbestos are readily available. Excavation and onsite transport are conventional operations which are simple to implement. Precautions must be taken to limit the spread of contamination onsite.

Onsite incineration of soil requires constant attention by skilled operators; however, contract services for onsite incineration include operators as part of the service. Air emissions from the incinerator (e.g., nitrogen oxides, hydrocarbons) and runoff from storage areas must be carefully monitored to prevent the migration of pollutants through these media. Incineration of soil for the removal and destruction of organic contaminants is a demonstrated technique. Equipment is well developed and reliable.

If EP toxicity tests for leachable metals are negative, the ash will be used as backfill in excavated areas. If the ash fails the EP toxicity

tests for metals, the ash will require disposal at a RCRA-approved landfill resulting in a substantially higher cost for incineration.

Incineration of soil for the removal and destruction of organic contaminants is a demonstrated technique. Equipment is well developed and reliable.

Implementability--Limiting onsite conditions for incinerator operation include a lack of water and utilities, which must be provided at the incineration site.

Transportable solid waste incinerators are readily available from several sources. Minimal onsite assembly or construction is required. Adequate space is available for the construction of the incinerator and auxiliary (e.g., laboratory, fuel storage) facilities.

The time to implement this alternative at the three areas of concern is estimated to be 3 years. This time is dependent on the rate of incineration, which can range from 1 to 4 cy/hr, and the rate at which sewerlines can be removed. Results are achieved immediately upon completion. Special precautionary measures must be taken during excavation to avoid frictional forces and/or confinement of potentially reactive sewerlines. Such measures may include the slurrying of excavated sewerline material with water and the use of blast shields. Technologies for the removal, handling, and incineration of explosives are demonstrated (Roy F. Weston, Inc., 1985).

Safety--Onsite safety concerns are mainly due to the high temperatures involved in incineration and the hazards of storing flammable auxiliary fuel. The hazards of soil excavation and transport result mainly from possible worker contact with contaminated soil. Maintaining good ventilation and avoiding open flames will alleviate explosion hazards. The transport of contaminated soil must be carefully executed and monitored to avoid the spread of contamination at WVOW.

Offsite safety concerns are mainly related to potential exposure to hazardous materials from the incinerator stack gas via air route. Conventional air pollution control measures will prevent community exposure.

The contaminated sewerlines demonstrate the characteristic of reactivity. Special precautions must be taken in materials-handling procedures and equipment design. Such handling procedures have been demonstrated for reactive explosives-contaminated sediments (Roy F. Weston, Inc., 1984).

Summary--The technical feasibility of soil incineration to remove organic contaminants is well established. If test burns show that after incineration the ash is still hazardous due to heavy metals content, the ash will require disposal at a RCRA-approved landfill. Special safety precautions must be used in the excavation, handling, and incineration of sewerlines due to their reactive characteristics.

4.1.2.2 Attains Requirements 2B Alternatives

Under these alternatives, contaminated soil is removed from the TNT Manufacturing Area and Burning Grounds Area and placed in an onsite landfill constructed to meet RCRA standards. Permits will not be required for the construction and operation of the landfill. Sewerlines will be flashed using a remotely operated flamer and subsequently placed in the landfill with the contaminated sewerline pipe. An estimated 11,000 cy of soil and sewerlines must be landfilled to meet the objectives of these alternatives. TNT residue must be flamed in situ prior to placement in the landfill. Asbestos and rubble will be disposed of in the onsite landfill along with the soils.

Performance--Removal and disposal in a RCRA-designed onsite facility will effectively isolate the contaminated soil from human and environmental contact. The double-liner system required under RCRA is designed to have a minimum of 30 years useful life (EPA, 1985d). The landfill may require repair sometime after 30 years to ensure its integrity.

Flashing of sewerlines using a remotely operated flamer will provide complete and rapid destruction of all explosive residues contacted by the flame. The effectiveness of this technology will depend on the required depth of thermal penetration; however, the expected volume of contaminants within a sewerline section is not expected to adversely affect the efficiency of the method. The useful life of this technology is infinite because contaminants are destroyed. In situ flaming also provides complete and rapid destruction of all explosive residues at the Burning Grounds Area.

Reliability--The reliability of excavation and transport operations and the hand-held flamer is described under the Offsite 1A2 Alternatives.

The reliability and availability of the remotely operated flamer used for flashing sewerlines are difficult to predict because of the complexity of the device and the potential for explosive detonation. The remotely operated flamer could be modeled after the Rockwell® design used successfully at AAAP (Rockwell, 1981).

Labor, equipment, and materials required for excavation, flaming, and construction of the landfill are readily available. The O&M requirements include ground water monitoring, leachate collection system maintenance, and landfill cover maintenance to ensure the integrity of the facility during its useful life. A properly constructed and well maintained landfill is an effective technology for the containment of contaminated soil.

The thick surficial layer at the Burning Grounds Area can provide a natural impermeable barrier to prevent the downward migration of pollutants. Consequently, the Burning Grounds Area offers good potential as a landfill site.

Implementability--The removal of all solids can be implemented quickly using conventional construction methods. The landfill site selected must have adequate natural barriers to prevent pollutant migration and landfill subsidence. Some areas at the WVOW site (e.g., Burning Grounds Area) have the potential to serve as a landfill site, whereas others (e.g., Red Water Reservoirs) are not suitable due to subsurface characteristics and proximity to public residences.

The time in which contaminated materials are left exposed in open cells must be minimized to avoid unnecessary generation of leachate caused by rainfall into an open cell. The removal of soil and subsequent placement of contaminated material can be coordinated such that the materials are exposed to the environment for a relatively short time period.

The remotely operated flamer requires a fuel source, hoses, regulators, and fire extinguishers as auxiliary equipment. The device should be occasionally relocated to minimize the distance of sewerline transport. Obstructions must be removed (e.g., pipe, excess dirt) to achieve complete destruction of contaminants.

The time to implement the 2B Alternatives is estimated to be 2 to 3 years from the time operations begin. The time of operation depends on the rate at which contaminated sewerlines can be removed. Results are achieved immediately upon implementation.

Safety--Onsite safety concerns are primarily due to the operation of heavy equipment and the potential for worker exposure to contaminated materials. Normal, prudent safety procedures for workers at the site will be sufficient to protect against these hazards. The transport of contaminated materials must be carefully executed and monitored to avoid the spread of contamination at WVOW. Sewerlines must be carefully excavated, handled, and flashed due to the reactive nature of the material.

Summary--An onsite landfill is a technically feasible alternative for contaminated soils at the WVOW site. In situ flaming for TNT residue and flashing of sewerlines are technically feasible but must be executed carefully due to the reactive nature of these materials. Post-closure O&M of the landfill must occur perpetually after closure to ensure its integrity.

4.1.2.3 Attains Requirements 2C Alternatives

Attains Requirements Alternative 2C includes multimedia capping of all areas of contaminated soil where the surficial soil concentration exceeds 50 µg/g. Using this criterion, an estimated 15,194 square yards (sq yd) (i.e., 3.1 acres) of soil must be capped at the WVOW site. Contaminated sewerlines must be removed to meet Attains Requirements objectives; therefore, there is no 2C Alternative for the sewerlines. The TNT residue must be in situ flashed prior to cap installation. Asbestos and rubble will be disposed of in an offsite landfill.

Performance--Capping contaminated soil minimizes the potential for direct exposure. The multimedia cap, which is designed to RCRA specifications, can last indefinitely if properly maintained. The land use over capped areas must be controlled to preserve the integrity of the cap. In situ flaming provides complete and rapid destruction of all explosive residues contacted by the flame.

Reliability--The labor, equipment, and materials required for multimedia cap construction are readily available. Onsite soils can be used to construct the vegetative (topsoil) and soil liner (clay) portions of the cap (Fig. 3.1-3). Offsite materials needed for construction include sand or gravel, filter fabric, and synthetic liner. The hand-held flamer can be obtained as off-the-shelf equipment.

Capping has proven performance as a containment technology at hazardous waste sites. The potential for contaminant spreading by transportation operations is removed because the contaminated soils are capped in place.

O&M requirements include regrading, revegetation, and maintenance of cracks occurring in the cover from climatic stress or burrowing animals. Post-closure maintenance of the cap must occur perpetually to ensure its integrity.

Implementability--Site conditions do not prohibit the installation of a multimedia cap; however, extensive clearing and grubbing are required around the Washer/Flaker building foundations in the TNT Manufacturing Area. The multimedia cap must be installed over a relatively flat surface area. A portion of the Burning Grounds Area is heavily eroded and steeply sloped, requiring grading and backfilling prior to cap installation. Land use restrictions will be required for capped areas.

The time required to implement this alternative at the TNT Manufacturing Area and Burning Grounds Area is estimated to be 1 year. Results are obtained immediately upon installation of the cap.

Safety--Safety concerns include the operation of heavy equipment and the direct contact of contaminated soil by workers installing the cap. The TNT residue can potentially explode when heated directly by flame.

Summary--Capping the contaminated soil prevents direct exposure. Extensive clearing and grubbing are required at the TNT Manufacturing Area before a cap can be properly installed. The Burning Grounds Area will require grading and backfilling to achieve the flat area needed for proper cap installation. Building foundations will remain in place and will not be covered by the multimedia cap. Land use over capped areas must be controlled to preserve the integrity of the cap.

4.1.3 TECHNICAL ANALYSIS OF EXCEEDS REQUIREMENTS ALTERNATIVES

4.1.3.1 Exceeds Requirements 3A Alternatives

The 3A Alternatives include the removal of contaminated soil to detectable levels and treatment in an onsite incinerator. Incinerator

ash, if determined to be nonhazardous through EP toxicity testing, will be used as backfill. To meet the alternative objectives, an estimated 99,680 cy of soil and sewerlines must be removed and incinerated from the three areas of concern. The contaminated soils underlying the sewerlines will be removed to a depth necessary to achieve complete removal of nitroaromatics contamination.

Performance--Performance of this alternative is the same as that described under 2A Alternatives (Sec. 4.1.2.1).

Reliability--Reliability for this alternative is the same as that discussed under Attains Requirements 2A Alternatives.

Implementability--The implementability for this alternative is the same as that discussed under 2A Alternatives, except that the time to implement is much longer due to the increased amount of materials to be excavated, handled, and treated. The estimated time to complete this alternative for the WVOW site is 6 to 8 years, assuming the use of one incinerator. The area of disturbed land is significantly greater if cleanup to nondetectable levels is to be achieved.

Safety--The safety concerns for this alternative are the same as those described for 2A Alternatives, except the degree of concern is greater due to increased activities associated with removal to background levels. The depth of trenches required to excavate soil below the sewerlines, potentially exceeding 15 ft in certain areas, presents a safety hazard to the work crew and to outsiders who gain access to these areas.

Summary--The technical feasibility of excavation, transport, and onsite incineration of potentially reactive material has been demonstrated (Roy F. Weston, 1985). Special safety precautions must be used during implementation of this alternative due to the reactive characteristics of the sewerlines and the depth of excavation required.

4.1.3.2 Exceeds Requirements 3B Alternatives

Under this alternative, approximately 99,680 cy of contaminated soil will be excavated and disposed of in an onsite landfill constructed to RCRA standards. The reactive sewerline materials must be flashed before placement in the onsite landfill.

Performance--Performance for this alternative is discussed under Attains Requirements 2B Alternatives.

Reliability--The reliability of this alterntive is the same as the 2B Alternatives.

Implementability--The implementability of an onsite landfill under this alternative is the same as that discussed under the 2B Alternatives, except that the time to implement is estimated to be up to 3 years.

Safety--The safety concerns of this alternative are similar to those discussed under the 2B Alternatives, except the degree of concern is greater due to the increased amount of materials handling.

Summary--An onsite landfill is a technically feasible alternative for the WVOW site. The facility will require significant O&M perpetually after closure.

4.1.3.3 Exceeds Requirements 3C Alternatives

Exceeds Requirements 3C Alternatives involve the placement of a multimedia cap over all areas where the surficial soil exceeds nondetectable levels. Using this criterion, an estimated 69,811 sq yd (i.e., 14.4. acres) must be capped in the TNT Manufacturing Area and Burning Grounds Area. The Industrial Sewerlines are not addressed under the 3C Alternatives.

Performance--The performance of a multimedia cap is discussed under the 2C Alternatives.

Reliability--The reliability of the alternative is discussed under the 2C Alternatives. O&M requirements are expected to be much greater than those for the 2C Alternatives due to the increased area of the cap.

Implementability--Capping under 2C Alternatives was mainly confined to soils surrounding the Washer/Flaker houses (Bldg. 806) at the TNT Manufacturing Area; under this alternative, soils surrounding all foundations will require capping. This will significantly increase the need for clearing, access roads, and surface and water controls to facilitate implementation of the cap. Land use restrictions must be applied to all capped areas.

The time to implement this alternative is expected to be 1 to 2 years. This time is primarily affected by the prevailing climatic conditions during implementation. Results are achieved immediately upon implementation.

Safety--Safety concerns are the same as those discussed under the 2C Alternatives, except the degree of concern is greater due to the increased area of the cap.

Summary--Capping the contaminated soil prevents direct exposure. Extensive clearing and grubbing are required at the TNT Manufacturing Area before a cap can be properly installed. Land use restrictions must be applied to a significant portion of the WVOW site to preserve the integrity of the cap.

4.1.4 TECHNICAL ANALYSIS OF CERCLA ALTERNATIVES

4.1.4.1 CERCLA 4A Alternatives

The CERCLA Alternative for the TNT Manufacturing Area and Burning Grounds Area involves the installation of a soil cover over all areas where the surficial contamination exceeds 50 µg/g. Using this criterion, approximately 15,194 sq yd (i.e., 3.1 acres) of soil must be capped at the WVOW site.

The CERCLA Alternative for sewerlines involves the removal and treatment of sewerlines by flashing. After flashing, the material is used as backfill in the sewerline trench and covered with topsoil.

Performance--Covering the contaminated soil minimizes the potential for direct exposure. Since migration of contaminants from the soil to the ground water is not a significant pathway, the permeability of local, available soils is not a factor. A stabilized cap is the most simple means of preventing direct contact with contaminated soils at the WVOW site.

The performance of in situ flaming of TNT residue at the Burning Grounds Area and flashing of sewerlines is the same as discussed under the Attains Requirements 2B Alternatives.

Reliability--Onsite soils can be used to construct the soil cover (Fig. 3.1-3). High-plasticity soils (clays) are susceptible to cracking when exposed to varying climatic conditions, especially during dry summer months. Topsoil over the clay should increase the ability of the soil cover to effectively isolate contaminants from direct contact. Frequent inspection and maintenance of the cover are required until vegetative growth has sufficiently stabilized the covered area. This technology is well demonstrated at hazardous waste sites.

Labor, equipment, and materials required for excavation and backfilling sewerlines are readily available. The O&M requirements for this alternative consist of inspection and maintenance of revegetated areas over the sewerline trench and covered areas.

The reliability of the remotely operated flamer is the same as discussed for the Attains Requirements 2B Alternatives.

Implementability--The implementability of the soil cover is the same as for 2C Alternatives. The time to implement the soil cover is approximately 1 year from the time operations begin.

The implementation of the 4A Alternative for the sewerlines is the same as that described for the sewerlines under Alternative 2B, except that no onsite landfill is required. The time to implement this alternative is approximately 2 to 3 years.

Safety--The safety concerns for this alternative are the same as those described for the 2C and 2B Alternatives.

Summary--The flashing and subsequent backfill of reactive sewerlines and the soil cover of contaminated soils are simple means of accomplishing remedial objectives for the sewerlines and soils.

4.1.5 TECHNICAL ANALYSIS OF THE NO ACTION ALTERNATIVES

4.1.5.1 No Action 5A Alternatives

Under Alternative 5A, no remedial actions will be implemented at the three areas of concern. However, a monitoring program will be implemented to provide information on the extent of contamination as a function of time. The monitoring program includes annual sampling and analysis of ground water wells (12), seeps (3), and surface waters (2) in the TNT Manufacturing Area; sampling and analysis of ground water wells (3) and surface water stations (4) in the Burning Grounds Area; and, monitoring of the ground water wells along the Industrial Sewerlines (5).

Performance--This alternative does not reduce or eliminate any of the impacts resulting from site contaminants. It will be effective in providing information about the movement of contaminants so that future remedial actions can be taken, if necessary.

Reliability--This is a labor-intensive alternative that requires workers skilled in obtaining representative environmental samples. Such are readily available. The sampling of surface and ground waters will be from existing sample stations and wells, so that no construction is necessary. Collection and analysis of environmental media for nitroaromatics rely on proven technologies.

Implementability--This alternative can be implemented without difficulty in all areas.

Safety--Safety concerns are due to worker exposure to contaminants. Protective garments will adequately protect workers during sampling efforts.

Summary--Long-term monitoring can provide useful data on the migration of contaminants from source areas. This alternative does not reduce any impacts resulting from site contamination.

4.2 ENVIRONMENTAL EVALUATION OF ALTERNATIVES

In the detailed evaluation and final selection of a remedial action alternative, adequate protection of public health, welfare, and the environment is a major concern. The NCP, Sec. 300.68(h)(2)(iv) and (vi), requires:

(iv) An assessment of the extent to which the alternative is expected to effectively prevent, mitigate, or minimize threats to, and provide adequate protection of, public health and welfare, and the environment.

(vi) An analysis of any adverse environmental impacts, methods for mitigating these impacts, and costs of mitigation.

In this section, the effects of each alternative under consideration for the TNT Manufacturing Area, Burning Grounds Area, and Industrial Sewerlines are evaluated. Both primary and secondary effects of each alternative are discussed and are often viewed as short-term and long-term effects, respectively. Primary effects are direct beneficial or adverse effects associated with implementation of the alternative. Beneficial effects include changes in the release of contaminants, final environmental conditions, and improvements in the biological environment. Secondary effects include effects on the economy of the area or future land use. Also discussed will be any mitigative measures needed to reduce adverse effects of the alternative.

Although the alternatives in each area differ to some degree, certain environmental impacts are the same. The site is not located in or near coastal zones, floodplains, critical habitats, prime agricultural lands, Federal parklands, national forests, or wild and scenic rivers. Neither onsite nor offsite activities will impact the aforementioned areas or commercially or recreationally important wildlife species. Also, threatened or endangered species will not be affected by the implementation of alternatives.

All of the alternatives, except Alternative 5A--No Action, will generate noise and dust (N&D) that will adversely affect the immediate vicinity of

the area under construction. Generally, onsite incineration Alternatives 2A and 3A will create the most N&D. Alternative 3A will generate more N&D than Alternative 2A due to the increased volume of material to be handled to meet more stringent cleanup criteria. Construction of an onsite landfill in Alternatives 2B and 3B will create less N&D than Alternatives 2A and 3A but more than other alternatives. Offsite Alternatives 1A and 1B will create less N&D than Alternatives 2B and 3B but more than Alternatives 2C, 3C, and 4A. The capping Alternatives 2C, 3C, and 4A will generate approximately the same amount of N&D but less than the other alternative categories. A graphic representation of relative N&D generation is presented in Table 4.2-1.

4.2.1 ENVIRONMENTAL EFFECTS OF OFFSITE DISPOSAL 1A2, 1B1, and 1B2 ALTERNATIVES

These alternatives consist of the incineration or landfill of contaminated soil in existing offsite RCRA-permitted or interim status facilities and landfill of asbestos in a local sanitary landfill. No offsite option exists for media that are classified as reactive, such as the sewerlines and the TNT residue.

These alternatives eliminate the exposure pathways of direct contact, ingestion, inhalation, and food-chain concentration for soil and asbestos. These pathways are eliminated through source control (removal and treatment of contaminated soil and asbestos/rubble). All contaminants will be removed to below detection or 10^{-6} risk levels.

Negative environmental effects are confined mainly to short-term impacts relating to removal activities. Excavation and transportation equipment will generate N&D. Noise levels may be of such frequency and intensity as to drive animals from the area and discourage others from entering. Dust control measures will be implemented to reduce blowing soil particles and particulates. These measures may include the spraying of water and cessation of excavation when climatic conditions co[illegible]

Table 4.2-1. Relative N&D Generation*

Alternative
3A/2A--Onsite Incineration
3B/2B--Onsite Landfill
1A/1B--Offsite Disposal
3C--Multimedia Cap
2C/4A--Multimedia Cap/Soil Cover

*In decreasing order.

Source: ESE, 1986c.

any visible fugitive emissions. Trucks hauling the excavated soil and asbestos will be covered and decontaminated prior to leaving the site to prevent the distribution of contaminated soil and asbestos offsite.

The exposure of contaminated soil and asbestos to rainwater during excavation activities may result in temporary contamination of surface water. Berms and swales will be constructed around areas being excavated to prevent both surface water runon and runoff. These measures minimize ponding and temporarily prevent the migration of surface water from the site.

The loading of contaminated materials into trucks for transport offsite presents a potential spill situation at the loading site. Spill pads will be constructed to collect any spilled material. This and other activities will be discussed in a Spill Prevention Plan prepared prior to implementation of either alternative.

The additional truck traffic generated by the removal of soil and asbestos will cause disruptions of local traffic patterns. A specific hauling route will be developed in consultation with local officials so as to have the least impact on local traffic. Local officials will be kept informed of hauling schedules to minimize any disruption. If necessary, traffic control personnel will be used to minimize traffic disruptions.

Implementation of these alternatives will not affect existing or future land use patterns. Contaminated soil and asbestos will have been removed to below detectable or 10^{-6} risk levels. Restoration measures to be employed will not restrict any type of current or future use.

Short-term socioeconomic impacts will consist of an increase in the sale of goods and services to nonresidents employed as part of the cleanup activities. Implementation of these alternatives may result in

additional jobs for local residents. Services provided to the site, such as water, telephone, electricity, etc., will not overtax local utilities.

Long-term environmental effects of the offsite disposal alternatives will be beneficial. The removal of site contaminants will remove exposure risks to potential receptors and indigenous plants and animals. This removal will also eliminate potential migration of contaminants. With the contaminants removed from the site, barriers to continued use of the site will have been removed. Restoration activities implemented on completion of cleanup activities will aesthetically improve the site. Purchase of additional land will not be required. No permanent facilities will be constructed as a result of these alternatives.

4.2.2 ENVIRONMENTAL EFFECTS OF ATTAINS REQUIREMENTS 2A ALTERNATIVES
Under these alternatives, contaminated soils and sewerlines are excavated and incinerated onsite. Incinerator ash will be used as backfill. Asbestos will be disposed of in an offsite sanitary landfill.

The exposure pathways of direct contact, ingestion inhalation, and food-chain concentration for soils, sewerlines, and asbestos will be eliminated by these alternatives. This is accomplished through the destruction or removal of the contaminants present at the site to 10^{-6} risk levels.

Implementation of these alternatives requires excavation of contaminated soils, sewerlines, and asbestos. The short-term impacts of and mitigation measures for these actions are the same as discussed for the offsite disposal alternatives.

The onsite incineration unit will produce airborne emissions during its operation. Pollution control devices will be installed on the incineration equipment to reduce these emissions. Operation of onsite incineration facilities will increase N&D levels at the site. These

facilities will be equipped with noise suppression devices to lessen these levels. However, noise levels may be of such frequency and intensity as to drive animals from the area and discourage others from entering.

Environmental effects of these alternatives are both short-term and long-term. Contaminated soils, sewerlines, and asbestos are removed to acceptable levels. Purchase of additional land will not be required. No permanent facilities are constructed due to the use of a mobile incinerator. Restoration measures to be employed will not restrict continued use of the site as a wildlife preserve and may even improve the potential for such use in the future.

Short-term socioeconomic impacts are the same as previously discussed for the offsite disposal alternatives.

Negative long-term environmental effects include excavation of contaminated soils, sewerlines, and asbestos, resulting in the destruction of existing vegetation as well as wildlife habit. Onsite incineration would be in place for 3 years and would prolong site activities.

Beneficial long-term effects include:

1. The removal and destruction of site contaminants will eliminate exposure pathways to receptors,
2. These actions will eliminate potential migration of contaminants,
3. Restoration activities will aesthetically improve the site, and
4. Purchase of additional land will not be required.

4.2.3 ENVIRONMENTAL EFFECTS OF ATTAINS REQUIREMENTS 2B ALTERNATIVES

These alternatives consist of excavation and onsite landfilling of contaminated soil. Prior to landfilling, all TNT residue at the Burning

Grounds Area will be thermally treated in situ by flaming. Asbestos and rubble will be disposed of in the onsite landfill along with contaminated soils. Industrial sewerlines will be excavated and flashed prior to disposal in the onsite landfill.

The exposure pathways of direct contact, ingestion, inhalation, and food-chain concentration for soils, sewerlines, and asbestos will be prevented by these alternatives. This is accomplished through the destruction and isolation of the contaminants present at the site to the 10^{-6} risk level.

Short-term environmental effects of excavation are the same as for the 2A Alternatives. Flaming TNT residue and flashing the sewerlines will produce more particulate emissions than incineration. These emissions will be largely uncontrolled.

Implementation of these alternatives requires the construction of an onsite landfill. More offsite truck traffic will occur than with 2A Alternatives due to the need to bring in materials for the liner and cap of the onsite landfill.

The construction of an onsite landfill will have a minor land use impact. Construction of a landfill will preclude the use of the landfill site for any other purpose. This may require the implementation of certain land use restrictions. Public resistance to the landfill construction and associated land use restrictions may occur. Purchase of additional land will not be required.

Short-term socioeconomic impacts will be the same as previously discussed.

Negative long-term environmental effects of these alternatives include:

1. Destruction of existing vegetation as well as wildlife habitat.
2. The onsite landfill will be a permanent facility,

3. Long-term O&M will be required due to the construction of an onsite landfill,
4. This construction will preclude the use of the landfill site for any other purpose, and
5. Public reaction to an onsite landfill may be adverse.

Positive long-term environmental effects include:

1. Destruction and isolation of site contaminants,
2. Elimination of potential contamination migration, and
3. Aesthetic improvement of the wildlife station.

4.2.4 ENVIRONMENTAL EFFECTS OF ATTAINS REQUIREMENTS 2C ALTERNATIVES

These alternatives consist of surface flaming of TNT residue in place at the Burning Grounds Area and construction of a multimedia cap over the areas of contaminated soil. Asbestos will be disposed of in an offsite sanitary landfill. There is no 2C Alternative for the industrial sewerlines.

The exposure pathways of direct contact, ingestion, and food-chain concentration for contaminated soil and asbestos, as well as the pathway of inhalation for asbestos, will be prevented by these alternatives. This is accomplished through the destruction of TNT residue, capping soil contaminants present at the site, and offsite disposal of asbestos.

Short-term environmental effects of this alternative are confined primarily to flaming of TNT residue and construction activities. Flaming will produce largely uncontrolled air emissions. Construction of a multimedia cap requires the use of soil excavation equipment. Control measures will be implemented as discussed for the offsite disposal alternatives. Temporary runon and runoff control measures will be implemented to minimize onsite surface water contamination and the offsite migration of contaminated surface water.

Implementation of this alternative will result in short-term negative impacts on local ecosystems. Placement of a multimedia cap will result in the destruction of existing vegetation on the site as well as wildlife habitat. However, the multimedia cap and other disturbed areas will be seeded with native grasses or other appropriate grass species. Construction activities will most likely create conditions unfavorable to indigenous animals. These animals would most likely leave the area until activities have ceased.

Short-term socioeconomic impacts will be the same as previously discussed.

Construction of a multimedia cap will preclude the use of the capped areas for any other purpose because of the contaminated soil remaining below the cap. Existing land use restrictions are sufficient to prevent breaches of the cap's integrity. These restrictions will have minimal impact on the operation and use of the wildlife station. Long-term O&M will be required for the cap. Purchase of additional land will not be required.

Negative long-term environmental effects of these alternatives are the same as discussed for the 2B Alternatives. Positive long-term environmental effects are the same as discussed for the 2B Alternatives.

4.2.5 ENVIRONMENTAL EFFECTS OF EXCEEDS REQUIREMENTS 3A ALTERNATIVES

These alternatives consist of the excavation and onsite incineration of contaminated soils, sewerlines, and the removal of asbestos material offsite to a sanitary landfill. Incinerator ash will be used as backfill in excavated areas.

The exposure pathways of direct contact, ingestion, and food-chain concentration for soil, sewerlines, and asbestos as well as the pathway of inhalation for asbestos will be prevented by these alternatives.

This is accomplished through the destruction and removal of the contaminants present at the site. Contaminants will be removed to below detectable levels.

Implementation of these alternatives requires excavation of soils and sewerlines. The short-term impacts of and mitigation measures for this action are the same as discussed for the offsite disposal alternatives. Offsite transport of asbestos will occur in covered trucks that will be decontaminated prior to leaving the site.

The onsite incineration unit will produce airborne emissions during its operation. Pollution control devices will be installed on the incineration equipment to reduce these emissions. Operation of onsite incineration facilities will increase N&D levels at the site. These facilities will be equipped with noise suppression devices, if necessary. However, noise levels may be of such frequency and intensity as to drive animals from the area and discourage others from entering.

Implementation of these alternatives will not adversely impact land use of the site after completion. Soil and sewerline contamination and asbestos are either destroyed or removed. No permanent facilities are constructed due to the use of a mobile incinerator. Restoration measures to be employed will not restrict continued use of the site as a wildlife preserve and may even improve the potential for such use in the future.

Short-term socioeconomic impacts are the same as previously discussed for the offsite disposal alternatives.

Long-term environmental effects of these alternatives will be beneficial. The removal and destruction of site contaminants will remove exposure risks to the surrounding population and indigenous plants and animals and also eliminate potential migration of contaminants. Restoration activities implemented upon completion of cleanup activities will

aesthetically improve the site. Purchase of additional land will not be required. No permanent facilities will be constructed, although the onsite incineration system would be in place for 6 years to implement these alternatives.

4.2.6 ENVIRONMENTAL EFFECTS OF EXCEEDS REQUIREMENTS 3B ALTERNATIVES
These alternatives are the same as discussed for the 2B Alternatives except contaminated soils are removed to detection limits.

The environmental effects are the same as 2B Alternatives. Contaminated sewerlines and soils will be removed to more stringent below detectable levels.

Long-term effects will be as discussed for 2B Alternatives.

4.2.7 ENVIRONMENTAL EFFECTS OF EXCEEDS REQUIREMENTS 3C ALTERNATIVES
These alternatives are the same as discussed for the 2C Alternatives except contaminated soil is capped to more stringent requirements.

The environmental effects are the same as discussed for the 2C Alternatives. Short-term socioeconomic impacts are the same as previously discussed. Long-term effects will be the same as discussed for 2C Alternatives.

4.2.8 ENVIRONMENTAL EFFECTS OF CERCLA 4A ALTERNATIVES
In this alternative, TNT residue is flamed and contaminated soil is covered with soil. The industrial sewerlines will be excavated, flashed, and backfilled onsite. Asbestos will be disposed of in an offsite sanitary landfill.

These alternatives provide the same degree of environmental protection as the 2C Alternatives.

The exposure pathways of direct contact, ingestion, inhalation, and food-chain concentration for soils, sewerlines, and asbestos will be prevented by these alternatives. This is accomplished through the destruction and isolation of the contaminants present at the site to the 10^{-6} risk level.

Short-term environmental effects of these alternatives are as discussed for the 2C Alternatives.

Short-term socioeconomic impacts are the same as previously discussed.

Negative long-term environmental effects of these alternatives are the same as discussed for the 2C Alternatives. Positive long-term environmental effects of these alternatives are the same as discussed for the 2C Alternatives.

4.2.9 ENVIRONMENTAL EFFECTS OF NO ACTION 5A ALTERNATIVES

This alternative consists of leaving the site in its current state and taking no action. Therefore, there will be no impacts related to construction. Endangerment to the environment will not be mitigated. Migration of contaminants from the site will continue unabated. The pathways of direct contact, ingestion, and food-chain bioconcentration will be unmitigated.

4.3 INSTITUTIONAL REQUIREMENTS EVALUATION

Institutional requirements refer to legislation and, more directly, laws or regulations that establish practice standards or performance standards specifically applicable to activities associated with the remediation of the WVOW site. As stated in the NCP, Sec. 300.68(h)(2)(iv): This shall include an evaluation of the extent to which the alternative attains or exceeds applicable or relevant and appropriate Federal public health and environmental requirements. Where the analysis determines that Federal public health and environmental requirements are not applicable or relevant and appropriate, the analysis shall, as appropriate, evaluate the risks of the various exposure levels projected or remaining after implementation of the alternative under consideration.

Sec. 300.68(a)(3) of the NCP states: Federal, state, and local permits are not required for Fund-financed remedial action or remedial actions taken pursuant to Federal action under Section 106 of CERCLA. However, remedial actions that involve storage, treatment, or disposal of hazardous substances or pollutants or contaminants at offsite facilities shall involve only such offsite facilities that are operating under appropriate Federal or state permits or authorization and other legal requirements. The Army is the lead agency in accordance with Executive Order 12316, the MOU between the Army and EPA, and the NCP. WVOW is being studied and evaluated in accordance with the RI/FS process described in the NCP and EPA's RI/FS guidance manuals. Other Federal agencies and their potential involvement with WVOW are presented in Table 4.3-1.

For all actions, therefore, the ability of the alternative to achieve the substantive requirements of local and state standards will be considered. However, remedial action alternatives will meet or exceed Federal requirements, including RCRA, SDWA, and CWA.

ORIGINAL
(Red)

Table 4.3-1. Federal Agency Coordination

Agency	Role
EPA	Through Executive Order 12316, the Army is the lead agency for sites where past activity has lead to onsite or offsite contamination. In accordance with this order and the NCP, an MOU was signed (Aug. 12, 1983) designating responsibilities for DOD agencies and EPA. For WVOW, the Army is the lead agency. However, EPA will write the Record of Decision (ROD).
Health and Human Services (HHS)	If necessary, HHS will be contacted for support in worker and community health and safety matters.
Occupational Safety and Health Administration (OSHA)	Operations onsite must meet OSHA regulations.
Bureau of Land Management (BLM)	No Federal lands are involved in the implementation of alternatives.
Advisory Council on Historic Preservation	No landmarks, historic sites, or areas of historic, scientific, or cultural interest will be affected by the implementation of alternatives.
U.S. Fish and Wildlife Service (USFWS)	No game species or fish are expected to be affected by implementation of alternatives. Regulatory lead will be provided by West Virginia DNR.
U.S. Forest Service (USFS)	No wild and scenic rivers will be affected by implementation of alternatives.
Department of Housing and Urban Development (HUD)	Coordination with HUD will not be necessary as the site does not lie in a floodplain.
DOT	All alternatives that include the offsite transportation of contaminated media will comply with DOT regulations regarding the transportation of hazardous materials.

Source: ESE, 1986c.

Under the NCP, permits are not excluded for offsite disposal actions (those involving removal and treatment, disposal, or destruction of wastes in offsite facilities). Offsite actions and their permit requirements for the three areas of concern at WVOW addressed in this FS are:

1. Transportation of hazardous waste to an offsite treatment, storage, or disposal facility (TSDF) requires RCRA TSDF and DOT permits.
2. Emissions of pollutants to the air must comply with the requirements of CAA depending on the substance emitted, its quantity, and the classification of the area.

4.3.1 COMPLIANCE WITH ENVIRONMENTAL STATUTES

In evaluating remedial action alternatives in accordance with the NCP, consideration is given to the substantive requirements of applicable or relevant and appropriate laws besides CERCLA for onsite activities and the requirements of such laws for offsite disposal actions. Primary consideration is given to attaining or exceeding relevant or applicable environmental and public health criteria and standards. In the alternatives assembled for WVOW and summarized in Tables 4.0-1 through 4.0-3, several environmental laws, regulations, and policies were considered applicable or relevant. These statutes, which were considered for some or all of the alternatives, are summarized in Table 4.3-2. Tables 4.3-3 through 4.3-5 summarize for each area the appropriateness and ability of the alternative considered to meet the applicable regulatory statutes. As appropriate, additional discussions of the applicability of specific regulations to alternatives are presented in Sec. 4.3.2.

4.3.2 SPECIFIC REQUIREMENTS OF REGULATORY STATUTES TO ALTERNATIVES

4.3.2.1 Offsite Disposal 1A and 1B Alternatives (TNT Manufacturing Area and Burning Grounds Area)

These alternatives consist of the incineration or landfilling of contaminated soils in an existing offsite RCRA-permitted facility.

Table 4.3-2. Summary of Applicable and Relevant or Appropriate Laws, Regulations, Policies, and Criteria

Law, Regulation, Policy, or Criterion	Analysis
Federal	
RCRA	Treatment and disposal of materials removed from WVOW to an offsite facility will be in compliance with current RCRA regulations issued in the HSWA of 1984. Onsite treatment and disposal operations will be in accordance with the substantive technical requirements of RCRA.
National Ambient Air Quality Standards (NAAQS)	Implementation of alternatives that include onsite incineration will result in the emission of pollutants into the air. The use of air pollution control equipment will minimize the effect of incinerator emissions on existing air quality. Incinerator performance standards will be attained, but permits will not be required. Because the emissions from surface flashing are largely uncontrollable, air quality standards may not be met during flashing operations. Particulate emissions during excavation will occur, although dust palliatives will be used to minimize fugitive dust. Onsite personnel, however, will be adequately protected.
DOT Hazardous Materials Transport Rules	The transport of hazardous materials to offsite facilities will be in compliance with these rules, including use of properly constructed and marked transport vehicles, a licensed transporter, and hazardous waste manifests.
Federal Water Quality Criteria (FWQC)	During the implementation of alternatives, the substantive requirements and standards of FWQC in creeks that drain the site and other downgradient surface water will be attained.

Table 4.3-2. Summary of Applicable and Relevant or Appropriate Laws, Regulations, Policies, and Criteria
(Continued, Page 2 of 2)

Law, Regulation, Policy, or Criterion	Analysis
Asbestos Disposal Rule (40 CFR, Part 61, Subpart M)	Since asbestos is present in the Burning Grounds Area, alternatives for asbestos disposal will meet or exceed this rule. Offsite alternatives will be in full compliance; onsite alternatives will meet technical requirements.
State of West Virginia Water Quality Standards (WVWQS)	In implementing alternatives, WVWQS in creeks that drain the site and other downgradient surface water will be considered. The substantive requirements will be complied with and the standards attained.
West Virginia Solid Waste Regulations	Implementation of alternatives will consider West Virginia regulations for noncontaminated materials taken to offsite sanitary landfills.
West Virginia Hazardous Waste Regulations	Implementation of alternatives will consider the requirements of current regulations, including manifest requirements.
West Virginia Air Pollution Control Commission (WVAPCC) Administrative Regulations	The substantive technical requirements of these regulations will be considered, and the standards and criteria of New Source Performance Standards (NSPS) will be considered.
West Virginia Pollution Discharge Elimination System (WVPDES) Regulations	The substantive technical requirements of these regulations will be considered, and the standards and criteria for point source discharges will be considered in implementation of the alternative.

Source: ESE, 1986c.

Table 4.3-3. Summary of Ability to Meet or Exceed Applicable Laws, Regulations, Policies, and Criteria for Alternatives for the TNT Manufacturing Area

Law, Regulation, Policy, or Criterion	ALTERNATIVE								
	Offsite Disposal 1A and 1B	Attains Requirements 2A	Attains Requirements 2B	Attains Requirements 2C	Exceeds Requirements 3A	Exceeds Requirements 3B	Exceeds Requirements 3C	CERCLA 4A	No Action 5A
RCRA	Meets	Meets	NA	NA	Meets	NA	NA	NA	NA
DOT	Meets	NA	NA	NA	NA	NA	NA	NA	NA
NAAQS	Meets	Meets	NA	NA	Meets	NA	NA	NA	NA
FWQC	Meets	Meets	Meets	Meets	Meets	Meets	Meets	Meets	Does Not Meet
Asbestos Disposal Rule	NA	NA	NA	NA	NA	NA	NA	NA	NA
WWQS	Considered	Considered	Considered	Considered	Considered	Considered	Considered	Considered	Does Not Meet
West Virginia Solid Waste Regulations	NA	NA	NA	NA	NA	NA	NA	NA	NA
West Virginia Hazardous Waste Regulations	Considered	Considered	Considered	Considered	Considered	Considered	Considered	Considered	Does Not Meet
WVAPCC	NA	Considered	NA	NA	Considered	NA	NA	NA	NA
WVPDES	NA	NA	NA	NA	NA	NA	NA	NA	NA

NA = Not Applicable.

Source: ESE, 1986c.

Table 4.3-4. Summary of Ability to Meet or Exceed Applicable Laws, Regulations, Policies, and Criteria for Alternatives for the Burning Grounds Area

Law, Regulation, Policy, or Criterion	ALTERNATIVE								
	Offsite Disposal 1A and 1B	Attains Requirements 2A	Attains Requirements 2B	Attains Requirements 2C	Exceeds Requirements 3A	Exceeds Requirements 3B	Exceeds Requirements 3C	CERCLA 4A	No Action 5A
RCRA	Meets	Meets	NA	NA	Meets	Meets	NA	NA	NA
DOT	Meets	NA	NA	NA	NA	NA	NA	NA	NA
NAAQS	Meets	Meets	Meets	Meets	Meets	Meets	Meets	NA	NA
FWQC	Meets	Meets	Meets	Meets	Meets	Meets	Meets	Meets	Does Not Meet
Asbestos Disposal Rule	Meets	Meets	Meets	Meets	Meets	Meets	Meets	Meets	NA
WWQS	Considered	Considered	Considered	Considered	Considered	Considered	Considered	Considered	Does Not Meet
West Virginia Solid Waste Regulations	NA	NA	NA	NA	NA	NA	NA	NA	NA
West Virginia Hazardous Waste Regulations	Considered	Considered	Considered	Considered	Considered	Considered	Considered	Considered	Does Not Meet
WVAPCC	NA	Considered	Considered	Considered	Considered	Considered	Considered	Considered	NA
WVPDES	NA	NA	NA	NA	NA	NA	NA	NA	NA

NA = Not applicable.

Source: ESE, 1986c.

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Table 4.3-5. Summary of Ability to Meet or Exceed Applicable Laws, Regulations, Policies, and Criteria for Alternatives for the Industrial Sewerlines

Law, Regulation, Policy, or Criterion	ALTERNATIVE					
	Attains Requirements 2A	Attains Requirements 2B	Exceeds Requirements 3A	Exceeds Requirements 3B	CERCLA 4A	No Action 5A
RCRA	Meets	NA	Meets	NA	NA	NA
DOT	NA	NA	NA	NA	NA	NA
NAAQS	Meets	Meets Flashing	Meets	Meets Flashing	Meets Flashing	NA
FWQC	Meets	Meets	Meets	Meets	Meets	Does Not Meet
Asbestos Disposal Rule	NA	NA	NA	NA	NA	NA
WVWQS	Considered	Considered	Considered	Considered	Considered	May Not Comply
West Virginia Solid Waste Regulations	NA	NA	NA	NA	NA	NA
West Virginia Hazardous Waste Regulations	Considered	Considered	Considered	Considered	Considered	NA
WVAPCC	Considered	Considered	Considered	Considered	Considered	NA
WVPDES	NA	NA	NA	NA	NA	NA

NA = Not applicable.

Source: ESE, 1986c.

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The implementation of offsite disposal alternatives will require compliance with several applicable or relevant and appropriate laws, regulations, policies, and criteria, specifically RCRA and DOT regulations.

Soil excavation equipment will generate noise offsite, but not in excess of OSHA noise standards. If OSHA standards are exceeded onsite, personnel will be required to wear ear protection.

For the Burning Grounds Area, disposal of asbestos in a landfill must also comply with the Asbestos Disposal Rule (40 CFR, Part 61, Subpart M).

4.3.2.2 Attains Requirements 2A Alternative (TNT Manufacturing Area, Burning Grounds Area, and Industrial Sewerlines)

Under this alternative, contaminated soil will be excavated and incinerated onsite. Incinerator ash, which will contain less than the 10^{-6} risk level (50 µg/g) of total nitroaromatics, will be used to backfill the excavated areas at each site. Because standards do not exist for nitroaromatics in soil, criteria developed in the EA will be used as a basis for this and other Attains Requirements alternatives.

The substantive technical requirements of RCRA will be attained during construction and operation of the onsite incinerator. To minimize airborne emissions produced during operation of onsite incinerators, pollution control devices will be installed to attain NAAQS standards. Operation of onsite incineration and treatment facilities will increase noise suppression devices so as not to exceed OSHA noise standards offsite. In addition, ear protection equipment will be worn by onsite personnel, as necessary.

Offsite disposal of asbestos from the Burning Grounds Area will meet the technical requirements of the Asbestos Disposal Rule for all onsite disposal alternatives.

4.3.2.3 Attains Requirements 2B Alternative

This alternative is similar to Alternative 2A except TNT residue will be flamed in place prior to soil excavation. Residues resulting from flaming will also be landfilled onsite. The volume of contaminated materials necessary to attain acceptable levels will be removed.

The construction of an onsite landfill will be in accordance with the technical requirements of RCRA as amended by HSWA of 1984. The landfill will have two liners with a leachate collection system above and between the liners. A ground water monitoring system will also be implemented as well as a leachate control system; therefore, point source discharge standards must be attained.

4.3.2.4 Attains Requirements 2C Alternative (TNT Manufacturing Area and Burning Grounds Area)

This alternative consists of the construction of a multimedia cap over the areas of contaminated soil. Contaminants will not be removed but isolated.

Construction of a multimedia cap will meet the technical requirements of RCRA as amended by HSWA. Post-closure ground water monitoring will be implemented.

4.3.2.5 Exceeds Requirements 3A Alternative (TNT Manufacturing Area, Burning Grounds Area, and Industrial Sewerlines)

This alternative consists of the excavation and onsite incineration of contaminated soil. Incinerator ash will be used as backfill in excavated areas. Contaminants will be treated to nondetectable levels.

Although the onsite incineration unit will meet or exceed the technical requirements of RCRA for operation and destruction efficiencies, this unit will produce airborne emissions during its operation. Pollution control devices will be installed on the equipment to meet WVAPPC

regulations. Operation of onsite incineration facilities will increase noise levels at the site. However, these facilities will be equipped with noise suppression devices, if necessary, so as not to exceed OSHA noise standards offsite.

4.3.2.6 Exceeds Requirements 3B Alternative (TNT Manufacturing Area, Burning Grounds Area, and Industrial Sewerlines)

In this alternative, contaminated soils and asbestos are excavated and placed in an onsite landfill. Reactive TNT residue will be flamed in place prior to soil excavation. The volume of contaminants necessary to attain nondetectable levels will be removed.

The construction of the onsite landfill will be consistent with the technical requirements of RCRA as amended by HSWA. The landfill will have two liners with a leachate collection system above and between the liners. A ground water monitoring system will also be implemented.

4.3.2.7 Exceeds Requirements 3C Alternative (TNT Manufacturing Area and Burning Grounds Area)

This alternative is the same as discussed for the 2C Alternative except contaminated soil is capped to more stringent requirements.

Construction of a multimedia cap will meet the technical requirements of RCRA as amended by HSWA. Post-closure ground water monitoring will be implemented.

4.3.2.8 CERCLA 4A Alternative (TNT Manufacturing Area, Burning Grounds Area, and Industrial Sewerlines)

In this alternative, a soil cover will be placed over contaminated soil areas. The contaminated soil is not removed; reactive TNT residue will be flamed in place prior to placing cover material.

Unlike the previous alternatives, this alternative will not meet Federal and state closure requirements. However, this alternative will eliminate

the exposure pathway (i.e., direct contact, ingestion, inhalation, and food-chain concentration) identified in the EA.

4.3.2.9 No Action 5A Alternative

This alternative consists of leaving the site in its current state and taking no action except to periodically monitor ground water and Pond 34. Endangerment to public health, welfare, and the environment will not be mitigated. Federal and state water quality criteria may be exceeded by surface runoff from the site during the 100-year storm event as a result of leaving contaminants in place and uncovered.

4.4 PUBLIC HEALTH EVALUATION OF ALTERNATIVES

The remedial action alternative selected for WVOW should adequately protect public health and welfare. As shown in Sec. 4.2, Sec. 300.68 (h)(2)(iv) of the NCP requires "an assessment of the extent to which the alternative is expected to effectively prevent, mitigate, or minimize threats to, and provide adequate protection of, public health and welfare, and the environment. This shall include an evaluation of the extent to which the alternative attains or exceeds applicable or relevant and appropriate Federal public health and environmental requirements." The public health evaluation discussed in this section presents the public health effectiveness attained by each alternative in the TNT Manufacturing Area, Burning Grounds Area, and Industrial Sewerlines. The extent to which each alternative meets the site-specific criteria established in the EA, minimizes or prevents exposure of the public to the contaminants at the site, minimizes or prevents potential exposure to the public expected during the remedial action, and minimizes or prevents the potential exposure expected after implementation of the remedial action is also discussed.

4.4.1 PUBLIC HEALTH EVALUATION OF OFFSITE DISPOSAL 1A2, 1B1, AND 1B2 ALTERNATIVES

These alternatives consist of incinerating or landfilling contaminated soil in existing offsite RCRA-permitted or interim-status facilities and landfilling asbestos in a local sanitary landfill. No offsite option exists for reactive TNT residue and Industrial Sewerlines. The reactive materials would be flamed onsite to eliminate the reactive nature of the material and would then be transported offsite for disposal.

These alternatives eliminate the exposure pathways of direct contact, ingestion, inhalation, and food-chain concentration for soil and asbestos. These pathways are eliminated through source control (removal and treatment of contaminated soil and asbestos). All contaminants will be removed to below detectable or 10^{-6} risk levels.

Negative public health effects are confined mainly to short-term effects relating to removal activities. Soil excavation equipment will generate noise, but not in excess of OSHA noise standards offsite. If OSHA standards are exceeded onsite, personnel will be required to wear ear protection. Onsite personnel will also be protected from the potential instability of chunks of crystalline TNT. All onsite personnel will wear protective clothing and be trained for safe handling of the material.

Soil and asbestos excavation activities will generate limited amounts of dust and particulates. Dust control measures will be implemented to reduce airborne contaminated soil particles and particulates and prevent exposure by inhalation. These measures may include the spraying of water and ceasing excavation when climatic conditions could cause any visible fugitive emissions. Trucks hauling the excavated contaminated soil and asbestos will be covered and decontaminated prior to leaving the site to prevent the distribution of soil and asbestos offsite.

The exposure of contaminated soil and asbestos/rubble to rainwater during excavation activities may result in the contamination of surface water. Berms and swales will be constructed to prevent both surface water runon and runoff. These measures minimize ponding and prevent the migration of this contaminated surface water from the site. The runoff water that is collected will be transported offsite and treated at a RCRA-permitted facility.

The loading of contaminated materials into trucks for transport offsite presents a potential spill and additional exposure situation at the loading site. Spill pads will be constructed to collect any spilled material. These and other activities will be discussed in a Spill Prevention Plan prepared prior to implementation of either alternative.

A specific hauling route for contaminated materials will be developed in consultation with local officials so as to present least exposure to

persons along the route. Local officials will be kept informed of hauling schedules.

Implementation of these alternatives will result in the removal of all contaminants from the area. The removal of site contaminants will eliminate exposure risks to the surrounding population and users of the wildlife area. This removal will also eliminate the continued migration of contaminants. With the contaminants removed from the area, barriers to continued use of the site will have been removed. Restoration activities implemented on completion of cleanup activities will aesthetically improve the site. No permanent hazardous waste management facilities will be constructed as a result of these alternatives.

4.4.2 PUBLIC HEALTH EVALUATION OF ATTAINS REQUIREMENTS 2A ALTERNATIVES
Under these alternatives, contaminated soils and sewerlines are excavated and incinerated onsite. Incinerator ash will be used as backfill. Asbestos will be disposed of in an offsite landfill. Reactive TNT residue at the Burning Grounds Area will be flamed prior to soil excavation.

The exposure pathways of direct contact, ingestion, inhalation, and food-chain concentration for soils, sewerlines, and asbestos will be prevented by these alternatives. This is accomplished through the destruction of the contaminants present at the site to 10^{-6} risk levels.

Implementation of these alternatives requires excavation of contaminated soils, sewerlines, and asbestos. The public health impacts of and mitigation measures for this action are the same as discussed for the offsite disposal alternatives. Asbestos will be transported offsite in covered trucks that will be decontaminated prior to leaving the site.

Onsite incineration facilities will produce airborne emissions during their operation. Pollution control devices will be installed on the incineration equipment to meet current regulations and standards.

Operation of onsite incineration facilities will increase noise levels at the site. These facilities will be equipped with noise suppression devices so as not to exceed OSHA noise standards offsite. In addition, ear protection equipment will be worn by onsite personnel, if necessary.

Onsite personnel will be protected from the potential instability of chunks of crystalline TNT. All onsite personnel will wear protective clothing and be trained for safe handling of the material.

Purchase of additional land will not be required. No permanent facilities are constructed due to the use of a mobile incinerator. Restoration measures to be employed will not restrict continued use of the site as a wildlife preserve and may improve the potential for such use in the future.

Implementation of these alternatives will result in the destruction and removal of site contaminants. This will remove exposure risks to the surrounding population and users of the wildlife area. These actions will also eliminate the continued migration of contaminants. Restoration activities implemented upon completion of cleanup activities will aesthetically improve the site.

4.4.3 PUBLIC HEALTH EVALUATION OF ATTAINS REQUIREMENTS 2B ALTERNATIVES

Under these alternatives, contaminated soil and asbestos/rubble are excavated and landfilled onsite. Reactive TNT residue at the Burning Grounds Area will be flamed in place prior to excavation of contaminated soil. Industrial Sewerlines will be excavated and flashed prior to disposal in the onsite landfill.

The exposure pathways of direct contact, ingestion, inhalation, and food-chain concentration for contaminated soil, sewerlines, and asbestos will be prevented by this alternative as well as the pathways of direct

contact and ingestion for surface water. This is accomplished through the destruction and isolation of the contaminants present at the site to 10^{-6} risk levels.

Public health effects of and mitigation measures for excavation are the same as for Alternative 2A. Surface flashing and burning will produce largely uncontrollable particulate emissions. Onsite personnel will be adequately protected. To minimize exposure to the surrounding population and users of the wildlife area, flashing will not occur on windy days. Onsite personnel will also be protected from the potential instability of crystalline TNT, as discussed for Alternative 2A.

Heavy equipment used to construct the onsite landfill will increase noise levels at the site. Effects of this noise and the mitigation measures to be employed are as discussed for Alternative 2A.

Implementation of these alternatives will isolate contaminants in an onsite landfill. Contaminants remaining will be at acceptable levels such that an endangerment to public health will not exist. The onsite landfill will be a permanent hazardous waste management facility. This facility will be adequately maintained and properly monitored in accordance with existing regulations, and land use restrictions will be implemented to prevent future exposure from the landfilled contaminants.

4.4.4 PUBLIC HEALTH EVALUATION OF ATTAINS REQUIREMENTS 2C ALTERNATIVES
These alternatives consist of construction of a multimedia cap over the areas of contaminated soil. Reactive TNT residue at the Burning Grounds Area will be flamed in place prior to construction of the cap. Asbestos will be transported offsite for disposal in a local sanitary landfill. Industrial sewerlines will be excavated, flashed, and returned as backfill to the excavation.

The exposure pathways of direct contact, ingestion, and food-chain concentration for contaminated soil and asbestos will be prevented by this alternative, as will the pathway of inhalation for asbestos. This is accomplished through the destruction and isolation of soil contaminants present at the site and the removal of asbestos.

Short-term public health effects for these alternatives are confined primarily to surface flashing and construction activities. These effects and mitigation measures will be the same as discussed for Alternative 2B.

Institutional impacts of this alternative are both short-term and long-term. Also, political jurisdictions other than Mason County, WV, will not be affected. Construction of a multimedia cap will preclude the use of the capped areas for any other purpose because of the contaminated soil remaining below the cap. Additional land use restrictions may need to be implemented to prevent breaches of the cap's integrity. Long-term O&M will be required for the cap. Purchase of additional land will not be required.

Construction of the multimedia cap will isolate soil contaminants from direct contact by humans and indigenous plants and animals, thus removing the existing endangerment. These actions will also eliminate the potential migration of contaminants during the 100-year storm event. The remaining contaminated soil will not present an endangerment unless the integrity of the multimedia cap is breached. The capped areas will be a permanent hazardous waste management facility. The cap will be adequately maintained and monitored to prevent future exposure from the capped contaminants. Restoration activities implemented upon completion of cleanup activities will not restrict continued use of the site as a wildlife preserve.

4.4.5 PUBLIC HEALTH EVALUATION OF EXCEEDS REQUIREMENTS 3A ALTERNATIVES
These alternatives consist of the excavation and onsite incineration of TNT residue, contaminated soil, industrial sewerlines, and the removal of asbestos material offsite to a sanitary landfill. Incinerator ash will be used as backfill in excavated areas.

The exposure pathways of direct contact, ingestion, and food-chain concentration for soil, sewerlines, and asbestos will be prevented by these alternatives, as will the pathway of inhalation for asbestos. This is accomplished through the destruction and removal of the contaminants present at the site to below detectable levels.

Implementation of these alternatives requires excavation of soil. The public health impacts of and mitigation measures for this action are the same as discussed for the offsite disposal alternatives. Offsite transport of asbestos will occur in covered trucks that will be decontaminated prior to leaving the site to prevent the spread of contaminants from the site.

Although the onsite incineration unit will meet or exceed the technical requirements of RCRA for operation and destruction efficiencies, it will produce airborne emissions during operation. Pollution control devices will be installed on the equipment to meet current standards and regulations. Operation of onsite incineration facilities will increase noise levels at the site. However, these facilities will be equipped with noise suppression devices, if necessary, so as not to exceed OSHA noise standards offsite. In addition, any necessary ear protection equipment will be worn by onsite personnel.

Onsite personnel will also be protected from the potential instability of chunks of crystalline TNT. All onsite personnel will wear protective clothing and be trained for safe handling of the material.

The removal and destruction of site contaminants to below detectable levels will remove exposure risks to potential receptors and users of the wildlife area. These actions will also eliminate the potential migration of contaminants during the 100-year storm event. Restoration measures to be employed will not restrict continued use of the site as a wildlife preserve and may improve the potential for such use in the future. No permanent hazardous waste management facilities will be constructed due to the use of a mobile incineration system.

4.4.6 PUBLIC HEALTH EVALUATION OF EXCEEDS REQUIREMENTS 3B ALTERNATIVES
In these alternatives, contaminated soil is excavated and placed in an onsite landfill. TNT residue at the Burning Grounds Area will be flamed in place prior to soil excavation. Asbestos is excavated and also placed in the onsite landfill. Industrial sewerlines are excavated, flashed, and backfilled onsite.

The public health impacts are the same as 2B Alternatives. However, contaminated soil will be removed to more stringent levels (below detection) than in 2B Alternatives.

4.4.7 PUBLIC HEALTH EVALUATION EXCEEDS REQUIREMENTS 3C ALTERNATIVES
These alternatives consist of construction of a multimedia cap over the areas of contaminated soil. Reactive TNT residue at the Burning Grounds Area will be flamed in place prior to construction of the cap. Asbestos will be transported offsite for disposal in a local sanitary landfill. Industrial sewerlines will be excavated, flashed, and returned as backfill to the excavation.

The public health impacts are the same as 2C Alternatives. However, contaminated soil will be covered to more stringent levels (below detection) than in 2B Alternatives.

4.4.8 PUBLIC HEALTH EVALUATION OF CERCLA 4A ALTERNATIVES

In these alternatives, contaminated soil is covered with soil. TNT residue at the Burning Grounds Area will be flamed in place prior to soil cover. The industrial sewerlines will be excavated, flashed, and backfilled onsite. Asbestos will be transported offsite to a local sanitary landfill.

These alternatives eliminate exposure to contaminants and endangerment to public health.

Construction of a soil cap and treatment of industrial sewerlines prevent direct contact with and ingestion of contaminated soils, sewerlines, and asbestos through construction of physical and legal barriers. These barriers also eliminate the pathway of inhalation for asbestos. The contaminated soil is not removed. However, the physical and legal barriers employed will eliminate the endangerment posed by these materials.

Short-term public health impacts for these alternatives are confined primarily to flashing, flaming, and construction-related activities and are the same as discussed for 2C Alternatives.

Construction of the soil cover will isolate soil contaminants from direct contact by humans and indigenous plants and animals. The covered areas will be a permanent hazardous waste management facility. The cover will be adequately maintained and monitored to prevent future exposure to the capped contaminants. Restoration activities implemented upon completion of remedial activities will not restrict the continued use of the site as a wildlife preserve.

4.4.9 PUBLIC HEALTH EVALUATION OF NO ACTION 5A ALTERNATIVES

This alternative consists of leaving the site in its current state and taking no action except to periodically monitor ground water [illegible]. Endangerment to public health will not be mitigated. This alternative may hinder the continued use of the site as a wildlife preserve.

4.5 DETAILED COST ANALYSIS OF ALTERNATIVES

Costs have been estimated for the remedial alternative components and the remedial alternatives as described in Sec. 3.0. Capital and O&M (including monitoring and post-closure care) costs were determined. In developing detailed cost estimates, the following steps were performed:

1. Estimation of costs: Capital and O&M costs were estimated for each remedial action alternative.
2. Present-worth analysis: Using estimated cost, the present-worth for each alternative was calculated using a discount factor of 10 percent.
3. Sensitivity analysis: The sensitivity of cost estimates to changes in key parameters, such as discount rates, was evaluated.
4. Cost-benefit analysis: This benefit analysis is based on the technical, environmental, institutional, and cost evaluations presented in preceding sections.

The data developed from the cost analysis provided input toward the selection of a recommended remedial alternative. A summary of the detailed cost estimates is contained in App. B.

4.5.1 COST ESTIMATION

Cost elements were identified for each component within a remedial alternative. Each cost element was determined to be either a capital cost or an O&M cost.

Capital costs are those expenditures that are initially incurred to develop and install a remedial action and major capital expenditures anticipated in future years. Both direct and indirect costs are included under capital costs.

Direct costs include construction costs, land and site development expenses, and costs for temporary buildings and services required for

mobilization purposes. Indirect costs include contingencies to total capital for unforeseen circumstances and scope changes which result in higher costs. In addition, engineering expenses, legal fees/permit costs, and startup/shakedown costs, when applicable, are calculated as indirect costs. All indirect costs are calculated as a percentage of the direct capital cost of each component.

O&M costs are those post-construction/installation costs necessary to ensure the continued effectiveness of a remedial action. O&M costs include such elements as post-closure well monitoring and maintenance of an onsite landfill. O&M costs are calculated on an annual basis.

The remedial alternatives capital and O&M costs for each component are presented in Tables 4.5-1 through 4.5-3.

In Table 4.5-1, the capital cost for the onsite landfill is about 2 percent less than the capital cost for the multimedia cap. This reflects the dependency of these costs on the cost of construction materials. The surface area to be capped under the multimedia cap alternative is significantly greater than the surface area of the landfill requiring similar materials. The cost of liners, filter fabrics, and soil placement for the cap offsets the excavation and design costs associated with the landfill. However, the O&M and present-worth costs for the landfill are consistently higher than the multimedia cap for the Attains and Exceeds Standards alternatives.

Table 4.5-1. Cost Components for the TNT Manufacturing Area Alternatives

Alternatives	Cost Components ($ x 1,000)																								Total	
	Stream		Solidification		Capping		Excavation and Loading		Offsite Area Landfill		Local Sanitary Landfill		Onsite RCRA Landfill		Offsite Incinerator		Planting		Onsite Incinerator		Surface Water Management		Backfill		Closure		Capital	O&M
	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M		
Offsite 1B2 Excavation (6,750 cy) Offsite Incinerator	25.5	—	166.6	—	—	—	148.1	—	—0	—	—	—	—	—	21,471.3	—	—	—	—	—	197.6	—	52.7	—	61.6		27,970.9	
Offsite 1B Excavation (51,000 cy) Offsite Landfill	88.7	—	166.2	—	—	—	1,311.1	—	11,677.6	—	21.2	—	—	—	—	—	8.9	--	—	--	199.2	—	402.1	—	171.2	--	16,207.2	
Offsite 1B2 Excavation (6,750 cy) Offsite Landfill	25.5	—	163.1	—	—	—	148.1	—	1,971.1	—	—	—	—	—	—	—	8.9	—	—	—	197.6	—	52.7	—	38.3		2,707.1	-
Action Requirements 2A Excavation (6,750 cy) Onsite Incinerator	42.7	—	276.1	—	—	—	148.1	—	—	—	—	—	—	—	—	—	—	—	3,788.9	—	197.6	—	7.7	—	66.3		4,779.7	
Action Requirements 2B Excavation (6,750 cy) Planting (19,200 ft²) Onsite Landfill	42.1	—	198.1	—	—	—	151.5	—	—	—	—	—	473.3	5.7	—	—	8.9	—	—	—	175.8	—	9.7	—	46.7		1,066.1	5.7
Action Requirements 2C Multimedia Cap (20,000 sq yd)	30.6	—	179.0	—	711.1	2.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	386.9	—	—	—	75.2		1,389.8	2.3
Remedy Requirements 3A Excavation (51,000 cy) Onsite Incinerator	70.3	—	436.7	—	—	—	1,311.1	—	—	—	21.2	—	—	—	—	—	—	--	21,088.8	—	538.2	—	61.1	—	186.2		24,139.6	
Remedy Requirements 3B Excavation (51,000 cy) Planting (19,200 sq yd) Onsite Landfill	98.3	—	168.9	—	—	—	1,311.1	—	—	—	—	—	3,686.8	38.5	—	—	8.9	--	—	--	402.6	—	86.1	—	138.1		5,837.8	38.5
Remedy Requirements 3C Multimedia Cap (51,795 sq yd)	388.9	—	302.7	—	2,636.1	9.6	—	—	—	—	—	—	—	—	—	—	—	--	—	--	538.8	68.6	—	—	186.7		4,787.9	9.6
ARAR 4A Soil Cover (20,000 sq yd)	98.8	—	52.8	—	488.5	1.7	—	—	—	—	—	—	—	—	—	—	1-	—	—	—	38.6	—	—	—	11.8		741.7	1.7
No Action Alternative Monitoring	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8	--	—	-			8

- Not applicable

Source: EPA, 1987.

Table 4.5-2. Cost Components for the Barclay Grounds Area Alternatives

Alternatives	Cost Component ($ x 1,000)																											
	Bitumuk		Rehilitation		Capping		Excavation and Loading		Offsite Area Landfill		Local Sanitary Landfill		Onsite RCRA Landfill		Offsite Incinerator		Flaming		Onsite Incinerator		Surface Water Management		Backfill		Closure		Total	
	Capital	OSM	Capital	OSM	Capital	OSM	Capital	OSM	Capital	OSM	Capital	OSM	Capital	OSM	Capital	OSM	Capital	OSM	Capital	OSM	Capital	OSM	Capital	OSM	Capital	OSM	Capital	OSM
Offsite 1A2 Excavation (1,625 cy) Offsite Incinerator	19.9	—	115.8	—	—	—	75.8	—	—	—	1.7	—	—	—	10,687.4	—	—	—	—	—	58.3	—	38.2	—	20.5	--	10,777.3	
Offsite 1B1 Excavation (17,000 cy) Offsite Landfill	38.2	—	121.9	—	—	—	412.8	—	4,738.2	—	1.5	—	—	—	—	—	—	—	—	—	61.3	—	168.3	—	51.6	-	5,595.9	-
Offsite 1B2 Excavation (1,625 cy) Offsite Landfill	19.9	—	115.8	—	—	—	75.8	—	953.7	—	1.7	—	—	—	—	—	2.1	—	—	—	58.3	—	38.2	—	20.5	-	1,271.8	-
Attain Requirements 2A Excavation (1,625 cy) Onsite Incinerator	35.8	—	197.6	—	—	—	88.9	—	—	—	1.7	—	—	—	—	—	—	—	1,886.9	—	58.3	—	6.2	—	26.3	-	2,301.8	--
Attain Requirements 2B Excavation (1,625 cy) Flaming (6,523 ft²) Onsite Landfill	35.8	—	156.6	—	—	—	81.9	—	—	—	—	—	369.0	6.1	—	—	2.1	—	—	—	58.3	—	6.3	—	21.9	-	673.8	6.1
Attain Requirements 2C Multimedia Cap (5,136 sq yd)	38.5	—	116.1	—	378.2	1.6	—	—	—	—	1.7	—	—	—	—	—	2.1	—	—	—	66.1	—	—	—	17.6	-	599.1	1.6
Exceeds Requirements 2A Excavation (17,000 cy) Onsite Landfill	53.7	—	223.3	—	—	—	412.8	—	—	—	1.7	—	—	—	—	—	—	—	7,888.5	—	26.1	—	38.8	—	98.6		8,698.5	
Exceeds Requirements 2B Excavation (17,000 cy) Flaming (6,523 ft²) Onsite Landfill	53.7	—	167.8	—	—	—	412.8	—	—	—	—	—	1,138.5	11.1	—	—	2.1	—	—	—	26.1	—	22.8	—	57.7	--	1,903.7	11.1
Exceeds Requirements 2C Multimedia Cap (18,766 sq yd)	98.8	—	138.9	—	1,381.6	3.8	—	—	—	—	1.7	—	—	—	—	—	2.1	—	—	—	61.1	—	—	—	47.6		1,631.6	3.8
CFR13A 66 Soil Cover (5,136 sq yd)	38.5	—	25.8	—	138.6	0.9	—	—	—	—	1.7	—	—	—	—	—	2.1	—	—	—	42.2	—	—	—	17.8		326.7	0.9
No Action 3A Monitoring	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	—	—	--			5

-- = Not applicable

Source: ERT, 1990

Table 4.5 2. Cost Components for the Industrial Incinerator Alternatives

Alternatives	Cost Component ($ x 1,000)																											
	Mobilization		Stabilization		Capping		Excavation and Loading		Offsite Area Landfill		Local Sanitary Landfill		Onsite RCRA Landfill		Offsite Incinerator		Flushing		Onsite Incinerator		Surface Water Management		Backfill		Closure		Total	
	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M
Action Requirements 2A, Excavation (20,000 cy) Onsite Incinerator on Landfill (Trenchless)	91.5	—	385.7	—	—	—	157.2	—	—	—	—	—	—	—	—	—	—	—	399.9	—	157.6	—	2.3	—	175.6	—	1,369.8	—
Action Requirements 2B, Excavation (20,000 cy) Flushing (65,000 lf) Onsite Landfill (Trenchless)	91.5	—	388.6	—	—	—	156.6	—	—	—	—	—	71.7	2.2	—	—	20.6	—	—	—	157.6	—	2.5	—	156.9	—	951.6	2.2
Remedy Requirements 2A, Excavation (67,000 cy) Onsite Incinerator (Trenchless/Soils)	83.9	—	361.7	—	—	—	804.5	—	—	—	—	—	—	—	—	—	—	—	12,099.9	—	388.3	—	38.7	—	367.6	—	14,338.7	—
Remedy Requirements 2B, Excavation (67,000 cy) Flushing (65,000 cy yd) Landfill (Trenchless/Soils)	83.9	—	338.7	—	—	—	804.5	—	—	—	—	—	1,082.8	17.2	—	—	39.5	—	—	—	388.3	—	43.1	—	367.6	—	3,588.6	17.2
CPOTLB 4A Flushing (000 cy)	38.3	—	388.1	—	—	—	165.6	—	—	—	—	—	—	—	—	—	20.6	—	—	—	157.6	—	2.5	—	156.5	—	871	—
No Action 3A Monitoring	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.3	—	—	—		—	2.3

— = Not applicable.

Source: ESE, 1986.

4.5.2 PRESENT-WORTH ANALYSIS

Present-worth costs were calculated for the remedial alternatives. Calculations were based on a 10-percent discount rate over a 30-year period. Costs in future years were not escalated to account for general price inflation, as per current Office of Management and Budget (OMB) guidance (EPA, 1985e). Present-worth costs are contained in Table 4.5-4.

If the remedial alternatives for the three areas of concern are combined in one alternative that addresses the WVOW site as a whole, cost savings are expected. Table 4.5-5 presents a comparison of the present-worth costs for the combined alternative and the summed total for the three areas.

Table 4.5-4. Present-Worth Costs for Remedial Alternatives

Alternative	TNT Manufacturing Area			Burning Grounds Area			Industrial Sewerlines		
	Capital (x $1,000)	O&M (x $1,000)	Present Worth (x $1,000)	Capital (x $1,000)	O&M (x $1,000)	Present Worth (x $1,000)	Capital (x $1,000)	O&M (x $1,000)	Present Worth (x $1,000)
Offsite 1A2 Excavation to attain criteria; offsite incineration	22,030	0	22,030	10,722	0	10,722			
Offsite 1B1 Excavation to exceed criteria; offsite landfill	16,287	0	16,287	5,575	0	5,575			
Offsite 1B2 Excavation to attain criteria; offsite incineration	2,582	0	2,582	1,271	0	1,271			
Attains Requirements 2A Excavation; onsite incineration	4,229	0	4,229	2,382	0	2,382	1,310	0	1,310
Attains Requirements 2B Excavation; flashing; onsite landfill	1,066	6	1,123	624	4	662	954	2	973
Attains Requirements 2C Multimedia cap	1,090	2	1,109	600	1	609			
Exceeds Requirements 3A Excavation; onsite incineration	26,339	0	26,339	8,459	0	8,459	14,332	0	14,332

Table 4.5-4. Present-Worth Costs for Remedial Alternatives (Continued, Page 2 of 2)

Alternative	TNT Manufacturing Area			Burning Grounds Area			Industrial Sewerlines		
	Capital (x $1,000)	O&M (x $1,000)	Present Worth (x $1,000)	Capital (x $1,000)	O&M (x $1,000)	Present Worth (x $1,000)	Capital (x $1,000)	O&M (x $1,000)	Present Worth (x $1,000)
Exceeds Requirements 3B Excavation; flashing; onsite landfill	5,678	31	5,970	1,924	11	2,028	3,518	17	3,678
Exceeds Requirements 3C Multimedia cap	4,798	9	4,883	1,632	4	1,670			
CERCLA 4A (TNT/BG Areas) Soil cover	594	2	613	327	1	336			
CERCLA 4A (Sewerlines) Excavate; flashing; backfill							855	0	855
No Action 5A Monitoring	0	8	75	0	5	47	0	2	19

Source: ESE, 1986c.

Table 4.5-5. Summed Cost of Alternatives Versus the Combined Alternative Cost

Alternative	TNT Manufacturing Area (A)		Burnings Grounds Area (B)		Industrial Sewerlines (C)		Alternatives Summary (A + B + C)		Combined Alternative		Cost Difference
	Quantity cy (sq yd)	Cost (x $1,000)	Quantity cy (sq yd)	Cost (x $1,000)	Quantity cy (sq yd)	Cost (x $1,000)	Quantity cy (sq yd)	Cost (x $1,000)	Quantity cy (sq yd)	Cost (x $1,000)	(x $1,000)
Offsite Category											
1A2-Incineration	6,710	22,030	3,625	10,722			10,335	32,752	10,335	28,532	4,220
1B1-Landfill	53,000	16,287	17,000	5,575			70,000	21,862	70,000	21,393	469
1B2-Landfill	6,710	2,582	3,625	1,271			10,335	3,853	10,335	3,650	203
Attains Requirements											
2A-Incineration	6,710	4,229	3,625	2,382	680	1,310	11,015	7,921	11,015	6,487	1,434
2B-Landfill	6,710	1,123	3,625	662	680	973	11,015	2,758	11,015	2,276	482
2C-Multimedia Cap	(10,060)	1,109	(5,134)	609			(15,194)	1,718	(15,194)	1,646	72
Exceeds Requirements											
3A-Incineration	53,000	26,339	17,000	8,459	29,680	14,332	99,680	49,130	99,680	46,421	2,709
3B-Landfill	53,000	5,970	17,000	2,028	29,680	3,678	99,680	11,676	99,680	10,638	1,038
3C-Multimedia Cap	(51,255)	4,883	(18,556)	1,670			(69,811)	6,553	(69,811)	6,419	134
CERCLA											
4A-TNT/BG	(10,060	613	(5,134)	336			(15,194)	949	(15,194)	947	2
4A-Sewerlines					680	855	680	855	680	855	0
No Action											
5A-Monitoring	30 years	75	30 years	47	30 years	19	30 years	141	30 years	141	0

Source: ESE, 1986c.

4.5.3 SENSITIVITY ANALYSIS

The purpose of the sensitivity analysis is to identify factors that can significantly change overall costs with small changes in the value of the factor. The identification of these factors and their impact are important in order to determine uncertainties in cleanup costs based on the site data available and to provide estimates for contingency or reserve funds.

Factors for WVOW which were assessed for their impact on costs included:

1. Effective life of remedial action,
2. O&M costs,
3. Period of performance,
4. Extent of cleanup (particularly pertaining to quantities of soil requiring excavation/treatment), and
5. Discount rate.

Effective life was not considered a significant factor for any of the alternatives because replacement costs of equipment or facilities are not necessary to maintain the effectiveness of the remedial actions evaluated. Period of performance was also not considered a factor because, with the exception of Alternatives 2A and 3A (which include incineration), the remedial actions are completed within 1 year. For Alternatives 2A and 3A (which extend up to 4 years), the major impact is one of contaminated volume rather than of the time value of money. The schedule for completing the incineration of materials can be expedited by use of multiple offsite incinerators or multiple or layer capacity onsite incinerators.

As shown in Tables 4.5-1 through 4.5-3, O&M costs for all alternatives considered are of a significantly lower magnitude compared to the capital cost of implementing the alternative. This is because the continual maintenance of the completed remedial action consists at most of the treatment of leachate and stormwater runoff and maintenance of

cap, as would be done for Alternative 3A. Hence, the overall remedial action costs are not sensitive to O&M activities or costs.

The most significant factor impacting remedial action cost is the extent of contamination. Figs. 4.5-1 through 4.5-6 are curves showing for each of the alternatives considered for the TNT Manufacturing Area the total cost of the alternative and the cost per cubic yard of contaminated material as a function of the potential quantity considered as contaminated.

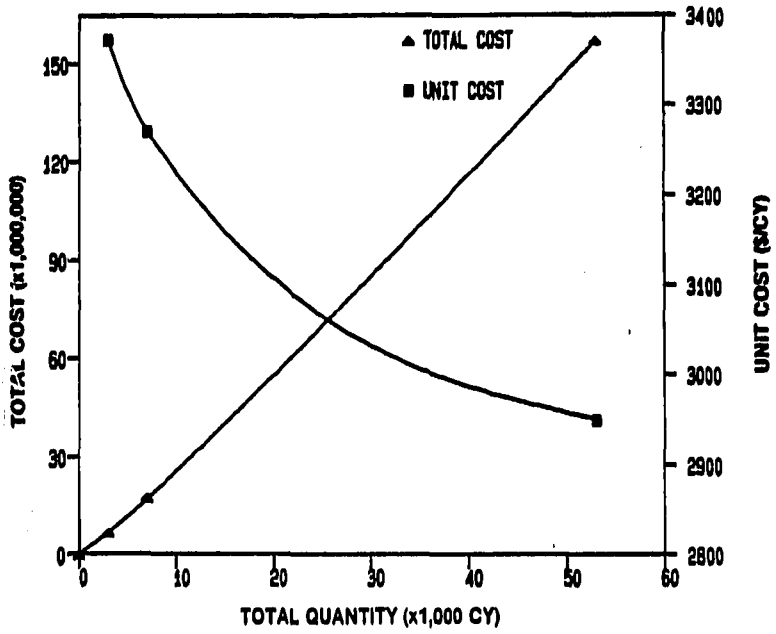
For Alternative 1A (which involves excavation, transportation, and offsite incineration), remedial action cost is significantly affected by slight changes in extent of contamination. As shown by Fig. 4.5-1, an increase from 30,000 to 32,000 cy (midrange of the quantity considered) could result in an overall cost increase of $6,000,000 or $3,000/cy. As shown by the unit cost curve, for small-volume quantities, the cost sensitivity is greater at approximately $3,400/cy. This is due to the significant mobilization and upfront costs that must be spread out over the quantity incinerated. As the quantity increases, upfront costs are absorbed and the unit cost approaches approximately $2,950/cy.

Alternative 1B is also highly sensitive to quantity, as shown by Fig. 4.5-2. An increase from 30,000 to 32,000 cy results in a total cost increase of approximately $600,000 or $300/cy. As shown by the unit cost curve, upfront and fixed costs impact remediation costs of lesser quantities (up to 20,000 cy) to a greater extent (up to $400/cy). The major cost components for these alternatives are the transportation and disposal in the offsite landfill. These are commercial charges and are not typically quantity discounted.

As shown in Fig. 4.5-3, costs for Alternative 2A (which incorporates onsite incineration) are also highly sensitive to the extent of

ORIGINAL
(Red)

WVOW PATH 8/96



SOURCE: ESE, 1986c.

Figure 4.5-1
TOTAL COSTS AND UNIT COSTS vs. QUANTITY FOR THE TNT MANUFACTURING AREA—OFFSITE INCINERATION

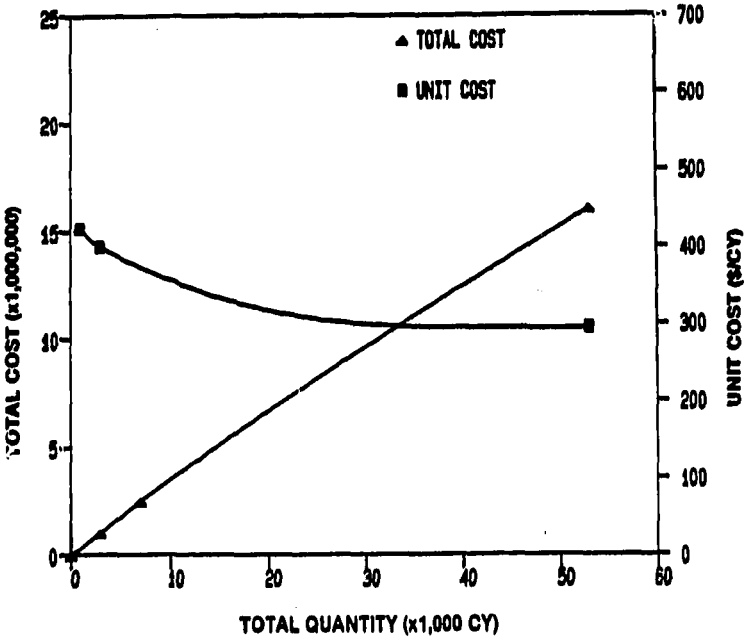
WEST VIRGINIA ORDNANCE WORKS
Feasibility Study

AR303603

AR303603

ORIGINA
(Red)

WVOW PATH 606



SOURCE: ESE, 1988c.

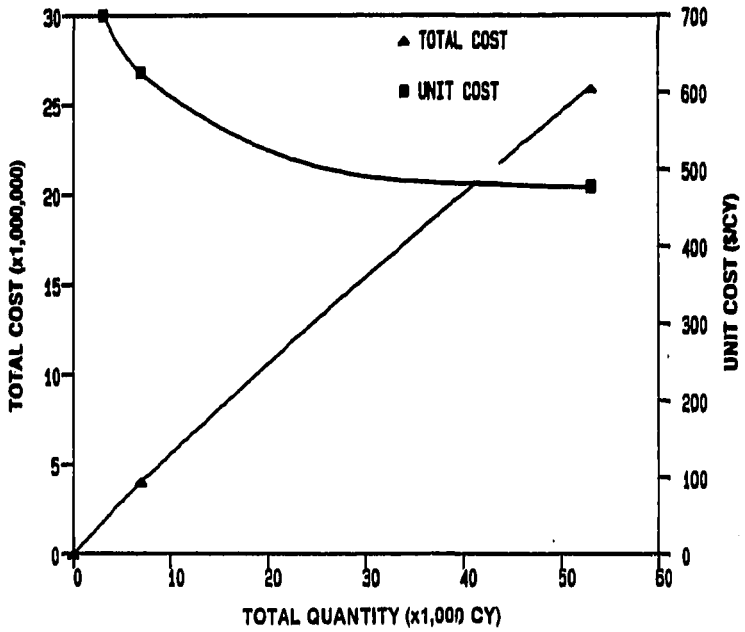
Figure 4.5-2
TOTAL COSTS AND UNIT COSTS vs. QUANTITY FOR THE TNT MANUFACTURING AREA—OFFSITE LANDFILL

AR303604

WEST VIRGINIA ORDNANCE WORKS
Feasibility Study

ORIGINAL (Red)

WYOW PATH 5/96

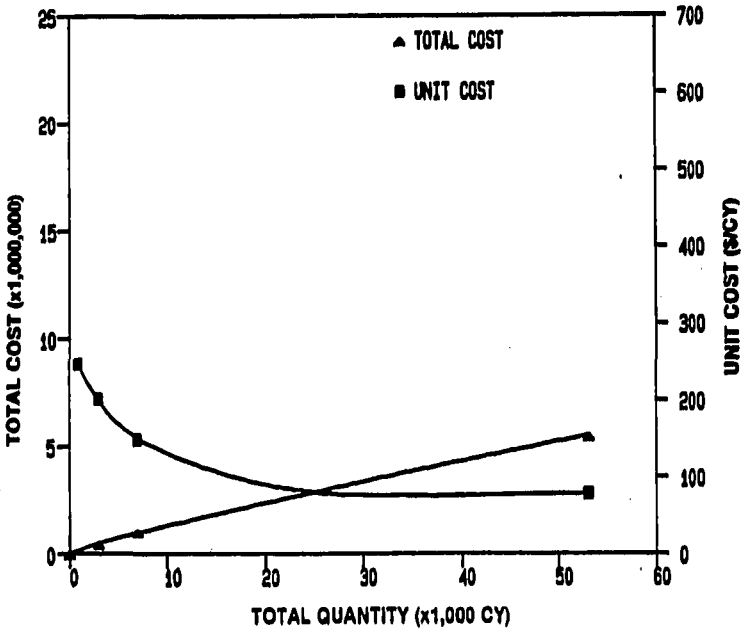


SOURCE: ESE, 1986c.

Figure 4.5-3
TOTAL COSTS AND UNIT COSTS vs. QUANTITY FOR THE TNT MANUFACTURING AREA—ONSITE INCINERATOR

AR303605

WEST VIRGINIA ORDNANCE WORKS
Feasibility Study



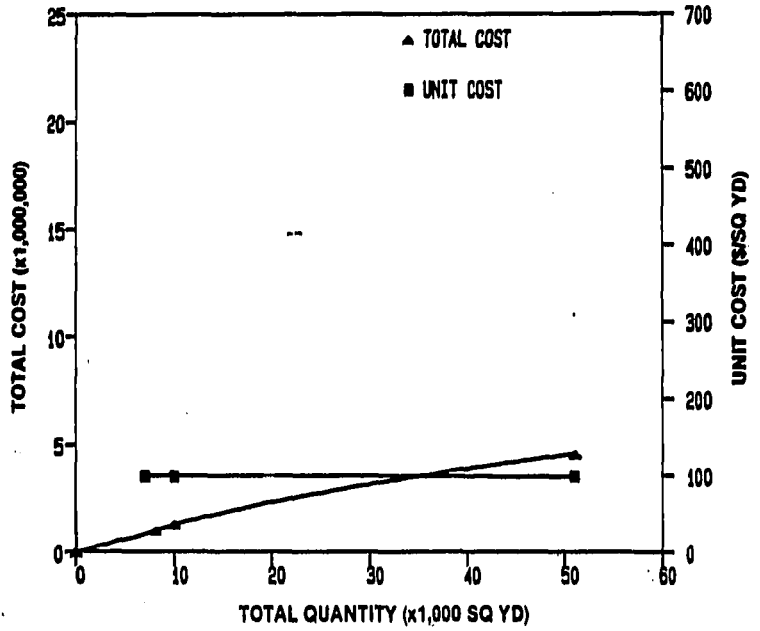
SOURCE: ESE, 1988c.

Figure 4.5-4
TOTAL COSTS AND UNIT COSTS vs. QUANTITY FOR THE TNT MANUFACTURING AREA—ONSITE LANDFILL

WEST VIRGINIA
ORDNANCE WORKS
Feasibility Study

ORIGINA
(Red)

WVOW PATH 506

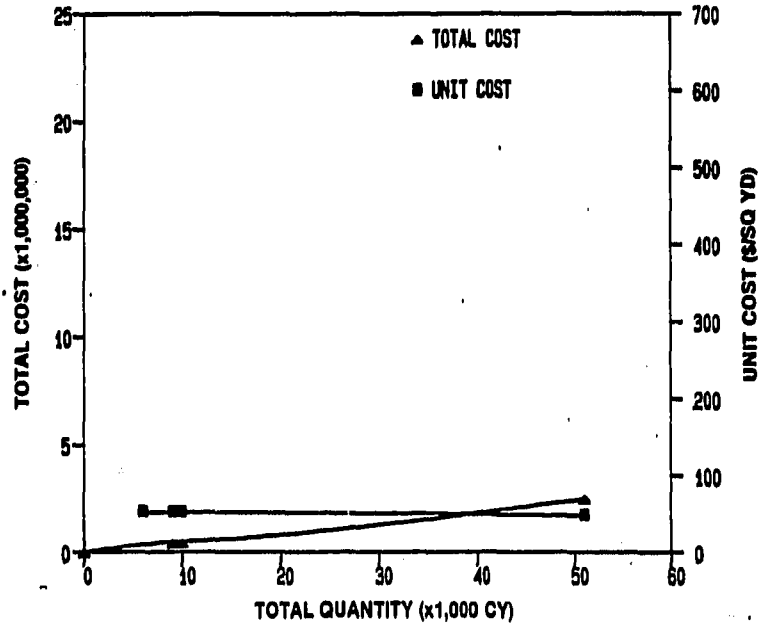


SOURCE: ESE, 1986c.

Figure 4.5-5
TOTAL COSTS AND UNIT COSTS vs. QUANTITY FOR THE TNT MANUFACTURING AREA—MULTIMEDIA CAP

AR303607

WEST VIRGINIA
ORDNANCE WORKS
Feasibility Study



SOURCE: ESE, 1988c.

Figure 4.5-6
TOTAL COSTS AND UNIT COSTS vs. QUANTITY FOR THE TNT MANUFACTURING AREA—SOIL COVER

WEST VIRGINIA ORDNANCE WORKS
Feasibility Study

contamination. The unit cost curves indicate that unit costs are significantly higher for smaller quantities and can exceed $700/cy. Costs for this alternative are based on contractor-owned and -operated equipment.

Costs for Alternative 3B are also sensitive to quantity, although the cost per cubic yard is much lower than the alternative previously discussed. The unit cost is also impacted by quantity, decreasing to approximately $100/cy for contaminated volumes greater than 20,000 cy.

The costs for Alternative 3C are directly related to the extent of contamination, and the unit costs are not affected by the quantity considered, as shown by Fig. 4.5-5. Similarly for Alternative 4A (Fig. 4.5-6), costs are directly sensitive to quantity, but the impact of quantity on unit costs for the quantity range considered is less than $10/cy.

Discount rates used to estimate present worth were also considered for impact on cost sensitivity. Table 4.5-6 shows the present worth for all alternatives considered at discount rates of 4, 7, and 10 percent. As shown by this table, the present-worth costs are directly impacted by the discount rate at which present worth is compared. However, since O&M costs for all alternatives are not significant compared to capital costs, the present-worth cost and, hence, sensitivity of these costs are not of concern in comparing alternative costs.

Table 4.5-6. Comparison of Present-Worth Cost for Discount Factors of 4, 7, and 10 Percent

Alternative	Capital (x $1,000)	O&M (x $1,000)	Present-Worth Discount Factor 4 Percent (x 1,000)	7 Percent (x 1,000)	10 Percent (x 1,000)
TNT Offsite 1A2	22,030	0	22,030	22,030	22,030
TNT Offsite 1B1	16,287	0	16,287	16,287	16,287
TNT Offsite 1B2	2,582	0	2,582	2,582	2,582
TNT Attains Requirements 2A	4,229	0	4,229	4,229	4,229
TNT Attains Requirements 2B	1,066	6	1,170	1,140	1,123
TNT Attains Requirements 2C	1,090	2	1,124	1,115	1,109
TNT Exceeds Requirements 3A	26,339	0	26,339	26,339	26,339
TNT Exceeds Requirements 3B	5,678	31	6,214	6,063	5,970
TNT Exceeds Requirements 3C	4,798	9	4,954	4,910	4,883
TNT CERCLA 4A	594	2	629	619	613
No Action 5A	0	8	138	99	75
Burning Grounds Offsite 1A2	10,722	0	10,722	10,722	10,722
Burning Grounds Offsite 1B1	5,575	0	5,575	5,575	5,575
Burning Grounds Offsite 1B2	1,271	0	1,271	1,271	1,271
Burning Grounds Attains Requirements 2A	2,582	0	2,582	2,582	2,582
Burning Grounds Attains Requirements 2B	624	4	693	674	662
Burning Grounds Attains Requirements 2C	600	1	617	612	609
Burning Grounds Exceeds Requirements 3A	8,459	0	8,459	8,459	8,459
Burning Grounds Exceeds Requirements 3B	1,924	11	2,114	2,060	2,028
Burning Grounds Exceeds Requirements 3C	1,632	4	1,701	1,682	1,670
Burning Grounds CERCLA 4A	327	1	344	339	336
Burning Grounds No Action	0	5	86	62	47
Sewerlines Attains Requirements 2A	1,310	0	1,310	1,310	1,310
Sewerlines Attains Requirements 2B	954	2	988	979	973
Sewerlines Exceeds Requirements 3A	14,332	0	14,332	14,332	14,332
Sewerlines Exceeds Requirements 3B	3,518	17	3,812	3,729	3,678
Sewerlines CERCLA 4A	855	0	855	855	855

Source: ESE, 1986c.

4.5.4 COST-BENEFIT ANALYSIS

This section discusses, for the areas at WVOW, the additional benefits and values that are derived for expenditure of additional cost in order to implement a more extensive and costly alternative or attain a greater action level.

This benefit analysis is based on the technical, environmental, institutional, public health, and cost evaluations presented in the preceding sections.

4.5.4.1 Comparison of Alternatives for TNT Manufacturing Area and Burning Grounds Area

Alternative 4A, the soil cover, is the least costly alternative (achieving response objectives) at a present-worth cost of $642,000 for the TNT Manufacturing Area and $342,000 for the Burning Grounds Area. This alternative achieves the response objectives of protecting against direct contact and minimizing exposure pathways. The cancer risk is reduced to the 10^{-6} risk level, or 1 additional incidence of cancer per 1,000,000 population. Alternatives 1B1, 3A, and 3B could reduce this potential to below the 10^{-6} risk level, but at costs between 5 and 25 times greater. The exposure pathways could be entirely eliminated, assuming that all contamination is removed, through implementation of their alternative; however, since direct human contact is the only endangerment pathway, the soil cover (Alternative 4A) adequately provides this protection.

For all alternatives considered, the environmental impacts are acceptably controlled, although the contamination remains onsite for Alternatives 2C, 3C, and 4A. However, for Alternatives 2C, 3C, and 4A, the area is less disturbed in that no excavation of materials would be required.

In all cases, the technologies involved in the alternatives are technically acceptable and proven, and no alternative offers

significant technical advantage to achieve response objectives or an advantage based on specific site conditions at WVOW. Alternative 4A does require long-term care to maintain the integrity of the cover, but the requirements and the costs are much less than those required to collect and analyze monitoring well samples.

All alternatives would be at least moderately acceptable to the public, although alternatives that leave contaminated materials on the site may be less desirable. However, alternatives that remove materials from the site may be objectionable because of disruption to the site and increased traffic during excavation and removal operations.

Alternative 4A achieves the objectives of protecting against direct contact and minimizing exposure pathways. From the evaluations presented in the preceding sections (Secs. 4.1-1 through 4.5-3), it is not apparent that additional significant benefits beyond those of Alternative 4A can be derived at the TNT Manufacturing Area or Burning Grounds Area.

Tables 4.5-7 and 4.5-8 summarize the capital and present-worth costs for the TNT Manufacturing Area and the Burning Grounds Area. At the 10^{-5} risk level, the cost of the multimedia cap is greater than the cost of the onsite landfill due to the greater materials cost of liners, fabrics, and soil placement. The excavation depth of the 10^{-5} risk level is about 1 ft, which results in a relatively smaller volume to be landfilled versus area to be capped compared to the 10^{-6} risk levels.

These tables show that for the multimedia cap and the soil cover in the TNT Manufacturing Area, the cost differential between the Attains Requirements (10^{-6}) criteria and the less stringent 10^{-5} risk level is only about 10 percent. For the Burning Grounds Area alternatives, the cost differential between the two risk levels is 25 and 35 percent for the multimedia cap and soil cover, respectively. The additional benefits obtained by covering a greater area with a multimedia cap or soil cover

Table 4.5-7. Capital Costs and Unit Costs for Exceeds Requirements, Attains Requirements, and 10^{-5} Risk Level Remedial Actions—TNT Manufacturing Area

Alternative	Exceeds Requirements			Attains Requirements (10^{-6} Risk Level)			10^{-5} Risk Level		
	Quantity cy (sq yd)	Capital (x $1,000)	Present Worth (x $1,000)	Quantity cy (sq yd)	Capital (x $1,000)	Present Worth (x $1,000)	Quantity cy (sq yd)	Capital (x $1,000)	Present Worth (x $1,000)
Offsite Incineration	53,000	156,356	156,356	6,710	22,030	22,030	2,960	9,966	9,966
Offsite Landfill	53,000	16,287	16,287	6,710	2,582	2,582	2,960	1,190	1,190
Onsite Incineration	53,000	26,339	26,339	6,710	4,229	4,229	2,960	2,060	2,060
Onsite Landfill	53,000	5,678	5,970	6,710	1,066	1,123	2,960	610	667
Multimedia Cap	(51,255)	4,798	4,883	(10,060)	1,090	1,109	(8,880)	980	999
Soil Cover	(51,255)	2,510	2,595	(10,060)	624	643	(8,880)	554	573

Source: ESE, 1986c.

Table 4.5-8. Capital Costs and Unit Costs for Exceeds Requirements, Attains Requirements, and 10^{-5} Risk Level Remedial Actions--Burning Grounds Area

Alternative	Exceeds Requirements			Attains Requirements (10^{-6} Risk Level)			10^{-5} Risk Level		
	Quantity cy (sq yd)	Capital (x $1,000)	Present Worth (x $1,000)	Quantity cy (sq yd)	Capital (x $1,000)	Present Worth (x $1,000)	Quantity cy (sq yd)	Capital (x $1,000)	Present Worth (x $1,000)
Offsite Incineration	17,000	52,184	52,184	3,625	10,722	10,722	1,129	4,018	4,018
Offsite Landfill	17,000	5,575	5,575	3,625	1,271	1,271	1,129	519	519
Onsite Incineration	17,000	8,458	8,458	3,625	2,382	2,382	1,129	865	865
Onsite Landfill	17,000	1,924	2,028	3,625	624	662	1,129	392	420
Multimedia Cap	(18,566)	1,632	1,670	(5,134)	599	612	(3,387)	448	457
Soil Cover	(18,566)	846	874	(5,134)	327	335	(3,387)	205	214

Source: ESE, 1986c.

in the TNT Manufacturing Area and a soil cover in the Burning Grounds Area would justify the cost differential. These tables further show that the cost to exceed the EA-derived criteria is more than 4 times greater for these alternatives.

These tables also demonstrate that offsite landfilling is within the range of the capping and covering alternatives for the less stringent 10^{-5} risk level. However, the incineration technologies are still several times more costly.

4.5.4.2 Comparison of Alternatives for Industrial Sewerlines

The least costly alternative is Alternative 4A, which consists of burning the sewerlines and then backfilling the area. This alternative meets the objectives of eliminating the reactivity of the sewerlines and protecting human receptors from the exposure. The present-worth cost of this alternative, which minimizes but does not eliminate exposure pathway, is $851,000.

Alternative 2A, however, also reduces cancer risk to 10^{-6} but totally eliminates exposure pathways. The cost of Alternative 2A is $1,306,000, an incremental increase of less than twice that of Alternative 4A. Both alternatives are comparable in all other areas evaluated.

The implementation, however, of an onsite incinerator for a small volume area is not as practical or viable an alternative as for larger sites. In addition, the sensitivity analysis discussion (Sec. 4.5.3) has demonstrated the extreme variation of cost of this alternative with slight changes in quantity. Therefore, any increase in estimated volume of contaminated sewerlines would significantly increase cost.

Table 4.5-9 is a summary of the quantity, capital costs, and present-worth costs for the Industrial Sewerlines for the onsite incinerator, flashing/landfill, and flashing/backfill alternatives. For these

Table 4.5-9. Capital Costs and Unit Costs for Exceeds Requirements, Attains Requirements, and 10^{-5} Risk Level Remedial Actions--Industrial Sewerlines

Alternative	Exceeds Requirements			Attains Requirements (10^{-6} Risk Level)			10^{-5} Risk Level		
	Quantity cy (sq yd)	Capital (x $1,000)	Present Worth (x $1,000)	Quantity cy (sq yd)	Capital (x $1,000)	Present Worth (x $1,000)	Quantity cy (sq yd)	Capital (x $1,000)	Present Worth (x $1,000)
Onsite Incineration	29,680	14,332	14,332	680	1,310	1,310	NA	NA	NA
Onsite Landfill	29,680	3,518	3,678	680	954	975	NA	NA	NA
Flashing/Backfill	NA	NA	NA	680	855	855	NA	NA	NA

NA = Not Applicable.

Source: ESE, 1986c.

alternatives, a 10^{-5} risk level is not applicable because the sewerlines are reactive and the standards must be achieved in order to meet the response objectives. For the flashing/backfill alternative, exceeding standards is not applicable because this is a CERCLA alternative which addresses only the Attains Standards criteria.

For the flashing/onsite landfill alternative, it could cost approximately 4 times more to exceed the standard. For the onsite incineration alternative, exceeding standards could cost 10 times more. Because of the significant differential in cost and lack of adequate quantification of the extent of soil contamination below the sewerlines, exceeding standards in these alternatives is difficult to justify.

5.0 SUMMARY OF ALTERNATIVES

A summary of the detailed technical, environmental, institutional, public health, and cost evaluations discussed in Sec. 4.0 is presented for each area of concern in Tables 5.0-1 through 5.0-3.

Selection of a remedial alternative is specified in Sec. 300.68(i)(1) of the NCP, which states:

> Except as provided in Sec. 300.68(i)(5), this will require selection of a remedy that attains or exceeds applicable or relevant and appropriate Federal public health and environmental requirements that have been identified for the specific site.

Federal public health and environmental requirements identified in Sec. 4.3.1 are presented in Table 5.0-4. All of the alternatives, except CERCLA 4A Alternative and No Action 5A Alternative, meet or exceed these requirements. The CERCLA 4A Alternative does not meet the RCRA standard for caps to prevent precipitation from infiltrating and leaching contamination into underlying ground water. This standard is, however, not applicable to the site as contamination of the ground water is not a problem at the TNT Manufacturing Area and no ground water is affected at the Burning Grounds Area.

All alternatives for each of the three areas, except No Action 5A Alternative, meet or exceed the remedial action criteria and objectives established by the EA and presented in Sec. 1.3. These criteria and objectives are to:

1. Remove or render unreactive all reactive wastes, and
2. Remove or cover the upper 2 ft of soil if total nitroaromatic contamination exceeds 50 µg/g to achieve less than 10^{-6} individual lifetime cancer risk.

Environmental and public health impacts of nitroaromatic contamination are eliminated or minimized to acceptable levels by implementation of . . .

Table 5.0-1. Source Control Alternatives Summary for the TNT Manufacturing Area

Alternative	Cost ($1,000) Capital	Cost ($1,000) Present Worth	Public Health Concerns	Environmental Concerns	Technical Concerns	Community Response Concerns	Other
1B1—Offsite Landfill	16,300	16,300	Eliminates exposure pathways. Reduces cancer risk to less than 10^{-6}.	Environmental impacts eliminated.	Proven technology. Future regulatory constraints.	Increased traffic. Acceptable.	Removal of waste to RCRA-permitted facility. Long-term monitoring not required.
1A2-1B2—Offsite Incineration-Offsite Landfill	21,957 2,509	21,957 2,509	Minimizes exposure pathways. Reduces cancer risk to 10^{-6}.	Environmental impacts minimized. Acceptable levels remain.	Proven technology. Future regulatory constraints.	Increased traffic. Acceptable.	Removal of waste to RCRA-permitted facility. Long-term monitoring not required.
2A—Onsite Incineration	4,206	4,206	Minimizes exposure pathways. Contamination destroyed. Reduces cancer risk to 10^{-6}.	Environmental impacts minimized. Acceptable levels remain.	Proven technology. Not limited by site conditions.	Moderately acceptable.	Monitoring of onsite incineration effectiveness required.
2B—Onsite Landfill	1,054	1,111	Minimizes exposure pathways. Contamination not destroyed. Reduces cancer risk to 10^{-6}.	Environmental impacts minimized. Permanent onsite facility.	Long-term maintenance required.	Moderately acceptable.	Long-term monitoring and potential leachate management required.
2C—Multimedia Cap	1,159	1,178	Minimizes exposure pathways. Contamination not destroyed. Reduces cancer risk to 10^{-6}.	Environmental impacts minimized. Permanent onsite facility.	Long-term maintenance required.	Acceptable.	Long-term monitoring required.

Table 5.0-1. Source Control Alternatives Summary for the TNT Manufacturing Area (Continued, Page 2 of 2)

Alternative	Cost ($1,000) Capital	Cost ($1,000) Present Worth	Public Health Concerns	Environmental Concerns	Technical Concerns	Community Response Concerns	Other
3A—Onsite Incineration	26,283	26,283	Eliminates exposure pathways. Contamination destroyed. Reduces cancer risk to less than 10^{-6}.	Environmental impacts eliminated.	Proven technology. Not limited by site conditions.	Moderately acceptable	Long-term monitoring not required.
3B—Onsite Landfill	5,588	5,880	Eliminates exposure pathways. Contamination not destroyed. Reduces cancer risk to less than 10^{-6}.	Environmental impacts minimized. Permanent onsite facility.	Long-term maintenance required.	Moderately acceptable.	Long-term monitoring and potential leachate management required.
3C—Multimedia Cap	4,783	4,868	Minimizes exposure pathways. Contamination not destroyed. Reduce cancer risk to less than 10^{-6}.	Environmental impacts minimized. Permanent onsite facility.	Long-term maintenance required.	Acceptable.	Long-term monitoring required.
4A—Soil Cover	623	642	Minimizes exposure pathways. Contamination not destroyed. Reduces cancer risk to 10^{-6}.	Environmental impacts minimized. Permanent onsite facility.	Long-term maintenance required.	Acceptable.	Lowest cost alternative. Meets CERCLA goals. Long-term monitoring required.
5A—No Action	0	0	Unacceptable exposure to nitroaromatics.	Exposure pathways remain. Use of wildlife preserve adversely affected.	—	Unacceptable.	—

Source: ESE, 1986c.

Table 5.0-2. Source Control Alternatives Summary for the Burning Grounds Area

Alternative	Cost ($1,000) Capital	Present Worth	Public Health Concerns	Environmental Concerns	Technical Concerns	Community Response Concerns	Other
1B1—Offsite Landfill	5,575	5,575	Eliminates exposure pathways. Reduces cancer risk to less than 10^{-6}.	Environmental impacts eliminated.	Proven technology. Future regulatory constraints.	Increased traffic. Acceptable.	Removal of waste to RCRA-permitted facility. Long-term monitoring not required.
1A2-1B2—Offsite Incineration-Offsite Landfill	10,720 1,268	10,720 1,268	Minimizes exposure pathways. Reduces cancer risk to 10^{-6}.	Environmental impacts minimized. Acceptable levels remain.	Proven technology. Future regulatory constraints.	Increased traffic. Acceptable.	Removal of waste to RCRA-permitted facility. Long-term monitoring not required.
2A—Onsite Incineration	2,380	2,380	Minimizes exposure pathways. Contamination destroyed. Reduces cancer risk to 10^{-6}.	Environmental impacts minimized. Acceptable levels remain.	Proven technology. Not limited by site conditions.	Moderately acceptable.	Monitoring of onsite incineration effectiveness required.
2B—Onsite Landfill	621	659	Minimizes exposure pathways. Contamination not destroyed. Reduces cancer risk to 10^{-6}.	Environmental impacts minimized. Permanent onsite facility.	Long-term maintenance required.	Moderately acceptable.	Long-term monitoring and potential leachate management required.
2C—Multimedia Cap	603	612	Minimizes exposure pathways. Contamination not destroyed. Reduces cancer risk to 10^{-6}.	Environmental impacts minimized. Permanent onsite facility.	Long-term maintenance required.	Acceptable.	Long-term monitoring required.

Table 5.0-2. Source Control Alternatives Summary for the Burning Grounds Area (Continued, Page 2 of 2)

Alternative	Cost ($1,000) Capital	Cost ($1,000) Present Worth	Public Health Concerns	Environmental Concerns	Technical Concerns	Community Response Concerns	Other
3A—Onsite Incineration	8,453	8,453	Eliminates exposure pathways. Contamination destroyed. Reduces cancer risk to less than 10^{-6}.	Environmental impacts eliminated.	Proven technology. Not limited by site conditions.	Moderately acceptable.	Remedial action effectiveness monitoring required.
3B—Onsite Landfill	1,909	2,013	Eliminates exposure pathways. Contamination not destroyed. Reduces cancer risk to less than 10^{-6}.	Environmental impacts minimized. Permanent onsite facility.	Long-term maintenance required.	Moderately acceptable.	Long-term monitoring and potential leachate management required.
3C—Multimedia Cap	1,631	1,669	Minimizes exposure pathways. Contamination not destroyed. Reduces cancer risk to less than 10^{-6}.	Environmental impacts minimized. Permanent onsite facility.	Long-term maintenance required.	Acceptable.	Long-term monitoring required.
4A—Soil Cover	333	342	Minimizes exposure pathways. Contamination not destroyed. Reduces cancer risk to 10^{-6}.	Environmental impacts minimized. Permanent onsite facility.	Long-term maintenance required.	Acceptable.	Lowest cost alternative. Meets CERCLA goals. Long-term monitoring required.
5—No Action	0	0	Unacceptable exposure to nitroaromatics.	Exposure pathways remain. Use of wildlife station adversely affected.	—	Unacceptable.	—

Source: ESE, 1986c.

Table 5.0-3. Source Control Alternatives Summary for the Industrial Swarlines

Alternative	Cost ($1,000) Capital	Present Worth	Public Health Concerns	Environmental Concerns	Technical Concerns	Community Response Concerns	Other
2A—Onsite Incineration	1,306	1,306	Minimizes exposure pathways. Contamination destroyed. Reduces cancer risk to 10^{-6}.	Environmental impacts minimized. Acceptable levels remain.	Proven technology. Not limited by site conditions.	Moderately acceptable.	Monitoring of onsite incineration effectiveness required.
2B—Onsite Landfill	949	968	Minimizes exposure pathways. Contamination not destroyed. Reduces cancer risk to 10^{-6}.	Environmental impacts minimized. Acceptable levels remain.	Long-term maintenance required.	Moderately acceptable.	Long-term monitoring and potential leachate management required.
3A—Onsite Incineration	14,300	14,300	Eliminates exposure pathways. Contamination destroyed. Reduces cancer risk to less than 10^{-6}.	Environmental impacts eliminated.	Proven technology. Not limited by site conditions.	Moderately acceptable.	Remedial action effectiveness monitoring required.
3B—Onsite Landfill	3,518	3,680	Minimizes exposure pathways. Contamination not destroyed. Reduces cancer risk to 10^{-6}.	Environmental impacts minimized. Permanent onsite facility.	Long-term maintenance required.	Moderately acceptable.	Long-term monitoring and potential leachate management required.
4A—Burn Backfill	851	851	Minimizes exposure pathways. Contamination not destroyed. Reduces cancer risk to 10^{-6}.	Environmental impacts minimized. Permanent onsite facility.	Proven technology.	Moderately acceptable.	Least cost alternative. Meets CERCLA goals. Long-term monitoring required.
5A—No Action	0	19	Unacceptable exposure to nitroaromatics.	Exposure pathways remain. Use of wildlife station adversely affected.	—	Unacceptable.	—

Source: ESE, 1984c.

Table 5.0-4. Summary of Applicable and Relevant or Appropriate Laws, Regulations, Policies, and Criteria

Law, Regulation, Policy, or Criterion	Analysis
Federal	
RCRA	Treatment and disposal of materials removed from WVOW to an offsite facility will be in compliance with current RCRA regulations issued in the HSWA of 1984. Onsite treatment and disposal operations will be in accordance with the substantive technical requirements of RCRA.
National Ambient Air Quality Standards (NAAQS)	Implementation of alternatives that include onsite incineration will result in the emission of pollutants into the air. The use of air pollution control equipment will minimize the effect of incinerator emissions on existing air quality. Incinerator performance standards will be attained, but permits will not be required. Because the emissions from surface flashing are largely uncontrollable, air quality standards may not be met during flashing operations. Particulate emissions during excavation will occur, although dust palliatives will be used to minimize fugitive dust. Onsite personnel, however, will be adequately protected.
DOT Hazardous Materials Transport Rules	The transport of hazardous materials to offsite facilities will be in compliance with these rules, including use of properly constructed and marked transport vehicles, a licensed transporter, and hazardous waste manifests.
Federal Water Quality Criteria (FWQC)	During the implementation of alternatives, the substantive requirements and standards of FWQC in creeks that drain the site and other downgradient surface water will be attained.

Table 5.0-4. Summary of Applicable and Relevant or Appropriate Laws, Regulations, Policies, and Criteria
(Continued, Page 2 of 2)

Law, Regulation, Policy, or Criterion	Analysis
Asbestos Disposal Rule (40 CFR, Part 61, Subpart M)	Since asbestos is present in the Burning Grounds Area, alternatives for asbestos disposal will meet or exceed this rule. Offsite alternatives will be in full compliance; onsite alternatives will meet technical requirements.
State of West Virginia Water Quality Standards (WVWQS)	In implementing alternatives, WVWQS in creeks that drain the site and other downgradient surface water will be considered. The substantive requirements will be complied with and the standards attained.
West Virginia Solid Waste Regulations	Implementation of alternatives will consider West Virginia regulations for noncontaminated materials taken to offsite sanitary landfills.
West Virginia Hazardous Waste Regulations	Implementation of alternatives will consider the requirements of current regulations, including manifest requirements.
West Virginia Air Pollution Control Commission (WVAPCC) Administrative Regulations	The substantive technical requirements of these regulations will be considered, and the standards and criteria of New Source Performance Standards (NSPS) will be considered.
West Virginia Pollution Discharge Elimination System (WVPDES) Regulations	The substantive technical requirements of these regulations will be considered, and the standards and criteria for point source discharges will be considered in implementation of the alternative.

Source: ESE, 1986c.

these alternatives. An onsite landfill or multimedia cap will require long-term monitoring and maintenance. Generally, the impetus for installing a landfill or multimedia cap, designed to meet RCRA standards, is to prevent ground water contamination. Ground water beneath the source areas at WVOW are either not a problem (TNT Manufacturing Area) or are unaffected (Burning Grounds Area). This standard, therefore, does not provide the basis to justify the extra expense required to implement these alternatives. Onsite incineration will have significant adverse impacts on the environment, wildlife, and humans through longer mobilization than other alternatives. None of the alternatives, except No Action 5A Alternative, will have a significant adverse affect on the continued use of the site as a wildlife preserve. Additional land use restrictions will probably be required for the areas containing an onsite landfill or multimedia-capped contaminated soil to protect the integrity of these structures. Existing wildlife station land use restrictions are adequate to protect the integrity of the CERCLA alternative soil cover; no additional restrictions are required. These restrictions will not affect the operation of McClintic Wildlife Station, as the affected areas represent less than 0.3 percent of the station's land.

Section 300.68(ii)(5) of the NCP states:

> (5) Notwithstanding §300.68(i)(1), the lead agency may select an alternative that does not meet applicable or relevant and appropriate Federal public health or environmental requirements in any of the following circumstances:
>
> (i) The selected alternative is not the final remedy and will become part of a more comprehensive remedy;
>
> (ii) Fund-Balancing: For Fund-financed responses only, the need for protection of public health and welfare and the environment at the facility under consideration for all of the alternatives that attain or exceed applicable or relevant and appropriate Federal requirements is outweighed by the need for action at other sites that may present a threat to public health or welfare or the environment, considering the amount of money available in the Fund. In the event of Fund-balancing, the lead agency shall select the alternative which most closely approaches the level of protection provided by applicable or relevant and appropriate Federal requirements, considering the specific Fund-balanced sum of money available for the facility under consideration. Fund-balancing is

not a consideration in determining the appropriate extent of remedy when the response will be performed or funded by a responsible party;

(iii) Technical Impracticality: Where no alternative that attains or exceeds applicable or relevant and appropriate Federal public health and environmental requirements is technically practical to implement at the specific site in question from an engineering perspective, the lead agency shall select the alternative that is reasonable to implement from an engineering perspective and that most closely approaches the level of protection provided by applicable or relevant and appropriate Federal public health and environmental requirements.

(iv) Unacceptable Environmental Impacts: Where all the alternatives that attain or exceed applicable or relevant Federal public health and appropriate environmental requirements will result in significant adverse environmental impacts if implemented, the lead agency shall select the alternative that most closely approaches the level of protection provided by applicable or relevant and appropriate Federal public health and environmental requirements, without resulting in significant adverse environmental impacts.

(v) Where the remedy is to be carried out pursuant to Federal action under CERCLA section 106, the Fund is unavailable, there is a strong public interest in expedited cleanup, and the litigation probably would not result in the desired remedy, the lead agency shall select the alternative that most closely approaches the level of protection provided by applicable or relevant and appropriate Federal public health and environmental requirements in light of the strong public interest in expedited cleanup.

The Army must, as the designated lead agency, recommend a cost-effective remedial alternative that effectively mitigates and minimizes threats to and provides adequate protection of public health and welfare and the environment. As the lead agency, the Army has limited funds available for remediation of sites such as: AAAP, Anniston Army Depot (ANAD), Letterkenney Army Depot (LEAD), Rocky Mountain Arsenal (RMA), Sharpe Army Depot (SHAD), Louisiana Army Ammunition Plant (LAAP), Cornhusker Army Ammunition Plant (CAAP), etc. The need for selection of a remedial alternative that attains or exceeds applicable or relevant and appropriate Federal public health and environmental requirements may be offset by the need for action at other sites that present a substantial

public health, welfare, or the environment. The present-worth cost of the 2B and 2C Attains Requirements Alternatives is $2,738,000 and $2,641,000, respectively, assuming the industrial sewerlines will be excavated and burned under the 2C Alternative. The present-worth cost of the CERCLA 4A Alternative is $1,835,000 and is approximately $800,000 lower in cost than the 2C Alternative. This savings will permit the Army to appropriately allocate funds for cleanup at other sites and will not compromise the effectiveness of the remedial action cleanup program at WVOW. At WVOW, only a fourfold decrease in the risk level associated with the No Action alternative is achieved by implementing any remedial alternative. Therefore, the selection of a remedy other than the least-cost CERCLA 4A alternative, which affords commensurate level of protection provided by applicable or relevant and appropriate Federal requirements, cannot be justified.

This alternative includes in situ flaming reactive TNT pieces at the Burning Grounds Area followed by a 2-ft soil cover over soils contaminated above the 10^{-6} risk level at the Burning Grounds Area and the TNT Manufacturing Area, offsite disposal of asbestos, and flashing and burying of reactive sewerlines.

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6.0 RECOMMENDED REMEDIAL ACTION

The recommended remedial action, as identified in Sec. 5.0, is the combined 4A--CERCLA alternative for the three source areas of WVOW. Implementing this alternative results in the in situ flaming of the reactive TNT residue on the surface of the Burning Grounds Area followed by the installation of a 2-ft soil cover over areas in the TNT Manufacturing Area and the Burning Grounds Area greater than 50 µg/g total nitroaromatics contamination. Asbestos from the Burning Grounds Area will be disposed of in an offsite sanitary landfill. Reactive sewerlines will be excavated, flashed, and backfilled in the trenches from which they were removed. This alternative will satisfy the objectives of the EA, as outlined in Sec. 1.3. All contaminated soil exceeding 50 µg/g at the surface will be covered to achieve the 10^{-6} risk level. The sewerlines will be rendered unreactive by flashing and buried deeper than 2 ft below ground surface. The contaminants, with the exception of asbestos, will not be removed offsite. The pathways of direct contact, ingestion, and plant uptake will be mitigated. The low permeability of the onsite soil targeted for cover material will minimize any potential infiltrating and leaching of contaminants. Six inches of topsoil and revegetating with native vegetation will protect the integrity of the cover and prevent contaminant migration by erosion and surface water runoff.

Special engineering considerations involve site grading to minimize the slope of the cover surface and thereby minimize erosion potential. A slope of approximately 5 percent is recommended to promote runoff and decrease infiltration without risking excessive erosion. Periodic regrading and maintenance may be necessary to eliminate depressions or changes in the slope caused by erosion or differential settlement of the underlying soils.

Execution of sewerline excavation and flashing also requires special handling to assure a safe and efficient operation. Examples of hazardous situations to be considered include potential initiation events such as friction, impact, and thermal events. Safety procedures could include remote operation of some equipment and the addition of water or inert material to reduce friction or spark initiated events.

Special studies involve borings and earthwork calculations to determine the exact location of a suitable soil cover borrow source. Additional studies recommended prior to implementation of sewerline excavation and flashing include sampling, reactivity testing, and a remote televideo survey of all sewerlines. The FS has conservatively assumed that all sewerlines are reactive and therefore require remediation. To date, only one sample from TNT Line 5 near the Washer/Flaker house has been tested for reactivity.

Normal construction-related O&M activities will be required during implementation of this alternative. Special safety precautions will be required during asbestos removal. EPA regulations require the wetting of asbestos material to prevent dust emissions. Air monitoring will be conducted during asbestos removal to determine levels of airborne asbestos for OSHA compliance. During the removal operation, all workers will wear full-face respirators while in work areas.

Approximately 100 cy of asbestos will be disposed of in a local offsite sanitary landfill. During final design, an offsite facility should be identified and contacted. Transportation of this material will be in covered trucks using local roads. The limited amount of material will not have a significant impact on the local landfill or transportation facilities.

Temporary storage requirements are limited to vehicles and equipment of the contractors involved in remediation activities.

Thermal treatment of solid reactive nitroaromatic wastes, capping nitroaromatic-contaminated soil, and sanitary landfilling of asbestos are effective and appropriate technologies.

Environmental effects of the alternative during implementation are confined to open burning and construction-related activities. Land clearing and soil excavation activities will generate limited amounts of N&D. Burning of sewerlines and reactive pieces from the surface of the Burning Grounds Area will create relatively uncontrolled air emissions.

Environmental impacts such as dust and air emissions from burning can be mitigated by employing a number of standard techniques. Dust from earthwork activities may be managed by sprinkling water and avoiding construction on excessively windy days. Air emissions can be controlled by using efficient burners supplying excess air and by scheduling burning during favorable weather conditions.

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