ORIGINAL

FIVE-YEAR REVIEW REPORT FOR DIXIE CAVERNS COUNTY LANDFILL SUPERFUND SITE ROANOKE COUNTY, VIRGINIA

U.S. Environmental Protection Agency
Region 3
Philadelphia, PA

September 2012

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U.S. EPA, Region 3

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LIST OF ACRONYMS

AOC	Administrative Order on Consent
ARARs	Applicable or Relevant and Appropriate Requirements
bgs	Below Ground Surface
BRA	Baseline Risk Assessment
CD	Consent Decree
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Contaminant of Concern
DCL	Dixie Caverns Landfill
DOT	Department of Transportation
EPA	United States Environmental Protection Agency
^{O}F	Degrees Fahrenheit
FCOR	Final Close-Out Report
FS	Feasibility Study
HRS	Hazard Ranking System
HTMR	High Temperature Metals Recovery
IC	Institutional Controls
MDS	Mississippian-Devonian-Silurian
msl	mean sea level
mg/kg	milligrams/kilogram
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	Operation and Maintenance
OU	Operable Unit
PA	Preliminary Assessment
PCB	Polychlorinated Biphenyls
ppb	Parts Per Billion
ppm	Parts Per Million
PRP	Potentially Responsible Parties
PVC	Polyvinyl Chloride
RA	Remedial Action
RAO	Remedial Action Objective
RAP	Response Action Plan

LIST OF ACRONYMS (cont.)

RCRA	Resource Conservation and Recovery Act
RES	Roanoke Electric Steel
RI	Remedial Investigation
RI/FS	Remedial Investigation and Feasibility Study
ROD	Record of Decision
RPM	Remedial Project Manager
SARA	Superfund Amendments and Reauthorization Act of 1986
SNL	Special Notice Letter
SVOC	Semi-volatile Organic Compoumd
µg/L	micrograms/Liter
USACE	United States Army Corps of Engineers
VA	Virginia
VADEQ	Virginia Department of Environmental Quality
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

The Dixie Caverns County Landfill was operated from 1965 to 1976. The site was the focus of two Removal Actions and two Records of Decision (RODs). Through these actions, a fly ash pile was removed for off-Site High Temperature Metals Recovery (HTMR); sediment from two streams that had been contaminated by this ash were excavated, stabilized, and landfilled on-site; numerous drums were removed from the site; and sludge and associated soils and sediment were excavated and disposed of off-site. (There is a closed municipal landfill at the site but this was not the focus of Superfund activities.)

The only waste remaining at the site, other than the solid waste in the closed municipal landfill, is contained in a landfill area of the site, specifically constructed for it, as "concrete-like" stabilized blocks, and in a small (5 cubic yards) pocket of fly ash-contaminated sediments, securely entombed deep in an inaccessible stream bank. The leachate collection system is functioning properly although no leachate has been produced, and therefore, no analysis was performed on leachate. The condition of the landfill and cap was determined to be in good condition during the five-year review. Consequently, the remedy implemented at the site for the stabilization and containment of sediments contaminated with electric arc-furnace fly ash (a RCRA K061 listed waste) has been, and remains, protective.

The Site achieved construction completion with the signing of the Final Close-Out Report (FCOR) on September 25, 1997. Although institutional controls (ICs) were not contemplated in the RODs for the Site, it was recommended during the last five-year review that an IC be implemented at the Site to ensure the long-term protectiveness of the remedy due to the presence of stabilized waste. The remedy is considered protective of human health and the environment in the short tenn, as the landfill containing waste is complete, the cap remains intact and in good condition, and the landfill is functioning properly. The County of Roanoke, with the assistance of EPA, has implemented legal documentation for the property that will provide the necessary institutional controls. An Explanation of Significant Differences (ESD), which identified the restrictions, is being prepared. In addition, the 2011 Site inspection recommendations were to continue the quarterly inspections with all of the reports being sent directly to EPA and that the bare patch of ground near the monofill cap should have vegetation reestablished and the ground should be properly sloped to allow for drainage.

The remedy is not protective in the long term, because the findings from quarterly monitoring could affect the long term protectiveness of the remedy; vegetation needs to be reestablished, and a bare patch near the monofill cap should be properly sloped; a general ecological health assessment of the Site should be performed.

GPRA Measures Review

As part of this Five-Year Review, the Government Performance and Results Act (GPRA) measures have also been reviewed. The GPRA measures and their current status are provided as follows:

Environmental Indicators

Human Health: Long-Term Human Health Protection Achieved
Groundwater Migration: Not a GW site

Sitewide RAU: The Site has been designated as Site-Wide Ready for Anticipated Use (SWRAU)

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Dixie Caverns County Landfill Superfund Site		
EPA ID: VAD980552095		
Region: 3	**State:** VA	**City/County:** Roanoke County
SITE STATUS		
NPL Status: Deleted		
Multiple OUs? Yes	**Has the site achieved construction completion?** Yes	
REVIEW STATUS		
Lead agency: EPA **If "Other Federal Agency" was selected above, enter Agency name:**		
Author name (Federal or State Project Manager): Ron Davis, Remedial Project Manager		
Author affiliation: EPA		
Review period: July 14, 2011 – May 31, 2012		
Date of site inspection: August 25, 2011		
Type of review: Statutory		
Review number: 3		
Triggering action date: September 27, 2007		
Due date *(five years after triggering action date)*: September 27, 2012		

Five-Year Review Summary Form (continued)

Issues/Recommendations

OU(s) without Issues/Recommendations Identified in the Five-Year Review:
Operable Unit 2: 9-28-1992

Issues and Recommendations Identified in the Five-Year Review:

OU(s): OU 1: 9-30-1991	Issue Category: Monitoring			
	Issue: Quarterly inspections of the Site should continue and reports should be sent directly to EPA.			
	Recommendation: Continue inspections			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	N/A
OU(s): OU 1: 9-30-1991	**Issue Category: Operations and Maintenance**			
	Issue: There is a bare patch of ground near the monofill cap.			
	Recommendation: Reestablish vegetation within the bare patch and properly slope the area to allow proper water drainage.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	May 2013
OU(s): OU 1: 9-30-1991	**Issue Category: Monitoring**			
	Issue: A general ecological health assessment of the Site should be performed.			
	Recommendation: Have a member of the BTAG be present during the next site inspection.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	EPA	EPA	May 2013

Protectiveness Statement(s)

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
OU1	Protective	NA

Protectiveness Statement:

The remedy is considered protective of human health and the environment in the short term, as the landfill containing waste is complete, the cap remains intact and in good condition, and the landfill is functioning properly. Institutional controls (i.e. deed notice) have been implanted at the Site, and an ESD, which identifies the restrictions, is being prepared. The remedy is not protective in the long term, because a general ecological assessment of the Site is needed to make this determination.

FIVE-YEAR REVIEW REPORT

I. INTRODUCTION

The purpose of the Five-Year Review (FYR) is to determine whether the remedy at a site is or is expected to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in FYR reports. In addition, FYR reports identify issues found during the review, if any, and recommendations to address them.

The U.S. Environmental Protection Agency (EPA) has prepared this FYR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) §121 and the National Oil and Hazardous Substance Contingency Plan (NCP). CERCLA § 121(c), states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often that each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The Agency interpreted this requirement further in the NCP; 40 Code of Federal Regulations (CFR) §300.430(f)(4)(ii) states: :

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

EPA Region 3 has conducted this FYR of all the remedial actions implemented at the Dixie Caverns County Landfill Superfund Site (the "Site") located in Roanoke County, Virginia. This review was conducted from July 14, 2011 through May 31, 2012 and documents the results of the review.

This is the third FYR for the Site. The triggering action for this statutory review was the signing of the last five-year review on September 27, 2007. The five-year review is required because of the continued presence of hazardous substances, pollutants, or contaminants at the Site above levels that allow for unlimited use and unrestricted exposure.

The table below (Table 1) summarizes the major areas of the Site and how they were addressed through the Removal and Remedial cleanup programs.

Table 1: Summary of Contaminated Areas Addressed at Dixie Caverns County Landfill Superfund Site

Item:	Addressed by:	Date of Action(s) taken:	Description of remedy:
Drum Disposal Area	1987 Removal Order (Consent Order)	Aug. 1988-May 1989	Drums stabilized and overpacked for transport off-site to a hazardous waste disposal facility.
Sludge Pit	1987 Removal Order (Consent Order)	Aug. 1988-May 1989	Removal, stabilization and off-Site disposal of approx. 500 cubic yards of sludge and contaminated soil.
Fly Ash Pile(K061)	1991 ROD (OU1), 1993 Consent Decree	Aug. 1994-Jan. 1996	Excavation and transport of approx. 9,000 cubic yards of fly-ash material to off-Site High Temperature Metals Recovery (HTMR) facility.
Stream Sediments and Soil	1992 Removal Order (Administrative Order by Consent)	1993 - 1997	Excavation, stabilization and containment of contaminated soils and stream sediments related to the fly ash pile, placing "concrete-like" blocks into an on-Site landfill.
Remainder of Site	1992 ROD (OU2)	n/a	No further actions were required for the remainder of the Site.

II. SITE CHRONOLOGY

Table 2 lists the chronology for selected events for the Dixie Caverns County Landfill Site, as shown below.

Table 2: Chronology of Events

Year	Remedial	Removal	Activity	Description
1965				Municipal and industrial wastes first disposed of at Site (operated by the County of Roanoke).
1972				County of Roanoke notified by Commonwealth of VA that operation must be phased out by July 1, 1973 (the deadline for jurisdictions to obtain a solid waste disposal permit).
1976 (July)			Landfill closed	The landfill ceased operations after several unsuccessful attempts to obtain a permit.
1983 (June)	✓		PA	EPA conducted a Preliminary Assessment (PA) of the Site, identifying several disposal areas (including a large fly ash pile of undetermined constituents).
1987 (Jan.)	✓		Proposed to NPL	Dixie Caverns County Landfill Site proposed for listing on the National Priorities List (NPL), 1/22/1987.
1987 (Sept.)		✓	"1st Removal" Order (drum area, sludge pit, fly ash stabilized)	As a result of the initial investigations, the County of Roanoke signed a Consent Agreement and Order with EPA to conduct a Removal Action ("first removal") at three disposal areas: 1. a discarded drum area 2. a sludge pit 3. the fly ash pile
1988 (Aug.)		✓	"1st Removal" Activity	The following activities were conducted by GSX Services: • Sludge and associated soils in the sludge disposal area were stabilized with cement kiln dust and covered with a plastic sheet, awaiting off-site disposal • Solidified sludge and soils, and some crushed drums, were shipped for

Year	Remedial	Removal	Activity	Description
				disposal to GSX's landfill in South Carolina • Full and partially full drums stored in a dumpster for later off-site disposal • Spot sampling conducted in the sludge and drum disposal areas • Fly ash remediation scheduled for October 1988 (though this did not occur)
1988 (Oct.)		✓		Roads cleared and graded to provide access to the fly ash disposal area. Adjacent ravine filled in, and the area cleared and graded. Trench dug for drainage pipe to divert water around the fly ash pile.
1989 (May)		✓		Olver, Inc. prepared a revised closure sampling and analysis plan for the sludge disposal area, and a preliminary closure sampling and analysis plan for a tire staging area. Closure sampling was undertaken at the sludge and drum disposal areas. Preparatory work for fly ash treatment was completed.
1989 (July)	✓		RI/FS	EPA initiated a Remedial Investigation and Feasibility Study (RI/FS) when the Potentially Responsible Parties (PRPs; notified by Special Notice Letter, or SNL) declined to perform the work. This RI was completed in 1992.
1989 (Oct.)	✓		Listed on NPL	Dixie Caverns County Landfill formally listed on NPL (54 FR 41015); ranked 619 of 929 NPL sites (with a Hazard Ranking System, or HRS, score of 34.60 - 35.57); 10/4/1989.
1991 (Sept.)	✓		OU1 ROD (fly ash)	Though the RI continued, EPA had enough information to determine the remedy for the fly ash (RCRA K061 waste), and issued a ROD for Operable Unit 1 (OU1; the fly ash pile). The fly ash was to be removed from the Site and treated with a High Temperature Metals Recovery (HTMR) process. This Remedial Action (RA) work began in August of 1994. All other areas of the Site were designated as OU2.
1992 (Jan.)	✓		OU2 RI Report	RI Report for OU2 (all other areas) revealed that surface water and sediments of the small streams were contaminated with high levels of lead, cadmium and zinc. The Superfund Removal Branch was notified, in order to determine the need for an expedited response.

Year	Remedial	Removal	Activity	Description
1992 (Aug.)		✓	"2nd Removal" Order (stream sediments, soils near fly ash)	EPA determined that there existed an imminent threat to public health, welfare and/or the environment due to the actual release of hazardous substances from the Site. Consequently, EPA and the PRPs entered into an Administrative Order by Consent for Removal Action (AOC, or Removal Order; the "second removal").
1992 (Sept.)	✓		OU2 ROD (remainder of Site)	EPA issued a "no further action" ROD for OU2, based on the rationale that all risks posed by the remainder of the Site had been or were to be addressed under prior and current remedial and removal actions.
1993 (June)	✓		OU1 CD	In June of 1993, the County of Roanoke, Roanoke Electric Steel (RES) (collectively the PRPs) and EPA entered into a Consent Decree (CD) for the PRPs to implement the remedy as described in the OU1 ROD (of Sept. 1991).
1993 -1997		✓	"2nd Removal" Implementation (RAP)	The Response Action Plan (RAP) developed in accordance with the 2nd Removal Order was implemented in five stages: 1. Planning; sampling and analysis; access to adjoining properties gained. 2. Contaminated soil and sediment removal. 3. Contaminated soils and sediment stabilization: on-Site stabilization using a proprietary process developed by Roanoke Electric Steel was demonstrated and approved by EPA and VA. 4. Ultimate disposal of the stabilized soils and sediment in an on-Site landfill. The landfill was filled, capped, and certified closed. 5. Site clean-up: accesses, roadways, and production areas were cleaned, equipment was decontaminated, and mixing equipment was disposed of contaminated soils from the clean-up were stabilized and disposed of in the landfill prior to closure.
1994 (Aug.)	✓		OU1 RA (fly ash)	The RA (construction) for OU1 was initiated on August 15, 1994. Approximately 9,000 cubic yards of fly ash material were excavated from the Site and transported to an HTMR facility. Both dust and erosion/sedimentation controls were implemented during the excavation of the fly ash.
1997		✓	FCOR	The Final Close-Out Report (FCOR, signed 9/25/1997) for the Site was written following the completion of removal and construction activities at the Site.

Year	Remedial	Removal	Activity	Description
1999 (Oct.)	✓		Five-Year Review visit	EPA visited the Site, accompanied by a representative of the County of Roanoke and Olver, Inc., to assess the protectiveness of the remedy.
2001 (May)				The County of Roanoke completed construction of a new training facility and shooting range on part of the Site (uphill from the NPL landfill).
2001 (July)	✓		1st Five-Year Review	First five-year review signed on 7/23/2001.
2001 (Sept.)			Delefion from NPL	Deletion from NPL became effective on 9/28/2001.
2005 (Nov.)	✓		2nd Five-Year Review	Second five year review started, 11/14/2005.
2007 (Sept.)	✓		2nd Five-Year Review visit	EPA visited the Site on 9/4/2007
2007 (Sept.)	✓		2nd Five-Year Review	Second five-year review signed on 9/24/2007
2011 (Aug.)	✓		3rd Five-Year Review visit	EPA visited the Site on 8/25/2011

III. BACKGROUND

Location

The Dixie Caverns Landfill Superfund Site (the "Site") is located in Roanoke County, near Salem, Virginia, along State Route 778, approximately one mile west of Exit 132 on Interstate 81 (heading south from Roanoke) (Figure 1). The landfill is currently owned by the County of Roanoke, and was operated by the County from 1965 until 1976.

The Site is located in a rural area with the nearest residence located approximately one half mile southeast along Twine Hollow Road. Approximately 235 residents live within a one-mile radius of the Site, and an estimated 2,110 live within three miles. Within one mile of the Site, private wells are used as the source of potable water (Figure 2). No site-related contamination was detected in ground water and a public water line is available in the vicinity of the Site.

Physical Characteristics

The topography in the region is characterized by long, narrow, parallel valleys and mountain ridges. The Site lies on a relatively steep ridge complex between two steep valleys, each of which contains an intermittent stream. The elevation at the Site ranges from approximately 1400 feet above mean sea level (msl) at the Site entrance to 1650 feet in the northwest corner.

Two unnamed headwater streams receive surface water runoff from the Site - one flows through the northern portion (hereinafter referred to as the "northern drainage area") of the Site across the base of the former fly ash pile located on the Site; the other flows along Twine Hollow Road just beyond the southern Site boundary. These streams discharge to the Roanoke River.

The average yearly temperature for the area is approximately 56°F, with a maximum in the 90's and a minimum in the 20's. The average precipitation is 44 inches, which is distributed fairly evenly throughout the year.

Groundwater within the Mississippian-Devonian-Silurian (MDS) aquifer system moves along bedding, fracture, and solution channels from recharge areas to discharge areas at springs and along stream valleys. The MDS aquifer system lies within clastic sandstone, siltstone, and shale iithologies. Natural groundwater recharge is rapid because of the thin soil mantle on the ridges. The depth to groundwater is usually greater than 20 feet, but less than 100 feet. Boring logs taken from the valley containing the drum disposal area and fly ash pile indicate that the depth to groundwater is found at 18.0 and 19.5 feet, respectively. In general, the groundwater flow in the area would be expected to be south to southeast ("south/southeast") in the direction of the Roanoke River parallel to the mountain chains. Groundwater quality within the MDS aquifer system is classified as poor to fair. The MDS aquifer system generally contains higher amounts of iron, manganese, and sulfate.

Land and Resource Use

The historic locations of the waste disposal areas are provided in Figure 3. Figure 4 provides a photograph of how the Site currently appears. When the Site was an active landfill, it was comprised primarily of the Solid Waste Disposal, Sludge Disposal, Tire Staging, and Drum Disposal Areas. The Solid Waste Disposal and Sludge Disposal Areas are now relatively level fields. The tires and drums have been removed from the Site and these areas appear relatively unaffected. There is a leachate collection system at the Site as well as another level field, which was the landfill for the stabilized sediments from the stream and the hillside that were contaminated with fly ash. The former fly ash pile area is now a vegetated hillside. The stream draining the ravine to the north is lined with vegetation and shows no hints of its former contaminated state. The Site is surrounded by forested mountainsides and ravines.

At the Site, the County of Roanoke Police Department has constructed several buildings including a new training facility with classrooms and an outdoor shooting range on high ground uphill from the upper leachate collection tanks and near the former sludge pit. In addition, there is a police driving course and an additional training building on the next hill over from the shooting range outside of the old landfill. The facilities are connected to the public water line to prevent possible site-related contamination. As a result of the new facilities at the Site, the County of Roanoke Police Department has installed new fencing and security cameras.

History of Contamination

Roanoke County first leased the Dixie Caverns site for garbage disposal in January, 1965, and municipal and industrial wastes were first disposed of at the Site by June of 1965. Sometime before June 30, 1966, Roanoke County purchased the property, and in 1971 submitted a permit application to operate the Dixie Caverns Landfill (DCL) site as a solid waste disposal facility.

In 1972 the County of Roanoke was notified by the Commonwealth of Virginia that their operation had to be phased out by July 1, 1973, which was the deadline for jurisdictions to obtain a solid waste disposal permit. After several unsuccessful attempts to obtain a permit, the landfill ceased operation in July 1976.

Four distinct areas were used for various types of waste disposal. In the Solid Waste Disposal Area, the primary landfill area in the southwest corner of the Site, bulk waste was dumped to fill ravines. Just to the north of the Solid Waste Disposal Area were the locations for the Tire Staging Area and the Drum Disposal Area, where approximately 300 drums of various chemical wastes were stored. To the east was a Sludge Disposal Area, in which an unknown quantity of liquid and sludge wastes were dumped. A large hillside to the northeast was covered by approximately 9,000 cubic yards of electric arc furnace fly ash (the "Fly Ash Pile"), which had been dumped from the road above.

During its operation, the landfill received unknown quantifies of industrial refuse, scrap metal, fly ash, sludge, and other industrial wastes. When the landfill was closed in July 1976, it contained an estimated 440,000 cubic yards of waste covering approximately 39 acres.

Initial Response

In June 1983, EPA completed a Preliminary Assessment of the Site and identified several disposal areas including a large fly ash pile of undetermined constituents. As a result of these initial investigations, the County of Roanoke signed a Consent Agreement and Order with EPA in September 1987 to conduct a removal action at three disposal areas - a discarded drum area, a sludge pit, and the fly ash pile. The County completed removal activities in the drum area and sludge pit. EPA approved the County plan to treat the fly ash using a proprietary stabilization process. The treated waste was to be placed on site. Prior to initiation of full-scale treatment, the Commonwealth of Virginia identified inconsistencies between the county plan and state regulations. EPA consequently recommended that the County suspend the removal action for stabilization of the fly ash pile.

For the Drum Disposal Area, removal activities consisted of the removal of construction debris, tires, and approximately 300 drums, along with identification (where possible) of the drum's origin. Prior to removal, each drum was visually inspected, field-tested, pumped, overpacked, and/or moved directly to a drum staging area. Drums were inspected for identifying labels or other information pertaining to their possible contents, drum integrity and volume of material. Drums containing liquids were pumped and/or overpacked prior to removal to the designated staging/sampling area. Compatible liquids were consolidated into a bulk storage/transportation tanker, and incompatible liquids and non-pumpable sludges were pumped, overpacked or stabilized in DOT-approved drums for off-site disposal in an approved hazardous waste disposal facility.

Drums containing solid material were overpacked, and/or removed and placed in the designated sampling/staging area. All solids requiring disposal were either blended with other solids for bulk disposal or disposed of as drummed waste in an approved hazardous waste facility. Sampling from the drum disposal area indicated high levels of volafile and semi-volatile organic compounds.

Removal activities for the sludge pit consisted of the removal of approximately 500 cubic yards of sludge and contaminated soil, followed by disposal off-site in an approved hazardous waste disposal facility, post excavation sampling to ensure all hazardous materials had been removed, backfill and grading with clean fill, and revegetating the area for erosion control. This area contained high levels of various organic compounds.

The Dixie Caverns Landfill Site was proposed for listing on the Superfund National Priorifies List (NPL) on January 22, 1987. The Site was formally listed on the NPL on October 4, 1989.

On January 2, 1988 and April 26, 1989, EPA sent special notice letters pursuant to Section 122(e) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U. S.C. Section 9622(e), to identified Potentially Responsible Parties (PRPs) and to offer them the opportunity to perform a Remedial Investigation and Feasibility Study (RI/FS) of the Site. When the PRPs declined to perform the work in July 1989, EPA initiated an RI/FS to determine the full extent and impact of contamination at the Site.

Basis for Taking Action

Although the Remedial Investigation had not yet been completed, EPA had sufficient information in September 1991, to determine the appropriate remedy for the fly ash, identified under Resource Conservation and Recovery Act (RCRA) as K061. This waste is a listed hazardous waste under the regulations promulgated at 40 C.F.R. Section 261.32 pursuant to RCRA, 42 U.S.C. Sections 6901 et seq. The K061 waste pile contained several metals, including lead, cadmium and zinc, at levels that presented an imminent and substantial threat to human health and the environment.

Although the fly ash is relatively immobile, there was visible evidence of fly ash migration away from the pile over the surface of the site. Also, the data collected during the RI/FS identified elevated metal concentration in the surface waters and sediments of streams receiving runoff from the fly ash pile. The goal of the removal actions was to remove and treat the fly ash to eliminate the principal threat posed by the metals and to protect human health and the environment from the risks posed by ingestion, dermal absorption, or inhalation of the fly ash by significantly reducing the toxicity of the fly ash. The selected remedial actions discussed in the following section, also included measures to protect human health and the environment from accidental releases or migration of contamination from the fly ash through air emissions and surface runoff.

Listed below are the indicator chemicals (i.e., chemicals observed at the site which were most likely to pose a threat to public health and the environment), and the media they applied to for the Dixie Caverns Site.

Fly Ash Pile

- Lead (concentration was 45,000 ppm or 4.5%)
- Cadmium (concentration was 1,600 ppm or 0.16%)
- Zinc (concentration was 220,000 ppm or 22%)
- Other inorganic contaminants (including chromium, manganese, silver, antimony, and barium, <2%)

Surface Water

- Lead
- Cadmium
- Zinc
- Other inorganic contaminants from the fly ash pile (including chromium, manganese, silver, antimony, and barium)
- Limited detections of VOCs and SVOCs during high-flow periods (primarily phthalates)

Stream Sediments

- Lead (maximum concentration was 35,500 mg/kg before removal)
- Cadmium (maximum concentration was 1,100 mg/kg before removal)
- Zinc (maximum concentration was 127,000 mg/kg before removal)
- Other inorganic contaminants from the fly ash pile (including chromium, manganese, silver, antimony, and barium)

Soils

- Inorganic contaminants related to the fly ash pile (including barium, beryllium, copper, lead, manganese, nickel, and zinc; these soils were removed)
- VOCs, SVOCs, PCBs, primarily in both the drum disposal and sludge pit areas prior to removal (low levels were detected elsewhere, but not widespread)

Ground Water

- Few very low concentrations of VOCs (acetone, bis(2-chloroethyl)ether), one SVOC (naphthalene, 3 ppb) and pesticides «0.01 ppb of several)
- In several off-site wells, metals were detected, including arsenic (4.5 ug/L) and lead (16 ug/L and 26 ug/L); (The well owners were notified, as these wells were outside of the influence of the site.)

Air (potential contaminants from airborne fly ash)

- Lead
- Cadmium
- Zinc
- Other inorganic contaminants in the fly ash pile prior to its removal

The primary chemicals of concern at the Site were inorganic metals derived from the fly ash pile, present mainly in surface waters and stream sediments in the vicinity of and downstream from the fly ash pile. VOCs and SVOCs (specifically, polycyclic aromatic hydrocarbons or "PAHs" and phthalate esters) were present primarily in the sludge pit and drum disposal areas and soils therein, and were addressed during the first removal action.

IV. REMEDIAL ACTIONS

Remedy Selection and Implementation

The fly ash pile was addressed separately from the rest of the Site as Operable Unit (OU1). On September 30, 1991 prior to the completion of the Remedial Investigation, EPA issued a Record of Decision (ROD) OU1 to address the approximately 9,000 cubic yards of K061 waste (fly ash) present at the Site. As described in the OU1 ROD, from 1991, the selected remedy for the fly ash pile was removal of the fly ash from the Site and treatment of the fly ash at a High Temperature Metals Recovery (HTMR) facility. The PRPs entered into a consent decree with EPA in June of 1993 agreeing to implement the remedy selected in the OU1 ROD. Specifically the OU1 ROD called for:

- Excavation of approximately 9000 cubic yards of fly ash material from the Site;
- Transportation of approximately 9000 cubic yards of fly ash material off-site for treatment using the HTMR process;
- Treatment of the fly ash at an EPA approved HTMR facility to achieve the treatment standards for K061 waste specified in 56 Federal Register 41164-41178. HTMR facilities bum waste at extremely high temperatures. The heat, which is generated from this process, may be used to produce electricity or steam. Metals are recovered from the ash and recycled. The recycled metal may be sold to other manufacturers.

- Implementation of dust controls and erosion and sedimentation controls during fly ash excavation.

The Remedial Action (RA; the construction of the remedy) was formally initiated on August 15, 1994, when the PRPs awarded the RA contract. The contractor conducted remedial activities as planned, and no additional areas of contamination were identified. EPA Concurrence Notices dated November 15, 1995 and January 30, 1996 were issued to the PRP pursuant to Sections XV.8.1 and XV.8.2 of the OU1 Consent Decree to document that the "Remedial Action" and the "Work" had been completed and the Performance Standards of the OU1 ROD had been achieved.

At the time that the 1991 ROD was issued, EPA designated all other areas of the Site (except the K061 fly ash waste pile) as Operable Unit 2 (OU2), and addressed these areas in the Remedial Investigation Report dated January 1992. As part of the Remedial Investigation for OU2, surface water and sediment samples were obtained from the small streams adjacent to the northern portion of the Site. The analytical results of these samples were evaluated and three contaminants of potential concern (lead, cadmium and zinc) were identified.

Because of the high levels of inorganic contaminants found in the stream sediments, the EPA Region III Superfund Removal Branch was notified to determine the need for an expedited response. EPA subsequently determined that an imminent threat to public health, welfare and/or the environment existed due to the actual release of hazardous substances from the Site. As a result, on August 28, 1992, EPA and the PRPs entered into an Administrative Order by Consent for Removal Action (Removal Order) pursuant to Sections 106(a) and 122(a) of CERCLA, 42 U.S.C. Sections 9606(a) and 9622(a). The Removal Order required that the PRPs:

- Identify the extent of contamination exceeding ecological risk-based levels in two streams at the Site and in soils in the vicinity of and directly beneath the K061 waste pile,
- Eliminate the effect of contamination on aquatic and vegetative species located in and around the two streams, and
- Remove, treat, and/or dispose of contaminated soils in the vicinity of and directly beneath the K061 waste pile.

The Removal Order required that the PRPs develop, gain EPA approval for, and implement a Response Action Plan (RAP) detailing the specific response action to be implemented to address the requirements of the Removal Order. The RAP presented a plan to reduce to acceptable levels the potential threat posed by releases from the former fly ash waste pile. The plan was to sample the streams to determine the extent of contamination, then excavate the sediment contaminated by the fly ash in the stream and the contaminated soils underlying the fly ash pile. The contaminated sediment and soil would be stabilized using a proprietary process developed by Roanoke Electric Steel and approved by EPA and Virginia regulatory agencies. The process would involve stabilizing the waste in concrete blocks, and then landfilling the blocks on-site in a properly designed landfill. After clean-up, sampling and analysis would confirm the success of the plan.

Implementation of the RAP to comply with the Removal Order took place over a five-

year period from 1993 to 1997. The work took place in five stages. The first step was planning. The RAP was written, submitted and approved by EPA. Sampling and analysis of stream sediment was conducted, and the results used to form remedial strategies. Erosion and sediment control measures were designed and implemented, access to adjoining properties was gained and plans were made to manage contaminated water.

The second step involved the removal of the contaminated soil and sediment. Soil sampling confirmed the success of the removal, and the control areas were certified clean. The next step was to stabilize the contaminated soil and sediment. On-site stabilization was demonstrated and approved by EPA. The stabilization process consisted of a treatment system which chemically fixated and immobilized the solid wastes containing hazardous constituents thereby greatly minimizing the dissolution and migration of these constituents into the environment. The utilized stabilization process is a proprietary process which is subject to trade secret protection. This process successfully neutralized the contaminated waste.

The fourth step was ultimate disposal. A geological and hydrogeological investigation confirmed the suitability of the site for landfill construction. The RCRA subtitie *"C"* compliant landfill was designed in compliance with all applicable regulations. In addition to constructing the landfill, a leachate collection system was constructed. To collect any potential leachate, a collection pipe was placed along the perimeter of the landfill. After construction, the landfill was operated and maintained in compliance with the RAP for disposal of the stabilized sediment and soil.

The final step was to clean-up the site. Access, roadway, and production areas were cleaned, equipment was decontaminated, and mixing equipment was disposed of Contaminated soils from the clean-up were stabilized and disposed of in the landfill prior to closure.

A report certifying the successful clean-up of soils in the vicinity of and directly beneath the K061 waste pile, including the Sampling and Analysis Plan, a summary of field sampling activities, analytical results and summary statistics was submitted by the PRPs on September 26, 1995. Work on sediment removal and stabilization continued through the early summer of 1997. A final inspection was conducted by EPA on July 31, 1997. A Report entitled "Implementation of a Response Action Plan to Remove, Stabilize, and Dispose of Soils and Sediment at Dixie Caverns Landfill" dated September 4, 1997 was submitted by the PRPs documenting that all requirements of the Removal Order had been met. EPA accepted this report on September 18, 1997.

EPA selected no further action as the remedy for OU2. The OU2 ROD addresses those areas of the Site which were not addressed by OU1 (the K061 waste pile) or the Removal Order (sediments in the adjacent stream and soils in the vicinity of and beneath the K061 waste pile). EPA's rationale for the "no further action" decision was that previous remedial and removal actions addressed all risks posed by the Site and no further action was necessary. The OU2 ROD was signed on September 28, 1992.

System Operation/Operation and Maintenance (O&M)

A Post-Closure Care Plan for the on-Site landfill containing the stabilized soils and

sediments was developed to provide methods and schedules for operation and maintenance of the landfill components, including vegetative cover, erosion and sediment control, and the landfill leachate collection and disposal system. A copy of the post-closure plan can be found in Appendix VI of the report entitled "Implementation of a Response Action Plan to Remove, Stabilize, and Dispose of Soils and Sediment at Dixie Caverns Landfill", dated September 4, 1997.

A small pocket of sediment in the south bank of the large sediment pond was unable to be excavated due to its inaccessible location. The pocket consists of about 5 cubic yards of contaminated sediment. The pocket is buried under 7 feet of clay and is protected from erosion by the stream by a large culvert directing flow around it. Abandonment of this sediment pocket was approved by EPA after demonstrations showed that long term entombment was practical. A yearly walk-by of this location for 5 years after closure was required to ensure that erosion did not begin to threaten the pocket. If future inspections indicate that the integrity of the pocket is threatened, repairs shall be made to ensure the entombment. The adjacent sediment control structures, including the piping and drop inlet are inspected regularly to verify that they are free of debris.

The only remaining activities to be performed at the Dixie Cavems County Landfill Superfund Site are the ongoing Operations and Maintenance (O&M) of the landfill containing the stabilized sediment and soils, O&M for the leachate collection system, and the quarterly and five-year review site inspections. The O&M for the sediment and soils involves maintaining the vegetation and preventing erosion, while the O&M for leachate collection system involves checking leachate levels and the electrical pumps. In general, the leachate collection system is in good shape and the County of Roanoke is prepared with a back up electric pump if necessary. Monitoring of the leachate collection from the Site continues even though no leachate has been produced by the Site. As previously recommended in the last five-year review, the quarterly inspections of the Site have continued. Currently, there are no plans to discontinue the quarterly inspections. Each year the County of Roanoke budgets about $27,000 to cover the O&M costs for the Site.

EPA deleted this Site from the NPL effective September 28, 2001.

V. PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

In general, there have been no changes at the Site since the last five-year review. The removal actions were completed in 1997 and no additional actions are necessary. The quarterly inspections of the Site have continued as recommended during the last five-year review. The inspections have noted two bare patches of ground near the monofill cap. Only one bare patch was seen during the five year inspection. The quarterly inspections have also noted that Benchmark #1 has been disturbed and the inspectors are unable to locate the benchmark.

During the last five-year review, EPA also recommended the development of a proposal to install a wear surface as a protective cover, which would replace the vegetated cover that now exists over the landfill cap and allow for reuse of the land. This recommendation was not evaluated but is ho longer considered necessary. There are no plans to build on the landfill cap. Portions of the Site are currently being utilized by the County of Roanoke Police Department,

but areas being utilized are not areas included in the RODs and do not affect the protectiveness of the Site. Another recommendation from EPA was to implement institutional controls to ensure the integrity of the landfill strnctures, and thus the long-term protectiveness of the remedy in the event of a transfer of ownership of the property. The County of Roanoke has implemented legal documentation for the property that will provide the necessary institutional controls. The final recommendation was to continue the five-year reviews. This recommendation has been abided by as exhibited by the completion of the third five-year review.

VI. FIVE-YEAR REVIEW PROCESS

Administrative Components

Members of EPA, Virginia Department of Environmental Quality (VADEQ), and Roanoke County were notified of the initiation of the five-year review in June 2011. This five-year review was performed by the USACE, Wilmington District. Erin Williams (Civil Engineer), with the USACE, Wilmington District was responsible for gathering and reviewing data and preparation of the report for this review. Raymond Livermore (Environmental Engineer) with the USACE, Wilmington District provided a quality assurance review of the report.

Laura Mohollen (EPA Remedial Project Manager (RPM)) participated during the inspection of Dixie Caverns County Landfill Superfund Site for the Five-Year Review. Ron Davis (EPA RPM) has replaced Ms. Mohollen as the RPM. Additional EPA technical support was provided by Bruce Rundell (Hydrogeologist), Dawn loven (Toxicologist), Bruce Pluta (Biological Technical Assistance Group (BTAG)), and Larry Johnson (Community Involvement Coordinator (CIC)).

Community Notification and Involvement

EPA advertised a notice announcing the start of the five-year review period for Dixie Caverns in *The Roanoke Times,* a widely-distributed local newspaper, on July 14, 2011.

Document Review

A complete list of documents reviewed can be found in Attachment 2. Documents reviewed in the process of conducting this five-year review included the last two five-year reviews, the RODs, and the past several years' worth of inspection reports. The Applicable or Relevant and Appropriate Requirements (ARARs) listed in the RODs were also reviewed, and are presented here in Attachment 5.

Data Review

The past several years' worth of inspection reports produced since the last five-year review report were reviewed. Since the leachate collection system has not indicated leachate from the Site, there has been no actual monitoring data from the system.

Site Inspection

A site inspection of the Dixie Caverns Landfill Superfund Site was conducted on

August 25, 2011. A site inspection checklist has been included as Attachment 3. The following individuals attended the site visit:

- Laura Mohollen, Remedial Project Manager, USEPA
- George W. Simpson, III, County Engineer, Roanoke County
- David Griffiths, Independent Consultant, Roanoke County
- Raymond Livermore, Environmental Engineer, USAGE, Wilmington District
- Erin Williams, Civil Engineer, USACE, Wilmington District.

The entrance to the Site is gated and fenced. The gates and fence were intact and can be secured. A camera system has been added within the property to monitor the facilities contained at the Site for the County of Roanoke Police Department.

The inspection started at the former Sludge Disposal Area. This area is covered in vegetation and appears well maintained (see Photo 1 in Attachment 4). Slightly south of this area is where the Police Department has built several gun ranges and a training center. The construction of these facilities appears to have little impact on the Site. The facilities are connected to the public water supply, as a result, possible contamination of the facilities water from the Site is unlikely.

The lower leachate collection and pre-treatment systems for the Site and the municipal landfill are located just inside the entrance to the Site along Twine Hollow Road. The lower leachate collection system appears to be in good working order. The upper leachate collection and leak detection system below the Sludge Disposal Area and near the monofill cap measure the leachate from the Site only. This system also appeared to be in good working order. Mr. Simpson and Mr. Griffiths confirmed the working condition of this equipment (see Photos 2 & 3) and noted that no leachate has been collected from the former NPL portion but a little leachate has been collected from the municipal landfill. The little leachate collected is no longer pre-treated but it is sampled periodically to confirm that no treatment is necessary.

The location of the landfill containing the stabilized sediment and soil is just east of the leachate collection system. The monofill cap on top of the landfill appears to be in good condition. The cap is heavily vegetated as shown in Photos 4 & 5. There appear to be animal trails and bedding areas within the vegetation but this is not causing a problem and no burrowing was seen during the inspection of the cap. Between the north east corner of the monofill cap and the hillside, a construction crew had placed fill material (soil) to store for later construction. Some of the fill material was removed and the ground where the material was removed has an appearance of a depression (Photo 6). This area may enable water to pond. Additionally, vegetation is sparse within this area. The remaining fill material is causing no damage to the landfill cover (Photo 7). Vegetation needs to be reestablished in the area in which the fill material was removed and the ground should be made level to allow water to properly flow from the cap of the landfill.

The former drum disposal area is shown in Photo 8. The drums were removed as part of the 1987 Removal Order for the Site. Contamination was not an issue in this section of the Site.

The 1992 Removal Order resulted in the removal of the contaminated soil from within

the channel of the stream at the bottom of the ravine shown in Photo 9. The soil removed from the stream is now contained under the monofill cap previously discussed. Mr. Griffiths mentioned during the inspection, that the rocks naturally found in the streambed were cleaned to prevent future contamination of the stream (Photo 10).

Photo 11 shows a pond that has formed above the culverted stream. The water from the pond filters naturally through the ground. The monitoring of the ground water has showed no contamination as a result of the water from the pond.

The final area inspected is where the culverted stream ends and where the fly ash was left in the ground entombed by a thick clay layer. The area where the fly ash is entombed is in good condition (Photo 12). The vegetation is thick over this area and the rocks channel water flow to prevent any erosion of the clay cover. At the time of the inspection, the stream was dry. No flow was seen exiting the culvert.

The overall condition of the Site was good. There is very little visible evidence of the removal action taken in the stream at the Site. Vegetation has taken hold at the stream and at the monofill cap. The vegetation appears quite healthy. The only action necessary at this time is to fill in or ditch the area noted near the monofill cap to prevent ponding from occurring and to make sure that water can flow properly.

Interviews

Ms. Laura Mohollen, Remedial Project Manager (RPM), EPA Region III (During Site Inspection):

Ms. Mohollen was interviewed via email and during the site inspection. She indicated there are no current significant issues regarding the Site for inclusion in the five-year review report. Ms. Mohollen was generally satisfied with the project and the performance of the remedy to-date. Ms. Mohollen did discuss with Mr. Simpson, Roanoke County, to continue the quarterly inspections of the Site and to send the reports directly to EPA.

Mr. George Simpson, III, County Engineer, Roanoke County:

Mr. Simpson was interviewed at the site inspection. During the inspection, the Site was found to be in good condition. The bare spot near the monofill cap was discussed. Mr. Simpson stated that the bare spot is from the removal of soil that had been stored near the monofill cap.

Mr. David W. Griffiths, Ph.D., Principal, Environmental Science Applications, Inc.:

Mr. Griffiths, formerly an engineer with Olver Inc., was interviewed via email and at the site inspection. Mr. Griffiths had stated that there has been minimal change in the conditions of the Site since the remedy has been in place, with the exclusion of the facilities within the Site's boundaries constructed by the County of Roanoke Police Department.

VII. TECHNICAL ASSESSMENT

Question A: Is the remedy functioning as intended by the decision documents?

Answer A: The performance of the remedy has been monitored by calendar year quarterly inspections since the completion of remedial actions. The documented findings which include, but are not limited to, observations of monofill cap integrity, and monitoring for flow of liquids from the leak detection zone of the monofill (of which there have been none) indicate that the remedy is continuing to function in accordance with all critical design specifications and criteria.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Answer B: The remedial action objectives and exposure assumptions remain valid to this date in time. Toxicity data and clean up levels for the primary contaminants of concern have not changed. The Site has quarterly inspections in which readings are to be recorded from the leachate collection system. However, no leachate is being produced by the Site. In addition, the County of Roanoke has followed the remedial objectives included in the Consent Decree. Since closure, the site has been put to beneficial reuse as a training facility for County police personnel. Training activities do not intrude onto or into those portions of the site that were the subject of remedial activities. Public access to the site remains strictly limited by locked gates, under the control of the County's police department. Overall, the remedial actions were valid and the systems at the Site are functioning as intended.

Question C: Has any information come to light that could call into question the protectiveness of the remedy?

Answer C: No.

Technical Assessment Summary

According to the data reviewed, the site inspection and the interviews, the remedy is functioning as intended by the RODs and Removal Actions. There have been no changes in the physical conditions of the Site that would affect the protectiveness of the remedy. There have been no changes in the toxicity factors for the contaminants of concern that were used in the baseline risk assessment, and there have been no changes to the standardized risk assessment methodology that could affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

VIII. ISSUES

Issues identified for this five-year review of the Dixie Cavems County Landfill Superfund Site are identified in Table 3. Corresponding recommendations to address the issues are included in Section IX.

Table 3. Five-Year Review Issues

Issue	Currently Affects Protectiveness	Affects Future Protectiveness
1. Continue quarterly inspections of the Site, even though this Site has been deleted from the NPL.	No	Yes
2. Reestablish vegetation and properly slope the bare patch of ground near the monofill cap.	No	Yes
3. A general ecological health assessment of the Site should be performed.	No	Yes

IX. RECOMMENDATIONS AND FOLLOW-UP ACTIONS

During the Site inspection, it was determined that the quarterly inspection should continue and that the reports need to be sent directly to EPA. The FCOR did not specify any monitoring activities past 10 years, i.e., 2007. Currently, only the five-year reviews are required by the FCOR. Another recommendation from this review is to reestablish vegetation and properly slope the bare patch of ground near the monofill cap. The bare patch may allow water to pond and could affect the monofill cap if water is unable to flow properly from on top of the cap. Finally, because the remedies implemented were based on human health risk, a general ecological health assessment should be performed to ensure ecological protectiveness.

X. PROTECTIVENESS STATEMENT(S)

The remedy is considered protective of human health and the environment in the short term, as the landfill containing waste is complete, the cap remains intact and in good condition, and the landfill is functioning properly. Institutional controls have been implemented at the Site, and an Explanation of Significant Differences (ESD), which identifies the restrictions, is being prepared.

A general ecological assessment of the Site is needed to determine whether the remedy is protective in the long term.

Institutional Controls

The County of Roanoke, with the assistance of EPA, has implemented legal documentation for the property that will provide the necessary institutional controls. An ESD, which identifies the restrictions, is being prepared,

XI. NEXT REVIEW

The next five-year review for the Dixie Caverns County Landfill Superfund Site will be due within five years of the date of this review.

ATTACHMENT 1. FIGURES

Figure 1. Site Location Map

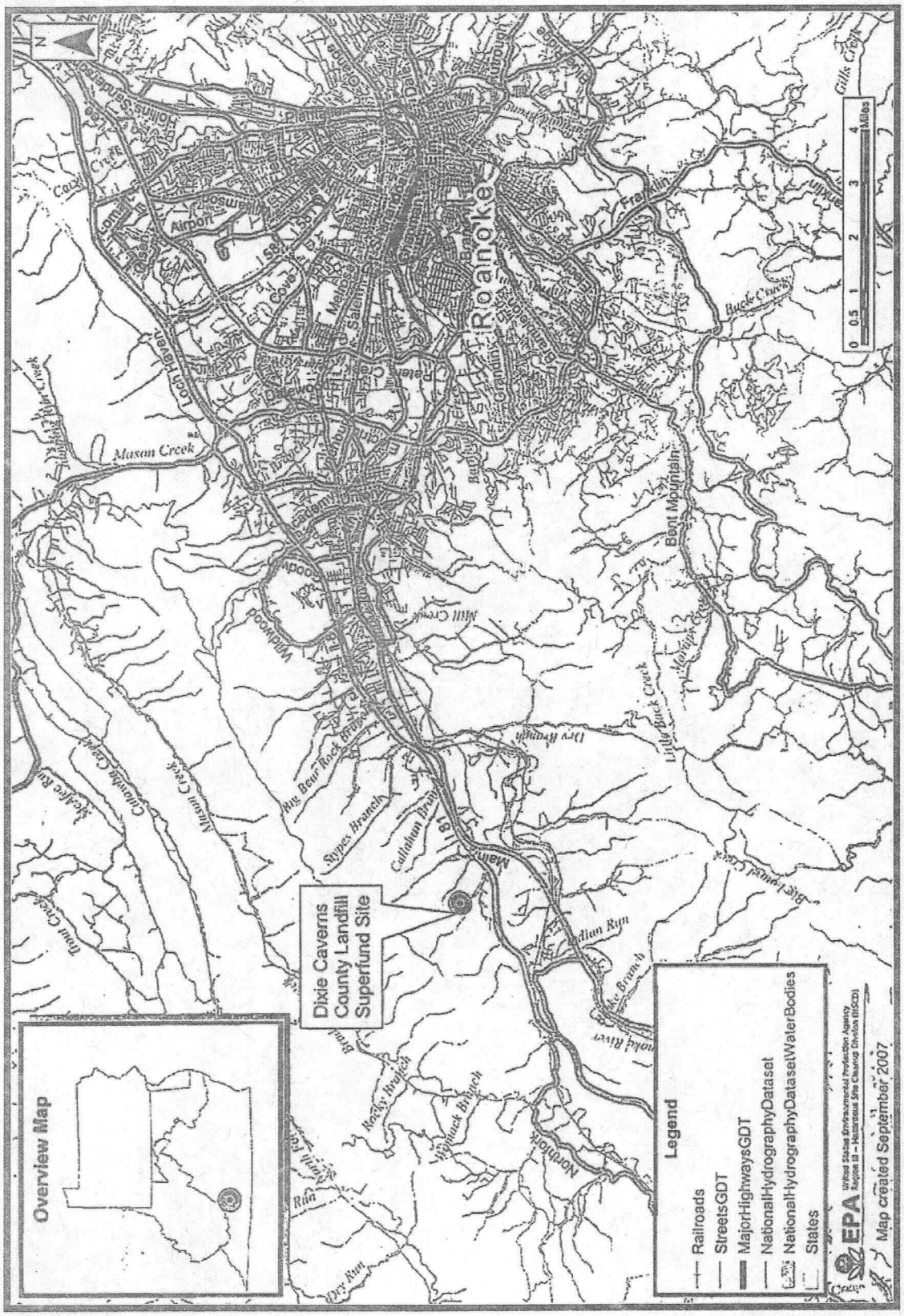


Figure 2. Residential Well Location Map

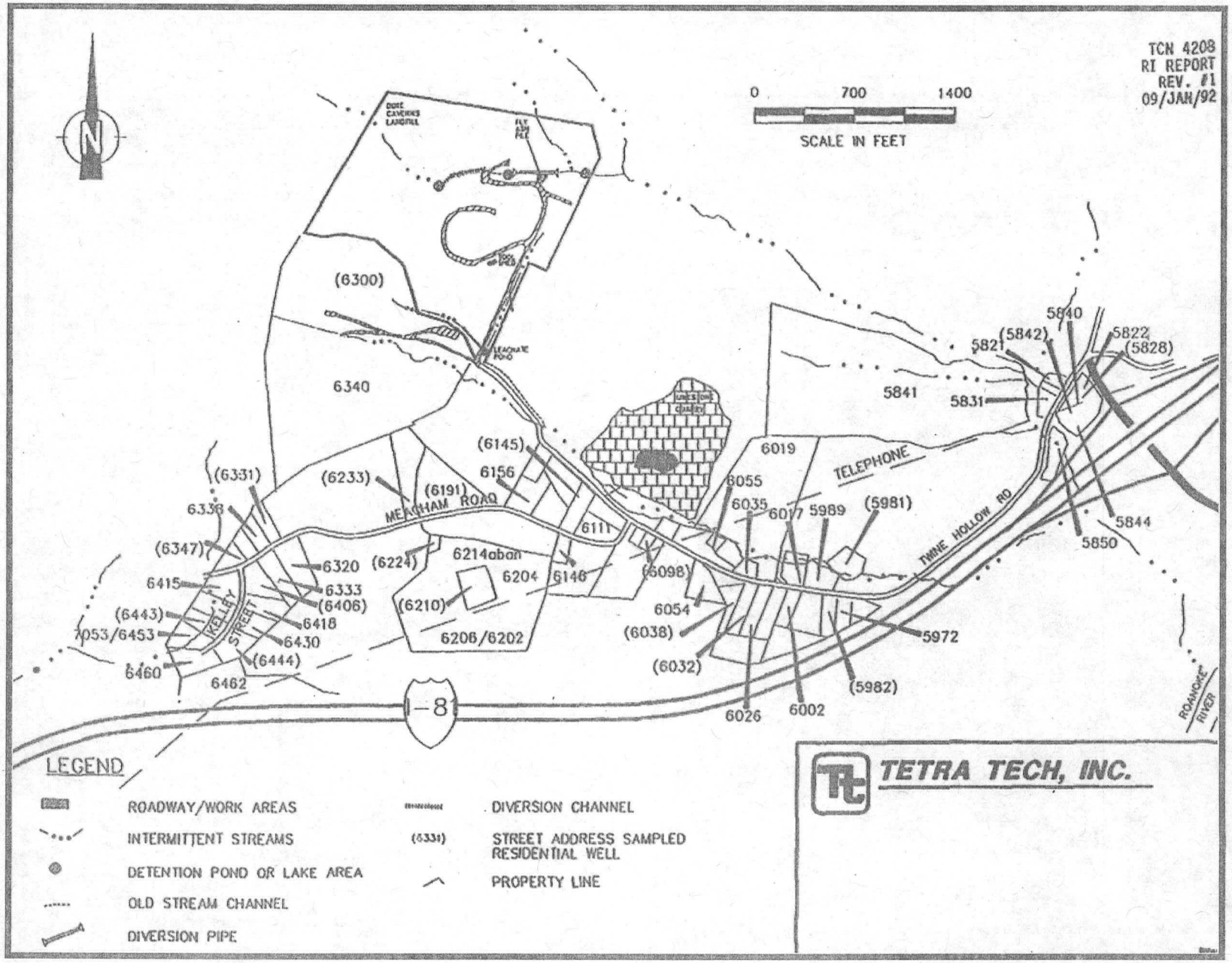


Figure 3. Historic Waste Disposal Areas

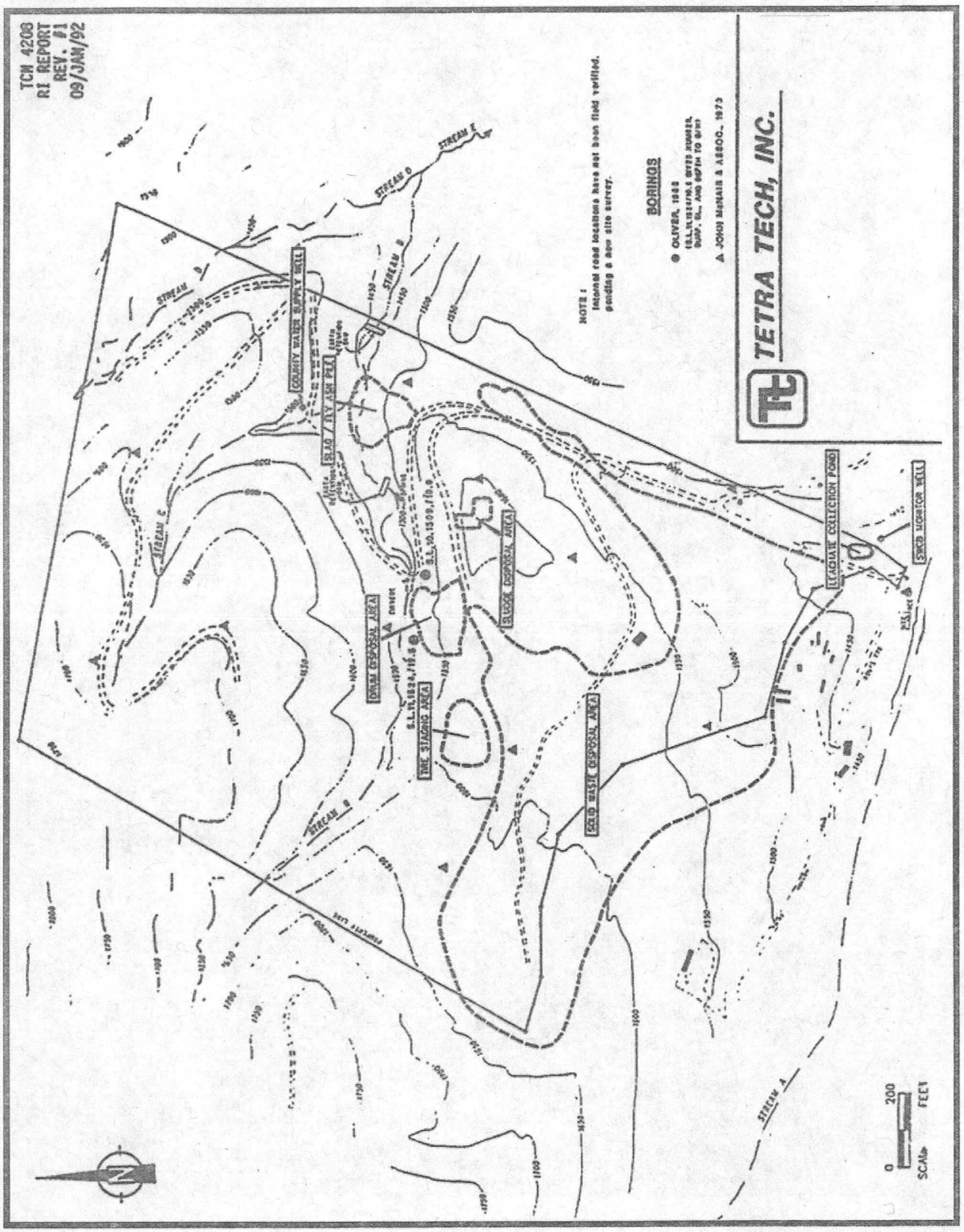
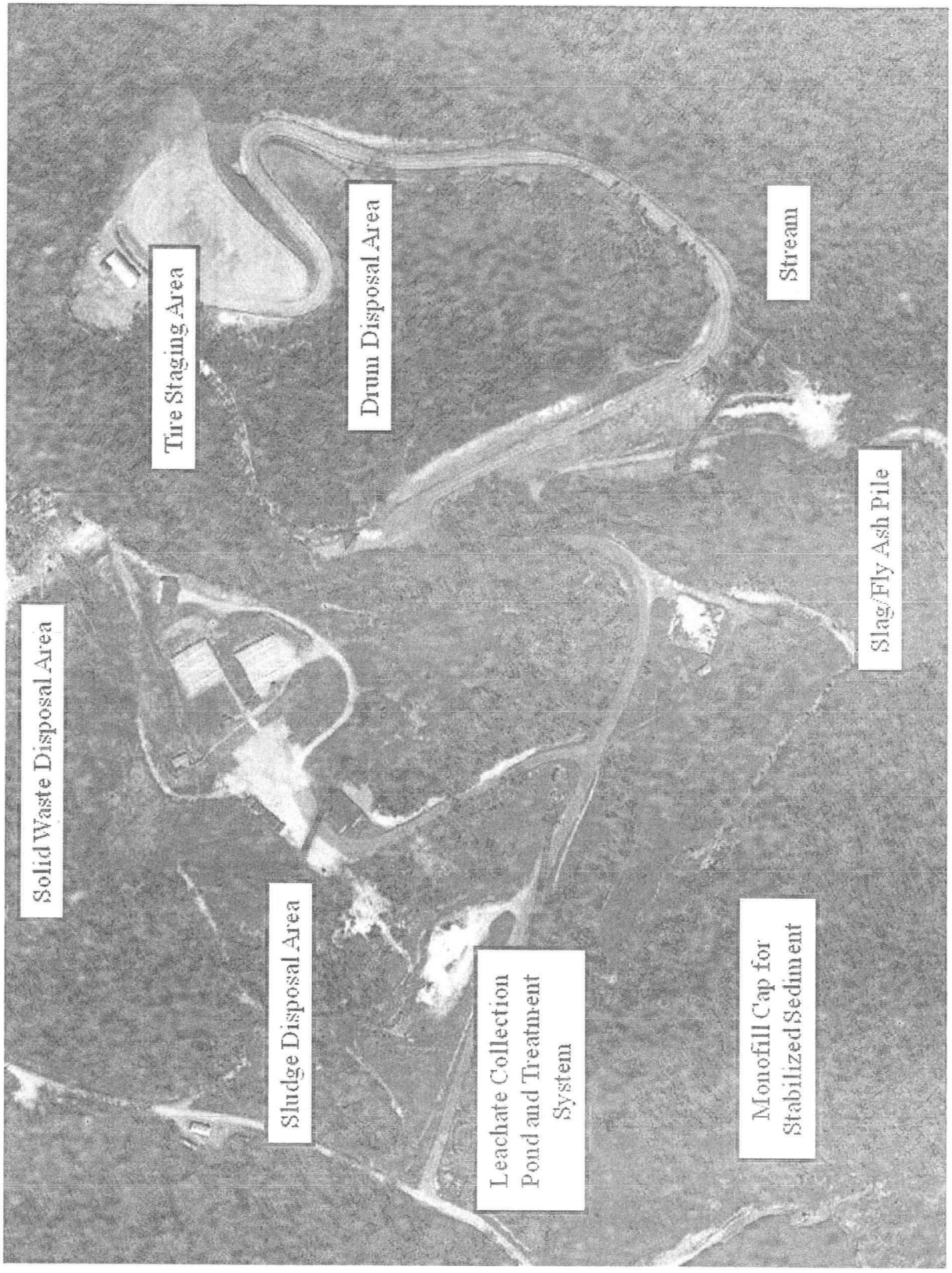


Figure 4. Site Layout



ATTACHMENT 2. LIST OF DOCUMENTS REVIEWED

List of Documents Reviewed

CERCLA Remedial Action/ Remedial Design Consent Decree, Civil Action No. 93-0336-R In the Matter Of: Dixie Caverns County Landfill Superfund Site; Salem, Roanoke County, Virginia, County of Roanoke and Roanoke Electric Steel Respondents. Entered by the court July 13, 1993.

Dixie Caverns Monofill for Stabilized Soil and Sediment Quarterly Inspection Reports, 2007-2011. Olver Incorporated; July 7, 2011.

NPL Site Deletion Narrative for Dixie Caverns County Landfill Superfund Site, U.S. Environmental Protection Agency, National Priorities List, Site Deletion Federal Register Notice: September 28, 2001.

Tetra Tech, Inc., Remedial Investigation Report for Dixie Caverns Landfill Site, January 1992.

U.S. Environmental Protection Agency, EPA First Five-Year Review Report, Dixie Caverns County Landfill Site, Roanoke County, Virginia, July 30, 2001.

U.S. Environmental Protection Agency, EPA Second Five-Year Review Report, Dixie Caverns County Landfill Site, Salem, Roanoke County, Virginia, September 24, 2007.

U.S. Environmental Protection Agency, EPA Superfund Record of Decision, Dixie Caverns County Landfill, OU 1, Salem, Virginia, September 30, 1991.

U.S. Environmental Protection Agency, EPA Superfund Record of Decision, Dixie Caverns County Landfill, OU 2, Salem, Virginia, September 28, 1992.

ATTACHMENT 3. SITE INSPECTION CHECKLIST

I. SITE INFORMATION

Site name: **Dixie** Caverns County **Landfill** Superfund Site	**Date of inspection: August 25, 2011**
Location and **Region: Roanoke County, VA Region III**	**EPA ID: VAD980552095**
Agency, office, or company leading the **five-year** review: **EPA and USACE**	**Weather/temperature: Sunny slightly overcast with a high of 95°F**

Remedy Includes: (Check all that apply)

- ✓Landfill cover/containment
- ✓Access controls
- ✓Institutional controls
- ☐Groundwater pump and treatment
- ☐Surface water collection and treatment
- ☐Monitored natural attenuation
- ☐Groundwater containment
- ☐Vertical barrier walls
- **Other** _____

Attachments: Inspection team roster attached Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M** site manager George Simpson (Name) County Engineer (Title) 8/25/11 (Date)
   Interviewed ✓at site ☐at office ☐by phone Phone no. 540-772-2096 ext 23
   Problems, suggestions; ☐Report attached _____

2. **O&M** staff David Griffiths (Name) Independent Consultant (Title) 8/25/11 (Date)
   Interviewed ✓at site ☐at office ☐by phone Phone no. 540-953-0511
   Problems, suggestions; ☐Report attached _____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.
   Agency _____
   Contact _____ (Name Title Date Phone no.)
   Problems; suggestions; Report attached _____
   Agency _____
   Contact _____ (Name Title Date Phone no.)
   Problems; suggestions; Report attached _____
   Agency _____
   Contact _____ (Name Title Date Phone no.)
   Problems; suggestions; Report attached _____
   Agency _____
   Contact _____ (Name Title Date Phone no.)
   Problems; suggestions; Report attached _____

4. **Other interviews** (optional) ☐Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. O&M Documents
- ☐O&M manual ☐Readily available ☐Up to date ✓N/A
- ☐As-buiit drawings ☐Readily available ✓Up to date ☐N/A
- ☐Maintenance logs ☐Readily available ☐Up to date ✓N/A

Remarks

2. Site-Specific Health and Safety Plan ☐Readily available ☐Up to date ✓N/A
- ☐Contingency plan/emergency response plan ☐Readily available ☐Up to date ✓N/A

Remarks

3. O&M and OSHA Training Records ☐Readily available ☐Up to date ✓N/A

Remarks

4. Permits and Service Agreements
- ☐Air discharge permit ☐Readily available ☐Up to date ✓N/A
- ☐Effluent discharge ☐Readily available ☐Up to date ✓N/A
- ☐Waste disposal, POTW ☐Readily available ☐Up to date ✓N/A
- ☐Other permits ☐Readily available ☐Up to date ✓N/A

Remarks

5. Gas Generation Records ☐Readily available ☐Up to date ✓N/A

Remarks

6. Settlement Monument Records ☐Readily available ☐Up to date ✓N/A

Remarks

7. Groundwater Monitoring Records ☐Readily available ☐Up to date ✓N/A

Remarks

8. Leachate Extraction Records ☐Readily available ✓Up to date ☐N/A

Remarks

9. Discharge Compliance Records
- ☐Air ☐Readily available ☐Up to date ✓N/A
- ☐Water (effluent) ☐Readily available ☐Up to date ✓N/A

Remarks

10. Daily Access/Security Logs ☐Readily available ☐Up to date ✓N/A

Remarks

IV. O&M COSTS

1. **O&M Organization**
   ☐State in-house ☐Contractor for State
   ☐PRP in-house ☐Contractor for PRP
   ☐Federal Facility in-house ☐Contractor for Federal Facility
   Other_____

2. **O&M Cost Records**
   ☐Readily available ☐Up to date
   ☐Funding mechanism/agreement in place
   Original O&M cost estimate_____ ☐Breakdown attached

   Total annual cost by year for review period if available

   From_____ To_____ _____ ☐Breakdown attached
   Date Date Total cost
   From_____ To_____ _____ ☐Breakdown attached
   Date Date Total cost
   From_____ To_____ _____ ☐Breakdown attached
   Date Date Total cost
   From_____ To_____ _____ ☐Breakdown attached
   Date Date Total cost
   From_____ To_____ _____ ☐Breakdown attached
   Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**
   Describe costs and reasons: _____

V. ACCESS AND INSTITUTIONAL CONTROLS ✓Applicable ☐N/A

A. Fencing

1. **Fencing damaged** ☐Location shown on site map ✓Gates secured ☐N/A
   Remarks_____

B. Other Access Restrictions

1. **Signs and other security measures** ✓Location shown on site map ☐N/A
   Remarks: County Police are utilizing the site and have improved security at the site.

C. Institutional Controls (ICs)

1. **Implementation and enforcement**
   Site conditions imply ICs not properly implemented ☐Yes ✓No ☐N/A
   Site conditions imply ICs not being fully enforced ☐Yes ✓No ☐N/A
   Type of monitoring (*e.g.*, self-reporting, drive by) _____
   Frequency Quarterly Inspections
   Responsible party/agency County of Roanoke
   Contact George Simpson County Engr. _____ _____
   Name Title Date Phone no.
   Reporting is up-to-date ✓Yes ☐No ☐N/A
   Reports are verified by the lead agency ✓Yes ☐No ☐N/A
   Specific requirements in deed or decision documents have been met ✓Yes ☐No ☐N/A

Violations have been reported ☐Yes ☐No ✓N/A
Other problems or suggestions: ☐Report attached
Remarks

2. Adequacy ✓ICs are adequate ☐ICs are inadequate ☐N/A
Remarks

D. General

1. Vandalism/trespassing ☐Location shown on site map ✓No vandalism evident
Remarks

2. Land use changes on site ☐N/A
Remarks County Police have added a gun range, training facility, and driving training course. These structtures do not effect the ICs in place for the landfill.

3. Land use changes off site ✓N/A
Remarks

VI. GENERAL SITE CONDITIONS

A. Roads ✓Applicable ☐N/A

1. Roads damaged ☐Location shown on site map ✓Roads adequate ☐N/A
Remarks

B. Other Site Conditions
Remarks

VII. LANDFILL COVERS ✓Applicable ☐N/A

A. Landfill Surface

1. Settlement (Low spots) ✓Location shown on site map ☐Settlement not evident
Areal extent 20 ft in length Depth >2 ft
Remarks There is an area next to the monofill cap from which stored soil was removed. This area may cause issues with water flow around the cap.

2. Cracks ☐Location shown on site map ✓Cracking not evident
Lengths Widths Depths
Remarks

3. Erosion ☐Location shown on site map ✓Erosion not evident
Areal extent Depth
Remarks

4. Holes ☐Location shown on site map ✓Holes not evident
Areal extent Depth
Remarks

5. Vegetative Cover ✓Grass ☐Cover properly established ✓No signs of stress
☐Trees/Shrubs (indicate size and locations on a diagram)
Remarks Grass covering is good with the exception of the area near the monofill cap that was discussed under settlement.

6. Alternative Cover (armored rock, concrete, etc.) ✓N/A
Remarks

7. Bulges ☐Location shown on site map ✓Bulges not evident
Areal extent Height
Remarks

8. **W**et Areas/**W**ater **D**amage ✓Wet areas/water damage not evident
   - ☐Wet areas Location shown on site map Areal extent_____
   - ☐Ponding Location shown on site map Areal extent_____
   - ☐Seeps Location shown on site map Areal extent_____
   - ☐Soft subgrade Location shown on site map Areal extent_____
   - Remarks_____

9. Slope **I**nstability ☐Slides ☐Location shown on site map ✓No evidence of slope instability
   - Areal extent_____
   - Remarks_____

B. Benches ✓Applicable ☐N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **F**lows **B**ypass **B**ench ☐Location shown on site map ✓N/A or okay
   - Remarks_____

2. **B**ench **B**reached ☐Location shown on site map ✓N/A or okay
   - Remarks_____

3. **B**ench **O**vertopped ☐Location shown on site map ✓N/A or okay
   - Remarks_____

C. Letdown **C**hannels ☐Applicable ✓N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. Settlement ☐Location shown on site map ☐No evidence of settlement
   - Areal extent_____ Depth_____
   - Remarks_____

2. **M**aterial **D**egradation ☐Location shown on site map ☐No evidence of degradation
   - Material type_____ Areal extent_____
   - Remarks_____

3. **E**rosion ☐Location shown on site map ☐No evidence of erosion
   - Areal extent_____ Depth_____
   - Remarks_____

4. **U**ndercutting ☐Location shown on site map ☐No evidence of undercutting
   - Areal extent_____ Depth_____
   - Remarks_____

5. **O**bstructions Type_____ ☐No obstructions
   - ☐Location shown on site map Areal extent_____
   - Size_____
   - Remarks_____

6. **E**xcessive **V**egetative **G**rowth Type_____
   - ☐No evidence of excessive growth
   - ☐Vegetation in channels does not obstruct flow
   - ☐Location shown on site map Areal extent_____
   - Remarks_____

D. Cover Penetrations ✓Applicable ☐N/A

1. **Gas Vents** ☐Active ☐Passive
   ☐Properly secured/locked ☐Functioning ☐Routinely sampled ☐Good condition
   ☐Evidence of leakage at penetration ☐Needs Maintenance ☐N/A
   Remarks

2. **Gas Monitoring Probes**
   ☐Properly secured/locked ☐Functioning ☐Routinely sampled ☐Good condition
   ☐Evidence of leakage at penetration ☐Needs Maintenance ☐N/A
   Remarks

3. **Monitoring Wells** (within surface area of landfill)
   ☐Properly secured/locked ☐Functioning ☐Routinely sampled ☐Good condition
   ☐Evidence of leakage at penetration ☐Needs Maintenance ☐N/A
   Remarks

4. **Leachate Extraction Wells**
   ✓Properly secured/locked ✓Functioning ✓Routinely sampled ✓Good condition
   ☐Evidence of leakage at penetration ☐Needs Maintenance ☐N/A
   Remarks There has been no leachate from this site since monitoring began.

5. **Settlement Monuments** ☐Located Routinely surveyed ✓N/A
   Remarks

E. Gas Collection and Treatment ☐Applicable ✓N/A

1. **Gas Treatment Facilities**
   ☐Flaring ☐Thermal destruction ☐Collection for reuse
   ☐Good condition ☐Needs Maintenance
   Remarks

2. **Gas Collection Weils, Manifolds and Piping**
   ☐Good condition ☐Needs Maintenance
   Remarks

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
   ☐Good condition ☐Needs Maintenance ☐N/A
   Remarks

F. Cover Drainage Layer ☐Applicable ✓N/A

1. **Outlet Pipes Inspected** ☐Functioning ✓N/A
   Remarks

2. **Outlet Rock Inspected** ☐Functioning ✓N/A
   Remarks

G. Detention/Sedimentation Ponds ✓Applicable ☐N/A

1. **Siltation**Areai extent_____ Depth_____ ✓N/A
   ☐Siltation not evident
   Remarks

2. **Erosion** Areal extent_____ Depth_____
   ✓Erosion not evident
   Remarks

3. **Outlet Works** ✓Functioning ☐N/A
   Remarks

4. Dam ☐Functioning ✓N/A
Remarks

H. Retaining Walls ☐Applicable ✓N/A

1. Deformations ☐Location shown on site map ✓Deformation not evident
Horizontal displacement_____ Vertical displacement_____
Rotational displacement_____
Remarks

2. Degradation Location shown on site map ✓Degradation not evident
Remarks

I. Perimeter Ditches/Off-Site Discharge Applicable ✓N/A

1. Siltation ☐Location shown on site map ✓Siltation not evident
Areal extent_____ Depth_____
Remarks

2. Vegetative Growth ☐Location shown on site map ☐N/A
✓Vegetation does not impede flow
Areal extent_____ Type_____
Remarks

3. Erosion ☐Loeation shown on site map ✓Erosion not evident
Areal extent_____ Depth_____
Remarks

4. Discharge Structure ☐Functioning N/A
Remarks

VIII. VERTICAL BARRIER WALLS ☐Applicable ✓N/A

1. Settlement ☐Location shown on site map ☐Settlement not evident
Areal extent_____ Depth_____
Remarks

2. Performance MonitoringType of monitoring_____
☐Performance not monitored
Frequency_____ ☐Evidence of breaching
Head differential_____
Remarks

IX. GROUNDWATER/SURFACE WATER REMEDIES ✓Applicable ☐N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ✓Applicable ☐N/A

1. Pumps, Wellhead Plumbing, and Electrical
✓Good condition ☐All required wells properly operating ☐Needs Maintenance ☐N/A
Remarks

2. Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances
✓Good condition ☐Needs Maintenance
Remarks

3. Spare Parts and Equipment
✓Readily available ☐Good condition ☐Requires upgrade ☐Needs to be provided
Remarks

B. Surface Water Collection Structures, Pumps, and Pipelines ☐Applicable ✓N/A

1. **Collection Structures, Pumps, and Electrical**
   ☐Good condition ☐Needs Maintenance
   Remarks

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   ☐Good condition ☐Needs Maintenance
   Remarks

3. **Spare Parts and Equipment**
   ☐Readily available ☐Good condition ☐Requires upgrade ☐Needs to be provided
   Remarks

C. Treatment System ✓Applicable ☐N/A

1. **Treatment Train (Check components that apply)**
   ☐Metals removal ☐Oil/water separation ☐Bioremediation
   ☐Air stripping ☐Carbon adsorbers
   ☐Filters
   ☐Additive (*e.g.*, chelation agent, flocculent)
   ✓Others Landfill Leachate
   ✓Good condition ☐Needs Maintenance
   ☐Sampling ports properly marked and functional
   ☐Sampling/maintenance log displayed and up to date
   ✓Equipment properly identified
   ☐Quantity of groundwater treated annually
   ☐Quantity of surface water treated annually
   Remarks The leachate collection system is checked regularly and no leachate has come trom the superfund landfill.

2. **Electrical Enclosures and Panels (properly rated and functional)**
   ✓N/A ☐Good condition ☐Needs Maintenance
   Remarks

3. **Tanks, Vaults, Storage Vessels**
   ☐N/A ✓Good condition ☐Proper secondary containment ☐Needs Maintenance
   Remarks

4. **Discharge Structure and Appurtenances**
   ✓N/A ☐Good condition ☐Needs Maintenance
   Remarks

5. **Treatment Building(s)**
   ☐N/A ✓Good condition (esp. roof and doorways) ☐Needs repair
   ☐Chemicals and equipment properly stored
   Remarks

6. **Monitoring Wells (pump and treatment remedy)**
   ☐Properly secured/locked ☐Functioning Routinely sampled ☐Good condition
   ☐All required wells located ☐Needs Maintenance ✓N/A
   Remarks

D. Monitoring Data

1. **Monitoring Data**
   ✓Is routinely submitted on time ✓Is of acceptable quality

2. Monitoring data suggests:
✓Groundwater plume is effectively contained ☐Contaminant concentrations are declining

E. Monitored Natural Attenuation

1. Monitoring Wells (natural attenuation remedy)
☐Properly secured/locked ☐Functioning Routinely sampled ☐Good condition
☐All required wells located ☐Needs Maintenance ✓N/A
Remarks_____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

_____
_____
_____
_____

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

_____
_____
_____
_____

C. Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high trequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

_____
_____
_____
_____

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

_____
_____
_____
_____

ATTACHMENT 4. PHOTOGRAPHS OF SITE VISIT

Photo 1. The sludge disposal area.

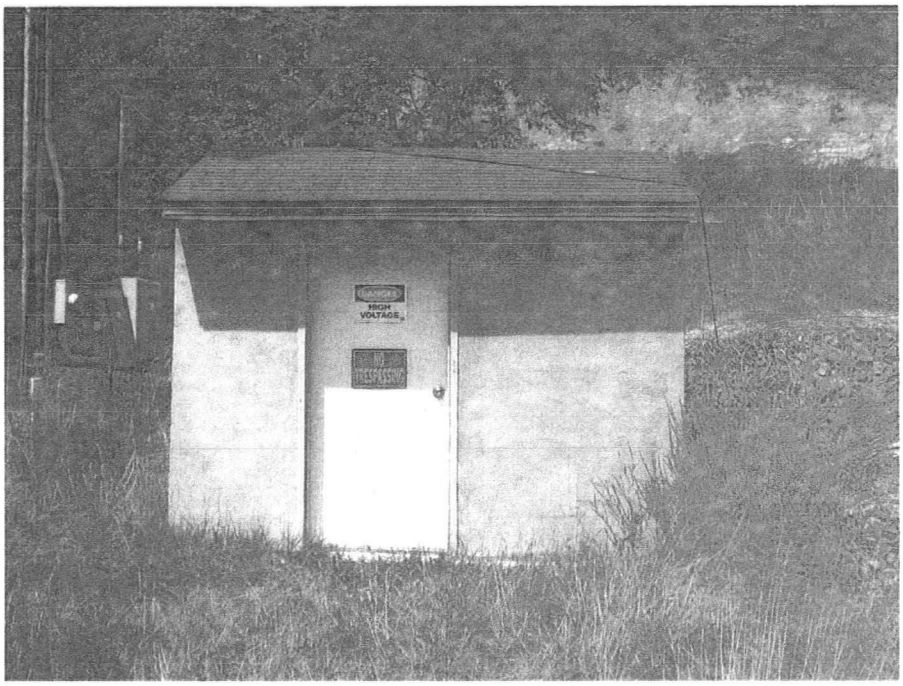


Photo 2. The leachate collection system pump house.

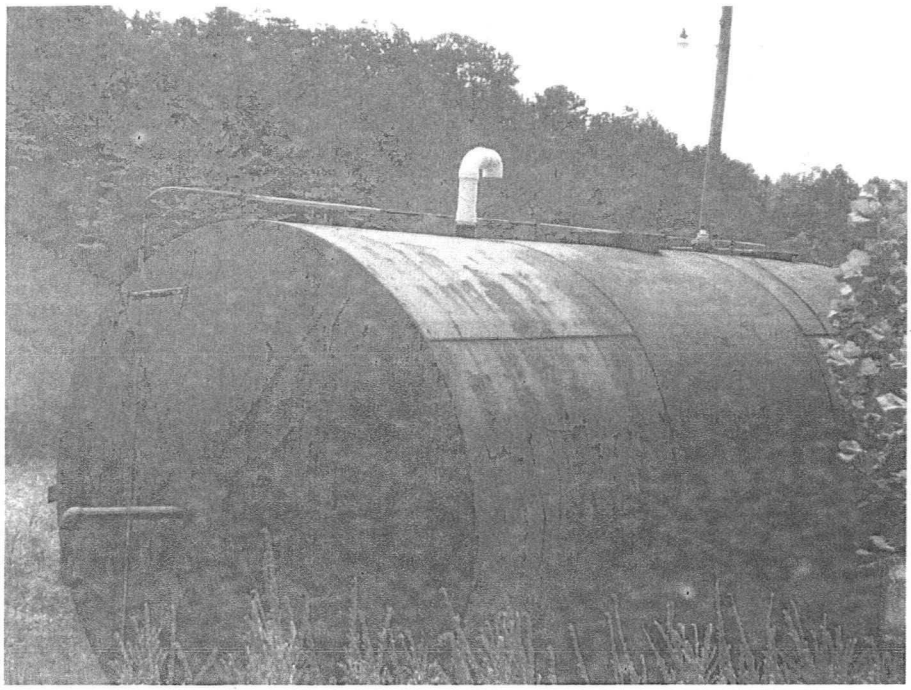


Photo 3. The leachate collection tank.

Photo 4. The vegetative cover on the monofill cap of the landfill.

Photo 5. A view of the monofill cap and the hillside east of the cap.

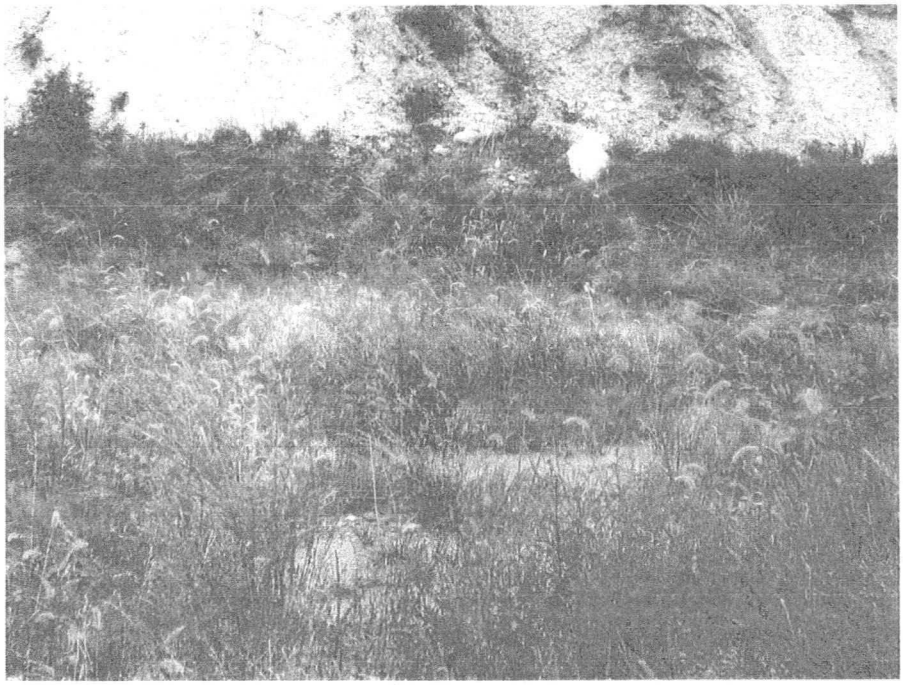


Photo 6. On the east side of the monofill cap there appears to be a depression with sparse vegetation.

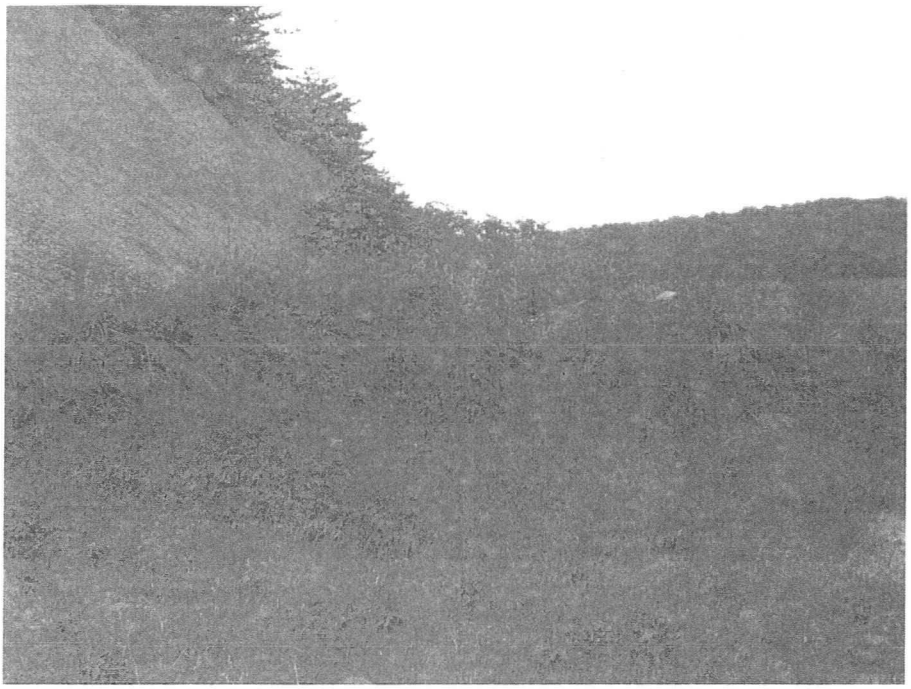


Photo 7. Soil stored for construction near the monofill cap and south of the depression.

Photo 8. The former drum disposal area.

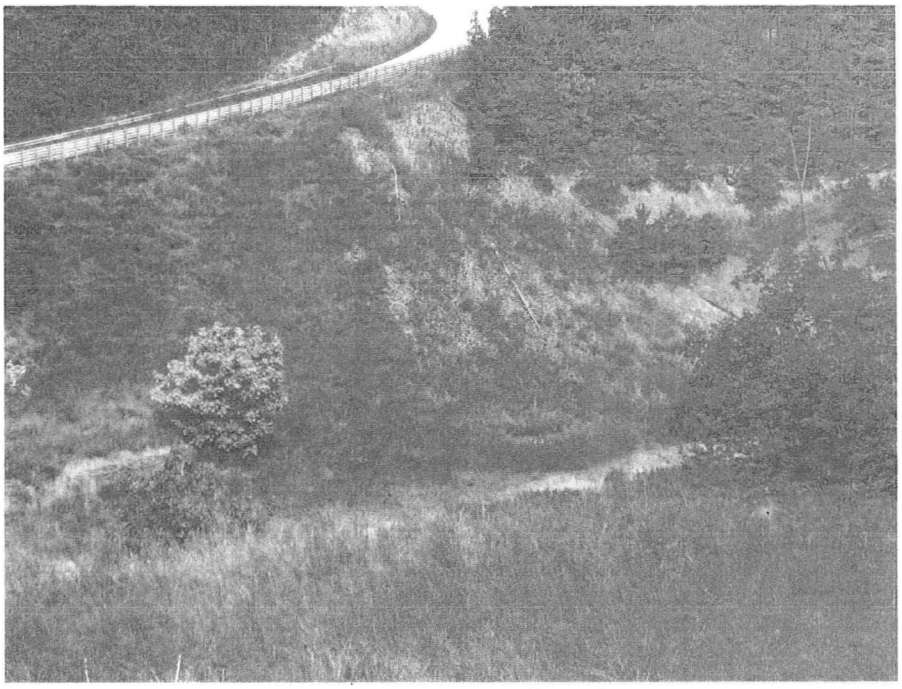


Photo 9. The ravine with the culverted stream.

Photo 10. Rocks in the ravine. Some rocks were cleaned because they were contaminated.

Photo 11. A pond in ravine above the culverted stream.

Photo 12. Fly ash is entombed in clay under the vegetation and rocks.

Photo 13. The start of the stream from the culvert. The stream is dry in this photograph.

ATTACHMENT 5. ARAR ANALYSIS MEMORANDUM

CHANGES IN CLEAN UP STANDARDS AND APPLICABLE OR RELEVANT AND APPROPRIATE STANDARDS (ARARS) DISCUSSION FOR THE DIXIE CAVERNS LANDFILL SUPERFUND SITE

Introduction

As part of the five-year review process, cleanup levels, standards, to-be-considered criteria (TBCs) and ARARs must be reviewed for changes. Changes (if any) are then evaluated to determine if the changes affect the protectiveness of the remedy. The 1991 ROD for OU1 identified only chemical- and action-specific ARARs for the site. No location-specific ARARs were listed in the ROD. The 1992 ROD for OU2 did not idenfify any ARARs.

The remedial action requirements for the soils/sediments related cleanup portions of the remedy have been completed (i.e., excavation and off-site disposal followed by replacement with clean fill). The 1991 ROD identified the following as ARARs for the remedy:

1. The Virginia erosion and sediment control law (Virginia Code § 10.1-560 et. sea.);
2. Land Disposal Restrictions and hazardous waste management practices as set forth in the solid waste management, as amended by the Resource Conservation and Recovery Act (RCRA) (40 CFR parts 262, 263, 266 and 268, including treatment standards for K061 waste delineated in EPA final rule for treatment standards (56 Fed. Reg. 41164) (August 19,1991);
3. The Virginia hazardous waste management regulations (VA Section 672-10-1, Part 7);
4. Air quality standards for criteria pollutants (40 CFR Part 50);
5. The Virginia Department of Air Pollufion Control's Standards for Non-Criteria Pollutants (VR Section 120-05-0301);
6. The Virginia Department of Air Pollution Control's Standards for Particulate Air Emissions (VRCAPP Section 04-01-01);
7. The Occupational Safety and Health Act (OSHA) (29 CFR Parts 1910 and 1926); and
8. The US Department of Transportation's Rules for Transportation of Hazardous Materials (49 CFR Parts 170, 171.1-172.558).

The majority of the ARARs listed above would have been implemented during the active phases of the remedy or removal action for OU2 such as the excavation, treatment, and disposal of soils and sediments on site. As those actions have been completed for the site or were associated with OU1 (ARAR number 2), there was no need to review the ARARs identified in the ROD for changes during this five-year review.

Summary

There have been no changes made to ARAR standards affecting the current or future protectiveness of the remedy.

ATTACHMENT 6. RISK ASSESSMENT MEMORANDUM

Introduction

This memorandum is prepared to address Question B of the technical assessment, "Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?", to determine whether the remedy is protective.

Changes in Standards and To Be Considereds (TBCs)

Changes in cleanup standards and applicable or relevant and appropriate requirements (ARARs) are discussed in the ARAR Analysis Memorandum.

Changes in Exposure Pathways, Toxicity, and Other Contaminant Characteristics

As part of the 1992 Remedial Investigation/Feasibility Study (RI/FS), a basehne risk assessment (BLRA) was conducted to evaluate the extent to which constituents present at or derived from the site may pose a threat to human health or the environment. The discussion of site risks is based on the 1992 BLRA for the Dixie Caverns.

The exposure assumptions used to develop the human health evaluation (HHE) identified potential receptors under current and future land use conditions. A local off-site resident (groundwater from wells), and children (trespasser for surface soils and off-site sediment and surface water from nearby streams) were identified as potential receptors under current land use conditions. Although it is not anticipated that the site will be developed for residential land use, a future on-site resident was identified as a potential receptor. The potential for exposure was evaluated for surface soil and groundwater. The HHE determined that the potential exposure pathways consist of the following:

1. Inhalation of soil as dust (surface)
2. Dermal contact with and incidental ingestion of soil (surface), sediment, and surface water
3. Ingestion and dermal absorption of groundwater

These assumptions are considered to be health protective and reasonable in evaluating risk for this site since the land use is expected to remain undeveloped and potential future residential development is unlikely.

The toxicity data available at the time of the remedy selection and the current toxicity values for the contaminants of concem (COCs) are provided below for comparison.

COC	Toxicity Values			
	RfDo (mg/kg-day)		Blood-lead level (µg/dL)	
	Previous[1]	Current[2]	Previous[3]	Current[4]
Cadmium	5.0E-04	5.0E-04	--	--
Zinc	2.0E-01	3.0E-01	--	--
Lead	--	--	10 µg/dL (IEUBK)	10 µg/dL (lEUBK)

Notes:
1. Obtained from Table 6-30, Baseline Risk Assessment in the Remedial Investigation Report dated January 1992, unless otherwise noted.
2. Obtained or derived from http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/pdf/cdmposite_si_table_run_NOV201i.pdf unless otherwise noted.
3. Obtained from Sections 6.1.4.2, Remedial Investigation Report dated January 1992, unless otherwise noted.
4. Obtained from http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm. unless otherwise noted.

mg/kg-day = milligrams per kilogram per day
RfDo = oral reference dose
µg/dL = micrograms per deciliter
IEUBK= Integrated Exposure-Uptake Biokinetic Model used to evaluate lead exposure
-- = no data

There have been no changes in the toxicity factors that could affect the protectiveness of the remedy.

Changes in Risk Assessment Methods

There has been no change to the standardized risk assessment methodology that could affect the protectiveness of the remedy; however, the 1992 BLRA was conducted prior to implementation of current guidance for human health and ecological risk assessments. While several changes are identified below, the outcome of the risk characterization is the same:

A conceptual site model (CSM) that shows how chemicals that have been released into the environment may be migrating and how current or future receptors, both human and ecological, might come into contact with contaminated environmental media is not provided.

Since a potential receptor is likely to be exposed to more than one chemical by more than one exposure route, dermal contact with groundwater should be included as a potential exposure pathway, and therefore, quantitatively evaluated in the risk assessment.

The EPA hierarchy of human health toxicity values generally recommended for use in risk assessments has been updated to reflect that additional sources of peer reviewed values have become available since 1989 and was revised on December 5, 2003.

List of Documents Reviewed

NPL Site Deletion Narrative for Dixie Caverns County Landfill Superfund Site, U.S. Environmental Protection Agency, National Priorities List, Site Deletion Federal Register Notice: September 28, 2001.

Tetra Tech, Inc., Remedial Investigation Report for Dixie Caverns Landfill Site, January 1992.

U.S. Environmental Protection Agency, EPA First Five-Year Review Report, Dixie Caverns County Landfill Site, Roanoke County, Virginia, July 30, 2001.

U.S. Environmental Protection Agency, EPA Second Five-Year Review Report, Dixie Caverns County Landfill Site, Salem, Roanoke County, Virginia, September 24, 2007.

U.S. Environmental Protection Agency, EPA Superfund Record of Decision, Dixie Caverns County Landtill, OU 1, Salem, Virginia, September 30, 1991.

U.S. Environmental Protection Agency, EPA Superfund Record of Decision, Dixie Caverns County Landtill, OU 2, Salem, Virginia, September 28, 1992.