70144.05

September 17, 1996

Mr. William McGlocklin
SKF USA, Inc.
1100 First Avenue
King of Prussia, Pennsylvania 19406-1352

Subject: Girmes Facility
Asheville, North Carolina

Dear Bill:

Enclosed is a revised copy of the CAP for the Girmes facility. The appendices and Plates 1 through 7 have not changed and; therefore, are not included. Plate 10, the schedule, is being finalized and will be sent to you tomorrow.

The CAP was revised to incorporate our response to NC DEHNR's comments. I have also made additional revisions to make the CAP consistent with the response to NC DEHNR's comments. These additional revisions are marked in the text. As part of these additional revisions, Section 4.9, Access Agreements, has been moved to Section 3.10. Section 4.10, Public Notice, has been moved to Section 3.11 and has been modified to eliminate reference to natural remediation. The addresses for Girmes and DOT have also been deleted.

The letters in Appendix E, Public Notice, will have to be modified. We will prepare revised language and fax it to you for review.

Please review the revised CAP and comment. Upon receipt of your comments, the CAP will be finalized and submitted to NC DEHNR.

If you have questions, please let me know.

Sincerely,

RMT, Inc.

Dan O. Madison, PG
Consulting Hydrogeologist

cc with enclosure: Mr. Allen Belenson
Mr. William Clarke
Mr. Robert Stevens

RMT, INC. — GREENVILLE, SC
100 VERDAE BOULEVARD • 29607-3825
P.O. BOX 16778 • 29606-6778
803/281-0030 • 803/281-0288 FAX

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CORRECTIVE ACTION PLAN

GIRMES SITE
FORMERLY SKF USA INC.
ASHEVILLE, NORTH CAROLINA

April 1996

Revised September 1996

David Roos
Process Department

Dan O. Madison, Jr., P.G.
Consulting Hydrogeologist

Robert P. Stevens, P.E.
Project Manager

Executive Summary

This Corrective Action Plan (CAP) has been prepared to address affected ground water at the Girmes Site, formerly SKF USA, Inc., located on Old Highway 74 East, Asheville, North Carolina. A Comprehensive Site Assessment (CSA) (RMT, November 1994) and this CAP have been completed in response to the Notice of Violation dated April 21, 1993 (Groundwater Incident Number 10038), and associated correspondence between SKF USA, Inc., and North Carolina Department of Environment, Health, and Natural Resources (NC DEHNR).

The CAP has been developed according to criteria established in two documents:

- North Carolina Administrative Code (NCAC) Title 15A, Subchapter 2L; Classifications and Water Quality Standards Applicable to the Groundwaters of North Carolina dated November 8, 1993.
- The North Carolina Department of Environment, Health, and Natural Resources (NC DEHNR) Division of Environmental Resources (DEM) Groundwater Section 15A NCAC 2L "Implementation Guidance" dated October 7, 1994.

The CSA identified two areas of ground water at the site that contain trichloroethene, vinyl chloride, and 1,2-dichloroethene. The outline for the CAP parallels conditions at the site, and proposes corrective action for one of the areas of concern. Corrective action on the second area of concern will be deferred to assess the effects resulting from operation of the remediation system at the other area.

NEW LANGUAGE

The purpose of this documentation is to delineate the technical rationale supporting corrective actions that are proposed to address affected ground water at the site.

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Section 1
Introduction

This Corrective Action Plan (CAP) has been prepared to address ground water with dissolved volatile organic compounds (VOCs) at the Girmes site located on Old Highway 74 East in Asheville, North Carolina. The facility is boarded by the North Carolina Department of Transportation (NC DOT) to the north and northeast. The southwest side of the site is boarded by Gashes Creek. Dotson Metal Finishing (Dotson) is the most significant property on the other side of Gashes Creek. The facility location is shown on Figure 1-1. A Comprehensive Site Assessment (RMT, November 1994) and this CAP have been completed in response to the Notice of Violation dated April 21, 1993 (Groundwater Incident Number 10032), and associated correspondence between SKF USA, Inc. (SKF), and the North Carolina Department of Environment, Health, and Natural Resources (NC DEHNR).

The CAP has been developed according to criteria established in two documents:

- North Carolina Administrative Code (NCAC) Title 15A, Subchapter 2L; Classifications and Water Quality Standards Applicable to the Groundwaters of North Carolina dated November 8, 1993; and
- The (NC DEHNR), Division of Environmental Resources (DEM) Groundwater Section 15A NCAC 2L "Implementation Guidance" dated October 7, 1994.

1.1 Purpose

The purpose of this documentation is to delineate the technical rationale supporting corrective actions that are proposed to address affected ground water at the site.

1.2 Areas of Concern

The Comprehensive Site Assessment (CSA) identified two areas of concern at the Girmes site. Each is shown on Figure 1-2. For clarity, the area on the southwest side of the facility will be referred to as the southwest plume, and the area located to the northeast will be referred to as the northeast plume.

Plate 1 shows the locations of ground water data points. Since submittal of the April 1995 Workplan for Correction Action Plan Field Work to NC DEHNR, the Data Point Location Map has been updated to include MW-28 and MW-28A. These wells were installed at the request of NC DEHNR to monitor water quality downgradient of the southwest plumes. Also added at the request of NC DEHNR are test recovery wells, RW-1 and RW-2 which were installed to test bedrock hydraulic characteristics.

Figure 1-1 Site Location Map

Figure 1-2 Areas of Concern

In compliance with Subchapter 2L, Section .0106(h), this CAP includes four specific items for the affected ground water plumes:

- A description of the corrective actions and reasons for their selection;
- Specific plans, including engineering details where applicable, for restoring ground water quality;
- A schedule for implementation and operation for the plans; and
- A monitoring plan for evaluating the effectiveness of the corrective actions and the movement of the southwest and northeast plumes.

Section 2
Site Background

2.1 Regional Geology

The Girmes site is located in Buncombe County, North Carolina, in the southeast area of Asheville (see Figure 1-1). The entire county lies within the Blue Ridge Physiographic Province which is typified by steep mountain ridges with high relief (100 to 3000 feet), frequent outcrops of bedrock, and valleys largely underlain by saprolite on crystalline rocks. Alluvium is generally confined to narrow flood plains with thicknesses of less than 100 feet. Colluvial deposits occur at the foot of steep slopes and consist of boulders and cobbles generated by mechanical weathering processes (Soller and Mills, 1991). The geology in the Asheville area has been identified as the Ashe Formation, which is a sequence of interlayered metasedimentary (gneisses, schists) and metavolcanic rocks (amphibolite) (Miller, Jr., 1990).

2.2 Site Geology

The site-specific geology has been assessed on the basis of boring logs prepared for 28 monitoring wells installed by Girmes prior to or during the CSA. In addition, soil characteristics were measured at 11 locations on the Girmes, NC DOT, and Dotson properties using continuous downhole cone penetrometer soundings (Piezocone) during the CSA. Locations of borings and soundings are shown on Plate 1. Boring logs for these wells along with piezocone sounding test data are provided in the appendices to the CSA.

Three hydrogeologic cross sections were constructed to illustrate subsurface geology of the site. Cross section A-A' (Plate 2) depicts the geology from west to east beneath the Girmes site. Cross section B-B' (Plate 3) depicts the geology from north to south beneath the eastern end of the Girmes site and the west side of the NC DOT facility. Cross section C-C' (Plate 4) depicts the geology beneath the southwestern edge of the site.

The Girmes site sits on a northwest trending hill that is approximately 80 feet higher in elevation than the adjacent properties. The hill is composed of saprolite soils covering crystalline bedrock. Saprolite throughout the site consists of silts, silty sands, and clayey silty sands. The NC DOT facility is located in a drainage swale adjacent to the Girmes site. The NC DOT facility was constructed such that the original drainage in the swale was channeled into a concrete storm drain. The swale was subsequently covered with soil fill material cut from adjacent slopes. Fill material was present at all seven well locations and all five Piezocone locations at the NC DOT facility. Fill thickness ranged from 7 feet at well MW-15 to 24 feet at

Piezocone sounding PC-5. Fill material consists primarily of sand, silt, and clayey soils. Piezocone data confirmed the nature and thickness of the fill material.

The Dotson facility is located in the floodplain of Gashes Creek. The alluvial deposits are composed of a silty sand layer underlain by a layer of gravel. The gravel layer is generally 5 feet thick and rests on saprolitic soils that are generally 10 feet in thickness.

Depth to bedrock beneath the Girmes facility ranges from 25 to 43 feet below land surface with the bedrock surface dipping to the northeast, northwest, and southwest. At the NC DOT facility, depth to bedrock ranges from 33.5 feet below land surface at well MW-16A, to 65 feet below land surface at well MW-15A. Depth to bedrock in the vicinity of the Dotson facility ranges from 17.5 to 21 feet. The resistant bedrock that comprises the bulk of the hill underlying the Girmes facility is generally observed to be a competent green-black amphibolite gneiss. This type of rock is composed primarily of amphiboles interlayered with some felsic minerals. The lower flanks of the hill are composed of the amphibolite gneiss which appear to be interlayered with a mica schist and a felsic gneiss. Bedrock is primarily composed of mica schist in the vicinity of wells MW-4, MW-5, and MW-17 on the northeast side of the Girmes facility, and near MW-22 and MW-24 on the southwest side of the site. Minor pegamite and quartz dikes are also present. The bedrock observed during drilling along the southwestern edge of the site was found to be more fractured compared to bedrock observed on top of the ridge and on the NC DOT property.

2.3 Site Hydrogeology

Site hydrogeology is based on data obtained from 17 ground water monitoring wells located on the Girmes property, eight monitoring wells located at the NC DOT facility, and three monitoring wells at the Dotson facility. Monitoring well locations are shown on Plate 1. Well construction diagrams are presented in the appendices of the CSA.

2.3.1 Water Table Configuration

Ground water elevations obtained in September 1994 from monitoring wells screened in saprolite and bedrock, the unused production well #1 (Dotson), and a surface water elevation measured in Gashes Creek (SG-1) were used to construct the water table map shown on Plate 5. The map shows that the water table mimics the ground topography. Ground water is recharged from the topographically higher area at the southeast end of the Girmes site, and flows northwest along the ridge. The ridge acts as a ground water divide and directs a portion of ground water flow southwest towards Gashes Creek and a portion of ground water flow north and northeast towards the NC DOT facility. The precise location of the ground water divide underneath the ridge has not been determined. Ground water at the NC DOT facility flows northwest towards the

Swannanoa River, where it is expected to discharge. On the southwest side of the Girmes site, ground water flows towards Gashes Creek where flow is expected to discharge. Ground water on the Dotson property flows in a northeasterly direction towards Gashes Creek.

The water table is below the bedrock surface on top of the ridge at the Girmes site and in the vicinity of wells MW-12 and MW-17 at the NC DOT facility. The water table is at or just above the bedrock surface on the southwest side of the Girmes property near Gashes Creek. The water table is above bedrock throughout the rest of the site including the entire Dotson property and most of the NC DOT property.

Horizontal ground water gradients range from 0.074 ft/ft on the northeast side of the Girmes site, to 0.084 ft/ft on the southwest side of the Site. Across the creek, gradients are very low, as evidenced by the low topographic relief. The gradient calculated in the vicinity of MW-25 is only 0.0067 ft/ft. At the NC DOT facility, gradients range from 0.014 ft/ft in the vicinity of MW-16, to 0.069 ft/ft near MW-13.

Water levels measured at the nested well pairs MW-15/MW-15A and MW-16/MW-16A were used to calculate vertical ground water gradients. Based on September 19, 1994, water level measurements, the well pair MW-15/MW-15A had a positive vertical gradient of 0.027 ft/ft, and well pair MW-16/MW-16A had a positive vertical gradient of 0.019 ft/ft. This finding indicates that ground water at the NC DOT site has an upward flow component which is in accordance with the conceptual model of topographically lower areas being ground water discharge points.

The water table is below the bedrock surface on top of the ridge at the Girmes site and in the vicinity of wells MW-12 and MW-17 at the NC DOT facility. The water table varies from 3 feet below bedrock to about 3 feet above bedrock at the southwest property line and at the northeast property line the water table is about 15 feet above bedrock.

2.3.2 Hydraulic Conductivity

A single well response test (slug test) was performed on each monitoring well during the CSA for the purpose of identifying differences in hydraulic conductivity across the site. In addition, hydraulic conductivity measurements were obtained during the field screening surveys from Hydrocone® sample locations. A summary of hydraulic conductivity values from each monitoring well and Hydrocone® sample location is shown in Tables 2-1 and 2-2, respectively.

TABLE 2-1
SUMMARY OF HYDRAULIC CONDUCTIVITY MEASUREMENTS
MONITORING WELLS

WELL	AQUIFER	CM/SEC	FT/SEC
NC DOT/GIRMES			
MW-20	Fill/Alluvium	$1x10^{-5}$	$5x10^{-7}$
MW-1	Upper Saprolite	$4x10^{-4}$	$1x10^{-5}$
MW-2	Upper Saprolite	$2x10^{-4}$	$6x10^{-6}$
MW-6	Upper Saprolite	$2x10^{-4}$	$8x10^{-6}$
MW-7	Upper Saprolite	$2x10^{-4}$	$8x10^{-6}$
MW-8	Upper Saprolite	$4x10^{-4}$	$1x10^{-5}$
MW-9	Upper Saprolite	$3x10^{-5}$	$1x10^{-6}$
MW-15	Upper Saprolite	$7x10^{-4}$	$2x10^{-5}$
MW-16	Upper Saprolite	$1x10^{-3}$	$3x10^{-5}$
MW-10	Lower Saprolite	$2x10^{-5}$	$8x10^{-7}$
MW-13	Lower Saprolite	$4x10^{-3}$	$1x10^{-4}$
MW-15A	Lower Saprolite	$2x10^{-5}$	$8x10^{-7}$
MW-16A	Lower Saprolite	$9x10^{-4}$	$3x10^{-5}$
MW-4	Bedrock	$8x10^{-6}$	$3x10^{-7}$
MW-5	Bedrock	$6x10^{-5}$	$2x10^{-6}$
MW-11	Bedrock	$1x10^{-5}$	$4x10^{-7}$
MW-12	Bedrock	$5x10^{-5}$	$2x10^{-6}$
MW-14	Bedrock	$1x10^{-4}$	$4x10^{-6}$
MW-17	Bedrock	$1x10^{-4}$	$3x10^{-6}$
DOTSON/GIRMES			
MW-25	Alluvium/Saprolite	$4x10^{-4}$	$1x10^{-5}$
MW-26	Alluvium/Saprolite	$5x10^{-4}$	$2x10^{-5}$
MW-18	Bedrock	$3x10^{-5}$	$1x10^{-6}$
MW-19	Bedrock	$8x10^{-5}$	$3x10^{-6}$
MW-21	Bedrock	$1x10^{-5}$	$3x10^{-6}$
MW-22	Bedrock	$4x10^{-4}$	$1x10^{-5}$
MW-23	Bedrock	$5x10^{-4}$	$2x10^{-5}$
MW-24	Bedrock	$8x10^{-5}$	$3x10^{-6}$
MW-27	Bedrock	$2x10^{-4}$	$8x10^{-6}$

TABLE 2-2
SUMMARY OF HYDRAULIC CONDUCTIVITY MEASUREMENTS
HYDROCONE® SAMPLE LOCATIONS

SAMPLE LOCATION	AQUIFER	CM/SEC	FT/SEC
NC DOT			
HC-1-19	Saprolite	$2x10^{-3}$	$1x10^{-4}$
HC-2-19	Saprolite	$5x10^{-4}$	$2x10^{-5}$
HC-3-9	Saprolite	$3x10^{-3}$	$1x10^{-4}$
HC-5-29	Saprolite	$2x10^{-4}$	$7x10^{-6}$
HC-6-24	Saprolite	$6x10^{-4}$	$2x10^{-5}$
HC-7-24	Saprolite	$2x10^{-3}$	$7x10^{-6}$
HC-8-24	Saprolite	$7x10^{-5}$	$7x10^{-6}$
DOTSON			
HC-10-15	Alluvium/Saprolite	$4x10^{-5}$	$1x10^{-6}$
HC-11-16	Alluvium/Saprolite	$1x10^{-4}$	$3x10^{-6}$
HC-12-12.5	Alluvium/Saprolite	$3x10^{-4}$	$1x10^{-5}$
HC-14-12.5	Alluvium/Saprolite	$7x10^{-5}$	$2x10^{-6}$
HC-15-13	Alluvium/Saprolite	$5x10^{-5}$	$2x10^{-6}$
HC-16-13	Alluvium/Saprolite	$5x10^{-5}$	$2x10^{-6}$
HC-17-13	Alluvium/Saprolite	$3x10^{-6}$	$1x10^{-7}$
HC-18-13	Alluvium/Saprolite	$6x10^{-5}$	$2x10^{-6}$

Monitoring well hydraulic conductivity (K) values were calculated using software developed by RMT. The software is based on the Bouwer and Rice Method (Bouwer and Rice, 1976; Bouwer, 1989). Hydrocone® K values are calculated by proprietary software developed by *In-Situ* Technology, Inc. The values of K for monitoring wells screened in saprolite and located on Girmes property range from 1×10^{-5} ft/sec to 8×10^{-7} ft/sec; the geometric mean is 4×10^{-6} ft/sec. Values of K for monitoring wells screened in bedrock and located on Girmes/DOT property range from 4×10^{-6} ft/sec to 3×10^{-7} ft/sec; the geometric mean is 1×10^{-6} ft/sec. Values of K for monitoring wells and Hydrocone® locations screened in saprolite, and located on NC DOT property, range from 1×10^{-4} ft/sec to 5×10^{-7} ft/sec. The geometric mean of both Hydrocone® locations and monitoring wells on NC DOT property is 2×10^{-5} ft/sec.

Values of K for monitoring wells and Hydrocone® locations screened in alluvium/saprolite and located on Dotson property ranged from 1×10^{-5} ft/sec to 1×10^{-7} ft/sec; the geometric mean is 3×10^{-5} ft/sec. Values of K for monitoring wells screened in bedrock on the southwest side of the Girmes site range from 1×10^{-5} ft/sec to 3×10^{-7} ft/sec; the geometric mean is 3×10^{-6} ft/sec. There are no monitoring wells screened in saprolite on the southwest side of the Girmes site. Values of K calculated for bedrock monitoring wells on the southwest side of the site are generally higher than those on top of the ridge and those which are located on the northeast side of the site. The competent rocks which make up the core of the ridge have not been as weathered by mechanical and chemical processes as the rocks located at the base of the ridge on the southwest side of the site. Thus, the bedrock on the southwest side is more conductive. Hydraulic conductivity test results are included in Appendix G of the CSA.

In June 1995, following completion of the CSA, two test recovery wells were installed at the Girmes facility to assess hydraulic characteristics of the bedrock. Well locations are shown on Plate 1. One well, RW-1, was installed on the southwest side of the site near the property line. The second well, RW-2, was installed on the northeast side of the site near the NC DOT property line. Both wells were constructed with a surface casing extending to the top of bedrock and are completed as open-hole within bedrock. Well construction diagrams and boring logs for these wells are presented in Appendix A.

Aquifer pumping tests were conducted on wells RW-1 and RW-2 at the site to measure the aquifer response to pumping and assess the hydraulic properties of the bedrock aquifer. Water level measurements collected during the pumping and recovery phases of each aquifer test were used to generate time versus drawdown graphs for each test. Curve-matching techniques were used to calculate aquifer transmissivity values using test data for which the drawdown and type curves could be matched. The Theis solution, with drawdowns corrected for unconfined conditions, and the Neuman

unconfined aquifer solution were used to analyze the pumping test data using the AQTESOLV program (Geraghty & Miller, 1995).

The pumping test at well RW-1 lasted approximately 41 hours, with the well pumped at an average rate of 3.2 gallons per minute (gpm). Drawdowns in observation wells monitored during the test ranged from 0.21 feet in monitoring well MW-19 located 491 feet from the pumping well, to 6.9 feet in monitoring well MW-21 located 30 feet from the pumping well. Maximum drawdown observed in the pumping well was 11.9 feet. Calculated transmissivity values ranged from 22 to 30 $feet^2$/day. Test results are summarized in Table 2-3.

The pumping test at well RW-2 lasted approximately 48 hours, with the well pumped at an average rate of 0.5 gpm. Drawdowns in observation wells ranged from 0.13 feet in monitoring well MW-5 located 179 feet from the pumping well, to 1.33 feet in monitoring well MW-9 located 33 feet from the pumping well. Maximum drawdown observed in well RW-2 during the test was 19.8 feet. Calculated transmissivity values ranged from 18 to 20 $feet^2$/day. Test results are also summarized in Table 2-3.

Ground water modeling was conducted to calculate theoretical capture zones for the proposed ground water extraction wells at the Girmes site. The GPTRAC module of the US EPA Wellhead Protection Area delineation program (WHPA) was used for the capture zone analysis. GPTRAC is a semi-analytical model which provides for pathline and time-related capture zone delineation using analytical velocity computation techniques.

The GPTRAC program assumes that pumping wells fully penetrate a homogeneous aquifer under a steady-state flow field. Aquifer characteristics are assumed to be uniform throughout the model area. Thus, variations in aquifer hydraulic conductivity, thickness, hydraulic gradient, and recharge are not represented in the model. Ground water flow through the aquifer is assumed to be two-dimensional in an areal x-y plane. The aquifer can be confined, semi-confined, or unconfined. The effects of well interference are accounted for through superposition of solutions resulting from pumping of individual wells.

2.3.3 Rate of Ground Water Flow

The seepage velocity of ground water (rate of ground water flow) was calculated for each area of the Site. An average hydraulic gradient was determined from the water table contour lines shown on Plate 5. The effective porosity of saprolite and bedrock was estimated to be 30 percent and 10 percent, respectively (Freeze and Cherry, 1979). The geometric mean of the hydraulic conductivity for the appropriate medium

TABLE 2-3
SUMMARY OF AQUIFER PUMPING TEST RESULTS

RW-1

Start Pumping:	06/26/95	18:04:59
End Pumping	06/28/95	13:00:42
Length of Pumping Phase:	2475 Minutes	
Pumping Rate:	3.2 gallons per minute	

OBSERVATION WELL NUMBER	DISTANCE FROM RW-1 (feet)	MAXIMUM OBSERVED DRAWDOWN	GEOLOGY OF SCREENED ZONE	AQUIFER TRANSMISSIVITY ($feet^2$/day) BASED ON CURVE-MATCHING TECHNIQUES
MW-21	30	6.9	Bedrock	24
MW-18	88	4.31	Bedrock	30
MW-23	104	0.54	Bedrock	22
MW-26	207	0.21	Alluvium/ Saprolite	No match possible
MW-24	312	0.58	Bedrock	No match possible
MW-14	350	0.13	Bedrock	No match possible
MW-19	491	0.21	Bedrock	No match possible
MW-5	707	None	Bedrock	No match possible

RW-2

Start Pumping:	06/29/95	12:00:38
End Pumping	07/01/95	11:59:00
Length of Pumping Phase:	2879 Minutes	
Pumping Rate:	0.5 gallons per minute	

OBSERVATION WELL NUMBER	DISTANCE FROM RW-1 (feet)	MAXIMUM OBSERVED DRAWDOWN	GEOLOGY OF SCREENED ZONE	AQUIFER TRANSMISSIVITY ($feet^2$/day) BASED ON CURVE-MATCHING TECHNIQUES
MW-9	33	1.329	Upper Saprolite	20
MW-10	66	0.46	Lower Saprolite	18
MW-4	143	None	Bedrock	No match possible
MW-5	179	0.13	Bedrock	20
MW-8	132	None	Upper Saprolite	No match possible
MW-7	192	None	Upper Saprolite	No match possible
MW-2	227	None	Upper Saprolite	No match possible

(saprolite or bedrock) was also used in each calculation. Calculations are shown in Appendix H of the CSA.

Seepage velocities of ground water in saprolite soils on the northeast side of the Girmes site range from 31 ft/yr on the Girmes site to a high of 145 ft/yr on the northwest portion of the NC DOT property. The higher velocity on the NC DOT property is due primarily to the more conductive soils found there. The seepage velocity in bedrock on the northeast side of the Girmes site is 23 ft/yr.

On the southwest side of the Girmes site, the average seepage velocity of ground water in bedrock was calculated to be 79 ft/yr. The higher seepage velocity observed on this side of the site may be due to a higher degree of fracturing in the bedrock, and/or the presence of a different rock unit (mica schist) which may be more conductive.

2.4 Ground Water Quality

Ground water quality information has been obtained from 16 *in-situ* ground water samples employing the Hydrocone® system; 28 monitoring wells installed on Girmes, NC DOT, and Dotson property during the CSA; and two monitoring wells (MW-2 and MW-2A) and two test recovery wells (RW-1 and RW-2), installed in June 1995, after the CSA. During the CSA, ground water data were collected during four phases of work. These phases are described in detail in Section 5 of the CSA and are summarized below.

2.4.1 CSA Investigation

Phase 1 Ground Water Field Screening - NC DOT Property

During the period of August 16-24, 1993, *in situ* ground water samples were collected on NC DOT property downgradient of the Girmes site to assess the lateral extent of VOCs in ground water. The *in-situ* ground water samples were collected either at specific intervals or at point of tool refusal at eight locations (HC-1, HC-2, HC-3, HC-5, HC-6, HC-7, HC-8, HC-9). Additional ground water samples were collected just below the water table at two locations (HC-2 and HC-3) to assess shallow ground water quality. Ground water samples were analyzed in the field for trichloroethene and 1,2-dichloroethene using a portable gas chromatograph. Select samples were also analyzed in the laboratory for trichloroethene, 1,2-dichloroethene, and vinyl chloride.

Trichloroethene and 1,2-dichloroethene were detected in some of the ground water samples collected at concentrations above the North Carolina 2L standards. As a result of the Phase 1 investigation, the extent of the VOC plume to the northeast and north was initially defined. The downgradient extent of the plume was not defined due to

subsurface obstructions encountered at locations in the northwest area of the NC DOT facility.

Phase 2 Ground Water Quality Results

As part of the Phase 2 ground water investigation, nine ground water monitoring wells were installed. Well locations are shown on Plate 1. Seven wells, MW-12, 13, 15, 15A, 16, 16A, and 17, were installed on NC DOT property to confirm the northeast extent of the plume and to determine the extent of the plume downgradient to the northwest. In addition, one well, MW-11, was installed at the Girmes site to assess the northwest edge of the plume on the ridge, and one well, MW-14, was installed on the southwest side of the Girmes site to assess general ground water quality on that side of the facility.

Ground water samples were collected from all 18 monitoring wells during November 1993. Trichloroethene and 1,2-dichloroethene were the primary constituents detected in ground water. These results of the Phase 2 investigation confirmed the findings of the Phase 1 field screening. The extent of the plume on the east and northeast of the site were defined as extending from the Girmes site to the northwest following the general direction of ground water flow. The highest concentrations of trichloroethene were detected in ground water samples obtained from bedrock well MW-5 and saprolite well MW-9, located adjacent to and downgradient of the area where waste debris may have been disposed of. Trichloroethene concentrations decrease with distance from the Girmes site.

During this phase, the ground water sample obtained from bedrock monitoring well MW-14, located on the southwest side of the Girmes facility, had a trichloroethene concentration of 0.52 mg/L. No other VOCs were detected.

Phase 3 Ground Water Investigation - Southwest Side Girmes Facility

Based on the analytical results obtained from well MW-14 during the Phase 2 investigation, additional areas located on Girmes property along Gashes Creek were identified for further evaluation. As part of this investigation, four monitoring wells, MW-18, MW-19, MW-21, and MW-22, were installed to determine the extent of the plume along Gashes Creek. A fifth well, MW-20, was installed to determine the downgradient extent of the plume identified on NC DOT property. Well locations are shown on Plate 1.

On April 20, 1994, ground water samples were collected from the five new wells. Samples were analyzed for trichloroethene, 1,2-dichloroethene, and vinyl chloride. In addition, samples of surface water from Gashes Creek (SW-1 to SW-4), an unnamed

intermittent tributary (SW-5), and a ground water seep (SW-6) on Girmes property were also collected and analyzed for VOCs.

VOCs were not detected in MW-20, so the extent of the plume on the DOT property has been defined. VOCs were also not detected in well MW-22 located on the northwest end of the Girmes facility.

VOCs were detected in MW-18, MW-19, MW-21, and at SW-4. These analytical results indicated that ground water is affected by VOCs on the southwest side of the Girmes facility and extends to Gashes Creek.

Phase 4 Ground Water Investigation - Dotson Property

During July 1994, *in-situ* ground water samples were collected on Dotson property to assess quality on the southwest side of Gashes Creek. The *in-situ* ground water samples were collected at the point of tool refusal at eight locations (HC-10, HC-12, HC-13, HC-14, HC-15, HC-16, HC-17, and HC-18). Sample locations are shown on Plate 1. Based on field screening results, three monitoring wells were installed to confirm the extent of affected ground water on the Dotson property. MW-23 was located to evaluate the vertical extent of affected ground water observed at HC-10. MW-25 and MW-26 were located to document the lateral extent of affected ground water on Dotson property. In addition, two wells, MW-24 and MW-27, were installed on the Girmes side of Gashes Creek to assess the southeast extent of affected ground water on the Girmes site. Ground water samples were collected from the five newly installed wells (MW-23 to MW-27), and the Dotson unused production well #1 on August 18, 1994. Wells MW-18, MW-19, and MW-21, and surface water sampling stations SW-1 through SW-4 were also sampled at this time to confirm previous results. Samples were analyzed for trichloroethene, 1,2-dichloroethene, and vinyl chloride. Ground water samples obtained from MW-23, MW-24, MW-26, and the Dotson unused production well #1 contained trichloroethene in excess of the NC limit of 0.0028 mg/L. The ground water sample from the Dotson unused production well #1 showed concentrations of 1,2-dichloroethene and vinyl chloride in excess of the NC limit of 0.07 and 0.000015 mg/L, respectively. Ground water samples obtained from MW-19 and MW-21 showed concentrations of trichloroethene above the NC limit. The surface water samples from stations SW-2, SW-3, and SW-4 contained low concentrations of trichloroethene below the NC limit of 0.0924 mg/L. SW-1 did not show any concentrations of VOCs.

On the basis of these results, a second round of ground water samples was collected from selected monitoring wells (MW-19, MW-23, and MW-24) and Dotson's unused production well #1 to verify the earlier results.

As a result of the Phase 4 investigation, the lateral extent of affected ground water on the southwest side of the Girmes site has been defined. Gashes Creek serves as the discharge point for affected ground water flowing downhill from the ridge above.

Ground water with elevated concentrations of trichloroethene and 1,2-dichloroethene has also been found on Dotson property across Gashes Creek from the Girmes site. The highest concentrations of trichloroethene on the southwest side of the site were found in this area and may be the result of operations at Dotson's facility.

2.4.2 Post CSA Investigations

Following the submittal of the CSA, additional investigation activities have been conducted to provide data necessary for the preparation of the CAP. These activities include the following: the installation of two ground water monitoring wells downgradient of the plume previously identified on the Dotson property; installation of two test recovery wells on the northeast and southwest sides of the Girmes property; the collection of two rounds of ground water samples from the monitoring and test recovery wells.

The two monitoring wells, MW-28 and MW-28A, were installed in June 1995 at the entrance road to the NC DOT facility. Well locations are shown on Plate 1. These wells were installed as a nest to assess ground water quality in flood plain deposits and the underlying bedrock downgradient of the plume on the Dotson property. The wells were drilled using hollow stem augers. The bedrock portion of well MW-28A was drilled using air rotary methods. Boring logs and well construction diagrams for these wells are presented in Appendix A. Test recovery wells RW-1 and RW-2 discussed in Section 2.3.4, were also installed in June 1995.

Ground water samples were collected from all 29 monitoring wells in June 1995 (note: well MW-25 was damaged in 1994, and has been abandoned). In addition, test recovery wells RW-1 and RW-2 were sampled at the beginning and at the end of pumping test conducted in June 1995. The monitoring and test recovery wells were sampled again in January/February 1996. Ground water samples were analyzed for trichloroethene, 1,2-dichloroethene, and vinyl chloride. In addition, wells on the northeast side of the Girmes site and test recovery wells RW-1 and RW-2 were analyzed for select parameters, hardness, alkalinity, total and dissolved iron, total and dissolved manganese, and total suspended solids. Analytical results are summarized in Tables 2-4 through 2-9. Laboratory reports are presented in Appendix B. Trichloroethene and 1,2-dichloroethene concentrations over time are summarized in Tables 2-10 and 2-11. Analytical results for VOCs for the January/February 1996 sampling event, along with the approximate boundary of the plume, are presented on Plate 6.

TABLE 2-4
SUMMARY OF VOLATILE ORGANICS ANALYSES [a]
JUNE 1995

LOCATION	SAMPLE DATE	COMPOUND		
		TRICHLOROETHENE	1,2-DICHLOROETHENE, (TOTAL)	VINYL CHLORIDE
NC 2L Standard		0.0028	0.070	0.000015
MW-1	6/21/95	<0.001	<0.002	<0.001
MW-2	6/23/95	0.058 D	0.012	<0.001
MW-4	6/22/95	0.95 D	0.67 D	<0.001
MW-5	6/22/95	5.8 D	0.085 E	<0.001
MW-6	6/21/95	<0.001	<0.002	<0.001
MW-7	6/23/95	<0.001	<0.002	<0.001
MW-8	6/22/95	<0.001	<0.002	<0.001
MW-9	6/22/95	1.8 D	0.045 E	<0.001
MW-10	6/22/95	0.042 E	0.60 D	<0.001
MW-11	6/22/95	0.0016	<0.002	<0.001
MW-12	6/21/95	<0.001	<0.002	<0.001
MW-13	6/21/95	<0.001	0.003	0.024
MW-14	6/23/95	0.080 D	<0.002	<0.001
MW-15	6/21/95	<0.001	<0.002	<0.001
MW-15A	6/22/95	0.0026	<0.002	<0.001
MW-15A (DUP-02)	6/22/95	0.0024	<0.002	<0.001
MW-16	6/21/95	0.0012	<0.002	<0.001
MW-16A	6/22/95	<0.001	<0.002	<0.001
MW-17	6/21/95	0.0039	<0.002	<0.001
MW-18	6/20/95	<0.001	0.0026	<0.001
MW-18 (DUP-01)	6/20/95	<0.001	0.0029	<0.001
MW-19	6/23/95	0.11 D	0.0085	<0.001
MW-20	6/21/95	<0.001	0.0029	<0.001
MW-21	6/20/95	0.35 D	0.25 D	0.0025
MW-22	6/23/95	<0.001	<0.002	<0.001
MW-23	6/20/95	11.0 D	0.38	<0.050
MW-24	6/20/95	0.22 D	0.003	<0.001
MW-26	6/20/95	0.0091	0.0098	<0.001
MW-27	6/20/95	<0.001	<0.002	<0.001
MW-28	6/23/95	<0.001	<0.002	<0.001
MW-28A	6/23/95	0.054 D	0.0073	<0.001
RW-01 [b]	6/20/95	9.9 D	0.56	<0.050
RW-01 [c]	6/28/95	0.91	0.24	<0.10
RW-02 [b]	6/23/95	0.52 D	0.023	<0.001
RW-02 [c]	6/30/95	0.73	<0.040	<0.020

[a] Analytical results are reported in parts per million unless otherwise noted.
[b] Sample collected prior to pump test.
[c] Sample collected at end of pump test.
D, DL Results from diluted sample.
E Concentration exceeds instrument calibration range.
< Concentration less than the Quantitation Limit or not validated if accompanied by "u" qualifier.

TABLE 2-5
SUMMARY OF INORGANICS ANALYSES[a]
JUNE 1995

LOCATION	DATE	COMPOUND						
		IRON total	IRON dissolved	MANGANESE total	MANGANESE dissolved	ALKALINITY as CaC03	SOLIDS total suspended	pH laboratory (s.u.)
MW-1	6/22/95	0.68	<0.10	0.013	<0.005	NA	11	NA
MW-2	6/23/95	<0.10	<0.10	0.0074	0.0062	NA	<10	NA
MW-4	6/22/95	2.5	<0.10	0.081	0.058	NA	140	NA
MW-5	6/22/95	10	<0.10	0.21	0.023	NA	290	NA
MW-6	6/22/95	10	<0.10	0.44	0.013	NA	310	NA
MW-7	6/23/95	1.4	<0.10	0.06	0.032	NA	15	NA
MW-8	6/23/95	0.14	<0.10	<0.005	<0.005	NA	11	NA
MW-9	6/23/95	1	<0.10	0.098	0.1 DA	NA	15	NA
MW-10	6/23/95	1.4	<0.10	0.035	0.022	NA	12	NA
MW-11	6/22/95	6.4	<0.10	0.21	0.038	NA	190	NA
MW-12	6/21/95	0.4	<0.1	0.11	0.099	NA	<10	NA
MW-13	6/21/95	34	35	14	13	NA	35	NA
MW-15	6/21/95	0.14	0.12	2.1	2.3	NA	<10	NA
MW-15A	6/22/95	3.6	0.92	4.3	4.5 DA	NA	45	NA
MW-15A (DUP-02)	6/22/95	0.92	4.2	4.5	NA	NA	38	NA
MW-16	6/21/95	1.6	0.8	0.16	0.16	NA	15	NA
MW-16A	6/22/95	3.1	0.78	0.45	0.055 DA	NA	22	NA
MW-17	6/21/95	<0.10	<0.1	<0.005	<0.005	NA	<10	NA
MW-20	6/21/95	24	25	2.4	2.6	NA	23	NA
RW-01[c]	6/28/95	<0.10	<0.10	0.009	0.006	150	14	7.0 H
RW-02 [b]	6/23/95	0.46	<0.10	0.052	<0.051	NA	<10	NA
RW-02 [c]	6/30/95	<0.10	<0.10	0.0055	<0.005	120	<10 H	6.6 H

[a] - Analytical results are reported in parts per million unless otherwise noted.

[b] - Sample collected prior to pump test.

[c] - Sample collected at end of pump test.

DA - Dissolved analyte greater than total analyte; analyses passed QC based on precision criteria.

NA - Not analyzed.

H - Analysis performed "n" days past holding time.

< - Concentration less than the Quantitation Limit or not validated if accompanied by "u" qualifier.

NA - Not analyzed.

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TABLE 2-6
SUMMARY OF GASES IN WATER ANALYSES [a]
JUNE 1995

LOCATION	DATE	COMPOUND		
		METHANE	ETHANE	ETHENE
MW-1	6/21/95	<0.0032	<0.0058	<0.0064
MW-2	6/23/95	<0.0033	<0.006	<0.0066
MW-4	6/22/95	0.0189	<0.0058	<0.0064
MW-5	6/22/95	<0.0034	<0.0061	<0.0068
MW-6	6/21/95	<0.0033	<0.0059	<0.0065
MW-7	6/23/95	<0.0032	<0.0058	<0.0064
MW-8	6/22/95	<0.0031	<0.0056	<0.0063
MW-9	6/22/95	<0.0032	<0.0058	<0.0065
MW-10	6/22/95	<0.0032	<0.0058	<0.0064
MW-11	6/22/95	<0.0033	<0.0059	<0.0066
MW-12	6/21/95	<0.0033	<0.0059	<0.0065
MW-13	6/21/95	0.1949	<0.0058	<0.0064
MW-15	6/21/95	0.0041	<0.006	<0.0066
MW-15A	6/22/95	<0.0033	<0.0059	<0.0065
MW-15A (DUP-02)	6/22/95	<0.0024	<0.006	<0.0067
MW-16	6/21/95	<0.0031	<0.0057	<0.0064
MW-16A	6/22/95	<0.0031	<0.0057	<0.0063
MW-17	6/21/95	<0.0034	<0.006	<0.0066
MW-20	6/21/95	0.0652	<0.0057	<0.0063
RW-01	6/20/95	0.0024	<0.0057	<0.0063
RW-02	6/23/95	0.0099	<0.0055	<0.0062
RW-02	6/30/95	<0.003	<0.0056	<0.0061

[a] Analytical results are reported in parts per million unless otherwise noted.
< Concentration less than the Quantitation Limit or not validated if accompanied by "u" qualifier.

TABLE 2-7
SUMMARY OF VOLATILE ORGANICS ANALYSES [a]
JANUARY/FEBRUARY 1996

LOCATION	SAMPLE DATE	COMPOUND		
		TRICHLOROETHENE	1,2-DICHLOROETHENE, (TOTAL)	VINYL CHLORIDE
NC 2L Standard		0.0028	0.070	0.000015
MW-1	1/30/96	<0.001	<0.002	<0.001
MW-2	1/31/96	0.088	<0.010	<0.005
MW-4	1/31/96	0.74	0.36	<0.10
MW-5	2/2/96	5.2	<0.40	<0.20
MW-6	1/31/96	<0.001	<0.002	<0.001
MW-7	1/31/96	<0.001	<0.002	<0.001
MW-8	1/31/96	<0.001	<0.002	<0.001
MW-9	1/31/96	2.7	<0.20	<0.10
MW-10	1/31/96	<0.10	0.38	<0.10
MW-11	2/2/96	<0.001	<0.002	<0.001
MW-12	1/30/96	<0.001	<0.002	<0.001
MW-13	1/30/96	<0.001	<0.002	0.0048
MW-14	2/1/96	0.08	<0.010	<0.005
MW-15	1/30/96	<0.001	<0.002	<0.001
MW-15A	1/30/96	<0.001	<0.002	<0.001
MW-16	1/30/96	<0.001	<0.002	<0.001
MW-16A	1/30/96	<0.001	<0.002	<0.001
MW-16A (DUP 01)	1/31/96	<0.001	<0.002	<0.001
MW-17	1/30/96	<0.001	<0.002	<0.001
MW-18	2/1/96	0.001	<0.002	<0.001
MW-19	2/2/96	0.028	<0.002	<0.001
MW-19 (DUP 02)	2/2/96	0.028	<0.002	<0.001
MW-20	1/30/96	<0.001	<0.002	<0.001
MW-21	2/1/96	0.32	0.2	<0.010
MW-22	2/2/96	<0.001	<0.002	<0.001
MW-23	1/30/96	14	<1.0	<0.50
MW-24	2/1/96	0.23	<0.020	<0.010
MW-26	1/30/96	0.0014	0.0078	<0.001
MW-27	2/1/96	<0.001	<0.002	<0.001
MW-28	2/1/96	<0.001	<0.002	<0.001
MW-28A	2/1/96	0.14	0.018	<0.005
RW-01	2/1/96	0.26	0.08	<0.020
RW-02	1/31/96	0.88	<0.040	<0.020

[a] Analytical results are reported in parts per million unless otherwise noted.
< Concentrations less than the Quantitation Limit or not validated if accompanied by "u" qualifier.

TABLE 2-8

SUMMARY OF INORGANICS ANALYSES[a]
JANUARY/FEBRUARY 1996

LOCATION	DATE	COMPOUND				
		IRON total	IRON dissolved	MANGANESE total	MANGANESE dissolved	SOLIDS total suspended
MW-1	1/30/96	120	0.32	1.3	0.011	1300
MW-2	1/31/96	27	<0.10	0.083	0.011	24
MW-4	1/31/96	4.3	<0.10	0.072	0.033	120
MW-5	2/2/96	7.8	<0.1	0.12	0.011	100
MW-6	1/31/96	24	0.2	0.81	0.011	410
MW-7	1/31/96	28	<0.10	0.47	0.041	230
MW-8	1/31/96	0.9	<0.10	0.02	<0.005	48
MW-9	1/31/96	2.1	0.21	0.12	0.12	25
MW-10	1/31/96	9.6	<0.10	0.074	0.0089	110
MW-11	2/2/96	5.5	<0.1	0.14	<0.005	250
MW-15	1/30/96	1.3	<0.10	0.81	0.860DA	34
MW-15A	1/30/96	12	2.1	4.8	7.6	180
MW-16	1/30/96	5.9	1.6	0.18	0.18	43
MW-16A	1/30/96	2.3	0.31	0.058	0.049	30
MW-16A (DUP 01)	1/31/96	2.7	0.33	0.063	0.05	26
MW-20	1/30/96	30	27	15	17DA	51
RW-02	1/31/96	8.2	0.38	0.21	0.19	19

[a] - Analytical results are reported in parts per million unless otherwise noted.

DA - Dissolved analyte greater than total analyte; analyses passed QC based on precision criteria.

< - Concentration less than the Quantitation Limit or not validated if accompanied by "u" qualifier.

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TABLE 2-9
SUMMARY OF GASES IN WATER ANALYSES [a]
JANUARY/FEBRUARY 1996

LOCATION	DATE	COMPOUND		
		METHANE	ETHANE	ETHENE
MW-1	1/30/96	0.0105	<0.006	<0.0063
MW-2	1/31/96	0.01	<0.006	<0.0063
MW-4	1/31/96	0.0159	<0.006	<0.0063
MW-5	2/2/96	0.0163	<0.006	<0.0063
MW-6	1/31/96	0.0146	<0.006	<0.0063
MW-7	1/31/96	0.0191	<0.006	<0.0063
MW-8	1/31/96	0.011	<0.006	<0.0063
MW-9	1/31/96	0.0132	<0.006	<0.0063
MW-10	1/31/96	0.012	<0.006	<0.0063
MW-11	2/2/96	0.0107	<0.006	<0.0063
MW-12	1/30/96	0.014	0.0084	<0.0063
MW-13	1/30/96	1.101	0.0099	<0.0063
MW-15	1/30/96	0.0194	<0.006	<0.0063
MW-15A	1/30/96	0.0232	<0.006	<0.0063
MW-16	1/30/96	0.014	<0.006	<0.0063
MW-16A	1/30/96	0.0087	<0.006	<0.0063
MW-16A (DUP 01)	1/31/96	0.011	<0.006	<0.0063
MW-17	1/30/96	0.0107	0.0073	<0.0063
MW-20	1/30/96	0.846	0.0132	<0.0063
RW-02	1/31/96	1.18	<0.006	<0.0063

[a] Analytical results are reported in parts per million unless otherwise noted.
< Concentration less than the Quantitation Limit or not validated if accompanied by "u" qualifier.

TABLE 2-10
SUMMARY OF TRICHLOROETHENE CONCENTRATIONS DETECTED IN GROUND WATER

WELL	SAMPLING DATE					
	NOV-93	APR-94	AUG-94	SEP-94	JUN-95	JAN/FEB-96
MW-1	ND	NA	NA	NA	ND	ND
MW-2	0.11	NA	NA	NA	0.058D	0.088
MW-4	1.5	NA	NA	NA	0.95D	0.74
MW-5	6.4	NA	NA	NA	5.8D	5.2
MW-6	ND	NA	NA	NA	ND	ND
MW-7	0.014	NA	NA	NA	ND	ND
MW-8	ND	NA	NA	NA	ND	ND
MW-9	3.0	NA	NA	NA	1.8D	2.7
MW-10	0.22	NA	NA	NA	0.042E	ND
MW-11	ND	NA	NA	NA	0.0016	ND
MW-12	ND	NA	NA	NA	ND	ND
MW-13	ND	NA	NA	NA	ND	ND
MW-14	0.52	NA	NA	NA	0.080D	0.08
MW-15	ND	NA	NA	NA	ND	ND
MW-15A	ND	NA	NA	NA	0.0026	ND
MW-16	ND	NA	NA	NA	0.0012	ND
MW-16A	ND	NA	NA	NA	ND	ND
MW-17	0.0075 (0.0076) *	NA	NA	NA	0.0039	ND
MW-18		0.0033	0.0017	NA	ND	0.001
MW-19		0.0037	0.18	0.04	0.11D	0.028
MW-20		ND	NA	NA	ND	ND
MW-21		0.49	0.49	NA	0.35D	0.32
MW-22		ND	NA	NA	ND	ND
MW-23			3.5	5.7	11.0D	14.0
MW-24			2.2	0.2	0.22D	0.23
MW-25			ND	NA	ABAND.	ABAND.
MW-26			0.017	NA	0.0091	0.0014
MW-27			ND	NA	ND	ND
MW-28					ND	ND
MW-28A					0.054D	0.14
RW-1					9.9/0.91**	0.26
RW-2					0.52/0.72**	0.88

ND None detected
NA Not analyzed
Concentration are in mg/l
* Analytical results for duplicate samples shown in parentheses.
** Analytical results for samples collected at the beginning/end of pumping tests.

TABLE 2-11
SUMMARY OF 1,2-DICHLOROETHENE CONCENTRATIONS DETECTED IN GROUND WATER

WELL	SAMPLING DATE					
	NOV-93	APR-94	AUG-94	SEP-94	JUN-95	JAN/FEB-96
MW-1	ND	NA	NA	NA	ND	ND
MW-2	0.025	NA	NA	NA	0.012	ND
MW-4	0.74	NA	NA	NA	0.67D	0.36
MW-5	ND	NA	NA	NA	0.085E	ND
MW-6	ND	NA	NA	NA	ND	ND
MW-7	0.0038	NA	NA	NA	ND	ND
MW-8	ND	NA	NA	NA	ND	ND
MW-9	ND	NA	NA	NA	0.045E	ND
MW-10	1.2	NA	NA	NA	0.60D	0.38
MW-11	ND	NA	NA	NA	ND	ND
MW-12	ND	NA	NA	NA	ND	ND
MW-13	ND	NA	NA	NA	0.003	ND
MW-14	ND	NA	NA	NA	ND	ND
MW-15	ND	NA	NA	NA	ND	ND
MW-15A	ND	NA	NA	NA	ND	ND
MW-16	ND	NA	NA	NA	ND	ND
MW-16A	ND	NA	NA	NA	ND	ND
MW-17	ND (ND)*	NA	NA	NA	ND	ND
MW-18		0.0086	0.0036	NA	0.0026	ND
MW-19		ND	ND	0.019	0.0085	ND
MW-20		ND	NA	NA	0.0029	ND
MW-21		0.13	0.14	NA	0.25D	0.2
MW-22		ND	NA	NA	ND	ND
MW-23			ND	ND	0.38	ND
MW-24			ND	ND	0.003	ND
MW-25			ND	NA	ABAND.	ABAND.
MW-26			0.0085	NA	0.0098	0.0078
MW-27			ND	NA	ND	ND
MW-28					ND	ND
MW-28A					0.0073	0.018
RW-1					0.56/0.24**	0.08
RW-2					0.023/ND**	ND

ND None detected
NA Not analyzed
Concentrations are in mg/L
* Analytical results for duplicate samples shown in parentheses.
** Analytical results for samples collected at the beginning/end of pumping tests.

2.4.3 Northeast Plume Definition

The configuration of the plume on the northeast side of the site has changed since the CSA. Plate 7 presents a comparison of trichloroethene concentrations detected in the northeast plume during the CSA with concentrations detected in January/ February 1996. As illustrated in Plate 7 and Table 2-10, trichloroethene concentrations in wells MW-7, MW-10, and MW-17 have declined over time to nondetect during the January/ February 1996 sampling event. Trichloroethene concentrations in well MW-4 also declined. Wells MW-7 and MW-17 exhibited a decline in 1,2-dichloroethene concentrations to nondetect. Wells MW-4 and MW-10 also showed declines in 1,2-dichloroethene concentrations with time; however, the most recent concentrations in January/February 1996 (0.38 mg/L and 0.036 mg/L, respectively) still exceeded the 2L standard. During the June 1995 sampling event, trichloroethene was detected in wells MW-11, MW-15A, and MW-16 at concentrations below the 2L standards. Trichloroethene was not detected in these wells when sampled in January/February 1996, nor was it detected in these wells during the CSA in November 1993.

Vinyl chloride has been detected in one well, MW-13, on the northeast side of the site. Concentrations have declined from 0.029 mg/L in November 1993 to 0.0048 mg/L in January/February 1996. VOC concentrations in the remaining wells remained relatively stable since the CSA began.

The configuration of the plume on the northeast side of the site now appears to have separated into two parts. The main body of the plume consists of trichloroethene and 1,2-dichloroethene and has the same general appearance as the plume presented in the CSA except that it appears to terminate just upgradient of well MW-17. A small portion of the plume appears to be detached from the main body and is centered around well MW-13. This portion consists of vinyl chloride only.

Well MW-20, located approximately 200 feet down gradient of the plume at well MW 13, had no detections of trichloroethene and vinyl chloride. A trace of 1,2-dichloroethene (0.0029 mg/L) was detected in MW-20 in June 1995, well below the 2L standard. 1,2-Dichloroethene was not detected in MW-20 during the last sampling event in January/February 1996. Well MW-20 remains downgradient of the plume and is over 4 years ground water travel time upgradient of the nearest receptor, the Swannanoa River.

2.4.4 Southwest Plume Definition

The configuration of the plume on the southwest side of the Girmes property remains generally unchanged since the CSA was completed. When test recovery well RW-1 was

installed in June 1995, it contained trichloroethene at a concentration of 9.9 mg/L. 1,2 Dichloroethene was detected at a concentration of 0.56 mg/L. At the end of 41 hours of pumping during the pump test, also conducted in June 1995, the trichloroethene concentration had lowered to 0.91 mg/L. 1,2-Dichloroethene declined to a concentration of 0.24 mg/L. When sampled in January/February 1996, trichloroethene and 1,2-dichloroethene concentrations had declined even further to 0.26 mg/L and 0.08 mg/L, respectively. The plume on the southwest side of the Girmes property extends westward from the facility to Gashes creek where it discharges. Gashes creek is the receptor of the affected ground water. The plume is not expected to migrate beyond the creek.

2.4.5 Dotson Plume Definition

On the Dotson property, trichloroethene concentrations declined in well MW-26 from the one analysis conducted during the CSA. Trichloroethene concentrations are now below the 2L standards. Trichloroethene concentrations continued to rise in bedrock well MW-23. When first sampled in August 1994, well MW-23 had a trichloroethene concentration of 3.5 mg/L. This concentration increased to 5.7 mg/L in September 1994. Since the CSA, concentrations continued to climb to 11.0 mg/L in June 1995 and 14.0 mg/L in January/February 1996. These concentrations are the highest detected in any of the monitoring wells. The steadily increasing concentrations indicate that there may be the remnants of a source area in the immediate vicinity of well MW-23. Well MW-23 may have intercepted the remnant source, possibly contained in small fractures, during drilling.

There are reports that Dotson had used trichloroethene in the past. With the highest trichloroethene concentrations consistently found in this well, it is not likely that the source of VOCs found on the Dotson side of Gashes creek originated on the Girmes property. Well MW-23 is the only well on the southwest side of the Girmes facility or on the Dotson property to demonstrate increases in trichloroethene concentrations. The other wells either maintained generally consistent concentrations, remained at non-detect, or displayed a decrease in concentrations.

Additionally, well MW-23 is at the same location that *in-situ* ground water sample HC-10 was collected during Phase 4 of the CSA. This sample had the highest trichloroethene concentration (1.3 mg/L) found in the unconsolidated soils on the Dotson property. Other *in-situ* ground water samples collected in the areas surrounding HC-10 all had lower trichloroethene concentrations, further indicating that there may have been a source in the immediate vicinity of HC-10 and well MW-23. The VOC plume on the Dotson side of Gashes creek is considered to be a separate plume, unrelated to the plume found on the Girmes side of the creek.

Since the CSA, two additional monitoring wells, MW-28 and MW-28A, were installed on the southwest side of Gashes creek, downgradient of the plume on the Dotson property. These wells were sampled in June 1995 and January/February 1996. No VOCs were detected in well MW-28, screened in the entire saturated portion of the soils (flood plain deposits) overlying bedrock. Bedrock well MW-28A had trichloroethene (0.054 mg/L) and 1,2-dichloroethene (0.0073 mg/L) detected in June 1995 indicating that the plume on the Dotson property has migrated northward within bedrock towards the Swannanoa River. In January/February 1996, trichloroethene was detected at 0.14 mg/L, and 1,2-dichloroethene was detected at a concentration of 0.018 mg/L. Both had increases over the June 1995 results.

2.5 Migration Pathways and Potential Receptors

The migration of constituents detected in Site samples were initially assessed by evaluating the transport and degradation processes of the site-specific constituents. Knowledge of chemical behavior in various environmental media (*e.g.*, surface water, ground water, sediments, and the atmosphere) is required to assess the extent to which human receptor populations may be affected by the chemicals (US EPA, 1989).

2.5.1 Constituent Fate, Transport, and Persistence

The rate at which a constituent may migrate to and with the underlying ground water depends on the physical and chemical properties of the constituent, local climatic conditions, and Site characteristics such as physical barriers to transport.

The physical and chemical properties of a released constituent that best describe its migration into a ground water system are its solubility in water and, for an organic chemical, its K_{oc}. An organic constituent having a relatively high K_{oc} value is likely to adsorb to soil and resist migration with ground water. Once in the ground water, the migration of an organic constituent is related to its water solubility and density, although organic adsorption may also influence migration. Constituents that dissolve in the ground water are transported in the direction of ground water flow at a rate that is usually slower than ground water flow.

The fate and persistence of organic compounds and complexes are related to volatilization rates, photolysis, hydrolysis, and biodegradation potential. These factors, in turn, depend on adsorption. The extent of adsorption of an organic constituent is determined by both the structure of the constituent and the physical and chemical properties of the media. Density is an important factor when undissolved concentrations are present.

The relative mobilities of the organic compounds described below are based on the mobility class scale used by Fetter (1988). Fetter classifies the mobility of organic constituents according to their organic carbon partition coefficient (K_{oc}) as follows:

K_{oc} (mL/g)	Mobility Class
0-50	Very High
51-150	High
150-500	Moderate
501-2000	Low
2001- 20,000	Slight
>20,000	Immobile

The following summaries describe the fate, transport, and persistence of the organic compounds detected at the Site.

Very High Mobility: The organic constituent identified as having a very high mobility as a result of its low K_{oc} value is vinyl chloride. Volatilization plays a significant role in the removal of this constituents from aquatic environments. Leaching from soils is expected to occur readily due to poor adsorption. Because of its miscibility in water, the mobility of vinyl chloride is very high in aqueous environments. Vinyl chloride is expected to undergo biodegradation in both aerobic and anaerobic environments.

High Mobility: The organic constituents detected at the Site that are characterized as having high mobility based on their K_{oc} values are 1,2-dichloroethene and trichloroethene. These compounds have high Henry's Law Constants and are expected to volatilize rapidly from aqueous environments. These compounds will volatilize from surface soil with some leaching occurring because of the low adsorption to soils. Deposition of dichloroethene and trichloroethene via precipitation from the atmosphere can occur and is governed by Henry's Law Constants. Disappearance from the air as the result of reaction with oxygen and hydrogen radicals also occurs. These compounds are expected to undergo biodegradation in the environment. The densities of trichloroethene, and 1,2-dichloroethene (>1.0 g/cm^3) indicate that these constituents can migrate downward once they reach the water table if they are present in undissolved concentrations in the ground water.

2.5.2 Migration Pathways

Results of this site assessment have demonstrated that ground water both northeast and southwest of the Girmes facility has been affected. The primary constituent is trichloroethene detected in 18 of 29 monitoring wells. Since the beginning of the CSA, 1,2-dichloroethene has been detected in 15 of 29 monitoring wells. Vinyl chloride has been detected in two wells. The presence of 1,2-dichloroethene and vinyl chloride indicate that natural biodegradation is occurring. These constituents are intermediate metabolites resulting from the biotransformation of trichloroethene with the ultimate biotransformation end product being carbon dioxide, chloride, and water. Ground water transport is the primary pathway for any constituent from the site. Air transport and direct contact are not indicated as pathways because the constituents exist at depth. There is evidence of some ground water discharge to surface waters, as discussed below.

Northeast Plume

As indicated by the water table map on Plate 5 and the configuration of the VOC plume on Plate 6, ground water on the northeast side of the Girmes site flows north towards the NC DOT facility and then flows northwest towards the Swannanoa River where it is expected to discharge. Ground water quality data collected to date show that constituent concentrations on the northeast side are decreasing downgradient of the site. Natural degradation in combination with dispersion as the plume migrates northwest is anticipated to result in the dissipation of the plume before it reaches the Swannanoa River.

Southwest Plume

Ground water on the southwest side of the Girmes site flows southwest and west towards Gashes Creek where it is expected to discharge. Trichloroethene has been detected from a seep (SW-6) and intermittent stream (SW-5) adjacent to Gashes Creek and in the creek at Station SW-4. This indicates that the plume extends to Gashes Creek. Affected ground water present on the Dotson property is not considered to be attributed to the plume on the Girmes side of Gashes Creek. Dotson's plume is expected to migrate north and northeastward towards Gashes Creek and towards the Swannanoa River.

Migration of trichloroethene in the surface waters of Gashes Creek is a secondary migration pathway. Gashes Creek flows northward along the edge of the site and then continues another 700 feet to the Swannanoa River where it discharges. It is expected that the low concentrations of trichloroethene detected in Gashes Creek will dissipate to a point of nondetection before reaching the Swannanoa River. As shown on Plate 1, Gashes Creek and Swannanoa River are the only surface water bodies in the area.

Underground Utilities

Underground utilities such as sewer lines and storm sewer lines located in the vicinity of the site are shown on Plate 1. One sewer line is located on the southwest side of the Girmes facility and extends across Gashes Creek. The sewer line is located near the water table in the vicinity of Gashes creek and is exposed where it crosses the creek. The sewer line is connected to a main north-south trunk line on Dotson's property. This sewer line is in the area of affected ground water both on the Girmes site and on Dotson's property. It is not known if the sewer line acts as a migration pathway.

A storm sewer is located along the edge of the parking area at the Girmes facility and extends northwest and away from the site. This storm sewer is relatively shallow below the land surface. The depth to the water table in this area is over 40 feet. It is unlikely that this storm sewer enhances constituent migration in ground water.

A second storm sewer is located on DOT property. This line was placed in the original drainage swale prior to placing fill at the site. The sewer collects some ground water seeps as well as surface water runoff and drains northwestward to Gashes Creek where it discharges.

2.5.3 Potential Receptors

Free phase volatile organic compounds have not been found on site, and their concentrations in ground water are relatively low. The potential for accumulation of free product or vapors is minimal. Therefore, there are no known structures at the site that are potentially at risk of being receptors of free product or vapors.

Potential receptors are limited to exposure through ground and surface water pathways. RMT completed a search for potential human receptors affected by ground water. Records maintained by the Asheville-Buncombe Water Authority were evaluated and a visual survey of the vicinity was conducted to identify ground water users within a 1,500-foot radius of the site boundary, as specified in the CSA guidance for determination of potential receptors. No probable users of ground water were identified within the 1,500-foot radius of the site. Three production wells have been identified: one on Girmes property and two on Dotson property. These are industrial wells and none of these wells are in use. The Asheville-Buncombe Water Authority services the entire area and provides service to residences within 1,500 feet of the Girmes site.

There are no surface water intakes for public water supply within the 1,500-foot boundary. A memorandum documenting the information provided by the Asheville-Buncombe Water Authority is included as Appendix K of the CSA.

The only residential area within the 1,500-foot radius of the site is located along Gashes Creek Road, east of the site (See Plate 1). This area is located on a ridge which acts as a ground and surface water divide. These homes are located upgradient of the site. Surface and ground water migration at the site is to the northwest, away from the residential area.

As required by the CSA, a compilation of owners of property located adjacent to the site has been gathered. Adjacent property owners are tabulated in Table 2-12 and their property locations are shown on Figure 2-1.

2.5.4 Constituent Toxicity

Noncarcinogenic Effects

The US EPA's preferred toxicity value for evaluating noncarcinogenic effects resulting from chemical exposure is the chronic reference dose (RfD). The chronic RfD is an estimate of a daily exposure level for the human population, including sensitive populations, that should not cause an appreciable risk of harmful effects during a lifetime of exposure. The RfDs for the site constituents evaluated are listed in Table 2-13 and were obtained from IRIS where possible. If no RfD was available in IRIS, HEAST values were used. Those compounds for which no RfD is available are not included in this table.

The confidence levels, uncertainty factors, and modifying factors reported in Table 2-13 address the reliability of the RfD, and are based on the underlying toxicological data. The inherent uncertainty of the toxicity data as reflected in the values contributed to the overall uncertainty of the risk associated with exposure to the compound.

Carcinogenic Effects

The classification of a substance as a carcinogen by US EPA, as well as US EPA's calculation of potency, may not reflect the current scientific consensus and, in most instances, will result in an overestimation of potential hazards. Potency values for constituents with potential carcinogenic effects are expressed as slope factor (SF). The SF is the value used to define the upper bound probability of an individual developing cancer as a result of a lifetime of exposure to a particular level of a potential carcinogen. Oral and inhalation SFs for site constituents are shown in Table 2-14 and were obtained from HEAST.

Table 2-14 also shows the US EPA Weight of Evidence (WOE) for each of the constituents that are considered by US EPA to be potential carcinogens. WOE is a classification system for characterizing the extent to which the available data indicate that an agent is a human carcinogen. Group A chemicals are listed as "known human

TABLE 2-12
SUMMARY OF ADJACENT PROPERTY OWNERS

MAP NUMBER	PIN NUMBER	OWNER NAME
1	9658-20-8152	State of North Carolina
2	9658-13-03-5331	Buncombe County
3	9658-17-00-8761	Ruby M. Pake
4	9658-17-00-9556	Brenda Ann Stinson
5	9668-17-00-6458	Ruth Teague
6	9658-17-00-7377	Georgia Miller
7	9657-08-99-3907	William H. Reed, Jr.
8	9658-20-90-2265	Grace Gordon Pless, *et al.*
9	9658-20-90-3532	Sweeten Creek Investments, Inc., *et al.*
10	9658-20-90-1866, 1790	Dotson Metal Finishing, Inc.
11	9658-20-91-1029	Gail C. Ballard, *et al.*

Figure 2-1 Adjacent Property Owners

carcinogens" by US EPA. Group B1 chemicals are listed as "probable human carcinogens," based on limited evidence of carcinogenicity in humans. Group B2 chemicals are called "probable human carcinogens," by US EPA, based on evidence of carcinogenicity in animals; human evidence is inadequate. Group C chemicals are "possible human carcinogens," based on limited evidence of carcinogenicity in animals; human evidence is inadequate. Group D chemicals are not classifiable as to human carcinogenicity. Group E chemicals show evidence of non-carcinogenicity in humans. Class A and B carcinogenic COPCs are presented in Table 2-14.

Table 2-13
Constituents Of Potential Concern
Toxicity Values: Potential Noncarcinogenic Effects

CHEMICAL	CHRONIC RfD (mg/kg-day)	CONFIDENCE LEVEL	CRITICAL EFFECT	RfD SOURCE	UNCERTAINTY FACTOR	MODIFYING FACTOR
ORAL ROUTE						
1,2-Dichloroethene	0.009	Low	Increased serum alkaline phosphatase in male mice	IRIS	1000	1
Trichloroethene	0.006	IRIS: A risk assessment is under review by a US EPA work group		US EPA NCEA Provision al Value	—	—

Table 2-14
Constituents Of Concern
Toxicity Values: Potential Carcinogenic Effects

CHEMICAL	SLOPE FACTOR (SF) $(mg/kg\text{-}day)^{-1}$	WOE[a] CLASS	TYPE OF CANCER	SLOPE FACTOR SOURCE
ORAL ROUTE				
Trichloroethene	0.011	B2	liver tumors	HEAST
Vinyl Chloride	1.9	A	lung and liver tumors	HEAST
INHALATION ROUTE				
Trichloroethene	0.006	B2	lung	US EPA NCEA Provisional Value
Vinyl chloride	0.3	A	liver tumors	HEAST

a Weight of Evidence Class

Section 3
Corrective Action - Southwest Plume

A ground water recovery and treatment system is proposed for active remediation of the southwest plume. The system consists of a series of ground water extraction wells along the property line and ground water recovery pumps to transfer the water to a ground water treatment system. Discharge of the treated ground water is proposed either to Gashes Creek under an NPDES permit or to the Publicly Owner Treatment Works (POTW).

3.1 Source Identification for Southwest Plume

Source identification within the southwest plume has taken three forms: former employee depositions and the results of soil and ground water analysis.

The former employee depositions revealed that former solvent disposal practices included pouring small quantities of spent solvent on the ground on the northeast side of the manufacturing building. Recent soil sampling in the area did not identify a continuing source of VOCs in vadose zone soils.

It was also reported that small quantities of solvents may have been poured into a drain that extended from the building to the edge of the parking area on the southwest side of the facility. Visual site surveys have failed to locate the reported drain.

Based on the depositions and analytical results, and given the length of time (approximately 20 years) that has passed since the discharge of VOCs to soils last occurred, it is reasonable to conclude that there is no active source of VOCs on the Girmes site.

3.2 Evaluation of Remedial Alternatives

Since no active source areas are likely in the soil, the primary objective of the corrective action in the southwest area of the site is to restore ground water quality in the southwest portion of the Girmes site.

A summary of remedial options for restoring ground water quality in the southwest portion of the Girmes site is provided in Table 3-1.

TABLE 3-1
REMEDIAL OPTIONS FOR RESTORING GROUND WATER QUALITY
SOUTHWEST PLUME

REMEDIAL OPTIONS	ADVANTAGES	DISADVANTAGES	CAPITAL COST ESTIMATES	YEARLY OPERATION COSTS (FIRST YEAR)
Air Sparging	*In-Situ* Technology that does not require ground water recovery operations	Technology is not reliable in treating ground water in bedrock.	$625,000	$50,000
Cut Off Wall with *In-Situ* Air Stripping	Cut off wall may form a physical barrier to plume migration. Air stripping effective treatment for water flowing through stripping section.	Ground water may travel in fractures around cut off wall. Cost prohibitive for installation into bedrock.	$850,000	$50,000
Air Stripping Trench	Trench design enhances VOC removal in ground water that flows through trench.	Ground water may travel in fractures around trench. Cost prohibitive for installation into bedrock.	$1,100,000	$50,000
Ground Water Recovery Treatment and Discharge	A cone of depression is produced around pumping wells that will retard plume migration. Affected ground water is removed and treated.	Must have outlet for treated ground water. Must have sufficient ground water yields.	$660,000	$50,000

The water table is below bedrock surface on top of the ridge at the Girmes site. The water table is at or just above the bedrock surface on the southwest side of the property near Gashes Creek.

A ground water recovery, treatment, and discharge system is the remedial option selected for the southwest plume. It has the advantage of removal and treatment of the affected ground water and producing a cone of depression around the pumping wells. This cone will tend to draw more affected water into the well and stop further plume migration.

The disadvantage of a ground water recovery system in bedrock is that it relies on recovery wells that intercept water producing fractures. Usually producing fractures that are encountered are tight and yield little ground water. As a result, capture zones for each recovery well are limited in size and thus, have a limited effect. Another disadvantage of ground water

recovery and treatment is the disposal of the treated ground water. Site topography (hillside location) and soil characteristics (silty clay) are not favorable for reinfiltration.

The treated ground water may be discharged through an NPDES outfall on Gashes Creek. As an option, discharge to the local POTW may be possible because the branch sewer line servicing the site may have sufficient capacity to receive up to 20,000 gallons of treated water per day.

3.3 Design Criteria

Design of the ground water recovery and treatment system was based on the delineation of the southwest plume, results of hydraulic conductivity tests, seepage velocity and vertical gradient calculations as found in the CSA, and results of pumping tests performed on well RW-1 in June 1995. This information produced the following basis for design:

- Ground water will be collected from three ground water recovery wells located near the southwest property line. The wells will be spaced approximately 160 to 180 feet apart. NEW
- The ground water recovery wells will be completed approximately 75 feet below the top of bedrock.
- Each well is estimated to yield 5 gallons per minute (gpm) for a total yield of 15 gpm.
- Following installation, the three recovery wells will be assessed for yield. If necessary, additional recovery wells may be installed or other options may be considered to improve ground water capture.
- Recovered VOCs will include trichloroethene, 1,2-dichloroethene, and vinyl chloride. The maximum detected concentrations for each of these VOCs is 14 mg/L, 0.67 mg/L, and 0.029 mg/L, respectively.
- VOC removal is expected to be the only treatment required for NPDES discharge.
- Air stripping will sufficiently remove VOCs from the ground water to meet discharge permit limits.
- VOC emissions from the air stripper will be less than 0.054 pounds per hour and are not expected to require a control device.
- Approval provided for discharge of treated ground water to Gashes Creek or to the POTW.

3.4 Process Approach

Overview

The ground water recovery and treatment system's process design consists of a system of recovery wells for the removal of ground water. An electric submersible pump will be installed in each recovery well. The pumps will transfer the ground water through a common header to a surge tank. Based on the surge tank's water level, a booster pump will periodically pump the

water from the surge tank to the top of the air stripper. The water will gravity flow through the air stripper to an integral sump. The treated ground water will gravity flow from the air stripper's sump through a parshall flume to a diffuser in Gashes Creek or to the sanitary sewer. A flow diagram of the ground water recovery and treatment system is provided as Figure 3-1. A general layout of the ground water recovery and treatment system is shown on Plate 8, and equipment vendor cut sheets are provided in Appendix C.

Ground Water Recovery

Capture zones were calculated for an area on the southwest property boundary in the vicinity of RW-1. The GPTRAC module of the US EPA Wellhead Protection Area delineation program (WHPA) was used for the capture zone analysis. GPTRAC is a semi-analytical model which provides for pathline and time-related capture zone delineation using analytical velocity computation techniques. Specific information descriptive of possible aquifer conditions at each of the areas was used as input to GPTRAC (Table 3-2). The aquifer was specified as unconfined. An effective porosity of 0.25 was assumed for the materials comprising the aquifer. The transmissivity value for model input was based on the pumping test results for well RW-1. The pumping rate is based on actual data collected from well RW-1 and an assumption that yield will increase to 5 gpm when the well is extended to a depth of 75 feet below the bedrock surface.

Plots showing the calculated theoretical capture zones for each area of ground water extraction is presented on Plate 9. The aquifer in the southwest portion of the site, in the vicinity of Gashes Creek, is generally expected to be more productive than elsewhere on the site as indicated by differences in well yield observed between RW-1 and RW-2. Therefore, a total of three ground water recovery wells (including RW-1) pumping at 5 gpm are each proposed along the southwest property boundary.

Well RW-1 will be drilled deeper to a total depth of 75 feet below the bedrock surface. In addition, two ground water recovery wells will be installed along the southwest property line. The wells will be constructed of 6-inch nominal, flush-joint schedule 40 PVC surface casing extending from land surface to the top of bedrock. The recovery wells will be completed approximately 75 feet below the top of bedrock. The wells will be constructed with an open hole completion within bedrock. Figure 3-2 is a typical well construction diagram of the recovery wells proposed for the southwest plume. A Grundfos Redi-Flo Model 5E12 electric submersible pump or equal will be installed in each recovery well. Each pump is equipped with a ½-horsepower motor and has an operating flow rate range of 1.2 to 7 gpm. At 100 feet of total dynamic head, the pump will produce 7 gpm.

The submersible pumps are expected to deliver an average flow rate of 15 gpm to the surge tank. A booster pump rated at 35 gpm will periodically pump the water from the surge tank to

TABLE 3-2
CAPTURE ZONE MODELING ANALYSIS INPUT PARAMETERS

PARAMETER	VALUE SOUTHWESTERN AREA	DATA SOURCE
Type of Aquifer	Unconfined	
Effective Porosity	0.25	CSA
Aquifer Thickness (feet)	65[a]	Information from RW-1 and RW-2
Transmissivity (ft^2/day)	39	Aquifer test results
Hydraulic Gradient	0.070	CSA
Boundary Conditions	Stream boundary	Presence of Gashes Creek
Areal Recharge Rate (inches/year)	8	USGS
Pumping Rate (gpm)	5	Estimated
Well Diameter (inches)	6	Design parameter
Number of Pumping Wells	3	

a Actual aquifer thickness is 75 feet. For the purpose of conservatively modeling the capture zone, an aquifer thickness of 65 feet was used to allow for an expected decrease in fractures and hydraulic conductivity with depth.

Figure 3-1 Flow Diagram of Ground Water Recovery and Treatment System

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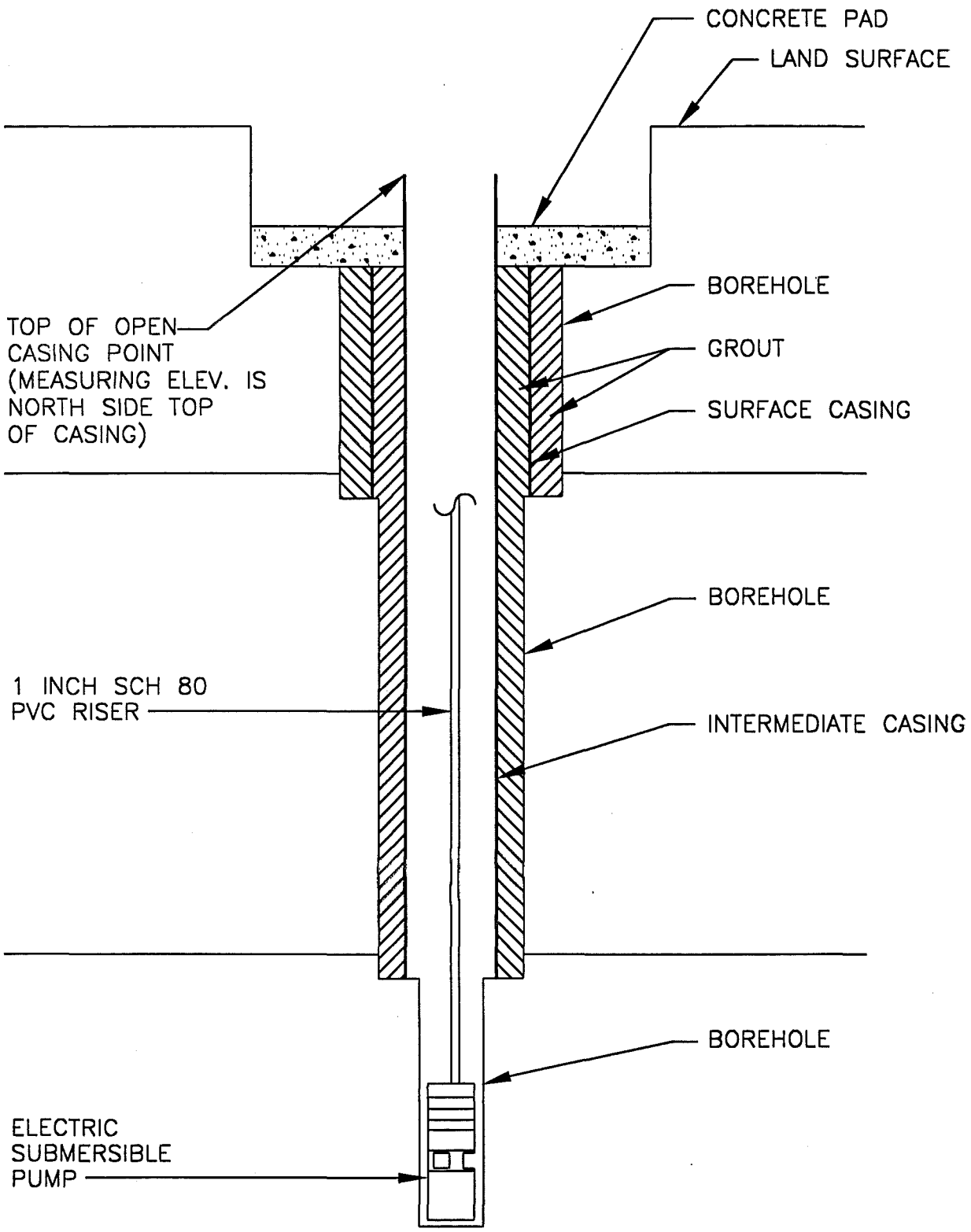


FIGURE 3-2

TYPICAL RECOVERY WELL CONSTRUCTION DIAGRAM

Not To Scale

RMT 70144.05 0396

GIRMES SITE
FORMERLY SKF USA
ASHEVILLE, NC

the air stripper. The submersible pumps are interlocked with the water level in the surge tank such that an abnormally high water level in the surge tank (high level alarm condition) will turn off the submersible pumps and prevent overflow of the surge tank. Under normal operating conditions the booster pump, operating at 35 gpm, will maintain the water below the high level alarm switch point and the submersible pumps will independently cycle depending upon water level in each recovery well.

The booster pump is also interlocked with the surge tank's water level and will operate between high and low water level switch points. This control is further described below.

The extracted ground water will be conveyed to the surge tank through a buried common header. The header will be constructed of 3-inch schedule 80 PVC or equal.

Surge Tank

The surge tank is a 2,500-gallon vertical tank. Level sensors monitor the water level within the tank, and provide system control for the following operating conditions.

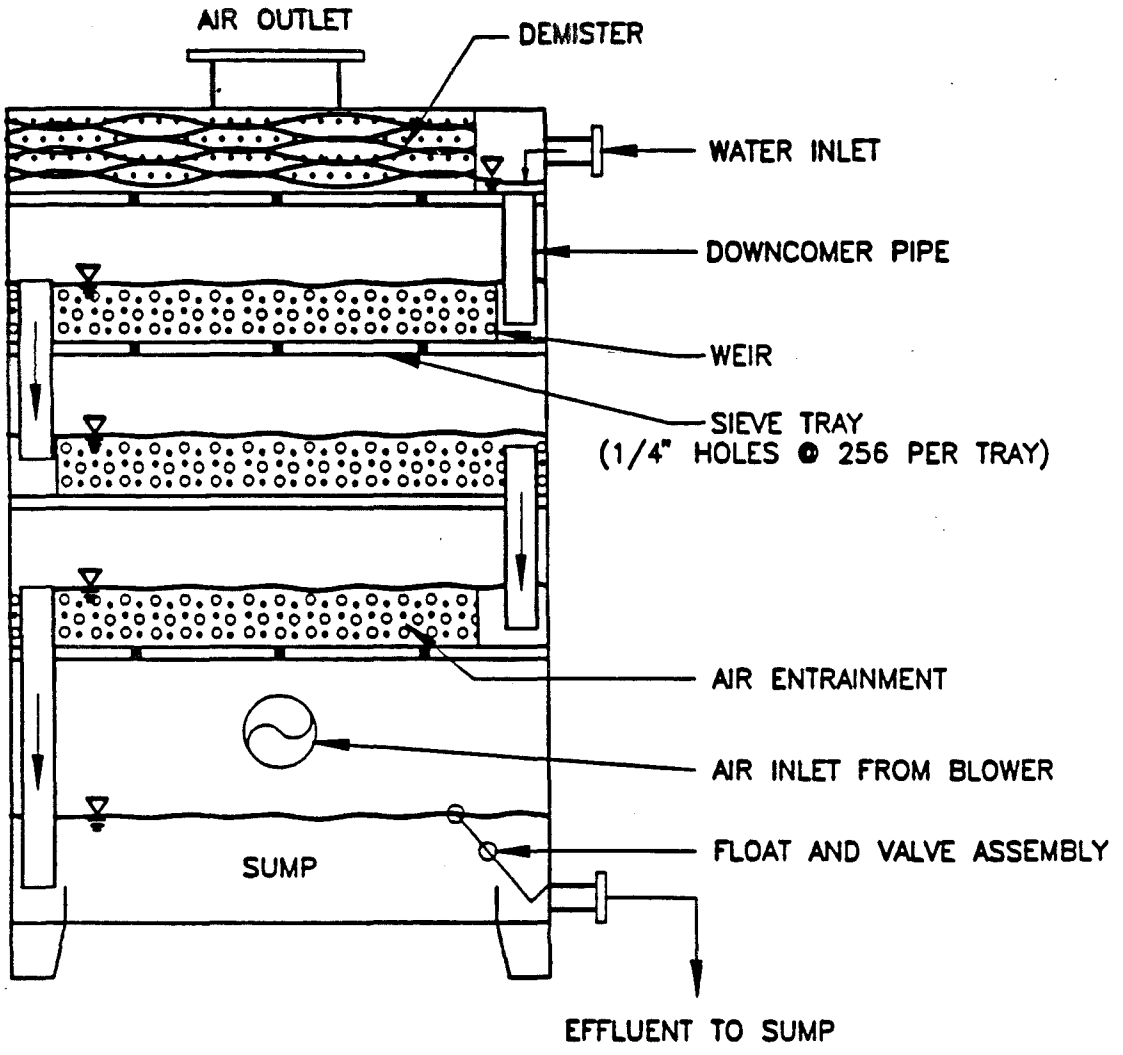
WATER LEVEL	CONDITION	SYSTEM CONTROL
High Level Alarm	Abnormally high water level	Shuts down system, activates autodialer, requires manual restart.
High Water Level	Surge tank is operationally full.	Turns on booster pump.
Low Water Level	Surge tank is operationally empty.	Turn off booster pump. Turn on submersible pumps.
Low Level Alarm	Abnormally low water level.	Shuts down system activates autodialer, requires manual restart.

Booster Pump

The booster pump is a DURCO Mark III ANSI process pump or equal. The pump is a ½-horse power centrifugal pump capable of delivering 35 gallons per minute at a Total Dynamic Head (TDH) of 30 feet.

Low-Profile Air Stripper

The extracted ground water is transferred to the top of the low profile air stripper unit (Figure 3-3) by the booster pump. Once in the unit, the water flows across the upper distribution tray of the air stripper where is it uniformly distributed over a pattern of 3/16-inch diameter holes through which a continuous stream of air is passed. The extracted ground water then drains by gravity through trays (maximum of six) to a sump located at the bottom of the air stripper. As the extracted ground water passes downward through these trays, an air stream is continuously forced upward through the ground water by an air blower.



NOTE: GIRMES SYSTEM AIR STRIPPER WILL HAVE SIX TRAYS

FIGURE 3-3

TYPICAL LOW PROFILE
AIR STRIPPER

RMT INC.

70144.05
0396

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This countercurrent flow of extracted ground water and air induces a mass transfer of VOCs from the ground water into the air stream. In this manner, VOCs are stripped from the water phase and introduced to the air phase. Treated ground water then flows by gravity from the low-profile air stripper through a flow-measuring flume and into the discharge pipe.

Based on the complete removal of the maximum expected VOC concentrations, the mass transfer of VOCs to the air stream should be at or less than 0.054 pounds per hour. Mass transfer calculations are provided in Appendix D.

Parshall Flume

A Parshall flume with a 1-inch throat will be used for measuring the discharge flow rate of the treated ground water.

3.5 System Layout

A layout of the system is provided in Plate 8. Three recovery wells will be installed along the southwest property line and a common underground header will convey recovered ground water to the treatment system. The ground water treatment system will be located within a new treatment building sited southeast of monitoring well MW-27. The discharge will be to the west of the treatment building either to Gashes Creek or to the POTW collection system.

3.6 System Security and Safety Measures

The recovery wells will be finished below grade in locked well vaults. All above ground piping and equipment is located in the treatment building. The treatment building will be locked to limit access. Area lighting will be provided at the treatment building.

The treatment system has been designed with automated controls having manual overrides. It is designed for unattended operation, and in the event of an abnormal operating condition, the system will shut down and an autodialer will phone the treatment system operator and inform the operator of the system shutdown.

Operation of the treatment system will require a certified operator. It is anticipated that the permit will require daily system inspections during startup and an initial period of operation. After a period of trouble-free operation, it is anticipated that the system inspections will be reduced to once per week.

3.7 Operations and Maintenance Manual

An Operations and Maintenance manual will be developed during the final design and will be finalized prior to system startup. Typical maintenance includes periodic washdown of the air

stripper's tray sections and cleaning the inlet screens on the air stripper's blower. A maintenance schedule will be provided in the O&M manual.

3.8 Ground Water Monitoring Program

A ground water monitoring program is proposed to monitor the VOC constituents in ground water at the site. This program includes sampling all of the recovery wells, monitoring wells, and surface water stations prior to startup of the remediation system. After system startup, the program will include sampling the recovery wells and monitoring wells MW-2, MW-4, MW-5, MW-9, MW-13, MW-14, MW-18, MW-19, MW-21, MW-23, MW-24, MW-26R (replacement well for abandoned well MW-26), MW-28A, and Dotson Production Well #1 on a quarterly basis. The remaining monitoring wells MW-1, MW-6, MW-7, MW-8, MW-10, MW-11, MW-12, MW-15, MW-15A, MW-16, MW-16A, MW-17, MW-20, MW-22, MW-27, and MW-28 will be sampled on a semiannual basis, and water levels will be measured quarterly. Surface water stations SW-1, SW-2, SW-3, and SW-4, located on Gashes Creek, will also be sampled semiannually. Samples will be analyzed for trichloroethene, 1,2-dichloroethene, and vinyl chloride. Following each quarter, SKF will submit quarterly reports to NC DEHNR. The reports will present analytical results for that quarter, a water table map of the site for that sampling event, and hydrographs of the water levels in the bedrock wells. After four quarters, the sampling regime may be evaluated. Ground water remediation and monitoring will continue until the criteria in NCAC Title 15A Subchapter 2L has been met.

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3.9 Required Permits

The treated ground water will be discharged to the POTW, if a permit can be obtained from the Metro Sewer District (MSD), or to Gashes Creek, if an NPDES permit can be obtained from NC DEHNR. The schedule provided in Section 6 of this report shows the estimated time required to implement the CAP based on receiving a permit from the MSD. If this permit is not issued, the schedule will need to be revised to include application for an issuance of an NPDES permit.

It is doubtful that an air permit will be required for operating the air stripper; however, a letter notifying the Department of Air Quality of the air stripper's operating parameter and requesting a permit waiver will be submitted to the state.

3.10 Access Agreements

The monitoring plan described in Section 3.8 requires access to the Dotson and NC DOT properties. An access agreement with Dotson and NC DOT has already been obtained and ground water is routinely sampled on their properties.

Former section 4-9

3.11 Public Notice

Notification that ground water contamination has occurred has been sent by certified mail to two parties:

James Westbrook, Jr. Asheville City Manager 70 City County Plaza Asheville, NC 28801 (704) 258-3223	George Bond Director Buncombe County Health Department 35 Woodfin Street Asheville, NC 28801 (704) 255-5682

Copies of the two letters and certified mail forms are included in Appendix E. The completed certified mail receipt will be forwarded under separate cover.

Section 4
Corrective Action - Northeast Plume

Corrective action for the northeast plume will be deferred to assess the effects resulting from operation of the southwest plume remediation system. After the remediation system has been in operation for 24 months, SKF will evaluate the impact of the system on the northeast plume. If it is determined that there is no effect on the northeast plume resulting from operation for the southwest plume remediation system, SKF will reevaluate other remedial options for the northeast plume. A ground water monitoring program is proposed to monitor the potential effects of operating the southwest plume remediation system and to monitor natural remediation processes occurring within the northeast plume, including the combined affects of natural attenuation and anaerobic biodegradation. Currently available data support the conclusions that natural remediation is occurring and that the northeast plume will be remedied prior to reaching the Swannanoa River.

MW-20 is located between the Swannanoa River and the leading edge of the northeast plume. It is also within the predicted hydraulic pathway of the northeast plume. Ground water sampling results from MW-20 will be used as the leading indicator of ground water restoration by natural remediation and as the control to determine if more active corrective measures are required.

4.1 Source Identification

Source identification within the northeast plume has taken three forms: former employee depositions and the results of soil and ground water analysis.

The former employee depositions revealed that former solvent disposal practices included pouring small quantities of spent solvent on the ground on the northeast side of the manufacturing building. There is no evidence of burial areas north of the manufacturing building. Recent soil sampling in the area did not identify a continuing source of VOCs in vadose zone soils.

Based on the depositions and analytical results, and given the length of time (approximately 20 years) that has passed since the discharge of VOCs to soils last occurred, it is reasonable to conclude that there is no active source of VOCs on the Girmes site and northeast of the manufacturing building.

4.2 Evaluation of Remedial Alternatives

Since no active source areas are likely in the soil, the primary objective of the corrective action in the northeast area of the site is to restore ground water quality in the northeast area of the Girmes site.

A summary of remedial options for restoring ground water quality in the northeast plume is provided in Table 4-1.

TABLE 4-1
REMEDIAL OPTIONS FOR RESTORING GROUND WATER QUALITY
NORTHEAST PLUME

REMEDIAL OPTIONS	ADVANTAGES	DISADVANTAGES	CAPITAL COST ESTIMATES	YEARLY OPERATION COSTS (FIRST YEAR)
Air Sparging	*In-Situ* Technology that does not require ground water recovery operations	Technology is not reliable in treating ground water in bedrock. Aeration will shut down the anaerobic degradation of TCE in the aquifer.	$718,000	$50,000
Cut Off Wall with *In-Situ* Air Stripping	Cut off wall may form a physical barrier to plume migration. Air stripping effective treatment for water flowing through stripping section.	Ground water may travel in fractures around cut off wall. Cost is prohibitive for installation into bedrock. Low water yields in bedrock.	$950,000	$50,000
Air Stripping Trench	Trench design enhances VOC removal in ground water that flows through trench.	Ground water may travel in fractures around trench. Cost prohibitive for installation into bedrock. Low water yields in bedrock.	$1,300,000	$50,000
Ground Water Recovery Treatment and Discharge	A cone of depression is produced around pumping wells that will retard plume migration. Affected ground water is removed and treated.	Insufficient water yields in bedrock.	$780,000	$50,000
Natural Remediation based on natural attenuation and intrinsic bioremediation	Uses naturally occurring mechanisms to restore aquifer quality. Cost effective.	Does not hydraulically contain the Plume.	$10,000	$39,000

The water table is below bedrock surface on top of the ridge at the Girmes site. The water table is above bedrock in most areas on the NC DOT property.

In-situ technologies such as air sparging, *in-situ* air stripping, and cut off walls are not appropriate for remediating ground water in fractured rock because the ground water can migrate around the treatment structures through other fractures. Therefore, *in-situ* technologies are not recommended. Since the existing bedrock wells in the northeast plume area yield very little water, ground water recovery is not recommended within the northeast plume. (Test well RW-2 has an estimated yield of 0.5 gallons per minute. Open hole bedrock monitoring wells MW-4 and MW-5 both go dry during purging with low yield sampling pumps.)

Natural remediation, based on natural attenuation and intrinsic bioremediation, is the recommended remedial option for the northeast plume. This process is shown to be occurring within the area of the northeast plume, and current data strongly suggests that the natural remediation mechanisms will sufficiently restore aquifer quality.

4.3 Capacity to Degrade

The pathway of microbial degradation of halogenated constituents under anaerobic conditions has been documented in several laboratory studies including the following:

- *Transformations of Halogenated Aliphatic Compounds.* Vogel *et al.* 1987;
- *Bioengineering Issues Related to in-situ Remediation of Contaminated Soils and Groundwater.* McCarty 1988;
- *In-situ Aquifer Restoration of Chlorinated Aliphatics by Methanotrophic Bacteria.* US EPA 1989;
- *Biotransformation of Tetrachloroethylene to Trichloroethylene, Dichloroethylene, Vinyl Chloride, and Carbon Dioxide under Methanogenic Conditions.* Vogel and McCarty, 1985;
- *Reductive Dehalogenation: A Subsurface Bioremediation Process.* Sims *et al.* 1990/91; and
- *Intrinsic Bioremediation.* R.E. Hinchec, J.T. Wilson, and D.C. Downey (editors) Batelle Press, 1995.

In general, this pathway of reductive dehalogenation results in the production of less halogenated constituents than originally present. The reductive transformation occurs when a source of carbon is available and environmental conditions favor the production of methane. Anaerobic microorganisms other than methane-producing bacteria may also participate in the reductive dehalogenation process. These above studies, as well as others, substantiate observations from field investigations in which constituents such as 1,2-dichloroethene are observed but are known to have never been used at the location. Studies such as the ones noted above indicate the biological conditions and processes that result in the transformation of chlorinated constituents. Knowledge of this pathway and the conditions that encourage microorganisms to degrade halogenated constituents, *e.g.*, trichloroethene to 1,2-dichloroethene

to vinyl chloride to ethene, and ultimately to CO_2, therefore, allows for the evaluation of this naturally-occurring or intrinsic bioremediation.

Biodegradation Products

The presence of 1,2-dichloroethene and vinyl chloride in the ground water suggest that the degradation of trichloroethene is occurring in the subsurface at the Girmes facility. Plate 6 shows 1,2-dichloroethene and vinyl chloride concentrations found in ground water at the specific monitoring locations. This map shows that sample points that have elevated concentrations of trichloroethene also have elevated concentrations of 1,2-dichloroethene.

MW-13 is shown to be the furthest ground water monitoring well downgradient of the manufacturing building and containing VOCs. MW-13 is on the downgradient edge of the plume and when last sampled in January 1996, has no detectable amounts of trichloroethene or 1,2-dichloroethene, and a detectable amount (0.0048 mg/L) of vinyl chloride. These data imply that by the time affected ground water reaches MW-13, potentially detectable amounts of trichloroethene have already degraded to 1,2-dichloroethene and vinyl chloride.

These data also imply that if anaerobic biodegradation of the trichloroethene had not occurred, a potential concentration of 0.0094 mg/L trichloroethene would be possible at MW-13. This potential concentration was obtained by calculating the amount of trichloroethene required to produce a 0.0048 mg/L solution of vinyl chloride. Since trichloroethene degrades to 1,2-dichloroethene and then to vinyl chloride, this calculation gives a rough approximation of the potential concentration of trichloroethene at MW-13 if degradation had not occurred.

Using the potential trichloroethene concentration as a basis, the data also implies that by the time affected ground water reaches MW-13, the following will occur:

- 100 percent of the potentially detectable trichloroethene has biodegraded to vinyl chloride,
- None of the potentially detectable trichloroethene is represented by 1,2-dichloroethene,
- Since trichloroethene degrades to 1,2-dichloroethane and then to vinyl chloride, and since only vinyl chloride is detected at MW-13, the degradation process is shown to be nearly complete by the time affected ground water reaches MW-13.

Reductive Dehalogenation Indicators

In the assessment of reductive dehalogenation as a method of intrinsic bioremediation, assessment of other parameters to indicate that anaerobic conditions exist in the aquifer provide additional data to support the conclusion that this naturally-occurring process is in progress.

The indicators of anaerobic (reducing) conditions chosen for this initial assessment include the gases methane, ethene, ethane, and minerals dissolved iron, and dissolved manganese. The gases indicate that anaerobic microbial metabolism is most likely occurring while the dissolved

minerals indicate that reducing conditions exist in the aquifer, which make it possible for anaerobic bacteria to thrive. As shown on Tables 2-5 and 2-8, MW-20 has dissolved and total minerals that are essentially equivalent, indicating the mineral is dissolved. These minerals tend to be in the dissolved phase when in a reducing environment, further substantiating the intrinsic bioremediation of trichloroethene. Similar results are shown for MW-9, MW-15, MW-15A, MW-16, MW-16A, and RW-02. As shown on Table 2-6, methane was detected in MW-4, MW-13, MW-15, MW-17, MW-20, RW-01, and RW-02. The presence of methane is another indicator that anaerobic microbial metabolism is most likely occurring. The evaluation of ethene and ethane was to assess whether the chlorinated parent constituent, trichloroethene, had been reductively dechlorinated. Neither ethene nor ethane was detected indicating the microbial transformation of these compounds has not occurred or the transmation of these compounds has occurred and they have been degraded to CO_2 and H_2O.

These dissolved or reduced minerals, and the presence of methane indicate that conditions exist in which anaerobic microorganisms can degrade halogenated constituents to less halogenated constituents and ultimately to CO_2.

4.4 Time and Direction of Constituent Travel

Constituent migration rates for the northeast plume can be estimated based on the average ground water flow rate for the northeast portion of the site and the estimated retardation factor for each constituent present. The velocity of each constituent can be estimated using the following equation:

$$V_C = V / [1 + Kd\,(\rho_b / n)]$$

where:

	V_c	= constituent velocity
	V	= ground water seepage velocity
	Kd	= distribution coefficient
	ρ_b	= soil bulk density
	n	= soil total porosity.

The distribution coefficient Kd for each constituent is estimated as a product of the soil adsorption coefficient (K_{oc}) for each constituent and the organic carbon content of the subsurface materials (f_{oc}). Table 4-1 presents constituent velocity calculations used to develop the estimates. Constituent velocities in saprolite soils on the northeast side of the Girmes site range from approximately 28 feet per year for trichloroethene to approximately 30 feet per year for 1,2-dichloroethene. Constituent velocities in saprolite soils on the northwest portion of the NC DOT property are higher, ranging from approximately 130 feet per year for trichloroethene to approximately 139 feet per year for 1,2-dichloroethene.

TABLE 4-2
CONSTITUENT VELOCITY ESTIMATES

Compound	K_{oc} (mL/g)	Kd (mL/g)	V_c (ft/yr)	
			V = 31 ft/yr	V = 145 ft/yr
Trichloroethene	126	0.0252	28	130
1,2-Dichloroethene	49	0.0098	30	139
Vinyl chloride	57	0.0114	29	138

K_{oc} values from *Basics of Pump-and-Treat Ground-Water Remediation Technology*, by James W. Mercer, David C. Skipp, and Daniel Griffin, 1990, US EPA/600/8-90/003.
Kd values calculated assuming an aquifer soil organic carbon content of 0.02 percent.
Assumes soil bulk density = 1.4 g/cc and porosity = 0.3.

The direction of constituent travel in the northeast plume can be estimated from the ground water flow directions present in Plate 5. The northeast plume is narrowing and the primary direction of constituent migration is expected to be to the north and northwest.

4.5 Constituent Concentration at Potential Receptors

Receptors include utility lines, basements, elevator shafts, public and domestic supply wells, surface water, and ground water areas identified for planned resource development. On the basis of information presented in the CSA and this CAP, no potential receptors will be affected by the northeast plume.

4.6 Potential Off-Site Migration

As shown on Plate 3, some off-site migration of the northeast plume has occurred; however, based upon the capacity for the constituents to degrade (Section 4.2) and time and direction of constituent travel (Section 4.3), further migration of constituents is not anticipated because the plume constituents are being depleted within the area of the existing plume through natural remediation.

4.7 Effects on Surface Water Quality

As stated in the previous section, further migration of constituents is not anticipated because the plume constituents are being depleted with the area of the existing plume through natural remediation.

4.8 Ground Water Monitoring Program

A ground water monitoring program is proposed to track the degradation and attenuation of VOC constituents within and downgradient of the northeast plume and to assess the affects

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resulting from operation of the southwest plume remediation system. The ground water monitoring program is presented in Section 3.8 of this document.

Section 5
Compliance with Environmental Law

Corrective actions have been discussed in this CAP for the remediation of the southwest and northeast plumes. The elements of those actions discussed in this plan have been written in an attempt to be consistent with other environmental laws.

Section 6
Schedule

A corrective action schedule is provided as Plate 10.

Section 7
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