THE WATAUGA COUNTY LANDFILL PERMIT NO. 95-02 ASSESSMENT PLAN ACTIVITY REPORT

Prepared for
Watauga County
Board of Commissioners

Prepared by
Draper Aden Associates

July 29, 1994

DAA Job No. 6520-14

Table of Contents

LIST OF TABLES

LIST OF FIGURES

AS SEPARATE:

LIST OF APPENDICES

I. Introduction

On July 7, 1993, Watauga County and the North Carolina Department of Environment, Health, and Natural Resources (NCDEHNR), Division of Solid Waste Management, Solid Waste Section entered into a Consent Agreement under which the County agreed to take steps to determine the status of groundwater and surface water quality at and in the vicinity of the Watauga County Landfill (Figure 1 is a Vicinity Map depicting the location of the Watauga County Landfill and the near vicinity). Pursuant to the Consent Agreement, Watauga County submitted the Watauga County Landfill Assessment Plan (DAA, September 3, 1993), prepared by Draper Aden Associates, to the NCDEHNR.

The Assessment Plan was approved by the NCDEHNR on September 30, 1993. The enclosed report presents the findings of the initial activities conducted thus far under the approved Assessment Plan. The report also identifies future monitoring activities and other areas of continued investigation. The initial field activities as defined in the Assessment Plan included the following:

- Landfill Cover Depth Verification,
- Landfill Gas Screening,
- Off-Site Assessment Monitoring Well Access and Easement Development,
- Assessment Monitoring Well Drilling Services Bid Procurement,
- Assessment Monitoring Well Drilling and Installation,
- Health and Safety Monitoring,
- Well Development,
- Aquifer Testing,
- Dedicated Pump Installation, and
- Laboratory Analytical Services Bid Procurement.

Section II of the enclosed report presents the results of the above initial field activities.

Approval of the Assessment Plan by the NCDEHNR was subject to the condition that, in addition to activities defined by the plan, further investigation would be conducted in the following two areas:

- the relationship between the fracture trace lineament and the formation contact between the Lower Precambrian amphibolite/hornblende gneiss and the Lower Precambrian "mixed rock" (primarily focusing on ascertaining the possible existence of a preferential flow path trending southward along the contact or lineament).

- suitability of spring locations along the formation contact and/or the tributary of Mutton creek in the Rocky Mountain Heights Subdivision for addition to the surface water sampling program.

Section II of the Activity Report also provides an updated discussion on the geology and hydrogeology of the site. Information obtained from recent well drilling, aquifer testing, and site reconnaissance is applied to refining the current assessment of geologic formation contacts, fracture trace lineaments, and spring occurrence across the site. A revised Geology Map (Figure 4) and Groundwater Potentiometric Surface Map (Figure 5) incorporating information obtained from these continuing investigations is also provided.

Potable Well Sampling and Analysis Program

A summary and evaluation of the ongoing investigation of potential contaminant migration pathways to potable wells neighboring the landfill site is presented in Section III of this report. This activity is currently being conducted jointly by the Appalachian District Health Department and the North Carolina State Laboratory of Public Health.

A total of seventeen (17) potable water wells neighboring the landfill site were sampled by the Appalachian District Health Department since the Assessment Plan was prepared. The analytical results from all the potable well sampling conducted in the past year indicate that the sampled well waters are acceptable for all uses due to either the lack of detection or only trace detection of organic analytes. An updated summary table (Table 3) and Vicinity Map (Figure 1) presents the analytical results and locations for all of the residential and business potable wells sampled to date, respectively.

New River Sediment Study

This report presents a one page summary in Section IV of the "New River Sediment Study", a three month-long geochemical study of the landfill drainage sediments, conducted by Dr. John Callahan of the Appalachian State University (ASU) Geology Department. Unable to obtain a copy of the study report prior to preparation of the following report, information obtained from an article in The Mountain Times, April 28, 1994, was utilized to compile the one page summary presented in this report.

The Mountain Times' article reported the "New River Sediment Study" was sponsored in part by Dr. Harvard Ayers, Dr. Brad Batchelor, Rhonda Sechrest, and the Watauga Chapter of the Blue Ridge Environmental Defense League (BREDL). The sediment study investigated the levels of thirty-one (31) metals in the stream sediments at sixteen (16) stream sites draining the Watauga County Landfill, and other areas in the New River drainage basin in and around the town of Boone. The article indicated the sediment study found no evidence of heavy metal pollution in the sediments of streams draining the area of the Watauga County Landfill.

Groundwater and Surface Water Monitoring Program

Groundwater and surface water assessment activities associated with the next phase of the Assessment Plan are outlined in Section V. The protocol for these activities are contained in Appendix I of the Assessment Plan, The Watauga County Landfill Groundwater and Surface Water Monitoring Program. Quarterly Assessment Reports will detail the results of these subsequent assessment activities.

Drawing Under Seperate Cover

II. Initial Assessment Field Activities

2.1 Landfill Cover Depth Verification

The initial evaluation of existing cover conditions compiled for the Assessment Plan report was conducted by discussing site operations with landfill personnel and visually inspecting the cover with the landfill supervisor. The preliminary cover characterization indicated that approximately two to four feet of cover were applied and graded on the landfill. Active fill areas were reportedly covered daily by six inches of soil. Further, the operational face of the landfill was kept to a minimum by the use and effective placement of compacted bales of waste.

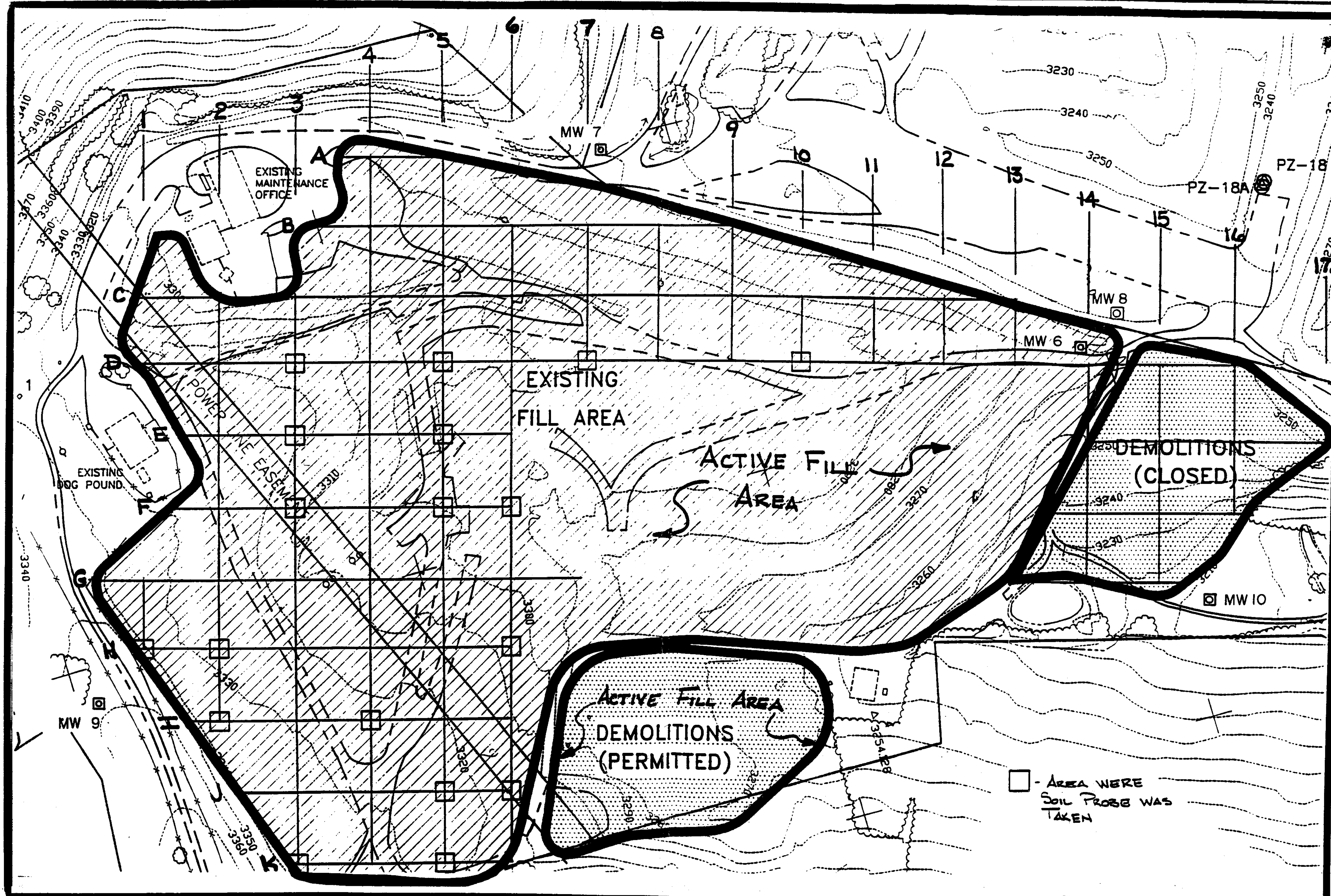
Draper Aden Associates performed cover depth verification tests on the closed out areas of the Watauga County Landfill on October 20, 1993. Soil probes were taken at random points to verify the total depths of cover material. The attached landfill grid diagram (Figure 2) shows where soil probes were taken. The overall cover depth at each point was 2 feet or greater, although an occasional piece of debris was partly exposed.

An additional 1 foot closure cap subbase grade is currently being installed over the waste disposal area. Installation of a preliminary closure cap will follow. Final cap specifications will be proposed pending the results of groundwater/surface water infiltration studies conducted on the waste disposal area.

2.2 Landfill Gas Screening

The landfill gas screening program was conducted by Draper Aden Associates concurrent with the landfill cover depth verification. The attached landfill grid diagram (Figure 2) was utilized in determining appropriate gas sampling locations. All areas were initially identified on the site plan, and gridded off on 100 foot centers. Based on the initial gas sampling plan, there were 114 grid nodes for sampling. However, upon arrival at the site, and discussions with landfill operation, it was recognized that it would not be feasible to sample active fill areas of the landfill. As a result, 31 grid node points were eliminated from the survey leaving a total of 83 sampling points. Using compass bearings, and recognizable physical features of the site, the grid was laid out across the existing fill area. This included both the sanitary fill and demolition fill areas. Stakes were driven at each grid note point for later reference. The relative accuracy of the sampling points should be considered to be roughly ± 20 feet in any direction.

After locating the sampling grid note points, the initial gas screening program was begun using a Geotechnical Instruments Limited infra-red gas analyzer. This instrument is designed to obtain accurate data on the concentrations of the main constituents of landfill gas; methane, carbon dioxide, and oxygen. It includes an internal sampling pump which draws gas samples through an attached sampling hose. The instrument is accurate to ± ½ of a percent by volume methane, ½ of a percent by volume carbon dioxide, and 1% by volume oxygen. The relative accuracy decreases by a factor of 2 as the upper explosive limit is reached.



Draper Aden Associates
CONSULTING ENGINEERS
Blacksburg, VA – Richmond, VA – Nashville, TN

WATAUGA COUNTY LANDFILL GRID DIAGRAM

JOB No.	DATE:	SCALE:	FIGURE
6520-14	10/20/94	1"=100' PRIOR TO REDUCTION	2

Because of the relatively high wind conditions on the exposed surface of the landfill, it was decided that a wind protected sample would be collected at each grid note point. To effect this, a plastic 2.5 gallon bucket was attached to the end point. Each sampling station was occupied for between 30 seconds and 2 minutes in order to allow the instrument to stabilize on a reading. In addition, the instrument was periodically field calibrated to assure accuracy. At grid nodes where cover validations were made, the soil gas screening was conducted over the cover validation probe hole.

The results of the initial gas screening indicated no methane production at the approximately 83 sampling points. In addition, no carbon dioxide production was measured. Oxygen by percent volume in the atmosphere varied approximately three tenths of 1%. At no time did oxygen percent by volume decrease to a level below 20.8 percent. The conclusions drawn from this initial gas survey are that methane or other volatile gas production does not appear to represent a significant human hazard at or near the landfill at this time.

2.3 Assessment Groundwater Monitoring Well Installation

Fourteen (14) additional assessment monitoring wells were installed at the site as proposed in the Assessment Plan for the delineation of the horizontal and vertical extent of the contaminant plume(s). Locations of all the assessment monitoring wells are presented on the Vicinity Map (Figure 1) and on the Groundwater Potentiometric Map (Figure 5). A summary of the completion data for each assessment well is presented in Table 1A.

Three (3) of the proposed additional assessment wells, MW-5, MW-6, and MW-7, were installed in August, 1992, along the topographic divide between the Bolick site and the landfill waste disposal area (originally designated PZ-19, PZ-24, and PZ-25).

Eleven (11) of the additional assessment wells, MW-7 through MW-18, were recently installed in January and February, 1994 after approval by the NCDEHNR Solid Waste Section. Three (3) of these additional assessment wells are located adjacent to the waste disposal area, six (6) are located beyond the landfill property boundary, and two (2) are located along the landfill property boundary.

2.3.1 Assessment Monitoring Well Location Revisions

The relocation of five (5) of the proposed additional assessment monitoring wells (MW-12, MW-13, MW-14, MW-15, and MW-18) was necessary due to the proposed rerouting of U.S. Highway 421, which is scheduled for construction over the next several years. The construction right-of-way for the proposed route 421 bypass would have directly impacted the original locations for these five (5) proposed assessment monitoring wells likely requiring their premature abandonment.

TABLE 1A

Watauga County Landfill, Monitoring Well Completion Data

All measurements are in feet and elevations are in feet above sea level.

Well No.	Ground Elevation	Casing Elevation	SWL Elevation	SWL*	Total Depth*	Screen Length Depth Inverval**	Filter Packing Depth Intervall**	Annular Seal Depth Interval**	Screened in Soil or Bedrock
MW-1	3339.03	3341.80	3305.37	36.43	76.65	80.0 - 70.0	85.0 - 48.0	48.0 - 46.0	Bedrock
MW-2	3151.24	3152.94	3146.34	6.60	177.50	180.0 - 168.0	185.0 - 168.0	168.0 - 166.0	Bedrock
MW-3	3182.25	3183.12	3165.34	17.78	39.60	42.0 - 32.0	42.0 - 30.0	30.0 - 28.0	Soil
MW-4	3150.06	3152.52	3142.18	10.34	29.40	32.0 - 22.0	32.0 - 21.0	20.0 - 18.0	Soil
MW-5	3263.81	3267.69	---	Dry	73.00	73.0 - 61.0	73.0 - 61.0	61.0 - 59.0	Bedrock
MW-6	3262.55	3266.04	3222.91	43.13	58.00	58.0 - 46.0	58.0 - 46.0	46.0 - 44.0	Bedrock
MW-7	3270.56	3273.53	3250.70	22.83	50.00	50.0 - 40.0	50.0 - 38.0	38.0 - 36.0	Bedrock
MW-8	3235.39	3239.77	3223.81	15.96	67.00	63.0 - 53.0	63.0 - 51.0	51.0 - 49.0	Bedrock
MW-9	3356.65	3359.23	3300.18	59.05	86.40	84.0 - 74.0	84.0 - 72.0	72.0 - 70.0	Bedrock
MW-10	3202.18	3203.87	3195.97	7.90	70.03	68.0 - 58.0	68.0 - 56.0	56.0 - 54.0	Bedrock
MW-11	3156.44	3159.60	3145.86	13.74	25.80	23.0 - 13.0	23.0 - 11.0	11.0 - 9.0	Soil
MW-12	3156.82	3159.15	3148.01	11.14	72.75	70.0 - 60.0	70.0 - 58.0	58.0 - 56.0	Bedrock
MW-13	3117.39	3119.72	3100.23	19.49	31.65	29.0 - 19.0	29.0 - 17.0	17.0 - 15.0	Soil
MW-14	3117.00	3120.09	3112.44	7.65	71.00	69.0 - 59.0	69.0 - 57.0	57.0 - 55.0	Bedrock
MW-15	3117.15	3120.65	3108.55	12.10	178.65	176.0 - 166.0	176.0 - 163.0	163.0 - 161.0	Bedrock
MW-16	3141.42	3142.72	3137.49	5.23	26.80	24.0 - 14.0	24.0 - 12.0	12.0 - 10.0	Soil
MW-17	3181.14	3183.62	3166.13	17.49	94.54	93.0 - 83.0	93.0 - 81.0	81.0 - 79.0	Bedrock
MW-18	3117.12	3119.63	3101.88	17.75	73.20	70.0 - 60.0	70.0 - 58.0	58.0 - 56.0	Bedrock

* as recorded from top of outer protective well casing on May 12, 1994.

** as recorded from ground elevation.

Survey by Draper Aden Associates on September 10, 1992 and February 15, 1994.

TABLE 1B

Watauga County Landfill, Bolick Site, Summary of Piezometers

All measurements are in feet and elevations are in feet above sea level.

Piezometer No.	Ground Elevation	PVC Casing Elevation	SWL Elevation	SWL*	Total Depth**	Screen Length Depth Interval**	Filter Packing Depth Interval**	Annular Seal Depth Interval**	Completed in Soil or Bedrock
PZ-13	3195.05	3198.33	3183.84	14.49	26.0	26.0-21.0	26.0-19.0	19.0-17.0	Soil
PZ-14	3214.80	3217.80	3204.25	13.55	25.5	25.5-20.5	25.5-18.5	18.5-16.5	Soil
PZ-17	3217.62	3220.79	3207.43	13.36	20.5	20.5-15.5	20.5-13.5	13.5-11.5	Soil
PZ-18	3233.60	3236.02	3221.44	14.58	50.0	50.0-35.0	50.0-33.0	33.0-28.0	Bedrock
PZ-18A	3233.95	3236.86	3221.11	15.15	25.0	25.0-20.0	25.0-18.0	18.0-16.0	Soil
PZ-22	3205.60	3208.84	3196.97	11.87	26.0	26.0-21.0	26.0-19.0	19.0-17.0	Soil
PZ-23	3221.74	3225.27	3205.84	19.43	36.5	36.5-31.5	36.5-28.5	28.5-17.0	Bedrock

* as recorded from top of PVC on May 12, 1994

** as recorded from ground elevation

Survey by Draper Aden Associates, September 10, 1992

The approximate location of the section of the proposed U.S. Highway 421 bypass and construction right-of-way that would have impacted the original proposed assessment monitoring well locations is presented in Figure 3. The Bypass Map (Figure 3) depicts the plume assessment monitoring well locations, as revised for the highway.

Location Revisions along Rocky Branch

Revised assessment monitoring well locations along Rocky Branch include MW-14 and MW-15.

The revised location for both MW-14 and MW-15 is northwest of the crossing of the proposed U.S. Highway 421 bypass across the landfill tributary of Rocky Branch and south of Rocky Branch. These two (2) wells are screened within the fracture aquifer system. The revised locations maintain the intent of the original proposed locations by providing two (2) additional fracture aquifer assessment wells, to delineate both the horizontal and vertical extent of contaminants within the bedrock fracture aquifer system, previously identified at MW-2.

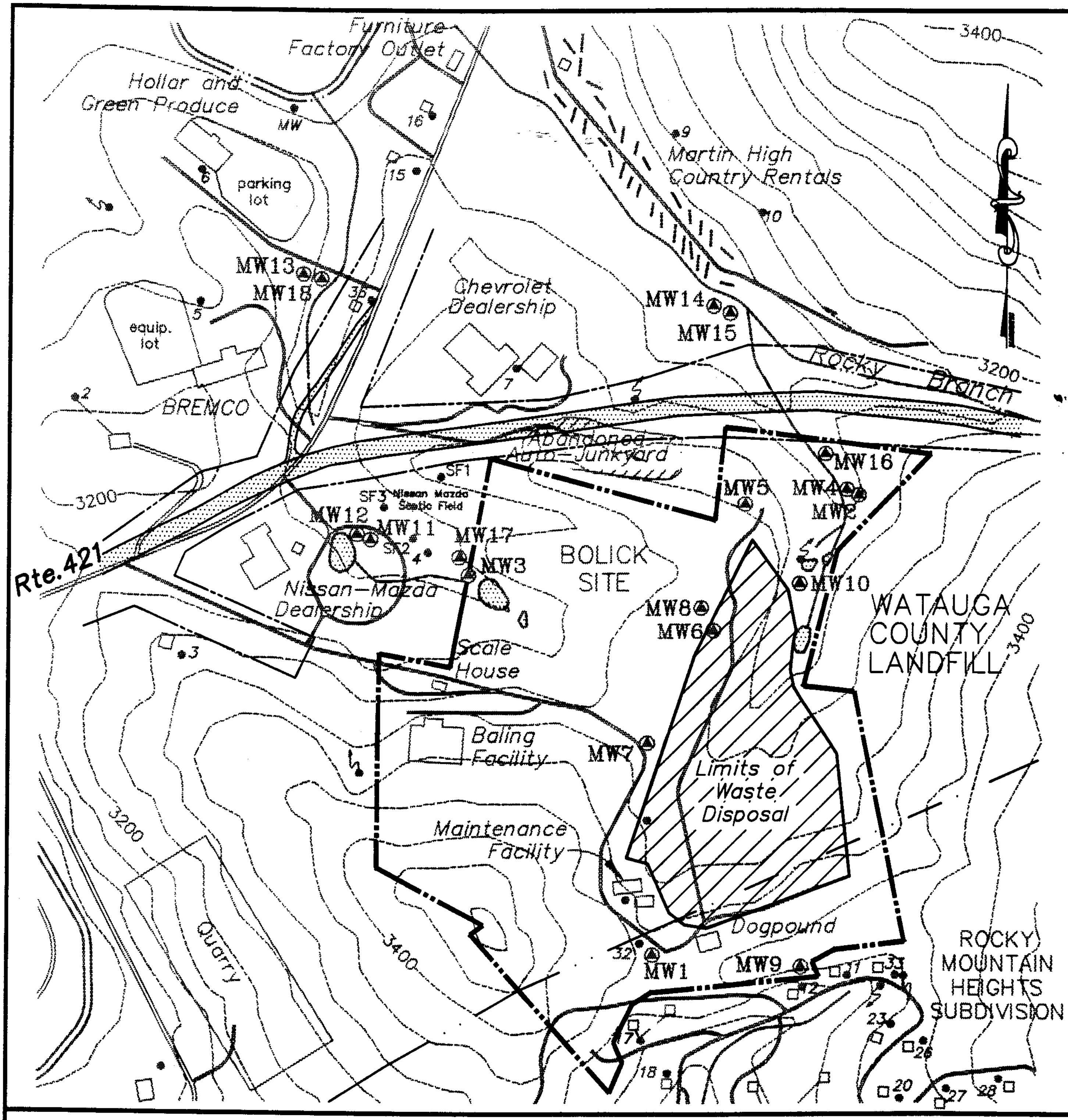
The screen interval of MW-14 is placed at a depth that coincides with the base of a weathered mica schist aquifer found at this location. Substantial water production was encountered during drilling within this bedrock zone. MW-15 is screened within a fracture system that coincides with the fracture zone assessed by MW-2. Both wells are screened to access a fracture system within a competent amphibolite/hornblende gneiss occurring at approximately 170 feet to 172 feet in depth. Monitoring of domestic wells accessing the fracture system below this location do not suggest that contaminants will be detected beyond the revised well locations.

Location Revisions below the Bolick Site (northwest drainage)

Revised assessment monitoring well locations below the Bolick site, along the northwest drainage, include MW-12, MW-13, and MW-18.

The revised location for MW-12 involved moving the original proposed location south of the proposed U.S. Highway 421 bypass. The revised locations for MW-13 and MW-18 involved moving the original proposed locations north of the proposed U.S. Highway 421 reroute. The revised locations for MW-13 and MW-18 are immediately south of the Hollar and Green Produce access road, as well as adjacent and west of the tributary draining the Bolick site.

The revised locations maintain the intent of the original proposed locations by providing two (2) monitoring wells, MW-11 and MW-13, to delineate the horizontal extent of the contaminant plume within the soil aquifer below the Bolick site and two (2) monitoring wells, MW-12 and MW-18, to delineate the horizontal extent of contaminants within the fracture system below the Bolick site. Contaminants have previously been detected within the soil aquifer below the Bolick site at MW-3. Contaminants have previously been detected within the fracture aquifer system below the Bolick site at the Nissan-Mazda dealership's production well.



3200 Existing Ground

Proposed Right-of-Way

Proposed Road Improvements

PROPOSED ROUTE 421 BYPASS MAP

Draper Aden Associates CONSULTING ENGINEERS Blacksburg, Va. – Richmond, Va. – Nashville, Tenn.	JOB No.	DATE:	SCALE:	FIGURE
	6520-14	10 JUN 94	1"=600'±	3

Location Revisions Below the Bolick Site (cont.)

Two (2) previous potable well sampling events identified the Boone Nissan-Mazda dealership's production well (well reference no. 4) to be significantly contaminated (presented in Table 3). The locations of MW-12 and MW-18 are designed to access the core fracture system zone below the Bolick site and the Nissan-Mazda dealership's production well as determined by fracture trace analysis. MW-12 and MW-18 are located a sufficient distance apart to account for potential fast flow rates that may be transporting contaminants along this preferential flow path.

The Nissan-Mazda dealership's production well is 204 feet in depth and encountered significant water production zones at 70 feet (20 gpm) and again at 175 feet (25 gpm) as indicated by the driller's well record. MW-12 and MW-18 are screened at a depth that coincides with the first substantial water production zone encountered. This allows the assessment monitoring well screen to be located in the aquifer domain closest to the known contaminant domain.

The Nissan-Mazda dealership's septic drain fields are located on the hillside immediately north of the Nissan-Mazda dealership's production well. Three (3) monitoring wells exist below the Bolick site that were installed by the dealership for the purpose of monitoring the portion of the soil aquifer potentially impacted by the dealership's septic drain fields. The location of the septic system suggests that septic effluent may be potentially impacting the potable well system. Liquid samples were obtained on April 29, 1993 from the Nissan-Mazda Dealership's septic system to investigate potential impacts on the Nissan-Mazda Dealership's potable well system. Sampling was performed by the Appalachian District Health Department and the NCDEHNR Solid Waste Section. Sample analysis was performed by the N.C. State Laboratory of Public Health.

Twenty-two (22) organic compounds were detected in septic effluent obtained from the Nissan-Mazda Dealership's septic system, comprised of chlorinated hydrocarbons, phenols, toluene, xylenes, benzene and substituted benzenes, napthelene and substituted napthelenes, phthalates, acetone and other related hydrocarbon compounds. Many of the compounds detected in the Nissan-Mazda Dealership's potable well are similar to either compounds found in the septic waste stream and/or transformation products of these septic waste stream compounds. The integrity of the well heads for additional landfill assessment wells, MW-11, MW-12, MW-13 and MW-18, may also be significantly compromised by the influence of potential drainfield contaminants.

2.3.2 Final Assessment Monitoring Well Locations

All other additional proposed assessment monitoring wells were installed at the approximate locations and anticipated depths as originally proposed in the Assessment Plan.

Locations Adjacent to the Disposal Area

Three (3) of the proposed assessment monitoring wells, MW-5, MW-6, and MW-7, were previously installed along the topographic divide separating the Bolick site from the waste disposal area during the initial Bolick site investigation in August of 1992. These wells were previously sampled during the initial Bolick site investigation and provided data useful in delineating contaminant plume concentration isopleths. Monitoring wells MW-5, MW-6, and MW-7 assess the fracture system aquifer at total depths of 50 feet, 58 feet, and 73 feet, respectively. The intent of the placement of the well screens for these three (3) wells was to tap the uppermost groundwater producing fracture regardless of total water production. None of the three (3) wells located along the topographic divide encountered groundwater above bedrock.

The additional assessment monitoring well MW-8 is located, as originally proposed, along the topographic divide separating the Bolick site from the waste disposal area, as indicated in Figure 1. The purpose of the additional well is to access a deeper, more productive fracture zone than that accessed by MW-7. The potential exists for preferential migration pathways to exist below the fractures accessed by the wells currently installed along the divide. The additional well installed along the divide will attempt to identify deeper fracture zones coinciding with the base grade of the adjacent fill that may be facilitating contaminant transport (i.e. approximate depth of 70 feet).

Assessment monitoring well MW-9 is located, as originally proposed, adjacent to the waste disposal area on the opposite side of the landfill drainage (as indicated in Figure 1), for the purpose of monitoring potential groundwater flow entering the Rocky Mountain Heights Subdivision. This well location is located immediately adjacent to the Carroll residence well (well reference no. 12). Two (2) previous residential potable well sampling events identified the Carroll residence well as significantly contaminated (presented in Table 3). MW-9 was drilled to attempt to access the same fracture system as the Carroll well at approximately 80 feet in depth.

The residential well sampling program has continued to be conducted within the Rocky Mountain Heights Subdivision to assess the risk to the residents and further investigate the source, nature and extent of groundwater contamination in the subdivision. Currently, the Carroll well is the only well within the Rocky Mountain Heights Subdivision that has shown significant signs of contamination. Several wells have shown trace levels of some of the same common contaminants detected in the groundwater beneath the landfill and several wells have shown trace levels of contaminants not detected in the groundwater beneath the landfill. At this time confirmation of the source of these trace level detections of contaminants is not available. Current and future residential well sampling results will be utilized to further assess potential plume migration within the subdivision. If future landfill and residential sampling and analysis results determine that significant contamination has potentially migrated into the Rocky Mtn. Heights area, current methods of plume characterization (i.e. installation of additional monitoring wells) will be re-evaluated.

Another additional assessment monitoring well located adjacent to the waste disposal area is monitoring well MW-10. MW-10 is located immediately downgradient of the fill area (as indicated in Figure 1). The two wells, MW-2 and MW-4, of the original groundwater monitoring network, monitor the groundwater flow path in this NE drainage, but are located approximately 400 feet away from the waste disposal area. MW-10 will provide groundwater quality data that will allow for further evaluation into source, transportation and migration rates, and fates of previously identified contaminants. Monitoring well MW-10 is screened at the first hydraulically conductive bedrock fracture zone encountered during drilling at approximately 59 feet in depth.

Locations along the Landfill Property Boundary

Two (2) additional assessment wells are located at the facility property boundary. Monitoring well MW-17 is located below the Bolick site and monitoring well MW-16 is located along the tributary of Rocky Branch.

Assessment monitoring well MW-17 is screened within the first significant water production zone encountered during drilling within the bedrock at approximately 88 feet in depth. The existing well monitoring the preferential flow path at this location, MW-3, is screened within the soil interval.

Assessment monitoring well MW-16, located at the facility property boundary along the tributary of Rocky Branch, is screened within the surficial soil aquifer. MW-4 of the current Watauga County Landfill Groundwater Monitoring Well Network is located at the facility property boundary, within the soil aquifer, along the Rocky Creek tributary. The intent of the additional soil aquifer assessment well is to further delineate the horizontal extent of the contaminants within the soil aquifer identified at MW-4.

2.3.3 Well Drilling and Installation

Previously Installed Assessment Monitoring Wells

The three (3) previously installed assessment monitoring wells, MW-5, MW-6, and MW-7, were drilled and constructed by Engineering Tectonics under the observation of Draper Aden Associates' geologist in August, 1992. Engineering Tectonics utilized a 6-inch air rotary hammer to drill the borings and Draper Aden Associates' geologist compiled boring logs from the returns observed at the surface.

MW-5, MW-6, and MW-7 were constructed using 2-inch schedule 40 polyvinyl chloride (PVC) monitoring well pipe, including a 0.01-inch factory slotted 10-foot screen with bottom plug. A filter pack of clean quartz sand (#2 well gravel) was poured around the screen interval, extending two feet above the screen slots. A two foot bentonite seal was placed above the filter pack and the remaining annulus of the well was filled with a 5% by volume mixture of Type I Portland cement grout and bentonite power. Locking steel casings and a 6-foot square concrete pad were recently installed to complete the construction of MW-5, MW-6, and MW-7 and meet monitoring well construction requirements of the NCDEHNR Solid Waste Section.

Recently Installed Assessment Monitoring Wells

Seven (7) of the recently installed assessment monitoring wells (i.e. MW-8, MW-9, MW-11, MW-12, MW-13, MW-17, and MW-18) were drilled and constructed by Groundwater Protection under the observation of Draper Aden Associates' geologist in January, 1994. Four (4) of the recently installed assessment monitoring wells (i.e. MW-10, MW-14, MW-15, and MW-16) were drilled and constructed by Bedford Environmental Well Drilling, also under the observation of Draper Aden Associates' geologist in February, 1994.

Groundwater Protection utilized a 8.25-inch ID hollow stem auger for the drilling of the monitoring wells installed in soil (i.e. MW-11, MW-13) and 8.25-inch and 6-inch diameter air rotary hammers for the drilling of the monitoring wells installed in bedrock (ie. MW-8, MW-9, MW-12, MW-17, and MW-18). Bedford Environmental Well Drilling utilized a 10-inch air rotary tri-cone bit and/or a 6-inch diameter air rotary hammer for the drilling of monitoring wells MW-10, MW-14, MW-15, and MW-16.

Groundwater Protection performed initial attempts to drill borings for MW-10 and MW-15, but was unsuccessful in providing adequately cleaned borings of sufficient depth for proper well installation. The resulting abandoned boreholes were refilled with a 5% by volume mixture of Type I Portland cement grout and bentonite powder. A tremmie tube was used to emplace the grout from the bottom of the borehole to the top. The bentonite prevents the grout mixture from shrinking after curing, and thus provides a good seal in the borehole to prevent possible paths of surface water contamination, and subsurface leachate contamination migration.

Bedford Environmental Well Drilling successfully drilled and installed MW-10 and MW-15 utilizing a 10-inch diameter air rotary tri-cone bit to drill to competent bedrock, followed by the installation of tremmie grouted 6-inch ID steel casing. A 6-inch diameter air rotary hammer was utilized to complete the borings to the desired total depths.

Recently installed monitoring wells MW-8 through MW-18 were constructed using 2-inch schedule 40 polyvinyl chloride (PVC) monitoring well pipe, including a 0.01-inch factory slotted 10-foot screen section with bottom plug. A filter pack of clean quartz sand (#2 well gravel) was tremmied around the screen interval, extending two feet above the screen slots, and bentonite chips, tremmied extending at least 2-feet above the filter packing, seals the well intake. The remaining annulus of the well was filled with a 5% by volume mixture of Type I Portland cement grout and bentonite power by tremmie method. A locking steel protective casing covers the wells, and a 6-foot square concrete pad provides a protective base for sample collection activities.

Monitoring well completion data is summarized in Table 1. The monitoring well boring and completion logs are contained in Appendix I.

2.3.4 Well Development

The three (3) previously installed assessment monitoring wells, MW-5, MW-6, and MW-7, were developed by Draper Aden Associates personnel soon after installation using a Grundfos submersible pump to surge and rapidly purge the wells to remove free sediments from the filter pack and inside of the well casing.

The eleven (11) assessment monitoring wells recently installed were developed by Draper Aden Associates personnel prior to aquifer testing and dedicated pump installation. Development procedures utilized a Grundfos submersible pump to surge and rapidly purge the wells to remove free sediments from the filter pack and inside of the well casing. Each of the assessment monitoring wells was developed until the water residing in the well appeared clear and silt-free.

2.3.5 Dedicated Pump Installation

Dedicated pumps were installed in the landfill groundwater assessment monitoring well network to eliminate the need for equipment blank analysis and prevent the chance of cross contamination during each sampling event. Grundfos Redi-Flo 2 dedicated submersible electric impeller-driven, TEFLON and stainless steel groundwater sampling pumps were installed in all but one of the eighteen (18) assessment wells. Assessment well MW-7 will be purged and sampled utilizing disposable bailers due to the low recharge rates observed in the fracture system assessed by this well.

Instrumentation Northwest, Inc. assembled and supplied the seventeen (17) dedicated pump systems, comprised of the following components:

- 2-inch Grundfos Redi-Flo 2 stainless steel and TEFLON, submersible electric propeller-driven pump;
- Teflon sealed, stainless steel check valve (situated one foot above pump)
- TEFLON-coated (inner diameter) Polyethylene discharge tubing bounded to motor lead;
- Bounded 316 stainless steel support cable and support cable bracket;
- 2-inch and 4-inch non-locking, aluminum and stainless steel slip-cap well seals as appropriate;
- TEFLON-coated (inner diameter) surface discharge tubing (3 feet lengths per well);
- 220 Volt converter control box.

To insure the integrity of the dedicated pump systems, an initial field blank was collected from the dedicated pump system installed in monitoring well MW-11 prior to installation. This dedicated pump system field blank was collected utilizing a decontaminated four-inch diameter pvc riser and bottom cap filled with de-ionized, distilled water. The field blank was analyzed for volatile organic compounds (EPA SW-848 Method 8240) and the fourteen (14) assessment metal constituents.

Preliminary review of the field blank analyses indicates the detection of Acetone at a concentration of 5.06 ppb and 1,2-Dichloroethane at a concentration below the method quantification limit estimated at 1.90 ppb. The detection of these two compounds is under investigation, noting the Grundfos Redi-flo-2 dedicated pump is approved by the EPA and commonly used to sample groundwater for volatile organic analysis. Draper Aden Associates and the distributor of the dedicated pump system are currently investigating whether these contaminants are trace residues of the pump manufacturer's cleaning process or a persistent byproduct of a component of the pump system. The potential also exists that these contaminants may be laboratory derived.

2.4 TCLP Analysis and Handling of Drill Cuttings

The drill cuttings from the eleven plume assessment wells recently installed at the Watauga County Landfill were contained and collected on plastic during drilling. The drill cuttings were then moved to a concrete pad located next to the landfill maintenance facility, utilizing both 55 gallon drums and a landfill loader bucket, and placed under plastic. Locations of individual monitoring well drill cuttings were maintained on the concrete pad in order to allow identification, sampling, and handling of individual stockpiles.

Toxicity characterization testing, utilizing the SW-846 Method 1311 Toxicity Characteristic Leachate Procedure (TCLP), was performed on a sample from the drill cutting stockpile identified as the most likely to contain elevated levels of contaminants. The TCLP testing indicates the drill cuttings sample to be nonhazardous. The TCLP analytical results indicate contaminant levels below method detection limits for most analytes and far below

Federal regulatory levels established for hazardous waste for the four (4) detected analytes. The TCLP analytical results are contained in Appendix II and discussed further below.

Sampling and toxicity characterization testing was conducted on the drill cutting stockpile from monitoring well MW-8. Previous contaminant plume characterizations, as well as air monitoring results obtained during drilling indicated the drill cuttings from MW-8 as the most likely to contain elevated levels of contaminants.

The TCLP analysis of the drill cuttings sample only detected one metal and three (3) volatile organic compounds above method detection limits. Barium was detected at 1.8 mg/l. This level is far below the Federal regulatory level for hazardous waste (40 CFR 261 established limit) of 100 mg/l. Chloroform, 1,1-Dichloroethylene, and Trichloroethylene were detected at 0.038 mg/l, 0.033 mg/l, and 0.025 mg/l, respectively. Again, these volatile organic compound levels are far below the federal regulatory levels for hazardous waste of 6.0 mg/l, 0.7 mg/l, and 0.5 mg/l, respectively. No other compounds were detected.

Draper Aden Associates requested, on behalf of Watauga County, approval from the NCDEHNR Solid Waste Section for the handling of drill cuttings from the eleven plume assessment monitoring wells recently installed at the Watauga County Landfill. The low levels of the four (4) compounds detected in the TCLP analysis of the drill cuttings sample do not warrant special disposal considerations. The NCDEHNR Solid Waste Section approved incorporating the drill cuttings in the closure cap subbase grade for the waste disposal areas of the Watauga County Landfill. Solid waste is no longer currently being disposed at the Watauga County Landfill and initial closure activities are currently underway.

2.5 Health and Safety Monitoring Program

An extensive health and safety program was conducted concurrent with all initial assessment field activities to assure that safe working conditions are maintained at the site. Appendix II of the Assessment Plan, the Health and Safety Plan (HASP), details the health and safety measures established to mitigate potential site physical and chemical hazards. The health and safety program incorporates site control, decontamination procedures, personal protective equipment, air monitoring activities, and other associated measures to protect assessment workers on site.

Air Monitoring

Air monitoring conducted during invasive drilling activities incorporated continuous real-time air monitoring utilizing a Photo Ionization Detector (PID) and Lower Explosive Limit (LEL) meter as well as the collection of gas/vapor Draeger detector tubes, personal charcoal filter tube air samples, and well bore ambient air samples.

The results obtained from the continuous real time air monitoring were utilized to guide initial personal protective equipment applications. PID and LEL readings were compared with the exposure criteria for all suspected contaminants established by the Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH). Exposure criteria levels for all suspected contaminants is listed in Attachment B of the Health and Safety Plan. When the real-time air monitoring indicated exposure levels exceeding the exposure criteria, personal protective equipment was upgraded appropriately as outlined in the Health and Safety Plan.

Real-time air monitoring indicated a non-explosive volatile spike occurred when the groundwater interface was reached during the drilling of the first monitoring well, MW-8. Corroborating air sampling, utilizing a combination of detection methods (i.e. Draeger tubes, personal charcoal filter tubes, and ambient well bore air samples), was unsuccessful in capturing and/or characterizing the spike indicated by the PID air monitoring. Extreme high moisture levels combined with the low ambient temperatures experienced during the drilling of MW-8 may have influenced the PID spike (16 ppm) observed when the groundwater interface was reached.

Personal protective equipment (PPE) was upgraded from the base level D when real time air monitoring indicated that airborne contaminants may have exceeded exposure criteria at the MW-8 well location. The PPE upgrade to level 'C' primarily involved utilizing an air-purifying respirator with organic vapor/acid gas-hepa cartridges and additional outerwear upgrades. The level C upgrade was maintained until the analytical results were obtained from corroborative air sampling indicating the nondetection of suspected contaminants. Continued real time air monitoring and corroborative air sampling conducted during the remainder of the drilling project did not indicate further exceedences of exposure criteria.

All of the combined gas/vapor Draeger detector tube, personal charcoal filter tube, and ambient air sampling and analyses collected during the recent assessment drilling project resulted in the nondetection of all suspected analytes. Personal charcoal filter tube and ambient air sampling and analyses results as well as real-time air monitoring and draeger tube analyses field notes are contained in Appendix III.

Gas/vapor Draeger Detector Tube Analysis

Gas/vapor Draeger detector tubes were collected during invasive drilling activities when the PID indicated potentially elevated gas/vapor levels. The four (4) gas/vapor analyte Draeger detector tubes utilized for the corroborative air sampling program are listed below.

Carbon Tetrachloride (CCl_4)
Chloroform ($CHCl_3$)
Benzene
Vinyl Chloride

The analytes for these four (4) gas/vapor Draeger detector tubes have relatively low established exposure criteria. The PID spike, observed during the drilling of MW-8 when the groundwater interface was reached, indicated the potential exceedance of the exposure criteria of these four (4) compounds. As indicated in the HASP air monitoring field notes (Appendix III), all of the gas/vapor Draeger tube testing resulted in the nondetection of these four (4) suspected volatile organic compounds.

Personal Charcoal Filter Tube Analysis

Personal charcoal filter tube air samples were collected during the drilling of each assessment monitoring well and analyzed for the eight (8) suspected volatile organic compounds with lower established exposure criteria. The PID spike, observed during the drilling of MW-8 when the groundwater interface was reached, indicated the potential exceedance of the exposure criteria for these eight (8) compounds. The eight (8) volatile organic compound analytes and respective test methods utilized to analyze the personal charcoal tube filter samples are listed below.

Carbon Tetrachloride (CCl_4)	NIOSH Method 1003
Tetrachloroethene (PCE)	NIOSH Method 1003
1,1-Dichloroethane (1,1-DCE)	NIOSH Method 1003
Chloroform ($CHCl_3$)	NIOSH Method 1003
1,1,1-Trichloroethane (1,1,1-TCA)	NIOSH Method 1003
Benzene	NIOSH Method 1501
Trichloroethene (TCE)	NIOSH Method 1022
Vinyl Chloride	NIOSH Method 1015

All of the personal charcoal filters tube air sample analyses (Appendix III) resulted in the nondetection of the eight (8) suspected volatile organic compounds.

Well Bore Ambient Air Analysis

Two (2) well bore ambient air samples were collected in Tedlar bags from the upper and lower head space of monitoring well MW-8 and analyzed for volatile organic compounds utilizing EPA SW-846 Method 8240. The analytical results from the well bore ambient air samples (Appendix III) did not indicate an exceedance of exposure criteria. It was noted that one confirmed (methylene chloride) and two (2) tentatively identified (hexane and 1,1,2-trichloro-1,2,2-triflouroethane) common laboratory solvents were detected. Methylene chloride and hexane were also detected in the laboratory blank.

2.6 Geologic and Hydrogeologic Investigations

Geohydrologic mapping of the Watauga County Landfill and vicinity was refined from the previous Assessment Plan mapping by utilizing information gained through recent drilling and site reconnaissance. The following discussion summarizes the refined geohydrologic model of the site. Primary discussion of the site geohydrology is contained in the Assessment Plan.

2.6.1 Geology

Geologic Formation Contacts

Geologic formations encountered during the drilling of the additional eight (8) bedrock assessment wells generally agree with expected formations as depicted on the geologic map compiled by Bryant and Reed (1970) and presented on Figure 5 of the Assessment Plan.

Rock encountered during the drilling of four (4) of the assessment wells recently installed in bedrock, MW-8, MW-9, MW-12, and MW-17, appears to be the rock assemblage referenced by Bryant and Reed as Lower Precambrian "mixed rocks" (p€m). The "mixed rocks" assemblage is a narrow band, less than one half mile wide, existing between a low grade layered cataclastic schist and gneiss and a tectonically overlying medium grade amphibolite and hornblende gneiss. The "mixed rocks" unit, as described by Bryant and Reed, consists of interlayered and intergrading amphibolite calc-silicate granofels, biotite-hornblende gneiss, hornblende-epidote-biotite gneiss, biotite-hornblende-plagioclase schist and gneiss, epidote-biotite-plagioclase schist and gneiss, and granitic gneiss ranging from quartz diorite to quartz monzonite.

Monitoring wells, MW-10 and MW-18, encountered the Lower Precambrian amphibolite and hornblende gneiss (p€a). These rocks tectonically overlie the "mixed rock" assemblage.

An exception to Bryant and Reed's generalized mapping was encountered in monitoring wells, MW-14 and MW-15, where approximately seventy (70) feet of the lower Precambrian biotite-muscovite schist and gneiss (p€ms) was encountered above the amphibolite and hornblende gneiss. The observed stratigraphic relationship refines Bryant and Reeds' mapping and is supported on the generalized cross section included on Figure 5 of the Assessment Plan and Figure 4 herein. Bryant and Reed's legend depict these two units as coexisting and Bryant and Reed provide the following statement as to why the two assemblages were not separated: the "mappable amphibolite units are intimately interlayered with the micaceous rocks" and the "mapping of contacts... is therefore extremely subjective in many areas". The presence of the biotite-muscovite schist and gneiss in the vicinity of monitoring well, MW-14 and MW-15 is supported as well by the Watauga County Soil Survey (USDA SCS, 1944), which depicts residual soils of weathered mica schist and gneiss in this vicinity.

A revised Vicinity Geology Map (Figure 4) is enclosed. The revised mapping incorporates information obtained from the recent drilling and site reconnaissance with information obtained from Bryant and Reed (1970) and the Watauga County Soil Survey (1944).

Refinements to Bryant and Reed's regional geologic mapping primarily involve the identification of pockets of biotite-muscovite schist and gneiss lenses existing above the amphibolite and hornblende gneiss. These micaceous lenses are preferentially distributed in the topographically low regions mapped as amphibolite and hornblende gneiss by Bryant and Reed (1970). Less prone to weathering and erosion relative to the mica schist and gneiss, the amphibolite and hornblende gneiss tend to occupy the topographical high areas of this region.

Alluvial deposits and residual micaceous soils are depicted on the Watauga County Soil Survey further to the north-northwest of the biotite-muscovite schist and gneiss, as depicted on the revised Geology Map. Recent reconnaissance failed to confirm the presence of the mica schist and gneiss bedrock further to the north-northwest of the biotite-muscovite schist and gneiss, as depicted on the revised Geology Map. Revisions to the geology map (Figure 4) avoided soil survey inferences which could not be verified in the field. The presence of these micaceous residual and alluvial soils suggest that further refinements of the geologic model may result from future study.

Fracture Trace Lineaments

Recent site reconnaissance and outcrop study documented the occurrence, nature, and orientations of fracture trace lineaments in local gneiss and schist bedrock assemblages.

The revised Vicinity Geology Map (Figure 4) depicts both the micro-textural and macro-textural linear features identified at the site. The micro-textural linear features observed at seven (7) site bedrock exposure locations are represented by strike and dip symbols. The macro-textural linear features of nine (9) site physiographic features are represented by trend symbols.

Two (2) primary lineament sets were observed at both the microtextural and microtextural scale. The major lineament set is oriented parallel with layering, lineation, and foliation trends at approximately N55°W. Layering and foliation lineaments dip approximately 45° NE. A minor lineament set is oriented parallel with fracture and joint trends at approximately N10°E and dips almost vertically at 80° to 85°SE.

Site physiographic features (microtextural) are directly related to the trends and orientation of mineral layering (microtextural) within the site bedrock. Layering within the "mixed rocks" (p€m) was produced by shearing of the migmatitic layering found in the underlying Cranberry Gneiss (p€c). The mixed rocks appear to be a gradation zone between migmatitic Cranberry Gneiss and the overlying schist, gneiss, and amphibolite and as such reflect characteristics of both. The most strikingly layered rocks are the most sheared. Conversely less sheared rocks are generally more granitic and have a migmatitic aspect (Bryant and Reed, 1970).

Northwest oriented site drainages developed over the most strikingly layered and sheared, schistose zones of the "mixed rocks". Northwest oriented site ridges developed over the more granitic zones of the "mixed rocks".

Drawing Under Seperate Cover

Recharge Sources

The upgradient recharge areas for the site aquifer media are comprised of Rocky Knob (approximate elevation 4000 ft.) to the east of the site and a smaller knob (approximate elevation 3500 ft.) to the southwest. Rocky Knob is the primary recharge source in the vicinity of the site. The Rocky Branch watershed is additionally recharged from the northeast by a northwest trending ridge (approximate elevation 3500 ft.). The approximate elevations of potentiometric surface of the aquifer media in the vicinity of the site range from 3100 ft. to 3305 ft.

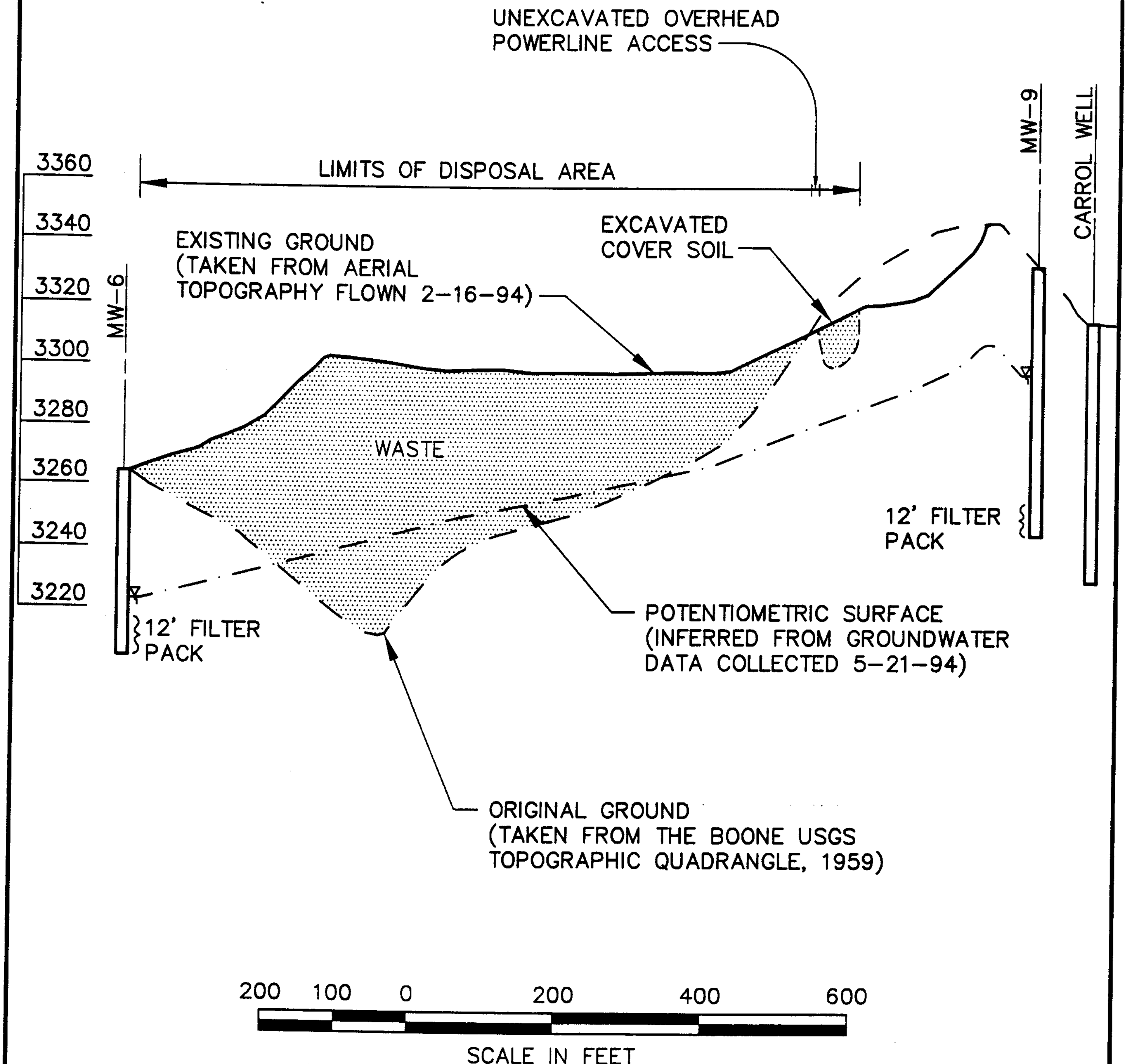
Along the base of Rocky Knob, discharge is expressed at the surface by the presence of springs along a northwest trending contact between the amphibolite/hornblende gneiss bedrock and the zone of "mixed rock" (Figure 5). A series of previously documented springs subsequently covered by landfill activities also follow this trend to the northwest.

Recharge to the springs at the base of Rocky Knob and recharge to the Rocky Mountain Heights subdivision is provided by the substantial upgradient area of Rocky Knob. The primary westward groundwater flow direction from Rocky Knob, and a subjugate topographic and hydraulic divide south of the landfill (Figure 5), likely inhibit flow from the north across the ridge separating the landfill from the Rocky Mountain Heights subdivision.

Per recommendations by the NCDEHNR, additional investigations will include sampling of the spring located at the base of Rocky Knob adjacent to the landfill (as described in Section 5.2 of this Activity Report). The spring to be sampled is located at the head of the drainage adjacent to the Carroll residence well (well reference no. 12) (Figure 5). The Carroll residence well is the only potable well in the Rocky Mountain Heights Subdivision identified as significantly impacted by volatile organic compounds.

The previously documented springs located beneath the landfill may be jointly recharged by both Rocky Knob and by the knob located to the southwest of the site. A spring capture outfall system was installed prior to waste disposal to pipe out the spring groundwater from beneath the waste. As outlined in Appendix I of the Assessment Plan, the spring capture outfall system is currently sampled semiannually as part of the assessment surface water sampling program.

As presented in the disposal area cross section (Figure 6), the potentiometric surface inferred between MW-6 and MW-9 could possibly be influenced by the spring capture outfall which may have failed, resulting in the doming of groundwater within the fill. An overhead power line traverses the upgradient, southern limits of the waste disposal area. An unexcavated area remains within the disposal area to support the transmission lines. Draper Aden Associates proposes to install a piezometer or monitoring well in the unexcavated area near the power line to provide addition potentiometric data and/or groundwater quality data between MW-6 and MW-9 to investigate potential mounding.



DISPOSAL AREA CROSS SECTION

WATAUGA COUNTY LANDFILL
WATAUGA COUNTY NORTH CAROLINA

Draper Aden Associates
CONSULTING ENGINEERS
Blacksburg, Va. – Richmond, Va. – Nashville, Tenn.

JOB No.	DATE:	SCALE:	FIGURE
6520–14	29 JUN 94	1"=200'	6

The paucity of leachate seeps year-round suggests that groundwater residing within the fill migrates into the underlying soil and bedrock aquifer(s) rather than direct discharge to the surface. Further study into leachate generation will involve discussions of historical leachate production with various landfill operators, as well as current site assessments. Leachate investigations will focus on determining the source, transport, and fate of water currently residing in the fill.

2.6.3 Aquifer Testing

A variety of aquifer tests were performed on the recently installed assessment monitoring wells to evaluate relative flow rates of each respective accessed aquifer medium. The approach applied to selecting appropriate aquifer test methods for various aquifer media is presented in the following section. The information derived from the aquifer testing is utilized to define the rate of groundwater flow within various fracture and soil aquifer media potentially impacted by landfill waste disposal activities. Aquifer test results support the flow regimes as presented in the previous section on site hydrogeology.

A summary of recent aquifer test results is presented on page 1 of Table 2. Aquifer test method calculations can be found in Appendix IV. A presentation of similar aquifer testing, performed on all previously installed monitoring wells and piezometers at the Watauga County Landfill, can be found in Section 3.1.8.1 of the Assessment Plan. A summary of aquifer test results from the previous aquifer testing is presented on page 2 of Table 2.

Aquifer Tests

Both slug (bail) tests and single-well recovery pump tests were performed initially. Test data and results were evaluated to determine the most appropriate method to utilize within specific aquifer mediums accessed by individual wells. After initial aquifer testing attempts, single-well recovery pump test methods were refined by tailoring pumping rates and durations to each individual well recovery rate. Slug test methods were refined by emphasizing either early or late data collection efforts. Test method refinements attempted to produce data that was more representative of individual aquifer media for method type-curve and straight line matching.

The Bouwer and Rice slug test method (Bouwer, 1989), applicable to unconfined systems, was utilized to calculate the hydraulic conductivity (K) from slug test data obtained from wells accessing the soil aquifer. The Cooper-Bredehoeft-Papadopulos slug test method (Cooper, et al, 1967), applicable here for confined systems, was utilized to calculate the transmissivity (T) and storage coefficient (S) from slug test data obtained from wells accessing the bedrock fracture system aquifer. The Theis recovery method (Theis, 1935) was utilized to calculate the transmissivity (T) and storage coefficient (S) from recovery pump test data obtained from all wells capable of sustaining sufficient pumping rates and purge durations. For the purpose of obtaining a comparative data set, transmissivity results were transformed to hydraulic conductivity (K) by dividing the transmissivity (T) by the well screen length. Aquifer thickness was taken to be the well screen length in hydraulic conductivity calculations under the assumption that the fracture bedrock production zone tapped by the well was unique, and provided all the recharge to the well.

TABLE 2
WATAUGA COUNTY LANDFILL ASSESSMENT
AQUIFER FLOW TESTING RESULTS SUMMARY

Monitoring Well	Filter Pack * Depth Interval (ft)	Aquifer Medium	Bouwer-Rice Slug Test	Cooper, Bredehoeft, Papadopulus Slug Test	Theis Recovery Test
MW-8	63.0 - 51.0	Layered Schist/Gneiss			T = 10.531 ft^2/day K = 0.877 ft/day
MW-9	84.0 - 72.0	Layered Schist/Gneiss			T = 2.379 ft^2/day K = 0.198 ft/day
MW-10	63.0 - 56.0	Amphibolite/ Hornblende Gneiss		T = 0.0322 ft^2/day K = 0.00268 ft/day	
MW-11	23.0 - 11.0	Soil			T = 78.235 ft^2/day K = 6.520 ft/day
MW-12	70.0 - 58.0	Layered Schist/Gneiss			T = 173.232 ft^2/day K = 14.436 ft/day
MW-13	29.0 - 17.0	Soil	K = 1.57E-04 cm/sec = 0.445 ft/day		
MW-14	69.0 - 57.0	Micaceous Schist/Gneiss			T = 141.926 ft^2/day K = 11.827 ft/day
MW-15	176.0 - 163.0	Amphibolite/ Hornblende Gneiss			T = 2.007 ft^2/day K = 0.154 ft/day
MW-16	24.0 - 12.0	Soil			T = 181.152 ft^2/day K = 15.096 ft/day
MW-17	93.0 - 81.0	Amphibolite/ Hornblende/Gneiss			T = 1.395 ft^2/day K = 0.116 ft/day
MW-18	70.0 - 58.0	Amphibolite/ Hornblende Gneiss			T = 190.656 ft^2/day K = 15.888 ft/day

T - Transmissivity
K = Hydraulic Conductivity

* as recorded from ground elevation

TABLE 2
WATAUGA COUNTY LANDFILL ASSESSMENT
AQUIFER FLOW TESTING RESULTS SUMMARY

Observation Well	Filter Pack* Depth Interval	Aquifer Medium	Bower - Rice Slug Test	Cooper, Bredehoeft, Papadopulos Slug Test	Theis Recovery Test
MW-1	85.0 - 48.0	Layered Schist/Gneiss			T = 27.36 ft^2/day K = 0.739 ft/day
MW-2	185.0 - 168.0	Amphibolite/ Hornblende Gneiss			T = 6.624 ft^2/day K = 0.390 ft/day
MW-3	42.0 - 30.0	Soil			T = 116.64 ft^2/day K = 9.72 ft/day
MW-4	32.0 - 21.0	Soil			T = 112.32 ft^2/day K = 10.21 ft/day
MW-5	73.0 - 61.0	Layered Schist/Gneiss			T = 1.28 ft^2/day K = 0.1445 ft/day
MW-6	58.0 - 46.0	Layered Schist/Gneiss			T = 1.872 ft^2/day K = 0.156 ft/day
MW-7	50.0 - 38.0	Layered Schist/Gneiss		T = 0.0086 ft^2/day K = .0007 ft/day	
PZ-13	26.0 - 19.0	Soil	K = 8.0222 ft/day		
PZ-14	25.5 - 18.5	Soil	K = 7.4557 ft/day		
PZ-17	20.5 - 13.5	Soil	K = 5.585 ft/day		
PZ-18	50.0 - 33.0	Layered Schist/Gneiss		T = 10.368 ft^2/day K = 0.610 ft/day	
PZ-18A	25.0 - 18.0	Soil	K = 0.165 ft/day		
PZ-22	26.0 - 19.0	Soil	K = 0.089 ft/day		
PZ-23	36.5 - 28.5	Layered Schist/Gneiss		T = 3.456 ft^2/day K = 0.432 ft/day	

T - Transmissivity
K = Hydraulic Conductivity

* as recorded from ground elevation

Evaluation of initial aquifer test results indicate that the single-well recovery pump test method was most robust for application to moderate and fast recovering wells and slug test methods were the most applicable to slow recovering wells. Table 2 provides the pump aquifer test results most representative of aquifer conditions, as chosen from the variety of tests performed. As previously noted, aquifer test results were chosen based on the ability of the test method to produce reliable method type-curve and straight line matching data.

The results from the conventional well-flow equations utilized for representing fracture flow rates (i.e. Cooper, Bredehoeft, Papadopulos slug test method and Theis recovery method) were developed for homogenous and isotropic aquifers and therefore may not describe fracture flow adequately. True fracture flow test methods will require prolonged (>2 days) pumping of the well and the existence and monitoring of several nearby nested well sets that also access the same fracture system. Prolonged, nested well pump tests may prove to be beneficial and cost effective after more information is attained during the plume assessment. The confined flow test methods were utilized primarily for comparison purposes and as such display the range of relative transmissivities existing within the various fracture systems.

Aquifer Test Results

Soil Aquifer Medium

Both the Bouwer and Rice slug test method and the Theis recovery method were analyzed to obtain hydraulic conductivity or transmissivity results from the three (3) assessment monitoring wells recently installed in the unconfined soil aquifer medium (i.e. MW-11, MW-13, and MW-16).

Well MW-13 exhibited slow recovery rates and was not capable of sustaining sufficient pumping rates and purge durations for obtaining proper, comparative recovery test data. Conversely, the recently installed soil aquifer well, MW-11, recovered too fast to provide useful slug test data with the field methods utilized. The Theis recovery method was chosen to calculate the transmissivity (T) from recovery data from both this fast recovering well, MW-11, and the moderately fast recovering well, MW-16.

The test results from the duplicate methods utilized for the moderately fast recovering well MW-16 exhibit the applicability of the Theis recovery method for faster recovering wells, when compared with the Bouwer and Rice slug test method. The calculated hydraulic conductivity from the Theis recovery method result was twice as fast (11.827 ft/day) than the Bouwer and Rice slug test method result (5.131 ft/day). The discrepancy between recovery pump test and slug test results increases with faster recovering wells. The increased accuracy and appropriateness of the recovery pump test method becomes apparent when necessary early-time slug test data is completely missed in the fast recovering wells and the comparative slug test result exhibit, in error, a relative decline in hydraulic conductivity.

As indicated in the final aquifer test result summary (Table 2), the calculated hydraulic conductivity for the slower recovering soil aquifer well (MW-13) was approximately 0.445 ft/day, compared with 6.520 ft/day (MW-11) and 15.096 ft/day (MW-16) for the faster recovering soil aquifer wells.

Amphibolite/Hornblende Gneiss Aquifer Medium

Both the Cooper-Bredehoeft-Papadopulus (C-B-P) slug test method and the Theis recovery method were utilized in initial attempts to calculate comparable transmissivity (T) from slug and pump test recovery data obtained from the four (4) assessment monitoring wells recently installed in the fractured amphibolite/hornblende gneiss aquifer medium (i.e. MW-10, MW-15, MW-17 and MW-18).

MW-10 exhibited slow recovery rates and was not capable of sustaining sufficient pumping rates and purge durations for obtaining proper, comparative recovery test data. Wells MW-15 and MW-17 exhibited slow to moderate recovery rates. Although the slug and recovery test method results compared favorably for MW-15 and MW-17, Theis single-well recovery pump test method results are presented in Table 2. It is generally recognized that the greater impact on the aquifer resulting from recovery pump test purge volumes produces more useful and accurate data for estimation pump of flow characteristics. Similarly, the Theis recovery method provided the most accurate and applicable data for the only well installed within the amphibolite/hornblende gneiss aquifer medium to exhibit fast recovery rates, MW-18.

As indicated in the final aquifer test result summary (Table 2), calculated hydraulic conductivity for the slower recovering amphibolite/hornblende gneiss aquifer well (MW-10) was approximately 0.0027 ft/day, compared with 0.154 ft/day (MW-15) and 0.116 ft/day (MW-17) for the slow to moderate, and 15.888 ft/day (MW-18) for the fast recovering amphibolite/hornblende gneiss aquifer well.

Layered Schist/Gneiss Aquifer Medium

Both the C-B-P slug test method and the Theis recovery test method were utilized in initial attempts to calculate comparable transmissivity (T) from slug and pump test recovery data obtained from the three (3) assessment monitoring wells recently installed in the layered schist/gneiss aquifer medium (i.e. MW-8, MW-9, and MW-12).

All three (3) of the wells installed in the layered schist/gneiss aquifer medium exhibited sufficient recovery rates to sustain pumping rates and purge durations necessary for obtaining proper recovery data. MW-9 exhibited slow to moderate recovery rates and the slug and recovery test method results compared rather favorably. Theis single-well recovery pump test results are presented in Table 2 in lieu of the slug test results for the reasons outlined previously. The applicability of the Theis recovery test for faster recovering wells was increasingly apparent with the moderate to fast recovering well MW-8 and the fast recovering well MW-12. MW-12 recovered too fast to provide useful slug test data.

As indicated in the final aquifer test result summary (Table 2), the calculated hydraulic conductivity for the layered schist/gneiss aquifer wells ranged from 0.198 ft/day (MW-9) to 0.877 ft/day (MW-8) to 14.436 ft/day (MW-12).

Micaceous Schist/Gneiss Aquifer Medium

The Theis single-well recovery pump test method was utilized to calculate the transmissivity (T) from recovery data obtained from well MW-14, recently installed in the micaceous schist/gneiss aquifer medium. Recovery in well MW-14 was too fast to provide useful slug test data.

As indicated in the aquifer test result summary (Table 2), calculated hydraulic conductivity for MW-14 was approximately 11.827 ft/day.

<u>Nested Well Test Observations</u>

The following three (3) sets of recently installed nested wells were observed during aquifer testing to determine the interconnectedness of the aquifer(s) at variable depths:

- MW-11 and MW-12
- MW-13 and MW-18
- MW-14 and MW-15

During purging of the deep well for each nested set, the water level in the adjacent shallow well was observed. Loss of groundwater elevation in the shallow well to the deeper portion of the aquifer being pumped via the deeper well, would indicate hydraulic communication in the aquifer.

Recovery rates found in the shallow nested wells MW-11 and MW-14, were much too fast to be impacted by the relatively short duration pumping (1½ hour) of the deeper nested well. Even the deep nested wells were capable of constant flow rates approaching 7 gallons per minute. Therefore, the inference provided by this observation is inconclusive and provides little actual indication as to the degree of interconnectedness at these aquifer depths.

Although the recovery rate found in the shallow nested well, MW-13, was relatively slow, the recovery rate of the deeper nested well, MW-18, was still too difficult to significantly overcome with the relatively short duration pumping (½ hour) of the recovery test. Nonetheless, a connection between the soil and bedrock aquifer was observed at the location of this nested well set. After pumping the bedrock aquifer at 3 gallons per minute for 18 minutes, the water level in the soil aquifer dropped 0.07 feet.

As indicated in the description of hydrogeologic conditions presented in section 2.6 of the Assessment Plan, the shared potentiometric surface of the various aquifer media suggest that these aquifer zones are interconnected by hydraulically conductive fractures, joints, and/or shear zones. Comparison of the individual potentiometric surfaces of the nested wells and piezometers indicate that groundwater from the fracture system is discharged to the soil aquifer at lower elevations. Groundwater discharge to the soil aquifer and surface eventually migrates to the South Fork of the New River and it's tributaries.

Comparison of the individual potentiometric surfaces within the micaceous schist/gneiss (MW-14) and the amphibolite/hornblende gneiss (MW-15), located adjacent to Rocky Branch, indicate a downward vertical flow direction exists at the contact between these two different metamorphic grade formations.

Aquifer Flow Summary

The recent aquifer flow testing results generally support the conclusions contained in the aquifer flow characterization presented in Section 3.1.8.1 of the Assessment Plan. The increased size of the area characterized revealed additional observations. Conservative estimates of the groundwater hydraulic conductivity rates of the mobile groundwater at the site continue to range from 0.01 ft/day to 10 ft/day. These findings generally agree with research provided by Zurawski (1978) that indicate hydraulic conductivity of the fractured metamorphic aquifer domain potentially range between 1 and 100 ft/day.

Additional observations of flow characteristics obtained from recent drilling and aquifer testing are summarized below.

1. Fast flow rates, comparable and even faster than flow rates observed within preferential soil flow paths, occur also within portions of the fracture system.

2. The nature and flow characteristics of the various bedrock fracture media can vary considerably depending on both metamorphic assemblage contrasts and physiographic location.

    a. The micaceous schist/gneiss aquifer medium is a relatively porous and permeable medium that supports relatively fast flow rates.

    b. The amphibolite/hornblende gneiss aquifer medium tends to be predominantly characterized by tight aperture, infrequent fractures that support relatively moderate flow rates. Fracture aperture widths, densities, and frequencies within this medium can be expected to vary considerably depending on physiographic location.

    c. The layered schist/gneiss aquifer flow rates are influenced by a variety of textural bedrock features (layering, shear zones, foliation, etc.) and appear related to physiographic location. Physiographic expressions within the layered schist/gneiss are influenced by textural contrasts related to the variable metamorphic assemblages comprising this mixed unit.

III Appalachian District Health Department Potable Well Sampling Program

The initial domestic and commercial use potable water well sampling event was developed and conducted by Draper Aden Associates on March 5, 1993 at the direction of Watauga County and approval of State officials to protect public health and welfare. The ongoing potable water well sampling and analysis program is currently being jointly conducted by the Appalachian District Health Department (ADHD) and the North Carolina State Laboratory of Public Health.

The objective of the potable well sampling and analysis program is to investigate and evaluate the potential influence and associated risks of the landfill on neighboring groundwater resources. Potable well water samples collected by the ADHD are analyzed for volatile organic compounds by the State Laboratory utilizing EPA Method 502.2. Potable water well locations with accompanying sampled well reference number can be found on the Vicinity Map (Figure 1). A summary of the analytical results of the potable well testing program collected to date are presented in Table 3. The North Carolina State Laboratory of Public Health analytical data sheets obtained since the Assessment Plan was prepared can be found in Appendix V.

The analytical results of the domestic and commercial use potable water well sampling and analysis program indicate that two (2) of the thirty eight (38) sampled potable wells neighboring the landfill are significantly impacted by volatile organic compounds. These two (2) significant impacted wells are the Carroll residence (well reference no. 12) and the Nissan-Mazda Dealership well (well reference no. 4).

At this time the cause or source of all the organics detected in the potable well sampling program cannot be determined. It should be noted that many of the detected compounds appear to be non-landfill related. Eight (8) of twenty-one (21) compounds detected in the Carroll residence potable well have not been detected in the landfill monitoring well network. Three (3) of fifteen (15) compounds detected in the Nissan-Mazda Dealership potable well have not been detected in the landfill monitoring well network. The presence of these nonlandfill related compounds in groundwater beneath these sites indicates potential impacts resulting from activities in the vicinity of the private well heads and/or components of the well systems.

The analytical results from all the potable well sampling conducted in the past year indicate that the sampled well waters are acceptable for all uses due to either non-detection or only trace detection of organic analytes. The two (2) potable water wells previously identified as significantly impacted have been replaced by alternative water sources and have not been resampled during the past year. Individual potable well analytical results obtained since the Assessment Plan was prepared are discussed below. Discussions of individual potable well analytical results obtained prior to preparation of the Assessment Plan can be found in Section 2.10 of the Assessment Plan.

TABLE 3A
POTABLE WELL TESTING - WATAUGA COUNTY, NC
RESULTS OF VOLATILE AND SEMI-VOLATILE ANALYSIS

CONSTITUENT	MARCH 5, 1993*	MARCH 18, 1993*	MARCH 24, 1993*	JUNE 23, 1993**	NCS	MCL
Carroll Residence (12)						
Benzene	2.1	1.7	NS	1.9	1.0	5
Chloroethane	173.4	74.5		ND	---	---
Chloromethane	ND	14.8		ND	---	---
Dichlorodifluoromethane	30.6	ND		ND	0.19	---
1,1-Dichloroethane	20.9	17.4		ND	700	---
1,1-Dichloroethene	4.1	1.5		ND	7	7
cis-1,2-Dichloroethene#	1.2	0.9		<1.0	70	70
2,2-Dichloropropane#	1.2	0.9		ND	---	---
4-Isopropyltoluene	ND	0.2		ND	---	---
Isopropylbenzene	0.6	ND		ND	---	---
Methylene Chloride	ND	43.0(XT)		138.2	5	5
Styrene	2.8	0.5		ND	0.014	100
Tert-Butyl Methyl Ether	ND	ND		2.4	200	---
Tetrachloroethene	5.4(X)	4.7		4.2	0.7	5
Toluene	ND	0.6(T)		ND	1000	1000
1,1,1-Trichloroethane	19.7	15.7		29.4	200	200
Trichloroethene	7.0(X)	5.5(X)		7.0	2.8	5
Trichlorofluoromethane	37.1	20.2		ND	2100	---
Vinyl Chloride	1.7(T)	ND		ND	0.015	2
p and m-Xylene	ND	ND		<1.0	400	10,000
o-Xylene	ND	3.4		2.9	400	10,000
Nissan-Mazda Dealership (4)						
Carbon Tetrachloride	0.2	NS	ND	NS	0.3	5
Chloroethane	19.1		ND		---	---
Dichlorodifluoromethane	8.2		8.7		0.19	---
1,1-Dichloroethane	98.5		63.1		700	---
1,2-Dichloroethane	ND		0.5		0.38	---
1,1-Dichloroethene	5.4		3.7		7	7
cis-1,2-Dichloroethene#	22.2		13.0		70	70
1,2-Dichloropropane	0.5		0.3		0.56	5
2,2-Dichloropropane#	22.2		13.0		---	---
Tetrachloroethene	21.8(X)		28.1(X)		0.7	5
Toluene	ND		0.8(T)		1000	1000
1,1,1-Trichloroethane	14.7		19.3		200	200
Trichloroethene	11.2(X)		9.1(X)		2.8	5
Trichlorofluoromethane	0.4		ND		2100	---
o-Xylene	0.4		0.5(T)		400	10,000

NOTE: All Concentrations are in ppb (ug/L).

(Other footnotes located on page 4)

TABLE 3A (Con't)
POTABLE WELL TESTING - WATAUGA COUNTY, NC
RESULTS OF VOLATILE AND SEMI-VOLATILE ANALYSIS

CONSTITUENT	March 5, 1993*	March 18, 1993*	May 11, 1993**	June 23, 1993**	March 30, 1994**	April 6, 1994**	NCS	MCL
Blue Ridge Electric Membership Company - (BREMCO) (5)								
1.1-Dichloroethane	0.7					<1.0	700	---
Naphthalene	0.6					**ND**	---	---
1,1,1-Trichlorothane	0.2					<1.0	200	200
Trichloroethene	0.5	NS	NS	NS	NS	<1.0	2.8	5
1,1-Dichloroethene	**ND**					1.0	7	7
cis-1,2-Trichloroethane	**ND**					<1.0	70	70
Tetrachloroethene	**ND**					<1.0	0.7	5
Bolick rental resident (2)								
tert-Butylbenzene	1.1					**ND**	---	---
Isopropylbenzene	0.7					**ND**	---	---
Trichloroethene	0.5					**ND**	2.8	5
1,3,5-Trimethylbenzene	0.7	NS	NS	NS	NS	**ND**	---	---
1,1-Dichloroethane	**ND**					trace	700	---
1,1-Dichloroethene	**ND**					trace	7	7
Methyl Ethyl Ketone	**ND**					trace	170	---
Perry Residence (11)								
Dichlorodifluromethane	2.5				**ND**		0.19	---
Naphthalene	0.7				**ND**		---	---
Chloromethane	<9	NS	NS	NS	**ND**	NS	---	---
Methylene Chloride	<0.6				**ND**		5	5
Chloroform					<1.0		0.19	5
Greer residence (15)								
Benzene						<1.0	1.0	5
Toluene						6.4	1000	1000
Tetrachloroethene	NS	**ND**	NS	NS	NS	trace	0.7	5
Ethylbenzene						trace	29	700
p and m - Xylene						<1.0	400	10,000
Styrene						trace	0.14	100
Ward residence (24)								
Methylene Chloride			3.2	**ND**	**ND**		5	5
1,1,1-Trichloroethane			<1.0	<1.0	<1.0		200	200
Trichloroethene			trace	trace	<1.0		2.8	5
Tetrachloroethene	NS	NS	**ND**	trace	<1.0	NS	0.7	5
Carbon Tetrachloride			**ND**		<1.0		0.3	5
1,1-Dichloroethane			**ND**		<1.0		700	---
Chloroform			**ND**		trace		0.19	5

NOTE: All Concentrations are in ppb (ub/L).

(Other footnotes located on page 4)

TABLE 3A (Con't)
POTABLE WELL TESTING - WATAUGA COUNTY, NC
RESULTS OF VOLATILE AND SEMI-VOLATILE ANALYSIS

CONSTITUENT	3/18/1993*	3/23/1993**	5/11/1993**	6/23/1993**	8/3/1993**	8/9/1993**	9/21/1993	10/20/1993**	3/30/1994**	NCS	MCL
Shared Well #1 (8 Houses) (13)											
sec-Butylbenzene	0.2									---	---
Carbon Tetrachloride	0.1									0.3	5
Methylene Chloride	1.5	NS	**ND**	NS	NS	NS	**ND**	NS	NS	5	5
alpha-Chlordane	0.4									0.27	2
gamma-Chlordane	0.3									0.27	2
Shared Well #2 (4 Houses) (14)											
1,4-Dichlorobenzene	0.5								**ND**	---	---
1,1-Dichloroethene	**ND**								<1.0	7	7
1,1,1-Trichoroethane	**ND**	NS	NS	NS	NS	NS	NS	NS	<1.0	200	200
Chloroform	**ND**								trace	0.19	5
Simko residence (20)											
Chloroform	NS	<1.0	NS	NS	NS	NS	NS	NS	NS	0.19	5
1,1,1-Trichloroethane		trace								---	200
Johnson residence (32)											
Chloroform	NS	NS	trace	NS	NS	NS	NS	NS	NS	0.19	5
McLean residence (26)											
Chloroform	NS	NS	NS	<1.0	NS	NS	NS	NS	NS	1.0	5
Yates residence (30)											
Chloroform	NS	NS	NS	NS	<1.0	NS	NS	NS	NS	0.19	5
McClintock residence (33)											
1,2-Dichloroethane	NS	NS	NS	NS	NS	<1.0	NS	<1.0	NS	700	---
Chloroform						<1.0		**ND**		0.19	5
Welch residence; Meadowview condominiums (38)											
Chloroform	NS	NS	NS	NS	NS	NS	NS	**<1.0**	**NS**	0.19	5

NOTE: All Concentrations are in ppb (ub/L)

(Other footnotes located on page 4)

TABLE 3B
POTABLE WELL TESTING - WATAUGA COUNTY, NC
WELLS SHOWING NO DETECTED ORGANIC COMPOUNDS

SAMPLING LOCATION	SAMPLING DATES
Colene Bolick residence (1)	March 5, 1993*
Roten residence (3)	March 5, 1993*
Hollar and Green Produce (6)	March 5, 1993*
Chevrolet Dealership (7)	March 5, 1993*
Vannoy residence (8)	March 5, 1993*
Martin High County Rentals #1 (9)	March 5, 1993*
Martin High Country Rentals #2 (10)	March 5, 1993*
Williamson residence (16)	March 18, 1993*
Suddreth residence (17)	March 18, 1993* and September 21, 1993**
Taylor residence (18)	March 18, 1993*
Hodges residence (19)	March 18, 1993*
Findt residence (21)	March 18, 1993*
Rusher residence (22)	March 23, 1993**
Younce residence (25)	May 11, 1993**
Medlin residence (27)	June 23, 1993**
Rector residence (28)	June 23, 1993**
Robinson residence (29)	June 23, 1993**
Cook residence (31)	August 3, 1993**
Animal Control Office (32)	August 3, 1993**
Green residence (34)	October 20, 1993**
Shared well #3 (35)	October 20, 1993**
BREMCO residence (36)	September 21, 1993**
Brook Hollow Trailer Park (37)	October 11, 1993**

TABLE 5A AND 5B NOTES:

The sampled well reference number as presented on the Vicinity Map (Figure 3) is denoted in parentheses following the sampling locations name

* Laboratory analysis performed by Central Virginia Laboratories and Constultants (CVLC) utilizing EPA Methods 502.2 (Volatiles) and 525.1 (Semi-Volatiles)

**Laboratory Analysis performed by NCDEHNR Division of Laboratory Services utilizing EPA Method 502.2 (Volatiles)

\# denotes compound co-elutes

ND denotes no compounds detected for entire analytical scan

NS denotes not sampled on that date

(T) denotes found in Trip Blank

(E) denotes estimated result

(X) denotes above MCL

NSC-North Carolina Water Qualtiy Standard (DEHNR-15A NCAC 2L.0202)

MCL-EPA Primary Drinking Water Standard Maximum Contaminant Level

3.1 August 3 and August 9, 1993 Sampling Events

The potable wells of three (3) residences located in Rocky Mountain Heights Subdivision and of the Watauga County Animal Control office, located between the landfill and the subdivision, were sampled during two sampling events conducted by the ADHD on August 3 and August 9, 1993. None of these four (4) potable wells were sampled and analyzed previously.

Two (2) of the potable wells, sampled on August 3, 1993, are located approximately 3000 feet from the landfill and reside on opposing sides of the Mutton Creek tributary draining the Rocky Mountain Heights Subdivision.

Cook Residence (well reference no. 31)

The water analyses of the Cook residence well, located approximately 200 feet from the Rocky Mountain Heights tributary, resulted in no detected volatile organic compounds.

Yates Residence (well reference no. 30)

The water analyses of the Yates residence well, located approximately 500 feet from the Rocky Mountain Heights tributary, detected only chloroform at unquantifiable levels below 1 part per billion (ppb). Chloroform is a common transformation product result from the chlorination of well systems.

Animal Control Office (well reference no. 32)

Animal Control Office well was also sampled on August 3, 1993. The Animal Control Office is located immediately adjacent to the landfill, between the landfill and the only significantly impacted potable well identified in the Rocky Mountain Heights Subdivision (well reference no. 12). The potable well for the Animal Control Office is located immediately to the northeast of the landfill upgradient well, MW-1. The water analysis of the Animal Control Office potable well resulted in no detected volatile organic compounds.

McClinton Residence (well reference no. 33)

The McClinton residence well, sampled on August 9, 1993, is located next to the landfill property along the ridge divide separating the landfill from the Rocky Mountain Heights Subdivision. The water analysis of the McClinton residence potable well detected 1) chloroform, a common well system chlorination transformation product, at unquantifiable levels below 1 ppb and 2) 1,2-dichloroethane at unquantifiable levels below 1 ppb. It is questionable whether 1,2-dichloroethane has been detected in the landfill monitoring network. 1,2-dichloroethane has only been detected only once at two (2) landfill monitoring wells and in both instances was detected at minimum method detection limits.

3.2 September 21, 1993 Sampling Event

The residence owned by the Blue Ridge Electric Membership Company (BREMCO), located adjacent to the U.S. Route 421 and the entrance to Hollar and Green Produce, was sampled for the first time on September 21, 1993.

Two (2) wells in the Rocky Mountain Heights Subdivision were resampled on September 21, 1993, to confirm the results of initial testing: 1) Shared Well #1, shared by eight (8) residences and 2) the Suddreth residence well, shared by two (2) residences.

BREMCO Residence (well reference no. 36)

The BREMCO residence is located along the tributary draining the Bolick site at the landfill, directly across from two recently installed nested plume assessment monitoring wells for the landfill (MW-13 and MW-18). The water analyses of the BREMCO residence well resulted in no detected volatile organic compounds.

Shared Well #1; 8 Residences (well reference no. 13)

The water analysis of Shared Well #1 resulted in no detected volatile organic compounds for the second consecutive sampling event.

The initial sampling of the Shared Well #1 resulted in the detection of two (2) chlordane compounds (a Termite insecticide) and one BTEX component typically associated with petroleum products (sec-butylbenzene) as well as two (2) chlorinated organic compounds (methylene chloride and carbon tetrachloride). All the levels of the organic compounds detected in the initial sampling event were detected at or below applicable North Carolina Groundwater Quality Standards (NCSs) or EPA Primary Drinking Water Standard Maximum Contaminant Levels (MCLs) except the two (2) Chlordane compounds which were detected above the NCS but below the EPA MCL. Again, the two (2) consecutive sampling events resulted in no detected volatile organic compounds.

Suddreth Residence (well reference no. 17)

The Suddreth residence is located adjacent to the landfill property, south of the waste disposal area. The September 21, 1993 resampling of the Suddreth residence also resulted in no detected volatile organics for the second consecutive sampling event. No sampling event to date has detected volatile organics in the Suddreth residence well.

3.3 October 11 and October 20, 1993 Sampling Events

Brook Hollow Trailer Park (well reference no. 37)

The potable well water from the Brook Hollow Trailer Park, located greater than 3600 feet and across Mutton Creek from the landfill, was sampled on October 11, 1993 to evaluate associated risks to the large community served by the trailer park well system. The water analyses of the Brook Hollow Trailer Park well system resulted in no detected volatile organic compounds.

Welch residence, Meadowview condominiums (38)

The potable well water from the Welch residence, located in the Meadowview condominiums, south of the Rocky Mountain Heights subdivision, was sampled on October 20, 1993 to evaluate associated risks to the condominium's shared well system. The water analysis of the Welch residence potable well water detected chloroform and trans-1,2-dichloroethene at unquantifiable levels below 1 ppb and trace levels of 1,1,1-trichloroethane and trichloroethene. Chloroform is a common transformation product from the chlorination of well systems and trans-1,2-dichloroethene has not been detected in the landfill monitoring well network to date. 1,1,1-trichloroethane and trichloroethene, detected at trace levels, are found in many common solvents which could be used at this site.

McClintock residence (well reference no. 33)

The potable well water from the McClintock residence, located next to the landfill property, along the ridge separating the landfill from the Rocky Mountain Heights Subdivision, was resampled on October 20, 1993 to confirm the results from the initial sampling event conducted on August 9, 1993. As detailed previously in section 3.1, the initial sampling event detected chloroform and 1,2-dichloroethane at unquantifiable levels below 1 ppb. The resampling resulted in no detection of chloroform and again detected 1,2-dichloroethane at unquantifiable levels below 1 ppb.

Green Residence (well reference no. 34)

The potable well from the Green Residence, located north of the landfill, Martin High Country Rentals, and Dee's Diner on U.S. Route 421 was also sampled on September 20, 1993. The potable well water sampling of the Green residence resulted in the detection of no volatile organic compounds.

Shared Well #3 (well reference no. 35)

Shared Well #3 is shared by two (2) houses and is located along the base of Rocky

Knob in the Rocky Mountain Heights Subdivision. The first sampling of Shared Well #3 was conducted on October 20, 1993, and resulted in the detection of no volatile organic compounds.

3.4 March 30 and April 6, 1994 Sampling Events

The following section discusses the analytical results from the residential and business potable well sampling recently conducted by the ADHD on March 30 and April 6, 1994. The potable wells of six (6) residences and one business (BREMCO), located near the Watauga County Landfill, were sampled and analyzed during these two sampling events. All of these potable wells were sampled and analyzed previously. Resampling was conducted to confirm the results of initial testing.

The following four (4) potable wells located north of the landfill and U. S. Route 421 were resampled during the recent sampling event. The results from this recent potable well water analyses detected only trace and unquantifiable levels below 1 part per billion (ppb) of volatile organic compounds with the exception of 1,1-dichloroethane, which was found at the detection limit of 1 ppb.

Blue Ridge Electric Membership Company, BREMCO (well reference no. 5)

Six (6) common chlorinated volatile organic solvent compounds were detected in the recent sampling of the BREMCO potable well (1,1-dichloroethane, 1-1-dichloroethene, cis-1,2-dichloroethene, 1,1,1,-trichloroethane, trichloroethene, and tetrachloroethene). The only compound detected at quantifiable levels was 1,1-dichloroethene (1,1-DCE), which was found at the detection limit of 1 ppb. The EPA Maximum Contaminant Level for 1,1-DCE is 7 ppb. The five (5) other detected organic compounds were observed at unquantifiable levels below 1 ppb. Only three (3) of the six (6) compounds detected in the recent resampling and naphthalene (a compound not detected in the landfill monitoring well network) were detected in the initial BREMCO potable well sampling event. The three (3) compounds detected both in the initial sampling event and in the recent resampling event were 1,1-dichloroethane, 1,1,1-trichloroethane, and trichloroethene. Naphthalene was not detected recently.

Bolick Rental Property (well reference no. 2)

The Bolick rental residence potable well, located directly to the southwest of the BREMCO business, was also resampled and analyzed during this sampling event. Only trace levels of two common chlorinated volatile organic compounds (1,1-dichloroethane and 1,1-dichloroethene) and methyl ethyl ketone (MEK) were detected. MEK has not been detected in the landfill monitoring well network. Coincidentally, three of the four compounds detected in the initial Bolick rental residence potable well sampling event conducted on March 5, 1993 were also not detected in the landfill monitoring well network.

Williamson Residence (well reference no. 16)

The Williamson residence and the Greer residence, located adjacent to each other, approximately 1,200 feet northeast of the BREMCO business, were also resampled and analyzed during this sampling event. The initial sampling event conducted on the potable wells from both of these residences on March 18, 1993 did not detect any organic constituents. The recent sampling of the Williamson residence potable well again did not detect any organic constituents.

Greer Residence (well reference no. 15)

The Greer residence had installed a new pump approximately a week before the recent sampling event. Low levels of six (6) organic compounds were detected from the recent sampling event. Four (4) of these compounds are BTEX components typically associated with petroleum products (benzene, toluene, ethylbenzene, and p and m-xylene) and one compound (styrene) is a component of plastics. The recent detection of these compounds, and the nondetection of these compounds in the initial sampling event, strongly suggest their presence may be related to the new pump system recently installed at the Greer residence. These five (5) compounds (with the exception of the common compound benzene) have not been detected in the landfill monitoring well network. One common chlorinated organic solvent compound (tetrachloroethene) was also detected in the recent sampling of the Greer residence potable well.

The following three (3) potable wells located within the Rocky Mountain Heights subdivision were resampled during the recent sampling event. These recent Rocky Mountain Heights potable well water analyses detected only trace and unquantifiable levels below 1 ppb of volatile organic compounds.

Ward Residence (well reference no. 24)

The Ward residence potable well sampling and analysis detected trace levels of chloroform and unquantifiable levels below 1 ppb of five (5) other chlorinated organic compounds (carbon tetrachloride, 1,1-dichloroethane, 1,1,1-trichloroethane, trichloroethene, and tetrachloroethene). Chloroform is a common transformation product result from the chlorination of well systems. Previous sampling of the Ward residence potable well has detected trace and unquantifiable levels below 1 ppb of three (3) chlorinated organic compounds (1,1,1-trichloroethane, trichloroethene, and tetrachloroethene). The initial Ward residence sampling event also detected methylene chloride at 3.2 ppb. The next two consecutive sampling events at the Ward residence resulted in the nondetection of methylene chloride. Methylene chloride is also a known laboratory contaminant.

Shared Well #2 (well reference no. 14)

Shared well #2 was originally sampled from the Cone residence on March 18, 1993 and again of September 21, 1993. Recent resampling of shared well #2 was conducted from the adjacent Edwards residence. The initial March 18, 1993 sampling detected only low levels of 1,4-dichlorobenzene, which is a compound that has not been detected in the landfill monitoring well network. The second September 21, 1993 sampling did not detect any organic constituents. Recent sampling detected trace levels of chloroform, which again is a common transformation product resulting from the chlorination of well systems. Recent sampling of shared well #2 also detected two (2) common chlorinated organic compounds (1,1-dichloroethene and 1,1,1-trichloroethane) at unquantifiable levels below 1 ppb.

Perry Residence (well reference no. 11)

Resampling of the Perry residence potable well only detected chloroform. Chloroform has been identified in seven (7) other potable wells located in the Rocky Mountain Heights Subdivision and it should be emphasized that this compound is a common transformation product resulting from the chlorination of well systems.

3.5 Recommendations

In summary, the analytical results from the recent potable well sampling indicate that the recently sampled well waters are acceptable for all uses due to either nondetection or very low level detection of the organic analytes. At this time the cause or source of the detected organics can not be determined. Many of the compounds detected as a result of the recent potable well sampling have not been detected in the landfill monitoring well network and/or are common contaminants of potable well systems.

Draper Aden Associates recommends that portable water well sampling program concentrate on sampling those few wells that have previously shown trace level detections of organics similar to those detected in the landfill groundwater monitoring well network. Duplicate sampling will indicate whether the organics detected are a persistent occurrence or uncommon event. Although alternate water supplies are currently provided, DAA also recommends continued periodic sampling of the (2) significantly impacted wells.

Draper Aden Associates will provide additional recommendations to the Appalachian District Health Department regarding additional/continued residential well sampling upon an evaluation of the initial groundwater assessment monitoring well network sampling and analysis results.

IV. Appalachian State University (ASU) Stream Sediment Study

Results obtained from the "New River Sediment Study", a three month-long geochemical study on the landfill drainage sediments conducted by Dr. John Callahan of the Appalachian State University (ASU) Geology Department, were summarized in an article in The Mountain Times, April 28, 1994. Information obtained from The Mountain Times' article was utilized to compile the following stream sediment study summary. Statements obtained from the article have not been verified.

The "New River Sediment Study" was sponsored in part by Dr. Harvard Ayers, Dr. Brad Batchelor, Rhonda Sechrest, and the Watauga Chapter of the Blue Ridge Environmental Defense League (BREDL). The sediment study investigated the levels of thirty-one (31) metals in the stream sediments at sixteen (16) stream sites draining the Watauga County Landfill and other areas in the New River drainage basin in and around the town of Boone. The sediment study found no evidence of heavy metal pollution in the sediments of streams draining the area of the Watauga County Landfill.

The sediment study sampling was begun in February, 1994 with the collection of sediments from sixteen (16) stream sites located in the local New River drainage basin as well as the landfill drainages. Dr. Callahan and William Stein, a recent geology graduate of ASU, sampled and analyzed sediment samples from the stream sites over a two-month period to determine if temporal changes in metal content occurred. The additional sampling did not show any major variation in metal content.

Stream sediment samples were obtained by digging to the clay layer of the stream bottom. The clay fraction of the stream bottom was chosen as the sample medium because the iron hydroxide present in the clay will tend to preferentially bind many potentially heavy metals. The collected samples were sieved to the fineness of flour then dissolved in acid and tested for the presence of the following thirty one (31) elements:

aluminum	chromium	manganese	strantium
antimony	cobalt	mercury	thorium
arsenic	copper	molybdenum	titanium
barium	gold	nickle	tungsten
bismuth	iron	phosphorus	uranium
boron	lanthanum	potassium	vanadium
cadmium	lead	silver	zinc
calcium	magnesium	sodium	

The stream sediment sampling and analysis results revealed no significant concentration of heavy metals arsenic, cadmium, mercury, or lead in the stream sediment samples obtained from the landfill drainages. The study did find a slight increase in cobalt, chromium, iron, manganese, nickel, and vanadium in the stream directly below the landfill. Slight increases in barium and phosphorus were also found in the clays downstream from the landfill.

V. Assessment Groundwater and Surface Water Sampling and Analysis Program

This section presents the schedule for the groundwater and surface water sampling program. The sampling program was initiated in June, 1994, following procurement of analytical laboratory services. The procedures to be implemented for collecting groundwater and surface water samples, analyzing the samples for specified parameters, and evaluating and reporting the resultant water quality data is detailed in Appendix I of the Assessment Plan, The Groundwater and Surface Water Monitoring Program.

5.1 Groundwater Sampling and Analysis

During the first year of Assessment groundwater monitoring, four (4) sampling events will be conducted on each monitoring well. Standard groundwater monitoring field collection forms for all eighteen (18) assessment groundwater monitoring wells are contained in Appendix VI.

The analytical scans that will be performed on each monitoring well will be designed to analyze for all the target analytes detected and confirmed as a result of the first comprehensive sampling event performed on the previously existing monitoring network MW-1 through MW-7 on March 5, 1993. The initial March 5, 1993 sampling event was comprised of the complete EPA Appendix II List of Hazardous Inorganic and Organic Constituents (40 CFR, Part 258) currently required for Assessment Monitoring under the North Carolina Department of Environment, Health, and Natural Resources (NCDEHNR) requirement for Municipal Solid Waste Landfills (15A NCAC 13B Section .1600). A summary and evaluation of the results of the initial March 5, 1993 sampling event are contained in Appendix VII of this Activity Report and detailed in Sections II and III of the Assessment Plan.

The four (4) initial sampling events will be performed for the purpose of collecting four independent samples for each well to establish background for any target analyte detected as a result of the complete EPA Appendix II Assessment analysis. For the purpose of accounting for temporal variation in the background data collection, the four (4) background sampling events performed after the initial Assessment Plan groundwater monitoring event will be conducted at three (3) month intervals.

One year after the initial Assessment groundwater monitoring and on an annual basis thereafter, the complete EPA Appendix II analysis will be repeated on the network of core plume assessment wells. The decision criteria for inclusion of an individual monitoring well into either the groups of core or boundary assessment wells is presented in Section 5.4 of this Activity Report.

If any additional constituents are detected, and verified through QA/QC validation as being present, that were not identified in prior Assessment monitoring events, amendments to the existing target analyte list will be evaluated and reviewed with the NCDEHNR. For amended target analytes, four (4) independent samples will be collected and analyzed for those additional constituents during the following semi-annual sampling events at all core and boundary assessment wells to establish background.

Groundwater monitoring events will also continue to be conducted on all wells on a semi-annual basis for the target analytes detected as a result of the complete EPA Appendix II analysis. Reevaluation of the site network and monitoring scheme will be evaluated after review of each sampling event results.

5.2 Surface Water Sampling and Analysis

Surface water and leachate monitoring will be conducted on a semi-annual basis during the first year of the Assessment Plan groundwater monitoring program and will continue semi-annually thereafter.

As per recommendations by the NCDEHNR, a spring located along the base of Rocky Knob, adjacent to the landfill, will be sampled if flowing during the initial sampling event, in addition to the four (4) surface water sampling points identified in Appendix I of the Assessment Plan. This spring is located at the head of the drainage adjacent to the Carroll residence well (well reference no. 12). The Carroll residence well is the only potable well in the Rocky Mountain Heights Subdivision identified as significantly impacted.

The decision criteria for subsequent sampling of the springs located in the Rocky Mountain Heights subdivision along the base of Rocky Knob, will be based on the results of the initial spring sampling as well as additional monitoring well and potable well sampling and analyses results. Springs located in other areas of the site, as designated on the Vicinity Map (Figure 1), will also be considered based on future evaluations of subsequent sampling events.

The analytical scans that will be performed on the surface water and leachate samples will be designed to analyze for all the target analytes detected as a result of the annual comprehensive Appendix II analysis. No intensive background data collection will be conducted for surface water monitoring due to the inherently variable nature of surface water quality. Background comparisons for surface water monitoring will be accomplished by evaluating semi-annual monitoring results.

5.3 Sampling and Analysis Schedule

The surface water monitoring program will solely utilize EPA Contract Laboratory Program (CLP) analytical methods. The groundwater monitoring program will follow a two-tiered analytical approach utilizing both EPA Contract Laboratory Program (CLP) Methods and low level risk assessment (LLRA) screening methods from EPA-SW846. The CLP methods will be utilized to generate a high-level quality data with documented QA/QC protocols. The low level SW-846 methods will be utilized for risk assessment screening to preliminarily identify low levels of constituents that may be present. The sampling and analytical schedule is outlined on the following page in Table 4.

During the first year of assessment groundwater monitoring, sampling events will be conducted on a quarterly basis on all plume assessment wells as detailed in the Watauga County Groundwater and Surface Water Monitoring Program. Analysis of the "core" assessment monitoring wells will utilize CLP analytical methods for all four (4) quarterly events. Analysis of the "boundary" assessment monitoring wells will alternate between CLP and LLRA analytical methods for each quarterly event. The decision criteria for inclusion of individual monitoring wells into either the group of core or boundary assessment wells is presented in Section 5.4 below.

After the first year of quarterly sampling events, the "core" assessment monitoring wells will be monitored on a semi-annual basis. The first semi-annual "core" sampling event will analyze for all the assessment monitoring parameters including the EPA Appendix II List of Hazardous Inorganic and Organic Constituents (40 CFR Part 258) utilizing LLRA analytical methods. The second semi-annual "core" sampling event will analyze for the target analyte assessment monitoring parameters. Analysis of the second semi-annual "core" well monitoring events will utilize CLP analytical methods.

After the first year of quarterly sampling events, "boundary" assessment wells will also be monitored on a semi-annual basis and only for the target analyte assessment monitoring parameters during both semi-annual monitoring events. Analysis of semi-annual "boundary" well monitoring events will continue to alternate between CLP and LLRA methods for each semi-annual event.

Table 4

Groundwater and Surface Water Monitoring Schedule

GROUNDWATER MONITORING	1st Year Quarterly Sampling Events				2nd Year Semi-Annual Sampling Events	
"CORE" ASSESSMENT WELLS						
Assessment Monitoring Parameters (ie: 40 CFR Part 258 Appendix II List)	-	-	-	-	Low Levels Risk Assessment Screening Methods	-
Target Analyte Monitoring Parameters	CLP Methods	CLP Methods	CLP Methods	CLP Methods	-	CLP Methods
"BOUNDARY" ASSESSMENT WELLS						
Target Analyte Monitoring Parameters	LLRA Methods	CLP Methods	LLRA Methods	CLP Methods	LLRA Methods	CLP Methods
SURFACE WATER MONITORING						
Target Analyte Monitoring Parameters	CLP Methods	-	CLP Methods	-	CLP Methods	CLP Methods

CLP - EPA Contract Laboratory Program Methods
LLRA - Low Level Risk Assessment Screening Methods (EPA SW-846)

5.4 Monitoring Well Network Revisions

After each sampling event conducted during assessment monitoring (detailed in Appendix I of the Assessment Plan, Watauga County Groundwater and Surface Water Monitoring Program), a re-evaluation of the horizontal and vertical extent of contamination will be conducted. Appropriate revisions to the network of assessment monitoring wells and monitoring program will be initialized after the re-evaluation of the horizontal and vertical extent of groundwater contamination. Proposed revisions to the Watauga County Landfill Groundwater Monitoring Program may include both withdrawal of non-impacted wells and/or installation of additional assessment wells, as well as modifications to analytical parameter lists for individual assessment monitoring wells. Proposed revisions to the Watauga County Landfill Groundwater and Surface Water Monitoring Program will be submitted to the NCDEHNR for review and approval.

Withdrawal and/or Installation

The placement of the proposed monitoring wells located beyond the landfill property is intended to provide groundwater samples that are representative of groundwater quality along the limits of contamination in both the surficial soil aquifer and fracture aquifer system. For purposes of Assessment, limit of the contamination shall be defined as the limit of migration of the contaminants detected in the property boundary monitoring wells above EPA Contract Required Detection Limits (CRDL) as defined by the CLP analytical methods. The selection of analytical methods and the determination of MDLs (for CRDLs) for each compound is detailed in Section F of the Groundwater and Surface Water Monitoring Program.

The placement of the proposed monitoring wells located adjacent to the waste disposal area is intended to provide groundwater samples that are representative of groundwater quality within the uppermost aquifer both within uppermost flow paths and deeper preferential flow paths occurring adjacent to the waste disposal area. The characterization of groundwater quality adjacent to the waste disposal area will provide information necessary to evaluate remediation alternatives.

After the first year of the Assessment Plan groundwater monitoring program, it is intended that non-impacted wells will be withdrawn from the groundwater monitoring system. Non-impacted wells will be defined by the absence (non-detection) of constituents identified as target analytes in the "core" assessment wells (discussed below).

"Core" and "Boundary" Analytical Parameters

In order to maximize the effectiveness and efficiency of the Watauga County Landfill Plume Assessment Monitoring Program, the assessment well network will be stratified into two groups of "core" and "boundary". "Core" assessment wells will be selected based on the well's ability to monitor and characterize migration of potential slugs of contaminants. The "boundary" assessment wells will be selected based on the well's ability to monitor and characterize the limits of the horizontal and vertical extent of the contaminants.

The decision criteria to be utilized for the selection of "core" assessment wells will be the exceedance of the groundwater protection standard for an individual constituent. The groundwater protection standard shall be based on an individual constituent's North Carolina Groundwater Quality Standard (NCS) or EPA Maximum Contaminant Level (MCL).

The decision criteria to be utilized for the classification of "boundary" wells in the assessment monitoring well network will be the exceedance of the CLP analytical methods' Contractor Required Detection Limit (CRDL) for constituents identified as target analytes in the "core" assessment wells. Currently, MW-2, MW-3, MW-4, and MW-6 are denoted as core assessment wells based on this criteria and available data. MW-1 will also be evaluated similarly for purposes of comparison. All other assessment monitoring wells are initially denoted as boundary assessment wells. All assessment monitoring wells will be appropriately reclassified after an evaluation of the first sampling event has been conducted on the upgraded assessment monitoring well network.

5.5 Data Evaluation

Assessment sampling and analysis activities will generate analytical data sets for four (4) primary routes of contaminant transport:

- groundwater
- surface water
- leachate and
- gas (air)

Gas (Air)

As previously discussed in Section 2.5 of this Activity Report, real-time air monitoring and corroborative air sample analytical results compiled during the assessment monitoring well drilling project were compared with the exposure criteria established by the Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH).

Air monitoring data collected to date indicates that volatile gas production resulting from assessment activities in the vicinity of the landfill does not pose a significant risk to assessment workers. Similarly, the results of the initial gas survey indicate that passive production of methane or other volatile gases from the water disposal area also does not represent a significant human hazard at or near the landfill.

Leachate

Leachate data will be obtained according to the occurrence or absence of leachate as determined by the schedule outlined in the Groundwater and Surface Water Monitoring Program. Leachate data will be evaluated with respect to potential impacts on surface water quality as well as investigations into source characterization. Attempts will be made to document relative leachate concentrations occurring both vertically and laterally within the fill in order to characterize contaminant transport and migration mechanisms occurring with the waste disposal area.

The results of the toxicity characterization testing (SW-846 Method 1311 TCLP) performed on the assessment monitoring well drill cuttings was compared with both Federal regulatory levels for hazardous waste defined in 40 CFR 261 and North Carolina regulatory levels for solid waste disposal. The TCLP testing indicates the contaminant concentrations detected in the drill cuttings to be nonhazardous. The low levels of three (3) chlorinated organic compounds detected in the drill cuttings suggests that vapor or groundwater transported contaminants are absorbing to material in the subsurface surrounding the fill. Future monitoring activities will continue to assess the impact of the subsurface contaminant media on contaminant transport, migration, and fate.

Surface Water

Surface water data will be obtained from a network of four (4) surface water sample collection points defined in the Groundwater and Surface Water Monitoring Program. Degradations in surface water quality will be reported to and evaluated by the NCDEHNR Solid Waste Section and reported to the NCDEHNR Division of Environmental Management for review. The primary objective of surface water data evaluation will be to assess the potential impact of landfill runoff and leachate on streams located downgradient of the waste disposal area.

Groundwater

Groundwater will be primarily evaluated with respect to US EPA Primary Drinking Water Standard Maximum Contaminant Levels (MCLs) and North Carolina Water Quality Standards (NCSs). MCLs and NCSs for the organic compounds detected in the landfill monitoring well network are contained in the detected organic compound summary table presented in Appendix VII.

The current data evaluation for constituents detected at the site to date can be found in Appendix VII.

A baseline risk assessment will be conducted in conjunction with the acquisition of additional data to assess potential risks posed by the site. The baseline risk assessment includes four major components: contaminant identification, exposure assessment, toxicity assessment and risk characterization. The baseline risk assessment will address all four components noted above to varying degrees based on the site complexity. Further discussion of the baseline risk assessment components are discussed in Assessment Plan.

REFERENCES

Bouwer, H.C., 1989, the Bouwer and Rice Slug Test - An Update, Groundwater. Vol. 27. No. 3 May-June.

Bryant, B. and Reed, J.C., Jr., 1970, Geology of the Grandfather Mountain Window and Vicinity, North Carolina and Tennessee: U.S. Geological Survey Professional Paper 615.

Cooper, H.H., Bradehoeft, J.D., and Papadopulus, S.S., 1967. Response of a Finite Diameter Well to an Instantaneous Charge of Water, Water Resources Research, Vol. 3, No. 1, p. 203-206.

Sorg, Thomas J., 1986. Plumbing Materials and Drinking Water Quality, Pollution Technology Review, Noyes Publications, Park Ridge, New Jersey.

Theis, C.V., 1935, The relationship between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage. Am. Geophysical Union, Trans., Vol. 16, p. 519-524.

United States Department of Agriculture Soil Conservation Service, 1944, Watauga County, North Carolina Soil Survey, Series 1944, No. 5.

Zurawski, Ann, 1978, Summary Appraisals of the Nation's Groundwater Resources, Tennessee Region, U.S. Geological Survey Professional Paper 8B-L, 35 pp.