

*Carmen Johnson*  
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95-02

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

**APPENDIX I:  
GROUNDWATER AND SURFACE WATER  
MONITORING PROGRAM**

DAA JN: 6520-13

*Prepared for:*

Board of Commissioners  
Watauga County

*Prepared by:*

Draper Aden Associates  
Consulting Engineers  
2206 South Main Street  
Blacksburg, Virginia 24060  
(703) 552-0444

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## *I. INTRODUCTION*

The Watauga County Landfill Groundwater and Surface Water Monitoring Program was specifically designed in response to a Consent Agreement between Watauga County and the NCDEHNR Solid Waste Section entered on July 7, 1993. Under the terms of the Consent Agreement, the enclosed groundwater and surface water monitoring program and the accompanying Watauga County Landfill Assessment Plan<sup>(1)</sup> was prepared to determine the impact on groundwater and surface water quality by the Watauga County Landfill. The goal of the groundwater monitoring program is to provide representative groundwater samples for assessing the horizontal and vertical extent of groundwater contamination both adjacent to the waste disposal area and beyond the landfill property boundary. The goal of the surface water monitoring program is to provide representative surface water samples for assessing the potential impact of the waste disposal area on the surface water locations around the landfill.

The enclosed groundwater and surface water sampling and analysis plan describes the procedures to be implemented for collecting groundwater and surface water samples, analyzing the samples for specified parameters and evaluating and reporting the resulting groundwater and surface water data. The discussion of laboratory analysis includes reference to appropriate test methods and associated detection limits as well as the laboratory's quality control and quality assurance procedures. Chain of custody requirements are also included.

The groundwater monitoring system described in this report is comprised of both existing and proposed monitoring wells. The existing groundwater monitoring system at Watauga County landfill was developed to provide one (1) groundwater monitoring point upgradient of the fill area and three (3) groundwater monitoring points downgradient of the fill area at the landfill property boundary. The primary design objective of the proposed groundwater monitoring wells is to determine the horizontal and vertical extent of groundwater contaminant plumes beyond the property boundary. A secondary design objective of the proposed groundwater monitoring wells is to characterize the nature and concentrations of contaminants adjacent to the waste disposal area. The proposed plume assessment wells are intended to characterize the extent of contamination in both the surficial soil aquifer and the underlying fracture system aquifer.

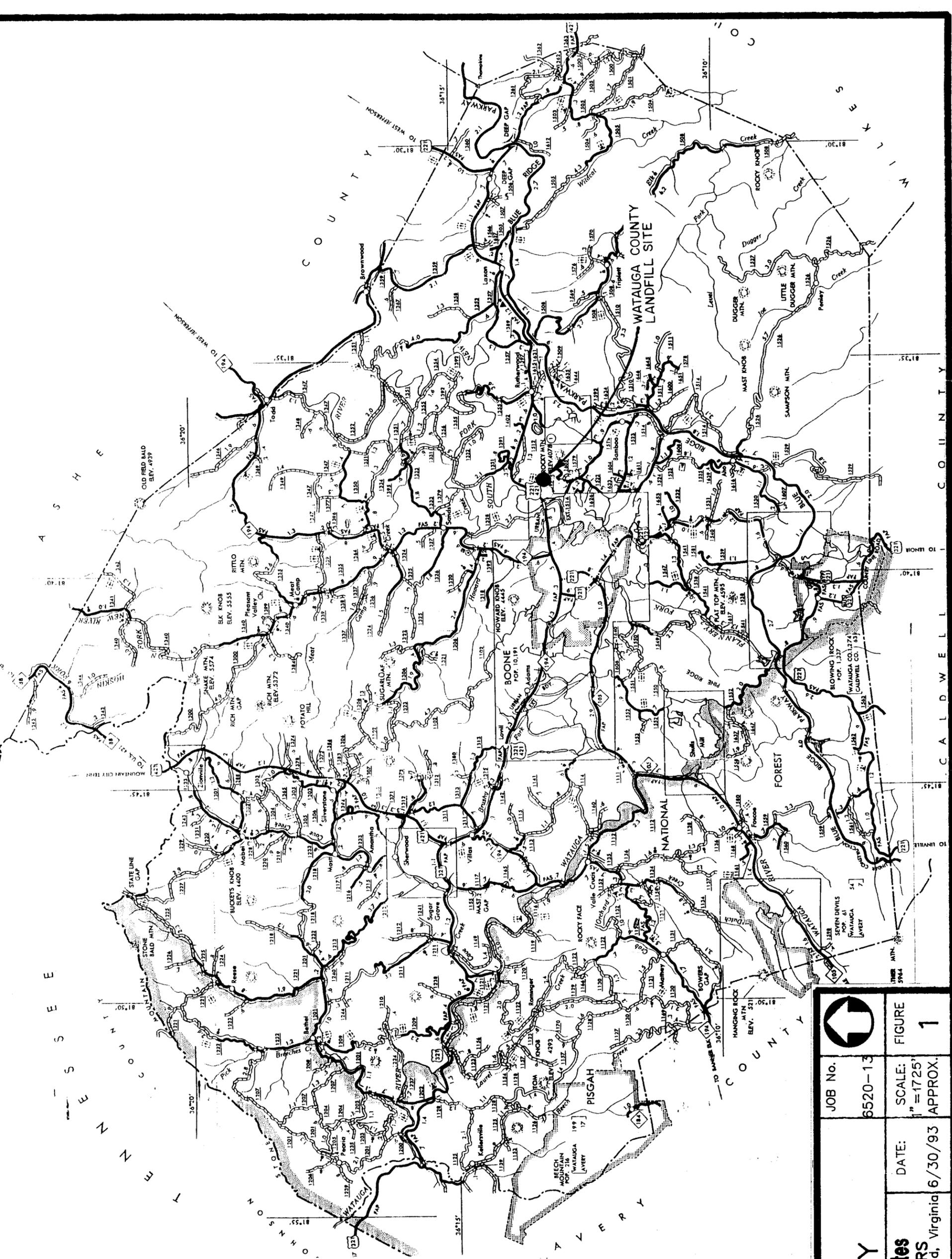
The groundwater monitoring system, comprised of both the existing and proposed monitoring wells, will be segregated into a network of "core" plume assessment wells and a network of "boundary" plume assessment wells.

The network of "core" plume assessment wells will be selected based on the well's ability to assist in identifying and to monitor the progress of potential future remediation efforts. The decision criteria to be utilized for the selection of "core" plume 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). Currently, MW-2, MW-3, and MW-4 are denoted as core plume assessment wells based on this criteria and available data. All other existing and proposed wells are initially denoted as boundary plume assessment wells.

The network of "boundary" plume assessment wells will be selected based on the well's ability to monitor the horizontal and vertical limits of groundwater contamination. The decision criteria to be utilized for the selection of "boundary" plume assessment wells will be the exceedance of the CLP analytical methods' Contractor Required Detection Limit (CRDL) for constituents identified as target analytes in the "core" plume assessment wells.

After the first year of the Assessment Plan groundwater monitoring program, 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" plume assessment wells.

The location of the landfill is illustrated on the Vicinity Map (Figure 1). The location of all groundwater and surface water sampling points as well as relevant surface features and Record Keeping and Reporting During Assessment Monitoring structures existing at the landfill is illustrated on the Groundwater and Surface Water Monitoring Program Site Map (Figure 2).



	JOB No.	6520-13	FIGURE	1
	SCALE:	1" = 1725'	DATE:	6/30/93
<b>LOCATION MAP</b> <b>WATAUGA COUNTY</b>		<b>Draper Aden Associates</b> CONSULTING ENGINEERS Blacksburg, Virginia - Richmond, Virginia Nashville, Tennessee		

## **II. DESIGN OF GROUNDWATER AND SURFACE WATER MONITORING SYSTEM**

### **2.1 SUMMARY OF SITE HYDROGEOLOGY**

The disposal area at the Watauga County Landfill resides at the head of a steep drainage within a natural bowl configuration. A small perennial drainage originates below the fill area. This drainage flows for approximately 1000 feet before discharging into Rocky Branch one half mile from the South Fork of the New River. Three (3) sediment ponds are situated below the fill area to prevent excess siltation of this drainage.

Groundwater under the Watauga County Landfill property is contained within a multiple aquifer system. An unconfined surficial soil aquifer and a deeper fracture aquifer system interconnect to supply groundwater at various depths. The soil aquifer is absent upgradient of the fill area. Springs located beneath the fill area discharge groundwater into the fill. Groundwater appears to migrate through the fill to leachate seeps as well as back into the fracture aquifer system. Groundwater from the fracture system is discharged above bedrock to the surficial soil aquifer both below and adjacent to the landfill. The Groundwater and Surface Water Monitoring Program Site Map (Figure 2) illustrates the potentiometric surface existing at the site.

Based on the potentiometric surface, site features, and the elevated levels of several volatile organic compounds observed adjacent to the landfill and below the waste disposal area, it appears that a considerable groundwater mound may have developed within the fill. The presence of springs beneath the fill and the absence of a relatively impermeable cap has likely resulted in the subsequent mounding of water within the fill. The proposed potentiometric surface resulting from the mounding of groundwater within the existing fill area is presented in Figure 2.

The presence of a considerable groundwater mound infers flow from the existing landfill across the northwestern topographic divide adjacent to the fill area. The elevated levels of several parameters in the groundwater across the northwestern topographic divide suggest that the presence of a strong groundwater potentiometric divide along the ridge is unlikely. In the absence of a groundwater mound within the existing fill areas, groundwater from under the landfill would need to be driven upgradient along the fractures to cause the elevated parameter levels observed within groundwater northwest of the fill area beneath the area referred to as the Bolick site.

### **2.2 SURFACE WATER SAMPLING LOCATIONS**

The goal of the surface water monitoring system at Watauga County Landfill is to provide representative surface water samples for assessing the potential impact of landfill runoff and leachate on the streams located downgradient of the waste disposal area. Four (4) surface water monitoring points combined with the sampling of any observed leachate production serve to provide this objective.

•(S1) The last of the series of sediment ponds shall be sampled to provide a representative sample for assessing the quality of the surface water originating from the landfill before the water discharges into the stream.

•(S2) The spring capture outfall located adjacent to the last of the series of sediment ponds shall be sampled to provide a representative sample for assessing the quality of the water originating from the spring capture system located beneath the fill area.

•(S3) The stream shall be sampled at the landfill property boundary (approximately 600 feet below the last sediment pond) to provide a representative sample for accessing the water quality of the stream below the waste disposal area. No sampling location is available upstream of the waste disposal area since the stream originates immediately below and adjacent to the disposal area.

•(S4) The stream located below the Bolick site shall be sampled approximately thirty (30) feet below the landfill property boundary to provide a representative sample for accessing the water quality of the surface water below the Bolick site. This sampling location is chosen instead of the sediment pond located on the Bolick site to provide a sample that is more representative of the potential influence of groundwater from the soil aquifer.

In addition to the four surface water sampling locations, any leachate production observed during surface water sampling events will also be sampled. A grid field screening inspection of the landfill will be conducted concurrent with the surface water sampling event to verify the presence or absence of leachate production occurring within the fill. Observations resulting from the inspection will be documented in the field notes.

The locations of the four (4) surface water monitoring locations, S1, S2, S3, and S4, are depicted on the Groundwater and Surface Water Monitoring Program Site Map (Figure 2).

## **2.3 PLACEMENT OF MONITORING WELLS**

The groundwater monitoring system described in this report is comprised of both existing monitoring wells and proposed monitoring wells. The locations of all existing and proposed monitoring wells are illustrated on the Groundwater and Surface Water Monitoring Program Site Map (Figure 2).

### **2.3.1 Existing Monitoring Wells**

The four (4) monitoring wells comprising the existing Watauga County Landfill groundwater monitoring well network were installed to provide one (1) upgradient and three (3) downgradient monitoring wells. The upgradient monitoring well was located at the base of the knob located southwest of the waste disposal area to provide groundwater samples representative of background groundwater quality. The downgradient monitoring wells were located at the landfill property boundary to ensure detection of contamination passing beyond the landfill property.

A summary of monitoring well completion data is presented in Table 1. The driller's log indicates that the upgradient monitoring well, MW-1, accesses a fracture within the fracture system aquifer at an approximate depth of 52 feet (although the filter pack extends from 48 feet to 85 feet in depth).

Two (2) of the existing downgradient monitoring wells, MW-2 and MW-4, are located adjacent to the drainage below the landfill approximately 400 feet from the northernmost limits of waste disposal. MW-2 accesses a fracture within the fracture system aquifer at an approximate depth of 172 feet with the filter pack extending from 168 feet to 185 feet in depth. MW-4 was installed adjacent to MW-2 at the request of the NCDEHNR Solid Waste Section to monitor the shallow surficial soil aquifer at this location. The filter pack of MW-4 extends from 21 feet to 32 feet in depth from the surface.

The other existing downgradient monitoring well, MW-3, is located below the northwest topographic divide separating the fill area from the Bolick site approximately 900 feet from the limits of waste disposal. MW-3 accesses the surficial soil aquifer with a filter pack extending from 30 feet to 42 feet in depth.

### **2.3.2 Proposed Monitoring Wells**

Fourteen (14) monitoring wells are proposed for the delineation of the horizontal and vertical extent of the contaminant plume (s).

Three (3) of the proposed plume assessment wells, MW-5, MW-6, and MW-7, were installed in August, 1992, along the northwest topographic divide between the Bolick site and the waste disposal area (originally designated PZ-19, PZ-24, and PZ-25). Monitoring wells MW-5, MW-6, and MW-7 assess the fracture system aquifer at total depths of 73 feet, 58 feet, and 50 feet, respectively. A filter pack twelve (12) feet in length was installed in each well. A summary of the previously installed proposed plume assessment wells' completion data is also presented in Table 1.

Nine (9) of the proposed plume assessment wells will be installed upon approval by the NCDEHNR Solid Waste Section. Three (3) of these proposed plume assessment wells are to be located adjacent to the waste disposal area. Seven (7) of the proposed plume assessment wells will be located beyond the landfill property boundary and one (1) additional well is proposed along the landfill property boundary. Locations of all the existing and proposed monitoring wells is presented on the Site Map (Figure 2).

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 the contaminant plumes in both the surficial soil aquifer and fracture aquifer system. The limit of the contaminant plume 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. As recommended by the EPA (EPA/540/1-89/002, December 1989), the PQL shall be defined as three to five times the compounds minimum detection limit (MDL). The selection of analytical methods and the

**TABLE 1**

**Watauga County Landfill, Monitoring Well Completion Data**

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

**Existing Monitoring Wells**

Well No.	Ground Elevation	Casing Elevation	SWL* Elevation	SWL* Elevation	Total Depth*	Screen Length Depth Interval**	Filter Packing Depth Interval**	Annular Seal Depth Interval**	Screened in Soil or Bedrock
MW-1	3339.03	3341.50	3304.59	36.91	76.65	80.0-70.0	85.0-48.0	48.0-46.0	Bedrock
MW-2	3151.24	3152.73	3145.80	6.93	177.50	180.0-170.0	185.0-168.0	168.0-166.0	Bedrock
MW-3	3182.25	3183.06	3164.46	18.60	39.60	42.0-32.0	42.0-30.0	30.0-28.0	Soil
MW-4	3150.06	3151.52	3141.71	9.81	29.40	32.0-22.0	32.0-21.0	20.0-18.0	Soil

**Proposed Monitoring Wells installed in August of 1992**

Well No.	Ground Elevation	Casing Elevation	SWL* Elevation	SWL* Elevation	Total Depth*	Screen Length Depth Interval**	Filter Packing Depth Interval**	Annular Seal Depth Interval**	Screened in Soil or Bedrock
MW-5 (PZ-19)	3263.81	3266.86	3216.11	50.75	73.0	73.0-63.0	73.0-61.0	61.0-59.0	Bedrock
MW-6 (PZ-24)	3262.55	3265.15	3223.19	41.96	58.0	58.0-48.0	58.0-46.0	46.0-44.0	Bedrock
MW-7 (PZ-25)	3270.56	3273.61	3246.46	27.15	50.0	50.0-40.0	50.0-38.0	38.0-36.0	Bedrock

\*As recorded from top of well casing on September 9, 1992

\*\*As recorded from ground elevation

Survey by Draper Aden Associates, September 10, 1992

determination of MDLs (or CRDLs) for each compound is detailed in Section F of this report. MCLs, CRDLs and NCSs for each compound are presented in Tables 4 and 4A.

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. A discussion of the reasons for the location of each individual plume assessment monitoring well can be found in Section 4.3.7 of the Watauga County Landfill Assessment Plan.

## **2.4 CONSTRUCTION OF THE GROUNDWATER MONITORING WELLS**

The drilling methods and materials used to construct monitoring wells MW-1, MW-2, MW-3, MW-4, and three previously installed proposed monitoring wells MW-5, MW-6, and MW-7 can be found in the well completion records contained in Appendix I of this Groundwater Monitoring Program.

### **2.4.1. Existing Monitoring Wells**

The four (4) monitoring wells comprising the existing Watauga County Landfill (MW-1, MW-2, MW-3, and MW-4) were drilled and constructed by Dewey Wright Well and Pump Co., Inc. MW-1 and MW-2 were installed in April, 1989 and MW-3 and MW-4 were installed in November, 1990. Dewey Wright utilized a 6-inch air rotary hammer to drill the well borings and compiled a drilling log from the returns observed at the surface. The drilling log can be found on the Well Completion Records (Appendix I).

MW-1 was constructed using 6-inch galvanized steel from 36 feet in depth to the surface and 4-inch schedule 40 polyvinyl chloride (PVC) well pipe from 36 feet to 70 feet in depth with a 0.02-inch factory slotted 10-foot screen from 70 feet to 80 feet in depth. MW-2 was constructed using 4-inch schedule 40 PVC well pipe with a 0.02-inch factory slotted 10-foot screen from 170 feet to 180 feet in depth. MW-3 and MW-4 were constructed using 2-inch schedule 40 PVC well pipe with 0.02-inch factory slotted 10-foot screens.

The annulus of four (4) wells of the original monitoring well system described above were all constructed utilizing a sand/gravel filter pack followed by a two feet bentonite seal and completed with a cement grout to the surface. The placement of the filter packs is discussed in the previous Section B. A locking steel casing covers all the wells.

### **2.4.2. Proposed Monitoring Wells**

The three previously installed proposed monitoring wells; MW-5, MW-6, and MW-7 (originally designated PZ-19, PZ-24, and PZ-25), were drilled and constructed by Engineering Tectonics under the supervision 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. The boring logs and well completion reports can be found in Appendix I.

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 powder.

MW-5, MW-6, and MW-7 were developed using a Grundfos pump to surge and rapidly purge the wells to remove free sediments from the filter pack and inside of the well casing. Installation of locking steel casings and a 6-foot square concrete pad is proposed to complete the construction of MW-5, MW-6, and MW-7 and meet monitoring well construction requirements of the NCDEHNR Solid Waste Section.

The proposed monitoring wells will be 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. PVC ensures a strong, economical, and chemically resistant well in the presence of aqueous phase organic and inorganic contaminants (See references [2], [3], and [4]). A filter pack of clean quartz sand (#2 well gravel) will be poured around the screen interval, extending two feet above the screen slots, and bentonite chips, extending at least 2-feet above the filter packing, will seal the well intake. The remaining annulus of the well will be filled with a 5% by volume mixture of Type I Portland cement grout and bentonite powder. A locking steel protective casing will cover the wells, and a 6-foot square concrete pad will provide a protective base for sample collection activities.

Cuttings produced during the drilling of the proposed monitoring wells will be collected for temporary containment in a central location at the landfill. A liner and cover system composed of three (3) layers of 6 ml plastic and contained by a straw bale berm will be utilized as the temporary containment system. Potential hazardous waste characteristics will be evaluated using the Toxicity Characteristic Leaching Procedure (TCLP) for analysis screening. This will be performed on the temporary drill cuttings stockpile and appropriate disposal measures will be implemented subsequent to the T-CLP analysis.

The proposed monitoring wells will additionally be developed using a surge device in combination with rapid purging to remove free sediments from the filter pack and inside of the well casing. A hydraulic conductivity determination for each new well will also be made. Monitoring well installation will be documented and certified as being in accordance with this plan by a qualified Groundwater Scientist. Boring Logs, Monitoring Well Completion Records, and a map showing the new well locations will be forwarded to the NCDEHNR Solid Waste Section upon completion of the approved wells within 14 days of certification.

## **2.5 WELL ABANDONMENT**

The well abandonment procedure that will be followed in the event that any well is abandoned is listed below:

1. The entire well bore is overdrilled to remove all casing, sand filter pack material and grout.
2. The resulting borehole will be refilled with a 5% by volume mixture of Type I Portland cement grout and bentonite powder. A tremmie tube will be 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 to the aquifer.
3. Upon completion of the well abandonment procedure, Watauga County will send a letter to the NCDEHNR Solid Waste Section describing in detail the well(s) that was abandoned, the procedure followed, and if necessary a map showing the location of the abandoned well. The letter will be certified as accurate by the signature of the person that observed the abandonment procedure.

### **III. GROUNDWATER AND SURFACE WATER SAMPLING AND ANALYSES**

This section describes the procedures for collecting groundwater and surface water samples, analyzing the samples for the specified water quality criteria, and evaluating the reported data from these analyses. The samples must be collected in strict accordance with the following guidelines to minimize alteration of the sampled water during collection and transport.

#### **3.1 SAMPLING FREQUENCY**

##### **3.1.1. Groundwater**

During the first year of Assessment groundwater monitoring, four (4) sampling events will be conducted on each monitoring well. The analytical scans that will be performed on the monitoring well will be designed to analyze for all the target analytes detected as a result of the comprehensive sampling event performed on the existing monitoring well network on March 5, 1993 (detailed in Sections II and III of the Assessment Plan). The March 5, 1993 sampling event analysis was comprised of the complete Appendix II List of Hazardous Inorganic and Organic Constituents (40 CFR Part 258) required for Assessment monitoring under the North Carolina Department of Environment, Health, and Natural Resources (NCDEHNR) proposed requirements for Municipal Solid Waste Landfill Facilities (15A NICAC 13B Section .1600). 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 constituent detected as a result of the complete Appendix II 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 Appendix II analysis will be repeated on the network of core plume assessment wells. 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 sampling events at all core and boundary plume assessment wells to establish background.

Groundwater monitoring events shall also continue to be conducted on all wells on a semi-annual basis for the target analytes detected as a result of the complete Appendix II analysis.

##### **3.1.2. Surface Water**

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

Table 2 presents the schedule for sampling frequency containing the number of samples and analyses required during Assessment monitoring.

**TABLE 2  
ASSESSMENT PLAN MONITORING SCHEDULE**

GROUNDWATER MONITORING	ANALYTICAL METHOD	POST-BACKGROUND FREQUENCY	BACKGROUND DETERMINATION
<b>"CORE" PLUME ASSESSMENT WELLS</b>			
Assessment Monitoring Parameters (ie: 40 CFR Part 258 Appendix II List)	Low level Risk assessment screening methods	Annual (Once per year) <sup>1</sup>	Not Applicable
Detected Assessment Monitoring Parameters	CLP methods	Annual (Once per Year) <sup>1</sup>	Four (4) Quarterly Sampling Events
<b>"BOUNDARY" PLUME ASSESSMENT WELLS</b>			
Detected Assessment Monitoring Parameters	Low level Risk Assessment Screening Methods	Semiannual (1st year) <sup>2</sup> Annual (Subsequent years)	Not Applicable
	CLP Methods	Semiannual (1st year) <sup>2</sup> Annual (Subsequent years)	Initial four (4) CLP Monitoring Sampling Events

(1) Also, for "core" plume assessment wells, post-background monitoring includes annual risk assessment screening, followed six months thereafter by confirmed CLP analysis of previously detected target analytes.

(2) Four (4) quarterly monitoring events are required during the first year of the Assessment Plan groundwater monitoring. The first and third quarterly monitoring events for "boundary" plume assessment wells will utilize the low level risk assessment screening methods to preliminarily identify low levels of constituents that may be present. The second and fourth quarterly monitoring events for "boundary" plume assessment wells will utilize CLP methods to generate defensible data with proven associated QA/QC protocols. Subsequent to first year monitoring, risk assessment screening and CLP analysis will alternately be conducted on a semi-annual basis.

SURFACE WATER MONITORING	ANALYTICAL METHOD	FREQUENCY	BACKGROUND DETERMINATION
Detected Assessment Monitoring Parameters	CLP Methods	Semi-Annual	Not Applicable

### 3.2 SAMPLE COLLECTION FIELD DOCUMENTATION

While samples are being collected, a field log comprised of field activity reports and a field logbook shall be kept adhering to the field note protocol detailed herein. The objectives adhering to the following protocol is to collect suitable groundwater samples and to record concise field notes, which follow a standard format, for easy review.

The field activity reports provide the means to provide consistent documentation of field activities. Sample field activity forms are enclosed in Appendix II. The field logbook supplements the field activity reports by recording additional site incidents and activities. The field logbook should contain information supplemental to decision making, such as conversations with key personnel, potential or actual problems encountered, explanations for changes in project plans, and other oversight discussions or observations.

Water-resistant ink should be used to complete the field activity forms and field logbook. All errors should be marked through and all corrections initialized. Upon completion, photocopies of the field logs should be bound with the field activity reports to accompany the laboratory analytical results of the sampling event.

### **3.2.1. Field Information Recorded for Each Groundwater Sampling Event**

The following information shall be documented in either the field log book or directly on the field activity forms at the outset of sampling if it is consistent and duplicated from well to well within the given sampling event. Any of the following information that is not consistent and duplicated for the given sampling event must be detailed for each individual well, concurrent with each individual well's sampling. All required information shall always be noted in either the field log book or the field activity forms. Completion of associated field activity forms should be noted in the field book.

- Name of collector;
- Well sampling sequence;
- Climatic conditions including air temperature;
- Static water level measurement technique;
- Well evacuation procedure and equipment;
- Sample withdrawal procedure and equipment;
- Sample filtering procedure and equipment;
- Types of sample containers used;
- Preservatives used;
- Internal temperature of field and shipping containers at the outset of the sampling event and/or day;
- Temperature, pH, and conductivity calibration and measurement equipment and technique;
- All specific conductivity calibration measurements (noting time).

Figure 1 in Appendix II is presented as a Standard Field Note Protocol for use in completing initial activity information required to be documented in either the bound field log book or on the enclosed field activity forms.

### **3.2.2. Field Information Recorded for Each Monitoring Well Sampled**

The following information is unique to each well sampled and should be documented concurrent with the sampling of each individual well:

Identification of the well;  
Condition of well;  
Static water level and total well depth;  
Water column length;  
Purge volume;  
Pumping rate;  
Time well purged;  
All measurements of temperature, pH, and specific conductivity taken during purging;  
All pH calibration measurements noting date and time;  
Four (4) final replicate measurements of temperature, pH, and specific conductivity.  
Date and time of collection;

In addition to any information recorded in the field note book, a Sample Collection Form shall be completed at the time of sampling, for each well. Figures 2A through 2G in Appendix II are Sample Collection Forms constructed specifically for each of the existing monitoring wells which will be used in this program. Figures 3A through 3G in Appendix II are Sample Collection Forms constructed specifically for each of the existing piezometers. The piezometers are not anticipated to be sampled during the program but are included in the event they may be used as sampling points during the course of implementation of the Watauga County Landfill Assessment Plan. Figure 4 in Appendix II is a blank Sample Collection Form for proposed wells. The sample collection form shall be utilized to calculate the minimum purge volume of water from the well prior to sample collection. The form is also used to record the field, pH, specific conductivity, and temperature measurements for each well sampled. Sample Collection Forms will be prepared and submitted for all proposed wells upon completion of the wells.

#### Purge Volume Calculations on Sample Collection Form for Each Well

Prior to collection of groundwater samples for each well, a minimum of three well volumes of water shall be purged from the well. A well volume is defined as the sum of the volume of water residing within the well casing, and residing in the filter packing or volume. The purge calculations contained in the Sample Collection Forms have been simplified for each individual well in order to facilitate ease and reliability of purge calculations when performed in the field. The following procedure shall be used to complete the well purge calculations in the Sample Collection Form:

- i. For each well, the depth to water (DTW) and total depth of the well (TD), referenced from the top of the well casing, are measured and recorded in feet on the Sample Collection Form by the sampling technician before the water in the well is disturbed.
- ii. The depth to water is subtracted from the total depth of the well (TD-DTW) in order to calculate the length of the water column in the well casing in feet ( $L_c$ ).
- iii. The volume of water in the well casing ( $V_c$ ) is calculated by multiplying the length of the water column in feet by a constant which incorporates the annular

area of the well casing converted from square feet to gallons per foot. Thus, multiplying the length of the water column in feet by the constant of gallons per foot results in the volume of water in the well casing in gallons.

An example calculation of the constant and final equation for  $V_c$  is presented below for monitoring well MW-3:

$$V_c = L_{c(ft.)} * K_{c(gal/ft.)}$$

where:

$$K_c = \Pi * (\text{radius of well} = 1")^2 * (\text{ft}^2/144 \text{ in}^2) * (7.48 \text{ gal.ft}^3) = 0.163 \text{ gal/ft.}$$

- iv. The volume of water contained within the pore volume of the saturated filter packing, in feet, is calculated next. The filter pack resides around the outside of the screened well intake. The length of the filter pack is listed on the Sample Collection Form for each monitoring well. If the water column length (calculated in step ii above) in the well is less than the length of the filter pack, then the volume of water in the filter pack length, the maximum length of saturated filter pack is limited to the length of the filter pack.

The volume of water in gallons residing in the filter pack porosity ( $V_f$ ) is calculated by multiplying the length of saturated filter packing in feet (not to exceed the recorded length of the filter pack as constructed) by a constant. The constant incorporates the annular area of the filter pack (minus the area of the well casing), filter packing porosity (40%), and a conversion from cubic feet to gallons.

An example calculation of the constant and final equation for  $V_f$  for monitoring well MW-3 is presented below:

$$V_f = [L_{c(ft.)} \leq 12 \text{ ft.}] * K_f$$

where:

$$K_f = \Pi * (\text{squared radius of bore} - \text{squared radius of well: } 3.0''^2 - 1''^2) * (\text{ft}^2/144 \text{ in}^2) * (7.48 \text{ gal/ft.}^3) * 0.40 = 0.0522 \text{ gal/ft.}$$

- v. One well volume of water residing in the well ( $V_w$ ) in gallons is calculated by summing the volume of water in the well casing ( $V_c$ ) and the volume of water residing in the pore volume of the filter pack ( $V_f$ ).
- vi. The minimum volume of water to be purged from the well prior to collecting samples is calculated by multiplying the well volume by a factor of three.

### **3.2.3 Field Information Recorded for Each Surface Water Sampling Event**

Before beginning the surface water sampling procedure, the general conditions of the water body (and sediments) shall be noted in the field log book. Water turbidity and turbulence are of particular interest as well as the presence of stratification (layers) or the presence of petroleum products or surface sheen. The presence, appearance, and relative locations of any discharges or tributaries, obstructions, or changes in the sampling location as well as present and recent weather and precipitation conditions should also be noted in the field log book.

During the grid field screening inspection of the landfill, the general conditions of the fill area and a detailed description of any observed zones of leachate production shall be noted in the field log book. Documentation shall encompass the presence, appearance, and relative locations of leachate discharges in relation to natural surface waters. Estimates of leachate production (i.e. flow rates and volumes) are of particular interest as well as descriptions of appearance, odors, etc. Obstructions or changes in waste disposal practices that may be resulting in the observed leachate production as well as present and recent weather and precipitation conditions should also be noted in the field log book.

### **3.2.4. Field Information Recorded After Each Sampling Event**

The following information shall be documented in the field book or field activity forms at the completion of the sampling event and/or day:

- Internal temperature of shipping containers at the completion of the sampling event and/or day;
- Sample shipping method and destination;
- Sampler signatures.

Figure 5 in Appendix II illustrates the information to be entered in the field book or field activity forms after the completion of each sampling event and/or day.

## **3.3 GROUNDWATER SAMPLE COLLECTION PROCEDURES**

Groundwater samples will be collected following the step-wise procedures listed below. The monitoring wells shall be sampled from upgradient to downgradient. This requirement entails that monitoring well MW-1 be sampled first, followed by the downgradient wells. The NCDEHNR shall be notified at least ten (10) days prior to any scheduled sampling event in order to determine if split samples will be analyzed.

A duplicate sample for all parameters being analyzed on each sample event must be collected from each tenth well sampled in order to provide a duplicate analysis of the monitored parameters as part of laboratory QA/QC (Matrix spike and Matrix spike duplicate) specified in this program.

## Step 1

Dedicated stainless steel and TEFLON electric submersible impeller-driven pumps will be used to purge and sample each well. Temperature, pH, and specific conductivity measuring probes or vessels shall be cleansed and decontaminated prior to sampling each well and prior to every calibration. This will be done by rinsing with deionized/distilled water followed by wiping dry with a clean tissue.

All disposable equipment utilized during each sampling event will be disposed of in a central location at the landfill. As determined necessary, all purge, wash, and rinse water generated during each groundwater sampling event will either be discharged to the ground downgradient of the well head or be containerized at each sampled well in a 55 gallon drum as determined necessary. Based on existing levels of contaminants detected, containerization will not be necessary. As needed, the purge, wash, and rinse water will be disposed of in a State approved wastewater treatment system or other appropriate medium or proper handling and treatment as indicated by subsequent analysis.

For each well to be sampled, make ready all forms, labels, and the following equipment:

- Dedicated submersible stainless steel and Teflon electric submersible impeller driven pumps with which to purge and collect groundwater samples.
- Electronic water level meter with measurement accuracy of 0.01 foot.
- Digital pH meter to measure the acidity of the groundwater with measurement accuracy  $\pm 0.01$  standard pH units.
- Digital or standard thermometer with measurement accuracy  $\pm 0.1^{\circ}\text{C}$ .
- Specific conductivity meter to measure the specific conductance, or current carrying capacity of the groundwater which gives an indication of its ionic strength. The instrument shall have measurement accuracy  $\pm 1$  umhos with a minimum method detection limit of 10 umhos or less.
- A sufficiently large cooler with ice or other cooling agent to keep temperature at approximately 4 C (39 F) for storage and transport of collected groundwater samples.
- A five (5) gallon bucket to collect initial purge water from well.
- VDOT approved Class 17 55 gallon drums for use as necessary to collect purge, wash, and rinse waters generated during sampling activities.
- Rubber surgical gloves, coat and protective eyewear, as well as any other necessary protective apparatus to shield workers from bottle preparation acid and/or contaminated groundwater. Gloves and coat shall be utilized by all workers and additional equipment as necessary to protect the safety of workers during all sampling activities.

Refer to Table 3 for proper sampling and preservative procedures.

### **Step 2**

Record well location and well number. Measure and record depth to groundwater in the well (static water level) with the electronic water meter. The measurement accuracy must be to 0.01 ft. The reference point from which the depth to water is measured shall be the top of the well casing.

### **Step 3**

Calculate and record the volume of water residing in the well (i.e. well volume) following the procedures detailed individually for each well on the Sample Collection Form.

### **Step 4**

At least three well-volumes of water (a well-volume was calculated in Step 3) shall be purged from each well prior to sample collection. High-yield wells should be purged at less than 4 gallons/minute to prevent further well development. The evacuation protocol for low-yield wells shall be to purge the well until dry without allowing formation water entering the well to cascade down the well casing.

Collect the purged water in a decontaminated 5 gallon bucket, making temperature, pH and specific conductivity measurements on approximately every well-volume of water purged from the well. This will be done to monitor for changes in groundwater quality during purging, and to verify that a sufficient purge volume of water has been removed from the well to insure that formation water is being sampled. Purging shall continue after three well volumes of water have been removed if pH and specific conductivity have not stabilized in the purged water. Stabilization for specific conductivity and pH, is defined as a tolerance of +/-10%, respectively, from the last measurement recorded during purging. If the values of pH and specific conductivity have not stabilized, purge an additional two (2) total well volumes, measuring and noting pH, specific conductivity, and temperature. Temperature, pH, and specific conductivity shall be recorded in the field book during these activities. Dispose of purge waters from the measuring 5 gallon bucket to the ground downgradient of the wellhead or in the 55 gallon drums located at each well as determined necessary.

### **Step 5**

After purging the well, reduce the flow rate of evacuated water to less than 100 ml/min. or 0.03 gal./min. Continue purging 15 seconds for every foot in depth of the well. This is done to evacuate potentially volatilized groundwater within the discharge hose down to the pump, prior to sampling. Begin filling the prepared sample bottles. Low yield wells must be sampled within 24 hours of sampling. If yield is insufficient to obtain the required sample volume, note samples not obtainable in the field log. During sample collection, all sample bottles shall be inspected prior to filling and unusual observations shall be recorded in the field

**TABLE 3  
FINAL DETECTION AND ASSESSMENT MONITORING  
SAMPLING AND PRESERVATIVE PROCEDURES<sup>1</sup>**

PARAMETER	CONTAINER/ VOLUME REQUIRED	PRESERVATIVE	MAXIMUM HOLDING TIME
<b>INORGANIC TESTS</b>			
Cyanide	P, G - 500 ml	Cool to 4°C, NaOH to pH>12, 0.6 g ascorbic acid.	14 days
Sulfide	P, G - 500 ml	Cool to 4°C, add Zinc acetate	7 days
<b>METALS TESTS</b>			
Mercury (total)	P - 300 ml	HNO <sub>3</sub> to pH<2	28 days
Metals (total) except Mercury and Chromium VI	P - 1 L	HNO <sub>3</sub> to pH<2	6 months
<b>ORGANIC TESTS</b>			
Acrolein and acrylonitrile	2 - 40 ml VOA <sup>3</sup> w/ G, Teflon-lined septum	Cool to 4°C, 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> , adjust pH to 4-5	14 days
Benzidines	G, Teflon-lined cap - 1 L	Cool to 4°C, 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> , adjust pH to 4-5	7 days until extraction; 40 days after extraction
Haloethers	G, Teflon-lined cap - 1 L	Cool to 4°C, 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	7 days until extraction; 40 days after extraction
Phthalate esters	G, Teflon-lined cap - 1 L	Cool to 4°C	7 days until extraction; 40 days after extraction
Nitrosamines	G, Teflon-lined cap - 1 L	Cool to 4°C, store in dark, 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	7 days until extraction; 40 days after extraction
Nitroaromatics and cyclic ketones	G, Teflon-lined cap - 1 L	Cool to 4°C, store in dark, 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	7 days until extraction; 40 days after extraction
PCBs	G, Teflon-lined cap - 1 L	Cool to 4°C	7 days until extraction; 40 days after extraction
Phenols	G, Teflon-lined cap - 1 L	Cool to 4°C, 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	7 days until extraction; 40 days after extraction
Purgeable Aromatic Hydrocarbons	2 - 40 ml VOA <sup>3</sup> G, Teflon-lined septum	Cool to 4°C, 0.008%, Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> , HCL to pH2	14 days
Purgeable Halocarbons	2 - 40 ml VOA <sup>3</sup> w/ G, Teflon-lined septum	Cool to 4°C, 0.0008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	14 days
Polynuclear aromatic hydrocarbons	G, Teflon-lined cap - 1 L	Cool to 4°C, 0.008% Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> . Store in dark.	7 days until extraction; 40 days after extraction
Chlorinated hydrocarbons	G, Teflon-lined cap - 1 L	Cool to 4°C	7 days until extraction; 40 days after extraction
<b>PESTICIDES TESTS</b>			
Pesticides	G, Teflon-lined cap - 1 L	Cool to 4°C. pH 5-9	7 days until extraction; 40 days after extraction

Notes:

- (1) Test Methods for Evaluating Solid Waste - Physical/Chemical Methods, SW-846, latest edition
- (2) P - Plastic, G - Glass, T - Fluorocarbon Resin (PTFE, Teflon, FEP, etc.)
- (3) Do not allow any head space in VOA container.
- (4) Shipping containers should be certified as to 4°C temperature at time of sample placement into these containers. Preservation of samples requires the temperature of collected samples be adjusted to 4°C immediately after collection.
- (5) Based on regulatory requirements, the volume collected must be sufficient to allow for the analysis on each parameter.

book. Depending on required analyses for that event, samples shall be taken from each well in the following order so as to diminish the loss of volatile components from the water:

NOTE: For all volatile and semi-volatile organic sampling as indicated below and in Table 3, it is critical that sample bottles be filled completely with the water sample, leaving no head space between the water sample and the cap. This can be done by overfilling the bottle and sliding the TEFLON cap over the water meniscus while making sure no air pockets are trapped under the lid. After sealing, the bottle shall be inspected for the presence of any air space and observations will be recorded in the field book.

#### Volatile Organic Compounds

- Purgeable Halocarbons
- Purgeable Aromatic Hydrocarbons
- Acrolein and acrylonitrile

#### Semi Volatile Organic Compounds

- Benzidines
- Phthalate esters
- Nitrosamines
- PCBs
- Nitroaromatics and cyclic ketones
- Polynuclear aromatic hydrocarbons
- Haloethers
- Chlorinated hydrocarbons

#### Total Metals

#### Phenols

#### Pesticides

#### Other Inorganics

- Cyanide
- Sulfide

### **Step 6**

Affix to each sample bottle a properly completed sample label listing the following information:

Watauga County Landfill  
Monitoring Well ID (#)  
Date  
Time  
Name of Collector  
Preservation method  
Analysis required

### **Step 7**

After collecting the water samples, place bottles into sealed clear plastic bags so sample labels are visible. Place bottles immediately in the cooler chilled to 4 C. Avoid exposure of samples to direct sunlight as much as possible due to the potential of increasing biological activity in the water and thus changing the sample quality. The cooled samples shall be transported in the 4 C cooler.

### **Step 8**

Utilizing pH measurements observed during purging, the pH meter shall be calibrated immediately prior to final field measurements for each well, using standard stock pH buffer solutions and clean micro cups. In the case that observed pH was generally acidic (i.e. <7.00), pH buffer solutions of  $4 \pm 0.01$  and  $7 \pm 0.01$  standard pH units shall be used for linear calibration. Otherwise, pH buffer solutions of  $7 \pm 0.01$  and  $10 \pm 0.01$  standard pH units shall be used. The specific conductance meter shall be calibrated, either in the laboratory or in the field, using a standard potassium chloride solution prepared by a competent laboratory. Calibration of the specific conductance meter shall occur at least once on the day of sampling and prior to sampling of any well. All calibrations shall be noted in the field book and shall indicate time of day and measurements.

Measure in four replicates, and record (and denote) as final measurements in the field book, the pH and specific conductance of the groundwater in the well after sample collection.

Measure and record temperature of the groundwater. Secure the monitoring well closed and locked.

### **Step 9**

A chain-of-custody form, shown in Figure 3, shall be initiated for each sample at the time of collection, and will accompany each sample from the time of collection onward, through all transportation. If the samples are to be shipped, enclose the Chain of Custody form and other



sample documentation accompanying the shipment in a waterproof plastic bag taped to the underside of the cooler lid.

### **3.4 SURFACE WATER SAMPLE COLLECTION PROCEDURES**

Surface water and leachate samples shall be collected according to the following methodology in order to produce a sample that is representative of the sampling location. The procedures required for the collection of surface water samples shall duplicate applicable procedures required for the collection of groundwater samples. Applicable procedures include label, container, preservative, and chain of custody requirements covered in the preceding and following sections.

The sampling equipment utilized for surface water and leachate sample collection shall be composed of glass, stainless steel or a Teflon-coated material and shall be decontaminated between sampling locations to reduce the possibility of cross-contamination. The decontamination procedure shall entail washing with non-phosphate soapy distilled water and rinsing three times with deionized/distilled water.

The surface water sample collected from the last of the series of sediment ponds shall be collected from the discharge of the pond into the stream located below the sediment pond.

The surface water sample collected from the stream shall be collected 600 feet downstream of the last of the series of sediment ponds at the landfill property boundary to ensure the sample location is clear of immediate point sources of contamination. The stream sample shall be collected toward mid-channel in a well-mixed, turbulent area to ensure that the sample is representative and proportional to the total flow of the stream.

Leachate samples shall be collected from the zone of maximum flow within the area of leachate production to ensure that the sample is representative and proportional to leachate potentially impacting surface water.

### **3.5 SAMPLE PRESERVATION AND HANDLING**

Samples will be preserved with the proper preservatives in accordance with Test Methods for Evaluating Solid Waste - Physical/Chemical Methods, SW-846<sup>(5)</sup> as summarized in Table 3, Guide to the Contract Laboratory Program<sup>(13)</sup> for low detection limits, or other referenced methods deemed appropriate.

Prior to sample collection, sample bottles will be prepared by the analyzing laboratory. If any or all samples leave the immediate control of the person(s) who collected, and are responsible for the samples (i.e. during shipment to a laboratory by common carrier), a seal must be placed on the shipping container or on each individual sample. The seal must verify that the samples were not disturbed during transport. All sample containers shall be packed in a cooler with ice as soon as they are collected. Ice should be sealed in plastic bags to contain melted water. Glass shipping containers should be packed with noncombustible packing material,

surrounding the sample bottles to avoid breakage. As previously noted, a custody seal should be placed across the cooler opening, in a manner that the seal would be broken if the cooler were opened. Shipping coolers must have a visible return address label on the outside. Samples shall be transported to the laboratory in this cooler.

In the event that final receipt by the laboratory of any shipping container or sample bottle indicates a broken seal or other evidence of compromised sample integrity, the laboratory QA/QC officer or his/her representative shall notify Watauga County or its representative within 24 hours of receipt.

### **3.6 SAMPLE DOCUMENT CUSTODY PROCEDURES**

All samples shall be properly documented to ensure timely, correct and complete analysis.

#### **3.6.1. Sample Number**

Each sample collected shall contain a unique sample number. Care shall be taken not to duplicate sample numbers. Sample container labels, noting the individual sample number, shall be written in indelible ink. Sample container labels shall be covered with clear, water proof tape to ensure sample label integrity.

#### **3.6.2. Chain-of-Custody Documentation**

A chain-of-custody form, as shown in Figure 3 or as provided by the analytical laboratory, shall be initiated for each sample collected to provide constant and accurate information on sample custody. The chain-of-custody form shall also be used to accurately designate the parameters for which each sample will be analyzed. Documentation of sample custody shall be provided from the time of sample collection, through laboratory analysis, until introduction as litigation evidence, if necessary.

The chain-of-custody shall be completed using waterproof ink. All corrections shall be made by drawing a single line through the error. All corrections shall be dated and initialed.

An original signed chain-of-custody copy shall be completed for each sample cooler shipped to the laboratory. The chain-of-custody copy shall be enclosed in plastic and taped to the underside of each cooler lid. A copy is retained for the sampler's files. Whenever samples are split for analysis, a separate chain-of-custody record must be prepared.

If any or all samples leave the immediate control of the sampler, (i.e. during shipment to the laboratory by common carrier), a custody seal must be placed on the shipping container, or on each individual sample, in a manner that the seal would be broken if the cooler were opened. The seal must verify that the samples were not disturbed during transport.

Upon laboratory receipt, a laboratory representative shall sign and date chain of custody record to acknowledge sample receipt and document sample conditions. As previously noted,

in the event that final receipt by the laboratory of any shipping container or sample bottle indicates a broken seal, bottle or other evidence of compromised sample integrity, the laboratory shall notify the County of Watauga or its representative within 24 hours. All original laboratory reports and chain-of-custody documentation shall be maintained in a secured area upon project completion for an indefinite period.

### **3.6.3 Sample Packaging and Shipment**

Samples shall be placed into waterproof, metal or hard plastic ice chests or coolers for sample transport. Inside the cooler, samples will be placed into clear plastic bags. Glass shipping containers should be packed with non-combustible packing material, surrounding the bottles, to avoid breakage.

All sample containers shall be placed in a cooler with ice, as they are collected, and prior to shipment if necessary. Ice should be sealed in plastic bags to contain melted water.

Shipping coolers must have a clearly visible return address label on the outside.

### **3.6.4. Additional Requirements if Undertaking Contract Laboratory Program (CLP) Services**

In addition to the above noted items if utilizing services through the Contract Laboratory Program (CLP) the following additional documentation procedures are required:

**Sample Tag:** Each sample submitted to the laboratory for analysis must include a sample tag, which specifies sample specific information. The sample tags are retained by the laboratory as physical evidence of sample receipt. The sample tag is attached to each sample container.

**Chain of Custody:** Upon laboratory receipt of the samples, the laboratory is responsible for maintaining internal logbooks and records to document the sample custody record.

**Sample Packaging and shipment:** All samples must be packaged for shipment in compliance with the most current U.S. Department of Transportation, state, local and commercial carrier regulations.

## **3.7 ANALYTICAL PROCEDURES**

The sampling and analysis methods set forth in the USEPA document Test Methods for Evaluating Solid Waste, SW-846 (latest edition)<sup>(9)</sup>, Contract Laboratory Program Statements of Work (SOW) (3/90, 6/91, 10/91), EPA Methods 502.2 and 524.2 set forth in the USEPA document Methods for the Determination of Organic Compounds in Drinking Water, or other analytical methods as necessary, will be utilized for all sample analyses performed at the Watauga County Landfill.

Table 4 presents a complete listing of assessment plan monitoring parameters. Table 4A

presents a complete listing of Detected Assessment Plan monitoring parameters. It should be noted that the following compounds detected to date, and considered target compounds, are denoted on both tables with a (\*). Tables 4 and 4A are found in Appendix III.

- Current Target Analyte List:
- Trichloroethene
  - 1,1,1-Trichloroethane
  - Tetrachloroethene
  - 1,1-Dichloroethane
  - 1,1-Dichloroethene
  - cis-1,2-Dichloroethene
  - Methylene Chloride
  - Vinyl Chloride
  - Dichlorofluoromethane
  - Chloroethane
  - Benzene
  - Trans-1,3-Dichloropropene
  - Cadmium
  - Iron
  - Mercury
  - Barium

With subsequent sampling events, additional target compounds may be added to this list. It should be noted that Benzo(-a) pyrene initially will be analyzed to meet the maximum contaminant level. If Benzo(-a) pyrene is not detected, subsequent analysis will be conducted at a slightly elevated detection level. (See Table 4 and 4A).

Analytical methods for Assessment monitoring will be listed in Table 4, along with associated method detection limits. Analytical methods for Detection Monitoring parameters will be referenced in Table 4A.

### **3.8 QUALITY ASSURANCE/QUALITY CONTROL**

Specific quality assurance objectives for the field and laboratory are provided in Section 4.1.2 of the Watauga County Landfill Assessment Plan<sup>(1)</sup>. The following are additional objectives for project QA/QC.

#### **3.8.1. Field Quality Assurance Objectives**

##### ***Field Blanks***

Two specific types of field blanks to be utilized in this project include a trip blank and equipment blank. Detailed descriptions are provided below.

- Trip blank: In order to monitor extraneous contamination that may be introduced during sample shipment and storage, a trip blank will be analyzed with each

sampling event. The trip blank shall be filled with distilled/deionized water by the laboratory and scheduled to complete the groundwater analysis. The trip blank shall accompany the sampling kit and remain unopened in the transport cooler at all times.

- Equipment blank: As dedicated sampling equipment will be maintained on site, an equipment blank, used to monitor sampling device cleanliness, for each sampling event is considered unnecessary. However, Draper Aden Associates recommends the collection of an equipment blank for the initial sampling event only, to document contaminants, if any, influencing the sample from the sampling equipment.

### ***Equipment Calibration***

A predetermined calibration schedule is established for each piece of field testing equipment. Records are kept for all testing equipment and are periodically reviewed.

### **3.8.2. Laboratory QA/QC Objectives**

The laboratory performing the analytical services shall follow all QA/QC procedures described for the referenced analytical method for each parameter. Prior to contracting a laboratory for analysis, the laboratory's specific QA/QC procedures will be reviewed by Watauga County or its representative.

Other laboratory QA/QC objectives not previously discussed include the following:

#### ***Precision and Accuracy***

In order to monitor and evaluate laboratory precision and accuracy on the site sample matrix, a duplicate sample for all parameters must be collected from every tenth well for matrix spike/matrix spike duplicate analysis.

#### ***Reporting of MDLs and PQLs***

Analytical results shall not be reported below the acceptable Method Detection Limit (MDL) or the stated MDL for each parameter listing in Table 4 for any sample unless full certification of laboratory protocol and standard operating procedure can be established which meet all recordkeeping requirements of SW-846 for laboratory specific determinations of MDLs.

The definition of MDL and Practical Quantitation Limit (PQL) are presented in Table 4. In all cases, the analyzing laboratory shall report the final result as below the quantified (MDL) if the value falls below the applicable MDL. If the value is detected above the MDL, the laboratory shall report this value as a final result. In all cases, the laboratory shall also report the applicable PQL for each sampling parameter.

### **3.9 ANALYTICAL REPORT SPECIFICATIONS**

#### **3.9.1. Laboratory Report Specifications**

Final results will be submitted in a bound report by the analyzing laboratory and will include the following:

Original Chain of Custody (include documentation of sample condition upon receipt)  
Date/time collected  
Date/time received by laboratory  
Date/time analyzed by laboratory  
Method detection limit (MDL) and  
Practical Quantitation Limit (PQL);  
or contract Required Detection Limit (CRDL) or Contract Required Quantitation Limit  
(CRQL)  
Sample matrix  
Client ID and location  
Result with data qualifier  
Referenced Analytical Method  
Copy of all required cover letters bound within the report

Should the primary laboratory subcontract out samples for analysis, the analytical results from the subcontract laboratory must be included in the primary laboratory's final report. The subcontracted laboratory report shall be provided as an appendix.

#### **3.9.2. QA/QC Report Requirements**

As QA/QC reporting requirements may vary, the following five QA/QC reporting levels are provided. QA/QC report selection will be based on final data package use, with Level V, being the most rigorous/defensible format. QA/QC reporting levels shall be selected prior to initiation of laboratory analysis.

##### **Level I**

- Statement of adherence to QA/QC procedures for each analysis as per the referenced method.
- Raw data and Chromatograms (optional)

##### **Level II**

- Statement of adherence to QA/QC procedures as per the referenced analytical method for each analysis (with adherence to QA/QC specifications detailed in Section 3.0 below, where applicable).

- Raw QA/QC data/chromatograms (optional)

#### Level III

- QA/QC report in "CLP" format in Summary Tables only
- Raw data/chromatograms (optional)

Note: Does not require CLP certification

#### Level IV

- QA/QC report in "CLP" format" with data validation
- Raw data and chromatograms (optional)

Note: Does not require CLP certification

#### Level V

- Adherence to Contract Laboratory Program (CLP) deliverables (including EPA data validation and raw data/chromatograms)

Note: Must be a certified CLP Laboratory

### **3.9.3 QA /QC Statement Specifications for Level II Reporting**

#### Instructions:

QA/QC report Level II requires a statement from the laboratory, for each analysis, regarding adherence to specific method QA/QC criteria. This narrative should summarize method criteria data obtained during analytical services, as well as note problems encountered which may affect the data integrity. As a minimum requirement, where applicable, the following general method criteria for both organic and inorganic analysis should be addressed. Additional method criteria may be necessary as per the referenced analytical method. The laboratory statement shall be signed by the laboratory director or duly authorized representative.

#### *Organic Analysis Method Criteria*

- Instrument/Tuning Performance Check: Provide statement of adherence to established method performance criteria in all circumstances for the Instrument/Tuning Performance Check. Performance criteria includes, but is not limited to analysis of the correct compound, at the required concentration and frequency range and within the relative ion abundance criteria.
- Initial Calibration: Provide statement of adherence to established method requirements.

Method requirements vary, but statement should address analysis of the required analyses, at the required number of levels and concentrations, within the required frequency and within the required response factor and linearity (% RSD) criteria.

- Continuing Calibration: Provide statement of adherence to method requirements for continuing calibration. Method requirements vary, but statement should address analysis of the required analyses, at the required concentrations, within the required frequency, and within the required response factor and precision (%D) criteria.
- Method Blanks: Provide statement of adherence to method quality control requirements for method blanks. Statements should address analysis of correct material source, at the required frequency, and within the required criteria for acceptable background levels.
- Sample Matrix Checks: Provide statement of adherence to method requirements. Statements should address accuracy (% recovery) and precision (relative percent difference)
- QA/QC Check Samples: Provide statement of adherence to method requirements.
- Provide statement of adherence to method holding times.
- Provide statement of adherence to method criteria regarding GC/MS sensitivity and response stability specifically for standard areas and retention times, where applicable.
- Provide statement of adherence to surrogate recovery criteria.
- Provide statement of other problems encountered.

#### *Inorganic Analysis Method Criteria*

- Initial and Continuing Calibration: Provide statement of adherence to calibration compliance requirements.
- Blanks: Statement of adherence to method requirements for blanks.
- Laboratory Control Sample (LCS): Provide statement of adherence to LCS requirements for meeting control limits.
- ICP Interference Check Sample: Provide statement of adherence to method requirements for duplicate sample analysis.
- Duplicate Sample Analysis: Provide statement of adherence to method requirements for duplicate sample analysis.
- Sample Matrix Checks: Provide statement of adherence to method requirements. Statement should address (% recovery), and specified spike recovery control limits.

- Furnish Atomic Absorption QC: Provide statement of adherence to method requirements, which include spike recovery and relative standard deviation (RSD).
- ICP Serial Dilution: Provide statement of adherence to method requirements, which include percent difference (%D) of the required dilution to the original result.
- Provide statement of adherence to technical holding times.
- Provide statement of other problems encountered.

### **3.9.4 Additional Requirements**

- Cover letter: As previously noted, for each analytical report, the laboratory will provide a cover letter with a statement of adherence to the established QA/QC method requirements utilized and as explicitly defined above and additional "QA/QC Specifications" described in items 2 through 7, directly below. The laboratory narrative shall discuss concerns or any quality control data not adhering to the referenced method performance criteria, in-house quality control performance criteria, or other unspecified problems potentially effecting the data integrity.

Should the laboratory subcontract out samples for analysis, a cover letter from the subconsulting laboratory noting adherence to the method requirements and any problems encountered is also required.

- The laboratory report will denote those compounds which utilize internal (in-house generated) QA/QC performance criteria control limits (not set forth in the referenced analytical method).
- If it is necessary to dilute a sample, the result listed in final report should be accompanied by the code "D", indicating the detection limit changed due to a dilution.
- Results determined using the method of standard additions should be accompanied by the code "S".
- Recoveries for any analyte which falls outside the EPA control limits, must be denoted as estimated by the code "E".
- Analytical results shall not be reported below the stated MDL unless the laboratory can meet all record keeping requirements for laboratory specific determination of MDLs.
- The analytical report must be signed by the Laboratory Director, or a duly authorized representative.

### **3.10 DATA VALIDATION/DATA QUALIFICATION**

The purpose of data validation is to determine the compliance of analytical data with the established method criteria and project specifications. Data Validation is dependent upon the requested level of QA/QC; (See Section I.2).

For QA/QC levels II through V, DAA will utilize the data validation guidelines established as appropriate. For data obtained from the Contract Laboratory Program SOWs, the following items listed for both organic and inorganic analysis, will be evaluated for adherence to the method criteria and Project Specification:

#### **3.10.1 Method Criteria (Organic Analysis)**

- Instrument/Tuning Performance Check:

DAA will review laboratory's statement of adherence to the established method performance criteria in all circumstances for Instrument/Tuning Performance Check. Performance criteria include analysis of the correct compound, at the required concentration and frequency range, and within the relative ion abundance criteria.

- Initial Calibration:

DAA will review the laboratory's statement of adherence to initial calibration method requirements. Method requirements vary but include analysis of the required analyses, at the required number of levels and concentrations, within the required frequency and within the required response factor and linearly (% RSD) criteria. Initial calibrations are performed prior to an analytical run.

- Continuing Calibration:

DAA will review the laboratory's statement of adherence to method requirements. Method requirements vary between methods but include analysis of the required analyses, at the required concentrations, within the required frequency and within the required response factor and precision (% D) criteria. Continuing calibrations are performed after the initial calibration and for each analytical run.

- Method Blanks:

DAA will review the laboratory's statement of adherence to quality control requirements for method blanks. Specifically, the laboratory must analyze the correct material source, at the required frequency, and within the required criteria for acceptable background levels.

- Sample Matrix Checks:

DAA will evaluate matrix spike and matrix spike duplicate data for analysis accuracy (reported as percent recovery) and precision (reported as relative percent difference).

- Other

- Preservation Procedures:

Draper Aden Associates will review preservation procedures for adherence to the method.

- Technical Holding Times:

Draper Aden Associates will review sample collection dates and sample analysis dates to verify technical holding times were met.

- Internal Standards:

Draper Aden Associates will review laboratory's statement of adherence to method requirements for internal standard areas and retention times or comparable to the associated calibration standard when not stated in the method.

- Surrogate Recoveries:

Draper Aden Associates will review surrogate recoveries to ensure recoveries are within method specific recovery criteria ranges.

- Background Contamination:

Draper Aden Associates will review results of background contamination, if any, and evaluate effects on sample results.

- Units/Detection Limits/Method References:

Draper Aden Associates will evaluate appropriateness of units, appropriateness of detection limits, and method references.

### **3.10.2. Method Criteria (Inorganic Analysis)**

- Initial and Continuing Calibration:

Draper Aden Associates will review laboratory's statement of adherence to calibration compliance requirements for the specific method of analysis. Instruments must be calibrated daily and each time the instrument is set up.

- Blanks:

Draper Aden Associates will review the laboratory's statement of adherence to quality control requirements for any blanks.

- Laboratory Control Sample (LCS):

Draper Aden Associates will review the laboratory's statement of adherence to LCS requirements for control limits.

- Duplicate Sample Analysis:

Draper Aden Associates will review the laboratory's statement of adherence to method requirements for duplicate sample analysis indicating laboratory precision. Samples identified as field blanks cannot be used for duplication sample analysis.

- Sample Matrix Spike Checks:

Draper Aden Associates will evaluate matrix spike data for analysis accuracy, reported as percent recovery, % R. Spike recovery must meet the specified control limits.

- Other

- Preservation Procedures:

Draper Aden Associates will review preservation procedures for adherence to method requirements.

- Technical Holding Times:

Draper Aden Associates will review sample collection dates and sample analysis dates to verify technical holding times were met.

- Background Contamination:

Draper Aden Associates will review results of background contamination, if any, and evaluate effects on sample results.

- Units/Detection Limits/Method References:

Draper Aden Associates will evaluate appropriateness of units, appropriateness of detection limits, and method references.

### **3.10.3 Data Qualification**

As the final step in data validation, where appropriate, data generated during this study will be validated and qualified utilizing substantial guidance from the "National Functional Guidelines for Organic Data Review", dated June 1991, and "Functional Guidelines for Evaluating Inorganic Analysis", dated July 1, 1988. These documents were created by the EPA to assist in the technical review of analytical data generated through the CLP program. However, these documents offer a feasible approach to identify technically valid data.

Questionable data, data that does not meet the required method specifications will be qualified by Draper Aden Associates according to nationally known qualifiers noted below:

- U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
- J - The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
- N - The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
- NJ - The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.
- UJ - The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- R - The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

Additionally, project specifications require the laboratory performing the analytical services to utilize the following data qualifiers:

- D - The sample was diluted to obtain the result.
- S - Method of Standard Additions was utilized to obtain the result.
- E - Laboratory recoveries fell outside EPA control limits. Results are approximate concentrations.
- TI - The laboratory tentatively identified the analyte.

### **3.11 EVALUATION OF GROUNDWATER QUALITY DATA**

The results of the groundwater sample analyses must be compiled, evaluated and interpreted before being submitted to the NCDEHNR Solid Waste Section. The parametric analysis of variance (ANOVA) test will be the primary statistical method in evaluating and interpreting the groundwater quality analytical results for monitoring wells in the network after background data collection is completed. Exploratory data analysis, as supported by the TEGD<sup>(10)</sup>, may also be used as necessary to evaluate data sets for use in statistical tests. Application of statistical procedures is further discussed below as taken from 15A NCAC 13B Section .1632 of the proposed requirements for Municipal Solid Waste Landfill Facilities.

### **3.11.1 Reporting of Low and Zero Values**

For parameters measured below the method detection limit of the analyses, the data shall be entered in the ANOVA statistical analysis as one half the reported method detection limit. This should provide the best criteria for unbiased test results. For parameters measured below the practical quantitation limit and above the method detection limit, data shall be reported, and entered in the ANOVA statistical analysis as such. In all cases, appropriate statistical procedures will be performed on data reported in this manner, but qualified as below the PQL for some data.

In assessing low concentrations and conducting statistical analysis, available statistical methods defined in references [6]-[9] may be used.

### **3.11.2 Missing Data Values and Outliers**

In the event of losing an analysis of the groundwater sample, for whatever reason, an evaluation to resample the well for the missing parameter(s) will be made. Missing data will not be desirable due to the critical role of the groundwater monitoring program in maintaining water quality and landfill operation. However, an evaluation of groundwater contamination will be made under situations where an entire data set for a well is missing, or a sampling event was stripped. According to the United States Environmental Protection Agency document RCRA Groundwater Monitoring Technical Enforcement Guidance Document (TEGD)<sup>(10)</sup> evaluation of groundwater sampling is encouraged even when entire data sets are missing. The following guidelines were taken directly from the above document and shall be followed for statistical analysis of groundwater samples during Assessment and Detection monitoring:

- If there are data from one upgradient well and one downgradient well, statistical comparisons should still be made. If data exists for three quarters at a well, statistical comparisons should be made after applying the rule described in the next bullet.
- If only one quarter of data is missing, values should be assigned for the missing quarter by averaging the values obtained during the other three quarters.
- If there are missing replicate measurements from a sampling event, then average the replicate(s) that are available for that sampling event.

The operator of the landfill or his/her representative may correct outliers of any data set under circumstances where such correction can be justified, and can be shown to be applicable, utilizing techniques or methods available in peer-reviewed literature within the scientific community. The correction of outliers of measured groundwater quality parameters can be done by qualified persons who are evaluating the data. The required documentation to correct outliers shall include the reason for correcting the value, the method of correction and any other pertinent information about the outlier(s). This documentation shall accompany the report on groundwater quality evaluation submitted to the NCDEHNR Solid Waste Section.

### **3.11.3 Non-Normal Data Distributions**

In the event that any individual data distribution for a given well is shown to be inappropriate for a normal ANOVA analysis after attempts to transform the data are unsuccessful, then the ANOVA based on ranks will be used. This will include evaluation of the normalcy of the residual for the given data distribution set. In the event that non-parametric ANOVA analysis cannot be completed, based on characteristics of the data distributions in question, then other non-parametric statistical procedures may be utilized. In this case, statistical procedures will be conducted in accordance with guidance provided in the TEGD<sup>(10)</sup> and guidance provided in references [6]-[9].

### **3.12 EVALUATION OF GROUNDWATER FLOW RATE AND DIRECTION**

The groundwater flow direction within the soil aquifer will be based on the results of measurements of static water levels in the groundwater monitoring wells and will be collected and compiled after each sampling event. The flow rate will be evaluated within the soil aquifer by conducting the Bouwer and Rice Slug Test.<sup>(1)</sup> A presentation of Bouwer and Rice Slug Tests performed during the initial Bolick site investigation is contained in Section 3.1.8 of the Watauga County Assessment Plan.<sup>(1)</sup>

The groundwater flow direction within the fracture aquifer will be evaluated based on investigations into the global geometry of the fracture system as well as the potentiometric surface of the aquifer. A discussion concerning proposed fracture trace analysis activities can be found in Section 4.3.4 of the accompanying Watauga County Assessment Plan.<sup>(1)</sup> The groundwater flow rate within the fracture aquifer system will be evaluated through the use of various slug, recovery and pump test methods. A presentation of Cooper, Bredehoeft, Papadopolus Slug Tests<sup>(14)</sup> and Theis Recovery Tests<sup>(15)</sup> performed during the initial Bolick site investigation is contained in Section 3.1.8 of the Watauga County Assessment Plan.<sup>(1)</sup>

The flow rate will be reevaluated on an annual basis by accounting for any changes in hydraulic gradient that may significantly impact groundwater flow rate. When evaluating the flow rate and direction, the location of monitoring wells will be reviewed to ensure satisfactory placement in relation to both the waste management unit boundary and the documented contaminant plume boundary.

#### **IV. DESCRIPTION AND ACTIVITIES OF THE MONITORING PROGRAM**

This section describes the overall activities and time frame for which the groundwater monitoring program will be implemented by the Watauga County Landfill. The procedures for collecting and evaluating the groundwater quality data were discussed in Section III of this report.

##### **Assessment Plan Monitoring Program**

Under the new NCDEHNR Municipal Solid Waste regulations, an Assessment Monitoring Program is required to be implemented whenever a statistically significant increase is observed in previous monitoring results obtained from downgradient groundwater monitoring wells when statistically compared to the upgradient and each individual monitoring wells' background arithmetic mean and variance. Noting the Watauga County Landfill is not currently regulated under either of the new Assessment or a Detection Monitoring Programs described in NCDEHNR Municipal Solid Waste regulations (15A NCAC 13B Section.1600), the triggering mechanism for Assessment Monitoring has been defined within the Consent Agreement between Watauga County and the NCDEHNR Solid Waste Section. Under the circumstances of the Consent Agreement, the triggering mechanism for Assessment Monitoring as outlined in the Assessment Groundwater and Surface Water Monitoring Plan shall be the acceptance and approval of the enclosed Watauga County Landfill Groundwater and Surface Water Monitoring Program and accompanying Assessment Plan<sup>(1)</sup> by the NCDEHNR Solid Waste Section.

Under the new regulations, the Assessment Monitoring Program is required to be established within 90 days and at a minimum shall determine the rate and extent of migration and the concentration of the solid waste constituents in the groundwater. The monitoring parameters that are required to be sampled and analyzed under EPA's Subtitle D Assessment monitoring are the complete Appendix II List of Hazardous Inorganic and Organic Constituents (40 CFR Part 258). These constituents, found listed in Table 4 of this document, will be monitored in this Assessment Plan. Included in the enclosed table of Assessment monitoring parameters are analytical methods from SW-846 and associated method detection limits. North Carolina Groundwater Quality Standards (NCSs) are listed for parameters that have NCSs established by the NCDEHNR and Maximum Contaminant Levels (MCLs) are also listed for parameters that have MCLs established by the Environmental Protection Agency.

##### **4.1 FIRST YEAR AND SUBSEQUENT MONITORING**

As discussed in Section II, the design of the groundwater monitoring system for Watauga County Landfill is comprised of a network of "core" plume assessment wells and "boundary" plume assessment wells. Section III.A discusses the decision criteria to be utilized for determining sampling frequency and analytical procedures for the phased Assessment Plan monitoring program.

Upon acceptance and approval of the Watauga County Landfill Assessment Plan, Watauga County will sample and analyze the groundwater for all constituents identified in the Appendix II List of Hazardous Inorganic and Organic Constituents (40 CFR Part 258) annually. A minimum of one sample must be collected from each "core" plume assessment monitoring well

during these events. The sampling event performed on March 5, 1993 will be utilized as the initial annual Assessment monitoring event for the purpose of establishing previously detected constituents. All the monitoring wells ("core" and "boundary" plume assessment wells) are required to be sampled and analyzed for any Assessment monitoring constituents identified as target analytes detected as a result of the annual Assessment Plan groundwater monitoring events.

Four (4) quarterly samples shall be collected at all core plume assessment wells and analyzed for the Assessment monitoring constituents detected as a result of the initial Assessment monitoring event in order to determine background for those constituents. Independent background data samples shall be collected at three (3) month intervals to account for temporal variations in constituent concentrations.

After the first year of the Assessment Plan groundwater monitoring program, sampling and analysis for all Assessment monitoring constituents (Appendix II List) will be conducted on the "core" plume assessment wells utilizing low level risk assessment screening methods on an annual basis. Sampling and analysis for target analytes will be conducted for every well (both "core" and "boundary" plume assessment wells) utilizing risk assessment and CLP analysis, on an alternate semi-annual basis.

## **4.2 CONTINUED ASSESSMENT ACTIVITIES**

After each sampling event conducted during the Assessment Plan groundwater monitoring, a re-evaluation of the horizontal and vertical extent of the contaminant plume will be conducted. Appropriate revisions to the network of plume assessment monitoring wells will be initialized after the re-evaluation of the horizontal and vertical extent of the contaminant plume as detailed in Section II. Proposed revisions to the Watauga County Landfill Groundwater Monitoring Program may include both withdrawal of non-impacted wells and/or as installation of additional plume assessment wells, as well as revisions to the networks of "core" and "boundary" assessment monitoring wells.

In order to maximize the effectiveness and efficiency of the Watauga County Landfill Plume Assessment Monitoring Program, a core of primary plume assessment wells will be identified after an evaluation of the first sampling event for assessment monitoring has been conducted on the fourteen (14) proposed plume assessment wells and the four (4) existing monitoring wells. The "boundary" plume 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 contaminant plume. The decision criteria for selecting the networks of "core" and "boundary" plume assessment wells is covered in Section II.

The "core" plume assessment wells will be monitored according to the schedule for Assessment Monitoring described in Section III.A of this document. "Boundary" plume assessment wells will be monitored on a semi-annual basis and for the previously detected (confirmed) assessment monitoring parameters (40 CFR, Part 258 - "Appendix II List of Hazardous Inorganic and Organic Constituents")

Monitoring under the Assessment Plan monitoring program will continue until all Assessment

monitoring constituents are detected at levels at or below associated groundwater protection standards for each individual monitoring well, for all target analytes, for two consecutive annual Assessment monitoring events. If two consecutive monitoring events result in consistent levels at or below associated groundwater protection standards, the facility shall notify the NCDEHNR Solid Waste Section of this finding and may cease monitoring requirements as defined in this Assessment Plan and associated Watauga County Groundwater and Surface Water Monitoring Program.

#### **4.3. EVALUATION OF DATA**

Arithmetic means are calculated for all the detected Assessment monitoring parameter results obtained from the four independent samples collected from each monitoring well for the purpose of defining background. Assessment monitoring results obtained subsequent to collection of background will be statistically compared to the upgradient and to each individual monitoring well's background arithmetic mean and variance. The comparison shall be performed utilizing the ANOVA statistical method.

The ANOVA statistical analysis will be utilized to indicate if detected Assessment monitoring parameters are either at or below background values, above background but below groundwater protection standards (described in the following section), or above groundwater protection standards. This evaluation will be performed to track and characterize the nature, migration, and extent of the contaminant plume.

Watauga County may demonstrate that a source other than the facility caused the contamination, or that the statistically significant increases over background resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. A report documenting this demonstration shall be certified by a qualified groundwater scientist and approved by the Division. If a successful demonstration is made, Watauga County shall cease groundwater monitoring requirements as defined in this Assessment Plan and associated Watauga County Groundwater and Surface Water Monitoring Program. Until a successful demonstration is made, Watauga County will comply with Assessment monitoring program requirements described in the enclosed Groundwater and Surface Water Monitoring Program.

#### **4.4 RECORD KEEPING AND REPORTING DURING ASSESSMENT MONITORING**

For each sampling event, within 30 days after collection of the Assessment monitoring analytical samples, a report must be submitted to the Solid Waste Section listing concentrations of all Assessment monitoring constituents found in the groundwater.

Groundwater protection standards must be established for all Assessment monitoring constituents detected in the downgradient wells. The groundwater protection standard shall be the maximum contaminant level (MCL) identified in the Safe Drinking Water Act for constituents for which an MCL has been established. For constituents for which a water quality standard has been established under the N.C. Rules Governing Public Water Systems (15A NCAC 18C), the water quality standard (NCS) for that constituent. For constituents for which a water quality standard has been established under the N.C. Groundwater Classifications and Standards (15A NCAC 2L.0202), the water quality standard (NCS) for that constituent.

A quarterly report shall be submitted to the NCDEHNR Solid Waste Section. This report shall include all data collected from each well during the previous quarter as well as the calculated arithmetic mean and variance of each detected Assessment parameter from each well. The report shall include the statistical analysis utilizing the ANOVA method where the arithmetic mean and variance of each downgradient well is compared to each individual well's own background and the upgradient well(s) background where possible. The quarterly report shall include the following information:

- a. All data collected during the previous quarter from the Assessment sampling events, including groundwater elevation and monitoring parameter concentrations presented in summarized tabular form;
- b. Trend analysis of all current detected Assessment monitoring parameter concentrations;
- c. The calculations of arithmetic mean and variance of the detected Assessment monitoring parameters from each well including exploratory data analysis to further evaluate data trends and to determine the validity of assumptions for parametric analysis;
- d. The calculation of the ANOVA statistical analysis for comparison of the arithmetic mean and variance of all parameters for each well with both the background results for the Assessment monitoring results for the upgradient well(s), and with each well's own background arithmetic mean and variance, where data is available. Comparison of the arithmetic mean and variance of the indicator parameter for each well to background data using the ANOVA will determine any statistically significant increase in any Assessment monitoring parameter over initial background. In the event assumptions for normalcy do not hold and a significant increase in Assessment monitoring parameters is observed, then non-parametric ANOVA analysis will be performed since the assumptions for the parametric ANOVA analysis do not hold.
- e. Any actions taken, or proposed, on account of sampling procedure failure, groundwater flow direction determination error or possible contamination of groundwater shall be specifically discussed.

## REFERENCES

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16. U.S. EPA, Methods for the Determination of Organic Compounds in Drinking Water document #EPA\600/4-88/039, December, 1988.

**Appendix 1**

**Boring and Well Completion Logs**

WELL COMPLETION RECORD

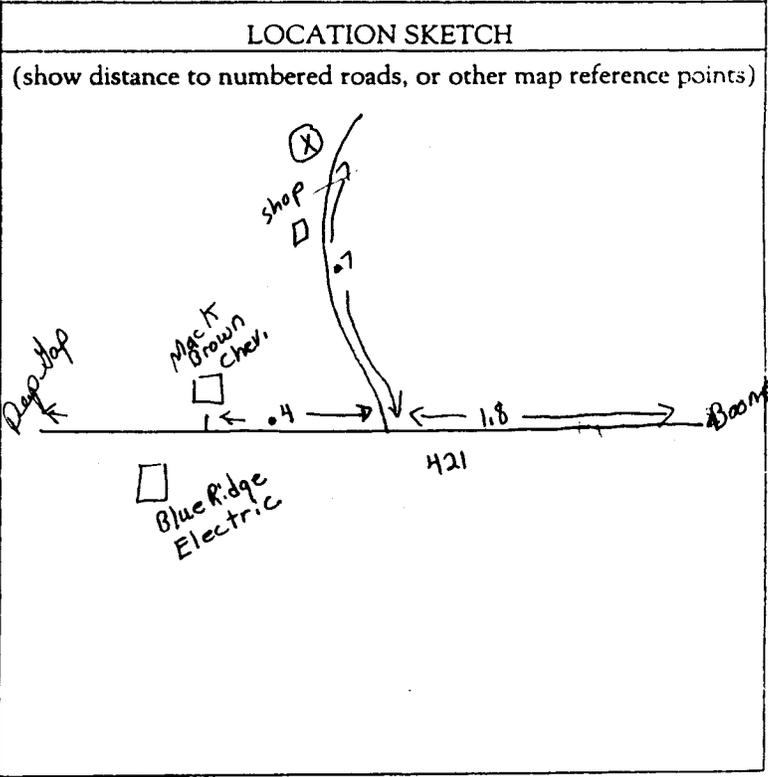
COMPLETE ALL INFORMATION REQUESTED BELOW FOR EACH WELL INSTALLED, AND RETURN FORM TO THE N.C. DEPARTMENT OF HUMAN RESOURCES, SOLID AND HAZARDOUS WASTE MANAGEMENT BRANCH, BOX 2091, RALEIGH, N.C. 27602

NAME OF SITE: <u>Watauga County Landfill</u>		Monitor <input checked="" type="checkbox"/> Well # <u>(1)</u>	PERMIT NO.:
ADDRESS: <u>Watauga County Courthouse</u>		OWNER (print): <u>Watauga County</u>	
DRILLING CONTRACTOR: <u>Dewey Wright Well + Pump Co Inc.</u>		REGISTRATION NO.: <u>2166</u>	

Type: PVC + Galv. dia. 6" + 4" in. Grout Depth: from 0 to 46' ft. - dia. 6 in.  
 Depth: from 0 to 36' ft. - dia. 4 1/4" in. Bentonite Seal: from 46' to 48' ft. - dia. 6 in.  
 Type: PVC pipe S1A20 dia. 4" in. Sand/Gravel PK: from 48' to 85' ft. - dia. 6 in.  
 Depth: from 70' to 80' ft. - dia. 4" in. Total Well Depth: from 0 to 85' ft. - dia. 6 in.

Water Level: 30' feet from top of casing Date Measured 04 / 12 / 89  
 (gpm): 2 gpm Method of Testing: Air Casing is 2' feet above land surface

DRILLING LOG		
DEPTH		FORMATION DESCRIPTION
0	10	dirt
	36	shale
	50	granite
	52	decomposed granite, quartz
	85	granite



REMARKS:

12-08-89 SIGNATURE: Willa Beach, Sec. © Dewey Wright Well + Pump Co. Inc.

# WELL COMPLETION RECORD

COMPLETE ALL INFORMATION REQUESTED BELOW FOR EACH WELL INSTALLED, AND RETURN FORM TO THE N.C. DEPARTMENT OF HUMAN RESOURCES, SOLID AND HAZARDOUS WASTE MANAGEMENT BRANCH, P.O. BOX 2091, RALEIGH, N.C. 27602

LOCATION OF SITE: Watauga County Landfill Monitor Well #12 PERMIT NO.: \_\_\_\_\_

ADDRESS: Watauga County Courthouse OWNER (print): Watauga County

INSTALLING CONTRACTOR: Watauga County Sanitation Dept. Room 003 Boone, NC REGISTRATION NO.: 266

Purvey Wright Well + Pump Co Inc.

Type: Sch 40 PVC dia. 4" in. Grout Depth: from 0 to 166 ft. - dia. 6 in.

Depth: from 0 to 170 ft. - dia. 4" in. Bentonite Seal: from 166 to 168 ft. - dia. 6 in.

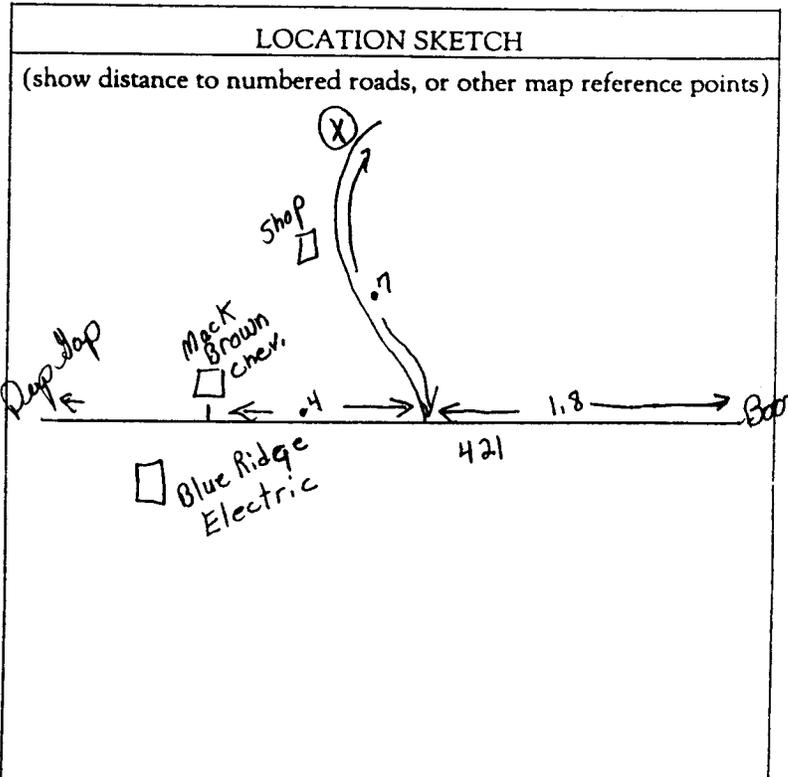
Type: PVC slot size 20 dia. 4" in. Sand/Gravel PK: from 168 to 185 ft. - dia. 6 in.

Depth: from 170 to 180 ft. - dia. 4" in. Total Well Depth: from 185 to \_\_\_\_\_ ft. - dia. 6 in.

Water Level: 10' feet from top of casing Date Measured 04 / 08 / 88

Flow Rate (gpm): 2 1/4 Method of Testing: Air Casing is 2' feet above land surface

DRILLING LOG	
DEPTH	FORMATION DESCRIPTION
10	dirt
68	shale, decomposed granite
170	granite
172	granite, quartz, shale
185	granite



REMARKS: \_\_\_\_\_

DATE: 12-08-89 SIGNATURE: Willa Beach, Sec. @ Purvey Wright Well + Pump Co





### MONITORING WELL/PIEZOMETER CONSTRUCTION LOG

**WELL NUMBER:** PZ-19 **Location:** N. edge of ridge between exist'g prop. sites  
**Project:** Wabasha Co. Landfill Hydrogeologic Study **Total Depth:** 73.0'  
**Project Number:** 6520-02 **Depth Water/24hr:** 50.75'  
**Date Start:** 8-10-92 **Ground Elevation:** 3263.81  
**Date Finish:** 8-10-92 **Riser Elevation:** 3266.86  
**Logged By:** JES **Protection Casing Elev.:** —

**DRILLING SUMMARY:** **Drillers:** ENGINEERING TECTONICS  
**Rig:** MOBILE DRILL (~~WATER~~ AIR ROTARY)

**Total Depth:** 73.0' **Bit Size/Type:** 5.5" **Drilling Fluid:** N/A  
**Depth Water Encountered:** 60.0' **Bore Hole Diameter(s):** 6"

**Comments:** Water produced in zone of mica schist

**WELL CONSTRUCTION MATERIAL DESCRIPTION:**

**Riser Material:** PVC  
**Riser Diameter:** 2"  
**Screen Material:** PVC  
**Screen Slot Width:** 0.010"  
**Joint Type(s):** Flush threaded  
**Surface Casing Description:** N/A

**Filter Packing Description:** #2 clean quartz sand

**Annular Seal Description:** 1/2" diameter 'Beroid' bentonite pellets

**Cement/Grout Description:** Portland Cement w/ 5% bentonite

**Method of Emplacement:** pour

**Surface Seal Design:** N/A

**Type of Protective Casing:** N/A

**WELL CONSTRUCTION DESIGN:**

**Screen Length/Depth Interval:** 73.0' - 63.0'

**Filter Packing Interval:** 73.0' - 61.0'

**Annular Seal Interval:** 61.0' - 59.0'

**Cement/Grout Interval:** 59.0' - surface

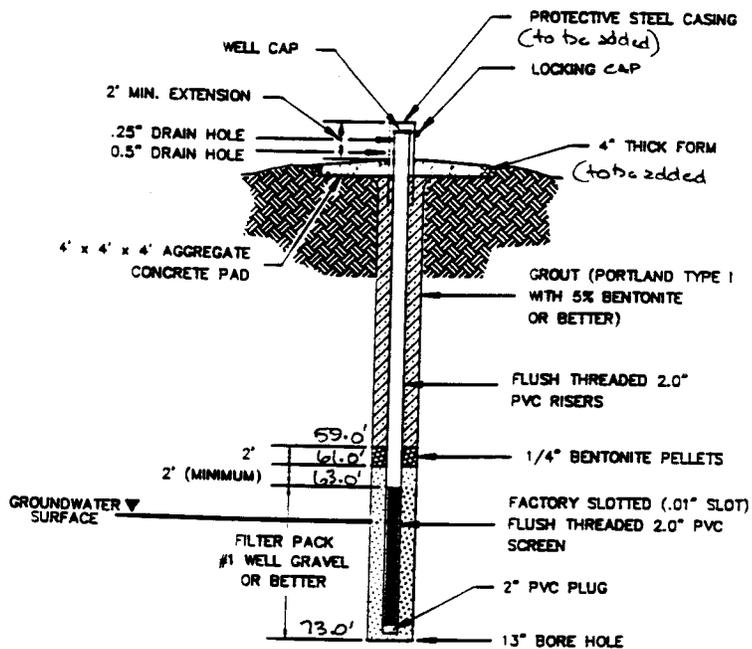
**Locking Cap:** Y/N

**Air Vent:** Y/N

**WELL DEVELOPMENT SUMMARY:**

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**DRAWING: WELL CONSTRUCTION**



**MONITORING WELL/PIEZOMETER CONSTRUCTION LOG**

WELL NUMBER: PZ-24  
 Project: Watauga Co. Landfill Hydrogeologic Study  
 Project Number: 6520-02  
 Date Start: 8-7-92  
 Date Finish: 8-7-92  
 Logged By: JES

Location: Saddle between existing and proposed sites  
 Total Depth: 58.0'  
 Depth Water/24hr: 41.96'  
 Ground Elevation: 3262.55  
 Riser Elevation: 3265.15  
 Protection Casing Elev.:     

DRILLING SUMMARY: Drillers: ENGINEERING TECTONICS  
 Rig: MOBILE DRILL (~~WATER~~ AIR ROTARY)

Total Depth: 58.0 Bit Size/Type: 5.5" Drilling Fluid: N/A  
 Depth Water Encountered: 38.0' & 52.0' Bore Hole Diameter(s): 6"

Comments: Water produced in zones of micis schist

**WELL CONSTRUCTION MATERIAL DESCRIPTION:**

Riser Material: PVC  
 Riser Diameter: 2"  
 Screen Material: PVC  
 Screen Slot Width: 0.010"  
 Joint Type(s): Flush threaded  
 Surface Casing Description: N/A

**Filter Packing Description:**

#2 clean quartz sand

**Annular Seal Description:**

1/2" diameter 'Beroid' bentonite pellets

**Cement/Grout Description:**

Portland Cement w/ 5% bentonite

**Method of Emplacement:**

pour

**Surface Seal Design:**

N/A

**Type of Protective Casing:**

N/A

**WELL CONSTRUCTION DESIGN:**

Screen Length/Depth Interval:  
58.0' - 48.0'

Filter Packing Interval:  
58.0' - 46.0'

Annular Seal Interval: 46.0 - 44.0

Cement/Grout Interval: 44.0 - Surface

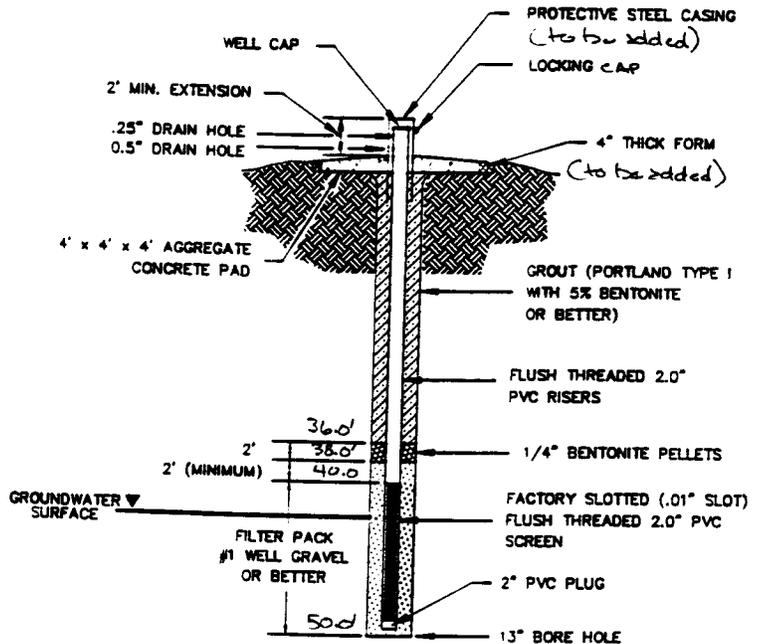
Locking Cap: Y/N

Air Vent: Y/N

**WELL DEVELOPMENT SUMMARY:**

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**DRAWING: WELL CONSTRUCTION**



**MONITORING WELL/PIEZOMETER CONSTRUCTION LOG**

WELL NUMBER: PZ-25  
 Project: Wabun Co. Landfill Hydrogeologic Study  
 Project Number: 6520-02  
 Date Start: 8-11-92  
 Date Finish: 8-11-92  
 Logged By: JES

Location: SE of Bolick Site adjacent to access road  
 Total Depth: 50.0'  
 Depth Water/24hr: 27.15'  
 Ground Elevation: 3270.56  
 Riser Elevation: 3273.61  
 Protection Casing Elev.: —

DRILLING SUMMARY: Drillers: ENGINEERING TECTONICS  
 Rig: MOBILE DRILL (~~WATER~~ AIR ROTARY)

Total Depth: 50.0 Bit Size/Type: 5.5" Drilling Fluid: N/A  
 Depth Water Encountered: 26.0' & 39.0' Bore Hole Diameter(s): 6"

Comments: Very slow water production (~1-2 ft/24 hrs) - Water produced in zones of micz schist

**WELL CONSTRUCTION MATERIAL DESCRIPTION:**

Riser Material: PVC  
 Riser Diameter: 2"  
 Screen Material: PVC  
 Screen Slot Width: 0.010"  
 Joint Type(s): flush threaded  
 Surface Casing Description: N/A

Filter Packing Description: 2 clean quartz sand

Annular Seal Description: 1/2" diameter 'Beroid' bentonite pellets

Cement/Grout Description: Portland Cement w/ 5% bentonite

Method of Emplacement: pour

Surface Seal Design: N/A

Type of Protective Casing: N/A

**WELL CONSTRUCTION DESIGN:**

Screen Length/Depth Interval: 50.0' - 40.0'

Filter Packing Interval: 50.0' - 38.0'

Annular Seal Interval: 38.0' - 36.0'

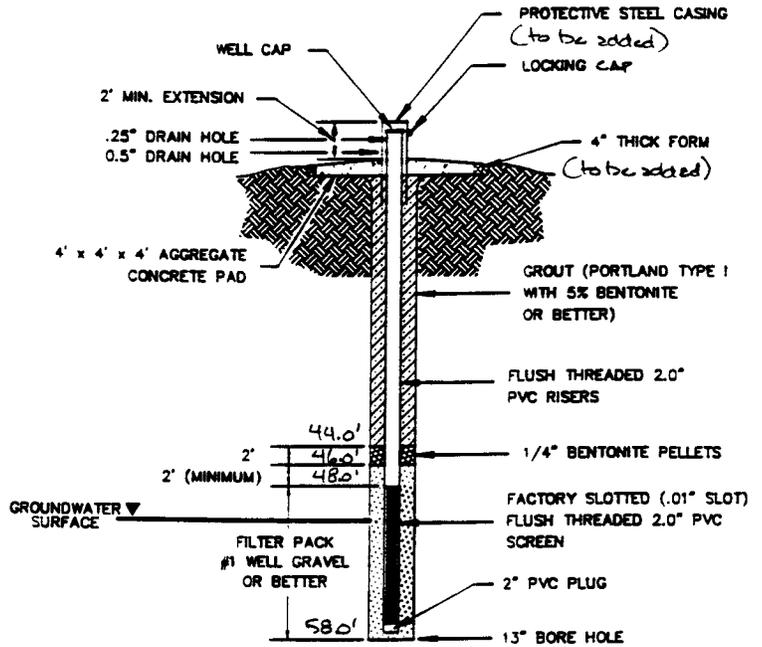
Cement/Grout Interval: 36.0' - surface

Locking Cap: (Y/N)

Air Vent: (Y/N)

**WELL DEVELOPMENT SUMMARY:**

**DRAWING: WELL CONSTRUCTION**



**FIELD BORING LOG FORM**

PROJECT: Watauga Landfill Hydrogeologic Study 6520-02      SHEET 1 OF 1  
 LOCATION: Bottom of Drainage above Sediment Ponds      HOLE NO.: B-13  
 DRILLER: Eng. Tectonics (Ron and Rodney)      DATE STARTED: 8-4-92  
 RIG TYPE: Hollow Stem Aug BIT/AUGER SIZE: 4.25'      DATE FINISHED: 8-4-92  
 LOGGED BY: JES      APPROX. GROUND ELEV.: 3198      TOTAL DEPTH: 26.0

DEPTH IN FEET	SPECIAL NOTES	SOIL SAMPLE			SOIL / ROCK DESCRIPTION / COMMENTS
		TYPE & #	BLOWS OR REC	DEPTH RANGE	
0-3.0					Orange-red-brown silty, fine sandy clay, moist, low plasticity
3-5					Orange silty, fine sandy clay moist, moderate plasticity
5-6.5	bulk sample collected	SS1	3	5-5.5	micaceous, clayey, silty fine sand
			5	5.5-6	grading into orange-red-black-
			4	6-6.5	yellow-green saprolitic micaceous hornblende gneiss moist, crumbly to wet
6.5-10	groundwater at ~6.0				same, saturated, clayey
10-11.5		SS2	4	10.0-	schistose saprolitic
				10.5	hornblende gneiss, clayey,
			6	10.5-	saturated
				11.0	
			4	11.0-	
				11.5	
15-15.5		SS3	4	15.0-	same, trending towards a mica schist, clayey
			5	15.5-	
				16.0	
			7	16.0-	
				16.5	
20.0-21.5		SS4	9	20.0-	banded orange-gray green-yellow-
				20.5	brown-black schislose, micaceous,
			8	20.5-	saprolitic hornblende gneiss,
				21.0	saturated
			16	21.0-	
				21.5	
25.0		SS5	50/5"	25.0-	same grading into quartz-feldspar phenocryst, saturated
				25.5	

**FIELD BORING LOG FORM**

PROJECT: Watauga Landfill Hydrogeologic Study 6520-02 SHEET 1 OF 2  
 LOCATION: Upper drainage adjacent to landfill access road HOLE NO.: B-14  
 DRILLER: Eng. Tectonics (Ron and Rodney) DATE STARTED: 8-3-92  
 RIG TYPE: Hollow Stem Auger BIT/AUGER SIZE: 4.25" DATE FINISHED: 8-3-92  
 LOGGED BY: JES APPROX. GROUND ELEV.: 3214 TOTAL DEPTH: 26.0

DEPTH IN FEET	SPECIAL NOTES	SOIL SAMPLE			SOIL / ROCK DESCRIPTION / COMMENTS
		TYPE & #	BLOWS OR REC	DEPTH RANGE	
0-5.0					orange-brown micaceous, clayey silty fine, sand dry, crumbly
5.0	bulk sample collected from 5'-10.0'	SS1	3	5-5.5	same with gneiss-schist rock
			3	5.5-6	fragments
			4	6-6.5	
6.5-10.0					same except moist, low plasticity
10-11.5		SS2	5	10.0-10.5	same with increasing saprolitic banded gneiss textures
			6	10.5-11.0	moist to wet, crumbly
			10	11.0-11.5	
11.5-13.0		SS3	4	11.5-12.0	same
			5	12.0-12.5	feldspar megacryst
			7	12.5-13.0	orange-red micaceous banded saprolitic hornblende gneiss. moist to wet
13.0-14.5	groundwater	SS4	8	13.0-13.5	same, wet to saturated w/ phenocrysts
			13	13.5-14.0	
			15	14.0-14.5	
14.5-16.0		SS5	1	14.5-15.0	same, saturated w/ phenocrysts
			7	15.0-15.5	
			8	15.5-16.0	

**FIELD BORING LOG FORM**

PROJECT: Watauga Landfill Hydrogeologic Study 6520-02 SHEET 2 OF 2  
 LOCATION: Upper drainage adjacent to access rd. to land. HOLE NO.: B-14  
 DRILLER: Eng. Tectonics (Ron and Rodney) DATE STARTED: 8-3-92  
 RIG TYPE: Hollow Stem Auger BIT/AUGER SIZE: 4.25" DATE FINISHED: 8-3-92  
 LOGGED BY: JES APPROX. GROUND ELEV.: 3214 TOTAL DEPTH: 26.0

DEPTH IN FEET	SPECIAL NOTES	SOIL SAMPLE			SOIL / ROCK DESCRIPTION / COMMENTS
		TYPE & #	BLOWS OR REC	DEPTH RANGE	
16.0-17.5		AA6	10	16.0-16.5	same, saturated with phenocrysts
			24	16.5-17.0	
			50/6"	17.0-17.5	
17.5-19.0		SS7	19	17.5-18.0	same, saturated with phenocrysts
			17	18.0-18.5	
			21	18.5-19.0	
19.0-20.5		SS8	9	19.0-19.5	same, saturated with phenocrysts
			13	19.5-20.0	
			17	20.0-20.5	
20.5-22.0		SS9	12	20.5-21.0	banded white - dark gray-green orange micaceous hornblende gneiss with abundant quartz-feldspar megacrysts saturated
			18	21.0-21.5	
			25	21.5-22.0	
25.0-26.0		SS10	35	25.0-25.5	same, saturated
			50/3"	25.5-26.0	
				26.0-26.5	

**FIELD BORING LOG FORM**

PROJECT:Watauga Landfill Hydrogeologic Study 6520-02 SHEET 1 OF 1  
 LOCATION:NW of B-16, NE of B-14 on Arm bet. 2 drainages HOLE NO.: B-15  
 DRILLER:Eng. Tectonics (Ronnie and Rodney) DATE STARTED: 8-3-92  
 RIG TYPE:Hollow Stem Auger BIT/AUGER SIZE:4.25" DATE FINISHED: 8-3-92  
 LOGGED BY:JES APPROX. GROUND ELEV.:3225 TOTAL DEPTH: 24.0

DEPTH IN FEET	SPECIAL NOTES	SOIL SAMPLE			SOIL / ROCK DESCRIPTION / COMMENTS
		TYPE & #	BLOWS OR REC	DEPTH RANGE	
0-5.0	saprolitic bedrock scraped with a loader on road (~40' section)				dark orange-brown micaceous silty fine sand with trace clay dry, crumbly
5.0-6.5	bulk sample collected from 5.0'-10'	SS1	7 9 12	5-5.5 5.5-6 6-6.5	orange-red-yellow-brown-black banded micaceous saprolitic hornblende gneis moist, crumbly
6.5-10.0					dark reddish brown micaceous silty fine sand
10.0-10.5		SS2	50/6"	10.0-10.5	white-gray ptz-feldspar megacryst, moist
11.5-12.0		SS3	50/6"	11.5-12.0	white-gray-black-dark gray green saprolitic hornblende gneiss, moist
13.0-13.5		SS4	50/5"	13.0-13.5	same, moist
14.5-15.0		SS5	50/3"	14.5-15.0	same with qtz phenocryst, moist
16.0-16.5		SS6	50/6"	16.0-16.5	same, schistose, moist
17.5-18.0		SS7	50/5"	17.5-18.0	same, schistose, moist
19.0-19.5		SS8	50/4"	19.0-19.5	same, schistose, moist
20.5-21.0		SS9	50/3"	20.5-21.0	same, schistose, moist



**FIELD BORING LOG FORM**

PROJECT:Watauga Landfill Hydrogeologic Study 6520-02  
 LOCATION:Central Drainage  
 DRILLER:Eng. Tectonics (Ron and Rodney)  
 RIG TYPE:Hollow Stem Auger BIT/AUGER SIZE:4.25"  
 LOGGED BY:JES APPROX. GROUND ELEV.:~3210

SHEET 1 OF 2  
 HOLE NO.:B-17  
 DATE STARTED:8-4-92  
 DATE FINISHED:8-4-92  
 TOTAL DEPTH:20.5

DEPTH IN FEET	SPECIAL NOTES	SOIL SAMPLE			SOIL / ROCK DESCRIPTION / COMMENTS
		TYPE & #	BLOWS OR REC	DEPTH RANGE	
0-5.0					dark maroon brown clayey, fine sandy silt moist, moderate to low plasticity
5-6.5		SS1	7	5-5.5	same, moist to dry, crumbly
	bulk sample collected from 5'-10'		10	5.5-6	
			8	6-6.5	
6.5-10.0					dark orange brown clayey, fine sandy silt, moist, moderate to low plasticity
10.0-11.5		SS2	7	10.0-10.5	same, moist, crumbly
			7	10.5-11.0	
			6	11.0-11.5	
11.5-13.0		SS3	5	11.5-12.0	same,
			12	12.0-12.5	saturated,
			14	12.5-13.0	crumbly to low plasticity
13.0-14.5		SS4	12	13.0-13.5	dark orange-brown-black-green clayey, silty, fine sandy
			14	13.5-14.0	micaceous schistose saprolitic hornblende gneiss, saturated,
			15	14.0-14.5	crumbly
14.5-16.0		SS5	6	14.5-15.0	same, saturated, crumbly
			7	15.0-15.5	
			9	15.5-16.0	



**FIELD BORING LOG FORM**

PROJECT:Watauga Landfill Hydrogeologic Study 6520-02 SHEET 1 OF 2  
 LOCATION:Top of excavated North drainage HOLE NO.:B-18  
 DRILLER:Eng. Tectonics (Ronnie and Rodney) DATE STARTED:8-6-92  
 RIG TYPE:Hollow Stem Auger BIG/AUGER SIZE:4.25" DATE FINISHED:8-6-92  
 LOGGED BY:JES APPROX. GROUND ELEV.:~3234 TOTAL DEPTH:50.0'

DEPTH IN FEET	SPECIAL NOTES	SOIL SAMPLE			SOIL / ROCK DESCRIPTION / COMMENTS
		TYPE & #	BLOWS OR REC	DEPTH RANGE	
0-2.0					lite tan silty fine sand with trace clay, dry, crumbly
2-2.5					brown silty fine sand with trace clay, dry, crumbly
2.5-5					dark gray green micaceous silty fine sand w/ gneiss rock fragments dry, crumbly
5-6	bulk sample collected from 5.0'-10.0'	SS1	20	5-5.5	same grading into schistose,
			50/3"	5.5-6	saprolitic hornblende gneiss dry
			----	6-6.5	crumbly
6-10					dark green grading into brown micaceous, silty fine sand dry crumbly
10.0-10.5		SS2	50/6"	10.0-10.5	dark green-brown-orange-black white-tan schistose, micaceous saprolitic gneissic schist dry, crumbly
11.5-12.0		SS3	50/3"	11.5-12.0	same
13.0-13.5		SS4	50/6"	13.0-13.5	same
14.5-15.0		SS5	50/3"	14.5-15.0	same with qtz-feldspar phenocryst
16.0-16.5		SS6	50/4"	16.0-16.5	same
17.5-18.5	groundwater	SS7	35	17.5-18.0	white-gray green-black saprolitic hornblende gneiss
			50/2"	18.0-18.5	wet crumbly









**FIELD BORING LOG FORM**

PROJECT:Watauga Landfill Hydrogeologic Study 6520-02  
 LOCATION:North Drainage  
 DRILLER:Eng. Tectonics (Ron and Rodney)  
 RIG TYPE:Hollow Stem Auger BIT/AUGER SIZE:4.25"  
 LOGGED BY:JES

SHEET 1 OF 1  
 HOLE NO.:B-22  
 DATE STARTED:8-4-92  
 DATE FINISHED:8-4-92  
 TOTAL DEPTH:26.0  
 APPROX. GROUND ELEV.:3200

DEPTH IN FEET	SPECIAL NOTES	SOIL SAMPLE			SOIL / ROCK DESCRIPTION / COMMENTS
		TYPE & #	BLOWS OR REC	DEPTH RANGE	
0-5.0					brown-gray green micaceous, silty medium sand, dry, crumbly
5-6.5	bulk sample collected from 5.0-7.5	SS1	4	5-5.5	orange-black-yellow-brown saprolitic mica schist
			4	5.5-6	moist, crumbly
			4	6-6.5	
7.5	groundwater				orange micaceous silty medium sand with trace clay
10.0-11.5		SS2	5	10.0-10.5	orange-yellow-brown-green-black clayey saprolitic mica schist
			6	10.5-11.0	wet, crumbly
			6	11.0-11.5	
15.0-16.5		SS3	9	15.0-15.5	same
			10	15.5-16.0	
			12	16.0-16.5	
20.0-21.5		SS4	25	20.0-20.5	saprolitic mica schist grading into very schistose saprolitic
			35	20.5-21.0	hornblende gneiss saturated
			50/5"	21.0-21.5	
25.0-26.0		SS5	50/5"	25.0-25.5	schistose saprolitic micaceous hornblende gneiss, saturated
				25.5-26.0	

**FIELD BORING LOG FORM**

PROJECT:Watauga Landfill Hydrogeologic Study 6520-02  
 LOCATION:Southern Spur  
 DRILLER:Eng. Tectonics  
 RIG TYPE:Hollow Stem Auger BIT/AUGER SIZE:4.25"  
 LOGGED BY:JES

SHEET 1 OF 2  
 HOLE NO.:B-23  
 DATE STARTED:8-4-92  
 DATE FINISHED:8-5-92  
 APPROX. GROUND ELEV.:3225  
 TOTAL DEPTH:36.5'

DEPTH IN FEET	SPECIAL NOTES	SOIL SAMPLE			SOIL / ROCK DESCRIPTION / COMMENTS
		TYPE & #	BLOWS OR REC	DEPTH RANGE	
0-5.0					orange-brown micaceous, silty fine to medium sand with trace clay, dry, crumbly
5-6.5		SS1	6	5-5.5	orange-brown-gray-green-black schistose, micaceous saprolitic hornblende with qtz.-plg. porphoroblasts gneiss, moist, crumbly
			7	5.5-6	
			8	6-6.5	
6.5- 10.0					same as 0.0-5.0
10.0- 11.5		SS2	9	10.0- 10.5	same as SS1
			11	10.5- 11.0	
			14	11.0- 11.5	
11.5- 13.0		SS3	17	11.5- 12.0	same as SS1
			21	12.0- 12.5	
			19	12.5- 13.0	
13.0- 14.5		SS4	15	13.0- 13.5	same, moist
			50/5"	13.5- 14.0	
			----	14.0- 14.5	
14.5- 15.5		SS5	19	14.5- 15.0	same, moist
			50/6"	15.0- 15.5	
			----	15.5- 16.0	
	A.R. - 16.0				



**FIELD BORING LOG FORM**

PROJECT:Watauga Landfill Hydrogeologic Study 6520-02 SHEET 1 OF 1  
 LOCATION:Saddle Between Existing and Proposed Sites HOLE NO.:B-24  
 DRILLER:Eng. Tectonics (Ron and Rodney) DATE STARTED:8-7-92  
 RIG TYPE:Air Rotary BIT/AUGER SIZE:5.25" Hammer DATE FINISHED:  
 LOGGED BY:JES APPROX. GROUND ELEV.:3260 TOTAL DEPTH:58.0

DEPTH IN FEET	SPECIAL NOTES	SOIL SAMPLE			SOIL / ROCK DESCRIPTION / COMMENTS
		TYPE & #	BLOWS OR REC	DEPTH RANGE	
0-3.0	rotor bit drilled				orange-brown silty clayey fine sand
	*installed 5" PVC 6" Riser				dry crumbly
3-10	easy hammering				same with gneiss-schist rock fragments, dry to moist
10.0-21.0	easy hammering				brown silty fine sand moist, crumbly alternating with tan silty medium sands and gradually becoming dry.
21.0	bedrock hard hammering				bedrock returned as white-tan silty medium sand, dry, crumbly
27.0	easy hammering				brown silty fine sand becoming gradually moist
35.0	hard hammering				bedrock returned as white-tan silty medium sand - dry
37.0	easy hammering				brown silty fine sand - moist
		GR1			
38.0	water - slight				moist to wet, water with air
48.0	hard hammering	GR2			bedrock returned as black-brown micaceous silty fine to medium sand, moist, crumbly
52.0	hard hammering water	GR3			bedrock returned as black-gray-green micaceous silty fine to medium sand, wet
58.0	stop hammering and installed 10.0' screen - 58.0'				
					12.0' sand - 46.0'
					20' bentonite - 44.0'

**FIELD BORING LOG FORM**

PROJECT:Watauga Landfill Hydrogeologic Study SHEET 1 OF 2  
 LOCATION:SE of prop.site acr,the st. from exist. rd HOLE NO.:PZ-25  
 DRILLER:Eng. Tectonics (Ronnie and Rodney) DATE STARTED:8-11-92  
 RIG TYPE:Air Rotary BIT/AUGER SIZE:5.5" Hammer DATE FINISHED:8-11-92  
 LOGGED BY:JES APPROX. GROUND ELEV.:3270 TOTAL DEPTH:50.0

DEPTH IN FEET	SPECIAL NOTES	SOIL SAMPLE			SOIL / ROCK DESCRIPTION / COMMENTS
		TYPE & #	BLOWS OR REC	DEPTH RANGE	
0-8.0	roller-bit drilled				brown micaceous, silty medium sand with trace clays
		GR1		5-8	dry, crumbly
8-12					gray-brown-tan micaceous, silty medium sand with trace clays, dry, crumbly
12-15					black-brown-green micaceous, silty medium sand with gneiss rock fragment dry.
15-19					red-brown-yellow silty medium sand with trace clay dry
19-21	hammering bedrock	*installed 20' PVC 6" casing plastic installed as buffer around outer casing to insure returns did not fall into boring outside of casing.			bedrock returned as green-brown-black-gray silty medium sand with gneiss rock fragments, dry
		GR2		19-21	
21-26		GR3		21-22	bedrock returned as gray hornblende gneiss rock fragments
26.0-26.5					small seam of mica schist returned as brown silty sand
26.5-29.0					gray hornblende gneiss
29.0-34.0					dark blue-gray hornblende gneiss
	*let boring sit for 1 hour during lunch - water produced				



**Appendix 2**

**Standard Groundwater Monitoring Field Collection Forms**

**FIGURE 1**

**STANDARD FIELD PROTOCOL - INITIAL ACTIVITIES**

Project Watauga County Landfill Permit #95-02 Date \_\_\_\_\_

Sampling Sequence \_\_\_\_\_ Weather/Temperature \_\_\_\_\_

Samplers \_\_\_\_\_

Static Water Level measurement equipment \_\_\_\_\_  
procedure \_\_\_\_\_

Well evacuation equipment \_\_\_\_\_  
procedure \_\_\_\_\_

Sample withdrawal equipment \_\_\_\_\_  
procedure \_\_\_\_\_

Sample filtration equipment \_\_\_\_\_  
procedure \_\_\_\_\_

Types of sample containers and method of preservation used for  
required analysis (in order of sequence of filling containers)

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Internal temperature of shipping containers at outset of sampling

\_\_\_\_\_  
Temperature equipment \_\_\_\_\_  
calibration procedure \_\_\_\_\_  
measurement procedure \_\_\_\_\_

pH equipment \_\_\_\_\_  
calibration procedure \_\_\_\_\_  
measurement procedure \_\_\_\_\_

Conductivity equipment \_\_\_\_\_  
calibration procedure \_\_\_\_\_  
measurement procedure \_\_\_\_\_

Conductivity calibration measurements/time \_\_\_\_\_

Sampler signatures (date/time) \_\_\_\_\_  
\_\_\_\_\_





**FIGURE 2C - EXISTING MONITORING WELL SAMPLE COLLECTION FORM**

Project: Watauga County Landfill Permit #95-02

Well # MW-3 date \_\_\_\_\_ time \_\_\_\_\_

Condition of well \_\_\_\_\_

Reference Point - Top of Well Casing:

Total Depth to water = DTW = \_\_\_\_\_ (in feet)

Total depth of well = TD = \_\_\_\_\_ (in feet)

Water column length =  $L_{c(ft.)} = (TD-DTW) =$  \_\_\_\_\_ (in feet)

Volume of water in well casing =  $V_{c(gal.)} = L_{c(ft.)} * 0.163 \text{ gal/ft.}$   
= \_\_\_\_\_

Volume of water in filter pack =  $V_{f(gal.)} =$   
= [  $L_{c(ft.)}$ , Not to exceed 12.0 ft.] \* 0.522 gal/ft.  
= \_\_\_\_\_

Unit Well Volume =  $V_w$  (Gallons) = (  $V_c + V_f$  ) = \_\_\_\_\_

Minimum Purge Volume (Gallons) =  $3 * V_w$  = \_\_\_\_\_

Description of water before purging \_\_\_\_\_

Measurements collected during purging:

	<u>Time</u>	<u>Temperature</u>	<u>pH</u>	<u>Conductivity</u>	<u>Pumping Rate</u>
1.	_____	_____	_____	_____	_____
2.	_____	_____	_____	_____	_____
3.	_____	_____	_____	_____	_____
4.	_____	_____	_____	_____	_____

Total volume of water purged ..... \_\_\_\_\_

Description of water after purging \_\_\_\_\_

Measurements collected after purging:

pH Calibration: \_\_\_\_\_

Final four (4) replicate measurements of:

	<u>Temperature</u>	<u>pH</u>	<u>Conductivity</u>	<u>Time</u>
1.	_____	_____	_____	_____
2.	_____	_____	_____	_____
3.	_____	_____	_____	_____
4.	_____	_____	_____	_____

Misc. Field Observations \_\_\_\_\_

Sampler signatures (date/time) \_\_\_\_\_  
\_\_\_\_\_

**FIGURE 2D - EXISTING MONITORING WELL SAMPLE COLLECTION FORM**

Project: Watauga County Landfill Permit #95-02

Well # MW-4 date \_\_\_\_\_ time \_\_\_\_\_

Condition of well \_\_\_\_\_

Reference Point - Top of Well Casing:

Total Depth to water = DTW = \_\_\_\_\_ (in feet)

Total depth of well = TD = \_\_\_\_\_ (in feet)

Water column length =  $L_{c(ft.)} = (TD-DTW) =$  \_\_\_\_\_ (in feet)

Volume of water in well casing =  $V_{c(gal.)} = L_{c(ft.)} * 0.163 \text{ gal/ft.}$   
= \_\_\_\_\_

Volume of water in filter pack =  $V_{f(gal.)} =$   
= [  $L_{c(ft.)}$ , Not to exceed 11.0 ft.] \* 0.522 gal/ft.  
= \_\_\_\_\_

Unit Well Volume =  $V_w$  (Gallons) = (  $V_c + V_f$  ) = \_\_\_\_\_

Minimum Purge Volume (Gallons) =  $3 * V_w$  = \_\_\_\_\_

Description of water before purging \_\_\_\_\_

Measurements collected during purging:

	<u>Time</u>	<u>Temperature</u>	<u>pH</u>	<u>Conductivity</u>	<u>Pumping Rate</u>
1.	_____	_____	_____	_____	_____
2.	_____	_____	_____	_____	_____
3.	_____	_____	_____	_____	_____
4.	_____	_____	_____	_____	_____

Total volume of water purged ..... \_\_\_\_\_

Description of water after purging \_\_\_\_\_

Measurements collected after purging:

pH Calibration: \_\_\_\_\_

Final four (4) replicate measurements of:

	<u>Temperature</u>	<u>pH</u>	<u>Conductivity</u>	<u>Time</u>
1.	_____	_____	_____	_____
2.	_____	_____	_____	_____
3.	_____	_____	_____	_____
4.	_____	_____	_____	_____

Misc. Field Observations \_\_\_\_\_

Sampler signatures (date/time) \_\_\_\_\_  
\_\_\_\_\_

**FIGURE 2E - EXISTING MONITORING WELL SAMPLE COLLECTION FORM**

Project: Watauga County Landfill Permit #95-02

Well # MW-5 date \_\_\_\_\_ time \_\_\_\_\_

Condition of well \_\_\_\_\_

Reference Point - Top of Well Casing:

Total Depth to water = DTW = \_\_\_\_\_ (in feet)

Total depth of well = TD = \_\_\_\_\_ (in feet)

Water column length =  $L_{c(ft.)} = (TD-DTW) =$  \_\_\_\_\_ (in feet)

Volume of water in well casing =  $V_{c(gal.)} = L_{c(ft.)} * 0.163 \text{ gal/ft.}$   
= \_\_\_\_\_

Volume of water in filter pack =  $V_{f(gal.)} =$   
= [  $L_{c(ft.)}$ , Not to exceed 12.0 ft.] \* 0.624 gal/ft.  
= \_\_\_\_\_

Unit Well Volume =  $V_w$  (Gallons) = (  $V_c + V_f$  ) = \_\_\_\_\_

Minimum Purge Volume (Gallons) =  $3 * V_w$  = \_\_\_\_\_

Description of water before purging \_\_\_\_\_

Measurements collected during purging:

	<u>Time</u>	<u>Temperature</u>	<u>pH</u>	<u>Conductivity</u>	<u>Pumping Rate</u>
1.	_____	_____	_____	_____	_____
2.	_____	_____	_____	_____	_____
3.	_____	_____	_____	_____	_____
4.	_____	_____	_____	_____	_____

Total volume of water purged ..... \_\_\_\_\_

Description of water after purging \_\_\_\_\_

Measurements collected after purging:

pH Calibration: \_\_\_\_\_

Final four (4) replicate measurements of:

	<u>Temperature</u>	<u>pH</u>	<u>Conductivity</u>	<u>Time</u>
1.	_____	_____	_____	_____
2.	_____	_____	_____	_____
3.	_____	_____	_____	_____
4.	_____	_____	_____	_____

Misc. Field Observations \_\_\_\_\_

Sampler signatures (date/time) \_\_\_\_\_  
\_\_\_\_\_

**FIGURE 2F - EXISTING MONITORING WELL SAMPLE COLLECTION FORM**

Project: Watauga County Landfill Permit #95-02

Well # MW-6 date \_\_\_\_\_ time \_\_\_\_\_

Condition of well \_\_\_\_\_

Reference Point - Top of Well Casing:

Total Depth to water = DTW = \_\_\_\_\_ (in feet)

Total depth of well = TD = \_\_\_\_\_ (in feet)

Water column length =  $L_{c(ft.)} = (TD-DTW) =$  \_\_\_\_\_ (in feet)

Volume of water in well casing =  $V_{c(gal.)} = L_{c(ft.)} * 0.163 \text{ gal/ft.}$   
= \_\_\_\_\_

Volume of water in filter pack =  $V_{f(gal.)} =$   
= [  $L_{c(ft.)}$ , Not to exceed 12.0 ft.] \* 0.624 gal/ft.  
= \_\_\_\_\_

Unit Well Volume =  $V_w$  (Gallons) = (  $V_c + V_f$  ) = \_\_\_\_\_

Minimum Purge Volume (Gallons) =  $3 * V_w$  = \_\_\_\_\_

Description of water before purging \_\_\_\_\_

Measurements collected during purging:

	<u>Time</u>	<u>Temperature</u>	<u>pH</u>	<u>Conductivity</u>	<u>Pumping Rate</u>
1.	_____	_____	_____	_____	_____
2.	_____	_____	_____	_____	_____
3.	_____	_____	_____	_____	_____
4.	_____	_____	_____	_____	_____

Total volume of water purged ..... \_\_\_\_\_

Description of water after purging \_\_\_\_\_

Measurements collected after purging:

pH Calibration: \_\_\_\_\_

Final four (4) replicate measurements of:

	<u>Temperature</u>	<u>pH</u>	<u>Conductivity</u>	<u>Time</u>
1.	_____	_____	_____	_____
2.	_____	_____	_____	_____
3.	_____	_____	_____	_____
4.	_____	_____	_____	_____

Misc. Field Observations \_\_\_\_\_

Sampler signatures (date/time) \_\_\_\_\_  
\_\_\_\_\_

**FIGURE 2G - EXISTING MONITORING WELL SAMPLE COLLECTION FORM**

Project: Watauga County Landfill Permit #95-02

Well # MW-7 date \_\_\_\_\_ time \_\_\_\_\_

Condition of well \_\_\_\_\_

Reference Point - Top of Well Casing:

Total Depth to water = DTW = \_\_\_\_\_ (in feet)

Total depth of well = TD = \_\_\_\_\_ (in feet)

Water column length =  $L_{c(ft.)} = (TD-DTW) =$  \_\_\_\_\_ (in feet)

Volume of water in well casing =  $V_{c(gal.)} = L_{c(ft.)} * 0.163 \text{ gal/ft.}$   
= \_\_\_\_\_

Volume of water in filter pack =  $V_{f(gal.)} =$   
= [  $L_{c(ft.)}$ , Not to exceed 12.0 ft. ] \* 0.624 gal/ft.  
= \_\_\_\_\_

Unit Well Volume =  $V_w$  (Gallons) = (  $V_c + V_f$  ) = \_\_\_\_\_

Minimum Purge Volume (Gallons) =  $3 * V_w$  = \_\_\_\_\_

Description of water before purging \_\_\_\_\_

Measurements collected during purging:

	<u>Time</u>	<u>Temperature</u>	<u>pH</u>	<u>Conductivity</u>	<u>Pumping Rate</u>
1.	_____	_____	_____	_____	_____
2.	_____	_____	_____	_____	_____
3.	_____	_____	_____	_____	_____
4.	_____	_____	_____	_____	_____

Total volume of water purged ..... \_\_\_\_\_

Description of water after purging \_\_\_\_\_

Measurements collected after purging:

pH Calibration: \_\_\_\_\_

Final four (4) replicate measurements of:

	<u>Temperature</u>	<u>pH</u>	<u>Conductivity</u>	<u>Time</u>
1.	_____	_____	_____	_____
2.	_____	_____	_____	_____
3.	_____	_____	_____	_____
4.	_____	_____	_____	_____

Misc. Field Observations \_\_\_\_\_

Sampler signatures (date/time) \_\_\_\_\_  
\_\_\_\_\_

**FIGURE 3A - PIEZOMETER SAMPLE COLLECTION FORM**

Project: Watauga County Landfill Permit #95-02

Well # PZ-13 date \_\_\_\_\_ time \_\_\_\_\_

Condition of well \_\_\_\_\_

Reference Point - Top of Well Casing:

Total Depth to water = DTW = \_\_\_\_\_ (in feet)

Total depth of well = TD = \_\_\_\_\_ (in feet)

Water column length =  $L_{c(ft.)} = (TD-DTW) =$  \_\_\_\_\_ (in feet)

Volume of water in well casing =  $V_{c(gal.)} = L_{c(ft.)} * 0.163 \text{ gal/ft.}$   
= \_\_\_\_\_

Volume of water in filter pack =  $V_{f(gal.)} =$   
= [  $L_{c(ft.)}$ , Not to exceed 7.0 ft.] \* 0.624 gal/ft.  
= \_\_\_\_\_

Unit Well Volume =  $V_w$  (Gallons) = (  $V_c + V_f$  ) = \_\_\_\_\_

Minimum Purge Volume (Gallons) =  $3 * V_w$  = \_\_\_\_\_

Description of water before purging \_\_\_\_\_

Measurements collected during purging:

	<u>Time</u>	<u>Temperature</u>	<u>pH</u>	<u>Conductivity</u>	<u>Pumping Rate</u>
1.	_____	_____	_____	_____	_____
2.	_____	_____	_____	_____	_____
3.	_____	_____	_____	_____	_____
4.	_____	_____	_____	_____	_____

Total volume of water purged ..... \_\_\_\_\_

Description of water after purging \_\_\_\_\_

Measurements collected after purging:

pH Calibration: \_\_\_\_\_

Final four (4) replicate measurements of:

	<u>Temperature</u>	<u>pH</u>	<u>Conductivity</u>	<u>Time</u>
1.	_____	_____	_____	_____
2.	_____	_____	_____	_____
3.	_____	_____	_____	_____
4.	_____	_____	_____	_____

Misc. Field Observations \_\_\_\_\_

Sampler signatures (date/time) \_\_\_\_\_  
\_\_\_\_\_

**FIGURE 3B - PIEZOMETER SAMPLE COLLECTION FORM**

Project: Watauga County Landfill Permit #95-02

Well # PZ-14 date \_\_\_\_\_ time \_\_\_\_\_

Condition of well \_\_\_\_\_

Reference Point - Top of Well Casing:

Total Depth to water = DTW = \_\_\_\_\_ (in feet)

Total depth of well = TD = \_\_\_\_\_ (in feet)

Water column length =  $L_{c(ft.)} = (TD-DTW) =$  \_\_\_\_\_ (in feet)

Volume of water in well casing =  $V_{c(gal.)} = L_{c(ft.)} * 0.163 \text{ gal/ft.}$   
= \_\_\_\_\_

Volume of water in filter pack =  $V_{f(gal.)} =$   
= [  $L_{c(ft.)}$ , Not to exceed 7.0 ft.] \* 0.624 gal/ft.  
= \_\_\_\_\_

Unit Well Volume =  $V_w$  (Gallons) = (  $V_c + V_f$  ) = \_\_\_\_\_

Minimum Purge Volume (Gallons) =  $3 * V_w$  = \_\_\_\_\_

Description of water before purging \_\_\_\_\_

Measurements collected during purging:

	<u>Time</u>	<u>Temperature</u>	<u>pH</u>	<u>Conductivity</u>	<u>Pumping Rate</u>
1.	_____	_____	_____	_____	_____
2.	_____	_____	_____	_____	_____
3.	_____	_____	_____	_____	_____
4.	_____	_____	_____	_____	_____

Total volume of water purged ..... \_\_\_\_\_

Description of water after purging \_\_\_\_\_

Measurements collected after purging:

pH Calibration: \_\_\_\_\_

Final four (4) replicate measurements of:

	<u>Temperature</u>	<u>pH</u>	<u>Conductivity</u>	<u>Time</u>
1.	_____	_____	_____	_____
2.	_____	_____	_____	_____
3.	_____	_____	_____	_____
4.	_____	_____	_____	_____

Misc. Field Observations \_\_\_\_\_

Sampler signatures (date/time) \_\_\_\_\_  
\_\_\_\_\_

**FIGURE 3C - PIEZOMETER SAMPLE COLLECTION FORM**

Project: Watauga County Landfill Permit #95-02

Well # PZ-17 date \_\_\_\_\_ time \_\_\_\_\_

Condition of well \_\_\_\_\_

Reference Point - Top of Well Casing:

Total Depth to water = DTW = \_\_\_\_\_ (in feet)

Total depth of well = TD = \_\_\_\_\_ (in feet)

Water column length =  $L_{c(ft.)} = (TD-DTW) =$  \_\_\_\_\_ (in feet)

Volume of water in well casing =  $V_{c(gal.)} = L_{c(ft.)} * 0.163 \text{ gal/ft.}$   
= \_\_\_\_\_

Volume of water in filter pack =  $V_{f(gal.)} =$   
= [  $L_{c(ft.)}$ , Not to exceed 7.0 ft.] \* 0.624 gal/ft.  
= \_\_\_\_\_

Unit Well Volume =  $V_w$  (Gallons) = (  $V_c + V_f$  ) = \_\_\_\_\_

Minimum Purge Volume (Gallons) =  $3 * V_w$  = \_\_\_\_\_

Description of water before purging \_\_\_\_\_

Measurements collected during purging:

	<u>Time</u>	<u>Temperature</u>	<u>pH</u>	<u>Conductivity</u>	<u>Pumping Rate</u>
1.	_____	_____	_____	_____	_____
2.	_____	_____	_____	_____	_____
3.	_____	_____	_____	_____	_____
4.	_____	_____	_____	_____	_____

Total volume of water purged ..... \_\_\_\_\_

Description of water after purging \_\_\_\_\_

Measurements collected after purging:

pH Calibration: \_\_\_\_\_

Final four (4) replicate measurements of:

	<u>Temperature</u>	<u>pH</u>	<u>Conductivity</u>	<u>Time</u>
1.	_____	_____	_____	_____
2.	_____	_____	_____	_____
3.	_____	_____	_____	_____
4.	_____	_____	_____	_____

Misc. Field Observations \_\_\_\_\_

Sampler signatures (date/time) \_\_\_\_\_  
\_\_\_\_\_

**FIGURE 3D - PIEZOMETER SAMPLE COLLECTION FORM**

Project: Watauga County Landfill Permit #95-02

Well # PZ-18 date \_\_\_\_\_ time \_\_\_\_\_

Condition of well \_\_\_\_\_

Reference Point - Top of Well Casing:

Total Depth to water = DTW = \_\_\_\_\_ (in feet)

Total depth of well = TD = \_\_\_\_\_ (in feet)

Water column length =  $L_{c(ft.)} = (TD-DTW) =$  \_\_\_\_\_ (in feet)

Volume of water in well casing =  $V_{c(gal.)} = L_{c(ft.)} * 0.163 \text{ gal/ft.}$   
= \_\_\_\_\_

Volume of water in filter pack =  $V_{f(gal.)} =$   
= [  $L_{c(ft.)}$ , Not to exceed 17.0 ft.] \* 0.082 gal/ft.  
= \_\_\_\_\_

Unit Well Volume =  $V_w$  (Gallons) = (  $V_c + V_f$  ) = \_\_\_\_\_

Minimum Purge Volume (Gallons) =  $3 * V_w$  = \_\_\_\_\_

Description of water before purging \_\_\_\_\_

Measurements collected during purging:

	<u>Time</u>	<u>Temperature</u>	<u>pH</u>	<u>Conductivity</u>	<u>Pumping Rate</u>
1.	_____	_____	_____	_____	_____
2.	_____	_____	_____	_____	_____
3.	_____	_____	_____	_____	_____
4.	_____	_____	_____	_____	_____

Total volume of water purged ..... \_\_\_\_\_

Description of water after purging \_\_\_\_\_

Measurements collected after purging:

pH Calibration: \_\_\_\_\_

Final four (4) replicate measurements of:

	<u>Temperature</u>	<u>pH</u>	<u>Conductivity</u>	<u>Time</u>
1.	_____	_____	_____	_____
2.	_____	_____	_____	_____
3.	_____	_____	_____	_____
4.	_____	_____	_____	_____

Misc. Field Observations \_\_\_\_\_

Sampler signatures (date/time) \_\_\_\_\_  
\_\_\_\_\_





**FIGURE 3G - PIEZOMETER SAMPLE COLLECTION FORM**

Project: Watauga County Landfill Permit #95-02

Well # PZ-23 date \_\_\_\_\_ time \_\_\_\_\_

Condition of well \_\_\_\_\_

Reference Point - Top of Well Casing:

Total Depth to water = DTW = \_\_\_\_\_ (in feet)

Total depth of well = TD = \_\_\_\_\_ (in feet)

Water column length =  $L_{c(ft.)} = (TD-DTW) =$  \_\_\_\_\_ (in feet)

Volume of water in well casing =  $V_{c(gal.)} = L_{c(ft.)} * 0.163 \text{ gal/ft.}$   
= \_\_\_\_\_

Volume of water in filter pack =  $V_{f(gal.)} =$   
= [  $L_{c(ft.)}$ , Not to exceed 7.0 ft.] \* 0.082 gal/ft.  
= \_\_\_\_\_

Unit Well Volume =  $V_w$  (Gallons) = (  $V_c + V_f$  ) = \_\_\_\_\_

Minimum Purge Volume (Gallons) =  $3 * V_w$  = \_\_\_\_\_

Description of water before purging \_\_\_\_\_

Measurements collected during purging:

	<u>Time</u>	<u>Temperature</u>	<u>pH</u>	<u>Conductivity</u>	<u>Pumping Rate</u>
1.	_____	_____	_____	_____	_____
2.	_____	_____	_____	_____	_____
3.	_____	_____	_____	_____	_____
4.	_____	_____	_____	_____	_____

Total volume of water purged ..... \_\_\_\_\_

Description of water after purging \_\_\_\_\_

Measurements collected after purging:

pH Calibration: \_\_\_\_\_

Final four (4) replicate measurements of:

	<u>Temperature</u>	<u>pH</u>	<u>Conductivity</u>	<u>Time</u>
1.	_____	_____	_____	_____
2.	_____	_____	_____	_____
3.	_____	_____	_____	_____
4.	_____	_____	_____	_____

Misc. Field Observations \_\_\_\_\_

Sampler signatures (date/time) \_\_\_\_\_  
\_\_\_\_\_

**FIGURES 4 - PROPOSED MONITORING WELL SAMPLE COLLECTION FORM**

Project: Watauga County Landfill Permit #95-02

Well # \_\_\_\_\_ date \_\_\_\_\_ time \_\_\_\_\_

Condition of well \_\_\_\_\_

Reference Point - Top of Well Casing:

Total Depth to water = DTW = \_\_\_\_\_ (in feet)

Total depth of well = TD = \_\_\_\_\_ (in feet)

Water column length =  $L_{c(ft.)} = (TD-DTW) =$  \_\_\_\_\_ (in feet)

Volume of water in well casing =  $V_{c(gal.)} = L_{c(ft.)} * \underline{\hspace{2cm}}$  gal/ft.  
= \_\_\_\_\_

Volume of water in filter pack =  $V_{f(gal.)} =$   
= [  $L_{c(ft.)}$ , Not to exceed \_\_\_\_\_ ft. ] \* \_\_\_\_\_ gal/ft.  
= \_\_\_\_\_

Unit Well Volume =  $V_w$  (Gallons) = (  $V_c + V_f$  ) = \_\_\_\_\_

Minimum Purge Volume (Gallons) =  $3 * V_w$  = \_\_\_\_\_

Description of water before purging \_\_\_\_\_

Measurements collected during purging:

	<u>Time</u>	<u>Temperature</u>	<u>pH</u>	<u>Conductivity</u>	<u>Pumping Rate</u>
1.	_____	_____	_____	_____	_____
2.	_____	_____	_____	_____	_____
3.	_____	_____	_____	_____	_____
4.	_____	_____	_____	_____	_____

Total volume of water purged ..... \_\_\_\_\_

Description of water after purging \_\_\_\_\_

Measurements collected after purging:

pH Calibration: \_\_\_\_\_

Final four (4) replicate measurements of:

	<u>Temperature</u>	<u>pH</u>	<u>Conductivity</u>	<u>Time</u>
1.	_____	_____	_____	_____
2.	_____	_____	_____	_____
3.	_____	_____	_____	_____
4.	_____	_____	_____	_____

Misc. Field Observations \_\_\_\_\_

Sampler signatures (date/time) \_\_\_\_\_  
\_\_\_\_\_

FIGURE 5

STANDARD FIELD PROTOCOL - FINAL ACTIVITIES

Project: Watauga County Landfill Permit #95-02 Date: \_\_\_\_\_  
Internal temperature of shipping containers at completion of sampling:

\_\_\_\_\_  
Sample destination \_\_\_\_\_  
Method of transportation \_\_\_\_\_

Sampler signatures (date/time) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Appendix 3**  
**Analytical Methods**

**TABLE 4**  
**ASSESSMENT PLAN MONITORING PARAMETERS**  
**(Low Level Risk Methods)**

As definitions for MDL and PQL have found to vary from laboratory to laboratory, the definition as applicable to this requested work are provided below:

Maximum Detection Limit (MDL): The detection limit is the lowest amount of a chemical that can be "seen" above the normal, random noise of an analytical instrument or method. A chemical present below that level cannot reliably be distinguished from noise. MDLs are chemical specific and instrument specific and are determined by statistical treatment of multiple analyses in which the ratio of the lowest amount observed to the electronic noise level (i.e. signal to noise ratio) is determined. On any given day in any given sample, the calculated limit may not be obtainable; however, a properly calculated limit can be used as an overall general measure of laboratory performance. The MDL takes into account the reagents, sample matrix, and preparation steps applied to a sample in specific analytical methods.

Practical Quantitation Limit (PQL): Due to the irregular nature of instrument or method noise, reproducible quantitation of a chemical is not always possible at the MDL. Generally, a factor of three to five is applied to the MDL to obtain a PQL, which is considered to be the lowest level at which a chemical may be accurately and reproducibly quantitated. MDLs indicate the level at which a small amount would be "seen", whereas PQLs indicate the levels at which measurements can be "trusted".

CONSTITUENTS	CAS RN	ANALYTICAL METHOD SUGGESTED	MDL (ug/L)	PQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Acenaphthene	83-32-9	8270	2	10	-	
Acenaphthylene	208-96-8	8270	2	10	-	
Acetone	67-64-1	8260	20	100	-	
Acetonitrile	75-05-8	8260	20	100	-	
Acetophenone	98-86-2	8270	2	10	-	
2-Acetylaminofluorene	53-96-3	8270	4	20	-	
Acrolein	107-02-8	8260	20	100	-	
Acrylonitrile	107-13-1	8260	40	200	-	
Aldrin	309-00-2	8080	1	5	-	
Allyl chloride	107-05-1	8260	2	10	-	
4-Aminobiphenyl	92-67-1	8270	4	20	-	
Anthracene	120-12-7	8270	2	10	-	
Antimony	Total	SW846-7041	5	60	6	
		(CLP)		3.0		
Arsenic	Total	SW846-7061	5	10	50	50
		(CLP)				
Barium *	Total	CLPILM03.0	20	200	2000	1000
		(ICP)				

CONSTITUENTS	CAS RN	ANALYTICAL METHOD SUGGESTED	MDL (ug/L)	PQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Benzene *	71-43-2	8021	0.3	1.5	5	1
Benzo[a]anthracene	56-55-3	8270	2	10	-	
Benzo[b]fluoranthene	205-99-2	8270	2	10	-	
Benzo[k]fluoranthene	207-08-9	8270	2	10	-	
Benzo[ghi]perylene	191-24-2	8270	2	10	-	
Benzo[a]pyrene	50-32-8	8310 <sup>6</sup>		0.2	0.2	
		8270	2	10		
Benzyl alcohol	100-51-6	8270	4	20	-	
Beryllium	Total	CLPILM03.0	3	5	4	
		(ICP)		1.0		
alpha-BHC	319-84-6	8080	1	5	-	
beta-BHC	319-85-7	8080	1	5	-	
delta-BHC	319-86-8	8080	1	5	-	
gamma-BHC (Lindane)	58-89-9	8080	1	5	0.2	0.0265
Bis(2-chloroethoxy)methane	111-91-1	8270	2	10	-	
Bis (2-chloroethyl) ether	111-44-4	8270	2	10	-	
Bis(2-chloro-1-methylethyl)ether	108-60-1	8270	2	10	-	

CONSTITUENTS	CAS RN	ANALYTICAL METHOD SUGGESTED	MDL (ug/L)	PQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Bis(2-ethylhexyl)phthalate	117-81-7	8270	4	20	-	
Bromochloromethane	74-97-5	8021	0.6	3.0	-	
Bromodichloromethane	75-27-4	8021	0.3	1.5	-	
Bromoform	75-25-2	8010	16	80	-	0.19
4-Bromophenyl phenyl ether	101-55-3	8270	2	10	-	
Butyl benzyl phthalate	85-68-7	8270	2	10	-	
Cadmium *	Total	SW846-7031	0.5	5	5	5
		(CLP)				
Carbon disulfide	75-15-0	8260	20	10	-	
Carbon tetrachloride	56-23-5	8021	1.3	6.5	5	0.3
Chlordane	See note 8	8080	10	50	2	0.027
p-Chloroaniline	106-47-8	8270	4	20	-	
Chlorobenzene	108-90-7	8021	0.3	1.5	100	300
Chlorobenzilate	510-15-6	8270	2	10	-	
p-Chloro-m-cresol	59-50-7	8040	1	5	-	
Chloroethane *	75-00-3	8021	1	5	-	

CONSTITUENTS	CAS RN	ANALYTICAL METHOD SUGGESTED	MDL (ug/L)	PQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Chloroform	67-66-3	8021	0.5	2.5	-	0.19
2-Chloronaphthalene	91-58-7	8270	2	10	-	
2-Chlorophenol	95-57-8	8040	1	5	-	0.1
4-Chlorophenyl phenyl ether	7005-72-3	8270	2	10	-	
Chloroprene	126-99-8	8260	4	20	-	
Chromium	Total	CLPILM03.0	10	10	100	50
		(ICP)				
Chrysene	218-01-9	8270	2	10	-	
Cobalt	Total	CLPILM03.0	10	50	-	
		(ICP)				
Copper	Total	CLPILM03.0	10	25	1300	1000
		(ICP)				
m-Cresol	108-39-4	8270	2	10	-	
o-Cresol	95-48-7	8270	2	10	-	
p-Cresol	106-44-5	8270	2	10	-	
Cyanide	57-12-5	SW846-9010	10	10	200	154
		(CLP)				
2,4-Dichlorophenoxyacetic acid; 2,4-D	94-75-7	8150	0.3	1.2	70	70
4,4'-DDD	72-54-8	8080	1	5	-	

CONSTITUENTS	CAS RN	ANALYTICAL METHOD SUGGESTED	MDL (ug/L)	PQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
4,4'-DDE	72-55-9	8080	1	5	-	
4,4'-DDT	50-29-3	8080	1	5	-	
Diallate	2303-16-4	8270	2	10	-	
Dibenz[a,h]anthracene	53-70-3	8270	2	10	-	
Dibenzofuran	132-64-9	8270	2	10	-	
Dibromochloromethane	124-48-1	8021	0.3	1.5	-	
1,2-Dibromo-3-chloropropane; DBCP	96-12-8	8011	1.6	5	0.2	0.025
1,2-Dibromoethane; EDB	106-93-4	8011	1.7	5	0.05	0.0005
Di-n-butyl phthalate	84-74-2	8270	2	10	-	
o-Dichlorobenzene; 1,2-Dichlorobenzene	95-50-1	8021	0.2	1	600	620
m-Dichlorobenzene; 1,3-Dichlorobenzene	541-73-1	8021	0.2	1	600	620
p-Dichlorobenzene; 1,4-Dichlorobenzene	106-46-7	8021	0.4	2	75	1.8
3,3'-Dichlorobenzidine	91-94-1	8270	4	20	-	
trans-1,4-Dichloro-2-butene	110-57-6	8021	20	100	-	
Dichlorodifluoromethane *	75-71-8	8021	1	5	-	0.19

CONSTITUENTS	CAS RN	ANALYTICAL METHOD SUGGESTED	MDL (ug/L)	PQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
1,1-Dichloroethane *	75-34-3	8021	0.7	3.5	-	700 <sup>4</sup>
1,2-Dichloroethane	107-06-2	8021	0.5	2.5	5	0.38
1,1-Dichloroethylene *	75-35-4	8021	0.7	3.5	7	7
cis-1,2-Dichloroethylene *	156-59-2	8021	0.4	2.0	70	70
trans-1,2-Dichloroethylene	156-60-5	8021	0.6	3.0	100	70
2,4-Dichlorophenol	120-83-2	8040	1	5	-	
2,6-Dichlorophenol	87-65-0	8270	2	10	-	
1,2-Dichloropropane	78-87-5	8021	0.3	1.5	5	0.56
1,3-Dichloropropane	142-28-9	8021	0.3	1.5	-	
2,2-Dichloropropane	594-20-7	8021	0.4	2.0	-	
1,1-Dichloropropene	563-58-6	8021	0.5	2.5	-	
cis-1,3-Dichloropropene	10061-01-5	8021	3.4	17	-	
trans-1,3-Dichloropropene*	10061-02-6	8021	3.4	17	-	
Dieldrin	60-57-1	8080	1	5	-	
Diethyl phthalate	84-66-2	8270	2	10	-	

CONSTITUENTS	CAS RN	ANALYTICAL METHOD SUGGESTED	MDL (ug/L)	PQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
O,O-Diethyl O-2-pyrazinyl	297-97-2	8270	4	20	-	
Dimethoate	60-51-5	8270	4	20	-	
p-(Dimethylamino) azobenzene	60-11-7	8270	2	10	-	
7,12-Dimethylbenz[a] anthracene	57-97-6	8270	2	10	-	
3,3'-Dimethylbenzidine	119-93-7	8270	2	10	-	
2,4-Dimethylphenol	105-67-9	8040	1	5	-	
Dimethyl phthalate	131-11-3	8270	2	10	-	
m-Dinitrobenzene	99-65-0	8270	4	20	-	
4,6-Dinitro-o-cresol	534-52-1	8270	10	50	-	
2,4-Dinitrophenol	51-28-5	8270	10	50	-	
2,4-Dinitrotoluene	121-14-2	8090	2	10	-	
2,6-Dinitrotoluene	606-20-2	8090	2	10	-	
DNBP (Dinoseb)	86-85-7	8150	2	10	7	
Di-n-octyl phthlate	117-84-0	8270	2	10	-	
Diphenylamine	122-39-4	8270	2	10	-	

CONSTITUENTS	CAS RN	ANALYTICAL METHOD SUGGESTED	MDL (ug/L)	PQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Disulfoton	298-04-4	8270	2	10	-	
Endosulfan I	959-96-8	8080	1	5	-	
Endosulfan II	33213-65-9	8080	1	5	-	
Endosulfan sulfate	1031-07-8	8080	1	5	-	
Endrin	72-20-8	8080	1	5	2	0.2
Endrin aldehyde	7421-93-4	8080	1	5	-	
Ethylbenzene	100-41-4	8021	0.2	1	700	29
Ethyl methacrylate	97-63-2	8270	2	10	-	
Ethyl methanesulfonate	62-50-0	8270	4	20	-	
Famphur	52-85-7	8270	4	20	-	
Fluoranthene	206-44-0	8270	2	10	-	
Fluorene	86-73-7	8270	2	10	-	
Heptachlor	76-44-8	8080	1	5	0.4	0.076
Heptachlor epoxide	1024-57-3	8080	1	5	0.2	0.038
Hexachlorobenzene	118-74-1	8120	0.5	2.5	1	0.02

CONSTITUENTS	CAS RN	ANALYTICAL METHOD SUGGESTED	MDL (ug/L)	PQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Hexachlorobutadiene	87-68-3	8021	0.2	1.0	-	
Hexachlorocyclopentadiene	77-47-4	8120	3.4	17	50	
Hexachloroethane	67-72-1	8120	0.3	1.5	-	
Hexachloropropene	1888-71-7	8270	2	10	-	
2-Hexanone; Methyl butyl ketone	591-78-6	8260	10	50	-	
Indeno[1,2,3-cd]pyrene	193-39-5	8270	2	10	-	
Iron*		SW 846 9041	9	100	300 (secondary MCL)	
		CLP				
Isobutyl alcohol	78-83-1	8260	20	100	-	
Isodrin	465-73-6	8260	2	10	-	
Isophorone	78-59-1	8270	2	10	-	
Isosafrole	120-58-1	8270	2	10	-	
Kepone	143-50-0	8270	4	20	-	
Lead	Total	CLP	3	3	15	50
		(ICP)				
Mercury *	Total	CLP	0.2	0.2	2	1.1
		(CV)				
Methacrylonitrile	126-98-7	8260	20	100	-	

CONSTITUENTS	CAS RN	ANALYTICAL METHOD SUGGESTED	MDL (ug/L)	PQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Methapyrilene	91-80-5	8270	20	100	-	
Methoxychlor	72-43-5	8080	10	50	40	100
Methyl bromide; Bromomethane	74-83-9	8021	11	55	-	
Methyl chloride; Chloromethane	74-87-3	8021	0.3	1.5	-	
3-Methylcholanthrene	56-49-5	8270	2	10	-	
Methyl ethyl ketone; 2-Butanone	78-93-3	8260	20	100	-	170
Methyl iodide	74-88-4	8260	2	10	-	
Methyl methacrylate	80-62-6	8260	6	30	-	
Methyl methanesulfonate	66-27-3	8270	2	10	-	
2-Methylnaphthalene	91-57-6	8270	2	10	-	
Methyl parathion	298-00-0	8270	2	10	-	
4-Methyl-2-pentanone; Methyl isobutyl ketone	108-10-1	8260	20	100	-	
Methylene bromide; Dibromomethane	74-95-3	8021	22	110	-	
Methylene chloride; Dichloromethane *	75-09-2	8021	1.9	9.5	5	5
Naphthalene	91-20-3	8021	0.6	30	-	

CONSTITUENTS	CAS RN	ANALYTICAL METHOD SUGGESTED	MDL (ug/L)	PQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
1,4-Naphthoquinone	130-15-4	8270	2	10	-	
1-Naphthylamine	134-32-7	8270	2	10	-	
2-Naphthylamine	91-59-8	8270	2	10	-	
Nickel	Total	CLP-IML03.0	20	40	100	150
		(ICP)				
o-Nitroaniline	88-74-4	8270	10	50	-	
m-Nitroaniline	99-09-2	8270	10	50	-	
p-Nitroaniline	100-01-6	8270	4	20	-	
Nitrobenzene	98-95-3	8270	2	10	-	
o-Nitrophenol	88-75-5	8040	1	5	-	
p-Nitrophenol	100-02-7	8040	1	5	-	
N-Nitrosodi-n-butylamine	924-16-3	8270	2	10	-	
N-Nitrosodiethylamine	55-18-5	8270	4	20	-	
N-Nitrosodimethylamine	62-75-9	8270	1.73	4	-	
N-Nitrosodiphenylamine	86-30-68270	8270	0.9	2	-	
N-Nitrosodipropylamine	621-64-7	8270	2	10	-	

CONSTITUENTS	CAS RN	ANALYTICAL METHOD SUGGESTED	MDL (ug/L)	PQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
N-Nitrosomethylethylamine	10595-95-6	8270	2	10	-	
N-Nitrosopiperidine	100-75-4	8270	4	20	-	
N-Nitrosopyrrolidine	930-55-2	8270	8	40	-	
5-Nitro-o-toluidine	99-55-8	8270	2	10	-	
Parathion	56-38-2	8270	2	10	-	
Pentachlorobenzene	608-93-5	8270	2	10	-	
Pentachloronitrobenzene	82-68-8	8270	4	20	-	
Pentachlorophenol	87-86-5	8040	1	5	1	220
Phenacetin	62-44-2	8270	4	20	-	
Phenanthrene	85-01-8	8270	2	10	-	
Phenol	108-95-2	8040	0.3	1	-	
p-Phenylenediamine	106-50-3	8270	2	10	-	
Phorate	298-02-2	8270	2	10	-	
Polychlorinated Biphenyls	See note 9	8080	10	50	0.5	
Pronamide	23950-58-5	8270	2	10	-	

CONSTITUENTS	CAS RN	ANALYTICAL METHOD SUGGESTED	MDL (ug/L)	PQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Propionitrile	107-12-0	8260	30	150	-	
Pyrene	129-00-0	8270	2	10	-	
Safrole	94-59-7	8270	2	10	-	
Selenium	Total	CLP-ILM03.3	5	5	50	10
		(ICP)				
Silver	Total	CLP-IML03.0	5	10	-	50
		(ICP)				
Silvex (2,4,5-TP)	93-72-1	8150	2	10	50	10
Styrene	100-42-5	8021	0.2	1	100	0.014
Sulfide	18496-25-8	SW846-9030			-	
		(CLP)				
2,4,5-Trichlorophenoxyacetic acid (2,4,5-T)	93-76-5	9150	5	25	-	
1,2,4,5-Tetrachlorobenzene	95-94-3	8270	2	10	-	
1,1,1,2-Tetrachloroethane	630-20-6	8021	0.1	0.5	-	
1,1,2,2-Tetrachloroethane	79-34-5	8021	0.1	0.5	-	
Tetrachloroethylene *	127-18-4	8021	0.8	4	5	0.7
2,3,4,6-Tetrachlorophenol	58-90-2	8270	2	10	-	
Thallium	Total	CLP ILM03.0	2	10	2	
		(FURNACE)				

CONSTITUENTS	CAS RN	ANALYTICAL METHOD SUGGESTED	MDL (ug/L)	PQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Tin	Total	SW846-6010	30	30	-	
		(CLP)				
Toluene	108-88-3	8021	1.1	5.5	1000	1000
o-Toluidine	95-53-4	8270	2	10	-	
Toxaphene	See note 10	8080	10	50	3	0.031
1,2,4-Trichlorobenzene	120-82-1	8021	0.3	1.5	70	
1,1,1-Trichloroethane *	71-55-6	8021	0.8	4	200	200
1,1,2-Trichloroethane	79-00-5	8260	1	5	5	
Trichloroethylene *	79-01-6	8021	0.2	1	5	2.8
Trichlorofluoromethane	75-69-4	8021	1.5	7.5	-	2100 <sup>4</sup>
2,4,5-Trichlorophenol	95-95-4	8270	2	10	-	
2,4,6-Trichlorophenol	88-06-2	8040	1	5	-	
1,2,3-Trichloropropane	96-18-4	8021	4	20	-	
O,O,O-Triethyl phosphorothioate	126-68-1	8270	2	10	-	
sym-Trinitrobenzene	99-35-4	8270	2	10	-	
Vanadium	Total	CLP ILM03.0	10	50	-	
		(ICP)				

CONSTITUENTS	CAS RN	ANALYTICAL METHOD SUGGESTED	MDL (ug/L)	PQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Vinyl acetate	108-05-4	8260	10	50	-	
Vinyl chloride *	75-01-4	8021	1.3	6.5	2	0.015
Xylenes	1330-20-7 See note 11	8021	0.4	2	10000	400
Zinc	Total	CLP ILM03.0	20	20	-	5000
		(ICP)				

1. Total analyses required for metals.
2. This value represents an EPA action level.
3. This value represents an EPA action level. Previous MCL was 0.05 mg/L.
4. Denotes proposed NC Groundwater Standard.
5. \* Denotes Target Compound as of 08/17/93.
6. Benzo[a]pyrene will be analyzed initially by method 8310. Should no compound be detected, subsequent analysis will be by method 8270.

NOTES:

1. The regulatory requirements pertain only to the list of substances; the right hand columns (Methods and PQL) are given for informational purposes only. See notes 5 and 6.
2. Common names are those widely used in government regulations, scientific publications and commerce; synonyms exist for many chemicals.
3. "CAS RN" denotes Chemical Abstracts Service Registry Number. Where "Total" is entered, all species in the groundwater that contain this element are included.
4. CAS index names are those used in the 9th Collective Index. It should be noted that the index names are not listed above table.
5. Analytical Methods refers to analytical procedure numbers used in EPA Report SW-846 latest "Methods for Evaluating Solid Waste", third edition, November 1986, as revised, December 1987.
6. Practical Quantitation Limits (PQLs) are the lowest concentrations of analytes in groundwaters that can be reliably determined within specified limits of precision and accuracy by the indicated methods under routine laboratory operating conditions. The PQLs listed are generally stated to one significant figure. PQLs are based on 5 mL samples for volatile organics and 1-Liter samples for semivolatile organics.
7. This substance is often called Bis(2-chloroisopropyl) ether, the name CAS applies to its noncommercial isomer, Propane, 2,2'-oxybis(2-chloro- (CAS RN 39638-32-9).
8. Chlordane: This entry includes alpha-chlordane (CAS RN 5103-71-9), beta-chlordane (CAS RN 5103-74-2), gamma-chlordane (CAS RN 5566-34-7), and constituents of chlordane (CAS RN 57-74-9 and CAS RN 12672-29-6). PQL shown is for technical chlordane. PQLs of specific isomers are about 20 ug/L by method 8270.
9. Polychlorinated biphenyls (CAS RN 1336-36-3); this category contains congener chemicals, including constituents of Aroclor 1016 (CAS RN 12674-11-2), Aroclor 1221 (CAS RN 11104-28-2), Aroclor 1232 (CAS RN 11141-16-5), Aroclor 1242 (CAS RN 53469-21-9), Aroclor 1248 (CAS RN 12672-29-6), Aroclor 1254 (CAS RN 11097-69-1), and Aroclor 1260 (CAS RN 11096-82-5). The PQL is an average value for PCB congeners.
10. Toxaphene. This entry includes congener chemical contained in technical toxaphene (CAS RN 8001-35-2), i.e. chlorinated camphene.
11. Xylene (total): This entry includes o-xylene, m-xylene, p-xylene, and unspecified xylenes (dimethylbenzenes) (CAS RN 1330-20-7). PQLs for method 8021 are 0.2 for o-xylene and 0.1 for m- or p-xylene. The PQL for m-xylene is 2.0 ug/L by method 8020 or 8260.

**TABLE 4A**  
**DETECTED ASSESSMENT PLAN MONITORING PARAMETERS**  
**(CLP Methods)**

CONSTITUENTS	CAS RN	STATEMENT OF WORK (SOW)	MDL (ug/L)	CRQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Acenaphthene	83-32-9	CLP-SEMI-VOLATILES		10	-	
		CLP-LOW LEVEL		5		
Acenaphthylene	208-96-8	CLP-SEMI-VOLATILES		10	-	
		CLP-LOW LEVEL		5		
Acetone	67-64-1	CLP-VOLATILES		100	-	
		CLP-LOW LEVEL		10		
Acetonitrile	75-05-8	CLP-VOLATILES		1000	-	
		CLP-LOW LEVEL		200		
Acetophenone	98-86-2	CLP-SEMI-VOLATILES		10	-	
		CLP-LOW LEVEL		TBD		
2-Acetylaminofluorene	53-96-3	CLP-SEMI-VOLATILES		25	-	
		CLP-LOW LEVEL		TBD		
Acrolein	107-02-8	CLP-VOLATILES		1000	-	
		CLP-LOW LEVEL		100		
Acrylonitrile	107-13-1	CLP-VOLATILES		1000	-	
		CLP-LOW LEVEL		100		

CONSTITUENTS	CAS RN	STATEMENT OF WORK (SOW)	MDL (ug/L)	CRQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Aldrin	309-00-2	CLP 3/90		0.05	-	
				0.01		
Allyl chloride	107-05-1	CLP-VOLATILES		50	-	
		CLP-LOW LEVEL		5		
4-Aminobiphenyl	92-67-1	CLP-SEMI-VOLATILES		10	-	
		CLP-LOW LEVEL		TBD		
Anthracene	120-12-7	CLP-SEMI-VOLATILES		10	-	
		CLP-LOW LEVEL		5		
Antimony	Total	SW846-7041	5	60	6	
		(FURNACE)		3.0		
Arsenic	Total	CLP -SW846	5	10	50	50
		(7061)				
Barium *	Total	CLP ILM03.0	20	200	2000	1000
		(ICP)				
Benzene *	71-43-2	CLP-VOLATILES		5	5	1
		CLP-LOW LEVEL		1		
Benzo[a]anthracene	56-55-3	CLP-SEMI-VOLATILES		10	-	
		CLP-LOW LEVEL		5		
Benzo[b]fluoranthene	205-99-2	CLP-SEMI-VOLATILES		10	-	
		CLP-LOW LEVEL		5		
Benzo[k]fluoranthene	207-08-9	CLP-SEMI-VOLATILES		10	-	
		CLP-LOW LEVEL		5		

CONSTITUENTS	CAS RN	STATEMENT OF WORK (SOW)	MDL (ug/L)	CRQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Benzo[ghi]perylene	191-24-2	CLP-SEMI-VOLATILES		10	-	
		CLP-LOW LEVEL		5		
Benzo[a]pyrene	50-32-8	CLP-SEMI-VOLATILES		10	0.2	
		CLP SAS		5		
Benzyl alcohol	100-51-6	CLP-SEMI-VOLATILES		20	-	
		CLP-LOW LEVEL		TBD		
Beryllium	Total	CLP ILM03.0	3	5	4	
		(ICP)		1.0		
alpha-BHC	319-84-6	CLP 3/90	0.0014	0.5		
				0.02		
beta-BHC	319-85-7	CLP 3/90	0.0036	0.05		
				0.02		
delta-BHC	319-86-8	CLP 3/90	0.0013	0.05	-	
				0.02		
gamma-BHC (Lindane)	58-89-9	CLP 3/90	0.0011	0.05	0.2	0.0265
				0.01		
Bis(2-chloroethoxy)methane	111-91-1	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
Bis (2-chloroethyl) ether	111-44-4	CLP SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
Bis(2-chloro-1-methylethyl)ether	108-60-1	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		

CONSTITUENTS	CAS RN	STATEMENT OF WORK (SOW)	MDL (ug/L)	CRQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Bis(2-ethylhexyl)phthalate	117-81-7	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
Bromochloromethane	74-97-5	CLP-VOLATILE		5	-	
		CLP-SEMI-VOLATILE		1		
Bromodichloromethane	75-27-4	CLP-VOLATILE		5	-	
		CLP-LOW LEVEL		1		
Bromoform	75-25-2	CLP-VOLATILE		5	-	0.19
		CLP-LOW LEVEL		1		
4-Bromophenyl phenyl ether	101-55-3	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
Butyl benzyl phthalate	85-68-7	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
Cadmium *	Total	SW846-7031	0.5	5	5	5
		FURNACE				
Carbon disulfide	75-15-0	CLP-VOLATILE		50	-	
		CLP-LOW LEVEL		5		
Carbon tetrachloride	56-23-5	CLP-VOLATILE		5	5	0.3
		CLP-LOW LEVEL		1		
Chlordane	See note 8	CLP 3/90		0.05/0.01	2	0.027
				0.05/0.01		
p-Chloroaniline	106-47-8	CLP-SEMI-VOLATILE		20.0	-	
		CLP-LOW LEVEL		5		

CONSTITUENTS	CAS RN	STATEMENT OF WORK (SOW)	MDL (ug/L)	CRQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Chlorobenzene	108-90-7	CLP-VOLATILE		5	100	300
		CLP-LOW LEVEL		1		
Chlorobenzilate	510-15-6	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
p-Chloro-m-cresol	59-50-7	CLP-SEMI-VOLATILE		20	-	
		CLP-LOW LEVEL		5		
Chloroethane *	75-00-3	CLP-VOLATILE		5	-	
		CLP-LOW LEVEL		1		
Chloroform	67-66-3	CLP-VOLATILE		5	-	0.19
		CLP-LOW LEVEL		1		
2-Chloronaphthalene	91-58-7	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
2-Chlorophenol	95-57-8	CLP-SEMI-VOLATILE		10	-	0.1
		CLP-LOW LEVEL		5		
4-Chlorophenyl phenyl ether	7005-72-3	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
Chloroprene	126-99-8	CLP-VOLATILE		50	-	
		CLP-LOW LEVEL		5		
Chromium	Total	CLP ILM03.0	10	10	100	50
		(ICP)				

CONSTITUENTS	CAS RN	STATEMENT OF WORK (SOW)	MDL (ug/L)	CRQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Chrysene	218-01-9	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
Cobalt	Total	CLP ILM03.0	10	50	-	
		(ICP)				
Copper	Total	CLP ILM03.0	10	25	1300	1000
		(ICP)				
m-Cresol	108-39-4	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL				
o-Cresol	95-48-7	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
p-Cresol	106-44-5	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
Cyanide	57-12-5	CLP	10	10	200	154
		9041				
2,4-Dichlorophenoxyacetic acid; 2,4-D	94-75-7	SW-846 8150		12	70	70
		(CLP)				
4,4'-DDD	72-54-8	CLP 3/90		0.11	-	
				0.02		
4,4'-DDE	72-55-9	CLP 3/90	0.003	0.04	-	
4,4'-DDT	50-29-3	CLP 3/90	0.004	0.12	-	
				0.02		
Diallate	2303-16-4	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		

CONSTITUENTS	CAS RN	STATEMENT OF WORK (SOW)	MDL (ug/L)	CRQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Dibenz[a,h]anthracene	53-70-3	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
Dibenzofuran	132-64-9	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
Dibromochloromethane	124-48-1	CLP-VOLATILE		5	-	
		CLP-LOW LEVEL		1		
1,2-Dibromo-3-chloropropane; DBCP	96-12-8	CLP-VOLATILE		5	0.2	0.025
		CLP-LOW LEVEL		1		
1,2-Dibromoethane; EDB	106-93-4	CLP-VOLATILE		5	0.05	0.0005
		CLP-LOW LEVEL		1		
Di-n-butyl phthalate	84-74-2	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
o-Dichlorobenzene; 1,2-Dichlorobenzene	95-50-1	CLP-VOLATILE		5	600	620
		CLP-LOW LEVEL		1		
m-Dichlorobenzene; 1,3-Dichlorobenzene	541-73-1	CLP-VOLATILE		5	600	620
		CLP-LOW LEVEL		1		
p-Dichlorobenzene; 1,4-Dichlorobenzene	106-46-7	CLP-VOLATILE		5	75	1.8
		CLP-LOW LEVEL		1		
3,3'-Dichlorobenzidine	91-94-1	CLP-SEMI-VOLATILE		20	-	
		CLP-LOW LEVEL		5		
trans-1,4-Dichloro-2-butene	110-57-6	CLP-VOLATILE		50	-	
		CLP-LOW LEVEL		5		

CONSTITUENTS	CAS RN	STATEMENT OF WORK (SOW)	MDL (ug/L)	CRQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Dichlorodifluoromethane *	75-71-8	CLP-VOLATILE		5	-	0.19
		CLP-LOW LEVEL		1		
1,1-Dichloroethane *	75-34-3	CLP-VOLATILE		5	-	700 <sup>4</sup>
		CLP-LOW LEVEL		1		
1,2-Dichloroethane	107-06-2	CLP-VOLATILE		5	5	0.38
		CLP-LOW LEVEL		1		
1,1-Dichloroethylene *	75-35-4	CLP-VOLATILE		5	7	7
		CLP-LOW LEVEL		1		
cis-1,2-Dichloroethylene *	156-59-2	CLP-VOLATILE		50	70	70
		CLP-LOW LEVEL		5		
trans-1,2-Dichloroethylene	156-60-5	CLP-VOLATILE		50	100	70
		CLP-LOW LEVEL		5		
2,4-Dichlorophenol	120-83-2	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
2,6-Dichlorophenol	87-65-0	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
1,2-Dichloropropane	78-87-5	CLP-VOLATILE		5	5	0.56
		CLP-LOW LEVEL		1		
1,3-Dichloropropane	142-28-9	CLP-VOLATILE		5	-	
		CLP-LOW LEVEL		1		
2,2-Dichloropropane	594-20-7	CLP-VOLATILE		5	-	
		CLP-LOW LEVEL		1		

CONSTITUENTS	CAS RN	STATEMENT OF WORK (SOW)	MDL (ug/L)	CRQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
1,1-Dichloropropene	563-58-6	CLP-VOLATILE		5	-	
		CLP-LOW LEVEL		1		
cis-1,3-Dichloropropene	10061-01-5	CLP-VOLATILE		5	-	
		CLP-LOW LEVEL		1		
trans-1,3-Dichloropropene *	10061-02-6	CLP-VOLATILE		5	-	
		CLP-LOW LEVEL		1		
Dieldrin	60-57-1	CLP 3/90	0.0007	0.02	-	
				0.02		
Diethyl phthalate	84-66-2	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
O,O-Diethyl O-2-pyrazinyl	297-97-2	CLP-SEMI-VOLATILE		20	-	
		CLP-LOW LEVEL		TBA		
Dimethoate	60-51-5	CLP-SEMI-VOLATILE		20	-	
		CLP-LOW LEVEL		TBD		
p-(Dimethylamino) azobenzene	60-11-7	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
7,12-Dimethylbenz[a] anthracene	57-97-6	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
3,3'-Dimethylbenzidine	119-93-7	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		

CONSTITUENTS	CAS RN	STATEMENT OF WORK (SOW)	MDL (ug/L)	CRQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
2,4-Dimethylphenol	105-67-9	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
Dimethyl phthalate	131-11-3	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		20		
m-Dinitrobenzene	99-65-0	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
4,6-Dinitro-o-cresol	534-52-1	CLP-SEMI-VOLATILE		50	-	
		CLP-LOW LEVEL		20		
2,4-Dinitrophenol	51-28-5	CLP-SEMI-VOLATILE		50	-	
		CLP-LOW LEVEL		20		
2,4-Dinitrotoluene	121-14-2	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
2,6-Dinitrotoluene	606-20-2	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
DNBP (Dinoseb)	86-85-7	SW-846	0.0600	0.07	7	
		8150				
Di-n-octyl phthiate	117-84-0	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
Diphenylamine	122-39-4	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		

CONSTITUENTS	CAS RN	STATEMENT OF WORK (SOW)	MDL (ug/L)	CRQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Disulfoton	298-04-4	CLP-SEMI-VOLATILE		50	-	
		CLP-LOW LEVEL		TBD		
Endosulfan I	959-96-8	CLP 3/90	0.0024	0.05	-	
				0.02		
Endosulfan II	33213-65-9	CLP 3/90	0.0015	0.10	-	
				0.02		
Endosulfan sulfate	1031-07-8	CLP 3/90	0.0884	0.10	-	
				0.02		
Endrin	72-20-8	CLP 3/90	0.0013	0.10	2	0.2
				0.02		
Endrin aldehyde	7421-93-4	CLP 3/90	0.003	0.10	-	
				0.02		
Ethylbenzene	100-41-4	CLP-VOLATILE		5.0	700	29
		CLP-LOW LEVEL		1.0		
Ethyl methacrylate	97-63-2	CLP-VOLATILE		50	-	
		CLP-LOW LEVEL		5		
Ethyl methanesulfonate	62-50-0	CLP-SEMI-VOLATILE		20	-	
		CLP-LOW LEVEL		TBD		
Famphur	52-85-7	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
Fluoranthene	206-44-0	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
Fluorene	86-73-7	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		

CONSTITUENTS	CAS RN	STATEMENT OF WORK (SOW)	MDL (ug/L)	CRQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Heptachlor	76-44-8	CLP 3/90	0.0040	0.05	0.4	0.076
				0.02		
Heptachlor epoxide	1024-57-3	CLP 3/90	0.0012	0.05	0.2	0.038
				0.01		
Hexachlorobenzene	118-74-1	CLP-SEMI-VOLATILE		10	1	0.02
		CLP-LOW LEVEL		5		
Hexachlorobutadiene	87-68-3	CLP-VOLATILE		5	-	
		CLP-LOW LEVEL		1		
Hexachlorocyclopentadiene	77-47-4	CLP-SEMI-VOLATILE		10	50	
		CLP-LOW LEVEL		5		
Hexachloroethane	67-72-1	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
Hexachloropropene	1888-71-7	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
2-Hexanone; Methyl butyl ketone	591-78-6	CLP-VOLATILE		5	-	
		CLP-LOW LEVEL		10		
Indeno[1,2,3-cd]pyrene	193-39-5	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
Iron*		CLP	9	100	300 (secondary MCL)	
		(ICP)				
Isobutyl alcohol	78-83-1	CLP-VOLATILE		2000	-	
		CLP-LOW LEVEL		200		

CONSTITUENTS	CAS RN	STATEMENT OF WORK (SOW)	MDL (ug/L)	CRQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Isodrin	465-73-6	CLP-SEMI-VOLATILE		20	-	
		CLP-LOW LEVEL		TBD		
Isophorone	78-59-1	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
Isosafrole	120-58-1	CLP-SEMI-VOLATILE		20	-	
		CLP-LOW LEVEL		TBD		
Kepone	143-50-0	CLP-SEMI-VOLATILE		25	-	
		CLP-LOW LEVEL		TBD		
Lead	Total	CLP-SW 846	3	3	15	50
		(ICP)				
Mercury *	Total	CLP-SW 846	0.2	0.2	2	1.1
		(CV-7470)		0.2		
Methacrylonitrile	126-98-7	CLP-VOLATILE		1000	-	
		CLP-LOW LEVEL		100		
Methapyrilene	91-80-5	CLP-SEMI-VOLATILE		TBD	-	
		CLP-LOW LEVEL				
Methoxychlor	72-43-5	CLP 3/90	0.0198	0.50	40	100
				0.10		
Methyl bromide; Bromomethane	74-83-9	CLP-VOLATILE		5	-	
		CLP-LOW LEVEL		1		
Methyl chloride; Chloromethane	74-87-3	CLP-VOLATILE		5	-	
		CLP-LOW LEVEL		1		

CONSTITUENTS	CAS RN	STATEMENT OF WORK (SOW)	MDL (ug/L)	CRQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
3-Methylcholanthrene	56-49-5	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
Methyl ethyl ketone; 2-Butanone	78-93-3	CLP-VOLATILE		100	-	170
		CLP-LOW LEVEL		10		
Methyl iodide	74-88-4	CLP-VOLATILE		50	-	
		CLP-LOW LEVEL		5		
Methyl methacrylate	80-62-6	CLP-VOLATILE		50	-	
		CLP-LOW LEVEL		5		
Methyl methanesulfonate	66-27-3	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
2-Methylnaphthalene	91-57-6	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
Methyl parathion	298-00-0	CLP-SEMI-VOLATILE		50	-	
		CLP-LOW LEVEL		TBD		
4-Methyl-2-pentanone; Methyl isobutyl ketone	108-10-1	CLP-VOLATILE		100	-	
		CLP-LOW LEVEL		10		
Methylene bromide; Dibromomethane	74-95-3	CLP-VOLATILE		5	-	
		CLP-LOW LEVEL		1		
Methylene chloride; Dichloromethane *	75-09-2	CLP-VOLATILE		5	5	5
		CLP-LOW LEVEL		1		
Naphthalene	91-20-3	CLP-VOLATILE		5	-	
		CLP-LOW LEVEL		1		

CONSTITUENTS	CAS RN	STATEMENT OF WORK (SOW)	MDL (ug/L)	CRQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
1,4-Naphthoquinone	130-15-4	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL				
1-Naphthylamine	134-32-7	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
2-Naphthylamine	91-59-8	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
Nickel	Total	CLP IML03.0	20	40	100	150
		(ICP)				
o-Nitroaniline	88-74-4	CLP-SEMI-VOLATILE		50	-	
		CLP-LOW LEVEL		20		
m-Nitroaniline	99-09-2	CLP-SEMI-VOLATILE		50	-	
		CLP-LOW LEVEL		20		
p-Nitroaniline	100-01-6	CLP-SEMI-VOLATILE		50	-	
		CLP-LOW LEVEL		20		
Nitrobenzene	98-95-3	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
o-Nitrophenol	88-75-5	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
p-Nitrophenol	100-02-7	CLP-SEMI-VOLATILE		50	-	
		CLP-LOW LEVEL		20		

CONSTITUENTS	CAS RN	STATEMENT OF WORK (SOW)	MDL (ug/L)	CRQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
N-Nitrosodi-n-butylamine	924-16-3	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
N-Nitrosodiethylamine	55-18-5	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
N-Nitrosodimethylamine	62-75-9	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
N-Nitrosodiphenylamine	86-30-68270	CLP-SEMI-VOLATILE		100	-	
		CLP-LOW LEVEL		5		
N-Nitrosodipropylamine	621-64-7	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
N-Nitrosomethylethylamine	10595-95-6	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		10		
N-Nitrosopiperidine	100-75-4	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
N-Nitrosopyrrolidine	930-55-2	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
5-Nitro-o-toluidine	99-55-8	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		

CONSTITUENTS	CAS RN	STATEMENT OF WORK (SOW)	MDL (ug/L)	CRQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Parathion	56-38-2	CLP-SEMI-VOLATILE		50	-	
		CLP-LOW LEVEL		TBD		
Pentachlorobenzene	608-93-5	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
Pentachloronitrobenzene	82-68-8	CLP-SEMI-VOLATILE		50	-	
		CLP-LOW LEVEL		TBD		
Pentachlorophenol	87-86-5	CLP-SEMI-VOLATILE		50	1	220
		CLP-LOW LEVEL		20		
Phenacetin	62-44-2	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
Phenanthrene	85-01-8	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
Phenol	108-95-2	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
p-Phenylenediamine	106-50-3	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
Phorate	298-02-2	CLP-SEMI-VOLATILE		100	-	
		CLP-LOW LEVEL		TBD		
Polychlorinated Biphenyls	See note 9	CLP 3/90		TBD	0.5	

CONSTITUENTS	CAS RN	STATEMENT OF WORK (SOW)	MDL (ug/L)	CRQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Pronamide	23950-58-5	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
Propionitrile	107-12-0	CLP-VOLATILE		1000	-	
		CLP-LOW LEVEL		100		
Pyrene	129-00-0	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
Safrole	94-59-7	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
Selenium	Total	CLP ILM03.0	5	5	50	10
		(ICP)				
Silver	Total	CLP ILM03.0	5	10	-	50
		(ICP)				
Silvex (2,4,5-TP)	93-72-1	SW-846	0.04	1.7	50	10
		8150				
Styrene	100-42-5	CLP-VOLATILE		50	100	0.014
		CLP-LOW LEVEL		5		
Sulfide	18496-25-8	SW846-9030	1000	1000	-	
2,4,5-Trichlorophenoxyacetic acid (2,4,5-T)	93-76-5	SW-846	0.03	2.0	-	
		8150				
1,2,4,5-Tetrachlorobenzene	95-94-3	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
1,1,1,2-Tetrachloroethane	630-20-6	CLP-VOLATILE		5	-	
		CLP-LOW LEVEL		1		

CONSTITUENTS	CAS RN	STATEMENT OF WORK (SOW)	MDL (ug/L)	CRQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
1,1,2,2-Tetrachloroethane	79-34-5	CLP-VOLATILE		5	-	
		CLP-LOW LEVEL		1		
Tetrachloroethylene *	127-18-4	CLP-VOLATILE		5	5	0.7
		CLP-LOW LEVEL		1		
2,3,4,6-Tetrachlorophenol	58-90-2	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
Thallium	Total	CLP ILM03.0	2	10	2	
		(Fumace)				
Tin	Total	SW846-6010	30	30	-	
		(CLP)				
Toluene	108-88-3	CLP-VOLATILE		5	1000	1000
		CLP-LOW LEVEL		1		
o-Toluidine	95-53-4	CLP-SEMI-VOLATILE		TBD	-	
		CLP-LOW LEVEL		TBD		
Toxaphene	See note 10	CLP 3/90	0.03	5	3	0.031
				1		
1,2,4-Trichlorobenzene	120-82-1	CLP-VOLATILE		5	70	
		CLP-LOW LEVEL		1		
1,1,1-Trichloroethane *	71-55-6	CLP-VOLATILE		5	200	200
		CLP-LOW LEVEL		1		
1,1,2-Trichloroethane	79-00-5	CLP-VOLATILE		5	5	
		CLP-LOW LEVEL		1		
Trichloroethylene *	79-01-6	CLP-VOLATILE		5	5	2.8
		CLP-LOW LEVEL		1		

CONSTITUENTS	CAS RN	STATEMENT OF WORK (SOW)	MDL (ug/L)	CRQL (ug/L)	MCL (ug/L)	NC GW STANDARD (ug/L)
Trichlorofluoromethane	75-69-4	CLP-VOLATILE		5	-	2100*
		CLP-LOW LEVEL		1		
2,4,5-Trichlorophenol	95-95-4	CLP-SEMI-VOLATILE		25	-	
		CLP-LOW LEVEL		20		
2,4,6-Trichlorophenol	88-06-2	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		5		
1,2,3-Trichloropropane	96-18-4	CLP-VOLATILE		5	-	
		CLP-LOW LEVEL		1		
O,O,O-Triethyl phosphorothioate	126-68-1	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
sym-Trinitrobenzene	99-35-4	CLP-SEMI-VOLATILE		10	-	
		CLP-LOW LEVEL		TBD		
Vanadium	Total	CLP ILM03.0	10	50	-	
		(ICP)				
Vinyl acetate	108-05-4	CLP-VOLATILE		5	-	
		CLP-LOW LEVEL		10		
Vinyl chloride *	75-01-4	CLP-VOLATILE		5	2	0.015
		CLP-LOW LEVEL		1		
Xylenes	1330-20-7 See note 11	CLP-VOLATILE		5	10000	400
		CLP-LOW LEVEL		1		
Zinc	Total	CLP ILM03.0	20	20	-	5000
		(ICP)				

1. Total analyses required for metals.
  2. This value represents an EPA action level.
  3. This value represents an EPA action level. Previous MCL was 0.05 mg/L.
  4. Denotes proposed NC Groundwater Standard.
  5. \* Denotes Target Compound as of 08/17/93.
  6. Benzo[a]pyrene will be analyzed initially by method 8310. Should no compound be detected, subsequent analysis will be by method 8270.
- TBD Denotes to be determined at a later date.

NOTES:

1. The regulatory requirements pertain only to the list of substances; the right hand columns (Methods and PQL) are given for informational purposes only. See notes 5 and 6.
2. Common names are those widely used in government regulations, scientific publications and commerce; synonyms exist for many chemicals.
3. "CAS RN" denotes Chemical Abstracts Service Registry Number. Where "Total" is entered, all species in the groundwater that contain this element are included.
4. CAS index names are those used in the 9th Collective Index. It should be noted that the index names are not listed above table.
5. Analytical Methods refers to analytical procedure numbers used in EPA Report SW-846 latest "Methods for Evaluating Solid Waste", third edition, November 1986, as revised, December 1987.
6. Practical Quantitation Limits (PQLs) are the lowest concentrations of analytes in groundwaters that can be reliably determined within specified limits of precision and accuracy by the indicated methods under routine laboratory operating conditions. The PQLs listed are generally stated to one significant figure. PQLs are based on 5 mL samples for volatile organics and 1-Liter samples for semivolatile organics.
7. This substance is often called Bis(2-chloroisopropyl) ether, the name CAS applies to its noncommercial isomer, Propane, 2,2'-oxybis(2-chloro- (CAS RN 39638-32-9).
8. Chlordane: This entry includes alpha-chlordane (CAS RN 5103-71-9), beta-chlordane (CAS RN 5103-74-2), gamma-chlordane (CAS RN 5566-34-7), and constituents of chlordane (CAS RN 57-74-9 and CAS RN 12672-29-6). PQL shown is for technical chlordane. PQLs of specific isomers are about 20 ug/L by method 8270.
9. Polychlorinated biphenyls (CAS RN 1336-36-3); this category contains congener chemicals, including constituents of Aroclor 1016 (CAS RN 12674-11-2), Aroclor 1221 (CAS RN 11104-28-2), Aroclor 1232 (CAS RN 11141-16-5), Aroclor 1242 (CAS RN 53469-21-9), Aroclor 1248 (CAS RN 12672-29-6), Aroclor 1254 (CAS RN 11097-69-1), and Aroclor 1260 (CAS RN 11096-82-5). The PQL is an average value for PCB congeners.
10. Toxaphene. This entry includes congener chemical contained in technical toxaphene (CAS RN 8001-35-2), i.e. chlorinated camphene.
11. Xylene (total): This entry includes o-xylene, m-xylene, p-xylene, and unspecified xylenes (dimethylbenzenes) (CAS RN 1330-20-7). PQLs for method 8021 are 0.2 for o-xylene and 0.1 for m- or p-xylene. The PQL for m-xylene is 2.0 ug/L by method 8020 or 8260.