PERMIT MODIFICATION
LANDFILL EXPANSION

Prepared for

White Oak Sanitary Landfill
Haywood County, North Carolina

June 16, 1997

STEFFEN ROBERTSON AND KIRSTEN (NC), INC.
Consulting Engineers and Scientists

PERMIT MODIFICATION FOR THE LANDFILL EXPANSION WASTE CELL 4 CONSTRUCTION WHITE OAK SANITARY LANDFILL HAYWOOD COUNTY, NORTH CAROLINA

Prepared for:

The White Oak Sanitary Landfill
S.R. 1338
Waynesville, North Carolina 28786

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SRK Project No. 83505

Permit Modification, Landfill Expansion
Waste Cell 4 Construction
White Oak Sanitary Landfill

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1 WASTE CELL 4 PERMIT APPLICATION OVERVIEW

The Haywood County White Oak Sanitary Landfill (WOSLF) seeks a permit modification to include the construction of the lateral expansion designated Waste Cell 4. This new phase would be constructed adjacent to the existing landfill overlapping portions of the existing waste cells 2 and 3.

The construction of Waste Cell 4 would allow the WOSLF to extend operations for approximately 1.5 years. During this time, the Haywood County Board of Commissioners intends to pursue permitting on a new landfill phase for future expansion.

This report includes all plans required under North Carolina Administrative Code (NCAC) 15A 13B .1600 as required for a permit modification request. These plans include:

1. Facility Plan
2. Engineering Plan
3. Construction Quality Assurance Plan
4. Operations Plan
5. Closure and Post-closure Care Plan
6. Water Quality Monitoring Plan

Since much of the design effort required to construct the previous phases of the WOSLF are applicable to this permit modification, frequent reference will be made to the existing permit and plans. The references will ensure consistent landfill operations through the use of previously approved design practices and parameters. However, where required, information specific to Waste Cell 4 will be addressed in this report.

2 FACILITY BACKGROUND INFORMATION

The WOSLF is a lined subtitle 'D' landfill which acquired a Permit to Operate (Permit No. 44-07) on October 8, 1993 from the North Carolina Division of Solid Waste Management (DSWM). The landfill began receiving waste for disposal on October 8, 1993. The permitted lined waste cell covers approximately 11.3 acres of the permitted 104-acre site.

The landfill is located ¼ mile west of S.R. 1338, 13 miles northeast of Waynesville , North Carolina on the south side of I-40 and adjacent to the Pigeon River. There are approximately 4 private residences within 2000 feet upgradient of the facility boundary. Residences are spread over a large area and none appear to be located hydraulically downgradient of the landfill. All of the residences receive their primary water supply from the individual potable wells or springs or both. The topography of the area is mountainous, and the entire area eventually drains to the Pigeon River. The Pigeon River flows northwest through Waterville Lake and on to Tennessee. A more detailed investigation and description of the area surrounding the landfill is contained in the approved Site Suitability Application.

For further information on the facility history, please see Chapter 1 of the *Transition Plan* written by DSA Design Group, Inc. in April 1994.

3 FACILITY PLAN

3.1 WASTE STREAM

A waste stream study was performed by Land-by-Sky Regional Council on June 6,1988. The study includes waste characterization and generation rates which were similar to the general waste stream of the state. This report is contained in the Approved Site Suitability application previously prepared by Tribble and Richardson, Inc., dated March, 1992.

3.1.1 Types of Waste

The WOSLF accepts only municipal solid waste generated in Haywood County and household hazardous waste for which the landfill is permitted. All waste disposed at the landfill is processed and baled at the Haywood County Materials Recovery Facility (MRF) located on Recycle Road in Clyde, North Carolina. The landfill accepts only waste approved by the NC Solid Waste Management Rules and Regulations. Hazardous and liquid waste is not accepted, as well as asbestos, lead batteries or sludge.

The collected waste is sorted at the MRF and only permitted waste is baled for disposal at the landfill. Waste oil and lead batteries are collected at the MRF for disposal or reuse by private contractors. Yard waste and inert debris is disposed of at the County's LCID landfill located in Canton, North Carolina.

3.1.2 Average Monthly Disposal Rates and Estimated Variance

The average monthly disposal rate of waste at the WOSLF is estimated at approximately 5,916 cubic yards (2,958 tons) per month. The coefficient variance for the disposal rate is approximately 14.5 percent.

3.1.3 Area Served by Facility

The WOSLF accepts only municipal solid waste generated in Haywood County, North Carolina.

3.1.4 Procedures for Segregated Management at Different On-Site Facilities

The WOSLF only accepts municipal solid waste material. No other disposal facilities are located on site. Waste generated in Haywood County is delivered to the Haywood County (MRF) and is sorted

by waste classification. Only waste permitted for disposal at the WOSLF is bailed and disposed in the landfill.

3.1.5 Equipment Requirements for Operation of the MSWLF Unit

Several pieces of equipment required for efficient operation and management of a sanitary landfill are already onsite and in use. First, WOSLF utilizes equipment to construct and maintain access roads around the landfill. A loader and haul trucks are used to excavate and transport soils needed to build up the roads. A pan is also available for transporting the soils to the construction and maintenance areas. A bulldozer is utilized to spread the soil materials for construction, as well as grading the roads and outer slopes to provide positive drainage away from the landfill waste area. A motor grader is also available onsite for maintaining the haul roads. A water truck is used to control nuisance dust from haul roads.

Operational equipment requirements for handling the waste include the use of a loader to unload the waste bails from transporting trucks and place the bails in the cell. The waste is stacked up to four bails high (12 - 15 ft.). Once the waste bails have been deposited in the disposal area, equipment is required to transport daily and intermediate cover soil and spread the soil. A pan is used to transport the daily cover soils and a D-6 bulldozer is used to spread the soil over the waste deposited in the disposal area at the end of each day. On wet weather days, a loader and an all terrain haul truck is used to load and haul the cover soils. As a contingency in the event that the bailer becomes disabled at the MRF, the WOSLF is permitted to receive loose waste. If loose waste is received at the landfill, a compactor is available onsite to compact the waste and daily cover in place to maximize storage capacity as well as reduce long term settlement.

3.2 LANDFILL CAPACITY AND ANALYSIS OF LANDFILL AND SOIL RESOURCES

The lateral expansion at the WOSLF is designed to extend the life of the landfill for approximately 1.5 years. Waste Cell 4 provides an additional 2 acres of waste disposal area to the already active landfill. The interior side slopes of the landfill and the final cap slopes at closure shall be a maximum of 3H:1V as approved in the previous applications. The maximum depth of the landfill will be approximately 80 ft. from the top of the composite liner to the final cap elevation. The landfill will accept approximately 200 cy (100 tons) of baled waste per day.

Using geometry of the site in conjunction with tools provided in the AutoCAD and Softdesk software, the capacity of Waste Cell 4 is calculated at approximately 112,000 cubic yards (60,000 tons) including the cover soils, intermediate cover, and the cap. The assumed in-place ratio of waste

to soil is 8:1. The volume of cap material required for this cell is approximately 4,800 cy of compacted clay liner material and 1,600 cy of vegetative cover. It should be noted that a portion of the estimated cap volume is part of the estimate previously calculated for the prior permitted phase.

The estimated quantity of compacted soils required for the construction, operation, and closure of the landfill are as follows:

Construction:

Sub-base layer: 3,300 cy (compacted)
Clay liner: 6,453 cy (compacted)
Protective drainage cover: 3,227 cy (uncompacted)
Gravel layer (57 stone): 2,111 cy (uncompacted)

Operation (assuming 8:1 waste to soil ratio):

Daily cover and Intermediate cover: 11,727 cy (compacted)
Baled Waste: 93,820 cy (compacted)

Closure

Clay liner: 4,840 cy (compacted)
Erosion layer (vegetative cover): 1,613 cy (uncompacted)

Using the approved borrow areas south of the facility, there are adequate quantities of soils with the desired qualities for construction and landfill operations.

3.3 CONTAINMENT AND ENVIRONMENTAL CONTROL SYSTEMS

Dust control measures shall be provided as necessary to prevent creating a nuisance to adjacent landowners or to landfill employees. No oils or chemicals (other than water) are used as dust suppression. Minimum dust control will include a water truck for wetting of haul roads.

Blowing litter shall be controlled by fencing and policing the area as required. Bailed waste does not promote extensive blowing debris.

Odor control measures shall be provided as necessary to prevent any nuisance to adjacent landowners. Minimum odor control measures will include regular daily cleanup of the site and a

constant cover of exposed waste. Having the waste processed at the MRF is very proactive in the mitigation of landfill odors.

Disease vectors, including rodents, flies, mosquitoes, or other animals and insects, capable of transmitting disease to humans shall controlled using techniques appropriate for the protection of human health and environment. Minimum disease vector control shall include placing regular daily cover over exposed waste.

3.4 LEACHATE MANAGEMENT

3.4.1 Leachate Collection Performance and Design

The landfill is designed with a composite liner of two (2) feet of compacted clay material with a permeability of no greater than 1 x 10^{-7} cm/sec and a flexible membrane liner above the clay layer made of HDPE material. The composite liner provides leachate containment within the landfill and prevents contamination of the environment. The flexible membrane liner shall be protected with two subsequent layers of non-woven geotextile fabric. At the base of the landfill, twelve (12) inches of washed No. 57 stone shall be place on top of the geotextile fabric to provide lateral drainage of the leachate. The 57 stone shall be enveloped by non-woven geotextile fabric by placing an additional layer on top of the stone. The geotextile fabric on top of the stone shall serve as a filter medium to prevent clogging of the drainage system. The stone and the geotextile fabric shall have a relatively high permeability (1 x 10^{-2} cm/sec or less) to allow leachate to flow freely along the liner toward the center of the cell. The base of the landfill shall be constructed at a slope of two (2) percent to the center of the cell where the leachate shall be intercepted by a 10 inch perforated drainage pipe which will convey the leachate to the leachate storage pond.. The drainage pipe shall have four rows of 3/8 inch perforations and will be staggered with 3 inch center to center spacing.

The pipe used in the leachate drainage system was designed to adequately support dead and live loads from construction and landfill operations in the previous Project Design Manual for phase II submitted by DSA Design Group dated March, 1992, and addenda. The depth of the new Waste Cell 4 is significantly less than Phase II and, thus, the overburden pressure will be less. The design drainage pipe will adequately support the loads subjected to it during construction and operation of the landfill.

A twelve (12) inch protective drainage layer shall be placed above the non-woven geotextile fabric that covers the N0. 57 stone. The protective drainage layer above the HDPE liner serves two purposes. First, the drainage layer protects the HDPE liner during construction and operation of the

landfill by absorbing the static and dynamic pressures. Second, the drainage layer conveys the leachate from the active area of the landfill to the leachate drainage system which consist of the No. 57 stone and the geotextile fabric, and leachate drainage pipes. The drainage layer will be a granular material and must have a maximum permeability of 1×10^{-5} cm/sec to allow the leachate to percolate to the drainage system.

The leachate management system is designed such that the leachate head on the composite liner is less than 1 foot at all times. The design is based on a study performed by DSA Design group in the document dated June 28, 1992, submitted as an addenda to their Design Manual dated March, 1992. To summarize their conclusions, based on testing of the native soils used for the protective cover and the No. 57 stone used for the drainage layer, the leachate head on top of the liner will never exceed 1 foot. The permeability of the compacted native soils range from 3 to 5×10^{-5} cm/sec. The permeability of the No. 57 stone is 1.0×10^{-1} cm/sec. The protective cover limits the flow of leachate to the liner as a result of the vast difference in flow rates. It was further determined that to limit the head on the protective cover, the hydraulic conductivity must be approximately 2.0×10^{-4} cm/sec, which falls in the range of the native soils in the uncompacted state (Ref.: Law Engineering).

The addenda also presents a discussion regarding the adequacy of the filter fabric used to envelope the No. 57 stone. In summary, the filter fabric will adequately convey fluids transmitted from the soil while only allowing 5% (D_{95}) of the native soil, used for protective cover, to pass. The filter fabric provides a permeability of 3.5×10^{-1} cm/sec. This exceeds the minimum permeability of 2.3×10^{-3} cm/sec required to adequately convey the fluids to the drainage system. The minimum pore size calculated to prevent clogging is 0.045mm. The geotextile proposed provides a minimum pore size of 0.10 mm as per manufacturers specification. Supporting calculations for the discussion have been included in Appendix B.

To assist in stormwater/leachate segregation and management, diversion dikes have been added to provide runoff relief. Refer to the bale placement detail and the typical cross section detail which includes the placement of diversion dikes to divert stormwater runoff. A temporary diversion dike shall be strategically placed outside the active disposal area to divert stormwater runoff away from the area of operation. The temporary diversion dike shall be relocated as needed to allow for progression of waste disposal and placement of daily and intermediate cover. A second diversion dike shall be placed from the sideslopes of the new Waste Cell 4 to the footprint of Waste Cell 4 where it ties into the existing cell No. 3. This diversion dike shall divert stormwater from the covered Cell No. 3 and drain away from the active area. The diversion dike shall remain in place until the elevation of the waste in the new cell reaches the elevation of Cell No. 3. Fill progression

will occur per the approved permit, and construction of diversion dikes and waste placement will proceed in a manner that minimizes stormwater run-on to the waste area.

At this point, operation can proceed in accordance with the approved operations plan in effect with the current permit.

3.4.2 Normal Operating Conditions

The HELP model was used by DSA Design Group to evaluate Phase II of the WOSLF for leachate head on the liner. Essentially the new phase of the landfill incorporates the same design, but at a smaller scale. The estimated leachate generation for the new Waste Cell 4 cell was determined by using a proportional relationship between the two phases. This estimate should be conservative since the depth of fill for Waste Cell 4 is considerably less than Phases I and II. The estimated values of leachate generation for Waste Cell 4 while it is active are as follows (see Leachate generation Calculation sheet in Appendix B):

Average Monthly Leachate Generation:	51,300 gallons
Average Monthly High Leachate Generation:	56,445 gallons
Peak Daily Leachate Generation:	4,471 gallons (0.007 cfs)

The leachate generation values will significantly depreciate as closure operations progress. Upon final closure of the landfill, leachate generation values expected for the entire landfill (all phases included) are as follows:

Average Monthly Leachate Generation:	25,525 gallons
Peak Daily Leachate Generation:	906 gallons (0.0014 cfs)

3.4.3 Leachate Management System

Estimated leachate generation values were used to design the piping system while accounting for surges from storm events. A ten (10) inch pipe shall be installed at the center of the cell at the low point, and shall have a slope of 2 percent. The pipe shall be perforated with four rows 3/8 inch holes with three (3) inch centers. The pipe is approximately 320 ft. long which gives the approximate number of perforations equal to 5,120 holes.

The adequacy of this design was determined by calculating the flow capacity of the pipe and the flow capacity of the perforations entering the pipe. The capacity of the pipe was calculated using Manning's equation assuming full flow. The capacity of the perforated holes was determined using the orifice equation. Assuming that one (1) foot of head on the liner is obtainable, the flow capacity of the holes was calculated by assuming that two inches of head is applied to the top two rows of holes and ten inches of head is applied to the bottom two rows of perforations. The calculated capacity of the pipe was less than the capacity of the perforated holes and was identified as the controlling factor. The flow capacity of the pipe was calculated as 4.48 cfs. This value was compared with the peak daily flow as determined by a proportional relationship between the new Waste Cell 4 and the previous leachate generation value determined by DSA Design Group for the Phase II cell in the Design Manual dated March, 1992. The expected peak daily leachate generation for Phase II was calculated as 4,471 gallons per day which is equivalent to 0.007 cfs. Through comparison, we conclude that the design drainage system is more than adequate.

Leachate flow is measured daily. The calculated peak flow rate is 4,471 gpd. A summary of average daily flow by month is provided in Table 3-1. Actual flow figures have a coefficient of variance of about 14.8% with a maximum of 2,059 gpd. Given this comparison, the design as proposed can be considered adequate (S.F.=2.17).

Table 3-1: Average Daily Leachate Flow Rate by Month

Month	Average Daily Flow Rate, gpm*	Average Daily Flow Rate, gpd	Month	Average Daily Flow Rate, gpm*	Average Daily Flow Rate, gpd
Nov-95	0.90	1,296	Sep-96	1.10	1,584
Dec-95	0.98	1,411	Oct-96	1.02	1,469
Jan-96	0.98	1,411	Nov-96	0.96	1,382
Feb-96	0.86	1,238	Dec-96	1.43	2,059
Mar-96	0.87	1,253	Jan-97	1.12	1,613
Apr-96	0.88	1,267	Feb-97	1.25	1,800
May-96	0.96	1,382	Mar-97	1.25	1,800
Jun-96	1.14	1,642	Apr-97	0.92	1,325
Jul-96	1.02	1,469	May-97	0.91	1,310
Aug-96	1.05	1,512			

Total Average Flow Rate, gpd	1,388
Standard Deviation, gpd	130
Coefficient of Variation, %	9.3%

* Per County flow records

The leachate storage pond was originally designed to provide thirty (30) days of storage capacity with two (2) feet of freeboard for safety. The leachate storage pond designed by DSA Design Group in the Project Design Manual dated March, 1992, specified a storage capacity of 250,000 gallons. This report also provides a calculation for the peak monthly leachate generation value of 93,135 gallons for the cells now in operation. The lateral expansion will not contribute a significant increase in discharges of leachate into the storage pond. The calculated monthly high value for leachate generation for the new cell is 56,445 gallons, giving a total potential discharge of 149,580 gallons. The leachate storage pond provides a storage safety factor of 1.7. The frequency at which the pond is pumped for treatment and disposal may be altered as necessary if storage problems arise.

Based on the given data, the leachate storage facility has an adequate capacity required for 30 day storage of leachate. The county is currently contracted with the Town of Waynesville Wastewater Treatment Facility to pump and haul the leachate for treatment

A minimum of 1.5 feet of freeboard shall be maintained in the leachate storage pond. This will be the controlling factor for the pump and haul schedule. The County will, at a minimum, haul to the treatment facility on a biweekly basis to minimize the amount of leachate in the holding facility. Due to the fluctuation of leachate in the leachate pond, as a result of variance in leachate produced in the landfill, a normal pool elevation is not specified, however, at no point will the pool elevation exceed the freeboard elevation.

3.4.4 Leachate Management Contingency Plan

As discussed in the previous section, the leachate storage pond has more than adequate storage capacity to contain leachate generated in the landfill for 30 days. However, storm surges may cause unexpected increase in leachate generation at the landfill which will accelerate the filling of the storage pond. Leachate levels shall be monitored every day and kept on records to provide advanced indication of the remaining storage available in the pond. At no point shall the pool elevation exceed the freeboard elevation. The leachate shall be pumped and hauled for treatment at least once every two weeks, and when it becomes apparent that the freeboard elevation will be exceeded. The County has two haul tankers that can haul the leachate produced at the landfill.

4 ENGINEERING PLAN

4.1 ANALYSIS OF FACILITY DESIGN

The EPA Subtitle 'D' regulation requires a composite liner system to be incorporated in the design of all new MSW landfills and lateral expansions of existing MSW landfills. The composite liner system shall consist of 24 inches of compacted soil with a permeability of no greater than 1×10^{-7} cm/sec, and a flexible membrane liner (FML) made with HDPE with a minimum thickness of 60 mil. To ensure that leachate is efficiently drained from the liner surface, a drainage layer must be placed on top of the HDPE liner. This leachate drainage layer consists of two layers of non-woven geotextile fabric which aid in protecting the liner, and a one foot layer of washed No. 57 stone. The stone shall be covered with an additional layer of geotextile fabric to act as a filter and prevent clogging of the drainage system. One foot of native protective soil shall be placed above the drainage layer to provide additional protection to the composite liner.

4.1.1 Foundation and Base Liner System

The bottom grades which are indicated on the construction plans (Sheet 2) represent the top of the composite liner. Construction of the new phased cell should begin with excavation and fill of native soil to an elevation of 24 inches below the contours the elevation of the HDPE liner which is indicated on the construction plans by the base contours. The fill/cut areas below the composite liner will be referred to as the 'sub-base'. All excess material shall be stock piled in the areas designated on the Plans or as directed by the Project Manager. All stock piled material shall be graded and trimmed to reasonably regular lines and stable slopes.

Construction of the composite liner shall begin with the placement and compaction of the clay liner. The clay liner shall consist of a mixture of native soils and bentonite at a proportion that will achieve a permeability of 1×10^{-7} cm/sec. The mix proportion of 93% soil to 7% bentonite was used in previous construction phases and met the permeability requirement. The proposed mixture is considered preliminary until confirmed by permeability testing. The clay liner shall be a minimum thickness of 24 inches and shall be placed directly above the subgrade. The contractor shall construct a test pad to determine the soil-to-bentonite ratio necessary to achieve the specified permeability of 1×10^{-7} cm/sec. The test pad shall also be used to determine the number of passes of a roller to achieve the specified compaction and permeability. Construction of the base layer will adhere to the specifications discussed in section 5.0 of this text.

The synthetic liner shall consist of high density polyethylene (HDPE) material. The clay liner shall be overlain by with a 60 mil HDPE liner. A smooth surface 60 mil HDPE liner may be used in the bottom of the landfill, while a textured 60 mil HDPE liner shall be used over the side slopes. The HDPE liner shall conform to, or surpass the requirements listed in the previous liner specifications. The textured HDPE liner shall have physical properties equal to the smooth surface liner. The requirements and specifications for the 60 mil HDPE liner are presented in Section 5.2 on page 5-19.

At the eastern limit of Cell 4, the new FML will be required to overlap the existing FML. Detail 22 on Sheet 12 of the construction plans shows the specific dimensions for overlapping the FML layers. This overlap will create a barrier which will resist water passage between the seems of the new and existing liners. Further prevention of seepage through the seems will be provided by a 10-foot strip of 60 mil FML. The new FML is required to overlap the existing FML on the 3H:1V side slopes by no less than 10 feet. All seems will be extrusion welded to provide proper seals and transfer of forces for anchoring.

4.1.2 Cap System

The cap for the new phase cell will tie into and be incorporated into the existing cap design previously proposed by DSA Design Group and approved by the North Carolina Department of Solid Waste Management. The final waste layer shall be capped with a compacted clay liner which will minimize infiltration through the closed MSWLF. The clay layer shall have a minimum thickness of 18 inches and will have a permeability of no greater than 1×10^{-7} cm/sec. Overlying the clay layer will be a FML layer with a demonstrated water vapor transmission rate of not more than 0.03 $g/m^2 \cdot day$. A 30 mil thickness of textured low-density polyethylene (LDPE) FML is suitable for the water vapor transmission rate. On top of the FML, an erosion layer that contains 6 inches of earthen material shall be placed which is capable of supporting native plant life. This layer shall minimize the erosion of the of the cap system and protect the low-permeability barrier from root penetration.

The low permeable clay layer shall consist of a mixture of native onsite soils excavated during construction and bentonite. The mixture proportions will be similar to that proposed for the composite liner. The erosion layer will consist of native onsite soils and permanent seeding shall be applied to stabilize the soil and slopes and provide erosion protection.

The final slope of the cap shall be 3H:1V at when closure is completed. Inspections shall be made periodically to evaluate settlement and soil loss of the landfill cap. Soil replacement, grading, and reseeding shall be performed as needed to repair and restore the integrity of the cap.

The sanitary solid waste material is contained between the HDPE liner and the cap barrier soil layer and, therefore, the methane produced from the degradation of the waste is confined within the waste fill area. Seven methane monitoring wells are presently located around the existing permitted landfill which are used for sampling and monitoring. Passive vents are installed throughout the waste cell for venting methane gas. Two additional landfill gas passive vents shall be installed in the new phase cell to relieve the gas pressures built up in the confining unit. Methane monitoring shall be performed on a quarterly basis as outlined in the Project Design Manual submitted by Tribble and Richardson dated March, 1992, and approved by the NCDSWM.

4.1.3 Leachate Storage Facilities

The leachate storage pond was designed with a storage capacity of 250,000 gallons. The pond was lined with a composite liner similar to that of the landfill. Twenty four inches of clay material was placed on top of the compacted native soils. The specifications for the clay liner called for a permeability not to exceed 1×10^{-7} cm/sec. A 100 mil HDPE textured liner was placed on top of the clay layer and was tied into the embankment using engineered anchor trenches. In addition to the FML, a layer of bentonite geocomposite liner was placed between the FML and the clay soil liner to further mitigate leakage. The crest of the embankment surrounding the outer slopes were covered with six inches of topsoil and seeded to prevent erosion. The base of the pond is sloped to drain to a sump where the leachate can be pumped through an eight (8) foot diameter wetwell on the embankment. A 10 Inch HDPE pipe connects the sump area of the leachate pond to the wetwell.

4.2 SUMMARY OF FACILITY DESIGN

4.2.1 Analytical Methodology

The critical conditions addressed in the design of Waste Cell 4 were developed as a result of the review of the approved permit documents prepared for the existing landfill. Issues such as sideslope based on slope stability, liner stability, leachate generation, and others all were evaluated in the initial permit application documents.

These design techniques and assumptions have been followed in this application. Some pre-construction assumptions required prior to landfill operation have been replaced by actual

operational data from the landfill. This data includes leachate generation and waste receiving rates among others.

In circumstances where calculations were required to properly assess the impact of the new waste cell, the previous design methods were followed. For example, ditch calculations have followed previously established stormwater runoff intensities, calculation methods, and evaluation parameters. The use of the previous methods has ensured consistency in the design of additions to the landfill.

4.2.2 Completion of Location Restriction Demonstrations

The demonstration of conformance of location restriction requirements was approved in the *Transition Plan* which was submitted by DSA Design Group dated April, 1994. The following text was extracted from that plan for reemphasis.

Airports

According to Rule .1622(1) of the Solid Waste Management Rules, a new MSWLF unit shall be located no closer than 5,000 feet from any airport runway used only by piston-powered aircraft and no closer than 10,000 feet from any runway used by turbine-powered aircraft.

The White Oak Landfill is not within the limits stated above and therefor presently complies with this Rule. The nearest airport runway of any kind is the Jackson County Airport locate 28 miles South of the landfill. The North Carolina Aeronautical Chart (1993) was used to locate the airport and determine its distance from the landfill.

Floodplain

According to Rule .1622(2) of the Solid Waste management Rules a MSWLF unit shall not be located in the 100-yr flood, reduce the temporary water storage of the floodplain, or result in the washout of solid waste so as to pose a hazard to human health and the environment.

The nearest drainage feature with a 100-yr floodplain, the Pigeon River, runs along the northern side of the facility. Flood Insurance Rate Map No. 370120 0080 B, dated July 15, 1984, indicates there are no areas within the permitted boundary that are located in a 100-year floodplain. A copy of this information was submitted in the Approved Site Suitability Application.

Unstable Areas

The area of the White Oak Landfill was evaluated to determine if it is "unstable as defined in Rule .1622(6) o the Solid Waste management Rules. Based on the evaluation, the area of the landfill was

determined to be stable. For further information refer to the following documents submitted to DSWM during the facility permitting process are part of the Approved Plan:

- Geotechnical Reports by Law Engineering dated July 26, 1991 and November 24, 1992
- Slope Stability Analysis by Law Engineering dated January 10, 1992
- Addendum No.1, Response to NCDSWM Comments by DSA Design Group dated May 29, 1992
- Project Design Manual by Tribble and Richardson, Inc., dated March 1992

5 CONSTRUCTION QUALITY ASSURANCE PLAN

5.1 EARTHWORK

5.1.1 Introduction

5.1.1.1 General

The Technical Specifications presented herein are for the Earthwork Construction of the lateral expansion of the White Oak Sanitary Landfill, Haywood County, North Carolina.

5.1.1.2 Scope of Work

The scope of work includes all earthwork required for the construction of the lateral expansion of the sanitary landfill, including site subgrade preparation. Specific work items include, but are not limited to the following:

- Mobilization of all equipment and material required for the work;
- Installation of temporary and permanent surface water control;
- Clearing, grubbing, and stripping in required areas;
- Excavation in required areas;
- Development of borrow areas outside the permitted boundaries;
- Foundation preparation for synthetic liner and fill placement;
- Haul road construction and maintenance;
- Installation of piping used for leachate removal from the newly constructed cell and tie-in to existing leachate system;
- Furnishing and installing all material and constructing all items appurtenant and incidental to the above;
- Grooming outside slopes of existing cells;

- Construction of surface water control facilities of the outside embankment slopes of the finished cells

- Removal and relocation of topsoil piles located within the proposed construction areas or borrow areas;

- Demobilizing, including removal of temporary structures and shaping, contouring, and grading final surfaces.

The contractor shall familiarize himself with the relevant and site specific conditions which may have an impact upon the work. Data relevant to the overall project are contained in reports in the possession of the owner, which are available for Contractor review.

Drawings to be read in conjunction with these Specifications are included with this document.

In the case of discrepancy or ambiguity in the Specifications, Drawings, codes, standards, or regulations, it is the intent of these Specifications that the most restrictive interpretation shall apply unless interpreted otherwise by the Design Engineer.

5.1.1.3 Definitions

The following definitions apply to these Specifications:

a. "Owner" is defined as an authorized representative of White Oak Sanitary Landfill (WOSLF);

b. "Construction Manager" is defined as an authorized representative of the Owner responsible for coordinating the activities of the Contractor;

c. "Quality Assurance Engineer" is defined as a qualified representative appointed and authorized by the Owner to monitor the quality of the completed construction product;

d. "Design Engineer" is defined as an authorized representative of the owner, currently holding valid professional registration in North Carolina, who has designed the facilities to be constructed and prepared the plans and specifications;

e. "Contractor:" is defined as the party or parties which have a contract agreement with the Owner and perform the actual construction activities.

f. "Specifications" is defined as this document of technical specifications prepared by Steffen Robertson and Kirsten (U.S.), Inc. for the White Oak Sanitary Landfill Project dated May, 1997.

g. "Drawings" is defined as the drawings in conjunction with these Specifications titled, "Engineering Report for the White Oak Sanitary Landfill, Haywood County, North Carolina" and are in a series numbered Sheet 1 through Sheet 12.

5.1.1.4 Applicable Codes and Regulations

The work shall conform to applicable Federal, State, County, and local regulations. Test procedures shall conform to applicable ASTM standards, as documented in the edition of the standards in force at the start of work.

5.1.2 Contractor's Responsibility

The contractor shall carefully examine all of the Specifications and Drawings, and the site of the work. He shall fully inform himself as to the character of all conditions at the site, local and otherwise, affection the execution of the work, including those conditions to which Federal, State, and local safety and/or health laws and regulations may be applicable. Failure to comply with the requirements of this section shall not relieve the Contractor of responsibility for complete performance of the work.

It shall be the sole responsibility of the Contractor to familiarize himself, by such means as he considers appropriate, with all matters pertaining to this work including, but not limited to:

- The location and nature of work:
- Climatic conditions:
- The nature and conditions of the terrain:
- Geologic conditions at the site:
- Transportation and communication facilities:
- Location and nature of construction materials available for use in the work;
- All other factors that may affect the cost, duration, and execution of the work.

Before accepting the work, the Contractor shall acknowledge in writing that he has inspected the site and determined the characteristics of the work and the conditions indicated above.

5.1.3 Inspection of Work

5.1.3.1 General

Unless other wise specified, full-time inspection of all construction activities defined by the Specification will be provided by the owner. Owner's inspection of all work shall be performed under the supervision and control of the Quality Assurance Engineer or his designated representative while such work is in progress. Said inspections are for the convenience, satisfaction, and benefit of the owner in determining that the work is performed in accordance with the Specifications. It shall be the Contractor's sole responsibility to provide all required materials (both natural and manufactured) and to perform all work in conformance with the Specifications. The Quality Assurance Engineer will inspect, test and report all findings to the WOSLF Project Coordinator. The WOSLF Project Coordinator shall be responsible for enforcing the specifications or initiating variances or design changes through the Design Engineer. Owner's inspections shall not relieve the Contractor of responsibility for the acceptability of the finished work or portions thereof.

5.1.3.2 Access

The quality Assurance Engineer and his representatives shall at all times have access to the work whenever it is in preparation or progress provided that they report their presence to the WOSLF Project Coordinator who is responsible for all activities onsite. The Contractor shall full cooperate with the Quality Assurance Engineer, shall provide proper facilities for access, and shall furnish labor and equipment reasonably needed for safe and convenient inspection, including the excavation of test pits. The Contractor shall give the Quality Assurance Engineer shall perform said inspection in such a manner as not to unnecessarily delay the work.

5.1.3.3 Examination

If any work should be covered up without prior approval or consent of the Quality Assurance Engineer, it must, if required by the Engineer, be uncovered for examination.

5.1.3.4 Samples and Tests

It is the intent of these specifications that materials shall be inspected and tested by the Quality Assurance Engineer before final acceptance of the work. Any item of the work which is found not to meet or exceed the Specifications, or which is improperly located or constructed, shall be removed and replaced. The Quality Assurance Engineer's inspections and test shall not relieve the Contractor from full responsibility to furnish and install materials in conformance with these Specifications.

5.1.3.5 Alteration to Drawings and Specifications

All alterations made to either the Specifications or Drawings shall be subject the Design Engineer's approval and, where applicable, to the approval of regulatory government agencies. All alterations shall be issued under a covering work order signed by the Design Engineer.

5.1.4 Environmental Requirements

5.1.4.1 Control of Sediment

The Contractor shall design, furnish, install, maintain and operate such equipment and structures as are necessary to contain and precipitate suspended solids (sediment) appearing in surface water immediately downstream of each work area, irrespective of the source of said suspended solids. Surface water released from the Contractor's sediment control facilities shall have turbidities which are less than or equal to the maximum values permitted by State or Federal law.

The contractor shall be fully responsible for sediment control and the attainment of effluent quality conforming to State and Federal laws.

5.1.4.2 Control of Fugitive Dust

During the performance of the work defined by these Specifications or any operations appurtenant thereto, whether on right-of-way provided by the Owner or elsewhere , the Contractor shall furnish all labor, equipment, materials, and means required, and shall perform proper and efficient measures wherever and as required to reduce the dust nuisance, and to prevent dust which has originated from the Contractor's operations from damaging land, vegetation, and dwellings, or causing a nuisance to persons. Dust shall be controlled to a degree acceptable to the appropriate state and Federal agencies, and acceptable to the WOSLF Project coordinator.

5.1.4.3 Limits of Work

The Contractor shall confine his apparatus, the storage of materials, and the operation of workmen to limits indicated by law, ordinances, permits or selected by the WOSLF Project Coordinator, and shall not unreasonably encumber the premises with his materials. Extreme caution shall be exercised at all times to avoid blocking facility or other roads or in any other way interfering with the Owner's operations or presenting a hazard to the Owner's personnel and equipment, or to the public.

5.1.4.4 Surface Water Control

Prior to beginning construction, the Contractor shall submit for approval a plan showing proposed method for collection and disposition of surface waters that may affect the execution and completion of work. The plan may be placed in operation upon review by and comment by the WOSLF Project Coordinator and Quality Assurance Engineer, but nothing in this section shall relieve the Contractor from full responsibility for the adequacy of the system.

Surface water control shall be accomplished in a manner that will result in all construction operations being performed free of excess moisture.

5.1.5 Excavation

5.1.5.1 General

5.1.5.1.1 Scope of Work

The excavations to be performed include, but are not limited to, site preparation: removal of topsoil and other unsuitable materials located within the proposed construction limits; shaping; and excavation or trenching for the surface water drains, pipeline channels, and in the project borrow area.

There shall be no classification of soil and rock excavations for these specifications as to type, hardness, moisture condition, or other characteristics for classification and payment purposes.

The Contractor shall be solely responsible for determining the excavatability of soil and rock materials, water table conditions, and other pertinent subsurface information. The Contractor shall satisfy himself with additional subsurface information, if he so desires and at his own expense, for bidding purposes.

5.1.5.1.2 Handling of Material

Insofar as is practicable in the permanent construction, the Contractor shall use materials obtained from designated borrow areas, as approved by the WOSLF Project Coordinator, which meet the applicable specifications. Such materials may be placed in the designated final locations direct from the excavation. The Contractor shall schedule excavation, placement, and compaction operations so as to avoid rehandling or stockpiling of excavated material.

5.1.5.1.3 Lines and Grades

All open-cut excavations shall be performed in accordance with the specifications to the lines, grades, and dimensions shown on the drawings or as established by the Design Engineer. Assumed excavation lines for the work are shown on the Drawings, but the final excavation may vary from lines shown. The assumed final lines for excavation, shown on the Drawings, shall not be strictly interpreted as accurately indicating the final or actual lines of excavation. When unfavorable conditions are discovered, they shall be corrected by excavation to lines, depths, and dimensions prescribed by the Design Engineer.

Fills tying-in to existing fills shall be keyed into the existing slopes. This shall be accomplished by blending (with the corner bit of dozer) the outer slopes into the imported fill minimum of three (3) feet (horizontal). Each lift shall be keyed into the existing slope.

Unless noted otherwise or specifically prescribed by the Design Engineer, the maximum permissible deviation from specified lines and grades shall be plus or minus 0.5 feet.

5.1.5.1.4 Cuts and Slopes

the Contractor shall inspect all temporary and permanent open-cut excavations on a regular basis for signs of instability. Should signs of instability be noted, the Contractor shall undertake remedial measured immediately and shall notify the WOSLF Project Coordinator as soon as possible. It shall be the Contractor's responsibility to remove all loose material from the excavation slopes and to maintain the slopes in a safe and stable condition at all times during the progress of the work.

5.1.5.1.5 Excess Excavation

All necessary precautions shall be taken to preserve the material below and beyond the lines of excavation in the soundest possible condition. Where excess excavations has been performed to complete the Work, such areas shall be refilled with materials furnished and placed to the

satisfaction of the Quality Assurance Engineer at the Contractor's expense. Over-Excavation required by the Quality Assurance Engineer, and subsequent backfilling, will be payable by the owner on the basis of the Contractors unit rates which will form a part of the Contract.

5.1.5.1.6 Disposal of Excavated Materials

Excavated materials unsuitable for permanent construction requirements shall be wasted. Waste piles shall be located outside the limits of the fill areas as shown on the Drawings, or as approved by the WOSLF Project Coordinator, where they will not interfere with the natural flow of streams, with the operation of the Owners facilities and other facility structures, and where they will neither detract from the appearance of the completed project nor interfere with the accessibility of the various parts of the work. Waste piles shall be graded and trimmed to reasonably regular lines and stable slopes.

5.1.5.2 Site Preparation

5.1.5.2.1 General

The Contractor shall clear, grub, and strip from the foundation areas of the additional cell, waste stockpile areas, borrow areas, and related structures, all material unsuitable for use as a foundation or acceptable fill material, as determined by the Quality Assurance Engineer.

5.1.5.2.2 Clearing

Clearing shall be done in the entire area with in the facilities limits delineated on the Drawings. Clearing shall extend a maximum of 20 feet outside the facilities limits.

Clearing shall consist of cutting brush to ground level, and removing such material along with wood, rubbish, and any other vegetation.

The vegetative material, rubbish, and other materials removed during clearing and grubbing shall be removed from the cleared area and disposed of in an area designated by the WOSLF Project Coordinator.

5.1.5.2.3 Grubbing

Grubbing shall consist of the removal of stumps, vegetation, and roots 1 inch diameter or larger from below the surface of the natural ground.

5.1.5.2.4 Stripping

Stripping of the upper 12 inches (maximum) of the soil shall be done in the entire area within the stripping limits of the facilities foundations, and in approved areas of the borrow sources. Stripping shall not be done below 12 inches from the original ground surface, unless otherwise directed by the Quality Assurance Engineer.

The stripped materials shall be removed from the stripped area and placed in designated stockpile areas. Placement of stripped soils outside of designated areas shall not be done unless otherwise directed by the WOSLF Project Coordinator.

Unsuitable materials to be removed by stripping shall include debris, topsoil, excessively wet or soft soil, and vegetable matter, including roots. Other perishable and objectionable materials unsuitable for use in permanent construction, and which might interfere with the proper bonding of fill with the foundations or the proper compaction of the materials in embankments and other fill areas, or which are other wise unsuitable as determined by the Quality Assurance Engineer, shall be removed.

Specific locations are identified on the Drawing for relocation of the topsoil existing within the foundation area of new cell.

5.1.5.2.5 Disposal of Material

Slash, tree debris, shrubs and other vegetation from clearing and grubbing may, following the request of the Contractor and approval of the WOSLF Project Coordinator, be collected at designated locations and disposed of by controlled burning.

Topsoil shall be stockpiled for later used in areas designated by the WOSLF Project Coordinator. Other material obtained from the grubbing and stripping operations shall be disposed in areas designated by the WOSLF Project Coordinator.

5.1.5.3 Access Roads

Contractor's access roads shall be planned such that construction of said roads shall coincide, as much as practicable, with the construction of the permanent roads associated with the project and other required excavation. Prior to construction of access roads, the Contractor shall submit a plan showing their location and size for the WOSLF Project Coordinator to submit for the Owner's and Design Engineer's approval.

5.1.5.4 Borrow Areas

To the extent practicable, earth and rock materials required for the work defined by these Specifications shall be obtained primarily from the borrow areas designated on the Drawings. Materials not available from said borrow areas shall be furnished by the Contractor from a source proposed by the Contractor and approved by the Design Engineer.

The Owner will select and used borrow areas which adhere to the overall mine plan for construction materials., provided the materials meet the specification requirements for the intended use, and are approved by the Design Engineer.

5.1.6 Fill Placement

5.1.6.1 General

5.1.6.1.1 Scope

The work covered by this section of the Specifications shall include, but is not limited to, fill placement for the new cell and access roads, reworking in-place foundation materials in the foundation areas, and earthwork incident thereto. The embankment and other pertinent structures shall have materials categorized as follows:

- FML (synthetic HDPE liner)
- liner fill
- protective soil layer
- inert fine grain fill (structural subgrade);
- filter fabric; and
- drain material.

5.1.6.1.2 Lines and Grades

Earthwork shall be constructed to the lines, grades, and cross sections shown on the Drawings, or as specified herein.

5.1.6.1.3 Foundation Preparation

Upon the completion of the required foundation stripping/excavation operations and removal of unsuitable foundation material, the excavated surface which is to be constructed upon shall be compacted and proofrolled in its entirety to examine the foundation for soft, unacceptable foundation conditions. The foundation shall be proofrolled using a loaded Cat 631 scraper or equivalent. No new fill shall be place in the foundation areas until the foundation has been inspected and approved by the Quality Assurance Engineer.

5.1.6.1.4 Placement

The procedures for the construction of required fills shall be described to and approved by the Quality Assurance Engineer prior to fill placement.

No brush, roots, sod, or other deleterious or unsuitable materials shall be placed in the engineered fills. The suitability of all fill materials intended for use in the construction work shall be subject to approval by the Quality Assurance Engineer. Fill placement shall be temporarily stopped, due to unsuitable weather conditions, at the discretion of the Quality Assurance Engineer. Under marginal weather conditions, the Contractor may place fill provided the fill, when tested, meets Specifications.

The distribution of materials shall be such that the fill is free from lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material. The combined borrow excavation and fill placement operation shall be such that the materials, when compacted in the fill, shall be blended sufficiently to ensure the best practicable distribution of the material, subject to the approval of the Quality Assurance Engineer. Fill shall be placed in approximately horizontal lifts of the maximum thickness specified for that material type, and leveled as needed in preparation for compaction.

If, in the opinion of the Quality Assurance Engineer, the surface of the prepared foundation or the surface of any layer of the fill is too dry or too smooth to bond properly with the layer of material to be placed thereon, it shall be moistened and/or worked with harrow, scarifier, or other equipment to provide a satisfactory bonding surface before the next layer of fill material is placed. If, in the opinion of the Quality Assurance Engineer, the surface of the prepared foundation or the rolled surfaced of any layer of the fill in place is too wet for proper compaction of the layer of fill material to be placed thereon, it shall be removed and allowed to dry or shall be worked with harrow, scarifier, or other equipment to reduce the moisture content to the required amount, and then compacted before the next layer of fill material is placed.

The placement of liner fill material in the Waste Cell 4 shall be to the lines and dimensions shown in the Drawings. Lift thickness, moisture conditions and compaction shall comply with the Specifications.

5.1.6.1.5 Moisture Control

During compaction operations, the liner fill materials shall be maintained or conditioned within the moisture content range required to permit proper compaction to the specified density. The moisture contend of the fill material prior to and during compaction shall be uniform throughout the material.

When materials is too dry for proper compaction, the Contractor shall spray water on the fill and work the moisture into the fill by harrowing, or other approved means, until a uniform distributions of moisture is obtained. Material that is too wet for proper compaction shall be removed from the fill or the material may be spread and permitted to dry, assisted by disking and harrowing, it necessary, until the moisture content is reduced to an amount suitable for obtaining the specified degree of compaction.

5.1.6.1.6 Compaction

Wherever necessary, after material has been placed and spread, or reworked in-place and moisture conditioned as specified, the layer shall be compacted by passing compaction equipment over the entire surface of the layer a sufficient number of times to obtain the required density, as determined by the Quality Assurance Engineer on the basis of field density tests and his observations of the fill operations.

The frequency of field density test performed on each type of material shall be as required by the Quality Assurance Engineer.

The Quality Assurance Engineer will continuously evaluate the Contractor's equipment and methods. If such equipment or methods are found unsatisfactory for the intended use, the Contractor shall be required to replace the unsatisfactory equipment with other types or adjust methods until proper compaction is achieved.

Compaction shall be based on ASTM D698 or compactive effort as approved by the Quality Assurance Engineer. In-place fill densities may be determined by the Sand Cone or Nuclear Gauge Methods. The Contractor shall construct test fills, as determined by the Quality Assurance Engineer, for fills outside the testing limits of ASTM D698, for establishing compactive effort procedures.

The USBR Rapid Method may be used in conjunction with the Standard Proctor Compaction Method to determine percent compaction.

5.1.6.1.7 Special Compaction Equipment

Only hand-guided mechanical tampers or hand-guided vibratory rollers shall be used for compaction around, over, near, or adjacent to pipes, HDPE liner , and/or concrete structures.

5.1.6.1.8 Sequence of Fill Operations

The contractor shall construct the fill areas such that the fill is approximately level at all times during construction. The fill surfaces shall be graded to prevent ponding of rainwater.

The Contractor shall leave the surface of compacted fill, at the end of each shift or day, in such a manner as to prevent an excessive increase in moisture content arising from precipitation. The Quality Assurance Engineer may require that the top layer be removed at the recommencement of fill placement if it has become too wet or is softened as a result of precipitation.

In areas of HDPE liner placement, following such placement, no vehicular traffic and minimal installation labor traffic shall be permitted on the liner surface. Special access across installed liner, if required, shall be approved by the Quality Assurance Engineer and may require fill placement at the Contractor's expense to protect the liner.

5.1.6.1.9 Contamination

The Contractor shall route equipment and take all actions necessary to prevent material of one type from being deposited inadvertently, either by dumping or through travel of equipment, in or on material of another type. Such improperly deposited material shall be removed from the fill areas as required by the Quality Assurance Engineer. Said removed material shall be wasted in locations designated by the WOSLF Project Coordinator.

5.1.6.1.10 Conduct of Work

The Contractor shall maintain and protect fills in a condition satisfactory to the Quality Assurance Engineer at all times until the final completion and acceptance of the work. Any approved fill material which becomes unsuitable for any reason whatsoever, after being placed in the fill and

before final acceptance of the work, shall be removed and replaced by the Contractor in a manner satisfactory to the Quality Assurance Engineer.

5.1.6.1.11 Access Roads

Permanent access roads shall be constructed as approved by the Owner. Foundation preparation and fill placement for access roads within required fill areas shall be as specified for the fill areas. Fill placement for access roads outside of the required fill areas shall be as approved by the owner.

Temporary access roads may be required by the Contractor to complete the specified work. The Contractor shall submit a plan showing the location and size of temporary access road fills for the WOSLF Project Coordinator to submit to the Owner for approval.

5.1.6.2 Liner Fill Material

Liner fills shall consist of liner fine grain material and shall be used in the construction of the leachate pipeline channels, as shown on the Drawings. Liner fill material shall consist of inorganic clays and silts, or clayey and silty sands with a maximum particle size of ¾ inch. It is intended that Type I material shall be entirely obtained from required borrow area excavations, as indicated on the drawings. The liner fill material shall be moisture conditioned to near optimum moisture content (within plus or minus 2 percent of optimum), placed in 8 inch maximum loose lifts and compacted to a minimum of 95 percent of maximum density as per ASTM D698.

Liner fill material shall be placed in horizontal lifts wide enough to accommodate placement and compaction with conventional construction equipment to meet Specifications. Liner fill material, within a zone of 5 feet adjacent to structures or HDPE liner, shall be compacted to a minimum of 95 percent of maximum density using special compaction equipment, unless otherwise approved by the Quality Assurance Engineer.

Liner fills shall have a maximum permeability of 1.0×10^{-7} cm/sec and conform to the following material specifications listed in Table 5-1.

Table 5-1: Liner Fill Sieve Analysis Specifications

U.S. Standard Sieve or Screen Opening	Percentage Passing by Weight
¾ inch	100
No. 4	85-100
No. 40	65-100
No 200	55-100

Liner fill shall be tested per the ASTM designation and at the frequencies shown in Table 5-2.

Table 5-2: Required ASTM Test Methods for Liner Fill

Parameter	Test Method	Min. Test Frequency
Density	ASTM- D2922	1 test every 2000 cy
Moisture Content	ASTM-D2216	1 test every 2000 cy
Undisturbed Permeability		
Lab permeability (From Borrow Source)		
Particle Size Analysis	ASTM D-422	1 test every 10,000 cy or every material change
Atterberg Limits	ASTM D4318	1 test every 10,000 cy or every material change
Final Compacted Liner Thickness	Probe by hand auger	1 test every 1 acre

5.1.6.2.1 HDPE Liner Foundation Preparation

This work shall consist of shaping, leveling, moisture conditioning, and smooth drum compacting the surfaces over which HDPE liner will be installed. All roots, rocks, and sharp objects which could damage or protrude through the HDPE liner shall be removed by either mechanical means or hand picking. This work shall be scheduled in conjunction with the liner contractor's operation and performed just prior to the deployment of the layer of HDPE liner. The finished surfaced shall be uniformly smooth - free of dips, divots, and irregular surfaces.

5.1.6.2.2 Anchor Trench Excavation & Backfill

This work shall consist of excavation the anchor trench, prior to the HDPE liner installation, and backfilling the anchor trench once the HDPE liner has been installed in the trench. The anchor trench shall be excavated to the lines and grades depicted on the Drawings. Anchor trench excavation shall be scheduled in conjunction with the liner contractor's schedule of deployment.

The excavated material shall be placed in the anchor trench in two equal lifts and pneumatically compacted, using heavy equipment, to a 90% standard Proctor density with a moisture content near optimum. It shall be the contractor's responsibility to ensure the equipment selected for the backfill and compaction operations does not damage the HDPE liner. In the event the equipment does damage the liner, it shall be the Contractor's responsibility to repair such damage. The final surface shall be graded to the specified finish grade.

5.1.6.3 Outside and Horizontal Structural Fine Grain Fill

Outside and horizontal structural fine grain fill shall be placed in areas where fill is required to construct haul roads and maintain the integrity of the new cell. Fill material shall consist of inorganic sandy gravelly silts and clays with minimum of 50% passing the No. 200 standard sieve with a maximum particle size of two (2) inches. Oversized particles shall be demonstrated to be friable and break down under normal compaction. The fine grain fill shall conform to the following material specifications:

Table 5-3: Outside and Horizontal Structural Fine Grain Fill Sieve Analysis Specifications

U.S. Standard Sieve or Screen Opening	Percentage Passing by Weight
2 inch	100
No. 4	85-100
No. 40	65-100
No 200	55-100

The structural fill shall be placed in 8 inch loose lifts, moisture conditioned to within 2 percent of the optimum moisture content, and compacted to a minimum of 95 percent of the maximum dry density, in accordance with ASTM D698. The fill shall be compacted with sufficient passes of a sheepsfoot roller or pneumatic roller to produce the required degree of compaction. The fill shall be graded

horizontally following placement to provide positive drainage to adjacent drainage structures, and away from the new cell.

5.1.6.4 Rippability Test

The contractor shall rip the production areas using a D-9N Cat Dozer, equipped with Grousers with less than 75% wear and a single medium duty ripper tip, or equivalent, until material hardness is such that ripping becomes ineffective. Rippability shall be determined by one or several of the ripping production methods listed in the Caterpillar Performance Hand Book. WOSLF Project Coordinator, the Contractor, and the Design Engineer shall observe the test and use the resulting data to determine the effectiveness of the ripping.

5.1.6.5 Drain Rock

The drainage layer shall consist of smooth, well rounded, washed river gravel that meets the gradation requirements for No. 57 stone. The drain rock shall be installed in manner that minimizes damage to the collection pipe and geomembrane liner, and shall be placed as shown in the Drawings.

5.1.6.6 Geotextile Fabric

The filter fabric shall be used in the construction of the leachate drainage system as shown in the drawings.

The geotextile fabric shall be a Trevira Type 1120, as manufactured by Hoechst Celanese Corporation, or an approved equal. The geotextile shall have the following minimum physical properties listed in Table 5-4 on page 5-18.

Table 5-4: Geotextile Fabric Properties Specifications

Fabric Property	Unit	Test Method	Value
Fabric Weight	oz/sy	ASTM D-3776	6.0
Thickness, t	mils	ASTM D-1777	95
Grab Strength	lbs	ASTM D-4632	230/180
Grab Elongation	%	ASTM D-4632	65/75
Trapezoid Tear Strength	lbs	ASTM D-4533	80/75
Puncture Resistance (5/16' hemispherical tip)	lbs	ASTM D-3787	100
Mullen Burst Strength	psi	ASTM D-3786	345
Water Flow Rate	gpm/sf	ASTM D-4491	180
Permeability	cm/sec	ASTM D-4491	.059
AOS (Mod to 10 min)	sieve size	ASTM D-4751	70-100
Roll Widths, Minimum	ft		15
Roll Length, Minimum	ft		300

Filter fabric shall be unrolled and loosely laid upon prepared surfaces, as shown on the Drawings, or on any other surfaces designated by the Quality Assurance Engineer. The fabric shall not be stretched. Ample material shall be left available so that it can readily conform to irregularities in the receiving surface.

Filter fabric placement shall be inspected and approved by the Quality Assurance Engineer before being covered with fill. Any rips, tears, or unsuitable materials, as determined by the Quality Assurance Engineer, shall be mended by the Contractor in a manner acceptable to the Engineer, or shall be replaced by the Contractor.

5.1.6.7 Protective Drainage Layer

A gravelly silty sand or sandy silt shall be used as the protective drainage layer. One foot of material shall be placed directly above the leachate collection and drainage layer, and two feet shall be placed on top of the HDPE liner and filter fabric on the side slopes of the cell. The protective drainage material shall have a maximum permeability of 1×10^{-5} cm/sec so that leachate may percolate to the

leachate collection system. The protective drainage material shall be placed as indicated on the Drawings and shall be inspected by the Quality Control Engineer.

5.2 LINER INSTALLATION

5.2.1 Introduction

5.2.1.1 General

The Specifications presented in the following paragraphs are Technical Specifications for the installation of a liner system for Waste Cell 4 at the WOSLF.

5.2.1.2 Scope of Work

The scope of work for these Technical Specifications shall include the installation of a single synthetic liner system for Waste Cell 4 Expansion located at the WOSLF in Haywood, North Carolina. Specific work items include, but are not limited to the following:

- Mobilization of all equipment and material required for the work;
- Placement of synthetic materials for liner on prepared surfaces;
- Furnishing and installing all material and constructing all items appurtenant and incidental to the above;
- Testing of completed facilities; and
- Demobilizing, which includes removal of temporary structures.

The contractor shall familiarize himself with the relevant regional and site specific conditions which may have an impact upon the work.

Drawings to be read in conjunction with these Specifications are included with this document, and are in a series numbered Sheet 1 through Sheet 12.

In the case of discrepancy or ambiguity in the Specifications, Drawings, codes, standards, or regulations, it is the intent of these Specifications that the most restrictive interpretation shall apply unless interpreted otherwise by the Engineer.

5.2.1.3 Definitions

The following definitions apply to these Specifications:

a. "Owner" is defined as an authorized representative of The White Oak Sanitary Landfill (WOSLF);

b. "Construction Manager" is defined as an authorized representative of the Owner responsible for coordinating the activities of the Contractor;

c. "Quality Assurance Engineer" is defined as a qualified representative appointed and authorized by the Owner to monitor the quality of the completed construction product;

d. "Design Engineer" is defined as an authorized representative of the owner, currently holding valid professional registration in North Carolina, who has designed the facilities to be constructed and prepared the plans and specifications;

e. "Contractor:" is defined as the party or parties which have a contract agreement with the Owner and perform the actual construction activities.

f. "Specifications" is defined as this document of technical specifications prepared by Steffen Robertson and Kirsten (U.S.), Inc. for the White Oak Sanitary Landfill, dated May, 1997.

g. "Drawings" is defined as the drawings in conjunction with these Specifications and are in a series numbered Sheet 1 through Sheet 12.

5.2.1.4 Applicable Codes and Regulations

The work shall conform to applicable Federal, State, County, and local regulations. Test procedures shall conform to applicable ASTM standards, as documented in the edition of the standards in force at the start of work. Liner material and installation shall, where not specifically covered in these Specifications, be to a minimum of that specified in National Sanitation Foundation Publication No. 54 (NSF54).

5.2.1.5 Limits of Work

The Contractor shall confine his apparatus, the storage of materials, and the operation of workmen to limits indicated by law, ordinances, permits or selected by the Construction Manager, and shall not unreasonably encumber the premises with his materials. Extreme caution shall be exercised at all times to avoid blocking plant or other roads or in any other way interfering with the Owner's operations or presenting a hazard to the Owner's personnel and equipment, or to the public.

5.2.2 Contractor's Responsibility

The contractor shall carefully examine all of the Technical Specifications and Drawings, and the site of the work. He shall fully inform himself as to the character of all conditions at the site, local and otherwise, affecting the execution of the work, including those conditions to which Federal, State, and local safety and/or health laws and regulations may be applicable. Failure to comply with the requirements of this section shall not relieve the contractor of responsibility for complete performance of the work.

It shall be the sole responsibility of the contractor to familiarize himself, by such means as he considers appropriate, with all matters pertaining to this work including, but not limited to:

- The location and nature of work;
- Climatic conditions;
- The nature and conditions of the terrain;
- Transportation and communication facilities;
- Other construction or waste placement activities at the Project site that may be underway simultaneously with the construction work for the WOSLF expansion; and
- All other factors that may affect the cost, duration, and execution of the work.

Before accepting the work, the contractor shall acknowledge in writing that he has inspected the site and determined the characteristics of the work and the conditions indicated above.

5.2.3 Inspection of Work

5.2.3.1 General

Unless otherwise specified, full-time inspection of all construction activities defined by the Specification will be provided by the owner. Owner's inspection of all work shall be performed under the supervision and control of the Quality Assurance Engineer or his designated representative while such work is in progress. Said inspections are for the convenience, satisfaction, and benefit of the owner in determining that the work is performed in accordance with the Specifications. It shall be the Contractor's sole responsibility to provide all required materials (both natural and manufactured) and to perform all work in conformance with the Specifications. The Quality Assurance Engineer will inspect, test, and report all findings to the Construction Manager. The Construction manager shall be responsible for enforcing the Specifications or initiating variances or

design changes through the Design Engineer. Owner's inspections shall not relieve the Contractor of responsibility for the acceptability of the finished work or portions thereof.

5.2.3.2 Access

The Quality Assurance Engineer and his representatives shall at all times have access to the work whenever it is in preparation or progress provided that they report their presence to the Construction Manager who is responsible for all activities onsite. The Contractor shall fully cooperate with the Quality Assurance Engineer, shall provide proper facilities for access, and shall furnish labor and equipment reasonably needed for safe and convenient inspection, including the excavation of test pits. The Contractor shall give the Quality Assurance Engineer ample notice of readiness of the work for inspection, and the Quality Assurance Engineer shall perform said inspection in such a manner as not to unnecessarily delay the work.

5.2.3.3 Examination

If any work should be covered up without prior approval or consent of the Quality Assurance Engineer, it must, if required by the Engineer, be uncovered for examination.

5.2.3.4 Samples and Tests

It is the intent of these Specifications that materials shall be inspected and tested by the Quality Assurance Engineer before final acceptance of the work. Any item of the work which is found not to meet or exceed the Specifications or which is improperly located or constructed shall be removed and replaced. The Quality Assurance Engineer's inspections and tests shall not relieve the Contractor from full responsibility to furnish and install materials in conformance with these Specifications.

5.2.3.5 Alteration to Drawings and Specifications

All alterations made to either the Specifications or Drawings shall be subject to the Design Engineer's approval and, where applicable, to the approval of regulatory government agencies. All alterations shall be issued under a covering work order signed by the Design Engineer.

5.2.4 Synthetic Material

5.2.4.1 Scope

The Contractor shall furnish and install synthetic materials including high density polyethylene (HDPE), and miscellaneous materials incident thereto in accordance with the manufacturer's recommendations. Alignments, lengths, and areas are shown on or derived from the Drawings.

Exact locations and lengths may be varied to suit conditions encountered in the field, as approved by the Quality Assurance Engineer.

Synthetic materials to be installed for the WOSLF expansion shall consist primarily of 60-mil HDPE. Synthetic materials to be installed shall be extrusion welded to the existing liner system where tie-in is required.

5.2.4.2 Synthetic Liners

5.2.4.2.1 Scope

The Contractor shall furnish and install synthetic liners and miscellaneous materials incident thereto as specified herein and in accordance with the manufacturer's recommendations. Installation includes excavation and backfilling of synthetic liner anchor trenches, as shown on the Drawings. Exact locations and lengths may be varied to suit conditions encountered in the field, as approved by the Quality Assurance Engineer.

5.2.4.2.2 General

The Contractor shall comply with the manufacturer's specifications concerning all aspects of shipping, storage, installation, seaming, and sealing of the liners. The liners shall be shipped to the site in rolls of the synthetic liner. Storage and handling, quality control, and quality assurance procedures shall be followed throughout the installation of HDPE membrane.

It is the Contractor's responsibility to install the liner without punctures, rips or faulty field seams. All rips, punctures, and faulty field seams shall be repaired to the satisfaction of the Quality Assurance Engineer. Approval of the liner foundation by the Quality Assurance Engineer does not relieve the liner contractor of the responsibility to repair damage to the liner. The Contractor should satisfy himself that the liner foundation is adequate to receive the liner before commencing liner installation.

The Contractor shall protect installed synthetic liners in a condition satisfactory to the Quality Assurance Engineer at all times until the final completion and acceptance of the work. Any approved installed liners which become damaged or unsuitable for any reason whatsoever before final acceptance of the work, shall be removed and replaced or repaired by the Contractor at his own expense in a manner satisfactory to the Quality Assurance Engineer.

5.2.4.2.3 Submittals

The Contractor shall furnish complete written instructions for storage, handling, installation and seaming of liner, in compliance with this Specification and conditions of warranty prior to construction. The Contractor shall also furnish drawings showing panel layouts and prepare and submit a time schedule for liner construction, including complete testing for acceptance prior to construction.

The following shall be furnished for resin used in the manufacture of proposed geomembranes:

- Statement of production date or dates;
- Certification that the resin meets the Specifications;
- Certification that all resin is from the same supplier;
- Copy of the quality control certificates issued by supplier;
- Test reports from the supplier; and
- A statement that no reclaimed polymer was added.

The Contractor shall provide a copy of the quality control certificate for production of geomembrane as well as the resin manufactured for this project seven days prior to receipt at site. The quality control certificate for the geomembrane shall include the following:

- Statement of the production date or dates;
- Laboratory certification that the 60-mil HDPE meets the Specifications outlined in Section 4.2.3.1;
- Certification that all HDPE rolls are from the same HDPE supplier;
- A copy of quality control certificates issued by supplier;
- Test reports from the supplier; and
- A statement that no reclaimed polymer was added.

The Contractor shall provide certification that the geomembrane and extrudate produced for this project have the same properties represented in the material Specification sheets in addition to meeting NSF-54 requirements. A copy of the quality control/quality assurance (QC/QA) program for geomembrane production shall also be provided. Before acceptance of installation by the Owner,

the Contractor shall furnish reproducible record as-built drawings showing, at the minimum, panel numbers, seam numbers, seaming equipment and operator identification, temperatures and speed settings of equipment, seam date and location of patches and destructive seam samples. The liner material and workmanship shall be guaranteed according to the warranty in Section 5.4.2.3.1 of these Specifications. All submittals shall be subject to approval by the Owner.

Table 5-5: Required Properties of High Density Polyethylene (HDPE)

REQUIRED PROPERTIES OF HIGH DENSITY POLYETHYLENE (HDPE)			
Property	**Test Designation**	**Property Values**	
		60 mil	80 mil
Thickness, mils Minimum Average	ASTM D751 (modified NSF 54)	60	80
Thickness, mils Lowest Individual Specimen	ASTM D751 (modified NSF 54)	54	72
Density, g/cm^3 Minimum	ASTM D792 or ASTM D1505	0.940	0.940
Melt Index, g/10 minutes Maximum	ASTM D1238 (190°C, 2.16kg)	0.4	0.4
Carbon Black Content, % Allowable Range	ASTM D1603	2.0 to 3.0	2.0 to 3.0
Carbon Black Dispersion Acceptable Levels	ASTM D3015 (modified NSF 54)	A1 or A2	A1 or A2
Tensile Properties (each direction) Minimum	ASTM D638 (modified NSF 54)		
1. Tensile Strength at Yield, lb/in width (lb/in^2)		126 (2100)	168 (2100)
2. Tensile Strength at Break, lb/in width (lb/in^2)		228 (3800)	304 (3800)
3. Elongation at Yield, %		12	12

REQUIRED PROPERTIES OF HIGH DENSITY POLYETHYLENE (HDPE)			
Property	**Test Designation**	**Property Values**	
		60 mil	80 mil
4. Elongation at Break, %		560	560
Tear Resistance, lbs (lbs/in thickness) Minimum	ASTM D1004	39 (650)	52 (650)
Puncture Resistance, lbs (lbs/in thickness) Minimum	FTMS 101 Method 2065	72 (1200)	96 (1200)
Low Temperature Impact, °C Max. allowable failure temp.	ASTM D746	-60	-60
Dimensional Stability, % Maximum allowable	ASTM D1204 1 hr @ 100°C	± 2.0	± 2.0
Volatile Loss, % Maximum	ASTM D1203	0.4	0.4
Resistance to Soil Burial, % Maximum change in original value	ASTM D3083 Type IV Specimen at 2 inches/minute	± 10	± 10
Environmental Stress Crack Minimum hours with no failures	ASTM D1693 (modified NSF 54)	1500	1500
Water Absorption, % Max. change in original weight	ASTM D570	0.1	0.1
Coefficient of Linear Thermal Expansion (cm/cm °c) x 10^{-4}	ASTM D696	1.2	1.2

REQUIRED PROPERTIES OF HIGH DENSITY POLYETHYLENE (HDPE)			
Property	**Test Designation**	**Property Values**	
		60 mil	80 mil
Moisture Vapor Transmission Rate (g/100 in^2 day)	ASTM E96 100° F, 100% relative humidity	0.025	0.020
Oxidation Induction Time of Polyolefins, minutes Minimum	ASTM D3895	100	100
Multiaxial Elongation at Break, % Minimum	ASTM D35	10	10
Larger Diameter Direct Shear Interface/Friction Angle Determination, degrees	ASTM D3080	13	13
As represented by the National Sanitation Foundation's (NSF's) Standard No. 54, Federal Test Method Standards (FTMS) and the American Society for Testing and Materials (ASTM)			

5.2.4.2.4 Delivery, Storage and Handling

The geomembrane rolls shall be packaged and shipped by appropriate means so that no damage is caused and shall be delivered to the site only after the Owner receives and approves the required submittals. The Contractor is responsible for the transportation, off-loading and storage of the geomembrane rolls. Off-loading shall be done in the presence of the Quality Assurance Engineer and any damage during the off-loading shall be documented by the Quality Assurance Engineer and Contractor. Damaged rolls shall be separated from undamaged rolls until proper disposition of material is determined by the Quality Assurance Engineer. Final authority on the determination of damage will be the Quality Assurance Engineer. The Contractor shall replace damaged or unacceptable material at no cost to the Owner.

Geomembrane rolls shall be stored on a prepared surface (not on wooden pallets) and shall be protected from puncture, dirt, grease, water, mechanical abrasions, excessive heat or other damage.

The geomembrane will be stacked no more than three rolls high. The Owner will allocate sufficient space to store the geomembrane rolls.

Any damaged rolls shall be rejected and removed from the site or stored at a location, separate from accepted rolls, designated by the Owner. All rolls which do not have proper manufacturer's documentation shall be stored at a separate location until all documentation has been received and approved.

The Contractor is responsible for on-site handling of the geomembrane and shall use appropriate handling equipment to load, move or deploy geomembrane rolls. Appropriate handling equipment includes cloth chokers and spreader bars for loading, and spreader and roll bars for deployment. The geomembrane material shall not be folded or dragged and any damage to the geomembrane shall be documented by the Quality Assurance Engineer and Contractor. Damaged geomembrane shall either be repaired to the satisfaction of the Quality Assurance Engineer or removed and replaced with acceptable geomembrane material if the damage cannot be satisfactorily repaired. Repair, removal and replacement of damaged geomembrane shall be at the Contractor's expense if the damage was caused by the Contractor.

5.2.4.2.5 Geomembrane Conformance Testing

5.2.4.2.5.1 Tests

After delivery, the Contractor shall assist the Quality Assurance Engineer in obtaining one geosynthetic sample per 100,000 square feet. The sample shall be forwarded to the Third Party Laboratory for the following tests:

- Density (ASTM D792 or ASTM D1505);
- Carbon black content (ASTM D1603);
- Thickness (ASTM D751 - modified NSF 54);
- Tensile characteristics (ASTM D638 - modified NSF 54);
- Puncture resistance (FTMS 101 Method 2065); and
- Carbon black dispersion (ASTM D3015 - modified NSF 54).

5.2.4.2.5.2 Sampling Procedure

Samples shall be taken across the entire roll width and shall not include the first three feet. Unless otherwise specified, samples shall be three feet long by the roll width. The Quality Assurance Engineer shall mark the machine direction and the manufacturer's roll identification number on the sample.

5.2.4.2.6 Geomembrane Resin

The geomembrane resin shall be new, first quality high density polyethylene resin (HDPE) produced in North America and shall be compounded and manufactured specifically for the purpose of producing flexible membrane. There shall be no intermixing with other resin types, blending of recycles or seconds, or reclaimed polymer added to the geomembrane resin. The geomembrane resin shall meet the following Specifications as listed in Table 5-6.

Table 5-6: Geomembrane Resin Specifications

TEST	DESIGNATION	REQUIREMENT
Density, g/cm^3 Minimum	ASTM D1505	0.94
Melt Index, g/10 minutes Maximum	ASTM D1238 (190°C, 2.16 kg)	0.4

One test shall be performed per batch of resin. The test results shall be submitted to the Quality Assurance Engineer at least seven days prior to shipping geomembrane to the site. For pre-compounded resin, the base resin density (prior to the addition of carbon black) shall be provided on the QC submittals.

5.2.4.2.7 Geomembrane Rolls

The geomembrane rolls shall be 60 mil-thick and 80 mil-thick seamless high density polyethylene (HDPE) produced in North America and supplied in rolls. Each roll shall be identified with a label indicating thickness, length, width and weight, manufacturer, roll number and plant location.

Processing aids, antioxidants, and additives shall be identified by name and percent. The total combined percentage of all additives shall be under 3.5 percent by weight of the finished geomembrane. All additives other than carbon black shall be no greater than 0.75% of the total

allowable value of 3.5 percent. All additives shall be thoroughly dispersed throughout the geomembrane.

The geomembrane shall have no holes, pinholes, bubbles, blisters, gels, undispersed resin, or contamination by foreign matter. There shall be no tears, abrasions, or cuts on liner edges. The HDPE geomembrane shall meet the Specifications presented in Sections 4.2.3.1.

5.2.4.2.8 Extrudate Rod or Bead

The extrudate rod or bead shall be a high density polyethylene (HDPE) for use on HDPE geomembrane for extrusion welding. The rod or bead shall be manufactured from the same resin used to produce the geomembrane, and shall be provided by the same supplier.

Processing aids, antioxidants, and additives other than carbon black used during manufacturing shall be identified by name and percent and the total combined percentage of processing aids, antioxidants, carbon black, and other additives shall be under 3.5 percent by weight of the finished product. All additives shall be thoroughly dispersed throughout the extrudate rod or bead. There shall be no contamination by foreign matter in the extrudate rod or bead. The extrudate rod or bead shall be of the same material type as that of the geomembrane and shall meet the criteria set forth within the required properties table (Section 4.2.3.1).

There shall be one test performed per batch of extrudate rod or bead. Certified test results shall be submitted to the Quality Assurance Engineer at least seven days prior to shipping the extrudate rod or bead to the site.

5.2.4.2.9 Execution

5.2.4.2.9.1 Examination

Upon notification by the Quality Assurance Engineer of release of area or areas for liner installation, the Contractor shall verify in writing that the surface on which the geomembrane will be installed is acceptable. The initiation of installation indicates acceptance of existing conditions. The Contractor shall be responsible for maintenance of the foundation surface in the accepted area or areas once installation of geomembrane begins. The maintenance of the surface includes repair or replacement of any surface damaged following acceptance.

5.2.4.2.9.2 Preparation

The Contractor shall maintain the surface suitability and integrity until the lining installation is completed and accepted. The Contractor shall repair rough areas and any damage to the subgrade

caused by installation of the lining and fill any ruts caused by equipment prior to geomembrane deployment. In order to avoid sharp bends in the geomembrane, the Contractor shall slightly round the leading edges of the anchor trench.

5.2.4.2.9.3 Deployment

Each panel shall be marked with an "identification code" (number or letter number) consistent with the layout plan. The identification code shall be simple and logical. The number of panels deployed in one day shall be limited by the number of panels which can be seamed or tack welded on the same day. The following procedures shall be followed by the Contractor during deployment of geomembrane:

- Equipment which will damage geomembrane by handling, trafficking, leakage of hydrocarbons or other means shall not be used;
- Do not allow personnel working on geomembrane to wear damaging shoes, or engage in activities that could damage geomembrane;
- Do not allow clamps and other metal tools to be dropped or thrown on the geomembrane;
- Unroll panels by a method that protects geomembrane from scratches and crimps and protects soil surface from damage;
- Use methods to minimize wrinkles, especially differential wrinkles between adjacent panels;
- Place adequate hold-downs to prevent uplift by wind;
- Use hold-downs that will not damage the geomembrane;
- Use continuous hold-downs along edges to minimize risk of wind flow under panels (sand bags, reclaimed tires);
- Minimize direct contact with geomembrane;
- Protect the geomembrane in heavy traffic areas by geotextile, extra geomembrane or other suitable materials;
- Sheet surfaces will be visually inspected during unrolling of geomembrane and faulty or suspect areas shall be marked for repair or testing; and

- Faulty geomembrane shall be replaced at no cost to Owner.

The geomembrane shall not be deployed during precipitation, in the presence of excessive moisture, in areas of ponded water, or in the presence of excessive winds.

5.2.4.2.9.4 Field Seaming

All seams shall be oriented parallel to the maximum slope; i.e., oriented down (not across) the slope. Seams shall be numbered with a numbering system which is compatible with the panel numbering system.

The Contractor shall minimize the number of field seams in corners, off-shaped geometric locations and outside corners. All corners will be triangulated with off-set tie-in connections.

No seaming shall be performed when deployed liner material has a temperature, as measured by a contact thermometer, which is in excess of 110° F or less than 40°.

Panels shall be overlapped by a minimum of four inches. Procedures used to temporarily bond adjacent panels together shall not damage the geomembrane and shall not be detrimental to seam weld material.

All tie-in "T" connections consisting of two fusion welds shall be patched with a minimum 12-inch diameter patch. Welding of HDPE membrane shall be performed prior to burial of the membrane in anchor trenches.

Solvents and adhesives shall not be used for seaming or temporary bonding of membranes. During the installation and repair of all HDPE geomembrane, only approved seaming methods shall be accepted (extrusion fillet welds and fusion bonding).

During the preparation of seams for welding, the Contractor shall:

- Clean surface of grease, moisture, dust, dirt, debris or other foreign material;
- Clean surface of oxidation by disc grinder not more than 1 hour before seaming (not required for HDPE fusion welding);
- Use number 80 grit sandpaper for disc grinding;
- Patch areas where grinding reduces the sheet thickness by more than 4 mils;
- Seams, small cuts, and scratches shall be repaired by a single extrudated bead;

- Grind liner surface beyond weld bead. The ground area should extend 1/16 to 1/8 inch beyond the extrudated bead;
- Use only soft bristle brush after grinding if brushing required, wire brushes shall not be used;
- Cut wrinkles and "fishmouths" along ridges;
- Overlap and seam wrinkles and fishmouths;
- Patch wrinkles and fishmouths where overlap is less than 3 inches;
- Use a firm, dry substrate (piece of geomembrane or other material) directly under seam overlaps where the subgrade is soft; and
- Use plywood or other firm material under seam overlaps when welding over the anchor trench.

5.2.4.2.9.5 Geomembrane Seaming Apparatuses

At least one spare operable seaming apparatus shall be maintained for each three seaming teams. The Contractor shall place a protective fabric or a piece of geomembrane beneath hot welding apparatus when resting the apparatus on the geomembrane lining. The Contractor shall provide a protective lining and splash pad large enough to catch spilled fuel under any electric generators or fuel powered equipment when it is located on the liner. All sharp parts protruding from any equipment shall be covered prior to placement on the geomembrane.

Extrusion welders shall be equipped with gauges giving temperatures in the apparatus and at the nozzle. The welding technician shall purge the welding apparatus of heat-degraded extrudate for at least 1 minute before welding if the extruder is stopped for longer than three minutes. All purged extrudate shall be disposed of outside the geomembrane covered area. The welding technician shall avoid stop-start welding. The technician shall grind existing welds two inches from the point of stoppage before resuming the welding process. Leaks evident in extrusion welds will require a minimum 12-inch diameter patch of the same material. The Contractor shall restart welds two inches from the point where the edge of the patch intersects a previous weld.

In performing fusion welding, the welding apparatuses shall be automated vehicular mounted device equipped with gauges giving applicable temperatures and speed. A smooth insulating plate or fabric shall be placed beneath the hot welding apparatus after usage. The Contractor shall protect against moisture buildup between sheets. No welding across previously welded seams shall be permitted.

Trial welds shall be performed by both fusion and extrusion type welders prior to start of work and once at mid-day. No equipment or technician is allowed to commence welding on the liner until a trial weld sample made by that equipment and technician has met the requirements of trial welding.

5.2.4.2.9.6 Trial Welds

Field seam tests shall be conducted on pieces of geomembrane liner to verify adequate seaming conditions at the following frequency:

- At beginning of the seaming period;
- At least once for each four hours of seaming;
- At the Quality Assurance Engineer's discretion;
- For each seaming apparatus used; and
- At least once before each shift for each welding technician performing seaming.

Trial welds shall be performed in the areas of seaming and in contact with subgrade or geotextile to simulate the condition in the work area of the geomembrane to be seamed. The seam sample should be at least 42 inches long and 12 inches wide with seam centered lengthwise. One-inch wide specimens shall be cut from the test seam. Specimens shall be quantitatively tested by the Contractor for peel adhesion and bonded seam strength (shear). Testing shall be performed in the presence of the Quality Assurance Engineer. A trial weld passes when specimens show:

- The break is a film tear bond (FTB); or
- The break is ductile; and
- The strength of break is as specified in Section 4.2.12.5 of these Specifications.

A break through the weld is considered a non-FTB (failure) if the break is ductile and if the strength is less than the required minimum. The welding technician shall repeat the test in its entirety when the trial weld fails. When repeated trial welds fail, the Contractor shall not utilize the seaming apparatus, or technician for welding until deficiencies or conditions are corrected and successful field test seams are achieved.

5.2.4.2.10 Anchor Trenches

Anchor trenches shall meet all requirements as set forth in these specifications and as shown on the drawings. Any changes must be submitted to the Engineer in writing prior to excavation and/or geomembrane placement. Anchor trenches shall at all times be clean of large debris (trash, rocks, etc.). All sharp edges shall be smoothed prior to geomembrane deployment.

5.2.4.2.10.1 Anchor Trench Backfill

The anchor trench shall be backfilled after the geomembrane has been placed and approved or as directed by the Quality Assurance Engineer. Backfill material shall be the same type as was excavated. The backfill material shall be placed in 1 foot loose lifts. Backfill material shall be near optimum moisture content and compacted to a minimum of 90 percent of maximum density as determined by ASTM D698. Compaction equipment shall be approved by the Quality Assurance Engineer and shall not damage the geomembrane.

5.2.4.2.11 HDPE Tie-In Connection

When the design involves new HPDE material to be connected with existing HDPE material, the following procedure shall be instituted:

- For geomembrane, overlap of new HDPE to existing HDPE shall be at a minimum of 6 inches. At no time will any horizontal slope seams be accepted;
- Extrusion welding only shall be permitted for tie-in connections;
- Vacuum testing shall be allowable as non-destructive test method used to accept this area. The Engineer will observe the operation and documentation of non-destructive testing shall be completed by the Quality Control Technician; and
- All extrusion welded seams on the initial overlap shall be covered with an additional layer of HDPE and shall be welded completely around that layer.

5.2.4.2.12 Field Quality Control

5.2.4.2.12.1 General

The Contractor shall designate a full time Quality Control (QC) Technician who shall be responsible for supervising and/or conducting the field quality control program throughout construction. The resume for the QC Technician shall be provided in the pre-construction submittals, and the QC

Technicians shall not be replaced without written authorization from the Quality Assurance Engineer. There shall be a designated QC technician present at all times during each work shift.

5.2.4.2.12.2 Non-Destructive Seam Testing

Non-destructive seam testing shall be performed over the full length of welds. Testing methods and procedures will be subject to the approval of the Quality Assurance Engineer.

Vacuum tests shall be performed concurrently with seaming work progress, not at completion of the project. All overlapped material, if applicable, shall be carefully trimmed using an approved cutting instrument. The "pull-tear" method of overlap removal shall not be accepted. The vacuum box assembly shall consist of the following:

- Ridge housing;
- Transparent viewing window;
- Soft rubber gasket attached to bottom of housing;
- Porthole or valve assembly; and
- Vacuum gauge.

A vacuum pump capable of delivering a minimum of 27 psi of vacuum shall be used.

When vacuum testing, the Contractor shall:

- Clean windows, gasket surfaces, and check for leaks;
- Wet a strip of geomembrane approximately 12 inches by 30 inches (length of box) with soapy solution;
- Place the vacuum box over the wetted area;
- Ensure that a leak-tight seal is created;
- For a period of not less than 15 seconds, examine the length of weld through the viewing window for the presence of soap bubbles;
- If no bubbles appear after 15 seconds, move the box over the next adjoining area with a minimum three inches of overlap and repeat the process;

- Areas where soap bubbles appear shall be marked, repaired, and retested; and
- All vacuum testing will be documented by the QC Technician and submitted to the QA Engineer at the end of each work shift.

All locations where seams cannot be non-destructively tested, the Contractor shall:

- Cap-strip seams with same geomembrane when possible;
- If the seam is accessible to testing equipment prior to final installation, non-destructively test the seam prior to final installation; and
- Seaming and cap-stripping operations will be observed by Quality Assurance Engineer for uniformity and completeness.

For double hot wedge seams, air pressure testing may be conducted. The equipment shall be comprised of the following:

- Air pumps equipped with a pressure gauge capable of generating and sustaining a pressure between 25 to 30 psi; and
- Sharp hollow needles or other pressure feed devices approved by the Quality Assurance Engineer.

To perform the test, the Contractor shall:

- Pass air through the channel to guarantee a clear pathway;
- Seal both ends of the seam to be tested:
- Insert a needle or other approved pressure feed device into the tunnel created by double hot wedge seaming;
- Energize the air pump to 25 to 30 psi; and
- Close the valve and sustain the air pressure for a minimum of five minutes.

If the loss of pressure exceeds 2 psi or does not stabilize, faulty areas shall be located and repaired. After testing, pressure feed devices shall be removed and insertion points sealed. All pressure testing shall be documented by the QC Technician and submitted to the Quality Assurance Engineer at the end of each work shift.

Alternative testing methods other than vacuum or pressure testing may be proposed by the Contractor and will be subject to the approval of the Quality Assurance Engineer prior to their use.

5.2.4.2.12.3 Destructive Seam Sampling

For destructive seam testing, the Quality Assurance Engineer shall be provided with a minimum of one destructive sample per 500 feet of seam length. The location shall be selected by the Quality Assurance Engineer and the Contractor shall not be informed in advance of the sample location. The Contractor shall visually observe, mark and repair suspicious looking welds before release of a section to the Quality Assurance Engineer for destructive sample marking. The Contractor shall cut samples as seaming and non-destructive testing progresses and prior to completion of liner installation, shall mark samples with consecutive numbering and seam location numbers. The Contractor shall record, in written form, date, time, location, seam number, ambient temperature, seaming unit number, name of seamer, welding apparatus temperatures, and pass or fail description. The Contractor shall immediately repair holes in geomembrane resulting from obtaining destructive samples. The size of destructive samples shall be:

- 12 inches wide by 30 inches long with the seam centered lengthwise; or
- 12 inches wide by 42 inches long with the seam centered lengthwise, if the Contractor desires a sample.

The Contractor shall cut the sample into two or three 14-inch long pieces and provide one piece of sample to Owner for archiving, one piece to the Quality Assurance Engineer for testing, and retain one piece, if required. The Quality Assurance Engineer will choose the piece of sample for the Contractor. In the event of a failure of the destructive test sample, the Contractor shall:

- Retrace the welding path a minimum of 10 feet in both directions from failed test locations and remove, at these locations, a sample 12 inches wide by 14 inches;
- Give the samples to the Quality Assurance Engineer for testing;
- Repeat the process if additional tests fail;
- Reconstruct the seam between passing test locations to the satisfaction of the Quality Assurance Engineer;
- Reconstruction may be by one of the following methods:
  - Cut out the old seam, reposition the panel and reseam; or

- Add a cap strip.

- Cut additional destructive samples from the reconstructed seam at the discretion of the Quality Assurance Engineer.

5.2.4.2.12.4 Quality Control Inspection

The Contractor shall inspect the seams and surfaces of geomembrane for defects, holes, blisters, undispersed raw materials, or signs of contamination by foreign matter. The Contractor shall brush, blow, or wash geomembrane surfaces if debris inhibits inspection. The Contractor shall distinctively mark repair areas and indicate the required type of repair.

Holes smaller than 1/8 inch shall be repaired by one extrusion bead weld. The surface of the geomembrane shall be ground to a minimum of one inch around holes immediately before welding and shall be vacuum tested after welding. The Contractor shall mark the result of the test, date of the test, and name of the tester.

Holes larger than 1/8 inch, blisters, undispersed raw materials, and contamination by foreign matter shall be patched. Tears shall also be patched with the ends of tears rounded prior to patching. Patches shall be round or oval in shape and made of the same material as the geomembrane. They shall extend a minimum of 6 inches beyond the edge of defects and shall be a minimum of 12 inches in diameter. The Contractor shall bevel the edge of the patch, heat seal to the geomembrane by an approved method, extrusion weld and then vacuum test the patch. The Contractor shall mark the result of the test, date of the test, and name of the tester.

Any extrusion weld that fails shall be required to have a patch. At no time during repairs will double extrusion beads be acceptable.

Daily documentation of non-destructive and destructive testing results shall be submitted to the

Quality Assurance Engineer before final acceptance. The documentation shall identify seams that initially failed the test and include evidence that test seams were repaired and retested successfully.

5.2.4.2.12.5 Required Field Seam Strength

The following test requirements shall apply to both trial welds and destructive seam testing and, is applicable to extrusion and fusion type welds.

Table 5-7: Required Seam Strengths for HDPE Geomembrane

Type of Test	Test Designation	Required Seam Strength	
		60 mil	80 mil
Bonded Seam Strength (Shear)	ASTM D4437	120 ppi	160 ppi
Peel Adhesion	ASTM D4437	78 ppi	104 ppi

For destructive seam samples each type of test (shear and peel) shall be performed by the Third-Party laboratory on five replicate specimens with an acceptable result being four out of five replicates satisfying the requirements. Breaks at weld sheet interface (adhesion) are considered a non-FTB (failure). Trial weld test results shall meet or exceed the applicable values in the above table and shall consist at a minimum of three replicate specimens or as directed by the QA Engineer. Individual test results shall be documented.

A break at the weld sheet interface (adhesion) is considered a non-FTB (failure) while a break through the weld is considered a FTB if the break is ductile and if the strength meets the minimum required values; otherwise the break is considered a non-FTB (failure).

When a destructive test sample fails, additional destructive samples shall be taken at a minimum of 10 feet each side of the failed sample until the seam passes the destructive test.

5.2.4.2.12.6 Acceptance

The Contractor shall retain ownership and responsibility for the geomembrane until acceptance by the Owner. The Owner shall accept the geomembrane installation when the installation is finished and the adequacy of field seams and repairs has been verified, and testing is complete. Also required are certifications, as-built drawings, and a final inspection carried out by the Quality Assurance Engineer. Any and all work required to facilitate the final inspection, such as cleaning of the liner shall be the responsibility of the Contractor. The construction area shall be cleaned of remnant pieces of geomembrane, debris, and garbage before acceptance. The inspection procedures shall be as follows:

- The Quality Assurance Engineer shall be informed of readiness for final inspection when installation is finished;
- In certain cases and with the Quality Assurance Engineer's approval, a section of installation may be released for inspection;
- Seams, panel surfaces, and repairs shall be visually inspected during the inspection;
- Defects, suspicious looking welds, permanent wrinkles, and bridging shall be distinctively marked for repair;
- Findings and corrective actions shall be documented;
- Arrangements for subsequent final inspection shall be made after corrective actions have been completed; and
- The results of final inspection shall be documented.

6 OPERATIONS PLAN

The approved Operations Plan will remain unchanged and is the primary reference for the operations in the new Waste Cell 4. This plan (reproduced in Appendix A) is contained in the *Transition Plan* dated April, 1994 prepared by DSA Design Group, Inc. Also refer to the previously submitted and approved WOSLF design plans by DSA Design Group dated September, 1992 and the Approved Plans submitted by Tribble and Richardson, Inc. A summary of the contents and characteristics of the Operations Plan is contained in this section.

6.1 LANDFILL DEVELOPMENT

Waste will be accepted in baled form from the Haywood County Materials Recovery Facility (MRF). These bales will be placed in lifts of up to 12 feet in depth. Each lift will be covered with 6 inches of daily cover. Final cover will consist of at least 24 inches of soil (or bentonite-augmented soil) with a permeability of less than or equal to 1×10^{-7} cm/s covered with a 30 mil low-density polyethylene (LDPE) FML and at least 6 inches of topsoil.

6.2 BORROW AREA OPERATIONS

SRK submitted a plan to utilize the proposed borrow area to the south of the current landfill limits. Approval to excavate in this area was sought and acquired through submittal to DEHNR, Land Quality Division of an updated *Sediment and Erosion Control Plan* dated January 27, 1997. DSWM was also given proper notification. This plan and attached drawings detailed excavation limits and sediment and erosion control. This borrow area will be utilized during the life of the new Waste Cell 4.

6.3 WASTE ACCEPTANCE AND DISPOSAL REQUIREMENTS

The WOSLF will continue to refuse waste outlined in Section 7.4 of the *Transition Plan*. This waste includes but is not limited to hazardous waste, PCBs (polychlorinated biphenyls), and liquid sludge. All waste accepted shall be disposed in the manner described in Section 7.5 of the *Transition Plan*.

6.4 SPREADING AND COMPACTING REQUIREMENTS

Baled waste shall be placed in the landfill to achieve the following goals: (1) keep working area as small as possible; (2) follow the downgradient direction during placement; (3) pack the waste as densely as practical into daily cells; and (4) collect windblown debris on a regular basis.

6.5 HAZARDOUS AND LIQUID WASTES SCREENING PROGRAM

The WOSLF will continue to implement the requirements of the Hazardous and Liquid Wastes Screening Program currently in place. This program is divided into two parts, (1) hazardous and liquid waste spotting and (2) random load inspections. The requirements of both parts are covered in section 7.7 of the *Transition Plan.*

6.6 COVER MATERIAL REQUIREMENTS AND VECTOR CONTROL

A minimum of 6 inches of daily cover will be placed on waste in the new cell to control blowing debris and vector populations. Intermediate cover material cover requirements are outlined in Section 7.8 of the *Transition Plan.*

6.7 EXPLOSIVE GAS CONTROL

Section 7.10 of the *Transition Plan* details measures required to detect and respond to explosive gas build-up. Several methane monitoring points have been established for sampling methane concentrations. Limits established by State regulations are reiterated in this section along with steps required in the event of detection of gas concentrations above those thresholds.

6.8 RECORD KEEPING

The WOSLF personnel shall keep records of the daily operations of the landfill. These parameters are outlined in section 7.15 of the *Transition Plan* and will continue to be implemented in the new Waste Cell 4.

7 CLOSURE AND POST-CLOSURE CARE PLAN

7.1 CLOSURE NARRATIVE

The intent of the closure plan and contours (refer to the approved plans prepared by Tribble & Richardson, Inc.) is to promote storm water runoff by increasing the final slopes of the landfill (thereby lessening water infiltration and thus leachate generation potential) and to reduce the potential for erosion of the slopes by providing bench channels and slope drains.

At closure, the side slopes of the landfill will be 3:1 with interval benches. The top slopes will be a minimum of 5%. The landfill will be phased so as to facilitate early closure by maintaining a minimum top slope of 5% at all time.

As the placement of waste reaches final contours the waste will be covered with a final cap system consisting of a barrier layer (18 inches clayey soils with a permeability of $1x10^{-7}$ cm/sec or less), erosion layer (6 inches top soil with permanent vegetation), and gas venting system. Cap system soils will be obtained from the borrow areas and stockpiles on-site. Soils excavated from the borrow areas for closure will be segregated and stockpiled. Geotechnical evaluations of on-site soils indicate bentonite will be needed to achieve the required permeability of the barrier layer. The appropriate QA/QC procedures will be used during the closure construction.

7.1.1 Cap System Specifications

The final cap system of the landfill shall consist of a barrier layer, FML, erosion layer, and gas venting system. Refer to the attached detail of the cap system and refer to the approved plans for details on the gas venting system, grading and erosion control.

7.1.2 Barrier Layer

The barrier layer shall consist of a natural soil or a soil and bentonite combination with a remolded permeability less than or equal to 1.0×10^{-7} cm/sec. The material shall be free of particles greater than three inches in any direction. The material shall be placed in at least three lifts compacted to at least 95 percent of the standard Proctor dry density at the molding (in-situ) moisture content (ASTM D-698). The final compacted thickness of each lift shall be a maximum of 6 inches. The moisture content of the barrier layer shall be controlled (± 3 percent wet of optimum).

7.1.3 Erosion Layer

The erosion layer shall consist of at least 6 inches of top soil or other soil capable of sustaining a healthy vegetative growth.

The erosion layer shall be placed on the barrier layer as soon as possible. The erosion layer shall be vegetated immediately after placement according to the approved Erosion and Sediment Control Plan. The vegetative growth shall be maintained for the post-closure care period to prevent growth of deep rooted plants. The final cap system will be bush hogged yearly to prevent deep rooted tree growth and vegetation.

7.1.4 Gas Venting System

A passive gas venting system was designed as part of the approved permit application and shall be constructed during the landfill's life to relieve the gas pressure within the landfill land minimize subsurface gas migration off the landfill unit. The gas venting system consists of vertical wells in the landfill which vent gas to the atmosphere. The approved permit application drawings and as-built drawing indicate details and location of the wells.

7.1.5 Construction Quality Control/Quality Assurance

Quality Control and Quality Assurance shall be performed in accordance with the approved QC/QC program established for the landfill's base liner system, and will generally consist of the following:

7.1.6 Test Pad [Ref.: .1624(b)(8)(B)(I)]

A test pad shall be constructed prior to beginning installation of the compacted barrier layer and whenever there is a significant change in soil material properties. The test pad may be located within the area of the landfill to be capped. The area and equipment, subgrade slope and conditions shall be representative of full scale construction. Acceptance and rejection criteria shall be verified for the tests specified below. For each lift, a minimum of three (3) test locations, within the test pad, shall be established for testing moisture content, density, and a composite sample for recompacted laboratory permeability. At least one (1) undisturbed shelby tube sample for laboratory permeability testing shall be obtained per lift within the test pad.

7.1.7 Quality Control Tests [Ref.: .1624(b)(8)(C)(I)]

- Particle size distribution analysis
- Atterberg limits
- Triaxial cell laboratory permeability's
- Moisture content
- Percent bentonite admixed with soil (if applicable)
- Moisture-density-permeability relation

7.1.8 Quality Assurance Tests [Ref.: .1624(b)(8)(C)(ii)]

- Moisture content (compare to appropriate moisture-density-permeability relation)
- Density (compare to appropriate moisture-density-permeability relation)
- Permeability

Any tests resulting in the penetration of the compacted clay liner shall be repaired using a sodium bentonite soil mixture.

7.1.9 Testing Responsibility

Haywood County shall employ a qualified independent geotechnical engineering testing agency to classify on-site and borrow soils to verify the soil comply with specified requirements and to perform required field and laboratory testing. If a contractor is employed, the contractor shall request in advance and schedule all required tests with the County's testing agency.

7.1.10 Inspection Activities

Periodic general inspections of the closure activities shall be performed by the project engineer in order that a certification may be issued verifying that the closure of the landfill was completed in accordance with the closure plan.

7.1.11 Sampling Strategies

Sampling strategies and schedules shall be coordinated between Haywood County, the engineer, contractor and testing agency. The contractor shall provide adequate notice to the testing agency when tests are required. It shall be the responsibility of the contractor to schedule all tests with the testing agency and other parties.

7.1.12 Documentation

Documentation and results of all tests and inspections performed shall be retained by the independent testing agency. Copies of all documentation and results shall be provided to the Certifying Engineer as the become available.

7.1.13 Construction Considerations

Preliminary laboratory tests (Law Engineering, May 1993) indicate that the natural moisture content of the on-site silt and clay soils are somewhat similar to the optimum moisture contents. Drying of, or water addition to the cap soils may be necessary during construction to achieve the specified moisture content and compaction. Drying may be accomplished by spreading, discing, and/or harrowing. Final cap material placement should be performed during the typically drier and warmer months of the year (May through October) to facilitate accurate and acceptable permeability. The addition of the water may be required to achieve wet of optimum compaction conditions.

Each lift of the barrier layer shall be compacted with a sheepsfoot roller to penetrations greater than the lift thickness. Each lift shall then be smooth rolled with a steel drum roller to promote surface water runoff while quality assurance testing is performed. During dry periods, each lift of the barrier layer shall be protected from excessive drying and related shrinkage cracking by temporarily covering the compacted lift with non-woven filter fabric, plastic sheeting, or by daily watering.

Each lift shall be scarified to promote bonding and eliminate lift interfaces.

7.2 WASTE AREA AND VOLUME ESTIMATES

The permitted White Oak Sanitary Landfill is approximately 11.3 acres in size and was permitted to receive waste for the next 2 to 5 years. According to County records 130,480.06 tons (287,057.23 cy) of municipal solid waste have been disposed in Waste Cells 1, 2 , and 3 which cover approximately 72,000 SF in surface area. Assuming an 8:1 waste to soil ratio as contained in the Approved Plan, a cumulative landfill volume (including cover soils) of 322,900 cy is estimated to be in place.

In February 1997, Herron Land Surveying, Inc. contracted to conduct a fly-over and generate an aerial topographic map of the existing conditions. To that date, 118,664 tons (261,061 cy) of waste were placed since the start of operations. Computer-generated triangular irregular network (TIN) surfaces were created from the aerial topographic maps from February 1997 and the as-built survey conducted by DSA Design Group, Inc. just prior to the start of operations. An average-end-area volume calculation was performed on the two TINs, and the total air space occupied by soil and waste through February 1997 was calculated to be 275,914 cy (upper bound of error of ±10%).

The new Waste Cell 4 cell will provide an increase in the approximate total disposal area to 13 acres, and an additional 48,000 tons (105,500 cy including cover soils) of storage capacity. This brings the disposal capacity of the entire landfill unit from 173,600 tons (382,000 cy) to 221,600 tons (487,500 cy).

7.3 CLOSURE SCHEDULE

Unless directed otherwise by DSWM, Haywood County must continue to receive solid waste at the White Oak Landfill for at least the next twenty (20) years. The current 11.3 acre waste cell is anticipated to operate for the next two to three (2-3) years. The closure slopes are anticipated to be capped as delineated in Landfill expansion Permit applications in October 2000. The following list of tasks is anticipated at the time of closure.

Table 7-1: Closure Schedule

TASK NO.	TASK/ACTIVITY
1	Cease receipt of waste for disposal at landfill
2	Place a notice of the intent to close the landfill in the Operating Record.
3	Notify the Division of Solid Waste Management that a notice of the intent to close the landfill has been placed in the Operating Record.
4	Begin closure activities of landfill no later than 30 days after the last receipt of waste.
5	Complete closure within 180 days from commencement of closure activities.
6	Have closure inspected and certified by Engineer. Place certification in Operating Record.
7	Notify DSWM of complete closure and that certification has been placed in the Operating Record.
8	Record a notation on the deed to the landfill facility property to advise any potential purchaser of the property that the land has been used as a landfill facility and its use is restricted under the closure plan approved by DSWM. Place a copy of the deed in the Operating Record. Notify DSWM of this action.

7.3.1 Contacts

The following persons or offices may be contacted regarding the landfill during the post-closure period.

Mr. Joe Walker
Haywood County
Solid Waste Director
1 Recycle Road
Clyde, NC 28721
(704) 627-8042

Mr. Jack Horton
Haywood County
County Manager
420 N. Main Street, County Annex
Waynesville, NC 27876
(704) 452-6625

7.3.2 Planned Use of Closed Landfill

The landfill will be maintained as a short growth pasture after closure.

7.3.3 Post-Closure Care

Complete inspections of the closed landfill shall be made, at a minimum, every six months for up to 30 years after closure. The duration of post-closure care may be shortened by DSWM if the landfill owner demonstrates that the reduced period is sufficient to protect human health and the environment or lengthened if DSWM determines that a longer period is necessary to protect human health and the environment. Proper completion of post-closure care must be certified by a registered professional engineer. The post-closure certification shall be placed in the Operating Record and DSWM shall be notified of this action.

The conditions of the items listed below and any necessary repairs made shall be documented. **Figure 7a - Post-Closure Care Inspection Report** may be used for the documenting of post-closure inspection activities. All documentation of post-closure activities shall be filed in the Operational Record.

1. The integrity and effectiveness of the cap system shall be maintained, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the cap system. Tree growth and deep rooted vegetation shall not be allowed on the capped areas. Gas vents in the cap system shall be inspected for damage and proper operation.

2. Groundwater and surface water shall be maintained in accordance with the NC Water Quality Monitoring Guidance Document for Solid Waste Facilities and the approved *Transition Plan* Monitoring reports and notes shall be kept in the Operational Records for review by DSWM.

3. All permanent erosion and sediment control measures and devices shall be maintained, including: sediment basins, channels, and ground cover.

4. Explosive gas monitoring shall be performed in accordance with the approved *Transition Plan.*

5. Monitoring reports and notes shall be kept in the Operational Records for review by DSWM.

Figure 7-1: Post-Closure Care Inspection Report

WHITE OAK LANDFILL

Date: _____ Inspected By: _____

CAP SYSTEM

Check:	Condition/Actions Taken:
____Settlement	_____
____Subsidence	_____
____Erosion	_____
____Ponded Water	_____
____Vegetative Cover	_____
____Gas Vent Operation	_____
____Tree Growth	_____
____Channels & Slope Drains	_____
____Other	_____

Notes: _____

_____

_____

EROSION & SEDIMENT CONTROL

Check: Conditions/Actions Taken:

____Sediment Basin _____

____Silt Fence (Temp.) _____

____Diversions/Channels _____

____Vegetative Cover _____

____Other _____

Notes: _____

_____

_____

GROUNDWATER MONITORING (Attach Copy of Results)

Date Sampled: _____ Well Sampled:_____

Sampled By:_____ Tested By:_____

Notes: _____

_____

_____

SURFACE WATER MONITORING (Attach Copy of Results)

Date Sampled: _____ Well Sampled:_____

Sampled By:_____ Tested By:_____

Notes: _____

_____

EXPLOSIVE GAS MONITORING (Attach Copy of Results)

Date Performed: _____ Performed By: _____

Notes: _____

_____

_____

OTHER

_____

_____

_____

_____

_____

Table 7-2: Post-Closure Care Schedule

ACTIVITY	REFERENCE[1]	FREQUENCY
Explosive Gas Monitoring - at wells at the compliance boundary, and on-site structures	Chapter 7	Quarterly
Groundwater and Surface Water Monitoring.	Chapter 12	Semi-Annually
Overall Inspection- including cap, gas venting system, and erosion and sediment control.	Chapter 9	Semi-Annually
Revise Post-Closure Cost Estimate	Chapter 10	Annually

7.4 CLOSURE AND POST-CLOSURE ASSUMPTIONS AND REQUIREMENTS

The following estimate includes the cost associated with closure and post-closure care of the White Oak Landfill. Estimates are based on the hiring of a third party to close the landfill at a point in landfill development that would be the most costly; i.e., when un-capped aerial limits of the landfill are greatest and post-closure care activities must be performed for the entire post-closure care period.

The estimate shall be adjusted annually for inflation within 60 days prior to the anniversary date of the establishment of the financial instrument until the end of the post-closure care period.

The estimate shall be increased if changes in the Closure or Post-Closure Plans or landfill conditions cause an increase in the estimated cost of closure or post-closure care at any time.

The estimate may be reduced, with DSWM approval, if the cost estimate exceeds the maximum cost of the closure and post-closure care remaining over the post-closure care period.

Two (2) copies of the Closure and Post-Closure Cost Estimate are provided below.

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[1] DSA Design Group, Inc. *Haywood County White Oak Sanitary Landfill Transition Plan.* April, 1994.

Closure and Post-Closure Cost Estimate - Copy No. 1

CLOSURE COSTS			April 1994
ITEM/TASK	**QUANTITY**	**UNIT COST**	**EXTENSION**
Final Cap System			
Barrier Layer (materials, installation, complete)	36,500 CY	$21.00	$766,500.00
Erosion Layer (materials, installation, complete)	9,300 CY	1.25	11,625.00
Seeding (include. Mulch, fertilizer, complete)	15 AC	600.00	9,000.00
30 mil FML (materials, installation, complete)	11.3 AC	8,900.00	100,570.00
Sediment and Erosion Control			
15" Slope Drain Pipe (materials, installation, complete)	460 LF	20.00	9,200.00
18" Slope Drain Pipe (materials, installation, complete)	185 LF	30.00	5,550.00
21" Slope Drain Pipe (materials, installation, complete)	140 LF	40.00	5,600.00
24" Slope Drain Pipe (materials, installation, complete)	140 LF	45.00	6,300.00
Other			
Contractor Profit	JOB	5%	45,718.00
Mobilization/Demobilization	JOB	5%	45,718.00
QA/QC Testing, Engineering and Certification	JOB	250,000.00	250,000.00
Administrative	JOB	10,000.00	10,000.00
Contingency	JOB	10%	91,435.00
TOTAL CLOSURE COSTS			$ 1,357,216.00

POST-CLOSURE CARE COSTS			April 1994
ITEM/TASK	QUANTITY	UNIT COST	EXTENSION
Inspections/Monitoring			
General Inspections (Semi-Annually)	60 EVENTS	$1,200.00	$72,000.00
Gas Monitoring (9 Wells, Quarterly)	120 EVENTS	32,000.00	144,000.00
Water Quality Monitoring (17 Locations, Semi -Annually)	60 EVENTS	32,000.00	1,920,000.00
Maintenance			
Leachate Management of the existing system (assuming the facility will function as projected in the application)	30 YRS	175,000	5,250,000.00
Fill Erosion/Settlement (Annually)	30 EVENTS	5,000.00	150,000.00
Mow/Bush Hog (Annually)	30 EVENTS	1,000.00	30,000.00
General Repair (Annually)	30 EVENTS	1,500.00	45,000.00
Other			
Record Keeping/Administrative	30 YRS	1,500.00	45,000.00
Contingency	JOB	15%	1,148,400.00
TOTAL POST CLOSURE CARE COSTS			$8,804,400.00
TOTAL CLOSURE AND POST CLOSURE CARE COSTS			$10,161,616.00

Closure and Post-Closure Cost Estimate - Copy No. 2

CLOSURE COSTS			April 1994
ITEM/TASK	QUANTITY	UNIT COST	EXTENSION
Final Cap System			
Barrier Layer (materials, installation, complete)	36,500 CY	$21.00	$766,500.00
Erosion Layer (materials, installation, complete)	9,300 CY	1.25	11,625.00
Seeding (include. Mulch, fertilizer, complete)	15 AC	600.00	9,000.00
30 mil FML (materials, installation, complete)	11.3 AC	8,300.00	100,570.00
Sediment and Erosion Control			
15" Slope Drain Pipe (materials, installation, complete)	460 LF	20.00	9,200.00
18: Slope Drain Pipe (materials, installation, complete)	185 LF	30.00	5,550.00
21" Slope Drain Pipe (materials, installation, complete)	140 LF	40.00	5,600.00
24" Slope Drain Pipe (materials, installation, complete)	140 LF	45.00	6,300.00
Other			
Contractor Profit	JOB	5%	45,718.00
Mobilization/Demobilization	JOB	5%	45,718.00
QA/QC Testing, Engineering and Certification	JOB	250,000.00	250,000.00
Administrative	JOB	10,000.00	10,000.00
Contingency	JOB	10%	91,435.00
TOTAL CLOSURE COSTS			$1,357,216.00

Closure and Post-Closure Cost Estimate - Copy No.2

POST-CLOSURE CARE COSTS			April 1994
ITEM/TASK	QUANTITY	UNIT COST	EXTENSION
Inspections/Monitoring			
General Inspections (Semi-Annually)	60 EVENTS	$1,200.00	$72,000.00
Gas Monitoring (9 Wells, Quarterly)	120 EVENTS	32,000.00	144,000.00
Water Quality Monitoring (17 Locations, Semi -Annually)	60 EVENTS	32,000.00	1,920,000.00
Maintenance			
Leachate Management of the existing system (assuming the facility will function as projected in the application)	30 YRS	175,000	5,250,000.00
Fill Erosion/Settlement (Annually)	30 EVENTS	5,000.00	150,000.00
Mow/Bush Hog (Annually)	30 EVENTS	1,000.00	30,000.00
General Repair (Annually)	30 EVENTS	1,500.00	45,000.00
Other			
Record Keeping/Administrative	30 YRS	1,500.00	45,000.00
Contingency	JOB	15%	1,148,400.00
TOTAL POST CLOSURE CARE COSTS			$8,804,400.00

TOTAL CLOSURE AND POST CLOSURE CARE COSTS	$10,161,616.00

8 WATER QUALITY MONITORING PLAN

8.1 GROUNDWATER QUALITY MONITORING PLAN

Refer to the water quality monitoring plan previously submitted by DSA Design Group in the Design Manual dated March, 1992. Thirteen groundwater monitoring wells are located at the WOSLF facility for groundwater quality monitoring. Two of these wells (MW-08 and MW-09) are wells added to the original monitoring plan. WOSLF shall sample and analyze these wells in accordance with the approved Ground Water Monitoring Plan.

8.2 SURFACE WATER QUALITY MONITORING PLAN

Refer to the water quality monitoring plan previously submitted by DSA Design Group in the Design Manual dated March, 1992. There are five surface water sampling points around the landfill site. The WOSLF shall sample and analyze water from these points in accordance with the approved Surface Water Monitoring Plan.

8.3 SEMIANNUAL MONITORING EVENTS

Each year two rounds of sampling have occurred for both the surface water and groundwater monitoring systems. These sampling events have occurred for the past 3 ½ years. All sampling results have been accepted by DSWM. The results further support this application.

APPENDIX A

DSA Design Group, Inc. Operations Plan from *Transition Plan*, April 1994

7.1 Operational Drawings

Refer to the previously submitted and Approved White Oak Sanitary Landfill design plans by DSA Design Group dated September, 1992 and the Approved Plans submitted by Tribble and Richardson, Inc. Also refer to the attached "as-built" drawing for other information including water quality and explosive gas monitoring locations.

The landfill will be operated so as to facilitate closure at any time while keeping the height of the landfill to a minimum by phasing from low to high areas. This will be accomplished by placing waste in layers and cells as indicated in the Approved Operations documentation. Operators will keep the size of the active area to a minimum.

Landfilling may begin by placing baled waste in daily lifts of up to 12 feet in depth. Each lift will be covered with 6 inches of daily cover soil and graded to drain away from the working area. When the placing of waste reaches the elevation of the top of the embankment the outside face of the waste shall be graded to match the slope of the outside face of the embankment (i.e., 3:1). Embankment faces will be covered with a minimum of 12 inches of intermediate cover soils and temporarily vegetated.

The slope of the outside face of the landfill will be interrupted every 20-30 feet. in vertical height by a bench with a drainage channel (refer to the approved closure contours shown on the Tribble & Richardson plans). The benches will help increase stability and reduce the slope length and erosion of the outside face of the landfill. The bench channels will be drained via slope drain pipes similar to those being presently utilized at the landfill.

Runoff from the landfill will be directed, via diversion channels, to the existing riser barrel sediment basin located to the north of the waste cell. The existing sediment basin will be excavated to its original or appropriate dimensions and regularly maintained. Maintenance shall include inspection and repair as needed to the embankment and spillway, cleaning or replacement of the gravel filter, and other repairs to ensure proper operation of all sediment basins. Sediment shall be removed from the basin when the accumulated sediment reaches one-half of the basin or trap depth.

In accordance with state regulations, a final cover layer consisting of at least 24 inches of soil (or bentonite augmented soil) with a permeability less than or equal to 1×10^{-7} cm/s covered with a 30 mil flexible membrane liner and at least 6 inches of topsoil shall be installed on the top and on outside slopes as soon as practical after the slopes are brought to final grade. The final cover shall be seeded immediately after installation to reduce erosion. Vegetation should be established within 30 working days or 120 days of completion of a phase of the landfill.

The cover and embankment soils for the existing operating landfill will be excavated onsite and stockpiled near the working area to be used for operational and final cover soils. The operational soils will be obtained from the approved borrow areas.

7.3 Borrow Area Operations

The required daily, intermediate, and final cover soils will be obtained from the existing and expanded borrow areas. The expanded borrow area consists of approximately 5 acres of wooded land that lies to the south of the borrow area currently being excavated (refer to drawings). The expanded borrow area soils were investigated by Law Engineering during the original geotechnical evaluation for the site. Test pits were excavated in the expanded borrow area in order to explore the general subsurface conditions, evaluate soil properties, and to provide information for an estimation of the quantity of cover soils available.

7.4 Waste Acceptance

The landfill accepts only waste generated in Haywood County and does not/will not accept any of the following:

- **Hazardous Waste** as defined in 15A NCAC 13A;
- **PCBs** (polychlorinated biphenyls);
- **Liquid Sludge**;
- **Lead Batteries**;
- **Asbestos**; and
- **Liquid and Wastes Containing Free Moisture** including the following:
    - **Bulk or Non-containerized Liquid Wastes** unless the waste is household waste;
    - **Septic Waste or Waste Oil**;
    - **Barrels or Drums** unless they are empty and perforated sufficiently to ensure that they contain no liquid or hazardous waste; and
    - **Containers Holding Liquid Waste** unless the container is a small container similar is size to that normally found in household waste, the container is designed to hold liquids for use other than storage, or the waste is household waste.

A waste is liquid, or contains free moisture, if it fails the Paint Filter Test (see Hazardous and Liquid Waste Screening Program for details).

7.5 Disposal Requirements

The following items shall be disposed in the manner described below:

- **All Municipal Solid Waste** received for landfilling shall be placed within the limits of the composite liner system.

- **Spoiled food, animal carcasses, abattoir (slaughterhouse) waste, hatchery waste, and other animal waste** shall be covered immediately.

- **Asbestos waste,** if accepted, should be covered immediately with soil in a manner that will not cause airborne conditions and must be disposed of separate and apart from other solid wastes at the bottom of the working face. It is current landfill policy not to accept asbestos for disposal.

- **Wastewater Treatment Sludges** will only be accepted if utilized as a soil conditioner and incorporated into or applied to the erosion layer of the final cap system, but in no case greater than six inches in depth. It is current landfill policy not to accept sludge for disposal.

- **Tires** will be collected and stored in a separate designated area at the MRF and convenience centers for periodic removal and processing, or for proper disposal.

- **White Goods** shall be collected and stored at the MRF. The CFCs shall be removed and the remaining appliance shall be salvaged or landfilled at the bottom of the working face. Currently all white goods are being removed and reused.

- **Wood Waste and Yard Waste** shall be disposed of at another location approved by DSWM. Currently, the approved LCID landfill in Canton is receiving this waste.

7.6 Spreading and Compacting Requirements

Operations for the landfill unit are more detailed in the Operation Plan and Operational Supplemental Document contained in the Approved Plan. Briefly, landfilling shall be performed in general accordance with the following placement requirements:

- Daily placement of baled solid waste will be restricted to the smallest area feasible. Keeping the active area as small as possible will:

    - minimize leachate generation;
    - decrease the quantity (not thickness) of cover soils used;
    - increase bale placement efficiency;
    - decrease potential of litter problems (blowing waste); and
    - discourage scavenging and permit the bales to be placed and covered in less time.

- In general, solid waste (bales) should be deposited at the bottom of the active face and placement should progress downgradient along the waste cell. Bales should be stacked according to a maximum 5:1 ratio; that is to say 5 bales should be placed along the toe before one is placed on top. This results in:

    - bale stability will be ensured, and the tumbling of bales will be mitigated;
    - better bale placement, as bales can be placed so that stormwater can shed away from the working face over covered waste;
    - better visibility, comfort, and safety for equipment operators; and
    - better litter control due to less exposure to wind and less surface area of the waste.

    Special daily field or disposal conditions may make downslope operations impractical. The judgement of the landfill operations manager will prevail concerning day-to-day operations.

- Bales should be placed as densely as practical into daily cells. Maximum placement efficiency of solid waste can be achieved by:

    - placing bales in one to two-bale height lifts (no more than six feet high);
    - minimize soils placement between bales and maintain bale alignment to ensure uniformity;
    - maintain active area slopes at or less than 3:1 (33%).

- Windblown waste resulting from operations shall be collected and returned to the disposal area on a regular basis. Haywood County may wish to construct a portable litter fence if it is determined there is a prevailing wind direction at the landfill.

7.7 Hazardous and Liquid Wastes Screening Program

The following screening program is a modification of the existing Random Load Inspection Program established for Haywood County. Currently, random deliveries of solid waste are inspected each week of operations at the Materials Recovery Facility (MRF) located on Recycle Road in Clyde, NC.

It is important to prohibit the disposal of hazardous and liquid wastes at the White Oak Landfill due to the potential risk to human health and the environment. Provisions in the NC Solid Waste Management Rules place long-term liability on Haywood County.

The Hazardous and Liquid Waste Screening Program consists of two parts, (1) Hazardous and Liquid Waste Spotting and (2) Random Load Inspections.

Definitions:

Characteristic Waste - Wastes which are deemed to be hazardous due to their nature. A waste is a characteristic hazardous waste if it is not a **listed waste** but exhibits one or more of the following four characteristics: **ignitable, corrosive, reactive,** or **TCLP toxic.**

Corrosive - A waste is corrosive if the pH of the waste is less than 2 or greater than 12.5.

Hazardous Waste - Wastes with characteristics, either physical or chemical, that could harm human health or the environment. A waste is categorized as hazardous if it meets either of the two following criteria: (a) a **listed waste** or (2) a **characteristic waste.** For landfilling purposes, a waste is NOT defined as hazardous if it is a **household waste** or **household hazardous waste (HHW).**

Household Waste - Wastes (including garbage, trash and liquids) derived from households (including single and multiple residences, hotels, motels, and other residential sources).

Household Hazardous Waste (HHW) - Waste which meets the criteria of a **hazardous waste** and is derived from households. *Household hazardous waste is allowed, by the NC Solid Waste Management Rules, for disposal at municipal solid waste landfills.*

Ignitable - A waste is ignitable if it has a flash point (will ignite) at a temperature of less than 140°F, causes a fire by friction under normal circumstances, or is an oxidizer. Examples of ignitable wastes include solvents, peroxide and petroleum products. Common sources of ignitable waste include automobile repair shops, machine shops and dry cleaners.

Listed Waste - Listed wastes are specific chemical compounds which have been deemed by the EPA to present significant risks to human health and the environment. The EPA's "Lists of Hazardous Wastes" are contained in 40 CFR 261.30 - 261.33 (Subpart D).

Liquid Waste - Waste shall be considered liquid if the waste fails the Paint Filter Test as described below:

> **Paint Filter Test:** Place a 100 milliliter sample of waste in a conical, 400 micron paint filter. If any liquid passes through the filter in five minutes, the waste fails the test.
>
> *Liquid wastes that are part of **household waste** are accepted at the landfill.*

PCBs - Polychlorinated biphenyls (PCBs) are a toxic material with the potential for poisoning animal and plant life and do not degrade over time. Examples of materials which may contain PCBs are transformers, capacitors and hydraulic systems.

Reactive - A waste is reactive if it is normally unstable; reacts violently with water; forms an explosive mixture with water; contains quantities of cyanide or sulfur that could be released to the air; or can easily be detonated or exploded.

TCLP Toxic - A waste is TCLP (Toxicity Characteristic Leaching Procedure) toxic if the concentration of any of the constituents listed below exceeds the standard assigned to that substance shown in parentheses.

Arsenic (5.0mg/l)
Barium (100)
Benzene (0.5)
Cadmium (1.0)
Carbon Tetrachloride (0.5)
Chlordane (0.03)
Chlorobenzene (100.0)
Chloroform (5.0)
Chloroform (6.0)
Chromium (5.0)
o-Cresol (200.0)
m-Cresol (200.0)
p-Cresol (200.0)
Cresol (200.0)
2,4-D1 (10.0)
1,4-Dichlorobenzene (7.5)
1,2-Dichloroethane (0.5)
1,1-Dichloroethylene (0.7)
2,4-Dinitrotoluene (0.13)
Endrin (0.02)
Heptachlor (0.008)
Hexachlorobenzene (0.13)
Hexachloroethane (3.0)
Lead (5.0)
Lindane (0.4)
Mercury (0.2)
Methoxychlor (10.0)
Methyl ethyl ketone (200.0)
Nitrobenzene (2.0)
Pentachlorophenol (100.0)
Pyridine (5.0)
Selenium (1.0)
Silver (5.0)
Tetrachloroethylene (0.7)
Toxaphene (0.5)
Trichloroethylene (0.5)
2,4,5-Trichlorophenol (400.0)
2,4,6-Trichlorophenol (2.0)
2,4,5-TP (Silvex) (1.0)
Vinyl Chloride (0.2)

The TCLP is designed to detect heavy metals, pesticides and a few other organic and inorganic compounds in order to prevent groundwater contamination by highly toxic materials.

Hazardous and Liquid Waste Spotting:

County personnel working at the scales, MRF and the active face of the landfill shall watch for suspicious wastes at all times. Personnel shall watch for the following:

- Hazardous placards, labels or markings
- Liquids
- Powder, dust, or vapors
- Sludges
- Bright or unusual colors
- Drums or commercial size containers
- "Chemical" or unusual odors
- Other waste not accepted at the landfill

MRF personnel shall pay special attention to waste originating from:

- auto repair and machine shops (solvents, paint wastes, lead acid batteries, grease and oil),
- dry cleaners (filters containing dry cleaning solvents), and
- other industries which generate a variety of undesirable wastes; e.g. chemical and related products, petroleum refining, primary metals, electrical and electronic machinery.

IF HAZARDOUS, LIQUID OR SUSPICIOUS WASTE IS DISCOVERED, landfill personnel shall proceed in accordance with the following:

1. Instruct the hauler to remain at the MRF until waste acceptance is determined by the Haywood County Emergency Management Coordinator and the appropriate information is obtained from the hauler to complete the Hazardous and Liquid Waste Screening Report.

2. Complete a Hazardous and Liquid Waste Screening Report and place a copy of the Report in the Operating Record.

   If the waste is identified while still in the haul vehicle, the MRF/landfill manager may refuse the load, however the following steps still must be completed.

3. Contact the Haywood County Solid Waste Director - Keith Burris (704-627-8137) and the Haywood County Emergency Management Coordinator - Nolan Palmer (704-452-6660).

4. Segregate the suspicious waste if safe to do so.

5. Allow the Emergency Management Coordinator to determine if the waste is hazardous or liquid.

   If the waste is determine to be hazardous or suspicious, Haywood County Emergency Management Personnel will:

   a. Notify the Local Office of Emergency Management (Asheville) and the State Office of Emergency Management (Raleigh).

   b. Contact a licensed hazardous waste hauler to remove and properly dispose of the waste, or advise the original hauler to properly remove and dispose of the waste. A list of licensed hazardous waste cleanup contractors is available from the Haywood County Emergency Management Coordinator.

   c. The MRF/landfill manager shall complete the remaining steps of this procedure.

   If the waste is determined to be liquid (and non-hazardous) by the Haywood County Emergency Management Personnel, the MRF/landfill manager will:

   a. Require the hauler of the waste to remove the liquid waste from the MRF, or arrange for its proper transport and disposal.

   b. Refer to Section 7.4 Waste Acceptance for requirements on the acceptance of liquid waste.

   c. Complete the remaining steps of this procedure.

6. If waste is to be removed from the site or if further on-site analysis is required and must remain on site overnight, cover the waste securely with a waterproof tarp or segregate the waste to a dry, covered area within the MRF.

7. Notify the Division of Solid Waste Management (919-733-0692) within 24 hours of attempted disposal of any waste the landfill is not permitted to receive, including hazardous and liquid wastes, PCBs, and waste from outside Haywood County.

Random Load Inspections:

Random Load Inspections shall be performed on randomly selected loads originating in part or total from commercial and/or industrial sources. Loads consisting entirely of household (residential) waste should not normally be included in the Random Load Inspection Program. Household hazardous/liquid waste is accepted at the White Oak Landfill, however, landfill personnel shall stay alert to household hazardous/liquid waste for their own protection.

Selection of Random Loads:

The Haywood County MRF receives approximately 75 loads of municipal solid waste per day. One (1) Random Load Inspection shall be performed each week, however, all loads deemed by the MRF operator to be suspicious should be inspected and documented.

The random load to be inspected will be determined by selecting the day of the week and the time of day at which the load crosses the MRF scale. Each operating week prior to opening for disposal operations, the MRF personnel will randomly select a day and time (e.g. Tuesday, 10:45 a.m.). The first load of waste, containing all or part commercial or industrial waste, which crosses the scales on or after the selected time will be the load inspected that day. If the randomly selected load is determined to consist entirely of household waste (no commercial or industrial waste) then the inspection shall be performed on the **next** load crossing the scales containing, in part or total, commercial and/or industrial waste.

Random Load Inspection Procedure:

1. Prior to accepting waste the MRF operator will designate an area to be used for random load inspection. The designated area shall be dry and away from other received waste on the MRF floor.

2. The randomly inspected vehicle will be directed to the designated area.

3. The waste should be inspected, as completely as possible, while still in the vehicle before dumping the load. If any of the items listed in step 5 below are observed then the operator should request that the hauler remain on site until waste acceptance is determined by the Haywood County Emergency Management Coordinator and the appropriate information is obtained from the hauler to complete the Hazardous and Liquid Waste Screening Report. The operator should then complete the Hazardous and Liquid Waste Screening Report and contact the Haywood County Solid Waste Director - Keith Burris (704-627-8137) and the Haywood County Emergency Management Coordinator - Nolan Palmer (704-452-6660). Allow the Emergency Management Coordinator to determine the method of disposal of the waste.

4. If no hazardous or liquid wastes are initially observed in Step 3 then the load shall be dumped in the area designated in Step 1 and spread out with a loader. Additional spreading of the load shall be carefully performed by MRF personnel. Any bagged or baled waste shall be broken up and spread out for observation.

5. MRF and landfill personnel shall perform a visual inspection of the waste. Below is a list of items to look for:
   - Hazardous labels or markings
   - Liquids
   - Powder, dust, or vapors
   - Sludges
   - Bright or unusual colors
   - Drums or commercial size containers
   - "Chemical" or unusual odors
   - Other waste not accepted at the landfill

6. Complete the Hazardous and Liquid Waste Screening Report and place a copy in the landfill's Operating Record. This report should be completed for each random load inspection whether or not hazardous/liquid waste is found.

7. If hazardous, liquid or suspicious waste is found, landfill personnel should follow the procedure outlined above entitled **"IF HAZARDOUS, LIQUID OR SUSPICIOUS WASTE IS DISCOVERED"**.

WHITE OAK LANDFILL/MRF

A. GENERAL INFORMATION:

Date: _____ Inspector: _____

Time: _____ Weather: _____

Screening Type:

_____ Random Load Inspection, _____ Spotted at Working Face/MRF, _____ Spotted in Haul Vehicle.

B. HAULER INFORMATION:

Hauler Name: _____ Vehicle No./Tag No.: _____ Weight of Load: _____

Driver Name & Lic. No.: _____ Hauler Phone No.: _____

Waste Generators: _____

C. WASTE INFORMATION:

Waste Identified as:
- ___ Non-Hazardous, Non-Liquid (Load acceptable)
- ___ Suspicious (Explain below)
- ___ Hazardous Waste (Explain below)
- ___ Liquid Waste (Explain below)

Notes: _____

D. DISPOSAL INFORMATION:

Waste Disposal:
- _____ Accepted
- _____ Refused (Removed by hauler)
- _____ Covered and temporarily stored on site for further tests (Attach additional documentation)
- _____ Removed by hauler licensed to transfer hazardous waste (Attach additional documentation)

GENERAL INSTRUCTIONS:

The White Oak Landfill/MRF Hazardous/Liquid Waste Screening Report shall be completed upon either of the following instances:

- A Random Load Inspection
- Spotting of a hazardous, liquid, or suspicious waste at the landfill gate, scales, or active face.

1. All MRF/landfill personnel shall stay alert for possible hazardous and liquid wastes at all times at the gate and active face. Special attention shall be given to waste loads originating from commercial and industrial sources. Household hazardous and household liquid wastes are acceptable at the landfill.
2. If a hazardous, liquid or suspicious waste is discovered while in a haul vehicle or on the landfill contact the Haywood County Solid Waste Director and the County Emergency Management Coordinator.
3. Notify the Division of Solid Waste Management (919-733-0692) within 24 hours of attempted disposal of any waste the landfill is not permitted to receive, including hazardous and liquid wastes, PCBs, and waste from outside of Haywood County.
4. Place a copy of all completed Hazardous/Liquid Waste Screening Reports in the Operating Record.
5. Refer to the White Oak Landfill Transition Plan for more detailed information and instructions.

Solid Waste Director - Keith Burris (704)627-8137 Emergency Management Coordinator - Nolan Palmer (704)452-6660.

7.8 Cover Material Requirements

All disposed solid waste must be covered with six inches of daily cover soils at the end of each operating day, or at more frequent intervals if necessary, to control disease vectors, fires, odors, blowing litter, and scavenging.

Areas which will not have additional wastes placed on them for 12 months or more, but where final termination of disposal operations has not occurred, shall be covered with a minimum of 12 inches of intermediate cover soils and vegetated.

7.9 Disease Vector Control

The appropriate use of daily and intermediate cover and the Disposal Requirements outlined in Section 7.5 of this chapter should be utilized by landfill personnel to control on-site populations of rodents, flies, mosquitoes, other animals, or insects, capable of transmitting disease to humans. If additional means of control are deemed necessary, landfill personnel shall contact the Waste Management Specialist, Jim Patterson (704-251-6208) for the facility regarding alternative solutions. Do not apply insecticides, pesticides or other chemicals to the landfill.

7.10 Explosive Gas Control

Methane gas (CH_4) is a by product of anaerobic decay (without free elemental oxygen) of organic constituents contained in solid waste, wastewaters, sludges, or naturally occurring features such as swamps. Methane, frequently referred to as swamp gas or marsh gas, along with carbon dioxide (CO_2) comprise the major constituents (approximately 99%) of landfill gas. Evidence of anaerobic decomposition resulting in methane release can be observed as the bubbling that occurs in a stagnant body of water when the bottom is disturbed thereby releasing the trapped methane gas. Methane gas generation and migration can pose serious health and safety problems. One should understand the characteristics of methane gas in order to appreciate the potential threats it poses.

Methane gas is lighter than air and consequently will rise given the opportunity. Methane has a specific gravity of 0.554, based on air having a specific gravity of one (1.0). Methane gas is odorless and colorless and has a flammable range of 5-15% by volume in air. The Lower Explosive Limit (LEL) is thus 5%. Methane as with any fluid will seek the path of least resistance when it flows or migrates. With the non-homogeneous nature of a landfill's contents, predictions as to where methane may migrate are difficult, thus the need to monitor its presence in enclosed areas, confined spaces and at landfill property boundaries. There are documented cases where methane has migrated underground several hundred feet from landfills to adjacent areas and even into basements or crawl spaces of residences.

The dangers posed by methane are well known and there are numerous documented incidences of explosions caused by methane. The gas can be trapped in unvented or poorly vented areas such as crawl spaces or even seep into buildings. There is also danger to personnel from asphyxiation upon entering confined spaces where methane may have displaced some of the normal atmospheric air. Of course there are other gases present from the biological decomposition. Many of these gases are organic acids and do have an odor. Carbon monoxide is also likely to be present as it is a product of anaerobic decay. Thus confined space entry procedures should be employed prior to entering such spaces. Confined space entry procedures generally consist of checking the space for the presence of explosive gases, carbon monoxide and oxygen deficiency, venting the confined space, and then entering only if necessary and equipped with life support breathing apparatus, safety lines, and safety personnel standing by. Gas detection meters are commercially available and can be purchased to detect a number of gases or gas categories.

The concentration of methane gas (CH_4) at the landfill must be monitored on a regular basis. An approved Permanent Gas Monitoring System must be constructed on or before October 9, 1994. The Temporary Gas Monitoring System must be used until the Permanent Gas Monitoring System is complete.

The following requirements pertain to both the Permanent and Temporary Gas Monitoring Systems:

Methane Gas Limits

25% of the LEL of methane in all FACILITY STRUCTURES.

100% of the LEL of methane at the facility PROPERTY BOUNDARY.

The LEL (Lower Explosive Limit) is the lowest percent by volume of a mixture of explosive gases in air that will propagate a flame at 25°C and atmospheric pressure. The LEL for methane is 5% by volume in air.

Monitoring Frequency

Gas monitoring shall be performed, at a minimum, every three (3) months unless directed otherwise by DSWM.

IF METHANE GAS CONCENTRATIONS ARE FOUND TO BE IN EXCESS OF THE LIMITS[1] listed above, the danger of explosion is high and landfill personnel shall proceed in accordance with the following:

1. Immediate action must be taken to protect human health from potentially explosive conditions. All persons should be evacuated from the area immediately.
2. Leave the door to the evacuated structure open for ventilation.
3. From a safe location, contact the Haywood County Solid Waste Coordinator - Keith Burris (704-627-8042) and the Haywood County Emergency Management Coordinator - Nolan Palmer (704-452-6660).
4. Notify the Division of Solid Waste Management (919-733-0692).
5. Within seven days of detection, place in the operating record the methane gas levels detected and a description of the steps taken to protect human health.
6. Within 60 days of detection, develop and implement a remediation plan for the methane gas releases, place a copy of the plan in the operating record, and notify the Division of Solid Waste Management that the plan has been implemented. The plan shall describe the nature and extent of the problem and the proposed remedy.

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[1]This page was revised on July 26, 1994 as required by comments made by DSWM. A response plan was developed for the Landfill Gas Monitoring System proposed for the White Oak Sanitary Landfill in Haywood County. Additionally, the methane detection limits were corrected to correspond with State requirements.

The concentration of methane gas (CH_4) at the landfill must be monitored on a regular basis. An approved Permanent Gas Monitoring System must be constructed on or before October 9, 1994. The Temporary Gas Monitoring System must be used until the Permanent Gas Monitoring System is complete.

The following requirements pertain to both the Permanent and Temporary Gas Monitoring Systems:

Methane Gas Limits

100% of the LEL of methane in all FACILITY STRUCTURES.

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Monitoring Frequency

Gas monitoring shall be performed, at a minimum, every three (3) months unless directed otherwise by DSWM.

Permanent Gas Monitoring System

Narrative:

The Permanent Gas Monitoring System is being proposed with the submittal of this Transition Plan to DSWM. This system or the entire Transition Plan must be approved by DSWM before the system can be installed and monitored. The Permanent Gas Monitoring System consists of gas monitoring wells located along the compliance boundary of the facility (refer to the attached plan for well locations) and an outlined procedure for monitoring of the gas wells and on-site structure(s).

Equipment:

- Explosive gas detection meter (*meter*) capable of measuring the percent of LEL and/or concentration of methane gas (combustible gasses) by volume in air.
- Permanently installed gas monitoring wells along the facility's compliance boundary.

Gas monitoring procedure:

1. Make arrangements with neighbors to measure gas in nearby structures, if needed.
2. Calibrate the *meter* according to the manufacturer's recommendations. Measure the concentration of methane gas in the FACILITY STRUCTURES before any heat source or fuel has been turned on in the structure. Take measurements in the basement or crawl space, near the floor along walls were gas may enter from below, and in every room of the structure. Record, in the Gas Monitoring Record, the concentrations and/or percent of LEL of methane gas for each location.
3. Measure gas as described in step 2. in nearby structures with owner's approval. Record results.
4. At each gas monitoring well, remove well cap and insert meter probe into well to approximately two (2) feet into well casing. Perform measurement of concentration or percent of LEL of methane gas in the well. Record measurements. Replace well cap.
5. Proceed to next monitoring point and repeat steps 4 & 5 until all locations have been monitored and recorded.
6. Place monitoring results in on-site landfill records.
7. Submit copy of test results to:
   Division of Solid Waste Management
   "Gas Monitoring Results"
   P.O. Box 2678
   Raleigh, NC 27611-7687.
8. If methane gas concentrations are found to be in excess of the established limits, the danger of explosion is high and landfill personnel shall follow the procedure outlined on page 26[2].

[2]This page was revised on July 26, 1994 as required by comments made by DSWM. A response plan was developed for the Landfill Gas Monitoring System proposed for the White Oak Sanitary Landfill in Haywood County. Additionally, calibration of the detection meter was noted.

Permanent Gas Monitoring System

Narrative:

The Permanent Gas Monitoring System is being proposed with the submittal of this Transition Plan to DSWM. This system or the entire Transition Plan must be approved by DSWM before the system can be installed and monitored. The Permanent Gas Monitoring System consists of gas monitoring wells located along the compliance boundary of the facility (refer to the attached plan for well locations) and an outlined procedure for monitoring of the gas wells and on-site structure(s).

Equipment:

- Explosive gas detection meter (*meter*) capable of measuring the percent of LEL and/or concentration of methane gas (combustible gasses) by volume in air.
- Permanently installed gas monitoring wells near the compliance boundary of the facility.

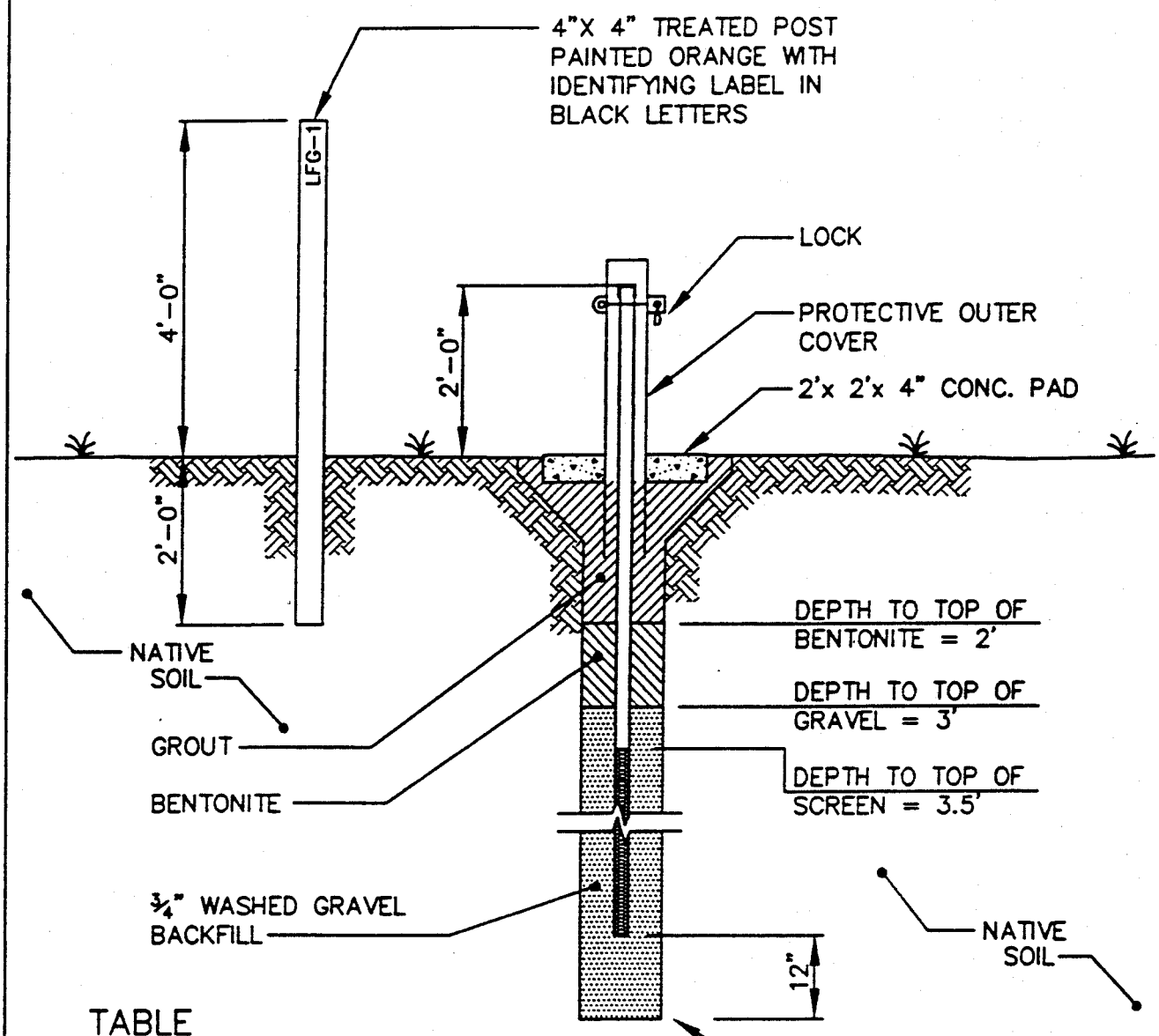
Gas monitoring procedure:

1. Using the *meter*, measure the concentration of methane gas in the FACILITY STRUCTURES before any heat source or fuel has been turned on in the structure. Take measurements in basement or crawl space, near the floor along walls where gas may enter from below, and in every room of the structure. Record, in the Gas Monitoring Record, the concentrations and/or percent of LEL of methane gas for each location.

2. At each gas monitoring well, remove the well cap and insert the meter probe into the well approximately two (2) feet into the well casing. Perform measurement of concentration or percent of LEL of methane gas in the well. Record measurements. Replace the well cap.

3. Submit copy of test results to:

   Division of Solid Waste Management
   Solid Waste Section
   "Gas Monitoring Results"
   P.O. Box 26787
   Raleigh, NC 27611-7687



TABLE

BOREHOLE O.D. = 12"
PIPE O.D. = 2"
PIPE TYPE = PVC SCH 40
SCREEN SLOT SIZE = 0.010"

BOREHOLE TO 1' TO 2' ABOVE SEASONAL HIGH WATER TABLE OR TOP OF BEDROCK, WHICHEVER IS SHALLOWER.

GAS MONITORING WELL

NOT TO SCALE

Temporary Gas Monitoring System

Narrative:

Until approval and installation of the Permanent Gas Monitoring System, landfill personnel will utilize the Temporary Gas Monitoring System as outlined below. The Temporary Gas Monitoring System consists of measuring concentrations of methane gas at the property line and on-site structures. The initial Temporary Landfill Gas Monitoring event for the White Oak Sanitary Landfill is scheduled for April 13, 1994. A report of these readings will be sent to DSWM.

Equipment:

- Explosive gas detection meter (*meter*) capable of measuring the percent of LEL and/or concentration of methane gas (combustible gasses) by volume in air.
- Metal stake with bullet end capable of being driven 2½ to 3 feet into the ground and removed leaving a hole large enough for insertion of the explosion meter probe.

Gas monitoring procedure:

1. Calibrate the *meter* according to the manufacturer's recommendations. Measure the concentration of methane gas in the FACILITY STRUCTURES before any heat source or fuel has been turned on in the structure. Take measurements in the basement or crawl space, near the floor along walls where gas may enter from below, and in every room of the structure. Record, in Gas Monitoring Record, the concentrations and/or percent of LEL of methane gas for each location.
2. At the monitoring point on the property boundary, drive stake into the ground to a depth of 2½ feet. Remove stake and insert the meter probe. Perform measurement for concentration or percent LEL of methane gas. Record measurement.
3. Proceed to next monitoring point and repeat steps 1 & 2 until all locations have been monitored and recorded.
4. Place monitoring results in the on-site landfill records.
5. Submit copy of test results to:

   Division of Solid Waste Management
   "Gas Monitoring Results"
   P.O. Box 26787
   Raleigh, NC 27611-7687

6. If methane gas concentrations are found to be in excess of the established limits, the danger of explosion is high and landfill personnel shall follow the procedure outlined on page 26[3].

[3]This page was revised on July 26, 1994 as required by comments made by DSWM. A response plan was developed for the Landfill Gas Monitoring System proposed for the White Oak Sanitary Landfill in Haywood County. Additionally, calibration of the detection meter was noted.

Temporary Gas Monitoring System

Narrative:

Until approval and installation of the Permanent Gas Monitoring System, landfill personnel will utilize the Temporary Gas Monitoring System as outlined below. The Temporary Gas Monitoring System consists of measuring concentrations of methane gas at the property line and on-site structures. The initial Temporary Landfill Gas Monitoring event for the White Oak Sanitary Landfill is scheduled for April 13, 1994. A report of these readings will be sent to DSWM.

Equipment:

- Explosive gas detection meter (*meter*) capable of measuring the percent of LEL and/or concentration of methane gas (combustible gasses) by volume in air.

- Metal stake with bullet end capable of being driven 2½ to 3 feet into the ground and removed leaving a hole large enough for insertion of the explosion meter probe.

Gas monitoring procedure:

1. Using the *meter*, measure the concentration of methane gas in the FACILITY STRUCTURES before any heat source or fuel has been turned on in the structure. Take measurements in the basement or crawl space, near the floor along walls where gas may enter from below, and in every room of the structure. Record, in Gas Monitoring Record, the concentrations and/or percent of LEL of methane gas for each location.

2. At the monitoring point on the property boundary, drive stake into the ground to a depth of 2½ feet. Remove stake and insert the meter probe. Perform measurement for concentration or percent LEL of methane gas. Record measurement.

3. Proceed to next monitoring point and repeat steps 1 & 2 until all locations have been monitored and recorded.

7. Place monitoring results in the on-site landfill records and send a copy to DSWM.

7.11 Air Criteria

A gas venting system is required and has been provided in the Approved Plan. The passive gas venting system consists of vertical wells installed progressively throughout the landfill cell and vented to the atmosphere. After construction, the passive system can be converted into a collection/flare system if the need or requirement arises (see paragraph below). At this time monitoring of the gas venting system in the landfill cap is not a requirement.

The EPA is expected to promulgate regulations known as Subpart WWW of 40 CFR 60 which will regulate landfill gas as an air pollutant under the Clean Air Act (CAA). Within nine months after promulgation, North Carolina will develop a State Implementation Plan (SIP) which implements the EPA regulations. Landfill owners and operators will be required to ensure that their landfills do not violate any applicable requirements of the North Carolina SIP. Subpart WWW proposes to control landfill emissions by regulating nonmethane organic compounds (NMOC's) in the landfill gas. Landfills emitting more than 167 tons per year of NMOC's would be required to operate gas collection systems and combust the captured landfill gases. In most cases, the new collection systems will be connected to the existing passive gas venting system installed in the landfill cap. In the future, the White Oak Landfill may be required to perform annual testing and calculation of NMOC's emitted from the Passive Gas Venting System.

7.12 Access and Safety

A locked electronic gate at the entrance to the facility and a perimeter, electrified fence is utilized to prohibit uncontrolled access to the landfill during off hours. Landfill personnel shall monitor the access to the landfill during operating hours.

Landfill personnel shall construct and maintain all weather access roads as indicated on the Approved Operational Drawings. Apply water to access road outside of waste cell when needed to control dust.

Landfill personnel shall maintain signs at facility which state: hours of operation; no hazardous or liquid waste accepted; the landfill permit number; and other pertinent information.

Landfill personnel shall prohibit the removal of solid waste from the landfill unless removal is approved by the landfill operator and is not performed on the working face of the landfill.

7.13 Erosion and Sediment Control

The Erosion and Sediment Control Plan for the White Oak Landfill was submitted to DSWM in March, 1992 as part of the approved White Oak Landfill Construction Plan. Approval of the Erosion and Sediment Control Plan was issued by the Division of Land Resources in July, 1993. A complete copy of the Erosion and Sediment Control Plan Report is provided in the Approved Plan. Refer to the previously submitted and approved White Oak Landfill Design Plans for Erosion and Sediment Control Plan and Details.

7.14 Drainage Control and Water Protection

Landfill personnel shall ensure that surface water is diverted from the operational area with the utilization of bench ditches, temporary channels, berms, slope drains, culverts, and other means as necessary to maintain positive surface drainage off the landfill. At no time shall surface water be allowed to collect over waste or waste be disposed of in water.

Landfill personnel shall utilize slope benches, slope drains, channels, and other methods indicated in the approved Erosion and Sediment Control Plan and the Operational Drawings to control drainage and prevent excessive erosion. The sediment basin shall be maintained to prevent excessive sediment from leaving the property. Surface water shall be monitored as detailed in ***Chapter 12 - Water Quality Monitoring***.

7.15 Record Keeping

A copy of the following items shall be kept in an Operating Record for the landfill at the MRF until it is closed at which time all records shall be kept at the office of the Haywood County Manager.

- Approved Transition Plan including:
  - Water Quality Monitoring System Plan
  - Water Quality Sampling and Analysis Plan (SAP)
  - Hazardous and Liquid Waste Screening Plan
  - Erosion and Sediment Control Plan
  - Operational Plan
  - Closure Plan
  - Post-Closure Plan
  - Closure and Post-Closure Cost Estimate
  - Financial Assurance Documentation
- Annual Updates of Closure and Post-Closure Cost Estimate
- Amounts and Sources of Solid Waste Received
- Solid Waste Permit and Amendments
- Inspection/Evaluation Reports
- Water Quality Monitoring Results
- Gas Monitoring Results
- Hazardous/Liquid Waste Screening Reports
- Citizens' Complaints and Disposition
- Closed Unit Certifications
- Post-Closure Certification
- All Correspondence
- Other Pertinent Data and Records required by DSWM

APPENDIX B

Calculations of Leachate Pipe Bearing Capacity and Flexible Membrane Liner Slope Stability, Project Design Manual, March 1992 and Addenda to Transition Plan

Project _____ Acct No. _____ Page _____ of _____

Subject SLOPE STABILITY Comptd. By MEJ Date _____

Detail N/A Ck'd. By _____ Date _____

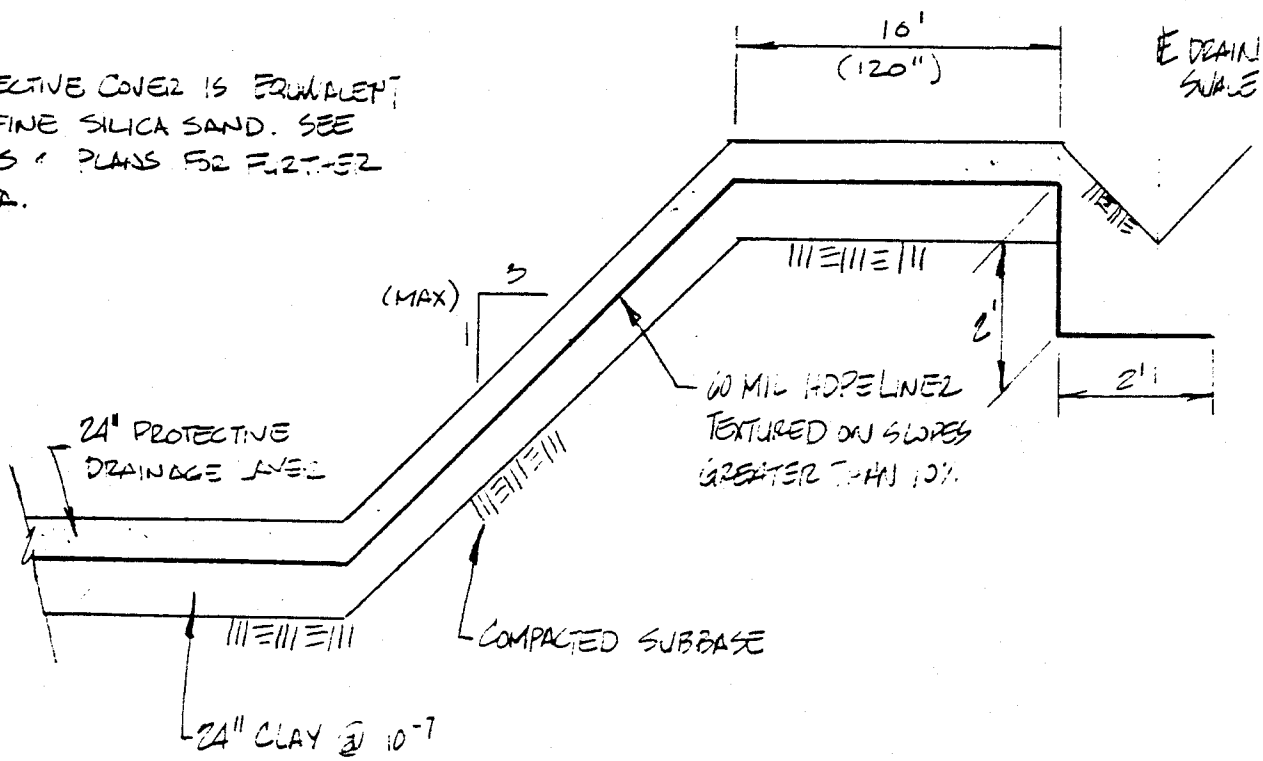
TRIBBLE & RICHARDSON INC.

SLOPE STABILITY:

STABILITY OF THE SIDE SLOPE WAS DETERMINED BY COMPARING THE MAXIMUM SIDE SLOPE ANGLE AND THE MINIMUM FRICTION ANGLE. THE MINIMUM FRICTION ANGLE IS LOCATED BETWEEN THE TEXTURED 60 MIL HDPE LINER AND THE COMPACTED CLAY BASE LINER. SINCE THIS ANGLE IS APPROXIMATELY 32 DEGREES (PER SLT OF NO AMERICA, INC) AND IS GREATER THE MAXIMUM STABLE SLOPE ANGLE OF 18.4 DEGREES (3:1), the slope is considered stable. THE FACTOR OF SAFETY IS:

$$\frac{\tan 32^\circ}{\tan 18.4^\circ} = 1.88$$

* PROTECTIVE COVER IS EQUIVALENT TO FINE SILICA SAND. SEE SPECS & PLANS FOR FILTER DATA.



PROPOSED LINER & ANCHOR TRENCH

Project _____ Acct No. _____ Page _____ of _____

Subject _____ Comptd. By _____ Date _____

Detail _____ Ck'd. By _____ Date _____

OBJECT: CALCULATE ANCHOR CAPACITY FOR PIPE LINER PLACED IN CORRUGATED PIPE

DEFINE ANCHOR TRENCH GEOMETRY. USING "GEOSYNTHETIC DESIGN GUIDANCE FOR HAZARDOUS WASTE LANDFILL & SURFACE IMPOUNDMENTS" pg II 2.05

T = tension force can withstand before failure

β = side slope angle

L = Embedment Length

d_{CS} = depth of soil cover

d_{AT} = depth of anchor trench

ϕ = soil friction angle between liner and clay

δ = Soil / Pipe Friction angle

γ_{CS} = Unit wt of cover material

K_A = coefficient of active earth pressure

K_P = " " passive " "

K_O = " " earth pressure at rest

$\beta = 18.4°$ (3:1)

$L = 5'$

$d_{CS} = 2'$

$d_{AT} = 2'$

$\phi = 32°$ (PER SLT OF AMERICA)

$\delta = 35°$ (PER SLT OF No. AMERICA, INC.)

$\gamma_{CS} = 120$ lbs / ft^3 (unsaturated)

$$K_A = \tan^2\left[(45 - \phi/2)\right] = 0.31$$

$$K_P = \tan^2\left[45 + \phi/2\right] = 3.25$$

$$K_O = 1 - \sin\phi = 0.47$$

$$q = (\gamma_{CS})(d_{CS}) = (120)(2) = 240 \text{ lb/ft}^2$$

TRIBBLE & RICHARDSON INC.

Project _____ Acct No. _____ Page _____ of _____

Subject _____ Comptd. By _____ Date _____

Detail N.A Ck'd. By _____ Date _____

DETERMINE ANCHOR CAPACITY:

$K = K_p$ or K_o

- TENSION UNDER PASSIVE EARTH PRESSURE:

$$T_{KP} = \frac{[(2)(L)(\tan\delta)] + (K + K_a)\tan\delta\left[0.5\,\gamma\cos\beta\,H^2 + 2\,qH\right]}{\cos\beta - \sin\beta\cdot\tan\delta}$$

$$= \frac{[(240)(5)(\tan 35)] + (3.25 + 0.31)\tan 35\left[0.5\,(120)(2) + 200/2\right]}{\cos 18.4° - \sin 18.4°\tan 35°}$$

$$= \frac{840.25 + 598.26}{0.73}$$

$$= 1970.56 \text{ lb/FT.}$$

- TENSION WHEN EARTH AT REST:

$$T_{K_o} = \frac{[(240)(5)(\tan 35)] + (0.47 + 0.31)\tan 35\left[0.5\,(120)(2) + 200\right]}{\cos 18.4° - \sin 18.4°\tan 35°}$$

$$= \frac{840.25 + 131.08}{0.73}$$

$$= 1330.59 \text{ lb/FT.}$$

$T = 1970.6$ lb/FT.

TRIBBLE & RICHARDSON INC.

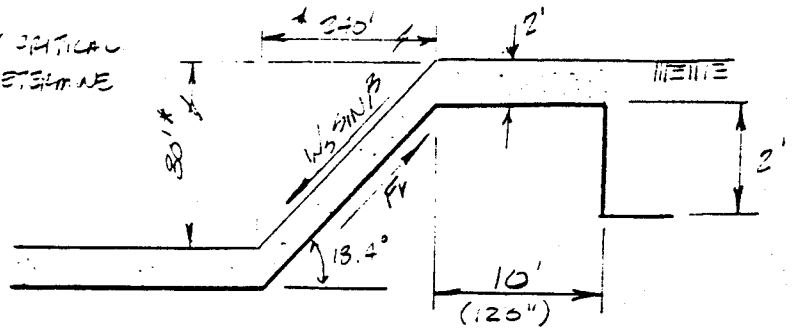
Project: _____ Acct No. _____ Page _____ of _____

Subject: SLOPE STABILITY Comptd. By: KE Date: _____

Detail: FS Ck'd. By: _____ Date: _____

DETERMINE LOADING MOMENT ON LINER:

*USED MOST CRITICAL SLOPE TO DETERMINE FACTOR.



W_L = WEIGHT OF LINER

W_S = WEIGHT OF SOIL

D = DEPTH = 80'

t = FML THICKNESS = $\frac{0.06}{12}$

60 MIL LINER - FML SPEC. GRAVITY = 0.940

FRICTION ANGLE = δ_L = 30° SAND. (PER SLT OF NORTH AMERICA, INC.)

β = 18.4°

- LINER WT.

$$W_L = (G\,\delta_w\,t)(1)(D/\sin\beta)$$

$$= (0.940 \cdot 62.4\ \text{lb/ft} \cdot \tfrac{0.06}{12})(1)(80/\sin 18.4°)$$

$$= 74.33\ \text{lb/ft}$$

- SOIL WEIGHT:

$$\text{AREA}_S = 2 \times 240' = 480\ \text{sq. ft}$$

$$\gamma_S = 120\ \text{pcf}\ (\text{UNSATURATED})$$

$$W_S = 480\ \text{SF} \times 120\ \text{pcf} = 57{,}600.\ \text{lb/ft}$$

$$\therefore (W_S + W_L)\sin\beta = (57{,}600 + 74.33)\sin 30° = 18{,}204.85\ \text{lb/ft}$$

$$\therefore F_2 = (W_S + W_L)\cos\beta \tan\delta$$

$$= (57674.33)(\cos 18.4°)(\tan 30°)$$

$$= 31{,}595.95\ \text{lb/ft}$$

- FACTOR OF SAFETY = $F.S. = \dfrac{T + F_R}{(W_S + W_L)\sin\beta} = \dfrac{(1970.6 + 31{,}595.95)}{(57674.33)\sin 18.4°}$

$$F.S. = 1.84$$ (AT WORST CASE SITUATION)

TRIBBLE & RICHARDSON INC.

FrictionFlex™ Application Data

FrictionFlex™ is the industry's first textured HDPE liner. It is the only geomembrane to date to be granted a U.S. Patent.* FrictionFlex™ is the result of over five years of SLT research and development committed to the innovation of new high-performance geomembrane materials. Offering design and construction advantages for composite lining design on steep slopes, FrictionFlex™ provides increased facility design capacity, service life and thereby total revenue potential. Containment slopes, vertical expansions and perimeter slopes in closures share the benefits of greater airspace and superior cover stability.

Most importantly, the advantages of FrictionFlex™ are available without compromise of any performance property or other issue of secure containment. A proprietary manufacturing process enables SLT to produce a textured liner (on one or both sides) exhibiting the same mechanical and chemical properties demanded of SLT's HyperFlex,™ the industry's premium grade smooth HDPE geomembrane. Non-textured edges facilitate welding and thickness measurements for superior quality control. Standard installation equipment and procedures ensure expedient construction.

The following reflects independent data confirming superior FrictionFlex™ performance in contact with soils and synthetics:

- Highest coefficient of friction with soils
- Highest coefficient of friction with synthetics
- Premium grade mechanical and chemical properties

SLT FrictionFlex™				Typical Smooth HDPE
Material	Coefficient of Friction	Adhesion (psf)	Average Friction Angle (degrees)	Comparable Friction Angle
Sandy Glacial Till	0.74	27	36	20
Sandy Clay	0.70	65	35	18
Smooth Clay	0.62	39	32	16
Ottawa Sand	0.59	21	30	19
Nonwoven Polyester Geotextile	0.54	116	28	11
Nonwoven Polypropylene Geotextile	0.65	133	33	12

NOTE: The above data is approximate. SLT recommends that specific data be developed for all application designs. Shear box testing of the specific geosynthetic and natural components of the composite is necessary to establish an appropriate design basis. SLT will be pleased to provide any necessary material samples for such purposes and invites comparative procedures.

FrictionFlex™ material properties are presented on the reverse side of this document.

*U.S. Patent No. 4,885,201

SLT NORTH AMERICA, INC.
Subsidiary of SLT Environmental, Inc.
Four Greenspoint Plaza 16945 Northchase, Suite 1750 Houston, Texas 77060
(800) 955-8085 (713) 874-2150 FAX (713) 874-2168

FrictionFlex™ Textured HDPE Lining Material

SLT FrictionFlex™, the industry leading textured smooth geomembrane produced from a specially formulated virgin HDPE geomembrane resin FrictionFlex™ has outstanding chemical resistance, mechanical properties, environmental stress crack resistance, dimensional stability and thermal aging characteristics. FrictionFlex™ contains approximately 97.5% polymer and 2.5% carbon black, anti-oxidants, heat stabilizers, and contains no additives, fillers and extenders. FrictionFlex™ has excellent resistance to UV radiation and is suitable for exposed conditions.

PROPERTY	TEST METHOD	NOMINAL VALUE		
Thickness	ASTM D751/1593/374	60mil	80mil	100mil
Density (g/cc)	ASTM D792/1505	0.944	0.944	0.944
Melt Flow Index (g/10 Minutes)	ASTM D1238-E	≤ 1.0	≤ 1.0	≤ 1.0
Tensile Properties Either Direction	ASTM D638 Type IV Dumbell, 2 ipm			
Tensile Strength at Break (lb/in Width)	Gauge length per	300	400	500
Tensile Strength at Yield (lb/in Width)	N.S.F. Std. 54	180	240	300
Elongation at Break (Percent)		800	800	800
Elongation at Yield (Percent)		15	15	15
Modulus of Elasticity (psi)		80,000	80,000	80,000
Tear Resistance Initiation (Pounds)	ASTM D1004 Die C	70	94	117
Low Temperature Brittleness	ASTM D746 B	-120°F	-120°F	-120°F
Dimensional Stability Percent Each Direction	ASTM D1204 248°F 1 hr.	±1	±1	±1
Volatile Loss (Max. Percent)	ASTM D1203 Meth. A	0.10	0.10	0.10
Resistance To Soil Burial	ASTM D3083			
Tensile Strength at Break or Yield	Percent Change	±5	±5	±5
Elongation at Break or Yield	Percent Change	±10	±10	±10
Ozone Resistance	ASTM D1149 7 days 100 pphm 104°F	No Cracks	No Cracks	No Cracks
Environmental Stress Crack Resistance (Minimum Hrs.)	ASTM D1693 Cond. C	5000	5000	5000
Puncture Resistance (Pounds)	FTMS 101C Method 2065	90	120	160
Water Adsorption (Percent Weight Change)	ASTM D570	0.0079	0.0079	0.0079
Coef. Linear Thermal Expansion 10^{-4}/°C	ASTM D696	1.2	1.2	1.2
Moisture Vapor Transmission (g/m²day)	ASTM E96	0.001	0.0009	0.00085
Oxidative Induction Time (Minimum Minutes)	ASTM D3895			
Compressed O_2 at 800 psi	130°C	2300	2300	2300
Pure O_2 at 1 Atmosphere	200°C	100	100	100
Tensile Impact Strength (Ft Lb/in²)	ASTM D1822	381	381	381

SLT FrictionFlex™ is manufactured 32.83 feet wide and up to 900 feet long and is the world's largest monolithic geomembrane lining material.

This data is provided for informational purposes only and is not intended as a warranty or guarantee. SLT assumes no liability in connection with the use of this data.

DESIGN CALCULATIONS:

1. Leachate Piping System: Design of the thickness of the HDPE leachate pipes are based on procedures outlined in the Driscopipe Systems Design Manual. The collection and header pipes were designed for both static and live loadings.

A. Leachate Header Pipe: The leachate header pipes are placed along the access roads to drain the collection pipes from the fill areas. These 8 inch pipes are buried between 10 and 20 feet in a bedded trench along the edge of the roadbed. A H20 live loading was assumed.

1) $P_t = P_s + P_L + P_i$

Where:

P_t = Total External Pressure

a) P_s = Static Load Pressure

b) P_L = Dynamic Load Pressure

c) P_i = External Pressure Due to Vacuum

a) $P_s = P_{DE} + P_{WE} + P_B$

Where: P_{DE} = Moist Earth Load Pressure
P_{WE} = Saturated Load Pressure
P_B = Surface Structure Load Pressure

P_{DE}: Assume moist earth load $= 120\ ^{lb}/ft^3$

@ 20' depth; $P_{DE} = 120(20) = 2,400$ PSF

@ 10' depth; $P_{DE} = 120(10) = 1,200$ PSF

P_{WE}: Assume pipe is not below maximum seasonal water table.
Thus, $P_{WE} = 0$

P_B: Assume pipe is not below permanent surface structure.
Thus, $P_B = 0$

$\therefore p_s = 2,400$ PSF @ 20' depth or 1,200 PSF @ 10' depth

b) P_L = Dynamic Load Pressure
-> an H20 loading is assumed

$$P_L = \frac{3Wz^3}{2\pi R^5}$$

Where: W = 1.5 times the dynamic load
Z = vertical distance from pt. load to the top of pipe
R = straight line distance from pt load to top of pipe

@ 20' depth

$P_{L1} = \frac{3Wz^3}{2\pi R_1^5}$ $P_{L2} \frac{3Wz^3}{2\pi R_2^5}$

Where: W = 16,000 lbs x 1.5 = 24,000 lbs.

$R_1 = \sqrt{x^2+y^2+z^2} = \sqrt{0+20^2}$

= 20' for inside wheel

$R_2 = \sqrt{6^2+20^2}$ = 20.9' for outside wheel

$P_{L1} = \frac{3(24,000)(20)^3}{2\pi(20)^5}$ $P_{L2} = \frac{3(24,000)(20)^3}{2\pi(20.9)^5}$

P_{L1} = 28.6 psf P_{L2} = 23.0 psf

$P_L = P_{L1} + P_{L2}$ = 51.6 psf @ 20' depth

@ 10' depth
Z = 10'
R_1 = 10'

$R_2 = \sqrt{6^2 10^2}$ = 11.7'

$P_{L1} = \frac{3(24,000)(10)^3}{2\pi(10)^5}$ $P_{L2} = \frac{3(24,000)(10)^3}{2\pi(11.7)^5}$

P_{L1} = 114.6 psf P_{L2} = 52.3 psf
P_L = 166.9 psf @ 10' depth

c) P_i = external pressure due to vacuum
= 0 due to gravity flow

Thus, $P_t = P_s + P_L + P_i$
@ 20' depth: P_t = 2,400 + 51.6
= 2,451.6 psf

@ 10' depth: P_t = 1,200 + 166.9 = 1,366.9 psf

Worst case is @ 20' depth:

P_t = 2,451.6 psf
or 17.0 psi

For a full cell:
@ Z = 70', P_t ~ 0 psf

2) Design for Wall Crushing

$$S_A = \frac{(SDR-1)}{2} P_t$$

Where: S^A = Actual compressive stress
SDR = Standard dimension ratio
P_t = External pressure

Try SDR21:

$$S_A = \frac{(21-1)}{2} 17.0 = 170 \text{ psi}$$

$$\text{Safety factor} = \frac{1500 \text{ psi}}{S_A}$$

Where 1500 psi is compressive yield strength of Driscopipe

$$\text{S.F.} = \frac{1500}{170} = 8.8 \text{ OK}$$

3) Design for Wall Buckling

$$P_c = \frac{2.32 E}{(SDR)^3}$$

Where: P_c = Hydrostatic, critical collapse differential pressure
E = Tensile modulus of elasticity

From Chart 25 pg 53 @ S_A = 170 psi,
E = 30,000 psi @ 170 psi
or 50 years @ 73.4°F

$$P_c = \frac{2.32(30,000)}{(21)^3} = 7.5 \text{ psi}$$

$$P_{cb} = 0.8 \sqrt{E' x P_c}$$

Where: P_{cb} = Critical buckling pressure
E' = Soil Modulus

Assume E'_{min} = 1,000 psi

$$P_{cb} = 0.8\sqrt{1000 \times 3} = 71.6 \text{ psi}$$

$$\text{Safety Factory} = \frac{P_{cb}}{P_t} = \frac{71.6}{17.0} = 4.2 \text{ OK}$$

4) Design for Ring Deflection

Pipe deflection equals soil strain, E_s

$$E_s = \frac{P_t}{E'_{min}} \times 100\% = \frac{17.0}{1000} \times 100$$
$$= 1.7\%$$

From Chart 27, page 55 allowable ring deflection for SDR21 equals 5.2%.

$$\text{Thus, Safety factor} = \frac{5.2}{1.7} = 3.1 \text{ OK}$$

Thus, use SDR21 for Leachate Header Pipes

B. Leachate Collection Pipes: The collection pipes are placed in the center of each lined cell. The 8-inch perforated pipe will be surrounded by 6 inches of #57 gravel. Twelve inches of sand will be placed over this prior to the placement of waste. A H20 live loading was assumed.

1) $P_t = P_s + P_L + P_i$

Where: P_t = total external pressure
a) P_s = Static load pressure
b) P_L = Dynamic load pressure
c) P_i = External Pressure due to vacuum

a) $P_s = P_{DE} + P_{WE} + P_{SW}$

Where: P_{DE} = Moist earth load pressure
P_{WE} = Saturated earth load pressure
P_{SW} = Waste load pressure

For an empty cell: -> assume sand is saturated ($132^{lb/ft^3}$) and gravel's unit weight is ($120^{lb/ft^3}$)

$P_{DE} = 0.5'(120\ ^{lb/ft^3}) + 1.0'(132\ ^{lb/ft^3})$
$= 192$ psf

For a full cell:
Unit weight of saturated garbage is $70^{lb/ft^3}$

$P_s = P_{Sempty} + P_{SW}$
$= 192 + 70'(70^{lb/ft^3}) = 5,092$ psf

b) P_L = Dynamic Load Pressure
-> and H2O loading is assumed

$$P_L = \frac{3WZ^3}{2\pi R^5}$$

Where: W = 1.5 times the dynamic load
Z = vertical distance from pt. load to the top of pipe
R = straight line distance from pt. load to top of pipe

For empty cell:

W = 24,000 lbs.
Z = 1.5'
R_1 = 1.5' for inside wheel

$$R_2 = \sqrt{x^2+y^2+z^2}$$

$R_2 = \sqrt{6^2+1.5^2} = 6.2'$ for outside wheel

$$P_{L1} = \frac{3(24,000)(1.5)^3}{2\pi(1.5)^5} \quad P_{L2} = \frac{3(24,000)(1.5)^3}{2\pi(6.2)^5}$$

$P_{L1} = 5,093.0$ psf $P_{L2} = 4.2$ psf
$P_L = P_{L1} + P_{L2} = 5,097.2$ psf

c) P_i = external pressure due to vacuum = 0

Thus, $P_t = P_s + P_L + P_i$

for an empty cell:

$P_t = 192 + 5,097.2 + 0 = 5,289.2$ psf

For a full cell:

P_t = 5,092 psf

Worst case is a empty cell:

. . P_t = 5,289.2 psf or 36.7 psi

2) Design for Wall Crushing

$$S_A = \frac{(SDR-1)}{2} P_t$$

Where: S^A = Actual compressive stress
SDR = Standard dimension ratio
P_t = External pressure

Try SDR21:

$$S_A = \frac{(21-1)}{2} 36.7 = 367 \text{ psi}$$

$$\text{Safety factor} = \frac{1500 \text{ psi}}{S_A}$$

Where 1500 psi is compressive yield strength of Driscopipe

$$S.F. = \frac{1500}{367} = 4.1 \text{ OK}$$

3) Design for Wall Buckling

$$P_c = \frac{2.32 E}{(SDR)^3}$$

Where: P_c = Hydrostatic, critical collapse differential pressure
E = Tensile modulus of elasticity

From Chart 25 page 53 @ S_A = 367 psi,
E = 22,500 psi @ 367 psi for 50 years @ 73.4°F

$$P_c = \frac{2.32(22,500)}{(21)^3} = 5.6 \text{ psi}$$

$$P_{cb} = 0.8 \sqrt{E' \times P_c}$$

Where: P_{cb} = Critical Buckling Pressure
E' = Soil Modulus

Assume E'_{min} = 2000 psi

$$P_{cb} = 0.8\sqrt{2000 \times 5.6}$$
$$= 84.7 \text{ psi}$$

$$\text{Safety Factory} = \frac{P_{cb}}{P_t} = \frac{84.7}{36.7} = 2.3 \text{ OK}$$

4) Design for Ring Deflection

Pipe deflection is equal to soil strain, E_s

$$E_s = \frac{P_t}{E'_{min}} \times 100\% = \frac{36.7}{2000} \times 100$$
$$= 1.8\%$$

From Chart 27, Page 55 ->
Allowable ring deflection for SDR21 is equal to 5.2%

$$\text{Thus, Safety Factor} = \frac{5.2}{1.8} = 2.9 \text{ OK}$$

∴ use SDR21 for Leachate Collection Pipes

DSA DESIGN GROUP
WINSTON-SALEM RALEIGH CHARLOTTE

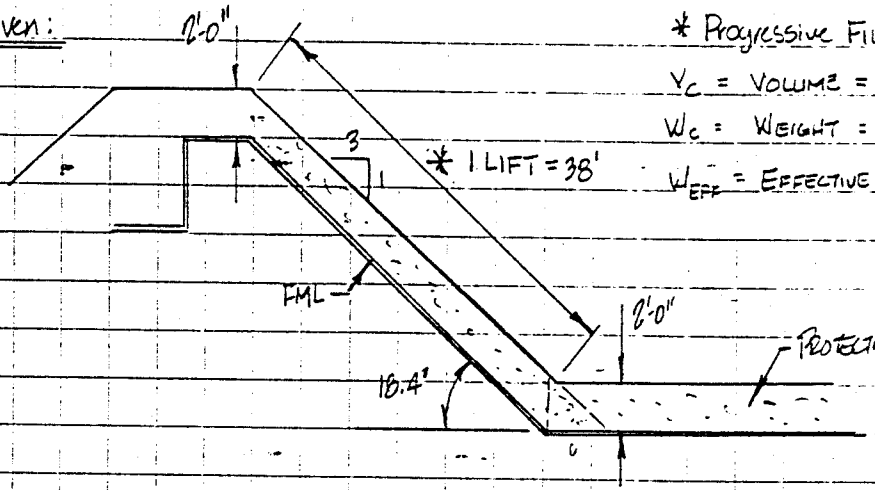
PROJECT NAME Haywood County - White Oak Landfill
PROJECT NO. 920520 SHEET 5 OF ____
BY NED DATE 6/8/92
CHECKED BY ____ DATE ____

OBJECTIVE: STABILITY OF SOIL COVER = VERIFY THAT SOIL COVER WILL NOT SLIDE ON FML. * ALSO VERIFY ANCHOR CAPACITY AND STRESS ON FML. PROJECT WILL USE PROGRESSIVE FILL METHOD. DETERMINE LIMIT OF FILL.

MATERIAL PROPERTIES:

ID	RANGE	TEST	STANDARD
SOIL COVER - FML FRICTION, S_L	10°-20°	DIRECT SHEAR	ASTM
FML - LCR FRICTION S_L	8°-15°	"	
YIELD STRESS, FML, G_Y	1000 - 2200 psi	TESION	ASTM D638

Given:



* PROGRESSIVE FILL METHOD - FILL ONE LIFT @ A TIME
Y_c = VOLUME = 38' x 2' = 76.0 FT²/
W_c = WEIGHT = 76 x 150 lbs/FT² = 11,400 lbs
W_{EFF} = EFFECTIVE WT. = 76.0 FT² x 67.6 lbs/FT² = 5138 lbs

* NOTE: ONE LIFT IS EQUAL TO 12' IN HEIGHT.

COVER SOIL:

γ_{SAT} = 150 PCF → γ_{norm} = 67.6 PCF (Ref.: Geosynthetic Design Guidance Manual, by Richardson & Koerner.)

SOIL/FML BOND:

δ = 30° c' = 0 (Ref. SLT of North America, Inc., Friction Flex Application Data, ATTACHED)

FML/LCR BOND:

δ = 28° c' = 0 (Ref.: Same as above, for Non woven geotextile)

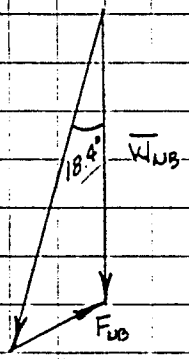
FML = thickness = 60 MIL, YIELD STRESS (G_Y) = 1800 PSI

DSA DESIGN GROUP
WINSTON-SALEM RALEIGH CHARLOTTE

PROJECT NAME Haywood County - White Oak Landfill
PROJECT NO. 92052.0 SHEET 6 OF
BY NED DATE 6/8/92
CHECKED BY DATE

STABILITY OF SOIL COVER (CONTD.):

• SOLVE NEUTRAL BLOCK FORCE POLYGON:



$W_{NB} = V_{NB} \gamma_{soil}$ where $V_{NB} = \frac{1}{2}\ 2 \cdot 6 = 6\ FT^2$

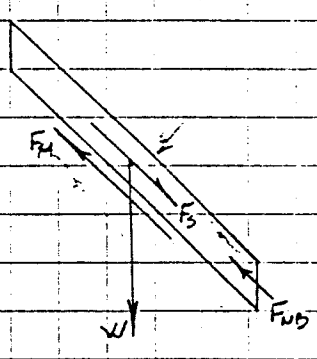
$= 6.0 \times 67.6$

$= 406$ lbs ✓

$F_{NB} = 135$ lbs (DRY CONDITIONS) ∴ USE

$F_{NB} = 260$ lbs (SATURATED CONDITION)

• SOLVE FOR SLIDING STABILITY: (SATURATED CONDITIONS, Worst Case)



$F_M = 5138 * \cos 18.4° * \tan 30°$

$= 2814.77$ ∴ 2815 lbs.

$F_S = 76\ FT^2 * 62.4 * \sin 18.4°$

$= 1497$ lbs

$SF = \frac{F_M + F_{NB}}{F_S} = \frac{2815 + 135}{1497} = 1.97$ MARGINAL

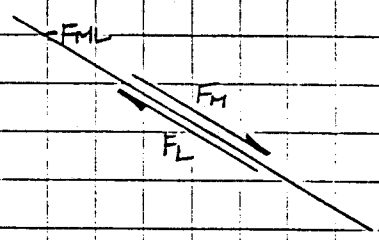
• CALCULATIONS REPRESENT A MARGINAL SAFETY FACTOR FOR STABILITY OF THE SIDESLOPES UNDER SATURATED CONDITIONS. Much care must be taken in the day to day operations to ensure slope stability. A Nonwoven filter fabric will be laid on top of the protective cover to direct stormwater away from the protective cover downslope to assist in erosion control. If during a storm event, sliding does occur, the operator must notify the field inspector for the Design, and allow inspection of the protective cover as it is replaced.

DSA DESIGN GROUP
WINSTON-SALEM RALEIGH CHARLOTTE

PROJECT NAME Haywood County - White Oak Landfill
PROJECT NO. 92052.0 SHEET 7 OF ____
BY NED DATE 6/16/92
CHECKED BY ____ DATE ____

Stability of the Soil Cover (Cont'd.):

- Solve For Membrane Tension:



$F_L = 11,400 \times \cos 18.4° \times \tan 28°$

$F_M = 5138 \times \cos 18.4° \times \tan 30°$

$T = F_m - F_L$

$= 2815 - 5752$

$= -2937$ lbs.

But T cannot be compressive $\therefore T = 0$

and $G_{FML} = 0$

- Verify Anchor Capacity:

Since $T = 0$, Anchor is not stressed.

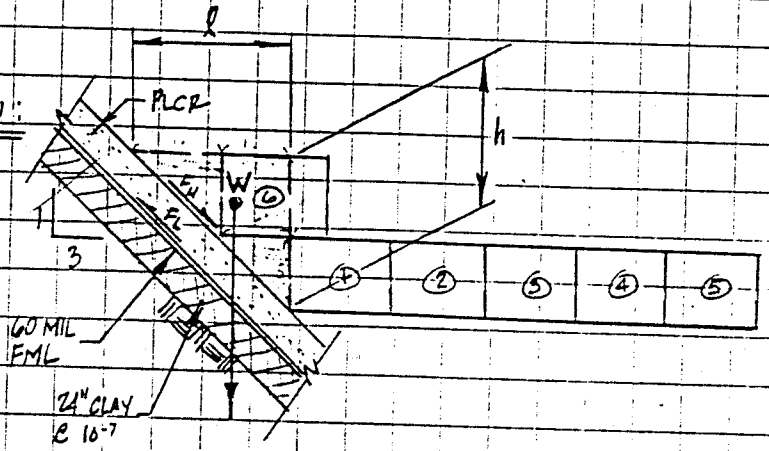
(Ref. calcs previously submitted to State for Anchor Trench Design.)

DSA DESIGN GROUP
WINSTON-SALEM RALEIGH CHARLOTTE

PROJECT NAME Haywood County - White Oak Landfill
PROJECT NO. 92052.0 SHEET 1 OF
BY NED DATE 6/8/92
CHECKED BY DATE

OBJECTIVE: TENSILE STRESS - DOWNDRAG DURING FILLING SEQUENCE;
- OPERATIONS REQUIRE 5:1 BALE PLACEMENT RATIO, therefore, calculate FML STRESS GENERATED DURING PLACEMENT OF BALES ADJACENT TO SIDEWALLS OF FACILITY. (Assume Bale Dimensions = 4' x 5' x 3')

GIVEN:



Assume WT. OF BALE IS 1400 lbs/C.Y.

- CELL THICKNESS (3 BALES) = h = 12 FT
- UNIT WT: γ =
  WASTE (BALE): 3000 lbs / BALE
  NATIVE SOIL: 150 lbs/CF
- SLOPE ANGLE: β = 18.4° (3:1)
- Friction Angles:
  + PLCR TO PFML = F_U = 30° *
  + PFML TO SLCR = F_L = 28° *
- 60 mil textured HDPE FML ON SIDESLOPES.

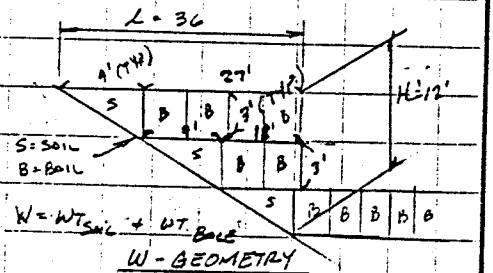
(* PF: SLT OF No. America, Inc. - FrictionFlex Application Data, ATTACHED.)

(1.) CALCULATE DOWNDRAG FORCE ON FML, $T = F_U - F_L$

WHERE:

$F_U = W (\cos\beta)(\tan\delta_U)$

$F_L = W (\cos\beta)(\tan\delta_L)$



W - GEOMETRY

$WT_{soil} = \frac{[0.5(9+3)]}{27} \times 3 + 150\ lbs/CF$

$= 225\ lbs/FT_W$

$WT_{BALES} = 9\ BALES \times \left(\frac{3000\ lbs/ea.}{4\ FT_W}\right)$

$= 6750\ lbs/FT_W$

$W = 6975\ lbs/FT$

$F_U = 6975 * \cos 18.4 * \tan 30°$

$= 3821.14 \therefore 3821\ lbs/FT$

$F_L = 6975 * \cos 18.4° * \tan 28°$

$= 3519.07 \therefore 3519\ lbs/FT$

$T = 3821 - 3519$

$= 302\ lbs/FT.$

DSA DESIGN GROUP
WINSTON-SALEM RALEIGH CHARLOTTE

PROJECT NAME Haywood County - White Oak Landfill
PROJECT NO. 92052.0 SHEET 2 OF
BY NED DATE 6/8/92
CHECKED BY DATE

TENSILE STRESS - DOWNDRAG DURING FILLING (CONT'D.):

(2.) CALCULATE FML TENSILE STRESS, σ:

$\sigma = T / t$ where t = FML THICKNESS

$$\sigma = \frac{302 \text{ lbs/FT}}{0.060 \text{ in}} * \frac{1 \text{ FT}}{12 \text{ in}}$$

$$= 419.4 \text{ lbs/FT}^2 \therefore 420 \text{ lbs/FT}^2$$

(3.) OBTAIN FML YIELD STRESS, σ_Y:

- PER SLT NORTH AMERICA, INC:

• 60 mil textured FML TENSILE STRENGTH @ YIELD = 180 lbs/in, width

$$\therefore \sigma_Y = \frac{180 \text{ lbs/in}}{0.060 \text{ in}} * \frac{12 \text{ in}}{1 \text{ FT}}$$

$$= 36{,}000 \text{ lbs/FT}^2$$

(4) CALCULATE DESIGN RATIO (SAFETY FACTOR): (DR $\geq$ 5.0 @ YIELD)

$$D.R. = \sigma_Y / \sigma$$

$$= \frac{36{,}000 \text{ lb/FT}^2}{420 \text{ lb/FT}^2}$$

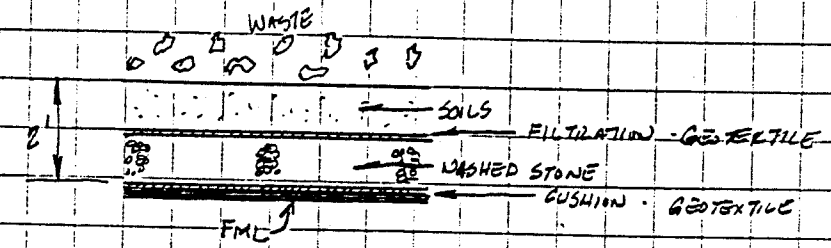
$$= 85.7 \therefore 88 \quad \text{OK}$$

DSA
DESIGN GROUP
WINSTON-SALEM RALEIGH CHARLOTTE

PROJECT NAME Haywood County - Whik Oak Landfill
PROJECT NO. 92052.00 SHEET ___ OF ___
BY NED DATE 6/23/92
CHECKED BY ___ DATE ___

OBJECTIVE: VERIFY USE OF FILTER FABRIC / SOIL COVER FOR RETENTION/PERMEABILITY, CLOGGING AND SURVIVERBILITY.

GIVEN:



(Ref.: Particle Size Dist. & Phys. Prop. Tests by Law Eng.)

		SOIL # 1 (B-103)	SOIL # 2 (B-113)
D_{85}		0.8 mm	1.8 mm
D_{60}		0.28 mm	0.30 mm
D_{15}		* 0.025 mm	* 0.028 mm
D_{10}		* 0.015 mm	* 0.010 mm
K_{AVG}		2.3×10^{-4}	4.4×10^{-5}
C_u	(D_{60}/D_{10})	18.67	3.0

(* Approximated)

1) OBTAIN AOS FOR GEOTEXTILE: (Ref. GUNDLE POLYFELT)

AOS = Apparent Opening Size = O_{95}

GIVEN AS >140 SIEVE < 0.10 mm

DSA DESIGN GROUP
WINSTON-SALEM RALEIGH CHARLOTTE

PROJECT NAME Haywood County White Oak Landfill
PROJECT NO. 92052.00 SHEET ___ OF ___
BY NED DATE 6/23/92
CHECKED BY ___ DATE ___

2.) EVALUATE FILTER CRITERIA:

- CARROLL/CHEN: $D_{95}/D_{85} = 0.10/0.80 = 0.13$ SOIL #1 < 2 OK ✓

$0.10/1.8 = 0.06$ SOIL #2 < 2 OK ✓

$O_{95}/D_{15} = 0.10/0.025 = 4.0$ SOIL #1 > 2 OK ✓

$0.10/0.028 = 3.6$ SOIL #2 > 2 OK ✓

- GIROUD (ASSUMING INTERMEDIATE DEPTH)

$C_U = 3.0 \Rightarrow O_{95} < (13.5\ D_{50})/C_U$ $D_{50} =$ 0.15 mm SOIL #1; 0.12 mm. SOIL #2

SOIL #1 = $0.10 < \frac{(13.5 \cdot 0.15)}{18.7}$

$0.10 < 0.11$ OK ✓

SOIL #2 = $0.10 < \frac{(13.5 \cdot 0.12)}{3.0}$

$= 0.10 < 0.54$ OK ✓

DSA DESIGN GROUP
WINSTON-SALEM RALEIGH CHARLOTTE

PROJECT NAME Haywood County - White Oak Landfill
PROJECT NO. 92052.00 SHEET ___ OF ___
BY NEO DATE 6/23/92
CHECKED BY ___ DATE ___

3.) Permeability Requirements:

Using Critical/Severe Conditions

$K_{geotextile} \geq 10 \times K_{soil}$

$K_{geo} \geq 10 \times 2.3 \times 10^{-4}$ (* Ref: Gundle Polyfelt Design Data)

$K_{geo} \geq 2.3 \times 10^{-3}$

$K_{geo} = {}^{*}0.35$ cm/sec $\geq$ 0.0023 cm/sec OK

4.) Clogging Evaluation:

Determine Minimum Pore Size Req'd.:

O_{95} AOS $\geq 3 \times D_{15}$

$\geq 3 \times 0.015 = 0.045$ mm.

$^{*}0.10 > 0.045$ OK

5.) Life Span Survivability Requirements:

Select Fabric for Class A condition (Ref.: Polyfelt) of severe application. Recommendations based upon application & observations.

	Req'd.	*Provided
Min. Grab.:	180 lbs	320-380 lbs
Puncture Strength:	80 lbs	155 lbs
Burst Strength:	290 psi	460 psi
Trapezoidal Tear:	50 lbs	120/150 lbs.

APPENDIX C

HELP Model Results on Estimating Leachate Generation

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HAYWOOD COUNTY WHITE OAK LANDFILL
OPEN CONDITIONS - CELL NO. 1
MARCH 30, 1992

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BARE GROUND

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5010 VOL/VOL
FIELD CAPACITY	=	0.2837 VOL/VOL
WILTING POINT	=	0.1353 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2837 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000189999992 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	180.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2942 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999980 CM/SEC

LAYER 3

LATERAL DRAINAGE LAYER

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4570 VOL/VOL
FIELD CAPACITY	=	0.1309 VOL/VOL

WILTING POINT	=	0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2466 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.001000000047 CM/SEC

LAYER 4

LATERAL DRAINAGE LAYER

THICKNESS	=	0.25 INCHES
POROSITY	=	0.9000 VOL/VOL
FIELD CAPACITY	=	0.0520 VOL/VOL
WILTING POINT	=	0.0490 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0520 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	1.000000000000 CM/SEC
SLOPE	=	8.00 PERCENT
DRAINAGE LENGTH	=	340.0 FEET

LAYER 5

BARRIER SOIL LINER WITH FLEXIBLE MEMBRANE LINER

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4300 VOL/VOL
FIELD CAPACITY	=	0.3663 VOL/VOL
WILTING POINT	=	0.2802 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4300 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000100000 CM/SEC
LINER LEAKAGE FRACTION	=	0.00010000

LAYER 6

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4096 VOL/VOL
FIELD CAPACITY	=	0.2466 VOL/VOL
WILTING POINT	=	0.1353 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1641 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000009500000 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	91.61
TOTAL AREA OF COVER	=	142800. SQ FT
EVAPORATIVE ZONE DEPTH	=	21.00 INCHES
POTENTIAL RUNOFF FRACTION	=	0.800000

UPPER LIMIT VEG. STORAGE	=	10.6920 INCHES
INITIAL VEG. STORAGE	=	7.4437 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	74.5813 INCHES

SOIL WATER CONTENT INITIALIZED BY PROGRAM.

CLIMATOLOGICAL DATA

USER SPECIFIED RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR ASHEVILLE NORTH CAROLINA

MAXIMUM LEAF AREA INDEX	= 3.30
START OF GROWING SEASON (JULIAN DATE)	= 110
END OF GROWING SEASON (JULIAN DATE)	= 296

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
36.80	39.10	46.40	55.70	63.30	69.80
73.20	72.60	66.90	56.00	46.40	39.30

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 79

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	5.07	3.67	6.39	4.03	5.88	4.66
	3.81	3.29	4.29	3.17	4.18	4.41
STD. DEVIATIONS	1.65	2.62	2.05	2.40	4.05	2.14
	2.60	1.51	2.84	1.54	0.96	0.93
RUNOFF						
TOTALS	0.657	0.510	0.920	0.842	1.155	0.448
	0.351	0.181	0.471	0.321	0.341	0.685
STD. DEVIATIONS	0.401	0.636	0.953	0.990	1.524	0.344
	0.356	0.312	0.613	0.273	0.245	0.350
EVAPOTRANSPIRATION						
TOTALS	1.301	1.844	2.949	3.306	4.819	4.693
	3.622	3.446	2.506	2.245	1.707	1.251

STD. DEVIATIONS	0.272	0.240	0.070	0.613	1.272	1.260
	1.427	1.586	1.208	0.776	0.408	0.280

LATERAL DRAINAGE FROM LAYER 4

TOTALS	0.6121	0.9173	1.3402	1.5438	1.4944	1.1851
	0.9902	0.8219	0.6796	0.6286	0.5736	0.6164
STD. DEVIATIONS	0.1194	0.2793	0.5720	0.7895	0.6887	0.4842
	0.3465	0.2527	0.1866	0.1793	0.2036	0.3077

PERCOLATION FROM LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION FROM LAYER 6

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 79

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	52.88	(13.501)	629272.	100.00
RUNOFF	6.883	(3.352)	81902.	13.02
EVAPOTRANSPIRATION	33.690	(4.525)	400911.	63.71
LATERAL DRAINAGE FROM LAYER 4	11.4031	(4.1092)	135697.	21.56
PERCOLATION FROM LAYER 5	0.0001	(0.0000)	1.	0.00
PERCOLATION FROM LAYER 6	0.0001	(0.0000)	1.	0.00
CHANGE IN WATER STORAGE	0.904	(3.185)	10760.	1.71

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 79

	(INCHES)	(CU. FT.)
PRECIPITATION	5.80	69020.0
RUNOFF	3.204	38126.1
LATERAL DRAINAGE FROM LAYER 4	0.0828	985.6
PERCOLATION FROM LAYER 5	0.0000	0.0
HEAD ON LAYER 5	0.1	
PERCOLATION FROM LAYER 6	0.0000	0.0
SNOW WATER	2.46	29274.0

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4305

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1372

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FINAL WATER STORAGE AT END OF YEAR 79

LAYER	(INCHES)	(VOL/VOL)
1	5.00	0.4170
2	62.03	0.3446
3	5.65	0.2354
4	0.04	0.1682
5	10.32	0.4300
6	1.97	0.1641
SNOW WATER	0.00	

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HAYWOOD COUNTY WHITE OAK LANDFILL
CLOSED CONDITIONS
MARCH 30, 1992

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GOOD GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	6.00 INCHES
POROSITY	=	0.5010 VOL/VOL
FIELD CAPACITY	=	0.2837 VOL/VOL
WILTING POINT	=	0.1353 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2837 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000797999965 CM/SEC

LAYER 2

BARRIER SOIL LINER

THICKNESS	=	18.00 INCHES
POROSITY	=	0.4300 VOL/VOL
FIELD CAPACITY	=	0.3663 VOL/VOL
WILTING POINT	=	0.2802 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4300 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000100000 CM/SEC

LAYER 3

VERTICAL PERCOLATION LAYER

THICKNESS	=	180.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL

WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2766 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	6.00 INCHES
POROSITY	=	0.4096 VOL/VOL
FIELD CAPACITY	=	0.2466 VOL/VOL
WILTING POINT	=	0.1353 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2466 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000009500000 CM/SEC

LAYER 5

VERTICAL PERCOLATION LAYER

THICKNESS	=	180.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2766 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 6

VERTICAL PERCOLATION LAYER

THICKNESS	=	6.00 INCHES
POROSITY	=	0.4096 VOL/VOL
FIELD CAPACITY	=	0.2466 VOL/VOL
WILTING POINT	=	0.1353 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2466 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000009500000 CM/SEC

LAYER 7

VERTICAL PERCOLATION LAYER

THICKNESS	=	180.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2766 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 8

LATERAL DRAINAGE LAYER

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4096 VOL/VOL
FIELD CAPACITY	=	0.2466 VOL/VOL
WILTING POINT	=	0.1353 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2466 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000009500000 CM/SEC

LAYER 9

LATERAL DRAINAGE LAYER

THICKNESS	=	0.25 INCHES
POROSITY	=	0.9000 VOL/VOL
FIELD CAPACITY	=	0.0510 VOL/VOL
WILTING POINT	=	0.0490 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0510 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	1.000000000000 CM/SEC
SLOPE	=	8.00 PERCENT
DRAINAGE LENGTH	=	340.0 FEET

LAYER 10

BARRIER SOIL LINER WITH FLEXIBLE MEMBRANE LINER

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4300 VOL/VOL
FIELD CAPACITY	=	0.3663 VOL/VOL
WILTING POINT	=	0.2802 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4300 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000100000 CM/SEC
LINER LEAKAGE FRACTION	=	0.00010000

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	74.98
TOTAL AREA OF COVER	=	435600. SQ FT
EVAPORATIVE ZONE DEPTH	=	21.00 INCHES
UPPER LIMIT VEG. STORAGE	=	3.0060 INCHES
INITIAL VEG. STORAGE	=	2.8461 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	177.9959 INCHES

SOIL WATER CONTENT INITIALIZED BY PROGRAM.

CLIMATOLOGICAL DATA

USER SPECIFIED RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR ASHEVILLE NORTH CAROLINA

MAXIMUM LEAF AREA INDEX = 3.30
START OF GROWING SEASON (JULIAN DATE) = 110
END OF GROWING SEASON (JULIAN DATE) = 296

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
36.80	39.10	46.40	55.70	63.30	69.80
73.20	72.60	66.90	56.00	46.40	39.30

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 79

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	5.07	3.67	6.39	4.03	5.88	4.66
	3.81	3.29	4.29	3.17	4.18	4.41
STD. DEVIATIONS	1.65	2.62	2.05	2.40	4.05	2.14
	2.60	1.51	2.84	1.54	0.96	0.93
RUNOFF						
TOTALS	3.810	2.016	2.827	1.781	1.540	0.420
	0.177	0.098	0.842	0.552	1.309	3.104
STD. DEVIATIONS	1.704	2.409	2.251	1.991	2.110	0.525
	0.434	0.241	1.443	0.687	1.316	1.144
EVAPOTRANSPIRATION						
TOTALS	1.358	1.888	3.019	3.359	4.391	4.353
	3.579	3.530	2.361	2.346	1.794	1.315
STD. DEVIATIONS	0.306	0.313	0.064	0.618	1.698	0.899
	1.535	1.632	1.072	0.864	0.475	0.295
PERCOLATION FROM LAYER 2						

TOTALS	0.1387	0.1185	0.1309	0.1138	0.0901	0.0528
	0.0353	0.0262	0.0341	0.0964	0.1115	0.1369
STD. DEVIATIONS	0.0010	0.0085	0.0054	0.0144	0.0267	0.0356
	0.0461	0.0399	0.0407	0.0539	0.0320	0.0032

LATERAL DRAINAGE FROM LAYER 9

TOTALS	0.0757	0.0696	0.0774	0.0757	0.0790	0.0772
	0.0804	0.0810	0.0789	0.0820	0.0798	0.0828
STD. DEVIATIONS	0.0173	0.0146	0.0145	0.0127	0.0118	0.0102
	0.0094	0.0083	0.0071	0.0064	0.0055	0.0050

PERCOLATION FROM LAYER 10

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 79

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	52.88	(13.501)	1919543.	100.00
RUNOFF	18.477	(9.493)	670722.	34.94
EVAPOTRANSPIRATION	33.292	(4.232)	1208514.	62.96
PERCOLATION FROM LAYER 2	1.0851	(0.2060)	39390.	2.05
LATERAL DRAINAGE FROM LAYER 9	0.9394	(0.1227)	34101.	1.78
PERCOLATION FROM LAYER 10	0.0001	(0.0000)	5.	0.00
CHANGE IN WATER STORAGE	0.171	(0.199)	6202.	0.32

****

****

PEAK DAILY VALUES FOR YEARS 74 THROUGH 79

	(INCHES)	(CU. FT.)
PRECIPITATION	5.80	210540.0

RUNOFF	4.535	164614.0
PERCOLATION FROM LAYER 2	0.0046	166.1
HEAD ON LAYER 2	6.6	
LATERAL DRAINAGE FROM LAYER 9	0.0028	100.8
PERCOLATION FROM LAYER 10	0.0000	0.0
HEAD ON LAYER 10	0.0	
SNOW WATER	2.46	89298.0

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5010

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1306

****

****

FINAL WATER STORAGE AT END OF YEAR 79

LAYER	(INCHES)	(VOL/VOL)
1	2.99	0.4989
2	7.74	0.4300
3	49.97	0.2776
4	1.77	0.2947
5	49.71	0.2762
6	1.76	0.2936
7	49.63	0.2757
8	7.04	0.2933
9	0.01	0.0581
10	10.32	0.4300
SNOW WATER	0.00	

****
****

OFFICE OF TOWN MANAGER

Town of Waynesville

July 31, 1991

Mr. Jack Horton
Haywood County Manager
Haywood County Courthouse
Main Street
Waynesville, NC 28786

Dear Mr. Horton:

Mr. Gary McKay has spoken to me concerning the feasibility of the Town of Waynesville Sewer Plant accepting leachate from the new Haywood County Landfill. This letter is to inform you that the Town is willing to work with the County in this matter.

Our plant has the capability to handle the expected quantities and disposal would be at our standard rate, assuming pretreatment by the Town is unnecessary.

We anticipate no problems in accepting and treating this waste. Let me know if further information or assistance is needed.

Sincerely,

William M. Sutton
Town Manager

WMS:pm

APPENDIX D

Approval Letter for Amendments to Sediment and Erosion Control Plan, February 26, 1997

State of North Carolina
Department of Environment,
Health and Natural Resources
Asheville Regional Office

James B. Hunt, Jr., Governor
Jonathan B. Howes, Secretary

DEHNR

LAND QUALITY SECTION

LETTER OF APPROVAL

February 26, 1997

Mr. Jack Horton
Haywood County Manager
Courthouse Annex
Waynesville, North Carolina 28786

Dear Mr. Horton:

This office has reviewed the erosion and sedimentation control plan submitted for the project listed below. We find the plan to be acceptable and hereby issue this Letter of Approval. Please be advised that Title 15A, North Carolina Administrative Code 4B.0017(a), requires that a copy of the approved soil erosion control plan be on file at the job site. Also, you should consider this letter to give the Notice required by NCGS §113A-61(d) of our right of periodic inspection to ensure compliance with the approved plan. This plan approval shall expire three (3) years following the date of approval, if no land-disturbing activity has been undertaken, as is required by Title 15A NCAC 4B.0029.

The State's Sedimentation Pollution Control Program is a performance-oriented program requiring protection of the natural resources and adjoining properties. If, following commencement of this project, it is determined that the plan is inadequate to meet the requirements of NCGS §113A-51 to 66, this office may require revisions to the plan and implementation of the revisions to ensure compliance with the Act.

Please note that this approval is based in part on the accuracy of the information provided in the Financial Responsibility Form which you have provided. You are requested to file an amended form if there is any change in the information included on the form. In addition, it would be helpful if you notify this office of the proposed starting date for this project. Your cooperation is appreciated.

Sincerely,

RARL

for Dennis G. Owenby
Asst. Regional Engineer

DGO:gc
Enclosures
cc: Norman Divers, III

Project name: White Oak Sanitary Landfill Borrow Area
Location: Haywood County
Date received: February 4, 1997
New submittal (X) Revision ( ) Modification ( )

Interchange Building,
59 Woodfin Place,
Asheville, North Carolina 28801

NC Reduce Reuse Recycle

Voice 704-251-6208 FAX 704-251-6452

APPENDIX E

Design Calculations Specific to Waste Cell 4

********** Sheet View **********

Pipe Label	Node Label	North [ft]	East [ft]	Station [ft]	Offset [ft]	Rim Elev. [ft]	Struct Type	Struct Dim. [in]	Node Drop [ft]	Sump Drop [ft]
PIPE	Node	-811873.4969	720881.7549	0.0000	0.0000	2587.4457	null	0.0000	0.0000	0.0000
PIPE	Node	-811806.1747	721229.9485	354.6421	0.0000	2571.7200	mh	48.0000	0.1000	0.5000
PIPE	Node	-811776.8850	721292.7954	423.9791	0.0000	2567.4900	mh	48.0000	0.1000	0.5000
PIPE	Node	-811738.3915	721505.3832	640.0239	0.0000	2549.0550	mh	48.0000	0.1000	0.5000
PIPE	Node	-811776.5743	721703.8286	842.1093	0.0000	2530.8396	mh	48.0000	0.1000	0.5000
PIPE	Node	-811919.6447	721699.2243	985.2537	0.0000	2509.7290	mh	48.0000	8.0046	0.5000
PIPE	Node	-812066.3953	721690.4761	1132.2649	0.0000	2479.1443	mh	48.0000	0.1000	0.5000
PIPE	Node	-812107.9405	721722.8130	1184.9117	0.0000	2471.3226	mh	48.0000	0.7000	0.5000
PIPE	Node	-812086.8368	721745.4396	1215.8524	0.0000	2468.3707	mh	48.0000	2.7000	0.5000
	Node	-812028.8608	721807.5990	1300.8524	0.0000	2462.0000	mh	48.0000	0.0000	0.5000

Sump Elev [ft]	Pipe Size [in]	Start Inv. [ft]	Finish Inv. [ft]	Cen-Cen 2DLength [ft]	Pipe Slope [ft/ft]	Pipe Drop [ft]	Pipe Descr.	Rough Coeff [MANNG]	Pipe Flow [cfs]
2573.6300	10.0000	2573.6300	2566.5372	354.6421	0.0200	7.0928	HDPE	0.0100	0.0090
2565.9372	10.0000	2566.4372	2561.9844	69.3370	0.0642	4.4528	HDPE	0.0100	0.0000
2561.3844	10.0000	2561.8844	2543.5206	216.0448	0.0850	18.3638	HDPE	0.0100	0.0000
2542.9206	10.0000	2543.4206	2525.3052	202.0854	0.0896	18.1154	HDPE	0.0100	0.0000
2524.7052	10.0000	2525.2052	2504.1946	143.1445	0.1468	21.0106	HDPE	0.0100	0.0000
2495.6900	10.0000	2496.1900	2471.1981	147.0112	0.1700	24.9919	HDPE	0.0100	0.0000
2470.5981	10.0000	2471.0981	2464.7000	52.6468	0.1215	6.3981	HDPE	0.0100	0.0000
2463.5000	10.0000	2464.0000	2461.4000	30.9408	0.0840	2.6000	HDPE	0.0100	0.0000
2458.2000	10.0000	2458.7000	2454.0000	85.0000	0.0553	4.7000	HDPE	0.0100	0.0000
2453.5000									

Lateral Name #1	Lateral Inv. #1 [ft]	Lateral Flow #1 [cfs]	Lateral Name #2	Lateral Inv. #2 [ft]	Lateral Flow #2 [cfs]	Infilt. Inflow [cfs]	Design Flow [cfs]	Design Vel. [fps]	% d/D
	0.0000	0.0000		0.0000	0.0000	0.0000	0.0090	1.5021	3.4971
	0.0000	0.0000		0.0000	0.0000	0.0000	0.0090	2.2518	2.6654
	0.0000	0.0000		0.0000	0.0000	0.0000	0.0090	2.4818	2.4972
	0.0000	0.0000		0.0000	0.0000	0.0000	0.0090	2.5281	2.4665
	0.0000	0.0000		0.0000	0.0000	0.0000	0.0090	2.9996	2.1995
	0.0000	0.0000		0.0000	0.0000	0.0000	0.0090	3.1563	2.1258
	0.0000	0.0000		0.0000	0.0000	0.0000	0.0090	2.8095	2.2981
	0.0000	0.0000		0.0000	0.0000	0.0000	0.0090	2.4720	2.5038
	0.0000	0.0000		0.0000	0.0000	0.0000	0.0090	2.1379	2.7597

Design Depth [in]	Wet Area [ft2]	Wet Perim. [in]	D.Point Flow [cfs]	Full Vel [fps]	Full Area [ft2]	Full Perim [in]	Full Flow [cfs]	HGL Elev In [ft]	HGL Elev Out [ft]
0.3497	0.0060	3.7623	4.0281	7.3854	0.5454	31.4159	4.0281	0.0000	0.0000
0.2665	0.0040	3.2799	7.2180	13.2340	0.5454	31.4159	7.2180	0.0000	0.0000
0.2497	0.0036	3.1738	8.3041	15.2254	0.5454	31.4159	8.3041	0.0000	0.0000
0.2466	0.0036	3.1541	8.5279	15.6356	0.5454	31.4159	8.5279	0.0000	0.0000
0.2200	0.0030	2.9771	10.9123	20.0074	0.5454	31.4159	10.9123	0.0000	0.0000
0.2126	0.0029	2.9264	11.7438	21.5319	0.5454	31.4159	11.7438	0.0000	0.0000
0.2298	0.0032	3.0436	9.9294	18.2053	0.5454	31.4159	9.9294	0.0000	0.0000
0.2504	0.0036	3.1781	8.2567	15.1384	0.5454	31.4159	8.2567	0.0000	0.0000
0.2760	0.0042	3.3380	6.6977	12.2800	0.5454	31.4159	6.6977	0.0000	0.0000
								0.0000	

Surface Flow [cfs]	Surface File	Surface On/Off	Cen-Cen 3DLength [ft]	Str-Str 3DLength [ft]	Thicknss In [ft]	Thicknss Out [ft]	Adjusted Length [ft]	EGL Elev In [ft]
0.0000		0.0000	354.7131	352.7127	0.0000	0.0000	352.7127	0.0000
0.0000		0.0000	69.4798	65.4715	0.0000	0.0000	65.4715	0.0000
0.0000		0.0000	216.8239	212.8094	0.0000	0.0000	212.8094	0.0000
0.0000		0.0000	202.8957	198.8797	0.0000	0.0000	198.8797	0.0000
0.0000		0.0000	144.6782	140.6354	0.0000	0.0000	140.6354	0.0000
0.0000		0.0000	149.1204	145.0630	0.0000	0.0000	145.0630	0.0000
0.0000		0.0000	53.0341	49.0047	0.0000	0.0000	49.0047	0.0000
0.0000		0.0000	31.0498	27.0357	0.0000	0.0000	27.0357	0.0000
0.0000		0.0000	85.1298	81.1237	0.0000	0.0000	81.1237	0.0000
								0.0000

EGL Elev Out [ft]	Critical Depth [in]	Critical Slope [ft/ft]	Critical Velocity [fps]	Froude Number	Flow Regime
0.0000	0.0402	0.0051	0.9327	1.8931	Supercrit.
0.0000	0.0402	0.0051	0.9327	3.2536	Supercrit.
0.0000	0.0402	0.0051	0.9327	3.7054	Supercrit.
0.0000	0.0402	0.0051	0.9327	3.7979	Supercrit.
0.0000	0.0402	0.0051	0.9327	4.7732	Supercrit.
0.0000	0.0402	0.0051	0.9327	5.1094	Supercrit.
0.0000	0.0402	0.0051	0.9327	4.3733	Supercrit.
0.0000	0.0402	0.0051	0.9327	3.6857	Supercrit.
0.0000	0.0402	0.0051	0.9327	3.0354	Supercrit.

********** Sheet View **********

Pipe Label	Node Label	North [ft]	East [ft]	Station [ft]	Offset [ft]	Rim Elev. [ft]	Struct Type	Struct Dim. [in]	Node Drop [ft]	Sump Drop [ft]
PIPE	Node	-811873.4969	720881.7549	0.0000	0.0000	2587.4457	null	0.0000	0.0000	0.0000
PIPE	Node	-811806.1747	721229.9485	354.6421	0.0000	2571.7200	mh	48.0000	0.1000	0.5000
PIPE	Node	-811776.8850	721292.7954	423.9791	0.0000	2567.4900	mh	48.0000	0.1000	0.5000
PIPE	Node	-811738.3915	721505.3832	640.0239	0.0000	2549.0550	mh	48.0000	0.1000	0.5000
PIPE	Node	-811776.5743	721703.8286	842.1093	0.0000	2530.8396	mh	48.0000	0.1000	0.5000
PIPE	Node	-811919.6447	721699.2243	985.2537	0.0000	2509.7290	mh	48.0000	8.0046	0.5000
PIPE	Node	-812066.3953	721690.4761	1132.2649	0.0000	2479.1443	mh	48.0000	0.1000	0.5000
PIPE	Node	-812107.9405	721722.8130	1184.9117	0.0000	2471.3226	mh	48.0000	0.7000	0.5000
PIPE	Node	-812086.8368	721745.4396	1215.8524	0.0000	2468.3707	mh	48.0000	2.7000	0.5000
	Node	-812028.8608	721807.5990	1300.8524	0.0000	2462.0000	mh	48.0000	0.0000	0.5000

Sump Elev [ft]	Pipe Size [in]	Start Inv. [ft]	Finish Inv. [ft]	Cen-Cen 2DLength [ft]	Pipe Slope [ft/ft]	Pipe Drop [ft]	Pipe Descr.	Rough Coeff [MANNG]	Pipe Flow [cfs]
2574.0500	10.0000	2574.0500	2566.9572	354.6421	0.0200	7.0928	HDPE	0.0100	0.0090
2566.3572	10.0000	2566.8572	2562.4044	69.3370	0.0642	4.4528	HDPE	0.0100	0.0000
2561.8044	10.0000	2562.3044	2543.9406	216.0448	0.0850	18.3638	HDPE	0.0100	0.0000
2543.3406	10.0000	2543.8406	2525.7252	202.0854	0.0896	18.1154	HDPE	0.0100	0.0000
2525.1252	10.0000	2525.6252	2504.6146	143.1445	0.1468	21.0106	HDPE	0.0100	0.0000
2496.1100	10.0000	2496.6100	2471.6181	147.0112	0.1700	24.9919	HDPE	0.0100	0.0000
2471.0181	10.0000	2471.5181	2464.7000	52.6468	0.1295	6.8181	HDPE	0.0100	0.0000
2463.5000	10.0000	2464.0000	2461.4000	30.9408	0.0840	2.6000	HDPE	0.0100	0.0000
2458.2000	10.0000	2458.7000	2454.0000	85.0000	0.0553	4.7000	HDPE	0.0100	0.0000
2453.5000									

Lateral Name #1	Lateral Inv. #1 [ft]	Lateral Flow #1 [cfs]	Lateral Name #2	Lateral Inv. #2 [ft]	Lateral Flow #2 [cfs]	Infilt. Inflow [cfs]	Design Flow [cfs]	Design Vel. [fps]	% d/D
	0.0000	0.0000		0.0000	0.0000	0.0000	0.0090	1.5021	3.4971
	0.0000	0.0000		0.0000	0.0000	0.0000	0.0090	2.2518	2.6654
	0.0000	0.0000		0.0000	0.0000	0.0000	0.0090	2.4818	2.4972
	0.0000	0.0000		0.0000	0.0000	0.0000	0.0090	2.5281	2.4665
	0.0000	0.0000		0.0000	0.0000	0.0000	0.0090	2.9996	2.1995
	0.0000	0.0000		0.0000	0.0000	0.0000	0.0090	3.1563	2.1258
	0.0000	0.0000		0.0000	0.0000	0.0000	0.0090	2.8721	2.2644
	0.0000	0.0000		0.0000	0.0000	0.0000	0.0090	2.4720	2.5038
	0.0000	0.0000		0.0000	0.0000	0.0000	0.0090	2.1379	2.7597

Design Depth [in]	Wet Area [ft2]	Wet Perim. [in]	D.Point Flow [cfs]	Full Vel [fps]	Full Area [ft2]	Full Perim [in]	Full Flow [cfs]	HGL Elev In [ft]	HGL Elev Out [ft]
0.3497	0.0060	3.7623	4.0281	7.3854	0.5454	31.4159	4.0281	0.0000	0.0000
0.2665	0.0040	3.2799	7.2180	13.2340	0.5454	31.4159	7.2180	0.0000	0.0000
0.2497	0.0036	3.1738	8.3041	15.2254	0.5454	31.4159	8.3041	0.0000	0.0000
0.2466	0.0036	3.1541	8.5279	15.6356	0.5454	31.4159	8.5279	0.0000	0.0000
0.2200	0.0030	2.9771	10.9123	20.0074	0.5454	31.4159	10.9123	0.0000	0.0000
0.2126	0.0029	2.9264	11.7438	21.5319	0.5454	31.4159	11.7438	0.0000	0.0000
0.2264	0.0031	3.0211	10.2502	18.7933	0.5454	31.4159	10.2502	0.0000	0.0000
0.2504	0.0036	3.1781	8.2567	15.1384	0.5454	31.4159	8.2567	0.0000	0.0000
0.2760	0.0042	3.3380	6.6977	12.2800	0.5454	31.4159	6.6977	0.0000	0.0000
								0.0000	

Surface Flow [cfs]	Surface File	Surface On/Off	Cen-Cen 3DLength [ft]	Str-Str 3DLength [ft]	Thicknss In [ft]	Thicknss Out [ft]	Adjusted Length [ft]	EGL Elev In [ft]
0.0000		0.0000	354.7131	352.7127	0.0000	0.0000	352.7127	0.0000
0.0000		0.0000	69.4798	65.4715	0.0000	0.0000	65.4715	0.0000
0.0000		0.0000	216.8239	212.8094	0.0000	0.0000	212.8094	0.0000
0.0000		0.0000	202.8957	198.8797	0.0000	0.0000	198.8797	0.0000
0.0000		0.0000	144.6782	140.6354	0.0000	0.0000	140.6354	0.0000
0.0000		0.0000	149.1204	145.0630	0.0000	0.0000	145.0630	0.0000
0.0000		0.0000	53.0864	49.0530	0.0000	0.0000	49.0530	0.0000
0.0000		0.0000	31.0498	27.0357	0.0000	0.0000	27.0357	0.0000
0.0000		0.0000	85.1298	81.1237	0.0000	0.0000	81.1237	0.0000
								0.0000

EGL Elev Out [ft]	Critical Depth [in]	Critical Slope [ft/ft]	Critical Velocity [fps]	Froude Number	Flow Regime
0.0000	0.0402	0.0051	0.9327	1.8931	Supercrit.
0.0000	0.0402	0.0051	0.9327	3.2536	Supercrit.
0.0000	0.0402	0.0051	0.9327	3.7054	Supercrit.
0.0000	0.0402	0.0051	0.9327	3.7979	Supercrit.
0.0000	0.0402	0.0051	0.9327	4.7732	Supercrit.
0.0000	0.0402	0.0051	0.9327	5.1094	Supercrit.
0.0000	0.0402	0.0051	0.9327	4.5041	Supercrit.
0.0000	0.0402	0.0051	0.9327	3.6857	Supercrit.
0.0000	0.0402	0.0051	0.9327	3.0354	Supercrit.

STEFFEN ROBERTSON & KIRSTEN
Consulting Engineers & Scientists

PROJECT: Haywood Cty. Phase III	NO.
CALCULATED BY: AFW	DATE: 5/19/97
CHECKED BY:	DATE:
SHEET 1 OF 2	

Area of Previous Phase Cell

$A = 3.3$ acres

Area of New Phase III Cell

$A \approx 2$ acres (which includes approximately 1 acre overlap w/ prior permitted phase)

Leachat Generation: (Determine By Help Model in Previous Transition Plan)

- Avg Monthly = 84,643 gal (open)
  ~~755~~ 21,271 (closed)
- Peak Daily Valve = 7,377 gal (open)
  755 (closed

Lechate Generation: (Estimated For New Phase III Cell)

- Avg Monthly

$$\frac{84,643 \text{ gal}}{3.3 \text{ acres}} = \frac{Q_{2acre}}{2acre}$$

$Q_{2acre} = 51,300$ gal Avg Monthly (open)

- Peak Daily

$$\frac{7,377 \text{ gal}}{3.3 \text{ acre}} = \frac{Q_{2acre}}{2acre},$$

$Q_{2acre} = 4,471$ gal Peak Daily open

STEFFEN ROBERTSON & KIRSTEN
Consulting Engineers & Scientists

PROJECT: Haywood Cty. Phase III	NO.
CALCULATED BY: AHL	DATE: 5/19/97
CHECKED BY:	DATE:
SHEET 2 OF 2	

Leachate Generation: (Estimated For New Phase III Cell)

- Avg Monthly (Closed)

$$\frac{21,271 \text{ gal}}{10 \text{ acre}} = \frac{Q_{TOT.}}{12 \text{ acre}}$$

$$Q_{TOT} = 25,525 \text{ gal}$$ Closed 12 acre

- Peak Daily (Closed)

$$\frac{755 \text{ gal.}}{10 \text{ acre}} = \frac{Q_{TOT}}{12 \text{ acre}}$$

$$Q_{TOT} = 906 \text{ gal}$$ closed 12 acre

Leachate Generation: (Estimate Monthly High Average For New Phase III)

Monthly High Average @ Previous Transition
= 93,135 gal

Avg Monthly High Value → Phase III

$$\frac{93,135 \text{ gal}}{3.3 \text{ acre}} = \frac{Q}{2 \text{ acre}} \Rightarrow Q = 56,445 \text{ gal}$$

open

STEFFEN ROBERTSON & KIRSTEN
Consulting Engineers & Scientists

PROJECT: Haywood Cty - WOSLF	NO. 83505
CALCULATED BY: RAH	DATE: 6/5/96
CHECKED BY:	DATE:
SHEET OF	

**Calculate Leachate Generation as Flow Rate

Peak Daily Value (open Cell IV)

Peak Daily Value = 4,471 gal.

Assume Spread over 1 day

$$Q = \frac{4,471\ gal}{day} \left| \frac{1\ day}{24\ hr} \right| \frac{1}{\cancel{24\ hr}} \left| \frac{1\ min}{60\ sec} \right| \frac{.1337\ CF}{gal}$$

$$= 0.007\ CFS$$

Peak Daily Value (Closed Total LF)

Peak Daily Value = 906 gal

Assume Spread over 1 day

$$Q = \frac{906\ gal}{day} \left| \frac{1\ day}{86,400\ sec} \right| \frac{.1337\ CF}{gal}$$

$$= 0.0014\ CFS$$

STEFFEN ROBERTSON & KIRSTEN
Consulting Engineers & Scientists

PROJECT: Haywood Cty Phase III	NO.
CALCULATED BY: AAh	DATE:
CHECKED BY:	DATE:
SHEET OF	

Soil Resourse Volume Calcs

A = 2 acres (with 1 acre overlapping prior permitted Phase)
= 87,120 SF

Construction : ~~Assume Additional Construction of Liner in~~

1. Sub Base: 1FT Thick

V = 87,120 SF (1FT) = 87,120 CF
= 3,227 CY

2. Clay Liner: 2FT Thick

V = (2 Ft)(87,120 SF) = 174,240 CF
= 6,453 CY

3. Stone (#57) : 1Ft Thick

Area of Bottom of LF

A = (380 Ft)(150 Ft)
= 57,000 SF

V = (57,000 SF)(1Ft) = 57,000 CF
= 2,111 CY

4. Protective Drainage Layor: 1 Ft. Thick

A = 2 acres = 87,120 SF

V = 87,120 CF
= 3,227 CY

STEFFEN ROBERTSON & KIRSTEN Consulting Engineers & Scientists	PROJECT:	NO.
	CALCULATED BY:	DATE:
	CHECKED BY:	DATE:
	SHEET OF	

Cap Construction

1. Clay Liner : 1.5 Ft Thick

$A = 2 \text{ acres} = 87{,}120 \text{ SF}$

$V = A(1.5') = 130{,}680 \text{ CF}$

$= 4{,}840 \text{ CY}$

2. Erosion Layer (Vegetative Cover) : 0.5 Ft Thick

$A = 2 \text{ acre} = 87{,}120 \text{ SF}$

$V = A(0.5) = 43{,}560 \text{ CF}$

$= 1{,}613 \text{ CY}$

Operational Material

~~1. Daily Cover~~

Capacity of Landfill = 112,000 CY

This includes Trash + Daily Cover + Intermediate Cover + Cap Material)

Vol (Trash + Daily / Intermediate Cover)

$= 112{,}000 \text{ CY} - (\text{Vol Cap})$

$= 112{,}000 \text{ CY} - 6453$

$= 105{,}547 \text{ CY}$

@ 8:1 Trash to Soil Ratio

Volume Waste = 93,820 CY

Volume Cover/Intermediate Soil = 11,727 CY

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SHEET 1 OF 4	

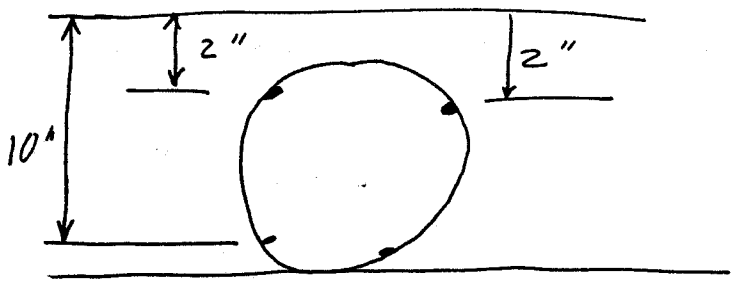
Pipe has 4 Rows of 3/8" Diam. perforations w/ 3" centers

Diam of Pipe = 10"

L(pipe) = 320'

Slope = 2% = .02 Ft/Ft

Assuming 12" Head on liner is obtainable



$$\#\ Holes = 320'\left(\frac{12"}{1Ft}\right)\left(\frac{4\ Hole}{3"}\right) = 5,120\ Holes$$

2,560 Holes w/ 2" Head

2,560 Hole w/ 10" Head

$$Area\ of\ Holes = \pi r^2 = \pi\left(\frac{3/8\ in}{2}\right)^2 = .1104\ in^2$$

$$= .00077\ Ft^2$$

Find Capacity of Flow For Holes Entering pipe

Use Orifice Eqn.

$Q = C A \sqrt{2gh}$

Q = Flow CFS

A = Area orifice $(FT)^2$

g = Acceleration gravity F/sec²
= 32.2 F/s²

h = head on orifice
= 2 in top set of Holes
= 10 in Bottom set holes

A = #holes x Area Holes
= (5120)(.00077 Ft²)
= 3.94 Ft²
1/2 3.94 = 1.97 Ft²

$Q = C A \sqrt{2gh_1} + CA\sqrt{2gh_2}$

$= .6(1.97)\sqrt{2(32.2)\left(\frac{2}{12}\right)} + .6(1.97)\sqrt{2(32.2)\left(\frac{10}{12}\right)}$

$= 1.182[3.28 + 7.326]$

$= 12.53$ CFS

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SHEET 3 OF 4	

Flow Capacity of Leachate Pipe

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

Assume

$n = .009$

$A = \pi r^2 = \pi \left(\frac{10}{2}\right)^2 = 78.54 in^2$

$= .545 SF$

$S = 2\% = .02 \ Ft/Ft$

$R = \frac{A}{P}$, Assume Full & not under pressure

$\therefore A = .545 SF$

$P = \pi d = \pi \left(\frac{10"}{12"/Ft}\right) = 2.618 Ft$

$R = 0.2083$

$$Q_{allowable} = \frac{1.49}{.009} (.545 Ft^2)(.2083)^{2/3} (.02)^{1/2}$$

$= 4.48 CFS$

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SHEET 4 OF 4	

$Q_{Holes} = 12.53$ CFS

$Q_{pipe\ capacity} = 4.48$ CFS

$Q_{Holes} > Q_{pipe\ capacity}$ ∴ Q_{pipe} controls

Max Peak Daily Flow, Determined by Relation of HELP Model

$Q_{pdaily} = 4,471$ gal/day

$= 597.77$ CF/day

$= 24.91$ CF/hr

$= 0.415$ CF/min

$= 0.007$ CFS

$Q_{peak\ daily} = .007$ CFS $<<<$ $Q_{pipe} = 4.48$ CFS

∴ Leachate drainage pipe More than Adequate

Haywood County Perimeter Ditch 1
Worksheet for Triangular Channel

Project Description	
Project File	n:\a_srk\jobs\92801_tondu\permdtch.fm2
Worksheet	East Perimeter Ditch
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

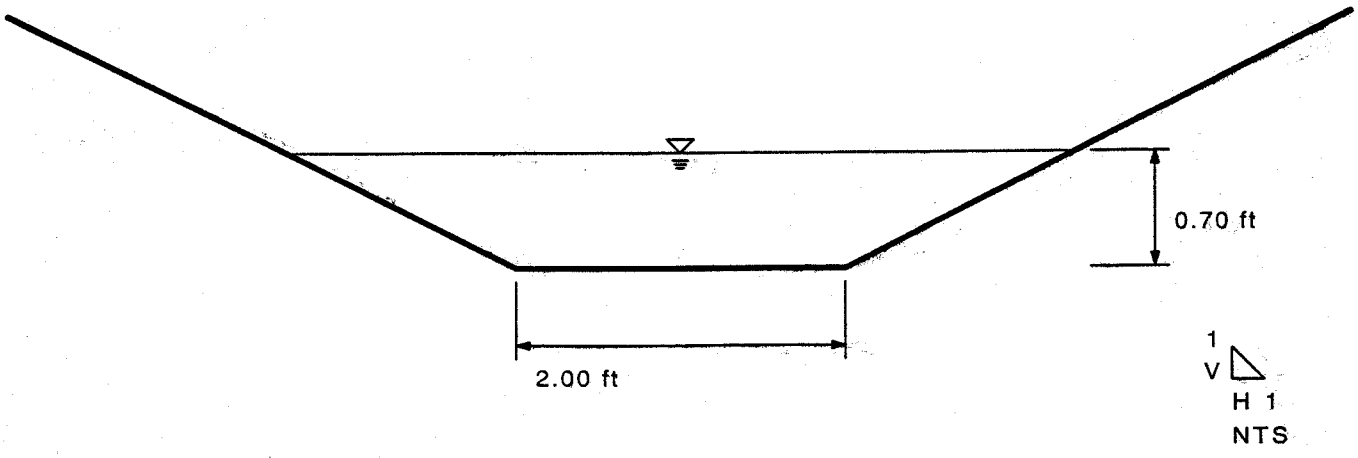
Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.049000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	11.34	cfs

Results		
Depth	0.95	ft
Flow Area	1.82	ft^2
Wetted Perimeter	4.27	ft
Top Width	3.82	ft
Critical Depth	1.15	ft
Critical Slope	0.018308	ft/ft
Velocity	6.22	ft/s
Velocity Head	0.60	ft
Specific Energy	1.56	ft
Froude Number	1.59	
Flow is supercritical.		

Ditch 2 Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Project File	n:\a_srk\jobs\92801_tondu\permdtch.fm2
Worksheet	Perimeter Ditch 2
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.035	
Channel Slope	0.050000	ft/ft
Depth	0.70	ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft
Discharge	13.68	cfs



Ditch 2 Cross Section
Cross Section for Trapezoidal Channel

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Flow Element	Trapezoidal Channel
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Solve For	Channel Depth

Section Data		
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Channel Slope	0.050000	ft/ft
Depth	0.70	ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft
Discharge	13.68	cfs