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LANDFILL No. 6
OPERATIONS & MAINTENANCE
MANUAL

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Prepared for
BLUE RIDGE PAPER PRODUCTS INC. – CANTON MILL
DBA EVERGREEN PACKAGING

CANTON, NORTH CAROLINA

July 2012

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Sevee & Maher Engineers, Inc.

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NORTH CAROLINA PROFESSIONAL SEAL 037702 ENGINEER GUY H. COTE, JR.

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1.0 GENERAL

1.1 Purpose

The purpose of this manual is to provide information to the personnel involved in the operation, maintenance, and closure of the Blue Ridge Paper Products, Canton Facility Landfill. Guidelines and procedures for the development and operation of the landfill are provided herein. It is important to recognize that some of the procedures in this manual may require modification over time as in response to new regulations or as improved methods are developed for carrying out the day to day landfill activities. Changes in procedures must be verified with the Canton mill area management, Environmental, Health and Safety Department (EHS) and Mill Engineering prior to implementation.

It is equally important for the personnel involved in landfill operations to understand the critical requirements for successful landfill operation and maintenance. Operation of a landfill is as much about managing water as it is the solid waste. Approximately one million gallons per acre of precipitation falls to the ground in the Canton, North Carolina area on a yearly basis. Management of this and other waters which may be associated with or absorbed by the incoming waste is a principal task of the landfill operations personnel.

The landfill has been designed to collect the precipitation and other water which becomes leachate. It is the operations personnel's goal to insure that maximum leachate collection efficiency is maintained while simultaneously minimizing leachate generation to the extent practical. Minimizing leachate generation is accomplished by separating clean surface runoff from the wastes, encouraging evaporation of leachate, and other procedures which are discussed herein.

This manual was prepared with regard to the Solid Waste Rules and Regulations of the North Carolina Department of Environment and Natural Resources (NCDENR). It includes descriptions of development procedures, landfill operations, site maintenance, safety procedures, monitoring requirements, leachate management, and numerous other important procedures which must be adhered to. Everyone associated with the management and

operation of the landfill should be familiar with this manual to insure a safe and environmentally secure facility.

1.2 Design Concept

It is not the purpose of this document to provide a detailed account of the design of the landfill; however, a general discussion of the design of the Blue Ridge Paper Products, Canton Landfill is presented herein. The landfill operations personnel are encouraged to review the Design Reports and Engineering Drawings which provide detailed descriptions of the landfill facilities.

The Landfill incorporates an engineered liner system beneath the waste to minimize the potential for leachate to impact the groundwater underlying the site. The current landfill design begins by placing a geosynthetic clay liner (GCL) over the cell base grades followed by a 60-mil thick high-density polyethylene (HDPE) geomembrane. Over the geomembrane is placed a non-woven geotextile followed by a 15-inch granular drainage (leachate collection) layer to collect and transport leachate. Embedded within the drainage layer is a network of perforated pipes to aid in the transport of leachate by gravity flow to a discharge sump or wet well. From the sump, the leachate is pumped to the mill's wastewater treatment plant. Leachate storage ponds are an integral part of the system and provide leachate storage during periods of heavy rainfall.

Once an area of the landfill has reached final waste grades, final cover is applied as detailed in Section 9.0. Final Cover is installed to reduce leachate generation and allow consolidation of the waste. The residual water within the waste will slowly percolate out via the leachate collection system as the waste consolidates.

1.3 Development Concept

The Blue Ridge Landfill uses natural geographic features in the area such as depressions to maximize the space utilized for the waste stream from the Canton Mill. The main waste stream entering the landfill is treatment plant sludge and lime from the papermaking process. The engineering properties of these two materials can vary significantly. Traditionally landfill

construction consists of building a small self-enclosing berm and installing a liner system inside on which to place waste. To circumvent any issues with the paper mill wastes (i.e., stability) and traditional landfilling techniques, the Canton Landfill enhances and utilizes the depression walls to buttress the waste to allow the same quantity of waste fill in a similar sized footprint as a typical Landfill that would accept municipal solid waste. Development and operation of the landfill in this manner allows for separation of clean surface water from the waste, thus minimizing leachate generation.

The initial landfill permit does not permit placement above the rim of the landfill depressions. Development typically begins by filling the space below the rim of the depression with waste and then filling above the rim, as shown on Figure 1-1. Applications to the NCDENR for successive Permits to increase the vertical height of the landfill areas will be made pending successful operation below the rim of each cell.

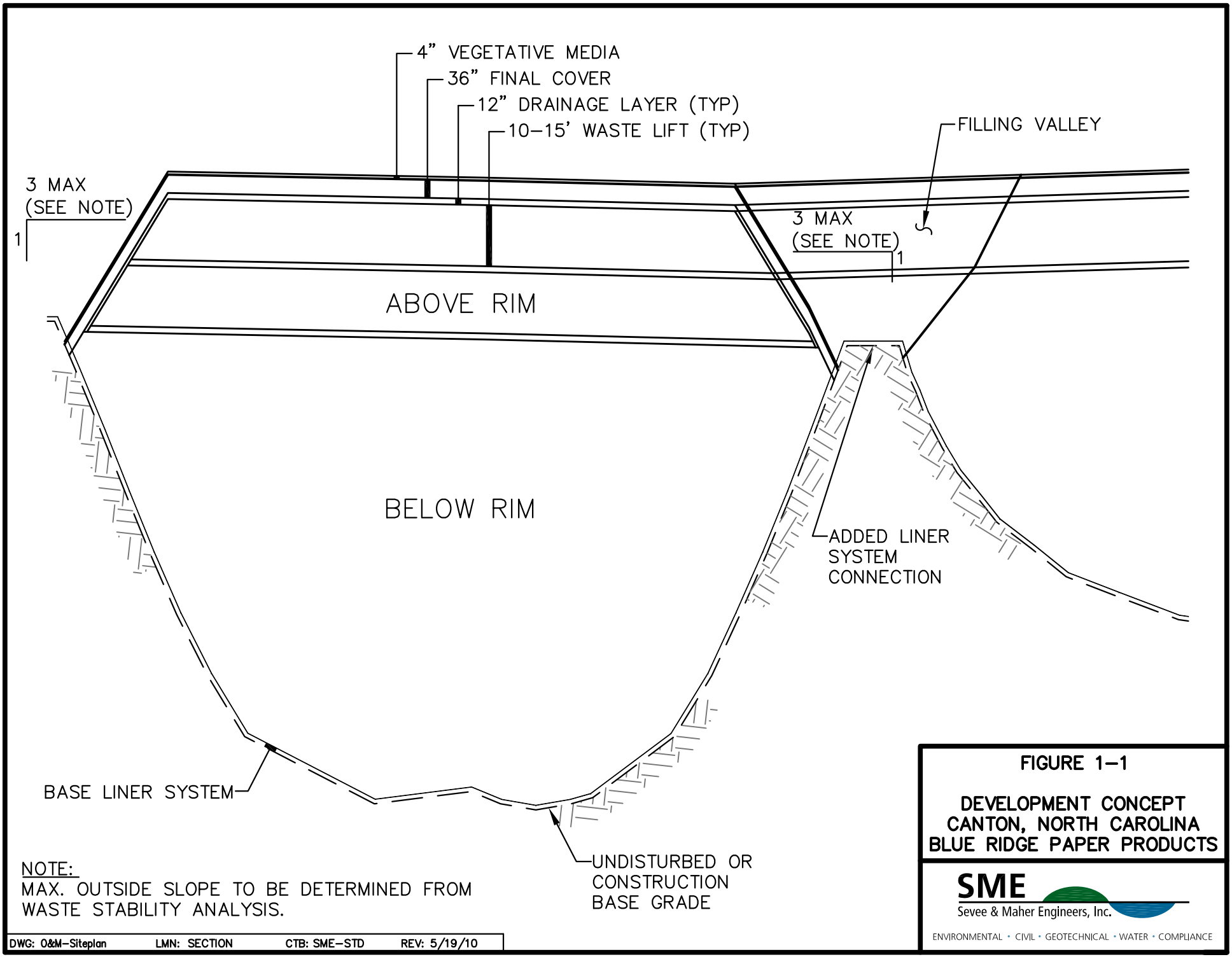


FIGURE 1–1

DEVELOPMENT CONCEPT
CANTON, NORTH CAROLINA
BLUE RIDGE PAPER PRODUCTS

2.0 OPERATIONAL PROCEDURES

2.1 Commencement of Operations

(a) At least 5 business days prior to commencing operation of a new landfill area, Blue Ridge Paper Products, Inc. shall notify the NCDENR of the intent to commence operations.

(b) The notice shall include the following:

(1) Facility identification, including permit number;
(2) Date of intended commencement of operations; and
(3) The name and telephone number of the facility manager or other primary contact person.

2.2 Site Access

All vehicles and visitors will enter the site via the gated road which accesses the Landfill. The entrance to the landfill will have a facility sign which includes the following:

- The facility name and permit number;
- The name, address, and telephone number of Blue Ridge Paper Products, Inc.;
- The type of wastes accepted and not accepted (i.e. "No hazardous or liquid waste accepted"); and
- The penalty for unlawful dumping.

All visitors will check in at the main gate which is located on Main Street. Only approved employees will have unrestricted access to the landfill facility. All others will proceed only after receiving clearance from security at the main gate and landfill management. No visitors will be allowed on-site unaccompanied and the number of visitors will be minimized.

During non-operational hours, the gate at the entrance to the site will be locked.

2.3 Operating Hours

The Landfill will normally accept mill wastes seven days per week, and up to a 12-hour per day schedule, depending on daylight hours. It is not uncommon for operations to be expanded to 24 hours per day during mill outages or process upsets.

The normal start of the workday for operators will be 5:30 A.M. The operators will perform daily maintenance and move the equipment to the operating area within 1/2 hour of commencement of dumping. An operator shall be present at the operating area at the commencement of dumping.

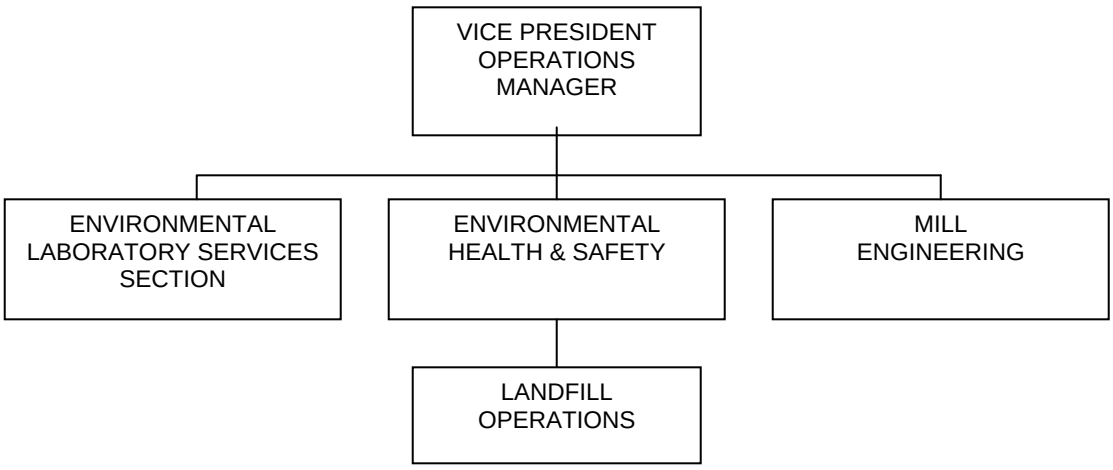
2.4 Personnel Responsibilities

The personnel and departments involved in the operation of the landfill include: 1) EHS department; 2) Mill Engineering; 3) RURU-Environmental Laboratory Services (ELS); and 4) landfill operations. The organization, responsibilities, and tasks conducted by these people are described below.

2.4.1 Organization. An organization chart, Figure 2-1, is presented to outline the chain of command and support groups which include the EHS Department and Mill Engineering.

FIGURE 2-1

ORGANIZATION CHART



2.4.2 Personnel.

2.4.2.1 Environmental, Health and Safety Department

The Environmental Health & Safety Department (EHS) is responsible for securing and assuring compliance with licenses and permits required for operating the landfill. This responsibility includes quantity estimates of all plant waste brought to the site and environmental monitoring of the landfill in accordance with the conditions of the landfill permit. In addition, the department's responsibility includes assuring that the landfill operation is in compliance with all regulations of the NCDENR. This responsibility includes periodic site audits and inspections as well as submission of appropriate data to the NCDENR.

EHS personnel are also charged with directing and overseeing the daily operation of the landfill to assure that the operating plans are being implemented properly. Responsibilities of the EHS personnel in this area include:

a. initiating site development to maintain continuity of operation;
b. directing the overall planning and scheduling of waste placement;
c. maintaining site records and tracking landfill volume consumption;
d. supervising and training personnel; and
e. supervising the site safety program.

In addition, this department is responsible for the maintenance of leachate collection systems, stormwater runoff facilities, and roads.

2.4.2.2 Mill Engineering

The Mill Engineering group is responsible for overseeing major construction projects at the landfill and providing support services for site maintenance. Major construction projects, such as landfill construction (i.e., cell development and closure), would be implemented by Mill Engineering.

2.4.2.3 Landfill Operator

The landfill site operators are responsible for the daily operation of the landfill's active face (current waste placement area).
The Operator will:

a. direct placement of the waste by haul vehicle operators,
b. spread and compact wastes,
c. apply cover materials as required,
d. inspect equipment and facilities,
e. abide by established safety rules,
f. maintain site security in conjunction with Canton Mill security,
g. immediately note and report unusual events or circumstances,
h. maintain such records as may be required (see Section 8.0),
i. immediately report any observed and/or imminent environmental impacts to EHS department management, and
j. strive to maintain neat and efficient operations.

The mill site operators and drivers of the haul vehicles will be responsible for the proper loading and handling of their loads. While on the landfill site, they will comply with the provisions of this manual and directions provided by the Landfill Site Operator. Problems encountered at the landfill should be reported to the Landfill Team and to EHS management.

2.5 Health, Safety and Fire Considerations

The following health and safety procedures will be adhered to at the landfill facility:

1. Only essential personnel will be involved in activities associated with operation of the landfill.

2. Manholes or other similar enclosed facilities at the landfill are classified as confined space structures. Entry into these structures will be in accordance with mill protocols for confined space entry, the inside air will be tested in accordance with the mill's confined space entry procedures.

3. Dumping areas will be maintained firm and level. After directing trucks to the dumping area, the operating personnel will stand clear of the truck.

4. The leachate storage pond gate will be locked at all times, except when access is required.

5. Exit ramps will be provided in the leachate storage pond for exit in the event that someone falls in.

6. In the event of an accident involving property damage, mill security personnel will be notified immediately, to generate necessary reports.

7. In the event of an accident involving personal injury, assess the severity of the injury and do one of two things. For serious or life threatening injuries call emergency personnel by dialing 911 outside the mill, or 2911 in the mill. If the resulting injuries are only minor, the injured person must report to the mill medical section.

8. In the event of an environmental emergency, the operator will follow the spill and release reporting procedure detailed in the Canton Mill Employee Safety Handbook or call mill extension 6711.

9. Keep gate locked when area not in use.

10. Follow all safety policies and procedures in accordance with the Canton Mill Employee Safety Handbook.

In the event of a fire, the following procedures will be implemented:

1. If it is an equipment fire, the fire extinguisher provided with all equipment will be utilized, if feasible, to extinguish the fire.

2. If the fire does not appear to be controllable with a fire extinguisher, or if the fire is associated with the landfilled wastes, the emergency dispatcher at mill extension 2911 will be contacted immediately. The emergency dispatcher will be provided with information concerning the location and extent of the fire.

3. The emergency dispatcher will mobilize the appropriate fire fighting equipment and personnel. All fire personnel should be notified in advance to alert them of the nature of hazards at the landfill so they may be appropriately prepared and equipped.

4. All efforts to keep applied water and fire fighting chemicals within the landfill limits will be made.

5. EHS department personnel will be notified as soon as possible so that an inspection can be made.

6. Hot ashes on the sludge pile will not be considered a fire hazard unless they are blown by strong winds.

7. EHS department will notify the NCDENR Division of Solid Waste Management, Solid Waste Section, verbally within 24 hours and a written notification must be made within 15 days of the occurrence. A sample fire occurrence form is shown in Appendix D.

2.6 Equipment Requirements

The following equipment will be available to conduct the daily landfilling activities, place final cover, minimize erosion, maintain roads, and operate the leachate system:

1. Bulldozer for fine grading;
2. Bulldozer for waste placement and grading;
3. Front-end loader to move cover material and construct temporary berms;
4. Two-way radio communication system.

2.7 Waste Delivery and Acceptance

To assure that all information regarding a waste delivery is accurately recorded, it is necessary to adhere to a "flow control" system. The details of the "flow control" system are described in this section and Section 2.8, as well as Section 8.0 which describes in detail the record keeping and reporting requirements which will be followed by this facility.

Each day, drivers will provide the following information:

1. The types and sources of the waste being delivered; and
2. The number of truck loads of each type of waste delivered.

Each month, drivers will provide the following information:

1. Weights of the trucks according to the established plan.

Sample waste receipt forms are shown in Appendix A.

Landfill personnel will determine if the landfill is permitted for the type and source of waste being delivered, see the following Section 2.8. When the truck arrives at the disposal area, the Landfill Operator will direct the unloading of the waste. Weigh tickets will be obtained

periodically from the Scale Operator by Landfill personnel for recording onto the monthly accounting forms.

A sample of trucks will be weighed and the gross weight recorded in accordance with Section 8.3. Tare weight will be determined by deducting the truck empty weight determined at the time the truck was acquired from the weight of the truck when it enters the site.

2.8 Waste Inspection Plan

The loader operator and truck driver will inspect the waste load and determine if the waste is accepted at the landfill according to the list of permitted wastes shown below. If there is any question as to the waste being accepted at the landfill, EHS management will be notified to obtain a decision on whether it is an acceptable waste.

The general categories of accepted waste are:

1. Fly ash from multi-fuel boilers;
2. Lime waste (mud);
3. Wastewater treatment plant sludge;
4. Wood waste debris;
5. Cinders;
6. Asbestos containing material (ACM); and
7. Biosolids

The landfill is not permitted to accept the following wastes:

1. Municipal wastes;
2. Hazardous wastes;
3. Radioactive waste materials;
4. Liquid wastes;
5. Non-Blue Ridge paper waste; and
6. Biomedical waste.

The landfill operator will also inspect each load. If an unpermitted waste is improperly accepted for disposal, the landfill operator shall notify EHS management.

In the event a special waste is generated, the owner will secure NCDENR approval prior to disposal.

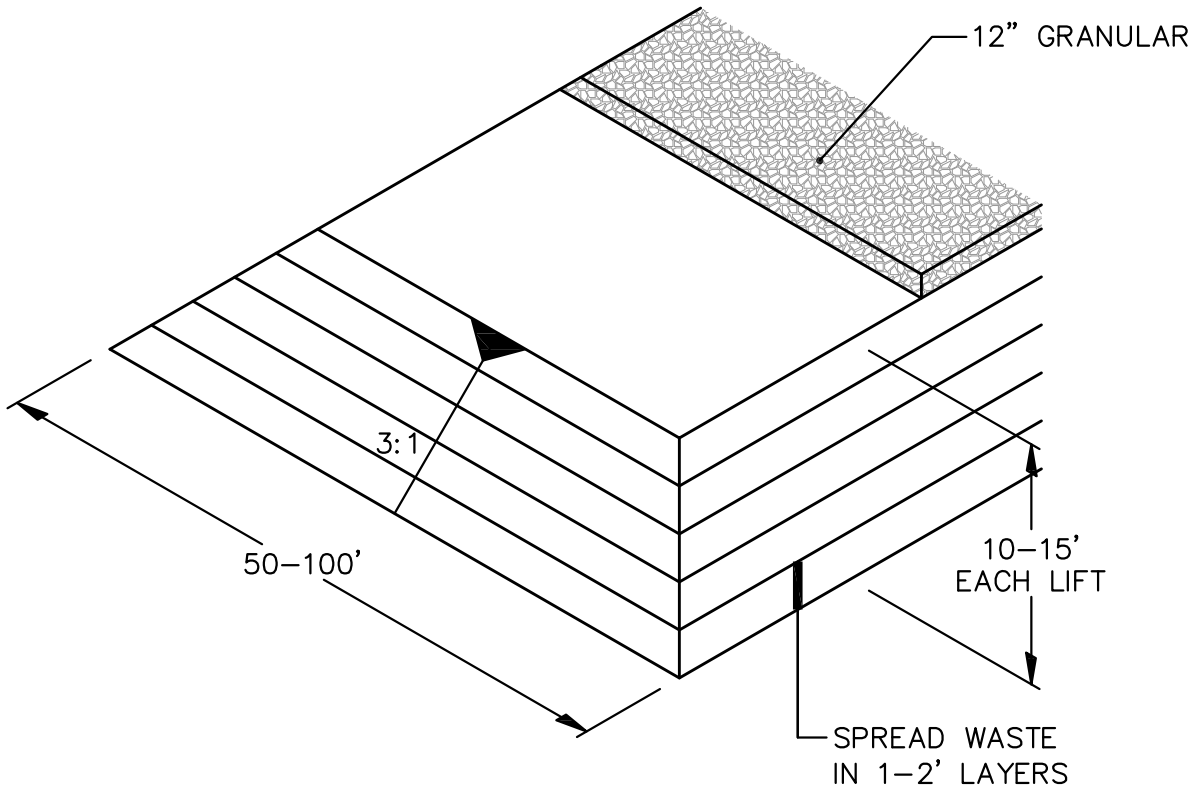
2.9 Waste Placement and Grading

2.9.1 Waste Placement Plan. The following is the waste placement plan. This plan is designed around the nature of the waste disposed at the facility and location below or above the rim of the landfill. Each lift shall be constructed as detailed herein to achieve the grades shown on the waste grading plans prepared as part of the engineering drawings for each phase. Failure to adhere to the procedures in this Manual could have negative results on overall or local landfill stability.

2.9.1.1 Waste Placement Below the Rim

The sludge, woodwaste, and lime mud will be dumped by the haul truck operator and spread by an equipment operator. Dumping of waste will start at the lower elevations within the cell. The landfill operator will push and spread the waste over the working face, in layers no greater than 2 feet thick as shown in Figure 2-2. Spreading the waste in thin layers, allows the waste to drain, achieves greater in-place compaction (density), and maintains the stability of the working face. The thin layers of waste will make up waste in lifts approximately 10 to 15 feet thick. Each lift of waste must achieve positive drainage either through proper waste grading or through a mechanical means described in the Special Handling of Waste Section.

Papermill sludge as a byproduct of the papermaking process contains varying amounts of clay that is used as filler. As the sludge is landfilled deeper, the consolidation of the sludge also makes the sludge less permeable; water does not drain as easily. In order to maintain good drainage within the landfill, the top surface of each lift will be covered



WASTE PLACEMENT

NTS

FIGURE 2–2

WASTE PLACEMENT
CANTON, NORTH CAROLINA
BLUE RIDGE PAPER PRODUCTS

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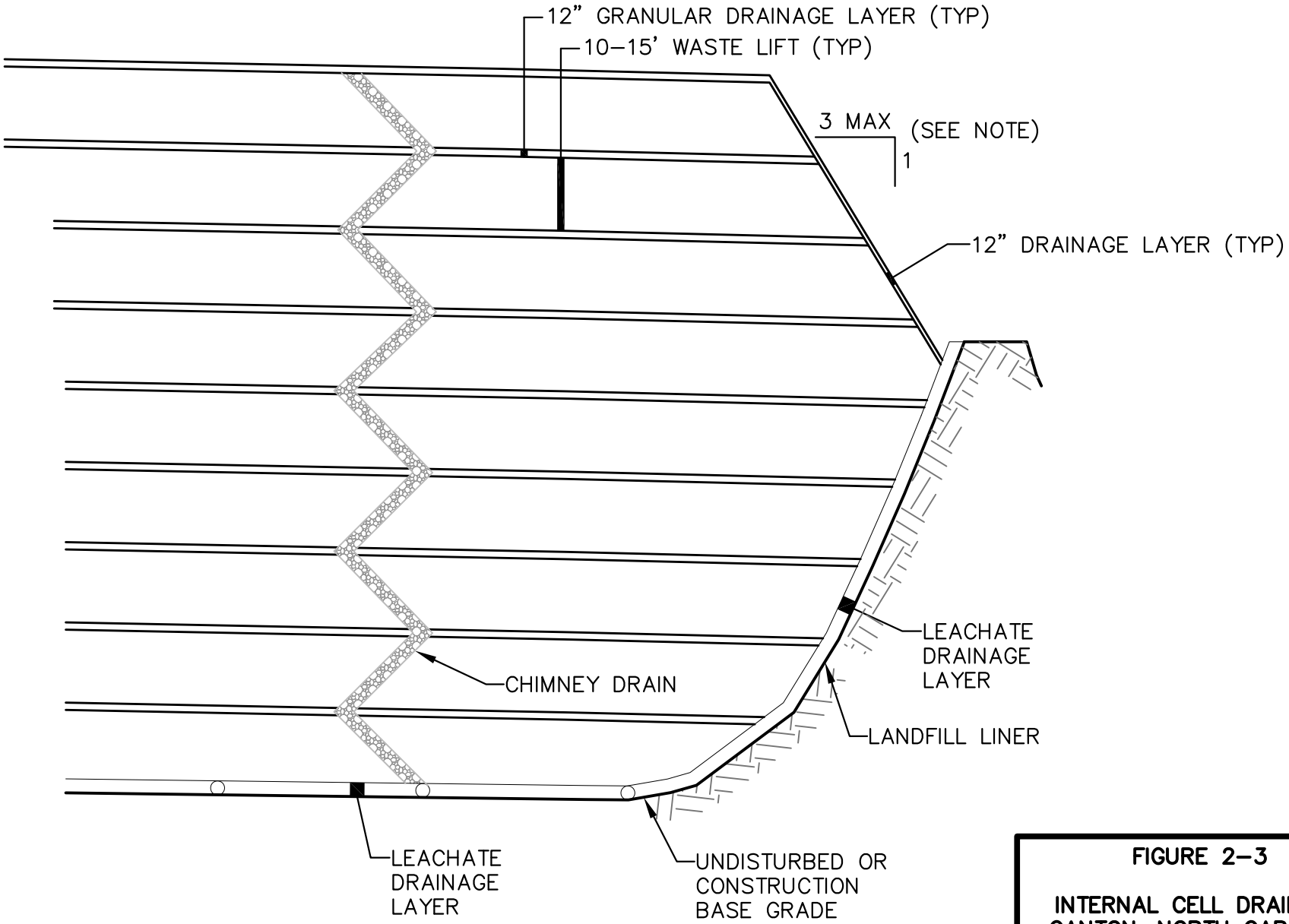
with a 12-inch thick layer of granular material, i.e. stone, gravel, etc. In certain locations within the landfill, the use of a substitute for the stone aggregate as the drainage layer is allowed as described under Leachate Drainage Layers in Section 4.2. The drainage layer will aid in draining the next lift of waste, making for a more stable landfill operation. In addition to the drainage layers, chimney drain strips will be expanded upward to the top of the base cells, as shown in Figure 2-3. As with the chimney drain strips, the stone drainage layer along the lined sideslopes will also be extended with each new lift of waste.

Special procedures will be implemented during winter operation of the landfill. Snow and ice removal from operational areas including roads and the working face of the landfill must be maintained to allow proper operation of the landfill. Waste placement, grading, and site cleanliness become more important during the winter since ungraded frozen sludge can become a barrier to traffic movement. The access road must be plowed and sanded to provide safe travel conditions. Salt should only be used if necessary, because it may seep into the groundwater and could affect groundwater quality data. Sanding will be the preferred method of road treatment in the winter months. Drainage structures such as culverts should be kept free of ice and snow to assure unrestricted runoff during thawing conditions.

Any damage to the liner system of the landfill that occurs as a result of construction or operational activities will be reported immediately to EHS management for appropriate action.

2.9.1.2 Waste Placement Above the Rim

Waste placed above the rim of the landfill does not have the depression wall to buttress against movement. Placement of waste above the rim is performed similar to waste placed below the rim with some exceptions. Proper waste placement above the rim is critical to landfill stability. Waste placed above the rim of the landfill will have outside slopes as determined by a stability analysis conducted during the design phase for each cell. Typical outside slopes are likely to range from 3 to 4 feet horizontal to 1 foot



NOTE:
MAX. OUTSIDE SLOPE TO BE DETERMINED FROM WASTE STABILITY ANALYSIS.

FIGURE 2–3

INTERNAL CELL DRAINAGE
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vertical. Soft wet wastes must be placed greater than 100 feet away from any outside slope to maximize slope stability.

2.9.2 Special Handling of Waste. Other than asbestos disposal, certain situations require special landfilling procedures to maintain the integrity of the landfill and protect the working area and surrounding environment. One special procedure is in areas of the landfill that have become too wet to work on and the other special procedures for disposal of boiler ash.

Occasionally, wetter than normal waste material will be delivered to the landfill for disposal. This saturated waste material will not be placed closer than 100 feet from and outside slope. When an area is too wet to work, a mechanism is needed to allow the excess water to drain freely away from the saturated waste area. Drainage and enhanced equipment flotation will be achieved by using a drainage layer that utilizes either a drainage geocomposite, used paper machine wires or used paper machine felts placed over the wet area. This will ensure a channel for excess water to drain from the saturated waste materials while allowing continued waste placement.

The safe disposal of ash will protect the working atmosphere and the surrounding environment. Boiler ash amounts to approximately 1,400 cy per week. Two types of ash are brought out to the landfill: cinders and fly ash. The cinders consist of inorganic boiler residue from the burning of coal and wood fuel. This material is landfilled by spreading it over the working face or used as a gravel substitute within the active area of the landfill. The fly ash is a much finer material and can dry out and become dusty. Landfilling the fly ash can be accomplished by spreading the fly ash and immediately placing a layer of sludge over it or working it into the sludge, depending on the moisture content of the sludge. This will prevent blowing of the ash, and, water from the sludge will minimize the generation of fly ash dust becoming airborne.

2.9.3 Asbestos Disposal Procedures.

2.9.3.1 Notification and Approval Procedures

A disposal area located between Areas F and H has been permitted in accordance with 40 CFR Part 61 and 15 NCAC 2D and 10A NCAC 41C to accept asbestos containing materials (ACM). Anyone wishing to dispose of ACM at Landfill No. 6 must contact the EHS Department at 646-2028. The EHS Department will determine that the material to be disposed of is ACM and will issue a coordinate the disposal with the contractor. ACM must be hauled and disposed of by a contractor permitted by the State of North Carolina. The ACM must be removed from the source, transported to the disposal site, and properly buried in compliance with Toxic Substance Control Act and North Carolina Rules.

Before approving the ACM disposal, the abatement contractor will assure that any personnel on the transport crew who may be exposed to asbestos fibers above the OSHA permissible exposure limit or are required to wear a protective respirator during asbestos unloading have complied with the requirements of Evergreen/Blue Ridge Respiratory Protection Program. Personnel or ambient air monitoring may be required during the disposal event.

2.9.3.2 Site Security and Maintenance

During the unloading of asbestos waste at the landfill**,** the Landfill Operator will assure that all personnel and equipment not directly involved with the unloading activity are kept at least 100 feet back from the disposal area. If the driver of the truck that hauled the asbestos has not been trained, he/she will remain in the truck with the windows up, or the driver should remain 100 feet away as per the Rules during a manual unloading process of friable asbestos or during clean-up of asbestos materials. All friable ACM is to be wetted and bagged according to the regulations. Within the disposal area, the bagged ACM is to be placed on an appropriate sized sheet of plastic, then covered with

plastic. Before the end of the day, at least 18 inches of soil will be placed over the plastic covered asbestos waste.

The asbestos disposal area at the landfill shall be permanently identified on a map as an asbestos waste disposal area in compliance with the Regulations.

2.9.3.3 Disposal Procedures

Vehicles used to transport asbestos-containing waste material must be marked during loading and unloading per 40 CFR 61.149(d)(1)(iii). All trucks must be weighed at the landfill scales on their way in and must reweigh when empty. The weight tickets must be signed by the transporter before departure. All friable or potentially friable asbestos waste will be transported to the disposal area in double 6-mil poly bags, labeled in compliance with 29 CFR 1926.58(k). The transport container shall be leak-tight and labeled in compliance with 40 CFR 61.152. Non-friable asbestos may be transported without bagging if the transport container is poly lined and the material is adequately wetted and covered with 6-mil poly cover and secured to prevent the effects of wind or evaporation on the material during transport. It is the responsibility of Blue Ridge Paper Products and their ACM contractor to properly package and label the asbestos waste. The landfill representative can reject loads that are not properly packaged and labeled. Non-friable asbestos shall not be shredded, crushed, or subjected to any other form of volume reduction prior to placement in the landfill.

Trucks approaching the asbestos unloading area shall approach as closely as possible before unloading waste. The ACM contractor and landfill operator will coordinate asbestos disposal in the designated area. Waste containers shall be lowered to the ground at the disposal area and not pushed or dropped from the back of a truck. All containers shall be inspected during unloading and any damaged containers shall be immediately wetted sufficiently to prevent dispersal of asbestos fibers during the burying of the waste. The operators can then cover the asbestos with the proper amount of cover material.

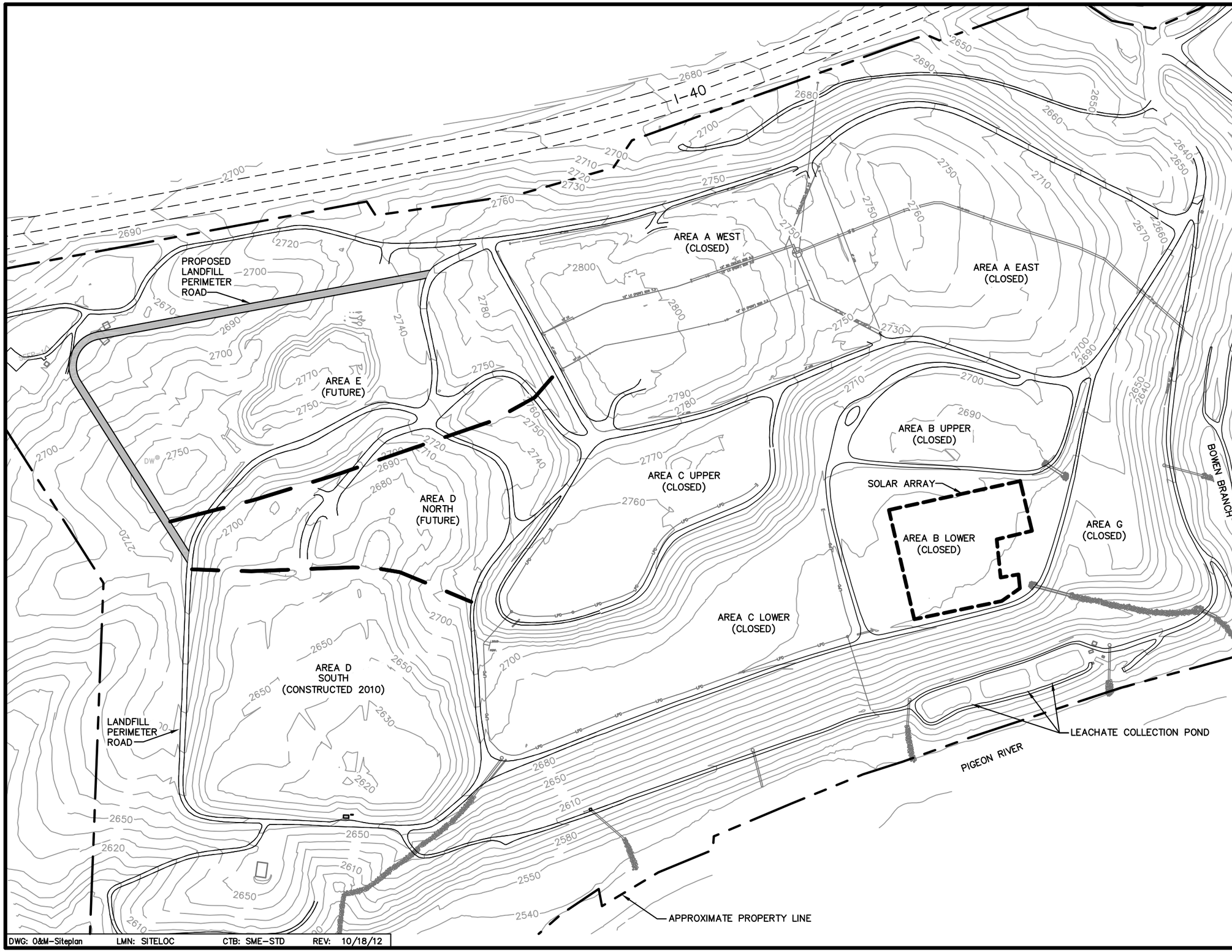
Damage to containers outside the disposal area may be repaired only by properly trained and licensed personnel under the supervision of the ACM contractor. The amount of asbestos material that may be repacked by the contractor crew is limited to minor asbestos abatement projects in accordance with 10A NCAC 41C.0605. These Rules allow the abatement of disturbances of less than or equal to 35 cubic feet (1 cubic meter), 160 square feet (15 square meters) or 260 linear feet (80 linear meters), of regulated asbestos containing material. If the quantities are greater than the allowed quantities, an asbestos abatement contractor shall be used to clean-up the asbestos release. Workers who must handle or repack damaged bags must wear proper protection equipment, which includes disposable protective clothing, gloves, and respirators equipped with HEPA filters, and must be properly trained and licensed to work with asbestos. All protective clothing and poly lining in the container shall be disposed of in compliance with the asbestos requirements of 29 CFR 1910.1001.

2.9.4 Wet Weather. During very wet weather, access to the working face may become difficult. Grit or gravel can be used to provide a stable traffic mat to improve movement of vehicles on the landfill as needed, but the amount of these materials should be held to a minimum.

3.0 LANDFILL DEVELOPMENT

Waste placement within each cell will begin at the lowest elevation and placed as outlined in Section 2.9 in a uniform layer over the entire open operational area. Subsequent lifts will be placed on top of the lower lifts in the same manner until the rim elevation is reached. The initial development of each cell does not permit placement of waste above the rim. Therefore, prior to achieving waste capacity at any given cell, the following cell will be constructed and tied into the current cell as necessary to allow for proper leachate containment, transport, and disposal. Waste placement within that cell will proceed as with the previous cell, beginning at the lowest elevations and buttressing against waste of the previous cell.

Upon reaching cell capacity beneath the rim, waste placement above the rim may commence after all necessary permits are acquired. All outer waste sideslopes should be graded as determined by a stability analysis conducted during the design phase for each cell. Typical outside slopes are likely to range from 3 to 4 feet horizontal to 1 foot vertical. Waste placement above the rim will continue as in previous cells, maintaining uniform layers over the entire open operational area until final waste grades are achieved, at which point final cover will be placed as outlined in Section 9.0. The current and future landfill development is shown on Figure 3-1.



NOTES:

1. MAPPING FOR LANDFILL AREA COMPILED USING PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED JUNE 18, 2010.
2. LOCATIONS OF OBJECTS SHOWN AND CONTOURS ARE APPROXIMATE. SITE CONDITIONS HAVE CHANGED SINCE THE COMPILATION OF THIS MAP AND STANDARD PRACTICE DICTATES THAT PLANS COMPILED IN THIS MANNER SHOULD BE FIELD VERIFIED, AS THE DESIGN MAY REQUIRE FIELD ADJUSTMENT FOR CONSTRUCTION.
3. GRID IS BASED ON NORTH CAROLINA STATE PLANE COORDINATE SYSTEM BASED ON NAGS (1983).
4. VERTICAL DATUM BASED ON NGVD (1929).
5. PROPERTY LINE DIGITIZED FROM LAW ENGINEERING DRAWING DATED JANUARY 14, 1984.
6. EXISTING GRADE CONTOUR INTERVAL IS 10 FT.

FIGURE 3–1

LANDFILL NO. 6 DEVELOPMENT
CANTON, NORTH CAROLINA
BLUE RIDGE PAPER PRODUCTS

SME
Sevee & Maher Engineers, Inc.
ENVIRONMENTAL • CIVIL • GEOTECHNICAL • WATER • COMPLIANCE

DWG: O&M–Siteplan LMN: SITELOC CTB: SME–STD REV: 10/18/12

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4.0 LEACHATE MANAGEMENT

4.1 Leachate Generation

Leachate will be generated in the landfill through two mechanisms. Precipitation infiltrating into and running off of the active waste face is the major source of leachate generation at the landfill. Waste consolidation and subsequent drainage of entrained water is the secondary mechanism by which leachate it generated at the landfill. Further discussion concerning the volumes of leachate may be found in the Design Report.

Leachate is collected and transported through a gridwork of perforated pipes that underlie the waste and drainage layers that are placed along the side slopes of the landfill and between waste lifts. Leachate will flow by gravity to the leachate pump station and storage ponds and pumped via a force main to the Canton Mill wastewater treatment plant.

4.2 Leachate Drainage Layers

Leachate drainage is an important element to the landfill operation. The landfill leachate drainage layers are typically constructed with stone aggregate consistent with gradations of ASTM #57, #67, and #78 stone size. The stone is placed along the bottom and sideslopes of each cell prior to landfill operations. Additional stone is used between each waste lift which drains to the exterior sideslope or to a centrally located chimney drain.

The use of stone aggregate is required for the base layer, along the sideslope, and for the chimney drain. The use of stone aggregate or recycled products is allowable for the drainage layers between waste lifts. The recycled products include tire derived aggregate (TDA) and reclaimed concrete aggregate (RCA). A description and handling procedures for the recycled products is described below.

4.2.1 Tire-Derived Aggregate.

TDA, also known as tire chips, may be substituted for #67 (¾") stone in select locations of the landfill. The use of TDA, however, carries several operational and handling changes than using stone that are addressed below.

TDA will only be used in the leachate drainage layers between the intermediate waste lifts at the Blue Ridge landfill. TDA shall not be used in the construction of chimney drains, in the drainage layer at the base of the landfill, or adjacent to any geosynthetic liner or cover material. The drainage characteristics of the TDA are dependent upon the grain size of the material. The grain size specification for the TDA will adhere to ASTM C136-05, Type B (See Appendix E) and the maximum particle size not to exceed three inches.

It is important to maintain safe handling and storage of tire chips at the landfill to minimize the potential of fires. The National Fire Protection Association (NFPA) and Rubber Manufacturers Association recommends tire chip storage piles not exceed 10,000 square feet in area and 10 feet in height. Tire chips will be stored in an area outside of the active cell but within an area that the stormwater drains through the erosion and sedimentation control structures. During active operations of Cell 6D-South, the TDA can be stored in the footprint of 6D-North where other landfill materials are stockpiled and stormwater discharges can receive pollutant treatment in the sedimentation pond. This location is preferred over the active waste cell as truck maneuverability can become difficult over non-compacted, i.e. loose, TDA layers.

Placement and compaction of TDA requires careful operational practices. Soft sludge areas require the use of a high strength geotextile separation fabric to prevent the migration of waste into the TDA void spaces. In addition, TDA may be tracked into soft waste with a crawler tractor to increase the strength of the waste surface before a geotextile is installed as a new drainage/travel layer. A two-foot layer of TDA is recommended when substituted for one-foot of aggregate stone thickness to maintain the hydraulic conductivity properties comparable to stone after compaction. Compaction of TDA should adhere to ASTM specification D6270-08, Standard Practice for Use of Scrap Tires in Civil Engineering Applications (See Appendix F).

Periodic inspections of the tire chip storage pile should be performed to maintain the recommended pile size and height.

4.2.2 Reclaimed Concrete Aggregate.

RCA may be substituted for #67 (¾") stone in select locations of the landfill. Identical to TDA, RCA will only be used in the leachate drainage layer in the intermediate waste lifts and shall not be used in the construction of chimney drains, in the drainage layer at the base of the landfill, or adjacent to any geosynthetic liner or cover material. The grain size specification for the RCA will have a maximum stone size of 6 inches and contain no more than 10 percent fines.

Placement and compaction of RCA is similar to stone aggregate. RCA layers shall be placed one-foot thick and may be tracked into soft sludge areas for added strength before a new drainage/travel layer is installed. RCA compaction shall follow the stone aggregate compaction specifications. RCA storage piles shall be located in the footprint of Cell 6D-North, with other material storage piles, and stormwater discharges can receive pollutant treatment in the sedimentation pond.

4.3 Leachate Storage

The leachate storage ponds utilize a synthetic liner to contain excess leachate. The ponds are designed to store leachate during extended wet weather periods prior to transportation to the WWTP. Typically, the ponds will be dry by design. The capacity of the ponds is approximately 1.7 million gallons. The location of the leachate ponds is shown on Figure 3-1.

4.4 Leachate Flow Control

The leachate transport piping system between the landfill and the wastewater treatment plant is designed with gate valves to control the flow if necessary. The following scenarios are described with the proper actions to be taken.

The leachate transport system includes a pump station with the capacity to handle up to 200 gpm of leachate flow. If this capacity is exceeded, the leachate flow in excess of 200 gpm will be directed to the leachate storage ponds. There are no actions required by the landfill operator for this scenario. Once the flow falls below 200 gpm, the ponds will begin to empty.

In the event the leachate transport pipe from the pump station to the treatment plant develops a leak, pipe break, blockage, or the pump station needs maintenance, the transport pipeline can be shut off. A gate valve located on the outlet of the pond can be opened, thereby allowing the ponds to fill. Leachate flow will then be directed to the leachate storage ponds for temporary storage while the problem is solved.

4.5 Leachate Disposal

The leachate generated during the operation of the secure landfill will be treated by Blue Ridge Paper Products, Inc.'s NPDES permitted wastewater treatment facility.

5.0 LANDFILL INSPECTION AND MAINTENANCE

5.1 General

Landfill inspection and maintenance will be an ongoing activity. All personnel will be expected to observe the condition of landfill facilities throughout their workday and notify the EHS management of areas and equipment which may need repair and maintenance. Formal landfill inspections will be conducted in the spring and fall of each year. Additional inspections may be warranted following unusual climatic or operational events including, but not limited to, major rain storms, flood, fire, hurricane, or earthquake. These inspections will follow the inspection forms attached in Appendix B. A description of the inspection items are discussed in the remainder of this section. EHS management is ultimately responsible to insure that the inspection and maintenance of all landfill facilities and equipment occurs.

5.2 Access Roads

The access roads to the landfill will be maintained by Blue Ridge Paper Products, Inc. Frequent inspections by the operators, especially during the spring and winter months will be made to insure that these roads are in safe condition. The summer months are most prone to dry, dusty conditions that can be a nuisance for operators and neighboring properties. Dust control measures are described in Section 5.9 for minimizing the dust problems.

Internal landfill access roads, including those within the landfill cells, will be maintained as all weather roads. Prompt attention to road repairs is the most cost-effective approach since deterioration becomes increasingly more rapid once it has begun.

Provisions will be made for snow removal during the winter to maintain relatively normal operations. Waste placement, grading, and site cleanliness become more important during the winter since waste such as ungraded frozen sludge can become a barrier to traffic movement. The access road will be plowed and sanded to provide safe travel conditions. Salt should be used sparingly. Sanding will be the preferred method of road treatment.

5.3 Equipment

Maintenance of equipment and landfill operations vehicles is critical in controlling and maintaining landfill operations. All equipment will be subject to a comprehensive, preventive maintenance program, as specified in the manufacturer's specifications. Critical parts or replacement equipment will be identified and obtainable within a short period of time to maintain continuity of operations.

5.4 Erosion Control Facilities

Open Areas - Areas outside of the landfill, which have been disturbed, will be seeded to prevent erosion. The seeding will be performed in accordance with the seeding schedule contained in the closure plan. Prior to any land disturbing activity greater than 1/2 acre, a soil and erosion plan must be secured by the appropriate mill group (EHS or Mill Engineering).

Ditches - Areas, which are riprapped or otherwise protected, will be repaired as necessary. All ditches, which are not riprapped or otherwise protected, will be seeded. All debris and other blockages will be removed from the ditch to allow for unobstructed drainage. Reseeding of the drainage ditches will be necessary from time to time, as erosion occurs.

Cover System – It is important that the Areas of the landfill that have received final cover remain intact to function to reduce leachate properly. The cover soils will be replaced and the area re-seeded in places where the final cover system has eroded. Repeated erosion in a particular area may require a different cover soil such as riprap as opposed to vegetative soil.

5.5 Leachate Collection Piping

A cleanout is located at the end of the leachate collection main. This device provides a means to remove blockages within the piping system, should they occur.

5.6 Leachate Storage Pond

To insure the integrity of the leachate storage pond, annual inspections will be made. When the ponds are empty, visual inspection of the liner will be made. Any tears or punctures will be noted and repaired.

5.7 Liner Repair

If tears or punctures occur in the liner within the pond or along the sideslopes of the landfill, they will be repaired as soon as possible. Punctures and tears less than 6 inches in length will be repaired by Blue Ridge Paper Products, Inc. personnel if trained personnel are available. Repairs will involve placement of an overlapping patch (6-inch minimum overlap) which will be tack-welded to the underlying liner. Extra liner will be stored on-site for field repairs. If the liner tear is greater than 6 inches in length, a liner installer will be contacted to make the necessary repairs.

5.8 Landfill Underdrain System

The landfill underdrain system will be inspected on a monthly basis. An inspection form, see Appendix B, will be filled out to document each inspection. The inspection will consist of the following list.

1. Pipe outlets shall be checked for blockages and that the discharge is not eroding the outlet ditch. Any blockages should be removed to provide free flow from the pipe outlet. If erosion should occur, the ditch outlet should be stabilized, riprapped, or otherwise reinforced. The end of the pipe also has a rodent guard to prevent animals from entering the pipe. This should be checked and repaired, if necessary.

2. Inspect the manholes for blockages or silt build-up. For either case, the EHS management should have the manhole cleaned and reinspected.

In addition to a monthly inspection, the underdrains shall be inspected after any major rain storms, floods, fire, hurricane, and earthquake or facility failure.

5.9 Fugitive Dust Control

Landfill activities can be a potential source of dust. Dust results from trucks driving over the gravel access roads, blowing of dry waste transported in the trucks, and dust emissions during the landfilling of dry waste. The special handling of dry waste such as fly ash and prevention of dust emissions during landfilling activities is described in Section 2.9.2.

The Canton Mill fly ash collection, storage, and loading vessel incorporates a wetting system to raise the moisture content of the fly ash so that it can be transported without dusting. Transport truck beds are covered with tarps to prevent escape of dust from dry waste during hauling. The application of dust control measures on gravel access roads within the landfill is discussed below.

Dust control measures will be implemented at the facility by utilizing water spray trucks to wet gravel roads during dry periods. Additional measures such as applying calcium chloride may be required on an as needed basis. The primary access road to the facility has been paved in order to reduce dust generation.

In addition to water, several alternative dust control agents exist for suppressing dust with sand utilized as needed. Some alternatives include natural salt brine solutions as a replacement for calcium chloride; asphalt emulsions; organic, non-bituminous materials; and polymers.

6.0 WATER QUALITY MONITORING

6.1 General

To aid in evaluating the performance of the landfill, a groundwater and surface water monitoring program will be conducted. The collection, preparation, preservation, and delivery of the samples to the laboratory shall be the responsibility of the EHS. A description of the sampling program and procedures is provided in the Environmental Monitoring Plan in Appendix C.

7.0 LANDFILL GAS MONITORING

7.1 Landfill Gas Characteristics

Landfill gas (LFG) is mixture of several gases that are produced through anaerobic (oxygen less) decomposition of organic wastes. Typically, LFG is composed of mainly methane and carbon dioxide with smaller amounts of nitrogen and water vapor. LFG is also composed of trace amounts of hydrogen sulfide, other sulfur compounds, and volatile organic compounds (VOCs). Typical components of LFG are shown below in Table 7-1.

TABLE 7-1

TYPICAL COMPONENTS OF LANDFILL GAS

Component	Percent (dry volume basis except moisture)
Methane	45 – 60
Carbon Dioxide	40 – 60
Nitrogen	2 – 5
Oxygen	0.1 – 1
Hydrogen sulfides, disulfides and other sulfur compounds	0 – 1
Ammonia	0.1 – 1
Hydrogen	0 – 0.2
Carbon Monoxide	0 – 0.2
Moisture	2 – 12
Volatile Organic Compounds (VOCs)	0.01 – 0.6

Section 7.2 of this manual outlines the requirements for landfill gas sampling and analysis which is undertaken as part of the system's operations. General landfill gas characteristics which an operator should be aware of include:

- LFG production undergoes changes over the life of the waste placed. Initially air entrained in the waste stimulates aerobic decomposition and produces mainly carbon dioxide. As the oxygen is depleted, large amounts of carbon dioxide are produced with some hydrogen. During complete anaerobic conditions, methane production begins and as the waste ages, the methane, carbon dioxide, and nitrogen production becomes fairly steady.

- LFG is primarily composed of methane (typically 50%) and carbon dioxide (typically 45%) both colorless and odorless gases. The odor associated with LFG is due to the lesser and trace gases, such as hydrogen sulfide, that are part of the LFG mixture.

- LFG is flammable and potentially explosive. Methane has a flammability range of 5 to 15 percent by volume in air. Five percent being the lower explosive limit (LEL) and 15 percent being the upper explosive limit (UEL). Between these limits, the LFG-air mixture is readily flammable. Just because LFG contains methane above the UEL does not mean that somewhere away from the source the conditions for flammability are not met.

- Methane and carbon dioxide have specific gravities of 0.55 and 1.52, respectively. However, the mixture that comprises LFG has a specific gravity closer to that of air (i.e., 1.0); it should not be assumed that LFG will rise.

- LFG can migrate within open conduits and through trench backfill or through the vadose zone (unsaturated soil or bedrock above the water table). This migration can allow it to accumulate to flammable or lethal levels in manholes, buildings and other structures designed for human occupancy. This migration through the vadose zone may also cause the LFG to separate into its component gases. LFG migration below the landfill is limited by the presence of a geosynthetic liner system.

7.2 LFG Monitoring

During the operation of the facility, gas monitoring will be conducted at six gas probes and the ambient air of the Crew House and the Pump Station Motor Control Room. These gas monitoring locations are shown on Figure 7-1. The gas monitoring locations have been selected between the waste boundary and the landfill property boundary to monitor the vadose zone for potential LFG intrusion. These probes, the Crew House, and the Pump Station Motor

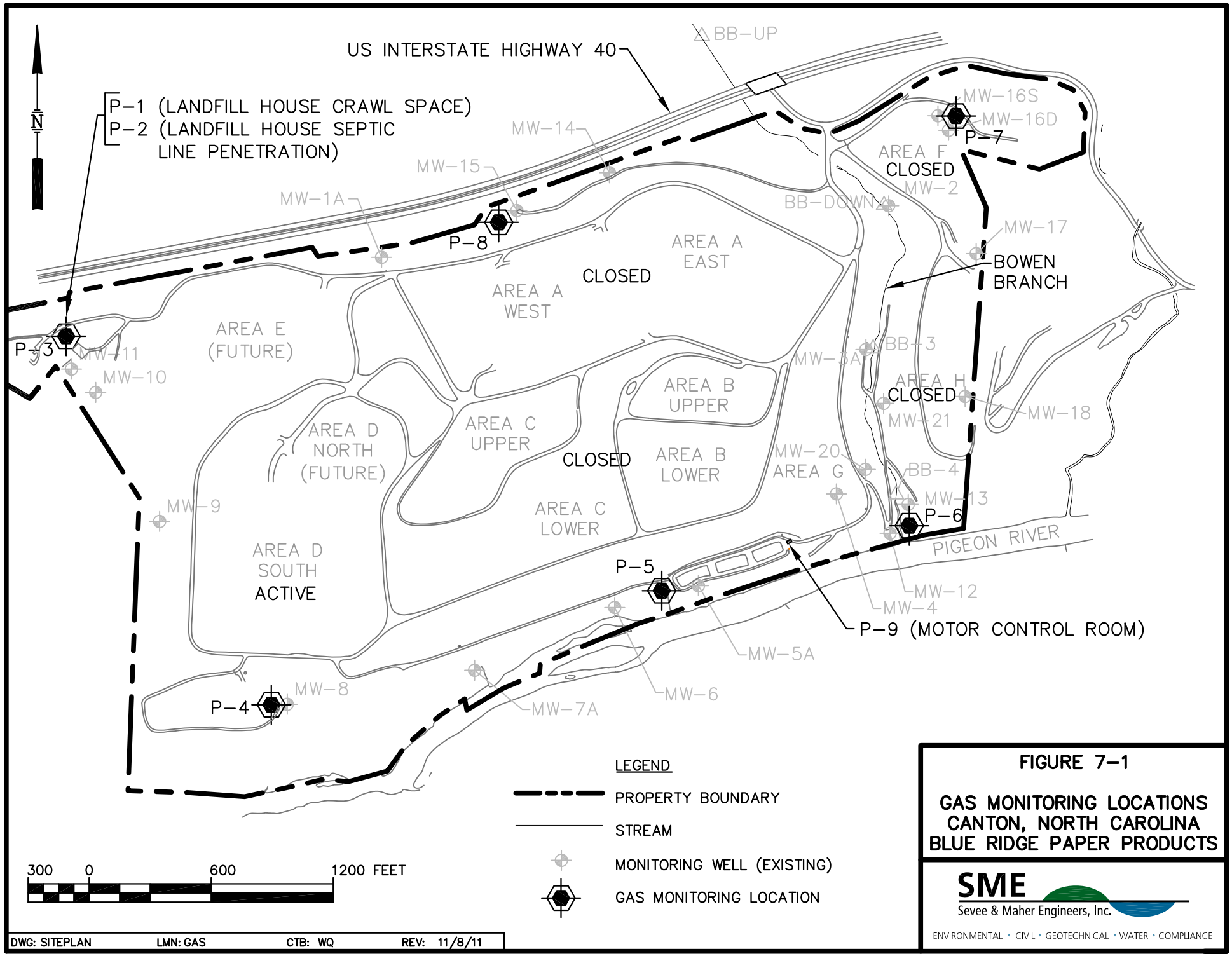

FIGURE 7-1

GAS MONITORING LOCATIONS
CANTON, NORTH CAROLINA
BLUE RIDGE PAPER PRODUCTS

Control Room are monitored on a semi-annual basis for methane concentration in % LEL and hydrogen sulfide in ppm. The equipment to monitor the gas concentrations includes:

- Industrial Scientific Meter, Model MX251 or equal; and
- CES-Landtec Gem 2000 Landfill Gas Monitor or equal.

If landfill gases are detected above 100 percent of the LEL at the property line monitoring locations or exceed 25 percent of the LEL at the Crew House or Motor Control Room, the EHS Department will notify NCDENR.

In the event the gas levels rise to the point where there is a hazard to health, safety, or property, the following steps shall be taken:

- Evacuate all personnel immediately to a safe distance upwind from the landfill;
- Ventilate any structures;
- Notify NCDENR;
- Investigate to determine the source of the gas release; and
- Remediate the problem.

8.0 RECORD KEEPING & REPORTING

8.1 General

One of the most important elements of a well run landfill is an efficient record keeping system. For a facility of this nature, it requires the timely collection, interpretation, and management of large volumes of data. Data collected will be presented in an annual report to the NCDENR. The annual report will include the source, type, and volume of waste accepted over the course of the calendar year.

A copy of the permit and operating plan will be maintained at the facility.

8.2 Operating Records and Annual Reports

(a) Blue Ridge Paper Products, Inc. will maintain documentation of all facility operations, including:

(1) Identification of the facility, owner, and operator;
(2) Quantity, type and source(s) of wastes received;
(3) Complete record of inspections, maintenance, repairs, and emergency event response;
(4) Data on all environmental monitoring required for current operating cell.

(b) Blue Ridge Paper Products, Inc. will file an annual report of operation with the NCDENR by July 31 of each year, for the previous 12 months of operation.

8.3 Waste Description

The Landfill is licensed to dispose of wastes which fall into six general categories. Regardless of the type of waste, similar accounting procedures will be used. Accounting will include logging the number of truckloads with regard to waste type and volume.

The general categories of accepted waste are:

1. Fly ash from multi-fuel boilers;
2. Lime waste (mud);
3. Wastewater treatment plant sludge;
4. Wood waste debris;
5. Cinders;
6. Asbestos containing material (ACM); and
7. Biosolids.

The scaled amount of each category of acceptable waste will be recorded on a truckload log sheet. Truck weight samples of each waste category will be logged as needed. A copy of the log sheet is included in Appendix A.

9.0 FINAL CLOSURE

9.1 General

Closure of the site is a continuing process which includes the following activities:

1. Final waste grading and shaping;
2. Closure of discontinued channels, pipes, or drains;
3. Placement of cover materials;
4. Seeding and fertilizing.

The principle goals of the closure plan for the Landfill are: 1) to minimize future generation of leachate; and 2) to provide a cover system suitable for developing a grass crop which will prevent erosion. The final cover system designed for this site will minimize future generation of leachate, and provide a suitable stormwater management plan which will minimize the potential of erosion.

Inspection and monitoring of closed areas are necessary to detect erosion and to initiate repair for prevention of significant damage to the landfill cover. Uneven settlement may result in ponding or breaks in the cover system, these areas will be rebuilt and/or regraded to restore proposed contours. In addition, maintenance and post-closure care will include periodic mowing to discourage large, deep-rooted vegetation which can damage the cover integrity.

The Owner may permit third-party use of select areas for alternative use; however, State approval must be obtained. One such use is the FLS Energy Solar array located on Area B-Lower which was approved in 2009. Further information is provided in Section 9.8, Alternative Uses.

9.2 Closure Procedures

The subsections which follow describe the various closure procedures and activities which must be performed.

9.2.1 Grading. The waste will be placed and graded to design final waste elevations. Prior to seeding, a surveyor will check elevations to insure that the proper grades exist and there are no low areas or depressions within the site. The surveyor will also check the perimeter slopes to be sure they do not exceed the proper grades. Spot elevations will be taken in the surface runoff ditches to insure that proper slopes exist.

9.2.2 Drainage Channels, Pipes, or Drains. The closure of channels, pipes, or drains will be accomplished in a manner which ensures the integrity of the system for the system's design life.

The design life of all components within the landfill is 50 years; typical products which have this life are stainless steel and high-density polyethylene (HDPE). Design of the closure should also take into consideration the forces acting on the area of interest.

9.2.3 Final Cover System. The final cover system over the Landfill will consist of three layers. The three layers from top to bottom are:

1. Four inches of vegetative cover soil;
2. 36 inches of suitable on-site soils, i.e. residual soils; and
3. 12 inches of granular drainage material.

The 12-inch granular drainage layer will tie into the stone leachate collection and drainage layer along the perimeter of the landfill.

Permanent markers consisting of metal or fiberglass placards will be placed at the waste boundary of landfill cells that have been permanently closed. The markers will extend up approximately 3 to 5 feet above the final cover surface, contain the words “Edge of Waste,” or

"EOW," and have a spacing not to exceed 250 feet. Caution should be taken when installing the sign post so as not to penetrate the liner.

9.2.4 Seeding. All areas which have final cover applied will be seeded. Seeding should normally occur between March 1 and October 15. All surface grading and construction of runoff control structures such as drainage ditches, berms, and culverts are to be performed prior to seeding. The top layer of soil shall be loosened by raking, discing, or other acceptable means before seeding. Lime (2 tons/acre or as needed based on testing) and fertilizer (1,000 lbs/acre of 10/10/10 or as needed based on testing) will be harrowed or disced into the soil at a minimum of 3 inches. If the site is hydroseeded, lime, fertilizer and seed can be applied simultaneously. The seed mixture to be used is as shown below.

SEEDING MIXTURE (OR EQUAL)

Tall Fescue (KY 31)	80 lb/acre
Sericea lespedeza	20 lb/acre
Kobe lespedeza	10 lb/acre
	110 lb/acre

The seed will be applied uniformly with a cyclone seeder, drill, cultipack seeder, or hydroseeder. Seed should not be planted if there is a danger of frost shortly after seed germination. Maximum seeding depth is 1/4 inch when using methods other than hydroseeding.

9.3 Erosion Control

The following procedures will be used for erosion control on the seeded areas:

- Slopes less than 4:1 - Apply unrotted, long-fibered hay, straw, or cellulose fiber at a rate of 2 tons per acre. Mulch material should be relatively free of all kinds of weeds, and should be anchored with a tractor drawn implement designed to punch and anchor it into the top 2 inches of soil. Anchoring of the mulch will be

performed immediately after placement to minimize loss by wind or water. This method of anchoring should be done on the contour wherever possible.

- Slopes steeper than 4:1 - On 4:1 slopes or steeper, the seed will be applied by hydroseeding with a binder or excelsior matting to control erosion. Siltation fences will be installed at the bottom of all seeded slopes. Berms will divert runoff from the top of the slopes to established slopes.

- Drainage ditches - The grass-bottomed drainage ditches will be seeded in the same manner as the remainder of the site. The same mulch specified above will be placed in these areas. Staples, lightweight biodegradable paper, plastic, or cotton nettings will be placed within the ditches to anchor the mulch.

9.4 Long-Term (Post-Closure) Maintenance

The subsections which follow describe the various activities which must be performed to insure the long-term integrity of the landfill subsequent to final closure.

9.4.1 Mowing. To prevent deep-rooted tree growth, the closed portions of the landfill and drainage ditches will be mowed at least twice per year. Evergreen/Blue Ridge permits local farmers to use several areas that have final cover applied for hay production provided they cut the area at least 2 times per year to prevent tree growth.

9.4.2 Site Inspection. Once the landfill is closed, the area will be inspected by the EHS in the spring and fall of each year for a period of at least three years to insure the cover system integrity is maintained against differential settlement, erosion and other problems. The inspection will include an examination of the following items:

- Surface drainageways
- Surface grading
- Grass growth

Each inspection will include notation of any problems and recommended remedial actions. Following the three years, an inspection frequency of once per year will be sufficient unless major problems develop, whereupon more frequent inspections will be made.

9.5 Leachate Collection

Leachate collection will continue past the closure of the landfill. The primary source of leachate during this period will be consolidation of waste. The amount of leachate which must be collected, transported, and treated will be greatly reduced from that generated during operation of the landfill.

9.6 Water Quality Monitoring

The semi-annual monitoring program described elsewhere in this manual will continue after site closure. After closure, if the concentrations of parameters analyzed stabilize, the NCDENR can be approached to reduce the frequency of sampling and the number of parameters analyzed.

9.7 Gas Monitoring

Landfill gas shall be monitored in accordance with Section 7.0 until the facility effectively ceases generation of gas.

9.8 Alternative Uses

The owner may permit third-party use of select areas of the landfill for alternative use; however, State approval must be obtained. In such cases, the person or company responsible for the operation and maintenance of the specific site must be made available. Examples of this may include but are not limited to security, fencing, mowing, and maintaining the integrity of the cap.

9.8.1 Solar Array. In 2009, approval was granted for FLS Energy to install and operate a solar array located on the closed portion of the landfill, Area B-Lower. This area is shown on Figure 3-1. FLS Energy maintains all responsibility for operating equipment associated with the

solar array, and is required to install perimeter fencing and maintain all interior vegetated areas according to Section 9.4.

FLS Energy Contact information:

FLS Energy Inc.
239 Amboy Road
Asheville, NC 28806
Ph# (828) 350-3993

APPENDIX A

WASTE RECEIPT FORMS

LANDFILL
MONTHLY LOAD WEIGHTS

MONTH/YEAR_____

DATE	LIME 25 LOADS P/M	SLUDGE 25 LOADS P/M	FLYASH 20 LOADS P/M	CINDERS 5 LOADS P/M	WOODWASTE 2 LOADS P/M
1					
2					
3					
4					
5					
6					
7					
8					
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21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					

APPENDIX B

INSPECTION FORMS

UNDERDRAIN INSPECTION RECORD

INSPECTION BY: _____

DAY | S | M | T | W | T | F | S |

DATE _____

UNDERDRAIN LOCATION: _____

WEATHER _____

_____

TEMP. _____

PIPE OUTLET

	PASS	CORRECTIVE ACTION REQUIRED
BLOCKAGES	_____	_____
RODENT GUARD	_____	_____
DITCH OUTLET	_____	_____

CORRECTIVE ACTION: _____

_____

MANHOLE

BLOCKAGES	_____	_____
SILT BUILD-UP	_____	_____
M.H. COVER IN PLACE	_____	_____

CORRECTIVE ACTION: _____

_____

FOLLOW-UP INSPECTIONS OF PREVIOUSLY REPORTED DEFICIENCIES _____

_____

_____

_____

DISTRIBUTION: 1. ELS MANAGEMENT
2. EOHS

SEVEE & MAHER ENGINEERS

LANDFILL INSPECTION RECORD

INSPECTION BY: _____ DAY | S | M | T | W | T | F | S |

LOCATION: _____ DATE: _____

REASON FOR INSPECTION: _____ TEMP.: _____

ACCESS ROADS	PASS	CORRECTIVE ACTION REQUIRED
ROAD SURFACE	_____	_____
CULVERTS	_____	_____

CORRECTIVE ACTION: _____

LEACHATE STORAGE POND / PIPELINE		
CONDITION OF VISIBLE LINER	_____	_____
FENCE	_____	_____
FLOW RECORDERS	_____	_____
MANHOLE COVERS	_____	_____
EROSION	_____	_____

CORRECTIVE ACTION: _____

LANDFILL OPERATIONS		
SLOPE STABILITY	_____	_____
WASTE COVERED	_____	_____
SETBACK ALONG DIKES	_____	_____
INLET STRUCTURES	_____	_____

CORRECTIVE ACTION: _____

CLOSURE AREAS		
SLOPE STABILITY	_____	_____
VEGETATION	_____	_____
EROSION	_____	_____
DITCHES	_____	_____

CORRECTIVE ACTION: _____

FOLLOWUP INSPECTIONS OF PERVIOUSLY REPORTED DEFICIENCIES _____

DISTRIBUTION:
1. ELS MANAGEMENT
2. EOHS

APPENDIX C

ENVIRONMENTAL MONITORING PLAN

ENVIRONMENTAL MONITORING PLAN
LANDFILL NO. 6
CANTON, NORTH CAROLINA

BLUE RIDGE PAPER PRODUCTS INC. – CANTON MILL
DIVISION OF EVERGREEN PACKAGING
CANTON, NORTH CAROLINA

MAY 2009

SME

Sevee & Maher Engineers, Inc.

Waste Management and Hydrogeologic Consultants

Cumberland Center, Maine

NORTH CAROLINA PROFESSIONAL SEAL 23489 ENGINEER JOHN E. SEVEE

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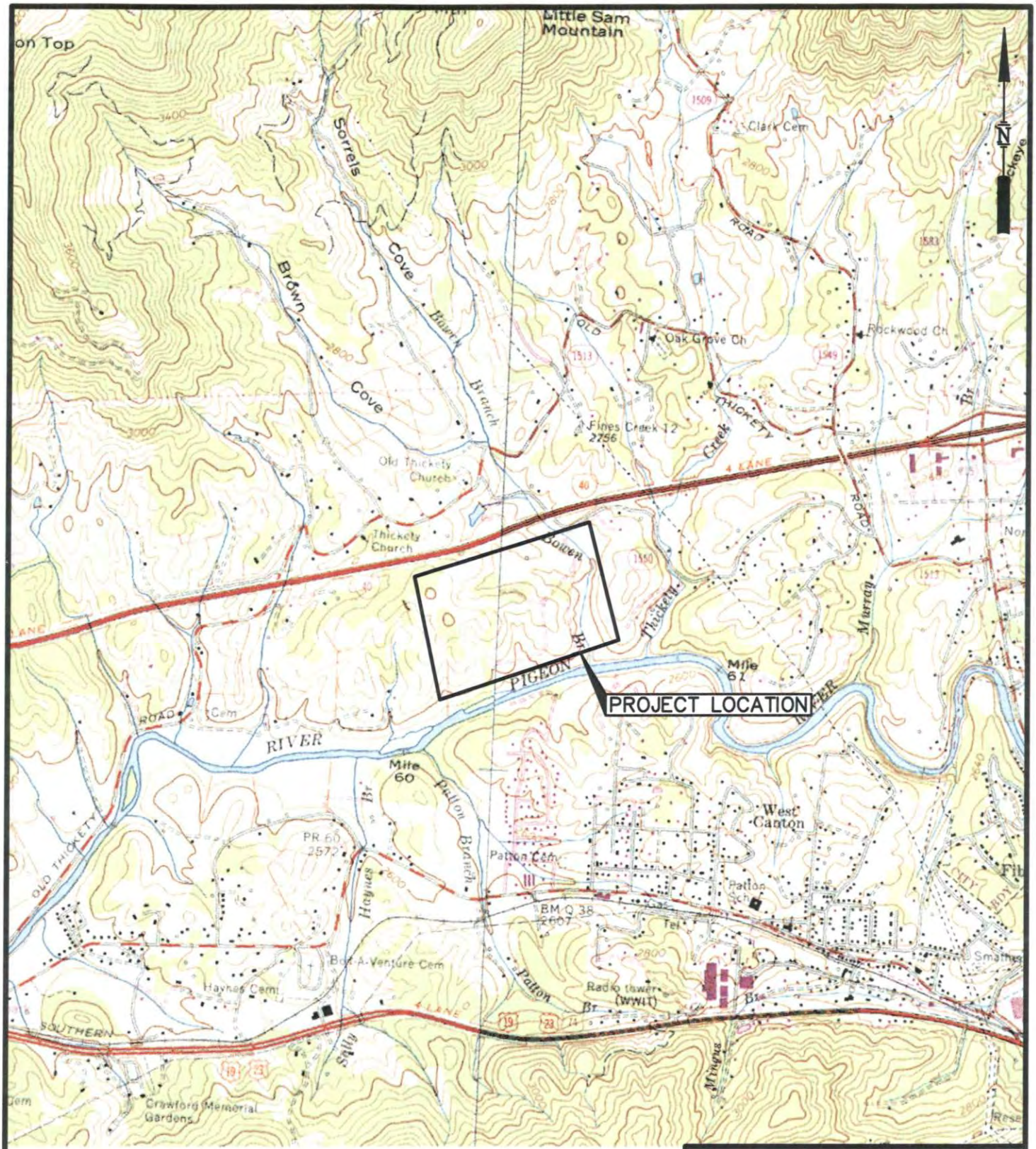
1.0 INTRODUCTION

This Environmental Monitoring Plan (EMP) summarizes the sampling procedures and analytical methods to be used for groundwater, surface water, underdrain, and leachate monitoring at the Blue Ridge paper Products Inc.'s (BRPP) Landfill No. 6 site in Canton, North Carolina (See Figure 1-1). The procedures, protocols, methods, and monitoring locations in this EMP shall not be changed or altered without approval from the North Carolina Department of Environment and Natural Resources (NCDENR).



BASE MAP ADAPTED FROM 7.5 MIN
USGS TOPOGRAPHIC QUADRANGLES:
CLYDE, NC–1978 & CANTON, NC–1990

1000 0 2000 4000 FEET

FIGURE 1–1
SITE LOCATION MAP
BLUE RIDGE PAPER PRODUCTS, INC.
LANDFILL NO. 6
CANTON, NORTH CAROLINA

SME
Sevee & Maher Engineers, Inc.

DWG: SITE LMN: NO–6 CTB: HPSTD REV: 4/22/09

\\Aserver\cfs\Brpp\NC\6a-west\acad\SITE.dwg, 4/24/2009 1:15:37 PM, paf

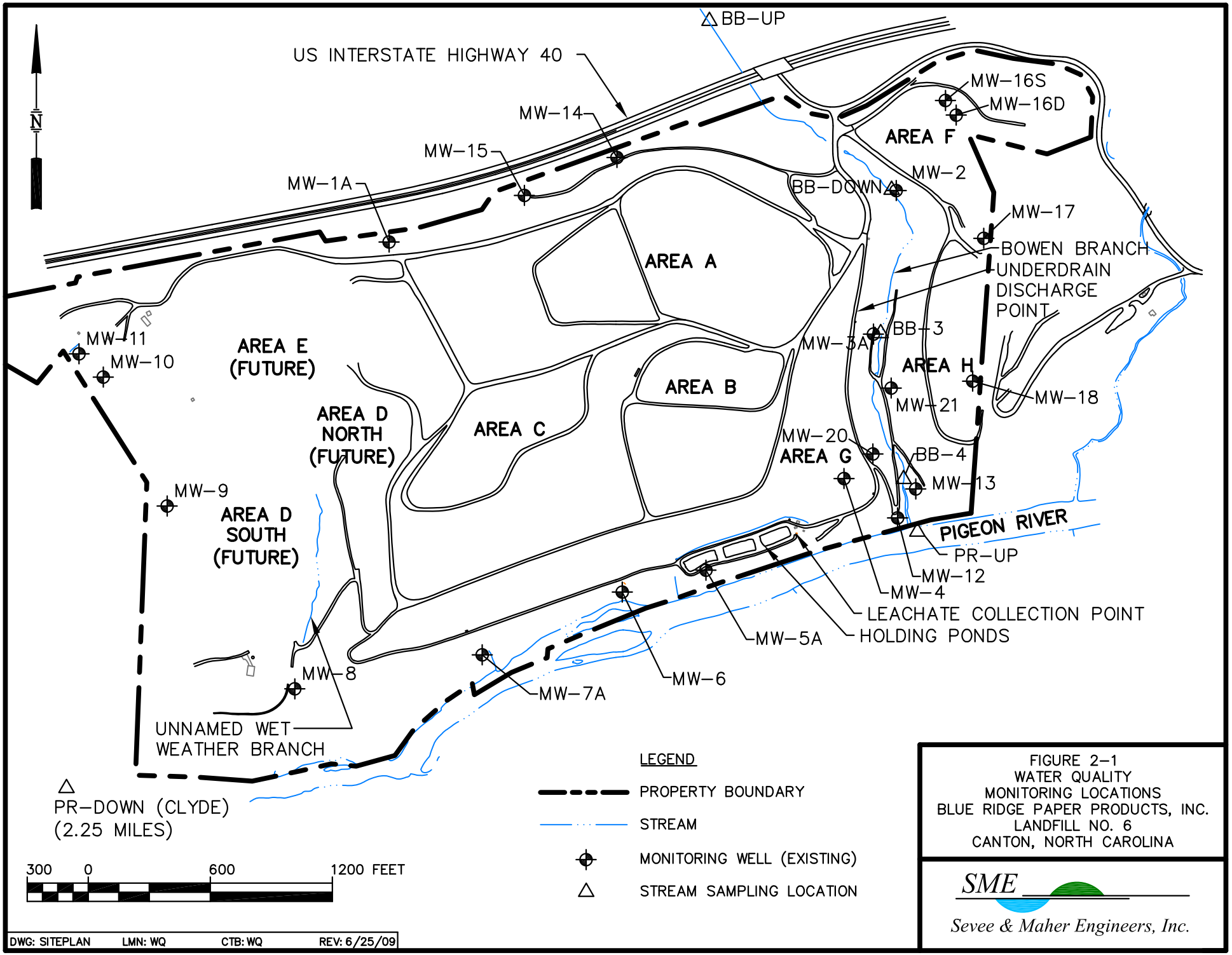
2.0 SAMPLING LOCATIONS AND FREQUENCY

Samples will be collected from twenty-one (21) groundwater locations, six (6) surface water locations, one (1) underdrain location, and one (1) leachate location on a semi-annual basis in March and November. The groundwater, surface water, underdrain, and leachate locations are listed in Table 2-1 and shown on Figure 2-1.

TABLE 2-1

ENVIRONMENTAL MONITORING LOCATIONS
LANDFILL NO. 6
BLUE RIDGE PAPER INC., CANTON, NORTH CAROLINA

GROUNDWATER LOCATIONS		
MW-1A	MW-8	MW-16S
MW-2	MW-9	MW-16D
MW-3A	MW-10	MW-17
MW-4	MW-11	MW-18
MW-5A	MW-12	MW-20
MW-6	MW-13	MW-21
MW-7A	MW-14	
	MW-15	
SURFACE WATER LOCATIONS		
BB-UP (Bowen Branch Upstream)		
BB-DOWN (Bowen Branch Downstream)		
BB-3		
BB-4		
PR-UP		
PR-DOWN		
UNDERDRAIN LOCATION		
Bowen Branch Underdrain Discharge Point		
LEACHATE LOCATION		
Leachate Collection Point in Area G		


N
US INTERSTATE HIGHWAY 40
BB-UP
MW-14
MW-15
MW-1A
MW-16S
MW-16D
AREA F
MW-2
BB-DOWN
MW-17
BOWEN BRANCH
UNDERDRAIN
DISCHARGE
POINT
AREA A
BB-3
MW-3A
AREA H
MW-18
MW-21
AREA B
AREA C
MW-11
MW-10
AREA E
(FUTURE)
AREA D
NORTH
(FUTURE)
MW-20
AREA G
BB-4
MW-13
MW-9
AREA D
SOUTH
(FUTURE)
PIGEON RIVER
PR-UP
MW-12
MW-4
LEACHATE COLLECTION POINT
HOLDING PONDS
MW-5A
MW-6
MW-7A
MW-8
UNNAMED WET
WEATHER BRANCH
PR-DOWN (CLYDE)
(2.25 MILES)
300 0 600 1200 FEET
LEGEND
PROPERTY BOUNDARY
STREAM
MONITORING WELL (EXISTING)
STREAM SAMPLING LOCATION
FIGURE 2-1
WATER QUALITY
MONITORING LOCATIONS
BLUE RIDGE PAPER PRODUCTS, INC.
LANDFILL NO. 6
CANTON, NORTH CAROLINA
SME
Sevee & Maher Engineers, Inc.
DWG: SITEPLAN LMN: WQ CTB: WQ REV: 6/25/09
P:\Brpp\NC\6a-Valleyfill\acad\Siteplan.dwg, 6/25/2009 10:46:02 AM, mbiskup

3.0 WATER QUALITY MONITORING PARAMETERS

The field and laboratory monitoring parameters, analytical methods, and reportable detection limits (RDLs) for the groundwater, surface water, underdrain, and leachate monitoring are shown in Table 3-1.

TABLE 3-1

ANALYTICAL PROGRAM
LANDFILL NO. 6
BLUE RIDGE PAPER INC., CANTON, NORTH CAROLINA

Water Quality Parameter	Units	Analytical Method	RDLs[1]
Specific Conductance at 25°C (Field)	µmhos/cm	SM 2510B	10
Temperature (Field)	degrees C	SM 2550B	0.1
pH (Field)	pH units	SM 4500 HB	0.1
Turbidity (Field)	NTU	Field Screen	1.0
Nitrate-Nitrite as N	mg/l	SM 4500 NO3H	0.20
Nitrite as N	mg/l	SM 4500 NO2B	0.01
Total Dissolved Solids	mg/l	SM 2540C	25
Total Organic Carbon	mg/l	SM 5310C	0.5
Total Recoverable Phenols	mg/l	EPA 420.1	0.005
Chloride	mg/l	EPA 300.0	1.0
Fluoride	mg/l	EPA 300.0	0.1
Sulfate	mg/l	EPA 300.0	1.0
Arsenic ICPMS	mg/l	EPA 200.8	0.005
Barium	mg/l	EPA 200.7	0.01
Cadmium ICPMS	mg/l	EPA 200.8	0.001
Calcium	mg/l	EPA 200.7	0.01
Chromium ICPMS	mg/l	EPA 200.8	0.002
Copper ICPMS	mg/l	EPA 200.8	0.005
Iron	mg/l	EPA 200.7	0.05
Lead ICPMS	mg/l	EPA 200.8	0.005
Magnesium	mg/l	EPA 200.7	0.01
Manganese ICPMS	mg/l	EPA 200.8	0.005
Mercury	mg/l	EPA 245.1	0.0002
Nickel ICPMS	mg/l	EPA 200.8	0.005
Potassium	mg/l	EPA 200.7	0.5
Selenium ICPMS	mg/l	EPA 200.8	0.005
Silver ICPMS	mg/l	EPA 200.8	0.002
Sodium	mg/l	EPA 200.7	0.05
Zinc	mg/l	EPA 200.7	0.02
TOX	mg/l	SW 846 9020B	0.03
BOD[2]	mg/l	SM 5210B	2.0
COD[2]	mg/l	EPA 410.4	20
Total Phosphorous[3]	mg/l	SM 4500 PE	0.02

Notes:
1. RDL = Reportable Detection Limits
2. BOD and COD are done on the leachate and underdrain samples only.
3. Total phosphorous as Phosphate is done on leachate only.

Method Reference: The analytical methods selected are presented in Test Methods for Evaluating Solid Waste, OSWER, SW-846, Third Edition, as revised; Methods for Chemical analysis of Water and Wastes, EMSL, EPA-600/4-79-020, revised March 1983; and Standard Methods for the Examination of Water and Wastewater, APHA, 19th Edition, 1995. Equivalent and appropriate analytical methods may be substituted with Juniper Ridge Landfill approval, e.g., manual for automated and vice versa.

4.0 SAMPLING PROCEDURES

The following sections describe the procedures to be followed for collecting groundwater, surface water, underdrain, and leachate samples at the BRPP site. Sample recordkeeping forms and chain-of-custody forms to be completed for each water quality monitoring location are presented in Appendix A. Monitoring well installation diagrams for the BRPP monitoring wells are presented in Appendix B.

4.1 Groundwater Sample Collection

There is typically one of three possible purging and sampling procedures followed for collection of samples from the monitoring well locations at the BRPP site. The specific sampling methods are shown in Subsection 4.1.2, 4.1.3, and 4.1.4.

4.1.1 Well Inspection and Water Level Measurement. Upon arrival at each groundwater sampling location, the sampling personnel will observe the physical condition of the monitoring well(s). The inspection will include observation of the condition of the ground surface seal and the well guard pipe to evaluate if any evidence of frost heaving, cracks, or vandalism are present. The condition of the monitoring well will be recorded on the field data records. Periodically, the area around the well may have to be cleared of weeds, brush, or other materials prior to beginning the water sampling activity.

Following inspection of the sampling location, the water level will be measured. The water level in the well casing will be determined by lowering a clean electronic sounding probe into the well until contact with the water surface is made. The distance from the monitoring well reference elevation to the water surface contact will be entered into the field records. Water levels in the monitoring wells will be measured to the nearest 0.01 foot. In all cases, the depth to water will be referenced to the top of the PVC well casing (permanently marked measurement reference point). In instances where water is flowing from the well casing, the water level will be noted as

such. Upon removing the water level probe, it will be decontaminated as described in Section 5.0.

4.1.2 Monitoring Wells Where a Bladder Pump is Used. A submersible bladder pump is used to purge and sample monitoring well locations listed below. The bladder pump is adjusted to remove water from the monitoring well at a rate of approximately 200 millimeters per minute. Field measurements for pH, conductivity, temperature, and turbidity are monitored at five-minute or more intervals until three consecutive field readings are within the field parameter stabilization listed below for approximately 30 minutes prior to sample collection. The use of a bladder pump is applicable at the following wells:

MW-13	MW-16S
MW-14	MW-18
MW-15	MW-21
MW-16D	

Field parameter stabilization criteria:

pH	± 0.1 standard pH unit with respect to previous pH measurement.
Specific conductance	± 10% of previous measurement.
Turbidity	± 10% or <10 NTU of previous measurement.
Temperature	± 1°C of previous measurement.

4.1.3 Monitoring Wells Where a Submersible Grundfos Pump is Used. A submersible Grundfos pump is used to purge and sample the monitoring well locations listed below. The Grundfos pump is adjusted to remove water from the monitoring well at a flow rate of between 1.0 and 1.5 gpm. Field measurements for pH, conductivity, temperature, and turbidity are taken every six to ten minutes until three or more well volumes are removed and the field parameters stabilize as discussed in Section 4.1.2. A sample is collected after completing the above purging process. If the water column is drawn down to the pump head, the pump will be turned off and a sample of

the recharge water will be collected. The use of a Grundfos pump is applicable at the following locations:

MW-10
MW-17
MW-20

4.1.4 Monitoring Wells Where a Bailer is Used for Sample Collection. A Teflon bailer is used to purge and sample the monitoring locations listed below. In the case where the well has sufficient recharge, three well volumes of water will be removed from the well prior to sample collection. In the case where the recharge is insufficient and the well water is drawn down significantly, the well will be purged close to dry and a sample of the recharge will be collected. In the case where the monitoring well produces three volumes of water, periodic field measurements of pH, conductivity, temperature, and turbidity will be monitored, and purging will continue until these parameters have stabilized as discussed in Section 4.1.2. The following wells will be sampled using a bailer:

MW-1A	MW-7A
MW-2	MW-8
MW-3A	MW-9
MW-4	MW-11
MW-5A	MW-12
MW-6	

4.2 Surface Water and Underdrain Sampling Procedure

Surface water samples from the six surface water locations as well as the one underdrain location listed in Table 2-1 will be collected in the following manner:

1. Collect the sample by immersing the sample bottle or sampling device not more than 1 foot below the water surface. If a stream is being sampled, the sample point will be upstream of the sampler with the opening of the sample bottle or sampling device oriented upstream, but avoiding floating debris. If a culvert is

being sampled, the sample bottle or sampling device will be placed where the water flows out of the bottom of the culvert.

2. Directly fill the appropriate sample containers from the sampling device if needed.

3. If possible, measure the following parameters in the water body:

   - temperature
   - pH
   - specific conductance
   - turbidity

   If direct measurement is not possible, these parameters will be measured from water remaining in the sampling device or a separate plastic bottle. This information will be recorded in the sample data record, sample labels will be completed, and the chain-of-custody (COC) procedures will be initiated.

4. Complete the Surface Water or Underdrain Sample Data Record (see Appendix A).

4.3 Leachate Sampling Procedure

Leachate samples will be collected from the leachate manhole by either using a Teflon bailer or a glass beaker attached to a pole. After filling sample bottles, pH, conductivity, temperature, and turbidity readings will be taken.

The information will be recorded on a Leachate Sample Data Record (see Appendix A), sample labels will be completed, and the COC procedures will be initiated.

4.4 Sample Volume, Preservation, and Holding Times

Obtaining required sample volumes, adhering to specified sample preservation procedures and complying with allowable sample holding times are necessary to produce analytical testing results which will be representative of the site water quality conditions. In preparing for each sampling event, the sampling personnel will prepare schedules which will permit adequate laboratory notification and sample delivery to allow testing within the allowable holding times. Preservation of collected samples is accomplished by refrigerating samples at 4 degrees Celsius (°C) and in some cases by acidification. Physical preservation of the samples will be accomplished by storing the filled sample bottles in covered insulated coolers constructed of impact resistant plastic. Efforts will be made to pack the coolers such that the sample bottles are not subject to movement or breakage.

4.5 Field Instrumentation Calibration

Sampling quality control will include the daily calibration of field equipment used to measure pH, turbidity, and specific conductance.

5.0 EQUIPMENT DECONTAMINATION

Decontamination of the sampling equipment and instrumentation is required prior to initiation of sampling and between each sample location to minimize the potential for cross contamination between samples. Clean nitrile or PVC gloves will be worn to reduce contamination potential when performing the decontamination activities, when handling decontaminated sampling equipment, as well as prior to and during all sampling.

5.1 Field Instrumentation Decontamination

Field instrumentation, i.e., pH, specific conductance, turbidity, and temperature probes and meters will, under no circumstances, be introduced into a sampling device or sample bottle. To minimize latent influences between sampling locations, the probes and meters will be rinsed with distilled water and, when appropriate, wiped dry with clean paper towels. The electronic water level probe will be introduced into monitoring well(s) prior to the purging process. Upon extraction from a monitoring well, the probe and associated electric lead wire(s) will be cleaned with consecutive rinses of distilled water.

5.2 Bladder Pump and Grundfos Pump Decontamination

The Grundfos pumps and bladder pumps used for well purging and sampling, along with the tubing attached to them, will be decontaminated as follows. The bladder pump is cleaned with a solution of soapy water, deionized (DI) water rinse, rinsed with alcohol, and followed by a DI water rinse. Each bladder as well as the pump seals and tubing are replaced between wells. The outside of the Grundfos pump is cleaned in the same manner as the bladder pump. Several gallons of DI water is pumped through the Grundfos pump and all tubing is replaced between samples.

5.3 Teflon Bailer Decontamination

Each Teflon bailer used to purge and sample at monitoring well locations will be cleaned in the Rogers and Callcott laboratory with a soapy hot water scrub, hot water rinse, alcohol rinse, and DI water rinse. Each bailer will be wrapped with tin foil after decontamination and prior to use.

6.0 SAMPLE CUSTODY

Chain-of-custody (COC) procedures will be followed during sample collection and handling activities during both the field and laboratory operations. The COC procedures assure that each sample is accounted for at all times. To maintain the highest degree of control in sample handling, preprinted labels will be utilized so that all necessary information is retained with the sample. COC records will be used to maintain control over sample access during and after shipment from the sampling location. Additionally, proper completion of field sample logs, accession books, tracking sheets, and extraction logs by appropriate field and laboratory personnel will provide for thorough tracking of the samples from collection through analysis and final reporting.

The objectives of sample identification, custody, and tracking procedures are as follows:

- All samples collected for analysis are uniquely labeled for identification purposes throughout the analytical process.
- Samples are correctly analyzed and results are traceable to field records.
- Important sample characteristics are preserved.
- Samples are protected from loss, damage, or tampering.
- Any alteration of samples (e.g. preservation or damage due to shipment or other processes) is documented.
- A record of sample integrity and analytical fate is established.

6.1 Sample Monitoring Forms

The use of standard forms accomplishes one or more of the specific objectives of sample identification, custody, and tracking. Standard forms used by the samplers for water quality monitoring are provided in Appendix A and are discussed below. See attached COC form, field sampling log, and calibration form.

6.1.1 Chain-of-Custody Record. The COC Record is initiated in the field by the individual physically in charge of sample collection. The COC must be completed prior to the shipment of samples to the laboratory. The COC contains information specific to the sample location, date and time of sample collection, the sampler, the project name and number, laboratory project number, the number of containers of each sample being shipped, an itemization of the analyses requested for each sample and any remarks about the sample(s) prior to shipment. The completed COC is signed by the sampler and enclosed with the samples. The COC is then signed each time possession of the samples changes, with the signatures of the persons relinquishing and receiving the samples, as well as the time and date of the sample exchange being indicated on the COC Record.

6.1.2 Sample Collection Forms. The Monitoring Well, Surface Water, Underdrain, and Leachate Sampling Forms will be completed in the field by the individual placed in charge of sample collection. This form correlates the assigned sample bottle designation to a specific well. The forms also list pertinent sampling information that must be recorded at the time of sample collection (i.e., date and time of sampling and field parameter test results).

6.1.3 Instrument Calibration Form Field instrument calibration procedures will be recorded on the Instrument Calibration Form on a daily basis.

6.2 Packing and Shipping

Samples will be packed and shipped so as to maintain the sample container integrity as well as to provide for the health and safety of the sample transporter.

6.2.1 Packing. Sample containers are generally packed in picnic coolers for shipment. Bottles are to be packed tightly so that no motion is possible. Styrofoam, vermiculite, and bubble-pack are suitable as bottle packing material for most instances. (High-hazard samples may require different packing.) Ice is placed in double Ziploc™ bags and added to the coolers in order to maintain the required 4°C preservation requirement. All necessary paperwork will be placed in a separate Ziploc™ bag and also placed in the cooler. The cooler top will then be closed and taped shut. Custody sealing and taping of coolers may be required for certain samples/occasions.

6.2.2 Shipping. The standard procedure followed for shipping environmental samples to the analytical laboratory is:

1. For projects where the laboratory can be practically accessed:

   - Deliver all samples directly to the laboratory.

2. For projects where the laboratory is not practically accessed:

   - All shipping of environmental samples must be done through Federal Express or an equivalent overnight delivery service.

   - If prompt shipping and laboratory receipt of the samples cannot be guaranteed (i.e. Sunday and holidays), the samplers will be responsible for proper storage of the samples until suitable transportation arrangements can be made.

7.0 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

Quality assurance/quality control (QA/QC) is an integral part of this EMP to provide for assessment of the adequacy of the analytical results and their intended use. QA/QC activities associated with sampling include utilization of standardized collection procedures and sample data records, calibration of field instruments, and adherence to COC procedures. Analytical QA/QC involves the use of approved analytical protocols by qualified laboratories. Assessment of analytical data quality is performed through review of method-specified quality control data, to be reported along with the analytical results. To ascertain that the QA/QC objectives are met, the following data validation methods will be used to verify the accuracy and precision of the reported results.

- Chain of Custody for each sample is continuous and included with report.
- Verification that all sample holding times were met.
- Identification of values falling outside of historical (>5 sample rounds) range.
- Identification of wells whose depths have changed since construction.

8.0 REPORTING

The BRPP program will include semi-annual and annual reporting to the NCDENR in accordance with current waste management regulations.

APPENDIX A

STANDARD RECORDKEEPING FORMS AND CHAIN OF CUSTODY FORM

ROGERS & CALLCOTT
LABORATORY SERVICES
P.O. Box 5655, Greenville, SC 29606
Phone (864) 232-1556 Fax (864) 232-6140
Shipping Address: 426 Fairforest Way
Greenville, SC 29607

CHAIN OF CUSTODY RECORD

PAGE ____ OF ____

Client Name _____

Address _____

_____

Report To: _____

Telephone No. _____ FAX No. _____

PO No. _____ Project No. _____

Rogers & Callcott Lab No.	Yr.__ Date	Time	Sample Description	Total Number of Containers	PARAMETERS								
													Filtered (Yes/No)
													Cooled (Yes/No)
													Container Type (P/G)
													Container Volume
													Sample Type (Grab/Composite)
													Sample Source (WW, GW, DW, Other)
													Sample Source Chlorinated (Yes/No)
													Lob Receipt Cl, Check
													Lob Receipt pH Check
													Preserved (Code)
													A–None D–NaOH G–Boric Acid B–HNO_3 E–HCL H–Ascorbic Acid C–H_2SO_4 F–$Na_2S_2O_3$ I– ____
													COMMENTS:

SAMPLER Relinquished by (Sig.) ①	Date/Time	Received by (Sig.) ② Shipper Name & #	Date/Time	KNOWN HAZARDS ASSOCIATED WITH SAMPLES
Relinquished by (Sig.) ③	Date/Time	Received by (Sig.) ④ Shipper Name & #	Date/Time	
Relinquished by (Sig.) ⑤	Date/Time	Received by (Sig.) ⑥ Shipper Name & #	Date/Time	Temperature of blank or representative sample At time of collection ____ °C At time of lab receipt ____ °C
Seal # ot'chd by ◯ Recvd. Intact by ◯		Seal # ot'chd by ◯ Recvd. Intact by ◯		

ACCREDITED IN ACCORDANCE WITH nelac

Columbia Analytical Services™

2655 Park Center Drive, Suite A
Simi Valley, CA 93065

Confirmation of Sample Receipt

To:	Guy Cote	**From:**	Kate Aguilera
Email:	guy@smemaine.com	**Email:**	KAguilera@caslab.com
Fax:	207-829-5692	**Fax:**	805-526-7270
Phone:	207-829-5016	**Phone:**	805-526-7161 x234

Samples for analysis have been received by Columbia Analytical Services on 4/29/09 and assigned our Service Request number **P0901459**. **Please verify the following information and notify me of any corrections as soon as possible.**

The estimated completion date for this work is: **5/13/09**

Client: Sevee & Maher Engineers, Inc.
Project: Quarterly & Annual Gas Analysis - Mt. Carberry/09004.02
PO Number: 09004.02

EDD Required: No
Tier: II

Report To: Guy Cote
Sevee & Maher Engineers, Inc.
4 Blanchard Road
PO Box 85a
Cumberland, ME 04021

Billing Address: Guy Cote
Sevee & Maher Engineers, Inc.
4 Blanchard Road
PO Box 85a
Cumberland, ME 04021

Comments: Canisters are backfilled with Helium.
The canister samples indicated on the CoC were shipped via FEDEX ground and will have a separate laboratory job number.

Thank you for your business!

A - Test is Authorized H - Test is On Hold P - Test is Authorized for Prep Only C - Test has been Cancelled * - Test has assigned QC

				ASTM D5504-01 Sulfur Bag	ASTM D5504-01 TRS H2S Bag
P0901459-001	SP-010-A	Air	4/28/09 1331	A	A
P0901459-002	SP-010-B	Air	4/28/09 1335	A	A
P0901459-003	SP-010-C	Air	4/28/09 1338	A	A

Test Comments:

Group	Test/Method	Samples	Comments
VOA GC AIR	ASTM D5504-01/TRS H2S Bag	1-3	Please include total TRS along with normal speciated 20 compound analysis.

FIELD DATA LOG FOR GROUND WATER SAMPLING

ROGERS & CALLCOTT ENGINEERS, INC.

Well Number:_____ ☐ Development ☐ Purging

Date:_____ Field Personnel:_____

Site Name/Location:_____

Page____ of ____

For Low Flow Sampling: Page _____ of _____

Method of Well Evacuation

Pump	Bailer
☐ Grundfos	☐ Non Disposable Teflon
☐ Submersible	☐ Disposable Teflon
☐ Peristaltic	☐ Disposable Poly
☐ Bladder	☐ Dedicated Teflon
☐ Waterra	☐ Dedicated PVC

☐ Continuous (Recovery Well)

☐ _____

One Volume Multiplier (gal/ft) = $\pi r^2 h$ (7.48) (r in feet)
Well Diameter (gal/ft.) 1"= 0.041; 2"= 0.163; 3"= 0.367
4"= 0.653; 6"= 1.470

Water Volume Calculations

Initial Depth to Ground Water (a):_____@_____
Total Depth of Well (b):_____
Length of Water Column in Well (b-a):_____
Well Casing Diameter (inches):_____
Depth to Immiscible Layer:_____

# of Casings	Gallons to be Removed	Gallons / mLs Removed
1 Casing Vol = (b-a) x Multiplier		
3 Casing Vol		

Circle One that Applies

Measuring Point:	TOC / Ground Surface
Riser Material:	PVC / Steel / Teflon
Steel Protective Casing?	Yes / No
Bollards?	Yes / No
Flush Mount?	Yes / No
Well Locked?	Yes / No
Well Pad Condition?	Okay / _____
Well Integrity Satisfactory?	Okay / _____
Vegetation:	Overgrown/ Moderate/ Light/ None

Water Removal / Field Analysis Data

Date	Time	Increment	Removal Rate (gal/m) or (ml/m)	Water Level, (feet)	Water Volume Removed (gal) or (ml)	pH (units) ±0.1-Stable	Temp (°C)	Conductivity (uS/cm) 10%-Stable	Dissolved Oxygen (mg/L)	Hydrogen Sulfide (ppm)	ORP (mVolts)	Odor (Subj*)	Turbidity (NTU)	Comments

Weather Conditions/~Temp:_____/_____°F

** Subjective (1) None (2) Slight (3) Moderate (4) Strong*

Well Yield: (Low/ Moderate/ High) Sample Clarity:_____ Precipitate:_____ Fe^{+2} mg/L=_____

Sample Collection Time _____

Comments _____

Reviewed by: _____ Date: _____

Revised 2/3/09

Rogers and Callcott Enginers

Continuing Calibration Verification

Client: _____ Date: _____

Conductivity Meter
EPA 9050A

Meter Make / Model: YSI EC300 SN: _____ Probe: _____

Time	Analyst	Conc. of Standard, µmhos/cm @25°C	Actual Reading of Standard, µmhos/cm
			@ _____ °C
			@ _____ °C

pH Meter
EPA 9040C

Meter Make / Model: YSI pH100 SN: _____ Probe: _____

Time	Analyst	Conc. of Buffer, units	Actual Reading of Buffer, units

Turbidity Meter
Field Screen Method

Meter Make / Model: Hach 2100P SN: _____

Time	Analyst	Assigned Conc. of Standard, NTU	Actual Reading of Standard, NTU

Field Duplicate

Well ID: _____

Time	Analyst	Conductivity, µmhos/cm	pH, units	Turbidity, NTU	Temperature, °C

Note: Refer to daily calibration log for instrument calibration and chemical inventory information / documentation.

Reviewed by: _____ Date: _____

Revised 03/18/09

Rogers and Callcott Enginers

Field Meter Calibration Record

Client: _____ **Date:** _____

Conductivity Meter Calibration
EPA 9050A

Meter Make / Model: YSI EC300 SN: _____ Probe: _____

Time: _____ Analyst: _____ Cell Constant _____

Chemical Inventory	Conc. of Standard, µmhos/cm @25°C		Actual Reading of Standard, µmhos/cm	Actual Reading of Standard, @ Temperature, °C
	SSS conc:			

Temperature compensation for conductivity meter : _____

Note: Temperature is recorded from the conductivity meter for reporting purposes.

pH Meter Calibration
EPA 9040C

Meter Make / Model: YSI pH100 SN: _____ Probe: _____

Time: _____ Analyst: _____ Slope: _____

Chemical Inventory	Conc. of Buffer, units		Actual Reading of Buffer, units
	4.0		
	7.0		
	10.0		
	SSS conc:		

Temperature compensation for pH meter : _____

Note: Temperature is recorded from the conductivity meter for reporting purposes.

Turbidity Meter Calibration
Field Screen Method

Meter Make / Model: Hach 2100P SN: _____ Date of most recent calibration: _____

Time: _____ Analyst: _____

Chemical Inventory	Assigned Conc. of Standard, NTU	Actual Reading of Standard, NTU

Reviewed by: _____ Date: _____

Revised 03/18/09

APPENDIX B

MONITORING WELL INSTALLATION DIAGRAMS

CORRELATION OF PENETRATION RESISTANCE WITH RELATIVE DENSITY AND CONSISTENCY

	NO. OF BLOWS, N	RELATIVE DENSITY
SANDS:	0-4	Very Loose
	5-10	Loose
	11-20	Firm
	21-30	Very Firm
	31-50	Dense
	OVER 50	Very Dense

		CONSISTENCY
SILTS & CLAYS:	0-2	Very Soft
	3-4	Soft
	5-8	Firm
	9-15	Stiff
	16-30	Very stiff
	31-50	Hard
	OVER 50	Very Hard

PARTICAL SIZE IDENTIFICATION

BOULDERS:		Greater than 300 mm
COBBLES:		75 mm to 300 mm
GRAVEL:	Coarse -	19.0 mm to 75 mm
	Fine -	4.75 mm to 19.0 mm
SANDS:	Coarse -	2.00 mm to 4.75 mm
	Medium -	0.425 mm to 2.00 mm
	Fine -	0.075 mm to 0.425 mm
SILTS & CLAYS:		Less than 0.075 mm

KEY TO DRILLING SYMBOLS

- Undisturbed Sample
- Split Spoon Sample
- Water Table 24 HR.
- Water Table at Time of Drilling
- Pressuremeter Test
- Loss of Drilling Water

KEY TO SOIL CLASSIFICATIONS

- ASPHALT
- CL - Low plasticity inorganic clays
- CH - High plasticity inorganic clays
- ML - Low plasticity inorganic silts and very fine sands
- MH - High plasticity inorganic silts
- SP - Poorly graded sands
- SW - Well graded sands
- GP - Poorly graded gravels
- PARTIALLY WEATHERED ROCK - A transitional material between soil and rock which retains the relict structure of the parent rock.
- CONCRETE
- GW - Well graded gravels
- OL - Low plasticity organic silts and clays
- OH - High plasticity organic silts and clays
- SM - Silty sands
- GM - Silty gravels
- SC - Clayey sands
- GC - Clayey gravels
- SP-SM - Typical Dual Classification

JOB NAME CHAMPION NO. 6 LANDFILL

JOB NUMBER 2410446501

WELL NUMBER MW-1A

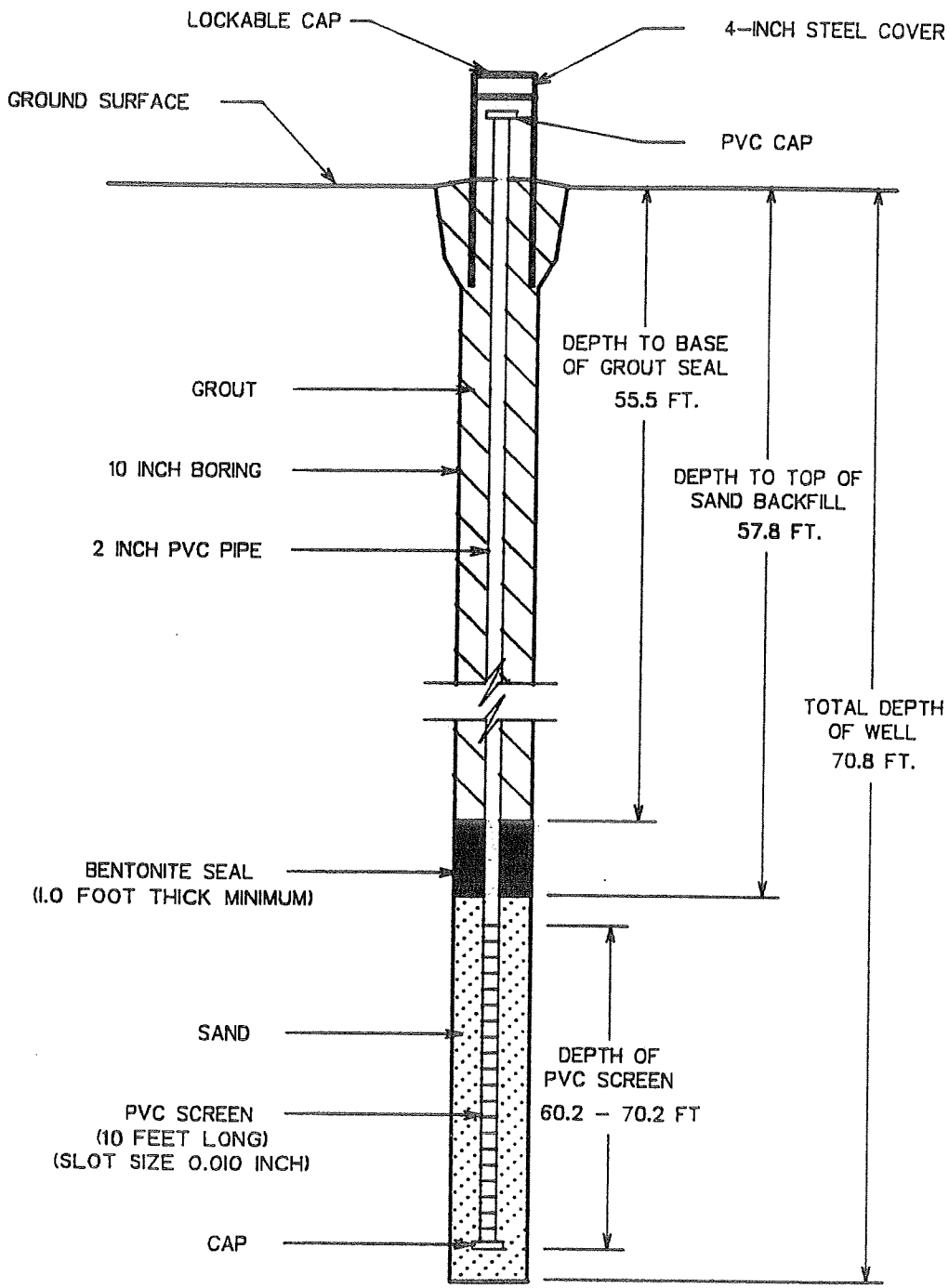
GROUND SURFACE ELEVATION 2765 FT. (MSL)

LOCATION SEE ATTACHED LOCATION MAP

MEASURING POINT ELEVATION

INSTALLATION DATE 1/29/92

LATITUDE LONGITUDE



LAW ENGINEERING
GREENVILLE, SOUTH CAROLINA

MONITORING WELL
INSTALLATION RECORD
CHAMPION LANDFILL NO. 6A
CANTON, SOUTH CAROLINA

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	PENETRATION - BLOWS/FOOT (0 10 20 30 40 60 80 100)
0.0	Hard moist reddish brown fine sandy micaceous SILT relic foliation - high angle - Residuum.		41
7.0	Hard dry reddish brown very micaceous SILT - relic foliation.		32
12.0	Very hard dry red to brown medium sandy micaceous SILT with relic structure.		54
18.0	Very hard dry tan to brown medium to coarse sandy micaceous SILT with relic structure.		74
			50=5.5"
27.0	Hard moist gray to reddish brown fine sandy very micaceous SILT with relic structure.		45
32.0	Hard moist gray to green minor medium sandy very micaceous SILT with relic structure.		41
38.0	Hard moist medium to dark gray minor medium sandy very micaceous SILT with relic structure.		39

REMARKS:

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	MW- 1A
DATE DRILLED	January 27, 1992
PROJECT NUMBER	2410446501
PROJECT	CHAMPION #6A LANDFILL
PAGE 1 OF 2	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	PENETRATION - BLOWS/FOOT (0 10 20 30 40 60 80 100)
43.0	Hard moist brown to gray fine to medium sandy micaceous SILT with relic structure.		32
48.0	Very stiff wet dark gray fine to medium sandy micaceous SILT with relic structure.		20
53.0	Hard wet tan to gray fine to medium sandy micaceous SILT with layering.		40
58.0	Partially weathered rock which sampled as (wet gray fine to medium sandy micaceous SILT with layering).		50=5"
63.0	Partially weathered rock which sampled as (wet brown fine to medium sandy micaceous SILT with layering).		50=3"
68.0	Partially weathered rock which sampled as wet light to dark brown medium to coarse sandy micaceous SILT with layering.		50=4.5"
70.8	Boring terminated at 70.8 feet. Auger refusal at 70.8 feet. Ground water encountered at 47.32 feet after 24 hours. Monitoring well installed to 70.2 feet on January 29, 1992.		

REMARKS:

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	MW- 1A
DATE DRILLED	January 27, 1992
PROJECT NUMBER	2410446501
PROJECT	CHAMPION #6A LANDFILL
PAGE 2 OF 2	

LAW ENGINEERING

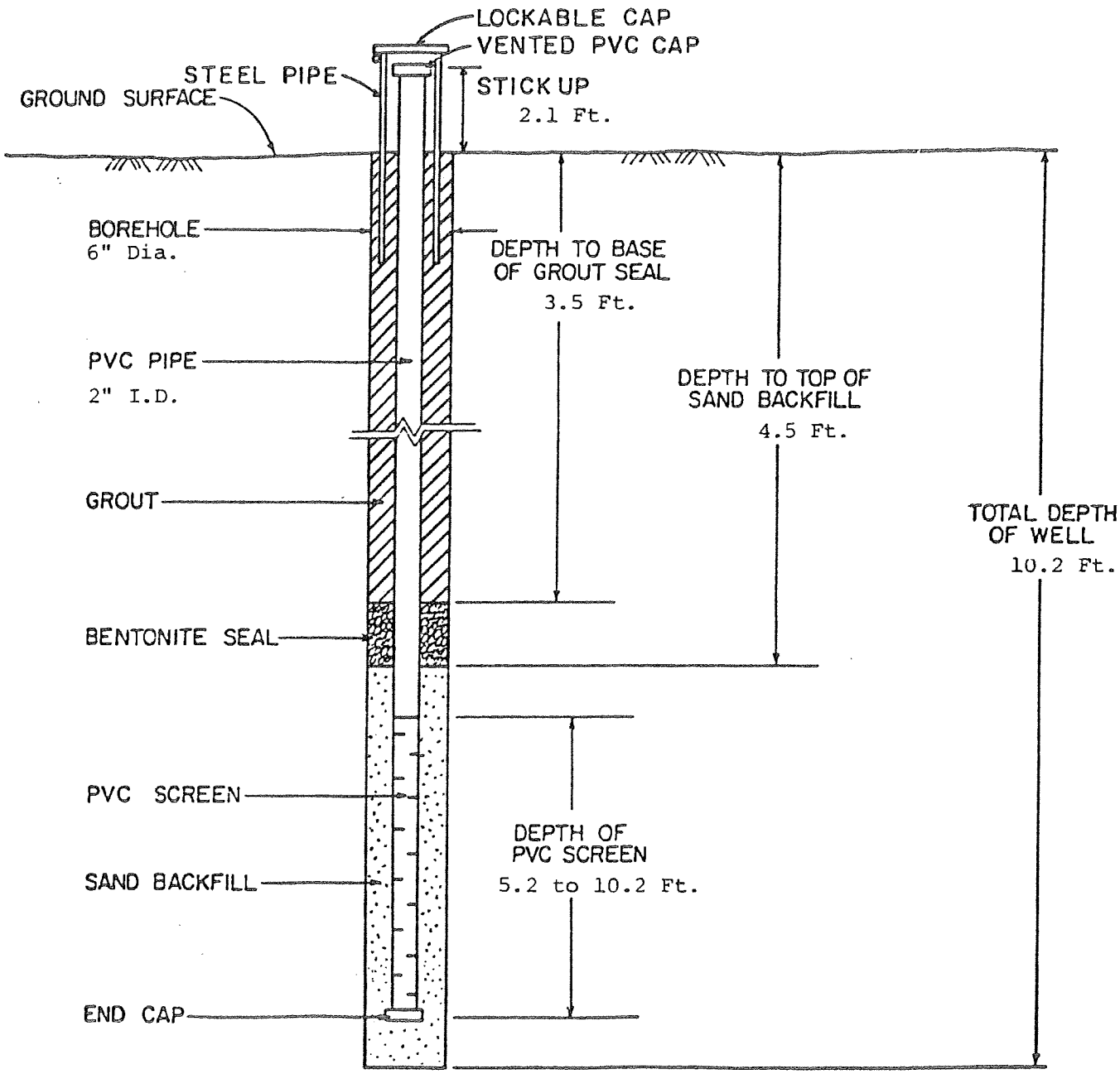
MONITORING WELL INSTALLATION RECORD

JOB NAME Landfill No. 6 JOB NUMBER CH 4507 C

WELL NUMBER MW-2 GROUND SURFACE ELEVATION 2595.31 Ft.

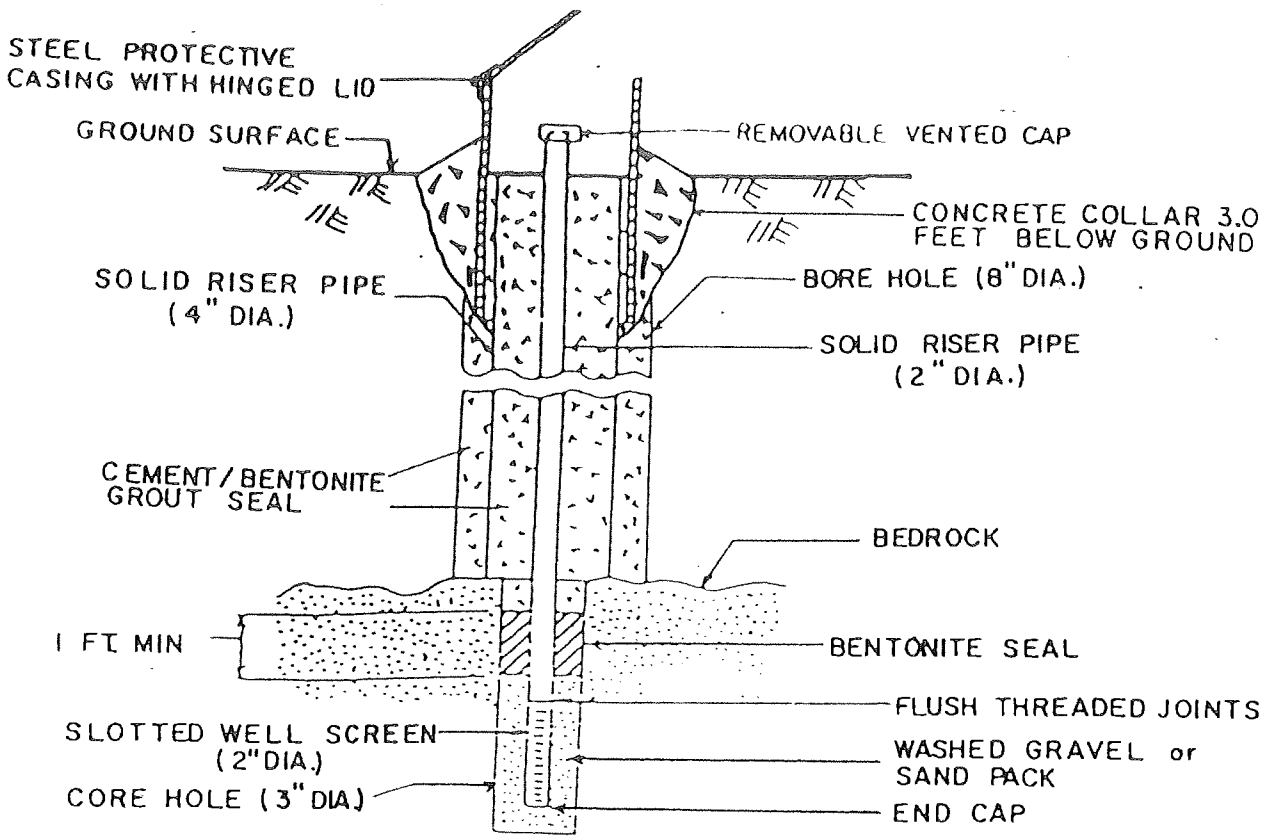
LOCATION Southwest of Area F

INSTALLATION DATE 7-6-83



Champion Papers Canton, North Carolina	LAW ENGINEERING TESTING COMPANY CHARLOTTE, NORTH CAROLINA	MONITORING WELL INSTALLATION RECORD MW-2

TYPICAL DIAGRAM – TYPE III MONITORING WELL



MONITORING WELL INSTALLATION DETAILS

WELL NUMBER	MW-3A				
GROUND ELEVATION (FT.)	--				
GROUND WATER ELEVATION (FT.) MEASURED ON:	--				
TOTAL DEPTH OF WELL BELOW GROUND SURFACE (FT.)	17.5				
MEASURING POINT ELEVATION (FT.)	--				
SCREEN LENGTH (FT.)	10.0				
SOLID RISER LENGTH BELOW GROUND SURFACE (FT.)	7.5				
PVC HEIGHT ABOVE GROUND (FT.)	2.5				
THICKNESS OF BENTONITE SEAL	1.2				
THICKNESS OF CEMENT SEAL	4.0				
4 INCH DIAMETER PVC LENGTH BELOW GROUND SURFACE (FT.)	5.0				

Champion International
Canton Landfill
Haywood County, N.C.

LAW ENGINEERING

INSTALLATION DETAILS
TYPE III MONITORING WELLS

JOB NO. AV-1834 | FIGURE 2

DEPTH FT.	DESCRIPTION	CORE SIZE	% @ TIME MIN.	ELEV.	REMARKS	% RQD
	Partially weathered rock sampled as red brown and black gray fine to coarse sandy SILT Auger refusal at 5 feet, moved 20 feet. Auger **	NQ			N = 50/1" N = 50/0"	
5.0	Hard to very hard white and light gray mica gneiss	100			Weathering slight to fresh 5.0 to 35.3 ft.	100
		100			Severly iron stained and soil filled joint Steep dip 15.6 to 17.1 ft	100
		100			◁ S	95
	** bore 0 to 5 feet. Auger refusal at 5 feet, set and grouted 4" PVC casing to 5 feet. Begin NQ coring	100			Iron and manganize stained joint Steep dip 25.3 to 25.5 ft.	100
		100			◁ S Closely to very closely spaced joints Low dip 32.5 to 33.4 ft.	100
		100			Very closely spaced Healed joints 33.4 to 33.7	98
35.3					◁ L	
	Coring terminated at 35.3 feet Boring terminated at 35.3 feet Monitoring well installed to 17.5 feet (see Figure 2 for details) Ground water measured at 0.5 feet after 24 hours	100				

NOTE: Boring MW-3B was backfilled with soil.

TEST BORING RECORD

BORING NO. MW-3A, B

DATE DRILLED 10-30-87

JOB NO. AV-1834

LAW ENGINEERING TESTING CO.

|50| % ROCK CORE RECOVERY — WATER TABLE, 1 HR.

N - STANDARD PENETRATION ◀ LOSS OF DRILLING WATER

R.Q.D. ROCK QUALITY DESIGNATION

◁ ROCK JOINT:

L = LOW DIP 0–30°

M = MED. DIP 30°–60°

S = STEEP DIP 60°–90°

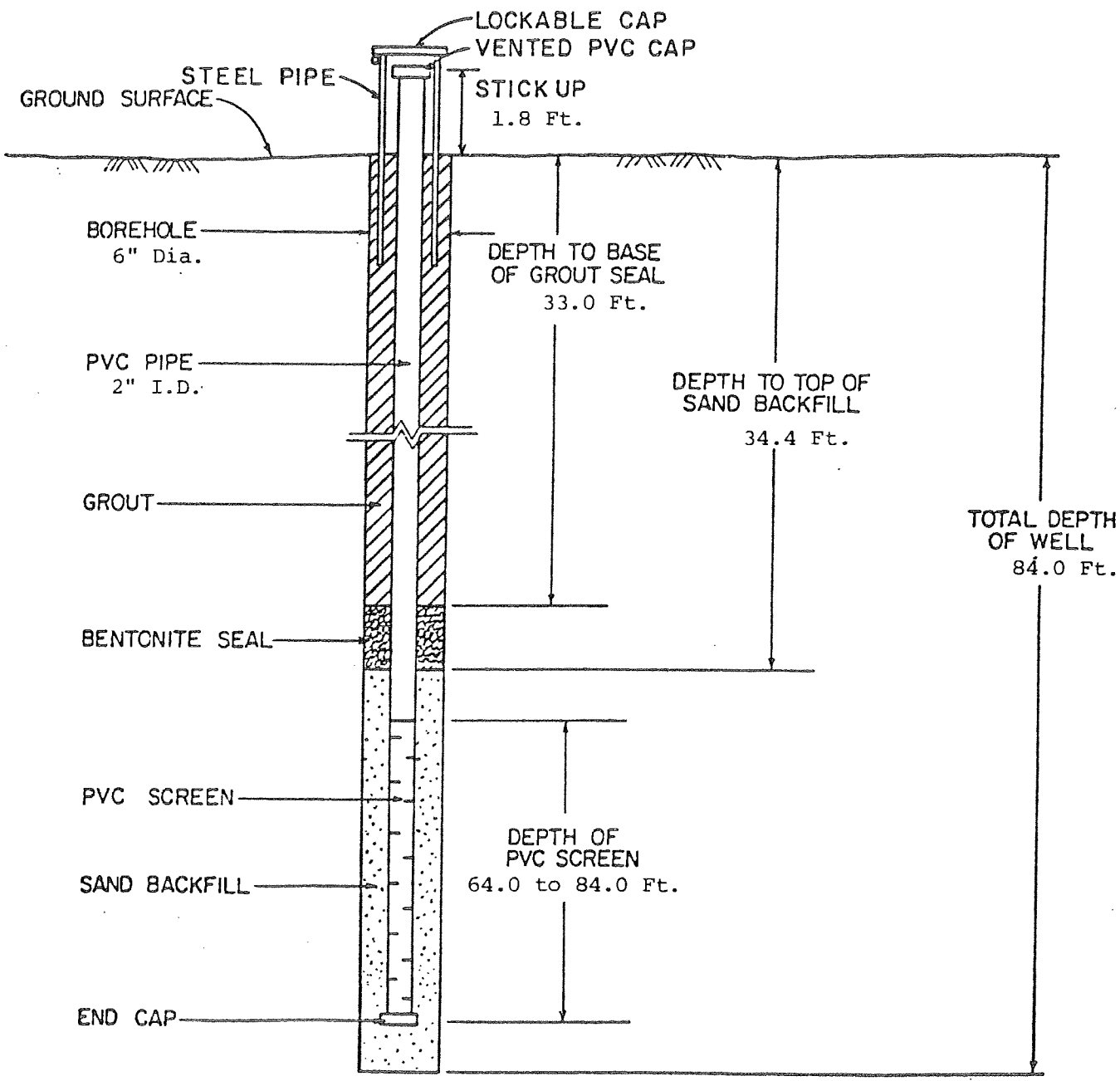
MONITORING WELL INSTALLATION RECORD

JOB NAME Landfill No. 6 JOB NUMBER CH 4507 C

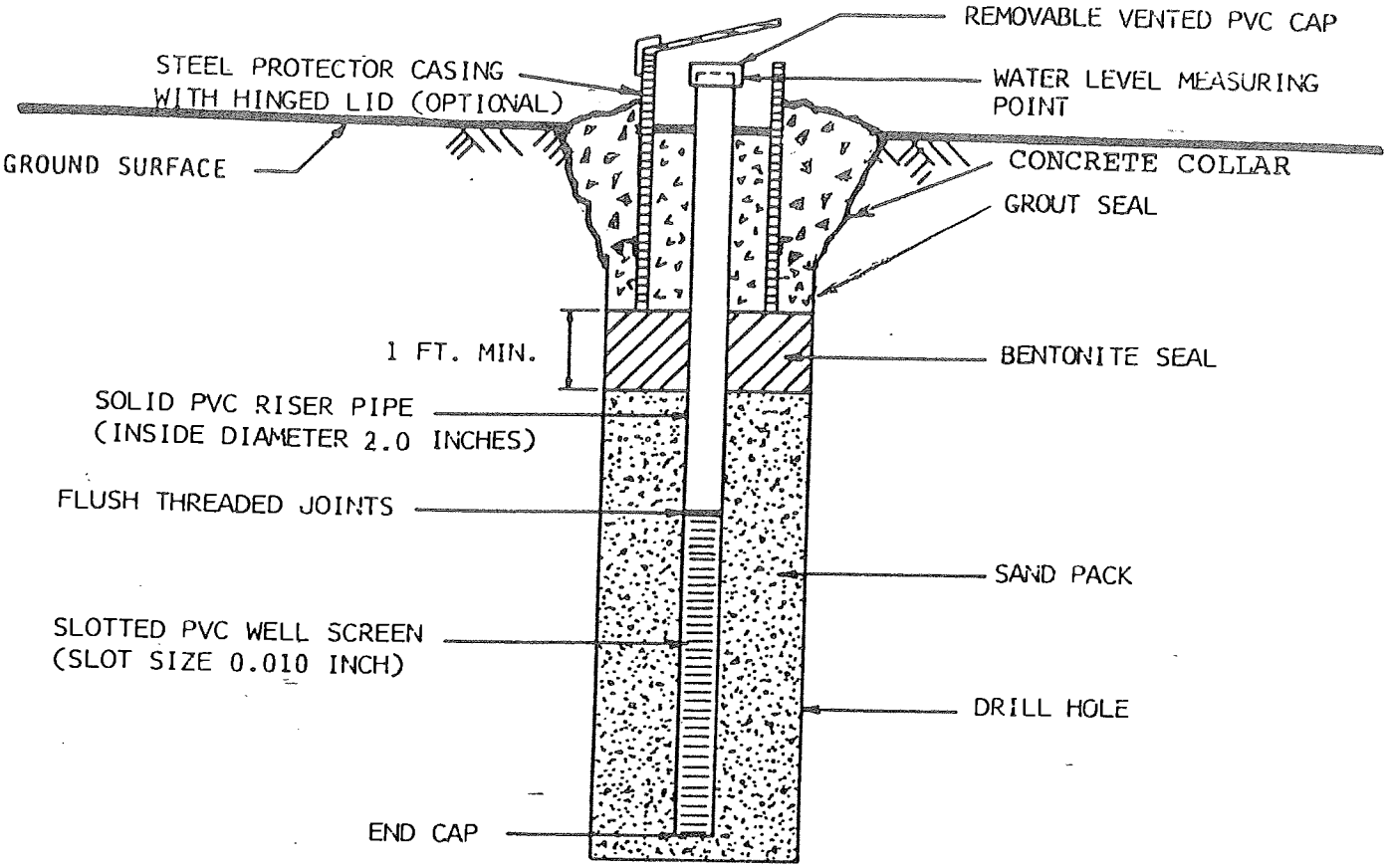
WELL NUMBER MW-4 GROUND SURFACE ELEVATION 2629.63 Ft.

LOCATION Southeast of Area B

INSTALLATION DATE 7-7-83



Champion Papers Canton, North Carolina	LAW ENGINEERING TESTING COMPANY CHARLOTTE, NORTH CAROLINA	MONITORING WELL INSTALLATION RECORD MW-4



TYPICAL DIAGRAM OF MONITORING WELLS
(NOT TO SCALE)

MONITORING WELL INSTALLATION DETAILS

WELL NUMBER	MW-5A	MW-7A	MW-13		
GROUND ELEVATION (FT.)	---	---	---		
GROUND WATER ELEVATION (FT.) MEASURED ON:	---	---	---		
TOTAL DEPTH OF WELL BELOW GROUND SURFACE (FT.)	42.0	23.5	34.0		
MEASURING POINT ELEVATION (FT.)	---	---	---		
SCREEN LENGTH (FT.)	10.0	10.0	10.0		
SOLID RISER LENGTH BELOW GROUND SURFACE (FT.)	32.0	13.5	24.0		
PVC HEIGHT ABOVE GROUND (FT.)	2.5	2.5	2.5		
THICKNESS OF BENTONITE SEAL (FT.)	1.1	1.3	1.5		
THICKNESS OF CEMENT SEAL (FT.)	28.3	9.5	19.6		

NOTES:

Champion International
Canton Landfill
Haywood County, N.C.

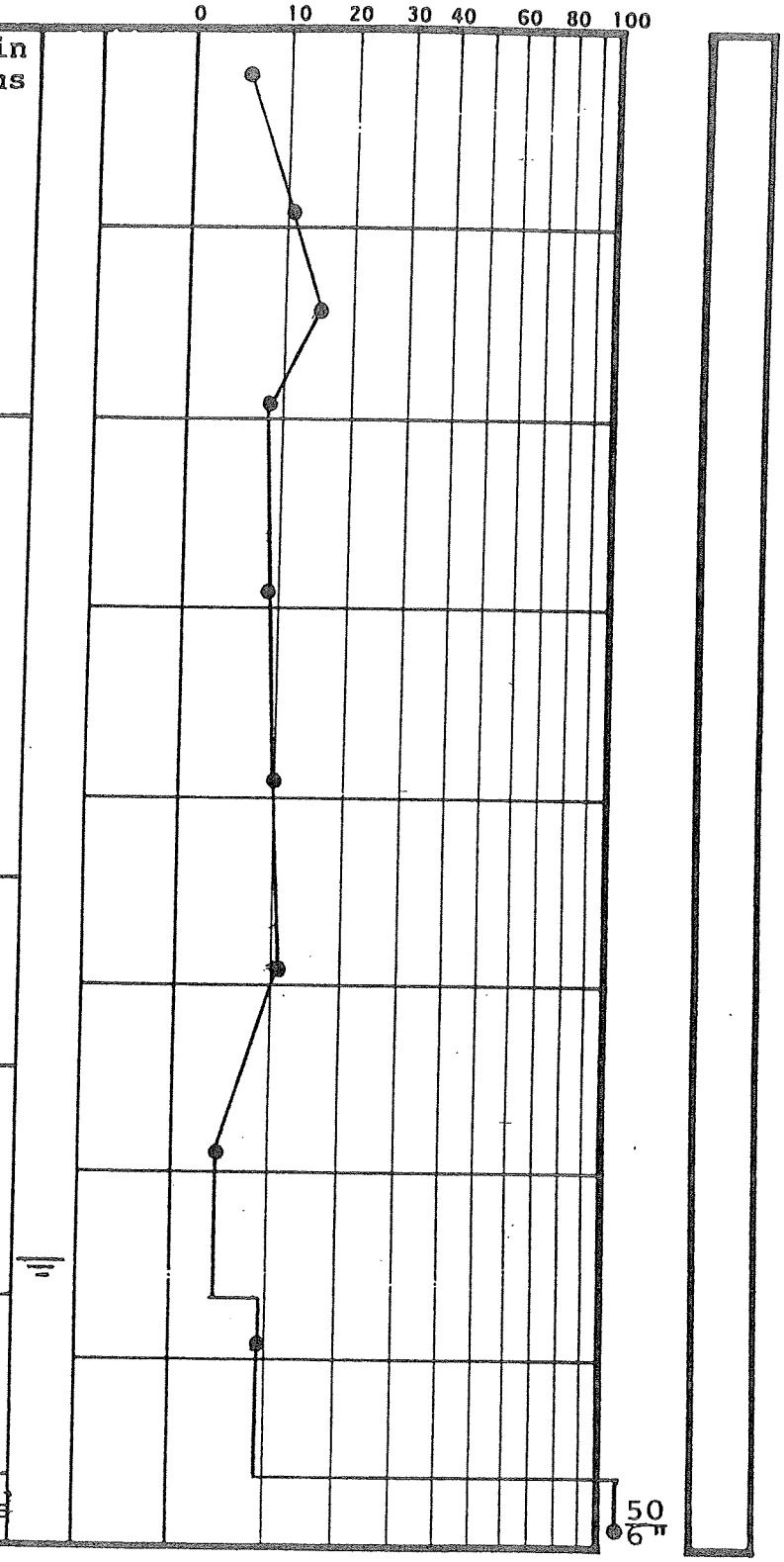
LAW ENGINEERING

MONITORING WELL INSTALLATION DETAILS

JOB NO. AV-1834

FIGURE 3

DEPTH FT.	DESCRIPT	PENETRATION-BLOWS PER FT.
0.0	6-inches of pea gravel underlain by firm to stiff brown micaceous fine to medium sandy SILT with rock fragments - Fill	
10.0	Stiff red brown and tan brown micaceous fine to medium sandy SILT - Fill	
22.0	Stiff brown clayey micaceous fine to coarse sandy SILT-Fill	
27.0	Firm brown micaceous fine to coarse sandy SILT - Fill	
33.0	Stiff gray brown micaceous fine to medium sandy SILT - Residuum	
38.0	Partially weathered rock sampled as tan gray brown silty micaceous fine to coarse SAND	



BORING AND SAMPLING MEETS ASTM D-1586

CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

50 % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. MW-5A

DATE DRILLED 10-29-87

JOB NO. AV-1834

PAGE 1 OF 2

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTI	PENETRATION-BLOWS PER FT. 0 10 20 30 40 60 80 100
38.0	Partially weathered rock sampled as tan gray brown silty micaceous fine to coarse SAND	
42.0	Auger refusal at 42.0 feet Boring terminated at 42.0 feet Monitoring well installed to 42.0 feet (see Figure 3 for details) Ground water measured at 32.3 feet after 24 hours	

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

50 % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. MW-5A

DATE DRILLED 10-29-87

JOB NO. AV-1834

PAGE 2 OF 2

LAW ENGINEERING TESTING COMPANY

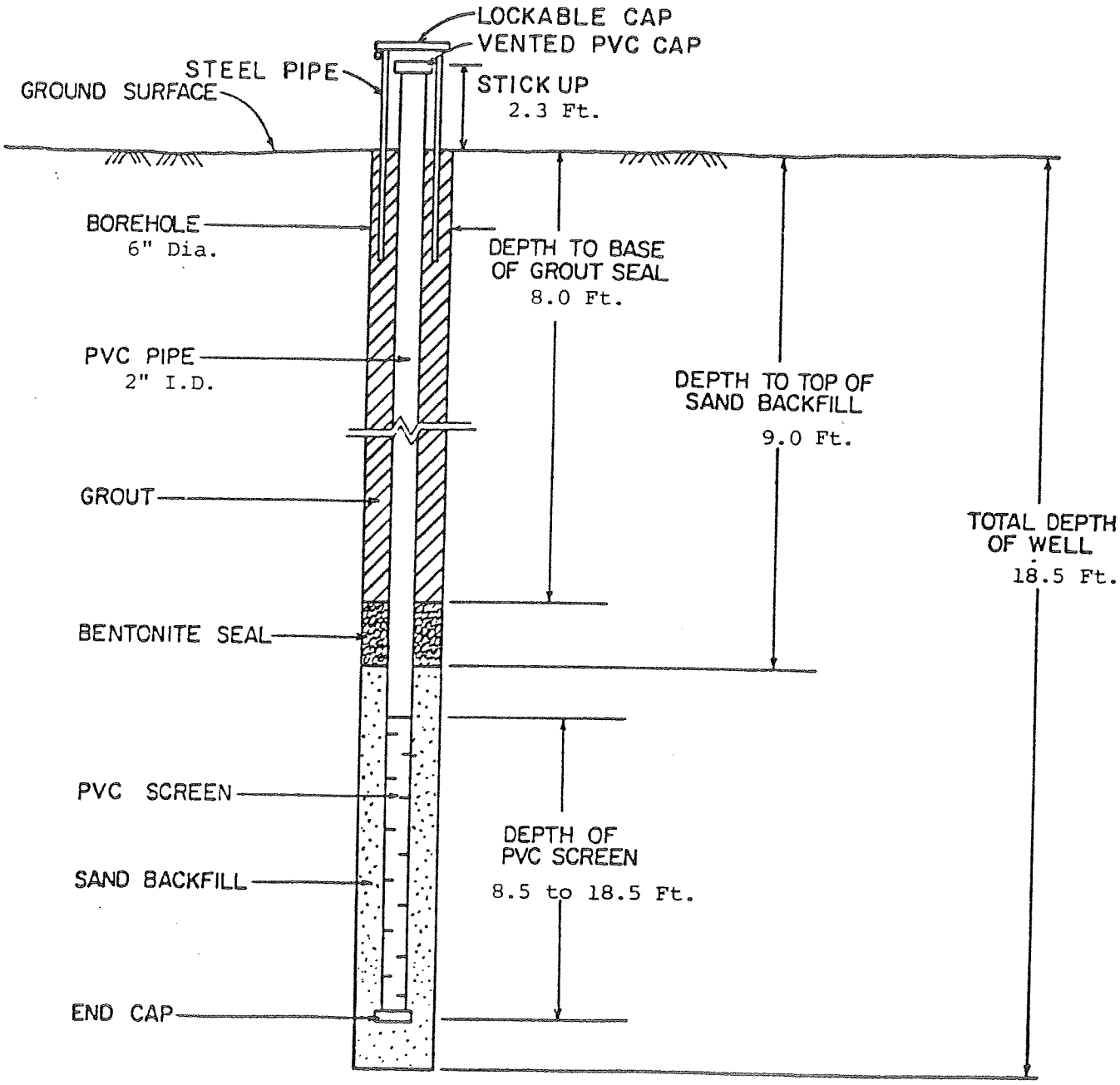
MONITORING WELL INSTALLATION RECORD

JOB NAME Landfill No. 6 JOB NUMBER CH 4507 C

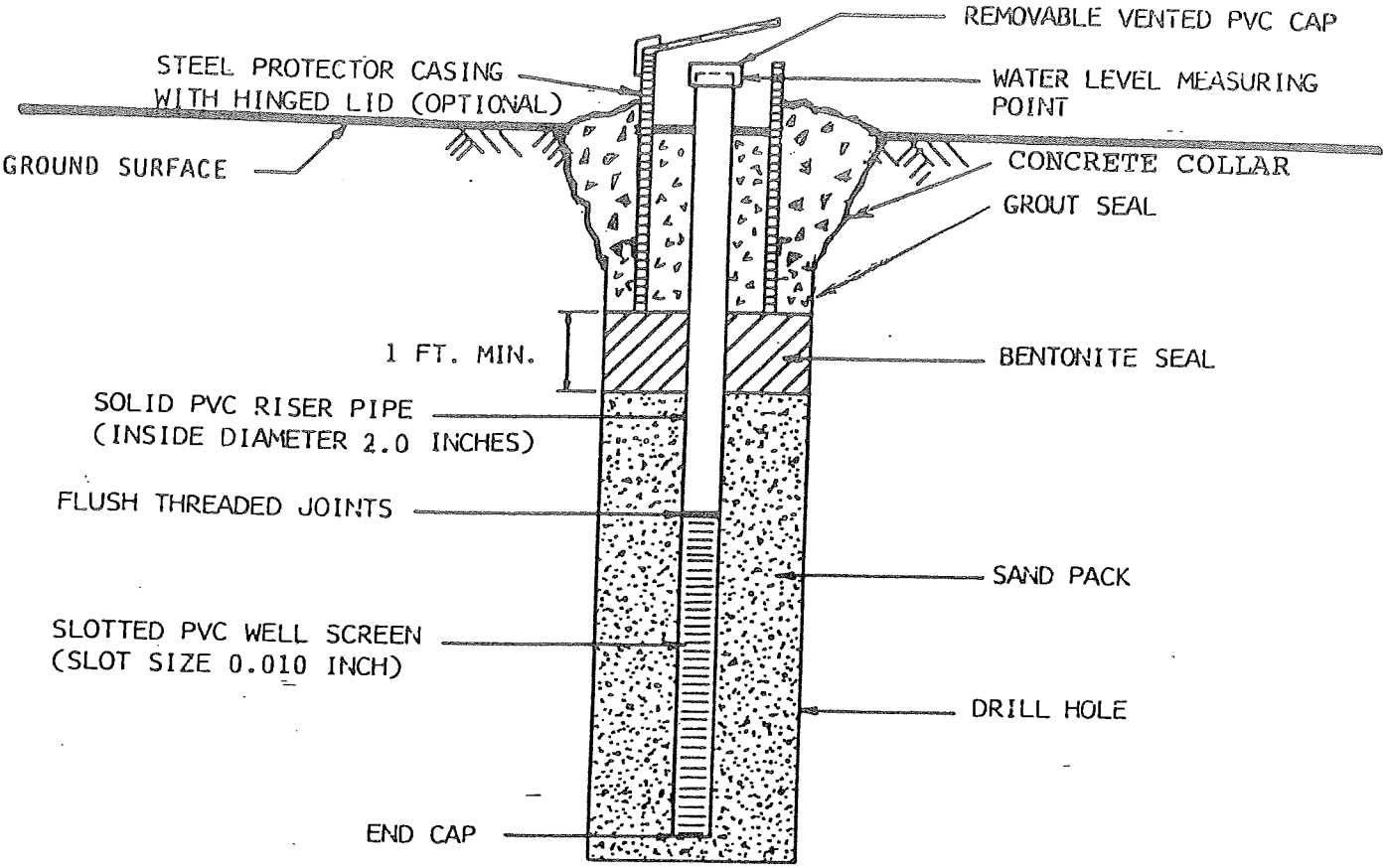
WELL NUMBER MW-6 GROUND SURFACE ELEVATION 2549.72 Ft.

LOCATION South - Southeast of Area C

INSTALLATION DATE 7-7-83



Champion Papers Canton, North Carolina	LAW ENGINEERING TESTING COMPANY CHARLOTTE, NORTH CAROLINA	MONITORING WELL INSTALLATION RECORD MW-6



TYPICAL DIAGRAM OF MONITORING WELLS
(NOT TO SCALE)

MONITORING WELL INSTALLATION DETAILS

WELL NUMBER	MW-5A	MW-7A	MW-13		
GROUND ELEVATION (FT.)	---	---	---		
GROUND WATER ELEVATION (FT.) MEASURED ON:	---	---	---		
TOTAL DEPTH OF WELL BELOW GROUND SURFACE (FT.)	42.0	23.5	34.0		
MEASURING POINT ELEVATION (FT.)	---	---	---		
SCREEN LENGTH (FT.)	10.0	10.0	10.0		
SOLID RISER LENGTH BELOW GROUND SURFACE (FT.)	32.0	13.5	24.0		
PVC HEIGHT ABOVE GROUND (FT.)	2.5	2.5	2.5		
THICKNESS OF BENTONITE SEAL (FT.)	1.1	1.3	1.5		
THICKNESS OF CEMENT SEAL (FT.)	28.3	9.5	19.6		

NOTES:

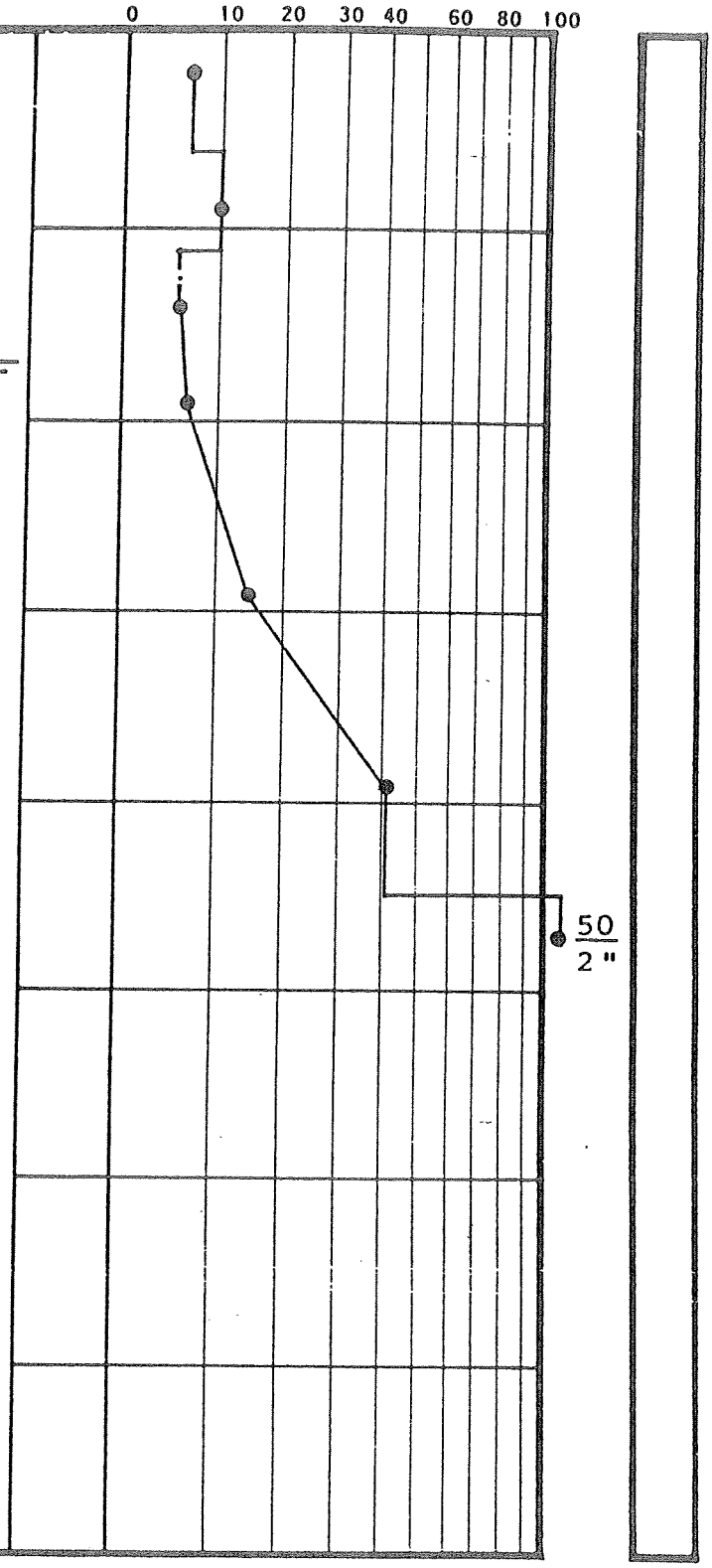
Champion International
Canton Landfill
Haywood County, N.C.

LAW ENGINEERING

MONITORING WELL INSTALLATION DETAILS

JOB NO. AV-1834 FIGURE 3

DEPTH FT.	DESCRIPTI	PE RATION-BLOWS PER FT.
0.0	Firm brown clayey micaceous fine to coarse sandy SILT - Fill	
3.0	Stiff gray tan micaceous fine to medium sandy SILT - Possible Residuum or Alluvium	
5.5	Firm gray brown fine sandy SILT - Residuum Boulders 11 feet to 12.5 feet	
12.5	Stiff to hard gray tan micaceous fine to coarse sandy SILT with rock fragments	
22.5	Partially weathered rock sampled as tan brown fine to coarse sandy SILT	50/2"
25.0	Boring terminated at 25.0 feet Monitoring well installed to 23.5 feet (see Figure 3 for details) Ground water measured at 8.5 feet after 24 hours	



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
WATER TABLE, 24 HR.
WATER TABLE, 1 HR.
LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. MW-7A
DATE DRILLED 10-27-87
JOB NO. AV-1834
PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

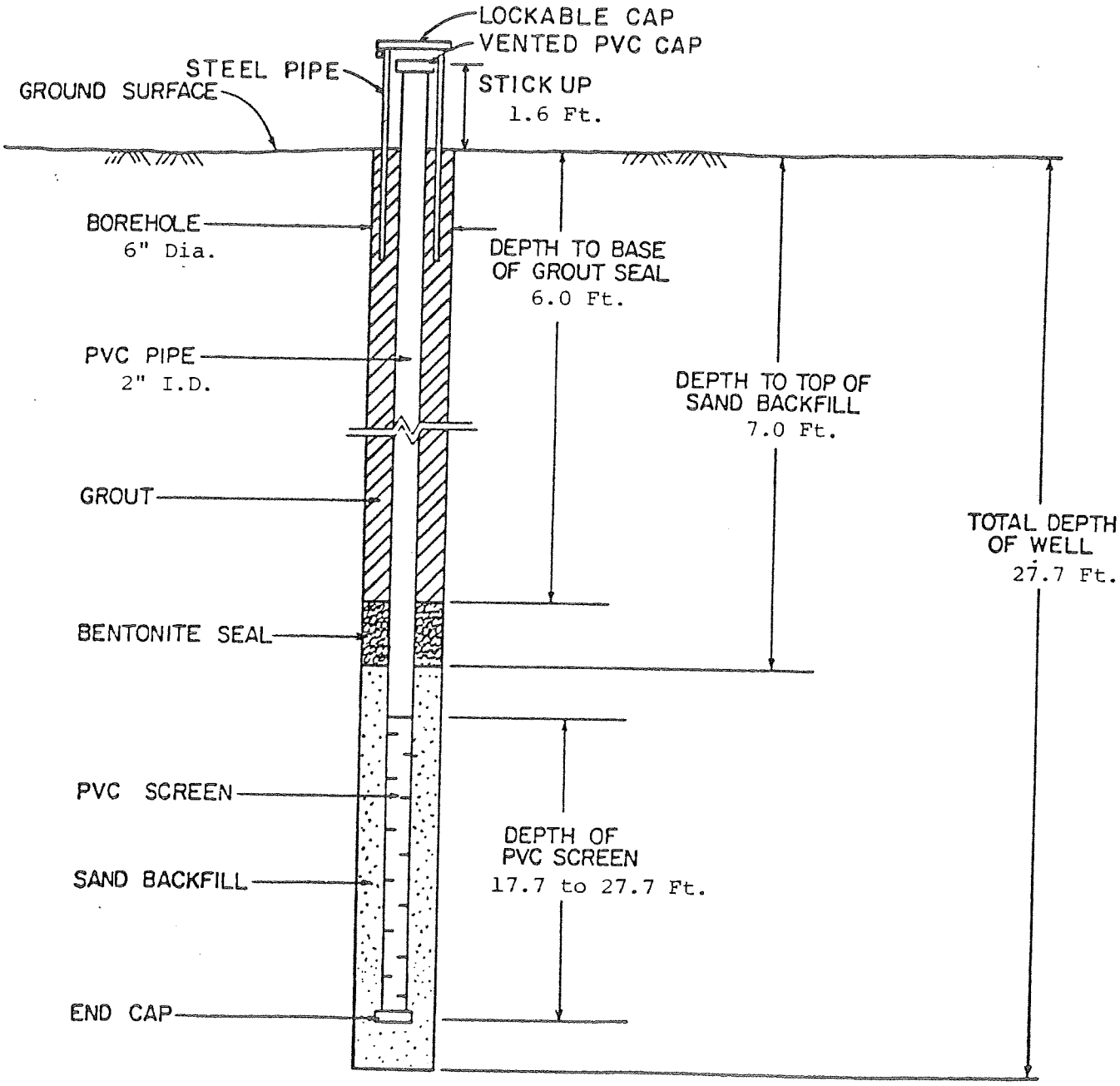
MONITORING WELL INSTALLATION RECORD

JOB NAME Landfill No. 6 JOB NUMBER CH 4507 C

WELL NUMBER MW-8 GROUND SURFACE ELEVATION 2594.39 Ft.

LOCATION South of Area D

INSTALLATION DATE 7-8-83



Champion Papers Canton, North Carolina	LAW ENGINEERING TESTING COMPANY CHARLOTTE, NORTH CAROLINA	MONITORING WELL INSTALLATION RECORD MW-8

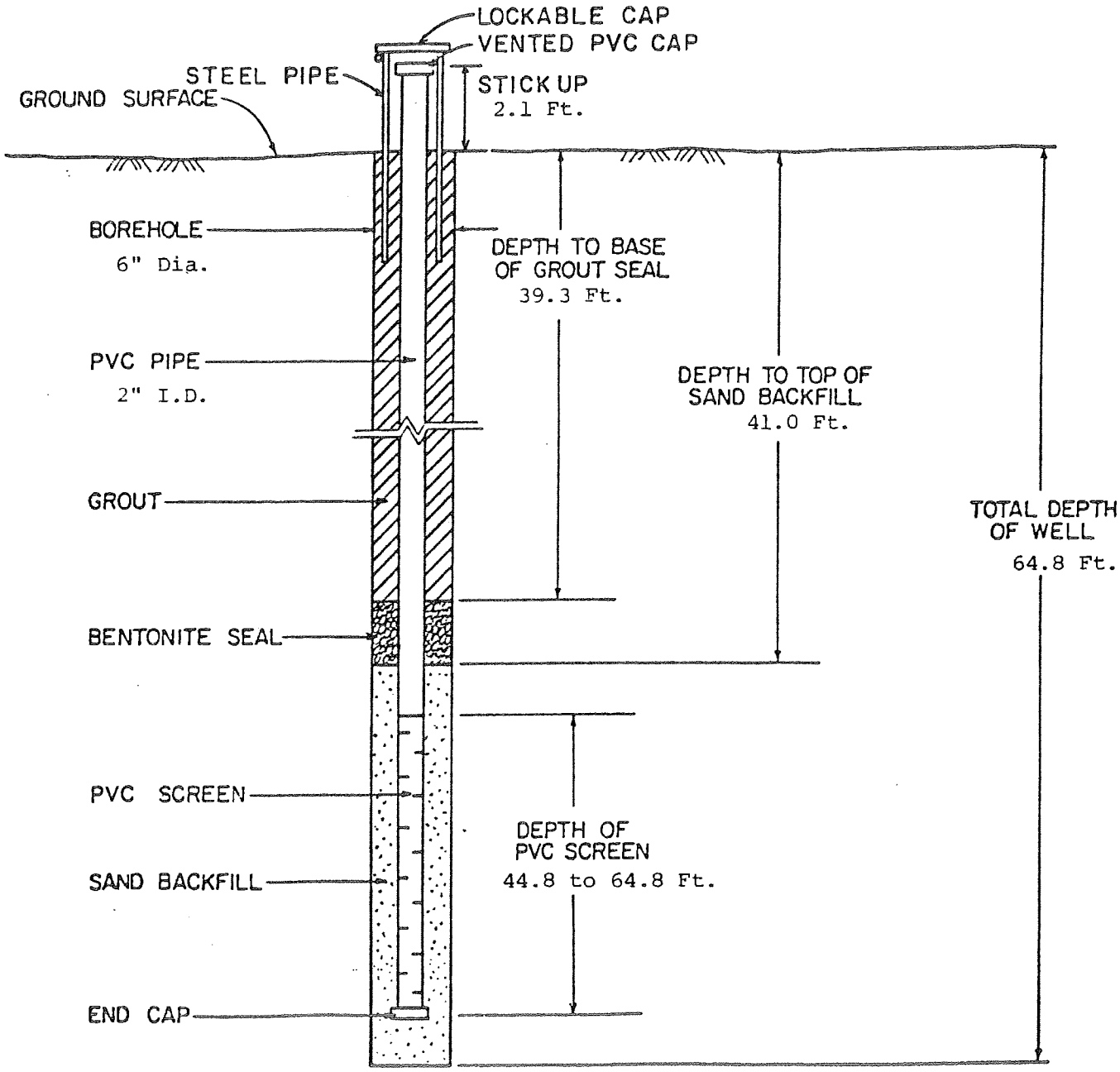
MONITORING WELL INSTALLATION RECORD

JOB NAME Landfill No. 6 JOB NUMBER CH 4507 C

WELL NUMBER MW-9 GROUND SURFACE ELEVATION 2684.02 Ft.

LOCATION West of Area D

INSTALLATION DATE 7-6-83



Champion Papers Canton, North Carolina	LAW ENGINEERING TESTING COMPANY CHARLOTTE, NORTH CAROLINA	MONITORING WELL INSTALLATION RECORD MW-9

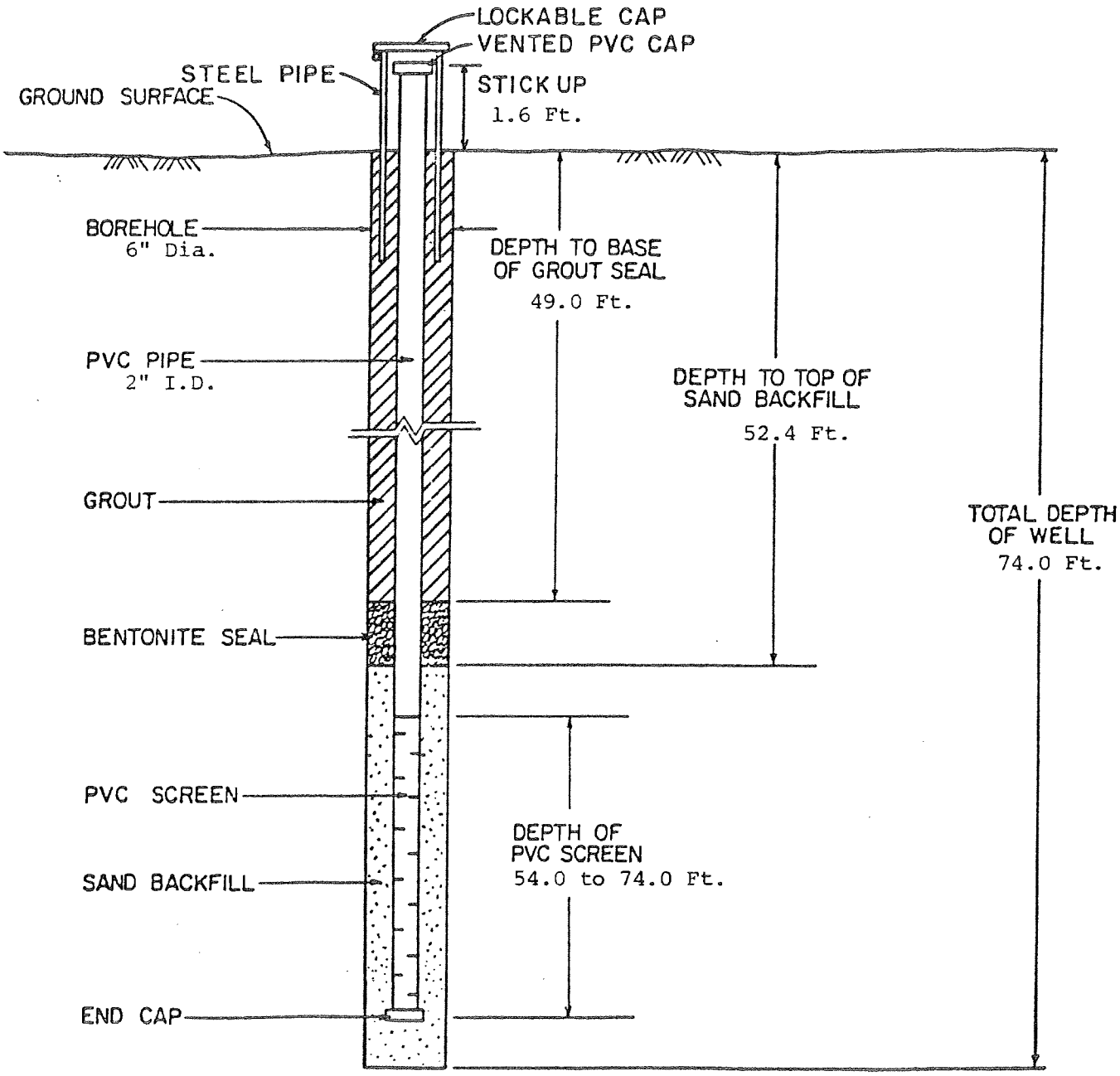
MONITORING WELL INSTALLATION RECORD

JOB NAME Landfill No. 6 JOB NUMBER CH 4507 C

WELL NUMBER MW-10 GROUND SURFACE ELEVATION 2677.78 Ft.

LOCATION West of Area E

INSTALLATION DATE 7-7-83



Champion Papers Canton, North Carolina	LAW ENGINEERING TESTING COMPANY CHARLOTTE, NORTH CAROLINA	MONITORING WELL INSTALLATION RECORD MW-10

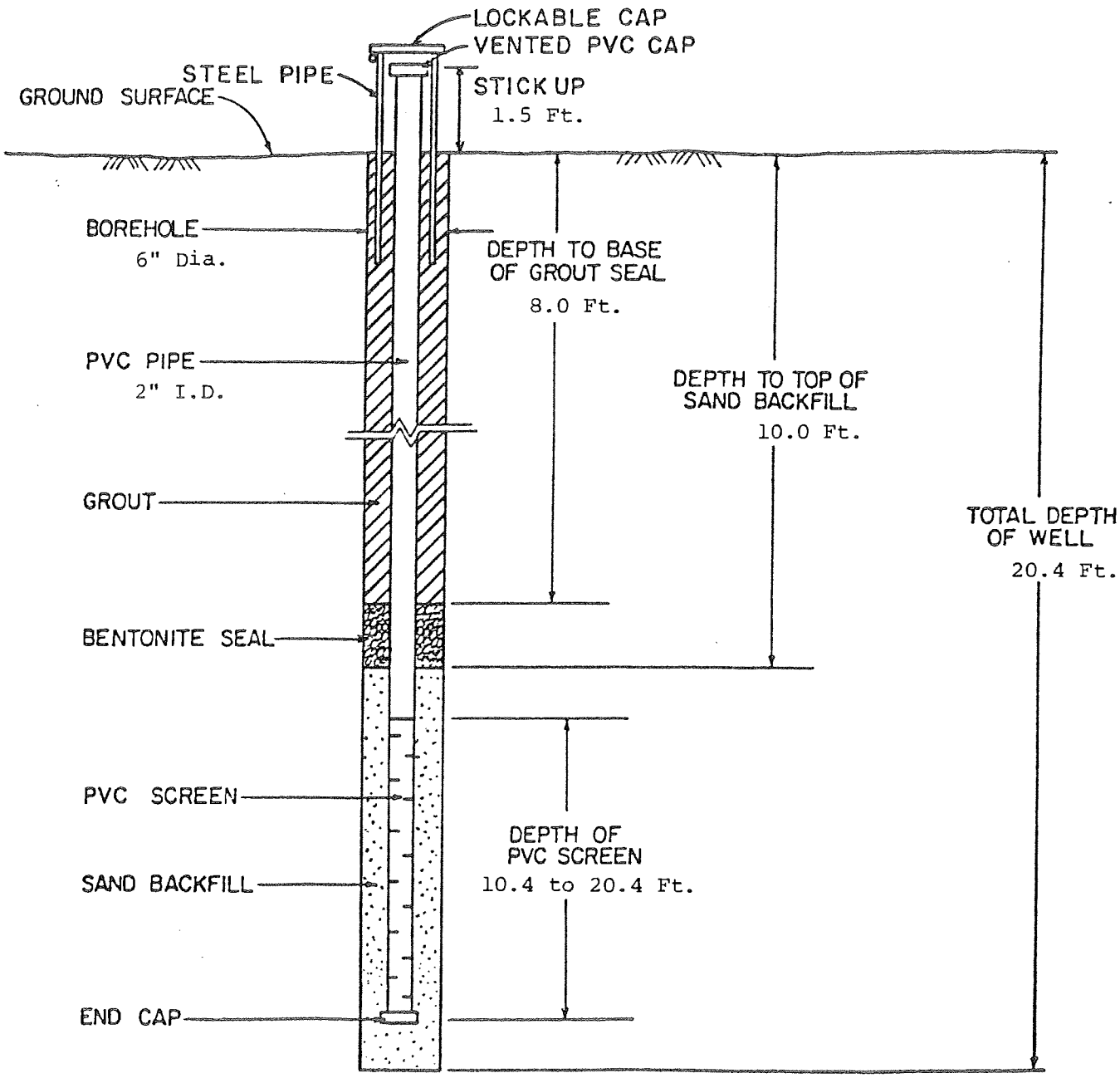
MONITORING WELL INSTALLATION RECORD

JOB NAME Landfill No. 6 JOB NUMBER CH 4507 C

WELL NUMBER MW-11 GROUND SURFACE ELEVATION 2639.44 Ft.

LOCATION West of Area E

INSTALLATION DATE 7-8-83



Champion Papers Canton, North Carolina	LAW ENGINEERING TESTING COMPANY CHARLOTTE, NORTH CAROLINA	MONITORING WELL INSTALLATION RECORD MW-11

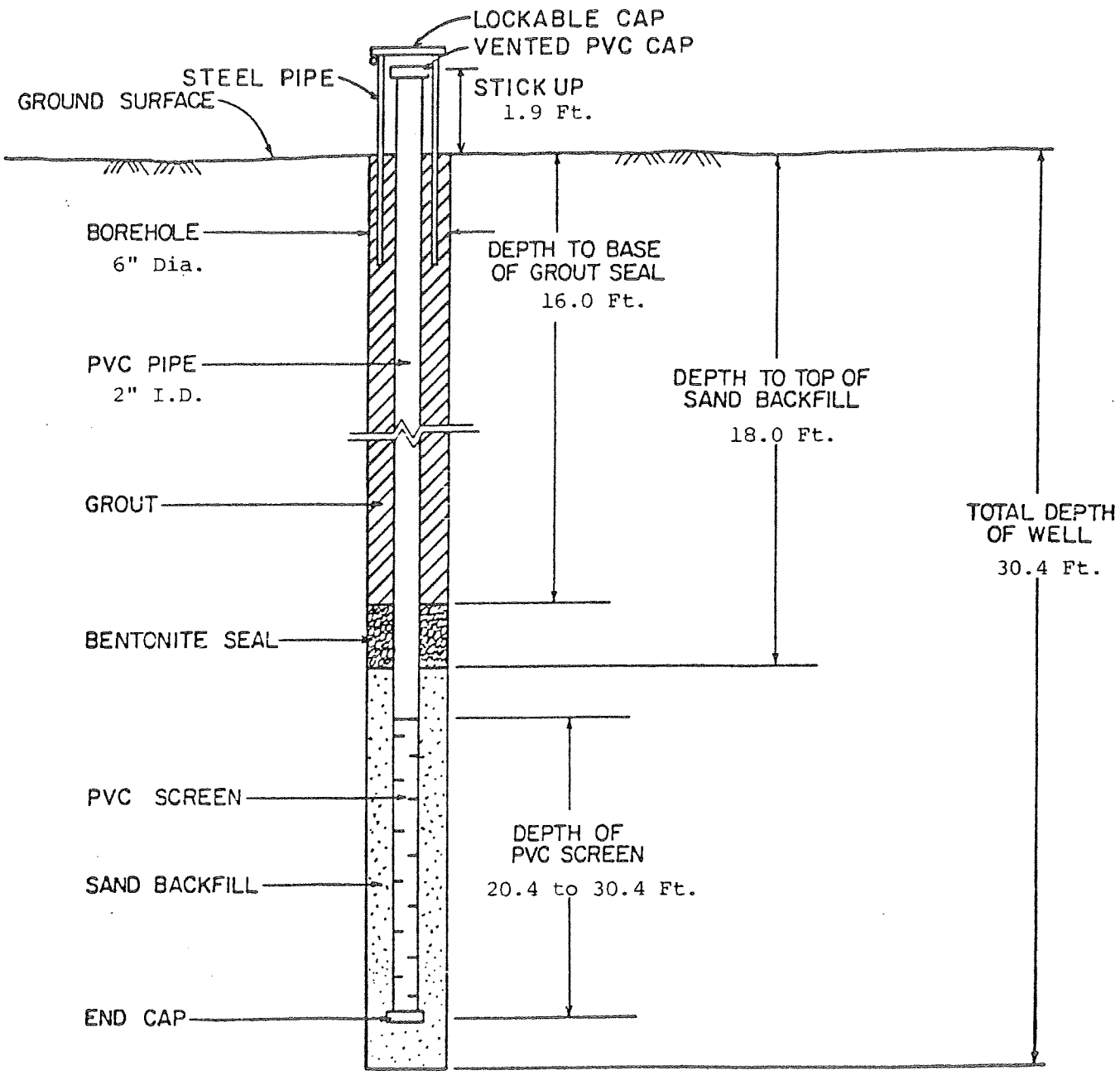
MONITORING WELL INSTALLATION RECORD

JOB NAME Landfill No. 6 JOB NUMBER CH 4507 C

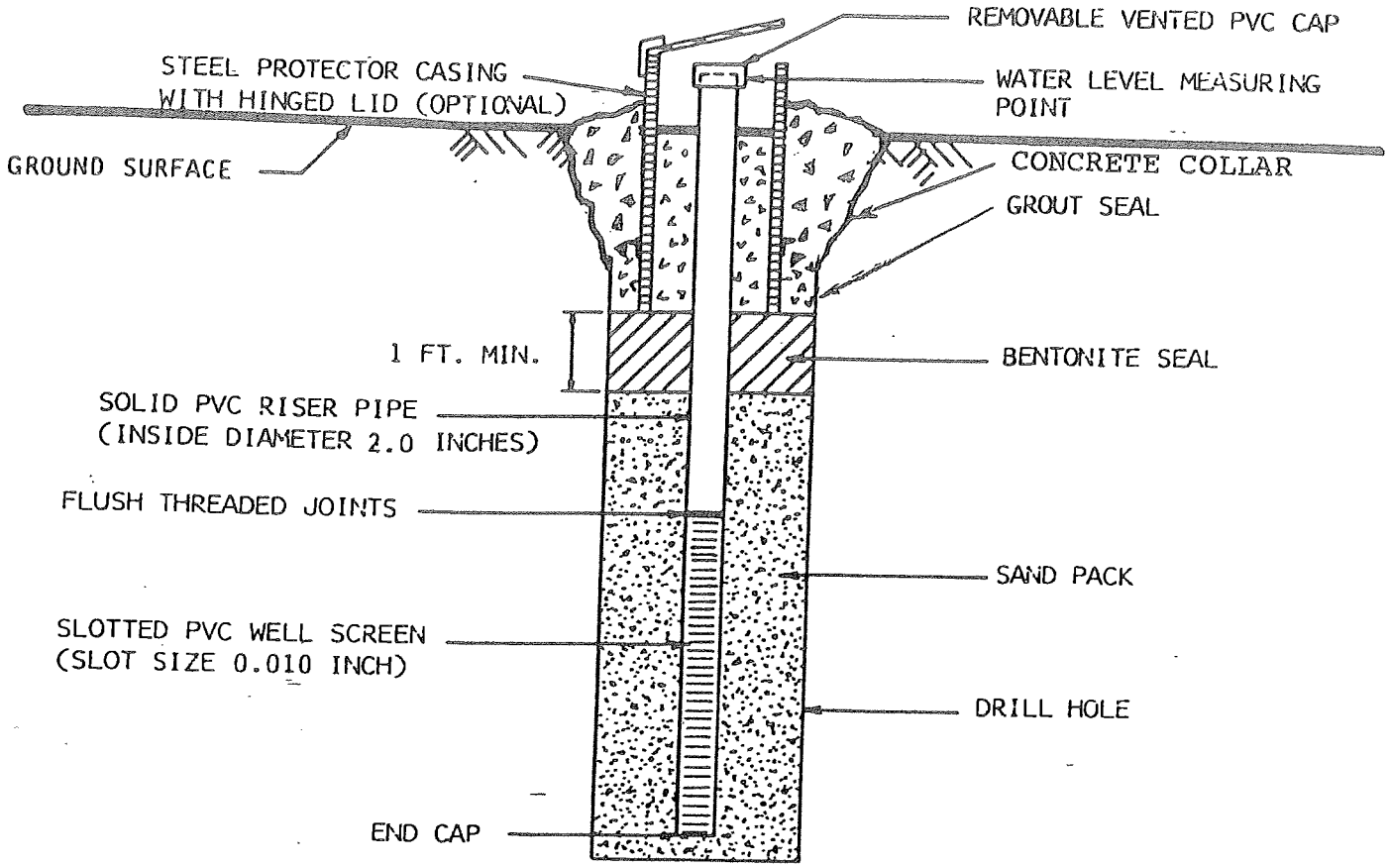
WELL NUMBER MW-12 GROUND SURFACE ELEVATION 2543.73 Ft.

LOCATION Northwest of Junction of Bowen Branch and Pigeon River

INSTALLATION DATE 7-6-83



Champion Papers Canton, North Carolina	LAW ENGINEERING TESTING COMPANY CHARLOTTE, NORTH CAROLINA	MONITORING WELL INSTALLATION RECORD MW-12



TYPICAL DIAGRAM OF MONITORING WELLS
(NOT TO SCALE)

MONITORING WELL INSTALLATION DETAILS

WELL NUMBER	MW-5A	MW-7A	MW-13		
GROUND ELEVATION (FT.)	---	---	---		
GROUND WATER ELEVATION (FT.) MEASURED ON:	---	---	---		
TOTAL DEPTH OF WELL BELOW GROUND SURFACE (FT.)	42.0	23.5	34.0		
MEASURING POINT ELEVATION (FT.)	---	---	---		
SCREEN LENGTH (FT.)	10.0	10.0	10.0		
SOLID RISER LENGTH BELOW GROUND SURFACE (FT.)	32.0	13.5	24.0		
PVC HEIGHT ABOVE GROUND (FT.)	2.5	2.5	2.5		
THICKNESS OF BENTONITE SEAL (FT.)	1.1	1.3	1.5		
THICKNESS OF CEMENT SEAL (FT.)	28.3	9.5	19.6		

NOTES:

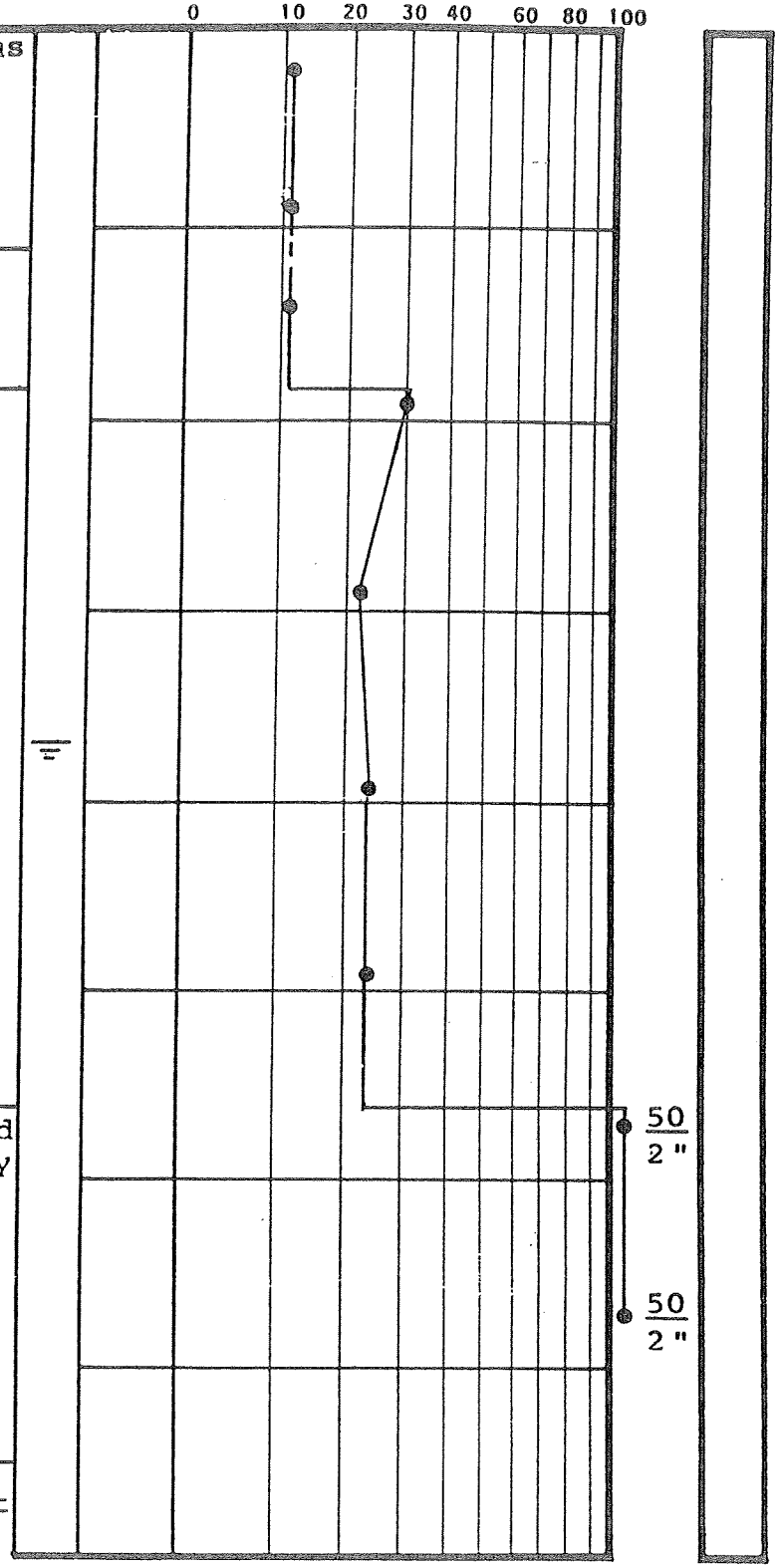
Champion International
Canton Landfill
Haywood County, N.C.

LAW ENGINEERING

MONITORING WELL INSTALLATION DETAILS

JOB NO. AV-1834 FIGURE 3

DEPTH FT.	DESCRIPTI(	PE TRATION-BLOWS PER FT.
0.0	Stiff red brown clayey micaceous fine to coarse sandy SILT with gravel and roots - Fill	
5.5	Stiff tan brown clayey fine to medium sandy SILT - Possible Residuum or Fill Rock seam 8.5 to 9.0 feet	
9.0	Very stiff gray brown and tan micaceous fine to medium and fine to coarse sandy SILT with rock fragments - Residuum	
28.0	Partially weathered rock sampled as tan gray fine to medium sandy SILT	
37.5	Boring terminated at 37.5 feet Monitoring well set to 34.0 feet (see Figure 3 for details) Ground water measured at 18.3 feet after 24 hours	



BORING AND SAMPLING MEETS ASTM D-1586

CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

50 % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. MW-13

DATE DRILLED 10-28-87

JOB NO. AV-1834

PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

JOB NAME CHAMPION NO. 6 LANDFILL

JOB NUMBER 2410446501

WELL NUMBER MW-14

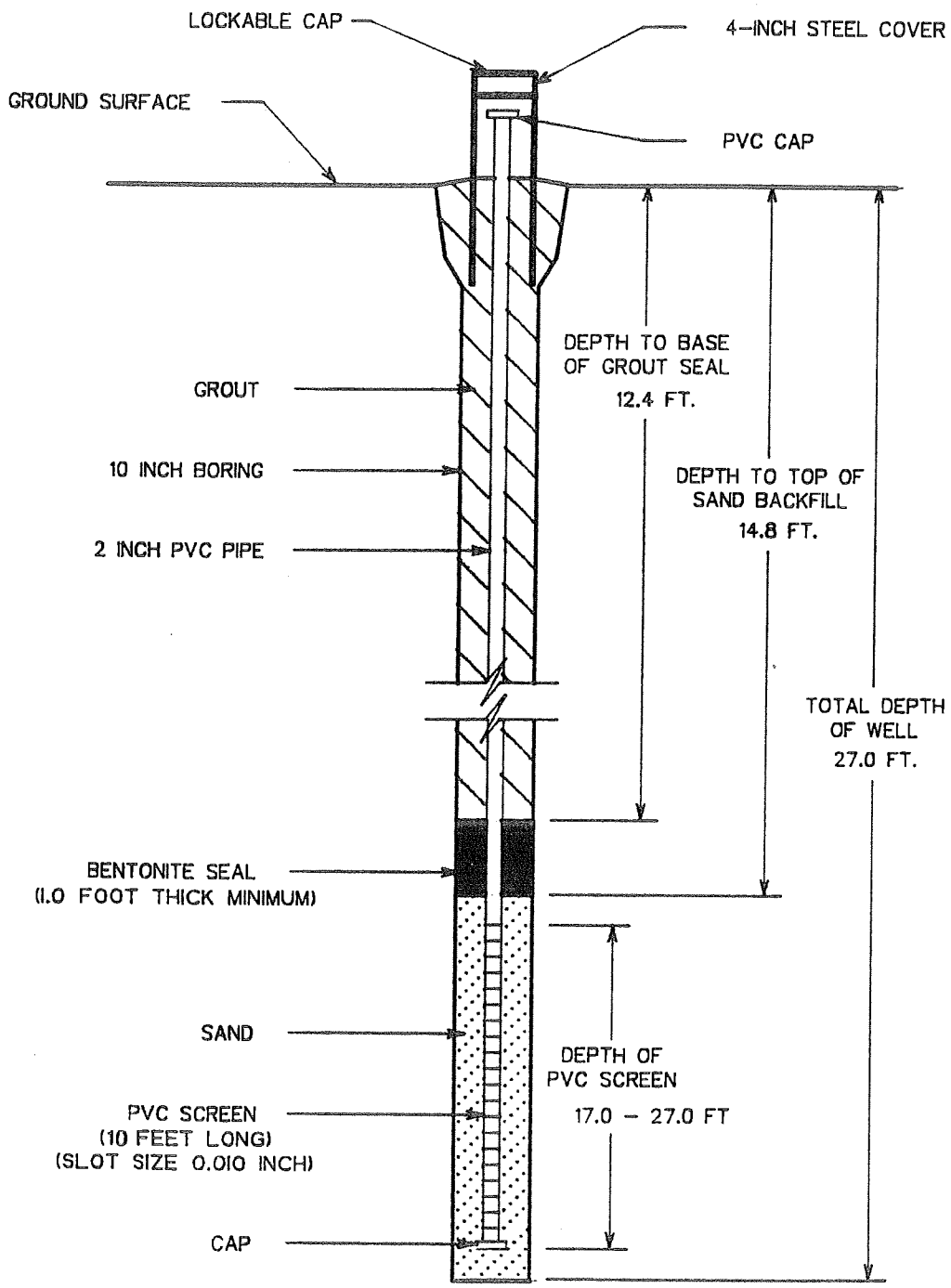
GROUND SURFACE ELEVATION 2650 FT. (MSL)

LOCATION SEE ATTACHED LOCATION MAP

MEASURING POINT ELEVATION

INSTALLATION DATE 1/24/92

LATITUDE LONGITUDE



LAW ENGINEERING
GREENVILLE, SOUTH CAROLINA

MONITORING WELL
INSTALLATION RECORD
CHAMPION LANDFILL NO. 6A
CANTON, SOUTH CAROLINA

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	PENETRATION - BLOWS/FOOT (0 10 20 30 40 60 80 100)
0.0			
0.5	Grass and topsoil.		
	Stiff moist light brown fine to medium sandy micaceous SILT - Residuum.		14
7.0	Stiff moist white to gray medium to coarse sandy micaceous SILT.		10
12.0	Firm wet light to medium brown fine to medium sandy micaceous SILT with relic foliation.		12
17.0	Firm wet light to medium brown micaceous silty medium to coarse SAND with relic structure.		13
22.0	Hard wet brown to black minor fine sand very micaceous SILT with relic foliation.		36
27.0	Boring terminated at 27.0 feet. Auger refusal at 27.0 feet. Ground water encountered at 10.43 feet at time of boring. Monitoring well installed to 27.0 feet on January 24, 1992.		

REMARKS:

TEST BORING RECORD

BORING NUMBER	MW-14
DATE DRILLED	January 24, 1992
PROJECT NUMBER	2410446501
PROJECT	CHAMPION #6A LANDFILL
PAGE 1 OF 1	

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

LAW ENGINEERING

JOB NAME CHAMPION NO. 6 LANDFILL

JOB NUMBER 2410446501

WELL NUMBER MW-15

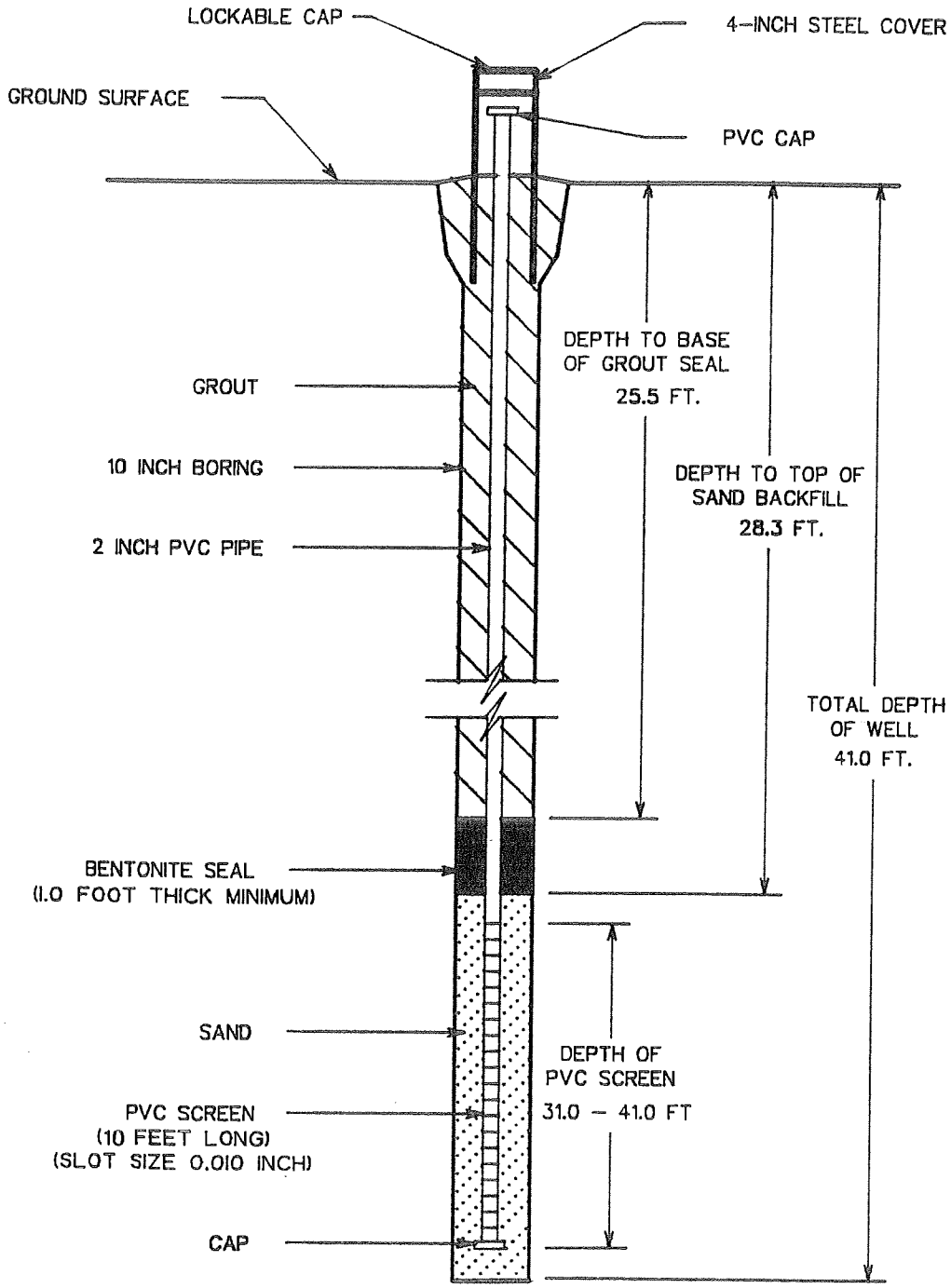
GROUND SURFACE ELEVATION 2610 FT. (MSL)

LOCATION SEE ATTACHED LOCATION MAP

MEASURING POINT ELEVATION

INSTALLATION DATE 1/27/92

LATITUDE LONGITUDE



LAW ENGINEERING
GREENVILLE, SOUTH CAROLINA

MONITORING WELL
INSTALLATION RECORD
CHAMPION LANDFILL NO. 6A
CANTON, SOUTH CAROLINA

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	PENETRATION - BLOWS/FOOT (0 10 20 30 40 60 80 100)
0.0	Drilling platform of fill soil.		
8.0	Very stiff moist light to medium brown fine sandy very micaceous SILT - Residuum.		17
11.0	Very stiff moist gray to brown minor fine sandy very micaceous SILT with relic foliation.		21
17.0	Very stiff moist gray very micaceous SILT with relic foliation.		23
22.0	Very stiff wet gray very micaceous SILT with minor white clayey inclusions.		18
27.0	Very stiff wet dark gray to dark brown fine sandy very micaceous SILT with relic foliation.		25
33.0	Very stiff wet dark gray very micaceous SILT with minor white clayey layering.		26
38.0	Very hard wet dark gray medium to coarse sandy micaceous SILT.		50/5"
40.0	Boring terminated at 40.0 feet. Auger refusal at 40.0 feet. Monitoring well installed to 41.0 feet on January 27, 1992. No ground water encountered at time of boring.		

REMARKS:

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	MW-15
DATE DRILLED	January 24, 1992
PROJECT NUMBER	2410446501
PROJECT	CHAMPION #6A LANDFILL
PAGE 1 OF 1	

LAW ENGINEERING

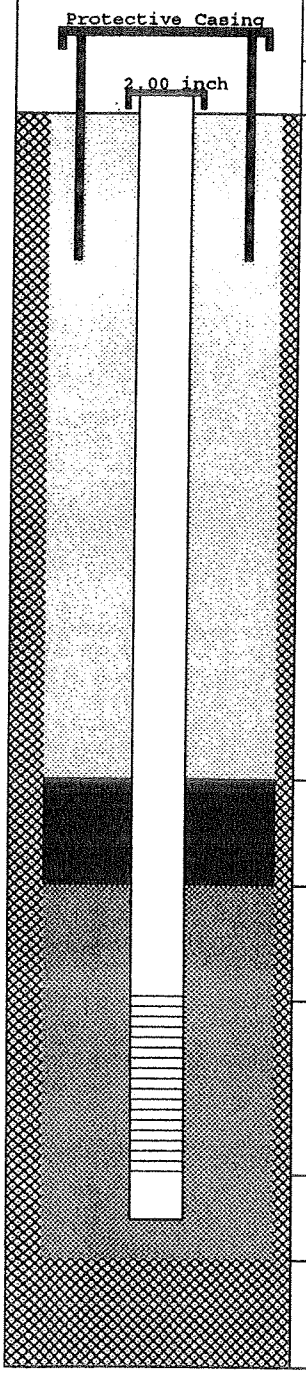
Well Completion Summary

Roy F. WESTON, Inc.

CLIENT	CHAMPION	DRILLING FIRM	GROUNDWATER PROTECTION INC.
SITE NAME	CHAMPION/LF-6	INSPECTOR	R.WILLIS

WELL ID	MW-16S
START DATE	01/24/96
COMPLETION DATE	01/24/96

WATER LEVELS



DEPTH		ELEV.
2.00	TC	2.00
0.00	GS	0.00
54.00	BN	-54.00
56.00	SP	-56.00
58.00	SC	-58.00
68.00	BS	-68.00
68.00	TD	0.00

DRILLING SUMMARY

Driller	M.SEILER
Drilling Fluid	NONE
Well Type	SINGLE CASED SCREENED

WELL DESIGN CONSTRUCTION

Casing #1 Diameter: 2.00 inch Interval: 0.00 to 58.00 ft.
Type : PVC SCH 40

Stick Up Inner Casing: 2.00 ft. Protective Casing: 3.00 ft.

Casing Grout: CEMT/BENT Interval: 0.00 to 54.00 ft.

Seal Type: BENTONITE Interval: 54.00 to 56.00 ft.

Sand Pack Type: #1 SAND Interval: 56.00 to 68.00 ft.
Grain Size: UNIFORM Median Diameter:
Screen Diameter: 2.00 Interval: 58.00 to 68.00 ft.
Type : PVC Slots: 0.010 inches

Silt Trap Interval: 0.00 to 0.00 ft.
Backfill Type: Interval: 0.00 to 0.00 ft.

COMMENTS

TC = Top of Casing	SP = Top Sand Pack	= Grout
GS = Ground Surface	SC = Top Screen	= Seal
BN = Top Seal	BS = Bottom Screen	= Sand Pack
	TD = Total Depth	= Formation

Additional Comments:

NOTE: Well Diagram not to Scale

Elevations are feet above mean sea level

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 68.00
SITE NAME	: CHAMPION/LF-6	LOGGER	: R.WILLIS
BORING ID	: MW-16S	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/24/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 01/24/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
				Interval Not Sampled						AUGERED INTERVAL.
-1	1									
-2	2									
-3	3									
-4	4			Sandy silt, ML	REDDISH BROWN	LSE	MST			
-5	5									
-6	6			Interval Not Sampled						AUGERED INTERVAL.
-7	7									
-8	8									
-9	9									
-10	10									
-11	11									
-12	12									
-13	13									
-14	14									
-15	15									
-16	16									
-17	17									
-18	18									
-19	19									
-20	20			Sandy silt, ML	RED	SFT	MST			

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 68.00
SITE NAME	: CHAMPION/LF-6	LOGGER	: R.WILLIS
BORING ID	: MW-16S	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/24/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 01/24/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
				Sandy silt, ML	RED	SFT	MST			
-21	21									
-22	22			Interval Not Sampled						AUGERED INTERVAL.
-23	23									
-24	24									
-25	25									
-26	26									
-27	27									
-28	28									
-29	29									
-30	30									
-31	31									
-32	32									
-33	33									
-34	34									
-35	35									
-36	36									
-37	37									
-38	38									
-39	39									
-40	40									

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 68.00
SITE NAME	: CHAMPION/LF-6	LOGGER	: R.WILLIS
BORING ID	: MW-16S	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/24/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 01/24/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
				Interval Not Sampled						AUGERED INTERVAL.
-41	41									
-42	42									
-43	43									
-44	44									
-45	45									
-46	46									
-47	47									
-48	48									
-49	49									
-50	50									
-51	51									
-52	52									
-53	53									
-54	54									
-55	55									
-56	56									
-57	57									
-58	58									
-59	59									
-60	60									

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 68.00
SITE NAME	: CHAMPION/LF-6	LOGGER	: R.WILLIS
BORING ID	: MW-16S	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/24/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 01/24/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
				Interval Not Sampled						AUGERED INTERVAL.
-61	61									
-62	62									
-63	63									
-64	64			Sandy elastic silt, MH	REDDISH BROWN	NA	WET			STARTING TO SHOW MOISTURE TD AT 68 FT.BGS.
-65	65									
-66	66									
-67	67									
-68	68									
-69	69									
-70	70									
-71	71									
-72	72									
-73	73									
-74	74									
-75	75									
-76	76									
-77	77									
-78	78									
-79	79									
-80	80									

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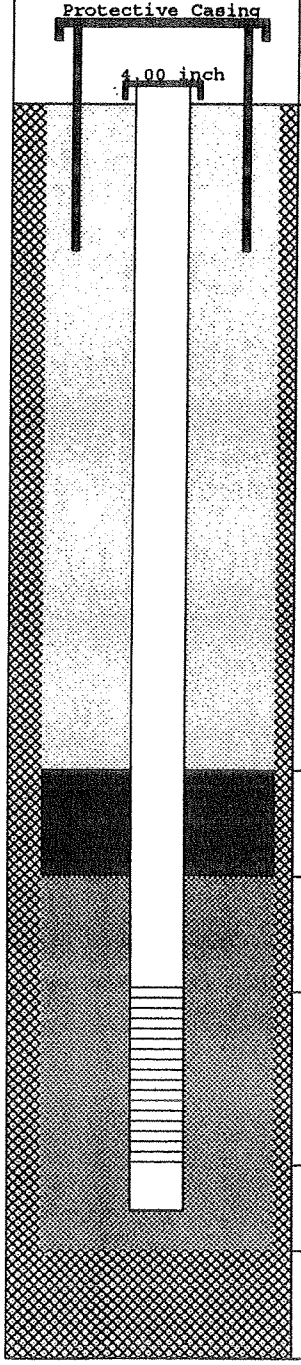
Well Completion Summary

Roy F. WESTON, Inc.

CLIENT	CHAMPION	DRILLING FIRM	GROUNDWATER PROTECTION INC.
SITE NAME	CHAMPION/LF-6	INSPECTOR	E.MACKEY

WELL ID	MW-16D
START DATE	01/23/96
COMPLETION DATE	01/24/96

WATER LEVELS



DEPTH		ELEV.
0.00	TC	0.00
0.00	GS	0.00
95.00	BN	-95.00
97.00	SP	-97.00
99.00	SC	-99.00
109.50	BS	-109.50
109.50	TD	0.00

DRILLING SUMMARY

Driller	M.SEILER
Drilling Fluid	AIR
Well Type	SINGLE CASED SCREENED

WELL DESIGN CONSTRUCTION

Casing #1 Diameter: 4.00 inch Interval: 0.00 to 99.00 ft.
Type : PVC SCH 40

Stick Up Inner Casing: 0.00 ft. Protective Casing: 0.00 ft.

Casing Grout: CEMT/BENT Interval: 0.00 to 95.00 ft.

Seal Type: BENTONITE MED.CHIPS Interval: 95.00 to 97.00 ft.

Sand Pack Type: #2 SAND Interval: 97.00 to 109.50 ft.
Grain Size: UNIFORM Median Diameter:
Screen Diameter: 4.00 Interval: 99.00 to 109.50 ft.
Type : PVC Slots: 0.010 inches

Silt Trap Interval: 0.00 to 0.00 ft.
Backfill Type: Interval: 0.00 to 0.00 ft.

COMMENTS

TC = Top of Casing	SP = Top Sand Pack	= Grout
GS = Ground Surface	SC = Top Screen	= Seal
BN = Top Seal	BS = Bottom Screen	= Sand Pack
	TD = Total Depth	= Formation

Additional Comments:

NOTE: Well Diagram not to Scale

Elevations are feet above mean sea level

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 109.50
SITE NAME	: CHAMPION/LF-6	LOGGER	: E.MACKEY/R.WILLIS
BORING ID	: MW-16D	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/23/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 01/24/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
			75	Sandy silt, ML	REDDISH BROWN	SFT	MST	6 12 12 12		
-1	1									
				No Sample Recovered						
-2	2		50	Sandy silt, ML	REDDISH BROWN	SFT	MST	10 12 13 15		
-3	3									
				No Sample Recovered						
-4	4		70	Sandy silt, ML	YELLOWISH RED	SFT	MST	132 14 16 20		
-5	5									
				No Sample Recovered						
-6	6		70	Sandy elastic silt, MH	RED	FRM	MST	42 10 12 13		TOP 6" WAS OLD ROADWAY WITH GRAVEL, SOIL BELOW WELL COMPACTED.
-7	7									
				No Sample Recovered						
-8	8		95	Sandy silt, ML	YELLOWISH RED	SFT	MST	7 13 20 27		SLIGHTLY MICACEOUS.
-9	9									
-10	10			No Sample Recovered						
			90	Sandy silt, ML	STRONG BROWN	SFT	MST	9 16 16 20		IRON STAINING, LARGE MICA FLAKES PRESENT.
-11	11									
-12	12			No Sample Recovered						
			95	Sandy silt, ML	STRONG BROWN	FRM	MST	8 8 9 12		
-13	13									
-14	14			No Sample Recovered						
			95	Sandy silt, ML	BROWN	FRM	MST	12 15 17 22		SOME SAPROLITIC CHARACTER ISTICS PRESENT.
-15	15									
-16	16			No Sample Recovered						
			80	Sandy elastic silt, MH	RED	STF	MST	12 32 18 21		CLAY CONTENT INCREASES WITH DEPTH.
-17	17									
				No Sample Recovered						
-18	18		75	Sandy elastic silt, MH	RED	FRM	MST	9 16 19 19		
-19	19									
				No Sample Recovered						
-20	20		70	Sandy elastic silt, MH	RED	FRM	MST	10 19 22 27		

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 109.50
SITE NAME	: CHAMPION/LF-6	LOGGER	: E.MACKEY/R.WILLIS
BORING ID	: MW-16D	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/23/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 01/24/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
				Sandy elastic silt, MH	RED	FRM	MST			
-21	21			Sandy silt, ML	DARK BROWN	SFT	MST			IRON STAINING.
				No Sample Recovered						
-22	22		75	Sandy silt, ML	BROWN	SFT	MST	6 12 14 20		
-23	23									
				No Sample Recovered						
-24	24		75	Sandy silt, ML	BROWN	FRM	MST	10 18 19 21		MICACEOUS.
-25	25									
				No Sample Recovered						
-26	26		65	Silty sand, SM	LT.YELLOW BROWN	FRM	MST	11 19 20 22		SAPROLITIC SOIL.
-27	27									
				No Sample Recovered						
-28	28		70	Sandy silt, ML	LT.YELLOW BROWN	FRM	MST	15 17 18 22		FOLIATION AND BANDING PRESENT, SAPROLITIC SOIL.
-29	29									
				No Sample Recovered						
-30	30		65	Sandy silt, ML	LT.YELLOW BROWN	FRM	MST	11 18 19 21		BANDING AND FOLIATION PRESENT.
-31	31									
				No Sample Recovered						
-32	32		75	Sandy silt, ML	OLIVE YELLOW	FRM	MST	11 15 19 25		SAPROLITIC SOIL.
-33	33									
				No Sample Recovered						
-34	34		70	Sandy silt, ML	OLIVE YELLOW	FRM	MST	15 18 19 25		
-35	35									
				No Sample Recovered						
-36	36		100	Sandy silt, ML	DK.YELLOW BROWN	SFT	MST	12 32 39 37		
-37	37									
-38	38		65	Sandy silt, ML	BROWN	LSE	MST	28 22 34 39		
-39	39									
				No Sample Recovered						
-40	40		100	Sandy silt, ML	BROWN	SFT	MST	19 50 0 0		SPOON REFUSAL AT 40.7'.

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 109.50
SITE NAME	: CHAMPION/LF-6	LOGGER	: B.MACKBY/R.WILLIS
BORING ID	: MW-16D	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/23/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 01/24/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
				Sandy silt, ML	BROWN	SFT	MST			SPOON REFUSAL AT 40.7'.
-41	41			Interval Not Sampled						AUGERED INTERVAL.
-42	42			Sandy silt, ML	BROWN	LSE	WET			AUGER REFUSAL AT 72'. SATURATION AT 64'.
-43	43									
-44	44									
-45	45									
-46	46									
-47	47									
-48	48									
-49	49									
-50	50									
-51	51									
-52	52									
-53	53									
-54	54									
-55	55									
-56	56									
-57	57									
-58	58									
-59	59									
-60	60									

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 109.50
SITE NAME	: CHAMPION/LF-6	LOGGER	: E.MACKEY/R.WILLIS
BORING ID	: MW-16D	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/23/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 01/24/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
				Sandy silt, ML	BROWN	LSE	WET			AUGER REFUSAL AT 72'. SATURATION AT 64'.
-61	61									
-62	62									
-63	63									
-64	64									
-65	65									
-66	66									
-67	67									
-68	68									
-69	69									
-70	70									
-71	71									
-72	72			Gneiss						BIOTITE GNEISS.WATER BEARING FRACTURE 105'-106'.TD AT 109.5 FT.BGS.
-73	73									
-74	74									
-75	75									
-76	76									
-77	77									
-78	78									
-79	79									
-80	80									

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 109.50
SITE NAME	: CHAMPION/LF-6	LOGGER	: E.MACKEY/R.WILLIS
BORING ID	: MW-16D	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/23/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 01/24/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
				Gneiss						BIOTITE GNEISS.WATER BEARING FRACTURE 105'-106'.TD AT 109.5 FT.BGS.
-81	81									
-82	82									
-83	83									
-84	84									
-85	85									
-86	86									
-87	87									
-88	88									
-89	89									
-90	90									
-91	91									
-92	92									
-93	93									
-94	94									
-95	95									
-96	96									
-97	97									
-98	98									
-99	99									
-100	100									

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 109.50
SITE NAME	: CHAMPION/LF-6	LOGGER	: B.MACKBY/R.WILLIS
BORING ID	: MW-16D	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/23/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 01/24/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
				Gneiss						BIOTITE GNEISS.WATER BEARING FRACTURE 105'-106'.TD AT 109.5 FT.BGS.
-101	101									
-102	102									
-103	103									
-104	104									
-105	105									
-106	106									
-107	107									
-108	108									
-109	109									
-110	110									
-111	111									
-112	112									
-113	113									
-114	114									
-115	115									
-116	116									
-117	117									
-118	118									
-119	119									
-120	120									

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Well Completion Summary

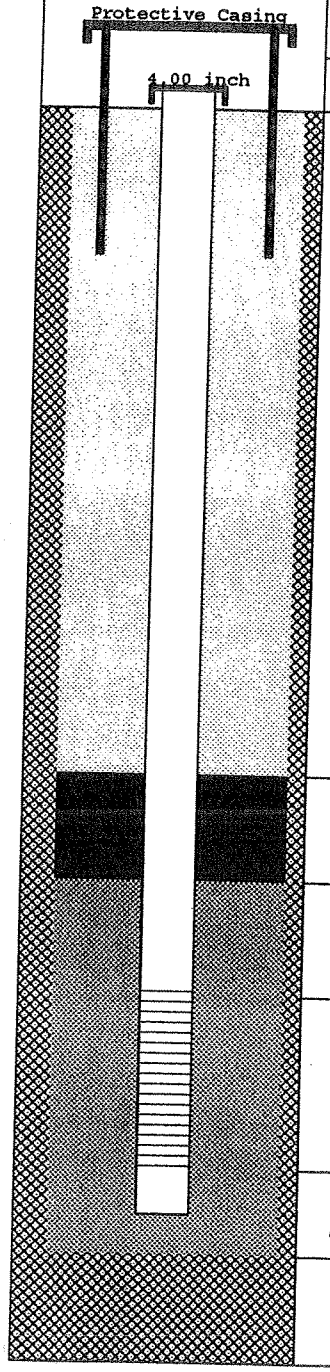
Roy F. WESTON, Inc.

CLIENT	CHAMPION	DRILLING FIRM	GROUNDWATER PROTECTION INC.
SITE NAME	CHAMPION/LF-6	INSPECTOR	E.MACKEY

WELL ID	MW-17
START DATE	02/01/96
COMPLETION DATE	02/01/96

WATER LEVELS

38.06 FT (TOC) ON 01/31/96



DEPTH		ELEV.
0.00	TC	0.00
0.00	GS	0.00
38.00	BN	-38.00
41.00	SP	-41.00
43.00	SC	-43.00
63.00	BS	-63.00
63.00	TD	0.00

DRILLING SUMMARY

Driller	M.SEILER
Drilling Fluid	AIR
Well Type	SINGLE CASED SCREENED

WELL DESIGN CONSTRUCTION

Casing #1 Diameter: 4.00 inch Interval: 0.00 to 43.00 ft.
Type : PVC SCH 40

Stick Up Inner Casing: 0.00 ft. Protective Casing: 0.00 ft.

Casing Grout: CEMT/BENT Interval: 0.00 to 38.00 ft.

Seal Type: BENTONITE MED.CHIPS Interval: 38.00 to 41.00 ft.

Sand Pack Type: #1 SAND Interval: 41.00 to 63.00 ft.
Grain Size: UNIFORM Median Diameter:
Screen Diameter: 4.00 Interval: 43.00 to 63.00 ft.
Type : PVC Slots: 0.010 inches

Silt Trap Interval: 0.00 to 0.00 ft.
Backfill Type: Interval: 0.00 to 0.00 ft.

COMMENTS

TC = Top of Casing
GS = Ground Surface
BN = Top Seal
SP = Top Sand Pack
SC = Top Screen
BS = Bottom Screen
TD = Total Depth

= Grout
= Seal
= Sand Pack
= Formation

Additional Comments:

NOTE: Well Diagram not to Scale

Elevations are feet above mean sea level

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03/28/96

Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 63.00
SITE NAME	: CHAMPION/LF-6	LOGGER	: E.MACKEY
BORING ID	: MW-17	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/25/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 02/01/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
			75	Sandy silt, ML	YELLOWISH RED	FRM	MST	3 9 10 12		
-1	1									
-2	2			No Sample Recovered						
			65	Sandy elastic silt, MH	LIGHT BROWN	FRM	MST	12 18 32 35		FILL.VERY MICACEOUS,MORE CLAY.
-3	3									
				No Sample Recovered						
-4	4									
			60	Sandy silt, ML	RED	FRM	MST	14 38 33 34		HIGHLY MICACEOUS SAPROLITIC SOIL.
-5	5									
				No Sample Recovered						
-6	6									
			65	Sandy silt, ML	DK.RED BROWN	FRM	MST	8 18 33 49		SAPROLITE,BANDING AND FOLIATION PRESENT, MICACEOUS.
-7	7									
				No Sample Recovered						
-8	8									
			100	Silty sand, SM	DARK BROWN	FRM	MST	18 98 50 0		SAPROLITE.
-9	9									
				Interval Not Sampled						AUGERED INTERVAL.
-10	10									
				No Sample Recovered				50		SPOON REFUSAL AT 10.2'.
				Interval Not Sampled				0 0 0		SAPROLITE,WELL CEMENTED. AUGERED INTERVAL. SAPROLITE.
-11	11									
-12	12									
-13	13									
-14	14									
-15	15									
-16	16									
-17	17									
-18	18									
-19	19									
-20	20									

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 63.00
SITE NAME	: CHAMPION/LF-6	LOGGER	: B.MACKEY
BORING ID	: MW-17	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/25/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 02/01/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
				Interval Not Sampled						
-21	21									AUGERED INTERVAL. SAPROLITE.
-22	22									
-23	23									
-24	24									
-25	25									
-26	26									
-27	27									
-28	28									
-29	29									
-30	30									
-31	31									
-32	32									
-33	33									
-34	34									
-35	35									
-36	36									
-37	37									
-38	38									
-39	39			Gneiss		MOD				BIOTITE GNEISS.FRACTURE @ 58-59'.TD AT 63 FT.BGS.
-40	40									

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 63.00
SITE NAME	: CHAMPION/LF-6	LOGGER	: E.MACKEY
BORING ID	: MW-17	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/25/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 02/01/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
				Gneiss		MOD				BIOTITE GNEISS.FRACTURE @ 58-59'.TD AT 63 FT.BGS.
-41	41									
-42	42									
-43	43									
-44	44									
-45	45									
-46	46									
-47	47									
-48	48									
-49	49									
-50	50									
-51	51									
-52	52									
-53	53									
-54	54									
-55	55									
-56	56									
-57	57									
-58	58									
-59	59									
-60	60									

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 63.00
SITE NAME	: CHAMPION/LF-6	LOGGER	: E.MACKEY
BORING ID	: MW-17	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/25/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 02/01/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
				Gneiss		MOD				BIOTITE GNEISS.FRACTURE @ 58-59'.TD AT 63 FT.BGS.
-61	61									
-62	62									
-63	63									
-64	64									
-65	65									
-66	66									
-67	67									
-68	68									
-69	69									
-70	70									
-71	71									
-72	72									
-73	73									
-74	74									
-75	75									
-76	76									
-77	77									
-78	78									
-79	79									
-80	80									

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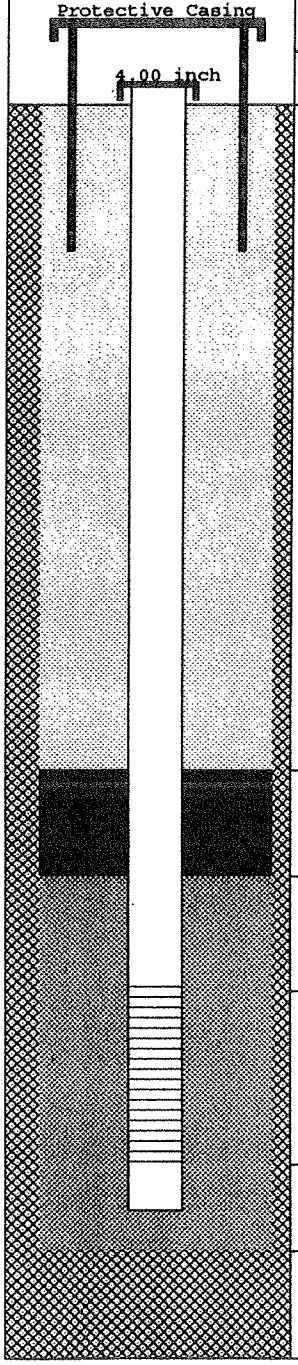
Well Completion Summary

Roy F. WESTON, Inc.

CLIENT	CHAMPION	DRILLING FIRM	GROUNDWATER PROTECTION INC.
SITE NAME	CHAMPION/LF-6	INSPECTOR	E.MACKEY

WELL ID	MW-18
START DATE	01/22/96
COMPLETION DATE	01/22/96

WATER LEVELS



DEPTH		ELEV.
0.00	TC	0.00
0.00	GS	0.00
96.00	BN	-96.00
98.00	SP	-98.00
100.00	SC	-100.00
110.00	BS	-110.00
110.00	TD	0.00

DRILLING SUMMARY

Driller	M.SEILER
Drilling Fluid	AIR
Well Type	SINGLE CASED SCREENED

WELL DESIGN CONSTRUCTION

Casing #1 Diameter: 4.00 inch Interval: 0.00 to 98.00 ft.
Type : PVC SCH 40

Stick Up Inner Casing: 0.00 ft. Protective Casing: 0.00 ft.

Casing Grout: CEMT/BENT Interval: 0.00 to 96.00 ft.

Seal Type: BENTONITE MED.CHIPS Interval: 96.00 to 98.00 ft.

Sand Pack Type: #1 SAND Interval: 98.00 to 110.00 ft.
Grain Size: UNIFORM Median Diameter:
Screen Diameter: 4.00 Interval: 100.00 to 110.00 ft.
Type : PVC Slots: 0.010 inches

Silt Trap Interval: 0.00 to 0.00 ft.
Backfill Type: Interval: 0.00 to 0.00 ft.

COMMENTS

TC = Top of Casing	SP = Top Sand Pack	= Grout
GS = Ground Surface	SC = Top Screen	= Seal
BN = Top Seal	BS = Bottom Screen	= Sand Pack
	TD = Total Depth	= Formation

Additional Comments:

NOTE: Well Diagram not to Scale

Elevations are feet above mean sea level

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 110.00
SITE NAME	: CHAMPION/LF-6	LOGGER	: E.MACKEY
BORING ID	: MW-18	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/19/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 01/22/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
-1	1		60	Blastic silt with sand, MH	RED	FRM	MST	3 4 4 3		
				No Sample Recovered						
-2	2		60	Sandy silt, ML	RED	FRM	MST	2 4 4 6		SLIGHTLY MICACEOUS.
-3	3			No Sample Recovered						
-4	4		70	Sandy silt, ML	RED	FRM	MST	8 9 12 13		SLIGHTLY MICACEOUS, LESS CLAY.
-5	5			No Sample Recovered						
-6	6		70	Silty sand, SM	REDDISH YELLOW	FRM	MST	23 20 25 30		SAPROLITIC SOIL.
-7	7			No Sample Recovered						
-8	8		85	Silty sand, SM	YELLOWISH RED	FRM	MST	23 50 50 52		SAPROLITIC SOIL.
-9	9			No Sample Recovered						
-10	10		60	Silty sand, SM	DARK BROWN	FRM	MST	16 30 32 33		SAPROLITIC SOIL, NO STRUCTURE OBSERVED.
-11	11			No Sample Recovered						
-12	12		65	Sandy silt, ML	RED	SFT	MST	9 14 14 14		SAME SAPROLITIC SOIL, LESS CEMENTED, SOME BANDING STRUCTURE VISIBLE.
-13	13			No Sample Recovered						
-14	14		75	Silty sand, SM	RED	FRM	MST	12 13 27 31		WELL FOLIATED, CEMENTED GNEISSIC BANDING.
-15	15			No Sample Recovered						
-16	16		40	Silty sand, SM	YELLOWISH RED	FRM	MST	20 24 25 25		
-17	17			No Sample Recovered						
-18	18		85	Silty sand, SM	REDDISH YELLOW	FRM	MST	13 40 52 33		SAPROLITIC SOIL, SOME FOLIATION.
-19	19			No Sample Recovered						
-20	20		65	Silty sand, SM	LIGHT BROWN	FRM	MST	18 21 28 29		WELL FOLIATED, BETTER CEMENTATION NEAR BOTTOM.

Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 110.00
SITE NAME	: CHAMPION/LF-6	LOGGER	: R.MACKEY
BORING ID	: MW-18	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/19/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 01/22/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
				Silty sand, SM	LIGHT BROWN	FRM	MST			WELL FOLIATED,BETTER CEMENTATION NEAR BOTTOM.
-21	21									
				No Sample Recovered						
-22	22		58	Silty sand, SM	LIGHT BROWN	STF	MST	18 24 34 50		MORE CEMENTED AT BOTTOM. GNEISSIC SAPROLITE.
-23	23									
				No Sample Recovered						
-24	24			Interval Not Sampled						AUGERED INTERVAL.
			70	Silty sand, SM	YELLOW	SFT	MST			LESS CEMENTED ZONE. SOME BANDING PRESENT.
-25	25							16 19 21 28		
				No Sample Recovered						
-26	26		75	Silty sand, SM	STRONG BROWN	FRM	MST	12 16 24 28		BANDED LAYERS W/CHANGING CEMENTATION.
-27	27									
				No Sample Recovered						
-28	28		75	Silty sand, SM	STRONG BROWN	FRM	MST	9 10 50 78		SAPROLITIC GNEISS.
-29	29									
				No Sample Recovered						
-30	30		83	Silty sand, SM	BROWN	FRM	WET	57 50		SAPROLITIC GNEISS.
				No Sample Recovered				0		
-31	31			Interval Not Sampled				0		AUGERED INTERVAL.
-32	32			Silty sand, SM	BROWN	FRM	WET			SPOON REFUSAL AT 32'. AUGER REFUSAL AT 33'.
-33	33			Silty sand, SM	BROWN	FRM	WET			SAPROLITE.
-34	34									
-35	35			Gneiss		MOD				BIOTITE GNEISS. TD AT 110 FT.BGS.
-36	36									
-37	37									
-38	38									
-39	39									
-40	40									

Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 110.00
SITE NAME	: CHAMPION/LF-6	LOGGER	: E.MACKEY
BORING ID	: MW-18	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/19/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 01/22/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
				Gneiss		MOD				BIOTITE GNEISS. TD AT 110 FT.BGS.
-41	41									
-42	42									
-43	43									
-44	44									
-45	45									
-46	46									
-47	47									
-48	48									
-49	49									
-50	50									
-51	51									
-52	52									
-53	53									
-54	54									
-55	55									
-56	56									
-57	57									
-58	58									
-59	59									
-60	60									

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 110.00
SITE NAME	: CHAMPION/LF-6	LOGGER	: B.MACKEY
BORING ID	: MW-18	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/19/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 01/22/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
				Gneiss		MOD				BIOTITE GNEISS. TD AT 110 FT.BGS.
-61	61									
-62	62									
-63	63									
-64	64									
-65	65									
-66	66									
-67	67									
-68	68									
-69	69									
-70	70									
-71	71									
-72	72									
-73	73									
-74	74									
-75	75									
-76	76									
-77	77									
-78	78									
-79	79									
-80	80									

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 110.00
SITE NAME	: CHAMPION/LF-6	LOGGER	: E.MACKEY
BORING ID	: MW-18	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/19/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 01/22/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
				Gneiss		MOD				BIOTITE GNEISS. TD AT 110 FT.BGS.
-81	81									
-82	82									
-83	83									
-84	84									
-85	85									
-86	86									
-87	87									
-88	88									
-89	89									
-90	90									
-91	91									
-92	92									
-93	93									
-94	94									
-95	95									
-96	96									
-97	97									
-98	98									
-99	99									
-100	100									

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 110.00
SITE NAME	: CHAMPION/LF-6	LOGGER	: E.MACKEY
BORING ID	: MW-18	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/19/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 01/22/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
				Gneiss		MOD				BIOTITE GNEISS. TD AT 110 FT.BGS.
-101	101									
-102	102									
-103	103									
-104	104									
-105	105									
-106	106									
-107	107									
-108	108									
-109	109									
-110	110									
-111	111									
-112	112									
-113	113									
-114	114									
-115	115									
-116	116									
-117	117									
-118	118									
-119	119									
-120	120									

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Well Completion Summary

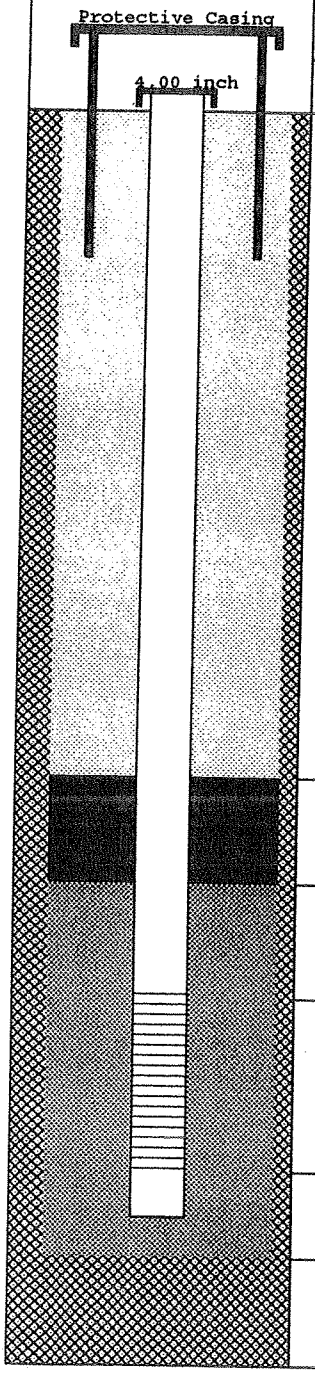
Roy F. WESTON, Inc.

CLIENT	CHAMPION	DRILLING FIRM	GROUNDWATER PROTECTION INC.
SITE NAME	CHAMPION/LF-6	INSPECTOR	E.MACKEY

WELL ID	MW-20
START DATE	01/18/96
COMPLETION DATE	01/18/96

WATER LEVELS

46.04 FT (TOC) ON 01/18/96



DEPTH		ELEV.
2.00	TC	2.00
0.00	GS	0.00
45.50	BN	-45.50
47.50	SP	-47.50
49.50	SC	-49.50
59.50	BS	-59.50
59.50	TD	0.00

DRILLING SUMMARY

Driller	M.SEILER
Drilling Fluid	AIR
Well Type	SINGLE CASED SCREENED

WELL DESIGN CONSTRUCTION

Casing #1 Diameter: 4.00 inch Interval: 0.00 to 49.50 ft.
Type : PVC SCH 40

Stick Up Inner Casing: 2.00 ft. Protective Casing: 0.00 ft.

Casing Grout: CEMT/BENT Interval: 0.00 to 45.50 ft.

Seal Type: BENTONITE MED.CHIPS Interval: 45.50 to 47.50 ft.

Sand Pack Type: #1 SAND Interval: 47.50 to 59.50 ft.
Grain Size: UNIFORM Median Diameter:
Screen Diameter: 4.00 Interval: 49.50 to 59.50 ft.
Type : PVC Slots: 0.010 inches

Silt Trap Interval: 0.00 to 0.00 ft.
Backfill Type: Interval: 0.00 to 0.00 ft.

COMMENTS

TC = Top of Casing	SP = Top Sand Pack	= Grout
GS = Ground Surface	SC = Top Screen	= Seal
BN = Top Seal	BS = Bottom Screen	= Sand Pack
	TD = Total Depth	= Formation

Additional Comments:

NOTE: Well Diagram not to Scale

Elevations are feet above mean sea level

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03/28/96

Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 59.50
SITE NAME	: CHAMPION/LF-6	LOGGER	: E.MACKBY
BORING ID	: MW-20	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/18/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 01/18/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
			60	Sandy silt, ML	RED	SFT	MST	4 3 2 2		
-1	1									
				No Sample Recovered						
-2	2									
			60	Elastic silt with sand, MH	DK.RED BROWN	FRM	MST	4 5 5 5		SLIGHTLY MICACEOUS.MORE CLAY.
-3	3									
				No Sample Recovered						
-4	4									
			65	Sandy silt, ML	DUSKY RED	FRM	MST	5 13 13 21		IRON STAINING.
-5	5									
				No Sample Recovered						
-6	6									
			100	Silty sand with gravel, SM	DARK RED	FRM	MST	25 56 50 0		SLIGHTLY MICACEOUS.IRON STAINING.
-7	7									
				Interval Not Sampled						AUGERED INTERVAL.
-8	8									
			60	Silty sand, SM	DARK BROWN	FRM	MST	20 40 30 22		VERY MICACEOUS SAPROLITE WITH YELLOWISH WHITE BANDING.
-9	9									
				No Sample Recovered						
-10	10									
			50	Silty sand, SM	DARK BROWN	FRM	MST	7 10 10 14		
-11	11									
				No Sample Recovered						
-12	12									
			55	Silty sand, SM	DARK BROWN	FRM	MST	5 9 13 20		SAME SAPROLITE.BIOTITE GNEISS.
-13	13									
				No Sample Recovered						
-14	14									
			100	Silty sand, SM	DARK BROWN	FRM	MST	10 14 19 23		SAPROLITIC BIOTITE GNEISS
-15	15									
-16	16									
			65	Silty sand, SM	DK.YELLOW BROWN	FRM	MST	11 24 26 16		SAPROLITIC BIOTITE GNEISS
-17	17									
				No Sample Recovered						
-18	18									
			100	Silty sand, SM	DK.YELLOW BROWN	FRM	MST	20 42 50 0		SPOON REFUSAL AT 19.3'. SAPROLITIC BIOTITE GNEISS
-19	19									
				Interval Not Sampled						AUGERED INTERVAL.
-20	20									
				Interval Not Sampled						AUGERED INTERVAL.CUTTINGS INDICATE SAPROLITE. TEXTURE CHANGE AT 35'. STILL DRY.

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 59.50
SITE NAME	: CHAMPION/LF-6	LOGGER	: E.MACKBY
BORING ID	: MW-20	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/18/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 01/18/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
				Interval Not Sampled						AUGERED INTERVAL.CUTTINGS INDICATE SAPROLITE. TEXTURE CHANGE AT 35'. STILL DRY.
-21	21									
-22	22									
-23	23									
-24	24									
-25	25									
-26	26									
-27	27									
-28	28									
-29	29									
-30	30									
-31	31									
-32	32									
-33	33									
-34	34									
-35	35			Gneiss	WHITE	STR				FRACTURE AT 54-55'.
-36	36									
-37	37									
-38	38									
-39	39									
-40	40									

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 59.50
SITE NAME	: CHAMPION/LF-6	LOGGER	: E.MACKEY
BORING ID	: MW-20	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/18/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 01/18/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
				Gneiss	WHITE	STR				FRACTURE AT 54-55'.
-41	41									
-42	42									
-43	43									
-44	44									
-45	45									
-46	46									
-47	47									
-48	48									
-49	49									
-50	50									
-51	51									
-52	52									
-53	53									
-54	54			Gneiss	WHITE	STR				TD AT 59.5 FT.BGS.
-55	55									
-56	56									
-57	57									
-58	58									
-59	59									
-60	60									

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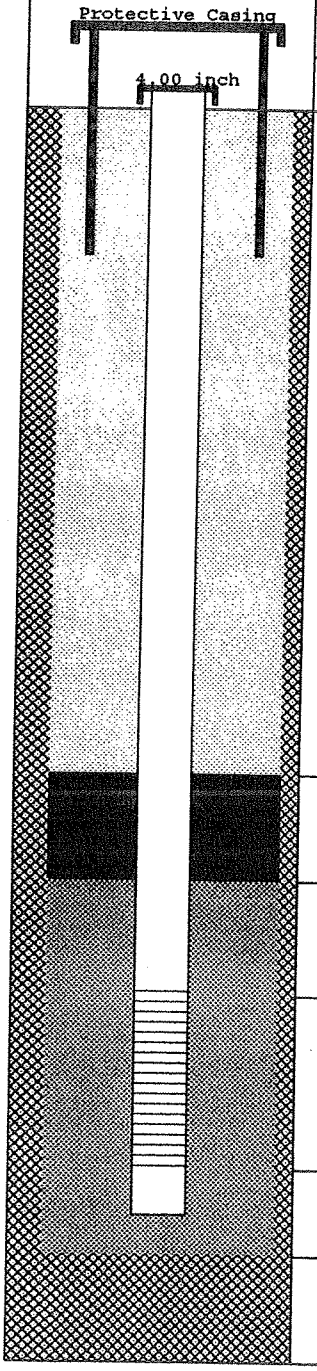
Well Completion Summary

Roy F. WESTON, Inc.

CLIENT	CHAMPION	DRILLING FIRM	GROUNDWATER PROTECTION INC.
SITE NAME	CHAMPION/LF-6	INSPECTOR	E.MACKEY

WELL ID	MW-21
START DATE	01/18/96
COMPLETION DATE	01/18/96

WATER LEVELS



DEPTH		ELEV.
0.00	TC	0.00
0.00	GS	0.00
12.00	BN	-12.00
14.00	SP	-14.00
16.00	SC	-16.00
26.00	BS	-26.00
26.00	TD	0.00

DRILLING SUMMARY

Driller	M.SHILER
Drilling Fluid	AIR
Well Type	SINGLE CASED SCREENED

WELL DESIGN CONSTRUCTION

Casing #1 Diameter: 4.00 inch Interval: 0.00 to 16.00 ft.
Type : PVC SCH 40

Stick Up Inner Casing: 0.00 ft. Protective Casing: 0.00 ft.

Casing Grout: CEMT/BENT Interval: 0.00 to 12.00 ft.

Seal Type: BENTONITE MED.CHIPS Interval: 12.00 to 14.00 ft.

Sand Pack Type: #1 SAND Interval: 14.00 to 26.00 ft.
Grain Size: UNIFORM Median Diameter:
Screen Diameter: 4.00 Interval: 16.00 to 26.00 ft.
Type : PVC Slots: 0.010 inches

Silt Trap Interval: 0.00 to 0.00 ft.
Backfill Type: Interval: 0.00 to 0.00 ft.

COMMENTS

TC = Top of Casing
GS = Ground Surface
BN = Top Seal
SP = Top Sand Pack
SC = Top Screen
BS = Bottom Screen
TD = Total Depth

= Grout
= Seal
= Sand Pack
= Formation

Additional Comments:

NOTE: Well Diagram not to Scale

Elevations are feet above mean sea level

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03/28/96

Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 26.00
SITE NAME	: CHAMPION/LF-6	LOGGER	: E.MACKEY
BORING ID	: MW-21	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/18/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 01/18/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
			70	Silty sand with gravel, SM	RED	LSE	WET	8 23 30 50		PROBABLE COBBLE ZONE AS DRILLING IS NEXT TO STREAM CHANNEL.
-1	1									
				No Sample Recovered						
-2	2			Interval Not Sampled						AUGERED INTERVAL.
			100	Silty sand with gravel, SM	RED	LSE	MST			COBBLE LAYER.RIG BOUNCING ON COBBLE.
-3	3			Interval Not Sampled				33 50 0 0		AUGERED INTERVAL.
-4	4		40	Silty gravel with sand, GM	DARK BROWN	SFT	WET	35 22 30 35		COBBLE LAYER WITH SOIL BETWEEN COBBLES.
-5	5			No Sample Recovered						
-6	6		66	Silty sand with gravel, SM	DARK BROWN	SFT	WET	47 35 13 50		COBBLE LAYER.SOME POCKETS OF MOIST-WET SOIL,BUT ALSO DRY-MOIST POCKETS. AUGER REFUSAL AT 7.5'.
-7	7			No Sample Recovered						
				Interval Not Sampled						DRILLED INTERVAL.
-8	8			Gneiss	WHITE	STR				BIOTITE GNEISS.FRACTURE AT 21-21.5'.GROUNDWATER AT 21'.
-9	9									
-10	10									
-11	11									
-12	12									
-13	13									
-14	14									
-15	15									
-16	16									
-17	17									
-18	18									
-19	19									
-20	20									

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Borehole Log

Roy F. WESTON, Inc.

PROJECT	: CHAMPION	TOTAL DEPTH	: 26.00
SITE NAME	: CHAMPION/LF-6	LOGGER	: E.MACKEY
BORING ID	: MW-21	DRILLING COMPANY	: GROUNDWATER PROTECTION INC.
NORTHING	: 0.0000 estimated	DRILLING RIG	: SPEEDSTAR 300
EASTING	: 0.0000 estimated	DATE STARTED	: 01/18/96
ELEVATION	: 0.000 estimated	DATE COMPLETED	: 01/18/96

ELEVATION	DEPTH	MATERIAL	% RECOVERY	CLASSIFICATION	COLOR	STRENGTH	MOISTURE	BLOW COUNT	FIELD INSTRUMENT READING	COMMENTS
				Gneiss	WHITE	STR				BIOTITE GNEISS.FRACTURE AT 21-21.5'.GROUNDWATER AT 21'.
-21	21			Gneiss	WHITE	STR				BIOTITE GNEISS. TD AT 26 FT.BGS.
-22	22									
-23	23									
-24	24									
-25	25									
-26	26									
-27	27									
-28	28									
-29	29									
-30	30									
-31	31									
-32	32									
-33	33									
-34	34									
-35	35									
-36	36									
-37	37									
-38	38									
-39	39									
-40	40									

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APPENDIX D

FIRE OCCURRENCE NOTIFICATION FORM

SOLID WASTE MANAGEMENT FACILITY
FIRE OCCURRENCE NOTIFICATION
NC DENR Division of Waste Management
Solid Waste Section

Notify the Section verbally within 24 hours and submit written notification within 15 days of the occurrence.
(If additional space is needed, use back of this form.)

NAME OF FACILITY: _____ PERMIT # _____

DATE AND TIME OF FIRE: _____ @ _____

HOW WAS THE FIRE REPORTED AND BY WHOM:

LIST ACTIONS TAKEN:

WHAT WAS THE CAUSE OF THE FIRE:

DESCRIBE AREA, TYPE, AND AMOUNT OF WASTE INVOLVED:

WHAT COULD HAVE BEEN DONE TO PREVENT THIS FIRE:

DESCRIBE PLAN OF ACTIONS TO PREVENT FUTURE INCIDENTS:

NAME: _____ TITLE: _____ DATE: _____

****

THIS SECTION TO BE COMPLETED BY SOLID WASTE SECTION REGIONAL STAFF

DATE RECEIVED _____

List any factors not listed that might have contributed to the fire or that might prevent occurrence of future fires:

FOLLOW-UP REQUIRED:

☐ NO ☐ PHONE CALL ☐ SUBMITTAL ☐ MEETING ☐ RETURN VISIT BY: _____ (DATE)

ACTIONS TAKEN OR REQUIRED:

Revised 6/8/09

APPENDIX E

ASTM D6270-08
STANDARD PRACTICE FOR USE OF SCRAP TIRES IN CIVIL ENGINEERING APPLICATIONS

Designation: D6270 – 08$^{\varepsilon 1}$

Standard Practice for Use of Scrap Tires in Civil Engineering Applications[1]

This standard is issued under the fixed designation D6270; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε^1 NOTE—Fig 1, Fig. 2 and Fig. X1.3 were improved and editorial changes were made throughout in July 2009.

1. Scope

1.1 This practice provides guidance for testing the physical properties, design considerations, construction practices, and leachate generation potential of processed or whole scrap tires in lieu of conventional civil engineering materials, such as stone, gravel, soil, sand, lightweight aggregate, or other fill materials.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C127 Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate

C136 Test Method for Sieve Analysis of Fine and Coarse Aggregates

D698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3(600 kN-m/m^3))

D1557 Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3(2,700 kN-m/m^3))

D2434 Test Method for Permeability of Granular Soils (Constant Head)

D3080 Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions

D4253 Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table

D2974 Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils

2.2 *American Association of State Highway and Transportation Officials Standard:*

T 274 Standard Method of Test for Resilient Modulus of Subgrade Soils[3]

M 288 Standard Specification for Geotextiles[4]

2.3 *U.S. Environmental Protection Agency Standard:*

Method 1311 Toxicity Characteristics Leaching Procedure[5]

3. Terminology

3.1 *Definitions:*

3.1.1 *baling, n*—a method of volume reduction whereby tires are compressed into bales.

3.1.2 *bead, n*—the anchoring part of the tire which is shaped to fit the rim and is constructed of bead wire wrapped by the plies.

3.1.3 *bead wire, n*—a high tensile steel wire surrounded by rubber, which forms the bead of a tire that provides a firm contact to the rim.

3.1.4 *belt wire, n*—a brass plated high tensile steel wire cord used in steel belts.

3.1.5 *buffing rubber, n*—vulcanized rubber usually obtained from a worn or used tire in the process of removing the old tread in preparation for retreading.

3.1.6 *carcass, n*—see *casing*.

3.1.7 *casing, n*—the basic tire structure excluding the tread (Syn. *carcass*).

3.1.8 *chipped tire, n*—see *tire chip*.

3.1.9 *chopped tire, n*—a scrap tire that is cut into relatively large pieces of unspecified dimensions.

3.1.10 *granulated rubber, n*—particulate rubber composed of mainly non-spherical particles that span a broad range of maximum particle dimension, from below 425 µm (40 mesh) to 12 mm (also refer to *particulate rubber*).[6]

3.1.11 *ground rubber, n*—particulate rubber composed of mainly non-spherical particles that span a range of maximum

[1] This practice is under the jurisdiction of ASTM Committee D34 on Waste Management and is the direct responsibility of Subcommittee D34.03 on Treatment, Recovery, and Reuse.

Current edition approved Sept. 1, 2008. Published December 2008. Originally approved in 1998. Last previous edition approved in 2004 as D6270 – 98 (2004). DOI: 10.1520/D6270-08E01.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] *Standard Specifications for Transportation Materials and Methods of Sampling and Testing, Part II: Methods of Sampling and Testing,* American Association of State Highway and Transportation Officials, Washington, DC.

[4] *Standard Specifications for Transportation Materials and Methods of Sampling and Testing, Part I: Specifications,* American Association of State Highway and Transportation Officials, Washington, DC.

[5] *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods,* 3rd ed., Report No. EPA 530/SW-846, U.S. Environmental Protection Agency, Washington, DC.

[6] The defined term is the responsibility of Committee D11 on Rubber.

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particle dimensions, from below 425 μm (40 mesh) to 2 mm (also refer to *particulate rubber*).[6]

3.1.12 *mineral soil*, *n*—soil containing less than 5 % organic matter as determined by a loss on ignition test (D2974).

3.1.13 *nominal size*, *n*—the average size product that comprises 50 % or more of the throughput in a scrap tire processing operation; scrap tire processing operations generate products above and below the nominal size.

3.1.14 *particulate rubber*, *n*—raw, uncured, compounded or vulcanized rubber that has been transformed by means of a mechanical size reduction process into a collection of particles, with or without a coating of a partitioning agent to prevent agglomeration during production, transportation, or storage (also see definition of *buffing rubber, granulated rubber, ground rubber,* and *powdered rubber*).[6]

3.1.15 *passenger car tire*, *n*—a tire with less than a 457-mm rim diameter for use on cars only.

3.1.16 *powdered rubber*, *n*—particulate rubber composed of mainly non-spherical particles that have a maximum particle dimension equal to or below 425 μm (40 mesh) (also refer to *particulate rubber*).[6]

3.1.17 *preliminary remediation guideline*, *n*—risk-based concentrations that the USEPA considers to be protective for lifetime exposure to humans.

3.1.18 *rough shred*, *n*—a piece of a shredded tire that is larger than 50 mm by 50 mm by 50 mm, but smaller than 762 mm by 50 mm by 100 mm.

3.1.19 *rubber fines*, *n*—small particles of ground rubber that result as a by-product of producing shredded rubber.

3.1.20 *scrap tire*, *n*—a tire which can no longer be used for its original purpose due to wear or damage.

3.1.21 *shred sizing*, *n*—a term which generally refers to the process of particles passing through a rated screen opening rather than those which are retained on the screen.

3.1.22 *shredded tire*, *n*—a size reduced scrap tire where the reduction in size was accomplished by a mechanical processing device, commonly referred to as a shredder.

3.1.23 *shredded rubber*, *n*—pieces of scrap tires resulting from mechanical processing.

3.1.24 *sidewall*, *n*—the side of a tire between the tread shoulder and the rim bead.

3.1.25 *single pass shred*, *n*—a shredded tire that has been processed by one pass through a shear type shredder and the resulting pieces have not been classified by size.

3.1.26 *steel belt*, *n*—rubber coated steel cords that run diagonally under the tread of steel radial tires and extend across the tire approximately the width of the tread.

3.1.27 *tire chips*, *n*—pieces of scrap tires that have a basic geometrical shape and are generally between 12 and 50 mm in size and have most of the wire removed (Syn. *chipped tire*).

3.1.28 *tire derived aggregate (TDA)*, *n*—pieces of scrap tires that have a basic geometrical shape and are generally between 12 and 305 mm in size and are intended for use in civil engineering applications. Also see definition of *tire chips* and *tire shreds*.

3.1.29 *tire shreds*, *n*—pieces of scrap tires that have a basic geometrical shape and are generally between 50 and 305 mm in size.

3.1.30 *tread*, *n*—that portion of the tire which contacts the road.

3.1.31 *truck tire*, *n*—a tire with a rim diameter of 500 mm or larger.

3.1.32 *whole tire*, *n*—a scrap tire that has been removed from a rim, but which has not been processed.

3.1.33 *x-mm minus*, *n*—pieces of classified, size-reduced scrap tires where a minimum of 95 % by weight passes through a standard sieve with an x-mm opening size (that is, 25-mm minus; 50-mm minus; 75-mm minus, etc.).

4. Significance and Use

4.1 This practice is intended for use of scrap tires including: tire derived aggregate (TDA) comprised of pieces of scrap tires, TDA/soil mixtures, tire sidewalls, and whole scrap tires in civil engineering applications. This includes use of TDA and TDA/soil mixtures as lightweight embankment fill, lightweight retaining wall backfill, drainage layers for roads, landfills and other applications, thermal insulation to limit frost penetration beneath roads, insulating backfill to limit heat loss from buildings, vibration damping layers for rail lines, and replacement for soil or rock in other fill applications. Use of whole scrap tires and tire sidewalls includes construction of retaining walls, drainage culverts, road-base reinforcement, and erosion protection, as well as use as fill when whole tires have been compressed into bales. It is the responsibility of the design engineer to determine the appropriateness of using scrap tires in a particular application and to select applicable tests and specifications to facilitate construction and environmental protection. This practice is intended to encourage wider utilization of scrap tires in civil engineering applications.

4.2 Three TDA fills with thicknesses in excess of 7 m have experienced a serious heating reaction. However, more than 100 fills with a thickness less than 3 m have been constructed with no evidence of a deleterious heating reaction (**1**).[7] Guidelines have been developed to minimize internal heating of TDA fills (**2**) as discussed in 6.11. The guidelines are applicable to fills less than 3 m thick. Thus, this practice should be applied only to TDA fills less than 3 m thick.

5. Material Characterization

5.1 The specific gravity and water absorption capacity of TDA should be determined in accordance with Test Method C127. However, the specific gravity of TDA is less than half the value obtained for common earthen coarse aggregate, so it is permissible to use a minimum weight of test sample that is half of the specified value. The particle density or density of solids of TDA (ρ_s) may be determined from the apparent specific gravity using the following equation:

$$\rho_s = S_a(\rho_w) \quad (1)$$

where:

S_a = apparent specific gravity, and
ρ_w = density of water.

[7] The boldface numbers in parentheses refer to the list of references at the end of this standard.

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5.2 The gradation of TDA should be determined in accordance with Test Method C136. However, the specific gravity of TDA is less than half the values obtained for common earthen materials, so it is permissible to use a minimum weight of test sample that is half of the specified value.

5.3 The laboratory compacted dry density (or bulk density) of TDA and TDA/soil mixtures with less than 30 % retained on the 19.0-mm sieve can be determined in accordance with Test Method D698 or D1557. However, TDA and TDA/soil mixtures used for civil engineering applications almost always have more than 30 % retained on the 19.0-mm sieve, so these methods generally are not applicable. A larger compaction mold should be used to accommodate the larger size of the TDA. The sizes of typical compaction molds are summarized in Table 1. The larger mold requires that the number of layers, or the number of blows of the rammer per layer, or both, be increased to produce the desired compactive energy per unit volume. Compactive energies ranging from 60 % of Test Method D698 (60 % × 600 kN-m/m^3 = 360 kN-m/m^3) to 100 % of Test Method D1557 (2700 kN-m/m^3) have been used. Compaction energy has only a small effect on the resulting dry density (**3**); thus, for most applications it is permissible to use a compactive energy equivalent to 60 % of Test Method D698. To achieve this energy with a mold volume of 0.0125 m^3 would require that the sample be compacted in 5 layers with 44 blows per layer with a 44.5 N rammer falling 457 mm. The water content of the sample has only a small effect on the compacted dry density (**3**) so it is permissible to perform compaction tests on air or oven-dried samples.

5.3.1 The dry densities for TDA loosely dumped into a compaction mold and TDA compacted by vibratory methods (similar to Test Method D4253) are about the same (**4, 5, 6**). Thus, vibratory compaction of TDA in the laboratory (see Test Method D4253) should not be used.

5.3.2 When estimating an in-place density for use in design, the compression of a TDA layer under its own self-weight and under the weight of any overlying material must be considered. The dry density determined as discussed in 5.3 are uncompressed values. In addition, short-term time dependent settlement of TDA should be accounted for when estimating the final in-place density (**7**).

5.4 The compressibility of TDA and TDA/soil mixtures can be measured by placing TDA in a rigid cylinder with a diameter several times greater than the largest particle size and then measuring the vertical strain caused by an increasing vertical stress. If it is desired to calculate the coefficient of lateral earth pressure at rest K_O, the cylinder can be instrumented to measure the horizontal stress of the TDA acting on the wall of the cylinder.

TABLE 1 Size of Compaction Molds Used to Determine Dry Density of TDA

Maximum Particle Size (mm)	Mold Diameter (mm)	Mold Volume (m^3)	Reference
75	254	0.0125	**(3)**
75	305	0.0146	**(4)**
51	203 and 305	N.R.[A]	**(5)**

[A] N.R. = not reported.

5.4.1 The high compressibility of TDA necessitates the use of a relatively thick sample. In general, the ratio of the initial specimen thickness to sample diameter should be greater than one. This leads to concerns that a significant portion of the applied vertical stress could be transferred to the walls of the cylinder by friction. If the stress transferred to the walls of the cylinder is not accounted for, the compressibility of the TDA will be underestimated. For all compressibility tests, the inside of the container should be lubricated to reduce the portion of the applied load that is transmitted by side friction from the sample to the walls of the cylinder. For testing where a high level of accuracy is desired, the vertical stress at the top and the bottom of the sample should be measured so that the average vertical stress in the sample can be computed. A test apparatus designed for this purpose is illustrated in Fig. 1 (**8**).

5.5 The resilient modulus (M_R) of subgrade soils can be expressed as:

$$M_R = A\theta^B \tag{2}$$

where:

θ = first invariant of stress (sum of the three principal stresses),
A = experimentally determined parameter, and
B = experimentally determined parameter.

5.5.1 Tests for the parameters A and B can be conducted according to AASHTO T 274. The maximum particle size typically is limited to 19 mm by the testing apparatus which precludes the general applicability of this procedure to the larger size TDA typically used for civil engineering applications.

5.6 The coefficient of lateral earth pressure at rest K_O and Poisson's ratio μ can be determined from the results of confined compression tests where the horizontal stresses were measured. A test apparatus designed for this purpose is shown in Fig. 1. K_O and μ are calculated from:

$$K_O = \frac{\sigma_h}{\sigma_v} \tag{3}$$

$$\mu = \frac{K_O}{(1 + K_O)} \tag{4}$$

where:

σ_h = measured horizontal stress, and
σ_v = measured vertical stress.

5.7 The shear strength of TDA may be determined in a direct shear apparatus in accordance with Test Method D3080 or using a triaxial shear apparatus. The large size of TDA typically used for civil engineering applications requires that specimen sizes be several times greater than used for common soils. Because of the limited availability of large triaxial shear apparatus, this method is generally restricted to TDA 25 mm in size and smaller. The interface strength between TDA and geomembrane can be measured in a large scale direct shear test apparatus (**9**).

5.8 The hydraulic conductivity (permeability) of TDA and TDA/soils mixtures should be measured with a constant head permeameter with a diameter several times greater than the maximum particle size. TDA with a maximum size smaller than 19 mm can be determined in accordance with Test Method

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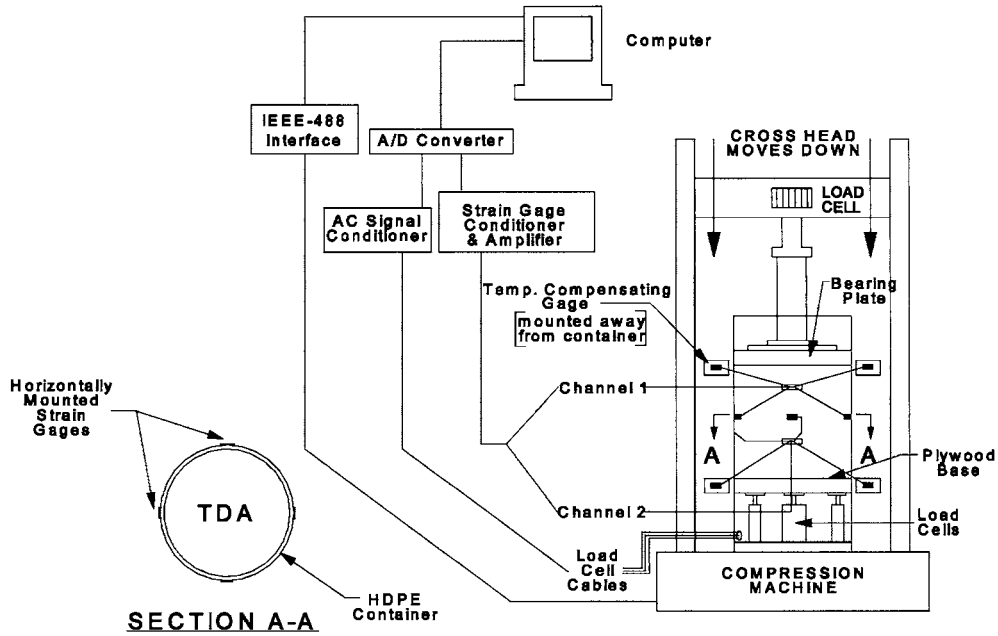

FIG. 1 Compressibility Apparatus for TDA Designed to Measured Lateral Stress and the Portion of the Vertical Load Transferred by Friction from TDA to Container (10)

D2434. However, TDA and TDA/soil mixtures used for civil engineering applications almost always have a majority of their particles larger than 19 mm, so this method is generally not applicable. Samples should be tested at a void ratio comparable to the value expected in the field. This may require a permeameter capable of applying a vertical stress to the sample to simulate the compression that would occur under the weight of overlying material. The high hydraulic conductivity of TDA should be accounted for in design of the permeameter. This includes provisions for an adequate supply of water and measuring the head loss across the sample using standpipes mounted on the body of the permeameter. An apparatus that takes these factors into account is shown in Fig. 2 (**10**).

5.9 The thermal conductivity of TDA is significantly lower than for common soils. For TDA smaller than 25 mm in size, the thermal conductivity can be measured using commercially available guarded hot plate apparatus. For TDA larger than 25 mm, it is necessary to construct a large scale hot plate apparatus (**11**). The thermal conductivity of TDA also can be back-calculated from field measurements (**11**).

6. Construction Practices

6.1 TDA have a compacted dry density that is one-third to one-half of the compacted dry density of typical soil. This makes them an attractive lightweight fill for embankments constructed on weak, compressible soils where slope stability or excessive settlement are a concern, as well as landslide repair.

6.2 The thermal resistivity of TDA is approximately eight times greater than for typical granular soil. For this reason, TDA can be used as a 150 to 450-mm thick insulating layer to limit the depth of frost penetration beneath roads. This reduces frost heave in the winter and improves subgrade support during the spring thaw. In addition, TDA can be used as backfill around basements to limit heat lost through basement walls, thereby reducing heating costs.

6.3 The low-compacted dry density, high-hydraulic conductivity, and low-thermal conductivity makes TDA very attractive for use as retaining wall backfill. Lateral earth pressures for TDA backfill can be about 50 % of values obtained for soil backfill (**7, 8, 9**). TDA can also be used as backfill for geosynthetic-reinforced retaining walls.

6.4 The hydraulic conductivity of TDA makes them suitable for many drainage applications including French drains, drainage layers in landfill liner and cover systems, and leach fields for on-site sewage disposal systems. For applications with a vertical stress less than 50 kPa, the hydraulic conductivity of TDA is generally greater than 1 cm/s, which is comparable to conventional uniformly graded aggregate. When TDA is used as a component of landfill leachate collection and removal systems, and other applications where the vertical stress would be greater than 50 kPa, the hydraulic conductivity and void ratio under the final design vertical stress should be considered. The hydraulic conductivity must meet applicable regulatory requirements and the void ratio must be sufficient to minimize clogging.

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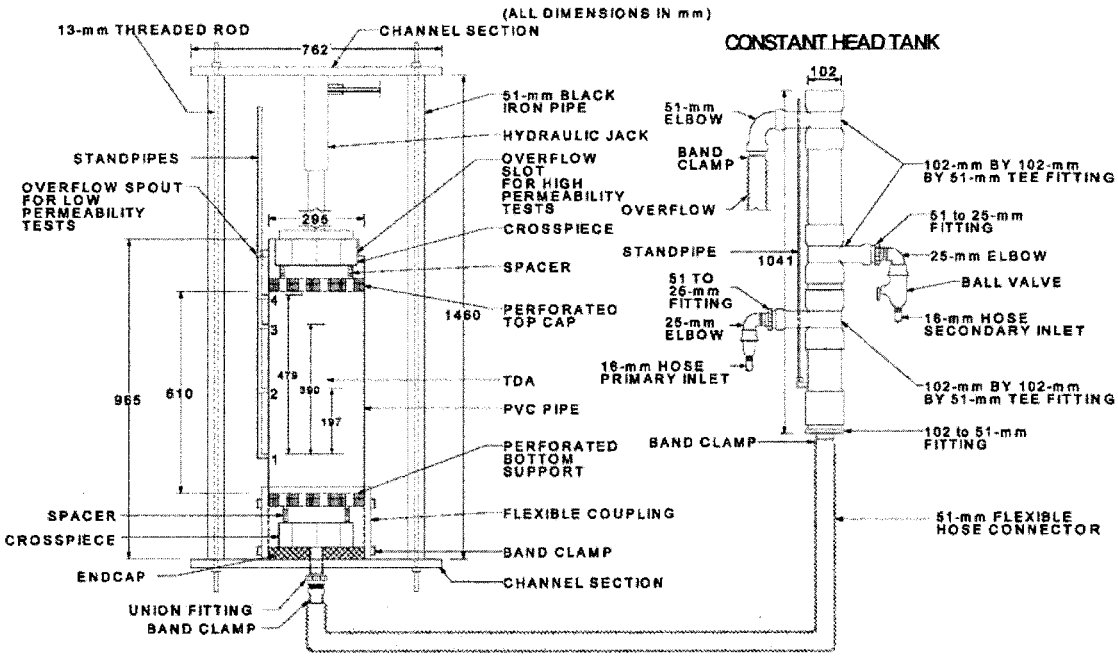

FIG. 2 Hydraulic Conductivity Apparatus for TDA with Provisions for Application of Vertical Stress (12)

6.5 TDA can be used as a vibration damping layer beneath rail lines to reduce the impact of ground bourn vibrations on residences and businesses adjoining the tracks. In this application, a 300-mm thick layer of 75-mm maximum size TDA is placed beneath the conventional ballast/subballast system (**13**).

6.6 Two different sizes of TDA are commonly used for the applications discussed above. One has a maximum size of 75 mm and the other has a maximum size of 300 mm. Rough shreds can also be used for some applications provided all tires are shredded such that the largest shred is the lesser of one-quarter circle in shape or 600 mm in length. In all cases, at least one side wall should be severed from the tread.

6.7 TDA with a maximum size of 75 mm or 300 mm are generally placed in 300-mm thick lifts and compacted by a tracked bulldozer, sheepsfoot roller, or smooth drum vibratory roller with a minimum operating weight of 90 kN. Rough shreds are generally placed in 900-mm thick lifts and compacted by a tracked bulldozer. For most applications a minimum of six passes of the compaction equipment should be used.

6.8 TDA should be covered with a sufficient thickness of soil to limit deflections of overlying pavement caused by traffic loading. Soil cover thicknesses as low as 0.8 m may be suitable for paved roads with light traffic. For paved roads with heavy traffic, 1 to 2 m of soil cover may be required. For unpaved applications, 0.3 to 0.5 m of soil cover may be suitable depending on the traffic loading. The designer should assess the actual thickness of soil cover needed based on the loading conditions, TDA layer thickness, pavement thickness, and other conditions as appropriate for a particular project. Regardless of the application, the TDA should be covered with soil to prevent contact between the public and the TDA which may have exposed steel belts.

6.9 In applications where pavement will be placed over the TDA layer, highway drainage applications, and retaining wall backfill, the TDA layer should be completely wrapped in a layer of non-woven or woven geotextile to minimize infiltration of soil particles into the voids between the TDA. AASHTO M 288 should be used for guidance on geotextile selection.

6.10 Whole tires and tire sidewalls that have been cut from the tire carcass can be used to construct retaining walls, reinforcing mats beneath roads constructed on weak ground, and erosion protection layers.

6.11 TDA fills should be designed to minimize the possibility of an internal heating reaction (**2**). Possible causes of the reaction are oxidation of the exposed steel belts and oxidation of the rubber. Microbes may play a role in both reactions. Factors thought to create conditions favorable for oxidation of exposed steel, or rubber, or both, include; free access to air; free access to water; retention of heat caused by the high insulating value of TDA in combination with a large fill thickness; large amounts of exposed steel belts; smaller TDA sizes and excessive amounts of granulated rubber particles; and the presence of inorganic and organic nutrients that would enhance microbial action.

6.11.1 The design guidelines given in the following sections were developed to minimize the possibility for heating of TDA fills by minimizing factors that could create conditions favorable for this reaction. In developing these guidelines, the insulating effect caused by increasing fill thickness and the favorable performance of projects with TDA fills less than 4-m thick have been considered Thus, design guidelines are less

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stringent for projects with thinner TDA layers. The guidelines are divided into two classes: Class I Fills with TDA layers less than 1-m thick, and Class II Fills with TDA layers in the range of 1 to 3-m thick. Although there have been no projects with less than 4 m of TDA fill that have experienced a catastrophic heating reaction, to be conservative, TDA layers greater than 3-m thick are not recommended. The guidelines are for use in designing TDA fills. Design of fills that are mixtures or alternating layers of TDA and mineral soil should be handled on a case by case basis.

6.11.2 For Class I Fills, the material shall meet the material requirements for Type A TDA given in 7.1.1 and 7.1.2. No special design features are required to minimize heating of Class I Fills.

6.11.3 For Class II Fills, the material shall meet the material requirements for Type B TDA given in 7.1.1 and 7.1.3.

6.11.4 Class II Fills shall be constructed in such a way that infiltration of water and air is minimized. Moreover, there shall be no direct contact between TDA and soil containing organic matter, such as topsoil. One possible way to accomplish this is to cover the top and sides of the fill with a 0.5-m thick layer of compacted mineral soil with a minimum of 30 % fines. The mineral soil should be separated from the TDA with a geotextile. The top of the mineral soil layer should be sloped so that water will drain away from the TDA fill. Additional fill may be placed on top of the mineral soil layer as needed to meet the overall design of the project. If the project will be paved, it is recommended that the pavement extend to the shoulder of the embankment or that other measures be taken to minimize infiltration at the edge of the pavement.

6.11.5 For Class II Fills, use of drainage features located at the bottom of the fill that could provide free access to air should be avoided. This includes, but is not limited to, open graded drainage layers daylighting on the side of the fill. Under some conditions, it may be possible to use a well graded granular soil as a drainage layer. The thickness of the drainage layer at the point where it daylights on the side of the fill should be minimized. For TDA fills placed against walls, it is recommended that the drainage holes in the wall be covered with well graded granular soil. The granular soil should be separated from the TDA with geotextile.

6.11.6 Embankments constructed in accordance with the guidelines have shown no evidence of self heating (**14**).

7. Material Specifications

7.1 The material specifications for TDA that are presented below take into consideration the need to limit internal heating of TDA fills as discussed in 6.11, producing a material that can be placed and compacted with conventional construction equipment, and limiting exposed steel belts to allow for rubber to rubber contacts between the pieces when placed in a fill. Moreover, TDA meeting the specifications can be produced with reasonably well-maintained processing equipment that has been properly selected for the size product being produced. Specifications are provided for two size ranges. The first is termed Type A and is suitable for many drainage, vibration damping, and insulation applications. The second is larger and is termed Type B. It is suitable for use as lightweight embankment fill, wall backfill, and some landfill drainage and gas collection applications.

7.1.1 The TDA shall be made from scrap tires which shall be shredded into the sizes specified in 7.1.2 for Type A TDA or 7.1.3 for Type B TDA. They shall be produced by a shearing process. TDA produced by a hammer mill will not be allowed. The TDA shall be free of all contaminants including but not limited to oil, grease, gasoline, and diesel fuel that could leach into the groundwater or create a fire hazard. In no case shall the TDA contain the remains of tires that have been subjected to a fire because the heat of a fire may liberate liquid petroleum products from the tire that could create a fire hazard when the TDA are placed in a fill. The TDA shall be free from fragments of wood, wood chips, and other fibrous organic matter. The TDA shall have less than 1 % (by weight) of metal fragments that are not at least partially encased in rubber. Metal fragments that are partially encased in rubber shall protrude no more than 25 mm from the cut edge of the TDA on 75 % of the pieces (by weight) and no more than 50 mm on 90 % of the pieces (by weight). The gradation shall be measured in accordance with Test Method C136, except that the minimum sample size shall be 6 to 12 kg for Type A TDA and 16 to 23 kg for Type B TDA.

7.1.2 Type A TDA shall have a maximum dimension, measured in any direction, of 200 mm. In addition, Type A TDA shall have 100 % passing the 100-mm square mesh sieve, a minimum of 95 % passing (by weight) the 75-mm square mesh sieve, a maximum of 50 % passing (by weight) the 38-mm square mesh sieve, and a maximum of 5 % passing (by weight) the 4.75-mm sieve.

7.1.3 Type B TDA shall have a minimum of 90 % (by weight) with a maximum dimension, measured in any direction, of 300 mm and 100 % with a maximum dimension, measured in any direction, of 450 mm. At least one side wall shall be removed from the tread of each tire. The side wall will be considered removed if the bead wire has been completely severed from the side wall. A minimum of 75 % (by weight) shall pass the 200-mm square mesh sieve, a maximum of 50 % (by weight) shall pass the 75-mm square mesh sieve, a maximum of 25 % (by weight) shall pass the 38-mm square mesh sieve, and a maximum of 1 % (by weight) shall pass the 4.75-mm sieve.

8. Leachate

8.1 The Toxicity Characteristics Leaching Procedure (TCLP) (USEPA Method 1311) is used to determine if a waste is a hazardous waste, thereby posing a significant hazard to human health due to leaching of toxic compounds. The TCLP test represents the scenario of acid rain percolating through the waste and exiting as leachate. For all regulated metals and organics, the results for TDA are well below the TCLP regulatory limits (**15, 16, 17**); therefore, TDA are not classified as a hazardous waste.

8.2 In addition to TCLP tests, laboratory leaching studies have been performed following several test protocols. Results show that metals are leached most readily at low pH and that organics are leached most readily at high pH (**17, 18**). Thus, it is preferable to use TDA in environments with a near neutral pH.

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8.3 The potential of TDA to generate leachate has been examined in field studies for both above and below groundwater table applications. The results have been compared to primary drinking water standards, secondary (aesthetic) drinking water standards, and USEPA preliminary remediation goals (PRG) (**19**). PRG are risk-based concentrations that the USEPA considers to be protective for lifetime exposure to humans (**19**). Freshwater aquatic toxicity has also been evaluated. These results were summarized in a literature review and statistical analysis performed for the USEPA Resource Conservation Challenge (**20**).

8.4 In above groundwater table applications the TDA is placed above the water table and are subjected to water from infiltration. Seven field studies have examined this category of applications (**21, 22, 23, 24, 25, 26, 27, 28**). A statistical comparison was performed (**20**) using procedures for censored environmental data recommended by Helsel (**29**).

8.4.1 The preponderance of evidence shows that TDA used above the water table does not cause the primary drinking water standards for metals to be exceeded. Moreover, a statistical comparison shows that TDA is unlikely to increase levels of metals with primary drinking water standards above naturally occurring background levels (**20**).

8.4.2 For above groundwater table applications, it is likely that TDA would increase the concentrations of iron and manganese, which have secondary drinking water standards. At the point where water emerges from a TDA fill, it is likely that the levels of iron and manganese will exceed secondary drinking water standards, and the PRG for tap water for manganese will also be exceeded. However, for two of three projects where samples were taken from wells adjacent to the TDA fills, the iron and manganese levels were about the same as background levels. The prevalence of manganese in groundwater is shown by the naturally occurring concentrations at three projects being above the secondary drinking water standard and PRG. For other chemicals with secondary drinking water standards, a statistical comparison shows that there is no evidence that TDA affects naturally occurring background levels (**20**).

8.4.3 Volatile and semivolatile organics have been monitored on two projects where TDA was placed above the water table (**22, 23, 24**). Substances are generally below detection limits. Moreover, for those substances with drinking water standards, the levels were below the standards. The concentrations were also below the applicable PRG (**20**). A few substances were occasionally found above the test method detection limit; however, the highest concentrations were found in a control section located uphill from the TDA (**22**), suggesting a source associated with active roadways. There are also laboratory studies showing that TDA has the ability to absorb some organic compounds (**30**).

8.4.4 Aquatic toxicity tests were performed on samples taken from one above groundwater table project. The results showed that water collected directly from TDA fills had no effect on survival, growth, and reproduction of two standard test species (fathead minnows and a small crustacean (*Ceriodaphnia dubia*) (**20, 23**).

8.5 TDA placed below the water table has been studied at three different sites (**31**). A statistical comparison was performed (**20**) using procedures for censored environmental data recommended by Helsel (**29**).

8.5.1 A statistical analysis of the data at these sites showed that use of TDA did not cause primary drinking water standards for metals to be exceeded. Moreover, the data shows that TDA was unlikely to increase levels of metals with primary drinking water standards above naturally occurring background levels (**20**).

8.5.2 For chemicals with secondary drinking water standards, it is likely that TDA below the groundwater table would increase the concentrations of iron, manganese, and zinc. For water that is collected directly from TDA fill below the groundwater table, it is likely that the concentrations of manganese and iron will exceed their secondary drinking water standards and PRG for tap water. The secondary drinking water standards and PRG for zinc were not exceeded even for water in direct contact with TDA. The concentration of iron, manganese, and zinc decreases to near background levels by flowing only a short distance though soil (0.6 to 3.3 m). For other chemicals with secondary drinking water standards, a statistical comparison showed little likelihood that TDA placed below the water table alters naturally occurring background levels (**20**).

8.5.3 Trace levels of a few volatile and semivolatile organics were found from water taken directly from TDA-filled trenches. The concentration of benzene, chloroethane, cis-1,2-dichloroethene, and aniline for water in direct contact with TDA are above their respective PRG for tap water. However, chloroethane, cis-1,2-dichloroethene, and aniline concentrations were below the PRG for all samples taken from wells 0.6 and 3.3 m downgradient. Moreover, the concentrations were below the detection limits for virtually all samples, indicating that these substances have limited downgradient mobility (**17**).

8.5.4 The data on benzene deserves additional discussion. The primary drinking water standard for benzene is 5 µg/L and its PRG is 0.35 µg/L. For six sample dates, the detection limit reported by the laboratory was 0.5 µg/L, slightly above the PRG. For the remaining four sample dates the detection limit was 5 µg/L. Focusing on the data from samples with a detection limit of 0.5 µg/L, the benzene concentration was below the detection limit in downgradient wells for all but one well, on a single date, when the concentration was 1 µg/L. This data shows that benzene also has limited downgradient mobility (**17**).

8.5.5 Aquatic toxicity tests were performed on samples taken on two dates. The results showed that water collected directly from TDA filled trenches had no effect on survival, and growth of fathead minnows. While there were some toxic effects of TDA placed below the groundwater table on *Ceriodaphnia dubia*, a small amount of dilution (up to 3-fold) as the groundwater flowed downgradient or when it entered a surface body of water would remove the toxic effects (**20, 23**).

8.5.6 In summary, TDA placed below the water table would be expected to have a negligible off-site effect on water quality (**20**).

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9. Keywords

9.1 construction practices; landfills; leachate; lightweight fill; rail lines; retaining walls; roads; scrap tires; TDA; tire chips; tire derived aggregate; tire shreds; vibration damping

APPENDIX

(Nonmandatory Information)

X1. TYPICAL MATERIAL PROPERTIES

X1.1 This appendix contains typical properties of TDA to aid in the selection of values for preliminary designs and to provide a basis for comparison for test results.

X1.2 Values of specific gravity and water absorption capacity reported in the literature are summarized in Table X1.1. Table X1.2 summarizes the compacted and uncompacted dry density of TDA. Compaction results for mixtures of TDA and soil also are available (**4, 5, 6, 32**). The results from one study are summarized in Fig. X1.1.

X1.3 Typical compressibility results are summarized in Table X1.3.

X1.4 A measure of compressibility applicable to vehicle loads is resilient modulus. Results determined by Ahmed (**5**) using AASHTO T 274-82 for mixtures of TDA and soil are summarized in Table X1.4. The parameter A, and therefore M_R, decreases as the percent TDA by dry weight of the mix increases. Results determined by Edil and Bosscher (**4, 33**) for mixtures of TDA and sand are summarized in Fig. X1.2. Shao et al (**34**) performed resilient modulus tests on crumb rubber (7-mm maximum size) and rubber buffings (1-mm maximum size). The resilient modulus values ranged from 700 to 1700 kPa.

X1.5 Typical values of coefficient of lateral earth pressure at rest and Poisson's ratio, measured as part of vertical compression tests, are presented in Table X1.5.

X1.6 The shear strength of TDA has been measured using triaxial shear (**5, 34, 35**) and using direct shear (**9, 32, 36, 37**). Failure envelopes for tests conducted at low stress levels (less than about 100 kPa) are compared in Fig. X1.3. The failure envelopes are non-liner and concave down, so when fitting a linear failure envelope to the data, it is important that this be done over the range of stresses that will occur in the field.

X1.7 The shear strength of TDA/soil mixtures has been measured using triaxial shear (**5, 38**) and direct shear (**4, 39**). Table X1.6 and Table X1.7 summarize the results from Ahmed (**5**). Edil and Bosscher (**4**), and Benson and Khire (**39**) were primarily interested in the reinforcing effect of TDA when added to a sand. Under some circumstances, the shear strength is increased by adding TDA.

X1.8 Typical hydraulic conductivities for TDA and mixtures of TDA and soil are reported in Tables X1.8 and X1.9, and Fig. X1.4.

X1.9 Measured thermal conductivities ranged from 0.0838 Cal/m-hr-°C for 1-mm particles tested in a thawed state with a water content less than 1 % and with low compaction to 0.147 Cal/m-hr-°C for 25-mm TDA tested in a frozen state with a water content of 5 % and high compaction (**34**). The thermal conductivity increased with increasing particle size, increased water content, and increased compaction. The thermal conductivity was higher for TDA tested under frozen conditions than when tested under thawed conditions. A thermal conductivity of 0.2 Cal/m-hr-°C was back-calculated from a field trial constructed using TDA with a maximum size of 51 mm (**40**). It is reasonable that the back-calculated thermal conductivity is higher than found by Shao et al (**34**) since the TDA for the former were larger and contained more steel bead wire and steel belt.

X1.10 The results of TCLP tests for regulated metals are summarized in Table X1.10. Results of field studies of the

TABLE X1.1 Summary of Specific Gravity and Water Absorption Capacity

TDA Type	Specific Gravity			Water Absorption Capacity (%)	Reference
	Bulk	Saturate Surface Dry	Apparent		
Glass belted (F&B)	- - - -	- - - -	1.14	3.8	**(32)**
Glass belted	0.98	1.02	1.02	4	**(41)**
Steel belted	1.06	1.01	1.10	4	**(41)**
Mixture	1.06	1.16	1.18	9.5	**(35)**
Mixture (Pine State)	- - - -	- - - -	1.24	2	**(32)**
Mixture (Palmer)	- - - -	- - - -	1.27	2	**(32)**
Mixture (Sawyer)	- - - -	- - - -	1.23	4.3	**(32)**
Mixture	1.01	1.05	1.05	4	**(41)**
Mixture (12.7 mm to 50.8 mm)	- - - -	0.88 to 1.13	- - - -	- - - -	**(5)**

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TABLE X1.2 Summary of Laboratory Dry Densities of TDA

Compaction Method[A]	Particle Size Range (mm)	TDA Type	Source of TDA	Dry Density (kg/m³)	Reference
Loose	2 to 75	Mixed	Palmer Shredding	341	(32, 36)
Loose	2 to 51	Mixed	Pine State Recycling	482	(32, 36)
Loose	2 to 25	Glass	F&B Enterprises	495	(32, 36)
Loose	2 to 51	Mixed	Sawyer Environmental	409	(3, 41)
Loose	51 max	Mixed	- - - -	466	(5, 6)
Loose	25 max	Mixed	- - - -	489	(5, 6)
Vibration	25 max	Mixed	- - - -	496	(5, 6)
Vibration	13 max	Mixed	- - - -	473	(5, 6)
50 % Standard	51 max	Mixed	- - - -	614	(5, 6)
50 % Standard	25 max	Mixed	- - - -	641	(5, 6)
60 % Standard	2 to 75	Mixed	Palmer Shredding	620	(32, 36)
60 % Standard	2 to 51	Mixed	Pine State Recycling	643	(32, 36)
60 % Standard	2 to 25	Glass	F&B Enterprises	618	(32, 36)
60 % Standard	2 to 51	Mixed	Sawyer Environmental	625	(3, 41)
Standard	2 to 51	Mixed	Sawyer Environmental	640	(3, 41)
Standard	51 max	Mixed	- - - -	635	(5, 6)
Standard	38 max	Mixed	- - - -	645	(5, 6)
Standard	25 max	Mixed	- - - -	653	(5, 6)
Standard	13 max	Mixed	- - - -	633	(5, 6)
Standard	20 to 75	- - - -	Rodefeld	594[B]	(4, 33)
Standard	20 to 75	- - - -	Rodefeld	560[C]	(4, 33)
Modified	2 to 51	Mixed	Sawyer Environmental	660	(3, 41)
Modified	51 max	Mixed	- - - -	668	(5, 6)
Modified	25 max	Mixed	- - - -	685	(5, 6)
- - - -	50.8	Mixed	- - - -	410 to 570	(35)

[A] Compaction methods:
Loose = no compaction; TDA loosely dumped into compaction mold.
Vibration = Test Method D4253.
50 % Standard = Impact compaction with compaction energy of 296.4 kJ/m³.
60 % Standard = Impact compaction with compaction energy of 355.6 kJ/m³.
Standard = Impact compaction with compaction energy of 296.4 kJ/m³.
Modified = Impact compaction with compaction energy of 2693 kJ/m³.
[B] 152-mm diameter mold compacted by 4.54 kg rammer falling 305 mm.
[C] 305-mm diameter mold compacted by 27.4 kg rammer falling 457 mm.

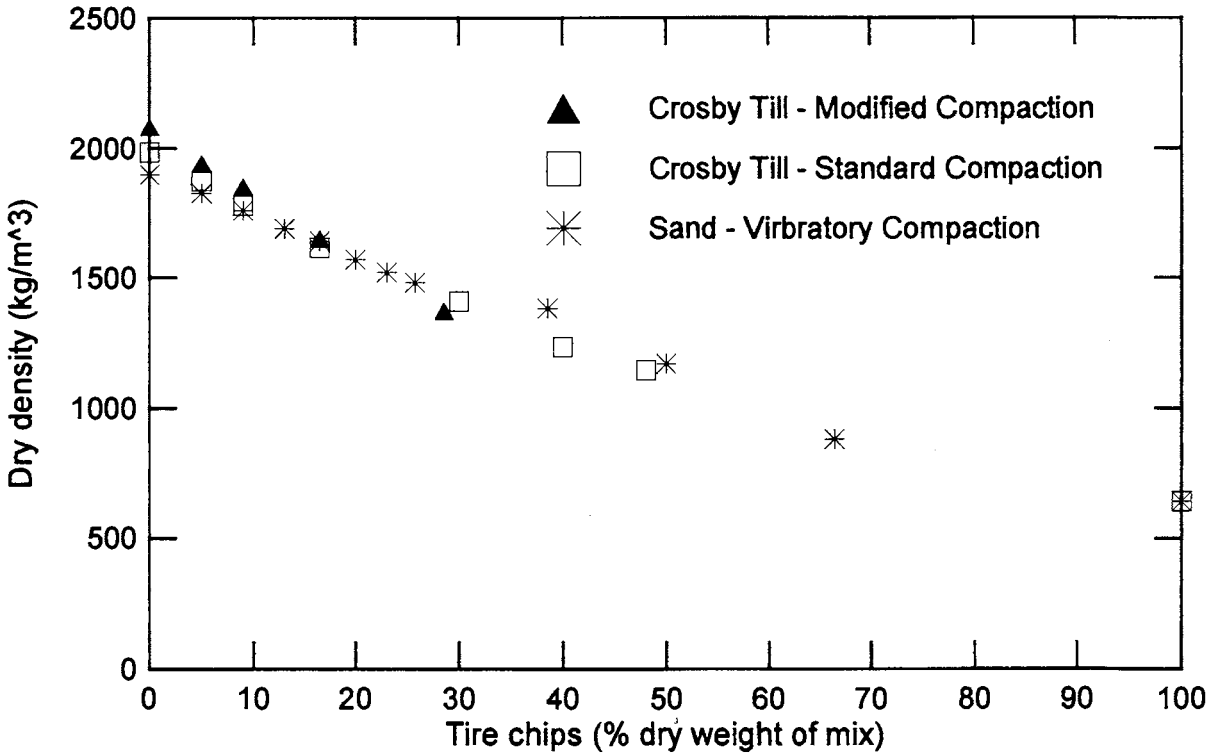

FIG. X1.1 Comparison of Compacted Dry Density of Mixtures of TDA with Ottawa Sand and Crosby Till (5)

effect of TDA on water quality are summarized in Tables X1.11 and X1.12, as well as Figs. X1.5 and X1.6.

X1.11 A typical material safety data sheet for whole scrap tires is included in Fig. X1.7.

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TABLE X1.3 Compressibility on Initial Loading

Particle Size Range (mm)	TDA Type	TDA Source	Initial Dry Density (kg/m³)	Vertical Strain (%) at Indicated Vertical Stress (kPa)					Reference
				10	25	50	100	200	
2 to 75	Mixed	Palmer	Compacted	7 to 11	16 to 21	23 to 27	30 to 34	38 to 41	**(41)**
2 to 51	Mixed	Pine State	Compacted	8 to 14	15 to 20	21 to 26	27 to 32	33 to 37	**(32)**
2 to 25	Glass	F&B	Compacted	5 to 10	11 to 16	18 to 22	26 to 28	33 to 35	**(32)**
2 to 51	Mixed	Sawyer	Compacted	5 to 10	13 to 18	17 to 23	22 to 30	29 to 37	**(41)**
	Mixed		Compacted	4 to 5	8 to 11	13 to 16	18 to 23	27	**(5)**
75 max	Mixed	Pine State	510 to 670	12 to 20	18 to 28	- - - -	- - - -	- - - -	**(8)**
2 to 51	Mixed	Pine State	Loose	18	34	41	46	52	**(32)**
2 to 25	Mixed	F&B	Loose	8	18	28	37	45	**(32)**
	- - - -		Loose	9	12 to 17	17 to 24	24 to 31	30 to 38	**(42)**

TABLE X1.4 Resilient Modulus of TDA and TDA/Soil Mixtures (5)

NOTE 1—Constants A and B are the constants for the regression equation and r^2 is the regression coefficient.
NOTE 2—Standard = Standard Proctor Energy = 296.4 kJ/m³.
NOTE 3—The constants A and B assume the units for θ and M_R are psi (1 psi = 6.89 kPa).

Test No.	TDA Max Size (mm)	Sample Preparation	% TDA Based on Total Weight	Soil Type	Constant A	Constant B	r^2
AH01	No shreds	Vibratory	No shreds	Sand	1071.5	0.84	0.95
AH02	13	Vibratory	15	Sand	524.8	0.83	0.95
AH03	13	Vibratory	30	Sand	269.2	0.90	0.67
AH04	13	Vibratory	38	Sand	42.7	1.15	0.89
AH05	13	Vibratory	50	Sand	38.9	0.83	0.84
AH06	13	Vibratory	100	Sand	36.3	0.55	0.74
AH07	19	Vibratory	38	Sand	34.7	1.21	0.92
AH08	No shreds	Standard	No shreds	Crosby Till	3162.3	0.49	0.83
AH09	13	Standard	15	Crosby Till	53.7	1.15	0.91
AH10	13	Standard	29	Crosby Till	61.7	0.91	0.94
AH11	13	Standard	38	Crosby Till	55.0	0.67	0.95

TABLE X1.5 Summary of Coefficient of Lateral Earth Pressure at Rest and Poisson's Ratio

Particle Size Range (mm)	TDA Type	Source of TDA	K_O	-μ	Reference
2 to 51	Mixed	Sawyer Environmental	0.44	0.30	**(3, 41)**
2 to 75	Mixed	Palmer Shredding	0.26	0.20	**(32, 36)**
2 to 51	Mixed	Pine State Recycling	0.41	0.28	**(32, 36)**
2 to 25	Glass	F&B Enterprises	0.47	0.32	**(32, 36)**
- - - -	- - - -	- - - -	- - - -	0.3 to 0.17	**(4, 33)**
13 to 51	Mixed	Maust Tire Recyclers	0.4[A]	0.3	**(42)**

[A] For vertical stress less than 172 kPa.

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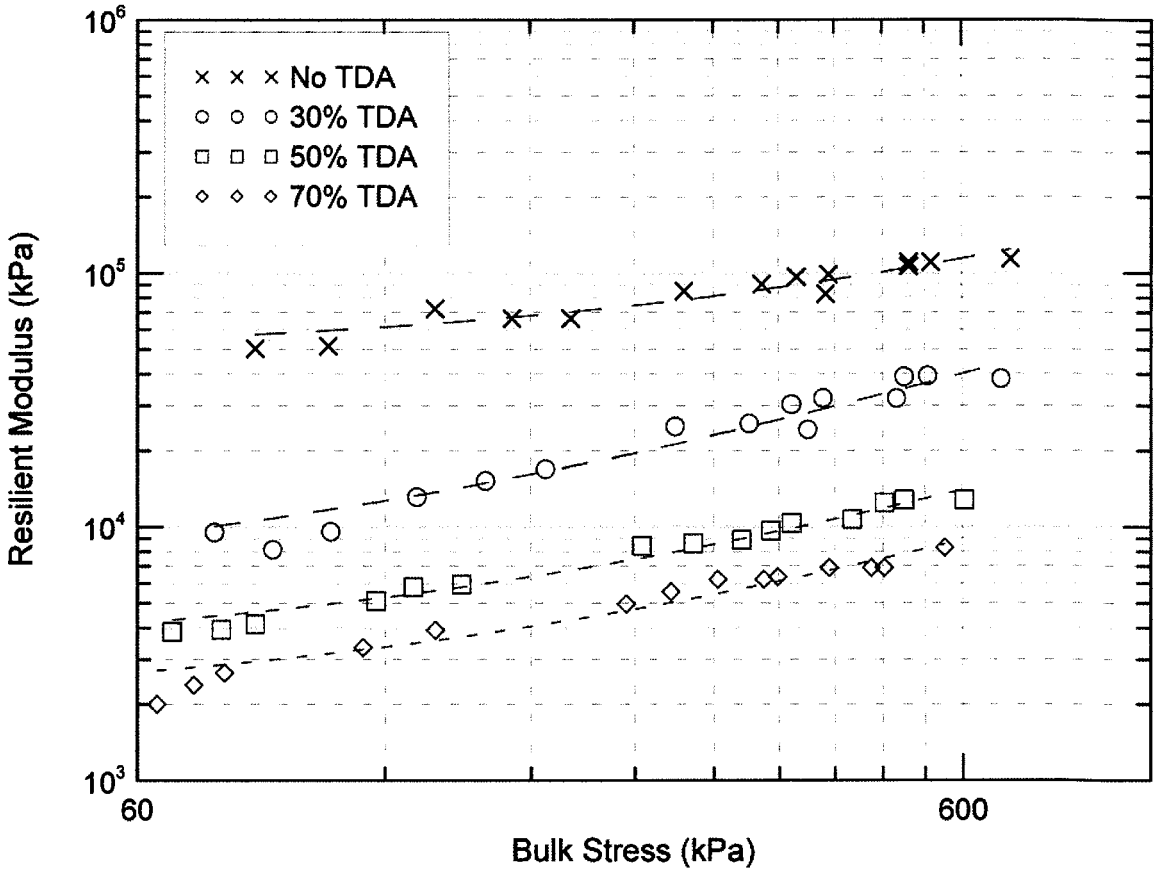

FIG. X1.2 Resilient Modulus of Mixtures of TDA and Clean Sand (4)

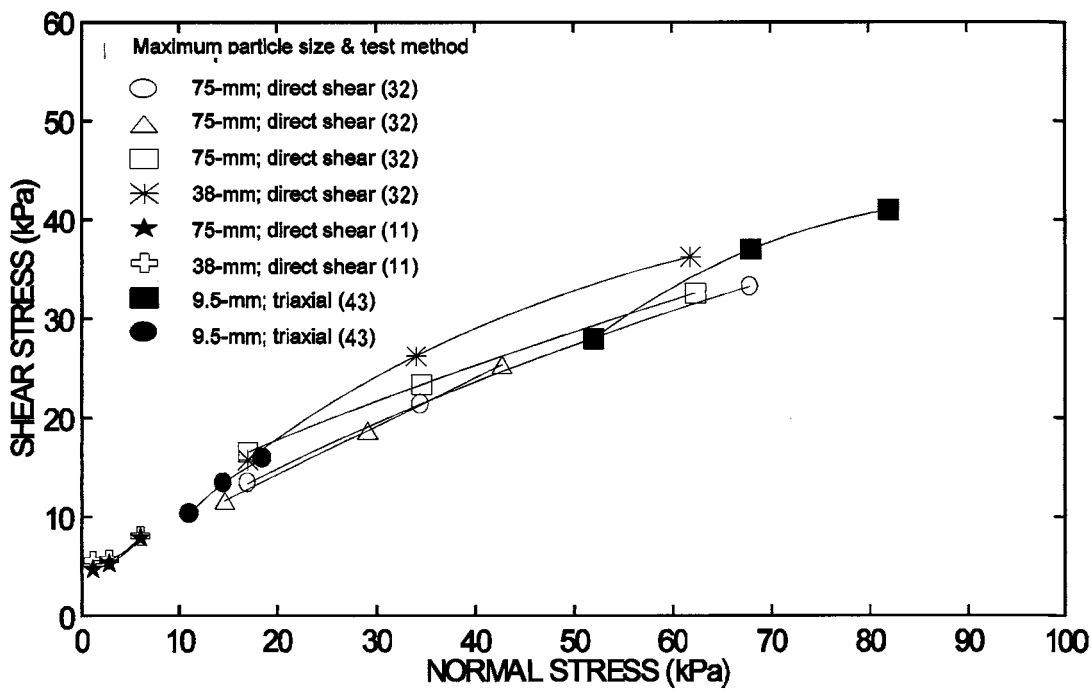

FIG. X1.3 Comparison of Failure Envelops of TDA at Low Stress Levels

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TABLE X1.6 Shear Strength of Mixtures of TDA and Ottawa Sand (5)

NOTE 1—All samples are prepared by using vibratory compaction.
NOTE 2—Chip ratio is the air dried weight to chips divided by dry weight of mix, expressed in percent.
NOTE 3—sin ϕ = tan α; c = a/cos ϕ.

Test No.	Size of Chips (in.)	Chip/Mix Ratio (%)	Confining Pressure (psi)	Strain Levels (%)	a (psi)	tan α	r^2	c (psi)	ϕ (°)
TRS01	No-Chip	0	4.50	5	-0.24	0.6615	0.9998	0	41.41
TRS02	No-Chip	0	14.36	10	-	-	-	-	-
TRS03	No-Chip	0	28.86	15	-	-	-	-	-
TRS04	1.00	16.5	4.64	5	2.17	0.6006	0.9996	2.71	36.91
TRS05	1.00	16.5	14.50	10	1.05	0.6252	0.9998	1.35	38.70
TRS06	1.00	16.5	28.86	15	-	-	-	-	-
TRS07	1.00	29.16	4.50	5	5.52	0.4944	0.9943	6.35	29.63
TRS08	1.00	29.16	14.50	10	3.04	0.6110	0.9992	3.84	37.66
TRS09	1.00	29.16	28.86	15	2.65	0.6286	0.9993	3.41	38.95
TRS10	1.00	40.00	4.64	5	5.15	0.3957	0.9988	5.61	23.31
TRS11	1.00	40.00	14.36	10	5.13	0.5413	0.9972	6.10	32.77
TRS12	1.00	40.00	28.86	15	4.09	0.6013	0.9999	5.12	36.96
TRS13	1.00	50.00	4.64	5	-0.68	0.3562	0.9601	0.00	20.87
TRS14	1.00	50.00	14.36	10	4.54	0.4362	0.9988	5.05	25.86
TRS15	1.00	50.00	28.71	15	3.84	0.5519	0.9986	4.60	33.50
TRS16	1.00	66.54	4.50	5	2.23	0.1699	0.9999	2.26	9.78
TRS17	1.00	66.54	14.36	10	1.89	0.3324	0.9901	2.00	19.41
TRS18	1.00	66.54	28.71	15	4.91	0.3759	0.9992	5.30	22.08
TRS19	0.50	37.85	4.64	5	5.26	0.3891	0.9998	5.71	22.90
TRS20	0.50	37.85	14.50	10	5.48	0.5383	1.0000	6.50	32.57
TRS21	0.50	37.85	28.71	15	4.42	0.6238	0.9998	5.66	38.59
TRS22	1.00	38.78	4.64	5	6.55	0.4299	0.9964	7.25	25.46
TRS23	1.00	39.32	14.36	10	5.17	0.5684	0.9985	6.28	34.64
TRS24	1.00	39.37	28.71	15	4.08	0.617	0.9999	5.18	38.10

TABLE X1.7 Shear Strength of Mixtures of TDA and Crosby Till (5)

NOTE 1—Chip ratio is the air dried weight of chips divided by dry weight of mix, expressed in percent.
NOTE 2—sin ϕ = tan α; c = a/cos ϕ .

Test No.	Size of Chips (in.)	Chip Ratio (%)	Confining Pressure (psi)	Strain Levels (%)	a (psi)	tan α	r^2	c (psi)	ϕ (°)
TRC01	No-Chip	0	4.50	5	6.14	0.4299	0.9970	6.80	25.46
TRC02	No-Chip	0	14.50	10	9.28	0.4914	1.0000	10.66	29.43
TRC03	No-Chip	0	28.71	15	9.72	0.5099	0.9996	11.30	30.66
				20	9.58	0.5151	0.9996	11.18	30.00
TRC04	1.00	16.27	4.64	5	7.43	0.3873	0.9979	8.06	22.79
TRC05	1.00	16.27	14.36	10	6.21	0.5810	0.9982	7.63	35.52
TRC06	1.00	16.27	28.71	15	7.77	0.5686	0.9992	9.45	34.65
				20	5.71	0.6232	0.9992	7.30	38.55
TRC07	1.00	30.18	44.52	5	6.82	0.2612	0.9991	7.67	15.14
TRC08	1.00	30.18	14.36	10	9.96	0.3740	0.9997	10.74	21.96
TRC09	1.00	30.18	28.86	15	9.88	0.4748	0.9973	11.23	28.35
				20	8.82	0.5460	0.9971	10.53	33.09
TRC10	1.00	40.05	4.64	5	5.50	0.2205	0.9947	5.64	12.74
TRC11	1.00	40.05	14.36	10	7.65	0.3598	0.9990	8.20	21.09
TRC12	1.00	40.05	28.71	15	8.19	0.4543	0.9991	9.42	27.02
				20	8.44	0.5271	0.9999	9.93	31.81
TRC13	1.00	48.49	4.64	5	4.93	0.2025	0.9985	5.03	11.68
TRC14	1.00	48.49	14.36	10	6.69	0.3472	0.9999	7.13	20.32
TRC15	1.00	48.49	28.86	15	7.81	0.4441	0.9999	8.72	26.37
				20	7.92	0.5208	0.9999	9.28	31.39
TRC16	0.50	39.80	4.64	5	6.17	0.1173	0.9980	6.21	6.74
TRC17	0.50	39.80	14.36	10	9.37	0.2181	0.9875	9.60	12.60
TRC18	0.50	39.80	28.86	15	11.07	0.3130	0.9866	11.66	18.24
TRC19	0.50	39.64	14.36						
TRC20	0.50	39.79	14.36						

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TABLE X1.8 Summary of Reported Hydraulic Conductivities of TDA

Particle Size (mm)	Void Ratio	Dry Density (kg/m³)	Hydraulic Conductivity (cm/s)	Reference
25 to 64		469	5.3 to 23.5	**(35)**
25 to 64		608	2.9 to 10.9	
5 to 51		470	4.9 to 59.3	
5 to 51		610	3.8 to 22.0	
38	- - - -	- - - -	1.4 to 2.6	**(44)**
19	- - - -	- - - -	0.8 to 2.6	
10 to 51	0.925	644	7.7	**(32, 36)**
10 to 51	0.488	833	2.1	
20 to 76	1.114	601	15.4	
20 to 76	0.583	803	4.8	
10 to 38	0.833	622	6.9	
10 to 38	0.414	808	1.5	
10 to 38		653	0.58	**(5)**

TABLE X1.9 Hydraulic Conductivities of Mixtures of TDA and Soil (5)

TDA Max Size (mm)	Soil Type	% TDA Based on Total Weight	Dry Density (kg/m³)	Hydraulic Conductivity (cm/s)
- - - -	Ottawa Sand	0	1890	1.6×10^{-4}
25	Ottawa Sand	15.5	1680	1.8×10^{-3}
25	Ottawa Sand	30.1	1530	3.5×10^{-3}
25	Ottawa Sand	37.7	1410	8.7×10^{-3}
- - - -	Crosby till	0	1910	8.9×10^{-7}
25	Crosby till	14.8	1700	1.8×10^{-5}
25	Crosby till	30.1	1390	2.1×10^{-3}
25	Crosby till	40	1200	8.8×10^{-3}
13	Crosby till	40	1190	9.7×10^{-3}

TABLE X1.10 Summary of TCLP Results for Regulated Metals (15, 16, 17)

Concentration in Extract	Ag µg/L (ppb)	As µg/L (ppb)	Ba µg/L (ppb)	Cd µg/L (ppb)	Cr µg/L (ppb)	Hg µg/L (ppb)	Pb µg/L (ppb)	Se µg/L (ppb)
TCLP Regulatory Limit	5000	5000	100 000	1000	5000	200	5000	1000
Virigina DOT	NA[A]	NA	NA	1.55	2.8	NA	19.6	NA
Scrap Tire Management[B]	ND[C]	2	590	ND	48	0.4	16	ND
Maine	ND	ND	357	185	84	ND	216	ND

[A] NA = not available, that is, not measured or not reported for that study.
[B] Maximum value reported for the seven tire products that were tested.
[C] ND = non-detect

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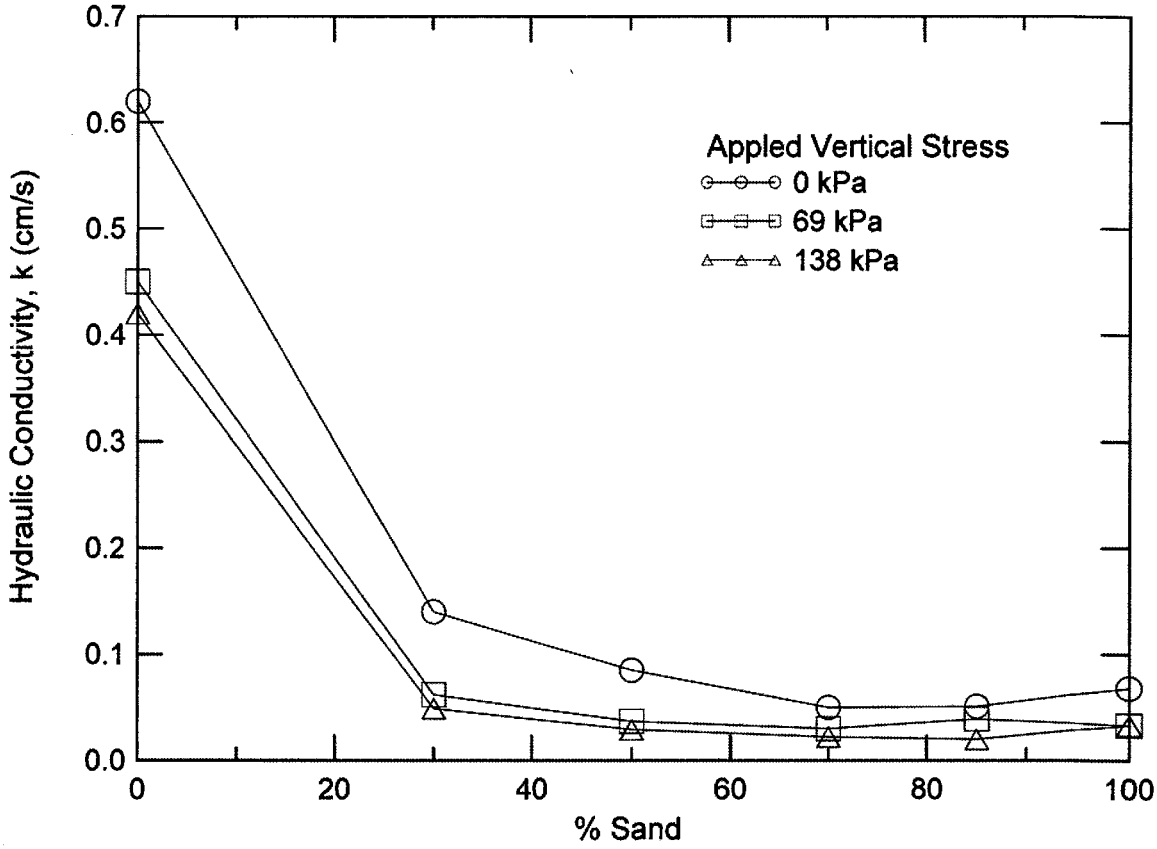

FIG. X1.4 Hydraulic Conductivities of Mixtures of TDA and Clean Sand (4)

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TABLE X1.11 Mean Concentrations of Inorganic Analytes with Primary Drinking Water Standards from Field Studies with Direct Collection of Samples (20)

NOTE—When possible, the calculated mean is reported; if the mean could not be calculated because of limited number of samples with concentrations above the detection limit, then the percent of the results below the detection limit is reported.

Analyte	RAL	PRG	Wisconsin		North Yarmouth			Witter Farm Road[A]	Ohio Monofills		Binghamton, NY	
			West 4"TDA	East 2"TDA	Control	TDA Section C	TDA Section D		C&E Monofill	American Monofill	Control TF2	TDA TF1
antimony (Sb)	0.006	0.015	NA	NA	100%<0.05[B]	100%<0.05[B]		NA	0.1290	100%<0.005	NA	NA
arsenic (As)	0.010	4.5×10^{-5}	NA	NA	NA	NA	NA	NA	0.31	67%<0.001	NA	NA
barium (Ba)	2.0	2.6	0.346	0.281	0.0688	0.0339	0.0395	0.017	0.218	0.0603	0.796	0.392
beryllium (Be)	0.004	0.073	NA	NA	100%<0.005[B]	100%<0.005[B]		NA	100%<0.1	100%<0.001	NA	NA
cadmium (Cd)	0.005	0.018	NA	NA	95%<0.0005	100%<0.0005	96%<0.0005	<0.0005	80%<0.1	67%<0.001	0.0325	0.00867
chromium (Cr)	0.1	0.11	NA	NA	0.0118	0.0126	0.0119	<0.006	NA	NA	NA	NA
copper (Cu)	1.3	1.5	NA	NA	91%<0.009	91%<0.009	96%<0.009	<0.009	80%<0.02	67%<0.01	NA	NA
fluoride (F)	4.0	2.2	NA	NA	NA	NA	NA	NA	0.8018	0.7356	NA	NA
lead (Pb)	0.015	NL	90%<0.003	0.008	88%<0.002	88%<0.002	94%<0.002	<0.002	0.19	67%<0.001	NA	NA
mercury (Hg)	0.002	0.011	NA	NA	100%<0.0005[B]	100%<0.0005[B]		NA	NA	NA	NA	NA
nitrate (NO_3^-)	10	10	NA	NA	NA	NA	NA	NA	0.9217	0.8933	NA	NA
selenium (Se)	0.05	0.018	NA	NA	NA	NA	NA	NA	0.231	100%<0.001	NA	NA
thallium (Ti)	0.002	0.0024	NA	NA	NA	NA	NA	NA	80%<0.002	100%<0.002	NA	NA

[A] Results from a single sample reported.
[B] Results from two unfiltered samples reported by Exponent **(45)**; results for TDA are a composite sample of TDA sections C and D.

Units = mg/L.
NA = Not available—parameter not tested for.
NL = Preliminary remediation goal for tap water not listed for this analyte.
Refs: Wisconsin **(21, 46)**; North Yarmouth **(22, 45)**; Witter Farm Road **(24)**; Ohio Monofills **(25)**; Binghamton **(26)**; RAL **(47)**; PRG **(19)**.

TABLE X1.12 Mean Concentrations of Inorganic Analytes with Secondary Drinking Water Standards from Field Studies with Direct Collection Of Samples (20)

NOTE—When possible, the calculated mean is reported; if the mean could not be calculated because of limited number of samples with concentrations above the detection limit, then the percent of the results below the detection limit is reported.

Analyte	Secondary Standard	PRG	Wisconsin		North Yarmouth			Witter Farm Road[A]	Ohio Monofills		Binghamton, NY	
			West 4"TDA	East 2"TDA	Control	TDA Section C	TDA Section D		C&E Monofill	American Monofill	Control TF2	TDA TF1
aluminum (Al)	0.2	36	NA	NA	81%<0.07	100%<0.07	100%<0.07	<0.07	7.97	67%< 0.1	NA	NA
chloride (Cl^-)	250	NL	477	600	345.8[B]	331.9[B]	338[B]	111	44.2	34.6	NA	NA
copper (Cu)	1	1.5	NA	NA	91%<0.009	91%<0.009	96%<0.009	<0.009	80%<0.02	67%<0.01	NA	NA
fluoride (F)	2.0	2.2	NA	NA	NA	NA	NA	NA	0.80	0.736	NA	NA
iron (Fe)	0.3	11	0.71	1.13	0.0198	0.0795	0.555	0.158	0.19	0.103	0.255	15.0
manganese (Mn)	0.05	0.88	1.129	1.522	0.0421	4.38	2.56	2.53	2.72	1.93	0.260	6.21
silver (Ag)	0.10	0.18	NA	NA	NA	NA	NA	NA	80%<0.005	100%<0.001	NA	NA
sulfate (SO_4^{2-})	250	NL	115	213	25.3[B]	18.9[B]	11.4[B]	3.51	468.5	600.7	NA	NA
zinc (Zn)	5	11	0.093	0.230	1.10	0.0111	0.0111	0.082	0.492	100%<0.005	0.300	0.0343

[A] Results from a single sample reported.
[B] Results for unfiltered sample reported.

Units = mg/L.
NA = Not available—parameter not tested for.
NL = Preliminary remediation goal for tap water not listed for this analyte.
References: Wisconsin **(21, 46)**; North Yarmouth **(22, 45)**; Witter Farm Road **(24)**; Ohio Monofills **(25)**; Binghamton **(26)**; Secondary Standard **(47)**; PRG **(19)**.

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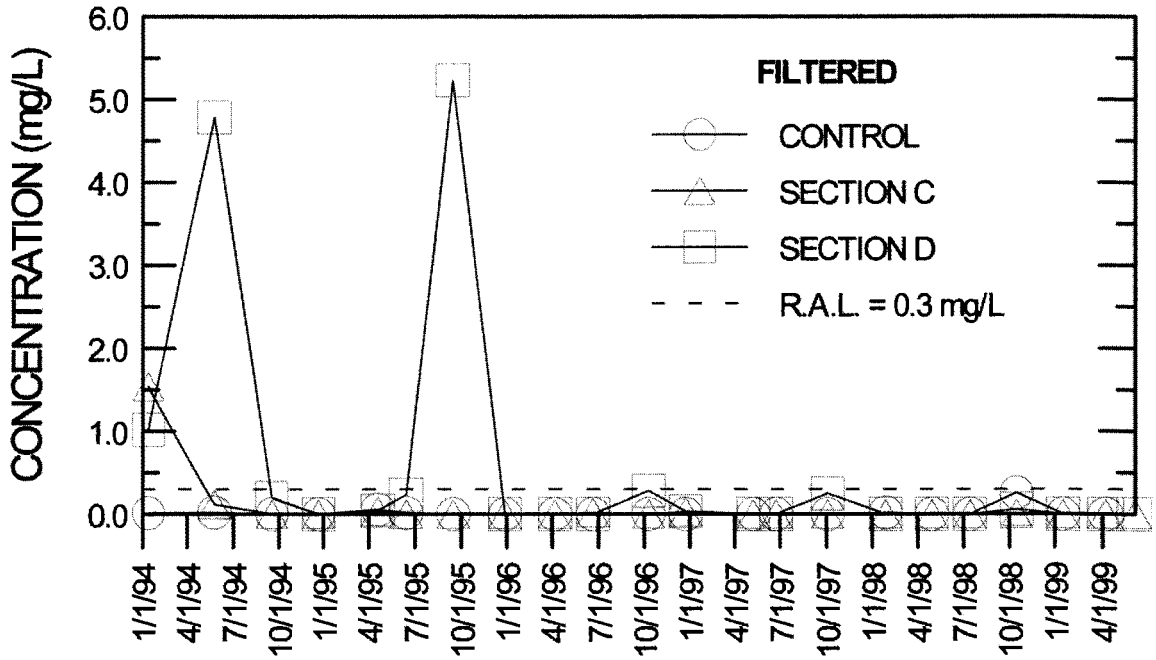

FIG. X1.5 Iron Levels for Filtered Samples at North Yarmouth Field Trial (22)

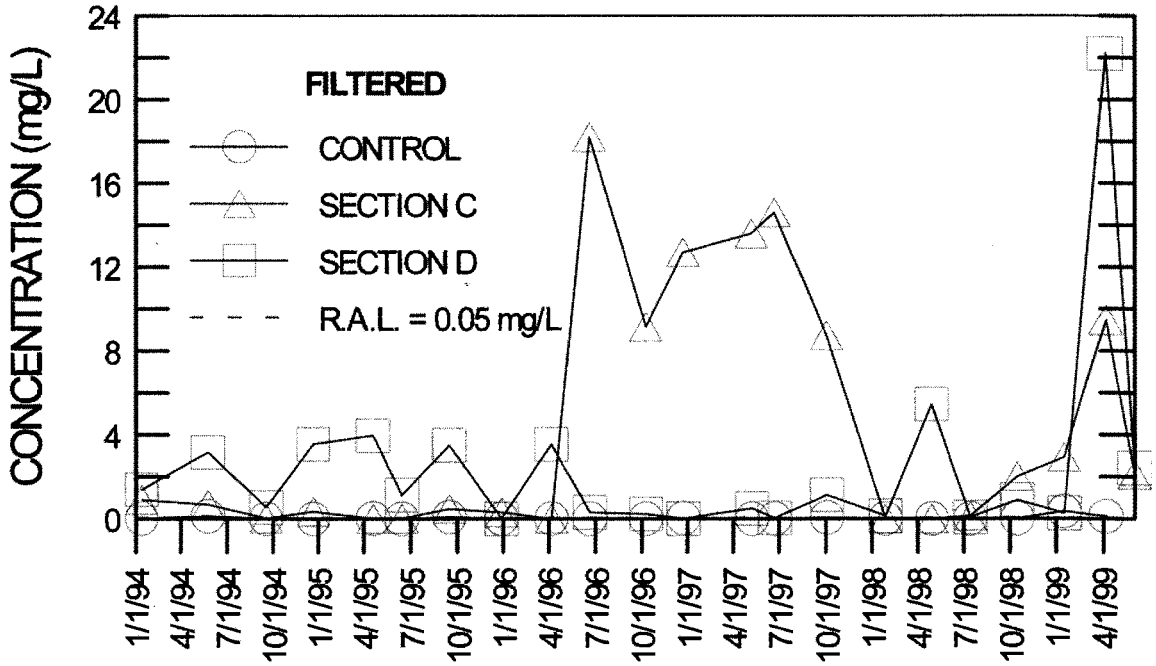

FIG. X1.6 Manganese Levels for Filtered Samples at North Yarmouth Field Trial (22)

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Whole Scrap Tire

MATERIAL SAFETY DATA SHEET

N/D = Not Determined (Unknown) **N/A = Not Applicable**

SECTION I **IDENTIFICATION**

CHEMICAL NAME Rubber Compound (Mixture) containing natural and synthetic that is physically/chemically bound with carbon black, clay, titanium dioxide, zinc oxide, sulfur and petroleum hydrocarbons.

COMMON NAME Scrap Tire (Whole)

MANUFACTURERS	TRADENAMES	EMERGENCY TELEPHONE NO.
	Scrap Tire (Whole)	

SECTION II **HAZARDOUS INGREDIENTS**

CHEMICAL NAME	CAS NUMBER	%	HEALTH HAZARD	OSHA (PEL) AOGIH (TLV)	PHYSICAL HAZARD
Carbon Black	1333-86-4	16-36	Irritant	3.5 mg/M^3	Non-hazardous
Clay	12141-46-7	<1.0	Irritant	N/D	Non-hazardous
Titanium dioxide	13463-67-7	<1.5	Irritant	10 mg/M^3	Non-hazardous
Zinc oxide	1314-13-2	<2.0	Irritant	5.0 mg/m^3	Non-hazardous
Sulfur	7704-34-9	<1.5	Irritant	N/D	Non-hazardous
Peteroleum hydrocarbons	8002-29-7	5-13	Irritant Carcinogen	5.0 mg/m^3	Non-hazardous

SECTION III **PHYSICAL DATA**

APPEARENCE	ODOR	MELT POINT	SPECIFIC GRAVITY	BOILING POINT
Solid Black Rubber	Rubber	N/D	1.085-1.331	N/A

BULK DENSITY	%VOLATILE BY VOLUME	VAPOR DENSITY (AIR=1)	VAPOR PRESS.	%SOL. H20
N/A	0	N/A	N/A	Insoluble

OTHER N/D

FIG. X1.7 Material Safety Data Sheet for Whole Scrap Tires

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Whole Scrap Tire

MATERIAL SAFETY DATA SHEET

N/D = Not Determined (Unknown) **N/A = Not Applicable**

SECTION IV	FIRE AND EXPLOSION HAZARD DATA		
FLASH POINT & METHOD	**IGNITION TEMP.**	**FLAMMABLE LIMITS**	
N/D	N/D	**LOWER**	**UPPER**
		N/D	N/D

FIRE EXTINGUISHING AGENTS AND SPECIAL PROCEDURES

Any of the following extinguishing agents may be used to combat any fires of this material: water (dispersed with fog nozzles), carbon dioxide, dry chemical, Halon or alcohol foam. Water, dispersed with fog nozzles, may be used to cool fire-exposed containers and to prevent pressure build-up.

Full protective clothing and MSHA/NIOSH (Mine Safety and Health Administration/National Institute for Occupatinal Safety and Health) approved, positive pressure, self-contained breathing apparatus should be used while firefighting. Thermal decomposition by-products may present a health hazard.

UNUSUAL EXPLOSIVE HAZARDS NONE

PRODUCTS EVOLVED WHEN SUBJECTED TO HEAT OR COMBUSTION

Potentially carcinogenic materials (including nitrosamines), carbon oixdes (carbon monoxide and carbon dioxide), acrid fumes, and flammable hydrocarbons may be liberated as a result of thermal decomposition or combustion. Avoid the smoke and fumes that result from thermal decomposition or combustion.

SECTION V	HEALTH EFFECTS - EFFECTS of Exposure	
LD50 ORAL (INGESTION)	**LD50 DERMAL (SKIN CONTACT)**	**LC50 (INHALATION)**
N/D	N/D	N/D

THRESHOLD LIMIT VALUE (TLV)	**PRIMARY ROUTE OF EXPOSURE**
N/D	skin (dermal) contact

EFFECT OF ACUTE (SHORT TERM) EXPOSURE:

No known health effects due to acute (short term) exposure.

EFFECT OF CHRONIC (REPEATED) EXPOSURE:

This material contains untreated naphthenic or aromatic extender oil. This oil could be released from the surface through skin contact. Prolonged contact with these oils has been shown to cause skin cancer in laboratory studies with animals. Untreated naphthenic and aromatic oils are classified as carcinogenic by IARC (International Agency for Research on Cancer). Prolonged or repeated contact may cause skin irritation or sensitization (allergic skin reaction).

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Skin Disorders

FIG. X1.7 Material Safety Data Sheet for Whole Scrap Tires *(continued)*

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Whole Scrap Tire

MATERIAL SAFETY DATA SHEET

N/D = Not Determined (Unknown) **N/A = Not Applicable**

SECTION VI **EMERGENCY AND FIRST AID PROCEDURES**

EYES: Not expected to be a problem.

SKIN: Wash thoroughly with soap and water. If reddening or irritation develops, obtain supportive medical attention.

INGESTION: Not expected to be a problem.

INHALATION: Not expected to be a problem.

OTHER INSTRUCTIONS:

Employees who have prolonged contact with material should practice good personal hygiene by frequent washing of hands and arms with soap and water. Remove contaminated clothing and launder before reuse. Shower at the end of each work day.

SECTION VII **CHEMICAL REACTIVITY**

CONDITIONS CAUSING INSTABILITY Stable under normal conditions.

INCOMPATIBILITY (MATERIALS TO AVOID) None.

HAZARDOUS DECOMPOSITION PRODUCTS

Potentially carcinogenic materials (including nitrosamines), carbon oxides (carbon monoxide and carbon dioxide), acid fumes, and flammable hydrocarbons may be liberated as a result of thermal decomposition or combustion. Avoid the smoke and fumes that result from thermal decomposition or combustion.

SECTION VIII **SPILL, LEAK, AND DISPOSAL INFORMATION**

STEPS TO BE TAKEN IN CASE MATERIAL IS SPILLED OR RELEASED

WASTE DISPOSAL: Reclaim or recycle material if possible. Dispose of materials-in accordance with applicable federal, state and local guidelines and regulations.

FIG. X1.7 Material Safety Data Sheet for Whole Scrap Tires *(continued)*

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Whole Scrap Tire

MATERIAL SAFETY DATA SHEET

N/D = Not Determined (Unknown) **N/A = Not Applicable**

SECTION IX	SPECIAL PROTECTION INFORMATION

All rubber products should be handled so as to prevent eye contact and excessive or repeated skin contact. Appropriate skin protection should be employed. Inhalation of dusts should be avoided

EYES: Not required for normal use.

SKIN: Use of protective gloves is recommended. Wash hands before eating, smoking or using the restroom.

INHALATION: Under normal conditions of use, respiratory protection should not be required.

ADDITIONAL PERSONAL PROTECTION INFORMATION:

Employees who have prolonged contact with material should practice good personal hygiene by frequent washing of hands and arms with soap and water. Remove contaminated clothing and launder before reuse. Shower at the end of each work day.

SECTION X	STORAGE INFORMATION

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE

Store indoors in a cool, dry, well ventilated area under ambient conditions. (Temperatures: 32-100°F 0°-38°C). Do not store in direct sunlight. Store and dispose of material in accordance with applicable federal, state and local guidelines and regulations.

SECTION XI	ADDITIONAL COMMENTS

Components of this product are included in the EPA Toxic Substances Control Act (TCSA) Chemical Substances Inventory.

FOR ADDITIONAL INFORMATION

NAME	COMPANY	TELEPHONE

FIG. X1.7 Material Safety Data Sheet for Whole Scrap Tires *(continued)*

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