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Allen Gaither
NC Department of Environment and Natural Resources
2090 U.S. Highway 70
Swannanoa, North Carolina 28778

Subject: Blue Ridge Paper Products, dba Evergreen Packaging
Landfill No. 6 – Operations and Maintenance Manual (Amendment)

Dear Mr. Gaither:

Blue Ridge Paper Products, Inc. (Blue Ridge) is submitting the revised pages of the Operations and Maintenance Manual (O&M) for approval by the North Carolina Department of Environment and Natural Resources (NCDENR) for Landfill No. 6, Permit Number 44-06. The revised O&M pages, provided as Attachment 1, includes Biosolids as an accepted landfill waste, dust control and the use of tire derived aggregate (TDA) and reclaimed concrete aggregate (RCA) as substitute leachate drainage layers. A bulleted list of changes to the O&M and descriptions of these changes is provided below to assist in your review.

- Cover Page: Revised *A Division of Evergreen Packaging* to *dba Evergreen Packaging*;
- Page 1, Table of Contents: Inserted Sections 4.2, 4.2.1, and 4.2.2; Leachate Drainage Layers, Tire Derived Aggregate, and Reclaimed Concrete Aggregate;
- Page 1, Table of Contents: Added Section 5.9, Dust Control;
- Page 2, List of Appendices: Added ASTM Specification D6270-08 (Standard Practice for Use of Scrap Tires in Civil Engineering Applications as Appendix E;
- Pages 2-7 through 2-8: Added and revised the list of accepted waste and unpermitted waste to Section 2.8;
- Page 2-9: Added a reference to Leachate Drainage Layers as Section 4.2;
- Pages 4-1 through 4-3: Inserted Sections 4.2, 4.2.1, and 4.2.2 describing the Leachate Drainage Layers, Tire Derived Aggregate, and Reclaimed Concrete Aggregate;
- Page 5-1: Revised Section 5.2: Access Roads;
- Page 5-4: Added Section 5.9 describing dust control;
- Page 8-2: Revised Section 8.3 listing the general categories of accepted waste; and
- Appendix E: Added Appendix E to include ASTM D6270-08.

This amendment requests the addition of Biosolids as an accepted waste at Landfill No. 6. The Biosolids originate from Blue Ridge's recovery process/tank cleaning operations. The Biosolids material has been assessed as a non-hazardous waste in a memorandum prepared by URS provided as Attachment 2. In addition, the memorandum describes the appropriate management and disposal of Biosolids from the process tanks. Attachment 3 provides analytical testing results for characterizing the Biosolids material which was performed by Pace Analytical Services.

The use of TDA is proposed as a substitute for aggregate stone in the leachate drainage layers between horizontal waste lifts. The location for TDA placement is restricted to the intermediate leachate drainage layers and prohibits placement in chimney drains, at the landfill base layer, or adjacent to any geosynthetic liner or material cover. Sevee & Maher Engineers, Inc. prepared a Tire Chip Usability Report outlining the beneficial use of TDA in the landfill operation which is provided as Attachment 4. The O&M provides a description on the material properties and handling.

The use of RCA is also proposed to be substituted for aggregate stone in the leachate drainage layers between horizontal waste lifts. The location for RCA placement is limited to the proposed TDA locations. The O&M provides a description on the material properties and handling.

If you have any questions during your review of the enclosed material, please do not hesitate to contact us.

Sincerely,

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File:Ops plan modifications 73112

Attachment 1: Blue Ridge, Canton, Landfill No. 6 Operations & Maintenance Manual (Revised Pages)
Attachment 2: URS Memorandum for Management and Disposal of Tank Clean-outs
Attachment 3: Pace Analytical Services Laboratory Analysis for Skim Tank Soap
Attachment 4: Sevee & Maher Engineers, Inc. Tire Chip Usability

ATTACHMENT 1

BLUE RIDGE, CANTON, LANDFILL NO. 6
OPERATIONS & MAINTENANCE MANUAL
(REVISED PAGES)

LANDFILL No. 6

OPERATIONS & MAINTENANCE

MANUAL

Prepared for
BLUE RIDGE PAPER PRODUCTS INC. – CANTON MILL
~~A DIVISION OF~~DBA EVERGREEN PACKAGING

CANTON, NORTH CAROLINA

July 2012

SME
Sevee & Maher Engineers, Inc.

ENVIRONMENTAL • CIVIL • GEOTECHNICAL • WATER • COMPLIANCE

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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 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.

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.~~2~~ **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.~~3~~ **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.~~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.

5.9 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.

The ~~six~~ 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; ~~and~~
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.

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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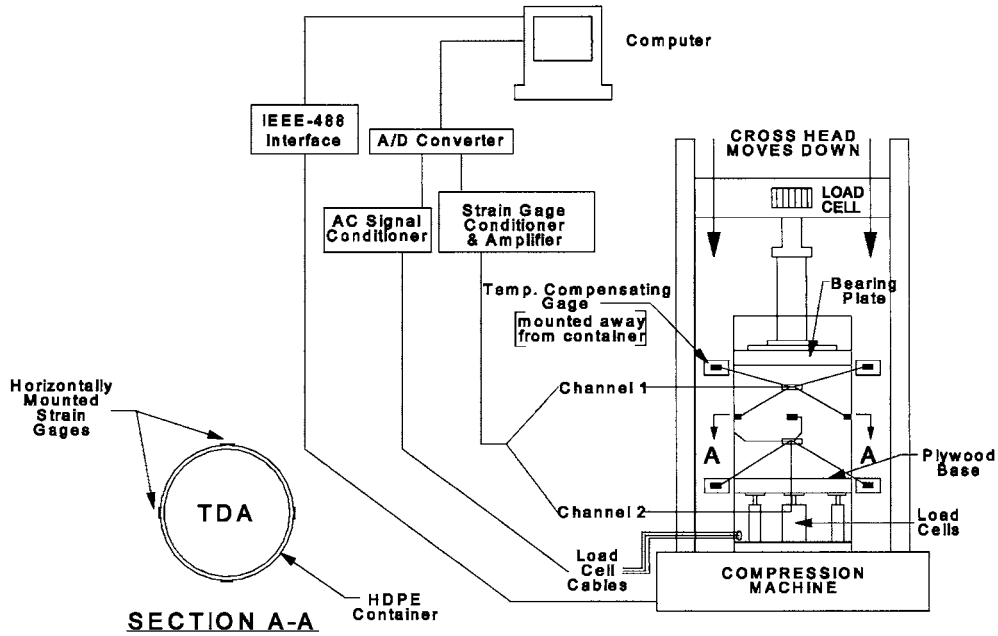

FIG. 1 Compressibility Apparatus for TDA Designed to Measured Lateral Stress and the Portion of the Vertical Load Transferred by Friction from TDA to Container (10)

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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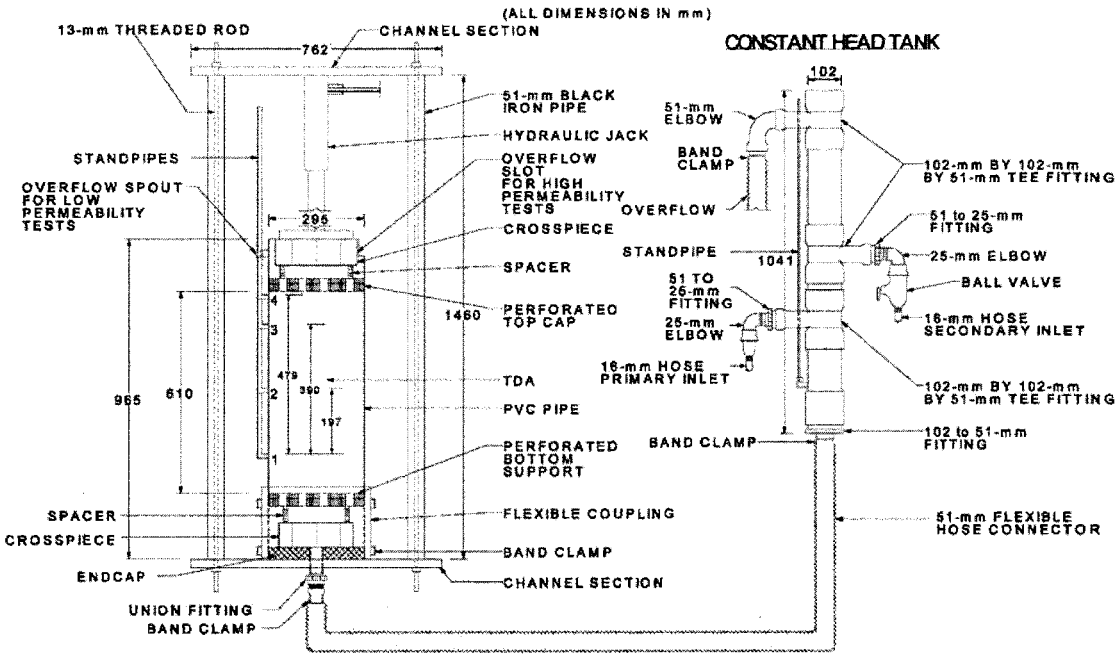

FIG. 2 Hydraulic Conductivity Apparatus for TDA with Provisions for Application of Vertical Stress (12)

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.

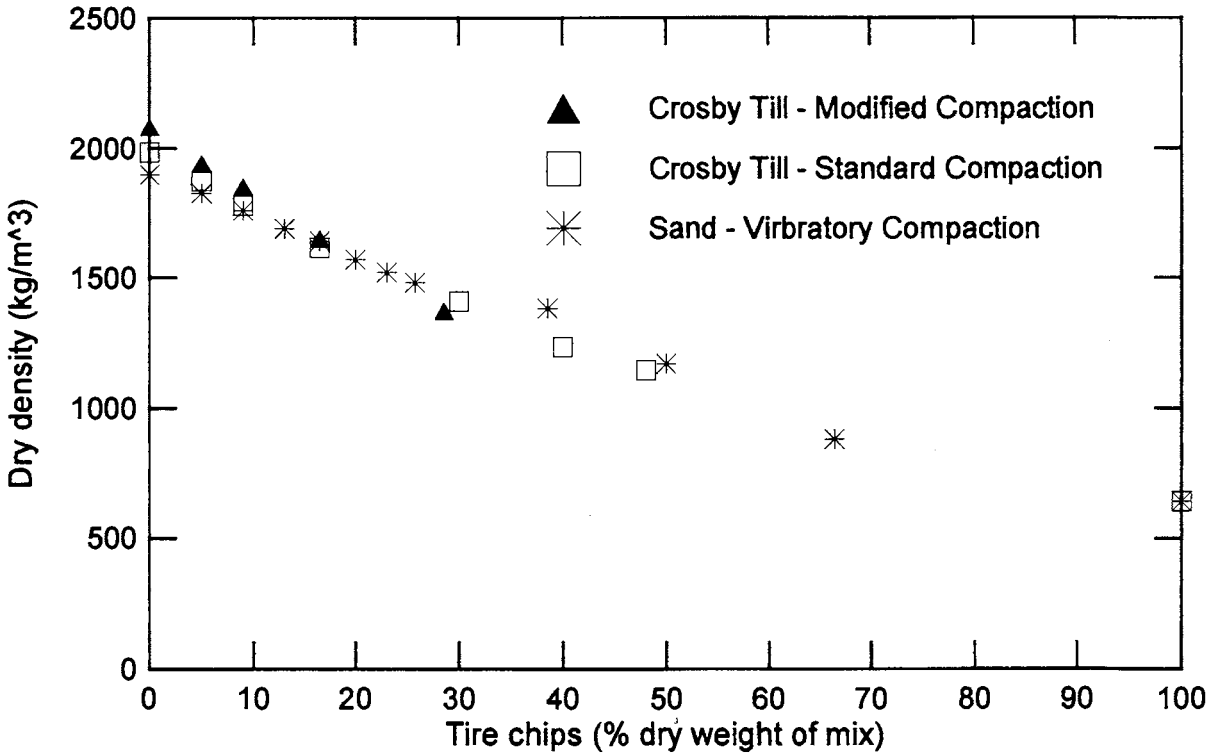

FIG. X1.1 Comparison of Compacted Dry Density of Mixtures of TDA with Ottawa Sand and Crosby Till (5)

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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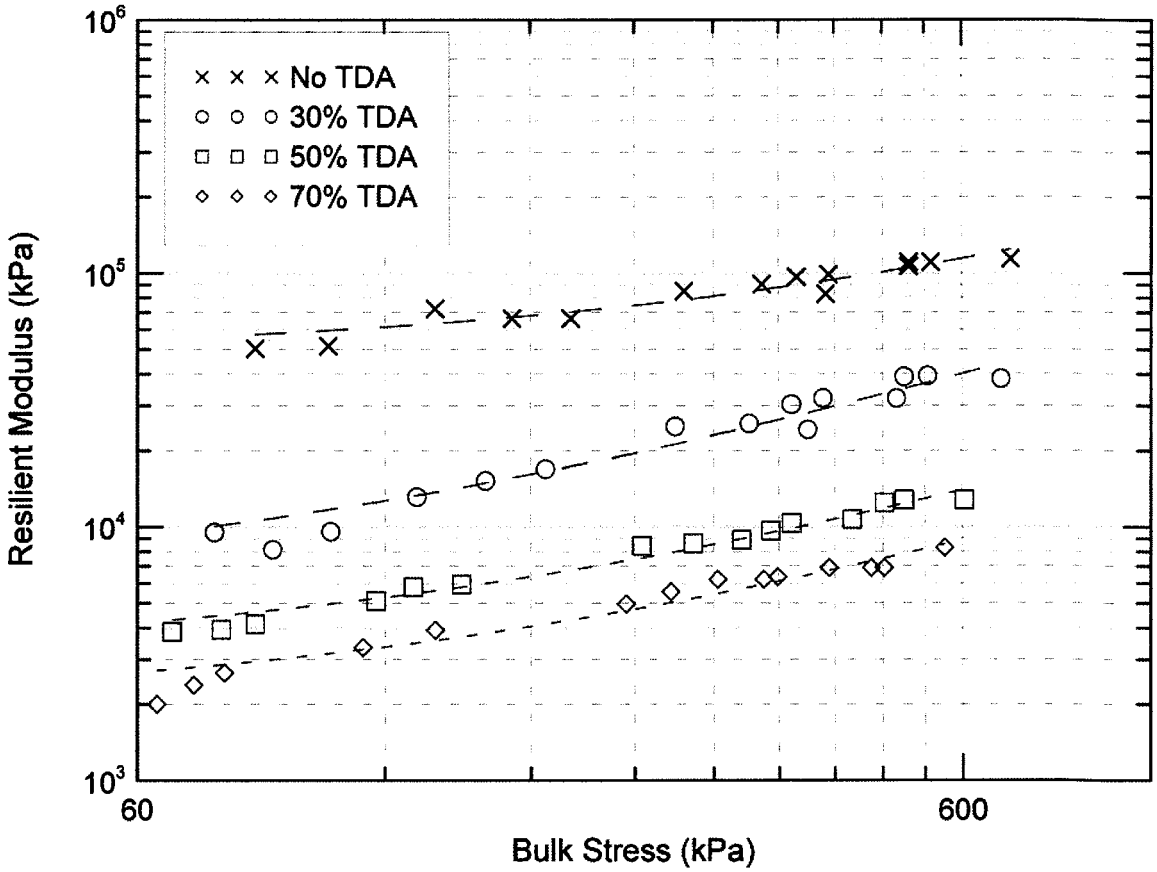

FIG. X1.2 Resilient Modulus of Mixtures of TDA and Clean Sand (4)

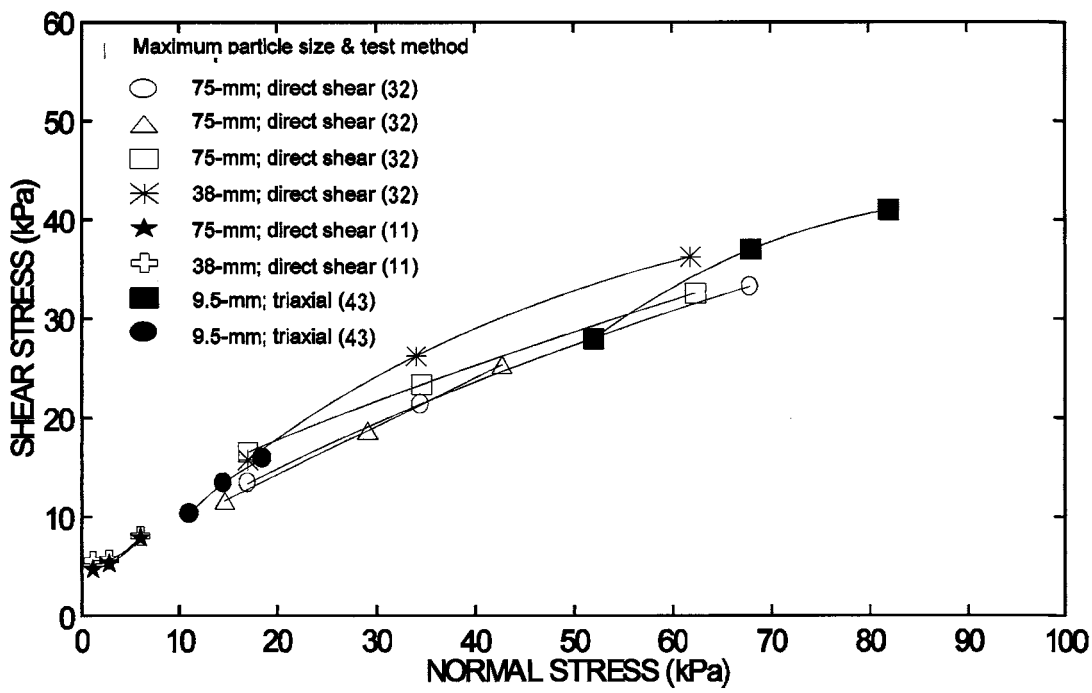

FIG. X1.3 Comparison of Failure Envelops of TDA at Low Stress Levels

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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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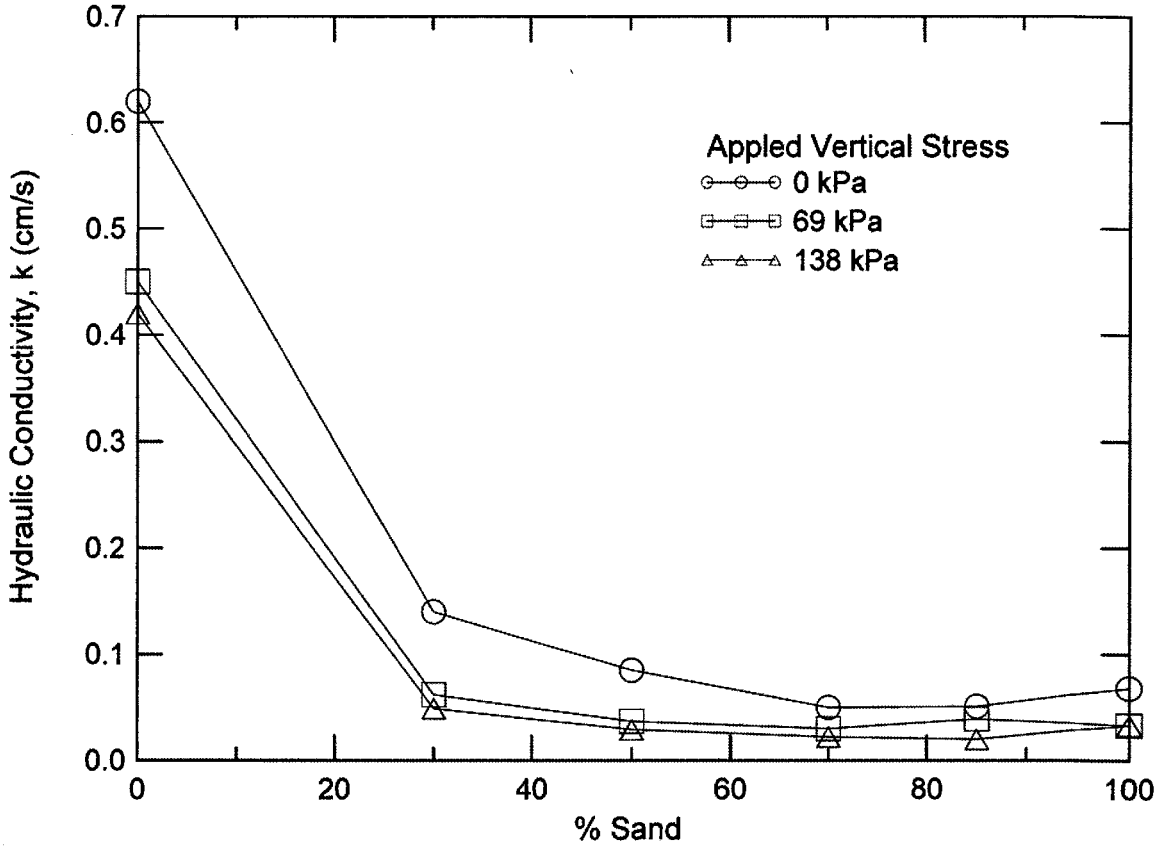

FIG. X1.4 Hydraulic Conductivities of Mixtures of TDA and Clean Sand (4)

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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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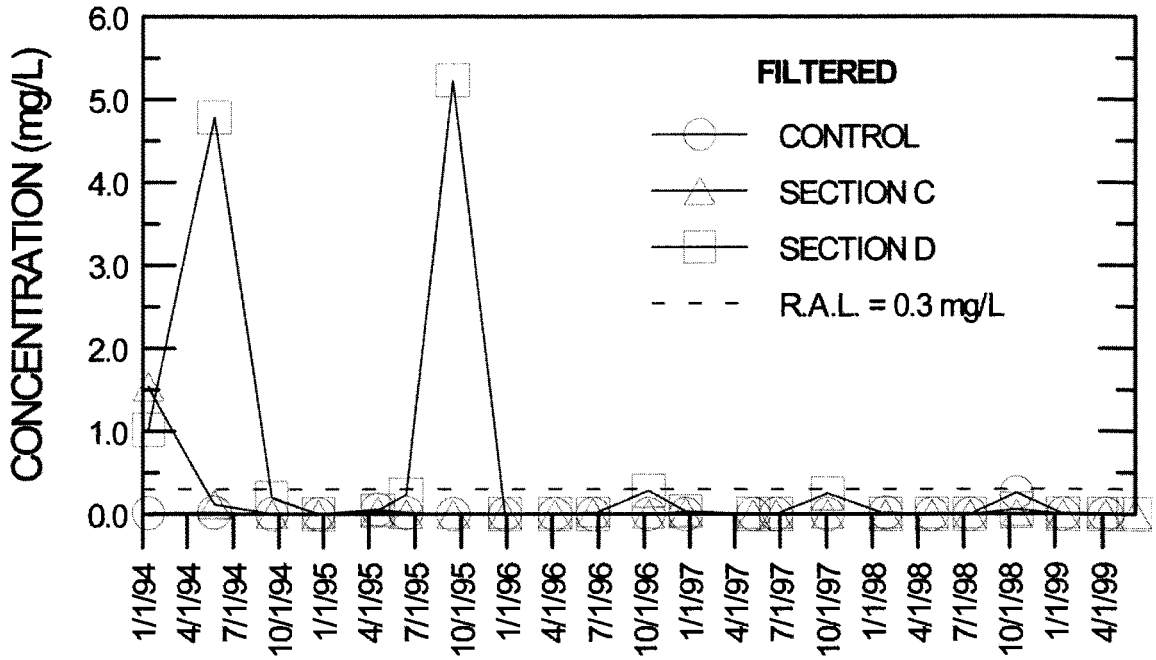

FIG. X1.5 Iron Levels for Filtered Samples at North Yarmouth Field Trial (22)

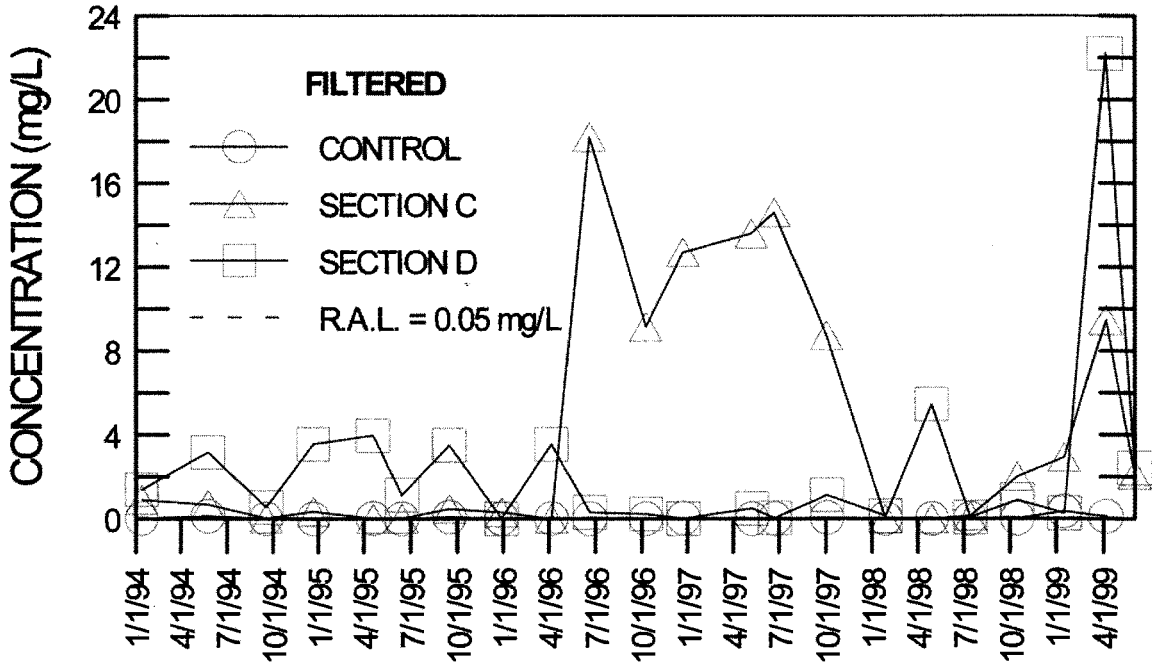

FIG. X1.6 Manganese Levels for Filtered Samples at North Yarmouth Field Trial (22)

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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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ATTACHMENT 2

URS MEMORANDUM FOR MANAGEMENT AND DISPOSAL OF TANK CLEAN-OUTS

URS

Memorandum

To:	Paul Dickens Environmental Affairs Manager Evergreen Packaging Canton Mill	**From:**	Brittany Robinson, URS
		Office:	Morrisville, NC
		Date:	July 12, 2012

Subject: Management and Disposal of Tank Heels from Black Liquor Tank Clean-outs

Background

The Evergreen Packaging Canton Mill called URS to inquire on the options for the management and disposal of tank heels from the clean-out of black liquor tanks. This is a routine activity in the industry as facilities are required to empty tanks prior to internal integrity inspections.

Regulatory Analysis

Tank heels from black liquor tanks are usually composed of solid material with some free liquids. It is noted that the free liquids from the tank clean-outs can have a pH at or above 12.5 and in this case the liquid would be hazardous waste as defined by 40 CFR 261.22.

In a letter from Matthew A. Straus, Chief of the Waste Characterization Branch of EPA on August 18, 1987, to Mineral By-Products, Inc.[1], EPA noted that the corrosivity characteristic (D002) applies only to aqueous and liquid wastes. There is no definition of a corrosive solid. Therefore, wastes in the solid phase cannot be characterized as corrosive (pH less than or equal to 2.0 or equal to or greater than 12.5). It is noted that EPA test SW-846, Method 9045 can be used to determine the pH of solids and soil that contain less than 20% water by volume; however, EPA has clarified that "Method 9045 is not [to be] used for corrosivity characteristic determinations."[2]

Based on these interpretations, the facility needs to separate the phases of the tank heel. The solid material would not be a corrosive hazardous waste (D002) and should not contain any other constituents that would cause it to be hazardous. For these reasons, the solid material can be disposed of in a non-hazardous waste landfill. Materials that pass the Paint Filter Test (SW-846, Method 9095B[3]) contain no free liquids and are not liquid wastes. This is confirmed in McCoy's RCRA Unraveled: "It is still acceptable to use the paint filter test to determine if a material is a liquid, and most generators are employing this approach."[4]

---

1 http://yosemite.epa.gov/osw/rcra.nsf/0c994248c239947e85256d090071175f/5776af1004588e588525670f006bd8c9!OpenDocument

2 60 FR 17003, April 4, 1995

3 http://www.epa.gov/osw/hazard/testmethods/sw846/pdfs/9095b.pdf

4 *MCcoy's RCRA Unraveled, 2008 Edition*, McCoy and Associates, Inc., January 2008, page 39.

The liquid phase of the tank heel would be hazardous based on corrosivity if the pH of the liquid is at or above 12.5. The EPA allows facilities to treat D002 corrosive hazardous wastes in elementary neutralization units (ENU). An ENU is defined in 40 CFR 260.10 as a device which:

- *Is used for neutralizing wastes that are hazardous only because they exhibit the corrosivity characteristic defined in 40 CFR 261.22 of this chapter and*
- *Meets the definition of tank, tank system, container, transport vehicle, or vessel in 40 CFR 261.10*

The EPA extends the ENU exemption "to include devices that are commonly considered to be tanks as well as devices such as flumes, gutters, troughs, and pipes which are not commonly considered to be tanks.[5] It is noted that the neutralized waste does not have to be discharged under a Clean Water Act Permit but this is the standard practice in the pulp and paper industry.

Standard for the Industry

URS spoke with Ashok Jain of NCASI regarding how most member companies handle these waste materials. Mr. Jain confirmed that most facilities will place the tank heel in a dumpster and allow the liquid to drain to the mill's sewer system for elementary neutralization and final discharge by the permitted CWA wastewater treatment system. The solid material is typically not hazardous, if it does not contain any underlying hazardous waste constituents, and is disposed of in a non-hazardous waste landfill.

Documentation

While the liquid material that is neutralized is exempt from RCRA requirements, the solid material from the tank heel is not. The facility needs to document that the solid material is non-hazardous based on generator knowledge.

If the site is a large quantity generator (LQG), the generation of the liquid material that undergoes elementary neutralization must be counted as hazardous waste on the biennial report. It is noted that generation of this material is not counted toward the facility's generator status determination[6] and must only be reported if the site is an LQG, excluding generation of this material, and is required to submit the biennial report.

---

[5] 45 FR 76078, RO 11173, November 17, 1980.
[6] 40 CFR 261.5(c)(2)

ATTACHMENT 3

PACE ANALYTICAL SERVICES LABORATORY ANALYSIS FOR SKIM TANK SOAP

Pace Analytical®
www.pacelabs.com

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9800 Kincey Ave. Suite 100
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July 13, 2012

Mr. Jim Giauque
Evergreen Packaging
PO Box 4000
Canton, NC 28716

RE: Project: W GB SKIM TANK SOAP pH 7/9
Pace Project No.: 92123443

Dear Mr. Giauque:
Enclosed are the analytical results for sample(s) received by the laboratory on July 09, 2012. The results relate only to the samples included in this report. Results reported herein conform to the most current TNI standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

Analyses were performed at the Pace Analytical Services location indicated on the sample analyte page for analysis unless otherwise footnoted.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Lorri Patton

Lorri Patton

lorri.patton@pacelabs.com
Project Manager

Enclosures

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CERTIFICATIONS

Project: W GB SKIM TANK SOAP pH 7/9
Pace Project No.: 92123443

Asheville Certification IDs
2225 Riverside Dr., Asheville, NC 28804
Florida/NELAP Certification #: E87648
Massachusetts Certification #: M-NC030
North Carolina Drinking Water Certification #: 37712
North Carolina Wastewater Certification #: 40
South Carolina Certification #: 99030001
Virginia Certification #: 00072
West Virginia Certification #: 356
Virgina/VELAP Certification #: 460147

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SAMPLE ANALYTE COUNT

Project: W GB SKIM TANK SOAP pH 7/9
Pace Project No.: 92123443

Lab ID	Sample ID	Method	Analysts	Analytes Reported	Laboratory
92123443001	**W.GB SKIM TANK SOAP pH**	EPA 9045	AES	1	PASI-A

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ANALYTICAL RESULTS

Project: W GB SKIM TANK SOAP pH 7/9
Pace Project No.: 92123443

Sample: W.GB SKIM TANK SOAP pH **Lab ID: 92123443001** Collected: 07/09/12 08:10 Received: 07/09/12 10:00 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
9045 pH Soil	Analytical Method: EPA 9045							
pH at 25 Degrees C	**11.6**	Std. Units	0.10	1		07/13/12 13:00		

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(704)875-9092

QUALITY CONTROL DATA

Project: W GB SKIM TANK SOAP pH 7/9
Pace Project No.: 92123443

QC Batch: WET/21599
QC Batch Method: EPA 9045
Analysis Method: EPA 9045
Analysis Description: 9045 pH
Associated Lab Samples: 92123443001

SAMPLE DUPLICATE: 794108

Parameter	Units	92121170001 Result	Dup Result	RPD	Qualifiers
pH at 25 Degrees C	Std. Units	8.1	8.2	0	

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QUALIFIERS

Project: W GB SKIM TANK SOAP pH 7/9
Pace Project No.: 92123443

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to changes in sample preparation, dilution of the sample aliquot, or moisture content.

ND - Not Detected at or above adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

PRL - Pace Reporting Limit.

RL - Reporting Limit.

S - Surrogate

1,2-Diphenylhydrazine (8270 listed analyte) decomposes to Azobenzene.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

SG - Silica Gel - Clean-Up

U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Acid preservation may not be appropriate for 2-Chloroethylvinyl ether, Styrene, and Vinyl chloride.

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

LABORATORIES

PASI-A Pace Analytical Services - Asheville

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QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: W GB SKIM TANK SOAP pH 7/9
Pace Project No.: 92123443

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
92123443001	**W.GB SKIM TANK SOAP pH**	EPA 9045	WET/21599		

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CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

Page: of

1555230

Section A Required Client Information:

Company: BRPP
Address: PO Box 4000
Canton, NC 28704
Email To: jim.giangue@everpack.com
Phone: 828-646-2028 Fax: 828-646-5892
Requested Due Date/TAT: ASAP

Section B Required Project Information:

Report To: Jim Giangue
Copy To: Paul Dickens
Purchase Order No.: 433624
Project Name: W GB Skin Tank Soap
Project Number:

Section C Invoice Information:

Attention: Same
Company Name:
Address:
Pace Quote Reference:
Pace Project Manager:
Pace Profile #:

REGULATORY AGENCY
☐ NPDES ☐ GROUND WATER ☐ DRINKING WATER
☐ UST ☐ RCRA ☐ OTHER

Site Location STATE:

Section D Required Client Information

Matrix Codes MATRIX / CODE: Drinking Water DW, Water WT, Waste Water WW, Product P, Soil/Solid SL, Oil OL, Wipe WP, Air AR, Tissue TS, Other OT

SAMPLE ID (A-Z, 0-9 / ,-) Sample IDs MUST BE UNIQUE

Requested Analysis Filtered (Y/N): Analysis Test: Standard pH (Rush)

ITEM #	SAMPLE ID	MATRIX CODE (see valid codes to left)	SAMPLE TYPE (G=GRAB C=COMP)	COLLECTED COMPOSITE START DATE	COLLECTED COMPOSITE START TIME	COLLECTED COMPOSITE END/GRAB DATE	COLLECTED COMPOSITE END/GRAB TIME	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	Analysis Test	Residual Chlorine (Y/N)	Pace Project No./ Lab I.D.
1	W GB Skin Tank Soap	P	G	7/9/12	0810				1	X										92123443001
2																				
3																				
4																				
5																				
6																				
7																				
8																				
9																				
10																				
11																				
12																				

ADDITIONAL COMMENTS	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	SAMPLE CONDITIONS			
	James Giangue/BRPP	7/9/12	1000		7/9/12	10:00	13.8	Y	—	Y
							Temp in °C	Received on Ice (Y/N)	Custody Sealed Cooler (Y/N)	Samples Intact (Y/N)

ORIGINAL

SAMPLER NAME AND SIGNATURE
PRINT Name of SAMPLER: Jim Giangue
SIGNATURE of SAMPLER: [signature] DATE Signed (MM/DD/YY): 7/12/12

*Important Note: By signing this form you are accepting Pace's NET 30 day payment terms and agreeing to late charges of 1.5% per month for any invoices not paid within 30 days.

F-ALL-Q-020rev.07, 15-May-2007

Pace Analytical www.pacelabs.com	Document Name: **Sample Condition Upon Receipt (SCUR)**	Document Revised: October 19, 2011 Page 1 of 2
	Document No.: F-ASV-CS-003-rev.07	Issuing Authorities: Pace Asheville Quality Office

Client Name: Evergreen Project # 92123443

Where Received: ☐ Huntersville ☑ Asheville ☐ Eden

Courier (Circle): Fed Ex UPS USPS Client Commercial Pace Other_____

Custody Seal on Cooler/Box Present: ☐ yes ☑ no Seals intact: ☐ yes ☑ no

Packing Material: ☑ Bubble Wrap ☑ Bubble Bags ☐ None ☐ Other_____

Circle Thermometer Used: IR Gun#2 -80344039 **Type of Ice:** Wet Blue None ☑ Samples on ice, cooling process has begun

IR Gun Back Up- 111565135

Temp Correction Factor: Add / Subtract 0.2 C

Corrected Cooler Temp.: 13.8 C **Biological Tissue is Frozen:** Yes No N/A

Temp should be above freezing to 6°C

Comments:

Date and Initials of person examining contents: L 7/9/12

Chain of Custody Present:	☑Yes	☐No	☐N/A	1.
Chain of Custody Filled Out:	☑Yes	☐No	☐N/A	2.
Chain of Custody Relinquished:	☑Yes	☐No	☐N/A	3.
Sampler Name & Signature on COC:	☑Yes	☐No	☐N/A	4.
Samples Arrived within Hold Time:	☑Yes	☐No	☐N/A	5.
Short Hold Time Analysis (<72hr):	☐Yes	☑No	☐N/A	6.
Rush Turn Around Time Requested:	☑Yes	☐No	☐N/A	7. ASAP
Sufficient Volume:	☑Yes	☐No	☐N/A	8.
Correct Containers Used:	☑Yes	☐No	☐N/A	9.
-Pace Containers Used:	☑Yes	☐No	☐N/A	
Containers Intact:	☑Yes	☐No	☐N/A	10.
Filtered volume received for Dissolved tests	☐Yes	☐No	☑N/A	11.
Sample Labels match COC:	☑Yes	☐No	☐N/A	12.
-Includes date/time/ID/Analysis Matrix: OT				
All containers needing preservation have been checked.	☑Yes	☐No	☐N/A	13.
All containers needing preservation are found to be in compliance with EPA recommendation.	☑Yes	☐No	☐N/A	L
exceptions: VOA, coliform, TOC, O&G, WI-DRO (water)	☐Yes	☑No		Initial when completed
Samples checked for dechlorination:	☐Yes	☐No	☑N/A	14.
Headspace in VOA Vials (>6mm):	☐Yes	☐No	☑N/A	15.
Trip Blank Present:	☐Yes	☐No	☑N/A	16.
Trip Blank Custody Seals Present	☐Yes	☐No	☑N/A	
Pace Trip Blank Lot # (if purchased):_____				

Client Notification/ Resolution: Field Data Required? Y / N

Person Contacted: _____ Date/Time: _____

Comments/ Resolution: _____

SCURF Review: LP **Date:** 7/10/12 **SRF Review:** LP **Date:** 7/10/12

Note: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office (i.e out of hold, incorrect preservative, out of temp, incorrect containers)

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July 18, 2012

Mr. Jim Giauque
Evergreen Packaging
PO Box 4000
Canton, NC 28716

RE: Project: W GB SKIM TANK SOAP 7/9
Pace Project No.: 92123442

Dear Mr. Giauque:
Enclosed are the analytical results for sample(s) received by the laboratory on July 09, 2012. The results relate only to the samples included in this report. Results reported herein conform to the most current TNI standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

Analyses were performed at the Pace Analytical Services location indicated on the sample analyte page for analysis unless otherwise footnoted.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Lorri Patton

Lorri Patton

lorri.patton@pacelabs.com
Project Manager

Enclosures

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CERTIFICATIONS

Project: W GB SKIM TANK SOAP 7/9
Pace Project No.: 92123442

Charlotte Certification IDs
9800 Kincey Ave. Ste 100, Huntersville, NC 28078
North Carolina Drinking Water Certification #: 37706
North Carolina Field Services Certification #: 5342
North Carolina Wastewater Certification #: 12
South Carolina Certification #: 99006001
South Carolina Drinking Water Cert. #: 99006003
Virginia Drinking Water Certification #: 00213
Connecticut Certification #: PH-0104
Florida/NELAP Certification #: E87627
Kentucky UST Certification #: 84
Louisiana DHH Drinking Water # LA 100031
West Virginia Certification #: 357
Virginia/VELAP Certification #: 460144

Asheville Certification IDs
2225 Riverside Dr., Asheville, NC 28804
Florida/NELAP Certification #: E87648
Massachusetts Certification #: M-NC030
North Carolina Drinking Water Certification #: 37712
North Carolina Wastewater Certification #: 40
South Carolina Certification #: 99030001
Virginia Certification #: 00072
West Virginia Certification #: 356
Virgina/VELAP Certification #: 460147

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SAMPLE ANALYTE COUNT

Project: W GB SKIM TANK SOAP 7/9
Pace Project No.: 92123442

Lab ID	Sample ID	Method	Analysts	Analytes Reported	Laboratory
92123442001	**W.GB SKIM TANK SOAP**	EPA 6010	JMW	7	PASI-A
		EPA 7470	SHB	1	PASI-A
		EPA 8270	PPM	18	PASI-C
		EPA 8260	DLK	15	PASI-C
		EPA 9095	LMD	1	PASI-A

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ANALYTICAL RESULTS

Project: W GB SKIM TANK SOAP 7/9
Pace Project No.: 92123442

Sample: W.GB SKIM TANK SOAP **Lab ID: 92123442001** Collected: 07/09/12 08:05 Received: 07/09/12 10:00 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP, TCLP	Analytical Method: EPA 6010 Preparation Method: EPA 3010							
	Leachate Method/Date: EPA 1311; 07/11/12 15:15							
Arsenic	ND	mg/L	0.025	1	07/12/12 14:00	07/13/12 15:03	7440-38-2	
Barium	**1.0**	mg/L	0.50	1	07/12/12 14:00	07/13/12 15:03	7440-39-3	
Cadmium	ND	mg/L	0.0050	1	07/12/12 14:00	07/13/12 15:03	7440-43-9	
Chromium	ND	mg/L	0.025	1	07/12/12 14:00	07/13/12 15:03	7440-47-3	
Lead	ND	mg/L	0.025	1	07/12/12 14:00	07/13/12 15:03	7439-92-1	
Selenium	ND	mg/L	0.10	1	07/12/12 14:00	07/13/12 15:03	7782-49-2	
Silver	ND	mg/L	0.025	1	07/12/12 14:00	07/13/12 15:03	7440-22-4	
7470 Mercury, TCLP	Analytical Method: EPA 7470 Preparation Method: EPA 7470							
	Leachate Method/Date: EPA 1311; 07/11/12 15:15							
Mercury	ND	ug/L	0.20	1	07/12/12 14:00	07/13/12 14:34	7439-97-6	
8270 MSSV TCLP Sep Funnel	Analytical Method: EPA 8270 Preparation Method: EPA 3510							
	Leachate Method/Date: EPA 1311; 07/11/12 14:10							
1,4-Dichlorobenzene	ND	ug/L	50.0	1	07/13/12 09:00	07/14/12 00:39	106-46-7	
2,4-Dinitrotoluene	ND	ug/L	50.0	1	07/13/12 09:00	07/14/12 00:39	121-14-2	
Hexachloro-1,3-butadiene	ND	ug/L	50.0	1	07/13/12 09:00	07/14/12 00:39	87-68-3	
Hexachlorobenzene	ND	ug/L	50.0	1	07/13/12 09:00	07/14/12 00:39	118-74-1	
Hexachloroethane	ND	ug/L	50.0	1	07/13/12 09:00	07/14/12 00:39	67-72-1	
2-Methylphenol(o-Cresol)	ND	ug/L	50.0	1	07/13/12 09:00	07/14/12 00:39	95-48-7	
3&4-Methylphenol(m&p Cresol)	ND	ug/L	50.0	1	07/13/12 09:00	07/14/12 00:39		
Nitrobenzene	ND	ug/L	50.0	1	07/13/12 09:00	07/14/12 00:39	98-95-3	
Pentachlorophenol	ND	ug/L	100	1	07/13/12 09:00	07/14/12 00:39	87-86-5	
Pyridine	ND	ug/L	50.0	1	07/13/12 09:00	07/14/12 00:39	110-86-1	
2,4,5-Trichlorophenol	ND	ug/L	50.0	1	07/13/12 09:00	07/14/12 00:39	95-95-4	
2,4,6-Trichlorophenol	ND	ug/L	50.0	1	07/13/12 09:00	07/14/12 00:39	88-06-2	
Surrogates								
Nitrobenzene-d5 (S)	69	%	12-102	1	07/13/12 09:00	07/14/12 00:39	4165-60-0	
2-Fluorobiphenyl (S)	52	%	13-107	1	07/13/12 09:00	07/14/12 00:39	321-60-8	
Terphenyl-d14 (S)	70	%	21-132	1	07/13/12 09:00	07/14/12 00:39	1718-51-0	
Phenol-d6 (S)	23	%	10-110	1	07/13/12 09:00	07/14/12 00:39	13127-88-3	
2-Fluorophenol (S)	31	%	10-110	1	07/13/12 09:00	07/14/12 00:39	367-12-4	
2,4,6-Tribromophenol (S)	79	%	27-108	1	07/13/12 09:00	07/14/12 00:39	118-79-6	
8260 MSV TCLP	Analytical Method: EPA 8260							
Benzene	ND	ug/L	190	38		07/11/12 22:26	71-43-2	
2-Butanone (MEK)	ND	ug/L	380	38		07/11/12 22:26	78-93-3	
Carbon tetrachloride	ND	ug/L	190	38		07/11/12 22:26	56-23-5	
Chlorobenzene	ND	ug/L	190	38		07/11/12 22:26	108-90-7	
Chloroform	ND	ug/L	190	38		07/11/12 22:26	67-66-3	
1,4-Dichlorobenzene	ND	ug/L	190	38		07/11/12 22:26	106-46-7	
1,2-Dichloroethane	ND	ug/L	190	38		07/11/12 22:26	107-06-2	
1,1-Dichloroethene	ND	ug/L	190	38		07/11/12 22:26	75-35-4	
Tetrachloroethene	ND	ug/L	190	38		07/11/12 22:26	127-18-4	

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ANALYTICAL RESULTS

Project: W GB SKIM TANK SOAP 7/9
Pace Project No.: 92123442

Sample: W.GB SKIM TANK SOAP **Lab ID: 92123442001** Collected: 07/09/12 08:05 Received: 07/09/12 10:00 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
8260 MSV TCLP	Analytical Method: EPA 8260							
Trichloroethene	ND	ug/L	190	38		07/11/12 22:26	79-01-6	
Vinyl chloride	ND	ug/L	190	38		07/11/12 22:26	75-01-4	
Surrogates								
1,2-Dichloroethane-d4 (S)	102	%	70-130	38		07/11/12 22:26	17060-07-0	1g
Toluene-d8 (S)	103	%	67-135	38		07/11/12 22:26	2037-26-5	
4-Bromofluorobenzene (S)	89	%	70-130	38		07/11/12 22:26	460-00-4	
Dibromofluoromethane (S)	111	%	70-130	38		07/11/12 22:26	1868-53-7	
9095 Paint Filter Liquid Test	Analytical Method: EPA 9095							
Free Liquids	**0**	mL/5min	1.0	1		07/10/12 23:18		

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QUALITY CONTROL DATA

Project: W GB SKIM TANK SOAP 7/9
Pace Project No.: 92123442

QC Batch: MERP/4350 — Analysis Method: EPA 7470
QC Batch Method: EPA 7470 — Analysis Description: 7470 Mercury TCLP
Associated Lab Samples: 92123442001

METHOD BLANK: 793388 — Matrix: Water
Associated Lab Samples: 92123442001

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Mercury	ug/L	ND	0.20	07/13/12 13:58	

LABORATORY CONTROL SAMPLE: 793389

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Mercury	ug/L	2.5	2.2	88	80-120	

MATRIX SPIKE SAMPLE: 793390

Parameter	Units	92123525001 Result	Spike Conc.	MS Result	MS % Rec	% Rec Limits	Qualifiers
Mercury	ug/L	ND	2.5	2.3	92	75-125	

SAMPLE DUPLICATE: 793391

Parameter	Units	92123294006 Result	Dup Result	RPD	Qualifiers
Mercury	ug/L	ND	ND		

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QUALITY CONTROL DATA

Project: W GB SKIM TANK SOAP 7/9
Pace Project No.: 92123442

QC Batch: MPRP/11003 — Analysis Method: EPA 6010
QC Batch Method: EPA 3010 — Analysis Description: 6010 MET TCLP
Associated Lab Samples: 92123442001

METHOD BLANK: 793428 — Matrix: Water
Associated Lab Samples: 92123442001

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Arsenic	mg/L	ND	0.025	07/13/12 14:36	
Barium	mg/L	ND	0.50	07/13/12 14:36	
Cadmium	mg/L	ND	0.0050	07/13/12 14:36	
Chromium	mg/L	ND	0.025	07/13/12 14:36	
Lead	mg/L	ND	0.025	07/13/12 14:36	
Selenium	mg/L	ND	0.10	07/13/12 14:36	
Silver	mg/L	ND	0.025	07/13/12 14:36	

LABORATORY CONTROL SAMPLE: 793429

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Arsenic	mg/L	2.5	2.3	92	80-120	
Barium	mg/L	2.5	2.3	92	80-120	
Cadmium	mg/L	2.5	2.3	92	80-120	
Chromium	mg/L	2.5	2.3	94	80-120	
Lead	mg/L	2.5	2.2	88	80-120	
Selenium	mg/L	2.5	2.3	93	80-120	
Silver	mg/L	1.2	1.1	92	80-120	

MATRIX SPIKE SAMPLE: 793430

Parameter	Units	92123525001 Result	Spike Conc.	MS Result	MS % Rec	% Rec Limits	Qualifiers
Arsenic	mg/L	ND	2.5	4.3	172	75-125	J(M1)
Barium	mg/L	ND	2.5	4.3	170	75-125	J(M1)
Cadmium	mg/L	ND	2.5	4.3	172	75-125	J(M1)
Chromium	mg/L	ND	2.5	4.4	175	75-125	J(M1)
Lead	mg/L	ND	2.5	4.1	165	75-125	J(M1)
Selenium	mg/L	ND	2.5	4.4	173	75-125	J(M1)
Silver	mg/L	ND	1.2	2.1	170	75-125	J(M1)

SAMPLE DUPLICATE: 793431

Parameter	Units	92123294006 Result	Dup Result	RPD	Qualifiers
Arsenic	mg/L	ND	ND		
Barium	mg/L	ND	.082I		
Cadmium	mg/L	ND	ND		
Chromium	mg/L	ND	.0084I		
Lead	mg/L	ND	ND		

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Huntersville, NC 28078
(704)875-9092

QUALITY CONTROL DATA

Project: W GB SKIM TANK SOAP 7/9
Pace Project No.: 92123442

SAMPLE DUPLICATE: 793431

Parameter	Units	92123294006 Result	Dup Result	RPD	Qualifiers
Selenium	mg/L	ND	ND		
Silver	mg/L	ND	ND		

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QUALITY CONTROL DATA

Project: W GB SKIM TANK SOAP 7/9
Pace Project No.: 92123442

QC Batch: MSV/19732
QC Batch Method: EPA 8260
Analysis Method: EPA 8260
Analysis Description: 8260 MSV TCLP
Associated Lab Samples: 92123442001

METHOD BLANK: 792297
Matrix: Water
Associated Lab Samples: 92123442001

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
1,1-Dichloroethene	ug/L	ND	5.0	07/11/12 11:47	
1,2-Dichloroethane	ug/L	ND	5.0	07/11/12 11:47	
1,4-Dichlorobenzene	ug/L	ND	5.0	07/11/12 11:47	
2-Butanone (MEK)	ug/L	ND	10.0	07/11/12 11:47	
Benzene	ug/L	ND	5.0	07/11/12 11:47	
Carbon tetrachloride	ug/L	ND	5.0	07/11/12 11:47	
Chlorobenzene	ug/L	ND	5.0	07/11/12 11:47	
Chloroform	ug/L	ND	5.0	07/11/12 11:47	
Tetrachloroethene	ug/L	ND	5.0	07/11/12 11:47	
Trichloroethene	ug/L	ND	5.0	07/11/12 11:47	
Vinyl chloride	ug/L	ND	5.0	07/11/12 11:47	
1,2-Dichloroethane-d4 (S)	%	103	70-130	07/11/12 11:47	
4-Bromofluorobenzene (S)	%	95	70-130	07/11/12 11:47	
Dibromofluoromethane (S)	%	105	70-130	07/11/12 11:47	
Toluene-d8 (S)	%	101	67-135	07/11/12 11:47	

LABORATORY CONTROL SAMPLE: 792298

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
1,1-Dichloroethene	ug/L	50	51.7	103	70-141	
1,2-Dichloroethane	ug/L	50	46.4	93	70-139	
1,4-Dichlorobenzene	ug/L	50	43.5	87	70-141	
2-Butanone (MEK)	ug/L	100	113	113	63-150	
Benzene	ug/L	50	49.5	99	70-132	
Carbon tetrachloride	ug/L	50	46.1	92	70-150	
Chlorobenzene	ug/L	50	44.8	90	70-134	
Chloroform	ug/L	50	49.7	99	70-130	
Tetrachloroethene	ug/L	50	44.5	89	70-137	
Trichloroethene	ug/L	50	44.7	89	70-131	
Vinyl chloride	ug/L	50	49.7	99	56-144	
1,2-Dichloroethane-d4 (S)	%			101	70-130	
4-Bromofluorobenzene (S)	%			95	70-130	
Dibromofluoromethane (S)	%			102	70-130	
Toluene-d8 (S)	%			99	67-135	

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QUALITY CONTROL DATA

Project: W GB SKIM TANK SOAP 7/9
Pace Project No.: 92123442

QC Batch: OEXT/18172 — Analysis Method: EPA 8270
QC Batch Method: EPA 3510 — Analysis Description: 8270 TCLP MSSV
Associated Lab Samples: 92123442001

METHOD BLANK: 794025 — Matrix: Water
Associated Lab Samples: 92123442001

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
1,4-Dichlorobenzene	ug/L	ND	50.0	07/13/12 21:21	
2,4,5-Trichlorophenol	ug/L	ND	50.0	07/13/12 21:21	
2,4,6-Trichlorophenol	ug/L	ND	50.0	07/13/12 21:21	
2,4-Dinitrotoluene	ug/L	ND	50.0	07/13/12 21:21	
2-Methylphenol(o-Cresol)	ug/L	ND	50.0	07/13/12 21:21	
3&4-Methylphenol(m&p Cresol)	ug/L	ND	50.0	07/13/12 21:21	
Hexachloro-1,3-butadiene	ug/L	ND	50.0	07/13/12 21:21	
Hexachlorobenzene	ug/L	ND	50.0	07/13/12 21:21	
Hexachloroethane	ug/L	ND	50.0	07/13/12 21:21	
Nitrobenzene	ug/L	ND	50.0	07/13/12 21:21	
Pentachlorophenol	ug/L	ND	100	07/13/12 21:21	
Pyridine	ug/L	ND	50.0	07/13/12 21:21	
2,4,6-Tribromophenol (S)	%	68	27-108	07/13/12 21:21	
2-Fluorobiphenyl (S)	%	53	13-107	07/13/12 21:21	
2-Fluorophenol (S)	%	26	10-110	07/13/12 21:21	
Nitrobenzene-d5 (S)	%	42	12-102	07/13/12 21:21	
Phenol-d6 (S)	%	16	10-110	07/13/12 21:21	
Terphenyl-d14 (S)	%	89	21-132	07/13/12 21:21	

LABORATORY CONTROL SAMPLE: 794026

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
1,4-Dichlorobenzene	ug/L	500	312	62	10-110	
2,4,5-Trichlorophenol	ug/L	500	303	61	39-108	
2,4,6-Trichlorophenol	ug/L	500	390	78	40-104	
2,4-Dinitrotoluene	ug/L	500	377	75	42-109	
2-Methylphenol(o-Cresol)	ug/L	500	206	41	31-110	
3&4-Methylphenol(m&p Cresol)	ug/L	500	187	37	30-110	
Hexachloro-1,3-butadiene	ug/L	500	416	83	10-110	
Hexachlorobenzene	ug/L	500	453	91	39-121	
Hexachloroethane	ug/L	500	287	57	10-110	
Nitrobenzene	ug/L	500	302	60	32-101	
Pentachlorophenol	ug/L	1000	822	82	18-108	
Pyridine	ug/L	500	127	25	10-110	
2,4,6-Tribromophenol (S)	%			100	27-108	
2-Fluorobiphenyl (S)	%			74	13-107	
2-Fluorophenol (S)	%			35	10-110	
Nitrobenzene-d5 (S)	%			58	12-102	
Phenol-d6 (S)	%			22	10-110	
Terphenyl-d14 (S)	%			91	21-132	

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QUALITY CONTROL DATA

Project: W GB SKIM TANK SOAP 7/9
Pace Project No.: 92123442

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 794027 794028

Parameter	Units	92123126001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Qual
1,4-Dichlorobenzene	ug/L	ND	500	500	322	306	64	61	30-150	5	
2,4,5-Trichlorophenol	ug/L	ND	500	500	305	329	61	66	30-150	7	
2,4,6-Trichlorophenol	ug/L	ND	500	500	402	394	80	79	30-150	2	
2,4-Dinitrotoluene	ug/L	ND	500	500	372	412	74	82	30-150	10	
2-Methylphenol(o-Cresol)	ug/L	ND	500	500	234	221	47	44	30-150	6	
3&4-Methylphenol(m&p Cresol)	ug/L	ND	500	500	203	194	41	39	30-150	4	
Hexachloro-1,3-butadiene	ug/L	ND	500	500	421	401	84	80	30-150	5	
Hexachlorobenzene	ug/L	ND	500	500	455	460	91	92	30-150	1	
Hexachloroethane	ug/L	ND	500	500	299	282	60	56	30-150	6	
Nitrobenzene	ug/L	ND	500	500	320	299	64	60	30-150	7	
Pentachlorophenol	ug/L	ND	1000	1000	883	878	88	88	30-150	1	
Pyridine	ug/L	ND	500	500	174	141	35	28	30-150	21	J(M0),J(M1)
2-Fluorobiphenyl (S)	%						74	69	13-107		
2-Fluorophenol (S)	%						42	41	10-110		
Nitrobenzene-d5 (S)	%						58	54	12-102		
Phenol-d6 (S)	%						28	27	10-110		
Terphenyl-d14 (S)	%						90	90	21-132		

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QUALITY CONTROL DATA

Project: W GB SKIM TANK SOAP 7/9
Pace Project No.: 92123442

QC Batch: WET/21550
QC Batch Method: EPA 9095
Analysis Method: EPA 9095
Analysis Description: 9095 PAINT FILTER LIQUID TEST
Associated Lab Samples: 92123442001

SAMPLE DUPLICATE: 791841

Parameter	Units	92123442001 Result	Dup Result	RPD	Qualifiers
Free Liquids	mL/5min	0	0		

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QUALIFIERS

Project: W GB SKIM TANK SOAP 7/9
Pace Project No.: 92123442

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to changes in sample preparation, dilution of the sample aliquot, or moisture content.

ND - Not Detected at or above adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

PRL - Pace Reporting Limit.

RL - Reporting Limit.

S - Surrogate

1,2-Diphenylhydrazine (8270 listed analyte) decomposes to Azobenzene.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

SG - Silica Gel - Clean-Up

U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Acid preservation may not be appropriate for 2-Chloroethylvinyl ether, Styrene, and Vinyl chloride.

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

LABORATORIES

PASI-A	Pace Analytical Services - Asheville
PASI-C	Pace Analytical Services - Charlotte

ANALYTE QUALIFIERS

1g	8260 results are from a total analysis which show that analytes are not present or that they are present but at such low levels that the appropriate regulatory levels could not possibly be exceeded, per Section 1.2 of Method 1311.
I	The reported value is between the laboratory method detection limit and the laboratory practical quantitation limit.
J(M0)	Estimated Value. Matrix spike recovery was outside laboratory control limits.
J(M1)	Estimated Value. Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.

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QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: W GB SKIM TANK SOAP 7/9
Pace Project No.: 92123442

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
92123442001	**W.GB SKIM TANK SOAP**	EPA 3010	MPRP/11003	EPA 6010	ICP/10104
92123442001	**W.GB SKIM TANK SOAP**	EPA 7470	MERP/4350	EPA 7470	MERC/4266
92123442001	**W.GB SKIM TANK SOAP**	EPA 3510	OEXT/18172	EPA 8270	MSSV/6495
92123442001	**W.GB SKIM TANK SOAP**	EPA 8260	MSV/19732		
92123442001	**W.GB SKIM TANK SOAP**	EPA 9095	WET/21550		

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CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

Page: of

1555229

Section A Required Client Information:

Company: BRPP
Address: PO Box 4000
Clinton, NC 28704
Email To: jimagaugue@everpack.com
Phone: 828-646-2028 Fax: 828-646-6892
Requested Due Date/TAT: ASAP

Section B Required Project Information:

Report To: Jim Gaugue
Copy To: Paul Dickens
Purchase Order No.: 433624 (supplemented)
Project Name: W. GB Skim Tank Soap
Project Number:

Section C Invoice Information:

Attention: Same
Company Name:
Address:
Pace Quote Reference:
Pace Project Manager:
Pace Profile #:

REGULATORY AGENCY: ☐ NPDES ☐ GROUND WATER ☐ DRINKING WATER ☐ UST ☐ RCRA ☐ OTHER

Site Location STATE:

Section D Required Client Information

Matrix Codes MATRIX / CODE: Drinking Water DW, Water WT, Waste Water WW, Product P, Soil/Solid SL, Oil OL, Wipe WP, Air AR, Tissue TS, Other OT

SAMPLE ID (A-Z, 0-9 / ,-) Sample IDs MUST BE UNIQUE

Requested Analysis Filtered (Y/N)

ITEM #	SAMPLE ID	MATRIX CODE (see valid codes to left)	SAMPLE TYPE (G=GRAB C=COMP)	COLLECTED Composite Start Date	Composite Start Time	Composite End/Grab Date	Composite End/Grab Time	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	Analysis Test Y/N: 8 RCRA Metals TCLP	TCLP Vol's	TCLP Semivols	Paint Filter	Residual Chlorine (Y/N)	Pace Project No./Lab I.D. 92123442
1	W. GB Skim Tank Soap	SL	G	7/9/12	0805				4	X								X	X	X	X		92123442-001
2																							
3																							
4																							
5																							
6																							
7																							
8																							
9																							
10																							
11																							
12																							

ADDITIONAL COMMENTS	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	SAMPLE CONDITIONS: Temp in °C	Received on Ice (Y/N)	Custody Sealed Cooler (Y/N)	Samples Intact (Y/N)
	JA Gaugue / BRPP	7/9/12	1000	[signature]	7/9/12	10:00	13.8	Y	—	Y

ORIGINAL

SAMPLER NAME AND SIGNATURE

PRINT Name of SAMPLER: James A. Gaugue

SIGNATURE of SAMPLER: [signature] DATE Signed (MM/DD/YY): 7/9/12

*Important Note: By signing this form you are accepting Pace's NET 30 day payment terms and agreeing to late charges of 1.5% per month for any invoices not paid within 30 days.

F-ALL-Q-020rev.07, 15-May-2007

Pace Analytical www.pacelabs.com	Document Name: **Sample Condition Upon Receipt (SCUR)**	Document Revised: October 19, 2011 Page 1 of 2
	Document No.: F-ASV-CS-003-rev.07	Issuing Authorities: Pace Asheville Quality Office

Client Name: Evergreen Project # 92129442

Where Received: ☐ Huntersville ☑ Asheville ☐ Eden

Courier (Circle): Fed Ex UPS USPS (Client) Commercial Pace Other_____

Custody Seal on Cooler/Box Present: ☐ yes ☑ no Seals intact: ☐ yes ☑ no

Packing Material: ☑ Bubble Wrap ☑ Bubble Bags ☐ None ☐ Other_____

Circle Thermometer Used: IR Gun#2 -80344039 **Type of Ice:** (Wet) Blue None ☑ Samples on ice, cooling process has begun
IR Gun Back Up- 111565135

Temp Correction Factor: Add / (Subtract) 0.2 C

Corrected Cooler Temp.: 13.8 C **Biological Tissue is Frozen:** Yes No N/A

Temp should be above freezing to 6°C

Date and Initials of person examining contents: 7/9/12

Comments:

Chain of Custody Present:	☑Yes ☐No ☐N/A	1.
Chain of Custody Filled Out:	☑Yes ☐No ☐N/A	2.
Chain of Custody Relinquished:	☑Yes ☐No ☐N/A	3.
Sampler Name & Signature on COC:	☑Yes ☐No ☐N/A	4.
Samples Arrived within Hold Time:	☑Yes ☐No ☐N/A	5.
Short Hold Time Analysis (<72hr):	☐Yes ☑No ☐N/A	6.
Rush Turn Around Time Requested:	☑Yes ☐No ☐N/A	7. ASAP
Sufficient Volume:	☑Yes ☐No ☐N/A	8.
Correct Containers Used:	☑Yes ☐No ☐N/A	9.
-Pace Containers Used:	☑Yes ☐No ☐N/A	
Containers Intact:	☑Yes ☐No ☐N/A	10.
Filtered volume received for Dissolved tests	☐Yes ☐No ☑N/A	11.
Sample Labels match COC:	☑Yes ☐No ☐N/A	12.
-Includes date/time/ID/Analysis Matrix: SL		
All containers needing preservation have been checked.	☑Yes ☐No ☐N/A	13.
All containers needing preservation are found to be in compliance with EPA recommendation.	☑Yes ☐No ☐N/A	
exceptions: VOA, coliform, TOC, O&G, WI-DRO (water)	☐Yes ☑No	Initial when completed
Samples checked for dechlorination:	☐Yes ☐No ☑N/A	14.
Headspace in VOA Vials (>6mm):	☐Yes ☐No ☑N/A	15.
Trip Blank Present:	☐Yes ☐No ☑N/A	16.
Trip Blank Custody Seals Present	☐Yes ☐No ☑N/A	
Pace Trip Blank Lot # (if purchased):		

Client Notification/ Resolution: Field Data Required? Y / N

Person Contacted: _____ Date/Time: _____

Comments/ Resolution: _____

SCURF Review: RP **Date:** 7/10/12 **SRF Review:** RP **Date:** 7/10/12

Note: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office (i.e out of hold, incorrect preservative, out of temp, incorrect containers)

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June 18, 2012

Mr. Jim Giauque
Evergreen Packaging
PO Box 4000
Canton, NC 28716

RE: Project: Soap Biosolids 6/15/12
Pace Project No.: 92121514

Dear Mr. Giauque:
Enclosed are the analytical results for sample(s) received by the laboratory on June 15, 2012. The results relate only to the samples included in this report. Results reported herein conform to the most current TNI standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

Analyses were performed at the Pace Analytical Services location indicated on the sample analyte page for analysis unless otherwise footnoted.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Lorri Patton

Lorri Patton

lorri.patton@pacelabs.com
Project Manager

Enclosures

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CERTIFICATIONS

Project: Soap Biosolids 6/15/12
Pace Project No.: 92121514

Asheville Certification IDs
2225 Riverside Dr., Asheville, NC 28804
Florida/NELAP Certification #: E87648
Massachusetts Certification #: M-NC030
North Carolina Drinking Water Certification #: 37712
North Carolina Wastewater Certification #: 40
South Carolina Certification #: 99030001
Virginia Certification #: 00072
West Virginia Certification #: 356
Virgina/VELAP Certification #: 460147

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SAMPLE ANALYTE COUNT

Project: Soap Biosolids 6/15/12
Pace Project No.: 92121514

Lab ID	Sample ID	Method	Analysts	Analytes Reported	Laboratory
92121514001	**Soap Biosolids**	EPA 9095	LMD	1	PASI-A

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ANALYTICAL RESULTS

Project: Soap Biosolids 6/15/12
Pace Project No.: 92121514

Sample: Soap Biosolids **Lab ID: 92121514001** Collected: 06/15/12 14:25 Received: 06/15/12 16:15 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
9095 Paint Filter Liquid Test	Analytical Method: EPA 9095							
Free Liquids	**0**	mL/5min	1.0	1		06/15/12 17:27		

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QUALITY CONTROL DATA

Project: Soap Biosolids 6/15/12
Pace Project No.: 92121514

QC Batch: WET/21261
QC Batch Method: EPA 9095
Analysis Method: EPA 9095
Analysis Description: 9095 PAINT FILTER LIQUID TEST
Associated Lab Samples: 92121514001

SAMPLE DUPLICATE: 780182

Parameter	Units	92121514001 Result	Dup Result	RPD	Qualifiers
Free Liquids	mL/5min	0	0		

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QUALIFIERS

Project: Soap Biosolids 6/15/12
Pace Project No.: 92121514

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to changes in sample preparation, dilution of the sample aliquot, or moisture content.

ND - Not Detected at or above adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

PRL - Pace Reporting Limit.

RL - Reporting Limit.

S - Surrogate

1,2-Diphenylhydrazine (8270 listed analyte) decomposes to Azobenzene.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

SG - Silica Gel - Clean-Up

U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Acid preservation may not be appropriate for 2-Chloroethylvinyl ether, Styrene, and Vinyl chloride.

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

LABORATORIES

PASI-A Pace Analytical Services - Asheville

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QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: Soap Biosolids 6/15/12
Pace Project No.: 92121514

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
92121514001	**Soap Biosolids**	EPA 9095	WET/21261		

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CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

Page: of

1539714

Section A Required Client Information:

Company: Evergreen Pkg.
Address: PO Box 4000
Canton NC 28716
Email To: jim.grangue@evergpack.com
Phone: 828-646-2028 Fax: 828-646-6892
Requested Due Date/TAT: 6/18/12 1 Day TAT

Section B Required Project Information:

Report To: Same
Copy To:
Purchase Order No.: 433624 (as supplemented)
Project Name: Soap Biosolids
Project Number:

Section C Invoice Information:

Attention: Same / Accounts Payable
Company Name:
Address:
Pace Quote Reference:
Pace Project Manager:
Pace Profile #:

REGULATORY AGENCY

☐ NPDES ☐ GROUND WATER ☐ DRINKING WATER
☐ UST ☐ RCRA ☐ OTHER _____

Site Location STATE: _____

Section D Required Client Information

SAMPLE ID (A-Z, 0-9 / ,-) Sample IDs MUST BE UNIQUE

Matrix Codes MATRIX / CODE: Drinking Water DW; Water WT; Waste Water WW; Product P; Soil/Solid SL; Oil OL; Wipe WP; Air AR; Tissue TS; Other OT

ITEM #	SAMPLE ID	MATRIX CODE (see valid codes to left)	SAMPLE TYPE (G=GRAB C=COMP)	COLLECTED COMPOSITE START DATE	COMPOSITE START TIME	COMPOSITE END/GRAB DATE	COMPOSITE END/GRAB TIME	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	Analysis Test	Y/N	Requested Analysis Filtered (Y/N)	Residual Chlorine (Y/N)	Pace Project No./ Lab I.D.
1	Soap Biosolids	SL	C	6/15/12	1410	6/15/12	1425		1	X								Paint Filter	X			92121514-001
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						

ADDITIONAL COMMENTS	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	SAMPLE CONDITIONS			
	Jim Grangue / Evergreen	6/15/12	1615	Lori Patton	6/15/12	1615	7.1	Y	N	Y

ORIGINAL

SAMPLER NAME AND SIGNATURE

PRINT Name of SAMPLER: James A. Grangue

SIGNATURE of SAMPLER: [signature] DATE Signed (MM/DD/YY): 06/15/12

Temp in °C | Received on Ice (Y/N) | Custody Sealed Cooler (Y/N) | Samples Intact (Y/N)

*Important Note: By signing this form you are accepting Pace's NET 30 day payment terms and agreeing to late charges of 1.5% per month for any invoices not paid within 30 days.

Pace Analytical www.pacelabs.com	Document Name: **Sample Condition Upon Receipt (SCUR)**	Document Revised: October 19, 2011 Page 1 of 2
	Document No.: F-ASV-CS-003-rev.07	Issuing Authorities: Pace Asheville Quality Office

Client Name: Evergreen Project # 92121514

Where Received: ☐ Huntersville ☑ Asheville ☐ Eden

Courier (Circle): Fed Ex UPS USPS (Client) Commercial Pace Other_____

Custody Seal on Cooler/Box Present: ☐ yes ☑ no Seals intact: ☐ yes ☐ no

Packing Material: ☐ Bubble Wrap ☐ Bubble Bags ☑ None ☐ Other_____

Circle Thermometer Used: IR Gun#2 - 80344039 **Type of Ice:** (Wet) Blue None ☑ Samples on ice, cooling process has begun

IR Gun Back Up- 111565135

Temp Correction Factor: Add /(Subtract) 0.2 c

Corrected Cooler Temp.: 7.1 c **Biological Tissue is Frozen:** Yes No N/A

Temp should be above freezing to 6°C

Date and Initials of person examining contents: 6/15/12 [illegible]

				Comments:
Chain of Custody Present:	☑Yes	☐No	☐N/A	1.
Chain of Custody Filled Out:	☑Yes	☐No	☐N/A	2.
Chain of Custody Relinquished:	☑Yes	☐No	☐N/A	3.
Sampler Name & Signature on COC:	☑Yes	☐No	☐N/A	4.
Samples Arrived within Hold Time:	☑Yes	☐No	☐N/A	5.
Short Hold Time Analysis (<72hr):	☐Yes	☑No	☐N/A	6.
Rush Turn Around Time Requested:	☑Yes	☐No	☐N/A	7. 1 Day TAT
Sufficient Volume:	☑Yes	☐No	☐N/A	8.
Correct Containers Used:	☑Yes	☐No	☐N/A	9.
-Pace Containers Used:	☑Yes	☐No	☐N/A	
Containers Intact:	☑Yes	☐No	☐N/A	10.
Filtered volume received for Dissolved tests	☐Yes	☐No	☑N/A	11.
Sample Labels match COC:	☑Yes	☐No	☐N/A	12.
-Includes date/time/ID/Analysis Matrix: S-L				
All containers needing preservation have been checked.	☑Yes	☐No	☐N/A	13.
All containers needing preservation are found to be in compliance with EPA recommendation.	☑Yes	☐No	☐N/A	LP
exceptions: VOA, coliform, TOC, O&G, WI-DRO (water)	☐Yes	☑No		Initial when completed
Samples checked for dechlorination:	☐Yes	☐No	☑N/A	14.
Headspace in VOA Vials (>6mm):	☐Yes	☐No	☑N/A	15.
Trip Blank Present:	☐Yes	☐No	☑N/A	16.
Trip Blank Custody Seals Present	☐Yes	☐No	☑N/A	
Pace Trip Blank Lot # (if purchased):_____				

Client Notification/ Resolution: Field Data Required? Y / N

Person Contacted: _____ Date/Time: _____

Comments/ Resolution: _____

SCURF Review: LP **Date:** 6/15/12 **SRF Review:** LP **Date:** 6/15/12

Note: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office (i.e out of hold, incorrect preservative, out of temp, incorrect containers)

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June 13, 2012

Mr. Jim Giauque
Evergreen Packaging
PO Box 4000
Canton, NC 28716

RE: Project: SOAP TANK 5/31
Pace Project No.: 92119733

Dear Mr. Giauque:
Enclosed are the analytical results for sample(s) received by the laboratory on May 31, 2012. The results relate only to the samples included in this report. Results reported herein conform to the most current TNI standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

Analyses were performed at the Pace Analytical Services location indicated on the sample analyte page for analysis unless otherwise footnoted.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Lorri Patton

Lorri Patton

lorri.patton@pacelabs.com
Project Manager

Enclosures

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CERTIFICATIONS

Project: SOAP TANK 5/31
Pace Project No.: 92119733

Charlotte Certification IDs
9800 Kincey Ave. Ste 100, Huntersville, NC 28078
North Carolina Drinking Water Certification #: 37706
North Carolina Field Services Certification #: 5342
North Carolina Wastewater Certification #: 12
South Carolina Certification #: 99006001
South Carolina Drinking Water Cert. #: 99006003
Virginia Drinking Water Certification #: 00213
Connecticut Certification #: PH-0104
Florida/NELAP Certification #: E87627
Kentucky UST Certification #: 84
Louisiana DHH Drinking Water # LA 100031
West Virginia Certification #: 357
Virginia/VELAP Certification #: 460144

Asheville Certification IDs
2225 Riverside Dr., Asheville, NC 28804
Florida/NELAP Certification #: E87648
Massachusetts Certification #: M-NC030
North Carolina Drinking Water Certification #: 37712
North Carolina Wastewater Certification #: 40
South Carolina Certification #: 99030001
Virginia Certification #: 00072
West Virginia Certification #: 356
Virgina/VELAP Certification #: 460147

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SAMPLE ANALYTE COUNT

Project: SOAP TANK 5/31
Pace Project No.: 92119733

Lab ID	Sample ID	Method	Analysts	Analytes Reported	Laboratory
92119733001	**SOAP TANK SAMPLE**	EPA 6010	JMW	7	PASI-A
		EPA 7470	JMW	1	PASI-A
		EPA 8270	PPM	18	PASI-C
		EPA 8260	DLK	15	PASI-C
		EPA 9045	EWS	1	PASI-A

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ANALYTICAL RESULTS

Project: SOAP TANK 5/31
Pace Project No.: 92119733

Sample: SOAP TANK SAMPLE **Lab ID: 92119733001** Collected: 05/31/12 08:10 Received: 05/31/12 16:33 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
6010 MET ICP, TCLP	Analytical Method: EPA 6010 Preparation Method: EPA 3010							
	Leachate Method/Date: EPA 1311; 06/09/12 17:45							
Arsenic	ND	mg/L	0.025	1	06/10/12 19:00	06/12/12 03:02	7440-38-2	
Barium	**1.8**	mg/L	0.50	1	06/10/12 19:00	06/12/12 03:02	7440-39-3	
Cadmium	ND	mg/L	0.0050	1	06/10/12 19:00	06/12/12 03:02	7440-43-9	
Chromium	ND	mg/L	0.025	1	06/10/12 19:00	06/12/12 03:02	7440-47-3	
Lead	ND	mg/L	0.025	1	06/10/12 19:00	06/12/12 03:02	7439-92-1	
Selenium	ND	mg/L	0.10	1	06/10/12 19:00	06/12/12 03:02	7782-49-2	
Silver	ND	mg/L	0.025	1	06/10/12 19:00	06/12/12 03:02	7440-22-4	
7470 Mercury, TCLP	Analytical Method: EPA 7470 Preparation Method: EPA 7470							
	Leachate Method/Date: EPA 1311; 06/09/12 17:45							
Mercury	ND	ug/L	0.20	1	06/11/12 14:40	06/12/12 12:55	7439-97-6	
8270 MSSV TCLP Sep Funnel	Analytical Method: EPA 8270 Preparation Method: EPA 3510							
	Leachate Method/Date: EPA 1311; 06/08/12 11:00							
1,4-Dichlorobenzene	ND	ug/L	50.0	1	06/11/12 08:50	06/11/12 19:24	106-46-7	
2,4-Dinitrotoluene	ND	ug/L	50.0	1	06/11/12 08:50	06/11/12 19:24	121-14-2	
Hexachloro-1,3-butadiene	ND	ug/L	50.0	1	06/11/12 08:50	06/11/12 19:24	87-68-3	
Hexachlorobenzene	ND	ug/L	50.0	1	06/11/12 08:50	06/11/12 19:24	118-74-1	
Hexachloroethane	ND	ug/L	50.0	1	06/11/12 08:50	06/11/12 19:24	67-72-1	
2-Methylphenol(o-Cresol)	ND	ug/L	50.0	1	06/11/12 08:50	06/11/12 19:24	95-48-7	
3&4-Methylphenol(m&p Cresol)	ND	ug/L	50.0	1	06/11/12 08:50	06/11/12 19:24		
Nitrobenzene	ND	ug/L	50.0	1	06/11/12 08:50	06/11/12 19:24	98-95-3	
Pentachlorophenol	ND	ug/L	100	1	06/11/12 08:50	06/11/12 19:24	87-86-5	
Pyridine	ND	ug/L	50.0	1	06/11/12 08:50	06/11/12 19:24	110-86-1	
2,4,5-Trichlorophenol	ND	ug/L	50.0	1	06/11/12 08:50	06/11/12 19:24	95-95-4	
2,4,6-Trichlorophenol	ND	ug/L	50.0	1	06/11/12 08:50	06/11/12 19:24	88-06-2	
Surrogates								
Nitrobenzene-d5 (S)	72	%	12-102	1	06/11/12 08:50	06/11/12 19:24	4165-60-0	
2-Fluorobiphenyl (S)	64	%	13-107	1	06/11/12 08:50	06/11/12 19:24	321-60-8	
Terphenyl-d14 (S)	41	%	21-132	1	06/11/12 08:50	06/11/12 19:24	1718-51-0	
Phenol-d6 (S)	28	%	10-110	1	06/11/12 08:50	06/11/12 19:24	13127-88-3	
2-Fluorophenol (S)	29	%	10-110	1	06/11/12 08:50	06/11/12 19:24	367-12-4	
2,4,6-Tribromophenol (S)	80	%	27-108	1	06/11/12 08:50	06/11/12 19:24	118-79-6	
8260 MSV TCLP	Analytical Method: EPA 8260							
Benzene	ND	ug/L	190	38		06/04/12 23:06	71-43-2	
2-Butanone (MEK)	ND	ug/L	380	38		06/04/12 23:06	78-93-3	
Carbon tetrachloride	ND	ug/L	190	38		06/04/12 23:06	56-23-5	
Chlorobenzene	ND	ug/L	190	38		06/04/12 23:06	108-90-7	
Chloroform	ND	ug/L	190	38		06/04/12 23:06	67-66-3	
1,4-Dichlorobenzene	ND	ug/L	190	38		06/04/12 23:06	106-46-7	
1,2-Dichloroethane	ND	ug/L	190	38		06/04/12 23:06	107-06-2	
1,1-Dichloroethene	ND	ug/L	190	38		06/04/12 23:06	75-35-4	
Tetrachloroethene	ND	ug/L	190	38		06/04/12 23:06	127-18-4	

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ANALYTICAL RESULTS

Project: SOAP TANK 5/31
Pace Project No.: 92119733

Sample: SOAP TANK SAMPLE **Lab ID: 92119733001** Collected: 05/31/12 08:10 Received: 05/31/12 16:33 Matrix: Solid

Results reported on a "dry-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
8260 MSV TCLP	Analytical Method: EPA 8260							
Trichloroethene	ND	ug/L	190	38		06/04/12 23:06	79-01-6	
Vinyl chloride	ND	ug/L	190	38		06/04/12 23:06	75-01-4	
Surrogates								
1,2-Dichloroethane-d4 (S)	100	%	70-130	38		06/04/12 23:06	17060-07-0	1g
Toluene-d8 (S)	103	%	67-135	38		06/04/12 23:06	2037-26-5	
4-Bromofluorobenzene (S)	91	%	70-130	38		06/04/12 23:06	460-00-4	
Dibromofluoromethane (S)	104	%	70-130	38		06/04/12 23:06	1868-53-7	
9045 pH Soil	Analytical Method: EPA 9045							
pH at 25 Degrees C	**12.6**	Std. Units	0.10	1		06/01/12 15:00		

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QUALITY CONTROL DATA

Project: SOAP TANK 5/31
Pace Project No.: 92119733

QC Batch: MERP/4282
QC Batch Method: EPA 7470
Analysis Method: EPA 7470
Analysis Description: 7470 Mercury TCLP
Associated Lab Samples: 92119733001

METHOD BLANK: 776792
Matrix: Water
Associated Lab Samples: 92119733001

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Mercury	ug/L	ND	0.20	06/12/12 12:28	

LABORATORY CONTROL SAMPLE: 776793

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Mercury	ug/L	2.5	2.2	86	80-120	

MATRIX SPIKE SAMPLE: 776794

Parameter	Units	92119391001 Result	Spike Conc.	MS Result	MS % Rec	% Rec Limits	Qualifiers
Mercury	ug/L	ND	2.5	2.6	103	75-125	

SAMPLE DUPLICATE: 776795

Parameter	Units	92119668001 Result	Dup Result	RPD	Qualifiers
Mercury	ug/L	ND	ND		

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QUALITY CONTROL DATA

Project: SOAP TANK 5/31
Pace Project No.: 92119733

QC Batch: MPRP/10790
QC Batch Method: EPA 3010
Analysis Method: EPA 6010
Analysis Description: 6010 MET TCLP
Associated Lab Samples: 92119733001

METHOD BLANK: 776574
Matrix: Water
Associated Lab Samples: 92119733001

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Arsenic	mg/L	ND	0.025	06/12/12 02:42	
Barium	mg/L	ND	0.50	06/12/12 02:42	
Cadmium	mg/L	ND	0.0050	06/12/12 02:42	
Chromium	mg/L	ND	0.025	06/12/12 02:42	
Lead	mg/L	ND	0.025	06/12/12 02:42	
Selenium	mg/L	ND	0.10	06/12/12 02:42	
Silver	mg/L	ND	0.025	06/12/12 02:42	

LABORATORY CONTROL SAMPLE: 776575

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Arsenic	mg/L	2.5	2.6	104	80-120	
Barium	mg/L	2.5	2.3	90	80-120	
Cadmium	mg/L	2.5	2.4	94	80-120	
Chromium	mg/L	2.5	2.4	94	80-120	
Lead	mg/L	2.5	2.2	88	80-120	
Selenium	mg/L	2.5	2.8	110	80-120	
Silver	mg/L	1.2	1.3	103	80-120	

MATRIX SPIKE SAMPLE: 776577

Parameter	Units	92119687001 Result	Spike Conc.	MS Result	MS % Rec	% Rec Limits	Qualifiers
Arsenic	mg/L	ND	2.5	2.7	107	75-125	
Barium	mg/L	0.51	2.5	2.8	91	75-125	
Cadmium	mg/L	ND	2.5	2.4	95	75-125	
Chromium	mg/L	ND	2.5	2.4	97	75-125	
Lead	mg/L	ND	2.5	2.2	90	75-125	
Selenium	mg/L	ND	2.5	2.8	110	75-125	
Silver	mg/L	ND	1.2	1.3	105	75-125	

SAMPLE DUPLICATE: 776576

Parameter	Units	92119668001 Result	Dup Result	RPD	Qualifiers
Arsenic	mg/L	ND	ND		
Barium	mg/L	ND	.35I		
Cadmium	mg/L	ND	.0039I		
Chromium	mg/L	ND	ND		
Lead	mg/L	ND	ND		

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QUALITY CONTROL DATA

Project: SOAP TANK 5/31
Pace Project No.: 92119733

SAMPLE DUPLICATE: 776576

Parameter	Units	92119668001 Result	Dup Result	RPD	Qualifiers
Selenium	mg/L	ND	ND		
Silver	mg/L	ND	ND		

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QUALITY CONTROL DATA

Project: SOAP TANK 5/31
Pace Project No.: 92119733

QC Batch: MSV/19318
QC Batch Method: EPA 8260
Analysis Method: EPA 8260
Analysis Description: 8260 MSV TCLP
Associated Lab Samples: 92119733001

METHOD BLANK: 772577
Matrix: Water
Associated Lab Samples: 92119733001

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
1,1-Dichloroethene	ug/L	ND	5.0	06/04/12 12:23	
1,2-Dichloroethane	ug/L	ND	5.0	06/04/12 12:23	
1,4-Dichlorobenzene	ug/L	ND	5.0	06/04/12 12:23	
2-Butanone (MEK)	ug/L	ND	10.0	06/04/12 12:23	
Benzene	ug/L	ND	5.0	06/04/12 12:23	
Carbon tetrachloride	ug/L	ND	5.0	06/04/12 12:23	
Chlorobenzene	ug/L	ND	5.0	06/04/12 12:23	
Chloroform	ug/L	ND	5.0	06/04/12 12:23	
Tetrachloroethene	ug/L	ND	5.0	06/04/12 12:23	
Trichloroethene	ug/L	ND	5.0	06/04/12 12:23	
Vinyl chloride	ug/L	ND	5.0	06/04/12 12:23	
1,2-Dichloroethane-d4 (S)	%	119	70-130	06/04/12 12:23	
4-Bromofluorobenzene (S)	%	93	70-130	06/04/12 12:23	
Dibromofluoromethane (S)	%	111	70-130	06/04/12 12:23	
Toluene-d8 (S)	%	104	67-135	06/04/12 12:23	

LABORATORY CONTROL SAMPLE: 772578

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
1,1-Dichloroethene	ug/L	50	60.2	120	70-141	
1,2-Dichloroethane	ug/L	50	59.1	118	70-139	
1,4-Dichlorobenzene	ug/L	50	52.1	104	70-141	
2-Butanone (MEK)	ug/L	100	122	122	63-150	
Benzene	ug/L	50	55.1	110	70-132	
Carbon tetrachloride	ug/L	50	55.4	111	70-150	
Chlorobenzene	ug/L	50	51.4	103	70-134	
Chloroform	ug/L	50	61.5	123	70-130	
Tetrachloroethene	ug/L	50	50.2	100	70-137	
Trichloroethene	ug/L	50	52.2	104	70-131	
Vinyl chloride	ug/L	50	49.8	100	56-144	
1,2-Dichloroethane-d4 (S)	%			113	70-130	
4-Bromofluorobenzene (S)	%			96	70-130	
Dibromofluoromethane (S)	%			111	70-130	
Toluene-d8 (S)	%			102	67-135	

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QUALITY CONTROL DATA

Project: SOAP TANK 5/31
Pace Project No.: 92119733

QC Batch: OEXT/17801
QC Batch Method: EPA 3510
Associated Lab Samples: 92119733001

Analysis Method: EPA 8270
Analysis Description: 8270 TCLP MSSV

METHOD BLANK: 776612
Matrix: Water
Associated Lab Samples: 92119733001

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
1,4-Dichlorobenzene	ug/L	ND	50.0	06/11/12 17:32	
2,4,5-Trichlorophenol	ug/L	ND	50.0	06/11/12 17:32	
2,4,6-Trichlorophenol	ug/L	ND	50.0	06/11/12 17:32	
2,4-Dinitrotoluene	ug/L	ND	50.0	06/11/12 17:32	
2-Methylphenol(o-Cresol)	ug/L	ND	50.0	06/11/12 17:32	
3&4-Methylphenol(m&p Cresol)	ug/L	ND	50.0	06/11/12 17:32	
Hexachloro-1,3-butadiene	ug/L	ND	50.0	06/11/12 17:32	
Hexachlorobenzene	ug/L	ND	50.0	06/11/12 17:32	
Hexachloroethane	ug/L	ND	50.0	06/11/12 17:32	
Nitrobenzene	ug/L	ND	50.0	06/11/12 17:32	
Pentachlorophenol	ug/L	ND	100	06/11/12 17:32	
Pyridine	ug/L	ND	50.0	06/11/12 17:32	
2,4,6-Tribromophenol (S)	%	71	27-108	06/11/12 17:32	
2-Fluorobiphenyl (S)	%	65	13-107	06/11/12 17:32	
2-Fluorophenol (S)	%	31	10-110	06/11/12 17:32	
Nitrobenzene-d5 (S)	%	63	12-102	06/11/12 17:32	
Phenol-d6 (S)	%	21	10-110	06/11/12 17:32	
Terphenyl-d14 (S)	%	69	21-132	06/11/12 17:32	

LABORATORY CONTROL SAMPLE: 776613

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
1,4-Dichlorobenzene	ug/L	500	296	59	10-110	
2,4,5-Trichlorophenol	ug/L	500	357	71	39-108	
2,4,6-Trichlorophenol	ug/L	500	349	70	40-104	
2,4-Dinitrotoluene	ug/L	500	342	68	42-109	
2-Methylphenol(o-Cresol)	ug/L	500	260	52	31-110	
3&4-Methylphenol(m&p Cresol)	ug/L	500	229	46	30-110	
Hexachloro-1,3-butadiene	ug/L	500	328	66	10-110	
Hexachlorobenzene	ug/L	500	379	76	39-121	
Hexachloroethane	ug/L	500	286	57	10-110	
Nitrobenzene	ug/L	500	263	53	32-101	
Pentachlorophenol	ug/L	1000	711	71	18-108	
Pyridine	ug/L	500	162	32	10-110	
2,4,6-Tribromophenol (S)	%			80	27-108	
2-Fluorobiphenyl (S)	%			66	13-107	
2-Fluorophenol (S)	%			33	10-110	
Nitrobenzene-d5 (S)	%			64	12-102	
Phenol-d6 (S)	%			23	10-110	
Terphenyl-d14 (S)	%			72	21-132	

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QUALITY CONTROL DATA

Project: SOAP TANK 5/31
Pace Project No.: 92119733

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 776614 776615

Parameter	Units	92120316001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Qual
1,4-Dichlorobenzene	ug/L	ND	500	500	297	289	59	58	30-150	3	
2,4,5-Trichlorophenol	ug/L	ND	500	500	362	353	72	71	30-150	2	
2,4,6-Trichlorophenol	ug/L	ND	500	500	369	349	74	70	30-150	6	
2,4-Dinitrotoluene	ug/L	ND	500	500	330	305	66	61	30-150	8	
2-Methylphenol(o-Cresol)	ug/L	ND	500	500	286	271	57	54	30-150	6	
3&4-Methylphenol(m&p Cresol)	ug/L	ND	500	500	261	240	52	48	30-150	8	
Hexachloro-1,3-butadiene	ug/L	ND	500	500	329	321	66	64	30-150	3	
Hexachlorobenzene	ug/L	ND	500	500	371	372	74	74	30-150	0	
Hexachloroethane	ug/L	ND	500	500	289	280	58	56	30-150	3	
Nitrobenzene	ug/L	ND	500	500	305	299	61	60	30-150	2	
Pentachlorophenol	ug/L	ND	1000	1000	791	735	79	73	30-150	7	
Pyridine	ug/L	ND	500	500	183	177	37	35	30-150	4	
2,4,6-Tribromophenol (S)	%						79	74	27-108		
2-Fluorobiphenyl (S)	%						65	62	13-107		
2-Fluorophenol (S)	%						41	40	10-110		
Nitrobenzene-d5 (S)	%						65	60	12-102		
Phenol-d6 (S)	%						30	29	10-110		
Terphenyl-d14 (S)	%						69	63	21-132		

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QUALITY CONTROL DATA

Project: SOAP TANK 5/31
Pace Project No.: 92119733

QC Batch: WET/21059
QC Batch Method: EPA 9045
Analysis Method: EPA 9045
Analysis Description: 9045 pH
Associated Lab Samples: 92119733001

SAMPLE DUPLICATE: 771613

Parameter	Units	5063665001 Result	Dup Result	RPD	Qualifiers
pH at 25 Degrees C	Std. Units	8.0	8.1	1	

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QUALIFIERS

Project: SOAP TANK 5/31
Pace Project No.: 92119733

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to changes in sample preparation, dilution of the sample aliquot, or moisture content.

ND - Not Detected at or above adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

PRL - Pace Reporting Limit.

RL - Reporting Limit.

S - Surrogate

1,2-Diphenylhydrazine (8270 listed analyte) decomposes to Azobenzene.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

SG - Silica Gel - Clean-Up

U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Acid preservation may not be appropriate for 2-Chloroethylvinyl ether, Styrene, and Vinyl chloride.

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

LABORATORIES

PASI-A	Pace Analytical Services - Asheville
PASI-C	Pace Analytical Services - Charlotte

ANALYTE QUALIFIERS

1g	8260 results are from a total analysis which show that analytes are not present or that they are present but at such low levels that the appropriate regulatory levels could not possibly be exceeded, per Section 1.2 of Method 1311.
I	The reported value is between the laboratory method detection limit and the laboratory practical quantitation limit.

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QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: SOAP TANK 5/31
Pace Project No.: 92119733

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
92119733001	**SOAP TANK SAMPLE**	EPA 3010	MPRP/10790	EPA 6010	ICP/9920
92119733001	**SOAP TANK SAMPLE**	EPA 7470	MERP/4282	EPA 7470	MERC/4199
92119733001	**SOAP TANK SAMPLE**	EPA 3510	OEXT/17801	EPA 8270	MSSV/6377
92119733001	**SOAP TANK SAMPLE**	EPA 8260	MSV/19318		
92119733001	**SOAP TANK SAMPLE**	EPA 9045	WET/21059		

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CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

Page: of

1539713

Section A Required Client Information:

Company: Blue Ridge Paper
Address: PO Box 4000
Canton, NC 28716
Email To: jim.giangue@everpack.com
Phone: 828-646-2008 Fax: 828-646-6892
Requested Due Date/TAT: ASAP

Section B Required Project Information:

Report To: Same
Copy To:
Purchase Order No.:
Project Name:
Project Number:

Section C Invoice Information:

Attention: Jim Giangue
Company Name: Same
Address:
Pace Quote Reference: Phone Quote
Pace Project Manager: Tom Williams
Pace Profile #:

REGULATORY AGENCY: ☐ NPDES ☐ GROUND WATER ☐ DRINKING WATER ☐ UST ☐ RCRA ☐ OTHER

Site Location STATE:

Section D Required Client Information

Matrix Codes (MATRIX / CODE): Drinking Water DW; Water WT; Waste Water WW; Product P; Soil/Solid SL; Oil OL; Wipe WP; Air AR; Tissue TS; Other OT

SAMPLE ID (A-Z, 0-9 / ,-) Sample IDs MUST BE UNIQUE

Requested Analysis Filtered (Y/N)

ITEM #	SAMPLE ID	MATRIX CODE (see valid codes to left)	SAMPLE TYPE (G=GRAB C=COMP)	COLLECTED COMPOSITE START DATE	COLLECTED COMPOSITE START TIME	COLLECTED COMPOSITE END/GRAB DATE	COLLECTED COMPOSITE END/GRAB TIME	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	Analysis Test (Y/N): RCRA Corrosivity	8 RCRA Metals TCLP	TCLP Vols	TCLP Semivols	Residual Chlorine (Y/N)	Pace Project No./ Lab I.D. (92119733)
1	Soap Tank Sample	OT	G	5/31/12	0810				4	X								X	X	X	X		92119733 007
2																							
3																							
4																							
5																							
6																							
7																							
8																							
9																							
10																							
11																							
12																							

ADDITIONAL COMMENTS	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	SAMPLE CONDITIONS: Temp in °C	Received on Ice (Y/N)	Custody Sealed Cooler (Y/N)	Samples Intact (Y/N)
	Jim Giangue/BRPP	5/31/12	1633	[signature]	5/31/12	16:33	3.3	Y	N	Y

ORIGINAL

SAMPLER NAME AND SIGNATURE

PRINT Name of SAMPLER: James A. Giangue

SIGNATURE of SAMPLER: [signature] DATE Signed (MM/DD/YY): 5/31/12

*Important Note: By signing this form you are accepting Pace's NET 30 day payment terms and agreeing to late charges of 1.5% per month for any invoices not paid within 30 days.

F-ALL-Q-020rev.07, 15-May-2007

Pace Analytical www.pacelabs.com	Document Name: **Sample Condition Upon Receipt (SCUR)**	Document Revised: October 19, 2011 Page 1 of 2
	Document No.: F-ASV-CS-003-rev.07	Issuing Authorities: Pace Asheville Quality Office

Client Name: RRPP Project # 92119733

Where Received: ☐ Huntersville ☑ Asheville ☐ Eden

Courier (Circle): Fed Ex UPS USPS Client Commercial Pace Other_____

Custody Seal on Cooler/Box Present: ☐ yes ☑ no Seals intact: ☐ yes ☑ no

Packing Material: ☑ Bubble Wrap ☑ Bubble Bags ☐ None ☐ Other_____

Circle Thermometer Used: IR Gun#2 -80344039 **Type of Ice:** Wet Blue None ☑ Samples on ice, cooling process has begun

IR Gun Back Up- 111565135

Temp Correction Factor: Add / Subtract 0.2 C

Corrected Cooler Temp.: 3.3 C **Biological Tissue is Frozen:** Yes No N/A

Temp should be above freezing to 6°C

Date and Initials of person examining contents: 6/5/12

				Comments:
Chain of Custody Present:	☑Yes	☐No	☐N/A	1.
Chain of Custody Filled Out:	☑Yes	☐No	☐N/A	2.
Chain of Custody Relinquished:	☑Yes	☐No	☐N/A	3.
Sampler Name & Signature on COC:	☑Yes	☐No	☐N/A	4.
Samples Arrived within Hold Time:	☑Yes	☐No	☐N/A	5.
Short Hold Time Analysis (<72hr):	☐Yes	☑No	☐N/A	6.
Rush Turn Around Time Requested:	☑Yes	☐No	☐N/A	7. ASAP
Sufficient Volume:	☑Yes	☐No	☐N/A	8.
Correct Containers Used:	☑Yes	☐No	☐N/A	9.
-Pace Containers Used:	☑Yes	☐No	☐N/A	
Containers Intact:	☑Yes	☐No	☐N/A	10.
Filtered volume received for Dissolved tests	☐Yes	☐No	☑N/A	11.
Sample Labels match COC:	☑Yes	☐No	☐N/A	12.
-Includes date/time/ID/Analysis Matrix: 01				
All containers needing preservation have been checked.	☑Yes	☐No	☐N/A	13.
All containers needing preservation are found to be in compliance with EPA recommendation.	☑Yes	☐No	☐N/A	
exceptions: VOA, coliform, TOC, O&G, WI-DRO (water)	☐Yes	☑No		Initial when completed
Samples checked for dechlorination:	☐Yes	☐No	☑N/A	14.
Headspace in VOA Vials (>6mm):	☐Yes	☐No	☑N/A	15.
Trip Blank Present:	☐Yes	☐No	☑N/A	16.
Trip Blank Custody Seals Present	☐Yes	☐No	☑N/A	
Pace Trip Blank Lot # (if purchased):_____				

Client Notification/ Resolution: Field Data Required? Y / N

Person Contacted: _____ Date/Time: _____

Comments/ Resolution: _____

SCURF Review: RP **Date:** 6/4/12 **SRF Review:** RP **Date:** 6/4/12

Note: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office (i.e out of hold, incorrect preservative, out of temp, incorrect containers)

ATTACHMENT 4

SEVEE & MAHER ENGINEERS, INC.
TIRE CHIP USABILITY REPORT

TIRE CHIP USABILITY REPORT

BLUE RIDGE PAPER PRODUCTS - LANDFILL No. 6

Prepared for

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

July 2012

SME
Sevee & Maher Engineers, Inc.

ENVIRONMENTAL • CIVIL • GEOTECHNICAL • WATER • COMPLIANCE

4 Blanchard Road, PO Box 85A, Cumberland Center, ME 04021 • Phone 207.829.5016 • Fax 207.829.5692 • www.smemaine.com

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EXECUTIVE SUMMARY

More than 240-million automobile tires are discarded every year in the USA. Blue Ridge Paper Products (Blue Ridge), dba Evergreen Packaging, is considering substituting tire chips for a portion of the gravel used in the operation of their landfill. The tire chips may be used for drainage layers between waste lifts and potentially for stabilization of soft waste. There are restrictions in placement of the tire chips that will limit their use within the cell. Specifically, placement adjacent to the liner is not recommended due to the wire belts in the chips that could puncture through the liner. In addition, stacking the tire chips in layers greater than 10 feet would restrict use in the chimney drains.

Like the stone, it will be necessary to have a quality control/quality assurance program in-place to ensure that the tire chips meet a set of standards. We suggest that standard meet ASTM D 6270-08, Standard Practice for Use of Scrap Tires in Civil Engineering Applications.

TIRE CHIP USABILITY REPORT
BLUE RIDGE PAPER PRODUCTS – NO. 6 LANDFILL
CANTON, NORTH CAROLINA

The purpose of this report is to evaluate potential use(s) of tire chips as a substitute for drainage gravel at Blue Ridge Paper Products (Blue Ridge), dba Evergreen Packaging, No. 6 Landfill in Canton, North Carolina.

1.0 BACKGROUND

Blue Ridge utilizes gravel (i.e., 3/8-inch, ¾-inch, and 1-inch crushed stone) for pipe bedding, drainage layers between waste lifts, leachate collection media, and construction of in-landfill travel ways on an ongoing basis at its No. 6 Landfill. During the period of February 2011 to February 2012 at approximately 17,000 cubic yards of gravel were used in conjunction with the operation of Landfill Cell 6D South. Table 1 provides a 12-month volume summary of materials delivered to Cell 6D South which further describes the gravel usage.

Blue Ridge is interested in substituting tire chips to the degree possible, for the gravel used at the landfill. The motivation for this interest is that tire chips may provide drainage and structural support characteristics similar to gravel at a reduced cost and would lessen the amount of natural resource (i.e., gravel) used in the landfill while beneficially increasing the use of another waste stream (i.e., tire chips).

2.0 PURPOSE

This report presents the options for using tire chips in place of #67 (3/4-inch) stone in the operation of the landfill. This report presents the potential options of using tire chips in lieu of gravel based on a review of technical literature and SME's experience using tire chips at other landfills. Specifically, the tire chips were evaluated for use as drainage material and for use as structural fill to bridge "soft" areas. Specifically, the tire chips are evaluated for possible use as drainage material and for use as structural fill to support landfill construction equipment.

TABLE 1

LANDFILL AREA 6D SOUTH
TOTAL CUBIC YARDS DELIVERED
FEBRUARY 27, 2011 THROUGH FEBRUARY 26, 2012

Process Waste Hauled -- 6D South:					
	Total Truck Loads	**X**	**CY/Load Factor ***	**=**	**Total Cubic Yards**
Total Truckloads - February 27 and 28, 2011: (None - all went to 6A West)					
WWTP Sludge	-		24		-
Lime	-		20		-
Fly ash	-		24		-
Cinders	-		20		-
Woodwaste	-		20		-
Total Truckloads - March 1, 2011 through December 31, 2011:					
WWTP Sludge	4,918		24		118,032
Lime	4,977		20		99,540
Fly ash	2,663		24		63,912
Cinders	191		20		3,820
Woodwaste	206		20		4,120
	12,955				
Total Truckloads - January 1, 2012 through February 26, 2012:					
WWTP Sludge	1,081		24		25,944
Lime	1,146		20		22,920
Fly ash	692		24		16,608
Cinders	58		20		1,160
Woodwaste	45		20		900
	3,022				
Total Cubic Yards of Waste Hauled					**356,956**
Total Gravel Usage -- February 27, 2011 Through February 26, 2012					

Type of Stone	Tons	/	Tons/CY Factor **	=	Total Cubic Yards
Soil	-		1.2		-
#67 (3/4")	14,078.70		1.2447		11,311
#78 (3/8")	4,964.63		1.1934		4,160
#127 Road Bond	-		1.492		-
#540 Ballast	129.51		1.2933		100
#57 or #467 (1")	591.84		1.2299		481
#511 Screenings	-		1.1421		-
#107 Road Bond	1,208.91		1.2		1,007
	20,973.59				
Total Cubic Yards of Gravel Hauled					**17,060**
Total Cubic Yards of Waste and Gravel Stored in 6D South					**374,016**
Between February 27, 2011 through February 2012					
file:Flyover 2008					

Notes:
* Conversion factors based upon truck capacity prior to compaction.
** Stone conversion factors per Vulcan Materials.

3.0 GEOTECHNICAL PROPERTIES OF TIRE CHIPS

Millions of tires are removed from service each year in the United States. An increasing portion of the tires are being used as a civil engineering material known as Tire Derived Aggregate (TDA). Considerable data is available in the technical literature for TDA, particularly for tire chips sizes of 3 inches and less. TDAs have been reported being as large as 12 inches; conventional geotechnical testing equipment however is generally limited to testing tire chip sizes of 3-inches and under, thus making data scarce on the larger size TDAs. A summary of the geotechnical properties of tire chips and the associated range of values, as contained in the literature, is presented in Table 2. Table 2 also provides the range of geotechnical values for ¾-inch gravel (i.e., drainage stone) for comparison purposes.

TABLE 2

SUMMARY OF TYPICAL GEOTECHNICAL PROPERTIES FOR TIRE CHIPS AND ¾-INCH DRAINAGE GRAVEL

	Tire Chips (maximum chip = 3-inch)	¾-inch Drainage Gravel (stone)
Specific Gravity SPG (G_s)	1.02 to 1.27	2.6 to 2.8
Unit Weight (γ)	21 to 48 pcf[1]	1.08 to 118 pcf
Void Ratio (e)		
Compacted	0.9 to 1.2	0.40
Uncompacted	1.5 to 2.5	0.50
Porosity (N)		
Compacted	0.45 to 0.55	0.27
Uncompacted	0.6 to 0.7	0.33
Compression Index – Avg. (C_c)	0.4	-
Recompression Index – Avg. (C_r)	0.06	-
Permeability (k)	0.01 to 59 cm/sec	0.01 to 9 cm/sec
Angle of Internal Friction (ϕ)	7.9 to 34.8[2] deg.	36 to 40 deg.
Cohesion (c)	2.2 to 5.4[2] psi	-

Notes:
1. Compaction test results for tire chips, maximum chip = 3 inches.
   No compaction to light compaction – 21 to 31 pcf
   Laboratory compaction – 32 to 44 pcf
   Field compacted – 41 to 48 pcf
2. Direct shear results for tire chips, maximum chip = 3 inches.

4.0 EVALUATION OF IN-LANDFILL PERFORMANCE OF TIRE CHIPS

For Blue Ridge, the most readily apparent opportunities to substitute tire chips for gravel would be in the horizontal drainage layers between waste lifts, in the chimney drains that extend upward from the landfill base through the sludge (and other waste) and for use as structural fill above paper machine wire or geosynthetic materials where soft sludge needs to support the landfill operating equipment and waste haul trucks.

5.0 DRAINAGE - GENERAL

Drainage is a function of the drainage media permeability (k) and flow gradient (i). Table 2 indicates the permeability for tire chips ranges from approximately 0.01 to 59 cm/sec depending on the compacted condition of the tire chips. By contrast, the permeability for ¾-inch gravels ranges from approximately 0.01 to 9 cm/sec. The comparatively higher permeability of the tire chips suggests that for equivalent areas and gradient the tire chips would present the greatest drainage opportunity. Much of the increased permeability of the tire chips is result of the increased void ratio of the tire chips as compared to gravel. Table 2 suggests the tire chips have approximately 3 to 5 times more drainable space than ¾-inch gravel, hence more water can move through the tire chips on an equal time/gradient basis.

The permeability of the tire chips will decrease as confining pressure around the mass increases. This decrease is attributed to the compressibility of the overall tire chips mass; as the tire chip mass is loaded it becomes compressed and the voids (and drainable space) become smaller thus a decrease in drainage capacity occurs. The extent of the reduction in permeability is dependent on the quality of the tire chips, the boundary conditions on either side of the tire chips, and the amount of loading. In general, a thicker lift of tires will likely compensate for the reduction in permeability. By comparison, the mass for ¾-inch gravel is relatively incompressible and can be generally expected to maintain its permeability regardless of confining pressure.

When evaluating use of tire chips for drainage media in a setting like that at Cell 6D South, considerations for clogging of the tire chip void spaces need also be given. In general, tire chips

exhibit larger void spaces than does gravel; this is in part due to the physical size of the tire chips and the exposed wire (tire belting) that remains in the tire chips after shredding. The exposed wire tends to give the tire chips added bulk and hence the larger size voids, especially at low confining pressures. Fine-grained materials, like soft sludge, can easily migrate into the large voids and significantly reduce the mass permeability of the in-place tire chips. To avoid such detrimental behavior the tire chips would likely need to be separated from the soft sludge by a geotextile layer. Experience at the Blue Ridge Landfill has shown that the ¾-inch gravel limit drainage layer requires a separation layer (paper machine wires) when the waste is soft. The tire chips will also require a separation layer like the stone.

6.0 HORIZONTAL DRAINAGE LAYERS AND STRUCTURAL FILL

Traditionally, Blue Ridge installs horizontal drainage layers in the waste at approximately 10- to 15-foot vertical intervals as the waste filling progresses. These drainage layers are necessary to collect the leachate expressed from the waste as it consolidates as well as collect precipitation falling onto the waste area. The horizontal drainage layers connect to vertical chimney drains which in turn connect to a sump at the base of the landfill. If the horizontal drainage layers were to be removed, or become non-functional, it is likely that much of the in-place waste would become saturated and much more difficult to work with.

Currently the horizontal drainage layers consist of approximately 12-inch thick layers of ¾-inch gravel. In areas where the in-place waste will support the operating equipment, the gravel is placed directly on the waste; in areas where the waste is soft, a layer of paper machine wire is used to separate the waste from the gravel (or additional waste layers). In either case, the gravel provides the necessary permeability to allow effective waste drainage.

An added benefit of using gravel for the horizontal drainage layers is that the gravel readily supports the landfill operating equipment and waste haul trucks with minimal difficulty. Very little compaction of the gravel is needed to mobilize the strength necessary for it to behave as a structural layer. Experience at the landfill has generally shown that the 12-inch thick layer of ¾-inch gravel is adequate to distribute the wheel loads imparted from the operating equipment

and haul trucks such that punching (i.e., rutting) into the underlying waste (i.e., the sludge) is minimized.

As indicated earlier in this report, tire chips can be expected to provide good drainage characteristics and as such, their substitution for gravel in the drainage layers would likely be favorable. Interpretation of the literature indicates that until the tire chips are overlain by a permanent load they will be loose and will not exhibit satisfactory structural strength as a layer until significantly compacted. To overcome such a situation the thickness of the tire chip drainage layer would likely need to be increased to at least 2 feet or possibly more. Even with two feet of tire chips, the haul trucks (and other rubber-tire vehicles) may have difficulty maneuvering on the tire chips. The difficulty would be based on the physical characteristics of the tire chips and that of haul vehicles. If the capability of trucks traveling directly on the chips becomes an issue, the mill should develop a sequence whereby there will be minimal rubber-tired traffic on the landfill where the TDA is used.

7.0 CHIMNEY DRAINS

Two vertical chimney drains are progressively constructed in Cell 6D South as the waste depth in the cell increases. The chimney drains start at the base of the landfill and are part of the overall leachate collection system for the Cell. The chimney drains consist of machine placed and end-dumped ¾-inch gravel. The chimney drains are estimated to range in width from 7 to 10- feet and have lengths generally consistent with the base of the Cell. The horizontal drainage layers (see above discussion) are connected to the vertical chimney drains. As indicated earlier tire chips exhibit permeabilities equal to or greater than ¾-inch gravel, especially when placed in a low confining pressure condition. Substitution of tire chips in the chimney drain construction will require that consideration be given to estimating horizontal stresses at depth in the landfill which could influence (i.e., confine/compress) the tire chips. It will be necessary to evaluate if the tire chip mass, when placed in the deeper portions of the landfill, will provide sufficient permeability and drainable void space to maintain the same or similar hydraulic performance as provided by the ¾-inch gravel.

8.0 OTHER OBSERVATIONS RELATING TO TIRE CHIP PERFORMANCE

In addition to the strength and permeability considerations discussed above, SME's direct experience with tire chips used at landfills indicate that trafficability can be an issue. Haul trucks often have difficulty turning on a tire chip surface; it seems that when the front wheels of haul vehicles are turned sharply the wheels tend to sink into the tire chips and plow them forward, sometimes to the point of the truck becoming mired. Additionally, we caution about the steel belting which protrudes from some of the tire chips. The exposed belting can be very sharp and tends to cut/puncture tires of the equipment operating on its surface. In addition, we have seen tire chips applied to the surface of soft waste and then tracked into that waste with a crawler tractor. In these cases, the tire chips were used to increase the strength of the waste surface somewhat before a geotextile and gravel were installed as a new drainage/travel layer.

At another landfill, tire chips were used to construct a leachate storage layer for a sump at the base of a new cell. The purpose of the storage layer was for it to fill and drain of leachate helping to optimize pump run times for leachate removal from the cell. The tire chips did not provide the drainable storage volume intended and leachate management issues occurred. Investigations showed that the tire chips, though generally free of foreign debris, contained sufficient soil to be ineffective in terms of quick drainage, thus reinforcing the premise that when tire chips are used for a drainage application that closely followed specifications and quality control testing are necessary.

9.0 INTERNAL HEATING AND COMBUSTIBILITY POTENTIAL

Internal heating and potential spontaneous combustion of tire chip stockpiles and tire chip fills are a concern that should be closely examined relative to substituting tire chips for gravel in Cell 6D South. Investigations have shown that as the exposed metal wire (i.e., the belting) embedded in the tire chips and the tire chip rubber itself begins to oxidize (i.e., rust or corrode) heat is generated. The tire chips have insulating properties several times greater than soil and consequently a portion of the generated heat is stored. Depending on the settling and source for the tire chips, low-flash point contaminants like oil or grease can be present on the tire chips which can ignite at low temperatures. SME has had experience with tire chip fires at one of the

landfills it provides services to; that experience shows that the fire(s) often cannot be extinguished without first having to excavate into the waste to expose the burning materials. ASTM D6270 (Standard Practice for Use of Scrap Tires in Civil Engineering Applications) provides guidance for specifying tire chip size and exposed wire as well as tire chip fill and stockpile thicknesses to minimize the internal heating/spontaneous combustion hazard. In general, the guidance recommends the thickness of fills to be limited to 10 feet. This guidance fits favorably with use of tire chips for construction of horizontal drainage layers in Cell 6D South but not the chimney drains, especially with respect to their length and depth.

The ASTM guidance also indicates that tire chips should be shredded in a way so as to minimize exposure of the steel belting used to reinforce tires and avoid inclusion of small crumb-like rubber fragments in the overall tire chip mass. (The crumbs are generally the easiest to ignite.) It is understood that shedding/chipping tires to the meet the ASTM guidance can be a challenge in that not all shredders and chippers available are capable of meeting the guidance, especially in the context of how much wire is exposed after processing. Several other factors are also included in ASTM D6270 which could affect internal heating. A copy of ASTM D6270 is provided as Appendix 1.

10.0 CHANGES TO OPERATIONS & MAINTENANCE MANUAL FOR TIRE CHIP USE

The current Operations and Maintenance (O&M) Manual for the No. 6 Landfill does not specifically address use of particular drainage materials. The O&M Manual does site the use of stone and gravel in several places but does not discuss parameters such as grain size distribution, permeability, or compaction.

If tire chips are used in the landfill, it is likely that North Carolina Department of Environment and Natural Resources view them as a being a beneficial use of an existing non-mill generated waste stream. It would seem reasonable that the O&M Manual be amended to include a separate section on the tire chips and their use in the landfill. To better appreciate tire chip compatibility with the landfill systems the new section would include:

- A grain size specification for the tire chips delivered to the landfill that would be beneficially used for drainage or structural fill.
- Quality Assurance procedures to for assuring that tire chips delivered to the landfill are consistent with the grain size specification.
- Requirements for placement and compaction of the tire chips and the relevance of those requirements with respect to the use of tire chips for drainage layers and structural fill.
- Areas in the landfill where use or placement of tire chips would be prohibited (e.g., no tire chips to be placed near or adjacent to geosynthetic liner or cover materials.
- Tire chip storage locations and limitations including storage pile size.
- A discussion the potential fire hazard associated with the tire chips.

11.0 OPERATIONS CONSIDERATIONS

Use of tire chips will require some modifications to the operations manual. Two options to consider for the installation of tire chips are: (1) having the supplier deliver the chips to the landfill and the operators placing the chips; or, (2) stockpile chips on-site and have the landfill operators truck and place the chips from the on-site stockpile. Stockpiling of tire chips on-site would require the development and permitting of a stockpile area. ASTM D 2670 recommends that the stockpiling height be limited to less than 10 feet because of spontaneous combustion issues. Greater heights may be possible with use of temperature monitoring equipment within the stockpile. The National Fire Protection Association and the Rubber Manufacturers Association recommend stockpiles encompass an area of 10,000 square feet or less. They also recommend a water supply capable of producing 1,000 gpm continuously for three hours. The volume of 10,000 square feet, 10-foot high stockpile is about 2,000 cubic yards. Assuming a loose thickness of 18 inches, a stockpile of this size would cover about 1 acre of waste. The monthly average usage of ¾-inch stone at the landfill is in the order of 1,000 cubic yards/month. Based on the average ¾-inch stone usage, the stockpile described above would last about two months.

The location of the stockpile would need to be in an area where the stormwater drainage would pass through one of the on-site sedimentation ponds or the stockpile could be located within the active waste cell. Hauling tire chips to the active area of the landfill would require that a loader be on-site to load trucks during the drainage layer installation; thereby, slightly increasing the cost of using tire chips.

Blue Ridge may elect to have all or portions of the tire chips delivered to the active areas as is currently done with the gravel. This option would require the chip supplier to have a stockpile at an off-site location.

The details of the installation of the chips will likely vary depending on physical characteristics of the waste. If the waste is soft, a geotextile or paper machine wire may be required to limit intrusion of the waste into the tire chips. The hydraulic and geotechnical properties of the chips will also determine the construction details of the drainage layer installation. These details can be developed when the tire chip characteristics are known from the processor.

12.0 SUMMARY AND RECOMMENDATIONS

In general, use of tire chips as a substitute for gravel (i.e., drainage stone) appears to be viable with respect to achieving the permeability for continued landfill drainage. Use of tire chips as a horizontal drainage layer or structural support layer for the landfill operation equipment are the two most likely scenarios for using TDA at the landfill. Experience has shown that 2 or more feet of tire chips is necessary to replace 12 inches of gravel with respect to adequately distributing wheel loads to avoid punching failures into underlying subgrade(s). Experience has also shown that landfill operating equipment can have difficulty traveling on a tire chip surface unless tire chip layers have been compacted or are confined by a layer of gravel above them. For chimney drains, the use of tire chips needs to be evaluated with respect to changes in permeability with respect to depth in the landfill. The literature shows that as confinement of tire chips increases permeability decreases. It would be necessary to evaluate the size of the chimney drains for hydraulic performance at depth.

Internal heating and combustibility potential of tire chips stored on-site and/or used to construct vertical chimney drains is a concern. In general, the chimney drain dimensions for Cell 6D South are expected to be sufficiently small to allow generated heat to dissipate. ASTM guidance does however suggest that the mass of the chimney drains is sufficient to store heat.

Tire chips will never be a 100 percent replacement for gravel, but certainly could be used to decrease gravel consumption. If interest in using tire chips to as a substitute for gravel at the No. 6 Landfill continues, it is recommended that Blue Ridge use tire chips conforming to ASTM D 6270-08. If the supplier cannot meet this standard, SME would recommend a pilot program for implementation in a limited area of the landfill. The minimum parameters to be evaluated during the pilot test would be length of wire protruding from the tire chip, density of the tire chips, and permeability of the tire chips when in confined conditions. The pilot program would also be used to directly observe the behavior of landfill operating equipment when travelling on the surface of the tire chips, and visually assess the hydraulic properties of the TDA.

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APPENDIX 1

ASTM D 6270-08
STANDARD PRACTICE FOR USE OF SCRAP TIRES IN CIVIL ENGINEERING PRACTICE

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.

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[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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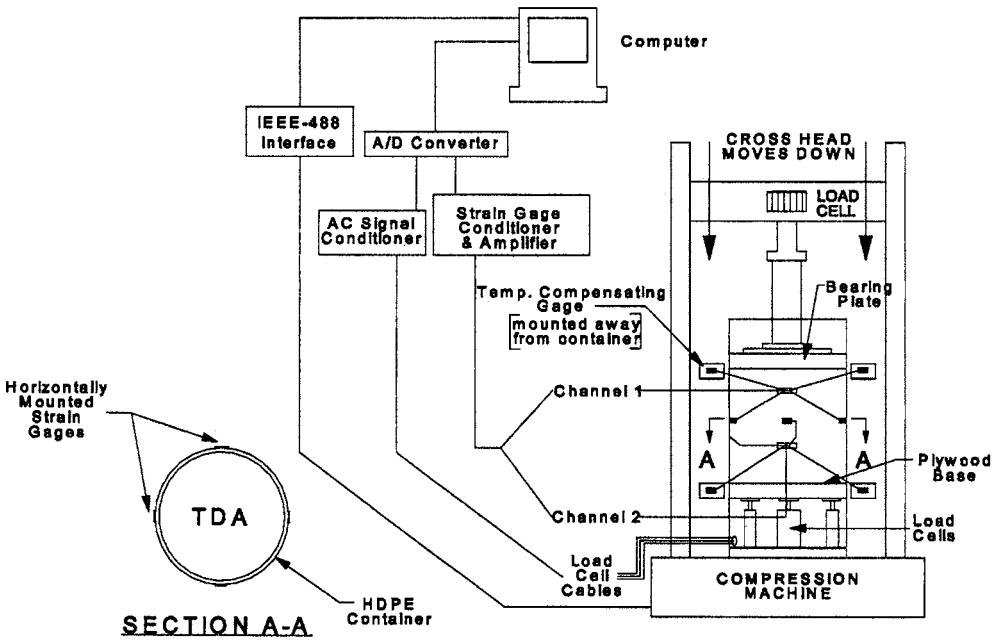

FIG. 1 Compressibility Apparatus for TDA Designed to Measured Lateral Stress and the Portion of the Vertical Load Transferred by Friction from TDA to Container (10)

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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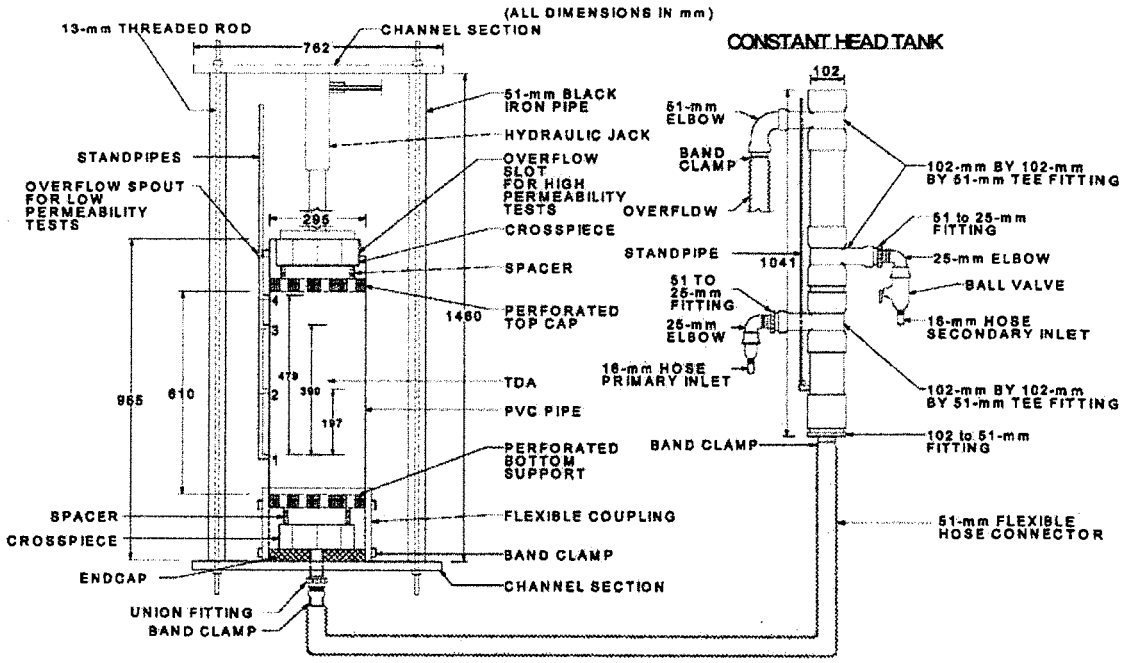

FIG. 2 Hydraulic Conductivity Apparatus for TDA with Provisions for Application of Vertical Stress (12)

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.

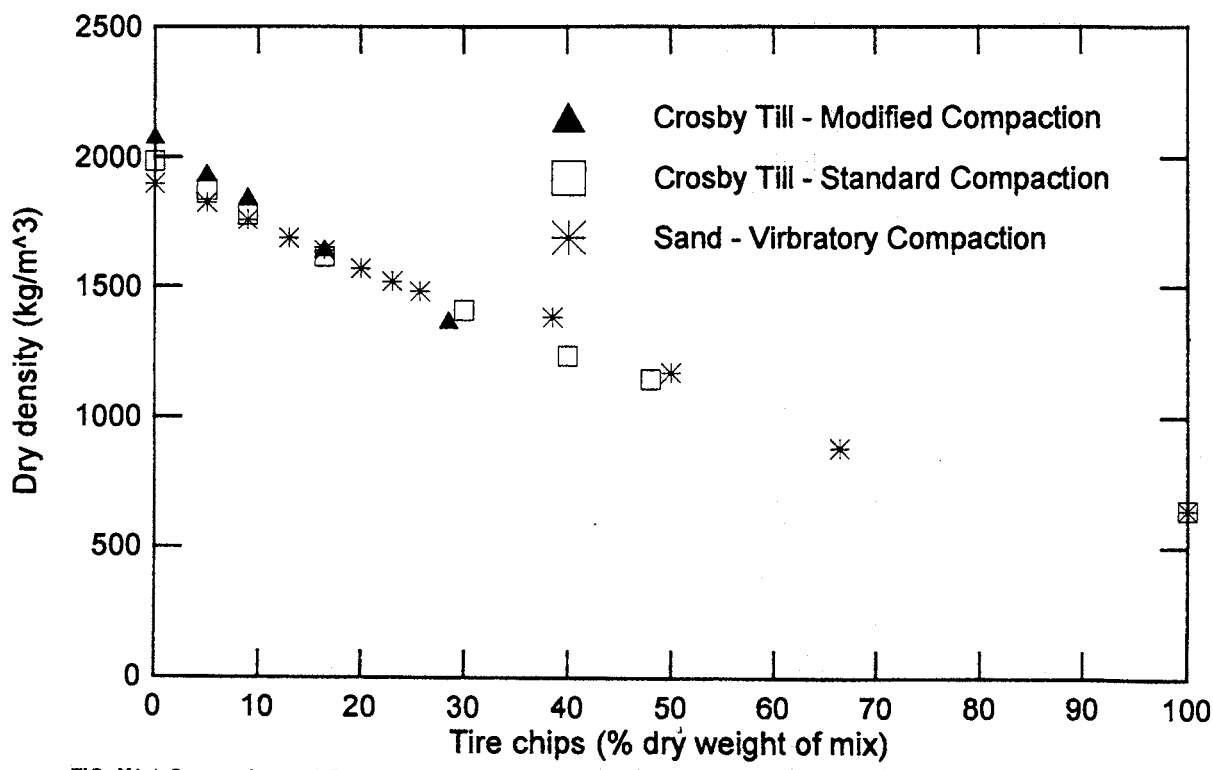

FIG. X1.1 Comparison of Compacted Dry Density of Mixtures of TDA with Ottawa Sand and Crosby Till (5)

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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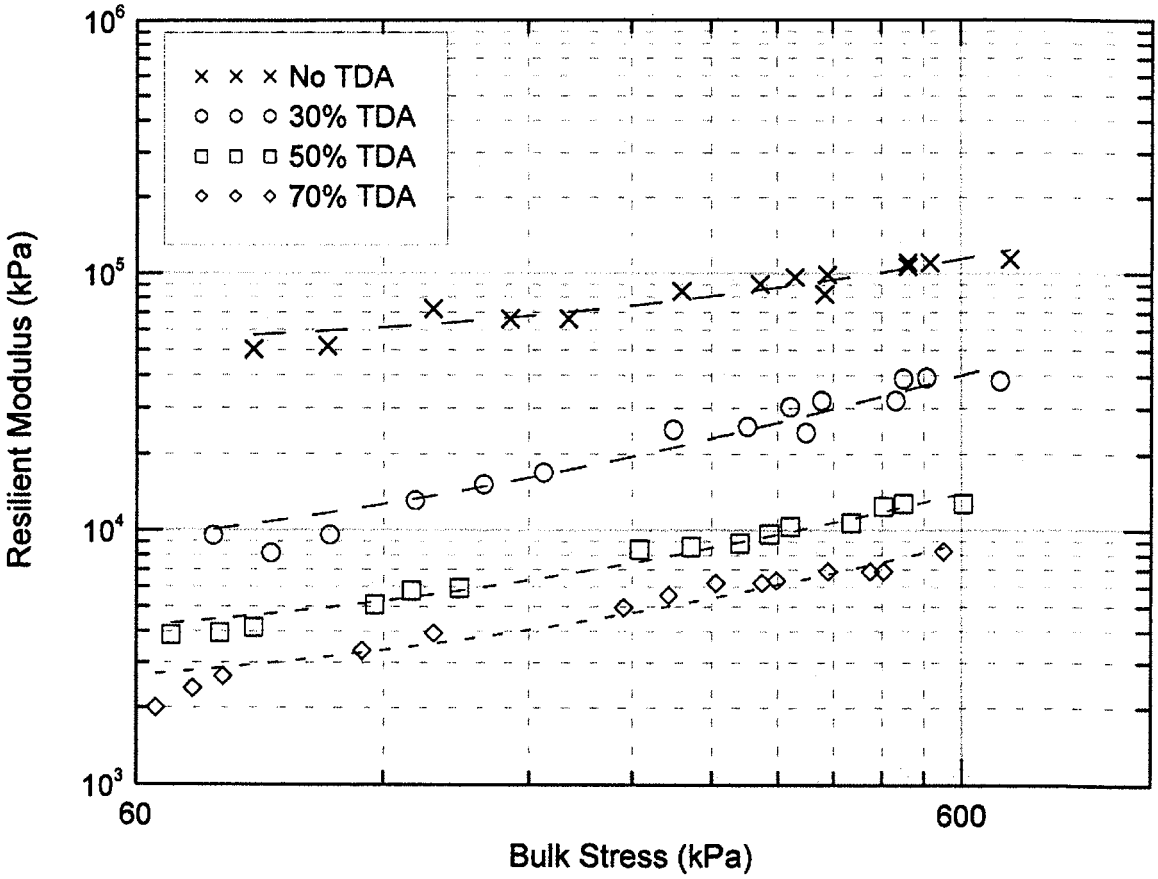

FIG. X1.2 Resilient Modulus of Mixtures of TDA and Clean Sand (4)

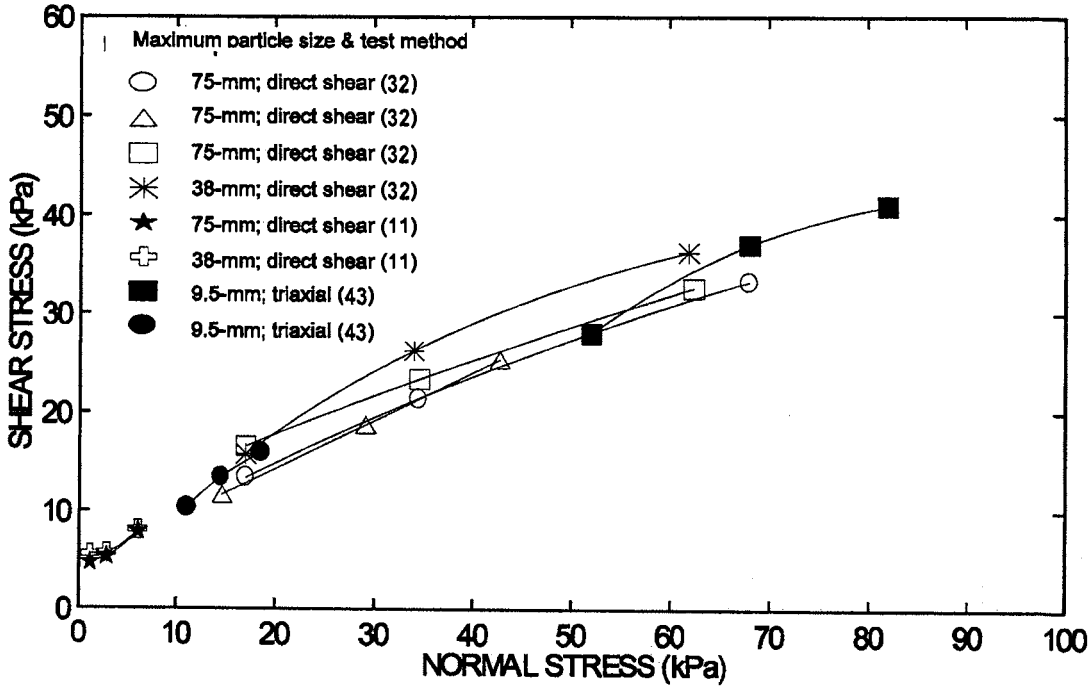

FIG. X1.3 Comparison of Failure Envelops of TDA at Low Stress Levels

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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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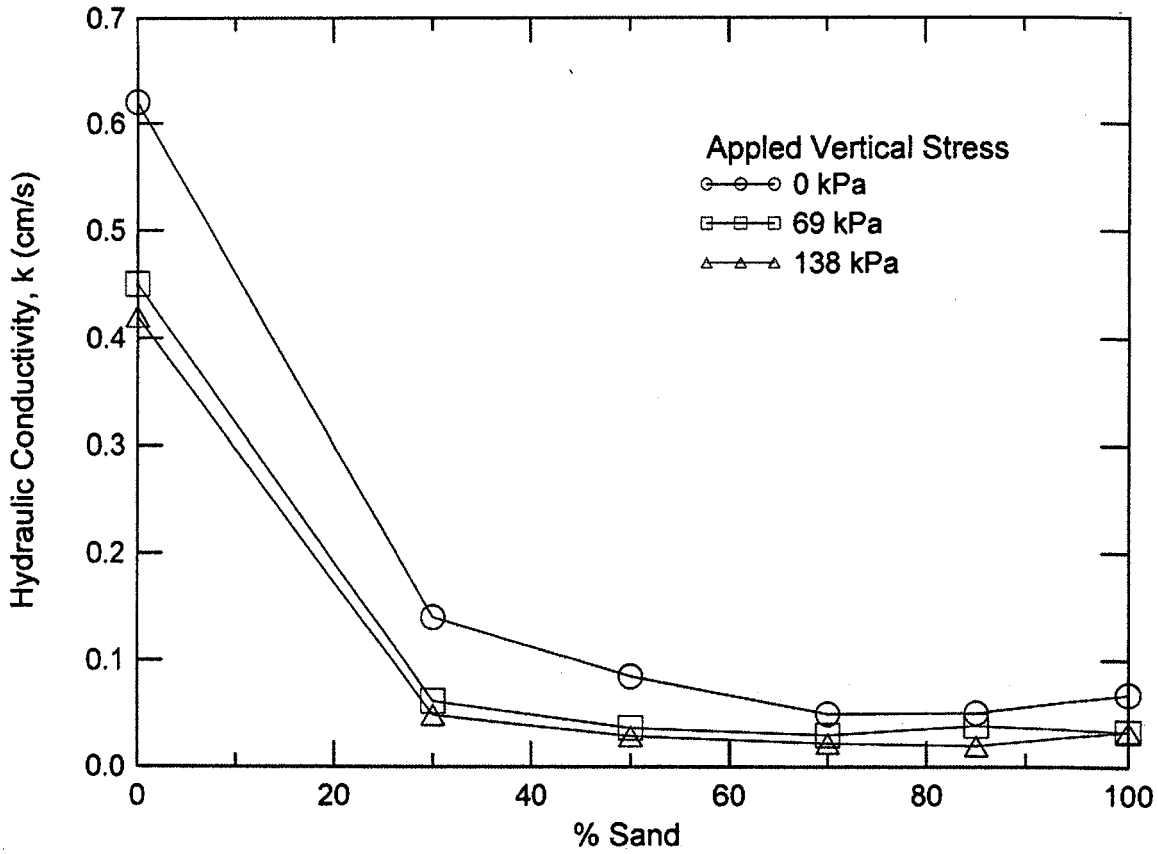

FIG. X1.4 Hydraulic Conductivities of Mixtures of TDA and Clean Sand (4)

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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 (Tl)	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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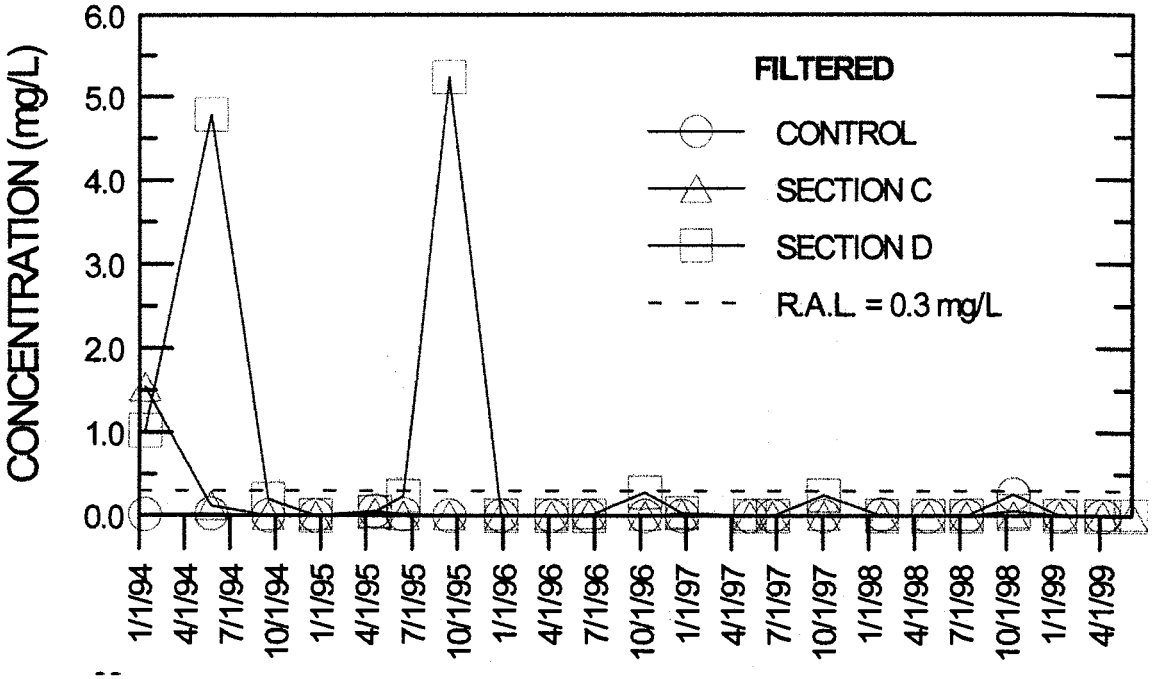

FIG. X1.5 Iron Levels for Filtered Samples at North Yarmouth Field Trial (22)

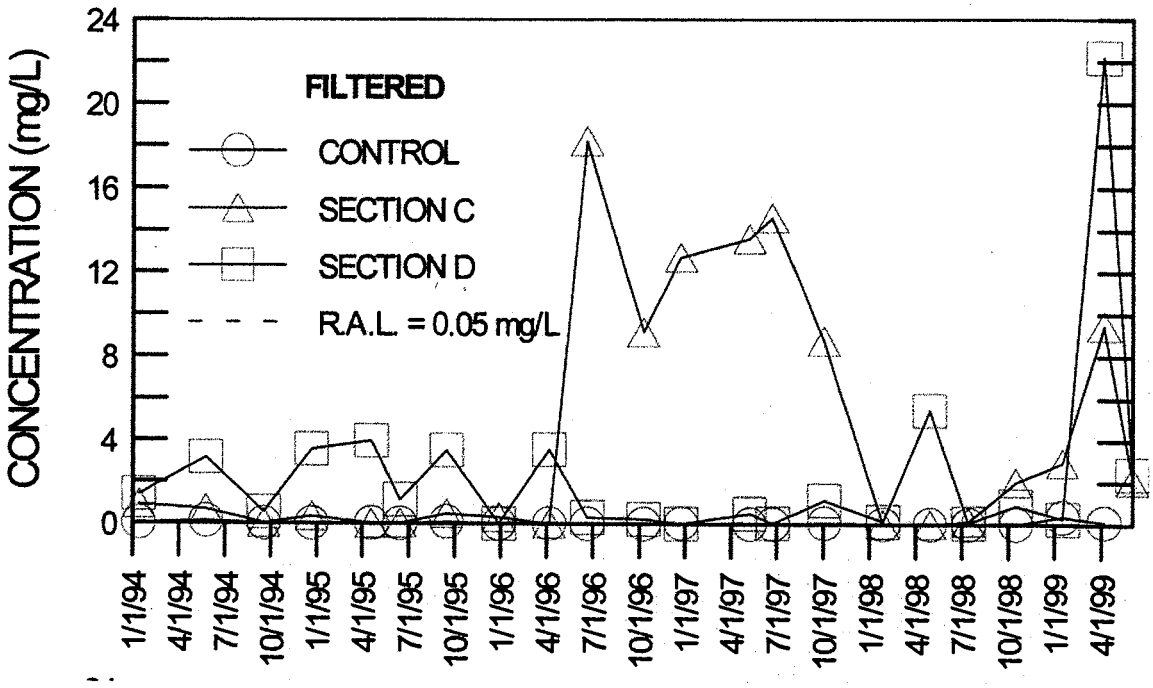

FIG. X1.6 Manganese Levels for Filtered Samples at North Yarmouth Field Trial (22)

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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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