The Use of Tire Chips in Septic System Leachfields

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Submitted to
Environmental Management Investment Group
Empire State Development
Albany, New York

September 2001
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1. INTRODUCTION

Ultimate disposal of used vehicle tires continues to be a challenge. Vehicle tires are made of natural and synthetic rubber, fabric, steel and carbon black. Their manufacture, incorporating advances in rubber chemistry and product design, has resulted in a tire that is safe, durable and wear resistant. These important qualities are also the reasons why tire disposal is such a problem.

The shape, ingredients and lack of easy recycling make them a challenge to the waste management industry. Additionally, the disposal problems coupled with the continuing rate of generation of scrap tires have resulted in the growth of tire stockpiles. These stockpiles are troublesome because they offer good environments for breeding mosquitoes, rodents, snakes, and other pests, some of which are vectors of human diseases such as encephalitis and West Nile Virus. Finally, tire stockpiles can be ignited, creating a fire hazard. These fires pose a problem in that they are extremely difficult to extinguish due to the 75% void space present in a whole waste tire and the amount of potential fuel in 20 lbs. of rubber. Furthermore, water used on tire fires can increase the production of pyrolytic oil, and provide a mechanism to carry this oil off site where it may contaminate soil and water. Air pollutants from these fires include black smoke, polyaromatic hydrocarbons (PAHs), CO₂, SO₂, NO₂, and HCl (United States Environmental Protection Agency, 1993). According to the Scrap Tire Management Council (STMC), over 266 million tires were generated in 1996 (STMC, 1997). Of these tires, only 202 million found a market and stockpiles held over 800 million scrap tires.

To reduce the burden created by scrap tires, plans for alternative uses of tires have been promoted (STMC, 1997). There are four basic alternative solutions that address the scrap tire problem. These actions conform to the waste management hierarchy expressed by New York State Department of Environmental Conservation (NYSDEC) and include: 1) waste reduction; 2) recycling; 3) resource recovery; and 4) landfilling.

The number of tires wasted can be reduced through utilization of longer lasting products. Truck and airplane tires can be reused several times if they are retreaded when worn, instead of discarded. Moreover, technologies are being utilized that create other products from used
tires such as playground equipment, artificial breakwaters and reefs, and highway crash barriers. Chipped and shredded tires can be used for pavement sub-grade, athletic surfaces, and alternate rubber and plastic products, such as garbage cans and plastic floor mats. Tires can be burned for fuel at least as efficiently as coal or wood, thus energy recovery is possible. Operations that currently burn tires for fuel include power plants, cement kilns, paper factories and tire manufacturers.

Unfortunately, there are technical and economic limits to recycling rubber from scrap tires into new tires. Finely ground rubber from scrap tires can be used to make new tires but only in small quantities. Accordingly, if scrap tires cannot be used in some beneficial manner, they must be landfilled. A major issue with tire landfilling is volume. Although whole tires are prohibited from sanitary landfills, chipping or shredding tires can greatly reduce the volume but at a substantial cost (Monet, 2001). If a market could be found for these chipped tires, not only would the volume of tires landfilled decrease, but also the cost to chip the tires could be offset.

The goal of this project was to evaluate an engineering application of chipped tires as a replacement medium for natural aggregate in septic system leachfields. Septic systems are used primarily for single or multi-family residences to provide treatment of household wastewater. Septic systems consist of a septic tank and a leachfield. Wastewater solids undergo removal by settling in the septic tank and the resulting clarified effluent flows out of the septic tank into the leachfield and surrounding soil. The role of the leachfield is to provide good distribution of the liquid wastewater to the surrounding soil where the majority of treatment occurs. In addition, a biofilm develops on the media which assists in the removal of oxygen demanding wastes. In most septic system installations, natural aggregate (stone) is used to distribute the wastewater to the surrounding soil and support biological growth. Given that chipped tires have geometry similar to natural aggregate and are relatively stable, there is interest in evaluating whether chipped tires could replace stone as the aggregate in septic system leachfields. If successful, the proposed application would provide a reuse option for chipped tires, save natural aggregate for other applications, and provide savings to the owners of septic systems.
Project Objectives
To evaluate chipped tires as a replacement medium for natural aggregate in septic system leachfields, Empire State Development, Environmental Management Investment Group provided funding for this project as part of its mission to develop markets for recyclable materials. Seven major objectives were delineated for the project. These were to:

1. Conduct a survey of the recognized published literature to determine the status of chipped tire reuse;
2. Conduct a national survey of all states to determine which states were using or were interested in using, chipped tires as a replacement medium for natural aggregate in septic system leachfields;
3. Evaluate the water distributing properties of chipped tires as measured by permeability;
4. Evaluate the potential of chipped tires leaching chemical constituents to groundwater;
5. Evaluate the ability of chipped tires to serve as a support structure for biological growth and provide treatment of wastewater constituents;
6. Analyze the economic feasibility of using chipped tires as a replacement for natural aggregate; and
7. Produce a video and brochure which will explain to the public the benefits associated with the use of waste tire aggregate.

Application of Project Results
Preliminary results from this project do support the use of chipped tires as a replacement aggregate for septic system leachfields. However, for this market opportunity to develop in New York State the two regulatory agencies—New York State Department of Environmental Conservation and New York State Department of Health—must make the appropriate changes in their regulations governing the designs of leachfields to allow the use of chipped tires.

Project Report Organization
Chapter 1 of the report provides an introduction to the need for tire reuse, an overview of the project objectives and how the results from this study will be employed to further tire reuse. The results of a literature search on tire reuse is presented in Chapter 2. The results of the national survey on the use of chipped tires are presented in Chapter 3. In Chapter 4, the results of permeability, leachability, and treatability testing generated during the pilot-scale phase of this project are presented and discussed. In Chapter 5, the results collected to date
from the full-scale septic system located at Modern Corporation are presented. An economic analysis for the use of chipped tires versus natural aggregate is presented in Chapter 6. A public information/promotion program to encourage the use of chipped tires as a replacement for natural aggregate is presented in Chapter 7. In Chapter 8, management recommendations for the use of chipped tires are presented. Conclusions developed from the project are presented in Chapter 9.
2. BACKGROUND

In discussions with the New York State Department of Environmental Conservation (NYSDEC) and New York State Department of Health (NYSDOH) as well as a review of the literature, a number of issues were isolated that were necessary to be addressed before any consideration of the use of tire chip aggregate (TCA). These included: 1) permeability of TCA in a leachfield; 2) compaction and compression of TCA, 3) potential for spontaneous combustion, and 4) chemical leachability of TCA. Information presented in this chapter reflects a consideration of these issues and includes information derived from background information in the literature, laboratory studies and field experience.

Permeability

The primary purpose of aggregate in septic system leachfields is to distribute water flowing from the septic to the surrounding soil where treatment occurs. Permeability is used to characterize the distribution of water in aggregate. One condition for the use of chipped tires to replace stone aggregate is that they have equal or greater permeability than stone. In a 1993 study, it was concluded that chipped tire aggregate had a permeability that was equivalent to that of clean gravel (Humphrey and Sanford, 1993).

Similarly, in a 1984 study (Bressette, 1984), permeability values of shredded and chipped tires were evaluated as compared to stone. Shredded tires were those that had rough edges with quite a bit of wire exposed. Both the shredded and chipped tires tested had permeability values comparable to values for 1.5 x 0.75 inch Class 3 coarse aggregate. These permeability values were on the order of 2-24 cm/sec for the shredded tires, and 5-60 cm/sec for chipped tires. The permeability values for the stone were similar and ranged from 5-56 cm/sec.

In Lewiston, New York, Modern Corporation conducted a series of tests to determine the hydraulic conductivity of chipped tires for use as drainage aggregate in a municipal solid waste landfill (Wehran Envirotech, 1990). The minimum permeability required was 1x10^-3 cm/sec. Chipped tires were irregular in shape and ranged in size from 1/½ to 3 inches. In tests conducted under loads ranging from 6,189 psf to 24,756 psf which were applied to simulate overburden of solid waste, chipped tires permeabilities were reduced with load and ranged from a high of 4
cm/sec to a low of 0.28 cm/sec. In an additional study done by Wehran Envirotech, it was found that chipped tires had a permeability that was two orders of magnitude higher than that required for a drainage blanket (Wehran Envirotech, 1991).

In another test conducted by Edil and Bosscher, hydraulic conductivity tests on chipped tires were done under variable vertical pressure, hydraulic gradient, and mixtures with sand ranging from 0% to 100% (Edil and Bosscher, 1994). It was determined that hydraulic conductivity of pure tires was difficult to measure. The hydraulic conductivity of pure tires without overburden depended on gradient, while an overburden caused some reduction in hydraulic conductivity. In mixtures with more than 30% sand, the sand controlled the hydraulic conductivity. It was concluded, however, that chipped tires had a hydraulic conductivity greater than 1 cm/sec, which could be reduced by mixing sand with the chips before placement.

The State of Oklahoma promotes the beneficial reuse of waste tires through its Waste Tire Recycling Act of 1989 (Daniels, 1996). One use of waste tires is in landfill construction. For the chipped tires to be used as a drainage layer in landfills, they had to meet a minimum hydraulic conductivity requirement of 0.01 cm/sec. Studies done by Rust Environment and Infrastructure tested the hydraulic conductivity of chipped tires at various compressive loads, ranging from 4,000 psf to 10,000 psf. In each case, the hydraulic conductivity was at least one order of magnitude higher than required by the State.

The New England Transportation Consortium sponsored permeability testing of tire chips for use as lightweight fill (Humphrey et al., 1992). A constant head permeameter was utilized. Chipped tires, sized 2 to 3 inches, were put into the apparatus in 5 layers, each compacted using 6 percent of standard Proctor energy. Permeability was measured with no compression and then in 2-inch increments of compression for a maximum of 5.5 to 6 inches total compression. Chipped tires from three different suppliers were tested. Under these conditions, permeability decreased linearly from 15.4 to 1.5 cm/sec with compression of chipped tires which was attributed to a decrease in the void ratio. There was some differences between the three different sources of chipped tires, however, these differences were small.
Summary. The results of the permeability literature are summarized in Table 2.1. Based on the information presented in the literature reviewed, it is clear that chipped tires have permeabilities at least equal to stone under loadings that would be typical of septic system applications.

### Table 2.1
A Summary of Permeability Results Obtained in other Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>State</th>
<th>Chip Size (in)</th>
<th>Permeability (cm/s)</th>
<th>Compression (psf)</th>
</tr>
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<tbody>
<tr>
<td>Edil and Bosscher (1994)</td>
<td>Wisconsin</td>
<td>NA</td>
<td>&gt;1</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.5 – 4.8</td>
<td>23% compression</td>
</tr>
<tr>
<td>Daniels (1996)</td>
<td>Oklahoma</td>
<td>NA</td>
<td>0.10 – 13.06</td>
<td>4,000 to 10,000</td>
</tr>
<tr>
<td>Wehran Envirotech (1990)</td>
<td>New York</td>
<td>1.5-3</td>
<td>0.281 – 4.01</td>
<td>6,189 to 24,756</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>0.160 – 1.070</td>
<td>12,384 to 24,768</td>
</tr>
<tr>
<td>Bressett (1984)</td>
<td>California</td>
<td>2-shreds</td>
<td>2-24</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2-chopped</td>
<td>5-60</td>
<td>None</td>
</tr>
<tr>
<td>Ahmed and Lovell (1993)</td>
<td>Indiana</td>
<td>1</td>
<td>0.54 – 0.65</td>
<td>None</td>
</tr>
</tbody>
</table>

Compaction and Compression

Chipped tire aggregate (TCA) varies greatly from stone aggregate in its compaction properties. Stone generally compacts only by realignment of its position. Chipped tires, on the other hand, compact through three different compression mechanisms. The first is rearrangement/sliding of the chips. This produces a small and irrecoverable compaction. Next, is bending and flattening of chips. This produces a major and recoverable compaction. Finally, there is elastic deformation of the chips. This produces a small and recoverable compaction (Ahmed and Lovell, 1993).

These generalizations were supported in compaction testing by Edil and Bosscher (1994). Experiments showed that bending and reorientation of chips and compression of individual chips...
under stress were the greatest contributors to aggregate compaction. The compaction of tire chips was found to be much higher than for soils. Furthermore, it was determined that the major compaction occurred in first loading cycle, and that there was significant plastic strain (unrecoverable). The tire chips were best compacted using pressure techniques rather than vibratory ones. The size of the chipped tires seemed to have no impact on overall compaction. A similar finding was obtained by Humphrey and Sanford, (1993) who determined that the vertical compaction of previously compacted (60% of standard Proctor energy) chipped tires was very high on first loading, then flattened out for later loadings, especially for chips with large amounts of exposed steel. There was also increased compaction with increased amounts of exposed steel belts in tires. This finding suggests that if the tires are subjected to compaction during installation they should be relatively stable and not prone to excessive settling once in place.

Ahmed (1992) developed a testing protocol to determine the compaction behavior of rubber soils. In these experiments, chipped tires ranged in size from sieve No. 4 to 2+ inches. Chipped tire/soil mixtures were tested ranging from 100% tires/0% soil to 0% tires/100% soil. Two types of compactors were used, a mechanical compactor and an electromagnetic, vertically vibrating table. The standard Proctor, modified Proctor (heavier compaction effort), and 50% standard Proctor compactions were done. For the soil-chip mixtures, the density decreased with increased percentage of chipped tires, until the mixture was about 40% chips (by dry weight of soil), beyond which there was no further reduction of density. The size of the chips did not significantly affect the dry density. For pure chipped tires, the density of the chips decreased with increased compactive effort, a result contrary to what was expected. The chip densities resulting from vibratory compaction were less than those from Proctor compaction, but greater than the densities of non-compacted tire chips. When vibratory compaction was used, the larger chips had lower densities than the smaller chips, presumably because the smaller chips were easier to rearrange than the larger chips. It was recommended that vibration not be used for chips larger than ½ inch.

**Summary.** The literature is clear relative to the compressibility of TCA. In thick applications (greater than two feet) where the TCA was not compressed there is the potential for poor stability
and other problems associated with unconsolidated subsoil. However, in septic system leachfield use where the TCA layer is ±12” thick, our experience at the test field site has shown that purposefully driving the construction equipment over the filled trenches several times compresses the soil and TCA sufficiently to avoid issues associated with “soft” subsoils.

**Fire Hazard**

Nightingale (1997) and Humphrey *et al.* (1998) have discussed the potential for internal heating and fires in deep tire chip fills (< 25 feet thick). A number of potential causative factors for fire hazards were discussed including: 1) normal oxidation of steel wires; 2) microbial digestion; and 3) heat ignition theory as discussed by Nightengale (1997).

The Scrap Tire Management Council (1997) in response to the threat of fire hazard posed by tire chipfills, issued design guidelines for minimizing internal heating of tire chipfills. These include making sure the tires are free of combustible contaminates and organic material and limitations on the size of the tire chips. In general it is accepted that the use of tires in septic system leachfields will pose no fire hazard, because the depth of the chipped tire layer is too shallow to permit the internal heating required for ignition (STMC, 1997).

**Chemical Leachability**

Chemical leachability from scrap tires and tire shreds/chips has been the focus of numerous studies. The results of these studies are highlighted in this section.

Thomas *et al.*, (1996) conducted a leachability study using both high-grade (few or no exposed wires) and low-grade (much exposed wire) tire chips. Iron and zinc were leached from the chipped tires. The concentration of iron present in the leachate increased with increasing amounts of exposed wire.

Environmental testing was done on tires in a waste tire test embankment in 1990 (Bosscher, et al 1992). Tests showed no likelihood of an adverse effect on groundwater due to the use of chipped tires although there were increases in the concentration of manganese and zinc over an eleven month period. The Richmond Field Test, conducted in 1997, was performed to evaluate the potential for contaminant leachability from placement of chipped tires above the groundwater.
table (Humphrey et al., 1997). Many of the chips had exposed metal protrusions. Samples were tested for a variety of substances. Fifteen inorganic compounds were tested for, including aluminum, barium, cadmium, calcium, copper, chromium, iron, lead, magnesium, manganese, selenium, sodium, zinc, chloride, and sulfate. None of these substances were found to be at concentrations above their primary and secondary drinking water standards with the exception of manganese. In a second field at North Yarmouth, Maine two seepage basins were installed to collect water for sampling. Analyses were conducted for both inorganic and organic constituents. The results collected indicated that for aluminum, barium, chromium, lead, and zinc, no increases over the control samples were noted. However, for iron and manganese, the levels were routinely higher or exceeded Maine's regulatory allowable limit. The results of organic analyses were below the test method detection limits (Humphrey et al., 1997).

In a study done by the Virginia Transportation Research Council (Hoppe, 1998), a shredded tires/soil mixture was used in an embankment. Groundwater wells, one control and one put beneath the foot of the embankment, were monitored for four years for parameters including calcium, magnesium, sodium, chloride, iron, lead, zinc, hardness, pH, total organic carbon, total organic halides, and specific conductivity. No significant changes in groundwater water quality were noted for any of the parameters.

In 1990, Twin City Testing Corporation performed leach tests on tire chips under various conditions to evaluate their performance for use in roadway sub-grades (Twin City Testing Corporation, 1990). Tires were tested under four scenarios. In the first, the extraction fluid was adjusted with acetic acid so that the pH was 3.5. In the second, the extraction fluid was maintained at a pH of 5.0. In the third, a 0.9% solution of sodium chloride was used as the extraction fluid to simulate possible effects of road salt on the tires. In the fourth, the extraction fluid was adjusted with ammonium hydroxide and ammonium acetate to maintain a pH of 8.0. Leachate from the waste tires and from asphalt were analyzed for the presence of metals including silver, aluminum, arsenic, barium, cadmium, calcium, chromium, iron, lead, mercury, magnesium, sulfur, selenium, tin, and zinc. Leachate was also tested for organic compounds including total petroleum hydrocarbons and polyaromatic hydrocarbons. Based on the result collected during the study, it was found that metals leached from tire chips in the highest
concentrations under acidic conditions. PAHs and Total Petroleum Hydrocarbons were found to be most leachable under basic conditions. Under these worse case scenarios (pH at or below 5.0), the Minnesota drinking water Recommended Allowable Limits (RALs) were exceeded for a number of chemicals of concern the most notable of which were arsenic, cadmium, lead, selenium, and zinc. However, it should be pointed out that chemical leaching from the asphalt materials often equaled or exceeded that found in tires.

Recently, the State of Massachusetts has conducted a series of experiments to further quantify the leachability of chipped tires (Sengupta and Miller, 1999). Metals tested included iron, aluminum, manganese, zinc, copper, and chromium. Other inorganic compounds included chloride and sulfate ions. The first experiment examined the effects of pH on inorganic leachate quality. Tests were done at pH 6.4 and pH 3.49. The next experiment examined leaching from chipped tires soaked for four days in deionized water at pH 6.4. The third experiment examined leaching from chipped tires submerged in deionized water (pH adjusted to 3.0 using HNO₃) for 26 hours. It was concluded that the only inorganic compounds that leached significantly were iron, manganese, chloride and sulfate. Over time, the concentrations of chloride and sulfate decreased with amount of water passed through the tires, however, the metals showed a consistent leachate concentration.

**Summary.** Leaching studies have shown that chemicals do leach from tires. Many of the studies performed were conducted under conditions that more closely mimic conditions observed for landfill leachate where pH may be low. Where measured, concentrations of semivolatile and volatile organics leached from tires have not been high enough to trigger concern for groundwater contamination. For inorganics, a number of different metals have been observed to leach from tires. Of the metals observed to leach, iron and manganese are the only contaminants that appear to leach consistently and at concentrations that would warrant concern relative to drinking water standards.
3. NATIONAL SURVEY RESULTS

Under sponsorship of Empire State Development, The University at Buffalo conducted a nationwide survey to ascertain if tire chips were permitted for use in septic systems and if so, to what extent. A questionnaire was developed (Appendix A) which was sent to the agency in each state that is responsible for solid waste management inquiring of their experiences/interest in the use of tire shreds/chips in septic systems. Specifically, it inquired whether shreds/chips were used, if specific approvals were necessary (for use), and if studies/evaluations were undertaken. A follow-up telephone call was made to 20% of the respondents to confirm the interpretation of their responses. Because many respondents qualified their responses, summarization of the data for presentation necessitated grouping responses into three general categories. These are:

- Not using chips
- Using or approved for use (statewide or case by case)
- Experimental use, demonstration project and awaiting approval

The data reviewed are presented in the following table (Table 3.1). Additionally, the results of a similar 1997 Florida survey also are presented for comparison. Using the aforementioned categories one important observation can be made. In the period between the two surveys, user states appear to have increased in number. More noticeable, thirteen states are investigating the potential of using tire chips via investigations/demonstration projects and several are proceeding through the process of regulatory approval for their use. This suggests that the issue of scrap tires is becoming more prominent for regulators and that beneficial use is seen as a real alternative. However, this view is tempered with concerns for the potential environmental impacts associated with their use, as discussed below.

In addition to the use information, a number of discrete issues were common to many respondents. These included:

1. Contaminants. Although many respondents mentioned contaminants in general, the contaminants most often cited as a concern from leachability were iron and manganese. Respondents appeared divided relative to whether these two elements could cause a groundwater problem in the application under consideration. In most cases the concentration of these two metals is considered within secondary standards which are based on discoloration and taste.

2. Approvals. While some states were satisfied that their regulatory review indicated environmental acceptability and gave statewide approval, most reviewed applications on a case-by-case basis. Some indicated that as a “track record” was developed, approvability would be more automatic.
3. **Users.** It was unclear whether builders had interest in the new application, found natural aggregate to be cheaper and more available or if the application was so new that they were not aware of it. For the most part, even in states where there had not been a strong interest from users of tire chips as a replacement for natural aggregate in septic systems, the regulatory agency had at a minimum reviewed the concept.

4. **Wire.** Respondents who approved the use of tire chips indicated a concern about exposed wire belting. The concern was focused on the exposed wire both as a source of leachable metals and as an impediment to material placement and the long-term integrity of the top geotextile.

5. **Chip Size.** Those who discussed tire chip size supported the notion that 2-4” chips were preferable.

6. **Value.** Some states indicated that aggregate material was still plentiful and rather inexpensive. They questioned the need for tire material if natural resources were not in jeopardy.

The aforementioned information was prepared in a different format and submitted to *Waste Age* magazine for publication. It appeared in the November 1999 issue of Waste Age (Appendix B).
Table 3.1 Results of National Survey of the Use of Tire Chips in Leachfields

<table>
<thead>
<tr>
<th>State</th>
<th>University at Buffalo Survey (1998-99)</th>
<th>Florida Survey (Florida DEP, 1997)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not Using</td>
<td>Demonstrated Experimented</td>
</tr>
<tr>
<td>Alabama</td>
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<tr>
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<tr>
<td>Totals</td>
<td>21</td>
<td>13</td>
</tr>
</tbody>
</table>

*approved on a case by case basis
4. PROJECT TEST RESULTS

To advance the use of chipped tires as an alternative to natural aggregate in septic system leachfields, the Center for Integrated Waste Management (CIWM) at the University at Buffalo (UB) undertook a testing program. The goal of this program is to evaluate the permeability, chemical leachability, and performance characteristics of tire chips relative to natural aggregate which has been used historically for leachfield applications. The results collected to date from these studies are summarized briefly in this chapter. Complete details of results summarized in this fact sheet can be found in Robinson (1999).

The tire chips used in this study were produced by Modern Corporation at their Lewiston, New York facility and were screened to be two inches or less in size. Two types of tire chips were used in the study. These were old tires, which were 15 years or older, and new tires which were less than 15 years old. New and older tires were evaluated separately because tire age may influence the engineering properties of the aggregate. The natural aggregate used in this study was number two stone.

**Hydraulic Permeability**

The aggregate in a septic system leachfield can be thought of as a porous media through which settled wastewater is distributed to the surrounding soil for treatment. A common method to evaluate flow through porous media is permeability. Media with high permeability allow water to pass through it with relative ease while low permeability media tends to suggest a restriction of water flow. Because of its importance in determining the functionality of leachfield media, permeability testing was conducted to test the water distribution characteristics of chipped tires relative to stone.

**Testing Procedure.** Permeability testing was performed at Modern Landfill. Figure 4.1 is a schematic of the permeability apparatus. The permeameter was a 12”x12” stainless steel box that had been designed for Modern for previous permeability testing (Wehran Envirotech, 1990). Vertical and horizontal tests were performed. Water was supplied using a large water truck with a hose connected to the permeameter. For each test, the head between the water source and the permeameter was kept at one foot by raising or lowering the permeameter.
Figure 4.1 Permeability Apparatus Used at Modern Landfill. Picture Courtesy of Wehran Envirotech, 1990.
To innate permeability testing, the permeameter was filled with the tire chips or stone to a depth of one foot and a load applied to the top. The load was applied to simulate overburden and to test for loss of permeability should compression of media occur. The chipped tires were tested at loads ranging from 0 psi to 100 psi. The stone was tested at loads of 0 psi and 25 psi. These loads were applied to the top of the aggregate using a hydraulic press. Since the permeameter was a rigid box, it was feared that the higher loading applied to the chipped tires would damage the permeameter if applied to the stone media. The loadings applied to each media are listed in Table 4.1.

<table>
<thead>
<tr>
<th>Aggregate</th>
<th>Horizontal Load (psi)</th>
<th>Vertical Load (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Tire Chips</td>
<td>0, 12.5, 25, 50, 100</td>
<td>0, 12.5, 25, 50, 100</td>
</tr>
<tr>
<td>New Tire Chips</td>
<td>0, 12.5, 25, 50, 100</td>
<td>0, 12.5, 25, 50, 100</td>
</tr>
<tr>
<td>#2 Washed Stone</td>
<td>0, 25</td>
<td>0, 25</td>
</tr>
</tbody>
</table>

**Permeability Results.** Shown in Figure 4.2 are the calculated permeabilities for old tires, new tires, and stone as a function of load for both vertical and horizontal permeability. Permeabilities of the chipped tires was similar to that of stone at all comparable loadings. In addition, the permeabilities measured are indicative of high water conductivity through the media. On the basis of these results, it is concluded that water flow through chipped tires is similar to that of stone.
Figure 4.2 Permeability Trends with Increased Compressive Load
Chemical Leachability

To evaluate whether tires would be a source of organic and metal contamination in groundwater when used in a septic system leachfield, chemical leachability testing was conducted. Leachability testing was conducted under two conditions. The first method evaluated leaching when the aggregate was submerged in wastewater to simulate water pooling in the bottom of a leachfield trench or long term contact. The second method simulated leaching that would occur as wastewater flows through the aggregate which would be more typical of actual septic system operation. Leaching was characterized for metals, volatile organic compounds (VOCs), and Semivolatile Organic Compounds (SOCs).

Testing Procedure. To determine the effects of long-duration exposure of the media to septic tank effluent, a TCLP-like procedure was done according to EPA method SW-840. To conduct these batch experiments, three standard 2.2-L EP toxicity vessels, composed of Teflon were stuffed, respectively, with old tires, new tires, and stone. Then, they were filled with septic tank effluent. A fourth vessel contained only the septic tank effluent. All four vessels were weighed, and then tumbled at 28 rpm for 18 hours using a Bodine Electric Company motor. Samples for metals, VOCs, and SOCs were taken from the vessels, and prepared as follows.

All metals samples were filtered using 47 cm borosilicate glass fiber filters with a pore size of 0.7 μm. The filtrates were then placed in 500-mL plastic containers with no preservatives. Samples for VOCs were collected in 40-mL glass vials and preserved with hydrochloric acid, making sure there was zero headspace in the vial. Samples for SOCs were collected in 1-L amber glass bottles with no preservatives.

To evaluate leaching under these conditions more typical of an operating septic system, pilot-scale leachfields were constructed using old tire chips, new tire chips, and stone. Influent to the pilot scale leachfields was Amherst, NY wastewater collected after grit removal. Leaching under these conditions was evaluated by comparing influent wastewater contaminant concentrations to those in the effluent of the pilot scale leachfields. The pilot facility was set up and operated at the Amherst, NY wastewater treatment plant. A schematic of the pilot scale facility is shown in Figure 4.3. A picture of the pilot scale leachfields is presented in Figure 4.4.
Figure 4.3  Schematic for Pilot Scale Septic System Operated at the Amherst NY Wastewater Treatment Facility
During operation of the pilot scale septic system, samples to characterize leachability of metals were collected for the baseline and media effluents from the sample points shown in Figure 4.3. The baseline sample was collected to give an idea of the quality of the influent to the leach fields. All samples for metals were filtered using borosilicate glass fiber filters with pore size of 0.7 μm. The filtrates were then placed in 500-mL plastic containers with no preservatives. Most of the metals initially tested for were not found in the leachate. With that in mind, they were deemed insignificant and removed from the testing protocol. Later analyses included only iron, lead, and manganese.

Samples for VOCs also were collected at the sample points shown in Figure 4.3. They were collected in 40-mL glass vials and preserved with hydrochloric acid, making sure there was zero headspace in the vial. None of the VOCs initially tested for were found in the leachate. With that in mind, they were deemed insignificant and removed from the testing protocol.
for SOCs were collected at the sample points shown in Figure 4.1. They were collected in 1-L amber glass bottles with no preservatives. Most of these semi-volatile organic compounds initially tested for were not found in the leachate. With that in mind, they were deemed insignificant and removed from the testing protocol. Later analyses included only aniline and phenol.

All metal and organic analyses completed on the leachate samples were performed by Advanced Environmental Laboratories, located in Niagara Falls, New York.

**Leachability Testing Results.** The results from the leachability testing are summarized briefly here. For a complete description of all the data collected the reader is referred to the work of Robinson (2000)

1. **Organic Leaching.** Leaching potential of volatile and semi volatile compounds under submerged conditions was evaluated by measuring the concentrations of fifty-one volatile and semi-volatile compounds. Of specific interest were aniline, benzoic acid, total cresois, and phenol based on earlier studies conducted by others. On the basis of this testing, no volatile organic compounds were detected for stone, old tires, or new tires. For SOCs, only aniline and total cresois were detected. Aniline was detected at concentrations exceeding those in the wastewater for new and old tire leachate. Benzoic acid was detected in the stone leachate.

   Organic leachability was evaluated, in the pilot scale leachfield on three occasions spanning approximately six months of operation. Under non-saturated conditions no VOCs or SOCs were detected in the effluent.

2. **Metal Leaching.** Iron, manganese, zinc, barium, and copper were detected in the leachate at concentrations higher than found for stone under submerged conditions. However, all measured concentrations for these metals were below the New York State Maximum Allowable Concentration for groundwater.
Metal concentrations were measured in the pilot scale leachfield periodically during the six-month testing program to assess leachability under field conditions. Arsenic, copper, nickel, barium, and zinc were measured on three dates, lead was measured on five, and manganese and iron were measured eight separate times. The results from this sampling are presented in Table 4.2 and compared to the New York State Maximum Allowable Concentration for groundwater. As shown in Table 4.2, iron was the only metal found at concentrations that exceeded the allowable limit, which occurred on two occasions for new tires. Both of the iron samples that exceeded the groundwater limit were considerably higher than the other iron measurements.

**Conclusions.** Tires do not contribute significant concentrators of volatile or semi-volatile organic chemicals to wastewater as it passes through the aggregate. For metals, tires do leach iron and manganese but at concentrations typically below the New York State Maximum Allowable Concentration for groundwater.

**Treatment Performance of Chipped Tires Versus Stone**

In addition to distributing septic tank effluent to the surrounding soil, leachfield media provides preliminary treatment of contaminants as wastewater flows over the media. Treatment is achieved by through metabolic activity of organisms attached to the media. Accordingly, when evaluating chipped tires as a replacement media, it is important to assess whether chipped tires provide the same level of treatment as achieved by stone. To answer this question, the treatment performance of old and new tires was evaluated relative to each other and stone in the pilot septic system described earlier during the leaching studies. Influent and effluent samples were compared for 5-day biochemical oxygen demand (BODs), chemical oxygen demand (COD), ammonia-nitrogen (NH$_4^+$-N), pH, nitrate, total suspended solids (TSS) and volatile suspended solids (VSS).
<table>
<thead>
<tr>
<th>Metal</th>
<th>Sample Date</th>
<th>Detection Limit</th>
<th>Metal Concentration, μg/L</th>
<th>NY State GW MAC</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
<td></td>
<td>Influent</td>
<td>Old Tire</td>
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<td></td>
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<td>ND</td>
<td>ND</td>
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<td></td>
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<td>9/24/99</td>
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ND - Not Detected
**Sampling Protocol.** Influent and effluent samples from the pilot scale facility were taken twice weekly for approximately 17 weeks to measure the performance characteristics of the chipped tires relative to stone. Samples were collected in either 2.2-L or 1-L polypropylene containers. Total and filterable BOD$_5$ and pH analyses were conducted immediately after sampling. All remaining samples; both filtered and unfiltered, were acidified to a pH below 2.0 and placed in cold storage at 4.0°C for later analysis. All parameters were analyzed using Standard Methods (Standard Methods, 2000).

**Treatment Performance Results.** Results from the treatment performance tests are presented here. Data for each parameter are presented separately. The section is concluded with a summary of the data for all of the parameters utilizing means and variances.

**BOD$_5$.** There were thirty sampling events for the filtered BOD$_5$ tests. The variation in BOD$_5$ over time for filtered BOD$_5$ samples is shown in Figure 4.5. Fluctuations between baseline and the media effluents closely mirrored each other. In general, there was good evidence for filtered BOD$_5$ removal in all of the three media. There were thirty sampling events for the unfiltered BOD$_5$ test. The variation in BOD$_5$ over time for unfiltered BOD$_5$ samples is shown in Figure 4.6. BOD$_5$ levels followed the same trends for the unfiltered samples as for the filtered samples however; the levels were somewhat higher, overall.

**COD.** There were thirty-two sampling events for the filtered COD tests. The filtered COD results over time for each medium vs. the baseline samples are shown in Figure 4.7. Baseline samples were somewhat variable and ranged from 52 to 162 mg/L O$_2$ over the study period. Filtered effluent COD samples were typically lower than baseline samples for all media suggesting organic removal occurred in all media types. For the unfiltered COD tests, there were twenty-eight sampling events. Unfiltered COD results over time for each medium vs. the baseline samples are presented in Figure 4.8. Again, based on differences in the baseline and media effluents, unfiltered COD removal appears to have occurred for all media.
Figure 4.5 Changes in BOD₅ for Filtered Effluents Relative to the Baseline
Figure 4.6 Changes in BOD₅ for Unfiltered Effluents Relative to the Baseline.
Figure 4.7 Changes in COD for Filtered Media Effluents Relative to the Baseline.
Figure 4.8  Changes in COD for Unfiltered Media Effluents Relative to the Baseline.
**Ammonia-Nitrogen.** Samples for ammonia-nitrogen were collected on thirty-four separate days. Sampled ammonia-nitrogen concentrations were variable over the study period. Baseline samples ranged from 12.3 mg/L to 28.0 mg/L ammonia-nitrogen. Old tire samples ranged from 8.8 mg/L to 19.9 mg/L ammonia-nitrogen. New tire samples ranged from 9.1 mg/L to 23.7 mg/L ammonia-nitrogen. Stone samples ranged from 9.7 mg/L to 21.0 mg/L ammonia-nitrogen.

Ammonia-nitrogen concentrations for both the baseline and leach field effluents showed a gradual increase over time, as depicted in Figure 4.9. This may have been due to greater ammonification in the collection system and/or the drier conditions prevalent during the summer months. In general, all media appeared to achieve decreases in ammonia-nitrogen as wastewater passed through them.

**Nitrate-Nitrogen.** Measurements for nitrate-nitrogen were taken on thirty-two separate sampling dates. Baseline samples ranged from 0.0 to 37.9 mg/L nitrate-nitrogen. The stone samples ranged from 2.3 mg/L to 27.4 mg/L nitrate-nitrogen. The new tire samples ranged from 0.0 mg/L to 29.9 mg/L nitrate-nitrogen. The old tire samples ranged from 1.2 mg/L to 38.7 mg/L nitrate-nitrogen. Comparisons of the baseline and the three media effluents are depicted in Figure 4.10.

**pH.** Samples were taken for pH on thirty-four sampling dates. Data collected for pH are presented in Figure 4.11. The pH for the stone samples ranged from 6.8 to 7.6. The pH for the baseline ranged from 6.6 to 7.1. The pH for the old tire samples ranged from 6.5 to 7.3. The pH for the new tire samples ranged from 6.7 to 7.5.

It appeared that the pH values for old tires vs. baseline and new tires vs. baseline samples were quite similar. On the other hand, the pH of the stone samples was consistently higher than the pH of the baseline samples.
Figure 4.9 Changes in Ammonia-Nitrogen Concentration Over Time of the Media Effluents Relative to the Baseline.
Figure 4.10  Changes in Nitrate-Nitrogen Concentration Over Time of the Media Effluents Relative to the Baseline.
**TSS.** Samples were taken for TSS on thirty separate days during the pilot period. The variation in TSS over time for the three media, as compared to the baseline influent, is shown in Figure 4.12. Baseline TSS remained somewhat constant throughout the study except for an occasional spike. TSS concentrations were more variable in the media effluents and ranged from 36 to 174 mg/L, 46 to 222 mg/L, and from 4 mg/L to 260 mg/L for old tires, new tires, and stone, respectively.

In general, TSS effluent concentrations appeared higher than baseline with the most pronounced increases occurring for stone. This result most likely occurs as a result from loss of fine particulates associated with stone.

**VSS.** Samples were taken for VSS on thirty separate days during the pilot period. The variation in VSS over time is shown in Figure 4.13. It appears that the VSS did not change appreciably with time, but rather, fluctuated randomly. VSS concentrations ranged from 26 to 86 mg/L, 12 to 99 mg/L, 28 to 85 mg/L and 31 to 89 mg/L for the baseline, old tires, new tires, and stone, respectively.

**Summary of Treatment Results and Conclusions.** For the process performance parameters tested, statistical analyses were done to determine the significance of the results. It was assumed that the sample populations were normally distributed. The primary analysis used to compare performance between chipped tires and stone was a single-factored ANOVA (Mendenhall and Sincich). The ANOVA (analysis of variance) was used to compare the treatment means of all three types of media to each other. The ANOVA produced an $F$ value that was compared to $F$-critical. If $F$ was higher than the $F$-critical, the null hypothesis (the means are statistically the same) was rejected. The means and variances for each parameter studied during the treatment studies is presented in Table 4.3.
Figure 4.11 Changes in pH Over Time of the Media Effluents Relative to the Baseline.
Figure 4.12  Changes in TSS Concentration Over Time of the Media Effluents Relative to the Baseline.
Figure 4.13  Changes in VSS Concentration Over Time of the Media Effluents Relative to the Baseline.
Table 4.3
Summary Table of Means and Variances of the Wastewater for Each of the Process Parameters Tested.

<table>
<thead>
<tr>
<th>parameter</th>
<th>baseline mean</th>
<th>baseline $\sigma^2$</th>
<th>stone mean</th>
<th>stone $\sigma^2$</th>
<th>old tire mean</th>
<th>old tire $\sigma^2$</th>
<th>new tire mean</th>
<th>new tire $\sigma^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD unfiltered</td>
<td>109</td>
<td>412</td>
<td>62</td>
<td>192</td>
<td>52</td>
<td>212</td>
<td>57</td>
<td>187</td>
</tr>
<tr>
<td>BOD filtered</td>
<td>75</td>
<td>226</td>
<td>37</td>
<td>143</td>
<td>30</td>
<td>77</td>
<td>32</td>
<td>154</td>
</tr>
<tr>
<td>COD unfiltered</td>
<td>176</td>
<td>875</td>
<td>111</td>
<td>811</td>
<td>123</td>
<td>1353</td>
<td>119</td>
<td>1242</td>
</tr>
<tr>
<td>COD filtered</td>
<td>107</td>
<td>607</td>
<td>67</td>
<td>266</td>
<td>63</td>
<td>198</td>
<td>63</td>
<td>161</td>
</tr>
<tr>
<td>Ammonia-nitrogen</td>
<td>19.6</td>
<td>18.7</td>
<td>15.0</td>
<td>10.4</td>
<td>14.8</td>
<td>11.4</td>
<td>15.1</td>
<td>10.6</td>
</tr>
<tr>
<td>Nitrate-nitrogen</td>
<td>7.0</td>
<td>70.1</td>
<td>7.6</td>
<td>45.1</td>
<td>9.3</td>
<td>90.4</td>
<td>6.8</td>
<td>60.6</td>
</tr>
<tr>
<td>pH</td>
<td>6.75</td>
<td>0.02</td>
<td>7.24</td>
<td>0.04</td>
<td>6.82</td>
<td>0.03</td>
<td>6.89</td>
<td>0.03</td>
</tr>
<tr>
<td>TSS</td>
<td>50</td>
<td>190</td>
<td>128</td>
<td>2632</td>
<td>73</td>
<td>1211</td>
<td>91</td>
<td>1687</td>
</tr>
<tr>
<td>VSS</td>
<td>43</td>
<td>150</td>
<td>50</td>
<td>182</td>
<td>47</td>
<td>384</td>
<td>53</td>
<td>283</td>
</tr>
</tbody>
</table>

The results of ANOVA tests at a 95% confidence level for the parameters tested are summarized in Table 4.4. A "not different" result in Table 4.4 suggests that there was no difference in treatment performance between any of the media. A "different" result suggests that at least one media gave a different result from another. As shown in Table 4.4, there was no suggestion of difference between BOD$_5$ filtered, COD filtered, COD unfiltered, ammonia, nitrate, and volatile suspended solids (VSS). There was a suggestion that BOD$_5$ unfiltered, pH, and TSS were different.
Table 4.4  
**Significant Difference Between the Three Media Effluent Means at the 95% Confidence Level Based on ANOVA.**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Statistical Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD$_5$ filtered</td>
<td>not different</td>
</tr>
<tr>
<td>BOD$_5$ unfiltered</td>
<td>different</td>
</tr>
<tr>
<td>COD filtered</td>
<td>not different</td>
</tr>
<tr>
<td>COD unfiltered</td>
<td>not different</td>
</tr>
<tr>
<td>Ammonia</td>
<td>not different</td>
</tr>
<tr>
<td>Nitrate</td>
<td>not different</td>
</tr>
<tr>
<td>pH</td>
<td>different</td>
</tr>
<tr>
<td>TSS</td>
<td>different</td>
</tr>
<tr>
<td>VSS</td>
<td>not different</td>
</tr>
</tbody>
</table>

For the parameters showing a different result, it is unclear why the BOD$_5$ unfiltered should show a different result for the different media. It is important to note that of the three media tested, stone showed the highest effluent BOD$_5$ unfiltered concentration mean suggesting that chipped tires were at least better or equal to the performance achieved by stone. The results for pH and TSS are easier to explain. The stone was an unwashed limestone. Water contact with this material resulted in higher pH and TSS values from dissolution of calcium carbonate.

From inspection of the collected data, the calculated means, and the ANOVA analysis, it is clear that chipped tires in the pilot septic system provided equal or better treatment of conventional wastewater parameters as compared to stone.
5. **FULL SCALE LEACHFIELD DESIGN, CONSTRUCTION, AND OPERATION**

To further evaluate the efficacy of chipped tires as an alternative to natural aggregate in septic systems, a full-scale-leaching field was designed, constructed and piped to a new toilet/workroom serving the employees at the Modern Corporation – Tire Recycling facility in Lewiston, New York. Specifically, the full-scale system is being monitored to evaluate whether the use of tire chips instead of stone alters the flow of wastewater from the trench to the surrounding soil. By incorporating different soil types and tire chip size into the design, construction and operation of the full-scale system is providing valuable data on how primary design variables of septic system leachfields affect hydraulic performance. The purpose of this Chapter is to describe the design, construction, and data collected to date.

**Septic System Service Facility**

The Tire Recycling Facility at Modern Corporation employs 12-15 persons in two shifts. This user base approximates the services needs of a 4-person household (± 500 gpd.). A picture of the facility is presented in Figure 5.1.

![Figure 5.1 Tire Recycling Facility at Modern Corporation](image-url)
System Design

The septic system was designed by a sub-contractor, Albert Gilewicz, P.E., and reviewed, modified and approved by the Niagara County Department of Health (with review and input from the New York State Department of Health). The design parameters were identical to those required of conventional (stone) leachfields. The design process started in September 1998 and proceeded through four major revisions to comply with the requirements and concerns of the Niagara County Department of Health and New York State Department of Health. Final approval was received in May 2000.

Due to the tight natural soils, the leachfield was constructed above the base soil, in a mound. By incorporating multiple leachfield trenches into the design, the full-scale septic system enabled comparison between natural aggregate and two sizes of chipped tires in highly drained soils and poorly drained soils. Number 2 stone, obtained from a local stone supplier, was used as the natural aggregate. Modern Corporation supplied 1 inch nominal chipped tires and 2 inch nominal chipped tires. The size distribution for these chipped tires sizes is presented in Table 5.1. For simplicity and ease of presentation, tire chips used in this study will be referred to as either 1 inch or 2 inch.

Table 5.1
Tire Chip Size Distribution for Full-Scale System Design (Modern, 2001)

<table>
<thead>
<tr>
<th>Screen Size Opening, Inches</th>
<th>Percent of Chips Passing Screen Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 Inch Nominal Tire Chip</td>
</tr>
<tr>
<td>3 n.m.</td>
<td>n.m.</td>
</tr>
<tr>
<td>2 n.m.</td>
<td>n.m.</td>
</tr>
<tr>
<td>1.5</td>
<td>100</td>
</tr>
<tr>
<td>1.25</td>
<td>92</td>
</tr>
<tr>
<td>1</td>
<td>69</td>
</tr>
<tr>
<td>0.75</td>
<td>28</td>
</tr>
<tr>
<td>0.5</td>
<td>3.9</td>
</tr>
<tr>
<td>0.375</td>
<td>1.9</td>
</tr>
</tbody>
</table>

n.m. not measured for that size tire chip
The leachfield mound was subdivided into two sections. One section contained highly permeable fill soils comprised of sand. These soils had percolation rates of 5-10 minutes per inch (MPI). The leachfield containing the 5-10 MPI soils contained a single 50 ft. trench for each aggregate. The second section of the leachfield was constructed with fill soils having water percolation rates in the range of 45-60 MPI. For the 45-60 MPI soils, the leachfield contained two 50 ft trenches for each aggregate. A schematic of the leachfield is shown in Figure 5.2. Each leachfield trench is labeled by a number on the schematic. These numbers are cross referenced in Table 5.2 to the aggregate type placed in that trench.

<table>
<thead>
<tr>
<th>Trench Number From Figure 5.2</th>
<th>Soil Percolation Rate</th>
<th>Aggregate Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5-10 MPI</td>
<td>1 inch TC</td>
</tr>
<tr>
<td>2</td>
<td>5-10 MPI</td>
<td>Number 2 Stone</td>
</tr>
<tr>
<td>3</td>
<td>5-10 MPI</td>
<td>2 inch TC</td>
</tr>
<tr>
<td>4</td>
<td>45-60 MPI</td>
<td>1 inch TC</td>
</tr>
<tr>
<td>5</td>
<td>45-60 MPI</td>
<td>Number 2 Stone</td>
</tr>
<tr>
<td>6</td>
<td>45-60 MPI</td>
<td>2 inch TC</td>
</tr>
<tr>
<td>7</td>
<td>45-60 MPI</td>
<td>1 inch TC</td>
</tr>
<tr>
<td>8</td>
<td>45-60 MPI</td>
<td>Number 2 Stone</td>
</tr>
<tr>
<td>9</td>
<td>45-60 MPI</td>
<td>2 inch TC</td>
</tr>
</tbody>
</table>
Figure 5.2 Schematic of Full-Scale Septic System Installed at Modern Corporation

Notes:
1. Sampling pipes (2" dia. w/ well screen) to be installed at 0', 25' and 50' along each distribution line.
2. Clay barrier three feet wide to be installed between different fill materials.
3. Total system capacity designed for 570 gpd flow rate.
4. See detail sheets for septic tank, pump tank, and distribution boxes attached herewith.
5. Install backflow valve on outlet to 5-10 MPI fill material distribution lines.
To construct the leachfield, approximately 500 tons of sand (5-10 MPI soils) and 750 tons of topsoil (45-60) MPI soil were placed in a mound using a small bulldozer. A picture of the completed mound is presented in Figure 5.3. To separate the two soil types and prevent water movement between the two sections of the leachfield, a 3 ft vertical clay barrier was installed between the two soil types. Leachfield trenches were dug with a backhoe and contained a minimum of 6 in. of aggregate below the invert of the perforated 4 in. PVC drain pipe. Trench construction is shown in Figure 5.4. A minimum of 2 in. of aggregate was placed on top of the drain pipe. To minimize soil migration into the trench, a filter fabric was placed between the aggregate and the cover topsoil that ranged from 6 to 12 inches. After trench construction, the mound was seeded with grass. Each trench contained three monitoring wells that were constructed of 2 in. PVC. These monitoring wells were placed at the two ends and midpoint of each trench.

Wastewater generated at the Tire Recycling Center flowed through a 1250-gallon septic tank and then into a 500-gallon wastewater storage tank. Wastewater in the storage tank was sent to a primary distribution box located adjacent to the leachfield through a macerator/pressure pump. This distribution box is shown at the bottom of Figure 5.2. From the primary distribution box, equal volumes of wastewater flowed to two secondary distribution boxes for the two separate sections of the leachfield. Accordingly, there was a distribution box to subdivide the flows to Trenches 1, 2, and 3 and a distribution box to subdivide the flows to Trenches 4, 5, 6, 7, 8, and 9. To maintain equal volumes of applied wastewater to each leachfield trench, speed levelers were placed in each distribution box and cleaned weekly.

**System Monitoring**

The septic system was placed into operation on October 1, 2000. To date, (May 2001) all systems are working as designed. Visual observations in the distribution splitter boxes indicate that wastewater was flowing to other boxes from the pressure system and then flowing to the trenches.
Figure 5.3  Completed Mound Septic System at Modern Corporation

Figure 5.4  Installation of Tire Chip Trench with Vertical Monitoring Wells
Weekly water level monitoring in the leachfield wells began on October 10, 2000. Before monitoring began, the tops of all wells were leveled to the same elevation. In addition, the distance from soil surface to top of well and the distance trench bottom to top of well were recorded to establish baseline conditions. Currently, each well is being monitored weekly for water levels with an electronic water level detector.

Presented in Figures 5.5 and 5.6 are the weekly trench water level data collected through May 2001. Each data point plotted in these figures represents an average of the three water levels recorded in each trench on each sample date. In Figure 5.5, trench water level data for each aggregate used in the 5-10 MPI soils are presented. As shown, water levels in the trenches at the beginning of operation were essentially zero but did show noticeable levels during the winter months. The spike seen during January 2001 was during an especially cold period and may represent the effects of water freezing in the mound system. More recently, trench water levels for all media have returned to near zero. In Figure 5.6, trench water level data for each aggregate used in the 45-60 MPI soils are presented. Again a very similar response has been observed for all media, with the highest levels observed during the colder months.

Based on the trench water level data collected to date, tire chips provide the same hydraulic distribution characteristics as stone.
Figure 5.5  Full Scale System Trench Water Levels for High Percolation Soils (5-10 MPI)
Figure 5.6  Full Scale System Trench Water Levels for Low Percolation Soils (45-60 MPI)
6. ECONOMIC POTENTIAL

The emphasis of this report so far has been on the technical and environmental aspects of the use of Tire Chip Aggregate (TCA) in septic system leachfields. The purpose of Chapter 6 is to examine the economic potential of recycled tires in this civil engineering application. It is recognized that the eventual acceptance of TCA as a natural aggregate replacement will be based on a number of factors in addition to the material’s technical qualities. Certainly, the economic attractiveness to homeowners and site contractors will be a predominate factor in the acceptance or rejection of the material.

To help determine TCA’s economic potential, several aspects of the material are examined in this section including the current availability and price of both natural aggregate and tire chip aggregate; transportation costs; and the location and geologic factors of residential development in the state. A cost comparison of TCA versus stone aggregate in a typical residential leachfield application is then presented.

Availability and Cost of Natural Stone Aggregate in New York State

Current sources of natural stone aggregates are generally well dispersed around New York State, as shown in the attached mineral resource map (see page 6-6) supplied by the New York State Department of Environmental Conservation (NYSDEC). The map shows the location of the mining operations, which are permitted by the NYSDEC to extract construction aggregate material (crushed stone, limestone, and construction sand and gravel). It should be noted that the map does not provide information on which sites are actually providing stone aggregate suitable for use in leachfield systems. In general, however, the NYSDEC Division of Natural Resources notes that New York is in the "top third of the states in the value of its mineral production ...(and) almost 90 percent of the mining in New York involves the excavation of sand, gravel, and limestone.”

One other issue to be considered concerning the supply of natural stone aggregate in the state is the trend of increasingly stringent mining regulations. It is possible that increased mining regulation will have a similar impact on that industry as new regulations had on the waste
management industry. The ultimate result of increased compliance costs may be that smaller operations and facilities are unable to compete with larger facilities, thereby reducing the number and dispersion of natural aggregate sources.

According to industry sources contacted, the cost of #2 stone aggregate is typically $6.50/ton at the source. It is not likely that there is a wide variation in price across Upstate New York, although in the Downstate Metropolitan New York City area this cost could be as much as doubled.

**Availability and Cost of Tire Chip Aggregate (TCA)**

On the national level, the Scrap Tire Management Council estimates that in the year 2000, 273 million scrap tires were generated. The breakdown of the fate of these scrap tires is listed below (found on the Rubber Manufacturers Association web site [http://www.rma.org/scraptires/facts_figures.html](http://www.rma.org/scraptires/facts_figures.html)).

- 125 million scrap tires (46%) were used for fuel;
- 30 million scrap tires (11%) were used for civil engineering applications;
- 18 million scrap tires (7%) were processed into ground rubber;
- 15 million scrap tires (6%) were exported;
- 4 million scrap tires (2%) were punched/stamped into new products;
- 77 million scrap tires (28%) were disposed of or stockpiled.

As at the national level, waste tires are plentiful in New York State. It is estimated that 12-15 million scrap tires are generated in the state on an annual basis. It is also estimated that there are at least 24 million scrap tires currently stockpiled around the state. (*Buffalo News*, 11/20/00, p.1)

While it is known that waste tires are not in short supply, the availability of TCA is less certain. According to the EPA generation figures for 1996 listed above, approximately 11% of
scrap tires undergo some type of grinding, and it is possible that some portion of the tires used for other purposes, such as civil engineering uses, are also ground. Comparable figures are not readily available for New York State. What is known in New York is that there are a limited number of regulatory-approved facilities that can manage or accept waste tires. Currently there are twenty registered and seven permitted waste tire storage facilities in New York State (Source: NYS Department of Environmental Conservation, Bureau of Waste Reduction and Recycling). Nine of the twenty-seven total facilities were not accepting tires at the time of writing. Of the twenty registered facilities, one was known to be currently shredding tires and that was for internal use only. Of the seven permitted facilities, two were no longer processing tires and one did not do shredding. It was found that there are four facilities that have currently tire-shredding capabilities. This number would be expected to increase as the demand for TCA increases.

As noted above, there are four NYS-permitted facilities currently known to the authors that have tire-shredding capabilities. The four facilities were contacted for current pricing. Three of the four facilities currently produce a tire chip that meets the specification for use in leach field systems as defined elsewhere in this report. The prices for this material ranged from $0 - $5 per ton at the source – no transportation included. Based on the reported current pricing, therefore, we assume an average cost of $2.50 per ton for TCA.

**Transportation Costs**
The stone aggregate and TCA costs provided above are based on point-of-sale prices. In order to evaluate the economic potential (i.e. attractiveness) of TCA vs. stone, transportation related costs must also be taken into account. In speaking with suppliers of TCA and stone, there was a consensus that trucking costs were dependent on several conditions current at the time of the sale such as fuel prices, overall demand for trucking services, availability of a “back-haul”, and the size of the material orders. When asked for “rule-of-thumb” numbers, there was general agreement that trucking prices for this type of material ran in the range of 10-15 cents per ton-mile, with a 1st mile charge of $.50 per ton. There were some variations noted, such as whether there is a “1st mile” cost, which typically pays for the cost of loading/unloading the material, however, overall the prices were fairly consistent among the several different
industry representatives contacted. For sake of comparison, therefore, we use 12.5 cents per ton-mile and a 1st mile charge of $.50 per ton, in the table below. (NOTE: 35 cu. yd. of aggregate material is needed for a typical residential leachfield. This volume of stone aggregate weighs approximately 52 ton, while the same volume of tire aggregate weighs only 16 ton.)

<table>
<thead>
<tr>
<th>Material</th>
<th>Distance from Source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25-miles</td>
</tr>
<tr>
<td>Stone Aggregate</td>
<td>$182</td>
</tr>
<tr>
<td>Tire Chip Aggregate</td>
<td>$56</td>
</tr>
</tbody>
</table>

Based on industry averages, therefore, the cost to transport the volume of material needed for a typical residential leachfield varies substantially between the two aggregates. As demonstrated in Table 4.1 above, transportation costs of TCA are roughly one-third of the transportation costs of stone aggregate.

**Location and Geologic Factors of Residential Development**

In New York State all of the major metropolitan areas, and many of the smaller cities and villages, are currently served by public sewer facilities. Potential users of TCA for leachfield applications, therefore, will be located in the areas outside of urban centers.

**Overall Cost Comparison**

The potential economic attractiveness of using TCA in place of stone is most influenced by differences in the “delivered price” of the material. A side-by-side comparison of the delivered price of each of the two materials in a typical application is presented in Table 6.2.
In the comparison it is assumed that the building site is 50-miles from the supplier of either stone or TCA.

### Table 6.2
**Comparison of Overall Costs for Stone and Tire Aggregate**

**Amount Required for One Residential Leachfield***

<table>
<thead>
<tr>
<th>Aggregate</th>
<th>Material Cost</th>
<th>Transportation Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stone</td>
<td>$338</td>
<td>$345</td>
<td>$683</td>
</tr>
<tr>
<td>Tire Chip</td>
<td>$40</td>
<td>$106</td>
<td>$146</td>
</tr>
</tbody>
</table>

* Stone required -35 cu. yd. = 52 ton @ $6.50/ton
* Tire Chip required -35 cu. yd. = 16 ton @ $2.50/ton

As can be seen from the above comparison, there would be a significant savings achieved by using TCA rather than natural stone aggregate in a typical residential leachfield – over $500. It is recognized, however, that each building site will have its own particular set of circumstances that could affect the costs of leachfield installation. For example, some building sites could be closer to a supplier of stone aggregate than a supplier of TCA. However, given the large difference in the cost of materials, as well as in their weights and subsequent transportation costs, the two suppliers would have to be substantially far apart to provide an economic justification for use of the stone. Another factor that will influence the economic potential of TCA is the cost of the material as the demand for it increases. There currently is a relatively low demand for the specific size/type of TCA being considered for use as a stone replacement. As the material’s acceptability for this application, or possibly for others, increases over time it is predictable that the price could increase. Nonetheless, this may be more of a long-term concern (ten or more years). In the short term, the availability of scrap tires for TCA should be ample to sustain growth in a variety of civil engineering applications.
7. Public Information/Promotion

The objectives of the public information element of the project included:

- To produce a brochure that offers information on TCA and guides the interested party to a source of assistance
- To produce a video that shows the specific application of TCA in septic systems

Both instruments will function to alert potential builders of septic systems of the existence of TCA and its use as a stone aggregate replacement. More important, the video and brochure will address those environmental concerns associated with TCA use and lead the interested party to a source of additional information.

Brochure

Several states have produced brochures to promote the use of TCA in septic system leachfields. These brochures range from the Texas extremely general offering (Appendix C) to the Arkansas brochure (Appendix D) which targets anyone planning a septic system to Virginia package (Appendix E) that included:

- a joint recommendation (Health and Environment Departments) to local health officials
- a copy of a permit application
- a memorandum of septic system contractors
- an indication of the standards for TCA use

In each of the aforementioned, it is apparent that the health and environmental agencies have joined in the mutual effort to promote the use of TCA in leachfields.

The University at Buffalo has similarly prepared a draft brochure along the Arkansas format describing the use of TCA (Appendix F). Before the brochure is finalized, the roles of the DEC and DOH in promoting TCA use must be clarified and that portion of the brochure be sent to Builders Associations, large house building contractors and septic system contractors. Additionally supplies of the brochure should be sent to all DEC offices and offices of the county departments of health.
Video
A video has been produced by a subcontractor following a prepared script (Appendix G). The video remains unfinished in that the final segment depicting the positions of the two critical state agencies has yet to be completed. Similar to the comments made above (brochure) after finalization, the video should be sent to the regional Builders Association, large home building contractors, septic system contractors and county departments of health.
8. Management Recommendations

The following recommendations are forwarded to facilitate the application of tire chips as an alternative aggregate for use in septic system leachfields.

1. While in-situ studies continue, we recommend that the DOH permit TCA use on a case-by-case basis.

2. The regulatory realm of septic systems (design, approval and operation) involves both the DEC and DOH. We recommend that both agencies review their regulations for household wastewater treatment systems and revise them where necessary to allow the use of TCA in accordance with environmental and health standards.

3. A management system to generate TCA exists in that several private tire chip generators presently produce material for sale. However, to promote the widespread use of TCA additional sources of material are necessary. N.Y.S should investigate other options, both public and private to make TCA more readily available to rural N.Y. Where the greater growth of new septic systems is anticipated.
9. Conclusions

Based on the literature review conducted, the national survey conducted and the results of both pilot and full-scale testing conducted as part of this project, the following conclusions are presented.

1. Interest in reuse of waste tires is growing in most states. Data collected in 1998 indicated that 29 states have tested or approved the use of TCA in leachfields.

2. Vertical and horizontal permeability of tire chips are equivalent to stone.

3. Leaching from tire chips under conditions operative in leachfields does not contribute concentrations of semivolatile or volatile organic compounds which are of concern for groundwater protection.

4. Leaching from tire chips under conditions operative in leachfields results in higher metals concentrations. Of the metals measured in the leachate, iron and manganese were found in the highest concentrations. Although elevated over that measured for stone, the concentration of both iron and manganese were typically below secondary groundwater standards.

5. Based on pilot scale testing, tire chip aggregate provides equal treatment of wastewater constituents such as BOD₅, COD, TSS, ammonia-nitrogen, and nitrate.

6. Based on data collected to date from the full-scale leachfield, the distribution of wastewater to the surrounding soil in tire chip trenches is equivalent to stone.

7. Significant savings can be achieved by using TCA rather than natural stone aggregate in a typical residential leachfield.
Appendix A
Tire Chip Use Questionnaire
Tire Chip Survey

State Surveyed:

1. Is the use of tire chips permitted for any septic system applications within the state such as drain aggregate, fill, etc. ______ yes ______ no

If so, what type of applications?

2. Has the industry shown enough interest to use the tire chips ______ yes ______ no

3. If the decision is made by contractors to use tire chips in a septic system, must they obtain a special site permit or is there a statewide approval for the use of chips (in lieu of stone aggregate?)

4. Have you conducted any chemical, physical, or biological studies in your evaluation of potential for using waste tire chips? ______ yes ______ no

5. Have you encountered any problem or noted concerns with the installed tire chip septic systems? ______ yes ______ no

If so, please describe.
6. If tire chip installations have been permitted, can you estimate the number installed per year?

7. After tire shredding are the chips washed prior to use?  _____yes _____ no

8. What is the chip size recommended in your applications?

9. What contacts within your state might we use for information concerning performance or observations of these applications?

10. We would appreciate any additional comments regarding tire chips and their applications.

11. Would you like to receive a copy of our studies report when complete?  _____yes _____ no

12. Response proposed by:

Thank you again for taking the time to assist us.
Appendix B

“An Alternative to Scrapping Scrap Tires”
An Alternative to Scrapping Scrap Tires

Scrap tires have many potential recycling and reuse applications, but marketing them can be a hard sell. The costs of processing scrap tires vs. the value of the end-product, its replacement potential and the unwanted constituents inherent in rubber tires make the economics questionable.

However, the Center for Integrated Waste Management at the State University of New York (SUNY) at Buffalo and Empire State Development are studying a promising use for scrap tires — as a replacement for stone in septic system leach fields.

As part of the project, which includes pilot-scale leaching studies and a field-scale demonstration project, a questionnaire was sent to all 50 states to find out how many of them currently allow scrap tires to be used in septic systems, and whether this use is regulated on a statewide or case-by-case basis. The questionnaire, which was sent to the state agency responsible for solid waste management, specifically asked whether shreds or chips were used. It also surveyed which states have attempted demonstration projects, how many states are interested in using scrap tires in septic systems and which states have no interest in this application.

SUNY Buffalo compared its results to a survey the state of Florida conducted in 1997. While comparing the results of the two surveys was difficult, one important observation was made — the number of states using scrap tires in septic systems is on the rise. Additionally, 13 states are investigating the potential of using tire chips in studies or demonstration projects, and some are seeking regulatory approval for their use. This suggests that the issue of scrap tires is becoming more prominent for regulators and that beneficial use is seen as a genuine alternative.

However, these views are tempered with concerns about the environmental impacts associated with using scrap tire chips, including:

- **Groundwater contaminants.** The long-term immersion of tires in water creates two main contaminants — iron and manganese. But in most cases, states considered these contaminants as secondary issues that could affect the color and taste of drinking water. The respondents appeared divided over whether the two contaminants would cause a significant groundwater problem (in septic system leach fields).

- **Approvals.** The permission method varies from state to state. While some states were satisfied that the application is environmentally safe and gave
statewide approval, most reviewed applications case-
by-case. Some indicated that as a "track record" was
developed, the approval process would be more effi-
cient.

- **Potential users.** Interest in this application varies. It
is unclear whether home builders or subcontractors
that construct septic systems, who were not interest-
ed in using scrap tires were not interested in the
application because they found natural aggregate to
be cheaper and more available or because they
weren't aware of the application. For the most part,
when states had an interest in using tire chips, the
regulatory agency reviewed the concept first.

- **Wire.** Respondents who approved tire chip use
expressed concerns that the exposed wire belting in
tires would be a source of leachable metals and an
impediment to material placement, as well as affect
the long-term integrity of the top geotextile.

- **Chip size.** Respondents said they pre-
ferred 2-inch to 4-inch chips.

- **Value.** Some states indicated that
aggregate material still was plentiful
and fairly inexpensive. Thus, some
questioned the need for tire material if
there wasn't a shortage of natural
resources.

While mixed feelings continue about
the use of tires as a replacement for
natural resources, in general, the sur-
vey found that tire chips have potential
use in septic system leach fields.
Although only one-third of the states
have approved some level of septic sys-
tem application, interest from scrap tire
regulators and managers continues to
grow. This especially is true where
scrap tires have few markets or where
stone is at a premium.

Data from state solid waste managers
suggest that automobile tires are dis-
carded at the rate of about one tire per
person each year. If not for tire-derived
fuel projects, municipal solid waste
(MSW) landfill leachate collection pro-
jects and civil engineering applications,
the size and number of waste tire piles
would continue to grow and present
greater environmental, safety and aes-
thetic problems.

As an alternative to scrap tire dispos-
al, state consultants and industry pro-
essionals, in conjunction with univer-
sities, are exploring engineering
applications for tires that would offer
both environmentally safe uses and
conserve natural resources such as
stone aggregate. Using tire chips in
leach fields may be one option.

— John J. Spagnoli,
A. Scott Weber and
Thomas J. Richards
Center for Integrated
Waste Management
State University of
New York at Buffalo

Circle No. 10 on Reader Service Card
Appendix C
"Using Tire Shreds in On Site Sewage Facilities"
Texas Brochure
Using Tire Shreds in On-Site Sewage Facilities

Texans generate 30 million waste tires each year. Under the TNRCC's Waste Tire Recycling Program, these tires are collected, shredded, and sent to an end user. One resourceful end use for tire shreds could save money for on-site sewage facility (OSSF) installers and their customers. TNRCC rules allow installers to use tire shreds as the porous media in the construction of OSSF lateral lines and leach fields, where appropriate. Tire shreds serve the same purpose as gravel in these systems and can be cheaper in some areas of the state. Use of tire shreds helps the environment by eliminating the need to excavate natural rock and providing an alternative to tire disposal.

How Can Tire Shreds Help Reduce Costs?
Costs for tire shreds that are suitable for use in septic systems are very competitive with prices for clean, washed and graded gravel. Replacing gravel with tire shreds could save 10 to 90 percent of the cost of using gravel. Transportation costs can also be less since tire shreds are about three times lighter than gravel (a cubic yard of gravel weighs about 2,800 pounds; a cubic yard of tire shreds weighs only about 800 pounds).

What Type of Shreds Can Be Used?
A tire shredding industry standard chip size called "2-inch minus" is comparable to the gravel size currently approved for on-site sewage facilities. The chip is no greater than 2 inches on a side, including any protruding wires, and will pass through a 2-inch by 2-inch sieve aperture. Many installers have successfully used larger 3-inch shreds which are abundant due to previous state requirements for tire shredding. Local wastewater authorities may approve the use of larger sizes of tire shreds on a case-by-case basis.

Are Tire Shreds Hard to Handle?
Because tire shreds are lighter than gravel, their use can be easier on loading and spreading equipment. The shreds can be easily managed with a rake to ensure that none are left above the ground on the site.

What about Environmental Concerns?
Studies conducted by the Radian Corporation, the state of Washington, and the state of Vermont have found that there is little, if any, release of contaminants into the environment surrounding drain fields in which tire shreds serve as the porous media. In fact, the use of tire shreds offers two environmental benefits: reduced excavation of natural rock and elimination of the need for tire disposal.

What about Other Special Considerations?
When tire shreds are used in the place of gravel in drain fields, some special care must be taken to prevent protruding wires from severely puncturing or tearing geotextile fabric. Contractors must avoid damage to the fabric by using a heavier textile.
What Kind of Paperwork Is Involved With Using Tire Shreds?
Tire shred users complete a one time only application and sign a waste tire shred manifest to document that the shreds were received. The waste tire processor (shred supplier) provides both of these forms, which are required for tracking purposes only and attach no additional liability to the homeowner.

Check with local wastewater authorities to confirm that local codes allow the use of tire shreds. For more information or to obtain a current list of waste tire processors that supply tire shreds, please contact Ms. Mary Wright at (512) 239-6683.

TNRCC disclaimer
Comments/Questions regarding Waste Tire Recycling Fund Program: tires@tnrcc.state.tx.us
Technical questions regarding the TNRCC Web Server: webmaster@tnrcc.state.tx.us
http://www.tnrcc.state.tx.us/enforcement/tires/septic.html

http://www.tnrcc.state.tx.us/enforcement/tires/septic.html
12/22/97
Appendix D

"Rollin' Along with Arkansas Waste Tire Chip Aggregate"
Arkansas Brochure
WHAT ARE THE ADVANTAGES?

- There is no significant loss of the tire chips.
- 12" of washed gravel.
- 4 tons of gravel = approx. 420 linear ft.
- 900 sq ft. tire = approx. 42 linear ft.

WHAT IS CHIP AGGREGATE?

- Cumulative, edging, or edger
- Durable and long-lasting
- Can be used in French drains and erosion control systems
- Safe for use in soils
- Can replace washed gravel
- Requirements for use in soil

HOW IS IT USED?

- Washed gravel is obtained from recycled tire chip aggregate systems. The chip gravel is used as a substitute or replacement for washed gravel.
Appendix E

Virginia Waste Tire Programs:

- Standards for Use of Tire Chips in a Residential Septic Drain Field
- Memo to Septic System Contractors
- Memo to UDH Field Staffs
APPLICATION

1. Tire chips are approved by the Virginia Department of Health (VDH) and the Virginia Department of Environmental Quality (DEQ) for use as course aggregate in non-proprietary subsurface absorption fields and may be substituted for stone aggregate on a one-on-one basis volumetrically.

2. Trenches design, installation and location are to remain unchanged. Untreated building paper or a geotextile (synthetic) fabric cover shall be used to cover the tire chips before backfilling.

3. Each installation must have a valid VDH permit; must be authorized by the property owner and certified by VDH and the installation contractor using the 4 part VDH-DEQ Certification of Use of Tire Chips in a Residential Septic Drainfield.

4. Propriety systems and systems designed by a professional engineer are not automatically authorized for use of tire chips. Changes to the aggregate must be approved in writing by either the manufacturer or the professional engineer, prior to approval.

CHIP SPECIFICATIONS

1. Chips are to be a nominal 2 inches in size and may range from one-half (½) to a maximum of four (4) inches in any one dimension.

2. Exposed wire may protrude no more than one-half (½) inch from the chip.

3. At least 95% of the aggregate by weight shall comply with the above specifications.

4. Fines, defined as any material less than 2mm in size, are prohibited.

Note: For questions concerning the septic installation, contact the local VDH environment health specialist. For questions on tire chips and potential suppliers, please contact the Waste Tire Program at (804) 698-4210.
See Attached

MEMORANDUM TO
SEPTIC SYSTEM CONTRACTORS
August 21, 1997
COMMONWEALTH of VIRGINIA
DEPARTMENT OF ENVIRONMENTAL QUALITY
Street address: 629 East Main Street, Richmond, Virginia 23219
Mailing address: P.O. Box 10009, Richmond, Virginia 23240
Fax (804) 698-4300  TDD (804) 698-4021
http://www.deq.state.va.us

MEMORANDUM

TO: SEPTIC SYSTEM CONTRACTORS

FROM: R. Allan Lassiter, Jr.  
Manager, Waste Tire Program, DEQ

SUBJECT: Use of Tire Chips in a Residential Septic Drain Field

DATE: August 21, 1997

The Virginia Department of Environmental Quality (DEQ) and the Virginia Department of Health (VDH) are pleased to announce that you may now begin to use "tire chips" in your residential septic system drain fields. In addition, you may qualify for DEQ's "end user reimbursement" of up to $22.50 per ton for use of Virginia generated tire chips, the amount could increase to $50 per ton if the tires come from a "certified" abandoned tire pile. For an average installation using 10 tons, your reimbursement could be $225, or possibly as high as $500, in a check from DEQ directly to you.

Contractors in the state of South Carolina have already received over $137,949 since January, 1995 for using chips from Virginia generated waste tires. The South Carolina Health Department has allowed this use of tire chips since 1993. South Carolina contractors prefer to use Virginia chips because they get direct payment from the reimbursement system, authorized by the Virginia General Assembly in 1993.

The procedures for using these "tire chips" in Virginia are contained in the enclosed Standard of Use of Tire Chips in a Residential Septic Drain field. In addition, each installation must be "certified" using the enclosed 4-part Certification of Use of Tire Chips in a Residential Septic Drain field available from DEQ. Please note that the certification must be signed by the property owner and a VDH Environmental Health Specialist (EHS). Your local EHS has recently been notified of these procedures in a GMP #91, dated August 21, 1997.
MEMORANDUM
August 21, 1997
Page two

The enclosed End User Reimbursement Application (DEQ-EURR 8/97) must be used by the septic contractor to apply for the reimbursement. Applications are accepted and paid on a calendar quarterly basis; it takes approximately 30 days to receive payment from DEQ. There is a 50 ton minimum per application. Should you wish to participate, call or write to DEQ to receive a full program package.

Several waste tire processors, both inside and outside Virginia, can supply tire chips to meet the required specifications. They must also provide you documentation that confirms the Virginia origin of the chips. This is achieved by the processor's use of the Waste Tire Certification (DEQ-WTC), an example of which is enclosed. You will be reimbursed the purchase price you pay the processor, up to $22.50 per ton which can include transportation or you may provide your own transportation and add its cost to the amount you pay the processor to reach the full $22.50 reimbursement. Remember, payments as high as $50 per ton may be available.

The firms below are known to generate qualified tire chips from Virginia waste tires:

Virginia Recycling Corp.
New Kent Co.
(804) 966-5159

SPSA
Suffolk, VA
(804) 548-2256

Atlantic Waste
Sussex Co.
(804) 834-8300

Emanuel Tire of Virginia
Appomattox Co.
(804) 352-8837

Resource Recycling
Lorton (Fairfax Co.)
(703) 339-6511

Shenandoah Co. Pub. Works
Woodstock
(540) 984-8573

Tire Recyclers, Inc.
Charles City Co.
(804) 358-1303

Rollins Enterprises
King George Co.
(804) 775-2442

HRTR
Newport News
(757) 244-8017

T.I.R.E.S., Inc.
Winston-Salem, NC
(910) 784-0390

Emanuel Tire
Baltimore, MD
(410) 947-0725

U.S. Tire
Concord (Charlotte), NC
(704) 784-1210

City of Bristol
Bristol, Virginia
(540) 645-7360

For questions concerning the septic installation and use of tire chips for aggregate, please call your local health official. For questions on tire chips, suppliers or reimbursements, call DEQ's Waste Tire Program at (804) 698-4210.

Enclosures
See Attached

MEMO to VDH Field Staff
"Use of Recycled Tire Chips"
(August 21, 1997)
To: District Environmental Health Managers
    District Health Directors
    OEHS Staff

From: Donald J. Alexander, Director
     Division of Onsite Sewage and Water Services

Subject: Use of Recycled Tire Chips

The Department of Environmental Quality (DEQ) has requested that VDH consider the use of recycled tire chips as a replacement for gravel in drainfield systems. Disposing of used tires has been problematic and DEQ has determined that their use as an aggregate material in drainfields could provide a beneficial use for a material that has been an environmental liability. This GMP authorizes the use of tire chips as an alternative aggregate in lieu of stone in gravel absorption trenches under the conditions in Appendix I.

Procedurally, no permit changes will be necessary. Any drainfield installer may, at their discretion, substitute chipped tire aggregate meeting the attached specifications, for gravel in any non-proprietary subsurface absorption system designed by the Department which requires aggregate. In general these will be conventional drainfield systems, pressure dosed systems, and low pressure distribution systems. This GMP does not include proprietary systems such as Puraflo™, the Aquorobic Filter Bed, or any other proprietary system with current or future approval. Systems designed by professional engineers (with either formal or informal plans) are excluded from this GMP unless the engineer specifies, or otherwise approves (in writing) chipped tire aggregate.

When an environmental health specialist (EHS) inspects a system where chipped tire aggregate has been used, the installer will request the EHS to sign a certification that tire chips were used. Department field staff are directed to sign the DEQ-VDH form entitled “Certification of Use of Tire Chips in a Residential Septic Drainfield” in the appropriate block, when it appears that tire chips were used to construct the system and after the form has been properly filled out and signed by the contractor and the homeowner. Incomplete forms should not be signed. The EHS should also note the permit number and enter the date of the inspection. The blue copy of the form is to be retained by the EHS and filed with permit. A copy of this form is attached.

Attachments

GMP #91
Onsite - Recycled chipped tire aggregate
Application

1. Tire chips are approved by the Virginia Department of Health (VDH) and the Virginia Department of Environmental Quality (DEQ) for use as coarse aggregate in non-proprietary subsurface absorption fields and may be substituted for stone aggregate on a one-for-one basis, volumetrically.

2. Trench design, installation, and location are to remain unchanged. Untreated building paper or a geotextile (synthetic) fabric cover shall be provided to prevent soil infiltration.

3. Each installation must have a valid VDH permit, must be authorized by the property owner and certified by VDH and the installation contractor using the 4 part VDH-DEQ Certification of Use of Tire Chips in a Residential Septic Tank Drainfield system.

4. Proprietary systems and systems designed by a professional engineer are not automatically authorized for use. Changes to the aggregate must be approved in writing by either the manufacturer or the professional engineer prior to approval.

Chip Specifications

1. Chips are to be a nominal 2 inches in size and may range from one-half ($\frac{1}{2}$) to a maximum of four (4) inches in any one dimension.

2. Exposed wire may protrude no more than one-half ($\frac{1}{2}$) inch from the chip.

3. At least 95% of the aggregate by weight shall comply with the above specifications.

4. Fines are defined as any material less than 2 mm in size and are prohibited.
Appendix F

“New Tire Chip Aggregate for Septic Leachfield Installations”
Environmental issues relating to Waste Tires

- Waste tires collect rainwater and offer an excellent breeding area for mosquitoes—some of which carry diseases like the West Nile virus.

- Waste tires burn easily. Burning piles of waste tires are hard to extinguish and (1) release dense smoke that may contain contaminants; and (2) produce about one gallon of oil per tire that can pollute surface or ground water.

- Waste tire piles may harbor rodents, snakes, and a variety of stinging insects.

- Waste tires and waste tire piles are unsightly and tend to attract additional illegally dumped solid waste.

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New York State Department of Environmental Conservation
Regional Offices

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<tr>
<th>Region 1</th>
<th>Stony Brook</th>
<th>516-444-0354</th>
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<tr>
<td>Region 2</td>
<td>Long Island City</td>
<td>718-482-4900</td>
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<td>Schenectady</td>
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<td>Region 8</td>
<td>Avon</td>
<td>716-226-2466</td>
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<tr>
<td>Region 9</td>
<td>Buffalo</td>
<td>716-851-7200</td>
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NEW TIRE CHIP AGGREGATE FOR SEPTIC SYSTEM LEACHFIELD INSTALLATIONS

Empire State Development Environmental Management Investment Group

New York State Department of Environmental Conservation Division of Solid and Hazardous Materials
WHAT IS TIRE CHIP AGGREGATE (TCA)?

- Tire chip aggregate (TCA) is made by cutting waste tires into small stone sized pieces.

DOES TIRE CHIP AGGREGATE WORK AS WELL AS STONE IN LEACHFIELDS?

- UB studies have indicated that the performance properties, permeability, porosity—are the same for TCA and stone.

DOES TIRE CHIP AGGREGATE RELEASE ANY CONTAMINANTS TO THE ENVIRONMENT?

- There are a number of leaching studies of TCA in addition to the UB work. All indicate that some leaching (primarily iron and manganese from steel belts) does occur. However, the levels of these contaminants are below levels of concern.

HOW DIFFICULT IS IT TO USE TCA?

- TCA is used as you would use stone. It replaces stone on a 1 to 1 basis.

IS ANY ADDITIONAL TRAINING EQUIPMENT OR DESIGN REQUIRED TO USE TCA?

- No. Handle TCA as you would handle stone.
- Use the same barrier material—geo textile/building paper/hay—as you use with stone.

IS TCA CHEAPER THAN STONE?

- TCA weighs about 1/3 as much as stone. Since it is less expensive to produce and lighter to transport, it can reduce your total costs (of material) by about 50%.

REMEMBER

USING TCA GIVES YOU EQUAL PERFORMANCE AND HELPS THE ENVIRONMENT BY USING WASTE TIRES

INFORMATION ON THE USE OF TIRE CHIP AGGREGATE IN SEPTIC SYSTEM LEACHFIELDS:

- Video—"Tire Chip Aggregate for Leachfields" available by request from:
  - DEC Regional Office*
  - County DOH Office

- Information on Permits—
  - County DOH Office

- Information on availability of TCA—
  - DEC Regional Office*
  - County DOH Office

*Regional DEC Phone numbers appear on back page of this brochure
Appendix G
Tire Chip Use Video Script
PROJECT: "Tire chip leachfields, an innovative application for domestic septic systems."

CLIENT: Center for Integrated Waste Management, University at Buffalo, State University of New York. Contact: Prof. Spagnoli

SCRIPT*

INTRO

Scene 1 (WHAT)

Suburban and rural houses
In many suburban and rural areas, sewer lines do not exist. As a result, houses built in these areas almost always rely on individual septic systems to treat their wastewater. These below ground systems consist of a holding tank and a leachfield usually made with stone.

New house construction
Researchers have shown that rubber tire chips are a viable alternative material to stone in these leachfields. In fact, tire chips perform as well as stone and at a lower cost. In addition, using recycled tires in septic systems provides a way to use a portion of the millions of waste tires generated each year.

Scene 2 (WHO is working on the product)

UB and Lab
With funding from Empire State Development, researchers at the University at Buffalo have been seeking alternative applications for used tires. At the Center for Integrated Waste Management, these researchers have studied the chemical, physical, and environmental properties of tire chips and compared them to stone when used in septic system leachfields. The data generated looks very good and suggests that tire chips work as well as stone and are environmentally acceptable. The data has been shared with New York State Department of Environmental Conservation and New York State Department of Health.

Scene 3 (WHAT is used FOR)

Cars on highway
About 20 million waste tires are generated in New York State each year. About one tire for each resident each year. Once worn out and discarded, tires can be used in a number of ways including:

Furnace and crushed rubber
Tires are made from petroleum and therefore can be burned to give off heat. Either whole or chipped, they are being used in a number of countries as fuel for power plants and cement kilns.

*Items in bold print indicate videotape topic
Road construction with waste tires
In some southern states crumb rubber from tires is incorporated into asphalt for roadway surfaces while in Maine and New York researchers have shown that tire chips make excellent lightweight backfill for bridge side slops and other fill areas.

Leachate collection layer of landfill
Lastly, because of their irregular shape, piles of tire chips offer an abundance of crevices through which water passes easily. Using tire chips as a drainage blanket in landfills allows contaminated water to effectively be collected at the bottom of a landfill. This collecting of waste at the bottom of the landfill allows for removal and treatment. New York State permits the use of tire chips as a drainage blanket under sanitary landfill.

Tire piles
Despite the many excellent ways of reusing waste tires, the total number discarded exceeds the number used. Therefore, piles of unused waste tires continue to unnecessarily accumulate through New York State and the country.

Tire piles
And without a use, tire pose an environmental and health management hazard and burden both the State and the country. Some issues of significance to New York State include the potential for both tire fires with associated land, air and water pollution and breeding areas for mosquitoes that can transmit a variety of health problems including the West Nile Virus. Finding ways of converting tires from a liability to a resource with economic value, presents a challenge for both Empire State Development and the Center for Integrated Waste Management at the University at Buffalo.

Septic Systems
Dr. Weber tape

(Animation)

(View of Report to Empire State Development)
The University at Buffalo has sent the data to New York State Department of Environmental Conservation and the New York State Department of Health for review. The outcome of the investigation concluded that:

♦ Tire chips have been shown to release only manganese and iron
♦ Iron and manganese levels are well within a safety margin
♦ Tire chips have been shown to function as well as stone for permeability (flow) of water
♦ Leachfields operate very similarly using stone or tire chips

HALF VIDEO

Scene 4 (HOW the product is made)

(Background – Modern operations at tire chip facility)
Scrap tires are collected by commercial operators like Modern Corporation in Lewiston. The process of making tire chips involves two stages—tire collecting and chipping. Collected tires are then transported to a New York State permitted storage and processing facility like the one at Modern. Here the tires are sorted. The usable ones are sent to recapping while the remaining tires are sent to the chipping operation. These are the tires
that will be converted for your septic system. Chipping entails cutting whole tires with large mechanical devices and screening the pieces into piles of various sized chips. With no further treatment, the chips are ready to use in leachfields.

**Background – Tire Recycling Office and Building at Modern**
The Center for Integrated Waste Management and Modern Corporation jointly constructed and tested a septic system tire chip leachfield. Although Modern’s facility is a commercial operation, the number of people on staff and hours of occupancy are similar to a typical household. Wastewater from the office and washrooms is directed to a holding tank to separate out the solids and then moved to the leachfield. Since this was designed to compare three types of material (stone, 2 inch chips and 4 inch chips) in two different soil conditions (sandy soil and clay), the water goes through several distribution boxes to provide equal volume to each test trench. These trenches are identical to those constructed in leachfields throughout New York State. The trenches were then filled with stone or chips and covered with a fabric and soil. The leachfield has been in operations since October of 2000.

**Scene 5 (RESULTS AND CONCLUSIONS)**
Tire chip aggregate is presently being used for septic system leachfields in 25 states either on a case-by-case basis or with statewide approval. All states surveyed indicate that they are satisfied with the tire chip performance. Studies have demonstrated that chips work as well as stone and are equally environmentally friendly. If septic systems are a part of your construction needs, consider using tire chips instead of stone. Remember, there are some important extra benefits of using tire chips. First, they work as well as stone and usually are much less expensive. Second, they are as easy to handle and install as stone. And finally, you can help your community find a way to use waste tires by specifying a recycled drainage material.