An integral part of this project was to conduct an investigation of the full scale septic system that has been operating continuously at Modern Landfill since 2000. The design of this system was described in detail in Spagnoli et al., (2001). This system provides an ideal test bed to evaluate the long-term acceptability of tire derived aggregate (TDA) as an alternative to stone as the system’s absorption trenches have parallel lines of stone and TDA aggregate, which allows for side-by-side comparison. To evaluate TDA’s long-term potential in this system, several project objectives were formulated to answer common questions concerning the potential of TDA. These objectives were:

- Conduct a field survey and video inspection of stone and TDA absorption trench lines to evaluate sludge buildup, aggregate/absorption trench settlement, and overall absorption trench integrity;
- To evaluate the current hydraulic performance of stone and TDA absorption trenches.
- To evaluate the physical properties of the TDA including wire length and physical integrity; and
- To evaluate metals leaching from the TDA and stone into the soils surrounding the absorption trenches.

**Inspection of System Absorption Trenches**

System absorption trenches were inspected visually and by video camera filming during the summer of 2006. Surface visualization was conducted to evaluate uneven settlement and video surveillance was conducted to evaluate sludge buildup, root intrusion, settlement issues, drainpipe cracking, and blockage.

Surface visualization revealed no differential settling in absorption trenches related to media differences. There was noticeable transverse settling perpendicular to all trenches at approximately their mid-section. Historical records of site activity were researched and the site chosen for the septic system was used previously for buildings, which undoubtedly contained utilities. Whether the differential settling of the surface in this location is related to the sites past history was not ascertainable.

Video inspection of all nine leach lines determined that trenches 8 and 9 were compromised due to a reverse gradient, which precluded even flow to these trenches. This reverse gradient was not media specific and occurred for both stone and TDA. It is possible that the reverse gradient occurred at construction. As a result, absorption trenches 7, 8, and 9 were not considered in the final evaluation of the system performance.

**Hydraulic Performance of Stone Versus Tire Derived Aggregate**

One of the key concerns related to the replacement of conventional stone in septic system
absorption trenches with TDA is potential reductions in hydraulic performance. Reduction of performance could be tied to the media’s intrinsic hydraulic conductivity but this has been proven to be not the case in earlier studies (Spanoli et al., 2001). Rather, the primary concern is movement of applied water across interface between the absorption trench media and surrounding soil. To evaluate this concern, hydraulic performance testing was conducted previously using the Modern Corporation system and these results were reported in Weber et al. (2002). In these studies, conducted after 2 years of continuous system operation, there was no difference noted in the hydraulic performance of stone and TDA.

To reevaluate stone and TDA after nearly seven years of continuous service, hydraulic testing of the absorption trenches was conducted as part of this study in the summer of 2006. Because water capacity to the system was limited, each absorption trench was tested sequentially rather than simultaneously. The order of testing was conducted randomly so as to not bias the results as it was unknown whether prior testing of adjacent trenches would influence the results. Each test was conducted as a slug hydraulic test with water level data (head) being collected in each of the trenches three wells with time to evaluate movement of water into the surrounding soil. These experiments were replicated for each absorption trench at least twice and in most cases, three times. Data collected were then evaluated using a standard hydraulic model to evaluate differences in the coefficients of hydraulic permeability. An example of the data collected in this test and the model fit is shown in Figure One.

Based on the field data collected and tested statistically, 1 inch TDA and stone performed equally well in sandy soils. Two inch TDA hydraulically outperforms both 1 inch TDA and stone aggregates in sandy soils. In the clay soils, 1 inch and 2 inch TDA hydraulic performances were statistically similar and both outperformed the stone aggregate. Accordingly, for absorption trench systems in operation for seven years, TDA continues to perform hydraulically at least equal to or better than stone as trench media.

TDA Integrity After Seven Years of Service
Recognizing that exposed wire degradation and overall physical integrity of TDA is an important consideration in its use, all nine leachfield absorption trenches were exposed by excavating test pits across each distribution line perpendicular to the direction of flow. The test pits were roughly four feet wide with the distribution line exposed in the center of the pit, two feet long (in the direction of flow) and 1 ½ feet deep or until the underlying soil was reached. TDA aggregate were harvested in six inch lifts starting from the geotextile fabric. TDA in each lift was visually inspected and wire length was measured by imagining randomly selected TDA samples.
Based on the visual inspection of TDA harvested from the trenches, there was no obvious physical degradation, although there was certainly discoloration and loss of wire due to corrosion. The majority of the discoloration was due to rust stains on the media. Both of these attributes are shown in Figure Two, which depicts media that has been in service for the past seven years and relatively new manufactured TDA from the Modern Tire Recycling Facility. Digital imaging of also showed no apparent loss of TDA integrity which might lead to trench failure or obstruction of fluid flow. The only obvious impact to TDA integrity was the corrosion of wire protrusions. Protruding wire lengths along the cut edges of TDA samples decreased with depth and in some cases caused TDA samples to break apart. TDA samples that had closely spaced steel wire networks exhibited corrosion of the steel wire within the core of the sample causing a separation of the two rubber halves along the rubber/wire bisect.

TDA average wire length for each lift was compared for each soil type. Based on this analysis, it was found that for both 1 inch and 2 inch TDA in sandy soils, average wire length decreased with increasing trench depth suggesting greater rates of corrosion at in the lower lifts. These results were statistically significant. For the clay soils, there was more scatter in the average wire length data and although the average length decreased with increasing depth for the 2 inch TDA, the results were not statistically significant. The reasons for these differences are postulated to arise from the greater level of moisture sustained in the lower permeable clay soils, which led to greater rates of corrosion and thus wire loss.

In summary, while metal corrosion clearly occurred in the TDA, it does not appear to influence performance or cause a drop in system performance. Accordingly, it would appear that no special maintenance requirements for TDA systems exist relative to stone aggregate.

Metal Concentrations in Surrounding Soils
As noted earlier, leaching of wire protruding clearly occurs in subsurface installations of TDA and there has been concern that metals associated with this corrosion may migrate from the system boundaries and potentially contaminate underlying groundwater. To evaluate this potential, soil directly beneath the absorption trenches was tested for iron, manganese, zinc, and lead. Soil concentration were tested at the absorption trench bottom/soil interface, 0-6 inches, 6-12 inches, and 12-18 inches. The latter three were composited samples and represent an average for these depths. For comparative purposes, soil concentrations in surrounding soils were taken at the same depth for each constituent.
For sandy soils, iron and zinc soil concentrations directly below the absorption trenches appear to be higher than background or the stone trenches, although there is significant scatter in the zinc data. Data collected for these metals is highlighted in Figure Three. For reference purposes, Trench 1 is filled with 1 inch TDA, trench 2 is filled with stone, and trench 3 is filled with 2 inch TDA. Although not shown here, there also was significant scatter in the manganese concentrations in sandy soils, which obscured any obvious trend and lead concentrations in these soils were below detectable limits.

It important to note that while TDA corrosion appears to have contributed iron and zinc to the surrounding underlying sandy soils, the measured concentrations of iron are well within typical rural background levels as measured in New York State. Zinc concentrations are somewhat higher than typical background but are well below New York States’ Brownfield Soil Cleanup Objectives for unrestricted residential use. Accordingly, these concentrations while not of significant concern at the current time, do bear continued observation and analysis.

Similar trends for concentration of leached metals in clay soils were observed as shown in Figure Four. For reference purposes, Trench 4 is filled with 2 inch TDA, trench 5 is filled with stone, and trench 6 is filled with 1 inch TDA. As with the sandy soils, iron concentrations in clay soils below the TDA were higher or similar to those observed for stone and generally higher than background for the site. Again, it should be noted that except for the interface concentrations where precipitates were held, the underlying iron concentrations are well within typical background concentrations in New York State. The zinc concentration data are a little higher in the clay soils and probably reflect a greater binding capacity. There is scatter in the data, as was the case for the sandy soils with the concentration at the interface very high for 1 inch TDA and a higher value for the 2 inch TDA at the 6-12 inch depth. However, as before these zinc concentrations are below New York States’ Brownfield Soil Cleanup Objectives for unrestricted residential use. Accordingly, as before, these concentrations while not of significant concern at the current time, do bear continued observation and analysis.
Figure Four. Iron and Zinc soil concentrations in Clay Soils for 2 inch TDA (Trench 4), Stone (Trench 5) and 1 inch TDA (Trench 6) relative to Background.

Key Learning Points
Key lessons learned from the field work conducted at the Modern Corporation Septic System Demonstration include:

✧ TDA absorption trench integrity was similar to stone;
✧ For absorption trench systems in operation for seven years, TDA continues to perform hydraulically at least equal to or better than stone as trench media.
✧ While metal corrosion clearly occurred in the TDA, it does not appear to influence performance or cause a drop in system performance. Accordingly, it would appear that no special maintenance requirements for TDA systems exist relative to stone aggregate.
✧ TDA does contribute to higher concentrations of selected metals directly below the aggregate/soil interface. After seven years of operation, these levels are not considered a health hazard but do bear continued observation and analysis.