

CITY OF JACKSONVILLE

Innovative Recycling Grant Project Report
Recycling of Food-Service Polystyrene as an Amendment in
Compost and Concrete Production

DEP Contract No. SW 160

Submitted to:

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Innovative Recycling Grant Project – Final Report

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Attachments

Section 1.0 Introduction

1.1 Background

Polystyrene, by volume, is one of the major components of solid waste produced by public schools in the United States. In Duval County, 18 million lunches are served per year to public school students, resulting in a large quantity of polystyrene trays. In an effort to promote recycling and alleviate landfilling costs, Duval County Public Schools (DCPS) started recycling polystyrene. The main problem facing the effort was transportation cost. The nearest facility for reclaiming polystyrene was located in Chicago. The transportation costs, plus fluctuations in the polystyrene market, spurred Duval County to investigate a more feasible method to recycle polystyrene.

Duval County Department of Solid Waste and Resource Management was awarded an Innovative Recycling Grant to explore and demonstrate alternative options for polystyrene food tray recycling. Awarded by the Florida Department of Environmental Protection (FDEP), the innovative grant examined various stages of managing polystyrene food trays from Duval County schools. The original objective of the grant was to investigate the use of ground polystyrene as a substitute for perlite, a common compost amendment in horticulture applications. Size reducing polystyrene using a portable grinder would size reduce polystyrene trays into a form which could be used as an amendment to compost. It was hypothesized that the ground polystyrene trays would be added to yard waste compost. The polystyrene and compost mixture would be lighter than traditional compost, and the polystyrene would provide aeration of the soil and plant root system in a manner similar to perlite. The enhanced compost could then be shipped back to the school system for use in landscaping projects.

Other options for recycling polystyrene were also examined. The following sections outline the four reuse options that were ultimately investigated as part of this project.

1. *Potting Soil Amendment:*

The ground polystyrene was blended with composted yard waste to produce an organic-rich, well-aerated potting soil at Enviro Comp, the City of Jacksonville's contracted yard waste recycler. The potting soil was delivered to public schools in the Jacksonville area for selected mini grant projects, gardens and other campus beautification projects. The schools have indicated that they are very pleased with the results of these efforts.

The potting soil was also delivered to the Jacksonville Electric Authority's (JEA) tree farm for use in the potting of trees. This soil is lighter than the potting soil they normally use, thus, it was easier to handle.

2. *Insulated Concrete Forms (ICF):*

RASTRA is a company that uses a mixture of styrofoam beads, Portland cement, and water to manufacture ICFs. RASTRA ICFs display good insulating properties, lend structural integrity to the building, are fire retardant, and are resistant to insects and vermin. The product was originally designed for its user-friendly properties in do-it-yourself construction. RASTRA is a concrete form system made of a lightweight material that provides a framework for a grid of reinforced concrete. RASTRA mixes the ground polystyrene with concrete to provide insulation for pre-cast walls. Recycled post-consumer polystyrene waste makes up 85% of its volume. This type of panel is used in Europe and the Western United States, but is relatively unknown in the Southeast.

RASTRA has incorporated the ground polystyrene product as a substitute for one-half of the styrofoam beads in the ICF mixture for the panels, with favorable results. The altered panels will be composed of one-third Portland cement powder, one-third recycled styrofoam beads and one-third recycled polystyrene. RASTRA has committed to manufacturing and providing wall panels using the ground product for a structure or structures on Duval County school property. Labor will also be provided by RASTRA to "dry in" the building(s). Negotiations were initiated by Moriah Industries.

A pilot is currently underway in conjunction with Englewood High School in Duval County. The school is planning to expand its concession stands, dugouts, and locker rooms for their baseball team. Preliminary plans are to ship bags of the ground polystyrene product to RASTRA's Arizona manufacturing facility. The finished wall panels will then be shipped to Englewood High School in Jacksonville for installation by RASTRA technicians.

The Jacksonville branch of Habitat for Humanities, HabiJax, plans to construct hundreds of homes in the Jacksonville area in the future and is interested in new building materials and methods to lower construction costs. RASTRA panels can be assembled by carpenters (a less expensive alternative to concrete masons). All of these properties make this product a promising building material for HabiJax.

3. *Concrete Additive:*

Florida Rock Industries is a major concrete and concrete product manufacturer in the Eastern United States. The company has shown interest in ground polystyrene as an additive to poured concrete. Florida Rock has offered to supply the concrete mixture for a sidewalk on school property, a dumpster pad at Ortega Elementary, and for the RASTRA building project at Englewood High School. Florida Rock will add five pounds of ground polystyrene to each cubic yard of poured concrete.

Concrete statutory manufacturers in the Jacksonville area were also provided samples of the ground product for testing. Sand aggregate in the concrete will be substituted with the ground polystyrene product, to make a lighter material than traditional concrete. Since strength is not an issue as it is with construction, a greater proportion of aggregate may be substituted with the ground polystyrene product.

4. *Soil additive for growing sod:*

Florida Carter is a firm specializing in sod development and installation as well as custom laser grading. They will develop test plots amended with up to 25% by volume of the ground polystyrene product and evaluate the product as a growing medium for sod.

1.2 Project Objectives

The primary objective of the project was to develop and demonstrate a more feasible alternative for polystyrene food tray recycling. The project addressed this objective as well as "closing the loop" for a recyclable material and serving as a prototype for other communities to follow. With the portable equipment, this project is certainly "transportable" throughout the state.

Another objective was to identify and troubleshoot any problems associated with polystyrene recycling. A portable grinder was constructed by Moriah Industries to reduce the polystyrene food trays. The grinder adequately reduced the polystyrene trays in size, but there were some concerns regarding personnel safety of the feeding and conveyance system. Also, appropriate methods for breaking down the trays prior to entrance into the conveyance system should be determined. These issues are easily resolved with further evaluation and testing.

1.3 Formal Presentation of Project Results

The progress and results of the project have been discussed and presented in a number of forums. The project was presented by Jack Saye (Duval County) at the 1999 Recycle Florida Today (RFT) Conference in Stuart, Florida, May 16-18. The project also received an award from RFT for "Best Innovative Recycling Grant 1998-1999". A copy of the RFT Annual Conference and Exhibition program is attached for viewing the formal presentation, as Attachment A, *Formal Presentation*.

A short article was written for the September 1999 issue of *Plastics in the Environment* titled "Moriah and Rastra cooperate to divert polystyrene trays into school buildings". The project was also discussed in the September 13, 1999 issue of *Plastics News* as well as the September 13, 1999 issue of *Waste News*. A paper discussing project results has been prepared and will also be submitted to *Resource Recycling* magazine. Jack Saye and Jackie Eldridge appeared on the government access cable talk show *Jacksonville on the Move* to discuss the polystyrene recycling project on Thursday, August 27, 1999.

Section 2.0

Project Implementation

This section describes the process of project implementation. Information is included on the parties and services contracted, methods of implementing the project, and the project tasks and timeline.

2.1 Equipment and Acquisition of Services

In order to meet the objectives of the project, a portable grinder with a screening mechanism was built by Moriah Industries, Rome, Georgia. Moriah was paid for research and development, and they retained ownership of the grinder. Moriah was also contracted to grind the polystyrene for use in the compost. They have also initiated communication with RASTRA to explore new business prospects.

The University of Florida Department of Environmental Engineering Sciences was contracted to conduct a market analysis for the ground polystyrene. The University was also contracted to perform analytical tests on various polystyrene mixtures and to evaluate the grinder. The results of their efforts are described in *Market Evaluation of Size-Reduced Polystyrene from School Cafeteria Food Trays*.

TIA Solid Waste Management Consultants were contracted to conduct a study to determine polystyrene recycling rates. A report was prepared in order to satisfy requirements set forth in the County's contract with FDEP.

Florida Rock Industries donated time and services to the project as well. These services include concrete, mixing, and analytical tests.

American Tire Recyclers donated the material for the REBOUND projects at the schools.

Michael Padgett Trucking, Inc. was contracted to haul the polystyrene/compost mixture to schools, parks, and nurseries in Duval County.

2.2 Implementation of Cooperative Recycling Effort

The County and School District partnered together to make the program work. Duval County alone serves over 18 million meals per year, making polystyrene food trays a large percentage of their waste stream. This project has addressed a common problem for school districts across the United States by implementing a program that targets one of the largest waste fractions. This project served as a model for other municipalities to follow.

2.3 Project Tasks and Timeline

The project was composed of several tasks. The first task was to collect the polystyrene food trays, grind them, blend the polystyrene/compost mix, and distribute this mixture to the schools. The second task was to conduct education through various media such as teachers, videos and newsletters. A third task was to investigate other polystyrene reuse options such as in RASTRA ICFs, and in concrete mixes. A detailed description of project elements follows. The project timeline is presented specifically in Attachment C, *Project Timeline*.

2.3.1 Composting and Distributing Ground Polystyrene Food Trays

The major elements of this project provided a local recycling alternative for the school district, since prior to the proposal, the polystyrene was being trucked to Chicago for recycling. The schools were visited and instructed on proper recycling techniques. Assistance was provided to the schools to encourage student polystyrene recycling. Custodial training sessions were provided and recycling information was included in paycheck envelopes of these employees to ensure proper procedures were being used when handling polystyrene. Meetings with cafeteria supervisors and managers were also held.

Students put their used polystyrene food trays into receptacles located in the cafeterias, and the material was then deposited in specially designated dumpsters by school custodial staff. Spent polystyrene food trays were collected from the dumpsters by BFI, the school system's contracted waste hauler. BFI then took the polystyrene to their recycling facility. MRF (Materials Recovery Facility) staff sorted and baled the spent food trays. BFI collected the polystyrene from the MRFs and trucked it to the Moriah processing center in Jacksonville for grinding until August 31, 1999, when their contract expired. Prior to bringing the grinder to Jacksonville, 37 bales of the polystyrene, which had stored at BFI Jacksonville, were transported to Rome, Georgia for early testing of the machine.

Two forty cubic yard roll off containers were filled with discarded, bagged polystyrene lunch trays from the Duval County Public Schools were delivered to the grinder weekly, until the end of the regular school year. During the summer break, BFI delivered baled polystyrene food trays, which had been stockpiled at the BFI Jacksonville MRF. If space allowed, several bales of polystyrene, which had been stockpiled at the BFI facility, were incorporated into the roll off for processing. Moriah then ground the polystyrene and Enviro-Comp, the City of Jacksonville's yard waste recycler, blended it with composted yard waste. Blended material was then sent back to the schools for landscaping as well as the JEA (Jacksonville Electric Authority) Tree Farm, Greenscape flowering tree sale sites, American Rubber Technologies and Tree Hill Nature Center. It is estimated that about 3.5 tons of ground polystyrene was produced each month, excluding processed baled polystyrene.

It is important to note that Moriah processed a total weight of 77,490 pounds of spent polystyrene food trays and that this material was made available for use in composting to schools and other businesses in Jacksonville. This amount of material represents almost

2 years worth of polystyrene, due to the fact that BFI stored approximately 500 bales instead of recycling it. Therefore, the actual amount of waste polystyrene that TIA calculated includes this extra 500 bales from BFI in addition to what was actually recovered.

2.3.2 Education and Information Dissemination

Samples of the product and flyers describing the Innovative Grant were presented to the Duval County Public School teachers as they visited the District's Teacher Supply Depot. The Depot serves as a warehouse of reusable materials from donations made by area businesses and community leaders. Hundreds of teachers visit the Depot at scheduled openings.

Activity booklets were distributed to students featuring recycling, composting and gardening techniques. Also, a handbook for use by the schools was written. It provides proper recycling and solid waste procedures, as well as descriptions of the school district's environmental activities and several locations for student field trips.

An informational video was supposed to have been written by one of the school district's television production magnet schools, but technical problems at the school prevented this from taking place. The project was also discussed on the local government access cable talk show *Jacksonville on the Move*.

This project served as a model for other cities and counties to follow. Many educational programs were and will continue to be presented about this program. Thus, educating everyone, from students and parents to government employees, on the benefits of recycling polystyrene. Educational materials were produced about the program and are now readily available to anyone for review.

2.4 Problems Encountered and Solutions Developed

No serious problems were encountered in this project. However, there were some changes made in the project elements and budget in order to implement the project as planned. These changes should be viewed as mistakes that future projects on this subject may avoid. They are discussed in the following paragraphs.

2.4.1 Operation/Production

Several production/operation difficulties with the grinder such as safety, engine speed, and capacity were identified, so a large quantity of used polystyrene in bale and bag form was initially transported to Rome, Georgia for grinding and then shipped to Enviro-Comp. Moriah Industries successfully repaired these problems and transported the machine to Jacksonville. Originally, the initial plan was to house the grinder at BFI, Inc., however, operational and design issues concerning the machine made placement of the

grinder at BFI impossible. To rectify the situation, Moriah Industries secured rental space at grant expense to house and allow for operation of the machine until the end of the grant period.

No major problems related to the operation of the grinding machine were further reported except some odor, which resulted in several complaints from neighbors close to the grinding site. Due to changes in the status of the contract between the school district and BFI, the need to relocate the machine was negated.

The contract between BFI and the school district expired on August 31, 1999. Polystyrene was excluded as a recyclable material in the new contract, therefore, the school district no longer had a hauler for the polystyrene food trays and the flow of incoming polystyrene food trays from the public schools has stopped. The spent food trays are now being placed into solid waste dumpsters instead of recycling containers, with the hope that a viable market for recycled polystyrene will be determined. A detailed discussion of these efforts is discussed in the introduction of this report, section 1.1. An amendment to the Innovative Recycling Grant contract was made to extend the length of the Innovative Grant Period to February 13, 2000. Another request for an amendment was made to allow a waste audit of the Duval County Public Schools spent food service polystyrene, and an analysis of potential markets for the polystyrene.

Section 3.0

Project Results

3.1 How Project Objectives Were Met

This project was developed by Duval County (Jacksonville) to demonstrate feasible alternatives for polystyrene recycling. The goals and objectives set forth in the grant project were met to their fullest expectations. The participants achieved this objective by identifying and fostering the development of a self-sustainable method for recycling spent food service polystyrene.

With respect to the Duval County Public Schools, all participants were very pleased with the results of their individual projects. Students have learned about recycling and composting, and have enjoyed the activities that have grown from receiving the polystyrene/compost mixtures. The REBOUND project for the football field has received praise as well.

It is anticipated that the public education and awareness of polystyrene recycling will continue to increase. Additionally, the equipment and procedures for processing polystyrene will continue to be evaluated. Necessary modifications to the process will be made in order to make the program operate as efficiently as possible.

Polystyrene recycling containers were administered at selected school sites and students and staff at the schools were instructed on proper recycling techniques. Recycling incentives and educational materials were provided for students and staff. Several schools received activity books featuring gardening and composting methods.

Amended soil was distributed to schools for use in school projects. Deliveries of the ground polystyrene/compost mix were made to numerous school sites for use in campus beautification projects. The schools have been very pleased with the results. Mini-grants were developed and awarded to schools for additional project materials. Several schools received funds to plant gardens, and one school incorporated the garden into the math and science curriculum.

A product called REBOUND was designed for use as a geomaterial, and has been incorporated in this project using the ground polystyrene food trays. This product generally results in a well-drained area and provides a bouncy feel for athletes, leading to fewer injuries. The ground polystyrene/compost mix was used as the organic supplement to ground shredded tires for use on athletic fields and has shown favorable results. REBOUND projects for two schools have proven to be successful.

RASTRA and Moriah Industries are working together to form a new company called EnviroWall in Florida, an offshoot of the two companies. Agreements with investors are to be handled in the next few months, with hopes to have an operating plant built within a year. It is evident that private industry is now taking the lead to establish a market for the ground polystyrene while gaining a profit.

Because all of these markets were explored and results were favorable, it has paved the way for developing additional markets and serving as a prototype for other communities to follow in solving their own polystyrene recycling issues.

3.2 Using Advanced Technologies or Processes

Prior to this proposal, the polystyrene was trucked to Chicago for recycling. This project provided a local recycling alternative. The portable grinder grinds the polystyrene, which is blended with the compost from the County's residential yard waste program. The blended polystyrene/compost mixture is then provided at no cost to schools and the public within the County, closing the loop for recycling polystyrene locally.

3.3 Increasing the Amount of Recovered Materials

Duval County was serving over 18 million meals per year to students on polystyrene food trays. The project created a beneficial use for these spent polystyrene food trays. Since this material was being trucked long distance prior to the proposal, there was no reuse benefit from using it. By mixing the polystyrene with compost as well as using it in the REBOUND project, these materials were recycled for beneficial use. Not only was the polystyrene reduced in size, but removed from the waste stream.

3.4 Transferability of Technology and Processes

This project served as a prototype for other counties/cities to follow. Many educational programs were and will continue to be presented about this program. Thus, educating a wide spectrum of the community, from students and parents to government employees, on the benefits of recycling polystyrene. Since the educational materials produced in this project are public domain, they are available for anyone to review.

3.5 Analysis of Cost Effectiveness

In an ideal setting, polystyrene recycling is economically feasible and environmentally beneficial. Reduced tipping fees and fewer waste pickups are examples of the economic and environmental benefits of polystyrene recycling. TIA Solid Waste Management Consultants found that 78 percent of the polystyrene in DCPS's waste stream could have been recovered. TIA further observed that this recovered polystyrene would be 4% of

DCPS's total solid waste stream. BFI estimated the total waste stream generated by DCPS between July 1998 and June 1999 to be 12,000 tons. Thus, approximately 470 tons of polystyrene would not have been landfilled as a direct result of these recycling efforts.

Although 470 tons of polystyrene were recovered, it should be noted that the actual recycling rate is likely less than 470 tons due to contamination levels. It was observed that participation and recycling rates increased when schools exercised more control over the recycling process. Suggestions were also made regarding recycling procedures by using signs close to the receptacles, posters throughout the schools and teacher/principal announcements to facilitate recycling.

Participation and recycling rates also increased from elementary schools to middle schools to high schools. This trend likely occurs because there is more supervision over elementary and middle school students than high school students during lunchtime.

Before the project was initiated, DCPS disposed of spent polystyrene using one of two routes: landfilling or shipping the polystyrene to Chicago to be recycled. The average tipping fee in Jacksonville for municipal solid waste (MSW) is approximately \$35 per ton. TIA estimated that 470 tons of polystyrene were recycled. Landfilling cost for the recycled polystyrene would have been close to \$16,500. On the other hand, if DCPS decided to recycle the polystyrene by shipping it to Chicago at a rate of \$1,500 per ton, the total for 470 tons would be an estimated \$700,000.

One of the recycling options for polystyrene that was addressed in this study is composting. The city of Jacksonville approximately composts 200,000 tons per year of yard waste. If polystyrene was added to the compost at a ratio of 1:5, 40,000 tons of polystyrene could potentially be added to compost per year. Polystyrene processing, excluding the hauling cost of \$1.33/ton, costs an average of \$675 per ton. Thus processing of 470 tons would cost \$320,000. This option is more cost effective (\$380,000 savings) than shipping it to Chicago for recycling. This will not only save money, but will create jobs in the local economy. However, polystyrene processing is more expensive than landfilling (\$300,000 more). This could be misleading since there are intangible environmental costs that could not be accounted for. Landfilling of the inert polystyrene uses up valuable landfill space, which could be used by other solid waste.

Another recycling option that was investigated is the addition of polystyrene to poured concrete. Florida Rock estimated a mix of polystyrene in concrete to be 7.5 pounds of polystyrene per cubic yard of concrete. According to a source at Florida Rock Industries, 37 tons per year of polystyrene could be recycled for use in concrete in the city of Jacksonville. Jeff O'Leary, director of technical services at Florida Rock, indicated that this option is not cost effective for Florida Rock. Nevertheless, the diversion of 37 tons of polystyrene at \$676.33 per ton processing cost would save DCPS an estimated

\$25,000 as opposed to shipping 37 tons to Chicago for processing at \$1,500 per ton. Again, this option would cost more than landfilling, but one could argue that closing the recycling loop and creating new jobs would outweigh the difference in cost.

3.6 Enhancing the Marketability of Non-Traditional Materials

Typically, polystyrene is not a recyclable material in most county/city recycling programs. Options are available if manufacturers exist in the area; however, this was not the case for Duval County. It was decided after careful consideration that removing polystyrene from the waste stream would be the most efficient and economical. The program has enhanced the visibility of recycling polystyrene. The three major markets that were explored are horticultural, geomaterial and construction applications. These markets were already available, but not in great use. The market analysis indicated that alternatives do exist for recycling polystyrene and that they are feasible.