



Leon County

Solid Waste Management Division

7550 Apalachee Parkway, Tallahassee, FL 32311

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Project Information (on applicant letterhead)

- 1) Applicant Name: Leon County (in partnership with Florida State University and Florida A&M University).
- 2) Primary contact person: Nancy Hopkins Paul
- 3) Complete Address: Leon County Recycling Coordinator, 7550 Apalachee Parkway, Tallahassee, FL 32311
- 4) Telephone Number(s) (including SunCom number): Phone:(850) 414-9346
- 5) E-mail address: : Pauln@mail.co.leon.fl.us
- 6) Project Title: Beneficial Reuse of Waste Materials (tire chips, glass cullet, M1 tire steel and yard waste) to Control Odors and Methane Release from Landfills.
- 7) Grant Request Amount: \$192,850 (with an additional \$58,000 of in kind matching)
- 8) Length of project (months): 12

Authorizing Signature

Title

PROJECT ABSTRACT

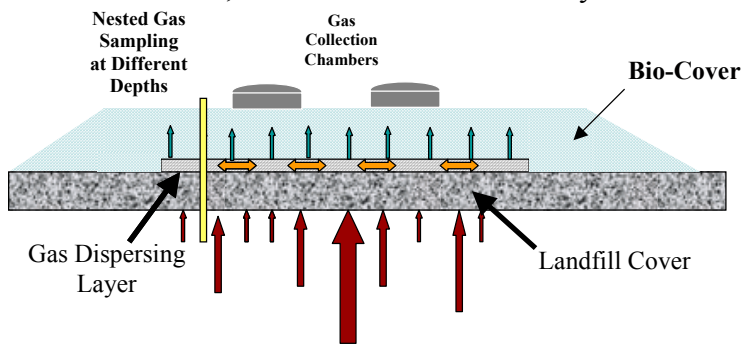
(No more than 20 lines. Every word over 20 lines will result in a one point deduction by grant application reviewers.)

Leon County proposes to team-up with Florida A&M and Florida State University to use tire chips, M1 steel (a waste product from the chipping of tires for which there is currently no use whatsoever), glass cullet, ground pallets and yard waste to construct (1) bio-cells capable of reducing odors and methane and organic compound emissions and (2) iron-containing cells to capture odorous sulfur gas emissions from landfills. The waste materials, tire chips, glass cullet and M1 steel, will be mixed with mulched yard waste and ground pallets and applied to the landfill surface as a “biocover.” The bio-cells will serve as attachment sites for methanotrophic bacteria and as a place for the reduced gases (methane and H₂S) to mix and co-mingle with O₂ in the presence of bacteria and tire iron. These bacteria specifically oxidize methane and other odor producing gases to form biomass and carbon dioxide (odorless). Hot spots of gas emission on the landfill surface will be identified with a portable gas analyzer. Emissions will be quantified and then a treatment of either glass cullet or waste tire chips mixed with compost will be applied. Different treatments will be investigated. Laboratory and field studies will be conducted to optimize the mobilization of iron from M1 steel in a field bio-cell application. Iron is quite reactive to hydrogen sulfide, a particularly foul smelling toxic compound that is released from C&D landfills from the decay of gypsum in sheetrock or wallboard. We anticipate that the iron in M1 steel can be used to sequester hydrogen sulfide as inert iron sulfide minerals. This project would target waste tires, which have a disposal fee and fund Florida’s Solid Waste Management Trust Fund. M1 steel has no use and is land-filled. We calculate that a 1 meter thick cover spread over an acre would use roughly 4500 cubic yards of waste material.

PROJECT DESCRIPTION (1 page)

Leon County Landfill and many other landfills across the state and country make bad neighbors due to emissions of odors associated with the decomposition of buried waste (Tallahassee Democrat, May 31, 2004). Waste decomposition in a modern landfill occurs under anoxic conditions resulting in the formation of reduced gases such as methane (CH_4), hydrogen sulfide (H_2S) and volatile reduced hydrocarbons (non-methane organic compounds, NMOCs). In larger landfills, federal regulations require active gas collection and flaring, but in smaller older facilities these systems are not required and are not feasible economically. Gas collection systems are also not required in C&D landfills. However, in all landfills, even landfills with gas collection systems, hot spots of gas release develop due to heterogeneity in the buried waste or soil cover, weaknesses in the soil cover or drying and desiccation followed by cracking of the soil itself. We propose to use mixtures of *tire chips, M1 steel, glass cullet, ground pallets and mulched yard waste* to treat and eliminate these emissions.

Recently, it has been learned that within the oxidized outer layer of soil covering landfills reside bacteria which specialize in consuming methane and NMOCs, thus attenuating their release to the atmosphere. Efforts have been devoted towards the design of approaches for measuring the effectiveness of these bacteria and for designing covers that optimize their performance. The reactivity of hydrogen sulfide (H_2S) has not been determined in these systems, but H_2S participates readily in chemical reactions with iron and oxygen, and can react to form either elemental sulfur or iron minerals, both of which are relatively inert.



We propose to construct biocells to oxidize methane and NMOCs, and iron-containing cells to oxidize and consume H_2S using waste materials: tire chips, M1 steel, glass cullet and mulched yard waste and pallets. These cells would be designed to enhance both biological and chemical oxidation of reduced gases. The cells would be placed over emission hotspots located by visual inspection and with a portable gas

analyzer. Gas emissions would be quantified before and after placing the proposed cells over the hot spots and the effectiveness of the biocell in reducing gas emission would be monitored over time. The idea is to construct an area where prolonged contact of the reduced gases and oxygen can co-mingle in the presence of bacteria, iron and moisture thus providing an optimum environment for the elimination of these odorous and infrared active compounds. The biocells will be constructed based on the previous experience developed by the team in designing compost biocells. Laboratory testing will be performed to optimize the effectiveness of steel shards in tire scraps (M1 steel) for the sequestration of H_2S through its reaction with iron. A field scale trial over a C&D landfill will then be constructed.

We have access to instrumentation to measure and analyze methane and hydrocarbon gases, but request funds to purchase and set up a state of the art facility for the analysis of sulfur gases including but not limited to H_2S . This would allow us to address the effectiveness of our recycling effort in the reduction of odors from landfills in a quantitative way.

Criteria 1: TECHNOLOGIES (1 page)

(35 points) 0-15 points for meeting one of the following sub-criteria, up to 10 more points for meeting two, and up to 10 more points for meeting all three

Sub-criteria 1 – Not in common use in Florida

This project will demonstrate a novel use of waste materials (waste tire recycling by-product, spent pallet waste from the commercial sector and mulch from residential yard waste collections) to reduce environmental pollution and make landfills more acceptable to their surrounding communities. The reuse or recycling of the targeted materials for the control of noxious gas emissions and odor reduction from landfills is not a common practice in Florida or in the United States. Currently in the USA only two studies have been conducted using bio-covers to reduce methane and NMOC emissions. One study was recently conducted by Waste Management Corporation at the Outer Loop Landfill near Louisville Kentucky. A biocover was constructed to consist of a 15cm thick layer of tire chips covered with a meter of shredded yard waste. The study concluded that such biocovers can reduce landfill gas emissions in the absence of a gas collection system and can serve as a polishing step in the presence of an active system. A second study is being conducted by the FSU/FAMU team (Drs. Abichou & Chanton) at the Leon County Landfill. This study employs biocovers consisting of 10 cm layers of glass cullet overlain by variable thickness and ages of mulched yard waste. In both of these studies, the tires and glass cullet serve as gas distribution layers with primary treatment provided by the compost layer. A third biocover study has been conducted in Austria by Marion Hummer for her Ph.D. work. This biocover consisted of a 30 cm gravel layer overlain by a meter of mulched yard waste mixed with sewage sludge. Interestingly, Dr. Hummer found that a considerable fraction of the methane and NMOC oxidation occurred in the gravel layer. Chanton/Abichou have observed similar findings in meso-scale laboratory studies, the distribution layer of glass or gravel can oxidize substantial quantities of methane.

This proposal builds on the previous work by expanding the distribution layer to be the primary treatment area. Thus we intend to construct cells three types of cells. Two types will contain primarily tire chips or primarily glass cullet. Both of these substrates will be mixed with 10 to 25% compost & ground pallets to retain moisture. This expanded use of tire chips and glass relative to compost has not been utilized previously. A third type of cell will investigate the use of steel chards from tires (M1 steel) to control hydrogen sulfide; to our knowledge, this has not been tried elsewhere.

Sub-criteria 2 – Novel application of an existing technology or process.

This proposal is to use recycled materials in a unique way to construct biological and chemical filters to reduce the emission of a powerful greenhouse gas (methane), toxic and carcinogenic hydrocarbons (NMOC's) and odorous compounds (NMOC and sulfur containing gases from landfill. This will make landfills better neighbors and raise property values in areas surrounding landfills.

Sub-criteria 3 – Overcoming obstacles to recycling/waste reduction in new or innovative ways

Creating uses for M1 steel is particularly important; currently it has no use whatsoever. It is just buried in landfills. Over 15 million waste tires are estimated to be generated in Florida annually and 70% of those tires that are collected and transported for "recycling" are burned as Tire Derived Fuel (TDF). A very small percentage of processed/recycled tires are used for innovative products in Florida (e.g., sport track and field surfaces, playground equipment and underlayment, and septic drain-field materials).

Criteria 2: TARGETS

(1 page)

(10 Points) Demonstrate innovative processes to collect and recycle or reduce these targeted materials/sectors: Construction and Demolition Materials, Commercial/Institutional Sectors, Waste Tires. Note: if the proposed project also includes materials/sectors other than those targeted by this criteria, the project will receive less than the maximum 10 points allocated for the criteria.

This project would provide the necessary information/data and field trials to demonstrate the widespread usefulness of processed tires chips and M1 steel, a by product from the production of tire chips for which there is currently no use whatsoever. We will also use glass cullet, mulched yard wasted and ground pallets. Our objective is to control landfill gas emission with the aim of odor abatement. This project, if successful, would reduce the market obstacles faced by the targeted materials. As an example, over 15 million waste tires are estimated to be generated in Florida annually and 70% of those tires that are collected and transported for “recycling” are burned as Tire Derived Fuel (TDF). A very small percentage of processed/recycled tires are used for innovative products in Florida (e.g., sport track and field surfaces, playground equipment and underlayment, and septic drain-field materials). Production of these innovative products generates M1 steel which is of no use. M1 steel is a “brillo”-like material with rubber tire pieces within it.

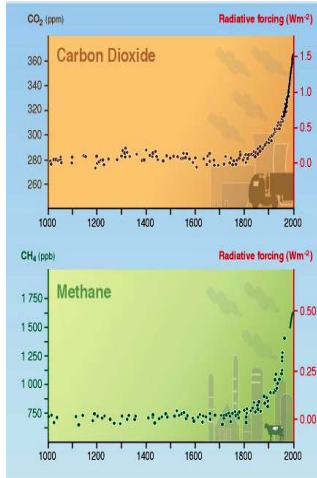
This innovative project will demonstrate effective solutions to solving solid waste problems resulting from the project’s targeted materials, particularly in the areas of enforcement and abatement of illegal tire dumping and activities to promote market development of waste tire products.

This project would use Leon County tires described above, transport them to Jacksonville’s ART (Advanced Rubber Technology) for size processing, and then bring these processed tires and M1 steel to the Leon County landfill for construction of gas abatement biocells.

Leon and surrounding counties in the panhandle of Florida currently have no other market outlets for waste tires. Tires are shredded or cut to minimum size requirements (set by DEP rule) and either land-filled or used as Tire Derived Fuel in permitted industrial boilers, mostly outside the state. In addition to waste tires, this project will utilize glass cullet, ground pallets and composted yard waste. It would be acceptable for the yard waste to contain shreds of plastic bags.

A large portion of the glass cullet will come from fluorescent light tubes. A commercial facility in Leon County removes mercury from these tubes and deposits the chipped glass at the Leon county landfill where it is stored in large piles. Our project would utilize this waste material.

Criteria 3: BENEFITS (1 page)



(35 points) Demonstrate the potential economic, environmental, and cost-effectiveness of the program's approach.

Sub-criteria 1 - Environmental Benefits (15 points)

Methane (CH₄) is a greenhouse gas with an infrared activity 25 times that of CO₂. Its concentration has increased in the atmosphere by a factor of 2 over the last century (Fig.). The bulk of CH₄ emissions are anthropogenic and could be reduced. On a global scale, landfills make up 40 Tg/yr of a 500 Tg/yr total source, 8%. The imbalance between sources and sinks of CH₄ in the global budget is less than 6% of the total of global sources so a small decrease in CH₄ source strength could result in stabilization of atmospheric CH₄ or even better, a reduction in the atmospheric concentration. As CH₄ is a more potent greenhouse agent than is CO₂, lowering the atmospheric CH₄ concentration is a very realistic and worthwhile goal. The relatively short residence time of CH₄ in the atmosphere (7-10 yr) relative to CO₂ (100 yr) means that the effects of mitigation efforts would be rapidly observed. Furthermore, CH₄ has no constituency, and grappling with the problem of excess greenhouse gases in the atmosphere (Figure) could be easily approached by reducing CH₄ emissions.

In addition to CH₄, landfill gas contains trace organic compounds (NMOCs) at pptv to ppmv levels including alkanes, aromatics, chlorinated aliphatic hydrocarbons, alcohols, ketones, terpenes, chlorofluoro compounds (CFCs), and siloxanes. Emission of NMOCs is a potential risk to human health, as compounds like vinyl chloride and benzene are proven carcinogens. Many of these compounds biodegrade under aerobic conditions, so that a cover that enhances CH₄ oxidation will also result in decreased emissions of trace organic compounds. Many of these NMOC's produce odors, and are partly responsible for the bad smells associated with modern landfills. Hydrogen sulfide is sulfur (S) containing gas produced from the reduction of calcium sulfate (gypsum) in wall board. It is a toxic volatile gas with a smell like rotten eggs. It is highly reactive with oxygen and with iron in steel.

Sub-criteria 2 – Economic Benefits (10 Points)

Because this project supports the utilization of a waste products (M1 tire steel), mixed glass cullet from the curbside recycling program and waste fluorescent tube glass, for which there very limited markets:

- ART (American Rubber Technology) will be able to reduce its disposal costs,
- Duval County's waste stream will be reduced (currently \$78/ton), (this is where the M1 steel currently is landfilled)
- Leon County's waste tire disposal costs will be reduced,
- Leon County will be demonstrating that landfills can, with proper odor control, be a good neighbor to surrounding residential neighborhoods, and
- Landfill management and recycling programs can compliment each other.
- **Sub-criteria 3 – Cost Effectiveness (10 Points)** Includes, but not limited to cost reduction, payback period, sustainability, and cost-effectiveness.

With increasing transportation costs for moving materials to markets, it is important for local governments to seek local markets for its recovered materials. With the State's permission to use these types of projects as recycling credit, overall solid waste management practices will improve. Additionally, passive gas treatment systems such as the one proposed here are much more cost effective than the installation of conventional landfill gas management strategies such as vacuum gas extraction and flaring.

Criteria 4: TRANSFERABILITY

(1 page)

(10 Points) Demonstrate transferability of technology and processes and specify how the project will promote transferability. Note: applicant may adjust space used to address each sub-criteria.

Sub-criteria 1 – Transferability of technology and processes (5 points)

The technology used in this Innovative project will be easy to duplicate and transfer to other public and private solid waste management facilities. The practices developed from this project can easily be incorporated into any post closure operating plan. The Leon County facility has an intermediate rather than a final cover situation which allows it to reserve existing capacity for emergency situations. This technology may allow similar landfills this same option for emergency capacity as regional landfills become the norm. Across the state there are 160 Construction demolition (C&D) landfills, 60 class 1 landfills and 34 class 3 landfills. Many of the 160 C&D landfills are privately owned. The technology would be applicable to every landfill both during ongoing landfilling operations and in final closure stages. Used tires, compost and glass cullet are waste streams which are widely available. We calculate that a 1 meter thick cover spread over an acre would use roughly 4500 cubic yards of waste material.

Sub-criteria 2 – How project will promote transferability (5 points)

With over 95 active Class I, II and III landfills and 163 active C&D landfills in Florida and many others closed and regulated or monitored, the potential for this project to transfer knowledge, data, and processes is documented and necessary. Reducing landfill gas emission is of primary importance, both in terms of odors and greenhouse gas production. With the partnership established here, FSU, FAMU and Leon County, transferability of data and information garnered from this project is guaranteed. FSU/FAMU School of Engineering with the help of the Service Learning Program at FSU will establish a mentoring program for other counties, particularly small rural counties in North Florida. One of the deliverables from this project will be a Best Management Practices Manual for Passive Management of Landfill Gases and Odors. Chanton and Abichou are both effective public speakers and will visit other counties across the state to advise them on the practices necessary to adopt the practices developed here. A power point presentation will be developed and a placed on a web site which will document the project. Information will be given in presentation to the Florida Association of Counties and article written for American City and County magazine. We will also contact local newspapers and television stations about this work. A Technical Advisory Group will also be formed for the project. This group will have quarterly meeting to review and guide the research activities throughout the duration of the project. Publications would be written for the scientific literature.

Jeff Chanton and Tarek Abichou are on the faculty of Florida State University and the FAMU/FSU College of Engineering respectively. Chanton has worked with greenhouse gas emissions in a number of settings from landfills, to northern wetlands to the deep sea. His landfill experience includes work in Florida, Kentucky, France and Sweden. Abichou is an civil/environmental engineer and specializes in alternative covers for landfills. He has been involved with EPA and NSF funded projects to manage water infiltration and gas emissions from a number of landfill setting across the USA.

Criteria 5: LOCAL SUPPORT

(1 page)

(10 Points) Demonstrate local support for the proposed project in commitment of cash or in-kind matching funds.

- **00 points 0% up to and including 1% of total project cost**
- **01 points Greater than 1% up to and including 10% of total project cost**
- **02 points Greater than 10% up to and including 20% of total project cost**
- **03 points Greater than 20% up to and including 30% of total project cost**
- **04 points Greater than 30% up to and including 40% of total project cost**
- **05 points Greater than 40% up to and including 50% of total project cost**
- **06 points Greater than 50% up to and including 60% of total project cost**
- **07 points Greater than 60% up to and including 70% of total project cost**
- **08 points Greater than 70% up to and including 80% of total project cost**
- **09 points Greater than 80% up to and including 90% of total project cost**
- **10 points Greater than 90% up to and including 100% of total project cost**

As the budget reflects, there is a 30% match of the \$192,850 budget request. Project partners are dedicated to this project and are confident that results will provide methods of reducing green house gases, reducing odors associated with landfills and contribute to the long term care of Florida's environment.

In kind matches are faculty time devoted to the project while Chanton and Abichou are on their regular 9 month appointments, Leon County support in terms of equipment operation and construction. American Rubber Technology use of permits and hauling, and use of FSU/FAMU facilities and equipment.

BUDGET (1 page using Budget Table Template)

Task 1. Purchase and set up gas chromatograph and chamber equipment to measure sulfur gas emissions from landfills. Specialized equipment is required to measure the response of Sulfur gas emissions to the bio-cell and M1 steel cell treatments. We will use Teflon dynamic chambers to measure gas emissions and a gas chromatograph with a Flame Photometric detector to measure Sulfur gas concentrations. Chanton (FSU) has considerable experience with gas chromatography. Additionally a permeation tube device is required to calibrate the gas chromatograph. Total costs for the gas chromatograph and permeation tube system is \$20,000. Personnel to set up the device and get it working is estimated at 2 technician months time at \$7000. An additional \$4000 in supplies for the construction of dynamic chambers is also requested. In kind match of Chanton's time \$5000.

Task 2. Survey the landfill with a portable methane emission detector to locate hot spots of landfill gas emission. We possess a portable device with a flame ionization detector which we can use to survey the landfill for gas emission hotspots. With a GPS we will locate these spots. Time estimated, 1.5 technician-months @ \$5250. Supplies include calibration gases and spare parts, \$400. In kind match of \$5000 for use of equipment @FSU/FAMU.

Task 3. Measure gas emissions from hot spots prior to treatment with bio-cells and chem.-iron cells. We will use our chamber techniques and measure methane and hydrocarbon gases emissions from a number of "hot spots" of landfill gas emission prior to treatment. Sulfur gas emissions will be treated in a separate task below. Methane concentrations will be measured by flame ionization gas chromatography in our lab at FSU/FAMU. NMOCs will be measured at a contract lab in California at a cost of \$3000. We estimate this portion of the project will consume 3 person months @ \$10,500. Supplies of \$600 will be consumed, calibration gases, carrier gases, sample containers, batteries. In kind match of \$5000 for use of equipment @FSU/FAMU.

Task 4a. Tire transportation and processing Contractor, American Rubber Technologies to shred and haul tires, \$15,000 plus an in-kind match of \$5,000 for permits and hauling.

Task 4b. Construction of biocells. Supervision of construction 1 person month of time, \$3500. In kind match, Leon County landfill, heavy equipment operation \$10,000.

Task 4c. Install thermocouples, water content reflectrometers at several depth of the biocover to monitor temperature and water content. Install data collection system powered with solar panel and rechargeable battery \$11,500

Task 5. Monitor emissions from biocells, following their construction for 9 months. Methane and NMOC emissions would be monitored with the chamber techniques and FID gas chromatography as described in Task 3. NMOC's will be measured at a contract lab in California at a cost of \$7000. We estimate 9 months of technician time at \$31,500, \$5000 for lab and field supplies. In kind match of \$5000 for equip. @ FSU.

Task 6. Lab studies to maximize sulfide uptake by M1 steel. Initial column studies in the laboratory will investigate the best ways to mobilize the M1 steel to increase its availability to sulfur. Variables studies will be exposure to moisture, oxygen and grain size and packing density of the M1 steel. We estimate 5 person-months at \$17,500 and \$5000 for laboratory supplies including columns, chemicals and reagents.

Task 7. Construct field biocell with M1 steel on C&D site. Labor, 1 person month at \$3500, supplies \$600, \$10,000 contractual to American Rubber Technologies. In kind match of \$5000 by Leon County for heavy equipment operation. Match of \$5000 from American Rubber for permits and hauling, Permit, \$500, other.

Task 8. Measure gas emissions from M1 steel biocell. Will use Sulfur gas chambers and analyzer. Four months of technician time estimated, \$14,000, lab supplies including high purity gasses for the gas chromatograph, standards, field supplies @ \$4000.

Task 9. Manage and administer project. Leon County \$10,000.

Task 10. Prepare quarterly and final reports. Leon County - \$10,000.

Task 11. Transfer information gained in this project: Abichou and Chanton workshops and seminars mentoring other counties, local workshop (in other), \$4000 In kind match, \$7000. Travel, \$3000, projector \$1500