

VOLUME 10

Deliverables to meet work plan objective 9: Provide a resource and training ground for students in the state university system, landfill operators, and engineers in Florida.

10.1 Work Plan Objective and Deliverables

Objective 9 of the project work plan was:

Provide a resource and training ground for students in the state university system, landfill operators, and engineers in Florida.

The work plan identified the following methodology to meet objective 8:

In addition to the students directly involved with the project research, the demonstration project will also be an opportunity for all students in the SUS to learn about bioreactor landfill technology. The Center will sponsor a series of meetings specifically for SUS students that include both classroom presentations and visits to the site. The project team will also explore other funding sources for summer student internships and co-ops working on the project.

The information gathered in the project will be disseminated in a manner that it will benefit interested landfill operators and engineers. Once the project is established, training courses coordinated by the Center will be held for landfill operators. Training courses also will be provided by the researchers in regard to the design and operating procedures developed as a result of the project. The information gathered in the project will be routinely presented to the solid waste community in Florida, at such forums as technical awareness group meetings and Florida SWANA meetings. All of the information gathered in the project will be made available as part of the project's web site.

The deliverables identified in the work plan included:

- *Schedule and description of training opportunities.*
- *Report on the attendance and results of training opportunities.*
- *Plan for extending training after the project.*

10.2 Knowledge Dissemination

The Florida bioreactor demonstration has contributed to provide a resource and training ground for students in the state university system, landfill operators, and engineers in Florida. Volume 10 summarizes the project contribution on programs in the state university system and training courses for landfill operators and engineers. Section 10.3 described the contribution of the project to students in state university system, section 10.4 described two bioreactor workshops, section 10.5 lists presentation made for the solid waste community, section 10.6 summarizes “Bioreactor Operation Guide” and section 10.7 lists conclusions.

10.3 Educational Contribution for Students in SUS

Students from both the University of Florida and the University of Central Florida played a major role in the project. A large number of graduate students used research from the project as the major subject of their thesis or dissertation. Other graduate students also participated on the project and were given practical and application-oriented experience. The research also provided research experience to many undergraduate students who provided laboratory and field assistance. Many of the students are now practicing professionals in the environmental field.

The following list provides information on a great number of former and current students, along with other personnel, who participated.

Batarseh, Eyad	Completed his PhD in environmental engineering at UCF and worked on the Florida Bioreactor Demonstration Project, “combined chemical and biological In-situ treatment of mature landfill leachate”. At present he is working for CDM as an engineer.
Berge, Nicole	Completed her PhD in environmental engineering at UCF and worked on the Long-Term Treatment and Disposal of Landfill Leachate project. At present she is working as a post doctoral associate in the greater Boston area.
Cho, Youngmin	A graduate student pursuing a Ph.D. degree. He conducts researches at Polk North Central Landfill. His main research interests are horizontal leachate injection performance analysis and waste mechanics in bioreactor landfills
Dhesi, P	Completed his masters’ degree at UCF. His research was focused on the study of addition of non-hazardous industrial and municipal wastewater to bioreactor landfills.
Dubey, Brajesh	Completed his PhD and post doc at UF on worked on environmental impacts of CCA treated wood. He is currently working as a faculty member at the University of Auckland.
Faour, A	Completed his masters’ degree at UCF. His research was focused on the First-order kinetic gas generation model parameters for wet landfills
Gawande, Nitin	A PhD student and developed the model BIOKEMOD-3P, for simulating solid waste biodegradation. His model is able to simulate the experimental data of anaerobic biodegradation of solid waste in laboratory scale bioreactor. This model is also used to simulate simultaneous nitrification and denitrification processes in laboratory-scale microcosms.

Gou, Vicky	Completed his masters' degree at UF. His research was focused on the Non-methane organic compounds (NMOC) emitted from the decomposition of municipal solid waste (MSW) components.
Jain, Pradeep	Assisted with the construction, operation, and monitoring of the NRRL bioreactor during his PhD at UF. His research on the NRRL bioreactor contributed better understanding on the bioreactor. Currently Dr. Jain works for Innovative Waste Consulting Services as a professional engineer.
Jonnalagadda, Sreeram	Worked on the field evaluation of moisture sensors as part of Florida Landfill Bioreactor Demonstration Project. He graduated from the University of Florida in December 2004 and am presently working for SCS Engineers in Tampa, Florida.
Jordan, Aaron Alan	Completed his Masters at UF and worked on assessment of the risk posed by engineered wood products by land-applied mulch and conducted field and laboratory analysis of how effectively quicklime can treat soils contaminated with industrial solvents. He is currently working for HDR
Kadambala, Ravi	Assisted with building the modified vertical well leachate recirculation system of cell 4 at New River for his research. He also is currently assisting NRRL with the maintenance and operation of the bioreactor and perusing his PhD at UF.
Kim, Hwidong	While pursuing his PhD in environmental engineering at UF, he assisted in earth pressure cells and leachate recirculation pipes at the NRRL bioreactor. He started biochemical methane potential (BMP) assay of solid waste samples. He also compared aerobic and anaerobic bioreactor landfills using lab-scale lysimeters for his doctoral dissertation. Dr. Kim is currently working at UF as a postdoc.
Ko, Jae Hac	As a postdoctoral associate at UF, he conducted research at NRRL bioreactor and provide oversight for Polk North Central Landfill and Alachua County Southwest landfill. Dr. Ko continues those efforts as a postdoc.
Kumar, Dinesh	Worked as a post doctoral associate at UF. His conducted some of the air injection and high pressure leachate injection experiments at the NRRL. He is presently working at Delhi Municipal Corporation, India
Kumar, Sendhil	A graduate research assistant at UF, currently carrying out research tasks at the Polk North Central Landfill (NCLF). Also, involved in assisting the operation of the Bioreactor landfill at Polk NCLF.

Larson, Judd Adam	Completed his Masters at UF and worked on Polk County North Central Landfill Bioreactor. His responsibilities have been to make plans for installing the injection lines, researching proper monitoring equipment, and ensuring laboratory as well as field quality assurance and quality control for sample analysis. He is currently working at CDM.
Mcknight, Tobin	Presently working as an engineer at JEA. He completed his masters degree at UF working landfill settlement.
Musson, Stephen	Completed his PhD and worked on several projects including the Florida Bioreactor Demonstration Project and Polk County North Central Landfill Bioreactor. He is currently working as post doctoral associate in Cincinnati.
Powell, Jon	Assisted with the operation, and monitoring of the NRRL bioreactor during his PhD at UF. He is presently working as an engineer at the Innovative waste consulting services. He completed his masters' degree at UF.
Semiz, Murat	Presently working as an engineer at CDM. He completed his masters degree at UF
Sheridan, Scott	Completed his masters' degree at UF. His research was focused on the Modeling solid waste settlement as a function of mass loss
Singh, Shrawan	A PhD student, working at the Alachua County Southwest Landfill. The focus of his PhD dissertation is to evaluate the effectiveness of various pretreatment methods for treating the stabilized bioreactor landfill leachate by nano filtration and reverse osmosis membrane systems.
Spafford, Mark	completed his Masters' degree at UF. His work focused on the Performance evaluation of landfill liner systems using pressure transducers.
Spalvins, Erik	Completed his PhD at UF and worked on Simulated Landfill Lysimeters for Evaluating Leachate Quality. He is presently working at the EPA office in Georgia.
Timmons, Jason	Assisted in contraction of the NRRL bioreactor. His UF Masters project report studied the use of earth pressure sensors as a monitoring instrument at landfill. He is currently practicing engineer with Jones Edmonds and Associates in Tampa, FL

Tolaymat, Thabet	While pursuing his PhD in environmental engineering at UF, he installed the first set of leachate recirculation pipes at the Polk County Bioreactor. He provided design support for the NRRL bioreactor. Dr. Tolaymat is now with the US EPA office of Research and Development in Cincinnati where he heads up US EPA's bioreactor research program.
Wadanambi, Lakmini	Completed her Masters degree at UF. Her work focused on the leaching of lead from lead-based paint in landfill environments and leaching of CCA-treated wood.
Xu, Qigong	While pursuing his PhD in environmental engineering at UF. Currently he works for Innovative Waste Consulting Services as a professional engineer.

The following list summarizes the student's thesis, dissertations, proposals and project reports completed as results of their project [copies of these documents can be found in Appendix C]

- Gawande, N., (2008). "Modeling biochemical processes of solid waste biodegradation" Preparing PhD Dissertation. University of Central Florida, Orlando, FL.
- Kadambala, R.S. (2007), "Evaluation of a modified vertical well leachate recirculation system for municipal solid waste landfills," PhD Research Proposal, University of Florida. Appendix C.
- Larson, J.A. (2007). "Investigations at a bioreactor landfill to aid in the operation and design of horizontal injection liquids addition systems" Master's Thesis, University of Florida, Gainesville, FL. Appendix C.
- Berge, N. (2006). "In-Situ ammonia removal of leachate from bioreactor landfills." Ph.D. Dissertation. University of Central Florida, Orlando, FL. Appendix C.
- Batarseh, E. (2006). "Chemical and biological treatment of mature landfill leachate." Ph.D. Dissertation. University of Central Florida, Orlando, FL. Appendix C.
- Mcknight, Tobin (2005). "Engineering properties and cone penetration testing of municipal solid waste to predict landfill settlement" Master's Thesis, University Of Florida, Gainesville, FL. Appendix C.
- Kim, H. (2005). "Comparative studies of aerobic and anaerobic landfills using simulated-landfill lysimeters." Ph.D. Dissertation. University of Florida, Gainesville, FL. Appendix C.
- Powell, J. (2005). "Trace gas quality, temperature control and extent of influence from air addition at a bioreactor landfill." Masters Thesis, University of Florida, Gainesville, FL. Appendix C.
- Jain, P. (2005). "Moisture addition at bioreactor landfills using vertical wells: mathematical modeling and field application." Ph.D. Dissertation. University of Florida, Gainesville, FL. Appendix C.

- Timmons, J. (2004). "Total earth pressure cells for measuring loads in a municipal solid waste landfill." Masters Project, University of Florida, Gainesville, FL. Appendix C.
- Jonnalagadda, S. (2004). "Resistivity and time domain reflectometry sensors for assessing in-situ moisture content in a bioreactor landfill." Master's Thesis, University of Florida, Gainesville, FL. Appendix C.
- Sheridan, S. (2003). "Modeling solid waste settlement as a function of mass loss." Master's Thesis, University of Florida, Gainesville, FL. Appendix C.
- Kumar, A. (2003). "Temperature inside the landfill: effects of liquid injection and ambient temperature." Masters Thesis, University of Central Florida, Orlando, FL. Appendix C.
- Dhesi, P. (2003). "Study of addition of non-hazardous industrial and municipal wastewater to bioreactor landfills." Masters Thesis, University of Central Florida, Orlando, FL.
- Faour, A. (2003). "First-order kinetic gas generation model parameters for wet landfills." Masters Thesis, University of Central Florida, Orlando, FL. Appendix C.
- Spafford, M. (2002). "Performance evaluation of landfill liner systems using pressure transducers." Masters Thesis, University of Central Florida, Orlando, FL. Appendix C.
- Thomas, P.A. (2001). "The testing and evaluation of a prototype sensor for the measurement of moisture content in bioreactor landfills." Masters Thesis, University of Central Florida, Orlando, FL. Appendix C.
- Saraf, S. (2000). "Use of pressure transducers to measure landfill head on liner." Masters Thesis, University of Central Florida, Orlando, FL. Appendix C.
- Gou, V. (2000). "Non-methane organic compounds (NMOC) emitted from the decomposition of municipal solid waste (MSW) components." Master's Thesis, University of Florida, Gainesville, FL. Appendix C.

10.4 Bioreactor Workshops

To promote training and education of landfill operators and other interested professionals, two bioreactor workshops were held during conducting the Florida bioreactor project in 2004 and in 2006. The first Bioreactor Landfill Workshop was held on March 22-23, 2004 in Gainesville, Florida. The second bioreactor landfill workshop was held on May 25-26 in Orlando. The two-day workshops included an overview of the design, management, operation and regulations associated with a bioreactor landfill. Participants visited field sites and observe new technology in operation. Workshop attendees learned about bioreactor landfills from inception to post-closure. There were a number of participants from throughout Florida, representing local and state government, industry, academicians and students. The presentation materials and a list of attendants are provided in Appendix H. Figure 10.1 show the percent of participants in compartments such as industry, student, FDEP, county, staff, city, university and others. Knowledge on bioreactors achieved from the project were shared with these educational activities.

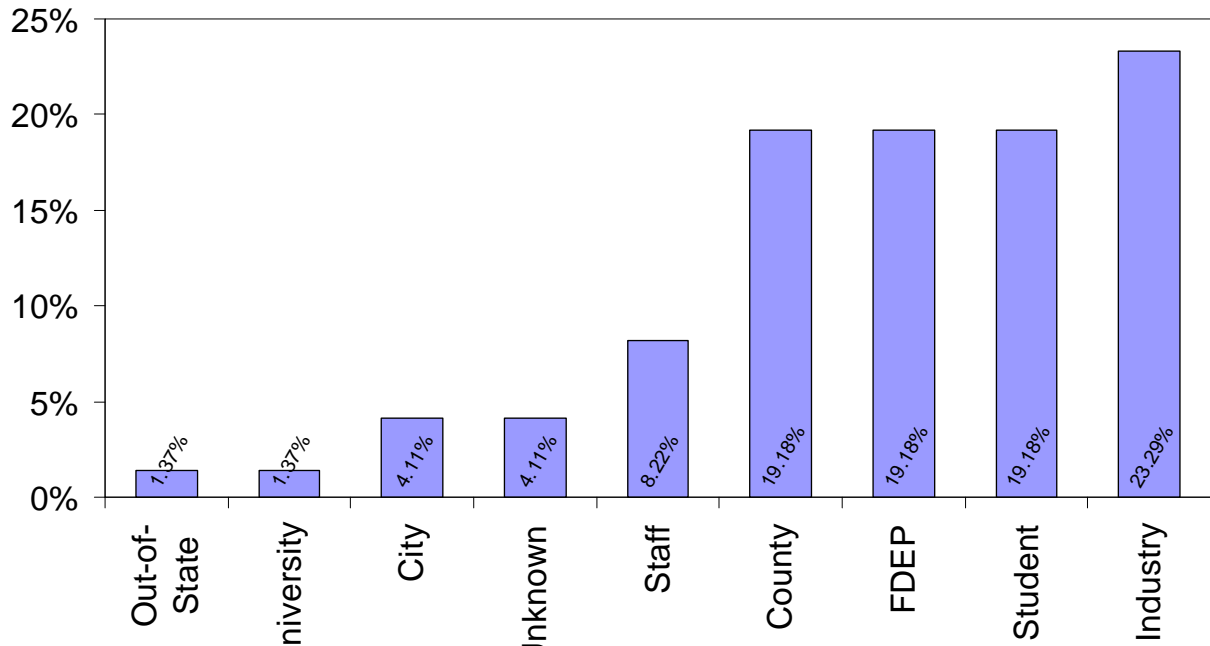


Figure 10.1. Participants of the second Bioreactor Workshop held in Orlando, FL

Appendix I. Bioreactor Workshops

- 2004 Bioreactor Workshop
- 2004 Bioreactor Workshop

10.5 Presentation of the Project to the Solid Waste Community in Florida

The team members presented information on the project throughout work period to a wide variety of audiences, including landfill operators. The audiences include state, national and international organization; the center advising board; The US EPA; and the FDEP. Appendix E provides the lists of presentations provided. Specific examples are included as follows.

The center Advisory board meeting

- | | | |
|-------------|---------------------------------------|-----------------------|
| • 2/25/2000 | NRRL Bioreactor Demonstration Project | FCSHWM Advisory Board |
| • 5/19/2000 | NRRL Bioreactor Demonstration Project | FCSHWM Advisory Board |
| • 2/9/2001 | NRRL Bioreactor Demonstration Project | FCSHWM Advisory Board |
| • 6/1/2001 | NRRL Bioreactor Demonstration Project | FCSHWM Advisory Board |
| • 9/7/2001 | NRRL Bioreactor Demonstration Project | FCSHWM Advisory Board |
| • 5/3/2002 | Bioreactor Update | FCSHWM Advisory Board |
| • 9/6/2002 | Bioreactor Update | FCSHWM Advisory Board |

- 1/31/2003 Bioreactor Update FCSHWM Advisory Board
- 5/21/1999 Update on Landfill Bioreactor Demonstration Project
FCSHWM Advisory Board
- 12/10/1999 Bioreactor Landfill Project Update FCSHWM Advisory Board
- 9/29/2000 Bioreactor Landfill Demonstration Project FCSHWM Advisory Board
- 5/9/2003 Bioreactor Update FCSHWM Advisory Board
- 12/10/2004 Bioreactor Update FCSHWM Advisory Board
- 12/10/2004 Bioreactor Update FCSHWM Advisory Board
- 5/13/2005 Bioreactor Landfill Demonstration Project Update FCSHWM Advisory Board
- 9/15/2006 Bioreactor update FCSHWM Advisory Board

The Solid Waste Association of North America

- 4/6/1999 Landfill Bioreactors SWANA at NC
- 4/2/2003 Florida Bioreactor Landfill Update SWANA NC Chapter Meeting, Concord, NC
- 6/23/2004 Update on New River Regional Landfill Bioreactor Project
SWANA Landfill Symposium, Monterey,
- 6/7/2005 Effect of Perched Water Conditions in MSW Landfills:
Considerations for Landfill Operators SWANA Landfill Symposium,
Bolder, Colorado
- 6/18/2003 Performance of Vertical Injection Leachate Recirculation Wells at
the New River Regional Landfill SWANA Landfill Symposium, Atlantic City
- 8/21/2003 New River Bioreactor Demonstration Project Operations Update
DeVitaSWANA- JAX
- 6/21/2004 Bioreactor Landfills and Discarded Electronics: A Look at Two
Hot Landfill Topics SWANA 2004
- 6/18/2001 Aerobic vs. Anaerobic Bioreactor Landfill Case Study: the New
River Regional Landfill SWANA
- 6/28/2000 Florida Bioreactor Landfill Demonstration Project SWANA
- 6/18/2001 Aerobic vs. Anaerobic Bioreactor Landfill Case Study: the New
River Regional Landfill SWANA
- 6/20/2003 The Solid Waste Manager's Guide To The Bioreactor Landfill
SWANA

10.6 Bioreactor Operation Guide for Operators and Landfill Engineers

As described in Volume 8, an outcome of the project was development of “Bioreactor Landfill Operation: A Guide for Development, Implementation, and Monitoring.” This was intended to serve as a tool for landfill owners, operators and other professionals evaluating or implementing bioreactor landfill technology.

- Volume 8, Attachment, Bioreactor Landfill Operation: A Guide for Development, Implementation and Monitoring, Version 1.0., 2008.

10.7 Summary and Conclusions

The Florida bioreactor project successfully provided a resource and training ground for students in the state university system, landfill operators, and engineers in Florida. Summary and conclusions were listed below.

- A large number of graduate and undergraduate students from both the University of Florida and the University of Central Florida assisted in the project. The project provided research topics, field experiences and laboratory experiences to the students.
- Bioreactor workshops were successfully held in 2004 and in 2006. The workshops helped engineers, students, and FDEP and County staffs, to understand bioreactor landfills.
- As a product of the project, “Bioreactor Landfill Operation: A Guide for Development, Implementation, and Monitoring” will help landfill owners, operators and other professionals in terms of implementing bioreactor landfill technology.