BIOREACTOR DEMONSTRATION PROJECT
WORK PLAN

July 4, 2006

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1.0 INTRODUCTION

The Florida Department of Environmental Protection (FDEP) awarded a grant to the Florida Center for Solid and Hazardous Waste Management (the Center) to conduct the demonstration of full-scale landfill bioreactor technology in Florida. The demonstration project will be managed by the Florida Center for Solid and Hazardous Waste Management in accordance with this Work Plan as required by the FDEP grant award, and will involve participation of various universities in the State University System.

Research conducted as part of this project will be performed at a number of different landfill sites in cooperation with their respective owners and operators. The sites that have been identified to date include the New River Regional Landfill in Union County owned and operated by the New River Solid Waste Association; the Tomoka Farm Road Landfill operated by Volusia County; and the Polk County North Central Landfill operated by Polk County; and Highlands county Landfill. Other sites will be incorporated into the bioreactor landfill research effort and added to this Work Plan as such partnerships are established. The research at each site will be conducted in accordance with a site management plan specific to each site.

The primary goal in pursuing landfill bioreactor technology is the operation of solid waste landfills in a manner resulting in accelerated stabilization of the waste. Landfill bioreactor operation includes, among other things, the addition of moisture to the solid waste to create an environment favorable for the microorganisms responsible for waste decomposition. This approach differs greatly from the traditional Resource Conservation and Recovery Act (RCRA) Subtitle D approach of managing solid waste landfills in a fashion that discourages waste decomposition by minimizing moisture entrance into the landfill. A primary feature of a landfill bioreactor is the recirculation of landfill leachate, or possibly other liquids, to the solid waste. The recirculation of leachate will be a major component of any bioreactor operation conducted as part of this project.

Another feature of a landfill bioreactor that has been proposed for the acceleration of waste decomposition and landfill stabilization is the addition of air. The addition of air, and thus oxygen, promotes the aerobic stabilization of the landfilled waste. This is the same process that decomposes waste in a traditional compost system. An evaluation of the use of aerobic processes for the rapid stabilization of landfilled waste will be a major focus of the project at the New River demonstration site. The project will incorporate a system that will enable both air injection and gas extraction. A temporary membrane cap will be placed on the surface of the landfill to allow the capture of the majority of the gas emissions from the landfill. Wells will be constructed in the bioreactor to allow not only leachate recirculation, but also, air injection, and gas extraction.

The FDEP selected the New River Regional Landfill (NRRL), in Union County, Florida, as the site to conduct a full-scale landfill bioreactor demonstration project comparing both aerobic and anaerobic waste decomposition processes. The FDEP has

also selected landfills in Volusia, Marion and Polk counties as additional sites to conduct bioreactor research. The project team believes that collection of field-scale data from as many different sites as possible is needed to better examine the utility of this technology.

Demonstrating bioreactor landfill technology in cells 1 and 2 at the NRRL will include the recirculation of leachate, the injection of air into portions of the landfill cell, and the ability to collect all gaseous emissions from the landfill. The landfill bioreactor will be instrumented for the purpose of collecting *in-situ* measurements of such parameters as leachate head on the liner, and moisture content and temperature of the waste. This project will result in a full-scale landfill being operated as a solid waste treatment system. The information and data collected will allow the technology to be fully evaluated as a method for managing solid waste in Florida.

This Work Plan is dynamic and will change as new information is obtained and sites become available for participation in the research effort. This Plan has five sections. The second section lists the Project's goals and objectives. The third section describes the activities and deliverables for meeting each of the Project's objectives. The fourth section provides a Site Management Plan (SMP) for each research site. These SMPs include a listing of research or monitoring objectives and needs, the instrumentation required to address those monitoring requirements, and other elements, including:

- A plan and schedule for the development and routine operation of each site;
- A monitoring plan for ensuring the safe operation of the bioreactor research;
- A schedule for meetings of project personnel;
- An identification of responsible parties;
- A procedure to coordinate research activities and visits to the site;
- A health and safety plan for project participants visiting or conducting work at the site; and,
- Site-specific information submitted to the Department in efforts to demonstrate compliance with regulatory requirements. The documents submitted to the Department for permitting purposes may be included in the Work Plan by reference.

The fifth section of this Plan contains overall Project cost estimates. These cost estimates include all sites under the Bioreactor Demonstration Research Project.

This document will evolve during the planning, design, and permitting phase, to include information such as the daily operation and monitoring of the bioreactor, protocol for visiting and conducting research at the site, plans for health and safety, and identification of team members and their responsibilities. Any changes and additions to this Work Plan (WP) will be submitted to the Department by the Center for incorporation into the WP.

2.0 GOALS AND OBJECTIVES

The primary overriding goal of the landfill bioreactor demonstration project is the

> ***design, construction, operation, and monitoring of a full-scale landfill bioreactor in Florida in a manner that permits a complete and fair evaluation of this technology as a method of solid waste management in Florida, with appropriate consideration of science, engineering, environmental and economic issues***.

The objectives of the landfill bioreactor demonstration are to:

- Design and operate the bioreactor technology using innovative techniques and concepts.
- Design and operate the bioreactor technology in at least one site in a manner to control and measure all major inputs and outputs.
- Evaluate the use of aerobic bioreactor landfill technology and compare the aerobic approach to the use of anaerobic bioreactor technology in at least one site.
- Instrument the landfills to permit *in-situ* monitoring of bioreactor activity and to measure previously unmeasured information (e.g. leachate head on the liner).
- Monitor the landfills in a manner to measure the impact of bioreactor activities and to allow control of the waste treatment process (e.g. leachate and gas composition and generation, waste characteristics, settlement).
- Collect data through instrumentation, field monitoring, and laboratory analysis that will enable the project team to assess the success of the project, the feasibility of this technology for other sites, and to enable the future design and operation of landfill bioreactors in Florida.
- Develop standardized design and operation procedures for this technology.
- Further define and quantify the true costs and benefits of landfill bioreactors.
- Provide a resource and training ground for students in the State University System, landfill operators, and engineers in Florida.

3.0 METHODOLOGY FOR MEETING PROJECT OBJECTIVES

The project goals and objectives were outlined in section 2.0. This section describes how the project goals and objectives will be met through the project's experimental methodology.

Objective 1: *Design and operate the bioreactor using innovative techniques and concepts.*

The bioreactor landfill will be designed, constructed, and monitored with a number of innovative techniques and concepts. While the operation of a landfill as a bioreactor is still a relatively new technology, research in this area has been conducted for a number of years, and some full-scale operations of limited scope have been performed. In addition to further refinement of existing bioreactor concepts at the full-scale, operating landfill level, some new approaches will be utilized.

- A system will be designed to allow the bioreactor to be operated aerobically or anaerobically. Aerobic operation in a large facility will be new, as will be the phasing of anaerobic and aerobic conditions.
- A gas collection cap system will be installed in combination with a leachate recycle system, a gas extraction system, and an air injection system.
- Instrumentation will be placed on the landfill liner surface, and within the waste mass, in an innovative manner.

Deliverables: Statement of successful placement and operation of instrumentation and equipment.
Presentation of data from instrumentation in periodic reports.
Establishment of a Bioreactor Web Site.

Objective 2: *Design and operate the bioreactor in a manner to control and measure all major inputs and outputs.*

A major limitation in the data collected from a full-scale bioreactor project to date is the inability to capture and measure all inputs and outputs. This is especially true with gas emissions in both aerobic and anaerobic systems. The landfill bioreactor at the NRRL will be equipped with a geomembrane cap to collect gas emissions from the surface. The leachate collection system will be utilized and monitor gas inputs and outputs. Leachate production will be measured on the basis of each individual leachate collection line. All landfill inputs will be measured using state of the art techniques. Thus all major inputs and outputs will be measured to the best of the project team's ability.

Deliverables: Description of inputs and outputs in periodic reports.
Presentation of data in periodic reports.

Objective 3: *Evaluate the use of aerobic bioreactor landfill technology and compare the aerobic approach to the use of anaerobic bioreactor technology.*

As previously stated, the system will be designed in a flexible manner such that it can be operated either aerobically or anaerobically. The impact of each of the technologies will be evaluated by operating some areas of the bioreactor aerobically, while others are operated anaerobically. The impact of these operation schemes on the bioreactor process will be measured through the instrumentation and monitoring described in Tables 4.3. and 4.4.

Deliverables: Presentation of data in periodic reports.

Objective 4: *Instrument the landfill bioreactor to permit in-situ monitoring of bioreactor activity and to measure previously unmeasured information (e.g. leachate head on the liner).*

Instrumentation will be installed for in-situ monitoring of landfill parameters. This instrumentation includes transducers for measuring head on the liner, and monitoring probes for measuring waste temperature and moisture content. Additional information on instrumentation is presented in Table 4.3. and respective tables for sites other than the New River Regional Landfill site.

Deliverables: Statement of successful placement and operation of instrumentation and equipment.

Presentation of data in periodic reports.

Objective 5: *Monitor the bioreactor in a manner to measure the impact of bioreactor activities and to allow control of the waste treatment process (e.g. leachate and gas composition and generation, waste characteristics, settlement).*

The landfill will be monitored to measure the impact of bioreactor operations on the treatment of the landfilled waste, as well as a mechanism to control the treatment. Leachate quality will be routinely measured to address the impact of operation on leachate quality and potential leachate treatment costs. The composition of gaseous emissions will be routinely measured, as will the settlement of the waste mass and the degree of biological stabilization of the solid waste. The parameters measured will be used to control the waste treatment process. For example, temperature and gas concentration will be measured using the monitoring probes as a means to control the rate of air injection into a given area of the landfill.

Deliverables: Models for use in generating protocols for controlling the waste treatment process.

Protocols for controlling the waste treatment process.

Methodology for quantifying settlement.

Presentation of data in periodic reports.

Objective 6: *Collect data through instrumentation, field monitoring, and laboratory analysis that will enable the project team to assess the success of the project, the feasibility of this technology for other sites, and to enable the future design and operation of landfill bioreactors in Florida.*

The data collected through the instrumentation (Table 4.3; Table 4.9) and field/laboratory monitoring (Table 4.4; Table 4.10; Table 4.15) for each site considered in this plan will be used to assess the success of the project. The rapid stabilization of the landfilled waste will be determined by measuring gas production, landfill settlement, and waste decomposition. Different treatment strategies will be evaluated for relative success in this manner.

Deliverables: Presentation of data in periodic reports.

Objective 7: *Develop standardized design and operation procedures for this technology.*

The data collected from the study will be used by the researchers to develop standardized design and operating procedures. This will also include the collection of data to allow the development of engineering models for bioreactor landfill simulation. Design procedures include the design of injection and extraction wells, spacing of such wells, design of leachate collection systems in bioreactor landfills, and the design of a gas collection cap.

Deliverables: Models for use in generating protocols for standard operating procedures.

Standard Operating Procedures.

Models for use in simulating physical, chemical, and biological processes occurring in landfill bioreactor.

Presentation of data in periodic reports.

Objective 8: *Further define and quantify the true costs and benefits of landfill bioreactors.*

A major goal of the project will be to quantify the actual costs of bioreactor landfill operation, both aerobic and anaerobic. The costs needed to operate a bioreactor will be determined. The benefits will be quantified to the extent possible. Benefits include increased landfill settlement and the resulting gain in landfill capacity. Other benefit issues to be addressed will include the landfill siting minimization and the possibility of a reduction in post-closure care.

Deliverables: Methodology for preparation of a cost/benefit analysis.

Periodic cost/benefit projection reports throughout project.

Project's Final Report to include a Cost/Benefit Chapter describing potential impact of bioreactor landfill on post-closure care costs and financial responsibility regulations.

Objective 9: *Provide a resource and training ground for students in the State University System, landfill operators, and engineers in Florida.*

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.

Deliverables: Schedule and description of training opportunities.

Report on the attendance and results of training opportunities.

Plan for extending training after the project.

4.0 SITE MANAGEMENT PLANS

4.1 DESCRIPTION OF LANDFILL BIOREACTOR AT NEW RIVER REGIONAL LANDFILL (NRRL)

4.1.1 Overview

The landfill bioreactor demonstration project at the New River Regional Landfill (NRRL) involves the modification of the existing landfill cells 1 and 2. These cells are contiguous and form one large lined area of approximately 16 acres. Cell 3 is not included as part of the current bioreactor work, but may be proposed for incorporation into the research project at a later date. Approximately 10 acres (cell 1 and part of cell 2) will be dedicated as an active bioreactor area. A leachate recirculation system, an air injection system, and a gas extraction system will be installed in this area. Instrumentation will be installed within the waste mass to assist in monitoring and control. Environmental sample collection and analysis, and field measurements, will be routinely performed to monitor the progress of bioreactor treatment. Instrumentation for measuring depth of leachate on the liner will be installed in an (as of February 1999) area of the cell 2 leachate collection system. The responsibility of the design and construction of the bioreactor landfill modifications rests with the NRSWA and its designated parties.

4.1.2 Summary of Basic Project Components

The basic components of the NRRL bioreactor demonstration project include:

1. A leachate recirculation system of wells will be installed in all of cell 1 and part of cell 2 (for a total of ten acres).
2. The leachate collection system will be modified to allow collection of leachate from distinct areas within the landfill.
3. A temporary membrane cap will be installed on the slopes and the top of the landfill area subjected to treatment.
4. A combination air injection and gas extraction system will be installed. This will allow the landfill to be operated both aerobically and anaerobically. All gas emissions will be collected and characterized.
5. Instrumentation, monitoring, and site management efforts will involve the facility administrative and operational staff, the researchers, and Center staff.
    - The NRRL staff as part of normal landfill operations will perform day-to-day bioreactor landfill operation (leachate recirculation, air injection). The bioreactor treatment strategy (amount of leachate recirculated, air injected, etc.) will be developed by the project researchers in cooperation with the landfill operators and their engineers.
    - The research team will routinely monitor a number of landfill bioreactor parameters. This includes the collection of samples (leachate, gas, waste)

and measurements of performance at the site (leachate and gas flow, settlement). Instrumentation will be installed in a number of locations in and around the landfill bioreactor. Unless otherwise instructed, the researchers (with proper training and with notification of the NRSWA) will perform this monitoring. The monitoring parameters are as follows:

- Leachate quality and quantity
- Gaseous emissions quality and quantity
- Amounts of leachate recirculated
- Amounts of air injected
- Landfill settlement
- Characteristics of landfill waste
- Instrumented measurement (temperature, head on the liner, etc.)

4.1.3 Site Management Plan

As part of the design and permitting process, a detailed Site Management Plan will be developed. Information included in this Site Plan will include, at a minimum, the following:

4.1.3.1 A plan for development and routine operation of the bioreactor activities at the site

A timeline of scheduled activities for the design, permitting, construction, and startup of the bioreactor is included in Table 4.1. A series of milestones are identified throughout the design, permitting, and construction process. Project meetings will be held at various stages of completion during this process so work can be reviewed by the researchers and other team members, and input can be made. A list of tasks, and the month or period during which they will be conducted, for each applicable activity listed in Section 3 of this Work Plan, is in Table 4.2 of this Site Management Plan.

Table 4.1 Schedule of Activities for New River Regional Landfill

Activity	Date
Design and Planning	Completed
Permitting Phase	Completed
Preconstruction Monitoring	July 1999 – June 2002
Construction	November 2001 – December 2002
Baseline Monitoring	July 2002 – April 2003
Startup Operations	June 2003
Routine Monitoring	May 2003 – June 2006
Assist with conversion of cells 3, 4 and 5 to bioreactor units	January 2004 – June 2006

Table 4.2 Project Objective Goals Timeline

Objective	Date
Design and operation of bioreactor system	Design – completed Construction – Schedule for completion in August 2002 Baseline Operation – July 2002 Startup Operation – June 2003
Control and measure inputs and outputs of bioreactor system	Construction completed in August 2002 Data gathering starting in July 2002
Evaluate and compare aerobic and anaerobic landfill technology	Construction completed in August 2002 Data gathering starting July 2002
Instrumentation for in-situ measurement of landfill parameters	June – 1999 (New River Cell 2 transducers) June 2000 – (New River Cell 3 transducers and load cells) March – April 2001 (MTG, thermocouple, TDR instrumentation installation
Monitor instrumentation to evaluate bioreactor technology	Currently monitoring transducers and load cells MTG, thermocouple and TDR since dates above
Collect instrumentation data	Currently monitoring transducers and load cells MTG, thermocouple and TDR since dates above
Develop standard design and operations procedures for bioreactor technology	Future
Define and quantify costs	Recorded all along, continue in future
Provide resource and training	Future

4.1.3.2 Monitoring plan

Numerous research activities will be coordinated with the design, construction, and operation of the facility. The objectives of the researchers will be incorporated during the design of the landfill bioreactor. Research activities will include instrumentation of the landfill as a means to collect valuable *in-situ* information about bioreactor performance. Responsibilities for the installation, operation, and upkeep of such instrumentation will be delineated during the design phase and developed as part of the detailed site management. The current plans for instrumentation are included in Table 4.3. The research will also involve the collection and analysis of numerous environmental samples (e.g. leachate, gas, waste), and the measurement of bioreactor performance in the field (e.g. settlement,

gas flow). Current plans for routine monitoring are included in Table 4.4. A diagram identifying the location of instrumentation devices will be provided and incorporated into this Site Management Plan as Figure 4.1. A site plan for the bioreactor is provided in Figure 4.2.

Table 4.3 Summary of Instrumentation

Instrumentation Location	Description
Liner and Leachate Collection System in an area of Cell 2 and Cell 3	A series of pressure transducers will be installed directly on top of the liner in cell 2 and cell 3. The purpose of the transducers will be to measure the head, or depth of leachate, ponded on the liner. Two different types of transducers will be evaluated. A total of 64 stainless steel and 64 titanium transducers (supplied by KPSI and Druck, respectively) will be installed in cell 2. Thirty of these transducers will be equipped with a temperature measurement option. The installation will be done in a 150 ft by 150 ft area in Cell 2. Five separate cross-sections of the liner will be instrumented in this area. One of these cross-sections will be a side-by-side comparison of the stainless steel and the titanium transducers. The Cell 3 transducer site will include only Druck pressure transducers placed throughout the 8-acre site. Included in the cell 3 transducer experiment are 24 Roctest Total Pressure Cells designed to measure the applied load forces and temperatures acting on a operating landfill liner system during filling procedures.
Monitoring Probes in Bioreactor Area	Monitoring probes will be installed in numerous locations in the active bioreactor area. These probes will contain instrumentation to help assess the degree of biological activity, the movement of leachate, and the movement of gases. At various depths in these probes, instrumentation and fluid conduit will be provided, including: ➢ Moisture sensors to track the distribution of water as a function of leachate recirculation activities and movement of gases. ➢ Temperature to track the degree of biological activity in the waste. Temperature will also be a key parameter in controlling the bioreactor operation. ➢ Gas sample ports to measure the concentration and pressure of gases migrating through the bioreactor.
Leachate Collection System Manholes	Flow meters will be installed in each leachate collection system manhole to continuously measure the flow of leachate from segregated areas of the landfill.

Table 4.4 Summary of Monitoring

Monitoring Activity	Description
Leachate	Samples of leachate will be collected from each manhole on a routine basis. The leachate will be analyzed for the following parameters. ➢ pH ➢ Conductivity ➢ Dissolved Oxygen ➢ Dissolved Solids ➢ Biochemical Oxygen Demand ➢ Chemical Oxygen Demand ➢ Organic Carbon ➢ Nutrients (NH_3, TKN, TP) ➢ Common Ions (Cl^-, NO_3-, NO_2^-, SO_4^{2-}, Na^+, K^+, Ca^{2+}, Mg^{2+}) ➢ Volatile Fatty Acids ➢ Organic Priority Pollutants ➢ Heavy Metals
Gaseous Emissions	Gas emissions from the landfill will be measured routinely as part of the operation of the bioreactor for CH_4, CO_2, O_2, and N_2. Samples will also be collected at times to measure NMOCs, H_2S, and N_2O.
Solid Waste	Solid waste samples will be collected to directly assess the degree of stabilization. Parameters to be evaluated include: ➢ Moisture content ➢ Volatile Solids ➢ Methane Yield ➢ Cellulose ➢ Lignin On occasion, the waste samples will also be analyzed for organic priority pollutants and heavy metals (total and leachable).
Landfill Settlement	The bioreactor landfill will be surveyed routinely using a GPS receiver/recorder to measure the degree of waste settlement (an indicator of biological decomposition).

Figure 4.1. NRRL Cell 3 Instrumentation Layout

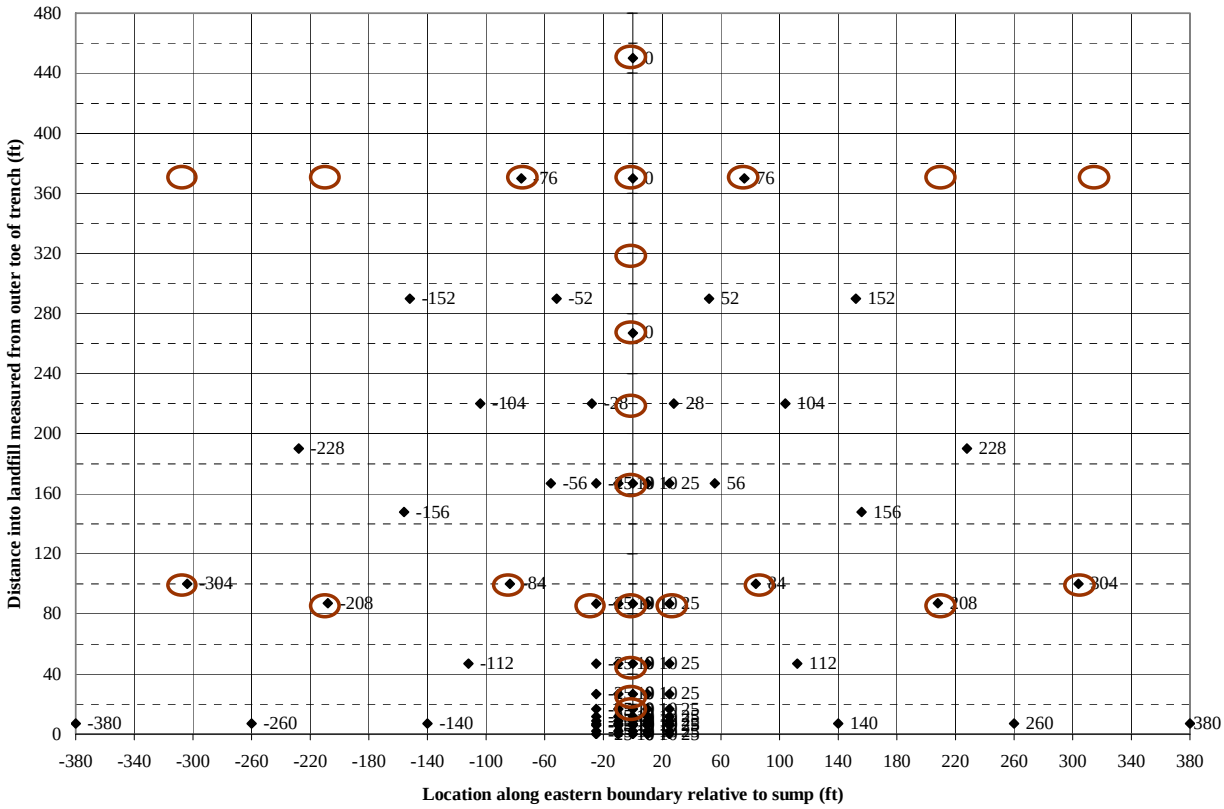
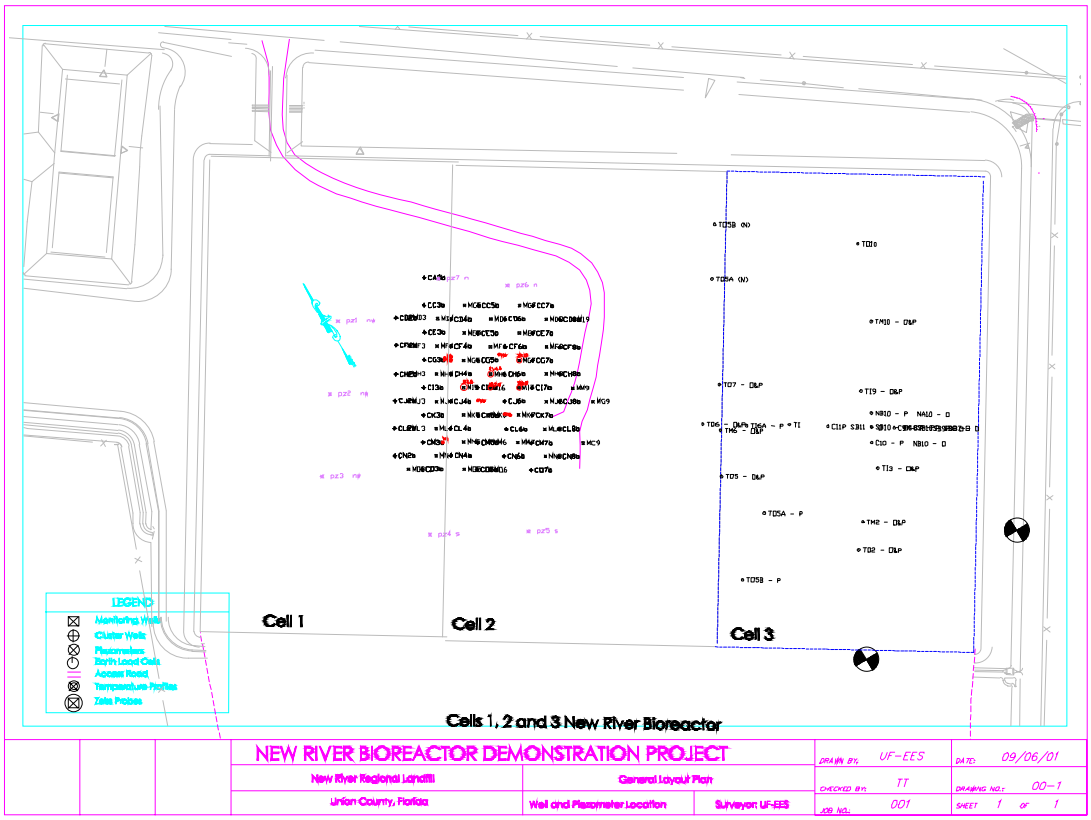


Figure 4.2: NRRL Bioreactor Site Plan



4.1.3.3 Meeting Schedule

Project team members will meet with project personnel on a regular basis in order to review the performance and status of the current project. At these times suggestions and input to the operation and management of the project can be made to optimize performance.

4.1.3.4 Responsible Parties

The responsible parties for the Florida Bioreactor Demonstration Project at the New River Regional Landfill include FDEP, the Center, NRSWA, University of Florida and University of Central Florida.

4.1.3.5 Coordination Procedures

Project team members will coordinate with the landfill operations personnel to schedule and conduct site visits and research activities. The procedure to inform the landfill personnel is to call the site, when possible, the day before a planned site visit and inform them of the visitors that will be arriving, the time of the visit and the reasons for the visit. When arriving to the landfill site, visitors will sign in at the front office of the landfill and inform the supervising landfill personnel of their arrival and plans for the visit or research activities.

4.1.3.6 Health & Safety Plan

A site safety plan is needed to ensure the health and safety of project participants, researchers, site operators, and site visitors during their

visits to the landfill bioreactor site. Project team members will observe all existing safety procedures used by the operating landfill. These include signing in at main landfill office, the use of hardhats in designated areas, proper attire, eye protection, appropriate footwear and any other safety equipment deemed necessary by the project site dependent on day-to-day environmental and working conditions. All project members and visitors to the site will observe the project health and safety program as outlined in the Landfill Bioreactor Demonstration permit (permit #SC63-271982) as well as the plan established by the New River Regional Landfill. The Safety Plan will have components addressing each of the types of visitors mentioned above. The Safety Plan will be developed as part of the Site Management Plan and submitted to the Department for inclusion in the Work Plan (see Table 4.5).

Table 4.5 Health and Safety Program– NRRL

Action	Health & Safety Program Requirement
Site Visits	• Contact Perry Kent, Superintendent at least 24 hours in advance, and check out at the front office upon completion.
Emergency Action Plan	• Report fires and emergencies to Emergency Coordinator Perry Kent or 911. • Carry first aid kits to the site. • In case of emergency evacuate to the front office.
Training	• Must be briefed on protocols and safety precautions by a 40 hour OSHA trained individual.
Eye, Head and Face Protection	• Protective equipment, including personal protective equipment (PPE) for eyes, face, head, extremities, protective clothing, respiratory devices and protective shields and barriers should be maintained in a sanitary and reliable condition.
Researcher	• Researchers working in the proximity of heavy machinery have the responsibility of making machine operators aware of their presence. Keep at least a 15-foot distance from any heavy machinery unless authorized. • Remain aware of all heavy traffic on paved and dirt roads.

Table 4.5 (continued)

Action	Health & Safety Program Requirement
Hazardous and Infectious Waste	• If any hazardous or infectious waste is encountered, keep a safe distance, mark the location, and report the location and nature of the waste to the landfill operator. • Before leaving the landfill, researchers must wash their hands and lower arms, face and neck. Any clothes should be washed at the first opportunity.
Confined Spaces	• All research work must be conducted without entry to confined spaces. • Individuals working near the space opening must wear a full body harness and be secured to an immovable structure. • At confined space locations, work must be performed by at least two people. The area must be ventilated for a period of three minutes prior to commencing any work.
Slip, Trip, Fall Hazards	• Approval from site superintendent is required prior to entering the work site. • Proper foot protection (steel toed boots with rubber soles) is required for work anywhere on the landfill. • At least one researcher on the work site must carry a cell phone or two-way radio. • Keep aware of the location of working machinery. • Follow landfill's housekeeping procedures. • In case of serious injury, contact site superintendent Perry Kent. • The researcher will not disturb contractor's stockpiles in any way. • Work near areas designated or flagged as dangerous should be conducted with precaution.
Heat Stress	• Prior to entering the work site where eating and drinking are prohibited, researchers must drink plenty of water to prevent dehydration. 5 to 7 ounces of water every 15 to 20 minutes is recommended. • Distribute the workload evenly throughout the day and incorporate work rest cycles. • Researchers should be trained to identify the signs of heat stress. • Observe and monitor each other periodically to watch for symptoms of heat stress. • Keep drinking water on the work truck in case of heat related illnesses.
Prison Work Gangs	• Researchers have the responsibility to understand and follow site policies regarding working proximate to work gangs.

4.1.4 Specific Research Tasks

The section provides a summary of the specific tasks associated with the research phase of the NRRL bioreactor. It identifies the roles of researchers and highlights how each task works toward meeting the objectives outlined in section 3 of this work plan.

4.1.4.1 Bioreactor Operation

Routine bioreactor operation activities will be conducted by the bioreactor field operator under supervision of the UF PI. Routine bioreactor activities include daily inspections and recording of data, routine operation and maintenance of the blower-flare station, operation of the leachate recirculation system, completion of required activity and monitoring forms, monitoring and balancing of the gas extraction well field, and normal bioreactor maintenance activities. Plans for specific bioreactor operation activities (i.e. when and where leachate or air is added) will be developed in consultation with UCF PI and with the site owners and their engineers (per the communications plan outlined previously).

Operation of the bioreactor is essential to meeting all of the project objectives outlined in section 3 of this work plan.

4.1.4.2 Leachate Sampling and Analysis

As previously outlined, leachate will be sampled routinely from the manholes. Leachate collection will be conducted by the bioreactor field operator under direction of the UF PI. Leachate samples will be analyzed in UF laboratories by graduate students.

Measurement of leachate quality is essential to meeting project objectives 2, 5 and 6 outlined in section 3 of this work plan.

4.1.4.3 Settlement Measurements

The surface elevations of the bioreactor will be measured on a monthly basis to assess the degree of settlement occurring in the bioreactor. This work will be conducted by UF graduate students with assistance from UCF graduate students.

Measurement of bioreactor settlement is essential to meeting project objectives 5 and 6 outlined in section 3 of this work plan.

4.1.4.4 Gas Measurements

Measurements of landfill gas will be collected from several locations in the bioreactor. Gas measurements at the flare station and in the gas collection system will be routinely collected (twice per week minimum) by the bioreactor field operator under direction of the UF PI. Gas measurements will also be taken from the sensor packs on a routine basis. This work will be shared by the UF and UCF graduate students.

Measurement of bioreactor landfill gas quality is essential to meeting project objectives 4, 5 and 6 outlined in section 3 of this work plan.

4.1.4.5 Leachate/water Recirculation

Leachate recirculation will be conducted as part of routine bioreactor operations (see 4.1.4.1). However, specific leachate recirculation experiments will be performed to characterize the hydraulics of vertical injection wells in bioreactor landfills. This work will be conducted by UF graduate students with assistance from UCF graduate students.

Characterization of water injection hydraulics of the vertical injection wells addresses project objectives 2, 6 and 7 outlined in section 3 of this work plan.

4.1.4.6 Air Injection

Air injection will be conducted as part of routine bioreactor operations (see 4.1.4.1). However, specific air injection experiments will be performed to characterize the performance of vertical wells for introduction of air into the landfill. This work will be conducted by UF graduate students with assistance from UCF graduate students.

Characterization of the air injection system at NRRL addresses project objectives 2, 3, 6 and 7 outlined in section 3 of this work plan.

4.1.4.7 In-Situ Instrumentation

In-situ instrumentation installed in the bioreactor will be monitored on a routine basis as part of tracking the progress of bioreactor activity. The development, installation and maintenance of in-situ instrumentation will be under the direction of the UCF PI. UCF and UF graduate students will share in the responsibility of collection and analyzing data from the in-situ instrumentation.

Measurement of in-situ instrumentation performance addresses project objectives 2, 4, 5, and 6 outlined in section 3 of this work plan.

4.1.4.8 Modeling of Bioreactor Moisture and Gas Movement

Models will be developed for the transport of moisture and gas in the bioreactor. Data collected from the instrumentation and field/laboratory analysis will be used to validate these modeling exercises. The UCF PI will head up this effort.

Modeling of bioreactor moisture and gas movement addresses project objectives 5 and 7 outlined in section 3 of this work plan.

4.1.4.9 Bioreactor Economics

An economic assessment of the bioreactor will be conducted to evaluate the true cost of bioreactor design and operation with respect to traditional landfill operation. Cost data gathered from throughout the

project will be used to validate these modeling exercises. The UCF PI will head up this effort.

Modeling of bioreactor moisture and gas movement addresses project objective 8 outlined in section 3 of this work plan.

4.1.4.10 Support for Bioreactor Activities in Cells 3, 4 and 5

The research team will assist NRRL and its engineer in developing and implementing a plan for continuing bioreactor activity in Cell 3, 4 and 5 at the site. This support will include assisting in the permitting, design and operation.

4.1.5 Site Cost Estimate

The following table (Table 4.6) provides a breakdown of project costs for the NRRL portion of the bioreactor landfill demonstration project. Costs are presented for the following budget categories: Project expenses paid to date, the Construction Phase costs estimate, and the Research Phase cost estimate.

The expenses paid to date are current through August 31, 2003. These expenses are broken down into the following five categories.

- New River Expenses
- Construction and Infrastructure Expenses
- Instrumentation Expenses
- Researcher Expenses
- Center Expenses

The construction phase expenses include all those costs necessary to construct the NRRL bioreactor to the point where it is ready for operation. These costs include the primary construction contract, the engineering fees associated with construction, and several miscellaneous construction costs to be carried out by the research team. The researcher and center costs for the operation phase are also estimated.

The research phase costs are an estimate of the budget needed to conduct research at the site throughout the grant period, and include costs for researcher expenses, NRRL power costs, and engineering services for the NRRL site owner.

In addition, $72,540 is allocated for support to the owner/operator to assist with expenses associated with permit modifications needed for additional bioreactor activities and support for the purchase and installation of additional instrumentation for these activities.

Table 4.6 Expenses for NRRL

A. Expenses Paid To Date (8/31/03)	
New River / D&A Expenses	**$487,222.73**

NRSWA, original Contract, Design	191,830.65	
NRSWA Am. 1, Well Test	13,035.30	
NRSWA Am. 2, High rise, leachate system	3,000.00	
NRSWA Am. 3, Bid Package Prep	17,970.00	
NRSWA Am. 4, Access Road	137,500.00	
NRSWA Am. 5, Eng. Services	47,821.00	
NRSWA Am. 6, Legal Svcs.	2,992.50	
NRSWA Am. 8, Legal Fees	50,000.00	
NRSWA Am. 9, Legal Fees	4,343.28	
Darabi & Assoc. (Road Design)	18,730.00	
Construction & Infrastructure	**231,904.97**	
Darabi & Assoc.	13,290.00	
Surveying (Pat Welch)	9,980.00	
Drill Test	1,305.00	
Well Installation - ECS	8,900.00	
Well Installation – Pipe	12,695.00	
Liner	78,020.00	
Field Office (Research Trailer)	16,060.75	
Misc. Construction Equip/Supplies	36,142.86	
Well Drilling	51,913.00	
Installation of Leach Field	3,598.36	
Instrumentation	**212,475.77**	
Transducers – NRRL	132,668.84	
Datalogger – NRRL	39,893.73	
GPS + training	28,495.23	
Well Sensor Packs	11,417.97	
Researchers	**942,088.06**	
UF (thru 8/31/03)	588,195.33	
UCF (thru 8/31/03)	290,447.46	
Mercer	5,282.80	
Travel	26,953.74	
Researcher Supplies (Lab, etc.)	31,208.73	
Center's Cost	**204,272.44**	
Salaries & Benefits	142,806.73	
OPS	9,796.15	
Travel	15,540.09	
Data Transmission – Cell Phones	3,260.16	
Miscellaneous Project Costs	32,869.31	
Total Direct	**2,077,963.97**	
Indirect Costs (5%)	103,898.19	
Total Project Expenses to Date		**2,181,862.16**

Table 4.6 Continued

B. Construction Phase Costs Paid (15 months)		
Primary Construction Contract paid through 8/31/03	1,795,086.29	
Engineering Services paid through 8/31/03	188,980.61	
Engineering – Liquidated charges	107,669.77	
Engineering Certification	9,200.00	
Record Keeping paid	15,000.00	
Liability Insurance paid	7,031.00	
Total Direct Construction Costs through 8/31/03	**2,122,967.67**	
Indirect Costs (5%)	106,148.35	
Total Costs for Construction through 8/31/03	**2,229,116.02**	
C. Operating Research Phases Costs (3 years)		
Operating Phase Recurring Costs through 8/31/03		
Record Keeping –Operating Phase	5,000.00	
Electrical Charges through 6/1/03	4,639.81	
NRSWA Operating Costs through 8/31/03	**9,639.81**	
Total Project Direct Expenses through 8/31/03		**4,210,571.45**
Indirect Costs (5%)		210,528.57
Total Costs through 8/31/03		**$4,421,100.02**
Operating Research Phases Costs (3 years)		
Researcher Costs – NRRL	745,303.00	
Additional Instrumentation	42,700.00	
Additional Contingency	100,000.00	
Training and Workshops	5,000.00	
Vehicle for travel to the Landfill	10,000.00	
Center Costs (est. $15,000 per year)	87,031.00	
Power Costs - NRRL (est. $32,000 per year)	121,500.00	
NRSWA – New Contract	72,540.00	
NRRL/Darabi Costs (est. $50,000 per year)	150,000.00	
Insurance on Instrumentation	9,992.46	
NRRL Record keeping ($12,000 per year –3 years)	54,972.50	
Total Direct	**1,326,498.96**	
Indirect Costs (5%)	66,324.94	
Total Research Phase Costs		**$1,392,823.90**

Total Estimated Costs -- NRRL **$5,813,923.96**

4.2 DESCRIPTION OF BIOREACTOR TECHNOLOGY AT TOMOKA ROAD LANDFILL IN VOLUSIA COUNTY

4.2.1 Overview

The Tomoka Road Landfill (TMRL) in Volusia County houses a number of solid waste disposal units, including an operating Class I unit for disposal of municipal solid waste. The current operating unit is 30 acres in area. The liner system is a double-liner system equipped with a primary leachate collection system and a leak detection system. Leachate is currently pumped into a leachate equalization and storage facility.

The landfill operator was considering implementation of bioreactor technology. In anticipation of this, a series of instruments were placed on top of the liner in one area of the lined cell. The instrumentation provided data on the head of leachate on the liner and the overpressure exerted by the waste. The use of transducers and load cells are important to both bioreactor and traditional landfill sites because the information is an indication of the performance of the landfill operations and leachate collection systems. Data from these instruments offer insight into the performance of leachate collection systems under bioreactor operation and the subsequent mass loss due to degradation of the waste.

4.2.2 Summary of Basic Project Components

Project components included:

- A series of pressure transducers for measuring head on the liner.
- A series of earth pressure cells for measuring overburden pressure exerted by the landfilled material (waste plus cover soil).

There were 96 Druck Series 1230 pressure transducers for the measurement of leachate heads and 24 RocTest TPC Series total earth pressure sensors (Figure 2) to measure the overburden force on the liner installed at the Tomoka Road landfill. The area instrumented encompasses three leachate collection bays and is 3.1 acres. This area is located in the northeast corner of the landfill.

The Druck transducer is constructed of titanium and is essentially a cylinder with a 0.7-inch (1.8-cm) diameter and a length of approximately 4 inches (10.2 cm). The unit is attached to the measurement station by a polyurethane-jacketed cable with a watertight and submersible connection between the cable and the transducer. Pressure measurements are taken using a differential voltage output with an excitation voltage of 2.5 volts. Seventy-two (72) of the 96 transducers were placed in the LCS on top of the geotextile, 12 were be placed at the surface of the LCS drainage media, and 12 were be placed in the waste mass. The sensor cables are routed back to monitoring station that is equipped with a cell phone and automatic dialer, which transmits the data to the lab at the University of Central Florida. The monitoring station, cell phone and automatic dialer are mounted on a tower.

The RocTest total earth pressure sensors consist of 2 stainless steel discs approximately 9 inches in diameter, which are welded together around the edges. The space between the discs is filled with oil or glycerol. Any forces exerted on the discs result in a change in the pressure of this liquid. The liquid pressure is measured via a

vibrating wire pressure transducer attached to the edge of the disc via an 18-inch long stainless steel tube. Twenty four (24) of these sensors were installed in conjunction with Druck transducers.

4.2.3 Site Management Plan

The landfill operator will conduct routine bioreactor activities at the Tomoka Road landfill. The researchers will provide technical assistance with regard to the design and operation of the bioreactor. The researchers met with the landfill operator on a quarterly basis to update the operator of the results of the data being collected.

As part of the design and permitting process, a detailed Site Management Plan will be developed. Information included in this Site Management Plan will include, at a minimum, the following:

4.2.3.1 A plan for development and routine operation of the bioreactor activities at the site

A timeline of scheduled activities for the design, permitting, construction, and startup of the bioreactor is included in the Table 4.7. A series of milestones are identified throughout the design, permitting, and construction process. Project meetings will be held at various stages of completion during this process so work can be reviewed by the researchers and other team members, and input can be made. A list of tasks, and the month or period during which they will be conducted, for each applicable activity listed in section 3 of this Work Plan, is in Table 4.8 of this Site Management Plan.

Table 4.7 Schedule of Activities for TRLF

Activity	Date
Install Instrumentation	Completed (July 2000)
Monitor Instrumentation	August 2000 – January 2002
Evaluate & report results	February 2002 – May 2002
Continue working with County staff on future bioreactor development	Ongoing

Table 4.8 Project Objective Timeline – TRLF

Project Objective	Timeline
Instrumentation for in-situ measurement of landfill parameters	July – 2000 (installation in landfill cell)
Monitor instrumentation to evaluate bioreactor technology	July 2000 – January 2002
Collect instrumentation data	July 2000 – January 2002
Evaluate & report results	February 2002 – May 2002
Continue working with County staff on future bioreactor development	Ongoing

4.2.3.2 Monitoring plan

Numerous research activities will be coordinated with the design, construction, and operation of the facility. Research activities included instrumentation of the landfill as a means to collect valuable *in-situ* information about bioreactor performance (Table 4.9 and Table 4.10). Responsibilities for the installation, operation, and upkeep of such instrumentation were delineated during the design phase and developed as part of this detailed site management plan. The research will also involve the collection and analysis of numerous environmental samples (e.g. leachate, gas, waste), and the measurement of bioreactor performance in the field (e.g. settlement, gas flow). The following research activities will be conducted by at the Tomoka Road landfill.

- Monitoring of leachate head on the liner as measured by the Druck pressure transducers (completed)
- Monitoring of landfill load on the liner as measured by the RocTest total earth pressure transducers (completed)
- Measurement of landfill surface elevation in the area above the instrumentation (completed)

A diagram identifying the location of instrumentation devices will be provided and incorporated into this Site Management Plan as Figure 4.3.

Table 4.9 Instrumentation Installed at TRLF

Instrumentation Location	Description
Liner and Leachate Collection System	The Volusia County transducer site has Druck pressure transducers placed throughout the 3-acre site. Included in the transducer experiment are 24 Roctest Total Pressure Cells designed to measure the applied load forces and temperatures acting on a operating landfill liner system during filling procedures.

Table 4.10 Monitoring Activities of Instrumentation at TRLF

Monitoring Activities	Description
Liner and Leachate Collection System	Data is collected in regular intervals from the transducer and load cell field located at the Volusia County landfill.

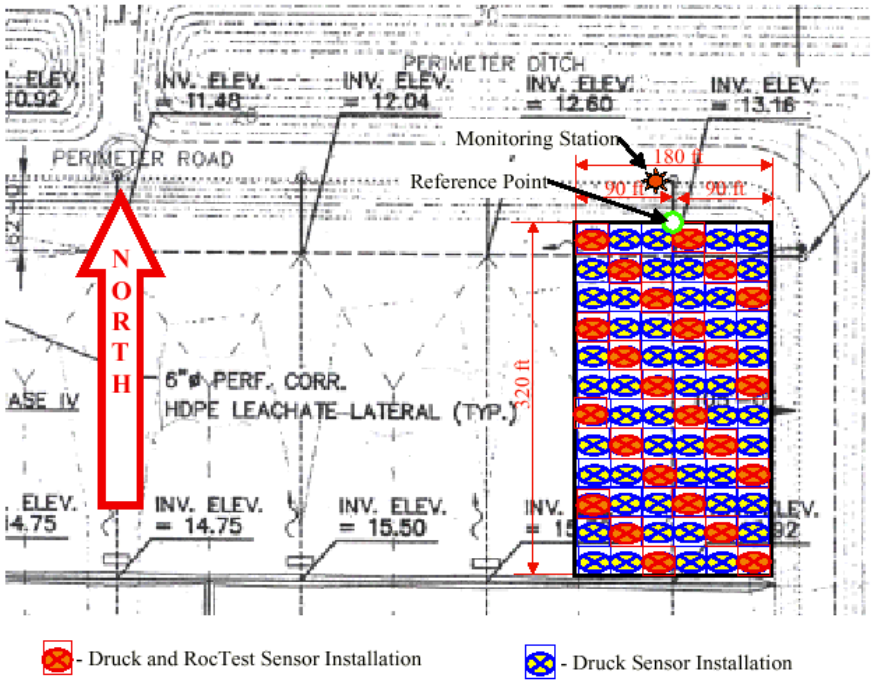


Figure 4.3: Volusia County Instrumentation Location Diagram

4.2.3.3 Meeting Schedule

Project team members will meet with project personnel on a quarterly basis in order to review the performance and status of the current project. At these times suggestions and input to the operation and management of the project can be made to optimize performance.

4.2.3.4 Responsible Parties

The responsible parties for the Florida Bioreactor Demonstration Project at the Tomoka Road Landfill include FDEP, the Center, University of Florida and University of Central Florida.

4.2.3.5 Coordination Procedures

Project team members will coordinate with the landfill operations personnel to schedule and conduct site visits and research activities. The procedure to inform the landfill personnel is to call the site, when possible, the day before a planned site visit and inform them of the visitors that will be arriving, the time of the visit and the reasons for the visit. When arriving to the landfill site, visitors will sign in at the front office of the landfill and inform the supervising landfill personnel of their arrival and plans for the visit or research activities.

4.2.3.6 Health & Safety Plan

Project team members will observe all existing safety procedures used by the operating landfill. These include signing in at main landfill office, the use of hardhats in designated areas, proper attire, eye protection, appropriate footwear, and any other safety equipment deemed necessary by the project site dependent on day-to-day environmental and working conditions. All project members and visitors to the site will observe the project safety plan as well as the plan established by the Tomoka Road Landfill. The following safety protocols will be followed, as well as all other protocols outlined specifically by the site personnel.

Table 4.11 Health and Safety Program Table – TRLF

Action	Health & Safety Program Requirement
Site Visits	• Contact site Superintendent at least 24 hours in advance, and check out at the front office upon completion.
Emergency Action Plan	• Report fires and emergencies to site Emergency Coordinator or 911. • Carry first aid kits to the site. • In case of emergency evacuate to the front office.
Training	• Must be briefed on protocols and safety precautions by a 40 hour OSHA trained individual.
Eye, Head and Face Protection	• Protective equipment, including personal protective equipment (PPE) for eyes, face, head, extremities, protective clothing, respiratory devices and protective shields and barriers should be maintained in a sanitary and reliable condition.
Researcher	• Researchers working in the proximity of heavy machinery have the responsibility of making machine operators aware of their presence. Keep at least a 15-foot distance from any heavy machinery unless authorized. • Remain aware of all heavy traffic on paved and dirt roads.
Hazardous and Infectious Waste	• If any hazardous or infectious waste is encountered, keep a safe distance, mark the location, and report the location and nature of the waste to the landfill operator. • Before leaving the landfill, researchers must wash their hands and lower arms, face and neck. Any clothes should be washed at the first opportunity.
Confined Spaces	• All research work must be conducted without entry to confined spaces. • Individuals working near the space opening must wear a full body harness and be secured to an immovable structure. • At confined space locations, work must be performed by at least two people. The area must be ventilated for a period of three minutes prior to commencing any work.
Slip, Trip, Fall Hazards	• Approval from site superintendent is required prior to entering the work site. • Proper foot protection (steel toed boots with rubber soles) is required for work anywhere on the landfill. • At least one researcher on the work site must carry a cell phone or two-way radio. • Keep aware of the location of working machinery. • Follow landfill's housekeeping procedures. • In case of serious injury, contact site superintendent. • The researcher will not disturb contractor's stockpiles in any way. • Work near areas designated or flagged as dangerous should be conducted with precaution.

Table 4.11 Continued

Action	Health & Safety Program Requirement
Heat Stress	• Prior to entering the work site where eating and drinking are prohibited, researchers must drink plenty of water to prevent dehydration. 5 to 7 ounces of water every 15 to 20 minutes is recommended. • Distribute the workload evenly throughout the day and incorporate work rest cycles. • Researchers should be trained to identify the signs of heat stress. • Observe and monitor each other periodically to watch for symptoms of heat stress. • Keep drinking water on the work truck in case of heat related illnesses.
Prison Work Gangs	• Researchers have the responsibility to understand and follow site policies regarding working proximate to work gangs.

4.2.4 Tomoka Farms Road Landfill

Pressure transducer data were collected between October 2000 and January 2002. In response to a request by the landfill operators, the data station was removed in January 2002. The following paragraphs give a brief overview of the results.

Between November 2000 and March 2001, average monthly head on liner values remained below 1.5 inches (3.8 cm). However, from April 2001 through September 2001, average monthly head on liner values increased to over 22 inches (56 cm). A possible cause for the observed increase in average head on liner is rainfall (discussed in following paragraph). A large rainfall amount of approximately 9 inches (23 cm) occurred during the month of March, after which the average head on liner increased from 0.14 inches (0.36 cm), during the month of February 2001, to 4.88 inches (12.40 cm) during the month of April 2001. In addition, average head on liner steadily increased to 23 inches (58 cm) during the month of September 2001 before beginning to decrease during the month of October 2001.

It appeared that during March 2001, rainfall had a significant effect on average head on liner. Average head on liner increased during this month from under 1 inch (2.5 cm) to over 5 inches (12.7 cm). Surprisingly, average head on liner continued to increase steadily, even in the absence of subsequent rainfall events. These data indicate that rainfall may have initiated an affect on the average head on liner recorded by the sensors.

Gas pressure at the Tomoka Farms site was measured using pressure transducers installed at the surface of the LCS drainage layer. Results from these sensors indicated that gas pressure was not a major factor in the addition of excess pressure exerted on the sensors.

The Tomoka Farms Landfill has a unique leachate collection system design. Transducer and load cell data provided insight regarding the performance of this design

under wet conditions. Although the experiment was discontinued prior to initiation of bioreactor operations (which may never occur), valuable information regarding LCS behavior was gathered during this experiment. For a more complete discussion of the results obtained from this site, please refer to "Performance Evaluation of Landfill Liner Systems Using Pressure Transducers", Masters Thesis, University of Central Florida, by Mark Spafford in May 2002.

Site Cost Estimates

The following table (Table 4.12) provides a budget estimate for the bioreactor research being conducted at the Tomoka Road landfill. The majority of the costs are associated with instrumentation at the landfill and its monitoring.

Table 4.12 Expenses for TRLF

BUDGET CATEGORY	
Instrumentation (paid through 12/31/02)	**$82,700.07**
Transducers - Volusia	71,019.03
Datalogger - Volusia	11,681.04
Researchers - UCF (paid through 12/31/02)	**$15,706.21**
Research Phase n/a	**0**
TOTAL	**$98,406.28**

Because of filling sequence Tomoka Road Landfill management asked researcher to remove the instrumentation and data loggers from the site. As of February 2002 the researcher stopped collecting data from the site and there are no plans to continue research in this location.

4.3 DESCRIPTION OF BIOREACTOR TECHNOLOGY AT POLK COUNTY NORTH CENTRAL LANDFILL

4.3.1 Overview

The North Central Landfill (NCLF) in Polk County is a county-operated disposal facility that includes: a materials recycling facility, a hazardous waste collection facility, a clay-lined closed Class III landfill, a lined Class I landfill that is closed (Phase I), and a lined Class I landfill that is open (Phase II, the bioreactor).

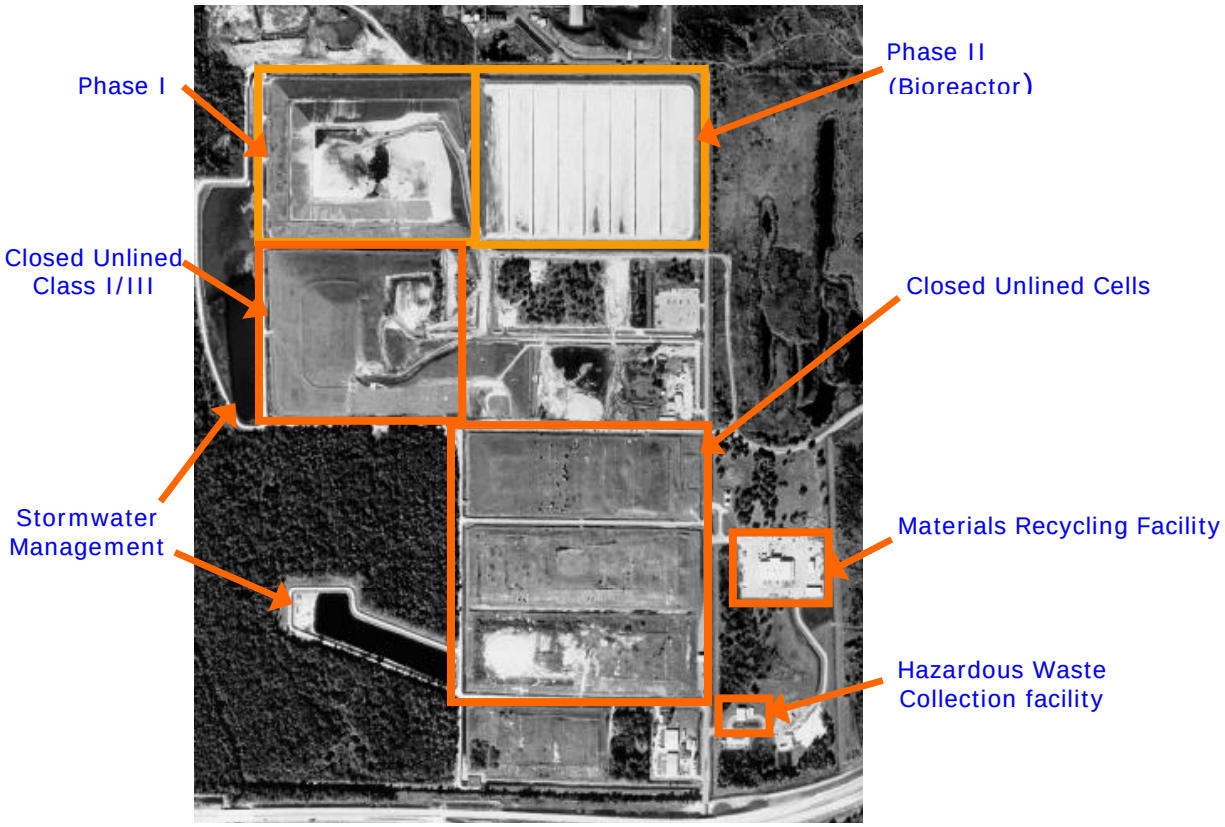


Figure: 4.4: Aerial photo of the NCLF

The landfill operator will use bioreactor technology in Phase II and apply it to Phase III, currently being constructed. The current operating unit is 43 acres in area. The research project is located on 38 acres. Figure 4.4 is an aerial photo identifying the location of the bioreactor area.

The NCLF bioreactor is being constructed by Polk County using Polk County funds. This includes resources for the design, permitting, installation, and operation of the horizontal injection leachate recirculation system. In addition, the County is also providing support for graduate students to work on the project. The researchers are assisting the county in creating a design of the system, construction and permitting of the system, and future monitoring of the system. Injection lines began being installed in 2001 (with the help of the researchers). During this time the county hired an engineering firm to design the pumping and supervisory control and data acquisition (SCADA)

system (with researcher input). The system began construction in early 2003 and became fully operational on May 18th, 2006.

4.3.2 Summary of Basic Project Components

The NCLF bioreactor includes the following components:

- A horizontal injection leachate recirculation system
- Instrumentation to measure injection flow and pressure through a SCADA system
- Leachate volume will be measured via the SCADA system
- Leachate quality will be measured
- The settlement of the landfilled waste will be tracked
- Instrumentation to measure *in situ* pore water pressure surrounding 3 different horizontal injection lines

4.3.3 Site Management Plan

As part of the design and permitting process, a detailed Site Management Plan will be developed. Information included in this Site Management Plan will include, at a minimum, the following:

4.3.3.1 A plan for development and routine operation of the bioreactor activities at the site

A timeline of scheduled activities for the design, permitting, construction, and startup of the bioreactor is included Table 4.13. A series of milestones are identified throughout the design, permitting, and construction process. Project meetings will be held at various stages of completion during this process so work can be reviewed by the researchers and other team members, and input can be made. A list of tasks, and the month or period during which they will be conducted, for each applicable activity listed in section 3 of this Work Plan, is in Table 4.14 of this Site Management Plan.

Table 4.13 Schedule of Activities for NCLF

Activity	Date
Install Horizontal Leachate Recirculation Laterals	Ongoing – Started in February 2001
Conceptual Design of Leachate Recirculation System	Completed
Design and Permitting	Completed
Construction of Leachate Pumping and Control System	Completed
Start of Recirculation	January 3, 2006

Table 4.14 Project Objective Timeline – NCLF

Objective	Date
Design and operation of bioreactor system	Completed design of horizontal bioreactor system and currently installing piping during operations.
Obtain permit for bioreactor operation	Completed
Evaluate the use of horizontal injection technology	Ongoing
Evaluate the use of automated leachate recirculation system	Ongoing
Develop standard design and operations procedures for bioreactor technology	Future – pertaining to horizontal well bioreactor systems
Define and quantify costs	Future
Provide resource and training	Future

4.3.3.2 Monitoring plan

Numerous research activities will be coordinated with the design, construction, and operation of the facility. Research activities will include instrumentation of the landfill as a means to collect valuable *in-situ* information about bioreactor performance. Responsibilities for the installation, operation, and upkeep of such instrumentation are delineated during the design phase and developed as part of this detailed site management plan.

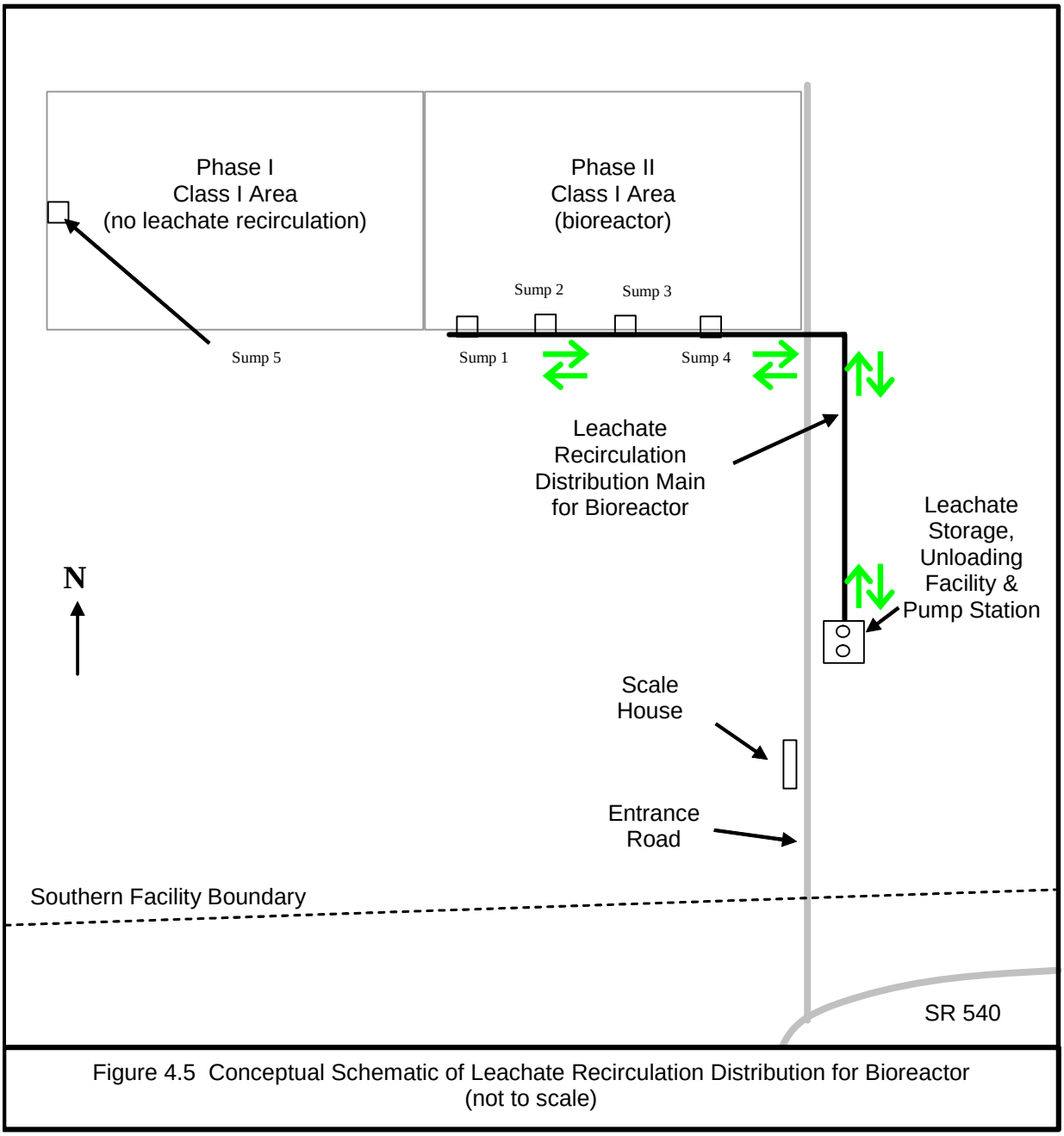


Figure 4.5 Conceptual Schematic of Leachate Recirculation Distribution for Bioreactor (not to scale)

To monitor leachate level, daily measurements of the liquid level within the wetwell will be taken. The wetwell will be equipped with an automatic recording device that measures the percent of leachate in the well.

Leachate recirculation will be performed in the Phase II landfill unit. Leachate collected from both Phase I and Phase II will be recirculated to Phase II; no leachate will be recirculated to Phase I. The leachate recirculation system will consist of a series of HDPE pipes placed horizontally within the landfill.

Leachate will be pumped from the leachate storage tanks to a primary leachate recirculation header that runs along the southern edge of the Phase II landfill. The leachate recirculation header is equipped with a series of valved tees that leads to 7 hydrants. These hydrants are connected to the secondary leachate recirculation header that has tee connections that lead to 20 valved standpipes. Each injection line is connected to one of these 140 standpipes and then runs up the slope of the landfill where it enters the landfill at the elevation it was constructed. Valves for this system are located at each hydrant and at each standpipe.

Table 4.15 Monitoring Activities

Monitoring Activity	Description
Leachate Injection Rate	• The flow rate and injection pressure will be monitored for each injection line
Leachate Quality	• Leachate quality will be tracked
Settlement	• Landfill surface elevation settlement will be monitored

4.3.3.3 Meeting Schedule

Project team members will meet with project personnel on a quarterly basis in order to review the performance and status of the current project. At these times suggestions and input to the operation and management of the project can be made to optimize performance.

4.3.3.4 Responsible Parties

The responsible parties for the Florida Bioreactor Demonstration Project at the Polk County Landfill include FDEP, the Center, University of Florida and University of Central Florida.

4.3.3.5 Coordination Procedures

Project team members will coordinate with the landfill operations personnel to schedule and conduct site visits and research activities. The procedure to inform the landfill personnel is to call the site, when possible, the day before a planned site visit and inform them of the visitors that will be arriving, the time of the visit and the reasons for the visit. When arriving to the landfill site, visitors will sign in at the front office of the landfill and inform the supervising landfill personnel of their arrival and plans for the visit or research activities.

4.3.3.6 Health & Safety Plan

Project team members will observe all existing safety procedures used by the operating landfill. These include signing in at main landfill office, the use of hardhats in designated areas, proper attire, eye protection, appropriate footwear and any other safety equipment deemed necessary by the project site dependent on day-to-day environmental and working conditions. All project members and visitors to the site will observe the project safety plan as well as the plan established by the Polk County Landfill. The following safety protocols will be followed, as well as all other protocols outlined specifically by the site personnel.

Table 4.16 Health and Safety Program Table – NCLF

Action	Health & Safety Program Requirement
Site Visits	• Contact the site superintendent at least 24 hours in advance, and check out at the front office upon completion.
Emergency Action Plan	• Report fires and emergencies to the site Emergency Coordinator or 911. • Carry first aid kits to the site. • In case of emergency evacuate to the front office.
Training	• Must be briefed on protocols and safety precautions by a 40 hour OSHA trained individual.
Eye, Head and Face Protection	• Protective equipment, including personal protective equipment (PPE) for eyes, face, head, extremities, protective clothing, respiratory devices and protective shields and barriers should be maintained in a sanitary and reliable condition.
Researcher	• Researchers working in the proximity of heavy machinery have the responsibility of making machine operators aware of their presence. Keep at least a 15-foot distance from any heavy machinery unless authorized. • Remain aware of all heavy traffic on paved and dirt roads.

Table 4.16 (continued)

Action	Health & Safety Program Requirement
Hazardous and Infectious Waste	• If any hazardous or infectious waste is encountered, keep a safe distance, mark the location, and report the location and nature of the waste to the landfill operator. • Before leaving the landfill, researchers must wash their hands and lower arms, face and neck. Any clothes should be washed at the first opportunity.
Confined Spaces	• All research work must be conducted without entry to confined spaces. • Individuals working near the space opening must wear a full body harness and be secured to an immovable structure. • At confined space locations, work must be performed by at least two people. The area must be ventilated for a period of three minutes prior to commencing any work.
Slip, Trip, Fall Hazards	• Approval from site superintendent is required prior to entering the work site. • Proper foot protection (steel toed boots with rubber soles) is required for work anywhere on the landfill. • At least one researcher on the work site must carry a cell phone or two-way radio. • Keep aware of the location of working machinery. • Follow landfill's housekeeping procedures. • In case of serious injury, contact site superintendent. • The researcher will not disturb contractor's stockpiles in any way. • Work near areas designated or flagged as dangerous should be conducted with precaution.
Heat Stress	• Prior to entering the work site where eating and drinking are prohibited, researchers must drink plenty of water to prevent dehydration. 5 to 7 ounces of water every 15 to 20 minutes is recommended. • Distribute the workload evenly throughout the day and incorporate work rest cycles. • Researchers should be trained to identify the signs of heat stress. • Observe and monitor each other periodically to watch for symptoms of heat stress. • Keep drinking water on the work truck in case of heat related illnesses.
Prison Work Gangs	• Researchers have the responsibility to understand and follow site policies regarding working proximity to work gangs.

4.3.3.7 Site Cost Estimates

The NCLF bioreactor is being constructed by Polk County using Polk County funds. This includes resources for the design, permitting, installation, and operation of the horizontal injection leachate recirculation system. In addition, the County is also providing support for graduate students to work on the project. This project is contributing a portion of Dr. Townsend's salary, which is $22,500 during the research phase. In addition, instrumentation estimated to cost $15,000 will be installed at this site. Table 4.17 provides a budget estimate for the bioreactor research being conducted at the North Central Landfill.

Current estimates of costs paid by Polk County are:

$100,000 in support for research team over the past 3 years

$75,000 in capital and operating expenses in constructing the lines

$200,000 in engineering services

Table 4.17 Expenses for NCLF

BUDGET CATEGORY	
Research Phase – UF Dr. Townsend's salary Instrumentation	**$22,500.00** **15,000.00**
TOTAL	**$37,500.00**

4.4 DESCRIPTION OF BIOREACTOR TECHNOLOGY AT MARION COUNTY BASELINE LANDFILL

4.4.1 Overview

The Marion County Baseline Landfill Bioreactor is a county-operated disposal facility that provides disposal units for municipal solid waste. The landfill bioreactor system is located in the partial closure area of Cells III-A, B and C. Instrumentation to monitor subsurface leachate levels was added to these cells. These leachate levels are important indicators of landfill liner and leachate collection system performance.

The Marion County Baseline Landfill Bioreactor was constructed by Marion County. Marion County is looking to have researchers assist the county in assessing the system design and devising a plan to get the recirculation system going, as well as future monitoring of the recirculation system.

4.4.2 Summary of Basic Project Components

The Marion County Baseline Landfill Bioreactor includes the following components:

- Injection pump station located at the leachate tank farm
- Leachate injection wells (16 vertical in Cells A and B, 13 horizontal in Cell C)
- Piezometric monitoring wells (3 in Cells A and B, 3 in Cell C)
- Recirculation flow meters (1 for Cells A and B, 1 for Cell C)

4.4.3 Site Management Plan

As part of the design and permitting process, a detailed Site Management Plan will be developed. Information included in this Site Management Plan will include, at a minimum, the following:

4.4.3.1 A plan for development and routine operation of the bioreactor activities at the site

A timeline of scheduled activities for the design, permitting, construction, and startup of the bioreactor is included Table 4.18. A series of milestones are identified throughout the design, permitting, and construction process. Project meetings will be held at various stages of completion during this process so work can be reviewed by the researchers and other team members, and input can be made. A list of tasks, and the month or period during which they will be conducted, is in Table 4.19 of this Site Management Plan.

Table 4.18 Schedule of Activities for MCBLF

Activity	Date
Assist county in developing future leachate recirculation plans	Ongoing – started May 2003
Compile and examine existing data on leachate, gas and other landfill characteristics	Ongoing – started May 2003
Monitor Leachate recirculation and bioreactor activities; conduct specific experiments to meet research objectives	Fall 2003

Table 4.19 Task List – MCBLF

Planned Tanks	Time
Assist landfill operators in monitoring leachate levels in the Cell C horizontal leachate injection lines	Summer 2003
Investigation and experimentation of other leachate level measuring devices in the horizontal leachate injection lines	Summer 2003
Assist in leachate recirculation planning	September 2003 and as needed
Compile leachate data	September 2003 and as needed
Compile gas data	September 2003 and as needed
Compile historical record of bioreactor activities	September 2003
Develop research experiment goals	October 2003
Collect data on performance of leachate recirculation systems	Future
Assist in future recirculation system development	Future
Compile economic evaluation	Future

4.4.3.2 Monitoring plan

Numerous research activities will be coordinated with the design, construction, and operation of the facility. Research activities will include instrumentation of the landfill as a means to collect valuable *in-situ* information about bioreactor performance. Responsibilities for the installation, operation, and upkeep of such instrumentation is delineated during the design phase and developed as part of this detailed site management plan.

Daily monitoring will include inspection of Cells A, B and C leachate collection wet wells for liquid level and quantity of leachate pumped from each. The injection area and side slopes are also inspected each day for signs of seepage. Additionally, well heads, orifice plate flow meters and other gas collection system components are inspected daily for leaks and damage.

4.4.3.3 Coordination Procedures

Project team members will coordinate with the landfill operations personnel to schedule and conduct site visits and research activities. The procedure to inform the landfill personnel is to call the site, when possible, the day before a planned site visit and inform them of the visitors that will be arriving, the time of the visit and the reasons for the visit. When arriving to the landfill site, visitors will sign in at the front office of the landfill and inform the supervising landfill personnel of their arrival and plans for the visit or research activities.

4.4.3.4 Health and Safety Plan

Project team members will observe all existing safety procedures used by the operating landfill. These include signing at main landfill office, the use of hardhats in designated areas, proper attire, eye protection, appropriate footwear and any other safety equipment deemed necessary by the project site dependent on day-to-day environmental and working conditions. All project members and visitors to the site will observe the project safety plan as well as the plan established by the Marion County Baseline Bioreactor Landfill. The following safety protocols will be followed, as well as all other protocols outlined specifically by the site personnel:

Table 4.20 Health and Safety Program Table – MCBLF

Action	Health & Safety Program Requirement
Site Visits	• Contact the site superintendent at least 24 hours in advance, and check out at the front office upon completion.
Emergency Action Plan	• Report fires and emergencies to the site Emergency Coordinator or 911. • Carry first aid kits to the site. • In case of emergency evacuate to the front office.
Training	• Must be briefed on protocols and safety precautions by a 40 hour OSHA trained individual.
Eye, Head and Face Protection	• Protective equipment, including personal protective equipment (PPE) for eyes, face, head, extremities, protective clothing, respiratory devices and protective shields and barriers should be maintained in a sanitary and reliable condition.

Table 4.20 Continued

Researcher	• Researchers working in the proximity of heavy machinery have the responsibility of making machine operators aware of their presence. Keep at least a 15-foot distance from any heavy machinery unless authorized. • Remain aware of all heavy traffic on paved and dirt roads.
Hazardous and Infectious Waste	• If any hazardous or infectious waste is encountered, keep a safe distance, mark the location, and report the location and nature of the waste to the landfill operator. • Before leaving the landfill, researchers must wash their hands and lower arms, face and neck. Any clothes should be washed at the first opportunity.
Confined Spaces	• All research work must be conducted without entry to confined spaces. • Individuals working near the space opening must wear a full body harness and be secured to an immovable structure. • At confined space locations, work must be performed by at least two people. The area must be ventilated for a period of three minutes prior to commencing any work.
Slip, Trip, Fall Hazards	• Approval from site superintendent is required prior to entering the work site. • Proper foot protection (steel toed boots with rubber soles) is required for work anywhere on the landfill. • At least one researcher on the work site must carry a cell phone or two-way radio. • Keep aware of the location of working machinery. • Follow landfill's housekeeping procedures. • In case of serious injury, contact site superintendent. • The researcher will not disturb contractor's stockpiles in any way. • Work near areas designated or flagged as dangerous should be conducted with precaution.
Heat Stress	• Prior to entering the work site where eating and drinking are prohibited, researchers must drink plenty of water to prevent dehydration. 5 to 7 ounces of water every 15 to 20 minutes is recommended. • Distribute the workload evenly throughout the day and incorporate work rest cycles. • Researchers should be trained to identify the signs of heat stress. • Observe and monitor each other periodically to watch for symptoms of heat stress. • Keep drinking water on the work truck in case of heat related illnesses.

4.4.3.5 Site Cost Estimates

This project is contributing 25% for a graduate assistant and a portion of Dr. Townsend's salary, which is $22,500, during the research phase.

Table 4.21 Expenses for MCBLF

BUDGET CATEGORY	
Research Phase – UF Dr. Townsend's salary	**$22,500.00**
TOTAL	**$22,500.00**

4.5 DESCRIPTION OF BIOREACTOR TECHNOLOGY AT HIGHLANDS COUNTY LANDFILL

4.5.1 Overview

The Highlands County Landfill in Highlands County is a county-operated disposal facility that includes: a materials recycling facility, a construction and demolition debris landfill, two lined Class I landfill Cell - 1, and Cell – 3.

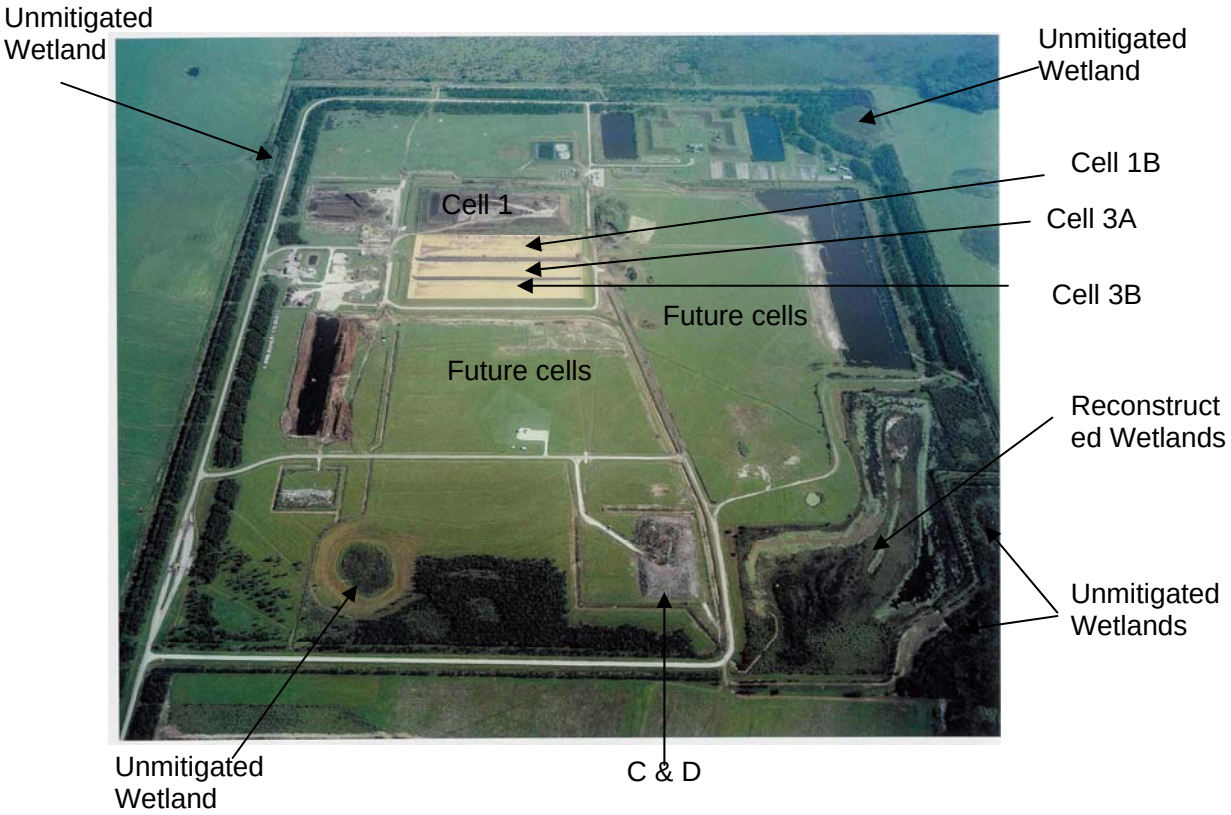


Figure: 4.5: Aerial photo of the Highlands County landfill

The landfill operator has recirculated leachate in cell -1 (A and B) in the past for several years. At present the landfill is having some problem with the leachate recirculation and the gas collection system for this cell. University of Florida research team is assisting the landfill personnel in figuring out the problem and possible solution for it. The present research project is located on 18.5 acres. Figure 4.5 is an aerial photo of the landfill area.

4.5.2 Summary of Basic Project Components

The Highlands bioreactor includes the following components:

- A horizontal injection leachate recirculation system
- Leachate injection line is also used for gas collection
- Onsite leachate treatment system using aerated leachate ponds and sand filter.

4.5.3 Site Management Plan

The project team has started work at the site on 20th April, 2006. In general the project scope will include:

- Compilation of summary of all existing data pertaining to the operation of the bioreactor.
- The team will work with the landfill operation staff to assess the current state of the leachate recirculation and gas recovery system. This task will involve field testing of the system.
- An analysis of the existing air-space recovery and utilization at the site, with a specific focus on the impact of the bioreactor, will be conducted. The results from air space saving will be compared to historical and future bioreactor expenses.
- Landfill gas generation will be forecasted and compared to existing estimates, and plans for the feasibility of gas to energy conversion will be evaluated.
- Recommendations for future design and operation of the bioreactor system will be made.

The results of these tasks will be summarized in periodic progress reports and a final project report.

Table 4.22 Schedule of Activities for Highlands County Landfill

Activities	Timeline						
	Mar	Apr	May	June	July	Aug	Sep
Kick off Meeting	X						
Compilation and review of historical data	X	X					
System evaluation			X	X	X		
Data evaluation and analysis			X	X	X	X	
Progress Report			X		X		
Final Report							X

4.5.4 Health & Safety Plan

Project team members will observe all existing safety procedures used by the operating landfill. These include signing in at main landfill office, the use of hardhats in designated areas, proper attire, eye protection, appropriate footwear and any other safety equipment deemed necessary by the project site dependent on day-to-day environmental and working conditions. All project members and visitors to the site will

observe the project safety plan as well as the plan established by the Polk County Landfill. The following safety protocols will be followed, as well as all other protocols outlined specifically by the site personnel.

Table 4.16 Health and Safety Program Table – Highlands Landfill

Action	Health & Safety Program Requirement
Site Visits	• Contact the site superintendent at least 24 hours in advance, and check out at the front office upon completion.
Emergency Action Plan	• Report fires and emergencies to the site Emergency Coordinator or 911. • Carry first aid kits to the site. • In case of emergency evacuate to the front office.
Training	• Must be briefed on protocols and safety precautions by a 40 hour OSHA trained individual.
Eye, Head and Face Protection	• Protective equipment, including personal protective equipment (PPE) for eyes, face, head, extremities, protective clothing, respiratory devices and protective shields and barriers should be maintained in a sanitary and reliable condition.
Researcher	• Researchers working in the proximity of heavy machinery have the responsibility of making machine operators aware of their presence. Keep at least a 15-foot distance from any heavy machinery unless authorized. • Remain aware of all heavy traffic on paved and dirt roads.

Table 4.16 (continued)

Action	Health & Safety Program Requirement
Hazardous and Infectious Waste	• If any hazardous or infectious waste is encountered, keep a safe distance, mark the location, and report the location and nature of the waste to the landfill operator. • Before leaving the landfill, researchers must wash their hands and lower arms, face and neck. Any clothes should be washed at the first opportunity.
Confined Spaces	• All research work must be conducted without entry to confined spaces. • Individuals working near the space opening must wear a full body harness and be secured to an immovable structure. • At confined space locations, work must be performed by at least two people. The area must be ventilated for a period of three minutes prior to commencing any work.
Slip, Trip, Fall Hazards	• Approval from site superintendent is required prior to entering the work site. • Proper foot protection (steel toed boots with rubber soles) is required for work anywhere on the landfill. • At least one researcher on the work site must carry a cell phone or two-way radio. • Keep aware of the location of working machinery. • Follow landfill's housekeeping procedures. • In case of serious injury, contact site superintendent. • The researcher will not disturb contractor's stockpiles in any way. • Work near areas designated or flagged as dangerous should be conducted with precaution.
Heat Stress	• Prior to entering the work site where eating and drinking are prohibited, researchers must drink plenty of water to prevent dehydration. 5 to 7 ounces of water every 15 to 20 minutes is recommended. • Distribute the workload evenly throughout the day and incorporate work rest cycles. • Researchers should be trained to identify the signs of heat stress. • Observe and monitor each other periodically to watch for symptoms of heat stress. • Keep drinking water on the work truck in case of heat related illnesses.
Prison Work Gangs	• Researchers have the responsibility to understand and follow site policies regarding working proximity to work gangs.

4.3.3.7 Site Cost Estimates

The Highlands county project is finded by the Highlands county solid waste authority. Additional resources from the Florida Bioreactor Demonstration project will be used as a seed momey to support some of the analytical services performed by the UF research team.

Current estimates of costs paid by Highlands County are:

$37,500 for the research team support including travel for this 6 month project

$30,000 for purchasing instruments such as settlement profiler, drilling charges for collecting garbage sample etc.

Table 4.17 Expenses for NCLF

BUDGET CATEGORY	
Research Phase – UF team support and travel Instrumentation purchase, drilling	**$37500.00** **$30000.00**
TOTAL	**$67,500.00**

5.0 COST ESTIMATES

5.1 Overview of Cost Estimate Information

The following section provides a summary of the cost estimate information for the project. This includes both expenditures to date as well as projected costs for the remainder of the project. Cost information is summarized as a function of expenditure category (e.g. construction costs, researcher, center costs). The cost expenditures as a function of each site location also are summarized.

5.2 Project Expenditures By Category

Table 5.1 presents a detailed summary of the project expenditures to date and projected costs for the remainder of the project. Cost information is presented as a function of:

- Planning Phase Costs
- Construction Phase Costs
- Operation Phase Costs

Table 5.1 Summary of Project Phases

	Planning thru 11/01	Construction thru 3/03	Operation thru 8/03	Operation thru 6/06	Total
NRSWA	129,990.77	22,031.00	9,639.81	259,004.96	420,666..54
Contractors - other	88,391.36	0.00	0.00	0.00	88,391.36
Construction contractor		1,795,086.29	0.00	0.00	1,795,086.29
Darabi	370,521.96	305,850.38	0.00	150,000.00	826,372.34
Researchers	605,649.53	256,694.51	64,241.50	832,306.00	1,758,891.54
Researchers' supplies	10,195.33	1,837.62	19,175.78	0.00	31,208.73
Instrumentation	295,175.84	0.00	0.00	42,700.00	337,875.84
Construction supplies	14,638.77	6,426.13	15,077.96	0.00	36,142.86
Field office	14,764.47	977.95	318.33	0.00	16,060.75
Liner	78,020.00	0.00	0.00	0.00	78,020.00
Center	201,494.44	1,802.25	975.75	102,031.00	306,303.44
Contingency	0.00	0.00	0.00	100,000.00	100,000.00
Total Direct Cost	1,808,842.47	2,390,706.13	109,429.13	1,486,041.96	5,795,019.69
Indirect Cost	90,442.12	119,535.30	5,471.45	74,302.09	289,750.98
Estimated Project Cost	**1,899,284.59**	**2,510,241.43**	**114,900.58**	**1,560,344.05**	**6,084,770.67**

In each of these phases, the costs are further subdivided into the following categories in Table 5.2:

- Contractor Costs
  - New River SWA
  - Engineering Services
  - Other Contractor Services

- Researcher Costs
    - Mercer University
    - University of Central Florida
    - University of Florida

- Center Costs
    - Instrumentation
    - Construction Supplies
    - Research Supplies
    - Field Office, Phone/Data Transmission
    - Center Salaries, Benefits, Travel
    - Liner
    - Miscellaneous Project Costs
    - Contingency

Table 5.2 Total Requested Budget

A. Expenses Paid To Date (8/31/03	Planning Phase	Construction Phase	Operation Phase
New River / D&A Expenses	**$487,222.73**		
NRSWA, original Contract, Design	191,830.65		
NRSWA Am. 1, Well Test	13,035.30		
NRSWA Am. 2, High rise, leachate system	3,000.00		
NRSWA Am. 3, Bid Package Prep	17,970.00		
NRSWA Am. 4, Access Road	137,500.00		
NRSWA Am. 5, Eng. Services	47,821.00		
NRSWA Am. 6, Legal Svcs.	2,992.50		
NRSWA Am. 8, Legal Fees	50,000.00		
NRSWA Am. 9, Legal Fees	4,343.28		
Darabi & Assoc. (Road Design)	18,730.00		
Construction & Infrastructure	**209,104.60**	**7,404.08**	**15,396.29**
Darabi & Assoc.	13,290.00		
Surveying (Pat Welch)	9,980.00		
Drill Test	1,305.00		
Well Installation - ECS	8,900.00		
Well Installation – Pipe	12,695.00		
Well Drilling	51,913.00		
Installation of Leach Field	3,598.36		
Misc. Construction Supplies	14,638.77	6,426.13	15,077.96
Liner	78,020.00		
Field Office (Research Trailer)	14,764.47	977.95	318.33
Researchers	**615,844.86**	**258,532.13**	**83,417.28**
UF (thru 8/31/03)	368,978.30	161,229.25	57,987.78
UCF (thru 8/31/03)	210,929.61	91,225.21	3,998.85
Mercer	5,282.80		
Travel	20,458.82	4,240.05	2,254.87
Researcher Supplies (Lab, etc.) (Paid by Center)	10,195.33	1,837.62	19,175.78
Instrumentation	**295,175.84**		
Transducers – NRRL	132,668.84		
Transducers – Volusia	71,019.03		
Datalogger – NRRL	39,893.73		
Datalogger – Volusia	11,681.04		
GPS + training	28,495.23		
Well Sensor Packs	11,417.97		
Center's Cost	**201,494.44**	**1,802.25**	**975.75**
Salaries & Benefits	142,806.73		
OPS	9,796.15		
Travel	15,439.46	89.03	11.60
Data Transmission – Cell Phones	1,926.68	1,087.79	245.69
Miscellaneous Project Costs	31,525.42	625.43	718.46
Subtotal Direct	**1,808,842.47**	**2,390,706.13**	**99,789.32**

Table 5.2 Continued

Construction Costs	Planning Phase	Construction Phase	Operation Phase
Primary Construction Contract paid through 8/31/03		1,795,086.29	
Engineering Services paid through 8/31/03		188,980.61	
Engineering – Liquidated charges		107,669.77	
Record Keeping paid		15,000.00	
Liability Insurance paid		7,031.00	
Total Construction Paid to NRSWA 8/31/03		**2,113,767.67**	
Engineer Certification		9,200.00	
Total Construction Costs through 8/31/03		**2,122,967.67**	
Operating Phase Recurring Costs through 8/31/03			
Record keeping-Operating Phase Balance			5,000.00
Electrical Charges through 6/1/03			4,639.81
NRSWA Operating Costs through 8/31/03			**9,639.81**
Subtotal Direct Costs through 8/31/03	**1,808,842.47**	2,390,706.13	**109,429.13**
Total Direct Costs through 8/31/03			**4,308,977.73**
Indirect Costs (5%)			215,448.88
Total Costs through 8/31/03			**4,524,426.61**

Table 5.2 Continued

B. Proposed Costs – Operation Phase	**$5.45 Million Allocation**	**Additional $634,771 Allocation**	**$6,084,771 Allocation**
Researcher – NRRL	$370,806.00	374,497.00	745,303.00
Researcher – Marion County	-	22,500.00	22,500.00
Researcher – Polk County	22,500.00	15,000.00	37,500.00
Research – New Site		27,003.00	27,003.00
Additional Instrumentation -- Center	42,700.00		42,700.00
Additional Contingency	100,000.00		100,000.00
Training and Workshops	5,000.00		5,000.00
Vehicle for travel to the Landfill -- Center	10,000.00		10,000.00
Center Costs	45,000.00	42,031.00	87,031.00
Power Costs - NRRL	89,500.00	32,000.00	121,500.00
NRRL – New Contract		72,540.00	72,540.00
NRRL/Darabi Costs (est. $50,000 per year)	150,000.00		150.000.00
Insurance on Instrumentation	9,992.46		9,992.46
NRRL Record keeping ($12,000 per year –3 years)	36,000.00	18,972.50	54,972.50
Total Direct	**881,498.46**	**604,543.50**	**1,486,041.96**
Indirect Costs (5%)	44,074.92	30,227.18	74,302.10
Total Projected Research Phase Costs	**925,573.38**	**634,770.68**	**1,560,344.06**
Total Estimated Project Costs	**$5,449,999.99**	**634,770.68**	**6,084,770.67**

Table 5.2 Continued

C. Breakdown of Operation Phase – 3 ½ Years	$5.45 Million Allocation	Additional $634,771.12 Allocation	$6,084,771 Total Allocation
UCF Researchers:			
Faculty Support ($15,000 per year)	45,000	7,722	52,722
Mercer Subcontract ($15,000 per year)	45,000	10,000	55,000
Grad. Research Assts. (2) 60% in field research 40% lab/computer (2 years) ($20,000 per year per student)	80,000	18,180	98,180
Expenses/Travel ($9,570 per year)	28,720	14,098	42,818
Total	**198,720**	**50,000**	**248,720**
UF Researchers:			
Faculty Support ($15,000 + fringe per year)	45,000	18,734	63,734
Engineer Assistant ($35,000 + fringe per year)	35,000	110,369	145,369
Graduate Research Assist. (3.5) ($20,000 per year) 60% in field research 40% lab/computer	90,000	130,007	220,007
Tuition		14,000	14,000
Expenses/Travel ($17,850 per year)	24,586	37,890	62,476
Instrumentation		60,000	60,000
Vehicle – NRRL		18,000	18,000
Total	**194,586**	**389,000**	**583,586**
Center Costs			
Salaries and Fringe	34,608	41,570	76,178
Gasoline for Research Vehicles ($710 per year)	2,025	461	2,486
Travel ($421 per year)	1,263		1,263
Cell Phones ($660 per year)	1,980		1,980
Vehicle Maintenance ($994 per year)	2,982		2,982
Miscellaneous Expenses	2,142		2,142
Total Center Expenses	**45,000**	**42,031**	**87,031**
NRSWA Expenses			
Power Costs – NRRL	89,500	32,000	121,500
NRSWA – New Contract		72,540	72,540
NRSWA/Darabi Costs (est. $50,000 per year	150,000		150,000
Insurance on Instrumentation	9,992.46		9,992.46
NRSWA Record keeping ($12,000 per year)	36,000	18,972.50	54,972.50
Total NRSWA Costs	**285,492.46**	**123,512.50**	**409,004.96**

Table 5.2 Continued

C. Breakdown of Operation Phase – 3 ½ Years	$5.45 Million Allocation	Additional $634,771 Allocation	$6,084,771 Total Allocation
Other Center Costs			
Additional Instrumentation	42,700		42,700
Additional Contingency	100,000		100,000
Training and Workshops	5,000		5,000
Vehicle for travel to the Landfill	10,000		10,000
Total Other Project Costs	**157,700**		**157,700**
Total Project Costs – Operation Phase	**$881,498.46**	**$604,543.50**	**$1,486,041.96**

The following sections provide a general description of each of the above project categories.

5.2.1 Contractor Costs

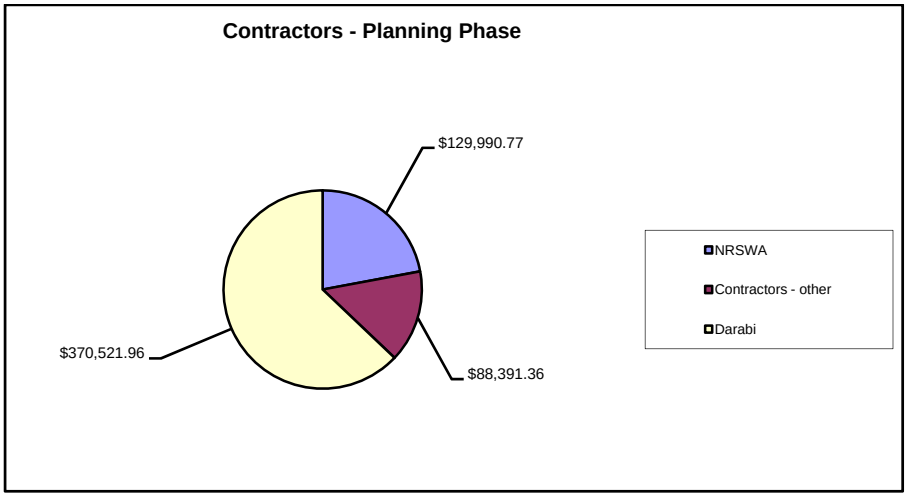
Several contractors were required for the planning, permitting, construction and operation of the bioreactor at NRRL. An engineering firm (Darabi and Associates) provided engineering services such as permitting, design, preparation of construction documents, construction oversight, and ongoing reporting to FDEP. In some cases, fees were paid directly to the engineer, while in other cases the fees were paid to the NRSWA.

5.2.1.1 Planning Phase - Contractors

In addition to acting as the host site for the NRRL bioreactor, the NRSWA provided several contracting services including construction of an access road. The total expense paid to NRSWA (excluding engineering services and attorney fees) during the planning phase for its services was $100,439.49. The total amount paid in the planning phase to Darabi and Associates was $370,521.96. Additional costs for attorney fees related to permitting totaled $29,551.28, for which the Center reimbursed NRSWA.

Additionally, several other contracting services were provided during the planning phase of the project. This included the hiring of a surveyor, a drilling company to install the injection wells for leachate and air, and installation of a leachate field. During the planning phase, the total expenditures for these other contracting services were $88,391.36. (The Center purchased liner during the planning stage that totaled $78,020, which is included in Center expenses.)

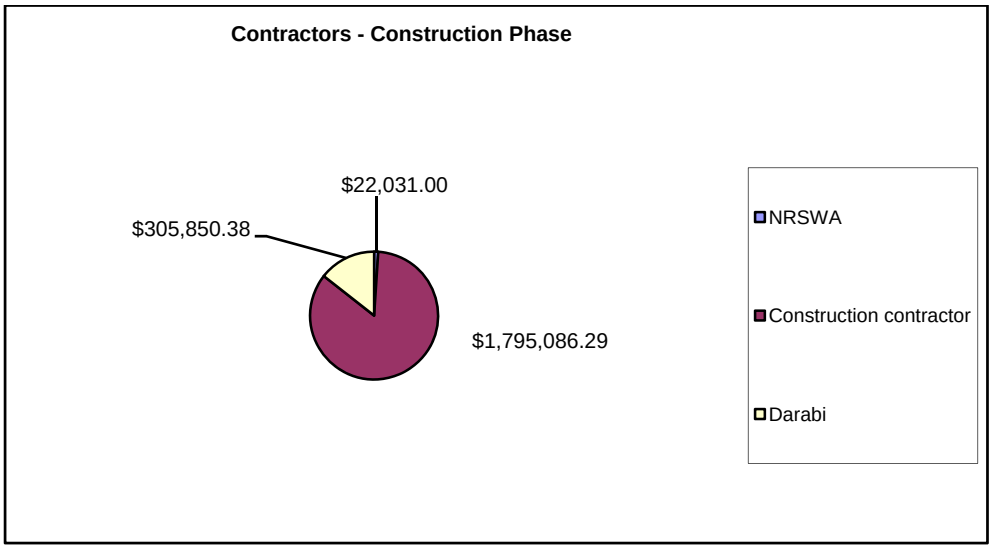
Figure 5.1 Contractors Costs – Planning Phase



5.2.1.2 Construction Phase - Contractors

The Center contracted with NRSWA to construct the bioreactor at the NRRL. The construction contractor hired by NRSWA was Serrot International Inc./GSE Lining Technology, Inc. The total expenditures for the construction activities were $1,795,086.29 to the contractor, $305,850.38 for engineering services and $22,031 for records maintenance and insurance premiums.

Figure 5.2 Contractors Costs – Construction Phase



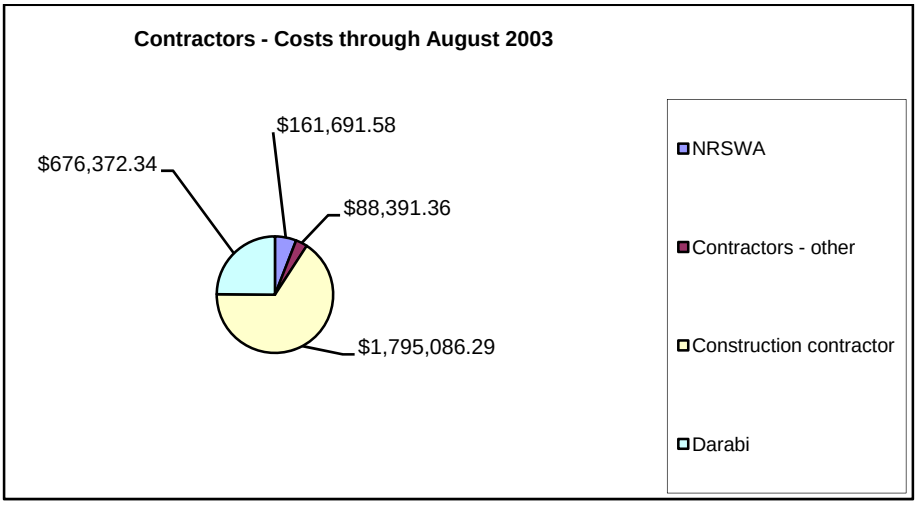
5.2.1.3 Initial Operation Phase – Contractors

During the initial operation phase, NRSWA costs were $9,639.81 for record keeping and electrical charges.

5.2.1.4 Contractors Cost to Date

As of August 31, 2003, contractor costs totaled $2,721,511.57, including $5,000 recording keeping and $4,639.81 electrical charges during the beginning of the operation phase.

Figure 5.3 Contractors Costs – through August 2003

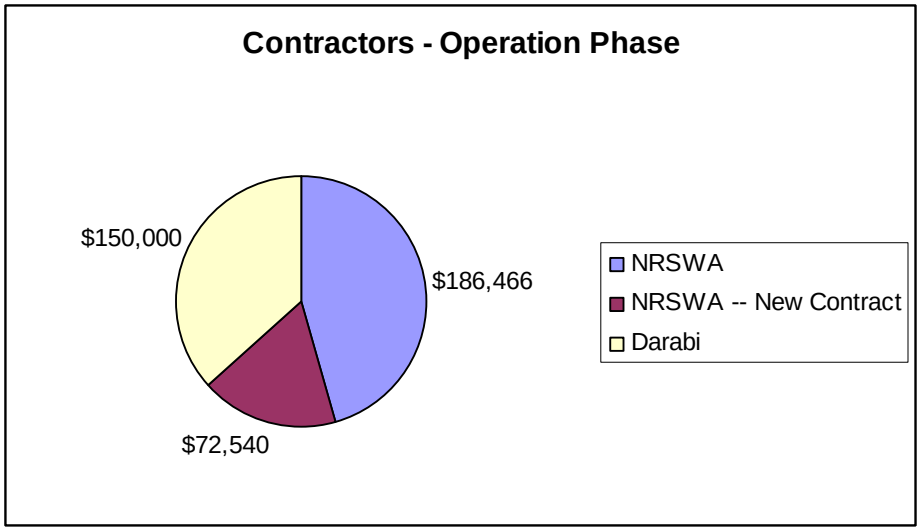


5.2.1.5 Proposed Contractors Costs - Operation Phase

During the Operation Phase, NRSWA will incur an estimated $121,500 in electrical expenses, $54,972.50 for record keeping and $9,993 for insurance expenses, which will be reimbursed by the Center. The Center also will reimburse NRSWA engineering services fees during this phase, which is estimated to be $150,000.

In addition, $72,540 is allocated for NRSWA for assistance with expenses associated with permit modifications and purchase and installation of additional instrumentation for expansion of activities in Cells 3, 4 and 5 at the NRRL.

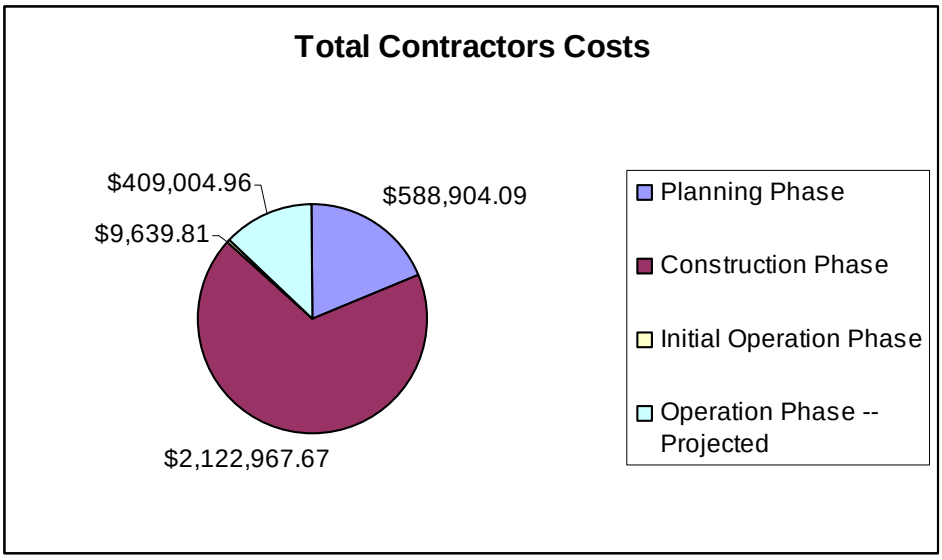
Figure 5.4 Contractors Costs – Proposed Operation Phase



5.2.1.6 Summary of Contractors Costs for Total Project

Contractors costs for the entire project are estimated to be $3,130,516.53. This total includes $420,666.54 for NRSWA, $1,795,086.29 for the construction contractor, $826,372.34 for Darabi and $88,391.36 for other contractors. Other contractors costs included surveying $9,980, a drill test $1,305, well installation $8,900, well installation pipe $12,695, well drilling $51,913 and leachate field installation $3,598.36.

Figure 5.5 Contractors Costs – Total Project



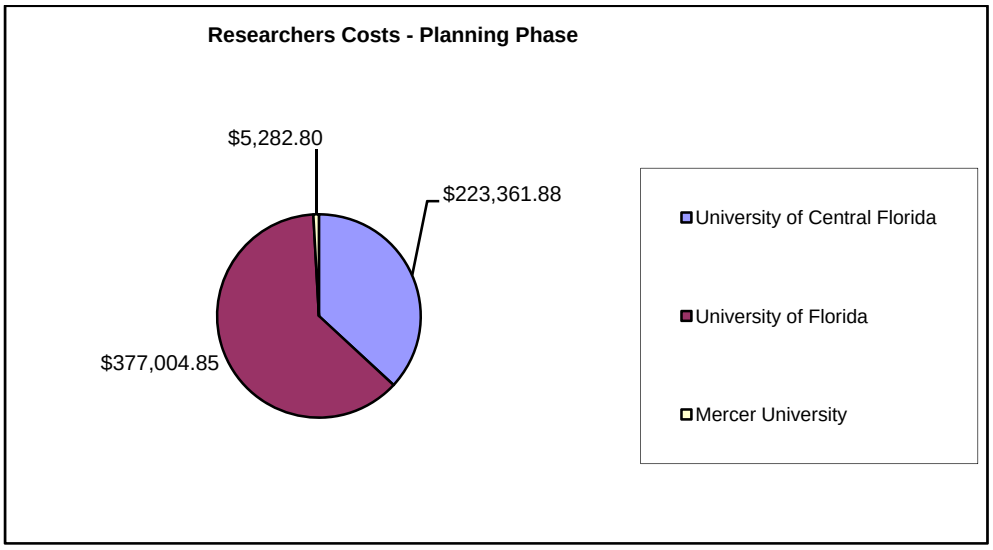
5.2.2 Researchers Costs

Researcher costs included sponsored research for the principal investigators of the project (University of Central Florida and University of Florida). (Other research costs included instrumentation and operating expenses, which were paid directly by the Center.) The UCF investigators developed and oversaw installation of most of the instruments in the bioreactor. The UCF researchers also assisted in the construction of those parts of the bioreactor that were the responsibility of the research team, and they contributed to the operation and data collection effort. The UF investigators assisted the engineer in the design and permitting of the bioreactor. They also oversaw the construction activities that were the responsibility of the research team, and headed up the field data collection effort.

5.2.2.1 Planning Phase - Researchers

During the planning phase, researchers' expenses totaled $605,649.53 ($223,361.88 to UCF, $5,282.80 to Mercer, and $377,004.85 to UF).

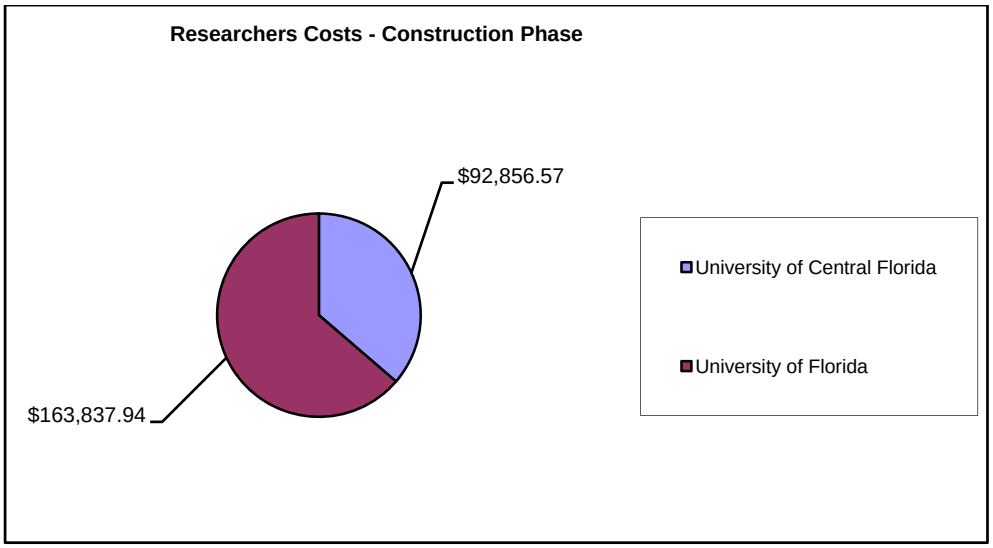
Figure 5.6 Researchers Costs – Planning Phase



5.2.2.2 Construction Phase - Researchers

The total expenditures for the investigators during the construction phase were $256,694.51 ($92,856.57 to UCF and $163,837.94 to UF).

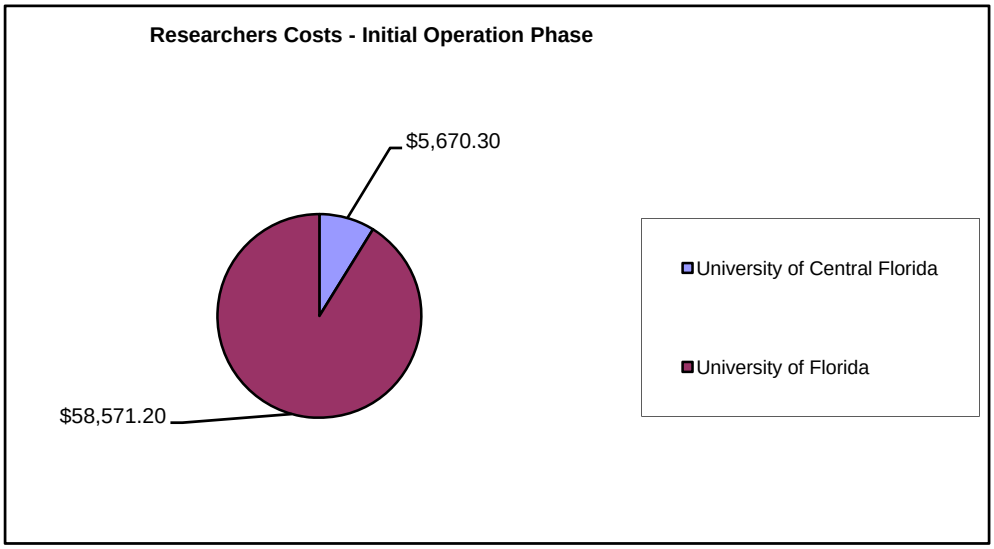
Figure 5.7 Researchers Costs – Construction Phase


Researchers Costs - Construction Phase
$92,856.57
$163,837.94
University of Central Florida
University of Florida

5.2.2.3 Initial Operation Phase - Researchers

Researchers costs during the initial phase totaled $64,241.50 (University of Central Florida $5,670.30 and University of Florida $58,571.20).

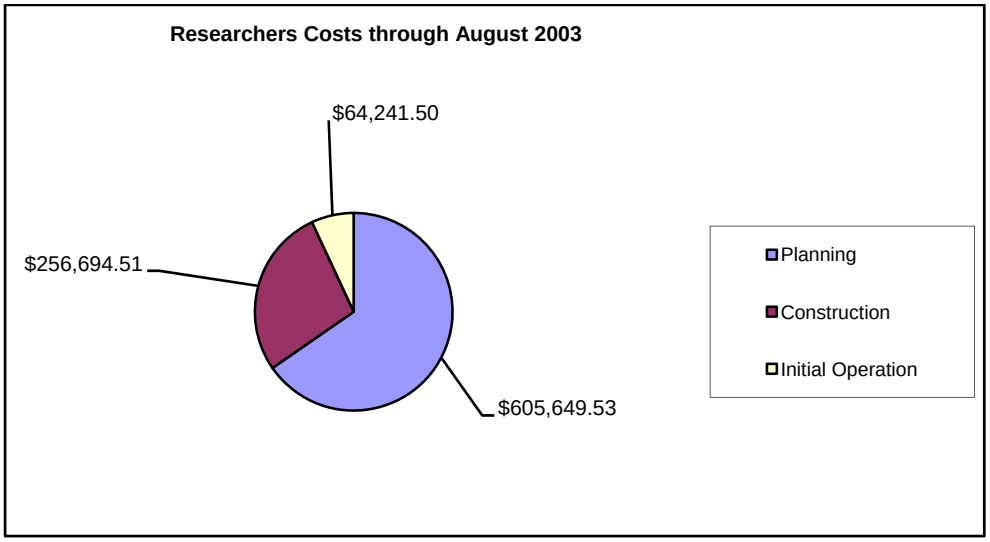
Figure 5.8 Researchers Costs – Initial Operation Phase



5.2.2.4 Researchers Costs to Date

As of August 31, 2003, researchers costs totaled $926,585.54, which includes $64,241.50 researchers costs during the initial operation phase.

Figure 5.9 Researchers Costs – through August 2003

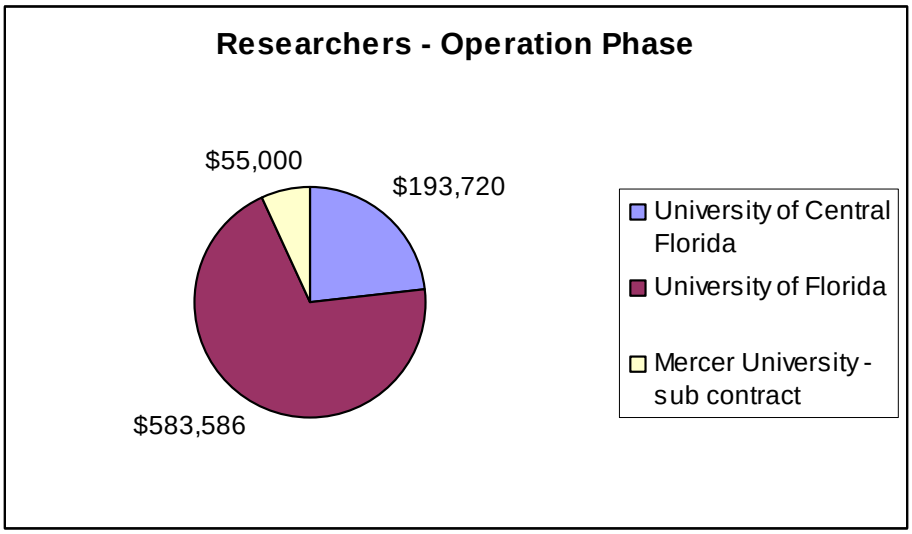


5.2.2.5 Proposed Researchers Costs - Operation Phase

The principal investigator of the UF research team is funded at approximately 312 hours per year. This time will be allocated to the NRRL bioreactor project, the Polk County bioreactor project and the Marion County bioreactor project. The remaining funds are dedicated to the NRRL bioreactor project (Polk County is supplying additional funding and resources for its project). The PI's time will be spent approximately on 50% field time (site meetings, project meetings, supervision), 30% on laboratory/office supervision of students (internal project meetings), and 20% on preparation and review of reports, paper, presentation, web pages and other project documents. The remaining project support will be dedicated to labor and expenses for the NRRL bioreactor. One full-time engineer assistant will be supported to work as the bioreactor operator. The UF EES PI will supervise this person. Duties of the bioreactor operator will include: operation of injection pumps and blowers; monitoring and routine maintenance of the blower-flare station; site inspection; weekly leachate collection; twice-a-week gas well field monitoring and balancing; assistance with graduate student research projects; data recording and management; and site tours. Three graduate research assistants are provided. One 0.5 FTE graduate research assistant will be in charge of field research experiments. This will include supervising injection experiments, collection of hydraulic and hydrologic data, conducting settlement measurements, overseeing collection of sensor readings, overseeing collection of waste samples, and coordinating research activities with other students (distribution 75% field, 25% lab/office). Another 0.5 FTE graduate student will be responsible for leachate analysis at NRRL and Marion County. This will involve conducting or supervising analysis of leachate samples from the 9 NRRL manholes as well as the leachate lift station (distribution: 95% lab/office, 5% field). A 0.25 FTE graduate research assistant will be responsible for performing the waste characterization analysis (volatile solids, biochemical methane potential, moisture content). This student also will work to conduct laboratory simulations on waste decomposition and settlement in both aerobic and anaerobic bioreactors. This person is only partially supported by the project, with additional funding coming from other projects. The annual expenses include funding for travel to and from the site, laboratory expendables, instrumentation maintenance agreements, miscellaneous field supplies, and undergraduate student laboratory assistance. A new graduate assistant will be added to project and will be responsible for the new site to be determined a later date. Researchers have allocated $18,000 for a vehicle for transportation to and from the bioreactor sites.

UCF's principal investigator's 320 hours will be spent 30% in the field, 30% in the lab, and 40% preparing reports and technology transfer. Mercer's assistant principal investigator's time will be spent 360 hours conducting field work (20%), lab work (30%), and computer support (50%). Two graduate assistants' time will be spent 50% in field research and 50% in lab work. These two positions will be funded by this project for only two and one-half years.

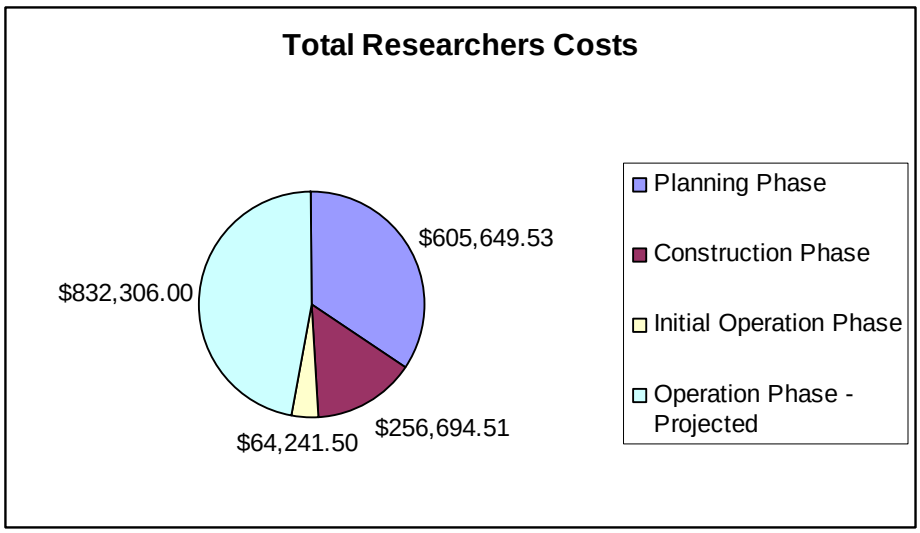
Figure 5.10 Researchers Costs – Operation Phase



5.2.2.6 Summary of Researchers Costs for Total Project

Researchers costs for the entire project are estimated to be $1,758,891.54. This total includes $1,182,999.99 for the University of Florida, $570,608.75 for the University of Central Florida and $5,282.80 for Mercer University.

Figure 5.11 Researchers Costs – Total Project



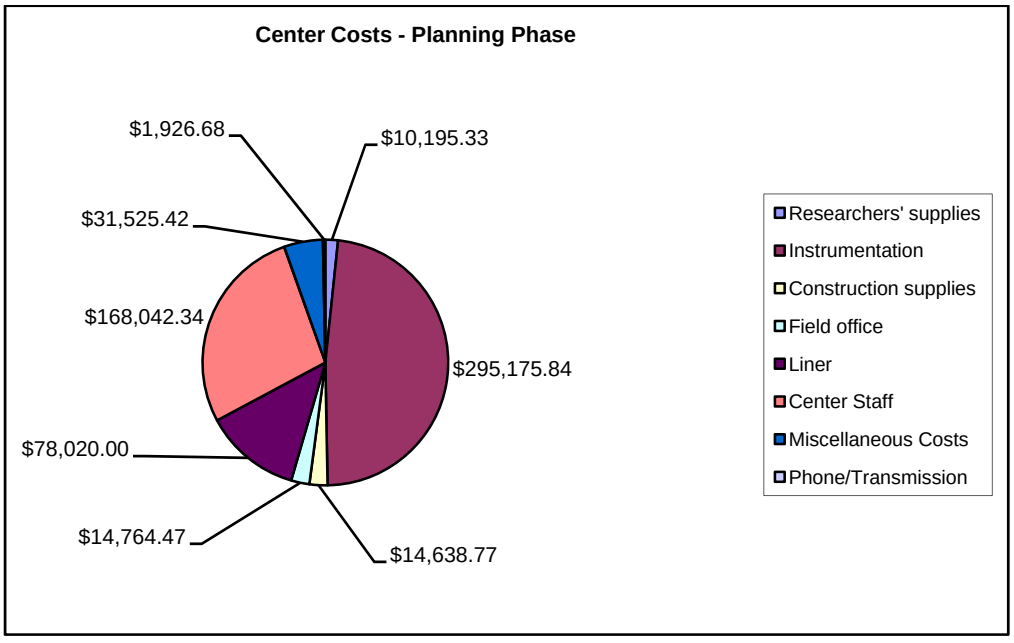
5.2.3 Center Costs

Center costs include salary, benefits and travel expenses for staff during the planning, construction and operation phases of the project. In addition to instrumentation costs, the Center paid for construction and research supplies, the research field office, vehicle maintenance and phone transmission lines.

5.2.3.1 Planning Phase – Center

During the planning phase of the project, Center costs totaled $614,288.85. This included $78,020 for liner, $295,175.84 for instrumentation, $10,195.33 for researchers' supplies, $14,638.77 for construction supplies, $14,764.47 for the field office, $1,926.68 for transmission lines, $31,525.42 for miscellaneous project costs, and $168,042.34 for salary, benefits, and travel for Center staff.

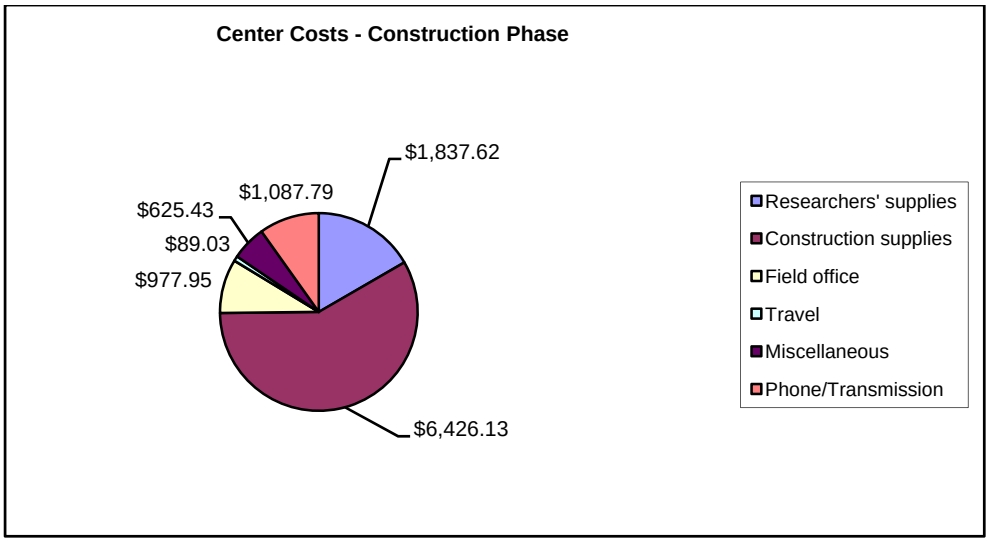
Figure 5.12 Center Costs – Planning Phase



5.2.3.2 Construction Phase – Center

During the construction phase of the project, Center costs totaled $11,043.95. This included $1,837.62 researchers' supplies, $6,426.13 construction supplies, $977.95 field office, $1,087.79 transmission and phone lines, $625.43 miscellaneous projects costs, and $89.03 travel for Center staff.

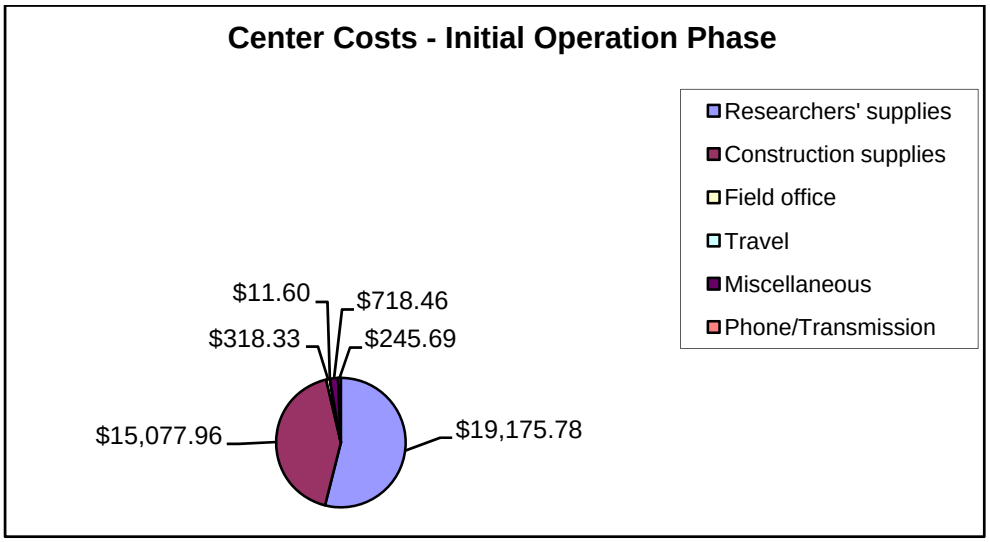
Figure 5.13 Center Costs – Construction Phase



5.2.3.3 Initial Operation Phase – Center

During the initial operation phase, the Center expenses totaled $35,547.82.

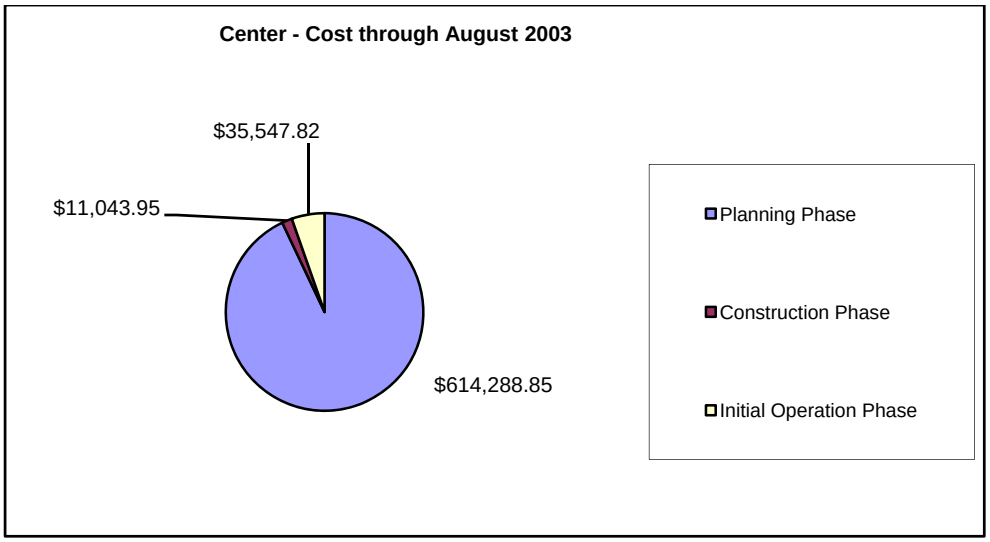
Figure 5.14 Center Costs – Initial Operation Phase



5.2.3.4 Center Costs to Date

As of August 31, 2003, center costs including instrumentation, liner, field office expenses, researchers' supplies and miscellaneous construction supplies totaled $660,880.62.

Figure 5.15 Center Costs – through August 2003



5.2.3.5 Proposed Center Costs During the Operation Phase

During the operating phase, the Center staff will oversee the management of the project. Three staff will spend a total of approximately four hours per week each in administration of the project. Staff will monitor research reports, process financial reports, and maintain the Bioreactor website. Other center costs will include telephone charges, vehicle maintenance, travel expenses to and from the project sites, and purchase of a vehicle to be used at the NRRL site. Additional instrumentation paid by the Center is estimated to be $42,700, and $100,000 is allocated for contingency for the project. Total projected cost for the Center during the operation phase is $244,731.

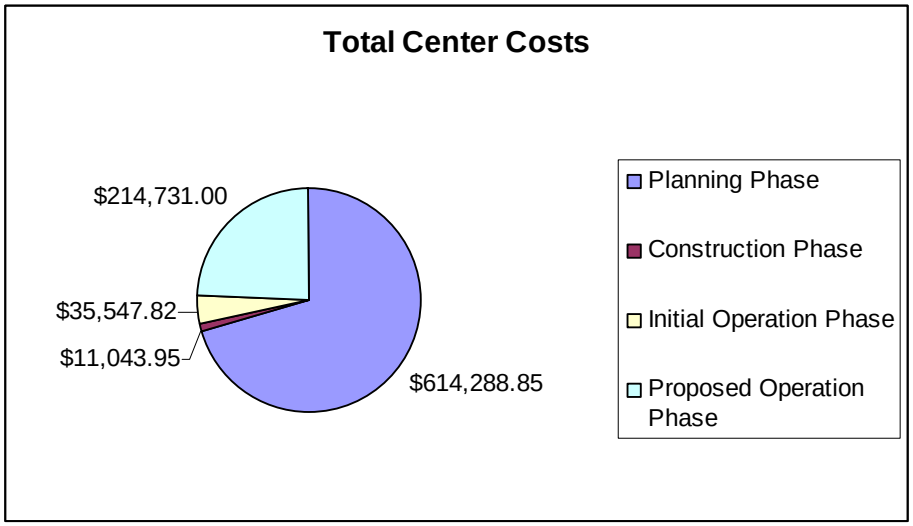
Table 5.3

Center Costs - Proposed Operation Phase	
Center Staff	76,178
Gasoline	2,486
Travel	1,263
Phone/Transmission	1,980
Vehicle Maintenance	2,982
Vehicle	10,000
Training and Workshops	5,000
Miscellaneous Expense	2,142
Additional Instrumentation	42,700
Contingency	100,000
Total Direct Cost for Center – Operation Phase	**$244,731**

5.2.3.6 Summary of Center Costs for Total Project

Center costs for the entire project are estimated to be $905,611.62.

Figure 5.16 Center Costs – Total Project



5.3 Project Expenditure by Sites

5.3.1 Overview

The project provides funding for five landfill sites. These sites are the New River Regional Landfill, the Tomoka Road Landfill in Volusia County, the North Central Landfill in Polk County, the Marion County Landfill and a new site to be selected. The expenses for NCLF include $37,500 ($22,500 researcher cost for salary and $15,000 for instrumentation). The expenses for MCL include researcher $22,500 costs for salary. NRRL expenses include planning, construction and operation expenses totaling $5,609,610.41 direct costs. The direct costs for the fourth site, TMRL, totaled $98,406.28. This amount included instrumentation ($82,700.07) and UCF researcher's salary ($15,706.21). The fifth site's estimated cost for graduate assistant support for one year is $27,003.

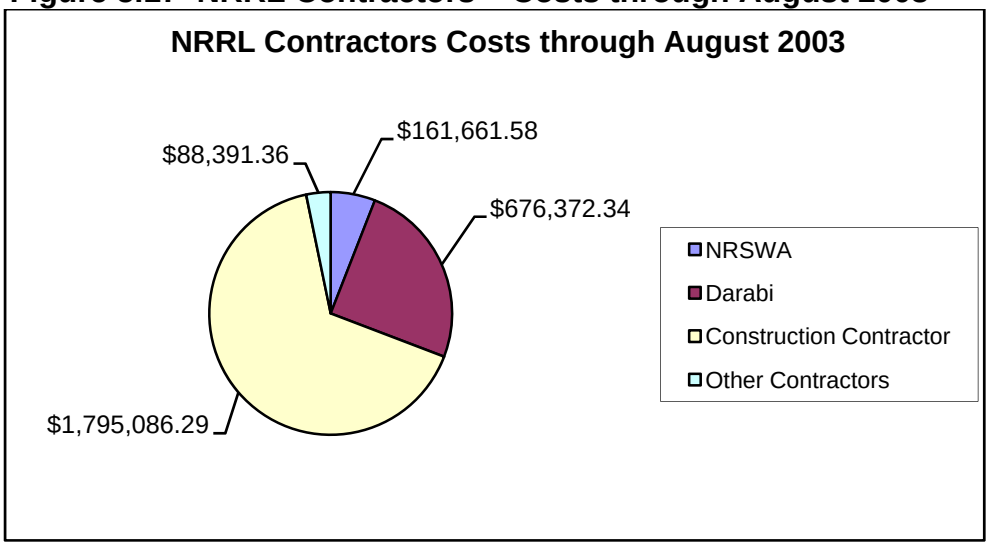
5.3.2 New River Regional Landfill Bioreactor Project

- Site Costs Components include:
- Contractors Costs to Date
- Researchers Costs to Date
- Center Costs to Date
- Total Costs to Date

5.3.2.1 New River Regional Landfill – Contractor Costs to Date

NRRL's contractors costs through August 2003 totaled $2,122,967.67. Darabi was paid $635,152.34 of $676,372.34 through the NRSWA contract.

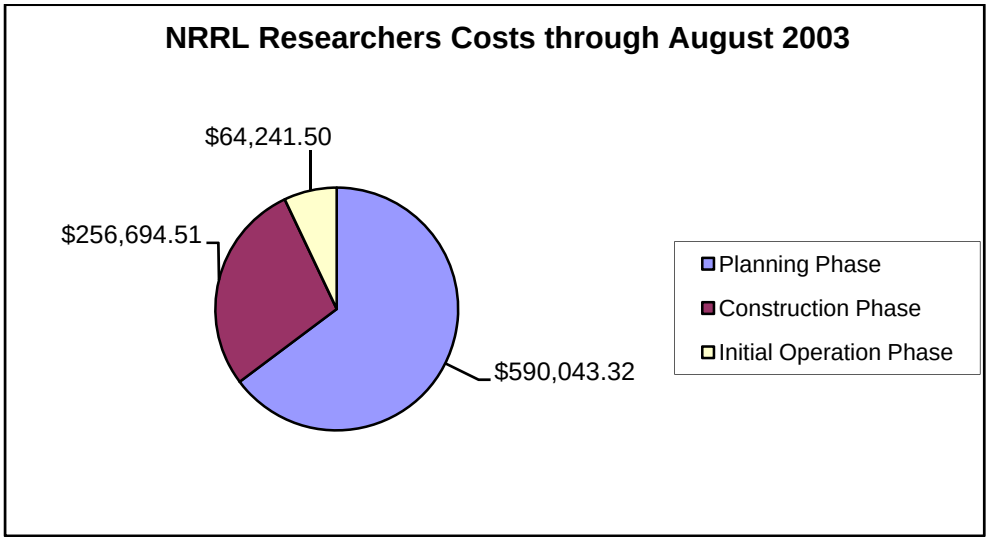
Figure 5.17 NRRL Contractors – Costs through August 2003



5.3.2.2 New River Regional Landfill – Researchers Costs to Date

Researchers costs at NRRL through August 2003 totaled $910,879.33. Costs included $306,182.54 for the University of Central Florida, $599,413.99 for the University of Florida and $5,282.80 for Mercer University.

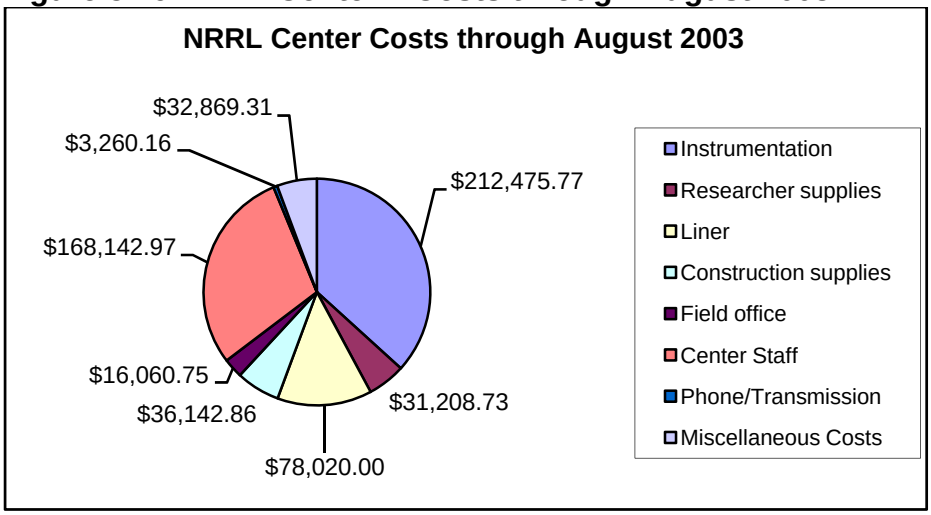
Figure 5.18 NRRL Researchers – Costs through August 2003



5.3.2.3 New River Regional Landfill – Center Costs to Date

Center Costs for NRRL through August 2003 totaled $578,180.55. Planning phase costs were $531,588.78, construction phase costs were $11,043.95 and initial operation phase costs were $35,547.82.

Figure 5.19 NRRL Center – Costs through August 2003



5.3.2.4. NRRL – Total Costs through August 2003

Direct costs for the planning, construction and initial operation phase of the project at NRRL totaled $4,210.571.45.

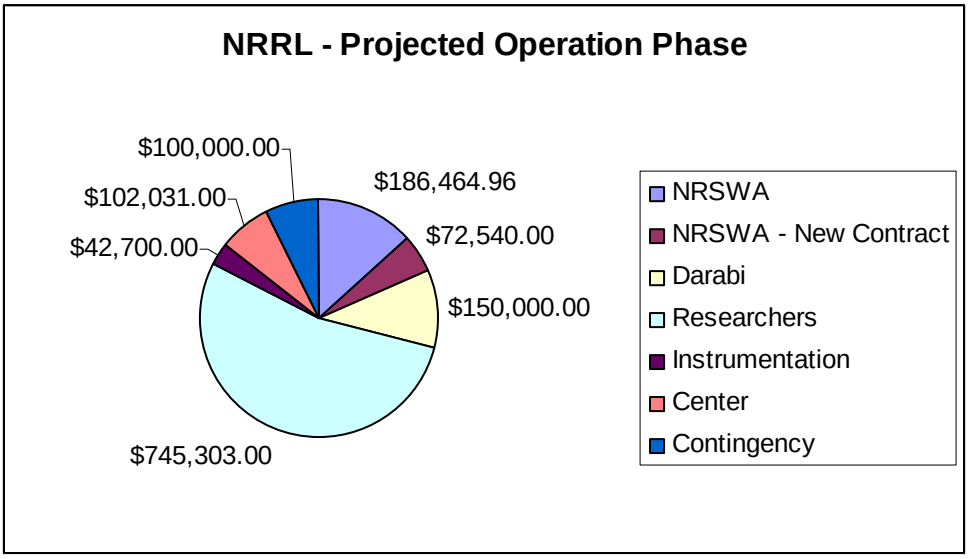
Table 5.4 NRRL - Total Costs through August 2003

NRSWA	161,661.58
Contractors - other	88,391.36
Construction contractor	1,795,086.29
Darabi	676,372.34
Researchers	910,879.33
Researchers' supplies	31,208.73
Instrumentation	212,475.77
Construction supplies	36,142.86
Field office	16,060.75
Liner	78,020.00
Center	204,272.44
Contingency	
Total Direct Costs	**4,210,571.45**

5.3.2.5. NRRL – Operation Phase

The projected direct costs for the operation phase at the NRRL is $1,399,038.96

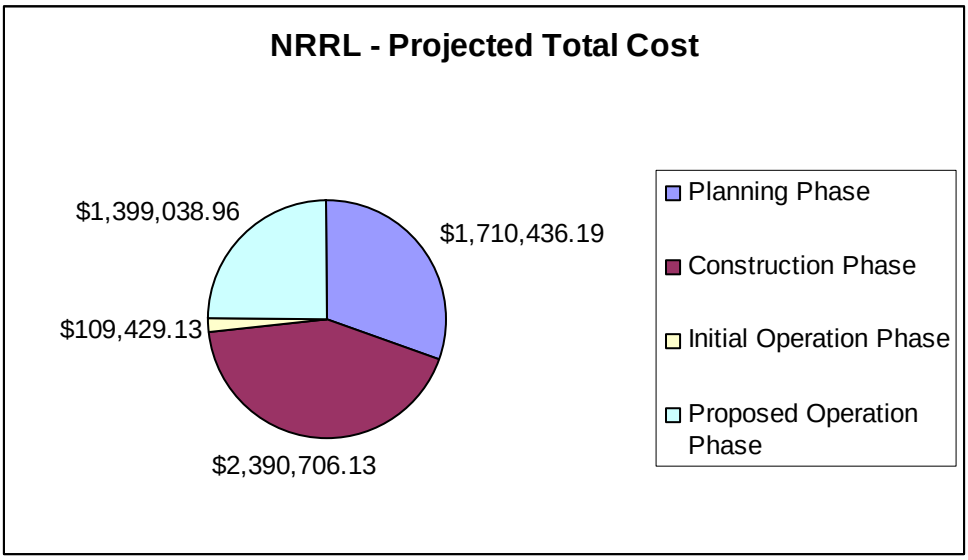
Figure 5.20 NRRL Total Projected Costs - Operation Phase



5.3.2.6. NRRL – Total Projected Costs

Total projected direct costs for the New River Regional Landfill Bioreactor Project are $5,609,610.41.

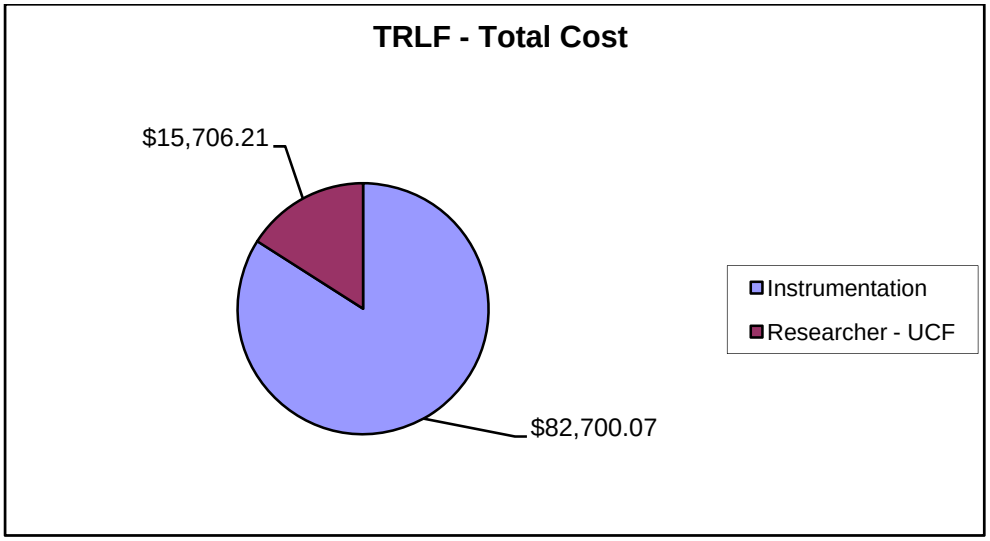
Figure 5.21 NRRL Total Projected Costs



5.3.3 Tomoka Road Landfill Expenses

The total direct costs for the Tomoka Road Landfill Bioreactor Project were $98,406.28. Researchers costs were $15,706.21 and instrumentation costs were $82,700.07.

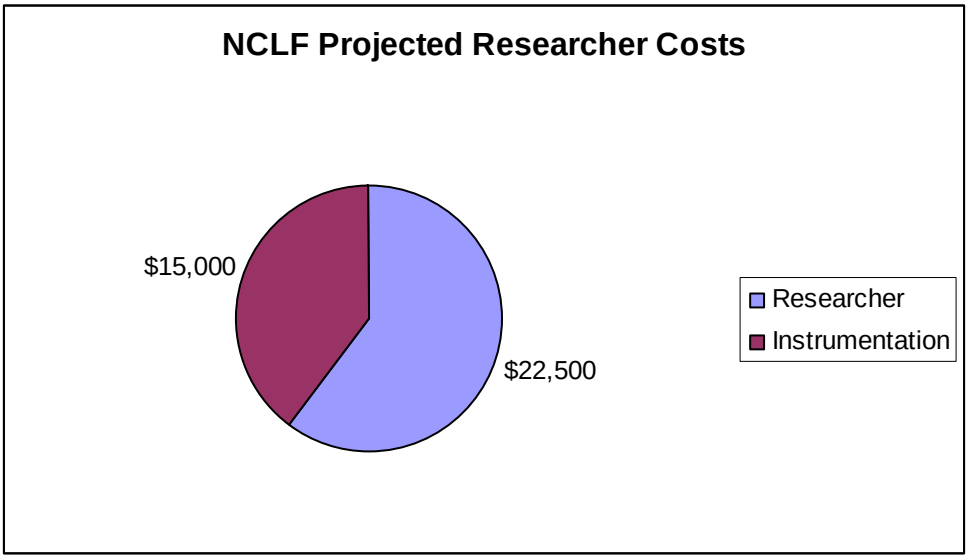
Figure 5.22 TRLF – Total Cost



5.3.4 North Central Landfill Projected Cost

The total estimated costs at the NCLF are $37,500, which includes researcher support and instrumentation costs during the operation phase.

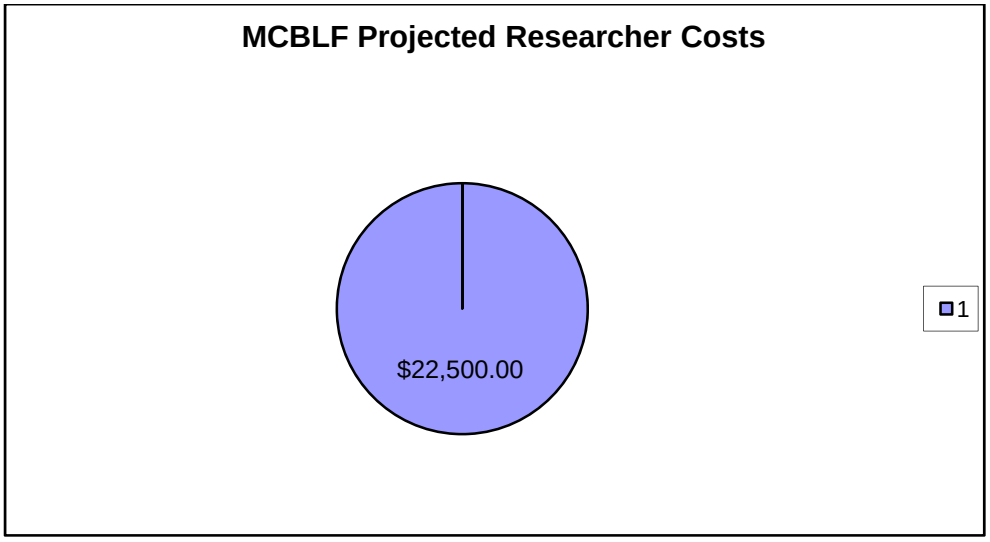
Figure 5.23 NCLF – Total Projected Costs



5.3.5 Marion County Baseline Landfill Projected Cost

The total estimated costs at the MCBLF are $22,500, which includes researcher support during the operation phase.

Figure 5.24 MCBLF – Total Projected Cost



5.4 Summary of Total Costs for Sites

Table 5.5 Cost Breakdowns by Site

	NRRL	TRLF	NCLF	MCBLF		Total
NRSWA	$ 420,666.54	0	0	0		$ 420,666.54
Contractors - other	88,391.36	0	0	0		88,391.36
Construction contractor	1,795,086.29	0	0	0		1,795,086.29
Darabi	826,372.34	0	0	0		826,372.34
Researchers	1,656,182.33	15,706.21	37,500.00	22,500.00	27,003.00	1,758,891.54
Researchers' supplies	31,208.73	0	0	0		31,208.73
Instrumentation	255,175.77	82,700.07	0	0		337,875.84
Construction supplies	36,142.86	0	0	0		36,142.86
Field office	16,060.75	0	0	0		16,060.75
Liner	78,020.00	0	0	0		78,020.00
Center	306,303.44	0	0	0		306,303.44
Contingency	100,000.00	0	0	0		100,000.00
Total Direct Costs	**$ 5,609,610.41**	**$ 98,406.28**	**$ 37,500.00**	**$ 22,500.00**	**27,003.00**	**$5,795,019.69**
Indirect Costs						289,750.98
Total Costs						
$6,084,770.67						

5.5 Summary of budget for the $6,084,770.67 awarded to the Bioreactor Demonstration Project.

The following tables give category details of the funds that have been budgeted for the award totaling $6,084,770.67.

Table 5.6 Total Awarded Budget by Categories and Phases for the Bioreactor Demonstration Project

A. Expenses Paid To Date (8/31/03	Planning Phase	Construction Phase	Operation Phase
New River / D&A Expenses	**$487,222.73**		
NRSWA, original Contract, Design	191,830.65		
NRSWA Am. 1, Well Test	13,035.30		
NRSWA Am. 2, High rise, leachate system	3,000.00		
NRSWA Am. 3, Bid Package Prep	17,970.00		
NRSWA Am. 4, Access Road	137,500.00		
NRSWA Am. 5, Eng. Services	47,821.00		
NRSWA Am. 6, Legal Svcs.	2,992.50		
NRSWA Am. 8, Legal Fees	50,000.00		
NRSWA Am. 9, Legal Fees	4,343.28		
Darabi & Assoc. (Road Design)	18,730.00		

Table 5.6 Continued

A. Expenses Paid To Date (8/31/03) Continued	Planning Phase	Construction Phase	Operation Phase
Construction & Infrastructure	**209,104.60**	**$ 7,404.08**	**$ 15,396.29**
Darabi & Assoc.	13,290.00		
Surveying (Pat Welch)	9,980.00		
Drill Test	1,305.00		
Well Installation - ECS	8,900.00		
Well Installation – Pipe	12,695.00		
Well Drilling	51,913.00		
Installation of Leach Field	3,598.36		
Misc. Construction Supplies	14,638.77	6,426.13	15,077.96
Liner	78,020.00		
Field Office (Research Trailer)	$ 14,764.47	$ 977.95	$ 318.33
Researchers	**$ 615,844.86**	**$ 258,532.13**	**$ 83,417.28**
UF (thru 8/31/03)	368,978.30	161,229.25	57,987.78
UCF (thru 8/31/03)	210,929.61	91,225.21	3,998.85
Mercer	5,282.80		
Travel	20,458.82	4,240.05	2,254.87
Research Supplies (Lab, etc.—paid by Center)	10,195.33	1,837.62	19,175.78
Instrumentation	**295,175.84**		
Transducers – NRRL	132,668.84		
Transducers – Volusia	71,019.03		
Datalogger – NRRL	39,893.73		
Datalogger – Volusia	11,681.04		
GPS + training	28,495.23		
Well Sensor Packs	11,417.97		
Center's Cost	**201,494.44**	**1,802.25**	**975.75**
Salaries & Benefits	142,806.73		
OPS	9,796.15		
Travel	15,439.46	89.03	11.60
Data Transmission – Cell Phones	1,926.68	1,087.79	245.69
Miscellaneous Project Costs	31,525.42	625.43	718.46
Subtotal Direct	**1,808,842.47**	**2,390,706.13**	**99,789.32**
Primary Construction Contract paid through 8/31/03		1,795,086.29	
Engineering Services paid through 8/31/03		188,980.61	
Engineering – Liquidated charges		107,669.77	
Record Keeping paid		15,000.00	
Liability Insurance paid		7,031.00	
Total Construction Paid to NRSWA 8/31/03		**2,113,767.67**	
Engineer Certification		9,200.00	
Total Construction Costs through 8/31/03		**2,122,967.67**	
Operating Phase Recurring Costs through 8/31/03			
Record keeping-Operating Phase Balance			5,000.00
Electrical Charges through 6/1/03			4,639.81
NRSWA Operating Costs through 8/31/03			**9,639.81**

Table 5.6 Continued

Construction Costs	Planning Phase	Construction Phase	Operation Phase
Subtotal Direct Costs through 8/31/03	**$1,808,842.47**	$2,390,706.13	**109,429.13**
Total Direct Costs through 8/31/03			**4,308,977.73**
Indirect Costs (5%)			215,448.88
Total Costs through 8/31/03			**$ 4,524,426.61**
B. Budgeted Costs – Operation Phase			
Researcher – NRRL			$ 745,303.00
Researcher – Marion County			22,500.00
Researcher – Polk County			37,500.00
Researcher – New Site			27,003.00
Additional Instrumentation			42,700,00
Additional Contingency			100,000.00
Training and Workshops			5,000.00
Vehicle for travel to the Landfill			10,000.00
Center Costs (est. $15,000 per year)			87,031.00
Power Costs - NRRL (est. $29,833 per year)			121,500.00
NRRL/Darabi Costs (est. $50,000 per year)			150,000.00
Insurance on Instrumentation			9,992.00
NRRL Record keeping ($12,000 per year –3 years)			54,973.00
New River – New Contract			72,540.00
Total Direct			**1,486,042.00**
Indirect Costs (5%)			74,302.09
Total Projected Research Phase Costs			**1,560,344.00**
Total Estimated Project Costs			**$ 6,084,770.00**

Table 5.7

Breakdown of Balance of Operation Phase – Three Years – Estimated Costs Awarded Budget	
UCF Researchers:	
Faculty Support ($15,000 per year)	$ 57,722
Mercer Subcontract ($15,000 per year)	55,000
Grad. Research Assts. (2) 60% in field research 40% lab/computer (2 years) ($20,000 per year per student)	98,180
Expenses/Travel ($9,570 per year)	42,818
Total	**248,720**
UF Researchers:	
Faculty Support ($15,000 per year+ fringe)	63,734
Engineer Assistant ($35,000 per year)	145,369
Graduate Research Assist. (3.5) ($20,000 per year) 60% in field research 40% lab/computer	220,007
Tuition	14,000
Instrumentation – paid by researcher	60,000
Vehicle – NRRL	18,000
Expenses/Travel ($17,850 per year)	62,476
Total	**583,586**

Table 5.7 Continued

Breakdown of Balance of Operation Phase – Three Years – Estimated Costs Awarded Budget – continued	
Center Costs ($15,000 per year)	
Salaries and Fringe ($21,750 per year)	76,178
Gasoline for Research Vehicles ($710 per year)	2,486
Travel ($421 per year)	1,263
Cell Phones ($660 per year)	1,980
Vehicle Maintenance ($994 per year)	2,982
Miscellaneous Expenses	2,142
Total Center Expenses	**87,031**
NRSWA Expenses	
Power Costs – NRRL (est. $29,833 per year)	121,500
NRSWA – New Contract	72,540
NRSWA/Darabi Costs (est. $50,000 per year	150,000
Insurance on Instrumentation	9,992.46
NRSWA Record keeping ($12,000 per year)	54,972.50
Total NRSWA Costs	**409,004.96**
Other Center Costs	
Additional Instrumentation	42,700
Additional Contingency	100,000
Training and Workshops	5,000
Vehicle for travel to the Landfill	10,000
Total Other Project Costs	**157,700**
Total Project Direct Costs – Operation Phase	**$1,486,041.96**
Indirect Costs (5%)	**74,302,09**
Total Budgeted Research Phase Costs	**$1,560,344.05**

5.6 Summary of Request for Additional Funding for Bioreactor Demonstration Project

The following table gives a breakdown of the request for additional funding for the Bioreactor Demonstration Project. For purposes of delineating the additional scope of work presented by these requests, the funding requests are designated as additional funding request A and additional funding request B.

Additional funding request A will be used to provide support to the researchers to continue bioreactor operation and monitoring through the end of 2005. This includes funding for existing graduate research assistants; the bioreactor landfill operator (the resident Engineer Assistant); faculty support; operation, monitoring, and travel expenses; power costs; and site expenses occurred by the owner/operator (engineering services and clerical support). New support being added as part of funding request A include additional graduate student support for running the NRRL bioreactor and for working with the Marion County bioreactor. New support is also being added for research examining the gaseous emissions from the NRRL bioreactor.

Additional funding request B will be used to provide support to the researchers to continue bioreactor operations and monitoring through June 15, 2006. The researchers believe that this period will allow sufficient time to effectively complete the majority of research tasks associated with the retrofit area of the NRRL (that operated in cells 1 and 2). The funding includes support for existing graduate research assistants; the bioreactor landfill operator (the resident Engineer Assistant); faculty support; operation, monitoring, and travel expenses; power costs; and site expenses occurred by the owner/operator. In addition, funding is being provided to assist in the expansion of bioreactor activities into Cells 3, 4 and 5 at the NRRL. Funding request B includes support for the owner/operator to assist with expenses associated with permit modifications needed for additional bioreactor activities and support for the purchase and installation of additional instrumentation for these activities. Support is also provided to assist other landfill owners/operators in starting bioreactor operations (sites to be identified later). Support is also provided to the Center for project management.

These additional funds will be used to support the Engineer Assistant at NRRL for two years, Graduate Assistants for an additional year, and additional miscellaneous researcher expenses. A vehicle for transportation to and from the landfill sites is included in the researchers budget. In addition, increased funding is requested to cover record keeping costs at the NRRL during the operation phase.

Table 5.8 Additional Funds Requested for the Bioreactor Demonstration Project

Request for Additional Funding – Operation Phase	Additional Funding Request A $184,771.12	Additional Funding Request B $450,000.00
Researchers – NRRL	146,500.00	227,997.00
Researchers – Marion County	22,500.00	
Researchers – Polk County		15,000.00
Researchers – New Site		27,003.00
NRRL Record keeping	6,972.50	12,000.00
NRSWA – New Contract		72,540.00
Center Salaries and Benefits		41,531.00
Power Costs		32,000.00
Vehicle Fuel		500.00
Total Direct	**175,972.50**	**428,571.00**
Indirect Costs (5%)	8,798.62	21,428.55
Total Projected Research Phase Costs	**184,771.12**	**449,999.55**
Total Estimated Additional Project Costs	**$184,771.12**	**$449,999.55**