Executive Summary

Orange County, Florida, (the County) owns and operates the largest publicly owned municipal solid waste landfill in Florida. When the County expanded its landfill into the Southern Expansion Site, it explored options to use the additional landfill gas (LFG) and determined the best option was a partnership with Orlando Utilities Commission (OUC).

Early in the project planning stages, the County and OUC developed a cooperative relationship that carried through to contract negotiations, resulting in a mutually beneficial agreement. Innovative approaches used on this project provide both environmental and economic benefits:

- LFG refrigeration removes condensate before gas enters the conveyance/delivery pipeline, allowing for a smaller diameter pipeline without condensate pump stations, reducing installation and operating costs.

- Expected County revenues will exceed $100 million over the next 30 years, while OUC gets fuel for the power plant at a lower cost than coal.

- Reliable power is provided to the facility by OUC because the processing/treatment facility is owned by OUC and is located close to its electric distribution system.

This project demonstrates that sustainability’s triple bottom line of economic, social, and environmental success can be achieved through careful planning, evaluation, engineering, and implementation.
Background

Orange County, Florida, (the County) owns and operates the largest publicly owned municipal solid waste landfill in Florida. The County is home to more than one million permanent residents and hosts more than 46 million visitors each year. The population of the County and the surrounding metropolitan area is projected to nearly double by 2030. The management of solid waste generated by the residents and visitors in an environmentally safe and economically efficient manner is an important ongoing challenge of the County’s Utilities Solid Waste Division. Realizing the impact on the environment, the County established goals and objectives to promote sustainability and improve management of the environment.

The Orange County Solid Waste Management Facility (OCSWMF) began operating in the early 1970s on 1,500 acres of land located in east Orange County. In the early 1990s, the County acquired an additional 3,500 acres of contiguous properties for landfill expansion (Southern Expansion Site, or SES), as shown on Figure 1. The County began planning for landfill expansion onto its SES in the mid-1990s and began operating the first disposal area on the SES in January 2005. Because of its disposal capacity and age, the OCSWMF is subject to Clean Air Act standards, specifically, New Source Performance Standards (NSPS) for stationary sources and Title V air emission requirements.

The County is committed to being a leader in reducing greenhouse gas (GHG) emissions, energy efficiency, and environmental protection. Since 1998, the County has been selling landfill gas (LFG) from its original 1,500-acre landfill through a third party for use as a fuel at the C. H. Stanton Energy Center (SEC), the Orlando Utilities Commission (OUC) power generation facility located adjacent to the landfill. Through this project, the County is able to maintain permit compliance, receive revenue for LFG sale, reduce odor, and reduce GHG emissions. In 2007, the County authorized its consulting engineers (a Joint Venture partnership between CH2M HILL and Neel-Schaffer, Inc.) to assist with the development of LFG utilization for the SES.

Landfill Gas Expansion

The site development plan for the SES designated approximately 700 acres for construction of a new Class I disposal area including ancillary and support

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FIGURE 1
Orange County Landfill Site
facilities with the remainder of the properties to be preserved as a conservation area. The development area included a 288-acre landfill to be constructed in four phases designated Cells 9, 10, 11, and 12, as shown on Figure 2. The cells are underlain with a double composite liner system equipped with a leachate collection and detection system. In addition to the disposal areas, the development includes stormwater management ponds, borrow areas, and other ancillary support facilities.

Each of the four cells is divided into multiple disposal bays, typically 220 feet wide, that are separated by removable berms. The use of discrete bays allows surface water management operation for stormwater removal in unused bays and leachate removal in bays that are partially or completely filled with solid waste. Each bay was designed and permitted to have horizontal LFG collection wells to pull the gas out as it is generated as a result of waste decomposition. These horizontal wells are complemented with traditional vertical LFG wells as final elevations are reached. In addition to the horizontal and vertical LFG wells, LFG collection wellheads are installed on the primary leachate collection pipes in each bay.

One of the design features outside of the lined area is a perimeter LFG transmission system that is connected to the horizontal and vertical wells and leachate collection pipe wellhead by lateral piping, conveying collected LFG to a designated LFG blower and flare station. Once the LFG comes out of the waste mound, its temperature is reduced and the cooling effect results in condensate generation in the LFG perimeter pipe. The condensate is collected and pumped from condensate sumps within the LFG mains to the leachate collection system, where it mixes with leachate and is pumped to the leachate storage tanks. Ultimately, the leachate and condensate are pumped from the leachate storage tanks to the County’s Eastern Water Reclamation Facility for treatment and disposal.

To date, the County has constructed Cells 9 and 10 on the SES. This 148-acre footprint provides approximately 18 million cubic yards of Class I disposal capacity. The expansion of the County landfill into the SES generates additional LFG that can be reused beneficially. The County systematically explored options to use the LFG generated through its landfill expansions, which began with an evaluation of the financial and technical feasibility of alternative onsite and offsite LFG utilization and emission control options. The options evaluated included the following:

- Title V compliance only
- Direct sale to a local utility
- Direct sale to a County wastewater treatment plant
- Onsite direct use

A benefit/cost analysis was developed for each option. The County prepared a basis of design for each...
alternative to better characterize the different alternatives to develop the project. Concurrent with the alternatives evaluation, OUC approached the County to contract directly with the County for utilization of the LFG generated in Cells 9-12.

Direct sale of LFG to OUC for use as supplemental fuel in its coal-fired generators at the SEC was selected as the most favorable option. Following the decision to send LFG to the SEC, the conceptual design for the SES LFG treatment system and transmission main was further developed to a preliminary design level for analysis of operational and economic feasibility.

**Permitting and Design Objectives**

The County’s engineer of record, CH2M/WCG Joint Venture (JV), evaluated scenarios for LFG utilization at the SES. The design objective for the County’s landfill gas-to-energy (LFGTE) project was to collect LFG from Cells 9-12, transmit the LFG through a dedicated pipeline to the SEC, and burn the LFG as boiler fuel offsetting the need for pulverized coal fuel. The preliminary design goal was established to develop a system capable of collecting, processing, treating, and delivering fuel quality LFG from Cells 9-12. The LFG will be managed in accordance with the Florida Department of Environmental Protection (FDEP) Solid Waste Management Facility and Title V Air Operation Permits. The LFGTE project will also complement the state of Florida’s GHG initiatives and provide OUC with a renewable source of fuel for electrical power generation.

The LFGTE preliminary design was based on LFG generation projections from solid waste disposal activities in Cells 9-12 over the next 30 years. The volume of LFG projected to be generated in the SES from solid waste activities is depicted in Figure 3. The generation model, run by the County in 2007, projects the LFG from Cell 9 to be approximately 1,800 standard cubic feet per minute (scfm) in 2009 and increase as new cells are developed to peak at 11,550 scfm in 2031. It was estimated that 50 percent of the gas generated was recoverable in the open landfill with horizontal wells, approximately 70 percent recoverable when the side slopes are closed and vertical wells are installed, and 90 percent recoverable when the landfill is fully closed. Subsequently, OUC’s engineers developed an LFG recovery model for the Cells 9-12 projected waste flow in the SES for engineering design of the treatment facility and equipment sizing. OUC’s model predicted the peak recoverable gas at 7,200 scfm in 2035.

Any LFGTE project, regardless of the line of responsibility between the County and OUC, has to comply with the rules and regulations governing the landfill operation. It was decided that all permits required for the landfill would be obtained by the County. The final design and construction of the LFGTE system, except for the extraction wells and collection piping, would be performed and paid for by OUC. OUC obtained the permits required for the modification at the SEC. Based on the eventual agreement between the County and OUC, the JV has obtained the landfill construction and operations permits for the LFGTE project and is overseeing the design and construction by OUC.

**Figure 3**

SES LFG Projections
Permitting and Design Elements
The permitting and design of the project are addressed in this section. The detailed equipment and systems for each design element are described in detail in Section 5, Utilization of Equipment/Systems and Technologies.

The overall LFGTE project includes the following components:

- **Extraction Wells and Collection Piping** collect LFG from the landfill disposal areas and transmit it to the processing/treatment facility site adjacent to Cells 9-12. This component includes horizontal and vertical extraction wells, lateral and perimeter piping, condensate pump stations, and the transmission pipeline from the landfill to the processing/treatment facility.

- **Processing/Treatment Facility** receives LFG for transmission to the SEC. The facility consists of compressors, flares, and chillers. The boundaries of this component are the outlet of the collection piping and the inlet to the conveyance/delivery pipeline.

- **Conveyance/Delivery Pipeline** delivers compressed LFG from the processing/treatment facility to the SEC. The boundaries of this component are the outlet of the conveyance/delivery pipeline and the inlet of the power plant utilization piping and equipment.

- **Power Plant Utilization Piping and Equipment** delivers compressed LFG from the outlet of the conveyance/delivery pipeline to the burner tips located within the main boilers. The system consists of a condensate knock-out and stainless steel LFG piping inside the power plant.

Construction
Cells 9 and 10, including the LFG perimeter piping and connections to the primary leachate collection pipes, were constructed as separate design/bid/build projects by the County with construction management services and liner system quality assurance provided by the JV. Installation of the horizontal and vertical LFG wells was performed by SCS Field Services under term contracts with the County.

OUC constructed the processing/treatment facility, conveyance/delivery pipeline, and power plant utilization piping and equipment through a design/build contract with SCS Energy. Installation of the power plant utilization piping and equipment was planned for scheduled maintenance outages at the power plant, and has been completed on Unit 1 and will be installed on Unit 2 during the next scheduled outage in October 2011. OUC provided construction management services for this project.
2. Environmental Controls

LFG Monitoring
Control and destruction of LFG emissions from municipal solid waste landfills have become more strictly regulated over the past 15 years because of the NSPS and Title V requirements as authorized under amendments to the Clean Air Act. Within the past 5 years, an added emphasis on the effects of global warming and the impending regulation of GHGs (principally carbon dioxide and methane for municipal solid waste landfills) have required landfill owners/operators to install LFG collection and control systems. Concurrent with the LFG control requirement, LFG has gained increasing importance because of its fuel value for electric power generation and as a direct fuel to power onsite or nearby offsite generators.

The County has been proactive in LFG emission management and control. In the 1990s, the County completed construction of a 109-acre Subtitle D lined landfill unit known as Cell 7B/8. The state regulations at that time required LFG venting for final cover system stability. In 1995, the County developed design plans to install an active LFG collection and control system for Cell 7B/8. The initial phase of the control system included approximately 35 passive vertical wells. Concurrently, the County solicited proposals for sale and use of the LFG. In 1996, the County entered into a 20-year agreement to sell LFG rights to an energy company that constructed dual blower/compressors, dual backup flares, and a pipeline to the SEC where the collected LFG is used for power generation.

As part of the agreement, the County tied in the later phases of Cell 7B/8 and installed an active gas collection system in a nearby closed landfill area designated as Cell A-K. Cell A-K, which was filled between 1985 and 1991, covered approximately 129 acres of unlined disposal area. The final cover system for Cell A-K was equipped with a passive LFG venting system that was subsequently converted to an active LFG collection system for inclusion in the LFG utilization system. The active LFG collection and control system for Cell 7B/8 and Cell A-K became operational in 1998. The system currently captures and conveys approximately 4,000 scfm of LFG to the SEC where it supplements Appalachian coal as a fuel source, reducing methane emissions by an estimated 31,000 tons per year.

Overall Project Impacts and Environmental Compatibility
The Title V air operation permit for the facility covers all landfill units with respect to LFG control and fugitive release minimization. As described previously, solid waste filling in Cell 9 on the SES began in early 2005. For compliance with NSPS, the County was required to install an effective capture and control system by January 2010. Because of the existing LFG utilization system from the original landfill and realizing the value of LFG as a fuel source, the County began a planned periodic installation of horizontal LFG collection pipe into the Cell 9 operational sequence lifts. The County connected the primary leachate collection piping to the LFG collection system in conjunction with Cell 9 and 10 construction, and began installing horizontal LFG wells as fill sequences reached capacity. Although capture and control of LFG was not specifically required by regulations until 5 years after initial waste deposition, the County chose to install a temporary compressor and flare to the LFG collection system as a “good neighbor” to control the LFG and odor emissions soon after Cell 9 began operations in 2005.

To date, 22 sequence lifts have been equipped with horizontal collection pipes. Each perforated pipe is connected to a solid pipe, lateral header that is manifolded into a down leg pipe connected to the west perimeter header. In 2006, the horizontal collector system was connected to a temporary blower and flare unit for LFG destruction. In conjunction with the SES utilization agreement with OUC, a 4,000-scfm capacity permanent flare was permitted in 2009 and installed in January 2010. This flare served as an interim control
measure while the LFG processing/treatment facility, conveyance/delivery pipeline, and power plant utilization piping and equipment were constructed by OUC. Facility completion is anticipated in April 2011. The flare currently used for LFG destruction will remain in place as a permanent backup to the SES LFG utilization system.

To gain approval for the flare installation, and as a prerequisite for utilization, the County had to demonstrate that the horizontal collector network met the requirements for a capture and control system under each subsection of Subpart 753, Part CCC and Subpart 759, Part WWW of Title 40. This demonstration was done using as-built plans, specifications for the installed components, and temporary flare operations. FDEP concluded in late 2009 that the installed horizontal collection system in Cell 9 met 40 CFR requirements and satisfied state requirements, allowing the operation of the interim flare.

**Landfill Gas Generation Projections**

The OCSWMF has the following multiple disposal areas:

- Class I solid waste disposal areas include the active Cells 9-10 disposal area
- Pre-1985 disposal areas
- Closed Cell A-K and Cell 7B/8 disposal areas
- Class III disposal areas include the active Cell 2 and inactive Cell 1, which is undergoing final closure

These disposal areas are in different stages of LFG generation. The majority of the LFG is currently generated in the SES portion of the landfill where the active Cells 9 and 10 are located. Cells 11 and 12 in the SES are planned in the near future after the disposal capacity of Cells 9 and 10 is depleted. The anticipated LFG generation from the SES disposal areas is shown on Figure 3, included in Section 1 of this award application. It is predicted that the peak LFG generation will be approximately 11,550 scfm occurring in 2031. It is estimated that approximately 70 to 80 percent of the gas generation is recoverable for power plant use.

The objective of this model, run by the County in 2007, is to provide LFG generation rates for sizing LFG system components capable of handling anticipated peak LFG generation rates. LFG generation from Cells 9-12 predicted by the model is based on filling to date and the latest configuration for this combined disposal unit.

LFG generation estimates from the model for Years 2010 and 2031 for Cells 9-12 are presented in Table 1. Approximately 90 percent of the LFG for the entire Orange County Landfill facility will be generated in SES Cells 9-12 in 2031. Approximately 50 percent of the LFG generated is recoverable initially and increases as sideslopes are closed and more wells installed.

During 2009 and part of 2010, an approximate average of 900 scfm of the Cell 9 LFG was flared to the atmosphere. In 2010, after a larger blower and interim flare were installed, the collected flow ranged between 1,100 and 1,400 scfm. In early 2011, the County installed 39 vertical LFG wells in areas where the final elevations have been achieved to increase the efficiency of the LFG collection. LFG collection in Cells 9 and 10 is expected to increase to 2,000 to 2,500 scfm (approximately 1,050 to 1,300 million cubic feet per year), once the LFG treatment and larger size blowers are in place. Because the side slopes of Cells 9 and 10 are still open, if too much vacuum is applied to the LFG wells, oxygen intrusion into the disposal area may occur and cause underground combustion in the waste mound. Once the landfill side slopes are capped with a liner, the blowers can apply more vacuum and recovery efficiency will increase.

<table>
<thead>
<tr>
<th>Landfill Cell</th>
<th>Projected LFG Generation-2010 (million cubic feet)</th>
<th>Projected LFG Generation-2031 (million cubic feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>1,900</td>
<td>260</td>
</tr>
<tr>
<td>10</td>
<td>-</td>
<td>950</td>
</tr>
<tr>
<td>11</td>
<td>-</td>
<td>2,260</td>
</tr>
<tr>
<td>12</td>
<td>-</td>
<td>3,420</td>
</tr>
<tr>
<td>Totals</td>
<td>1,900</td>
<td>6,890</td>
</tr>
</tbody>
</table>

**Table 1**

Modeled LFG Generation Estimates for Cells 9-12 for the Entire Year in 2010 and 2031.
This LFGTE project complies with the Clean Air Act to reduce emissions from solid waste disposal operations by collecting LFG from Cells 9-12 in the SES, and transmitting it through a dedicated pipeline to the SEC for use as supplemental fuel to offset coal usage.

The system is capable of collecting, processing, treating, and delivering LFG from Cells 9-12 to the SEC for the next 30 years. The LFG emissions from Cells 9-12 have to be managed in accordance with the County’s current FDEP Solid Waste Management Facility Operations and Title V Air Emission Permit. The utilization of the collected LFG will also complement the state of Florida’s GHG initiatives and provide OUC with a renewable fuel to use for electrical power generation.

**Compliance Monitoring**

Attaining regulatory compliance is a result of proper system design and continuous operation. Monitoring the operation for compliance depends on the instrumentation and controls.

The controls used for Cells 9 and 10 are similar to the control system installed for the LFG vacuum/compressor system that transmits LFG from the original landfill to the SEC. The SES processing/treatment facility will be managed to monitor and control integral process parameters and safety features. Operational control is achieved through an operator interface within a control panel at the processing/treatment facility and will also be installed at the SEC for trending and viewing real time and historical data. Gas composition (methane, carbon dioxide, oxygen) is continuously monitored at the processing/treatment facility inlet and outlet. Maximum oxygen level (2.5 percent by volume) and minimum methane concentration level alarms are set based on safety and minimum British thermal unit (Btu) content.

The LFG flow rate to the conveyance/delivery pipeline or the flares is continuously monitored using instrumentation designed for the accurate measurement of LFG. All flow and gas measurement devices/equipment are consistent with industry standards for the purpose intended, whether custody transfer, sales, or meeting Title V permit requirements. Flow meters are installed just prior to the backup flares and at the discharge point of the LFG treatment facility, prior to the SES LFG transmission main to the SEC. Alarms are designed for audible and visible annunciation and recorded to facilitate historical data review.

**Facility Inspection Data**

The County, as the permit holder for the comprehensive Title V Air Permit, contracts for vendor emissions monitoring, LFG flow and quality monitoring, emission test results, and startup/shutdown and malfunction (SSM) plan reporting. Each of these vendor/operators prepares monthly operation summaries.

An independent consultant reviews and organizes vendor-submitted data. Any minor deviations from the standard operating procedures in the SSM plan are noted in semiannual air operation reports prepared for FDEP. The County reviews all significant operation data and results before compliance certification. For the past 7 years, the County has certified that it is Title V compliant.

**Air Emissions Calculations**

The LFG control system for the entire landfill facility is currently permitted under Title V of the Clean Air Act. Under current regulations, the County is required, at a minimum, to operate a flare for the emissions below the non-significant source levels. Guidance for calculating potential emissions is provided by the U.S. Environmental Protection Agency’s (EPA’s) guidance document, AP-42, Fifth Edition, *Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources*. Based on the AP-42 guidance, the emission quantities were calculated for both flare operation and LFG utilization in the SEC for power generation to determine the avoided emission quantities if the collected LFG is used at the power plant instead of flared. The cumulative total in avoided emissions over the next 20 years is summarized in Table 2.
The avoided emissions resulting from LFG utilization offsite will enable the County to remain a non-PSD (Prevention of Significant Deterioration) facility and remain in compliance with its Title V Air Permit conditions.

<table>
<thead>
<tr>
<th>Cells 9-12 Flare Emissions at OCSWMF</th>
<th>Emissions Avoided (tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volatile organic compounds</td>
<td>32</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>6,892</td>
</tr>
<tr>
<td>Sulfur dioxide and sulfur compounds</td>
<td>5</td>
</tr>
<tr>
<td>Nitrous oxides</td>
<td>1,267</td>
</tr>
</tbody>
</table>

TABLE 2
Differences in Avoided Emissions (2011-2031)
LFGTE System Planning

The expansion of the County landfill into the SES generated additional LFG that can be reused beneficially. The County systematically explored options to use the LFG generated through its landfill expansion, which began with an evaluation of the financial and technical feasibility of alternative onsite and offsite LFG utilization and emission control options. The following options were evaluated:

- Title V compliance only
- Direct sale to the OUC power plant (SEC) located adjacent to the landfill
- Direct sale to the County’s Utilities Water Reclamation Division for a potential biosolids treatment and drying plant
- Direct sale to a private vendor for onsite electricity generation
- Onsite direct use for leachate evaporation, electricity generation for onsite consumption, and other solid waste facility use

Each option was developed specifically for the County landfill operation to be in compliance with the Title V Air Permit requirements, and to reduce odors for the surrounding properties as a “good-neighbor” policy. For each option, a benefit/cost analysis was prepared and evaluated.

Direct sale to OUC was selected as the most favorable option because it met the County’s sustainability goals and the objectives of the “Orange-to-Green” program, which was established to encourage a move to green energy by 2020. OUC was familiar with the value of using LFG as fuel in its power plant as part of a previous third-party contract for LFG generated in an older part of the County landfill. Negotiations were conducted and an agreement was reached between the County and OUC to purchase LFG generated from the SES disposal area for up to 40 years (30-year agreement and two consecutive 5-year options).

Agreement between Orange County and OUC

The County and OUC decided early in the planning stage of the project to work cooperatively. This approach resulted in an agreement that met the needs of both entities, and enabled the County and OUC to solve logistical challenges such as site leases, rights-of-way, and easement accommodations. The agreement clearly defined the responsibilities of the County and OUC over the 30-year term, plus two consecutive 5-year options. Key provisions of the agreement are summarized in Table 3.

The agreement also includes the following:

- Defines the project’s primary objective of environmental compliance, which is to control LFG migration and emissions to meet all local, state, and federal regulatory requirements and the requirements of the existing landfill permits

<table>
<thead>
<tr>
<th>Provision</th>
<th>Entity</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sale and Purchase of LFG</td>
<td>County</td>
<td>Sells LFG from the site “As Is” to OUC, exclusively</td>
</tr>
<tr>
<td></td>
<td>OUC</td>
<td>Purchases all LFG generated at the site, except during upsets at the power plant at which time LFG is flared</td>
</tr>
<tr>
<td>Environmental Attributes</td>
<td>County</td>
<td>Retains the rights related to the capture of carbon</td>
</tr>
<tr>
<td></td>
<td>OUC</td>
<td>Retains the rights related to the use of LFG to generate electricity</td>
</tr>
<tr>
<td>Construction/Operation</td>
<td>County</td>
<td>Designs, permits, constructs, operates, and maintains the LFG collection system</td>
</tr>
<tr>
<td></td>
<td>OUC</td>
<td>Designs, permits, constructs, operates, and maintains the processing/treatment facility and portions of the conveyance/delivery pipeline</td>
</tr>
</tbody>
</table>

TABLE 3
Key Provisions of the County/OUC Agreement
Establishes the sales price of the LFG and the escalation provisions

- Specifies equipment ownership and end-of-contract decommissioning responsibilities
- Prescribes dispute resolution procedures and termination provisions

As a result of effectively working together toward a common goal, the County and OUC developed the contract and received Board of County Commissioners’ approval in approximately 5 months.

The project structure shown in Figure 4 is the approach used to carry out the agreement. The County retains the ability to maintain the requirements/environmental responsibility for LFG collection at the County landfill, while allowing for a reasonable methodology to share equity investment in the LFGTE project with OUC. Under this structure, the “Point of Sale,” is at the discharge from the processing/treatment facility where gas enters the conveyance/delivery pipeline.

**Alternative Evaluation**

The County and JV evaluated several routes and scenarios for transmission of LFG to SEC. The routes were evaluated for constructability, permitability, capital costs, and operations and maintenance (O&M) costs. Two alternate routes were eliminated from further consideration because of environmental impacts and probable conflict with existing pipelines, roadways, and drainage facilities. The route selected is along an existing road and the perimeter boundary of the original landfill property where there are few apparent conflicts or significant environmental issues (see Figure 5).
The JV evaluated the pipe sizing and delivery pressure. During the introductory meeting, OUC indicated that an LFG delivery pressure of 10 to 12 pounds per square inch (psi) at the boiler tips was preferable. One alternative evaluated by the JV was a low-pressure pipe with pump stations along the route to collect condensate. The other alternative evaluated was a high-pressure pipeline with a chiller at the compressor station to remove the majority of the moisture from the LFG before transmitting it to the SEC. The chiller system eliminates the need for the majority of the condensate pump stations along the pipeline.

Previous modeling of LFG generation indicated a peak collection rate of approximately 10,500 scfm (assumed 90 percent recovery). The County’s FDEP solid waste permit includes provisions for leachate recirculation back into the landfill. If implemented, this operational procedure promotes more rapid decomposition of the solid waste, and is expected to increase the peak LFG generation rate to approximately 12,000 scfm. A leachate recirculation system, including a dedicated force main and pumping system, was constructed as part of Cell 10 construction. Provisions for installation of a leachate injection system are included in the overall conceptual sequencing plan.

The JV prepared opinions of probable construction cost for the following scenarios that reflect potential variations of the processing/treatment facility and conveyance/delivery pipeline components identified previously:

1. Low pressure (30 psi) 10,500 scfm
2. Low pressure (30 psi) 12,000 scfm
3. High pressure (90 psi) 10,500 scfm
4. High pressure (90 psi) 12,000 scfm

The relative benefits and drawbacks for each of these scenarios were considered from a technical, construction, operational, and cost perspective. Based on the preliminary analysis, the JV recommended that the County and OUC consider the high-pressure (90-psi), 12,000-scfm processing and conveyance/delivery scenario for further analysis and design development. This system will allow the County and OUC to readily adapt to changing delivery demands and compliance requirements, and protract capital and O&M costs.

Future Expansion Capability
The LFG generation model by the JV indicated the initial generation in 2009 to be approximately 1,800 scfm, with a peak generation in year 2031 at approximately 11,550 scfm. Using a different model, the recoverable LFG was estimated by the OUC engineers at 1,300 scfm in 2010 and peaking at 7,200 scfm in 2035. The system was therefore designed to be expanded at least once, possibly twice, during the next 30 years. Additional blowers and compressors will be added to match LFG control requirements as capacity demand increases based on landfill expansion and closure. The system scalability also allows for installing one blower/compressor/flare more than needed for safety, compliance, and O&M redundancy for the site.

LFGTE System Operations and Financial Management
Extraction Well Development and Operation
The FDEP solid waste construction and operation permit allows the County to install horizontal wells as each lift is completed. The horizontal wells are subsequently connected to the perimeter LFG collection main constructed as part of the Cell 9 and 10 initial construction. Once the side slopes for each bay reach the permitted elevations, the County installs vertical wells to enhance the LFG collection efficiency. It is critical that the collection wells are operated optimally. The vacuum applied for LFG collection should not introduce oxygen to the waste mound, which could cause underground combustion. Also, the vacuum applied cannot be so low that the LFG escapes to the surface and causes odors or uncontrolled emissions. The vacuum applied to the well field is therefore balanced weekly to optimize the gas production and comply with the solid waste and Title V operation requirements.

The County obtained a term contract to install the horizontal LFG collection wells and provide and operate an LFG flare. The contract was awarded to SCS Field Services for 5 years and included the installation of stormwater downcomers and the placement of sod on the side slopes after the intermediate cover is placed. The initial temporary flare was skid mounted, had a capacity of 1,200 scfm, and was installed primarily for odor control. When the waste has been in place for
5 years, a permanent LFG control system is required. OUC installed a permanent blower and flare with a capacity of 4,000 scfm. The flare began operation in January 2010.

The County entered into a new term contract with SCS Field Services effective February 2011. This contract covers the operation of the collection wells, extraction, and condensate systems. The installation of LFG horizontal collectors, vertical LFG collection wells, associated lateral and header piping, stormwater downcomers, and placement of sod are also included. To date, 39 vertical collection wells and 22 horizontal collectors have been installed. OUC has piggybacked on this contract for the operation of the flare station.

The capital cost to the County for well field development and operation is funded through several sources. The County is required to maintain an escrow fund for final closure and long-term care of the landfill. One item required as part of the closure is installation of an active LFG collection and control system. The County’s installation of horizontal and vertical wells is funded as part of the final closure. The cost for collection well operation is funded from landfill operations. The value of the term contract for development of horizontal wells, vertical wells, sod and stormwater structure installation, and collection well O&M is estimated at $1,545,000 per year for the next 3 years. As new wells are constructed and the well field is expanded, the cost to the County is expected to increase proportionally.

**LFG Treatment, Conveyance, and Operations**

The capital cost for the LFG processing/treatment facility, conveyance/delivery pipeline, and power plant utilization piping and equipment are the responsibility of OUC. OUC also operates and maintains the primary blowers, treatment facility, secondary blowers, and the conveyance pipeline to the SEC. The estimated and actual capital cost for the initial phase, and the estimated cost of future expansion is presented in Table 4 in 2010 dollars.

The O&M costs for the treatment facility are estimated to be approximately $1 million per year. OUC has extended a power line from the SEC to the processing/treatment facility and will supply power to the blowers and treatment system directly.

**Health and Safety Training**

The County’s operational employees are trained to operate equipment safely on and around the landfill units. Vendor LFG technicians must follow LFG vendor/
operator health and safety protocol established by their organizations. The County is not responsible for any health and safety matters beyond supplying the LFG at a point adjacent to the landfill cell.

The County’s vendor, SCS Field Services, the construction contractor for this project, reports a continual downward trend in its Occupational Safety and Health Administration (OSHA) Lost Time Incident Rate and Lost Time Severity Rate to historic lows, as shown on Table 5.

<table>
<thead>
<tr>
<th></th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lost Time Severity Rate</td>
<td>118.3</td>
<td>96.8</td>
<td>3.5</td>
</tr>
<tr>
<td>OSHA Lost Time Incident Rate</td>
<td>1.7</td>
<td>0.6</td>
<td>0.2</td>
</tr>
</tbody>
</table>

**TABLE 5**
OSHA-Reported Data

SCS is continually improving its health and safety practices to protect the public and its greatest assets — its employees. Their goal is to eliminate unsafe practices and conditions, and have zero accidents and injuries while offering the highest quality client service.
Extraction Wells and Collection Piping

The LFG collection system is being implemented in phases to provide LFG controls in compliance with FDEP solid waste and Title V operation permits.

LFG collection is accomplished through a series of horizontal and vertical LFG extraction wells and collection headers connected to each of the primary leachate collection pipes. Collection piping consists of a perimeter pipe and lateral piping that connects the perimeter pipe to the extraction wells and primary leachate collection pipes. The initial phase of the perimeter pipe was designed, permitted, and constructed as part of the Cell 9 expansion. The remainder of the currently installed perimeter pipe was designed, permitted, and constructed as part of the Cell 10 expansion. At buildout, the perimeter pipe will create a loop around Cells 9-12.

The County’s conceptual sequence plan for Cells 9-12 is shown on Figures 6 and 7. The plan shows the planned operational sequence by cell, bay, and lift. One horizontal LFG extraction well is planned for each lift. The typical horizontal extraction well consists of 6-inch diameter perforated SDR 11 high-density polyethylene (HDPE) pipe surrounded by tire chips, and is connected to a solid HDPE pipe manifold at the west end of the lift. In addition to the horizontal LFG extraction wells, the County is installing vertical LFG extraction wells on approximately 200-foot centers throughout the landfill as areas reach their final fill height. Details of typical horizontal and vertical extraction wells are shown on Figures 8 and 9, respectively.
Gas is recovered from the horizontal and vertical wells by pressure differential. Vacuum provided by the extraction blowers in the processing/treatment facility creates a differential pressure with the atmospheric pressure allowing the LFG to be collected. Integral to the common header is a condensate management system, which is composed of a series of sumps to collect the LFG condensate and discharge it into the leachate collection system. Figure 10 is a photograph of the condensate management system, and Figures 11 and 12 show the condensate pump station details. The County owns and operates the extraction and collection system to ensure compliance with the FDEP solid waste and Title V operating permits.
Processing/Treatment Facility

The processing/treatment facility is designed to handle 100 percent of the anticipated LFG production, and a minimum required excess capacity to meet the minimum level of LFG control, as required by the Title V permit for each development phase. A process flow diagram is shown on Figure 13.

The processing/treatment facility includes two 4,000-scfm extraction blowers that provide vacuum for the extraction wells and collection system. A third 4,000-scfm blower is planned to be added in the future.

The LFG is recovered at approximately 80 inches of water column (at the blower inlet) and discharged at approximately 2 pounds per square inch gauge (psig) to the flare on the first stage heat exchanger. For safety and compliance, a 4,000-scfm flare is also included to destroy LFG not used at the SEC. An additional 4,000-scfm flare is planned to be added in the future. The processing/treatment facility consists of two 2,000-scfm oil-flooded screw-type compressors. Two additional 2,000-scfm compressors are planned to be added in the future.

The gas will be discharged from the screw compressors at about 45 psig, and routed to a 40-degree Fahrenheit (°F) dew point refrigeration system. The purpose of the refrigeration system is to dehydrate the LFG and produce a dry gas for transmission through the pipeline. The system consists of an inlet moisture separator, an LFG-to-chilled water shell-and-tube-type heat exchanger, a chiller, a final moisture separator, and an LFG-to-LFG shell-and-tube-type reheat heat exchanger. The reheat heat exchanger increases the chilled LFG temperature from 40°F to 65°F.
The condensate generated as a result of refrigeration will be collected and transmitted to the County’s Cells 9-12 leachate storage facility for disposal. The processing/treatment facility, conveyance/delivery piping, and power plant utilization piping and equipment is owned and operated by OUC.

The agreement requires OUC to pay the County per million Btus (mmBtus) delivered. The unit price will be adjusted after the first 2 years, based on an escalation formula agreed to by both parties. All flow and gas measurement devices/equipment are consistent with industry standards for the purpose intended, whether for custody transfer, sales, or meeting Title V permit requirements.

The LFG flow rate will be measured with an orifice-plate-type meter, coupled to an in-situ flow computer. LFG composition will be determined using an infrared sensor to measure gas composition. The output of the infrared sensor will be sent to the processing/treatment facility’s supervisory control and data acquisition system where it is combined with flow data to provide totalized energy delivered to the power plant in mmBtus.

**Conveyance/Delivery Pipeline**

During the alternatives evaluation, the County project manager and the JV evaluated several routes and scenarios for transmission of LFG to SEC. The routes were evaluated for constructability, permitability, and initial capital and O&M costs. The route selected is along an existing road and perimeter boundary line of the original landfill properties where there are few conflicts or significant environmental issues. OUC’s design/build firm, SCS Engineers, confirmed the selected route, which is depicted on the aerial photograph included in Section 4 (Figure 5).

The JV also evaluated the pipe sizing and delivery pressures and recommended a dry, high-pressure 12,000-scfm processing and conveyance/delivery scenario for design development. SCS Engineers concurred with the dry, high-pressure delivery approach and has designed and constructed an 18-inch HDPE pipeline. Accompanying the pipeline is a conduit for fiber optic cable for communication between the processing/treatment facility and the SEC.
Power Plant Utilization Piping and Equipment
The SEC power plant will receive dry, compressed LFG at approximately 25 psig. This delivery pressure was selected to accommodate potential future alternative uses of the LFG at the SEC, and compensate for any pressure loss resulting from possible future treatment requirements. The pressure will be reduced to approximately 10 psig and will be distributed to each coal-fired boiler via stainless steel utilization piping connected to individual gas injection burner tips installed on the boilers.

LFG enters the power plant in 12-inch stainless steel pipes and passes through a series of manual and pneumatically operated isolation valves, pressure control valves, and flow meters that are connected to the main control room of the power plant for monitoring and system control. Flow to each boiler will be monitored in the control room and used along with meter and pressure data from the compressor station to account for and control LFG contribution to boiler heat input. The pressure control will be set to optimize gas velocity at the burner tips.

LFG is injected into the boiler through 2-inch stainless steel burner tips. The LFG burner tips are installed integral to the pulverized coal burners that provide the primary boiler fuel. LFG flow to the burner tips is monitored and controlled by valves and pressure transmitters mounted between the distribution piping and the inlet of the burner tips.

The power plant utilization piping and equipment is designed per the National Fire Protection Association (NFPA) Standard 85, and is equipped with double block and bleed valves should the boiler trip and all fuel must be shut off. Pressure is transmitted back to the compressor station for feedback, and to shut off the station in case pressure builds up should both boilers be offline simultaneously for an extended period. LFG trapped in the distribution system inside the power plant building at the time of a shutdown is routed through stainless steel piping to roof-mounted vents, where it is vented safely to the atmosphere reducing the risk of fire or explosion in the power plant building.

Routine Maintenance and Employee Training
The County has a term contract with SCS Field Services and Absolute Water to conduct routine maintenance on the landfill’s leachate and condensate systems and associated control equipment. SCS Field Services operates and maintains the LFG extraction wells and collection piping.

SCS Field Services is currently under contract with OUC to provide O&M services. One factor in the selection of SCS Field Services was to take advantage of the synergy that can be realized by having the same contractor operate the blow/flare station and collection system. OUC supplements SCS Field Services with its own highly trained technicians and repair contract resources, as necessary, during emergencies and special troubleshooting evolutions.

During construction, equipment vendors provide training to the landfill equipment operators, as well as other landfill employees who may be required to operate the equipment. These training sessions are videotaped to provide training for future equipment operators, as needed.
Sustainability Partnership Benefits the Community
On the LFGTE project, a positive, collaborative relationship was developed between two local government entities (the County and OUC). Because the facilities (Orange County Landfill and the SEC) are located adjacent to each other requiring only 5 miles of pipeline, the project is both environmentally and economically feasible.

The County and OUC have also partnered on a stormwater project — the County transmits stormwater from the landfill and reclaimed water from the Eastern Water Reclamation Facility to OUC for use as cooling water in the power plant. These projects improve the quality of life of residents living in Orange County, help achieve Orange County’s sustainability goals and objectives of its “Orange-to-Green” Climate Change Plan, and contribute to achieving the state of Florida’s 2050 goals of GHG reduction and renewable fuel use.

Community Education and Customer Service
Approximately 30 landfill tours are conducted each year, and half of those are for school children. At the 2010 Orange County Recycles Day Celebration, 680 people toured the landfill during the 26 tours conducted. Each year, the County holds numerous community outreach events, such as Earth Day celebrations. In 2010, the Solid Waste Division staff handled 38,000 calls on its Solid Waste Hotline.

Landfill Appearance and Aesthetics
The OCESWMF is maintained in a neat and clean condition, is located at the end of a dead-end road so no through traffic passes by the facility, and does not detract from the quality of life of nearby residents. In fact, the landfill is located in close proximity to residential neighborhoods and was permitted without public challenge.

The construction was planned and phased to provide visual buffers during construction to the extent practical. Now that construction is complete, a visual buffer of trees and other vegetation helps screen landfill operations from view, another benefit to the community environment. Hurricane-safe structures were designed to allow the landfill to remain operational and ready to function immediately following a significant storm. The employee breakroom also provides a storm-safe haven to protect the health and safety of landfill employees. Wetland and protected upland area mitigation alleviates impacts associated with planned development on the SES, providing sustainable benefits to the community. Permitting was secured for the wetlands to cover the next 25 years of planning and development. The conceptual design and wetland mitigation provide approximately 25 years of Class I landfill capacity for Orange County residents. The Conservation Easement provides wetland and upland habitat that is an overall environmental asset for the County and its residents. A wetland/upland combination was required to mitigate wetland and upland construction impacts. The combined conservation easement provides a more environmentally friendly habitat for the native animals.
**Overall Benefits**

The County will start receiving revenue for the recovered LFG, and OUC is receiving fuel for the power plant at a lower cost per mmBtu than coal. OUC will receive potential environmental attributes, such as renewable energy credits (RECs) for the next 30 years with two 5-year option extensions; generate energy using a renewable resource; have access to a local, less expensive alternative fuel source; and reduce emissions that will benefit its bottom line.

The County will receive more than $100 million in revenues during the next 30 years. This project provides economic, environmental, and social benefits for the County, demonstrating that through careful planning, evaluation, engineering, and implementation, sustainability’s triple bottom line of economic, social, and environmental success can be achieved. There is no doubt that both Orange County and OUC will be working together to identify future ventures and opportunities for a sustainable environment in Orange County.
Both the relationship and the geography were unique on this LFGTE project. A positive, collaborative relationship was developed between two local government entities (the County and OUC), and the facilities (Orange County Landfill and the SEC) are located adjacent to each other requiring only 5 miles of pipeline, thereby making the project much more feasible. The innovative and creative aspects of this facility include the following:

- **Better control of odor and GHG emissions through the LFG horizontal collection system**
  Historically, LFG wells were installed as part of landfill closure. At the County landfill, the LFG horizontal collection system is installed during operations and vertical wells are installed as areas reach final elevation. In addition, the County began collection and flaring of LFG 4 years before it was required by regulation as a “good neighbor.” These actions help to control landfill odors and reduce GHG emissions.

- **Recycled products used to reduce cost**
  Waste tire chips are used instead of gravel in the horizontal LFG collection system, which results in a price savings of $10 per linear foot, and puts recycled waste tires to good use.

- **LFG perimeter pipe constructed as part of the initial construction**
  While LFG collection and control systems are typically installed during landfill closure, the main LFG header and condensate collection systems are being installed as part of cell construction. Perimeter piping for Cells 9 and 10 are in place and operational. Active collection of LFG and flaring began in 2006 approximately 1 year after the first load of waste was placed in Cell 9. The benefits to this innovative approach are reduced costs, minimized landfill operation disruption, and collection of LFG as soon as it starts to produce (typically 4 to 6 months after waste is placed).

- **LFG wellhead installation on leachate collection pipe clean-outs**
  Installation of wellheads on leachate collection pipe clean-outs supplements the collection of LFG, in effect placing horizontal gas collection wells at the bottom of the landfill. Initially, wellheads were installed on the west (high) end of the leachate collection pipes, but during operation the County added wellheads to the east end of the leachate collection pipes, reducing surface emissions.

- **LFG refrigeration before conveyance to the power plant**
  Refrigerating LFG reduces the moisture content of the gas, thus removing condensate before the LFG is transmitted through the conveyance/delivery pipeline to the SEC. This innovative approach along with high-pressure transmission of the LFG allows the use of smaller diameter pipe and reduces the slope and depth of the pipeline. In addition, condensate pump stations are not required periodically along the pipeline, reducing capital and operating costs.

- **Extension of power from OUC to the Processing/Treatment Facility**
  The western portion of the OCSWFM is located in Progress Energy’s franchise area and the County receives its power for the SES from Progress Energy. Since OUC owns the processing/treatment facility, OUC is allowed to supply power to its own equipment even though it is located in Progress Energy’s franchise area. OUC extended overhead power lines from the SEC to the processing/treatment facility, providing less expensive power for operation of the processing/treatment facility.

- **County and OUC chose to enter into direct negotiations instead of usual RFP for a third party developer**
  After evaluating alternatives and having preliminary discussions with OUC, the County chose to enter into direct negotiations with OUC rather than issuing the more traditional third party request for proposal (RFP). This approach allowed the County and OUC to develop an agreement that was beneficial to both parties, eliminated the cost and time delays associated with the RFP process, and eliminated a potential third party markup on the sale price of the LFG.
Shared responsibilities between both government entities
Under the project structure provided in the agreement, the County retains the ability to maintain the requirements/environmental responsibility for LFG collection at the Orange County Landfill while allowing the County and OUC to share equity investment in the project. The County expects to receive more than $100 million in revenues over the next 30 years, while OUC gets fuel for the power plant at a lower cost than coal.

Agreement between two government entities for the common good benefits the community
Early in the project, the County and OUC developed a cooperative relationship that carried through to contract negotiations, resulting in a mutually beneficial agreement.

The County and OUC have been innovative and creative in their approach to developing this project, which has been and will continue to be mutually beneficial to the partners in the agreement and County residents for many years.