USING NSPS TO GET OUT OF NSPS

Carlo F. Lebron
SCS Engineers
Tampa, Florida

Laurel C. Ackison
SCS Engineers
Tampa, Florida

Lois E. Rose
Solid Waste Division
Sarasota County
Nokomis, Florida

ABSTRACT

A little over 15 years ago many landfills had to install landfill gas collection and control systems (GCCSs). Since that time many of those landfills have been closed. A landfill needs to cross one more hurdle until it is allowed to cap and remove the GCCS. This hurdle requires sampling and analyzing for NMOC on three separate occasions to confirm that the concentrations are below 50 megagrams (Mg). The following is a case study of Sarasota County's Bee Ridge Landfill and the steps they took to meet the U.S. Environmental Protection Agency's (EPA's) standards for air emissions from municipal solid waste (MSW) landfills [40 CFR 60.752(b)(2)(v)].

The Bee Ridge Landfill was operational for almost 30 years and at closure had a GCCS installed. Now that the 15-year timeframe has passed, the control system is having a hard time maintaining continuous functionality. The County is proceeding with the required three sampling events to see if they can have greater flexibility with the operations of their GCCS. This case study will discuss the history of the landfill, discussions with regulators, challenges the County is having with the landfill GCCS, research performed to confirm the feasibility of removing the GCCS from New Source Performance Standards (NSPS) requirements, sampling results, and lastly, what the next steps are for the Bee Ridge Landfill.

HISTORY

The Bee Ridge Landfill is an approximate 220-acre, Class I landfill with a design capacity of 5,352,695 metric tons, located in Sarasota County, Florida. In 1971, the County purchased the landfill from a private owner who was using it to dispose of waste. The landfill accepted mostly MSW in the beginning with co-disposal of construction and demolition (C&D) waste towards the latter years of the life of the landfill. Waste placement at Bee Ridge Landfill was placed in four phases. Phase I East and Phase I West are located in the northeast and northwest portions of the landfill, respectively. Phase II and Phase III are located in the southwest and southeast portion of the landfill, respectively. The final phase to receive garbage, Phase IV is located centrally in the landfill and was closed in 1998. The closure sequences for Bee Ridge Landfill are shown in **FIGURE 1**.

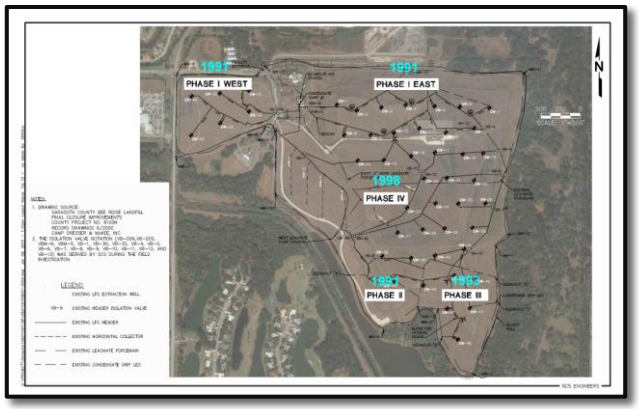

FIGURE 1 - BEE RIDGE LANDFILL (WITH CLOSURE SEQUENCE)

The Bee Ridge Landfill's Title V Air Operation Permit (Title V) renewal was granted on June 10, 2013. Three emissions units are covered within the permit: EU 001 (MSW Landfill), EU 005 (Flare), and EU 006 [Emergency Compression Ignition (CI) Reciprocating Internal Combustion Engine (RICE)]. According to the permit, the facility is not classified as a major source of hazardous air pollutants (HAPs). In 2013, a LandGEM emissions model for Bee Ridge Landfill was submitted as part of the Title V permit renewal; this model estimated that by 2014, NMOC emissions at the landfill would be approximately 5 Mg.

The landfill was initially developed using trench and fill techniques with no bottom liner - as was typical at that time. In 1987 the County completed installation of Bentonite Slurry Wall around the perimeter of the landfill thus defining the footprint of the Bee Ridge Landfill. A slurry wall landfill operates with an inward hydrologic gradient utilizing pumps to maintain liquid levels lower on the landfill side of the slurry wall than the groundwater level in the surrounding area. In 1998 the County opened a new landfill that was more centrally located within the county and had all waste diverted to this new landfill.

Although the landfill is closed, it is by no means sitting idle. The County has a public works facility, animal shelter, and a chemical collection center on the property surrounding the landfill. There is a public park with a passive trail system that surrounds the landfill site that is used on a daily basis by the public. Lastly, the landfill has a radio-controlled air field on a portion of the top of the landfill as well as a solar panel demonstration project on another portion of the landfill **(Figure 2)**.

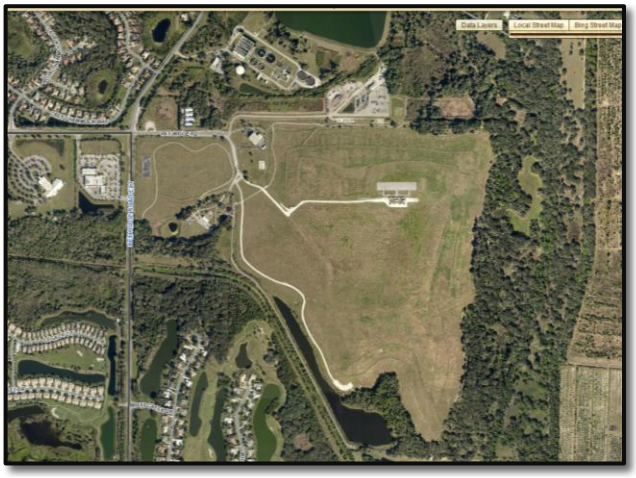

FIGURE 2 - OVERVIEW OF BEE RIDGE LANDFILL WITH ANCILLARY FACILITIES SHOWN

VIEW OF THE SOLAR FIELD AT THE BEE RIDGE LANDFILL.

GAS COLLECTION AND CONTROL SYSTEM

Bee Ridge Landfill is equipped with a landfill GCCS that consists of 53 landfill gas (LFG) wells, 47 vertical collection wells, and six horizontal collection wells. An as-built plan reviewed by SCS Engineers (SCS) shows 17 isolation valves incorporated within the GCCS. The LFG emissions are collected and controlled by a non-assisted open candlestick flare.

In 1995 the current flare station, a LFG Specialties candle stick flare with a maximum flow rate of 3,000 cfm, was commissioned. The flare was recently retrofitted with a 24-hour LFG monitoring and notification system.

ISSUES

The greatest challenge Sarasota County has with the Bee Ridge Landfill GCCS is to maintain the flare station operating at all times. This challenge is largely in part due to the quality and steady decline in gas being generated at the landfill.

The landfill's Title V air permit allows alternative operation of the landfill GCCS at the landfill as specified by an Addendum requested by SCS on behalf of Sarasota County, dated June 7, 2006. The Addendum addresses diminishing flow conditions and requests that as methane generation decreases, select LFG extraction wells be taken off-line for potential decommissioning as necessary. The permit provided a baseline for evaluations, particularly for an updated LFG production prediction.

The Bee Ridge Landfill's 2013 USEPA Greenhouse Gas (GHG) report, states the total surface area of the landfill containing waste is 890,308 square meters, or approximately 220 acres. The 2011 to 2014 monthly flare emissions data shows the average flow rate at the flare station to be 536 scfm (though this rate is trending downward as shown in **Error! Reference source not found.**). Based on an average 2012-2014 gas composition of 37 percent methane noted at the flare, one can conclude the average methane emission footprint for the landfill is approximately 0.90 scfm methane per acre.

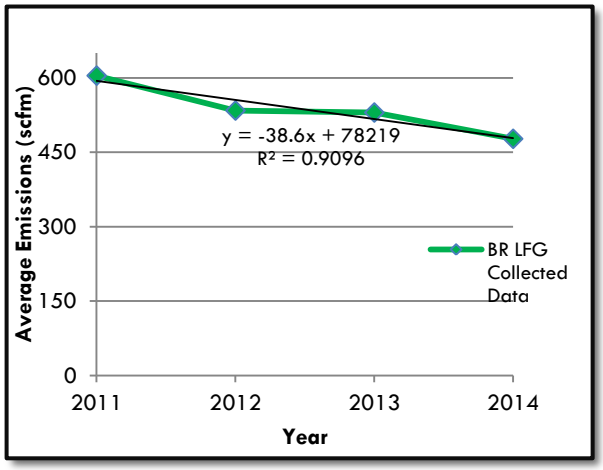

FIGURE 3 - AVERAGE FLARE EMISSIONS (2011-2014)

This average was calculated as follows:

$$CH_4\ Footprint = \frac{Avg.\ Gas\ Emission_{(2011-2014)} * Avg.\ CH_4\ fraction_{(2012-2014)}}{Landfill\ Acreage}$$

$$= \frac{536\ scfm * 0.37\ CH_4}{220\ acres}$$

$$= \frac{0.90\ scfm\ CH_4}{acre}$$

Gas extraction wells with the greatest methane content and measured flow rates are concentrated in the center of the landfill in the Phase IV region. Waste in this area is newest and still in a stage of relatively high production. LFG extraction wells with lowest methane content and measured flow rates are found on the periphery of the landfill in Phase I East and Phase I West. As expected, gas extracted from wells in these older regions is not ideal for flare system operation, due to the age of waste. LFG monitored at horizontal wells east of Phase IV was also found to have low concentrations of methane and high concentrations of oxygen content.

VIEW OF THE FLARE SYSTEM AT BEE RIDGE LANDFILL.

All these issues combined illustrate why the flare station is challenged to stay operational for long periods of time. This in turn presents a challenge for the County to maintain compliance with the Title V air permit and the associated regulations. One approach the County had, was to determine if it was feasible to remove the GCCS (specifically the flare station) from meeting the requirements of the NSPS as stipulated in the Title V permit. To that end, the County wanted to explore all the options to confirm this was the best approach to initiate.

LANDFILL GAS EVALUATION

In April 2014, SCS was tasked to provide Sarasota County with engineering and field services support to evaluate and make a recommendation on the possible removal of the landfill GCCS from NSPS regulations at the Bee Ridge Landfill.

SCS reviewed historical waste acceptance data from the most recent Title V Permit renewal application, dated February 20, 2013. Waste acceptance rates were available for the years 1971 to 1998, when the Bee Ridge Landfill was closed (**TABLE 1**). The average acceptance rate for this time interval was 191,168 metric tons per year. An email dated May 9, 2014, from Sarasota County staff indicated that a portion of the waste accepted at the landfill consisted of C&D debris. This portion of waste acceptance increased over time. Considering this information, SCS estimates conservatively that 25 percent of waste accepted was non-putrescible, while the remaining 75 percent is typical MSW. **TABLE 2** shows waste acceptances, adjusting for 25 percent C&D debris.

TABLE 1 - HISTORICAL WASTE ACCEPTANCE DATA (ASSUMING 100% MSW)

Year	Mg/year	Year	Mg/year
1971	52,983	**1985**	238,173
1972	58,869	**1986**	239,273
1973	65,410	**1987**	284,586
1974	72,678	**1988**	306,935
1975	80,754	**1989**	299,495
1976	89,726	**1990**	292,728
1977	99,695	**1991**	280,330
1978	110,773	**1992**	237,275
1979	123,081	**1993**	235,372
1980	136,756	**1994**	221,749
1981	151,952	**1995**	203,579
1982	169,817	**1996**	341,332
1983	219,586	**1997**	324,040
1984	216,199	**1998**	199,547

TABLE 2 - HISTORICAL WASTE ACCEPTANCE DATA (ASSUMING 75% MSW)

Year	Mg/year	Year	Mg/year
1971	39,737	**1985**	178,630
1972	44,152	**1986**	179,455
1973	49,058	**1987**	213,440
1974	54,509	**1988**	230,201
1975	60,566	**1989**	224,621
1976	67,295	**1990**	219,546
1977	74,771	**1991**	210,248
1978	83,080	**1992**	177,956
1979	92,311	**1993**	176,529
1980	102,567	**1994**	166,312
1981	113,964	**1995**	152,684
1982	127,363	**1996**	255,999
1983	164,690	**1997**	243,030
1984	162,149	**1998**	149,660

The County also provided SCS with LFG data for review. Gas wellfield monthly readings provided consisted from January 2012 to April 2014 and monthly flare system data from December 2010 to April 2014. Localized pressure, gas flow rate, and gas composition were among data of particular importance. This data was mapped in order to determine if any spatial patterns or areas of concern were present at the landfill. System pressure readings were not available in the data provided by the County, so adjusted static pressures were evaluated to assess vacuum performance.

TYPICAL VERTICAL EXTRACTION WELL INCORPORATED IN BEE RIDGE LANDFILL'S GCCS.

Emissions data collected from the Bee Ridge Landfill flare station were compiled from years 2011 to 2014. During this timeframe, emissions show a downward trend (R^2 = 0.91). The site-collected data shows that LandGEM predictions (both historical and revised) are biased high. Percent error between predictions and site-collected emissions data is shown in

.

TABLE 3 - PERCENT ERROR OF LANDGEM MODELS

GEM Model	Year	Error (% D)
2014 – C&D	2011	33%
	2012	38%
	2013	36%
	2014	40%
2013	2011	50%
	2012	54%
	2013	52%
	2014	55%

FIGURE 4 shows the average methane composition of LFG from January 2012 to April 2014. Gas quality (percent methane by volume) appears to be consistently degrading, with the exception of data from May to October of 2012. At this time, the landfill experienced a leak in a lateral gas line that was found in the latter part of June 2012 and repaired in early July 2012 by SCS Field Services.

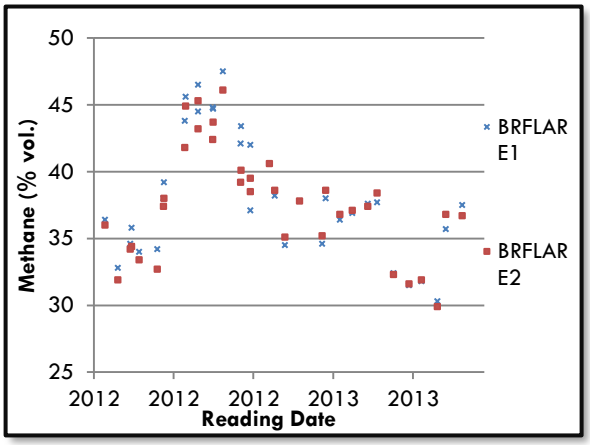

FIGURE 4 - AVERAGE METHANE COMPOSITION FOR MONTHLY FLARE READINGS

Average system pressures from 2012 to 2014 for Bee Ridge Landfill are shown in **FIGURE 5**. The wells with the greatest vacuum are within the red shaded area. Wells in Phase IV of the landfill demonstrate the greatest vacuum. Recent pressures from March 2014 are of lower magnitude than average pressure, suggesting a reduction of system vacuum since 2012. Low methane content and vacuum are

expected, considering the age of the landfill. The lowest pressure and methane content readings were found in Phase I of the landfill, where waste was first added. Phase IV was the last region of the landfill in which waste was placed. Therefore, Phase IV waste is comparatively young and is responsible for the greatest amount of gas production.

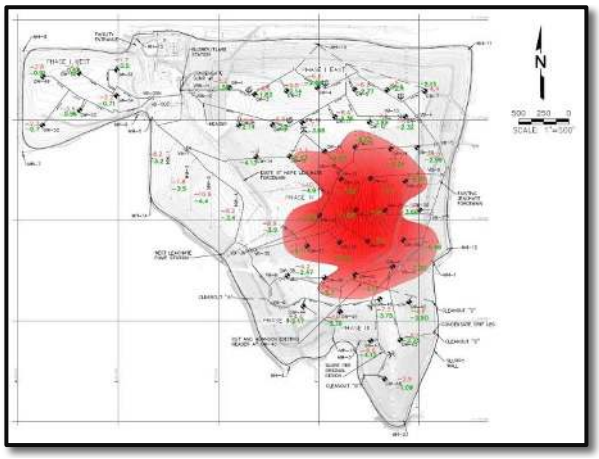

FIGURE 5 - PRESSURE MAP OF BEE RIDGE LANDFILL

Gas flow rate at each well was also examined. As with the system pressure readings, average flow rates are highest in the Phase IV area of the landfill, with lower flow rates (less than 5 scfm) in northern Phase I regions. Horizontal wells HW-1 to HW-4 on the western perimeter of Phase IV are currently closed off to improve collection efficiency in other wells in the Phase IV region of the landfill. In **FIGURE 6**, average flow rates are displayed for each well. The wells with the greatest flow are within the blue shaded area. Gas quality, including oxygen, carbon dioxide, and specifically percent methane, was evaluated in order to determine any methane-deficient locations which may be a source of flare shutdown.

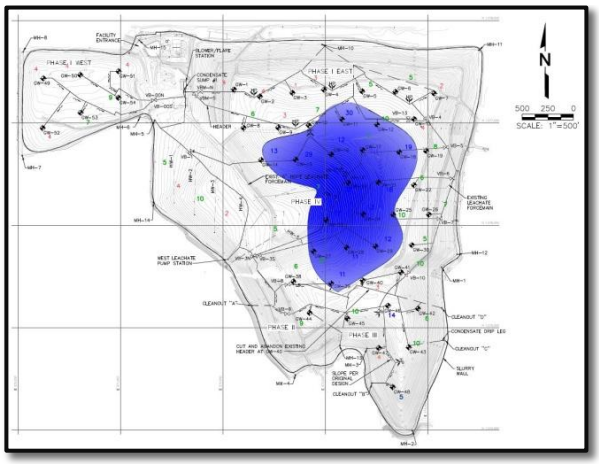

FIGURE 6 - FLOW MAP OF BEE RIDGE LANDFILL

Average methane composition for 2012 to 2014 for each well was summarized and mapped to provide a visual representation of methane-deficient wells. As seen in **FIGURE 7**, Phase IV of the landfill demonstrates gas with the highest percent methane while wells along the periphery of the landfill and particularly in Phase I West are methane-deficient. The wells with the highest concentration of methane are within the green shaded area. Wells outside of this area have gas quality which is below the ideal operating range of 30 to 50 percent methane for the flare system. This will present challenges in terms of maximizing the methane content at the flare unless vacuum and flow from these areas are minimized, if not eliminated.

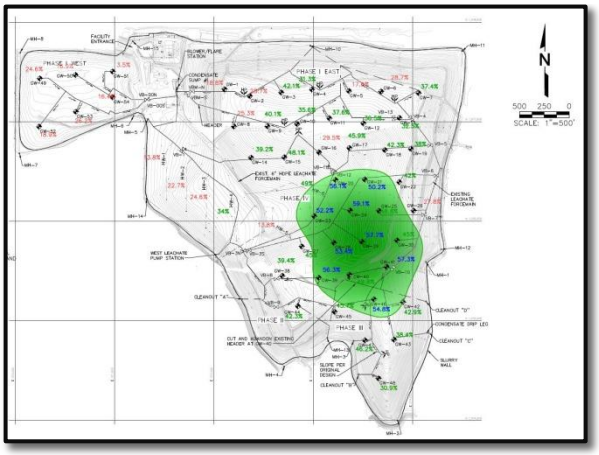

FIGURE 7 - METHANE CONCENTRATION MAP AT BEE RIDGE LANDFILL

Outlier wells which demonstrate lower pressure, average flow, or gas quality relative to surrounding wells were examined closely in the field study.

In addition to mapping LFG data, the most recent LFG production prediction, dated February 19, 2013, was reviewed by SCS. As mentioned previously, the waste accepted by the landfill can be estimated as 25 percent C&D and 75 percent typical MSW. Given this estimate, it is likely that this historic LandGEM based on acceptance rates of 100 percent typical MSW overestimates potential production rates. The historic 2013 LandGEM prediction is shown in **FIGURE 8**.

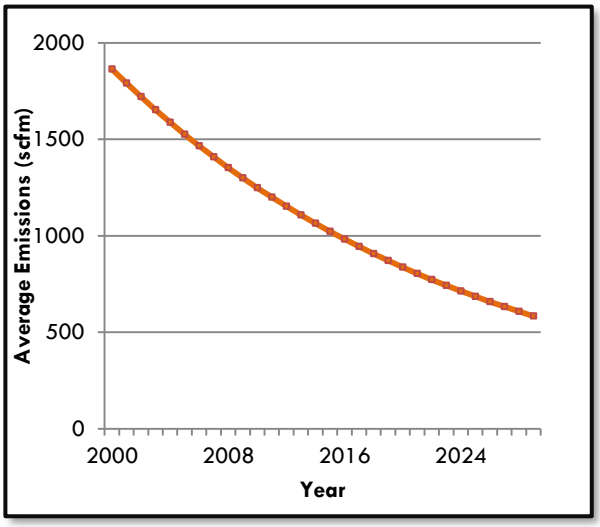

FIGURE 8 - HISTORIC 2013 LANDGEM EMISSIONS PREDICTION

The LandGEM model using the revised waste tonnages is shown in **FIGURE 9**. The percent error was then determined between the two model predictions, as shown in

on page 4.

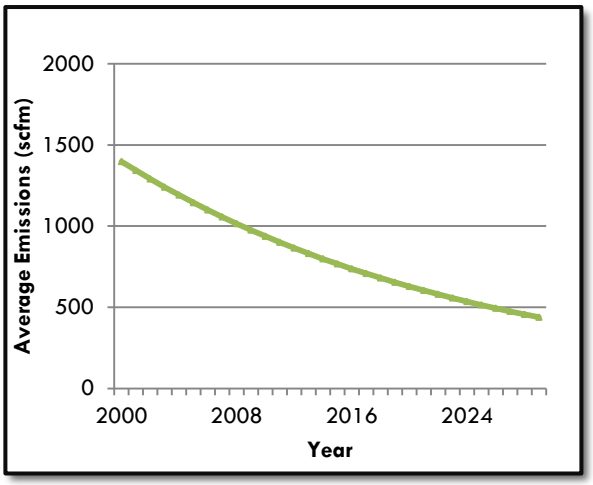

FIGURE 9 - UPDATED 2014 LANDGEM EMISSIONS PREDICTION

FIGURE 10 compares the latest LandGEM produced in 2013 for the most recent Title V air permit revision with the updated 2014 LandGEM generated by SCS to take into account the C&D fraction in historic waste accepted by the landfill. The models were validated with average monthly flare emissions data provided by the County. The predicted value of each emissions model was higher than the emissions data collected by the County with the 2014 LandGEM model values resulting in lower percent error when compared to actual flows.

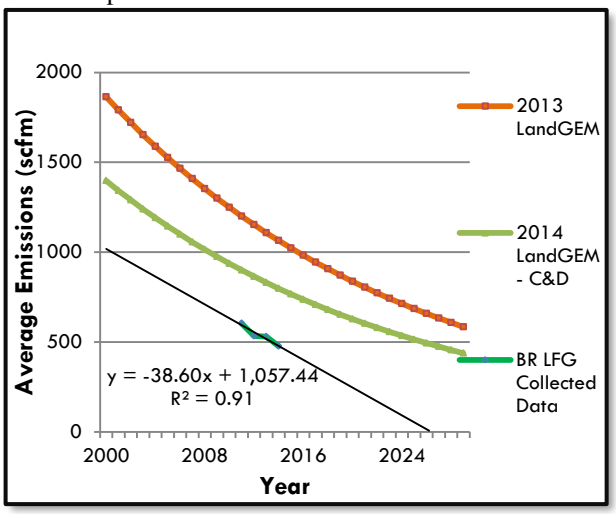

FIGURE 10 - LANDFILL GAS EMISSIONS PREDICTIONS COMPARISON

In addition to assessing predicted gas emissions, historical liquid level data, dated April 16, and April 17, 2012 was reviewed to assess well conditions at Bee Ridge Landfill. Liquid levels from June of 2005 were also reviewed to determine whether any notable changes have occurred since the more recent liquid level data set. Well liquid level data reviewed from 2005 show similar conditions as that of 2012. The majority of wells during the 2012 event were dry, with the exception of GW-3, with 41 percent slotted pipe submerged in 2012 and 74 percent slotted pipe submerged in 2005. Comments and concerns in the table do not indicate gas system flaws, but rather, ambient disturbances such as the presence of water, mud, or well blockage.

WELL WITH WATER IN LATERAL; HOWEVER, THE MAJORITY OF WELLS AT BEE RIDGE WERE DRY IN THE MAY 2014 FIELD INVESTIGATION.

To supplement the historical data review, SCS Field Services performed a field investigation on May 21, 2014, to collect data where insufficient or no information was present and to perform a LFG extraction system inspection. Gas readings were collected from each well. A calibrated GEM 5000 and GEM 2NAV were used to collect readings during the field investigation. Wells of concern, identified during historical document review, were flagged for detailed scrutiny. At these wells, liquid levels as well as detailed structural inspections were conducted.

Besides minor improvements typical to normally-operating landfills, the field investigation did not reveal any items of serious concern regarding the integrity and state of the GCCS. Additionally, from historic data review and a field investigation, SCS has found minimal areas to improve gas collection to affect flare station performance. With this in mind it is believed that flare shutdowns are due to low gas flow, lack of methane content in gas and, ultimately, the age of the waste at Bee Ridge Landfill.

Based on the findings of this evaluation, the County implemented procedures for the removal of the reporting and/or operational requirement and/or portions of the GCCS.

SCS'S MAY 2014 FIELD INVESTIGATION.

REGULATIONS

Considering the investigations and evaluations performed, it was recommended that the system could be exempt from NSPS requirements specified in 40 CFR 60.753.

In light of this recommendation, the County elected to seek GCCS removal from NSPS. This option was discussed with the Florida Department of Environmental Protection (FDEP) in order to determine an approach to achieve concurrence with the regulatory body to proceed with future activities related to removal or reduced operational procedures. These discussions resulted in NMOC constituents sampling in order to satisfy conditions necessary for potential GCCS removal. A sampling protocol was developed that outlined in general the sampling procedures to be used and the laboratory analysis to be performed along with a proposed schedule. The FDEP accepted the approach presented and requested that reminder notifications be sent to them one week prior to site sampling.

As stipulated in the sampling protocol and the regulations, per 40 CFR 60.752 (b)(2)(v)(C), three Tier 2 sampling events for NMOC constituents were conducted no less than 90 days apart and no more than 180 days apart. To date, SCS has completed all three sampling events and is in the process of developing a final report for the County documenting testing procedures and methods.

The County and SCS will discuss with the FDEP the conditions listed in 40 CFR 60.752 (b)(2)(v) for final submittal to the FDEP and attend a meeting with the FDEP to present the findings and discuss necessary future steps for the GCCS. It is assumed the landfills Title V air permit will be modified to incorporate these new findings. These adjustments will include: reporting requirements, operating and monitoring schedules, and emissions limitations.

SAMPLING

SCS performed the required LFG sampling and analysis using the parameters established in §60.754(b). During each NMOC sampling event, SCS recorded gas flow rates from the calibrated flow meter in accordance with the USEPA determination dated July 27, 2011. The flow rate of the calibrated in-place flow meter was recorded prior to taking each NMOC sample in lieu of performing Method 2. The thermal mass flow meter calibration certificate will be included with the final NMOC Report that SCS is currently developing for the County.

SAMPLE TRAIN WITH SUMMA CANISTER DURING ONE OF THE THREE SAMPLING EVENTS.

In order to determine the NMOC concentrations at the landfill, SCS collected four 30-minute samples using four

pre-evacuated 6-L Summa canisters at the header sampling point. Three of the four samples were analyzed as described below, with the fourth sample serving as a backup sample. Prior to each gas sample being taken, a GEM-2000 was utilized to record methane, carbon dioxide and oxygen concentrations from the gas sampling stream to confirm that the LFG quality is consistent with concentrations typically observed at the site. The samples were then shipped to a NELAC-certified laboratory and analyzed according to USEPA Method 25C for NMOC and Method 3C for methane, carbon dioxide, nitrogen, and oxygen concentrations. Sampling logs completed by SCS document the pre-sampling LFG concentrations, header flow rate, time of sample collection, and ambient conditions.

RESULTS

The laboratory analyzed each canister according to USEPA Method 25C for NMOC and Method 3C for nitrogen and oxygen concentration. The NMOC concentrations measured by the laboratory were presented in units of parts per million by volume (ppmv) as carbon. Analytical results included corrected NMOC concentrations based on sample temperature and barometric pressure at the time of sampling, moisture content, and nitrogen concentration within the sample. These results are shown in **Table 4.**

TABLE 4 – NMOC EMISSIONS CALCULATION SUMMARY

Sampling Event	Sample Date	NMOC Conc. Average (ppmv Hexane)	Average LFG Flowrate (scfm)	Average LFG Flowrate[1] (m_3/min)	NMOC Emissions (Mg/yr)
1 of 3	7/17/14	42	369	10.5	0.8
2 of 3	10/28/14	84	483	14.0	2.2
3 of 3	1/26/15 & 1/29/15	145	328	9.0	2.5
AVERAGE ANNUAL NMOC EMISSIONS (Mg/yr):					**1.8**
1. Assume one cubic meter is equal to 35.3147 cubic feet.					

For each canister, the NMOC concentration was converted from ppmv as carbon to ppmv as hexane by dividing by a factor of six. SCS calculated the average NMOC concentrations for use in calculating the NMOC emission rate using the equation given in §60.754(b).

60.754 (b) $M_{NMOC} = 1.89 \times 10^{-3} Q_{LFG} C_{NMOC}$

- M_{NMOC} = mass emission rate of NMOC, Mg per year
- Q_{LFG} = flow rate of LFG, cubic meters per minute
- C_{NMOC} = NMOC concentration, parts per million by volume as hexane

In accordance with the preceding equation, NMOC concentrations reported by the laboratory were used to calculate estimated annual NMOC emissions at the landfill. Based on the average NMOC concentrations and average flow rates measured during the three sampling events, the final average annual NMOC emission estimate is 1.8 Mg/year. This amount is under the 50 Mg/year criterion for operating a GCCS in compliance with NSPS requirements.

NEXT STEPS

Due to the challenges associated with operating a GCCS under the conditions previously described, SCS and the County discussed several options for moving forward. It is important to note that the approaches listed below took into account the activities currently in place and around the landfill site. Portions of the Bee Ridge landfill property have been converted to recreational facilities with paved trails and a radio-controlled airplane field located on top of a portion of the landfill. Additionally, there is a playground south of the Phase I West footprint and residential communities have been developed that surround the property to the south and west. These elements combined the need to minimize risk factors and any potential offensive odors that may be emitted from the landfill. Lastly, the landfills air permit will need to be taken into account on what changes can be made. It assumed the FDEP will issue a new air permit based on the landfill's new NMOC emission rates that will allow the LFG collection to be operated outside of the parameters listed in NSPS.

If the wells are not decommissioned or retrofitted, the County could maintain the valves on each wellhead in an open position and allow the gas to passively vent at the flare station (assuming the station will stay in place). SCS does not recommend closing the valves on the wellhead until pressure at the wells has consistently maintained zero (0) inches of water for a period of six months or more.

If the County retrofits the gas wells to passive venting, SCS recommends a phased approach. Considering the goal of odor control, wells that are producing more than ½ inch of water of positive pressure and have methane levels above 5 percent should not be allowed to freely vent. Prior

to retrofitting, pressure and methane content at these wells should be evaluated for a period of six months.

The County could elect to implement limited controls on the some wells that are to be retrofitted from an active to passive collection system depending on the amount of flow and methane being produced from the well. These controls include installing continuous spark flares or semi-active vents. The spark flares have a continuous sparking mechanism that ignites the methane gas venting from the well. This allows for control of the methane and the subsequent odors generated from LFG. If this option is selected, it is recommended that the spark flares be secured to prevent unauthorized access by the public. An alternate retrofit would be the use of wind driven turbines atop the passive vents. These are made of aluminum or some other outdoor weather resistant material and allow for a slight vacuum to be placed on the well when the vents spin. Both features allow for the reduction of pressure build-up from LFG that may still be generated within the waste mass of the landfill. However, both of these options add a level of maintenance and/or liability the County is currently not facing.

PICTURE OF THE FLARE AT BEE RIDGE, WHICH IS PART OF THE LANDFILL'S GCCS.

If the County elects to continue to operate the LFG collection system, it could close or dramatically reduce the vacuum to some of the wells that historically have had low concentrations of methane to increase the amount of BTU combusted at the flare station. Wells in low gas producing areas could be effectively isolated by closing valves. For groups of wells that are in the same area, such as those in Phase I West, if the resulting collective methane level in those wells are below 5 percent, the County could close the header valve to this section and leave the wellheads open.

In order to accommodate the decline in the quality and quantity of gas production, the County could also retrofit the existing flare station so that it is able to operate more efficiently at a reduce flow rate and methane concentration. Dependent upon cost, replacing the entire flare station could also be an option of the County to consider. By operating a gas destruction system, the risk of emitting odors at the site is reduced significantly.

CONCLUSION

The County's decision on how to continue to manage the declining production of LFG at the Bee Ridge site will be based on the evaluation of criteria that will include safety and risk factors, management of odor, and cost. It is highly likely that the County will decide to implement a combination of the options discussed in the above section based upon projected gas production rates.

THOUGH BEE RIDGE LANDFILL IS CLOSED AND THE GCCS MAY NO LONGER BE SUBJECT TO NSPS COMPLIANCE REQUIREMENTS, THE LANDFILL PROPERTY CONTINUES TO ATTRACT VISITORS WITH NATURE TRAILS AND A RADIO-CONTROLLED AIR FIELD. THE SUN HAS NOT YET "SET" ON BEE RIDGE LANDFILL.