Case #3448-18 AQMD Vs BFIC dba Sunshine Canyon Landfill,

September 3, 2025,

My name is Wayde Hunter. I am the President of the North Valley Coalition of Concerned Citizens Inc. I did submit a bound document this morning to the Clerk for your review that included, among other things, the most current posted AQMD chart (**Exhibit 1**) that the last Hearing Board found most helpful. Please note that the odor complaints have not gone down since the Stipulated Order of Abatement for Odors was issued March 19, 2025. In fact, in April there were 215, May 129, June 46, and July 101 and 12 NOVs issued. This level of odors parallels and even exceeds those experienced in 2016 when the last Abatement Order was issued and it was another year before those odors were reduced. That Order also included a late 9 a.m. opening, and a ban on stacking of long-haul trucks and curbside trash pickup trucks before 9 a.m.

I have also included a Technical Paper on Automated Landfill Gas Collection by Loci Controls (**Exhibit 2**) that specifies a site in the US in response to the Board's question at the previous Hearing on March 19, 2025, when I was asked "did I know of any sites where this technology had been employed". Answer: McCommas Bluff Landfill, Dallas, Texas, Oklahoma City Landfill, Oklahoma, Loess Hills Regional Sanitary Landfill, Malvern, Iowa, plus 5 other landfill gas-to-high-BTU operations but not identified due to confidential concerns. Apis Solutions is another company dealing in this technology.

Landfills typically have one landfill gas well per acre, but Sunshine Canyon has three wells per acre. Why the difference and why can't they capture all the gas and stop the odors. The amount of organics interred previously and currently being placed in the landfill is around 70%. Do the math... if they are accepting 2,100,000 tons per year of municipal solid waste (MSW) that is 1,470.000 tons of organics yearly. Based on past deposition it would appear to be at least 82 million tons of MSW are already in place, and the potential for another 25 million tons exists before 2037 landfill closure. That would amount to a staggering 57,400,000 tons of organic matter.

In the past we have heard from landfill personnel that only 65% of the gas was being captured. In order to collect gas and not create landfill fires the amount of air introduced into the landfill has to be manually tuned once or twice a month. This results at best in only about 80 – 85% of the gas being captured, and the rest is outgassed at the surface. The installation of an automated system could maximize the gas collection and allow the monitoring and control of each well to maximize gas collection and prevent fires.

However, as I previously submitted at the March 19, 2025 Hearing, BFIC/Republic has it all figured out. They take us all for fools, and in the future after there is hopefully a decrease in odors similar to the last Order for Abatement circa 2016, they will return to past bad practices and once again pile up violations and submit to, yet another Hearing Board's conditions cyclically every 5 + years, so that it all becomes "a cost of doing business", allowing them to accept another 25 million tons of municipal solid waste before closure and to gross billions of dollars more in revenue.

As the largest landfill in the City and County of Los Angeles it already bears a disproportionate amount of the City and County waste stream, it has the worst record for odor reports and violations (before 5 months Chiquita Canyon hydrogen sulfide problem), and it was 2-1/2 times worse than the other 15 landfills combined within the 10,750 square miles that the SCAQMD administers. The surrounding community deserves relief now, and suggestions for improvements both previously employed and new approaches should be taken.

You need to do more. The Stipulated Order does not go far enough. That is why at the very least there should be a change in the opening hours from 6 a.m. to 9 a.m., a ban on stacking of long-haul trucks and curbside pickup trash trucks before 9 a.m., a reduction in daily MSW tonnage to 5,500 or 6,600 tons per day, and yes, the installation of an automated gas collection system. In closing, you must require another date to reasonably assess the success or failure of the order to May 2026 as we believe a 6-month review in February or March will be too soon to determine if the remedial actions taken have covered what is historically the worst months of the year.

Wayde Hunter

President, North Valley Coalition of Concerned Citizens Inc. (NVC)

EXHIBIT 1

SCAQMD Sunshine Canyon Landfill Odor Complaints Reported to the AQMD and Notices of Violations

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

Sunshine Canyon Landfill, Facility ID No. 49111

Odor Complaints Reported to South Coast AQMD Alleging SCL; and Notices of Violation (NOV) Summary from 2009 through July 2025

Public Nuisance: South Coast AQMD Rule 402; Calif. H&S 41700

Year		Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec	Total NOVs	Total Complaints
2016	Complaints	100	188	185	181	30	74	52	85	206	193	206	59		1559
	NOVs	2	4	6	5	0	1	1	1	2	4	4	1	31	
2017	Complaints	200	254	274	116	19	10	14	30	44	27	22	18		1028
	NOVs	6	7	6	1	0	0	0	0	0	0	0	0	20	
2018	Complaints	32	18	21	9	5	9	16	6	33	21	2	36		208
	NOVs	0	0	0	0	0	0	0	0	0	0	0	1	1	
2019	Complaints	17	17	76	12	2	5	7	7	95	82	14	16		350
	NOVs	0	1	1	0	0	0	0	0	1	2	0	0	5	
2020	Complaints	29	17	12	33	98	20	23	82	105	121	18	22		580
	NOVs	0	0	0	0	2	1	0	1	3	4	0	1	12	
2021	Complaints	7	10	3	22	4	31	27	71	55	74	59	83		446
	NOVs	0	0	0	1	0	0	0	2	1	2	0	0	6	
2022	Complaints	158	84	58	38	17	40	12	40	85	64	25	32		653
	NOVs	5	1	0	1	0	2	0	0	2	1	0	0	12	
2023	Complaints	226	191	146	185	32	22	34	264	148	230	130	113		1721
	NOVs	6	7	5	11	1	0	1	9	4	6	7	4	61	
2024	Complaints	204	474	272	266	18	31	47	65	179	405	141	85		2187
	NOVs	9	17	9	6	0	0	0	0	5	11	6	2	65	
2025	Complaints	118	340	304	215	129	46	101							1253
	NOVs	3	12	9	6	4	0	2						36	

Total R402 NOVs Issued to Date

Total Complaints * 18,399

Total R402 NOVs Issued ** 412

* Includes 8,414 Complaints from 2009 through 2015

** Includes 163 NOVs from 2009 through 2015

*** Includes eight NOVs from 2011 through 2015

August 6, 2025

	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec	
2016	0	0	0	0	0	0	0	0	0	0	0	0	0
Rule													
2017	0	0	0	0	0	0	0	0	0	0	0	0	0
Rule													
2018	1	0	0	0	0	0	0	0	0	0	0	0	1
Rule	3002, 431.1												
2019	0	0	0	0	0	0	0	0	0	0	0	0	0
Rule													
2020	0	0	0	0	0	0	0	0	0	0	0	0	0
Rule													
2021	0	0	0	0	0	0	0	0	0	0	0	0	0
Rule													
2022	0	0	0	0	0	0	0	0	0	0	0	0	0
Rule													
2023	1	0	0	0	1	0	1	2	1	0	0	0	6
Rule	403				402		403	403	403				
2024	0	1		0	1	0	0	0	0	0	0	0	2
Rule		1150.1			403								
2025	0	0	0	0	0.	0	0					0	0
Rule													

Total Other NOVs Issued***	17

* Includes 8,414 Complaints from 2009 through 2015
** Includes 163 NOVs from 2009 through 2015
*** Includes eight NOVs from 2011 through 2015

August 6, 2025

EXHIBIT 2

Technical Paper on Automated Landfill Gas Collection by Loci Controls

Automated Landfill Gas Collection Improves Operations and Increases Revenue for one of the Largest High-BTU Landfill-Gas-to-Energy Sites in the US

Technical Paper

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Abstract

Dallas Clean Energy McCommas Bluff, LLC ("DCEMB") operates one of the largest landfill gas-to-high-BTU projects in the United States at the McCommas Bluff Landfill in Dallas, Texas.

Loci Controls ("Loci") is the leader in automated landfill gas collection. Loci's products and services provide remote wellfield control through a cloud-based software application that maximizes landfill gas collection. Loci products have been installed at over 20 projects, including landfill gas-to-electricity projects, and Loci is currently providing automated landfill gas-collection services to six operational landfill gas to-high-BTU operations.

This paper highlights a case study where Loci provided automated landfill gas collection to DCEMB at the McCommas Bluff Landfill. In July 2017, Loci installed landfill gas-collection hardware, controlling 20% of DCEMB's gas flow and operated those 60 wells for a year. After reviewing the year's performance, the data on the aggregate flow was not consistent with the flow trends observed at the plant. The Loci wells were showing approximately 20% improvement in aggregate, but the plant was not reflecting this trend (in fact, DCEMB reported that they were seeing a decrease in flow at the plant). However, upon further investigation, it was discovered that operating only a small percentage of the wellfield, does not effectively manage the system's gas flow, and wells that are tuned more frequently with automated tuning may have been stealing gas from neighboring wells and not increasing the overall flow captured. Furthermore, with only this partial installation in place, it was unclear whether the overall gas collection on the remainder of the wellfield was trending in the right direction. Therefore, Loci and DCEMB agreed to run a trial on 75% or greater of the wellfield gas flow to see if that would deliver increased flow at the plant level. Loci installed landfill gas-collection hardware on 200 wells and began operating them in December 2018. As soon as Loci's automated gas-collection operation commenced on this larger scale, there was a marked improvement in gas collection when compared to the same month's performance the year prior, with a 24% average improvement in MMBTUs captured from December 2018 through March 2019. Following this latest trial, in April of 2019, DCEMB and Loci Controls entered into a 3-year agreement to continue operating the 200 wells, controlling approximately 75% of the wellfield's gas flow.

Background

Automated Landfill Gas Collection

Founded in 2013 by MIT engineers, Loci Controls is the first company to provide automated landfill gas collection. Loci utilizes patented and patent pending technology and control algorithms to monitor and control the landfill gas -collection process. Through continuous monitoring and control of the landfill gas-collection system, Loci increases gas-collection system efficiency. Loci increases methane collection, gas quality, and profits for landfill gas-to-energy project operators. Through the use of wellhead monitoring and automated control, both plant and employee productivity are also improved, and there is a significant reduction in man-hours spent manually tuning wells in vast wellfields. Loci's products and services are proven to improve gas-collection efficiency while reducing fugitive emissions and odors emanating from landfills.

The landfill gas-collection system consists of a large number of interconnected vertical gas-collection wells and horizontal pipes in trenches. Loci continuously monitors collection wells and makes continuous, incremental valve adjustments to maximize the collection of methane from the whole wellfield. Each Loci wellhead-mounted product includes a NIST traceable calibration gas bottle and on-demand pressure regulator, which allows for gas-composition sensor calibration on an automated, or on-demand basis. Additionally, Loci uses aggregate gas composition measurement equipment, such as gas chromatographs, and/or precision gas meters as top-level automation control. This ensures that aggregate gas quality meets the plant's processing requirements. While each landfill has a unique operating environment, Loci's automated gas-collection system has proven to increase gas collection by 10% or more, all while improving the productivity of plant and on-site personnel, and mitigating the environmental, health, and safety risks by reducing the number of wellfield technician man hours spent in the landfill, and associate

Loci's products and services use wellhead- and header-mounted hardware, connected via cellular networks to its WellWatcher• user interface and analytics platform. Working with personnel on site, Loci gas-collection analysts provide remote oversight of the landfill gas-collection process. In addition, Loci provides on-site support to help its customers optimize the overall gas-collection and gas-to-energy processes.

Loci Controllers and Guardians are wellhead-mounted products with an onboard sensor package that remotely monitors pressure, temperature, system vacuum, flow, oxygen, carbon dioxide, methane, and balance gas (calculated). The Controller unit is designed for high-flow wells (>15 SCFM) at LFG-to-high-BTU projects where the performance requirements and value of incremental gas collection is greatest and required precision with all measurements is down to tenths of a percent. The Guardian unit is designed for lower flowing wells at high-BTU projects or for collection wells on gas-to-electricity sites where the performance requires precision down to the percentage point. Both the Controller and the Guardian include an automated flow valve that regulates the flow at each individual well.

To optimize gas-collection system efficiency, algorithms are used to make fine-tuning adjustments on individual collection wells on an ongoing basis. Automation is also used to make simultaneous adjustments to multiple collection wells in response to changing gas composition as measured at the plant. In addition, Loci utilizes monitoring-only Sentry devices, which are mounted on individual gas headers to provide aggregate gas composition from sectional areas of the landfill.

Dallas Clean Energy McCommas Bluff, Dallas, Texas

The McCommas Bluff landfill in Dallas, Texas began accepting waste in 1980, is an open site, and has approximately 50 million tons of waste in place. The landfill is owned by The City of Dallas. Dallas Clean Energy McCommas Bluff, LLC (managed by Energy Power Partners and its affiliates), owns the landfill gas rights, the landfill gas-collection and control system (GCCS), and the landfill gas-to-high-BTU pipeline injection plant. The gas-collection project has been in operation since 2000. This project generates Renewable Identification Numbers (RINs) from the methane injected into the pipeline as part of the Renewable Fuel Standards Program.

The McCommas Bluff landfill has 390 vertical gas-collection wells and 80 horizontal gas collectors, for a total of 470 gas-collection points, with average LFG collection of 10,000 SCFM of landfill gas. The landfill has been manually tuned historically, with typical gas composition of the landfill gas at the inlet being no less than 55.2% methane. To meet pipeline injection requirements, a minimum of 950 BTU, <0.25% O_2, <1.5% Nitrogen, and <3% CO_2 is required.

The DCEMB plant does not have a Nitrogen Rejection Unit, so nitrogen must be controlled in the wellfield through the collection process. The plant uses a proprietary vacuum pressure swing adsorption (VPSA) system processing technology. At the plant, the LFG is compressed to over 100 PSIG and sent through a pretreatment system to remove moisture and trace constituents. The gas is then processed through the VPSA system to separate carbon dioxide from methane. In this highly automated process, the gas follows a sequence of adsorption, high-pressure rinse, depressurization, evacuation, and re-pressurization steps. The result is a gas stream of pipeline-quality methane.

The plant has the capacity to process over 15 million cubic feet of LFG into eight million cubic feet of pipeline-quality methane per day; enough to supply the needs of up to 20,000 homes. DCEMB delivers the gas into the Atmos Energy Pipeline Company distribution pipeline system.

Project

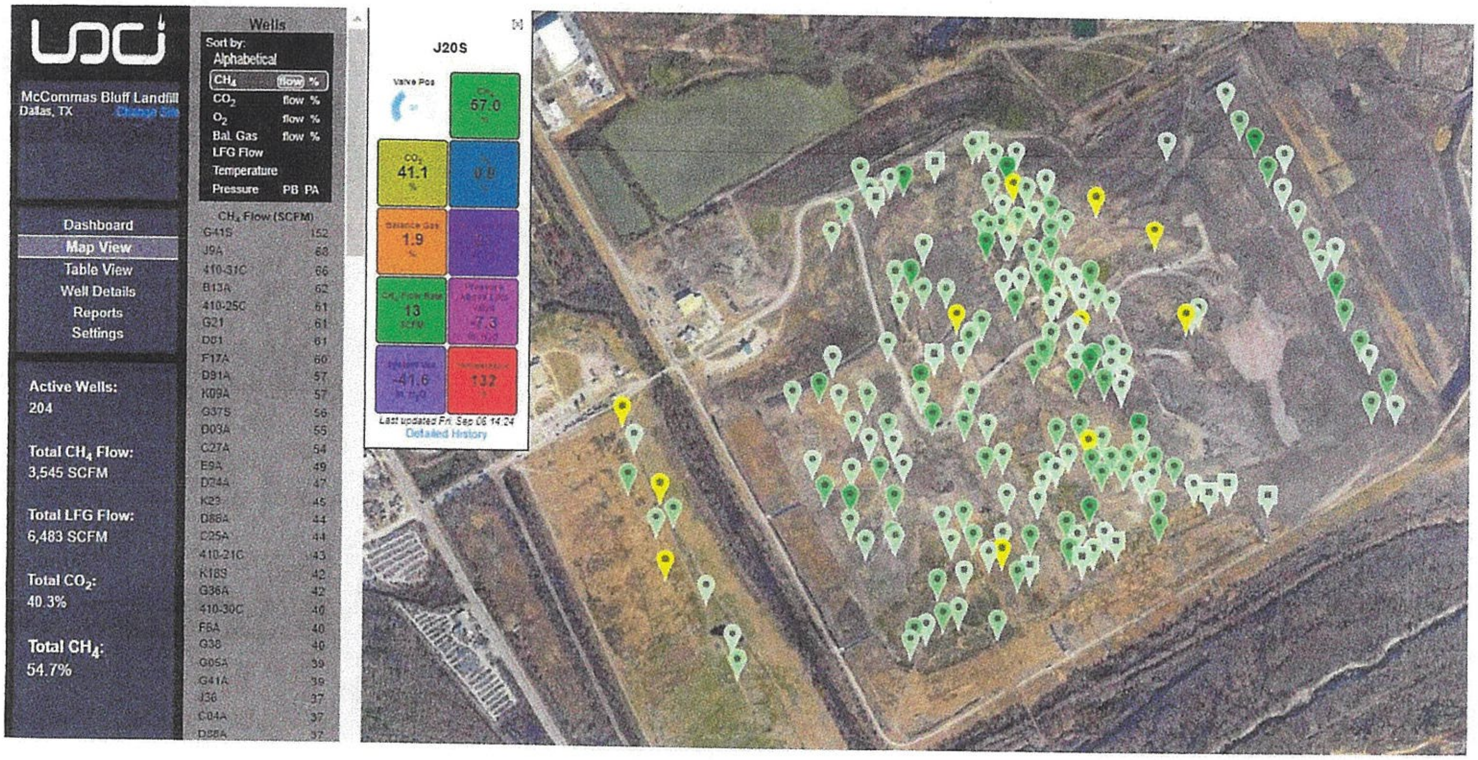
Automated Landfill Gas Collection on Majority Flow

In the summer of 2017, Loci and DCEMB worked together to deploy an automated landfill gas-collection system at the McCommas Bluff Landfill in Dallas, TX. Loci deployed 60 Controllers, and 11 Sentry units to provide control of 20% of the total flow with the automated gas-collection system. Controllers were deployed on wells with historical performance above 15 SCFM of flow. Ten Sentry H units were installed on key header locations to monitor gas quality from sections of the wellfield and aid in troubleshooting of air intrusions from wells on which Loci did not have Controllers installed. The remaining Sentry unit was deployed to monitor inlet gas by relaying the inlet GC readings in real time. The Sentry was used to make a direct connection to the ABB PGC 1000 Gas Chromatograph ("GC") at the EPP plant to monitor aggregate gas quality at the plant as a top-level control in the Gas Composition Threshold Automation. Installation on 75% of gas collection, plus the data connection to the GC at the DCEMB plant, allowed for optimal operation of the automated landfill gas-collection system.

Starting in October 2018, Loci automated landfill gas collection was expanded to 200 collection wells, representing 70% – 80% of the total gas collection from this landfill. The 10 Sentry header-monitoring products remain for this expanded installation.

Photo 1: Loci Controller unit on well at the McCommas Bluff landfill in 2018

Photo 2: Loci WellWatcher• Map of DCEMB wellfield with data shown for a sample well.



Large Site with Challenging Access

As one of the nation's largest landfill sites, and with the permitted area covering 965 acres, maintaining and tuning the gas-collection system at DCEMB has historically been challenging. It is a 2-mile drive to the far side of the landfill from the plant/flare station, with 470 collection points and an estimated 37 miles of gas-collection piping. The waste footprint currently covers approximately 480 acres, with another 53 acres of new cells ready to be placed into service. The landfill brings in ~6,000 tons per day via 1,800 trucks per day, so the work face and haul roads are constantly moving.

In addition to the sheer size of the site, the landfill design poses several management challenges. Most of the plateau surface of the landfill is flat, making it difficult to maintain adequate fall on the gas-collection piping, resulting in condensation buildup in the pipes. Older areas of the landfill that have settled is an ongoing process, requiring that landfill gas wells constantly need to be disconnected, raised, and later re-connected to the gas-collection and control system. This also entails frequently relocating the gas piping. Additionally, the landfill lacks a permanent cap, historic waste compaction is low, and the soil cover throughout is fairly porous, facilitating air intrusion. The flat plateau and porous cover also facilitate the infiltration of stormwater. With a highly permeable soil cover, gas quality is also very sensitive to changes in ambient atmospheric conditions, such as barometric pressure and temperature swings.

Prior to retaining Loci, DCEMB's internal goal was to manually tune each well twice per month. Unfortunately, DCEMB's technicians often get diverted to resolve emergencies encountered in the operations and maintenance of the gas-collection and control system due to the dynamic and expansive characteristics of the site. As a result, wells were often only tuned once per month, if subsequent extreme weather made accessing the wellfield impossible. Given the size and complexity of the site, DCEMB's staff also did not have the time or resources to analyze the historic manual well-tuning data, or spot trends and anomalies in the monthly well-tuning readings.

Gas Composition and Flow Tuning Challenges

Prior to retaining Loci, DCEMB's technicians would tune each well so that it would meet DCEMB's RNG plant's incoming gas spec during each and every hour up until the next tuning event. This effectively meant that each well was tuned to the worst-case condition that could historically be expected to occur during the next 720 hours (in the case of *monthly* tuning). As a result of this static tuning program, wells were often tuned to a lower flow setting in order to be conservative in terms of gas quality, meaning that a fair amount of additional "in spec" gas was not collected during many hours of the month when it was available.

During dynamic weather events, the impact of a static tuning regimen posed even greater challenges. In anticipation of a high-barometric front approaching the area — typical of the winter months — DCEMB would implement system-wide adjustments to the wellfield vacuum. This typically entailed simply dropping the vacuum at the plant and involved some guesswork. Because these changes were applied uniformly across the site and were implemented primarily based on manual estimations, flow drops were substantial, gas quality was inconsistent, and plant shutdowns were fairly frequent. In the three years prior to incorporating Loci's 200 units, DCEMB experienced significant total RNG plant downtime due to weather-induced poor incoming gas quality, with 17 hours of downtime in the 2015-2016 winter, 125 hours of downtime in the 2016-2017 winter, and 17 hours of downtime in the 2017-2018 winter (Nov-March).

Operational Challenges

The greater Dallas, TX area typically experiences a few rainy seasons throughout the year. These periods of significant rainfall cause huge areas of the (flat) plateau on the landfill to become inaccessible. Many of the access roads to the wells become impassable due to mud and deep ruts. DCEMB staff would often have to wait up to a week for the areas to dry out so that the wells could be reached.

Additionally, oxygen intrusions frequently resulted in a multi-day effort to find the source of the problem before field technicians could repair it. If a Fernco coupling or hose breaks loose on a wellhead, the ensuing oxygen intrusion will typically contaminate the entire gas flow and shut the RNG plant down. Similarly, air intrusions affecting gas-header pipes, lateral pipes, or other sections of the landfill gas-collection and control system would also lead to plant shutdowns. Prior to retaining Loci, the DCEMB staff would have to manually inspect all 470 wells and 37 miles of pipe spread over 500 acres in order to find the source of a problem. This effort frequently took many hours or days and was made even more difficult when such an incident occurred after dark.

Results

Automation of landfill gas collection on 200 wells, affecting approximately 75% of flow, has been in continuous operation since December 2018. The primary goals of the project for DCEMB are to increase overall CH_4 flow and MMBTU/sales, and to minimize plant downtime due to the landfill gas-collection system not meeting gas composition specifications. The results have been significant and compelling. Overall, MMBTUs/Day sold has increased by 16% from December 2018 – July 2019, compared to the same 8 months in the prior year. The total plant downtime due to landfill gas quality delivered to the plant not meeting specifications has been <u>reduced to **zero**</u> over the 2018-2019 winter.

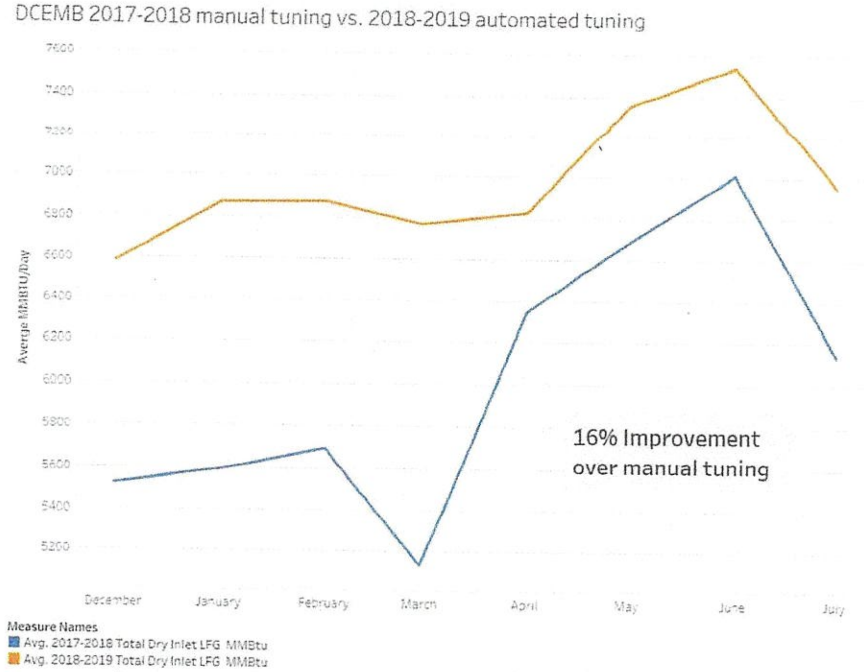


Figure 1. Sustained Increased LFG Collection Over Manual Tuning.

24/7/365 Monitoring and Control

With the Loci system now in place, site personnel can access data on the monitored wells at any time, freeing up technician time for higher value-added tasks and improving operations. DCEMB now only has to tune the wells not controlled by Loci approximately once per month, while Loci provides continuous monitoring and control of the Loci-controlled wells to maximize methane flow and maintain gas quality. DCEMB's technicians are now freed up to perform necessary wellfield operations and maintenance work without the fear of gas-quality deterioration leading to a potential shutdown of the RNG plant. DCEMB estimates the savings being the equivalent of two full-time landfill gas technicians (although they have not reduced their staff, nor do they plan to, as knowledgeable wellfield technicians are highly valuable and there remain plenty of other tasks to maintain the wellfield than wellfield tuning).

Additionally, Loci has been able to analyze the site data and make recommendations for improved performance and design. For example, Loci identified certain wells where the 2" wellheads were restricting the available gas flow. DCEMB replaced the 2" wellheads with 3" wellheads, thereby increasing the available gas flow and subsequent RNG sales. Loci and DCEMB also installed the appropriate orifice plates on wells that had very inconsistent and potentially inaccurate tuning readings. The proper orifice plates are now providing DCEMB with accurate and reliable data.

Increasing the wellhead size from a 2-inch wellhead to a 3 inch wellhead when the methane composition is above 56%, the oxygen and balance gas is low to none and the valve is mostly 100% open, allows the well to be operated at its flow potential. On average in these cases a well's flow can be increased another 10-15%, for example from 90 SCFM to 110 SCFM. Each well is unique and results very. The idea is to be able to increase flow to the point balance gas and oxygen as detected and so the well can be tuned at the appropriate position to control composition.

Gas Composition and Flow

Loci's original automated gas-collection algorithm uses frequent (hourly) gas-composition and flow measurements at each collection well to make small incremental valve adjustments. This automatic "fine tuning" of each collection well results in optimized CH_4 flow, while maintaining individual well-gas composition requirements within balance gas (N_2) and O_2 thresholds.

While the previous manual-tuning approach required tuning to worst-case conditions throughout the month in order to ensure high-quality gas for the duration of the month, Loci's automated tuning protocol has unlocked new potential in terms of gas flow while ensuring that composition thresholds are always maintained. With continuous tuning throughout the month, the automated tuning protocol can be much more responsive than manual tuning. The Loci automated control algorithms pull harder on a well when conditions allow for increased methane flow and acceptable gas composition, and then reduce the vacuum applied to the well when needed. As a result, DCEMB can maintain the gas quality with high precision to the required gas spec for the RNG plant and downstream sales gas pipeline specification.

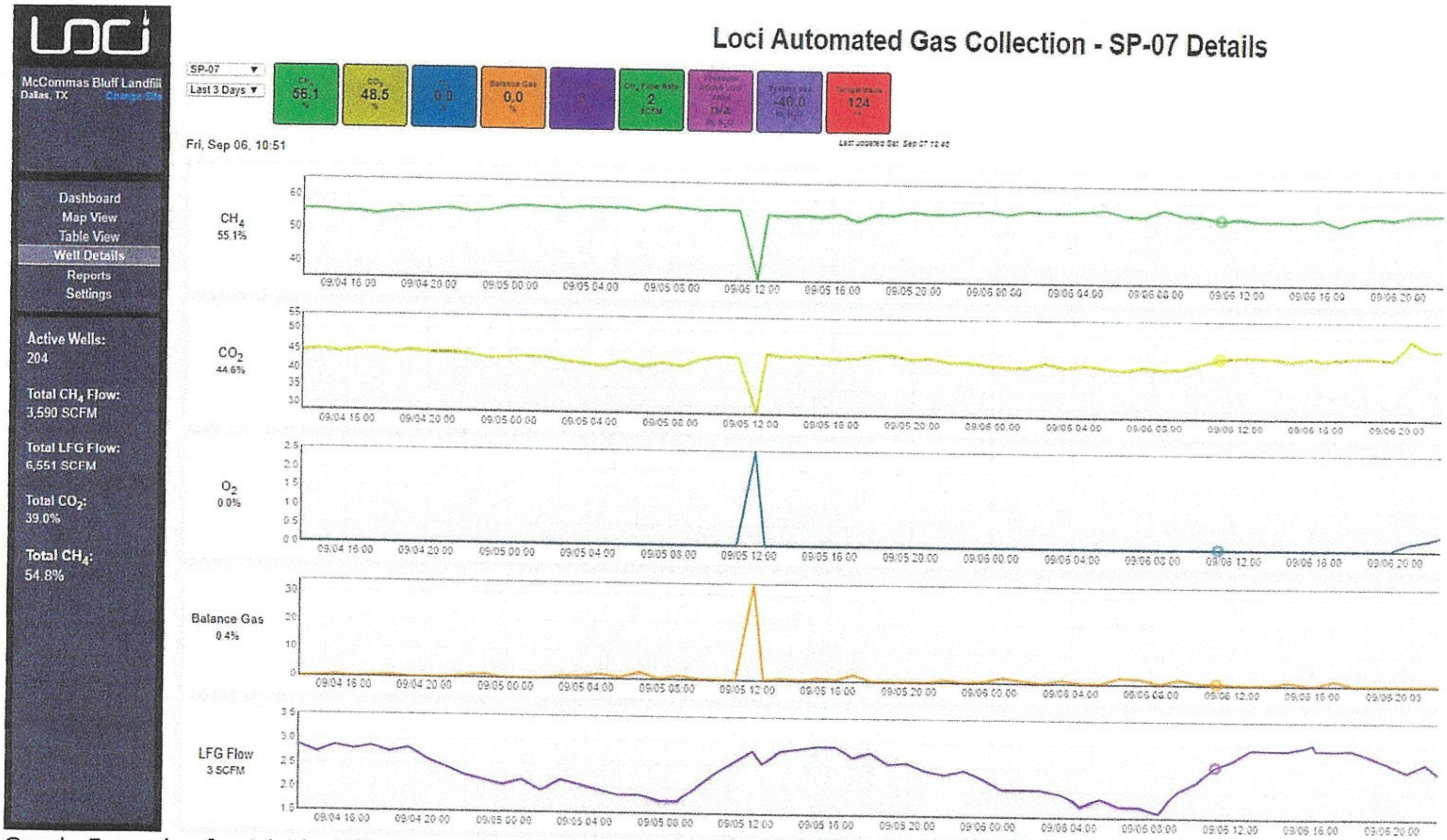
In addition to individual well readings, the Loci algorithm uses the plant GC data on aggregate gas composition from the entire wellfield, to optimize the landfill gas-collection process. Adjustments to valve positions on each individual collection well are weighted by gain factors, which reflect how responsive an individual well's gas composition is to a given valve adjustment. For some collection wells, small valve adjustments have a large impact on gas composition; for other collection wells, larger valve adjustments are required to change the gas quality. With full visibility into the plant's gas specs, the Loci algorithm can also make calculated trade-offs to increase flow from particular wells, because even if an individual well is temporarily "below-spec" on gas quality, Loci can maintain aggregate composite flow into the plant within spec and ensure the well is operating safely. By adopting this approach, DCEMB has thus eliminated a huge portion of the "factor of safety" buffer that it had previously incorporated into its process, which restricted the volume of sales gas.

Furthermore, the gas DCEMB was selling was oftentimes generously exceeding the minimum gas-quality standard that DCEMB is obligated to meet with the pipeline company with no financial upside. Loci's precision tuning approach has contributed to the recovery and sale of 0.5% to 35% of additional MMBTUs for a given day compared to the same day the prior year under DCEMB's prior manual-tuning program.

Loci has also used the aggregate gas composition readings to enable a rapid response algorithm to address changes in barometric pressure or other acute weather events. When the BTU value at the GC approaches either the high or low limits of a desired range, or process set points, Loci's automated system makes batch valve adjustments in the wellfield to stabilize the BTU values and maintain them within the optimal range. This has resulted in the ability to maintain gas quality specs at a much higher rate than the previous approach of manual adjustments to the full wellfield. During the first winter (Nov. 2018 – Mar. 2019) that Loci controlled the majority of the gas flow (with 200 units installed), DCEMB had zero hours of downtime due to weather-induced poor gas quality. This translated into increased RNG sales.

Operational Benefits

Loci's automated landfill gas-control system has provided new visibility into site operations, enabling both rapid problem solving in real-time, as well as new insights into the overall operating environment. Continuous well tuning is provided even during the worst weather conditions when manual tuning would be impossible. DCEMB can instantly see, on the real-time WellWatcher web screen, which collection well or group of wells has experienced a failure resulting in air intrusion so onsite staff can to go directly to that well to repair it. This translates into little-to-no plant downtime, as the Loci unit can also simultaneously start closing the control valves on other collection wells to compensate for a single struggling collector, until DCEMB staff arrives for the repair. This also provides savings in labor costs, as no time is wasted searching for the culprit well. Loci header monitors are located on the main subheaders and instantly notify DCEMB as to which area of the landfill they should focus their attention on. This translates into minimizing plant downtime and increasing RNG sales.



Graph: Example of quick identification and correction

In addition to these benefits from increased data and site visibility, the automated gas-collection and service package provides several additional benefits. A Loci employee provides on-site support and is an additional set of eyes/ears that might spot something awry in the wellfield that DCEMB staff may have missed. Loci service is available to address/monitor an unusual circumstance or event. Loci identifies and alerts DCEMB to variations in gas quality at a given well (where DCEMB technicians might never notice such on their own). Since Loci is controlling 75-80% of the total gas flow, DCEMB has found that they can get by only tuning the other "non-Loci" wells once per month, although the goal is to read all collector locations twice a month. This also translates into labor savings and frees up the DCEMB staff to work on more pressing O&M-related tasks. In addition, Loci provides more stability in the day-to-day gas flows than DCEMB staff could manually provide (as staff wouldn't have time to revisit wells after making tuning adjustments). The result is that the RNG operation is smoother and employee satisfaction has increased as consistency has improved, callouts have decreased, and problems are readily identifiable.

Conclusion

The use of automation to optimize landfill-gas collection and improve gas quality has lead to a significant ROI for DCEMB. Through constant monitoring and automatic well tuning, DCEMB's technicians are able to monitor the entire wellfield in real time and quickly respond to emergencies should they arise, drastically reducing labor costs. Plus, with a 24% average improvement in MMBTUs captured from December 2018 through March 2019, Loci's initial trial period was a resounding success. These results demonstrated a substantial value-add for DCEMB's business, leading to a 3-year commitment that promises to be profitable for Loci Controls and DCEMB alike.

About the Authors

Energy Power Partners

Renewable Investments With Sustainable Results

Mark C. Messics, P.E., Director – Field Optimization and Development,
Mark has a B.S. in Civil Engineering and an MBA from Lehigh University. He has over 30 years of experience developing, permitting, constructing, and managing landfill gas-to-energy projects. He has worked at over 140 landfills, with prior employers including Waste Management, Inc., DTE Biomass Energy and PPL Renewable Energy. Mark has been with EPP Service Company since November 2015, when Energy Power Partners acquired the former PPL Renewable Energy power plants. His current focus is on optimizing landfill gas production at the City of Dallas' McCommas Bluff Landfill, where EPP operates the largest high-BTU plant in the country. He is a registered professional engineer in Pennsylvania and resides near Allentown, PA.

Energy Power Partners

Renewable Investments With Sustainable Results

Adam Andara, Operations & Maintenance Supervisor
Adam brings a wealth of knowledge and 20 years of experience in the landfill gas industry with him to EPP Services. He got his start in 1999 at RSS Environmental managing SEM for landfills in Orange and San Bernardino Counties. In 2000, he accepted a role with GSF Energy as a welltech at Olinda Alpha Landfill in Brea, CA. As one of two technicians at the 565-acre site, he managed and operated a gas-collection system with over 400 gas-collection points. In 2009, while still with GSF Energy, Adam relocated to North Dallas, TX, where he helped start and manage a 2-engine Cat 3520 power generation site in McKinney, TX, before helping to start a SECOND similar site in Tulsa, OK — all while managing the gas-collection system at both plants. In 2016, he joined EPP Services as the Operations & Maintenance Supervisor overseeing wellfield and daily plant operations at the Dallas Clean Energy McCommas Bluff high BTU gas processing plant.

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THE LEADER IN AUTOMATED
LANDFILL GAS COLLECTION

Nicole Neff, Landfill Gas Collection Project Manager and Sales
As the Landfill Gas Collection Project Manager for Loci Controls, Inc., Nicole is responsible for daily oversight of Loci's systems across the U.S. and has been instrumental in paving the way for remote and automated landfill gas collection and control. Nicole has worked in the management of environmental spatial analytics for 7 years. Loci's innovative approach to managing LFG collection is the perfect platform for applying her passion; she enjoys using spatial relationships with environmental data to maximize LFG collection and be a good steward of our environment. She holds a Master of Civil Engineering from Norwich University and a Bachelor of Environmental Science from the University of Washington.

8. Best Practices for Landfill Gas Collection System Operation and Maintenance

Photo credit (left): Smith Gardner, Inc.

A landfill's gas collection system (GCS) requires frequent monitoring and operational adjustments to optimize its performance to meet its design and operational goals. Proper operation and maintenance (O&M) can minimize air leaks in the system and reduce the amount of time a system is taken down for repair. Appendix A provides a series of flowcharts presenting typical wellhead monitoring procedures and operational adjustments for oxygen, temperature, methane, flow and vacuum. In addition, proper health and safety considerations and training are necessary to ensure the well-being of GCS operators.

This chapter provides an overview of GCS O&M best practices. GCS operators can use this information to better understand options to ensure a well-maintained GCS to minimize surface emissions and system downtime and ensure the health and safety of employees. Each best practice may not be suited for a particular landfill so application must be determined on a site-specific basis. Information in this chapter is not official guidance; rather, it provides general information about options and considerations for GCS O&M. Landfill owners and operators are responsible for compliance with applicable regulations.

8.1 System Vacuum

Blowers provide a consistent vacuum, often measured in inches of water column (in. WC), to convey LFG from individual wells, laterals and headers to a central location for combustion in a flare or energy recovery. Although the vacuum applied to individual wells may vary based on the function and location of each well or collector, the vacuum should remain relatively stable over time at a given point in the collection system. Large fluctuations in vacuum at the same collection point in the system suggest potential concerns with condensate buildup or a blockage in the system.

Commonly, blowers use a pressure sensor and a variable frequency drive (VFD) attached to the blower to control and stabilize the vacuum applied to the GCS. The pressure sensor measures the vacuum on the header which, via a programmable logic controller and VFD, controls the frequency and voltage supplied to the motor. This in turn controls the speed at which the blower impeller(s) operate. The VFD can speed up or slow down the blower to maintain a consistent vacuum on the GCS. With such controls, technicians can more accurately tune each well, knowing that the applied vacuum from the system is relatively consistent. Adjustments to a well should be made in small increments and then re-monitored to assess how those changes affect the operations. Large adjustments can lead to wide swings in operational adjustments at the well and at adjacent extraction points.

The vacuum applied to the GCS by the blower must be sufficient to provide the furthest point of the landfill with a minimum vacuum, typically 5 to 15 in. WC at full flow conditions. However, the vacuum cannot be so high that it becomes difficult to tune the wellfield or compromises the condensate management system. Systems are typically designed for a vacuum ranging from 30 to 60 in. WC or more, depending upon the overall size and number of LFG extraction points in the wellfield. The vacuum that the well applies to the waste is adjusted at each individual wellhead and must balance the need to achieve a high gas collection efficiency to avoid odors and surface emissions, while also avoiding excessive vacuum that can lead to air infiltration.

Control System Types

Beyond identifying and managing the physical conditions of the wellfield, it is just as important to understand the control goals. Systems are typically set up in one of three control modes: vacuum, flow rate or heat content (in British thermal units or Btu). The control setup is an important consideration in wellfield operation because operators need to understand how tuning a single well can affect the rest of the system and therefore its impact on meeting the overall objective.

- Vacuum control – The control system maintains a constant vacuum while allowing the LFG flow rate and heat content to vary. In this situation, vacuum at every well is controlled individually and does not affect the vacuum at the other wells. Once a wellfield is tuned, the vacuum should stay very stable. Vacuum control, however, requires flexibility of the end use to handle variable flows and heat content levels.
- Flow rate control – The site sets a desired LFG flow rate at a flow meter and the VFD maintains this rate. In this situation, when the flow rate at an individual well is increased, the flow rate at every other well will decrease slightly to maintain constant flow. This operating situation is not ideal and typically occurs only for short periods of time when the system has reached a minimum or maximum limit for the LFG end use.
- Heat content control – This type of system is often used for landfills with an energy project and is the most complicated system for tuning. Every time an individual well is adjusted, the flow and vacuum for other wells in the system also change. For this reason, it is important for operators to work slowly and make small changes. Heat content control systems are the easiest to make significant changes to the gas quality, whether positive or negative. It is the system type typically used for beneficial-use wellfields, because it incorporates not only parameters for regulatory compliance (i.e., vacuum application and gas quality) but also parameters needed for an effective LFG energy recovery project, including volumetric flow and fuel value.

Well Tuning

Operating a GCS is a balancing act of applying vacuum to a collector to obtain the largest radius of influence possible and thus collecting as much LFG as possible, while not pulling too hard on the collector so as to avoid air intrusion through the cover, into the waste mass and into the LFG collector. Over-pulling (applying excess vacuum) on an LFG collector can lead to excessive oxygen in the waste mass, which could reduce methane production or in severe cases start a subsurface oxidation event (fire). Applying too little vacuum does not create a large enough radius of influence around the collector, preventing overlapping radii of influence with the adjacent collectors and allowing fugitive LFG to escape through the cover.

The operational goals of a wellfield are typically determined during the design of the GCS since the goals of the system will influence both its design and operation. Common end goals of a GCS are:

- Maintain compliance;
- Generate electricity;
- Produce medium-Btu gas; or
- Produce renewable natural gas (RNG).

Because these goals have very different tuning approaches, it is difficult to meet all the goals at the same time. However, with the primary goal in mind, operators can tune the wellfield to meet the needs of the system as a whole.

To maintain compliance by controlling odors and gas migration, operators aim to optimize LFG collection at each well. This may result in a small amount of atmospheric air infiltrating the surface of the landfill during attempts to keep the entire landfill under vacuum and maximize the influence of each well. In a typical landfill, tuning for 48 to 52 percent methane content in the LFG will result in some infiltration of atmospheric air. Balance gas (nitrogen) may constitute 10 to 15 percent of the LFG with 0 to 2 percent oxygen. (See Identifying Air Leaks below for additional information on this topic.)

For the purpose of collecting LFG to supply an energy generation project, it may seem appropriate to increase the vacuum on the system as a whole or at individual wells to collect more gas on a flow basis. However, this approach causes two problems: (1) it pulls air into the landfill, diluting the LFG that is collected and reducing its heat content, and (2) it pulls oxygen into the waste mass, creating aerobic conditions that are not ideal for methane production. Instead, a balanced approach of maximizing the radius of influence without creating aerobic conditions is most effective. This often requires upgrading cover materials, installing new gas collectors and modifying wellfield tuning procedures.

Some types of energy generation facilities or other LFG end uses require a minimum quality of gas to meet either the contract or equipment requirements that further dictate how the system is tuned. The Solid Waste Association of North America (SWANA) developed a range of relative methane concentration target values based upon the goal(s) of GCS operation, as shown in Table 8-1.

Table 8-1. Example Methane Target Values[1]

Target (%)	Application
50-55	Interior wells for energy recovery
45-50	Interior wells where environmental control is important
40-45	Aggressively trying to control LFG migration
30-40	Interior wells where acute LFG emission problems are occurring (but there may be an increased risk of fires at some sites when operating in this range)
<30	Perimeter gas wells outside of refuse

Identifying Air Leaks

An air leak in a GCS is a problem that must be actively identified and repaired. Air leaks lower the gas quality for beneficial use facilities and can also cause individual wells to underperform by diluting the methane concentration and possibly requiring the applied vacuum to be lowered during well tuning to meet operational goals. To quickly identify these air leaks, operators should look for 4 parts balance gas to 1 part oxygen in all gas readings (4-to-1 ratio), the ratio of balance gas to oxygen in the atmosphere.

Nitrogen is typically not produced during the generation of LFG so any nitrogen present in a gas well has been pulled into the system from the atmosphere. A typical well that is balanced will be operating at 2 to 10 percent nitrogen (monitored and read as balance gas), indicating that the well's vacuum is pulling to the surface but not introducing excessive atmospheric air. The exact target for nitrogen content should be based on the operational goal of the GCS (e.g., for compliance alone or compliance and a beneficial use

[1] Solid Waste Association of North America. Landfill Gas Operation & Maintenance Manual of Practice, Version 1.0, revision September 2002, Table 9.3.

project). Nitrogen/balance gas targets assume that the air intrusion is through the waste mass and not an air leak in the collection system itself.

Wells that are operating above 20 percent balance gas should be corrected immediately, because this can affect the methane-producing (anaerobic) bacteria by creating aerobic conditions, thereby reducing methane production. Additionally, the transition from an anaerobic to an aerobic environment is exothermic (i.e., produces heat). If atmospheric air intrusion is allowed to persist, the waste mass may begin to oxidize locally, risking a sub-surface fire. This negatively affects not only local LFG production but also the structural integrity of the GCS and the cover system.

Ranges of residual nitrogen and their likely impacts are provided in Table 8-2. These interpretations can be incorporated into the tuning scheme for the wellfield to increase the effectiveness of GCS operations.

Table 8-2. Interpretation of Residual Nitrogen in LFG[2]

Residual Nitrogen (%)	Interpretation
0-6	Normal to under-stressed; typical for a wellfield supporting an RNG project where low nitrogen is desirable
6-12	Normal desirable operating range without compromises for problem areas
16-20	Excessive nitrogen, may be necessary for aggressive perimeter migration control, side slope emission control or where other compromise is required
>20	Over-stressed; this level of nitrogen should be avoided if possible, except for aggressive emission control

Identifying Vapor Locked Wells

Vapor locked wells are restricted by some means and do not allow for sufficient gas flow as designed. The wells can be full of liquids or be pinched, broken, plugged or fouled and these conditions can be identified by interpretation of collected wellfield data. Vapor locked wells have a header vacuum that is very close to the applied vacuum because flow creates a pressure drop across the wellhead. These wells also typically have high methane quality, showing ample LFG available but minimal flows.

Issues Due to Waste Settlement

Waste filling practices in areas of the landfill with a GCS already in place can lead to negative impacts on the GCS from damage caused by operations or settlement. Landfills that accept large amounts of waste tend to have more settlement of the waste mass, which can negatively impact GCS components by creating low points in piping or blockages. Typically, the GCS at these sites may require more frequent component inspections and a plan for replacement to maintain operational goals.

Similarly, sites that fill large flat areas across several cells gain airspace from settlement over time, but the GCS tends to have shallow wells, laterals with minimum slopes and high liquid infiltration causing higher GCS operational costs. In these situations, GCS components may become buried and ultimately

[2] Solid Waste Association of North America. Landfill Gas Operation & Maintenance Manual of Practice, Version 1.0, revision September 2002, Table 9.4.

unusable. Portions of the GCS at these sites should be considered sacrificial as they may need to be repaired or replaced multiple times during the life of the landfill.

8.2 Managing Excess Liquids in Collection System

Moisture can become a major issue for gas generation, gas collection and slope stability when it becomes free standing liquid within the waste mass. Liquids in wells and within the landfill should be managed and removed regularly, even at sites that are operating under a liquids recirculation plan. If wells or lateral/header piping become flooded with liquids, they will not be able to extract the LFG and convey it to the flare or other equipment. A variety of techniques exist to monitor for flooded wells or piping, including simple observations to more advanced techniques.

The following general observations can indicate "watered-in" wells or piping:

- High well vacuum but low or no flow;
- Drops in header system vacuum from well to well;
- Audible surging of liquids, either at individual wells or in the collection lines between the wells when walking along the surface of the landfill.

More advanced monitoring techniques for liquids include:

- Checking liquid levels periodically in the wells;
- Measuring the liquid recharge rate in wells after pumping;
- Inserting a camera down the well to identify the depth of the water or other well damage;
- Adding submersible or "diver" dataloggers inside of problematic wells to allow a landfill operator to continuously measure and track liquid levels.

Preventing liquids from entering the GCS is the most practical and cost-effective solution. One inch of precipitation over an acre of exposed surface results in more than 27,000 gallons of potential liquid infiltration. A variety of operational techniques are available to reduce surface liquids:

- Apply alternate daily cover such as "Posi-Shell" and tarps in new cells that will not be in service for a long time.[3]
- Consider early partial closure of areas with geomembrane. Place temporary geomembrane caps over areas that will not receive waste for a long time and final cover on final slopes to eliminate rainwater percolation.[4]
- Maintain a smaller and appropriately sloped working face to limit precipitation intrusion.
- Avoid overuse of recirculation practices and consider limiting recirculation to surface spraying of active working face.

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3 Szczepanski, Mallory. 10 Tips for Preventing Landfill Leachate. July 2017. http://www.waste360.com/leachate/10-tips-preventing-landfill-leachate/gallery?slide=5.

4 Szczepanski, Mallory. 10 Tips for Preventing Landfill Leachate. July 2017. http://www.waste360.com/leachate/10-tips-preventing-landfill-leachate/gallery?slide=2.

Pumps

In some cases, pumping will be required, despite efforts to minimize surface water or other liquids from entering the landfill. Many systems employ pump systems within individual LFG extraction wells to reduce local zones of waste saturation and improve the operations of individual LFG collectors. Because LFG wells are typically the most permeable components within the waste mass, liquids tend to accumulate in these locations.

When liquids accumulate in wells, the elevated liquid levels within the well casing diminish the efficiency of the extraction well. As the liquid level rises within the perforated casing section, vacuum is applied to an increasingly smaller volume of waste. This not only reduces the potential volume of LFG that can be recovered from an individual well, but also increases the potential for air intrusion since more vacuum is applied to the top of the perforated casing section.

Pneumatic pumps are typically used to remove liquids from LFG extraction wells. They provide a slow (less than 2 gallons per minute), steady rate of withdrawal over a wide range of discharge head requirements. By using a slow withdrawal rate, the operator limits the potential for fouling the backfill by keeping the liquid velocity relatively low as it travels through the waste mass, thereby limiting the ability of the flowing fluid to carry fine particles.

Monitoring of the liquid levels, along with comparisons of changes in LFG recovery performance, should be continued on at least a monthly basis until a steady-state condition is achieved. Pumping may be required for an extended period of time, depending upon the degree of local waste saturation and re-charge from precipitation or other liquid addition. If a "maintenance level" of liquid can be achieved that does not require additional pumping, the pumping equipment may be removed for another installation.

Air Compressors

A pneumatic pumping system requires air compressors designed for continuous, industrial applications. Air compressors for LFG applications are typically oil-free screw compressors with relatively large receivers. The compressed air must also be conditioned to avoid filling the compressed air mains with condensate from the compression process. This requires an industrial-level air dryer and filtration system to maintain a usable air supply. Laboratory-quality compressed air is not required, however a uniform and "clean" air supply will increase the reliability of the pumping system and reduce costly maintenance of both the compressed air supply system as well as pumping components.

If the GCS includes pneumatic components that are critical for GCS operation, such as fail-close valves and a condensate management system at the blower station, then a backup or segregated compressed air system or the use of compressed nitrogen for emergency purposes may be necessary.

8.3 GCS Monitoring

A robust and proactive monitoring system, consisting of both physical inspection and analytical data collection techniques, can detect operational problems early and minimize system downtime. State and federal rules prescribe certain monitoring of a GCS, which should be viewed as minimum requirements. State or federal wellhead monitoring requirements may include:

- Surface emissions monitoring for methane;
- Vacuum present at the wellhead (i.e., less than 0.0 in. WC);
- Oxygen and nitrogen content; and
- Wellhead temperature.

For relatively high wellhead temperature readings (i.e., above 62.8°C (145°F)), federal rules require enhanced monitoring of other parameters including visual observations for subsurface fires, carbon monoxide content and methane content. For higher wellhead temperatures (i.e., above 73.9°C (165°F)), federal rules require monitoring of temperature down in the well in addition to the wellhead temperature.

Exceptions may apply to these thresholds in certain cases, such as when there is concern that applying vacuum to a well may exacerbate conditions where a subsurface fire is suspected. Additionally, positive pressure may be allowed in areas with a geomembrane or synthetic cover, provided that engineering calculations have been performed to determine the amount of allowable pressure that will not pose a risk of uplift and cap failure. Finally, these requirements may not apply to wells that have been permanently decommissioned, if LFG continues to be collected in the area.

Variances, in the form of higher operating values or alternative operating parameters may also be requested for approval to allow operating wells at higher temperatures. These requests must be supported by sufficient data to demonstrate that higher values will not pose a risk of subsurface fire or inhibit the production of methane.

In addition to minimum regulatory parameters above, flow rate should be monitored at all wellheads. A well may be under vacuum but not collecting any gas if leachate or condensate is covering the perforated zone. Total system flow and gas quality at the header should be monitored as well, as significant changes in header flow or quality can alert operators to issues in the wellfield that warrant investigation.

Closed landfills with final cover and a fully built-out GCS do not generally require the same level of attention as an active landfill and may be monitored on a monthly basis at a minimum. Voluntarily operated systems at a closed landfill may be monitored less frequently, although monthly monitoring continues to be recommended. Active landfills with partially installed systems may require more frequent monitoring. These systems are more susceptible to impacts from moisture (e.g., precipitation, leachate recirculation) due to potentially large areas of active filling and/or intermediate cover as well as air infiltration. Gas flow rates and quality may also vary due to atmospheric pressure changes. Additionally, waste filling operations may damage collection wells in active filling areas, requiring repair.

For wellfields supporting an energy recovery project, more frequent monitoring is generally recommended due to the financial incentive to maximize methane flow, not just LFG flow. Energy projects producing RNG require the highest level of wellfield tuning, to minimize air infiltration to the maximum extent possible.

Wellfield data should be collected and maintained in a database following each monitoring activity. Landfills with mandatory GCS operational requirements have as few as five days to initiate corrective action on wells exceeding certain compliance parameters, so early detection is critical. These data should be maintained for a minimum of five years, in order to observe trends over time and understand the impacts of GCS or landfill operations on gas generation and collection over time. For example, a landfill that recirculates leachate may experience a faster generation rate of LFG, as well as a more rapid decline, than predicted by LFG modeling.

Databases for wellfield data may be simple spreadsheets or data reporting tools included in many office software packages such as Microsoft® Excel or Access. Data may be filtered or sorted to view changing conditions and trends by wellhead over time, such as declining flow rates or increasing temperatures. Wellhead vacuum can be compared to header vacuum to identify wells that may be "watered-in." Conditional formatting within spreadsheets can help identify regulatory exceedances at a glance. Landfills with a larger, complex GCS may benefit from more robust data management software packages. These solutions may include Geographic Information Systems (GIS) functionality to generate maps depicting areas of high temperature, declining methane or other operational concerns. Automated graphing and report generation may be included as options for some of these packages to facilitate wellfield data trending and evaluation.

In addition to gas flow and quality trends over time, monitoring data can be used to identify unintended subsurface conditions in landfills that that may be caused in part by GCS operations, including subsurface reactions and subsurface oxidations (fires).

Subsurface reactions are seen in landfills where relatively deeper, wetter areas of waste experience an interruption in the anaerobic production of methane. These conditions tend to cause heat accumulation and inhibit methane production. Certain waste types, including ash and metals, may react exothermically as they corrode to produce additional heat. Rapid dewatering of deep wells may inadvertently introduce oxygen to the surrounding waste mass, further upsetting the anaerobic conditions. This subsurface reaction, not to be confused with subsurface combustion, forms products seen in the early aerobic stages of waste degradation, including fatty acids and hydrogen. These reactions also form positive pressure and carbonation of leachate in the well, leading to wellheads "popping off" and leachate foaming. Rapid localized settlement of several feet may occur around one or multiple wells during these reactions. In addition to enhanced monitoring requirements under regulations, monitoring data, including LFG collection for lab analysis, may indicate that a subsurface reaction is occurring. These data include:

- Elevated temperature;
- Low methane-to-carbon dioxide ratio;
- Positive well pressure;
- Well foaming;
- Low oxygen;
- High hydrogen levels;
- High ammonia levels; and
- Rapid localized settlement around one or several wells.

Hydrogen and ammonia may be read as balance gas and assumed to be nitrogen. Gas samples will need to be collected for laboratory analysis to confirm their presence.

Subsurface fires occur when waste below the landfill surface undergoes combustion. These combustion events may occur when air is introduced into the waste mass as a result of wells placed under excess vacuum, commonly referred to as "over-pulling." These events typically occur from just under the landfill surface to depths of as much as 15 to 20 feet. Parameters that may indicate subsurface fires include:

- High temperature;
- Low methane-to-carbon dioxide ratio;
- Carbon monoxide;
- Visible smoke or discoloration of flexible wellhead hose from heat/smoke;
- Air infiltration and aerobic conditions in waste; and
- Rapid localized settlement around one or several wells.

Subsurface reactions and subsurface fires may exhibit some of the same parameters. Thus, it is important to collect as much data as possible and evaluate all parameters together.

Emerging technology may improve wellfield operations and improve LFG collection. Remote monitoring of LFG flow rates and quality through telemetry and other methods have been proven technologies at flares and blower skids for several years. The industry has seen attempts to monitor and control individual wellheads in recent years. Wellheads may be equipped with sensors and radio or cellular transmitters to relay flow and gas quality data to a central data collection point. Remotely actuated valves may be installed to control vacuum and flow rates at the individual wellhead based on direct operator input, setpoints for various parameters or complex algorithms which attempt to balance multiple parameters.

The objective of these efforts is to reduce costly labor and optimize LFG flow rates and boost overall methane yields. Due to initial capital cost, ongoing maintenance related to sensor replacement and programming, adoption of these technologies is limited and primarily confined to landfills able to generate revenue from LFG energy projects.

8.4 Health and Safety

There are many details associated with GCS health and safety through industry guidance as well as Occupational Safety and Health Administration (OSHA) and National Fire Protection Association (NFPA) requirements for various activities. Personnel working with a GCS should be aware of any site-specific health and safety requirements, including the site-specific Health and Safety Plan (HASP).

Every employee is responsible for his or her own safety, as well as the safety of those around them.

Although a comprehensive safety review encompassing all potential impacts is not provided in this document, there are several general items applicable to all GCS facilities, listed below. This list is intended to be an overview and does not take the place of a HASP developed by a trained safety professional. Additional guidance can be obtained from SWANA's *Landfill Gas Operation & Maintenance Manual of Practice*[5] and other industry publications.

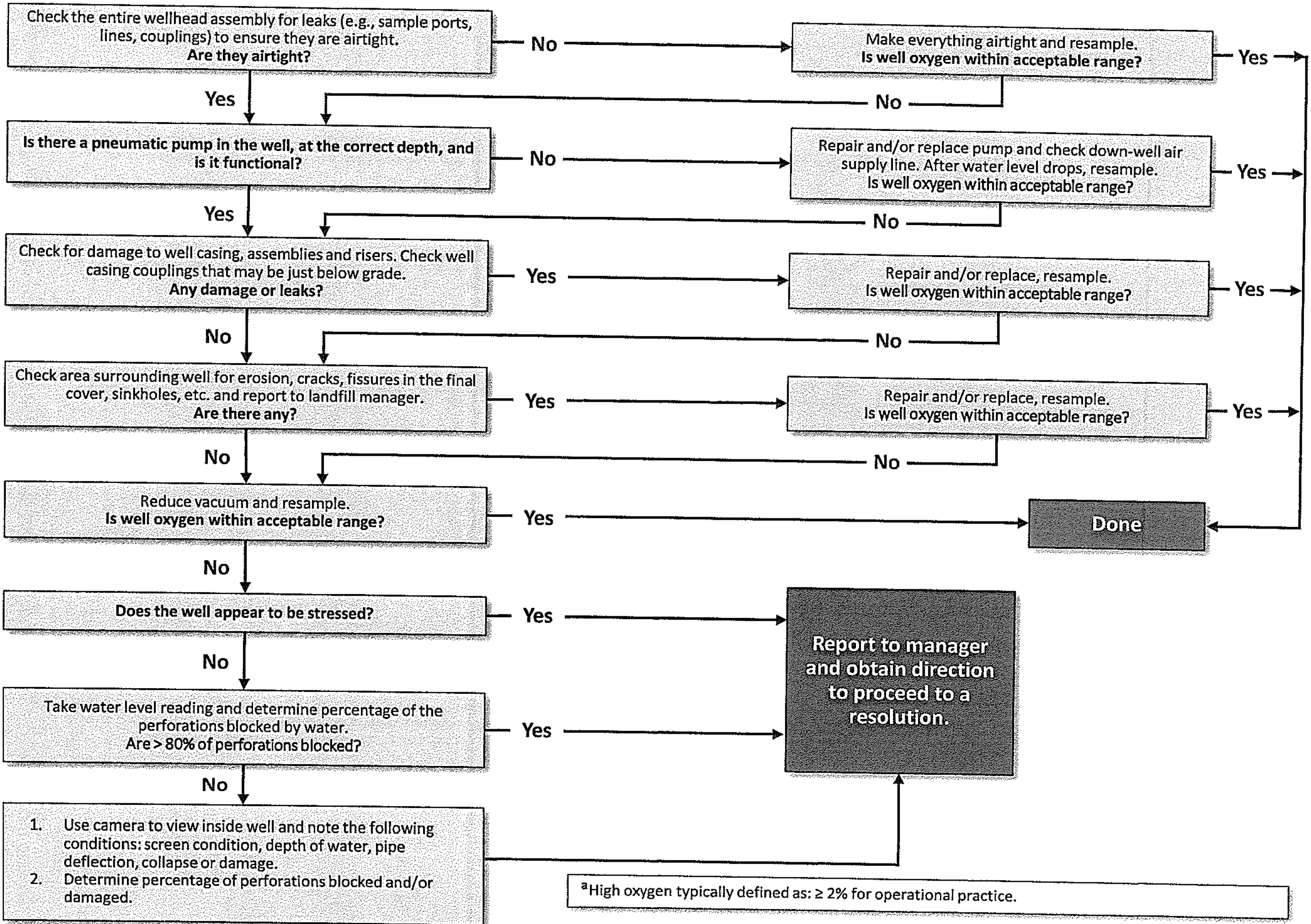
1. Do not smoke or allow other sources of ignition within 25 feet of any source of LFG, including LFG components and portions of the leachate and condensate management systems.
2. Use a personal combustible gas meter when working around any GCS components. Meters should have a minimum capability of monitoring for oxygen-deficient conditions, carbon monoxide concentrations and methane concentrations.
3. Understand the potential hazards of working in proximity to LFG and LFG condensate.
4. Wear appropriate personal protective equipment (PPE) for all tasks and be aware of the relative limitation of each level of PPE. Level D is the minimum requirement.
5. Make sure that all PPE is in good, working condition.
6. Make sure that all monitoring equipment is fully charged and calibrated per manufacturer's requirements.
7. Verify that all pressures are relieved, and that any potential sources of pressurization are de-energized or locked out, before opening any vessels.
8. Always comply with mechanical, electrical, pneumatic and hydraulic lock-out/tag-out procedures.
9. Have personnel trained to identify and work in permit-required confined spaces.
10. Have personnel trained to identify trenching and excavation activities compliant with OSHA requirements.
11. Never leave open excavations (including well bore holes) unmarked, unsecured or unattended, including the use of grates during well drilling, setting casings, backfilling and well completion.
12. Understand the hazards of working in proximity to flares and associated combustion systems.
13. Understand the hazards of working in proximity to rotating equipment, including blowers, compressors and pumps.

[5] Solid Waste Association of North America. Landfill Gas Operation & Maintenance Manual of Practice, Version 1.0, revision September 2002.

Appendix A

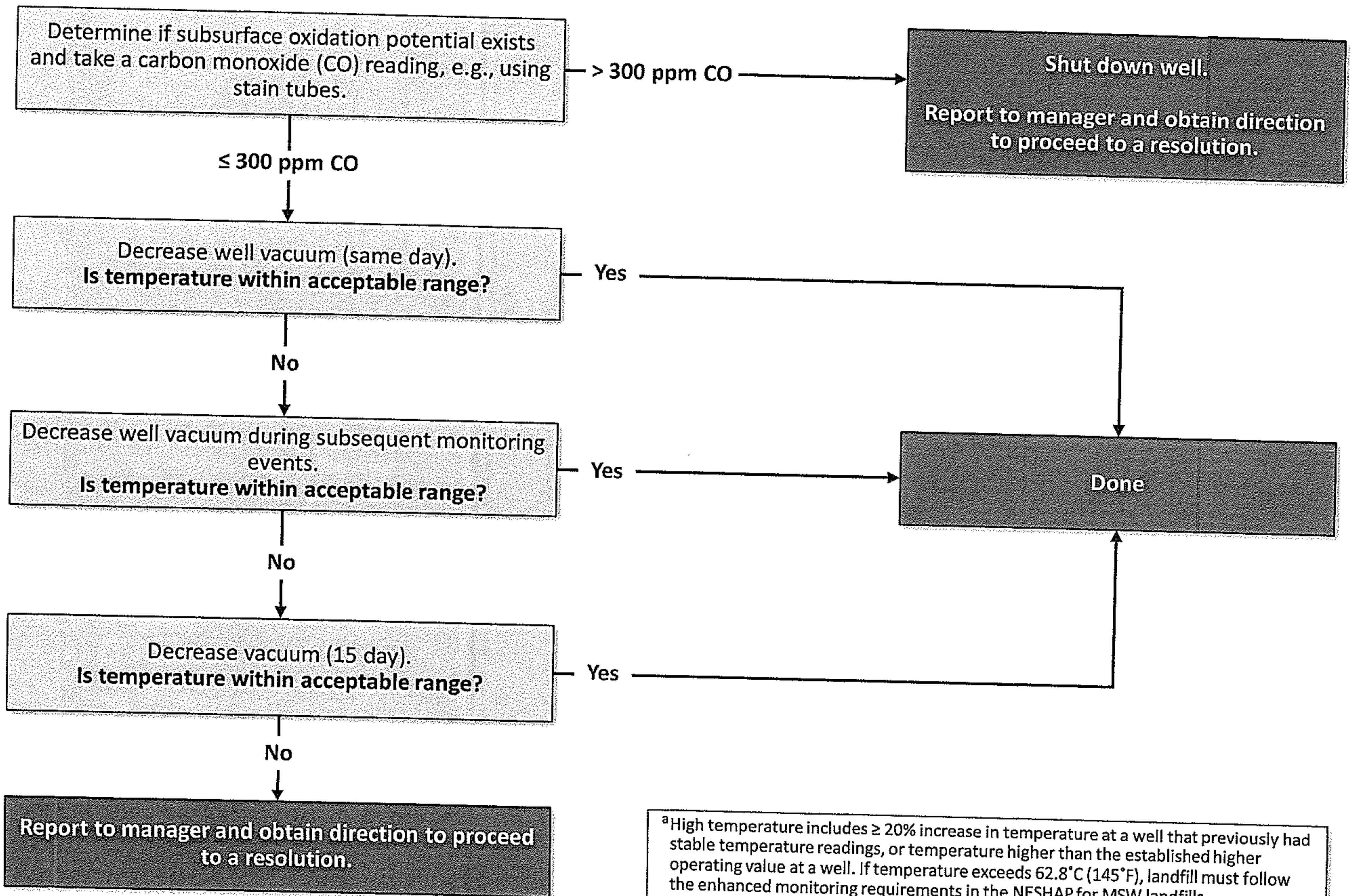
Typical Wellhead Monitoring Procedures and Operational Adjustments for Oxygen, Temperature, Methane, Flow and Vacuum

High Oxygen Monitoring Procedure[a]



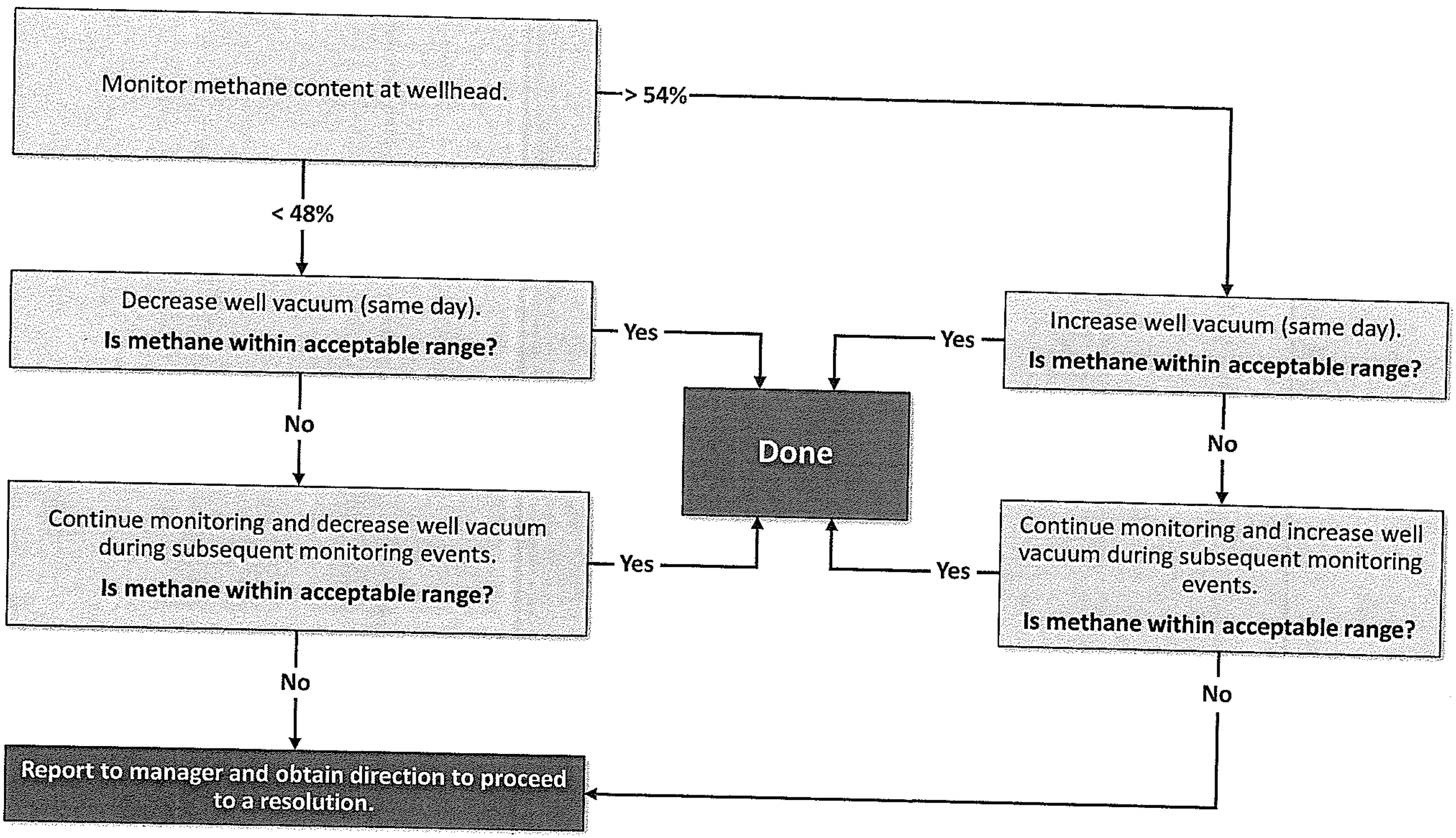
[a]High oxygen typically defined as: ≥ 2% for operational practice.

High Temperature Monitoring Procedure[a]



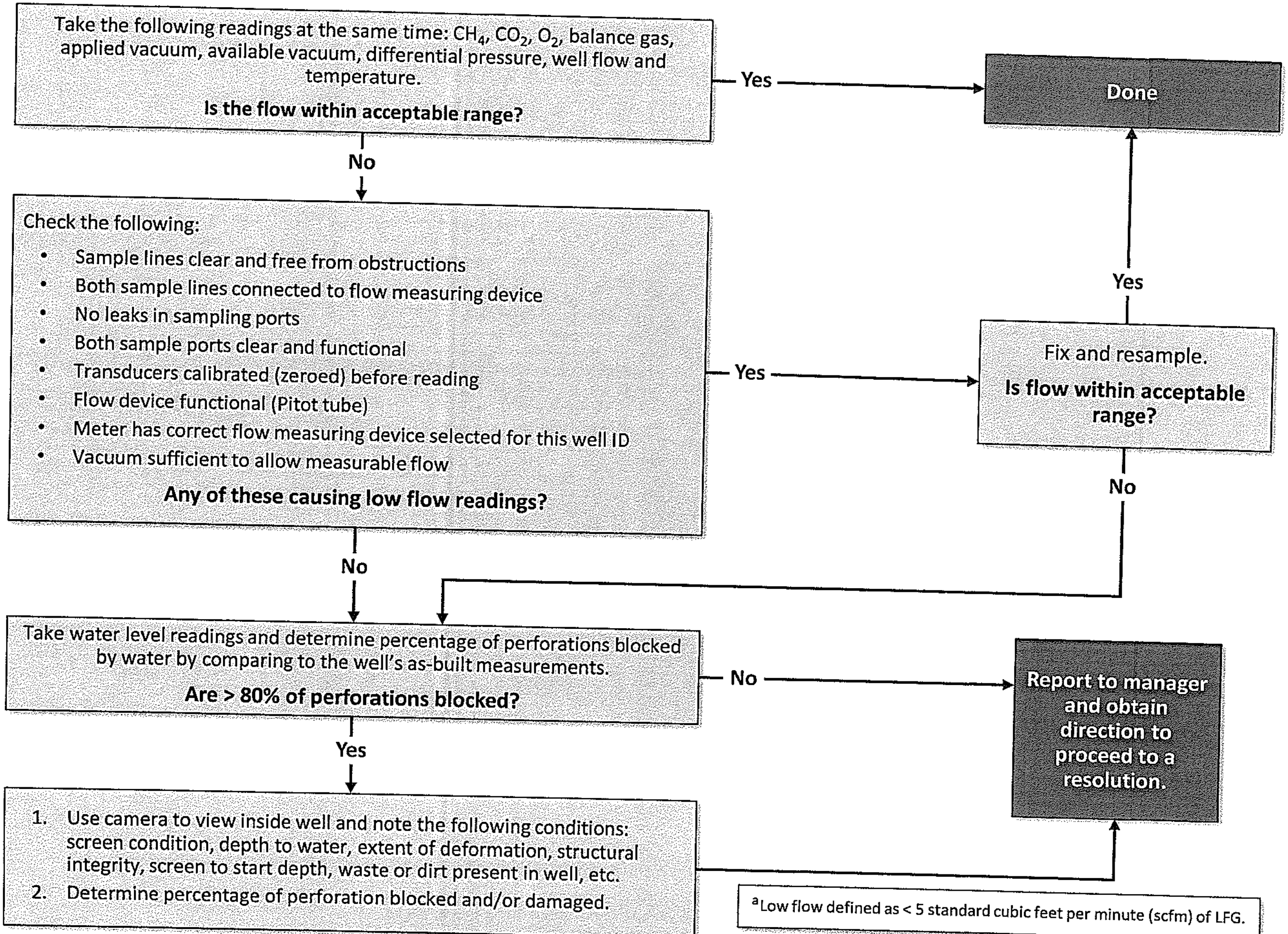
[a] High temperature includes ≥ 20% increase in temperature at a well that previously had stable temperature readings, or temperature higher than the established higher operating value at a well. If temperature exceeds 62.8°C (145°F), landfill must follow the enhanced monitoring requirements in the NESHAP for MSW landfills.

Low/High Methane Monitoring Procedure[a]



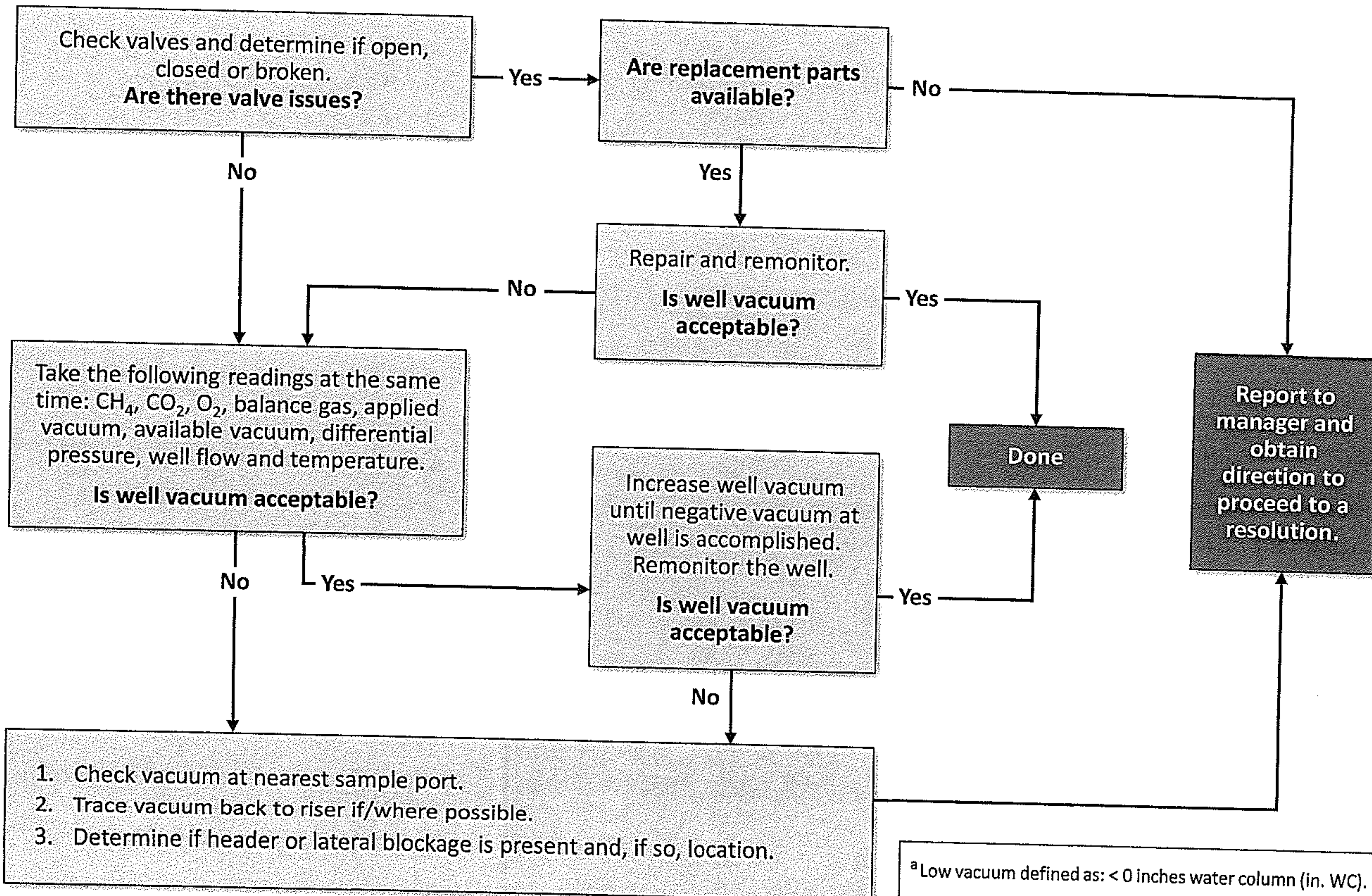
[a]Low methane defined as: < 48%; High methane defined as: > 54%.

Low Flow Monitoring Procedure[a]



[a] Low flow defined as < 5 standard cubic feet per minute (scfm) of LFG.

Low Vacuum Monitoring Procedure[a]



[a] Low vacuum defined as: < 0 inches water column (in. WC).