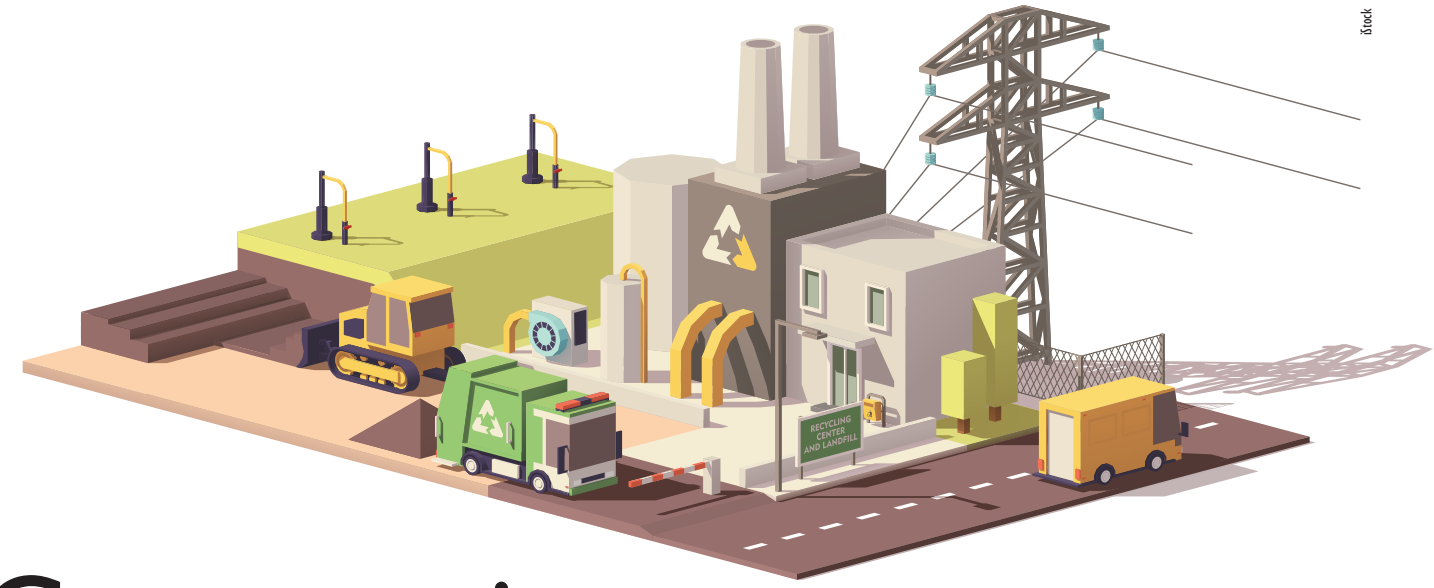

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Construction Quality Assurance

Part 2 of a 3-part series on creating a landfill gas collection and control system

BY SRIVIDHYA VISWANATHAN, ALI KHATAMI, AND DAVID FISHER

Part 1 of the 3-part article series discussed essential elements of the piping system in a landfill gas collection and control system (GCCS). We discussed landfill GCCS design perspective and the benefits of designing landfill gas (LFG) headers outside of the waste boundary.

In Part 2, we focus on construction quality assurance (CQA) services and outline the process of taking the design drawings through completion of the CQA report.

Understanding Design Intent

CQA services are performed to ensure construction compliance with design drawings, to allow necessary field adjustments during construction, and to facilitate documentation of the elements of a GCCS construction event. When performing CQA, it is critical for CQA personnel to understand the overall intent of the design drawings. The intent allows the CQA personnel to respond to any questions the construction contractor may have and to make any modifications to the design (in communications with the design engineer) based on changed field conditions.

Construction Permitting

Depending on the applicable regulations, your site may be required to obtain construction permits and mitigation measures from one or more local, state, and federal agencies. It is possible that depending on the permits and mitigation measures to obtain, both the owner and construction contractor may need to submit applications separately

All Photos: SCS Engineers

Trench for road crossing

Fusion of 12-inch HDPE SDR 17 header

36-inch core barrel

Completed single landfill gas extraction well

to appropriate agencies, as applicable. Some jurisdictions may also require local permits for the installation of LFG extraction wells.

For sites that accept asbestos, an additional layer of documentation required is the National Emission Standards for Hazardous Air Pollutants (NESHAP) notification. The NESHAP notification must be filed a minimum of 45 days ahead of the proposed construction start date and must provide the names of the owner and the asbestos handling contractor. There may be additional local and state requirements applicable to asbestos-containing landfills depending on the location of the site. Owners or owners' representatives are encouraged to thoroughly review applicable regulations and site permit conditions based on the refuse materials accepted at the site.

Site Familiarization

CQA personnel inspect the site to become familiar with the site conditions upon arrival onsite to begin the project. The CQA personnel should locate the soil stockpile area for building pads on slopes where drilling of the LFG wells occurs, the aggregate stockpile area for the GCCS construction project, piping laydown area, and other storage areas for ancillary parts. They should identify access roads to the project area and how each well location will be accessed as work progresses onsite. Locating safety grates delivered to the site is an important item. Take notes to document any questions and inquiries regarding materials delivered or slated for delivery to the site. Clearly and openly discuss this information during the pre-construction meeting.

Setup for drilling

Well bore reinforcement gate

Pre-Construction Meeting

Once all relevant permitting and mitigation measures are obtained, and before the start of construction, owners should call an onsite meeting with all involved parties. The meeting typically includes the site manager, operations manager, site engineer, design engineer, CQA engineer, piping contractor, and drilling contractor (if they are different). Discussion of several items, including but not limited to the project's start and sequence, anticipated duration of construction, location(s) for staging construction materials, health and safety, sanitary facilities, odor control requirements, and any other permit and compliance requirements for the sites happens during this meeting. The project team will talk about the overall scope of construction, i.e., sizes and total lengths of proposed LFG header piping, proposed number of LFG extraction wells, and any pertinent information from prior drilling and construction events. The team should also discuss the clearance above cell bottom liner, as noted on the design drawings, regardless of whether this liner is composed of geomembrane or clay. Complete utility mark-outs before the pre-construction meeting, especially for closed landfills and landfills with other end-users on the site. The project team should discuss access to utilities in the vicinity of the construction area and should visit the locations in question.

Gravel backfilling

Since communication is a key aspect in the successful completion of any project, the chain of communication should be established at this meeting and a list of cell phone numbers distributed. Immediate reporting of any particular conditions encountered in the field is specified by the site engineer during the meeting and becomes part of the record; conditions such as excessive temperatures, significant odors, asbestos coming out of the borehole, or punching through the liner are all good examples. The guidelines for handling asbestos should be reviewed to ensure all parties are familiar with the procedures. The site engineer can also describe the process of managing a liner punch-through condition. Review the remediation plan if it is already available and discuss the guidelines. If no remediation plan is in place, discuss preliminary measures for properly securing the boring. The final LFG extraction well schedule should also be circulated at this meeting and signed by all parties. We recommend that all parties visit and walk the locations for the proposed LFG extraction wells, LFG headers, and other appurtenances of significance.

As noted above, discuss all safety matters related to the type of work and anticipated conditions during the course of the project at the pre-construction meeting. All parties involved in the construction should confirm their familiarity with the site safety plan. If safety measures above and beyond those in the site safety plan are necessary, then discuss the measures while all parties are present during the meeting. Any additional measures agreed upon should be documented in the pre-construction minutes.

Review and check the emergency contact information, name and location of the nearest hospital, and any specific protocol(s) for reporting emergency conditions and note them in the meeting minutes. For landfills located in rural areas, clarify whether a phone call to an emergency center is transferred through a different communications center than a center which is local to the landfill location. What may seem to be a non-issue at first glance can save lives. The co-authors are aware of emergency calls routed to a different emergency center with emergency response teams arriving at the wrong landfill location. Delays in providing medical support are preventable with detailed planning by experienced professionals and good communication.

Discuss the task of preparing meeting minutes and assign one of the parties to prepare meeting minutes. It is important to document all agreements during the pre-construction meeting in the minutes of the meeting.

Progress Meetings

In addition to the pre-construction meeting, hold regular progress meetings in the field or an office throughout the construction duration. Participants in these meetings discuss work progress, delays, special circumstances that require coordination with parties other than the field parties, materials deficien-

cies, mobilizing equipment not included in the original construction plan, or possible/potential concerns based on data becoming available during the course of the project.

The site engineer may require an updated construction schedule to be submitted by the contractor during progress meetings. Communicate to all involved parties by email any important decisions which can positively or negatively impact the project such as changes in materials and equipment availability, changes in fill operations, significant increases or decreases in cost, or any other decisions which impact the project made during these meetings.

Construction Operations

Before commencement of drilling operations, CQA personnel visit the locations of all proposed vertical LFG extraction wells to safeguard that pre-construction survey stakes at the well locations are undisturbed. Should any stakes be found missing, CQA personnel will communicate the information to the design engineer to arrange a new survey and re-stake the wells. Only then can drilling operations safely commence. If the boring location changes, the elevation of the liner below the waste may change as well, increasing the risk of the drill rig bucket punching through the liner.

LFG Extraction Well Drilling Operations

Based on the sequence of construction determined at the pre-construction meeting, the drill rig is brought to the location of the first LFG extraction well. By this time, any missing survey stakes should have been re-staked. CQA personnel check the information on the stake and verify against the signed final LFG extraction well drilling schedule. Once the location and information of the proposed LFG extraction well are confirmed, drilling operations can commence. A vacuum box comprising a metal ring the size of the borehole surrounded with flaps and connected to an air blower and activated carbon drum can help reduce odors.

While positioning the drill rig at the first boring location, the CQA party confirms the presence of a properly-sized well construction safety grate at the location of drilling. The well grate should be in place at all times when drilling is not actively in progress (drill auger in the hole). Workers in the vicinity of the borehole must maintain a pre-specified minimum distance from the bore opening unless they wear a properly-anchored fall protection harness and tether. Take special care to maintain the fall protection tether from becoming a trip or entanglement hazard. Breathing air around the borehole should be continuously monitored to detect if a buildup of explosive or toxic gases occurs.

Setting of HDPE well casing

We recommend full-time CQA services for well drilling operations. As the refuse is being drilled and brought to the surface, the CQA personnel logs the waste composition and other waste characteristics such as moisture content and temperature in 10-foot intervals, at a minimum. However, certain owners and site conditions can deem logging of waste characteristics at 5-foot intervals.

Well logs describing the waste composition provide a breakdown of the various types of materials observed in the waste cuttings to the highest degree possible. Additionally, when logging waste temperatures, use compost thermometers instead of temperature guns, which use infrared (IR) beams, to determine the most accurate temperature of the waste mass. Observations of waste cutting temperatures are found to be more precisely measured by between 5–15°F when using a compost thermometer. Taking temperature readings becomes more challenging when waste materials contain asbestos since the waste is to be wetted and covered when bringing it to the surface.

The CQA personnel in coordination with the site engineer oversee completion of items on the punch list.

Liquids in landfills may pose additional challenges to drilling operations. These liquids are usually a result of the type of waste accepted at a site and improper drainage of stormwater. Liquids trapped in landfills can significantly reduce the overall rate of vertical drilling.

It is vital to have an understanding of the extent of liquids in the landfill and how they may potentially present themselves during construction, as "slow-drilling" can have significant financial impacts to both the construction and CQA budgets. Slow-drilling, increased number of days for construction of LFG extraction wells, and added CQA days could increase the cost of construction projects considerably.

The role of the CQA personnel intensifies when drilling in these conditions. Daily logs prepared by CQA staff should specifically document the depths at which changes in waste composition specific to liquids content occur. Changes in the rate of drilling and the approximate volumes of liquids recovered from the well location along with the temperatures of both the waste and liquids should be well-documented and communicated back to the site engineer and design engineer. The daily logs, communication, and any photographic documentation assist in charting the design approach for future construction projects at the site.

LFG Extraction Well Installation

When the drilling operations at a well are complete, and the field well bore depth is verified against the signed final well drilling schedule, installation of the well can begin. At this time, CQA personnel verifies the well casing dimensions, i.e., distribution of solid versus perforated section of pipe, against the distribution shown on the well schedule. Since well casings are built ahead of time, any changes in field conditions may necessitate adjustments to the casing before lowering in the well bore.

Follow proper rigging procedures to support and guide the well column properly. All strapping should be in good condition and rated for the calculated load. Well installation requires personnel to stand near the support well column and on the safety grate. Multiple hazards are present during the process: for example, potential energy from the suspended well column, dust from the placement of the well packing, trip hazards, and fugitive emissions from the borehole. Only after all packing material has been placed should the safety grate be removed, followed by the installation of a permanent rebar grate.

LFG Header and Lateral Piping Installation

Many times, the well-drilling contractor is different from the LFG piping installation contractor, and both are working on different aspects of the construction project at the same time. In such cases, assign more than one CQA personnel to the site. However, unlike LFG extraction well drilling which requires full-time CQA, above-grade LFG header and lateral piping CQA may be performed on a part-time basis. CQA personnel will verify the pipe size, standard dimension ratio (SDR) rating, alignment, and slope against the construction drawings. In case of any changes in field conditions, CQA personnel must contact the design engineer to make the appropriate modifications with little or no delay to the project timeline.

When installing below-grade piping, we strongly recommended a full-time CQA staff onsite. Specifically, in below-grade applications such as road crossings, the CQA personnel safeguard utilization of the appropriate size encasement pipe with sufficient slope. The personnel also make sure

Checking slope on lateral

that there is an adequate height of cover materials, consistent with design plans, over the encasement piping. We recommend for landfills with known liquid impacts that the encasement pipe be large enough to accommodate any future compressed air and dewatering force main lines.

The CQA personnel confirms that obvious safety signs are visible in the vicinity of trenches excavated in waste to alert the landfill equipment operators or other landfill personnel. The backfilling of trenches to reduce safety issues should be discussed during the pre-construction meeting and documented in the meeting minutes. If and when a trench is left open overnight or for an extended period, the contractor and CQA personnel, in coordination with the site engineer, confirm and document that the proper safety measures are taken to prevent accidents.

LFG Header and Lateral Piping Pressure Testing

Before placement into service, we recommend that LFG header and lateral piping be pressure tested to verify the integrity of the new piping joints or connections. CQA personnel and the piping contractor should

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coordinate the proposed timing and section of piping intended for pressure testing ahead of time. We recommend that pressure testing is done earlier in the day to overcome impacts of changing temperatures.

Performing testing is usually accomplished by introducing compressed air into the test section of piping. After stabilizing the pressure, record the pressure test starting time and pressure. We recommend waiting at least an hour before recording the end time and pressure. A pressure loss of greater than 10% indicates a leak or a failed connection.

Setting of vacuum box

Geomembrane skirt with boot

Recommended testing pressure can vary depending on the proposed use of the pipe. Compressed air and dewatering force main piping are commonly tested at 100 pounds per square inch (psi) whereas LFG piping tests are at much lower pressures (5–10 psi). Accordingly, pressure gauges with appropriate precision tapped into the piping test section will accurately measure the exact pressure loss.

When conducting pressure tests, PVC or chlorinated PVC (CPVC) blind flanges should never be used to seal pipe ends; the materials are not designed for use in pressurized conditions. PVC and CPVC materials tend to shatter upon failure due to high pressure and can cause death or serious injury.

As-Built Drawings

As-built drawings are prepared to reflect the final construction of the project. These drawings, also known as record drawings, demonstrate the field variations from the original design plans. The drawings should be prepared based on a field survey performed by a licensed surveyor. Survey data includes coordinates (easting and northing) and surface elevations for all vertical LFG extraction wells. The original signed well schedule should also be updated based on the survey information and included in the as-built drawing set.

For LFG header and lateral piping, and appurtenances such as valves and tees, survey data should include coordinates and elevations for top of pipe and appurtenances. For compressed air lines, the survey data should include coordinates and elevations for top of pipe and any special features such as air isolation valves and blow-offs. In case of dewatering lines, the data should also reflect all piping, valves, tees, and locations for all cleanouts.

Where buried piping is involved, CQA and the construction personnel communicate ahead of time in order to determine if the survey is performed before backfilling the trench or installing pipe markers to allow the survey of the top of the pipe at a later time, well after backfill is complete.

Substantial Completion

CQA personnel responsible for the project should typically prepare a punch list near completion of the project. The CQA personnel in coordination with the site engineer oversee completion of items on the punch list. The site engineer determines at what stage of completing the items on the punch list the project is considered substantially complete.

The site engineer may also seek CQA personnel's assistance for preliminary review of invoices submitted by the contractor. If the owner purchases piping and ancillary parts, the site engineer may assign the CQA personnel responsible for the monitoring of piping installation to perform an inventory of pipe materials, gas wellheads and accessories, valves, fittings, and any other materials required to complete the project. The inventory requires close coordination between the CQA personnel and the piping contractor.

Construction Quality Assurance Reports

CQA reports include a brief description of the project and the names and responsibilities of all parties associated with the construction including the owner's representatives, contractors' representatives, designer's representatives, and the CQA party's representatives. CQA reports contain boring and well construction logs, daily logs, photo logs, as-built record drawings, and results of pressure testing of new piping. Boring logs describe the depth of drilling, the composition of waste cuttings, observed moisture content and temperature of waste cuttings, and odors, if any. CQA reports also contain specific logs that document the handling of asbestos extracted from LFG well borings. Daily logs provide a summary of daily construction which detail location, description, and quantities of construction. Daily logs should also have pertinent information relating to the location of construction, equipment challenges, and any construction variations from the design plans. Perform an as-built survey of all elements of the GCCS construction. Original design plans should then be updated based on the as-built survey to prepare construction record drawings for the CQA report. Include copies of any permits and mitigation measures obtained before construction in the CQA reports.

Conclusion

CQA is essential for assuring the proper construction of GCCS and meeting the intent of the design, and can help prevent safety mishaps. Even highly experienced design-build teams invest in expert CQA professionals to protect their capital investment, maintain maximum LFG capture through constructed GCCS, and keep operating and maintenance costs in line. It is critical for CQA personnel to understand the overall intent of the design drawings, current field conditions, long-term conditions, and strict safety protocols. They must also have the expertise to respond to the questions contractors have during construction, especially regarding modifications to the design which will positively impact safety, long-term performance, and maintenance. **MSW**

***Ali Khatami**, Ph.D., PE, LEP, CGC, is a Project Director and a Vice President of SCS Engineers. **Srividhya Viswanathan**, PE, is a Senior Project Director with over 10 years of engineering experience. **David Fisher** is an SCS National OM&M Compliance Manager with 18 years of environmental experience.*