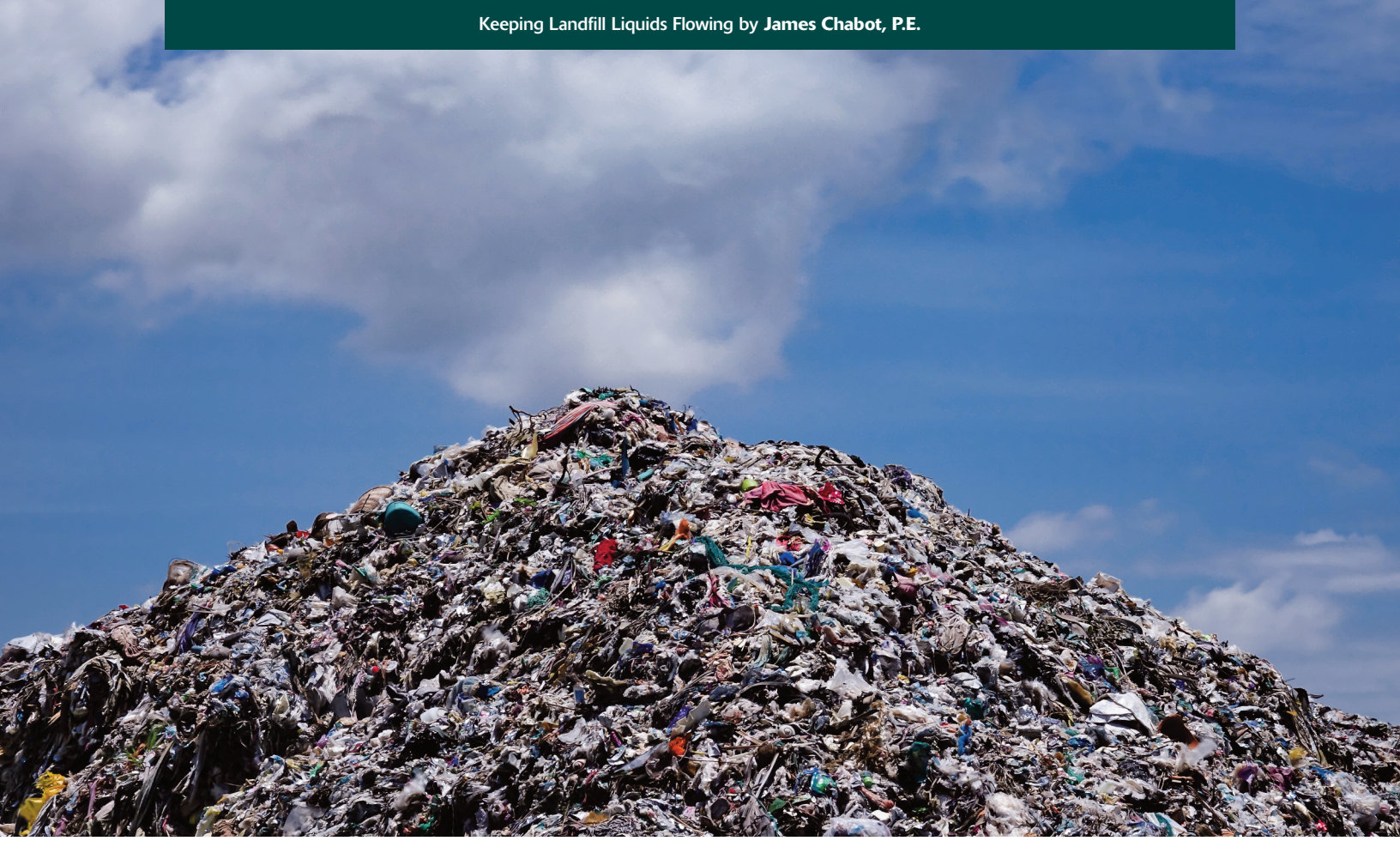

Keys to Keeping Landfill Liquids Flowing

by James Chabot, P.E.

Solid waste management isn't just about managing solid waste. It's also about managing liquids, particularly leachate. (It's also about managing gases, but that's a topic for another article.) Managing the liquids that flow through your landfill is an important part of controlling costs and reducing the potential for unpleasant surprises.

What is landfill leachate and how is it managed? Landfill leachate is the liquid that is generated as water percolates through solid waste in the landfill. The source of the water can be rainfall, or surface- or ground water, or free liquids expressed from the buried solid waste. If leachate escapes the landfill, it may contaminate groundwater and surface water. Accordingly, landfills are required to install leachate barriers and collection systems to prevent leachate migration into the environment. An impermeable liner system, typically including a geomembrane, is installed at the bottom of the landfill to prevent leachate migration into groundwater. In addition, to prevent leachate migration from the landfill, either through subsurface migration or at the surface, a system of perforated piping is installed within the landfill to collect the leachate. Then, a system of solid piping is used on the outside of the landfill to convey the collected leachate to onsite storage, pending subsequent treatment and disposal (see Figure 1).

This article addresses six best practices for leachate management with a focus on leachate piping systems at municipal solid waste landfills. It is based on several decades of experience in landfill management and design in many parts of the United States, as well as on fundamental engineering principles.

Learn to Live without Geotechnical Support within the Landfill

Civil engineers designing underground utility pipeline networks of any type pay close attention to the ability of the surrounding medium—soil—to support the pipe without causing it to deform or break. Landfill engineers cannot rely on municipal solid waste within the landfill to provide similar support to buried pipe that collects and conveys leachate. The plastic pipes commonly used in landfills are considered flexible pipe. So, it's to be expected that when there is differential settlement of the supporting solid waste that the pipe will bend, buckle, or pinch. Realistically, landfill operators must accept that a leachate collection system pipe in a landfill will have a limited functional life, somewhere from one to ten years. Therefore, landfill owners and engineers should plan on realigning or replacing pipe buried in the waste at some frequency over the life of the site.

Figure 1. Excavation in the landfill for leachate force main installation.

Photo courtesy of by Sanborn, Head & Associates, Inc.

Plan for Durability of Pipelines Outside the Landfill

While leachate collection systems inside the landfill may have a relatively short lifespan, pipelines outside the landfill footprint should be designed with geotechnical considerations for long-term pipe support. Outside-the-landfill pipelines should be expected to last for the life of the site and beyond. This starts with constructing pipeline underground wherever possible to provide mechanical and environmental protection.

To be able to find the pipe in the future, the designer should include pipeline markers spaced between 200 and 400 feet apart and at all bends in the alignment. Other techniques to mark the pipeline can also be used including trace wire or conductive marker tape, so long as there is access to allow them to be energized. Markers should show what is in the pipeline, such as leachate, landfill gas, gas condensate, or compressed air. Color coding can also help staff recognize each pipeline and its contents. We find it's best to avoid markers made from PVC pipe as they become brittle with exposure to sunlight and therefore don't last very long.

Pipelines installed on the ground surface will likely need anchoring to limit movement due to gravity or thermal expansion and contraction. Above-ground pipelines also need to be marked to limit the potential for damage from site landfilling equipment and/or other vehicles, including lawn mowers.

Avoid use of steel rebar stakes or other small diameter metal stakes to support the pipe, as they create an impalement hazard to workers. Rebar safety caps provide a short-term solution but may get knocked off their stakes. Consider using soil piles, percussion driven earth anchors with a wire rope loop, or some other means to secure the pipeline without creating safety hazards for the landfill staff.

In constructing polyethylene (PE) pipelines, field extrusion welds should be avoided. It is difficult for even the best installers to make these welds strong enough to resist stresses from internal or external pressures, differential settlement, or thermal stress movements. Only fusion welding techniques should be allowed in the field.

Figure 2. Example of a pipeline high point that needs an air release valve to eliminate air locking.

Photo courtesy of by Sanborn, Head & Associates, Inc.

Design plans and specifications should include torque specifications for flanged connections, even if no flanges are shown on the drawings. Many times, flanges may need to be added as a field change to be able to assemble a connection to an existing pipeline, or for other constructability reasons. The specifications should also require use of a torque wrench to secure fasteners.

Invest in Air and Vacuum Relief Valves

Gas bubbles will form in any leachate collection system and aggregate at high points in the pipeline. Figure 2 illustrates an extreme example of a high point. Unless there is enough liquid velocity to move them along, these bubbles may constrict or block the pipeline, commonly referred to as "air locking" the pipeline. Such blockages can cause premature wear and tear on pumps, requiring their early replacement, and may also slow leachate removal. Best practice includes identifying high points in the pipelines and installing air release valves (ARVs) at those locations.

Similarly, vacuum can develop in a pipeline, contributing to stresses that may lead to a buckling failure of the pipeline. It may be necessary to include vacuum relief valves (VRVs) in the design to allow air to enter the pipeline to eliminate such vacuum-induced stress.

ARVs and VRVs should be rated for wastewater use, with seals rated for the relatively low pressures typically encountered in landfill liquids management systems. Seals of different durometers (hardness) are available from some manufacturers as options. These valves may "spit" liquid from time to time, so they should have a flexible hose from the vent to a nearby liquid tote or some other vessel that is routinely monitored for liquid. Alternatively, the vent can be connected to a gravity main which would allow the liquid to be put back into the system.

ARVs and VRVs, like most equipment in leachate and condensate service, must be routinely checked and cleaned to function properly. They must be properly supported and installed with an isolation valve to allow the ARV or VRV to be removed for maintenance or replacement.

We find that many operators resist the idea of ARVs and VRVs, on the principle that maintenance and replacements are too costly. We believe that it's money well spent to install and maintain these valves to keep the leachate moving out of the landfill.

Design Pipes to Drain

Force mains are pipelines that convey the liquid under pressure, typically from the discharge side of a pump. Force main vertical alignments should be designed to allow the pipe to empty between pump cycles. This design will limit scaling (see Figure 3) and reduce the accumulation of sediment in the pipe invert. This feature may require careful design of a site's liquids management system to function for interim conditions as well as for the full buildout condition.

Force main diameters should be designed to provide an operating fluid flow velocity between three and nine feet per second to limit scaling and sedimentation in the pipeline. This is particularly challenging for shared force mains that connect to pneumatic controllerless pumps. Any number of the pumps sharing the force main may operate simultaneously without predictability, which prevents a consistent velocity in the pipeline. And, if the design diameter is smaller than three inches, there may also be maintenance challenges to clean the pipeline. A better approach is to aggregate flows in satellite pump station wet wells and then pump to the storage location.

Ensure You Have the Right Design Skills on Hand

You need the right design consultant to provide quality construction plans with consideration of the topics above, either on staff or from a third-party consultant. A little up-front cost to get the right expertise can easily pay off in reduced maintenance, operation, and replacement costs over the life of the infrastructure.

Skills to look for include:

- Geotechnical awareness to provide adequate support for buried flexible pipelines;
- Construction experience to understand pipeline construction techniques and preparations needed for commissioning new construction;
- Selecting pipeline materials for compatibility with the products conveyed and the installed environment (i.e., secondary containment, seismic potential, extreme temperatures, UV exposure, etc.);

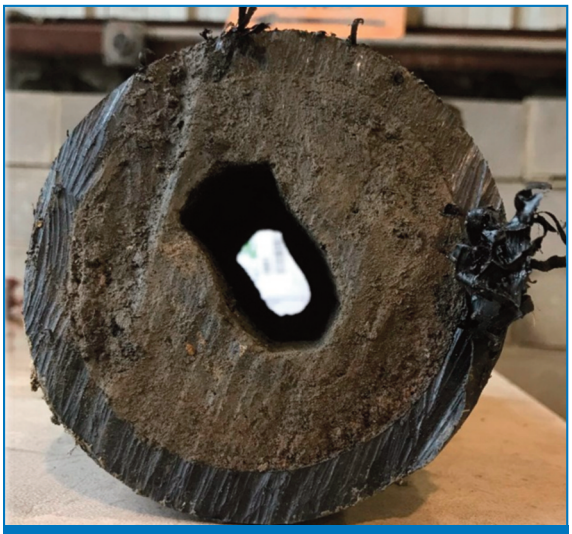

Figure 3. Extreme scaling within an improperly configured force main pipeline for pumping liquid leachate.

Photo courtesy of by Sanborn, Head & Associates, Inc.

- Designing gravity and force mains;
- Choosing pipeline sizes (diameter and wall thickness) to be compatible with expected pressures and liquid velocities to limit chemical precipitation and sedimentation management;
- Designing proper thrust restraint and support for bends and certain fittings;
- Designing safety measures for installation and operation, including lockout/tagout and blocking and bleeding energy dissipation; and
- Designing pipelines not only for operation, but also for maintenance (i.e., access, slope adjustments, cleaning, mechanical or environmental protection).

Choose the Right Contractor to Support Your Project

As well as the design considerations cited above, ask your contractor for qualifications specifically related to pipeline construction with materials specified for your project. Their construction superintendents may have pipeline construction experience ranging between none to extensive. Many landfill gas contractors have no experience properly bedding and backfilling pipe with structural materials. Find a superintendent who has experience constructing utility pipelines, as they should understand how to construct the proper pipe bedding and support. This particular need is more applicable to pipelines installed in soil outside the waste containment.

Consider requiring your contractor to provide a work plan that includes:

- Techniques to limit liquids management and related systems downtime during construction;
- Lockout/Tagout procedures;
- Health and safety protocols for work on the landfill (gas meters, etc.);
- Pipe fusion or solvent welding techniques, especially during inclement weather;
- Pipe materials staging techniques (e.g., welding stringers in one location and dragging pipe);
- Crew member certifications for fusion or solvent welding;
- Compaction techniques and equipment;
- Techniques to manage liquid outbreaks in excavations or work areas;
- Odor management techniques and implementation criteria;
- Waste spoils management protocol;
- Excavation safety protocol to meet federal and state OSHA requirements;
- Pipe cleaning procedure prior to commissioning; and
- Pipe pressure testing procedure, test pressures, and equipment.

During pipeline construction, be sure the contractor is handling the pipe and related supplies properly. Pipe segments should be capped to keep the inside of the pipes clean and animal-free. The contractor should limit dragging the pipe long distances, either individual segments or welded up stringers. If the pipeline is dragged into position, the pipe needs to be checked for deep gouges or holes.

Along with a qualified contractor, be sure to retain a qualified, independent construction quality assurance (CQA) engineer. While fusing or solvent welding pipe and installing pipe are generally a straightforward exercise, there are circumstances that can compromise the quality of the installation. A qualified CQA engineer should work well with your contractor to keep the landfill's best interest at the forefront.

Summary

This article summarizes six best practices for landfill leachate management with a focus on proper engineering of leachate piping systems. In designing, constructing, and operating landfill liquid pipelines, a key priority is to assure effective removal of gas from the pipe and to enable draining pipelines between liquids pumping cycles. Consistent application of engineering fundamentals, along with a good dose of common sense, can go a long way in keeping your landfill liquids flowing. **em**

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