Solid Waste News & Notes

A Newsletter from the Solid Waste Unit of the Hazardous Materials and Waste Management Division

Vol. 2, No. 1 March 1999

"Powered By Gas"

Hazards of Landfill Gases - Migration, Asphyxiation Danger and Explosive Mixtures

(Part 2 of a 4 Part Series on Municipal Solid Waste and Landfill Gas)

In Part 1 of this series we cooked up some landfill gases: gases that result from the decomposition of organic wastes buried in a landfill and are composed mainly of methane, CH_4, and carbon dioxide, CO_2, and possibly small amounts of other gases. Alright now, so these gases are present in the landfill—what's the concern? Aren't they buried in the landfill? Yes, they are buried in the landfill when generated, but because they are gases they can move. And move they will, following the laws of nature.

Let's now look at some laws of nature that govern how and why gases move. Recall that there are three states of matter—solid, liquid and gaseous. Liquids and gases are fluids, meaning they do not have their own shape as solids do, but rather take the shape of whatever container they occupy. Additionally, the components within fluids are free to move about, so most fluids tend to be uniform mixtures. Liquids are generally much heavier (denser) than gases, so gravity is the main factor controlling how and where they travel. For example, dam a ditch and a free-flowing liquid in it is stopped. As with solids, it is external forces such as gravity that cause liquids to move.

Gases, on the other hand, have internal forces that usually determine how they move. The molecules of matter in the gaseous state are in constant motion. They knock into each other and repulse one another, causing the gas to expand as much as possible. This internal driving force is called diffusion. With gases lighter than air, such as methane (Specific Gravity 0.554, relative to air at 1.000), gravity is not the major factor affecting their movement. This allows diffusion to move them in any direction available, even straight up.

Colorado Department of Public Health and Environment

Concentrations of heavier gases such as carbon dioxide (Specific Gravity 1.52) initially move outward more than upward, due to gravity. Perhaps you have seen "smoke" flowing across a stage to enhance a magician's act. This is actually a fog of water vapor, formed from the air as carbon dioxide is released and expands by diffusion. As it expands, it cools the air below the dew point and a fog forms. Though seeming to flow sideways, wisps are also seen to rise. The effect is not long lasting because the carbon dioxide diffuses fairly rapidly. Remember, it is condensed water vapor that you see, not the carbon dioxide, which is invisible.

Gases move in response to pressure changes as well. An increase in pressure can be induced by the generation of more of the gases, by a decrease in volume, such as when additional loading of landfill materials causes more

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Compliance Assistance from the Unit Leader

On January 20, 1999, the Colorado Board of Health adopted a set of additions and modifications to the Solid Waste Regulations. Pending review of the rules by the Colorado Attorney General's Office, the changes should become effective on March 31, 1999. The Board considered comments received during the January 20 public hearing and input provided during the comment period. A few modifications were made, but generally the Board adopted the proposed rules with little change.

What does this mean to the regulated community? The changes represent the Solid Waste Program's continuing effort to improve the quality and functionality of the Solid Waste Regulations. Confusing terminology has been eliminated, or better defined, and the Program's fee structure has been streamlined. In addition, changes to the Inspection and Enforcement section should help us better assist you in complying with the regulations. The Solid Waste Program, like all regulatory programs, is largely dependent on voluntary compliance and self monitoring by our customers — so anything we can do to ease the compliance process is in our mutual interest!

The proposed rule changes are located on our web site at http://www.cdphe.state.co.us/hm/, and summary information is provided inside this newsletter. Once the final version is approved, it also will be made available on the Internet. As always, my staff and I are available to explain any aspect of the regulations or the new changes.

— *Glenn Mallory, Solid Waste Unit Leader*
(303) 692-3445

SAMS CORNER (#2)

Second Site Chosen for Site Analysis Management System

A lot has happened in *SAMS Corner* since our last edition. Two trainers from EarthSoft came to the Department to conduct a three-day training on the use of the application: Environmental Quality Information System, or EQuIS. If you recall, the EQuIS database product is at the heart of the Division's new Site Analysis Management System (SAMS). The training was provided to a small group of Department staff that had been identified as the "core user group" for the system.

One of the most striking things I learned from the training is that EQuIS is only a part of SAMS. The EQuIS product provides the core of the system with a sophisticated warehouse to store the data, a data verification/validation module on the front end and interface modules to convert data into our most frequently used applications. With the addition to Division staff of system administrator, Andy Putnam, we are able to modify the basic system to include applications such as Sanitas™, a ground water and statistics software. We can also add additional fields to the data model to capture data not originally included in EQuIS. The system administrator is crucial to our being able to support and troubleshoot the system, as well as aid users in both data import and data evaluation. Andy is especially suited to this job as he came to us with experience as both a geologist and programmer. By using SAMS we can analyze data quickly and more efficiently than was possible in the past.

Our work on the BFI Fountain Landfill has reached a point where we now can use it to demonstrate the power of SAMS to the people who have an interest in the system. We gave a demonstration to Division staff in December, and the turnout was quite impressive. Another demo was given to Division managers in January. Early feedback from both meetings is very positive. A tentative demonstration for Solid Waste Association of North America (SWANA) members is scheduled for their late March meeting.

We have been adding additional information to the Fountain database as it is developed. BFI drilled two additional monitoring wells at the site. Through SAMS ArcView component, we were able to provide feedback on the accuracy of the data provided to them by their contract surveyors. We are also gaining a better understanding of the hydrogeologic conditions present in their expansion area. We believe this understanding will speed up the review time on the new Design and Operations Plan they have submitted for the site. We received the document on January 6, and we hope to have comments back to them by mid March. This is a little less than half of our statutorily mandated maximum review time of 180 days.

We have chosen and begun the process of building the second solid waste site into SAMS, the soon to open Phantom Landfill. The Phantom Landfill is located in Fremont County and is owned by Twin Landfill Corporation of Fremont County. This site is an ideal candidate for SAMS because it is brand new; no waste has yet been placed in the landfill. The Phantom is scheduled for opening in mid February. Kudos to Twin for volunteering to be the second solid waste site to go into SAMS.

The Division is developing a technically-oriented web page for SAMS. At present we plan to make templates for Electronic Data Submittals (EDS) available there. This will allow easy access to the Division's preferred data submittal formats. As time goes on, we will be adding additional information to the SAMS web site. Your input is always appreciated. If you have ideas of what you would like to see on the web site, please let us know!

— Ron Forlina, Solid Waste Unit

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Powered By Gas *(continued from front page)*

compaction, or by a temperature increase. Even changes in weather or barometric pressure can affect how landfill gases move.

Mixtures of gases also tend to be homogeneous, meaning the individual gases diffuse to mix together until the components are distributed evenly throughout the volume. That's what happened to the magician's carbon dioxide—it diffused into the air. Air is an example of a common homogeneous gaseous mixture. Air is composed of 78% nitrogen, 21% oxygen, and 1% other gases (argon, carbon dioxide, helium, etc). Consequently, a certain proportion of oxygen (21%) is present wherever there is pure air. Another example of gas diffusion is the addition of a small amount of a very smelly substance, methyl or ethyl mercaptan, to natural gas, which itself is odorless and colorless, to warn of its presence. The mercaptan vaporizes and mixes completely throughout the natural gas utility system, and by design, only a few parts per million in the natural gas from a leak in your gas utility line is needed for detection, thus alerting you of the leak.

For landfill gases, the methane and carbon dioxide, and possibly trace organic compounds, diffuse internally to *(continued on page 7)*

Construction Debris Rule

In the December 1998 edition of this newsletter, mention was made of a pending federal rule that, if promulgated, would greatly modify the ability of solid waste facilities that accept municipal solid waste (MSW) to accept certain construction debris. The proposed rule was published in the Federal Register on December 18, 1998, and is open for comments through April 2, 1999. Colorado Counties Inc. (CCI) was informed of this pending rule and notified members of its existence.

While the proposed rule would probably facilitate the removal of architectural waste that is contaminated with lead-based paint, because it would exempt these wastes from the full authority of RCRA C (Resource Conservation and Recovery Act, Hazardous Waste Rules), it would *prohibit* these wastes from entering a solid waste facility that accepts MSW. Further, even if a facility accepting MSW was to open a cell dedicated only to this type of waste stream, disposal would be restricted *unless that facility was to receive a new permit.*

The Solid Waste Unit has a limited number of hard copies of the proposed rules available. They also may be accessed at www.epa.gov/lead, for the fact sheet; www.epa.gov/fedrgstr, for the notice. We would urge all facility owners and operators to follow this proposed rule, as it has the real potential of affecting your operation.

Composting Rules

The Department will soon be requesting comments on draft composting rules. You may recall that draft rules were withdrawn from consideration in late 1996. Since then the legislature amended the solid waste statute (House Bill 98-1324) in a manner that should allow some legal flexibility for small facilities. Currently a draft is being reviewed by our management, and once approval is obtained, solid waste customers will be sent notification. The draft will be made available on our web page and via mail for those not connected to the Internet.

Recycling Rules

House Bill 98-1324 contained language authorizing recycling rules. While a draft is not yet available, the new statutory language requires that the Department build and maintain a database on materials recycled that is to be updated annually. Also, HB 98-1324 requires that recycling facilities establish an operating volume for their sites. The purpose of the operating volume requirement is to minimize speculative accumulation.

Your ideas on either the Composting or the Recycling Rules are appreciated at any time. Please give these topics your expert consideration. If you require a copy of House Bill 98-1324, or the current statute, please do not hesitate to contact Unit staff. As always, comments are preferred in writing and should be directed to:

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4300 Cherry Creek Drive South
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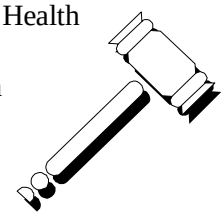
(303) 759-5355 *fax*,
(303) 692-3300 *receptionist*



Colorado Board of Health Approves Regulation Changes

On January 20, 1999, the Colorado Board of Health adopted a set of additions and modifications to the Solid Waste Regulations. The changes are summarized as follows:

1. Additions to the financial assurance portion (Section 1.8) of the regulations include: the addition of a Corporate Test/Guarantee, modeled after the federal rule; a portion allowing the Department to use contractors for closure or post-closure work at facilities; the addition of a Certificate of Deposit as a financial option; various edits to portions of the Section 1.8 and Appendix A for clarification.
2. A completely revised Inspection and Enforcement chapter (Section 1.9) that has been authorized by statutory changes passed in House Bill 98-1324.
3. Revisions to Section 2.1.2 expanding the concept of waste characterization required at solid waste facilities and deleting the term “special waste” from the list of definitions in Section 1.2 and its use throughout the regulations. The expanded waste characterization concept was authorized by House Bill 98-1324 in Section 30-20-110(g).
4. The addition of various new definitions per House Bill 98-1324, House Bill 98-1096, and Senate Bill 98-053. The deletion from Section 1.7 of all reference to the annual registration fees for solid waste facilities (yes, the registration fees are now officially history!).

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Regulation Changes *(continued from page 3)*

Response to Comments

During the course of consideration of the public comment on the newly promulgated regulations, two questions came to light that were subsequently addressed in the *Statement of Basis and Purpose* of the regulations. Portions of the revised *Statement* are provided below.

The first comment deals with the interrelationship between Sections 2 and 3 of the regulations and states, in part, "...there remains fairly widespread confusion in the regulated community regarding the interrelationship between Section 2 and Section 3 of the Department's Solid Waste Regulations."

Response: The purpose for separation of the Minimum Standards (Section 2) from Section 3, and subsequent sections, is that topics addressed in Section 2 need to be addressed by all facilities. Section 2 requires an applicant to consider areas such as hazardous waste screening, ground water monitoring, explosive gas monitoring, nuisance conditions and minimum closure and post-closure conditions. While all of the items addressed in Section 2 may not be applicable to all facility types addressed in subsequent chapters, it was felt at the time of regulation design, in 1993, that having this information in one place was more efficient than repeating it in several sections. Section 1.3.11 of the existing regulations states that Section 2 is to be used in conjunction with all other sections and that all portions of Section 2 may be not applicable to all types of facilities. During an application review these areas of non-applicability are identified as such.

This response was meant to clarify the comment. If this issue is not clear please let me, or your solid waste contact, know, and please detail your concerns so we may better address the concept.

The second comment received concerned the potential applicability of the waste characterization plan that has been newly promulgated to facilities that are exempt from a certificate of designation under C.R.S. 30-20-102(3). This section is commonly known as the "one's own waste exemption."

Response: Since all such facilities are required to meet the substantive requirements, per statute they would have to characterize such waste prior to conducting their "one's own waste" disposal activities on their site. It is not the intent of the Department routinely to require such a plan to be reviewed and approved by the Department. However, in the event that the Department responds to complaints at such a facility, an approved plan should be available for review. Please call your solid waste contact for more information or assistance with plan development.

Once the rules are approved by the Attorney General's Office, they will be made available on the Hazardous Materials and Waste Management Division's web page: (http://www.cdphe.state.co.us/hm/). Look for the heading: *Summary of Solid Waste Regulations*. In addition to the summary, a link will allow customers to download a revised copy of the regulations.

— Glenn Mallory, Solid Waste Unit Leader, (303) 692-3445

Biosolids in Colorado

The term "biosolids" is the new name for what previously had been referred to as sewage sludge. Biosolids are primarily organic treated wastewater residual materials from municipal wastewater treatment plants (with emphasis on the word **treated**) that are suitable for recycling as soil amendments. "Sewage sludge" now refers to untreated primary or secondary organic solids that, if left untreated, cannot be beneficially recycled as soil amendments.

According to EPA 503 Regulations, Colorado's biosolids are considered to be of high quality, Grade I with respect to heavy metals concentrations, as opposed to a Grade II with higher heavy metals concentrations. Currently, Colorado beneficially reuses 82% of the biosolids generated in the state. Beneficial reuse of biosolids includes: land application, for agricultural uses (wheat and corn fields), compost-containing biosolids are produced for home and garden use, and mined land reclamation projects use biosolids for revegetative purposes. Nationally, there are states in the upper Midwest, such as Minnesota and Wisconsin, that beneficially reuse 95%-98% of the biosolids generated in their states. Neighboring states to Colorado--South Dakota, Wyoming and Utah--beneficially reuse around 90% of the biosolids generated in their states. Therefore, percentage wise, Colorado does not lead the nation in land application of biosolids, however, beneficial reuse in the state is higher than the national average.

Due to development in Colorado, many wastewater treatment facilities can no longer apply their biosolids to land near their plant. Agencies either find farmers who want the material applied as soil amendment, or buy land for the purpose of applying biosolids on it in a manner consistent with state and federal regulations so that is environmentally safe and beneficial. Biosolids can be

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Study May Provide New Market and Recycling Opportunity for Tires

After long and faithful service on the "old" family car, SUV or truck, tires no longer perform the tasks for which they were designed. More than 250 million scrap tires are generated annually in the United States. That's the equivalent to almost one tire for every man, woman and child in the country. Approximately four million waste tires are produced in Colorado, with the majority ending up in a land disposal facility. As a result of such volume, the used tire industry has developed many alternative uses for scrap tires, such as: tire-derived fuel; asphalt pavement construction; highway crash barriers; surfaces for playgrounds and walkways; construction building material; alternative daily cover at municipal solid waste landfills and numerous other innovative applications. The search for alternative uses of scrap tires continues to develop and is an evolving process.

A potential scrap tire alternative that may not be as widely known is as a substitute for gravel aggregate in septic system leachfields. Associated with this application is the environmental concern of the potential leachability of organic and inorganic constituents into the ground water from the tires. Although tire shreds are currently being used as septic system aggregate in several states, review of the industry literature appears to indicate no project has been conducted that employs valid scientific methodology. To this end, the Colorado Department of Public Health and Environment, and the Weld County Health Department, with partial assistance from U.S. EPA, have partnered to conduct a study

of the reaction between tire chip aggregate and residential septic system effluent. The primary focus of the study is to evaluate the effect on effluent waters by the tire chip aggregate and appraise the potential impact to shallow groundwater. The study is anticipated to last several years, with sampling and observations conducted quarterly.

Two septic systems are proposed for installation in Weld County. Each system will consist of a tank and distribution box, while the absorption field will be equally divided into both tire chip and rock aggregate trenches. Engineered sampling ports will be installed in both types of trenches for effluent collection, with "control" data samples being collected from the distribution box.

Installation of one system occurred in April 1998. Due to differential settling following installation, effluent was not equally distributed between the tire chip and rock aggregate trenches. Subsequent corrections were made to the distribution lines in August 1998 and samples collected in November 1998. Taking what was learned during installation of the first system, installation of the second system is anticipated to begin mid-1999.

The study's ultimate goal is to take the information obtained and use it to gain Colorado Board of Health approval for statewide use of scrap tires for this type of application. It is hoped that this may create a continuous long-term market for tire shreds in Colorado that would decrease the potential of tires going to a land disposal facility, while establishing a potential market for tire recyclers.

Although Colorado currently does not have a ban on tire disposal at landfills, many states do prohibit such practice. As such, the Department recognizes the need to find new methods for scrap tire reuse. The above research project is a way to demonstrate tire chip aggregate use in a septic system leachfield as an effective application of scrap tires.

Periodic updates on this project will be provided in future articles.

— Roger Doak, Solid Waste Unit
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Function of a Septic System

While septic systems are individually designed for each site's conditions, most are based on the same principles. A conventional septic system consists of a septic tank and absorption (leach) field. The septic tank holds the liquid sewage for a short period of time, where heavy solids and lighter solids, greases and oils are allowed to separate from the wastewater. The stored solids in the tank are decomposed by bacteria and later removed, along with the lighter greases and solids.

The partially treated wastewater leaves the tank and is distributed into the absorption field, where the effluent can seep into the soil for further treatment and purification from bacteria living in the soil. After the bacteriological treatment and filtering, the once-liquid sewage is basically water that will return to ground water. Here it is eventually evaporated to some extent or taken up by plants.

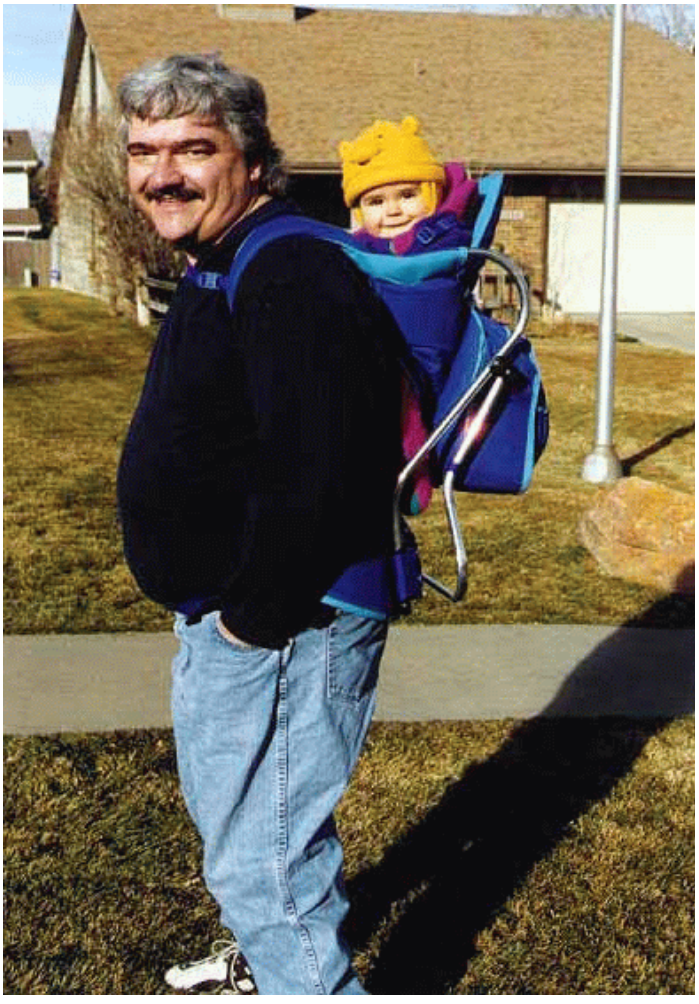
THE LIFE AND TIMES . . . STAFF BIOGRAPHIES

In an effort to make the Solid Waste Unit a more "user friendly" establishment, the next several issues of the newsletter will carry a profile of each of our staff members. By providing background on our staff, as well as putting a face with a name, it is the Unit's hope that the regulated community becomes better acquainted and more comfortable with the folks charged with enforcing the regulations.

That said, our biography series kicks off with Ronald J. Forlina (Ron), our senior staff member and recent first-time father. Ron became the proud papa of Abbie on March 16, 1998. He and his wife of nine years, Andie, welcomed their new daughter and introduced her to the family—Gus, a 3-year, 120 pound Bernese Mountain dog, and two lurking cats, Edgar and Roxanne.

Ron's path to solid waste regulation began at Penn State University where he studied geosciences and obtained a B.S. in geology and geochemistry. Following graduation, this East Coast native moved west and made Colorado his new home, a move Ron describes as the best he ever made.

The early 1980s were booming times for the oil industry, and Ron was able to begin work as a stratigrapher where he remained for nine years. Unfortunately, the boom did not last, and Ron found himself laid off (along with many others) only 10 days before his marriage to Andie in 1989!



Ron and Abbie Forlina

Thanks to the passing of the Trade Readjustment Act, many laid-off individuals were given an opportunity to continue their education, and Ron found himself at the University of Northern Colorado studying towards a master's degree in psychology.

During his studies, Ron sought employment with the State of Colorado, and was selected (along with approximately 300 other geologists) to sit for an employment screening test. Results of the test placed Ron in the top 30, but it was his continued persistence over a number of months that paid off in the end. New degree in hand, Ron joined the Solid Waste Unit in the Spring of 1992.

As a member of the Unit, Ron oversees facilities in 15 counties located mainly in south-central Colorado, including the Fountain, Trinidad and San Luis Valley Regional Landfills. Ron maintains that handling a variety of facility types, sizes and issues has given him the opportunity to apply everything he has ever learned, stating, "Everything has come to bear."

Ron is very passionate about one particular aspect of his position, however, managing ground water data and conducting statistical analysis, utilizing computer databases and modeling programs (See SAMS CORNER for Ron's series on data management systems). Beyond regulation, Ron simply enjoys playing with his daughter and is "looking forward to showing her the world . . . and introducing her to the computer!"

When asked what one thing best describes him, Ron replied, "When I was young, the only thing I wanted to be was a good person, and I always try to conduct myself with that in mind each day."

Next issue we will profile: Mr. Roger Doak.

— Brenda Lujan, Solid Waste Unit
(303) 692-3335

Editor's Note: Brenda Lujan is leaving the Solid Waste Unit to accept a new assignment as a practicing attorney for the firm of Burns, Figa & Will, P.C., as part of their Environmental Law group. She has agreed to continue the staff biography series for this newsletter, and we are grateful for that. We wish Brenda all the best in her new position!

Biosolids in Colorado *(continued from page 4)*

provided in several forms: liquid, cake, pelletized and composted. All are equally advantageous depending upon the beneficial use project's desired outcome. Biosolids are safe and economically beneficial when used as directed by state and federal regulations.

— Lori Tucker, Water Quality Control Division
(303) 692-3613

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form an even mix. The density of the mixture is generally close to that of air. There is a higher concentration of the gases, or simply more gases present, at the points of generation, causing gases to disperse and spread. Pushed by pressure gradients and diffusion, landfill gas will move as far as it can go, most of it following the easiest pathways available. Trash, even with compaction, has abundant void spaces that allow gases to easily move through most landfill materials. Individual molecules of gas are very, very tiny, allowing them to move through even the minute pores present in most soils. They travel easily through topsoil, uncompacted soil, fill material in excavations, and even natural sandy lenses in the ground. So, by their very nature, landfill gases try to get out of the landfill! Consequently, as more and more gases are generated, there is more pressure on them to move. You might say they try really hard to dissipate themselves into the air, and pathways are usually available for them.

Before we consider the dangers presented by accumulations of landfill gas itself, let us look at some trace components that may be of concern. Of special interest is hydrogen sulfide, H_2S: a highly toxic gas. H_2S is considered immediately dangerous to life and health at 100 ppm (parts per million). Greater concentrations can kill a person in a short amount of time! H_2S has the smell of rotten eggs and is detectable by most people at concentrations of one or two ppm. However, a word of warning: H_2S rapidly fatigues your sense of smell, so it cannot be relied upon to warn of continuous exposure. At the first sniff, take precautions! Although usually not the main concern with landfill gas, one should be alert to the danger from this possible component. Small amounts have been detected in several old landfills in Colorado.

Volatile Organic Compounds (VOCs) may also be associated with landfill gas. These are usually found only in trace amounts, especially at old landfills. Large, currently operating municipal solid waste landfills may have more. There are new air regulations addressing emissions of large quantities of non-methane organic compounds. Part 3 of this series will address regulations in more detail.

Some of the landfill-generated gases may find their way to ground water, especially if ground water is in contact with the waste materials. Due to higher solubility, more carbon dioxide than methane can be captured by the water, in part accounting for common detections of more than 60% methane by volume in landfill gases at old, unlined landfills. In addition, the water may take up some of the VOCs, presenting the owner/operator with ground water contamination problems.

So now we have landfill gases on the move and trying to reach the open air. This is fairly easily accomplished at old landfills with only soil cover. The gases rise through the soil and dissipate directly into the air. A cover of hard, compacted clay or pavement presents a barrier and forces the gases to migrate mainly laterally. Many old landfills were located in gravel pits, a convenient way to dispose of trash and wastes, and reclaim the area for other uses. If edges of the gravel pits were defined by property lines, rather than clay soil, the sandy or gravelly material still in place could furnish a relatively easy pathway for horizontal migration. As long as the landfill gases keep moving towards dissipation in air, without accumulating in areas where they could present a hazard, little harm is done. One problem occurs, however, if landfill gases displace air in the soil such that the vegetation does not have enough oxygen or moisture in the root zone for growth. In such cases, patches of poor vegetation over landfills may be indicative of the presence of landfill gases.

Generally, there are no landfill gas hazards to humans in flat, open space on and around landfills. Diffusion takes care of landfill gases as soon as they reach the air. The dangers occur where landfill gases are able to accumulate and displace air—usually in partial or full enclosures.
A partial enclosure may be a trench dug into the ground or a utility manhole. Full enclosures include basements and other underground structures. The hazards presented by accumulations of landfill gases in enclosures fall into two types: asphyxiation and formation of an explosive mixture.

The danger of asphyxiation is obvious. If landfill gases displace air to the extent there is not enough oxygen in the atmosphere, humans and animals could die or be seriously injured from lack of sufficient oxygen. If the oxygen content is reduced from the normal 21% to about 16%
(a dilution by about one quarter landfill gas), a person experiences impaired breathing, judgement and coordination. At half to three-quarters landfill gases, physical illness and loss of consciousness will occur. In an atmosphere containing more than three-quarters landfill gases, people would die quickly.

The problem of an explosive mixture is not as well known. Methane is a light hydrocarbon that burns readily. It is the main component of natural gas used as a fuel in burners, heaters and generators. In order for a hydrocarbon gas to ignite and burn, however, there must be oxygen present to support combustion. Under normal conditions, combustion occurs only when methane is present in quantities of 5% to 15% by volume in air (the explosive mixture range for methane in air). The 5% figure is called the Lower Explosive Limit (LEL) because mixtures below that amount are too lean to burn. The 25% upper limit is called the Upper Explosive Limit (UEL) as mixtures with more than 25% methane are too rich to burn. I would not relax if I measured a methane concentration above the UEL, however, because somewhere close by there could be an explosive mixture!

It is important to understand that the presence of methane in the explosive mixture range will result in an explosion or fire only if there is a source of ignition. The mixture will not spontaneously ignite. Realize though, that to reach the 5% LEL, only about 10% landfill gas needs to mix with air in a basement or other enclosure to form an explosive mixture. And basements contain numerous potential sources of ignition. It takes only a spark, not just an open flame such as a pilot light, to ignite an explosive mixture. Thus any light switch, thermostat, telephone or appliance containing an

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electrical contact, is a potential source of ignition. This is why the gas company tells you to go to a neighbor's house to call them about a possible gas leak.

Modern landfills collect the gases, destroy the methane and dissipate the carbon dioxide above the ground. Owners, operators and neighbors of older landfills without gas collection systems should be aware of potential gas hazards and guard against them. Obviously the best protection against landfill gas hazards is to prevent accumulation. If there is no entrapment of landfill gases as they move towards dissipation, hazards are avoided. Buildings and structures elevated above grade are usually safe because the airspace allows landfill gases to diffuse into the air. Buildings on slabs or with basements require more attention as there are numerous possible pathways for landfill gases to enter: cracks, unsealed joints in concrete and utility line entries. In addition, utility trenches and corridors may be easy pathways for gases to get to a building.

It is important to remember that methane and carbon dioxide are odorless and colorless gases. Some people even say they are utterly tasteless, too! Consequently, we cannot rely on our senses to warn of their presence. Any poorly ventilated area on or near a landfill is prone to problems due to landfill gases. Landowners near old landfills need to be aware of possible dangers and be responsible for protecting themselves, the public and their property. Homeowners can protect themselves by sealing joints and cracks, keeping floor drains filled with water at least monthly and ventilating rooms regularly. For landfill owners and operators there are regulations in Colorado that set thresholds for action. These will be reviewed in the next article in this series: "Part 3 *Colorado Regulations Pertaining to Landfill Gases."*

— Pete Laux, Solid Waste Unit, (303) 692-3455

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