Fuels in sewers

Emergency Response Program

A primer for dealing with petroleum and petroleum vapors in sewer systems.

Introduction

Every year, the Minnesota Pollution Control Agency's (MPCA) Emergency Response Program (ERP) receives over 3,000 reports of spills and releases of chemicals and hazardous materials. More than 80 percent of these are spills of some type of petroleum, and in a significant number of instances, these products find their way into storm or sanitary sewers.

Petroleum products in sewers represent a special set of problems, including vapors that can sometimes reach explosive levels. This document outlines procedures emergency response personnel should take when dealing with petroleum and petroleum vapors in storm and sanitary sewers.

Sources of fuels in sewers

Gasoline, diesel and fuel oil are among the most common petroleum products spilled or released to sewer systems. There are a number of ways these materials get into sewers and the most common sources are:

- Spills from traffic accidents.
- Overfilling of storage tanks.
- Overfilling of vehicles at gas stations.
- Leaking storage tanks, both aboveground and underground.
- Accidental or intentional discharges.
- Pipeline leaks and ruptures.
- Runoff from roads and parking lots.

Streets, roads, and parking lots are sloped to drain water to catch basins, which in turn drain into storm sewers. Spills and overfills on the street, at gas stations, and at petroleum bulk plants can enter the storm sewer via catch basins, too.

Storm sewers carry storm water and snow melt to streams, lakes, ditches, wetlands, and holding ponds. If the water is contaminated with petroleum, it can damage vegetation, get on people and pets, and harm fish and wildlife.

Sanitary sewers move sewage or wastewater generated from homes, businesses, and industries to a wastewater treatment plant. If petroleum is carried along with the wastewater, it can severely hinder a treatment plant's effectiveness.

Petroleum can also get into sanitary sewers when basement heating oil tanks lose their contents, either by a rupture, from loose or broken pipe fittings, or from overfills during delivery. Typically, fuel will collect in a sump and be pumped from there into the sewer or enter the sewer through floor drains. In these cases, the source of the fuel will be easily discovered, but sometimes not until hours after the petroleum and vapors show up in sewer or treatment plant.

And of course, industries and individuals sometimes have accidents or equipment malfunctions which result in petroleum and/or chemical discharges to sewers. Notifying the city sewer department or treatment plant operator is required of some companies and a joint effort may occur to respond to the spill.

Intentional dumping into sewers occurs, too. Examples include used oil poured into catch basins, unused gasoline from lawnmowers or other equipment drained to catch basins, or oils or parts cleaner flushed into a drain connected to a sanitary sewer. This is illegal and consequences can include fines and large cleanup costs.

If petroleum leaks from a corroded storage tank, the underground path it travels is not very clear. In general, the fuel will follow the easiest path available. It may move through the surrounding soil until it intersects a sewer line and then follow that path, either by infiltrating the sewer line directly or moving through the fill surrounding the sewer pipe and traveling along the pipe. Petroleum products and vapors can infiltrate utility access shafts in the same manner.

Storm and sanitary sewer construction

When petroleum products are discovered in a sewer system, the first step is to determine whether it's a storm sewer or a sanitary sewer. In most cases, it is easy to determine the sewer type, but in others it is not so clear cut. The following two sections outline the basics of sewer design and construction and should help responders in determining sewer type.

Storm sewers

Storm sewers transport storm water and snow melt from roadways, drainage ways, catch basins and foundation drains to an "outfall" at some type of surface water, such as a wetland, stream, river or lake. Once it has been determined that the problem is in a storm sewer, the discharge point needs to be determined quickly. After obtaining and reading sewer maps, someone should be dispatched to the sewer outfall as quickly as possible to assess the situation there. For more information on handling petroleum at outfalls, see the section on recovering petroleum from storm sewers on page 8.

Storm sewers generally consist of:

- Catch basins and surface inlets;
- Concrete, clay tile, corrugated metal or brick collection lines;
- Manholes to allow for maintenance or grade changes, "storm" may be stamped on the manhole cover and some are grated to allow water to flow through them; and
- Bedding material such as sand or fine gravel to provide a stable base for the sewer line.

Storm sewer lines are usually constructed with "push-on" joints and are not normally watertight unless they are built in an area where the water table is high. This means that petroleum entering the sewer from the surface can seep out of the sewer line into the bedding material and surrounding soil. Conversely, petroleum from leaking underground storage tanks can percolate through the soil surrounding the sewer line and enter it through the joints or seams.

Overall, storm sewers are usually not as deep below the surface as sanitary sewers.

Sanitary sewers

Sanitary sewers are constructed to transport sewage or wastewater generated from homes, businesses, and industries to a treatment facility. Sanitary sewer systems generally consist of:

- Service lines which carry sewage from buildings to lateral or branch lines;
- Lateral and branch lines at the upper ends of the system—typically they are at depths of 7 feet or greater to prevent freezing;
- Main lines, trunk lines, and interceptor lines that collect the wastewater from several lines and carry it to the treatment plant—these lines are larger in diameter and carry larger quantities of wastewater;
- Manholes used for line maintenance or grade/alignment changes—covers may be stamped with "sanitary" and are usually solid so that surface water cannot infiltrate the line; and
- Lift stations to pump wastewater to higher elevations to maintain a flow by gravity, or to a force main.

Plastic, concrete, clay tile, and ductile iron pipe are commonly used in the construction of sanitary sewers.

Unlike storm sewers, sanitary sewers are constructed to be watertight. Joints may have gaskets, cement mortar, or be mechanically jointed.

Gasket material is usually a neoprene or rubber-like material. However, the joints of older sewers may no longer be watertight due to their age, settling of soil, or other construction problems. Additionally, sewer pipes can crack and/or pull away from the manholes.

Sanitary sewers are often cradled in a bedding material which provides stability for the installation. In general, the bedding material is more porous than the natural soil adjacent to the sewer line. The porosity of the soil allows liquid (water/fuel) to flow alongside the sewer until crossing an opening where the liquid can enter the sewer, or until an easier pathway is encountered.

When the slope of the sewer line is not sufficient to maintain adequate velocity for gravity flow, a lift station is built into the line. Lift stations pump wastewater to higher elevations so flow can continue with gravity, or to a force main. The atmosphere in a lift station is corrosive and potentially explosive due to the decomposition of the sewage and the byproduct gases generated within.

Sanitary sewers flow to wastewater treatment facilities. If large concentrations of petroleum products reach a facility, explosive conditions can be created quickly. Any type of petroleum has the potential to cause serious damage to a treatment plant by killing the microorganisms that treat wastewater. This greatly reduces the treatment plant's ability to properly treat incoming sewage.

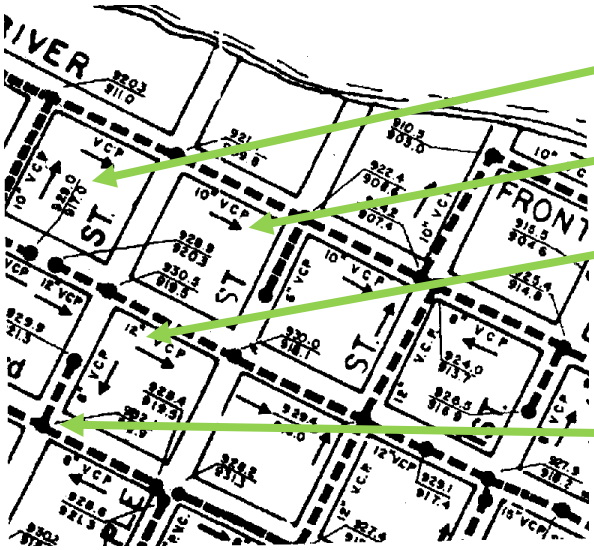
Reading sewer maps

When faced with investigating petroleum products and vapors in sewers, being able to read sewer maps is an absolute necessity. The ability to read a sewer map enables the reader to predict and track petroleum pathways in sewers.

Before an incident occurs, familiarize yourself with the maps available for your area and get to know staff in the public works department. The working knowledge of these employees can be quite valuable, especially in areas where the "as built" condition of sewers is not the same as shown on maps.

Be sure to read the map legend or key for symbol interpretation. Also be aware that sewer maps often represent the planned sewer construction, not "as built" conditions. So as mentioned before, many times the maps are not accurate or in some cases outdated and may not represent the actual layout of the sewer system.

Maps vary from city to city, but some of the basic information provided on sewer maps usually includes:



Elevations of the lines, manholes, grit chambers and lift stations

Flow direction, depicted with arrows

Diameter and type of pipes-clay, concrete, drain tile, etc.

Locations of manholes, lift stations, bypass points, grit chambers and outfalls – some cities number their manholes;

Hazards

The following hazards should be recognized, planned for and monitored to keep yourself and others safe. **Unless you are completely familiar with the type of product you are dealing with and the other substances normally carried by the sewer line, assume you are working in an atmosphere with toxic, flammable, irritating substances which can cause disease — protect yourself accordingly!**

1. **Explosions.** An explosion can occur if there is a buildup of flammable gases in the sewer line or connected structures. Proceed very cautiously while investigating and assume that an explosion is possible until your monitoring instruments tell you otherwise.

   Vapor from petroleum is unpredictable and uncontrollable during an investigation. Use an instrument to measure the percent of the lower explosion limit (LEL) of flammable gas present to determine if it is safe to proceed (more information on LELs is given on page 6). If conditions are right, a spark from a vehicle, tool, or open flame, such as a cigarette or lighter, can set off an explosion in the sewer, damaging homes, businesses, and sometimes entire streets.

2. **Poisonous or toxic gases.** Various gases can be generated from natural decomposition of the organic solids in wastewater, from chemical dumping, or from reactions of two or more chemicals present in the sewer. Hydrogen sulfide is the most dangerous and most likely encountered gas because it is generated during decomposition of organic matter. It is heavier than air and tends to concentrate in low areas.

   Hydrogen sulfide smells like rotten eggs, but the human nose tends to lose its sensitivity to it. Because of this, responders should not rely on their sense of smell to tell if gases are present. Use an instrument equipped with a hydrogen sulfide sensor to measure the presence of the gas before working in the area.

3. **Oxygen deficiency.** Since sewers are somewhat of a closed system, oxygen can run low due to the decomposition of the sewage and the restricted air flow. If the oxygen content is below 19.5 percent, there is not enough oxygen to support life. Use an instrument to measure the oxygen content before working in the area.

4. **Biological.** Sewers are not clean places to work because of the infectious organisms found in sewage. Therefore, wear gloves and eye protection, take care not to splash sewage on yourself, and practice good personal hygiene. Wash your hands as soon as possible after working in and around sewers, and wash your clothing as soon as possible, too. Do not eat, drink, or smoke while working around sewers.

5. **Slip and trip.** Use care on wet pavement and icy areas. If petroleum is spilled on asphalt it can create very slippery conditions. Watch your footing and do not leave equipment lying on the ground.

6. **Traffic.** Sewers and manholes are almost always located in streets, so make yourself visible to traffic. Wear highly visible safety vests and use traffic barricades or your vehicle to block off or regulate traffic in the work zone so that you can do your work safely.
7. **Confined space.** Sewers and lift stations are considered confined spaces. Be sure to follow OSHA regulations for safety when working in them. Never enter a confined space alone.

Petroleum characteristics

Another key factor to consider when dealing with petroleum products in sewers are the characteristics of the particular type of fuel. In general, petroleum fuels float on water and are toxic and flammable. Some heavier oils may sink, especially in cold weather. Below are the characteristics of some common petroleum products. Gasoline will evaporate and the vapor can accumulate and reach explosive conditions in a sewer line or connected buildings. Fuel oils are not an explosion hazard but can create odor problems in a sewer and connected buildings. Vapor and odors can infiltrate buildings through dry drain traps and vent lines in the buildings' sewer piping.

Characteristics

Product	Vapor production	Flashpoint	Floats on water	Toxicity
Gasoline	High	-45° F	Yes	Short and long term
Crude oil	High and low, depending on source	20° F - 90° F, depending on source	Yes	Short/long term, often contains sulfur
Diesel and home fuel oils	Less than gasoline	126° F	Yes	Long term
No. 6 fuel oil	Less than diesels and home fuel oils	150° F	Usually, but may sink when cold	Long term

Measuring vapors

When investigating petroleum in sewers, some specialized equipment is needed. Most important are instruments used to measure lower explosive limit (LEL), oxygen, and organic gases. All sewer departments should have access to the instruments needed to reliably measure percent oxygen, percent LEL of flammable gases, percent carbon monoxide, and parts per million of hydrogen sulfide. Instruments that can do all four are called "four gas meters." However, there are other names for them, such as "gas sniffers," "atmospheric alarm units," "combustible gas indicators" or "explosimeters." Some instruments can only measure one or two of these gases.

To safely assess conditions in a sewer, all four of these compounds need to be measured. Many fire departments have explosimeters that only measure the LEL of flammable gases. Check with your local public works department if your fire department does not have the instruments needed to measure oxygen and hydrogen sulfide.

If you have the necessary instruments, be sure they are properly calibrated, you are trained and that you are familiar with their operation. If you cannot get the instruments to measure these compounds, do not proceed to investigate a sewer with petroleum in it. Call your neighboring city or mutual aid departments to borrow the necessary equipment or call the Minnesota Duty Officer to request assistance from the Minnesota State Fire Marshall's Office, MPCA, and/or to request a state Hazardous Material Team. These numbers and more information about the assistance available from these organizations can be found on page 9.

Conducting a sewer survey

When petroleum odors are detected in a sewer system, it is necessary to find out where the petroleum is coming from and where it is going. A sewer survey will help emergency responders assess the conditions and determine the best control measures to implement. By following a step-by-step assessment of the situation, you may be able to locate the source of the petroleum and determine what serious effects it might have.

The following equipment is necessary or helpful to perform a survey:

- Four gas meter, properly calibrated;
- Organic vapor monitor or photo ionization detector (PID);
- Non-sparking pick or manhole pry bar;
- Intrinsically safe flashlight (or mirror if it is a sunny day);
- Nomex or turnout gear;
- Protective gloves;
- One-gallon pail with a handle;
- Rope;
- Traffic cones and vests (or other traffic-control devices); and
- Sewer maps.

In addition, the following people or organizations are helpful for their knowledge, equipment and expertise:

- Local fire department for fire/explosion hazard assessment;
- Local/county police department or MnDOT for traffic control;
- Local sewer department for maps, equipment and knowledge of sewer system; and
- MPCA Emergency Response Program staff for specialized equipment and inventory of potential sources in the area.

Step 1: Map reading and starting out

Using a city sewer map, locate the problem area and determine the direction the sewer flows. If you are unable to locate a map, begin sketching one.

Beginning at the manhole closest to the complaint area, take an explosimeter reading through the hole in the manhole cover or by cracking the cover open. Record this reading.

Step 2: Instrument readings

If the Lower Explosive Level (LEL) is greater than 50 percent, an explosion hazard exists—DO NOT OPEN THE MANHOLE! If the fire department is not already on site, call 911 to report this potential explosion hazard. Before investigating any further, the sewer must be ventilated to decrease the threat of an explosion. See Step 6 for more information on how to ventilate sewers.

If the LEL is less than 50 percent, remove the manhole cover and take another reading deeper in the hole. Use a sample extension hose or lower the instrument down with rope, being careful not to submerge the probe. Petroleum vapors are heavier than air, so expect higher readings closer to the sewage or water. Record the reading and wastewater flow direction. Take note of the amount of flow and any visible pipe connections.

Step 3: Checking for product

Wearing protective gloves, lower a bucket on a rope and collect a wastewater sample. Look for petroleum rainbows or sheen and the presence of petroleum odor. Let the sample settle for a few minutes—sometimes droplets of petroleum will surface.

Pour the sample back into the sewer. If product is visible and you have sorbent pads available, tie one onto a rope and lower it into the wastewater. After a few minutes check to see whether the sorbent has absorbed any product. Record your observations.

Step 4: Tracking product up the line

If petroleum product is found, repeat steps 2 and 3 upstream, using your instruments and visual observations to track the presence of product in the sewer. Remember to check the sewer maps for incoming lateral lines and consider the possibility of the product coming from one of those lines. And remember that many times sewer maps are not completely accurate, so lateral lines may exist even if not shown on a map. Some cities may not even have sewer maps available, so local knowledge of the system is critical.

Step 5: Determining the source

Once product is traced as far upstream as possible, look for potential sources of the material. Determine whether the source is a one-time spill into the sewer or a continuous infiltration of the sewer. Be aware that sometimes drafts in a sewer can pull vapors upstream of the actual source.

If the source is a small one-time spill, recover as much product as possible and then flush the sewer line with water. If flushing within the sewer does not seem to eliminate the odor problem, look for other potential sources, such as gas stations, other tank facilities (look for fill and vent lines in the area), and other possible sources nearby.

Step 6: Ventilating

If, during your investigation, LEL readings were recorded at 10 percent or higher consistently, the sewer should be ventilated on a long-term basis. Place an intrinsically safe fan or blower on the manhole closest to the highest reading. Position the fan to pull air out of the sewer, creating a negative pressure in the sewer line. Do NOT blow air in—this could push explosive vapors toward an ignition source.

Use barricades or other safety devices to warn people and vehicles to stay away. Control ignition sources where flammable vapors are being exhausted. It is advised to monitor for LEL and consider establishing an exclusion zone where vapor concentrations are elevated. If the closest manhole is in a very busy road, select a manhole in a safer area upstream or downstream.

To power the fan, use an extension cord to a nearby outlet or generator. If possible, direct the exhaust away from passersby, buildings, and fresh-air intakes.

Step 7: Control and recovery of oil

Sanitary sewers

If a substantial amount of petroleum is present in the sewer and if it might threaten the operation of the wastewater treatment plant, recovery of the product should be started as soon as possible. One way to do this is to tie several sorbent pillows or a sorbent boom to a rope and float them in the sewer to absorb the oil. Or, if flow in the sewer is low, sandbagging the wastewater and absorbing, skimming, or pumping out the oil may be possible. As mentioned previously, be sure that someone has notified the treatment plant of the situation.

Since most homes have floor drains in either their basement or shower stalls, an attempt to assess whether homeowners are affected should be undertaken. Go door to door and check some drains in the neighborhood to see whether petroleum vapors are infiltrating homes.

If infiltration is occurring, instruct homeowners to add water to their floor drain traps and cover the traps with wet rags, plastic, and tape, or some other type of barrier. As a last resort, running water through the drains may help eliminate the odor problem temporarily on chronic problems, or permanently for one-time spill situations. However, use caution when flushing drains. Use low volumes of water initially and gradually increase the flow.

Storm sewers

As is the case with sanitary sewers, attempt recovery of the petroleum within the sewer line if possible, especially in low-flow lines where pockets of product are visible.

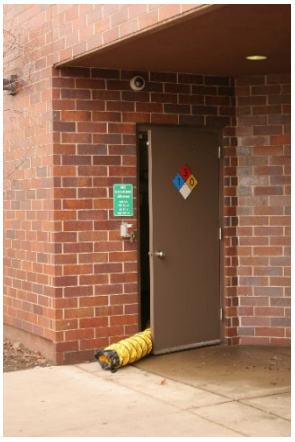
All storm sewers discharge to some type of surface water. Responders will need to locate the outfall of the storm sewer and assess the water coming out of the line. If a rainbow sheen or visible product is being discharged, place sorbent boom in the water around the outfall. Sorbent boom is a synthetic polypropylene material wrapped in plastic mesh. The sorbent boom soaks up oil and repels water. It normally comes in 10-foot links that can be joined together with fasteners to make a long, continuous floating barrier to encircle the discharge pipe or culvert. If containment boom is available, it may be more effective to deploy containment boom and then deploy some sorbent boom between the containment boom and the discharge pipe or culvert, especially if free product is present.

Once boom is in place, a controlled flush of the sewer can be done to collect the oil at the discharge point and further assess how much oil is present in the line. For a large volume of fuel in the sewer, it may be advisable to consider waiting to flush the line until a vacuum truck is on scene to recover the fuel.

Petroleum vapors in buildings

Buildings with vapors present should be treated as confined spaces and handled with caution.

Step 1: Entry



Take continuous explosimeter readings upon entering the building. Self-contained breathing apparatus is recommended if any odors are present and until the building conditions have been assessed. No further entry is recommended if a reading greater than 10 percent LEL is found within the building.

Step 2: Assessment

Try to determine the path through which the vapor is entering the building. Vapors can infiltrate through the floor, sink or shower drains, sewer vent lines, cracks in foundation walls or floors, or earthen floors. Common pathways include improperly piped drains, cracked vent lines or cleanout plugs, or dry drain traps. Check these locations and record your observations.

Step 3: Vapor control

Building evacuation is recommended if the LEL readings are above 10 percent. Try to block vapor entry by pouring water in dry traps, covering traps with wet rags or plastic and tape, or sealing cracks and crevices with caulk. Record your actions and locations.

If the LEL readings are above 10 percent anywhere inside the building, ventilate the building using an intrinsically safe fan or blower. Always position the fan to pull air out of the building—do not blow air into the building. Exhaust air should be vented so that it is not a nuisance to others. Protect from ignition sources at the exhaust point also.

Reporting and resources

Those responsible for spills and releases of pollutants are required to report their incident to the Minnesota Duty Officer. This fulfills their required notification to the MPCA, too. The Minnesota Duty Officer telephone numbers are (651) 649-5451 or (800) 422-0798.

The source of some spills is a mystery when it comes to determining who is responsible. The MPCA requests that local sewer and fire departments call the Minnesota Duty Officer and report these types of incidents when they encounter them.

Assistance available from the MPCA

The MPCA has an Emergency Response Program (ERP) available to assist in these incidents 24 hours a day. The MPCA's ERP staff have investigation and cleanup expertise that is helpful in these situations. Please do not hesitate to call for assistance from the MPCA staff, who can be reached through the Minnesota Duty Officer.

The MPCA also has many fact sheets that describe cleanup requirements and disposal options. In addition, MPCA staff are available to meet and discuss response issues with local fire departments.

Other resources available

Minnesota has, through the Department of Public Safety, a Hazardous Materials Regional Response Team Program to assist local public safety officials in handling hazardous material incidents. This program offers response teams to assist local police or fire departments.

These teams can assess situations and their hazards and have four gas meters and other instruments which may be helpful. The teams can provide some hands-on assistance, such as deploying sorbent boom or containment boom at outfalls. To receive assistance from these teams, the Incident Commander (typically the Fire Chief) can call the Minnesota Duty Officer and make a request. In most cases, these teams can respond more quickly than the MPCA.

For your information

For petroleum tank owners or operators experiencing a release or spill, report your incident immediately and request direction from the on-call MPCA Emergency Response Program staff.

For information about emergency response, call the MPCA office nearest you:

- St. Paul (651) 296-6300 or toll-free (800) 657-3864
- Detroit Lakes (218) 847-1519
- Brainerd (218) 828-2492
- Duluth (218) 723-4660
- Mankato (507) 389-5977
- Marshall (507) 537-7146
- Rochester (507) 285-7343

Information is also available on the MPCA's website at
https://www.pca.state.mn.us/about-mpca/emergency-response