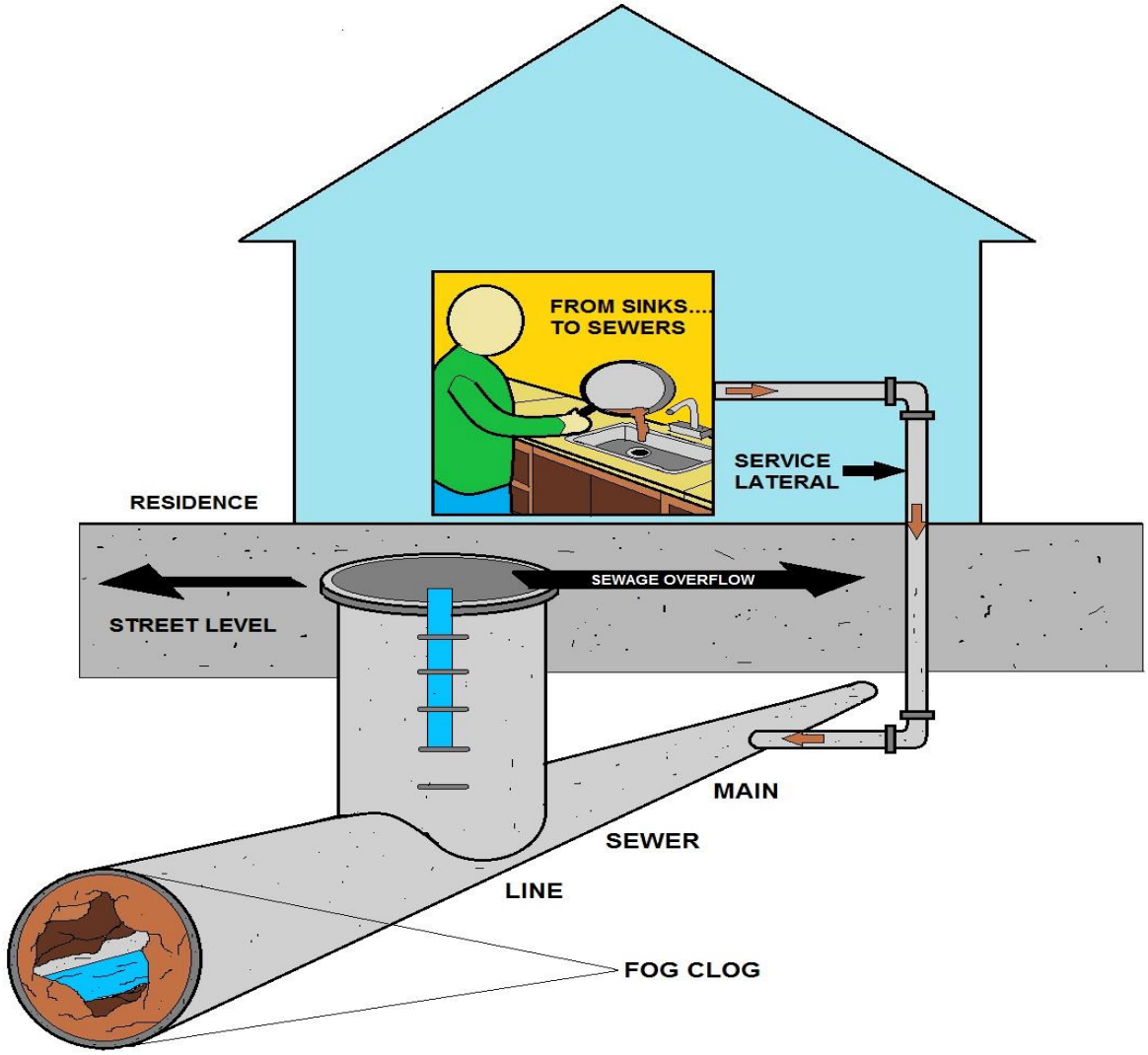
FOG
FATS, OILS AND GREASE
CONTINUING EDUCATION
PROFESSIONAL DEVELOPMENT COURSE



Technical Learning College

Printing and Saving Instructions

TLC recommends that you download and save this pdf document and assignment to your computer desktop and open it with Adobe Acrobat DC reader.

Adobe Acrobat DC reader is a free computer software program and you can find it at Adobe Acrobat's website.

You can complete the course by viewing the course on your computer or you can print it out. This course booklet does not have the assignment (the test). Please visit our website and download the assignment (the test).

Printing Instructions: Once you have purchased the program, we will give you permission to print this document. If you are going to print this document, it was designed to be printed double-sided or duplexed but can be printed single-sided.

Hyperlink to Assignment…
http://www.abctlc.com/downloads/PDF/FOGASS.pdf

State Approval Listing Link, check to see if your State accepts or has pre-approved this course. Not all States are listed. Not all courses are listed. Do not solely trust our list for it may be outdated. It is your sole responsibility to ensure this course is accepted for credit. No refunds.

State Approval Listing URL…
http://www.abctlc.com/downloads/PDF/CEU%20State%20Approvals.pdf

Hyperlink to the Glossary and Appendix
http://www.abctlc.com/downloads/PDF/WWTGlossary.pdf

You can obtain a printed version from TLC for an additional $89.95 plus shipping charges.

All downloads are electronically tracked and monitored for security purposes.

Some States and many employers require the final exam to be proctored.

Do not solely depend on TLC's Approval list for it may be outdated.

A second certificate of completion for a second State Agency $50 processing fee.

Most of our students prefer to do the assignment in Word and e-mail or fax the assignment back to us. We also teach this course in a conventional hands-on class. Call us and schedule a class today.

Responsibility

This course contains EPA's federal rule requirements. Please be aware that each state implements collections / onsite / wastewater / safety regulations that may be more stringent than EPA's or OSHA's regulations. Check with your state environmental agency for more information. You are solely responsible in ensuring that you abide with your jurisdiction or agency's rules and regulations.

Copyright Notice

Contributing Editors

James L. Six Received a Bachelor of Science Degree in Civil Engineering from the University of Akron in June of 1976, Registered Professional Engineer in the State of Ohio, Number 45031 (Retired), Class IV Water Supply Operator issued by Ohio EPA, Number WS4-1012914-08, Class II Wastewater Collection System Operator issued by Ohio EPA, Number WC2-1012914-94

Joseph Camerata has a BS in Management with honors (magna cum laude). He retired as a Chemist in 2006 having worked in the field of chemical, environmental, and industrial hygiene sampling and analysis for 40 years. He has been a professional presenter at an EPA analytical conference at the Biosphere in Arizona and a presenter at an AWWA conference in Mesa, Arizona. He also taught safety classes at the Honeywell and City of Phoenix and is a motivational/inspirational speaker nationally and internationally.

James Bevan, Water Quality Inspector S.M.E. Twenty years of experience in the environmental field dealing with all aspects of water regulations on the federal, state, and local levels. Experience in the water/wastewater industry includes operation of a wastewater facility, industrial pretreatment program compliance sampling, cross-connection control program management, storm water management, industrial and commercial facility inspections, writing inspection reports for industry, and technical reports per EPA permit requirements. Teacher and Proctor in Charge for Backflow Certification Testing at the ASETT Center in Tucson for the past 15 years and possess an Arizona Community College, Special Teaching Certificate in Environmental Studies. Extensive knowledge and experience in college course and assignment/assessment writing.

Dr. Pete Greer S.M.E., Retired biology instructor, chemistry and biological review.

Jack White, Environmental, Health, Safety expert, City of Phoenix. Art Credits.

A vactor truck is often utilized in the pumping and cleaning of clogged sewer lines. Always be careful of all construction and maintenance concerns for everything in the sewer or septic field is dangerous and many operators have been injured and killed.

Check with your state environmental/health agency for more information. These rules change frequently and are often difficult to interpret and follow. Be careful to not be in non-compliance and do not follow this course for proper compliance.

Technical Learning College's Scope and Function

Welcome to the Program,

Technical Learning College (TLC) offers affordable continuing education for today's working professionals who need to maintain licenses or certifications. TLC holds several different governmental agency approvals for granting of continuing education credit.

TLC's delivery method of continuing education can include traditional types of classroom lectures and distance-based courses or independent study. TLC's distance based or independent study courses are offered in a print - based distance educational format. We will beat any other training competitor's price for the same CEU material or classroom training.

Our courses are designed to be flexible and for you to finish the material at your convenience. Students can also receive course materials through the mail. The CEU course or e-manual will contain all your lessons, activities and instruction to obtain the assignments. All of TLC's CEU courses allow students to submit assignments using e-mail or fax, or by postal mail. (See the course description for more information.)

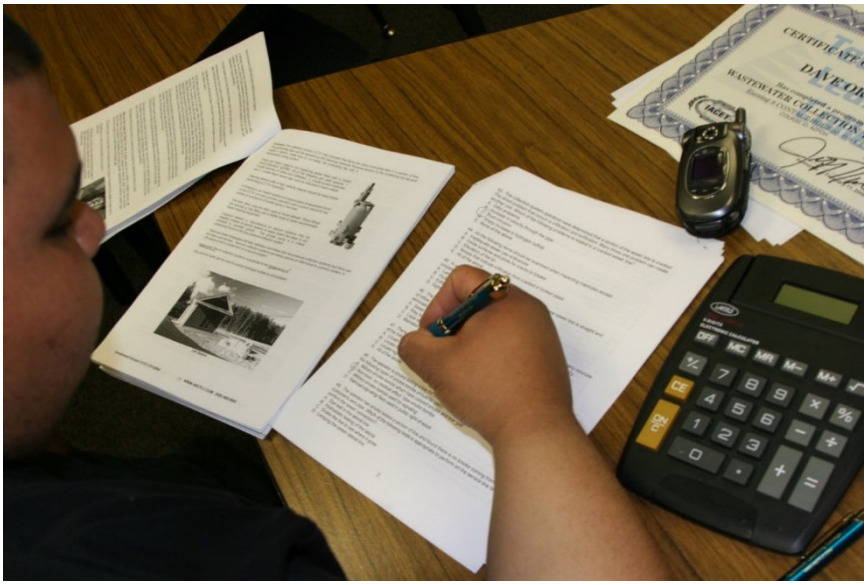
Students have direct contact with their instructor—primarily by e-mail or telephone. TLC's CEU courses may use such technologies as the World Wide Web, e-mail, CD-ROMs, videotapes and hard copies. (See the course description.) Make sure you have access to the necessary equipment before enrolling, i.e., printer, Microsoft Word and/or Adobe Acrobat Reader. Some courses may require proctored closed-book exams, depending upon your state or employer requirements.

Flexible Learning
At TLC there are no scheduled online sessions or passwords you need contend with, nor are you required to participate in learning teams or groups designed for the "typical" younger campus-based student. You will work at your own pace, completing assignments in time frames that work best for you. TLC's method of flexible individualized instruction is designed to provide each student the guidance and support needed for successful course completion.

Course Structure
TLC's online courses combine the best of online delivery and traditional university textbooks. You can easily find the course syllabus, course content, assignments, and the post-exam (Assignment). This student-friendly course design allows you the most flexibility in choosing when and where you will study.

Classroom of One
TLC offers you the best of both worlds. You learn on your own terms, on your own time, but you are never on your own. Once enrolled, you will be assigned a personal Student Service Representative who works with you on an individualized basis throughout your program of study. Course specific faculty members (S.M.E.) are assigned at the beginning of each course providing the academic support you need to successfully complete each course. Please call or email us for assistance.

Satisfaction Guaranteed
We have many years of experience, dealing with thousands of students. We assure you, our customer satisfaction is second to none. This is one reason we have taught more than 40,000 students.



We welcome you to do the electronic version of the assignment and submit the answer key and registration to us either by fax or e-mail.

If you need this assignment graded and a certificate of completion within a 48-hour turn around, prepare to pay an additional rush charge of $50.

Contact Numbers

Fax (928) 468-0675
Email Info@tlch2o.com
Telephone (866) 557-1746

Fats, Oils and Grease (FOG) CEU Training Course

CEU Course Introduction

This three-contact hour CEU course is a review of fats, oil and greases primarily relating to wastewater collection maintenance and/or grease interceptor operation. This course was designed to provide continuing education credit to wastewater treatment /collection / onsite operators.

This course was designed to provide continuing education credit to wastewater treatment /collection / onsite operators.

Course Purpose

The main purpose of this course is to provide continuing education in understanding various FOG concerns, including remedies, Hydrogen Sulfide safety, CMOM, cleaning methods and best management practices.

This course is general in nature and not state specific, but will contain commonly found wastewater collection cleaning methods, hydrogen sulfide safety and general FOG information. You will not need any other materials for this course.

Target Audience

The target audience for this course is primarily for operators who work in wastewater operations; Onsite, Pretreatment, Wastewater Treatment and Collections.

Also included are people interested in working in a wastewater treatment or onsite facility and/or wishing to maintain CEUs for a certification license or to learn how to perform their job safely and effectively, and/or to meet education needs for promotion. There are no prerequisites, and no other materials are needed for this course.

Course Statement of Need

All wastewater related personnel and/or work for Administrative Authorities, Maintenance facilities, Municipalities, Onsite or Septic Pumpers should have an understanding of the problems associated with fats, oils and grease and CMOM related concerns.

Instructions for Written Assignments

The ***Fats, Oils and Grease (FOG)*** distance learning course uses a multiple-choice style answer key. You can find the answer key in the front section of the assignment.

Feedback Mechanism (Examination Procedures)

Each student will receive a feedback form as part of his or her study packet. You will be able to find this form in the front of the course assignment or lesson.

Security and Integrity

All students are required to do their own work. All lesson sheets and final exams are not returned to the student to discourage sharing of answers. Any fraud or deceit and the student will forfeit all fees and the appropriate agency will be notified. A random test generator will be implemented to protect the integrity of the assignment.

Grading Criteria
TLC will offer the student either pass/fail or a standard letter grading assignment. If TLC is not notified, you will only receive a pass/fail notice. In order to pass your final assignment, you are required to obtain a minimum score of 70% on your assignment.

Required Texts
The ***Fats, Oils and Grease (FOG)*** course comes complete with a short summary of the EPA's CMOM Regulations and related standards. If you need more information or a complete set of Rules, you can download them off the EPA's web page, www.epa.gov or contact your local state environmental agency. You may need to contact a laboratory or state agency for certain sampling information.

Recordkeeping and Reporting Practices
TLC will keep all student records for a minimum of seven years. It is the student's responsibility to give the completion certificate to the appropriate agencies. TLC will not release any records to any party, except to the student.

ADA Compliance
TLC will make reasonable accommodations for persons with documented disabilities. Students should notify TLC and their instructors of any special needs. Course content may vary from this outline to meet the needs of this particular group. There is an option course assignment available, please contact an instructor for further assistance.

Mission Statement
Our only product is educational service. Our goal is to provide you with the best education service possible. TLC will attempt to make your learning experience an enjoyable opportunity.

Student Verification
The student shall submit a driver's license for signature verification and track their time worked on the assignment. The student shall sign an affidavit verifying they have not cheated and worked alone on the assignment. All student attendance is tracked on the student attendance database.

Environmental Terms, Abbreviations, and Acronyms
TLC provides a glossary in the front of this manual that defines, in non-technical language, commonly used environmental terms appearing in publications and materials, as well as abbreviations and acronyms used throughout the EPA and other governmental agencies.

Record Keeping and Reporting Practices
TLC keeps all student records for a minimum of five years. It is the student's responsibility to give the completion certificate to the appropriate agencies.

Educational Mission

The educational mission of TLC is:

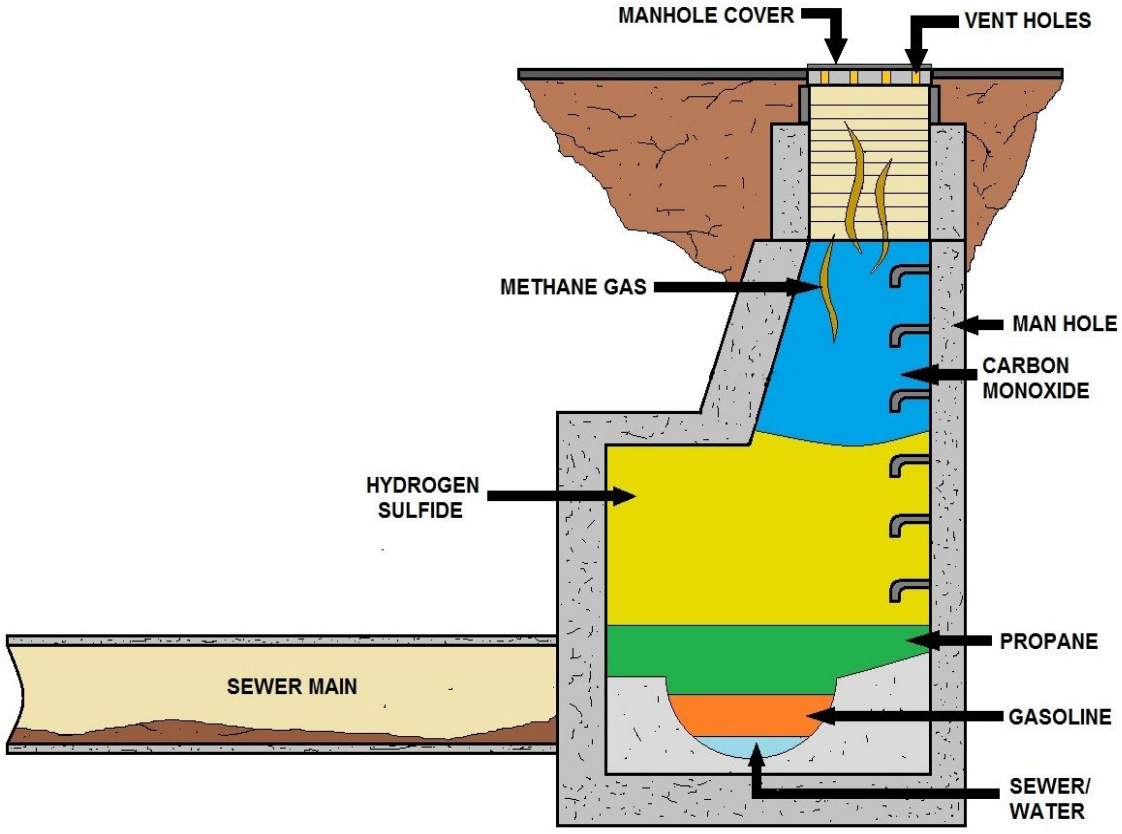
To provide TLC students with comprehensive and ongoing training in the theory and skills needed for the environmental education field,

To provide TLC student's opportunities to apply and understand the theory and skills needed for operator certification,

To provide opportunities for TLC students to learn and practice environmental educational skills with members of the community for the purpose of sharing diverse perspectives and experience,

To provide a forum in which students can exchange experiences and ideas related to environmental education,

To provide a forum for the collection and dissemination of current information related to environmental education, and to maintain an environment that nurtures academic and personal growth.



POSSIBLE HAZARDOUS ATMOSPHERES PRESENT IN A CONFINED SPACE (EXAMPLE IS OF A SEWER MAIN)

TABLE OF CONTENTS

In this photo, you can see an automatic sampler and a pickle jar which are commonly used in a pretreatment program. The Inspector is pouring off a composite FOG sample for compliance testing. pH sampling is essential for a proper wastewater sampling program.

Preface

The industrial boom in the United States during the 1950s and 60s brought with it a level of pollution never before seen in this country. Scenes of dying fish, burning rivers, and thick black smog engulfing major metropolitan areas were images and stories repeated regularly on the evening news. In December of 1970, the President of the United States created the U.S. Environmental Protection Agency (EPA) through an executive order in response to these critical environmental problems.

In 1972, Congress passed the Clean Water Act (CWA) to restore and maintain the integrity of the nation's waters. Although prior legislation had been enacted to address water pollution, those previous efforts were developed with other goals in mind. For example, the 1899 Rivers and Harbors Act protected navigational interests while the 1948 Water Pollution Control Act and the 1956 Federal Water Pollution Control Act merely provided limited funding for State and local governments to address water pollution concerns on their own.

The CWA required the elimination of the discharge of pollutants into the nation's waters and the achievement of fishable and swimmable water quality levels. The EPA's National Pollutant Discharge Elimination System (NPDES) Permitting Program represents one of the key components established to accomplish this feat.

The NPDES program requires that all point source discharges to waters of the U.S. (i.e., *"direct discharges*") must be permitted. To address *"indirect discharges*" from industries to Publicly Owned Treatment Works (POTWs), the EPA, through CWA authorities, established the National Pretreatment Program as a component of the NPDES Permitting Program. The National Pretreatment Program requires industrial and commercial dischargers to treat or control pollutants in their wastewater prior to discharge to POTWs.

In 1986, more than one-third of all toxic pollutants entered the nation's waters from publicly owned treatment works (POTWs) through industrial discharges to public sewers. Certain industrial discharges, such as slug loads, can interfere with the operation of POTWs, leading to the discharge of untreated or inadequately treated wastewater into rivers, lakes, etc. Some pollutants are not compatible with biological wastewater treatment at POTWs and may pass through the treatment plant untreated.

This "pass through" of pollutants impacts the surrounding environment, occasionally causing fish kills or other detrimental alterations of the receiving waters. Even when POTWs have the capability to remove toxic pollutants from wastewater, these toxins can end up in the POTW's sewage sludge, which in many places is land applied to food crops, parks, or golf courses as fertilizer or soil conditioner.

The National Pretreatment Program is unique in that the General Pretreatment Regulations require all large POTWs (i.e., those designed to treat flows of more than 5 million gallons per day) and smaller POTWs with significant industrial discharges to establish local pretreatment programs. These local programs must enforce all national pretreatment standards and requirements in addition to any more stringent local requirements necessary to protect site-specific conditions at the POTW.

More than 1,500 POTWs have developed and are implementing local pretreatment programs designed to control discharges from approximately 30,000 significant industrial users. Since 1983, the Pretreatment Program has made great strides in reducing the discharge of toxic pollutants to sewer systems and to waters of the U.S. In the eyes of many, the Pretreatment Program, implemented as a partnership between the EPA, States, and POTWs, is a notable success story in reducing impacts to human health and the environment. These strides can be attributed to the efforts of many Federal, State, local, and industrial representatives who have been involved with developing and implementing the various aspects of the Pretreatment Program.

The EPA has supported the Pretreatment Program through development of numerous guidance manuals. The EPA has released more than 30 manuals that provide guidance to the EPA, States, POTWs, and industry on various pretreatment program requirements and policy determinations. Through the EPA's guidance, the Pretreatment Program has maintained national consistency in interpretation of the regulations. Nevertheless, turnover in pretreatment program staff has diluted historical knowledge, leaving new staff and other interested parties unaware of existing materials.

The intent of this correspondence course, *FOG (Fats, Oils and Grease)*, is to:
(1) provide a reference for anyone interested in understanding the basics of pretreatment and/or CMOM program requirements, *and*
(2) provide a roadmap to additional and more detailed guidance materials for those trying to implement specific elements of the Pretreatment and/or CMOM Program.

While the Pretreatment Program has demonstrated significant reductions in pollutants discharged to POTWs, Congress' goals of zero discharge of toxic pollutants and fishable/swimmable water quality have not been realized. The EPA is currently working to establish more cost-effective and common-sense approaches to environmental protection (e.g., using watershed, streamlining, and reinvention concepts), creating new responsibilities for all those involved in the National Pretreatment Program. Many current challenges remain, while many new ones likely lie ahead.

This course is intended to provide an understanding of the basic concepts that drive the Program, the current status of the Program and program guidance, and an insight into what the future holds for all those involved with implementing the Pretreatment Program.

Two lab techs examine various samples, including QA/QC and Trip Blanks to ensure both sample integrity and lab equipment/sample equipment quality.

Glossary of Commonly Used Acronyms and Terms

LIST OF ACRONYMS

AMS	Asset Management System
APP	Aquifer Protection Permit
ASTM	American Society for Testing and Materials
CADD	Computer-Aided Drafting and Design
CCTV	Closed-Circuit Television
CIP	Capital Improvement Plan or capital improvement project
CIPP	Cured-In-Place Pipe
CMMS	Computerized Maintenance Management System
CMOM	Capacity, Management, Operation and Maintenance
COOL	Computerized On-line Operations Log
CPM	Capital Project Management
CWA	Clean Water Act
d/D	depth divided by diameter
DIP	Ductile Iron Pipe
DVD	Digital Video Disk
EPA	Environmental Protection Agency
ERP	Enterprise Resource Planning Software; Emergency Response Plan
FOG	Fats, Oil, and Grease
fps	Feet per second
GIS	Geographic Information System
gpm	Gallons per minute
GPS	Global positioning system
HVAC	Heating, ventilation, and air conditioning
I/I	Infiltration and Inflow
IAS	Information Access System
IGA	Intergovernmental Agreement
IT	Information Technology
JEPA	Joint Exercise of Powers Agreement (SROG)
lf	Linear Feet
mgd	Million gallons per day
NOI	Notice of Intent
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and Maintenance
PLC	Programmable Logic Controller
POTW	Publicly Owned Treatment Works
Psi	Pounds per square inch

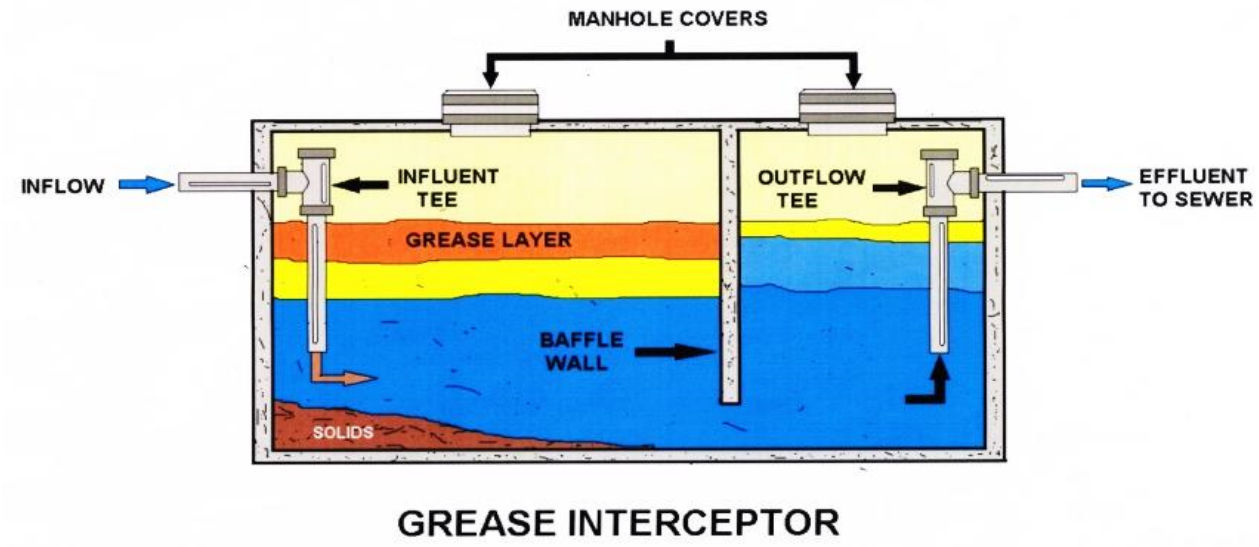
LIST OF ACRONYMS (continued)

PVC	Polyvinyl Chloride
RDBMS	Relational Database Management System
RFQ	Request for Qualifications
SAI	Southern Avenue Interceptor
SDR35	Standard Dimension Ratio 35
SCADA	Supervisory Control and Data Acquisition
SECAP	System Evaluation and Capacity Assurance Plan
SIU	Significant Industrial User
SROG	Sub-Regional Operating Group
SSO	Sanitary Sewer Overflow
SSORP	Sanitary Sewer Overflow Response Plan
VCC	Virtual Call Center
VCP	Vitrified Clay Pipe
WO	Work order
WRF	Water Reclamation Facility
WRP	Water Reclamation Plant
WTP	Water Treatment Plant
WWTF	Wastewater Treatment Facilities (may include WWTP and WRP)
WWTP	Wastewater Treatment Plant

Compliance sampling flume used by commercial facilities for both water quality and volume.

Underground Grease Interceptor Introduction

Underground grease interceptors are commonly used in commercial kitchens to collect fats, oils and greases (FOG) before they enter a wastewater disposal system. Regulations are increasingly mandating their use as an important step in improving municipal wastewater treatment plant efficiency.



GREASE INTERCEPTOR

Their use is also important in removing FOG from the waste stream of an onsite wastewater system. This diagram shows how the inflow waste inters the interceptor and how the influent separates. FOG will float to the top while the heavier solids sink to the bottom. It is important that the Interceptors are sized correctly. The most efficient way to deal with the solids and collected FOG is to have them pumped out as needed. This will keep the FOG from entering the sewer and keep odors under control.

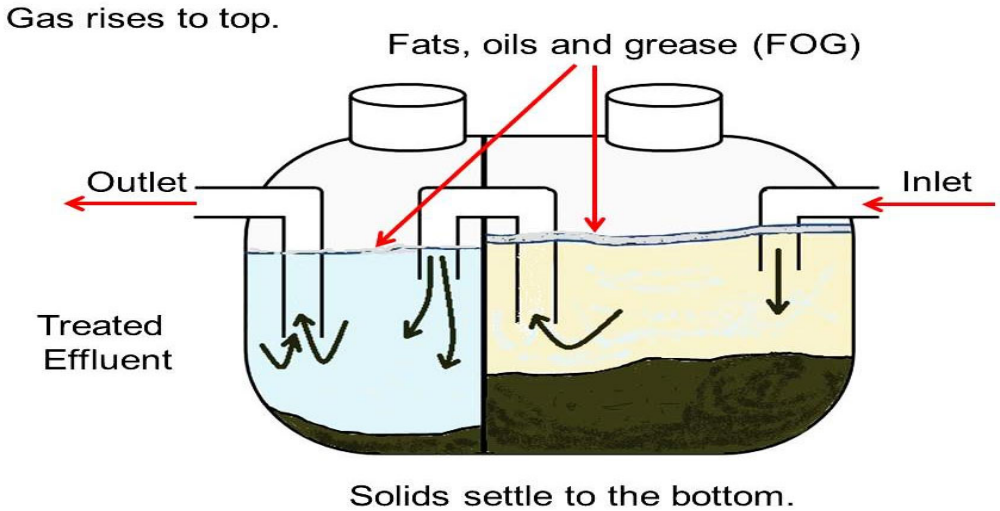
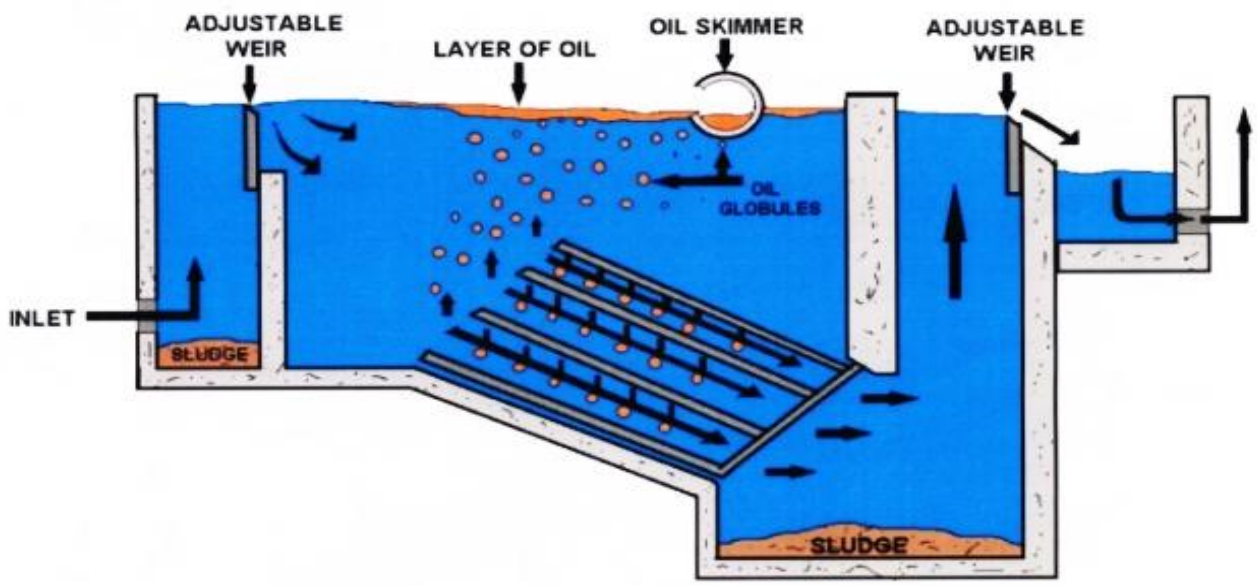


Diagram of a two-compartment grease interceptor's operation.



OIL SEPARATOR

Oil Water Separators

Oil water separators are devices used to remove small amounts of oil and other petroleum products from industrial wastewater and/or storm water systems.

Oil/water separators are large capacity underground cement vaults installed between a drain and the connecting sewer pipe. Other brands, PSI for example, market steel single wall, double wall, and UL listed fiberglass jacketed secondary containment construction models.

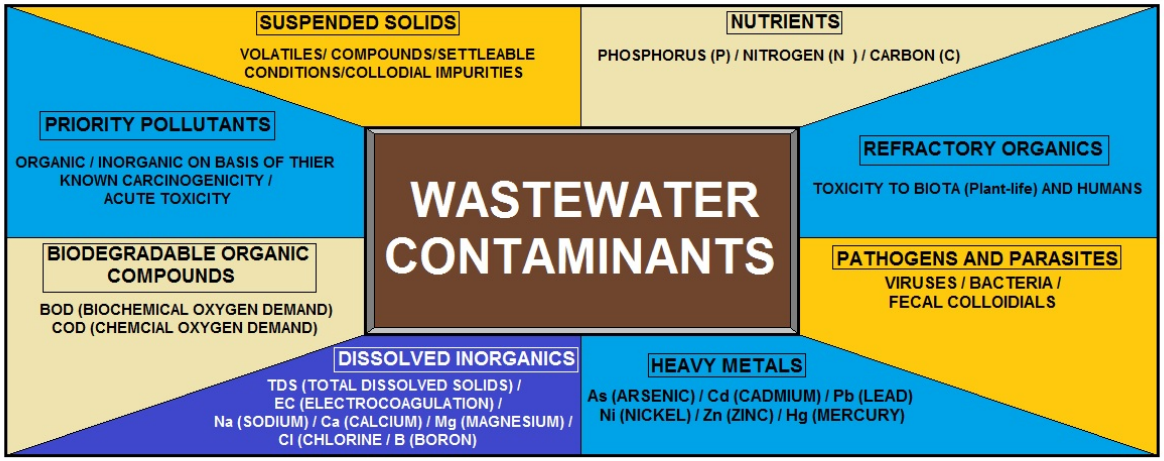
As shown in the diagram, the oily wastewater influent enters the inlet of the separator. Water turbulence is stabilized by the first baffle and solids are settled and accumulated as sludge in the bottom of the separator.

As the wastewater flows to the second chamber located at the center of the separator, oil droplets rise to the top of the water and are prevented from exiting by a second baffle. Thus, solid sludge heavier than water can be collected and oil droplets lighter than water can be accumulated on top of the wastewater and routed to a holding chamber or tank.

Gravity oil/water separators are not designed to separate other products such as solvents, detergents, or metals. Misuse of these systems can upset treatment plants, cause discharge permit violations, increase sludge disposal costs and/or eliminate beneficial reuse of wastewater or sludge.

What is in Wastewater?

Wastewater is mostly water by weight. Other materials make up only a small portion of wastewater but can be present in large enough quantities to endanger public health and the environment. Because practically anything that can be flushed down a toilet, drain, or sewer can be found in wastewater, even household sewage contains many potential pollutants. The wastewater components that should be of most concern to homeowners and communities are those that have the potential to cause disease or detrimental environmental effects.



Technical Learning College

TYPES OF WASTEWATER CONTAMINANTS

Organisms

Many different types of organisms live in wastewater and some are essential contributors to treatment. A variety of bacteria, protozoa, and worms work to break down certain carbon-based (organic) pollutants in wastewater by consuming them. Through this process, organisms turn wastes into carbon dioxide, water, or new cell growth.

Bacteria and other microorganisms are particularly plentiful in wastewater and accomplish most of the treatment. Most wastewater treatment systems are designed to rely in large part on biological processes.

Pathogens

Many disease-causing viruses, parasites, and bacteria are also present in wastewater and enter from almost anywhere in the community. These pathogens often originate from people and animals that are infected with or are carriers of a disease. Graywater and blackwater from typical homes contain enough pathogens to pose a risk to public health. Other likely sources in communities include hospitals, schools, farms, and food processing plants.

Some illnesses from wastewater-related sources are relatively common. Gastroenteritis can result from a variety of pathogens in wastewater, and cases of illnesses caused by the parasitic protozoa Giardia lambia and Cryptosporidium are not unusual in the U.S. Other important wastewater-related diseases include hepatitis A, typhoid, polio, cholera, and dysentery.

Outbreaks of these diseases can occur as a result of drinking water from wells polluted by wastewater, eating contaminated fish, or recreational activities in polluted waters. Some illnesses can be spread by animals and insects that come in contact with wastewater.

Even municipal drinking water sources are not completely immune to health risks from wastewater pathogens. Drinking water treatment efforts can become overwhelmed when water resources are heavily polluted by wastewater. For this reason, wastewater treatment is as important to public health as drinking water treatment.

Organic Matter

Organic materials are found everywhere in the environment. They are composed of the carbon-based chemicals that are the building blocks of most living things. Organic materials in wastewater originate from plants, animals, or synthetic organic compounds, and enter wastewater in human wastes, paper products, detergents, cosmetics, foods, and from agricultural, commercial, and industrial sources.

Organic compounds normally are some combination of carbon, hydrogen, oxygen, nitrogen, and other elements. Many organics are proteins, carbohydrates, or fats and are biodegradable, which means they can be consumed and broken down by organisms. However, even biodegradable materials can cause pollution. In fact, too much organic matter in wastewater can be devastating to receiving waters.

Large amounts of biodegradable materials are dangerous to lakes, streams, and oceans, because organisms use dissolved oxygen in the water to break down the wastes. This can reduce or deplete the supply of oxygen in the water needed by aquatic life, resulting in fish kills, odors, and overall degradation of water quality.

The amount of oxygen organisms need to break down wastes in wastewater is referred to as the biochemical oxygen demand (BOD) and is one of the measurements used to assess overall wastewater strength.

Some organic compounds are more stable than others and cannot be quickly broken down by organisms, posing an additional challenge for treatment. This is true of many synthetic organic compounds developed for agriculture and industry.

In addition, certain synthetic organics are highly toxic. Pesticides and herbicides are toxic to humans, fish, and aquatic plants and often are disposed of improperly in drains or carried in stormwater. In receiving waters, they kill or contaminate fish, making them unfit to eat. They can also damage processes in treatment plants.

Benzene and toluene are two toxic organic compounds found in some solvents, pesticides, and other products. New synthetic organic compounds are being developed all the time, which can complicate treatment efforts.

Oil and Grease
Fatty organic materials from animals, vegetables, and petroleum also are not quickly broken down by bacteria and can cause pollution in receiving environments. When large amounts of oils and greases are discharged to receiving waters from community systems, they increase BOD and they may float to the surface and harden, causing aesthetically unpleasing conditions. They also can trap trash, plants, and other materials, causing foul odors, attracting flies, mosquitoes and other disease vectors. In some cases, too much oil and grease causes septic conditions in ponds and lakes by preventing oxygen from the atmosphere from reaching the water.

Onsite systems also can be harmed by too much oil and grease, which can clog onsite system drainfield pipes and soils, adding to the risk of system failure. Excessive grease also adds to the septic tank scum layer, requiring more frequent tank pumping. Both possibilities can result in significant costs to homeowners.

Petroleum-based waste oils used for motors and industry are considered hazardous waste and should be collected and disposed of separately from wastewater.

Inorganics
Inorganic minerals, metals, and compounds, such as sodium, potassium, calcium, magnesium, cadmium, copper, lead, nickel, and zinc are common in wastewater from both residential and nonresidential sources. They can originate from a variety of sources in the community including industrial and commercial sources, stormwater, inflow and infiltration from cracked pipes and leaky manhole covers. Most inorganic substances are relatively stable and cannot be broken down easily by organisms in wastewater.

Large amounts of many inorganic substances can contaminate soil and water. Some are toxic to animals and humans and may accumulate in the environment. For this reason, extra treatment steps are often required to remove inorganic materials from industrial wastewater sources. For example, heavy metals which are discharged with many types of industrial wastewaters are difficult to remove by conventional treatment methods.

Although acute poisonings from heavy metals in drinking water are rare in the U.S., potential long-term health effects from ingesting small amounts of some inorganic substances over an extended period of time are possible.

Nutrients
Wastewater often contains large amounts of the nutrients nitrogen and phosphorus in the form of nitrate and phosphate, which promote plant growth. Organisms only require small amounts of nutrients in biological treatment, so there is normally an excess available in treated wastewater. In severe cases, excessive nutrients in receiving waters cause algae and other plants to grow quickly depleting oxygen in the water. Deprived of oxygen, fish and other aquatic life die, emitting foul odors.

Nutrients from wastewater have also been linked to ocean "red tides" that poison fish and cause illness in humans. Nitrogen in drinking water may contribute to miscarriages in pregnant women and is the cause of a serious illness in infants called methemoglobinemia or "blue baby syndrome."

Solids
Solid materials in wastewater can consist of organic and/or inorganic materials and organisms. The solids must be significantly reduced by treatment, or they can increase BOD when discharged to receiving waters and provide places for microorganisms to escape disinfection. They also can clog soil absorption fields in onsite systems. Listed are the characteristics of solids.

- Settleable solids-Certain substances, such as sand, grit, and heavier organic and inorganic materials settle out from the rest of the wastewater stream during the preliminary stages of treatment. On the bottom of settling tanks and ponds, organic material makes up a biologically active layer of sludge that aids in treatment.
- Suspended solids-Materials that resist settling may remain suspended in wastewater. Suspended solids in wastewater must be treated, or they will clog soil absorption systems or reduce the effectiveness of disinfection systems.
- Dissolved solids-Small particles of certain wastewater materials can dissolve like salt in water. Some dissolved materials are consumed by microorganisms in wastewater, but others, such as heavy metals, are difficult to remove by conventional treatment. Excessive amounts of dissolved solids in wastewater can have adverse effects on the environment.

Gases
Certain gases in wastewater can cause odors, affect treatment, or are potentially dangerous. Methane gas, for example, is a byproduct of anaerobic biological treatment and is highly combustible. Special precautions need to be taken near septic tanks, manholes, treatment plants, and other areas where wastewater gases can collect.

The gases hydrogen sulfide and ammonia can be toxic and pose asphyxiation hazards. Ammonia as a dissolved gas in wastewater also is dangerous to fish. Both gases emit odors, which can be a serious nuisance. Unless effectively contained or minimized by design and location, wastewater odors can affect the mental well-being and quality of life of residents. In some cases, odors can even lower property values and affect the local economy.

Dispose of Household Hazardous Wastes Safely
Many household products are potentially hazardous to people and the environment and never should be flushed down drains, toilets, or storm sewers. Treatment plant workers can be injured, and wastewater systems can be damaged as a result of improper disposal of hazardous materials.
Other hazardous chemicals cannot be treated effectively by municipal wastewater systems and may reach local drinking water sources. When flushed into septic systems and other onsite systems, they can temporarily disrupt the biological processes in the tank and soil absorption field, allowing hazardous chemicals and untreated wastewater to reach groundwater.

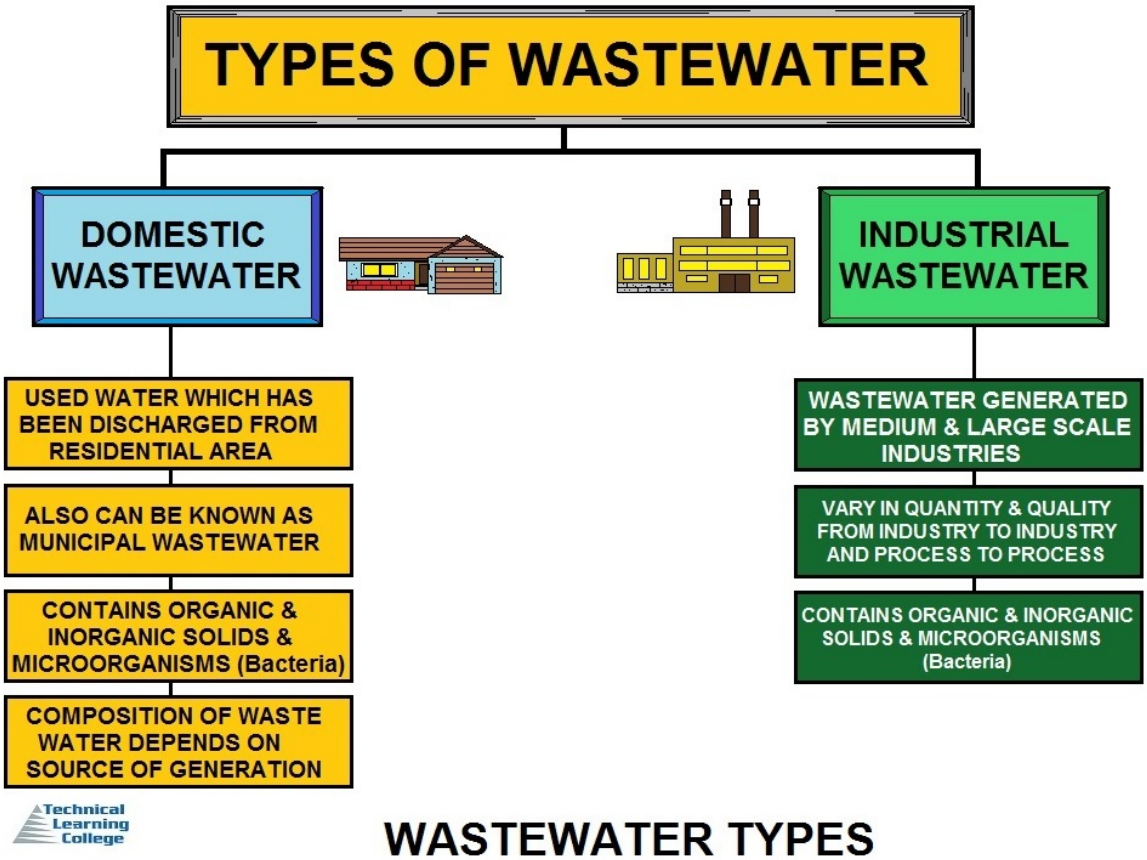
Some examples of hazardous household materials include motor oil, transmission fluid, antifreeze, paint, paint thinner, varnish, polish, wax, solvents, pesticides, rat poison, oven cleaner, and battery fluid. Many of these materials can be recycled or safely disposed of at community recycling centers.

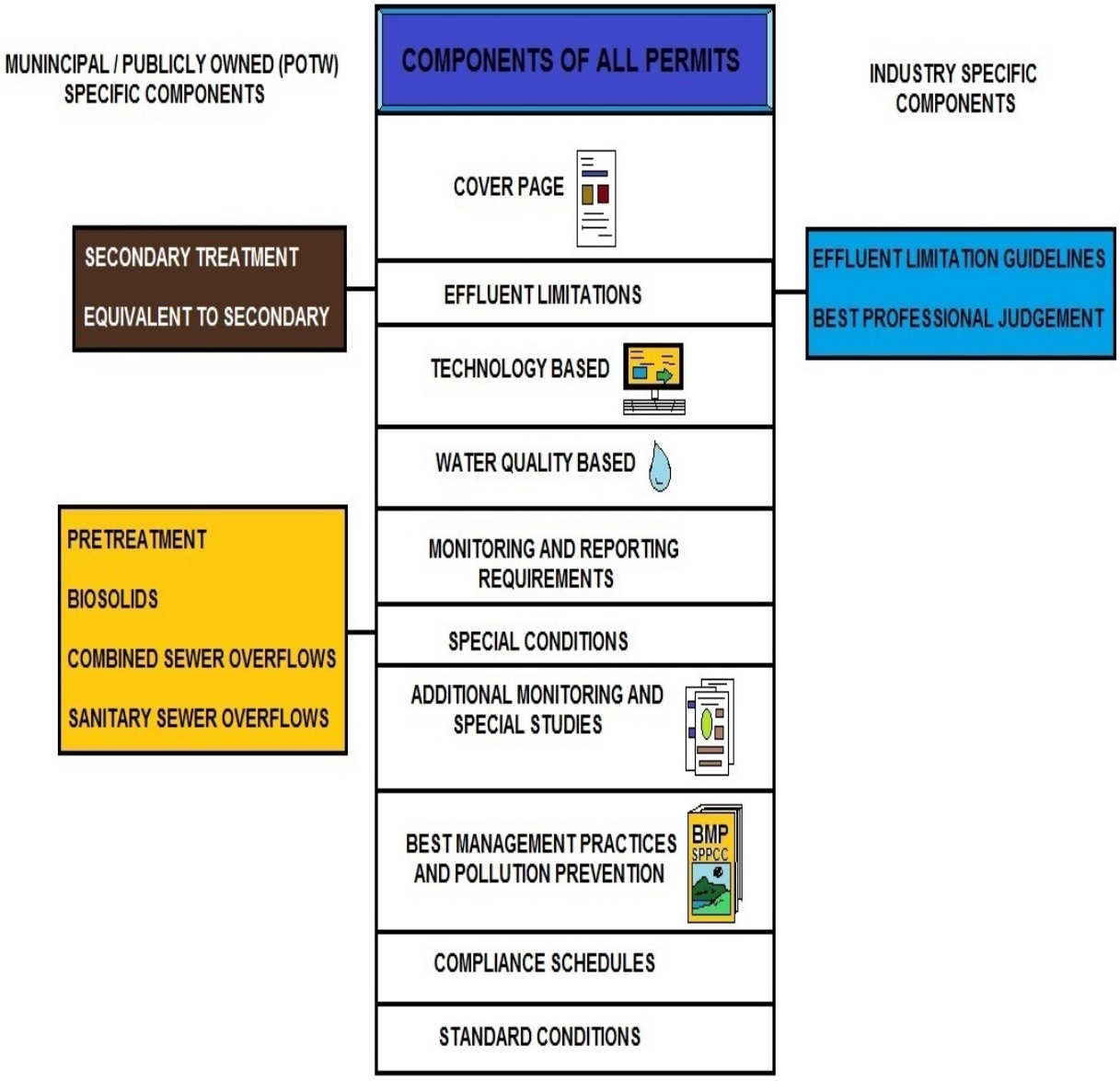
Other Important Wastewater Characteristics
In addition to the many substances found in wastewater, there are other characteristics system designers and operators use to evaluate wastewater. For example, the color, odor, and turbidity of wastewater give clues about the amount and type of pollutants present and treatment necessary. The following are some other important wastewater characteristics that can affect public health and the environment, as well as the design, cost, and effectiveness of treatment.

Temperature
The best temperatures for wastewater treatment probably range from 77 to 95 degrees Fahrenheit. In general, biological treatment activity accelerates in warm temperatures and slows in cool temperatures, but extreme hot or cold can stop treatment processes altogether. Therefore, some systems are less effective during cold weather, and some may not be appropriate for very cold climates.

Wastewater temperature also affects receiving waters. Hot water, for example, which is a byproduct of many manufacturing processes, can be a pollutant. When discharged in large quantities, it can raise the temperature of receiving streams locally and disrupt the natural balance of aquatic life.

pH
The acidity or alkalinity of wastewater affects both treatment and the environment. Low pH indicates increasing acidity; while a high pH indicates increasing alkalinity (a pH of 7 is neutral). The pH of wastewater needs to remain between 6 and 9 to protect organisms. Acids and other substances that alter pH can inactivate treatment processes when they enter wastewater from industrial or commercial sources.





Technical Learning College

PERMIT COMPONENTS

FOG Introduction

Keeping Fats, Oils, and Grease out of the Sewer System
Fats, oils, and grease—FOG—comes from meat fats in food scraps, cooking oil, shortening, lard, butter and margarine, gravy, and food products such as mayonnaise, salad dressings, and sour cream.

FOG poured down kitchen drains accumulates inside sewer pipes and cause damage to the collection system. As the FOG builds up, it restricts the flow in the pipe and can cause untreated wastewater to back up into homes and businesses, resulting in high costs for cleanup and restoration.

Manholes can overflow into parks, yards, streets, and storm drains, allowing FOG to contaminate local waters, including drinking water. Exposure to untreated wastewater is a public-health hazard and is an EPA violation. FOG discharged into septic systems and drain fields can cause malfunctions, resulting in more frequent tank pump-outs and other expenses.

Restaurants, cafeterias, and fast-food establishments spend tens of thousands of dollars on plumbing emergencies each year to deal with grease blockages and pump out grease traps and interceptors. Some cities also charge businesses for the repair of sewer pipes and spill cleanup if they can attribute the blockage to a particular business.

Some cities also add a surcharge to wastewater bills if a business exceeds a specified discharge limit. These expenses can be significant.

Communities spend billions of dollars every year unplugging or replacing grease-blocked pipes, repairing pump stations, and cleaning up costly and illegal wastewater spills. Excessive FOG in the sewer system can affect local wastewater rates. So, keeping FOG out of the sewer system helps everyone in the community.

Controlling Fats, Oils, and Grease Discharges from Food Service Establishments
FOG gets into our sewer collection system mainly from residential customers pouring the substances down their drains and from commercial food preparation establishments with inadequate grease controls. Fats, oils and grease are a byproduct of cooking and are mostly found in the following:

- ✓ Meats
- ✓ Cooking oil
- ✓ Lard or shortening
- ✓ Butter or margarine

Our sewer system is not designed to handle or treat these substances in excess. Over time, without proper disposal of fats, oils and grease, they build up in the sewer system and eventually block collection pipes and sewer lines, resulting in sewer backups and overflows on streets, properties and even in customers' homes and/or businesses. Overflows may also impact the environment negatively and can result in contamination of ponds, streams or rivers.

Food Service Establishments (FSEs)
Food Service Establishments (FSEs) are a significant source of fats, oil and grease (FOG) because of the amount of grease used in cooking. POTW Commercial FOG Programs are generally developed to assist restaurants and other FSEs with proper handling and disposal of their FOG.

Through implementation of Best Management Practices (BMPs), these establishments should be able to significantly reduce the amount of FOG that goes down their drains. This will minimize back-ups and help business owners comply with the POTW's requirements.

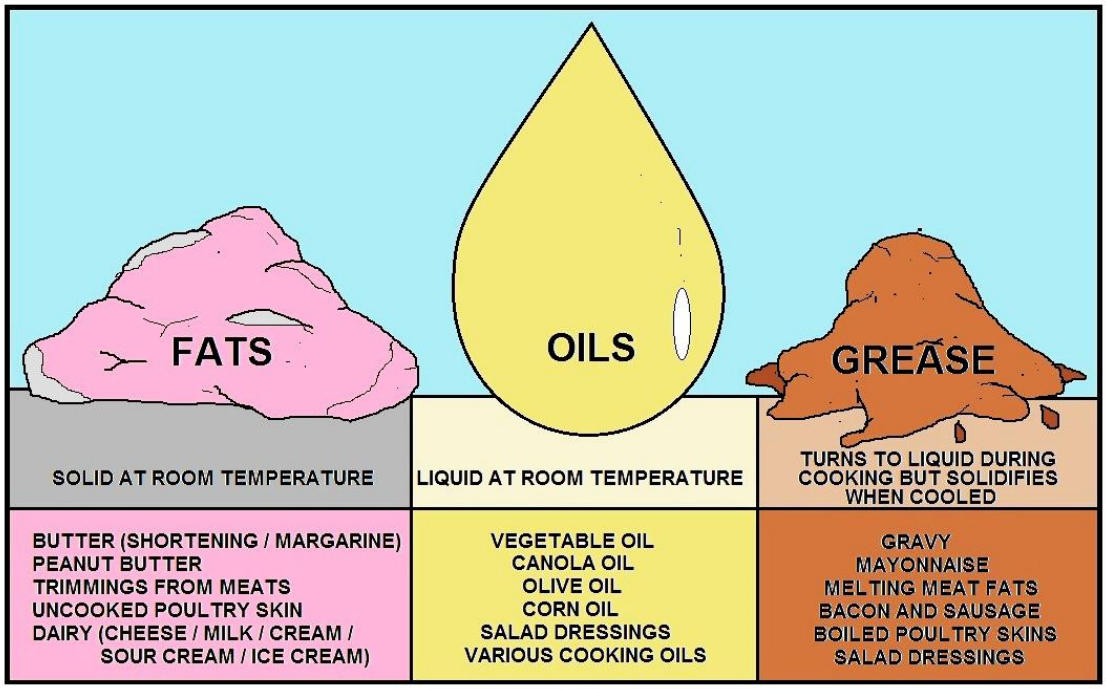
To work effectively, sewer systems need to be properly maintained, from the drain to the treatment plant. If wastes are disposed of correctly, the POTW's sewer system can handle them without any problem. Grease is an example of a waste that the sewer system cannot handle, and therefore should not be put down the drain.

The POTW needs businesses and individuals to do their part to maintain the system because repeated repairs are disruptive to residences and businesses alike. Furthermore, proper disposal by commercial establishments is required by law.

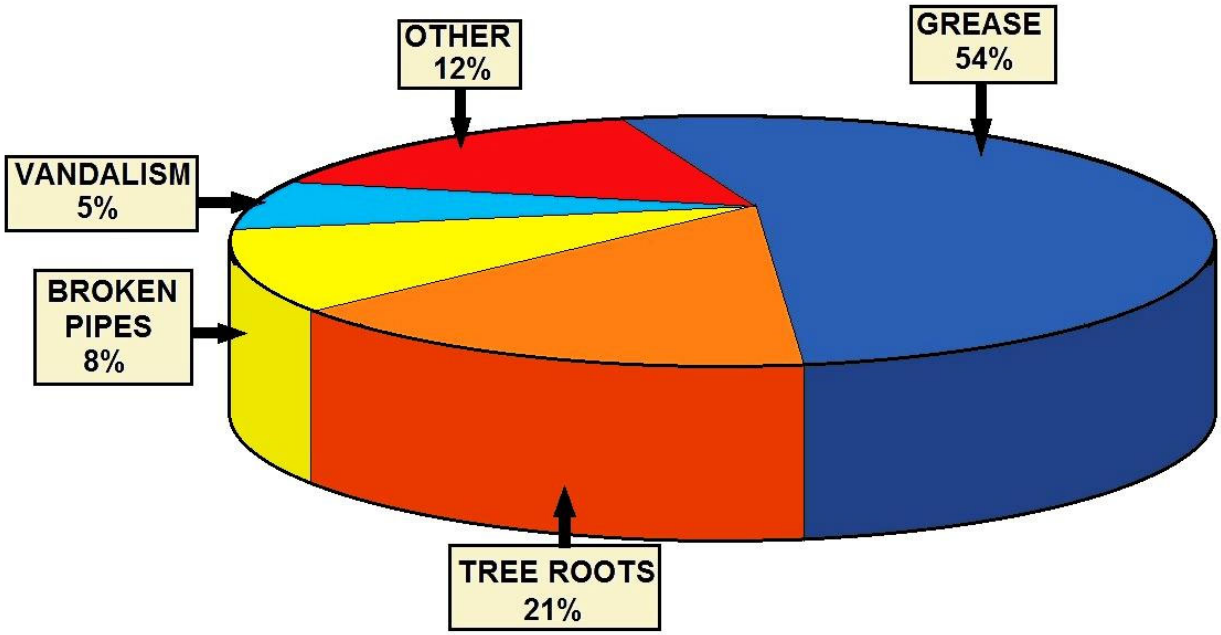
Environmental Problem with FOG Sewers
FOG that enters the sewer system eventually solidifies and forms grease balls. These grease balls can range in size from marbles to the size of cantaloupes and must be removed periodically.

Since the sewer system is unable to handle or treat these substances effectively, this incurs greater expenditures on the maintenance of the collection systems and/or treatment plants which in turn can lead to higher customer rates.

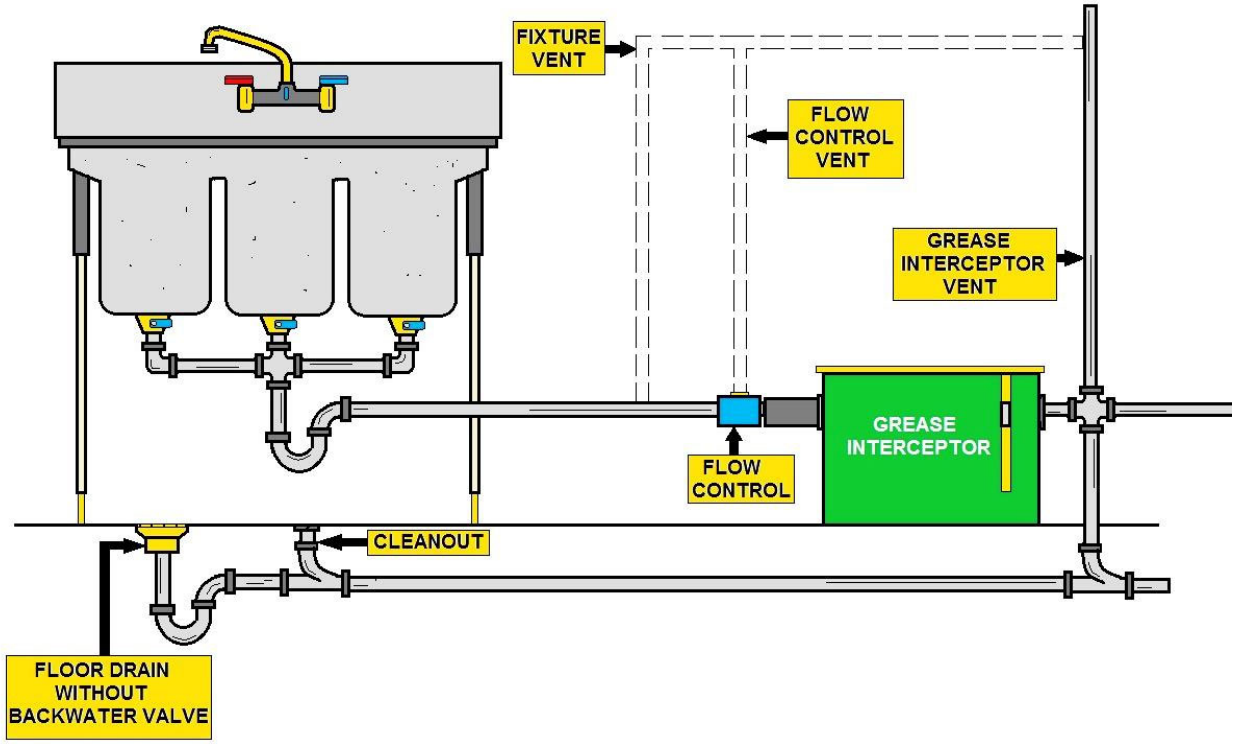
Sewer backups can also cost customers thousands of dollars for the repair or replacement of their damaged property.

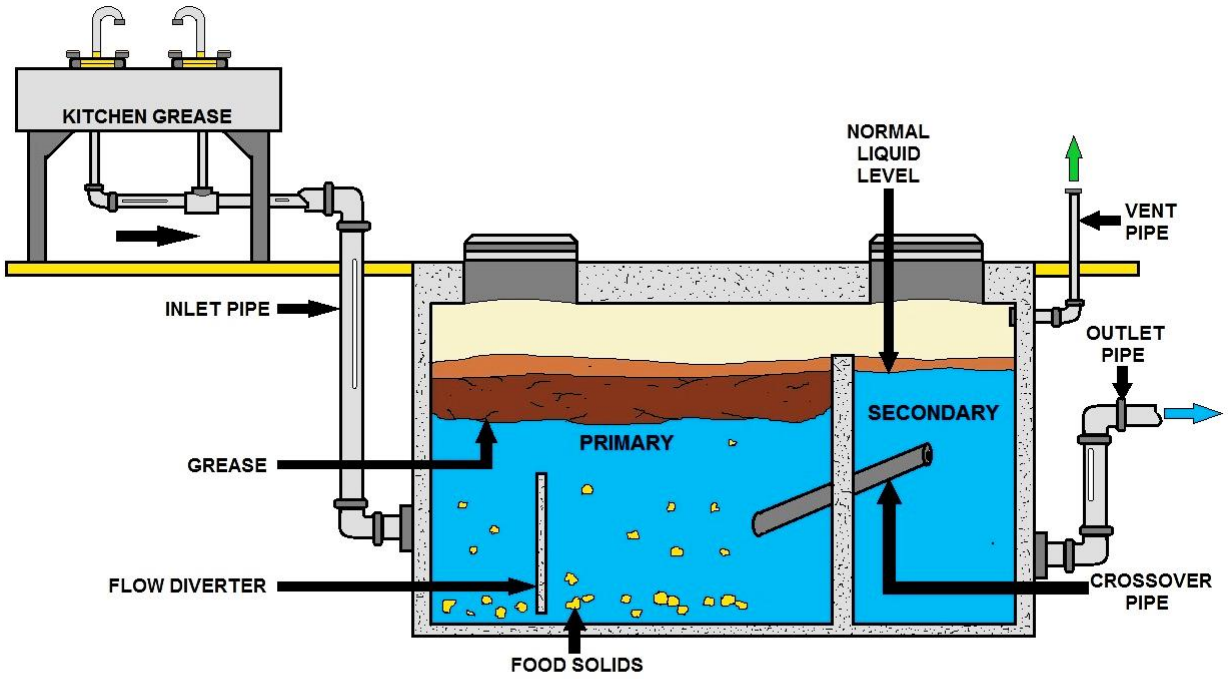


FOG (Fats / Oils / Grease) CONTRIBUTORS



CAUSES OF SANITARY SEWER OVERFLOWS

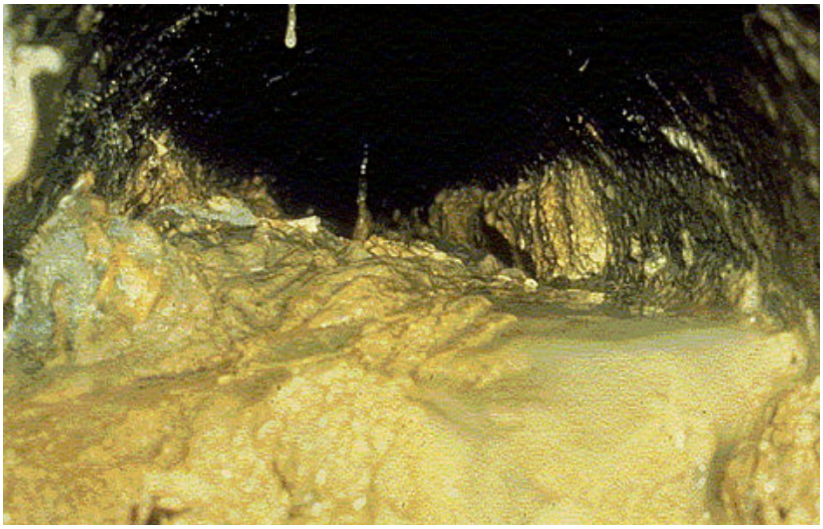




EXAMPLE OF HOW A GREASE TRAP WORKS

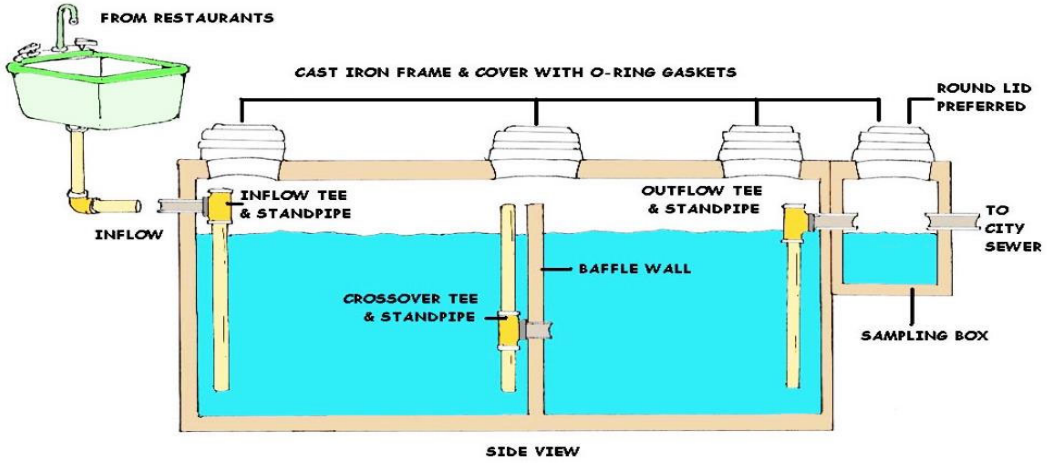
Cooking Grease

If left unmanaged, grease can cause interference in wastewater collection, transmission, and treatment systems. Blockages due to grease build-up are a common cause of sanitary sewer overflows, and grease accumulation at treatment facilities can lead to pass-through of contaminants. Proactive municipal governments have a grease ordinance which provides them legal authority to require that grease generators have devices to catch the grease before it enters the public wastewater system. These devices are often referred to as "grease traps."



Grease build-up inside a sewer causing interference with flow.

Proactive municipal governments also have in place an inspection and enforcement program to ensure grease generators clean the traps on an appropriate schedule and in a proper manner. Failure to do so incurs a penalty levied by the municipality, so there is incentive to correct problems before they result in sanitary sewer overflows, interference, or pass-through. Proactive municipalities often have public education programs to ensure non-commercial contributions of grease to the wastewater system are minimized.



Cooking Grease

Did you know that cooking grease is one of the major causes of residential sewer main clogs resulting in sewer spills?

Cooking grease coats pipelines much like fatty foods clog human arteries. The grease clings to the insides of the pipe, eventually causing blockage and potential sewer spills. By following a few simple steps, you can help prevent costly sewer spills in the future.

- All cooking oil (this includes salad oil, frying oil and bacon fat) should be poured into an old milk carton, frozen juice container, or other non-recyclable package, and disposed of in the garbage.
- Dishes and pots that are coated with greasy leftovers, should be wiped clean with a disposable towel prior to washing or placing in the dishwasher.
- Instead of placing fat trimmings from meat down the garbage disposal, place them in a trash can.

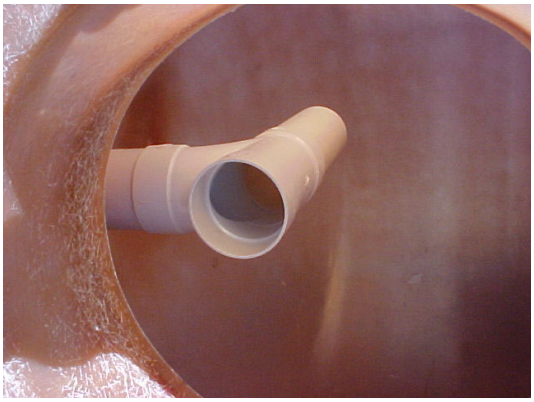
Grease Trap

The trap prevents excess grease from getting into the sewer system from existing plumbing lines within facilities. Traps are small and are usually installed inside a facility. Generally, they range in size from 20 gallons per minute (gpm) to 50 gpm.

In-floor Grease trap being removed and replaced with a grease interceptor.
Unfortunately, most grease traps are not properly maintained.

Grease Interceptors

High-volume or new establishments use grease interceptors which are larger than the traps and are installed underground, outside of a facility. Grease is actually "intercepted" in these concrete or fiberglass tanks before it reaches the sewer main. Grease interceptors should be accessible by three manhole covers, and a sample box. Interceptors and traps cause the flow of water to slow down, allowing the grease to naturally float to the top of the tank for easy removal.



New fiberglass three compartment grease interceptor. You will need to fill the interceptor with water before connecting it to the sewer main.

Plan Checks and Inspections
All plans for new commercial food establishments (including new construction remodels and retrofits) should receive a plan review from the POTW. This review assures that appropriate grease-removal equipment is installed during construction.

Grease Blockages
Shortly after sewer-spills caused by grease are reported or discovered, POTW inspectors investigate facilities within the immediate area. A determination is made as to which commercial facilities contributed to the blockage, and more in-depth inspections are conducted at those facilities.

Where appropriate, additional requirements and/or procedures are put in place. When requirements are made for additional grease-removal equipment, the facility is given a due date to comply.

A Notice of Violation, with an administrative fee, is issued once a facility has passed its final due date. Administrative hearings, permit revocation, and ultimately, termination of sewer service may occur for those facilities that remain out of compliance.

Regular Grease Inspection
Regular inspection and maintenance are essential to the proper operation of a grease removal device. The local ordinance should require a minimum cleaning frequency of once every six months.

However, that frequency will increase depending on the capacity of the device, the amount of grease in the wastewater, and the degree to which the facility has contributed to blockages in the past.

Regular cleaning at the appropriate interval is necessary to maintain the rated efficiency of the device. Equipment that is not regularly maintained puts the food service facility at risk of violating the sewer use ordinance, and this may not be known until an overflow and violation have occurred.

Most POTWs suggest businesses start with quarterly cleanings and should be done when 75 percent of the retention capacity of the unit is 75 percent full of accumulated grease. A large measuring stick and/or a clear piece of conduit may be used to determine the depth of the grease accumulation. You should require that restaurants contract with a licensed grease hauler to remove it from the premises for appropriate disposal.

Choosing a Grease Hauler

When you speak to a restaurant owner, inform them that while selecting a grease hauler, be aware that services and prices can vary. Minimum services should include:

- Complete pumping and cleaning of the interceptor and sample box, rather than just skimming the grease layer.
- Deodorizing and thorough cleaning of affected areas, as necessary.
- Disposal/reclamation at an approved location.
- Notes concerning the condition of the interceptor
- Complete pumping and cleaning record.

The restaurant owner and grease hauler should agree on an adequate cleaning frequency to avoid blockage of the line. Waste grease from a kitchen is recyclable for use in making soap, animal feed, etc. Grease from a grease trap or interceptor may not be reused in this way. For recyclable grease, some POTWs recommend that all facilities have waste grease containers with tight fitting lids that are either secondarily contained or kept in a bermed area to protect floor drains and storm drain inlets from spills.

Keeping up-to-date Records

Careful record keeping is one of the best ways to ensure that the grease removal device is being cleaned and maintained on a regular basis. City codes and ordnances require records be maintained for a minimum of three to five years.

Other Types of Devices

A grease trap may be approved in lieu of an interceptor for full-service food service facilities only in very limited circumstances when space is not available. Grease traps may also be approved by the Industrial Pretreatment Program for facilities such as delicatessens and small bakeries that produce small quantities of oil, grease, or fat. Refer to the International Plumbing Code for requirements related to grease traps such as installation of flow-control devices, flow rates, and other structural requirements.

Please Note: Flow restrictors are required for grease traps because they increase retention time and efficiency.

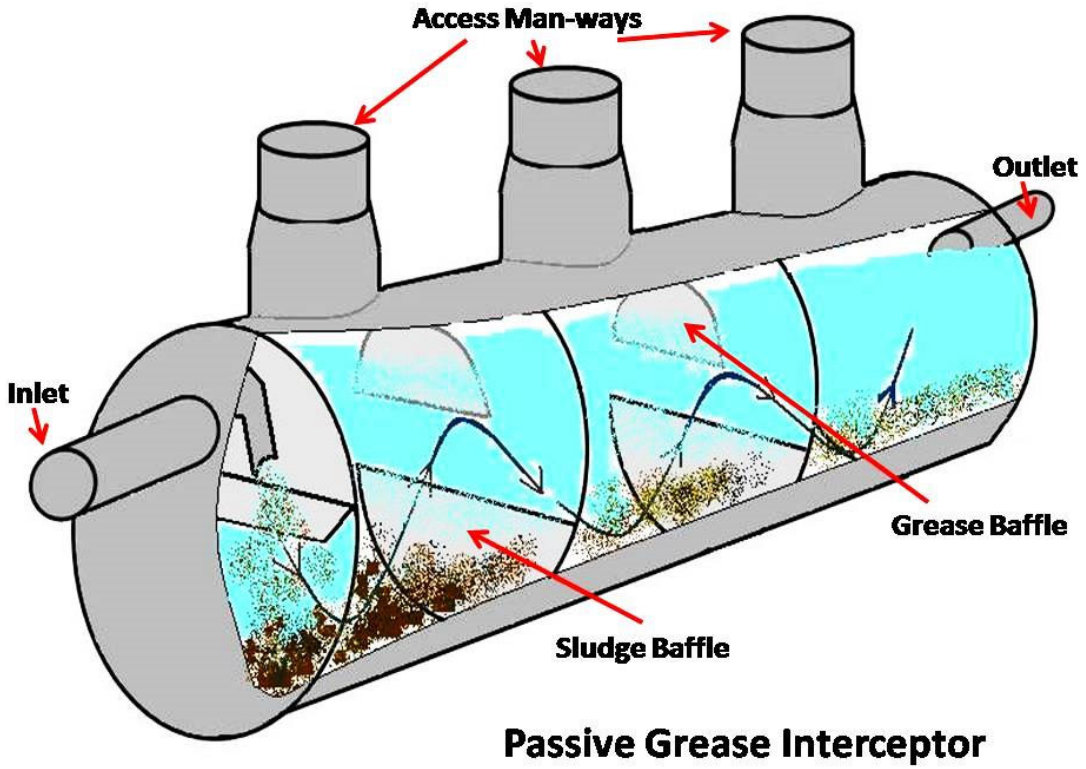
Automatic grease skimming devices collect small volumes of water and remove grease into a side container at preset times each day. Usually, special approval from the Industrial Pretreatment Staff or the POTW is required to install one of these devices in lieu of a grease interceptor.

Magic Grease “Bugs” and Bacterial Additives
Manufacturers of bacterial additives claim that their products remove grease and enhance the performance of grease traps and interceptors. Such additives cannot be substituted for a grease removal device and regular inspection and maintenance. If a customer decides to use an additive, they need to make sure the product you select is not an emulsifier, which simply keeps grease in suspension temporarily and allows it to flow to the sewer system.

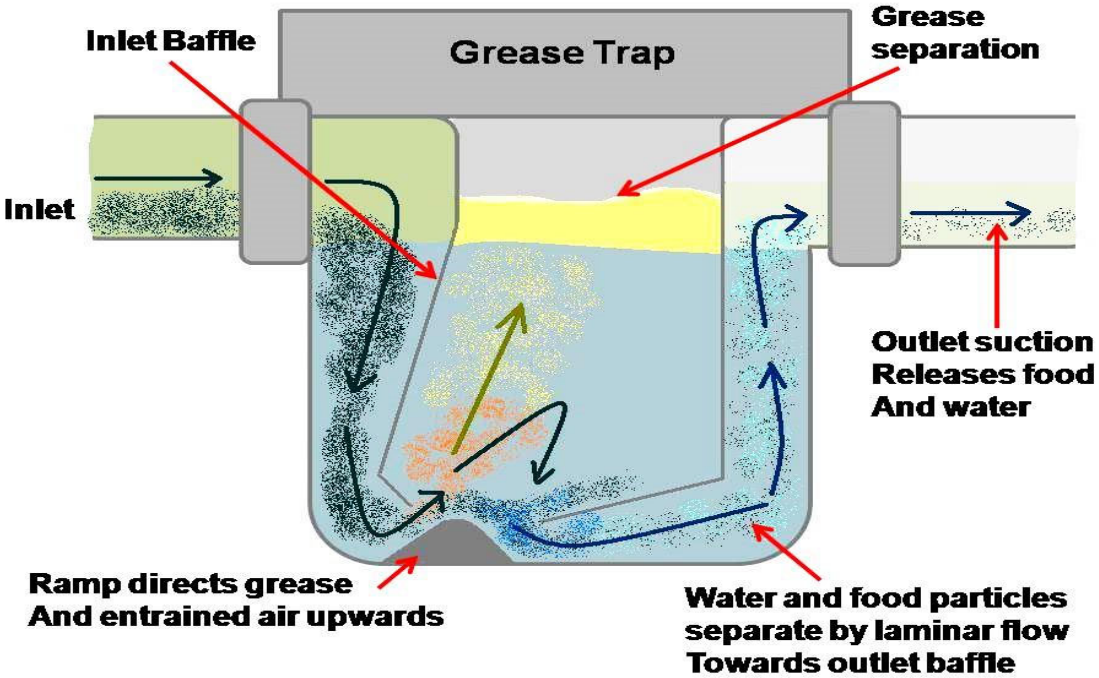
Obtaining necessary permits
• Building departments prefer in-ground installations that drain by gravity to the sanitary sewer. Avoid pumps and other mechanical devices in your connection to the sewer if possible.
• The interceptor or grease trap needs to be properly sized in accordance with the International Plumbing Code, IAPMO, or local ordinance.

Chain Cutter
This tool is attached to the flush truck. When water pressure is applied, the 3 chains at the head spin at tremendous speeds. These spinning chains will cut roots, grease build-up, and even a protruding tap.

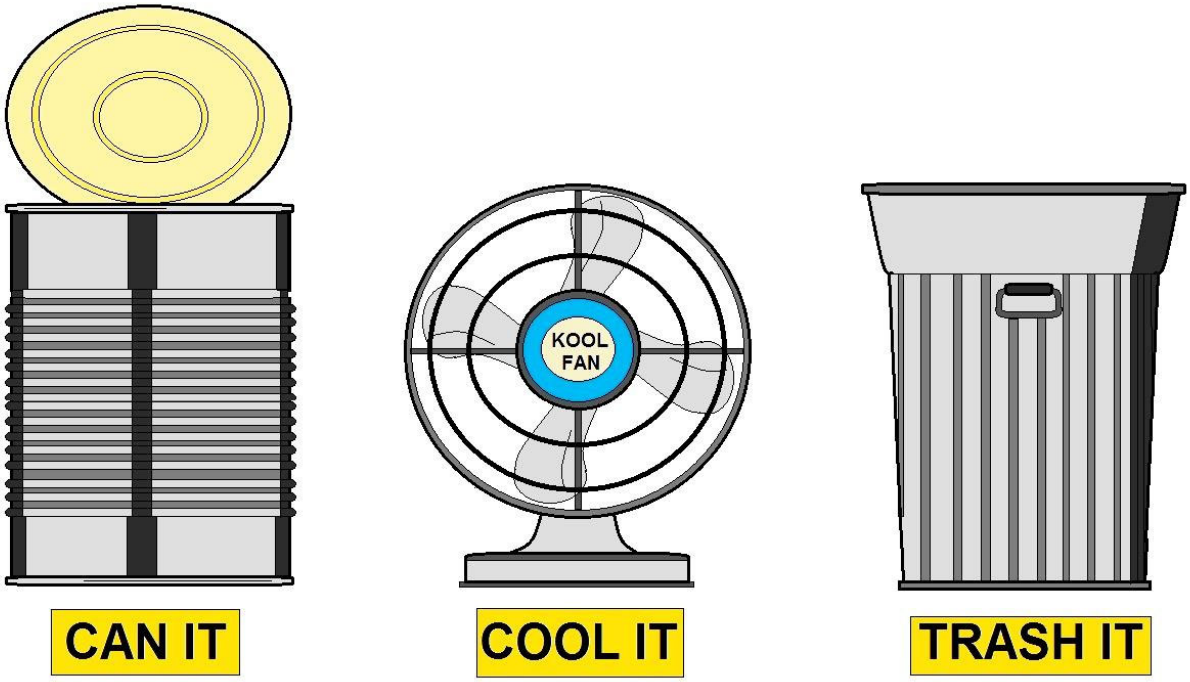
This is a sewer line that has a large amount of grease buildup that will be cut out. Grease gets into the sewer line by pouring grease left over from cooking, down the kitchen sink.



Passive Grease Interceptor



Controlling FOG Discharges



WAYS TO GET RID OF GREASE

FOG wastes are generated at FSEs as byproducts from food preparation activities. FOG captured on-site is generally classified into two broad categories: yellow grease and grease trap waste. Yellow grease is derived from used cooking oil and waste greases that are separated and collected at the point of use by the food service establishment.

The annual production of collected grease trap waste and uncollected grease entering sewage treatment plants can be significant and ranges from 800 to 17,000 pounds/year per restaurant.

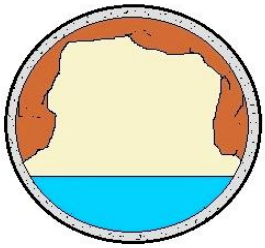
The National Pretreatment Program already provides the necessary regulatory tools and authority to local pretreatment programs for controlling interference problems. Under the provisions of Part 403.5(c)(1) & (2), in defined circumstances, a POTW must establish specific local limits for industrial users to guard against interference with the operation of the municipal treatment works.

Consequently, pretreatment oversight programs should include activities designed to identify and control sources of potential interference and, in the event of actual interference, enforcement against the violator.

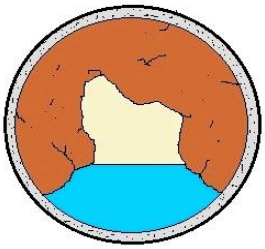
Food service establishments can adopt a variety of best management practices or install interceptor/collector devices to control and capture the FOG material before discharge to the collection system.

For example, instead of discharging yellow grease to POTWs, food service establishments usually accumulate this material for pick up by consolidation service companies for re-sale or re-use in the manufacture of tallow, animal feed supplements, biofuels, or other products.

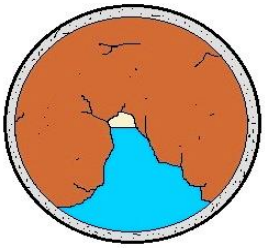
Additionally, food service establishments can install interceptor/collector devices (e.g., grease traps) in order to accumulate grease on-site and prevent it from entering the POTW collection system.



THE START OF BLOCKED PIPE BEGINS WITH SOLIDS AND GREASE COLLECTING ON TOP AND SIDES OF PIPE INTERIOR.



OVER TIME, THE BUILD-UP INCREASES WHEN GREASE AND DEBRIS ARE WASHED DOWN A DRAIN.



EXCESSIVE ACCUMULATION RESTRICTS THE FLOW OF WASTEWATER THAT CAN RESULT IN AN OVERFLOW OF SANITARY SEWER

HOW SEWER BLOCKAGE FORMS

POTWs control methods for FOG discharges from FSEs

Proper design, installation, and maintenance procedures are critical for these devices to control and capture the FOG.

For example,

- ✓ Interceptor/collector devices must be designed and sized appropriately to allow FOG to cool and separate in a non-turbulent environment.
- ✓ FSE must be diligent in having their interceptor/ collector devices serviced at regular intervals.

Best Management Practices (BMPs) Introduction

Best Management Practices (BMPs)
The required maintenance frequency for interceptor/collector devices depends greatly on the amount of FOG a facility generates as well as any best management practices (BMPs) that the establishment implements to reduce the FOG discharged into its sanitary sewer system. In many cases, an establishment that implements BMPs will realize financial benefit through a reduction in their required grease interceptor and trap maintenance frequency.

A growing number of control authorities are using their existing authority (e.g., general pretreatment standards in Part 403 or local authority) to establish and enforce more FOG regulatory controls (e.g., numeric pretreatment limits, best management practices including the use of interceptor/collector devices) for food service establishments to reduce interferences with POTW operations (e.g., blockages from fats, oils, and greases discharges, POTW treatment interference from Nocardia filamentous foaming, damage to collection system from hydrogen sulfide generation).

Non-Compliance Rate Example

For example, since identifying a 73% non-compliance rate with its grease trap ordinance among restaurants, New York POTW has instituted a $1,000-per-day fine for FOG violations. Likewise, more and more municipal wastewater authorities are addressing FOG discharges by imposing mandatory measures of assorted kinds, including inspections, periodic grease pumping, stiff penalties, and even criminal citations for violators, along with ‘strong waste’ monthly surcharges added to restaurant sewer bills. Surcharges are reportedly ranging from $100 to as high as $700 and more, the fees being deemed necessary to cover the cost of inspections and upgraded infrastructure.

Residential and Commercial Guidelines
The fats, oil and grease (FOG) found in food ingredients such as meat, cooking oil, shortening, butter, margarine, baked goods, sauces and dairy products is a major concern for POTW’s sewers. When not disposed of properly, FOG builds up in the sewer system constricting flow, which can cause sewer back-ups into homes and overflow discharges onto streets. It can also interfere with sewage treatment processes at the POTW’s Wastewater Treatment Plants.

To remediate this problem, many control authorities have developed an outreach program aimed at eliminating FOG from the sewer system. FOG buildup in sewer lines has many harmful and costly effects.

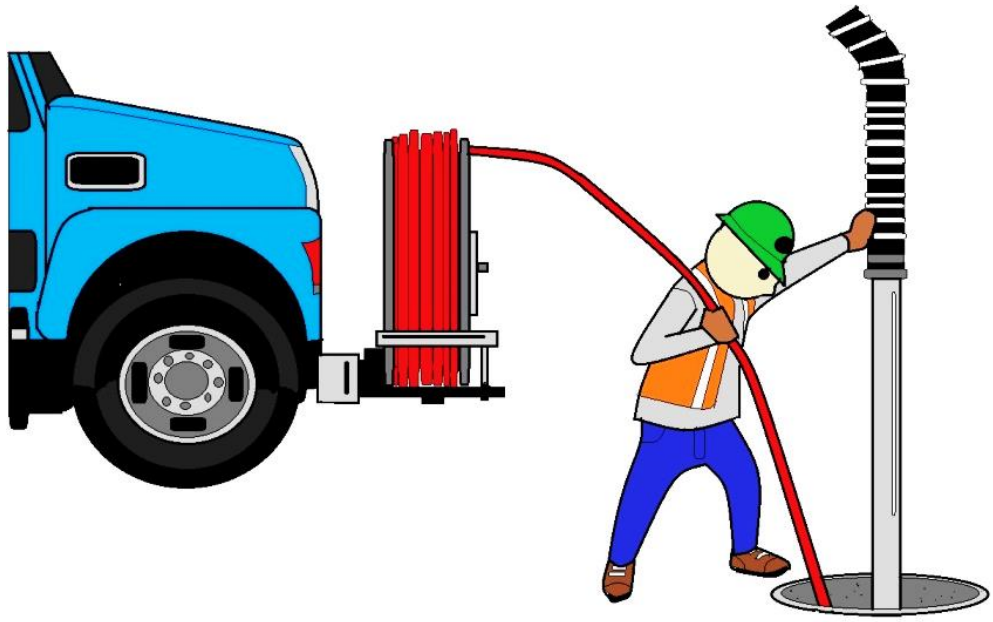
Sewer backups into homes create a health hazard as well as an unpleasant mess that can cost hundreds and sometimes thousands of dollars to clean up. In certain parts of the POTW, FOG can enter storm drains and flow directly into water bodies and onto beaches creating serious environmental and health conditions.

In addition to problems caused by cooking oils, petroleum-based oils can also cause sewer-related problems.

POTW residents or customers may not be aware of or understand their role in these sewer-related problems or pollution, but they can do a lot to help eliminate FOG and other contaminants from the sewer system.

For example:
Other related components of a FOG or CMOM program will include:

- Car washing can result in soap and oil residue entering the storm sewers.
- Run-off from your sprinkler, watering hose, or from the rain can carry yard waste and fertilizer into storm sewers.
- Littering can cause trash and debris to clog catch basins and storm drains.
- A gallon of oil poured down a storm drain could contaminate up to one million gallons of water.



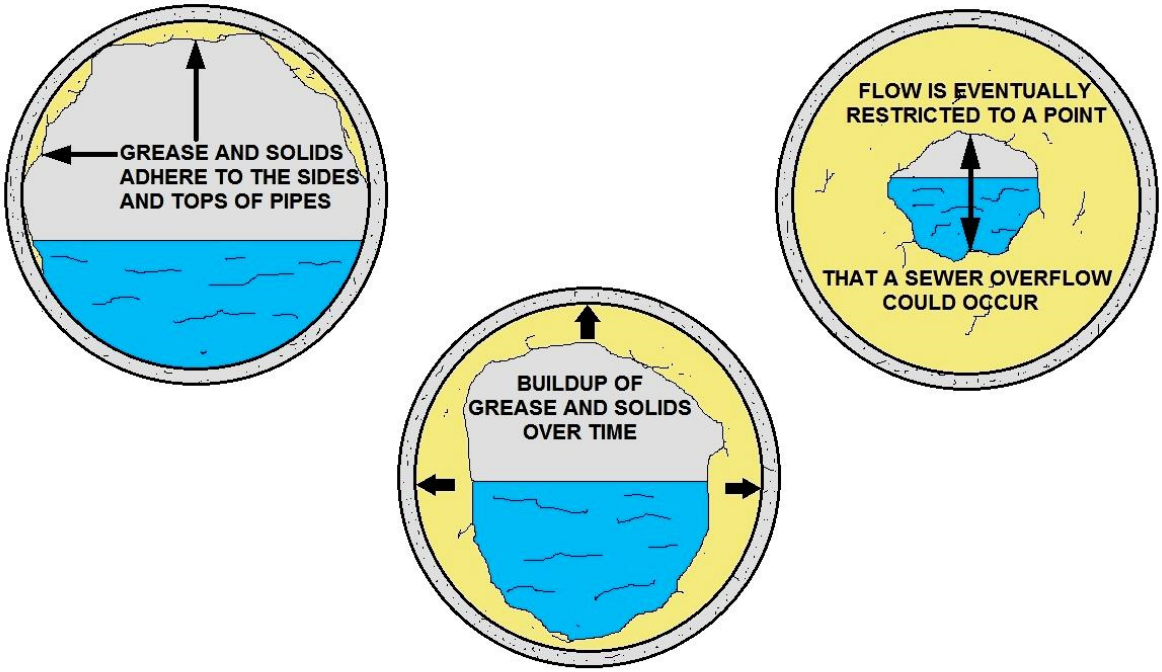
USING A VACUUM TRUCK TO CLEAN SEWER
Often the Vactor is called out to clean out the above concerns.

Reducing Fats, Oils, and Grease in Your Commercial Kitchen

How commercial kitchens can reduce disposing of fats, oil, and grease down the drain.

Any business or institution with a commercial kitchen has to deal with fats, oils, and grease (FOG).

Commercial kitchens are found in restaurants, hospitals, churches, hotels, nursing homes, mobile food preparation facilities, etc.



EFFECTS OF GREASE AND SOLIDS ON SEWER FLOW

Using Best Management Practices Can…

- Lessen the likelihood of losing revenue to emergency shutdowns caused by sewage backups and expensive bills for plumbing and property repairs.
- Lessen the likelihood of lawsuits by nearby businesses over sewer problems caused by your negligence.
- Lessen the likelihood of lawsuits from workers or the public exposed to raw sewage during a backup.
- Reduce the number of times you have to pump and clean your grease interceptors or traps.
- Lessen the likelihood of surcharges from your local sewer authority, or chargebacks for repairs to sewer pipes attributable to your FOG.
- Reduce testing requirements imposed due to a history of violations.
- Lessen the likelihood of enforcement action by local authorities due to violations of ordinances.

Industrial Uses (Fats, Oils, and Grease)
Fats, Oils, and Grease Resources
Liquid fats and solid meat products are materials that should not be sent to landfills or disposed of in the sanitary sewer system. Fats, oils, and grease (FOG) can clog pipes and pumps both in the public sewer lines as well as in wastewater treatment facilities. This prevents combined sewer overflows, which protects water quality and lowers bills.

FOG should be sent to the rendering industry to be made into another product, converted to biofuels, or sent to an anaerobic digester.

Proper Disposal Methods

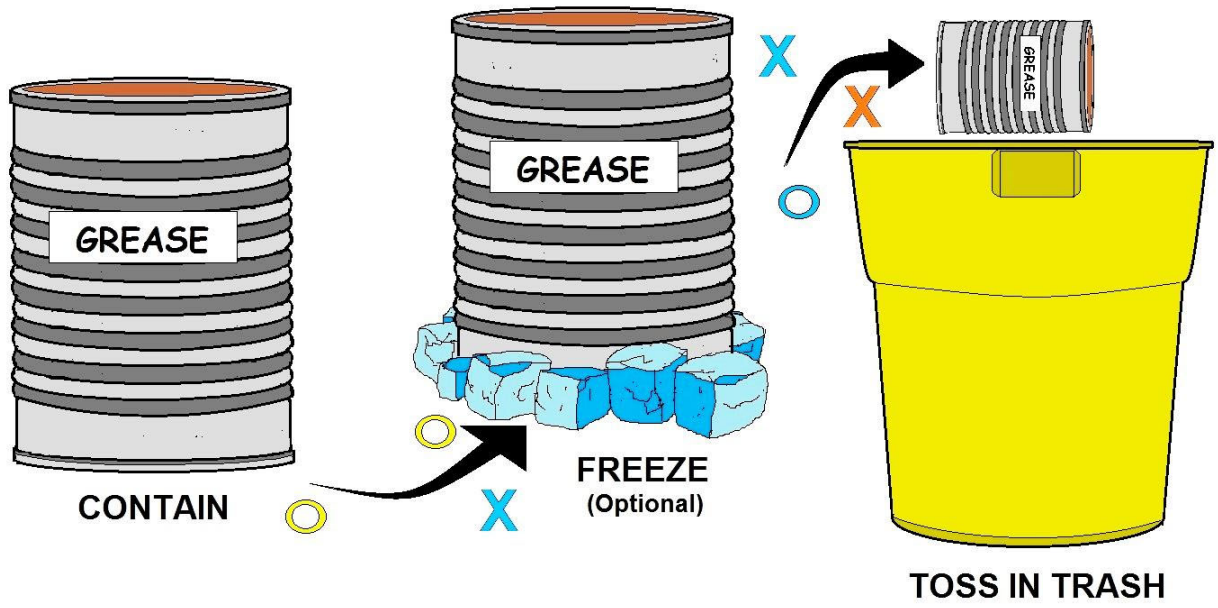
Ways in which a customer can reduce the amounts of FOG that enters the sewer system is by doing the following:

- ✓ Have grease interceptors or traps inspected, maintained and cleaned regularly. (Usually every 6 months they should be pumped out).
- ✓ Scrape grease and food residue from dishes and pans into a garbage bag before placing them into your dishwasher or sink.
- ✓ Allow grease to cool to a safe temperature after cooking before disposal.
- ✓ Only dispose of fat and grease in an approved container or by an approved method.
- ✓ Recycle used cooking or motor oil at a recycling center.
- ✓ First freeze the grease or oil and then throw the hardened oil away on trash day.
- ✓ Mix oils with unscented kitty litter, sawdust or sand to solidify the oil (Avoid scented or disinfectant types of kitty litter as they can react with the oil and cause a fire).
- ✓ Use a paper towel to wipe small amounts of cooking oil, such as meat drippings, and throw the paper towel in the trash.
- ✓ Install “No Grease” signs around sinks to remind employees to avoid dumping fry grease and other fat products down the drain.
- ✓ Frying oils can generally be stored for up to six months and also can be reused for up to six hours of frying time. Store oil in the original container after cooling and strain for foreign materials as it is being poured back into the container.

Methods that should be avoided:

- ✓ Pouring household grease into sinks, garbage disposals or other drains. This is one of the major contributors to sewer stoppages.
- ✓ Flushing grease, diapers, sanitary napkins, newspapers, soiled rags, and/or paper towels down toilets.
- ✓ Pouring oil or grease into a storm drain; it is the same as pouring it directly into a lake.
- ✓ Ignoring your grease trap maintenance schedule.

Ways to Recycle FOG



THE SINK SHOULD NEVER BE USED TO DISPOSE OF:

OILS , FATS OR GREASE

Rendering FOG

Liquid fats and solid meat products can be used as raw materials in the rendering industry, which converts them into animal food, cosmetics, soap, and other products. Many companies will provide storage barrels and free pick-up service.

Converting FOG to Biodiesel

FOG are collected and converted by a local manufacturer into environmentally friendly biodiesel fuel. Biodiesel is an alternative fuel produced from renewable resources such as virgin oils (soybean, canola, palm), waste cooking oil, or other bio-waste feedstock.

Biodiesel significantly reduces greenhouse gases, sulfur dioxide in air emissions, and asthma-causing soot. Along with creating less pollution, biodiesel is simple to use, biodegradable and nontoxic.

Inspection Checklists

Pretreatment programs are developing and using inspection checklists for both food service establishments and municipal pretreatment inspectors to control FOG discharges.

Additionally, EPA identified typical numeric local limits controlling oil and grease in the range of 50 mg/L to 450 mg/L with 100 mg/L as the most common reported numeric pretreatment limit.

EPA expects that blockages from FOG discharges will decrease as POTWs incorporate FOG reduction activities into their Capacity, Management, Operations, and Maintenance (CMOM) program and daily practices.

CMOM programs are comprehensive, dynamic, utility specific programs for better managing, operating and maintaining sanitary sewer collection systems, investigating capacity constrained areas of the collection system, and responding to SSOs.

Collection system owners or operators who adopt FOG reduction activities as part of their CMOM program activities are likely to reduce the occurrence of sewer overflows and improve their operations and customer service.

Summary

The National Pretreatment Program provides regulatory tools and authority to state and local POTW pretreatment programs for eliminating pollutant discharges that cause interference at POTWs, including interference caused by the discharge of Fats, Oils, and Grease (FOG) from food service establishments (FSE).

More specifically, the Pretreatment Program regulations at 40 CFR 403.5(b)(3) prohibit “solid or viscous pollutants in amounts which will cause obstruction” in the POTW and its collection system.

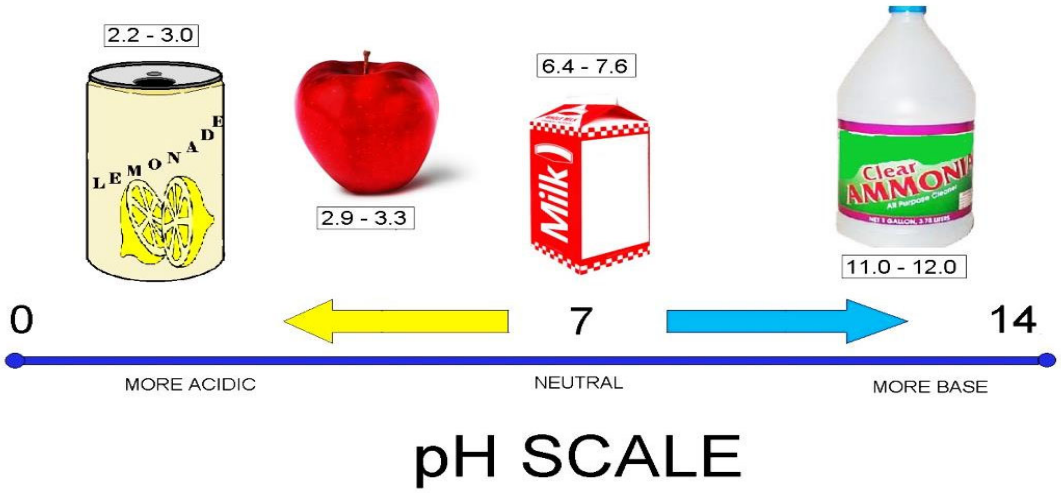
EPA’s Report to Congress on combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs) identified that “grease from restaurants, homes, and industrial sources are the most common cause (47%) of reported blockages.

Grease is problematic because it solidifies, reduces conveyance capacity, and blocks flow.”

Controlling FOG discharges will help POTWs prevent blockages that impact CSOs and SSOs, which cause public health and water quality problems.

Controlling FOG discharges from FSEs is an essential element in controlling CSOs and SSOs and ensuring the proper operations for many POTWs. The interference incidents identified in CSO/SSO report to Congress may indicate the need for additional oversight and enforcement of existing regulations and controls.

pH Section



pH SCALE

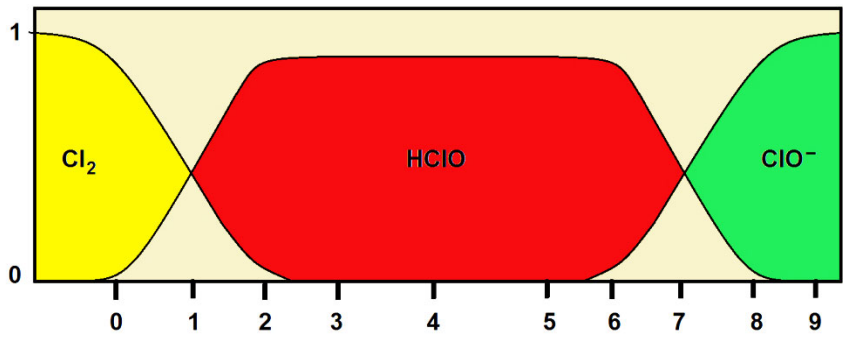
In a FOG or CMOM, it is essential to measure and report pH values in the sewer system. Fats and oils will lower the pH making Hydrogen Sulfide gas and Hypochlorous acid. Most Inspectors should carry a pH meter in their vehicles. In this section we will understand the principles behind pH.

In chemistry, **pH** is a measure of the acidity or basicity of an aqueous solution. Solutions with a pH less than 7 are said to be acidic and solutions with a pH greater than 7 are basic or alkaline. Pure water has a pH very close to 7.

The pH scale is traceable to a set of standard solutions whose pH is established by international agreement. Primary pH standard values are determined using a concentration cell with transference, by measuring the potential difference between a hydrogen electrode and a standard electrode such as the silver chloride electrode.

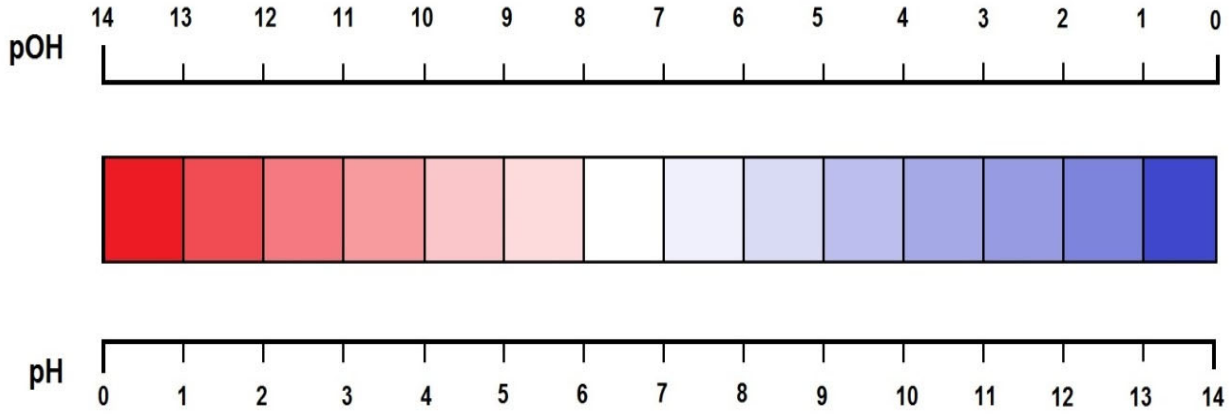
Measurement of pH for aqueous solutions can be done with a glass electrode and a pH meter or using indicators.

pH measurements are important in medicine, biology, chemistry, agriculture, forestry, food science, environmental science, oceanography, civil engineering, chemical engineering, nutrition, water treatment & water purification, and many other applications.



pH - VALUE

Mathematically, pH is the negative logarithm of the activity of the (solvated) hydronium ion, more often expressed as the measure of the hydronium ion concentration.



IN RELATION BETWEEN p(OH) AND p(H) (red= ACIDIC / blue= BASIC)

pH Definition and Measurement

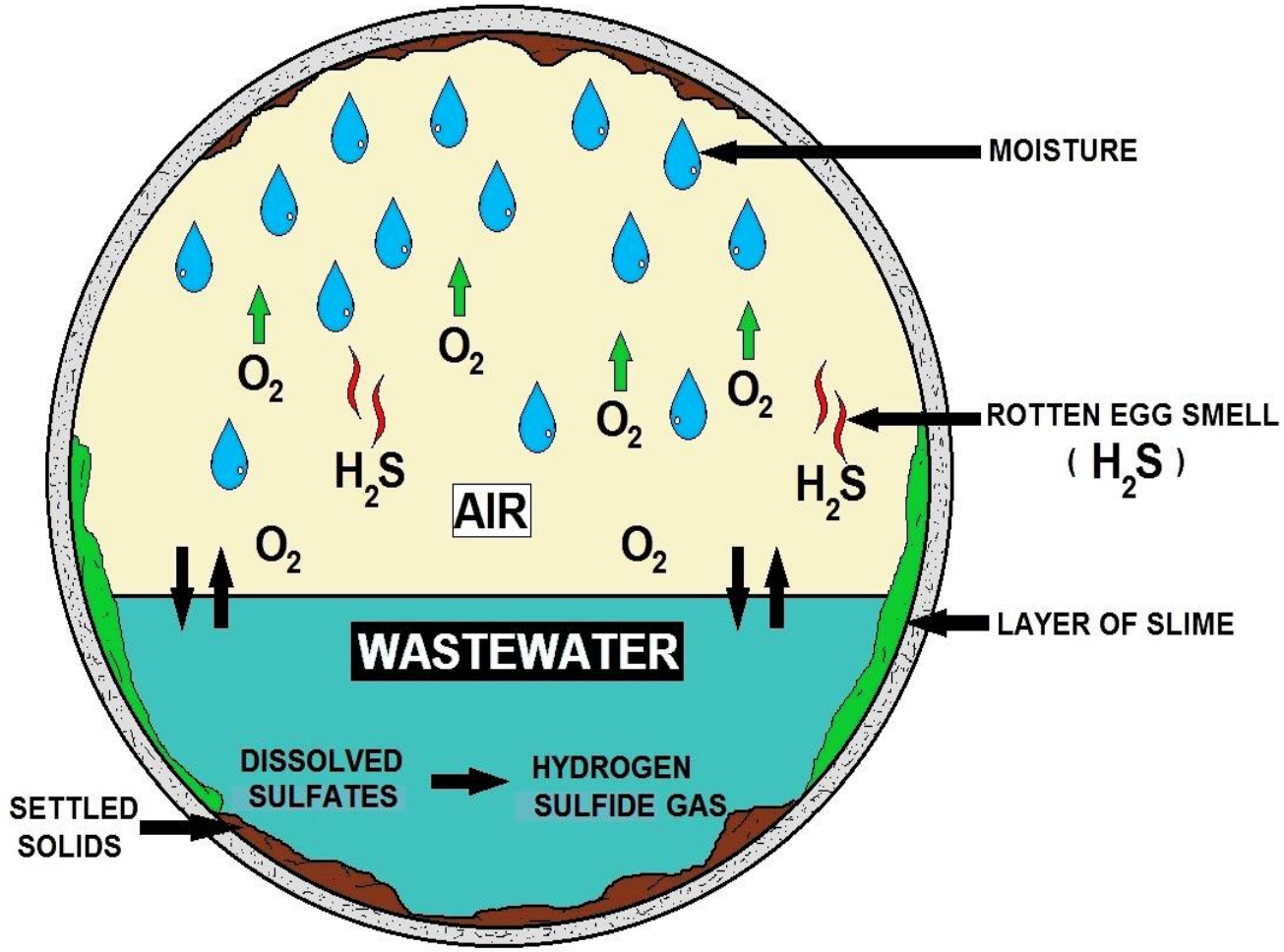
CONCENTRATION OF HYDROGEN IONS COMPARED TO DISTILLED H2O			EXAMPLES OF SOLUTIONS AND THEIR RESPECTIVE pH
1/10,000,000	14	LIQUID DRAIN CLEANER CAUSTIC SODA	
1/1,000,000	13	BLEACHES OVEN CLEANERS	
1/100,000	12	SOAPY WATER	
1/10,000	11	HOUSEHOLD AMMONIA (11.9)	
1/1,000	10	MILK OF MAGNESIUM (10.5)	
1/100	9	TOOTHPASTE (9.9)	
1/10	8	BAKING SODA (8.4) / SEA WATER EGGS	
0	7	"PURE" WATER (7)	
10	6	URINE (6) / MILK (6.6)	
100	5	ACID RAIN (5.6) BLACK COFFEE (5)	
1000	4	TOMATO JUICE (4.1)	
10,000	3	GRAPEFRUIT & ORANGE JUICE SOFT DRINK	
100,000	2	LEMON JUICE (2.3) VINEGAR (2.9)	
1,000,000	1	HYDROCHLORIC ACID SECRETED FROM STOMACH LINING (1)	
10,000,000	0	BATTERY ACID	

pH Scale

pH

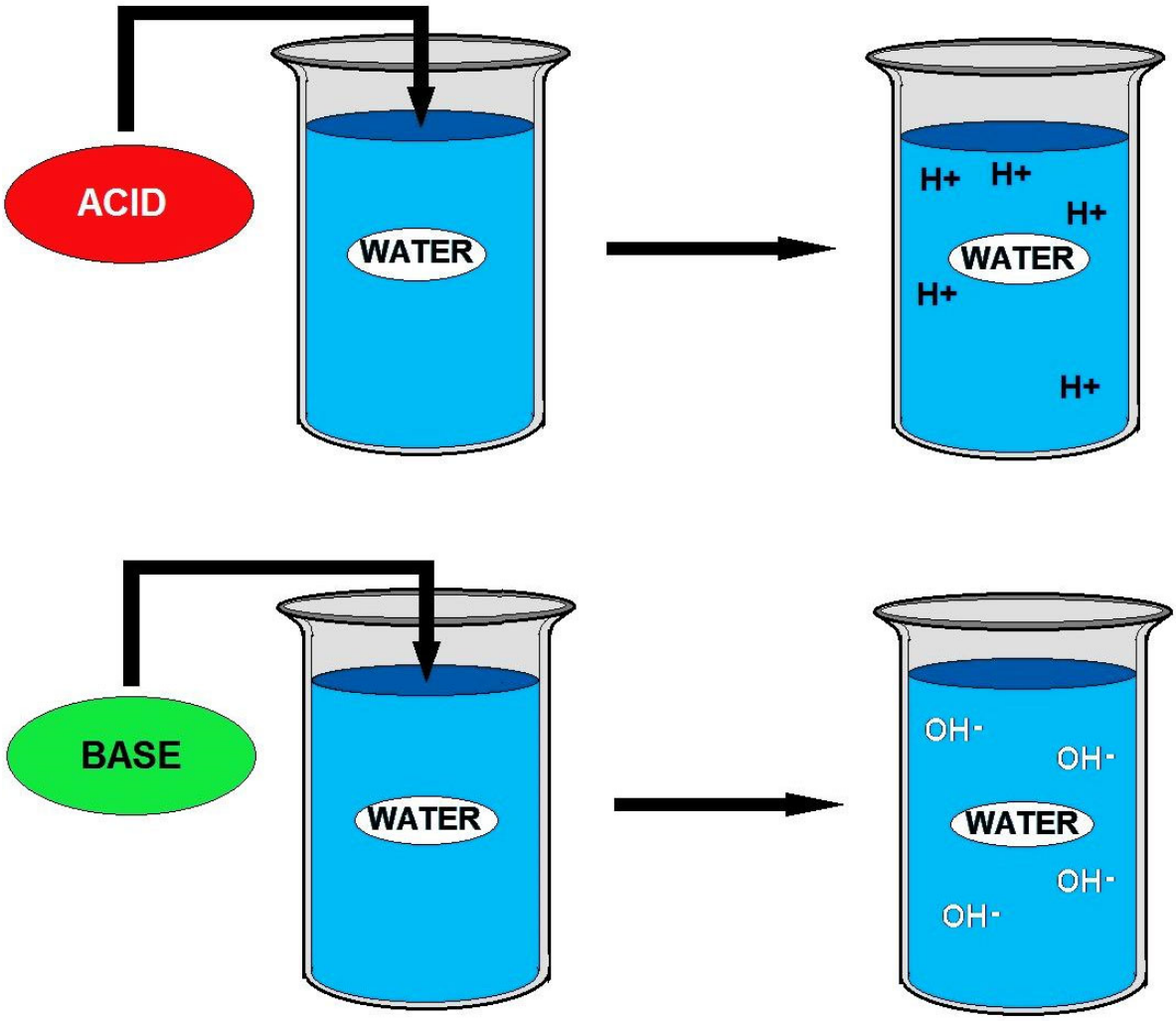
pH is defined as the decimal logarithm of the reciprocal of the hydrogen ion activity, $a_{H}+$, in a solution.

H_2S BACTERIA + $2O_2$ = SULFURIC ACID ➡ CORROSION



HOW CORROSION FORMS IN SEWER PIPING

Even coffee shops create huge acid demands on the sewer system.



Example of the Hydrogen Ion placement in Acids compared to Bases.

pH Definition and Measurement

CONCENTRATION OF HYDROGEN IONS COMPARED TO DISTILLED H2O				EXAMPLES OF SOLUTIONS AND THEIR RESPECTIVE pH
	1/10,000,000	14	LIQUID DRAIN CLEANER CAUSTIC SODA	
	1/1,000,000	13	BLEACHES OVEN CLEANERS	
	1/100,000	12	SOAPY WATER	
	1/10,000	11	HOUSEHOLD AMMONIA (11.9)	
	1/1,000	10	MILK OF MAGNESIUM (10.5)	
	1/100	9	TOOTHPASTE (9.9)	
	1/10	8	BAKING SODA (8.4) / SEA WATER EGGS	
	0	7	"PURE" WATER (7)	
	10	6	URINE (6) / MILK (6.6)	
	100	5	ACID RAIN (5.6) BLACK COFFEE (5)	
	1000	4	TOMATO JUICE (4.1)	
	10,000	3	GRAPEFRUIT & ORANGE JUICE SOFT DRINK	
	100,000	2	LEMON JUICE (2.3) VINEGAR (2.9)	
	1,000,000	1	HYDROCHLORIC ACID SECRETED FROM STOMACH LINING (1)	
	10,000,000	0	BATTERY ACID	

pH Scale

pH

pH is defined as the decimal logarithm of the reciprocal of the hydrogen ion activity, $a_{H}+$, in a solution.

$$pH = -\log_{10}(a_H+) = \log_{10}\left(\frac{1}{aH+}\right)$$

This definition was adopted because ion-selective electrodes, which are used to measure pH, respond to activity.

Ideally, electrode potential, E, follows the Nernst equation, which, for the hydrogen ion can be written as

$$E = E^0 + \frac{RT}{F} In\,(a_H+) = E^0 - \frac{2.303RT}{F} pH$$

where E is a measured potential, E^0 is the standard electrode potential, R is the gas constant, T is the temperature in kelvin, F is the Faraday constant. For H^+ number of electrons transferred is one. It follows that electrode potential is proportional to pH when pH is defined in terms of activity.

Precise measurement of pH is presented in International Standard ISO 31-8 as follows: A galvanic cell is set up to measure the electromotive force (E.M.F.) between a reference electrode and an electrode sensitive to the hydrogen ion activity when they are both immersed in the same aqueous solution.

The reference electrode may be a silver chloride electrode or a calomel electrode. The hydrogen-ion selective electrode is a standard hydrogen electrode.

Reference electrode | concentrated solution of KCl || test solution | H_2 | Pt

Firstly, the cell is filled with a solution of known hydrogen ion activity and the emf, E_S, is measured. Then the emf, E_X, of the same cell containing the solution of unknown pH is measured.

$$pH(X) = pH(S) + \frac{E_S - E_x}{Z}$$

The difference between the two measured emf values is proportional to pH. This method of calibration avoids the need to know the standard electrode potential. The proportionality constant, *1/z* is ideally equal to $\frac{1}{2.303RT/F}$ the "Nernstian slope".

To apply this process in practice, a glass electrode is used rather than the cumbersome hydrogen electrode. A combined glass electrode has an in-built reference electrode. It is calibrated against buffer solutions of known hydrogen ion activity. IUPAC has proposed the use of a set of buffer solutions of known H^+ activity.

Two or more buffer solutions are used in order to accommodate the fact that the "slope" may differ slightly from ideal.

To implement this approach to calibration, the electrode is first immersed in a standard solution and the reading on a pH meter is adjusted to be equal to the standard buffer's value. The reading from a second standard buffer solution is then adjusted, using the "slope" control, to be equal to the pH for that solution. Further details are given in the IUPAC recommendations.

When more than two buffer solutions are used the electrode is calibrated by fitting observed pH values to a straight line with respect to standard buffer values. Commercial standard buffer solutions usually come with information on the value at 25 °C and a correction factor to be applied for other temperatures. The pH scale is logarithmic and therefore pH is a dimensionless quantity.

pH Indicators
Indicators may be used to measure pH, by making use of the fact that their color changes with pH. Visual comparison of the color of a test solution with a standard color chart provides a means to measure pH accurate to the nearest whole number. More precise measurements are possible if the color is measured spectrophotometrically, using a colorimeter of spectrophotometer. Universal indicator consists of a mixture of indicators such that there is a continuous color change from about pH 2 to pH 10. Universal indicator paper is made from absorbent paper that has been impregnated with universal indicator.

pOH
pOH is sometimes used as a measure of the concentration of hydroxide ions, OH^-, or alkalinity. pOH values are derived from pH measurements. The concentration of hydroxide ions in water is related to the concentration of hydrogen ions by

$$[\mathrm{OH^-}] = \frac{K_W}{[\mathrm{H^+}]}$$

where K_W is the self-ionization constant of water. Taking logarithms

$$\mathrm{pOH} = \mathrm{pK_W} - \mathrm{pH}$$

So, at room temperature pOH ≈ 14 − pH. However, this relationship is not strictly valid in other circumstances, such as in measurements of soil alkalinity.

Extremes of pH
Measurement of pH below about 2.5 (ca. 0.003 mol dm^{-3} acid) and above about 10.5 (ca. 0.0003 mol dm^{-3} alkali) requires special procedures because, when using the glass electrode, the Nernst law breaks down under those conditions. Various factors contribute to this. It cannot be assumed that liquid junction potentials are independent of pH.

Also, extreme pH implies that the solution is concentrated, so electrode potentials are affected by ionic strength variation. At high pH the glass electrode may be affected by "alkaline error", because the electrode becomes sensitive to the concentration of cations such as Na^+ and K^+ in the solution. Specially constructed electrodes are available which partly overcome these problems. Runoff from mines or mine tailings can produce some very low pH values.

Non-aqueous Solutions
Hydrogen ion concentrations (activities) can be measured in non-aqueous solvents. pH values based on these measurements belong to a different scale from aqueous pH values, because activities relate to different standard states. Hydrogen ion activity, a_{H^+}, can be defined as:

$$a_{H+} = \exp\left(\frac{\mu_{H+} - \mu^{\ominus}_{H+}}{RT}\right)$$

where μ_{H^+} is the chemical potential of the hydrogen ion, $\mu^{\ominus}_{H^+}$ is its chemical potential in the chosen standard state, R is the gas constant and T is the thermodynamic temperature. Therefore, pH values on the different scales cannot be compared directly, requiring an intersolvent scale which involves the transfer activity coefficient of hydrolyonium ion.

pH is an example of an acidity function. Other acidity functions can be defined. For example, the Hammett acidity function, H_0, has been developed in connection with superacids.

The concept of "Unified pH scale" has been developed on the basis of the absolute chemical potential of the proton. This scale applies to liquids, gases and even solids.

Applications
Water has a pH of $pK_w/2$, so the pH of pure water is about 7 at 25 °C; this value varies with temperature.

When an acid is dissolved in water, the pH will be less than that of pure water. When a base, or alkali, is dissolved in water, the pH will be greater than that of pure water.

A solution of a strong acid, such as hydrochloric acid, at concentration 1 mol dm^{-3} has a pH of 0.

A solution of a strong alkali, such as sodium hydroxide, at concentration 1 mol dm^{-3}, has a pH of 14. Thus, measured pH values will lie mostly in the range 0 to 14, though negative pH values and values above 14 are entirely possible.

Since pH is a logarithmic scale, a difference of one pH unit is equivalent to a tenfold difference in hydrogen ion concentration.

The pH of an aqueous solution of a salt such as sodium chloride is slightly different from that of pure water, even though the salt is neither acidic nor basic. This is because the hydrogen and hydroxide ions' activity are dependent on ionic strength, so K_w varies with ionic strength. The pH of pure water decreases with increasing temperatures.

For example, the pH of pure water at 50 °C is 6.55.

Seawater
The pH of seawater plays an important role in the ocean's carbon cycle, and there is evidence of ongoing ocean acidification caused by carbon dioxide emissions. However, pH measurement is complicated by the chemical properties of seawater, and several distinct pH scales exist in chemical oceanography.

As part of its operational definition of the pH scale, the IUPAC defines a series of buffer solutions across a range of pH values (often denoted with NBS or NIST designation).

These solutions have a relatively low ionic strength (~0.1) compared to that of seawater (~0.7), and, as a consequence, are not recommended for use in characterizing the pH of seawater, since the ionic strength differences cause changes in electrode potential.

To resolve this problem, an alternative series of buffers based on artificial seawater was developed. This new series resolves the problem of ionic strength differences between samples and the buffers, and the new pH scale is referred to as the **total scale**, often denoted as **pH_T**.

Calculations of pH

The calculation of the pH of a solution containing acids and/or bases is an example of a chemical speciation calculation, that is, a mathematical procedure for calculating the concentrations of all chemical species that are present in the solution. The complexity of the procedure depends on the nature of the solution.

For strong acids and bases no calculations are necessary except in extreme situations. The pH of a solution containing a weak acid requires the solution of a quadratic equation.

The pH of a solution containing a weak base may require the solution of a cubic equation. The general case requires the solution of a set of non-linear simultaneous equations.

A complicating factor is that water itself is a weak acid and a weak base. It dissociates according to the equilibrium

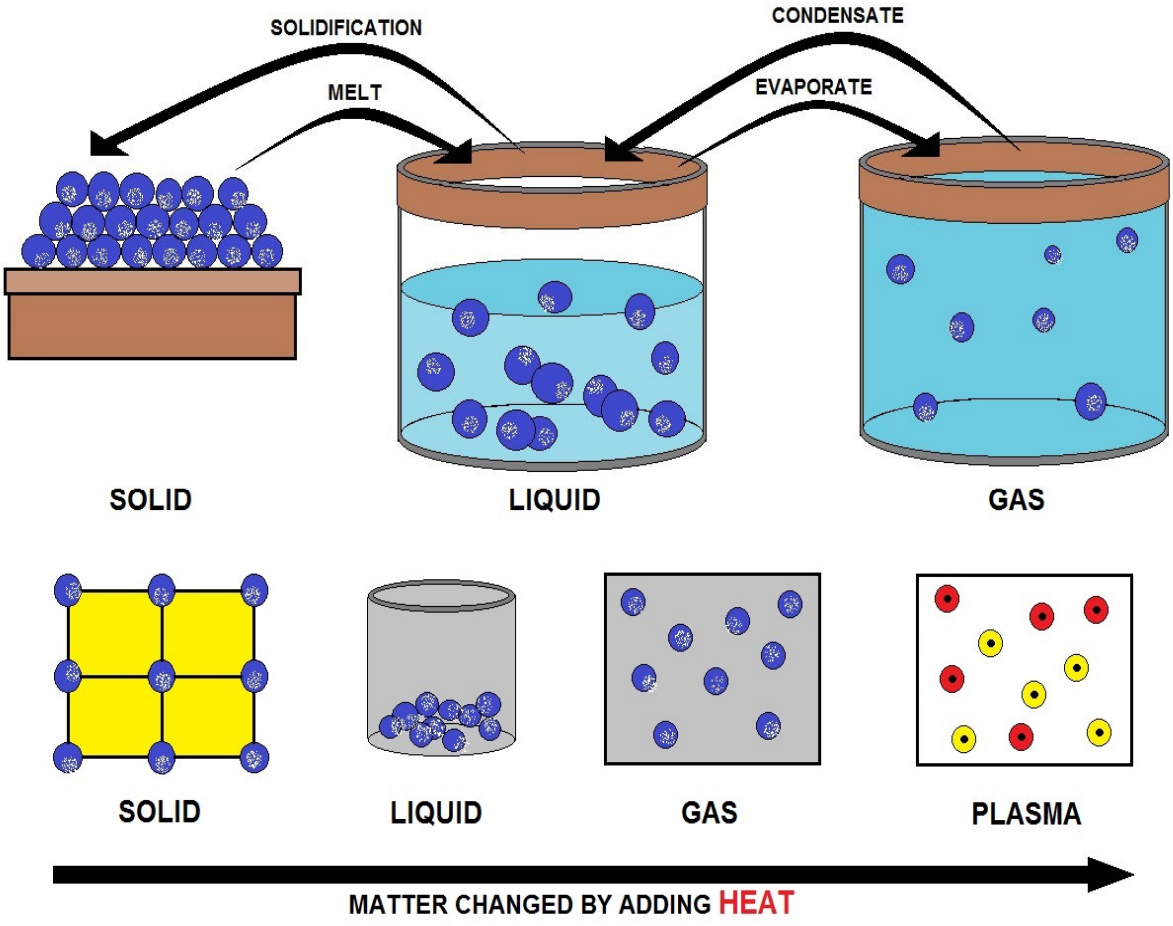
$$2H_2O \rightleftharpoons H_3O^+(aq) + OH^-(aq)$$

with a dissociation constant, K_w defined as

$$K_w = [H^+][OH^-]$$

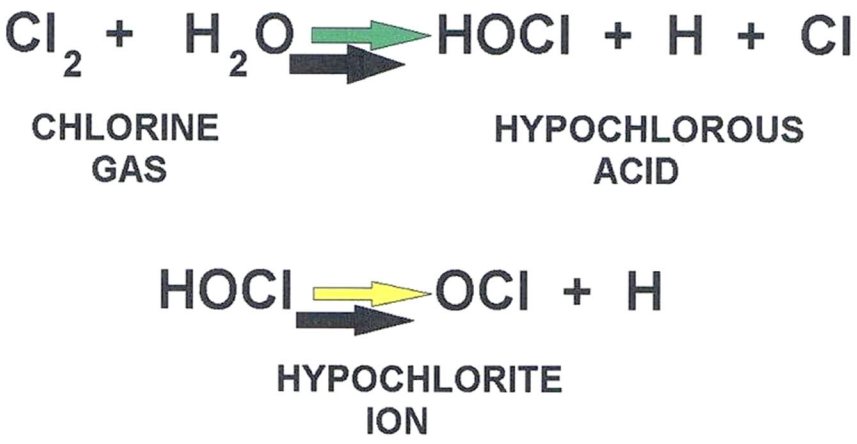
where $[H^+]$ stands for the concentration of the aquated hydronium ion and $[OH^-]$ represents the concentration of the hydroxide ion. K_w has a value of about 10^{-14} at 25 °C, so pure water has a pH of about 7.

This equilibrium needs to be taken into account at high pH and when the solute concentration is extremely low.



STATES OF MATTER

Strong Acids and Bases



Strong acids and bases are compounds that, for practical purposes, are completely dissociated in water. Under normal circumstances this means that the concentration of hydrogen ions in acidic solution can be taken to be equal to the concentration of the acid. The pH is then equal to minus the logarithm of the concentration value.

Hydrochloric acid (HCl) is an example of a strong acid. The pH of a 0.01M solution of HCl is equal to $-\log_{10}(0.01)$, that is, pH = 2.

Sodium hydroxide, NaOH, is an example of a strong base. The p[OH] value of a 0.01M solution of NaOH is equal to $-\log_{10}(0.01)$, that is, p[OH] = 2.

From the definition of p[OH] above, this means that the pH is equal to about 12. For solutions of sodium hydroxide at higher concentrations the self-ionization equilibrium must be taken into account.

Weak Acids and Bases

A weak acid or the conjugate acid of a weak base can be treated using the same formalism.

Acid: $HA \rightleftharpoons H^+ + A^-$

Base: $HA^+ \rightleftharpoons H^+ + A$

First, an acid dissociation constant is defined as follows. Electrical charges are omitted from subsequent equations for the sake of generality

$$K_a = \frac{[H][A]}{[HA]}$$

and its value is assumed to have been determined by experiment. This being so, there are three unknown concentrations, [HA], $[H^+]$ and $[A^-]$ to determine by calculation. Two additional equations are needed.

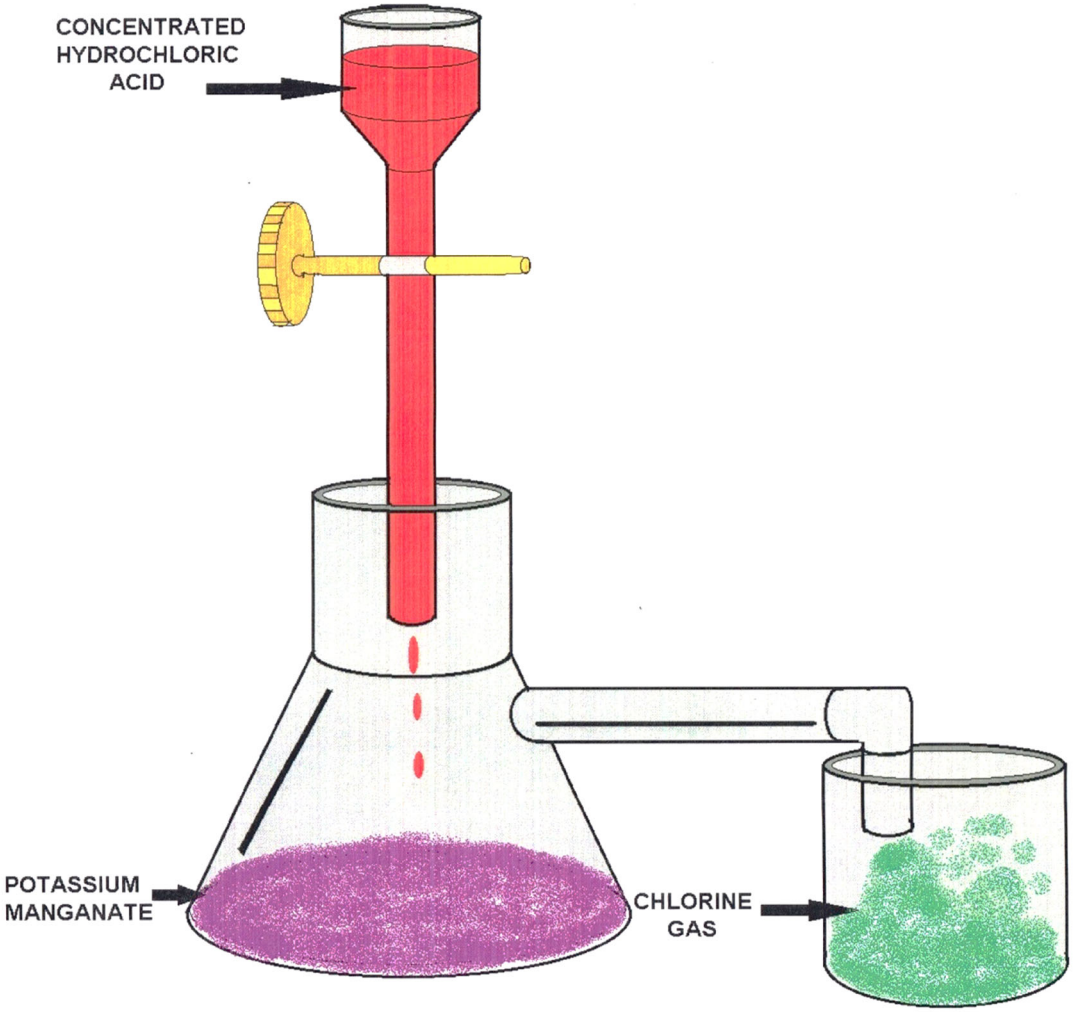
One way to provide them is to apply the law of mass conservation in terms of the two "reagents" H and A.

$$C_A = [A] + [HA]$$
$$C_H = [H] + [HA]$$

C stands for analytical concentration. In some texts one mass balance equation is replaced by an equation of charge balance. This is satisfactory for simple cases like this one but is more difficult to apply to more complicated cases as those below.

Together with the equation defining K_a, there are now three equations in three unknowns. When an acid is dissolved in water $C_A = C_H = C_a$, the concentration of the acid, so [A] = [H]. After some further algebraic manipulation an equation in the hydrogen ion concentration may be obtained.

$$[H]^2 + K_a[H] - K_aC_a = 0$$



Capacity, Management, Operation and Maintenance
CMOM Section

Proper function of sanitary sewer systems is vital to protect public health, property, and waterways in the surrounding area. Most utilities have a management, operation, and maintenance (MOM) plan to ensure their system is in working order.

However, more than 40,000 sanitary sewage overflows SSOs occur every year, causing huge monetary losses, damage to fish/shellfish beds, polluting groundwater, and decreased tourism. Sanitary sewage overflows (SSOs) release raw sewage from the collection system before it can reach a treatment facility. Sewage may flow out of manholes, into businesses and homes, and eventually ends up in local waterways.

Many factors are involved in SSOs. Many municipalities started constructing sewer systems over 100 years ago. Some of these have not been adequately maintained, improved, or repaired over the last century. Cities have used a wide variety of building materials, designs, and installation techniques, which aren't durable enough to withstand heavy, continuous use. Problems can be especially bad where an older system is attached to a new system, or an older system has fallen into disrepair.

The Management, Operation and Maintenance (MOM) Programs Project is a pilot enforcement approach developed by EPA Region 4 to bring municipal sewer systems into full compliance with the Clean Water Act by eliminating sanitary sewer overflows (SSOs) from municipal sewer systems. A SSO is a release of untreated wastewater before the flow reaches a treatment plant. SSOs pose a significant threat to public health and water quality.

Treatment Balance and the Effects of Undesirable Solids
For any wastewater treatment plant to operate properly, the operator has to maintain a skillfully balanced mixture of microorganisms which contact and digest the organics in the wastewater, and bacteria then grows on this media to treat the wastewater. When a plant is properly maintained these bacteria or bugs eat the dissolved organics in the water, thus removing BOD, Ammonia, Nitrates, and Phosphorus.

All of these constituents must be treated and removed from the water. When this is accomplished, you achieve a low turbidity and clean decantible water which is then filtered and chlorinated to kill all the remaining bacteria. This incredible process leaves extremely clean and reusable water that can be injected back into the ground, sent to ponds or used for irrigation.

Certain compounds and undesirable solids, like grease and grass clippings, can disturb this delicate balance and necessary process at the wastewater treatment facility. There are compounds and mixtures that should never be introduced into a sanitary sewer system.

These destructive compounds include but are not limited to: cleaning solvents, grease (both household and commercial), oils (both household and commercial), pesticides, herbicides, antifreeze and other automotive products.

The solids include but are not limited to: plastics, rubber goods, grass clippings, metal products such as aluminum foil, beer or soda cans, wood products, glass, paper products such as disposable diapers and sanitary napkins. Items such as these disturb or even kill the delicate balance of microorganisms and bacteria that are needed to treat the wastewater.

These will also clog the sanitary sewer causing backups and sewer overflows.

First, we will examine the damage to equipment, and we will finish with resolution methods.

Municipality Self-Assessment
Under the MOM Programs Project, Region 4 invites municipalities to undertake a detailed self-assessment of their MOM programs. The municipalities submit this self-assessment along with recommendations for improvements to the MOM programs and/or remedial measures to correct sewer infrastructure problems.

In consideration for undertaking the self-assessment, the municipality is able to establish its own reasonable goals and schedules, and the Region may use its discretion to significantly reduce penalties related to SSOs. SSO's are generally related to sewer blockages, in which FOG is the primary concern.

Where an enforcement action is necessary, the Region works with the municipality to identify necessary remedial measures and to establish schedules. The Region will likely defer any penalty decision until after the completion of the necessary improvements.

Leading Causes of SSOs

Problem/Cause	% of SSOs	Description
Blockages	43%	Blockages may be caused by tree roots or a build-up of sediment and other materials (i.e., grease, grit, debris). Structural defects and a flat slope can also cause excessive deposits of material. Build-ups can cause pipes to break or collapse.
Infiltration and Inflow (I/I)	27%	Infiltration and inflow occurs when rain or snowmelt enters the ground and seeps into leaky sanitation sewers, which were not designed to carry rainfall or drain property. Inflow can also occur when excess waters from roof drains, broken pipes and bad connections at sewer service lines infiltrates the sanitary sewer.
Structural Failures	12%	Line/main breaks are a major result of structural failure. Undersized systems do not have large enough pumps or lines to carry all the sewage generated by the buildings attached to them. This is especially true for new subdivisions or commercial areas. SSOs can occur at sewer service connections to houses or buildings. Some cities estimate that up to 60% of SSOs come from service lines.
Power Failure	11%	Stops pump operation, interrupting sewage flow
Other	7%	Scheduling, vandalism

What are Sanitary Sewer Overflows?

Sanitary Sewer Overflows (SSOs) are discharges of raw sewage from municipal sanitary sewer systems. SSOs can release untreated sewage into basements or out of manholes and onto city streets, playgrounds, and into streams before it can reach a treatment facility. SSOs are often caused by blockages and breaks in the sewer lines.

Why do Sewers Overflow?
SSOs occasionally occur in almost every sewer system, even though systems are intended to collect and contain all the sewage that flows into them. When SSOs happen frequently, it means something is wrong with the system.

Problems that Can Cause Chronic SSOs Include:

- Infiltration and Inflow (I&I): too much rainfall or snowmelt infiltrating through the ground into leaky sanitary sewers not designed to hold rainfall or to drain property, and excess water inflowing through roof drains connected to sewers, broken pipes, and badly connected sewer service lines.
- Undersized Systems: Sewers and pumps are too small to carry sewage from newly developed subdivisions or commercial areas.
- Pipe Failures: blocked, broken or cracked pipes, tree roots grow into the sewer, sections of pipe settle or shift so that pipe joints no longer match, and sediment and other material builds up causing pipes to break or collapse.
- Equipment Failures: pump failures, power failures.
- Sewer Service Connections: discharges occur at sewer service connections to houses and other buildings; some cities estimate that as much as 60% of overflows comes from the service lines.
- Deteriorating Sewer System: improper installation, improper maintenance; widespread problems that can be expensive to fix develop over time, some municipalities have found severe problems necessitating billion-dollar correction programs, often communities have to curtail new development until problems are corrected or system capacity is increased.

Why are SSOs a Problem?
The EPA has found that SSOs caused by poor sewer collection system management pose a substantial health and environmental challenge. The response to this challenge varies considerably from state to state. Many municipalities have asked for national consistency in the way permits are considered for wastewater discharges, including SSOs, and in enforcement of the law prohibiting unpermitted discharges.

In response, the EPA has convened representatives of states, municipalities, health agencies, and environmental advocacy groups to advise the Agency on how to best meet this challenge.

This SSO Federal Advisory Subcommittee examines the need for national consistency in permitting and enforcement, effective sewer operation and maintenance principles, public notification for SSOs with potential health or environmental dangers, and other public policy issues.

The EPA carefully considers the Subcommittee's recommendations for regulatory and non-regulatory actions to reduce SSOs nationally.

CMOM Program Specifics

Utility Specific
The complexity and expense associated with a utility's CMOM, or MOM programs is specific to the size and complexity of the Publicly Owned Treatment Works (POTW) and related infrastructure. Factors such as population growth rate and soil/groundwater conditions also dictate the level of investment which should be made.

Purposeful
When MOM programs are present and properly maintained, they support customer service and protect system assets, public health, and water quality.

Goal-Oriented
Proper MOM programs have goals directed toward their individual purposes. Progress toward these goals is measurable, and the goals are attainable.

Uses Performance Measures
Performance measures should be established for each MOM program in conjunction with the program goal. These measures are quantifiable, and used in determining progress to, or beyond, the program goal.

Periodically Evaluated
An evaluation of the progress toward reaching the goals, or a reassessment of the goals, should be made periodically and based upon the quantified performance measures.

Available In Writing
The effectiveness of a MOM program quickly breaks down unless it is available in writing. Personnel turnover and lapses in communication between staff and management can change otherwise proper MOM programs to improper ones. Written MOM programs are useful only if they are made readily available to all personnel and clearly documented.

Implemented by Trained Personnel
Appropriate safety, equipment, technical, and program training is essential for implementing MOM programs properly.

What MOM programs should be audited?
MOM activity at a utility involves its entire wastewater infrastructure. Common utility management activities and operations and maintenance activities associated with sewer systems and pretreatment are listed in the Self-Audit Review Document.

If a utility owns treatment works or a pond system, then activities associated with the management, operation, and maintenance of these facilities should also be included in the audit. A helpful guide for this part is the NPDES Compliance Inspection Manual. Instruction for obtaining this manual is provided in a list of references.

Elements of a Proper Self-Audit

Initial Assessment
Begin by performing a general assessment of the utility and prioritizing the order of programs to be audited. The NPDES Compliance Inspection Manual and Guidance may be useful references in making this assessment.

Develop the Audit Plan
Identify the MOM programs present and/or needed at the utility, establish performance measures, and develop a schedule for auditing the programs.

Conduct the Audit
Evaluate each MOM program against the defined elements of a proper program. This can be accomplished by reviewing the program's records and resources, conducting a field evaluation, and comparing the program understanding of both personnel and management.

Identify Deficiencies
Define any programs needed, or improvements to programs needed, and any infrastructure deficiencies found. Identify any unpermitted discharges which have occurred in the past five years.

Develop Improvement Plan
Define the utility's plan/schedule to remediate the necessary improvements. This plan should include any short-term or long-term program improvements, and any short-term or long-term capital improvements which need addressing.

Prepare the Self-Audit Report
Generate a report of the audit results, including any deficiencies found and the corresponding improvement plan, which is useful for the utility. This report should be capable of serving the utility as a reference when conducting any needed remedial measures, and as a reference to compare current performance with future self-audit results.

Are there federal grants or other compliance assistance resources available to conduct a Self-Audit?
Currently, there are no funds available for the specific purpose of conducting a MOM Programs Self-Audit. However, the Office of Wastewater Management offers a number of financial resources to assist qualified utilities in making improvements to their programs.

Small publicly-owned wastewater treatment plants which discharge less than 5 million gallons per day are also eligible for the Wastewater Treatment Plant Operator On-Site Assistance Training Program. The program provides on-site operator training, financial management, troubleshooting, and other operation and maintenance assistance.

A network of operator training personnel, EPA Regional Office Coordinators and States and State Training Centers work in the field with small under-served communities to help solve their operation and maintenance problems. There is no cost incurred by the facility in need of assistance. The only requirement of the program is the willingness to work with a trainer to correct the facility's problems.

What Health Risks do SSOs present?
Because SSOs contain raw sewage they can carry bacteria, viruses, protozoa (parasitic organisms), helminths (intestinal worms), and borroughs (inhaled molds and fungi). The diseases they may cause range in severity from mild gastroenteritis (causing stomach cramps and diarrhea) to life-threatening ailments such as cholera, dysentery, infectious hepatitis, and severe gastroenteritis.

People can be Exposed Through:
- Sewage in drinking water sources.
- Direct contact in areas of high public access such as basements, lawns or streets, or waters used for recreation. At least one study has estimated a direct relationship between gastrointestinal illness contracted while swimming and bacteria levels in the water.
- Shellfish harvested from areas contaminated by raw sewage. One study indicates that an average of nearly 700 cases of illness per year were reported in the 1980s from eating shellfish contaminated by sewage and other sources. The number of unreported cases is estimated to be 20 times that.
- Some cases of disease contracted through inhalation and skin absorption have also been documented.

What other Damage can SSOs do?
SSOs also damage property and the environment. When basements flood, the damaged area must be thoroughly cleaned and disinfected to reduce the risk of disease. Cleanup can be expensive for homeowners and municipalities. Rugs, curtains, flooring, wallboard panels, and upholstered furniture usually must be replaced. A key concern with SSOs that enter oceans, bays, estuaries, rivers, lakes, streams, or brackish waters is their effect on water quality. When bodies of water cannot be used for drinking water, fishing, or recreation, society experiences an economic loss. Tourism and waterfront home values may fall. Fishing and shellfish harvesting may be restricted or halted. SSOs can also close beaches. One 1994 study claims that SSOs closed beaches across the nation that year for a total of more than 300 days.

How can SSOs be Reduced or Eliminated?
Many avoidable SSOs are caused by inadequate or negligent operation or maintenance, inadequate system capacity, and improper system design and construction. These SSOs can be reduced or eliminated by:
- Sewer system cleaning and maintenance
- Reducing infiltration and inflow through system rehabilitation and repairing broken or leaking service lines.
- Enlarging or upgrading sewer, pump station, or sewage treatment plant capacity and/or reliability.
- Construction of wet weather storage and treatment facilities to treat excess flows.

Communities also should address SSOs during sewer system master planning and facilities planning, or while extending the sewer system into previously unsewered areas.

A few SSOs may be unavoidable. Unavoidable SSOs include those occurring from unpreventable vandalism, some types of blockages, extreme rainstorms, and acts of nature such as earthquakes or floods.

What Costs are involved with Reducing or Eliminating SSOs?
Sanitary sewer collection systems are a valuable part of the nation's infrastructure. The EPA estimates that our nation's sewers are worth a total of more than $1 trillion. The collection system of a single large municipality is an asset worth billions of dollars and that of a smaller city could cost many millions to replace. Sewer rehabilitation to reduce or eliminate SSOs can be expensive, but the cost must be weighed against the value of the collection system asset and the added costs if this asset is allowed to further deteriorate. Ongoing maintenance and rehabilitation adds value to the original investment by maintaining the system's capacity and extending its life.

The costs of rehabilitation and other measures to correct SSOs can vary widely by community size and sewer system type. Those being equal, however, costs will be highest, and ratepayers will pay more in communities that have not put together regular preventive maintenance or asset protection programs. Assistance is available through the Clean Water Act State Revolving Fund for capital projects to control SSOs. State Revolving Funds in each state and Puerto Rico can help arrange low-interest loans. For the name of your State Revolving Fund contact, please call the EPA Office of Water Resource Center, (202) 566-1729.

To reduce sanitary sewer overflows (SSOs), the EPA is proposing to clarify and expand permit regulations that are already in force under the Clean Water Act. This will affect over 19,000 municipal sanitary sewer systems, including 4800 satellite collection systems that will be regulated for the first time. It will allow streamlined CMOM requirements for small communities and permit them to skip self-audits and annual reports if an SSO hasn't occurred.

The new rule establishes:

- Three standard permit conditions for inclusion in NPDES permits for publicly owned treatment works (POTWs) and municipal sanitary sewer collection systems
- A framework under the NPDES permit program for regulating municipal satellite collection systems.

The EPA would like to establish three standard permit conditions that will be included as part of NPDES permits for publicly owned treatment works (POTWs) and municipal sanitary sewer collection systems.
The proposed standard permit conditions:

- Address capacity, management, operation, and maintenance requirements for municipal sanitary sewer collection systems (proposed 40 CFR 122.42(e))
- Prohibit discharges to waters of the United States that occur before the discharge reaches a (POTW) treatment facility (includes a framework for defense for unavoidable discharges) (proposed 40 CFR 122.42(f))
- Establish requirements for reporting, public notification, and record keeping for discharges from municipal sanitary sewer system (proposed 40 CFR 122.42(g)).

These proposed standard permit rules are based on the Clean Water Act, sections 304(i), 308, and 402(a). The rules were developed from existing permit conditions to specifically address municipal systems and discharges. The proposed rules will help cities upgrade wastewater collection systems across the nation, protecting one of the nation's most valuable assets. Under these proposed rules, facilities will be required to implement new programs for:

- Capacity assurance, managing, operating, and maintaining systems (CMOM) - These programs will help communities provide adequate wastewater collection and treatment facilities. It will include many standard operation and maintenance activities to ensure good system performance.

- Public notification – cities and local interests will establish a custom program to notify the public of overflows according to the risk they pose. The EPA is also proposing that yearly summaries of SSOs be made public. In addition, this proposal will clarify existing requirements for keeping records and requirements for reporting to the state.

More Specifically, CMOM will Require Facilities to:

- Establish general performance standards.
- Have a management program.
- Create an overflow response plan.
- Ensure system evaluations.
- Verify capacity assurance.
- Submit to periodic audits of the CMOM program.
- Notify the public and regulatory agencies of SSOs.

General Performance Standards

A CMOM program will ensure:

- There is enough capacity to handle base and peek flows.
- The use of all reasonable measure to stop SSOs.
- Proper collection, management, operation and maintenance of the system.
- Prompt notification of all parties that may be exposed to an SSO.

Management Programs

Management program documents must include:

- The goals of the CMOM program (may differ depending on the facility.)
- Legal authorities that will help implement CMOM.
- The “chain of command” for implementing CMOM and reporting SSOs.
- Design and performance requirements.
- Measures that will be taken to help implement CMOM.
- Monitoring/performance measures to how effective the CMOM program is.
- Communication plan.

Overflow Response Plan

The overflow response plan should be designed provide a quick response to SSOs. Rapid response to an SSO can mitigate structural damage, pollution of waterways, and the public health risk. The plan must include the following:

- SSO response procedures.
- Immediate notification of health officials.
- Public notification.
- Plan made available to the public.
- Distribution to all appropriate personnel.
- Revision and maintenance of the plan by appropriate personnel.

System Evaluation and Capacity Assurance Plan

These two activities work hand-in-hand to detect and address deficiencies and scheduling. These will provide:

- An evaluation of parts of the collection system that have substandard performance.
- Capacity assurance measures to address substandard performance.
- Explanation of prioritization and scheduling.

Performance measures and indicators are important in evaluating collection system performance and implementing capacity management, operation and maintenance programs.

Potential Performance Indicators

Input measures	Per capita costs Number of employee hours
Output measures	Length of pipe maintained Number of service calls completed Percentage of length maintained repaired this year Percentage of length maintained needing repair Length of new sewer constructed Number of new services connected
Outcomes	Number of stoppages per 100 miles of pipe Average service response time Number of complaints
Ecological/Human health/ Resource use	Shellfish bed closures Benthic Organism index Biological diversity index Beach closures Recreational activities Commercial activities

CMOM Audits
CMOM will require regular, comprehensive audits, done by each facility. These audits will help identify non-conformance to CMOM regulations so problems can be addressed quickly. All findings, proposed corrective actions and upcoming improvements should be documented in the audit report.

Communication/Notification
If an SSO occurs, sanitary sewer facilities will be required to immediately notify the NPDES permit authority, appropriate health agencies, state authorities, drinking water suppliers, and, if necessary, the general public in the risk area. This rule will also require an annual report of all overflows, including minor SSOs such as building backups. Facilities must post locations of recurrent SSOs and let the public know that the annual report is available to them. The record keeping provisions mandate that facilities must maintain records for three years about all overflows, complaints, work orders on the system, and implementation measures.

According to the EPA, an effective CMOM program would help NPDES permitees to:

- Develop/revise routine preventive maintenance activities that prevent service interruption and protect capital investments.
- Create an inspection schedule and respond to the inspection results.
- Investigate the causes of SSOs and take corrective measures.
- Respond quickly to SSOs to minimize impacts to human health and the environment.
- Identify and evaluate SSO trends.
- Develop budgets and identify staffing needs.
- Plan for future growth to ensure adequate capacity is available when it's needed.
- Identify hydraulic (capacity) and physical deficiencies and prioritize responses, including capital investments.
- Identify and develop appropriate responses to program deficiencies (e.g., lack of legal authority, inadequate funding, and inadequate preventive maintenance).

- Keep parts and tools inventories updated and equipment in working order.
- Report and investigate safety incidents and take steps to prevent their recurrence.

Implementation
The EPA estimates that implementing this rule will impose an additional $93.5 to $126.5 million every year on municipalities (includes planning and permitting costs). A system serving 7,500 people may need to spend an average of $6,000 every year to comply with the rule.

CMOM regulations will be added to the permit when facilities need to have a permit re-issued. Although a compliance deadline has not been set, the EPA recommends that facilities begin to implement "SSO Standard Conditions" right after the proposed rule is published. Considering the time and costs associated with compliance, this may be good advice.

Proposed Deadlines for CMOM Documentation After Permit Issuance

Avg. Daily Flow	Summary of CMOM program	Overflow Emergency Response Plan	Completion of Program Audit Report	Submission of Program Audit Report	System Evaluation and Capacity Assurance Plan
>=5 mgd	Within 18 mos.	Within 1 year	Within 18 mos.	Within 18 mos.	Initial sub-basins: 3 yrs.; All sub-basins: 5 yrs.
>1 but <5 mgd	Within 2 yrs	Within 1 yr.	Within 2 yrs.	With permit renewal application	Initial sub-basins: 3 yrs.; All sub-basins: 5 yrs.
<= 1 mgd	Within 3.5 yrs.	Within 1 yr.	Within 3.5 yrs.	With permit renewal application	Within 5 yrs.

Continuous Training
Procedures for emergency response plans should be understood and practiced by all personnel in order to ensure safety of the public and the collection system personnel responding. Procedures should be specific to the type of emergency that could occur. It is important to keep detailed records of all past emergencies in order to constantly improve response training, as well as the method and timing of future responses.

The ability to deal with emergencies depends on the knowledge and skill of the responding crews, in addition to availability of equipment.

The crew should be able to rapidly diagnose problems in the field under stress and select the right equipment needed to correct the problem. If resources are limited, consideration should be given to contracting other departments or private industries to respond to some emergency situations, for example, those rare emergencies that would exceed the capacity of staff.

Routine Preventative O&M Activities – Wastewater Collection Lines

Routine preventative operations and maintenance activities for wastewater collection lines shall be performed by the system's personnel and outside contractors.

A qualified outside contractor can also be utilized to perform hydraulic cleaning using a jet hydro-vac combination truck and mechanical cleaning using a rodding machine.

Routine operations and maintenance activities including cleaning and removing roots from small and large diameter lines. The system's goal should be a minimum of cleaning between 20-30% of the sewers every year.

Closed-circuit television (CCTV) is used to assess the condition of the sewers. There are four types of activities that the system or a CCTV contractor can also perform:
1) inspect new work,
2) inspect condition of older portions of the wastewater collection system,
3) routine inspection of approximately 10% of the wastewater collection, and
4) problem identification to determine the cause of selected overflow events. Manhole inspection, manhole coating (to prevent concrete deterioration) and manhole painting (for roach control) are also routinely performed.

Combined Sewer Overflows

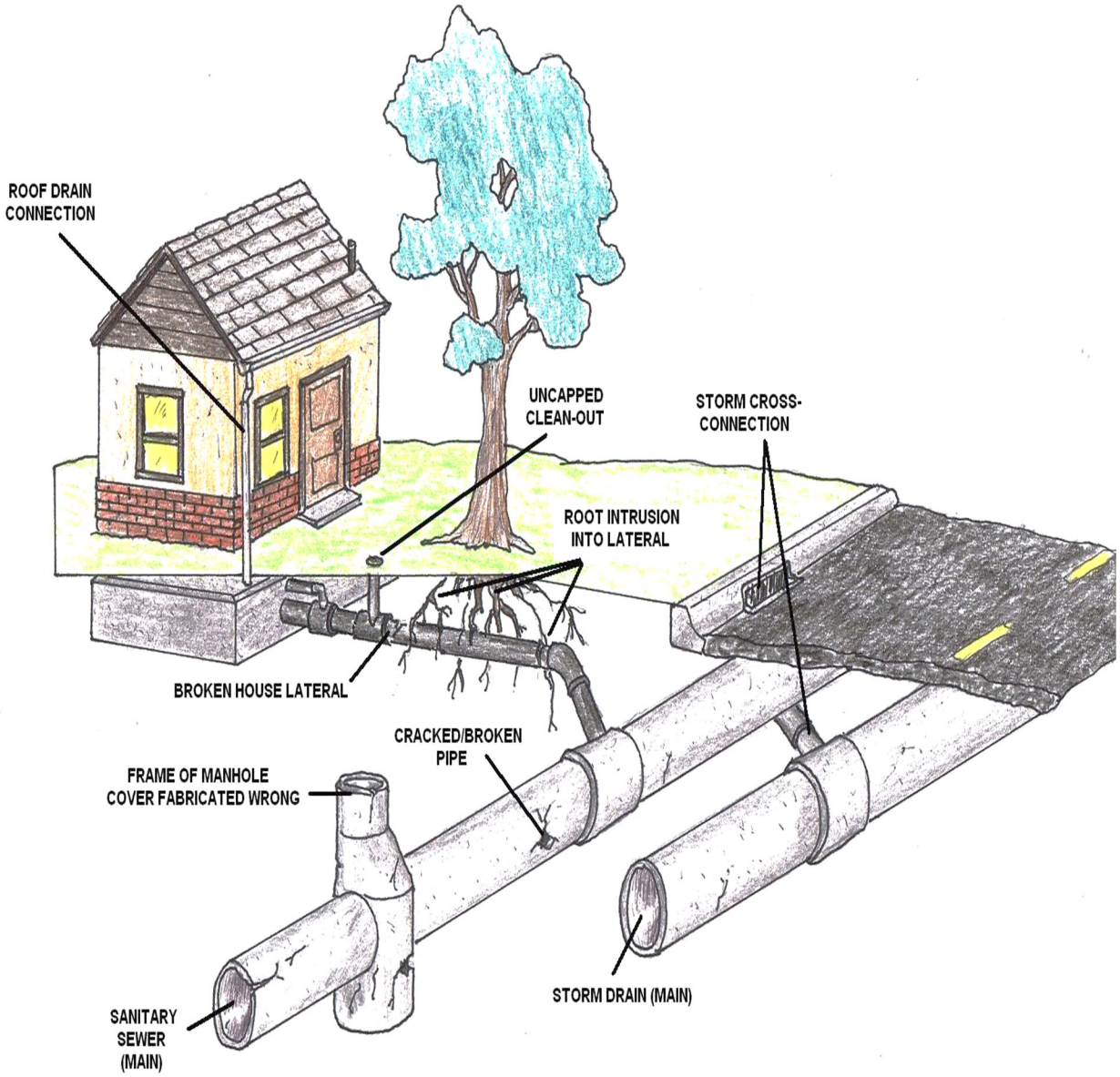
Combined sewer systems are sewers that are designed to collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipe. Most of the time, combined sewer systems transport all of their wastewater to a sewage treatment plant, where it is treated and then discharged to a water body.

During periods of heavy rainfall or snowmelt, however, the wastewater volume in a combined sewer system can exceed the capacity of the sewer system or treatment plant.

For this reason, combined sewer systems are designed to overflow occasionally and discharge excess wastewater directly to nearby streams, rivers, or other water bodies.

These overflows, called combined sewer overflows (CSOs), contain not only storm water but also untreated human and industrial waste, toxic materials, and debris. They are a major water pollution concern for the approximately 772 cities in the U.S. that have combined sewer systems.

CSOs may be thought of as a type of "urban wet weather" discharge. This means that, like sanitary sewer overflows (SSOs) and storm water discharges, they are discharges from a municipality's wastewater conveyance infrastructure that are caused by precipitation events such as rainfall or heavy snowmelt. The EPA's CSO Control Policy, published April 19, 1994, is the national framework for control of CSOs.



Preventive Maintenance Approach

As part of a preventive maintenance approach, most collection system operators also have been using combination trucks with both flush and vacuum systems. To control roots, most collection system operators use a vapor rooter eradication system which can ensure that no roots return to the line for up to five years. The cleaning and inspection crews will usually consist of two members to operate each of the combination trucks and TV trucks.

Sewer Cleaning Section

The purpose of sewer cleaning is to remove accumulated material from the sewer. Cleaning helps to prevent blockages and is also used to prepare the sewer for inspections. Stoppages in gravity sewers are usually caused by a structural defect, poor design, poor construction, an accumulation of material in the pipe (especially grease), or root intrusion. Protruding traps (lateral sewer connections incorrectly installed so that they protrude into the main sewer) may catch debris, which then causes a further buildup of solids that eventually block the sewer.

Results of Various Flow Velocities
Velocity Result
2.0 ft/sec.....Very little material buildup in pipe.
1.4-2.0 ft/sec.....Heavier grit (sand and gravel) begin to accumulate.
1.0-1.4 ft/sec.....Inorganic grit and solids accumulate.
Below 1.0 ft/sec.....Significant amounts of organic and inorganic solids accumulate.
1.0 to 1.4 feet per second, grit and solids can accumulate leading to a potential blockage.

Sewer Cleaning Methods
There are three major methods of sewer cleaning: hydraulic, mechanical, and chemical.

Hydraulic cleaning (also referred to as flushing) refers to any application of water to clean the pipe. Mechanical cleaning uses physical devices to scrape, cut, or pull material from the sewer.

Chemical cleaning can facilitate the control of odors, grease buildup, root growth, corrosion, and insect and rodent infestation.

Sewer Cleaning Records
The backbone of an effective sewer cleaning program is accurate recordkeeping. Accurate recordkeeping provides the collection system owner or operator with information on the areas cleaned. Typical information includes:
• Date, time, and location of stoppage or routine cleaning activity
• Method of cleaning used
• Identity of cleaning crew
• Cause of stoppage
• Further actions necessary and/or initiated
• Weather conditions

The owner or operator should be able to identify problem collection system areas, preferably on a map. Potential problem areas identified should include those due to grease or industrial discharges, hydraulic bottlenecks in the collection system, areas of poor design (e.g., insufficiently sloped sewers), areas prone to root intrusion, sags, and displacements. The connection between problem areas in the collection system and the preventive maintenance cleaning schedule should be clear.

The owner or operator should also be able to identify the number of stoppages experienced per mile of sewer pipe. If the system is experiencing a steady increase in stoppages, the reviewer should try to determine the cause (i.e., lack of preventive maintenance funding, deterioration of the sewers due to age, an increase in grease producing activities, etc.).

Parts and Equipment Inventory
An inventory of spare parts, equipment, and supplies should be maintained by the collection system owner or operator. The inventory should be based on the equipment manufacturer's recommendations, supplemented by historical experience with maintenance and equipment problems.

Without such an inventory, the collection system may experience long down times or periods of inefficient operation in the event of a breakdown or malfunction.

Files should be maintained on all pieces of equipment and major tools. The owner or operator should have a system to assure that each crew member has adequate and correct tools for the job.

The owner or operator should maintain a yard where equipment, supplies, and spare parts are maintained, and personnel are dispatched.

Very large systems may maintain more than one yard. In this case, the reviewer should perform a visual survey at the main yard. In small to medium size systems, collection system operations may share the yard with the department of public works, water department, or other municipal agencies.

In this case, the reviewer should determine what percentage is being allotted for collection system items. The most important features of the yard are convenience and accessibility.

The reviewer should observe a random sampling of inspection and maintenance crew vehicles for equipment as described above. A review of the equipment and manufacturer's manuals aids will determine what spare parts should be maintained.

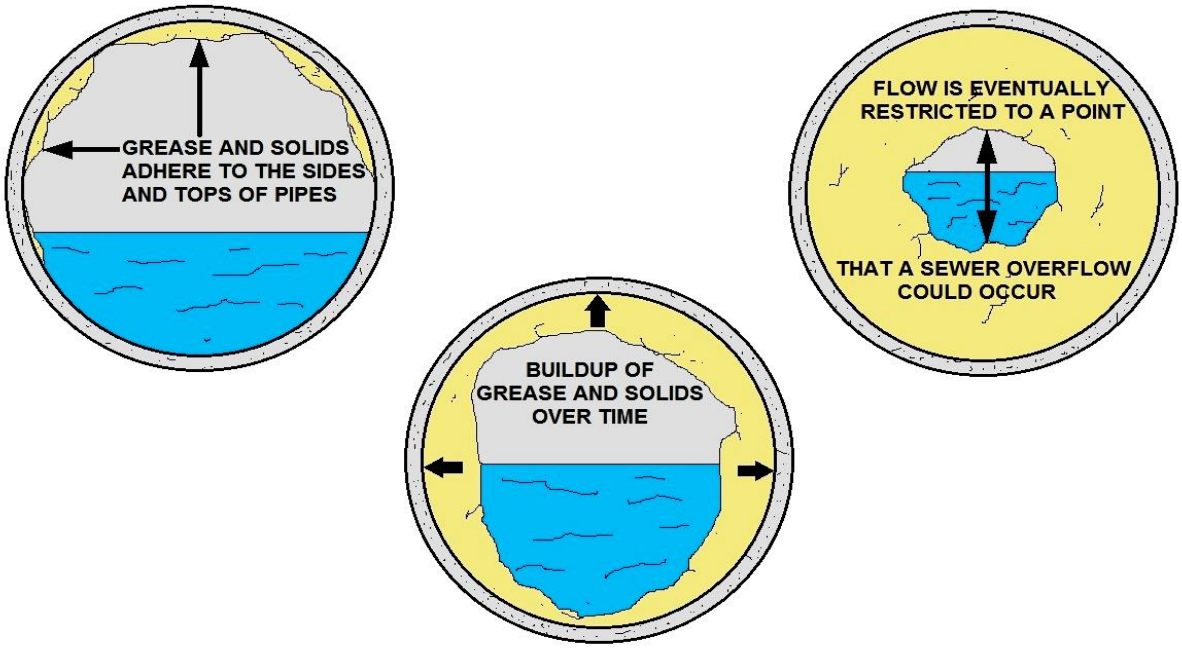
The owner or operator should then consider the frequency of usage of the part, how critical the part is, and finally, how difficult the part is to obtain when determining how many of the part to keep in stock. Spare parts should be kept in a clean, well-protected stock room.

Owner or Operator - Point to Note
The owner or operator should have a procedure for determining which spare parts are critical for the proper operation of the collection system.

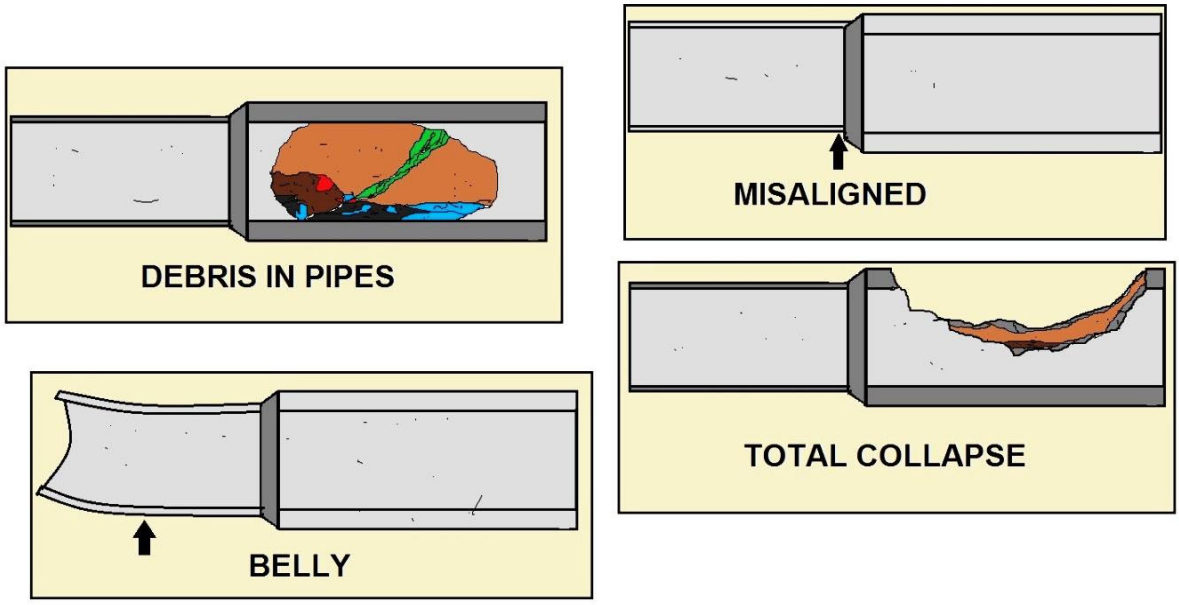
Similar to equipment and tools management, a tracking system should be in place, including Guide for Evaluating CMOM Programs at Sanitary Sewer Collection Systems procedures on logging out materials, and when maintenance personnel must use them.

The owner or operator should be able to produce the spare parts inventory and clearly identify those parts deemed critical. The reviewer should evaluate the inventory and selected items in the stockroom to determine whether the specified numbers of these parts are being maintained.

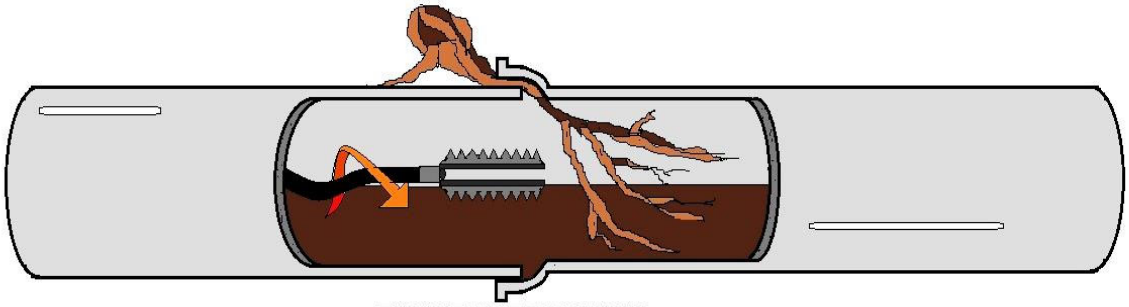
Common Sewer Problems and Solutions



EFFECTS OF GREASE AND SOLIDS ON SEWER FLOW

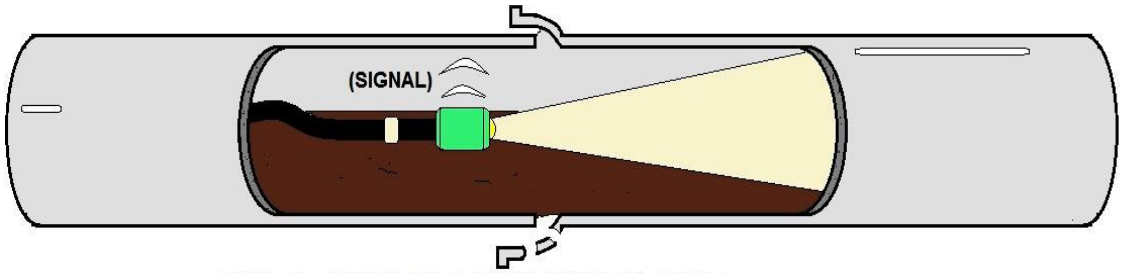


DAMAGED SEWER PIPE EXAMPLES



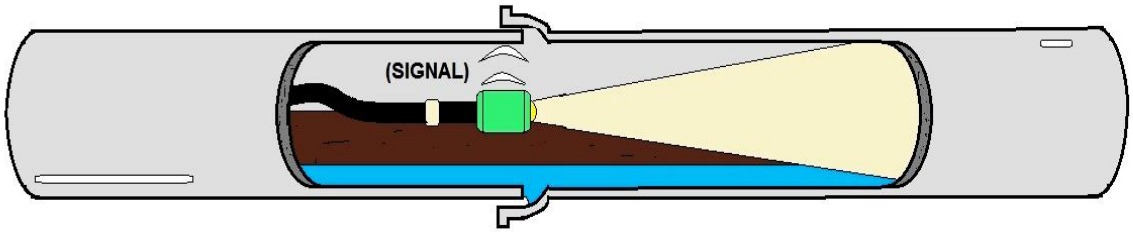
ROOT INTRUSION

(CLEANED WITH A CABLE FITTED WITH A ROOT-CUTTING BLADE)



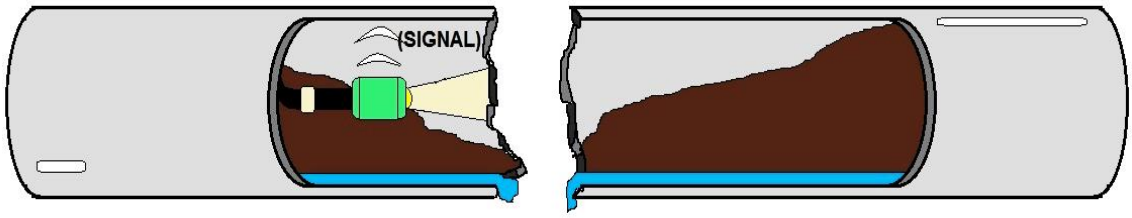
MIS-ALIGNED / CRACKED PIPE

(A CAMERA IS USED TO SHOW THE LOCATION OF THE PROBLEM VIA A SIGNAL)



PIPE WITH A BELLY

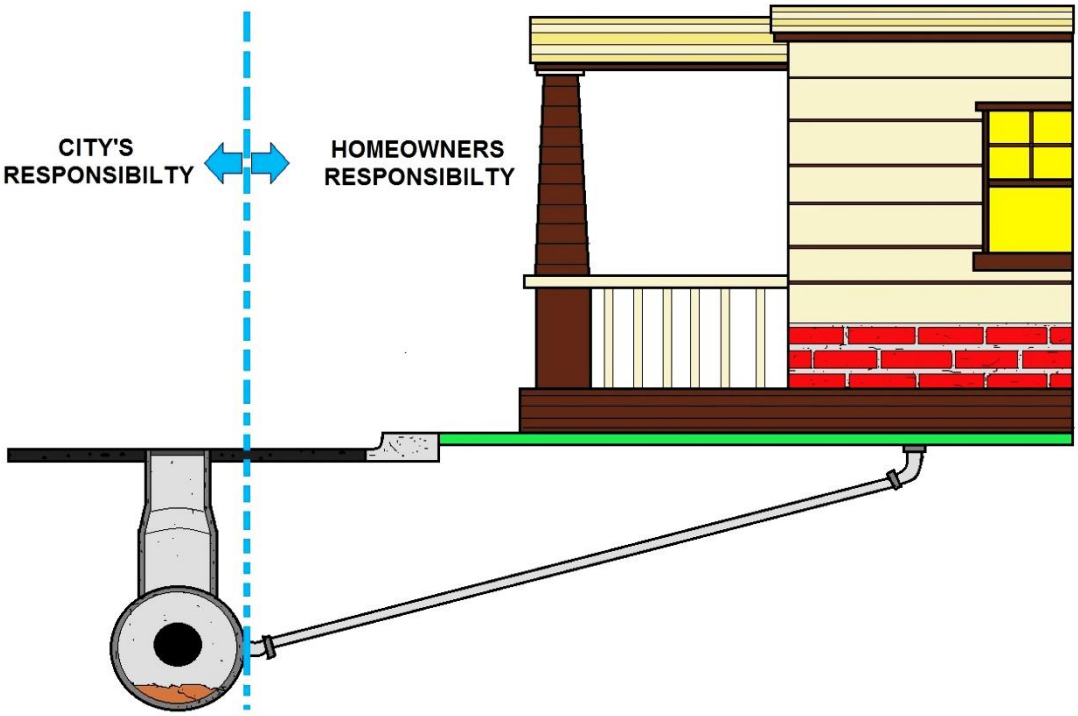
(A CAMERA IS USED TO SHOW THE LOCATION OF THE PROBLEM VIA A SIGNAL)



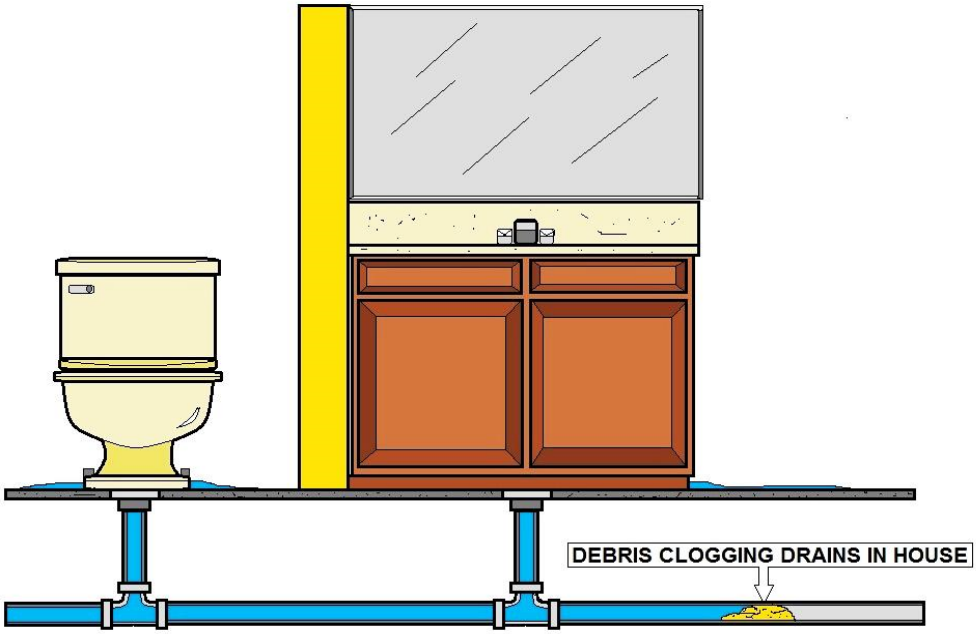
PIPE THAT HAS BEEN CRUSHED

(A CAMERA IS USED TO SHOW THE LOCATION OF THE PROBLEM VIA A SIGNAL)

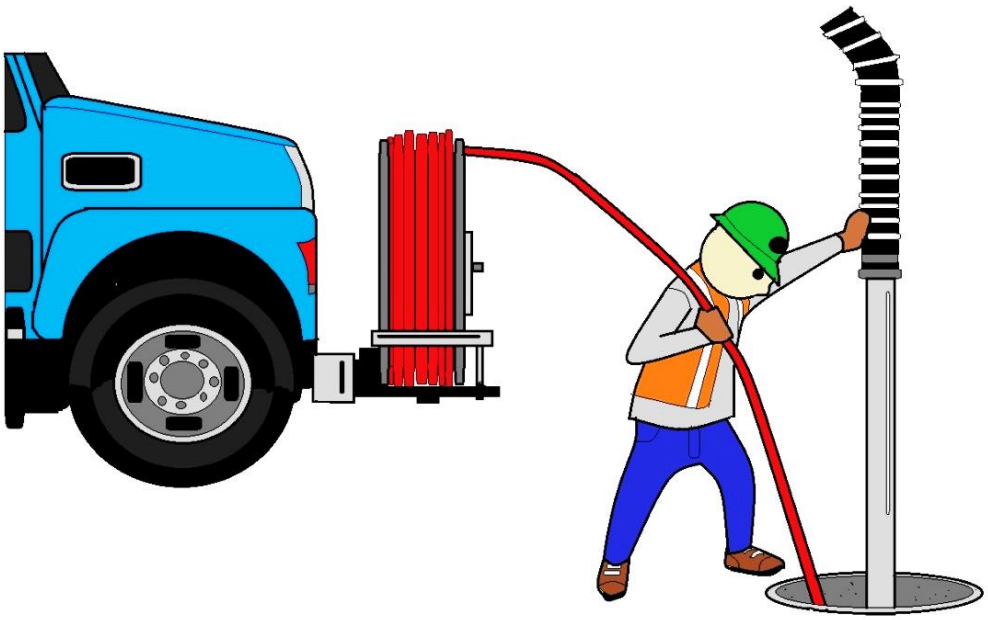
PROBLEMS IN SEWER PIPING



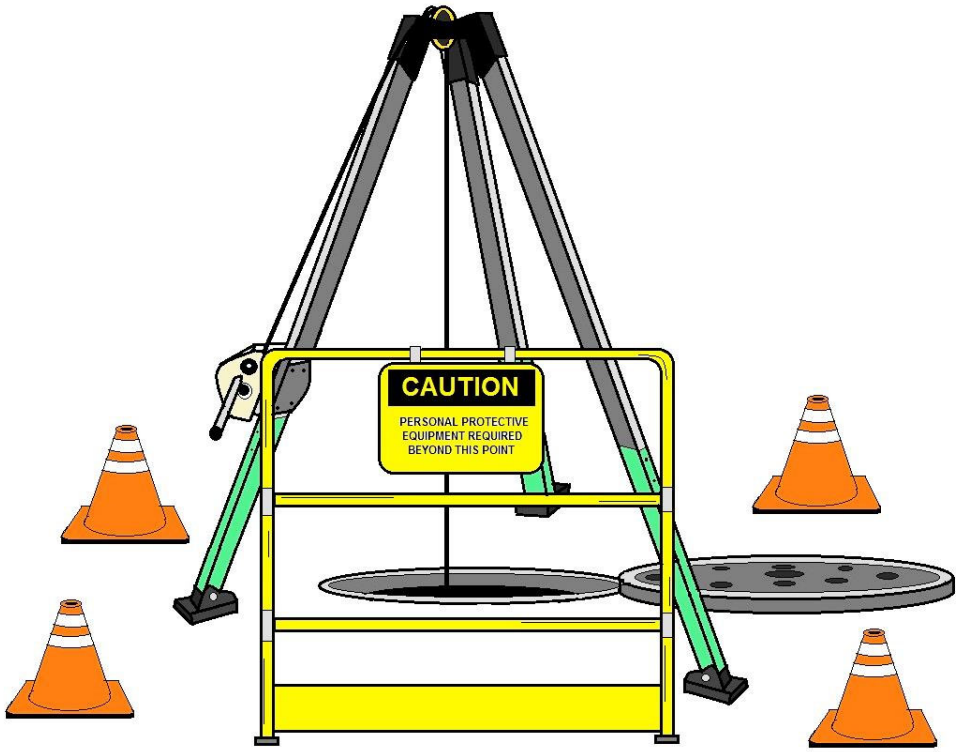
DESIGNATING SEWER MAINTENANCE RESPONSIBILTY



CLOGGED SEWER LINE IN HOUSE

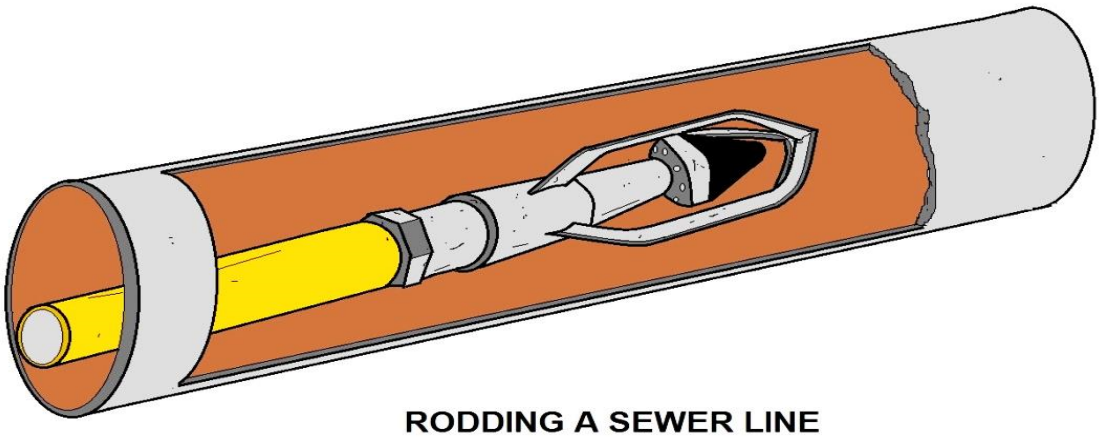


USING A VACUUM TRUCK TO CLEAN SEWER



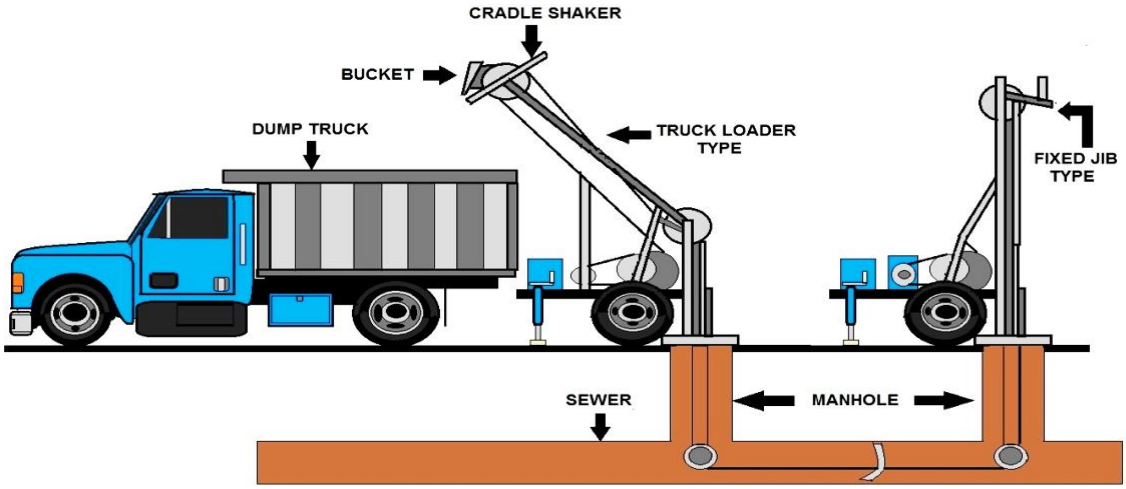
SAFETY EQUIPMENT TO ENTER A SEWER SAFELY

Commonly Found Sewer Technology Uses and Applications



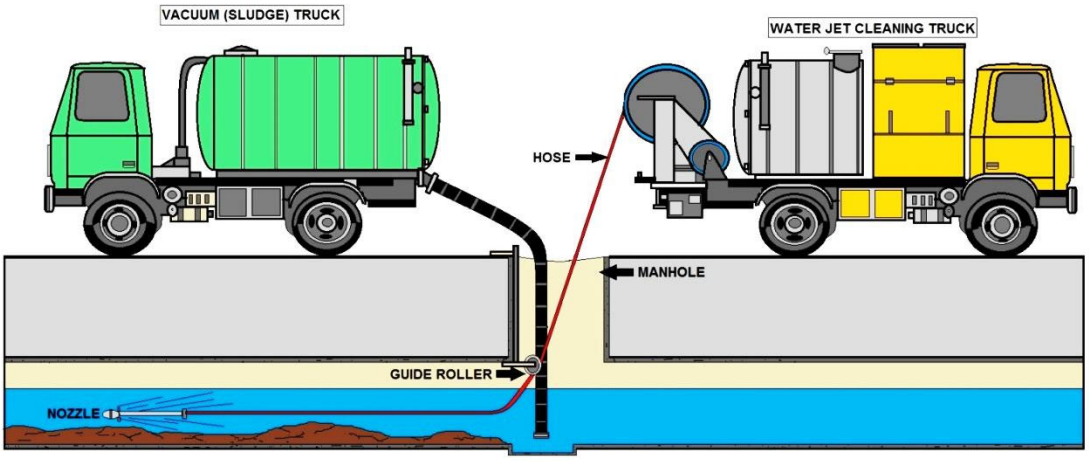
RODDING A SEWER LINE

Mechanical
Rodding
• Uses an engine and a drive unit with continuous rods or sectional rods.
• As blades rotate, they break up grease deposits, cut roots, and loosen debris.
• Rodders also help thread the cables used for TV inspections and bucket machines.
• Most effective in lines up to 12 inches in diameter.



TRAILER MOUNTED BUCKET MACHINES

Bucket Machine
• Cylindrical device, closed on one end with 2 opposing hinged jaws at the other.
• Jaws open and scrape off the material and deposit it in the bucket.
• Partially removes large deposits of silt, sand, gravel, and some types of solid waste.



HYDRAULIC SEWER CLEANING PROCESS

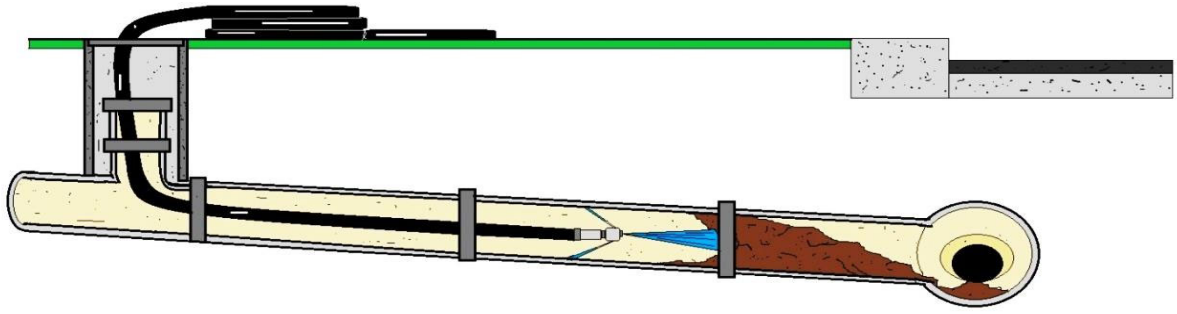
Hydraulic

Balling

• A threaded rubber cleaning ball that spins and scrubs the pipe interior as flow increases in the sewer line.
• Removes deposits of settled inorganic material and grease build-up.
• Most effective in sewers ranging in size from 5-24 inches.

Flushing

• Introduces a heavy flow of water into the line at a manhole.
• Removes floatables and some sand and grit.
• Most effective when used in combination with other mechanical operations, such as rodding or bucket machine cleaning.

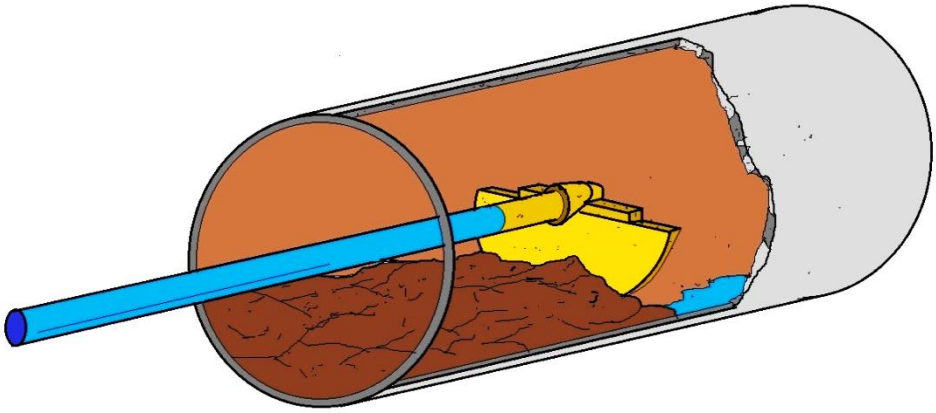


JETTING A SEWER LINE

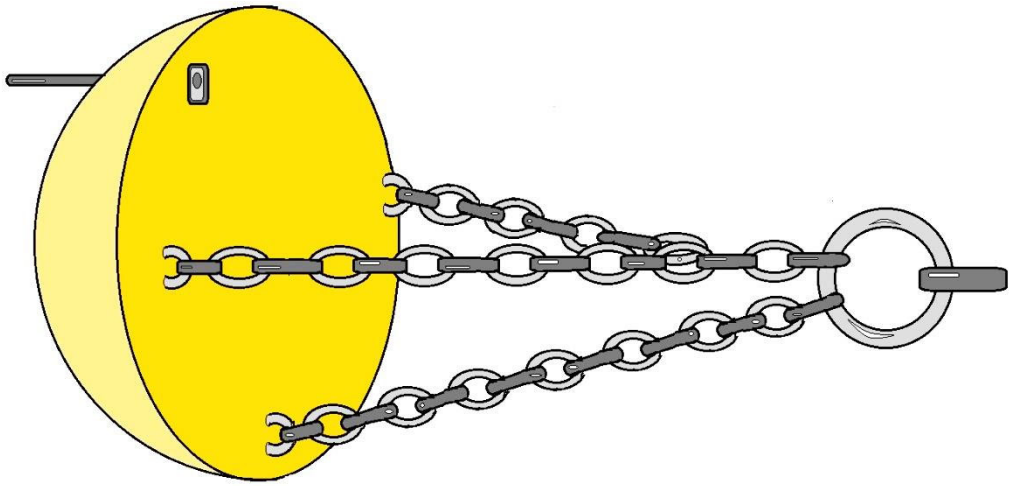
Jetting

• Directs high velocities of water against pipe walls.
• Removes debris and grease build-up, clears blockages, and cuts roots within small diameter pipes.
• Efficient for routine cleaning of small diameter, low flow sewers.

Sewer Cleaning Technology Applications



DROP SCRAPER



SEWER SCRAPER

Scooter

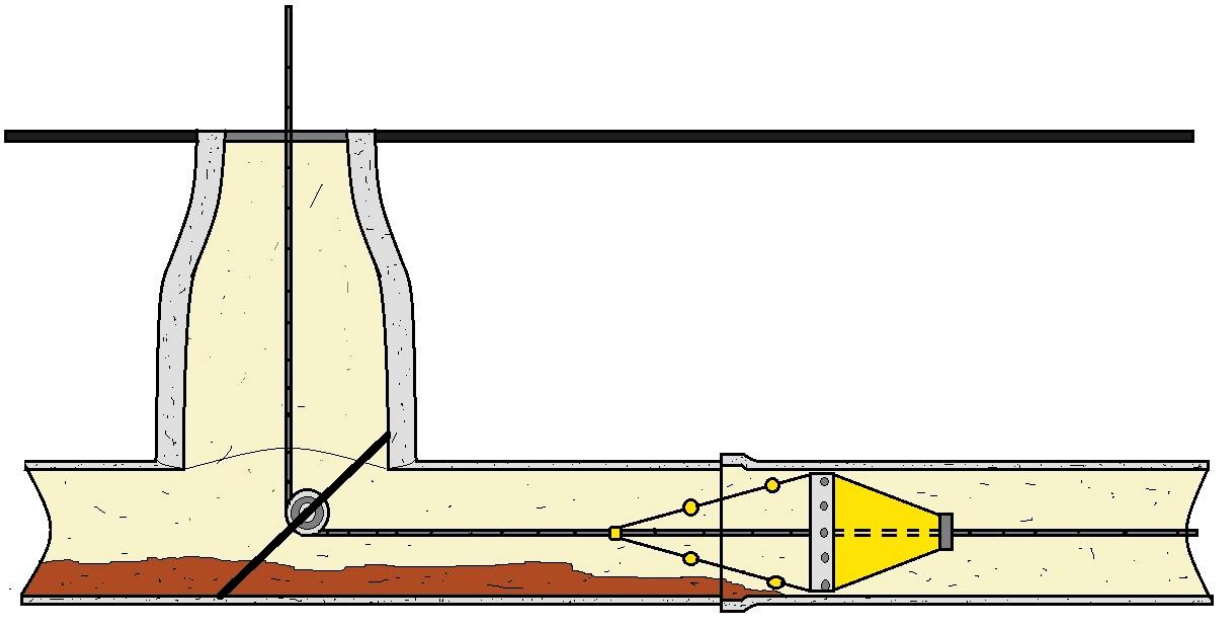
• Round, rubber-rimmed, hinged metal shield that is mounted on a steel framework on small wheels. The shield works as a plug to build a head of water.
• Scours the inner walls of the pipe lines.
• Effective in removing heavy debris and cleaning grease from line.

Kites, Bags, and Poly Pigs

• Similar in function to the ball.
• Rigid rims on bag and kite induce a scouring action.
• Effective in moving accumulations of decayed debris and grease downstream.

Silt Traps

• Collect sediments at convenient locations.
• Must be emptied on a regular basis as part of the maintenance program.



SEWER KITE

Grease Traps and Sand/Oil Interceptors

• The ultimate solution to grease build-up is to trap and remove it.
• These devices are required by some uniform building codes and/or sewer-use ordinances. Typically, sand/oil interceptors are required for automotive business discharge.
• Need to be thoroughly cleaned to function properly.
• Cleaning frequency varies from twice a month to once every 6 months, depending on the amount of grease in the discharge.
• Need to educate restaurant and automobile businesses about the need to maintain these traps.

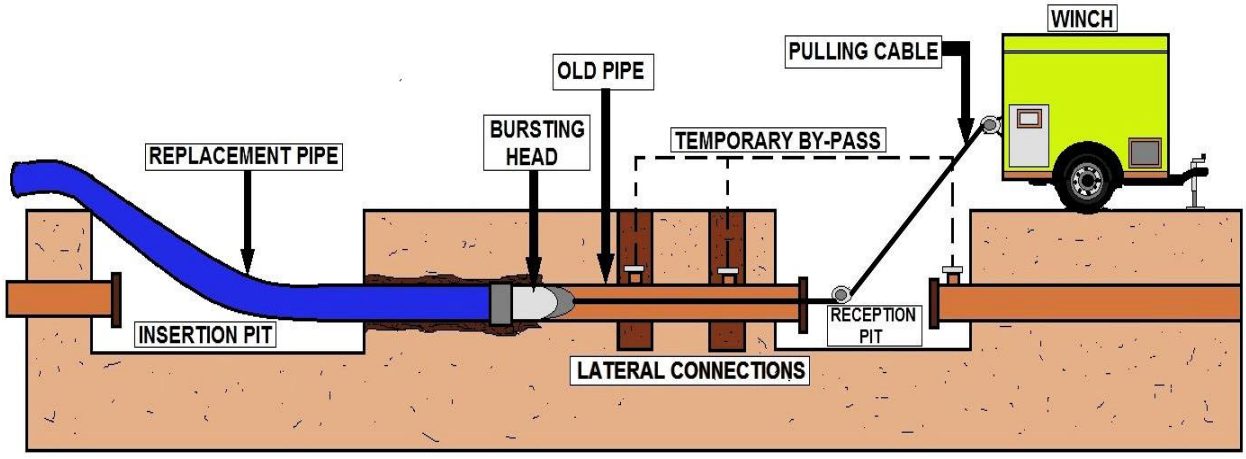
Chemicals

Before using these chemicals review the Safety Data Sheets (SDS) and consult the local authorities on the proper use of chemicals as per local ordinance and the proper disposal of the chemicals used in the operation. If assistance or guidance is needed regarding the application of certain chemicals, contact the U.S. EPA or state water pollution control agency.

• Used to control roots, grease, odors (H_2S gas), concrete corrosion, rodents and insects.
• *Root Control* - longer lasting effects than power rodder (approximately 2-5 years).
• *H_2S gas* - some common chemicals used are chlorine (Cl_2), hydrogen peroxide (H_2O_2), pure Oxygen (O_2), air, lime ($Ca(OH_2)$), sodium hydroxide (NaOH), and iron salts.
• *Grease and soap problems* - some common chemicals used are bioacids, digester, enzymes, bacteria cultures, catalysts, caustics, hydroxides, and neutralizers.

Source: Information provided by Arbour and Kerri, 1997 and Sharon, 1989.

More on Sewer Cleaning Procedures

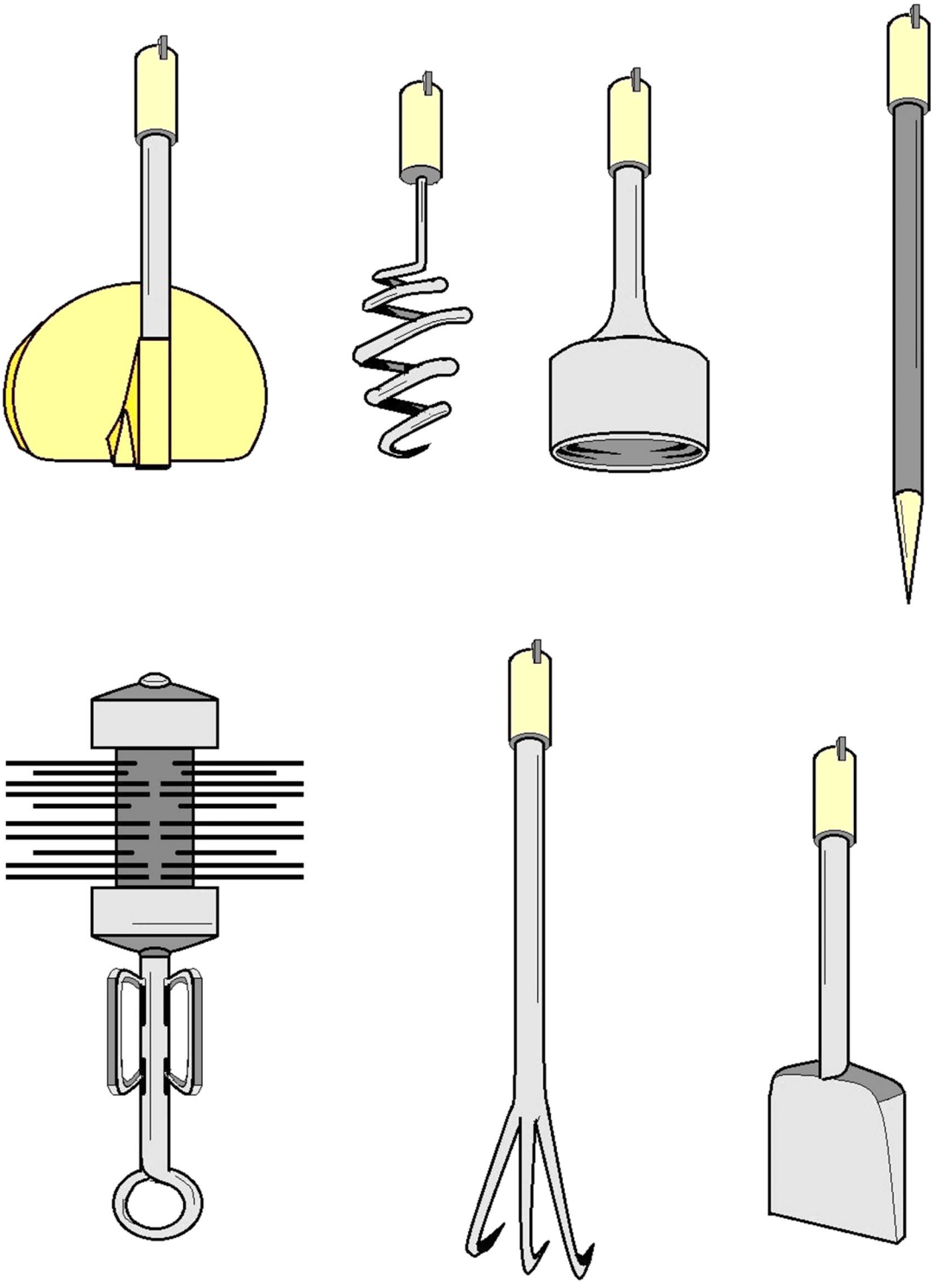


TRENCHLESS PIPE REPLACEMENT

In the above diagram, because of a lack of pipe maintenance, sewer pipe can no longer be cleaned, therefore the pipe has to be replaced. Pipe replacement is very expensive and still not the remedy for a lack of proper pipe maintenance.

Most cities that take advantage of sewer cleaning procedures are able to determine that as the maintenance frequency increased, there was an increase in system performance. Garland recommended 70 inspections and maintenance activities for every 30 cleanings. Inspections are considered more important because they help define and prevent future problems. A study performed by the American Society of Civil Engineers reports that the most important maintenance activities are cleaning and CCTV inspections. A maintenance plan attempts to develop a strategy and priority for maintaining pipes based on several of the following factors:

- Problems- frequency and location; 80 percent of problems occur in 25 percent of the system (Hardin and Messer, 1997).
- Age- older systems have a greater risk of deterioration than newly constructed sewers.
- Construction material- pipes constructed of materials that are susceptible to corrosion have a greater potential of deterioration and potential collapse. Non-reinforced concrete pipes, brick pipes, and asbestos cement pipes are examples of pipes susceptible to corrosion.
- Pipe diameter/volume conveyed- pipes that carry larger volumes take precedence over pipes that carry a smaller volume.
- Location- pipes located on shallow slopes or in flood prone areas have a higher priority.
- Force main vs. gravity-force mains have a higher priority than gravity, size for size, due to the complexity of the cleaning and repairs.
- Subsurface conditions- depth to groundwater, depth to bedrock, soil properties (classification, strength, porosity, compressibility, frost susceptibility, erodibility, and pH).
- Corrosion potential- Hydrogen Sulfide (H_2S) is responsible for corroding sewers, structures, and equipment used in wastewater collection systems. The interior conditions of the pipes need to be monitored and treatment needs to be implemented to prevent the growth of slime bacteria and the production of H_2S gases.



SEWER CLEANING TOOLS

Sewer Cleaning Advantages and Disadvantages

The primary benefit of implementing a sewer maintenance program is the reduction of SSOs, basement backups, and other releases of wastewater from the collection system due to substandard sewer conditions. Improper handling of instruments and chemicals used in inspecting and maintaining sewer lines may cause environmental harm.

Examples include:
• Improperly disposing of collected materials and chemicals from cleaning operations.
• Improperly handling chemical powdered dyes.
• Inadequately maintaining inspection devices.

Visual Inspection
In smaller sewers, the scope of problems detected is minimal because the only portion of the sewer that can be seen in detail in near the manhole. Therefore, any definitive information on cracks or other structural problems is unlikely. However, this method does provide information needed to make decisions on rehabilitation.

Closed Circuit Television (CCTV)
This method requires late night inspection and as a result, the TV operators are vulnerable to lapses in concentration. CCTV inspections are also expensive and time consuming. Sometimes the video camera does not fit into the pipe and during the inspection, the camera remains only in the maintenance hole. The newer cameras are smaller and can fit in these tight spaces.

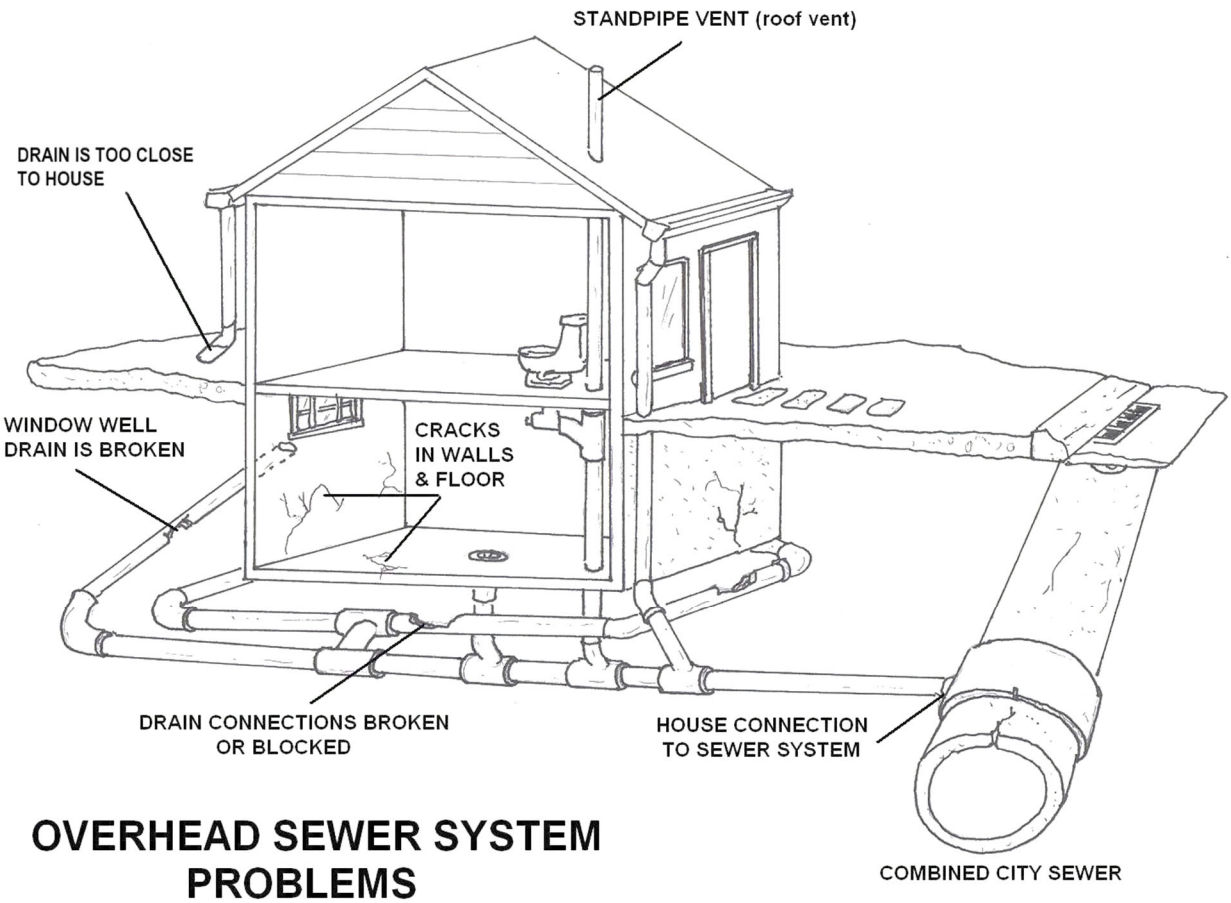
Lamping Inspection
Is generally used in the first 10 feet of the pipe. Source: Water Pollution Control Federation, 1989. Some instruments have a tendency to become coated with petroleum-based residues and if not handled properly they can become a fire hazard.

Lamping Inspection
As a result, only the first 10 feet of the pipe can be viewed or inspected using this method.
Source: Water Pollution Control Federation, 1989. Some instruments have a tendency to become coated with petroleum-based residues and if not handled properly they can become a fire hazard.

The following case study provide additional case study data for sewer cleaning methods.

Fairfax County, Virginia
The Fairfax County Sanitary Sewer System comprises over 3000 miles of sewer lines. As is the case with its sewer rehabilitation program, the county's sewer maintenance program also focuses on inspection and cleaning of sanitary sewers, especially in older areas of the system. Reorganization and streamlining of the sewer maintenance program, coupled with a renewed emphasis on increasing productivity, has resulted in very significant reductions in sewer backups and overflows during the past few years.

1998, there were a total of 49 such incidents including 25 sewer backups and 24 sewer overflows. The sewer maintenance program consists of visual inspections, scheduled sewer cleanings based on maintenance history, unscheduled sewer cleanings as determined by visual or closed-circuit television inspections, and follow-up practices to determine the cause of backups and overflows.



OVERHEAD SEWER SYSTEM PROBLEMS

Cleaning Method Limitations

Balling, Jetting, Scooter: In general, these methods are only successful when necessary, water pressure or head is maintained without flooding basements or houses at low elevations.

Jetting - The main limitation of this technique is that cautions need to be used in areas with basement fixtures and in steep-grade hill areas.

Balling - Balling cannot be used effectively in pipes with bad offset joints or protruding service connections because the ball can become distorted.

Scooter - When cleaning larger lines, the manholes need to be designed to a larger size in order to receive and retrieve the equipment. Otherwise, the scooter needs to be assembled in the manhole. Caution also needs to be used in areas with basement fixtures and in steep-grade hill areas.

Bucket Machine -This device has been known to damage sewers. The bucket machine cannot be used when the line is completely plugged because this prevents the cable from being threaded from one manhole to the next. Set-up of this equipment is time-consuming. Bucket machines are rarely used because cleaning by this method tends to be time consuming. Some cities/counties use mechanical, rather than chemical, methods to remove grease and roots. Introducing chemicals into the cleaning program may requires hiring an expert crew, adopting a new program, and instituting a detention time to ensure the chemicals' effectiveness.

Flushing - This method is not very effective in removing heavy solids. Flushing does not remedy this problem because it only achieves temporary movement of debris from one section to another in the system.

High Velocity Cleaner- The efficiency and effectiveness of removing debris by this method decreases as the cross-sectional areas of the pipe increase. Backups into residences have been known to occur when this method has been used by inexperienced operators. Even experienced operators require extra time to clear pipes of roots and grease.

Kite or Bag - When using this method, use caution in locations with basement fixtures and steep-grade hill areas.

Rodding - Continuous rods are harder to retrieve and repair if broken and they are not useful in lines with a diameter of greater than 300 mm (0.984 feet) because the rods have a tendency to coil and bend. This device also does not effectively remove sand or grit but may only loosen the material to be flushed out at a later time. Source: U.S. EPA, 1993.

More on Cleaning Methods Limitations

• Sewer Cleaning and Stoppage Section- this section responds to customer complaints, pinpoints problems within the lines, and clears all blockages.
• TV Section- this section locates defects and building sewer connections (also referred to as taps) within the system.
• Preventive Maintenance Section- this section cleans and inspects the lines and also provides for Quality Assurance and Quality Control (QA/QC).

Most of collection inspections use CCTV system. However, a large percent of the lines in the worst and oldest sections of the system are inspected visually. Visual inspections are also used in the most recently installed lines and manholes. The collection system will normally utilize a variety of cleaning methods including jetting, high velocity cleaning, rodding, bucket machining, and using stop trucks (sectional rods with an attached motor).

As part of a preventive maintenance approach, most collection system operators also have been using combination trucks with both flush and vacuum systems. To control roots, most collection system operators use a vapor rooter eradication system which can ensure that no roots return to the line for up to five years. The cleaning and inspection crews will usually consist of two members to operate each of the combination trucks and TV trucks.

Operation and Maintenance Section

Lift station operation is usually automated and does not require continuous on-site operator presence. However, frequent inspections are recommended to ensure normal functioning and to identify potential problems. Lift station inspection typically includes observation of pumps, motors and drives for unusual noise, vibration, heating and leakage, check of pump suction and discharge lines for valving arrangement and leakage, check of control panel switches for proper position, monitoring of discharge pump rates and pump speed, and monitoring of the pump suction and discharge pressure.

Weekly inspections are typically conducted, although the frequency really depends on the size of the lift station. If a lift station is equipped with grinder bar screens to remove coarse materials from the wastewater, these materials are collected in containers and disposed of to a sanitary landfill site as needed.

If the lift station has a scrubber system for odor control, chemicals are supplied and replenished typically every three months. If chemicals are added for odor control ahead of the lift station, the chemical feed stations should be inspected weekly, and chemicals replenished as needed.

The most labor-intensive task for lift stations is routine preventive maintenance. A well-planned maintenance program for lift station pumps prevents unnecessary equipment wear and downtime. Lift station operators must maintain an inventory of critical spare parts. The number of spare parts in the inventory depends on the critical needs of the unit, the rate at which the part normally fails, and the availability of the part.

The operator should tabulate each pumping element in the system and its recommended spare parts. This information is typically available from the operation and maintenance manuals provided with the lift station.

Visual inspections are carried out by using a mirror attached to a pole; however, use of portable cameras has been recently introduced to enhance the effectiveness of visual inspections. Older areas of the sewer system are inspected every two years, whereas the inspection of relatively new areas may be completed in 3 to 4 years.

Cleaning is an important part of pipe maintenance.

Sewer line cleaning is prioritized based on the age of the pipe and the frequency of the problems within it. The county uses rodding and pressurized cleaning methods to maintain the pipes.

Operating Costs
Lift station costs depend on many factors, including
(1) wastewater quality, quantity, and projections;
(2) zoning and land use planning of the area where the lift station will be located;
(3) alternatives for standby power sources;
(4) operation and maintenance needs and support;
(5) soil properties and underground conditions;
(6) required lift to the receiving (discharge) sewer line;
(7) the severity of impact of accidental sewage spill upon the local area; and
(8) the need for an odor control system.

These site and system specific factors must be examined and incorporated in preparing a lift station cost estimate.

Construction Costs
The most important factors influencing cost are the design lift station capacity and the installed pump power. Another cost factor is the lift station complexity. Factors which classify a lift station as complex include two or more of the following:
(1) extent of excavation;
(2) congested site and/or restricted access;
(3) rock excavation;
(4) extensive dewatering requirements, such as cofferdams;
(5) site conflicts, including modification or removal of existing facilities;
(6) special foundations, including piling;
(7) dual power supply and on-site switch stations and emergency power generator; and
(8) high pumping heads (design heads in excess of 200 ft).

Mechanical, electrical, and control equipment delivered to a pumping station construction site typically account for 15 to 30 percent of total construction costs.

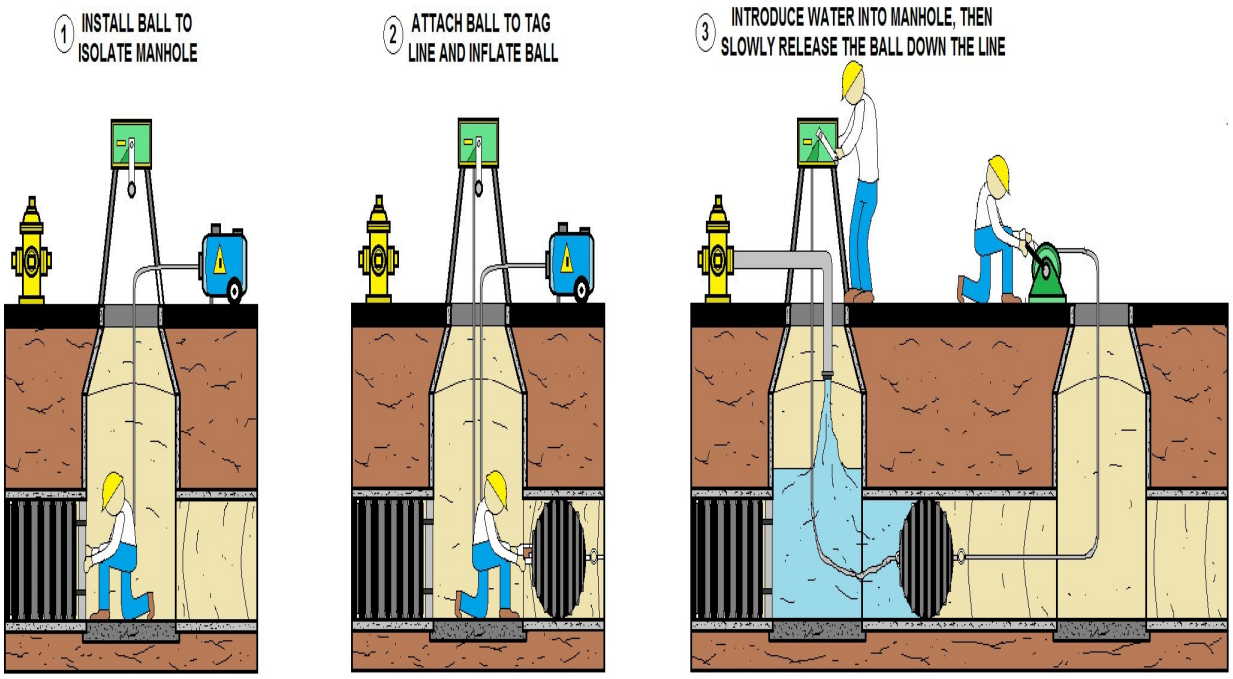
Lift station construction has a significant economy-of-scale.

Typically, if the capacity of a lift station is increased 100 percent, the construction cost would increase only 50 to 55 percent.

An important consideration is that two identical lift stations will cost 25 to 30 percent more than a single station of the same combined capacity. Usually, complex lift stations cost two to three times more than more simple lift stations with no construction complications.

Operation and Maintenance Costs
Lift station operation and maintenance costs include power, labor, maintenance, and chemicals (if used for odor control). Usually, the costs for solids disposal are minimal, but are included if the lift station is equipped with bar screens to remove coarse materials from the wastewater.

Typically, power costs account for 85 to 95 percent of the total operation and maintenance costs and are directly proportional to the unit cost of power and the actual power used by the lift station pumps. Labor costs average 1 to 2 percent of total costs. Annual maintenance costs vary, depending on the complexity of the equipment and instrumentation.

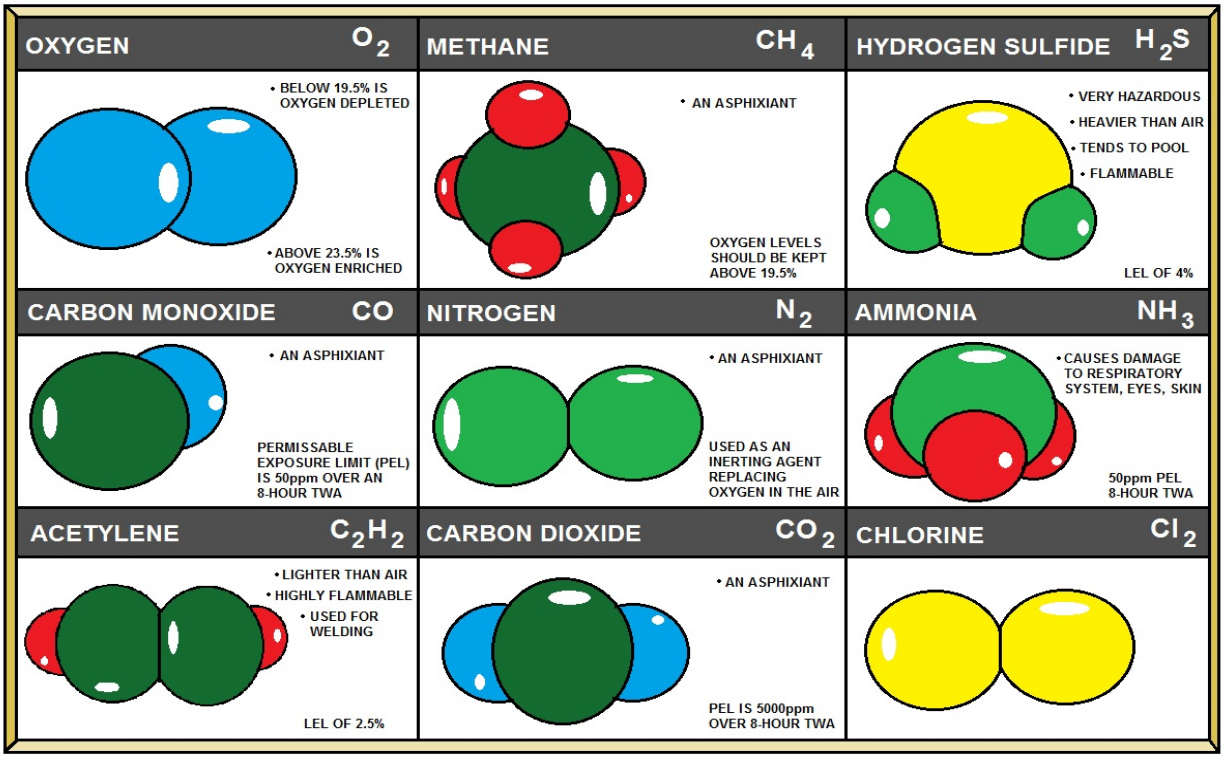


Technical Learning College

CLEANING BALL APPLICATION

Hydrogen Sulfide Section

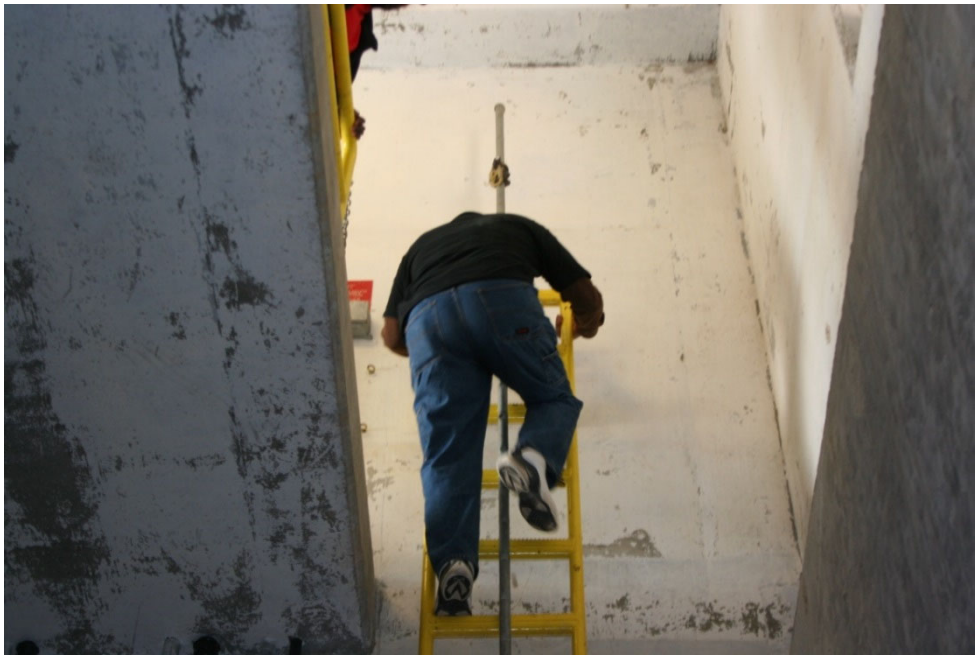
The corrosive effects of Sulfuric acid are created by Hydrogen Sulfide gas.



COMMON GASES THAT CAN BE FOUND IN CONFINED SPACE

A confined space inside another confined space. No permit required signage.

What should you do? Death traps are everywhere. Don't mean around, make these spaces safe.



Never climb down a fixed ladder without a safety harness as this man is doing. Notice the steel support pole in the middle of the ladder.

Hydrogen Sulfide Gas

This section provides answers to basic questions about hydrogen sulfide gas. It will explain what hydrogen sulfide gas is, where it is found, how it can affect your health, and what you can do to prevent or reduce exposure to it. Hydrogen sulfide gas is also known as “sewer gas” because it is often produced by the decay of waste material. Hydrogen sulfide gas has a strong odor at low levels. At higher levels, your nose can become overwhelmed by the gas, and you cannot smell it. At these higher levels, hydrogen sulfide gas can make you sick and even kill you.

Hydrogen Sulfide Gas
If you wait for a warning, it may be too late
Hydrogen sulfide is a powerful and deadly gas which smells like rotten eggs at low concentrations and has a sweet smell at high concentrations. But workers should not rely on the smell as a warning. At high concentrations H_2S may overcome one's sense of smell. The result could be instant death. Long exposure to low concentrations will also deaden the sense of smell.

What it is
H_2S is explosive - it will ignite and explode when subjected to a spark or an ordinary flame - in any concentration from 4% to 44% of the air. It is also soluble in water and oil, so it may flow for a considerable distance from its origin before escaping above ground or in an entirely unexpected place. Because the vapor (gas) is heavier than air, it may travel for a long way until ignited and then flash back towards the source. Hydrogen sulfide is found in large amounts in the wastewater collection system.

H_2S Sources
H_2S is found widely in the industry and a good manager will warn operators of its dangers or of their exposure. It is formed by the decomposition of organic materials, so it is found in sewers and cesspools.

Health Effects of H_2S Acute Exposure
First, and most importantly, H_2S can kill you. The extent of acute poisoning danger depends on the concentration of H_2S in the atmosphere. When you breathe in H_2S, it goes directly through your lungs and into your bloodstream. To protect itself, your body "oxidizes" (breaks down) the H_2S as rapidly as possible into a harmless compound. If you breathe in so much H_2S that your body can't oxidize all of it, the H_2S builds up in the blood and you become poisoned. The nervous centers in your brain which control breathing are paralyzed. Your lungs stop working and you asphyxiate--just as though someone had come up and put their hands around your neck and strangled you.

A worker can be overcome by H_2S and lose consciousness in a few seconds. If he is luckily rescued in time and is given artificial respiration within a few minutes, the worker may recover. Either artificial mouth-to-mouth or an oxygen supply system of resuscitation will work if it is done in time, because, with an adequate source of oxygen and no further H^2S intake, the body will quickly break down the H_2S still in the blood.

This is acute poisoning. It can occur with no warning at all, since even the sense of smell may be overcome, and it can be fatal within a few seconds. Although acute poisoning is deadly if it is not caught in time, when caught and treated it is reversible; this is why rescue attempts with proper safety equipment are so important. Recent evidence has shown irreversible brain damage from acute high doses.

Chronic Effects
H_2S can also cause a wide range of sub-acute and chronic effects. At very low concentrations of 10-100 ppm, headache, dizziness, nausea and vomiting may develop, together with irritation of the eyes and respiratory tract (the lungs and trachea and bronchi, or air pipes from the nose and mouth to the lungs).

The eyes become red, sore, inflamed, and sensitive to light. Respiratory system effects include cough, pain in the nose and throat, and painful breathing.

If exposure at low levels continues, the worker may develop a state of chronic poisoning. In addition to eye and respiratory tract irritation, there will be a slowed pulse rate, fatigue, insomnia, digestive disturbances, and cold sweats. More dangerous, if exposure at the level of 100 ppm (which results in eye and respiratory tract irritation and drowsiness after 15 minutes) lasts for several hours, it may result in death within the next 48 hours.

Symptoms of chronic exposures at low levels are conjunctivitis (eye infections), headache, and attack of dizziness, diarrhea, and loss of weight. Chronic hydrogen sulfide intoxication is marked by headaches, eye disorders, chronic bronchitis, and a grey-green line on the gums. Reports of nervous system disorders including paralysis, meningitis, and neurological problems have been reported, but not confirmed. A study of workers and community residents of a California Wastewater Treatment facility forum complained of headaches, nausea, vomiting, depression, personality changes, nosebleeds and breathing difficulties. When compared to a non-exposed group of people, the exposed people showed abnormalities of color discrimination, hand-eye coordination, balance, and mood disturbances. In rats, exposure to hydrogen sulfide has caused teratogenic effects.

How Much is Safe?
The OSHA Permissible Exposure Limit (PEL) for a ceiling concentration is 20 ppm hydrogen sulfide, a level which may not ever be exceeded. The acceptable maximum peak, for 10 minutes only, once during an 8-hour day if there is no other measurable exposure, is 50 ppm. There is no time-weighted average because H_2S is so fast-acting that no fluctuations above 20 ppm are safe; only one peak per day is allowed.

This level is too high and recent recommendations are that it be lowered to 10 ppm. You should remember, however, that H_2S is an invisible gas, floating freely and unpredictably, and a reading even below a 10 ppm Permissible Exposure Limit (PEL) may not guarantee your safety. There are no particular medical exams for exposure to H_2S.

Work Practices and Emergency Procedures
Whenever you enter a confined space such as a tank, make sure that you follow strict work practices, including a permit system. Make sure that the Confined Space Entry Standard 1910.146 is followed, that the air is continually monitored for the presence of H_2S, and that an attendant be stationed outside a confined space. Both of you should wear supplied air and lifelines and rescue equipment must be immediately available.

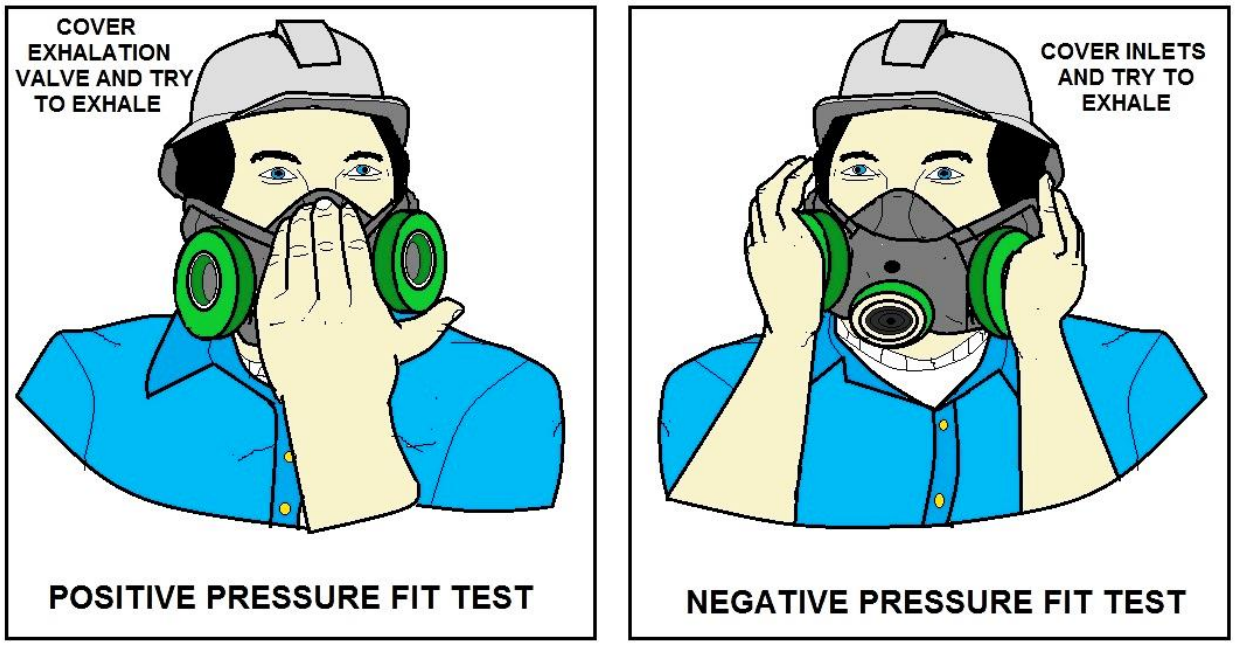
- **If you work with H_2S make sure that:**
  Your employer has trained you in the hazards of H_2S.
  Your employer has appropriate rescue equipment on-site.

Hazard Information Bulletin

Following are excerpts from a Hazard Bulletin issued by OSHA after a fatality due to H_2S exposure.

Fundamentally, employers and employees must be alert to the fact that working with a "**closed system**" does not always ensure safety. Operations involving the opening of valves or pumps on otherwise closed systems or working on such equipment that is not isolated or locked out, are particular sources of danger. When a normally closed system is opened, the potential exists for releasing hazardous chemicals into the workers' breathing zones in unknown concentrations.

Respiratory Protection -- Respirators must be provided by the employer when effective engineering controls are not feasible, or while they are being instituted, when such equipment is necessary to protect the health of the worker. The employer must provide respirators that are applicable for the purpose intended. Written procedures must be developed for the safe use of respirators during the performance of operations presenting a potential exposure to hazardous chemicals. Under circumstances where individuals may be exposed to an unknown concentration of hydrogen sulfide or some other hazardous chemical, back-up personnel with appropriate respirators and emergency equipment must be present.



POSITIVE AND NEGATIVE PRESSURE FIT CHECKS

You must be careful around sewer mains and always be careful of Hydrogen Sulfide and Carbon Monoxide gases. Never try to enter a confined space to rescue a downed employee unless you have been trained in rescue procedures and have called 911 first.

One sad fact about these deadly gases is that you may have killed yourself and don't realize it for ten, twenty, thirty years down the road.

Hydrogen Sulfide Safety Highlights

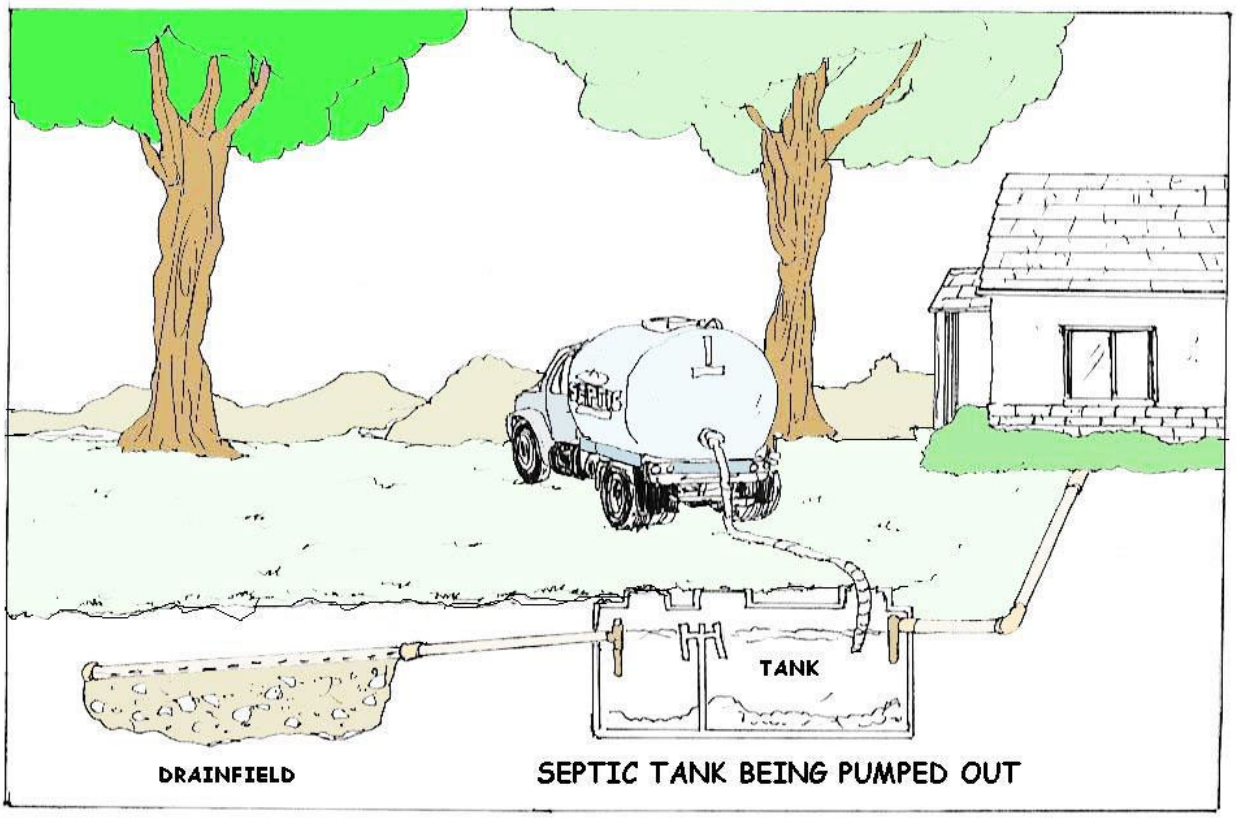
Hydrogen sulfide or H_2S problems are very common in the collection and wastewater system. There are many chemicals used to help or treat this problem. Salts of zinc, lime, hydrogen peroxide, chlorine and magnesium hydroxide are used in the treatment of hydrogen sulfide problems.

Hydrogen sulfide production in collection systems can cause a number of problems, including the following: Corrosion of the pipes and manholes, creation of hazardous atmospheres and foul odors.

The best method of controlling hydrogen sulfide is to eliminate its habitat or growth area by keeping sewers cleaner, this will harbor fewer slime bacteria.

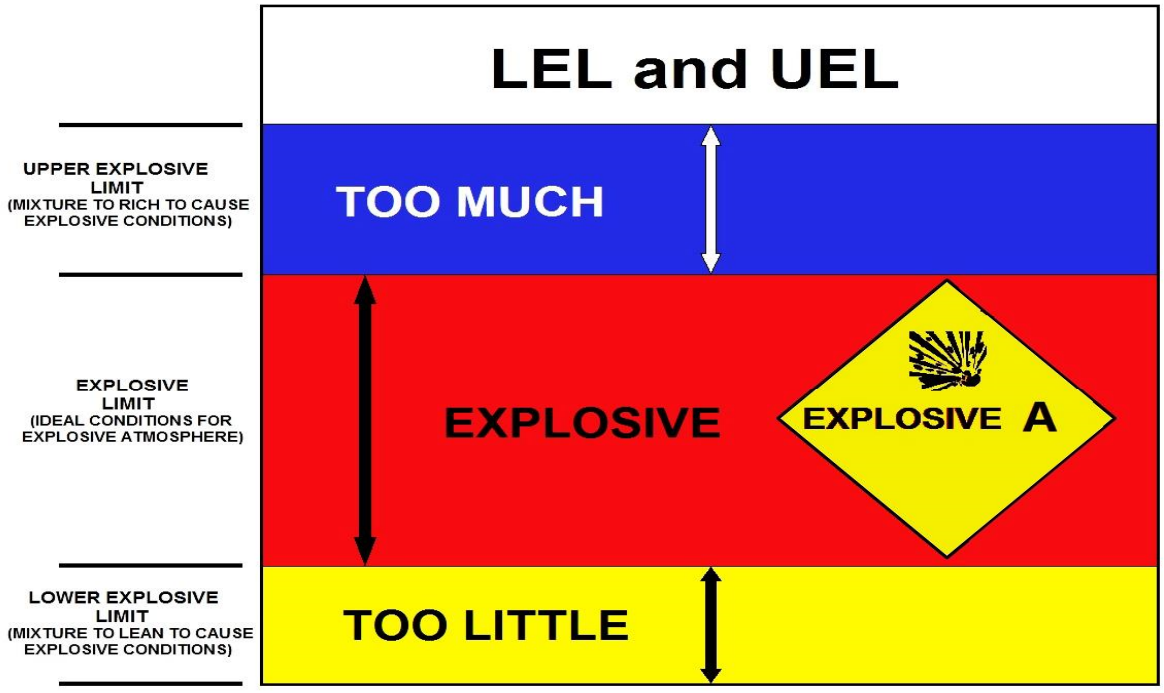
Here are some important statements regarding the reduction of hydrogen sulfide: Salts of zinc and iron may precipitate sulfides, lime treatments can also kill bacteria which produce hydrogen sulfide, but this creates a sludge disposal problem. Chlorination is effective at reducing the bacteria which produce hydrogen sulfide.

Hydrogen sulfide conditions occur in the sewer system because of the lack of oxygen.



COMMON HAZARDOUS GASES THAT MAY BE PRESENT IN CONFINED SPACE					
SUBSTANCE *	8-HOUR TIME-WEIGHTED AVERAGE (TWA)	15-MINUTE SHORT-TERM EXPOSURE LIMIT (STEL)	CEILING LIMIT (Never To Be Exceeded)	IMMEDIATELY DANGEROUS TO LIFE AND HEALTH (IDLH)	RECOMMENDED ALARM SETTINGS (Low / High)
AMMONIA	25 ppm	35 ppm	—	300 ppm	13 ppm / 25 ppm
CARBON MONOXIDE	25 ppm	100 ppm	—	1200 ppm	13 ppm / 25 ppm
CHLORINE	0.5 ppm	1 ppm	—	10 ppm	0.25 ppm / 0.5 ppm
HYDROGEN SULFIDE	—	—	10 ppm	100 ppm	5 ppm / 10 ppm
METHANE	1000 ppm	—	—	—	500 ppm / 1000 ppm
NITROGEN DIOXIDE	—	—	1 ppm	20 ppm	0.5 ppm / 1 ppm
SULFUR DIOXIDE	2 ppm	5 ppm	—	100 ppm	1 ppm / 2 ppm
OXYGEN	—	—	—	—	20.5 % of Atmosphere
LOWER EXPLOSIVE LIMIT (LEL)	—	—	—	—	5 % LEL

EXAMPLE OF A CHART OF CONFINED SPACE GASES



UNDERSTANDING UPPER (UEL) & LOWER (LEL) EXPLOSIVE LIMITS

Confined Space Entry Program Section

Purpose

The Confined Space Entry Program is provided to protect authorized employees that will enter confined spaces and may be exposed to hazardous atmospheres, engulfment in materials, conditions which may trap or asphyxiate due to converging or sloping walls or contains any other safety or health hazards.

Reference: OSHA-Permit-Required Confined Spaces (**29 CFR 1910.146**).

Scope

You are required to recognize the dangers and hazards associated with confined spaces, and this program is designed to assist you in the safety of and compliance with the OSHA standards associated with such.

Most communities will utilize the Fire Department for all rescues and additional assistance dealing with confined spaces, understanding that most Fire Department operations utilize additional in house SOG's/SOP's pertaining to such operations.

Definitions

Confined space:

Is large enough or so configured that an employee can bodily enter and perform work.

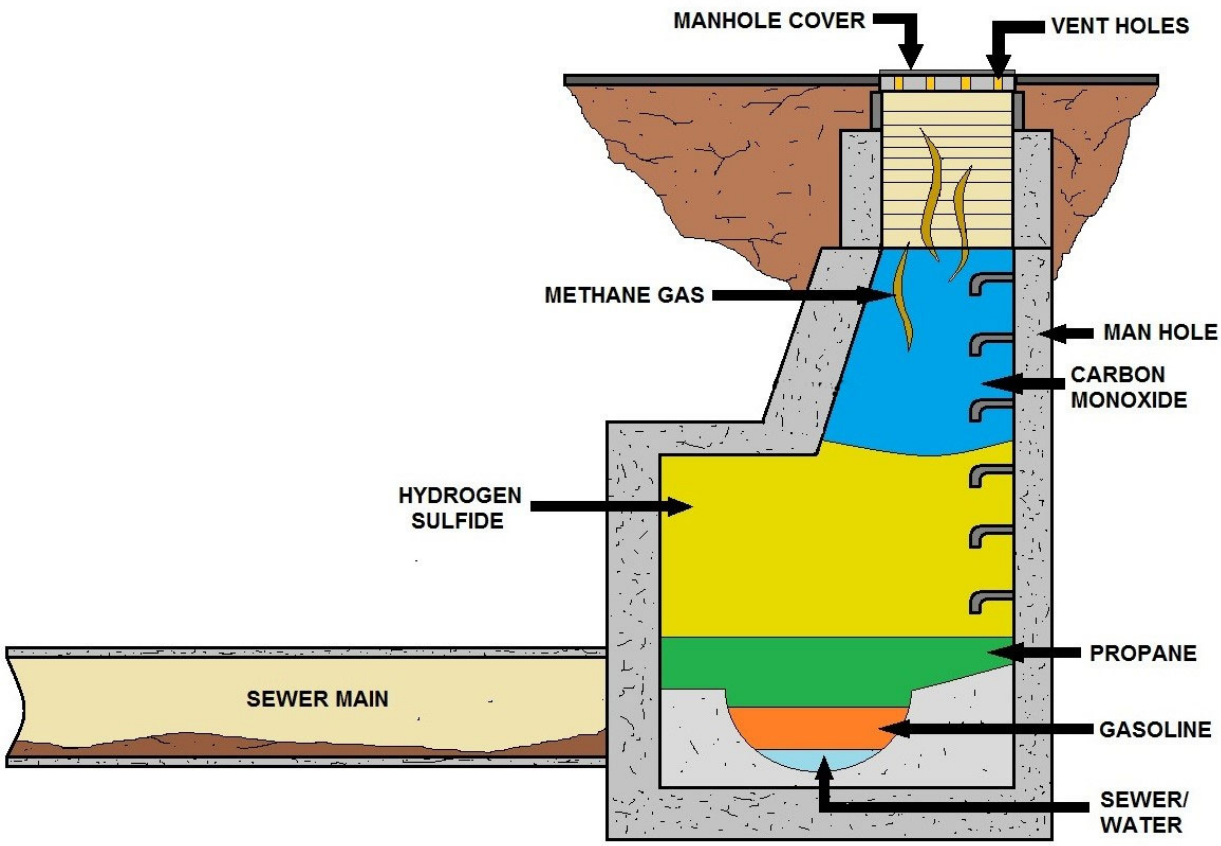
Has limited or restricted means for entry or exit (i.e., tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry).

Is not designed for continuous employee occupancy.

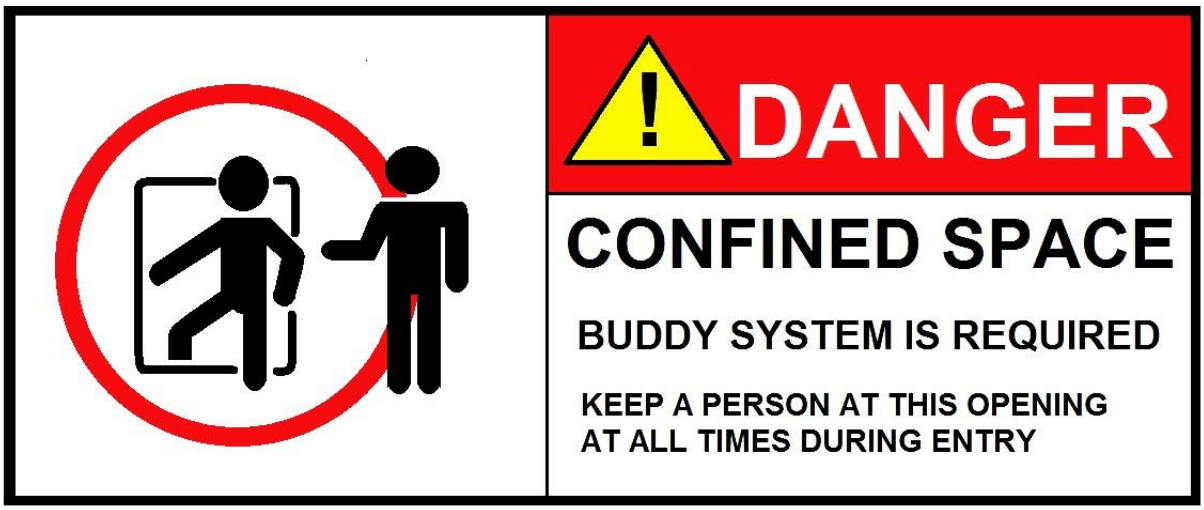
Permit required confined space (permit space), is a confined space that has one or more of the following characteristics:

1. Contains or has a potential to contain a hazardous atmosphere.
2. Contains a material that has the potential for engulfing an entrant.
3. Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly covering walls or by a floor which slopes downward and tapers to a smaller cross-section.
4. Contains any other recognized serious safety or health hazard.

Each Permit-Required Confined Space will be marked
"***Confined Space - Entry Permit Required***".



POSSIBLE HAZARDOUS ATMOSPHERES PRESENT IN A CONFINED SPACE (EXAMPLE IS OF A SEWER MAIN)



EXAMPLE OF A CONFINED SPACE ENTRY DANGER SIGN

New Confined Space Construction Standard

On May 4, 2015, OSHA issued a new standard for construction work in confined spaces, which became effective August 3, 2015. Confined spaces can present physical and atmospheric hazards that can be avoided if they are recognized and addressed prior to entering these spaces to perform work. The new standard, Subpart AA of 29 CFR 1926 will help prevent construction workers from being hurt or killed by eliminating and isolating hazards in confined spaces at construction sites similar to the way workers in other industries are already protected.

The new standard, Subpart AA of 29 CFR 1926, will help prevent construction workers from being hurt or killed by eliminating and isolating hazards in confined spaces at construction sites similar to the way workers in other industries are already protected.

Training requirements
Employers must provide training to each employee whose work is regulated by this standard, at no cost to the employee, and ensure that employees possess the understanding, knowledge and skills necessary to safely perform the duties assigned under this standard. Training must result in an understanding of the hazards in the permit space and the methods used to isolate, control or in other ways protect employees from these hazards. For employees not authorized to perform entry rescues, it must convey the dangers of attempting such rescues.

Affected employees must be trained:

- In both a language and vocabulary that the employee can understand;
- Before the employee is first assigned duties under this standard;
- Before there is a change in assigned duties;
- Whenever there is a change in permit space entry operations that presents a hazard about which an employee has not previously been trained; and
- Whenever there is any evidence of a deviation from the permit space entry procedures required by paragraph §1926.1204(c) of this standard or there are inadequacies in the employee's knowledge or use of these procedures.

The training must establish employee proficiency in the duties required by this standard and must introduce new or revised procedures, as necessary, for compliance.

The employer must maintain training records to show required training has taken place. Training records must contain each employee's name, the name of the trainers, and the dates of training. Documentation must be available for inspection by employees and their authorized representatives, for the period of time the worker is employed by that employer.

Common questions
To assist employers in complying with the new standard, here are some frequently asked questions and answers outline by on its website at www.osha.gov:

How do I know whether to follow the general industry or construction confined space rule?
If you are doing construction work – such as building a new structure or upgrading an old one – then you must follow the construction confined space rule.

Why did OSHA believe that the former standard needed to be changed?
Previously the only requirement for confined spaces in construction was training. OSHA concluded this was inadequate as injuries and fatalities continued to occur.

How does the new final rule differ from the rules that previously applied to construction work performed in confined spaces?
The rule requires employers to determine what kinds of spaces their workers are in, what hazards could be there, how those hazards should be made safe, what training workers should receive, and how to rescue those workers if anything goes wrong.

Where can I find the final rule for Confined Spaces in Construction?
Information on the new confined spaces standard can be found on the Confined Spaces page at www.osha.gov/confinedspaces/index.html.

How can I contact OSHA if I have questions about the final rule?
For compliance assistance regarding application of the final rule contact: Directorate of Construction, Room N3468, OSHA, U.S. Department of Labor, 200 Constitution Avenue NW, Washington, DC 20210; telephone (202)-693-2020 or fax (202)-693-1689.

Who is affected by Subpart AA?
All construction employers whose workers may be exposed to confined space hazards.

Do I need to do anything if there are permit spaces at the worksite, but my employees will not need to enter the permit space?
Yes, you must take effective steps to prevent your employees from entering the space.

What standard should I follow if my workers are doing construction AND general industry work in confined spaces?
An employer whose workers are engaged in both construction and general industry work in confined spaces will meet OSHA requirements if that employer meets the requirements of 29 CFR 1926 Subpart AA - Confined Spaces in Construction.

Confined Space Hazards

Fatalities and injuries constantly occur among construction workers who, during the course of their jobs, are required to enter confined spaces. In some circumstances, these workers are exposed to multiple hazards, any of which may cause bodily injury, illness, or death.

Newspaper and magazine articles abound with stories of workers injured and killed from a variety of atmospheric factors and physical agents. Throughout the construction jobsite, contractors and workers encounter both inherent and induced hazards within confined workspaces.

Inherent Hazards
Inherent hazards, such as electrical, thermal, chemical, mechanical, etc., are associated with specific types of equipment and the interactions among them.

Examples include high voltage (shock or corona discharge and the resulting burns), radiation generated by equipment, defective design, omission of protective features (no provision for grounding non-current-carrying conductive parts), high or low temperatures, high noise levels, and high-pressure vessels and lines (rupturing with resultant release of fragments, fluids, gases, etc.).

Inherent hazards usually cannot be eliminated without degrading the system or equipment, or without making them inoperative. Therefore, emphasis must be placed on hazard control methods.

Induced Hazards
Induced hazards arise, and are induced from, a multitude of incorrect decisions and actions that occur during the actual construction process. Some examples are: omission of protective features, physical arrangements that may cause unintentional worker contact with electrical energy sources, oxygen-deficient atmospheres created at the bottom of pits or shafts, lack of safety factors in structural strength, and flammable atmospheres.

Typical Examples of Confined Workspaces
Following are typical examples of confined workspaces in construction which contain both inherent and induced hazards.

Vaults
A variety of vaults are found on the construction jobsite. On various occasions, workers must enter these vaults to perform a number of functions.

The restricted nature of vaults and their frequently below-grade location can create an assortment of safety and health problems.

Oxygen-Deficient Atmosphere
One of the major problems confronting construction workers while working in vaults is the ever-present possibility of an oxygen-deficient atmosphere.

Explosive or Toxic Gases, Vapors, or Fumes
While working in an electrical vault, workers may be exposed to the build-up of explosive gases such as those used for heating (propane). Welding and soldering produce toxic fumes which are confined in the limited atmosphere.

Electrical Shock
Electrical shock is often encountered from power tools, line cords, etc. In many instances, such electrical shock results from the fact that the contractor has not provided an approved grounding system, or the protection afforded by ground-fault circuit interrupters or low-voltage systems.

Purging
In some instances, purging agents such as nitrogen and argon may enter the vault from areas adjacent to it. These agents may displace the oxygen in the vault to the extent that it will asphyxiate workers almost immediately.

Materials Falling In and On
A hazard normally considered a problem associated with confined spaces is material or equipment which may fall into the vault or onto workers as they enter and leave the vault.

Vibration could cause the materials on top of the vault to roll off and strike workers. If the manhole covers were removed, or if they were not installed in the first place, materials could fall into the vault, causing injury to the workers inside.

Condenser Pits
A common confined space found in the construction of nuclear power plants is the condenser pit. Because of their large size, they are often overlooked as potentially hazardous confined spaces.

These below-grade areas create large containment areas for the accumulation of toxic fumes, gases, and so forth, or for the creation of oxygen-deficient atmospheres when purging with argon, Freon, and other inert gases.

Other hazards will be created by workers above dropping equipment, tools, and materials into the pit.

Manholes
Throughout the construction site, manholes are commonplace. As means of entry into and exit from vaults, tanks, pits, and so forth, manholes perform a necessary function. However, these confined spaces may present serious hazards which could cause injuries and fatalities.

A variety of hazards are associated with manholes. To begin with, the manhole could be a dangerous trap into which the worker could fall. Often covers are removed and not replaced, or else they are not provided in the first place.

Pipe Assemblies
One of the most frequently unrecognized types of confined spaces encountered throughout the construction site is the pipe assembly. Piping of sixteen to thirty-six inches in diameter is commonly used for a variety of purposes.

For any number of reasons, workers will enter the pipe. Once inside, they are faced with potential oxygen-deficient atmospheres, often caused by purging with argon or another inert gas. Welding fumes generated by the worker in the pipe, or by other workers operating outside the pipe at either end, subject the worker to toxic atmospheres.

The generally restricted dimensions of the pipe provide little room for the workers to move about and gain any degree of comfort while performing their tasks. Once inside the pipe, communication is extremely difficult. In situations where the pipe bends, communication and extrication become even more difficult. Electrical shock is another problem to which the worker is exposed.

Ungrounded tools and equipment or inadequate line cords are some of the causes. As well, heat within the pipe run may cause the worker to suffer heat prostration.

Ventilation Ducts
Ventilation ducts, like pipe runs, are very common at the construction site. These sheet metal enclosures create a complex network which moves heated and cooled air and exhaust fumes to desired locations in the plant.

Ventilation ducts may require that workers enter them to cut out access holes, install essential parts of the duct, etc. Depending on where these ducts are located, oxygen deficiency could exist. They usually possess many bends, which create difficult entry and exit, and which also make it difficult for workers inside the duct to communicate with those outside it. Electrical shock hazards and heat stress are other problems associated with work inside ventilation ducts.

Tanks
Tanks are another type of confined workspace commonly found in construction. They are used for a variety of purposes, including the storage of water, chemicals, etc.

Tanks require entry for cleaning and repairs. Ventilation is always a problem. Oxygen-deficient atmospheres, along with toxic and explosive atmospheres created by the substances stored in the tanks, present hazards to workers. Heat, another problem in tanks, may cause heat prostration, particularly on a hot day.

Since electrical line cords are often taken into the tank, the hazard of electrical shock is always present. The nature of the tank's structure often dictates that workers must climb ladders to reach high places on the walls of the tank.

Sumps
Sumps are commonplace. They are used as collection places for water and other liquids. Workers entering sumps may encounter an oxygen-deficient atmosphere. Also, because of the wet nature of the sump, electrical shock hazards are present when power tools are used inside. Sumps are often poorly illuminated. Inadequate lighting may create an accident situation.

Containment Cavities
These large below-grade areas are characterized by little or no air movement. Ventilation is always a problem. In addition, the possibility of oxygen deficiency exists. As well, welding and other gases may easily collect in these areas, creating toxic atmospheres. As these structures near completion, more confined spaces will exist as rooms are built off the existing structure.

Electrical Transformers
Electrical transformers are located on the jobsite. They often contain a nitrogen purge or dry air. Before they are opened, they must be well vented by having air pumped in. Workers, particularly electricians and power plant operators, will enter these transformers through hatches on top for various work-related reasons. Testing for oxygen deficiency and for toxic atmospheres is mandatory.

Heat Sinks
These larger pit areas hold cooling water in the event that there is a problem with the pumps located at the water supply to the plant--normally a river or lake--which would prevent cooling water from reaching the reactor core.

When in the pits, workers are exposed to welding fumes and electrical hazards, particularly because water accumulates in the bottom of the sink.

Generally, it is difficult to communicate with workers in the heat sink, because the rebar in the walls of the structure deaden radio signals.

Wastewater Collections Glossary

Aeration: A method of controlling hydrogen sulfide by chemical treatment which is considered the least expensive.

Air Gap Installation: The only acceptable method to prevent a cross-connection when filling a tank truck from a fire hydrant.

Air Gap: This device should be observed when filling a water truck to clean sewers. There should be an air gap between the discharge line and the top of the water level to prevent a cross connection.

Ambient Temperature: The surrounding temperature.

Anaerobic: The absence of dissolved molecular oxygen.

CCTV: The main purpose for using a video camera while inspecting a sewer line is that it provides operators with a picture record, for log entries and of conditions of trouble spots in the lines. During a CCTV inspection of a sewer line, roots intruding a joint, illegal taps or cracks may be observed.

Centrifugal Pump: Centrifugal pumps are a sub-class of dynamic axisymmetric work-absorbing turbomachinery. Centrifugal pumps are used to transport fluids by the conversion of rotational kinetic energy to the hydrodynamic energy of the fluid flow. The rotational energy typically comes from an engine or electric motor.

Confined Space: The definition of a hazardous atmosphere is an atmosphere that is explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen-deficient, toxic, or otherwise harmful that may cause death, illness, or injury. Below 19.5%O2 percentage an atmosphere is considered oxygen deficient. The detailed plan for emergency response to an injury or other emergency within the confined space should be described in detail in the water system's Confined Space Entry Program. Entry into a confined space requires a confined space entry permit. Atmospheric monitoring in a confined space should be performed continuously from pre-entry to exit. Hot Work permit type is required when operations may cause a source of ignition to a material or substance, or create a work induced hazard by ignition within any confined space. A Type 2 confined space or permit required confined space has the characteristic of containing or has the potential to contain a hazardous atmosphere.

Ductile iron pipe (DIP): A type of pipe that is recommended when crossing another underground utility.

Ferric Chloride: (FeCl3) This chemical can be used to remove sulfides by precipitation.

Fire Point: The temperature at which oil vaporizes enough to keep burning.

Gas Chlorine: Discharged when opening the top valve on a one-ton chlorine cylinder.

Gravity Sewer: A sewer systems that conveys sewage via gravity. Components of a gravity collection system: Main sewers, Manholes, Lateral sewers and Lift stations, but does not contain Vacuum interface pumps or Grinder Pumps.

Grease Removal: Various methods are often implemented to control grease, including Ordinances, Violations of codes, Inspections and complaints. Some chemicals will remove grease, but chemicals may be very effective under specific conditions, but may not work in all conditions. The best method is for the customer to maintain the grease device and for regular cleaning.

Hazardous Energy: Hazardous energy comes in different forms. Understanding these sources of hazardous energy is very important in the overall process of controlling it. First is kinetic or mechanical energy, which comes from moving parts of machines like propellers, blades, moving chains, and conveyor belts. When not properly controlled, these can lacerate, cut, crush, amputate, and fracture body parts. Another form of hazardous energy is electrical energy, which generates electricity and can be stored in batteries and capacitors. Pneumatic and hydraulic system, springs, gas tanks, and pressure vessels uses potential energy. On the other hand, some hazards can come from thermal energy. But whatever the source of energy, it all boils down to one point: it can bring danger and therefore, must be controlled.

Hearing Protection: It is the employer's responsibility to ensure that you are provided proper hearing protection. The first step to ensure adequate protection for employees is to ensure that engineered controls are used on equipment whenever possible and provide hearing protection.

Hydro-brake: A vortex flow regulator.

Hydrogen Sulfide: Hydrogen sulfide is the chemical compound with the formula H 2S. It is a colorless chalcogen hydride gas with the characteristic foul odor of rotten eggs. It is very poisonous, corrosive, and flammable. Hydrogen sulfide often produced from the microbial breakdown of organic matter in the absence of oxygen gas, such as in swamps and sewers; this process is commonly known as anaerobic digestion which is done by sulfate-reducing microorganisms.

Hydrogen Sulfide Reduction: Salts of zinc and iron may precipitate sulfides. Lime treatments can kill bacteria which produce hydrogen sulfide but create a sludge disposal problem. Chlorination is effective at reducing the bacteria which produce hydrogen sulfide. Chemical treatment is not the preferred treatment method for reducing hydrogen sulfide, but regular cleaning is. A concentration of 0.4 or 40% hydrogen peroxide should be used to control hydrogen sulfide.

Hypochlorous acid: This species of chlorine is the most germicidal of all chlorine compounds with the possible exception of chlorine dioxide.

Invert: The invert of a pipe is the inner bottom of the pipe.

Lamping: Using reflected sunlight or artificial light to inspect a sewer between two adjacent manholes. The light is directed down the pipe from one manhole. If it can be seen from the next manhole, it indicates that the line is open and straight. The purpose of lamping a new collection system is to test for obstructions and straightness.

Lift Station: A **lift station** is a type of pumping **station** used to move wastewater from a lower elevation to a higher one. It is typically used to move raw sewage to a treatment facility for processing. Most failures of a lift station can be avoided by proper preventive maintenance. The following pieces of equipment would be expected in a dry well: Electric controls, Motors, Pumps but not float switches

Lift Station Book: A book or log inside the lift station contains all the ID numbers and maps of the station.

Lift Station Pump: A positive pressure develops when a lift station pump discharges into the force main. A Swing check valve is used to prevent the discharged wastewater from flowing back into the wet well when the pump shuts off.

LOTO Lock: See hazardous energy: The definition of an "Energy Isolating Device" is a mechanical device that physically prevents the transmission or release of energy. Pneumatic, Chemical, Hydraulic, Kinetic, Electrical, Thermal and Mechanical are all forms of hazardous energy. The following are listed as a form of hazardous energy under OSHA 29 CFR 1910.147: Electrical energy in a pump station, Hydraulic pressure in a pipeline, known as static Head, Mechanical energy in a surge-relief valve, but not magnetic energy in a motor coil.

Magnetic Starters: A magnetic starter is an electromagnetically operated switch which provides a safe method for starting an electric motor with a large load. Magnetic starters also provide under-voltage and overload protection and an automatic cutoff in the event of a power failure.

Manhole: A manhole is the top opening to an underground utility vault used to house an access point for making connections, inspection, valve adjustments or performing maintenance on underground and buried public utility and other services including water, sewers, telephone, electricity, storm drains, district heating and gas. The following items are to be examined when inspecting a manhole: Inside surfaces and joints for cracks or breaks, Elevation of the lid and noises that indicate infiltration from cracked or broken pipes, not inadequate sewer use ordinances. If a manhole has been covered due to construction, landscaping, or other activities, bring the entry up to grade. Upstream and downstream manholes should be inspected prior to excavating a section of sewer for replacement to determine the volume of flow.

Mechanical seals: A **mechanical seal** is a device that helps join systems or mechanisms together by preventing leakage (e.g., in a plumbing system), containing pressure, or excluding contamination. Most mechanical seals require tap water lubrication.

Megger: A piece of equipment used to aid in testing for insulation resistance in a submersible pump motor. **Megohmmeter** is a special type of ohmmeter used to measure the electrical resistance of insulators. Insulating components, for example cable jackets, must be tested for their insulation strength at the time of commissioning and as part of maintenance of high voltage electrical equipment and installations. For this purpose, megohmmeters, which can provide high DC voltages (typically, in ranges from 500 V to 5 kV, some are up to 15 kV) at specified current capacity, are used. Acceptable insulator resistance values are typically 1 to 10 megohms, depending on the standards referenced.

Offset Stakes: Are control points and are set from the actual sewer line at 5 ft. - 10 ft.

Ohmmeter: See Megger. A Coil or relay might be tested using an Ohmmeter. Infinity is the most likely Ohmmeter reading of a circuit or relay that is found to be defective.

Olfactory Fatigue: Olfactory fatigue is the loss of smell. Common with Cl_2 and H_2S.

Oxygen Deficient: The condition of deficient oxygen is **hypoxia**, and the condition of no oxygen is anoxia. Blood cells are aerobic, so they need oxygen to survive. If you have below normal

oxygen levels, you're not providing your blood with its fuel; you're basically starving your blood cells. Typically, any time your gas meter reads less than 19.5 percent oxygen.

Piezometer: An instrument used to measure the pressure head in a pipe, tank, or soil.

Piston Pump: Concerning the discharge of water from a piston pump, the discharge valve should always remain open. Relief valve on discharge side of pump is used in order to prevent injuries or severe damage to piston pumps.

Plug Valve: Can be used to replace a suction side pump valve that is continually clogging.

Pump Closed-Coupled: A close-coupled pump means that there is no coupling between the motor and pump.

Pump Curve: Used to compare the actual pump efficiency to its expected efficiency.

Pump Problems: A Plugged exhaust port might cause a positive displacement diaphragm pump to cycle improperly.

Relative Compaction: Refers to the level of compaction obtained compared to the level possible under ideal conditions.

Rodding: A stick, wand, staff, or the like, of wood, metal, or other material used to clean a sewer line. It may be advantageous to rod a sewer line from an upstream position if a high head of water developed at the stoppage. Rodding the line would be the best suited for cutting roots, removing hardened grease, and for scraping and dislodging certain types of materials found in sewers.

Scouring Velocity: Refers to the flow required to prevent the deposition and buildup of solids.

Sewer Bedding: The proper method for bedding a sewer line is to bed the new section 6 to 12 inches above the top of the pipe.

Sewer Cleaning: Sewer cleaning should be scheduled on a regular cycle: for example, 100 percent of the pipes are cleaned every 1, 3, or 5 years. However, unless the cleaning schedule is adjusted to take into account the actual conditions in various parts of the collection system pipelines, routine cleaning can result in over-maintenance of the system. In most collection systems, some sections do not require frequent cleaning while other sections may require cleaning on a more frequent basis, such as monthly, if they are susceptible to blockages. Information from the inspection program should be used to help identify chronic problem areas in the gravity sewer system and related structures in the wastewater collection system, quantify defects and problem areas, and develop a preventive maintenance sewer cleaning program based on actual conditions in a particular wastewater collection system.

Cleaning is either scheduled or unscheduled. Scheduled cleaning is proactive in that cleaning is done on a preventive basis to remove material prior to a stoppage occurring. Preventive cleaning activities can be supplemented by additional cleaning on an as-needed basis in cases where predictive information such as previous history, inspection data, pipe age and material, slope, or other information indicates a need for more frequent cleaning.

Scheduled cleaning is usually coordinated with planned CCTV since televising requires a clean pipe for access and visually provides a much better picture of conditions.

Unscheduled cleaning is usually the result of a reported stoppage and is therefore reactive. When reactive maintenance is the primary form of maintenance (that is, waiting until a failure occurs before performing maintenance), it will always result in poor system performance, especially as the system ages. Normally, this type of cleaning is done on an emergency basis to clear a stoppage, restore pipe capacity to full flow, and relieve a surcharging situation in the sewer that has caused a backup into homes and/or an overflow.

Sewer Map: Elevations typically represented on a collection system map by the elevation of the invert.

Sewer Odor: Primarily is H_2S. A major problem with using an odor-masking agent is that they do not eliminate the source of the odor problem.

Sewer Problem: A few problems that result from the blockage of a sewer system: Overflowing manholes, septic wastewater, flooded basements and buildings but not increased annual flows. An air seal will form; causing odor problems that could be expected in a sewer line that enters a larger sewer line below the water level.

Smoke Testing: A method used to detect any water other than wastewater entering the **sewer** system. This water could be coming from roof leaders, cross connections between the wastewater and stormwater systems, cleanouts, driveway and yard drains, damage to the wastewater system, loose joints in the wastewater pipes, etc. When smoke testing a line, a non-toxic smoke bombs should be used.

Thermal overload: The greatest cause of failure in an electric motor. A **thermal overload** relay is a small electromechanical device that protects motors from overheating. These relays help to control the electrical current that goes to the motor to prevent it from overheating.

Time-delay fuse: The recommended type of fuse to use in the circuit leading to the electric motor.

Trench: Is a type of excavation or depression in the ground that is generally deeper than it is wide (as opposed to a wider gully, or ditch), and narrow compared with its length (as opposed to a simple hole).

Trench Safety: If a trench is more than five feet deep the spoil must be placed at least 2 feet from the trench and only on one side of the trench.12 inches is the minimum compaction height of backfill when laying piping in Class A or Class B bedding. Subsidence of ground and/or adjacent structures could possibly happen when groundwater is removed from a construction site or trench. The maximum depth of the cut below the bottom of a shield when used for earth excavation: Earth excavation to a depth of 2 ft (0.61 m) below the shield is permitted, but only if the shield is designed to resist the forces calculated for the full depth of the trench. The definition of a “trench” excavation is a narrow excavation (in relation to its length) made below the surface of the ground.

Collection References

Water Resource Center
U.S. EPA
Mail Code RC-41OO
401 M Street, S.W.
Washington, D.C. 20460
Telephone: (202) 260-7786
Fax: (202) 260-0386
Internet: waterpubs@epamail.epa.gov

National Small Flows Clearinghouse
West Virginia University
Post Office Box 6064
Morgantown, WV 26506
Telephone: (800) 624-8301
Fax: (304) 293-3161
Internet: http://www.nsfc.wvu.edu
National Center for Environmental
Publications and Information (**NCEPI**)
11029 Kenwood Road
Building #5
Cincinnati, OH 45242
Telephone: (513) 489-8190 or (800) 490-9198

FOR MORE SPECIFIC INFORMATION ABOUT WASTEWATER PROGRAMS:
Office of Wastewater Management
(**OWM**)
U.S. EPA
Mail Code 4201
401 M Street, S. W.
Washington, D.C. 20460
Internet: http://www.epa.gov/owm/

FOR GENERAL INFORMATION ABOUT THE U.S. EPA:
EPA Information Resources Center
U.S. EPA
Mail Code 3404
401 M Street, S. W.
Washington, D. C. 20460
Telephone: (202) 260-5922
Fax: (202) 260-6257

References

29 CFR 1926, Subpart P. Excavations.
Construction Safety Association of Ontario. Trenching Safety. 74 Victoria St., Toronto, Ontario, Canada M5C2A5.
International Labour Office (ILO). Building Work: A Compendium of Occupational Safety and Health Practice. International Occupational Safety and Health Information Centre (CIS): ILO, Geneva, Switzerland.
National Safety Council. Accident Prevention Manual for Industrial Operations, Engineering and Technology, 9th ed., Chicago, IL: National Safety Council.
National Safety Council. Protecting Worker's Lives: A Safety and Health Guide for Unions. Chicago, IL: National Safety Council.
National Safety Council. Industrial Data Sheets: I-482, General Excavation, and I-254, Trench Excavation, Chicago, IL: National Safety Council.
National Utility Contractors Association, Competent Person Manual-1991.
NBS/NIOSH, Development of Draft Construction Safety Standards for Excavations. Volume I, April 1983. NIOSH 83-103, Pub. No. 84-100-569. Volume II, April 1983. NIOSH 83-2693, Pub. No. 83-233-353.
Scardino, A.J., Jr. 1993. Hazard Identification and Control--Trench Excavation. Lagrange, TX: Carlton Press.
National Institute for Occupational Safety and Health, Criteria for a Recommended Standard, Working in Confined Spaces. DHEW (NIOSH) Publication No. 80-106, December 1979.
National Institute for Occupational Safety and Health, Criteria for a Recommended Standard, Occupational Exposure to Carbon Monoxide, HSM Publication 73-11000, 1972.
Golden, F. Hypothermia: A Problem for North Sea Industries, J. Soc. Occup. Med. 1976; 26:85-88.
National Institute for Occupational Safety and Health, Alert - Request for Assistance in Preventing Occupational Fatalities in Confined Spaces. DHHS (NIOSH) Publication No. 86-110, January, 1986.
National Institute for Occupational Safety and Health, A Guide to Safety in Confined Spaces. DHHS (NIOSH) Publication No. 87-113, July, 1987.
National Institute for Occupational Safety and Health, Guide to Industrial Respiratory Protection. DHHS (NIOSH) Publication 87-116, September, 1987.
American National Standards Institute, Inc. (ANSI), Safety Requirements for Confined Spaces, ANSI Z117.1-1989.
National Fire Protection Association (NFPA), Fire Department Self-Contained Breathing Apparatus Program, NFPA 1404, 3-1, 1989.
National Fire Protection Association, (NFPA), Fire Department Occupational Safety and Health Program, NFPA 1500, 3-1, 1987.

Course References

Other EPA Fact Sheets can be found at the following web address: ttp://www.epa.gov/

ADS Environmental Services, 1998. “Sewer Evaluation Services.” Internet site at [http://www.adsenv.com/what_we_do services-syeval.html], accessed June, 1998.

Arbour, R. and K. Kerri, 1997. *Collection Systems: Methods for Evaluating and Improving Performance.* Prepared for the EPA Office of Wastewater Management by the California State University, Sacramento, CA.

Bates, Roger G. *Determination of pH: theory and practice*. Wiley, 1973.

Black & Veatch, 1998. *Optimization of Collection System Maintenance Frequencies and System Performance*. Prepared for the EPA Office of Wastewater Management under a cooperative agreement with American Society of Civil Engineers.

Coe, C.D., K. Fu, and M.G. Wade, 1997. “Sewer Cleaning as a Diagnostic Tool,” In *Collection Systems Rehabilitation and O&M: Solving Today’s Problems and Meeting Tomorrow’s Needs,* pp.12:27-12:32.

Fairfax County, Virginia, 1998. I. Khan, Director, Line Maintenance Division, Department of Public Works & Environmental Services, Fairfax County, Virginia, personal communication with
Parsons Engineering Science, Inc.

City of Fort Worth, Texas, 1998. C. Hanson, Superintendent, City of Fort Worth, Texas, personal communication with Parsons Engineering Science.

Grande, Novac & Associates, Inc., 1998. “Flushing Device for Retention Tanks and Sewers.” Internet site at [http://www.gnainc.com/self.html], accessed May 1998.

Hagekhalil, A.; J. Carabantes, D. Marske, K.Runzer, and D. Parikh, 1997. “The City of Los Angeles’ Primary Sewer Condition Assessment Program,” In *Collection Systems Rehabilitation and O&M: Solving Today’s Problems and Meeting Tomorrow’s Needs,* pp. 8:27-8:38.

Hardin, D. and C. Messer, 1997. “Old Data and New Tools-Maintaining the Sewers That Need It.” *Proceedings of the Water Environment Federation Conference on Collection Systems Rehabilitation and O&M Specialty.*

KA-TE, 1998. “The KA-TE Cutter.” Internet site at [http://www.nodig.com/ka=te/kt-03.htm], accessed 1998.

Kerri, K.D. and J. Brady, 1993. *Operation and Maintenance of Wastewater Collection Systems*, Volume 1. Prepared for the EPA Office of Water Program Operations by the California State University, Sacramento, CA.

City of Los Angeles, 1998. B. Bergren, Manager, Public Works Sanitation and Wastewater Collections System Division, City of Los Angeles, personal communication with Parsons Engineering Science Inc.

City of Los Angeles, 1998. *Wastewater Collection System Operation, Maintenance, and Management*.

May, J., D. Harding, G. Rames, and R. Nelson, 1996. “Using Maintenance Frequencies To Set, Plan, and Schedule I/I Control and Maintenance Activities,” In *Collection System Symposium: Maintenance Management,* pp.483-494.

Nelson, R.E., P. Hsiung, and A. Witt, 1998. *Optimization of Collection System Maintenance Frequencies and System Performance*. Prepared for the EPA Office of Wastewater Management by the American Society of Civil Engineers and Black & Veatch.

Patrick, R., J. Rompala, A. Symkowski, W. Kingdom, R. Serpente, and N. For more information contact: Municipal Technology Branch U.S. EPA Mail Code 4204 401 M St., S.W.

Washington, D.C., 20460 Freemn,1997. *Benchmarking Wastewater Operations-Collection, Treatment, and Biosolids Management.* Water Environment Research Foundation.

Pisano, W. N. Grande, and G. Novac, 1997. “Automated Sewer Flushing Large Diameter Sewers,” In *Collection Systems Rehabilitation and O&M: Solving Today’s Problems and Meeting Tomorrow’s Needs.* pp. 12:9-12:20.

18. Price, T.O., 1997. “Investigation of Corrosion, Debris and Deformation in Large Diameter Pipes Using the Sonic Caliper,” In *Collection Systems Rehabilitation and O&M: Solving Today’s Problems and Meeting Tomorrow’s Needs,* pp.14:1-14:7.

Reid, S., G. Irwin, G.E. Knott, and D. Singleterry, 1997. “Optimizing Large Diameter Inspections,” In *Collection Systems Rehabilitation and O&M: Solving Today’s Problems and Meeting Tomorrow’s Needs,* pp. 8:39-8:48.

Sharon, J. D., 1989. *Combined Sewer Overflow Pollution Abatement: Manual of Practice No. FD17*. Prepared for the Water Pollution Control Federation by the Task Force on CSO Pollution Abatement.

Thomas, D. H. and T.W. Trybus, 1995. Collection Structural Integrity Better Understood Through Visualization Provided With Desktop Mapping.

UEMSI®, 1998.“The Predator®.” Internet site at [http://www.uemsi.com/predator.htm], accessed 1998.

Water Environment Research Foundation (WERF), 1997. *Benchmarking Wastewater Operations - Collection, Treatment, and Biosolids Management*. Project 96-CTS-5.

Casada, Don. *Pump Optimization for Changing Needs*. Operations Forum. Vol. 9, No. 5, 14-18, May 1998.

Cavalieri R.R. and G. L. Devin. *Pitfalls in Wet Weather Pumped Facilities Design.* In Proceedings of the Water Environment Federation, 71st Annual Conference, Orlando, Florida, Vol. 2, 719-729, October
1998.

Gravette B. R. *Benefits of Dry-pit Submersible Pump Stations*. In Proceedings of the Water Environment Federation, 68th Annual Conference, Miami Beach, Florida, Vol. 3, 187-196, October 1995.

Graham B, J., Pinto T.G., and T. Southard. *Backyard Pumping Stations – The Low-pressure Grinder Systems That Call Old Septic Tanks Home.* Operations Forum, Vol. 10, No. 5, 25-29, May 1993.
Jackson J. K. Variable Speed Pumping Brings Efficiency to Pump Systems. Operations Forum, Vol. 13, No. 5, 21-24, May 1996.
James M. Montgomery Consulting Engineers, 1988. "Sewerage System Preliminary Cost Estimating Curves."
Lindeburg, Michael R. *Civil Engineering Reference Manual*, 6th ed., Professional Publications, Inc., revised edition 1995.
Makovics J. S. and M. Larkin. *Rehabilitating Existing Pumping Systems: Trips, Traps and Solutions*. Operations Forum, Vol. 9, No. 5, 10-17, May 1992.
Metcalf & Eddy Inc., *Wastewater Engineering: Collection and Pumping of Wastewater*, McGraw Hill Book Company, 1981.
National Fire Protection Association. *National Fire Codes.* Volume 7, Section 820. Quincy, Massachusetts, 1995.
Paschke N.W. *Pump Station Basics –Design Considerations for a Reliable Pump Station*. Operations Forum, Vol. 14, No. 5, 15-20, May 1997.
Public Works Journal. *The 1997 Public Works Manual*. April 15, 1997.
Qasim, Syed R. *Wastewater Treatment Plants - Planning Design, and Operation*. Technomic Publishing Company, Inc., 1994.
Russell Edward. *Screw-Pump Preservation.* Operations Forum, Vol. 9, No. 5, 18-19, May 1992.
For more information contact: Municipal Technology Branch U.S. EPA
Sanks R. L., Tchobanoglous G., Newton D., Bosserman, B.E., and Jones, G. M. *Pump Station Design*, Butterworths, Boston, 1998.
Schneller T. M. *Pumping it Up? Practical Means for Evaluating Lift Station Fitness*. In Proceedings of the Water Environment Federation, 68th Annual Conference, Miami Beach, Florida, Vol. 3, 155-166 October 1995.
Smith E. C. *Don't Lose the Pump Efficiency Game*. Operations Forum, Vol.11, No. 7, 18-21, July 1994.
U.S. Environmental Protection Agency. *Design Manual. Odor and Corrosion Control in Sanitary Sewerage Systems and Treatment Plants*. EPA/625/1-85/018, October 1985.
Water Environment Federation. *Existing Sewer Evaluation and Rehabilitation. Manual of Practice No. FD6*, 1994.
Water Environment Federation. *Operations and Maintenance of Wastewater Collection Systems. Manual of Practice No. 7*, 1985.
Water Environment Federation. *Wastewater Collection Systems Management. Manual of Practice No. 7*, 1992.
Workman G. and M.D. Johnson. *Automation Takes Lift Station to New Heights.* Operations Forum, Vol. 11, No. 10, 14-16, October 1994.

We welcome you to complete the assignment in Microsoft Word. You can easily find the assignment at www.abctlc.com.

Once complete, just simply fax or e-mail the answer key along with the registration page to us and allow two weeks for grading. Once we grade it, we will e-mail a certificate of completion to you.

Call us if you need any help. If you need your certificate back within 48 hours, you may be asked to pay a rush service fee of $50.00.

You can download the assignment in Microsoft Word from TLC's website under the Assignment Page. www.abctlc.com

You will have 90 days in order to successfully complete this assignment with a score of 70% or better. If you need any assistance, please contact TLC's Student Services. Once you are finished, please mail, e-mail or fax your answer sheet along with your registration form.