Client:	***Certus***
Project:	Online Class Content
Topic:	Sanitary Drainage Systems
Learners:	Journeyman Plumbers – continuing education & prep for state licensing test Plumbing Apprentices & Students – prep for state licensing test
Deadline:	August 2024

I. Sanitary Drainage Systems

A. Definition & Importance

A Sanitary Drainage System (SDS) is one of three sub-systems within a plumbing system. The others are a Storm Drainage System and Potable (drinking) Water System. An SDS serves two primary functions, with its first to control and perform the collection of wastewater or sewage from receptacles (i.e. sink or bathtub), appliances (i.e. dishwasher or washer), and equipment (i.e. hot water heater or water softener) and distribution safely to an approved disposal point. The system must do it effectively, reliably, and efficiently while maintaining clean and sanitary conditions.

The second function is preventing wastewater or sewage, and related gases or odors from escaping out of a plumbing system. Keeping wastewater out of potable water systems is critical to keep drinking water drinkable and retain use of a supply and distribution system. Water supply and distribution systems must comply with strict standards and thresholds for water quality and sanitation that are set by the Centers for Disease Control and Prevention (CDC), Uniform Plumbing Standards (UPC), state and local regulations and rules.

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If a water company or municipality fails to comply standards or experiences a contamination event it can quickly cause a crisis with serious outcomes. For example, if a pathogen like bacteria leaks into a potable water supply and distribution system any person who consumes it can put their health at risk. They may experience diarrhea, vomiting, cramps, nausea, headaches, fever, fatigue, or even death.

In 2013-14, a total of 42 drinking-water-associated bacteria outbreaks were reported to the CDC in the United States, according to the Centers for Disease Control and Prevention (CDC). Failure of water companies or municipalities to properly maintain their SDS led to American's consuming infectious pathogens, chemicals, or toxins in 19 states. These events resulted in over 1,006 people experiencing illness where 124 were hospitalized and 13 died.

Therefore, it is imperative that as a future or current plumber you learn and understand what a Sanitary Drainage System's is, does, and the variables like flow dynamics that affect its operation.

In this lesson you will learn the primary components of sanitary drainage systems. One of them is pipes and the different materials of construction used to manufacture them will be explained. Traps and interceptors will be covered as well including P, S and Q traps. By the end of this lesson, you will have a solid base of knowledge to discuss sanitary drainage systems with fellow plumbers and other water industry professionals.

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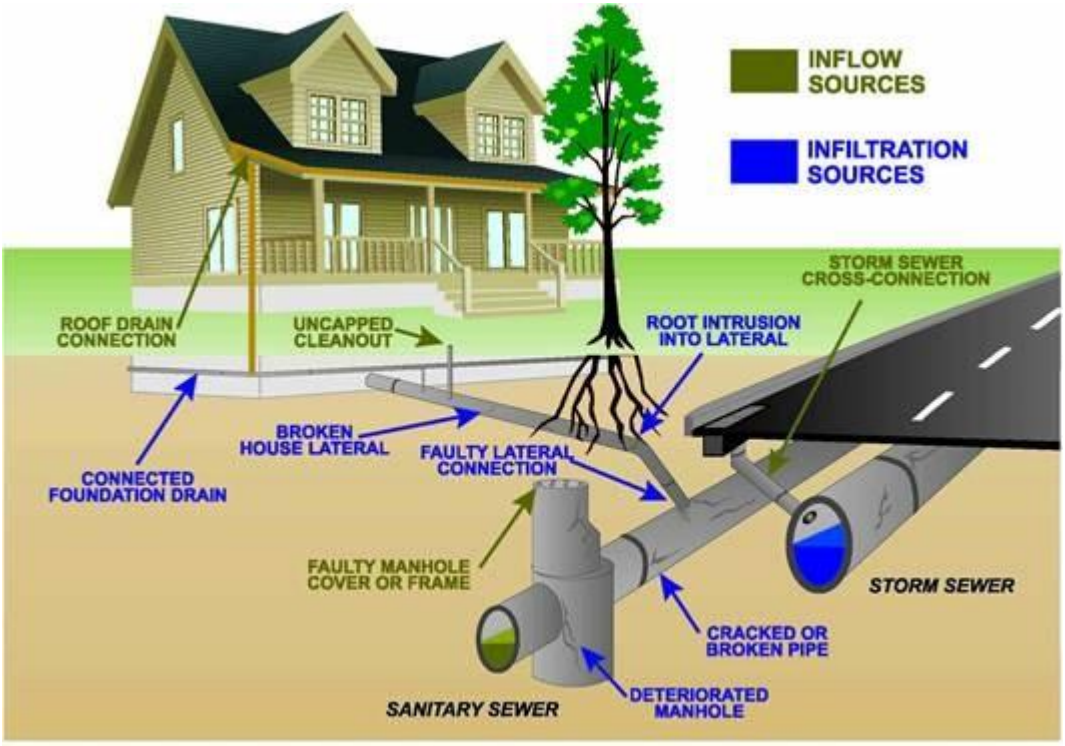

B. Components of a Sanitary Drainage System

There are several components or parts that are used to construct an SDS. In general, the system includes pipes, traps, vents, and cleanouts. The material, type and size you select will determine system competency and compliance.

1. Types of Pipes

The type of pipe you select for an SDS should be of diameters that can accommodate the intended flow and not be prone to breakage or blockages. You also need to consider expected flow rates, the type of waste being conveyed, local regulations, and the topography of the area. Plus, the type of material a pipe is made from is important.

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Different plumbing pipe types are reserved for different purposes. In general, for plumbing the five most used types of pipe used for plumbing are PVC, PEX, ABS, copper, and cast iron or galvanized steel. However, some cannot be used for SDS. The type of material approved in Chapter 7 of the UPC for SDS aboveground pipe are in the following table along with considerations.

Pipe Material	Considerations
ABS	• Smooth surface provides excellent carrying capacity • Resistant to tree root intrusion • Cost-effective choice • Will not flake, peel, rot, dissolve, fade, or leak (unless it's punctured) • Ideal for use outside, underground, and in extreme cold climates • Should not be exposed to direct sunlight • It must be installed carefully as plastic is not as strong as other materials and can bend or collapse
Cast Iron	• Strong and durable material with a long lifespan • In sizes over 4" it can withstand almost 5,000 pounds of pressure per linear foot • Cast Iron pipe is heavy • Prone to rust corrosion that causes • clogs and slow drains • Connection joints often contain lead
Copper or Copper Allow	• Copper plumbing pipes have proven to be incredibly durable • Can handle pressure of up to 1000 psi • Lifespan range from 50 – 70 years depending on variables such as the surrounding climate, water quality, and operating patterns • Able to withstand cold and hot temperatures • Bacteria cannot thrive in copper pipes • Copper itself does not pollute water • Copper pipes are expensive • The metal can add a metallic flavor to water

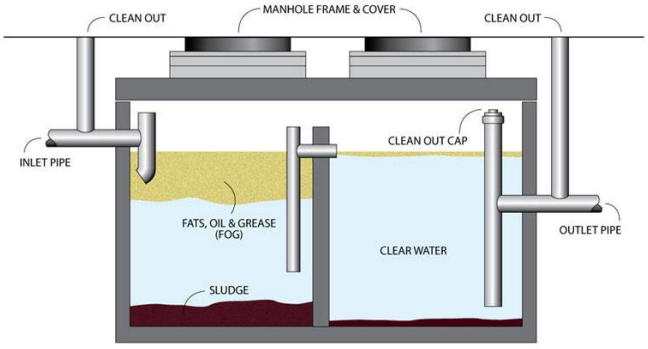
	• It will not withstand acidic water
Galvanized Steel	• Coated in a layer of zinc to prevent rusting • More affordable than copper • Highly rigid and able to withstand heavy loads • Easy to install • Short life span (20-50 years) • Despite Zinc coating it will eventually rust • Prone to clogs after minerals build up over time • Extremely heavy pipe • If damaged, the pipe is vulnerable to corrosion in a short amount of time
Glass	• Great for corrosive wastes, due to acids resistance • High chemical and temperature resistance • Can break easily if dropped or mishandled
PE (Polyolefin)	• Durable • Lightweight and easy to connect/disconnect • Resistant to chemicals and fertilizers • Capable of handling high-level water pressure • Resistance to corrosion and abrasion • Not resistant to oxidizing acids, ketones, or chlorinated hydrocarbons • If exposed to UV light it will degrade
PVC (Polyvinyl chloride)	• Smooth surface provides excellent carrying capacity • Resistant to corrosion • Lightweight & easy to install • Durable and strong • Resistant to low impact • Easy to mold • Weak for high heat • Potential for freezing
PVDF (Polyvinylidene fluoride)	• Passes the 25/50 flame spread/smoke developed rating for return-air plenums • Can withstand 212° F liquids

	• Can be used for the highest-purity water laboratory or microchip systems • Expensive
Stainless Steel	• More expensive than copper but higher quality of pipe • Strong and corrosion-resistant • Available in both flexible and rigid versions • Can be used extensively in buildings and underground

The list of approved materials for underground pipe is the same as aboveground, plus HDPE (polyethylene) can be used,

2. Types of Traps & Interceptors

Plumbing fixtures are in nearly all applications required to have traps or interceptors. These two terms are used interchangeably for different types. However, interceptors are smaller than traps and designed for indoor connection to individual sinks and other fixtures (usually with a total flow less than 50-100 gpm).



The purpose of traps or interceptors is to stop wastewater or sewage gases and related odors from leaking out of fixtures (i.e., sink, bathtub, or toilet). They prevent incidents such as wastewater leaking into a sink and causing it to overflow onto the floor which can causing damage. Plumbing traps or interceptors are also beneficial because they can reduce water loss. The example shown is a grease interceptor.

However, keep in mind traps can cause problems if not cleaned regularly and maintained. Hair and other debris can cause buildup of grime and

soap scum that leads to clogs, slow drains, and reduced water pressure. Unattended traps can also become breeding grounds for bacteria and mold that can lead to cross-contamination.

Traps or interceptors are installed below or within a plumbing fixture. They should maintain an efficient water seal under all water flow conditions. There most frequently used traps are:

- **Gully Traps**
  Gully Traps are used outside of a building to carry discharge from washbasins, sinks, bathroom etc. They ensure wastewater is pushed into the sewage system through a sewage outlet pipe. This type of trap has a deep seal, so water seal depth needs to be at least 2” (50 mm).

  Gully Traps also prevent the entry of cockroaches and other insects from sewer line to waste pipes carrying wastewater.
- **P Traps**
  The P Trap is shaped as its name implies, with the pipe forming a letter P. Part of the trap also forms a letter “J” and is called a J Bend. The P Trap is connected via J bend on one end to a sink, bathtub, or shower. The other end is connected to a drainage system.

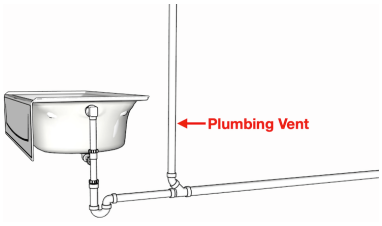
  P Traps are manufactured using either brass or polypropylene. While the brass version is more aesthetically pleasing it will corrode over time with repetitive use. The polypropylene version is lightweight, easy to assembly/disassemble, resists corrosion and acids.
- **Q Traps**
  The Q Trap is a soil, wastewater, and rain (SWR) trap used for non-pressure plumbing systems. Like the P Trap, it captures water

in the “U” shaped region of its body. They are often used in upper levels of building with multiple floors and bathrooms like hotels, resorts, and hospitals.

This trap can be connected to a shower area or water closet if the branch line outlet is in the vertical position. Q Traps are corrosion and fire resistant, easy to install, and ensure a smooth flow rate.

- **Floor Traps**
  Floor traps, also called Nahni traps, and installed on the floor to collect wastewater from a bathroom, wash zone, washbowl, or kitchen sinks. They are constructed of either PVC, UPVC, or CI, and do not have a vent pipe.
- **S Traps**
  Another type of trap is an S Trap often seen in older plumbing systems. It was replaced by the P Trap and is no longer allowed by UPC. Others traps or interceptors prohibited by the UPC are Bell, Crown-vented, and Drum.
- **Grease Traps**
  Grease traps are also commonly installed for commercial kitchens. However, they have a different purpose. In this application the are used to intercept and separate fats, oils, and grease from wastewater to prevent clogs in the drainage system.

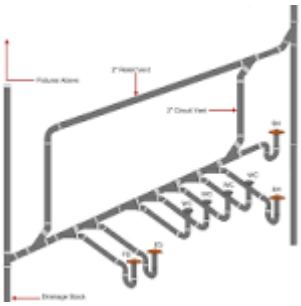
3. Vents



Vents are used in plumbing systems to protect trap/interceptor seals by balancing the air pressure inside the drainage system. This prevents occurrences of negative (siphonage) or positive (backpressure) air pressure from breaking a trap or interceptor seal. A break in seal can release contaminated liquids and harmful gases into a building. Vents also improve drain flow, and lower drain noise.

There are different types of vents available and those used most often are called branch, circuit, common, combination, conventional, island, wet, circuit and single stack. The vents are usually installed either side-by-side or back-to-back.

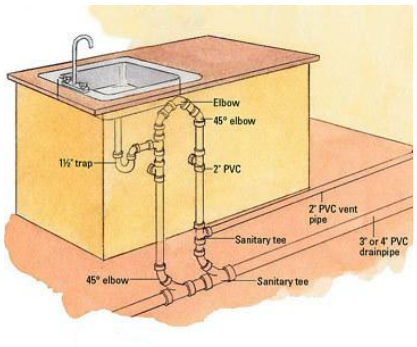
- **Branch Vent**
  Branch vents are used to connect a horizontal branch with a vent stack or stack vent.
- **Circuit Vent**
  A circuit vent is used to connect 2-8 fixtures to a single vent. They are often used in buildings with several bathrooms. The circuit vent connects between the two most upstream fixtures.



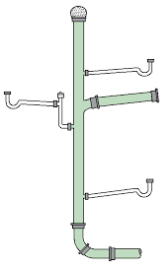
  For this method, a relief valve is needed for the following situations.
  - If four or more water closets connect to the circuit-vented horizontal branch drain.
  - The circuit-vented branch drain connects to a drainage stack receiving discharge from fixtures on an above floor.
- **Common Vent**
  A common vent is an individual vent that connects the intersection of two pipes. It provides an easy way to connect two plumbing fixtures and use only one vent.
- **Combination Waste & Vent (CWV)**
  The combination waste & vent is a horizontal wet vent with one or more sinks, floor drains, lavatories or drinking fountains connected by means of a common waste and vent pipe. Pipe is

oversized to allow the free movement of air (above the drain's flow line).

- **Conventional Vent or Individual Vent**
  The conventional of individual vent is attached to only one fixture. This method is often used for bathtubs and when a single vent pipe terminates outdoors to open air through the roof.
- **Island Fixture Vent or Island Sink Vent**
  There are several names used for this vent, including loop vent, island vent, island sink vent, bow vent and Chicago loop vent. The UPC refers to it as an Island Fixture Vent. An island fixture vent is used when an individual vent cannot be installed because a sink isn't next to a wall.



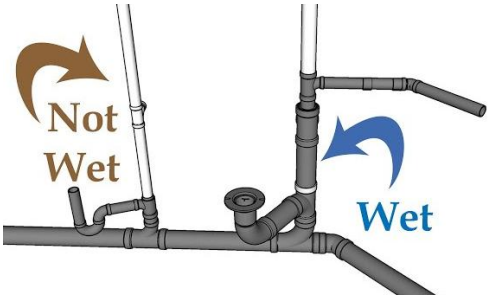
  This vent differs from a conventional individual vent because it offsets horizontally below the sink's flood level rim. Plus, use is limited to only fixtures located in an island**.**
- **Single-Stack Vent**
  The single-stack vent is installed along with a drainage stack and branch connections that are oversized. The assembly serves as both the drain and vent.



- **Vent Stack & Stack Vent**
  The terms "vent stack" and "stack vent" are often used interchangeably. However, they are not the same thing. A vent stack does not carry waste. It is only used as a stack for venting and required for every five branch interval or more.

A stack vent is an extension of a waste stack. It is the uppermost part of the waste stack that connects to the uppermost part of the roof. Stack vents are only used to vent sewer gas and to allow drains and toilets to operate efficiently. They also require a supply of air to operate correctly.

- **Wet Vent**



The wet vent is used to vent a single bathroom. It is a quick, effective, and less expensive approach since it needs less fittings than the conventional vent method. Wet vents are constructed either vertically or horizontally. Keep in mind, wet venting is limed to fixtures belonging to one bathroom group in the UPC.

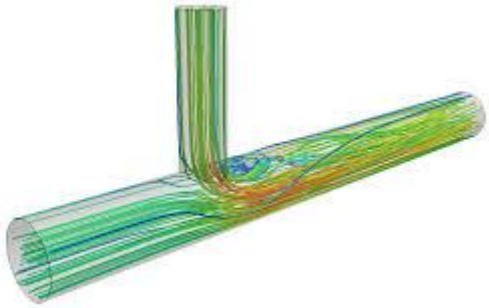
Another method is Waste Stack Venting; however, it is not permitted by the UPC**.**

4. Cleanouts

A plumbing cleanout is an access point installed in the drainage pipe for the purpose of accessing and cleaning out drains when problems such as clogs occur. They also make it easier to identify where problems are located within an SDS. Without cleanouts plumbers needs to use more invasive measures like removing toilets to access and resolve problems. Common locations of these points are floors, walls, yards, roofs, and sewers.

C. Flow Dynamics

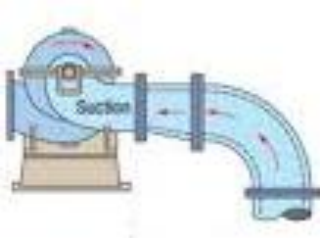
When designing a plumbing system, fluid dynamics (how fluids move) like energy and momentum need to be considered. Plus, related variables, including velocity, flow rate, flow pressure, and resistance. This data needs to be your foundation for decisions for the size of a part (i.e., pipe, fitting) and equipment (i.e., pumps).



The first two variables are velocity and flow rate which have different physical quantities yet are related. Velocity is defined as the distance traveled over time (e.g., feet per minute, miles per hour). Flow Rate is the volume of fluid over time as it passes through a point in the pipe (e.g., cubic feet per minute).

To make the distinction clear, think about the velocity and flow rate of Brazil's Amazon and São Francisco Rivers. The Amazon River carries far more water than the São Francisco River. Therefore, the narrower São Francisco River (smaller pipe) will restrict the flow rate of water and increase its velocity. If your pipe is too small, the amount of water and times it takes to move will be inadequate.

The ability of a liquid in pipe to move is also affected by Flow Pressure. It is defined as the amount of force or pressure a liquid needs to overcome resistance within a pipe to move forward in the direction it is traveling. It is affected by a plumbing system design, including distance, cavity bends, and height of parts or assemblies. The longer a pipeline, more changes in direction, bends (i.e., P Traps), number of attached appliances and equipment increases the quality of pressure (Pressure Gradient) needed from one point to another within a pipe for fluid to flow.



Friction is another variable that affects flow. It is the force that resists motion between objects or substances. Obstructions within pipe like clogs and sediment can increase friction which will affect pressure and can cause problems. For example, if the water pressure is too high or too low in your plumbing system, it can damage to equipment such as pipes and fixtures.

Achieving and sustaining a balance between flow rate, velocity, and pressure is critical. Failing to effectively manage it can lead to any or all of the following.

- Excessive wear and tear on pipes and appliances, leading to premature replacements.
- Increased chances of leaks, which can result in significant amounts of water being wasted and high utility bills.
- Noisy water pipes, which may translate to constant snores and hisses as water tries to fight its way through.
- Inability to supply the needed amount of water and when needed at points within a building.

Two other variables that affect the flow of liquid in pipes are gravity and siphonage. Gravity provides the necessary force to move water and siphonage protects plumbing systems from becoming contaminated.

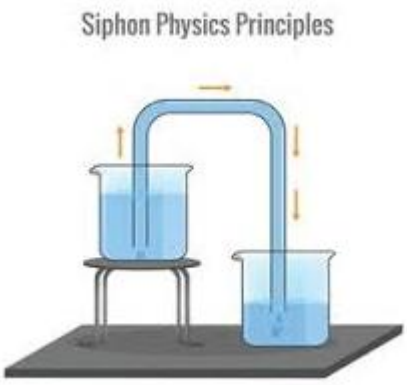
- **Gravity**

  As in rivers, gravity is what moves contents within pipes. The water flows down a gravitational gradient, and the source of energy for this downhill movement is gravitational energy. For example, when you flush a toilet, it is gravity that pulls down water and waste in the bowl down into a sewer system. Drains work the same way with gravity pulling down water from a fixture and into a drain. Without gravity

toilets could not flush, water would not flow out of faucets or shower heads.

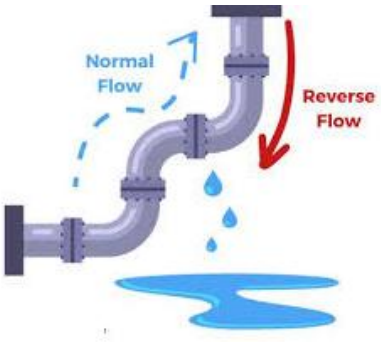
The pull of gravity can cause problems including reduced flow rates, backups, and overflows if a plumbing system becomes clogged by events like solid matter getting into a plumbing system.

- **Siphonage**



Plumbing systems have traps that create water seals to prevent wastewater or sewage and gases from escaping out of a fixture into a building. These water seals can be broken if an SDS experiences a loss of pressure called Siphonage. It occurs because the change in pressure causes liquid in pipes to flows into the highest portion of a bend pipe and it is then pulled down by gravity. The action creates suction and a partial vacuum inside the pipe which breaks the seal. Once broken, wastewater or sewage and gases can come out of fixtures to the point of overflowing onto a floor. But avoidance measures can be taken with backflow prevention devices or assemblies.

- **Backflow & Backflow Prevention**



Backflow is an event you want to prevent from occurring in any water supply and distribution systems. It is defined as the flow of water or other liquids, mixtures, or substances into a potable water supply and distribution system from a sources other than its intended source. For example, contaminants can enter your potable

water system through open cross-connections to other plumbing systems, equipment, appliances, or tools like a hose. This can cause contamination of the water and system whereby making it no longer safe for human consumption.

The most common cause of internal backflow is a hose bib, faucet, or other device attached to the system is turned on without first being opened. This action creates backpressure, which is pressure that rises higher than inside the source. As a result, flow of plumbing system contents is reversed back toward its source. The redirection creates suction in the system that pulls in hazards via cross-connections.

The risk posed by backflow can be mitigated by using preventive devices and assemblies, include the following.


AVB

- Atmospheric Vacuum Breaker (AVB)
- Double Detector Check Valve Assembly (DDCVA)
- Double Check Detector Assembly (DCDA)
- Double Check Detector Fire Protection Assembly (DCDFPA)
- Double Check Valve Assembly (DCVA)
- Hose Connector Backflow Preventer (HC)


DCDFPA

- Pressure Vacuum Breaker Assembly (PVB)
- Reduced Pressure Detector Fire Protection Assembly (RP)
- Reduced Pressure Zone Device (RPZD)
- Reduced-Pressure Principle Assembly (RP)


RPZD

- Spill-Resistant Pressure Vacuum Breaker (SVB)

D. Conclusion

To ensure the protection of human health and the environment, sanitary drainage systems must safely and reliably remove wastewater. This includes sewage, greywater, and other household waste from buildings or structures. The wastewater must also be pumped to treatment facilities or designated disposal areas. How efficiently and efficiently sanitary drainage systems do this function depends upon the type of pipes, traps, vents, and interceptors selected and installed. They are all crucial components, and the right choices can help rather than hinder flow dynamics.