

EVANSTON UTILITIES DEPARTMENT

Study / Training Guide for Water Worker I, Distribution & Sewer

WATER DISTRIBUTION SYSTEM

The Evanston Water Distribution System is comprised of 157 miles of water main, approximately 2,050 distribution valves, approximately 1,400 fire hydrants and approximately 14,350 water services, two water storage facilities and the pumping station at the treatment facility. The water mains convey treated water that is pumped under pressure from the Evanston water treatment facility to the approximate 14,350 retail customers in Evanston and the City's two wholesale water customers, the Village of Skokie and the Northwest Water Commission (Arlington Heights, Buffalo Grove, Palatine, and Wheeling).

The main purposes of the distribution system are: 1) to deliver adequate quantities of water at sufficient pressures at all times and 2) protect the quality of the water by maintaining continuous positive water pressure in the distribution system to assure that the potable water is not contaminated by ground water.

Generally, water should be delivered at a minimum pressure of 35 pounds per square inch (psi) and 20 psi is the absolute lowest acceptable pressure needed to assure that the potable water is not contaminated by ground water.

WATER MAINS

Water mains are pipelines that supply water from the water plant pumping station to the water services that serve individual buildings. Water mains in Evanston vary in size from 3-inch diameter to 48-inch diameter. Long ago the water mains were constructed of wood, but all of the wood water mains have been replaced. The oldest, active water mains in the Evanston were installed in the 1890's and are made from cast iron material. The joints on these old water mains are made of lead caulk material. Cast iron water main pipes continued to be used until 1970 when ductile iron water main pipes began to be used. Ductile iron was used because it is stronger and more fracture resistant than cast iron. The joints of the ductile iron pipes are generally of bell and spigot type with a rubber gasket. Larger diameter water mains installed after 1948 have generally been constructed of pre-stressed concrete cylinder pipe. The pipe starts as a steel cylinder that is wrapped with pre-stressed wires and then covered with concrete both on the inside and outside. Because the water inside the pipe is under pressure (between 30 to 60 pounds per square inch) it is important that the larger pipes don't explode from the internal water pressure.

Cast iron and ductile iron pipes, like most materials that contain iron, are susceptible to corrosion. As the wall thickness of the pipe deteriorates due to this corrosion, the water mains are subject to failure causing water leaks. Shear pipe breaks frequently occur when the ground moves as a result of frost penetrating deeper into the ground. To try and avoid these types of water main

breaks, the water mains in Evanston are buried a minimum of five feet – six inches (5' 6") deep.

Another type of water main break occurs when small weakened sections of the water main wall "blow out" due to the internal water pressure, forming a hole in the wall of the pipe which results in the water leak.

Evanston has begun using polyvinyl chloride or PVC water main pipe in some specific locations. This type of pipe material is not susceptible to corrosion like the cast and ductile iron pipes. Water mains can also be made of steel, but Evanston does not have any steel pipe in their distribution system.

Several larger diameter water mains don't have any water services connected to them, but help supply water to all areas of the City's water distribution system. These pipelines are called transmission mains.

DISTRIBUTION VALVES

Distribution valves are installed in the water main system in order to shut down and isolate a section of water main for repair or maintenance. Distribution valves are generally located at street intersections and are installed in valve vaults or valve boxes. Valve vaults are generally 48-inch diameter structures, constructed of brick, concrete block or concrete sections that are placed over the valve and allow access to the valve for maintenance purposes through a 22-inch diameter frame and solid cover at the street level. Valve boxes are 6-inch diameter sections of pipe set vertically over the valve operating nut to the street level. Valve boxes allow operation of the valve using a valve key. Valves are strategically placed to limit the number of water services that will be impacted when a section of water main is isolated. Sections of water main are isolated to allow for the repair of a leaking water main, the installation of a new fire hydrant or new large-diameter water service.

Gate valves are generally used in the distribution system because when the valve is fully open there is no obstruction in the flow path of the water. The gate or wedge portion of the valve slides into the bonnet portion of the valve getting completely out of the path of the fluid. As such, there is no loss of flow through a gate valve. Gate valves placed on larger diameter water mains usually require the valve to be placed on their side, meaning that the bonnet is next to rather than above the water main. Gate valves placed on their side can become difficult to operate over time because the bottom track that the gate slides on gets filled with debris.

Evanston has also used butterfly valves in the distribution system on some of the larger diameter water mains. This type of valve is less expensive, but even in the open position, the disk of the valve is in the path of water causing resistance. Butterfly valves operate very quickly from the open to close position.

FIRE HYDRANTS

The primary purpose of a fire hydrant is to provide water to the fire department in the event of a fire. Fire hydrants should be placed so that no more than 200 feet of fire hose is needed between the fire hydrant and the fire. As such, fire hydrants are generally spaced every three hundred feet on a water main. Fire hydrants are also used to flush or clean debris and sediment from the water main at the time of new water main installation or after making a water main repair. Occasionally, water is flushed from fire hydrants to bring fresh water to a section of water main, increasing the water quality in the area. This type of flushing can occur anywhere, but should be done at least annually on dead end water mains. For these reasons, at least one fire hydrant should be placed within any section of water main that can be isolated by closing valves, in order to provide a flushing point and a location to release air from a water main that was dewatered.

Evanston uses a dry-barrel type of fire hydrant to prevent the fire hydrant from freezing in the cold winter weather. The fire hydrant valve is located at the bottom of the fire hydrant assembly along with a weep hole. Unless the fire hydrant valve is fully open or fully closed, water will drain out of the weep hole. After closing a fire hydrant, the user should feel suction when they place their hand against an open port. This is an indication that the weep hole is functioning properly and that the water is properly draining from the barrel section.

Evanston uses a 3-port type of fire hydrant. It has two smaller ports on the sides that a fire hose can hook up to directly. There is also a larger center port called the pumper port. This is the port used by the fire department when they need to increase the flow and pressure of water needed to fight a fire. A hose is used to connect the fire hydrant to the fire truck and is used to fill a tank on the fire truck. The fire truck then has a pump that pumps the water from the tank into the fire hoses connected to the fire truck.

WATER SERVICES

Water services are the pipes that convey the treated water under pressure from the water main in the street to the building. Most single family residential homes have water services that range in size from $\frac{3}{4}$ " to 2". Older water services are constructed of lead pipe but there are also a few water services that are made from galvanized steel pipe. Neither of these pipe materials are allowed to be installed per current regulations. Any new water services 2" or less are constructed of copper tubing. Larger diameter water services are constructed of cast or ductile iron pipe, and only ductile iron pipe is currently used for new construction.

The location where the water service connects to the water main is called a tap. For water services 2" or less, a hole is drilled into the wall of the water main and a corporation stop is screwed directly into the water main wall or attached using a pipe saddle. The corporation stop has a ball valve in it and can be operated

during the installation process. However, after the water service is installed, the corporation stop is buried under the ground in the open position.

Copper tubing is connected to the corporation stop and installed from the water main to the parkway (the grassy area between the street curb and the sidewalk). A shut off valve, called a curb stop, is installed on the copper tubing at this location and defines the point of where the responsibility for maintenance of the water service transfers from the City to the property owner. The curb stop is a quarter turn ball valve, meaning that the valve goes from fully open to fully closed with only a quarter turn of the operating nut. A cast iron tube called a B-box is installed vertically over the curb stop to allow the valve to be operated using a valve key. The copper water service then continues from the curb stop into the building.

WATER METERS

Once inside the building a water meter must be installed to measure and display the amount of water passing through it for billing purposes. Meters are classified as small-flow meters, large-flow meters, and combination large/small-flow meters.

Since the majority of water customers in Evanston are single family homes, small-flow meters are typically used. Evanston uses a displacement-type meter called a nutating-disc meter, for this application. A displacement meter measures the flow by registering the number of times the meter chamber is filled and emptied. Nutating means nodding, and each time the meter chamber fills and empties the disc inside the meter nods and registers the known volume of water inside the chamber passed through the meter. Displacement meters can measure wide variations of flow rate and are accurate in registering low flows.

Large-flow meters are generally used on large water mains. In Evanston, large-flow meters are used to measure the amount of water leaving the water treatment facility and to measure the amount of water being delivered to its wholesale water customers. These types of meters are called velocity type meters. Venturi, turbine and propeller meters are examples of these types of large-flow, velocity meters.

A combination meter is frequently called a compound meter. This type of meter is used for larger buildings that have both high water flows and low water flows. The compound meter might include the use of a positive displacement meter to capture low flows working in conjunction with a turbine meter that captures the high flows.

SEWER SYSTEMS

A sewer system is a separate underground carriage system specifically used for transporting sewage and waste water from houses as well as from commercial and industrial buildings to a treatment facility. Most sewers flow by gravity due

to a change in elevation of the sewer pipe from a higher elevation to a lower elevation. However, on occasion, it is not feasible to have the sewage flow by gravity so it is pumped under pressure through a pipeline. A pipeline conveying sewage under pressure is called a force main.

The slope or change in elevation of the sewer pipe must be appropriate. If the slope is too great the liquids will flow away too quickly leaving the solids in the pipe, and if the slope isn't enough then the sewage doesn't flow at all. Sewers are generally installed in a straight line to: 1) help keep the sewage flowing, thus preventing stoppages and build up of solids, 2) to make cleaning and inspecting the sewer easier, and 3) to make it easier to locate the sewer. The joints between the pipes must be tight in order to prevent ground water from infiltrating into the sewer, to prevent the exfiltration of sewage from the sewer, and to prevent tree roots from growing into the sewer.

Sanitary sewers are pipelines that begin with the pipes from buildings to one or more levels of larger underground trunk mains, which transport the sewage to a sewer treatment facility.

Pipes conveying sewage from an individual building to a common sewer line are called laterals. The laterals flow into a branch sewer which is generally located under the street pavement. Branch sewers flow into larger, deeper sewers called trunk sewers. Larger cities have sewers called interceptors that receive flow from multiple trunk sewers.

Manholes are 48-inch diameter vertical pipes that connect the sewer mains to the surface. A metal frame with a solid cover is set on the top of the manhole at the street level and allows access to the sewer. Manholes are used for access to the sewer pipes for inspection and maintenance purposes. Manholes are required when the sewer pipe makes a bend, when the sewer pipe diameter size changes, and when two or more sewer mains intersect.

Storm sewers are designed to drain excess rain and ground water from paved streets, parking lots and sidewalks. A drainage structure (similar to a manhole, but with an open grate at the street level) allows rain water to flow into it. Drainage structures are generally located at the low spots in the street next to the curb and have open grate covers that allow storm water to flow into the structure. Catch basins and inlets are specific types of drainage structures. Catch basins have a sump at the bottom of the structure to collect leaves and debris that might flow into the structure during a rain event. The outfall pipe from the catch basin to the branch sewer is above the sump and allows the rain water to flow into the branch sewer while leaving the debris in the catch basin. Inlets are drainage structures like catch basins, except that they do not have a sump. For this reason, inlets should never be directly connected to the sewer main. Inlets should drain to a catch basin before draining to the sewer main.

Sewer systems that use the same pipe to convey sewage and storm water during rain events are called combined sewers. In these types of systems, laterals from the buildings as well as the outfall pipes from the drainage structures are connected to the same branch sewer main. Combined sewer systems are generally found in older communities and are not installed any more. Unfortunately, during severe storms more rain water can enter the sewer than the sewer can hold. This overwhelms, or surcharges the sewer, which results in sewage water backing up the sewer lateral into the basements of buildings. Drainage structures connected to a combined sewer need to have a trap on the outfall pipe to prevent odors in the sewer main from escaping into the atmosphere through the drainage structure.

Evanston's Sewer System

The Evanston sewer system is comprised of three types of systems: a combined sewer system, a relief combined sewer system and a storm sewer system. The City does not have a sewage treatment plant. All of Evanston's sewage flows to the Metropolitan Water Reclamation District (MWRD) system and is treated at the MWRD North Side Water Reclamation Plant at the intersection of McCormick Blvd. and Howard Street in Skokie.

The Evanston combined sewer system was constructed as the city was developed, and the majority of the system is 80 to well over 100 years old. Typical of combined sewer systems built at the time, the combined sewer conveys sanitary waste as well as storm water during rain events.

The majority of the combined sewer system is constructed of 12-inch diameter vitrified clay tile pipes (branch sewers) with the larger (36-inch or greater) diameter pipes constructed of brick or segmental clay tiles (trunk sewers). In Evanston the trunk sewers connect to interceptor pipes owned by the MWRD that convey the sewage to their treatment plant.

Between 1991 and 2008 a relief combined sewer system was constructed in Evanston. This system acts mostly like a storm sewer system, but can receive sanitary waste overflows from the combined sewer system during severe rain events. The relief sewer pipes are constructed of ductile iron, PVC or concrete. Some of the relief sewer pipes are 60 feet deep and are 10-feet in diameter.

There are several locations in Evanston where storm sewers were installed. Storm sewers only convey rain water - they do not carry any sewage. Storm sewers convey rain water to the North Shore Channel or to Lake Michigan, not to the treatment plant. These pipelines are constructed of ductile iron, PVC or concrete pipe.

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Terms used in the water industry:

Buffalo Box or B-box: A B-box (also known as a “Buffalo Box” because they were first made at a foundry in Buffalo, NY) is an underground structure made of cast iron located over a curb stop valve (roundway) that allows the valve to be operated using a valve key. B-boxes are usually located in the front parkway in the grassy area or in the sidewalk. The B-box is accessed to operate the curb stop valve on a water service line to shut off water to a particular building for non-payment of the utility bill or if internal piping repairs necessitate that the water be turned off outside the building. The City is responsible for the maintenance and repair of the water service from the water main to the curb stop / B-box. After the curb stop, the property owner is responsible for the water service.

Cross Connection: A connection between a drinking (potable) water system and an unapproved (non-potable) water supply.

Curb Stop (roundway): A water service shutoff valve located in a water service pipe near the curb and between the water main and the building. This valve is usually operated by a wrench or a valve key and is used to start or stop flows in the water service line to a building. Also call a roundway.

Distribution Valve: A valve installed in the water main system in order to shut down and isolate a section of water main for repair or maintenance. Distribution valves are generally located at street intersections. Gate valves are the type of valves primarily used in the water distribution system. However, butterfly valves are occasionally used on larger diameter water mains.

Distribution System: A network of pipes, valves, fire hydrants, service lines, meters, pumping station(s) and storage facilities, that delivers water to homes, businesses and industries for drinking, fire protection and other uses.

Fire Hydrant: A fire hydrant provides access to the water in a water main through underground piping and an above ground structure with ports on it to allow for the connection of fire hoses. The primary purpose of a fire hydrant is to provide water to the fire department in the event of a fire. Fire hydrants are also used to clean water mains by flushing water at high velocities through the fire hydrants.

Gate Valve: A gate valve is the type of valve frequently used in a water distribution system to isolate a section of water main for repair. When a gate valve is fully open, the gate or wedge portion of the valve is completely removed from the flow path of the water.

Potable Water: Water that does not contain pollution, contamination, minerals or infective agents and is considered satisfactory for drinking.

Service Pipe: The pipeline extending from the water main to the building served or to the customer's system.

Valve Box: A valve box is an underground structure which is a 6-inch diameter cast iron pipe set vertically over a valve operating nut. It provides access to operate the valve using a valve key. A cast iron lid is placed on the top of the valve box to prevent dirt and debris from filling up the pipe. The valve box comes in sections of pipe which allows the overall pipe height to be adjusted to match the ground elevation.

Valve Vault: Valve vaults are underground structures used to provide access to underground distribution valves on water mains and are usually found in a street, parking area or sidewalk. Access is required to periodically inspect, repair or operate the valve. Valve vaults typically have heavy round solid covers.

Water Mains: Pipelines that supply water from the water plant pumping station to the water services that serve individual buildings. Water mains used to be constructed of cast iron, but are now constructed of ductile iron, PVC, concrete or steel. The purposes of a water main are: 1) to deliver adequate quantities of water at sufficient pressures at all times and 2) protect the quality of the water by maintaining continuous positive water pressure in the distribution system, ensuring that the potable water is not contaminated by ground water.

Water Meter: Water meters are devices that measure and display the amount of water passing through the meter. This information is used for billing purposes. The majority of the water meters in single family residential homes are 5/8-inch positive displacement meters with a nutating disc. This type of meter is used because they can measure wide variations of flow rates and are accurate in registering low flows. The property owner is responsible for the proper operation of the valves that should be placed on either side of the water meter.

Water Service: Water services are the pipes that convey the treated water under pressure from the water main in the street to the building. Water services 2" or less can be made from lead or copper, but current regulations do not allow the use of lead any more. Larger diameter water services are constructed of cast or ductile iron pipe, and only ductile iron pipe is currently used for new construction. The water service includes the corporation stop at the water main, the copper tubing from the corporation stop to the curb stop, the curb stop and B-box, the copper tubing from the curb stop to the water meter and the water meter. The City is responsible for the maintenance and repair of the water service from the water main to the curb stop. (Refer to Water Service Connection Detail.)

Terms used in the sewer industry:

Catch Basin: A type of drainage structure that collects rain water from the street and drains to the sewer system. Catch basins are generally located along the curb line in the low spots along the street and have an open grate cover. Catch basins have an area below the outfall pipe called a “sump” that catches leaves and debris. By catching the debris from the street in the drainage structure, the sewer main is less likely to become blocked.

Combined Sewer System: A type of sewer system designed to carry both sanitary waste and surface runoff from rain events.

Drainage Structure: A storm water drain designed to drain rain from paved streets, alleys and parking lots. Catch basins and inlets are specific types of drainage structures.

Hydroflushing: A method of cleaning sewer mains using high pressure water delivered through a hose and special jet nozzle that scours debris from the pipeline.

Inlet: An inlet is a drainage structure with an open grate cover located along the curb in the low areas of the street. Inlets do not have a sump and should therefore be connected to a catch basin before draining to the sewer pipe.

Invert: The lowest point on the inside of a pipe.

Manhole: Sewer manholes are underground structures used to provide access to underground sewer lines and are usually found in a street, parking area or sidewalk. Access is required to periodically inspect and clean the sewer lines. Sewer manholes typically have heavy round solid covers.

Relief Combined Sewer System: A type of sewer system designed to carry storm water as well as overflows from the combined sewer system. During dry weather there is generally no flow in the relief sewer system since sewer services are not directly connected to the relief sewer system.

Rodding: A method of cleaning a sewer main using high pressure water and a mechanical device to cut roots in a sewer main.

Sanitary Sewer: Sanitary sewers are pipelines that begin with the pipes from buildings to one or more levels of larger underground trunk mains, which transport the sewage to a sewer treatment facility. They convey only sewage and industrial waste. Sanitary sewers do not convey rain water.

Sewage: The used household water and water-carried solids that flow in sewers to wastewater treatment plant. Also known as wastewater.

Sewer Cleaning Machine: A truck mounted machine used for sewer maintenance. The machine can be used to clean sewer mains using a high pressure jet hose and nozzles or to clean drainage structures using a vacuum system to suck debris from the structure into a debris box mounted on the truck bed.

Sewer Lateral: The sewer pipe installed between the building and the City's combined sewer system. A private sewer lateral is also referred to as a building sewer or house lateral. Per the Evanston City code, the home owner is responsible for the maintenance and repair of the sewer lateral from the building up to and including the connection to the City's branch sewer. (Refer to Sewer Lateral Detail.)

Sewer System: A sewer system is a separate underground carriage system specifically used for transporting sewage and waste water from houses as well from as commercial and industrial buildings to a treatment facility. Most sewers flow by gravity due to a change in elevation of the sewer pipe from a higher elevation to a lower elevation.

Storm Sewer System: A type of sewer system designed to carry only storm water. Evanston's storm sewer system discharges to the North Shore Channel and to Lake Michigan.

Terms used in the construction industry:

Backfill: The material used to fill up an excavation. Excavations under the street pavement or other improved surfaces are generally backfilled with sand or stone. Excavations under grassy area can be backfilled with sand or the soil removed during the excavation. (Refer to trench backfill detail)

Combination Loader / Backhoe Machine: A piece of equipment that can be used either as a backhoe to excavate a hole or as a loader to carry stone or debris.

Commercial Driver's License (CDL): A drivers license required in the United States to operate any type of vehicle which has a gross vehicle weight rating of 26,001 pounds or more for commercial use.

Confined Space: Any space that: has limited or restricted means of entry/exit; is large enough for a person to enter; and is not designed or configured for continuous occupancy. OSHA requires a permit to enter a confirmed space that has the potential to contain a hazardous atmosphere. Manholes, valve vaults and large sewer mains are examples of a confined space that require a permit to enter.

Material Safety Data Sheet (MSDS): A document which provides pertinent information and a profile of a particular hazardous substance or mixture. An MSDS is required to be made available to employees whenever there is the likelihood of the hazardous substance or mixture being introduced into the work-place.

Occupational Safety and Health Act (OSHA): The federal law designed to protect the health and safety of industrial workers. The Act regulates the design, construction, operation and maintenance of water supply systems, sewer systems and water treatment plants. OSHA also refers to the federal and state agencies which administer the OSHA regulations. In the state of Illinois, the Illinois Department of Labor (IDOL) assumes responsibility of OSHA.

Personal Protective Equipment (PPE): OSHA requires the use of personal protective equipment to reduce employee exposure to hazards when performing their job functions. This includes the use of hard hats, ear protection, protective eye glasses/ goggles, gloves, safety vests, steel toed shoes/boots, etc.

Traffic Barricade: A traffic barricade is made of metal, wood or plastic and usually has highly reflective striping on it. They are designed to dissuade passage into a protected or hazardous area. They are sometimes called a saw horse.

Traffic Control: The use of warning signs and barricades to advise pedestrians and motorists of a work zone in order to help protect the workers within the work space.

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WATER & SEWER ABBREVIATIONS

CB	catch basin
CDL	Commercial Driver's License
cu ft	cubic feet
cu yd (CY)	cubic yard
ft (')	feet or foot
gal	gallon
gal/day	gallons per day
GIS	Geographic Information System
GPM	gallons per minute
In (")	inch
In	Inlet
Lb (#)	pound
lbs/sq in	pounds per square inch
MH	manhole
MGD	million gallons per day
SDS	Safety Data Sheet
MTU	Meter Transmission Unit
OSHA	Occupational Safety and Health Act
PPE	Personal Protective Equipment
psi	pounds per square inch

WATER & SEWER ABBREVIATIONS
(continued)

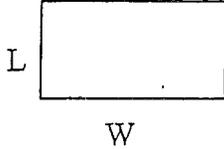
RPM	revolutions per minute
sq ft (SF)	square feet
sq in	square inches
VB	Valve Box
VV	Valve Vault

MATH EQUATIONS USED IN THE WATER INDUSTRY

FORMULA

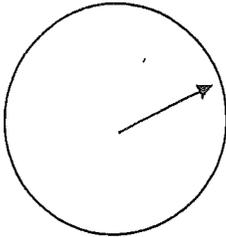
The AREA of a *SQUARE* or *RECTANGLE* is equal to Length times Width

$$A = L \times W$$



The AREA of a *CIRCLE* is equal to π times the Radius squared

$$A = \pi r^2$$



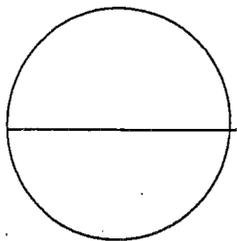
which is equal to $3.14 (r^2)$

(pi is a known value ≈ 3.14)

Or

The AREA of a *CIRCLE* is equal to π over 4 times the Diameter squared

$$A = \frac{\pi}{4} d^2$$

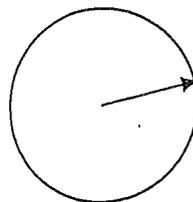
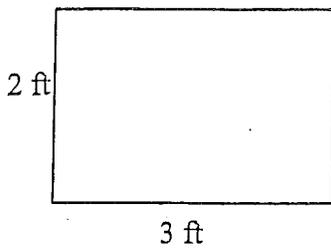


which is equal to $.785 (d^2)$

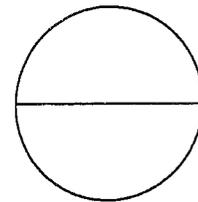
$$\frac{\pi}{4} = \frac{3.14}{4} = .785$$

EX. Find the AREA

note: you will always have square inches, feet, etc. in your answer to an Area problem.



radius = 2 ft



diameter = 4 ft

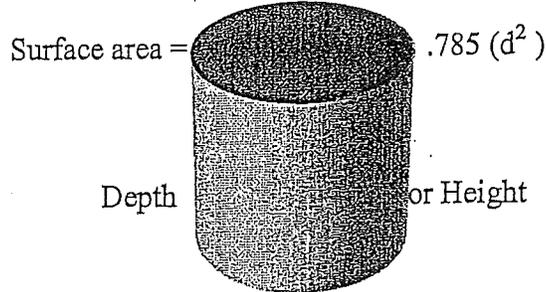
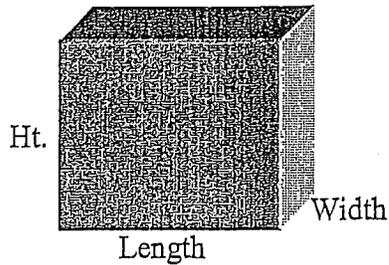
$$2\text{ft} \times 3\text{ft} = 6\text{ft}^2$$

$$3.14 \times 2\text{ft} \times 2\text{ft} = 12.56\text{ft}^2$$

$$.785 \times 4\text{ft} \times 4\text{ft} = 12.56\text{ft}^2$$

The VOLUME of a *CIRCULAR, SQUARE, or RECTANGULAR TANK* is equal to the AREA times the DEPTH or HEIGHT

FORMULA
 $V = A \times H$



Note: You will always have cubic inches, feet, etc. in a volume problem.

EXAMPLES.

Find the volume in ft³ of a container 3 ft high by 3 ft wide by 3 ft long.

$$3\text{ ft} \times 3\text{ ft} \times 3\text{ ft} = 27\text{ ft}^3$$

Find the volume in ft³ of a container that is 2 ft in diameter and 3 ft deep.

$$.785 \times 2\text{ ft} \times 2\text{ ft} \times 3\text{ ft} = 9.42\text{ ft}^3$$

CONVERTING VOLUME to GALLONS

We know that each cubic foot of volume in a tank or basin will hold 7.48 gallons of liquid. We know they are equal. 1 cu.ft. = 7.48 gal. This is a *CONVERSION FACTOR*. Conversion factors are used because they don't change the equation's value, only the units expressed.

$$\frac{1\text{ cu.ft.}}{7.48\text{ gal}} \quad \text{or} \quad \frac{7.48\text{ gal}}{1\text{ cu.ft.}} \quad \text{expressed as fractions, both are equal to 1}$$

The VOLUME in GALLONS is equal to the volume in cu.ft. of a tank, basin, pipeline, etc. times 7.48

FORMULA
 $y\text{ cu. ft.} \times \frac{7.48\text{ gal}}{1\text{ cu.ft.}} = z\text{ gal}$

Or ...VOL in ft³ x 7.48 = GAL

EX. How many gallons are contained in a tank which is 2 ft in diameter and 3 ft deep?

$$.785 \times 2\text{ft} \times 2\text{ft} \times 3\text{ft} = 9.42 \text{ ft}^3 \times \frac{7.48 \text{ gal}}{1 \text{ ft}^3} = 70.5 \text{ gallons}$$

COMMON CONVERSION FACTORS USED IN WATER TREATMENT

We often need to convert hours to minutes, days to minutes, million gallons to gallons, liters to gallons, pounds to gallons, pounds to grams, psi to ft of head, grains per gallon to mg/L, ppm to ppb, and the list goes on depending upon what we are asked to find. Some of the conversions unique to water math are due to the need to convert from the English System (pounds, for example) to the Metric System (grams or milligrams, for example) and vice versa. Conversion factors allow us to take information we know, or can measure, and turn it into different or more useful units of measure.

Convert:

$$\text{Days to minutes} \quad 1 \text{ day} \times \frac{24 \text{ hours}}{1 \text{ day}} \times \frac{60 \text{ minutes}}{1 \text{ hour}} = 1440 \text{ minutes}$$

$$\text{Million gallons to gallons} \quad 1 \text{ MG} \times \frac{1,000,000 \text{ gal}}{1 \text{ MG}} = 1,000,000 \text{ gallons}$$

$$1.5 \text{ MGD to gpm} \quad \frac{1.5 \text{ MG}}{\text{Day}} \times \frac{1 \text{ day}}{1440 \text{ min}} \times \frac{1,000,000 \text{ gal}}{1 \text{ MG}} = \frac{1041.7 \text{ gal}}{\text{minute}} \text{ or } 1042 \text{ gpm}$$

Many operators will use conversion factors that have been reduced to a single number from a more complicated calculation, and some conversion factor tables use that format. Most operators find that with time and frequent use they usually know which factor to use, and whether the operation calls for multiplication or division. The following are some of the frequently used equivalents.

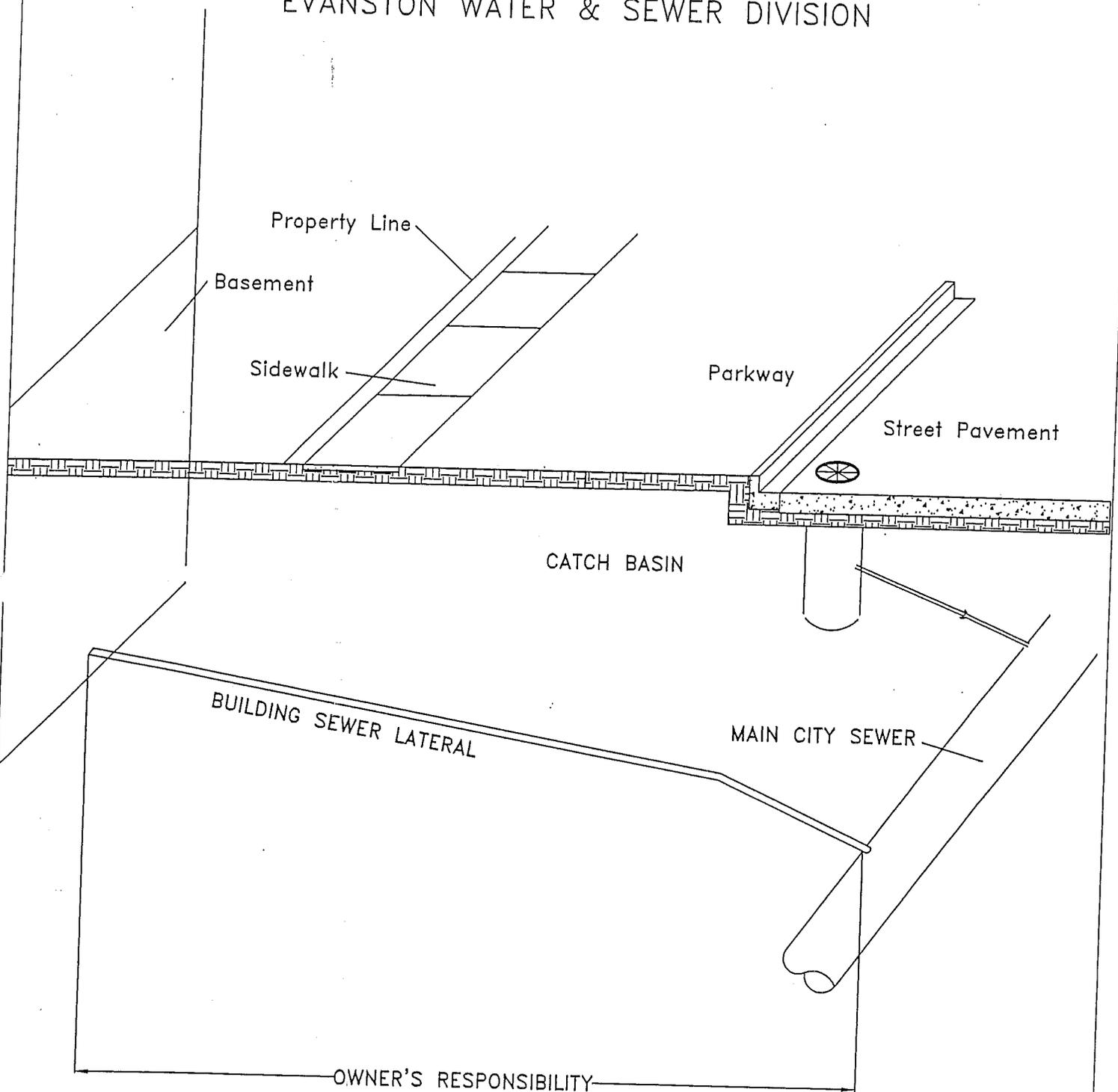
1 ft³ = 7.48 gal
1 gal = 8.34 lb
1 gal = 3.785 L
1 lb = 454 grams

1 mg/L = 8.34 lb/MG
1 mg/L = 1 ppm
1 ug/L = 1 ppb
1 ppm = 1000 ppb
1% = 10,000 mg/L

1L = 1000 ml
1 psi = 2.31 ft of water
1 in Hg = 1.13 ft of water
1 day = 1440 min

SEWER LATERAL DETAIL

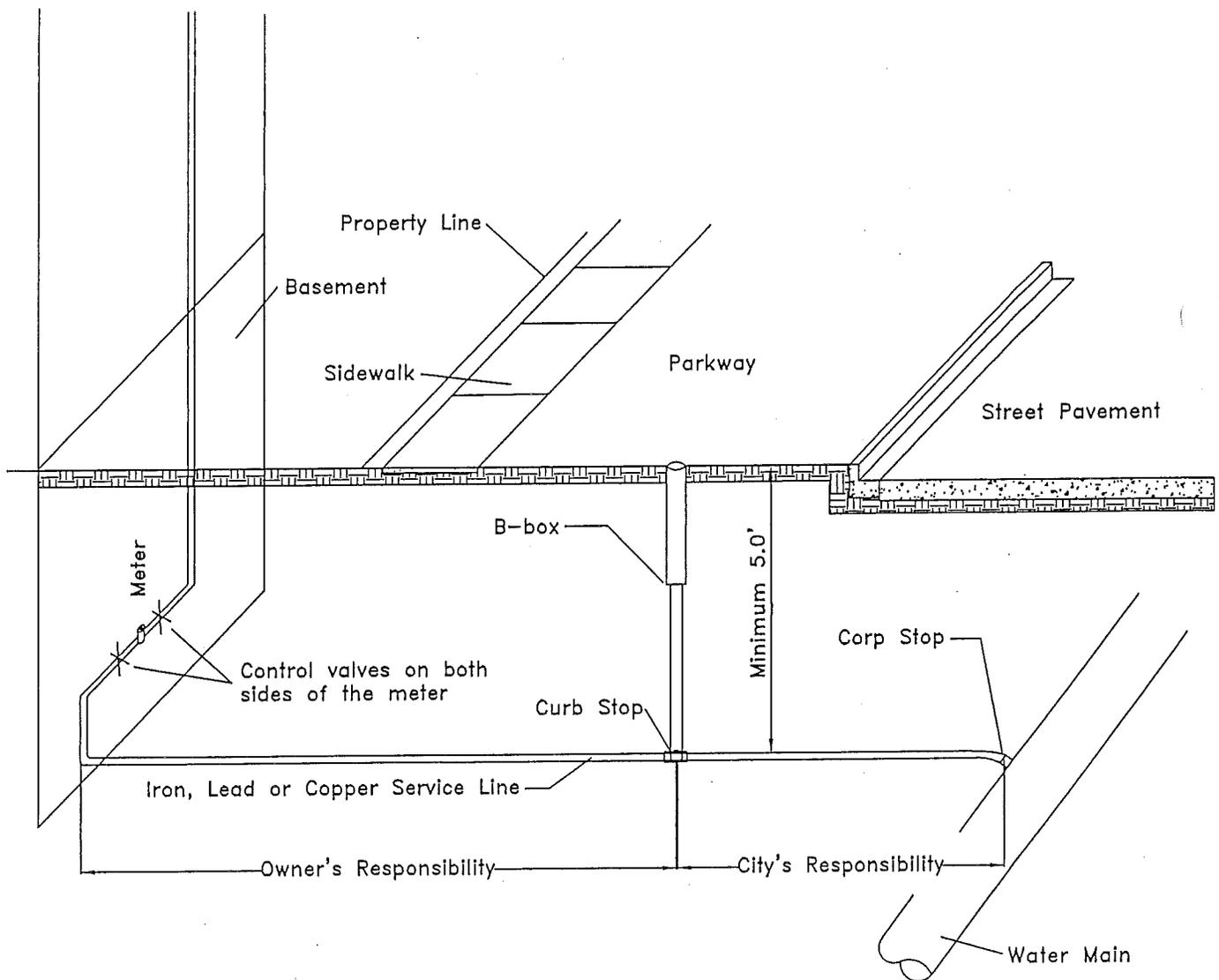
EVANSTON WATER & SEWER DIVISION



OWNER'S RESPONSIBILITY: COMPRISES THE ENTIRE BUILDING SEWER SERVICE INCLUDING THE TAP ON THE MAIN CITY SEWER

WATER SERVICE DETAIL FOR CONNECTIONS 2" AND SMALLER EVANSTON WATER & SEWER DIVISION

Meter shall be installed no more than 5 feet from where the service line enters the building



* Iron and lead are no longer allowed on new work