LYNN REGIONALWATER PULLITON FACILITY
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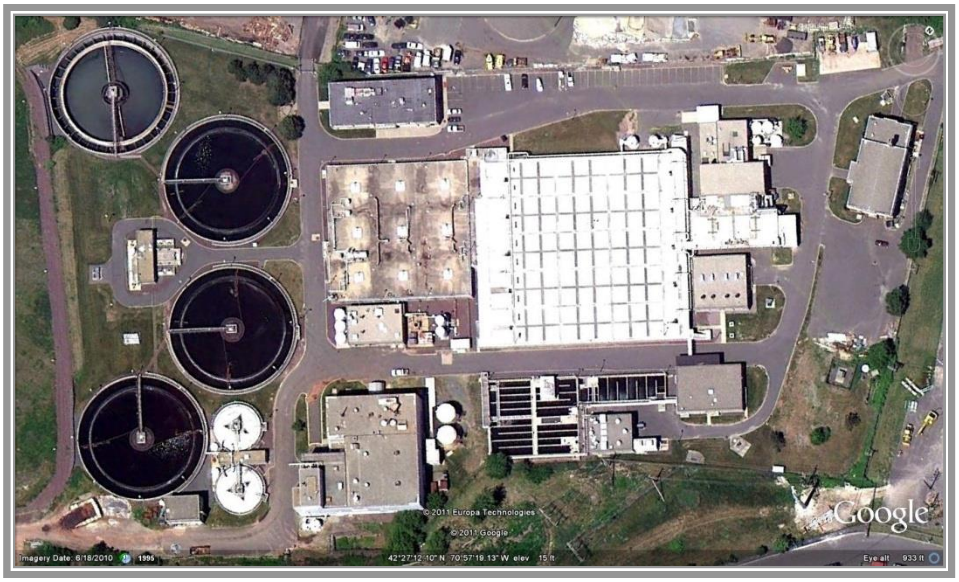


HISTORY
The Lynn Water and Sewer Commission (LWSC) was created in 1982 by the City of Lynn in conjunction with the Commonwealth of Massachusetts. Through its Regional Water Pollution Control Facility, the Commission provides wastewater treatment services for Lynn, Saugus, Swampscott and Nahant.

The LWSC began building its 65 million dollar Primary Wastewater Treatment Facility in 1980 and became operational in 1985. The 53.8 million dollar Secondary Treatment expansion became operational September 1990. The LWSC entered into a long term (20-year) contract with Veolia Water North America for the operations and maintenance of its Wastewater Treatment facility in 2001.

PROCESS and OPERATIONS
The Lynn WWTP is a primary and secondary treatment plant. The purpose of the primary treatment is to remove Settleable and floatable material (sludge, grease, etc.). The secondary treatment is directed related toward the removal of biodegradable organic and suspended solids. Under normal operating conditions the facility removes a minimum of eighty-five percent (85%) of the Influent total suspended solids and eighty five percent (85%) of BOD5. The plant has been designed to process flows averaging 25.8 million gallons per day during dry weather periods. During wet weather conditions, the plant can process flows in excess of 110.8 million gallons per day.

The Lynn WWTP receives flows from four communities; the City of Lynn, and the Towns of Saugus, Nahant and Swampscott. Saugus, Swampscott and Nahant deliver flow to the facility via three force mains; two 30 inch and an 18 inch, respectively. The Lynn flow goes through preliminary treatment through barsceens and afterwards is then combined with the other communities where is passes through aerated grit chambers. Primary clarifiers then remove settleable pollutants. Non-settlable pollutants pass to secondary treatment where microorganisms help to remove these non settleable pollutants. Chlorine is used to disinfect the treated water before it is discharged out into the outer harbor. The solids or sludge produced by the removal of pollutants through primary and secondary treatment, go through a solids dewatering process and are either incinerated on site, removed to a remote location for either composting, land application, incineration or placed in a landfill.

PRELIMINARY TREATMENT
Preliminary treatment of wastewater is a process by which sticks, bottles, cans, stone, grit, rags and other large objects are remove to protect the equipment in the plant from physical damage. The Lynn flow enters the facility via a 72 inch gravity interceptor where it is received at the Lynn Influent Pumping Station and Screening Room. Activated carbon odor control units scrub (remove) odors out of the buildings air before it is discharged to the atmosphere.

The next process is for the flow to go through mechanical bar screens. These bar screens are composed of vertical bars that wastewater can pass through, yet large pieces of material (bottles, cans, rags, sticks) in the waste stream can not pass through. The materials are caught by the bars, then removed from the screen by a mechanical rake, compacted to remove excess water and removed from the site for ultimate disposal.

The screened Lynn wastewater is combined with the Nahant, Saugus and Swampscott flows just prior to the grit removal system. Grit is sand and small hard inorganic material that, much like sand paper will wear down expensive equipment if not removed in the beginning of the plant. Grit removal is the next process for which all four combined flows receive treatment.

There are four aerated grit chambers in which a mild aeration process freshens and keeps light organic solids suspended in the wastewater while allowing the heavier inorganic solids to settle to the bottom of the tank and be collected by the screws and pimped through cyclone units which removes these inorganic solids from the waste stream. Once removed, these solids are washed, collected and discharged into containers. Grit is transported in these containers to an onsite landfill, where the grit is deposited and covered.

AERATED GRIT CHAMBERS
The aerated grit chambers are designed to remove heavy inorganic materials like sand, stones, and gravel that are very abrasive and will wear out equipment. These inorganic materials also cannot be fed on by the biological treatment process that occurs in this plant. These chambers are tanks with a sloped bottom down to a trough with conveyer (screw conveyer) in the bottom. Materials settle to the bottom of the tank, roll down its' sloped sides and collect in the trough. The screw conveyer in the trough carriers these to pumps for disposal in the permitted on-site landfill.

Air is bubbled through diffusers (diffuseres act like air stones in a fish tank) into the wastewater in the tank. The air has several beneficial effects on the treatment of the wastewater. First it lessens the density of the wastewater (the mixture of wastewater and air is actually lighter than just wastewater alone) causing heavy materials to sink quickly to the bottom.

PRE TREATMENT
Secondly, the air stirs up the wastewater making it *very* turbulent and keeping lighter materials suspended in the water to be treated later. These lighter materials are usually soft and organic (organic materials in general are like food and fecal materials that bacteria and microorganisms can feed on). These materials do not have the abrasive qualities of grit and will not wear out equipment quickly. Last, the air adds oxygen to the wastewater and it freshens the wastewater.

Wastewater may spend enough time in the pipes coming to the plant that bacteria in the pipes have used up all the oxygen in the wastewater. This lack of oxygen is called an anaerobic (without oxygen) condition which cause many of the odors associated with wastewater. Although some odors may be driven out of the wastewater by this process it prevents the increase of these odors to an unbearable level.

PRIMARY CLARIFIERS

The wastewater flows from the preliminary treatment grit chambers to the primary treatment process which removes Settleable and floatable materials from the wastewater. This occurs in the primary clarifiers which provide a quiescent zone for the sludge to settle and be collected into hoppers by a traveling flight and chain system. Primary sludge is pumped out of the clarifier and on to the Solids Handling process.

The primary clarifiers are large rectangular tanks that are so big that the wastewater stream slows down to a rate that many of the materials in the waste stream settle to the bottom. A mechanical scraper (flight), scrapes the settled material on the bottom of the clarifier into troughs on one end where it is pumped out of the primary clarifier to a gravity thickener (to be discussed later). Floating material such as oil and grease are also scraped off the top of the clarifier into a trough and sent to a concentrator.
The treatment process up to this point is called primary treatment. This removes about 45 -50 % of the pollutants.

The aeration reactors are sealed rectangular tanks with three inter connected compartments. wastewater, oxygen (85-98% pure oxygen) and microorganisms (bacteria, fungus, rotifers) are sent into the tank. Each compartment has a mixer to keep the wastewater well mixed and in contact with the oxygen on top of the wastewater. With plenty of oxygen in the wastewater the microorganisms feed rapidly on the organic pollutants in the wastewater. After passing through the aeration reactors the wastewater goes to the secondary clarifiers.

SECONDARY TREATMENT

Pollutants dissolved in the wastewater or that would not settle in the primary clarifiers flow on in the wastewater to the Secondary treatment process. Secondary treatment further reduces organic matter (BOD5) through the addition of oxygen to the wastewater which provides an aerobic environment for microorganisms to biologically break down this remaining organic matter. This process increases the percent removals of BOD and TSS to a minimum of 85 percent to meet the standards required in the NPDES discharge permit.

The secondary treatment facilities are comprised of Oxygenation Tanks, Pure Oxygen Generating Plant, Liquid Oxygen Storage Tanks, Secondary Clarifiers, Return Sludge Pumping Station and Splitter Box, Sludge Thickeners, Pumping Station, Sludge and the Dewatering Building Addition.

The Pure Oxygen Generation System incorporates a pressure swing adsorption (PSA) system oxygen generating system. PSA system is capable of providing 27 tons per day of pure oxygen to the oxygenation system. As a backup to the oxygen generating system, there are two liquid oxygen storage tanks capable of holding 18,000 gallons of liquid oxygen.

The oxygenation system is comprised of three covered oxygenation tanks, mechanical mixing system, and pressure-controlled oxygen feed and oxygen purity-controlled venting system. The primary effluent enters the head end of the tanks where it mixes with return activated sludge which consists of microorganisms "activated" by the organic matter and oxygen. This combination of primary effluent and return sludge forms a mixture known as "Mixed Liquor". This mixed liquor is continuously and thoroughly mixed by the mechanical mixer in each tank. The oxygen gas produced in the PSA system is introduced into the first stage of each tank and then remains in contact with the mixed liquor throughout the oxygenation system.

Once the mixed liquor goes through the complete oxygenation process, it flows to four secondary clarifiers where the biological solids produced during the oxygenation process are allowed to settle and be pumped back to the head of the system. These settled solids being pumped, called return activated sludge, mix with the primary effluent to become mixed liquor. Since the population of microorganisms is growing some microorganisms in the return activated sludge are removed from the system. This solids waste stream is called waste activated sludge and flows to the secondary gravity thickener for Solids Processing. The cleaned wastewater flows over the weir of the secondary clarifier and on to the disinfection (chlorination) process.

The activated sludge process is an aerobic, suspended growth, biological treatment method. It employs the metabolic reactions of microorganisms to produce a high quality effluent by oxidation and conversion of organics to carbon dioxide, water and biosolids (sludge).

Basically the system speeds up nature and supplies oxygen so the aquatic environment will not have to. High concentrations of microorganisms (compared to a natural aquatic environment) in the activated sludge use the pollutants in the primary treated wastewater as food and remove the dissolved and nonsettleable pollutants from the wastewater. These pollutants are incorporated into the microorganisms bodies and will then settle in the secondary clarifiers. Oxygen needs to be supplied for the microorganisms to survive and consume the pollutants.

SECONDARY CLARIFIERS

The secondary clarifiers are large circular
tanks (4 of them) that slow the wastewater stream to allow the well fed microorganisms to settle to the bottom, leaving a clear liquid on top which overflows the tank into a trough and is sent to the chlorine contact tanks for disinfection. The microorganisms that settle are sucked off the bottom by draft tubes (draft tubes vacuum the bottom of the clarifier like a vacuum cleaner). A portion of the microorganisms are sent back to the aeration reactors to feed again on the incoming wastewater the extras are sent to the gravity thickeners.

CHLORINE CONTACT CHAMBERS

The clear water from the secondary clarifiers goes to the chlorine contact chamber. Chlorine is injected into the water at the beginning of this long tank. The tank is long to give the chlorine enough time to disinfect the water from harmful bacteria. This chlorine is then removed and the resulting effluent is discharged into the ocean. This discharged water is actually cleaner than the ocean water itself.

GRAVITY THICKENERS

The gravity thickeners take the waste materials collected in the primary and secondary clarifiers and hold them long enough to help them settle to a thicker sludge mixture. This thicker mixture has a polymer (a charged molecule that helps remove water) added to it as it goes to two high speed centrifuges for further de-watering. These centrifuges remove additional water and the remaining sludge (at 45%) is either burned in the onsite incinerator, processed at another facility or sent to a permitted landfill.

SOLIDS RESIDUAL HANDLING

Dewatering (the removal of water from sludge) is a very important process. The more water one removes from sludge the less it costs to burn in an incinerator. In incineration, wet sludges reduce capacity, decrease incinerator "bed" temperature and increase fuel costs.

Gravity thickeners are the first and least expensive method of dewatering sludge. Gravity thickeners hold sludge and allow the sludge to settle down to the bottom and thicken by gravity. Primary clarifier sludge is sent to one thickener and secondary clarifier sludge is sent to the other gravity thickener. Primary sludge mixed only with effluent water for conditioning naturally settles easily in one of the two gravity thickeners. A polymer is added to the secondary sludge before it enters the other gravity thickener to aid in settling. This is because secondary sludge is mostly microorganisms and does not settle easily.

The primary and secondary sludge are combined immediately before the gravity thickeners. Potassium Permanganate is occasionally added to the conditioned sludge for odor control. The sludge mixture is mixed with a polymer into one of two centrifuges to remove more water. The remaining product is a sludge cake which is approximately twenty to thirty percent (20-30%) solids.

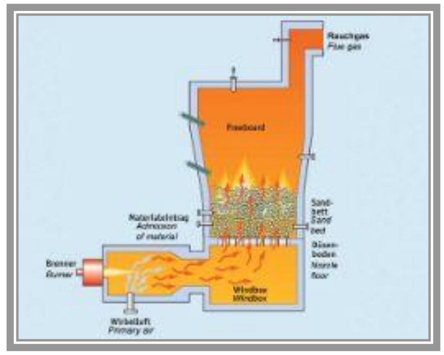
The next step in the dewatering process is to squeeze the water out of the sludge with diaphragm filter presses. The thickened sludge from the gravity thickeners are blended together then mixed with a polymer to help coagulate particles together which aids in the dewatering process. This mixture is feed into the centrifuges. The dry sludge "sludge cake" then fall down into a bin where it is pumped with cement type pumps "schwing pumps" to the incinerator.

The separation of a liquid-solids slurry during centrifugal process is similar to the separating process in a gravity thickener. In a centrifuge, however, the applied force is centrifugal rather than gravitational and is usually 500 to 3000 times the force of gravity. Separation is achieved as the result of the applied centrifugal force causing the suspended solids particles to migrate through the suspending liquid, toward or away from the axis of rotation of the centrifuge depending on the difference in densities between the liquid and solids phases. The increased settling velocity imparted by the centrifuge force, as well as the short settling distance, of the particles, are affected by a number of process variables.

The process variables that affect the centrifuge includes; feed rate, rotational speed of the centrifuge, depth of the settling zone (pool depth), chemical used (polymers) and the physiochemical properties of the suspended solids and suspending liquid (such as particle size and shape, particle density, temperature, and liquid viscosity). The operator must be aware of these variables to optimize the centrifuge performance.

INCINERATION

The cake residue from the centrifuge process is then incinerated. The Lynn incineration system is comprised a Von Roll fluidized bed incinerator which burn the sludge at approximately 1400 degrees Fahrenheit. The remaining ash is hauled to the on-site landfill for disposal. A fluidized bed incinerator has sand heated to about 1500 F by oil or gas. The sand is blown around "fluidized" in the incinerator by a hot air blower "fluidizing blower" blowing from the bottom upwards.



As the sludge enters the incinerator the heated fluidized sand hits the sludge both breaking it apart like a sand blaster and burning it. The gas and ash from the burning process are carried out the top of the incinerator and through a heat exchanger, which preheats the ambient air up to 800 F before it enters the windbox. The exhaust gas then passes through an economizer heat exchanger that recovers more heat, and supplies the solids building with hot water for the boiler and heats the entire solids building in the winter months.

About 99.9 percent of the resulting ash is then removed in the venturi gas scrubber. The gas stream then flows through a wet electrostatic precipitator (ESP). This device first pH adjusts the gas stream to remove sulfur dioxide. Then the gas passes by high voltage electrical coils which charge any particles of ash still in the gas stream and then removes those particles with an oppositely charged plate much like a magnet. The gas exiting the stack into the air has some water vapor with almost no particulate.

The incinerators are permitted by the states Department of Environmental Protection (DEP). There is a continuous emissions monitoring system (CEM) on each incinerator measuring Sulfur Dioxide Oxides of nitrogen, and Carbon Monoxide. The information from these delicate and sensitive instruments are then collected by a data logger and sent to a computer located in the incinerator control room. These results are then compiled for quarterly and semi-annual reports for both DEP and EPA. The incinerator operators use this information to operate the incinerators within the guidelines of the DEP permit as well as achieve the optimum efficiency and performance without excess emissions.

CHLORINE

The effluent from the secondary treatment process is discharged into the chlorine contact basins. At the beginning of these chambers, chlorine is ejected. The purpose of chlorination during this time is to kill pathogenic bacteria (disease carrying) microorganisms that may be present. Excess chlorine is removed with the chemical addition of sodium metabisulfite. This is to protect sensitive aquatic organisms in the Lynn Harbor and the surrounding ocean.

Flow is discharged to the ocean through two outfalls; the Outer Harbor discharge line is capable of allowing 73.3 million gallons per day of treated wastewater to be discharged. Any effluent flows that are greater than 73.3 MGD are discharged to the Lynn Inner Harbor discharge line.

BIOCHEMICAL OXYGEN DEMAND

Biochemical oxygen demand (B.O.D.) is the rate at which microorganisms and chemicals use oxygen in water or wastewater while stabilizing decomposable materials. This is a means of expressing the strength of organic material in wastewater. In domestic wastewater systems, microorganisms use up about 0.2 pounds of oxygen per day per person using the system (as measured by the standard five day BOD test). Since BOD is costly to treat, often population equivalents are used to help determine how much and industry or town must pay to have their wastewater treated. This is a fairer way to determine actual cost to dispose of wastewater than just the number of gallons discharged into the sewer.

As shown above distilled water has no B.O.D. because there are no decomposable materials in it. A biological oxygen demand is created by the decomposition of sugar, in the sugar water solution, by bacteria (in doing so the bacteria respire "breath" and use oxygen).A chemical oxygen demand is created in the container with water and iron by the oxidation "rusting" of the iron which uses oxygen.

The biochemical oxygen demand in wastewater may be composed of both biological and chemical oxygen demands. At first glance it would seem that sending nutrients B.O.D. into a stream should increase the food supply for the microorganisms, plants and fish. This is true to some extent, but there is not enough dissolved oxygen in the stream and the plants may grow at .:: rate that will fill in the"stream nr pond. Most fish can thrive in water containing 5 mg/l oxygen and other favorable conditions.

When B.O.D. (oxidizable material) are discharged into a stream, bacteria begin to feed on the waste, break down complex substances into simple compounds. The aerobic bacteria (bacteria that "breath" by using dissolved oxygen in the water)use the dissolved oxygen in the stream until the food supply runs out or the oxygen supply runs out. Thus the more B.O.D. discharged into a stream the more oxygen bacteria use to break it down and the less oxygen available for other aquatic organisms like fish. If the oxygen gets too low the fish in the stream die.

AWARDS and RECONIGZATIONS

George W. Burke Safety Award
The Lynn Regional Wastewater Treatment Plant was selected by the Water Environment Federation for the George W. Burke safety award. This award was established in 1982 in honor of George W. Burke, Jr. for his numerous years of work in the water environment field. Receipt of the award encourages installation and maintenance of active and effective safety programs in municipal and industrial wastewater facilities.

The Lynn Water and Sewer Commission' Wastewater Treatment Plant is operated by Veolia Water. This award recognizes Veolia's impressive safety initiative that has resulted in no lost-time accidents over the past 6-years. Veolia management said, "*our efforts in Lynn are continually being recognized by regulatory agencies as well as our peers - setting higher standards in the water industry*."

PLANT PERFORMANCE AWARDS
The Lynn Regional Wastewater Treatment Facility (WWTF) continually seeks to excel in water pollution control. Over the years this facility has experienced many significant capital improvements and operational strategies that have proven to be successful.

Similar to the Lynn Water Treatment Plant, one method the WWTF utilizes towards gauging its success is in applying for awards amongst its peers. Throughout the years the WWTF has also been fortunate to be recognized with individual achievements associated with its safety, laboratory performance, maintenance and its plant housekeeping efforts.

The Lynn facility earned the Massachusetts Water Pollution Control Association 2009 and 2011 Best Performing Large Waste Water Plant with a design flow more than 10 million gallons per day. This is a performance based award. The plant's operational criteria for 2008 and 2010 was evaluated against other large Wastewater Treatment Plants throughout Massachusetts.

OTHER ACHIEVEMENTS
Awarded the 2011 Massachusetts Energy Improvement Award for Energy Improvements made during the past 10 years. Through many energy incentives the Lynn Facility has reduced its electrical cost in excess of 3 million dollars.

The facility is also in the process of installing a 600KY Wind Turbine with anticipated construction to be completed in September of 2012.

Passed all EPA and DEP announced, and unannounced, inspections and audits during the past 10 years. These inspections are conducted on a regular basis several times a year, separately, by both agencies.

Successfully passed an OSHA Audit / Inspection in 2010

CONTACTS:
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Robert Tina, Director of Operations | Lynn Water and Sewer Commission | 781-592-7048 x 113

DIRECTIONS

The Regional Water Pollution Control Facility is located at 2 Circle Avenue in Lynn, MA 01905-3037.

Rt. 129 to Lynn, Continue on rt. 129 until you come to Boston Street, take a right onto Boston Street, you will go by Dunkin Donuts, Stop and Shop.

Take a left onto Park Street, continue across Western Ave. and take a right at the end.

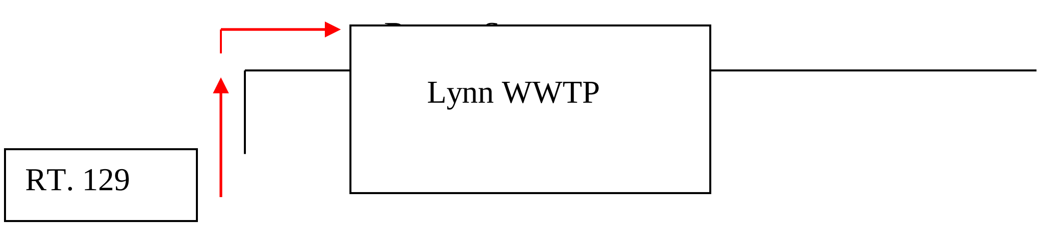
You will now be going along the Lynn Commons, take the first left, as if you would be going back along the other side of the common.

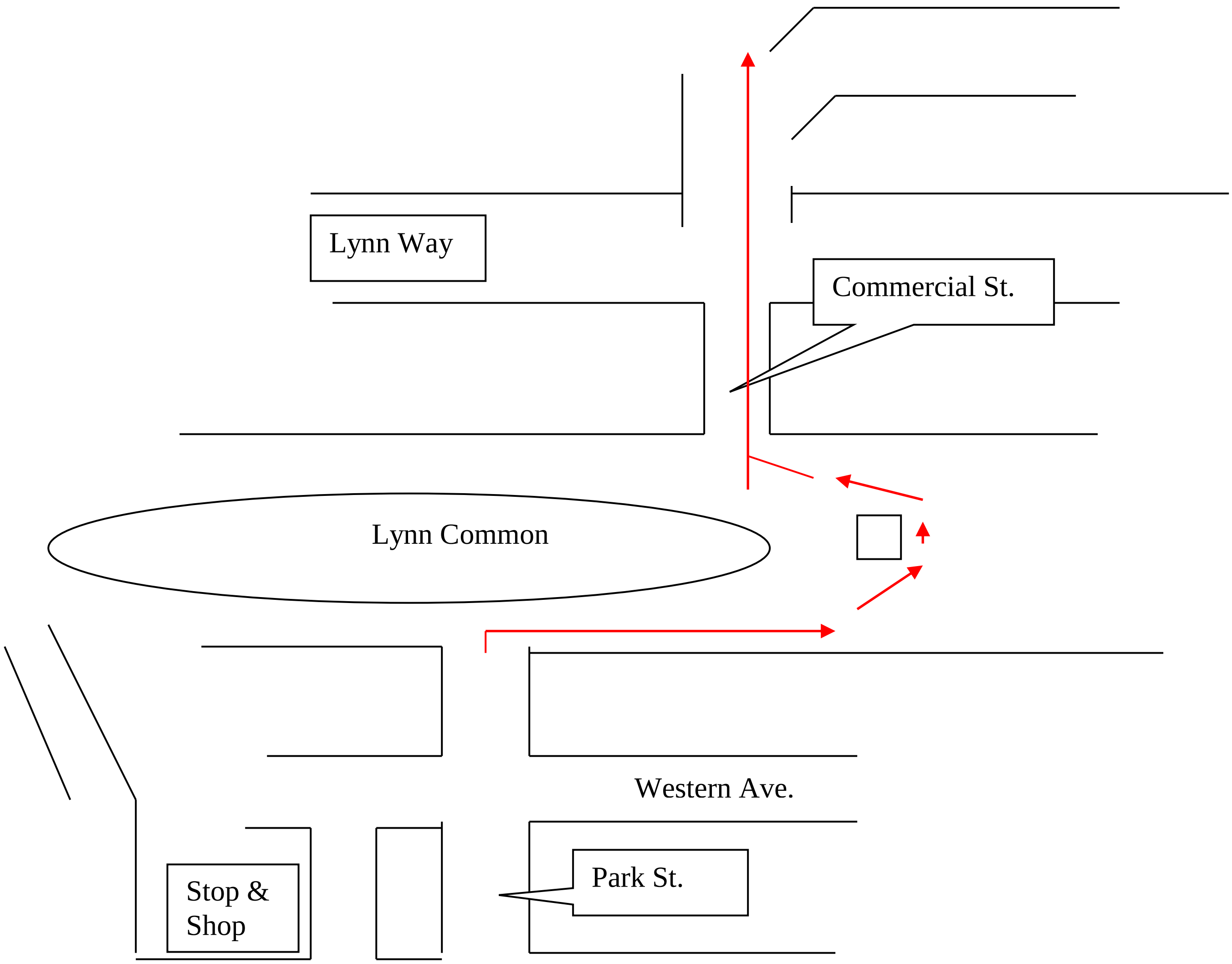
Almost immediately after taking the above left take a right onto Commercial Street.

Continue on Commercial Street going across the Lynnway.

Continue going straight after you have crossed the Lynnway.

The WWTP is straight in front of you do not follow the road to the right.





Lynn Way
Commercial St.
Lynn Common
Western Ave.
Park St.
Stop &
Shop