Karna Dahal

Analysis of the quality of wastewater from the service stations located in the operative area of Helsinki Region Environmental Services Authority

Helsinki Metropolia University of Applied Sciences
Bachelor of Engineering
Environmental Engineering
Thesis
10 January 2012

Author(s) Title Number of Pages Date	Karna Dahal Analysis of quality of wastewater from the service stations located in the operative area of Helsinki Region Environmental Services Authority 51 pages + 26 appendices 10 January 2012
Degree	Bachelor of Engineering
Degree Programme	Environmental Engineering
Specialisation option	Renewable Energy
Instructor(s)	Lindedahl Kaj, Senior Lecturer (Metropolia UAS) Lindberg Heli, Control Engineer (HSY) Helin Marja-Leena, Control Engineer (HSY) Paananen-Porkka Minna, Senior Lecturer (Metropolia UAS)

The objective of this thesis was to analyse the data of pollutant parameters for waste water from the service stations situated in the operative area of the Viikinmäki and Suomenoja WWTPs in the Helsinki Region Environmental Services Authority (HSY). The main reason for this analysis was that HSY wanted to know about the quality of waste water discharged from the service stations into the influent of its WWTPs.

The number of cars used in Finland is increasing day by day; hence, automatic car wash services as well as car washes by hand at home are likely to increase in the same proportion. Automatic car wash services in Finland are often located at service stations. Car wash operation does not need an environmental permit, but the wastewater produced from car washes needs to be treated before sending it to the municipal sewer network to protect the treatment equipments in the municipal WWTPs. The Viikinmäki and Suomenoja WWTPs are two WWTPs in Helsinki Region Environmental Services –Authority (HSY). The Viikinmäki WWTP treats about 270 000 cubic meters of daily flow of wastewater and the Suomenoja WWTP treats about 100 000 cubic meters of daily flow of wastewater.

The sources of pollutants in the wastewater of service stations are dirt from the surfaces of vehicles, from the different parts of vehicles and washing equipment, from yards of the service stations, and used chemicals from car washes and cleaning washing lines and oil spillages. There are various types of chemicals from different manufacturers used for car washes in Finland. The excessive amount of pollutants in wash water damages the sewer system, impairs the wastewater treatment processes and worsens the quality of waste water. The car wash must be equipped with sand separators, oil separators, and a combined sampling shaft and closing valve well. The design of the sewer network in the service stations also affects the treatment system in the service stations.

The analyses of data are solely based on the comparison between and within the old data from 2006 to 2010 and the new data obtained in 2011. The pollutant parameters that were analysed are pH, conductivity, suspended solids, BOD_7, COD_{Cr}, total phosphorus, total nitrogen, heavy metals and total hydrocarbon (THC). The main target of the project was to analyse THC. The comparison of old and new data reveals that most of the service stations treat their wastewater properly and effectively, abiding by the rules of the HSY, however, there is always a need for an improvement in the quality.

Keywords	WWTPs, car washes, wastewater, pollutant parameters, wash chemicals, oil separators, sand separators, data analysis

Acknowledgement

This thesis is the last academic assignment of my environmental engineering in the Helsinki Metropolia University of Applied Sciences and a small project of the Helsinki Region Environmental Services Authority (HSY). This thesis would not have been possible without the guidance, instructions, and encouragement of several people who were involved directly and indirectly in this thesis project. I would like to show my deepest gratitude to all of them.

First, I heartily thank my academic supervisor, Senior lecturer Kaj Lindedahl and company supervisors Er. Heli Lindberg and Er. Marja-Leena Helin who instructed and guided me with their tremendous ideas and knowledge to carry out my thesis project. I sincerely thank Dr. Minna Paananen-Porkka, the English language supervisor from the university who offered me guidance in language use and citation styles. It would not have been possible to successfully conduct the thesis project without their help. My great thanks go to Dr. Esa Toukoniitty, Head of Environmental Engineering Degree Program, who created a favorable working environment for this thesis project and the whole study period in Metropolia. I am also thankful to Metropolia laboratory Engineer Marja-Leena Äkerman who helped me by providing written material for this thesis. I would like to thank to Chemist Timo Lukkarinen and his colleageus in Metropoli laboratory, who had instructed me in the analyses procedures. Similarly, it is my pleasure to thank to all the laboratory chemists and assistants in the Suomenoja wastewater laboratory who analysed the samples for this thesis work and guided me in my work in the laboratory. I must thank to Lecturer Riikka Hiidenkari who helped me in the technical part of this thesis paper. I am indebted to many of my colleagues from HSY and the Helsinki Metropolia University of Applied Sciences for their support during this thesis project.

I am so grateful to my father Mr. Yadu Prasad Dahal, who persistently inspired and encouraged me to study hard and do something in my life. I owe my deepest gratitude to Dr. Ismo Halonen, former Head of Degree Program in Environmental Engineering who encouraged me to cross out every difficult situation during my study period in Metropolia. Lastly, I offer my regards and respect to all of those who supported me in any context during the completion of the project.

Karna Dahal, Helsinki, Finland.

Contents

Appendices

Appendix 2. Email conversation between HSY and Metropoli lab for the analysis of Total Hydrocarbon

Appendix 3. Both the old and new data of the service stations D, H, E, M, K and G for comparison and analyses

Appendix 4. The new data consisting of the laboratory results for all the service stations

Appendix 5. The whole data record from 2005 to 2011 for all the service stations including other service stations in the operative area of HSY

Appendix 6. Emission limits for sewer water in the operative area of Viikinmäki and Suomenoja wastewater treatment Plants

Appendix 7. Harmful and hazardous substances specified in the different environmental legislations (VVY Industrial Wastewater Guide Book 2011)

1 Introduction

Wastewater is one of the major environmental problems arising in many densely populated and industrial areas of the world. Wastewater is mainly generated by landfill sites, households, drainage systems, hospitals, offices, industries, surface run-off and service stations. Lack of proper manipulation of wastewater creates many environmental pollutions such as ground water contamination, soil and air pollution. Groundwater contamination is a big threat in the many areas of the world because it contaminates clean water, which is one of the finite resources and used for drinking, among other things. According to water.org (n.d), 884 million people lack access to safe water supplies, 3.575 million people die each year of water-related diseases; less than 1% of the world's fresh water (or about 0.007% of all water on earth) is readily accessible for direct human use, and more than 80% of sewage in developing countries is discharged untreated, polluting rivers, lakes and coastal areas. One source of wastewater is car washes in the service stations. In the industrialized countries, many people use cars daily for transportation and commuting. As population is growing rapidly, the use of vehicles and the amount of wastewater produced by car washes are increasing respectively. For example, the number of cars used in Finland is increasing day by day; hence automatic car wash services as well as car wash by hand at home are likely to increase in the same proportion. According to the traffic safety agency Trafin (2011), Finland had 2 486 283 cars, 289 824 vans, 94 334 lorries and 11 610 buses till the end of 2010 and the figures are expected to increase by 2.9 million by 2030 if the increment is expected to remain the same as it was in 2006 (Hakala, 2011).

The aim of this thesis was to analyse the data of pollutant parameters for waste water from the service stations situated in the operative area of the Viikinmäki and Suomenoja wastewater treatment plants (WWTPs) in Helsinki Region Environmental Services Authority (HSY). Every year the HSY examines almost all the wastewater pollutant parameters in the laboratories and analyse the obtained data in detail. The inaccessible amount of oil in the wastewater damages the sewer properties as well as harms the treatment processes in the wastewater treatment plant. It usually harms the biological treatment of the treatment plant. The quantity of THC needs to be minimized for the better treatment processes of wastewater. Another objective of this thesis project was to analyze the other pollutant parameters such as pH, suspended solids,

BOD_7, $COD_{Cr,}$ heavy metals and THC. In addition, old recorded data from 2006 to 2010 was compared with the new analysed data in 2011 so that improvement of the quality of wastewater in the service stations during this 6 years period could be visualized. To sum up, the main reason for research and analysis in this thesis work was that HSY wanted to know about the quality of wastewater discharged from the service stations.

All the information and material required in the thesis project were received from control engineers Marja-Leena Helin and Heli Lindberg on behalf of HSY. Similarly, Kaj Lindedahl, the supervisor from the university, provided theoretical and technical guidance and instruction during the project, and Dr Minna Paananen-Porkka, the English language supervisor from the university, offered guidance in language use and citation styles. To perform the recent laboratory tests on the service stations' wastewater, samples were collected from 13 service stations of Espoo and Helsinki and tested in the HSY's wastewater laboratory in Suomenoja and Metropoli lab in Helsinki. All the parameters, except for THC, were examined in Suomenoja laboratory; but THC was tested in Metropoli lab due to the availability of proper test instruments. The data obtained from recent lab examinations were analysed and compared with the previous data from the HSY WWTPs. Sampling places for previous data are not necessarily the same as new data except for service station E. These values were also compared with the limit values of emission pollutants from different EU countries and some non-EU countries as well.

2 Legislation for Car Wash

According to section 1 of the Finnish environmental regulation (Environmental protection act 169/2000), car wash operation does not need an environmental permit. If the car washes are not connected to a public sewer system, the wastewater is treated according to the law regarding ground water, river-bed or the pool; thus, it does not present a risk to the environment (Environmental Protection Act 86/2000, 103§). If the car washes are connected to the water supply plant's sewer system, wastewater generated during car washes must not contain harmful substances, which damage wastewater treatment plant operations.

Government decree on liquid fuel distribution stations (Environmental protection act 444/2010) explains the treatment of oily wastewater in the liquid fuel filling stations containing fuel tank capacity of at least 10 m^3. The decree states that if the automatic washing line is located in the hall and the wash water is discharged into the public or municipal sewer network, it must be dealt with the EN class II oil separators, and when the discharged wastewater is led to natural receptors, waterways, it must be dealt with EN class I oil separators. In the out-going wastewater from EN class II oil separators, the concentration of hydrocarbon should not be exceeded 100 mg/l, and in the case of class I oil separators, it should not be exceeded 5 mg/l. Car washing operations must be done according to the standards mentioned in paragraph 12 and separators must be equipped with the colored shut-off valve (Petrol filling station standards, SFS 3352). Some decisions of government for the management of waste oil have been explained in 101/1997 of the Environmental regulations. Similarly, selection of grease and oil separators and design criteria for different functions of separators are mentioned in the Finnish Building Code D1, 2007.

3 Viikinmäki and Suomenoja Wastewater Treatment Plant Process Description

This chapter will describe the background to the wastewater treatment processes in both the wastewater treatment plants (WWTPs) of Helsinki Region Environmental Services Authority (HSY) i.e. Viikinmäki and Suomenoja wastewater treatment plants. It is very important to understand the wastewater treatment process to understand the quality and analysis of quality of wastewater generated from any sources. This chapter will also present the differences in the treatment processes between the Viikinmäki and Suomenoja WWTPs. The chapter, which follows, will present the theoretical framework for the study.

The Viikinmäki and Suomenoja wastewater treatment plants (WWTPs) are two wastewater treatment plants in Helsinki Metropolitan area and are owned by the Helsinki Region Environmental Services Authority (HSY, 2011). The Viikinmäki WWTP is the largest treatment plant in Finland as well as in the Nordic countries; its operational process is located in a rock tunnel. The Viikinmäki wastewater treatment plant treats 270 000 cubic meters of daily flow or 100 million cubic meters of yearly flow of wastewater collected from 800 000 inhabitants of Helsinki, Eastern and Central part of Vantaa, Kerava, Tuusula, Järvenpää and Sipoo (HSY, 2011). Similarly, the Suomenoja wastewater treatment plant is the second largest treatment plant in Finland, which serves almost 310 000 inhabitants of Espoo, Western part of Vantaa, Kaunianen and Kirkkonummi. The Suomenoja wastewater treatment plant treats 35 million cubic meters per year and an average daily flow of about 100 000 cubic meters (HSY, 2011).

The pollutant parameters, such as chemical oxygen demand, the biological oxygen demand, phosphorus, nitrogen, suspended solids, total solids and metals must be limited for the proper treatment in the wastewater treatment plants (WWTPs). Typical amounts of pollutant parameters in municipal wastewater are listed in Table 1 below:

Table 1: Typical Amounts of Pollutants Parameters in Wastewater (Lindedahl, 2011)

Compound	Common values (g/person/day)	Average value in HSY (mg/l)
Chemical oxygen demand	120-180	480 – 530
Biochemical oxygen demand	60-90	260
Phosphorus (P)	2.0-3.5	9
Nitrogen	10-14	60
Suspended solids (SS)	70-90	350
Total solids (TS)	150-250	-

The removal efficiency of wastewater treatment plant for these compounds is dependent on the techniques used in the treatment process. It is also dependent on the quality of industrial wastewater discharging into the treatment plant and the design of treatment process.

3.1 Main processes in the Viikinmäki wastewater treatment plant

Viikinmäki wastewater treatment plant has been operating as an activated sludge plant. The wastewater treatment system in Viikinmäki WWTP consists of three stages; mechanical, biological treatment combined with chemical treatment and biological secondary filtration process. Wastewater treatment unit operations in Viikinmäki WWTP are: input pumping, screens, sand and grease removal, pre-aeration, sedimentation, aeration, digestion, a secondary settlement, biological filtration and removal pumping (see Figure 1). The following paragraphs will also briefly describe treatment processes in the Suomenoja WWTP together with the description of treatment process in Viikinmäki WWTP.

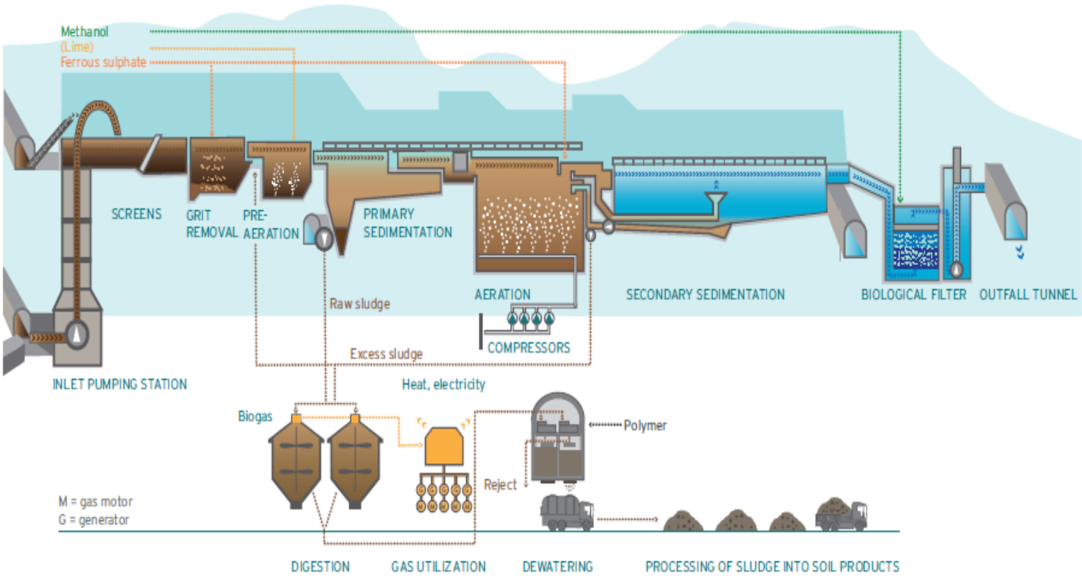

Figure 1: Wastewater treatment process at the Viikinmäki wastewater treatment plant (Sopiva Design)

Mechanical treatment: The collected wastewater in the Viikinmäki WWTP enters into the treatment process through the rock tunnel. There are several pumps at the beginning of the process, which pump the wastewater to the screening unit. The coarse solid materials (bigger than 10 mm) are separated by the automatic screens and then wastewater enters into the grit removal chamber. The velocity of the incoming wastewater in this stage is adjusted to allow the settlement of sand, grits, stones, broken glasses and other tiny solid materials. An adequate amount of ferrous sulphate is fed into the tank to remove phosphorus from the wastewater. Then, water is sent to the pre-aeration tank where the oxygen content and coagulation capacity of wastewater is increased. The pre-aeration process helps suspended solids to sink in the pre-sedimentation basins and also to reduce the odor of wastewater. Then, water enters into the primary sedimentation tank where heavy suspended solids are settled down. The collected sludge is sent to digesters for digestion.

Chemical treatment: The main chemical treatment occurs in the aeration tank where sludge is constantly mixed and aerated by compressors located at the bottom of the tank. The wastewater is mixed with the sludge culture in which organic compounds are used for the growth of microorganisms and for respiration, which results mostly in the formation of carbon dioxide and water (Lindberg, 2011). The biological removal of the nutrients nitrogen and phosphorus occurs in this stage. The ferrous sulphate is dosed to remove the phosphorus and lime is dosed to reduce acidity of water. About 80 % of ferrous sulphate is dosed into the grit removal chamber and about 20 % of ferrous sulphate is dosed in the aeration stage (Lindberg, 2011). The sludge is collected at the bottom of the clarifier and then recycled to the aeration tank to consume more organic material.

One purpose of the chemical treatment process is to remove phosphorus from the wastewater. Phosphorus in the wastewater is obtained from sanitary and washing chemicals. During chemical treatment washing soaps and detergents from car wash are treated. In the chemical treatment phase, phosphorus contained in the water is efficiently precipitated with Iron salt, and it is bound to the sludge as (so called) bio-phosphorus. Approximately 95 % of the phosphorus is treated in Viikinmäki WWTP annually (Cleaners wastewater, Helsinki water).

Biological treatment: The Biological treatment of wastewater mainly occurs in the secondary sedimentation tank where the secondary sludge produced is settled down. Most of the sludge here is organic matter washed from biofilter. One part of the settled sludge is sent back to the biological stage to grow micro-organisms and another part is pumped to the sludge treatment process. In this phase, approximately 80 % of BOD is reduced and most of the suspended solids are also removed.

In both the Viikinmäki and Suomenoja WWTPs, the biological treatment process is based on an activated sludge process, in which microbes feeding on organic matters form a growing biomass. This biomass sinks to the bottom of the sedimentation tanks.

In the Viikinmäki WWTP, ferrous sulfate is used as a coagulant in both the mechanical and biological treatment processes to remove phosphorus and in the Suomenoja WWTP ferrous sulphate is used only in mechanical process.

Biological treatment comprises two stages in the Viikinmäki wastewater treatment plant: The first stage consists of biological treatment combined with chemical treatment, and the second stage is biological post filtration (see the previous paragraph). The main objective of the biological treatment is to treat nitrogenous waste materials in the wastewater. Wastewater containing microbes are utilized to dissolve the organic matters in the water. The actual biological treatment is conducted in an aeration tank where activated sludge is growing due to the organic growth of microorganisms. There is a separate mixing area at the inlet of the aeration tank where raw wastewater entering into the tank is re-seeded with the return activated sludge from secondary sedimentation tank and from the outlet of aeration tank. In the secondary sedimentation tank, organic matter and nutrient rich biomass, i.e. activated sludge, is separated from the wastewater by means of settling. Nitrification process occurs in the aeration tank and nitrogen gas is produced. The nitrates contained in wastewater are removed by conversion of NO_3 to N_2 gas by bacterial metabolism. In order for de-nitrification to occur, methanol dose into the process is required. The pH and temperature has to be maintained. The nitrogen contained in water is released into the air as nitrogen gas which is naturally abundant in the atmosphere. Some of the nitrogen is bound to the sludge as bio-nitrogen.

In the nitrification de-nitrification process, ammonium nitrogen is first oxidized to nitrites by nitrosomonas bacteria and then to nitrogen nitrates by nitrobactors and finally reduced in anoxic zones to nitrogen gas (see previous paragraph also):

$$NH_4^+ \xrightarrow{O_2} NO_2^- \xrightarrow{O_2} NO_3^- \xrightarrow{BOD} N_2 \text{ (gas)} \qquad (1)$$

The nitrogen, which is in gaseous form is removed from wastewater and transferred to the air. In the first nitrification part, autotrophic microorganisms oxidize ammonia nitrogen to nitrate with the consumption of dissolved oxygen (Lindedahl, K., 2011):

$$2NH_4^+ + 3O_2 \xrightarrow{\text{Nitrosomonas}} 2NO_2^- + 2H_2O + 4H^+ \quad (2)$$

$$2NO_2^- + O_2 \xrightarrow{\text{Nitrobactor}} 2NO_3^- \quad (3)$$

Then in the de-nitrification part, nitrate is reduced to nitrogen gas in anoxic tanks, where heterotrophic microorganisms deliver oxygen from combined oxygen sources, such as nitrate, due to a lack of elemental oxygen (Lindedahl, K., 2011):

$$2NO_3^- + 2H^+ \longrightarrow N_2\ (\text{gas}) + H_2O + 2.5O_2 \quad (4)$$

In the Suomenoja WWTP, nitrogen removal is based on the de-nitrification process where the pre-clarified wastewater, internally circulated sludge and return sludge are first sent to the de-nitrification part of biological treatment process. In the nitrification part, autotrophic microorganisms oxidize ammonia nitrogen to nitrate with consumption of dissolved oxygen (DO), and in the de-nitrification part, denitrifying bacteria reduce nitrate to nitrogen gas in the anoxic conditions and sufficiently high carbon to nitrogen ratio ($BOD_{7\ ATU}/N_{TOT} > 3$) of the pre-clarified wastewater. About 10 – 50 g/m^3 methanol (CH_4OH) is used as an external carbon source in the de-nitrification part. Similarly, about 20 – 50 g/m^3 Soda (Na_2CO_3) is used to increase the alkalinity in the nitrification part (Espoo water, 2003).

Further removal of nitrogen in Viikinmäki WWTP is performed by a biofilter in the post biological treatment stage of the process where growing microorganisms become attached to the surface of the wastewater and form a biological layer or fixed film. Organic matter in the wastewater diffuses into the film, which helps to grow the microorganisms. The thickness of the biofilm increases as new organisms grow. The layer of biofilm is separated from the liquid in a secondary clarifier and discharged to sludge processing. All treated wastewater from Viikinmäki WWTP is led to the open sea through a submarine rock tunnel. The discharge point is about 8 kilometers offshore.

3.2 Sludge treatment

All the collected raw sludge from the primary sedimentation and secondary sedimentation are pumped to digestion. The digestion is done at a temperature of 36-37 ^{0} C in Viikinmäki WWTP (HSY, 2011). The digested sludge is exploited and dewatered in a centrifuge to make it dry. The sludge digestion process takes about three weeks. Digestion in Viikinmäki and Suomenoja WWTP is done by anaerobic process where methane gas is generated. The biogas produced is used for carbon neutral electricity and heat for the plant's own purposes. The dewatered sludge produced consists of small amounts of suspended solids. The extracted and dried sludge from Viikinmäki WWTP is delivered to Metsäpirtti composting site and the dewatered sludge from Suomenoja WWTP is transported to the composting plant of Vapo Ltd at Numijärvi and a part of the composted sludge to the Ämmäsuo landfill sites (HSY, 2011; Espoo water, 2003). The area of Metsäpirtti composting site is 20 hectares (Lindberg, 2011).

In Viikinmäki WWTP, about 65 % of the gas produced in digestion is methane, while the rest is mainly carbon dioxide and in Suomenoja about 63 % of the gas produced is methane. The digester gas is burnt in the gas turbine generator unit to generate electricity and thermal energy for the treatment plant. Viikinmäki is about 50 % self- sufficient in electrical energy, and Suomenoja is about 40 % self – sufficient in electrical energy. The reduction efficiency is about 95 % for phosphorus and organic matter and for over 80 % for nitrogen in Viikinmäki WWTP (Espoo water, 2003; HSY, 2011).

4 Determination of pollutants (chemicals) in car wash wastewater and the effects of these chemicals on the wastewater treatment plant process

This chapter will outline the determination of chemical pollutants in car wash wastewater and the effects of those chemicals on the Viikinmäki and Suomenoja wastewater treatment processes. The chemicals found in car wash wastewater are responsible factors for damaging the treatment processes and equipment in any wastewater treatment plants. Determining the concentrations of such chemicals in the wastewater is very important to know the quality of wastewater which is transported to the municipal wastewater treatment plants for further treatment. A picture of car washing line will be presented just to show how a car is washed with the chemicals in the car washing lines.

Figure 2: Car washing machine (Oil Federation 1994, p.14)

There are 900 automatic car wash centers in Finland where 10 million cars are washed annually. It is assumed that 25 % of the washings are performed in automatic wash lines in Finland and that brushless wash lines account for a similar proportion of the washings (BAT - car washing facilities, 2007, 13). Most common types of chemicals used for car wash and in service stations are described below. Approximately 150 m^3/year wash chemicals are used in Espoo (Helin, 2011). There are 80 automatic washes centers in the operative areas of the HSY which consume huge amount of chemicals and produces various types of pollutants (Helin, 2011)

4.1 Pollutants (chemicals) in wastewater from service stations and car wash

The most common sources of car wash pollutants are road mud (e.g. asphalt and salt), cold degreasing agents, micro-emulsions and alkaline water, soluble degreasing agents (e.g. oils and tensides), car shampoos and foam products, waxes, rim cleaners, acid cleaners, hall cleaners and flocculants (e.g., aluminum salts, orthophosphates and polymers). Usually, oils and tensides are released from detergents, metals, the vehicle and the different equipment in the washing line, polycyclic aromatic hydrocarbons (PAHs) from tires and plasticizer diethyl hexyl phthalate and underbody coatings from jointing compounds (BAT –Car washing facilities. 2007). The other wastes, which can enter into the service stations wastewater and to the WWTPS via sewer network, are waste from sand and oil separators, tank and separators cleaning wastes, fluids from radiators, brakes, and clutches, and, fluids and precipitates from washer parts and washing and maintenance chemicals (Lindberg, 2011).

The contents and functioning of the products used for car washes can be summarized as follows:

Cold-degreasing agents are solvent types in nature and contain mainly hydrocarbons and 2- 4 % tensides. The petroleum based cold degreasing agents used in car wash centers consist of normal paraffins (C_{10}-C_{13}) and are naptha free of or low in aromatic hydrocarbons (BAT, Car washing facilities, 2007).

Micro-emulsions refer to the homogeneous combination of water, surfactants and oily phase. The content of washing hydrocarbon solvents and the amount of chemical needed for washing can be significantly reduced by using micro-emulsions. These are formed by a distribution of the very small oil droplets, which are surrounded by a curtain consisting of surfactants. The cleaning performance of micro-emulsions is better than that of a lower solvent concentration. The contact area between the oil and water is much larger than with traditional petroleum hydro-carbon solvents. Micro-emulsions are water based and they are diluted with water before use. The composition consists of 10-20 % of hydrocarbon solvent, 20-30 % surfactants, 50-70 % water and other complex agents and alcohol. Micro-emulsions are usually sensitive to temperature variation. They will break if the temperature in the bounds goes above or below the normal temperature. (The oil industry federation, 1994, p. 21-24)

Alkaline degreasing agents consist of an aqueous solution of alkali such as sodium meta-silicate, potassium or sodium hydroxide and a small amount of tensides. The ready for use degreasing agents have a pH value about 12 (BAT, Car washing facilities, 2007).

Shampoo; Foam shampoos and brush shampoos are used in automatic car wash centers. Foam shampoo is used in summer time, and it is alkaline in nature. Air is applied to create foam during washing. It mostly contains water, tensides and other components such as alkali and complex agents. Brush shampoo is used in brush washing machines, and it also helps to clean the brushes. It contains water, tensides and other components such as solvents (e.g. alcohols) and complex agents. Wax shampoos are another type of shampoos with emulsified waxes (BAT, Car washing facilities, 2007).

Rinsing and waxes: Softeners (dry waxes) are surface active substances which increase the surface tension of water, improve rinse accumulation and drying process of water run-off. Typically, rinsing and warm waxes consist of surfactants, waxes and various alcohols. Polishing waxes contain usually natural carnauba wax and catchment substances. Rinsing agents are sprayed on the car surface at the last rinse cycle. Rinsing agent can also be used for so-called warm wax which acts as flushing material as well as a protective film on the surface of the car. (The oil industry federation, 1994, p. 21-24)

In the winter time, salts and studs cause release of particles from the road surface and tires of the cars. The load on the water treatment plants increases considerably due to the utilization of larger amounts of chemicals and more potent chemicals for car wash. More degreasing agents are needed in severe mud conditions. The degreasing agents may vary from alkaline products in less severe circumstances to micro-emulsions or petroleum- based degreasing agents under more severe conditions. Degreasing agents are not so much needed in the summer time washing, and the products are often diluted with a larger volume of water or only alkaline detergents and shampoos are used. Table 2 below exemplifies the use of chemicals at an automatic wash line with a portal washing machine for cars in the summer and in the winter. The use of products varies depending on the choice of the washing program and the type of degreasing agent used. There may be differences in recommended quantities and dilution ratios between different suppliers of washing machines and chemicals.

Table 2. Use of chemicals at an automatic car wash line with Portal Washing Machine in the summer and in the winter (BAT, Car washing facilities, 2007)

Product	Summer	Winter
Alkaline Degreasing Agent	1,5-1,8 liters/wash, of a 4% solution ready for use	1,5 -2,5 l/wash of a 10 – 20 % solution ready for use
Micro-emulsion	-	1,5- 2 l/wash of a 10-20 % solution ready for use
Cold degreasing, petroleum based	-	0,3-1 l/wash
Foam shampoo	1-3 cl/wash	1-3 cl/wash
Brush shampoo	3-5 cl/wash	5-8 cl/wash
Wax	2-4 cl/wash	2-4 cl/wash
Run-off/rinsing agent	2-4 cl/wash	2-4 cl/wash

Washing bigger vehicles consume more detergents. Automatic washing lines for lorries and buses may consume about 15 liters/vehicle of ready-for-use solutions of either alkaline detergents or micro-emulsions (vehicles 12 m long). Examples of concentrations of active substances in ready-for-use solutions are 4 – 10 % for alkaline detergents and 10 – 20 % for micro-emulsions. An additional degreasing agent is often applied manually with a hand sprayer to certain parts of the vehicle to get it completely clean, especially in winter. When washing a lorry, 10 or more liters/vehicle of a detergent (e.g. a 20 % solution of a micro- emulsion) is consumed. Cold- degreasing agents are also used with lorries. (BAT, Car washing facilities, 2007)

Flocculants: Various types of process chemicals, for example precipitants or flocculants and pH- adjusting agents are used for chemical treatment of wastewater from vehicle washes. Poly aluminum chloride and orthophosphate are examples of precipitants and flocculants. The pH-value is often adjusted with caustic soda or lime. But in Finland, all the service stations use sand and oil separators for the treatment of wastewater and do not need of process chemicals. Therefore, flocculants do not need in Finnish service stations (Helin, 2011).

Washing place-cleaning agents: As a rule, same chemicals are used for cleaning the washing hall and washing machines for the cleaning process. Concentration of the chemical solutions used for cleaning the hall is much higher than that of the solutions used for cleaning the car washing machines. Using the same cleaning chemicals for washing the wash hall and washing machines makes easier for availability. This ensures the best performance of oil separators. The best result of cleaning the wash halls is achieved by using prewash chemicals. (The oil industry federation, 1994, p. 21-24)

Other cleaners and germicides: Degreasing agents and other cleaners are used to keep the wash halls clean. They may be petroleum based or of an alkaline type. Acid cleansing substances are also used to remove deposits of lime. Germicides or agents against odors may be used in wash halls with water recycling. The most frequently used are hydrogen peroxide, UV irradiation or ozone.

The solvent type detergents are more efficient cleaners, above all against stains of asphalt. Other types of mud are just as efficiently removed by the alkaline water based detergents. From an environmental point of view, the alkaline water type detergents are preferable. The totally closed systems use solvent based degreasing (low in aromatic hydrocarbons). This is acceptable, since the washing liquid does not enter the wastewater and since employees carrying out manual high pressure washing are required to wear protective clothing against the aerosol mist in the washing hall. (BAT – Car washing facilities, 2007).

There are a large number of car wash chemical manufacturers in Finland which manufacture, pack and deliver the products to the car wash centers and petrol stations. The authorities approve, update from time to time and old and harmful ones are banned. The laws for approving washing chemicals and detergents came into effect in 1993 (The oil industry federation, 1994).

Detergents approval: Combination of chemicals used for vehicle washing must be approved according to the SFS 3352 standard. The oil industry federation approves and registers the combination of vehicle washing chemicals. The oil federation has published a guide book on the cleaning chemical products for washing the vehicles such as pre wash detergents, solvents, shampoo, detergent foams, rinsing agents, and waxes. If the combinations of detergents are already approved to replace or remove one or more previous chemicals, the change notification must be given to the oil industry federation. Similarly, if one or more detergents need to be added to the combination of detergents and changes in the content of hydrocarbon oil in detergent combination are necessary, a new application must be submitted to the central oil industry federation. (The oil industry federation, 1994, p. 21-24)

4.2 Chemicals used in the specified service stations

It is not possible to describe all the chemicals used in all the service stations located in the operative area of HSY because of the availability of information of the chemical contents in the products and different manufacturers in Finland, but it is, however, possible to list the car wash chemicals used in the Service Station A which is located in the operative area of the HSY WWTPs. The Service Station A has been using chemicals produced by Mac Rolls/Prowash Oy; these chemicals are also used by some other service stations in the Helsinki Metropolitan area. Appendix 1 lists the chemicals manufactured by Mac Rolls/Prowash Oy, and approved and updated by the authorities of the Helsinki Metropolitan area. Some of the car wash products of Mac Rolls for car wash are presented in more detail below:

McRolls Esipesuaine (McRolls Prewash) is designed to prewash the vehicles all year round. It can also be used as foam and tire cleaning agent as well as for removing car dirts. The features of this chemical consists of removing sandy dirt, brake dust, soot and dirt particles originated from stones. During the summer months, the concentration for the prewash solutions is less than 5 % and during the winter months 9 -20 %. Detergents must not be left to dry on washed surfaces. It contains sodium metasilicate of less than 1 % and C_9 –C_{11} alcohol ethoxylate. The risk phrases for this chemical are R34 (corrosive), R36 (eye irritating), R37 (irritating on respiratory systems) and R41 (serious damages to eyes). Safety phrases for the risks are S25 (avoid contact with eyes) and S26 (In case of contact with eyes, rinse immediately with plenty of water and seek medical help).

McRolls Vaahto (McRolls foam) is designed to foam the vehicles all year around. It removes sandy dirt, brake dust, soot and dirt particles originated from stones. The required concentration for summer use needed is 5 % and that for winter use is less than 5 %. The foam must not be left to dry on the washed surfaces. Different color foam products can be found in the market.

McRolls Micro emulsion (McRolls Micro emulsion) is designed for forming the vehicles all year around. The main feature of this chemical is that it eliminates the salt-borne dirt and rock dust. The required concentration for summer use is less than 5 % and that for winter use is less than 4 -30 %. Special attention must be paid when using this chemical so that detergent it is not allowed to dry on washed surfaces in a closed room at a temperature of 5 – 30 degrees.

4.3 Effects of pollutants (chemicals) on the treatment processes

An excessive amount of pollutants in wash water damages the sewer system, impairs the wastewater treatment process and worsens the quality of wastewater. Harmful chemicals corrode parts of the sewer system such as the pump, sewer pipes, and concretes, and ultimately cause their breakdown. Breakdown of the sewer system increases the operation and maintenance costs. High amount of chemicals in the wastewater also impairs the different treatment processes, such as the biological treatment process, which is affected due to the high chemical oxygen demand (COD). Stagnant water in the wells constructed in the service stations may produce unpleasant odors due to the formation of hydrogen sulfide from the used chemicals. Some other solvents such as PAHs may also give rise to odors. Lower molecular mass PAHs can be removed easily whereas higher molecular mass PAHs are resistant to the biological treatments and lower the quality of sludge (Organic pollutants (n.d.)).

The chemicals used in washing cars possess different toxic compounds which are harmful for the biological treatment of wastewater in the municipal WWTPs. For instance, cold degreasing agents have hydrocarbon chains of normal paraffins (C_{10}-C_{13}), naphtha, aromatic hydrocarbons and tensides. Micro-emulsions consist of petroleum hydrocarbons, and alkaline degreasing agents consist of sodium meta-silicate, potassium or sodium hydroxide and tensides. Waxes contain hydrocarbon chain of C_{24}-C_{34}; run-off/rinsing agents and shampoo consist of an aqueous solution of alkali salts, alcohols and tensides. Similarly, McRolls prewash contains C_{10} alcohol, fatty alcohol, ethoxylated sulfate, sodium salt and formic acids. Some of these chemical compounds are easily biodegradable, some are moderately biodegradable and some are less easily biodegradable compounds. The chlorides and petrochemicals are toxic to microorganisms at very high levels. The chloride part of the wash chemicals is also corrosive to both the micro-organisms in the wastewater treatment plants and the treatment equipment. Surfactants cause foaming decreases oxygen transfer efficiency. Alcohols, potassium or sodium hydroxides are easily biodegradable compounds while formic acids, naphtha and ethoxylated compounds are moderately biodegradable and tensides and some other aromatic compounds are less easily biodegradable (Daniel, 2009). Less easily and moderately easily biodegradable compounds are highly harmful for the biological wastewater treatment and also toxic to the microorganisms. They prevent the growth of micro-organisms and ultimately impair the biological treatment process. Some other chemicals such as heavy metals inhibit microbial activity at relatively low concentrations. Some of the heavy metals are also toxic for microbial growth. Similarly, fluoride has an inhibitory effect on the main microbial populations responsible for the removal of organic constituents and nutrients in the wastewater treatment process. It has also inhibits nitrification as nitrifying bacteria appear to adapt rapidly to fluoride.

5 Sewer network design in the service stations

This chapter will present the background information of sewer network design in the service stations. The design of sewer network affects the wastewater treatment system in the service stations. It also affects the soil quality in the service station. The piping connections and the placement of sand and oil separators in the sewer network play vital role on the leakage and collection of wastewater from various sources and also to the cleaning capacity of treatment equipments. This chapter will provide information regarding the design of sewer network in most of the service stations located in the operative area of HSY.

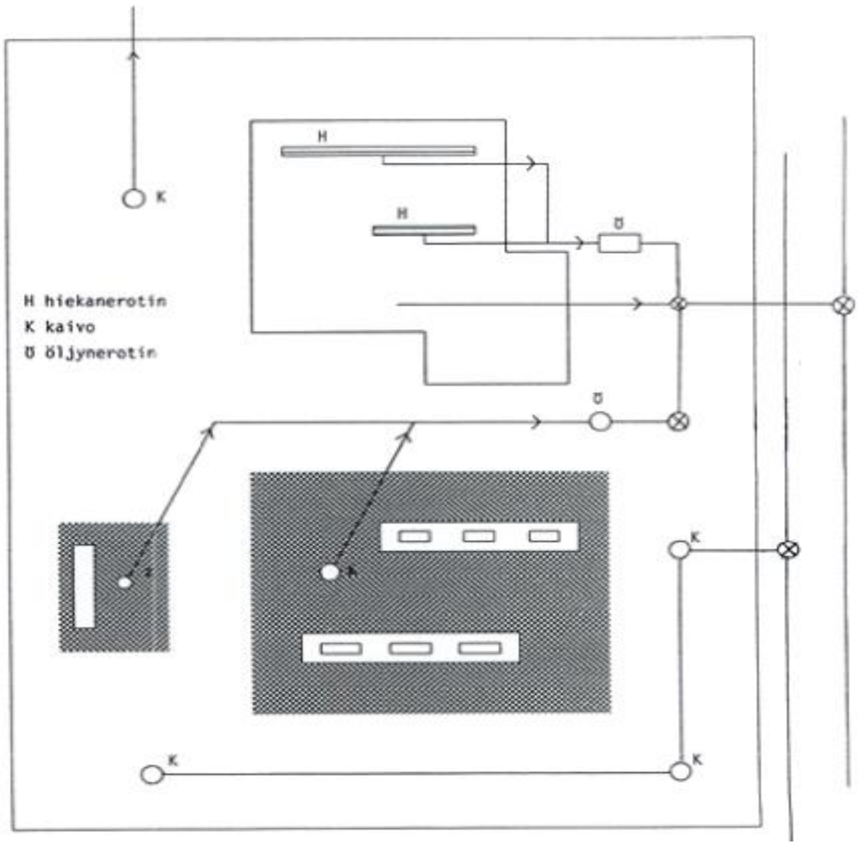

Figure 3: Service station sewer network (Finnish Building Code D1)

The sewer network in the service stations must be designed according to part D1 of the Finnish national building codes (Helin, 2011). The civil design of any service station sewer network is always dependent on location, geography of the location and accessibility of the public sewer collection if the treated water is to be sent for further treatment. A service station generates wastewater from various sources such as car wash line, petrol filling place, parking and surface run off from the service station area. Most of the service stations in Finland possess restaurants as well. Thus, wastewater generated at the restaurant can also be included as another source. However, the design is always made for the collection of wastewater from the various sources in the service station yard, for the arrangement of treatment systems and for the connection of service station sewer network to the public sewer network. It must be considered that the equipments, pipes and concretes selected for constructing the network must be corrosion proof and long-lasting. There are various types of treatment systems and alternative cleaning methods for the car wash wastewater. Therefore, the appropriate treatment system must be selected beforehand. If the water is sent to a public sewer network for further treatment, an advanced type of treatment system is not needed. The capacity of the manhole well and the storage container must be big enough to handle extreme flow levels caused by rainwater streams so that the contamination of underground soil due to the overflow of oily water from the well or the container can be prevented. Construction of wells in the different points of the service station yard makes it easier to collect the run-off water. The water treatment facility is mostly constructed near the car wash hall and sand filtration is put exactly under the washing place in the car wash hall but if there is not a suitable underground place for installing the treatment equipment just under the car wash drainage, it is possible to install them a bit away from that place, connecting them with a smooth straight pipe and pumping with a positive displacement pump. The construction design of a sewer network presented in Figure 3 is taken from one of the service stations located in the operative area of the HSY WWTPs. The design has one oil separator on the right bottom side of the parking place which is intended for cleaning of collected water from the parking place and the petrol filling station, and then the extension of sewer network after the oil separator has been connected to the municipal or public sewer network for further treatment of that water. Similarly two sand filtrations and after that one oil separator in the car wash place have been designed to treat the wastewater generated from the car wash. The treated water is then sent to the public or municipal sewer network. Four gutters in the service station yard have been designed so that run-off water can be sent to the public sewer network. The design also consists of a shaft valve. This is just a sample design of a sewer network in the service station but many other designs can be made to meet the requirements of the geography, the equipments and other conditions of the service stations.

6 Oil and sand separators used in service stations

The most common service station wastewater treatment technologies in Nordic countries are sand and oil separators either without substrate or with wash water recycling. Almost all the automatic car washes in Finland have installed sand and oil separators in their wastewater treatment systems.

6.1 Sand separators

Sewage sludge can be separated by sand filtration. The sand separator is usually placed in the sewage gutters or drain allowing sufficient height for the output water from the drainage channel of the car wash hall. The sand trapped from wash water improves the operation of the oil separator and reduces the running cost. The water to be treated flows into the sand separator, which separates sand, sludge and other types of heavy solid materials from the water. The solid free water flows from the sand and sludge separator into the oil separator. According to the EN 858 standard, a sand separator is always a part of the oil separator system (Wavin-Labko Oy, (n.d.)).The alarm system added in the sand separator controls the filling of sludge and sand storage space and indicates an alarm when the separator must be emptied. Usually 1/3 of the water capacity is filled with sand is any indication of emptying time. The timely emptying of the sand and sludge ensures the proper functioning of the oil separator. Many of the service stations located in the operative area of the HSY have used sand separators manufactured by Wavin-Labko Ltd. Wavin-Labko manufactures various sand separators, which can be used for car wash stations. Civil designs of sand separators used in one of the service stations located in the operative area of the HSY are presented in Figure 4:

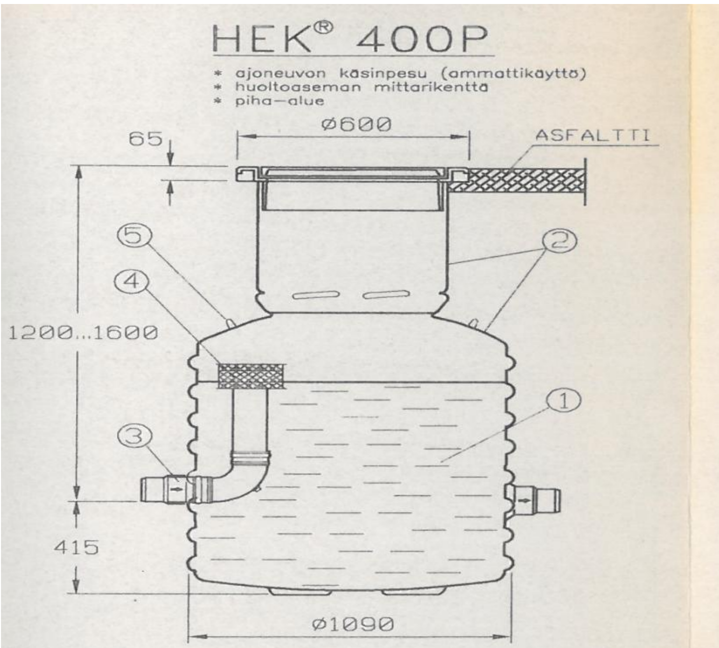

Figure 4: Sand Separator

1.Sludge space 2. PEM-frame 3. Drainage 4. Inlet sewer 5. Glosket

Both the sand separator shown in Figure 4 and the oil separator shown in Figure 5 have been manufactured by Waving-Labko and have passed the tests according to the EN standard defining the flow rate and purification efficiency. The mechanical ground pressure resistance of the maintenance shafts has also been ensured by tests according to the EN 1825 standards (SFS- EN 1825-1, 2004).

6.2 Oil separators

Oil separators are made for separating oils from washing wastewater. Various types of oil separators can be manufactured to treat the different amounts of mixed oils which have to be separated from wastewater. The amount of mixed oil is dependent on the sources of wastewater. The oil separators must fulfill the cleaning requirements described in the SFS-EN-858-1 standards (Wavin-Labko Oy (n.d.)). They must be designed and tested according to the Part D1 of the National Building Code of Finland (Wavin-Labko Oy (n.d.)). There are two types of oil separators; EN class I and EN class II oil separators and they are used in the different situations according to the legislations (see chapter 2). Most of the class II oil separators are based on gravitation and made of polyethylene or reinforced plastic (glass-fiber reinforced plastic, GRP). Usually these systems are corrosion-proof and better than oil separators made of concrete. They are equipped with a monitoring and alarm system. The alarm system is meant for the getting notification of the oil situation in the oil separators. The oil separator is normally designed to cope with a hydraulic load of 1 m/h (m^3/m^2 and hour) and residence time of one to two hours (BAT-Car washing facilities, 2007, p36). Sometimes the water is re-circulated after the discharge from the oil separator.

Performance of the oil separators depend on the inflow and outflow conditions. Small droplets of oil in the inflow require big separators and more time to coalesce. Emulsifying agents such as soaps and detergents in the wash water include small sizes of oil droplets. In order to prevent bigger droplets, gravity flow must be applied in the inlet piping, the inlet pipe must be sized for minimum pressure drops, i.e. it should be straight and there should be a minimum number of elbows, tees, valves and other fittings. Positive displacement pump must be used rather than a centrifugal pump to provide minimum disturbance of the fluid. The inlet piping must be manufactured from smooth PVC to avoid turbulence caused by pipe roughness. Downstream piping and other facilities must be adequately sized to process the quantity of water and oil from any likely event. Effluent piping must be designed with siphon breaks so that it is not possible to siphon oil and water out of the separator during low flow conditions (Mohr, n.d.). Oil must be removed from the separator on a regular basis. If not removed in a timely manner, this oil may fill the separator, blinding the media and causing high effluent oil contents.

Civil designs of Oil separators that are used in one of the service stations located in the operative area of the HSY are shown in Figure 5:

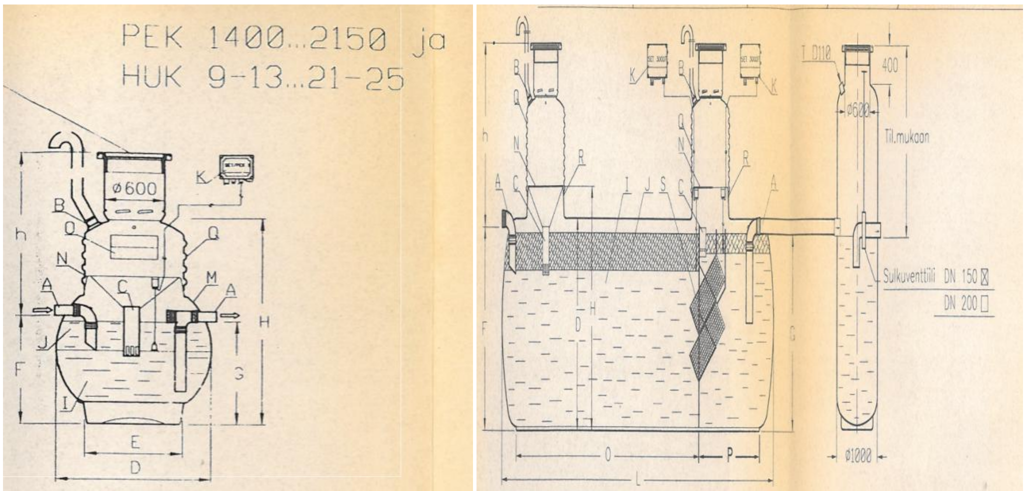

Figure 5: Oil separator 1 on the left and Oil separator 2 on the right

For Oil separator 2: A= inlet discharge, B= sewer vent, C= Fuel shell, D= Separator’s diameter, E= runner’s width, F= feet inlet, G=feet discharge, H=total height, I=water oil mixture volume, J=oil storage capacity, K=control sensor and junction box, L=total length, M=structure N= maintenance shaft mounting spigot, O=length of the nose, P=rear length, Q=grit separator connected to ground, S= sensor array, and R=Maintenance shaft seal

6.3 Arrangement of sand and oil separators in wastewater treatment systems at the service stations

The Figure 6 outlines the arrangement of wastewater treatment systems in the service stations. A service station is designed according to the basic infrastructure shown in Figure 6 but it can also be constructed by other alternatives and according to the need of quality of water to be treated.

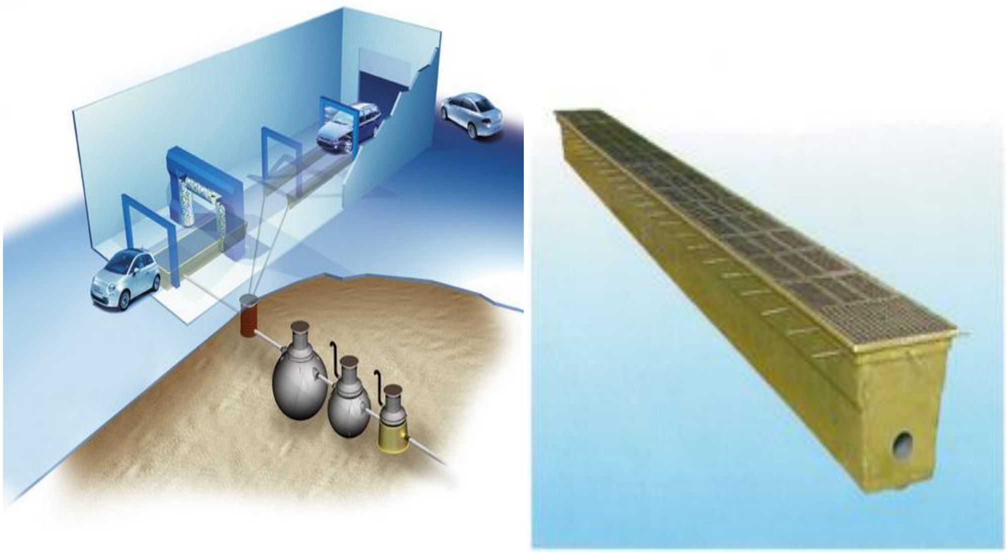

Figure 6: Treatment system in the car wash center and silt trap drainage channel (Wavin-Labko Ltd, 2011)

The water treatment system in car wash facilities usually includes the following units: a silt trap channel, an inspection well, sand filtration, oil separators and a sampling/shut off valve well unit. The silt trap channel is constructed in the floor of the wash hall where cars are placed for washing and the drainage is connected to the sewer network. It traps silt and other solid materials from the wash water. It must be at least as long as the vehicle to be washed so that all solids will be carried by wash water into the separator system. Two separate small channel lines or only a big channel line of enough width for placing cars of various sizes of cars can be constructed in the wash hall. The larger slit particles are trapped here. A drainage channel can be included on the sides of the silt trap channel which will accelerate the wash water flow to the treatment systems. If the wastewater is collecting from parking place surface run off, an inspection well unit must be added in order to control the flow. Then the water is treated in the sand separator where sands and other solid materials are filtered. After that the water can be sent to oil separator where big amount of oils are separated. The amount is dependent on the type of oil separators and density the density of oils. There is a shut off valve at the end of the treatment system called a sampling well from where samples can be extracted for analysis. Further treatment is required to decrease the concentration level of pollutants if the water is not sent to wastewater treatment plants. Usually the sand filtration system is placed before the oil separator in the treatment system but another sand filtration system can be placed after the oil separator if needed. If the water is re-circulated, another sand filtration is arranged after the oil separator.

Besides these sand and oil separation methods, there are many other ways to treat the wash water from the car wash centers in order to improve the quality of treated water. If micro emulsions are extremely used in the car wash, it is a better idea to use chemical flocculants such as aluminum salts or phosphates with polymers (BAT, car washing facilities, 2007, p.35). The pH should be adjusted to the appropriate level to coagulate the oil emulsion and to improve the separation of other pollutants. The oily portion of the sludge is trapped in the sand and oil separators and the oil layer becomes thinner on the surface of the oil separator (BAT, car washing facilities, 2007, p.35).

7 Determination of pollutant parameters and the effects of pollutants on wastewater treatment plants

Various types of pollutant parameters affect the quality of wastewater generated from service stations. Those parameters are analysed in laboratories in order to determine the level of concentrations as well as the possible reduction of concentrations to improve the quality and to control the harmful effects on the sewer system and the treatment processes of wastewater treatment plants. The main parameters causing harmful effects on the Viikinmäki and Suomenoja wastewater treatment plants are examined from time to time to prevent their harmful effects. These parameters are: pH, conductivity, suspended solids, BOD_7, COD_{cr}, total phosphorus, total nitrogen, metals such as Cu, Zn, Cd, Cr, Pb and Ni, VOCs (C_5 - C_{10}) and total hydrocarbons (C_{10} – C_{40}). The effects of these pollutant parameters on the treatment processes are described as follows:

7.1 PH-fluctuations

Wastewater pH in the treatment plant has a significant impact on biological activities. Sudden changes in the pH of an activated sludge process may cause disturbances in the micro-organisms culture. Biological process works at the best when the pH level is 7 to 8. A low pH of water (pH< 6) causes corrosion to the sewer system network. Weak acids such as carbonic acids from the wash chemicals dissolves the lime in the concrete pipe lines of the sewer network and thereafter causing the concrete corrosion. Acids can corrode the cement stone compounds because the cement stone is alkaline. Acid changes the calcium compounds and potassium salts of the cement and damages the internal structure of the cement compounds. The damage rate of concrete is dependent on the strength of acid and volume of acid coming into contact in the given time period. PH can be adjusted in the car wash wastewater by certain pH adjusting agents. The pH limit for sewer water is generally between 6 -11 (see Appendix 6).

7.2 Conductivity

Conductivity is defined as the ability of the solution to conduct electric current. The conductivity of a solution is proportional to its ion concentration and the amount of ions is proportional to the amount of pollutants present in the sample wastewater. Thus, the conductivity describes as the amount of solute in the wastewater. If the conductivity increases, it is advisable to study why it has happened. For example, sea water in the sewer network may appear as elevated electrical conductivity. Standard unit of measurement for conductivity is mS/m (Siemens per meter per ml), or µs/cm (micro-Siemens per centimeter), mS/m = 10 µs/cm. The conductivity value is 5 to 10 mS/m for inland water, 20 mS/m for ground water, 200 mS/m for Baltic Sea Beach and the highest for ocean water from 1000 to 1200 mS/m (Industrial wastewater guide book (Annon., 2011)).

7.2 Suspended solids (SS)

Suspended solids are solid materials including both the organic and inorganic matters suspended in the water. We can visualise suspended solids easily. It gives a measure of the turbidity of the water, hence can be measured by light transmission method i.e. turbidity (nephelometric) measurement. High concentrations of suspended solids can cause jams and damages the equipments in the sewer system and the pumping stations. The value of suspended solids is usually expressed as ppm (mg solids per liter of water). Suspended solids in the service station wastewater come from the grit and dust particles (located) in the car tires and on the surfaces of the car, from the run-off water from the parking place and also from some chemicals and detergents. The limit value for total suspended solids in HSY is 300 - 800 mg/l.

7.3 BOD_7

Biological oxygen demand (BOD) is defined as the quantity of oxygen consumed to break down the organic matters in wastewater. For the purpose of European Standard, BOD_7 means the mass concentration of dissolved oxygen consumed under specific conditions by the biochemical oxidation of organic and/or inorganic matters in water in 7 days incubation time (SFS EN 1899-1, 1988). A high BOD can cause formation of explosive methane, odor, and indirectly the anaerobic corrosion in the sewer network. Certain types of organic matters from the car wash breakdown the sewer network and exceeding amount of them may cause problems in sewage treatment processes. BOD load also causes large variations in filamentous bacterial growth and thus problems such as poor settling of sludge. Service station water organic load is dependent on different waxes and chemicals used in car wash. If the sanitary water is included in the service station's wastewater, the wastewater generated increases the BOD level. According to the Finnish Building code D1, if any restaurant prepares 50 portions food per day, it must have food waste removal system to treat the oil and other harmful substances.

7.4 Heavy metals and semi metals

Heavy metals and semi metals are mainly bound to micro-organism in the activated sludge. Some heavy metals such as cadmium, chromium, iron, copper, nickel, zinc and lead at high concentrations inhibit the nitrification. Toxicity of cadmium, mercury and lead is very high as compared to other types of metal substances.

7.4.1 Cadmium

Cadmium is classified as an environmental and hazardous chemical. Cadmium compounds are fairly or very toxic to aquatic organisms. Cadmium is produced in the manufacture of red glass and in the reuse of glass where a glass items are crushed. High amount of cadmium is also present in wood ash. Cadmium is produced especially as industrial byproducts of zinc and copper mining. Zinc containing materials can contain cadmium. Cadmium substances from the road dust are attached to the surface of the car and transferred to the car wash centers. Cadmium can also be present in the petroleum fuel used in cars. Cadmium binds approximately 30 to 60 % of sewage sludge (Industrial wastewater guidebook (Annon., 2011)) . The limit value of cadmium in sewer wastewater is 0.01 mg/l in HSY (see Appendix 6).

7.4.2 Chromium (Total chromium, Cr)

Chromium is highly toxic to most aquatic organisms and hence to the micro-organisms in the biological wastewater treatment, but it has been shown mainly to accumulate in the food chain. Hexavalent chromium is carcinogenic and mutagenic. Chromium comes into the service station wastewater from car paints and used inks in the cars. Chromium binds 20 to 80 % of sewage sludge (Industrial wastewater guide book (Annon., 2011)) and limit value for total chromium in HSY is 1.0 mg/l (see Appendix 6).

7.4.3 Copper (Cu)

Copper compounds are toxic to most aquatic organisms. Copper can be emitted from printers, dyes and other color users. Copper is obtained from copper pipes, hot water, surface finishing industry, printed circuit board manufacturing, metal fabrication, paints, lacquers and dyes. The blue dye also contains copper. Copper in the service station wastewater comes from the washing car engines and other copper containing parts of the car. Dust particles attached to car surfaces may also remain copper substances. Copper binds 40-90 % of sewage sludge (Industrial wastewater guide book (Annon., 2011)) and limit value for copper in HSY is 2.0 mg/l (see Appendix 6).

7.4.4 Lead (Pb)

Lead is highly toxic to aquatic organisms. Lead is obtained from paints, and electronic glaze colors. Lead is also used in alloys, such as zinc alloys. Lead can enter into the wastewater through storm water and air deposition. Lead in the service station wastewater comes from washing car engines and painting different parts of the car. Lead binds about 50-90 % of sewage sludge (Industrial waste water guide book (Annon., 2011)) and limit value for lead in HSY is 0.5 mg/l (see Appendix 6).

7.4.5 Nickel (Ni)

Some nickel compounds are highly toxic to aquatic organisms. Nickel is used in the manufacture of stainless steel, and in the surface treatment of metals. Emissions from coal combustion may result in atmospheric deposition of nickel. Food vessel metals and metal products are main sources of nickel in wastewater. Nickel in service station wastewater comes from the washing of attached dust particles in the car surfaces and machine lines. Nickel binds 20-80 % of sewage sludge (Industrial waste water guide book (Annon., 2011)) . The limit value of Nickel for sewer is 0.5 mg/l (see Appendix 6).

7.4.6 Zinc (Zn)

Some zinc compounds are highly toxic to aquatic organisms, many galvanized products such as car mirrors, buildings, roofs, facades, and pipe joints contain a lot of zinc. Zinc is used as antirust pigment. Zinc is emitted to wastewater from metal working, surface treatments, paint and varnish manufacturing, transport (brakes, wheels, and asphalt) and galvanized surfaces. Mostly zinc comes from household foods and hygiene products. Zinc in the service station wastewater comes from the washing chemicals such as shampoos and detergents and from car wheels and other parts of the cars during car wash. Zinc binds approximately 30-80 % of sewage sludge (Industrial waste water guide book (Annon., 2011)). Limit value of zinc for sewer wastewater in HSY is 3.0 mg/l (See Appendix 6).

7.5 Total Hydrocarbon (THC)

Hydrocarbon is the chain of organic compounds composed of hydrogen (H) and carbon (C) and total hydrocarbon is the total amount of hydrocarbon present in any laboratory analysis (Wikipedia). Total hydrocarbon here means the carbon chain of C_{10}- C_{40}. Hydrocarbon chain C_5-C_{10} is considered the volatile organic compounds (VOCs). The hydrocarbon differ both in the total number of carbon and hydrogen atoms in their molecules and in the proportion of hydrogen to carbon. Hydrocarbons can be classified as saturated hydrocarbons (alkanes), unsaturated hydrocarbons (alkenes), cycloalkanes, aromatic hydrocarbons (arenes). Hydrocarbons can be gases, liquids, waxes or low melting solids or polymers (e.g. polyethylene, polypropylene and polystyrene). (Alther A. 1997).

Table 3: Classification of Hydrocarbons (Alther A. 1997)

Products	Carbon chain range	Boiling point (^0C)	Uses
Gases black	C_1-C_4	-164 to +30	Fuel, Carbon
Petroleum Ether	C_6-C_7	30-90	Solvent,Dry Cleaning, Refrigerant
Straight Run Gasoline	C_{12}-C_{16}	40-200	Motor Fuel
Kerosene	C_{12}-C_{24}	200-315	Lighting and Oil Stove Fuels, Diesel Engines
Diesel	C_{12}-C_{24}	200-315	Motor Fuel
Fuel Oil	C_{15}-C_{18}	Up to 375	Furnace Oils, Diesel Engines
Lubricating Oils	C_{16}-C_{20}	350+	Lubrication, Candles, Sticks, Household Cleaning
Greases, Vaseline	C_{20+}	Semisolids	Lubrication, Candles
Paraffin Wax Match	C_{26+}	Melts at 51-55	Sticks, Household Cleaning
Petroleum Coke	C_{26+}	Residue	Fuel, Carbon
Pitch and Tar Paving	C_{26+}	Residue	Roofing, Rubber

Almost all fractions of the total hydrocarbon in the service station wastewater is obtained from the oils and chemicals used in the service station and cars and from the run-off water which consist of spilled oils collected from parking places and petrol filling place. If the amount of total hydrocarbon is higher in the wastewater, it will severely effect on treatment processes. They will float in wastewater and form a surface layer. Heavier fractions of the hydrocarbons accumulate on the bottom of the treatment basins and corrode the equipments in the basin. The limit values for volatile organic compounds (voc) and total hydrocarbon or mineral oils (C_{10} – C_{40}) are 3 mg/l and 100 mg/l respectively in HSY (See Appendix 6).

7.6 COD $_{cr}$ measurement

Chemical Oxygen demand (COD_{cr}) is defined as the measure of oxygen requirement of a sample that is susceptible to oxidation by strong chemical oxidant called dichromate.

8 General description of analytical methods and equipments used for laboratory work

The laboratory analyses for all the pollutant parameters were done in the HSY wastewater laboratory in Suomenoja and Metropolia Laboratory in Viikki. The author participated in the analyses of some pollutant parameters was in Suomenoja laboratory as a trainee but author did not perform any analyses for this thesis, however, he collected the samples from the several service stations. Thus, some laboratory analysis procedures mentioned in this chapter are taken from the different standard methods which are applied in HSY laboratory.

8.1 Analytical procedures for THC analysis

THC analysis for (hydrocarbons C_{10} – C_{40}) is conducted by means at liquid – liquid extraction with hexane, which is based on the principles of standard method SFS-EN ISO 9377 -2). After extraction, hexane is put through a Floricil Catridge which absorbs the polar compounds from the extract. Thus, only non –polar compounds pass through the Catridge and are analyzed. After concentration of the extract, it is analysed by GC-MSD. The chromatogram is made with the Scan operation of the MSD. Standard solutions are used to make the calibration, after which $>C_{10}$ –C_{21} and $>C_{21}$ – C_{40} are calculated. C_5 – C_{10} hydrocarbons are analysed with a Headspace (HS –GC-MSD) analyser as volatile organic compounds (VOC). The MSD is operated with Scan mode and hydrocarbons are calculated as toluene (Lukkarinen, 2011).

8.2 Analytical methods for pH measurement

PH is measured in lab with the help of pH electrodes. The pH electrode is immersed into the sample water and measurement sensors inside the electrode sense the acidity or alkalinity of the samples. Before measuring the sample calibration of the pH electrode has to be done with the fresh water, i.e. pH has to be adjusted to 7 which is the neutral point for any pure samples. If the wastewater is acidic the measurement decreases from 7 and if it is alkaline pH increases. The maximum acidic point is 1 and the maximum alkaline point is 14.

8.3 Analytical methods for conductivity measurement

Conductivity is measured with a conductivity meter, also called a conductometer. The electrode in the conductometer is immersed into the sample water to measure the conductivity of the wastewater samples. After measuring one sample the immersed part of electrode has to be ringed with the distilled water in order to get the precise accuracy of the measurement. Before starting any measurement with the conductivity meter it has to be adjusted a zero point. If not, calibration has to be done.

8.4 Analytical methods for BOD_7 measurement

Collected wastewater sample is pre-treated and diluted with varying amounts of a dilution water rich in dissolved oxygen, which contains a seed of aerobic microorganisms, with suppression of nitrification. The pre-treated sample is incubated for 7 days at 20 ^{0}C in the dark, in a completely filled and stoppered bottle. Then, the dissolved oxygen concentration is determined before and after incubation. Calculation of the mass of oxygen consumed per liter of sample gives the BOD_7. Dilution water containing less than 0.01 mg/l of copper and without chlorine and chloramines is used. Urban wastewater having about 300 mg/l of COD and 100 mg/l of TOC is used as seeding water. Similarly, phosphate buffer solution of pH 7.2 is used as salt solution. (SFS- EN-1899)

8.5 Analytical methods for COD_{Cr} measurements

A sample is refluxed in strongly acidic solution with a known excess of potassium dichromate ($K_2Cr_2O_7$). After digestion the remaining unreduced $K_2Cr_2O_7$ is titrated with ferrous ammonium sulfate to determine the amount of $K_2Cr_2O_7$ consumed and the oxidizable matter is calculated in terms of equivalent. This is applicable to COD values between 40 and 400 mg/l. Higher COD values can be obtained by careful dilution or by using higher concentrations of dichromate digestion solution. When a sample is digested, COD material in that sample is oxidized by the dichromate iron. The result is the change in chromium from the hexavalent (VI) to the trivalent (III) state. In the 600 nm region, it is the chromic ion that absorbs strongly and the dichromate ion has nearly zero absorption (Hanna Instruments Pty Ltd, what is COD).

8.6 Analytical methods for total Nitrogen (N) measurement

There are two main analytical processes for nitrogen measurement; 4500-N_{org} B. macro-kjeldahl method applicable for samples containing either low or high concentrations of organic nitrogen where the large sample volume is required for low concentration samples and 4500-N_{org} B. Macro-Kjeldahl Method applicable for samples containing high concentrations of organic nitrogen where the sample volume should be chosen to contain organic plus ammonia nitrogen in the range of 0.2 to 2 mg. The Macro-Kjeldahl Method is accepted for both the low and high concentrated samples. The analytical procedure for 4500-N_{org} B. Macro-Kjeldahl Method has been explained below.

4500-N_{org} B. Macro-Kjeldahl Method: Total nitrogen is determined in the presence of H_2SO_4, potassium sulfate (K_2SO_4), and cupric sulfate ($CuSO_4$) catalyst, and conversion of amino nitrogen to ammonium. After selecting the proper amount of samples, ammonia removal, digestion, distillation and final measurement of ammonia are applied for the analytical procedure. (EPA, 1999)

8.7 Analytical methods for total Phosphorus (P) measurement

Digestion method is an appropriate method to determine total phosphorus. Digestion oxidizes organic matter effectively to release phosphorus as orthophosphate. The nitric acid- sulfuric acid method is the most common method. After digestion, determine liberated orthophosphate. Colorimetric method is used to determine the ortho phosphate. The stannous chloride method or the ascorbic method is more suited for the range of 0.01 to 6 mg /l of phosphorus.

8.7.1 Per sulfate method for digestion

Use 50 ml or a suitable portion of thoroughly mixed sample. Add 0.005 ml (1 drop) phenolphthalein indicator solution. If a red color develops, add H_2SO_4 solution drop wise to just discharge the color. Then add 1 ml H_2SO_4 solution and either 0.4 g solid

$(NH_4)S_2O_8$ or 0.5 g solid $K_2S_2O_8$. Boil gently on a preheated hot plate for 30 to 40 min or until a final volume of 10 ml is reached. Cool, dilute to 30 ml with distilled water, add 0.05 ml (1 drop) phenolphthalein indicator solution, and neutralize to a faint pink color with NaOH. Make up to 100 ml with distilled water. Determine phosphorus by one of the calorimetric methods.

8.7.2 Ascorbic Acid Method to determine orthophosphate

Treatment of sample: Pipette 50.0 ml sample into a clean, dry test tube or 125-ml Erlenmeyer flask. Add 0.05 ml (1 drop) phenolphthalein indicator. If a red color develops add 5*N* H_2SO_4 solution drop wise to just discharge the color. Add 8.0 combined reagent and mix thoroughly. After at least 10 min but no more than 30 min, measure absorbance of each sample at 880 nm, using reagent blank as the reference solution.

Then correlate for turbidity by interfering color and prepare a calibration curve to determine the exact amount.

Determine the total phosphorus with the following formula:

[1] The amount of total phosphorus present in the sample (mg /l) = mg P (in approximately 58 ml final volume) * 1000 /ml sample. (EPA 1999)

9 Data obtained from laboratory analyses

The data obtained from laboratory work have been divided into two categories for further analyses. The first category consists of the data with comparison between old and new laboratory results and the second category consists of the new laboratory results of several service stations which were not possible to compare with the old data. Both the data categories are explained in the subsections 9.1 and 9.2.

9.1 Data with comparison between old and new laboratory results

This data series contain both the old laboratory results from 2006 to 2010 and new laboratory result of 2011 (see Appendices 3 and 4). It has been prepared according to the old data from certain service stations related to recently chosen service stations for the new examinations of the pollutant parameters. There, are only six out of thirteen service stations chosen for this thesis project have been included in this excel data series. Original data containing the data from 2005 to 2011 but not all the parameters were examined for each service station in the old recorded data. So, the data have been selected from original data provided by the company to make it easier for comparing them. More than one sample were taken and analysed from some service stations. In such cases averages of the analysed samples have been calculated. The data can be found in Appendix 3.

9.2 Recent lab results from remaining service stations

These data contain only the results of laboratory analysis done for this thesis project. Two different samples have been tested for two service stations and only one sample was tested for the rest of the stations. The data have been very recently obtained from the service station's wastewater. Therefore, it can show the recent situation of wastewater treatment system in the car wash centers. It has been compared only with the limit values of HSY, other water works in Finland and international limit values. The data can be found in Appendix 4.

10 Analysis of results and conclusions

Analysis of data obtained from laboratory analysis is the main focus of this thesis project. The quality of the wastewater is always affected by these data values. Comparison between the old data and the new experimental data determines the present condition of wash water treatment and improvement or carelessness in the treatment procedure, which is supposed to be done according to the regulations of local authorities. If the treatment methods applied to refine the wastewater in the car wash centers are advanced, the quality of treated wastewater is qualitative and, hence fulfills the requirements of the authorities, but if the treatment method is seeming type, the quality does not meet the level. This will also affect further treatments in the municipality WWTPs. Therefore, the quality of treated wastewater always depends on the used technologies for treatment. For instance; the number and type of oil and sand separators, filter types, the design of the treatment system in the sewer network, the capacity of the separators and the amount of used chemicals for washing.

Two types of data were analysed. The old data is from the records of 2005 to 2010 and the second one is from the new experimental data obtained from recent laboratory analysis done for the chosen 13 service stations located in the operative areas of Viikinmäki and Suomenoja WWTPs in HSY. For the comparison of these data, certain data series were selected because of the unmatched service stations and the parameters. All parameters were not analysed or reported in the old data records available for service stations chosen for the analysis of this project. For example, some recorded data series had values included from some other service stations which were not included in this project. Thus these data were removed. Furthermore, analyses were not done for certain pollutant parameters. Hence, the column charts for pollutant parameters cannot show all the columns for all parameters in each year of laboratory results. In some years, the examinations were done twice and the very different results were obtained. In this case averages have been taken and analysed. For instance, the service stations A and B had two different samples from the same sample places, but the samples were taken in different dates. However, averages have been taken from them and anaysed. This makes it easier to analyse and compare the available data.

The service stations with only a few data for each parameter were analyzed by just visualizing. The old data did not include any record of many of the heavy metals and total hydrocarbons. Hence, they were also analyzed by visualizing. Among all the parameters, the analysis of THC was more important than others because it was also the main target. An attempt was made to examine them more precisely. Another purpose of data analysis was to compare the data with the limit values. All the parameters were compared with the limit values of HSY, other waterworks in Finland and also with the other international limit values. The results for different parameters are compared and analysed in the following sections:

10.1 PH analysis

This section will outline the analyses of pH of data from 2006 to 2011 for the different service stations. Figure 7 below depicts the analyses and comparison of the results for pH.

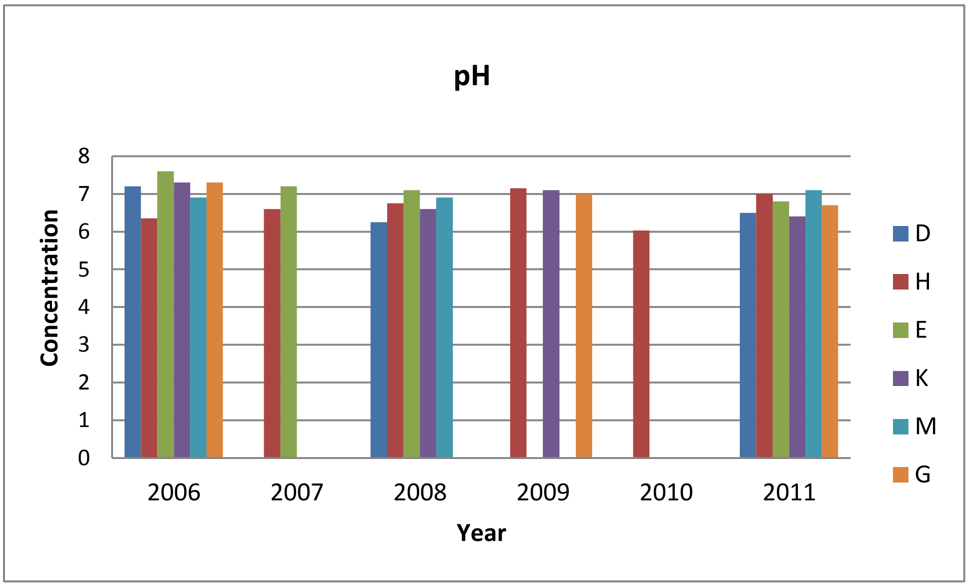

Figure 7: Analysis of pH values from the service stations D, H, E, K, M and G

The limit values for pH in HSY is 6-11 (see Appendix 6). All pH values of service stations D, H, E, K, M and G from 2006 to 2011 are within the limits. Similarly, according to the new data from recent lab analyses for service stations A, B, C, F, I, J and L specified in Appendix 4, the pH value ranges from 6 to 7 which means they are also within the limits.

10.2 Conductivity analysis

This section will present the anayses of conductivity from 2006 to 2011 for the different service stations. Figure 8 below depicts the analyses and comparison of the results for conductivity.

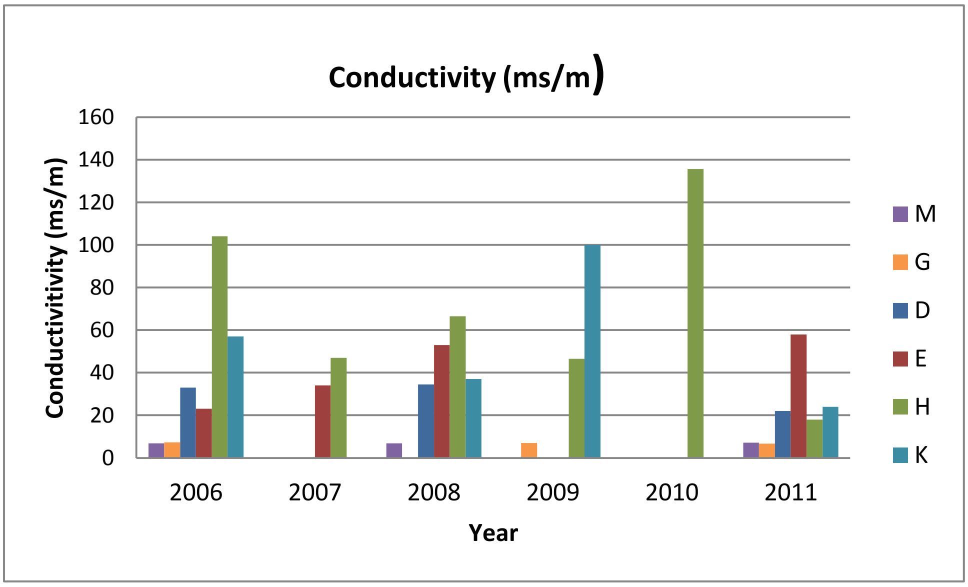

Figure 8: Analysis of conductivity values from the service stations D, H, E, K, M and G

The normal value for conductivity in HSY is 80 to 120 ms/m. Figure 8 shows that most of the service stations in the different years from 2006 to 2011 have a conductivity values ranges of 20 to 100 ms/m and especially in the year 2011, all the service stations specified in Figure 8 have the values within this normal value of HSY i.e. below 60 ms/m. In 2006, service station H and in 2009, service station K had higher amount of conductivity than usual. However, in 2010, the amount of conductivity in the service station H had higher than the normal value. It might be due to higher load of suspended solids in the wastewater at that time. The conductivity crossed the normal value that year, but in 2011, it had been improved significantly and came below the normal value. Similarly, rest of the service stations A, B, C, F, I, J and L in 2011 had result of conductivity in between 10 to 45 which is below the normal value of HSY (see Appendix 4).

10.3 Suspended solids analysis

This section will outline the anayses of suspended solids from 2006 to 2011 for the different service stations. Figure 8 below illustrates the analyses and comparison of the results for suspended solids.

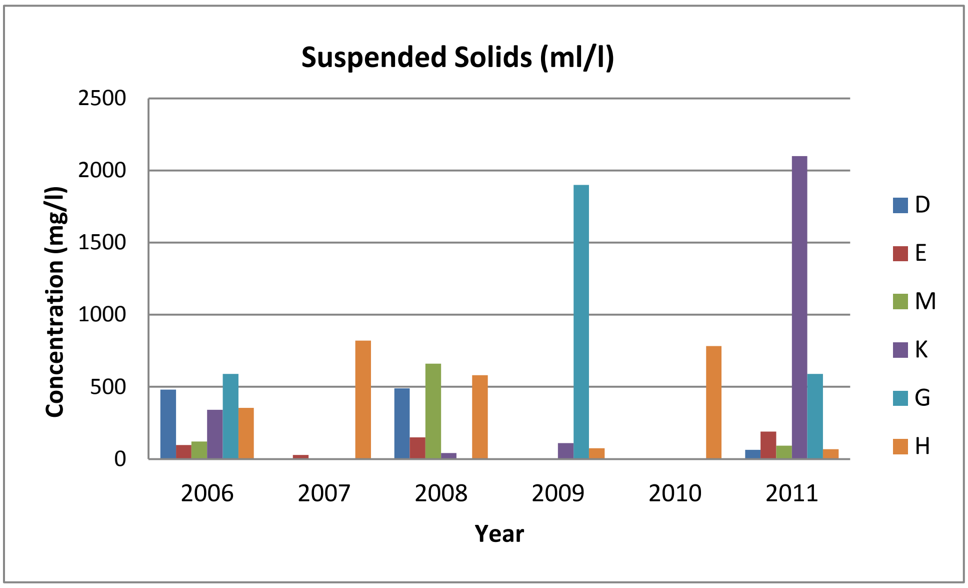

Figure 9: Analysis of total suspended solids values from the service stations D, E, M, K, G and H.

The limit value for total suspended solids in HSY is 300 - 800 mg/l. In the Figure 9, most amount of suspended solids for service stations D, E, M, K and G and H from the years 2006 to 2011 are within the limits except for service station G in 2009 and service station K in 2011. The amount of suspended solids in service station G in 2009 had reached up to 1900 mg/l and service station K in 2011 had reached up to 2100 mg/l and which was twice of the limit value in HSY. Similarly, other service stations A, B, C, F, I, J and L had the amount of the suspended solids within the limit value range of HSY (see Appendix 4). Service stations J and F had a bit more amount of suspended solids than other four service stations but still within the limit range. Service stations A, B, C, I and L had very low amount of suspended solids which is beyond the limit value range of HSY. This result is qualitative and very good for the further treatment of wastewater in the wastewater treatment plants.

10.4 BOD_7 analysis

This section will outline the anayses of BOD_7 from 2006 to 2011 for the different service stations. Figure 10 below illustrates the analyses and comparison of the results for BOD_7.

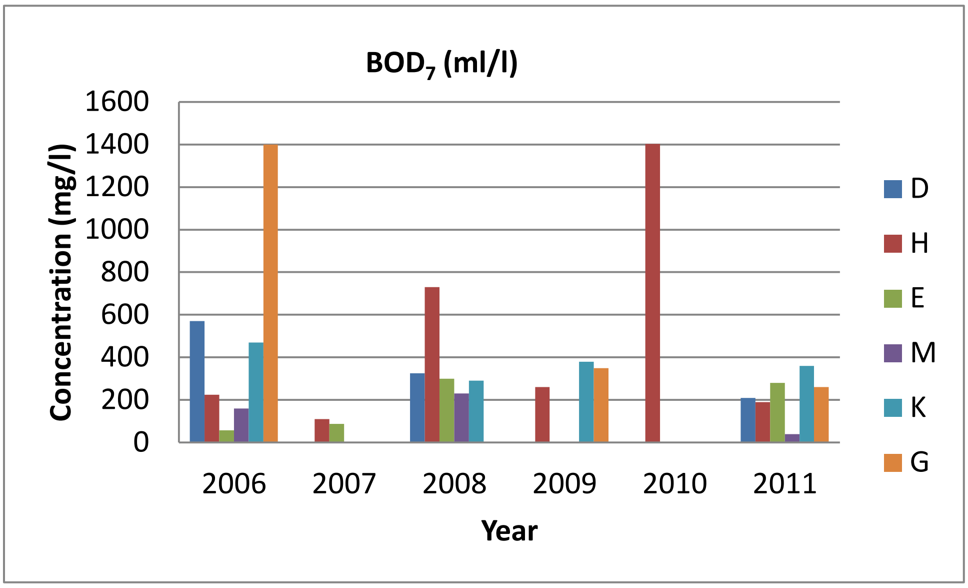

Figure 10: Analysis of total BOD_7 values from the service stations D, E, M, K, G and H.

HSY does not have limit value for BOD_7 but payment for industrial wastewater is made according to the normal household wastewater value which is 260 mg/l. If we compare this normal household value of BOD_7 with the values in Figure 10, we can see that service stations D, K and G in 2006, Service station K in 2009 and Service station H in 2010 had high level of BOD_7. Service station G in 2006 and H in 2010 had insignificantly higher levels of BOD_7 but in 2011, all the service stations specified in figure 10 had less than 300 mg/l of BOD_7 which is almost within the normal household value of BOD_7. There might have been several reasons for increasing the amount of BOD_7 in previous years. For instance; use of low quantity of chemicals and waxes for washing the cars and wastewater with high BOD produced from the sanitary located in those service stations. However, the value for BOD_7 has been reduced significantly in 2011 up to the normal household wastewater level. According to the laboratory result analysed in 2011, rest of the service stations A, B, C, I, and L had normal value of wastewater i.e. less than 260 mg/l but service stations F and J had exceeded the amount of BOD_7 (see Appendix 4). The service station J has unusual amount of BOD_7 which needs to be controlled for quality improvement.

10.5 CODCr analysis

This section will outline the anayses of COD_{Cr} from 2006 to 2011 for the different service stations. Figure 11 below illustrates the analyses and comparison of the results for COD_{Cr}.

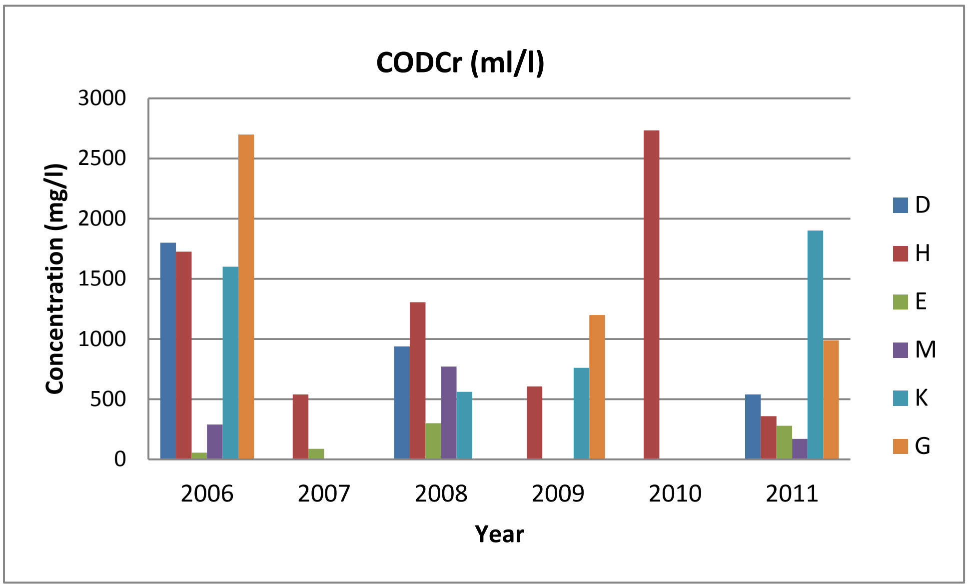

Figure 11: Analysis of total COD_{Cr} values from the service stations D, H, E, M, K, and G.

HSY does not have any limit values for Chemical Oxygen Demand (COD) but Australian limit value for COD is 1200 mg/l. If we take this limit value as a reference limit value for COD, most of the service stations in the years 2006 – 2011, specified in Figure 11 had fulfilled the required level. Some service stations such as D, K and G in 2006 had higher level of COD than limit value. Similarly, service station H in 2010 and K in 2011 had also exceeded the limit value. The amount of COD for service station H in 2010 was exceptionally high because it had not exceeded the limit values in the previous four years.

10.6 Total Phosphorus analysis

This section will outline the anayses of Total Phosphorus from 2006 to 2011 for the different service stations. Figure 12 below illustrates the analyses and comparison of the results for Total Phosphorus.

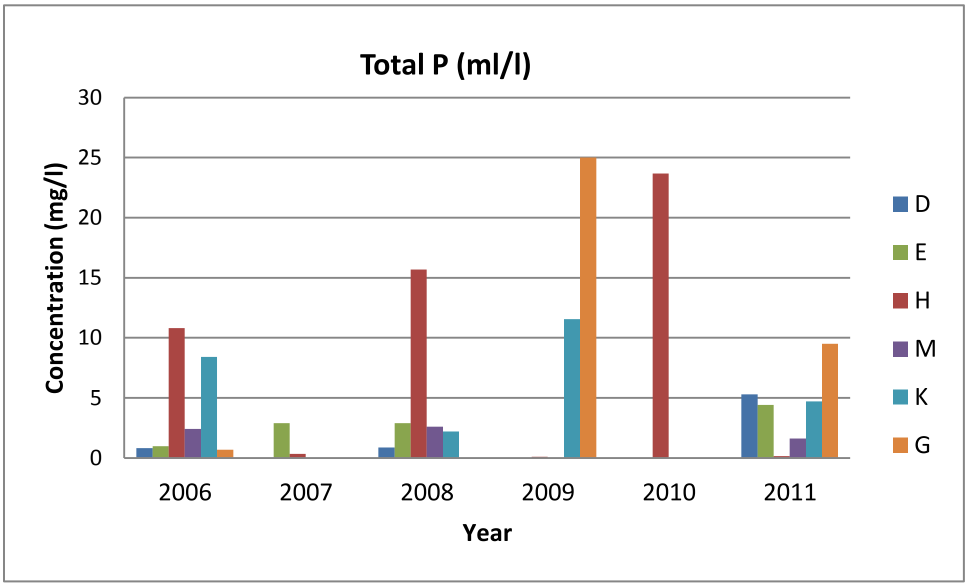

Figure 12: Analysis of total Phosphorus from the service stations D, E, M, K, G and H.

The normal value for total phosphorus in HSY is 9 mg/l and in Norway is 10.5 mg/l. Average value in HSY as compared to limit value in Norway is quite stringent. The values for total Phosphorus presented in Figure 12 shows that except for service stations K and G in 2009 and H in 2010, all the service stations had the amounts within the average value. According to the laboratory analyses done in 2011 for service stations A, B, C, F, I, J and L, the amount of total phosphorus except for service station C was within the average value (see Appendix 4). Service station C had extremely high amount of total phosphorus in 2011 which should be checked. However, except service station C, all the service stations have the amount of total phosphorus within the average value of HSY.

10.7 Total Nitrogen analysis

This section will outline the anayses of Total Nitrogen from 2006 to 2011 for the different service stations. Figure 13 below illustrates the analyses and comparison of the results for Total Nitrogen.

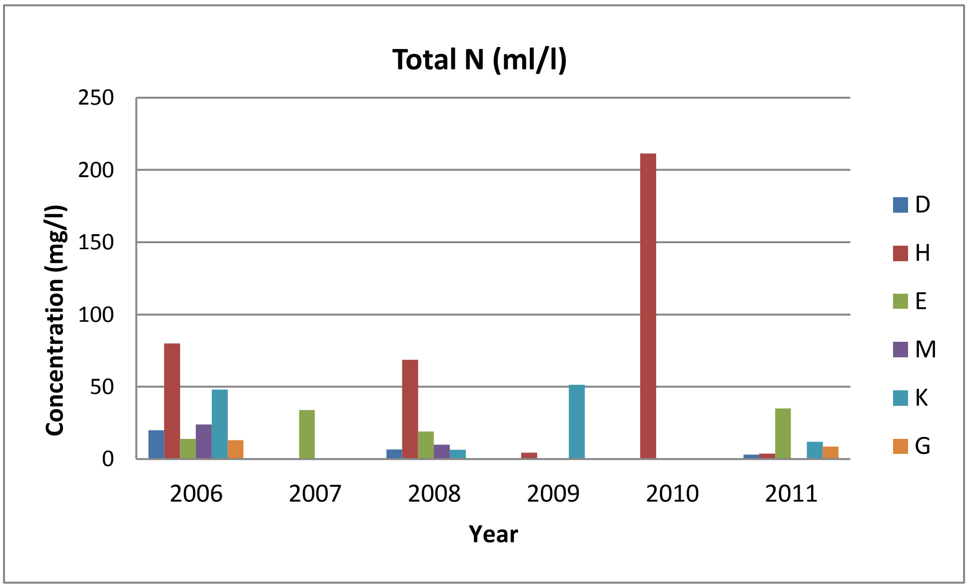

Figure 13: Analysis of total Nitrogen from the service stations D, E, M, K, G and H.

Normal value for total nitrogen in HSY is 60 mg/l. The amount of total nitrogen for the service stations presented in Figure 13 has clearly shown that almost all the service stations have their total nitrogen amount within the average value and less than 50 mg/L. In 2010, service station H had very high amount of total nitrogen. It had also exceeded the average value in 2006. Similarly, in 2009, service station K had the higher value but not very higher than the average value. Similarly, according to the laboratory analyses done in 2011, service stations A, B, C, F, I, J and L had less than 17 mg/l of total nitrogen which are very good results (see Appendix 4). However, according to the analyses done in 2011, all the service stations have very good condition of total nitrogen.

10.8 Heavy metals analysis

This section will outline the anayses of heavy metals from 2006 to 2011 for the different service stations. Figure 14 below illustrates the analyses and comparison of the results for heavy metals.

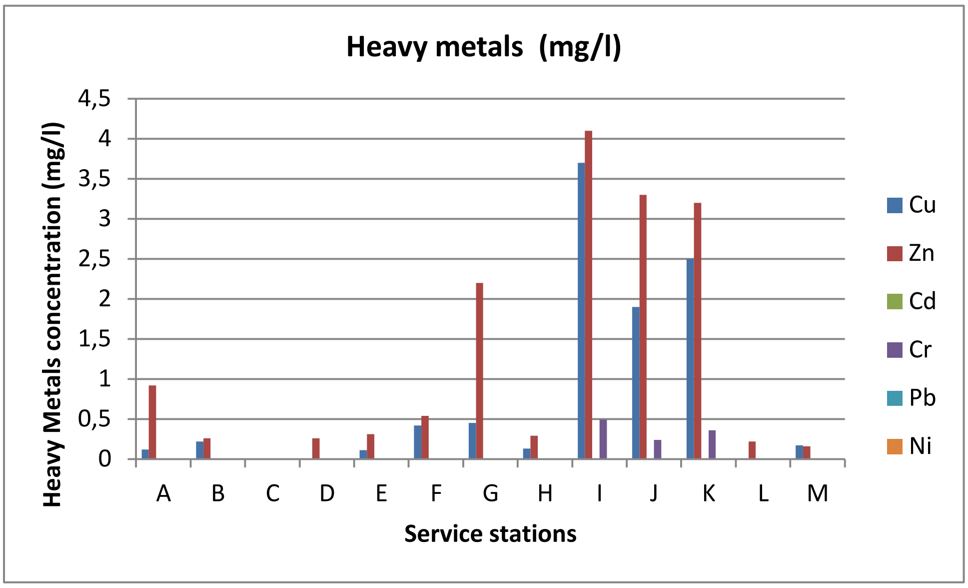

Figure 14: Analysis of heavy metals from all the service stations A, B, C, D, E, F, G, H, I, J, K, L and M.

There are not any data for heavy metals in the old data records of HSY but it can be analysed from the new data. Figure 14 was made by the absolute data obtained from lab analyses done in 2011. Though, service stations A and B had two different samples, the heavy metals were analysed only for one sample and they are presented in the figure 14. The heavy metals have not been measured for service station C. The limit values for heavy metals in HSY are given in the table below (see also in Appendix 6):

Heavy Metals	Cu	Zn	Cd	Cr	Pb	Ni
Concentrations(mg/l)	2	3	0.01	1	0.5	0.5

10.8.1 Copper analysis

Except for service stations I and K, all the service stations have the limited amount of copper but in the service station I has the value of Cu almost double of the limit value and service station K has a bit more than the limit value.

10.8.2 Zinc analysis

Except for service station I, J and K, all the service stations have limited amount of zinc. Service station I has quite higher amount of Zn than the limit value of it but service station J and K have crossed just a limit level.

10.8.3 Cadmium and chromium analysis

All the service stations have the cadmium and chromium level under the limit value.

10.8.4 Lead and Nickel analysis

All the service stations have lead and nickel amount less than 0.1 mg/l which is far below the limit value of them.

10.9 Total Hydrocarbon analysis

This section will outline the anayses of Total Hydrocarbon for the data obtained in 2011 from the different service stations. Figure 15 below illustrates the analyses and comparison of the results for Total Hydrocarbon.

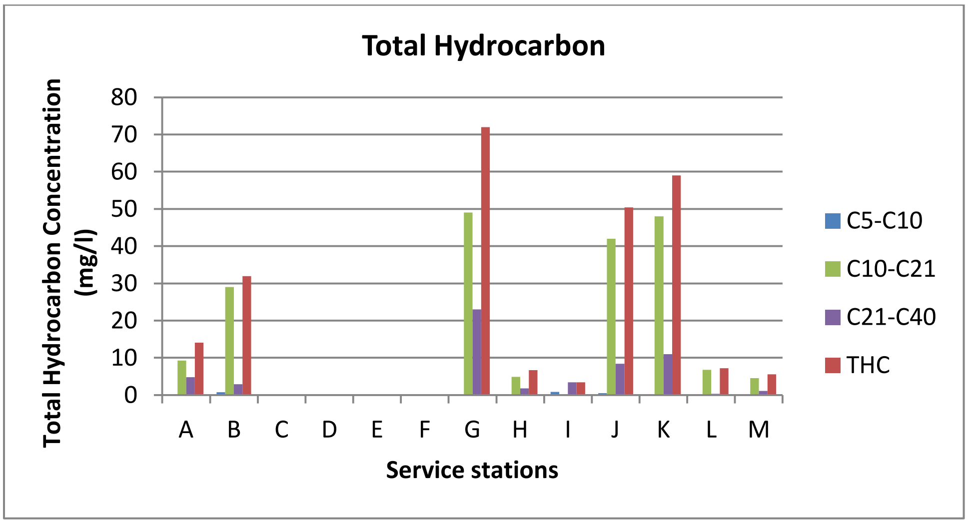

Figure 15: Analysis of Total Hydrocarbons from all the service stations A, B, C, D, E, F, G, H, I, J, K, L and M.

The limit value for C_5-C_{10} or Volatile Organic Compounds (VOCs) and Total Hydrocarbon (THC) in HSY are 3 mg/l (3000 µg/l) and 100 mg/l (100000 µg/l) respectively (see Appendix 6). Total hydrocarbon (THC) has been assumed as the sum of hydrocarbons C_{10}-C_{21} and C_{21}-C_{40}. VOCs are the carbon chains from C_5 to C_{10} which are the composition of gases black and petroleum ether abundant in the service stations. In the Figure 15 above, amount of VOCs in all the service stations are below 1 mg/l and the limit is 3 mg/l. Therefore, the risk of problems caused by VOCs in the sewer network and wastewater treatment plant cannot be denied. Hydro-carbon chain C_{10}-C_{21} contains straight run gasoline, kerosene, diesel, fuel oil, lubricating oil and greases which are commonly found in the service station wastewater. Hence, the amount of C_{10} –C_{21} hydrocarbons is higher than the other two types of hydrocarbon chains.

The service stations A and B had two different samples from the same sample places but the samples were taken in different dates. However, the averages have been taken from them and analysed. Almost all the service stations have up to 50 mg/l of C_{10} – C_{21} hydrocarbon chains but still have not exceeded the limit value of HSY. C_{21} to C_{40} hydrocarbon chains contain Vaseline, paraffin waxes, petroleum coke, pitch and tar paving which are dependent on the amount of such chemicals used in the service stations because they are not very commonly found in the service station's waste water. Therefore, their values in the chart are also comparatively low. Most of the service stations except for service stations G and K have less than 10 mg/l of C_{21}-C_{40} hydrocarbon compounds, which does not significantly affect the total amount of hydrocarbons because total hydrocarbon values for all the service stations are less than 70 mg/l which is far below the limit value of total hydrocarbon in HSY.

11 Recommendation and Future Improvement

After comparing all the measured parameters with the limit values, it can be concluded that most of the service stations have a proper treatment for their waste water, and the treatment is effective, complying with the rules given by HSY, but there is always a need for an improvement on the quality. There are also some parameters which have values higher than the limit values and have to be controlled. For instance, Service station K in 2011 has exceeded the limit values for suspended solids and COD, copper and zinc, and service station I has exceeded the limit values for copper and zinc in 2011. Similarly, service station J had exceeded the limit values of zinc. It seems that service station K does not have a proper treatment system. Hence, from time to time a regular analysis of wastewater from service stations K, I and J is recommended. It is also possible that service station K might need to change or improve its present treatment system.

By looking into the previous records of data, it has been seen that most of the service stations have improved their quality of wastewater, but this is not the case for all service stations. It can also be seen that some parameters have surprisingly increased in the mid period of recorded data. Mere viewing of the values does not give the true evaluation of the quality of wastewater because there are various factors affecting the quality of wastewater. The quality of wastewater in the service station also depends on the types of oil separators and sand filtrations used in the treatment system. While selecting oil separators or sand separators for treatment design for the service stations, it must be noted that design of sewer vent, runner's width and height of the separators should be well fitted for effectiveness of the treatment system. Many service stations may have improved their treatment system or changed the whole treatment systems in recent years, so previous data records might not give a true picture over the period in question. Some parameters such as heavy metals and THC were not measured in the previous years, so we cannot conclude whether their amount in the wastewater has been improved or not. In such a case, from time to time a second measurement is recommended as a follow-up analysis.

The overall analysis depicts that there is not a bad situation of the quality of waste water in all of the selected service stations, but still some parameters can be improved by improving in the treatment system and/or use of less toxic chemicals for car wash. All the selected service stations lack of an advance treatment methods. So adding of advance treatment methods into the existing treatment systems is recommended. Similarly, a regular and schedule inspection as well as a frequent removal of excessive oil and sands from the oil and sand traps are recommendable to all service stations.

In fact, as explained in chapter two, car washes do not need to follow any specific environmental rules and regulations but it is enough for them, if they follow the some instructions of HSY to prevent harmful effects of pollutants to the sewer systems and the treatment processes in the WWTPs. The instructions explain that service stations must identify the hazardous chemicals and wastes (as explained in chapter 4.1) which can enter into the wastewater treatment plants. They have to collect, label and store them properly. They have to empty the sand and oil separators on the regular basis and keep the separators alarm systems in good condition. Then they have to use appropriate detergent combinations. All the separators and shut-off valve manhole needs to be covered tightly in order to prevent the wastewater leakage in the waste water treatment system. (Lindberg, 2011)

It is very important that when selecting the chemicals for car washes or for other purposes in the service stations, the service stations must know the affectivity of the chemicals. More dangerous and hazardous chemicals for water environment have to be avoided as much as possible. Appendix 7 lists the hazardous and dangerous chemicals for the water environment. The list is complies with the different environmental legislations of Finland and European Union. The service stations are recommended to read about these chemicals to know about material safety data sheet (MSDS) of them.

If all the service stations follow the instructions, the quality of wastewater generated by them will be improved. Thus, it is highly recommended to service station's car washes lines to follow the instructions.

References

Alther A., 1997. Oils found in wastewater. [e-book] Biomin. Available through: Biomin Incorporated Website:<http://www.biomininc.com/ > [Accessed 29 October 2011]
BAT-car washing facilities, 2007. TamaNord 2007:587, Copenhagen: Nordic Council of Ministers Nordic Countries.

Daniel F. (ed.) 2009, Secondary wastewater treatment, The Nalco Water Handbook, McGraw-Hill.

Environmental Protection Act 169/2000 [Available at :< http://www.finlex.fi/fi/laki/ajantasa/2000/20000169> [23 September 2011]

EPA, 1999. Standard methods for the examination of water and wastewater (online) New York: UMASS (2002) Available at :< http://www.umass.edu/tei/mwwp/acrobat/sm5210B5dayBOD.PDF> [Accessed 30 October 2011]

EPA, 1999. Standard methods for the examination of water and wastewater (online) New York: UMASS (2002) Available at :< http://www.umass.edu/tei/mwwp/acrobat/sm4500OrgN.PDF> [Accessed 30 October 2011]

EPA, 1999. Standard methods for the examination of water and wastewater (online) New York: UMASS (2002) Available at :< http://www.umass.edu/tei/mwwp/acrobat/sm4500P-E.PDF> [Accessed 30 October 2011]

EPA, 2003. Analytical Method for Turbidity Measurement Method 180.1 (draft) [online], EPA (published 2003) Available at :< http://www.epa.gov/ogwdw/disinfection/lt2/pdfs/guide_lt2_pwsguide_appendix-j_turbidity-180.1.pdf> [Accessed 28 October 2011]

Espoo Water (2003), Suomenoja wastewater treatment plant, Espoo water [Brochure], Espoo water: author (n.d.)

Hakala, J. 2011. Wastewaters of car washes sampling and analysis plan for VESITUR-VA- project, Bachelor Thesis, Lahti University of Applied Sciences, Lahti, 6p.

Hanna Instruments Pty Ltd (n.d.), what is COD. [Online] Available at: <http://www.hannainst.com.au/Pro/what_is_cod.htm> [Accessed 2 September 2011]

Helin M., 2011. Handouts for sewer network design, Helsinki Region Environmental Services Authority (HSY), unpublished.

HSY, 2011. Suomenoja wastewater treatment plant. [Online] (28.7.2011) Available at :< http://www.hsy.fi/en/waterservices/services/wetreatwastewaterefficiently/treatmentplants/suomenojawastewatertreatmentplant/Pages/default.aspx> (20 September 2011)

HSY, 2011. Viikinmäen jätevedenpuhdistamo. [Online] (28.7.2011) Available at: <http://www.hsy.fi/vesi/jatevedenpuhdistus/viikinmaki/Sivut/default.aspx> (20 September 2011)

Industrial wastewater guide book (Annon., 2011). VVY, Helsinki

Lindberg, H, 2011. Control engineer. Helsinki Region Environmental Services Authority. Interview 02.12.2011

Lindedahl, K., 2011, Wastewater treatment plant design, TG00AA58-2000 Technology. Metropolia University of Applied Sciences, unpublished.

Lukkarinen, T.,Timo.Lukkarinen@metropolia.fi, 2011. About the test procedures. [email] Message to D. Karna and L. Heli (Dahal.Karna@hsy.fi, Heli.Lindberg@hsy.fi). Sent: Tuesday 20 September 2011, 12:24. Available at: webmail.hsy.fi [Accessed 21 September 2011]

Mohr (n.d.), how oil-water separators work and how to use them, Mohr separations research Inc. [Online] Available at :< http://www.oilandwaterseparator.com/how_they_work_2010.pdf> [Accessed 25th October 2011]

Organic pollutants (n.d.), [online] European Commission. Available at: <http://ec.europa.eu/environment/waste/sludge/pdf/sludge_pollutants_3.pdf> [Accessed 22 September 2011]

SFS- EN 1825-1. 2004. The Grease separators. Part 1: Principles of design, performance and testing, marking and quality control. Helsinki: Finnish Standards

SFS-EN 1899-1. 1988. The water quality. Determination of biochemical oxygen demand (BOD) of water. Dilution method. Helsinki: Finnish Standards

Sopiva Design. [Image Online] Available at: <http://www.hsy.fi/vesi/Documents/Ohjeet_ja_esitteet/HSY_AT_j_tevesi_A5_15032011_ENG.pdf> [20 September 2011]

The oil industry federation, 1994, p.21-24. Service station wastewater. Detergent used, cleaning methods and wastewater treatment equipments. Cleaning chemicals classifications and restrictions, Oil industry federation.

Water circulation (n.d.), [Online) HSY. Available at:<http://www.hsy.fi/en/waterservices/services/wetreatwastewaterefficiently/wastewatercirculation/Pages/default.aspx > [Accessed 21 September 2011]

Water.org (n.d), water facts. [Online] Available at: <http://water.org/learn-about-the-water-crisis/facts/> [accessed date 20 September 2011]

Wavin-Labko Oy (n.d.) [Online] Available at :< http://www.wavin-labko.fi/en/products/separator_systems/sand_separators/> [Accessed 2 November 2011]

Wikipedia, Hydrocarbon. [Online] Available at:
http://en.wikipedia.org/wiki/Hydrocarbon

Chemicals manufactured by McRolls/Prowash Oy

Approval number	Test certificate reference	Approved Solvent and a combination of approved shampoos and waxes
ÖKL 558	Kemanalys 8783:1B	MacRolls Tehoemulsio (8 %)
		McRolls Vaahto, sininen (0,2 %)
		McRolls Esipesuaine (0,2 %)
		McRolls Superhuuhteluvaha (0,2 %)
		McRolls Tuoksu, Purukumi (0,1 %)
		McRolls Kiillotusvaha (0,5 %)
ÖKL 560	Kemanalys 8783:3	McRolls Mikroemulsion (6 %)
		McRolls Vaahto (0,2 %)
		McRolls Esipesuaine (0,2 %)
		McRolls Harjashampoo (0,5 %)
		McRolls Superhuuhteluvaha (0,2 %)
		McRolls Kiillotusvaha (0,5 %)
ÖKL 561	KEMANALYS 8783:4	Snowclean Snowchem 102-Z (5 %)
		Snowclean Snowchem 201-X (0,5 %)
		McRolls Vaahto (0,2 %)
		McRolls Esipesuaine (0,2 %)
		McRolls Talviharjashampoo (0,5 %)
		McRolls Superhuuhteluvaha (0,2 %)
		McRolls Kiillotusvaha (0,5 %)
ÖKL 562	KEMANALYS 8783:2	Snowclean Snowchem 201-X (0,5 %)
		McRolls Esipesuaine (0,2 %)
		McRolls Talviharjashampoo (0,5 %)
		McRolls Superhuuhteluvaha (0,2 %)
		McRolls Tuoksu, purukumi (0,1 %)
		McRolls Kiillotusvaha (0,5 %)
ÖKL 563	KEMANALYS 8783:2	Snowclean Snowchem 103-Z (5 %)
		Snowclean Snowchem 201-X (0,5 %)
		McRolls Vaahto, oranssi (0,2 %)
		McRolls Esipesuaine (0,2 %)
		McRolls Talviharjashampoo (0,5 %)
		McRolls Superhuuhteluvaha (0,2 %)
		McRolls Tuoksu, sitruuna (0,1 %)
		McRolls Kiillotusvaha (0,5 %)
ÖKL 564	KEMANALYS 8783:2	Snowclean Snowchem 103-Z (5 %)
		Snowclean Snowchem 201-X (0,5 %)
		McRolls Vaahto (0,2 %)
		McRolls Esipesuaine (0,2 %)
		McRolls Talviharjashampoo (0,5 %)

		McRolls Superhuuhteluvaha (0,2 %)
		McRolls Kiillotusvaha (0,5 %)
ÖKL 565	KEMANALYS 8577	Snowclean Snowchem 101-Z (5 %)
		Snowclean Snowchem 201-X (0,5 %)
		McRolls Vaahto, violetti (0,2 %)
		Mcrolls Hyönteisirrote(0,2 %) McRolls Esipesuaine (0,2 %)
		McRolls Harjashampoo (0,5 %)
		McRolls Superhuuhteluvaha (0,2 %)
		McRolls Tuoksu, kirsikka (0,1 %)
		McRolls Kiillotusvaha (0,5 %)
ÖKL 566	KEMANALYS 8577	Snowclean Snowchem 101-Z (5 %)
		Snowclean Snowchem 201-X (0,5 %)
		McRolls Vaahto, vihreä (0,2 %)
		Mcrolls Hyönteisirrote(0,2 %)
		McRolls Esipesuaine (0,2 %)
		McRolls Harjashampoo (0,5 %)
		McRolls Superhuuhteluvaha (0,2 %)
		McRolls Tuoksu, omena (0,1 %)
		McRolls Kiillotusvaha (0,5 %)
ÖKL 567	KEMANALYS 8577	Snowclean Snowchem 101-Z (5 %)
		Snowclean Snowchem 201-X (0,5 %)
		McRolls Vaahto (0,2 %)
		Mcrolls Hyönteisirrote(0,2 %)
		McRolls Esipesuaine (0,2 %)
		McRolls Harjashampoo (0,5 %)
		McRolls Superhuuhteluvaha (0,2 %)
		McRolls Kiillotusvaha (0,5 %)
ÖKL 568 EL		McRolls Esipesuaine
		McRolls Vaahto, violetti
		McRolls Hyönteisirrote
		McRolls Harjashampoo
		McRolls Talviharjashampoo
		McRolls Tuoksu, kirsikka
		McRolls Superhuuhteluvaha (0,2 %)
		McRolls Kiillotusvaha (0,5 %)
ÖKL 569 EL		McRolls Esipesuaine
		McRolls Vaahto
		McRolls Hyönteisirrote
		McRolls Harjashampoo
		McRolls Talviharjashampoo
		McRolls Superhuuhteluvaha (0,2 %)
		McRolls Kiillotusvaha (0,5 %)
ÖKL 570 EL		McRolls Esipesuaine

		McRolls Vaahto, vihreä
		McRolls Hyönteisirrote
		McRolls Harjashampoo
		McRolls Talviharjashampoo
		McRolls Tuoksu, omena
		McRolls Superhuuhteluvaha (0,2 %)
		McRolls Kiillotusvaha (0,5 %)
ÖKL 571 EL		McRolls Esipesuaine
		McRolls Vaahto, oranssi
		McRolls Hyönteisirrote
		McRolls Harjashampoo
		McRolls Talviharjashampoo
		McRolls Tuoksu, sitruuna
		McRolls Superhuuhteluvaha (0,2 %)
		McRolls Kiillotusvaha (0,5 %)
ÖKL 572 EL		Snowclean Snowchem 301-Y
		Snowclean Snowchem 201-X
		Snowclean Borsttvättschampo
		Snowclean Borsttvättschampo Vinter Extra
		Snowclean Glanstork Extra (0,2 %)
		McRolls Kiillotusvaha (0,5 %)

Email conversation between HSY and Metropoli lab for the analysis of Total Hydrocarbon

Lindberg Heli

Lähettäjä: Timo.Lukkarinen@metropolilab.fi
Lähetetty: 20. syyskuuta 2011 12:24
Vastaanottaja: Dahal Karna
Kopio: Lindberg Heli
Aihe: VS: About the test procedures!!

Dear Karna and Heli,

THC analysis (hydrocarbon index C10-C40) was made with Liquid-Liquid extraction with hexane (Standard method SFS-EN ISO 9377-2).
After extraction, hexane was put through Floricil cartridge, which takes the polar compouds from the extract.
So, only non-polar compounds come through the cartridge and are analysed.
After concentration of the extract it is analysed with GC-MSD.
The chromatogram is made with Scan-operation of the MSD.
Standard solutions are used to make the calibration, >C10-C21 and >C21-C40 are calculated.

C5-C10 hydrocarbons are analysed with Headspace (HS-GC-MSD) as volatile organic compounds (VOC).
MSD is operated with Scan mode and hydrocarbons are calculated as toluene.

Kind regards
Timo Lukkarinen

My new e-mail address is:
timo.lukkarinen@metropolilab.fi

Timo Lukkarinen, Chemist
MetropoliLab Oy
Viikinkaari 4, 00790 HELSINKI
Tel. +358 10 3913 461
timo.lukkarinen@metropolilab.fi www.Metropolilab.fi

This mail is confidential.
Please, let me immediately know if this mail was not meant for You.

Both the old and new data of the service stations D, H, E, M, K and G for comparison and analyses

				pH	Conductivity	SS	BOD7	CODCr	Total P	Total N	Oil level	F	AshSS	Cu	Zn	Cd	Cr	Pb	Ni	C5-C10	C10-C21	C21-C40
				4	4	6,8	13	15,9	14	18,4		11,4	4,7	9,5	9,5	9,5	9,5	9,5	9,5			
Sample Number	Date	Codes	K ±		± mS/m	± mg/l	± O2 mg/l	± O2 mg/l	± mg/l	± mg/l	± cm	± mg/l	± mg/l	± mg/l	± mg/l	± mg/l	± mg/l	± mg/l	± mg/l	± µg/l	± µg/l	± µg/l
2006-00498-01	2006	D	X	7,2	33	480	570	1800	0,82	20	-	-	-	-	-	-	-	-	-	-	-	-
2008-00768-01	2008	Dave	X	6,25	34,5	490	325	940	0,865	6,65		-	-	-	-	-	-	-	-	-	-	-
2011-00239-01	2011	D		6,5	22	64	210	540	5,3	3,2	1		15	<0,1	0,26	<0,1	<0,1	<0,1	<0,1	-	-	-
2006-00239-01	2006	Have	X	6,35	104	355	225	1725	10,8	80	50,5	-	-	-	-	-	-	-	-	-	-	-
2007-00057-01	2007	H	X	6,6	47	820	110	540	0,34		1,9	-	-	-	-	-	-	-	-	-	-	-
2008-00567-01	2008	Have	X	6,75	66,5	580	730	1305	15,69	68,65	0,5	-	-	-	-	-	-	-	-	-	-	-
2009-00460-01	2009	Have	X	7,15	46,5	73,5	260	605	0,1	4,5	-	-	31	-	-	-	-	-	-	-	-	-
2010-00496-01	181010	Have	X	6,0	135,7	783,3	1403,3	2733,3	23,7	211,3	-	-	120	-	-	-	-	-	-	-	-	-
2011-00247-01	2011	H		7	18	68	190	360	0,14	3,7	0		46	0,13	0,29	<0,1	<0,1	<0,1	<0,1	47	4900	1800
2006-00189-01	2006	E	X	7,6	23	97	57	260	0,98	14	3	-	-	-	-	-	-	-	-	-	-	-
2007-01415-01	2007	E	X	7,2	34	28	88	250	2,9	34	1\2	-	-	-	-	-	-	-	-	-	-	-
2008-00158-01	2008	E	X	7,1	53	150	300	1100	2,9	19	-	-	-	-	-	-	-	-	-	-	-	-
2011-00240-01	2011	E		6,8	58	190	280	690	4,4	35	1		28	0,11	0,31	<0,1	<0,1	<0,1	<0,1	-	-	-
2006-00198-01	2006	M	X	6,9	27	120	160	290	2,4	24	-	-	-	-	-	-	-	-	-	-	-	-
2008-01430-01	2008	M	X	6,9	41	660	230	770	2,6	9,9	8	-	-	-	-	-	-	-	-	-	-	-
2011-00252-01	2011	M		7,1	18	92	39	170	1,6	<2,0	0		64	0,17	0,16	<0,1	<0,1	<0,1	<0,1	60	4500	1100
2006-00493-01	2006	K	X	7,3	57	340	470	1600	8,4	48	1	-	-	-	-	-	-	-	-	-	-	-
2008-01211-01	2008	K	X	6,6	37	42	290	560	2,2	6,5	3	-	-	-	-	-	-	-	-	-	-	-
2009-01092-01	2009	Kave	X	7,1	100	110	380	760	11,55	51,5		-	4	-	-	-	-	-	-	-	-	-
2011-00250-01	2011	K		6,4	24	2100	360	1900	4,7	12	3		1900	2,5	3,2	<0,1	0,36	<0,1	<0,1	189	48000	11000
2006-00497-01	2006	G	X	7,3	33	590	1400	2700	0,68	13	-	-	-	-	-	-	-	-	-	-	-	-
2009-00458-01	2009	G	X	7	33	1900	350	1200	25		2	1	1600	-	-	-	-	-	-	-	-	-
2011-00246-01	2011	G		6,7	35	590	260	990	9,5	8,7	1		480	0,45	2,2	<0,1	<0,1	<0,1	<0,1	24	49000	23000

The new data consisting of the laboratory results for all the service stations

				pH	Conductivity	SS	BOD7	CODCr	Total P	Total N	Oil level	F	AshSS	Cu	Zn	Cd	Cr	Pb	Ni	C5-C10	C10-C21	C21-C40
				4	4	6,8	13	15,9	14	18,4		11,4	4,7	9,5	9,5	9,5	9,5	9,5	9,5			
Sample Number	Date	Codes	K ±		± mS/m	± mg/l	± O2 mg/l	± O2 mg/l	± mg/l	± mg/l	± cm	± mg/l	± mg/l	± mg/l	± mg/l	± mg/l	± mg/l	± mg/l	± mg/l	± µg/l	± µg/l	± µg/l
2011-00168-01	300511	A1	X	6,9	22	190	89	330	2,2	5,1	0		130	-	-	-	-	-	-	-	-	-
2011-00168-02	160811	A2		6,9	19	59	47	180	0,99	3,2	0		31	0,12	0,92	<0,1	<0,1	<0,1	<0,1	25	9300	4800
2011-00195-01	160611	B1	X	6,9	20	76	66	170	2,2	<2,0	0		45	-	-	-	-	-	-	-	-	-
2011-00195-02	160811	B2		6,7	20	110	66	220	3,2	<2,0	0		81	0,22	0,26	<0,1	<0,1	<0,1	<0,1	745	29000	2900
2011-00204-01	210611	C	X	6,6	41	25	340	710	25	4,1	1		-	-	-	<0,1	-	-	-	-	-	-
2011-00239-01	80811	D		6,5	22	64	210	540	5,3	3,2	1		15	<0,1	0,26	<0,1	<0,1	<0,1	<0,1	-	-	-
2011-00240-01	90811	E		6,8	58	190	280	690	4,4	35	1		28	0,11	0,31	<0,1	<0,1	<0,1	<0,1	-	-	-
2011-00241-01	90811	F		6,7	9	320	52	420	1,4	<2,0	0		250	0,42	0,54	<0,1	<0,1	<0,1	<0,1	-	-	-
2011-00246-01	110811	G		6,7	35	590	260	990	9,5	8,7	1		480	0,45	2,2	<0,1	<0,1	<0,1	<0,1	24	49000	23000
2011-00247-01	110811	H		7	18	68	190	360	0,14	3,7	0		46	0,13	0,29	<0,1	<0,1	<0,1	<0,1	47	4900	1800
2011-00248-01	120811	I		6,7	22	2000	280	1500	7,3	17	0		1800	3,7	4,1	<0,1	0,49	<0,1	<0,1	842	20	3400
2011-00249-01	120811	J		6,7	27	630	240	1700	10	10	0		540	1,9	3,3	<0,1	0,24	<0,1	<0,1	474	42000	8400
2011-00250-01	150811	K		6,4	24	2100	360	1900	4,7	12	3		1900	2,5	3,2	<0,1	0,36	<0,1	<0,1	189	48000	11000
2011-00251-01	150811	L		6,4	24	33	87	250	5,5	<2,0	3		10	<0,1	0,22	<0,1	<0,1	<0,1	<0,1	96	6800	360
2011-00252-01	150811	M		7,1	18	92	39	170	1,6	<2,0	0		64	0,17	0,16	<0,1	<0,1	<0,1	<0,1	60	4500	1100

Whole data record from 2005 to 2011 for all the service stations including other service stations in the operative area of HSY

Min:
Norm.:
Max: 11

Näyte	Päivä	Asiakas	X ±	pH 4.00	Sähkönjoht 4.00 ± mS/m	Kiintoaine 6.80 ± mg/l	BOD7 13.00 ± O2 mg/l	CODCr 15.90 ± O2 mg/l	Pkok 14.00 ± mg/l
2005-00172-01	250505	–		7.2	35	26	160	400	0.09
2005-00225-01	280605	–		7.1	21	240	190	590	0.34
2005-00297-01	090905	–		6.9	29	7300	410	2500	6.7
2005-00428-01	011205	D		7.0	24	37	21	100	0.95
2006-00135-01	010606	H		5.0	120	500	180	2800	12
2006-00160-01	210606	–	X	6.9	25	1100	350	1400	1.2
2006-00180-01	310706	–	X	6.7	21	230	200	470	0.45
2006-00186-01	030806	–	X	7.4	110	520	590	1200	23
2006-00189-01	040806	E	X	7.6	23	97	57	260	0.98
2006-00198-01	110806	M	X	6.9	27	120	160	290	2.4
2006-00218-01	180806	–		6.7	58	66	340	610	1.6
2006-00239-01	060906	H	X	7.7	88	210	270	650	9.6
2006-00240-01	060906	–	X	5.9	21	220	250	550	0.60
2006-00245-01	070906	–	X	5.8	21	290	300	550	0.71
2006-00258-01	140906	–		5.4	110	290	1300	1900	9.7
2006-00289-01	171006	–		6.8	150	620	1300	1900	19
2006-00347-01	011106	–	X	7.6	19	19	66	210	0.08
2006-00493-01	051206	K	X	7.3	57	340	470	1600	8.4
2006-00497-01	071206	G	X	7.3	33	590	1400	2700	0.68
2006-00498-01	071206	D	X	7.2	33	480	570	1800	0.82
2007-00057-01	150107	H		6.6	47	820	110	540	0.34
2007-00113-01	120107	–		-	-	-	-	-	-
2007-00535-01	300407	–	X	8.2	190	2700	740	2300	37
2007-00536-01	300407	–	X	5.4	39	94	580	1100	1.4
2007-01415-01	040907	E	X	7.2	34	28	88	250	2.9
2008-00041-01	140108	–	X	6.6	99	3300	750	3900	12
2008-00135-01	050208	H	X	6.1	100	1100	1200	2000	31
2008-00139-01	060208	–	X	6.8	47	360	300	700	0.32
2008-00158-01	110208	E	X	7.1	53	150	300	1100	2.9
2008-00542-01	200508	D	X	6.2	34	760	380	1000	1.0
2008-00566-01	230508	–	X	6.9	37	20	450	880	0.23
2008-00567-01	230508	H	X	7.4	33	60	260	610	0.38
2008-00698-01	100608	–	X	7.2	46	290	350	660	4.2

Min:
Norm.:
Max: 11

Näyte	Päivä	Asiakas	K ±	pH 4.00	Sähkönjoht 4.00 ± mS/m	Kiintoaine 6.80 ± mg/l	BOD7 13.00 ± O2 mg/l	CODCr 15.90 ± O2 mg/l	Pkok 14.00 ± mg/l
2008-00768-01	250608	D	X	6.3	35	220	270	880	0.73
2008-00769-01	250608	–	X	7.1	170	1900	330	990	2.3
2008-01162-01	230908	–	X	7.1	40	34	510	1300	4.8
2008-01172-01	240908	–	X	6.9	41	17	270	440	0.20
2008-01173-01	240908	–	X	6.8	180	500	820	1200	38
2008-01211-01	021008	K	X	6.6	37	42	290	560	2.2
2008-01214-01	021008	–	X	7.3	22	150	30	180	1.0
2008-01215-01	021008	–	X	7.0	38	21	29	140	2.2
2008-01216-01	021008	–	X	6.8	38	3500	590	2500	16
2008-01224-01	061008	–	X	7.1	37	5200	700	3500	6.1
2008-01254-01	141008	–	X	5.4	32	33	410	710	0.06
2008-01327-01	031108	–	X	7.0	42	220	140	670	11
2008-01328-01	031108	–	X	6.5	31	39	94	280	9.8
2008-01355-01	101108	–	X	6.3	110	970	1300	2600	15
2008-01426-01	271108	–	X	6.7	150	340	650	1300	31
2008-01430-01	281108	M	X	6.9	41	660	230	770	2.6
2008-01461-01	081208	–	X	7.2	54	120	460	1600	3.1
2008-01462-01	081208	–	X	6.2	47	1400	630	2000	2.7
2008-01467-01	091208	–	X	7.0	40	100	230	560	0.10
2008-01468-01	091208	–	X	7.3	51	1900	850	2500	1.3
2008-01498-01	161208	–	X	6.2	98	630	830	1900	12
2009-00161-01	120209	H	X	7.3	64	97	300	690	0.10
2009-00214-01	270209	–	X	7.2	93	200	210	590	1.4
2009-00219-01	020309	–	X	8.0	81	330	460	1400	3.5
2009-00348-01	310309	–	X	6.2	68	1800	460	2500	2.4
2009-00349-01	310309	–	X	7.1	26	120	120	370	0.76
2009-00356-01	020409	K	X	6.9	50	140	290	650	2.1
2009-00458-01	040509	S		7.0	33	1900	350	1200	25
2009-00459-01	040509	–		7.0	33	110	100	360	5.6
2009-00460-01	040509	H	X	7.0	29	50	220	520	0.10
2009-00834-01	070809	–	X	6.8	25	20	160	260	0.13
2009-00983-01	100909	–	X	6.7	27	210	81	400	9.6
2009-01092-01	051009	K	X	7.3	150	80	470	870	21

Min:
Norm.:
Max: 11

Näyte	Päivä	Asiakas	K ±	pH 4.00	Sähkönjoht 4.00 ± mS/m	Kiintoaine 6.80 ± mg/l	BOD7 13.00 ± O2 mg/l	CODCr 15.90 ± O2 mg/l	Pkok 14.00 ± mg/l
2009-01093-01	051009	-	X	8.0	42	1200	800	1900	42
2009-01358-01	101209	-	X	5.3	89	1700	1500	3000	12
2010-00232-01	070410	-	X	6.4	110	1300	650	2500	12
2010-00234-01	080410	-	X	7.1	37	51	280	590	7.2
2010-00352-01	210610	H	X	5.3	110	630	1200	2500	19
2010-00399-01	160810	-	X	6.3	27	230	300	670	5.6
2010-00496-01	181010	H	X	6.0	97	620	810	2400	14
2010-00497-01	181010	-	X	6.4	66	190	510	960	7.4
2010-00557-01	221110	H	X	6.8	200	1100	2200	3300	38
2011-00168-01	300511	A		6.9	22	190	89	330	2.2
2011-00168-02	160811	A	X	6.9	19	59	47	180	0.99
2011-00195-01	160611	B		6.9	20	76	66	170	2.2
2011-00195-02	160811	B	X	6.7	20	110	66	220	3.2
2011-00204-01	210611	C	X	6.6	41	25	340	710	25
2011-00239-01	080811	D	X	6.5	22	64	210	540	5.3
2011-00240-01	090811	E	X	6.8	58	190	280	690	4.4
2011-00241-01	090811	-	X	6.7	9	320	52	420	1.4
2011-00246-01	110811	G	X	6.7	35	590	260	990	9.5
2011-00247-01	110811	H	X	7.0	18	68	190	360	0.14
2011-00248-01	120811	-	X	6.7	22	2000	280	1500	7.3
2011-00249-01	120811	J	X	6.7	27	630	240	1700	10
2011-00250-01	150811	K	X	6.4	24	2100	360	1900	4.7
2011-00251-01	150811	-	X	6.4	24	33	87	250	5.5
2011-00252-01	150811	M	X	7.1	18	92	39	170	1.6

Min:
Norm.:
Max: 11

Näyte	Päivä	Asiakas	K ±	pH 4.00	± Sähkönjoht 4.00 mS/m	± Kiintoaine 6.80 mg/l	± BOD7 13.00 O2 mg/l	± CODCr 15.90 O2 mg/l	± Pkok 14.00 mg/l

Tilasto

	pH	Sähkönjoht	Kiintoaine	BOD7	CODCr	Pkok
Lkm.:	89	89	89	89	89	89
Keskiarvo:	6.8	56	669.6	425.1	1144	7.5
Min:	5	9	17	21	100	0.06
Max:	8.2	200	7300	2200	3900	42
Keskihajon	0.6	43	1132.3	392	906	9.89

Näyte	Nkok	Öljykerros	F	HehkutusSS	Maksu	Cu	Zn	Cd
Min:								
Norm.:								
Max:			1,5					
	18.40		11.40	4.70		9.50	9.50	9.50
	± mg/l	± cm	± mg/l	± mg/l	± €/m3	± mg/l	± mg/l	± mg/l
2008-00768-01	7.4	1	-	-	-	-	-	-
2008-00769-01	9.4	1	-	-	-	-	-	-
2008-01162-01	13	-	-	-	-	-	-	-
2008-01172-01	3.1	-	-	-	-	-	-	-
2008-01173-01	420	-	-	-	-	-	-	-
2008-01211-01	6.5	3	-	-	-	-	-	-
2008-01214-01	<2.0	-	-	-	-	-	-	-
2008-01215-01	<2.0	-	-	-	-	-	-	-
2008-01216-01	11	-	-	-	-	-	-	-
2008-01224-01	25	-	-	-	-	-	-	-
2008-01254-01	6.2	-	-	-	-	-	-	-
2008-01327-01	5.0	1	-	-	-	-	-	-
2008-01328-01	<2.0	1	-	-	-	-	-	-
2008-01355-01	110	1	-	-	-	-	-	-
2008-01426-01	320	1	-	-	-	-	-	-
2008-01430-01	9.9	8	-	-	-	-	-	-
2008-01461-01	4.9	0	-	78	-	-	-	-
2008-01462-01	11	0	-	1100	-	-	-	-
2008-01467-01	4.1	-	-	79	-	-	-	-
2008-01468-01	11	-	-	1600	-	-	-	-
2008-01498-01	60	-	-	-	-	-	-	-
2009-00161-01	5.4	-	-	57	-	-	-	-
2009-00214-01	4.9	-	-	140	-	-	-	-
2009-00219-01	5.1	-	-	270	-	-	-	-
2009-00348-01	9.2	1	-	1500	2.01	-	-	-
2009-00349-01	4.9	1	-	79	0,76	-	-	-
2009-00356-01	19	1	-	98	0.93	-	-	-
2009-00458-01	2.0	1	-	1600	-	-	-	-
2009-00459-01	<2.0	0	-	83	-	-	-	-
2009-00460-01	3.6	-	-	31	0.75	-	-	-
2009-00834-01	2.7	1	-	5.0	-	-	-	-
2009-00983-01	4.9	1	-	150	0.98	-	-	-
2009-01092-01	84	3	-	4.0	1.58	-	-	-

Min:
Norm.:
Max: 1,5

	Nkok	Öljykerros	F	HehkutusSS	Maksu	Cu	Zn	Cd
	18.40		11.40	4.70		9.50	9.50	9.50
Näyte	± mg/l	± cm	± mg/l	± mg/l	± €/m3	± mg/l	± mg/l	± mg/l
2009-01093-01	100	1	-	120	2.89	-	-	-
2009-01358-01	53	-	-	1000	-	-	-	-
2010-00232-01	120	-	-	910	-	-	-	-
2010-00234-01	20	0	-	17	-	-	-	-
2010-00352-01	94	-	-	210	-	-	-	-
2010-00399-01	21	-	-	-	-	-	-	-
2010-00496-01	110	-	-	120	-	-	-	-
2010-00497-01	66	-	-	48	-	-	-	-
2010-00557-01	430	-	-	160	-	-	-	-
2011-00168-01	5.1	<1	-	130	-	-	-	-
2011-00168-02	3.2	<1	-	31	-	0.12	0.92	<0.01
2011-00195-01	<2.0	<1	-	45	-	-	-	-
2011-00195-02	<2.0	<1	-	81	-	0.22	0.26	<0.01
2011-00204-01	4.1	1	-	-	-	-	-	-
2011-00239-01	3.2	1	-	15	-	<0.1	0.26	<0.01
2011-00240-01	35	1	-	28	-	0.11	0.31	<0.01
2011-00241-01	<2.0	<1	-	250	-	0.42	0.54	<0.01
2011-00246-01	8.7	1	-	480	-	0.45	2.2	<0.01
2011-00247-01	3.7	<1	-	46	-	0.13	0.29	<0.01
2011-00248-01	17	<1	-	1800	-	3.7	4.1	<0.01
2011-00249-01	10	<1	-	540	-	1.9	3.3	<0.01
2011-00250-01	12	3	-	1900	-	2.5	3.2	<0.01
2011-00251-01	<2.0	3	-	10	-	<0.1	0.22	<0.01
2011-00252-01	<2.0	<1	-	64	-	0.17	0.16	<0.01

Min:								
Norm.:								
Max:			1,5					

	Nkok 18.40	Öljykerros	F 11.40	HehkutusSS 4.70	Maksu	Cu 9.50	Zn 9.50	Cd 9.50
Näyte	± mg/l	± cm	± mg/l	± mg/l	± €/m3	± mg/l	± mg/l	± mg/l

Tilasto								
Lkm.:	89	52	1	38	7	12	12	12
Keskiarvo:	44.45	1	0.7	391.6	1.414286	0.83	1.31	0.01
Min:	1.3	0	0.7	4	0.75	0.1	0.16	0.01
Max:	430	8	0.7	1900	2.89	3.7	4.1	0.01
Keskihajon	87.8	1		576.7	0.801308	1.2	1.47	0

Min:
Norm.:
Max:

Näyte	Cr 9.50 ± mg/l	Pb 9.50 ± mg/l	Ni 9.50 ± mg/l	C5-C10 ± µg/l	C10-C21 ± µg/l	C21-C40 ± µg/l
2005-00172-01	-	-	-	-	-	-
2005-00225-01	-	-	-	-	-	-
2005-00297-01	-	-	-	-	-	-
2005-00428-01	-	-	-	-	-	-
2006-00135-01	-	-	-	-	-	-
2006-00160-01	-	-	-	-	-	-
2006-00180-01	-	-	-	-	-	-
2006-00186-01	-	-	-	-	-	-
2006-00189-01	-	-	-	-	-	-
2006-00198-01	-	-	-	-	-	-
2006-00218-01	-	-	-	-	-	-
2006-00239-01	-	-	-	-	-	-
2006-00240-01	-	-	-	-	-	-
2006-00245-01	-	-	-	-	-	-
2006-00258-01	-	-	-	-	-	-
2006-00289-01	-	-	-	-	-	-
2006-00347-01	-	-	-	-	-	-
2006-00493-01	-	-	-	-	-	-
2006-00497-01	-	-	-	-	-	-
2006-00498-01	-	-	-	-	-	-
2007-00057-01	-	-	-	-	-	-
2007-00113-01	-	-	-	-	-	-
2007-00535-01	-	-	-	-	-	-
2007-00536-01	-	-	-	-	-	-
2007-01415-01	-	-	-	-	-	-
2008-00041-01	-	-	-	-	-	-
2008-00135-01	-	-	-	-	-	-
2008-00139-01	-	-	-	-	-	-
2008-00158-01	-	-	-	-	-	-
2008-00542-01	-	-	-	-	-	-
2008-00566-01	-	-	-	-	-	-
2008-00567-01	-	-	-	-	-	-
2008-00698-01	-	-	-	-	-	-

Min:
Norm.:
Max:

Näyte	Cr 9.50 ± mg/l	Pb 9.50 ± mg/l	Ni 9.50 ± mg/l	C5-C10 ± µg/l	C10-C21 ± µg/l	C21-C40 ± µg/l
2008-00768-01	-	-	-	-	-	-
2008-00769-01	-	-	-	-	-	-
2008-01162-01	-	-	-	-	-	-
2008-01172-01	-	-	-	-	-	-
2008-01173-01	-	-	-	-	-	-
2008-01211-01	-	-	-	-	-	-
2008-01214-01	-	-	-	-	-	-
2008-01215-01	-	-	-	-	-	-
2008-01216-01	-	-	-	-	-	-
2008-01224-01	-	-	-	-	-	-
2008-01254-01	-	-	-	-	-	-
2008-01327-01	-	-	-	-	-	-
2008-01328-01	-	-	-	-	-	-
2008-01355-01	-	-	-	-	-	-
2008-01426-01	-	-	-	-	-	-
2008-01430-01	-	-	-	-	-	-
2008-01461-01	-	-	-	-	-	-
2008-01462-01	-	-	-	-	-	-
2008-01467-01	-	-	-	-	-	-
2008-01468-01	-	-	-	-	-	-
2008-01498-01	-	-	-	-	-	-
2009-00161-01	-	-	-	-	-	-
2009-00214-01	-	-	-	-	-	-
2009-00219-01	-	-	-	-	-	-
2009-00348-01	-	-	-	-	-	-
2009-00349-01	-	-	-	-	-	-
2009-00356-01	-	-	-	-	-	-
2009-00458-01	-	-	-	-	-	-
2009-00459-01	-	-	-	-	-	-
2009-00460-01	-	-	-	-	-	-
2009-00834-01	-	-	-	-	-	-
2009-00983-01	-	-	-	-	-	-
2009-01092-01	-	-	-	-	-	-

Min:
Norm.:
Max:

Näyte	Cr 9.50 ± mg/l	Pb 9.50 ± mg/l	Ni 9.50 ± mg/l	C5-C10 ± µg/l	C10-C21 ± µg/l	C21-C40 ± µg/l
2009-01093-01	-	-	-	-	-	-
2009-01358-01	-	-	-	-	-	-
2010-00232-01	-	-	-	-	-	-
2010-00234-01	-	-	-	-	-	-
2010-00352-01	-	-	-	-	-	-
2010-00399-01	-	-	-	-	-	-
2010-00496-01	-	-	-	-	-	-
2010-00497-01	-	-	-	-	-	-
2010-00557-01	-	-	-	-	-	-
2011-00168-01	-	-	-	-	-	-
2011-00168-02	<0.1	<0.1	<0.1	25	9300	4800
2011-00195-01	-	-	-	-	-	-
2011-00195-02	<0.1	<0.1	<0.1	745	29000	2900
2011-00204-01	-	-	-	-	-	-
2011-00239-01	<0.1	<0.1	<0.1	-	-	-
2011-00240-01	<0.1	<0.1	<0.1	-	-	-
2011-00241-01	<0.1	<0.1	<0.1	-	-	-
2011-00246-01	<0.1	<0.1	<0.1	24	49000	23000
2011-00247-01	<0.1	<0.1	<0.1	47	4900	1800
2011-00248-01	0.49	<0.1	<0.1	842	20	3400
2011-00249-01	0.24	<0.1	<0.1	474	42000	8400
2011-00250-01	0.36	<0.1	<0.1	189	48000	11000
2011-00251-01	<0.1	<0.1	<0.1	96	6800	360
2011-00252-01	<0.1	<0.1	<0.1	60	4500	1100

HSY

4.10.2011

Emission limits for sewer water in the Operative area of Viikinmäki and Suomenoja wastewater treatment Plants

Limit Values of Metals

Metal		Maximum concentration in mg/l
Arsenic	(As)	0,1
Mercury	(Hg)	0,01
Silver	(Ag)	0,2
Cadmium	(Cd)	0,01
Total Chromium	(Cr)	1,0
Chromium (VI)	(Cr^{6+})	0,1
Copper	(Cu)	2,0
Lead	(Pb)	0,5
Nickel	(Ni)	0,5
Zinc	(Zn)	3,0
Tin	(Sn)	2,0

Other special limit values

Aciditic (pH-value)	6,0 - 11,0
Temperature	40ºC
Sulphate	400 mg/l
Total Cyanide CN	0,5 mg/l

Specific Limit Values

Specific limit and load values can be set for sewerage and refinery actions, for example:

Acidity (pH-value)
Solids
Metals
Fat (Food industry)
BOD_7 (Biological oxygen demand)
Interfering substances for nitrogen removal

Helsingin seudun ympäristöpalvelut -kuntayhtymä HSY
PL 100, 00066 HSY, Opastinsilta 6 A, 00520 Helsinki
Puh. 09 156 11, Fax 09 1561 2011, Y-2274241-9, www.hsy.fi

Samkommunen Helsingforsregionens miljötjänster HRM
PB 100, 00066 HSY, Semaforbron 6 A, 00520 Helsingfors
Tfn. 09 156 11, Fax 09 1561 2011, FO-2274241-9, www.hsy.fi

4.10.2011

Volatile Organic Compounds (VOC) – Solvent Guidelines

1. Extremely flammable, highly flammable solvents and water insoluble VOCs (for example, diethyl ether, petroleum ether, cyclohexane).
    - It's not allowed to apply them into the sewer system.
2. Chlorinated VOCs (eg. trichloroethylene, chloroform and carbon tetrachloride)
    - It's not allowed to apply them into the sewer system.
3. Chlorine-free VOCs (eg. toluene and xylene).
    - Compounds in effluent of wastewater to a sewerage system must not contain more than 3 mg/l.
4. Water content mineral oil discharge (C_{10}-C_{40}) must not be exceeded more than 100 mg /l. (Government decree 444/2010, Environmental protection requirements of liquid fuel distribution stations).

Pay Attention

1. If the treated water does not meet the above requirements, it should not be diluted to achieve the limit values. Limit values concern also batches of waste water to sewer. The application of above limit values is described in agreements.
2. In case of non-residential wastewater discharges following Government's regulations must be followed:
    - Government's regulations for the water environment, dangerous and harmful substances in 868/2010.
    - Environmental protection decree no 889/2006 (36 §), list of substances found from Annexes 1 and 2.
3. Cleaning chemicals and detergents used in service stations, garages and car washes must be approved by the Finnish Petroleum Federation (SFS 3352/8.11.2004: Instructions for stations distributing flammable substances)

Harmful and hazardous substances specified in the different environmental legislations (VVY Industrial Wastewater Guide Book 2011)

LIITE 12 TOIMINNAHARJOITTAJAN ILMOITUS KÄYTTÄMISTÄÄN HAITALLISISTA JA VAARALLISISTA AINEISTA

1 = Valtioneuvoston asetus ympäristönsuojeluasetuksen muuttamisesta (889/2006):

2 = Valtioneuvoston asetus vesiympäristölle vaarallisista ja haitallisista aineista annetun valtioneuvoston asetuksen muuttamisesta (868/2010)

3 = Euroopan parlamentin ja neuvoston asetus (EY) N:o 166/2006 epäpuhtauksien päästöjä ja siirtoja koskevan eurooppalaisen rekisterin perustamisesta ja neuvoston direktiivien 91/689/ETY ja 96/61/EY muuttamisesta

Substances	CAS-nro	Decree
(bentsotiatsoli-2-yylitio) metyylitiosyanaatti (TCMTB)	21564-17-0	2
1,1,1-trikloorietaani	71-55-6	3
1,1,2,2-tetrakloorietaani	79-34-5	3
1,2,3,4,5,6-heksakloorisykloheksaani (HCH)	608-73-1	3
1,2-diklooribentseeni	95-50-1	2
1,2-dikloorietaani (EDC)	107-06-2	2.3
1,4-diklooribentseeni	106-46-7	2
Aineet ja seokset, jotka voivat haitata vesien käyttöä		1
Aineet ja valmisteet, joilla osoitetaan olevan karsinogeenisia, mutageenisia tai lisääntymiseen vaikuttavia ominaisuuksia		1
Alakloori	15972-60-8	2.3
Aldriini	309-00-2	2.3
Ammoniakki (NH3)	7664-41-7	3
Antimoni ja antimoniyhdisteet		1
Antraseeni	120-12-7	2.3
Arseeni ja arseeniyhdisteet		1.3
Asbesti	1332-21-4	3

Atratsiini	1912-24-9	2.3
Barium ja bariumyhdisteet		1
Bentseeni	71-43-2	2.3
Bentso(a)pyreeni	50-32-8	2
Bentso(b)-fluoranteeni	205-99-2	2
Bentso (g,h,i)peryleeni	191-24-2	2.3
Bentso(k)-fluoranteeni	207-08-9	2
Bentsotiatsoli-2-tioli (di(bentsotiatsoli-2-yyli)disulfidin (CAS 120-78-5) hajoamistuote)	149-30-4	2
Bentsyylibutyyliftalaatti (BBP)	85-68-7	2
Beryllium ja berylliumyhdisteet		1
Biosidit ja kasvinsuojeluaineet		1
Biosidivalmisteet ja niiden johdannaiset		1
Boori ja booriyhdisteet		1
Aine	**CAS-nro**	**Asetus**
Bromatut difenyylieetterit (PBDE)	32534-81-9	2.3
Bronopoli (2-bromi-2-nitropropaani-1,3-diol)	52-51-7	2
C10-13-kloorialkaanit	85535-84-8	2
DDT	50-29-3	2.3
Di(2-etyyliheksyyli) ftalaatti (DEHP)	117-81-7	2.3
Dibutyyliftalaatti (DBP)	84-74-2	2
Dieldriini	60-57-1	2.3
Dikloorimetaani (DCM)	75-09-2	2.3
Dimetoaatti	60-51-5	2
Dityppioksidi (N2O)	10024-97-2	3
Diuroni	330-54-1	2.3
Elohopea ja elohopeayhdisteet		3
Elohopea ja elohopeayhdisteet	7439-97-6	1,2,3

Endosulfaani	115-29-7	2.3
Endriini	72-20-8	2.3
Etyleenioksidi	75-21-8	3
Etyleenitiourea (mankotsebin (CAS 8018-01-7) hajoamistuote)	96-45-7	2
Etyylibentseeni	100-41-4	3
Fenolit	108-95-2	3
Fluoranteeni	206-44-0	2.3
Fluori ja epäorgaaniset yhdisteet		3
Fluoridit		1.3
Fluorihiilivedyt (HFC-yhdisteet)		3
Halogenoidut orgaaniset yhdisteet (AOX:nä)		3
Halonit		3
Happitasapainoon epäedullisesti vaikuttavat aineet		1
Heksabromibifenyyli	36355-1-8	3
Heksaklooribentseeni (HCB)	118-74-1	2.3
Heksaklooributadieeni (HCBD)	87-68-3	2.3
Heksakloorisykloheksaani (gamma-isomeeri, lindaani)	608-73-1	2
Heptakloori	76-44-8	3
Hiilidioksidi (CO2)	124-38-9	3
Hiilimonoksidi (CO)	630-08-0	3
Hiilitetrakloridi	56-23-5	2
Hiukkaset (PM10)		3
Hopea ja hopeayhdisteet		1
Indeno (1,2,3-cd)pyreeni	193-39-5	2
Isodriini	465-73-6	2.3
Isoproturoni	34123-59-6	2.3
Kadmium ja kadmiumyhdisteet (veden kovuusluokasta	7440-43-9	1,2,3

riippuen)		
Kasvinsuojeluaineet ja niiden johdannaiset		1
Aine	**CAS-nro**	**Asetus**
Kloori ja epäorgaaniset yhdisteet		3
Kloorialkaanit, C10–C13	85535-84-8	2.3
Klooribentseeni	108-90-7	2
Kloorifluorihiilivedyt (CFC-yhdisteet)		3
Klordaani	57-74-9	3
Klordekoni	143-50-0	3
Klorfenvinfossi	470-90-6	2.3
Kloridit		3
Klorpyrifossi (klorpyrifossi-etyyli)	2921-88-2	2.3
Koboltti ja kobolttiyhdisteet		1
Kokonais-DDT	ei sovelleta	2
Kokonaisfosfori		3
Kokonaistyppi		3
Kromi ja kromiyhdisteet		1.3
Ksyleenit	1330-20-7	3
Kupari ja kupariyhdisteet		1.3
Lindaani	58-89-9	3
Lisääntymiselle vaaralliset yhdisteet		1
Lyijy ja lyijy-yhdisteet	7439-92-1	1,2,3
MCPA (4-kloori-2-metyylifenoksietikka-happo)	94-74-6	2
Metaani (CH4)	74-82-8	3
Metallit ja niiden yhdisteet		1
Metamitroni (4-amino-3-metyyli-6-fenyyli-1,2,4-triarsiini-5-oni)	41394-05-2	2
Mineraaliöljyt		1

Mireksi	2385-85-5	3
Molybdeeni ja molybdeeniyhdisteet		1
Muut haihtuvat orgaaniset yhdisteet kuin metaani (NMVOC-yhdisteet)		3
Muut vesiympäristölle tai vesiympäristön kautta terveydelle tai ympäristölle vaaralliset tai haitalliset aineet		1
Naftaleeni	91-20-3	2.3
Nikkeli ja nikkeliyhdisteet	7440-02-0	1,2,3
Nonyylifenoli (4-nonyyli-fenoli)	104-40-5	2
Nonyylifenoli ja nonyylifenolietoksylaatit (NP/NPE-yhdisteet)		3
Oktyylifenoli ((4-(1,1,3,3-tetrametyyli-butyyli)-fenoli))	140-66-9	2
Oktyylifenolit ja oktyylifenolietoksylaatit	1806-26-4	3
Orgaaniset tinayhdisteet		1
Orgaanisen hiilen kokonaismäärä (TOC)		3
Orgaaniset fosforiyhdisteet		1
Aine	**CAS-nro**	**Aset us**
Orgaaniset halogeeniyhdisteet ja aineet, jotka vesiympäristössä voivat muodostaa sellaisia yhdisteitä		1
Orgaaniset tinayhdisteet		1.3
Organofosforiyhdisteet		1
Osittain halogenoidut kloorifluorihiilivedyt (HCFC-yhdisteet)		3
Para-para-DDT	50-29-3	2
PCDD + PCDF (dioksiinit + furaanit) (TEQ)		3
Pentaklooribentseeni	608-93-5	2.3
Pentakloorifenoli (PCP)	87-86-5	2.3
Perfluorihiilivedyt (PFC-yhdisteet)		3

Perimää vaurioittavat yhdisteet		1
Polyklooratut bifenyylit (PCB-yhdisteet)	1336-36-3	3
Polysykliset aromaattiset hiilivedyt (PAH-yhdisteet)		2.3
Prokloratsi (N-propyyli-N-[2-(2,4,6-trikloorifenoksi)etyyli]-1H-imidatsoli-1-karboksamidi)	67747-09-5	2
Pysyvät hiilivedyt		1
Pysyvät sekä biokertyvät myrkylliset orgaaniset aineet		1
Rehevöitymistä aiheuttavat aineet, erityisesti nitraatit ja fosfaatit		1
Resorsinoli (1,3-bentseenidioli)	108-46-3	2
Rikin oksidit (SOx/SO2)		3
Rikkiheksafluoridi (SF6)	2551-62-4	3
Seleeni ja seleeniyhdisteet		1
Simatsiini	122-34-9	2.3
Sinkki ja sinkkiyhdisteet		1.3
Suspendoituneet aineet		1
Syaanivety (HCN)	74-90-8	3
Syanidit		1.3
Syklodieeni-torjunta-aineet: aldriini dieldriini endriini isodriini	309-00-2 60-57-1 72-20-8 465-73-6	2
Syöpää aiheuttavat yhdisteet		1
Tallium ja talliumyhdisteet		1
Telluuri ja telluuriyhdisteet		1
Tetrakloorietyleeni (PER)	127-18-4	2.3
Tetrakloorimetaani (TCM)	56-23-5	3
Tina ja tinayhdisteet		1
Titaani ja titaaniyhdisteet		1
Toksafeeni	8001-35-2	3
Tolueeni	108-88-3	3

Aine	**CAS-nro**	**Asetus**
Tribenuroni-metyyli (metyyli-2-(3-(4-metoksi-6-metyyli-1,3,5-triatsiini-2-yyli)3-metyyliureidosulfonyyli) bentsoaatti)	101200-48-0	2
Tributyylitina ja tributyylitinayhdisteet		3
Tributyyli-tinayhdisteet (tributyylitina-kationi)	36643-28-4	2.3
Trifenyylitina ja trifenyylitinayhdisteet		3
Trifluraliini	1582-09-8	2.3
Triklooribentseeni (1,2,4-triklooribentseeni)	12002-48-1	2
Trikloorietyleeni	79-01-6	2.3
Trikloorimetaani (kloroformi)	67-66-3	2.3
Typen oksidit (NOx/NO2)		3
Uraani ja uraaniyhdisteet		1
Vanadiini ja vanadiiniyhdisteet		1
Vinyylikloridi	75-01-4	3
Öljyperäiset hiilivedyt		1