Community. Commitment. Continuity.

Wastewater 101

A Primer to Our Wastewater System Treatment Process

Beyond 100 Years of Sustainability

ENV

Public Baths Pump Station circa 1944.

Many future goals and advancements.

Continuous testing preserves a healthy environment.

Synagro, an In-Vessel Bioconversion Facility, produces fertilizer from Sand Island WWTP sludge.

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A Primer to Our Wastewater System Treatment Process

Beyond 100 Years of Sustainability

By Markus Owens

Paid for by the taxpayers of the City and County of Honolulu.

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ENV Mission Statement

"The mission of the Department of Environmental Services is to protect public health and the environment by providing effective and efficient management of wastewater, stormwater and solid waste disposal systems for the City and County of Honolulu."

ENV is serious about its responsibility to lay the best plans for the future, while working within fiscal constraints of the present to educate the public on measures protecting the public health and the environment.

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Introduction

Water is a vital component of life. Since the dawn of time, man has always searched and made his home near water, which covers most of the Earth. Water is the body's most important nutrient, is involved in every bodily function and makes up about 70 percent of your total body weight. Water helps maintain body temperature, transforms body fat, aids in digestion, lubricates and cushions organs, transports nutrients and flushes toxins from your body.

There's a whole lot of water on Earth! Something like 326 million trillion gallons of water can be found on our planet. This water is in a constant cycle – it evaporates from the oceans, travels through the air, rains down on the land and then flows back to the oceans.

Oceans are huge. Oceans cover about 70 percent of the planet, and the average depth is several thousand feet. Oceans contain about 98 percent of the water on the planet, however, unusable for drinking because it is too salty. About two percent of the planet's water is fresh, but 1.6 percent of the planet's water is locked up in the polar ice caps and glaciers. Another 0.36 percent is found underground in aquifers and wells. Only about 0.036 percent of the planet's total water supply is found in lakes and rivers. That's still thousands of trillions of gallons, but it's a very small amount compared to all the water available. The rest of the water on Earth is either floating in the air as clouds and water vapor or locked up in plants and animals.

Nevertheless, as Earth's population grew since the dawn of man, a solution was needed to harvest fresh drinking water and tend to human waste, keeping it from contaminating public drinking water.

Waterborne diseases, transmitted by humans as a result of poor hygiene and mismanagement of water, became a significant problem over time. At the end of the 19th century, Louis Pasteur and his students demonstrated that germs played a key role in infectious diseases and verified the importance of good hygiene. Among the bacterial disorders, cholera was the most notorious in Europe killing hundreds of thousands in France during the 1854 epidemic.

Diseases prompted countries and communities to devise a way to handle human waste around the turn of the 20th century, which is when Hawaii began developing its wastewater infrastructure.

Acknowledgements

Wastewater 101 implements the goals and ideals of the City's 21st Century Ahupua'a concept. It is targeted toward Hawaii's middle school children - the future citizens and caretakers of the City and County of Honolulu - to provide them with a basic understanding of our wastewater treatment system. This is by no means a complete account of all aspects associated with wastewater, but serves as a guide to familiarize our young people with an integral part of our daily lives that may be otherwise taken for granted. Our wastewater system is a vast, mostly underground network of sewage treatment that remains primarily invisible or unnoticed until a Sanitary Sewer Overflow (SSO) or disaster occurs in a public area.

Following a span of 100 plus years, Honolulu has transformed itself into a progressive, forward thinking city and county, with an infrastructure ready to tackle immediate treatment problems and to alleviate environmental issues. Technological advancements and a concerted effort to protect our valuable resources today underscore a commitment by the Department of Environmental Services (ENV). Continuous testing nearshore and offshore certify successful wastewater treatment. Recycled water, biosolid fertilizer, membrane bioreactors (MBR) and cogeneration (the conversion of byproducts to produce useable energy) are among new implemented technologies that explore the new frontier of wastewater treatment.

The most important resource, of course, for Honolulu's continued sustainability, is our youth. It is their enlightened perspective that will determine the future. They are our future property owners, dwellers and business owners. Their knowledge of where to plant trees, how to eliminate grease from sewer pipes, or how to handle waste as manufacturers will dictate the success of tomorrow's generations in our beautiful 'aina. Awareness is the first step.

I would like to tip my cap to the tens of thousands of men and women who laid the framework of our wastewater system for more than 100 years to assure the health and safety of everyone on Oahu. The City and County of Honolulu's Department of Environmental Services is built upon hard-working individuals who take pride in their work.

I would like to thank a number of people from the Mayor down to every ENV employee who inspired me to put this research together.

I am indebted to many who provided support, including Director Timothy Steinberger and Deputy Director Ross Tanimoto, who enabled me to develop a clearer understanding of the subject.

Special thanks go to Ronald Slauson, who contributed countless professional images depicting every aspect associated with wastewater, and Anne Pulfrey at the Municipal Library, who provided access to the City's photo archives.

Finally, I am grateful to Pax:Up (Pacific Suppliers), more specifically, Wes Osano, Kathy Ohtani and Kit Wilson, for their creativeness, professionalism and editorial assistance throughout this project.

I trust that **Wastewater 101** is truly that…the beginning for a better, protected and beautiful Honolulu and state of Hawaii.

Markus Owens
ENV Public Communications Officer

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Chapter One

History of Sanitation

Latrines preserved at Housesteads Roman Fort on Hadrian's Wall.

The first sanitation system was found around 4000 B.C. where excavations documented that the prehistoric Babylonia civilization (i.e. Middle East today) had some of the earliest known drainage piping leading from homes and buildings to cesspools.

Evidence indicates that the Royal Palace of Knossos in Crete around 2500 B.C. had the first "flush" toilet. A latrine on the ground floor consisted of a wooden seat, earthenware "pan" and rooftop reservoir captured rainwater used to flush the waste.

More documented and complex systems evolved around 800 B.C. in Rome. Romans were proud of the "rooms of easement" (i.e. latrines). There, Roman officials would sometimes hold discussions with visiting dignitaries while sitting on the latrines. Elongated rectangular platforms with several adjacent seats were utilized (some with privacy partitions, but most without). Latrine rooms were often co-ed, as were the baths. Water from the public baths, or brush water from the aqueduct system, flowed continuously in troughs beneath the latrine seats; the sewage (along with waste bath water) was delivered to either open sewers or beneath the city, and eventually to the Tiber River.

The Cloaca Maxima or "Greatest Sewer", was one of the world's earliest used to drain local marshes and remove human waste from Rome to the river.

Essentially, very little progress was made from 100 B.C. through the early 19th century. Diseases were prevalent and decimated cities and villages. Cholera and plague killed 25 percent or

more of the ancient European population.

In the 1830s, a series of cholera epidemics started, and the reawakening began. New and larger sewers were constructed like the "Les egouts" in Paris. The early sewers were created for stormwater runoff. Sanitary sewage was added later, resulting in a "combined" system.

"Combined" versus "Separate" Sewer System

Basically, there are two philosophies to handling sewage – "combined" or "separate" systems.

A **combined sewer** is a type of sewer system that collects sanitary sewage and stormwater runoff in a single pipe system. Combined sewers can cause serious water pollution problems due to combined sewer overflows, which are caused by large variations in flow between dry and wet weather. This type of sewer design is no longer used in building new communities, but many older cities continue to operate combined sewers.

The principle of creating separate systems for receiving and conveying human wastes was developed as early as 1842 by Edwin Chadwick (considered by many to be the "Father of Sanitation" in England).

Babylonian knee and T-joints dated 4000 B.C.

Separate sanitary sewer systems are designed to transport only sewage. In communities served by separate sanitary sewers, another pipe system is constructed to convey stormwater runoff directly to surface waters. Oahu and most municipal sewer systems constructed today are separate sewer systems.

Sanitary Sewer System Begins in Honolulu:

The ancient Hawaiians depended on streams and springs for their water supply. Typically, they used the bathroom in the bushes where they would dig a hole and bury their waste. In some families, wooden bowls or hollowed gourds were used as chamber pots and disposed of outside later.

In the late 1840s, Honolulu began work on its first piped water supply, conveying water from a taro patch to a water tank.

The first flush toilets appeared in King Kamehameha IV's new

On the horizon, Kakaako Pump Station circa 1901.

house on the Iolani Palace grounds in 1856. Washington Place, built between 1844 and 1847 and now thought to be the oldest continuously occupied residence in the islands, was one of the earliest private dwellings to have modern plumbing.

Cesspools, privies and public bathhouses sprouted up over Oahu.

This led to unhealthy and unsanitary living conditions resulting in numerous diseases, which wiped out great numbers in Hawaii.

The aftermath of a cholera epidemic in the late 19th century gave the Hawaiian Republic sufficient concern to prepare plans for a sanitary sewerage system for Honolulu.

Rudolph Hering, contracted through the Department of Interior, is credited with being the first supervising engineer for the project in 1896. By 1898, Hering supplied complete plans for an entire system for Honolulu. His plans called for a series of sewer lines to be installed in the streets that led to a main reservoir that would then pump out to sea. His original recommendation was that the outfall should be at a depth of 100 feet. The area encompassed by the first system was from the harbor to River, Alapai and South streets. Also included were the main sewers on King Street from Alapai to Thomas Square and the construction of the main sewer reservoir, at the Historic Kakaako Pump Station site, where record drawings designate the underground reservoir as the Hering Reservoir.

That same year, the system was extended to the remaining portion of what was then considered "town," between Liliha (Ewa side), Artesian Street (beyond Punahou to Judd Street), including the Kewalo District. The expansion was halted in 1900 due to a lack of funding. Much of the extension work

Kaimuki Sewer Interceptor inspected in 1944.

thereafter was performed by property owners who were furnished piping and sewer components by the government. The sewer outfall to the ocean was built in 1899. The outfall extended 3,800 feet out to sea at a depth of 40 feet of water rather than 100 feet, again due to funding constraints. On Jan. 8, 1900, a contract was awarded to D.L. Davis & Company for the construction of a pump house and screen house.

The actual work on Honolulu's first sewer system began before the Great Chinatown Fire on Jan. 20, 1900.

The Kakaako Pump Station commenced operations in 1901 and was utilized until 1955, when it was decommissioned.

The Kakaako Pump Station on Ala Moana Boulevard stands today as a reminder of days when wastewater systems on Oahu were simple and basic. Construction on the initial sewer system – gravity flow to a low point – began in 1899 when the population was relatively low, life was agrarian and concern for wastewater's impact on the environment had yet to emerge. For decades, untreated waste was collected in cast iron pipes and discharged into the ocean just a half-mile off shore.

On April 29, 1925, the Legislature, by Act 150, created a special commission of five appointed members by the Governor known as the Honolulu Sewer and Water Commission. Honolulu instituted the act to meet the public health emergency by authorizing the construction of needed sewer and water improvements by special commission with funds provided by a bond issue.

The City issued bonds valued at $6 million with about 60 percent going towards improvements to the Honolulu Water Works system and 40 percent designated to the sewer system.

Ala Wai Sewer work in 1950.

In 1927, the Commission started the construction of two high-level intercepting sewers – Kalihi Interceptor on School Street and Manoa-Kaimuki Interceptor on Wilder Avenue. A year later, the first major wastewater treatment plant was built in Wahiawa.

The 1929 Legislature removed the water works management from political control and established a commission through Act 96. The Honolulu Sewer and Water Commission dissolved, creating the Board of Water Supply.

Mayor George Fred Wright proposed a five-year, $10 million program dedicated to public works in 1936 with about half of it spent on extensions of the inadequate sewer system.

In 1940 and 1941, the Chamber of Commerce sponsored a sanitary survey of the waters between Diamond Head and the Kewalo sewer outlets. This led Samuel W. Tay, then Director of Sanitation of the Territorial Board of Health, to conclude that sufficient evidence obtained showed "the need of providing treatment of the sewage before discharging it into the sea" in order to protect the recreational beaches and water.

The jet age of the 1950s witnessed a rise in tourism and a growing economy, which increased demands on wastewater capacity. A series of individual systems appeared along the coast. Septic tanks and cesspools became widespread with the post-World War II housing boom. Control systems were expanded and upgraded in what was basically an island decentralized telemeter system.

Oahu's population blossomed during the 1960s to approximately 350,000 with major wastewater treatment plants built in Kailua (1965) and Waianae (1968).

Over the years, Oahu's

Tremendous changes since post-war Honolulu.

wastewater collection system developed in response to an ever-expanding population. Hawaii's water pollution control program began in the late 1960s and was codified in 1973. As the population grew, so did national awareness about damage to the environment and risks to public health were reaching dangerous levels.

The federal government became much more active in the regulation of the discharge of sewage. The National Environmental Policy Act (NEPA) was signed into law Jan. 1, 1970. This led to the creation of the Environmental Protection Agency in December 1970 to regulate pollution control programs for air, water and solid wastes.

The Federal Water Pollution Control Act of 1948 was the first major U.S. law addressing water pollution. Growing public awareness and concern for controlling water pollution led to sweeping amendments in 1972. As amended in 1977, the law became commonly known as the Clean Water Act (CWA).

During the next three decades, more wastewater treatment plants were built utilizing deep ocean outfalls and underground injection wells. The city installed an island-wide Supervisory Control and Data Acquisition (SCADA) system.

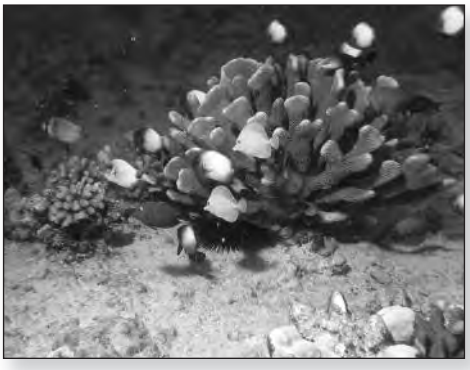
This computerized system allows remote monitoring and control of wastewater equipment from a host computer, which is housed at Sand Island Waste-water Treatment Plant (WWTP).

Today, the city's wastewater treatment system is a mix of high technology, hard work and professional commitment. Hundreds of people oversee and operate sophisticated treatment plants, computerized data systems, biological laboratories and deep-sea research.

SCADA monitors all wastewater facilities.

Presently, the city's Department of Environmental Services monitors its island-wide wastewater system through the SCADA central command center, which is manned continuously – 24 hours a day, 7 days a week – and keeps a watchful eye on 70 wastewater pump stations, two storm drain pump stations, nine wastewater treatment plants and four preliminary treatment facilities, while maintaining 2,100 miles of pipe in the collection system in accordance to both state and federal regulatory agencies.

Clean Water Act



Nearly 20 years of scientific data show no adverse affect on marine life near outfalls.

The Clean Water Act (CWA) is closing in on its 40th anniversary as landmark legislation that spawned changes and improvements to the water environment in the United States. Actually, the federal government's involvement in prevention of pollution of interstate waters began more than 100 years ago with the enactment of the Rivers and Harbors Act of 1899, which made it a misdemeanor to discharge refuse matter of any kind into navigable waters.

Little was done with the pollution problems until the 1940s. Following World War II, the U.S. prospered and Americans enjoyed a higher standard of living, but sacrifices were made and millions of tons of untreated or inadequately treated wastes were dumped daily into rivers and lakes. Many water bodies had become too dirty for fishing and swimming or too polluted for aquatic and wild life, which prompted the Water Pollution Control Act of 1948.

Congress enacted bills that not only toughened the controls over discharges, but also included incentives in the form of authorizations for loans and grants to states to develop comprehensive plans and standards to control the discharge of pollutants and for the construction of projects that conformed to such plans and standards.

Pollution was not, however, being effectively controlled primarily because of an unmanageable system of setting discharge limits for each individual discharger based on the impacts of its discharge on the receiving water quality. With increasing closures of beaches and fishing beds and incidents

like the Cuyahoga River in Ohio catching fire, public indignation turned to outrage and Congress was spurred to action. Changes to the environmental strategy of the nation such as the establishment of the U.S. Environmental Protection Agency (EPA) culminated in the enactment of the 1972 amendments to the Federal Water Pollution Control Act of 1948 and subsequently led to the CWA. The primary goals of the CWA were to have all waters of the U.S. clean enough to fish and swim, ending all discharges of pollutants into waters.

With this act, a new era of pollution control began.The act required all dischargers to the nation's waters, industrial as well as municipal, to have discharge permits. Furthermore, it set national uniform minimum treatment requirements that were technology based for discharges. The requirements for most municipal discharges were for a minimum of secondary treatment. Lower levels of treatment could be allowed for discharges into marine waters because of natural dilution and disinfection processes.

Higher levels of treatment of the effluent being discharged could be required if water quality dictated a need. Senator Edmund Muskie, one of the prime authors of this historic piece of legislation, described it as offering "Uniformity, Enforceability and Finality."

The Clean Water Act consists of two general parts:

1. Regulation of pollution discharges into waterways with the goal of making the surface water "fishable and swimmable."
   - EPA sets water quality standards for surface water contaminants;
   - Industries must treat discharge and municipal treatment plants must provide secondary treatment;
   - Requires anyone who discharges pollutants directly into surface water to obtain a permit;
   - U.S. Army Corp of Engineers issue permits for wetlands development;
   - U.S. Department of Agriculture is responsible to minimize runoff from farms;

Ocean Team ready to lower ROV, an unmanned deep ocean camera.

- National Oceanic and Atmospheric Administration helps protect coastal waters.

2. Federal government's grant program to help cities build wastewater treatment plants.
   - From 1972 to 2000, the federal government provided $69 billion for treatment plants, and state and local governments spent an additional $25 billion;
   - In 1996, the EPA released reports projecting the need for an additional $139.5 billion in projects over the next 20 years.

Water Quality Program for Oahu

Honolulu's efforts to resolve its water quality problems began three years before the CWA with the implementation of the Water Quality Program for Oahu. This study set out to:

- Identify the water quality problems on Oahu;
- Identify wastes contributing to the problems and their characteristics and quantities;
- Recommend alternative waste water management systems to meet existing and future needs;
- Establish priorities and plan of action.

The final product of this effort was a report labeled the Water Quality Program for Oahu with Special Emphasis on Waste Disposal, which was completed, coincidentally, in February 1972, the year of the CWA. The conclusion stated that the design of water quality control systems should be directed toward the conservation of corals and other indigenous aquatic organisms, the protection of the aesthetic qualities of the water environment, and the protection of the various recreational uses of the waters. This was the plan that Honolulu used to guide the course it took to alleviate the water quality problems.

Waivers from Secondary Treatment Requirements

Under the CWA, waivers from secondary treatment requirements were granted by the EPA for deep ocean discharges from municipal wastewater treatment plants. The municipality must demonstrate that its discharge of less than secondary treated effluent has no harmful impacts on the marine environment and public health. The City and County of Honolulu was granted waivers for its discharges from its Honouliuli and Sand Island WWTPs. Recently, the EPA denied the waivers for both WWTPs, which the city is appealing.

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Chapter Three

Following The Flush

Schematic illustration of typical residential sewer pipe system.

We all, at one point or another, have taken certain everyday habits for granted like turning on a light switch or taking a shower with clean water. However, many people do not give a second thought where that water goes after flushing a toilet or washing their hands unless it backs up because of a clog.

The hydrologic cycle is very cylindrical by nature. Thousands of feet above Oahu, water vapor condenses and falls to Earth as rain on the Koolau or Waianae mountain ranges, which eventually makes its way to streams and reservoirs or percolates through the permeable soil to an aquifer. This process takes about 25 years.

In 1929, the Legislature took unilateral control of water from the city after a Supreme Court battle and turned it over to the newly created Honolulu Board of Water Supply, a semi-autonomous city agency.

BWS provides Oahu residents and businesses with fresh, potable water for everyday usage. However, the used portion that goes down drains, sinks, bathtubs and toilets must be collected and treated to ensure public health and safety. This is where the Department of Environmental Services (ENV) enters the picture.

Wastewater travels through a network of underground pipes known as the sewer system. ENV constructed about 2,100 miles of piping, collecting wastewater and sending it to nine treatment plants on Oahu. These plants handle approximately 104 million gallons a day and treat it to various levels before discharging back into the environment.

Sewage treatment is a multi-stage process to renovate

Residential pipes connect to the City collection system usually near the streets.

wastewater before it reenters a body of water, is applied to the land or is reused. The goal is to reduce or remove organic matter, solids, nutrients, disease-causing organisms and other pollutants from wastewater. Each receiving body of water has limits to the amount of pollutants it can receive without degradation. Therefore, each sewage treatment plant must obtain a permit from U.S. Environmental Protection Agency or Hawaii Department of Health listing the allowable levels of BOD5, suspended solids, coliform bacteria and other pollutants. The discharge permits are called NPDES (National Pollutant Discharge Elimination System) permits.

Preliminary Treatment

Upon arrival via the sewer system, the wastewater is sent through a bar screen, which removes large solid objects such as sticks and rags. Leaving the bar screen, the wastewater flow is slowed down entering the grit tank. This allows sand, gravel, and other heavy material that was small enough not to be caught by the bar screen to settle to the bottom. All the collected debris from the grit tank and bar screen is disposed of at the landfill. The purpose of preliminary treatment is to protect the equipment used for wastewater treatment.

Primary Treatment

Primary treatment is the first step in wastewater treatment. It allows for the physical separation of solids and greases from the wastewater. The screened wastewater flows into a primary settling tank where it is held for several hours. This allows solid particles to settle to the bottom of the tank, allowing oils and greases to float to the top.

Secondary Treatment

Secondary treatment is a biological treatment process that

UV disinfection used at many facilities.

removes dissolved organic material from wastewater. The partially treated wastewater from the settling tank flows by gravity into an aeration tank. Here it is mixed with solids containing micro-organisms that use oxygen to consume the remaining organic matter in the wastewater as its food supply. The aeration tank uses air bubbles to provide the mixing and the oxygen, both of which are needed for the micro-organisms to multiply.

From here, the liquid mixture, composed of solids with micro-organisms and water, is sent to the final clarifier. Here the solids settle to the bottom where some of the material is sent to the solids handling process, and some is recirculated to replenish the population of micro-organisms in the aeration tank to treat incoming wastewater.

Final Treatment

Wastewater that remains is disinfected to kill harmful micro-organisms before being released into receiving waters. Although there are many methods available to kill these micro-organisms, ultraviolet disinfection is the most widely used by the city.

Following disinfection, the treated wastewater (now called final effluent) can be returned to the environment. The flow is conveyed to an outfall and discharged through a series of diffusers into the Pacific Ocean or Underground Injection Wells.

Solids processing

Primary solids from the primary settling tank and secondary solids from the final clarifier are sent to a digester. During this process, micro-organisms use the organic material present in the solids as a food source and convert it to by-products such as methane gas and water. Digestion results in a 90 percent reduction in pathogens and the production of a wet soil-like material called

Wastewater solids turned into a marketable fertilizer.

"biosolids" that contain 95-97 percent water. To remove some of this water and reduce the volume, mechanical equipment such as filter presses or centrifuges are used to squeeze water from the biosolids. The biosolids are then sent to the landfill or beneficially used as a soil amendment.

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Chapter Four

Environmental Quality

The mission of the Monitoring and Compliance Branch (M&C) of ENV is to show compliance with existing National Pollutant Discharge Elimination System (NPDES), air and underground injection (UIC) well permits along with other environmental regulations.

Through monitoring and testing, this branch acts as ENV's own internal check-and-balance system to make sure our air, streams, ocean and ground are protected and that Oahu's wastewater treatment and disposal meet all state and federal regulations.

M&C currently oversees, from a permit and regulatory perspective, six wastewater treatment plants (WWTP) – Sand Island, Honouliuli, Kailua Regional, Waianae and Wahiawa WWTPs – and three underground injection control (UIC) WWTPs (Waimanalo, Kahuku, and Paalaa Kai WWTPs). A ninth plant – Laie Wastewater Reclamation Facility (WRF) – treats the wastewater to R-1 level for irrigational reuse on the North Shore.

M&C is responsible for submitting and demonstrating compliance for these facilities and does not address effluent nor solid reuse activities, which are reassigned to the Regulatory Control Branch. M&C, however, oversees enforcement, actions such as Notices of Violation, Consent Orders, Stipulated Orders and Consent Decrees. Additional tasks are technical support services for the Division of Treatment & Disposal (T&D). We are also expanding our air and water quality computer modeling capabilities, and have been assigned the cognizant group for odor and noise issues.

Tests measure the levels of specific pollutants in the waters at all steps in the treatment process, not just the final stages when the treated effluent is released. The Ocean Team routinely samples bacterial levels at wastewater outfalls and designated shoreline and near shore stations. Evaluating the results is the job of the state Department of Health (DOH) and U.S. Environmental Protection Agency (EPA). If pollution levels increase, quality control specialists look for immediate causes – equipment failure, sewer overflow, breaks in the line – as well as long-term system needs.

Ocean Monitoring – Water sampling done at nearshore and at deep ocean outfalls.

In the case of a sanitary sewer overflow, crews take water samples from various locations. Crews post warning signs and monitor streams and currents until recreational areas are safe. The M&C Branch addresses all reporting requirements for these overflows.

The EPA oversees water quality compliance nationwide, working with state agencies for local oversight. In Hawaii, EPA works through DOH.

The city has a strong commitment to reduce and prevent sanitary sewer overflows. Wastewater treatment plant improvements are ongoing. A comprehensive plan is in place to upgrade our wastewater collection system where many of the pipes are between 50 and 100 years old.

Ocean Team

ENV has an extensive ocean monitoring program, which covers marine waters spanning the Leeward to Windward coasts.The program is run by nine professionals whose main purpose is to monitor our marine environment. These SCUBA-certified divers utilize 25 foot Boston Whalers and a larger, 37 foot craft to deploy ocean profilers and a remotely operated vehicle (ROV) for data gathering. In addition, the team must collect marine fauna and perform sediment dredging by hand for various analyses.

ENV tests for a number of important 'indicator organisms' every four to six days in shoreline, nearshore and offshore waters. All water quality parameters, such as nutrients, are measured quarterly. The results help ENV and DOH determine if there are public health risks due to the discharge of treated effluent. ENV monitors farther offshore quarterly, at minimum, for

Samples continously studied at the lab.

possible environmental impacts. Annually, tests are conducted for 129 priority pollutants in the effluent, fish tissue and sediments around the outfall while also observing fish close up for any abnormalities.

The Oceanographic Team also performance odor monitoring and manages certain odor measurement devices for the department.

At the Lab

A full-service ENV laboratory of more than 35 chemists and technicians analyze:

- Bacteria levels
- Micro-mollusk populations (tiny seashell organisms)
- 64 chemicals in the flesh of fish caught in the area
- Abnormal growths in the livers of fish caught in the area
- Nutrient levels (nitrogen, phosphorus)
- Chlorophyll levels (which are related to algae growth)
- Turbidity and temperature
- Properties of the sand and sediment from the sea floor

Data from these tests help determine how the ocean environment is changing and whether treated effluent is affecting fish or fauna in Hawaiian waters. The work by ENV, the ongoing tests by EPA-certified labs on the mainland and independent studies by researchers at the University of Hawaii, all reflect that the city's wastewater facilities have little to no effect on the health and well-being of our island's ecosystem.

Pretreatment Program

ENV's Regulatory Control Branch (RC), within the Division of Environmental Quality (EQ), conducts a Pretreatment Program to monitor discharges of any substance that might harm the environment or cause damage to the wastewater system.

ENV lab performs tests on sea urchin's ability to survive, grow and reproduce.

RC reviews the disposal operations of businesses to determine if discharges pose a threat to the operations and health of the system.

Establishments such as battery shops, dental facilities, print shots, etc. are regulated by the RC Branch. Fats, oils and grease – collectively known as FOG – is the number one enemy in the city sewer system.

Commercial food industries contribute to FOG build up in sewer pipes and these businesses must install a pretreatment system connecting all kitchen fixtures to a Grease Interceptor (GI). Kitchen fixtures include sinks, floor drains, dish washers, etc. GIs must be properly maintained and are monitored by ENV inspectors. RC Branch also regulates waste haulers and responds to sanitary sewer overflows by posting warning signs.

What Can Residents Do?

Roots: A common cause of SSOs.

Honolulu operates a separate sanitary sewer system. The sewer system collects and conveys only wastewater discharged from sinks, drains, showers and washing machines into the system. This system is not designed to carry rainwater.

The primary purpose of a sanitary sewer is to protect public health and the environment. Raw sewage contains disease-causing organisms, which can threaten public health.

Sanitary Sewer Overflows (SSOs) occur when raw or partially diluted sewage is discharged from the sewer collection system, many times through manholes, before it reaches one of the city's nine treatment plants. SSOs can expose people to disease-causing bacteria called "pathogens," such as E. coli, which are present in sewage. SSOs can also have a negative impact on the natural environment, like causing poor water quality if it reaches receiving waters.

What can you as citizens of Honolulu do to help protect the environment and limit SSOs in the future?

Many property owners are not aware that the maintenance of the sewer line connection between their home or business and the main sewer line in the street is their responsibility. When poorly constructed or improperly maintained, these connections frequently cause raw sewage to back up in basements.

The connection of down-spouts from rooftops or sump-pump drains directly to the service lateral adds excess water to the main sewer lines, and can contribute to raw sewage being discharged into the streets and other public areas. Homes and

Odor Control Systems are a vital component of treatment plants.

small businesses, such as restaurants, can contribute to SSOs by disposing grease into the sewer line. When grease cools, it can form blockages, which leads to overflows.

What Should You Do When You Identify an SSO?

Make sure that people are kept away from the area of the overflow, typically a manhole cover. This is especially important for children and pets that may play near the overflow area (street, Public Park or local stream). Report the overflow immediately to the appropriate authority. Precautions can then be taken to reduce the risk of public exposure to raw sewage by monitoring the impact of the overflow and ensuring proper cleanup.

What Can You Do to Prevent and Reduce SSOs?

You can prevent and reduce SSOs if you . . .

- Make sure the basement sump pump does not connect to your sewage drain pipes or to a sink or floor drain. Such connections are illegal. The water from these pumps can surcharge the system causing raw sewage to overflow into a stream, street or a public area.
- Inspect the gutters on your house or business to see if the down spout connects to a sewer line. Such connections are illegal. If the gutters are connected to the sewer line, have them disconnected. The runoff water from the roof can contribute to an SSO.
- Look for and check your sewer clean out. The clean out usually is a small pipe, about 4-inches in diameter, outside your house that is used to access the service lateral for cleaning the sewer line. You can find it near the house, where the service lateral comes out, and/or near the street, where the service lateral connects to

Wastewater goes into clarifiers where oils and grease and are skimmed off the top and sludge settles to the bottom and scraped off by large, rotating arms.

the main sewer line. Make sure the cap to the clean out pipe is on and has not been damaged. Replace missing caps; otherwise, rain can get into the sewer line, causing it to overflow.

- Avoid pouring grease down your sink. When the grease cools in the sewer line, it solidifies and can form clogs and blockages, which then can cause the sewer to over flow or back up into buildings. Grease can also contribute to restricted flow in your home plumbing and service laterals, resulting in costly repairs.

Solar powered manholes provide ENV with an early alert system to respond quicker to possible overflows.

A bypass constructed along the highway in Niu Valley.

- Avoid planting trees and shrubs above or near the service lateral that runs from your home to the street. In Hawaii, roots are a big problem and can enter and clog sewers, causing them to back up and overflow.
- Support local programs aimed to improving the way your sanitary sewer system is maintained and operated. Proper operation and maintenance of the sanitary sewer system are key to preventing damage caused by SSOs and prolonging the life of the sewer system, saving taxpayer dollars.

Wastewater treatment in Hawaii is only about 100 years old; however, only recently, standards for clean water have been established with billions of dollars committed towards our collection system and treatment plants to preserve our natural way of life on Oahu.

Everyone can be a steward of the environmental and do their part at home to reduce and prevent SSOs from our neighborhoods.

Capsulation

For thousands of years, people recognized the importance of sanitation. Wastewater treatment and collection followed paths of both historic and scientific discoveries. From a historic perspective, as communities grew, so did the need for quality water. The need to supply safe water, remove wastes from water, and to protect public health, have been the endeavors and concern of many generations.

Scientifically, as public health issues and the discovery of bacteria and "waterborne" diseases such as cholera, dysentery and typhoid led to great strides in public sanitation efforts and the building of infrastructure and development of processes that can be used to end these issues. Honolulu was not exempt from these outbreaks.

Wastewater disposal and treatment is a constant state of evolution. Honolulu has been working to meet these challenges for more than 100 years. As regulations and technologies change, the city will respond to demands and adapt new methods to be sustainable.

Sustainability

The word "sustain" is defined as: to support, maintain; keep in existence without weakening; and implies long-term support or performance.

The City and County of Honolulu's sustainability strategy – developed by Mayor Mufi Hannemann's Administration – is an application of principals in a 21st Century Ahupua'a plan to formulate Honolulu into a more self-sufficient and sustainable community in terms of its infrastructure and operation to achieve harmony with our island environment.

ENV's treatment and disposal, along with collection system maintenance divisions, are constantly working on ways to improve services and save on costs. Unfortunately, many improvements that need to be done require increased expenditure of funds. ENV's wastewater management is funded through user fees rather than tax money. The cost of compliance with ever increasing regulatory requirements will remain constant or become more stringent. Modification of the infrastructure will not come without a price.

On The Horizon

Honolulu is looking into several areas of improvements in anticipation of future needs. Staff is working constantly and insightfully on a program of improvements to give the treatment process everything required to insure our ability to

meet water quality standards in the future. A program of upgrading and replacing portions of the collections system will also be necessary.

The demand for clean water drives advances in wastewater treatment. The primary motive for wastewater treatment is that less than 1 percent of the world's water is suitable for drinking. New technologies in the industry are being examined and implemented such as recycled water, biosolid fertilizer, Membrane Bioreactors (MBR) and Cogeneration.

In August 2000, the city opened the Honouliuli Reclamation Facility, built adjacent to the Honouliuli Wastewater Treatment Plant (WWTP), is the largest in the Hawaiian Islands and has the capability of producing approximately 13 million gallons daily. The facility produces two types of recycled water , R-1 water, which is used for landscape, agriculture and golf course irrigation, and reverse osmosis water (RO), which is used for industrial purposes such as boiler feed water, or ultra-pure process water. Laie Wastewater Reclamation Facility, acquired by the city in 2006, produces both recycled water and biosolids compost, which are beneficially reused by area farms, nurseries and landscapers.

Synagro, a bioconversion facility located at Sand Island WWTP, transforms the sludge from the plant into a fertilizer used by city parks and golf courses along with local farmers and nurseries. This process diverts about 5,650 dry tons of dewatered sludge from the landfill.

Two other endeavors on the horizon are membrane bioreactors (MBR) and cogeneration.

The city is installing a MBR treatment system at its Wahiawa WWTP, which discharges into the Wahiawa Reservoir. This technology is a relatively new advancement in the wastewater field by producing R-1 quality water at a significantly reduced footprint.

Cogeneration entails converting byproducts of the wastewater treatment process to produce useable energy such as heat and electricity. The sludge or solids separated at the treatment plant goes into an airtight anaerobic digester where microorganisms eat away at the material, while generating heat, and producing methane gas. The gas is captured and used to generate electricity for use at the plant or sold to the electric company's grid. Plans for cogeneration are in the works for Kailua Regional WWTP, Synagro and Honouliuli WWTP.

ENV will continue to rely on a well-trained and experienced staff to maintain a high level of economical service. Wastewater collection and treatment is an

expensive business, but one that must be maintained, reliable, and sustainable. Honolulu has come a long way since the late 1890s, but we must continue educating the public as a crucial component.

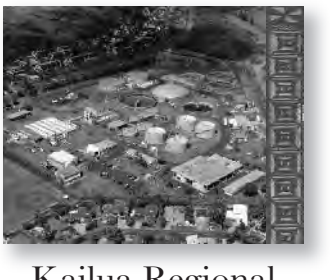
Orange County in California has taken wastewater treatment one step further and converted it into drinking water. Is this the something Honolulu will be looking at in the near future? Possibly.

Wastewater Treatment Plants

Waianae

Paalaa Kai

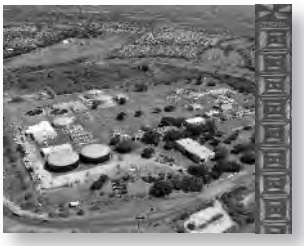
Sand Island



Kailua Regional

Wastewater Treatment Plants

Wahiawa



Honouliuli

Laie

Waimanalo

Kahuku

25-Question Wastewater Quiz

Please see answers on page 39.

1. Laid end-to-end, the sewer pipes underground on Oahu would stretch from Honolulu to:

a) Just short of California
b) Just short of Hilo
c) Just short of the moon

2. Oahu's first municipal sewer system began the same time period as:

a) Hawaii became a state
b) World War II was beginning
c) The year the Territory of Hawaii legislature first met

3. Wastewater in our system is:

a) 50% mud
b) 99% water
c) 40% toilet tissue

4. What's the rotten smell that comes sometimes from wastewater?

a) Bacteria burbling
b) Decaying rodents that climb into the system
c) Food particles rotting in the water

5. Every day, the volume of wastewater Honolulu's Department of Environmental Services treats is:

a) Enough to fill 174 Olympic-size swimming pools
b) The equivalent of 25 gallons of wastewater for every person on Oahu
c) Not very much

6. What is the best way to handle cooking oil, fat and grease?

a) Wash them down the sink, using lots of water to flush
b) Soak it up in paper towels or newspaper and put it in the garbage
c) Pour it onto the lawn

7. Which island was home to the world's first flushing toilet?

a) Crete
b) Fiji
c) Madagascar
d) Sicily

8. What role does ultraviolet (UV) light play in wastewater treatment?

a) Kills bacteria and viruses with UV radiation beams
b) Provides light for the workers to do their jobs
c) Sterilizes the bacteria

9. Oahu's population at the time its first municipal sewer system was built was the size of what city today?

a) Juneau, Alaska
b) Pearl City, Oahu
c) Helena, Montana
d) Annapolis, Maryland
e) All of the above

10. Oahu's population today is how much larger than it was in 1900?

a) 10 times larger
b) 15 times larger
c) 20 times larger
d) 50 times larger

11. What famous scientist discovered the scientific principle most used in treating wastewater?

a) Sir Isaac Newton
b) Galaleo Galilei
c) Louis Pasteur
d) Copernicus

12. How much water is there in the world today compared to 1900?

a) The same amount
b) Less
c) More
d) We do not know

13. What is the purpose of the larger purple pipes?

a) Disposing cleansed wastewater into the ocean
b) Carrying storm water to a nearby stream, lake or ocean
c) Delivering recycled water to users
d) To add a little color to the world

14. What does F.O.G. stand for?

a) First Our Government
b) Fats, Oils and Grease
c) Free Of Gas

15. Can grease cause sanitary sewer overflows?

a) Yes
b) No

16. How much unwanted rainwater flows into sewer lines from private residential properties?

a) None
b) 25%
c) 50%
d) 75%

17. How much have sewer fees been raised since 1993?

a) 25%
b) 55%
c) 75%
d) 100%

18. Which of these are appropriate, regulated uses for R-1 treated recycled water?

a) Golf courses
b) Landscaping irrigation at parks, homes and businesses
c) Industrial cleaning
d) All of the above

19. What agency is responsible for monitoring and testing Oahu's wastewater treatment and disposal systems?

a) Environmental Protection Agency (EPA)
b) Hawaii Department of Health (DOH)
c) Hawaii Department of Land and Natural Resources (DLNR)

20. Some cities, such as Washington D.C., have combined stormwater and wastewater systems. Others, such as Honolulu, have separate. Generally, separate ones are:

a) A good thing
b) A bad thing
c) It doesn't make any difference

21. A manhole is:

a) A place for construction workers to get out of the rain
b) An underground vault
c) A heavy metal disk in the road

22. Movies that had scenes set in sewer systems included:

a) Teenage Mutant Ninja Turtles
b) Shawshank Redemption
c) The Third Man
d)All of the above

23. The U-shaped bend under your sink (and hidden beneath your toilet) is to:

a) Keep gases and odors out of your house
b) Sucks the water out of the sink or toilet
c) A "stopper" pipe that allows you to retrieve the ring you dropped in it

24. A septic tank is:

a) The tank truck that cleans out cesspools
b) A small scale wastewater treatment plant
c) A holding tank for used cooling water

25. What is the amount of wastewater the average person in the industrialized world produces each day?

a) About the same as a Ford pickup gas tank
b) Enough to fill up the Ford pickup three to seven times every day
c) The equivalent of a bathtub full

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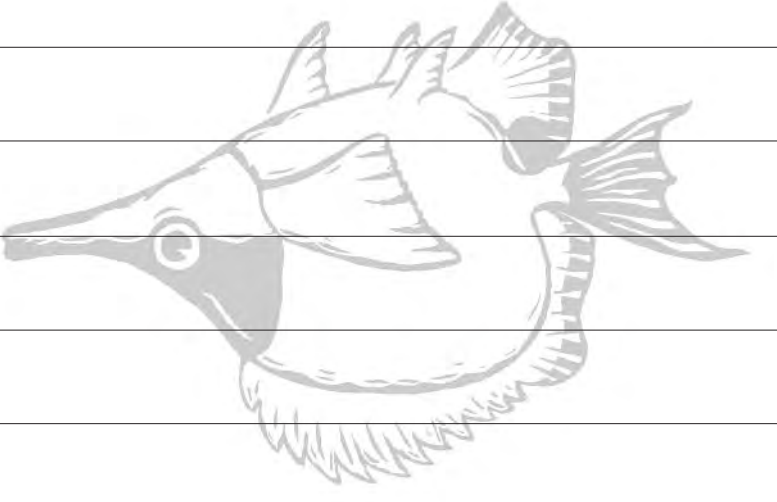
Answers to Quiz, pp. 32-37:

1. a	10. c	19. b
2. c	11. a	20. a
3. b	12. a	21. b
4. a	13. c	22. d
5. a	14. b	23. a
6. b	15. a	24. b
7. a	16. c	25. b
8. a	17. d	
9. e	18. d	



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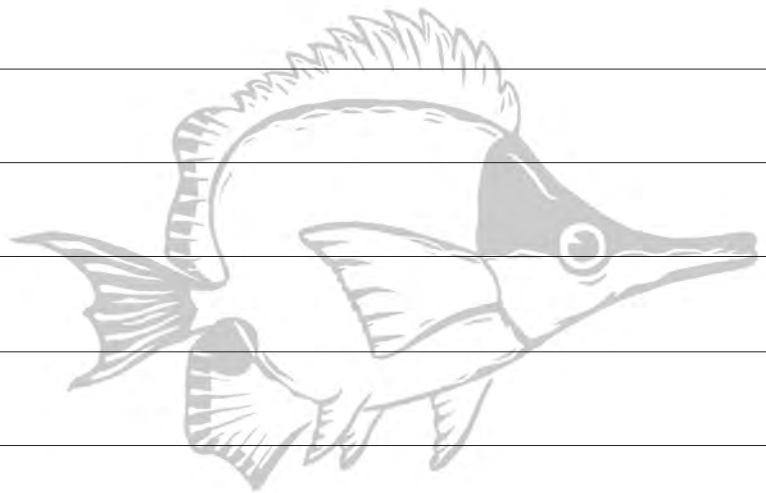

ENV

Oceanographic Team gathering specimens.

State-of-the-art Vactor truck.

Leeward golf courses utilize recycled water and biosolids.

Underground microtunneling drill.

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