2019 HAWAII INFRASTRUCTURE REPORT CARD

ASCE American Society of Civil Engineers

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EXECUTIVE SUMMARY

Often overlooked, infrastructure is vital to our daily lives. Whether we're flying from one island to another, swimming at the beach, or drinking water from the tap, infrastructure plays an important role in not only providing ground and air transportation but also in keeping our waters clean and preserving Hawaii's natural environment.

In an effort to help Hawaii's residents and policy makers understand the needs of its infrastructure, the ASCE Hawaii Chapter developed this inaugural 2019 Infrastructure Report Card. This report provides an evaluation of some of Hawaii's key areas of infrastructure, including aviation, bridges, coastal areas, dams, energy, roads, schools, solid waste, stormwater, wastewater, and drinking water. Common challenges facing Hawaii's infrastructure across the board include aging infrastructure, lack of funding, and sea level rise.

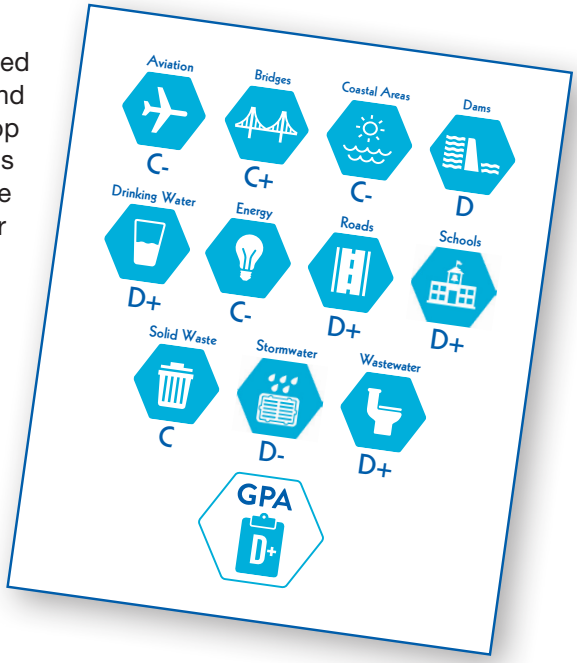
The majority of Hawaii's infrastructure has been operating beyond its useful life, and some components of systems are over 100 years old. Due to a lack of funding, it has been difficult to effectively maintain and improve the existing infrastructure systems to keep up with increasing usage and rapidly changing lifestyles. As population, economic growth, and development increase, the strain on Hawaii's infrastructure will continue to escalate with many of its infrastructure systems struggling to stay in operable condition. Water main breaks, flood water damage, loss of property from coastal erosion, and beach and park closures from brown water advisories are all results of deteriorating infrastructure. The slow but steady sea level increases in the coming years will also present new challenges that will threaten not only our infrastructure, but also our iconic beaches and coastlines.

As we continue to face these challenges, Hawaii must decide how important infrastructure is to our daily lives and what we want to prioritize moving forward. We hope this report will provide some insight into Hawaii's infrastructure.

ABOUT THE INFRASTRUCTURE REPORT CARD

GRADING CRITERIA

The Hawaii 2019 Report Card Committee is a group of dedicated civil engineers from Hawaii, who volunteer their time to collect and analyze data, prepare, review, and revise each section, and develop the final Report Card. The committee worked with the ASCE's Committee on America's Infrastructure and ASCE Infrastructure Initiative staff to provide Hawaii with a snapshot of the state of our infrastructure, as it relates to us at home, and on a national basis.



The Report Card Sections are analyzed based on the following eight criteria:

CAPACITY
Does the infrastructure's capacity meet current and future demands?

CONDITION
What is the infrastructure's existing and near-future physical condition?

FUNDING
What is the current level of funding from all levels of government for the infrastructure category as compared to the estimated funding need?

FUTURE NEED
What is the cost to improve the infrastructure? Will future funding prospects address the need?

OPERATION AND MAINTENANCE
What is the owners' ability to operate and maintain the infrastructure properly? Is the infrastructure in compliance with government regulations?

PUBLIC SAFETY
To what extent is the public's safety jeopardized by the condition of the infrastructure and what could be the consequences of failure?

RESILIENCE
What is the infrastructure system's capability to prevent or protect against significant multi- hazard threats and incidents? How able is it to quickly recover and reconstitute critical services with minimum consequences for public safety and health, the economy, and national security?

INNOVATION
What new and innovative techniques, materials, technologies, and delivery methods are being implemented to improve the infrastructure?

GRADING SCALE

EXCEPTIONAL: FIT FOR THE FUTURE
The infrastructure in the system or network is generally in excellent condition, typically new or recently rehabilitated, and meets capacity needs for the future. A few elements show signs of general deterioration that require attention. Facilities meet modern standards for functionality and resilient to withstand most disasters and severe weather events.

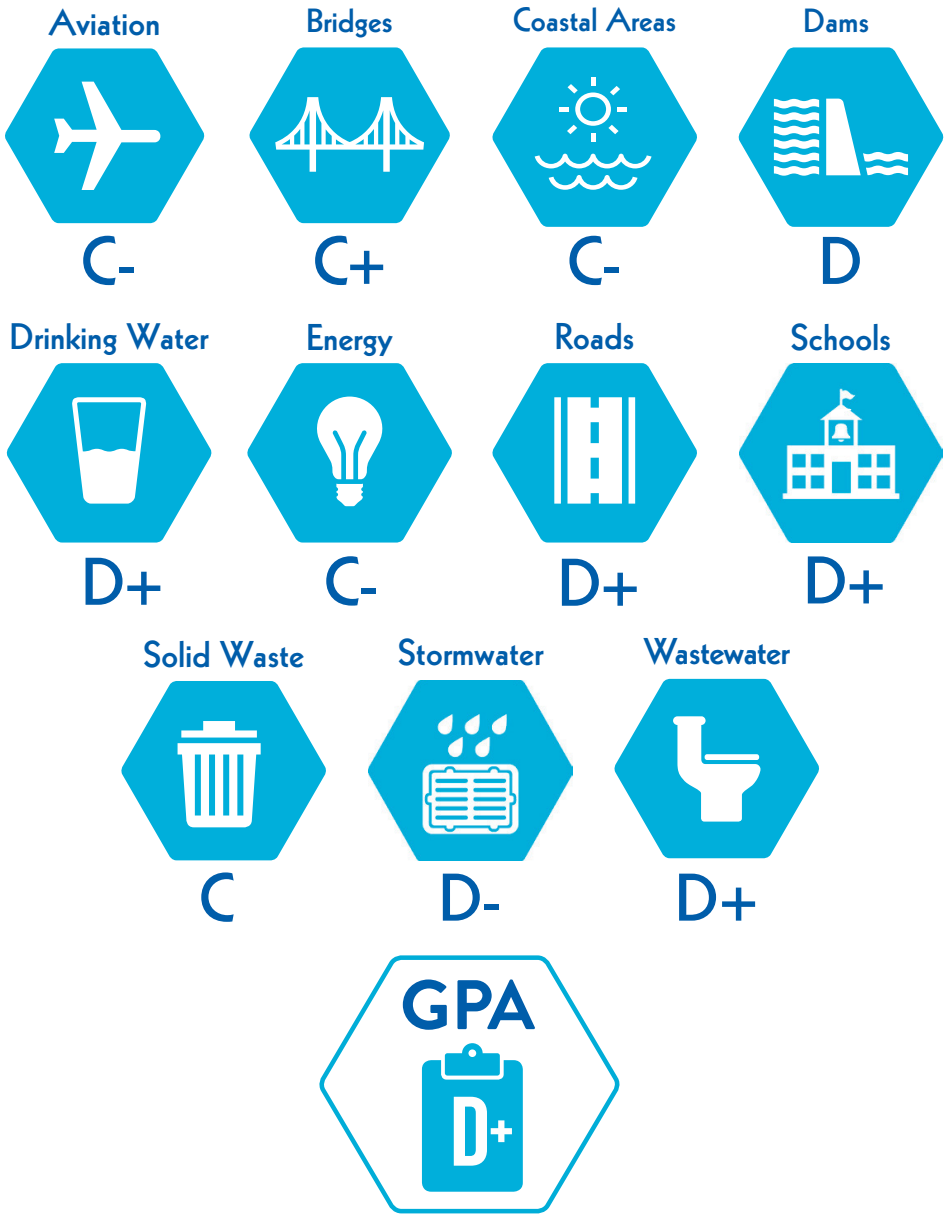
GOOD: ADEQUATE FOR NOW
The infrastructure in the system or network is in good to excellent condition; some elements show signs of general deterioration that require attention. A few elements exhibit significant deficiencies. Safe and reliable with minimal capacity issues and minimal risk.

MEDIOCRE: REQUIRES ATTENTION
The infrastructure in the system or network is in fair to good condition; it shows general signs of deterioration and requires attention. Some elements exhibit significant deficiencies in conditions and functionality, with increasing vulnerability to risk.

POOR: AT RISK
The infrastructure is in poor to fair condition and mostly below standard, with many elements approaching the end of their service life. A large portion of the system exhibits significant deterioration. Condition and capacity are of significant concern with strong risk of failure.

FAILING/CRITICAL: UNFIT FOR PURPOSE
The infrastructure in the system is in unacceptable condition with widespread advanced signs of deterioration. Many of the components of the system exhibit signs of imminent failure.

HAWAII INFRASTRUCTURE GRADES SUMMARY



RECOMMENDATIONS TO RAISE THE GRADE

STAY ABOVE THE RISING TIDE

Hawaii needs to fund short and long-term strategies to address the impacts of sea-level rise. In the short term, education regarding beach nourishment should continue to take place, and adequate funding should be identified and directed toward shoreline protection projects. In the longer term, funding to address the impacts of sea level rise is needed. Projections show that by 2100, sea levels will rise by approximately 3.2 feet, meaning over 20,000 people would be displaced, roughly 5,700 structures would be impacted, and approximately 40 miles of coastal roads would be at risk of sea inundation. Portions of the major coastal arterials or 'belt' roads in each county would be impassible, affecting certain communities that lack parallel facilities and rely solely on these corridors for access. Strategic and comprehensive planning and robust funding to support necessary projects is needed now to plan for tomorrow.

SUPPORT SUPPLEMENTAL FUNDING STRATEGIES

Hawaii's roadways are among the most congested in the nation, and there is a $23 billion transportation infrastructure funding gap over the next 20 years. To help close the investment gap and to address growing construction costs, the state legislature should increase the state gas tax and support innovative funding mechanisms. New revenue can help toward paving potholes,managing congestion, and reducing the number of structurally deficient bridges in Hawaii.

INVEST IN DAM SAFETY

93% of Hawaii's dams are high-hazard potential, meaning failure could result in significant loss of life or property. According to the Association of State Dam Safety Officials, 76% of Hawaii's High Hazard Potential dams are in poor condition and 8% are rated unsatisfactory. Significant funding for engineering investigations, repairs and maintenance are necessary to help Hawaii's dams meet current safety standards and minimize the risk to downstream communities and the general public.

PROTECT OUR WATER SYSTEMS

Hawaii's drinking water and wastewater systems are plagued by infiltration of saline groundwater and both exhibit significant funding gaps when it comes to available revenue versus total needs. Additionally, the impact of sea level rise and wave inundation on facilities could potentially release wastewater or hazardous waste to local waters and habitats. Rates for both drinking water and wastewater utilities should reflect the true cost of service. Additionally, Hawaiian communities should leverage available loan and grant programs to ensure public safety and the environment is protected.

RECOGNIZE THE VALUE OF STORMWATER

Stormwater in Hawaii drains directly into the ocean. Pollutants, trash, and debris entering Hawaii's water resources is especially harmful as the state has experienced an increase in extreme flooding caused by high tides, storm surges, hurricanes, tsunamis and sea level rise. Dedicated funding from stormwater utilities can provide funding for drainage system upgrades, but there are currently no user fees or charge rates in place. Better recognition of stormwater as a utility and resource and further development of county stormwater utility fees to pay for the retrofitting of flood control infrastructure and water quality improvement projects.

AVIATION

EXECUTIVE SUMMARY

Hawaii is the only state not accessible via ground transportation. The only methods of transportation to and from Hawaii and between islands are by sea or air, with the majority of travel occurring by air. In 2017, enplanements statewide rose 2.7% over 2016. Over half of those enplanements were made by visitors.

In general, the majority of Hawaii's airports are in fair condition. Recently, the State of Hawaii, Department of Transportation, Airports Division (DOT-A) has undertaken several terminal modernization programs to upgrade several of their airport facilities across the state. Although each airport generates revenue from their operations, federal grants and state appropriations are still needed to undertake major improvement projects. Hawaii's airports are vulnerable to environmental hazards such as rising sea levels, hurricanes, tsunamis and earthquakes. Continued improvements are required to increase capacity, enhance conditions, and increase resiliency and sustainability efforts.

BACKGROUND

As the only state not accessible via ground transportation, aviation and its infrastructure is critical in Hawaii. Residents and businesses depend on airports for the transportation of goods, services, and people. Because of Hawaii's remote location and heavy dependence on imported goods, Hawaii depends on the aviation system for delivery of perishable items like fresh fruit and vegetables which are flown in, rather than shipped.

Tourism is one of Hawaii's main economic drivers. In 2017, spending by visitors arriving by air rose to $16.6 billion. In 2017, over half of the 17.3 million people enplaned in Hawaii, or 9.3 million, were non-residents. As an integral part of Hawaii's economy and day to day operations, it is essential that Hawaii's airports are improved and modernized to effectively serve residents, businesses, and visitors.

The State of Hawaii, Department of Transportation, Airports Division (DOT-A) operates and maintains all fifteen (15) National Plan of Integrated Airport Systems (NPIAS) airports in the state. The Daniel K. Inouye International Airport (HNL), located on the Island of Oahu, is the state's largest airport. In 2017, enplanements at HNL accounted for 56% (9.7 million) of enplanements Statewide. The HNL also accepted the most cargo (74%, 2.5 billion pounds) in 2017. Other main airports include medium hub Kahului Airport (OGG) on the Island of Maui, small hubs Hilo International Airport (ITO) and Ellison Onizuka Kona International Airport (KOA) on the Island of Hawaii, and small hub Lihue Airport (LIH) on the Island of Kauai.

Other NPAIS airports include Dillingham Airfield (on lease from the US military) and Kalaeloa Airport (JRF, formerly Barbers Point Naval Air Station) on the Island of Oahu; Kapalua and Hana Airports on the Island of Maui; Lanai Airport (LNY) on the Island of Lanai; Molokai (MKK) and Kalaupapa Airports on the Island of Molokai; Waimea-Kohala and Upolu Airports on the Island of Hawaii; and Port Allen Airport on the Island of Kauai. Except for Upolu Airport and Port Allen Airport, which are used exclusively by general aviation, all of these facilities are utilized by air carriers, general aviation, and the military. Hawaii's smaller airports account for approximately 1.5% of air traffic in the State.

CAPACITY

In 2018, Hawaii's airports serviced 37.6 million passengers, with HNL servicing approximately 21.2 million passengers. As the State's busiest airport, HNL regularly experiences capacity issues at the gate during peak travel hours (between 10am and 2pm) when all gates are typically occupied. Airside capacity issues also exist with existing infrastructure, like taxiways and pedestrian bridges unable to accommodate wide-body or double-decker aircraft.

In general, the main public airports on each island appear to meet current capacity needs. However, Hawaii's

airports may need to be improved to meet future capacity needs as the resident population is projected to increase by 15.4% from 1.43 million in 2016 to 1.74 million by 2045. In addition, it is anticipated that the number of visitors will continue to increase each year.

As land is extremely valuable in Hawaii, HNL and the adjacent Joint Base Pearl Harbor Hickam operate as a joint use facility, allowing them to share runways and taxiways. DOT-A also utilizes former military airfields such as Dillingham Airfield and Kalaeloa Airport to help relieve demands at HNL without construction of additional airfield facilities.

CONDITION, OPERATIONS AND MAINTENANCE

The majority of the public use airports are in fair condition, with some in better condition than others. Ongoing and regular maintenance is required for paved runways, taxiways, aprons, landscaping, lighting, utilities, equipment, hangars, and terminals. In 2018, DOT-A's operating expenses were approximately $413 million, up from $389 million in 2017. Of the $413 million, $44 million was spent on repairs and maintenance, $34.6 million on utility costs and $183 million on salaries, wages and personnel services.

The DOT-A utilizes a Pavement Management System (PMS) Program, which uses the Pavement Condition Index (PCI) and other data inputs, to develop long-term pavement maintenance planning. The program is used to determine whether preventative maintenance, major rehabilitation, or additional improvements are needed.

The general aviation hangars at HNL and OGG are in poor condition, with structural members exhibiting signs of section loss due to corrosion. New hangars at JRF are being built, allowing for relocation of general aviation activities from HNL, freeing up land and capacity for HNL operations.

FUTURE NEED

A formal Statewide Airport System Plan (SASP) was last prepared in 1998, with the main airports having individual master plans developed more recently. With increasing population growth and tourism posing future challenges, DOT-A began implementing its $2.7 billion Hawaii Airports Modernization Program in 2013. The program includes phased development and redevelopment of its existing infrastructure to accommodate increased air traffic, meet heightened security requirements, and improve passenger experience at airports across the State. The program's remaining costs are $671 million.

Major projects at HNL include a new mauka concourse for larger aircrafts and additional gate capacity during peak hours; a consolidated rental car facility and parking structure; a new cargo maintenance facility; runway and taxiway repairs; widening improvements; and refurbishment of the Diamond Head concourse.

HNL's Master Plan also proposes a $1.1 billion future reconstruction of the Diamond Head concourse to include additional gates and a new customs and border protection facility.

Current and future projects at other airports include a new access road, taxiway and runway repairs, and a consolidated rental car facility at OGG; terminal modernization at KOA to accommodate mainland and international travel; a new 64,000 sf cargo facility and energy efficient equipment at ITO; and security upgrades and a consolidated rental car facility at LIH.

FUNDING

Funding for public airports is jointly provided by the Federal and State governments. In past years, requests for federal grants have been made through the Federal Aviation Administration (FAA) Airport Improvement Program (AIP). In 2018, Hawaii's total 5-year (2019-2023) development estimate of improvements eligible for the AIP grants was $383 million. DOT-A was awarded $24.1 million for HNL apron reconstruction, KOA Aircraft Rescue and Fire Fighting (ARFF) training facility, and JRF runway repairs. Grants were also awarded to ITO, OGG, MKK and LNY to acquire ARFF vehicles.

Although the DOT-A receives no general funds from the State, their budget appropriations require approval from the State legislature. Legislative approval and bond issuance occur on a bi-annual basis with the opportunity for interim funding. Bonds are repaid by revenue generated by passenger facilities charges (PFCs), customer facility charges (CFCs), and airport leases and concessions. Passengers are charged PFCs when tickets are

purchased on commercial air carriers. The fee, established by US Federal law, goes toward airport operations and maintenance. Meanwhile, CFC's are fees collected for the use of rental cars.

In 2018, Hawaii collected $44.9 million in PFC charges and $76.5 million in rental car CFCs. Total revenue generated at Hawaii's airports was $629.3 million, up 15.5% from 2017. Financially, DOT-A has been operating with increases in positive cash flow. DOT-A is seeking to transfer control of the airports to a private authority or corporation, which would expediate the funding and procurement process, and allow for increased operational efficiencies and flexibility.

PUBLIC SAFETY

Hawaii's main airports are secured in accordance with FAA and TSA guidelines. The smaller airports, like Molokai Airport, Port Allen and Hana Airport are minimally secured, which is reflective of the amount of traffic they serve. For flights that don't meet the TSA threshold, passengers are screened at other airports. Striping, apron lighting, signals and other safety related items must also be compliant with state and federal regulations. As of January 2018, significant changes had been made to runway holding position markings at HNL to reduce the likelihood of general aviation incursions.

RESILIENCE

Environmental hazards that may affect Hawaii's airports include hurricanes, earthquakes, and tsunamis. Although there is volcanic activity on Hawaii Island, all of the public airports are located outside of the rift zones. In the event of environmental hazards and harbor closures, airports are the primary method of emergency access and receiving aid from the mainland. ITO and OGG are especially vulnerable to hurricanes, as they are on the windward side of their respective islands.

Rising sea levels resulting from climate change may eventually impact HNL, the lowest airport in the State. Its iconic reef runway sits offshore at 10 feet above mean sea level. If taken out of service, the amount of air traffic HNL will be able to handle will be severely impacted.

Aligning with local legislation and the airport sustainability movement, DOT-A developed the Sustainable DOT-A program to promote sustainability across Hawaii's airports. The program is committed to implementing initiatives and maintaining best practices that focus on creating a more sustainable air transportation system that is operationally efficient, environmentally responsible and culturally appropriate. As the first initiative and pilot program for DOT-A's airport system sustainability program, SustainableHNL set forth several short-term goals for reducing energy, carbon emissions, potable water usage, waste generation, and downstream stormwater impacts by 2020 at HNL.

INNOVATION

DOT-A is in the process of undertaking a handful of innovative approaches to enhance its existing infrastructure, operations, and impact. Improvements include installation of new LED lighting systems that provide better energy efficiency and airfield visibility. DOT-A has partnered with a private company to deliver the largest single-state energy savings performance contract in the US. The $158 million investment is guaranteed to generate over $500 million in savings over 20 years. Improvements include replacing 98,000 lighting fixtures with LED and other energy-efficient lighting, upgrading HVAC systems, installing over 33,000 solar panels, and roof repairs and equipment replacement that had been previously deferred.

In addition to reducing energy use, DOT-A is continuing to reduce potable water usage and increase usage of alternative water sources. A $12 million design-build contract was awarded in 2018 for four water reuse projects. The projects include interception and delivery of non-potable water from Sumida Farms at HNL, an onsite membrane bioreactor plant and delivery system at OGG, a distribution system at OGG for reclaimed wastewater from the nearby Kahului Wastewater Reclamation Facility, and a stormwater collection and rainwater harvesting system at KOA.

NextGen is a Federal Aviation Administration (FAA)-led modernization of the National Airspace System. With the help of technological advances and new procedures, NextGen will increase the airports safety, efficiency capacity, predictability and resiliency. Once initial infrastructure improvements are completed in 2025,

implementation should reduce flying times, fuel use, and aircraft emissions while getting passengers to their destinations at more predictable times.

RECOMMENDATIONS

Recommended actions to improve Hawaii's aviation infrastructure include:

1. Continue implementing projects to renovate and upgrade existing facilities.
2. Continue to increase sustainability and resiliency efforts with innovative designs, projects, partnerships and delivery methods.
3. Update the 1998 Statewide Airport System Plan (SASP).
4. Continue to pursue the creation of an airport authority that operates independently of the state legislature to expedite delivery and execution of projects.
5. Continued and accelerated implementation of NextGen air traffic control system infrastructure and procedures.

SOURCES

http://hidot.hawaii.gov/airports/library/financial-audit-reports -Financial Statements and Supplemental Schedules, June 30, 2018 (with Independent Auditor's Report Thereon) – BKD CPAs and Advisors

http://hidot.hawaii.gov/administration/federal-aviation-administration-awards-24-1-million-in-infrastructure-grants-to-hawaii-airports - 2018 FAA Grants Press Release

http://hidot.hawaii.gov/airports/doing-business/engineering/passenger-facility-charge - Air Carrier Consultation Meeting Package

http://hidot.hawaii.gov/airports/doing-business/engineering/sustainabledota/ - SustainableDOT-A

http://airports.hawaii.gov/hnl/airport-info/sustainablehnl/ - SustainableHNL

https://hands.ehawaii.gov/hands/opportunities/opportunity-details/9035 - AS1095-07 Design-Build RFP for Install Wastewater and Water Treatment Systems, Statewide Airports

https://aviation.hawaii.gov/wp-content/uploads/2015/03/Statewide-Airport-System-Plan-1998.pdf - 1998 Statewide Airport System Plan, RM Towill, State of Hawaii, Department of Transportation, Airports Division

https://www.faa.gov/airports/planning_capacity/npias/reports/ - National Plan of Integrated Airport Systems Report, 2019-2023 NPIAS Report, Appendix A, List of NPIAS Airports with 5-Year Forecast Activity and Development Estimate

https://www.faa.gov/nextgen - What is Next Gen?

https://www.faa.gov/TV/?tag=Honolulu – FAA TV: HNL Runway Safety Vignette

https://www.hawaiitourismauthority.org – Hawaii Tourism Authority

http://www.airport-world.com/features/airport-profiles/6827-green-hawaii.html - Airport World, Green Hawaii

https://www.civilbeat.org/2018/12/chad-blair-things-are-actually-looking-up-at-honolulu-airport- Honolulu Civil Beat Column, December 7, 2018

https://www.johnsoncontrols.com/insights/2016/buildings/case-study/hawaii-dot - Johnson Controls Hawaii Case Study

2015 Hawaii Catastrophic Hurricane Plan – FEMA Region IX Hawaii Catastrophic Annex

Airports Council International – North America (ACI)

BRIDGES

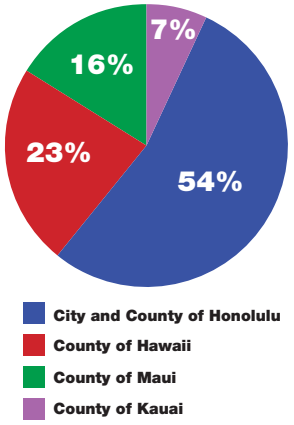
EXECUTIVE SUMMARY

Hawaii's bridges are a vital part of the state infrastructure, providing passage for residents, businesses, and emergency services. Hawaii's 1,135 bridges have an average bridge age of 60 years. Of these bridges, 6.9% are structurally deficient bridges. While the percentage of bridges rated to be in good condition has risen over the past several years due to rehabilitation efforts, the number of structurally deficient bridges has also increased during the same time period. In addition, due to the state's isolated location, marine environment and various natural hazards, bridge construction costs are the highest in the nation. Therefore, current efforts by state and county agencies are focused on preserving the existing bridge inventory and maintaining safety rather than upgrading bridge capacity or resilience to meet future needs. To this end, there are 44 state bridges and up to 34 City and County of Honolulu bridges slated for repair in the next four to six years.

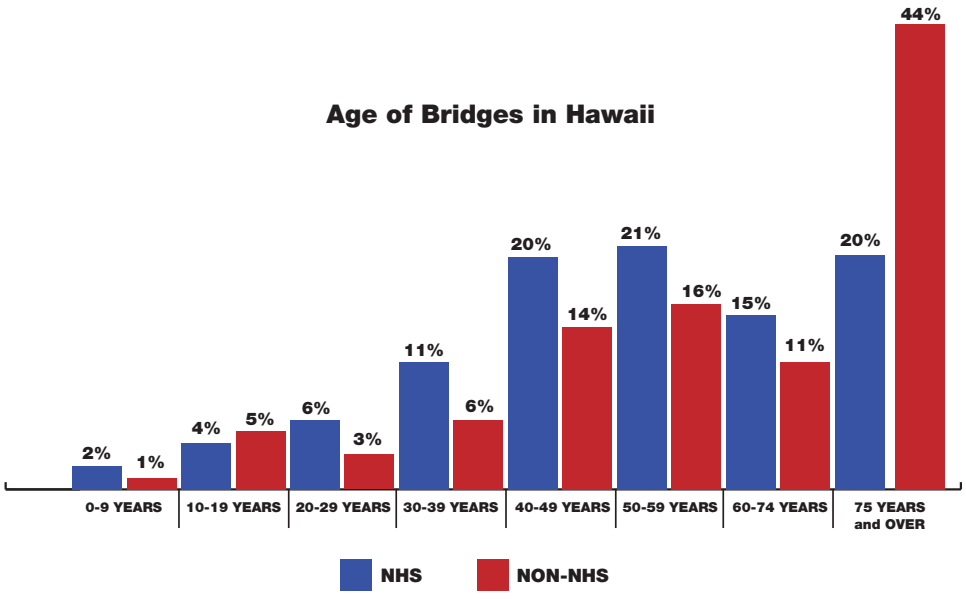
CONDITION AND CAPACITY

As of 2018, there are a total of 1,135 bridges throughout the state of Hawaii. The average bridge age in Hawaii is approximately 60 years, which is significantly higher than the nation's average bridge age of 43 years reported in the 2017 ASCE Infrastructure Report Card.

The majority of bridges in Hawaii are concrete girder structures. However, a number of the bridges along the northern shore of the Island of Hawaii were originally constructed for the sugar plantation railroads and are of an older steel trestle construction, which were later retrofitted to carry vehicular traffic. There are a few wooden bridges that are slated for replacement. With the large number of older bridges in Hawaii, the state and counties implement repairs and rehabilitation to try to extend the service life of bridges as much as possible. Bridge replacement projects are expensive and usually challenging, given environmental and historical issues.

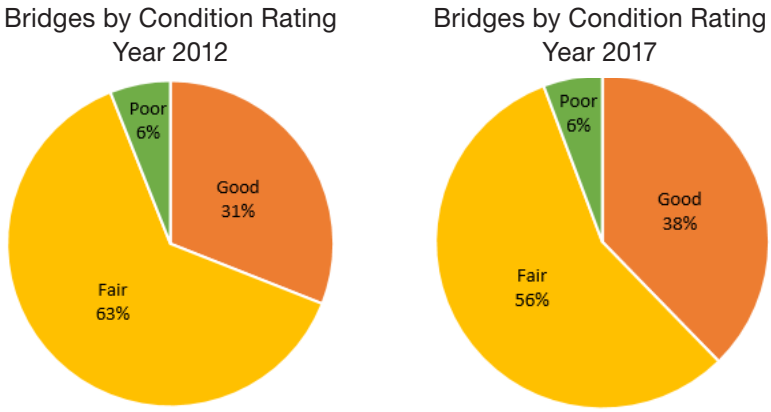


% of Bridges by County



Most bridges in Hawaii's inventory were typically designed for a 50-year service life. Currently, over 750 bridges are at least 48 years old, and 67 bridges are over 98 years old. Bridge service life may be extended by maintenance, rehabilitation or retrofit; however, functional obsolescence, severe structural deficiencies or the need to meet current standards may eventually require replacement. One-hundred fifty bridges are posted for load, meaning that vehicles of certain weights and sizes are not allowed to cross the bridge, limiting service to those areas.

From past bridge inspection data, the percentage breakdown of Hawaii bridges rated as good, fair, and poor in the years 2012 and 2017 is presented in the following charts.



The increase in percentage of "good condition" bridges from 2012 to 2017 indicates that in general, the condition of existing bridges has improved due to current rehabilitation and maintenance efforts.

In 2017, 78 bridges (6.9%) were deemed structurally deficient. While structurally deficient bridges are not unsafe, without substantial improvements, these bridges are at risk of becoming unsafe and may need to be closed in the future. Structurally deficient bridges require significant maintenance and more frequent inspections. More than a third (30%) of the bridges deemed structurally deficient are located in the City and County of Honolulu, which is the most populated county in the State of Hawaii. As a result, some of our busiest trafficked bridges are structurally deficient. In addition, as the percentage of structurally deficient bridges has increased significantly in recent years, continual funding for bridge rehabilitation and replacement should be a priority.

NETWORK SYSTEM	2013	2014	2015	2016	2017
NHS - ALL	20	21	23	24	31
Non-NHS	38	36	41	42	47
TOTAL	58	57	64	66	78

Table 3.9. Number of Structurally Deficient Bridges

Both the state as well as the City and County of Honolulu plan to reverse this trend with future bridge rehabilitation projects. In order to optimize funding and to comply with federal and state mandates, current efforts are focused on preserving the existing bridge inventory and maintaining safety.

OPERATIONS AND MAINTENANCE, PUBLIC SAFETY, FUNDING, AND FUTURE NEED

National bridge replacement unit costs in 2016 show that Hawaii has the highest estimated unit cost for bridge replacement, with costs of $674 per square foot for National Highway System Bridges and $787 per square

foot for non-National Highway System Bridges. These high costs are primarily due to Hawaii's isolated location. Based on the 2016 unit costs, the Federal Highway Administration estimates that Hawaii would require approximately $149 million to replace all structurally deficient bridges, or $101 million to rehabilitate all structurally deficient bridges.

State funding for bridge maintenance and repair is provided by the Highway Special Revenue Fund, which consists of revenue gained through taxes and fees related to liquid fuel, vehicle registration, rental and tour vehicle surcharges, and periodic motor vehicle safety inspections.

Currently, the State of Hawaii Department of Transportation (HDOT) implements federally funded biennial bridge inspections for all state and county bridges in accordance with Federal law. Biennial inspections are performed by certified inspectors to assess the current condition of bridges and to provide quantifiable data on bridge components that may require maintenance or repair. Where existing conditions warrant, bridges are inspected at shorter intervals. A portion of this inspection data is incorporated into load rating calculations to determine whether the structure can adequately support the anticipated vehicle traffic over the bridge or whether load posting is required. From analysis of this inspection data and taking into account agency specific factors, the state and counties identify and prioritize those bridges requiring repair or replacement.

For the 443 state bridges, HDOT initially reviews bridge sufficiency ratings generated by inspection data to develop an initial list of bridge maintenance projects. This list, as well as any decision to repair, retrofit or replace a bridge is then revised by considering local conditions, such as long-term durability, capacity projections or historic/environmental constraints. For example, as the Farrington Highway Bridge 3 in Makaha is of less durable timber construction, it is slated for replacement, whereas the recently rehabilitated Karsten Thot Bridge was repaired due to its classification as a historic structure. Based on this list, the state has currently approved a budget for 44 bridge maintenance projects at $10 to $15 million dollars per bridge, to be implemented over the next four years. The state has also allocated over $10 million dollars to update the load rating for selected bridges by 2019 in order to meet federal load rating standards.

Farrington Highway Bridge 3 to be Replaced

Recently Rehabilitated Karsten Thot Bridge

For its 201 bridges, the City and County of Honolulu also reviews inspection data with consideration of other local factors to develop a priority list of maintenance projects. The City currently has two bridges under construction, five bridges awaiting the start of construction and 14 bridges in various stages of design with the goal of bidding for construction within the next three years. The City has identified 34 other bridges for further assessment to determine whether or not they need be rehabilitated over the next six years and projects a total design and construction budget for bridges over the next six years of $40 million.

No funding is currently allocated for future need, particularly with regard to upgrading or increasing bridge capacity, which will become an issue with projected population growth.

RESILIENCY

Resiliency refers to the ability of the bridge to withstand extreme events without failure and to remain in

operation for use by essential services. Hawaii's bridges are subject to a large number of hazards. Timber and bridges, although much less common than concrete bridges, are more susceptible to damage from hurricanes as well as deterioration from dry rot or corrosion common in a temperate marine environment. Parts of the state, such as the Big Island of Hawaii, are highly seismically active; thus bridges in those areas must be designed to withstand significant earthquake loads. Many bridges are located within areas vulnerable to scour, flooding, or tsunamis. Additional funding may be required for new bridge designs that must account for these events as well as future hazards such as sea level rise. Although state and county efforts concentrate on maintenance and repair, both agencies encourage repair solutions that increase resiliency, such as increased earthquake or scour resistance, where it can be economically incorporated into the repair scheme.

INNOVATION

The implementation of innovative materials, design approaches and construction methods can be used to extend bridge service life and resiliency or to reduce construction duration. To this end HDOT sponsors workshops to introduce new design and construction methodologies, such as the Accelerated Bridge Construction workshop held in April 2018. HDOT also encourages new construction techniques, such as the Halona Street Bridge Replacement project in 2017 where prefabricated bridge elements were used to aid in construction efficiency. Current HDOT sponsored bridge research includes a $400,000, five-year study to monitor seismic instrumentation in the base-isolated Kealakaha Bridge and a $700,000 remote structural health monitoring of the Kolekole Bridge and the ultra-high performance concrete joints of the Umauma Stream Bridge. The state is also working with the University of Hawaii on a study regarding the impact of sea level rise on bridges and is also exploring open end contracts for consultants and contractors to decrease time in project delivery.

The HDOT is working on its Bridge Management System to incorporate life cycle planning into its Bridge Program. By considering the current condition of system assets relative to their lifecycle, actions can be developed which reduce long-term costs and extend the service life, which in turn allows a wider range of investment choices.

RECOMMENDATIONS

Hawaii's bridges are generally in fair or good condition; however, frequent inspections and maintenance are necessary to ensure that the bridges can continue to serve the needs of the state.

Recommended actions to improve Hawaii's bridges include:

1. Continue funding repair projects to maintain the existing bridge inventory and to reduce the number of load restricted and structurally deficient bridges at a more uniform rate.
2. Develop and implement a long-term bridge maintenance and prioritization plan to mitigate deterioration of bridges in satisfactory condition and to reduce the number of future repair projects.
3. Plan for future capacity needs and future hazards such as sea level rise.

SOURCES

https://www.fhwa.dot.gov/bridge/britab.cfm - Tables of Frequently Requested NBI Information, U.S. Department of Transportation Federal Highway Administration

http://hidot.hawaii.gov/blog/2017/09/29/halona-street-bridge-replacement-project-completed-on-schedule/ - Halona Street Bridge Replacement Project Completed on Schedule, State of Hawaii Department of Transportation

http://hidot.hawaii.gov/administration/about/ - About, State of Hawaii Department of Transportation Administration

http://www.cee.hawaii.edu/research-2/structural-engineering/ - Ian Robertson and David Ma, Structural Engineering Research, University of Hawaii at Manoa, Civil and Environmental Engineering

Meeting with Edwin Sniffen (July 9, 2018), State of Hawaii Department of Transportation, Deputy Director – Highways

Meeting with Keith Kalani (July 6, 2018), City and County of Honolulu Department of Design and Construction – Civil Division, Bridge Engineer

COASTAL AREAS

EXECUTIVE SUMMARY

Hawaii's beaches and oceans are one of the foundations of the state's economy and the highlight of local culture and lifestyle. Sandy, accessible beaches are a vital piece to the recreation and tourism sector. Due to shoreline erosion, Hawaii's coastlines are faced with the following challenges: availability of suitable sand reserves, enough funding and efficient permitting. Although limited, developing and applying local and regional beach management strategies and restoration projects will be essential to decreasing the risk exposure for coastal areas. Doing so is imperative; research projects an anticipated 3.2 feet of sea level rise by 2100, which will put approximately 5,700 structures surrounding coastal areas and 40 miles of coastal roads at risk of sea inundation. Future legislation regarding development near coastal areas are one of the keys to ensuring that beaches will remain for future generations.

CAPACITY AND CONDITION

Over 750 miles of coastline surround all of the eight major Hawaiian Islands. The coastlines vary in environments from sandy beaches, fishponds, and rocky shorelines. Nearly half of the coastlines found on Oahu, Maui, and Kauai are considered sandy shorelines and are susceptible to shoreline erosion. A USGS study in 2012 found that 70 percent of the beaches on Oahu, Maui and Kauai are eroding and approximately 13 miles of sandy coastline have been completely lost to erosion.

According to the Hawaii Sea Level Rise Vulnerability and Adaptation Report (2017) by the State of Hawaii, research projects an anticipated 3.2 feet of sea level rise by 2100. With 3.2 feet of sea level rise, approximately 5,700 structures surrounding coastal areas and 40 miles of coastal roads would become at risk to sea inundation.

A study and model generated by the University of Hawaii School of Earth Science and Technology in 2013 explored the combined impacts of sea-level rise and coastal inundation due to tsunami and hurricane events within the urban core of Honolulu from Pearl Harbor to Diamond Head. Under the assumption of three feet of sea level rise and the effects of storm surge and tsunami run-up from hurricane and tsunami forces, an estimated $34.8 billion, or 80%, of the study area's economy would be at risk. The added effects of storm surge and rare tsunami events will only exacerbate the current shoreline erosion issue in areas throughout the state.

For properties along the shoreline, beach armoring has become a common solution for owners in the past. Despite the inclination to protect their homes, studies have shown that hardening shorelines through the construction of sea-walls and shoreline structures can have detrimental impacts such as reducing recreational beach widths and even increasing the rate of coastal erosion in the surrounding areas.

OPERATION AND MAINTENANCE

Beach nourishment in Hawaii can be defined by two methods: beach maintenance and beach restoration. During particular times of the year, sand accretion can develop on one segment of the beach while sand decline occurs at another segment of the beach. Sand back-passing, a form of beach maintenance, reallocates the distribution of sand by pushing or scraping to reshape the beach profile. Other forms of beach maintenance include dune restoration and re-vegetation. Frequently, sand is completely lost from the beach system and importing of sand is required as a restoration practice.

Challenges associated with beach nourishment projects in Hawaii include lack of sand resources, funding, and obtaining appropriate permits. There are very strict requirements when it comes to importing sand for beach nourishment projects. The imported sand must match the characteristics of the particles found on the beach to avoid harm to the reef ecosystem. Locating and importing sand can be costly as the supply of beach-quality

sand found on the shores of Hawaii's beaches has either been depleted or protected from being used for beach nourishment. The feasibility of transporting sand to beach nourishment sites can also be challenging.

The length of time that it takes to obtain the necessary permits and clearances to perform beach nourishment present additional challenges to completing the project as the profile of the beach could change tremendously before permits can be obtained. One of the biggest hurdles, for example, is the fact that under the 2011 Hawaii Code, Division 1 Government, Title 19, 342D, sand is designated as a "water pollutant" which creates a ripple effect by complicating the permitting process and reviews across several local agencies. Developing and applying local and regional beach management strategies will be essential to decreasing the risk exposure in coastal areas.

PUBLIC SAFETY

Sea level rise will pose a public safety risk for industrial facilities located near coastal shorelines. Impacts of sea level rise and wave inundation toward these facilities could potentially release wastewater or hazardous waste to local waters and habitats. Residential wastewater facilities could also become affected by sea level rise and release contaminants to nearby beaches and waters. For example, the Pearl Harbor Naval Complex on Oahu is an active military location that has been established as a source for contaminated soil, sediment, and groundwater with metals, and petroleum hydrocarbons and sits within a flood zone that is expected to be affected by the 3.2 feet of sea level rise.

In December 2017, Sunset Beach on the island of Oahu experienced unprecedented levels of beach erosion that raised concerns about the public's safety. The bike path running along Sunset Beach and the local lifeguard station were adversely affected by that incident, with pieces of the bike path falling nearly 20 feet before hitting the eroded ground surface below.

A six-part plan has been established to restore Sunset Beach. The plan includes removing the damaged bike path, pushing sand, planting native coastal plants to rebuild the sand dune(s), marking beach access pathways to prevent widespread foot erosion, installing access features, and fence and signage to encourage the use of pathways to respect the dune restoration. Beach restoration work began in August 2018.

FUNDING

According to the Hawaiian Island National Shoreline Management Study (2017), funding opportunities to support beach nourishment projects are limited and include: State of Hawaii Department of Land and Natural Resources (DLNR) Beach Fund, Legislative Capital Improvement Project allocations, County allocations, and Special Tax Districts. The most effective approach for funding shoreline projects seems to come from special tax districts such as the Waikiki Beach Special Improvement District, which exclusively contributes to a fund that helps pay for the restoration and maintenance of shorelines of Waikiki Beach on the island of Oahu. The table below summarizes notable beach nourishment projects and their funding sources:

FUNDING	PROJECT
County	Kailua (Oahu) Makaha (Oahu) Ehukai (Oahu) Poipu (Kauai) Kapaa (Kauai)
Private & State (cost share)	Kaanapali (Maui) Waikiki (Oahu)
Private	Sunset Beach-Rocky Point

Federal and State beach nourishment projects between 2007 and 2018 have totaled nearly $35 million, while maintaining beach nourishment projects in Waikiki alone was estimated at $1.4 million per year for the next 10 years.

FUTURE NEEDS

With the threat of sea level rise, potential loss due to the threat have been explored in the recent Hawaii Sea Level Rise Vulnerability and Adaptation Report. In monetary terms, it has been estimated that with 1.1 feet of sea level rise, there is a potential for approximately $6.9 billion in economic losses statewide, and $16.8 billion in losses with 3.2 feet of sea level rise. Estimates for Oahu top the islands at $4.1 billion and $12.9 billion in losses for 1.1 and 3.2 feet of sea level rise respectively. In terms of potential displacement of communities, over 4,000 residents could be displaced due to 1.1 feet of sea level rise statewide, and close to 20,000 people could be without homes due to 3.2 feet of sea level rise statewide. Overall with sea level rise, the State of Hawaii will experience irreparable damage to the coastal areas and infrastructure while significantly changing the coastline as we understand and experience it today.

RESILIENCE

Maui County is leading an effort to build resilience to sea level rise by holding workshops within communities that address and understand priorities for each community when rebuilding. As a result of these community meetings, the County of Maui was able to develop protocols to employ post-disaster. These protocols include deploying public service announcements in post-disaster settings that provide guidance to landowners on what steps need to be taken to restore any damage that may have occurred. The goal of this implementation is to ensure proper steps are taken to apply forward-thinking and resilient reconstruction along the coastline to prevent future events and sea level rise from inundating coastal structures and beaches.

RECOMMENDATIONS

- Restrict or limit permitting of coastal armoring and sea wall construction/projects
- Standardize coastal management plans and setback restrictions similar to Maui County statewide
- Implement localized studies to further understand and develop sustainable practices to hinder losing sand from the coastal system (e.g. the littoral cell)
- Identify and pursue potential federal sources for coastal restoration
- Re-evaluate the definition of “sand” as a water pollutant in the current Hawaii Code state regulations while still securing the integrity of the protections and permitting process

SOURCES

Hawaii Sea Level Rise Vulnerability and Adaptation Report
https://climateadaptation.hawaii.gov/wp-content/uploads/2018/01/SLR-Report_-January-2018.pdf

Hawaiian Islands National Shoreline Management Study
http://www.aldenst.com/wordpress/wp-content/uploads/2016/08/Draft-Hawaii-Report__-Incomplete_NSMS.pdf

Hawaii Ocean Resources Management Plan
http://files.hawaii.gov/dbedt/op/czm/ormp/ormp_update_reports/final_ormp_2013.pdf

Multihazard Coastal Inundation Rise and Vulnerability Assessment: A New Generation of Inundation Information for Community Resilience Planning in Honolulu, Hawaii
http://nsgl.gso.uri.edu/hawau/hawaur13026.pdf

Section 309 Assessment and Strategy FY 2016-2020
http://files.hawaii.gov/dbedt/op/czm/program/doc/hczmp_final_sec%20309%20assessment%20and%20strategy_2016-2020.pdf

Hawaii 2050 Sustainability Plan
http://files.hawaii.gov/auditor/Reports/2018/2018H2050.pdf

DAMS

EXECUTIVE SUMMARY

The State of Hawaii regulates 132 dam across the state. The majority of these dams were constructed as part of irrigation systems during the rise of the sugar cane industry and many are nearly 100 years old. Due to old age, these dams have deteriorated over time and present risks to downstream, now developed, communities. Of the 132 state-regulated dams, 123 dams (93%) are classified as High Hazard Potential (HHP) meaning a dam failure could result in significant loss of life or property and three are classified as Significant Hazard Potential (SHP), meaning dam failure could result in significant loss of property. State law requires all HHP dams to have an Emergency Action Plan (EAP) which outlines contact information and operations to maximize the safety of downstream residents in the event of a dam failure or dam emergency. 100% of state regulated HHP dams have an EAP, which is above the national average of 77%. All SHP dams have EAPs as well. As the majority of the dams are privately owned, increased funding is needed to support engineering investigations, repairs and maintenance necessary to help Hawaii's dams meet current safety standards and minimize the risk to downstream communities and the general public.

BACKGROUND

The majority of Hawaii's dams were originally constructed to support the sugar cane industry in the 1900s and agricultural farming. Today, dams continue to provide an important resource for irrigation, water supply, flood control and debris control. There are over 300 dams and reservoirs located across the state. The U.S. Army Corps of Engineers National Inventory of Dams (NID) tracks 133 dams; the rest are smaller structures. Of the 133 NID dams, 132 are regulated by the State of Hawaii, Department of Land and Natural Resources (DLNR). There is one dam in Hawaii that is federally regulated by the Department of Defense. The majority of the dams are privately owned earthen structures.

Since the Ka Loko dam failure in 2006, the state has increased its focus on dam safety. State regulations focusing on dam safety were passed in 2007 and state funding for the dam safety program also increased to support routine dam safety inspections, enforcement, and training by the state.

CONDITION AND CAPACITY

Dams are categorized nationally to indicate the consequences that could result if the dam were to fail and release large amounts of water downstream. Nationally, hazard potential of dams are classified by the following criteria:

- High Hazard Potential (HHP) – dam failure could result in significant loss of life or property.
- Significant Hazard Potential (SHP) – dam failure could result in significant loss of property.
- Low Hazard Potential (LHP) – dam failure results in no probable loss of human life and low economic and/or environmental losses

According to the 2017 Association of State Dam Safety Officials (ASDSO) Dam Safety Performance Report for Hawaii, 124 of the 132 state-regulated dams are classified as HHP; three dams are classified as SHP; and six are considered LHP. Many of the dams that would have been classified as low or significant hazard potential dams are now being classified as high hazard dams due to the development of downstream communities and the increased risk of loss of life should the integrity of the dam be compromised.

Depending on its regulatory jurisdiction, the condition of the dam is either assessed by the DLNR or the Army Corps of Engineers (COE). According to the ASDSO Dam Safety Performance Report for Hawaii, the condition

of Hawaii's HHP dams are as follows:

- 5% are rated Satisfactory (acceptable performance expected under all design loading conditions);
- 8% are rated Fair (rare or extreme events may result in a dam safety deficiency),
- 76% are rated Poor (a dam safety deficiency is recognized for loading conditions which may occur); and
- 8% are rated Unsatisfactory (emergency action required for problem resolution).

For deficient dams, DLNR, through its jurisdictional powers, is working with dam owners to address the various deficiencies. Each dam and dam owner are at different stages in terms of addressing the respectively deficiency(s)

State law requires all HHP state-regulated dams to have approved Emergency Action Plans (EAP) in place. An EAP establishes emergency contact information and operations to maximize the safety of downstream residents in the event of a dam failure or dam emergency. 100% of HHP dams and all three of the SHP dams have approved EAPs.

OPERATION AND MAINTENANCE

The average age of Hawaii's dams is 85 years old. Approximately 50% of the dams were built prior to 1919, meaning half of the dams in the state are more than 100 years old. Due to their old age, many of the dams have features that are now considered deficient. Intensive engineering investigations are required to evaluate their compliance with current dam safety design requirements.

Individual dam owners are responsible for performing routine maintenance, inspections and engineering investigations as required to ensure public safety of their respective dams. With the decline of the sugar industry in the early 1980s, many of the dams that generated agriculture revenue to fund maintenance operations have fallen into a state of disrepair.

DLNR is the agency that governs the compliance of state regulated dams with respect to state dam safety requirements. DLNR is responsible for, conducting periodic safety inspections, reviewing permit applications for modifications/improvements to existing dams, conducting emergency preparedness and other training as part of its compliance efforts.

FUNDING AND FUTURE NEEDS

Funding for dams is needed to mitigate deterioration, meet changing technical standards, and better protect growing downstream populations. Unfortunately, many dam owners, particularly private dam owners, struggle to identify and secure funding to complete the necessary rehabilitation and mitigation projects.

With 84% of the State's HHP dams being in the Poor or Unsatisfactory condition, a large number of dams require improvements and maintenance in order to perform safely under normal and adverse conditions. DLNR is actively working with dam owners to support the owner's progress in addressing deficiencies. However, 75% of the HHP dams in Poor or Unsatisfactory condition are privately owned. To support private owners in need of financial assistance to address dam safety deficiencies, voters approved a bond measure in 2014 which allows State Legislature the ability to issue bonds to dam owners in need of financial support.

PUBLIC SAFETY AND RESILIENCE

In March 2006, a dam failure occurred following of heavy rains at the privately-owned Kaloko Dam on the island of Kauai. The dam failure resulted in the death of seven people and significant property damage.

Subsequent to the Kaloko Dam failure, Hawaii developed a renewed focus on Dam Safety practices and regulatory oversight. Efforts include the passing of revised State regulations for dams in 2007. The regulations include conducting safety inspections of State regulated dams a minimum of every five years, obtaining permits for dam alterations and improvements, preparing hazard classification studies, coordinating with land owners

to prepare and update their EAP, and providing technical trainings for dam owners and Engineers on the State's dam requirements and best engineering practices.

RECOMMENDATIONS

1. Recommended actions to improve Hawaii's dam infrastructure include:
2. Secure funding for repairs and maintenance for HHP dams.
3. Since many of the HHP dams are in Poor or Unsatisfactory condition, continued emphasis needs to be placed for dam owners to routinely maintain, update, and implement EAPs.
4. Conduct engineering investigations to determine the extent of deficiencies of high hazard dams in poor condition.

SOURCES

Department of Land and Natural Resources, Hawaii Administrative Rules §13-190.1-1

Association of State Dam Safety Officials- Dam Safety Performance Report: Hawaii (2017). https://damsafety.s3.amazonaws.com/s3fs-public/HI_PerformanceReport_v2.pdf

National Inventory of Dams Website, 2016 Inventory. http://nid.usace.army.mil/cm_apex/f?p=838:3:0::NO::P3_STATES:HI

https://dlnr.hawaii.gov/wp-content/uploads/2017/10/EN18-Dam-Safety-Rpt-FY17.pdf

DRINKING WATER

EXECUTIVE SUMMARY

Hawaii's drinking water systems are comprised of groundwater, surface water, water catchment, wastewater injection, and desalinization. Each of the four counties in Hawaii manage and operate separate water supply systems. Private and military systems supplement these county systems. Capacity is sufficient, but significant funding is needed to address aging infrastructure and source development. Across the state, the availability of ground water sources is being threatened by the lack of recharge and contamination from salt water intrusion and urban pollutants. Honolulu has identified over $5 billion in infrastructure needs over the next 30 years, Kauai requires $150 to $200 million to address deficiencies and future needs over the next 20 years, and Maui DWS needs $400 million over the next 20 years for source development and transmission improvements. Deterioration of the aged distribution infrastructure compounds the reliability of the systems. For example, on the island of Kauai, much of the water distribution pipes were installed during the plantation era in the early 1920s. Urbanization on the island have increased water usage without replacing these sometimes undersized and deteriorating systems.

BACKGROUND

Approximately 90 percent of potable water in Hawaii comes from groundwater sources and supplemented by surface water and other sources. Each of the four counties manages their own individual municipal potable water systems.

On Oahu, the City & County of Honolulu Board of Water Supply (Honolulu BWS) provides the majority of Oahu's drinking water supply; a handful of small private water systems, including military ones, supply the rest of the island. The Honolulu BWS maintains approximately 2,100 miles of pipeline, 21,000 fire hydrants, 171 enclosed above ground reservoirs, 192 booster pumps, 5 shafts, 13 tunnels, 13 treatment facilities, and 194 groundwater wells and source pumps to serve over 170,000 connections.

On Maui, the County of Maui Department of Water Supply (DWS) utilizes both groundwater and surface water sources for drinking water on the islands of Maui and Molokai. The Maui DWS maintains 750 miles of water lines, 145 storage tanks with 295 million gallons of water storage capacity, 6 surface water treatment facilities, and 35 groundwater sources. The Lanai Water Company provides water on Lanai.

On Kauai, the County of Kauai's Department of Water (DOW) relies on groundwater to provide the majority of the potable water on the island. Private utilities also provide potable water on Kauai.

On Hawaii Island, the County of Hawaii Department of Water Supply (DWS) provides potable water from groundwater and some surface water sources. Where Hawaii DWS does not provide water service, privately owned and operated public water systems, and private rainwater catchment systems provide potable water. The Army's Pohakuloa Training Area is served by a State of Hawaii owned water system. The Army's Kilauea Military Camp and US Parks Service's Hawaii Volcanoes National Park operates and maintains their own water catchment system.

While Hawaii is fortunate to receive an abundance of rainfall, much of the water quickly flows over steep mountains and short floodplains and into the ocean. With the continued growth and demand for fresh water, growing maintenance and repair problems of the aging infrastructure, and threats of contamination to existing water sources, the challenges to delivering drinking water is ever increasing. Climate change is believed to exacerbate the lack of ground water recharge as periods of rainfall are decreasing, while periods of drought are increasing. The intensity of rainfall and drought have also increased in recent year.

CAPACITY

Oahu's potable water system is sourced from deep groundwater aquifers, which are recharged during and after rainfall events as runoff filters through the islands' volcanic geology. The Honolulu BWS provides an average of 145 million gallons per day (MGD) to 1 million people. This estimate includes tourists staying at hotels connected to public water systems. The Pearl Harbor aquifer is Oahu's largest aquifer serving about two-thirds of the island. Each aquifer has a designated sustainable yield, or maximum amount of water that can be withdrawn each day without adversely affecting the aquifer. The Honolulu BWS has the capacity to provide more than 180 MGD, which is below the sustainable yields from the groundwater sources. In other words, capacity is sufficient.

Maui's DWS potable water system provides an average of 32 MGD of potable water to more than 160 thousand people from a combination of groundwater and surface water sources. Maui is currently undergoing challenges in meeting future water needs in Lahaina and Upcountry areas. The total sustainable yield of aquifers across the island of Maui is 427 MGD. On Lanai, 2.24 MGD was pumped in 2008 from ground water sources. The Lanai system has a sustainable yield of 6 MGD.

Kauai's water system provides over 12.7 MGD of potable water to over 70 thousand people. Of the 12.7 MGD average, approximately 10.4 MGD is from groundwater and 2.3 MGD is from surface water.

Water systems on Hawaii Island are operated and maintained by both public and private entities. The Hawaii County DWS maintains 23 public water systems providing an average of 25 MGD to over 100 thousand people. Hawaii Island's potable water supply is made up of ground water, surface water, and rainwater catchment. Rainwater catchment is prevalent where county-provided service is not available. There are also several private water systems on Hawaii Island that provide both drinking water and non-potable water. It is estimated that approximately 275 MGD is provided to residents of Hawaii Island. However, it is difficult to ascertain the total amount of water as records may not be kept or consistently submitted. The total sustainable yield of aquifers across the entire island is 2,431 MGD.

CONDITION

Infrastructure deficiencies continue to remain a challenge throughout all water systems in the state. For example, Kauai's Water Plan 2020, which provides a comprehensive plan for addressing aging and deteriorating infrastructure, indicated that major structural deficiencies were found in three of the six water districts. As a result, 250 actions/projects were identified and prioritized to address deficiencies, long-term needs, system resiliency, and projected growth. In 2017, deficiencies were identified in five of the six districts due to a lack of replacement or rehabilitation actions. As of March 2019, the status of the 250 projects initially identified are as follows: 81 completed; 5 under construction; 17 under design; 147 no action.

In 2016, Honolulu BWS assessed the condition of their infrastructure:

- Pump stations: There is sufficient capacity to meet all current flow conditions. There is a need, however for additional backup pumps (redundancy) and refurbishment: Sixty-two percent of the existing pumps need routine maintenance work; and 26 percent need moderate rehabilitation work and 12 percent need higher priority repair/rehabilitation work to improve operation, reliability, and efficiency.
- Pipelines: Because pipelines are buried, their condition cannot be easily assessed. The frequency of water main breaks, a visual predictor of the condition of the water mains, has generally been on the decline for the past several years. The reduction from about 400 water main breaks per year (fiscal year 2010) to 322 (fiscal year 2018) was due to changes in operational practices, pressure management, proactive leak detection and replacement of selected critical pipelines. The average age of the pipes in the system is below 50 years. The life span analysis performed in the BWS-WMP recommends that the Honolulu BWS should increase pipeline replacement to approximately 21 miles per year indefinitely using the pipeline risk analysis tools to prioritize pipeline replacement projects.
- Treatment: Eighty-five percent of the granular activated carbon facilities are in good condition; requiring only routine maintenance and 15 percent need mechanical/structural repairs that would

extend the useful lifespans, increase efficiency and address corrosion issues, but would not affect water quality.

- Reservoirs: Majority of the reservoirs were in good to excellent condition: Eight percent need normal routine maintenance; 81 percent would benefit from some structural retrofit and 11 percent are in need of higher priority structural and seismic repair/rehabilitation work.

The Kauai DOW reports that overall the water distribution system is in poor condition due to inaccessibility for maintenance and undersized pipelines. Over 100 miles of pipeline will be due for replacement within the next 20 years.

FUNDING

Over the next 30 years, the Honolulu BWS plans to implement over 800 infrastructure projects totaling more than $5.3 billion. Honolulu BWS Capital Improvement Program budget for the 2018 fiscal year is $144.3 million. Effective September 10, 2018 through June 30, 2023, Honolulu BWS enacted rate increases that are expected to generate an additional $60 million to fund operations and infrastructure projects. The financial policies adopted by the Honolulu BWS target debt to net assets at less than or equal to 50%, allowing them to maintain a strong credit rating (AA+ - Fitch, Aa2 – Moody's) and future financial flexibility.

For Kauai DOW, approximately $70 million is needed to address current deficiencies in the system within the next five years. It is estimated that an additional $80 to 130 million is needed to address water infrastructure needs within the next 20 years. Kauai DOW's ability to implement their 2020 Plan is impacted by their ability to fund capital improvement projects in any given year.

For Maui DWS's four systems, the estimated combined cost of source development and transmission improvements is $400 million over the next 20 years.

While drinking water infrastructure is funded primarily through a rate-based system, the federal and state governments offer some financial support in the form of low interest loans. The Environmental Protection Agency (EPA) Drinking Water State Revolving Fund program provided over $11 million in 2018 in the form of loans to projects in Hawaii that help achieve or maintain compliance with drinking water standards or help protect public health and the environment. From fiscal year 2005 to present, the Honolulu BWS has received $135 million in SRF loans.

FUTURE NEED

By 2030, an additional 100 MGD of fresh water supply is planned throughout the state. Water demand is projected to increase by 79 MGD while groundwater supplies are projected to decrease by 21 MGD due to factors such as saltwater intrusion, sea level rise, and decrease in recharge as the state continues to urbanize and there is an increase in impervious area. Additionally, the population of Hawaii is expected to grow from 1.43 million in 2016 to 1.65 million by 2045, based on estimates from the State of Hawaii Department of Business Economic Development and Tourism.

The Honolulu BWS identified the following needs to meet the demands of a growing population through 2040:

- Water Supply: The Metropolitan Low water system will an additional 9 million gallons per day (mgd) and the Ewa-Waipahu water system will also need an additional 9 mgd.
- Water Pumping Capacity: The following water systems will need additional pumping capacity – Metropolitan Low - 10 mgd; Metropolitan High – 14.6 mgd; Leeward – 9 mgd; Ewa-Waipahu – 15 mgd; Pearl City – 3.8 mgd; Aiea-Halawa – 8.6 mgd; Kahuku – 2 mgd; North Shore – 3.5 mgd.
- Water Storage Capacity: The Metropolitan Low water system has the most significant current and future storage needs. Alternatives to meet these needs include new storage facilities in Honolulu; new wells between Honolulu and Kahala to meet peak demands; new infrastructure to the west of the Metropolitan Low water system due to limited availability of land; or a combination of these alternatives. Additional storage capacity in other water systems include: Leeward – 1.5 mg; Pearl City – 0.4 mg; Kahuku – 0.2 MG and North Shore – 1.0 mg.

- Water Pipeline Capacity: The Metropolitan Low water system will need up to 6.5 miles of new pipelines, varying is size from 8 to 42 inches in diameter. The Ewa-Waipahu water system will need up to 2.6 miles of new pipeline, varying in size from 24 to 36 inches in diameter. The North Shore water system will need 2.3 miles of upsized and new pipeline, varying in size from 8 to 36 inches in diameter.
- Water Pipeline Renewal and Replacement: The Honolulu BWS will be significantly ramping up its pipeline replacement program, increasing from 6 miles in 2017 to 21 miles per year over a 10-year period.

Maui's water supply from stream diversions have been reduced following the recent increase in instream flow standards designed to improve aquatic habitat. These standards are set by the State of Hawaii, Department of Land and Natural Resources, Commission on Water Resource Management (CWRM). This reduction in diversions from Maui streams will require Maui DWS to develop new water sources to make up the losses in water supply quantity.

The Kauai DOW has taken on more aggressive plans for capital improvement, rehabilitation and replacement programs, with proposed water rate adjustments and charges needed to support the implementation of the next 5-year plant and longer-term 20-year plan.

Hawaii DWS will be performing a needs assessment and subsequent rate adjustment to fund future capital improvement projects.

OPERATION AND MAINTENANCE

As mandated by federal and state law, the State of Hawaii, Department of Health and water purveyors regularly test their drinking water to ensure they meet stringent safe drinking water standards. Occasionally, service is temporarily suspended/interrupted during a recorded contamination event or water main break. Automated asset management systems have been developed by each agency that is used to plan operations, maintenance, repairs and replacement activities.

The Honolulu BWS has been and continues to be fully compliant with all federal and state drinking water regulations delivered through the current infrastructure. Treatment facilities are installed, operated and monitored to ensure the water served is safe to drink and protective of public health and safety.

PUBLIC SAFETY

The Navy Red Hill Bulk Fuel Facility stores nearly 200 million gallons of fuel a mere 100 feet above Oahu's sole source drinking water aquifer. The fuel facility stores jet fuel and marine diesel, within 20 fuel storage tanks (225 million-gallon capacity), 18 of which (187 million gallons) are active. Each tank is big enough to fit the Aloha Tower that stands at over 224 ft. high. In 2014, 27,000 gallons of jet fuel leaked from Tank 5 at Red Hill.

Wells operated and maintained by the Honolulu BWS presently show no detectable levels of petroleum contamination. However, the Navy has documented numerous leaks from the tanks and Navy tests continue to show the presence of fuel contaminants in the groundwater and rocks underneath the facility. Given these findings, the storage of an enormous amount of fuel in tanks built more than 75 years ago, which continue to age, poses a serious risk of irreversibly contaminating Oahu's groundwater resource. Major improvements to the Navy's Red Hill tank infrastructure are needed to protect public safety.

Despite environmental laws and policies, Hawaii has approximately 88,000 cesspools still in use. As sea level and water table rises, the risk of wastewater contaminating potable water sources continues to increase. The highest priority area is Upcountry Maui where 7,400 cesspools have caused elevated nitrate levels in a few drinking water wells. Recorded levels of nitrate in two private water system wells which are located down gradient from a high density of cesspools were 6.8 and 8.7 mg/L, which is concerning considering the legal limit is 10 mg/L. The Maui DWS upcountry wells are located down gradient from limited or scattered density of cesspools have recorded levels between 0.4 mg/L to 4.1 mg/L.

Because of the numerous rural areas on Kauai, minimum fire flow requirements are not met. The Kauai DOW and Fire Department are developing alternative means to achieve fire protection in these areas.

RESILIENCE

Over the last 30 years, Hawaii has experienced a 22 percent drop in rainfall. At the same time, sea levels are projected to rise 1 foot by 2050 and 3 feet by 2100. Water supply sources will need to be diversified to address threats to water quantity and quality.

Hawaii water purveyors are taking climate change and sea level rise into account in their plans and strategies. Efforts to better understand the vulnerability of water systems and develop adaptation strategies are being funded and undertaken.

Efforts include the construction of a 1 MGD seawater desalination facility in West Oahu to address drought and water supply shortages. Honolulu BWS also recently acquired the State's brackish water desalination plant in Kapolei District and plans to reconstruct their system to provide 0.7 MGD of desalinized water to supplement the water supply for Kapolei, in addition to commissioning climate change studies with researchers at the University of Hawaii to better understand the effects of Oahu groundwater sources so it can develop effective mitigation plans.

The Honolulu BWS is also committed to expanding water conservation and watershed management programs to protect and sustain Oahu's water supply and watersheds by setting aside 8 percent of its annual Capital Improvement Program budget to fund watershed management and water conservation programs.

Hawaii DWS is pursuing high level, spring, and other sources (deep, freshwater aquifer below basal lens) that are less impacted by seal level rise.

Kauai DOW partners with the Kauai Watershed Alliance and the Nature Conservancy by providing $200,000 in funding annually to support the Nature Conservancy's efforts for watershed protection and restoration through removal of invasive species.

In 2013, the Hawaii Fresh Water Initiative Council was formed to bring together multiple, diverse parties to develop a consensus-based approach to solving Hawaii's future fresh water challenges. The Council, consisting government water managers and scientists, water purveyors, large land owners, academia, and regulators, developed a vision to reach a state-wide goal of conserving, recharging and reusing 100 MGD by 2030 to provide for a more secure and sustainable water future. The Council developed action plans, policies, and legislative acts to fulfill this goal.

INNOVATION

Through water conservation, the Honolulu BWS has cut daily water usage by about 30 gallons per day per person resulting in savings of more than 12 MGD. Rain-barrel water for non-potable uses, xeriscape gardens, and water efficient fixtures and home appliances have contributed to these savings. Life cycle costing of projects and materials may be implemented to reduce overall cost. The Honolulu BWS has also partnered with the University of Hawaii (UH) to study surface water injection into the ground to recharge aquifers. Hawaii DWS is also partnering with UH to study groundwater recharge benefits based on watershed protection projects in specific areas.

RECOMMENDATIONS

Recommended actions to improve Hawaii's drinking water infrastructure include (sources include County plans and Fresh Water Initiative):

1. Increase water rates to better reflect the true cost of service and to finance current and future infrastructure capital improvement, maintenance and repair needs. Secure grants, issue bonds, and/or take out loans to minimize impact to rate payers.
2. Identify methods to decrease project costs, including outsourcing the maintenance and repair projects to private contractors to accelerate implementation of projects, when appropriate.

3. Protect existing groundwater sources from contamination by reducing urban contaminants in storm water runoff.
4. Increase ground water recharge by creating more stormwater retention.
5. Develop new sources of surface water diversions.
6. Develop more desalination sources.
7. Incorporate life cycle costing as a means of reducing over infrastructure project costs.

SOURCES

http://bigislandliving.com/water.htm
http://files.hawaii.gov/dlnr/cwrm/planning/conwmp2013.pdf
http://files.hawaii.gov/dlnr/cwrm/planning/wudpla2011.pdf
http://governor.hawaii.gov/newsroom/latest-news/news-release-on-water-monitoring-of-pesticides/
http://hawaiifirstwater.org/groundwater/page/2/
http://hawaiifirstwater.org/streams-rivers/page/2/
http://hawaiifirstwater.org/what-is-the-current-state-of-fresh-water-supplies-in-honolulu-and-oahu-will-we-have-enough-water-for-the-future-2/
http://hawaiiindependent.net/story/honolulus-water-worries
http://health.hawaii.gov/cwb/files/2016/03/160328-DOH-CWB-Water-Monitoring-Mahaulepu-Sanitary-Survey.pdf
http://health.hawaii.gov/opppd/files/2015/06/340E-33-Drinking-Water-Treatment.pdf
http://health.hawaii.gov/sdwb/drinking-water-state-revolving-fund/
http://health.hawaii.gov/sdwb/files/2013/06/Water_Spot_Volume14_Issue3.pdf
http://health.hawaii.gov/sdwb/files/2015/09/M03_NSWMPGovWaterConfAug62015.pdf
http://health.hawaii.gov/sdwb/files/2017/02/DWSRFPrivatePWSWorkshopHandout.pdfhttp:/health.hawaii.gov/sdwb/files/2017/02/DWSRFPrivatePWSWorkshopHandout.pdf
http://health.hawaii.gov/sdwb/raincatchment/
http://health.hawaii.gov/water/files/2014/09/2014-DOH-DRAFT-Water-Quality-Plan.pdf
http://hipaonline.com/images/uploads/InfrastructureReport-7-7-10.pdf
http://hipaonline.com/images/uploads/StateOfPhysicalInfrastructureinHawaiiPhaseII.pdf
http://iopscience.iop.org/article/10.1088/1748-9326/10/6/064009
http://iopscience.iop.org/article/10.1088/1748-9326/10/6/064009/pdf
http://knowledge.wharton.upenn.edu/special-report/partners-resilience-constructing-future-sustainable-infrastructure/
http://lanaiwatercompany.com/
http://lanaiwatercompany.com/about-us/history/
http://lanaiwatercompany.com/water-reports/
http://mauicounty.us/infrastructure/county-to-appeal-unprecedented-ruling-on-injection-wells/
http://mauicounty.us/water/state-again-turns-its-attention-to-cesspool-issue/
http://mauicounty.us/wp-content/uploads/2015/01/Request-Lanai-Cmty-Plan-151207.pdf
http://mauinow.com/2017/12/19/upcountry-maui-is-a-priority-area-for-cesspool-upgrades/
http://mauinow.com/2018/04/25/gabbard-introduces-bill-to-upgrade-water-infrastructure-in-hawaii/
http://mauisierraclub.org/category/water/
http://maui-tomorrow.org/mauis-water-resources-a-general-overview/
http://plankauai.com/wp-content/uploads/160203-Infrastructure-Assessment-v3.pdf
http://seagrant.soest.hawaii.edu/sites/default/files/publications/ka_pili_kai_summer_2016_finalsm.pdf
http://thechart.blogs.cnn.com/2010/12/20/carcinogen-found-in-31-of-35-cities-water-supply/
http://www.beachapedia.org/State_of_the_Beach/State_Reports/HI/Water_Quality
http://www.bettercropshawaii.com/home/another-set-of-kauai-drinking-water-quality-tests-another-clean-bill-of-health/
http://www.boardofwatersupply.com/customer-service/bws-seeks-community-input-proposed-rate-changes
http://www.boardofwatersupply.com/water-quality
http://www.boardofwatersupply.com/water-quality/frequently-asked-questionshttp://www.boardofwatersupply.com/water-quality/safe-drinking-water

http://www.boardofwatersupply.com/water-quality/water-quality-report
http://www.chicagotribune.com/sns-bc-us--leaky-fuel-tanks-20151001-story.html
http://www.circleofblue.org/2015/world/hawaii-transforms-watershed-protection-technology/
http://www.civilbeat.org/2014/07/denby-fawcett-in-defense-of-hawaiis-tap-water-drink-it-and-thrive/
http://www.civilbeat.org/2016/01/ige-we-live-in-a-time-of-extraordinary-change/
http://www.civilbeat.org/2017/12/from-bad-to-worse-hawaiis-1-75-billion-cesspool-problem/
http://www.civilbeat.org/topics/honolulu-infrastructure/
http://www.cleanwatercouncil.org/hawaii.html
http://www.governing.com/topics/transportation-infrastructure/what-is-water-recycling.html
http://www.hawaiidws.org/7%20the%20water/ccr/2016/CCRSHiloHilo2016lo.pdf
http://www.hawaiifreepress.com/ArticlesMain/tabid/56/ID/21500/State-Supreme-Court-to-Hear-Molokai-Ranch-Water-Case.aspx
http://www.hawaiifreepress.com/ArticlesMain/tabid/56/ID/3428/Honolulu-is-2-on-Erin-Brockovich-hexavalent-chromium-hit-list.aspx
http://www.hawaiihealthmatters.org/content/sites/hawaii/2015_Maui-County-CHNA.pdf
http://www.hawaiinewsnow.com/story/13717932/study-finds-cancer-causing-chemical-in-honolulus-tap-water
http://www.hawaiinewsnow.com/story/33780639/water-quality-concerns-raised-on-molokai-due-to-damaged-storage-tanks
http://www.hawaiinewsnow.com/story/36990410/banned-contaminant-found-in-kauai-drinking-water-tank
http://www.hawaiinewsnow.com/story/37105090/cesspools-could-soon-impact-your-drinking-water-doh-says
http://www.hawaiinewsnow.com/story/37970514/residents-in-some-kauai-communities-urged-not-to-drink-tap-water
http://www.hawaiinewsnow.com/story/38194518/water-infrastructure-repair-technologies-market-2018-development-trend-segmentation-and-industry-forecasts-to-2023
http://www.hawaiiwaterservice.com/docs/ccr/2016/kuk_2016.pdf
http://www.honolulumagazine.com/Honolulu-Magazine/February-2017/Is-Water-Fluoridation-the-Answer-to-Hawaiis-Rampant-Tooth-Decay-Problem/
http://www.kauaihomeinspection.com/water-quality.htm
http://www.kauaiwater.org/ce_waterplan2020.asp
http://www.kauaiwater.org/ce_waterqualityrpt.asp
http://www.kauaiwater.org/cp_waterboard_agendas/November 2017 agenda pdf/Manager's Report No. 18-82
http://www.kauaiwater.org/Kdow/valueofwater.html
http://www.kauaiwater.org/wqr_hanalei.pdf
http://www.kauaiwater.org/wqr_kalaheo.pdf
http://www.kauaiwater.org/wqr_waimea.pdf
http://www.khon2.com/news/local-news/critics-say-progress-slow-to-replace-oahus-aging-water-mains_20180104063407284/901510467
http://www.khon2.com/news/local-news/health-officials-blame-cesspools-for-contaminated-water-but-solution-unclear_20180306072043997/1012671069
http://www.khon2.com/news/local-news/molokai-residents-warned-against-water-use-schools-closed-after-tanks-vandalized_20180104064029957/901570271
http://www.kitv.com/story/32350445/gov-ige-signs-package-of-bills-to-protect-hawaiis-water-supply
http://www.kitv.com/story/33155908/should-i-worry-about-chromium-6-in-my-drinking-water
http://www.mauinews.com/news/local-news/2016/11/study-injection-wells-fouling-maui-bays-reefs/
http://www.mauinews.com/news/local-news/2016/12/e-coli-bacteria-found-treated-in-molokai-water/
http://www.mauinews.com/news/local-news/2017/09/water-panel-seeks-solution-for-s-maui-irrigation/
http://www.mauinews.com/news/local-news/2017/10/long-term-results-in-watershed-restoration-to-be-studied/
http://www.mauinews.com/news/local-news/2018/02/cesspools-concern-residents/
http://www.mauinews.com/news/local-news/2018/03/county-e-coli-found-in-molokai-well-but-water-safe/
http://www.mauinews.com/news/local-news/2018/03/water-rates-to-be-the-topic-on-molokai/
http://www.mauinews.com/opinion/columns/2017/10/purchase-of-water-company-would-be-a-good-investment/
http://www.mcwane.com/upl/downloads/resources/americas-water-infrastructure-challenge/reinvesting-in-drinking-water-infrastructure.pdf
http://www.molokaipropertieswater.com/frequently-asked-questions/
http://www.princevilleutilities.com/Documents/2016_Water_Quality_Report.pdf

http://www.pulamalanai.com/public/pulamalanai/files/documents/PLDESAL5.21.pdf
http://www.savewestmaui.com/news_staradvertiser_180205.htm
http://www.staradvertiser.com/2016/04/09/breaking-news/hawaii-tap-water-safer-from-lead-than-other-states/
http://www.staradvertiser.com/2016/05/13/hawaii-news/20m-grant-to-help-uh-study-isles-fresh-water/
http://www.staradvertiser.com/2018/04/16/breaking-news/kauai-residents-warned-not-to-drink-tap-water-in-wainiha-haena/
http://www.staradvertiser.com/2018/05/22/breaking-news/public-meetings-on-cesspools-set-for-oahu-big-island-and-kauai/
http://www.thegardenisland.com/2018/05/25/hawaii-news/road-to-recovery/
http://www.westmauiwatershed.org/explore/waters/distribution
https://19january2017snapshot.epa.gov/newsreleases/epa-awards-hawaii-over-186-million-improve-water-quality-protect-public-health_.html
https://americaninfrastructuremag.com/hawaii-receives-18m-water-infrastructure/
https://bnanews.bna.com/environment-and-energy/epa-nearly-half-a-trillion-needed-for-drinking-water-infrastructure
https://cnic.navy.mil/content/cnic/cnic_hq/regions/cnrh/om/environmental/water_quality_information/_jcr_content/par1/pdfdownload/file.res/2016JBPHHWQRpt_Final051716.pdf
https://cnic.navy.mil/regions/cnrh/installations/pacific_missile_range_facility_barking_sands/about/resources/2014-annual-pmrf-water-quality-report.html
https://damontucker.com/tag/safe-drinking-water-act/
https://earthjustice.org/news/press/2018/federal-appeals-court-reaffirms-maui-clean-water-act-decision
https://gabbard.house.gov/news/press-releases/rep-tulsi-gabbard-introduces-bill-upgrade-water-infrastructure-hawai-i
https://gabbard.house.gov/transportation
https://gcahawaii.org/gca_newsletter/2016-1011BWSPresentation.pdf
https://governor.hawaii.gov/newsroom/latest-news/water-quality-continues-to-improve-at-kauai-beaches-as-additional-brown-water-advisories-are-lifted/
https://hdoa.hawaii.gov/wp-content/uploads/2013/07/ADCannual2001.pdf
https://health.hawaii.gov/opppd/files/2017/12/Act-125-HB1244-HD1-SD3-CD1-29th-Legislature-Cesspool-Report.pdf
https://health.hawaii.gov/wastewater/files/2018/02/Upcountry_report.pdf
https://hi.water.usgs.gov/publications/pubs/fs/fs126-00.pdf
https://news.nationalgeographic.com/2016/08/obama-creates-world-s-largest-park-off-hawaii/
https://patch.com/hawaii/across-hi/nasty-pollutants-hawaii-drinking-water-put-your-health-risk
https://pubs.er.usgs.gov/publication/70161774
https://pubs.usgs.gov/circ/2004/1239/pdf/circular1239.pdf
https://pubs.usgs.gov/fs/fs006-98/pdf/fs006-98.pdf
https://pubs.usgs.gov/wri/1997/4155/report.pdf
https://sierraclubhawaii.org/court-rules-red-hill-tanks-violate-state-law/
https://sierraclubhawaii.org/red-hill-water-security/
https://sierracluboahu.org/category/red-hill/
https://sierracluboahu.org/civil-beat-threat-to-drinking-water-remains-as-navy-studies-options-for-fuel-tanks/
https://techcrunch.com/2017/03/08/teslas-kauai-solar-facility-will-offset-1-6m-gallons-of-fuel-use-per-year/
https://themolokaidispatch.com/know-your-water-know-your-responsibilities/
https://themolokaidispatch.com/ranch-seeks-to-renew-water-permit/
https://wikitravel.org/en/Talk:Hawaii
https://www.boardofwatersupply.com/about-us/bws-strategic-plan
https://www.boardofwatersupply.com/bws/media/files/bws-long-range-financial-plan-2018-02.pdf
https://www.boardofwatersupply.com/bws/media/files/hbws-30-year-infrastructure-investment-plan-summary-2018-03.pdf
https://www.boardofwatersupply.com/bws/media/files/hbws-long-range-financial-plan-summary-2018-4-24.pdf
https://www.boardofwatersupply.com/bws/media/files/water-master-plan-public-draft-summary-2016-07.pdf
https://www.boardofwatersupply.com/bws/media/files/water-matters-2017-summer.pdf
https://www.boardofwatersupply.com/water-resources/water-master-plan
https://www.boardofwatersupply.com/water-resources/watershed-management-plan
https://www.centerforfoodsafety.org/files/monsanto-memo_molokai_oct-14-2015_05281.pdf

https://www.ctahr.hawaii.edu/sustainag/newfarmer/news/bfpnewsletter43015.pdf
https://www.epa.gov/drinkingwatersrf/epas-6th-drinking-water-infrastructure-needs-survey-and-assessment
https://www.epa.gov/newsreleases/us-epa-announces-new-funding-water-infrastructure-projects
https://www.epa.gov/red-hill/drinking-water-quality-red-hill
https://www.epa.gov/sites/production/files/2015-07/documents/epa816r13006.pdf
https://www.epa.gov/sites/production/files/2016-06/documents/hawaii_response_letter_508.pdf
https://www.epa.gov/sites/production/files/2018-03/documents/sixth_drinking_water_infrastructure_needs_survey_and_assessment.pdf
https://www.epa.gov/sites/production/files/2018-11/documents/hawaii_dwsrf_nims_rpt_2018_.pdf
https://www.gao.gov/products/GAO-17-559
https://www.garrison.hawaii.army.mil/sustainability/Documents/DW/FS.pdf
https://www.gpo.gov/fdsys/pkg/CHRG-113shrg87360/html/CHRG-113shrg87360.htm
https://www.hawaii.edu/news/2015/01/23/large-fresh-water-supply-discovered-by-uh-researchers-on-hawaii-island/
https://www.hawaii-aloha.com/blog/2016/01/12/is-hawaii-tap-water-safe-to-drink/
https://www.hawaiibusiness.com/our-water-world/
https://www.hawaiibusiness.com/water-warning/
https://www.hawaiicommunityfoundation.org/file/cat/Fresh_Water_Blueprint_FINAL_062215_small.pdf
https://www.hawaiicommunityfoundation.org/file/Hawaii-Fresh-Water-Initiative-Summary-Report.pdf
https://www.hawaiimagazine.com/blogs/hawaii_today/2015/1/26/hawaii_island_fresh_water_found
https://www.hawaiipacifichealth.org/MEDIA/1709/CHNA-WILCOX.PDF
https://www.higp.hawaii.edu/hggrc/projects/geothermal-digital-collection/geothermal-topic-guides/water-quality-and-wells-hydrology/
https://www.honolulu.gov/dfmswq/learningctr/875-site-dfm-swq-cat/20889-water-quality.html
https://www.honolulu.gov/rep/site/ocs/roh/ROH_Chapter_30_.pdf
https://www.huffingtonpost.com/entry/inside-hawaiis-forbidden-island_us_559f57ece4b096729155e13a
https://www.infrastructurereportcard.org/wp-content/uploads/2017/01/Drinking-Water-Final.pdf
https://www.marketwatch.com/story/hawaii-wants-to-ban-certain-sunscreens-to-protect-coral-reefs-should-you-stop-using-them-2018-05-02
https://www.mauicounty.gov/126/Department-of-Water-Supply
https://www.mauicounty.gov/2051/Maui-Island-Water-Use-Development-Plan
https://www.mauicounty.gov/226/Maui-Water
https://www.mauicounty.gov/247/Water-Quality-Report
https://www.mauicounty.gov/574/Chloramines
https://www.mauicounty.gov/DocumentCenter/View/102581/050_19_Water-Supply
https://www.mauicounty.gov/DocumentCenter/View/10485/Infrastructure-and-Public-Facilities-Technical-Is
https://www.mauicounty.gov/DocumentCenter/View/10486/Maui-Infrastructure-Assessment-Update-condensed
https://www.mauicounty.gov/DocumentCenter/View/10811/The-County-of-Mauis-Water-Reuse-Program
https://www.mauicounty.gov/DocumentCenter/View/10968/Molokai-Wellhead-Protection-Strategy-DRAFT
https://www.mauicounty.gov/DocumentCenter/View/12729/Lanai-WUDP-Feb-25-2011
https://www.mauicounty.gov/DocumentCenter/View/14904/SWAP_Maui_6-27-11
https://www.mauicounty.gov/DocumentCenter/View/88404/070-10-CIP-Water-Supply-Project-Sheet-Report
https://www.mauicounty.gov/DocumentCenter/View/98158/52015-Water-Workshop-Presentation-DHHL
https://www.mauireefs.org/wp-content/uploads/2017/12/MNMRC-Options-to-Improve-Wastewater-Management-in-South-Maui.pdf
https://www.nacwa.org/docs/default-source/clean-water-current-pdf/06-sep-16/mauisummary-(hawaii).pdf
https://www.napawash.org/uploads/Academy_Studies/NAPA_EPA_FINAL_REPORT_110117.pdf
https://www.nrdc.org/resources/threats-tap-widespread-violations-water-infrastructure
https://www.nrdc.org/sites/default/files/wat_14111801b.pdf
https://www.nytimes.com/interactive/projects/toxic-waters/contaminants/hi/kauai/index.html
https://www.pressreader.com/usa/honolulu-star-advertiser/20161102/281887297865389
https://www.pressreader.com/usa/honolulu-star-advertiser/20161120/281487865941794
https://www.quora.com/Lana%CA%BBi-What-is-the-water-situation-in-Lanai
https://www.schatz.senate.gov/press-releases/hawaii-congressional-delegation-introduces-legislation-to-protect-oahus-

drinking-water-and-improve-the-red-hill-fuel-storage-facility
https://www.sciencedirect.com/science/article/pii/S2214581815002062
https://www.suezwatertechnologies.com/kcpguest/salesedge/documents/Case%20Studies_Cust/Americas/English/CS-GROV-MUNDW-EN.pdf
https://www.veolianorthamerica.com/en/media/press-releases/honolulu-board-water-supply-renews-environmental-water-reuse-partnership-veolia
https://www.wateronline.com/doc/hawaii-officials-want-tougher-wastewater-rules-0001
https://www.wsj.com/articles/hawaiis-cesspools-threaten-drinking-water-tourism-1518357620
https://www.wwdmag.com/water/epa-awards-497100-county-maui-department-water-supply

ENERGY

EXECUTIVE SUMMARY

Hawaii is an island state that does not have any naturally occurring fuel sources, but is blessed with abundant renewable energy resources. Currently, Hawaii has the highest electricity cost per kilowatt hour in the nation, approximately 2 ½ times the national average. To bring costs down and better protect the environment, Hawaii has mandated 100 percent of electricity generation with renewable sources by 2045. With solar energy readily available and significant technological/cost advancements, solar electricity and water heating has become Hawaii's most popular and cost-efficient energy source. The state leads the nation in both residential solar power generated per household and is third in total solar photovoltaic capacity installed. Meanwhile, over $1.5 billion has been spent by the Hawaiian Electric Companies to upgrade and strengthen poles, lines and equipment to prepare for increasingly severe storms.

BACKGROUND

Hawaii has a unique arrangement of individual utilities providing a bulk of electricity generation and delivery to each island. The largest utility company is Hawaiian Electric Companies, which is comprised of three utilities - Hawaiian Electric Company (HECO), Maui Electric Company (MECO), and Hawaii Electric Light Company (HELCO). HECO serves the island of Oahu, MECO serves the islands of Maui, Lanai, and Molokai, and HELCO serves the island of Hawaii. The island of Kauai is served by Kauai Island Utility Cooperative (KIUC). Electricity generation by the Hawaiian Electric Companies and KIUC is provided mostly by burning oil and coal. On Oahu, the Hawaii Gas distribution system provides customers with synthetic natural gas (SNG) through approximately 1,000 miles of pipeline. Customers not near this system and on other islands are serviced with propane, either by Hawaii Gas or another company. The utilities are regulated by the Hawaii Public Utilities Commission (PUC).

Hawaii does not have any naturally occurring oil, natural gas or coal resources, but because of its availability and ease of storage and transport, oil and derived products (e.g., gasoline) have become the primary source of energy. Approximately 1/3 of the fossil fuels imported to Hawaii are used to generate electricity and 2/3 for transportation. Hawaii has by far the highest average retail electricity price per kilowatt hour in the nation at $0.3246/kWh, approximately 2 ½ times the national average. Gasoline prices are usually around $1/gallon higher than mainland U.S. prices and other factors.

CONDITION & CAPACITY

Due to the increasing frequency of high wind events in recent years, significant capital investments has are been being made in increasing the reliability of the electrical transmission system. Hawaii's transmission system is unlike most others due to its inability to share generation with other utilities due to the separation of the islands. In addition, loss of main generation typically causes a loss of residential solar PV generation. Because of this, local infrastructure reliability is critical and each transmission and distribution (T&D) system has been identified as an aging asset that needs to be addressed.

There are no on-island sources or production facilities for coal or oil. Hawaii Gas imports natural gas via liquefied natural gas (LNG) and produces SNG locally by converting byproducts, from the oil-refining process, and hydrogen, from reclaimed water, into methane. In December 2018, Hawaii Gas and the City and County of Honolulu completed Hawaii's first renewable natural gas (RNG) facility to capture and purify biogas from the City's Honouliuli Wastewater Treatment Plant.

Hawaii has an abundance of renewable natural resources for energy production. Besides fossil-based electricity generation, Independent Power Producers (IPP) also generate electricity by hydropower, wind,

solar, geothermal energy, solid waste, and biomass. There is currently adequate capacity for power generation versus consumption. Reliability and cost reductions will be accrued as additional renewable energy sources are added.

A focus of the utilities in Hawaii has been on increasing the amount of renewable energy that is available for use. Due to the availability of renewable energy resources and high cost of electricity, state bills have been passed that set a renewable portfolio standard (RPS) of 30 percent of net electricity sales by 2030 and 100 percent of net electricity sales by 2045. Currently, approximately 30 percent of the electricity generated in Hawaii is produced by renewable energy, putting Hawaii ahead of its targeted timeline. Increasing the renewable energy portfolio decreases the cost for electricity and stabilizes its price. See Figures 1 and 2 for electric companies' renewable portfolios.

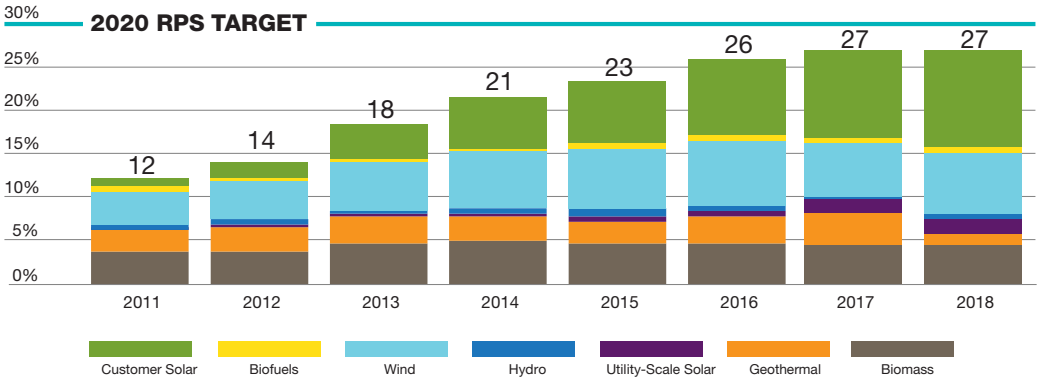


Figure 1: Hawaiian Electric Companies Renewable Portfolio, 2017-2018 Sustainability Report

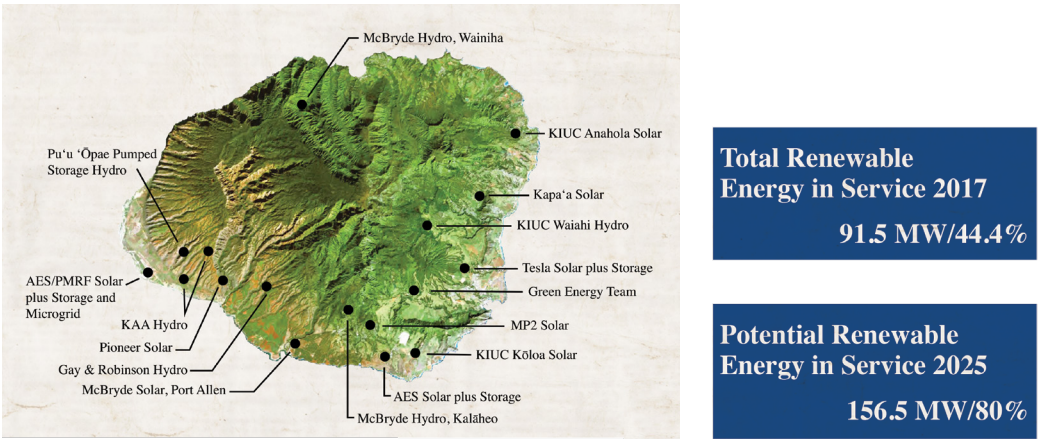


Figure 2: Kauai Renewable Energy Projects, KIUC Annual Report 2017

Due to variations in renewable energy production, storage systems, smart grid and demand driven technologies are being incorporated by the utilities. Since Hawaii leads the nation in both residential solar power generated per household and solar photovoltaic per capita and is third in total solar photovoltaic capacity installed, implementing smart grid technology is critical to the operation of the grid.

Outages in Hawaii are mainly caused by equipment deterioration, cable faults, auto accidents, or vegetation. 2017 service reliability indices, as calculated using the IEEE1366 guidelines, for the electric companies are below.

UTILITY COMPANY	SAIFI (OCCURRENCES)	SAIDI (MINUTES)
Hawaiian Electric Company	1.4	139
Hawaii Electric Light Company	1.8	186
Maui Electric Company	3.5	831
Kauai Island Utility Cooperative	5.8	228

SAIFI (System Average Interruption Frequency Index) indicates how often an interruption occurs. SAIDI (System Average Interruption Duration Index) indicates the amount of time electrical service is not available.

OPERATIONS & MAINTENANCE, FUNDING & FUTURE NEED

Hawaii's utilities have invested millions of dollars in research and development projects to improve efficiency and reliability, especially as related to the implementation of renewable energy sources. Cybersecurity has become increasingly important as smart grid technology is being implemented. Utilities need to monitor risks of both physical and cyber-attacks. Aging infrastructure is also being upgraded to address the increased frequency of severe natural weather events.

More than half of the existing infrastructure of the utilities is older than 40 years old and will soon be approaching their expected life. Approximately 20% of the operating budget, which is approved by the Public Utilities Commission, is used for maintenance of existing facilities which includes testing and treating wood and steel structures, inspections, transformer maintenance, generation equipment maintenance, etc.

Similar to many utilities the United States, the Hawaii utilities are not dependent on electricity usage for profit. Instead, rates and profit are decoupled, which allows the utilities to support energy efficiency, energy conservation, and use of renewable energy resources. Rates with IPP's are fixed for durations of 20 years or more which allow for price stability and typically lower energy costs.

PUBLIC SAFETY, RESILIENCE, & INNOVATION

Hawaii's residents are dependent on a reliable energy system for safety, daily tasks, and the economy. Utilities have implemented technology to allow customers the ability to report outages as well as show updated restoration times using mobile apps.

Drones and lidar are used for inspection and rapid response to assess condition or damage to existing infrastructure. Data is collected relatively quickly and safely. This data can then be utilized by engineers and crews in a controlled environment to safely plan next steps.

Hawaii is susceptible to hurricanes and tropical storms, so the utilities invest a significant amount of time planning and preparing for emergency response. Coordination and communication between internal and external agencies, including all levels of the government, are critical to rapid restoration if required. Information is also disseminated to the public advising best practices to prepare for emergencies. Additionally, over $1.5 billion has been spent by the Hawaiian Electric Companies to upgrade and strengthen poles, lines and equipment. In 2018, the Schofield Generating Station became operational, increasing Oahu's resiliency as the only power plant on island located inland and away from coastal hazards. Developed in partnership with the US Army, Schofield can isolate itself as a critical operations center to assist with recovery during and after an emergency.

With solar energy readily available and significant technological advancements, solar farms have become Hawaii's most popular and cost-efficient renewable energy source. In order to maximize the efficiency of a renewable solar energy source, battery storage is critical so that there is enough capacity for both the day and night electricity peak usage. Hawaii's utilities are among the leaders in battery storage. KIUC had the world's first utility-scale solar plus battery storage generation facility, and the Hawaiian Electric Companies are

currently looking to add over 1 gigawatt of battery storage, which would nearly double the amount of battery storage in all the United States.

In addition to the 2015 state law mandating 100% of electricity generation from renewable energy sources by 2045, each of the counties have committed to 100% renewable fuel sources for ground transportation by 2045.

RECOMMENDATIONS

1. Continue to improve system reliability and safety by investing in infrastructure upgrades to withstand the increasing frequency and intensity of severe weather events.
2. Continue to implement projects that diversify the renewable energy portfolio and allow for reduced environmental impacts and lower, more stable, electricity costs.
3. Continue to support research of new technology, such as implementation of utility-scale storage, in order to meet the 100 percent RPS by 2045.
4. Increase incentives to accelerate the RPS, promote energy conservation, use or production of alternative fuels, and adoption of electric vehicles to reduce fossil fuel imports, and associated costs and environmental impacts.

RESOURCES

Transcending Oil, Hawaii's Path to a Clean Energy Economy – Rhodium Group, April 2018

Hawaiian Electric Companies 2017-2018 Sustainability Report

Hawaiian Electric Companies 2016 Annual Service Reliability Reports

Kauai Island Utility Cooperative 2017 Annual Report

Kauai Island Utility Cooperative 2016 Annual Service Reliability Report

www.hawaiigas.com – About Us, Current Gas Operations, Clean Energy

Hawaii Gas Annual Renewable Energy Report for 2017

Hawaii 2016 Energy Report Card – Blue Planet Foundation

U.S. Energy Information Administration (EIA), "Hawaii, State Profile and Energy Estimates", November, 2018, https://www.eia.gov/state/analysis.php?sid=HI

ROADS

EXECUTIVE SUMMARY

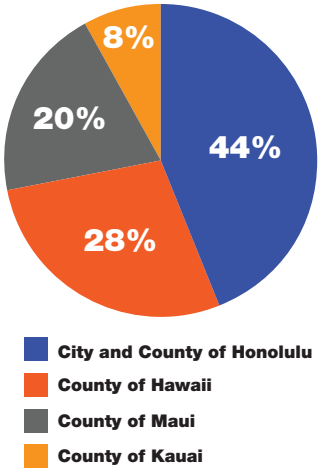
Hawaii's roadway networks are essential for handling multiple modes of transportation, from pedestrians, bicycles, and passenger vehicles to the heavy loads of high-volume freight trucks and tour buses. Usable land in Hawaii is very limited and many roadways are confined by developments or natural topographic features. Honolulu and its surrounding neighborhoods regularly experience some of the worst traffic congestion in the nation; the 27-mile H1 freeway that runs through Honolulu's urban core operates at Level of Service F during AM and PM peak traffic, with certain segments exhibiting volume/capacity ratios well over 1. Meanwhile, roadway travel demand statewide is projected to continue to increase from 2.4 million daily vehicle trips in 2007 to 3.4 million daily vehicle trips by 2035, and sea level rise and flooding threatens existing roadways. Continued maintenance, improvement and expansion of our aging infrastructure is crucial to the efficiency and reliability of the road network.

BACKGROUND

Comprised of several major islands, Hawaii does not have the luxury of a continuous land transportation network connecting the entire state. Unlike other states, the useable land area in Hawaii is very limited. Many of the roadways are confined by developments abutting the facilities or by natural topographic features. Expansion of existing facilities or construction of alternative routes is cost-prohibitive and comes with significant environmental impacts. In addition, the high cost of construction is exacerbated by the limited resources (including materials and labor) on the islands due to Hawaii's geographic isolation. Despite these limitations, Hawaii's roadway networks are a crucial piece of the state's overall transportation system. It is the primary system used for all modes of ground transport involving residents, visitors and freight. A scarcity of other land transportation options further exacerbates the state's dependence on its roads.

Statewide, Hawaii's transportation system consists of 9,800 lane miles and 1,137 bridges. The federal-aid system, which consists of interstates, arterials, and collectors, makes up 40 percent of the entire system. The remaining 60 percent is owned by the State or County.

The island of Oahu is the most developed island in the state, with roughly a quarter of the island classified for urban land use. Most of the urbanized areas on Oahu are concentrated to the south side of the island in the Honolulu district, where an extensive network of roads is used to service the region's travel demands. It is also the only island in the state utilizing an 'interstate' freeway system. With the exception of the Honolulu area, other population centers and economic hubs throughout the state are generally focused around each island's perimeter. The other four counties of Kauai, Maui and Hawaii primarily utilize perimeter arterial highways or 'belt roads' to provide access to these locations. These belt roads serve both regional and local needs as the only means of access between regions due to the mountainous interior of the islands. Figure 1 illustrates the size difference in roadway networks between the island counties.



% of Pavement by County

Figure 1 – Percent Pavement by County

CAPACITY AND CONDITION

In 2015, the number of vehicle miles traveled (VMT) in Hawaii was 10.3 billion VMT. With the statewide population forecasted to grow 31% by 2035, the state will need to continue to implement its long-term statewide and regional transportation plans to keep up with future growth and demand.

Oahu is home to roughly 70% of the state's 1.43 million residents with the primary urban core of Honolulu being the most densely populated region in the state. Honolulu and its surrounding neighborhoods regularly experience some of the worst traffic congestion in the nation. A roadway's traffic condition can be categorized into one of six levels of service (LOS) based on a number of performance measures. Figure 2 provides a summary of the six levels of service used to measure the quality of traffic flow.

Figure 2 – Level of Service Flow Conditions

Level of Service	Flow Condition Description
LOS A	Free flow operation, vehicles can maneuver unimpeded with no restriction from other vehicles
LOS B	Stable to free flow operation, vehicles can maneuver with few restrictions from other vehicles
LOS C	Stable flow operation, vehicles have freedom to maneuver with noticeable restriction from other users
LOS D	High density free flow operation, freedom to maneuver vehicle is limited by other users, with driver beginning to experience reduced level of comfort
LOS E	High density traffic flow operation, vehicular flow becomes unstable with momentary stoppage as conditions approach road capacity, driver's level of comfort is poor
LOS F	Breakdown or forced flow operation, with unpredictable travel times and extended periods of stoppage, roadway condition is at or exceeding capacity (constant traffic jam)

Almost 20% of Oahu's major arterials operate at a LOS D or worse during peak commute times, particularly the island's freeway network. The H-1 freeway corridor is one of Oahu's most critical stretches of roadway, handling a high percentage of users traveling the area. This 27-mile freeway corridor runs through the urban core, connecting the surrounding communities to downtown Honolulu and Waikiki. A lack in adequate alternate facilities to ease demand can cause unpredictable commute times and extended peak hours of traffic. Steady population growth around and beyond the primary urban core has generated widespread capacity issues along the H-1 corridor. Several portions of the H-1 continue to operate at LOS F during the AM and PM peak traffic with certain segments exhibiting volume/capacity (v/c) ratios well over 1. The State of Hawaii Department of Transportation (HDOT) H-1 Corridor Study identifies several improvement projects to help alleviate congestion and account for future growth in the region. Currently, an elevated rail transit system is under construction in Honolulu and should deliver an alternate mode of ground transportation once full build-out is complete. Despite providing another travel option for residents and tourists, this Honolulu Rail Transit Project (HRTP) will not be enough to alleviate the increasing travel demand on Hawaii's roads.

Traffic operations across the entire state are expected to worsen. By 2035, the percentage of arterial lane miles operating at the lowest LOS is projected to increase to 54% in Maui County, 24% in Hawaii County and 25% in Kauai County. At the lowest LOS, heavy traffic, roadway delays and unpredictable traffic conditions are frequent occurrences.

OPERATION AND MAINTENANCE

Freight vehicles must share the same roadways as passenger and transit vehicles with no rail or high-volume transport corridors. The heavy weight involved with moving high volumes of goods can greatly deteriorate roads and affect the lifespan of the pavement. A decrease in revenue in recent years has led to insufficient funding for the maintenance of existing facilities leading to delayed maintenance on many of Hawaii's roads.

Current pavement assessment under the Pavement Condition Index (PCI) of streets owned by the City and County of Honolulu found 57% of streets to be of adequate condition and 28% to be in an unsatisfactory state. Several segments along the state-managed H-1 corridor received PCI ratings below 55, showing an immediate need for pavement reconstruction. Evaluations like these provide important data for asset management and determining when specific segments of road will require rehabilitation or reconstruction. Currently no comprehensive pavement condition assessment report exists for the entire state.

The National Highway System (NHS) is a subset of the entire roadway system. It provides an interconnected system of freeway and principal arterial routes that serve population centers, ports, airports, military bases, public transportation facilities, and other intermodal transportation facilities and major travel destinations. Although there are no inter-state or international border crossings, the NHS is a vital infrastructure providing service to Hawaii. Figure 3 summarizes the current condition of pavement (2016) on the NHS, while Figure 4 summarizes NHS pavement inventory and conditions by jurisdiction.

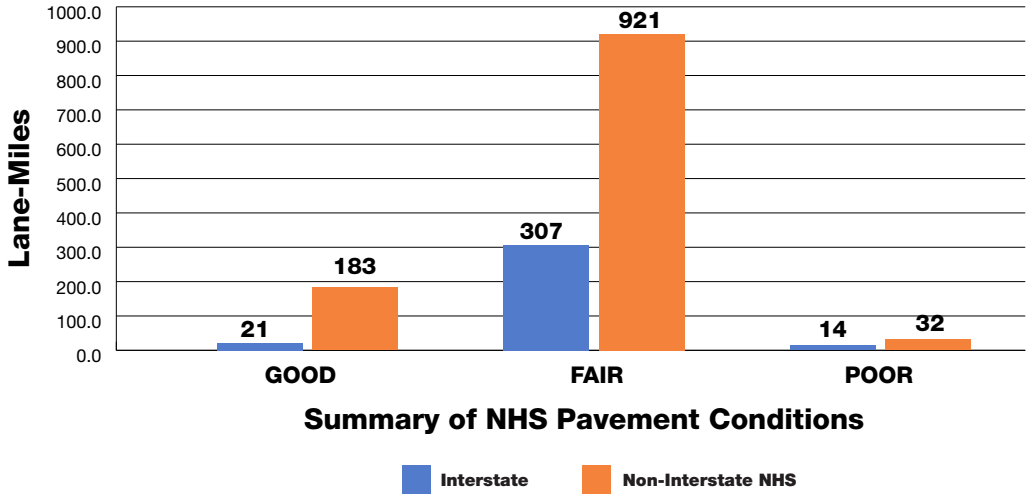


Figure 3 – Summary of NHS Pavement Conditions

	Lane- Miles	Good	Fair	Poor	
All NHS					
Interstate	342	6%	90%	4%	
Non-Interstate NHS	1136	16%	81%	3%	
By Jurisdiction					
Oahu District	895	5%	93%	2%	
Hawaii District	247	34%	63%	3%	
Maui District	177	39%	61%	0%	
Kauai District	54	7%	93%	0%	
City and County of Honolulu	81	0%	87%	13%	
County of Hawaii	24	0%	100%	0%	

Figure 4 – NHS Pavement Inventory and Conditions

PUBLIC SAFETY

Traffic related fatalities in Hawaii spiked in 2016 with 120 deaths after a downward trend from 2013 to 2015. The total count decreased in 2017, but it remained above the century mark with 106 traffic related deaths. The number of pedestrian fatalities decreased by more than half, from 32 deaths in 2016 to 14 in 2017. The alarming number of fatal crashes associated with impaired driving still stands at over 50% of all incidents year over year.

To improve public safety, the state implemented the Hawaii Strategic Highway Safety Plan (HSHSP) in 2007 to provide a multidisciplinary guideline and strategy to help address traffic-related issues across the state and reduce fatalities. Working towards the ultimate goal of zero deaths, the current milestone is to decrease yearly traffic fatalities to 80 or fewer by 2018. The plan was updated in 2013 with the same ultimate goal of zero deaths. The current plan's areas of emphasis include:

1. Reducing speeding & impaired vehicle operation
    a. Strengthen enforcement programs and prosecution of violations
    b. Develop and expand education of responsible driving
2. Increasing safety for all types of road users

a. Continue implementation of 'complete streets' in roadway design and planning

b. Improve bike and pedestrian facilities

3. Enhancing first responder capabilities to respond to traffic related situations

4. Improving management of traffic and safety data

FUNDING AND FUTURE NEEDS

Hawaii's transportation is funded by a combination of county, state, and federal funds. Federal contributions to the state are usually provided through an allocated portion of the Highway Trust Fund, which collects its revenue from the federal gas tax. Annual federal revenue to the state between fiscal year (FY) 2002 to FY 2011 averaged $152 million. Under the MAP-21 Act, the state steadily received approximately $163 million from FY 2012 to FY 2015. Under the current federal highway authorization, the FAST Act, Hawaii receives between $163 million and $187 million annually from FY 2015 to FY2020.

At the state level, funding is comprised of several sources: highway fuel license taxes, vehicle registration fees, vehicle weight taxes, rental/tour vehicle surcharges, investment interest of Highway Special fund and other revenues collected from miscellaneous fees. The State Highway Fund is trending upward, with $232 million in revenue during the FY 2012 to an increase in FY 2015 with $268 million. Combined state and federal funding from 2015 totaled approximately $431 million. In 2018, state lawmakers passed legislation to increase the daily rental vehicle surcharge by $2, injecting an estimated $38 million into the State Highway Fund.

According to the state's long-range land transportation plan and each regions' projected transportation needs, an overall statewide amount of $30 billion between 2014 and 2035 will be needed. Projected total funds available for the same time period is approximately $11 billion ($7 billion adjusted for inflation), resulting in a statewide shortfall of $23 billion. Due to future shortfall projections in funding, the state will need to prioritize future investments. Through the implementation of the Statewide Federal-Aid Highways 2035 Transportation Plan, the state's future distribution of funds puts a priority on improving and enhancing current assets and preserving/maintaining the current infrastructure system. Despite a promising trend in recent years for Hawaii's total transportation revenue, more forms of supplemental funding will be needed to lessen the projected $23 billion budgeting gap. Furthermore, non-funding strategies should be implemented to decrease private vehicle road users, thereby decreasing demand and prolonging and preserving the lifespan of our roadways.

Innovation and Resilience

Forecast models of global sea level rise due to climate change project 3.2 feet of sea level rise by the end of the century. Under this bleak scenario, an estimated 38 miles of roads statewide would be inundated. Portions of the major coastal arterials or 'belt' roads in each county would be impassible, affecting certain communities that lack parallel facilities and rely solely on these corridors for access. Affected major arterials include Kuhio Highway on Kauai, Kamehameha Highway on Oahu and Honoapiilani Highway on Maui. Recent natural hazard events like the record flooding on the north side of Kauai highlights such scenarios these communities face and the urgency to implement plans to preserve or relocate roadway facilities in zones identified to be inundated by sea level rise.

RECOMMENDATIONS

Recommended actions to improve Hawaii's road infrastructure include:

1. Supplemental Funding Strategies – To help bridge the $23 billion gap between statewide projected costs and revenues over the next 20 years, lawmakers will need to devise funding alternatives to offset the failing traditional funding methods. Potential funding strategy alternatives and sources include: mileage-based user fees, public/private partnerships in transportation project delivery, bicycle registration, developer assessed impact fees and attraction of private investors. Legislation is currently under review to increase the state's gas tax, vehicle weight tax and registration fees, which could garner an additional $40 million a year. Such proposals are supported by ASCE to ensure our infrastructure is properly funded.

2 Transportation Demand Management Strategies – Reduce the demand on Hawaii's roadway networks by promoting other modes of travel. Improving facilities for bicyclists and pedestrians would attract more users, while increasing transit service and routes and providing efficient connectivity to other modes of transportation. Implementation of the complete streets program aims to improve safety for other modes of transportation.

3 Hit the Pavement – Implement a comprehensive pavement condition assessment report and perform evaluations at regular intervals to maintain current pavement data to improve allocation of maintenance resources.

4. Revised Land Use Planning – Develop '20-minute neighborhoods' or dense mixed-use areas that encourage other modes of transportation besides single-occupancy vehicles by modifying zoning laws and regulations. Minimizing the need for vehicle trips by creating travel demand locally through the influence of mixed-use zones could reduce the need for future roadway investments. Oahu's dense urban landscape could benefit from these flexible zones, especially those centered on rail stations from the impending Honolulu Rail Transit Project.

5. Designated Freight Lines - Implement plan that designates freight routes along roadway networks near harbors and airports to maximize operational efficiency & lifespan of roadway surfaces.

6. Multi-Jurisdictional Coordination - Improve coordination efforts between government agencies and jurisdictions on projects to increase delivery efficiency (budget and time).

7. Stay Above the Rising Tide – Identify roadway facilities to be affected by climate change and provide alternate (bypass) access corridors or reinforce existing roadways to improve resiliency and security, especially during times of emergency.

SOURCES

City and County of Honolulu Department of Facility Maintenance. 2012. Pavement Condition Report. December.

Federal Highway Administration (FHWA). MAP-21. https://www.fhwa.dot.gov/map21/funding.cfm.

Hawai'i Climate Change Mitigation and Adaptation Commission. 2017. Hawai'i Sea Level Rise Vulnerability and Adaptation Report.

Oahu Metropolitan Planning Organization (OMPO). 2016. Oahu Regional Transportation Plan 2040. April.

State of Hawaii Department of Transportation (HIDOT). 2014. Federal-Aid Highways 2035 Transportation Plan for District of Hawaii. July.

State of Hawaii Department of Transportation (HIDOT). 2014. Federal-Aid Highways 2035 Transportation Plan for District of Maui. July.

State of Hawaii Department of Transportation (HIDOT). 2014. Federal-Aid Highways 2035 Transportation Plan for District of Kauai. July.

State of Hawaii Department of Transportation (HIDOT). Financial Statements. https://hidot.hawaii.gov/highways/library/financial-statements/.

State of Hawaii Department of Transportation (HIDOT). 2016. H-1 Corridor Study. August.

State of Hawaii Department of Transportation (HIDOT). HDOT Highways Program Status. https://histategis.maps.arcgis.com/apps/MapSeries/index html?appid=39e4d804242740a89d3fd0bc76d8d7de.

State of Hawaii Department of Transportation (HIDOT). 2013-2018. Hawaii Strategic Highway Safety Plan.

State of Hawaii Department of Transportation (HIDOT). 2018. HDOT Transportation Asset Management Plan. April.

State of Hawaii Department of Transportation (HIDOT). 2014. Statewide Federal-Aid Highways 2035 Transportation Plan. July.

SCHOOLS

EXECUTIVE SUMMARY

School facilities have a measurable impact on student achievement. There is a direct impact of the school's condition, design and utilization on student and staff attendance, teacher retention and curriculum offerings. Unfortunately, Hawaii's public schools are aging and many face chronic capacity constraints. As of 2017, the average age of the schools that overseen by the Hawaii Department of Education (HIDOE) was 62 years old, while 53 buildings were over 100 years old. When a facility is beyond its useful life, higher maintenance and repair costs are anticipated. For its FY19 capital improvements budget, the HIDOE requested a total of $1.46 billion, with $879.2 million intended to address condition or capacity deficiencies. Only $602.3 million was appropriated. While the HIDOE is undertaking innovative projects to increase sustainability and reduce costs, the legislature needs to consider an increase in funds to invest in the future generation of the State of Hawaii.

BACKGROUND

The HIDOE oversees 256 public schools and 36 charter schools throughout the State of Hawaii. The Department employs over 13,000 teachers, serves approximately 180,000 students annually, and is the ninth largest school district in the nation. The HIDOE is separate from the University of Hawaii public system of higher education, which is not addressed in this report.

The HIDOE public school system encompasses total of 33 high schools, 44 middle schools, 168 elementary schools, four elementary-middle schools, and seven elementary-middle-high schools.

The HIDOE's Office of School Facilities and Support Services (OSFSS) oversees the development of new facilities and the repair and maintenance of existing facilities.

CAPACITY

Across the state, public and charter schools encompass of a total of approximately 20.7 million square feet across approximately 4,410 buildings.

Compared to the rest of the United States (U.S.), HIDOE school facilities have a smaller average square foot of classroom space per student for all grade levels. This is especially prevalent at the elementary school and middle school level.

Enrollment at HIDOE high schools is 137% higher than the rest of the US.

Grade Level	Average Enrollment			Average School SF			Average SF/Student		
	HI	US	% of Nat'l Avg	HI	US	% of Nat'l Avg	HI	US	% of Nat'l Avg
Elementary School	514	520	→ 99%	52,962	77,792	↓ 68%	103.0	149.6	↓ 69%
Middle School	774	705	→ 110%	97,310	12,2177	↓ 80%	125.8	173.3	↓ 73%
High School	1,362	992	↑ 137%	193,088	172,806	↗ 112%	141.7	174.2	↘ 81%

CONDITION, OPERATION AND MAINTENANCE

As of 2017, the average age of the schools that HIDOE oversees is 62 years old. There are 53 buildings that are over 100 years old. The average age of the main institutional building at schools across the United States is 44 years old.

Capital improvement projects (CIP) and repair/maintenance projects are initiated at the individual school level.

Each school's principal and supporting staff conduct preliminary assessments of their school's facilities and develop a needs list of capital improvement projects and repair/maintenance projects. With help from the Facilities Maintenance Branch, each school determines the cost, need and urgency of each project identified from the assessment. Projects are then added to the new facilities backlog list or the repair/maintenance backlog list by priority for consideration for funding by the State Legislature.

In 2014, HIDOE contracted a private consultant to conduct a comprehensive survey of all the state's school facilities. The purpose of the survey was to enable HIDOE to support data-driven decisions, optimize capital resource allocation, and foster equity. The scope of the survey included:

- Compiling composite site plans/floorplans and a comprehensive space inventory database;
- Benchmarking all facilities against HIDOE facility educational standards and identifying program gaps/needs;
- Developing facility adequacy scores/ranks; and
- Measuring school enrollment capacities and utilization.

The data collection phase of the study was completed in 2015 to 2017. Initial findings from the survey identified that the top 10 major facility deficiencies are:

- Buildings beyond expected useful life
- Special education rooms lack life skills equipment
- Cafeteria less than 50% of required space
- Kitchen less than 50% of required space
- Library less than 50% of required space
- Athletic locker rooms less than 50% of required space
- Music count or area less than 50% of required space
- Capacity utilization over 120%
- More than 25% of capacity in portables
- Administrative offices less than 50% of required space

With buildings being beyond their useful life, higher maintenance and repair costs are anticipated. An aggressive plan needs to be developed and implemented to increase the State's investment for new, modern facilities that meet the current space requirements for learning.

PUBLIC SAFETY AND RESILIENCE

The condition of a school's infrastructure has an impact on the students, faculty and administrators that use them on a daily basis and the public that rely on them for community meetings, elections and disaster relief centers.

Hawaii's potential for hurricane and other severe weather events is moderately high. Hawaii's hurricane season extends from June to November; although hurricanes can impact the islands at any time of the year.

Under severe weather conditions, schools are typically used as disaster relief centers. Although facilities may be able to endure major storm events like a hurricanes, the facilities may not necessarily be designed for that type of impact when they were constructed over 45 years ago. This is a risk that State leaders should be aware of when appropriating funding for proposed CIP for Hawaii's schools.

FUNDING AND FUTURE NEEDS

HIDOE has two sources of funding for capital improvement projects: legislative funding and school impact district fees.

Legislative Funding

The State of Hawaii runs its budget on a fiscal biennium which is submitted to the legislature during odd-numbered years. Course-corrections and new asks are submitted during the intervening years as a supplemental budget. The Board of Education approves HIDOE's budgetary ask annually in October. The budget is then modified by the State of Hawaii Department of Budget and Finance prior to a formal submission to the Hawaii State Legislature when its session begins in January.

The HIDOE's budget is composed of an operating budget and a Capital Improvements Program (CIP) budget for expenses to maintain, develop, and upgrade school facilities and campuses.

CIP are renovations, repairs and major maintenance to existing facilities, landscape improvements, new construction, land acquisition, and utility modifications. The CIP budget is set by the state as part of a comprehensive program to manage state facilities, and is handled separately from the operating budget.

The table below shows Board-approved CIP budgetary requests (REQUESTED) and the legislature's appropriation (APPROVED) for FY19. Amounts are in millions and rounded.

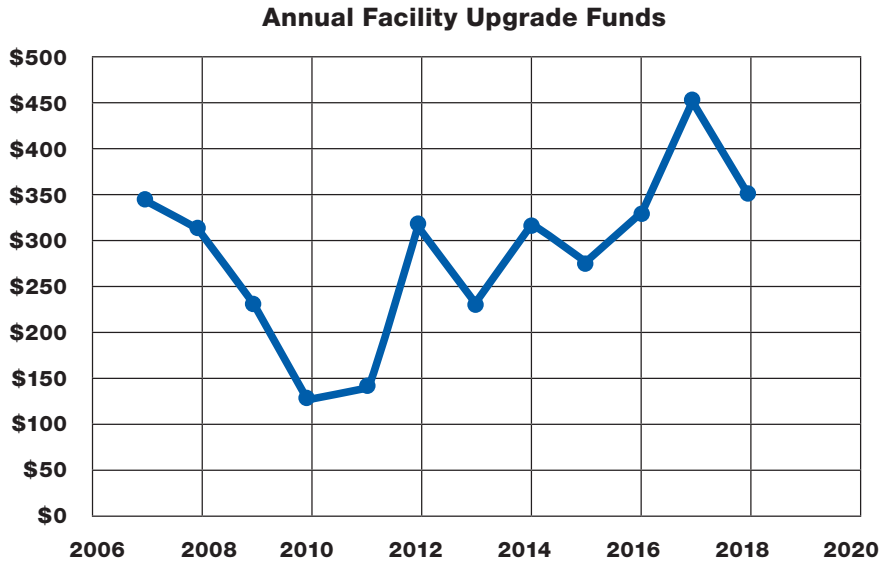
Table FY19 CIP Appropriations

	FY18 (BIENNIUM BUDGET)		FY19 (SUPPLEMENTAL BUDGET)	
	REQUESTED	APPROVED	REQUESTED	APPROVED
Condition	$159.3	$90.0	$213.3	$ 54.5
Capacity	$259.6	--	$247.0	--
Equity	$146.0	$33.0	$199.4	$ 10.0
Program Support	$100.7	$33.0	$123.9	$ 17.0
Lump Sum (project completion, Title IX, equipment)	$9.0	--	--	$ 33.0
TOTAL	$674.6	$156.0	$783.6	$ 114.5
Legislative Add-Ons		$118.5		$166.9
Special: Act 57, energy eff./heat abatement	$30.8	$46.4	--	--
TOTAL	$705.4	$320.9	$783.6	$281.4

Of the $1.46 billion requested, only $602.3 million was appropriated. $285.4 million of the appropriation were from Legislative add-ons, some of which were added by individual Legislators. Only $144.5 million, or 16% of the requested amount, was initially approved.

The amount of funds that the legislature has approved for HIDOE facility upgrades has varied. However, it has generally trended upward in the last few years. See graph below.

Table	
Facility Upgrade Funds	
Fiscal Year	Funding
2007	$344,036,000
2008	$313,193,000
2009	$232,531,000
2010	$127,771,000
2011	$143,346,000
2012	$313,272,000
2013	$233,472,000
2014	$320,294,000
2015	$279,108,000
2016	$332,445,000
2017	$451,415,000
2018	$350,356,000



Based on the current level of funding, it is estimated that it would take over 150 years to complete current and future repairs at all schools.

School Impact District Fees
The Hawaii State Legislature Act 245 authorizes the Board of Education to designate and approve School Impact Districts. These districts are areas of high growth that require the construction of new schools, or the expansion of existing schools, to accommodate the increase in new families and school enrollments. Fees collected from this program are managed by OSFSS. Commercial projects, industrial projects, senior housing projects, replacement homes or projects to enlarge existing homes are exempt.

INNOVATION

Because of the fluctuation of Legislative funds allocated to schools, HIDOE has undertaken some innovative projects to reduce future costs.

Renewable Energy Generation
HIDOE is seeking to reduce its reliance on fossil fuel-based energy by 90 percent by 2040, as directed by the Board of Education's Policy 6710 and passage of Act 96, SLH 2006. It has ambitious yet achievable goals to power its schools through sustainable energy generation through the implementation of photovoltaic (PV) projects In addition to meeting Act 96, the project will help fulfill the Hawaii Clean Energy Initiative's goal of 70 percent clean energy by 2030, through energy efficiency and the development and implementation of renewable energy sources.

Alternative Design
HIDOE is testing a new portable building design in hopes of giving students and teachers more creative and flexible spaces while saving money on utility bills. While the initial upfront investment cost is higher, the "life-cycle cost" of the building is lower. Spread over 40 years, the DOE estimates more than $100,000 in energy savings alone.

Other benefits of the structure's design are its larger-than-average classroom size which gives teachers more

flexibility, more natural light and ventilation, and large glass windows on the sides of the building and windows at the roof level to help let the hot air out.

RECOMMENDATIONS

1. Recommended actions to improve Hawaii's school infrastructure include:
2. Continue implementing and investing in projects to upgrade aging school facilities. Complete the current comprehensive study and implement as many of the recommendations in as short a time period as possible. Work with the principals and community to impose political will to take improvements to our educational facilities more seriously.
3. Conduct comprehensive facilities assessment studies in five year cycles to better understand current conditions and needs of schools.
4. Continue to investigate and implement alternative and innovative means of reducing operating costs and construction of modern designs for school facilities

SOURCES

Hawaii Institute for Public Affairs, "Building Better School Facilities: The Infrastructure Deficit", June 11, 2016

State of Hawaii, Department of Education Website, August 2018.

State of Hawaii, Department of Education, Office of Schools Facilities and Support Services, "Update on Department of Education's Facilities Assessment Study to State Legislature Finance and Infrastructure Committee" July 18, 2017.

Institute of Educational Sciences, National Center for Educational Statistics, "Condition of America's Public School Facilities: 2012-2013", March 2014.

SOLID WASTE

EXECUTIVE SUMMARY

Hawaii's solid waste infrastructure is generally in good condition, including the operation and maintenance of collection, transfer, and disposal of wastes. However, in the near future, landfill capacity increases will be needed. Landfills expected to reach capacity soon are Molokai by mid-2020, Lanai in 2020, Kauai as soon as 2025, and Maui by 2026. Landfill capacity is expected to be reached by 2038 on Oahu and beyond 2040 on the Big Island. This assessment does not account for the ability of these facilities to handle a significant threat or incident, such as a hurricane or tsunami, when large amounts of solid waste are suddenly generated. Converting solid waste to energy and recycling have been key strategies for reducing and diverting waste from landfills, to extend their life. Attention is also needed to develop innovative solutions to minimize shipping of recycled waste from Hawaii.

BACKGROUND

Oahu has three active landfills: Waimanalo Gulch (county) for municipal solid waste, PVT Land Company (private) for construction debris, and Kaneohe Marine Corps Base Hawaii (federal) for municipal solid waste and construction debris. The City and County of Honolulu (City) also has six convenience centers to drop off residential waste material, and three transfer stations that accept waste from residents and commercial waste haulers.

Maui has three active landfills: Central Maui Landfill (county) for municipal solid waste, Hana Landfill (county) for municipal solid waste and construction debris, and Maui Demolition and Construction (private) for construction debris. Maui County also has a recycling and refuse convenience center in Olowalu. Molokai has the Molokai ISWM Facility for municipal solid waste, green waste, and materials recycling. Lanai has the Lanai Landfill for municipal solid waste and construction debris.

Hawaii Island has two landfills: South Hilo Landfill (county) for municipal solid waste and construction debris, and West Hawaii Landfill (county) for municipal solid waste and construction debris. Hawaii County also has 22 recycling and transfer stations.

Kauai has the Kekaha Landfill (county) for municipal solid waste and construction debris. Kauai County also has 4 refuse transfer stations in Hanalei, Kapaa, Lihue, and Hanapepe.

CAPACITY

The Solid & Hazardous Waste Branch of the State of Hawaii, Department of Health provides oversight of solid waste facilities in Hawaii. In 2016, the solid waste generated in each county was 246,296 tons in Hawaii; 144,233 tons in Maui; 147,957 tons in Kauai; and 2,521,264 tons in Honolulu. The percent of solid waste sent to landfills has generally declined since 2009 and was less than 50 percent in 2015. The national average of municipal solid waste generated and sent to landfills is 53 percent.

Landfill capacities are expected to be reached on Molokai by mid-2020, Lanai in 2020, Kauai as soon as 2025, Maui by 2026, Oahu by 2038, and Hawaii Island beyond 2040.

On Oahu, about 1.2 million tons of municipal solid waste is processed at the Honolulu Program of Waste Energy Recovery facility (H-POWER). This facility generates electrical energy while reducing the volume of municipal solid waste by 90%. From June 1, 2017 to May 31, 2018, Waimanalo Gulch Landfill received 134,430 tons of H-POWER Ash, 21,559 tons of H-POWER residue, and 115,702 tons of municipal solid waste.

The H-POWER Energy-from-Waste facility was recently expanded with the addition of a third boiler to increase the facility's capacity by 900 tons and bring the facility's total daily capacity to 3,000 tons of municipal solid waste per day. The expansion allows the facility to process all of the island's post-recycled municipal solid waste that does not need to be landfilled.

Most of Maui's waste goes to the Central Maui Landfill. This landfill accepts about 500 tons per day of waste on average. If nothing is done to divert waste from the landfill through increased recycling and WasteTEC (waste to energy), the landfill capacity will be reached by 2026. Efforts to increase diversion could increase landfill capacity until 2042.

Kauai's Kekaha Landfill is undergoing a lateral expansion to increase capacity for another 7.7 years until 2027.

CONDITION

In general, the condition of solid waste infrastructure appears to be good. Maui is requesting additional staffing to maintain closed landfills. During heavy rains, landfill slopes erode and trash is exposed at Makani Landfill. No other issues have been reported at any of the other sites.

FUNDING

Typically, solid waste facilities are publicly funded through property taxes, tip fees, garbage collection fees, and other revenue sources. Residential collection fees vary, and range from $384 (for Maui and Molokai) to $0 (for Oahu) per year. The national average is between $140 and $240 annually. Landfill tipping fees may be as high as $119 per ton (Kauai County) while the national average is $55 per ton. Some facilities are privately funded with special contractual arrangements with county agencies.

Kauai will need $15 million to close the Kekaha landfill, and an additional $625,000 annually for post-closure monitoring and maintenance. The county recently implemented a "pay as you throw" program for residential refuse collection and a base Refuse Transfer Station fee. Funding of landfill closure and post-closure activities, however, will remain a challenge for the county.

In 2014, Maui signed a 20-year contract with Anaergia Services to finance, design, construct, own, and operate a recycling facility. The facility is anticipated to divert 85 percent of Maui's municipal solid waste from the landfill when in becomes fully operational. A recent county audit has determined that instead of a cost savings of $18.3 million, there will be a projected extra expense of $16.7 million over the term of the contract. The discrepancy is primarily attributed to the valuation assessed to landfill space. Depending on the actual valuation realized, the county may encounter a funding shortfall in the future.

Due to successful recycling, reuse, and waste diversion efforts, solid waste generated between 2013 and 2016 on Oahu decreased. Honolulu did not deliver enough waste to H-POWER and had to provide an additional $6.2 million to support operations.

Except for Hawaii County, each county currently has curbside recycling and recycling centers. Hawaii County only has recycling centers. To encourage recycling, the state manages a deposit beverage container program.

FUTURE NEED

Kauai is planning to construct a new landfill at Maalo. The new landfill and access road is estimated to cost $80 million. The life of the existing and new landfills may be extended with the implementation of curbside recycling, green waste collection, and a Materials Recovery Facility (MRF) at a cost of $18 million.

Maui County is currently proposing expansions on the property of the Molokai ISWM Facility to address the island's future disposal needs. These expansions are estimated to cost $6.5 million. Maui County is also currently planning to expand their Central Maui Landfill. Design and construction of the next lateral expansion (Phase VI-A) is budgeted at $3.625 million, and the cost to acquire additional land for the next phases of expansion (Phases VI-B and VI-C) is $1 million. No information was readily available on the status of expanding the Lanai landfill.

OPERATION AND MAINTENANCE

The City and County of Honolulu prepares annual reports for the Waimanalo Gulch Landfill as required by a State Land Use Commission order. The most recent report dated June 12, 2018 provides an update to identify and develop new landfill sites, Waimanalo Gulch Sanitary Landfill operations, and compliance with the City's imposed order. The report also addresses the City's efforts to use alternative technologies and to seek beneficial re-use of stabilized, dewatered sewage sludge.

Maui has requested additional personnel to maintain all landfills: three closed landfills, one partially closed landfill, and the first two phases of the Central Maui Landfill. Personnel shortages have been blamed for numerous temporary closures or early closures of landfills.

PUBLIC SAFETY

At the Keehi Refuse Transfer Station, the City received a field citation on October 4, 2018 for leachate discharges into storm drains that empty into Moanalua Stream which feeds into Keehi Lagoon. Corrective action was taken and the administrative case was resolved on October 23, 2018. No other issues have since been reported.

RESILIENCE

Hawaii's landfills are not susceptible to sea level rise but are vulnerable to extreme weather events. In 2011, as an example, rains flooded the Waimanalo Gulch Landfill while a stormwater diversion system up-canyon of the landfill was under construction. Debris was sent into the ocean and onto beaches around Ko Olina Resort. Although this incident has not been repeated, it does highlight the necessity for proper safeguards to be in place and properly maintained.

More must also be done to plan for a sudden generation of large amounts of solid waste arising from a significant threat or incident (e.g., hurricane or tsunami).

INNOVATION

Sustainable solid waste management practices include source reduction and recycling. Examples of innovative sustainable programs underway are presented in this section.

The City and County of Honolulu is seeking demonstration of facilities for recycling H-POWER residue, fly ash, bottom ash, and auto shredder residue to reduce the amount of waste disposed at the landfill. The City is also pursuing the processing and conversion of glass into usable material.

In Hawaii County, BioEnergy Hawaii is building a privately-funded resource recovery facility in Waikoloa. Beginning late 2019 when fully operational, the facility will divert up to 70 percent of the solid waste from the West Hawaii Sanitary Landfill in Puuanahulu. The facility will separate recyclable materials from other types of solid waste. Organic waste and non-recyclable materials will be processed to create renewable biofuels, electricity, and compost.

RECOMMENDATIONS

Recommended actions to improve Hawaii's solid waste infrastructure include:

Work diligently to expand landfill capacity on Molokai, Lanai, Kauai, and Maui before the additional capacity is needed.

Maintain adequate funding and staffing levels to support solid waste operations.

Expand use of materials (e.g., glass or paper products) that can be recycled and reused locally.

Develop/update contingency plans for handling a surge in solid waste generated from a hurricane or a tsunami.

RESOURCES

Information presented in this chapter was collected from articles and documents found through a key word search:

http://www.compostingconsultant.com/images2/hawaii-zero-waste-plan.pdf
http://hipaonline.com/images/uploads/StateOfPhysicalInfrastructureinHawaiiPhaseII.pdf
http://biomassmagazine.com/articles/13253/ferc-33-mw-of-biomass-capacity-added-in-march
http://health.hawaii.gov/shwb/solid-waste/
http://journals.sagepub.com/doi/abs/10.1177/0308518X15599286
http://lelenviro.com/news/174-covanta-completes-honolulu-energy-from-waste-facility-expansion
http://mauicounty.us/molokaicommunityplan/
http://mauicounty.us/solidwasteaudit/
http://www.honolulu.gov/rep/site/oca/oca_docs/City_Recycling_Program_Final_Report_rev._102717.pdf
https://www.eastwestcenter.org/system/tdf/private/api121.pdf?file=1&type=node&id=35418
http://www.opala.org/solid_waste/pdfs/Draft_Revised_ISWMP_Update.pdf
http://www.bottlebill.org/assets/pdfs/legis/usa/HI_2011%20OSWM%20Annual%20Report.pdf
http://kohalacenter.org/pdf/waste_mgmt.pdf
http://www.hawaiifreepress.com/ArticlesMain/tabid/56/ID/21489/Honolulu-Worlds-Best-City-Sanitation.aspx
http://www.hawaiizerowaste.org/
http://www.hawaiizerowaste.org/recycle/greenwaste/
http://www.kitv.com/story/36937364/new-assessment-oahu-needs-new-landfill-in-2038-mayor-disagrees
http://www.mauiekocompost.com/
http://www.opala.org/solid_waste/archive/facts2.html
http://www.opala.org/solid_waste/archive/History%20_Garbage_in_paradise.html
http://www.opala.org/solid_waste/archive/How_our_City_manages_our_waste.html
http://www.opala.org/solid_waste/archive/technical_studies.htm
http://www.worldcat.org/title/final-environmental-impact-statement-on-the-kalamaula-landfill-closure-project/oclc/29414093
https://health.hawaii.gov/shwb/files/2013/06/lbpwaste.pdf
https://health.hawaii.gov/shwb/files/2013/06/neighborlandfills3.pdf
https://health.hawaii.gov/shwb/files/2013/06/swmgmpln1.pdf
https://health.hawaii.gov/shwb/files/2013/06/swplapp51.pdf
https://hub.aashe.org/browse/casestudy/17028/Kauai-Community-College-Tiny-House-Hydro-Electric-Micro-Grid-Project
https://legiscan.com/HI/text/HB2648/id/1314698
https://onlinelibrary.wiley.com/doi/pdf/10.1111/sjtg.12089
https://www.alohawastesystemsinc.com/
https://www.eia.gov/state/analysis.php?sid=HI
https://www.environmentalleader.com/2017/02/bioenergy-hawaii-build-waste-energy-plant/
https://www.fema.gov/appeal/218599?appeal_page=analysis
https://www.hawaiibusiness.com/wasted/
https://www.honolulu.gov/ocs/roh/193-site-ocs-cat/964-chapter-14-public-works-infrastructure-requirements-including-fees-and-services.html
https://www.honolulu.gov/rep/site/oca/oca_docs/citizen_centric_report_fy2014.pdf
https://www.kauai.gov/ISWMP
https://www.kauai.gov/PublicWorks/SolidWaste
https://www.kauai.gov/WDR
https://www.mauicounty.gov/1017/Solid-Waste-Refuse-Services-and-Informat
https://www.mauicounty.gov/765/Landfill-Information
https://www.mauicounty.gov/DocumentCenter/View/84681/Chapter-6
https://www.mauicounty.gov/DocumentCenter/View/90088
https://www.mauicounty.gov/DocumentView.asp?DID=1711
https://www.mauicounty.gov/DocumentView.asp?DID=4487
https://www.mauicounty.gov/DocumentView.asp?DID=4502
https://www.mauicounty.gov/DocumentView.asp?DID=4590
https://www.mauicounty.gov/DocumentView.asp?DID=4591

https://www.mauicounty.gov/DocumentView.aspx?DID=1713
https://www.nps.gov/stateoftheparks/kala/parkinfrastructure/parkinfrastructure.cfm
https://www.nps.gov/stateoftheparks/kala/parkinfrastructure/solidwastemanagement.cfm
https://www.nytimes.com/2010/05/23/us/23garbage.html
https://www.wastedive.com/news/kauai-hawaii-new-landfill-capacity-looms/521328/
https://www.wastedive.com/news/update-honolulu-city-council-defers-decision-on-sending-recyclables-to-wte/508375/
journals.sagepub.com/doi/pdf/10.1177/0308518x15599286
kahoolawe.hawaii.gov/KICC/20120822180814813.pdf
kahoolawe.hawaii.gov/KICC/Restoring%20a%20Cultural%20Treasure.pdf
kiuc.coopwebbuilder2.com/sites/kiuc/files/PDF/annualreport/annualreport2004.pdf
kohalacenter.org/pdf/hawaii_county_baseline_energ.pdf
pacificbiomass.org/documents/hawaiibiomassassessment.pdf
uhero.hawaii.edu/assets/StudyForClimateActionPlanningKauai.pdf
uxoinfo.com/blogcfc/client/enclosures/kahclear.pdf
www.bidnet.com/bneattachments?/471049437.pdf
www.co.maui.hi.us/DocumentView.aspx?DID=11416
www.hawaiicleanenergyinitiative.org/storage/hepr_full_report_080407.pdf
www.mauicounty.gov/DocumentView.asp?DID=79
www.opala.org/solid_waste/pdfs/WGSL%20Assessment%202017.pdf
http://www.opala.org/solid_waste/pdfs/Annual%20Report-LUC-SUP-WGSL-6-25-18.pdf

STORMWATER

EXECUTIVE SUMMARY

In recent years, Hawaii has experienced an increase in extreme flooding caused by high tides, storm surges, hurricane rainfall, tsunamis, and sea level rise. As the frequency and intensity of rainfall events increase, it is important that Hawaii's stormwater infrastructure is regularly maintained and can accommodate rainfall during storm events to prevent flooding of highways, businesses and residences. The majority of stormwater systems in Hawaii are owned and maintained by state and county agencies and lack adequate capacity. Since Hawaii's stormwater systems drain directly into the ocean, affecting marine life, regulating agencies are emphasizing the need to reduce the amount of trash, debris and pollutants entering stormwater systems. Based on the Environmental Protection Agency's 2018 assessment, 88 of the 108 marine water bodies did not meet water quality standards. Dedicating funding from utility charges can provide additional sources of funding for drainage system upgrades; however, there are currently no user fees or charge rates in place.

BACKGROUND

Hawaii's storm drainage systems are separate from sanitary sewer systems. Instead of being treated to water quality standards, stormwater in Hawaii drains directly into the ocean. As a result, it is important that Hawaii's stormwater systems are maintained, and land owners and developers follow best management practices to reduce the amount of trash, debris and pollutants that enter these systems, to protect Hawaii's water resources. If stormwater systems are not properly maintained or retrofitted to meet current needs, during heavy rainfall events, these systems may clog or overflow creating flooding hazards and damages to roads, residences and businesses.

Storm drainage systems are owned and managed by both state and county agencies. In urbanized areas, storm drain infrastructure is primarily owned and operated by the respective county agency. Meanwhile, the State of Hawaii, Department of Transportation (HDOT) is responsible for drainage systems along state highways, and at the harbors and airports. All state and county stormwater programs are regulated by the State of Hawaii, Department of Health (DOH) Clean Water Branch (CWB) which administers the Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) Permit program. The NPDES Permit program regulates point-source discharges to waters of the United States in order to protect and restore coastal and inland waters for human recreation, marine life and wildlife. These regulations emphasize Low Impact Development (LID) goals that aim to restore pre-development runoff patterns by encouraging infiltration, reuse, biofiltration and detention of runoff.

CONDITION AND CAPACITY

While there is no centralized public database of all existing stormwater facilities in the state, the counties and HDOT are responsible for tracking and managing their respective systems. Currently, the City and County of Honolulu (CCH) and HDOT, as a requirement of their NPDES Municipal Separate Storm Sewer System (MS4) permits, both have robust stormwater programs to manage and maintain their facilities and educate the public. Other counties are in the process of developing similar programs.

Recurring flooding events indicate inadequate stormwater infrastructure in both urban and rural areas of the state across all counties. Supporting data has not been obtained, but it is likely that a significant amount of existing drainage systems are operating beyond their design life and with limited resources for maintenance. Due to the development of upstream lands, many engineered and natural channels, including bridge and culvert crossings and ocean outfalls, no longer have adequate capacity or are operationally compromised due to lack of maintenance. Storm surges, high tides, and sea level rise can exacerbate flooding. Additional data

should be collected to determine flood control and drainage system needs.

Recent regulations are now requiring new development and redevelopment projects to implement LID elements to minimize the amount of runoff that results from rainfall. Long-term operation and maintenance of these LID Best Management Practices (BMPs) is required to meet water quality standards and mitigate flood risk.

Island	Inland	Marine	Total
Kauai	29	40	69
Oahu	58	78	136
Maui	13	78	91
Molokai	1	3	4
Lanai	0	6	6
Hawaii Island	20	59	79
Total	121	264	385

Table - 2018 Integrated Report 303(d) Listings

The DOH is required to assess the water quality of receiving water bodies (inland and marine) in the state every two years. The assessment can help determine if the LID and NPDES requirements are having a beneficial effect in the restoration and improvement of water quality. The 2018 assessment identified impaired waterbodies that do not meet the State's water quality standards. Of the 108 marine water bodies assessed, 88 did not meet water quality standards for at least one or more conventional pollutants. Approximately 66% of waterbodies statewide (385 out of 582) are on the 303(d) List of Impaired Waters. Turbidity and nutrients are the leading causes of impairment.

OPERATIONS AND MAINTENANCE

Each agency is responsible for operation, maintenance and upgrades to their stormwater infrastructure. The counties and DOT perform regular street sweeping, storm drain cleanings and culvert and channel maintenance to ensure that trash and debris are removed from their structures and the system is able to operate as intended during rain events. Additionally, local community organizations and businesses volunteer to adopt blocks and streams to help with maintenance efforts.

PUBLIC HEALTH AND SAFETY

Increases in the frequency of extreme rainfall events pose regular threats to flash flooding, inundation, and impaired water quality. 2018 brought major stormwater disasters to each county during April's severe storms and August's Hurricane Lane. Heavy rain and high tides forced highway closures while localized flooding impacted access to residences and businesses.

Major development of the Ala Wai Watershed, combined with steep slopes and high rainfall in the upper area of the watershed, has contributed to a high susceptibility to flooding, degradation of native species habitats and declining water quality. The Ala Wai Canal, which serves as the northern boundary of the Waikiki tourist district, has previously overtopped and flooded Waikiki during several historic events. Modeling efforts indicate that a 100-year event would result in damages to more than

Image: Model of Ala Wai watershed in 100-year storm (US Army Corps of Engineers)

3,000 structures in the watershed with total damages exceeding $1 billion. Despite the canal being impaired by nitrogen, phosphorous, sediments, pathogens, metals and pesticides, it is one of the most used inland waterways in the State for recreational paddling, boating and fishing.

FUNDING AND FUTURE NEED

Funding for stormwater infrastructure comes from a variety of sources including county, state and federal government, private property owners, Clean Water Act grants, general obligation bonds, etc. Alternative and innovative methods are still needed to minimize gaps in funding.

In 2018, after over a decade of planning, Congress authorized and appropriated $345 million for improvements to the Ala Wai Canal. An additional $100+ million will be provided by the CCH and state. Annual maintenance costs are estimated at $1 million. Capital costs and operations and maintenance costs for other flood control facilities were not obtained.

The CCH capital program and budget indicates that over the next six years, approximately $170.5 million will be dedicated to public safety-flood control and highways and streets-storm drainage projects. For comparison, 51% (or approximately $446 million) of the $875 million FY2019 CCH capital budget is dedicated to sanitation-wastewater and solid waste. The CCH FY19 NPDES Monitoring Plan budget for its Municipal Separate Storm Sewer System (MS4) Permit is estimated at $2.5 million. This is for compliance efforts only and includes stream sampling, work plan development, lab analyses, USGS joint monitoring agreements, biological assessments, implementation and monitoring plans for TMDLs and BMPs, and other partnership monitoring efforts.

The CWB currently receives approximately $1.7 million dollars in federal funds and $845,000 in state funds to administer the NPDES program, regulate discharges of pollutants, issue permits, and enforce and monitor permit requirements. CWB's also receives approximately $1.2 million in Federal funds through the Clean Water Act Section 319(h) grant program. Approximately $11 million is required annually for state watershed management. In 2019, watershed funding increased to $9.6 million from $2.5 million in 2018, with the additional $7.1 million coming from general obligation bonds.

In 2015, Act 042 – Relating to Stormwater Management (HB 1325 HD1 SD1) was signed into state law. This law authorized the counties to establish and charge user fees to create and maintain any stormwater management system or infrastructure. There are currently no user fees or charge rates in place.

RESILIENCY

Recurring localized flooding, recent extreme flood damage, and near-miss hurricanes have highlighted the need for resiliency in Hawaii. Resiliency refers to the ability to maintain and restore stormwater infrastructure and surface water quality in the event of natural or man-made incidents, extreme weather events, and climate change.

Image: Kuhio Highway landslides on Kauai's north shore after April 2018 storms (DLNR)

Residents and businesses impacted by the April 2018 flooding on Kauai and Honolulu are undertaking recovery efforts with heightened awareness to the importance of resiliency. Without consideration for resiliency, towns and communities may continue to be impacted by the effects of natural events for several months after the fact. Such is the case with access to Kauai's North Shore which remains restricted as emergency repairs to Kauai's Kuhio Highway, estimated at $77 million, will continue into 2019.

With climate change and extreme weather events becoming common occurrences, stormwater infrastructure must be designed to be resilient. Green multi-benefit infrastructure, especially in urban and flood-prone

areas, can help to combat flooding and capture pollutants, while augmenting groundwater supplies and enhancing communities.

INNOVATION

Innovation, along with collaboration and multi-benefit solutions, are necessary to address Hawaii's current and future stormwater infrastructure challenges.

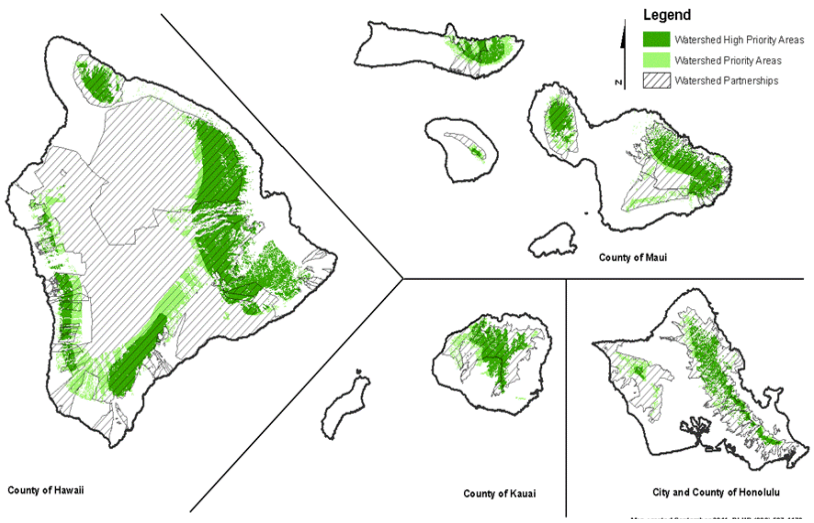


Image: Watershed Partnership Priority Areas (DLNR, 2015)

There are currently 11 island-based watershed partnerships in Hawaii with more than 71 public and private partners protecting over 2.2 million acres of vital forested watershed lands. Management of these upstream watershed areas contributes to reduced runoff in low-lying areas by capturing rainfall and moisture, increasing groundwater recharge, reducing erosion and habitat damage, and decreasing sediment transport to the ocean. Watershed partnerships have been critical to protecting watersheds and their unique biodiversity across large landscapes and different ownership boundaries.

The benefits of collaborative management practices include:

1. Management actions across large landscapes and threats affecting multiple habitats and species;
2. Leveraging of limited dollars for maximum benefits and allow the pooling of resources as well as expertise to reduce redundancy efforts;
3. Providing capacity building for landowners; and
4. Conserving other ecosystem services such as water, recreation, culture, education, and jobs

Transit oriented-development opportunities are being developed as a result of the future light rail system of the CCH. The Chinatown River Walk Revitalization and Kapalama Canal Revitalization Plan are two examples of projects which seek to implement green infrastructure and improve flood control while improving social, economic and environmental quality.

RECOMMENDATIONS

Hawaii's stormwater infrastructure is generally in need of attention and recommended improvements include:

1. Increase recognition of stormwater as a utility and a resource. Further develop county stormwater utility fee structures to create a dedicated funding source for flood control and water quality infrastructure improvements and maintenance.
2. Continue development of integrated, watershed-based management plans and implementation of multi-benefit projects which also address flood control and water quality issues. Effectively use asset management and watershed management modeling systems to prioritize the most sustainable and effective projects.
3. Reevaluate existing state drainage and flood control standards. Incorporate future capacity needs and future hazards such as sea level rise into infrastructure being built and planned now.

SOURCES

http://dlnr.hawaii.gov/ecosystems/wpp/about/ - State of Hawaii, Department of Land and Natural Resources, Division of Forestry and Wildlife, Watershed Partnerships Program, About

https://www.capitol.hawaii.gov/session2015/bills/HB1325_SD1_.htm - Hawaii State Legislature 2015 Archives, HB1325 HD1 SD1 Relating to Stormwater Management

https://dlnr.hawaii.gov/rain/plan/ - State of Hawaii, Department of Land and Natural Resources, The Rain Follows the Forest, Watershed Plan

https://dashboard.hawaii.gov – Aloha+ Challenge Dashboard, Natural Resource Management, Watershed Forest Area, Watershed Funding Secured

2018 State of Hawaii Water Quality Monitoring and Assessment Report: Integrated Report to the US Environmental Protection Agency and the US Congress – Hawaii State Department of Health, Clean Water Branch, July 11, 2018

Report to the 29th Legislature, State of Hawaii, 2018 Regular Session, Relating to Cesspools and Prioritization for Replacement – Hawaii State Department of Health, Environmental Management Division, December 2017

2016 Stormwater Utility Survey, A Black & Veatch Report – Black & Veatch Management Consulting

Hawaii's Nonpoint Source Management Plan 2015 to 2020 – Hawaii State Department of Health, Clean Water Branch, Polluted Runoff Control Program

Ala Wai Canal Flood Risk Management Study, Oahu, Hawaii Feasibility Study with Integrated Environmental Impact Report, Interim Final Report – US Army Corps of Engineers, May 2017

Fiscal Year 2019 Annual Monitoring Plan for City and County of Honolulu, Municipal Separate Storm Sewer System NPDES Permit No. HI S000002 Covering the Period: July 1, 2018 to June 30, 2019 – City and County of Honolulu, Department of Facility Maintenance, May 2018 Draft

National Municipal Separate Storm Sewer System (MS4) Needs Assessment Survey – WEF Stormwater Institute, SWI-2017-FS-FS-002, MS4 Survey

Six Year Capital Program and Budget, Fiscal Years 2019+2024 – City and County of Honolulu, Executive Program and Budget, Fiscal Year 2019, Volume 2

WASTEWATER

EXECUTIVE SUMMARY

Effective wastewater management is essential to safeguard public health, valuable coral reefs and aquatic ecosystems, and the tourism-based economy in Hawaii. Despite significant progress in mitigating health and environmental impacts following the 1972 Clean Water Act, Hawaii's wastewater infrastructure remains in need of attention and substantial funding. While some owners and operators of wastewater infrastructure, including the City and County of Honolulu, have done a commendable job of upgrading assets, adding capacity, and preparing for the future, capital improvements for wastewater systems statewide remain in the billions. However, this does not include adequate funding for several vital wastewater infrastructure programs that could potentially require an additional several billion dollars. More funding will be needed to increase resilience to climate change impacts associated with sea level rise and increased severity of storm events. New and expanded wastewater infrastructure are also anticipated to be required to eliminate many of the estimated 88,000 cesspools statewide that have significant public health and water quality impacts.

BACKGROUND

Hawaii experienced major water quality and public health challenges in the 1960s. On Oahu alone, more than 40 wastewater treatment plants were discharging to streams, harbors, bays and nearshore waters. Prior to 1976, the ocean floor was smothered with sludge from raw sewage discharged less than 3/4 mile off Sand Island at a depth of about 40 feet. Algal growth and suspended solids, resulting from nutrient-rich wastewater effluent discharged to Kaneohe Bay, blocked sunlight needed for healthy corals. The water quality and ecology of Pearl Harbor were also severely impacted by wastewater discharges. The majority of homes on the neighbor islands and in rural Oahu were serviced by cesspools, which are prone to overflows when overloaded and can discharge nutrients via groundwater flow to inland and nearshore waters and potable water wells.

After comprehensive data gathering and analysis of water quality problems in the late 1960s and early 1970s, major projects to upgrade the wastewater infrastructure were implemented statewide. The work included sewer system expansion to eliminate many cesspools and construction of new and upgraded regional wastewater treatment plants (WWTPs) to eliminate nearly all discharges to inland waters. Major upgrades to wastewater infrastructure resulted from comprehensive research and planning studies as well as stringent new State of Hawaii Department of Health (DOH) Water Quality Standards (Chapter 11-54). Construction was funded primarily by the Construction Grants Program of the Clean Water Act.

The majority of the centralized wastewater systems consisting of gravity sewers, pumping stations, force mains (pressurized sewers) and treatment facilities in Hawaii are owned and operated by the four counties: City and County of Honolulu, County of Hawaii (aka Hawaii Island), County of Maui (including islands of Molokai and Lanai), and County of Kauai. Other centralized and smaller wastewater facilities are owned and operated by various private entities and the U.S. government (i.e., military facilities). This report focuses primarily on publicly-owned facilities operated by the four counties, but also examines other noteworthy statewide wastewater management issues.

CAPACITY

The capacity of the treatment plants operated by the four counties are generally adequate. The DOH wastewater regulations (Chapter 11-62) require that planning and design/construction for expansion of treatment facilities begin when flows reach 75 percent and 90 percent of the plant's design capacity, respectively. There are currently 25 municipal treatment plants with a total capacity of approximately 200

million gallons per day (mgd). The plants treat an average of approximately 138 mgd of wastewater, which represent about 69 percent of the available capacity. The Kailua and Kaunakakai WWTPs currently operate at more than 90 percent capacity, but flows are not expected to increase in the future.

Despite efforts to rehabilitate defective sewers, high wet weather flows due to rain-induced (wet-weather) infiltration and inflow remains a challenge in some areas. High wet-weather flows, which can be five to even ten or more times the average flow, can result in sewage overflows, also known as sanitary sewer overflows (SSOs). From 2016 through 2018, 15 percent of municipal SSOs were attributed to high wet-weather flows.

The four counties have programs to test and inspect sewers to identify and control illicit private discharges to sewers, such as rainwater from roof gutters and outdoor drains. Effective public education programs should be implemented to inform homeowners to eliminate illicit connections and to not open cleanouts and manhole covers to drain flooded yards and streets. SSOs caused by clogging problems can be reduced by educating residents to avoid using toilets as a trash can (no flushing of "flushable wipes," paper towels, cotton swabs, feminine products, dental floss, etc.) and minimize discharge of cooking oil and grease in sinks.

Climate change is projected to increase the frequency and intensity of extreme rainfall events and cause sea level rise. Higher wet-weather flows from increased infiltration and inflow of groundwater and rainwater into sewers will add to wastewater system capacity challenges. Cesspools and other onsite disposal systems that rely on leaching of wastewater into the ground will experience greater risk of overflows due to saturated soil conditions from higher water table levels and heavy rainfall.

CONDITION

Hawaii faces many challenges in keeping its wastewater infrastructure in satisfactory operating condition and providing adequate maintenance.

Many pumping stations and treatment plants, which rely on mechanical and electrical equipment, are in coastal areas subject to wind-blown, salt-laden air that promotes corrosion. This results in the need to replace corroded equipment, upkeep protective coatings, and utilize costly corrosion-resistant materials.

There is an ongoing need to replace and upgrade Hawaii's sewer lines and force mains due to capacity and structural integrity issues. Hawaii's warm climate and infiltration of saline groundwater with high sulfate content result in generation of corrosive hydrogen sulfide gases. Ground settlement causes "sags" in gravity flow sewer lines that result in sluggish flow and pipe clogging from grease and sediment accumulation. This increases sewer cleaning requirements and the risk of SSOs. Data on SSOs is presented in subsequent discussions on public health and safety.

In 2010, a comprehensive Consent Decree settlement agreement was reached between the City & County of Honolulu and the U.S. Justice Department and EPA, State of Hawaii, and three environmental groups to address Clean Water Act compliance issues with Honolulu's wastewater collection and treatment systems. The City and County of Honolulu is successfully meeting and exceeding its Consent Decree requirements for replacement and rehabilitation of sewer lines.

OPERATION AND MAINTENANCE

Timely and cost-effective rehabilitation of the City & County of Honolulu sewers is being achieved through extensive CCTV inspection of sewer lines, a semi-automated computer algorithm to evaluate CCTV results, and efficient indefinite delivery/indefinite quantity (IDIQ) contracts. Under the IDIQ program, multiple simultaneous contracts are awarded to various contractors who submit fixed unit cost pricing for various defined types of work.

Maintaining skilled staff to operate wastewater facilities is an ongoing challenge for all counties. Operations can be severely impacted by loss of senior staff with key operational knowledge. Finding skilled staff to operate, maintain and repair computer-based digital controls and monitoring systems can be especially challenging.

As noted in the previous section, there are constant maintenance challenges due to the harsh coastal environmental conditions. General observations indicate that upkeep of equipment and protective coatings varies among facilities and could be improved at many locations to reduce long-term replacement costs.

PUBLIC HEALTH AND SAFETY

Sanitary sewer overflows (SSOs) periodically occur due to clogging and capacity issues previously discussed. Statewide, there were 124 documented municipal SSOs from 2016 through 2018. Based on an estimated 1,870 miles of sewers, this represents 2.2 spills per 100 miles of sewer per year, which is well below EPA's target benchmark of four sewage overflows per 100 miles of sewer per year. As indicated in Table 1 below, SSOs per 100 miles of sewer are low for Honolulu and Maui, and higher for Hawaii Island and Kauai.

Table 1 Sanitary Sewer Overflows (SSOs) from Municipal Facilities (2016 – 2018)

Municipal Agency	Cause/Nature of Wastewater Spill (SSO)					Total Spills (2016 - 2018)	Avg. Spills Per Year	Est. Miles of Sewer Lines[1]	Spills Per Year Per 100 Miles of Sewer
	Blocked/ Broken Sewer Pipe	High Flow (rainwater infiltration/ inflow)	Force Main (pressure pipe) Failure	Spills at Treatment Plant or Pumping Station (equipment malfunction or other problem)	Not Confirmed and Other Causes				
C&C of Honolulu	26	14	5	16	19	80	26.7	1,500	1.8
County of Hawaii	6	3	0	7	0	16	5.3	90	5.9
County of Maui	10	1	2	5	0	18	6.0	220	2.7
County of Kauai	5	0	0	5	0	10	3.3	50	6.7
Total	47	18	7	33	19	124	41.3	1,860	2.2

[1]Length of gravity main line sewers only. Excludes length of force mains and sewer laterals although spills from these lines that are under the agency's jurisdiction are included in the spill data.

Continuing widespread use of cesspools in unsewered areas has recently gained significant attention. There are an estimated 88,000 cesspools statewide. Impacts to public health and the environment include overflow of sewage from defective cesspools, and discharge of nutrients, primarily nitrogen in the form of nitrates, to groundwater. Impacts to potable water wells and aquatic ecosystems vary depending on the location and subsurface geology. Despite a $10,000 tax credit program enacted in 2015 to upgrade cesspools in designated sensitive areas, only 47 applications for the credit were processed by the end of 2017. Most homeowners are unable or unwilling to spend $20,000 to $30,000 to upgrade to septic

Example of failing cesspool (Photo credit: Hawaii Public Radio and Department of Health)

Example of failing cesspool (Photo credit: Hawaii Public Radio and Department of Health)

tank or aerobic treatment systems. Septic tank replacement systems may also leach nitrates to the groundwater. Securing the significant funds required for new sewers, pump stations, treatment plants to reduce the use of cesspools and other onsite systems is extremely difficult. DOH has the primary responsibility in addressing the cesspool issue. In 2018, DOH established a technical working group to develop a comprehensive plan to meet mandated conversion of cesspools by 2050 and conduct research on cesspools and sewage contamination issues.

Another serious and often overlooked wastewater disposal issue is the impact of wastes from Hawaii's substantial homeless population. The lack of restroom facilities can result in discharge of pathogens and other microbiological contaminants to storm drains, streams and nearshore waters. Increases in sewer fees would not be conducive to reducing homelessness as many residents are living paycheck to paycheck. A survey by the Hawaii Foodbank noted that one in five residents in Hawaii (nearly 290,000 people) face hunger issues, and 62 percent of these residents reported having to choose between paying for food and utility bills.

FUNDING AND FUTURE NEEDS

The cost for future wastewater capital improvement program (CIP) projects over the next 20 years for the four counties is expected to exceed $9 billion. This is based on an assumed inflation rate of 3 percent. Approximately $7 billion of this amount is associated with the City & County of Honolulu and their comprehensive plan for complying with its Consent Decree requirements. It should be noted that the $9 billion in needed funds, based on updated budget projections, is significantly higher than the $2.16 billion statewide estimate reported in the 2012 EPA Clean Water Needs Survey for publicly-owned wastewater infrastructure. The total statewide wastewater operating budget for the four counties, excluding debt service, is currently on the order of $250 million per year, which is separate and in addition to the CIP funding needs.

A review of the CIP budgets indicates minimal funding for extension of sewers to eliminate cesspools and for projects to mitigate climate change impacts. These largely unfunded and yet-to-be-defined needs represent a funding gap that could potentially total several billion dollars.

A 15 percent increase in statewide residential population from 1.43 million in 2016 to 1.65 in 2045 is projected. Private developers, along with various county and government development agencies, would be expected to fund much of the wastewater infrastructure expansion required to accommodate future population growth.

Securing adequate funding for CIP projects and O&M needs is a constant challenge. Utility bills for Honolulu are near the limits that are considered affordable. For all agencies, significant increases have been politically difficult to implement. The City & County of Honolulu and Maui have had more success than other counties in increasing sewer fees due to mandated work under their Consent Decrees. Clean Water State Revolving Funds, which are low interest loans available for publicly-owned wastewater projects, should continue to be used to the extent possible.

Adequate funding for DOH, the State's regulator of municipal and private wastewater systems, is also critical. Meeting federal mandates of the Clean Water Act and addressing other issues such as eliminating cesspools has been a major challenge, particularly following the staff reductions from the 2008 recession. Thoughtful and science-based monitoring programs, permit requirements, and enforcement actions are critical to promote sound regulatory oversight, development of reasonable and effective permit and monitoring requirements, and cost-effective use of limited funds.

Sewer users currently shoulder most of the water pollution control costs despite cesspools also having substantial public health and water quality impacts. Imposing a fee for owners of cesspools and other onsite disposal systems who do not currently pay sewer fees should be considered. The funds could be used for a statewide DOH program to improve identification of onsite disposal systems that have problematic overflow and seepage issues, and to provide grants and other financial assistance for corrective actions. As an example, a modest $5.00 per month fee on 88,000 cesspools would equate to $5.2 million in revenues.

INNOVATION

While Hawaii's extremely stringent water quality standards has virtually eliminated point wastewater discharges to inland and nearshore waters, it has also resulted in compliance and permitting issues, particularly those related to discharges from deep ocean outfalls and injection wells. Significant expenditures for wastewater projects can indirectly reduce available funding for potentially very cost-effectives projects related to watershed protection and stormwater pollution control.

Two of Honolulu's major treatment plants (Sand Island and Honouliuli) had previously operated under a 301(h) waiver from the EPA for secondary treatment due to the unique conditions of their deep ocean outfalls. The plants are currently operating under National Pollutant Discharge Elimination System (NPDES) permits. Under the City and County of Honolulu's Consent Decree, both plants are scheduled to be upgraded to meet secondary treatment standards of the Clean Water Act. The capital costs, in current dollars, are expected to exceed several billion dollars with additional annual operating costs amounting to tens of millions of dollars. Based on decades of extensive research and water quality monitoring, scientists and engineers have concluded that primary treatment with the deep ocean outfalls have had no deleterious effects. Primary treatment is considered a more sustainable solution than secondary treatment due to less energy use and natural degradation of soluble organic matter in the deep ocean with less release of microorganism-generated CO2 into the atmosphere. Innovative renegotiation of the Consent Decree, or a special exemption through Congressional action, should be pursued to allow use of funds for other pollution control initiatives.

EPA recognizes municipalities are faced with multiple water quality issues and limited resources, and that the highest priority projects should be implemented first. The EPA's Integrated Planning Program is designed to empower local community stakeholders in setting priorities, evaluate affordability issues, and incorporate sustainable technology and green solutions. This program promotes cooperative prioritization of funds and projects among agencies, regulators, lawmakers, environmental groups and the general public. While the program does not carry the authority to supersede mandated wastewater treatment requirements, it does provide an opportunity to negotiate with the EPA to better prioritize and address the most pressing water quality issues. The Integrated Planning Program is evolving and may potentially offer more flexibility and options in the future as stormwater is increasingly recognized as being a key factor in resolving water quality challenges. Honolulu could devote more attention and funds to much needed stormwater pollution control, if prioritized over the scheduled wastewater plants upgrades. Postponing the treatment upgrade to meet secondary treatment standards may also allow for the implementation of new technology that is more cost-effective and energy efficient.

RESILIENCE

Forecast models of global sea level rise due to climate change project 3.2 feet of sea level rise in Hawaii by the end of the century. With much of Hawaii's population located along the coastline, the resiliency of the wastewater infrastructure in coping with sea level rise and increasing severity of storm events is extremely critical. A formal directive was issued by Honolulu's mayor to take action to meet the growing impacts of sea level rise and climate change. Other counties should similarly direct attention and funding to this issue.

Recycled wastewater from wastewater treatment facilities is routinely used for golf course and landscape irrigation and other beneficial uses. As of 2014, approximately 22 mgd (16.4 percent) of the 134 mgd of the wastewater treated statewide was being recycled. Increased infiltration of saline groundwater into sewers due to sea level rise may increase chloride levels in the recycled water to the point where it may be unsuitable for irrigation reuse. Increased rehabilitation of coastal sewers below the water table affected by sea level rise may be required to reduce infiltration and maintain acceptable chloride levels in recycled water.

RECOMMENDATIONS

Recommended actions to improve Hawaii's wastewater infrastructure include:

1. Projects to upgrade aging wastewater infrastructure such as sewers, pumping station, force mains and treatment plants should continue to be implemented. The counties of Hawaii, Maui and Kauai counties should consider utilizing innovative procurement methods, such as

Honolulu's successful indefinite delivery/indefinite quantity (IDIQ) program, to expedite routine sewer rehabilitation and upgrade work. Sewer fee increases should be pursued, particularly for Hawaii and Kauai counties.

2. Adequate funding should be provided for proactive recruiting of new employees and training new and existing staff.
3. Programs involving sewer testing, inspection and public education to reduce wet-weather flows, sewers clogging and SSO problems should be expanded. Public education should inform homeowners: 1) to eliminate illicit private property rainwater discharges to reduce wet-weather flows, and 2) to not dispose of wipes and other trash in toilets and grease in sinks to reduce clogging and SSO problems.
4. A comprehensive holistic study should be conducted to investigate and better identify the nature and causes of water quality, ecological and public health impacts related to wastewater infrastructure and discharges to promote effective use of funds. The study should assess the full range of factors, including surface and subsurface discharges from cesspools, injection wells, ocean outfalls, and runoff (urban, agricultural and conservation lands). Impacts on coral and aquatic biota, potable water, and recreational waters should be assessed with respect to organic loading, sediments, microbiological contaminants, and emerging contaminants such as endocrine disrupters and pharmaceuticals. Assessments should also consider the impact of future sea level rise and increased severe weather events. A list of prioritized actions and associated costs should then be developed.
5. EPA's Integrated Planning program should be implemented to obtain input from stakeholders to prioritize use of limited environmental protection funds. Innovative solutions should be pursued to overcome "one-size-fit-all" regulations and mandates that often do not result in cost-effective use of limited funds.
6. Additional funding should be provided to DOH to improve monitoring programs, permitting, enforcement, and overall regulatory oversight.
7. For cesspools, low-cost options should be developed and evaluated to improve the nutrient removal performance. Consideration should be given to assessing a fee on cesspool users. Funds may be used to increase DOH inspections and pursue enforcement actions to eliminate overflows, and to provide financial assistance for corrective actions.
8. Funding should be allocated to increase the resilience of wastewater infrastructure to climate change impacts, which include sea level rise and increased severity of storm events. Rehabilitation of coastal sewers to reduce infiltration of saline groundwater should be implemented as needed to maintain acceptable chloride levels in recycled water.

SOURCES

American Water Works Association and Raftelis Financial Consultants, Inc., "2014 Water and Wastewater Rate Survey," 2015.

Black & Veatch, "50 Largest Cities Water/Wastewater Rate Survey, A Black & Veatch 2012/2013 Report."

City and County of Honolulu, Climate Change Commission, "Climate Change Brief," Adopted June 5, 2018.

City and County of Honolulu, Climate Change Commission, "Sea Level Rise Guidance," Adopted: June 5, 2018.

Hawaii Climate Change Mitigation and Adaptation Commission, "Hawaii Sea Level Rise Vulnerability and Adaptation Report," 2017, Prepared by Tetra Tech, Inc. and the State of Hawaii Department of Land and Natural Resources, Office of Conservation and Coastal Lands, under the State of Hawaii Department of Land and Natural Resources Contract No: 64064.

Shintaku, Gerald, “Hunger in Hawaii is a Complex Problem,” article in Honolulu Star-Advertiser, October 3, 2017, page A9.

State of Hawaii, Department of Business, Economic Development and Tourism, “Projections for the State of Hawaii to 2045,” June, 2018.

State of Hawaii, Department of Health, Environmental Health Administration, “Draft Water Quality Plan 2014,” August 4, 2014.

State of Hawaii, Department of Health, Clean Water Branch, “2018 State of Hawaii Water Quality Monitoring and Assessment Report: Integrated Report to the U.S. Environmental Protection Agency and the U.S. Congress Pursuant to §303(d) and §305(b), Clean Water Act (P.L. 97-117), Final,” July 11, 2018.

State of Hawaii, Department of Health, Hawaii Administrative Rules, Chapter 11-54, “Water Quality Standards,” November 15, 2014.

State of Hawaii, Department of Health, Hawaii Administrative Rules, Chapter 11-62, ‘Wastewater Systems,” March 21, 2016.

State of Hawaii, Department of Health, “Draft Highlights - Hawaii DOH Environmental Health Management Report - 2016-217,” at https://health.hawaii.gov/epo/files/2016/11/2016-SV-Draft-EHM-Plan-Highlights-2016-17-on-11.3.16-v2.pdf.

State of Hawaii, Department of Health, “Hawaii’s Nonpoint Source Management Plan, 2015 to 2020.”

State of Hawaii, Department of Health, “Report to the Twenty-ninth Legislature, State of Hawaii, 2018 Regular Session, Relating to Cesspools and Prioritization for Replacement,” December 2017.

U.S. Environmental Protection Agency, “Clean Watersheds Needs Survey 2012, Report to Congress,” EPA-830-R-15005, January 2016.

U.S. Environmental Protection Agency, Website information on “Consent Decree and Amended: City and County of Honolulu: Civil No.94-00765DAE-KSC,” at https://www.epa.gov/enforcement/consent-decree-and-amended-city-and-county-honolulu-civil-no94-00765dae-ksc.

U.S. Government Accountability Office, “Drinking Water and Wastewater Infrastructure Information on Identified Needs, Planning for Future Conditions, and Coordination of Project Funding,” September 2017, GAO-17-559.

Whittier, Robert B. and Aly I. El-Kadi, “Human And Environmental Risk Ranking Of Onsite Sewage Disposal Systems, Final,” December 2009, Prepared for State of Hawaii, Department of Health, Safe Drinking Water Branch.

https://www.epa.gov/npdes/integrated-planning-municipal-stormwater-and-wastewater

ADDITONAL SOURCES: Informal discussions and emails with staff and data from DOH and various county wastewater agencies.

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Use your zip code to find your elected officials

KNOW

Check the HI Legislative Tracking Center to find legislation that you care about (hint… infrastructure)

DISCUSS

Now that you know who your elected officials are, EMAIL THEM and VISIT THEIR OFFICES to share the Hawai'i grades and solutions

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ABOUT THE HAWAII SECTION OF ASCE

ABOUT ASCE

Founded in 1852, the American Society of Civil Engineers represents more than 150,000 civil engineers worldwide and is America's oldest national engineering society. ASCE works to raise awareness of the need to maintain and modernize the nation's infrastructure using sustainable and resilient practices, advocates for increasing and optimizing investment in infrastructure, and improve engineering knowledge and competency.

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