A Blueprint for Action

Water Security for an Uncertain Future

2016-2018

Hawai‘i Fresh Water Initiative

HAWAI‘I COMMUNITY FOUNDATION
Amplify the Power of Giving

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EXECUTIVE SUMMARY

Hawai'i has been blessed with consistent rainfall, advantageous geology, and high-quality drinking water stores for centuries. Recent findings, however, have raised concern about long-term fresh water security for our Islands. University of Hawai'i and other scientists have documented troubling trends including reduced rainfall, higher evaporation rates, and declining stream flows in recent decades. These findings, coupled with the demand of an ever-increasing population, suggest that Hawai'i is entering an era of fresh water uncertainty.

The Hawai'i Fresh Water Initiative (Initiative) was launched in 2013 to bring multiple, diverse parties together to develop a forward-thinking and consensus-based strategy to increase water security for the Hawaiian Islands. Organized by the independent, nonprofit Hawai'i Community Foundation (HCF), the Initiative relied on a blue ribbon advisory panel of individuals (Hawai'i Fresh Water Council or Council) with deep knowledge of water and a collaborative spirit to articulate a vision for a more secure and sustainable water future based on shared values, and shared sacrifice. This Blueprint is the result of their work, and provides Hawai'i policy and decision-makers with a set of solutions that have broad, multi-sector support in the fresh water community that should be adopted over the next three years to put Hawai'i on a path toward water security. The Blueprint also builds on the good work, findings, and recommendations over the years by preceding stewards of Hawai'i's most important resource.

THE IMMENSE VALUE OF WATER IS INDICATED BY THE FACT THAT THE NATIVE HAWAIIAN WORD FOR FRESH WATER IS "WAI." THE WORD FOR WEALTH? "WAIWAI."

Goal

The Fresh Water Council distilled nearly two years of research and analysis into a single goal: ***creating 100 million gallons per day (mgd) in additional, reliable fresh water capacity for our islands by 2030.***

To achieve the ambitious goal of 100 mgd in additional fresh water capacity, the group outlined three aggressive water strategy areas and individual targets that the public and private sectors must work together to achieve by 2030:

1. ***Conservation:*** Improve the efficiency of our population's total daily fresh groundwater water use rate by 8% from the current 330 gallons per day/person to 305 gallons per day/person.[1] By 2030, this goal will provide 40 mgd in increased water availability.

2. ***Recharge:*** Increase Hawai'i's ability to capture rainwater in key aquifer areas by improving storm water capture and nearly doubling the size of our actively protected watershed areas.[2] By 2030, this goal will provide 30 mgd in increased water availability.

3. ***Reuse:*** More than double the amount of wastewater currently being reused in the Islands to 50 mgd.[3] By 2030, this goal will provide an additional 30 mgd in increased water availability.

The Council lays out 18 specific policy and implementation recommendations to adopt that will both help Hawai'i meet the goal of 100 mgd of new fresh water available supply, and begin to build a twenty-first century fresh water infrastructure that addresses three important challenges. First, Hawai'i must embrace more decentralized systems that diversify capture, encourage reuse, and reduce transmission—qualities that protect fresh water supplies and bottom lines as energy and pumping costs rise. Second, our islands' natural ability to capture and store fresh water has been degraded to the point where far too much of the rain that falls on our land winds up as runoff in the ocean. Forests should be managed for maximum fog and rain capture, agricultural practices that enhance capture and reduce runoff should be encouraged, and urban areas need to gradually be re-tooled to increase permeability. Third, the current financial model supporting our water system must be revisited. A secure water future depends on a model where conservation practices do not undermine the stability of our water providers' revenue and where the full value of water—including source protection—is included in the price paid by users.

This Blueprint is designed to serve both as a guide for initial action, and a catalyst for Hawai'i's leaders and citizens to determine how to best ensure long term water security for our island state. Lively discussions about how to increase local food production and energy self-sufficiency are already underway, and are an encouraging sign that the public is keenly interested in building a sustainable future for Hawai'i. A sustainable, stable, affordable fresh water supply is the cornerstone of that effort.

RISING CONCERN

Fresh water is the lifeblood of society. As an island people, we inherently understand that the quantity and quality of available fresh water in our Islands directly impacts our health, our economy, our fisheries, our capacity for food production, the health of our native ecology, Native Hawaiian cultural practices, and other elements of our quality of life. The California drought and water crisis currently unfolding across the Pacific serves as a potent reminder of the economic and environmental risks at stake if our fresh water supplies falter. Worldwide,

WHEN THE WELL'S DRY, WE KNOW THE WORTH OF WATER.
– BENJAMIN FRANKLIN

one-third of the world's population does not have adequate fresh water, and this fraction is expected to rise to two-thirds by 2025.[4] Hawai'i has been blessed with consistent rainfall, advantageous geology, and high-quality drinking water stores for centuries. However, recent findings have raised concern among scientists, farmers, and others about the long-term fresh water security of our Islands.

In 2012, the Pacific Islands Regional Climate Assessment stated that throughout the Pacific, warmer and drier conditions will decrease fresh water supplies.[5] In 2014, the Hawai'i State Legislature found that "climate change is the paramount challenge of this century, posing both an urgent and long-term threat to the State's economy, sustainability, security, and way of life…" and that "… drought and rising temperature are already having measurable impacts on Hawai'i and are expected to accelerate in the years to come."[6] The legislature concluded: "With...

rain continuing to diminish, and sea levels projected to rise one foot by 2050 and three feet by 2100, Hawai'i is highly vulnerable."[7] These assessments echo the findings of University of Hawai'i and other scientists who have discovered and documented concerning trends of reduced rainfall,[8] higher evaporation rates,[9] and declining stream flows[10] in recent decades. These trends, coupled with demands from an ever-increasing population, and new threats to existing sources of water (sea level rise and contamination at areas such as Red Hill) indicate that Hawai'i is entering an era of increasing uncertainty regarding our long-term water security.

This uncertainty overlays an already complex water landscape. Some areas of our state have ample water supplies,[11] and unexpected new discoveries of water sources highlight our limited knowledge of the hydrogeology of our Islands.[12] At the same time, various computer climate models predict divergent precipitation futures for Hawai'i, although there seems to be common agreement that our rainfall future will be increasingly extreme and inconsistent.[13] There is also high variation throughout the islands in terms of each watershed's ability to catch and hold water. In sum, the question is not whether Hawai'i will have water in the future, but rather will Hawai'i continue to have an affordable, predictable supply in the places we need at the times that we need for a growing population? With key Hawai'i aquifers under increasing pressure and facing an uncertain future, concern is understandably rising about the need for public and private action to mitigate risk and ensure a stable and affordable fresh water supply for our citizens.

To hedge against this risk, Hawai'i has already made some positive inroads on the water front. Per capita water use has fallen on O'ahu thanks to conservation efforts.[14] Upgrades in agricultural irrigation and transportation technology at select sites have vastly reduced water loss.[15] Maui now reuses nearly a quarter of its domestic waste water for agriculture and landscape irrigation.[16] Hawai'i Island is host to a certified "Living Building" in Waimea, where the Hawai'i Preparatory Academy's Energy Lab

Uncertainty Factors

Reduced Rainfall

- Rainfall in Hawai'i decreased by 18% over a 30 year period in Hawai'i from 1978 to 2007.
- Annual "tradewind days" have declined 28% from 291 days in 1973 to 210 days in 2009, resulting in less rain and recharge of aquifers.

Increased Drought

- Hawai'i has been feeling the impact of prolonged drought. In the summer of 2013, 75% of Hawai'i's land area was "Abnormally Dry."
- Groundwater provides 99% of the state's domestic water use and in several key areas groundwater levels have been dropping.

Land Use Changes.

- Half of Hawai'i's original watershed forests have been destroyed, and only 13 percent of those that remain are in active protection.
- Increased development in Hawai'i means more impervious surface and resulting runoff, and less water percolating back into our aquifers.

Increased Evapotranspiration.

- Increased temperatures associated with global warming mean increased evaporation for surface water and soil moisture.
- Certain invasive plant and tree species have higher evapotranspiration rates than native species in Hawai'i. Hawai'i forests are increasingly encroached on by invasives.

captures all of its own drinking water and treats all of its wastewater—one of only five such structures in the world.[17]

But these examples are not enough on their own. The scale of changing rainfall patterns (especially on the dry, populated sides of our Islands), population growth, plans for increased local food production, and land use changes[18] demand a prudent and proactive approach to water security that protects a sustainable and affordable water supply. The environmental risk factors identified by the Council would cause concern even if Hawai'i's agricultural and urban water supply systems were robust and resilient. But for the most part, our agriculture and urban water infrastructure is aging, often sited in areas that are prone to dangerous weather events, and subject to budget cuts that resulted in deferred maintenance.

We are not alone in facing these challenges. According to a recent U.S. Environmental Protection Agency (EPA) infrastructure report to Congress, U.S. water utilities will need to spend $384 billion over the next 15 years just to *maintain* adequate drinking water service.[19] Many of the massive water infrastructure investments of the 1970s are nearing the end of their useful life and will soon require renovation or replacement. With climate change rapidly altering Hawai'i's water reality and unprecedented infrastructure challenges on the horizon, a modern and efficient water system for the 21st Century must be realized. The size and scale of looming issues around the predictability of our fresh water supply calls for a strategic and coordinated response.

THE HAWAI'I FRESH WATER INITIATIVE

The Hawai'i Fresh Water Initiative was launched in 2013 to bring multiple, diverse parties together to develop a forward-thinking and consensus-based strategy for water security for the Hawaiian Islands. Organized by the independent, nonprofit Hawai'i Community Foundation (HCF), the effort identified and recruited a blue ribbon panel of individuals with deep knowledge of water and a collaborative spirit to guide the Initiative. The resulting Fresh Water Council represents a robust collaboration of federal, state, county, nonprofit, academic, and private sector stakeholders who

Hawai'i Fresh Water Council

- **William Aila**
- **Stephen Anthony***
- **Meredith Ching**
- **Derek Chow**
- **Ka'eo Duarte**
- **Sumner Erdman**
- **Mark Fox**
- **Tom Giambelluca**
- **Timothy Johns (Chair)**
- **Howard Killian**
- **Patrick Kobayashi**
- **Ernest Lau**
- **Jerry Ornellas**
- **Monty Richards**
- **Kapua Sproat**
- **David Taylor**
- **Dennis Teranishi**
- **Barry Usagawa**

*United States Geological Survey Liaison/ Science Advisor to HCF

worked together for over a year to articulate a vision for a more secure and sustainable water future based on shared values, and shared sacrifice. See Appendix A for the Council's work process. The Council reviewed dozens of studies, recommendations, and policy solutions to arrive at a common understanding regarding the current state of fresh water in Hawai'i, the uncertainty that looms over our water future, and a proactive, pragmatic path forward.

Council members recognize that every business and individual in Hawai'i depends on a sustainable source of fresh water for our society to function. By coming together now *before* a major water crisis strikes to make tough choices that share responsibility equitably, the Council intends to set a tone of collaboration for water issues in the Hawaiian Islands. This cooperative approach from multiple perspectives stands in stark contrast to the debate over other heated subjects in the islands, and provides the best opportunity in decades to make real, practical progress on water issues in the state. Each recommendation outlined below demands different levels of commitment from different sectors, but in the end provides a far larger benefit to the community overall. This Blueprint outlines a cohesive approach where all can see their role, and all can see an ultimate benefit in an extremely complex arena.

Given the major challenges presented by reduced rainfall, increasing population pressure, and aging infrastructure, the Council found that Hawai'i needs to make immediate changes to slowly increase our ability to capture, store, and efficiently utilize fresh water—moves that will increase our long-term fresh water security. Doing so will protect our quality of life for current and future generations and pay financial dividends as well. One recent University of Hawai'i Economic Research Organization (UHERO) study estimated that investing $43.2 million in watershed restoration work in the Ko'olau mountains could result in over $900 million in actual realized water value for O'ahu.[20]

Beyond cost savings, however, is the basic fact that water is essential to life. Perhaps even more important than our much-discussed dependence on imported fuel and food—water is the one resource essential to life with few cost-effective alternatives for replacement. Finding that the risk of inaction was too great, the Council dedicated over a year of their time to visit multiple sites on several islands, conduct research, consult with experts, vet solutions, and ultimately issue this consensus "Blueprint for Action."

This Blueprint has two intended uses. The first is to guide the investments and actions of HCF and the Council as the Fresh Water Initiative continues to convene stakeholders, track key measures and data, and facilitate a collaborative approach across the fresh water sector. The second is to provide Hawai'i policy and decision makers with a set of solutions that

Fresh Water Council Members engaged in joint learning, including a site visit on Maui.

have broad, multi-sector support in the fresh water community and should be adopted in the near term. It is important to note that many of the recommended solutions will take many years to fully implement and positively impact our fresh water supply, and that the Council is careful to note that risk management must begin now in order to address an uncertain future. The Council ultimately defined "water security" for Hawai'i as a *"sustainable, plentiful, and cost-effective fresh water supply for all of Hawai'i's agricultural, cultural, domestic, economic, and ecosystem needs by 2030."* The Fresh Water Initiative has highlighted the essential goals and policies that need to be approved to achieve water security given the considerable threats our islands face. In an arena often characterized by conflict and litigation, the joint findings and recommendations included in this Blueprint have met the approval of multiple constituencies and will make a measurable difference when adopted.

INITIATIVE GOALS FOR 2030

Recognizing that readily accessible, economically available fresh water supplies are threatened in Hawai'i, the Council adopted an over-arching goal for the Initiative: to achieve "no net loss"[21] for our current aquifer water stores by creating 100 mgd in additional, reliable, fresh water capacity by 2030.

To achieve this ambitious "no net loss" goal that directly increases water security and maintains overall aquifer health in the face of declining rainfall and an expected rise in demand, the Council outlined three aggressive water strategy areas and volume targets that our state should work to achieve by 2030. Based on population projections (demand) and the considerable uncertainty challenging future aquifer recharge (supply), the Council agreed that a conservative estimate of 100 mgd of additional capacity would be needed to effectively offset increased demand and uncertainty surrounding recharge. The following strategies and metric targets cumulatively provide 100 mgd in critical, additional fresh water availability for the Hawaiian Islands:

1. ***Conservation:*** Improve the efficiency of our population's total daily underground aquifer water use rate by 8% from the current 330 gallons per day/person[22] to 305 gallons per day/person. By 2030, this goal will provide a target 40 mgd in increased water availability.

2. ***Recharge:*** Increase Hawai'i's ability to capture rainwater in key aquifer areas[23] by improving storm water capture and nearly doubling the size of our actively protected watershed areas.[24] By 2030, this goal will provide a target 30 mgd in increased water availability.

3. ***Reuse:*** More than double the amount of wastewater currently being reused in the islands to 50 mgd while reducing by nearly half the amount of wastewater currently being discharged directly into the ocean around the Hawaiian Islands.[25] By 2030, this goal will provide a target 30 mgd in increased water availability.

The Council consulted with many entities during the creation of these goals. Multiple experts briefed the Council and key areas of interest were researched in detail by a half dozen contractors. The Council settled on these goals and targets based on an understanding of the best information available. A regular assessment of progress made across the state towards these targets will help refine the overall goals, identify areas of promise, and allocate resources as the Initiative progresses. The Council intends for this Blueprint to continue to evolve as policies shift and new paths emerge to achieve the overarching goal of 100 mgd of new fresh water capacity by 2030. Although the goals and targets were

intentionally developed as general state-wide recommendations, the Council recognizes that individual solutions will need to be prioritized and adopted for each island, where geology, culture, cost factors, and water needs vary widely. Nevertheless, water supply is an issue facing every island in Hawai'i. The Initiative's goals are aggressive, and it will take a determined effort to ensure that the state achieves fresh water security over the long term.

A focused, collective effort to achieve these goals will protect Hawai'i's natural environment and cultural practices, increase Hawai'i's agricultural and economic security, foster and demonstrate innovation in the water sector, and (in combination with advances in clean energy infrastructure) further position Hawai'i as a green model for the U.S. and for the world. Already, young entrepreneurs are making their way to Hawai'i as a recognized frontier for renewable energy development and integration. As worldwide water supply challenges grow and fresh water becomes the "new oil," Hawai'i has an opportunity to attract talent and technology, and lead in yet another critical field.

Hawai'i Water

For centuries after their arrival from Polynesia, Native Hawaiians divided the land into *ahupua'a* — subdivisions running from the ocean to the mountains, roughly defined by their watersheds. Fresh water flowed through complex ditch systems called *'auwai*, often to flood taro *lo'i*, where it supported the cultivation of hundreds of variety of taro—a dietary mainstay for the population. Intact native forests in the *wao akua*, along with diversion systems of *'auwai* and *lo'i* in the lowland areas slowed down water flow and increased aquifer recharge in each watershed. Eventually, the water returned through more *'auwai* to the stream where the nutrient-rich water flowed *ma kai* to enrich fishponds and reef life.

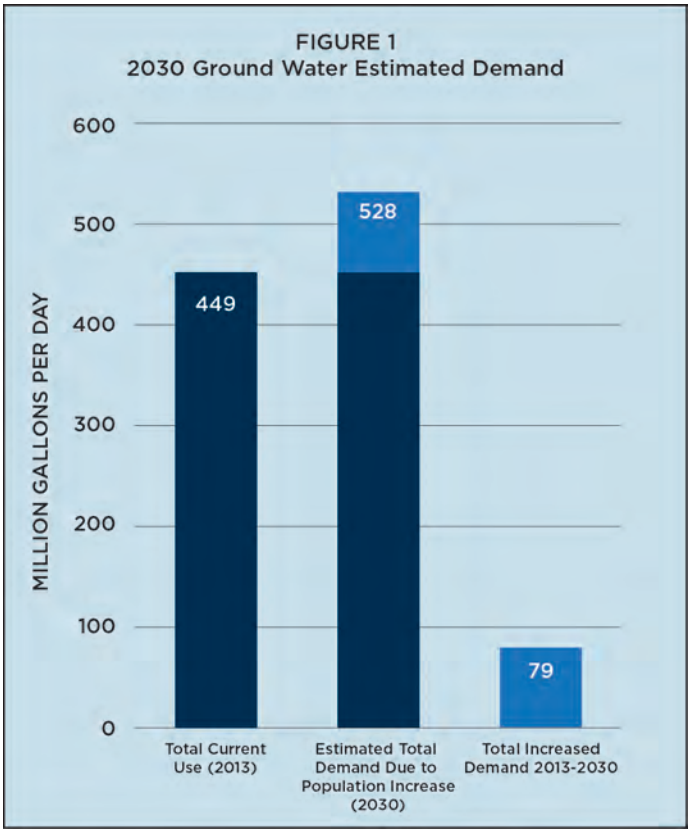
Since the time of the *Konohiki*, Hawai'i has maintained a tradition of fresh water supply being held in trust for citizens, compared to water held as a private property right as it is throughout much of the United States. From some of the first written laws in Hawai'i, to the first constitution of the Kingdom of Hawai'i in 1840, to Article 11 of the Hawai'i State Constitution to the Water Code, water has been defined as a public good. Water is the only natural resource addressed in a stand-alone section in our state constitution.

While private property and public trust approaches to water have their own benefits and drawbacks, thanks to our unique geology and steady tradewinds the history of water in Hawai'i has been one defined by relative abundance. Current trends, however, indicate that Hawai'i will have less water in our shared future and we will all have to adapt to a new reality. Fortunately, aspects of Hawai'i's existing laws and policies on water management already include many adaptive elements such as public trust framework and a statewide agency responsible for water policy.

The Fresh Water Initiative recognizes our unique water history in Hawai'i and the valuable lessons from our past. The Council finds that Hawai'i's long-term water supply faces an uncertain future, that our institutional structures have certain advantages, but that critical areas of concern must be addressed if Hawai'i is to maintain water security going forward.

URGENCY AND TIMELINE

While computer models differ markedly in their predictions regarding precipitation patterns and water availability in Hawai'i over the coming decades, the unmistakable *observed* trend is one of decreasing rainfall and increased incidences of drought.[26] In fact, if the current trend line holds, Hawai'i in 2030 will receive only three quarters of the rain that fell in 1985 on our islands. In addition, multiple prediction models tend to agree that regardless of overall rainfall amounts, the dry/leeward sides of our Islands where the bulk of our population live will experience reduced rainfall and increased potential evapotranspiration—simultaneously creating less supply and more demand. Along with projected population rise, the Council found these trends troubling and generate a sense of uncertainty and urgency to guard our future water supply.



To develop a rational and conservative approach to achieving "no net loss" for our current fresh groundwater supplies, the Council utilized a straight-line approach to predicting future fresh groundwater demand (Figure 1). Using 2013 as a baseline, the Council relied on publicly available data measuring an overall 449 mgd groundwater pumping rate provided by the state Commission on Water Resource Management.[27] Dividing this number by the current population in Hawai'i, the Council projected the expected annual demand in 2030 based on population projections by the state Department of Business, Economic Development, and Tourism. The Council expects 79 mgd of additional water demand within the next fifteen years.

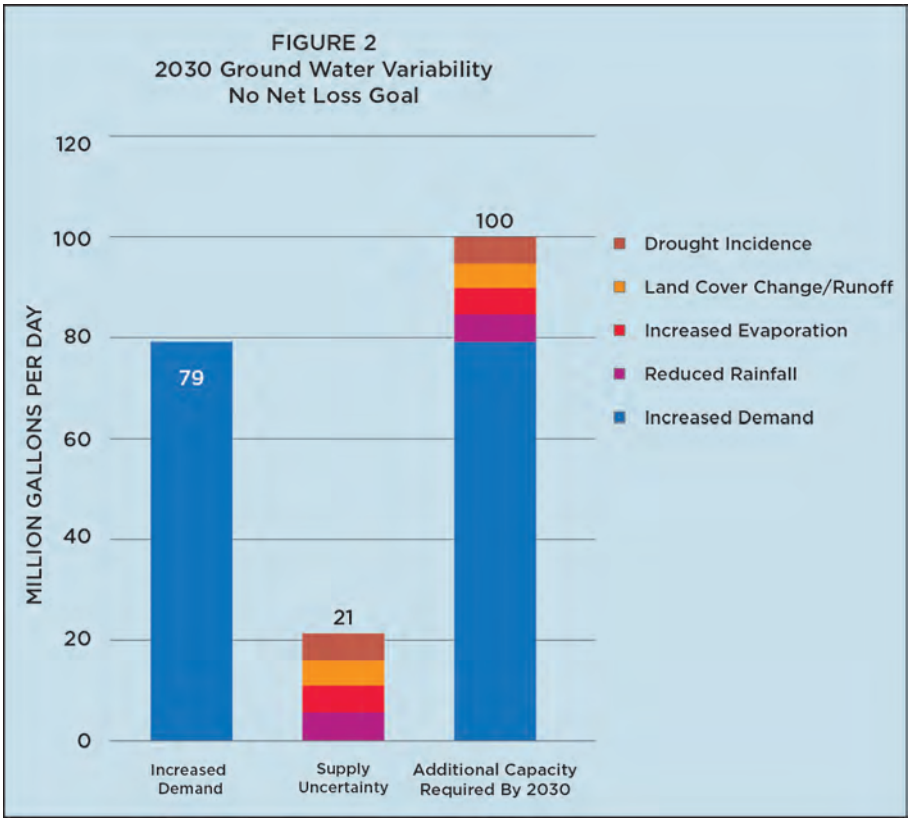
Next, the Council evaluated the potential impact of four major "uncertainty factors" (Figure 2) on current water supply including: reduced rainfall; increased drought; land use changes; and, increased evapotranspiration. Weighing the potential impact of each, the Council assigned a total uncertainty factor of 5% to apply to the amount of currently pumped groundwater.[28] This conservative uncertainty factor that includes changes in drought incidence, land cover change, increased evaporation, and reduced rainfall results in an expected reduction of 21 mgd to Hawai'i's groundwater supply over the next 15 years.

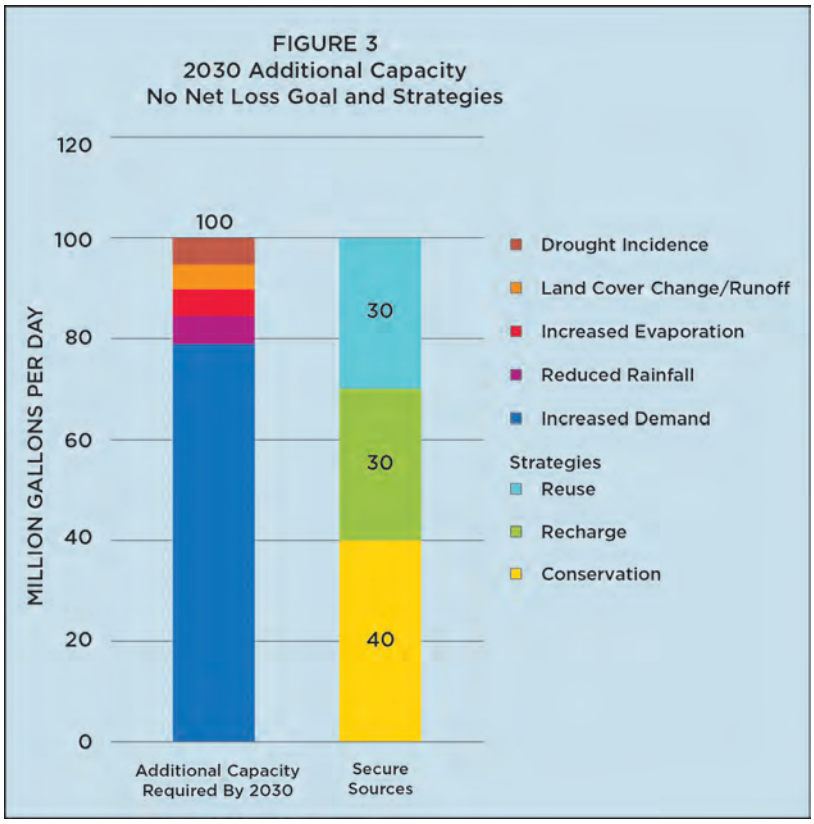
Next, adhering to a strategy of "no net loss" to our underground water resources, the Council added the expected increase in demand (79 mgd) with the uncertainty figure (21 mgd) to estimate an overall goal: 100 mgd of additional available fresh water supply by 2030 (Figure 2).

Providing 100 mgd of new capacity will help manage risk, increase the predictability of our water supply, and make all of Hawai'i's fresh water supply more reliable and secure over the next 15 years.

Finally, the Council identified three fresh water sources that have the realistic potential to provide 100 mgd in additional capacity by 2030. Figure 3 shows tables for yields of 40 mgd via conservation, 30 mgd via recharge, and 30 mgd via reuse to offset the expected increase in demand and supply uncertainty over the next 15 years.

While it is impossible to predict exactly what Hawai'i's demand and supply water future will look like, the Council's diverse and experienced members worked together to come up with projections, estimates, and targets that reflected the shared knowledge of the group. The Council believes that given increased demand and threats to future supply it is prudent of the state to adopt a goal of increasing the available water supply by 100 mgd by 2030 through the strategies that follow.





STRATEGIES FOR 2030 WATER SECURITY

Increase Conservation

As is the case with energy, water *conservation* is initially the least expensive and most efficient path to increase available supply. Improving the efficiency of water transport and use in Hawai'i requires more attention to system loss, increased funding for water-saving technology, and moving towards a pricing structure that clearly encourages conservation behavior.

The Honolulu Board of Water Supply has taken an aggressive approach to reducing water loss from their system, successfully reducing leaks and transport loss from 15% to 12% over the past decade. However, losses for other systems statewide are for the most part untracked and unknown. While some leakage may in fact return to the aquifer depending on location, water loss also incurs economic costs via increased pumping (electricity costs) and infrastructure damage. On the other side of the meter, residential and commercial use of potable water can be cut dramatically by reducing landscape use, utilizing efficient fixtures and encouraging efficient behavior. These improvements not only reduce water use, but also result in significant economic savings to local households.

In the face of projected increased demand and supply uncertainty, the Fresh Water Council recommends improving the efficiency of our total daily fresh groundwater use rate by 8% by 2030, reducing the current 330 gallons per day/person use to 305 gallons per day/person over the next fifteen years.

To achieve this goal, the Council recommends that our state implement and advance the following policies by the end of 2018:

1. **Reduce Potable Water Use On Landscape Areas.** For existing residential and commercial properties, provide tax incentives/rebates to owners who choose to adopt rain barrel/roof catchment systems for landscape water use. For new development, encourage xeriscape or non-potable water use for irrigation. Encourage conservation behavior through conservation tier pricing for potable water used for landscape irrigation. An estimated 50% of current potable residential water use is for landscape watering. *(15 mgd by 2030)*

2. **Encourage Leak Detection Systems.** Require that all Department of Health-regulated potable water system operators annually report to the Commission on Water Resource Management regarding what leak detection system they have in place, and their plan to achieve national standard leakage rates by 2030. *(15 mgd by 2030)*

3. **Improve Agricultural Water Efficiency.**

A quarter of all pumped groundwater is used for agricultural irrigation.[29] To effectively allow agricultural water distributors to implement metering and other water-saving practices with farmers/consumers, the state legislature should codify that water for bona-fide agriculture/irrigation purposes need not be regulated by the Public Utilities Commission. Other efforts should include upgrading ditch systems to enclosed pipe, lining reservoirs, and cost-sharing such projects with private landowners, with a priority on those systems that convey pumped groundwater. *(10 mgd by 2030)*

Total conservation policy water savings by 2030: 40 mgd.

INITIATIVE PRINCIPLES

The following shared principles were adopted by the Council as they forged consensus to adopt the policy recommendations listed in this section.

- Water is a complex issue that demands a comprehensive set of solutions.
- Solutions will come from many different sectors, and a good solution in one geographic area may not be appropriate for another area.
- Solutions should focus on financial sustainability and cost effectiveness.
- Better information and access to accurate data facilitates good decision-making.
- Entering an era of climate unpredictability argues for more aggressive gathering and monitoring of water data than currently occurs.
- "Applied" and/or "targeted" education efforts are more effective than general outreach and awareness campaigns.
- Water is as important to our economy and culture as it is to our ecology.
- The current price of water in Hawai'i does not reflect its "true cost."
- Any successful supply solution must provide for Hawai'i's broad spectrum of water uses.
- Hawai'i is better-positioned than many other geopolitical bodies to meaningfully address long-term fresh water sustainability.
- Native Hawaiian cultural traditions place a high value on water and can provide guidance on how best to steward water.
- Public Trust doctrine and our state water code provide an adaptable framework.
- There is an urgency to the fresh water supply issue that is not widely evident to the public.
- Costs to address fresh water supply will rise with each year of delay.
- The nexus between water and energy is clear and compelling.

Increase Recharge

The Fresh Water Council believes that a critical element of protecting long-term water security in the Hawaiian Islands is to aggressively increase our ability to capture rainfall and surface storm water. Our underground fresh water supply can be restored with: 1) reduced pumping from the aquifers; 2) increased rainfall; and/or, 3) increased effective recharge. Conservation and reuse can help minimize upward pressure on pumping rates due to increasing population and plans for a revitalized local agricultural sector. However, future rainfall rates in critical watershed areas are uncertain due to climate change, and water loss via evapotranspiration may rise with the continued invasion of non-native plants. Therefore, directly increasing effective recharge rates is a critical factor in protecting our aquifers.

Initiative priorities include: 1) Direct recharge improvement through watershed protection and restoration over key aquifers; and 2) Facilitating new codes and policies that encourage pervious surfaces, storm water collection, and recharge in other land use areas. In the words of one observer, we need to move from the "drain" age into the "retain" age.[30] The Council believes that small investments made now — installing green infrastructure up front and protecting watershed capture areas through fencing, fire control, and removing invasive species — will incur much less financial hardship than trying to restore dysfunctional capture opportunities after the fact. Consistent, reliable public funding is the most difficult and important part of watershed protection and storm water capture.

In the face of projected increased demand and supply uncertainty, the Council recommends capturing an additional 30 mgd through enhanced watershed protection and runoff capture through improved built and natural infrastructure.

To achieve this goal, the Council recommends that our state implement and advance the following policies by the end of 2018:

1. **Authorize and Implement Storm Water Utilities.** Pass legislation at the state level to authorize individual counties to establish storm water utilities and supporting fees at the county level. Currently, there are more than 1,400 storm water utilities on the mainland serving as an important tool for local governments to reduce runoff pollution, recharge local aquifers, and mitigate flood damage. Counties with pressing runoff issues should immediately implement storm water utilities. *(10 mgd by 2030)*

2. **Enhance and Increase Large Recharge and Reservoir Areas.** Support policies and/or incentives that support retention basins, Low Impact Development best practices, constructed wetlands and reservoir sustainability, thereby increasing the amount of recharge and decreasing the amount of runoff at scale. Begin this process by approving and implementing the Waikīkī Risk Mitigation Project, an effort to hold and retain floodwater in the upper reaches of Mānoa and Pālolo Valleys preventing runoff and flooding in the Ala Wai[31] area. Support the preservation of state reservoirs by creating a pooled, state insurance program for reservoir risk based on the successful Hawai'i Property Insurance Association lava model; allowing hydro power as a permitted use on agriculture-zoned land; and, providing support for a de-silting effort statewide for existing reservoirs. *(5 mgd by 2030)*

3. **Strengthen Watershed Partnerships.** Increase the scale and quality of active forest stewardship via Hawai'i's watershed partnerships that increase recharge in aquifer systems. UHERO estimates that for every $2.54 invested in forest protection, 1,000 additional gallons of fresh water will be captured and available over the next 50 years. The Council recommends nearly doubling the amount of protected/actively stewarded watershed areas to 211,125 acres statewide by 2030 as a conservative estimate to meet recharge goals. *(15 mgd by 2030)*

Total recharge policy water savings by 2030: 30 mgd.

Increase Reuse

Currently, throughout our Islands approximately 120 million gallons of wastewater from treatment plants are discharged directly into the ocean each day.[32] Additional wastewater is disposed of on land via cesspools, septic tanks, and other means. To divert wastewater to other fresh water applications, Hawai'i needs to ensure that the right quality water is matched with the right and safe end use, and eliminate barriers to recapture and reuse. However, the total cost to treat and reuse recycled water can be twice that of the production cost of potable water. Reuse is also limited by distance and elevation. Finding the right locations for small-scale water filter plants that divert wastewater to irrigation use for parks, golf courses, and local agriculture would contribute to decentralizing our water infrastructure while also protecting our potable water supply. Currently, the County of Maui leads reuse efforts in the state, reclaiming 22% of their wastewater for secondary use.[33]

In the face of projected increased demand and supply uncertainty, the Council recommends more than doubling the current amount of wastewater being reused in the islands to 50 mgd, replacing demand for potable water to be used for irrigation and other purposes.[34]

To achieve this goal, the Council recommends that our state implement and advance the following policies by the end of 2018:

1. **Revise Water Reuse Guidelines.** To lower barriers to reuse in residential, industrial, and agricultural applications, revise the Hawai'i Department of Health Water Reuse Guidelines for the treatment and use of recycled water in a manner that makes it more user-friendly and expands the potential uses of reused water, but continues to ensure the health and safety of residents. *(15 mgd by 2030)*

2. **Revise Greywater Guidelines.** Promote the expanded use of greywater for landscape irrigation and groundwater recharge via updated state and county rules for new construction, while also allowing existing facilities and homeowners to retrofit current plumbing systems. Toward this end, counties should prioritize adoption of the 2012 Uniform Plumbing Code update. *(5 mgd by 2030)*

3. **Increase Water Reuse for Large Landscape Areas.** Encourage county government at the time of zoning approval to require the appropriate level of water quality for the type of use proposed. Counties should require developments with large landscaped areas (such as golf courses, parks, or schools), roadway landscaping, and industrial processes to install dual water lines and use reused water where imminently available. Where a current water treatment plant/distribution line is not within likely connection range to the development in the near future, the use of a scalping plant should be considered to increase treatment decentralization and water reuse. *(10 mgd by 2030)*

Total reuse policy water savings by 2030: 30 mgd.

IMPLEMENTATION

To be fully effective, the Council believes that the tactics recommended above require adequate funding, a higher level of collaboration, better data, and more transparency in Hawai'i's water sector. During the development of this Blueprint, the Council made a concerted effort to consult with a wide range of experts and specialists while also reviewing relevant research to determine which policies were likely to have the most positive, cost-effective impact on water supply. Unfortunately, the Council realized quickly that data collection and analysis in Hawai'i's fresh water arena has decreased markedly since the end of the plantation era. As a result, in certain cases the Council made assumptions that comport with common sense and the findings of small-scale or limited studies. For instance, based on historic observation and recent, limited scientific study, an assumption has been made that intact native forests have a markedly better capacity to capture rainwater than degraded invasive forests. But the degree to which this is true will have a marked impact on predicted outcomes. Increased resources to capture accurate data will help the state's efforts to increase water security become more targeted and cost-effective over time.

Similarly, the Council believes that the tactics recommended above must be tracked and measured over time to demonstrate progress and ultimate return on investment for both public and private dollars. In order to demonstrate progress, consistent metrics must be adopted across the sector, and disparate, fragmented data should be aggregated and leveraged where possible. The Council notes that the independent sector lacks water supply expertise, and that there are limitations on the role and missions of the excellent public entities engaging in fresh water work. The goals of this Blueprint will be more readily achieved if an entity dedicates itself to facilitating consistent metrics and tracking of measures over time, ensuring that data from multiple sources is harmonized in a centralized and secure location, and coordinating adoption of the recommendations over the next three years.

To successfully implement the Conservation, Recharge, and Reuse goals and policies above that will provide 100 mgd in additional water capacity by 2030, the Council recommends the following:

Measure Progress

1. **Consistent Metrics.** The Council recommends that USGS, CWRM, and county water departments develop and establish consistent methods, standards, and indicators to monitor the status and trends in fresh water availability statewide, including an agreed annual measure of aquifer health for key aquifer systems. These groups should simultaneously identify a *minimum level* of data collection required across the state to effectively make decisions regarding water resources, and then work collaboratively to coordinate and reduce gaps in surface-water and groundwater data collection networks.

2. **Dedicated Entity.** The Council recommends the establishment of a new (or alignment with a current) water-centered entity that can serve as a secure, shared water data clearinghouse while developing the capacity of such an entity to track Blueprint goal progress, issue material to educate decision-makers, and re-convene the Council one to two times per year to continue implementation of Blueprint recommendations. This entity should also eventually work to digitize all available historical water data collected by plantations and upload into open source water database.

3. **Track Progress.** Ensure that the Hawai'i State Sustainability "Dashboard" being developed under the Aloha+ Challenge to track statewide sustainability metrics includes measures of: 1) Key aquifer health indicators;

2) Annual statewide groundwater use per citizen; 3) Actively protected watershed area in the state; and, 4) Wastewater reuse rate.

New Resource Support

1. **Establish a Water Security Fund.** The Council recommends the establishment of a "Water Security Fund" (Fund) to be administered or contracted by the Department of Land and Natural Resources (DLNR) or the Department of Business, Economic Development, and Tourism. The Fund should be seeded with a minimum general fund appropriation of $5 million and matched by a minimum $1million in non-state funds. Based on other successful models such as the Legacy Land Fund administered by DLNR that leverages federal, county and private funds and the Energy Excelerator investment fund that combines state, federal and private funds, the Fund should make grants and payments based on the recommendation of an independent advisory group. The advisory group should include individuals with water-related knowledge including: one member from an entity whose membership includes all four county water departments; one member with knowledge of agricultural water storage and delivery systems; one member of a private landowning entity that actively partners with a watershed partnership; one member with knowledge of Hawaiian culture; and one member of a conservation organization. Public, nonprofit and private entities may submit to the Fund grant proposals that contain a minimum 1-1 cash match and increase water security in the state via programs or projects that: advance a new/additional water reuse project; establish or increase new areas for water recharge; improve agricultural water system efficiency; reduce potable water use for landscape irrigation; establish a new water audit/leak loss project or program for a potable water distribution system; or improve innovation or technology in the above fields. Projects should track and report the amount of fresh water conserved, recharged or reused as the result of the project. The Council recommends a total target of 10 mgd collectively netted through all projects (roughly equally distributed between conservation, recharge and reuse) by the end

ACKNOWLEDGMENT OF EXPERTISE

The following organizations engaged with and assisted the Council with critical information during the creation of this Blueprint. The Council acknowledges their expertise and deeply appreciates their contribution.

- Accord 3.0
- Brown and Caldwell
- C-Dots
- Collaborative Leaders Network
- Hawai'i State Commission on Water Resource Management
- Hawai'i Leadership Forum
- Honolulu Board of Water Supply
- Research Corporation of the University of Hawai'i
- Roth Ecological Design
- SMS Hawai'i
- University of California at Berkeley, Center for Law, Energy & the Environment
- University of Hawai'i, Economic Research Organization
- University of Hawai'i, Richardson School of Law
- University of Hawai'i, School of Ocean and Earth Science and Technology
- University of Hawai'i, Water Resources Research Center
- University of North Carolina, Environmental Finance Center
- US Army Corps of Engineers
- US Geological Survey
- Ward Research
- Where Talk Works

of a two year pilot period, representing 10% of the overall goal of 100 mgd in improved water security by 2030. If pilot projects demonstrate success and ability to scale up, the Council recommends the establishment of a dedicated, reliable, permanent funding source for the Water Security Fund to continue annual grantmaking and investment at an increased level through 2030. The Council believes that the Water Security Fund should be additive and designed to spur innovation in the water sector. It is not meant to replace consistent long-term core funding for water reuse, efficiency and watershed management work.

2. **Encourage County Water Department Support for Watershed Protection.** The Council recommends the establishment of a benchmark amount of funds (measured in terms of millions of dollars per mgd of water delivered) provided annually by Hawai'i water utilities to support watershed restoration activity on their islands. Currently, Maui County leads in this arena by providing approximately $1.5 million per year and delivering an average of 35 mgd for a ratio of 4%. The Council recommends a 5% target for each utility to dedicate toward annual watershed stewardship in their jurisdictions. Example: the Honolulu Board of Water Supply pumps approximately 159 mgd therefore a 5% dedication would equal $7.95 million in annual watershed support. Polling conducted during the Council's research phase indicated customers' willingness to pay up to an additional $5 per month statewide to help protect watershed areas.

3. **Allocate Funds to Pilot Decentralized Water Reuse.** Encourage an appropriation from the state legislature to: 1) perform a comprehensive statewide study and mapping of potential large-scale end users of secondary-treated wastewater; and 2) each county pilot the installation of one regional reclamation plant[35] (medium volume wastewater on-site treatment) at an appropriate golf course, public park, or agricultural field system.

Additional Actions

1. **Education.** Develop and implement a joint campaign to insure consumer awareness of the origins and importance of fresh water, as well as the need to conserve it as a resource.

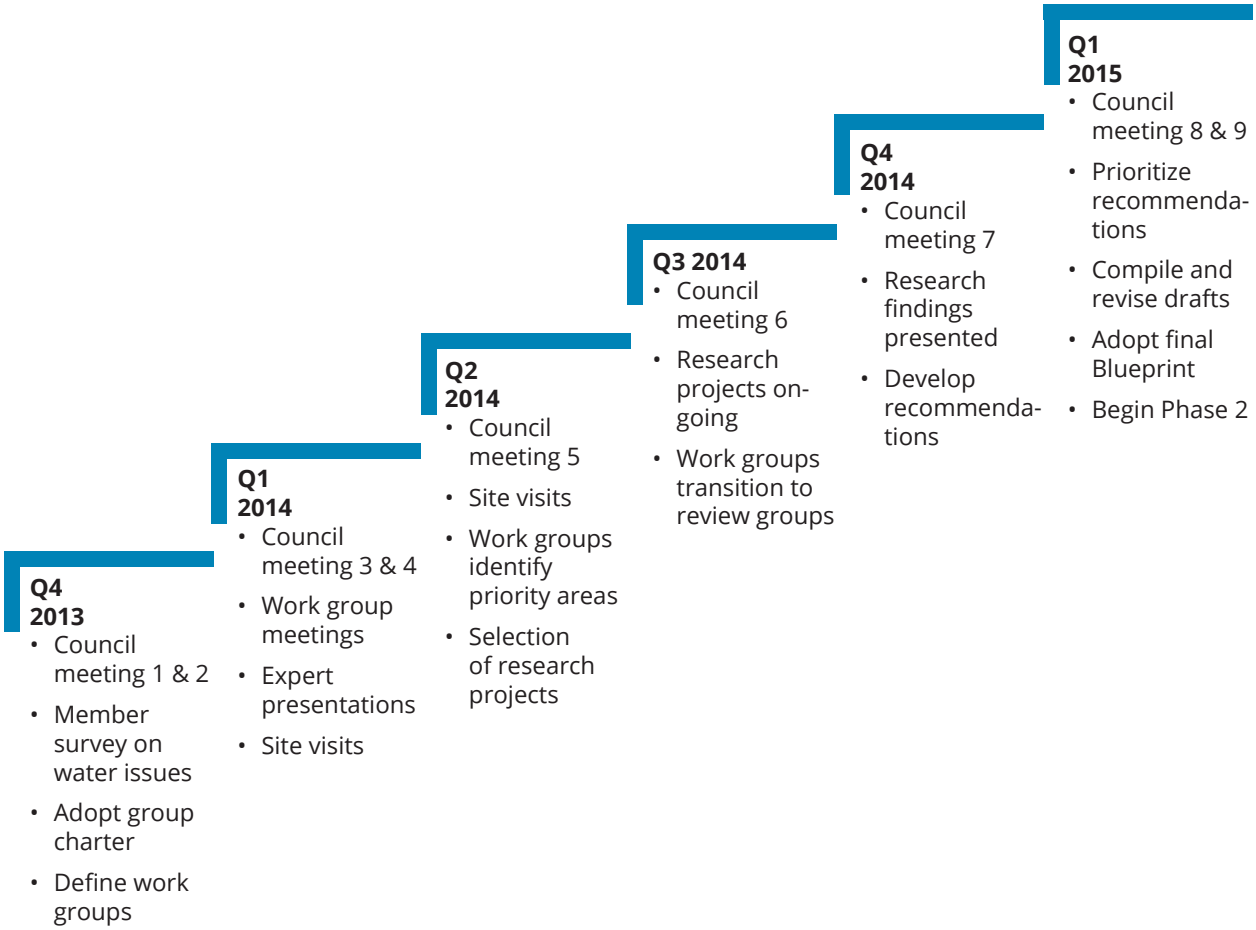
2. **Code Expansion.** Increase new construction water efficiency codes by adopting elements of the Green Plumbing Code for statewide implementation by the Hawai'i State Building Code Council and by each County as a standard to be implemented alongside the 2012 Uniform Plumbing Code.

3. **Consistent Watershed Protection/ Maintenance Funds at State Level.** While the Water Security Fund pilot above may support new techniques or tactics in recharge areas, the Council believes that dedicated, long-term, core funding for expanding protected areas and providing for watershed maintenance in areas already under some level of protection is critical for true water security in the state.

The recommendations above represent the Council's priority actions over the next three years (2016-2018) to reorient Hawai'i toward a more secure fresh water future, and provide an estimated 100 mgd in additional fresh water capacity by 2030. As the Hawai'i Fresh Water Initiative progresses, new data and methods will no doubt come to light that will better inform Hawai'i's efforts. The Council also developed a short summary of "Planning Principles" (included in the Appendix) that should be kept in mind by Hawai'i water decision-makers as future water projects and policies are debated and adopted. Only by consistently addressing fundamental underlying structural challenges and gradually moving toward a water system that is designed for resilience, water capture, and charging the full value of our fresh water will our state truly achieve fresh water security.

APPENDICES

A - Fresh Water Council's Work Process



B - Water Planning Principles

As Hawai'i confronts an aging water infrastructure and reduced rainfall, three significant barriers have emerged that threaten our ability to develop a modern, resilient water supply system for the 21st century. First, questions have been raised about the sustainability and viability of maintaining large, centralized systems that were designed to extract, treat, and dispose water covering large geographic areas. Distributed systems that diversify capture, encourage reuse, and reduce transmission can protect both fresh water supplies and bottom lines as energy costs rise. Second, our natural ability to capture and store fresh water has been degraded to the point where far too much of the rain that falls on our islands winds up as runoff in the ocean. The destruction of mauka native forests and poor practices in makai urban and agricultural landscapes need to be addressed and reversed. Third, utilities and others have tremendous concerns about the financial model supporting our water infrastructure—and by extension, what defines the "full value" of water. However, for each of these "barriers" to water security, there is a positive long-term planning principle that should guide Hawai'i's future decision-making in a new direction.

System Resilience. As Hawai'i slowly replaces and rebuilds water infrastructure, decentralizing and relocating water system assets has the potential to save long-term costs and reduce risks of large system failure. For instance, relocating wastewater treatment facilities that are currently on the coast to higher elevation inland locations provide several benefits. First, removing facilities from the coast and rising sea levels and storm surge reduces exposure and damage during coastal hazard events. Second, scaling down and relocating wastewater treatment plants to multiple inland locations increases opportunities for system redundancy, flexibility, and recycling wastewater. Third, increasing system modularity by building multiple smaller plants has the potential to save critical funds that otherwise would be incurred for electricity costs pumping water over long distances and against gravity. A market move toward system resilience is already occurring naturally in the electric utility arena, and should be embraced with water infrastructure as well.

Capture. Our most valuable water infrastructure lies underground: a network of vast, natural aquifers that retain our precious fresh water. These aquifers are nourished by Hawai'i's forested watersheds and open spaces where seasonal rains fall and replenish the soil. Unfortunately, over time Hawai'i has increasingly lost its ability to capture and hold this rain — even as we have received less rainfall in recent decades. In order to capture those drops that do land on our islands, and protect our water supply in the 21st century, Hawai'i should immediately increase our investment in our natural capital. Forests must be managed for maximum fog and rain capture, agricultural lands need to be configured to prevent and/or capture runoff, and urban areas should be slowly retooled to maximize permeability. An aggressive move to restore our islands' absorptive capacity on a large scale will increase aquifer recharge, protect our beaches and reefs from runoff, avoid economic damage from flooding, and reduce pollutants in our near shore waters.

Full Value Pricing. The third major issue that must be addressed over time to ensure water security in Hawai'i is fresh water pricing. Hawai'i citizens (and Americans at large) have not paid and have been largely unaware of the true cost of capturing, treating, and delivering clean, safe water to their taps. In fact, we pay less for water across the United States than do residents of most other developed nations. Water is typically the lowest percentage utility cost per household (although combined billing with sewer fees has complicated the perception of this reality for many in Hawai'i). The historic under-pricing of water both for domestic and agricultural use is largely due to a long-held view that water is "free," readily and easily supplied by the earth. Water departments recognize that efforts to protect our forests and maintain the vast infrastructure required to extract, treat, and deliver water — as well as the energy embedded in all of the above — is far from free. A historic lack of investment in infrastructure, coupled with challenges to water departments' ability to hold funds and reinvest in their physical plant, have left both our natural and built infrastructure in serious disrepair. Moving toward full value pricing will not only help water utilities continue to provide customers with safe and clean water but will have the added benefit of encouraging more conservative use, ensuring a sustainable supply for future generations.

These barriers identified in Hawai'i are echoed by findings from the U.S. Environmental Protection Agency that evaluated water problems across the fifty states. Recently, the agency proposed a "four pillars" approach to renewing water systems that closely parallel our own findings: 1) an integrated structure of better management; 2) full value pricing; 3) more efficient use of water; and, 4) watershed management approaches. When making future water infrastructure and program decisions in Hawai'i, the Council recommends alignment with national programs where possible to increase the chance of leveraging federal funding for local projects.

ENDNOTES AND ILLUSTRATIONS

1 The Hawai'i Commission on Water Resources Management (CWRM) reported pump totals of all aquifers in the state at 448.791 mgd in 2013. CWRM provided this information at the request of the Hawai'i Community Foundation. The population of Hawai'i according to the 2010 Census was 1,360,301. The current annual amount of pumped, underground, fresh water resources per individual is therefore 330 gallons per day. Hawai'i Department of Business, Economic Development and Tourism (DBEDT) projects the population of Hawai'i in 2030 to be 1,602,300. DBEDT, *Population and Economic Projections for the State of Hawaii to 2040*. http://files.hawaii.gov/dbedt/economic/data_reports/2040-long-range-forecast/2040-long-range-forecast.pdf. With this expected population growth and a straight line demand expectation, the total amount expected to be pumped to serve future demand in 2030 would equal 529 mgd.

2 SMS Consulting. *Fresh Water White Paper*. Report commissioned by Hawai'i Community Foundation, September, 2014. Per Hawai'i State Department of Land and Natural Resources, currently 13.3% of Priority I and II watershed areas are in active protection across the state (111,935 acres of a total 840,000 watershed acres). The Initiative's metric goal is to approximately double the amount of Priority I and II watershed in active protection to 211,135 acres (approximately 25% of the total area). The 211,135 number is consistent with previously articulated Department of Land and Natural Resource goals developed initially for their "Rain Follows the Forest" campaign.

3 SMS Consulting. *Fresh Water White Paper*. Report commissioned by Hawai'i Community Foundation, September, 2014. Per Hawai'i State Department of Health, in 2012 Hawai'i treated approximately 141 mgd of wastewater and disposed of 120 mgd over wastewater directly into the ocean. Twenty-one mgd was, therefore, reused on land in various industrial and agricultural applications. The Initiative's goal is to more than double the current amount reused on terrestrial reclaimed applications to 50 mgd by 2030.

4 Populations on the continental United States also suffer from inadequate drinking water supply, as the California drought has highlighted for rural farming communities. Tara Lohan, Ed. *Water Consciousness*, (AlterNet Books, 2008), 12.

5 While some areas may see increased rainfall in specific geographies, the general trend is one of less consistent rainfall. Victoria W. Keener et al., eds., "Climate Change and Pacific Islands: Indicators and Impacts. Report for The 2012 Pacific Islands Regional Climate Assessment." (Washington, DC: Island Press, 2012), xi. http://www.cakex.org/sites/default/files/documents/NCA-PIRCA-FINAL-int-print-1.13-web.form_.pdf. For a broader discussion of trends in Hawai'i's water supply as well as multiple citations illustrating this point and others below see Hawai'i Department of Land and Natural Resources, "The Rain Follows the Forest: A Plan to Replenish Hawai'i's Source of Water." (November 2011). http://dlnr.hawaii.gov/rain/files/2014/02/The-Rain-Follows-the-Forest.pdf.

6 The Hawai'i State Legislature has long recognized the reality and threat of climate change for our Island state, and formally stated these findings in several Acts, including Hawai'i State Legislature Act 83, 2014. http://www.capitol.hawaii.gov/session2014/bills/HB1714_CD1_.PDF

7 Hawai'i State Legislature Act 83, 2014. http://www.capitol.hawaii.gov/session2014/bills/HB1714_CD1_.PDF

8 Thomas W. Giambelluca et al., "2013: Online Rainfall Atlas of Hawai'i." *Bull. Amer. Meteor. Soc.* 94, 313-316, doi: 10.1175/BAMS-D-11-00228.1. http://rainfall.geography.hawaii.edu/rainfall.html

9 Thomas W. Giambelluca et al., "Evapotranspiration of Hawai'i." Final report submitted to the U.S. Army Corps of Engineers—Honolulu District, and the Commission on Water Resource Management, State of Hawai'i, 2014. http://evapotranspiration.geography.hawaii.edu/

10 Reduced funding for stream flow gauges have limited the amount of information available, but the data available show overall decline in stream flow. USGS. See: http://hi.water.usgs.gov/studies/GWRP/baseflow.html

11 Many of Hawai'i's aquifers on the windward sides of the islands where populations are small and rainfall highest have relatively small amounts of their sustainable yield currently being pumped. For a complete map of aquifers and 2012 percentage sustainable yield in watershed areas across the state, refer to Endnote 23.

12 A recent discovery of unexpected and previously unknown water stores on Hawai'i Island highlighted the relatively small amount of overall information we have. "Large fresh water supply discovered by UH researchers on Hawai'i Island," *University of Hawai'i*. http://www.hawaii.edu/news/2015/01/23/large-fresh-water-supply-discovered-by-uh-researchers-on-hawaii-island/

13 Some models predict increased overall levels of precipitation in the already "wet" parts of the Hawaiian Islands, conflicting with other models that indicate less overall rainfall in these areas. However, the majority of precipitation models forecast more extreme weather, meaning even if overall rainfall amounts may rise in certain areas they are likely to come in large events and may not have a correlating positive impact on recharge. Oliver Elison Timm, Thomas W. Giambelluca, and Henry F. Diaz. "Statistical downscaling of rainfall changes in Hawai'i based on the CMIP5 global model projections." *J. Geophys. Res. Atmos*. 120, (2015): 92–112, doi:10.1002/2014JD022059. http://onlinelibrary.wiley.com/doi/10.1002/2014JD022059/abstract

14 The Honolulu Board of Water Supply has been particularly active regarding water conservation. Hao, Sean. "Oahu drinking-water use down 7% since 2001." Honolulu Advertiser, August 9, 2009. http://the.honoluluadvertiser.com/article/2009/Aug/09/ln/hawaii908090367.html

15 Agricultural water system upgrades, such as the improvement of the Punalu'u diversion by Kamehameha Schools, have the potential to reduce leakage and maintenance. "Punaluu Stream Kamehameha Schools Irrigation System Improvements Project 2009," *City and County of Honolulu Board of Water Supply*. http://www.boardofwatersupply.com/cssweb/display.cfm?sid=2141

16 The US Environmental Protection Agency's (EPA) Region 9 featured Maui County's water reuse program and noted that it resulted in saving approximately 400 million gallons annually. "Water & Energy Efficiency in Water and Wastewater Facilities," *EPA*. http://www.epa.gov/region9/waterinfrastructure/water-conserv.html

17 The Hawai‘i Preparatory Academy targeted LEED Platinum and Living Building Challenge certification. The building catches its own water and has a net zero water footprint. “Hawaii Preparatory Academy Energy Lab,” *International Living Future Institute.* http://living-future.org/case-study/hpaenergylab

18 Broadly supported efforts and plans to increase food security in Hawai‘i will require increased irrigation supply. State Department of Agriculture, *Agricultural Water Use and Development Plan*, December 2004, 20. http://dlnr.hawaii.gov/rain/files/2014/02/The-Rain-Follows-the-Forest.pdf

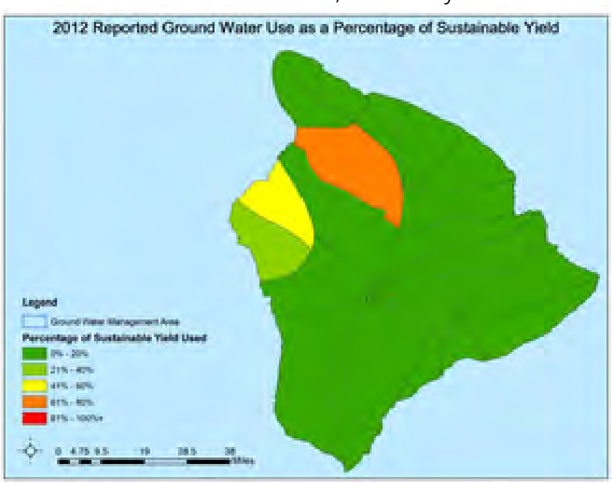
19 US Environmental Protection Agency, *Drinking Water Infrastructure Needs Survey and Assessment: Fifth Report to Congress*, April 2013, i. http://water.epa.gov/grants_funding/dwsrf/upload/epa816r13006.pdf

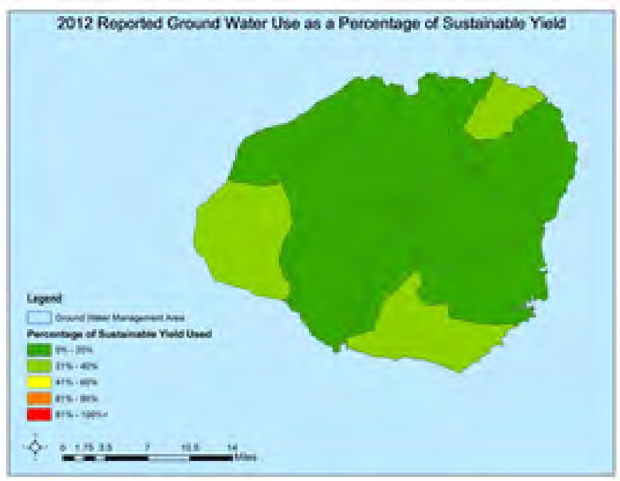
20 Basharat Pitafi and James Rousmasset. “Watershed Conservation and Efficient Groundwater Pricing.” Prepared for the Agricultural and Applied Economics Association Annual meeting, Denver, CO, 2004. See also: Brooks Kaiser et al., *The Economic Value of Watershed Conservation*, http://www.uhero.hawaii.edu/assets/EconValueWatershed.pdf

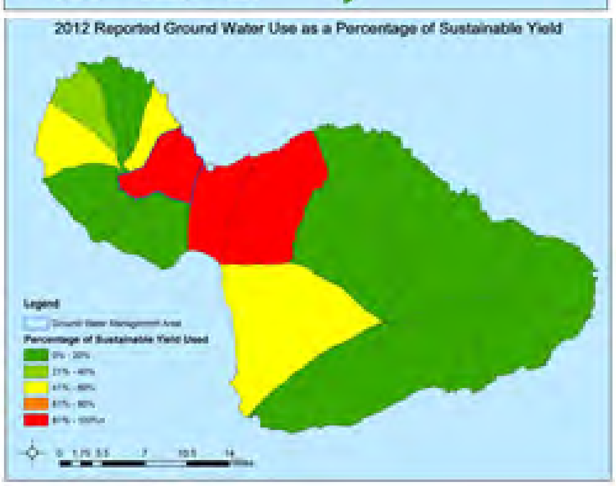
21 “No net loss” is a balancing approach that allows declines to occur to a natural resource as long as they are offset by gains elsewhere. This type of approach is often used in the federal context for wetland preservation. “No Net Less Wetlands Policy.” *Wikipedia.* http://en.wikipedia.org/wiki/No_net_loss_wetlands_policy

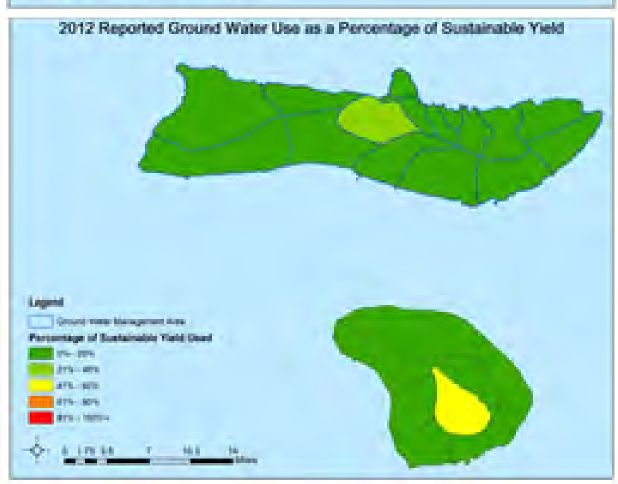
22 As noted above in note 1, the most recent data from CWRM in 2013 indicate overall state groundwater pumping to be 448.791 mgd. This is the baseline annual amount the Council selected to use (note: this amount does include limited amounts of brackish groundwater that is included in well pumping information reported to CWRM). The population of Hawai‘i according to the 2010 Census was recorded at 1,360,301. The Council chose to use a conservative straight-line demand increase figure. However, each island has its own demand projection. On O‘ahu, freshwater demand is expected to increase by 26% according to the City & County of Honolulu—a much higher projection of demand growth that would require greater fresh water availability than the 100 mgd goal for new availability identified under the Council’s relatively conservative figure. John A. Engott et al., “Spatially distributed groundwater recharge for 2010 land cover estimated using a water-budget model for the Island of O‘ahu, Hawai‘i.” *U.S. Geological Survey Scientific Investigations Report*, 2015–5010, 2015, 49. doi:10.3133/sir20155010. http://pubs.usgs.gov/sir/2015/5010/.

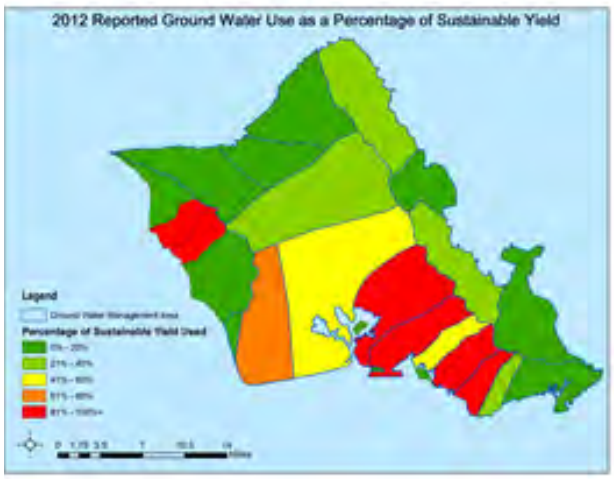
23 Recognizing that monetary investments for watershed protection will yield more groundwater recharge benefit in certain geographic areas versus others, the Council deferred this prioritization judgment to those made by DLNR—both within the land division and at CWRM whose maps, below, indicate which aquifers are currently the most stressed. There are also more specific, non-public maps that show direct recharge areas for major potable wells that may further inform the prioritization of restoration areas. However, for security reasons these maps and areas were not requested for this document.











24 SMS Consulting. *Fresh Water White Paper*. Report commissioned by Hawai'i Community Foundation, September, 2014. Currently 13.3% of Priority I and II watershed areas are in active protection across the state (111,935 acres of a total 840,000 watershed acres). As stated above, the Council goal is to approximately double the areas in active protection, consistent with the stated DLNR goal, to 211,135 acres of Priority I and II areas. USGS estimates that approximately 36% of precipitation (rainfall and fog interception) results in actual recharge on O'ahu, equaling 661 million gallons per day. See: John A. Engott et al., "Spatially distributed groundwater recharge for 2010 land cover estimated using a water-budget model for the Island of O'ahu, Hawai'i." *U.S. Geological Survey Scientific Investigations Report*, 2015–5010, 2015, 49. doi:10.3133/sir20155010. http://pubs.usgs.gov/sir/2015/5010/

25 SMS Consulting. *Fresh Water White Paper*. Report commissioned by Hawai'i Community Foundation, September, 2014. According to the Hawai'i Department of Health, in 2012 Hawai'i treated approximately 141 mgd of wastewater and discharged 120 mgd directly into the ocean.

26 During times of drought, recharge rates are on average 37% less than during normal climate conditions on O'ahu. USGS Report: Spatially Distributed Groundwater Recharge for 2010 Land Cover Estimated Using a Water-Budget Model for the Island of O'ahu. John A. Engott et al., "Spatially distributed groundwater recharge for 2010 land cover estimated using a water-budget model for the Island of O'ahu, Hawai'i." *U.S. Geological Survey Scientific Investigations Report*, 2015–5010, 2015, 49. doi:10.3133/sir20155010. http://pubs.usgs.gov/sir/2015/5010/. For Maui see: Adam Johnson, John Engott, and Maoya Bassioun. "Spatially distributed groundwater recharge estimated using a water-budget model for the Island of Maui, Hawai'i, 1978–2007." *U.S. Geological Survey Scientific Investigations Report,* 2014–5168, 2014, 53. http://pubs.usgs.gov/sir/2014/5168/

27 Email from Lenore Oyhe, Chief, Planning Branch, Hawai'i Commission on Water Resource Management, March 9, 2015.

28 Council members considered the following trends and statistics to arrive at a 5% supply uncertainty figure: 1) Likely increase in incidences of drought; 2) 13% potential drop in overall precipitation if current trend line holds; 3) On-going conversion of agricultural and other open land to urban use and correlating increase in hardened surfaces over the next 15 years; and, 4) increased evapotranspiration rates due to climate change. Thomas W. Giambelluca et al., "Evapotranspiration of Hawai'i." Final report submitted to the U.S. Army Corps of Engineers—Honolulu District, and the Commission on Water Resource Management, State of Hawai'i, 2014. http://evapotranspiration.geography.hawaii.edu/

29 Molly Maupin et al., "Estimated use of water in the United States in 2010." *U.S. Geological Survey Circular*, 2014, 1405, 56. http://dx.doi.org/10.3133/cir1405.

30 Tara Lohan, Ed. *Water Consciousness*, (AlterNet Books 2008), 105.

31 U.S. Army Corps of Engineers. "Ala Wai Canal Project: Flood Risk Management Project." Focus Group Meeting Presentation, March, 2014. http://alawaicanalproject.com/meetings/AlaWai_FocusGroup_presentation_27March2014_PROPOSED.pdf. The Ala Wai Canal Project is a proposed public/private partnership between the US Army Corps of Engineers, the State of Hawai'i, the City and County of Honolulu, and private entities in the Waikīkī flood area.

32 SMS Consulting. *Fresh Water White Paper*. Report commissioned by Hawai'i Community Foundation, September, 2014. According to the Hawai'i Department of Health, in 2012 Hawai'i treated approximately 141 mgd of wastewater and discharged 120 mgd directly into the ocean.

33 As noted above, the EPA Region 9 featured Maui County's water reuse program. "Water & Energy Efficiency in Water and Wastewater Facilities," *EPA*. http://www.epa.gov/region9/waterinfrastructure/water-conserv.html

34 The Department of Health had a goal of 30 mgd wastewater being reclaimed by 2015. Hawai'i Department of Health. "Water Quality Planning and the Department of Health." Slide 22, http://files.hawaii.gov/dlnr/cwrm/submittal/2013/sb201310D2.pdf. This goal has not been met. Currently, the state reclaims approximately 20mgd. *Environment Hawai'i*, Vol 24, No. 5, Nov 2013, 2.

35 An example of a small scale scalping plant for local wastewater reuse. Such a unit has been proposed for the Ala Wai Golf Course, where treated wastewater could replace potable water currently utilized for large-scale irrigation. For a summary of scalping plant technology, see Kristin Byrne, "Decentralized Scalping Plants," an unpublished paper. http://www.cwea.org/e-bulletin/images/ByrnePaper.pdf

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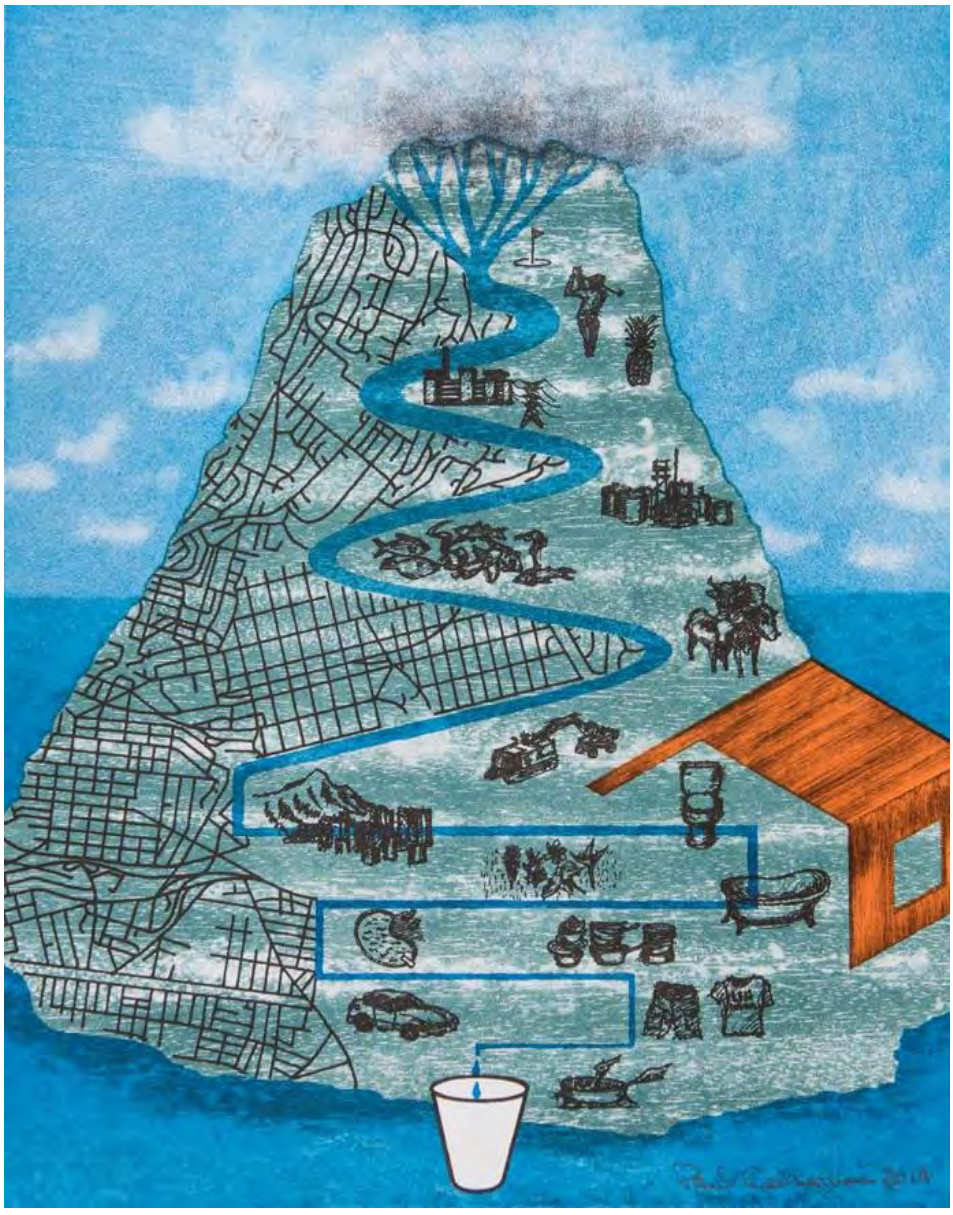

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