Water

Solutions for sustainable water use practices and water conservation

Floating Islands

Modular plant platforms made from 100 percent recycled and recyclable materials clean the water in rivers, lakes, ponds and canals.

A BioMatrix floating island in Killingworth Lake, U.K.

The Impact

Artificial floating islands (also referred to as floating ecosystems or floating treatment wetlands) are artificial plant platforms that clean water at the ecosystem level, removing as much as 98 percent of excess nutrients and harmful toxins by harnessing natural biological processes that keep water abundant and healthy. They have applications in habitat creation, urban waterscaping, water quality management, and wastewater treatment. Recently, they were adopted by the U.S. Environmental Protection Agency to reduce the negative effects of harmful algal blooms across the nation. They are made from 100 percent recycled and recyclable materials.

Where It's Been Implemented

Floating islands have been successfully implemented worldwide by various local governments, businesses, individuals, communities and environmental and conservation groups. According to Floating Island International, a company that specializes in this technology, more than 10,000 island systems have been launched worldwide. And in 2020, a series of floating island projects along the Rochdale canal in Manchester, England, constructed by BioMatrix Water in collaboration with the Canal and River Trust, won a Green Flag award, an international accreditation for well-managed and accessible green spaces.

Other projects involving floating islands/ecosystems include:

MentraPark, Billings, Mont. A BioHaven Floating Island installed in the City of Billings' MentraPark stormwater pond has effectively removed metals, nutrients and other contaminants, with removal

percentages from 63 to 98 percent. The floating island's effectiveness substantially improved after its vegetation had matured for two growing seasons.

Faisalabad, Pakistan. Researchers installed full-scale floating treatment wetlands (FTWs) in stabilization ponds receiving sewage and industrial wastewater and evaluated their treatment performance over three years. The FTWs substantially improved all recorded water quality indicators and reduced heavy metal concentrations. The maximum removal capacities of the system were 79 percent of chemical oxygen demand, 88 percent of biochemical oxygen demand and 65 percent of total dissolved solids. During the second and third years of operation, about 60 million cubic meters per year of wastewater was treated at a cost of $0.00026 per cubic meter.

Bridgewater Basin, Manchester, England. Bridgewater Basin is a disused branch of the Rochdale Canal in the heart of central Manchester. It was devoid of healthy aquatic life and completely surrounded by vertical hard stone and concrete edging. The frequent fluctuations of water levels and the concrete edges limited the basin's water quality, aesthetics and natural waterscape appeal. To address these issues, BioMatrix Water worked with the Manchester City Council's green infrastructure team and BDP Landscape Architects to install a series of floating waterscape gardens over two years that greatly increased the quality and functionality of the basin and provided a place for native plant species to re-establish themselves.

Oakland, Calif. Evidence of rising sea levels in San Francisco Bay has raised concerns over habitat loss for endangered species such as the California Clapper Rail, whose habitats are extremely vulnerable to rapid variations in water levels. FTWs were identified as a way to provide critical habitats for these birds, as they provide upland roost habitat during fluctuating tides and sea levels. Ten FTWs deployed in September 2010 were found to be extremely effective. The U.S. Geological Survey team reported that Clapper Rails at Arrowhead Marsh quickly adapted to the presence of FTWs, with all 10 islands receiving moderate-to-heavy use from a Clapper Rail population of 30 to 40 birds.

Description

Most water bodies are currently facing excessive nutrient loads due to both man-made and natural runoff from the land. This excessive richness of nutrients in water is known as eutrophication, which leads to algal blooms (i.e., cyanobacteria) and low-oxygen (hypoxic) waters that can reduce water clarity and quality, taint drinking water supplies, degrade recreational opportunities, and create dead zones where no organisms are able to survive. Floating islands were developed as a cost-effective solution to eutrophication.

Rather than using chemical additives to remove potential toxins from the water, floating islands clean water by mimicking natural biological processes. Above the surface, the plants on the islands offer vital habitats for birds and pollinators and improve air quality. Below the water, there exists a micro-wilderness of submerged roots where fish can thrive and communities of microorganisms break down harmful substances, effectively filtering pollution from the water like an artificial wetland does. Not only do floating islands help the ecosystem by engaging in both plant-based and microbe-based nutrient uptake, but they also nourish the ecosystem by producing food for fish and aquatic insects.

These islands have a variety of applications and benefits, including but not limited to water quality management, wastewater treatment, water restoration, fish/bird habitat creation, stormwater management, urban waterscaping, and shoreline protection. The applications and impacts of floating island technology have expanded in recent years as new forms of the technology, such as floating solar panels and floating farms, have been developed. The main benefits of floating islands include improving water quality, increasing plant biodiversity, increasing public amenities and recreational opportunities,

providing a sheltered refuge for birds, improving fish stocks and promoting sustainability through the production of clean, renewable energy with floating solar panels.

Floating islands are also extremely versatile. The technology is immune to fluctuating water levels since the islands rise and fall with water level, allowing them to be applied to almost any water body. Additionally, floating islands are available in a variety of shapes, sizes and structures and can be planted with a myriad of plants, allowing for endless combinations and possibilities. Most companies that produce them offer a range of products, from mini islands for small ponds to large-scale floating islands built to suit whatever the need, as well as specialized products to treat wastewater or stormwater runoff. Moreover, the islands are made from 100 percent recycled and recyclable material and incorporate the elements of biomimicry into every design.

Key Drivers

Eutrophication is a growing issue in many water bodies throughout the world. Overgrowth of algae such as blue-green algae (i.e., cyanobacteria) and golden algae (prymnesium parvum) due to eutrophication results in the release of various toxins that deplete oxygen levels in the water, resulting in the deaths of fish and other oxygen-dependent organisms. It also creates a pungent odor that can disturb the surrounding landscape and community. Floating islands are a proven, cost-effective solution to combating eutrophication in water bodies.

Key Factors for Success

While floating islands can be installed by almost anyone, local governments and environmental/conservation groups most commonly contract with a floating island company to undertake a project. The key to successfully implementing a floating island project is convincing local policymakers, city councils and residents of the safety and efficacy of floating islands.

Key Obstacles

Maintenance could be considered an obstacle to implementation. However, the amount of maintenance required varies depending on the size and objective of the project. For relatively small and simple projects, very little maintenance is required. It typically involves weeding plants and checking the anchor connectors, cables and ropes and replacing them every once in a while. Another obstacle is the lack of widespread awareness and understanding of floating islands. For example, local officials may have concerns that the islands will create plastic waste even though the plastics used in the islands have protective coating and don't break down into microplastics. Without support and approval from local authorities and residents, floating islands cannot be implemented.

Timeline to Implementation

Depending on the size of the floating island project and the public sentiment surrounding biological remediation, floating island projects could take anywhere from two weeks, to three months, to several years to implement. Most projects can be successfully implemented within a year.

Return on Investment

Each floating island project is unique. Detailed financial calculations are necessary in the planning process. For reference, an average-sized project in Green Lake in Seattle, Wash., cost approximately $35 per square foot, including the floating island sections, underwater media columns, shipping, plants and anchoring system, according to Friends of Green Lake. Total costs vary with the size and scale of the project, but are typically around $40,000 to $50,000. A detailed project plan and preliminary design are required in order to develop accurate and precise costs and feasibility studies.

References and Resources

Companies

Floating Islands West Contact: Laddie Flock, laddie@floatingislandswest.com

BioMatrix Water

Floating Island International

Case Studies

Mentra Park, Billings, Montana Case Study

Faisalabad, Pakistan Study

Bridgewater Basin, Manchester Case Study. Contact: Dave Barlow, Manchester City Council, d.barlow@manchester.gov.uk

Oakland, Calif. Case Study

Articles

U.S. Environmental Protection Agency, 7 Dec. 2018, "EPA Uses Floating Vegetated Islands to Remove Excess Nutrients from Water"

CNN, 8 Sept. 2021, "How Floating Islands Can Make Urban Waterways Green and Clean"

National Oceanic and Atmospheric Administration, 26 Feb. 2021, "What is Eutrophication?"

Friends of Green Lake, 22 Sept. 2019, "Floating Wetlands Project"

Flood Insurance Community Rating System

Participating communities can strengthen flood risk management efforts, improve safety and reduce costs for residents and businesses.

Photo by OneShoreline

The Impact

Participating in the National Flood Insurance Program's Community Rating System (CRS) saves community members money on flood insurance premiums, reduces damage to private property and public infrastructure, and enhances public safety, resulting in a more flood-resilient community.

Description

Home and business owners in flood-prone areas are often required to purchase flood insurance which can be very costly. CRS is a voluntary incentive program of the National Flood Insurance Program (NFIP) in which communities strengthen floodplain management efforts beyond minimum NFIP requirements to earn discounts on flood insurance premiums. CRS assigns rankings based on how many additional measures a city is taking to protect against flood risk. Rankings range from 10 to 1 where each improvement in rank corresponds to an additional 5 percent discount. The maximum discount of 45 percent is attained at rank 1.

To participate in the CRS, a community must inform the Federal Emergency Management Agency (FEMA) regional office of its interest and submit an application with documentation verifying flood mitigation efforts. This application is submitted to the Insurance Services Office (ISO)/CRS Specialist, which works on behalf of FEMA to review applications, verify a community's efforts and standing, and perform program improvement tasks. Upon approval, communities hire a CRS Coordinator and adopt and enforce a floodplain management ordinance to regulate development in flood-prone areas.

Flood-risk mitigation efforts that a community can undertake to improve its standing include flood emergency preparedness planning, open space preservation within designated flood plains, maintenance of elevation certificates and benchmarks, and community education efforts on flood risk and flood insurance. Every year, a community may report additional floodplain management efforts and renew its participation in the CRS program by submitting a recertification application.

Where It's Been Implemented

More than 1,500 communities across the country participate in the National Flood Insurance Program including Atherton, Belmont, Brisbane, Burlingame, Colma, Daly City, East Palo Alto, Foster City, Half Moon Bay, Hillsborough, Menlo Park, Millbrae, Pacifica, Portola Valley, Redwood City, San Bruno, San Carlos, South San Francisco, and Woodside within San Mateo County. As of 2021, 89 communities in California participate in CRS, benefiting more than 167,000 policyholders statewide and saving local residents and businesses at least $14.5 million annually.

In 2015 the City of Palo Alto's public information efforts on flood hazards, flood protection insurance, drainage system maintenance and dumping regulations placed the city at a rank of 7 on the CRS scale. The city's 15 percent CRS discount from these efforts saved local community members approximately $670,000.

In 2019 Norfolk, Virginia's ongoing flood resilience and risk management efforts qualified each NFIP policyholder in that city for an average annual savings of $168, resulting in $1.1 million in annual savings for Norfolk residents.

Key Drivers

With more coastline than any other county in the state, San Mateo County is the most vulnerable county in California to sea level rise. Approximately 49,744 properties in San Mateo County are currently at risk of flood damage, and by 2050, an estimated 56,174 will be at risk. Without proper flood-risk management, rising shorelines will render coastal communities uninhabitable. Storm surges and extreme weather patterns disproportionately impact financially vulnerable populations that are often unable to afford repairs. More frequent and severe flooding negatively impacts real estate values along the coast and raises costs farther inland.

Key Factors for Success

According to CRS's Green Guide, maintaining current and accurate information about the county is critical to the success of CRS elements. These efforts include investing in up-to-date data on land cover and ownership, endangered species, and the locations and extent of waterways. Keeping a careful inventory of this information using a geographic information system (GIS) is recommended for spatial analysis and implementation. Throughout the entire process of CRS implementation, meticulous documentation is necessary to receive credit.

Additionally, partnerships with local programs to educate the community on flood-preparedness would help maximize savings from CRS involvement. The profiles provided by CRS in conjunction with the Flood Science Center offer snapshots of the potential credits earned, the difficulty of implementation, and the benefits of flood management initiatives.

Key Obstacles

Some flood mitigation efforts, such as expanding green space or building floodwalls and levees, are costly and may require special permits. Additionally, resistance from local residents and growing "not-in-my-backyard" sentiments slow efforts toward climate resilience. Public concern regarding the cost of strengthened flood mitigation efforts and potential tax increases could also decrease support.

Next Steps

The timeline of next steps could include but is not limited to:

1. Inform FEMA Regional Office of city's interest in applying to the CRS
2. Upon approval, hire a CRS coordinator and complete CRS training
3. Develop Multi-Jurisdictional Program for Public Information (PPI) to inform local community members of the importance of flood resiliency efforts and other measures indicated in FEMA applications to qualify for certain discount ranking
4. Submit CRS application

References and Resources

Carl Walker, Walker Floodplain Management Services, walkerfpm@gmail.com

Impact of Climate Change on Housing

San Mateo County Flood Risk

NFIP Community Rating System: A Local Official's Guide to Saving Lives, Preventing Property Damage, and Reducing the Cost of Flood Insurance

Reduce Insurance Costs and Conserve Species | FEMA.gov

Success Stories

Leading the Nation in Flood Control - Roseville, California

City Leader's Foresight Protects Floodplains as Open Space

European Commission Framework for Emergency Flood Management

A flood next time? | News | Palo Alto Online

CA Department of Water Resources CRS Support Program

Landscape Design Assistance

A free or discounted landscape analysis service can help commercial and residential customers transition to water-efficient landscaping.

The Impact

A landscape design assistance program can support water conservation by aiding customers in their transition from turf lawns to water-efficient landscaping. Many cities offer turf conversion rebates that are often underutilized, primarily due to their cost. Supplementary design assistance programs can increase participation in these programs and make attractive, user-friendly and sustainable lawns more accessible. For example, Sacramento's program has yielded high participation, receiving about 10 applications per month during its first two years (and a total of 285 applications as of July 2021 since the program's launch in June 2018). More than half of the city's 2019 turf rebate participants used its landscape design assistance program.

Where It's Been Implemented

Many jurisdictions in California offer these programs. Menlo Park launched a landscape analysis program in 2014 for commercial and multifamily customers. In Sacramento, a similar reimbursement is available for single-family participants in its turf rebate program. Other water districts with such programs include the Contra Costa Water District, the Chino Basin Water Conservation District (for single-family customers), the Solano County Water Agency (for disabled persons and low-income seniors), Santa Clara Valley Water and Aurora, Colo.

Description

California's Model Water Efficient Landscape Ordinance (effective 1993, updated 2015) requires cities to regulate water conservation for new or renovated landscapes, but cities can go above and beyond this law by encouraging water customers to transition to a water-efficient landscape. Many San

Mateo County water districts already participate in the Bay Area Water Supply and Conservation Agency's (BAWSCA's) Lawn Be Gone program, which offers a rebate of $1 to $4 per square foot of turf removed from lawns. The amount offered is determined by each jurisdiction. A free or discounted landscape analysis program can increase participation in programs like these by facilitating the process.

In the City of Sacramento, for example, single-family home or duplex customers pay $200 for a two-hour landscape design consultation from a city-approved designer, and the amount is later reimbursed by the city. Sacramento found the largest return on investment was from residences because businesses eligible for turf conversion rebates usually already have resources for landscape design, and turf is the largest form of water consumption for residences. Meanwhile, Solano County offers similar design assistance specifically to disabled or low-income senior residents.

Key Drivers

Nearly 9 billion gallons of water are used on residential landscaping in the United States each day, accounting for as much as 30 percent of a household's water use. Water-efficient landscaping plays a crucial role in California's response to drought. Replacing turf with native plants that are drought-resistant saves water, requires lower maintenance and respects the natural beauty of the region. However, landscaping can be a daunting task for property owners. Water customers often lack the time and ability to navigate resources for turf conversion or fill out required materials such as plant lists and yard sketches. These factors can lead to poor use of turf conversion rebates. Design assistance is a solution to this problem.

Key Factors for Success

Strong marketing is crucial for this program to make an impact. A city could send emails, include information about the program in its water quality report and create bill inserts to spread the word.

Additionally, a list of city-approved landscape designers who are willing to participate must also be created. A city may want to collaborate with local designers or reach out to an organization such as the Association of Professional Landscape Designers for insight on the structure of the program from a designer's point of view. It is important to point out that designers can gain publicity and new, long-term customers through this program.

Key Obstacles

Limited funding may be an obstacle to the implementation of this program. BAWSCA's Lawn Be Gone program may be expensive for some cities, and reimbursing homeowners for the cost of landscape design introduces an extra cost. Yet helping customers transition to water-efficient landscaping could prove a crucial step in a city's water conservation. One approach is to set a budget and offer the service to residents on a first-come, first-served basis as long as the funding lasts.

Finding willing designers with expertise in this area can also be difficult since some may not be willing to consult for a discounted rate. Sacramento finds $200 for a two-hour consultation to be the sweet spot between accessibility for customers and a reasonable rate for designers. Creating a menu of options, where customers can opt for additional services for an increased price, may be another way to support designers while keeping the program accessible

Finally, ease of use and initiative for customers can be obstacles. Customers might not understand or have the incentive to complete the application process swiftly. Sacramento addresses this issue by making document submission a prerequisite to lawn pre-inspections.

Timeline to Implementation

The speed with which this program is implemented will depend on each city's capacity. Sacramento discussed the project for a year before implementing it and modeled its program after that of the Contra Costa Water District. Time-consuming factors may include discussing logistics of the program and identifying willing landscape designers.

References and Resources

William Granger,WGranger@cityofsacramento.org, Department of Utilities' Water Conservation Coordinator, City of Sacramento, 916-808-1417

California's Model Water Efficient Landscape Ordinance

Menlo Park's rebates and incentives for water conservation

Sacramento's landscape design assistance programSacramento's turf and other "river friendly" rebate programs

Contra Costa's comprehensive Landscape Resources page

Contra Costa's landscape design assistance program

Chino Basin landscape design assistance program

Solano County landscape assistance program

Aurora, Colo., landscape design program

BAWSCA's Lawn Be Gone program

Association of Professional Landscape Designers

Rain Barrel Rebate

Financial incentives for rain barrels increase rainwater reuse.

The Impact

Rainwater reuse is a simple, cost-effective way for water customers to engage in water sustainability. Harvesting rainwater using a rain barrel not only saves money and water for irrigation, but also helps prevent stormwater pollution from urban runoff and moderates flooding.

A rebate on water barrels, coupled with workshops and public education, encourages residents to participate in water sustainability. During the 2021-22 fiscal year, San Mateo County residents submitted 368 applications for rebates, with a total capacity of 33,734 gallons. There have been a total of 1,763 rain barrels installed in the county (2,084 rain barrels over the entire Bay Area Water Supply and Conservation Agency service area) under the program since it began in 2014.

Where It's Been Implemented

As of June 2022, all residents of San Mateo County were eligible for a rain barrel rebate of up to $150 per barrel (limit two) by the Flows to Bay, the San Mateo Countywide Water Pollution Prevention Program. Ten water districts were eligible for an additional $50 rebate per barrel (limit 2) from their participating agency. See Flows to Bay's Rain Barrels and Rebate Program in the Resources and References section below.

Description

Rain barrels capture roof runoff to be saved and used for irrigation or other non-potable purposes. While rain barrels capture only part of a roof's runoff, they are a cost-effective step for implementing water reuse into daily life. In turn, one barrel can capture about 312 gallons of water for every half-inch of rain that falls on a 1,000 square foot roof.

As of 2022, residential customers serviced by water supply agencies subscribing to the Bay Area Water Supply and Conservation Agency (BAWSCA) rebate partnership are eligible for up to two rain barrel rebates each for up to $200 each, depending on the rain barrel size.

Key Drivers

In the face of droughts and climate change, water conservation remains a priority in California. Accounting for nearly a third of residential water use, landscape irrigation takes up valuable drinking water. Using alternative water sources for landscape irrigation is an area in which many water customers can take action. Rainwater may even be healthier for landscaping because it doesn't contain the additives present in sanitized water, which accumulate in the soil over time.

Meanwhile, pollution from urban runoff poses a threat to local creeks, bays and the ocean. Excessive rainwater can also contribute to land erosion, moisture in building foundations and seasonal flooding. By diverting rainwater for reuse, customers can mitigate these harmful impacts as well.

Key Factors for Success

The primary factors for the success of a rain barrel rebate program are awareness and instructive resources. BAWSCA and Flows to Bay both offer free flyers for cities and workshops for customers. In its 2021-22 Annual Report, Flows to Bay stated that 65% of 121 survey respondents had applied for a BAWSCA rain barrel rebate for their purchased barrels. 26% of respondents plan to apply soon and 9% will not be applying.

Key Obstacles

Although the program saw high agency participation during the peak of the 2011-2019 drought, it subsequently lost member agencies as a result of "conservation fatigue." Previously low customer participation might discourage member agencies from putting in the effort required for staff training, publicity and rebate processing. Although BAWSCA doesn't charge for the program's operation, water agencies are responsible for funding rebates.

Customers may not participate because rain barrel installation requires time and commitment, or simply because they're unaware that rain barrels are a cost-effective possibility. For these reasons, effective publicity and education can prove essential.

Timeline to Implementation

Implementation of a rain barrel rebate program is straightforward. After a water agency signs a participation agreement, the main initial time demand is a few hours of staff training, as well as advertising for the program.

References and Resources

Reid Bogert, Senior Stormwater Program Specialist at City/County Association of Governments, San Mateo County (Calif.), rbogert@smcgov.org

Negin Ashoori, Water Resources Engineer, BAWSCA, nashoori@bawsca.org

Kyle Ramey, Water Resources Specialist, BAWSCA, kramey@bawsca.org

Flows to Bay's Rain Barrels and Rebate Program

BAWSCA's Rain Barrel Rebate

BAWSCA's Water Conservation Rebate Portal

Rain Garden Rebate

Rain gardens are affordable and sustainable alternatives to capture stormwater runoff.

The Impact

Rain gardens absorb runoff water up to 40 percent more efficiently than a standard lawn. In turn, they are a cost-effective and sustainable solution to reduce water runoff in residential and urban environments.

Where It's Been Implemented

The Bay Area Water Supply and Conservation Agency (BAWSCA) offers a Lawn Be Gone Program with a $300 rebate for customers who wish to convert their lawns to more water-efficient landscapes. Residents from the following regions in San Mateo County are eligible to participate in the program: Brisbane/Guadalupe Valley Municipal Improvement District, City of Millbrae, Foster City/Estero Municipal Improvement District, North Coast County Water District, City of Redwood City, City of Menlo Park, Mid-Peninsula Water District and City of San Bruno. The rebate application includes a draft rain garden plan, terms and conditions, and tips for effectively implementing a rain garden.

Description

Rain gardens consist of a shallow bed of soil planted with deep-rooted native plants and grasses which help capture, clean and absorb rainwater that may have otherwise run off from a roof, driveway or street. Stormwater is naturally absorbed as it flows through the garden. Rain gardens placed at least 10 feet from property can help redirect moisture from the building's foundation, reducing the likelihood of flooding and other water-related issues. They can be located adjacent to paved parking lots to capture

runoff. In addition to redirecting water, rain gardens can also help filter out pollutants in water and serve as a home for pollinators and birds.

Key Drivers

Rain gardens are an attractive alternative to impervious surfaces. These gardens can help filter pollutants, protect local ecosystems and promote the breeding of beneficial insects that eliminate pests. Homeowners benefit from rain gardens because they can reduce flooding and garden upkeep while also increasing property value. Rain gardens planted with native plants are more sustainable than grass or non-native landscaping.

Key Factors for Success

Rain gardens should take advantage of the direction in which rainwater flows. Doing so will help the garden be more sustainable and effective. Placing a rain garden in partial to full sun will ensure that the plants receive the proper amount of sunlight. Also, rain gardens should be built where the waterbed is at least two inches below the surface. Waterbeds that are shallower than two inches should be turned into a wetland garden instead.

Key Obstacles

A rain garden may not flourish if the soil becomes compressed by foot or vehicle traffic. A silt fence made of fabric stretched between wooden posts can protect the garden until it is well established. A silt fence will also prevent soil erosion during and after the planting process. Additionally, rain gardens must be constructed to avoid septic tanks, utilities and obstacles such as large tree roots.

Timeline to Implementation

To qualify for BAWSCA's rain garden rebate, residents need to submit a proposed plan that abides by the parameters outlined by BAWSCA's rain garden rebate application. Residents who live outside of BAWSCA's jurisdiction may wish to ask their city to adopt a similar program.

References and Resources

Reid Bogert, Senior Stormwater Program Specialist, City/County Association of Governments, San Mateo County, rbogert@smcgov.org, 650-599-1433

Bay Area Water Supply and Conservation Agency (BAWSCA) Lawn Be Gone Rebate

BAWSCA $300 Rain Garden Rebate

USDA Rain Garden Overview (fact sheet to download)

Rain Gardens - CalRecycle Home Page

Soak Up the Rain: Rain Gardens | US EPA

Recycled Water Ordinance

Requiring the use of recycled water for irrigation, landscaping and toilet flushing can result in dramatic water savings

The Impact

Increasing the use of municipal recycled water reduces the use of freshwater and accelerates the transition to a more sustainable water system.

Where It's Been Implemented

The California cities of Palo Alto, Mountain View, Redwood City and San Francisco currently have ordinances requiring the use of recycled water for certain purposes.

Description

Water and sanitary districts across the United States collaborate to treat and redistribute recycled water. In California alone, more than 170 billion gallons of water are recycled each year. Recycled water is treated wastewater that can be used safely for certain non-potable purposes, such as irrigating public parks, playgrounds, sports fields, golf courses, and even gardens and crops, as well as dust control or surface cleaning of roads and construction sites, and in industrial cooling systems.

"Dual plumbing" systems allow municipal buildings to use recycled water indoors by distinguishing potable water for drinking and washing purposes from recycled water for toilets and urinals. Pipes carrying recycled water to properties, such as golf courses and businesses, are often called "purple pipes" due to their lavender color, which allows people to easily distinguish them from pipes carrying potable water.

A recycled water ordinance can regulate the use of recycled water infrastructure. For example, Palo Alto's ordinance requires "identified customers" within areas with purple pipe infrastructure to use

recycled water for irrigation (excluding single-family homes). If these properties have dual plumbing, they must also use recycled water for flushing. The ordinance requires new land use or building permit applications for properties of a certain size to show plans to use recycled water and include dual plumbing. It also instructs customers to pursue a recycled water permit if recycled water is available to them. Exemptions may be made if existing landscaping could be harmed by recycled water. Failure to comply with the ordinance could lead to a surcharge on water or discontinuation of irrigation water.

Key Drivers

Cities often begin recycled water projects in response to excess demand for water, excess wastewater beyond what can be treated and released into a bay or ocean, or sustainability concerns.

Water sustainability is one of the most pressing issues in California today. There is no reason to use potable freshwater for purposes such as irrigation, flushing, cleaning, cooling systems and certain industrial processes, when water is becoming a more valuable and scarce global resource. An ordinance requiring the use of recycled water for landscaping, irrigation and flushing is a great start to conserve freshwater and help ensure a city's water resilience.

Key Factors for Success

Support from local leaders and public support are important and will likely require education on the safety, cleanliness and types of usages of treated, recycled water. Palo Alto offers an FAQs handout to assuage public fears (see Resources below). Mountain View highlights the benefits of recycled water, ensures customers a clear, easy process, establishes lower fees for recycled water and guarantees that the transition won't impact performance in any way.

This ordinance only makes sense for cities where recycled water is already supplied in at least part of the city. A city's decision to install or expand recycled water pipelines usually depends on a variety of factors. One of these is having enough customers who can use and afford them, such as big developments, major landscaping projects or business/industrial parks.

Collaboration with the city's building department and resources for engineers on recycled water standards are also important factors for facilitating dual plumbing.

Key Obstacles

The up-front cost of purple pipe infrastructure to a city or its water agency, as well as the cost of dual plumbing to developers, remain obstacles to an expansive recycled water system that would make a recycled water ordinance effective. Different approaches will work for different cities. Centralized and decentralized recycled water systems may work in concert with other approaches such as potable reuse, depending on a city's needs and water customers.

Another obstacle may be concern for the safety of recycled water for humans, such as on lawns where children play. While recycled water should not be directly sprayed on people, a lawn irrigated with recycled water is perfectly safe, as treatment standards should easily meet or exceed standards for uses such as irrigation.

Timeline to Implementation

An ordinance can be passed quickly. For example, Palo Alto's ordinance was passed less than one month after it was introduced and went into effect 31 days after its adoption. The timeline to implementation at the facility level, however, can require time for retrofitting projects with dual plumbing and connecting to the recycled water pipeline.

References and Resources

Samantha Engelage, Senior Engineer, Environmental Services, Palo Alto, Samantha.Engelage@CityofPaloAlto.org, 650-329-2123

Justin Chapel, Public Works Superintendent, City of Redwood City, jchapel@redwoodcity.org, 650-780-7469

Salman Husaini, Assistant Engineer, City of Mountain View, Salman.Husaini@mountainview.gov, 650-903-6238

Palo Alto's Ordinance for Recycled Water Use

Palo Alto's FAQs on Water Reuse

Mountain View Ordinance for Recycled Water Use

Redwood City Ordinance for Recycled Water Use

San Francisco Brochure on Recycled Water Ordinance

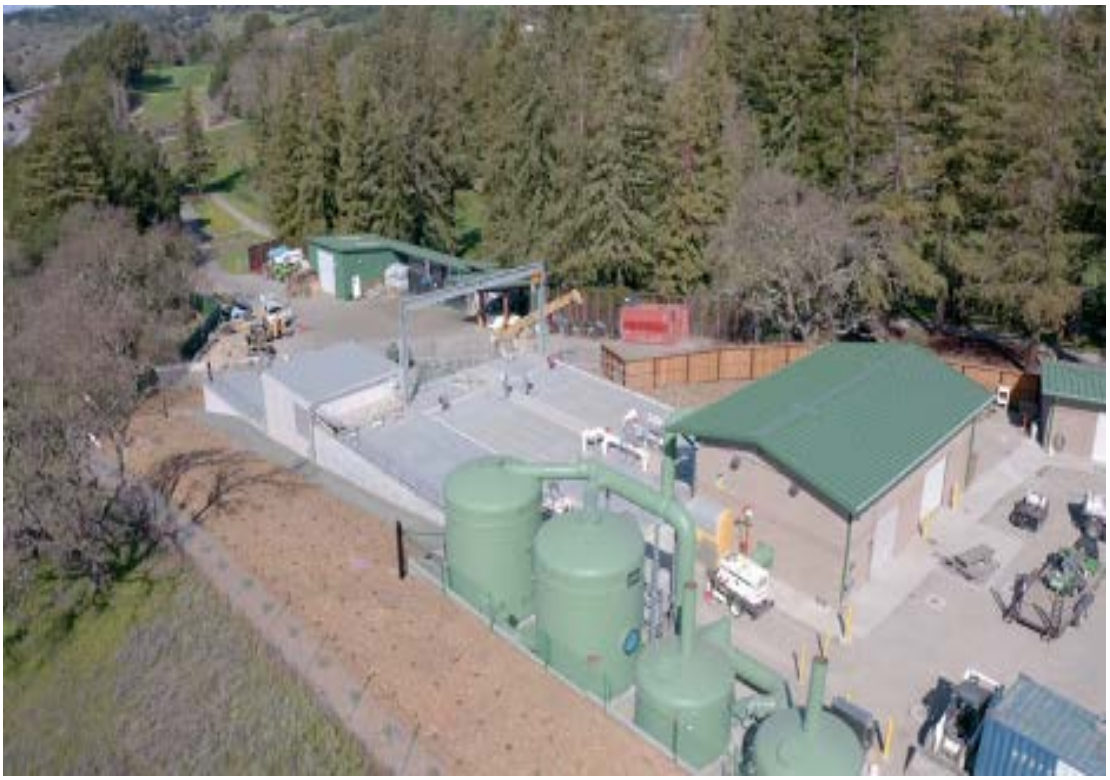
"Wastewater Becomes a Resource in Silicon Valley," KQED, April 6, 2016

The WateReuse Association (trade association webpage with helpful resources)

"Expanding San Diego's Water Supply," San Diego Union-Tribune, January 11, 2015

Satellite Water Treatment Facility

Satellite plants provide an effective way to secure access to recycled water



The Impact

Satellite water treatment plants are an ideal solution for businesses looking to improve water resilience when they are far away from treatment plants and centralized recycled water pipelines. In 2020 the Sharon Heights Golf and Country Club facility in Menlo Park, Calif., completed construction of a satellite treatment facility. This plant is expected to replace up to 400,000 gallons of freshwater a day with recycled water that would otherwise be treated and released into San Francisco Bay.

Satellite plants offer a reliable non-potable water supply to businesses while opening up freshwater supply to the rest of users' water districts. By treating water closer to its source and next to its destination, satellite plants and their pipelines also form smaller, more energy-efficient circuits. The Sharon Heights project should pay for itself within seven years. As most central water treatment plants in the San Francisco Bay Area are also at risk of becoming disabled due to sea level rise, inland satellite treatment facilities are sustainable options for wastewater services.

Where It's Been Implemented

Sharon Heights Golf and Country Club (SHGCC) partnered with the West Bay Sanitary District (WBSD) to construct a satellite facility on Sand Hill Road in Palo Alto, Calif. Similar projects exist in Southern California, but the SHGCC plant is the first satellite plant in Northern California that uses more advanced technology. It uses a small-footprint membrane bioreactor rather than a sequencing catch reactor.

Description

For large water customers with high non-potable demand that are located far from centralized recycled water pipelines, satellite treatment facilities represent an investment in a practical and sustainable water supply. A business, alone or with a group of nearby businesses, can collaborate with a sanitary district on a plan to construct a nearby plant that extracts water from municipal sewage pipes to treat and redistribute recycled water through a pipeline to a customer's property. This water would be used for landscape irrigation, toilet and urinal flushing, and other approved non-potable uses. Due to its high salinity, the business or group of businesses would want to first test recycled water on hardier plants before using it to irrigate more vulnerable plants such as redwoods or golf greens. Future phases could expand pipeline access to other customers.

Although the sanitation district would not pay for the facility, this public-private partnership may allow the project to secure federal grants and loans. The business and other users of the pipeline would cover capital payments as well as operations and maintenance (O&M). In return, the business wouldn't receive a water bill from the potable water purveyor for this water.

Key Drivers

Businesses with high non-potable water demand can suffer from regional water shortages and restrictions during increasingly harsh dry seasons and droughts. Many seek alternative, more resilient water sources. Satellite treatment facilities may be the most feasible and offer the most benefits, especially if a business is far from central plants and recycled water pipelines and is located near other businesses or industries. Compared to expanding a centralized recycled water system, constructing a satellite facility can save money and energy while ensuring a sustainable, non-potable water supply.

Key Factors for Success

The location of the plant, overall demand and quality of the local wastewater will play roles in a satellite treatment facility's effectiveness. The business should make sure there are enough users and/or enough demand to sustain a satellite treatment facility. The satellite plant should be nearby, especially if the business is on a hill, to save energy associated with pumping. The SHGCC plant is particularly effective because it treats water from a primarily residential local neighborhood, circumventing the issue of high salinity from industrial wastewater collected closer to the central facility.

Additionally, a design-build product delivery can save time and money. Instead of hiring a designer and putting a separate bid out for a contractor, a designer and contractor would work together, and construction could begin before designs are finalized.

Key Obstacles

Identifying an investor or group of investors willing to pay for a project can present a major obstacle. Only some businesses will find satellite treatment facilities worth the cost. SHGCC paid about $17 million for construction and will continue to cover the costs of operations and maintenance.

Besides the first step of gaining interest from a sanitary district, negotiating loans and grants can be an obstacle. Obtaining necessary permits presents yet another obstacle. The business may need to negotiate with the state water board and department of drinking water and transportation authority, among other agencies.

Timeline to Implementation

Securing loans and agreements may take a few years, and construction may take a year or more. SHGCC and West Bay Sanitary District began discussing a satellite facility in earnest in 2014, announced the project in 2018 and completed construction in the spring of 2020.

Return on Investment

WBSD predicts that SHGCC's transition to recycled water will pay for itself within the first seven years.

Background

During the 2011-2019 drought, SHGCC realized it needed a more reliable source of non-potable water for irrigation. After learning a well wasn't feasible on its property or elsewhere in Menlo Park, it reinitiated a conversation with West Bay Sanitary District in 2014 about constructing a satellite treatment plant on Sand Hill Road. A feasibility study suggested the project would cost $17 million (much less than expected). The project ultimately cost $22 million, but as a public agency WBSD was able to secure a $5 million federal grant and a 1 percent interest state loan for the rest of the project from the Clean Water State Revolving Fund. Funding came from grants from the U. S. Environmental Protection Agency and other sources. The district is discussing the second phase of the project, which would extend the supply to the SLAC National Accelerator Laboratory and other neighbors.

References and Resources

Sergio Ramirez, District Manager, West Bay Sanitary District, sramirez@westbaysanitary.org, 650-321-0384

West Bay Sanitary District's Recycled Water page (includes links)

West Bay Sanitary District's "Recycled Water Project – Sharon Heights" Description

West Bay Sanitary District's Final Facility Plan Report

Streamlined Residential Gray Water Use

Simplifying requirements for gray water systems can encourage residents to participate in water reuse and conservation.

The Impact

By adopting an accessible permitting policy for gray water use and providing resources on safe practices and the installation process, cities can demonstrate support for gray water, speed up implementation of residential gray water projects, and increase public education and active participation in water sustainability.

Where It's Been Implemented

The City and County of Santa Barbara has played a major role in California's acceptance of gray water systems. In 2015, it became the first jurisdiction in the state to allow permit-exempt simple gray water systems using shower water, and it published a handbook of safe practices in 2017. Marin County has also made simple systems permit-free and provides several resources on its website. San Francisco requires permits for systems other than laundry-to-landscape connections but offers a rebate and a manual.

Description

Gray water is lightly used water, including water from laundry, showers and bathroom sinks, but not toilets or kitchen sinks. Altogether, gray water makes up 50 to 80 percent of residential wastewater. This water can be reused safely for purposes such as landscape irrigation.

Water from dishwashers and kitchen sinks is often referred to as "dark gray water" as it has a higher load of chemicals, fats and other organic matter. Dark gray water is not recommended for use in gardens. Gray water does not include water from toilets, which is referred to as "black water."

In 2009 California updated its plumbing code to allow laundry-to-landscape systems to be installed without a permit. Other simple gray water systems (direct, isolated connections with a discharge capacity of 250 gallons per day or less) can be permit-free at the discretion of the local permitting agency in coordination with the corresponding water provider. Residential gray water systems, particularly simple systems, present little health risk, yet many cities still require permits for all projects except laundry-to-landscape ones and do not provide resources for customers to consider and navigate this process. Many cities' websites don't even mention the possibility of gray-water projects or the lack of a permit requirement for laundry-to-landscape systems.

Santa Barbara and other cities have not only made both laundry-to-landscape and simple systems permit-free, but have also provided information for customers interested in both simple and complex gray water systems. Through these resources, customers can determine their interest in a gray water system, whether their project needs a permit and the proper steps toward implementation.

On its Graywater and Rainwater webpage, the City of Santa Barbara includes links to the county's extensive handbook on safe gray water use, simple system registration, a complex system permitting guide, the state plumbing code and other resources. The city also offers classes and installation workshops for interested customers. These programs increase participation and ensure safety by discussing the long-term maintenance and attention associated with these systems. In the past, the city also offered rebates on three-way valves and other pieces of simple gray water systems.

Key Drivers

Gray water systems offer an exciting way for water customers to participate in water sustainability, opening the door to increased awareness and reduction of water use. However, a complicated and expensive permitting process can prevent interested customers from undertaking this water-saving project.

Those who do are often unsure how to initiate a gray water system and can be easily discouraged by the lack of information and guidance. Meanwhile, when even the simplest gray water systems cost roughly $700 to install, the additional permit fee can be enough to dissuade interested customers. A simplified permitting process and extensive resources and guidance can encourage widespread participation.

Key Factors for Success

A city and its residents should understand that installing a simple gray water system is not a primary water saving source. For example, merely directing shower, bathroom sink and laundry water to landscaping may only result in 6 percent savings. A "systems approach" that treats gray water as the "central hub" for optimizing various water-saving strategies can save up to 10 times more water, achieving a 60 percent savings. Those additional measures include using rainwater and stormwater on plants, recycling rainwater to toilets and laundry use, installing water-efficient fixtures and adopting water-efficient habits.

Key Obstacles

Often a city hasn't made the switch to a no-permit process for simple systems simply because the topic has never demanded attention. But regulating the safety of no-permit gray water systems is important. While sickness from gray water has never been documented as a pressing health issue, especially to pets and younger children, it is essential to make sure customers don't allow gray water to run off the property and, instead, ensure it is contained by a mulch basin. To avoid potential contamination of the potable water system, city officials can collaborate with their water agency to

provide information on safe practices for customers and/or gray water installers. Streamlining the process and providing resources increases safety in the implementation of these projects.

Gray water systems currently demand money, time and personal investment that prevent them from becoming widely accessible. However, streamlining the process for customers who are interested makes residential water reuse easier and engages residents in water sustainability.

Timeline to Implementation

While a city's resources for gray water can be expanded over time, the timeline for expanding no-permit gray water options depends primarily on how frequently the city modifies its building code.

References and Resources

Madeline Wood, Water Conservation Supervisor, City of Santa Barbara, MWood@SantaBarbaraCA.gov, 805-897-2672

California Plumbing Code (see Chapter 16)

Santa Barbara: Graywater and Rainwater

Santa Barbara: County Graywater Handbook

Santa Barbara: Free Registration of Simple Graywater Systems

Santa Barbara: Guide to Permitting a Single-Family Graywater System

Marin County: Graywater Systems

San Francisco Water Power Sewer: Graywater

San Francisco: Graywater Design Manual for Outdoor Irrigation

Greywater Action: Homepage

"Greywater Reuse for Irrigation Is Safe, Study Shows," Science Daily, December 16, 2015

Other Solutions to Explore

Comprehensive City Water Conservation

Even when a city isn't experiencing a drought, it makes sense to consider creative ways to cut back on municipal water use. The following are some ideas modeled by the California cities of South San Francisco and Menlo Park. Here are some ways residents can implement to make their homes more water efficient:

- Rather than hand watering or turning on sprinklers, water-efficient alternatives include drip irrigation and/or rotating sprinkler heads. Smart sprinkler controls can also allow residents to regulate how much water they are using and when, given the current weather conditions.
- Use permeable pavement systems in landscaping, which include pores or joints that allow water to flow through. These systems reduce runoff, thereby increasing water quality and erosion in local waterways.

Here are some suggestions for making cities more water efficient:

- Train staff involved with civic landscapes on water-efficient landscaping through Rescape's Maintenance Qualification Training.
- Ensure meridian landscaping is water efficient.
- Wash city cars less often (a practice that saves Menlo Park 78,000 gallons a year).
- Use stormwater to clean sidewalks (Menlo Park saves 10,000 gallons a year). Also regulate water runoff. Soap, dirt and other debris often collected from cleaning sidewalks drain into local aquatic ecosystems. Being more cognizant of what solutions are used for cleaning can mitigate the runoff of toxic substances into the ocean and other bodies of water.
- Use water from water main flushing to run city fountains (Menlo Park saves 2,000 gallons a year with this practice).

On-Site Water Reuse for Businesses

Stanford's Codiga Resource Recovery Center

On-site water reuse systems make buildings more sustainable and resilient in their water use. These systems treat wastewater from or surrounding a building (blackwater, gray water, stormwater or rainwater) to be reused within the same building for non-potable applications such as toilet flushing, cooling towers, laundry and irrigation. Up to 50 percent of water demands in multifamily residential buildings and 95 percent in commercial buildings are non-potable, creating a large potential for water reuse. These systems also save money by reducing water and sewer impact fees and by lowering monthly utility bills. Depending on the project and its water reuse potential, businesses can see returns after four or five years, making the systems financially sustainable.

The early-stage company Epic Cleantec offers an on-site treatment reuse approach that converts wastewater into treated water, natural soil products, and recovered wastewater heat energy. After running trials at Stanford's Codiga Resource Recovery Center (shown above), the company successfully finished its pilot in 2020, based in the NEMA residential tower in San Francisco, with a processing facility and showcase garden nearby, and will be deploying a blackwater system for the Park Habitat project in downtown San Jose.

Due to the scale and cost of construction, operations and maintenance, on-site reuse systems make the most sense for larger development projects. These systems may become common in cities

with higher density buildings such as San Francisco, which adopted an ordinance in 2015 requiring large development projects to incorporate on-site water reuse. For these reasons, rather than viewing on-site or decentralized water reuse as a replacement for centralized recycled water systems, cities, agencies and businesses should pursue a patchwork of water solutions and collaborations, considering the needs and features of each municipality.

More information on water reuse projects can be found here. For more information on Epic Cleantec's work, please contact info@epiccleantec.com.

Permeable Pavement Rebate

Permeable pavement promotes more sustainable landscaping, ensuring that runoff is slowly allocated into the soil, decreasing runoff and erosion. This type of pavement has porous surfaces that contain underlying stone reservoirs. During heavier rains, these reservoirs mitigate high runoff volume by temporarily storing water, then later allow the water to slowly drain into the soil.

Permeable pavement can be made of pervious concrete, porous asphalt or permeable interlocking pavers. It can serve as a cost-effective solution to regions with high land cost and a likelihood of flooding.

The City of Palo Alto has established a permeable pavement rebate program, offering $1.50 per square foot. Permeable pavement typically costs $3 to $40 per square foot, so the rebate addresses a portion of the cost. To qualify for the rebate, residents need to submit an application for the rebate before installing the pavement. Once approved, residents can install the pavement and they receive a rebate upon the project's completion.