San Francisco
Water Power Sewer
Services of the San Francisco Public Utilities Commission







Onsite Water Reuse System Projects Around the World

San Francisco Public Utilities Commission
December 2021

Single Building District Scale

Table of Contents

An onsite reuse system (image courtesy of Aquacell)

San Francisco
Water Power Sewer
Services of the San Francisco Public Utilities Commission

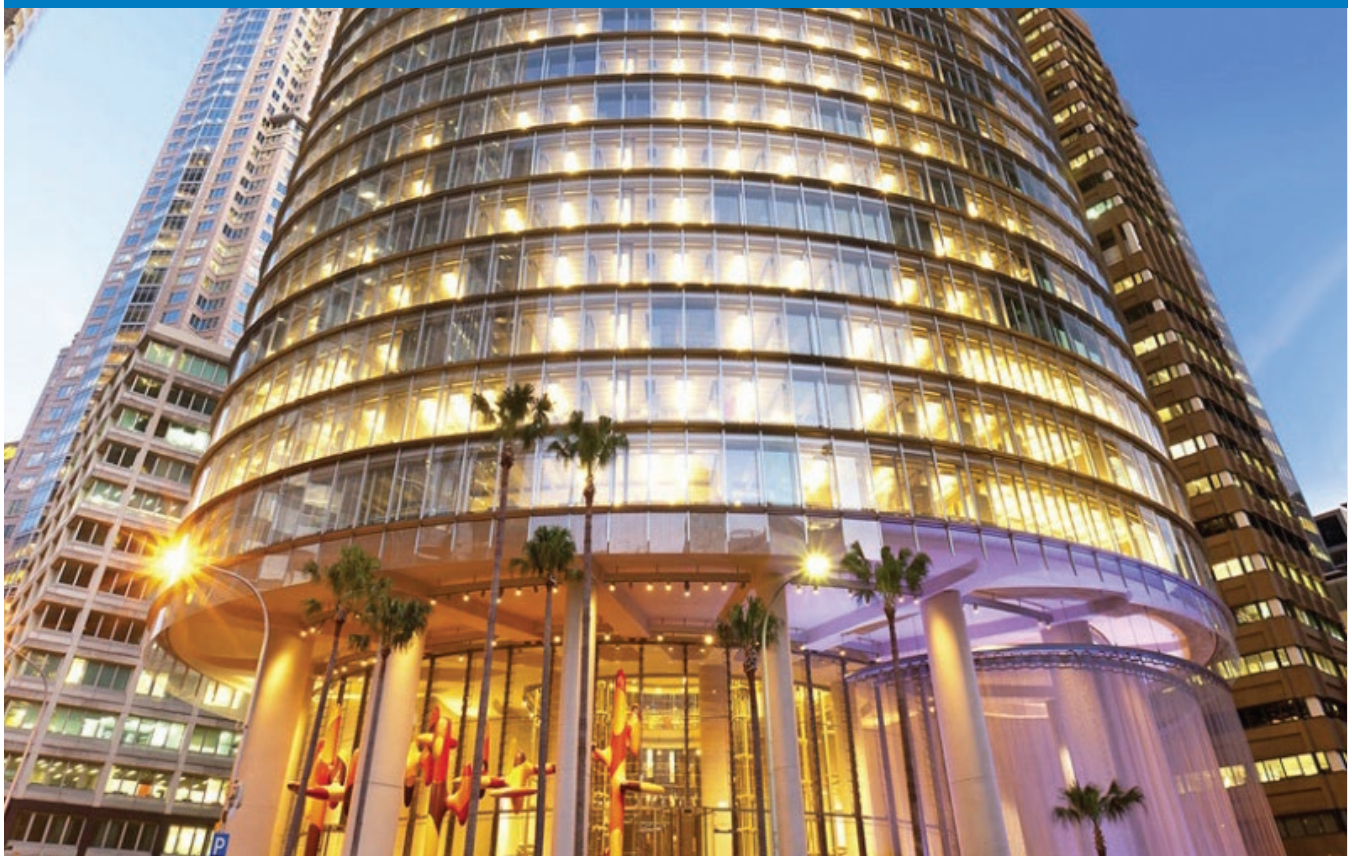
Buildings are sources of water and produce a variety of alternate sources of water including rainwater, stormwater, foundation drainage, graywater, and blackwater. When collected and treated properly, these water sources can be used for non-potable applications such as toilet flushing, irrigation, and cooling towers. Onsite water treatment systems embody the One Water principle of matching the right resource to the right use because it promotes treating water to the appropriate level that is needed for its end use. Moreover, these systems can transform the way water is managed in buildings. For example, onsite water systems can reduce potable water use up to 45% in residential buildings, and up to 75% in commercial buildings.

This report is intended for developers, architects, and designers of onsite water reuse systems. Numerous people around the world were contacted to share their stories, projects, and lessons learned so that they may share proof of concepts to encourage transformation in the water sector. These projects range from individual buildings recycling wastewater to entire neighborhoods actively engaged in the management of their water. While water reuse remains a central theme within the case studies, each project showcases a unique, innovative approach to using more water efficiently.

2nd stage of a wetland treatment (image courtesy of Denver Water)

An onsite reuse system's mechanical room (image courtesy of Sustainable Water)

1 Bligh Street – Sydney, Australia



1 Bligh Street (image from ARUP on Archello)

Project Status: Completed

Project Size: 460,000 Square Feet

Alternate Water Sources:
- Blackwater

End Uses:
- Toilet Flushing
- Irrigation
- Cooling Towers

Treatment System Size: 26,500 Gallons/Day

Potable Water Use Reduction: 90%

Drivers: 6 Star Green Star

System Cost: $780,000

Annual O&M Cost: $65,000

Owner: Cbus Property, Dexus Property, and the Dexus Wholesale Fund

Project Description:

Completed in 2011, 1 Bligh Street was the first commercial high-rise building in Sydney to incorporate onsite blackwater recycling. The project was awarded the first combined private network and retailer's water recycling license in New South Wales, allowing Aquacell, the technology/system provider, to install a sewer mining system to supplement the building's blackwater supply. The sewer mining arrangement ensures that 100% of the non-potable demand within 1 Bligh Street can be met with recycled blackwater.

Drivers for Onsite Water Reuse:

The primary driver for onsite water reuse was achieving a 6-star Green Star rating for the building, the highest level for Australia's sustainability rating system for buildings. A cost benefit is achieved from operating the plant when compared to the 'business as usual' model.

Ownership Model:

Cbus Property, Dexus Propert,y and the Dexus Wholesale Fund own the building and its blackwater recycling system. Aquacell is engaged to manage the ongoing operation of the system and holds the private network and retailer licenses for the water recycling scheme. Annual audits are conducted by the Independent Pricing and Regulatory Tribunal (IPART), a branch of the New South Wales government.

Role of Public Utility in Project:

Sydney Water issued the sewer mining access agreement, which allows the water reuse system to draw additional blackwater into its treatment plant as a supplementary supply for the building's non-potable reuse. Sydney Water also entered into a trade-waste agreement with the building owners for the recycled water scheme at 1 Bligh Street, which determines the mechanism for reduction of potable water and sewer discharge fees.

Project Cost and Funding:

The total project cost $210,650,000 at the time of construction, with the water reuse system cost of approximately $780,000, and was funded by Cbus Property, Dexus Property, and the Dexus Wholesale Fund, who continue to manage the property. 1 Bligh Street was built by the construction firm Grocon and was a design collaboration between Architectus of Australia and Ingenhoven Architects of Germany.

Lessons Learned:

As this was the first major blackwater recycling scheme in Sydney, this project helped pave the way for several similar schemes in Australia and elsewhere globally.

There were significant learnings around how to integrate a sophisticated plant into the basement of a high-rise building of this size while ensuring safe access for installation, maintenance, and operation. Additional considerations included proper design and operation to provide fit-for-purpose water quality, addressing noise, odor, and incorporation of sustainable materials.

The system's continuous operation since the plant was commissioned has provided previously non-existent information, about the methodology and cost of maintaining and operating such a blackwater recycling facility, to many other projects built since.

Because there is significant regulatory oversight of this type of water recycling scheme, it was advantageous for a single organization to keep track of and manage regulatory approvals during each phase of the project's design, construction, and operation.

Reference: Colin Fisher, Aquacell (colinf@aquacell.com.au) +61 2 4721 0545

1 Bligh Street's onsite reuse system (image courtesy of Aquacell)

City of Austin Permitting and Development Center – Austin, TX

City of Austin Permitting and Development Center (Image courtesy of Austin Water)

Project Status: Completed

Project Size: 260,000 Square Feet

Alternate Water Sources:
- Rainwater
- A/C Condensate
- Blackwater

End Uses:
- Toilet Flushing
- Irrigation
- Cooling Towers

Treatment System Size: 5,000 Gallons/Day

Potable Water Use Reduction:
75%; up To 1,500,000 Gallons/Year

Drivers:
- Demonstration Project
- Public Education
- Promotion of Onsite Reuse

System Cost: $1,700,000 For Blackwater Reuse System and Dual Plumbing; $625,000 for Rainwater and Condensate Reuse System

Annual O&M Cost: Tbd

Owner: City Of Austin

Project Description:

Completed in the summer of 2020, Austin's new 260,000 square foot Permitting and Development Center was designed to office all city personnel involved in planning and development processes. The building is the ideal location for the City to demonstrate and promote sustainable water management practices. Signage throughout the property is meant to educate customers and visitors about the building's innovative water reuse systems.

Blackwater from the building is treated onsite through a 5,000 gallon per day Membrane Aerated Bioreactor (MABR) and is reused for toilet and urinal flushing. The blackwater treatment system and equipment room are tucked under an outdoor pedestrian walkway. Plants growing out of one of the treatment reactors blend with the walkway's landscaping. Water from the building's rain runoff and A/C condensate is collected in two 20,000-gallon storage tanks and is reused for landscape irrigation and a circulating water feature. The two tanks are buried under the building's lawn which hosts gatherings and exercise classes.

Drivers for Onsite Water Reuse:

In 2018, the City of Austin adopted its Water Forward Plan, a long-term integrated water resources plan for the next 100 years. Water Forward recommends

developing major water supply projects and incremental solutions such as demand management and reuse. The onsite water treatment and reuse systems installed at the new Permitting and Development Center were implemented in accordance with Water Forward's recommendations.

Water Forward also recommends a city ordinance to require new commercial and multifamily buildings over a threshold size to install dual plumbing and to re-use water generated onsite for indoor and outdoor non-potable purposes. The installation and operation of the reuse systems at the Permitting and Development Center provide valuable experience that is informing policy maker's development of the City's onsite reuse ordinance.

Ownership Model:

The City owns the building and reuse systems. The rainwater/condensate reuse system is operated and maintained by a third-party facility management contractor, and the blackwater reuse system is operated and maintained by Austin Water, the City's water, wastewater, and reclaimed utility. State regulations require that blackwater reuse systems are operated by a licensed wastewater treatment plant operator such as Austin Water.

Role of Public Utility in Project:

While Austin Water initiated the blackwater reuse demonstration project and owns the treatment system, the building itself and the rainwater/condensate reuse system are owned by the City's Development Services Department. Interdepartmental collaboration was key to the success of the overall project, especially since the blackwater reuse system was proposed after the building had been designed.

Project Cost and Funding:

The blackwater reuse system cost $1,700,000 which included $145,000 for dual plumbing. The project manager noted that a portion of this cost was incurred by making construction accommodations for the treatment system after the building had already been designed. The rainwater/condensate reuse system cost $625,000.

Lessons Learned:

As a first of its kind project in the City of Austin, it was critical to hold in-person meetings with city staff to explain the project and its purpose. Getting the blackwater reuse system through the City's development review process was challenging, with hang-ups at multiple stages of review and approval. As a result of this project and the expectation of more to come, the City will be requiring backflow prevention plans to be submitted earlier on in the development review process. This will facilitate fewer construction and building occupancy disruptions while ensuring adequate cross-connection prevention measures between the potable and non-potable water supplies. Early consultation with the City's backflow prevention group resulted in the incorporation of a time and water saving dye injection system that allows cross-connection testing to occur without shutting the building down to drain water lines.

Reference: Katherine Jashinski, Austin Water (Katherine.Jashinski@austintexas.gov) 512-972-0390

Onsite reuse system treatment room (image courtesy of Austin Water)

Denver Water Administration Building – Denver, Colorado

3rd stage of wetland treatment during its construction on the roof (image courtesy of Denver Water)

Project Status: Completed

Project Size: 186,000 Square Feet

Alternate Water Sources:
- Rainwater
- Blackwater

End Uses:
- Toilet Flushing
- Irrigation

Treatment System Size: 7,000 Gallons/Day

Potable Water Use Reduction:
1.4 Million Gallons/Year

Drivers:
- Stretch Limited Water Supplies in an Arid Environment
- Eliminate Barriers for Future Water Reuse Projects in Denver
- Demonstration Project

System Cost: $1.83 Million

Annual O&M Cost: $127,000

Owner: Denver Water

Project Description:

Two sources of water will be collected and reused at Denver Water's new Administration Building. Rainwater will be collected from the roof and from the solar panels that cover a portion of the new parking garage. This water will be filtered and stored for landscape irrigation.

The second source of water is blackwater collected from all sinks, toilets, drinking fountains, and cafeteria operations in the building, diverting 100% of the water that would normally go to the sanitary sewer. This water will undergo large-object screening, aerobic and anaerobic biological treatment, three stages of wetland treatment (tidal and plug flow), cartridge filtration, ultraviolet light disinfection, and chlorination. The treatment process is designed to meet Colorado regulations for onsite non-potable reuse, with 8.5-log virus, 7.0-log protozoa, and 6.0-log bacteria removal. Purified water from this process will be used to flush toilets in the Administration Building and any excess will supplement captured rainwater for irrigation.

After basic equipment testing and commissioning by the contractor, Denver Water staff will start, optimize, and run the system.

Drivers for Onsite Water Reuse:

Denver is located in a high plains desert where its water supply (snowmelt from the Rocky Mountains) is frequently threatened by drought and a changing climate. Denver Water opened a 30 MGD non-potable reuse plant and associated distribution system in 2004; this onsite recycling project aims to demonstrate an additional way to reuse water and the future of sustainable urban water use in Colorado.

Ownership Model:

The system is owned and operated by Denver Water.

Role of Public Utility in Project:

This project was a joint effort between the public utility agency Denver Water and its design partners, Stantec and Aquanova. Denver Water staff developed a model to determine the volume of rainwater and blackwater that could be collected, the amount required to meet the entire demand for toilet flushing, and how much excess would remain for irrigation. This model was used to size storage tanks and determine the amount of landscaping that could be irrigated with non-potable water, as there is not enough supply to irrigate the entire site.

At the project's inception, toilet flushing with recycled water was not permitted in Colorado. Denver Water worked with legislators to introduce a bill in the Colorado General Assembly to change that. Staff then worked with the Colorado Department of Public Health and Environment to enact risk-based water quality standards for onsite non-potable water systems based on guidance from the National Blue Ribbon Commission for Onsite Non-potable Water Systems.

Rainwater capture at this scale is also prohibited by Colorado water law. Denver Water planners and attorneys filed, argued, and won a case in water court by promising to replace the volume of rainwater harvest with water from other sources in order to keep the Platte River whole, and to satisfy the rights of downstream water users.

2nd stage of wetland treatment in building's interior (image courtesy of Denver Water)

Denver Water hopes that the effort to legalize, permit, and demonstrate onsite non-potable water reuse at its Administration Building will pave the way for installation of onsite water reuse systems at future developments in Colorado.

Project Cost and Funding:

The total cost of the Administration Building was approximately $55 million. This includes the cost of the onsite non-potable water system, which was $1.83 million. Denver Water issued revenue bonds that included Green Bonds to pay for the building, which was part of a $204.8 million campus redevelopment.

Lessons Learned:

Denver Water needed project approval from both the City of Denver and the State's regional wastewater authority. Denver Water staff had to work with the City's policy team and the regional wastewater authority to determine which inspection responsibilities belonged to which regulating body. Significant effort was required to coordinate between the City's Water, Wastewater, and Public Works departments, especially since in Denver they exist as separate entities rather than within the same organization. And a late design alteration was required when it was discovered that the regional wastewater authority does not allow stormwater to be discharged into the sanitary sewer, even if through an emergency overflow.

Also, it was not anticipated that dual water and wastewater certifications would be required to operate the facility, which posed a challenge for staff to obtain additional certification.

The guidance developed by the National Blue Ribbon Commission and its model regulations for onsite non-potable reuse were incredibly helpful to the Colorado Department of Public Health and Environment enacting its own standards for onsite non-potable water systems. All stakeholders supported the model regulations which allowed them to be adopted quickly with minimal modification.

Reference: Jeremy Ross, Denver Water (jeremy.ross@denverwater.org), 303-628-6596

DGS Natural Resources Building – Sacramento, CA

DGS Natural Resources Building under final stage of construction (image courtesy of HTEC)

Project Status: Under Construction (Estimated Completion Late 2021)

Project Size: 838,000 Square Feet

Alternate Water Sources:
- Graywater

End Uses:
- Toilet Flushing

Treatment System Size: 6,000 Gallons/Day

Potable Water Use Reduction: 25%; 1.52 Million Gallons/Year

Drivers: Leed Platinum Certification

System Cost: $300,000 (Estimated)

Annual O&M Cost: $3,500 (Estimated)

Owner: State Of California

Project Description:

Installation is underway for a 6,000 gallon per day graywater reuse system in the State of California's Department of General Services Natural Resources Building in Sacramento, CA. The building, located on P Street in the heart of downtown Sacramento, will serve as the new Department of Natural Resources headquarters. The 20-story, 838,000 square foot tower will include a 300-seat auditorium, office space, retail space, a food court, and a childcare facility that will be able to accommodate 120 children.

The reuse system filters graywater from showers and bathroom sinks through an 800-micron prefilter before it is collected and treated in a combined collection/bioreactor tank. The membrane bioreactor is NSF-350 certified and allows the water to be transferred to a treated water storage tank without any additional chemical treatment. The treated water will be recycled for toilet and urinal flushing. System performance and maintenance will be monitored locally by the building management system, with the capability of remote monitoring via cellular connection.

Drivers for Onsite Water Reuse:

The system was implemented to help the building achieve its LEED Platinum rating by reducing the potable water demand by 25%.

Ownership Model:

The building and its internal graywater treatment system is owned by the State of California. Heat Transfer Equipment Company will either conduct the O&M services or provide the necessary training for owner operation.

Role of Public Utility:

No involvement in design or operations.

Project Cost and Funding:

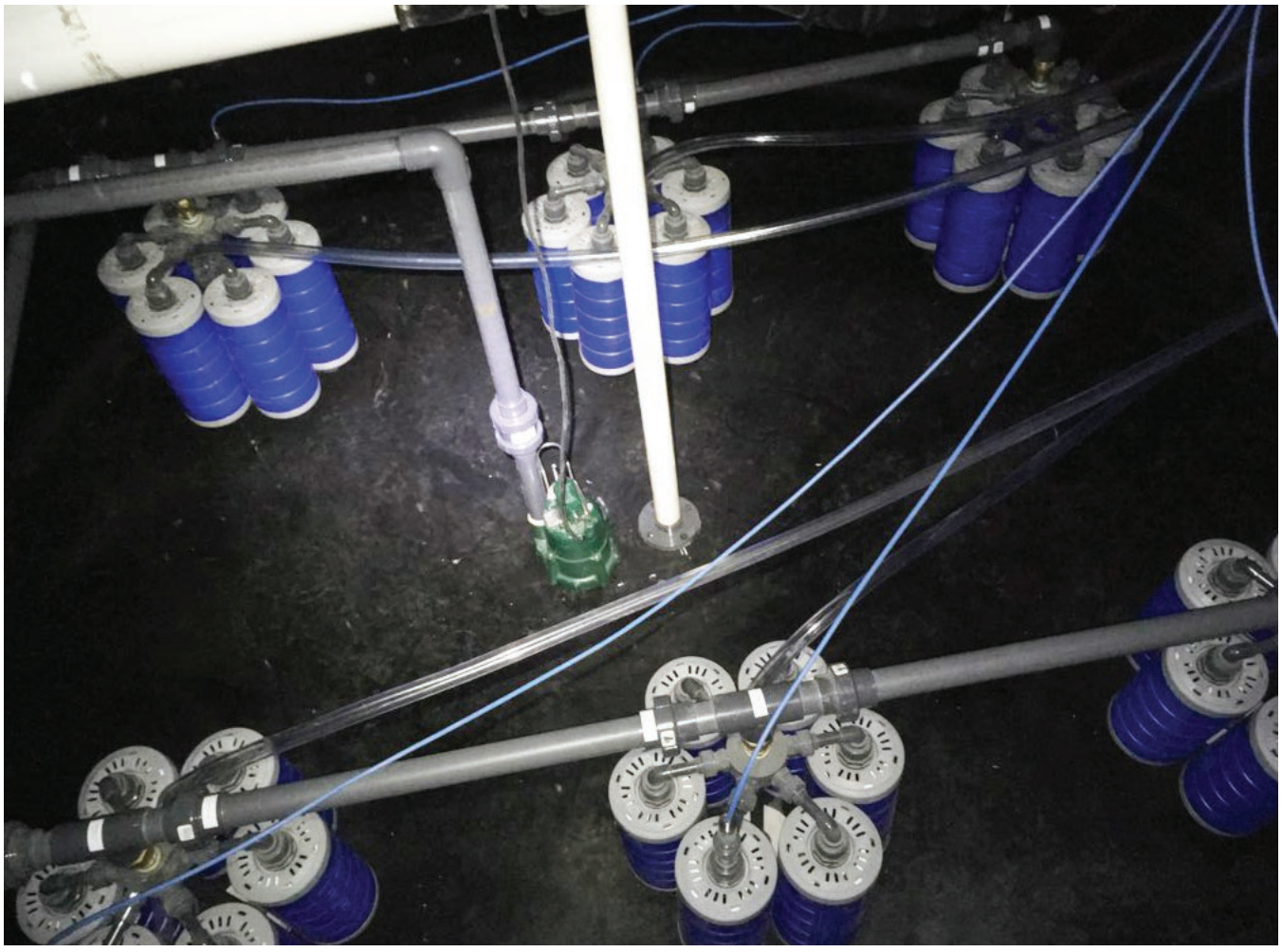
It is estimated that the graywater treatment and reuse system cost roughly $300,000, and the O&M will cost about $3,500 annually.

Lessons Learned:

It was a challenge to accurately estimate the volume of graywater flows. Over the course of project design, fixture counts and occupancy numbers were constantly being revised and updated, which caused the estimated amount of graywater supply to drastically change. As a result, the originally specified system could no longer handle the revised design conditions. Due to the necessary design update being recognized late in the project development process, additional space could not be allocated for increasing the system's treatment capacity.

Fortunately, the manufacturer was able to scale up the graywater treatment capacity within the limitations of the existing footprint so that the facility could still meet its LEED Platinum design goals of a 25% water reduction without having to allocate additional space for the increased system capacity.

Reference: Bill McCabe, Heat Transfer Equipment Company (bill@htecompany.com)



Onsite reuse system's filter cartridges (image courtesy of HTEC)

Allianz Field at Midway Development District – Saint Paul, MN

Installation of underground rainwater storage tank outside of stadium (image courtesy of the City of St. Paul)

Project Status: Completed

Project Size: 35 Acres

Alternate Water Sources:
- Rainwater

End Uses:
- Irrigation
- Toilet Flushing
- Laundry

Treatment System Size: 205,920 Gallons/Day

Potable Water Use Reduction:
- 1.3 Million Gallons/Year (Phase 1)
- Estimated 2 Million Gallons/Year at Ultimate Development

Drivers:
- Stakeholder Input
- Site Contamination
- Development Benefits
- Improve Water Quality of Mississippi River

System Cost: $2,100,000

Annual O&M Cost: $30,000 (Estimated)

Owner: City of Saint Paul

Project Description:

In collaboration with the Capitol Region Watershed District, the City of Saint Paul developed a landmark rainwater reuse system capable of recycling over 2 million gallons annually. Completed in 2019, the project is located at Allianz Field, the new stadium for the soccer team the Minnesota United FC, which is within the 35-acre Midway Development District (District).

The rainwater reuse system utilizes a 675,000-gallon underground storage tank installed just outside the stadium to collect roof runoff from the stadium, and in the future from neighboring buildings once they are built. Water is pumped from the storage tank through a treatment system called a “smart hub”, which can read weather forecasts to predict rainfall and adjust water levels accordingly. The treated water is used to irrigate the entire stadium site, which includes 150,000 square feet of green public space and 200 mature trees. New development in the District will be able to connect to the system for supply of recycled water for non-potable uses such as laundry, irrigation, or restroom flushing.

More than 5 acres of new street grid were necessary to support Allianz Field as a catalytic development. Engineered tree “trenches” were deployed across the grid to collect and treat street runoff. The tree trenches had to be separated from the rainwater harvesting system because of the oils, salts, and other compounds inherent to roads. This integrated green infrastructure system doubles down on value and environmental benefit. During dry periods, 18 tree trenches that contain 60 new street trees will be nourished by drip irrigation that utilizes harvested rainwater.

Drivers for Onsite Water Reuse:

A stormwater visioning workshop was held to inform a redevelopment Master Plan for the District. A common theme that came out of the workshop included using harvested and cleansed stormwater runoff as an iconic site feature to set the District apart from other developments. Another key driver was that infiltration was restricted over much of the development area due to contamination from the historic land use, making rainwater reuse a more feasible option for stormwater management.

Another key project driver was to help spur development in the District. The centralized stormwater facility at Allianz Field eliminates the need for developers to construct individual stormwater facilities at each new building, which streamlines the construction process and gives builders greater flexibility. In exchange, developers are required to contribute funds for the ongoing operation and maintenance of the central system.

Ownership Model:

The entire system is owned by the City and operated as a public asset.

Role of Public Utility in Project:

The system was designed by a private sector development partner as part of the broader public infrastructure design and delivery agreement. The Sewer Utility Division within the City's Public Works department provided technical input regarding design of the underground vault which houses the "smart hub" treatment components. They also interfaced with the development partner for turnover and acceptance of the system. The City's Department of Safety and Inspections provided technical input regarding cistern requirements, treatment performance standards, and commissioning testing.

Project Cost and Funding:

The capital cost of the reuse system was approximately $2,100,000. The City funded the infrastructure work and established a Green Infrastructure District for the project area. The Metropolitan Council awarded a $200,000 grant to the Capitol Region Watershed District for their involvement in the project, and additional funding was provided by the Clean Water, Land and Legacy Amendment's Clean Water Fund. All future buildings in the District are required to connect and pay a "standard" stormwater connection fee at the time of development.

Lessons Learned:

The district-scale reuse system was considered a design alternate in the civil infrastructure package until district-based supplemental funding was secured. Therefore, much of the detailed design did not occur until very late in site development. Many aspects of the innovative system transcended established protocols for infrastructure testing, acceptance, and operation. The public-private partnership model, in addition to the design-build nature of the work, streamlined delivery but constrained typical owner oversight and protections. In summary, the City carried an extensive level of risk in order to capitalize on an opportunity to "move the needle" with a project of this scale and complexity.

Key takeaways were to: start earlier with detailed design rather than waiting for supplemental funding to allow more time to evaluate design considerations, create a roadmap of criteria to achieve necessary municipal approvals, and to avoid unnecessary overdesign of the treatment system.

Reference: Wes Saunders-Pearce, City of St. Paul (wes.saunders-pearce@ci.stpaul.mn.us), (651) 266-9112

Onsite reuse system's "Smart Hub" (image courtesy of the City of St. Paul)

The WaterHub® at Emory University – Atlanta, Georgia

Exterior of the WaterHub greenhouse at Emory University (image courtesy of Sustainable Water)

Project Status: Completed

Project Size: 7,800 Square Feet (3,500 Greenhouse/Building, 3,000 Outdoor Hydroponics)

Alternate Water Sources:
- Blackwater

End Uses:
- Boiler Makeup
- Cooling Tower Makeup
- Toilet Flushing

Treatment System Size: 440,000 Gallons/Day

Potable Water Use Reduction: 40%

Drivers: Drought, Aging Infrastructure, EPA Consent Decrees, Rising Water & Sewer Rates, Conserving Community Water Resources

System Cost: Not Available

Annual O&M Cost: Not Available

Owner: Third-Party Investor

Project Description:

Since it was commissioned in May 2015, the WaterHub at Emory University has provided over 350 million gallons of recycled water to the campus and is designed to reduce the campus's total water demand by 40%. Wastewater is mined directly from the municipally owned sewer system on campus, and reclaimed water is provided to campus HVAC/utility systems (makeup for central chiller and steam plants). The treatment process is housed in a greenhouse to allow for the integration of technology and nature deploying a hydroponic moving bed biofilm reactor (MBBR) treatment train. The greenhouse also serves as a gathering place for a student led docent program providing 3 tours per week and a central facility for the Living, Learning Laboratory for the campus. While the WaterHub currently serves five central utility plants through a reclaimed water distribution network of 4,400 linear feet, the non-potable service will expand to as many as five other campus-owned utility systems over the next few years, including the University Hospital.

In addition to servicing campus utilities, the WaterHub is connected to a residential dormitory delivering it with non-potable water for toilet flushing. Emory

University plans to connect the WaterHub® to dormitories coming online in the future that are designed to accepted non-potable water.

Drivers for Onsite Water Reuse:

In the last decade, Atlanta has witnessed numerous water-related stresses, including severe drought. The EPA mandated consent decrees to resolve critical water infrastructure failures and an extended political dispute over water rights in the so-called "Tri-State Water Wars". As a result of these challenges, Emory University set out to explore ways to minimize its impact on community water resources and the environment with a more strategic and impactful water management solution: campus-wide water reclamation and reuse.

Ownership Model:

Through a Water Processing Agreement (WPA), Sustainable Water designed, built, commissioned, and continues to oversee operations of the WaterHub on behalf of the university. Under a services agreement, a third-party operator hired by the investor takes responsibility for the ongoing operations, maintenance, and compliance. This model eliminates development and operational risk for the client while delivering long-term water utility savings through a guaranteed discounted rate structure.

Role of Public Utility in Project:

Dekalb County was instrumental in the permitting and final approval processes of this project. With Dekalb County working towards the federally mandated infrastructure improvements to meet their consent decrees, they welcomed the sewer flow reductions that would result from the treatment and beneficial reuse across Emory University's campus.

Project Cost and Funding:

The project was funded through a Water Processing Agreement with no capital or operating costs borne by Emory University and guaranteed savings accruing over the life of the project.

Lessons Learned:

- Engage with academic stakeholders early and do not under estimate the value these stakeholders have in a campus utility / facilities design process.
- Never under estimate public interest in local sustainability initiatives and plan for interactive tours.
- Plan for the future. Design for the next 30 years of development, demand, and hydraulic constraints.

Reference: Bob Salvatelli, Sustainable Water (bob.salvatelli@sustainablewater.com) (973) 632-8560

Interior of the greenhouse (image courtesy of Sustainable Water)

Nye Sustainable Suburb – Aarhus, Denmark

Homes surrounding Nye's central lake/storage reservoir (image courtesy of Aarhus Vand)

Project Status: Under Construction

Project Size: 42 Acres

Alternate Water Sources:
- Rainwater

End Uses:
- Toilet Flushing
- Laundry

Treatment System Size: Not Available

Potable Water Use Reduction: 40%; 10-13 Gal/Person/Day; up to 800,000 Gallons/Year

Drivers: Sustainability Goals, Conserving Groundwater Resources, Localized Stormwater Management

System Cost: $1.4 Million (Estimated)

Annual O&M Cost: TBD (Estimated $42,000/Year)

Owner: Aarhus Vand A/S, Denmark

Project Description:

The construction of Nye, a new suburb of Aarhus, Denmark, is a city-driven initiative to meet Aarhus's increasing housing demand with a water-wise urban district that will make sustainable living more effortless for its citizens. Nye is designed to be resilient to the anticipated effects of climate change by incorporating blue/green structures that will also serve as natural amenities for residents and increase biodiversity. The private developer, local water utility Aarhus Vand, and Aarhus municipality collaborated to build a pilot rainwater harvesting system that will be the first of its kind in Denmark. Rainwater from roofs, roads, and open areas are to be collected and conveyed through a network of trenches and ponds to a central lake, which will serve as a storage reservoir. A central treatment plant will pump recycled water through a secondary pipe network to meet the non-potable demands of the community's households, such as toilet flushing and laundry.

The Nye suburb is still under construction, but its first inhabitants moved in during 2018 and the water re-use system will be ready to go online in 2021. Meter data from the first 50 households shows that non-

potable water use accounts for approximately 40% of the total household water use, which confirms the expected potable water use reduction. By the time the entire development is completed, it will be able to house approximately 15,000 people.

The close collaboration between the private developer, Taekker Group; the consultant engineer, COWI; the City of Aarhus; and the water utility Aarhus Vand has resulted in a radical new approach to sustainable urban development and master planning residential areas for rainwater harvesting.

Drivers for Non-potable Water Reuse:

The main objectives are to fully manage stormwater runoff, to protect Nye from flooding from the 100-year stormwater event, and to conserve the region's groundwater, which the city of Aarhus depends on for its drinking water supply. Additionally, Nye is designed to meet a number of the UN's 17 Sustainable Development Goals (SDGs), specifically those defined by SDG 6: Clean Water and Sanitation; SDG 9: Industry, Innovation, and Infrastructure; SDG 11: Sustainable Cities and Communities; and SDG 13: Climate Action.

Ownership Model:

The water utility Aarhus Vand will own the water infrastructure.

Project Cost and Funding:

Estimated cost of the Treatment Facility and Pipe System is $1,400,000 USD.

Role of Public Utility in Project:

Motivated by maintaining a sustainable dependence on local groundwater resources to supply Aarhus with water as the city continues to grow, the utility Aarhus Vand worked closely with the municipality and the private developer to design and develop Nye with a rainwater harvesting system to reduce its potable water demand by 40%. As the owner of Nye's water treatment plant, Aarhus Vand will charge residents the same rate for the local non-potable water service as they are charged for their potable water service.

References: Mariann Brun, Project Manager, Aarhus Vand (mariann.brun@aarhusvand.dk); Pia Jacobsen, Head of Development – Operation Division, Aarhus Vand (pia.jacobsen@aarhusvand.dk)

Schematic of the central treatment plant (image courtesy of Aarhus Vand)

The WaterHub® At Philip Morris USA – Richmond, Virginia

The WaterHub's greenhouse, administrative building, and reclaimed water storage tank (image courtesy of Sustainable Water)

Project Status: Completed

Project Size: 8,200 Square Feet

Alternate Water Sources:
- Blackwater

End Uses:
- Cooling Tower Makeup
- Open-Air Chiller Makeup

Treatment System Size: 650,000 Gallons/Day

Potable Water Use Reduction: 40%

Drivers: Operational Resiliency, Corporate Sustainability, Conserving Community Water Resources, Relieving Strain on Municipal Infrastructure

System Cost: Not Available

Annual O&M Cost: Not Available

Owner: Third-Party Investor

Project Description:

Located on the site of a former coal-fired power plant, the WaterHub at Philip Morris USA (PMUSA) is a symbol of an industrial park's turn to green infrastructure. The WaterHub, which began operation in 2019, can produce 650,000 gallons per day while also serving as the primary water supply for a district-energy system with 27,000 tons of refrigeration capacity. The WaterHub is expected to decrease total potable water use for the industrial park by approximately 40% and decrease total wastewater discharge by up to 70%. Moreover, the system is designed to reduce risk of manufacturing center downtime by providing a redundant source of makeup for critical utility (cooling tower makeup and open-aired chillers) operations.

The full project scope includes approximately 6,000 linear feet of water conveyance and distribution piping in addition to 150,000 gallons of clean water storage. The facility contains a full-service water testing laboratory, operator offices, and a conference room for staff and guests. System operations are highly automated, leveraging cloud-based state-of-the-art SCADA and 24-hour remote monitoring capabilities.

Drivers for Onsite Water Reuse:

Like many cities in the United States, the City of Richmond has a combined sewer system, which is prone to overflows during even minimal rain events. Combined sewer overflow (CSO) events have been a significant source of pollution to the James River Watershed and the larger Chesapeake Bay Watershed. The City, working with the Department of Environmental Quality to meet the goals set in its Watershed Action Plan, welcomed the sewer flow and discharge reductions that the WaterHub would achieve by diverting for treatment and reuse across the industrial campus. Altria, the parent company of PMUSA, was also looking for an opportunity to provide industry leadership in water sustainability by conserving community water resources, relieving the strain on local municipal infrastructure, and insulating their operational viability, all of which is accomplished by the WaterHub system.

Ownership Model:

Through a Water Processing Agreement (WPA), Sustainable Water designed, built, and operates the WaterHub at PMUSA. Under a services agreement, Sustainable Water takes responsibility for all permitting, compliance, and maintenance matters through the life of the contract. This development model eliminates development and operational risk for the Client while delivering long-term water utility savings through a guaranteed discounted rate structure.

Role of Public Utility in Project:

The City of Richmond was instrumental in the permitting and final approval processes of the project.

Project Cost and Funding:

The project was funded through a WPA with no capital or operating costs borne by Philip Morris USA and guaranteed savings accruing over the life of the project.

Lessons Learned:

A key learning was that industrial clients such as Philip Morris USA tend to have higher variability of influent concentrations, especially after cleaning processes are conducted during semi-annual maintenance protocols. Another lesson was to plan ahead for the possible expansion of the water reuse system's distribution components.

Reference: Bob Salvatelli, Director of Business Development at Sustainable Water
(bob.salvatelli@sustainablewater.com)
(973) 632-8560

The onsite reuse system's mechanical room (image courtesy of Sustainable Water)