On-Site Gray Water Reuse in High-Rise Residential Projects

Case Studies: Ālia and Kuilei Place

KOBAYASHI GROUP

Commercial Plumbing Inc.
AN EMPLOYEE OWNED COMPANY

Why Water Reuse Is Important for Hawai‘i

Buildings produce ~40% of global CO_2 emissions.

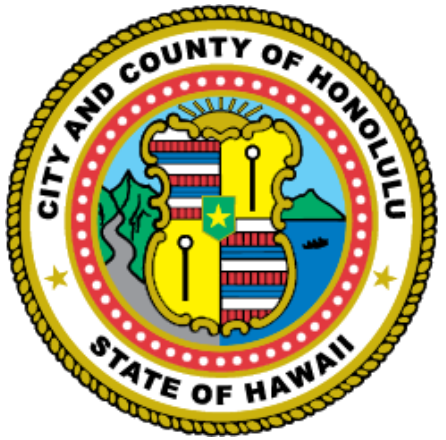
Global construction is projected to double by 2060.

Hawai‘i faces rising seas and groundwater intrusion (UH studies, Dr. Chip Fletcher).

Navigating Hawai‘i’s Regulatory Framework

Developed in partnership with key agencies including:

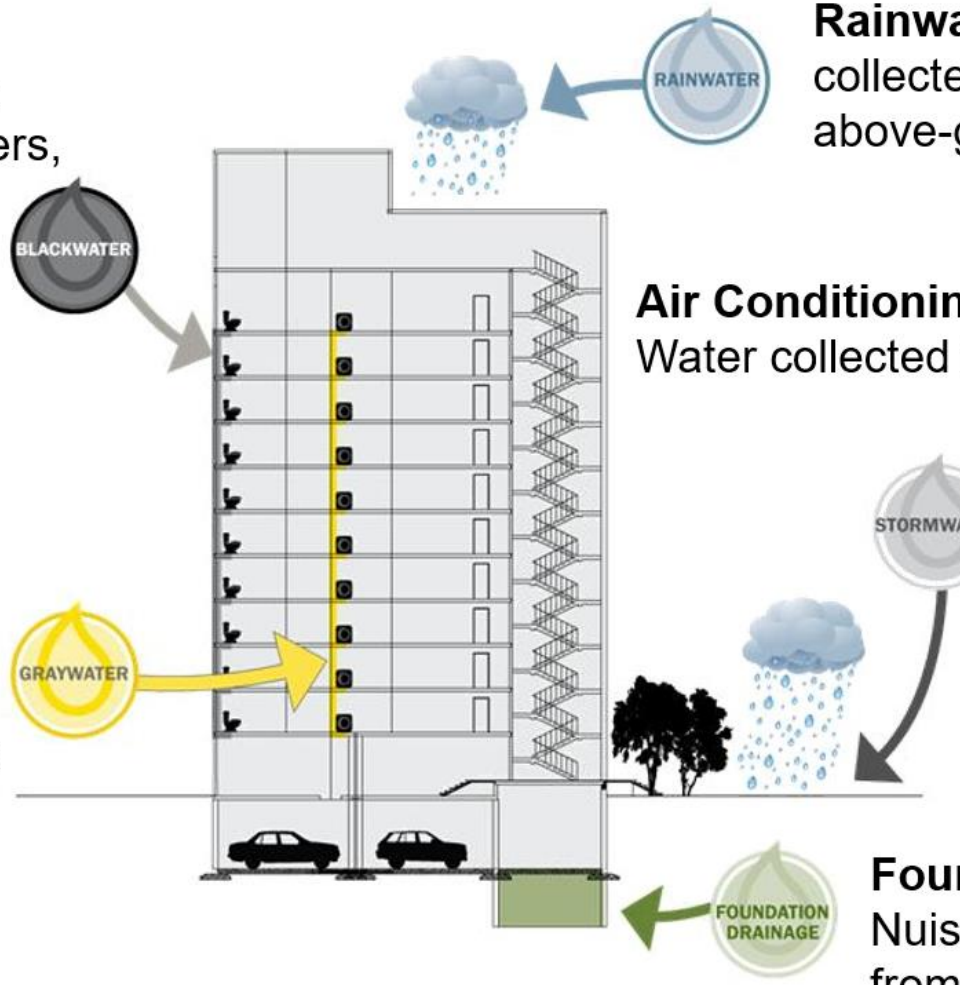
- Hawai‘i Department of Health (DOH)
- City & County of Honolulu Department of Planning and Permitting (DPP)
- Board of Water Supply (BWS)
- Department of Environmental Services (ENV)



Graywater Collection and Reuse System Flow

Blackwater:
Wastewater from toilets, dishwashers, kitchen sinks, and utility sinks

Greywater:
Wastewater from clothes washers, bathtubs, showers, and bathroom sinks



Rainwater: Precipitation collected from roofs and above-grade surfaces

Air Conditioning Condensate:
Water collected from evaporator coils

Stormwater:
Precipitation collected at or below grade

Foundation Drainage:
Nuisance groundwater from dewatering operations

Research & Benchmarking

- Visited five California systems:
  • 1 blackwater • 3 graywater • 1 stormwater installation
- Observed filtration design, maintenance access, and system monitoring

Key Takeaways:

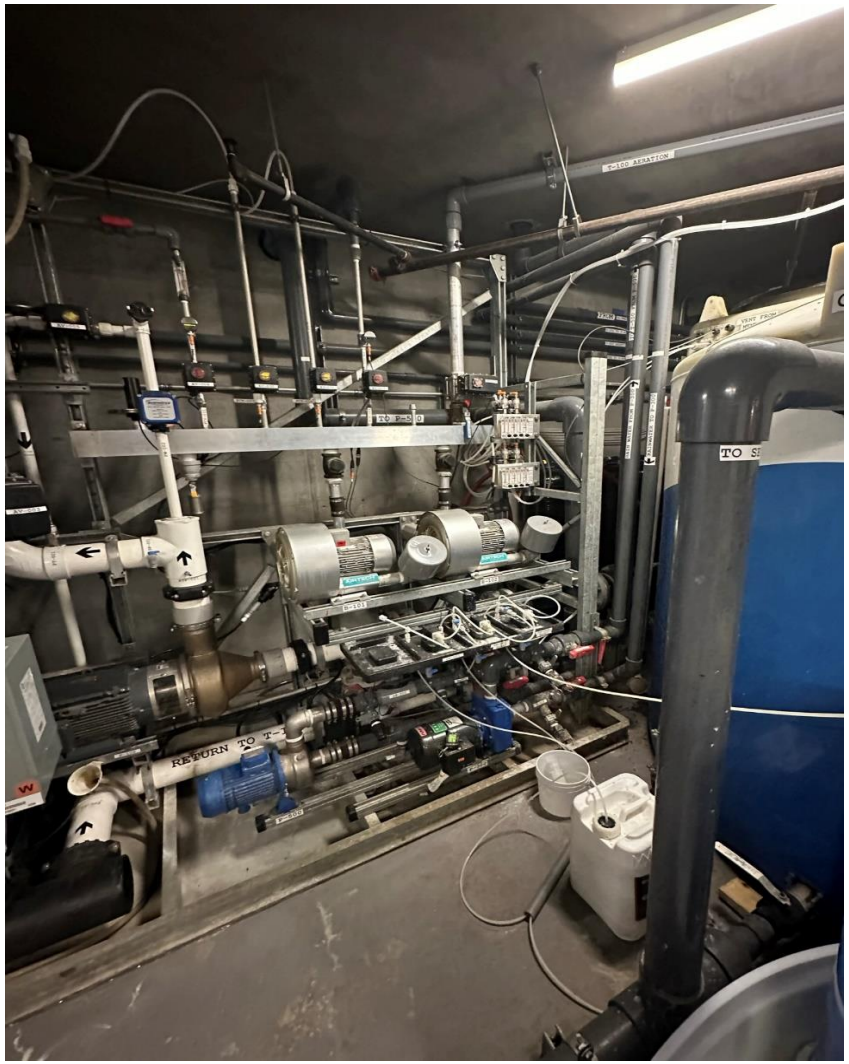
- Simpler systems = greater long-term reliability
- Integrate early in design to avoid retrofit challenges
- Collaboration among owner, engineer, and operator critical
- California’s 30+ years of experience demonstrate regulatory maturity

1550 Mission
San Francisco

- 30+ years of proven graywater reuse in California
- First San Francisco high-rise permitted for R-1 reuse
- Reference for system design & operation in Hawai‘i‘i

1550 Mission Street – San Francisco

Membrane Filtration Skid



Aerobic Tank and Filtration

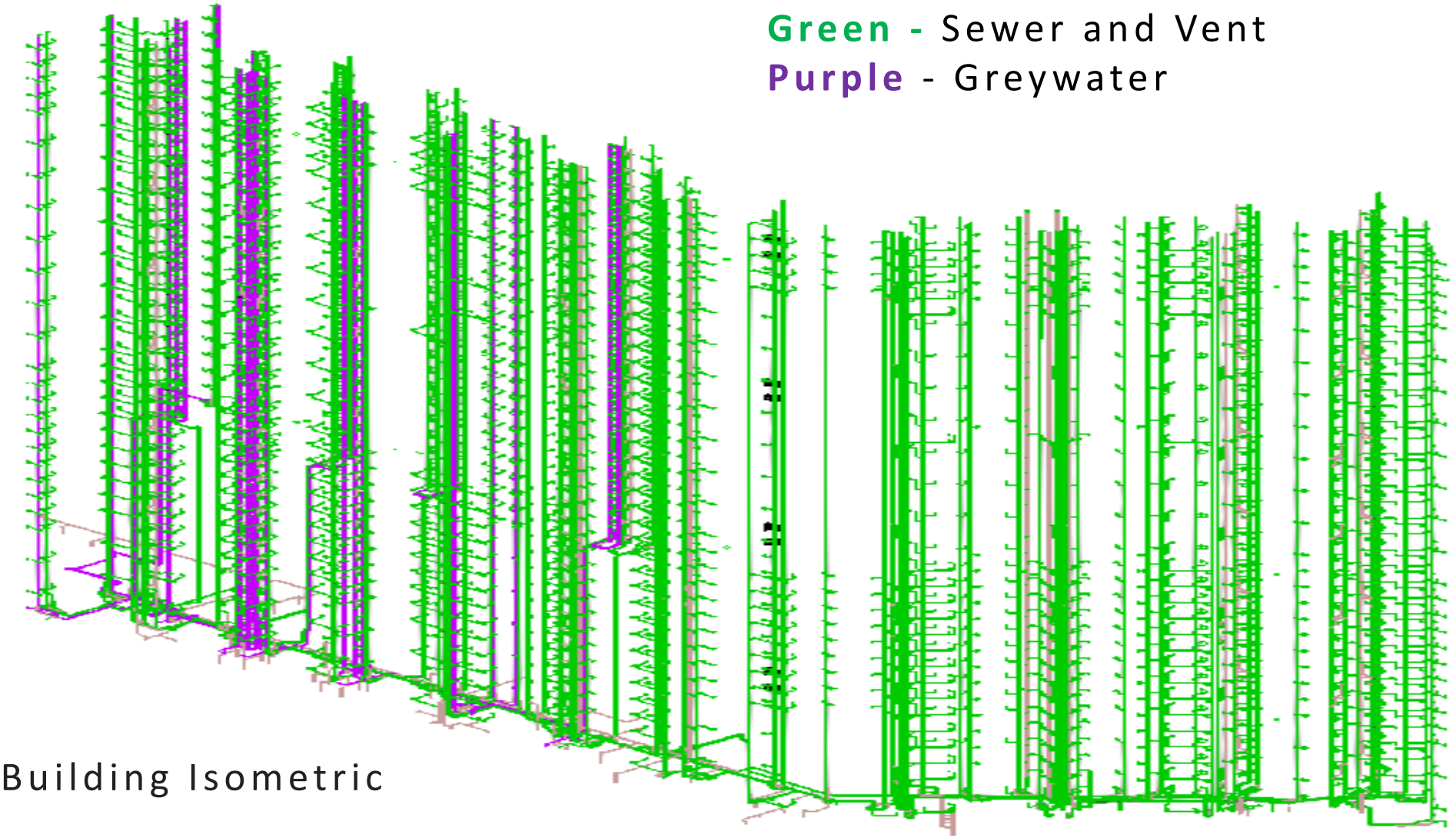
R-1 Booster Pump

On-Site Graywater Reuse Pilot System

Kuilei PLACE

Scaling Graywater Reuse for Mixed-Income Housing

Filtration & Treatment Process



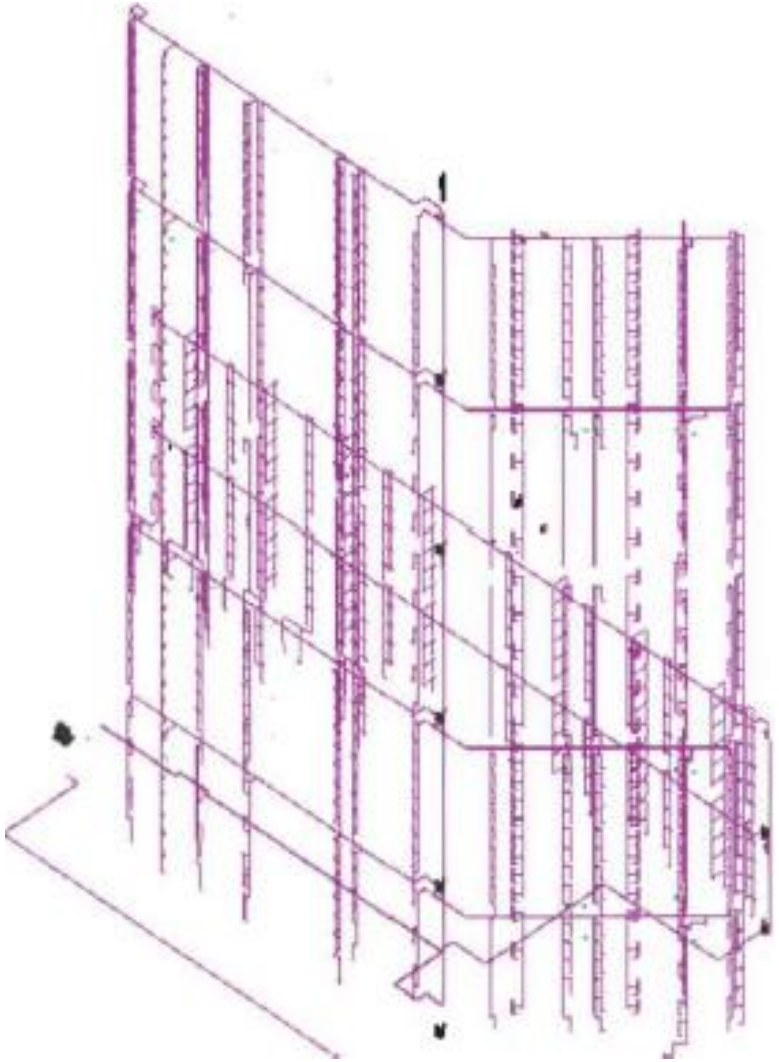
Green - Sewer and Vent
Purple - Greywater

Tower Building Isometric

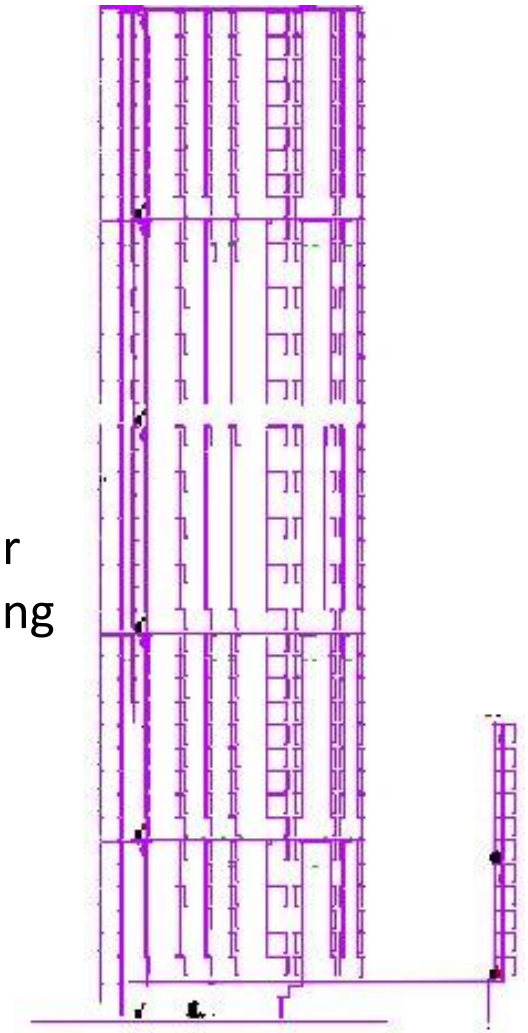
R-1 Water Distribution

Distribution of R-1 water to every toilet in residential buildings and irrigation

Isometric View

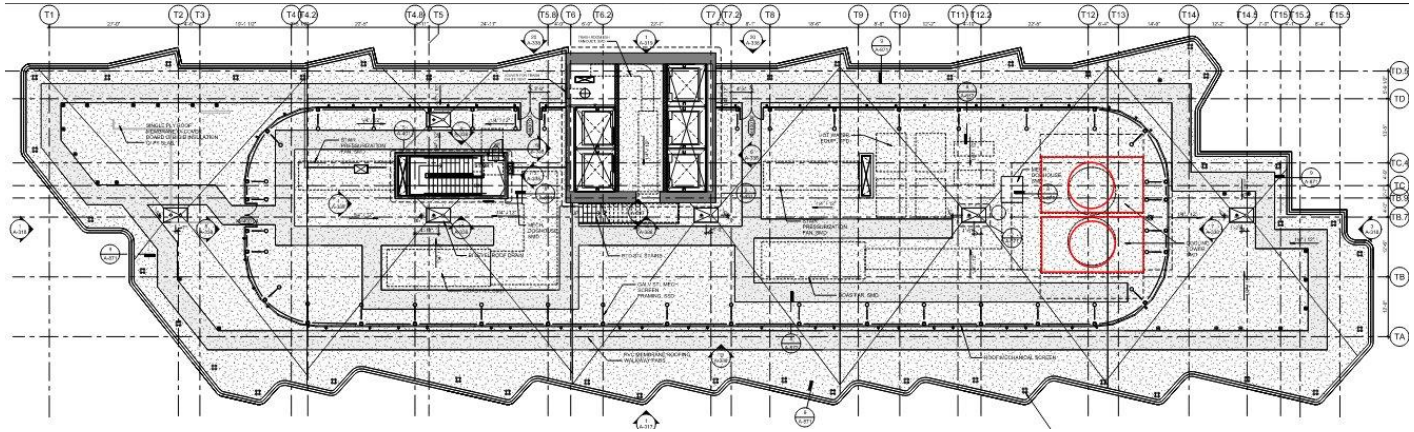


Side View Tower and Liner Building



R-1 Water Distribution & End Uses

Distribution of R-1 water for cooling tower make up and irrigation



Cooling Towers on Roof

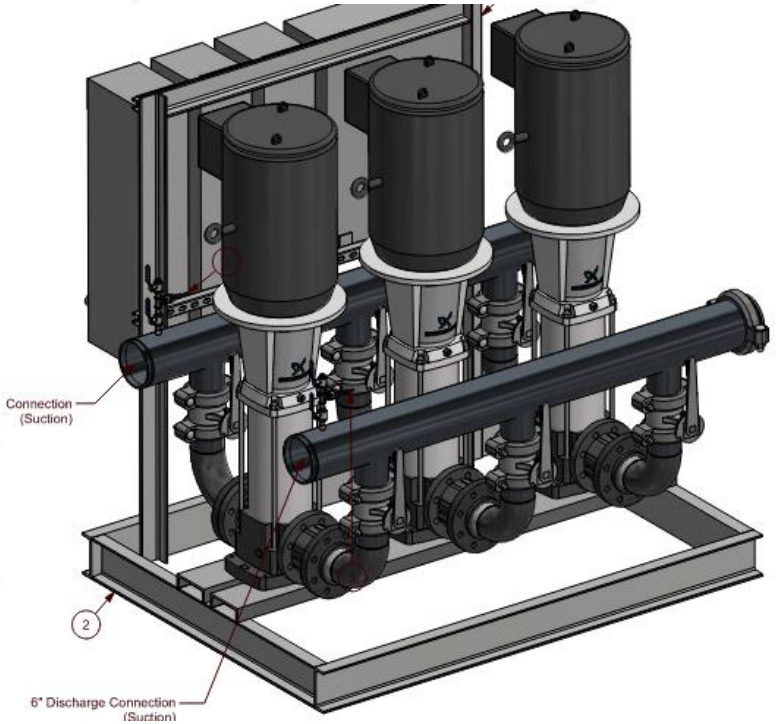
R-1 Water Distribution & End Uses

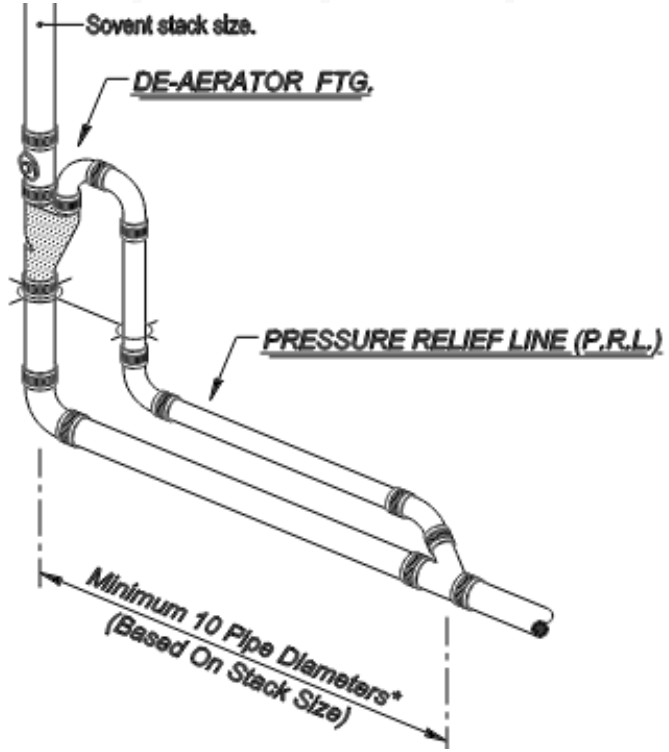
Partial Landscaping 1st Floor

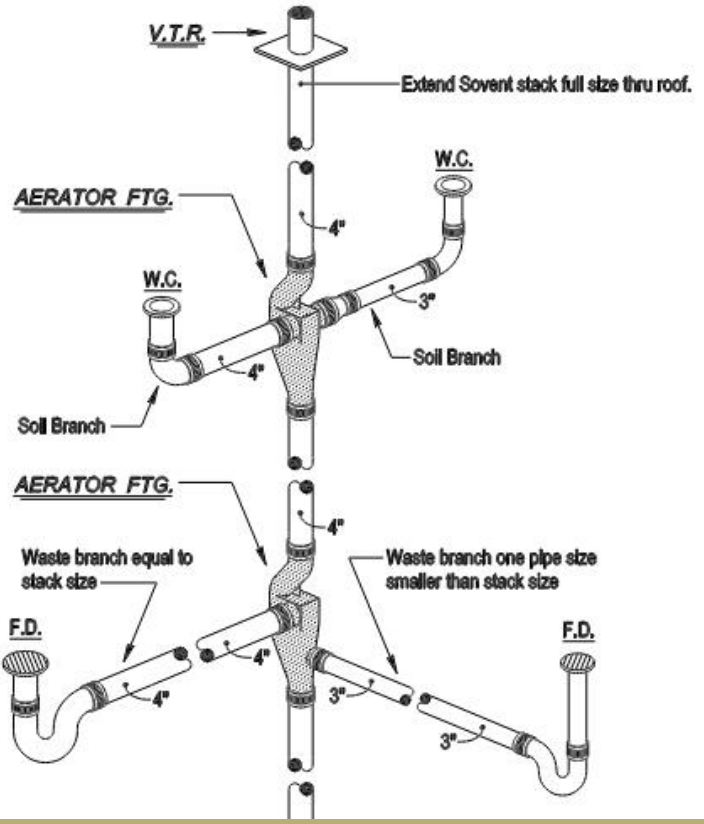
Landscaping 6th Floor Recreation Deck

System Integration in Building Design

- Systems designed like other O‘ahu high-rise projects
- Domestic water: Triplex booster pump system with VFDs and pressure-reducing valves at each zone.
- Sewer: Pre-engineered single-stack waste and vent system.







Greywater Processing Equipment

20,000 gal Equalization Tank

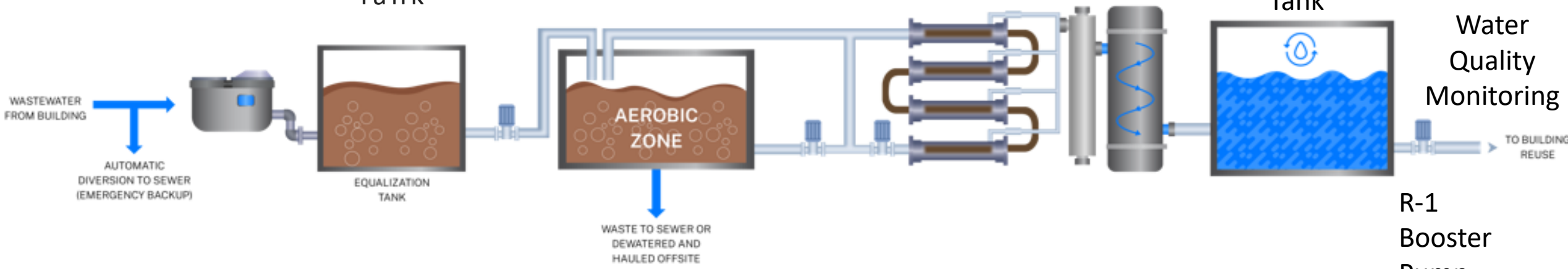
7,600 gal Aerobic Tank

Sand & Membrane Filtration

UV & Chlorine Disinfection

18,800 gal R-1 Storage Tank

Real-Time Water Quality Monitoring



R-1 Booster Pump

1 PREFILTRATION AND EQUALIZATION

Collected wastewater sources is stored in an equalization tank that buffers out flow, reducing the size of the downstream system.

2 BIOLOGICAL TREATMENT

The raw wastewater undergoes biological treatment for removal of organics, known as Biological Oxygen Demand, or BOD.

3 MEMBRANE FILTRATION

Water is then is rigorously filtered using membranes with a nominal pore diameter of .04 microns.

4 DISINFECTION & STORAGE

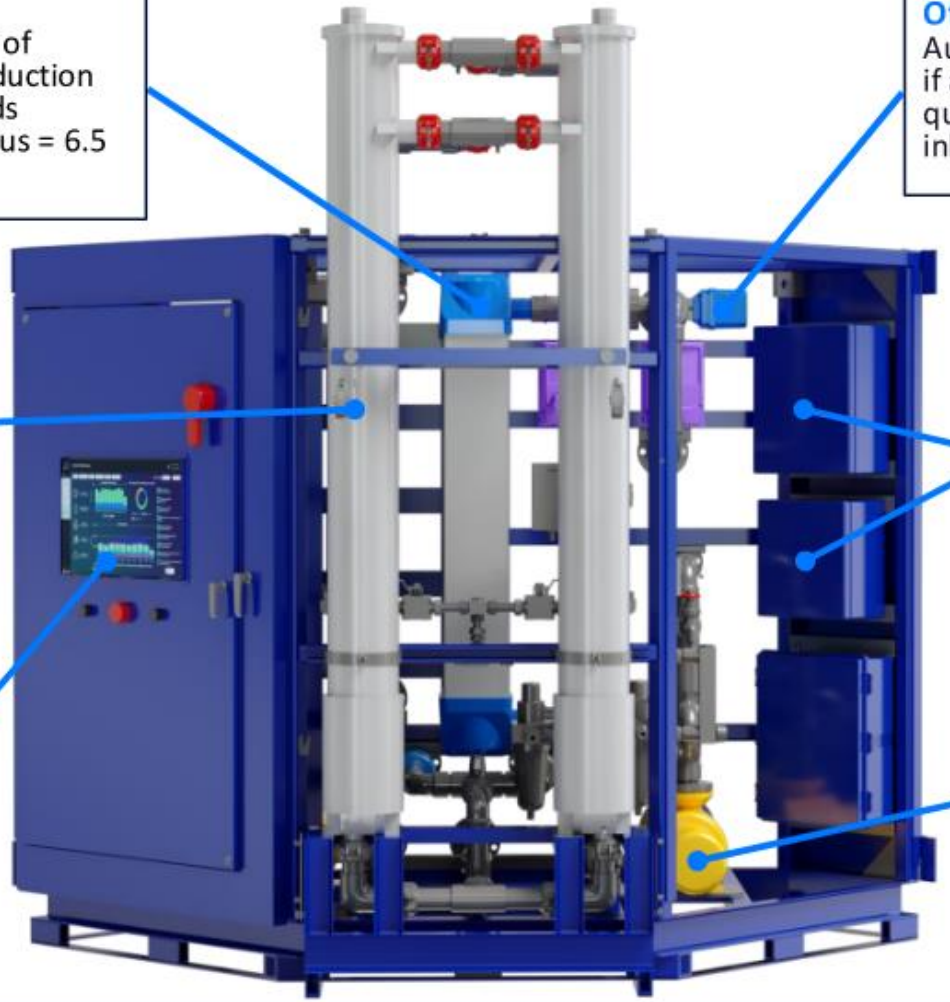
Before pumping for reuse in the building, water undergoes multiple steps of disinfection via ultraviolet light and chlorine, which render the water safe for reuse in non-potable applications.

Epic Cleantec's OneWater™ System Overview

UV Disinfection
Ultraviolet light units provide 80 mJ/cm² of dosage to meet Title 22 standards for reduction of potentially harmful pathogens. Exceeds regulatory LRT credits. Log reduction: Virus = 6.5 | Protozoa = 7 | Bacteria = 9

Ultrafiltration Membranes
With a nominal pore size of 0.04 microns, these membranes effectively remove particulate and microorganisms, reduces turbidity. Physical barrier to prevent dangerous matter from passing through the filtration step.

Eco-Insights Dashboard
The main control center for the system, owners and operators can view system performance metrics, alarms, and water savings trends remotely or on this integrated display.



Off Spec Diversion Valve
Automatically diverts the water to sewer if any parameter doesn't meet water quality requirements based on various inline continuous sensors.

Turbidity & Chlorine Analyzer
These devices provide real-time measurement of clarity and chlorine levels in the effluent, ensuring effective disinfection. Off-spec water is automatically diverted to the sewer for disposal.

Pumps
Skid-integrated pumps convey wastewater between the EQ Tank, Aerobic Tank, and membrane filtration.

Inside The Treatment Room

CIP Skid
Automatically cleans and regenerates membrane filters as particulates accumulate on membrane surface.

Pre-Filter
This initial filtration step removes coarse debris such as hair & lint to protect membranes and increase disinfection efficiency.

Epic's OneWater™ System
This skid houses essential components like pumps, membrane filters, UV units, and more.

Recycled Water Booster Pumps
These pumps deliver recycled water to non-potable end uses like irrigation, toilet flushing, and cooling tower makeup water.

Odor Control Unit
Granular activated carbon (GAC) odor control units can be used to reduce or eliminate the presence of odors that are typically associated with wastewater treatment.

Internet Connectivity
The system is monitored in real-time to ensure optimal performance. Epic's operators can log in remotely to make system adjustments and troubleshoot any issues.

Water Quality Monitoring & Reporting

- Continuous monitoring required by the Department of Health (DOH)
- Parameters tracked: chlorine residual, UV intensity, turbidity, and pH
- Automated alarms trigger shutdown and divert greywater to sewer
- Regular sampling and reports submitted to DOH
- Cloud-based dashboard enables real-time monitoring and maintenance access

Comparison of Treated Greywater Effluent Water Standards

The proposed OneWater™ onsite non-potable water treatment and reuse system meets or exceeds all water quality criteria outlined in SFPUC Article 12C and Volume 1, Section D of the Hawai'i State Department of Health's (DOH) Water Reuse Guidelines. The system includes instrumentation for real time measurement of water quality with automatic diversion to sewer if any parameter does not meet water quality requirements. City municipal potable water can supply the cooling towers as a backup source versus non-potable water if needed and is protected with an air gap fill mechanism for cross connection control purposes.

Constituent	R-1 Recycled Water	Article 12C	Proposed System
BOD_5	< 5 mg/L	< 25 mg/L	< 5 mg/L
TSS	< 5 mg/L	< 30 mg/L	< 5 mg/L
Membrane Filitration & Turbidity	< 0.2 NTU more than 5% of the time within a 24-hour period < 0.5 NTU at any time. Diversion of wastewater is required if turbidity exceeds 0.5 NTU	95% maximum: 0.2 NTU Absolute maximum: 0.5 NTU	95% occurrences <0.2 NTU Always <0.5 NTU
UV Disinfection (with membrane filtration)	Design UV dose > 80 mJ/cm^2 Filtered UV transmittance (UVT) > 65% at 254 nm Disinfection systems shall comply with the NWRI UV Guidelines	Per Table 3 in Article 12C regulations. UV dosage value is not a fixed value but based on Log Reduction Targets being achieved, see below.	160 mJ/cm^2 (two units in series, double dose of 80 mJ/cm^2)
Log Reduction Targets (LRT)	N/A	Enteric Virus = 6.0 Parasitic Protozoa = 4.5 Bacteria = 3.5	Enteric Virus = 6.5 Parasitic Protozoa = 7.0 Bacteria = 9.0
Fecal Coliform	< 2.2 MPN/100 mL for the last seven days < 23 MPN/100 mL in more than one sample in any 30-day period No sample shall exceed 200 MPN/100 mL	7-sample median: < 2.2 MPN/100 mL 30 day max: 23 MPN/100 mL Absolute maximum: 240 MPN/100 mL	7 day median: < 2.2 MPN/100 mL 30 day single occurrence: < 23 MPN/100 mL Max: < 200 MPN/100mL
pH	N/A	6 - 10	6 - 9
Secondary Chlorine Residual	N/A - Not required when not using chlorine for primary disinfection method	95% of the time: > 0.5 mg/L Absolute minimum: 0.3 mg/L	0.5 mg/L

Grey Water Treatment Process – From Source to Reuse

Greywater Estimates & Anticipated Water Savings

Category	Kuilei Place	Ālia
Greywater Discharge (gallons per day)	43,250	52,000
Recycled Water Demand - Water Closet (gallons per day)	24,240	N/A
Recycled Water Demand - Irrigation (gallons per day)	5,500	7,700
Recycled Water Demand - Cooling Tower (gallons per day)	N/A	18,300
Total Daily Demand (gallons)	29,740	24,105
Monthly Water Savings (gallons)	904,592	733,194
Annual Water Savings (gallons)	**10,855,100**	**8,798,325**

*The estimate is based on shower, tub, basin, and lavatory group for sizing. Shower estimates only based on AWWA data results in 33,600 gallon estimated discharge.
**100% occupancy estimate. Building occupancy expected to settle at 50-65%.
***Peak estimated cooling demand. Minimum winter demand is expected to be 14,510 gallons per day.

Cost of Installation, Equipment & Operations

Initial Capital Savings
- BWS Water Facility (Toilets): $593,724 (Fixture fee credit)

Average Annual Utility Savings over the next 10 years with BWS and Sewer Fee Increases:
- Water Savings: $87,250
- Sewer Savings: $74,270

Total Annual Utility Savings: $161,520

Initial Capital Expenditures
- Piping & Install: $2,455,000
- Epic Equipment: $479,894
- Equipment Install: $50,000
- Booster Pump Equipment & Install: $150,000
- Design /Construction Documents: $90,000

Annual Expenditures
- Sampling & Reporting: $2,800
- Consumables: $15,000
- Equipment Maintenance: $6,000
- Electricity: $9,700

Total Initial Capital Expenditures: $3,224,894
Total Annual Expenditures: $33,500

Total Initial Capital Expenditures: $3,224,894 | Total Initial Capital Savings: $593,724 | Total Annual Expenditures: $33,500

Cost of Installation, Equipment & Operations

Initial Capital Savings
• BWS Water Facility System (Cooling Tower): Negligible fixture fee credit

Average Annual Utility Savings over the next 10 years with BWS and Sewer Fee Increases:
- Water Savings: $70,720
- Sewer Savings: $53,470

Total Annual Utility Savings: $124,190

Initial Capital Expenditures
- Piping & Install: $950,000
- Equipment: $479,894
- Equipment Install: $50,000
- Booster Pump & Install: $150,000
- Design / CDs: $82,000

Annual Expenditures
- Sampling & Reporting: $2,800
- Consumables: $15,000
- Annual Equipment: $6,000
- Electricity: $7,200

Total Initial Capital Expenditures: $1,711,894
Total Annual Expenditures: $31,000

Total Initial Capital Expenditures: $1,711,894 | Total Initial Capital Savings: $0 | Total Annual Expenditures: $31,000

KOBAYASHI GROUP | Commercial Plumbing Inc. AN EMPLOYEE OWNED COMPANY

The Path Forward:

Advancing Water Reuse in Hawai‘i Together

KOBAYASHI GROUP

Commercial Plumbing Inc.
AN EMPLOYEE OWNED COMPANY