Partnership for a Sustainable Water Future

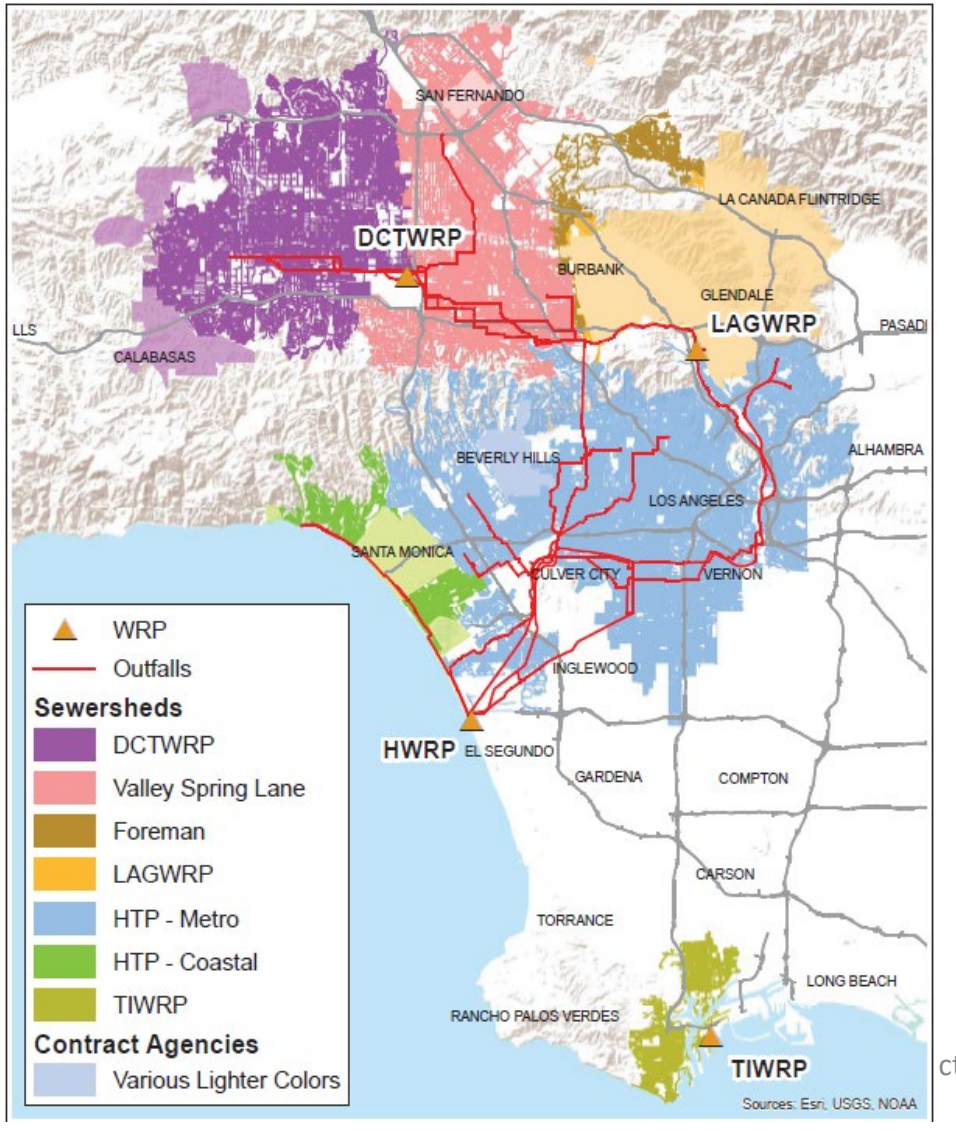
Los Angeles Groundwater Replenishment Project

LASAN Background

- **About LASAN**
  - 4.7 million people served
  - 600 square miles
  - 29 contract agencies
  - 6,700 Miles of sewer lines
  - Average System Flow: 313 MGD

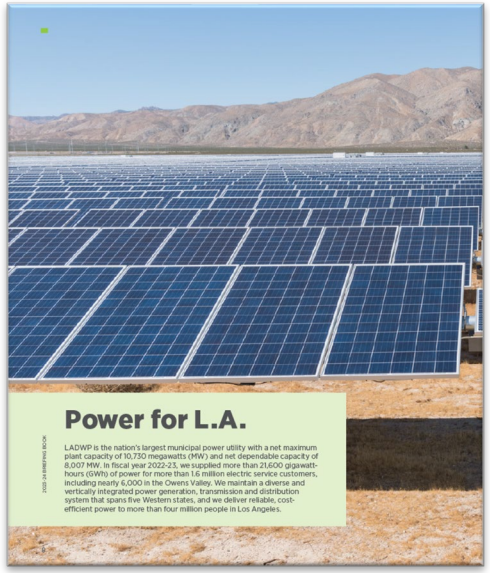
- **Hyperion Service Area: 3 Interconnected Plants**
  - Tillman Water Reclamation Plant (100% Recycled Flow)
  - Los Angeles-Glendale WRP (100% Recycled Flow))
  - Hyperion WRP (27% Recycled Flow)

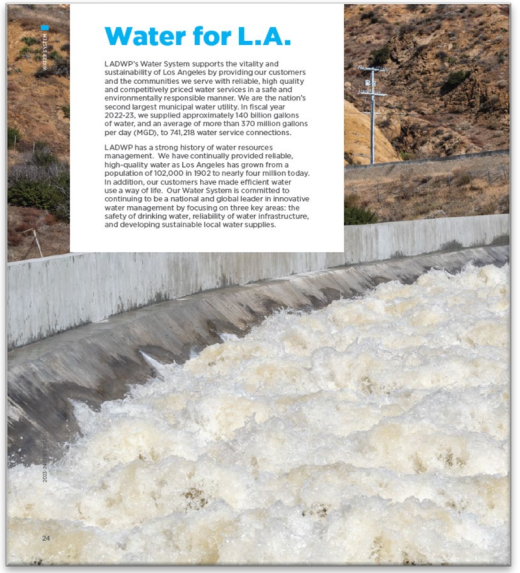
- **Terminal Island Service Area**
  - Terminal Island WRP (100% of Flow is Recycled)



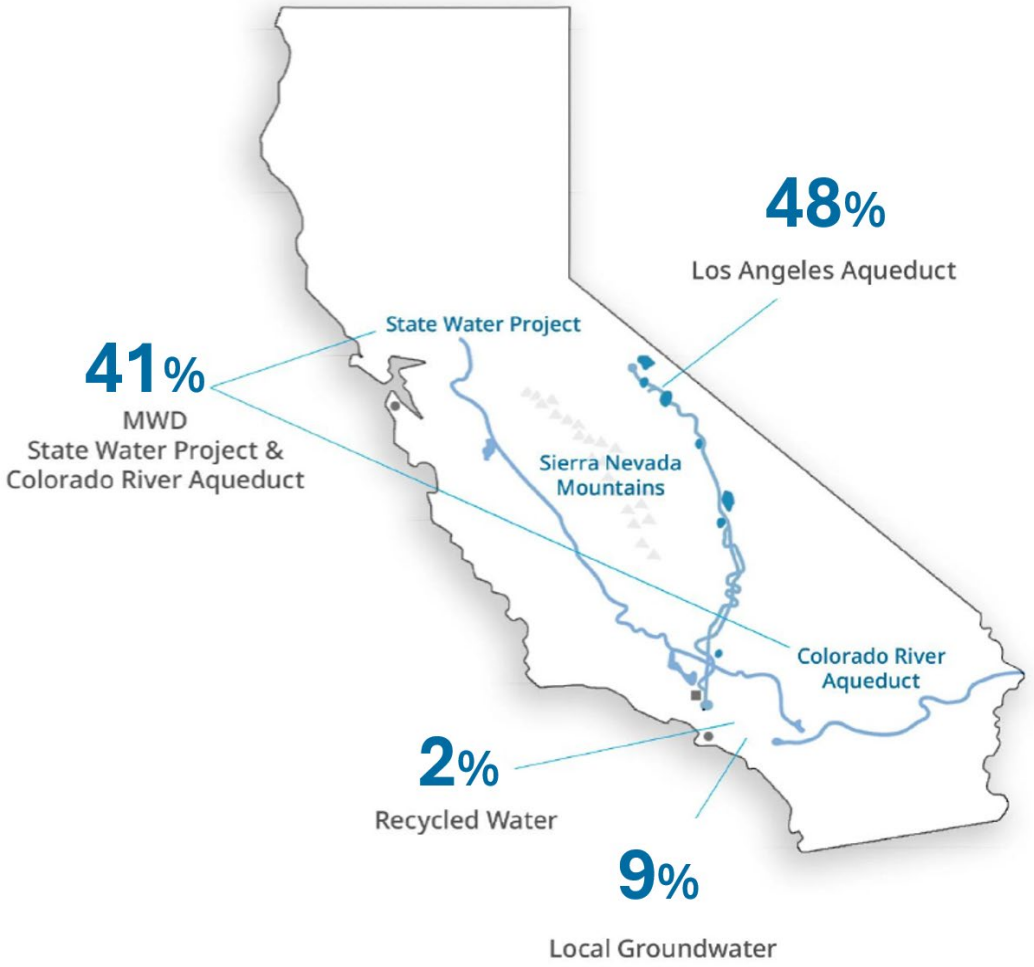
LADWP Background

- Serves a population of **3.9 million** in the City of Los Angeles
- Provides an average of **477,000 AFY** of water
- Facilities include:
  - **7,300** miles of distribution pipeline
  - **28** treatment facilities
  - **117** in-city tanks and reservoirs
  - **86** pump stations



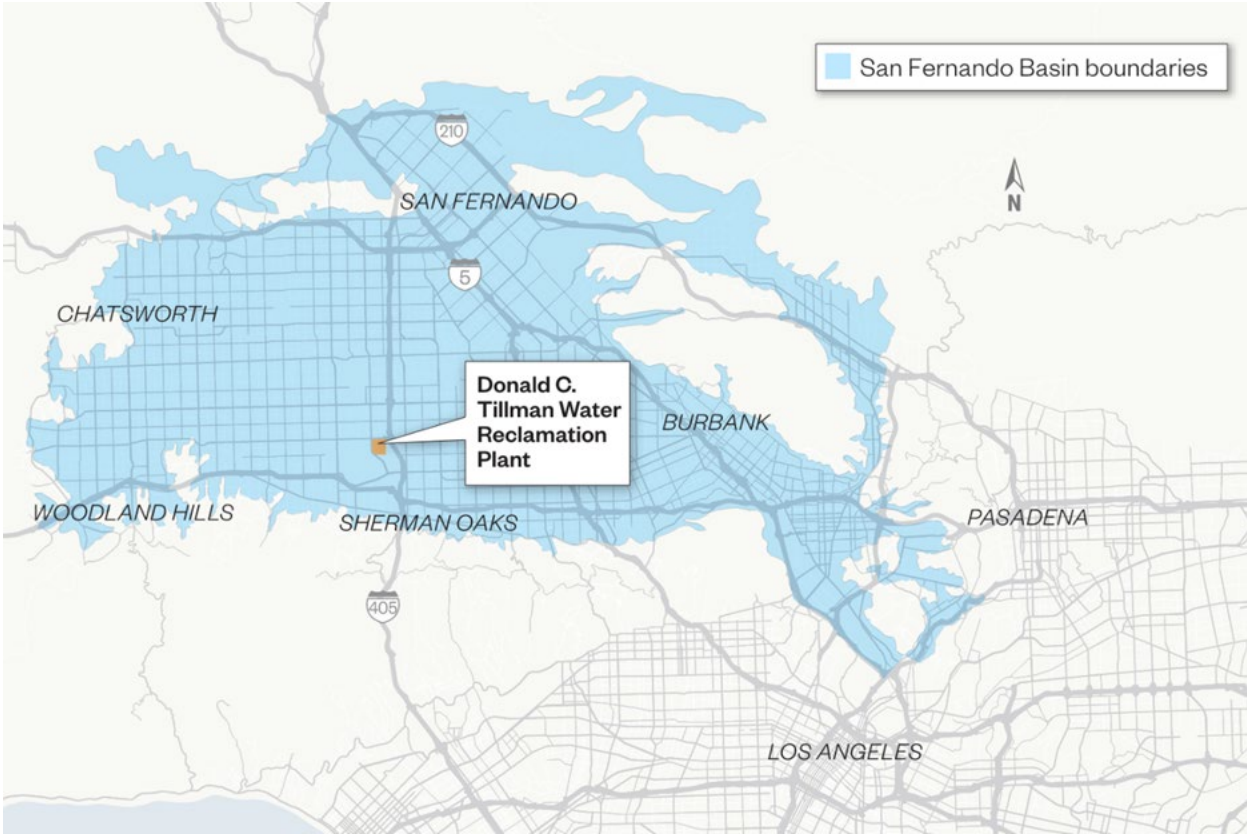


City of Los Angeles Water Supply



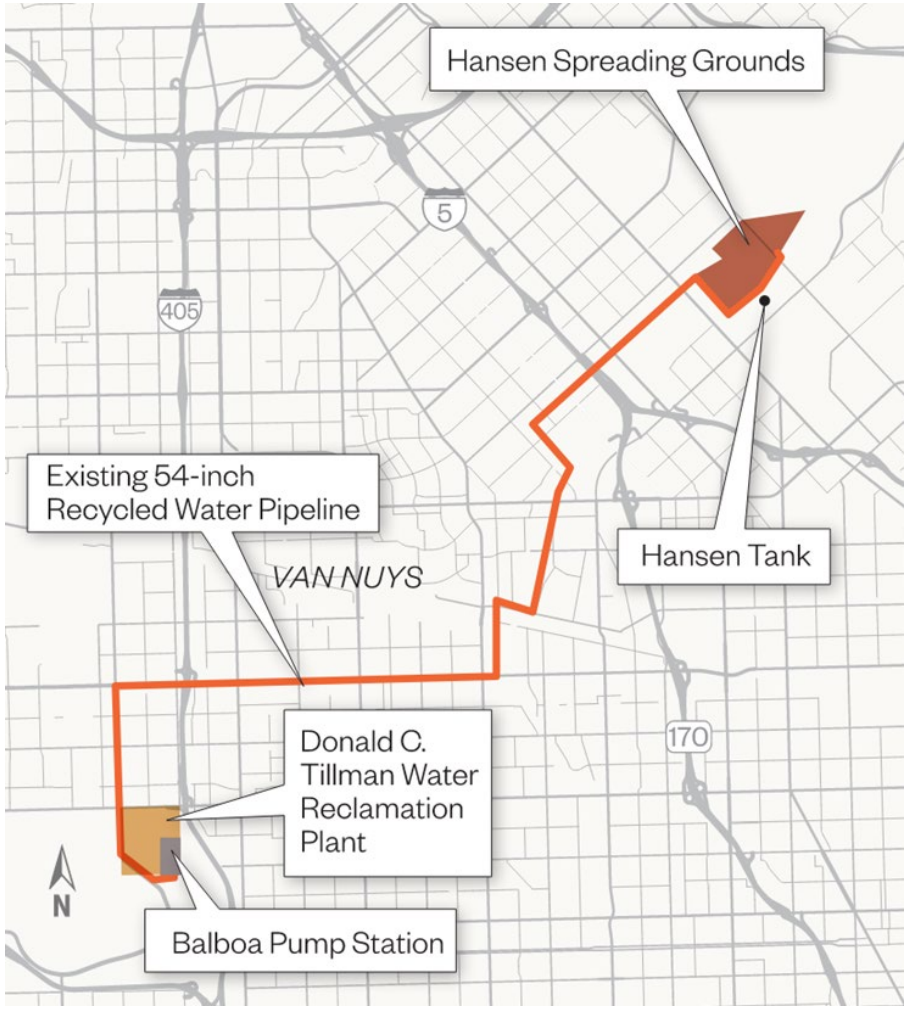
Groundwater Replenishment

- San Fernando Groundwater Basin is the principal groundwater resource for the City of Los Angeles
- Up to **23%** of total water supply **during drought years**
- *Replenishment increases resilience of local water supply*

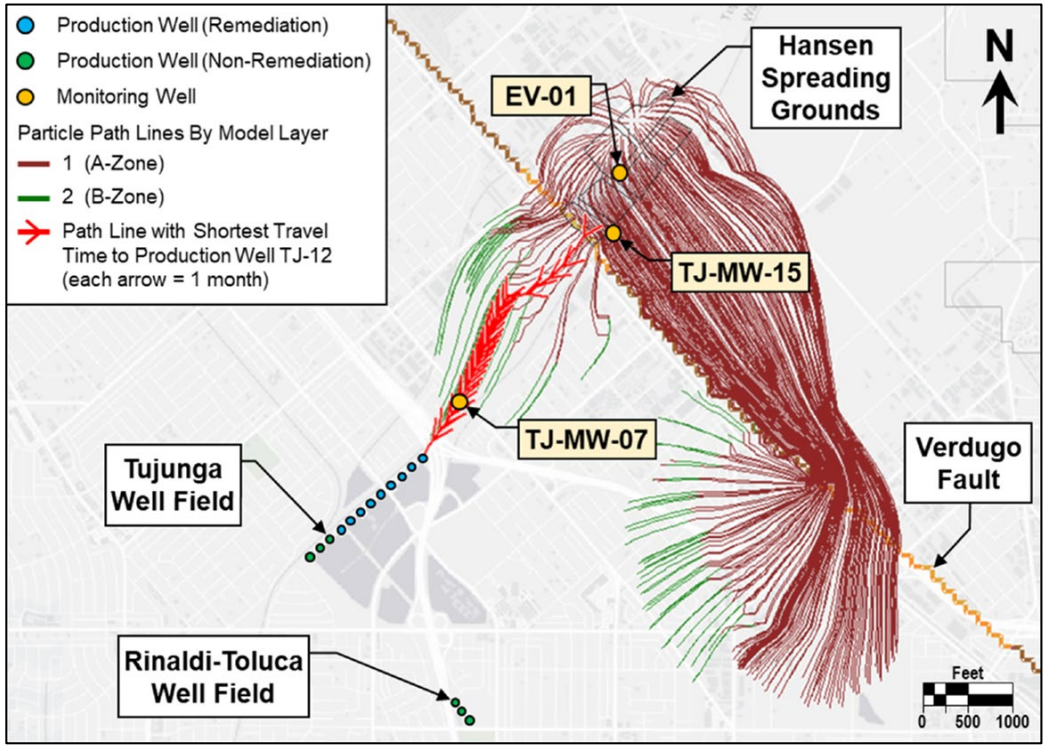


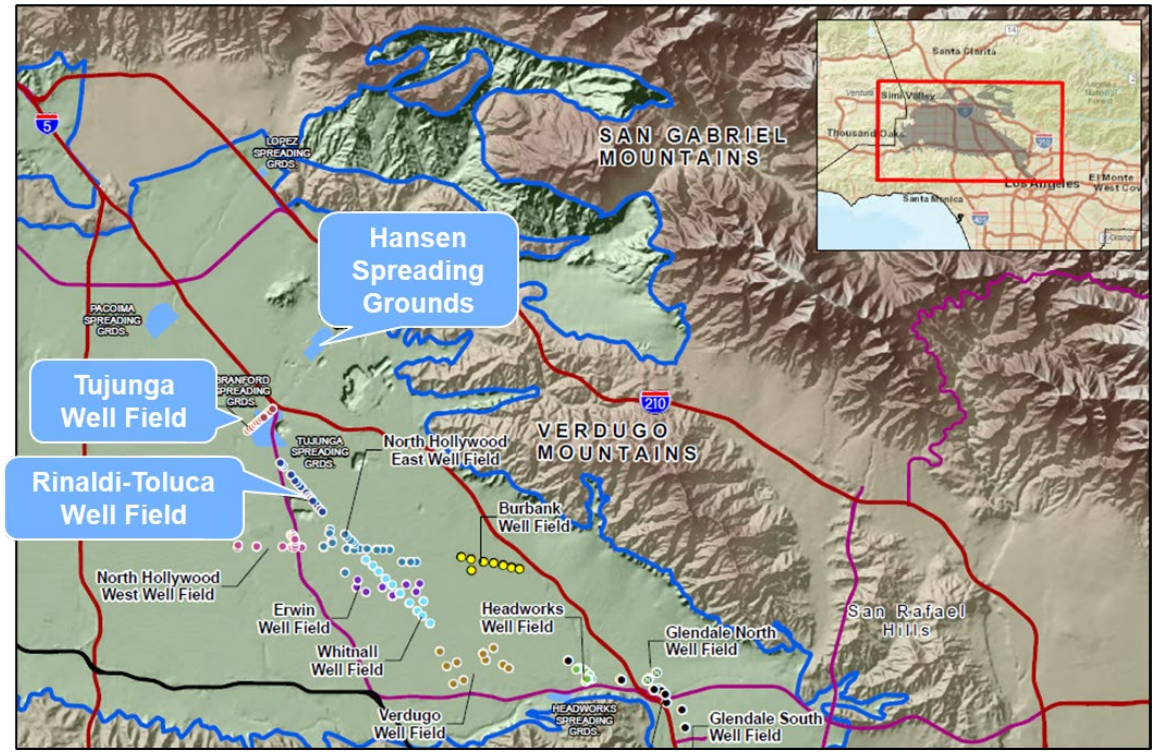
Groundwater Replenishment Project

- Treatment of Tertiary Effluent from Donald C. Tillman (**DCT**) via a new Advanced Water Purification Facility (**AWPF**)
  - **25 Million Gallons per Day (MGD) of Purification**
- Conveyance to Hansen Spreading Grounds via Existing Balboa Pump Station and 54” Pipeline
- Surface Spreading at Hansen Spreading Grounds



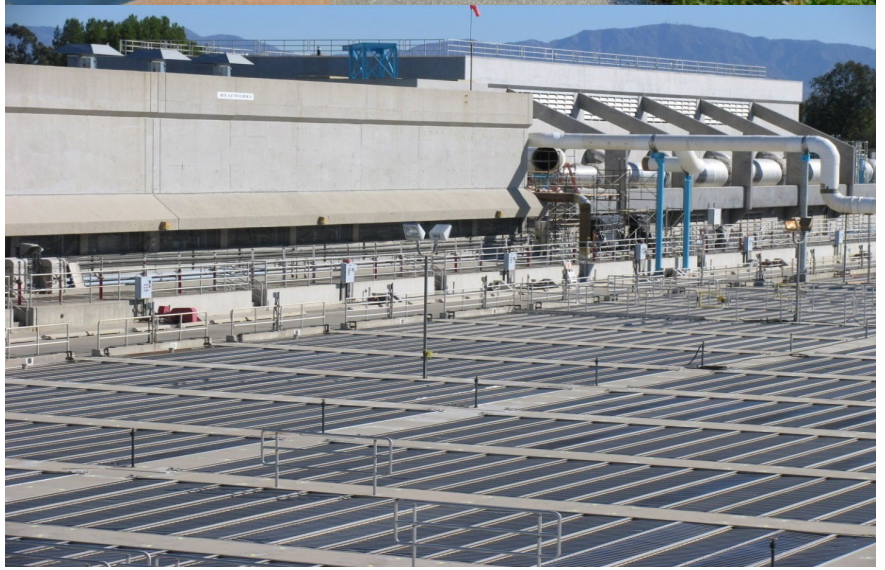
Replenishment and Extraction



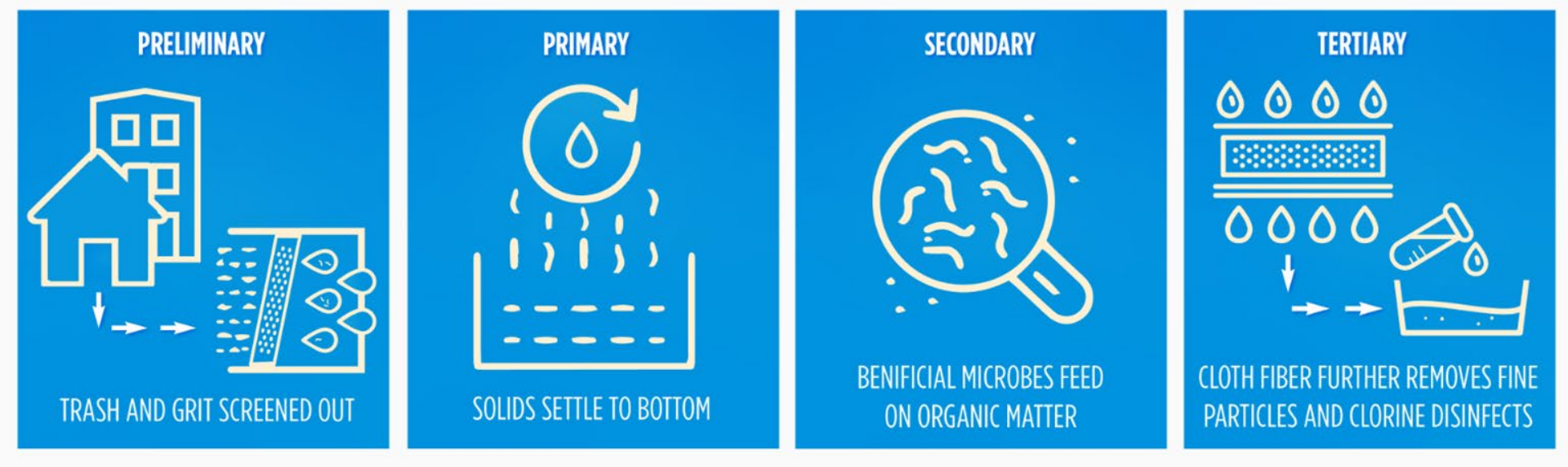


Donald C. Tillman WRP

- Treatment Capacity - 80 MGD
- Plant Size: 90 acres
- Built Dates
  - Phase I - 1984
  - Phase II - 1991
- Plant services 800,000 residents
- 70% from residential and 30% from industrial sources
- Biosolids process at Hyperion WRP
- LASAN User's Investment (10yr) 29 Capital Improvements Projects



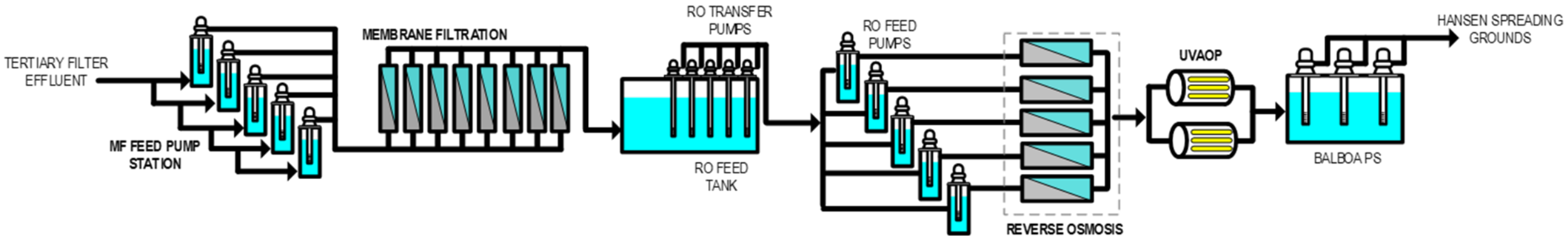
DCTWRP Conventional Treatment



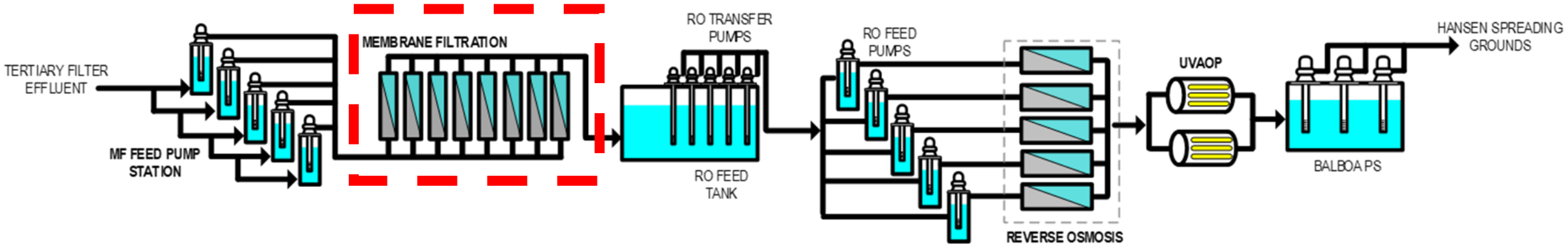
AWPF

Rendering of the Advanced Water Purification Facility (left), Learning Center (top right), and treatment floor (bottom right)

AWPF Treatment Train



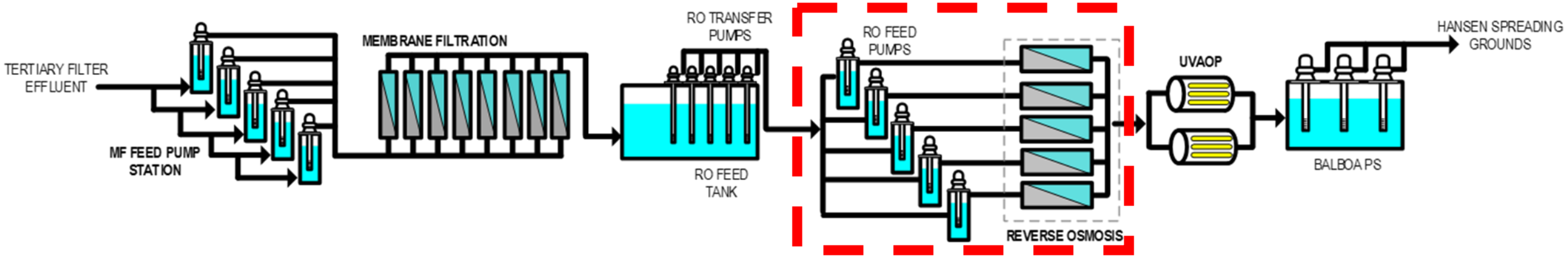
AWPF Treatment Train: MF



Membrane Filtration

- Removes Suspended Solids
- Prevents fouling of RO

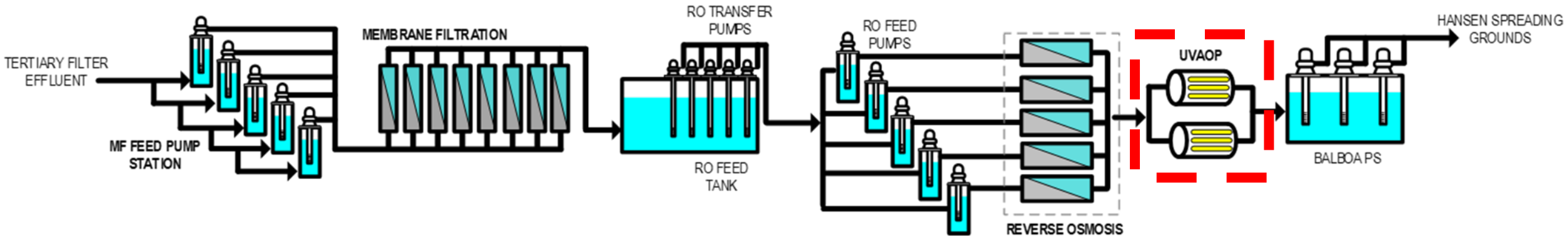
AWPF Treatment Train: RO



Reverse Osmosis

- Removes Dissolved Solids
  - Ex: PFAS

AWPF Treatment Train: UVAOP

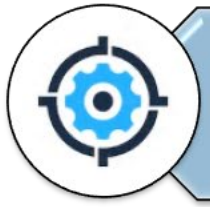


Ultraviolet Advanced Oxidation

- Disinfection of Pathogens
- Destruction of CECs

Jacobs Innovations

#1  Increase AWPF Flow

#2  Accelerated pilot testing to reduce risk from CECs

#3  Better water quality definition to optimize design

#4  Design enhancement to facilitate startup and commissioning

Jacobs Innovations

- Flow meter installation and construction/testing of spray system reduced scum waste
- Scum flow savings and other plant optimization increased AWPF design capacity by >30%

Scum Flow Reduction

3.6 mgd → 0.5 mgd

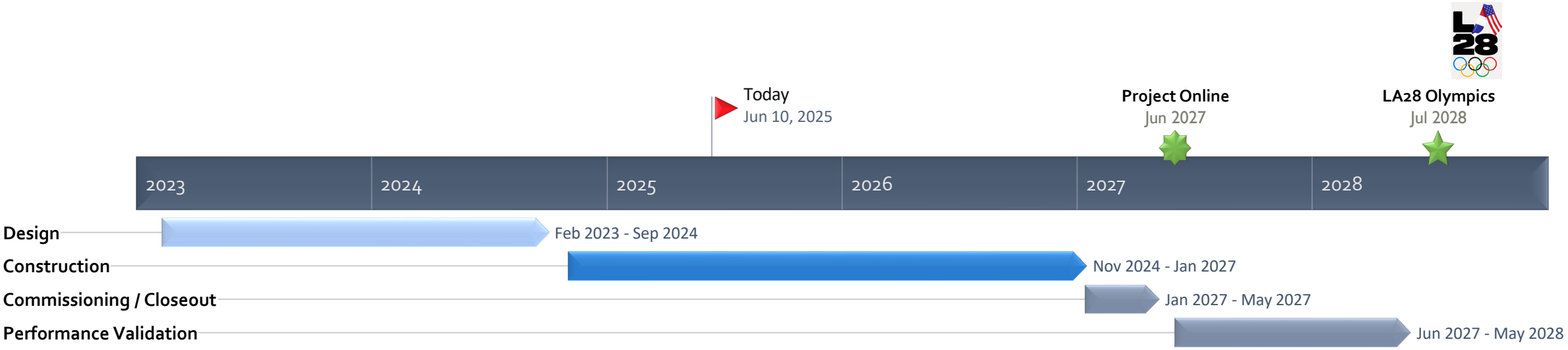
Original Design — Modified Design

AWPF Design Capacity Increase

19 mgd → 25 mgd

Original Design — Modified Design

GWR Project Schedule



Project Budget and External Funding

MWD LRP

EPA WIFIA

SWRCB SRF

BOR Title XVI

GWR awarded Title XVI Bureau of Reclamation Grant (May 2024)

Total External Funding

$426 million

Thank you!

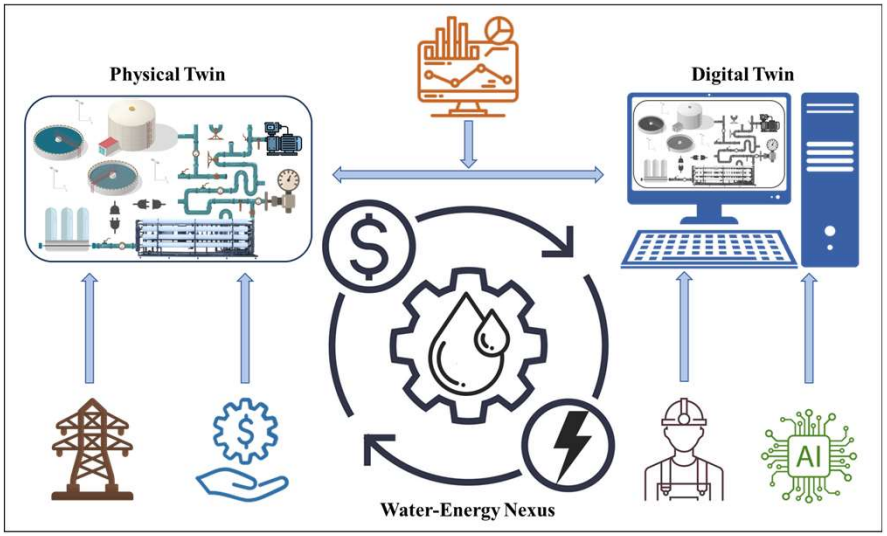

City of Los Angeles
Groundwater Replenishment Project
LA DWP Los Angeles Department of Water & Power
environment LASANITATION CITY OF LOS ANGELES zero waste · zero wasted water
Jacobs

Digital Twin Application in Water Reuse Systems – Energy and Cost Optimization

WateReuse LA Chapter Series

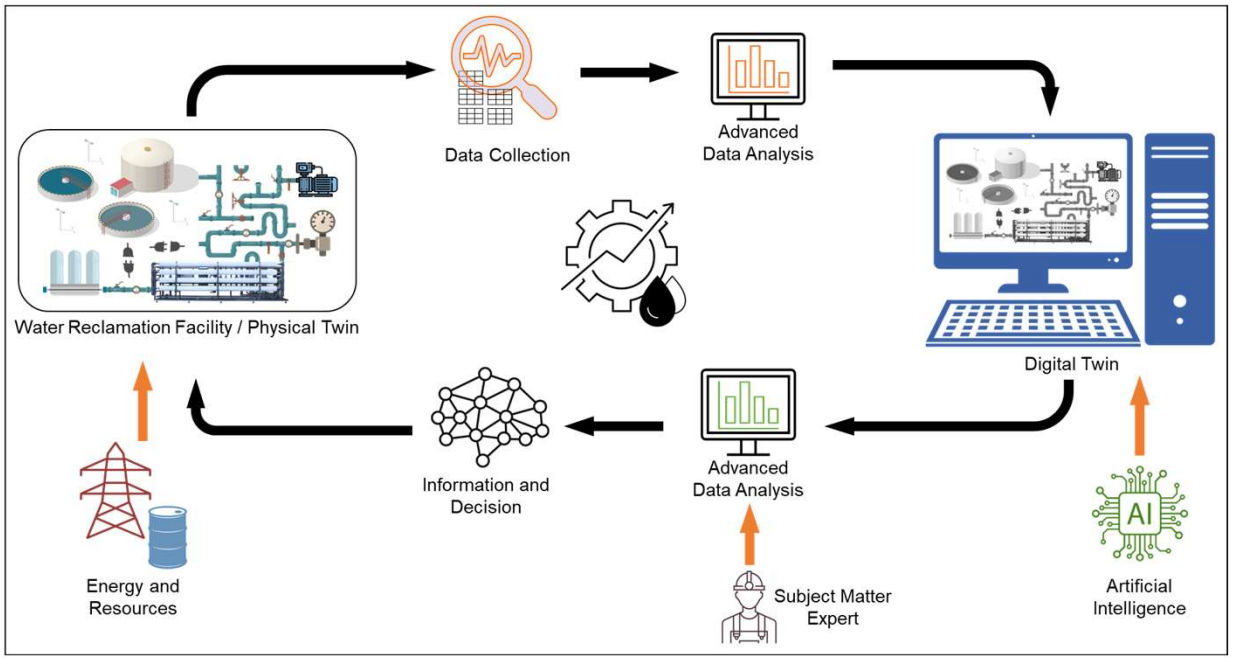
June 10, 2025

Nader Rezaei, Ph.D.



Digital Twin

- **Definition:** A virtual representation of an operating physical entity, synchronized at a specified frequency and fidelity.
- **Components:**
  - ✓ Physical Entity
  - ✓ **High-Fidelity Simulator**
  - ✓ Physical Sensors
  - ✓ Soft Sensors
  - ✓ **Physical-to-Virtual Connection**
  - ✓ Advanced Data Analysis
  - ✓ Interaction and Service
- **Applications**:
  - ✓ Monitoring (MDT)
  - ✓ Optimizing (ODT)
  - ✓ Autocalibrating (ADT)
  - ✓ Forecasting (FDT)
  - ✓ Sensitivity (SDT)
  - ✓ Wrapper



Digital Twin in the Water Industry

- **Digital Twin** (DT) in the **Water Industry**
  - ✓ Reviewed the application of DT in other industries.
  - ✓ Reviewed over 100 studies on application of DT in the water sector.
  - ✓ Major **gaps, barriers, and challenges of implementation**.
- **Innovations** in the **Water Industry**
  1. **Full-scale implementation of a DT in the water sector** (water reuse).
  2. Evaluate the approach applications using advanced data analytics methods.
  3. Identify and assess the **higher-level barriers and challenges of implementation**.

		Study Area										Digital Twin Components													
Author	Year	Collection System	Wastewater Treatment	Wastewater System	Water Reclamation	Water Distribution System	Water Treatment	Water System	Desalination	Review and Concepts	Location	Physical Entity	Physical Sensors	Modeling	Simulator (Virtual Entity)	Soft Sensors	Advanced Data Analysis	Physical-to-Virtual Connection	Controllers (Integration)	User Interface	Services (Perceived Benefits)	Conceptual/Technical Study	Review Study
Conejos et al.	2020					■					Spain	*	*		*	*		*			*	*	
Bartos & Kerkes	2021	■									USA	*		*							*		
Pedersen et al.	2021	■									Denmark											*	
Alex et al.	2020		■								Germany				*	*					*		
Curl et al.	2019				■						USA										*		
Wei et al.	2022		■								Singapore			*							*		
Therrien et al.	2020			■							Canada										*	*	*
Yang et al.	2021				■						USA			*	*						*		
Hallaji et al.	2021		■								Australia												*
Hallaji et al.	2022		■								Australia												*
Heo et al.	2022		■								South Korea	*	*	*			*				*		
Tao et al.	2019									■	China											*	*
Pesantez et al.	2022							■			USA	*	*		*			*			*		
Bonilla et al.	2022					■					Colombia	*	*		*			*			*		
Schneider et al.	2022					■					Japan											*	*
Matheri et al.	2022		■								South Africa											*	
Torfs et al.	2022					■					Belgium											*	
Jan et al.	2022					■		■			China - Australia	*	*		*	*		*	*	*	*		
Rasheed et al.	2020									■	Norway											*	
Komulainen & Johansen	2021		■								Norway	*											
Moretta et al.	2021		■								Italy	*		*							*		
He et al.	2022					■					China	*	*	*		*					*		
Ramos et al.	2022					■					Portugal	*	*		*		*				*		
Wallin & Nordlander	2022		■								Sweden											*	
Mihály et al.	2022		■								Romania	*		*							*		
Albarrán et al.	2021						■				Venezuela	*		*							*		
Rooij et al.	2021								■		USA	*	*	*	*	*	*	*	*	*	*		
Gunter et al.	2022								■		USA	*	*		*	*	*				*		
Daza	2021		■								Japan	*	*	*							*		
Moser et al.	2020									■	Germany			*								*	
Jones et al.	2020									■	United Kingdom											*	*
Ferguson et al.	2017							■			USA											*	
Lim et al.	2019									■	Singapore												*
Tello & Degeler	2021									■	Netherlands											*	
Conejos et al.	2019							■			Spain	*	*		*		*		*	*			
Huynh & Zondervan	2022									■	Netherlands											*	
Patriarca et al.	2022					■		■			Israel	*	*	*							*		
Morani et al.	2020							■			France			*							*		
Lumley	2022	■									Sweden	*	*		*	*		*			*		
Qaden	2022			■							United Kingdom											*	
Carvalho	2020									■	Brazil											*	
Brooks et al.	2021									■	United Kingdom	*	*	*		*					*		
Kazala et al.	2022									■	Poland											*	
Li & Vanrolleghem	2021				■						Canada	*		*							*		
Johnson	2021				■						Singapore											*	
Jacobs	2020				■						Singapore											*	
Savić	2022								■		Netherlands											*	*
Eichenwald	2021	■									USA	*	*		*	*		*			*		
Zhu et al.	2022		■								USA	*	*	*		*						*	
Fu et al.	2022								■		United Kingdom												*
Cousins	2020								■		United Kingdom											*	
Kiiak	2021								■		Malta											*	*
Chen et al.	2018							■			China											*	
Li et al.	2021		■								China	*	*		*		*				*		
Feng et al.	2021									■	Czech Republic											*	*
Tao & Qi	2019									■	China											*	
Cheng et al.	2020		■								Saudi Arabia	*	*	*							*		
Beil & Lade	2022									■	China												*
Ye et al.	2022								■		Belgium											*	*
Akroyd	2022	■									United Kingdom											*	*
Inoue et al.	2017									■	Japan	*	*	*							*		
Kreizik	2020					■					Denmark											*	
Therrien et al.	2020					■					Canada											*	
Cody et al.	2020					■					Canada	*	*	*							*		
Dairi et al.	2019		■								Saudi Arabia	*	*	*							*		
Filipe et al.	2019	■									Portugal	*	*	*							*		
Macedo et al.	2022								■		Denmark			*							*		
Yoon et al.	2021							■			Republic of Korea	*	*	*							*		
Ouahebeur et al.	2022					■					Belgium			*							*		
WEF	2018									■	USA											*	
Mitkowski et al.	2021		■								Poland											*	*
Alsarayreh et al.	2020								■		United Kingdom												*
Kongo et al.	2016		■								Spain												*
Kim et al.	2016		■								Republic of Korea	*		*							*		
Huang et al.	2022								■		USA											*	
Laing et al.	2020		■								United Kingdom	*		*							*		
Huijie et al.	2015	■									China	*		*							*		
Shafiee et al.	2020									■	USA	*		*							*		
Mihály et al.	2022		■								Romania	*		*							*		
Cârbureanu et al.	2022		■								Romania	*		*							*		
Yang et al.	2022		■								USA			*	*	*					*		
O'Dwyer et al.	2020									■	United Kingdom			*	*	*					*		
Gaska et al.	2019		■								Poland	*		*							*		
Fomenkova et al.	2019		■								Russia			*							*		
Jun-Fei et al.	2021		■								China			*							*		
Cao et al.	2020		■								China			*							*		
Valverde-Pérez et al.	2021								■		Denmark											*	*
Remigi	2022				■						Italy	*	*		*		*			*	*		
Bellandi	2022		■								Belgium	*	*	*			*				*		
Regmi	2022								■		Denmark											*	*
Zekri et al.	2022								■		Sultanate of Oman	*	*	*							*		
Wei et al.	2022							■			Singapore	*		*							*		
Berglund et al.	2022						■				USA											*	
Wang et al.	2022								■		China	*		*			*				*		
Vedova et al.	2022	■									Italy			*							*		
Grieves and Vickers	2016									■	USA											*	
Rivas-Perez et al.	2019								■		Peru	*	*	*							*		

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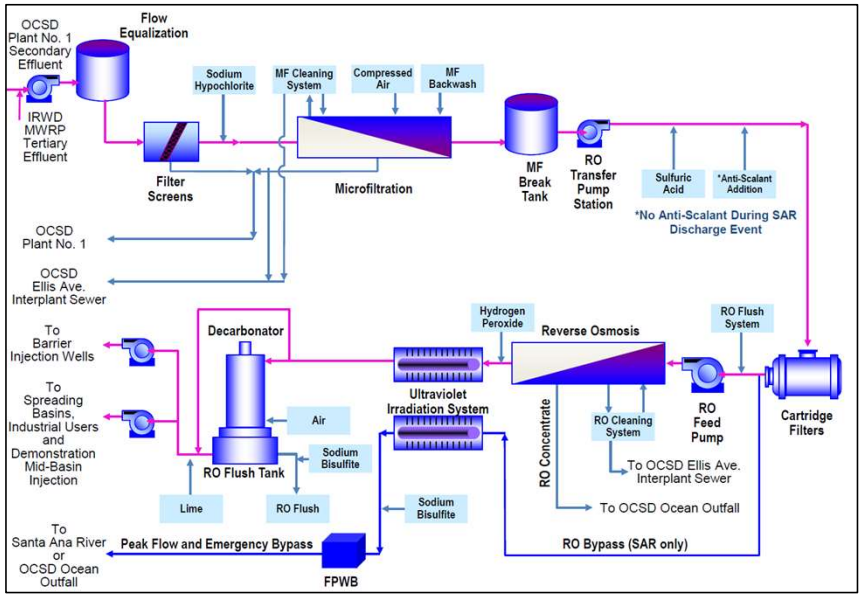
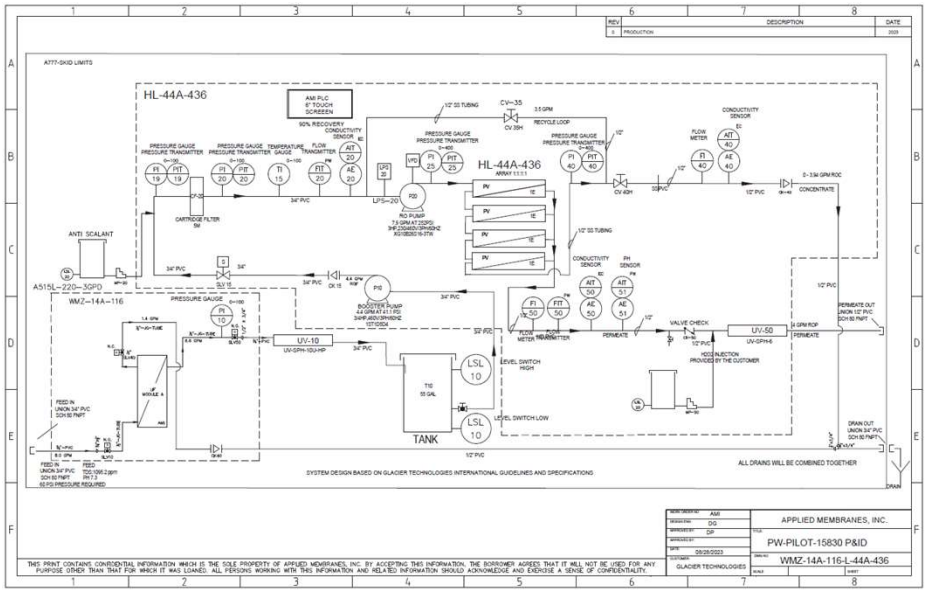
Development of Digital Twin for a Water System



Treatment Process Flow at OCWD



Treatment Process Flow for the Designed DT Pilot

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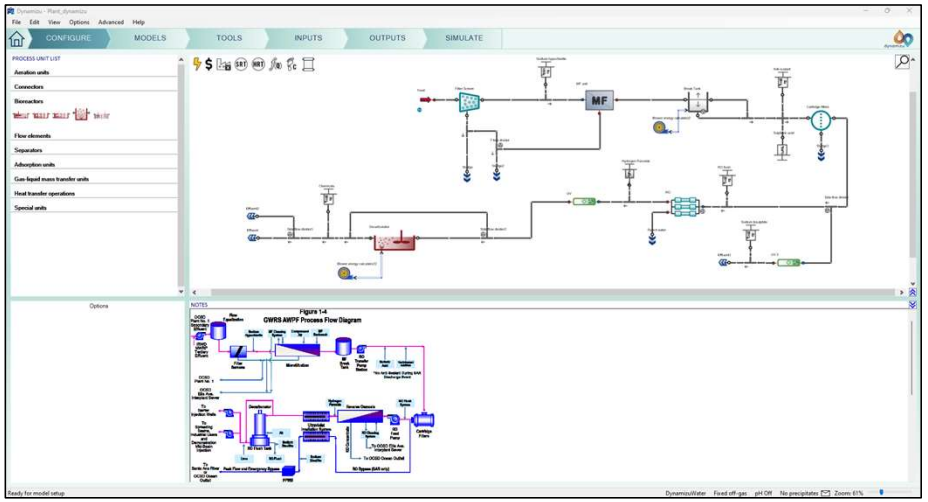
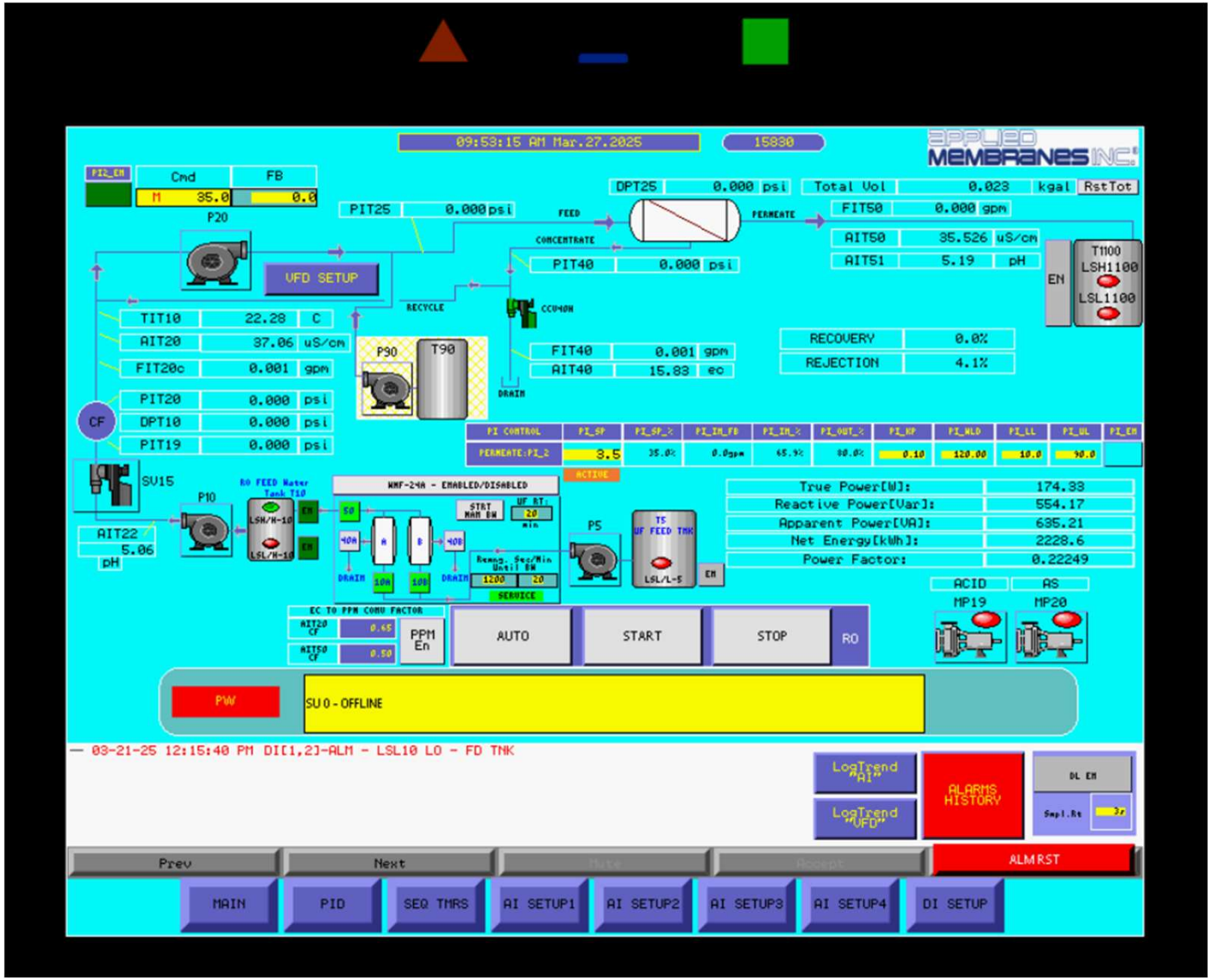
Development of Digital Twin for a Water System

Physical Pilot at OCWD

Human-Machine Interface (HMI)

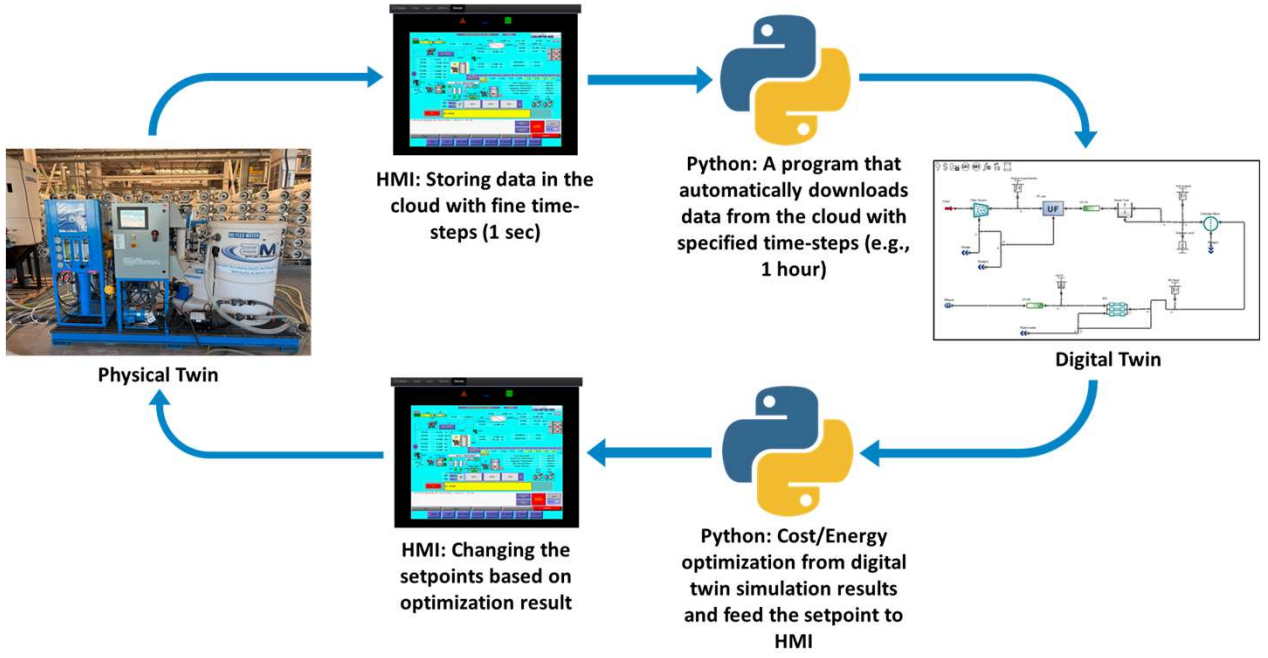


High-Fidelity Process Simulator (SUMO/Dynamizu by Dynamita)


09:53:15 AM Mar.27.2025
15830
applied MEMBRANES INC.
Cmd
FB
P20
VFD SETUP
PIT25 0.000psi
DPT25 0.000 psi
Total Vol 0.023 kgal RstTot
FIT50 0.000 gpm
AIT50 35.526 uS/cm
AIT51 5.19 pH
FEED
CONCENTRATE
PERMEATE
RECYCLE
PIT40 0.000 psi
T1100
LSH1100
LSL1100
EN
TIT10 22.28 C
AIT20 37.06 uS/cm
FIT20c 0.001 gpm
PIT20 0.000 psi
DPT10 0.000 psi
PIT19 0.000 psi
P90
T90
DRAIN
FIT40 0.001 gpm
AIT40 15.83 ec
RECOVERY 0.0%
REJECTION 4.1%
CF
SU15
AIT22 5.06 pH
P10
P5
PI CONTROL
PERMEATE:PI_2
3.5
ACTIVE
True Power[W]: 174.33
Reactive Power[Var]: 554.17
Apparent Power[VA]: 635.21
Net Energy[kWh]: 2228.6
Power Factor: 0.22249
ACID
AS
MP19
MP20
AUTO
START
STOP
RO
PPM En
PW
SU 0 - OFFLINE
03-21-25 12:15:40 PM DI[1,2]-ALM - LSL10 LO - FD TNK
LogTrend "AI"
LogTrend "VFD"
ALARMS HISTORY
Prev
Next
ALMRST
MAIN
PID
SEQ TMRS
AI SETUP1
AI SETUP2
AI SETUP3
AI SETUP4
DI SETUP

Development of Digital Twin for a Water System

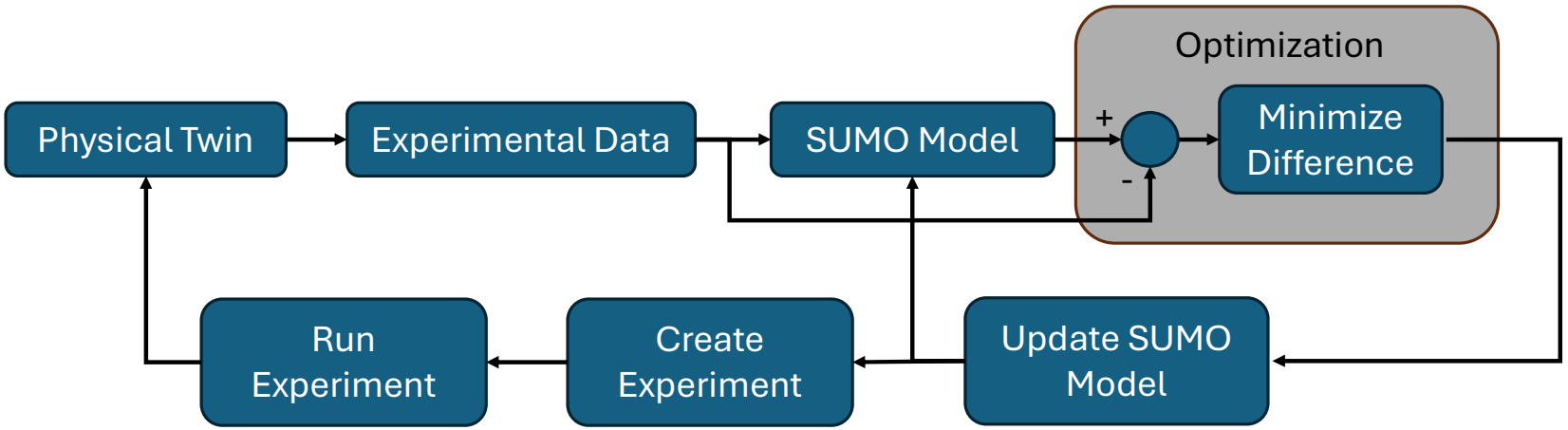
- Physical to digital twin connection:
  - HMI: Enables continuous data storage in the Cloud.
  - Python program was developed to automatically download data from the Cloud with a specified temporal resolution and feed the data to SUMO.
- Digital to physical twin connection:
  - Python program was developed to optimize the cost/energy and then feed the setpoints to the HMI.
  - HMI enables remote control and changing the setpoints.



Digital-physical Twins two-way connectivity

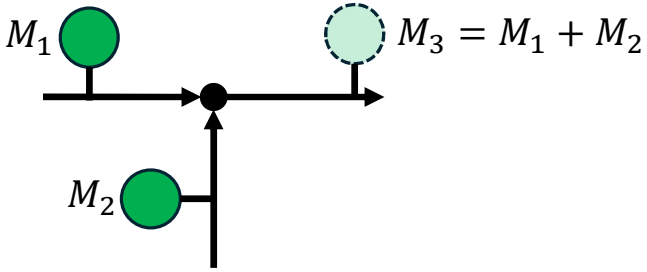
- With the 2-way communication fully implemented, experimental designs are conducted to:
  1. Scenario analysis of process anomalies (defined with the treatment plant team).
  2. Energy and cost analysis of the water reuse process.

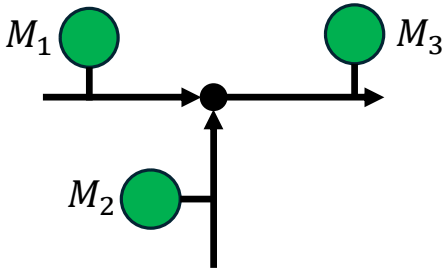
Development of Digital Twin: SUMO Model Calibration

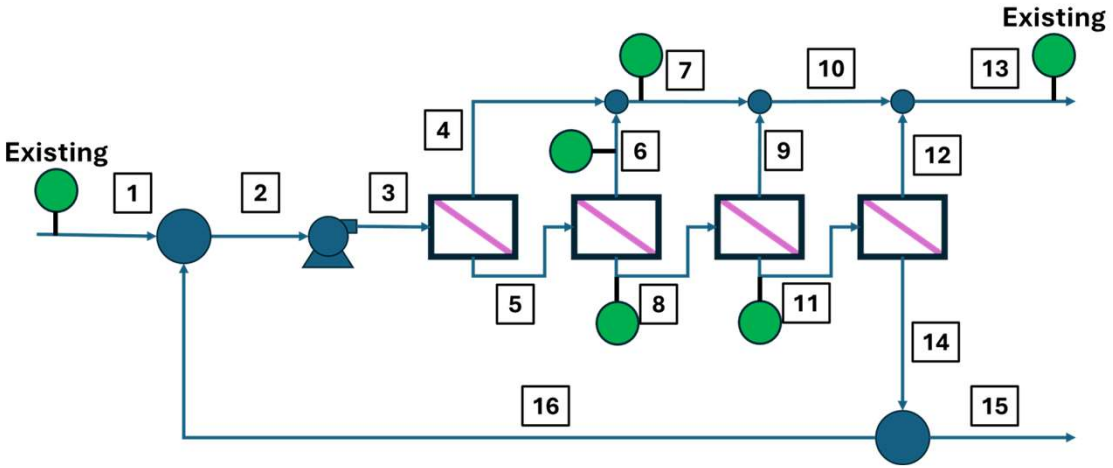


Development of Digital Twin: Sparse Machine Learning for Optimization, Soft Sensors, and Data QA/QC

M_3 is observable

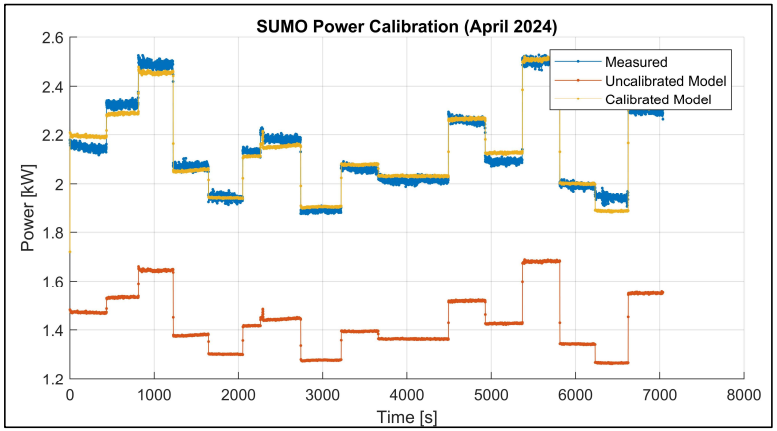




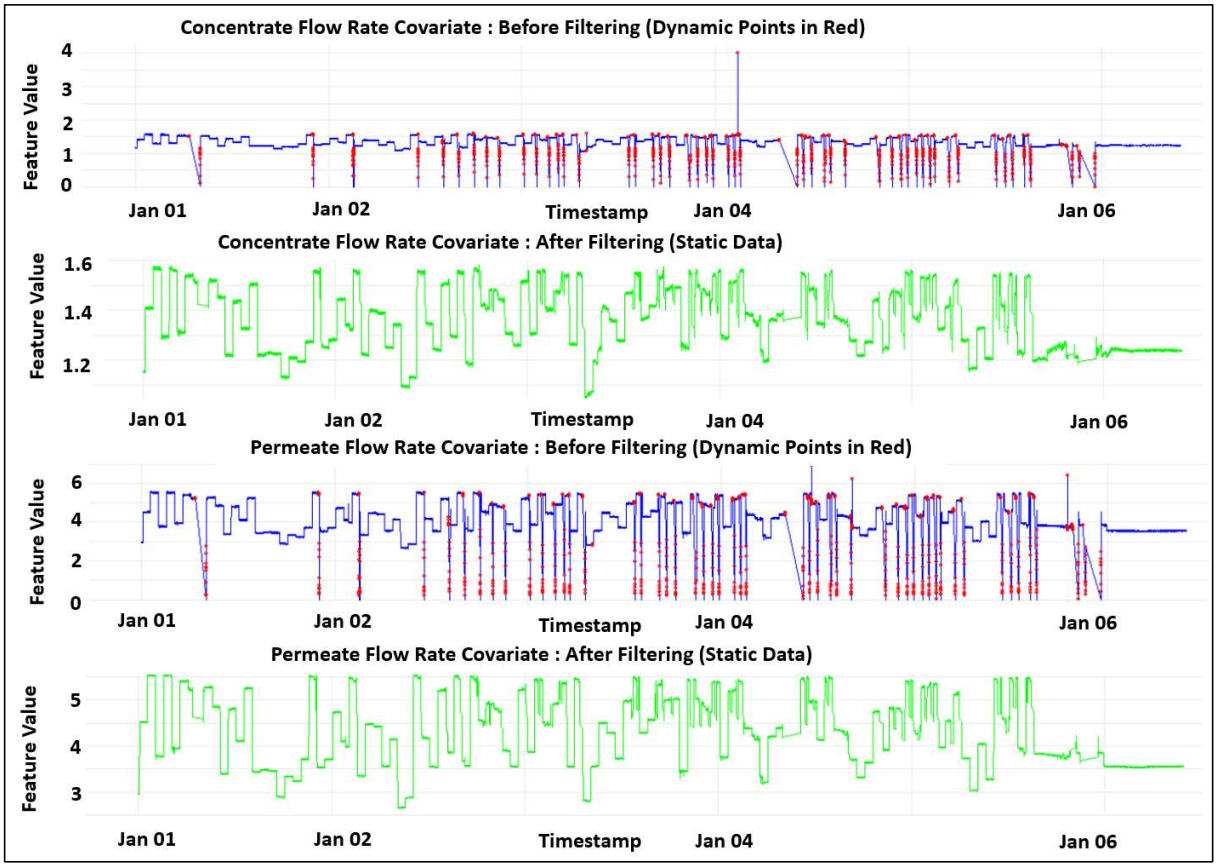


Minimum set of WQ sensors needed for full flowrate observability on pilot

Development of Digital Twin for a Water System

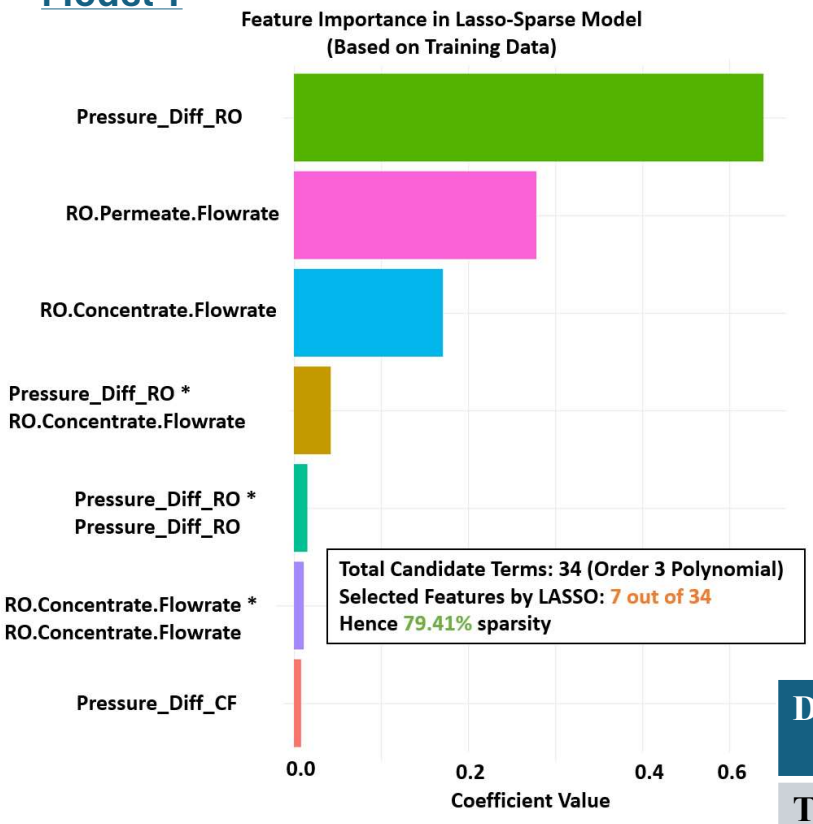


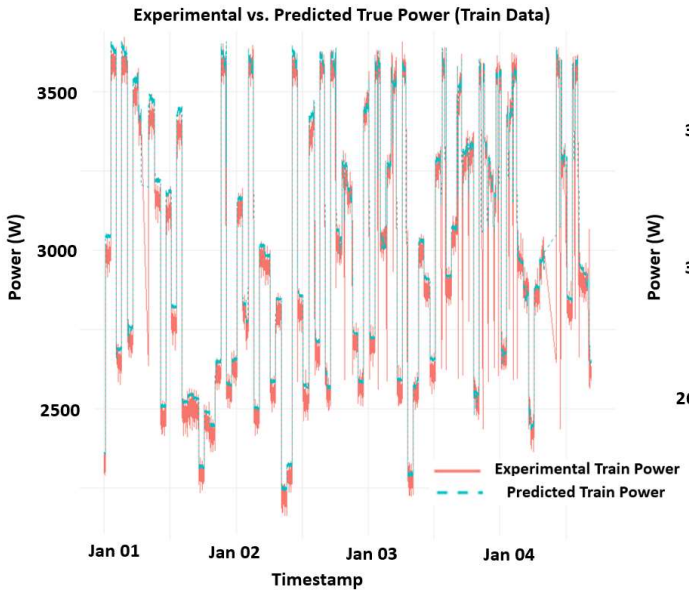
- The SUMO model is used to calculate the power consumption and permeate flow.
- The digital twin is calibrated
  - Autonomously
  - Daily (pending)
  - Using experimental data from the physical twin
  - By adjusting the pump efficiencies in the SUMO model

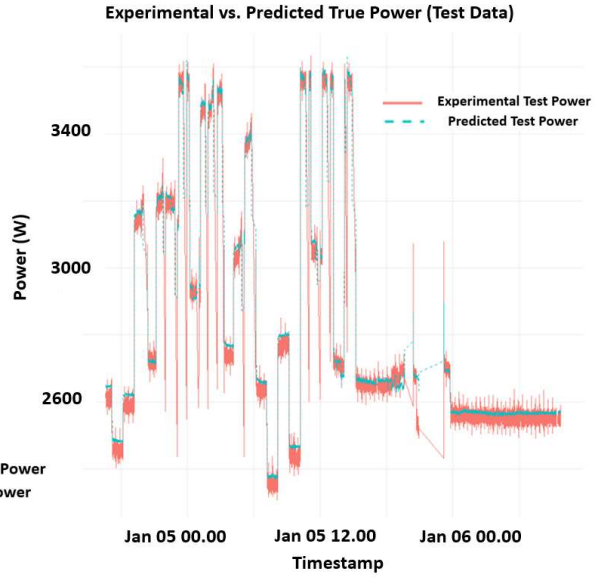


Development of Digital Twin: Sparse Machine Learning for Optimization (Subrata)

Model 1





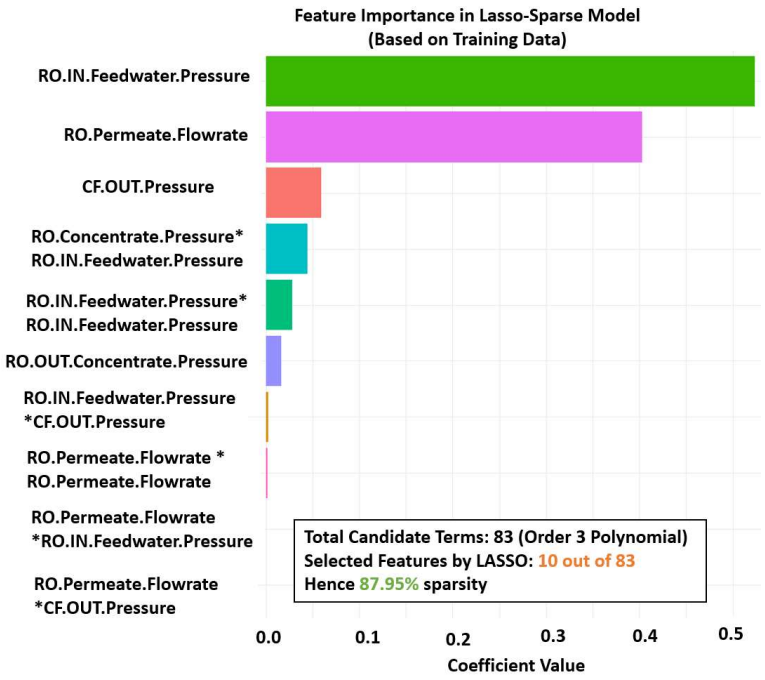


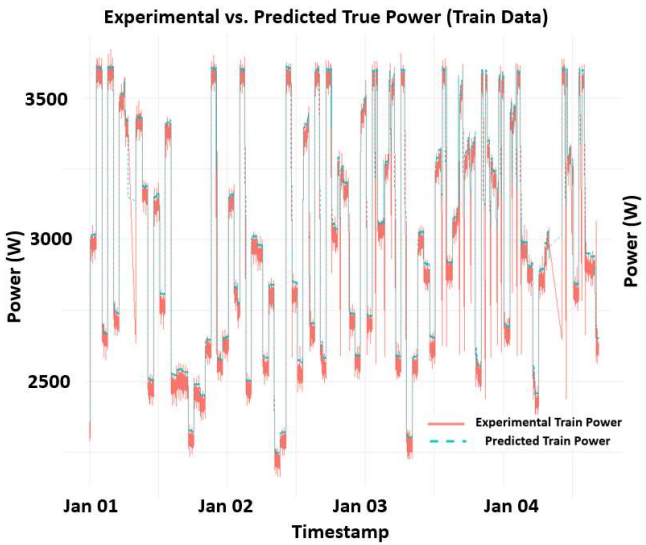
Percentage of observations within ± 50 W error range (Test Data): 95.62%

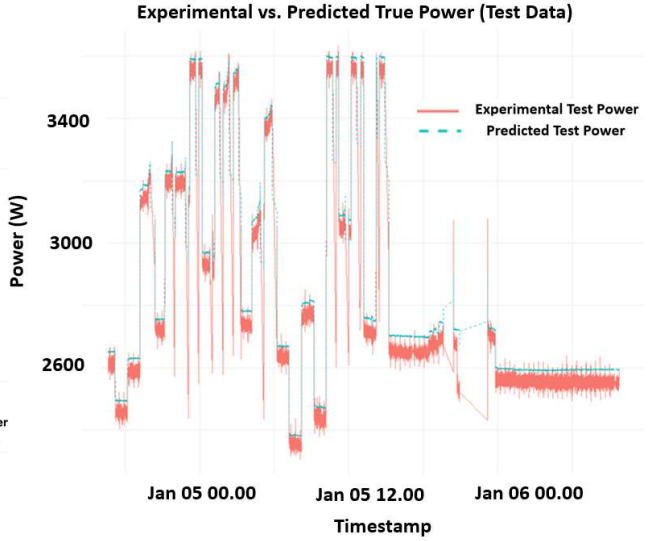
Dataset	RMSE Actual	RMSE Scaled (Standardized)
Training	34.27	0.097
Test	24.45	0.072

Development of Digital Twin: Sparse Machine Learning for Optimization (Subrata)

Model 2



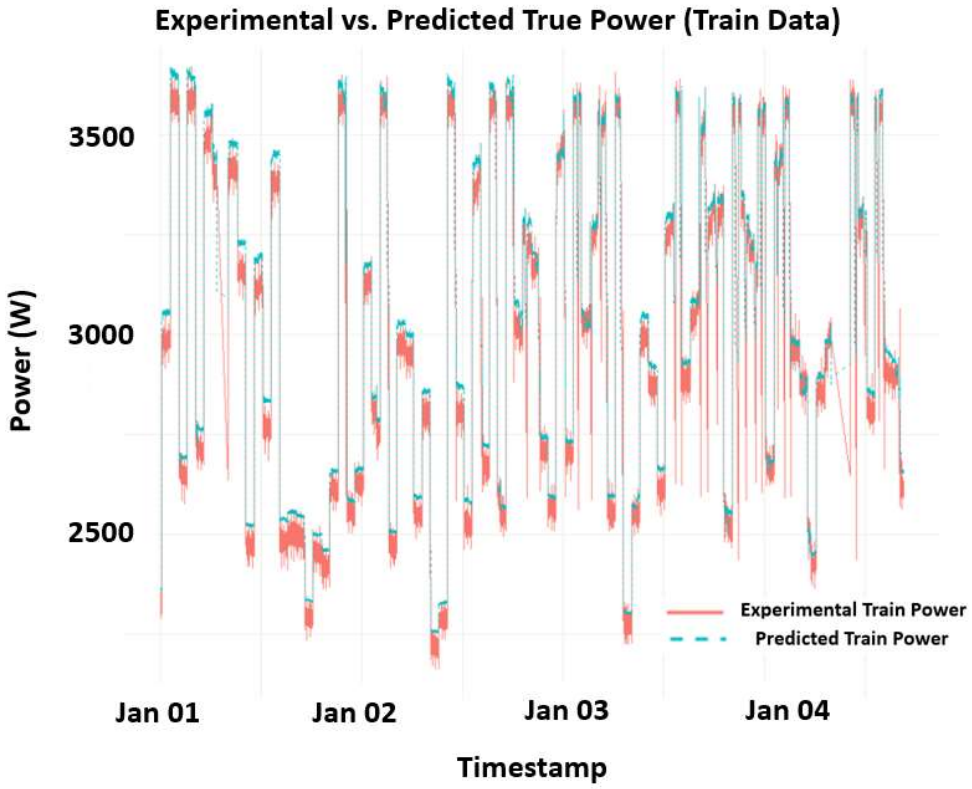


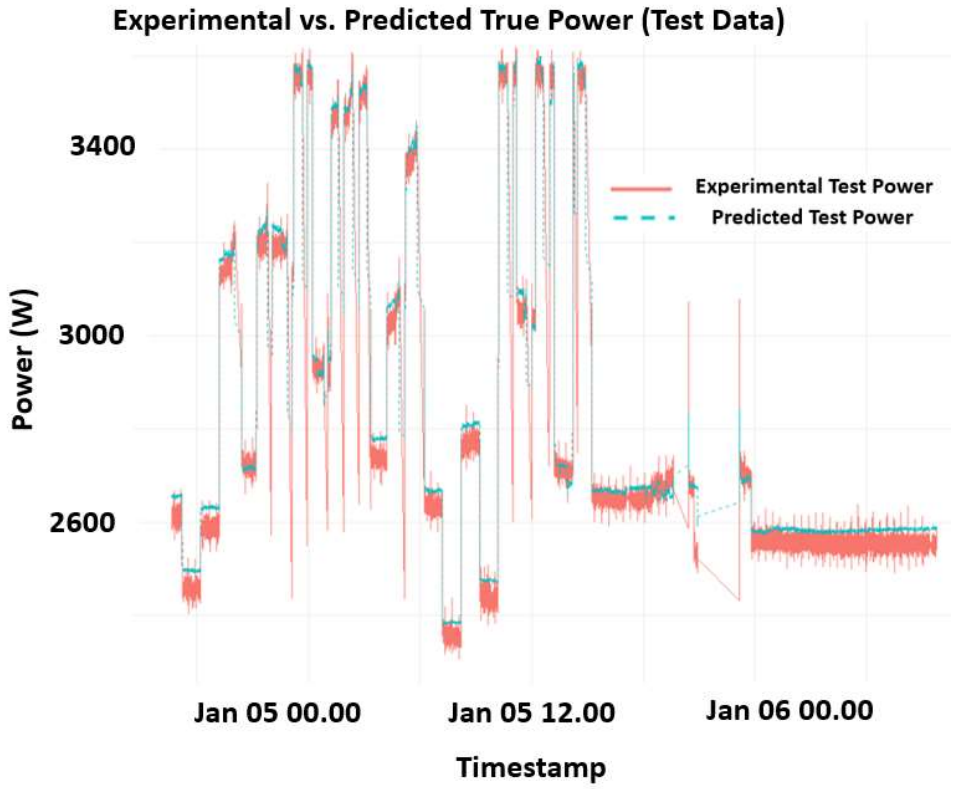


Percentage of observations within ± 50 W error range (Test Data): 78.13%

Dataset	RMSE Actual	RMSE Scaled (Standardized)
Training	34.19	0.0916
Test	38.83	0.11

Development of Digital Twin: Sparse Machine Learning for Optimization (Subrata)

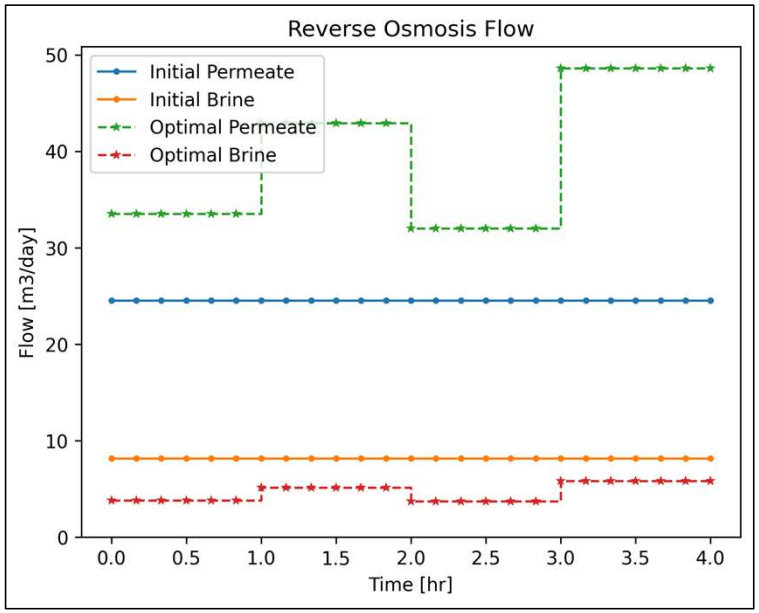


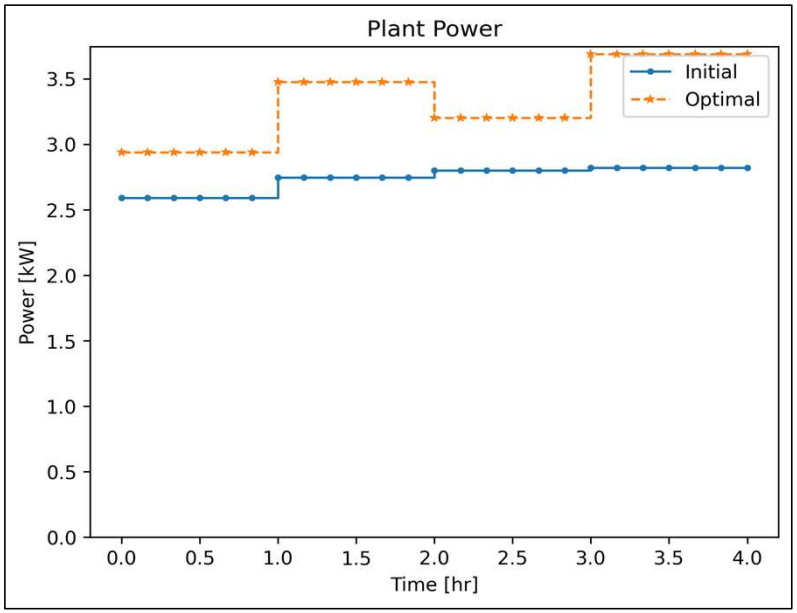


Percentage of test observations within ± 50 W (<2%) error range: 90.76%

Development of Digital Twin for a Water System

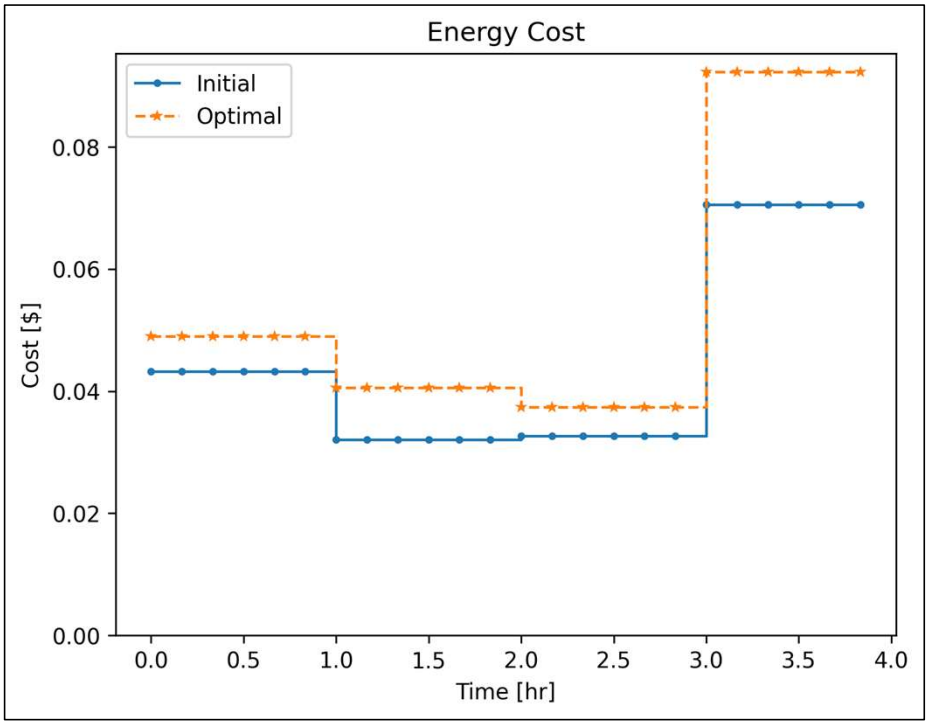
- Developed an optimization framework to vary operating parameters in response to an electricity tariff.
- This optimization framework is currently being tested on the dynamic Digital Twin of the pilot.
- Currently working on translating the optimization framework for use on the full-scale model of OCWD:
  - Looking to garner insights on differences between pilot and full-scale energy/cost predictions
  - Discussion and feedback with plant team to highlight applications

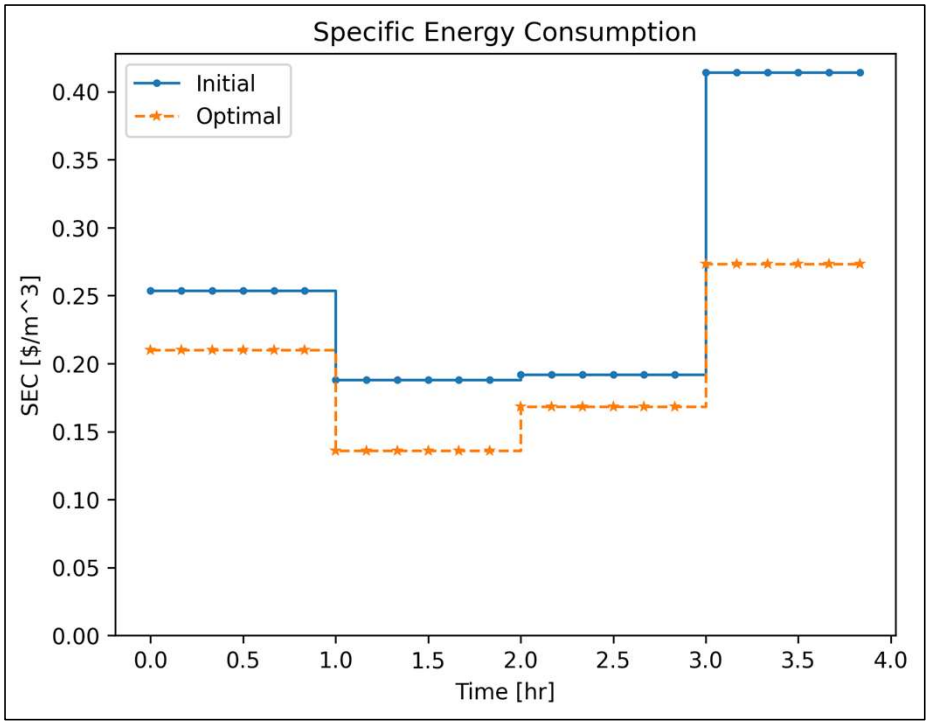




Development of Digital Twin for a Water System

- Cost-optimization applied to the pilot but currently working on full-scale:





Thank you.

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LOS ANGELES COUNTY
SANITATION DISTRICTS
Converting Waste Into Resources

WateReuse Legislative Update, LA Chapter

Phillip Vander Klay

Legislative Liaison, LACSD

June 10, 2025

Federal Update

One Big Beautiful Bill

- Trump 1 tax extender
- New Trump tax cut proposals - $4+ trillion cost
- Massive cuts – Biden infrastructure and energy funding
- Should be done by year-end

PFAS

- Recent announcement that Biden MCLs remain (PFOA, PFOS in 2031)
- Further regulations paused and under review – “will follow the science”

Legislative Update

California Budget

- May Revision = Budget problems
  - Trump economic costs - $16 billion
  - State corrective actions - $12 billion
  - Prop. 4 or nothing
- Things could get worse

Appropriations & House of Origin Deadline

Legislative Update

Key California Bills

- PFAS
  - AB 794 (Gabriel) Emergency PFAS MCLs
  - SB 494 (McNerney) PFAS mitigation fund
  - SB 682 (Allen) Nonessential uses ban
- SB 31 (McNerney) Recycled water
- SB 496 (Hurtado) ACF emergency exemption
- SB 601 (Allen) WOTUS nexus waters

Legislative Outlook

Money Rules Everything Around Here

- Beware the Other Appropriations Committee
- The “problem” can always get worse
  - LA fires emergency funding?
  - Medicaid cuts?
  - Who implements enforcement?
- An unrestrained veto pen

LOS ANGELES COUNTY
SANITATION DISTRICTS
Converting Waste Into Resources

Questions?

Phillip Vander Klay

phillipvanderklay@lacsd.org

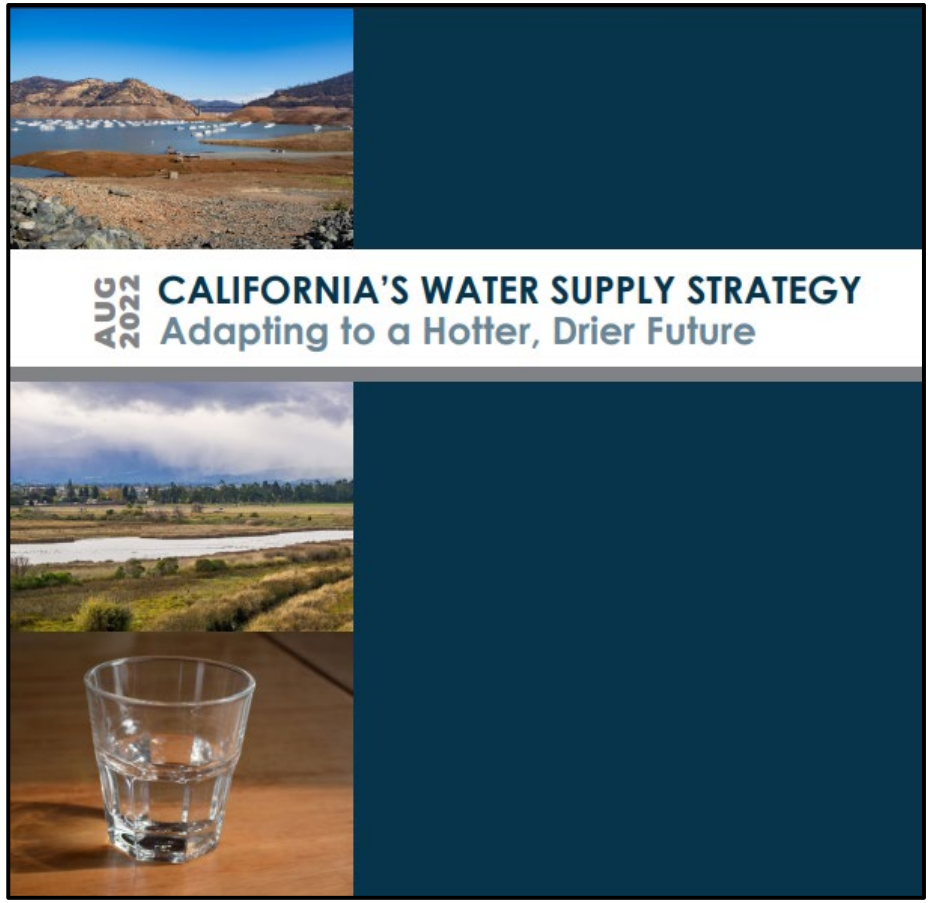
(562) 783-1965

Recycled Water Statistics and Updates

2023-2024 Volumetric Statistics

Stormwater Recharge

Recycled Water Goals for the region



2024 Recycled Water Reuse Results

- 190,710 acre-ft total reuse
- 6,000 acre-feet reuse increase from 2023
- 4 Additional facilities reporting

Other Non-potable Uses

- Dust suppression
- Sewer Flushing

16,201

Seawater Intrusion Barrier

- West Coast Barrier
- Alamitos Gap
- Dominguez Gap

17,671

Landscape Irrigation

- Institutional areas
- Parks
- Excludes agric. irrigation and golf courses

29,234

Groundwater Recharge

- Montebello Forebay
- Santa Monica SWIP
- Oxnard GREAT
- Albert Robles Center - GRIP

50,210

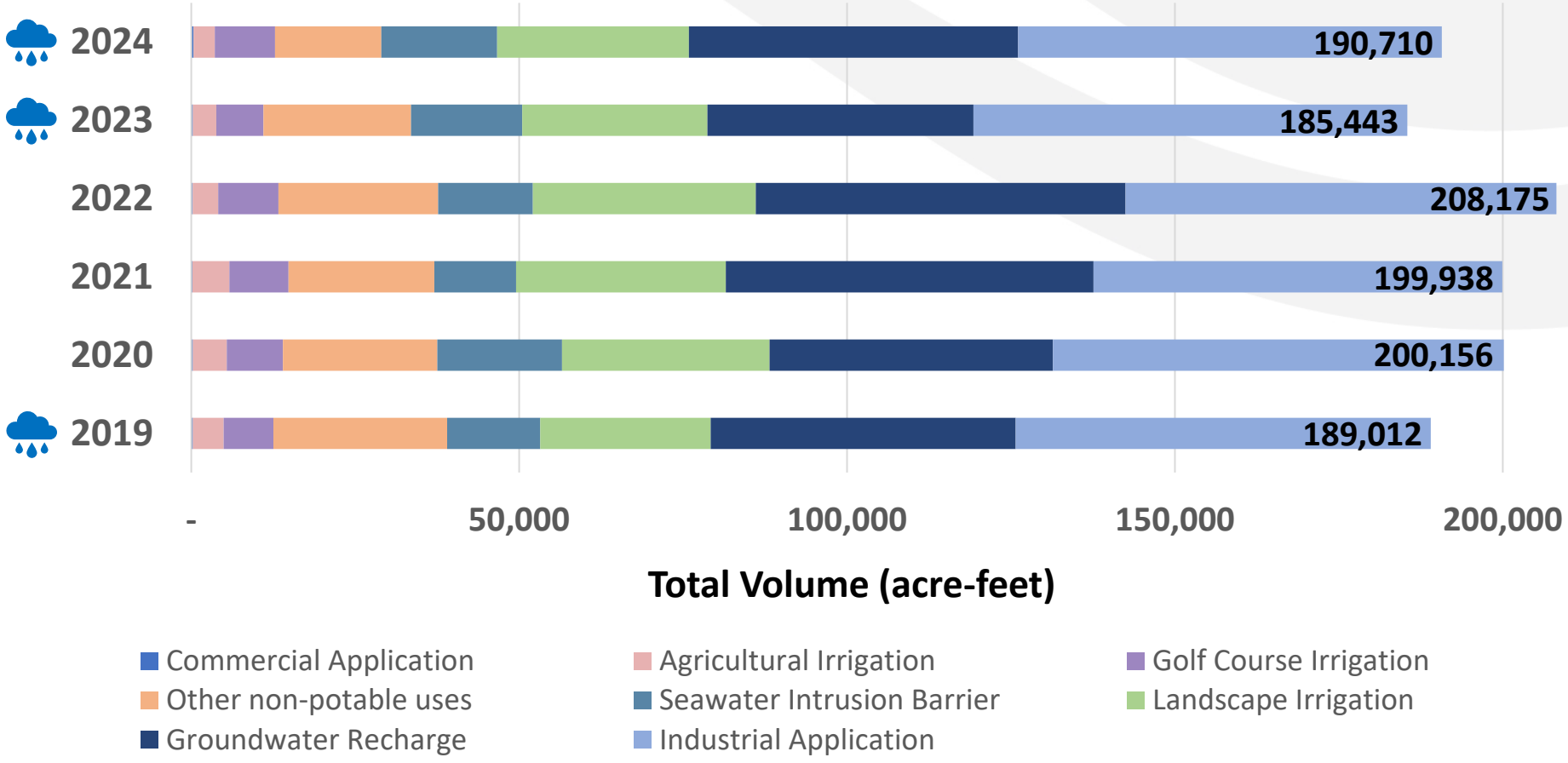
Industrial Application

- Boiler Feedwater
- Cooling Tower
- Evaporative Condensers
- Air conditioning
- Process Waters

64,615

*All volumetric numbers are provided in acre-feet (1 ac-ft is equal to 325,851 gallons)

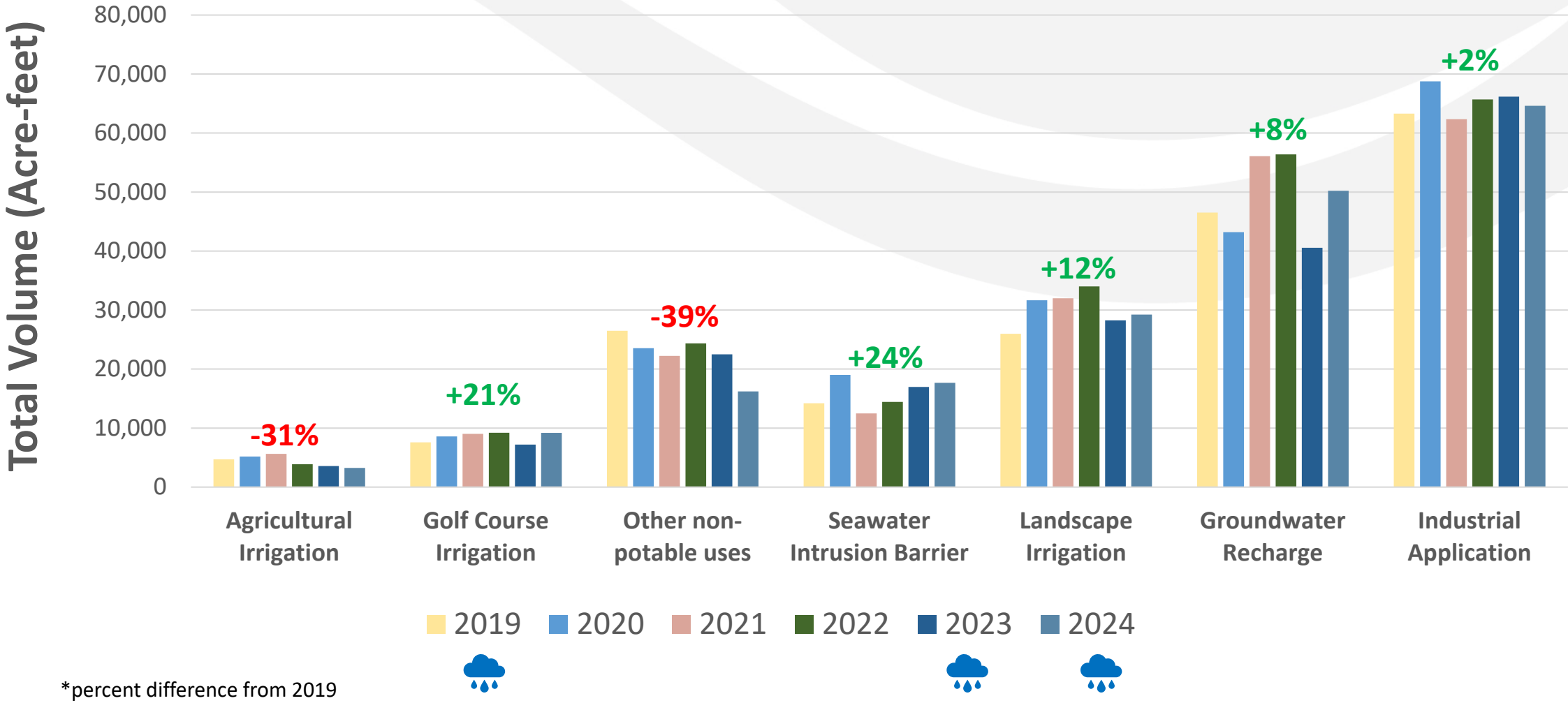
Recycling Trends



Key Trends

- 2024 total volume increased from 2023
- 2019, 2023 and 2024 were wet years, resulting in less recycled water reused
- No noticeable change in recycled water usage resulting from COVID

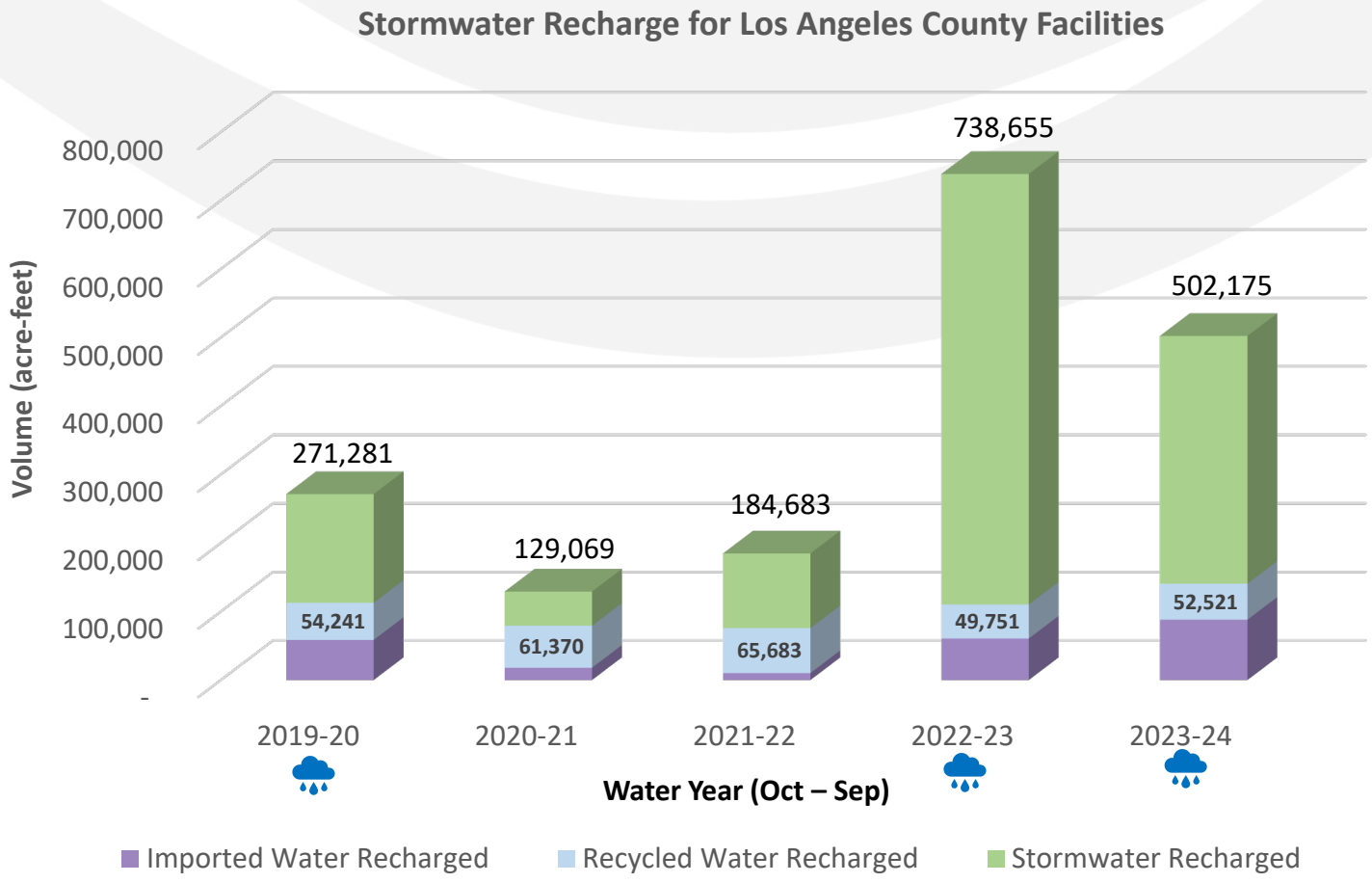
Production Trends by Use Type



*percent difference from 2019

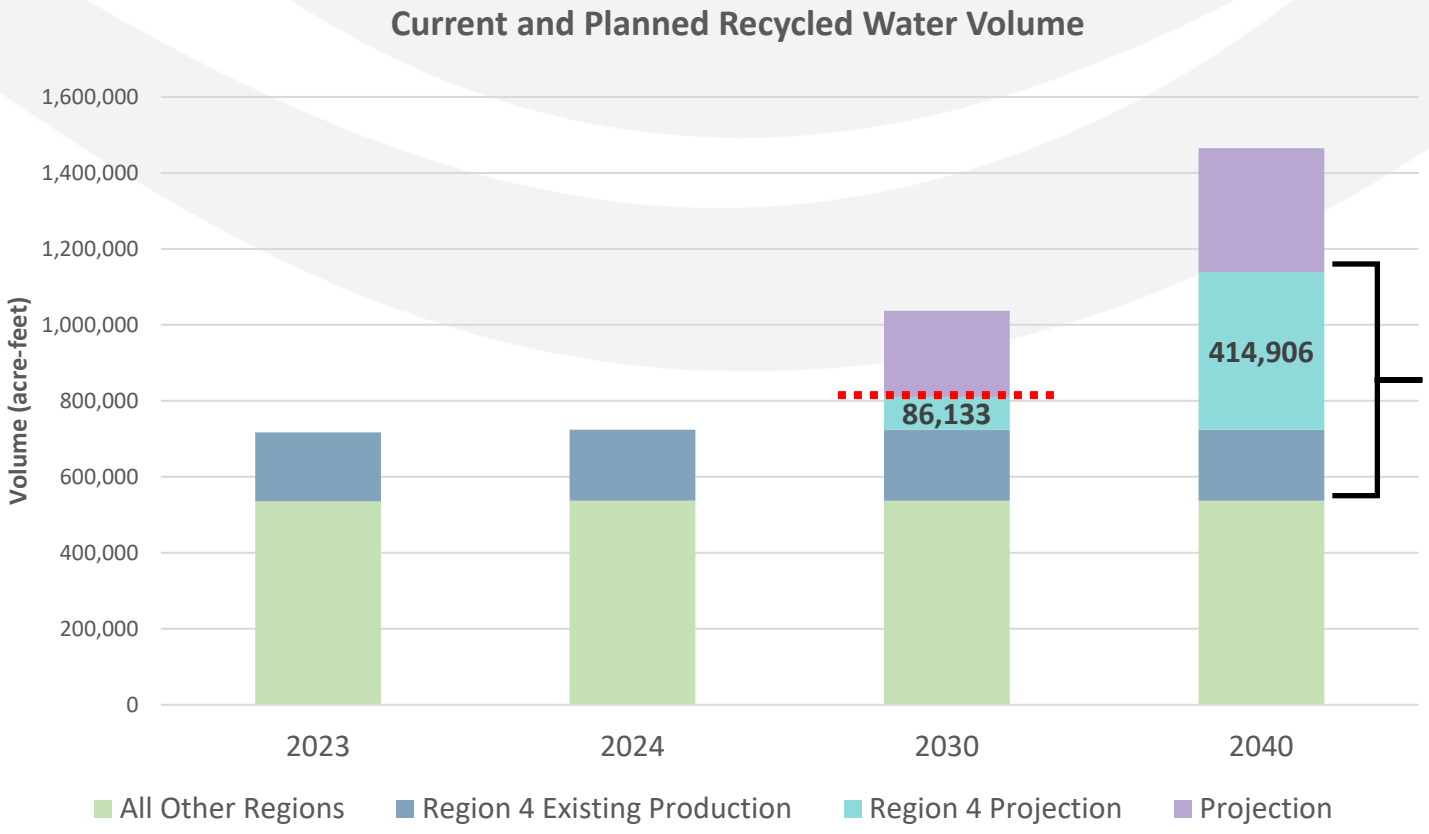
Stormwater Recharge

- Correlation between precipitation, imported water and recycled water recharge
- Recycled water was able to supplement recharge during dry seasons



Water Supply Strategy Goals

- California's Water Supply Strategy (2022) established a goal of 800,000 ac-ft by 2030 and 1,800,000 ac-ft by 2040
- Region 4 is anticipated to produce an additional ~415,000 ac-ft of recycled water by 2040



Chapter Trustee Updates
WATEREUSE LA Chapter – June 10, 2025

Last Board of Trustees Meeting: February 10, 2025

WRCA Managing Direct Report

APPROVED

- Potable Reuse and Compliance Committee
  - Permitting & Compliance, DPR Implementation, Communications Collaborative Group
- 2025 and 2026 conference planning is progressing
  - Record number of Abstracts for San Diego – 60% increase
  - Average open newsletter rate – 27.5%
- WaterLoop Video Series
  - Locations: San Diego, Los Angeles, Orange County, Sacramento, Central Coast
  - Output: 6 full length videos, 30+ short films, 6 reels, newsletters, podcast feed
  - Live Presentation at WRCA Conference – Sept 22, 2025
- Strategic Plan nearing completion

Chapter Trustee Updates
WATEREUSE LA Chapter – June 10, 2025

Last Board of Trustees Meeting: May 2, 2025

Trustee Meeting Minutes

APPROVED

- WRCA Quarter 1 Minutes

FY2025 Financial Dashboard

APPROVED

- YTD Net Asset Increase: $274,294
- Total ending Net Assets: $1,144,877
- WaterLoop Fundraising on Track

Operator Resources Funding (with Cal-Nevada AWWA)

APPROVED

- Contribution from WRCA Reserves to support development of resources for Operator certifications
  - AWT textbook
  - Practice Exams
  - Development of Instructor Powerpoints and diagrams
  - Reference Guides

Chapter Trustee Updates
WATEREUSE LA Chapter – June 10, 2025

Last Board of Trustees Meeting: May 2, 2025

2025 WateReuse Annual Conference

- San Diego, CA - Town & Country Resort
  - September 21st – 23rd , 2025
- 2 Facility Tours & NEW Emerging Leader Award
- Registrations:
  - 3/31 - 6/24 (Early Bird)
  - 6/25 – 9/3 (Advance)
  - 9/21 – 9/3 (Onsite)

REimagine the possibilities | 2025 WateReuse CA CONFERENCE SAN DIEGO • CA September 21-23, 2025

Chapter Trustee Updates
WATEREUSE LA Chapter – February 11, 2025

Last Board of Trustees Meeting: May 2, 2025

Proposed 2025 WRCA Special Projects

1. Water Loop Videos
   - Produce engaging video series to showcase the potential of watereuse
2. Strategic Plan Implementation
   - Deliver the NEW strategic plan 1st quarter of 2025
3. Southern California Water Coalition Video
   - WRCA & SCWC to develop videos focused on improving perception of DPR
4. Reuse Implementation Set Aside
   - WRCA workshop 11/7/2025 focusing on implementation needs for DPR
5. Regulation Guidebook
   - WRCA to develop regulatory guidebook for other states

LA Chapter Updates

- Communications Chair: *Oliver Slosser* *oslosser@lvmwd.com*
- Ad Hoc Urban Irrigation Manual Update Co-Chairs: *Monica Sanchez, Erika Bensch, and Jesus Gonzalez* *monicasanchez@lacsd.org*
- *Rising Professionals Committee Chair: Wen Cong* *wenc@trusselltech.com*
- Technical Topics Co-Chairs: *Dinaz Kureishy* *Dinaz.Kureishy@santamonica.gov*

WATEREUSE LOS ANGELES

LADWP Headworks DPR Project Tour

- Date: July 16, 2025
- Time: 10:00 AM
- 25 spots have been filled.
  - The first 25 registrants will receive a confirmation email soon.
  - A waitlist will be maintained in case any spots open up.

- Parking is limited – carpooling recommended.
- Bring a hard hat and a reflective vest if you have them.

- *For questions contact Wen Cong (wenc@trusselltech.com)*

Member Agency Roundtable

- CA WateReuse Conference
  - September 21-23, San Diego, CA
- 41st WateReuse Symposium
  - March 2026, Los Angeles, CA
  - Call for Presentations Open Until 8/11/25
- Member Agency Updates
  - Encourage each Member Agency to provide an update or share milestones & upcoming events
- Needed - Chapter Meeting Hosts & Sponsors
- Needed - Technical Topic
  - Please contact Dinaz Kureishy (Dinaz.Kureishy@santamonica.gov) if interested to present!

WATEREUSE LOS ANGELES