Jacobs Challenging today. Reinventing tomorrow.

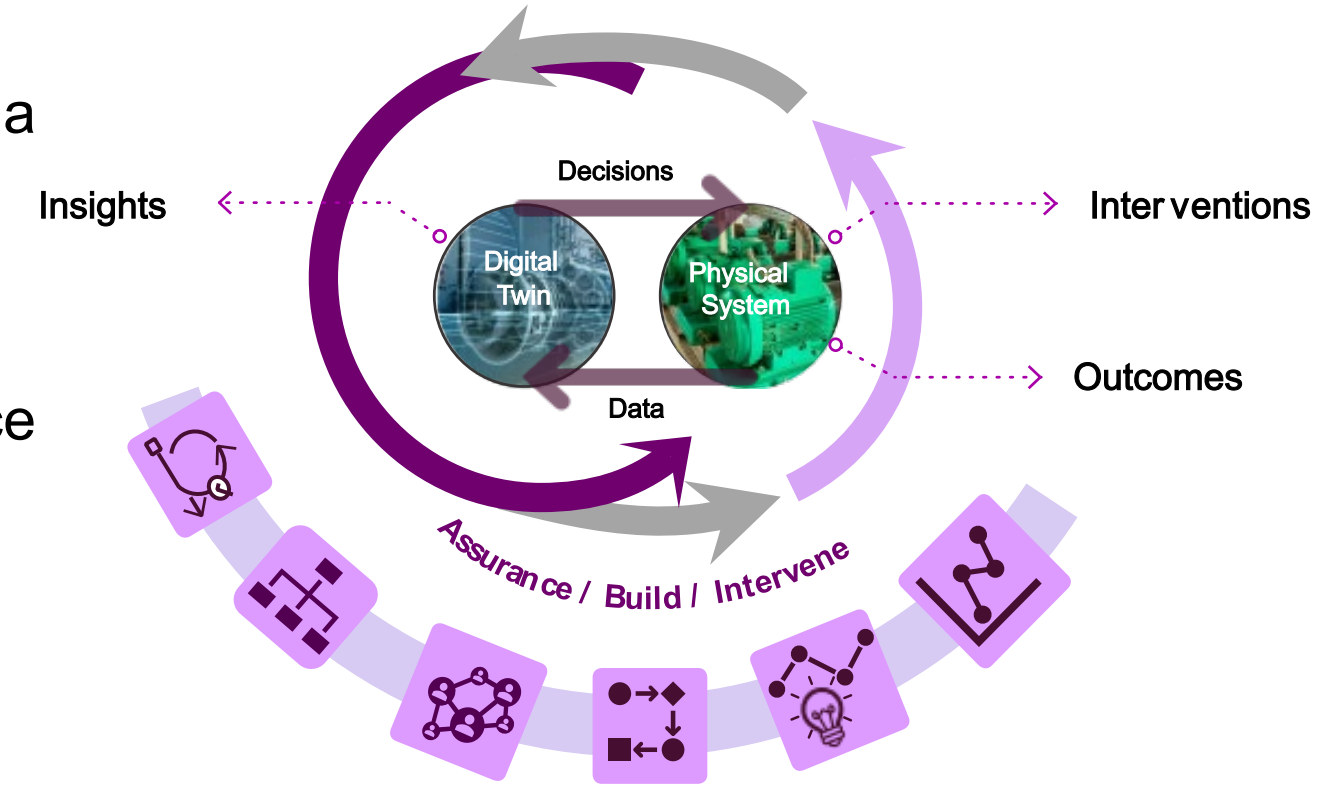
Leveraging a Digital Twin to Implement Complex Control Logic at the 3Kings Water Treatment Plant

Agenda

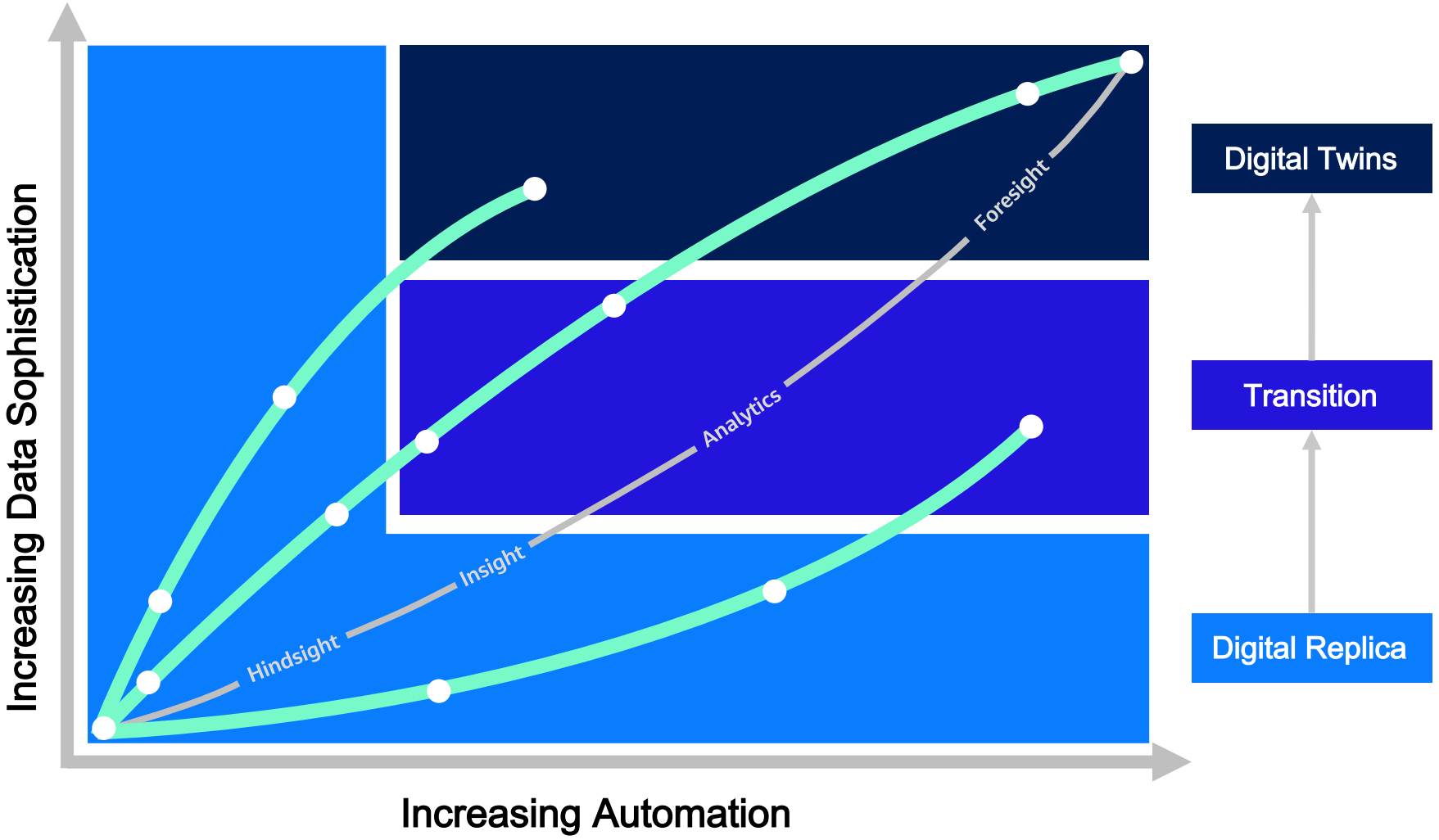
- Digital Twins Definition
- Replica Operations Introduction
- 3Kings Water Treatment Plant Digital Twin

Digital Twin Owner Benefits

- Increase the effectiveness of decision making within an organization
- Offer insights into the physical system in a risk-free environment
- Communicates and visualizes insights to provide Data Driven decision making
- Scenario Analysis and Asset Performance Management
  - Test hypothesis in zero risk, low-cost environment
  - More resilient solutions
  - Reduce start-up risk and shorten schedule
  - Predictive Maintenance
  - Optimize performance



Digital Twin Maturity



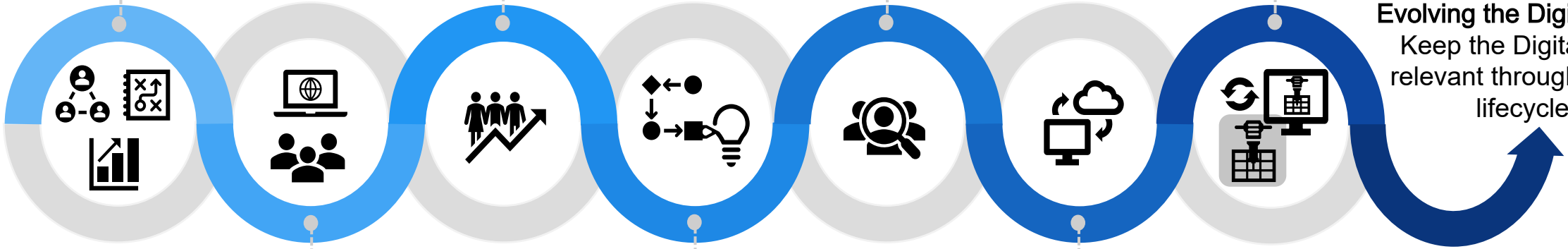
Digital Twin Approach

Establish Business Goals
Ensure Digital Twin adoption is driven by clear business needs

Define Insights
Incorporate performance metrics to meet stakeholder expectations

Identify Sponsor
The Digital Twin must be owned and actively managed

Enable Digital Twins
Single integrated source of truth



Evolving the Digital Twin
Keep the Digital Twin relevant throughout its lifecycle

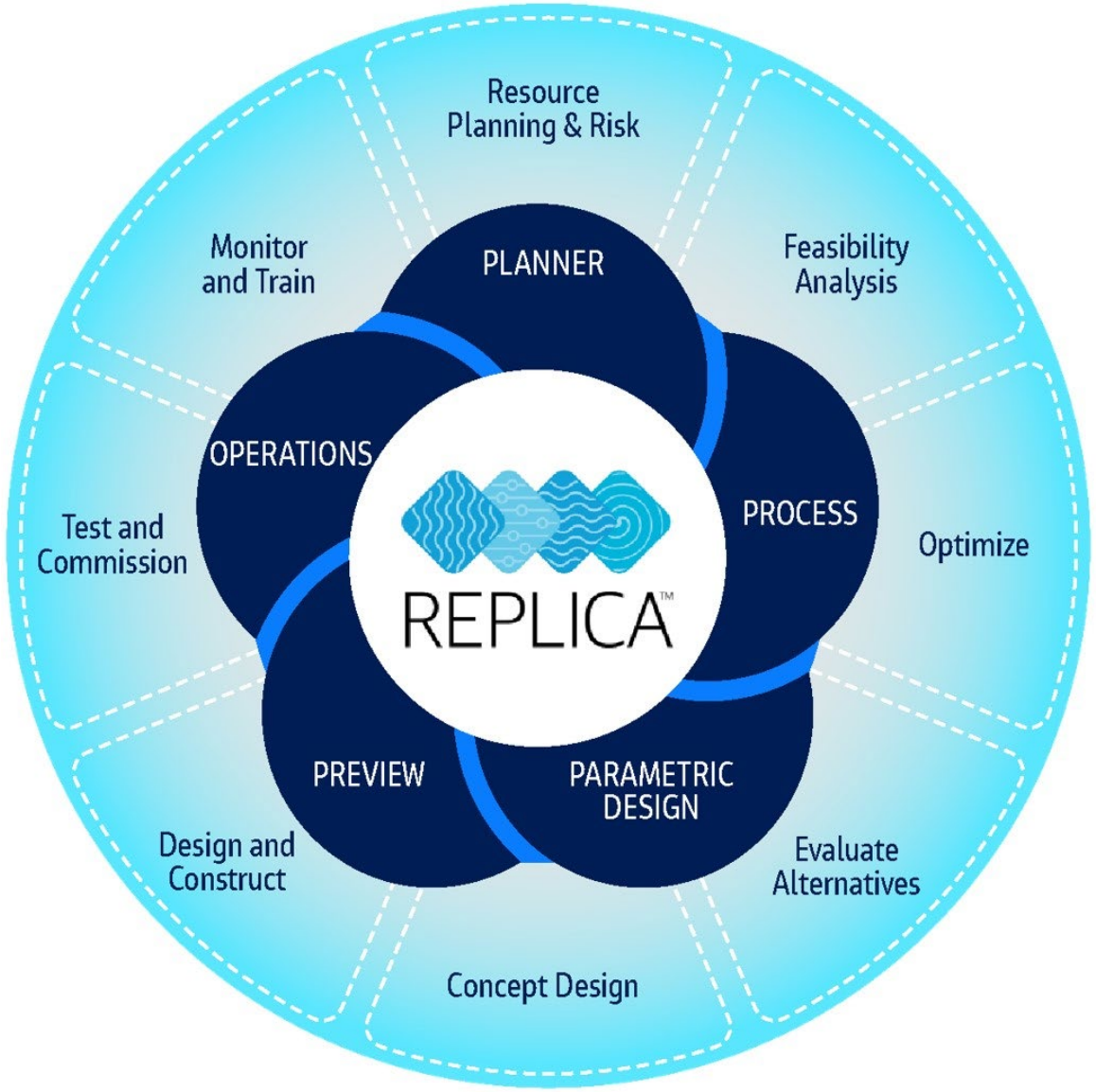
Understand Guiding Purpose
Make sure the level of digitalization matches the organization's readiness, objectives and priorities

Technology
Establish which digital tools should be utilized to facilitate the process

Connect Data
Leverage the 'big data' used to inform the people, process, and technology

REPLICA is Jacobs' suite of software for digital twins

- Developed for >20 years
- Capabilities across the project lifecycle
- Built on a foundation of domain knowledge, computational power, data connectivity, and intuitive interfaces



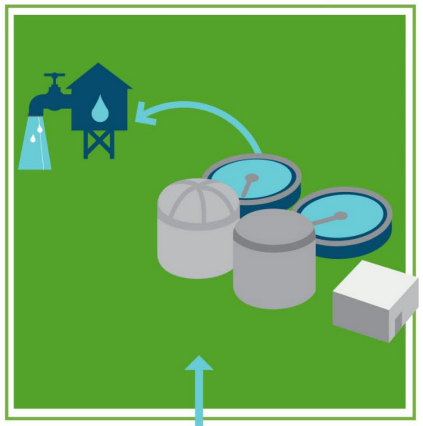
https://www.jacobs.com/insights/digital-twin-technologies

Digital Twin Architecture

REPLICA™

SWAN
THE SMART WATER NETWORKS FORUM

PHYSICAL SYSTEM



Sensing/Control

SENSORS
Pressure, Temperature, Flow, etc.

ACTUATORS
Hydraulic, Electrical, Mechanical, etc.

ADVANCED MONITORING
IoT, AMI, Edge Devices etc.

Data Collection and Sources

BUSINESS & OPERATIONAL SYSTEMS
LIMS, CIS, GIS, CMMS, CAD/BIM etc.

AUTOMATION SYSTEMS
SCADA, Telemetry, etc.

ATTRIBUTES
Spatial
Transactional
Temporal

DIGITAL TWIN

Data Integration

DATA INGESTION AND INTEGRATION

DATA MANAGEMENT

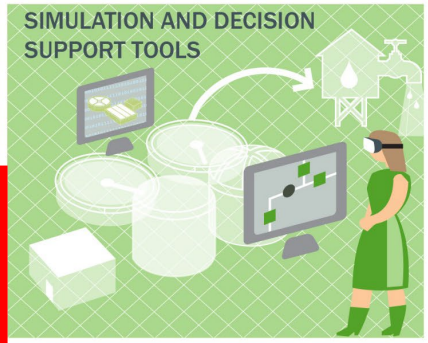
Analytics

DATA DRIVEN MODELS
Machine Learning, AI, etc.

PHYSICS BASED MODELS
Hydraulic, Biological, etc.
(Static and Dynamic)

Visualization

SIMULATION AND DECISION SUPPORT TOOLS



User Experience

WHAT/IF SCENARIOS

REAL-TIME PERFORMANCE DASHBOARDS

AUGMENTED/VIRTUAL REALITY

MOBILE ALERTS

ADVANCED AUTOMATION

Actionable Results < Optimized Performance < Informed Decisions

Secure and Connected Utility

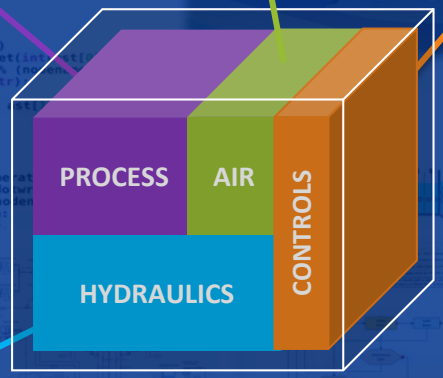
Replica Operations/Process

Process
- Track components (Water Quality)
  - Treatment processes
  - Separation
  - Reactions
- Linkage
  - SOURCE
  - Dynamic Pro2D

Air
- Model compressible fluids through system
  - Blowers
  - Conduits
  - Valves

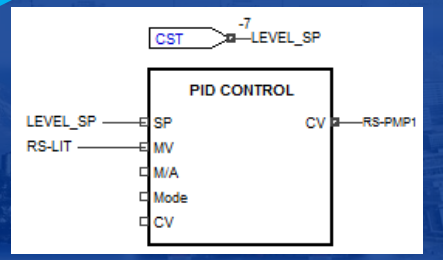
Controls
- Drives system operation
  - Measuring devices
  - Transmitters
  - Control Algorithms
  - Controls Tuning
- Linkage with Control Software
  - Rockwell
  - Ovation
  - Siemens

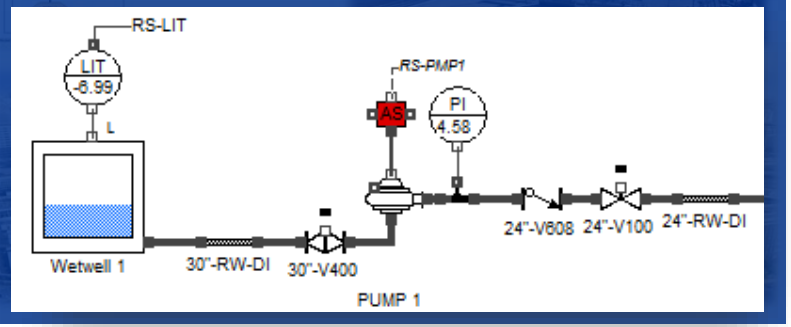
COMPLETE DYNAMIC PROCESS MODEL



OPTIMIZATION

Hydraulics
- Move fluids through system
  - Pipes
  - Pumps
  - Valves
  - Storage
  - Channels





Park City, UT

3Kings Water Treatment Facility

Replica Operations

3Kings Water Treatment Facility

- Construction of greenfield 8.0 MGD drinking water facility
- Complex control strategies to:
  - Utilize several water sources of varying qualities
  - Provide multiple treatment bypasses
  - Fully automate all filter service control and associated backwashes

Objectives

Operational Requirements

1. Treat water from 3 different sources, including treatment of 100% of Judge mine water
2. Meet customer demand
3. Automatically bring filters and adsorbers online based on loading rates

The Challenge:

Commission complex controls on tight schedule.

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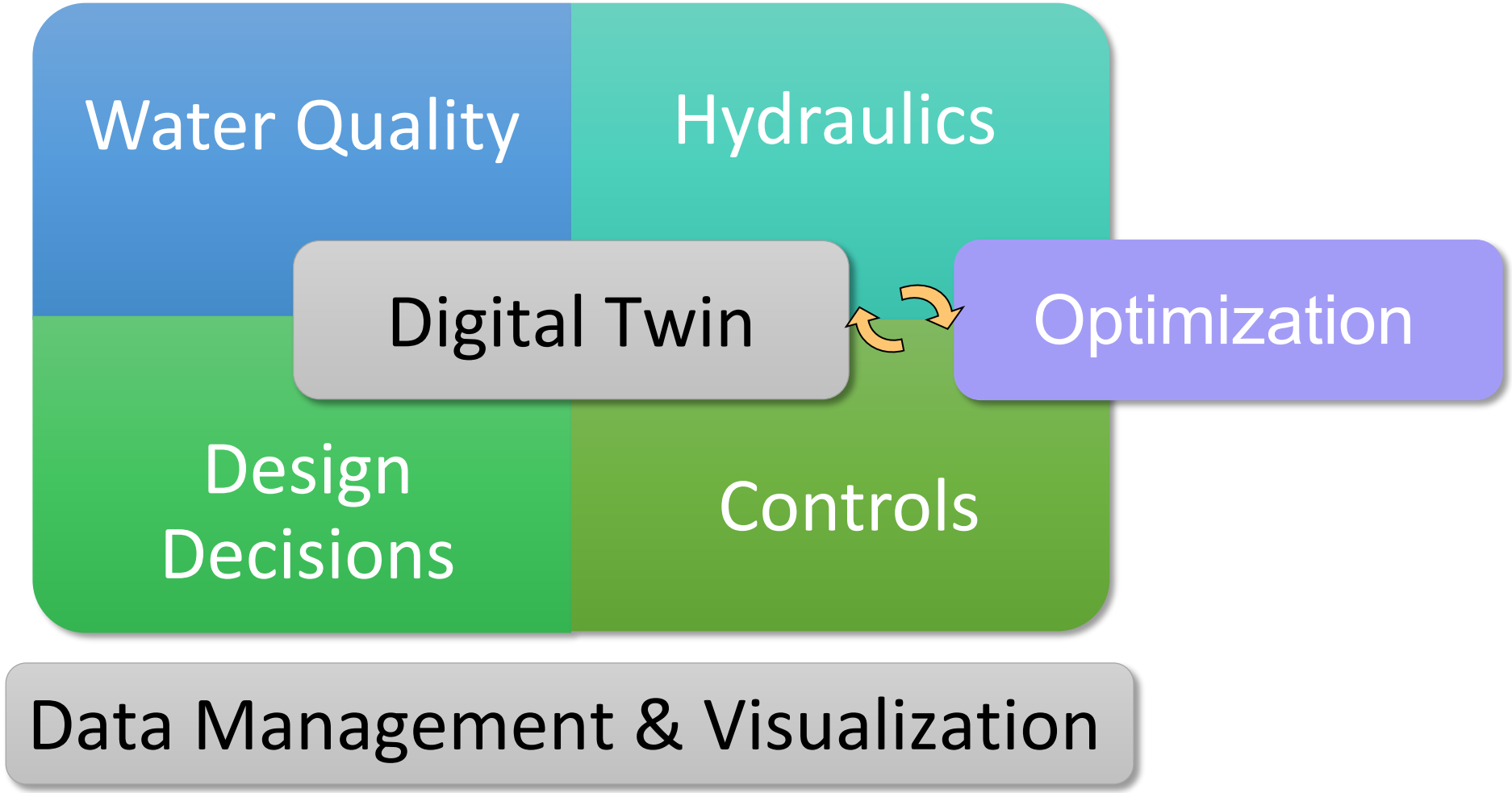
Digital Twin – Integrate Multiple Tools/Data Sources for Decision Support



Digital Twin Workflow

Engineer, system integrator and owner input

Hydraulic and controls model

Verify control strategy

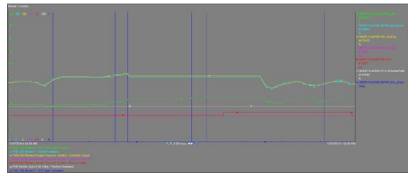
Program PLC and develop SCADA graphics based on control narrative

Connect PLC to model for software testing

De-bug code and Pre-tune control loops

Effective control system commissioning

Code troubleshooting and on-site tuning minimized



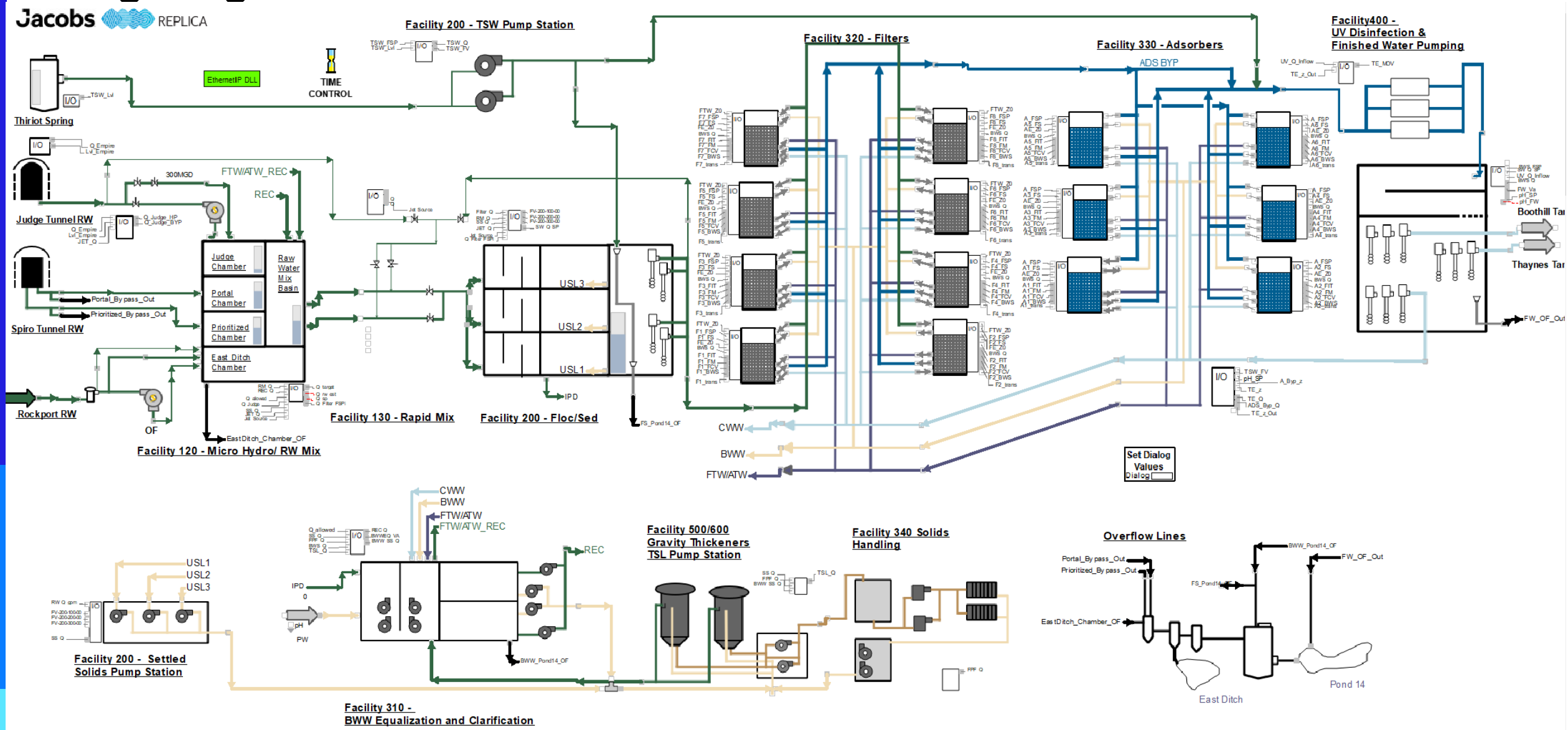
Design

System Integration

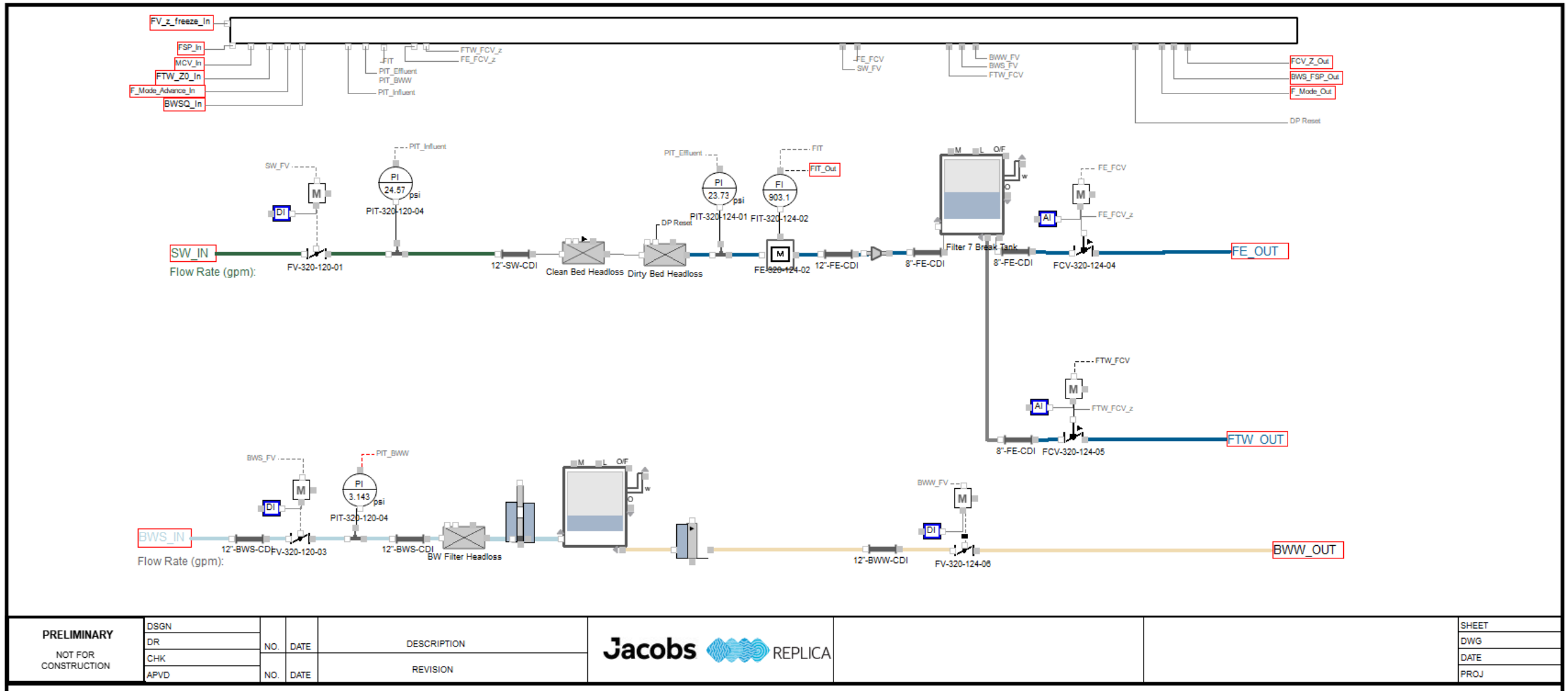
Startup

REPLICA™

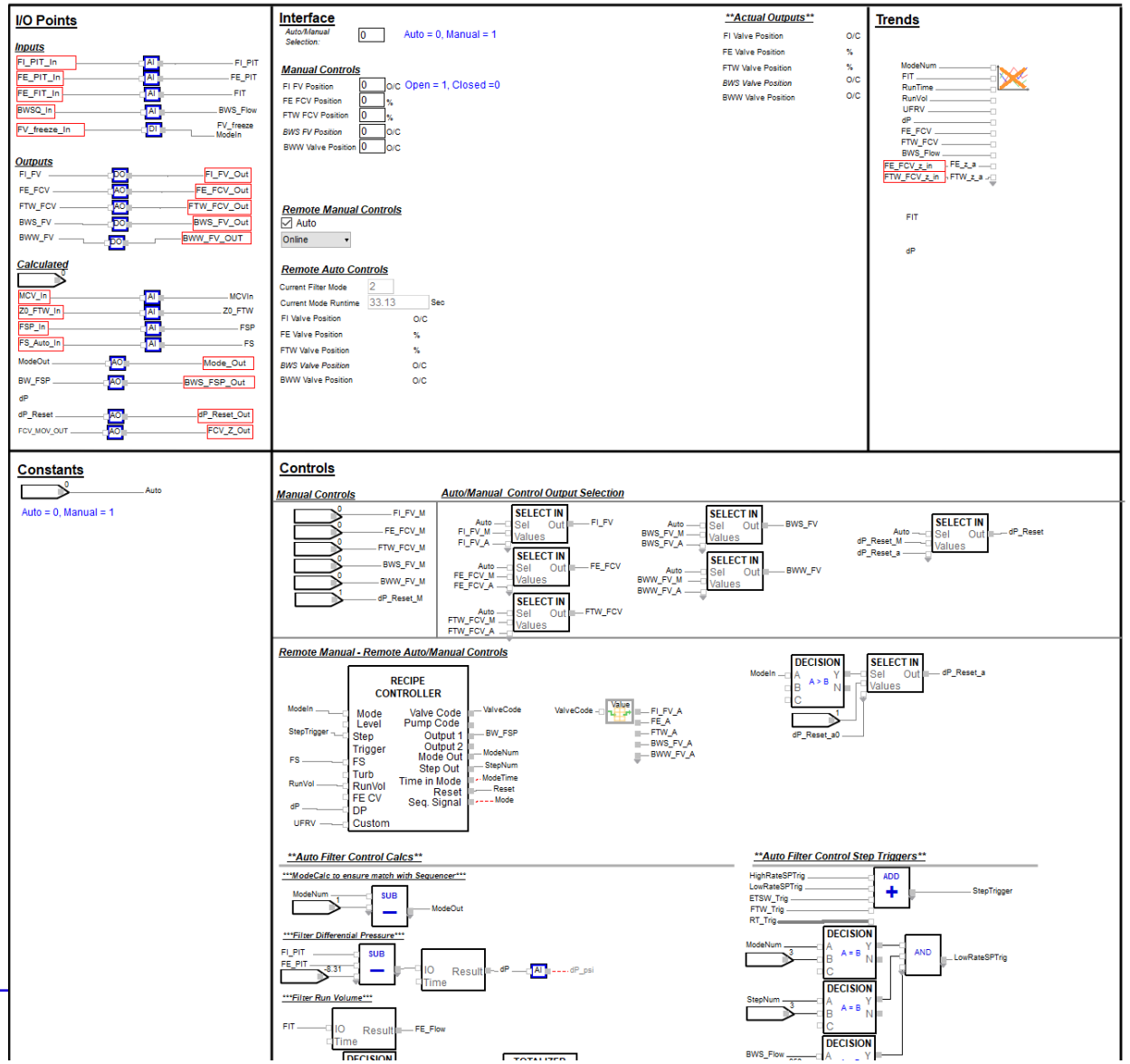
3Kings Digital Twin – Overview Screen

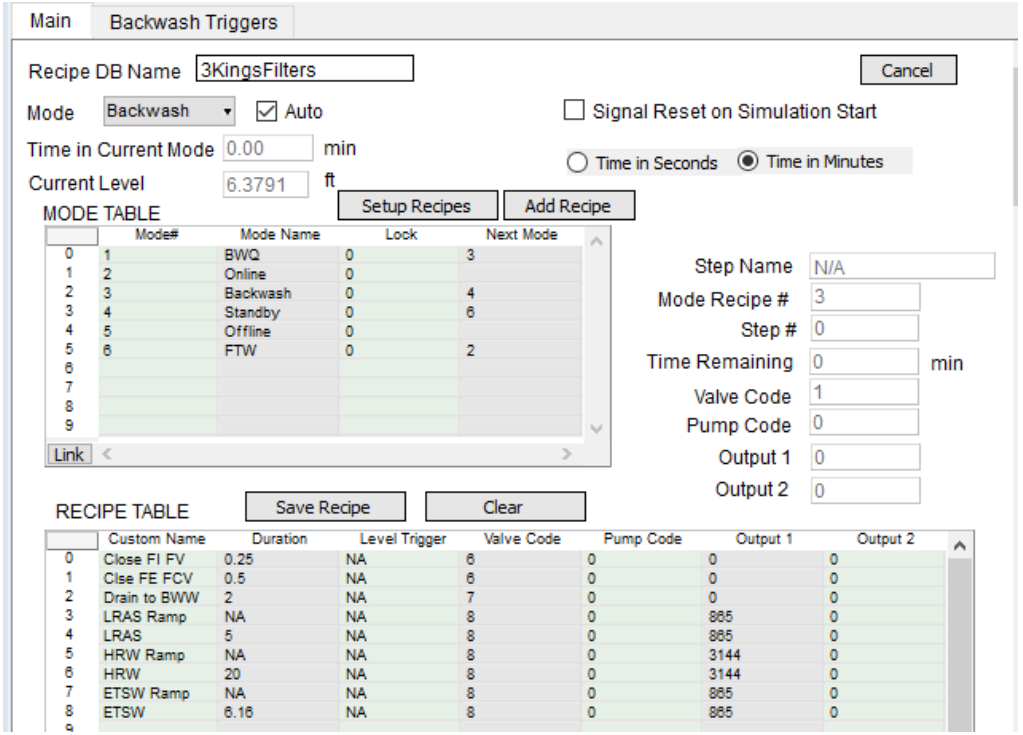


3Kings Digital Twin – Filter 1 Hydraulics

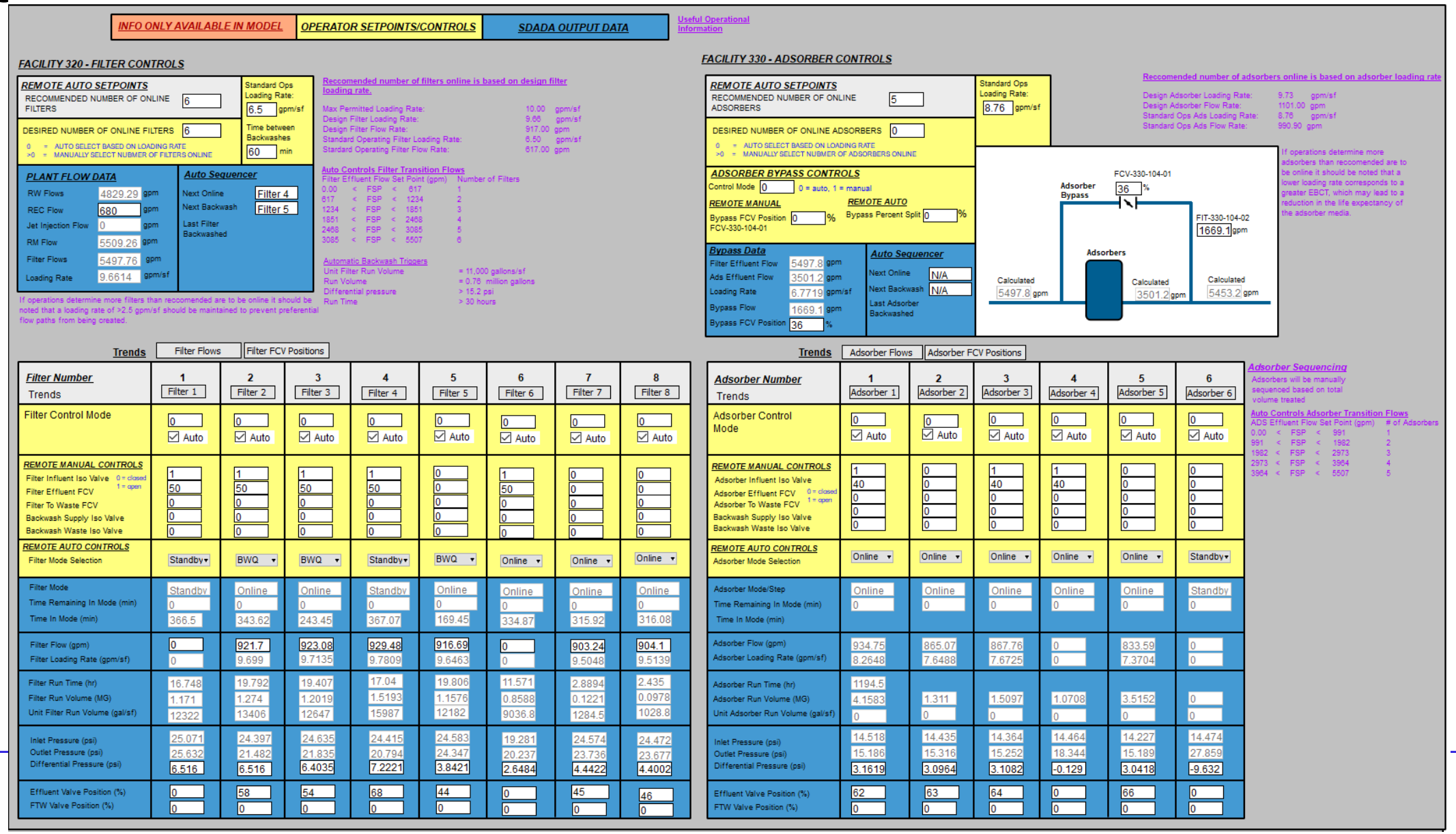


3Kings Digital Twin – Filter 1 Controls





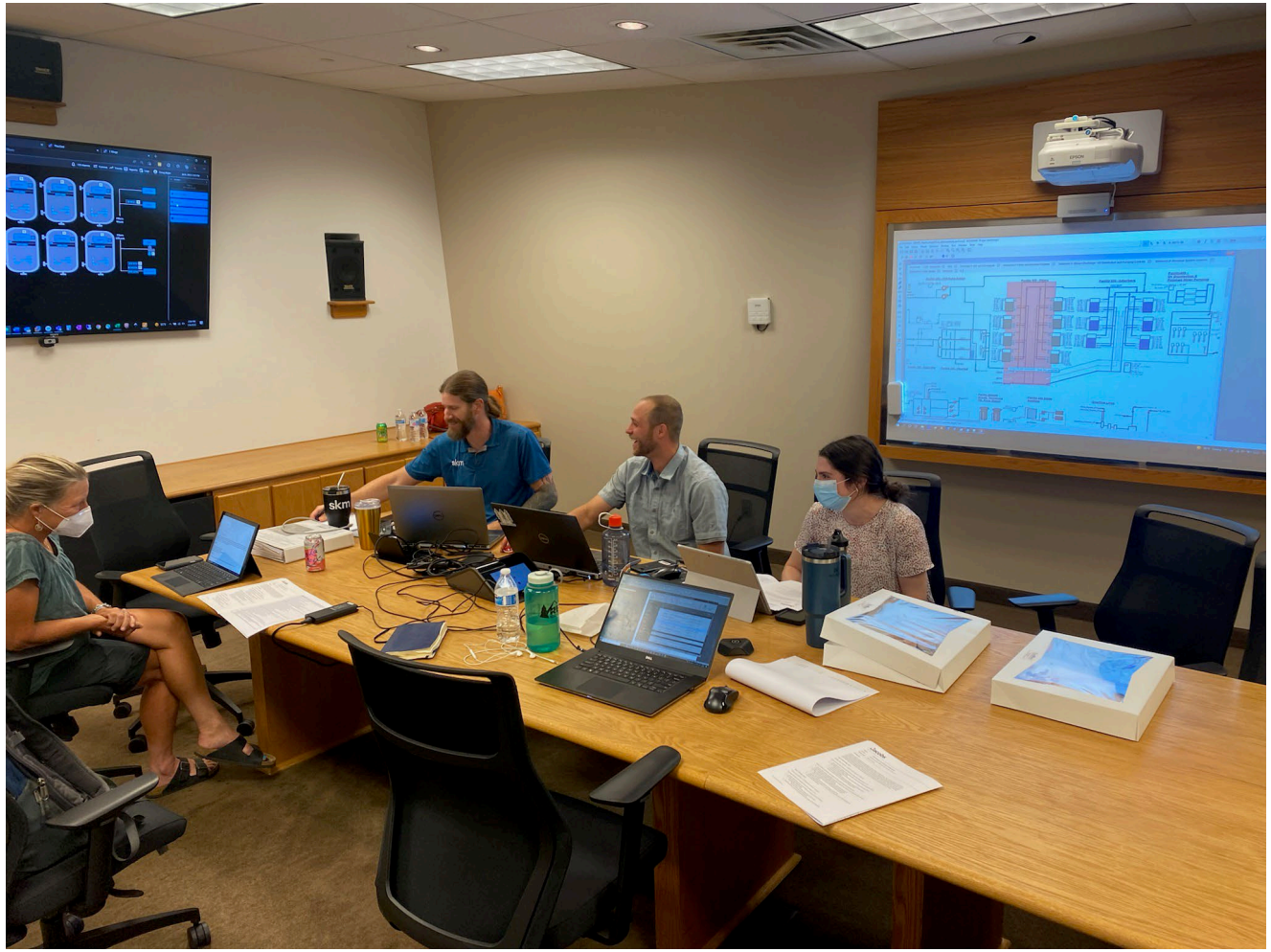
3Kings Digital Twin – Filters User Interface



Functional Acceptance Testing (FAT)

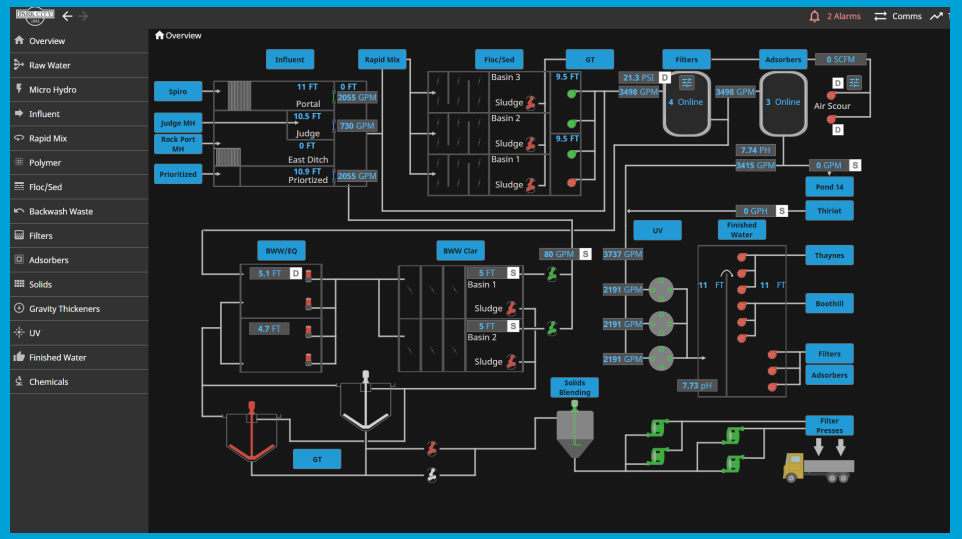
- Traditional FAT
  - Force bits and values in the code
  - Visualization at SCADA
  - No system response

- Dynamic FAT
  - Test updated PLC code using calibrated model rather than live WTP

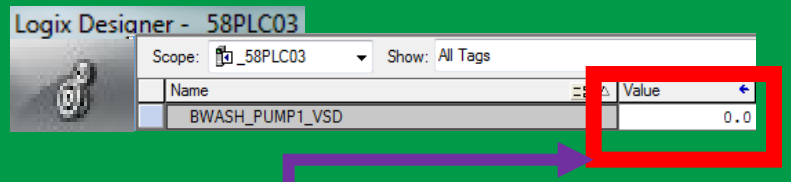


Traditional FAT

SCADA



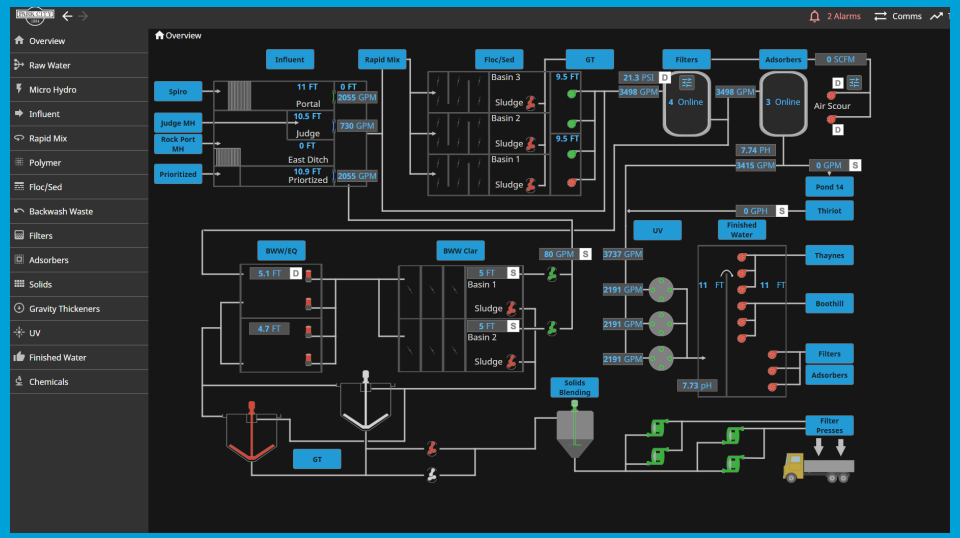
PLC



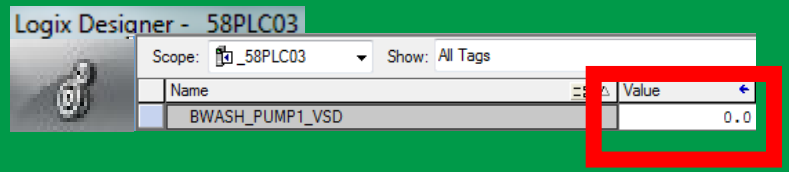
Values of PLC tags manually changed with no process feedback

Dynamic FAT

SCADA



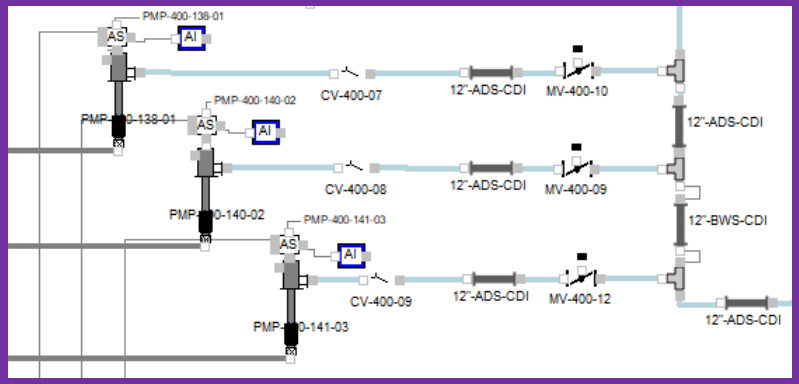
PLC



Inputs (Flow, level, pressure…)

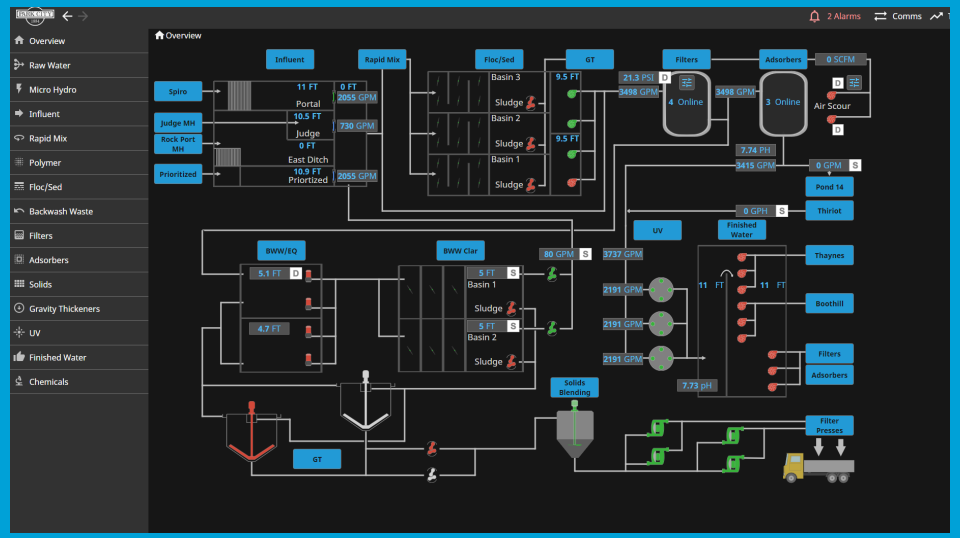
Outputs (Valve position, pump speed…)

Replica

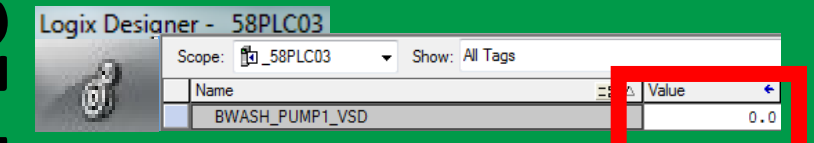


On Site Start Up

SCADA



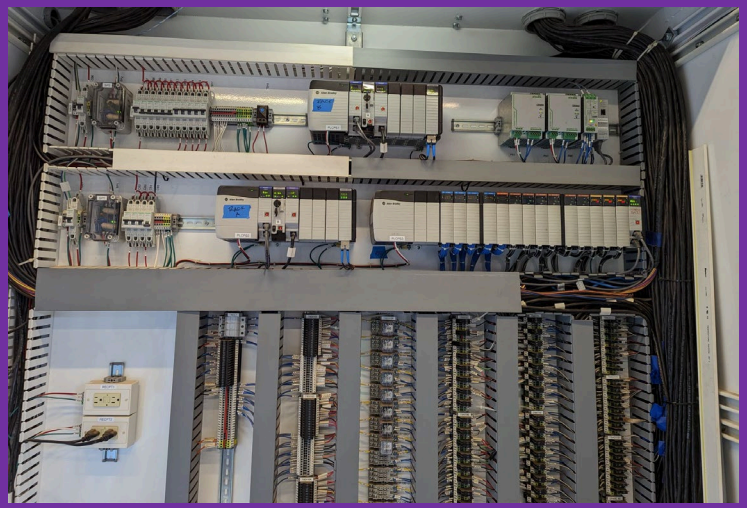
PLC



Inputs (Flow, level, pressure…)

Outputs (Valve position, pump speed…)

Control Panel



Dynamic FAT benefits

- Reduce risk during start up
- Troubleshoot and identify code errors prior to plant implementation
- Test code across variety of ‘what if’ scenarios
- Effective communication between design engineer, system integrator and operations staff
- Gain better understanding of code and system

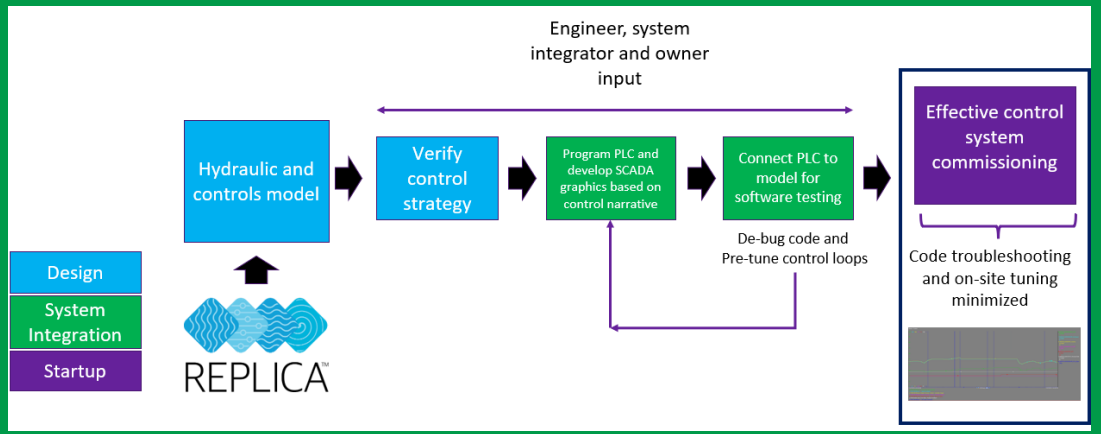
Challenge

Operational Requirements

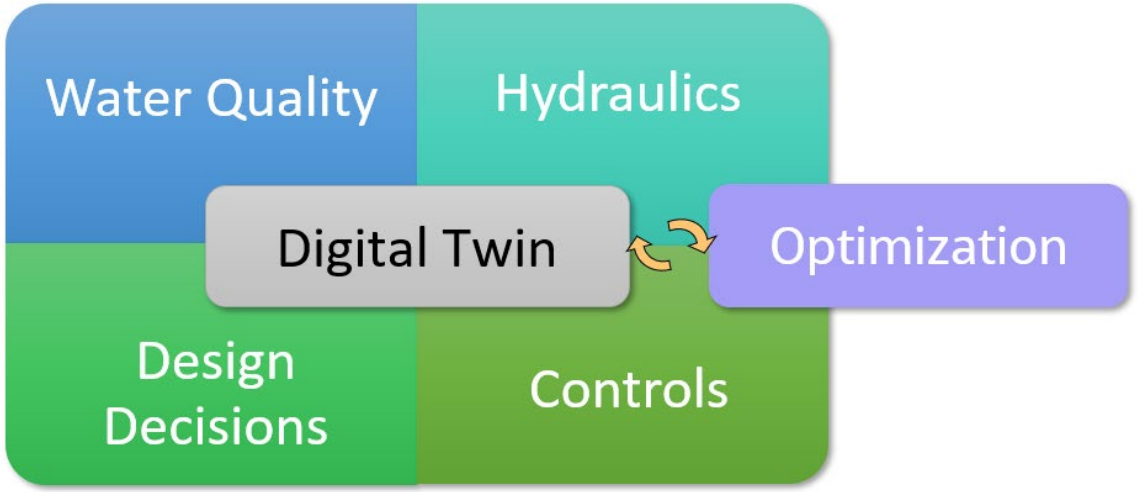
1. Treat water from 3 different sources, including treatment of 100% of Judge mine water
2. Meet customer demand
3. Automatically bring filters and adsorbers online based on loading rates

The Challenge:
Commission complex controls on tight schedule.

Solution



Value



Thank You

Questions?