

Taking GIS into the Well

Building a Replicable Condition Assessment Framework with Survey123

Background

Objectives

- *Develop a strategy for how to manage assets with incomplete or inconsistent records*
- *Develop a sustainable process to assess the condition of assets*
- *Draw conclusions from the data and evaluate for decision-making*



Who We Are

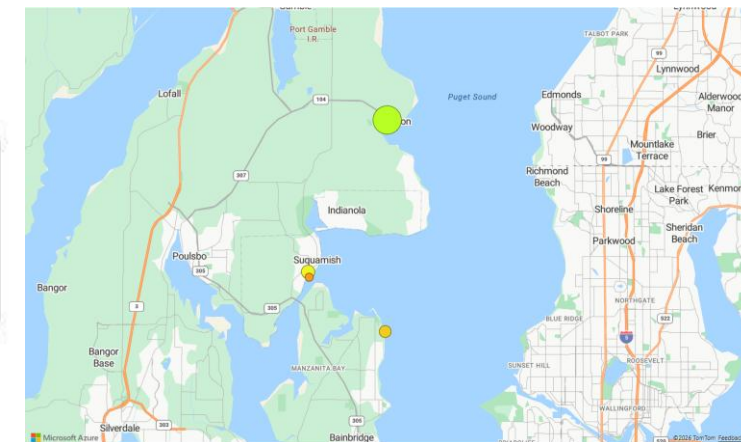
Hazen

- 75 years in the water industry
- Working across all aspects of water – wastewater, drinking water, stormwater
- Recently expanded to PNW including work with Shoreline, King County, Kennewick, Sammamish, Bellevue, and Kitsap County.
- Asset management focus



Kitsap County

- Owns and operates 63 pump stations for its sewer collection system
- Sewer staff have previous experiences with asset management, but they haven't been established in a coherent manner



Purpose of Project

- Establish a proactive asset management process
- Utilize a comprehensive condition assessment framework
- Build a foundation for risk-based maintenance, rehab and replacement, and CIPs

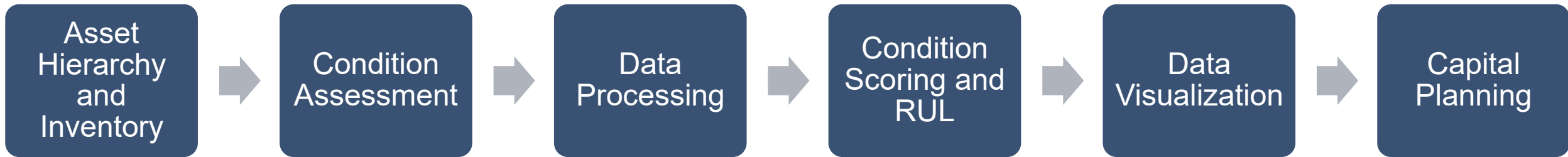


Combined CA Score (Avg + Max)/2

Average CA Score: 2.7142857

Max CA Score: 5

Combined CA Score: 3.8571429

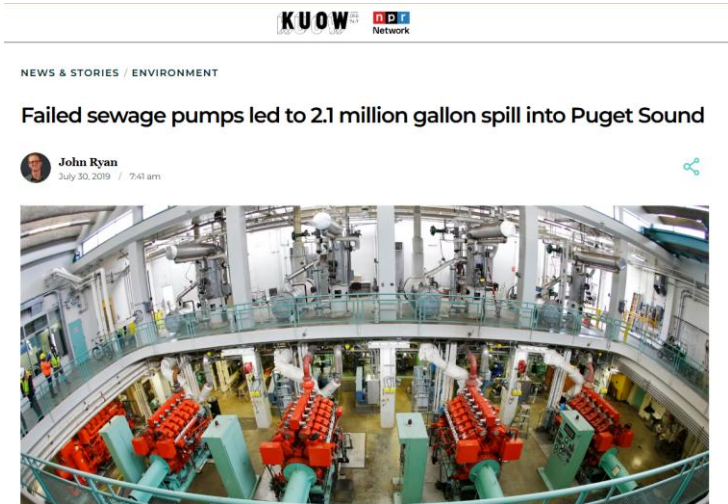
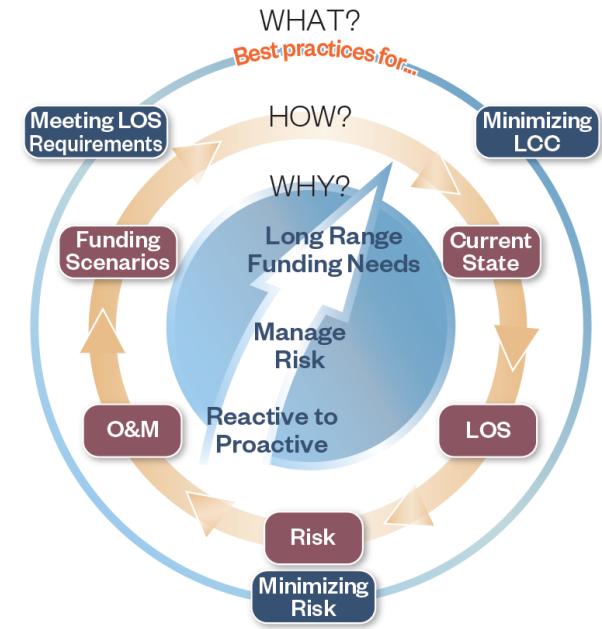


Condition Assessment and Asset Management Approach

Asset Management Overview

• Why does asset management matter?

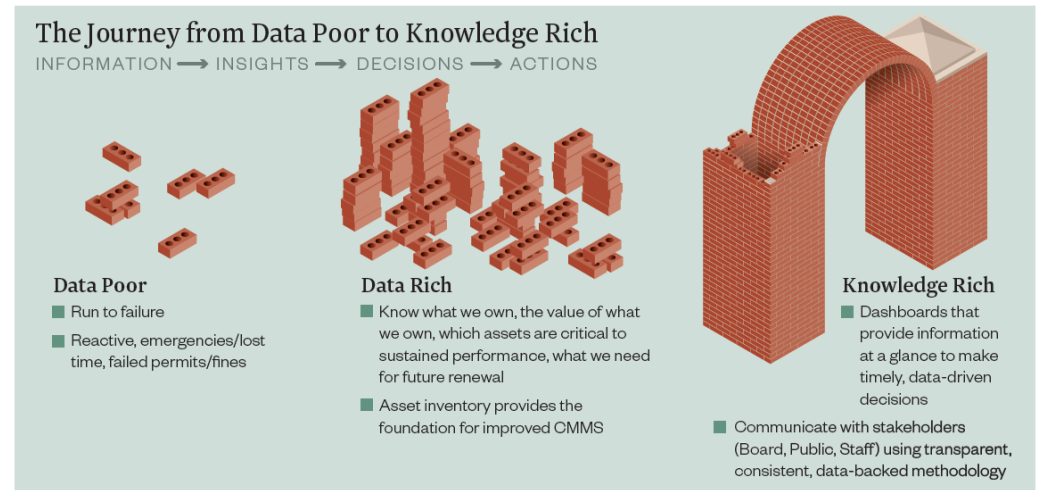
- Prepare and plan for the future
- Utilize existing data (GIS, work orders, CMMS data) to predict and plan ahead
- Minimize risk
- Meet regulatory requirements



LOCAL
**From Sea-Tac to schools:
 Bursting pipes wreak havoc
 across Western Washington**

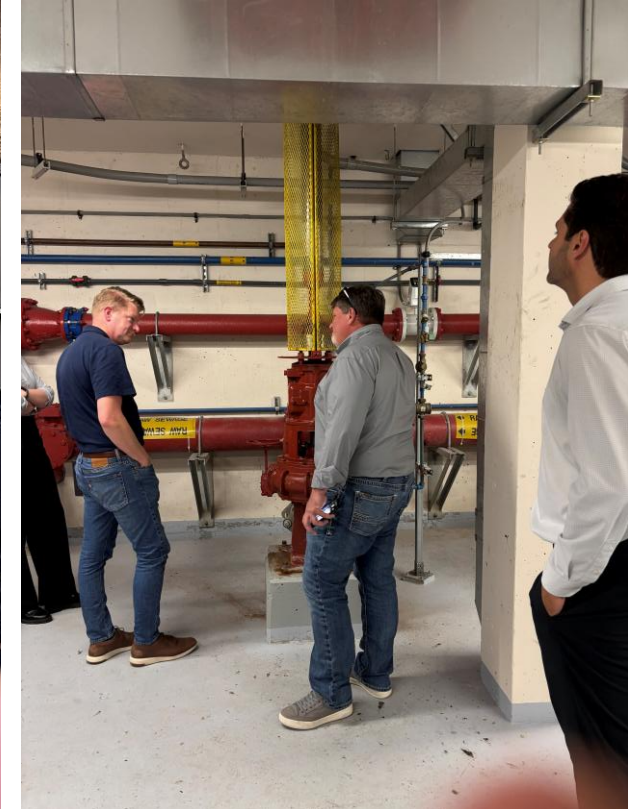
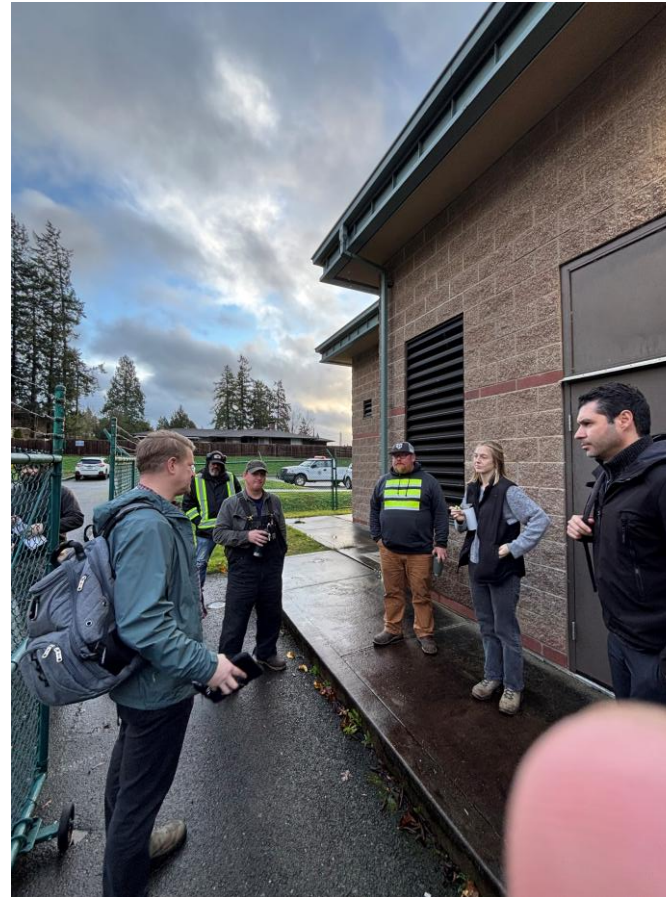


By KIRO 7 News Staff
 January 16, 2024 at 7:10 am PST



Training Approach with Kitsap County

- Established structure for condition assessment
 - Tested with one pump station
- Refined condition assessment framework
 - Tested again with three pump stations
- Eventual implementation with the client moving survey and process to their environment



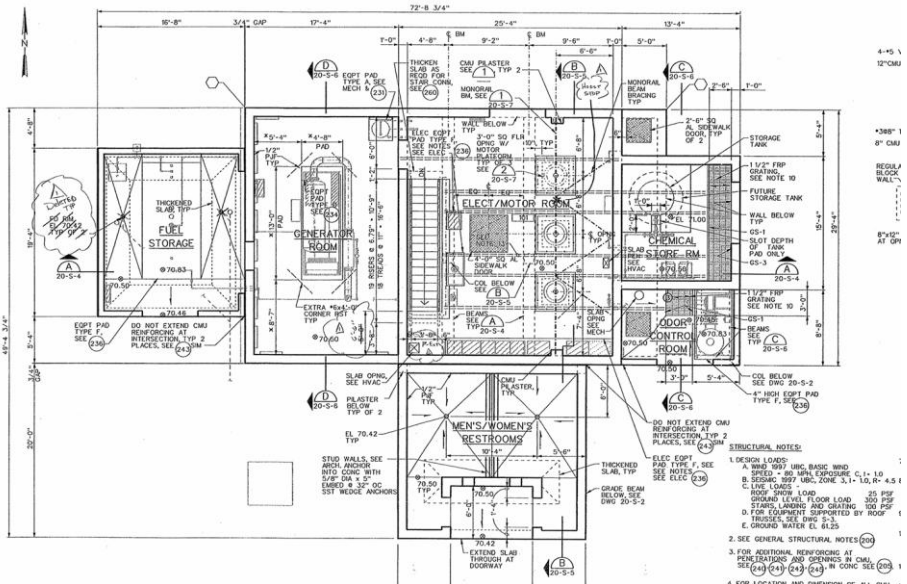
Condition Assessment Framework

- Asset Class specific questions
- Scoring based on objective criteria

label	Answer (1)	Answer (2)	Answer (3)	Answer (4)	Answer (5)	Asset Class
Absence of Burn Marks	No burn marks or discoloration are visible on electrical components, indicating proper operation and no signs of overheating or electrical faults.				Burn marks or discoloration are present on electrical components, suggesting overheating, arcing, or potential electrical faults requiring immediate attention.	{'VARIABLE_FREQUENCY_DRIVE', 'BREAKERS', 'AUTOMATIC_TRANSFER_SWITCH', 'TRANSFORMER', 'PANEL', 'BATTERY_PERIPHERAL', 'SWITCHES_PROCESS', 'MCC'}
Acceptable Debris/Moisture	Minor: No Buildup.		Moderate: Slight buildup or accumulation of debris and/or moisture.		Significant: Excessive Buildup or accumulation of debris and/or moisture.	{'DUCTING', 'BATHROOM_FIXTURE', 'VARIABLE_FREQUENCY_DRIVE', 'WELL', 'VAULT', 'TRANSFORMER', 'AUTOMATIC_TRANSFER_SWITCH', 'MCC', 'PANEL', 'FILTER'}
Acceptable Vibration	No unusual vibration or indicators of excess movement present.		Moderate vibration or indicators of moderate wear due to vibration present.		Observed excess vibrations and/or indicators of noticeable movement.	{'MOTOR', 'AIR_VENT', 'PUMP', 'BLOWER', 'FAN', 'AIR_FILTER', 'ENGINE', 'GENERATOR', 'AC_UNIT', 'FILTER'}
Belt/ Direct Drive/ Couplings	Excellent: Belts, sheaves, and couplings are in pristine condition with no visible wear, cracking, or corrosion. Alignment, tension, and lubrication (if applicable) are within optimal specifications, with no abnormal noise or vibration.	Good: Minor wear on belts, sheaves, or coupling surfaces, with slight misalignment or looseness not impacting functionality. Tension and lubrication are adequate, and no unusual noises or vibrations are present.	Fair: Visible wear on belts (e.g., glazing or fraying), sheaves (e.g., groove wear), or couplings (e.g., surface damage). Misalignment or improper tension is noticeable.	Poor: Belts show cracking, significant wear, or improper fit; sheave grooves are visibly worn or out of profile; couplings exhibit severe wear or looseness. Alignment and tension are outside acceptable ranges, and vibration or noise is pronounced.	Critical: Belts are slipping, severely cracked, or detached; sheaves are visibly damaged or heavily worn; couplings are failing with evident damage or separation. Alignment, tension, and vibration are far beyond acceptable limits, compromising system integrity.	{'DAMPER', 'AIR_VENT', 'PUMP', 'BLOWER', 'FAN', 'ENGINE', 'GENERATOR', 'AC_UNIT'}

Data Gathering

- Used existing records to pre-fill data when possible and generate a functional asset register.
- In most cases, existing records lack enough detail to adequately complete the attributes for an asset register
 - Installation year
 - Current condition
- Existing records may need verification of accuracy in the field



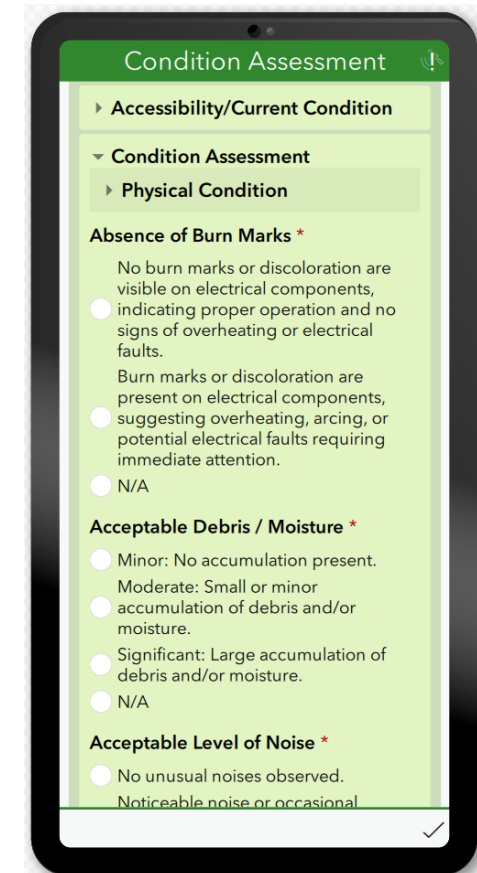
Hierarchy								Physical Attributes							
Hazen ID	Division (Level I)	Service Area (Level II)	System (Level III)	Facility Type (Level IV)	Facility (Level V)	Location (Level VI)	Sub-Location (Level VII)	Asset Description (Level VIII)	Unit 1	Size 2	Unit 2	Size 3	Unit 3	Manufacturer	Model
54 0027	Sewer Utility Division	Squamish	Collections	Pump Station	PS-54	Site		Junction Box, PS-54	LFT	2 DFT		2 WFT			
54 0019	Sewer Utility Division	Squamish	Collections	Pump Station	PS-54	Wet Well		Submersible Pump 2, PS-54	HP	350@40	GPM@TDH	4 in	(Discharge Diam.)	ABS Pumps	AFP1042-M70(4)EX
53 0018	Sewer Utility Division	Squamish	Collections	Pump Station	PS-53	Wet Well		Air Vent, PS-53	DIN						
53 0017	Sewer Utility Division	Squamish	Collections	Pump Station	PS-53	Site		Safety Switch, PS-53	Amps	600	Volts			Square D	8233RB
53 0006	Sewer Utility Division	Squamish	Collections	Pump Station	PS-53	Wet Well		Wet Well, PS-53	HFT	211.51	GAL/FT				
41 0001	Sewer Utility Division	Kingston	Collections	Pump Station	PS-41	Dry Well		Access Hatch, PS-41	FT DIA						
53 0012	Sewer Utility Division	Squamish	Collections	Pump Station	PS-53	Dry Well		Check Valve 2, PS-53	DIN						
53 0014	Sewer Utility Division	Squamish	Collections	Pump Station	PS-53	Dry Well		Inlet Isolation Valve 2, PS-53	DIN						
41 0024	Sewer Utility Division	Kingston	Collections	Pump Station	PS-41	Dry Well		Bubbler Compressor, PS-41	SCFM	125	PSI				12782F
53 0003	Sewer Utility Division	Squamish	Collections	Pump Station	PS-53	Dry Well		Check Valve, PS-53	DIN						
53 0009	Sewer Utility Division	Squamish	Collections	Pump Station	PS-53	Wet Well		Ladder, PS-53	HFT						
53 0011	Sewer Utility Division	Squamish	Collections	Pump Station	PS-53	Dry Well		Pump Motor, 1, PS-53	HP						
71 0022	Sewer Utility Division	Kingston	Collections	Pump Station	PS-71	Chemical Storage Room		Bioxide Storage Tank, PS-71	GAL	104	DIN				
41 0022	Sewer Utility Division	Kingston	Collections	Pump Station	PS-41	Dry Well		Bubbler Control Panel, PS-41	Volts					Smith & Lowless	
41 0005	Sewer Utility Division	Kingston	Collections	Pump Station	PS-41	Dry Well		Centrifugal Pump, 1, PS-41	HP	240@92	GPM@TDH	4 in		Smith & Lowless	483
41 0008	Sewer Utility Division	Kingston	Collections	Pump Station	PS-41	Dry Well		Centrifugal Pump, 2, PS-41	HP	240@92	GPM@TDH	4 in		Smith & Lowless	483
53 0022	Sewer Utility Division	Squamish	Collections	Pump Station	PS-53	Dry Well		Bubbler Compressor, PS-53	SCFM	125	PSI				12782F
41 0010	Sewer Utility Division	Kingston	Collections	Pump Station	PS-41	Dry Well		Check Valve, PS-41	DIN						
41 0013	Sewer Utility Division	Kingston	Collections	Pump Station	PS-41	Site		Circuit Breaker, PS-41	Amps	480	Volts AC			Square D	#8-4C
53 0021	Sewer Utility Division	Squamish	Collections	Pump Station	PS-53	Dry Well		Bubbler Control Panel, PS-53	Volts					Smith & Lowless	
53 0020	Sewer Utility Division	Squamish	Collections	Pump Station	PS-53	Site		Float Control Box, PS-53	Volts	4	Relays	2	Level	Electromate Enclosures	
54 0002	Sewer Utility Division	Squamish	Collections	Pump Station	PS-54	Valve Vault		Valve Vault, PS-54	IN	78	IN				

ArcGIS Survey123 Implementation

Condition Framework to xls Form

- Condition assessment framework consists of dozens of Excel sheets for each asset class
 - This enables disciplinary experts to review and revise questions
- Python scripts were used to help transform the Excel spreadsheet into a:
 - Choice list
 - Question names
 - Relevant queries to limit visibility of questions for the appropriate asset classes

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Data Model or Schema

- Related tables
- Feature layer with attributes
- Related table with condition scoring questions
- *Why would we do this?*
 - *More efficient data storage*
 - *For repeated assessments, no need to add attribute information repeatedly*
 - *Separates the spatial feature from the extended data table of attributes, preserving geometry*
 - *Immediate symbology or other field updates in map visuals through form logic rather than using webhooks or scripts*

globalid	Facility Type (Level IV)	Facility (Level V)	Location (Level VI)	Sub-Location (Level VII)	Asset Description (Level VIII)
{28770C45-0777-4CD2-B24C-F8D75978EA94}	Pump Station	PS-54	Site		Junction Box, PS-54
{B18D19DC-9C32-45E1-A3A6-B84DFE889A27}	Pump Station	PS-54	Wet Well		Submersible Pump 2, PS-54
{B354D9AF-455B-49A9-BF54-C3C136B3D1DD}	Pump Station	PS-53	Wet Well		Air Vent, PS-53
{6908235D-C81E-4E25-82BA-16A325DC1216}	Pump Station	PS-53	Site		Safety Switch, PS-53



Parent GlobalID	Acceptable Level of Noise	Acceptable Oil Grease	Acceptable Smell or Heat	Acceptable Vibration
{B354D9AF-455B-49A9-BF54-C3C136B3D1DD}		3		3

Survey Design

- Design elements

- Asset attributes and required fields
- Cascading queries
- Questions dependent on asset class and type
- Photos organized with guided questions

- Lessons learned in survey design

- Organize questions based on location for inspection (e.g. in and out of cabinets) rather than alphabetically
- Originally tried to document each photo, but users wanted more flexibility to take many photos (considered using multiline)
- Needed to require asset class and type to ensure relevant questions were visible
- Desire for text to explain question scoring
- *Desire to improve search in inbox – unresolved currently due to Esri limitations*

The image shows a mobile application interface for 'Condition Assessment'. The form is organized into several sections:

- Asset Information**: A section header with a dropdown arrow.
- Division (Level I)** and **Service Area (Level II)**: Two dropdown menus.
- System (Level III)** and **Facility Type (Level IV)**: Two dropdown menus.
- Facility (Level V)** and **Location (Level VI)**: Two dropdown menus.
- Sub-Location (Level VII)** and **Asset Description (Level VIII)**: Two text input fields.
- Asset ID** and **Material**: Two text input fields.
- Size 1** and **Unit 1**: A text input field and a dropdown menu (with example text 'e.g. DIN, HP, GAL').
- Size 2** and **Unit 2**: A text input field and a dropdown menu.
- Size 3** and **Unit 3**: A text input field and a dropdown menu.

A green checkmark is visible in the bottom right corner of the form area.

Publishing

- Appending asset register and field mapping
 - **Most time-intensive effort**
- Collect vs inbox
- Review the settings used
- Portal vs AGO: discuss the pros and cons of each with licensing, and limitations

AGO	Portal
Simpler transfer process between accounts	Requires testing in the portal environment which has risks
Similar versioning	Version limitations
High cost per license	Preferable licensing for many users

Results

Condition Scoring



- Acceptable Level of Noise: 5
- Acceptable Smell or Heat: 1
- Acceptable Vibration: 1
- Belt Direct Drive Couplings: 4
- Coating or Paint Condition: 1
- Corrosion: 1
- Duct Work: 1
- Electrical Cable Conduit Condition: 1
- Fan and Fan Motor Operational: 1
- Installation Accessibility: 3
- Mounting Physical Support: 1
- Physical Damage: 3

Supply Fan 20-SF-01, PS-71

Combined Condition Score, (1 – 5)

$$= \frac{Avg + Max}{2} \text{ (of condition assessment question scores)}$$

Age Based Condition, (1 – 5)

$$= \left(\left(\frac{Age\ of\ asset}{Customized\ Useful\ Life} \right) \times 4 \right) + 1$$

Adjusted Condition Score

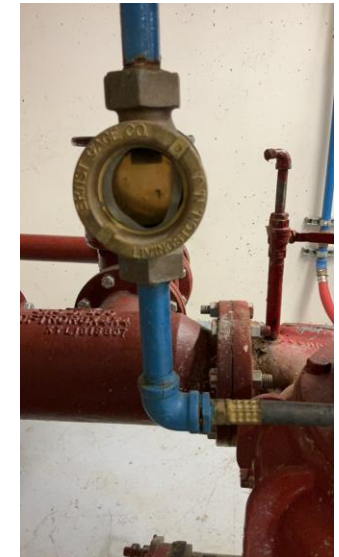
$$= (50\% \times Combined\ Condition) + (50\% \times Age\ Based\ Condition)$$

Condition Category	Adjusted Condition Score Range
Poor	4.5 – 5.0
Fair	3.5 – 4.49
Average	2.5 – 3.49
Good	1.5 – 2.49
Excellent	1.0 – 1.49

Average CA Score	Max CA Score	Combined CA Score (Avg + Max)/2	Age of Asset	Customized Useful Life	Age-Based Condition	Adjusted Condition Score
1.91666667	5	3.45833333	23	40	3.3	3.379166667

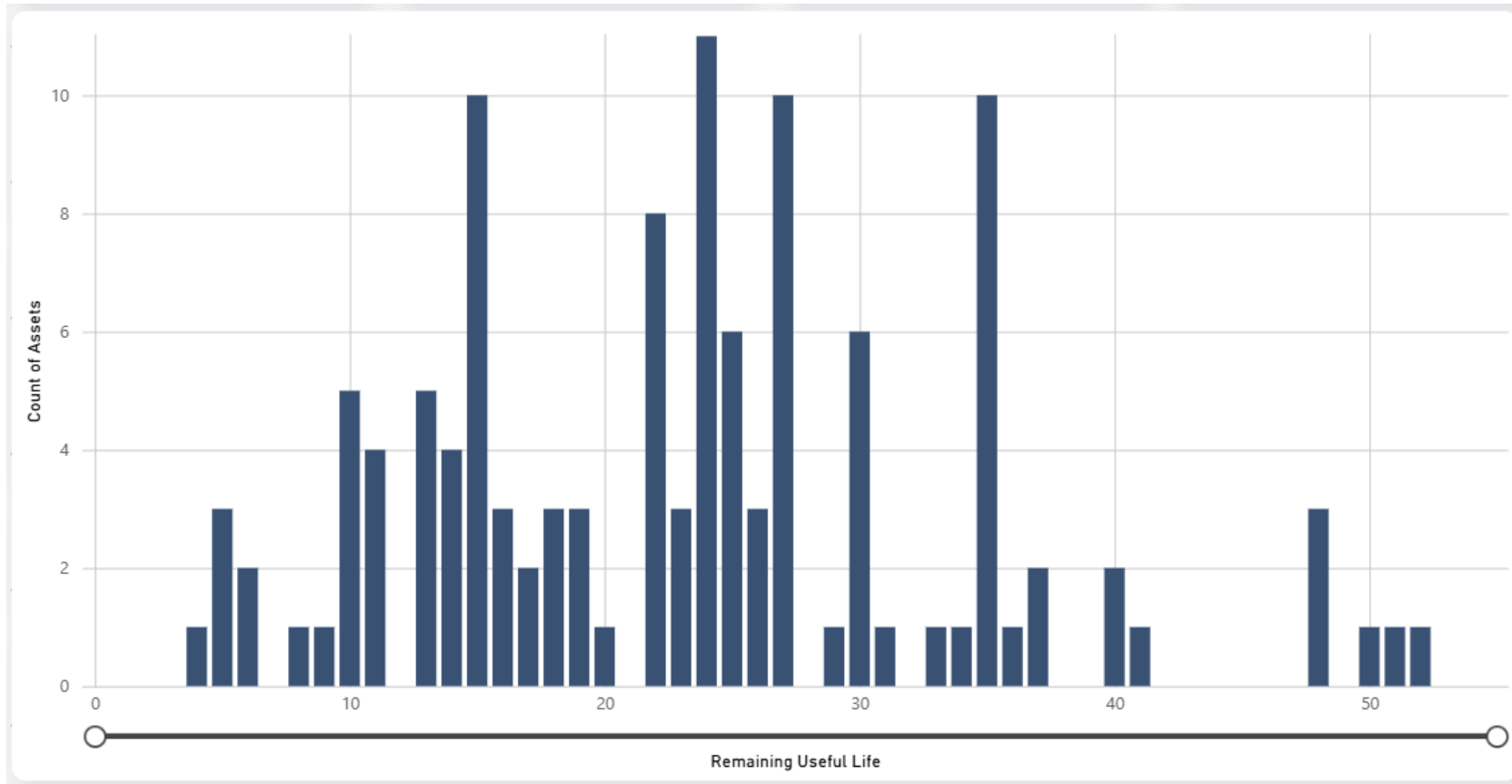
Condition Scoring

Asset	Entries	Average CA Score	Max CA Score	Combined CA Score	Age of Asset	Customized Useful Life	Age-Based Condition	Adjusted Condition Score
Check Valve, 2, PS-53	AbsenceofLeaks: 5 Corrosion: 3 FlangeBoltCondition: 1 InstallationAccessibility: 1 PhysicalDamage: 1 PipeAlignment: 1	2	5	3.5	49	40	5	4.25
Swing Valve (FL) 2, PS-54	AbsenceofLeaks: 1 Corrosion: 3 Dampener: 5 FlangeBoltCondition: 3 InstallationAccessibility: 1 PhysicalDamage: 4 PipeAlignment: 1	2.57	5	3.79	29	40	3.9	3.84
Pump, P-101, PS-71	AbsenceofLeaks: 1 AcceptableLevelofNoise: 3 AcceptableSmellorHeat: 1 AcceptableVibration: 1 CoatingorPaintCondition: 1 Corrosion: 1 DisplayIndicatorOk: 5 DriveShaft: 3 InstallationAccessibility: 1 MountingPhysicalSupport: 3 PackingGlandMechanicalSeal: 1 PhysicalDamage: 1 PipeAlignment: 1	1.77	5	3.38	23	35	3.63	3.51

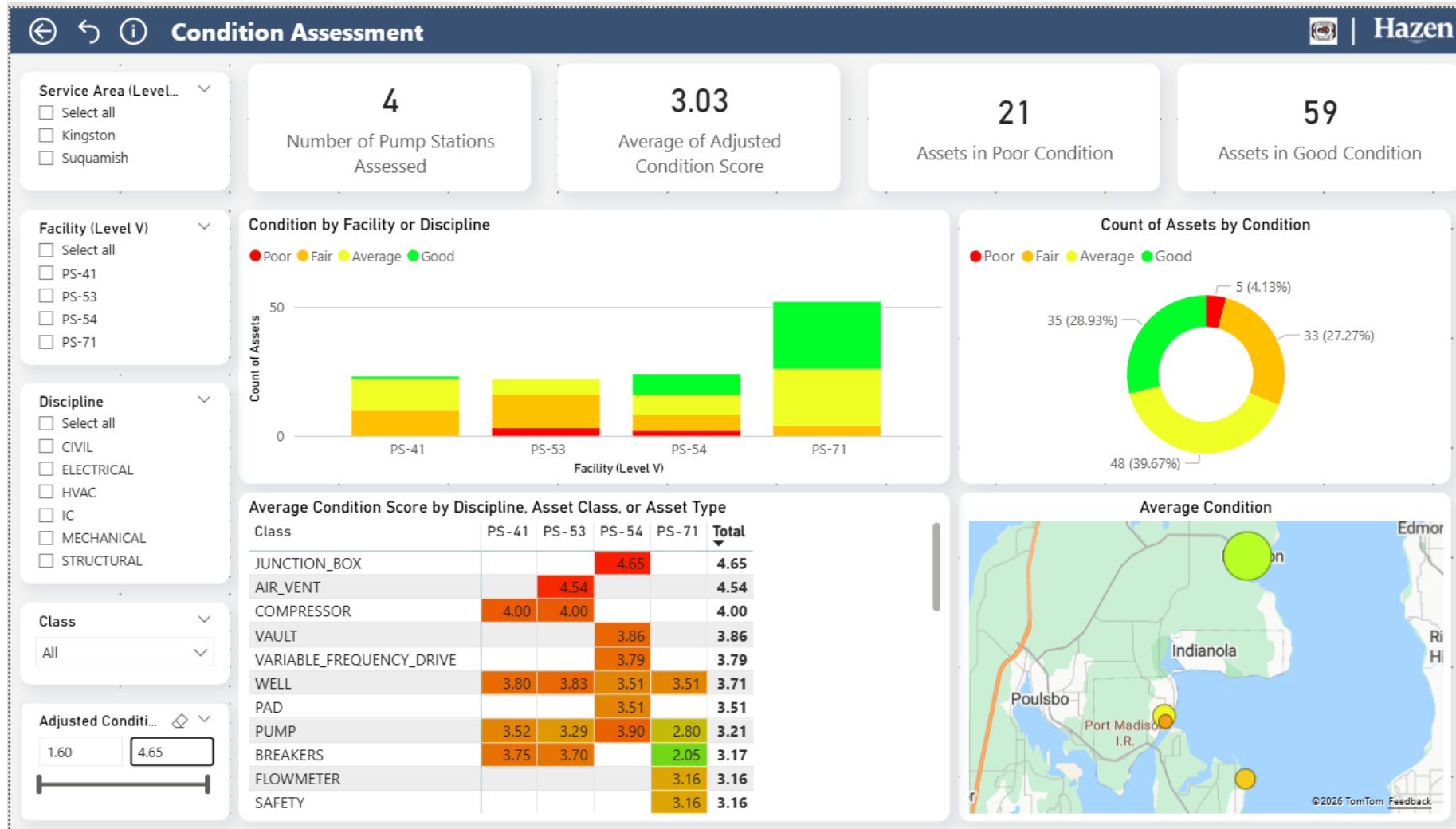


Remaining Useful Life

Asset Class	Asset Type	Average of Condition Score	Average of Age	Industry Useful Life	Remaining Percent of Life	Custom Useful Life
HATCH	VAULT	2.2	39	50	64%	60
LADDER	LADDER_GENERAL	2.3	37	50	63%	60
MOTOR	AC_INDUCTION	1.7	40	30	71%	40
PANEL	CONTROL_PANEL	2.3	33	30	62%	45
PUMP	CENTRIFUGAL	1.7	36	25	71%	35



Dashboard



Take Home Framework

Develop a condition assessment framework

Use Survey123 or any other digital tool to support with data collection

Host in ArcGIS Online or Portal depending on infrastructure capacity

Automate scoring to enable effective asset management decisions