Yakima, Washington
May 4, 2012

Lessons Learned on Bellevue's Reservoir Recoating Projects

Daniel Williams, MWH
Chris Brookes, City of Bellevue

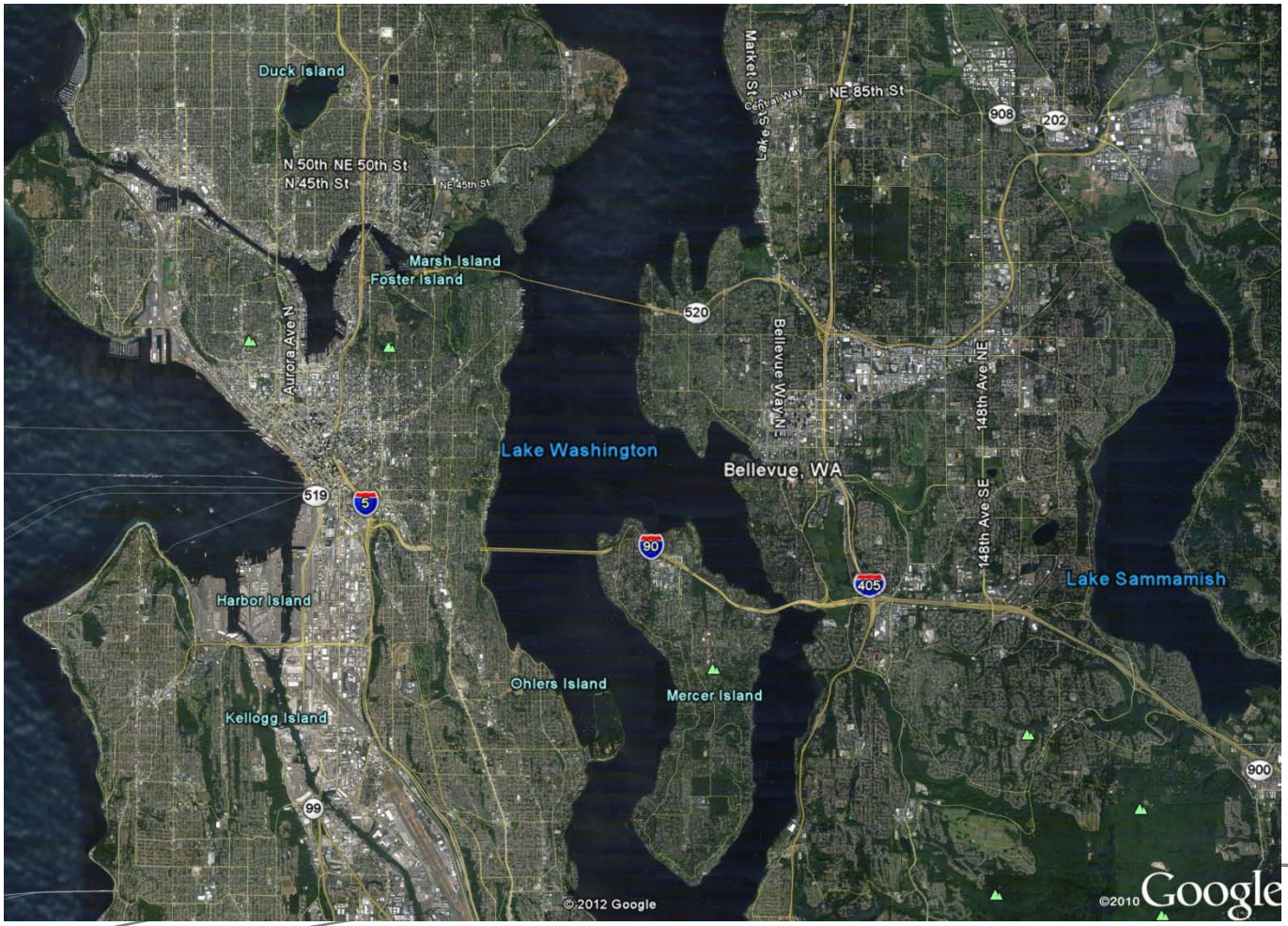
MWH
BUILDING A BETTER WORLD

This Presentation will Cover the following Topics:

- Introduction
- Asset Management
- Reservoir Inspection
- Example Coating Projects
- Summary of Lessons Learned

INTRODUCTION - 1

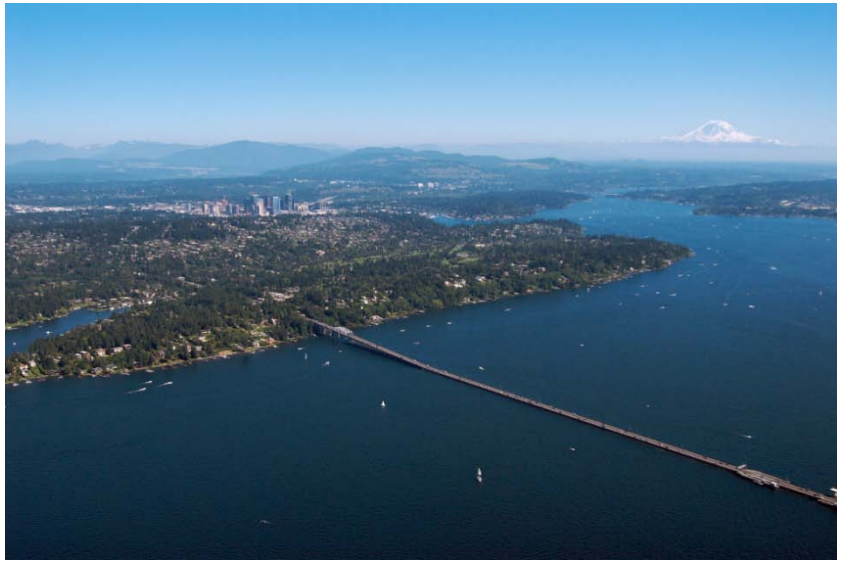
Bellevue Location Map



INTRODUCTION - 2

City of Bellevue:

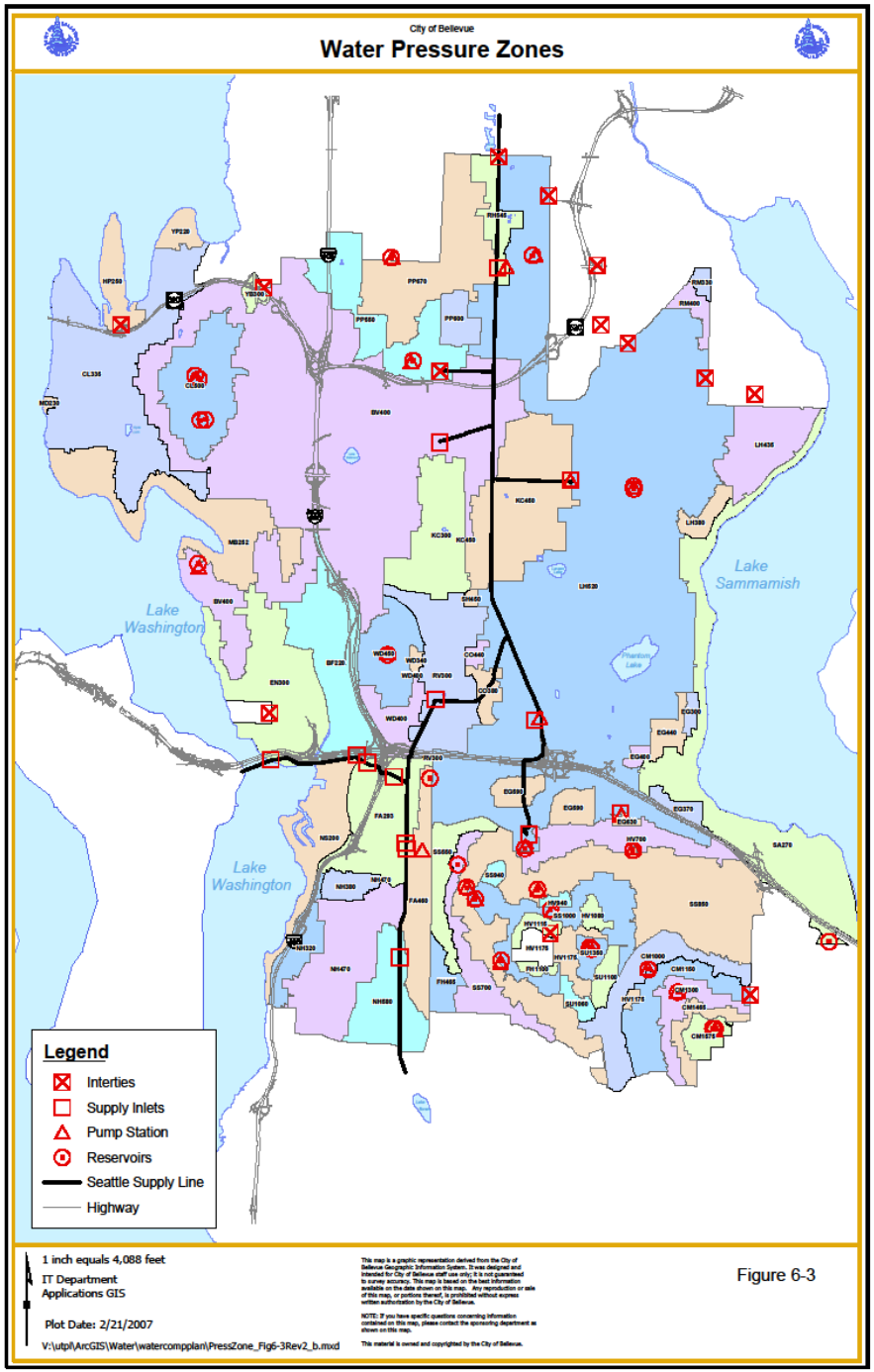
- **Population:** 122,000
- **Area:** 31 square miles
- **City employees:** 1,242
- **Companies:**
  - Microsoft
  - Expedia
  - Puget Sound Energy
  - PACCAR
- **Elevation:** 25 feet to 1,450 feet



INTRODUCTION - 3

Bellevue Water Distribution System:

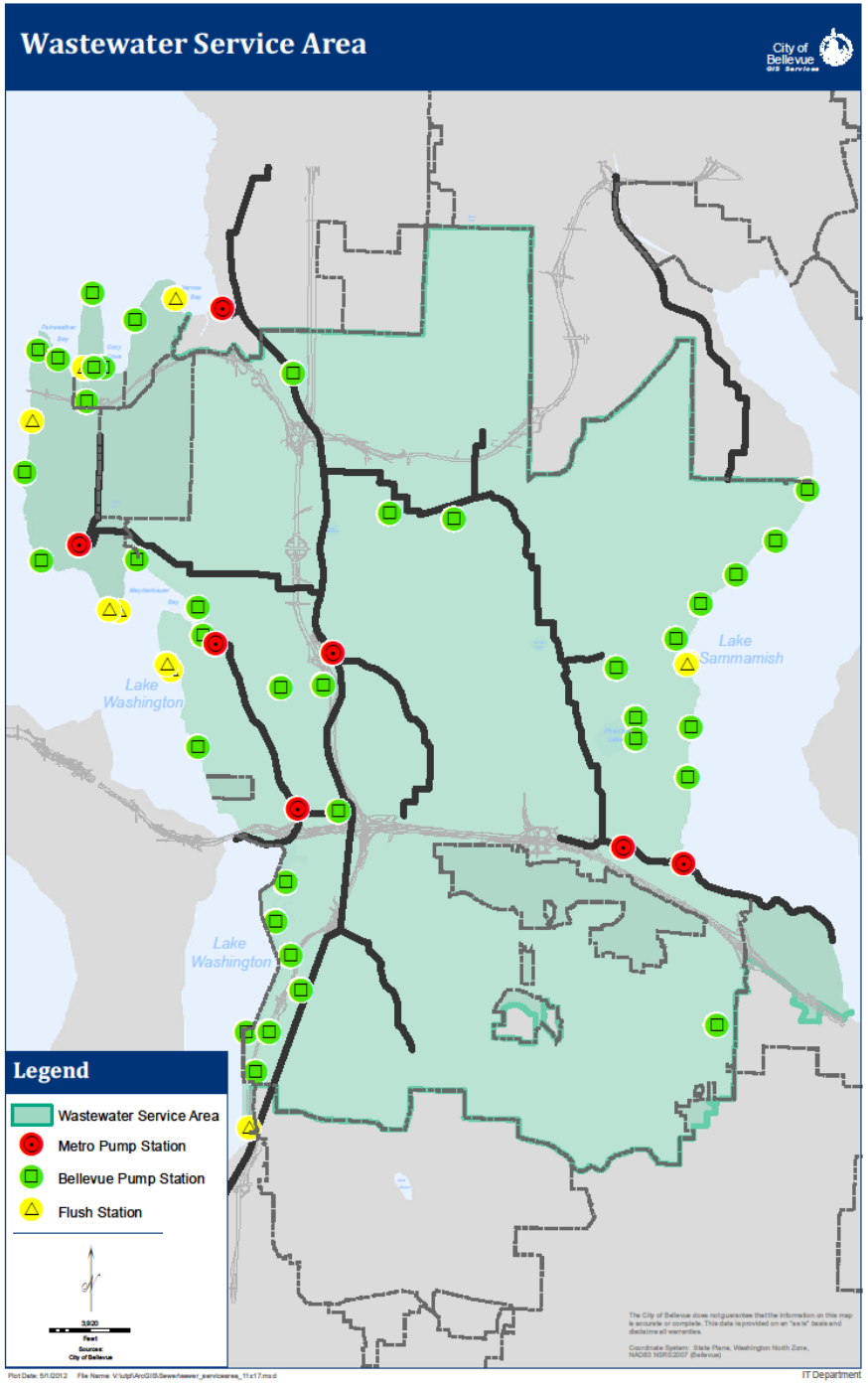
- Purchase water from SPU/CWA
- Storage:
  - 13 concrete tanks
  - 12 steel tanks
- Inlets:
  - 15 SPU
  - 1 CWA
- Pump Stations: 23
- PRV Stations: 160



INTRODUCTION - 4

Bellevue Wastewater Collection System:

- Discharge WW to King County
- Pump Stations:
  - 37 – Owned by Bellevue
  - 7 – Owned by King County



ASSET MANAGEMENT –1

Reservoir Inspection Program:

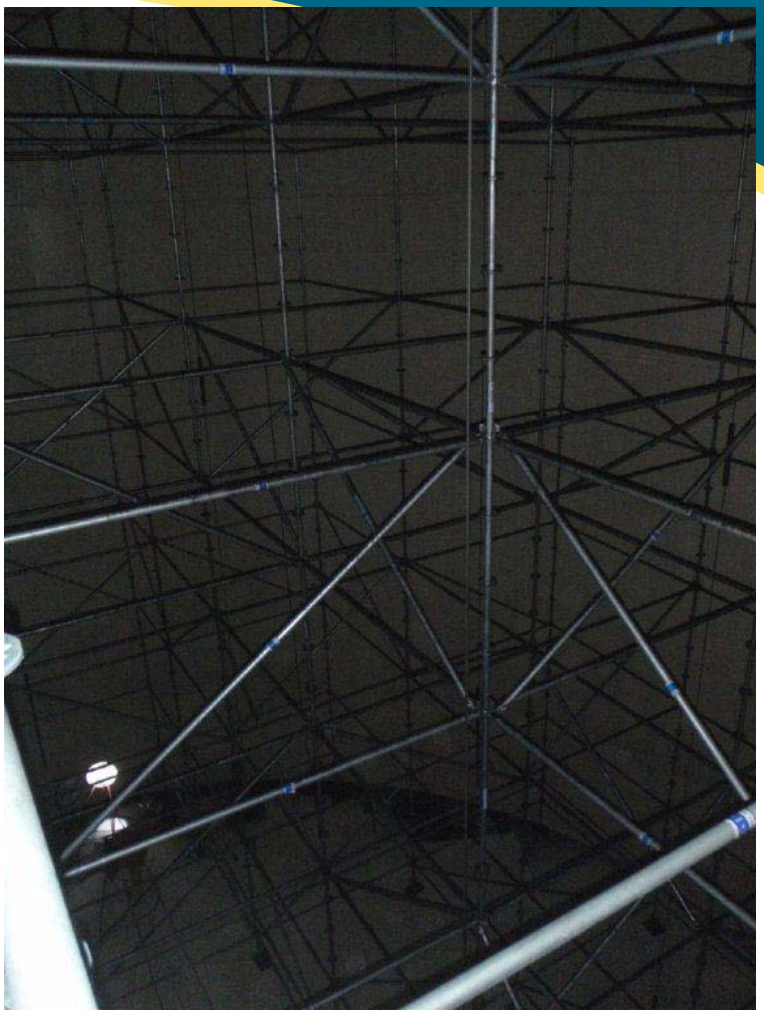
- 3 to 4 year cycle
- Exterior
- Interior
- Floating Inspections
- Specialty inspections
  - Coatings
  - Cathodic Protection

- Reservoirs: 8 to 60 years old
- Reservoir Capacities: 100,000 gallons to 4 MG

RESERVOIR RECOATING INSPECTION PROCESS DURING CONSTRUCTION - 1

Interior Recoating

- Pre-bid Assessment
- Safety (confined space entry, ventilation)
- Access to tank interior:
  - Exterior hatch
  - Cut Door (Seismic improvements)
- Manlift / Spider / Ladder / Scaffold
- Assembled scaffold deck height
- Dehumidification (bid item)
- Abrasive blasting (check profile)



RESERVOIR RECOATING INSPECTION PROCESS DURING CONSTRUCTION - 2

Interior Recoating

- Stripe Coat (Brush / Roller)
- Coating Applications “Criticals”
  - Humidity
  - Air Temperature
  - Surface Temperature
- Measure DFT’s (Dry Film Thickness) each coat
- Caulking Inaccessible Areas (Non-Sag) – Sikaflex 2c NS
- Final Cleaning, “Holiday testing, Touch up”

RESERVOIR RECOATING INSPECTION PROCESS DURING CONSTRUCTION - 3

Exterior Recoating

- Safety (Lead Abatement – Clean Room)
- Containment System (Shrink Wrap, Drainage)
- Ventilation / Climate Controls / Heaters
- Abrasive Blasting (Check Profile)

RESERVOIR RECOATING INSPECTION PROCESS DURING CONSTRUCTION - 4

Exterior Recoating

- Stripe Coat (Brush / Roller)
- Coating Applications “Criticals”
  - Humidity
  - Air Temperature
  - Surface Temperature
- Measure DFT’s (Dry Film Thickness) each coat
- Final Cleaning, “Holiday testing, Touch up)

Factoria Reservoir - 1

Factoria Reservoir Improvements Project

- Replaced Interior Coating System
- Top-coated exterior Roof
- Pressure washed walls
- Other misc improvements
- Low Bid = $356K

Factoria Reservoir - 2

Factoria Reservoir - 3

Rafter Beam / Roof Plates -- Before

Rafter Beam / Roof Plates
w/ Caulking after 7 Years

Factoria Reservoir - 4

Rafter Beam / Roof Plates -- Before

Rafter Beam / Roof Plates
w/ Caulking after 7 Years

Factoria Reservoir - 5

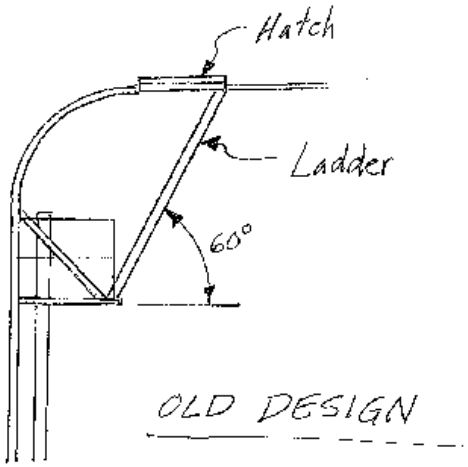
Rafter Beam / Roof Plates -- Before

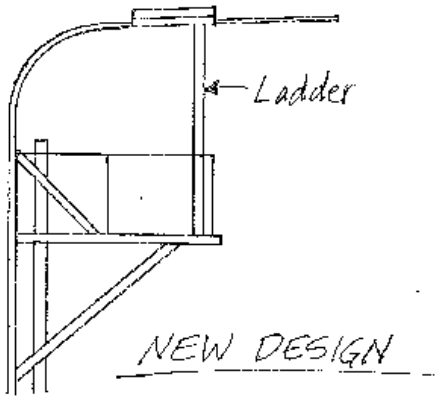
Rafter Beam / Roof Plates
w/ Caulking after 7 Years

Factoria Reservoir - 6

New Vent with modified Fall Protection

Factoria Reservoir - 7

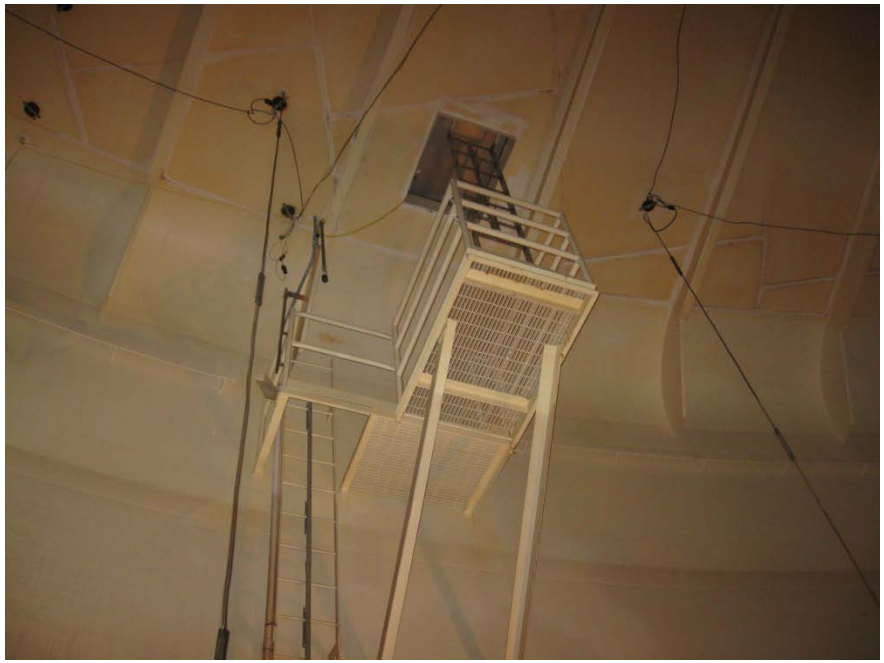


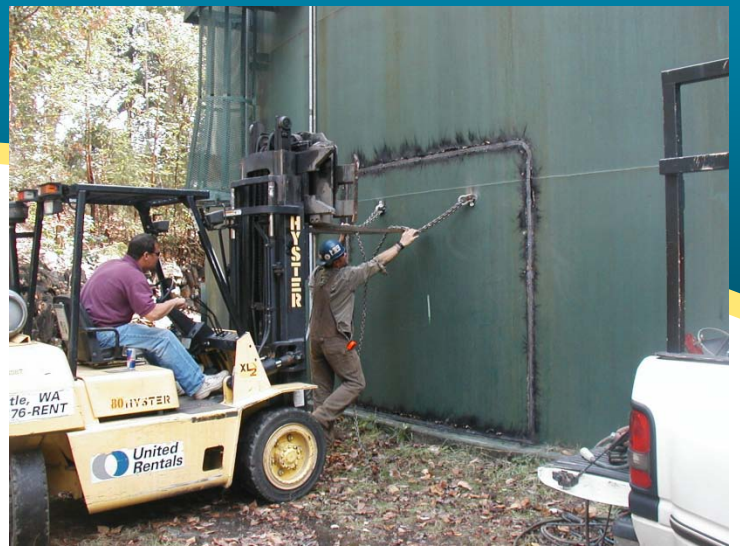


Factoria Reservoir - 8

Ladder / Landing -- Before

Ladder / Landing -- After




HYSTER
United Rentals

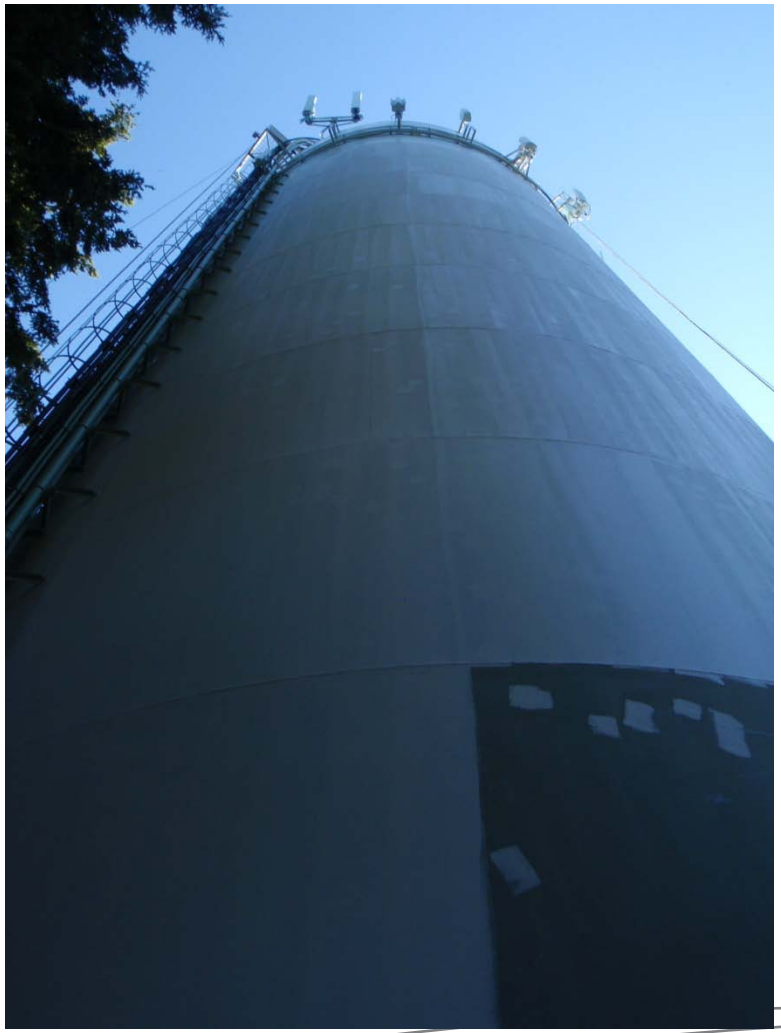
Clyde Hill 465 Standpipe - 1

Clyde Hill 465 Standpipe Reservoir Repainting Project

- 36 feet in diameter
- 90 feet tall
- Top-coated exterior Walls

Clyde Hill 465 Standpipe - 2

Clyde Hill 465 Standpipe - 3



Clyde Hill 465 Standpipe - 4

Forest Hills Reservoir - 1

Forest Hills Reservoir Roof Membrane Coating Replacement Project

- 2 MG concrete tank (DYK)
- Diameter = 120 feet
- Wall height = 25 feet
- Low Bid = $75K

Forest Hills Reservoir - 2

Forest Hills Reservoir - 3

Forest Hills Reservoir - 4

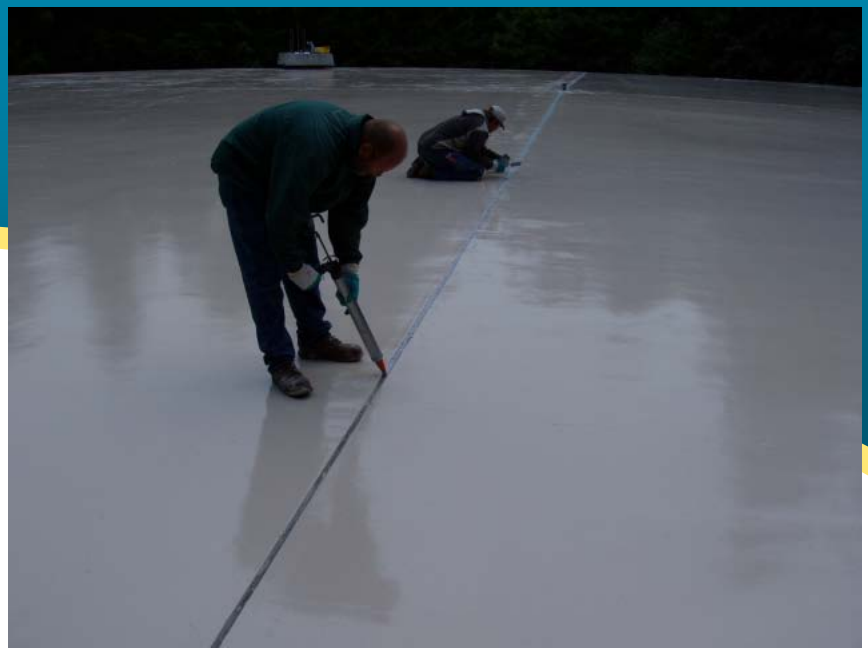
Newport Reservoir - 1

Newport Reservoir Roof and Sidewall Recoating Project

- 3 MG concrete tank (DYK)
- Diameter = 160 feet
- Wall height = 20 feet
- Replace roof coating system

Newport Reservoir - 2

Newport Reservoir - 3



Cherry Crest Reservoir - 1

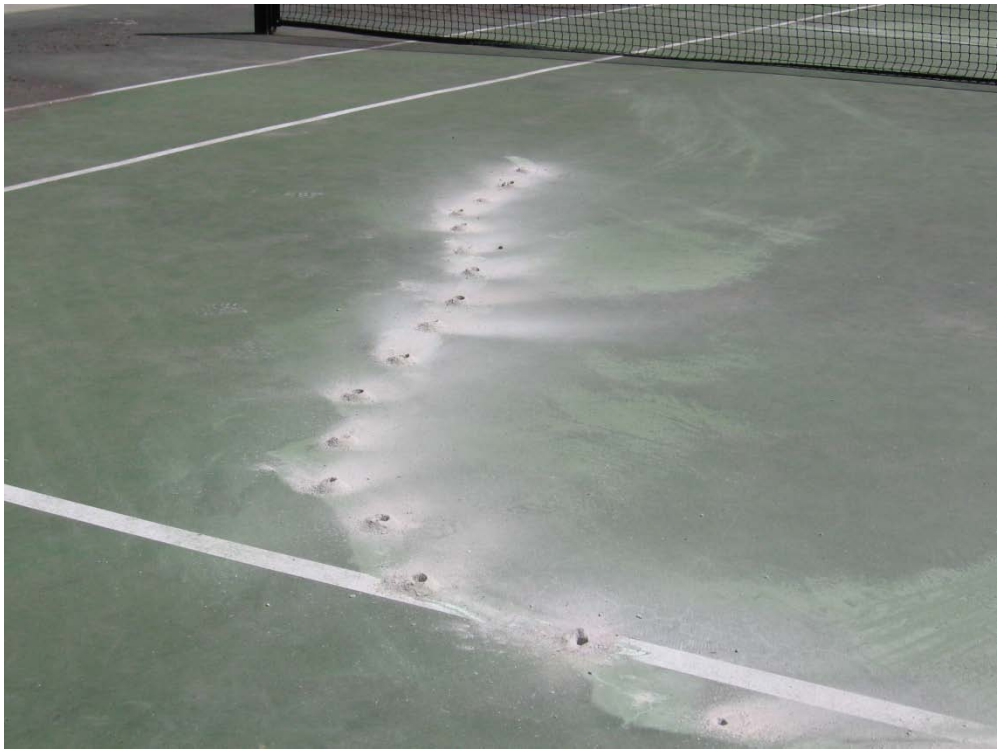
Cherry Crest Reservoir Concrete Repairs

- 3 MG concrete tank
- Diameter = 160 feet
- Wall height = 20 feet
- Epoxy grout cracks in Roof

Cherry Crest Reservoir - 2

Cherry Crest Reservoir - 3

Cherry Crest Reservoir - 4



Cherry Crest Reservoir - 5

Cherry Crest Reservoir - 6

Currently – No Visible Leaking through Crack Repairs

- AWWA D110-2.8
- AWWA D115-2.12
- DOH
- DYK
- Xpex

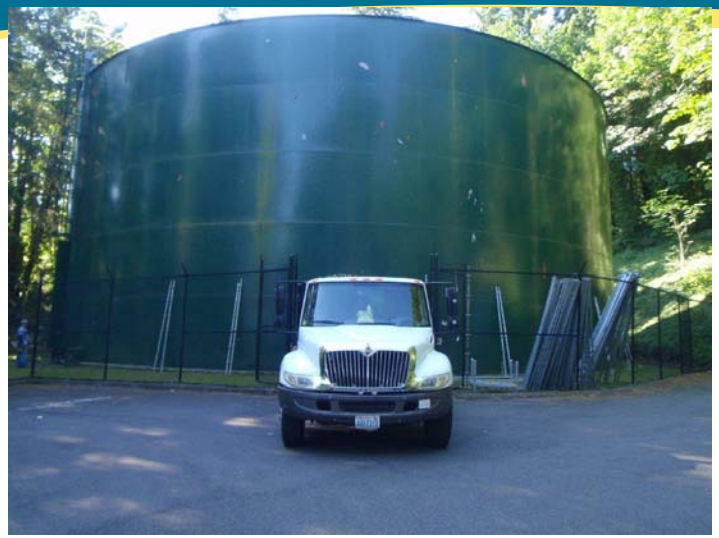
Sport court is removed. City to leave Tank Un-coated

Parksite - 1

Parksite Reservoir Recoating Project

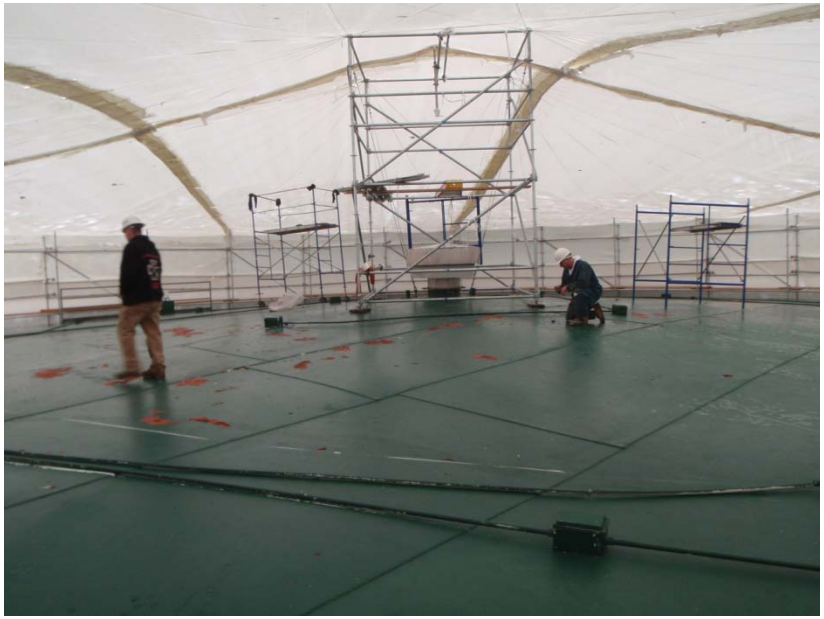
- 2 MG steel tank
- Diameter = 93 feet
- Wall height = 40 feet
- Remove lead-based coating system
- Class 1A containment
- Recoat entire exterior surface
- Low bid = $248K
- Class 1A Containment = $48K
- Lead-based coating removal = $109K

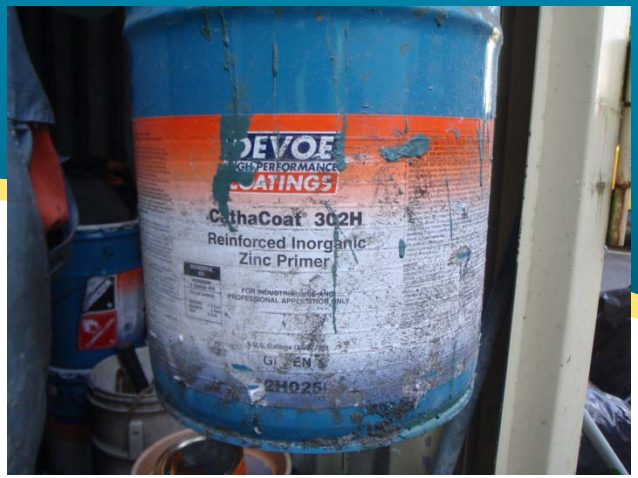
Parksite - 2



Parksite - 3

Parksite - 4





Parksite - 5


© 7/15/2011 sky-pix.com


© 8/19/2011 sky-pix.com


© 9/9/2011 sky-pix.com

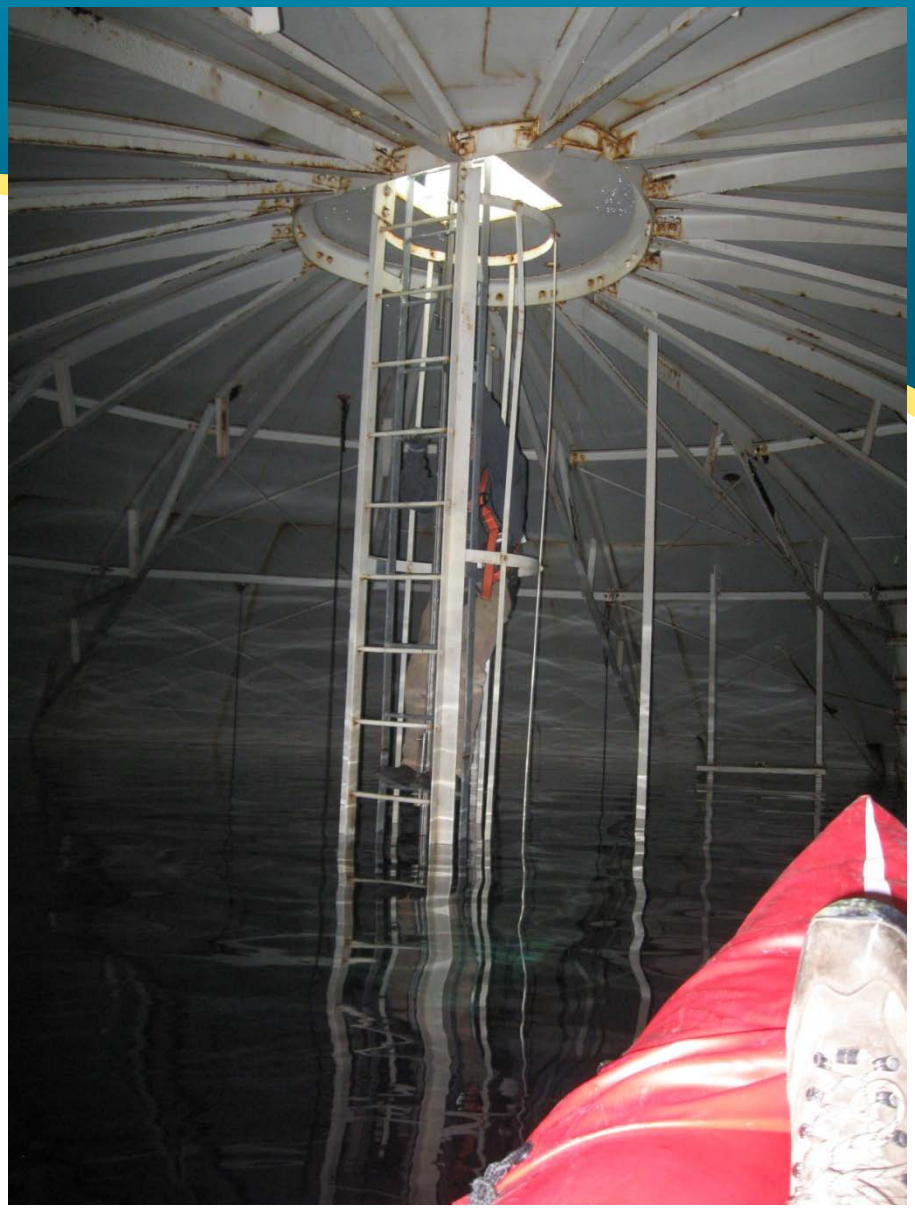

© 3/9/2012 sky-pix.com

Crossroads North - 1

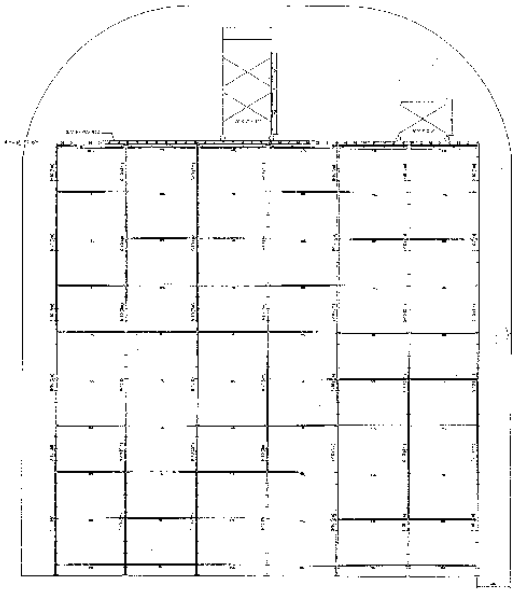
Crossroads North Reservoir Recoating Project

- 2 MG steel tank
- Diameter = 68 feet
- Wall height = 63 feet
- Recoat interior ceiling
- Low bid = $141K
- Scaffolding = $51K
- Replace bolts = $16/EA

Crossroads North - 2



Crossroads North - 3



Scaffolding System ($51K)

Crossroads North - 4

SIDEWALL REMOVAL REQUIREMENTS:

TO FACILITATE THE ENTRANCE/EXIT AND USE OF A LIFT OR OTHER EQUIPMENT, CONTRACTOR MAY TEMPORARILY REMOVE A PORTION OF THE RESERVOIR SIDEWALL FOLLOWING REVIEW AND APPROVAL OF A RESERVOIR SIDEWALL REMOVAL/REPLACEMENT PLAN.

THE PLAN SHALL BE PREPARED AND SEALED BY A PROFESSIONAL STRUCTURAL ENGINEER LICENSED IN WASHINGTON AND SHALL INCLUDE WELDED JOINT DETAILS, ACCESS DETAILS, STIFFINER DETAILS, COATING REMOVAL/REPLACEMENT PROCEDURES AND PRODUCTS AND QUALIFICATIONS OF WELDING PROCEDURES, WELDERS, AND WELDING INSPECTORS.

ALL WORK SHALL BE IN ACCORDANCE WITH ANSI/AWWA D100 AND THESE CONTRACT DOCUMENTS. THE OWNER SHALL RECEIVE COPIES OF ALL WELDING INSPECTOR AND RADIOGRAPHY REPORTS.

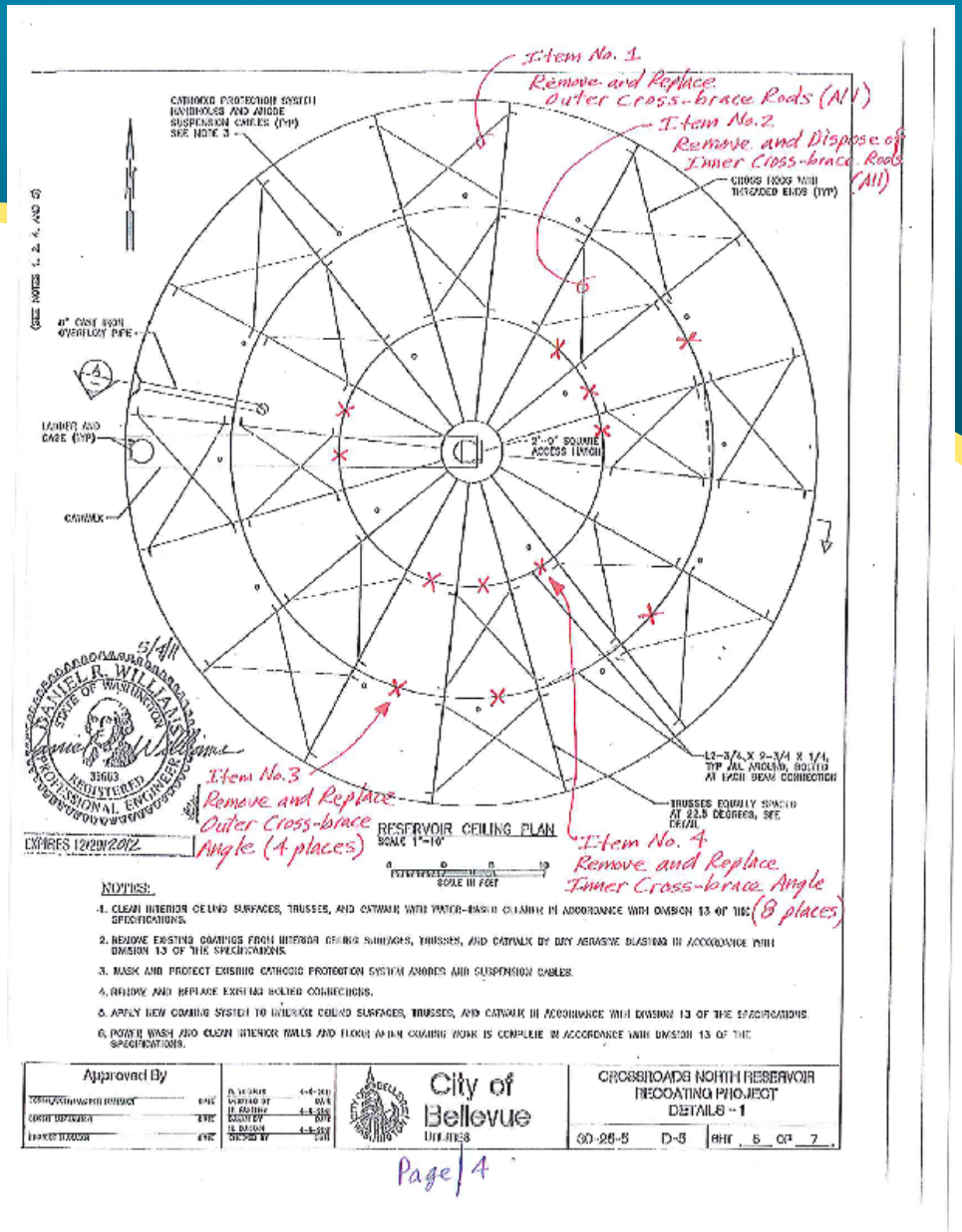
MODIFCATIONS TO THE EXISTING FOUNDATION AND POST TENSIONED SEISMIC ANCHORS AND CHAIRS ARE PROHIBITED.

Crossroads North - 5

Existing Corrosion

Crossroads North - 6

Change Order to Replace Cross-brace Angles ($6K)

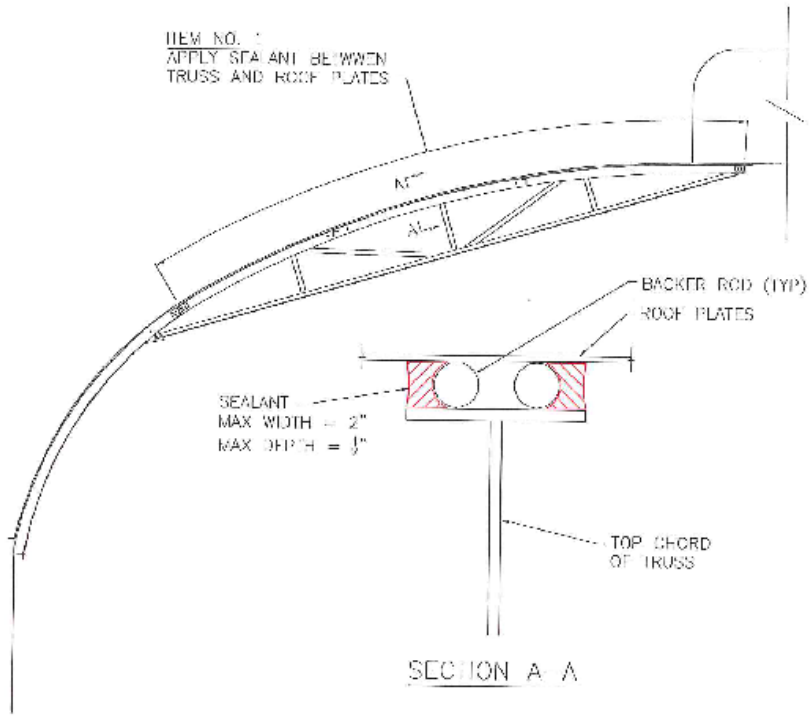


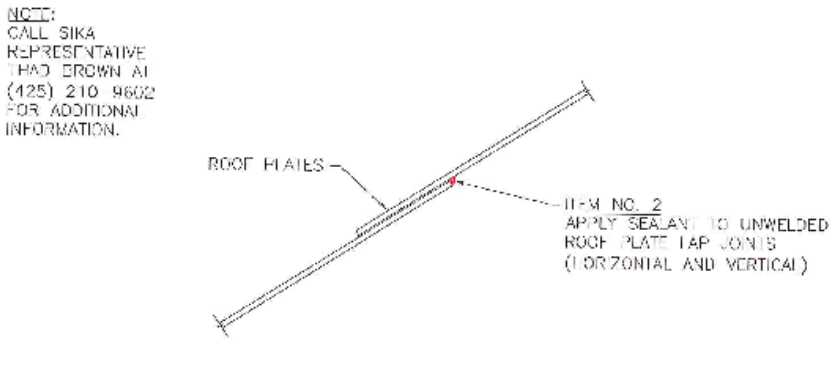
Crossroads North - 7

Change Order to Caulk unwelded Roof Plate Lap Joints ($5/LF)

Change Order to Caulk between Rafter Beams and Roof Plates($8/LF)

Total Change Order = $12K



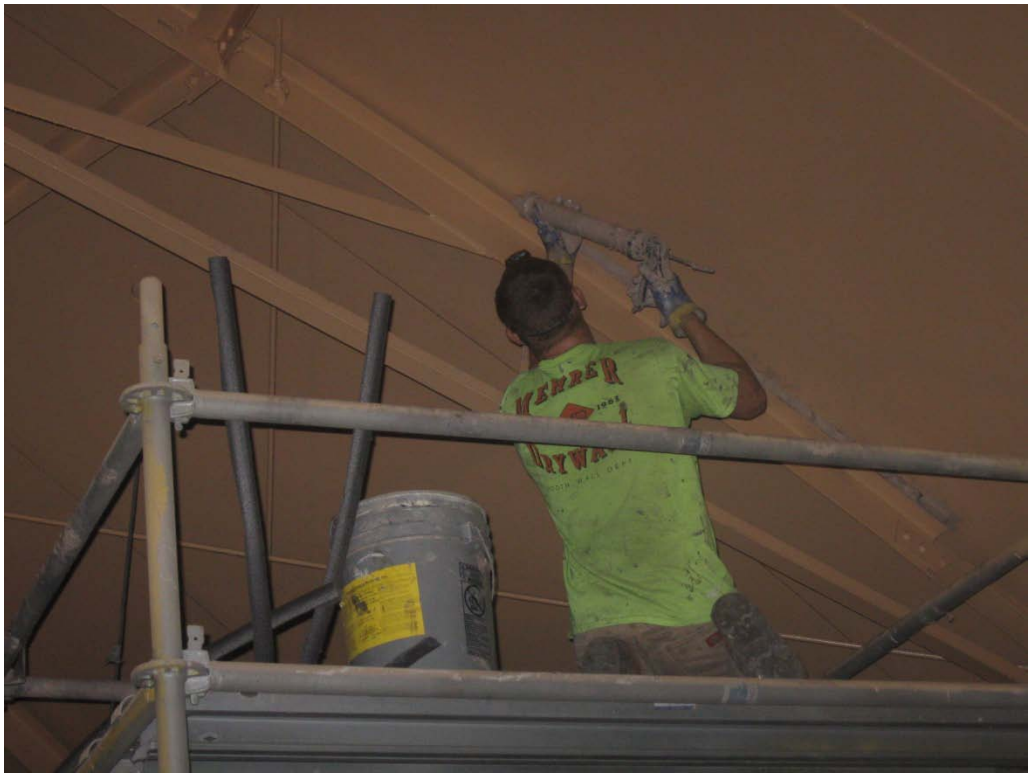


Crossroads North - 8

Stripe Coating w/Brush

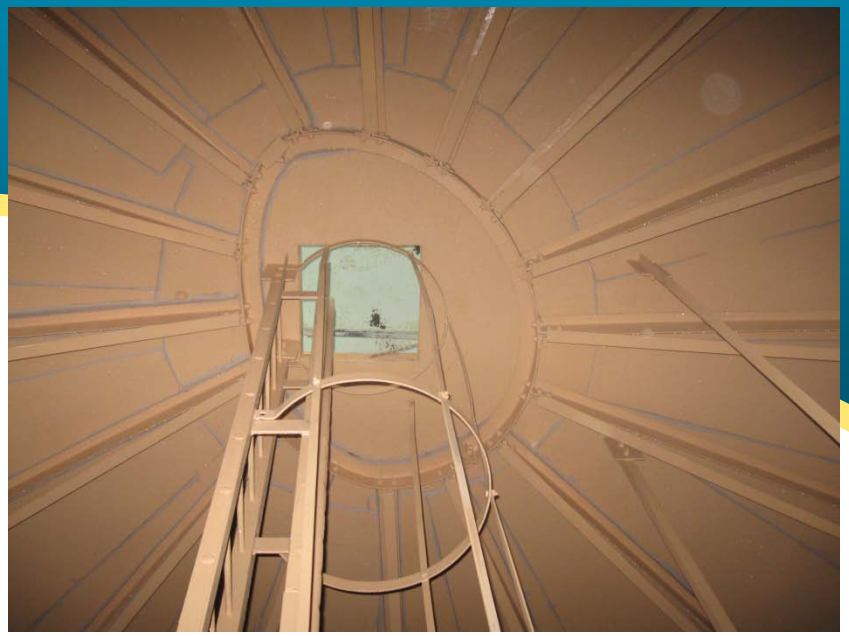
Dehumidifier

Crossroads North - 9



Caulking between Truss
and Roof Plates

Crossroads North - 10



Meydenbauer Reservoir

Hatch Components –
Corrosion after 7 years

Lessons Learned

- Include Bid Item for Dehumidification
- Door sheet vs Scaffolding
- Get communications firms to paint your tank
- Test existing Coating Systems and Include results in bid documents
- Include NACE specifications in Bid Documents (Appendices)
- Record (as-built) Drawings should include Coating Products / Photos
- Coating projects/warranties should be input into Asset Management Plan
- Understand acceptable roof loading scenerios – include in bid documents
- Seal weld rafter beams to roof plates / avoid corrosion by design
- Consider handrail to top of tank for Communications Equipment
- Hatch components should be corrosion resistant
- Stripe coating should be applied with a brush before prime coat (specify)
- Read and understand coating manufacturer warranties carefully

Questions?

City of

Houston

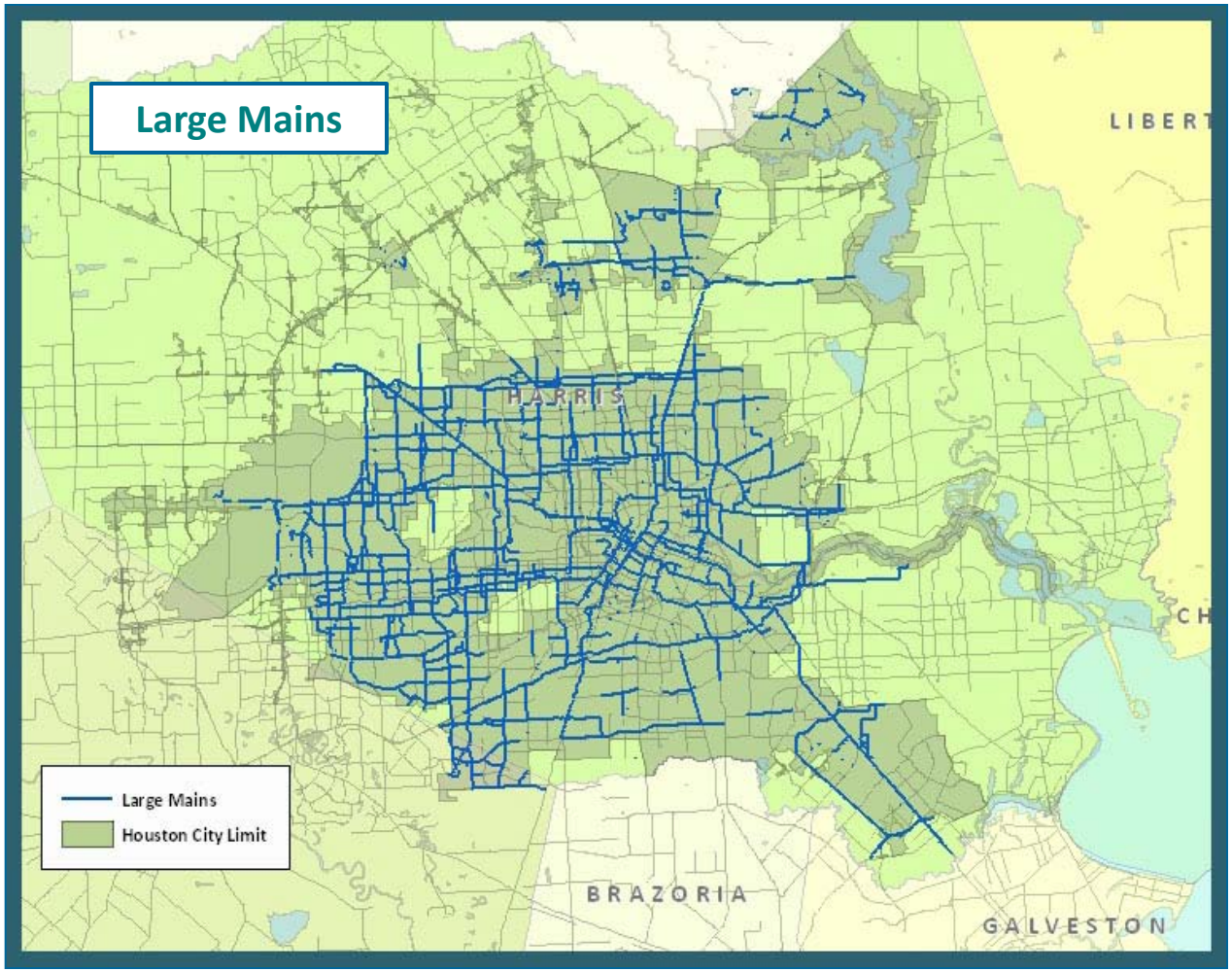
Asset Management In The Fast Lane: Final Report

Sandeep Aggarwal PE, Managing Engineer, City of Houston
Yvonne W. Forrest, Senior Assistant Director, City of Houston
Paul Schumi, Director, WACHS Water Services

Presentation Overview

- Houston Water System
- Large Valve Assessment & Mapping Program
- Findings To Date
- Asset Information & Analysis
- Benefits
- Questions / Answers

Houston Water System



- 2.8 million people
- 7,400 miles of main
- 144,000 valves
- 55,000 hydrants
- 750 MGD Capacity
- 3 treatment plants
- 92 pump stations
- 600 sq. miles

Large Valve Assessment & Mapping Program

Large Valve Program

Objective:

Improve System Reliability and Operability of the Transmission System.

- Focused on 4,500 “Control Points” (valves) sized 16” – 96” throughout the transmission system.

Large Valve Testing Program

Scope of Work:

- Locate, Inspect and Assess
- Operate
- Repair / Rehab / Replace
- Data Collection
- GPS mapping (mapping grade accuracy)
- Integrate into GIS & WMS Data Platforms

Large Valve Testing Program

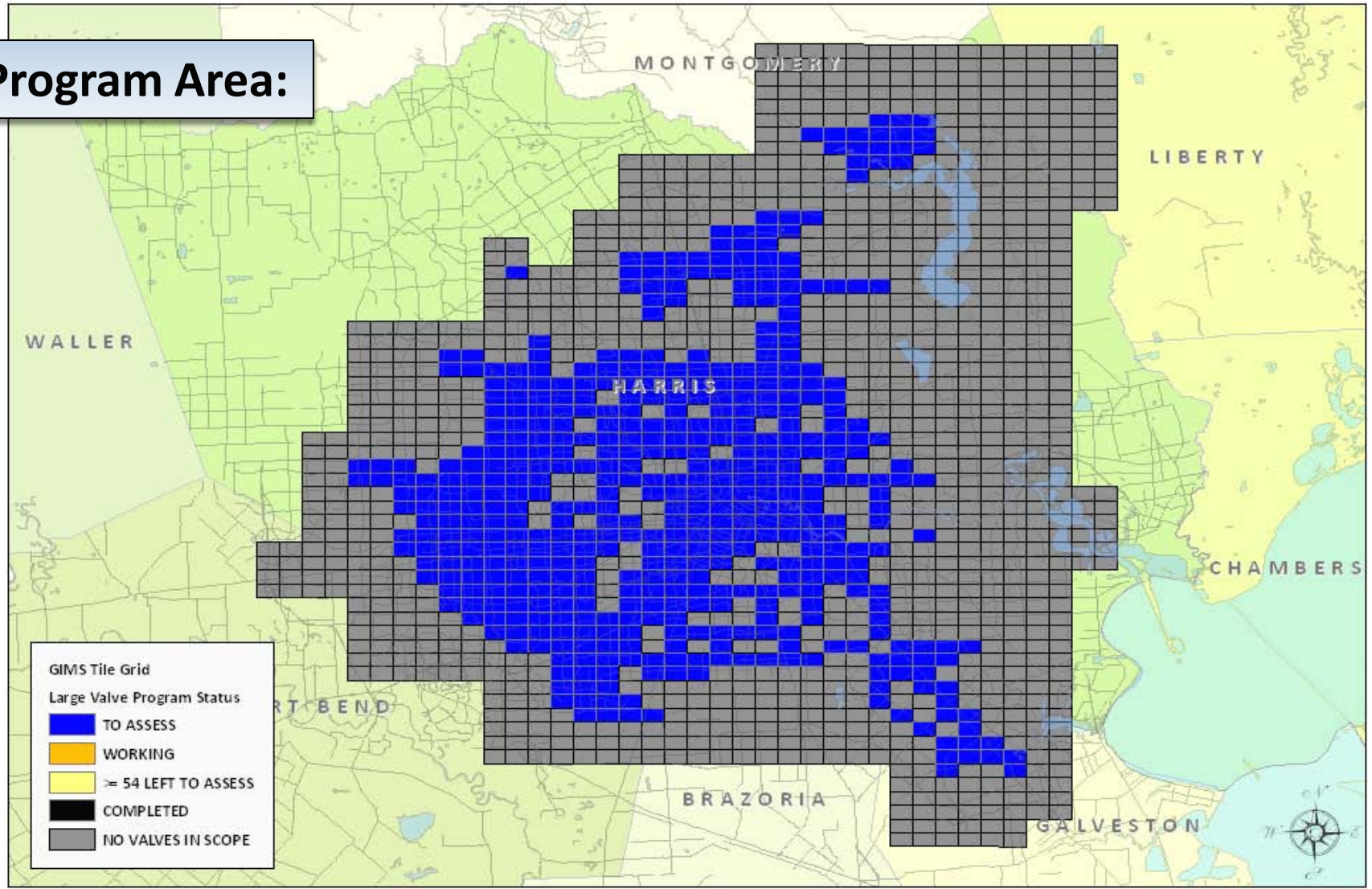
Contract:

- The City concluded Large Asset Testing was a “Non-core” Activity
- Procured via a Competitive “best value” Bid
- 3-Year Contract
- Started in January 2008


WachsWater
SERVICES

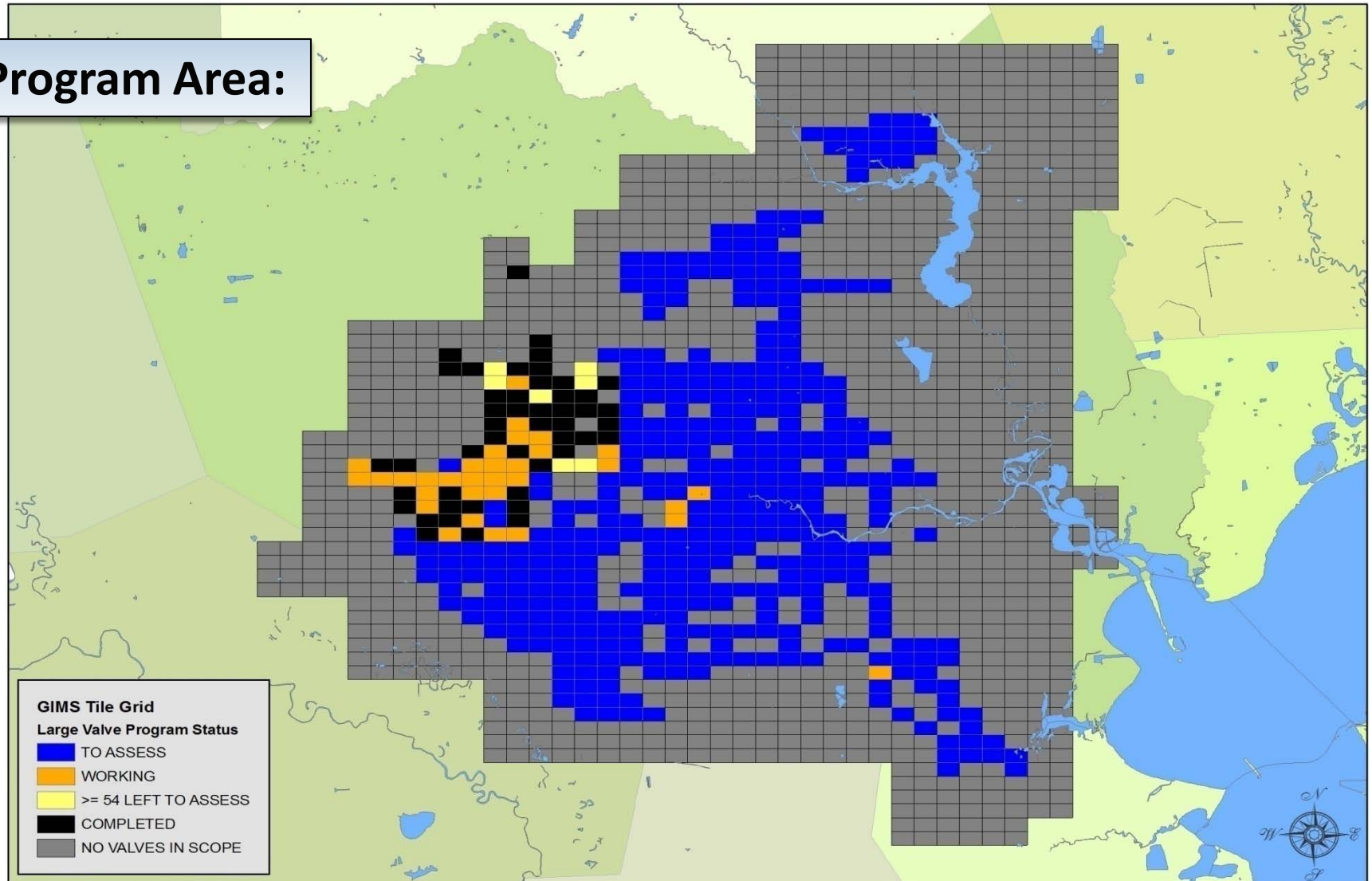
Progression Tracking - Begin

Program Area:



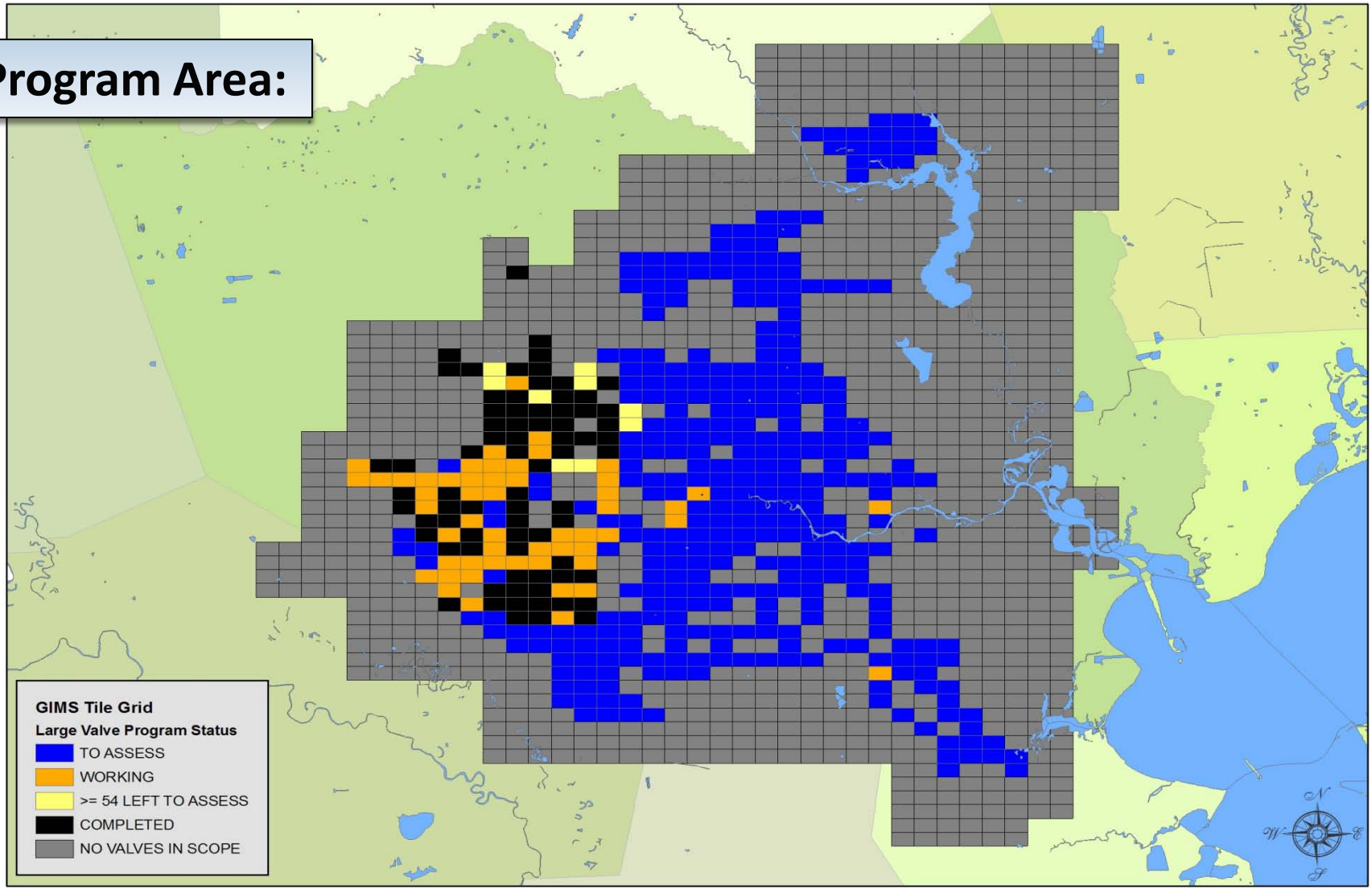
Progression Tracking – 3 months

Program Area:



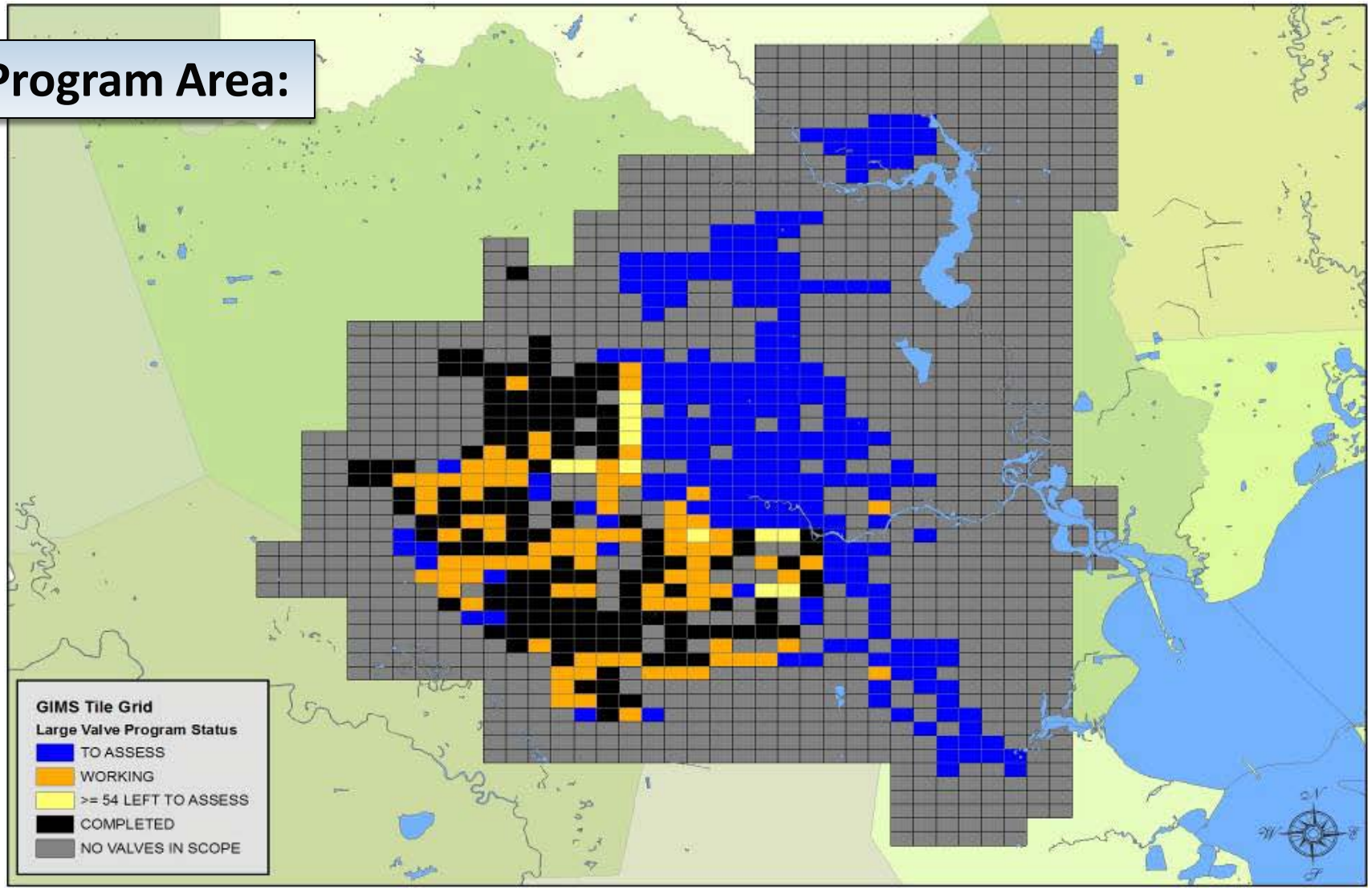
Progression Tracking – 6 months

Program Area:



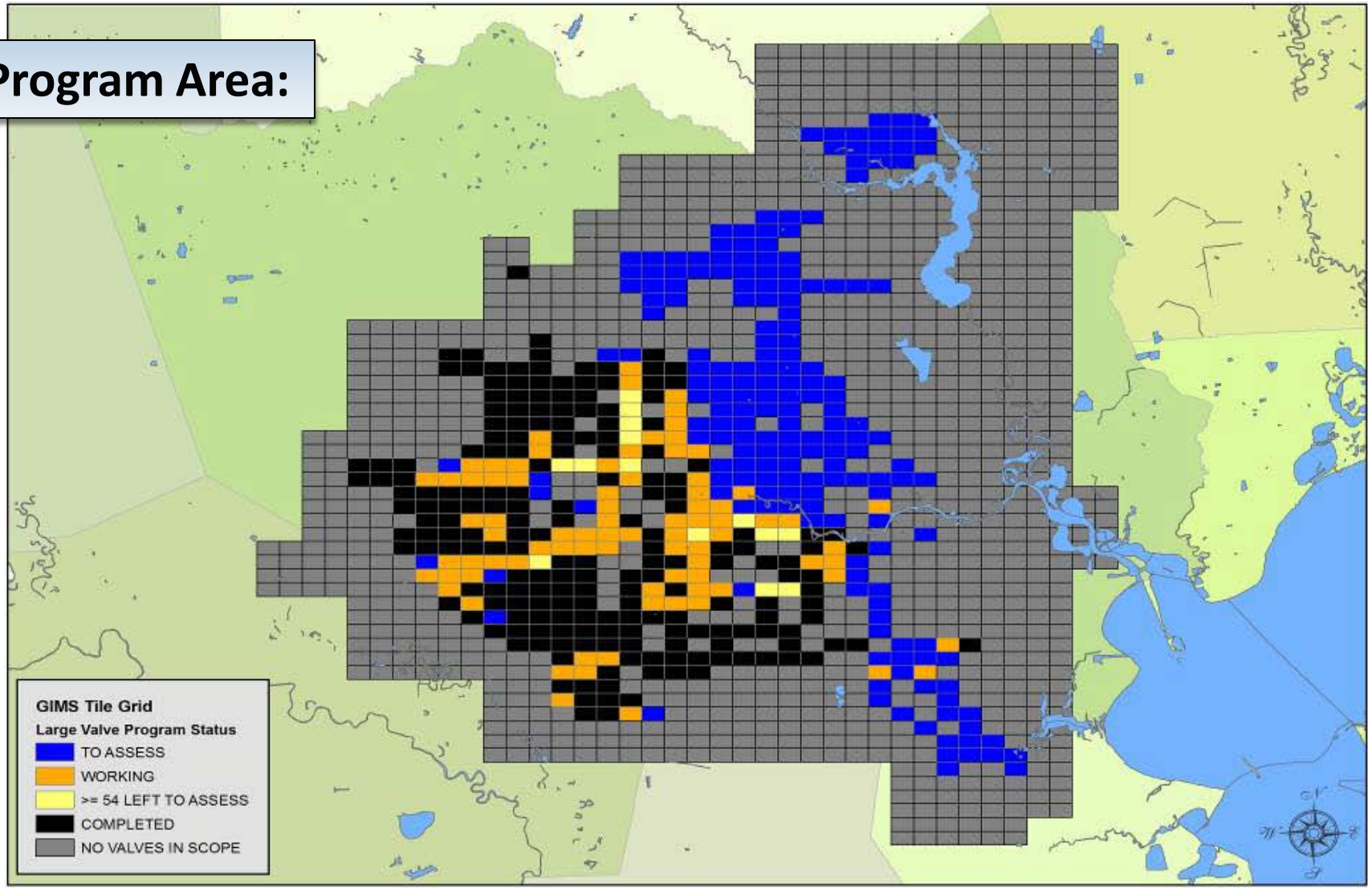
Progression Tracking – 1 year

Program Area:



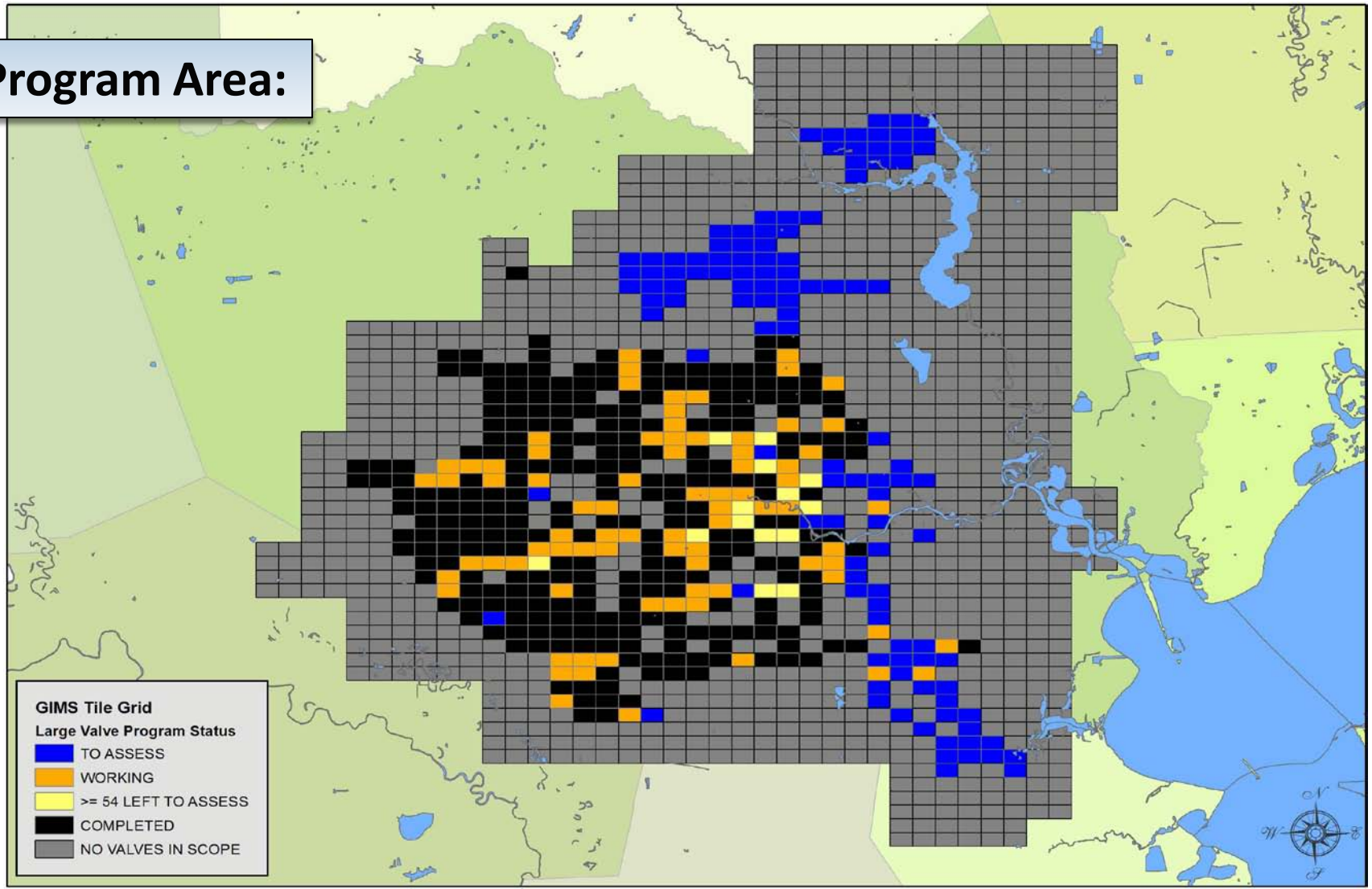
Progression Tracking – 1-1/2 years

Program Area:



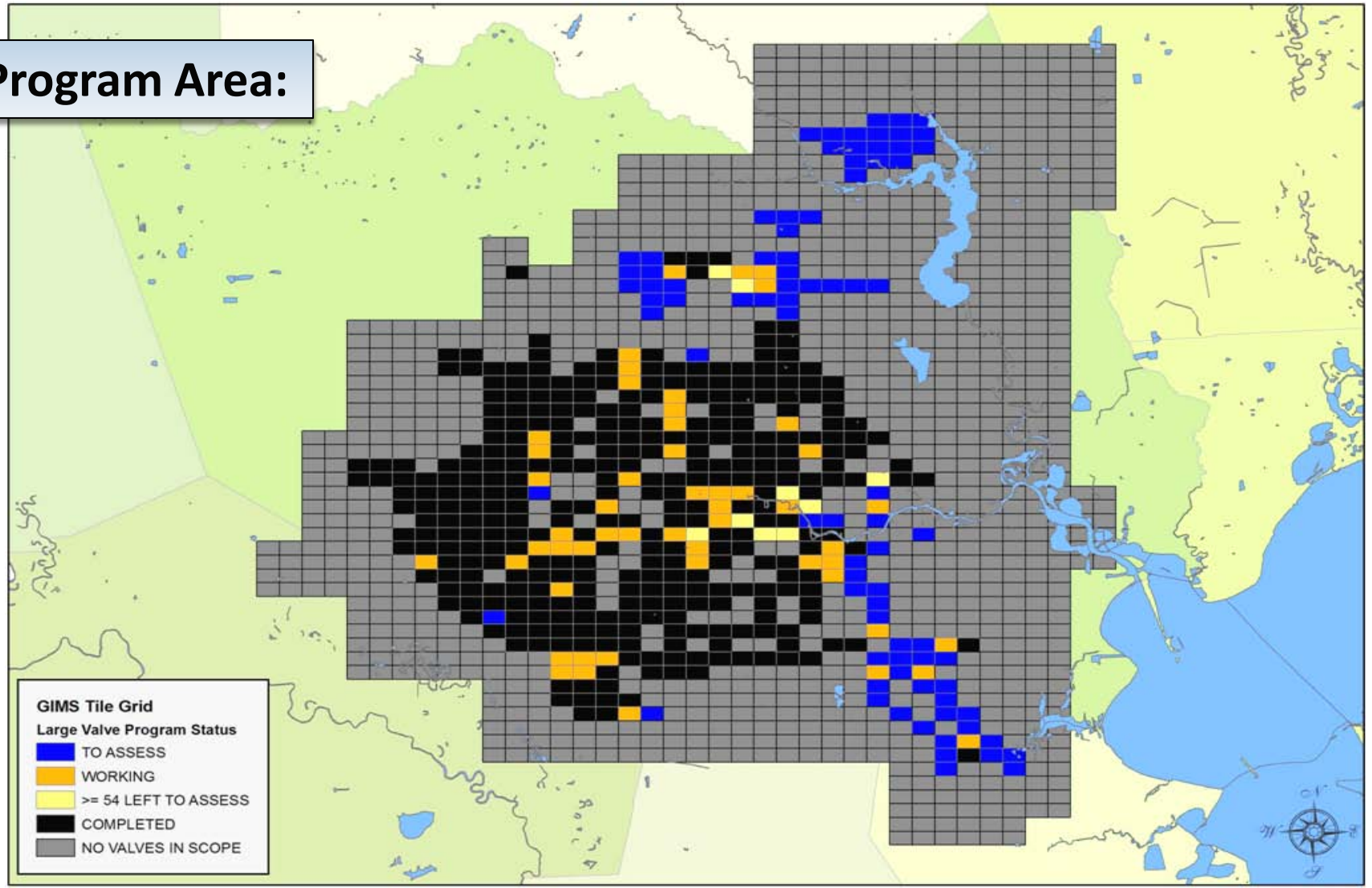
Progression Tracking – 2 years

Program Area:

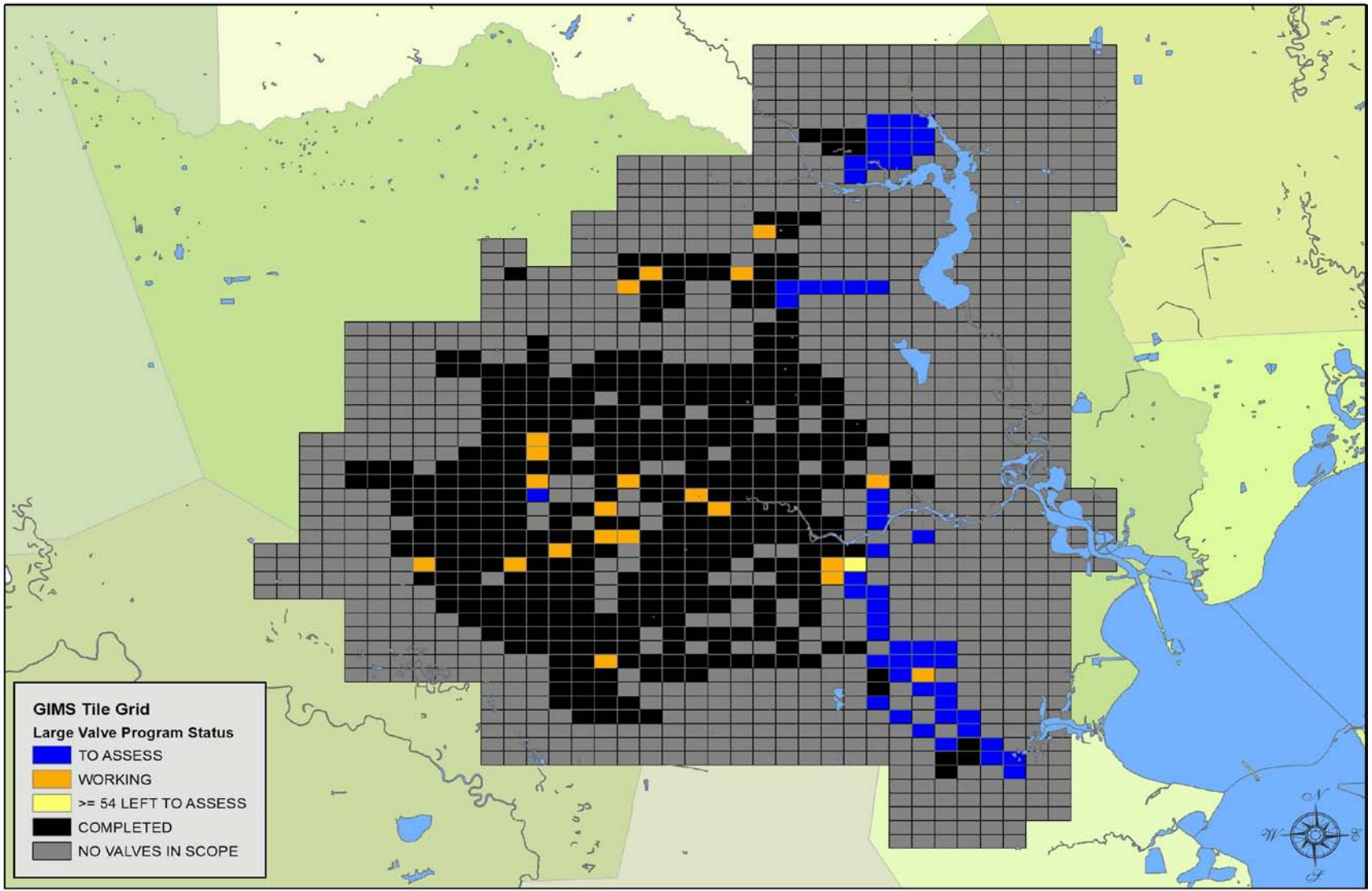


Progression Tracking – 2-1/2 years

Program Area:



Progression Tracking - Today



Program Findings

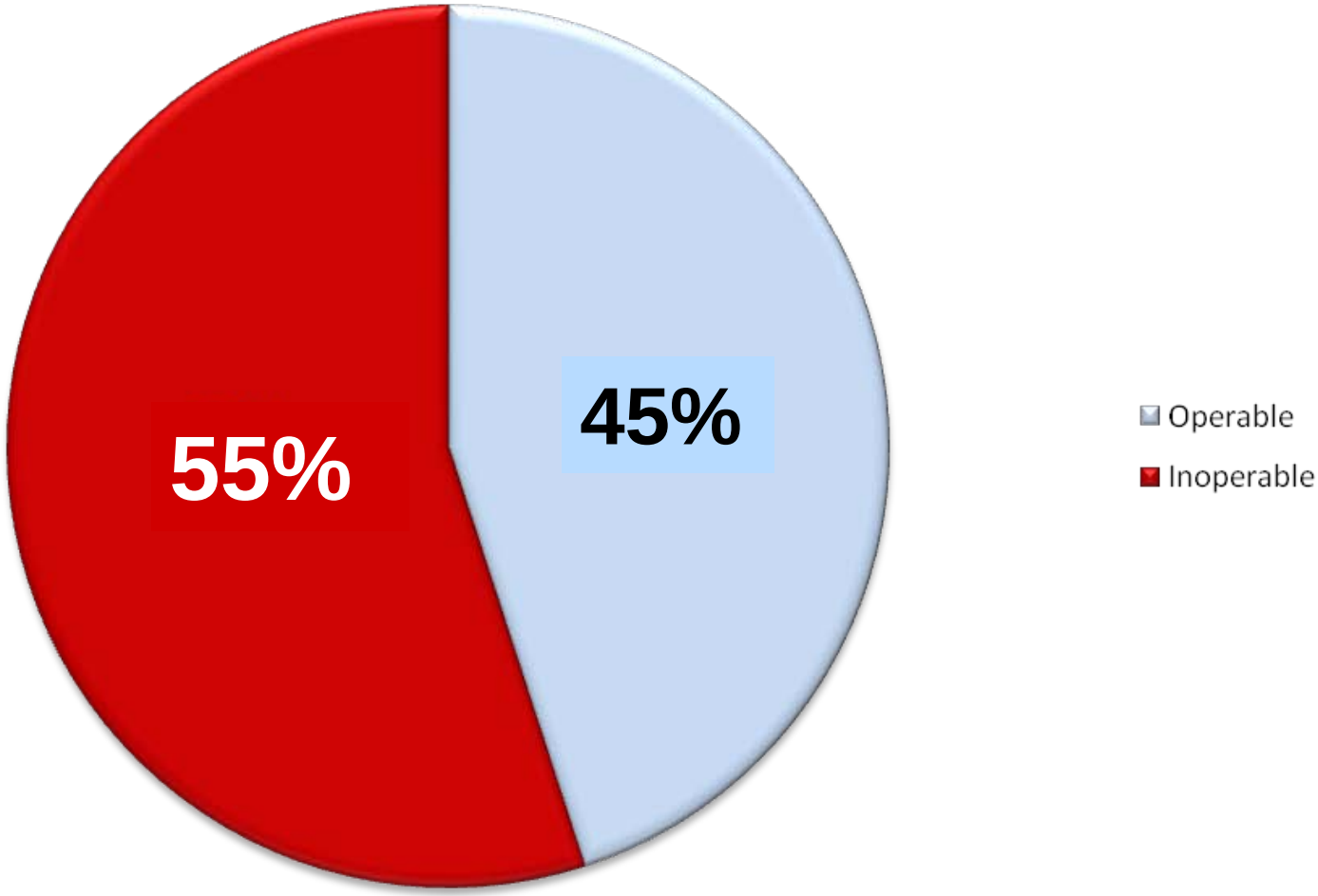
Valve Operability

Operability Definitions

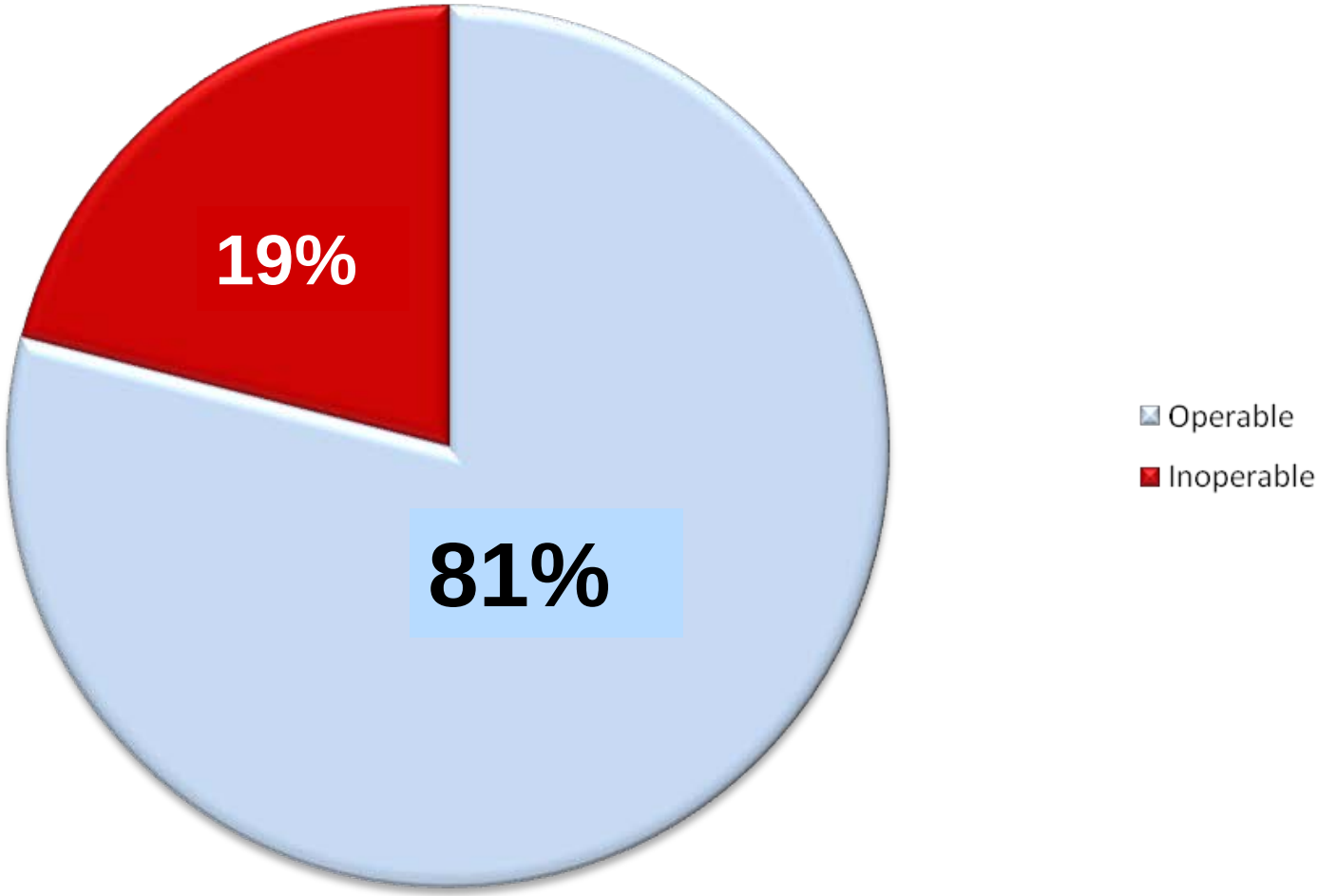
Initial Operability: Upon arrival, can the valve be found and easily operated by the crew? **Right Here, Right Now!**

Current Operability: The valve operability after all assessment and repair work has been completed.

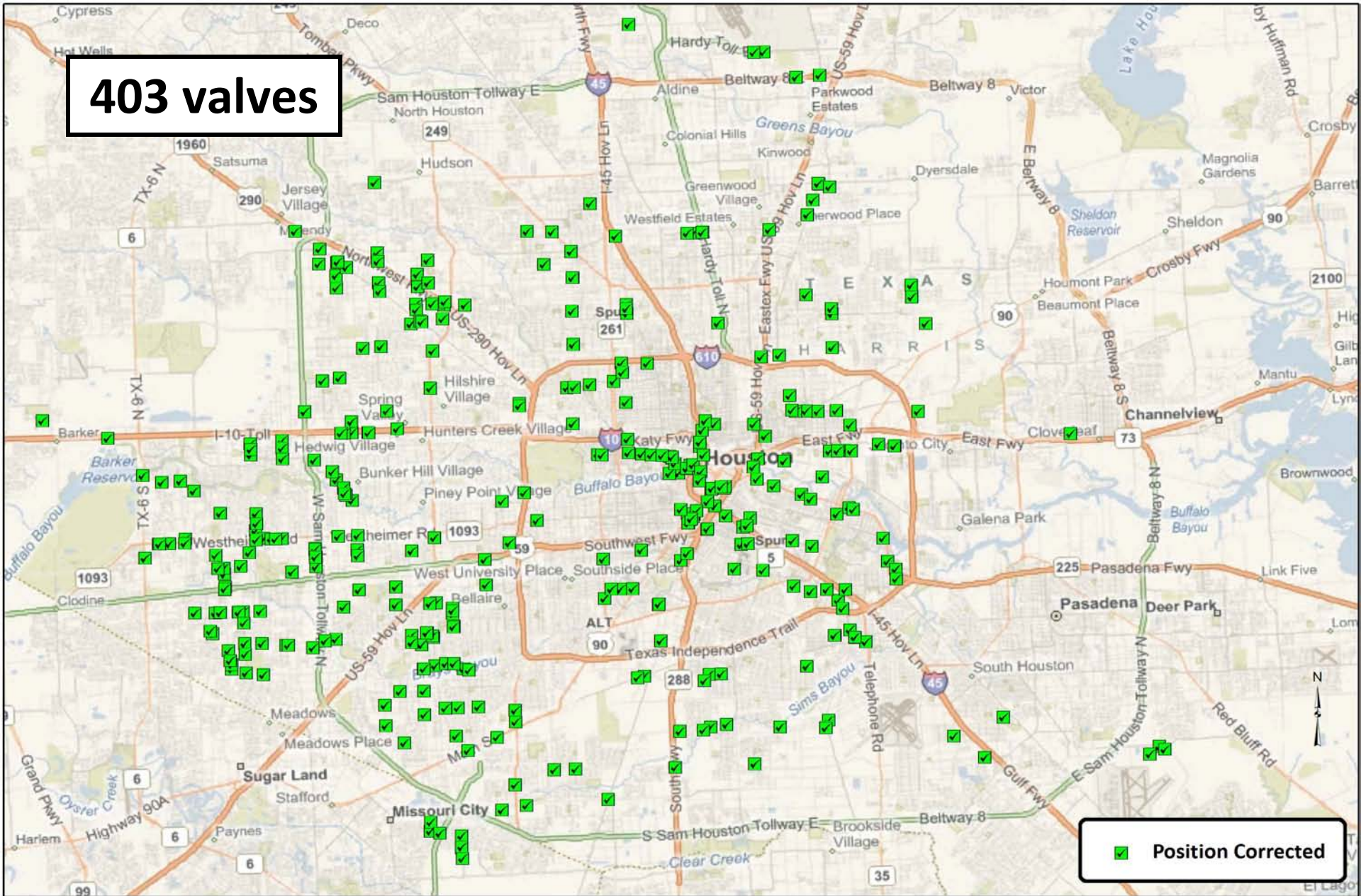
Initial Valve Operability



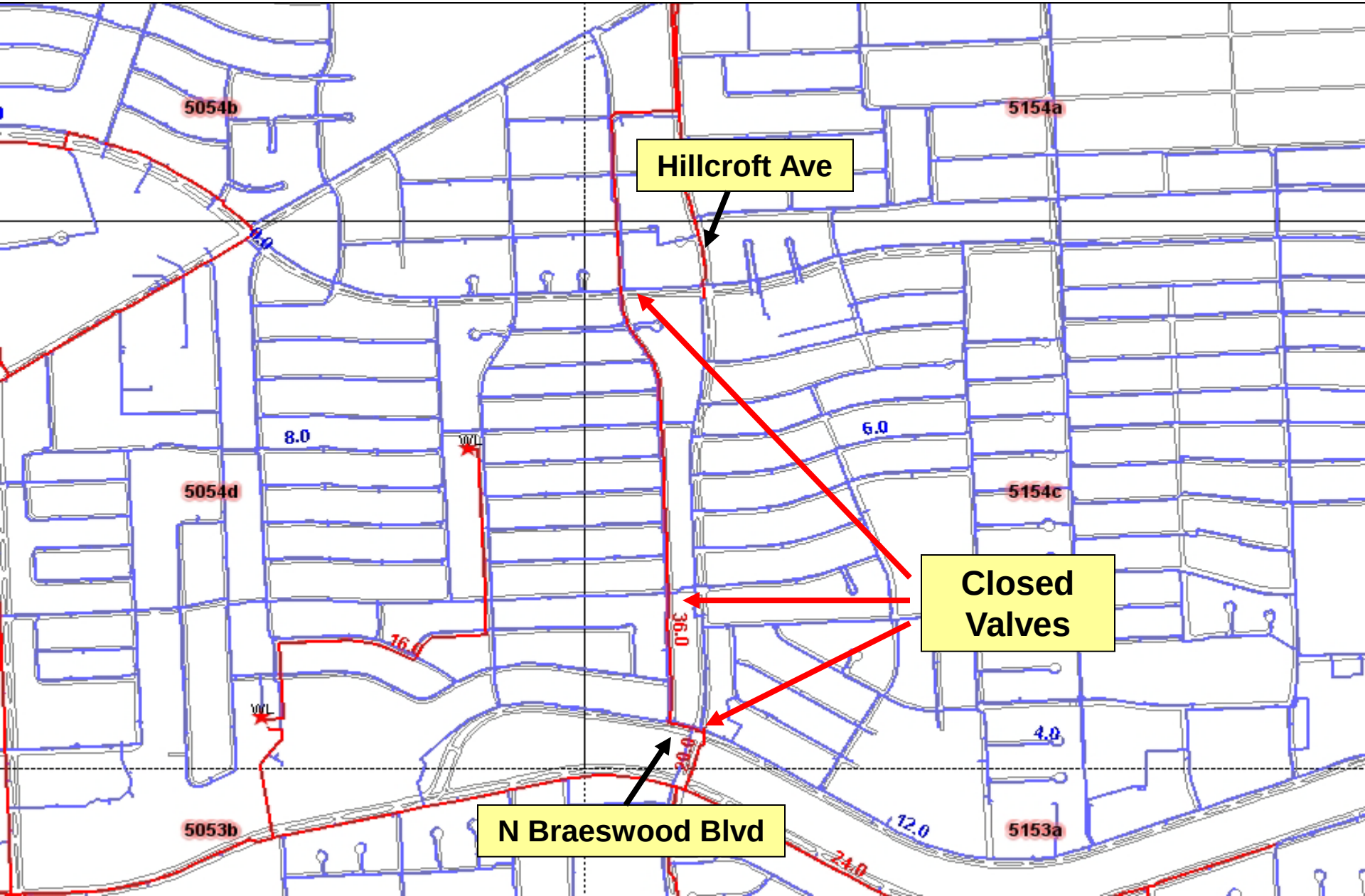
Current Valve Operability



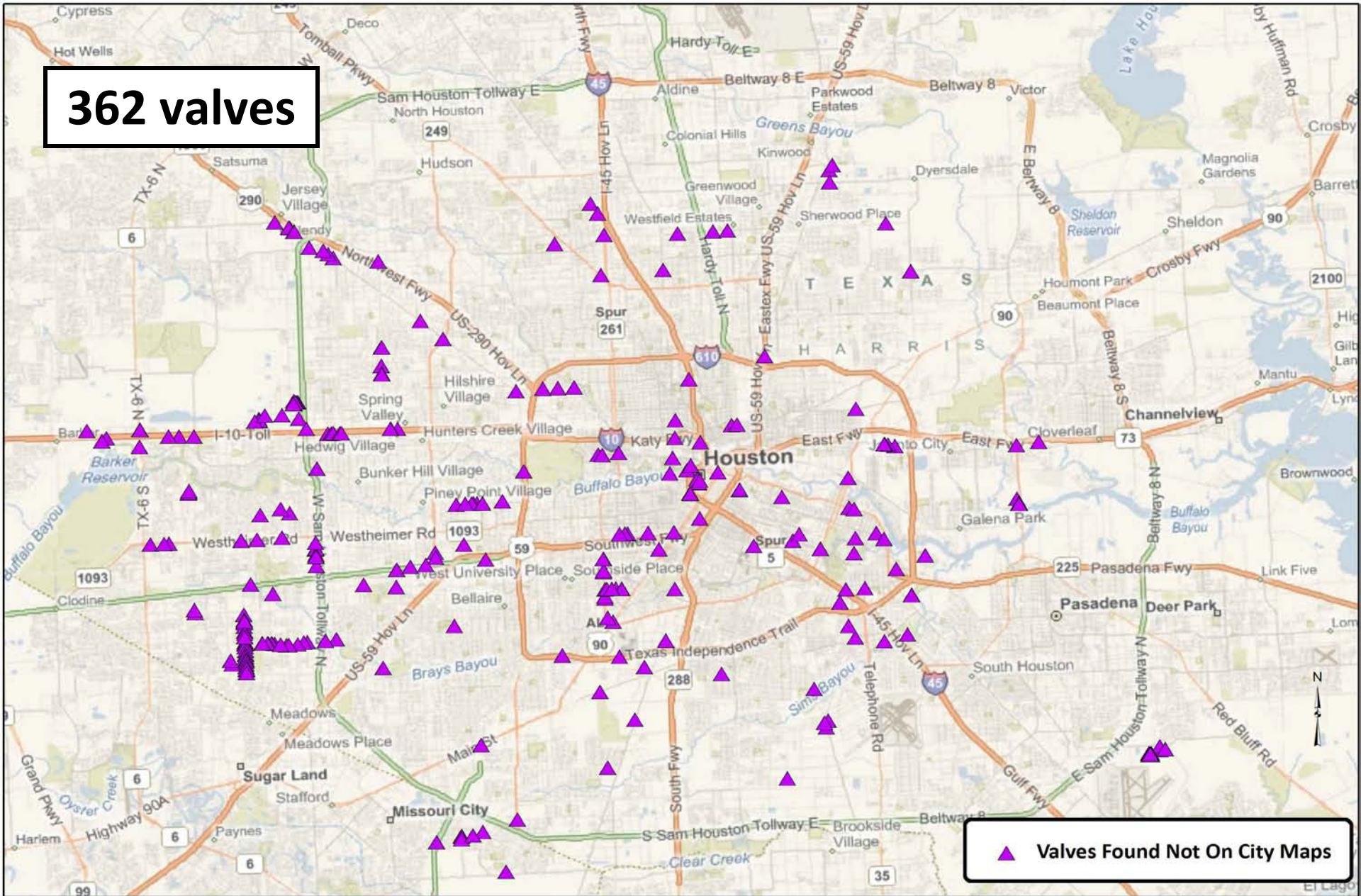
Position Corrected



36” Main Found Closed



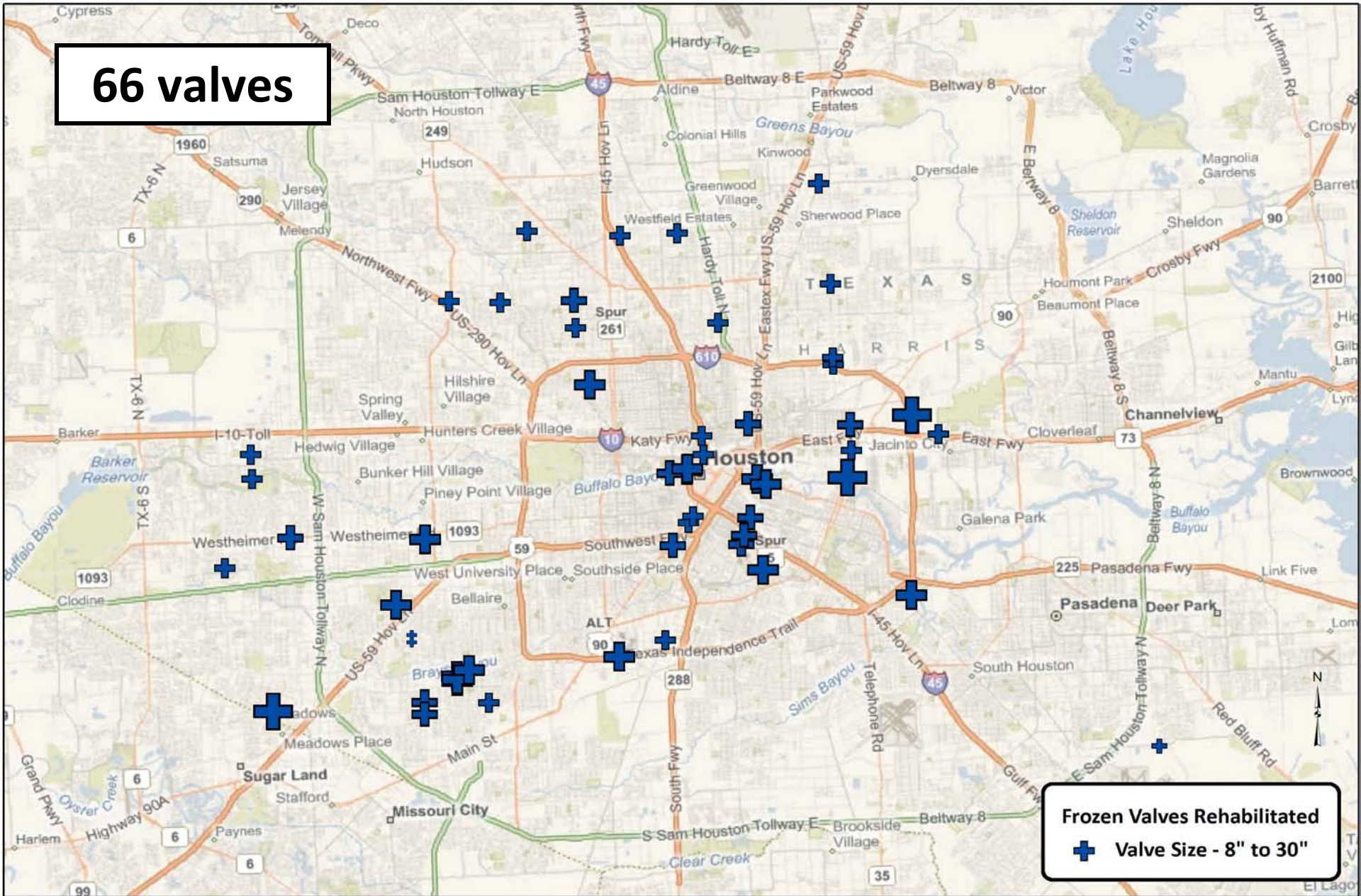
Valves Found: Not on City Maps



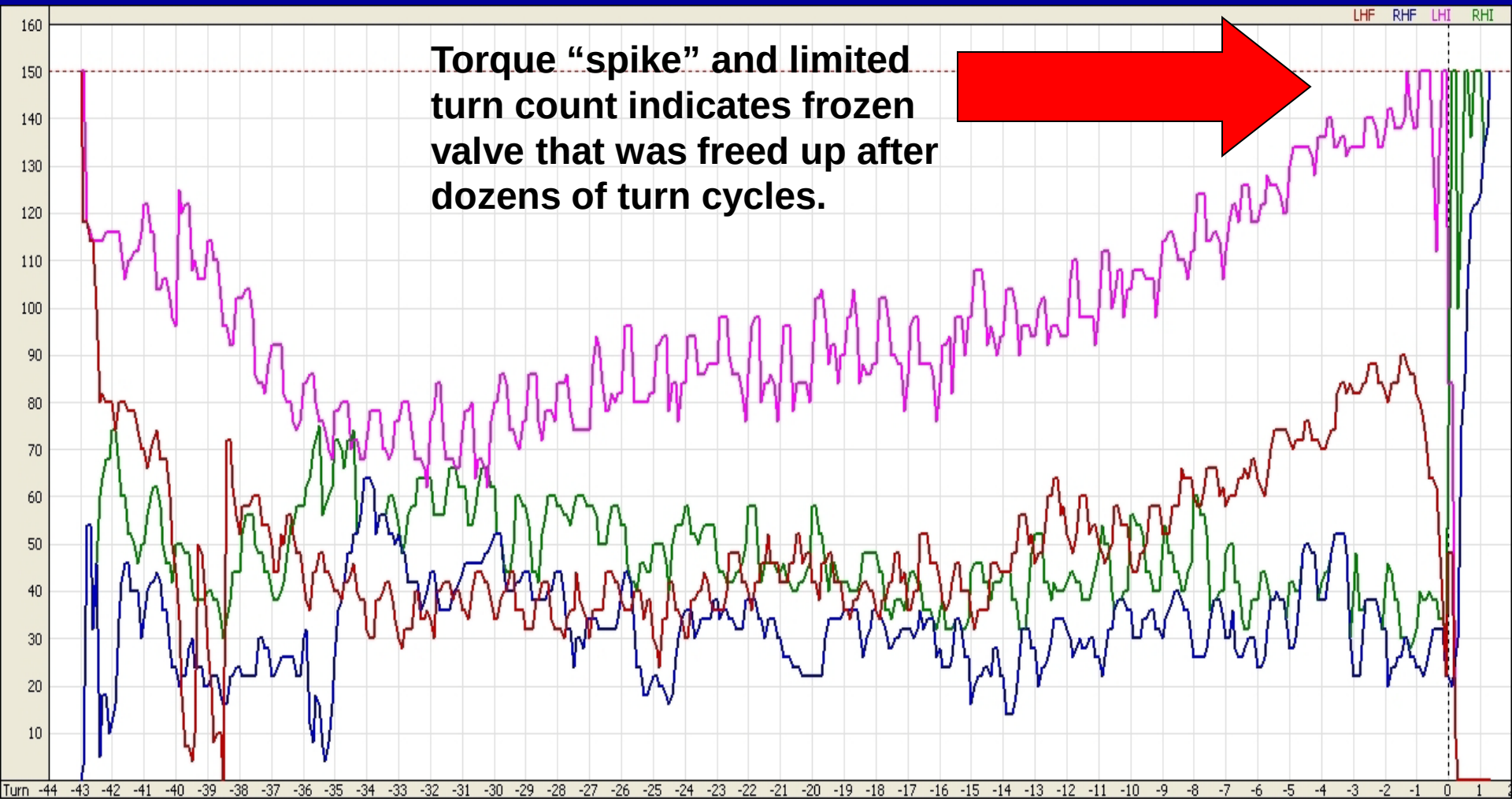
Paved Over Valves

16” Valve Found Under Asphalt

Frozen Valves Rehabilitated

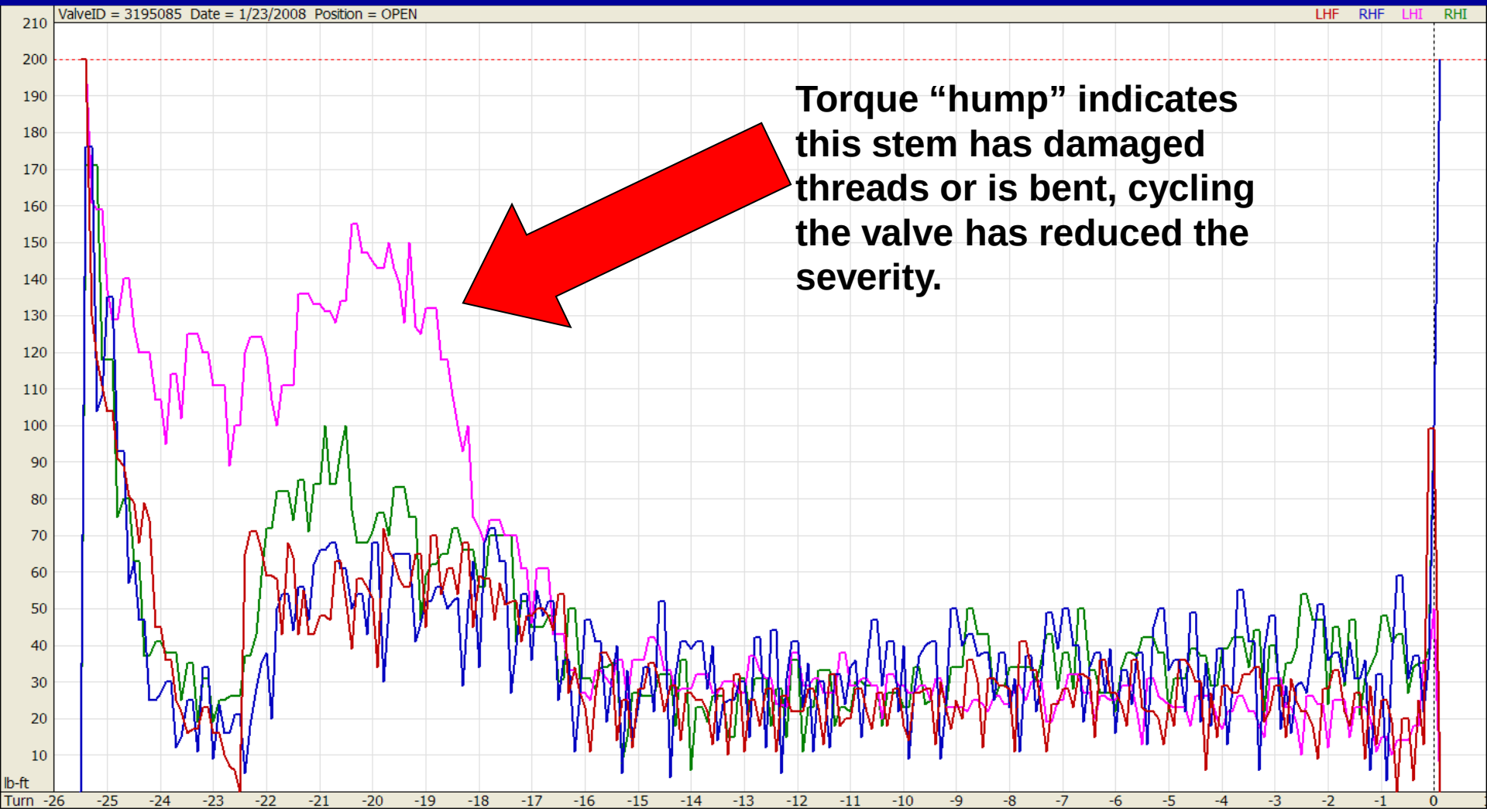


Torque Chart – Frozen Valve



30” Butterfly Valve @ West Bellfort Ave. & Kirkwood Dr.

Torque Chart – Bent Stem



16" Gate Valve @ Clara Rd. & Okanella St.

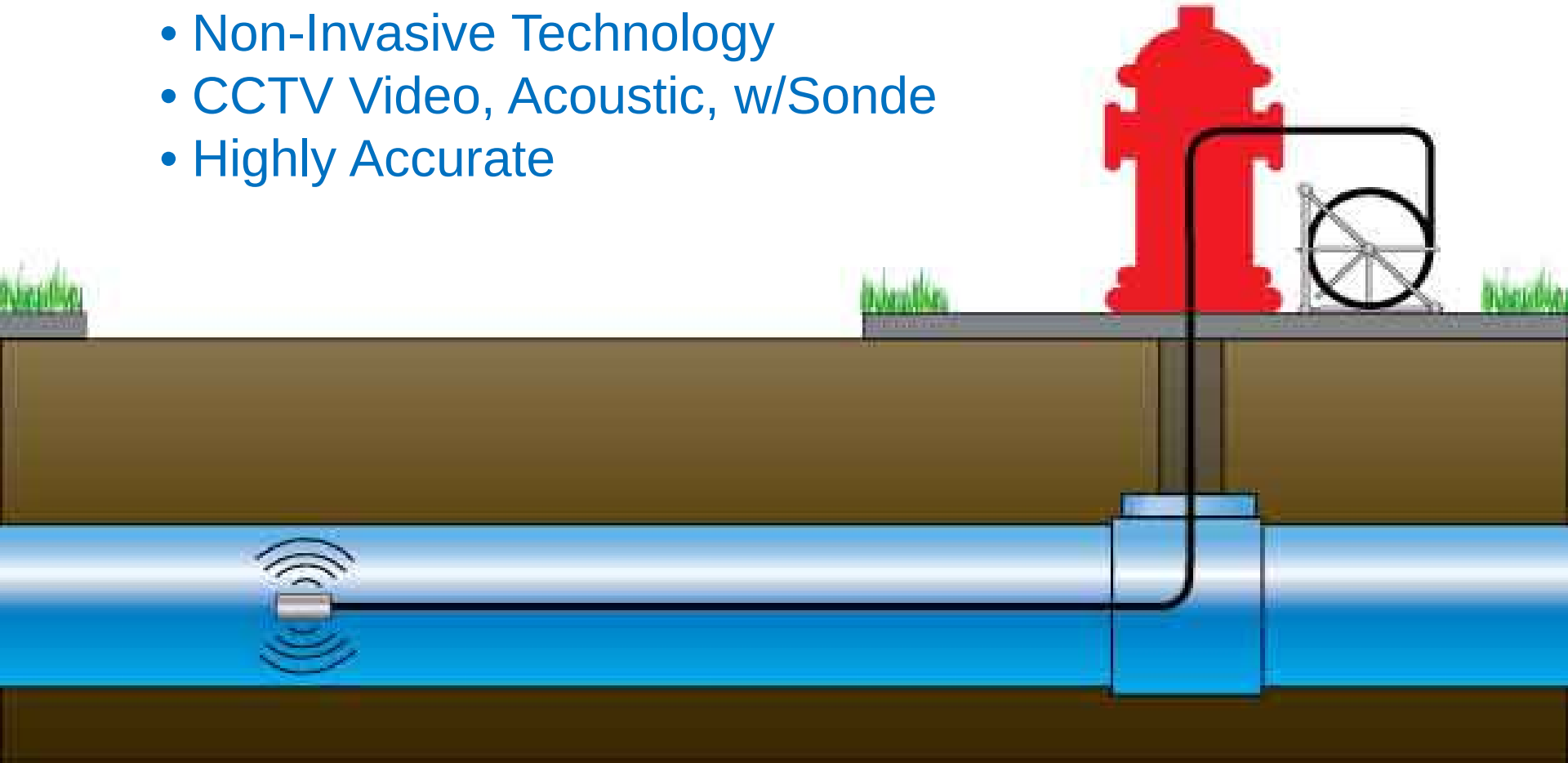
Program Findings

Description	Quantity	% of valves
Valves Assessed	4,119	-
“Initially” Operable	1,854	45%
Currently Operable	3,336	81%
Wrong Position (corrected)	403	10%
Buried / Paved Over Valves	258	6%
Map Discrepancies	593	14%
Missing / Broken Lids (replaced)	490	12%
Frozen Valves (rehabilitated)	66	1.6%
Cannot Locate Valves (initial)	705	17%
Cannot Locate Valves (current)	488	12%

Specialized Locating Tools

Investigator™

- Non-Invasive Technology
- CCTV Video, Acoustic, w/Sonde
- Highly Accurate



Investigator™

Asset Information & Analysis

Asset Information

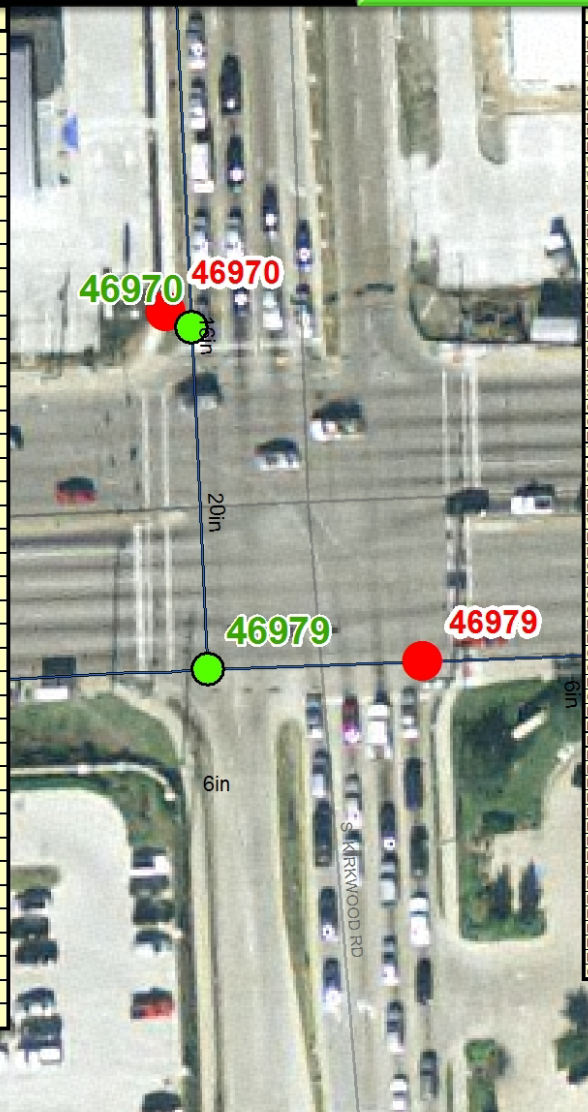
- 30–50 attributes captured per valve
  - Physical and Operational Observations
- GPS coordinates of valve positions
  - Integrated into GIS
- Valve Operation Records
  - Torque Charts
  - Broken Valves: which need to be replaced
  - Other Work Orders
- Analysis
  - Back End / Deliverables

Asset Attributes

DATA BEFORE

MISSING

GIMS Database	
OBJECTID	4215
Shape	Point
AREA	0
PERIMETER	0
WATER_NP_	208416
WATER_NP_I	208416
ANGLE	182
CODE	TV
FAC_ADDR	
FAC_NAME	
HFD_NO	
MATERIAL	
MTR_TYPE	
PJ_NUM	
PJ_TYPE	
PLN_DATE	<null>
PLN_NUM	
PLN_TYPE	
PU_R_ID	
PV_	
SIZE1	20
SIZE2	16
SIZ_MAIN	0
SOURCE	
SRV_ADDR	
SRV_DATE	<null>
STATUS	E
TYPE	124
UFID	46979
VLV_DIR	
VLV_STAT	
VLV_TURN	0
WAR_DATE	<null>
NP	N
PLN_NUM_TY	
PJ_NUM_TYP	
COUNCILDIS	G
KEYMAP	489S
TILE_NAME	4856d
HFD_DISTRI	69
CYCLE_NUM	11

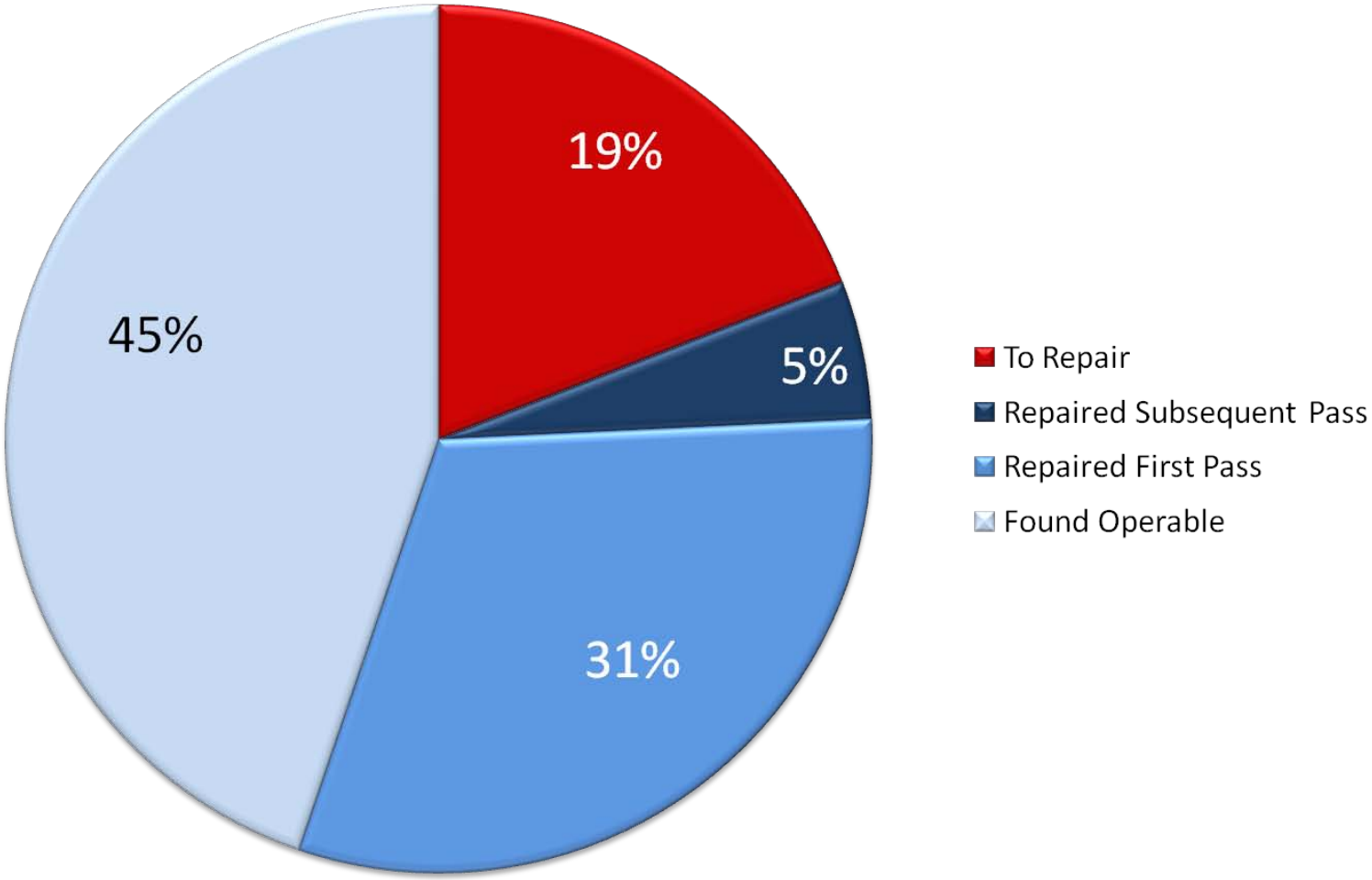


DATA AFTER

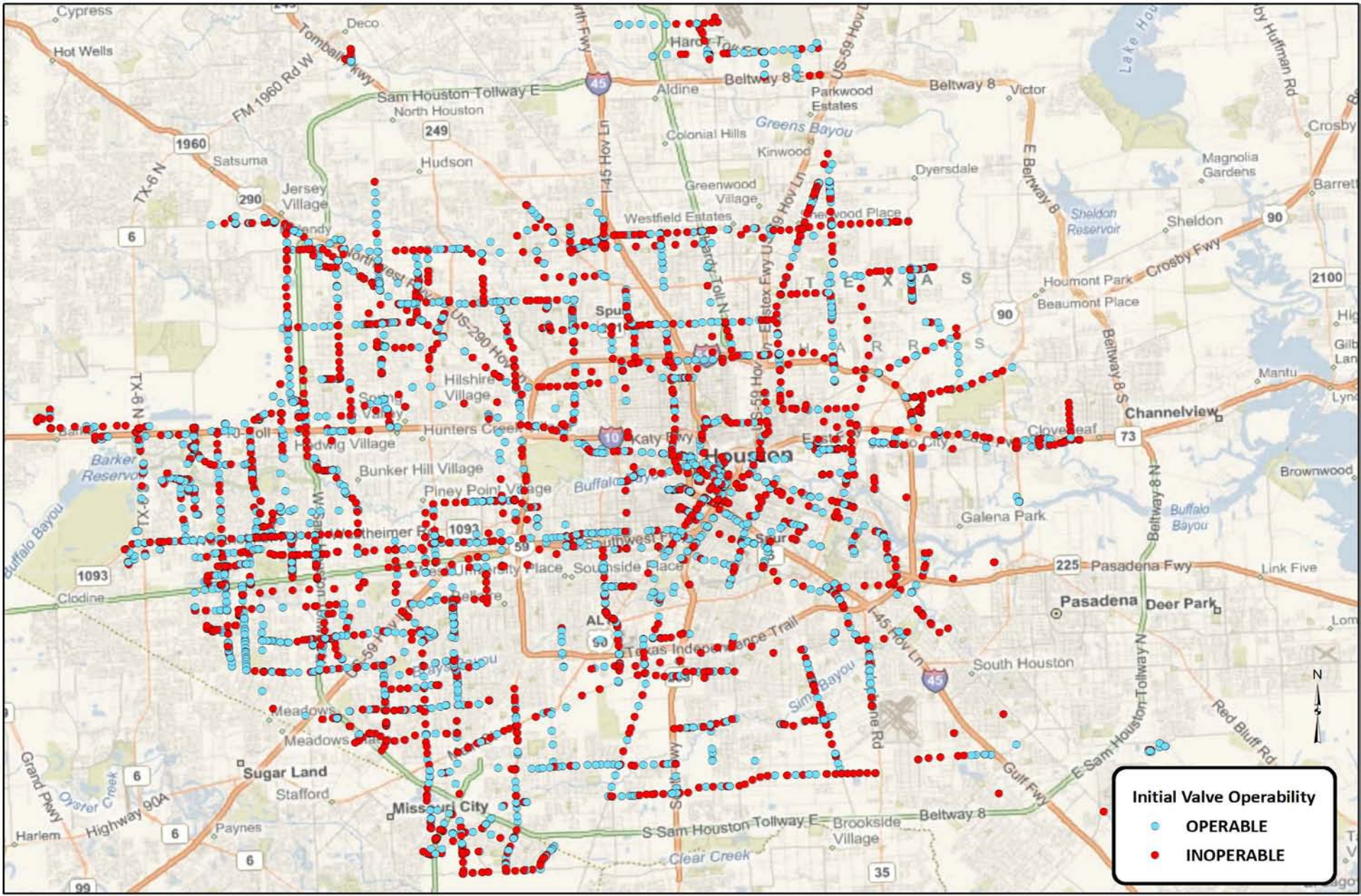
COMPLETE

Wachs Utility Services Maintenance Database	
Easting	3050998.77
Northing	13831074.21
CREW_CHIEF	ERNIE_COLLE
OS_DATE	4/23/2008
OS_TIME	10:13:15 AM
PRIMARY_ACTIVITY	CONDITION ASSESSMENT
UFID	46979
MAP	4856d
WUS_ADDRESS	11800
WUS_STREET	WESTHEIMER RD
WUS_CROSS_STREET	KIRKWOOD DR
LOCATION_NOTES	EAST SIDE OF KIRKWOOD RD
MAP_DISCREPANCY	CONFLICT TURNS/SIZE
MAP_DISCREP_COMMENT	VALVE IS ON EAST SIDE OF KIRKWOOD RD INSTEAD OF WEST SIDE - TURNED LIKE A 20" GATE VALVE
VALVE_USE	IN LINE
VALVE_SIZE	16
VALVE_TYPE	GATE NOT GEARED
SURFACE_COVER	ASPHALT
COVER_LEVEL	AT GRADE
UID_CONDITION	GOOD
UID_SIZE	ROADWAY
CLEANOUT	NONE
INITIALLY_OPERABLE	YES
STRUCTURE	BOX
STRUCTURE_CONDITION	GOOD
ORIENTATION	VERTICAL
OPNUT_DEPTH	5.5
EXERCISE	FULL
TURNS	61
OP_METHOD	ELECTRIC
CLOSE_DIRECTION	LEFT HAND
MAX_TORQUE	200
FINAL_TORQUE	
VALVE_CONDITION	GOOD
POSITION_FOUND	OPEN
POSITION_LEFT	OPEN
COMMENTS	
PACKING_LEAK	NONE
CANNOT_LOCATE	NO
COVERED_OVER	NO
NEED_TO_RAISE	NO
FROZEN	NO
OTHER_DISCREP	NO
OTHER_DESCRIPTION	NONE
BROKEN	NO
OUT_OF_SCOPE_NOTES	NONE
BYP_VALVE_PRESENT	NO
BYP_UID_SIZE	NA
BYP_UID_CONDITION	NA
BYP_OPERATOR	NA
BYP_EXERCISE	NA
BYP_TURNS	0
BYP_CONDITION	NA
BYP_POSITION_FOUND	NA
BYP_POSITION_LEFT	NA
BYP_COMMENT	N/A
BYP_CANNOT_LOCATE	NO
BYP_COVERED_OVER	NO
BYP_NEED_TO_RAISE	NO
BYP_PACKING_LEAK	NONE
BYP_FROZEN	NO
BYP_OTHER_DISCREP	NO
BYP_OTHER_DESCRIP	NONE
BYP_BROKEN	NO
CALLED_CITY	NO

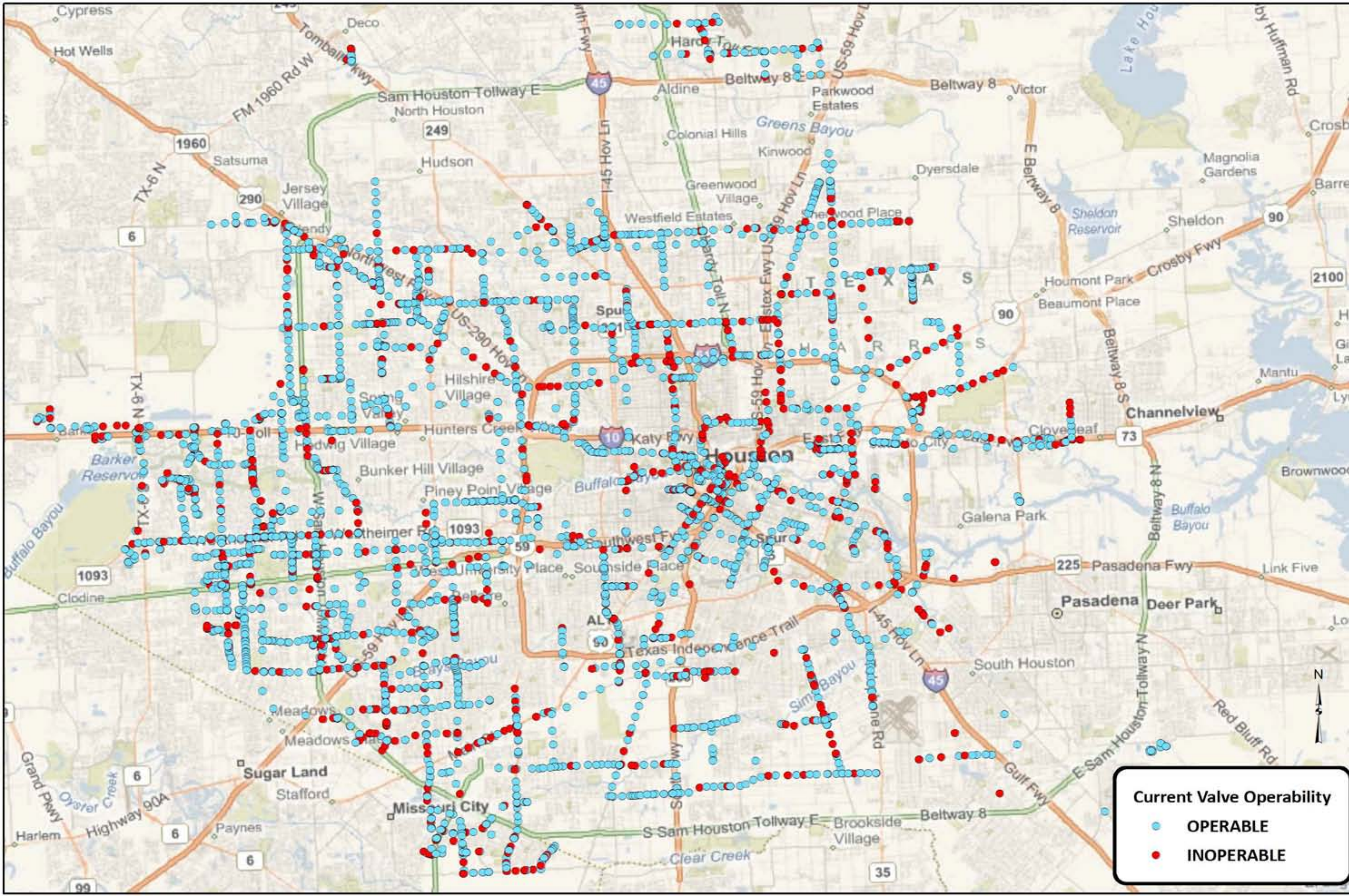
Valve Operability - Breakdown



Analysis: Initial Valve Operability



Analysis: Current Valve Operability



Benefits

Benefits

- Measurable Increase in Valve Operability and Reliability
- Effective Water Main Shutdowns
- Improved Water Quality
- Accurate & Actionable Asset Information
- Increased Efficiency Reduced O&M Costs
- Increased Operator Confidence…

Benefits

Estimated from ***Just*** (66) frozen valves rehabilitated, the City has saved more than the entire cost of the program to date.

Valve Size	Qty. Valves Saved
8"	1
12”	2
16"	28
20"	11
24"	20
30”	4
TOTAL:	66

Benefits

Estimated from ***Just*** (66) frozen valves rehabilitated, the City has saved more than the entire cost of the program to date.

Replacement Costs (Saved):	**$ 2,600,000**
Program Cost (To Date):	**– $ 1,645,000**
SURPLUS SAVINGS:	**$ 955,000**

**assumes replacement costs of $2k per inch average*

Objective Achieved

- The overall program objective “To improve system reliability and operability” has exceeded all expectations and has gone far beyond the expected program benefits.
- Great strides have been made to achieve objectives, improve system reliability AND the City has saved money in the process.

SPECIAL THANKS TO:

Sandeep Aggarwal, P.E., Managing Engineer, Drinking Water Operations, City of Houston

Yvonne W. Forrest, Senior Assistant Director, Drinking Water Operations, City of Houston

QUESTIONS?

Paul Schumi
pschumi@wachsws.com
(312) 884-1602

May 4 | 2012

Small Hydro - Generate Revenue and Offset Rising Energy Costs

PNWS-AWWA 2012 Conference

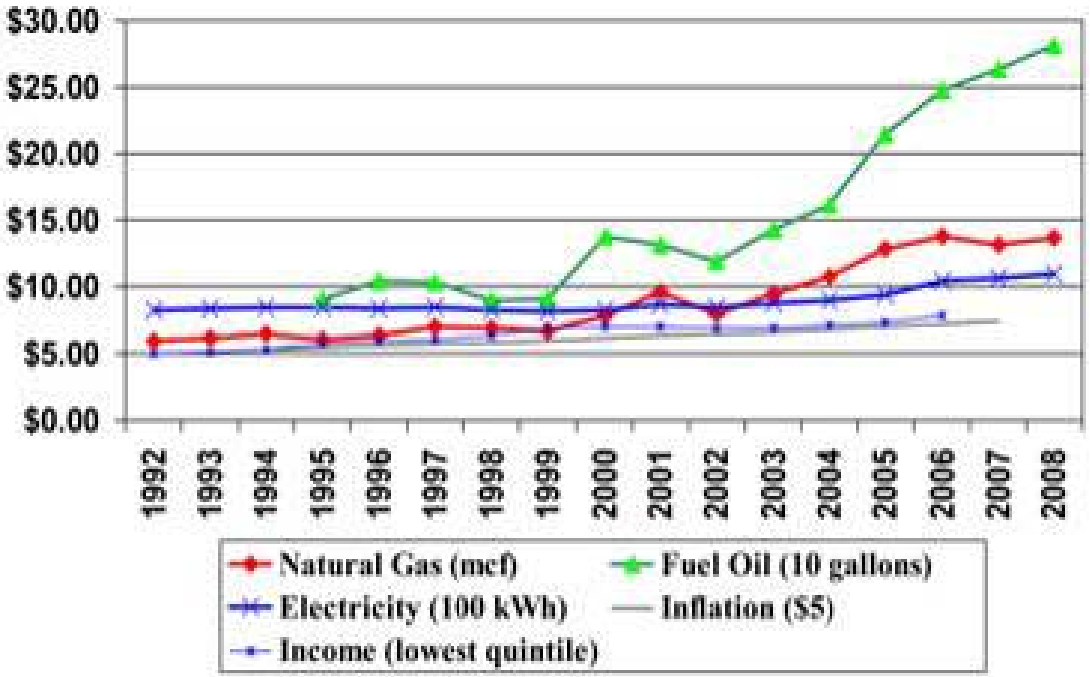
Pete Oveson, P.E., Brown and Caldwell

Presentation Overview

- Overview of opportunities
- Finding a suitable site
- Turbine selection
- Feasibility studies
- Financial incentives
- Example projects

Why Consider Small Hydro?

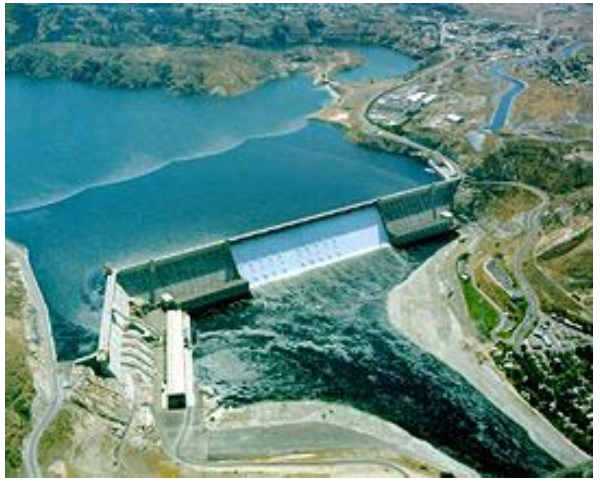
- Customer & agency interest in sustainability
- Rising energy costs
- Renewable energy interest
- Make use of existing infrastructure



Traditional Hydropower

70% of electricity in Northwest is currently from hydropower, mostly from very large projects

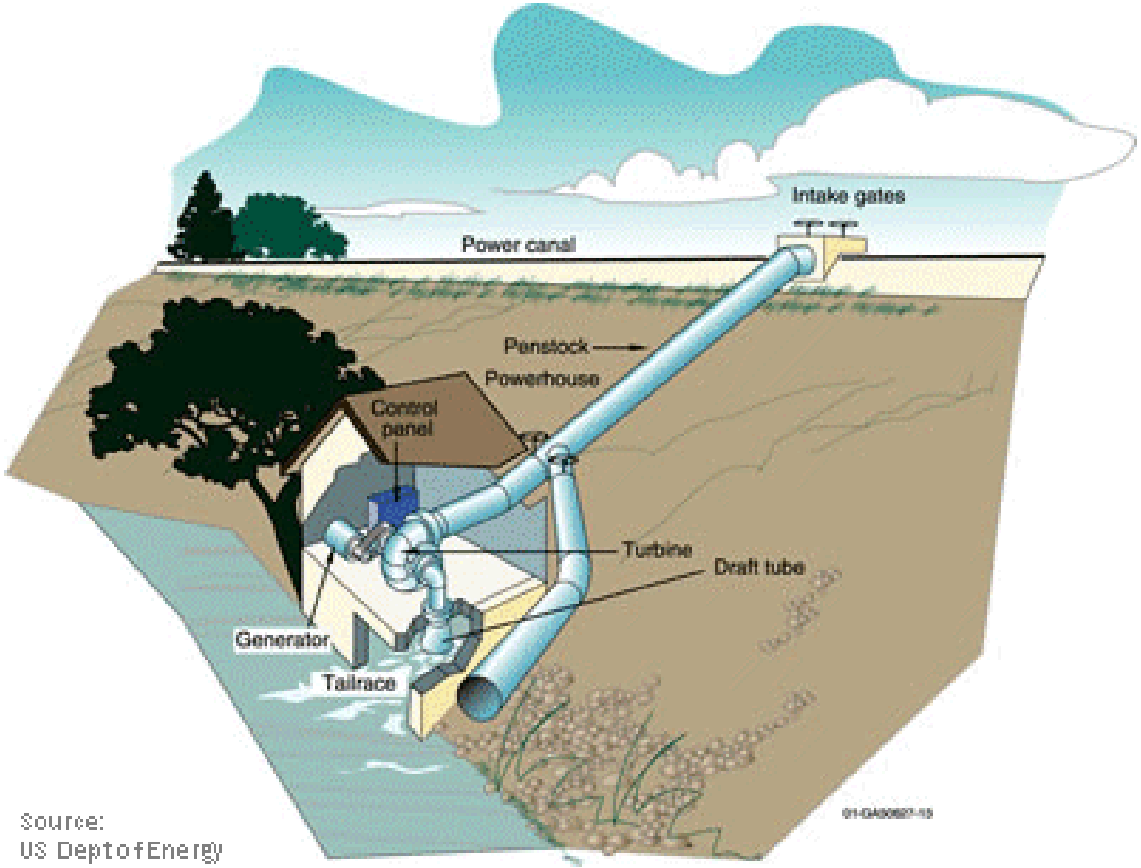
The Bonneville Dam



The Grand Coulee Dam

Small Hydro

- Less than 1 MW
  - Micro < 100 kW
  - Mini < 1 MW
- Low Impact
- Low Cost



Source:
US DeptofEnergy

Finding a Suitable Site

- Overview of opportunities
- Can be installed anywhere with sufficient head and flow
- Simple Guide:

  kW = QH/14

  Q = Flow (cfs)

  H = Head Differential (ft)

  Turbine/generator efficiency assumed at 85%

Finding a Suitable Site

- Head is more important than flow…
- Low head – high flow turbines can very big, expensive, and complicated
- Typically need at least:
  - 30 ft of Head
  - 10 cfs of Flow

Example Suitable Sites

- Pressure reducing station
- Water treatment plant inlet
- Wastewater treatment plant outfall
- Open channel applications
- Existing Dam

Turbine Selection

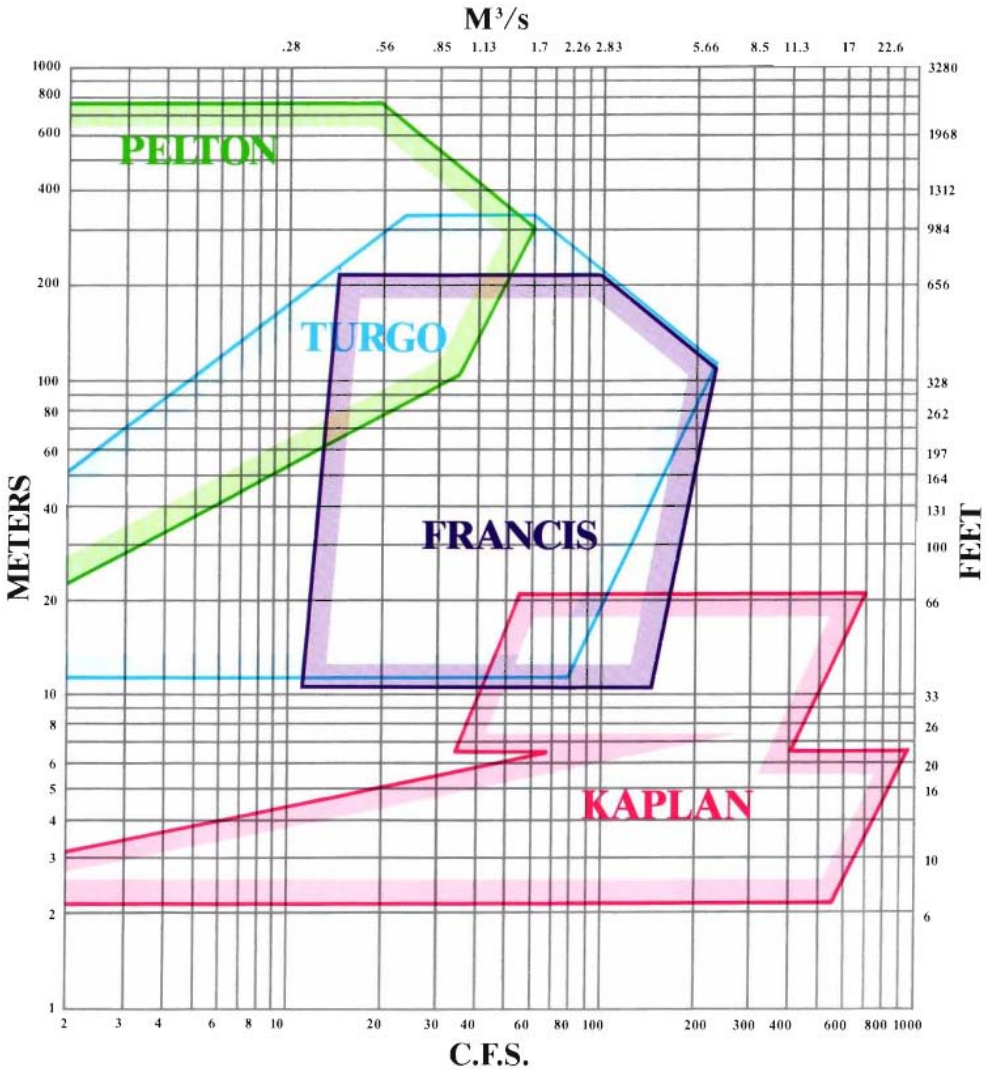
- Reaction Turbine
  - Water passes around the blades of the turbine
  - Requires water pressure /suction or full submergence
- Impulse Turbine
  - Water jet impacts blades of turbine
  - Open to atmospheric pressure - no water pressure or submergence requirements

Turbine Selection

- Common Reaction Turbines
  - Francis
  - Kaplan
  - Fixed Propeller
  - Reversible Pump

- Common Impulse Turbines
  - Pelton
  - Turgo
  - Crossflow

Turbine Selection



Turbine Selection

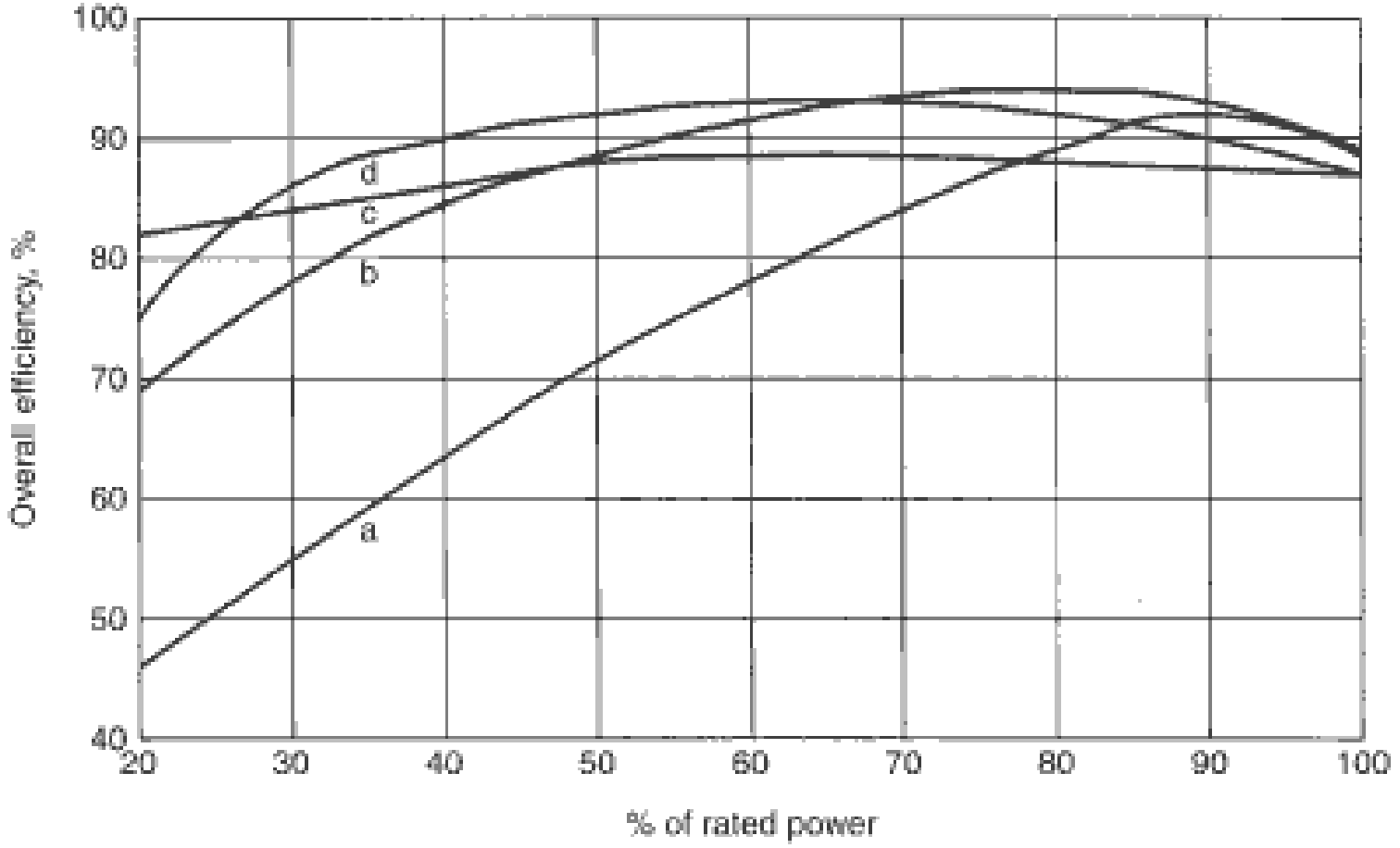
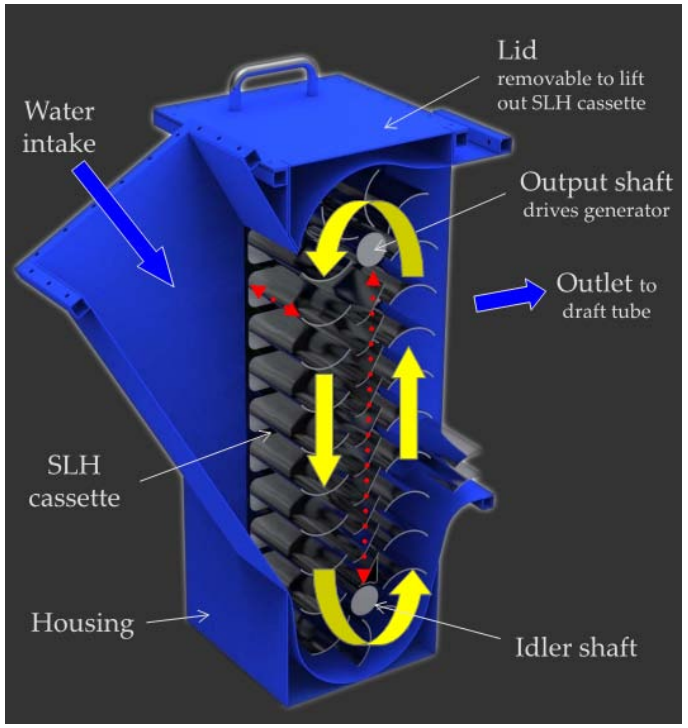


Figure 3-2 Efficiency as a function of rated power for different turbines. (a) Fixed blade axial; (b) Francis; (c) Impulse; (d) Kaplan.

Turbine Selection

Emerging Technology

- Reversible Well Pumps (Recharge Wells)
- SHL (Schneider Liner Hydro-Engine)
- Kinetic Turbine
- Darrieus Turbine

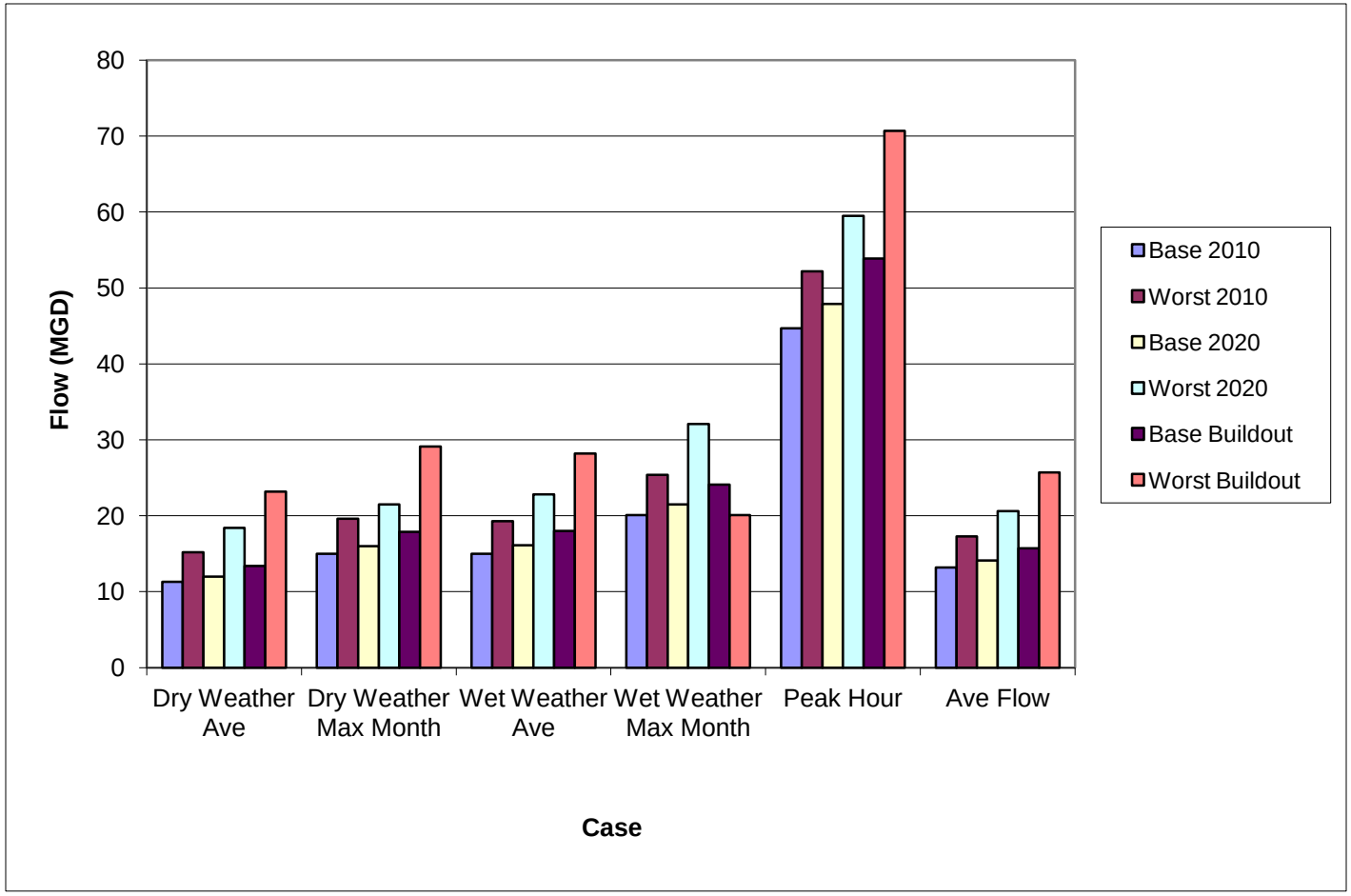


Feasibility Study

- Hydraulic conditions
- Equipment identification
- Permitting needs
- Power sales
- Preliminary design
- Estimate project capital cost
- Predict revenue and payback period

Hydraulic Conditions

- Average flow/head data is not always an accurate prediction of power generation



Equipment Identification

- What type of turbine will work best with the system?

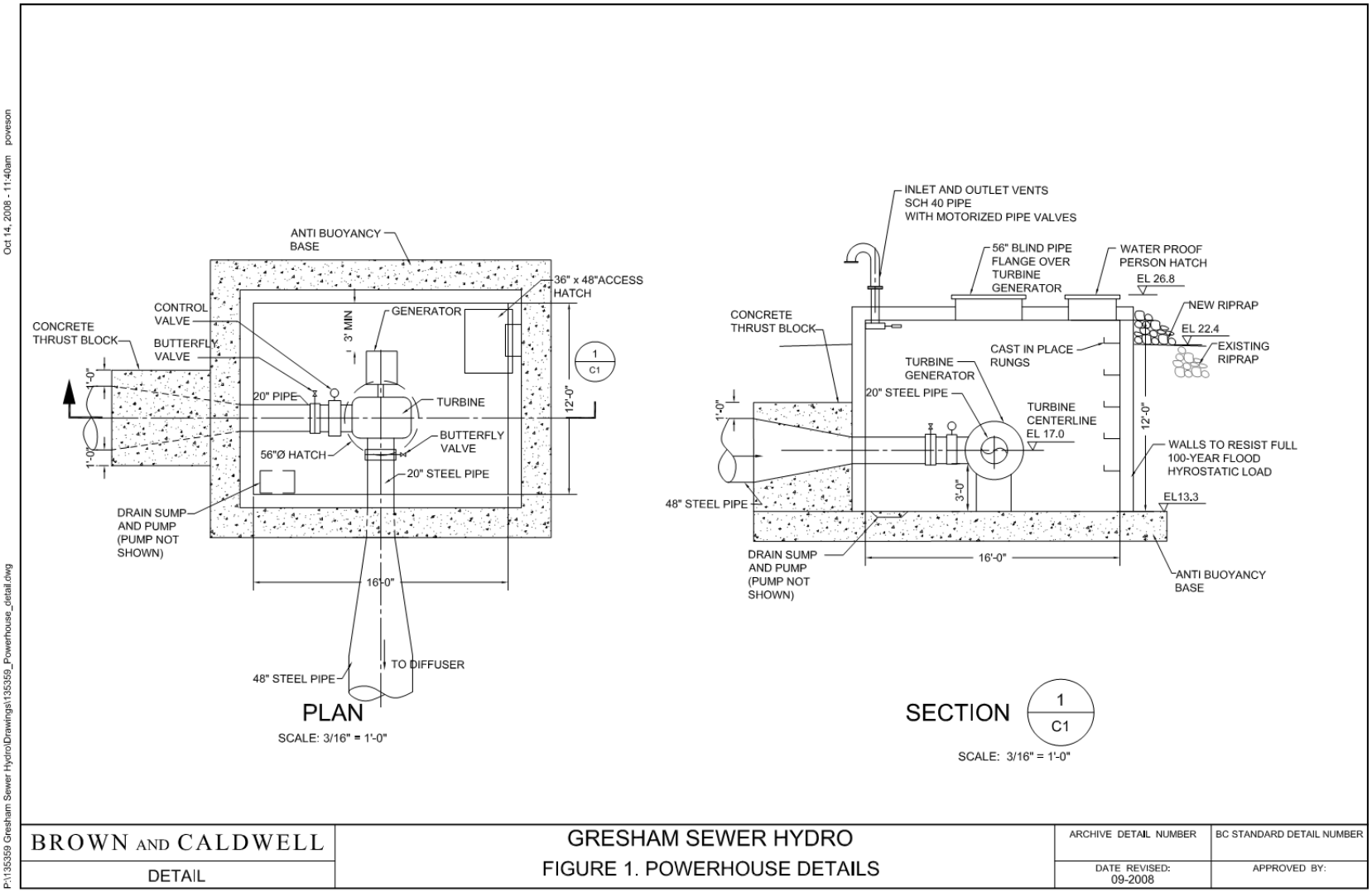
Permitting Needs

- Federal Energy Regulatory Commission (FERC)
  - Conduit exemption
    - Less than 15 MW
    - Primary use of infrastructure is not hydropower
    - Developer owns property
- Water rights
  - Non-consumptive use
- Every site is different… may need to deal with various other federal, state, and local agencies

Power Sales

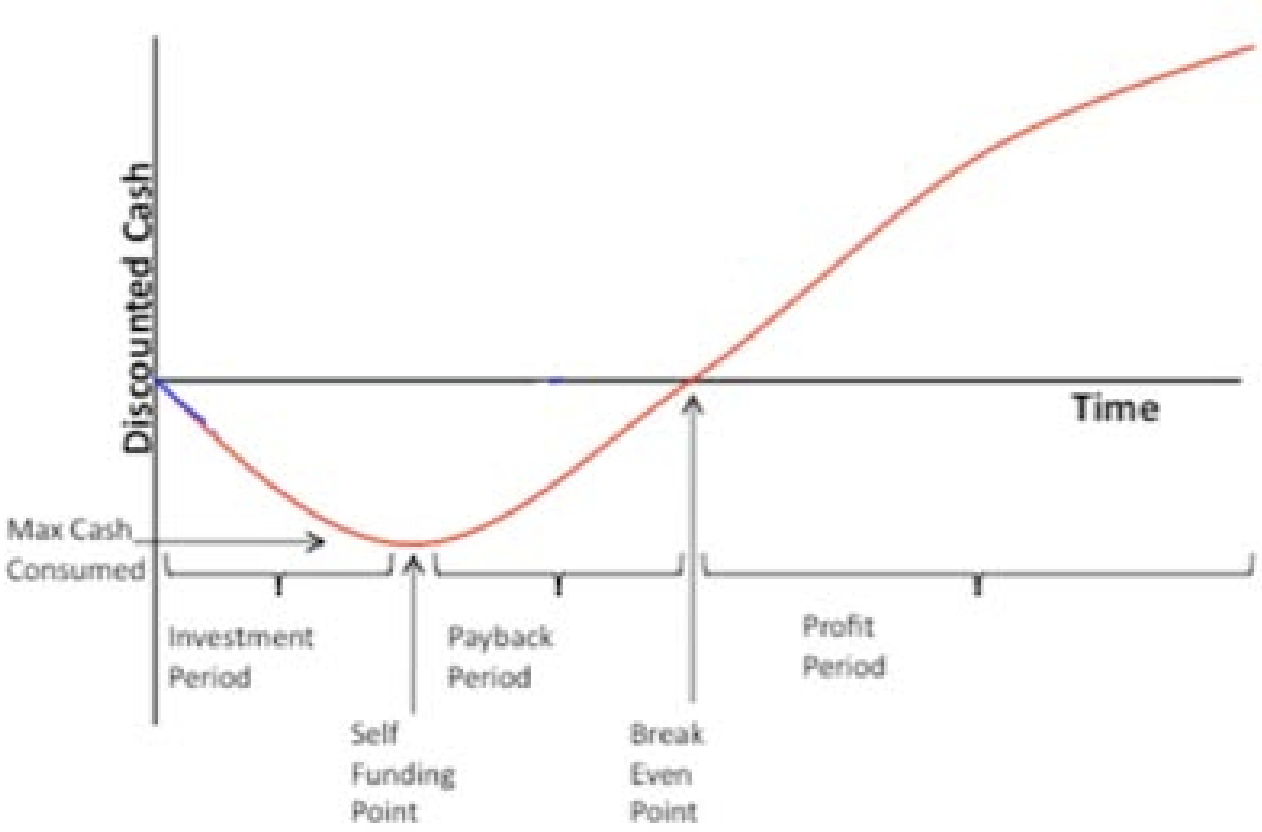
- Power Purchase Agreement (PPA)
- Net Metering

Preliminary Design/Cost Estimate



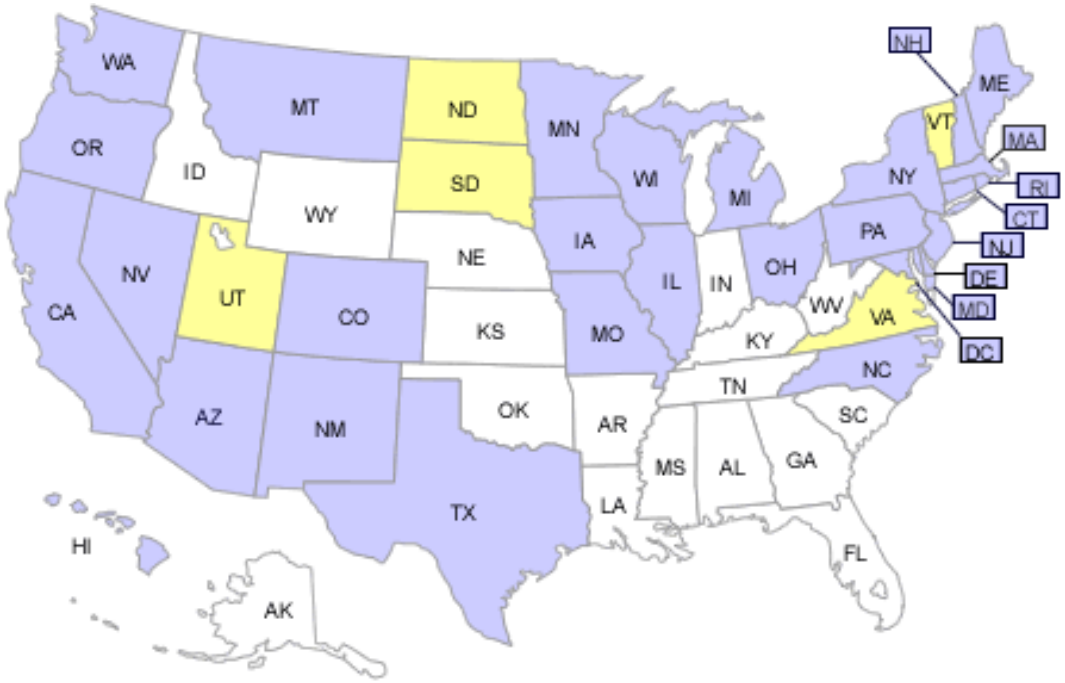
Project Payback

- A solid project should have a payback around 10 years



Financial Incentives

- DSIRE website
- Grant opportunities for feasibility studies
- Green Tags or Renewable Energy Credits (RECs)



Gresham WWTP Study

- Turbine in WWTP outfall to the Columbia River
- 50 kW plant from 30 feet of head and 15.7 MGD
- Capital funding from Oregon BETC and ETO
- FERC conduit exemption

Midway WWTP Study

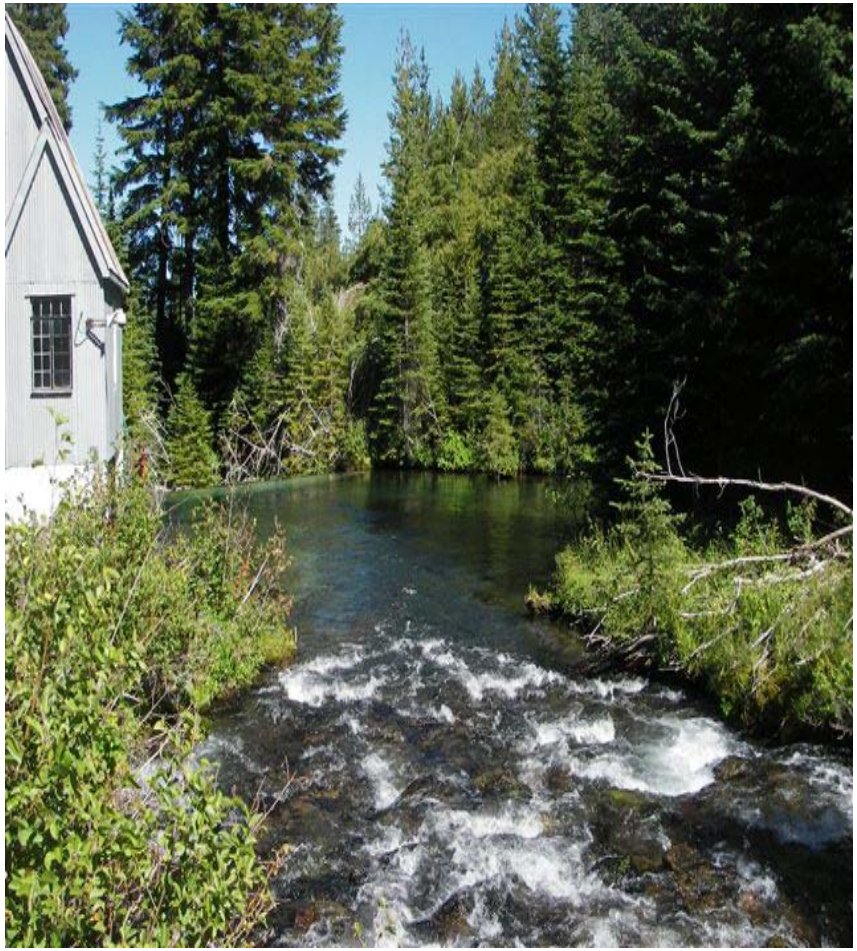
- Turbine in WWTP outfall to the Puget Sound
- 30 kW plant from 50 feet of head and 8 MGD

Oregon City PRV Study

- Turbines at existing PRV stations
- Received grant funding for feasibility study
- 10 - 40 kW from 70 psi of head at 300 - 1700 gpm
- Lesson learned: NEED RELIABLE FLOW DATA

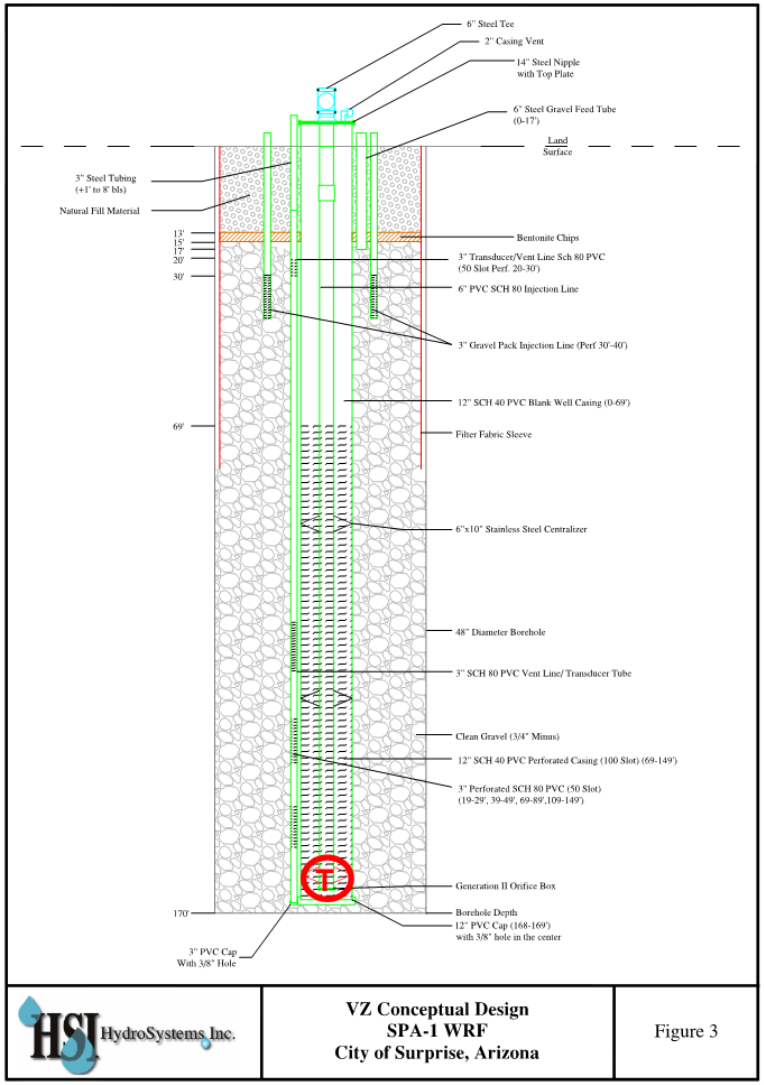
Bend Water Distribution Study

- 1.5 MW plant from 1,000 feet of head and 13.5 MGD
- May reduce capital funding needed for water distribution upgrades



City of Surprise (AZ) Recharge Well Study

- Turbines located in the bottom of recharge wells
- 7.5 kW per well with 100 feet of head and 450 gpm of flow
- Turbine will be a reversible well pump
- BOR grant application pending



Small Hydropower

Questions?

Pete Oveson, P.E.

poveson@brwncald.com