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25 YEARS
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FORT WORTH'S STORM DRAIN REHABILITATION PROGRAM –

COWTOWN'S APPROACH TO WRANGLING STORM DRAINS

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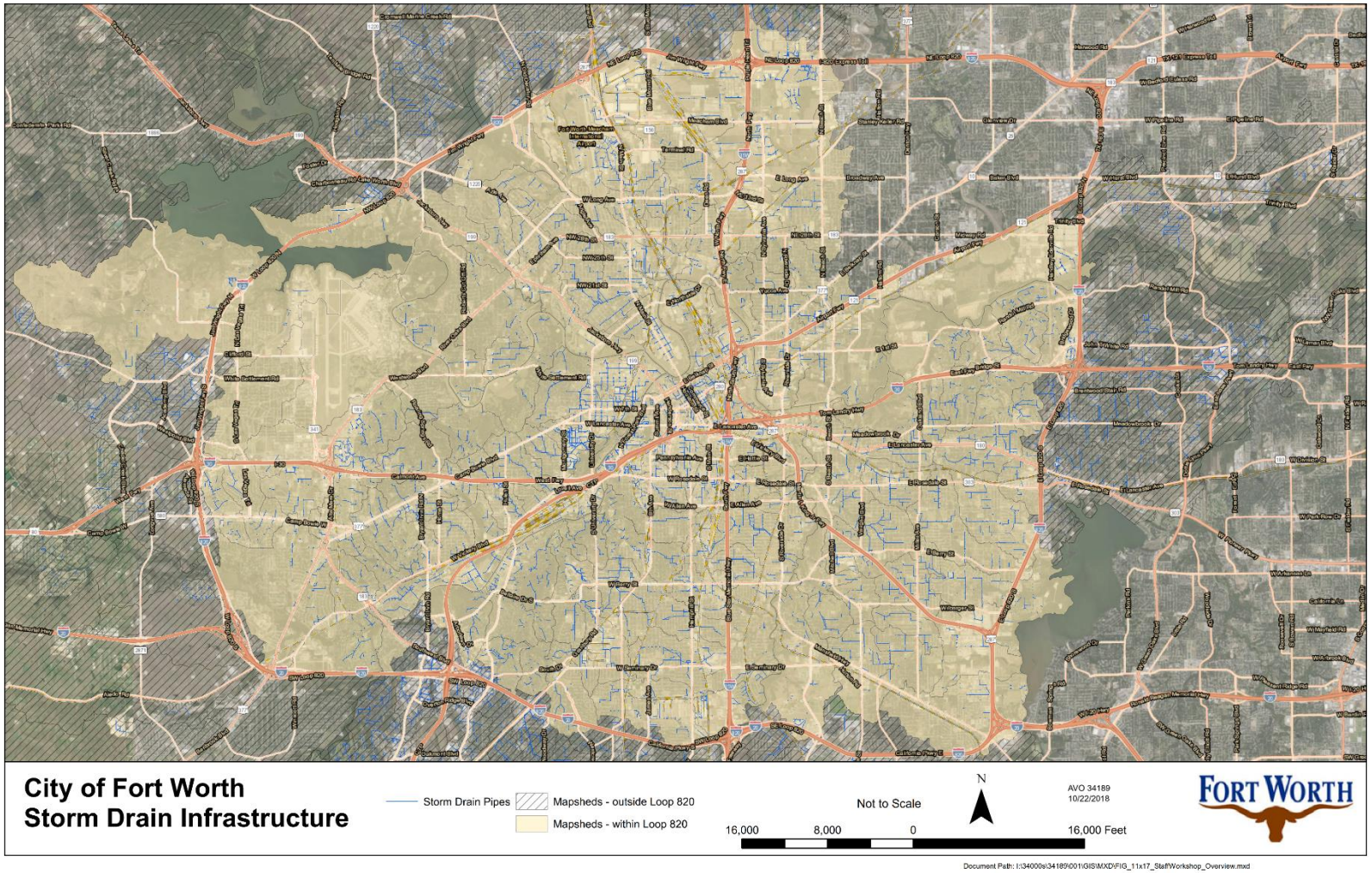
FORT WORTH

JANUARY 30, 2020

HALFF

AGENDA

- Background
- Program framework
- Initial assessment
- Condition assessment
- Prioritize
- Corrective action
- Lessons Learned



STORM DRAIN REHABILITATION

BACKGROUND

CFW STORM WATER UTILITY (SWU)

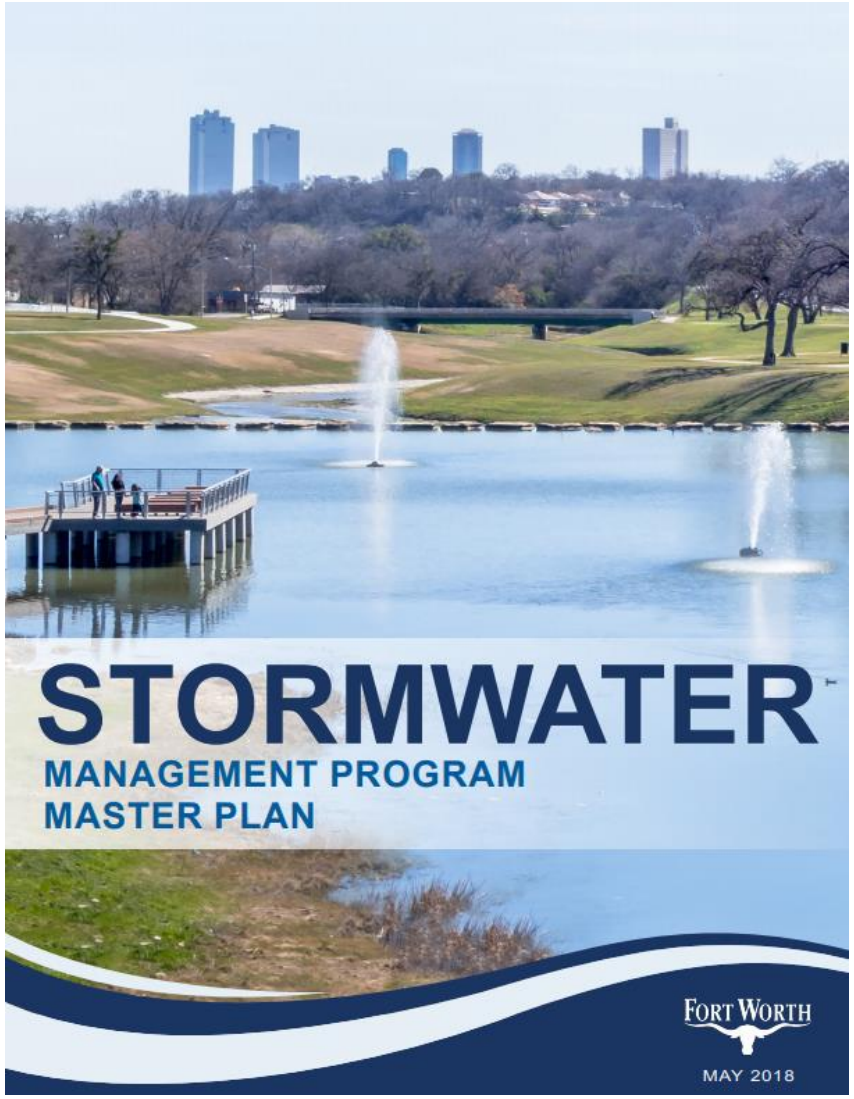
- SWU established in 2006
- Sold $150M bonds
  - Maintenance Program
  - Planning
  - Development Services
  - Equipment/Technology
  - Flood reduction capital projects
  - Communications
- Transitioning from Bond Funds to “Pay Go”
- Storm Water Master Plan

STORMWATER MASTER PLAN

- Developed strategic direction
- Identified Key Initiatives
- **Level 1 Priority – Storm Drain Rehabilitation Program**

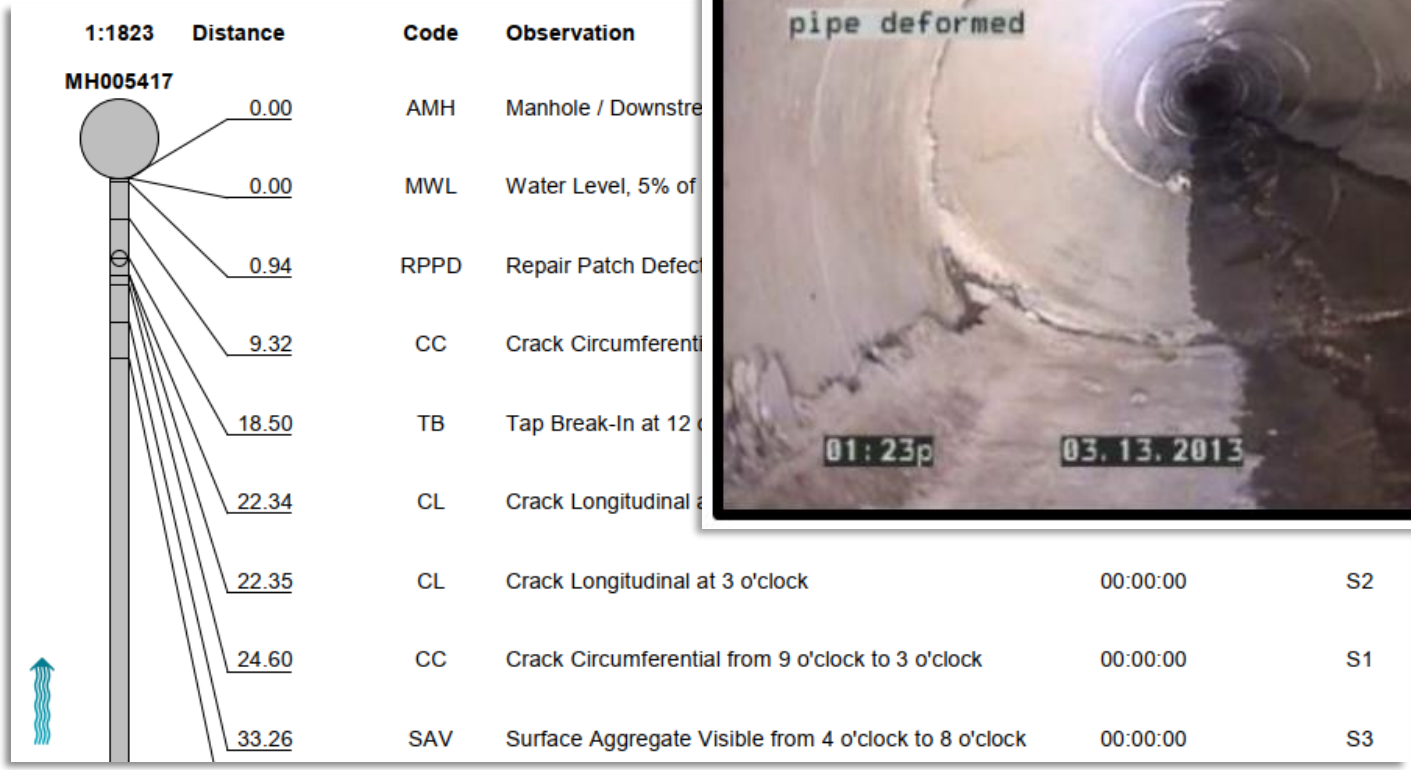
Prioritization Strategy:

Continue to expand the acquisition and effective use of data to inform programming decisions



STORM DRAIN REHAB PROGRAM

- SD rehab is a Priority Initiative for TPW
- Objectives
  - Enhance safety of Fort Worth
  - Proactive vs reactive O&M
  - Doing more with less
  - Improve level of service



STORM DRAIN REHABILITATION

PROGRAM FRAMEWORK

PROGRAM FRAMEWORK

- Define Level of Service (LOS) goals and Key performance indicators (KPIs)
- Program tasks
- Manpower

Program Task	Manpower
Cleaning and access	SWFOs
Inspection	Contract initially, then in-house
Assessment, needs identification, prioritization	Consultant
Corrective actions	Contract (best-value bid process) and supplement with SWFO in opportunistic areas

STORM DRAIN REHABILITATION

INITIAL STORM DRAIN ASSESSMENT

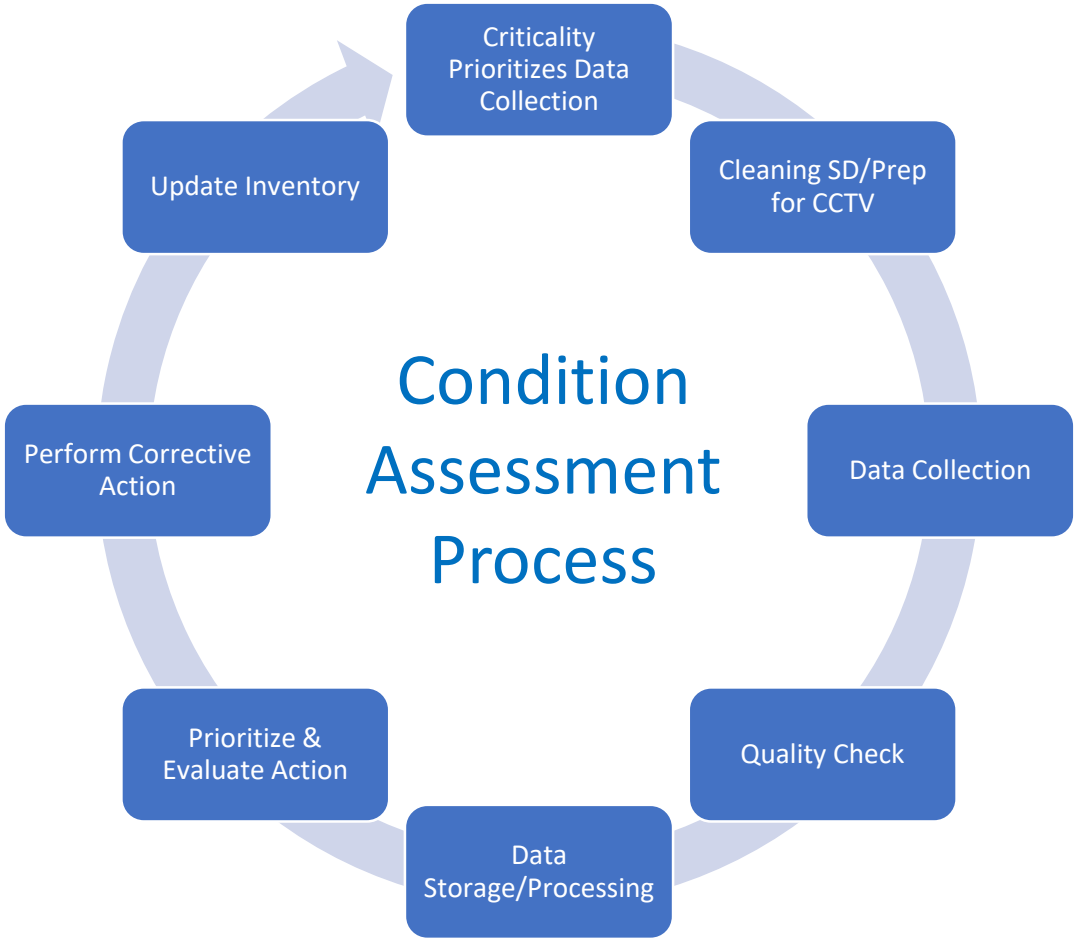
INITIAL STORM DRAIN ASSESSMENT

- Initial project prioritization
  - COF-basis
  - Consideration of proximity to structures
  - Easement status
- Easement research and verification
- Staff knowledge workshop
  - Discussed and gathered institutional knowledge
  - System maintenance, rehab, failure

STORM DRAIN REHABILITATION

HOW TO EVALUATE STORM DRAIN CONDITION?

HOW TO ASSESS STORM DRAIN CONDITION?



CITY OF FORT WORTH – PROGRAM OVERVIEW

- Inspection approach:

1. Tiers 1 & 2
2. MH to MH (vs by pipe segment)
3. Condition score by pipe segment

- Scoring approach:

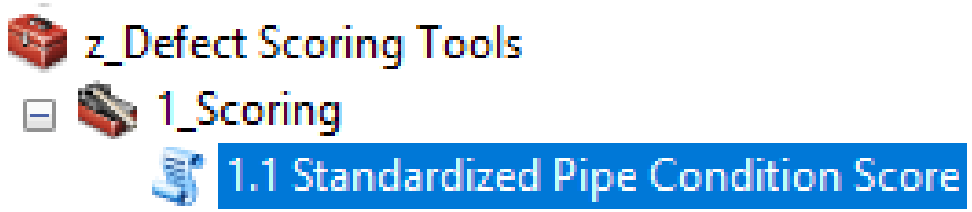
1. PACP with post-processing for storm drain defect - structural defect/condition rating on scale of 1 to 10

- Goals:

1. Inspect 25-50 miles of system / year
2. Apply a proactive, strategic program
3. Utilize risk-based prioritization using custom GIS tools
4. Predictive condition modeling (LOF) using historical data

HOW TO ASSESS STORM DRAIN CONDITION?

- Use equipment and scoring for storm drains
- City plans to implement in-house CCTV
- PACP-based Standardized Pipe Condition Score



Table

Storm Drain BRE

UNIQUE_ID *	Shape_Length	POF	COF	RiskScore	RiskRank	MS_Number	RiskGroup	MPACP	RiskScoreMPACP	RiskRankMPACP
PI007343	366.665035	4.5	7.6	3.42	819	55	High	8.5	6.46	1
PI007330	310.28936	7.8	5.55	4.329	286	55	High	10	5.55	2
PI007562	161.573843	3.7	6.1	2.257	2895	55	Medium	8.5	5.185	3
PI007294	700.198571	7.3	5.15	3.7595	540	55	High	10	5.15	4
PI007296	314.974681	7.9	5.15	4.0685	382	55	High	9.5	4.8925	5
PI007487	43.266137	7.3	5.35	3.9055	455	55	High	8.666667	4.636667	6
PI081229	218.768775	7.9	4.75	3.7525	542	55	High	8.833333	4.195833	7
PI007538	121.111311	8.1	4.2	3.402	832	55	High	9.166667	3.85	8

0 (0 out of 19513 Selected)

Storm Drain BRE

1-PAGE SUMMARIES

- Summary of defects, considerations, and risks by pipe
- Rehabilitation method recommendations

FORT WORTH

STORM DRAIN REHABILITATION SUMMARY - PI012266

Pipe Information

Street: Clover Lane and Lafayette Avenue
Priority: Tier 1

Pipe Information										
Site ID	CCTV Video	CCTV Report	Unique Pipe ID	Start MH	Length (ft)	Size (in)	Pipe Shape	Building Intersect (y/n)	Building Intersect Value ($)	ROW or Easement (y/n)
8 - Clover and Lafayette	Clover MH005385_PI012266_MH005417_2017-08-30_10-25_0000_US to DS.mp4	Thomas IN010944_PI012258_MH005385_2017-09-05_11-45_0000.pdf	PI012266	IN010944 - correct in current GIS	500	3' x 4'	Arch	y	$0	n

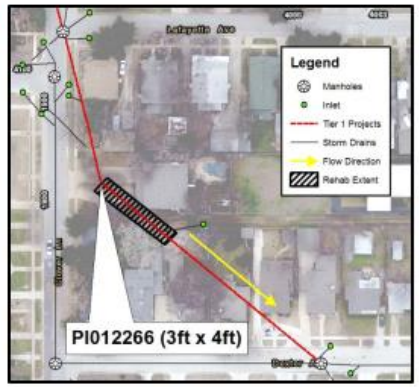
Description of Storm Drain

Description
Storm drain PI012266 is located at Clover Lane and Lafayette Avenue on the west side of Fort Worth. This line contains Arch 3'x4' pipe that run southeast through residential lots and streets. The total length of this storm drain is approximately 500 feet long.

Defects
Corrosion was found at the base of the walls throughout much of the arch section. A structural point repair is recommended where the pipe has collapsed, as well as 15 ft upstream and downstream of the defects.

The pipe defects shown on the plan & profile sheet were identified during the most recent CCTV inspection (Aug/Sept 2017).

Project Location



Potential Rehabilitation Methods

Recommended
- Spray-on methods (geopolymer, epoxy, cementitious)
- Spiral-wound

Not Recommended
- CIPP (lacks structural support)
- Slip-lining (better manhole to manhole)
- Pipe bursting (better manhole to manhole)

CCTV Representative Image

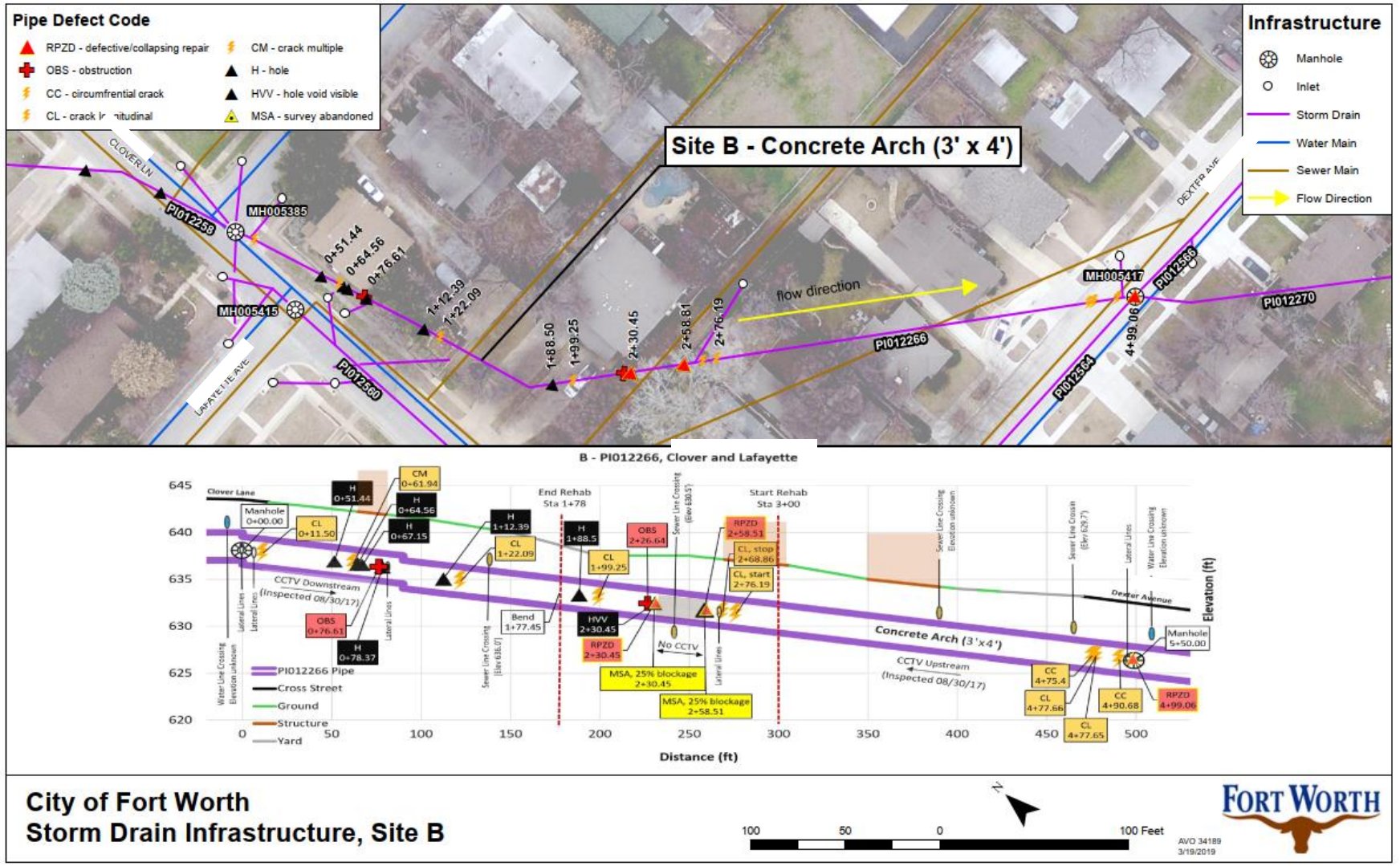
Estimated Rehabilitation Cost

The estimated total cost for this point repair (100 LF) is anticipated to range between $50K and $80K.

Site Specific Risks Potential for easement required; pre-rehab point repair likely needed.

PLAN & PROFILE SHEETS

- Plan and profile sheets developed from CCTV data and as-builts
- Map with defects referenced



STORM DRAIN REHABILITATION

HOW TO PRIORITIZE STORM DRAINS?

HOW TO PRIORITIZE STORM DRAINS?

- Establish program framework
- Business Risk Exposure to prioritize
  - Condition assessment
  - Corrective action
- Software framework
  - ITPipes
  - Accela
  - ESRI & custom GIS toolboxes
- Risk matrix criteria

1. Probability & Consequence of Failure
2. Risk of Failure (ROF) = [LOF x COF] / 10

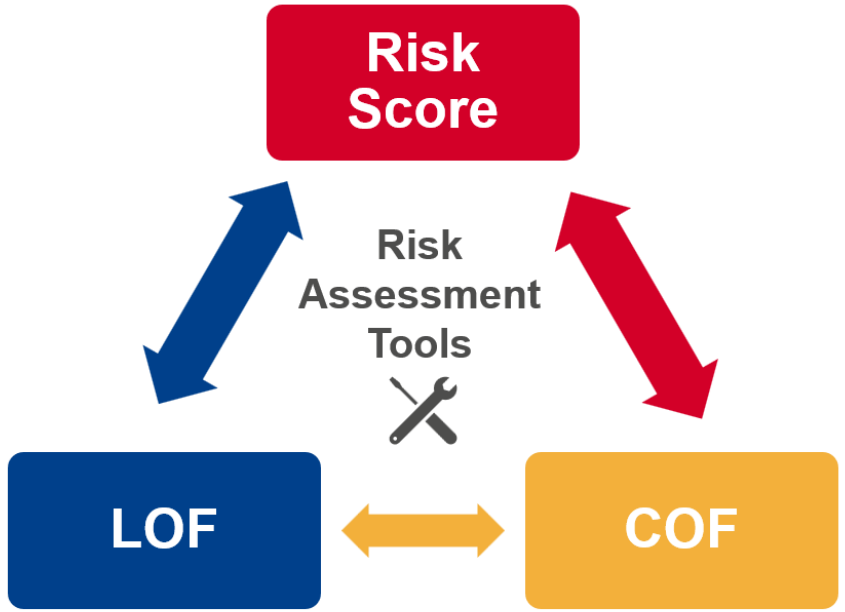
- Refine prioritization

Probability of Failure	Weight (%)
Percent Consumed	30%
Capacity	10%
Operating Environment	20%
Material	20%
Soils	20%
TOTAL	100%

Consequence of Failure	Weight (%)
Size	40%
Buildings	15%
Roads	15%
Critical Service	15%
Sag Inlets	15%
TOTAL	100%

HOW TO PRIORITIZE STORM DRAINS?

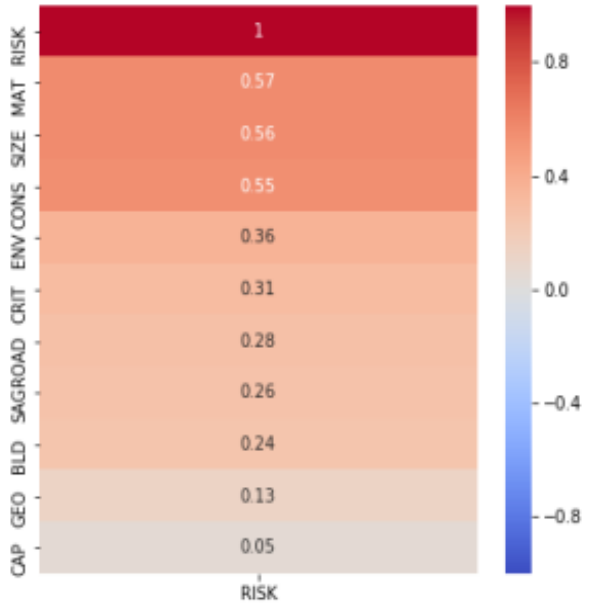
- Develop risk prioritization tools in ArcGIS
- Perform initial/baseline prioritization
- Refine prioritization approach using field data

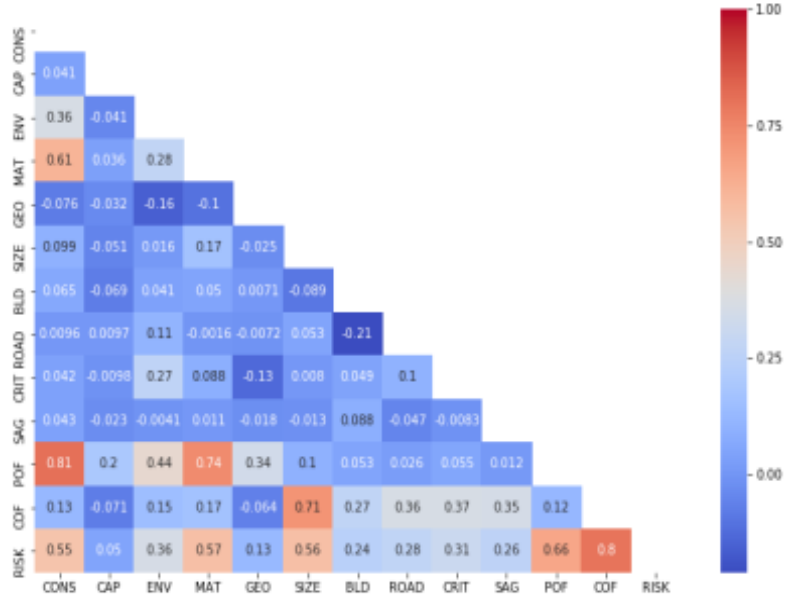


CONDITION DATA & PROJECT MODIFIERS

- Apply risk criteria
  1. Baseline prioritization – LOF based on surrogate data (no condition)
  2. Refine prioritization criteria with correlation analysis and field data
  3. Second prioritization – LOF replaced by pipe condition score
- Apply project modifiers with engineering judgement

Correlation Analysis

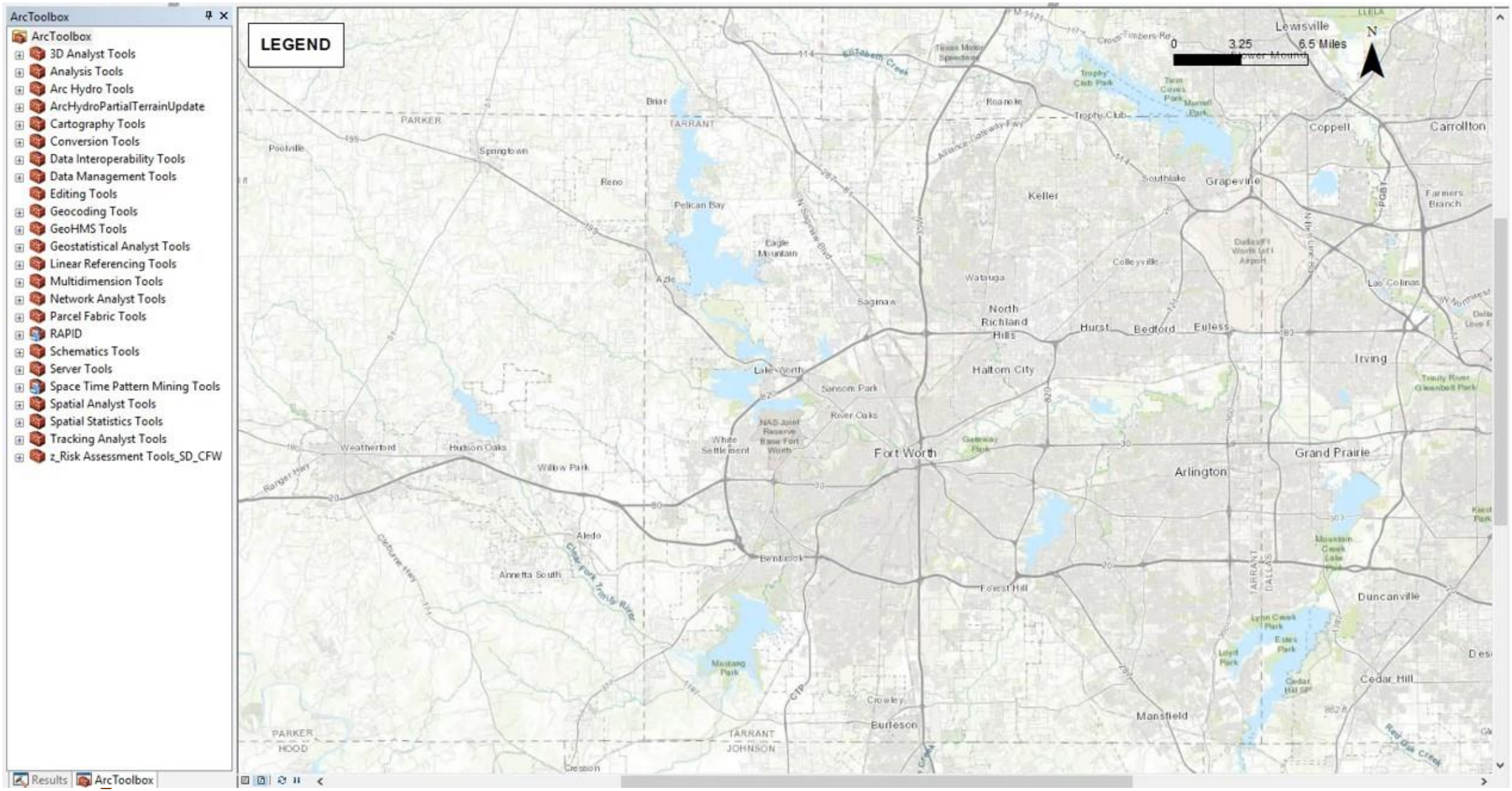




PRIORITIZATION TOOLS DEMO

GIS based

STORM DRAIN REHABILITATION | HOW TO PRIORITIZE STORM DRAIN PIPES? (GRAPHIC ONLY)



STORM DRAIN REHABILITATION

HOW TO IMPLEMENT CORRECTIVE ACTION?

NEAR-TERM PRIORITY AND SCHEDULE

Condition assessment – BRE-based schedule

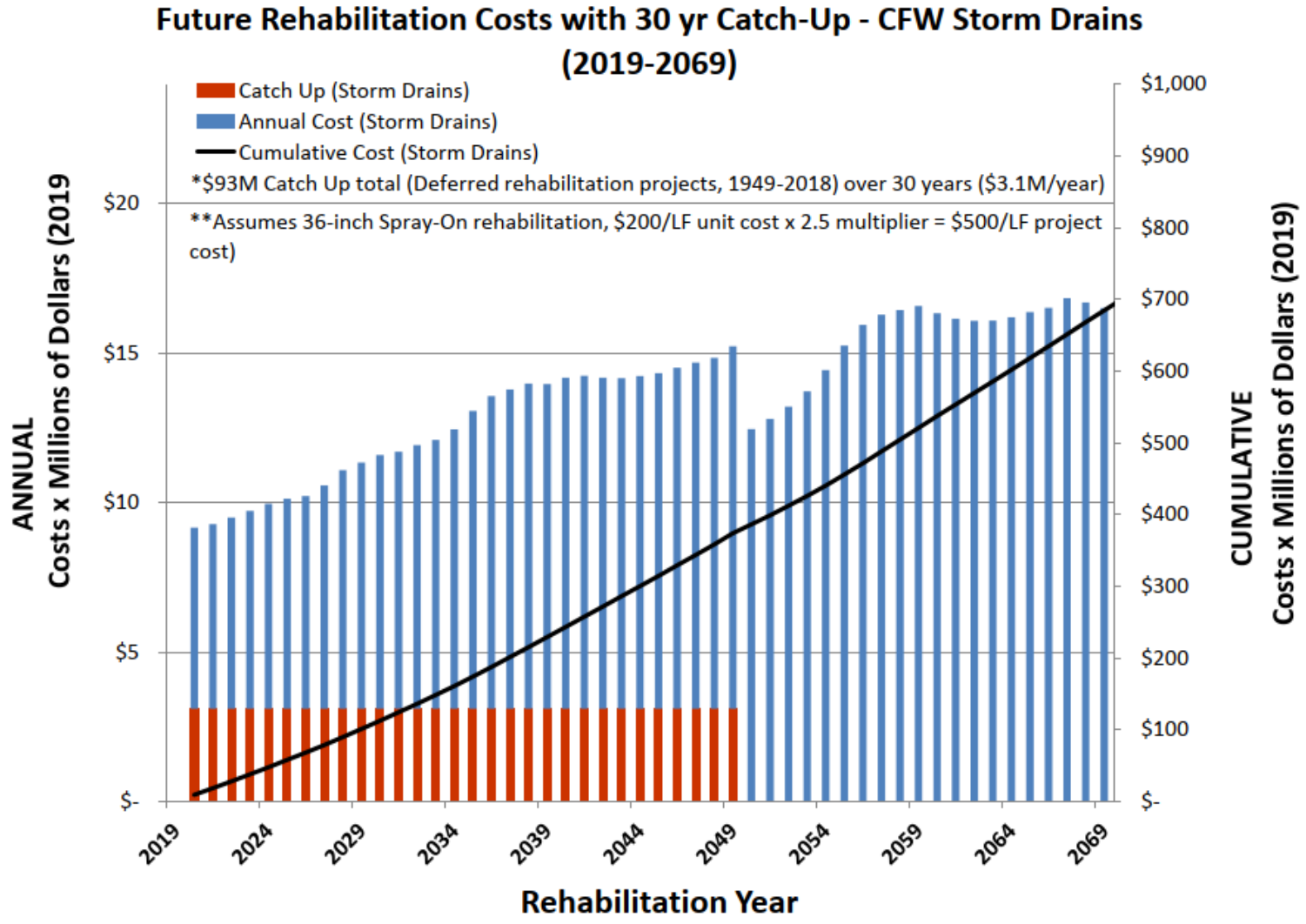
Basin	Area_SQMI	Area_Acres	RankBRE	RankInspect	Basin_Rank_Comment	Inspect_YR	HighRisk_LF	Total_LF	HR_Pct	EditDate	Equity	Council District
A	6.88	4,400	28	1	Prioritized as first Basin - fewer access issues	FY20	3,390	25,857	13	2019-10-14	1	2
B	0.77	492	3	2	Prioritized as an initial Basin - Apr 2020 project	FY20	10,613	36,614	29	2019-10-14	1	2
C	0.97	618	1	3	BRE rank	FY20	17,360	34,534	50	2019-10-14	1	3
D	0.59	379	2	4	BRE rank	FY21	13,118	36,058	36	2019-10-14	1	4
E	1.2	769	4	5	BRE rank	FY21	8,928	26,875	33	2019-10-14	1	7
F	1.31	839	5	6	BRE rank	FY21	8,881	34,995	25	2019-10-14	1	8
G	6.42	4,109	6	7	BRE rank	FY22	7,736	75,091	10	2019-10-14	1	8
H	1.24	796	7	8	BRE rank	FY22	7,205	33,254	22	2019-10-14	1	9
I	0.91	580	8	9	BRE rank	FY22	6,706	27,338	25	2019-10-14	1	1
J	0.74	471	9	10	BRE rank	FY22	6,701	20,699	32	2019-10-14	1	2

Utility conflict – prioritization table

Pipe ID	Code	Observation Text	Remarks	Score	Utility Location	Percent Intruding	Structural Issue	Separation Recommended	Ranking
SWGM024814	OBI	Obstacle Intruding Thru Wall		8.0	low to middle	60	yes	yes	1
SWGM027068	OBP	Obstacle External Pipe or Cable		7.0	low	10	yes	yes	2
SWGM026667	OBP	Obstacle External Pipe or Cable	EXTERNAL UTILITY PIPE AT MANHOLE	7.0	middle	50	yes	yes	3
SWGM026576	OBP	Obstacle External Pipe or Cable	EXTERNAL UTILITY LINE AT MANHOLE	7.0	middle	50	yes	yes	4
SWGM004045	OBI	Obstacle Intruding Thru Wall	UTILITY BORING LINE	5.3	high	40	yes	yes	5
SWGM000265	MGO	General Observation	LINE INSTALLED THROUGH STORM PIPE	5.3	middle to high	20	yes	yes	6
SWGM018534	OBP	Obstacle External Pipe or Cable	CONDUIT RUNNING THROUGH PIPE	4.7	low	20	no	yes	7
SWGM009259	OBP	Obstacle External Pipe or Cable		4.3	top	10	yes	yes	8
SWGM004047	OBI	Obstacle Intruding Thru Wall	UTILITY PIPE	4.3	high	10	yes	no	9
SWGM022445	OBI	Obstacle Intruding Thru Wall	UTILITY LINE	4.3	low to middle	30	no	yes	10

LONG-TERM

BUDGET



CORRECTIVE ACTION

- Prioritize critical storm drain pipes

  Severity per CCTV x Consequence of failure = "Business Risk Exposure" (BRE)
- Select corrective action - rehab methods matrix*(trenchless preferred)
- Best-value rehabilitation bidder ranking and selection; work order basis
- RFP advertised summer 2019; first work orders in FY20

Methods Matrix					
Spray-on (EPOXY)	**Spray-on (CEMENTITIOUS)**	**CIPP**	**Slip-lining**	**Pipe bursting**	**Spiral-wound**
A spray-on or hand troweled lining (epoxy) is applied to a cleaned and dried existing pipe crack, joint or wall.	A spray-on lining (cementitous) is applied to a cleaned and dried existing pipe wall.	An impregnated liner is inserted inside of an existing pipe and cured with water or steam.	A new pipe is inserted inside of the existing pipe and grouted for structural support.	New pipe is inserted while bursting or splitting the existing pipe.	Above ground spool feeds PVC profile to the winding machine, which forms the new pipe by spirally interlocking

**LA Tech TAG-R, NASSCO, Najafi, et al research text*

STORM DRAIN REHABILITATION

LESSONS LEARNED

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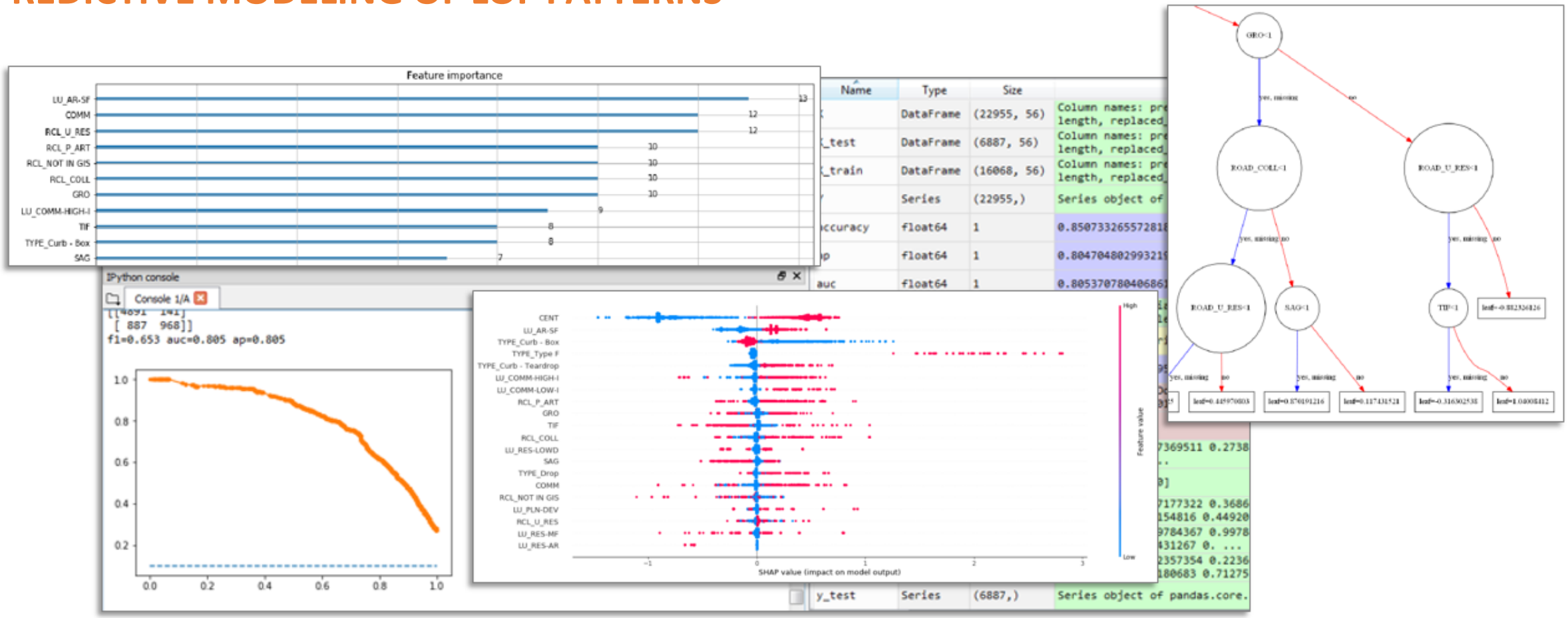
LESSONS LEARNED

- 1. Strategic planning
- 2. Stakeholder priorities
- 3. Measure success
- 4. Get started with what you have!
- 5. Storms vs sanitary sewers
- 6. Condition assessment – don’t need all assets to start
- 7. Prioritization - risk and “constructability”
- 8. Collect the “right” data today for evaluation tomorrow

PREDICTIVE MODELING OF LOF PATTERNS



THANK YOU

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