



Pipe**AId**[™]

Cost savings on an Accelerated Schedule Utilizing AI

May 3, 2024

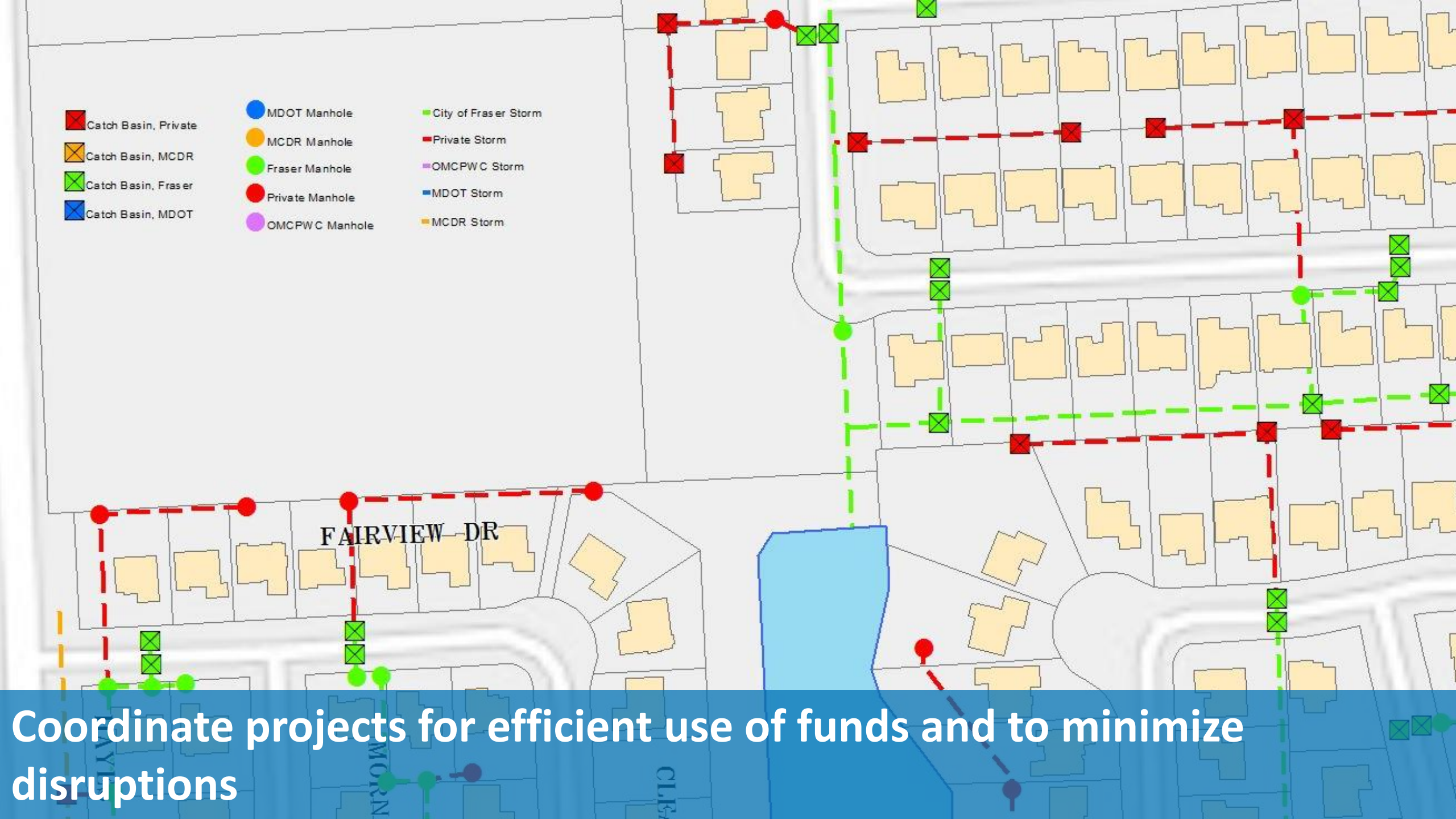
Why Do We Need Pipe Inspections?

- Sewer networks represent the least visible, most expensive asset a city owns
- Maintain
 - Provide high level of service to customers
- Maximize useful life
- Prevent failures



- | | | |
|--|---|--|
|  Catch Basin, Private |  MDOT Manhole |  City of Fraser Storm |
|  Catch Basin, MCDR |  MCDR Manhole |  Private Storm |
|  Catch Basin, Fraser |  Fraser Manhole |  OMCPWC Storm |
|  Catch Basin, MDOT |  Private Manhole |  MDOT Storm |
| |  OMCPWC Manhole |  MCDR Storm |

Coordinate projects for efficient use of funds and to minimize disruptions





Emergency Repairs

Current Sewer Inspection Issues



Human Element

- 2-year veteran vs 20-year veteran
- Subjectivity
 - 2 people code same line differently
- Misidentified, missed and continuous codes



Time

- Field
- Office



Current Sewer Inspection Issues - Time

- Time to clean and inspect
 - 300' pipe segment
 - Inspected at 30 fpm
 - 10 min (no coding)
- Typically 20+ minutes



Current Sewer Inspection Issues - Time

- Beneficial for camera to follow jet head
 - More efficient
 - Cleaning
 - Root/Deposit Cutting
 - Better coordination between vector
 - Pulling water level down
- Time in the Office
 - QA/QC
 - Review at 2x or 3x speed



The Solution?

PipeAid™



A Tool for Efficiency

- AI doesn't replace our engineers, it supplements them
- Unbiased tool to reduce error
- Tool for efficiency
- Uses Machine Learning algorithms paired with Computer Vision that detects and classifies sewer defects



A Tool for Efficiency

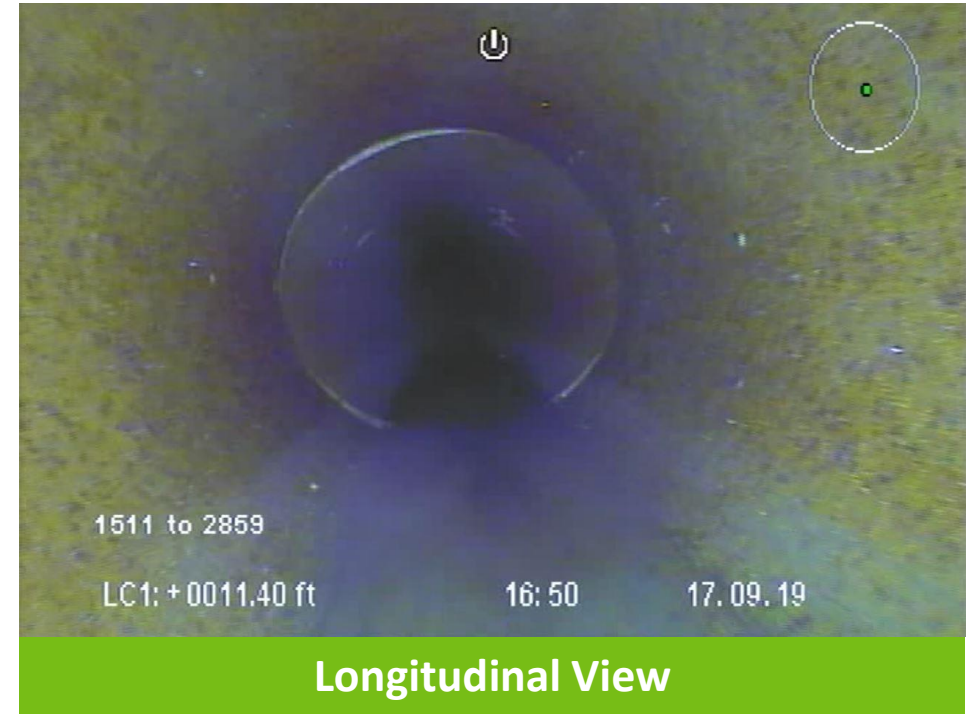


Thousands of photos for each data set increases AI accuracy

Material | Cleaning Equipment | Conditions | Pipe vs. Manhole | Size | Jet Head



PipeAid



PipeAid

Benefits of Two Models



Mimics
current
process



No training
required



Utilize existing
data and
equipment



More
detailed
analysis

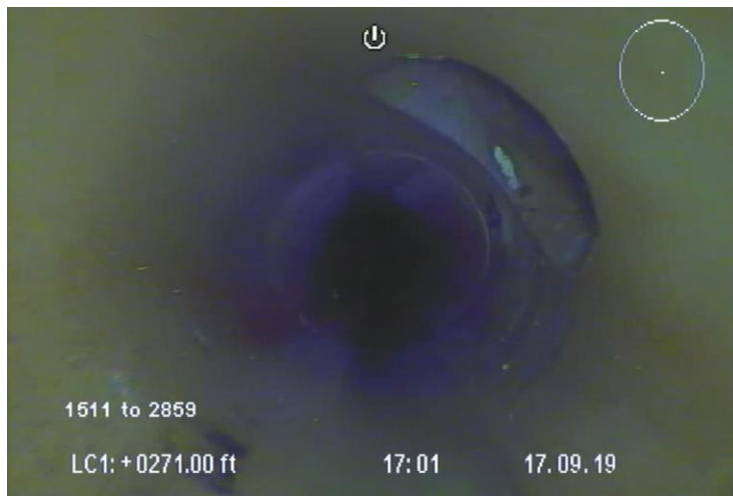


Less likely
to miss a
defect



Detailed Analysis with Two Models

■ Taps



Detailed Analysis with Two Models

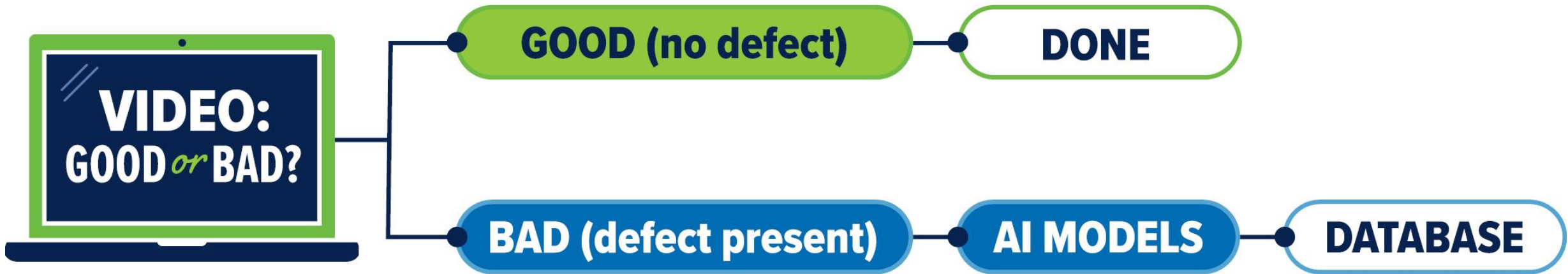
- Breaks & Holes



* Sewer Inspection Need 📍 Sewer Inspection Origin ! Current Issues 🌀 PipeAid ✓ PipeAid Applications 💬 Q&A

Workflow

— PipeAid™ WORKFLOW —



AI Model Capabilities

- Targets defects that lead to failure:



Backups



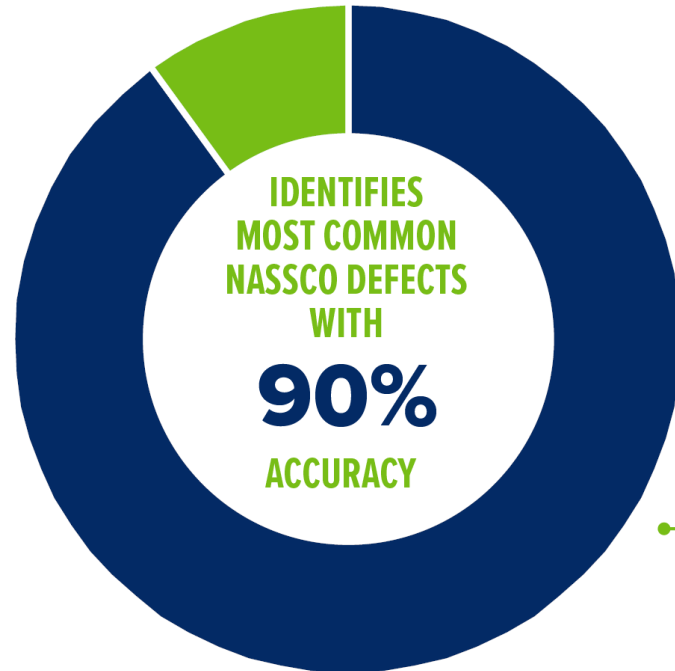
Overflows



Collapse



AI Model Capabilities



→ **Structural:** Cracks, Fractures, Holes, Breaks

→ **O&M:** Roots, Deposits

→ **Construction Features:** Taps



Code Not Recognized

- When a more obscure “non-learned” defect is observed, it is flagged for a NASSCO-certified engineering to code and the software to learn.



Digital Twin

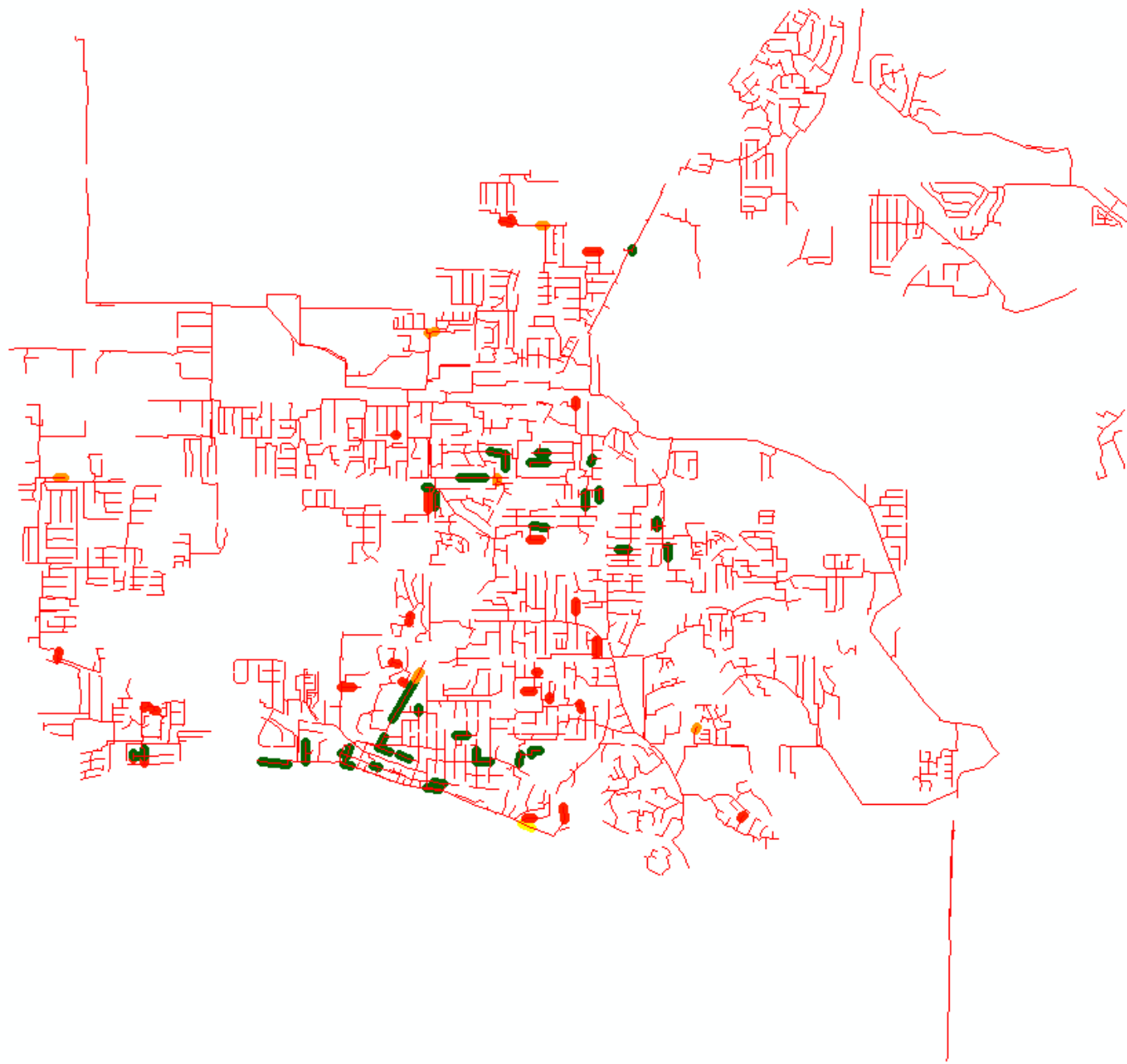


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- Layers
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- Manhole
- Export_Output
- Gravity_Routes_layer
- Gravity_Routes_layer
- Gravity_Routes_layer
- Gravity_Routes_layer
 - Material
 - Ductile Iron Pipe
 - Polyvinyl Chloride
 - Reinforced Plastic Pipe (Truss Pipe)
 - Vitrified Clay Pipe
- Basemap
 - World Imagery
- Basemap
 - World Street Map

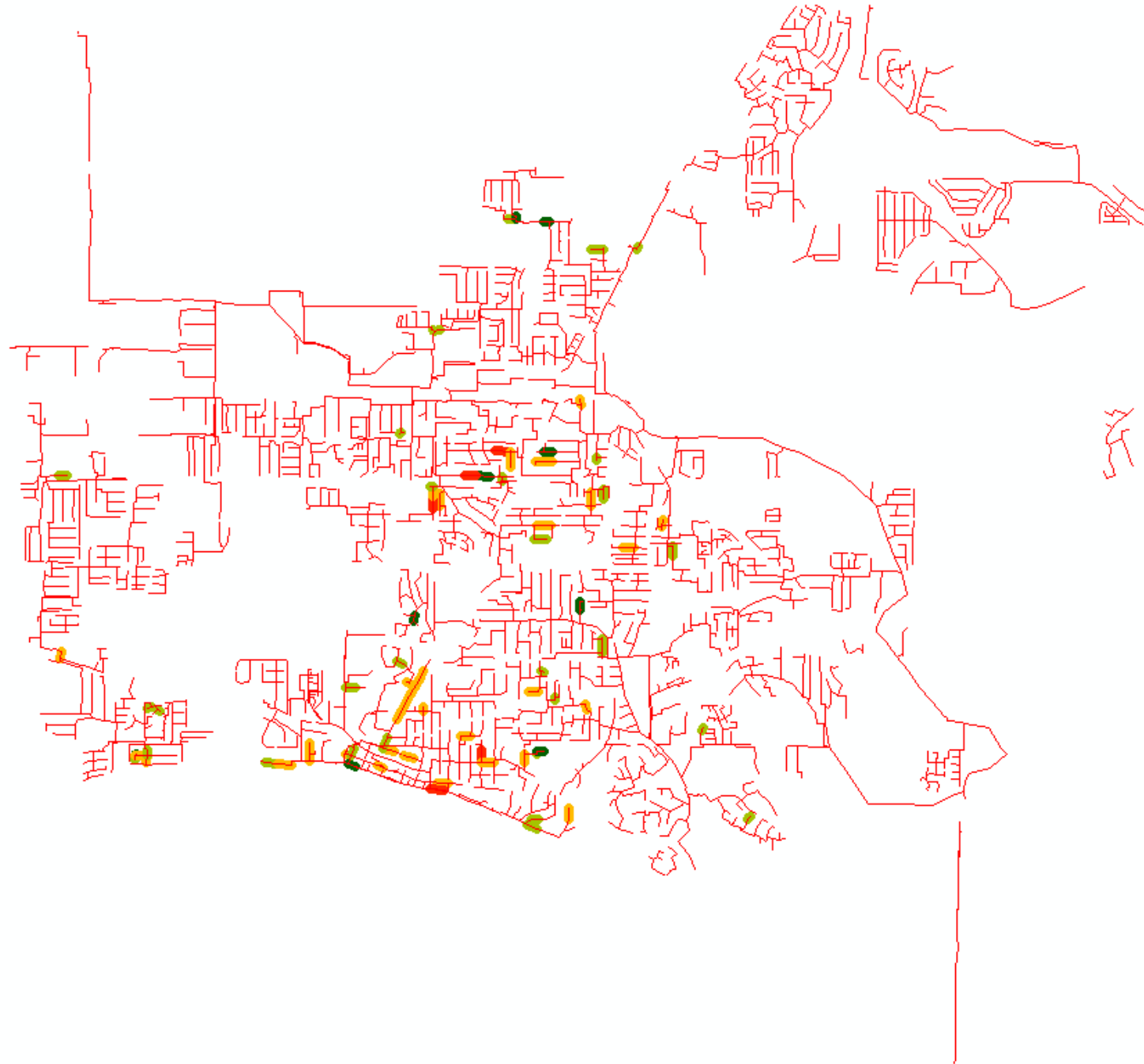


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 Gravity_Routes_layer
 Gravity_Routes_layer

DIA

- 6
- 8
- 10
- 12
- 15

Gravity_Routes_layer
 Basemap
 Basemap

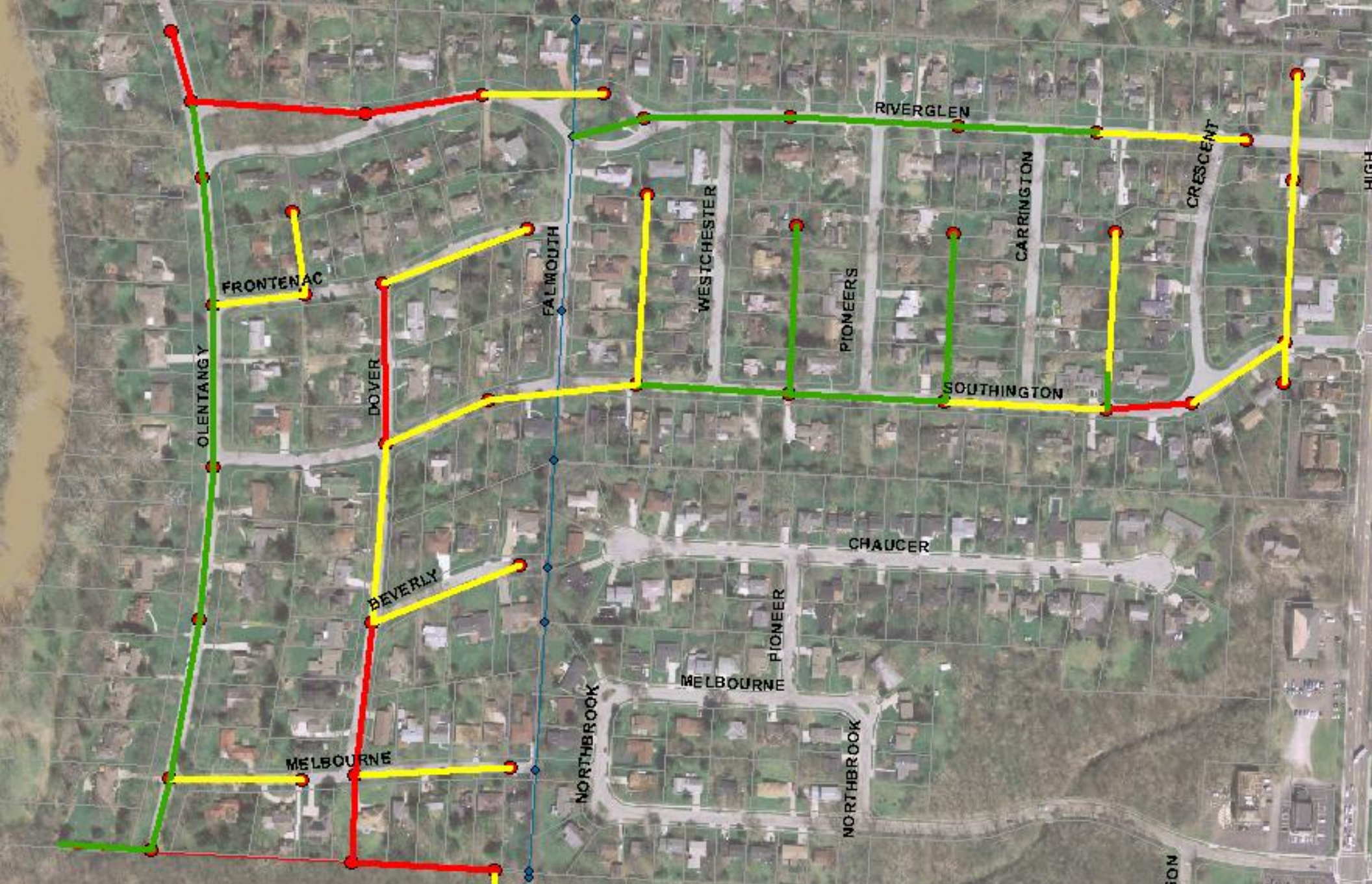


Layers

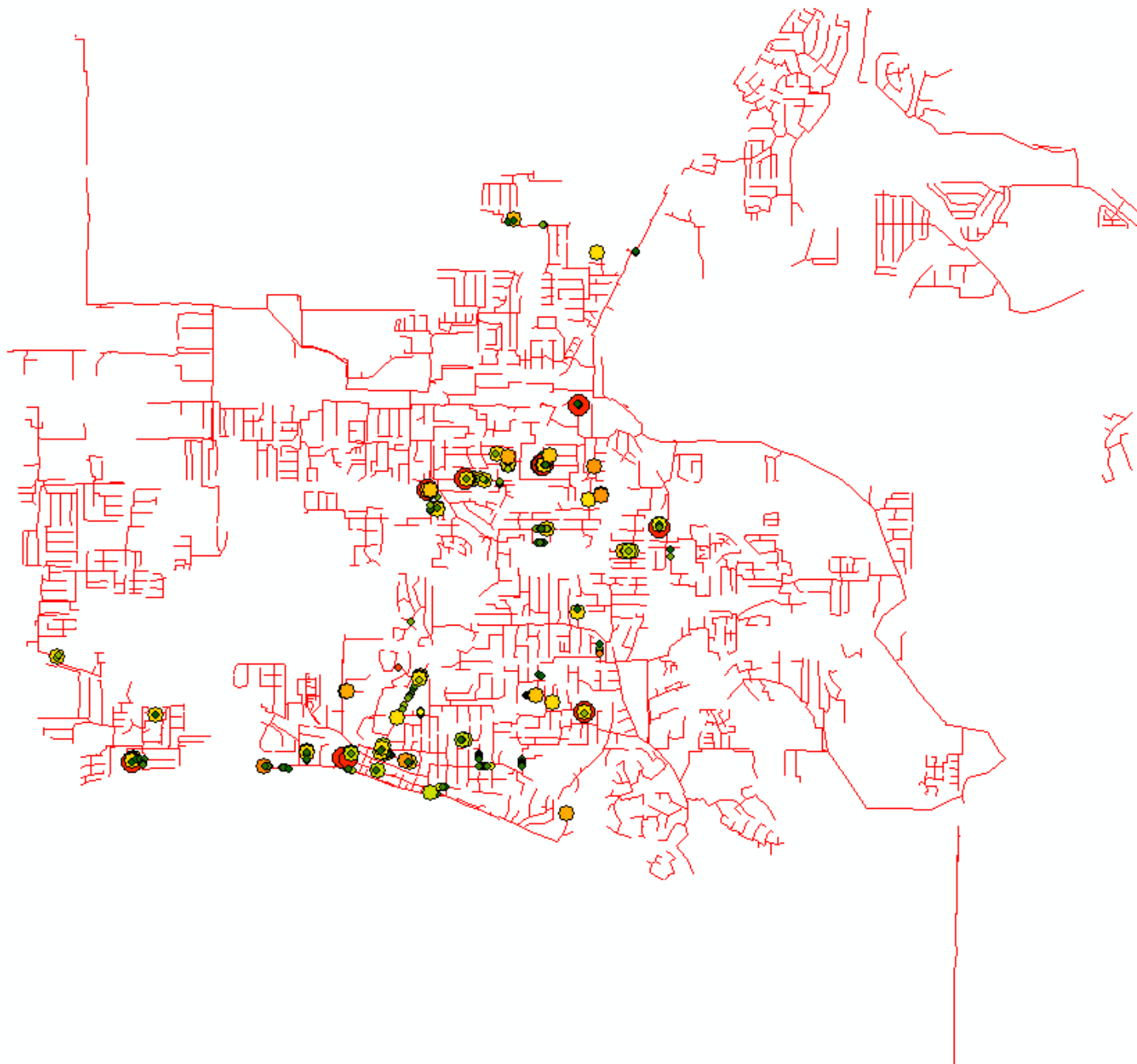
- Not Used
- Defects
 - I/I
 - Roots
 - Deposits
 - Break
 - Cracks
 - Fractures
 - Taps
- O&M Condition
 - OM_Condition
 - Fair
 - Good
 - Poor
- Structural Condition
- Sanitary MH_Worthington
- Sanitary Sewer_Worthington
- Manholes Inspected
- Sanitary Manhole_Riverlea
- Sanitary Sewer_Inspected
- Sanitary Sewer_Riverlea
- PumpStation
- Recommendations
- General



O&M Condition



- Layers**
- Not Used
 - Defects
 - I/I
 - Roots
 - Deposits
 - Break
 - Cracks
 - Fractures
 - Taps
 - O&M Condition
 - Structural Condition
 - Structural_Condition
 - Fair
 - Good
 - Poor
 - Sanitary MH_Worthington
 - Sanitary Sewer_Worthington
 - Manholes Inspected
 - Sanitary Manhole_Riverlea
 - Sanitary Sewer_Inspected
 - Sanitary Sewer_Riverlea
 - PumpStation
 - Recommendations
 - General



- Structural
 - Code_Resul
 - ◆ CC
 - ◆ CL
 - ◆ CS
 - ◆ CM
 - ◆ FC
 - ◆ FL
 - ◆ FS
 - ◆ FM
 - ◆ FH2
 - ◆ FH4
 - ◆ B
 - ◆ BSV
 - ◆ H
 - ◆ HSV
 - ◆ D
 - ◆ DR
 - ◆ DFBR
 - ◆ X
- Roots
 - Code_Resul
 - ◆ RFJ
 - ◆ RFC
 - ◆ RTD
 - ◆ RMJ
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 - ◆ RBJ
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 - Code_Resul, Grade
 - ◆ DAE, 2
 - ◆ DAGS, 2
 - ◆ DAZ, 2
 - ◆ DAGS, 3
 - ◆ DAZ, 3
- I/I
 - Code_Resul
 - ◆ IS
 - ◆ IW
 - ◆ ID
 - ◆ IR
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 - Code_Resul, Grade
 - ◆ MWLS, 2
 - ◆ MWLS, 3
 - ◆ MWLS, 4
 - ◆ MWLS, 5
 - ◆ MWLS, 6

Pop-up

- Fracture (1)
 - District6-AMH6-117-AMH6-116-Coventry_frame0134.jpg

Pop-up

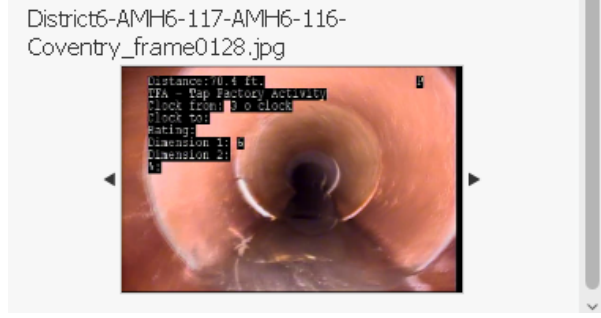
- Fracture (1)
 - District6-AMH6-117-AMH6-116-Coventry_frame0134.jpg

Fracture - District6-AMH6-117-AMH6-116-Coventry_fra...

Clock Postion End	11
Percentage	
Remarks	
Group	4
StartFinish	
Dimension1	
Dimension2	
Distance	72.8
Joint	1
Upstream MH	6-117
Downstream MH	6-116
Direction	Downstream
Height	8
Width	8
Material	Vitrified Clay Pipe
GlobalID	{E91E9CC9-476C-45F8-9730-4D37AA5A8E75}

Fracture - District6-AMH6-117-AMH6-116-Coventry_fra...

Clock Postion End	11
Percentage	
Remarks	
Group	4
StartFinish	
Dimension1	
Dimension2	
Distance	72.8
Joint	1
Upstream MH	6-117
Downstream MH	6-116
Direction	Downstream
Height	8
Width	8
Material	Vitrified Clay Pipe
GlobalID	{E91E9CC9-476C-45F8-9730-4D37AA5A8E75}



Contents

Search

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- FC,2
- FH2,3
- FL,3
- FS,3
- FH3,4
- FH4,4
- FM,4
- Break/Hole
 - Code Result,Grade
 - B,4
 - BSV,5
 - HSV,5
 - HVV,5
- Structural
 - Code Result,Grade
 - JOM,3
 - JSM,3
 - JOL,4
 - JSL,4
- Structural Condition
 - Str_Grade
 - 1
 - 2
 - 3
- O&M
- Taps
 - Code Result
 - TB
 - TF
 - TBD
 - TBI
 - TFD
 - TFC
- Miscellaneous
- MSA




Pop-up

- DAE (1)
 - District1-AMH1-1-AMH1-ALLEY1-Wyandotte_frame0134.jpg

DAE - District1-AMH1-1-AMH1-ALLEY1-Wyandotte_fram...

Start	
Clock Postion End	5
Percentage	30
Remarks	
Group	
StartFinish	
Dimension1	
Dimension2	
Distance	82.8
Joint	1
Upstream MH	1-1
Downstream MH	1-ALLEY1
Direction	Downstream
Height	8
Width	8
Material	Vitrified Clay Pipe
GlobalID	{B8E6C2A8-6F5F-4B36-8FD8-83908E90AAEC}

District1-AMH1-1-AMH1-ALLEY1-Wyandotte_frame0134.jpg

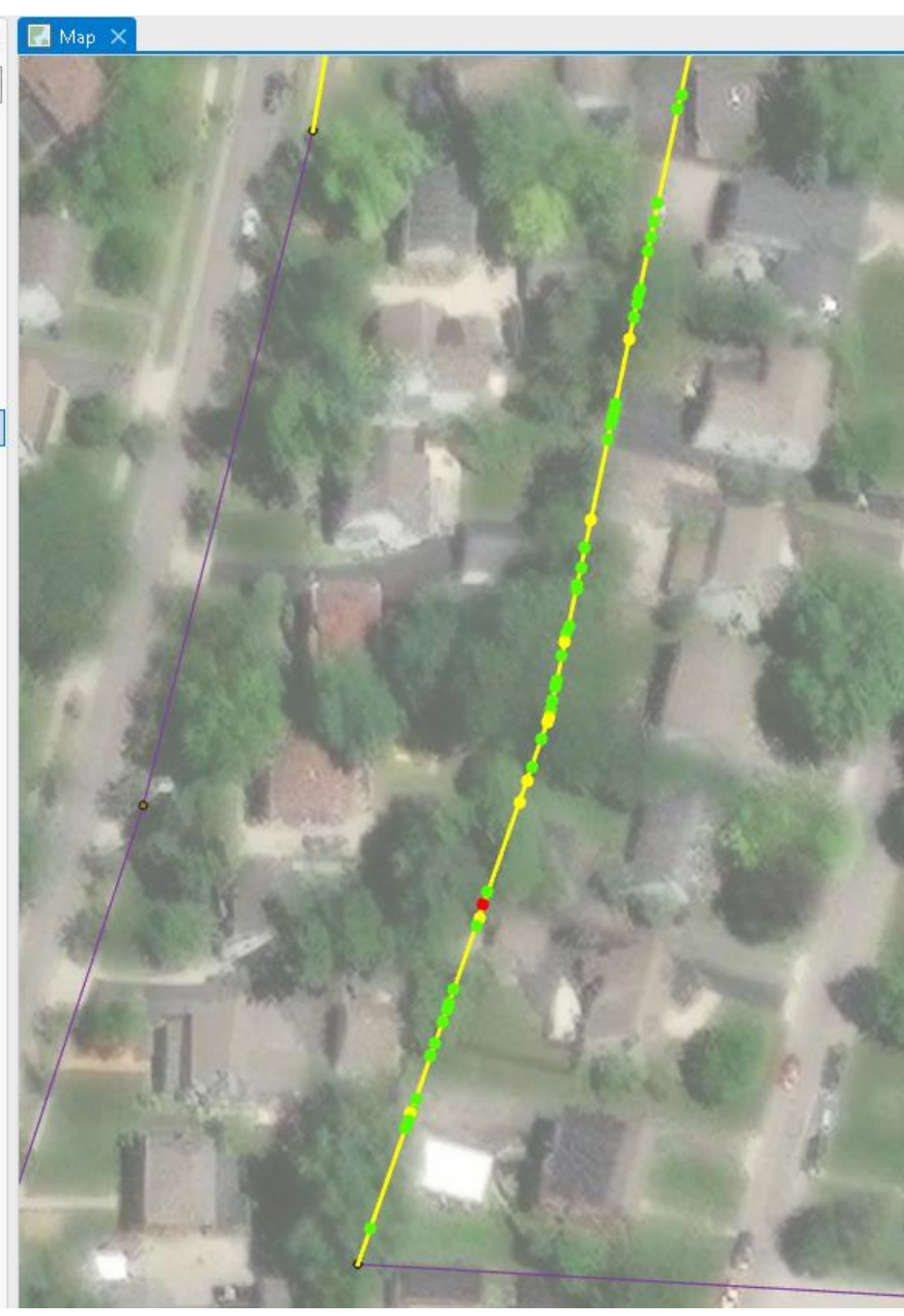


Contents

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 - DAE
 - Code Result, Grade
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 - DAE,3
 - DAE,4
 - DAE,5
 - DAGS
 - DEPOSIT_OTHER
 - Inspections_GIS
 - Taps
 - Miscellaneous
 - MSA
 - Detections_GIS2
 - Material
 - Size
 - SanitaryLateral
 - Inspections_GIS2
 - SanitaryManhole
 - SanitarySewer
 - World Imagery
 - Standalone Tables



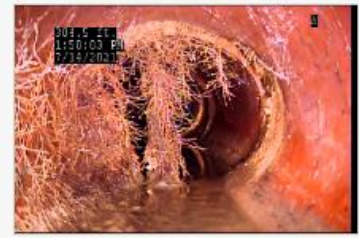
Pop-up

- Roots (1)
 - District6-AMH6-STUB69-AMH6-69-_frame0338.jpg

Roots - District6-AMH6-STUB69-AMH6-69-_frame0338.jpg

Clock Postion Start	6
Clock Postion End	3
Percentage	
Remarks	
Group	
StartFinish	
Dimension1	
Dimension2	
Distance	304.5
Joint	1
Upstream MH	6-STUB69
Downstream MH	6-69
Direction	Upstream
Height	8
Width	8
Material	Vitrified Clay Pipe
GlobalID	{574E70A1-5A64-4F7E-9A7E-65A1927B5195}

District6-AMH6-STUB69-AMH6-69-_frame0338.jpg



Contents

Search

Drawing Order

- Map
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 - Code Result
 - RFC - 1
 - RFJ - 1
 - RMJ - 3
 - RMC - 3
 - RD - 2
 - RBJ - 4
 - DAE
 - DAGS
 - DEPOSIT_OTHER
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 - Detections_GIS2
 - Material
 - Size
 - SanitaryLateral
 - Inspections_GIS2
 - SanitaryManhole
 - SanitarySewer
 - World Imagery
 - Standalone Tables



Start	
Clock Postion End	3
Percentage	
Remarks	
Group	2
StartFinish	
Dimension1	
Dimension2	
Distance	27
Joint	0
Upstream MH	6-118
Downstream MH	6-117
Direction	Upstream
Height	8
Width	8
Material	Vitrified Clay Pipe
GlobalID	{81319474-091E-491D-98D2-72595B2121A6}

District6-AMH6-118-AMH6-117-Coventry_1_frame0072.jpg



1 of 1 | 1,812,267.15E 727,977.76N ftUS

Start	
Clock Postion End	3
Percentage	
Remarks	
Group	2
StartFinish	
Dimension1	
Dimension2	
Distance	27
Joint	0
Upstream MH	6-118
Downstream MH	6-117
Direction	Upstream
Height	8
Width	8
Material	Vitrified Clay Pipe
GlobalID	{81319474-091E-491D-98D2-72595B2121A6}

District6-AMH6-118-AMH6-117-Coventry_1_frame0087.jpg



Contents

Search

Drawing Order

- Map
 - Structural
 - O&M
 - Taps
 - Code Result
 - TB
 - TF
 - TBD
 - TBI
 - TFD
 - TFC
 - Miscellaneous
 - MSA
 - Detections_GIS2
 - Material
 - Size
 - SanitaryLateral
 - Inspections_GIS2
 - SanitaryManhole
 - SanitarySewer
 - World Imagery
 - Standalone Tables




Pop-up

- MSA (1)
 - District1-AMH1-32-AMH1-25-Ashland_2_frame0389.jpg

MSA - District1-AMH1-32-AMH1-25-Ashland_2_frame0389...

Start	
Clock Position	
End	
Percentage	
Remarks	CAMERA FLIPPED
Group	
StartFinish	
Dimension1	
Dimension2	
Distance	250
Joint	0
Upstream MH	1-32
Downstream MH	1-25
Direction	Downstream
Height	8
Width	8
Material	Other
GlobalID	{1FFB2DD5-7E03-471B-86DD-44423597E620}

District1-AMH1-32-AMH1-25-Ashland_2_frame0389.jpg



Distance: 250.0 ft.
 MSA - Miscellaneous Survey Abandoned
 Clock from:
 Clock to:
 Setting:
 Dimension 1:
 Dimension 2:
 1:
 Camera Flipped



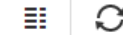
PipeAid

Portal

Welcome, test@burgessniple.com. [Sign out](#)

Files (Archive)

[exit archive storage](#)



Files	Files	G-MH3-32-104-MH3-32-103/		
	<input type="checkbox"/>	Name	Date Modified	File Size
		..	1/16/2023	
		3-32-104-103Pre-Video_2021_08_05.mp4	12/13/2022	41.3 MB

Video Hosting

- Online Portal
 - Hyperlinked Videos Open in Web Browser for Viewing



How is PipeAId Applied?

Village Cleaning and Televising Project

- 114,000' of pipe
 - 8" to 36"
- Traditional Cleaning and Inspection
 - Central Ohio Area Average \$4/ft to \$8/ft
 - \$500,000+
- Phase out over two years



Cleaning and Televising Project

- Lower Cost and Reduce Time
- Contractor
 - Light Cleaning
 - Capture Video
 - Document Header Data
 - Look up laterals
 - Sufficiently document severe structural defects
- PipeAid
 - PACP Coding
 - Digital Twin



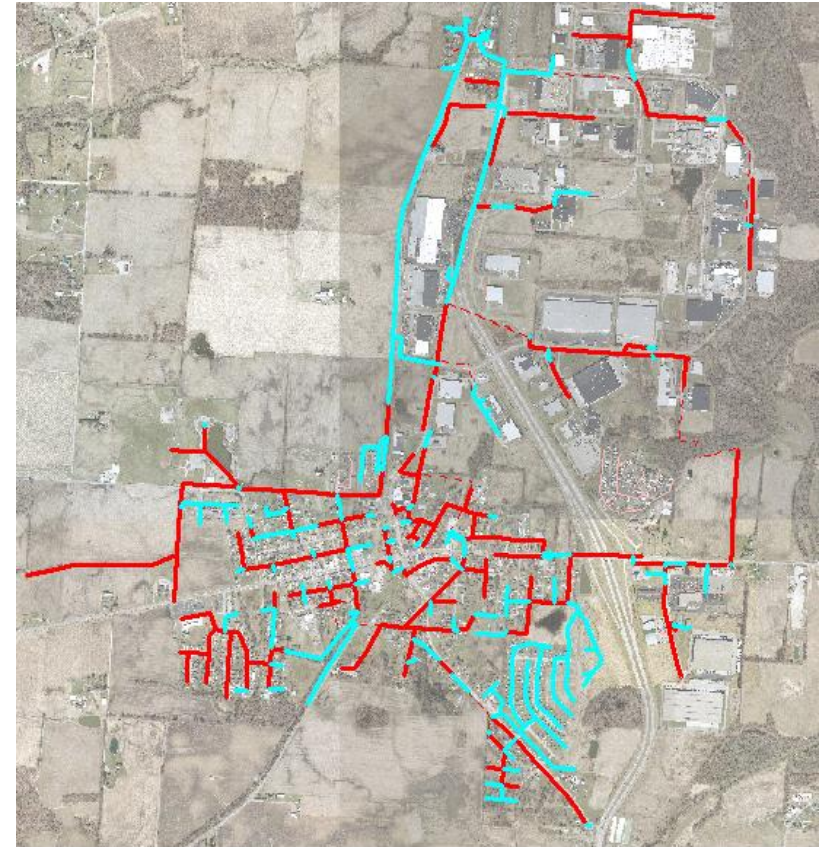
Cleaning and Televising Bid Prices

- Contractor 1 - \$1.54/ft to \$1.89/ft
- Contractor 2 - \$1.60/ft to \$5.97/ft
- Contractor 3 - \$1.76/ft to \$4.00/ft
- Contractor 4 - \$2.00/ft to \$3.00/ft
- Contractor 5 - \$3.00/ft - \$5.50/ft
- Contractor 6 - \$3.25/ft - \$7.00/ft
- Contractor 7 - \$4.50/ft to \$5.50/ft



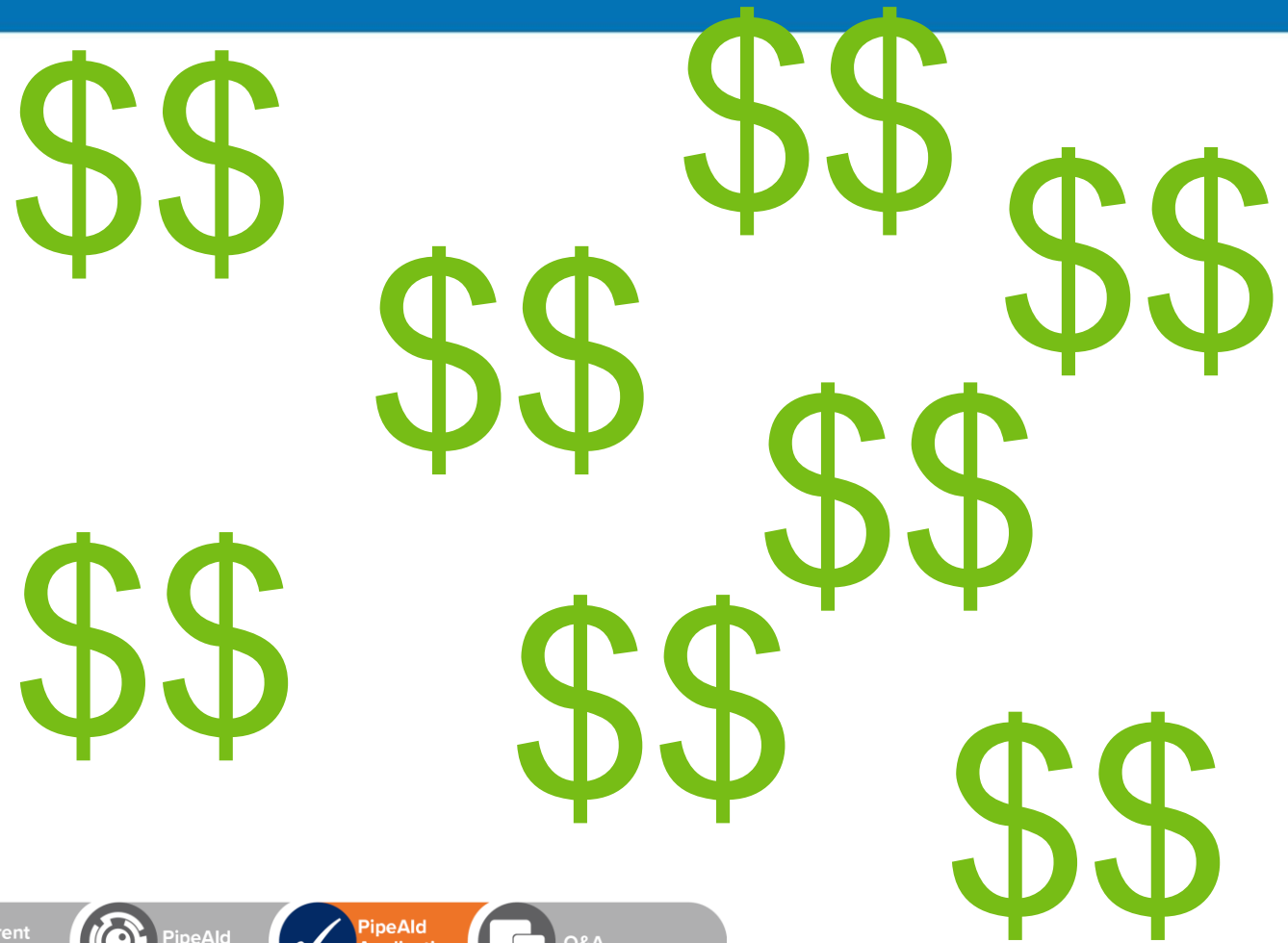
Production Rates

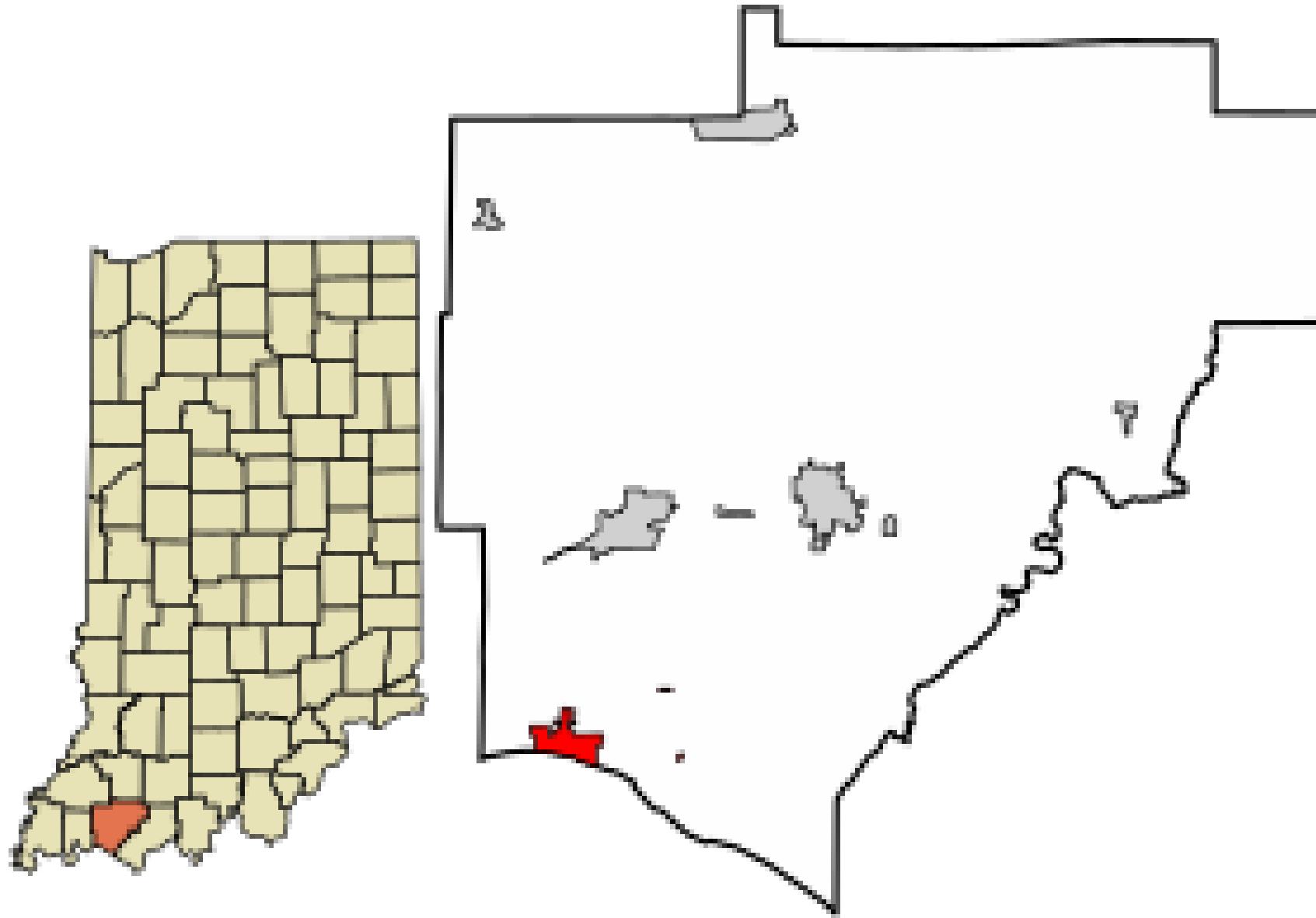
- Estimate production rate of 1,000 ft/day to 1,500 ft/day
- Contractor is hitting 3,000 ft/day



Cleaning and Televising Project

- Contractor 7 ~ \$500,000
- Contractor 1 ~ \$200,000
- PipeAid added
 - \$0.25/ft for coding
 - \$0.10/ft digital twin
 - Total cost just under \$50,000
- Cost savings \$250,000
- Completed this year





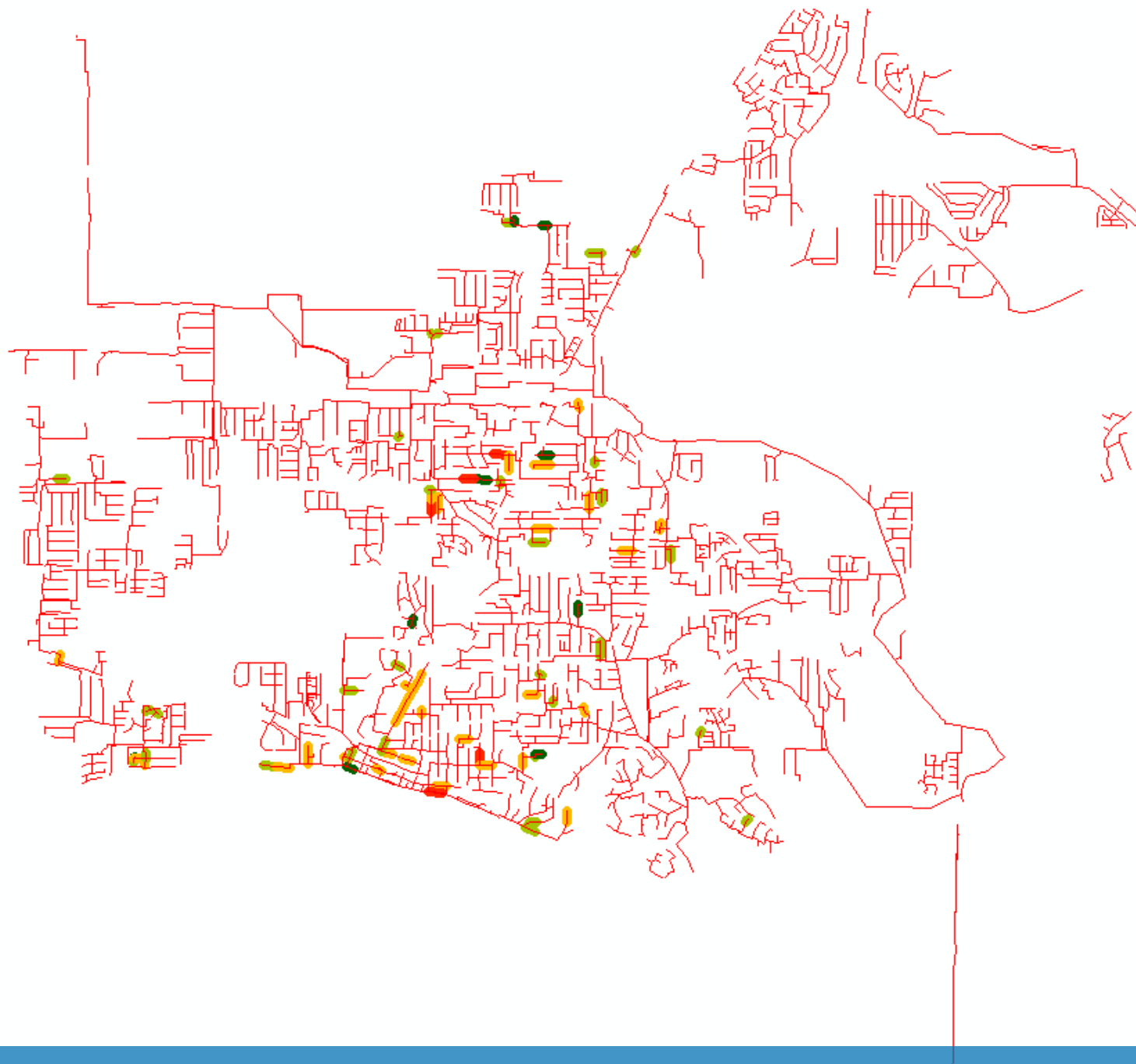


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 Gravity_Routes_layer
 Deterioration
 better
 same
 worse
 worse*
 Gravity_Routes_layer
 Gravity_Routes_layer
 Basemap
 Basemap

Segment Reference	O&M Pipe Rating	O&M Pipe Rating Index	O&M Quick Rating	Structural Pipe Rating	Structural Pipe Rating Index	Structural Quick Rating	Overall Pipe Rating	Overall Pipe Rating Index	Overall Quick Rating	Deterioration
L01-01CO	7	2.3	3211	2	2	2100	9	2.3	3221	better
L01-01CO	6	3	3200	-	-	-	6	3	3200	
L01-02CO	9	2.3	4131	-	-	-	9	2.3	4131	same
L01-02CO	9	1.8	3213	-	-	-	9	1.8	3213	
L01-13	3	1	1300	2	2	2100	7	1.4	2213	worse
L01-13	2	1	1200	7	2.3	3122	11	1.8	3123	
L01-18				5	2.5	3121	5	2.5	3121	same
L01-18	-	-	-	5	2.5	3121	5	2.5	3121	
L01-19	1	1	1100	-	0	-	1	1	1100	worse
L01-19	3	1	1300	12	2.4	3223	15	1.9	3223	
L02-02CO	8	2.7	4131	-	-	-	13	2.6	4132	same
L02-02CO	-	-	-	-	-	-	-	-	-	
L02-Stub7	4	2	3111	-	-	-	4	2	3111	same
L02-Stub7	-	-	-	-	-	-	-	-	-	
L02-32	32	2.1	412A	22	2.2	4129	61	2.2	422B	better
L02-32	7	2.3	3122	6	3	3200	13	2.6	3322	
L03-181	4	2	2200	-	-	-	4	2	2200	same
03-181	-	-	-	-	-	-	-	-	-	
L05-10	13	1	1A00	10	2.5	4123	27	1.4	4125	better
L05-10	9	1.3	3116	5	2.5	3121	24	1.7	3226	
L05-11	5	1	1500	3	1.5	2111	12	1.3	2316	better
L05-11	18	1.3	321A	-	-	-	20	1.3	3221	
L05-16	21	1.9	3516	7	2.3	3122	32	2	3624	worse
L05-16	33	2.4	4138	9	3	3300	48	2.4	413A	
L05-17	2	1	1200	9	3	4131	11	2.2	4131	better
L05-17	1	1	1100	2	2	2100	3	1.5	2111	
L05-29	10	2	2500	14	3.5	5141	28	2.5	5141	worse
L05-29	-	-	-	12	4	5141	21	3.5	5241	
L09-02	-	-	-	11	2.8	3321	17	2.4	3324	worse
L09-02	50	2.1	412C	5	2.5	3121	57	2.1	4131	
L09-111	21	1.8	4319	8	2.7	4122	29	1.9	4422	worse
L09-111	41	1.7	322A	20	2.9	4232	61	2	4234	
L09-122	4	4	4100	14	2.8	3421	22	2.8	4134	worse*
L09-122	13	1.9	2611	22	2.2	3326	51	2.3	4235	
L09-135	17	2.1	4131	10	2	2500	31	2.1	4131	worse
L09-135	6	1.5	2212	11	2.2	3124	23	1.9	3129	

Deterioration

Segment Reference	O&M Pipe Rating	O&M Pipe Rating Index	O&M Quick Rating	Structural Pipe Rating	Structural Pipe Rating Index	Structural Quick Rating	Overall Pipe Rating	Overall Pipe Rating Index	Overall Quick Rating	Deterioration
L09-16	-	-	-	10	2	2500	21	2.1	3129	worse
L09-16	35	2.1	312B	6	3	4121	47	2.1	4131	worse
L09-19	2	1	1200	7	3.5	4131	17	2.1	4131	same
L09-19	13	1.9	3314	7	3.5	4131	24	2.2	4134	same
L09-31	61	2	423A	6	2	3121	77	2	423A	worse
L09-31	28	1.4	341B	16	3.2	4232	56	1.8	4236	worse
L09-38	10	1.3	3117	22	2.4	4132	48	1.9	4133	worse
L09-38	26	1.4	3321	7	3.5	5121	45	1.7	5133	worse
L09-47	6	3	4121	17	3.4	4331	19	3.2	4331	same
L09-47	21	2.1	3129	17	3.4	4331	37	2.5	4332	same
L09-98W	50	2.3	4135	-	-	-	52	2.3	4135	worse
L09-98W	52	2.2	4133	2	2	2100	56	2.2	4133	worse
L09-99	-	-	-	6	3	3200	11	3.7	5132	worse*
L09-99	12	2	2600	10	2.5	4123	22	2.2	4129	worse*
L10-03CO	-	-	-	-	-	-	-	-	-	same
L10-03CO	-	-	-	-	-	-	-	-	-	same
L10-112	57	2.7	5143	9	4.5	5141	70	2.9	5245	same
L10-112	43	2.3	4133	9	4.5	5141	52	2.5	5142	same
L10-216	4	2	2200	9	4.5	5141	21	3.5	5143	better
L10-216	2	2	2100	-	-	-	2	2	2100	better
L10-239	1	1	1100	-	-	-	1	1	1100	worse
L10-239	21	1.6	2815	1	1	1100	26	1.6	2A16	worse
L10-51	-	-	-	-	-	-	2	2	2100	same
L10-51	2	2	2100	-	-	-	2	2	2100	same
L10-65	5	1.7	2211	5	2.5	4111	12	2	4123	worse
L10-65	-	-	-	2	2	2100	4	2	2200	worse
L10-65	1	1	1100	4	4	4100	7	2.3	4121	worse
L10-66	2	2	2100	4	2	2200	14	2	2700	worse
L10-66	-	-	-	-	-	-	9	3	4131	worse
L10-67	2	2	2100	2	2	2100	4	2	2200	worse
L10-67	-	-	-	8	2.7	3221	8	2.7	3221	worse
L10-68	-	-	-	30	3	5137	30	3	5137	worse
L10-68	2	2	2100	26	3.7	5143	30	3.3	5143	worse
L10-81	38	2.4	362A	5	2.5	3121	45	2.4	372A	worse
L10-81	52	2.5	4236	6	3	3200	60	2.5	4238	worse

Deterioration

What AI Does



Time Savings



Cost Savings



Reliable Dataset



Repeatable Results
(decay rate)



What the Digital Twin Does

- Leverage GIS infrastructure
 - Simplicity of use
 - No extra cost
- Every Day Tool & Easy To Understand
- More insight to your system
 - Managers
 - Field Staff
 - Residents/customers
- Coordinate Work



Next Steps With Digital Twin - Risk Analysis

- Likelihood of failure
 - Rate of Deterioration
 - PACP Score
 - Clock Position
 - Age
 - Material
 - Cohorts
 - Other
- Consequence/Criticality
 - Proximity to Critical Infrastructure
 - Depth
 - Size or Upstream Contribution
 - Hydraulic impacts
 - WIBs
 - SSOs
 - Other



Next Steps With Digital Twin- Root Cause Analysis

- Maintenance issues
 - Roots
 - FOG
 - I/I
- Installation issues
- Density of Utilities
- Pipe Material
- Depth
- Location/Proximity



Next Steps With Digital Twin - Predictive Maintenance

- Historic Inspection Data Comparison to Establish Rate of Deterioration
- Incorporating Additional Data to Establish Trends
- Incorporate Maintenance Data
- **Optimize timing of maintenance
 - Recommendations
 - Repair/Replace
 - Maintain
 - Regular Cleaning Intervals
 - FOG
 - Root



Questions? Booth 705



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