

# EXPEDITED SEWER REHABILITATION USING PROGRESSIVE DESIGN - BUILD

River Valley Highlands Sewer

June 26, 2019





Conditions in 2004



Conditions in 2004









Graph: Min, Avg, Max Elevation: 845, 864, 885 ft  
 Range Totals: Distance: 1.06 mi Elev Gain/Loss: 78.6 ft, -109 ft Max Slope: 14.7%, -25.9% Avg Slope: 3.1%, -3.1%



Google Earth

Imagery Date: 4/7/1994 39°44'43.51" N 82°38'18.31" W elev 845 ft eye alt 6771 ft

# Recurring Sewage in Basements

2661 Two Ridge	3/1/17	11/6/17
2664 Two Ridge	3/1/17	
2667 Two Ridge	3/1/17	11/6/17
2672 Two Ridge	3/1/17	
2678 Two Ridge		11/6/17
2679 Two Ridge	3/1/17	11/6/17
2684 Two Ridge	3/1/17	11/6/17
2685 Two Ridge		11/6/17
2695 Two Ridge	3/1/17	
1813 Far View	3/1/17	
2711 Fernwood	3/1/17	11/6/17
2715 Fernwood		11/6/17
2720 Fernwood	3/1/17	11/6/17
2776 Cross Creek		11/6/17





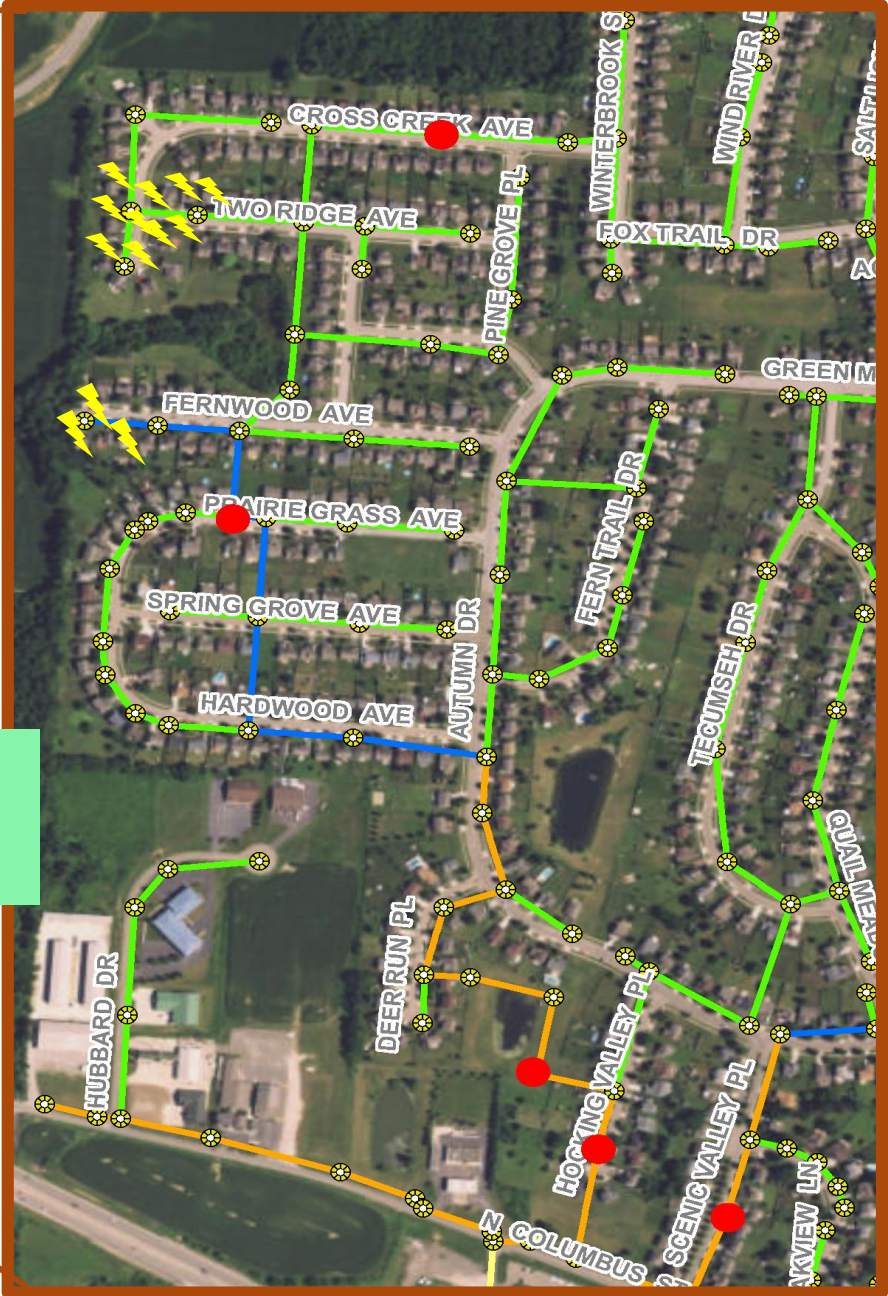


Conditions in 2004





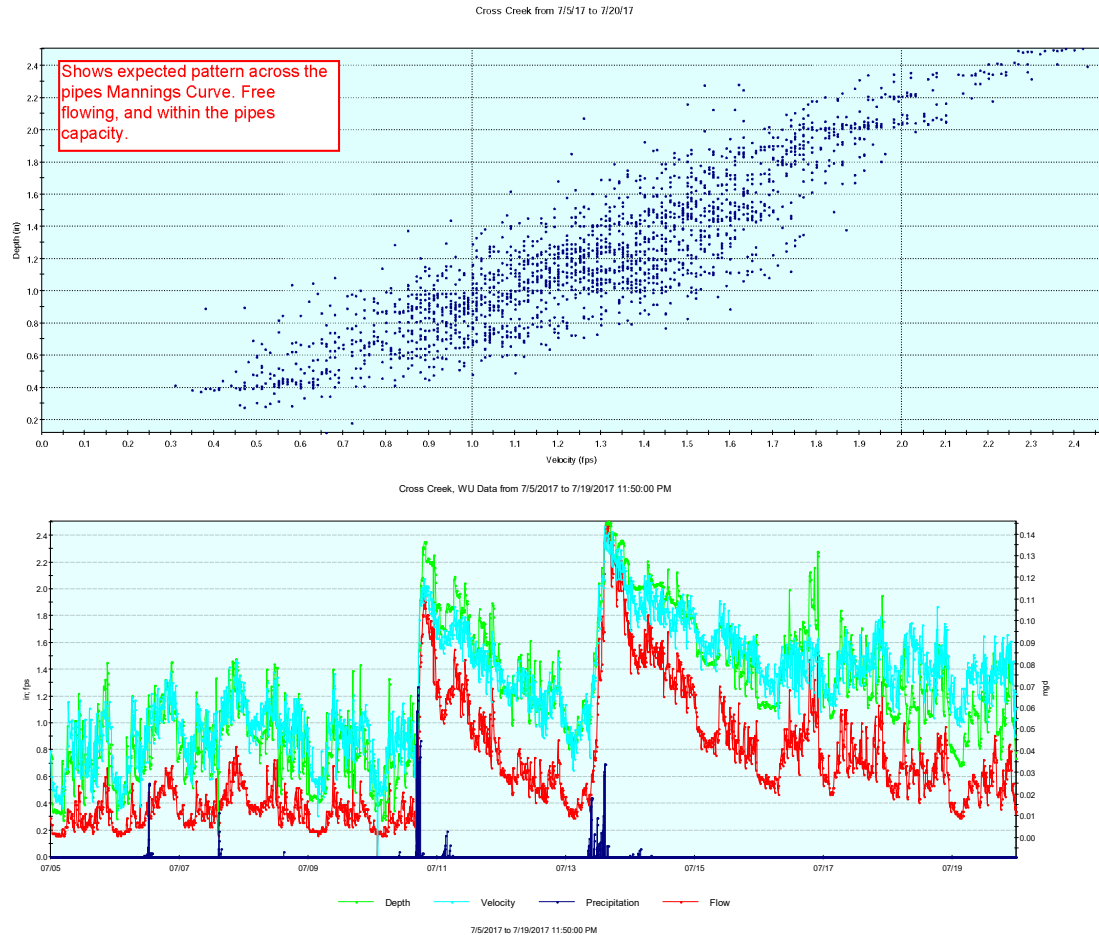
Conditions today



FILE: G:\Projects\06491079 - Lancaster MSA\GIS\River Valley Highlands Sewers.mxd

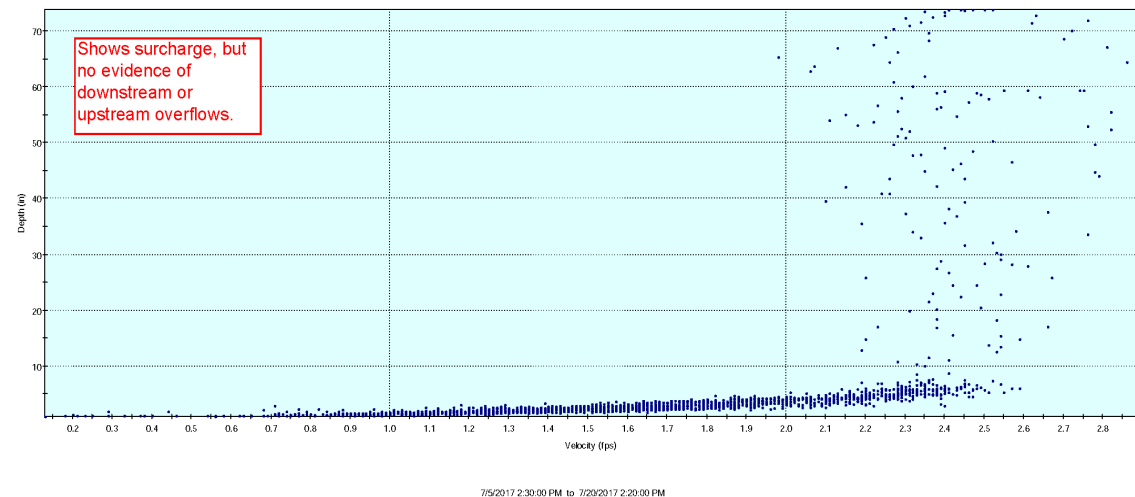
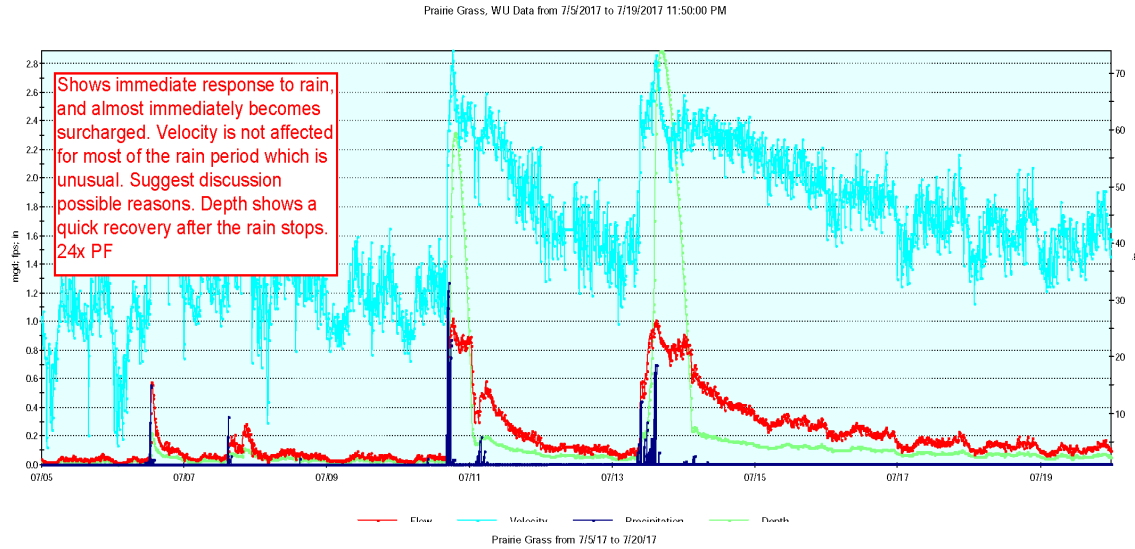


# Cross Creek Conclusions



- Extremely high levels of I&I (14X Peak on 2" rain)
- Days to recover to normal levels
  - Something is acting like French drain
  - Second storm impact was immediate and doubled
- No blockage or pipe restriction
- Some form of immediate leakage
  - Roof Drains
  - Sump Pumps
  - Ponded RII
  - RII

# Prairie Grass Conclusions



- Extraordinary levels of I&I (24X Peak on 2" rain)
- Days to recover to normal levels
  - Something is acting like French drain
  - Second storm impact was immediate and doubled
  - Old swales probably bad actors
- No downstream pipe restriction, just very high wet weather loading
- Some form of immediate leakage
  - Roof Drains
  - Sump Pumps
  - Ponded RII
  - RII



# Source Location Recommendations

---

# Smoke Test

- Ensure there are no roof or area drains
- Determine if there are any indirect cross connections between storm and sanitary pipes
- Identify clipped cleanouts





# Basement Inspections



- Conduct while smoke testing
- Identify illegal sump pumps or punctured floor drains

- 29 basement inspections



# Low Area/Wet Weather Observations

- Best done right after rain event
- Identify inundated manholes
- Identify soft ground





# CCTV



- Confirm pipe physical condition
- No cleaning before CCTV
- 7300 lf of mainline inspection



# Air Test Joints and Taps



- Evaluate if joints are structurally sound but leaking
- Evaluate if taps and lower lateral are leaking



- Tested 215 mainline joints and 34 taps/laterals

# Locate Cleanouts and Inspect Laterals



- Locate cleanouts and identify configuration
- Mainline launch lateral inspection and sonding

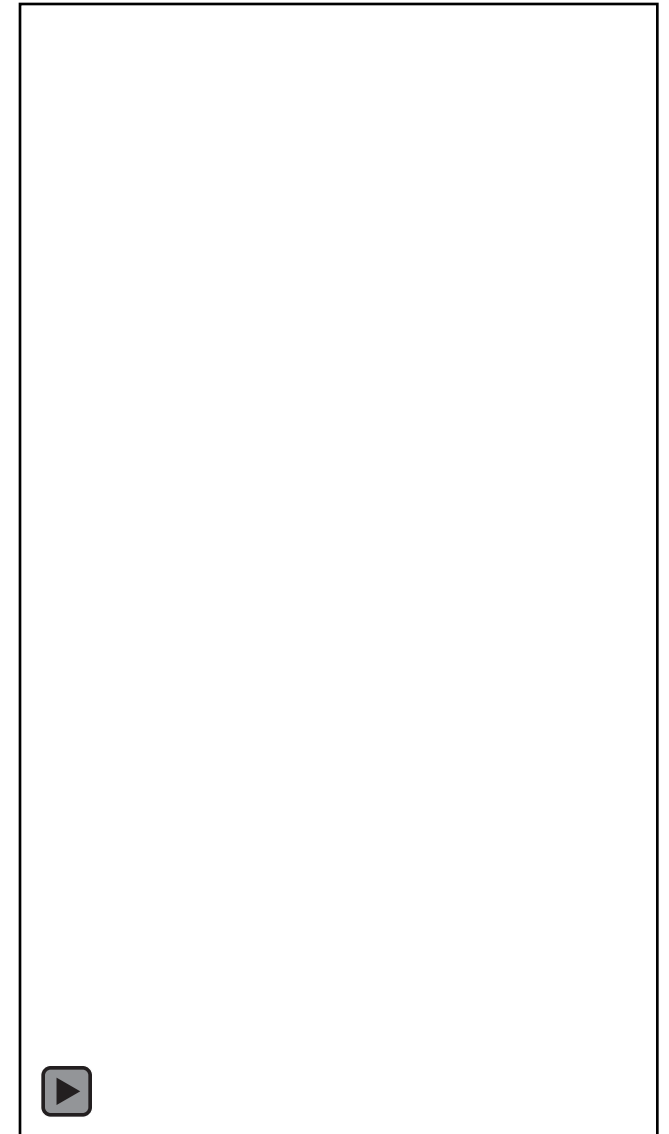
- 165 laterals inspected

# Combined SSES and Joint Testing Investigation Phase



# Pipe Findings

- 1 fracture only
- Half pipes had 1 – 7 visibly leaking joints
- 20% of laterals had visibly leaking joints



# Manhole Findings

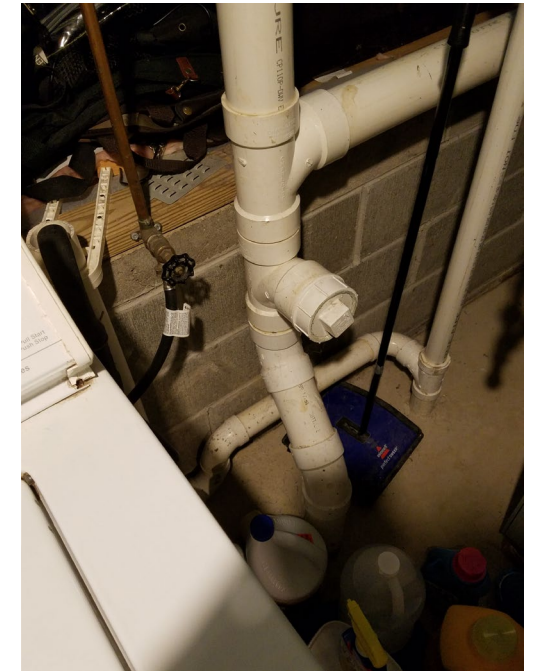
- 8 manholes with minor joint leakage
- Offset chimneys with failed mechanical chimney seals
- Sags in several sections (low land swamp areas)
- One manhole sunk ~1'





# House Inspection Findings

- Basement inspections
- No roof drains or illegal sump pumps



	Knocked	Refused Entry	Inspected	No Answer
Houses	117	8	29	80



# Test and Seal Trials



Sequence	Mainline Joints Tested	Mainline Joints Grouted	Mainline Failure Rate	Mainline Grout	Ave Gal Per Failed Mainline Jt
7	58	3	5.17%	8	2.67
25	26	4	15.38%	12	3.00
33	67	16	23.88%	39	2.44
34	64	14	21.88%	34	2.43
<b>Overall Total</b>	215	37	17.21%	93	2.51

17% of the mainline joints and 41% of the lateral tap connections tested failed basic air tests.

Sequence	Laterals Tested	Laterals Grouted	LTC Failure Rate	Lateral Grout	Ave Gal per Failed LTC
7	12	1	8.33%	3	3.00
27	11	6	54.55%	25	4.17
31	9	5	55.56%	29	5.80
32	2	2	100.00%	8	4.00
<b>Overall Total</b>	34	14	41.18%	65	4.64



# Conclusions

- Pipe is structurally in great shape
- Contractor just didn't know how to joint clay pipe properly
  - *So, rebuild the defective gaskets rather than replace/reline the pipe*

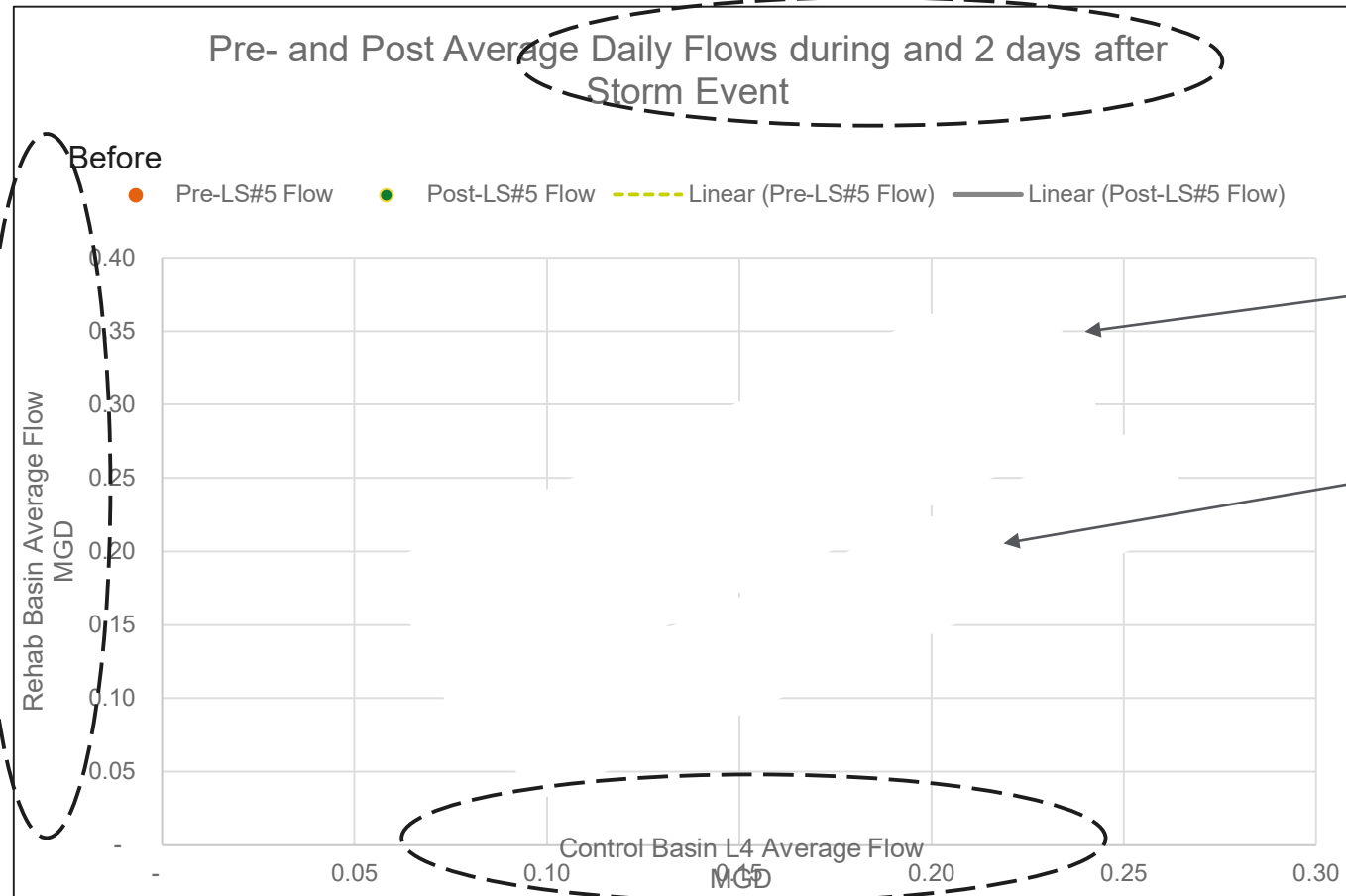
# Value Propositions for Grouting Sewers

1. Lowest initial capital and life cycle cost technique available
2. Lasts *at least* 25 years
3. 50%-75% RDII reductions with documented sustainability >10 years so far
4. Broad application – addresses >95% of pipes and laterals



# Rehab Effectiveness – Control Basins

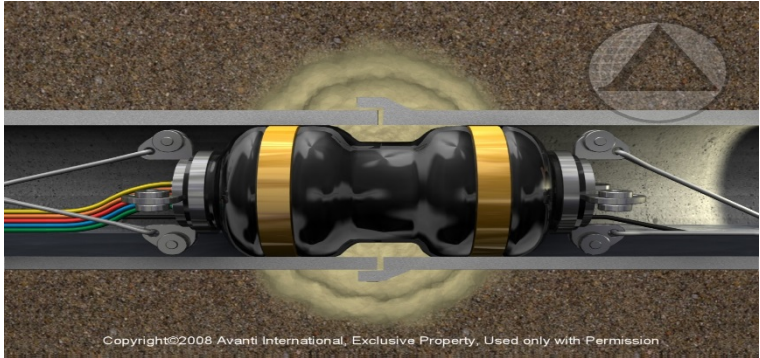
REDUCE I&I LEAKAGE BY 25%



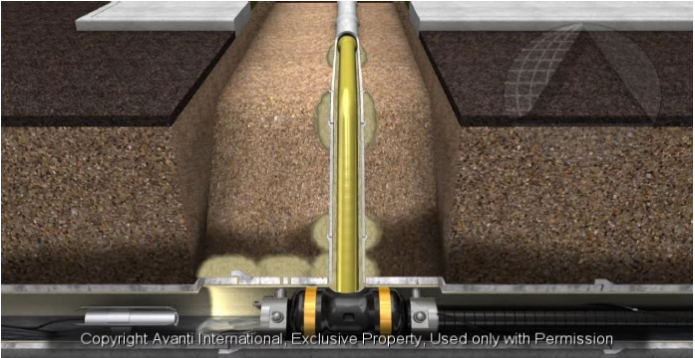
36% reduction in total flow

47% reduction in I&I

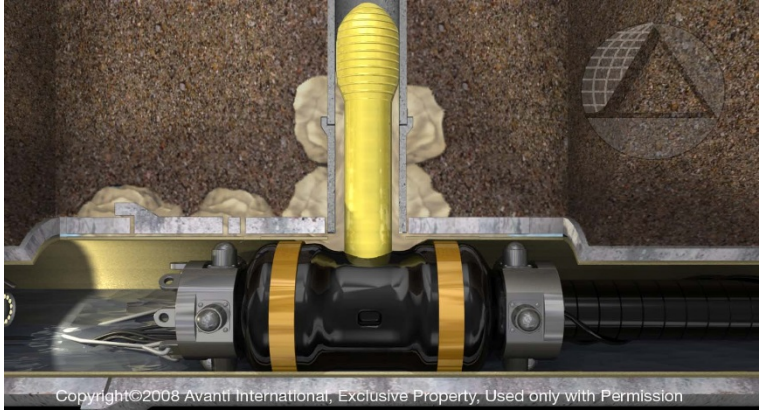
# Long-term seals almost all leakage points of entry and stabilizes pipe



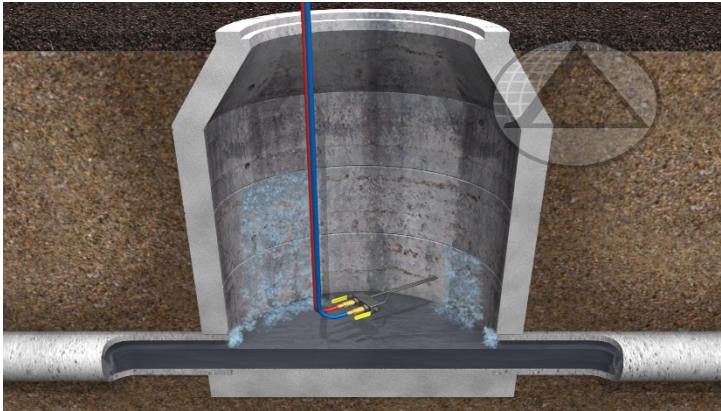
**Mainline Joints**



**Laterals to 30 ft from MH**

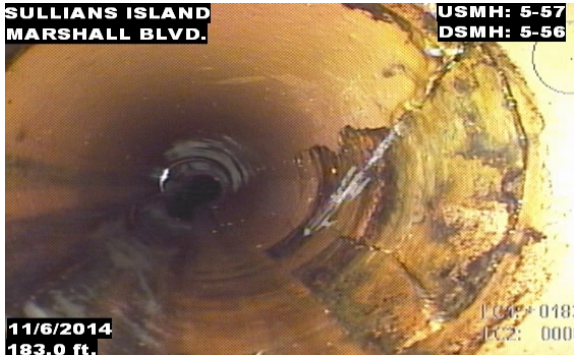


**Tap Connections**



**Manholes**

## Longitudinal & Multiple Fractures



**Laterals to 150 ft**



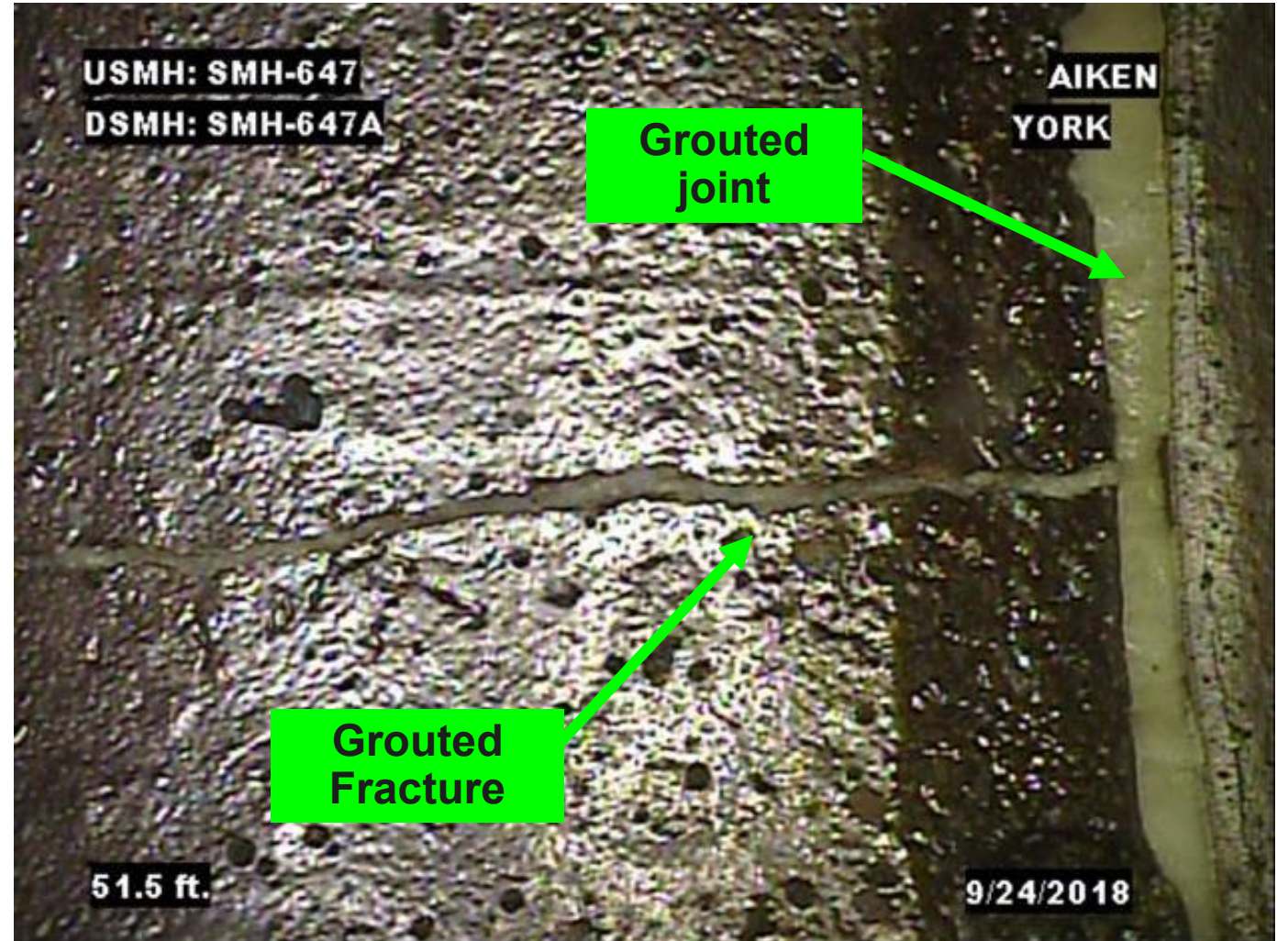


# Mainline Packers



# Many Joints have Structural Defects

Using a new technique called “Low Pressure End Element MLJ” that has proven *hugely successful*





# Lateral Tap Connection Packers





# Ultralong Lateral Tap Connection (ULLTC) Packers

20 footer

*Up to 38'  
from main  
without  
cleanout,  
including  
transition*

38 footer





# Lateral Connected to Manhole (LCM) Packers



*Up to 150'  
from manhole*



# Lateral Accessed from Cleanout (LACO) Packers



*Up to 150' from cleanout to main*



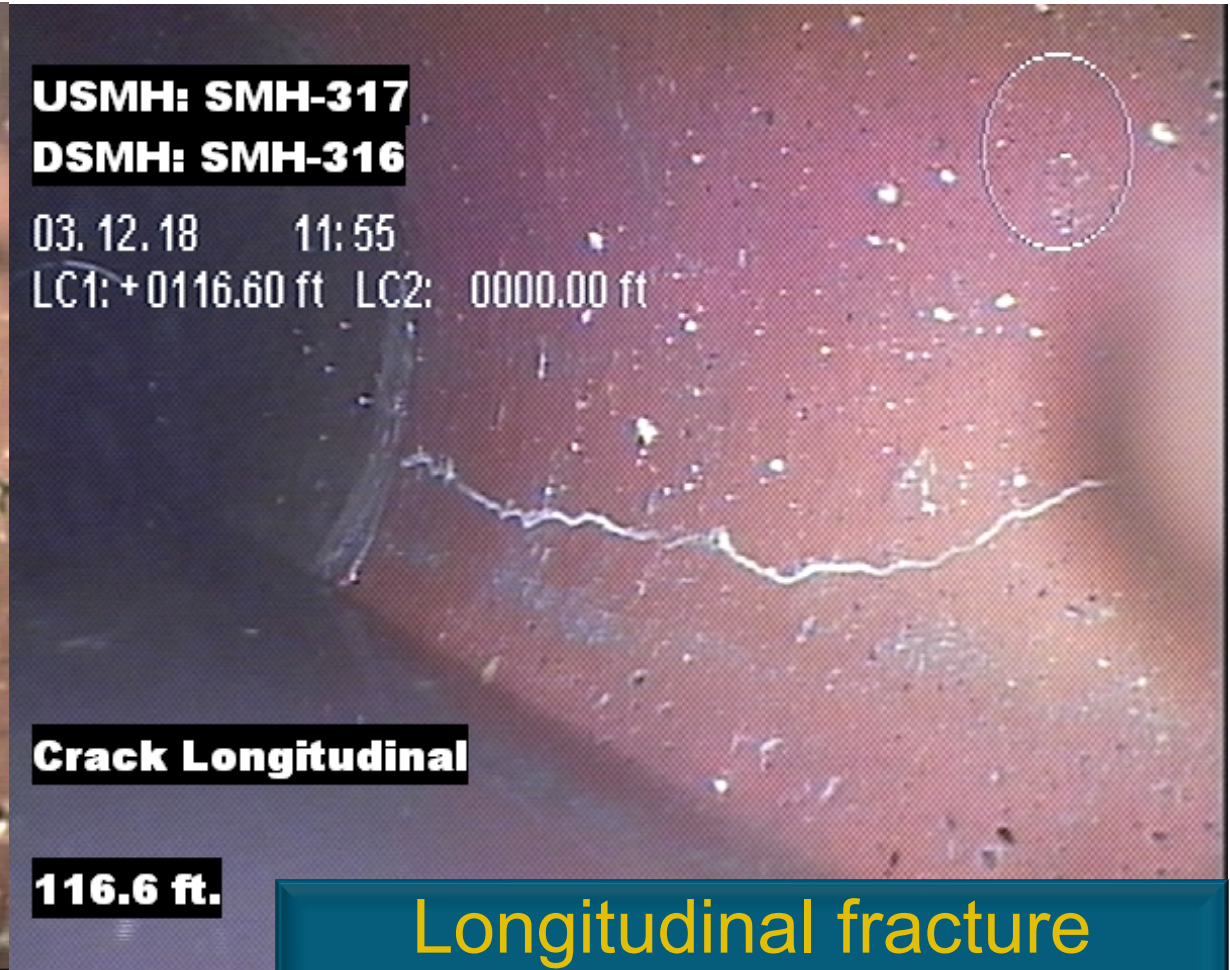
# Longitudinal Fracture Defect (LFD) Packers







Longitudinal fracture before rehabilitation



Longitudinal fracture grouted – 18 months later



SULLIVANS ISLAND

JASPER

USMH:

DSMH:

**Infiltration Runner**

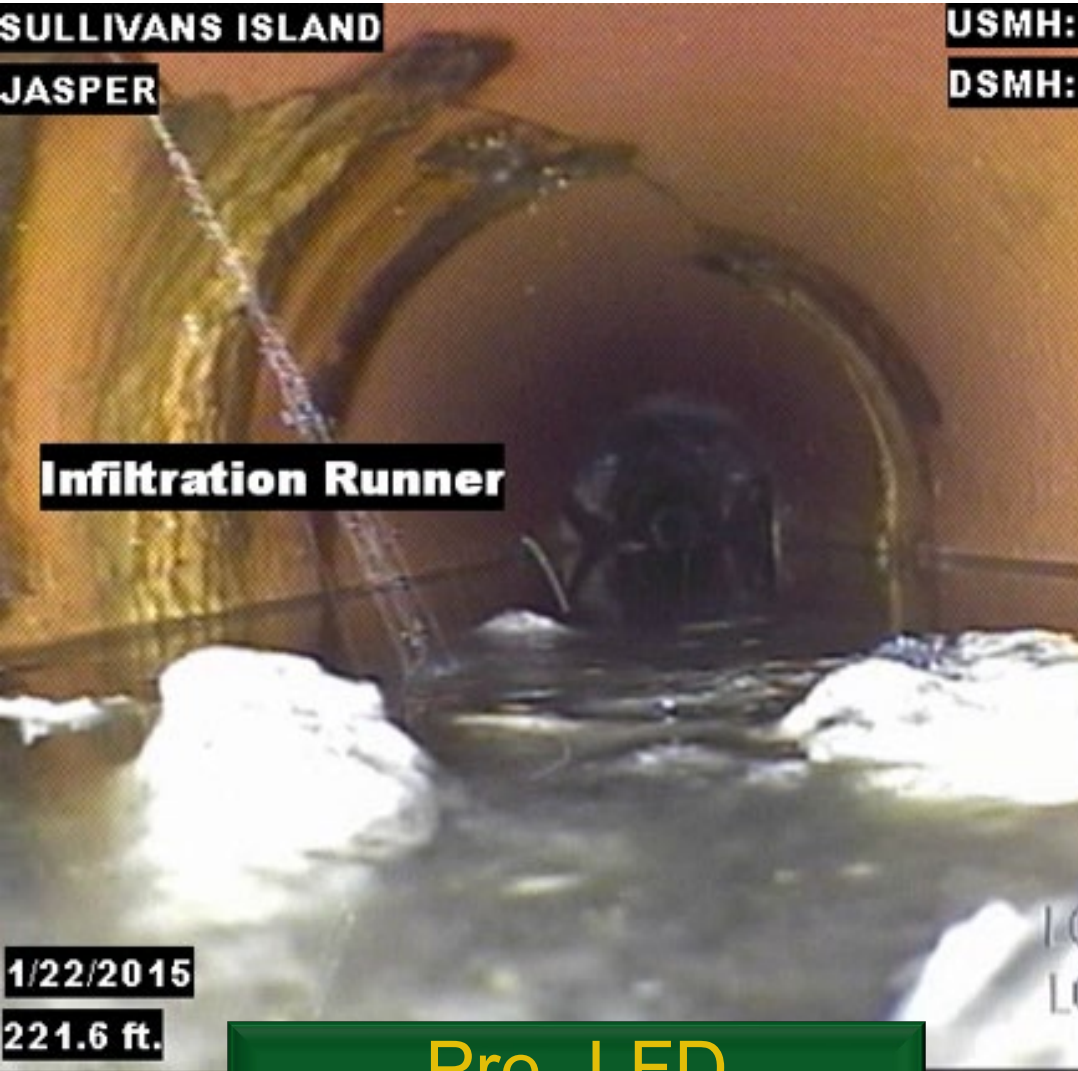
1/22/2015

221.6 ft.

**Pre- LFD**

FEET: 0221.9

**Post – LFD 18 months later**





FEET: 0127.5

**Grouted  
Spiral  
Fracture**



# Decision to use Design-Build



- Engineering and Construction Management expertise was limited
- Contractor base was not schooled in Capital Grouting
- More traditional, far shorter longevity, less applicable Maintenance Grouting techniques
- No single contractor could do the work within time constraints



# Progressive Design Build

---



- Design phase - Preliminary Services Agreement – Lump Sum – DBIA 520
  - Develop Specifications, Plans, and Costing
  - Transparent Costing and Subcontractor Pricing

# Progressive Design Build

## 2. Construction Phase – DBIA 530 and 535

- Total Cost for Work – Unit Priced and Hourly Cost Rate (0% profit)
  - Full Risk of Cost overrun on Arcadis
  - Full Risk of Subcontractor performance on Arcadis
  - No windfall for early/lower cost delivery
- Fixed Cost for Project Management – Lump Sum
- Fixed Profit – Full risk of costs on Arcadis
- Liquidated Damages – Full risk on Arcadis
- Contingency – Lancaster owned. Returned if not used





# Three Primary Subcontractors

- Split the work to optimize overall pricing
- Areas of the work held out as incentive for best performing contractors

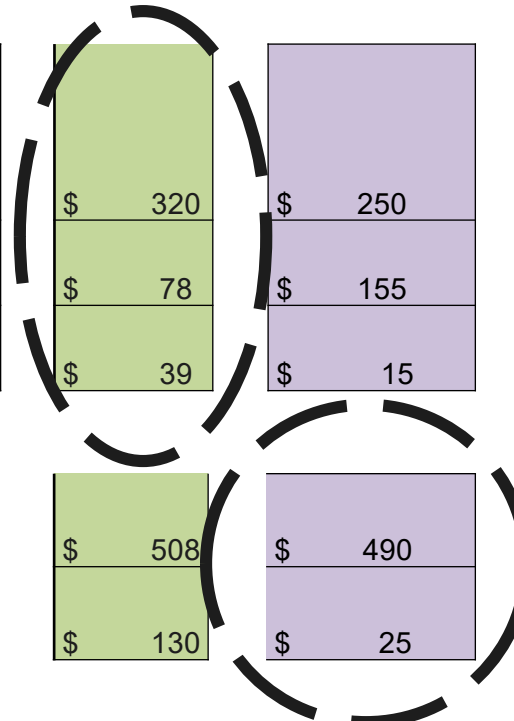


Diversified Infrastructure	Michels	Lake County Sewer
\$ 950,171	\$ 1,030,719	\$ 805,708
32%	25%	43%

# Three Primary Subcontractors

- Split the work to optimize pricing by line item

9	Pre-construction cleaning, root removal, pre-testing CCTV, post-grouting cleaning, post-grouting CCTV of LCMs	each	25	\$ 1,275	\$ 320	\$ 250
10	Testing LCM joints	joint	150	\$ 155	\$ 78	\$ 155
11	Packer injection grouting of LCM joints	joint	38	\$ 147	\$ 39	\$ 15
12	Testing 12' LTC	tap	457	\$ 325	\$ 508	\$ 490
13	Grouting 12' LTC	tap	183	\$ 490	\$ 130	\$ 25







**Substantial Completion in 3 months**  
**Final Completion in 4 months**



# Results

- Most laterals did not have cleanouts
  - Decided to postpone cleanout installation (\$500K cost) to see if mains, taps, and lower laterals achieved goal
- Only a single structural defect in 22,582 lf of main line sewer
- Tested 4652 mainline joints, 489 taps, and ~1200 lateral joints

Summary											
	Segments	Mainline Joints Tested	Mainline Joints Grouted	Mainline Failure Rate	Mainline Grout	Grout Per Mainline Jt	Laterals Tested	Laterals Grouted	Lateral Failure Rate	Grout per LTC	Lateral Grout
All Mainlines	91	4652	961	20.66%	2244	2.34	489	256	52.35%	6.55	1677
8"	75	3902	626	16.04%	1309	2.09	426	202	47.42%	6.68	1350
10"	8	459	207	45.10%	517	2.50	43	40	93.02%	6.33	253
12"	8	291	128	43.99%	418	3.27	20	14	70.00%	5.29	74

45% of the 10" and 12" pipes, which tended to be in the wetter, lower lying area, were found to leak.

93% of the laterals on 10" pipe and 70% of the laterals on 12" pipes, which tended to be in the wetter, lower lying area, were found to leak.



# Results

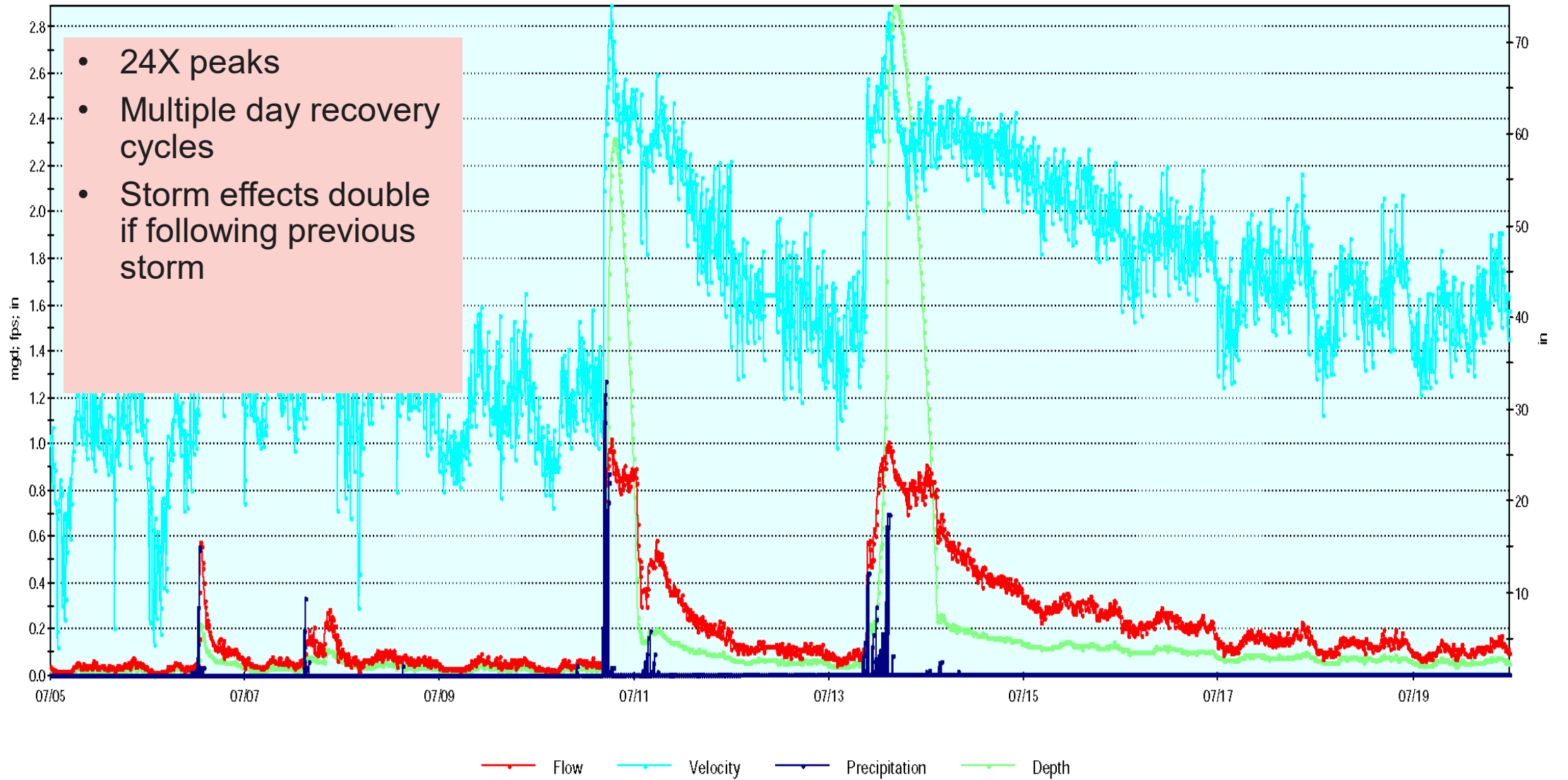
- Cost of Work Delivered for 83% of budgeted amount
- Project Delivered 25% under schedule
- Failure rate was almost exactly what was predicted by pre-design work



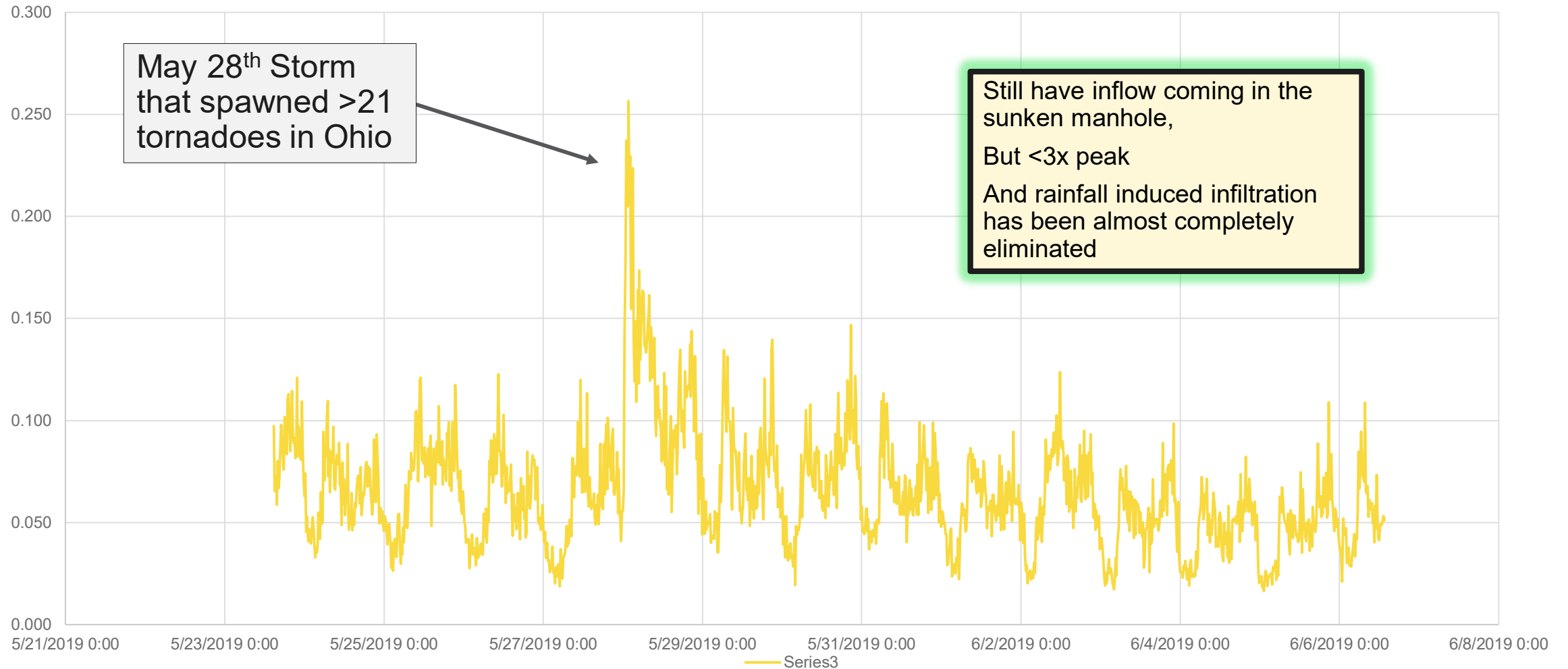
# Flow Reductions

- Post-rehabilitation flow metering not completed
- BUT – Wettest year in last 20 years and **ZERO** basement backups!!





Prairie Grass Meter



May 28<sup>th</sup> Storm  
that spawned >21  
tornadoes in Ohio

Still have inflow coming in the  
sunken manhole,  
But <3x peak  
And rainfall induced infiltration  
has been almost completely  
eliminated





**Jim Shelton, P.E.**

National Technical Director - ARCADIS

316 Covered Bridge Road

King of Prussia, PA 19406

302.723.1450

[James.Shelton@arcadis.com](mailto:James.Shelton@arcadis.com)



**Questions?**