ASSET MANAGEMENT PROGRAM

Hazen

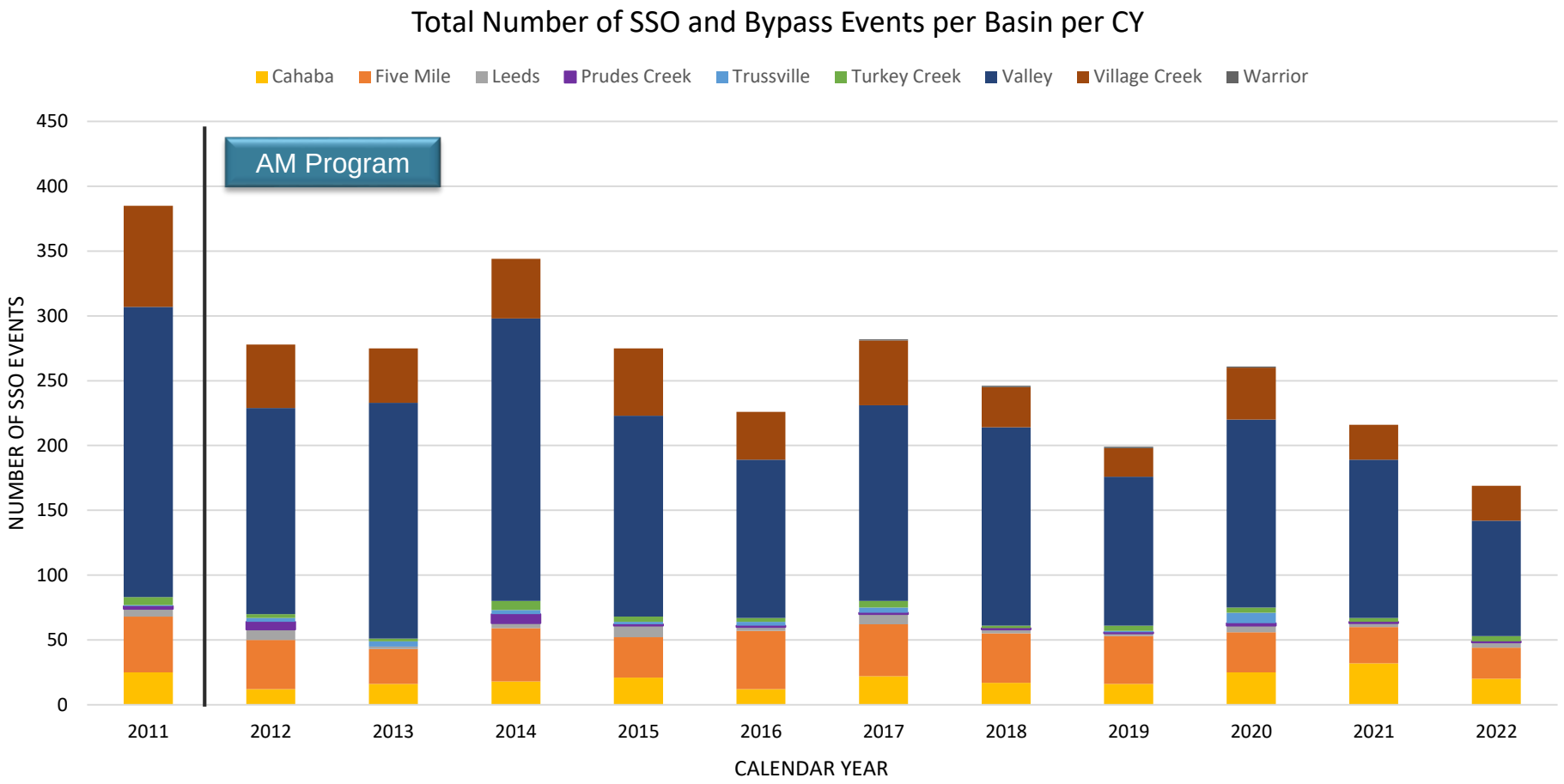
Optimizing a Capital Improvement Program – How to Measure and Improve Effectiveness

Stephen King, P.E., BCEE
Hazen and Sawyer

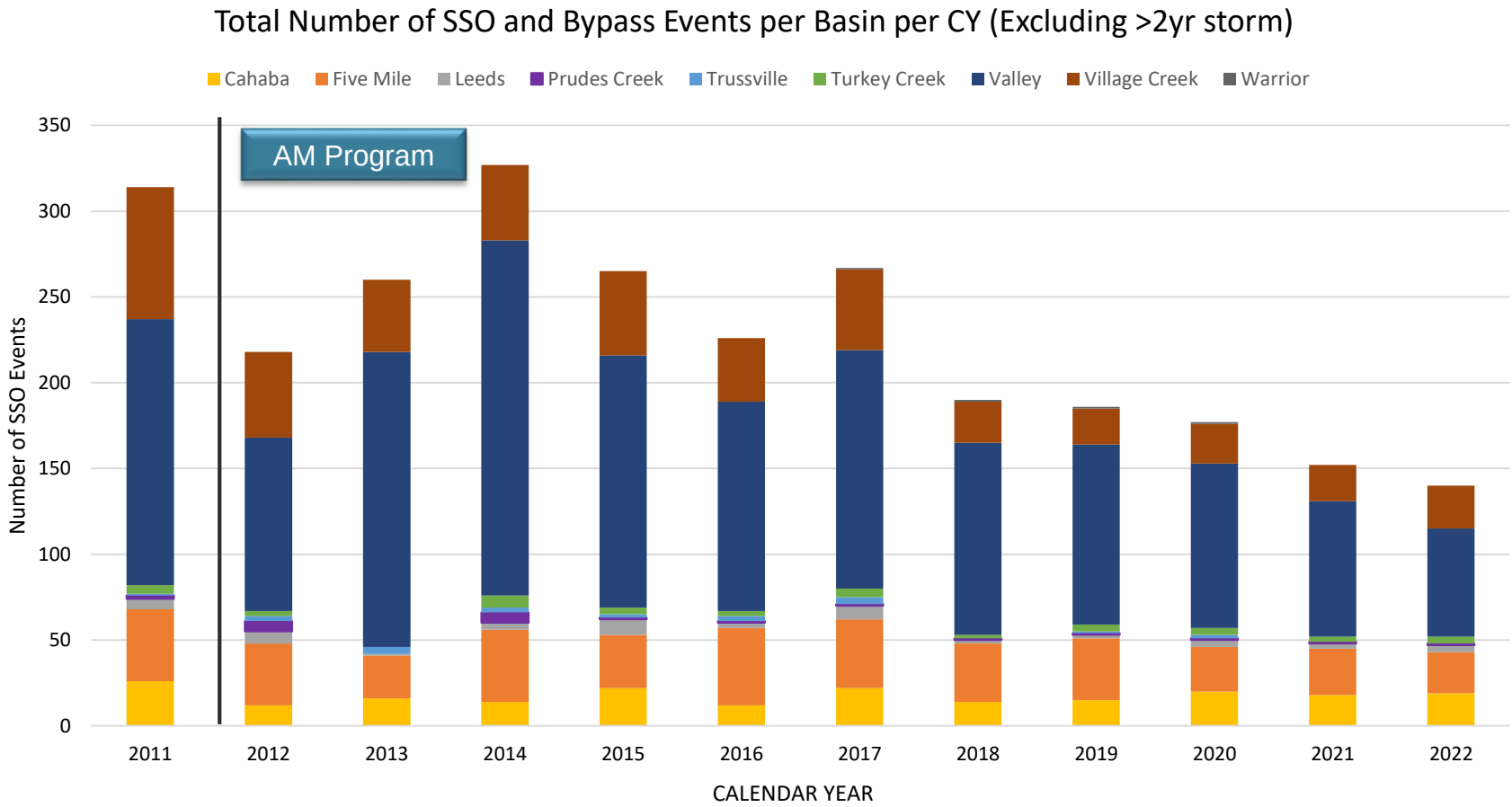
New England Water Environment Association
2023 Annual Conference
January 23, 2023

System Performance
(Is the CIP Effective?)

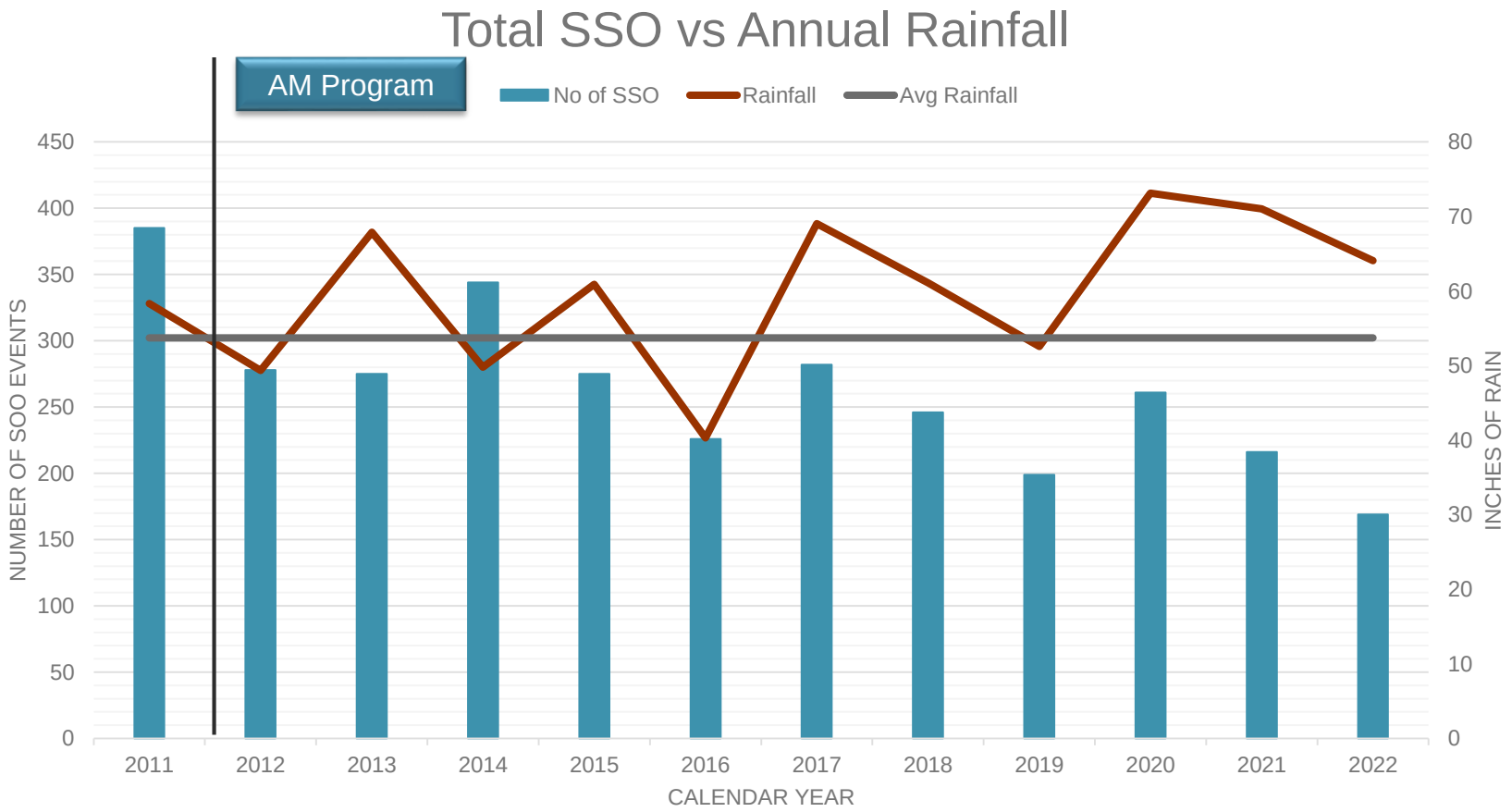
System Performance – All SSOs by Count



System Performance –SSOs by Count (Excluding >2yr Storm)

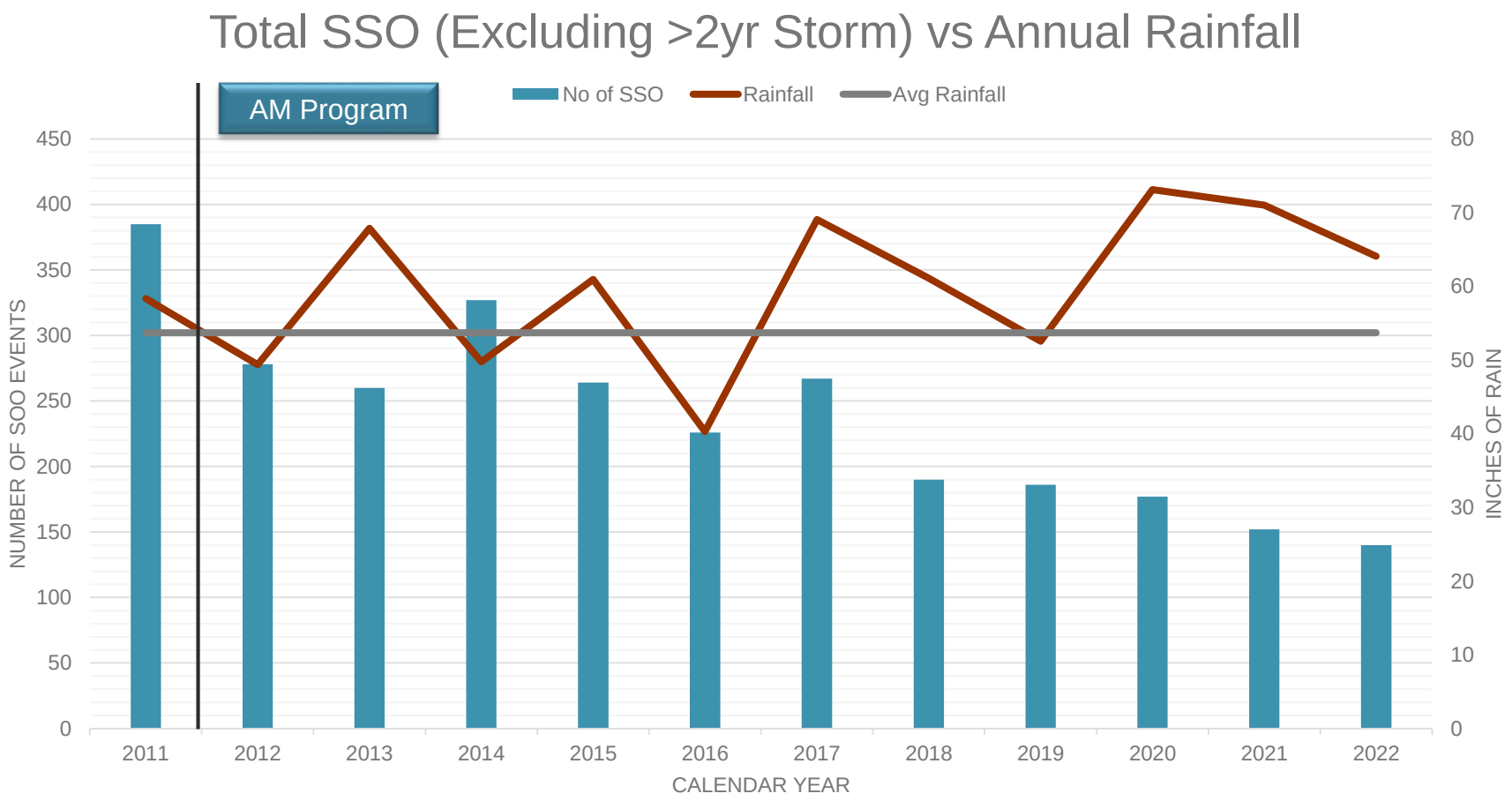


SSO Counts Compared to Rainfall Totals



Note: Rainfall data as recorded at the Birmingham Airport

SSO Counts (Excluding >2yr Storm) Compared to Rainfall Totals



Note: Rainfall data as recorded at the Birmingham Airport

Asset Condition Assessment and Management (Informed Decision Making)

Structural Failures

Infiltration Gusher

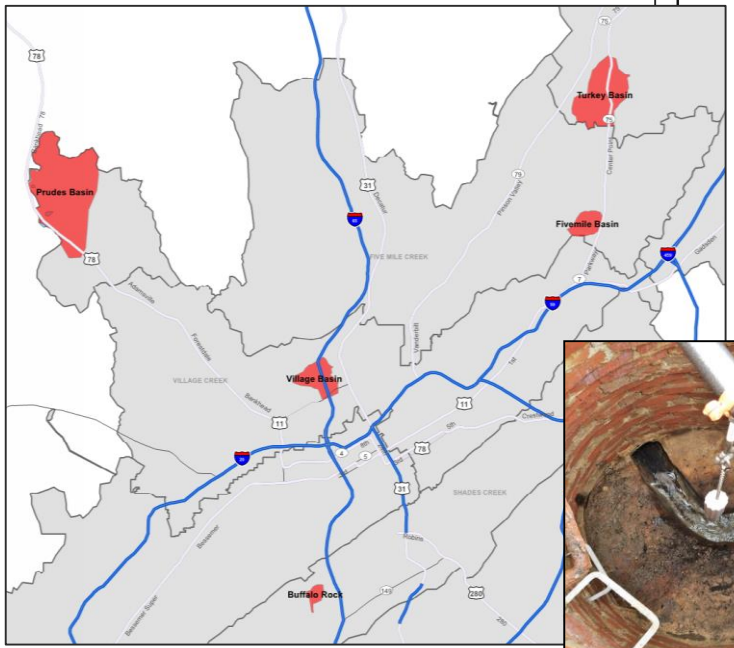
Fractures

Collapsed Pipe

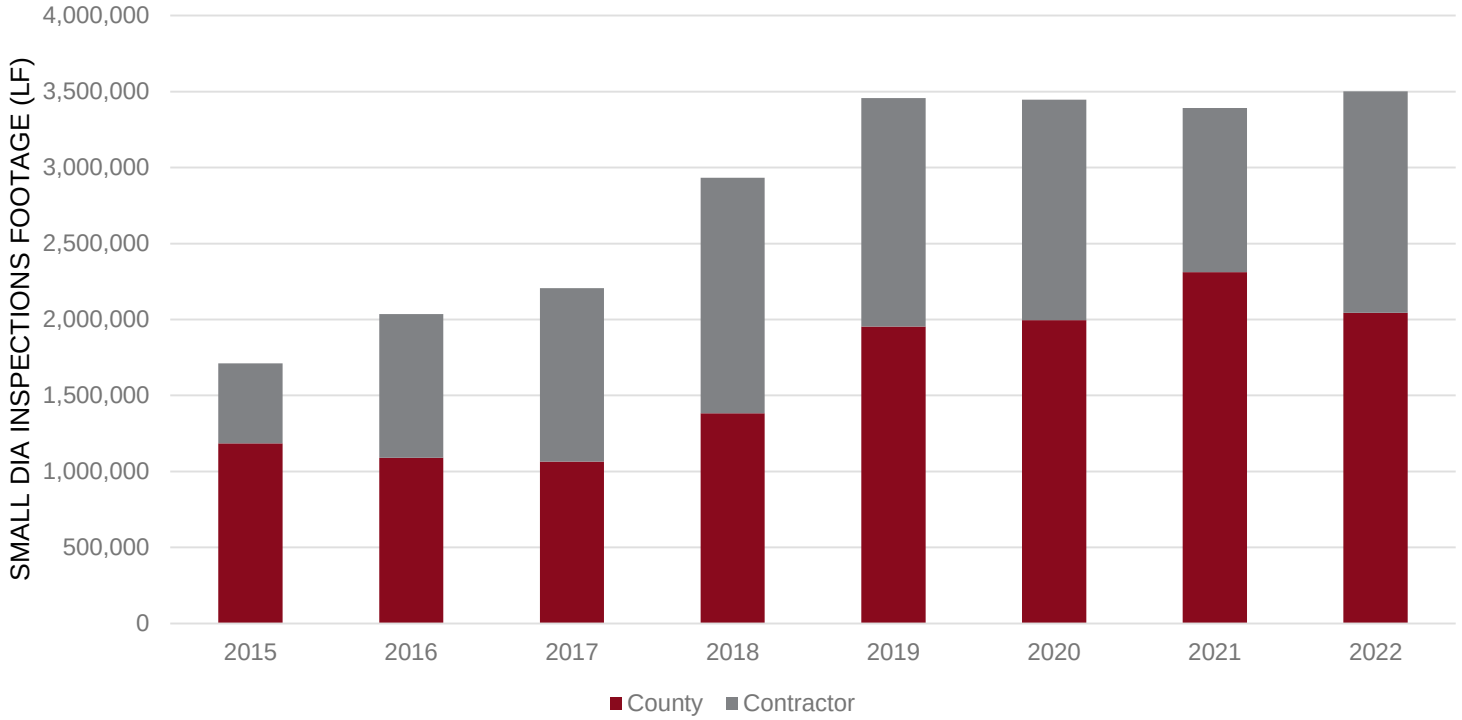
I/I Source Detection

Utilizing various technologies to narrow down sources of I/I for follow-up CCTV inspection

- I-Trackers
- Flow Meters
- Mission Units at pump stations
- ADS Echo's
- Model



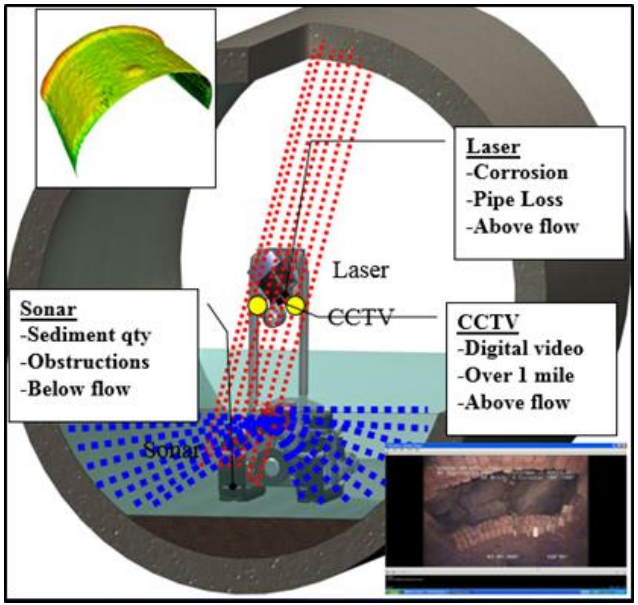
Small Diameter Assessment Program (Pipe <24”)



Large Diameter Assessment Program (Pipe ≥ 24”)

- Assesses structural condition, measures debris levels and confirms corrosion models
- Data is used to schedule rehab, repairs or reinspection
- Data is also fed back into the model to improve accuracy

Large Diameter Inspection Phases	Total LF	Status
Phase 1 (included portions of Shades Creek, Valley Creek, Five Mile Creek, Village Creek, Leeds and Cahaba River basins)	355,644	Completed in FY 2018
Phase 2 (includes Shades Creek and Five Mile Creek basins)	222,318	Completed in FY 2020
Phase 3 (includes remainder of large diameter sewers)	332,100	Completed in FY 2021
Total	**910,062**	



Multi-Sensor Inspection

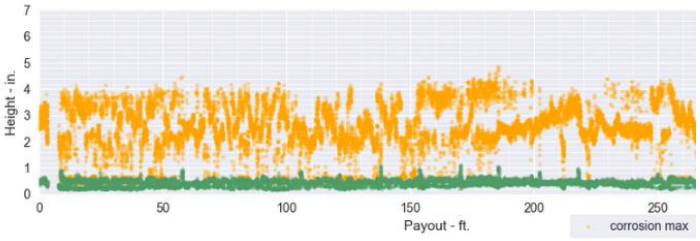
Hazen & Sawyer
Upstream Manhole: MH009053-082676-015
Downstream Manhole: FT009053-077591

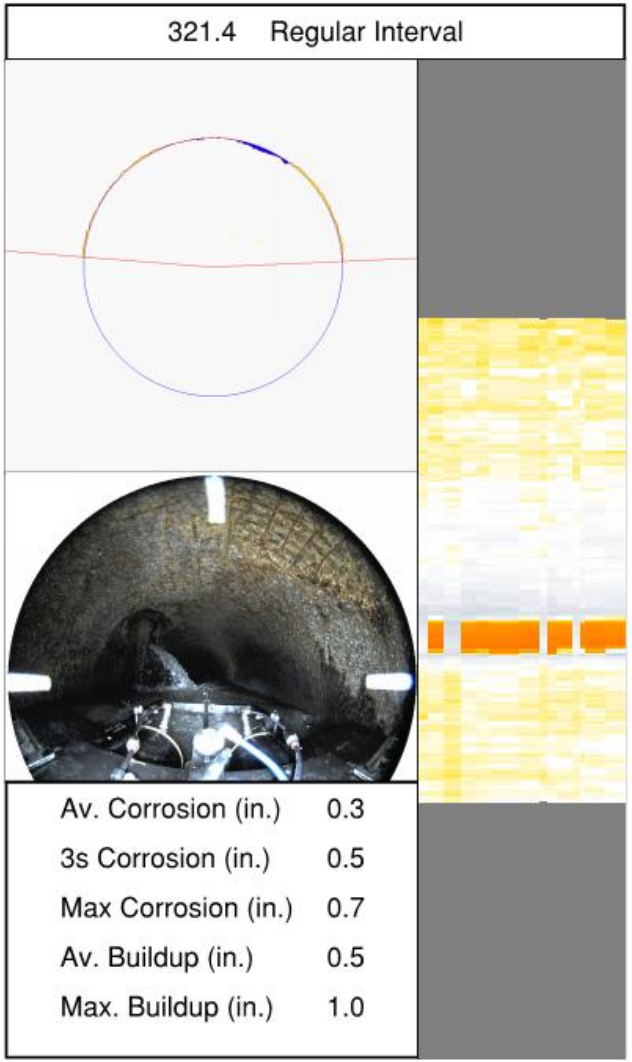
Payout: 320.2
2017-07-19 17:16:46

Corrosion avg in: 0.58
Corrosion max in: 3.26

Buildup avg in: 0.42
Buildup max in: 1.43

HD Video





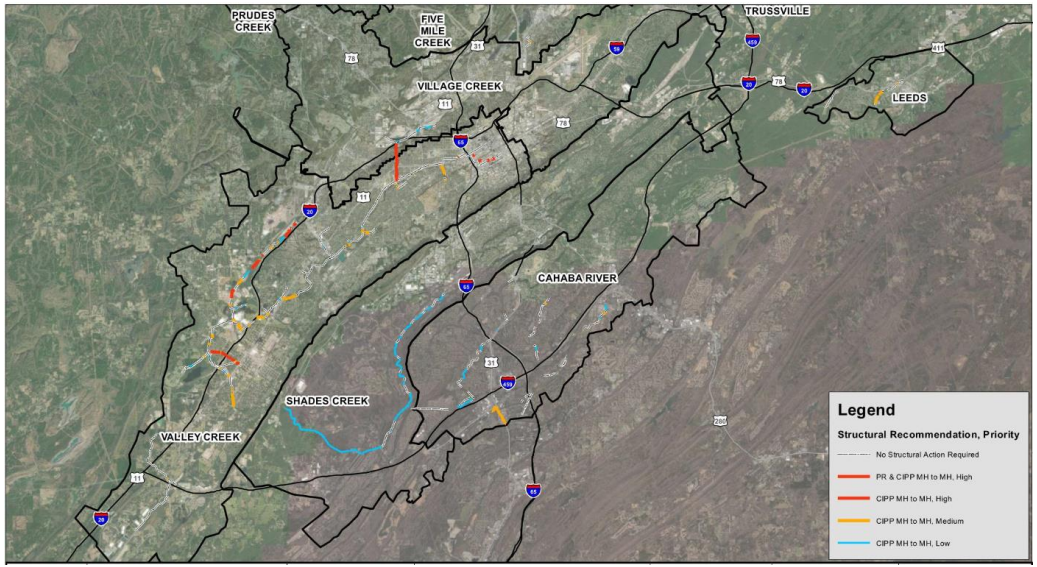

REV


HYDRION

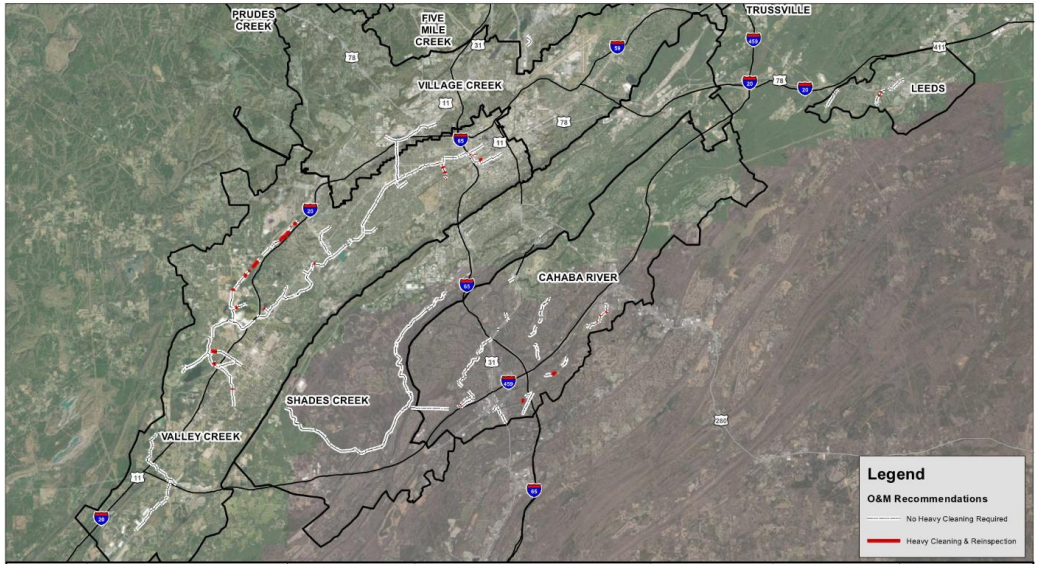

HYDRION

Large Diameter Phase 1 Results

- Approx. 122,000 LF of large diameter pipes will need rehabilitation within the next 5 years
- Remainder of the pipes are slated for reinspection within the next 10-15 years
- 16,100 LF of pipes will require heavy cleaning to remove debris



Phase 1 Structural Recommendations



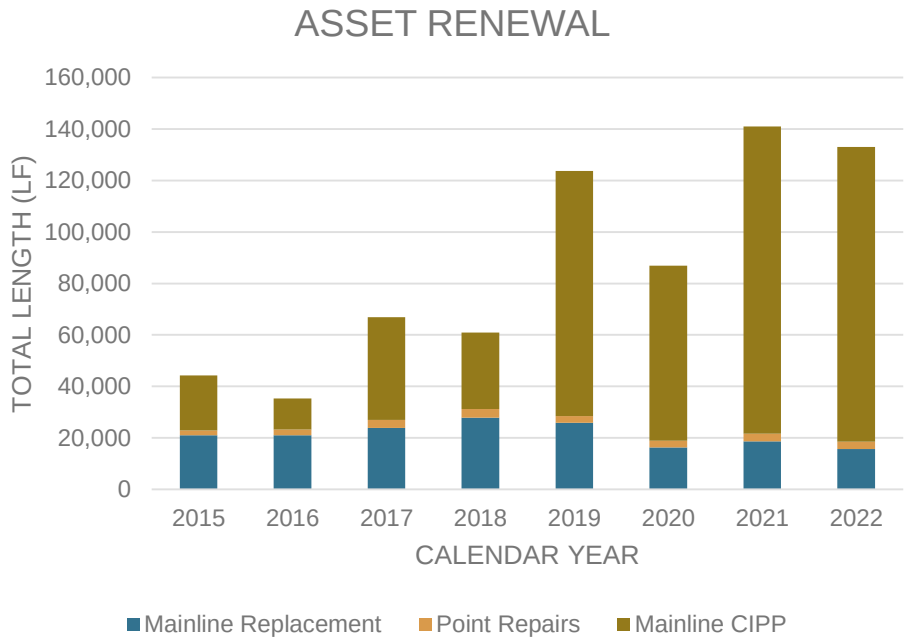
Phase 1 O&M Recommendations

Asset Renewal

- Over 62 miles of pipe repair/replacement or rehabilitation have been completed

Completed to Date*					
Mainline Replacement (LF)	Point Repairs (LF)	Mainline CIPP (LF)	CCTV Inspection (LF)	Manhole Inspections (EA)	Manhole Rehab (EA)
170,432	21,577	529,982	21,444,043	55,331	3,667

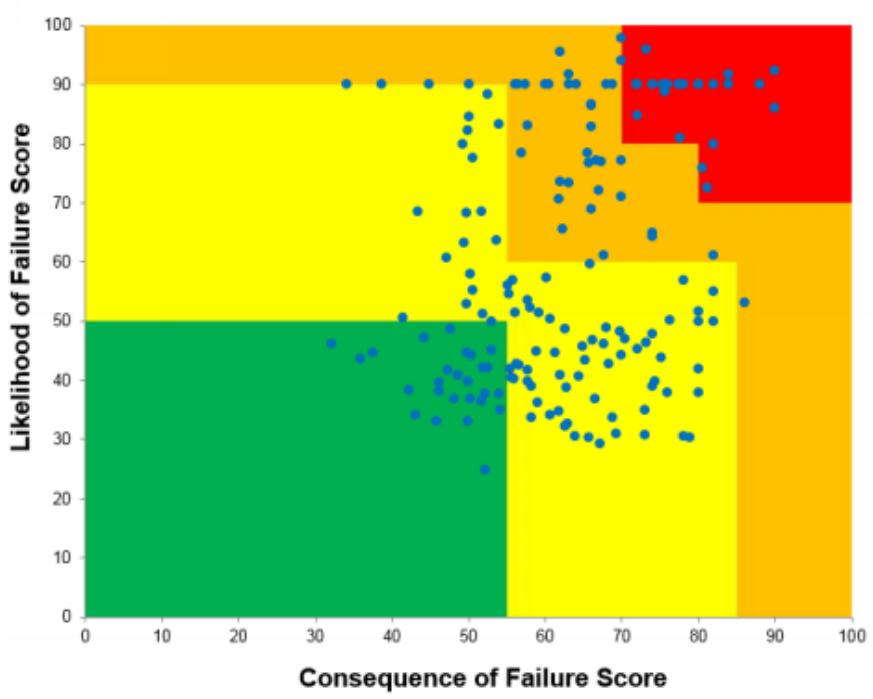
*2015 through 2022



Pump Station Risk-Based Prioritization

- Performed assessments on 170 of 178 total pump stations (132 MGD in firm pumping capacity)
- 25 Pump Stations identified as Critical (31 MGD in firm pumping capacity) and are either currently under design or are scheduled for design

Pump Station Upgrades	Planned Targets for Completion					
	Units	FY2019	FY2020	FY2021	FY2022	FY2023
Pump Station Firm Capacity Improvements	MGD (132 MGD of Total PS Firm Capacity)	1 PS 6.2	2 PS 0.4	0 PS 0	8 PS 3.1	14 PS 12.5



Vertical Asset Management

- Assessment of all major equipment, structures, electrical and instrumentation systems at each of the nine (9) Water Reclamation Facilities to determine current and future needs.
- Currently in inventory, prioritization and CityWorks implementation phase
- Data will be used to develop a prioritized list of equipment and structural needs at each WRF.

Belt Presses, Cross Conveyors, and Transfer Conveyors

Intermediate Clarifier – Internals – Peeling of the topcoat was typical throughout Intermediate Units exposing a white colored undercoat/product.

Wet Weather Management Program (High Cost Problems Require Efficient Solutions)

Chapel PS I/I Reduction
Cost Comparison – Comprehensive Rehabilitation vs. Upsizing

Upsizing

Item	Cost
1,780 LF of 15-inch Gravity Pipe	$700,000
1,020 LF of 6-inch Force Main	$140,000
New 0.6 MGD Pump Station	$360,000
Construction Contingency (30%)	$360,000
Total Construction Cost	$1,560,000

Comprehensive Rehabilitation

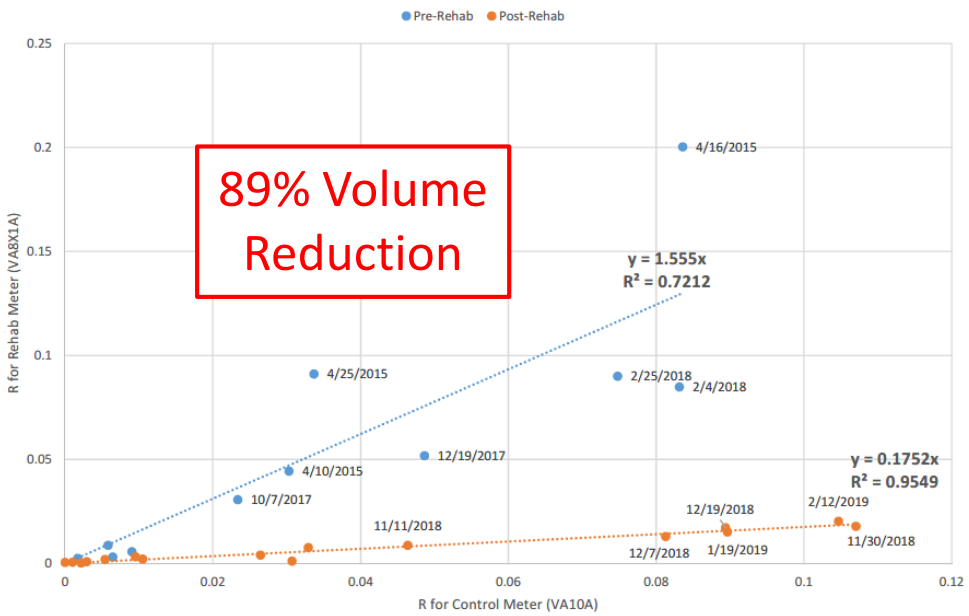
Cost as Bid	$810,295.50
Cost at Closeout	$776,381.50

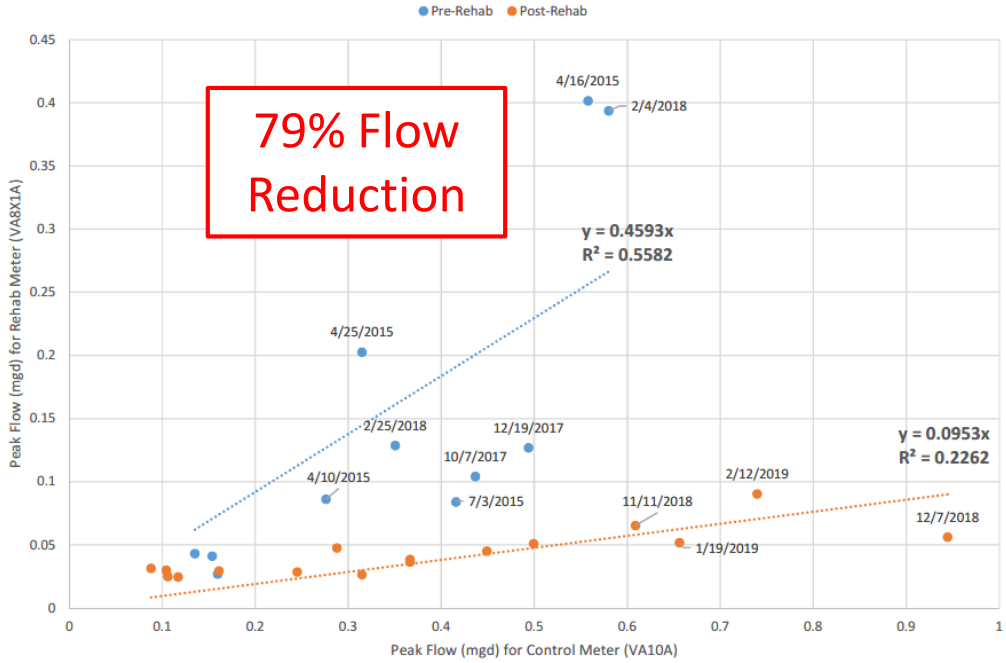
Status	Services (Each)
ACTIVE	89
INACTIVE	100
TOTAL	189

Mainline with full circle wrap

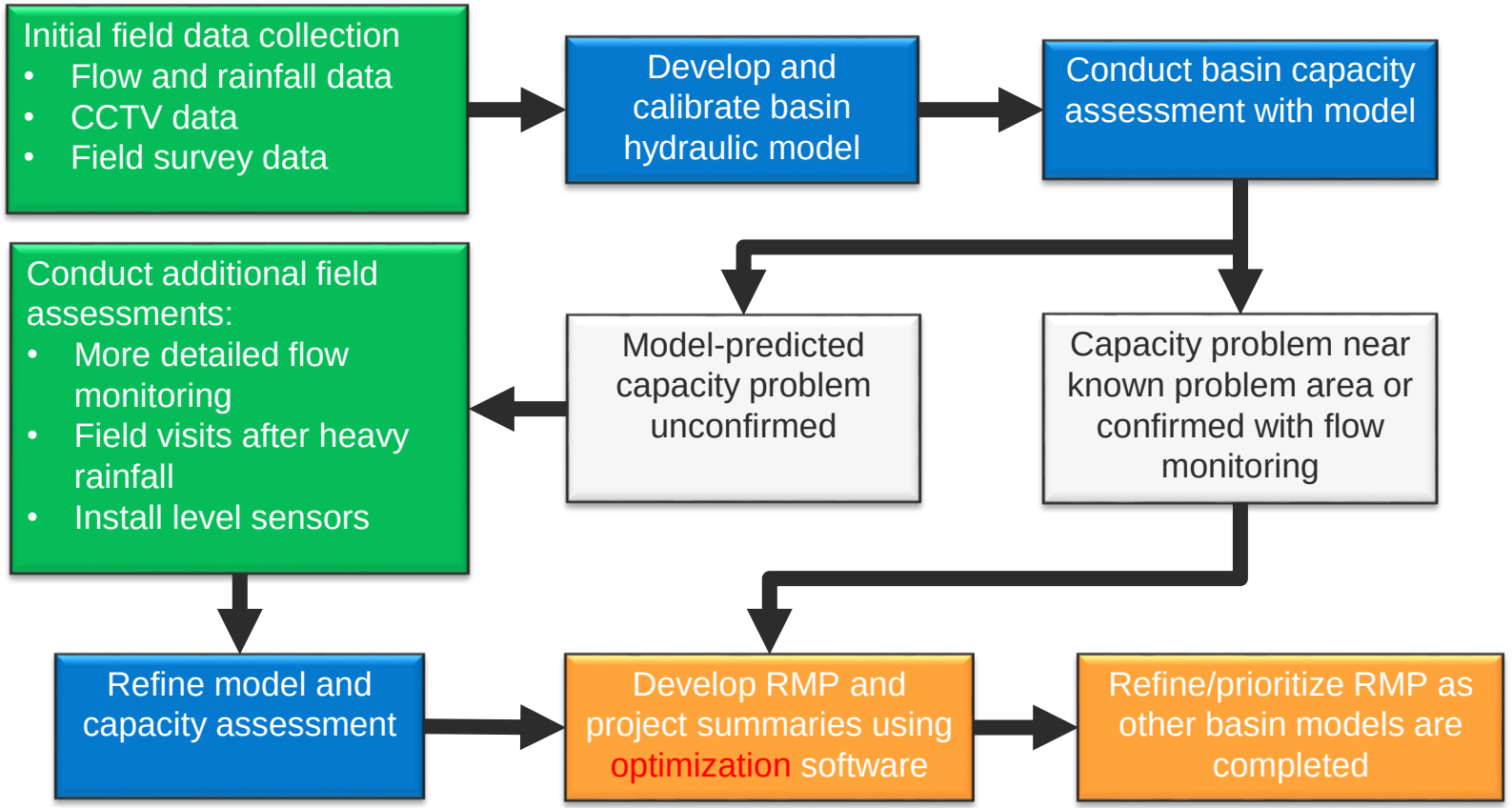
Service line CIPP

Chapel PS I/I Reduction - Comp Rehab Results



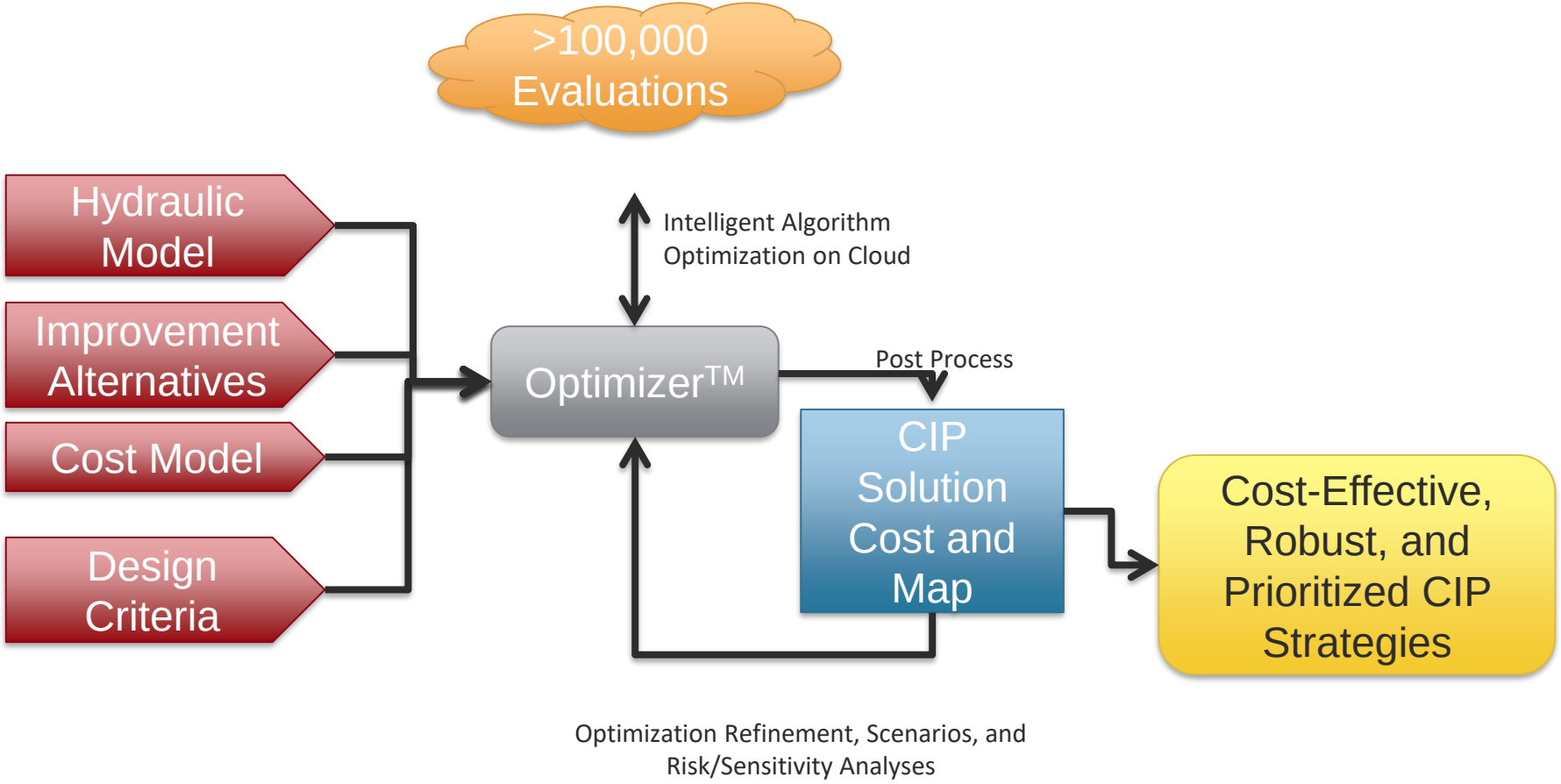


Remedial Measures Plan (RMP) Development Process



Remedial Measures Planning with Optimization Based CIP Development

(using Optimatics™ software)



Unit Cost Rates – Basis of Cost

Total Life Cycle Cost = Capital Cost + PV O&M + PV Replacement

Present Value Variables		
Analysis Period (years)	n	100
Effective interest rate	ER	5.0%
100-Yr PV Annual Cost Multiplier	PV	19.85

Annual O&M Costs	
Storage Facilities	1.5%
Gravity & Pressure Mains	0.3%
Pump Stations ($/MGD)	$4,820

Asset Life		
Asset	**Expected life (yr)**	**PV Replacement Cost over Lifespan (% capital)**
Gravity Pipes	80	2.04%
Pressure pipes	60	5.61%
Storage Tank	60	5.61%
Pumps stations	35	21.98%

Unit Cost Rates – Example Pipe Unit Costs

Total Life Cycle Cost = Capital Cost + PV O&M + PV Replacement

Capital Costs for Gravity Sewers - Trenched No Surf Rest (New)		
Pipe Diameter (feet)	<15'	>15'
0.67	$468	$584
0.83	$488	$610
1.00	$512	$640
1.25	$555	$693
1.50	$606	$758
1.75	$665	$831
2.00	$731	$914
2.25	$805	$1,006
2.50	$884	$1,105
3.00	$1,061	$1,326
3.50	$1,258	$1,572
4.00	$1,471	$1,839
4.50	$1,698	$2,123
5.00	$1,935	$2,418
5.50	$2,178	$2,722
6.00	$2,423	$3,029
6.50	$2,668	$3,335
7.00	$2,908	$3,635
7.50	$3,140	$3,925
8.00	$3,361	$4,201
8.67	$3,632	$4,540
9.17	$3,812	$4,765

+

Life Cycle O&M for Gravity Sewers - Trenched No Surf Rest (New)		
Pipe Diameter (feet)	<15'	>15'
0.67	$28	$35
0.83	$29	$36
1.00	$30	$38
1.25	$33	$41
1.50	$36	$45
1.75	$40	$50
2.00	$44	$54
2.25	$48	$60
2.50	$53	$66
3.00	$63	$79
3.50	$75	$94
4.00	$88	$110
4.50	$101	$126
5.00	$115	$144
5.50	$130	$162
6.00	$144	$180
6.50	$159	$199
7.00	$173	$216
7.50	$187	$234
8.00	$200	$250
8.67	$216	$270
9.17	$227	$284

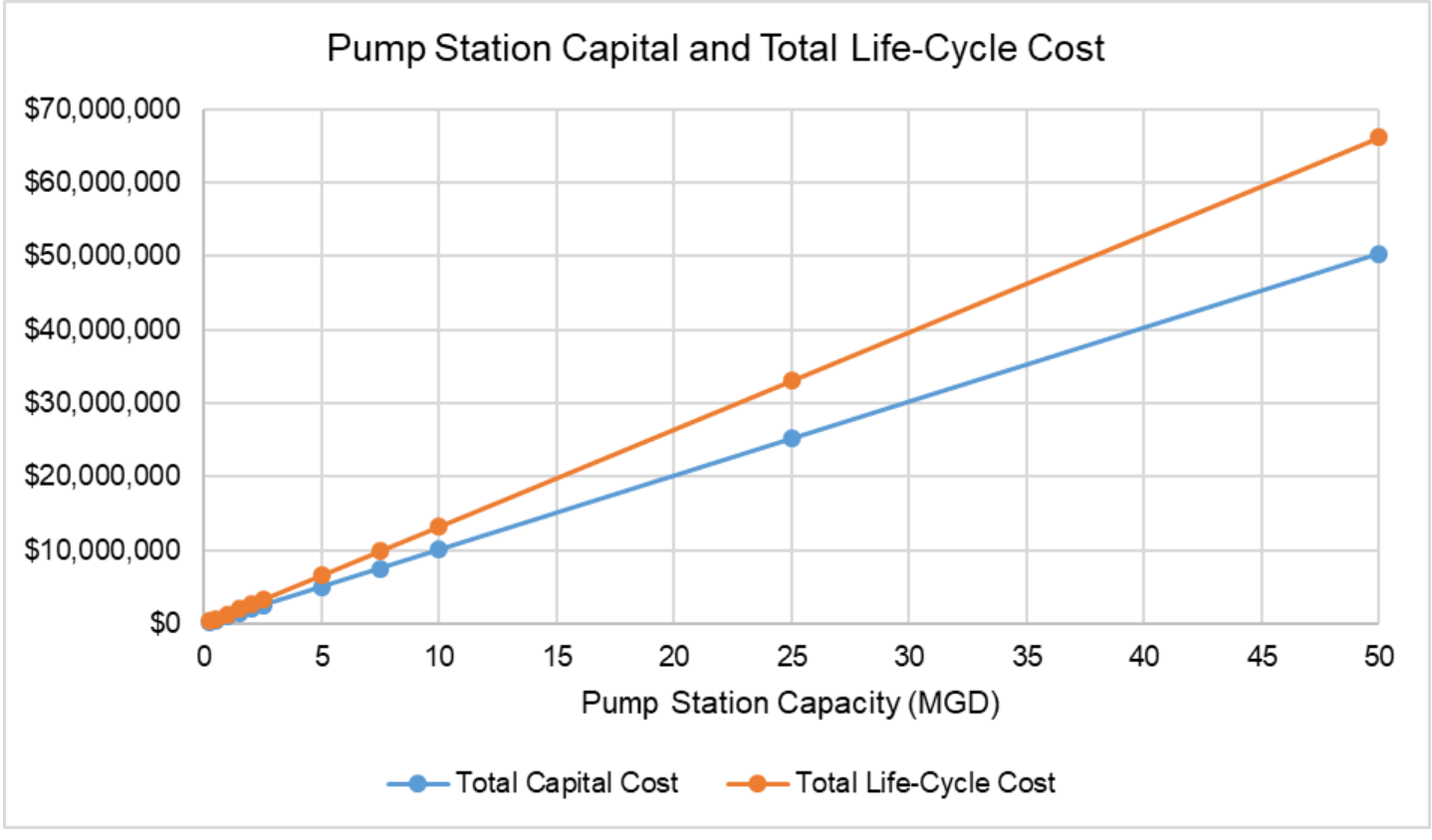
+

Life Cycle Rep. for Gravity Sewers - Trenched No Surf Rest (New)		
Pipe Diameter (feet)	<15'	>15'
0.67	$4	$4
0.83	$4	$5
1.00	$4	$5
1.25	$4	$5
1.50	$5	$6
1.75	$5	$6
2.00	$6	$7
2.25	$6	$8
2.50	$7	$8
3.00	$8	$10
3.50	$10	$12
4.00	$11	$14
4.50	$13	$16
5.00	$15	$18
5.50	$17	$21
6.00	$18	$23
6.50	$20	$25
7.00	$22	$28
7.50	$24	$30
8.00	$26	$32
8.67	$28	$35
9.17	$29	$36

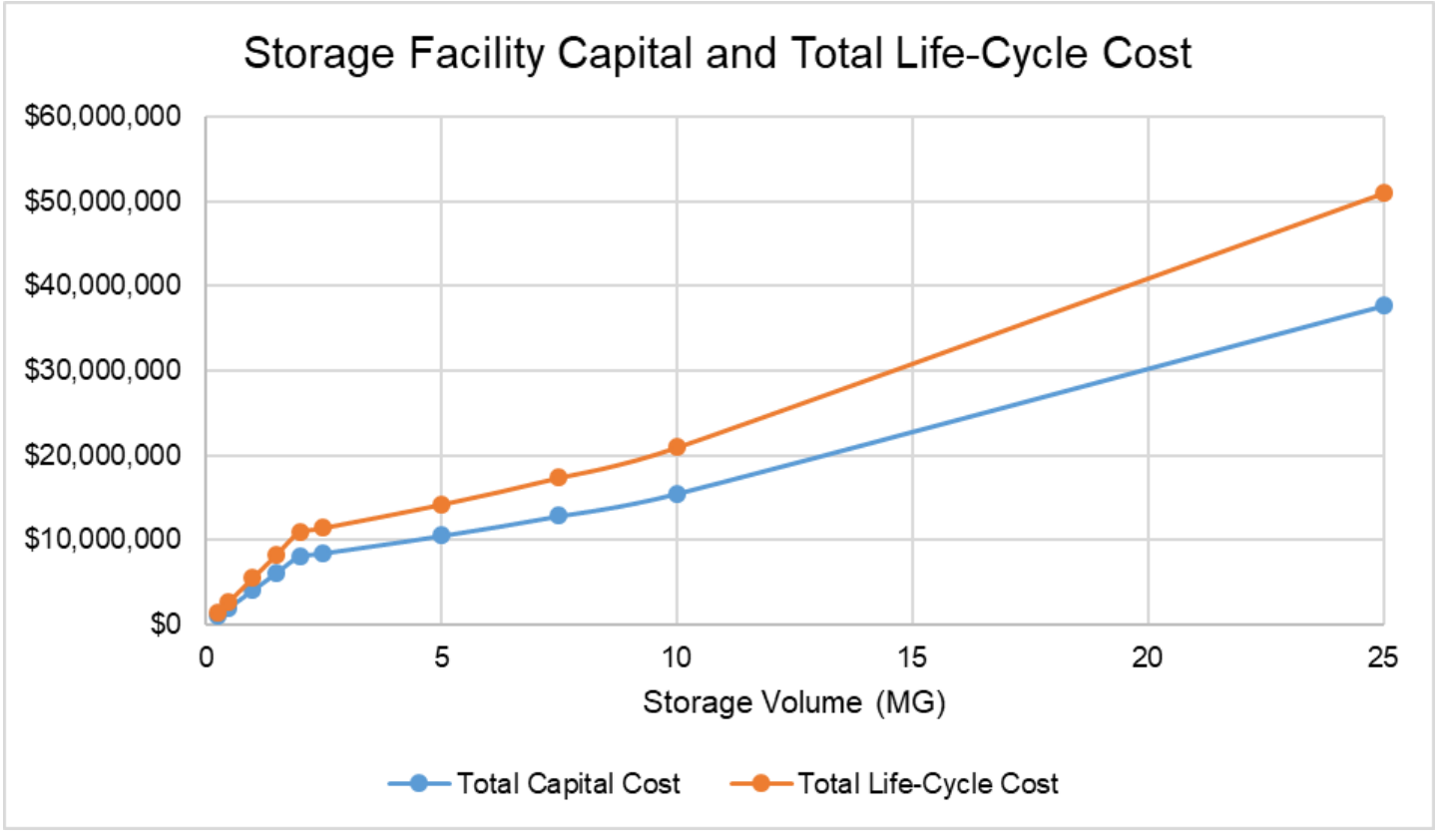
=

Total Project Cost for Gravity Sewers - Trenched No Surf Rest		
Pipe Diameter (feet)	<15'	>15'
0.67	$499	$624
0.83	$520	$650
1.00	$546	$682
1.25	$592	$740
1.50	$647	$808
1.75	$710	$887
2.00	$780	$976
2.25	$859	$1,073
2.50	$943	$1,179
3.00	$1,132	$1,415
3.50	$1,342	$1,677
4.00	$1,570	$1,963
4.50	$1,812	$2,265
5.00	$2,065	$2,581
5.50	$2,324	$2,905
6.00	$2,586	$3,232
6.50	$2,847	$3,559
7.00	$3,103	$3,879
7.50	$3,351	$4,189
8.00	$3,587	$4,484
8.67	$3,875	$4,844
9.17	$4,068	$5,085

Unit Cost Rates – Pump Station Upgrade



Unit Cost Rates – Storage Tanks

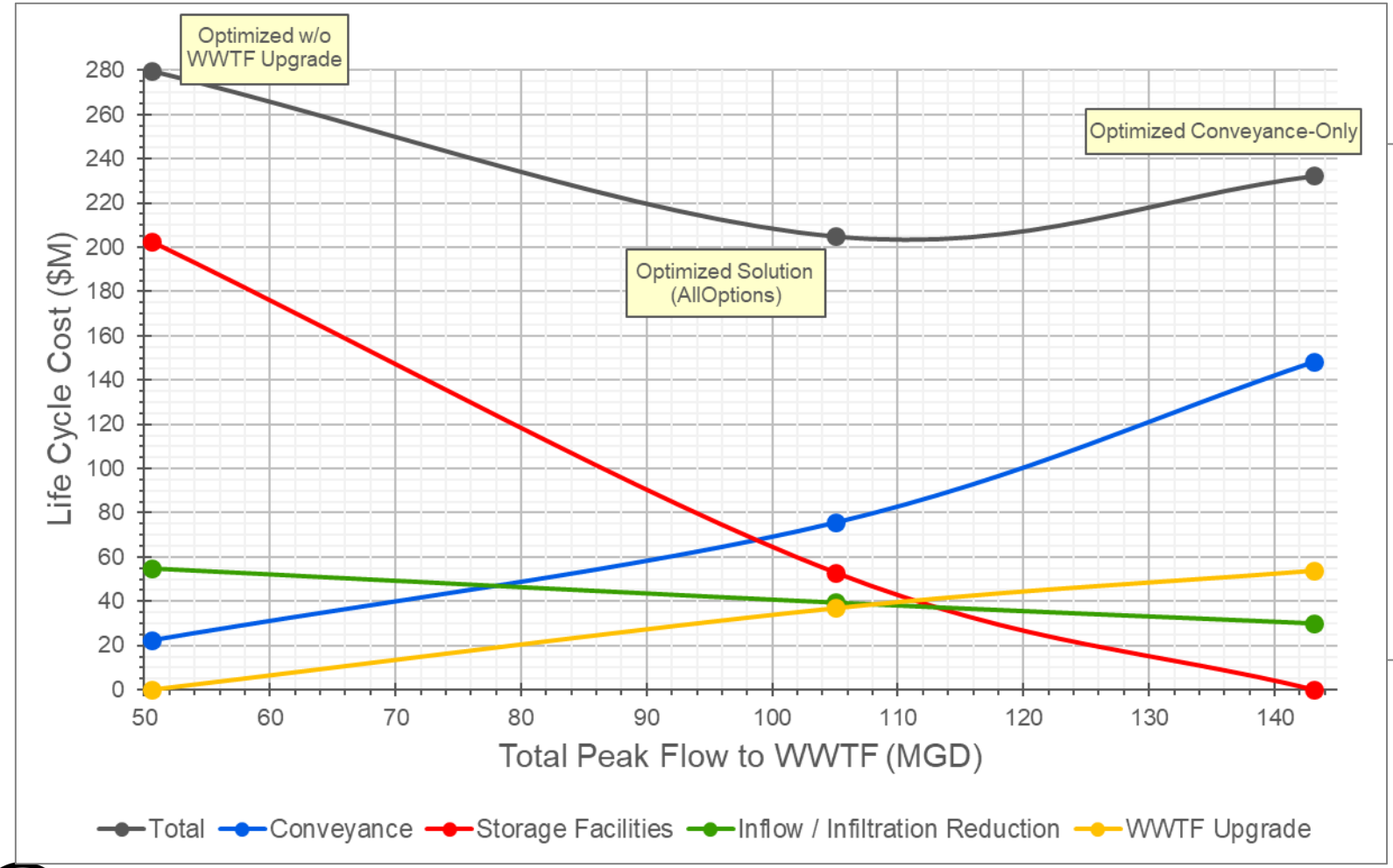


I/I Reduction Alts / Costs - Conservative

Flow Meter Catchment (FMC) ID	Average R	Max I/I Reduction	Max I/I Red. Aggressive	Max I/I Red. Conservative	$/LF	Av. Remain. Life (yrs)	Discount $/LF	Total FMC Length (LF)	Conservative I/I Options									
									I/I Opt. 1	I/I Opt. 1 Cost	I/I Opt. 2	I/I Opt. 2 Cost	I/I Opt. 3	I/I Opt. 3 Cost	I/I Opt. 4	I/I Opt. 4 Cost	I/I Opt. 5	I/I Opt. 5 Cost
UPPERVALLEY-UV1_Flow_NET	27%	65%	60%	30%	$ 95	53	$ 88	26,948	0%	$ -	10%	$ 790,475	20%	$ 1,580,949	30%	$ 2,371,424		
UPPERVALLEY-UV10_Flow_NET	4%				$ 95	49	$ 86	20,056										
UPPERVALLEY-UV11_Flow_NET	4%				$ 95	50	$ 87	30,760										
UPPERVALLEY-UV11A_Flow	6%	27%	20%	10%	$ 95	58	$ 89	20,253	0%	$ -	10%	$ 1,802,517						
UPPERVALLEY-UV2_Flow	24%	62%	60%	30%	$ 95	93	$ 94	21,737	0%	$ -	10%	$ 681,093	20%	$ 1,362,185	30%	$ 2,043,278		
UPPERVALLEY-UV3_Flow_Net	13%	46%	40%	20%	$ 95	44	$ 84	29,183	0%	$ -	10%	$ 1,225,686	20%	$ 2,451,372				
UPPERVALLEY-UV3A_Flow_NET	16%	51%	50%	30%	$ 95	40	$ 82	59,415	0%	$ -	10%	$ 1,624,010	20%	$ 3,248,020	30%	$ 4,872,030		
UPPERVALLEY-UV3B_Flow	2%				$ 95	39	$ 81	28,356										
UPPERVALLEY-UV4_Flow_NET	17%	53%	50%	30%	$ 95	46	$ 85	37,156	0%	$ -	10%	$ 1,052,753	20%	$ 2,105,507	30%	$ 3,158,260		
UPPERVALLEY-UV4B_Flow_NET	16%	52%	50%	30%	$ 95	67	$ 91	31,433	0%	$ -	10%	$ 953,468	20%	$ 1,906,935	30%	$ 2,860,403		
UPPERVALLEY-UV5_Flow	9%	36%	30%	20%	$ 95	62	$ 90	31,160	0%	$ -	10%	$ 1,402,200	20%	$ 2,804,400				
UPPERVALLEY-UV6_Flow	28%	66%	60%	30%	$ 95	43	$ 83	14,762	0%	$ -	10%	$ 408,415	20%	$ 816,831	30%	$ 1,225,246		
UPPERVALLEY-UV7_Flow	11%	41%	40%	20%	$ 95	38	$ 80	41,707	0%	$ -	10%	$ 1,668,280	20%	$ 3,336,560				
UPPERVALLEY-UV9_Flow_NET	6%	26%	20%	10%	$ 95	47	$ 85	48,812	0%	$ -	10%	$ 4,149,020						
VA10A_Flow	5%	22%	20%	10%	$ 95	66	$ 91	22,400	0%	$ -	10%	$ 2,038,400						
VA11A_Flow	1%				$ 95	58	$ 89	29,370										
VA11B_Flow	27%	65%	60%	30%	$ 95	999	$ 95	4,430	0%	$ -	10%	$ 140,283	20%	$ 280,567	30%	$ 420,850		
VA13A_Flow	23%	61%	60%	30%	$ 95	999	$ 95	9,237	0%	$ -	10%	$ 292,505	20%	$ 585,010	30%	$ 877,515		
VA13B_Flow	10%	39%	30%	20%	$ 95	999	$ 95	25,898	0%	$ -	10%	$ 1,230,155	20%	$ 2,460,310				
VA14D_Flow	6%	24%	20%	10%	$ 95	999	$ 95	5,083	0%	$ -	10%	$ 482,885						
VA16B_Flow	3%				$ 95	999	$ 95	7,783										
VA16C_Flow	16%	51%	50%	30%	$ 95	999	$ 95	16,299	0%	$ -	10%	$ 516,135	20%	$ 1,032,270	30%	$ 1,548,405		
VA1X1J_Flow	1%				$ 95	999	$ 95	17,222										
VA2B_Flow	3%				$ 95	999	$ 95	19,875										
VA3A3_Flow	19%	57%	50%	30%	$ 95	999	$ 95	36,160	0%	$ -	10%	$ 1,145,067	20%	$ 2,290,133	30%	$ 3,435,200		
VA3A4_Flow	12%	45%	40%	20%	$ 95	999	$ 95	31,379	0%	$ -	10%	$ 1,490,503	20%	$ 2,981,005				
VALLEY-SVA1_Flow_NET	20%	57%	50%	30%	$ 95	56	$ 89	29,840	0%	$ -	10%	$ 885,253	20%	$ 1,770,507	30%	$ 2,655,760		
VALLEY-SVA1A_Flow	9%	37%	30%	20%	$ 95	71	$ 92	31,260	0%	$ -	10%	$ 1,437,960	20%	$ 2,875,920				
VALLEY-SVA1B_Flow	5%	24%	20%	10%	$ 95	80	$ 93	51,241	0%	$ -	10%	$ 4,765,413						
VALLEY-SVA2_Flow_NET	9%	38%	30%	20%	$ 95	74	$ 92	46,936	0%	$ -	10%	$ 2,159,056	20%	$ 4,318,112				
VALLEY-SVA2A_Flow_NET	2%				$ 95	84	$ 93	82,378										
VALLEY-VA10_Flow_Net	7%	30%	30%	10%	$ 95	999	$ 95	17,908	0%	$ -	10%	$ 1,701,260						
VALLEY-VA11_Flow_Net	22%	60%	50%	30%	$ 95	999	$ 95	18,538	0%	$ -	10%	$ 587,037	20%	$ 1,174,073	30%	$ 1,761,110		
VALLEY-VA12_Flow	13%	47%	40%	20%	$ 95	54	$ 88	66,390	0%	$ -	10%	$ 2,921,160	20%	$ 5,842,320				
VALLEY-VA13_Flow_NET	12%	44%	40%	20%	$ 95	999	$ 95	18,196	0%	$ -	10%	$ 864,310	20%	$ 1,728,620				
VALLEY-VA14_Flow_NET	32%	70%	60%	40%	$ 95	55	$ 89	7,561	0%	$ -	10%	$ 168,232	20%	$ 336,465	30%	$ 504,697	40%	$ 672,929
VALLEY-VA14A_Flow	15%	49%	40%	20%	$ 95	97	$ 94	12,806	0%	$ -	10%	$ 601,882	20%	$ 1,203,764				
VALLEY-VA14B_Flow	13%	46%	40%	20%	$ 95	56	$ 89	20,810	0%	$ -	10%	$ 926,045	20%	$ 1,852,090				
VALLEY-VA14C_Flow_NET	8%	35%	30%	20%	$ 95	70	$ 92	14,781	0%	$ -	10%	$ 679,926	20%	$ 1,359,852				
VALLEY-VA15_Flow_NET	14%	48%	40%	20%	$ 95	89	$ 94	32,307	0%	$ -	10%	$ 1,518,429	20%	$ 3,036,858				
VALLEY-VA15A_Flow	9%	36%	30%	20%	$ 95	90	$ 94	18,459	0%	$ -	10%	$ 867,573	20%	$ 1,735,146				

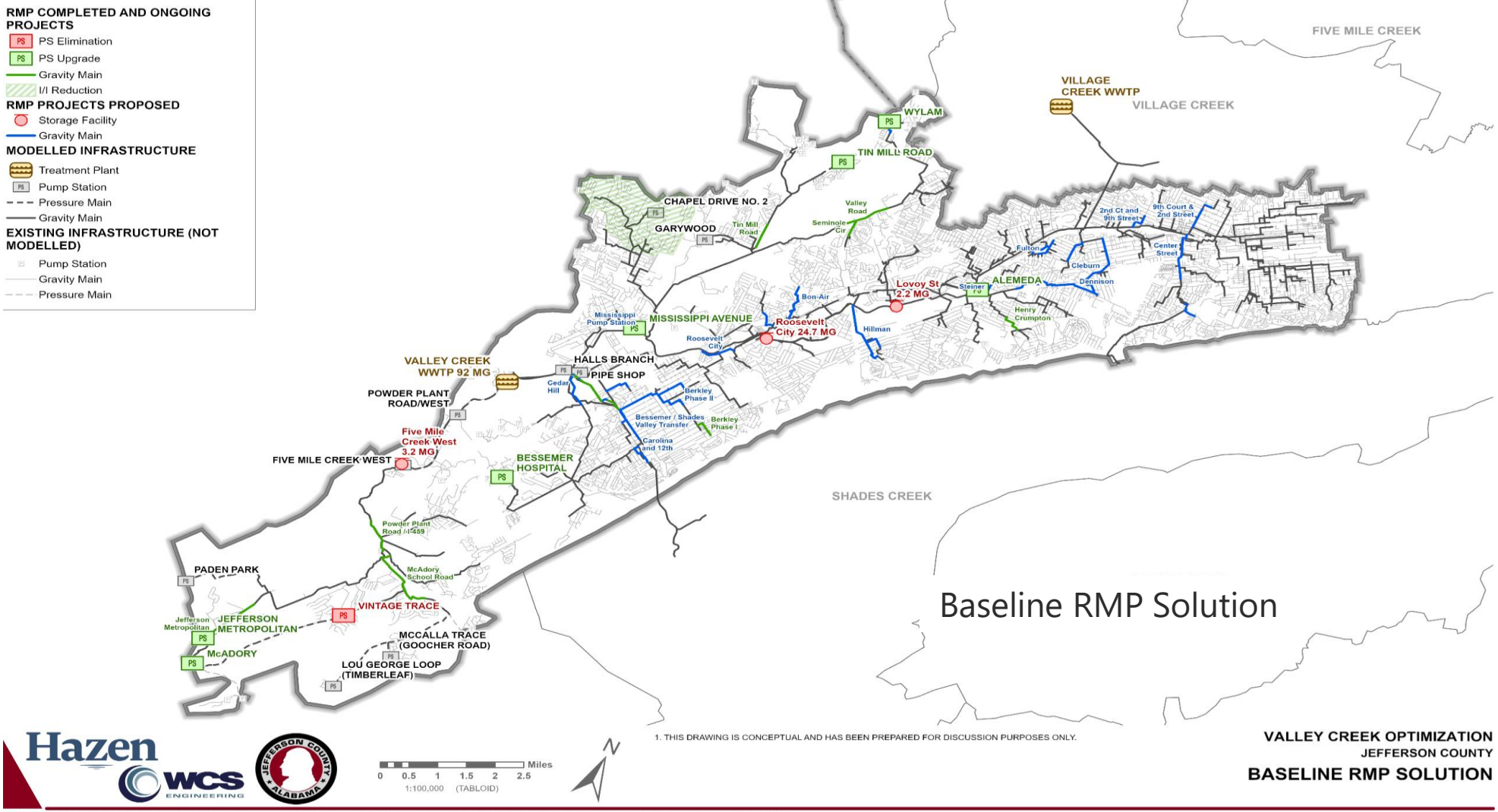
$$\text{RDII \% Reduction} = \textit{Initial RDII factor} \times \textit{Percentage Complete}$$
$$= (0.257Ln(-0.0445x + 0.0445 + RDII_{Pre}) + 0.988) \times x^{1.055}$$

Optimization Alternatives Considered (Valley Creek)



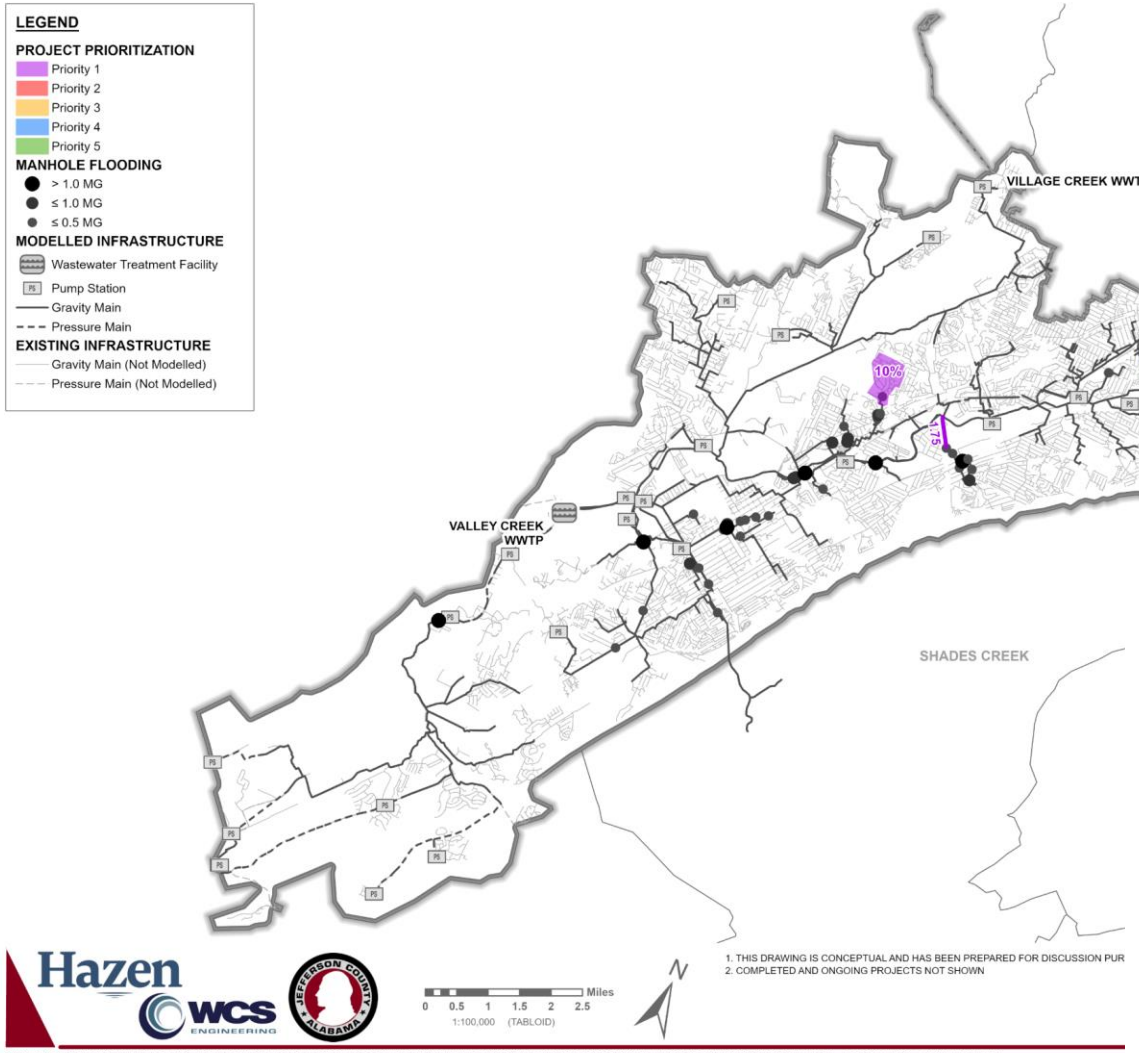
Alternatives include:

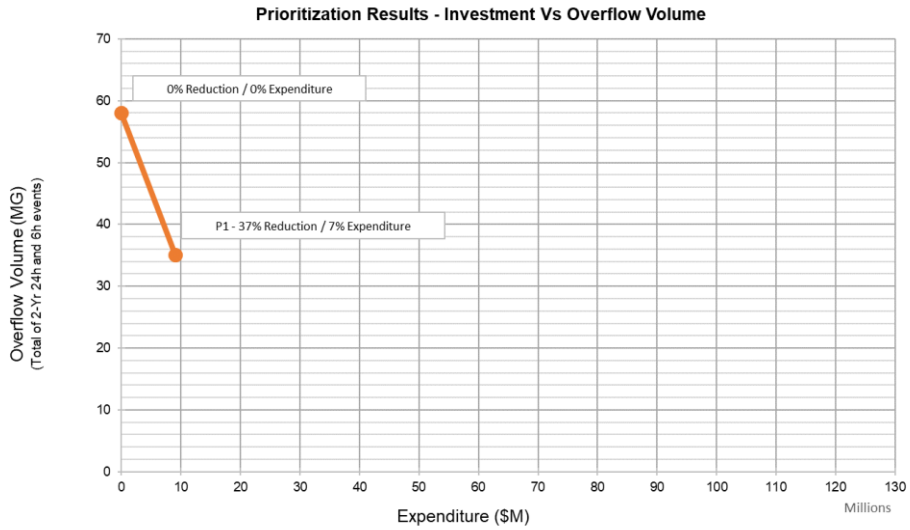
- 130,000 LF of upsize gravity sewers
- 89,700 LF of parallel gravity sewers
- 29,300 LF of force main
- 2 pump upgrade options
- 1 new wet weather PS option
- 11 storage sites
- 72 I/I reduction basins


RMP COMPLETED AND ONGOING PROJECTS
PS PS Elimination
PS PS Upgrade
Gravity Main
I/I Reduction
RMP PROJECTS PROPOSED
Storage Facility
Gravity Main
MODELLED INFRASTRUCTURE
Treatment Plant
Pump Station
Pressure Main
Gravity Main
EXISTING INFRASTRUCTURE (NOT MODELLED)
Pump Station
Gravity Main
Pressure Main
FIVE MILE CREEK
VILLAGE CREEK WWTP
VILLAGE CREEK
WYLAM
TIN MILL ROAD
CHAPEL DRIVE NO. 2
GARYWOOD
Tin Mill Road
Valley Road
Seminole Cir
2nd Ct and 9th Street
9th Court & 2nd Street
Fulton
Center Street
Cleburn
Dennison
ALEMEDA
Steiner
Lovoy St 2.2 MG
Bon-Air
Hillman
Henry Crumpton
MISSISSIPPI AVENUE
Mississippi Pump Station
Roosevelt City
Roosevelt City 24.7 MG
VALLEY CREEK WWTP 92 MG
HALLS BRANCH
PIPE SHOP
Cedar Hill
Berkley Phase II
Berkley Phase I
Bessemer / Shades Valley Transfer
Carolina and 12th
POWDER PLANT ROAD/WEST
Five Mile Creek West 3.2 MG
FIVE MILE CREEK WEST
BESSEMER HOSPITAL
SHADES CREEK
Powder Plant Road /I-459
PADEN PARK
McAdory School Road
VINTAGE TRACE
Jefferson Metropolitan
JEFFERSON METROPOLITAN
MCCALLA TRACE (GOOCHER ROAD)
McADORY
LOU GEORGE LOOP (TIMBERLEAF)
Baseline RMP Solution
Hazen
WCS ENGINEERING
JEFFERSON COUNTY ALABAMA
0 0.5 1 1.5 2 2.5 Miles
1:100,000 (TABLOID)
1. THIS DRAWING IS CONCEPTUAL AND HAS BEEN PREPARED FOR DISCUSSION PURPOSES ONLY.
VALLEY CREEK OPTIMIZATION
JEFFERSON COUNTY
BASELINE RMP SOLUTION
ATH: C:\USERS\ALVAR\WCS\WCS - DOCUMENTS\01 ACTIVE PROJECTS\312 JEFFERSON COUNTY\01 VALLEY CREEK\06 MAPPING\02 PROJECTS\JC_VC_RMP.APRX - USER: ALVAR - DATE: 11/12/2019

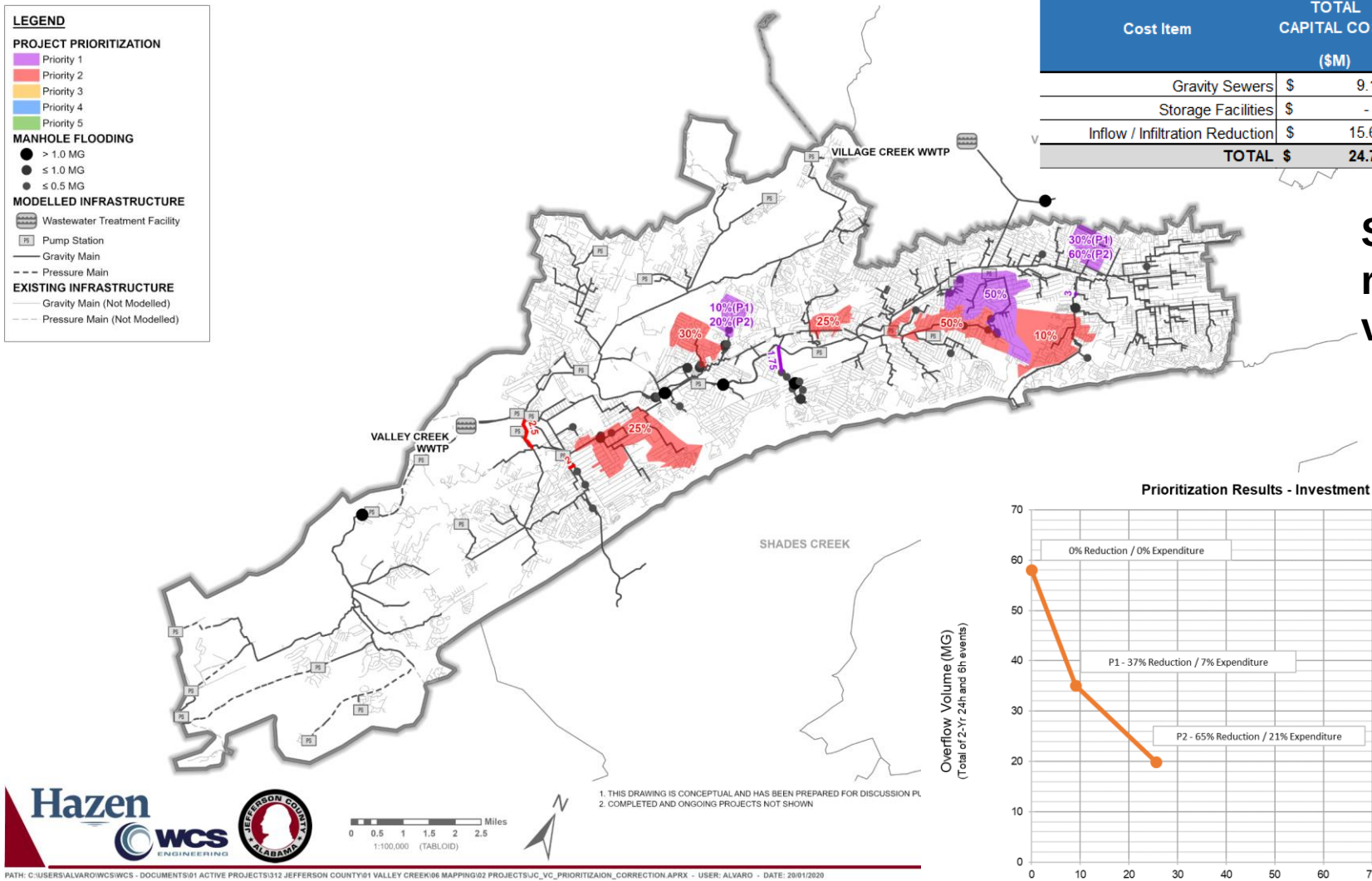
Cost Item	TOTAL CAPITAL COST ($M)	100Y PV O&M COST ($M)	100Y PV REPLACE. COST	TOTAL LIFE CYCLE COST ($M)
Gravity Sewers	$ 3.16	$ 0.19	$ 0.06	$ 3.41
Storage Facilities	$ -	$ -	$ -	$ -
Inflow / Infiltration Reduction	$ 5.62	$ -	$ -	$ 5.62
TOTAL	**$ 8.78**	**$ 0.19**	**$ 0.06**	**$ 9.03**

Spend $8.8M and reduce SSO volume by 37%



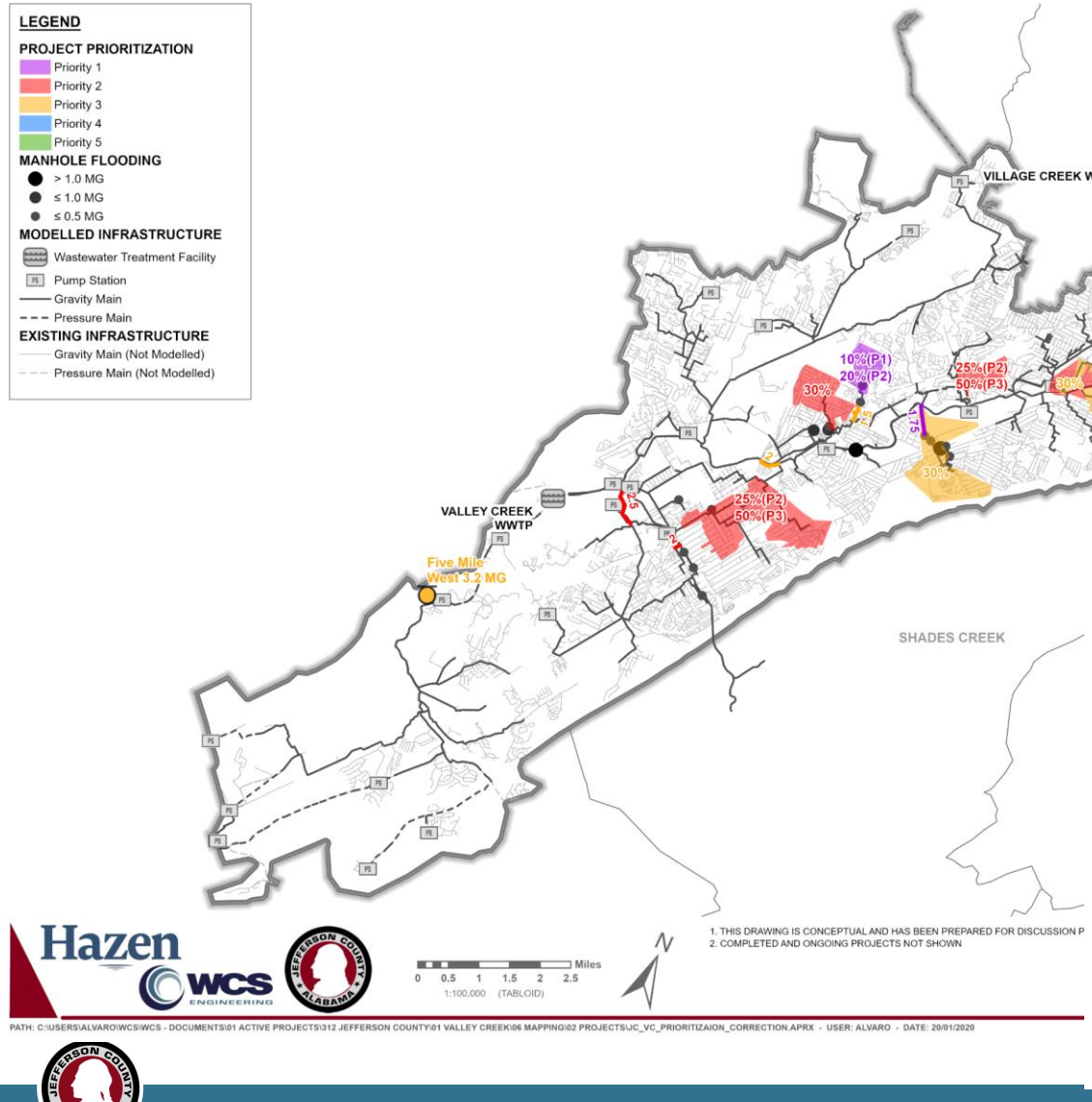


Cost Item	TOTAL CAPITAL COST ($M)	100Y PV O&M COST ($M)	100Y PV REPLACE. COST	TOTAL LIFE CYCLE COST ($M)
Gravity Sewers	$ 9.18	$ 0.55	$ 0.19	$ 9.92
Storage Facilities	$ -	$ -	$ -	$ -
Inflow / Infiltration Reduction	$ 15.61	$ -	$ -	$ 15.61
TOTAL	**$ 24.79**	**$ 0.55**	**$ 0.19**	**$ 25.53**

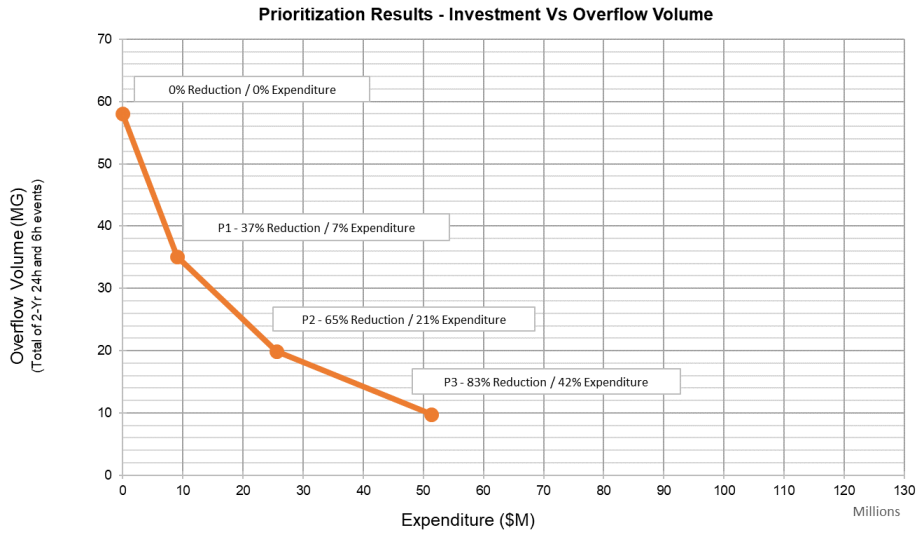


Spend $16M and reduce SSO volume by 28%

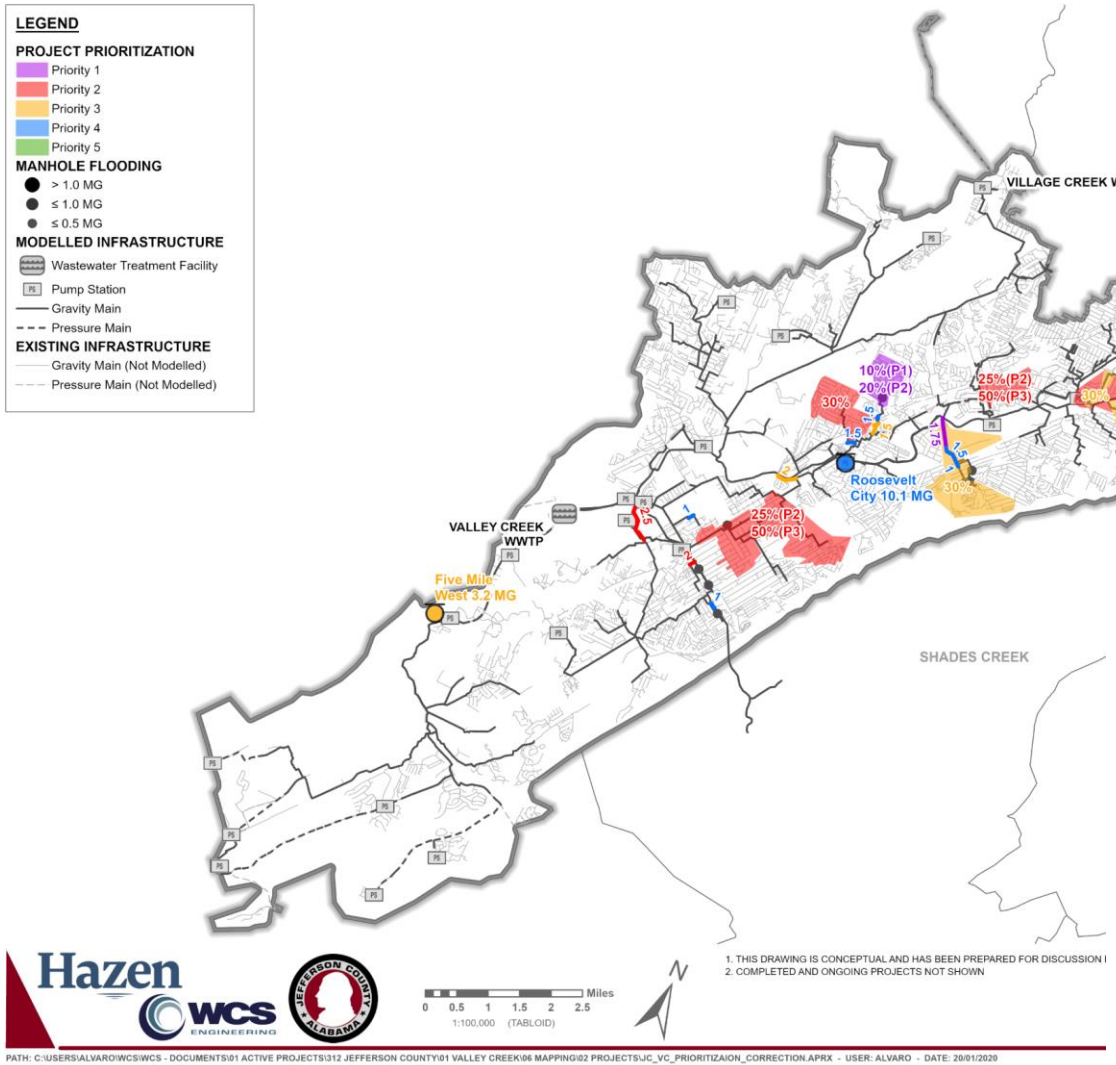
Cost Item	TOTAL CAPITAL COST ($M)	100Y PV O&M COST ($M)	100Y PV REPLACE. COST	TOTAL LIFE CYCLE COST ($M)
Gravity Sewers	$ 15.15	$ 0.90	$ 0.31	$ 16.36
Storage Facilities	$ 9.00	$ 2.68	$ 0.50	$ 12.18
Inflow / Infiltration Reduction	$ 22.86	$ -	$ -	$ 22.86
TOTAL	**$ 47.01**	**$ 3.58**	**$ 0.81**	**$ 51.41**



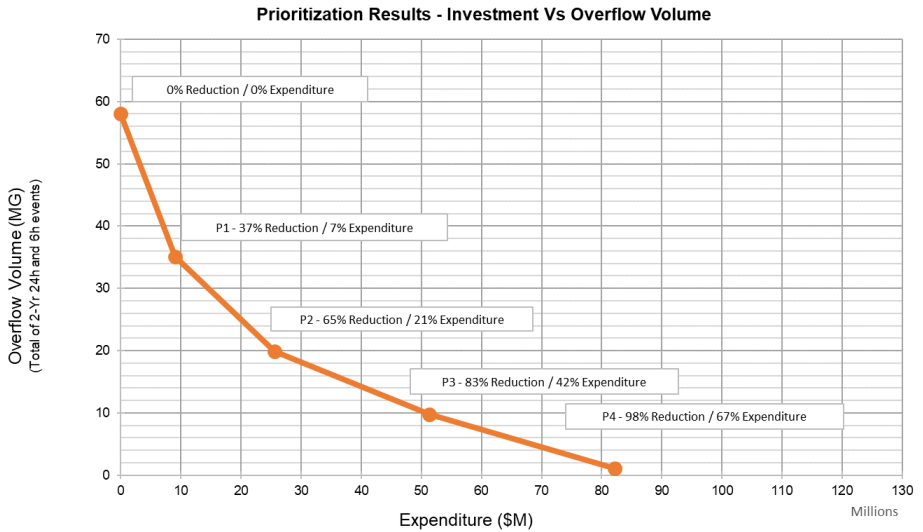
Spend $22.2M and reduce SSO volume by 18%



Cost Item	TOTAL CAPITAL COST ($M)	100Y PV O&M COST ($M)	100Y PV REPLACE. COST	TOTAL LIFE CYCLE COST ($M)
Gravity Sewers	$ 24.10	$ 1.43	$ 0.49	$ 26.02
Storage Facilities	$ 24.59	$ 7.32	$ 1.38	$ 33.29
Inflow / Infiltration Reduction	$ 22.86	$ -	$ -	$ 22.86
TOTAL	**$ 71.55**	**$ 8.76**	**$ 1.87**	**$ 82.17**

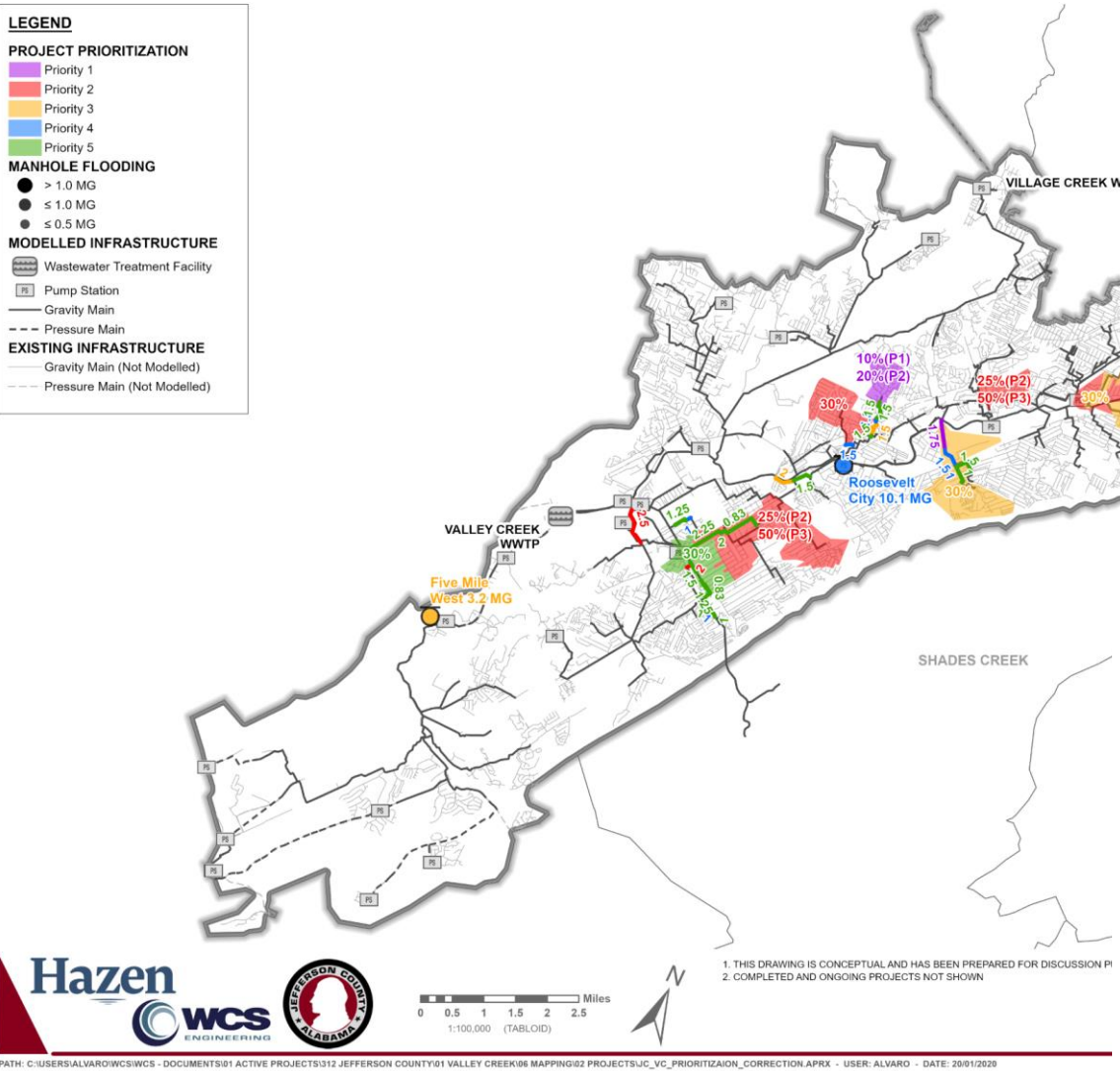


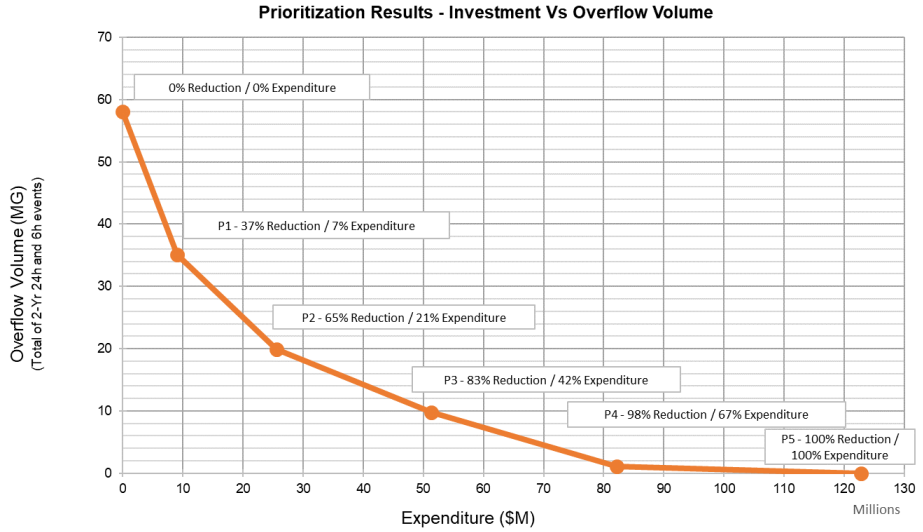
Spend $24.5M and reduce SSO volume by 15%



Cost Item	TOTAL CAPITAL COST ($M)	100Y PV O&M COST ($M)	100Y PV REPLACE. COST	TOTAL LIFE CYCLE COST ($M)
Gravity Sewers	$ 59.77	$ 3.56	$ 1.22	$ 64.54
Storage Facilities	$ 24.59	$ 7.32	$ 1.38	$ 33.29
Inflow / Infiltration Reduction	$ 25.03	$ -	$ -	$ 25.03
TOTAL	**$ 109.38**	**$ 10.88**	**$ 2.60**	**$ 122.86**

Spend $37.8M and reduce SSO volume by 2%

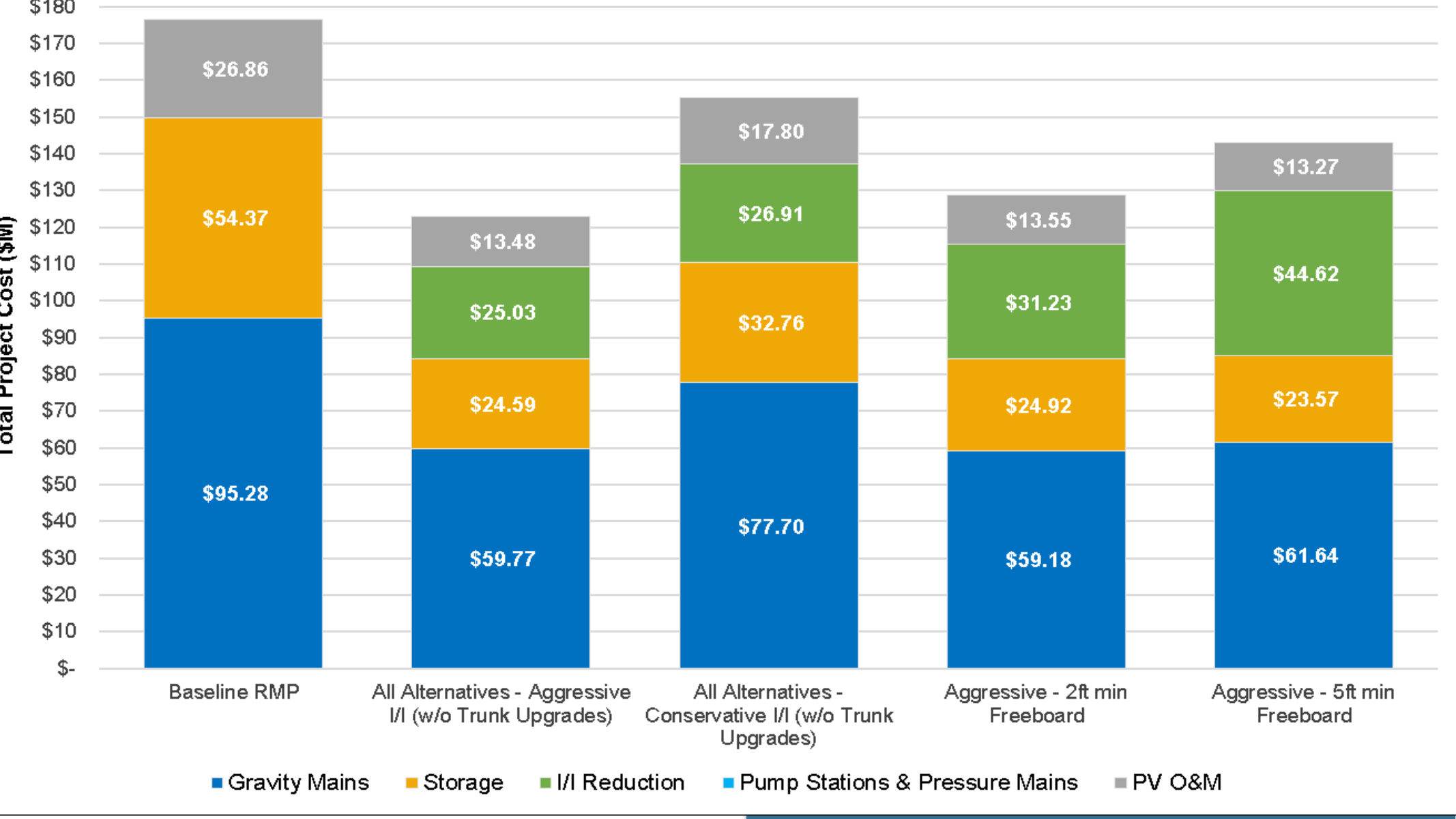




Remedial Measures Prioritization

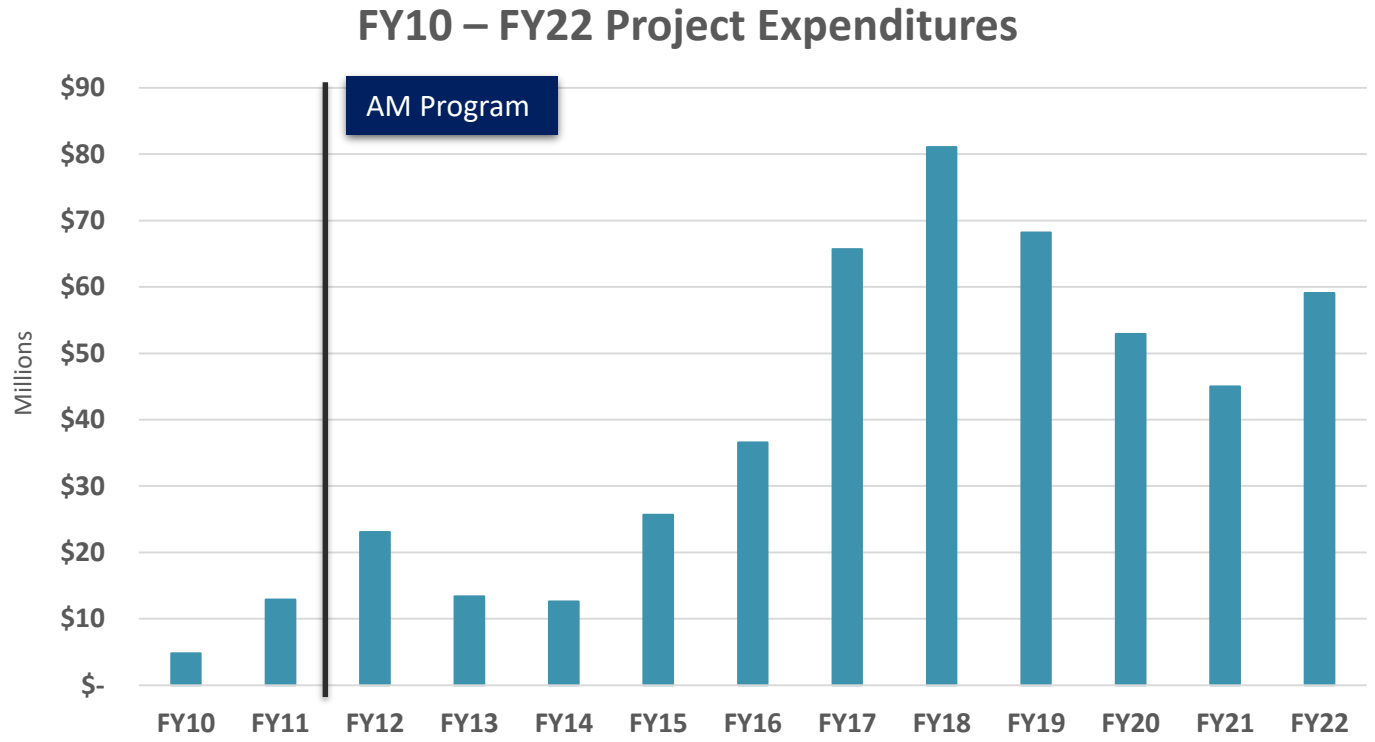
- Following initial optimization and prioritization, Remedial Measures Projects are further prioritized based on:
  - Greater confidence
  - Higher volume
  - # of locations
  - $/gallon
  - Future condition
- The comprehensive system-wide prioritization plan will be updated as models and optimization are completed

Project Category	Description	Priority Score
A	Model-Predicted SSO(s) and Recurring Reported Capacity-Related SSO(s)	5
B	Model-Predicted SSO(s) and Reported Capacity-Related SSO(s) (< 4 occurrences)	4
C	Model-Predicted SSO(s), No Reported Capacity-Related SSOs, but Flow Monitor in Vicinity Indicates Hydraulic Issues exist	4
D	Model-Predicted SSO(s), No Reported Capacity-Related Overflows and Flow Monitor in Vicinity Does not Indicate Hydraulic Issues Exist	2
E	No Model-Predicted SSO, Reported Capacity-Related SSO(s)	2
F	Model-Predicted SSO(s) in Future Flow Condition Only	1


Total Project Cost ($M)
$180
$170
$160
$150
$140
$130
$120
$110
$100
$90
$80
$70
$60
$50
$40
$30
$20
$10
$-
$26.86
$54.37
$95.28
$13.48
$25.03
$24.59
$59.77
$17.80
$26.91
$32.76
$77.70
$13.55
$31.23
$24.92
$59.18
$13.27
$44.62
$23.57
$61.64
Baseline RMP
All Alternatives - Aggressive I/I (w/o Trunk Upgrades)
All Alternatives - Conservative I/I (w/o Trunk Upgrades)
Aggressive - 2ft min Freeboard
Aggressive - 5ft min Freeboard
Gravity Mains
Storage
I/I Reduction
Pump Stations & Pressure Mains
PV O&M

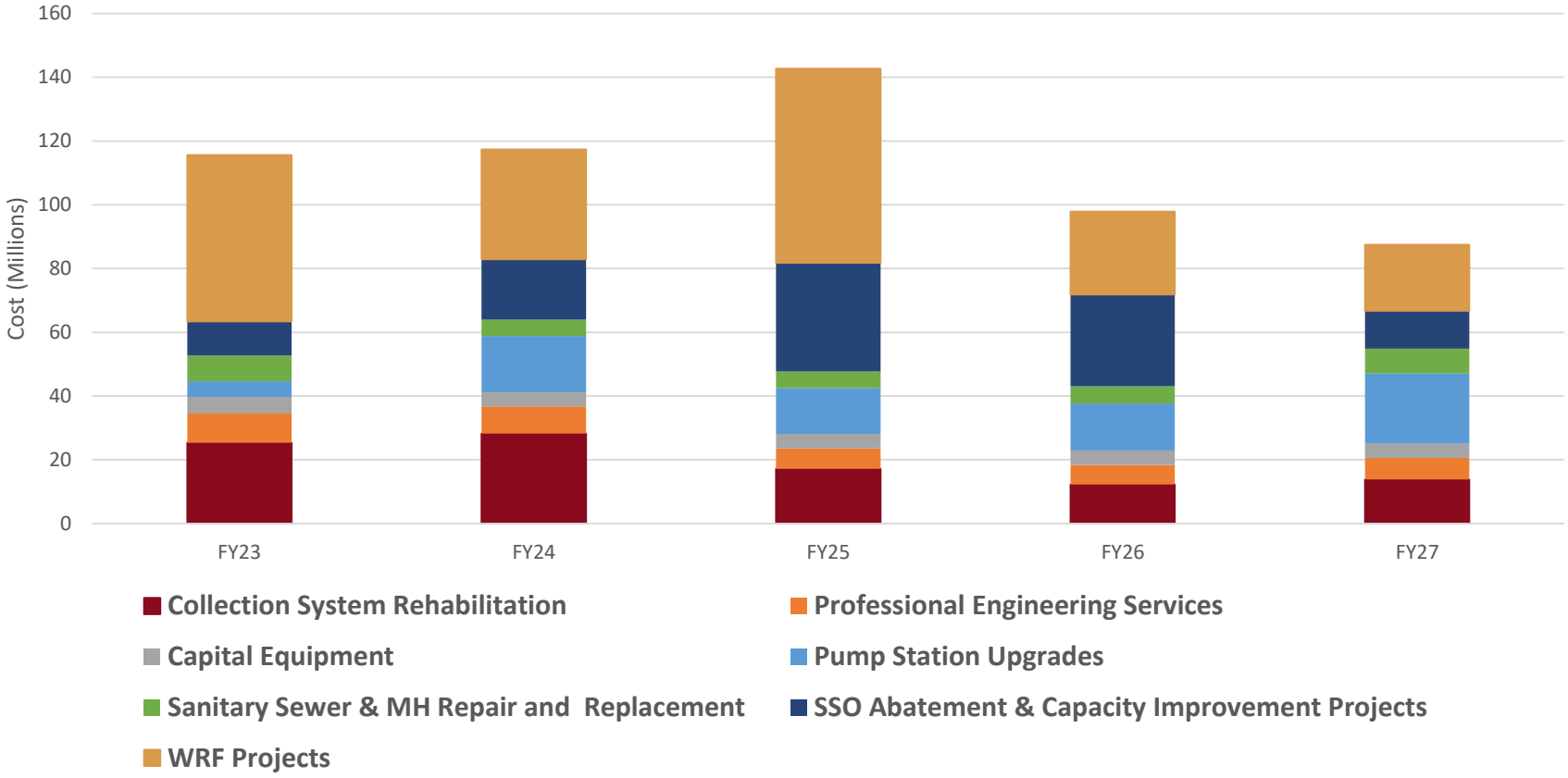
Projected CIP and Cash Flow

Annual Project Expenditures

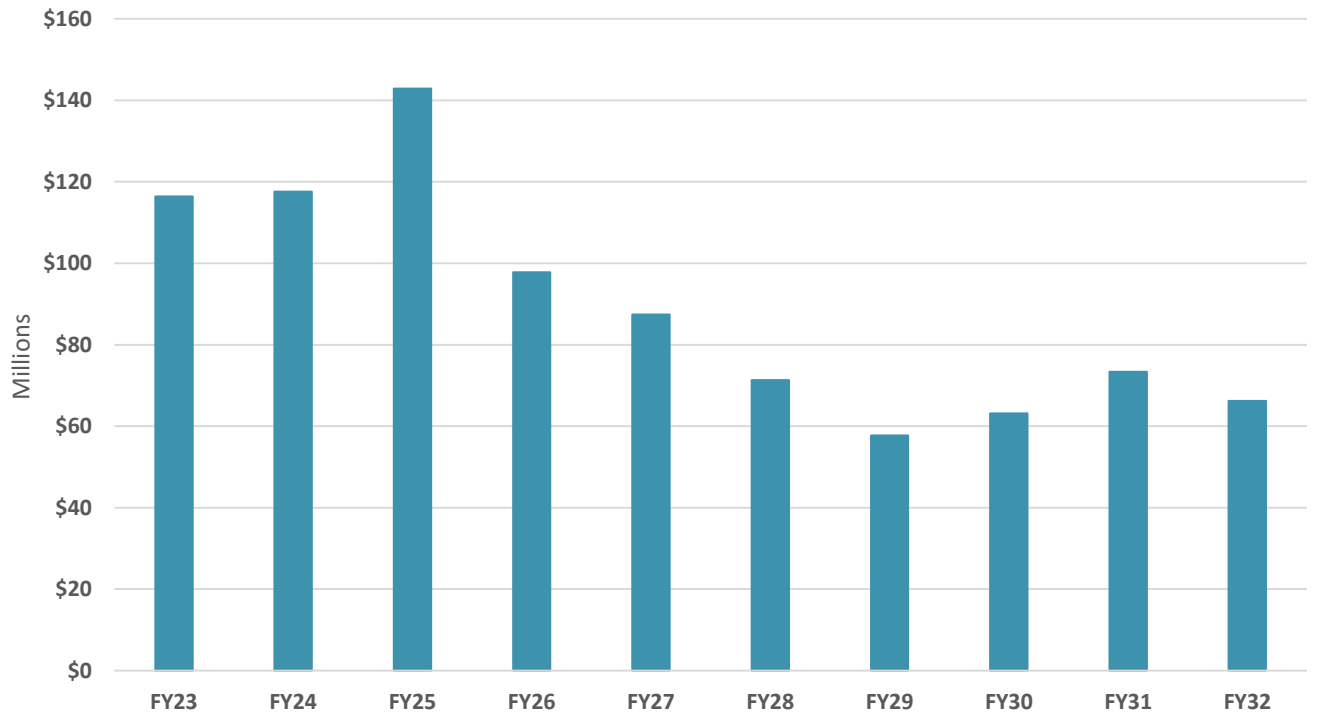


Five Year Capital Improvement Plan

*As of Jan 2023



Ten Year Capital Improvement Plan



*As of Jan 2023

Questions

Stephen King, P.E., BCEE – Hazen and Sawyer
sking@hazenandsawyer.com