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Optimized Collection System Master Plan: Overview of SIAG Role and Participation

Outline

- Introductions
- Presentation Objectives
- Overview of Optimization Process
- Optimization Test Runs on a Hypothetical Bend Collection System Model
- Recent Case Study Example for City in Indiana
- Discussion

Objectives:

- Strengthen SIAG's understanding of the Optimization tool and how it will be used in developing the Master Plan.
- Communicate how SIAG can participate in and influence the optimization process.

Optimization Benefits (recap)

- Ability to evaluate thousands of possible options
  - Transparent
  - Identifies lowest life-cycle cost solutions
  - Identifies only solutions that provide capacity
- Unbiased when compared to traditional planning methods
- >$100M of system improvements = opportunity to look for savings and prioritize investment

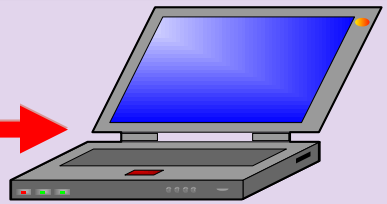
How Does Optimizer WCS™ Work?

Hydraulic Model
(input from SIAG, City of Bend, and MSA Team)

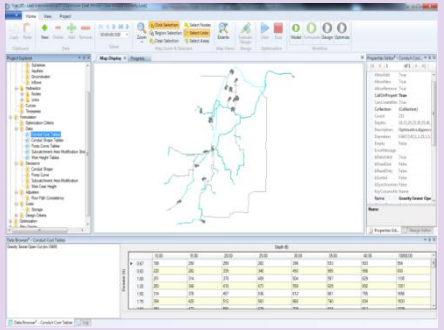
Improvement Options
(input from SIAG, City of Bend, and MSA Team)

Costs
(input from SIAG, City of Bend and MSA Team)

Performance Criteria
(input from SIAG, City of Bend and MSA Team)



Optimizer WCS™



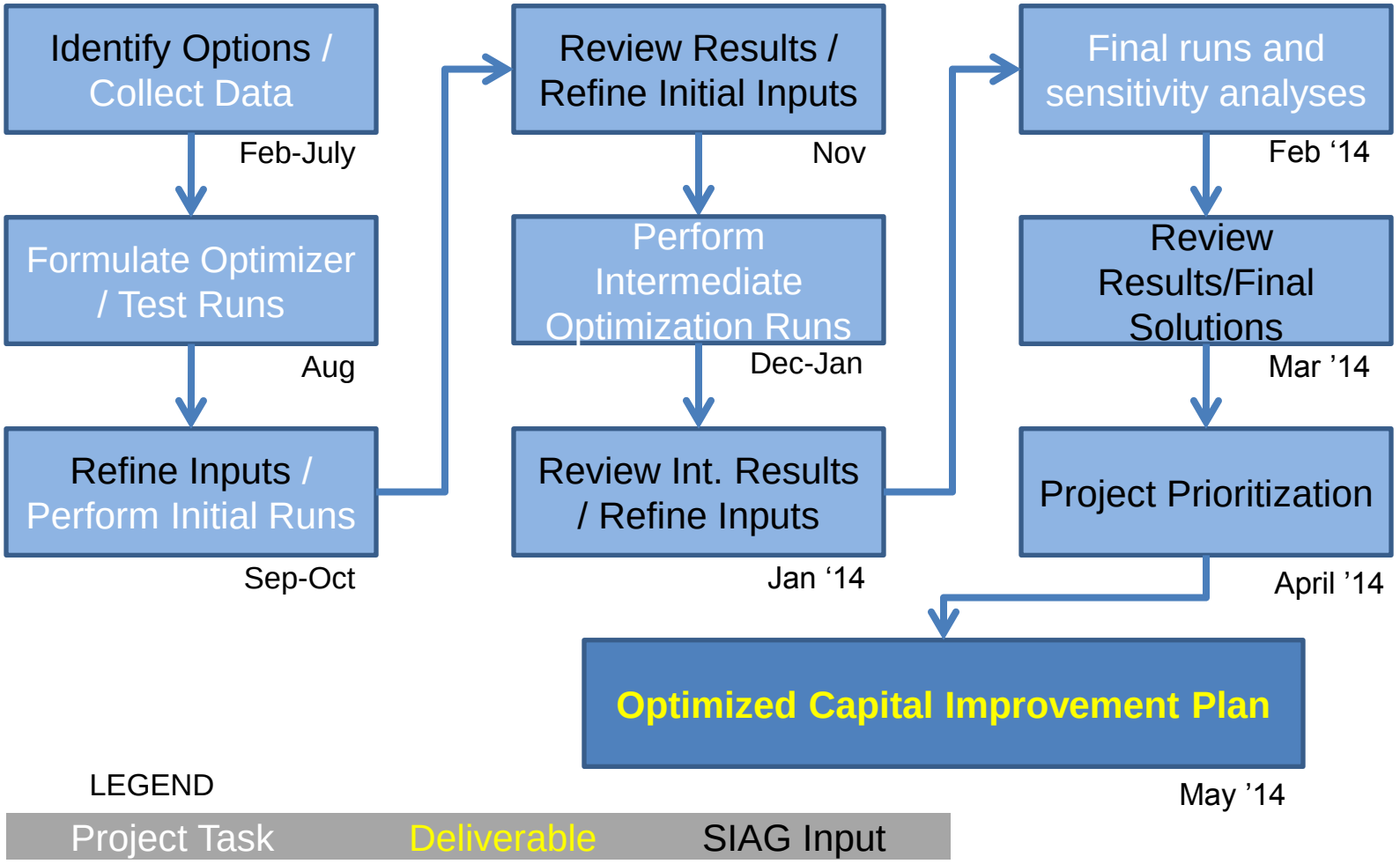
Cost Item	Optimized Solution Cost ($M)
Pipes	44.4
Pumps	0.8
Storage	19.4
Treatment	0.6
Inflow and Infiltration	55.7
Operating Costs	28.8
TOTAL ($M)	149.7

Once initial Optimization Formulation is processed, alternate Scenarios as well as Sensitivity Runs can be performed efficiently

Bend CSMP Optimization SIAG Input

Hydraulic Model (input from SIAG)	Improvement Options (input from SIAG)	Capital / O&M Costs (reviewed by SIAG)	Performance Criteria (reviewed by SIAG)
Land Use - Community values related to density and zoning preferences.	**Pipes** – Alignment alternatives (e.g., weigh in on location preferences).	- Open-cut pipe costs - Trenchless construction costs - Land-use & geol. factors	- Eliminate overflows - System capacity goals
	Pumps – Provide guidance on location preferences for new pumps and aesthetics	- Capital costs for new/upgraded pumps - Energy / O&M costs	- Pump operating requirements - Energy costs
	Storage – Location preferences and review of storage type/technology	- Capital and O&M - Site restoration - Land acquisition - Site specific costs	- Siting requirements - Operating flexibility
	Treatment – Location preferences, technologies (green and traditional)	- Costs for different technologies - Constr / O&M costs	- Land use needs - Nuisance issues - Discharge requirements - Discharge location(s) - Effluent volume limitations

Summary of Optimization Milestones and Opportunity for SIAG Involvement



Key Optimization Tasks and SIAG Inputs

Timing	Tasks	Date
February	• Intro to Optimization • Review Life Cycle, Design Criteria, Viability Criteria	• **Feb 7 SIAG** • **Feb 21 SIAG**
March	• Present pipe/pump/storage options for consideration	• **Mar 7 SIAG** • **Mar 21 (as Req.)**
April	• Present sewer treatment options for consideration	• **April 4 SIAG** • **April 18 (as Req.)**
June/July	• Review location options for pumps, pipes, storage and treatment	• **Date TBD SIAG**
August	• Review unit cost assumptions for all options	• **August 15 SIAG**
November	• Present initial solutions to SIAG and review all options considered to date • SIAG to provide feedback on initial solutions (e.g. options to be added/removed, detailed considerations, etc.)	• **Nov 14 SIAG**

Key Optimization Tasks and SIAG Inputs

Timing	Tasks	Date
January ‘14	• Present intermediate solutions to SIAG • SIAG to provide feedback on interim solutions (e.g. options to be added/removed, detailed considerations, etc.)	• **Jan SIAG**
March ‘14	• Review final solutions with SIAG	• **March SIAG**
May ‘14	• Prioritize Capital Improvement Plan	• **May SIAG**

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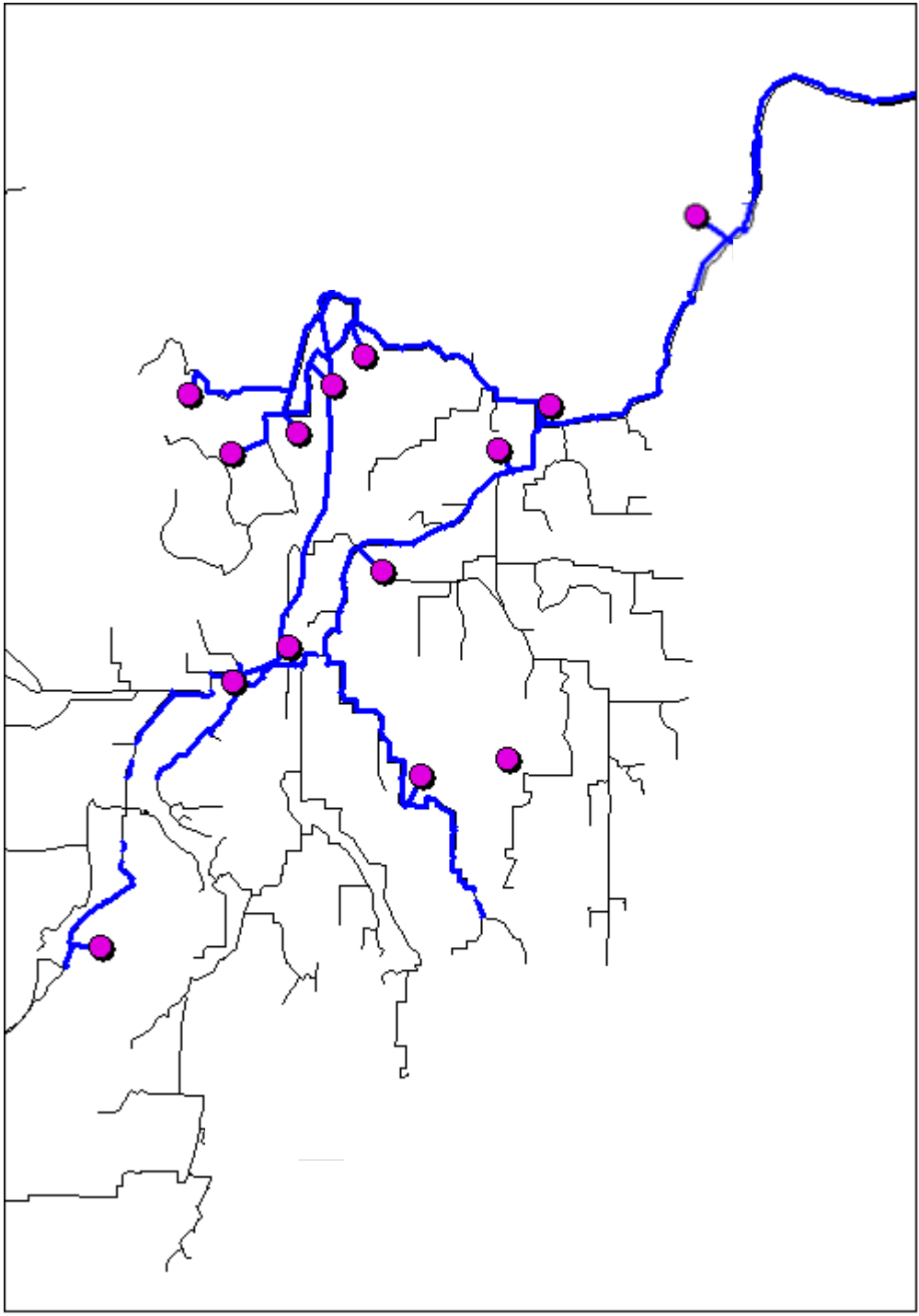
Optimizer Test Runs Using Hypothetical Bend CS Model

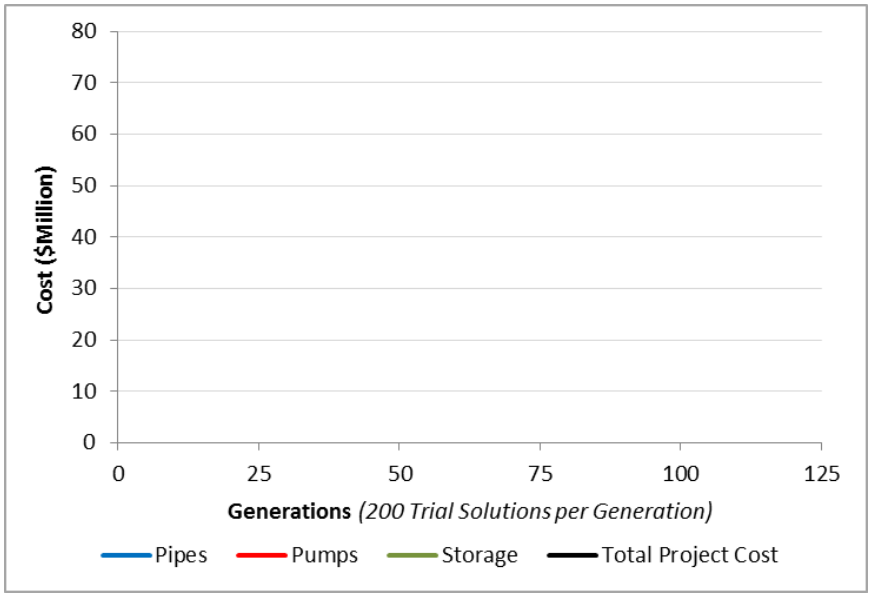
Bend CS Model Prep. for Optimization

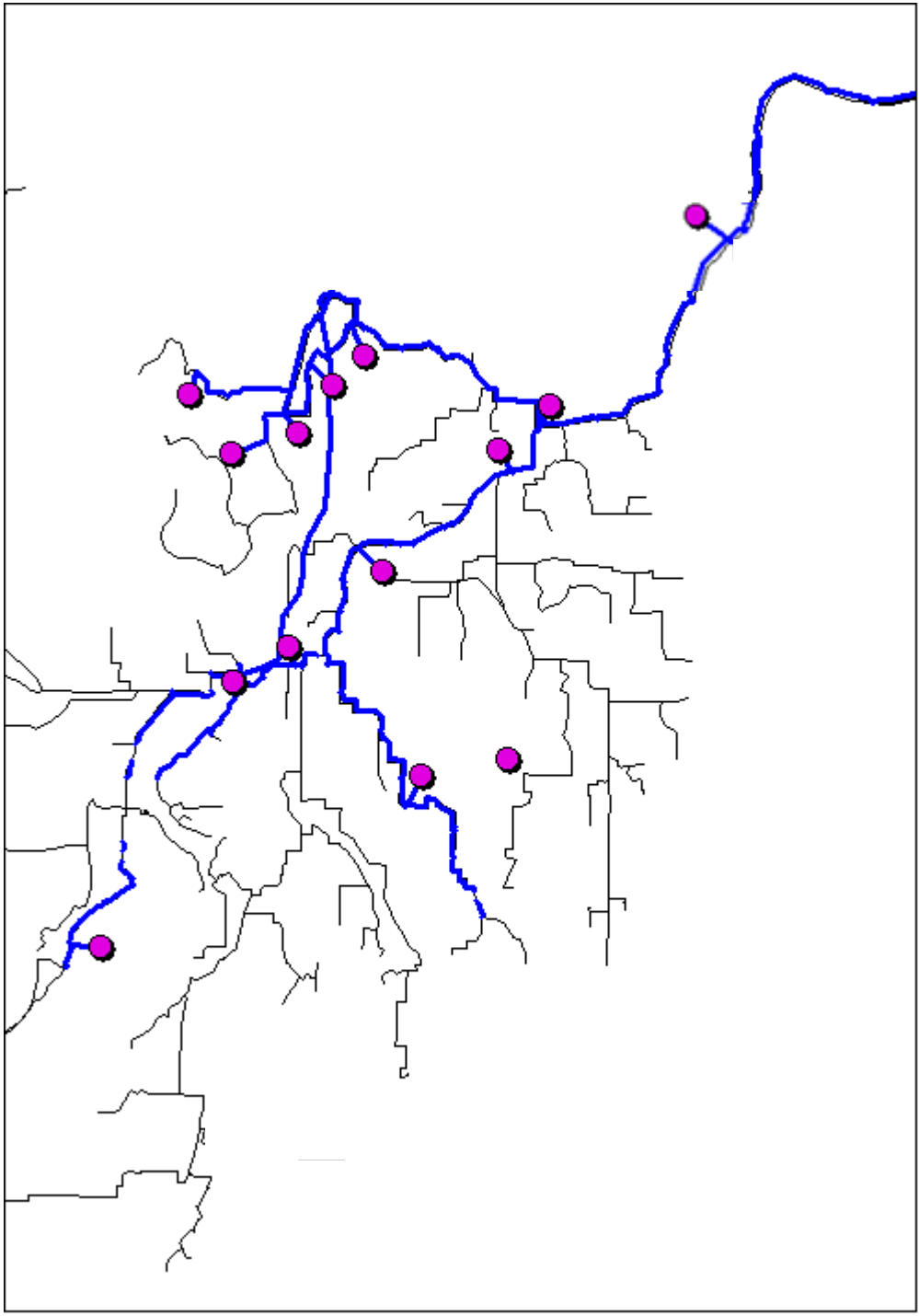
- Pipe and pump options shown in blue
- Storage options shown in purple (14 locations)



Optimization Progress for Initial 200 Trial Solution Evaluations

Cost Item	Total Cost ($ Arb) (Including O&M)
Pipes	
Pumps	
Storage	
Total Project Cost	

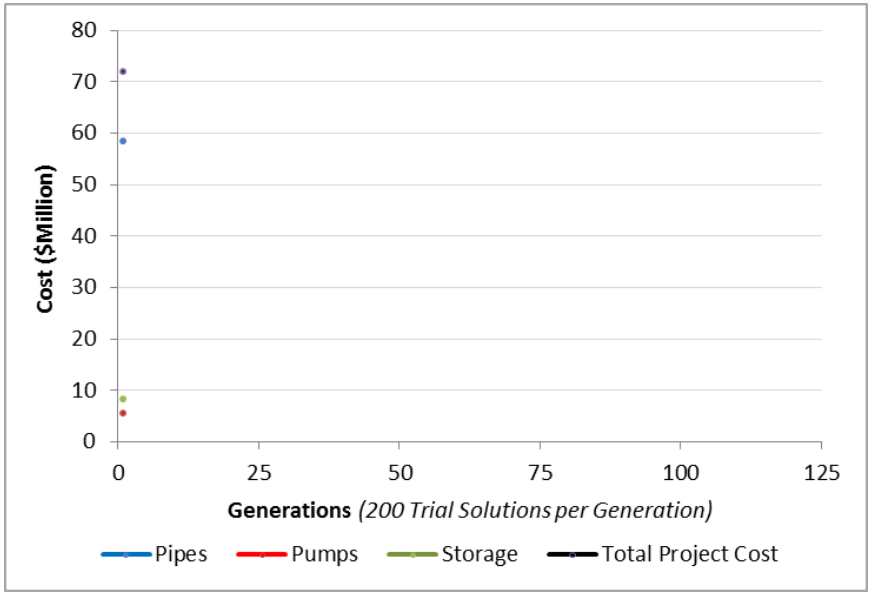




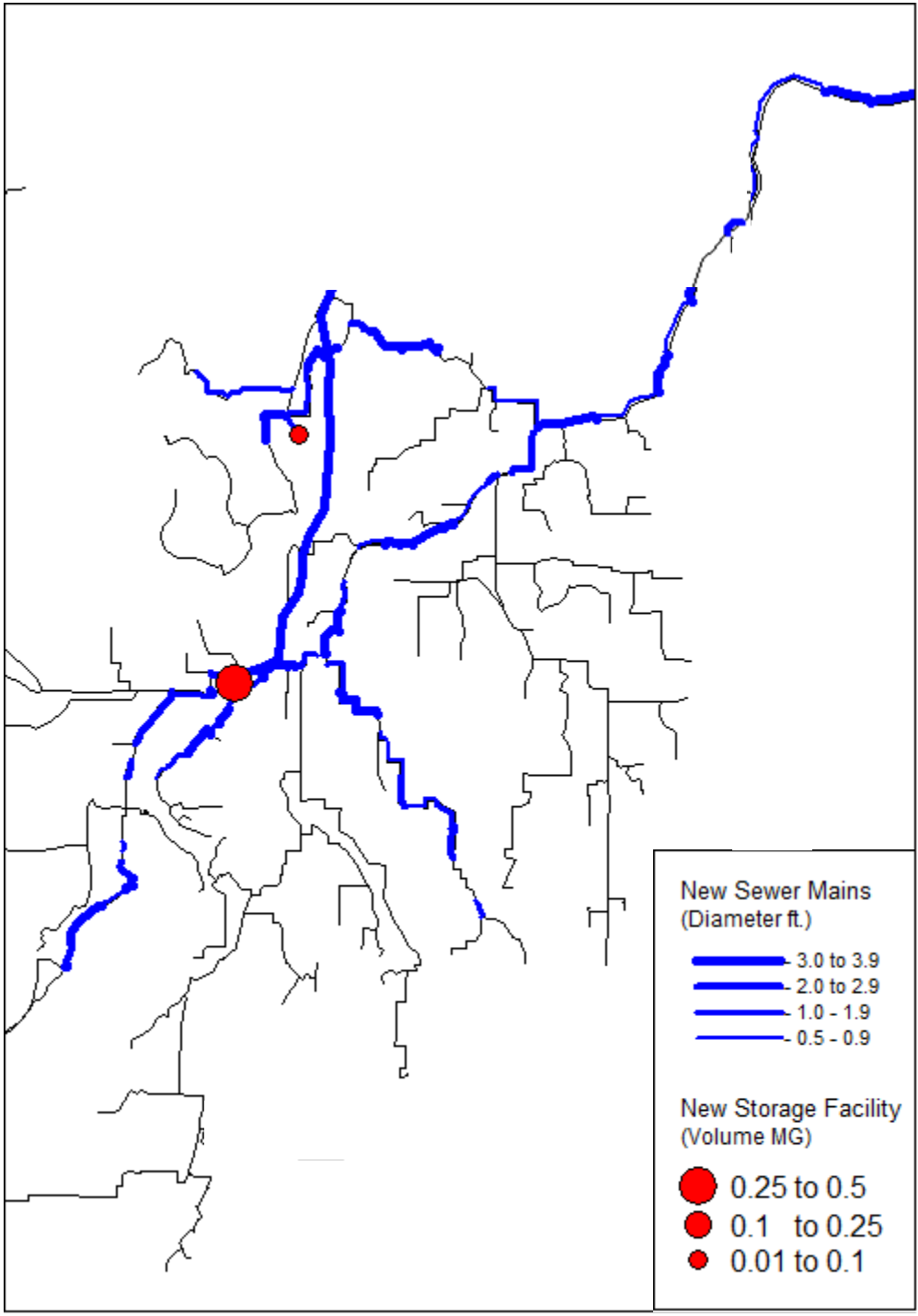
Generation 1 (200 Trial Solutions)

Best Solution in 1st Generation

Cost Item	Total Cost ($ Arb) (Including O&M)
Pipes	58.3
Pumps	5.4
Storage	8.3
Total Project Cost	**72.0**



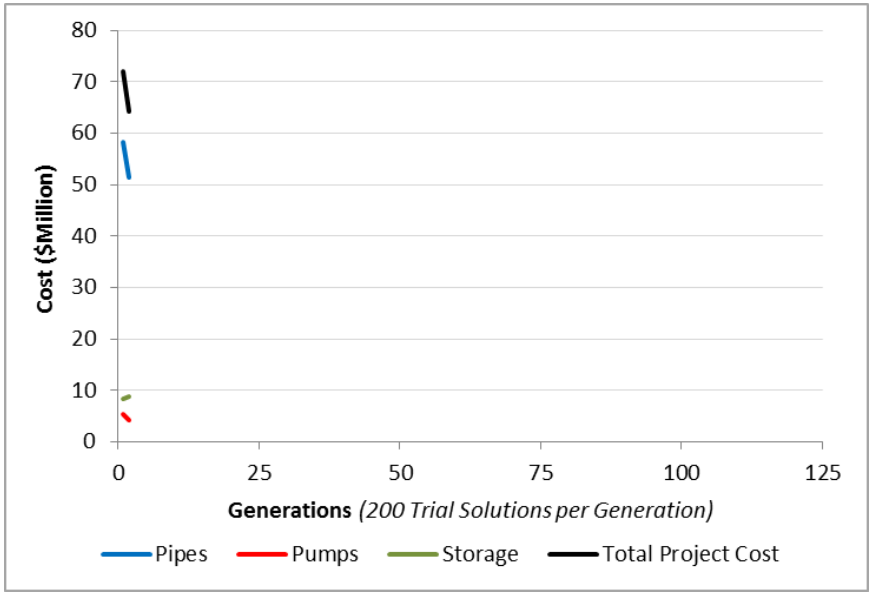
- Actual processing time: 0.15 hours
  (cloud computing using 104 cores in parallel)
- Complete hydraulic analysis of each trial solution
- Detailed life-cycle cost analysis of each trial sol.
- All costs divided by arbitrary value for purpose of demonstration



Generation 2 (400 Trial Solutions)

Best Solution in 2nd Generation

Cost Item	Total Cost ($ Arb) (Including O&M)
Pipes	51.3
Pumps	4.3
Storage	8.7
Total Project Cost	**64.3**



- Actual processing time: 0.3 hours
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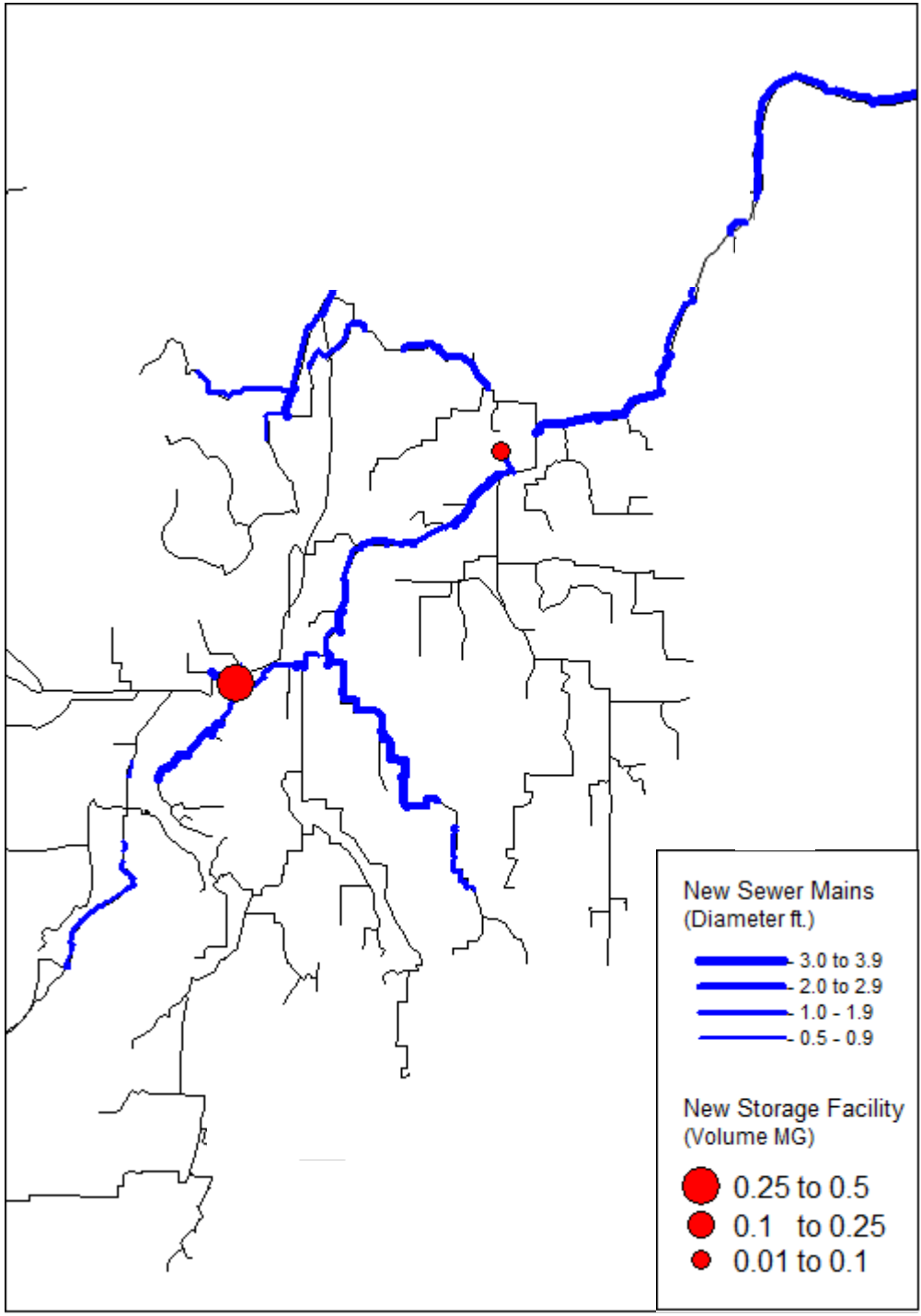
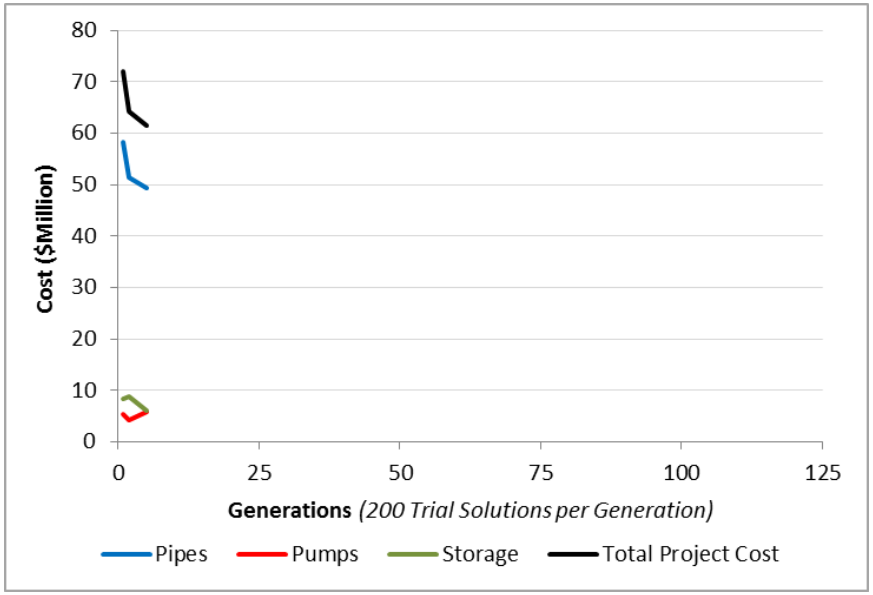
- Complete hydraulic analysis of each trial solution
- Detailed life-cycle cost analysis of each trial sol.
- All costs divided by arbitrary value for purpose of demonstration



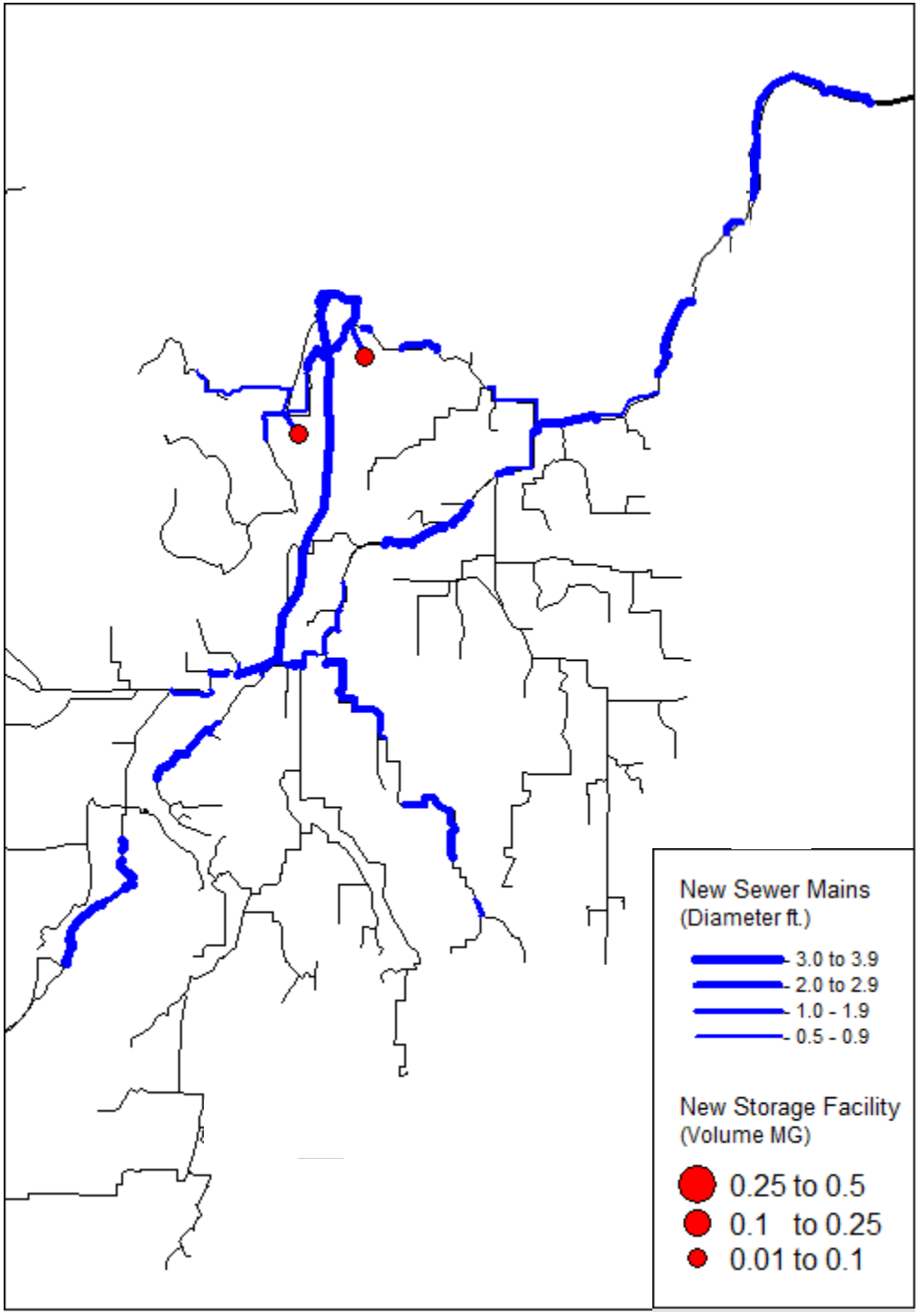
Generation 5 (1,000 Trial Solutions)

Best Solution in 5th Generation

Cost Item	Total Cost ($ Arb) (Including O&M)
Pipes	49.4
Pumps	5.9
Storage	6.1
Total Project Cost	**61.4**



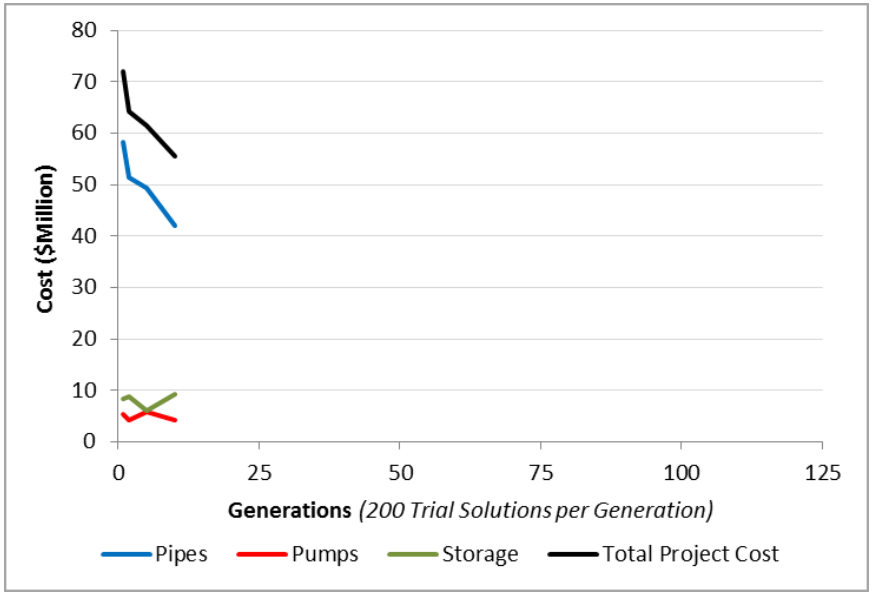
- Actual processing time: 0.75 hours
  (cloud computing using 104 cores in parallel)
- Complete hydraulic analysis of each trial solution
- Detailed life-cycle cost analysis of each trial sol.
- All costs divided by arbitrary value for purpose of demonstration



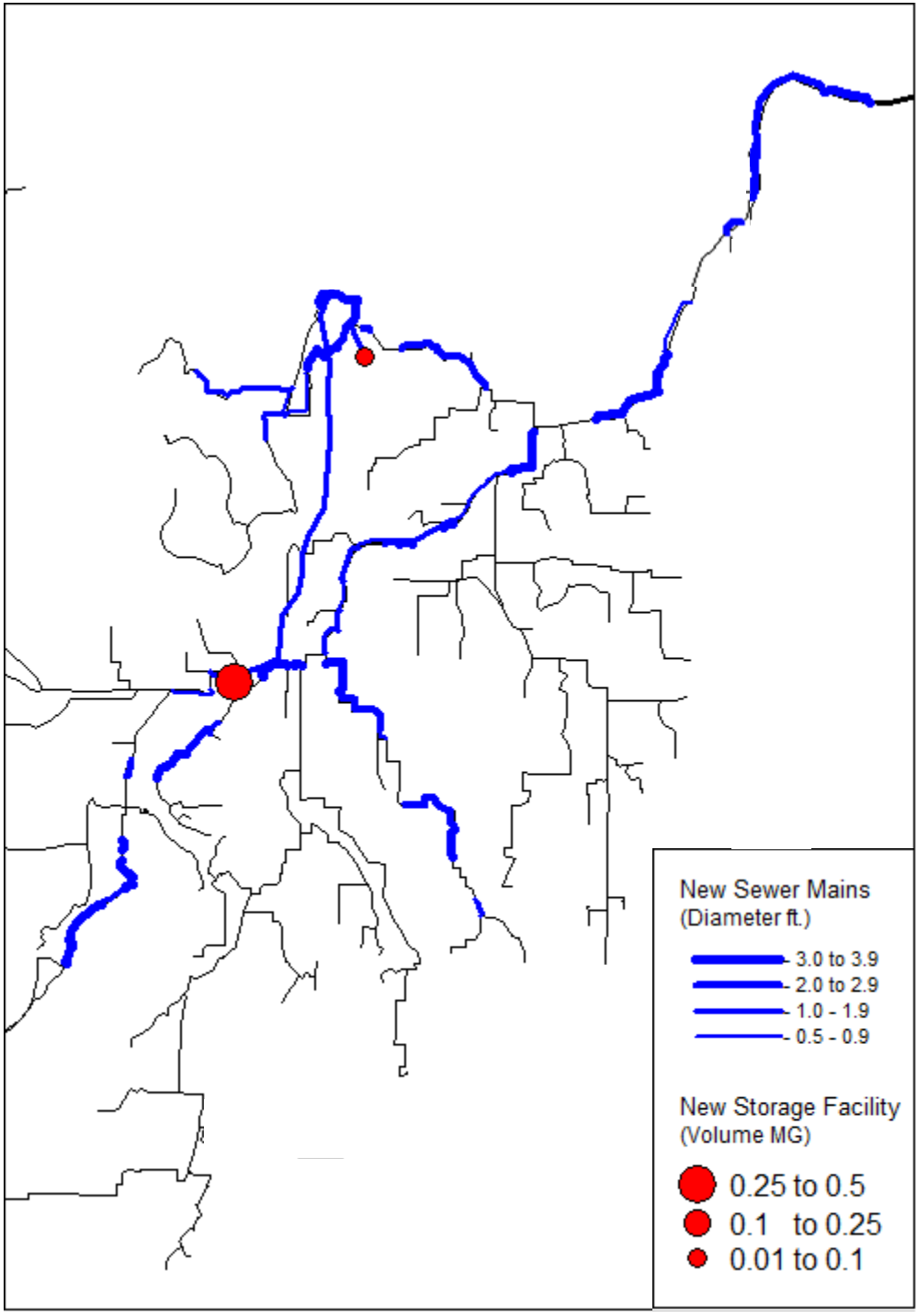
Generation 10 (2,000 Trial Solutions)

Best Solution in 10th Generation

Cost Item	Total Cost ($ Arb) (Including O&M)
Pipes	42.0
Pumps	4.3
Storage	9.3
Total Project Cost	**55.6**



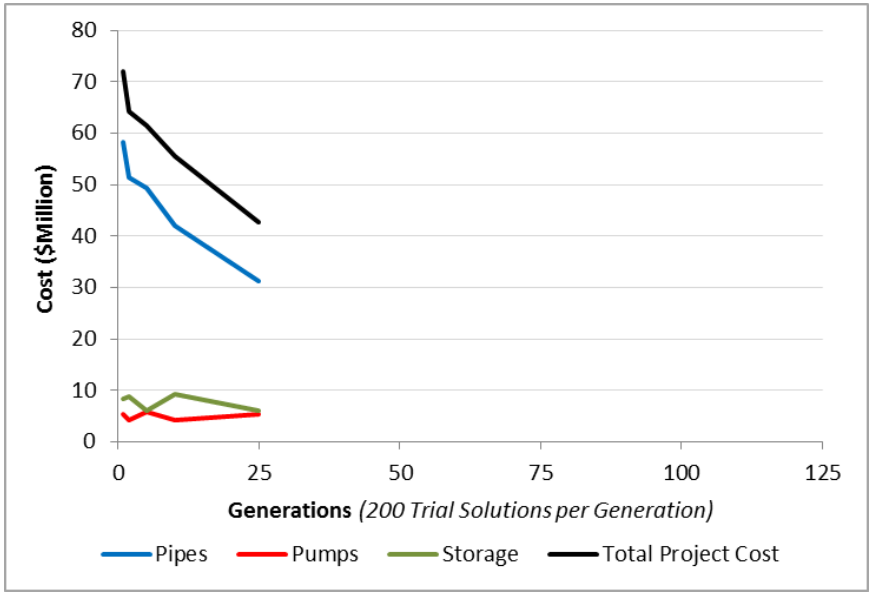
- Actual processing time: 1.50 hours
  (cloud computing using 104 cores in parallel)
- Complete hydraulic analysis of each trial solution
- Detailed life-cycle cost analysis of each trial sol.
- All costs divided by arbitrary value for purpose of demonstration



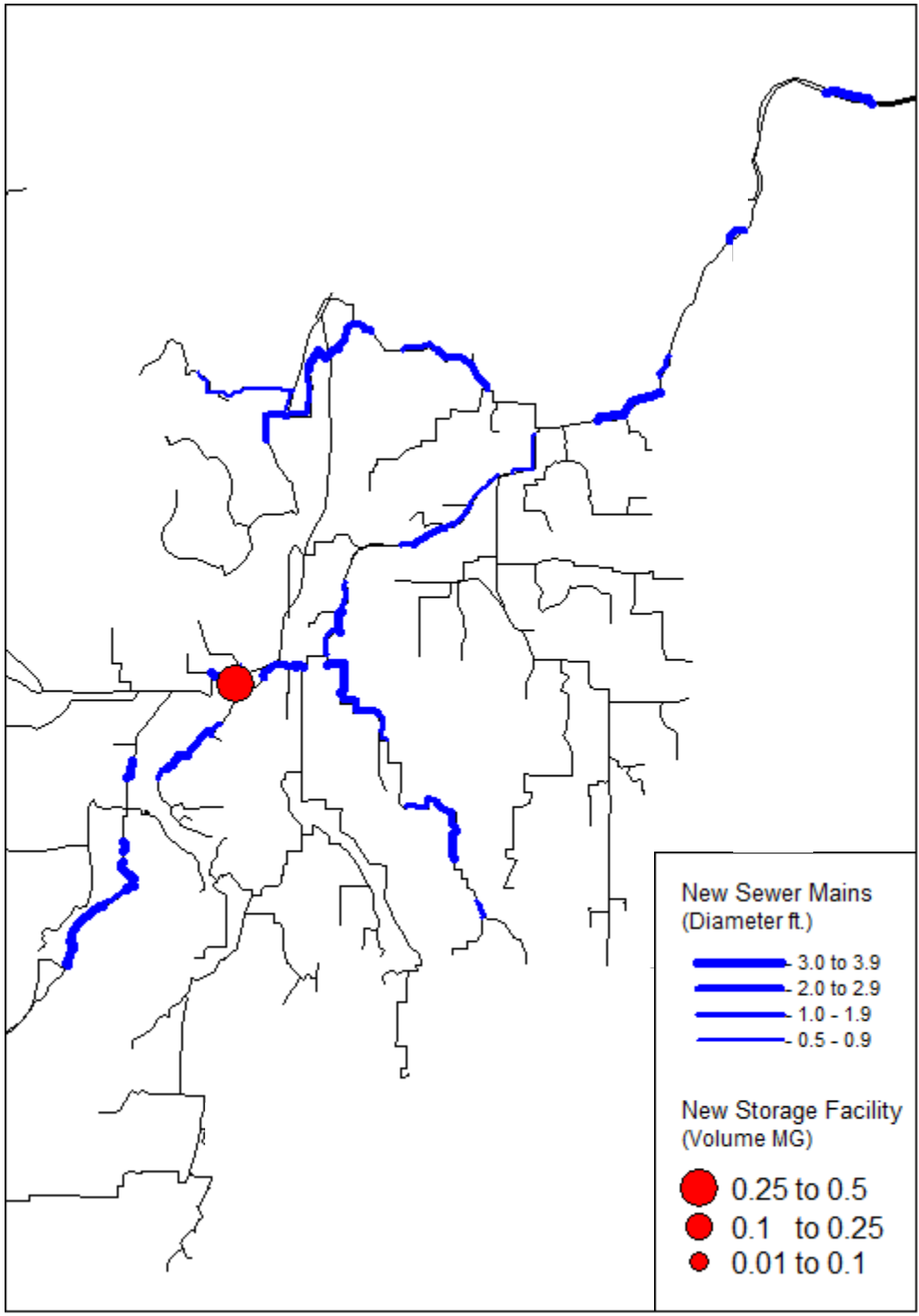
Generation 25 (50,000 Trial Solutions)

Best Solution in 25th Generation

Cost Item	Total Cost ($ Arb) (Including O&M)
Pipes	31.2
Pumps	5.4
Storage	6.1
Total Project Cost	**42.7**



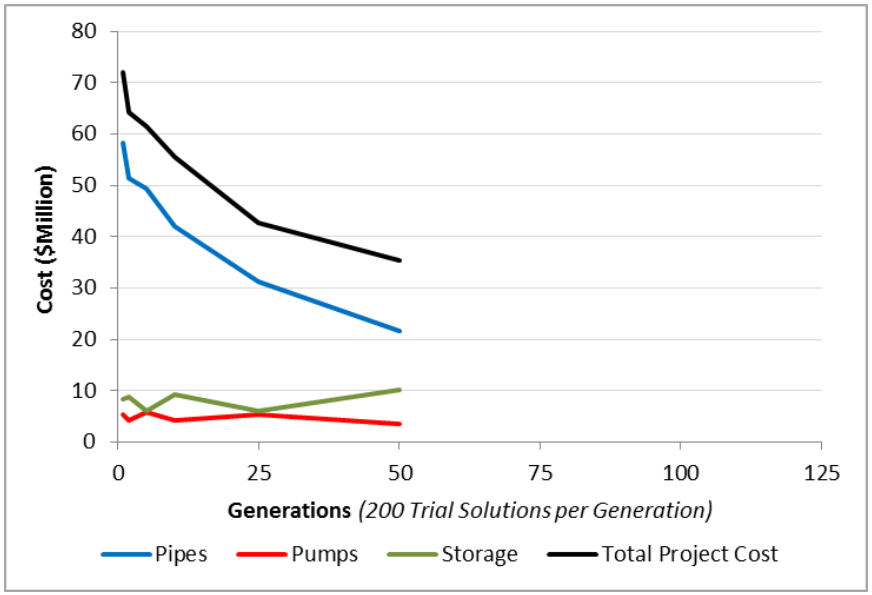
- Actual processing time: 3.75 hours
  (cloud computing using 104 cores in parallel)
- Complete hydraulic analysis of each trial solution
- Detailed life-cycle cost analysis of each trial sol.
- All costs divided by arbitrary value for purpose of demonstration



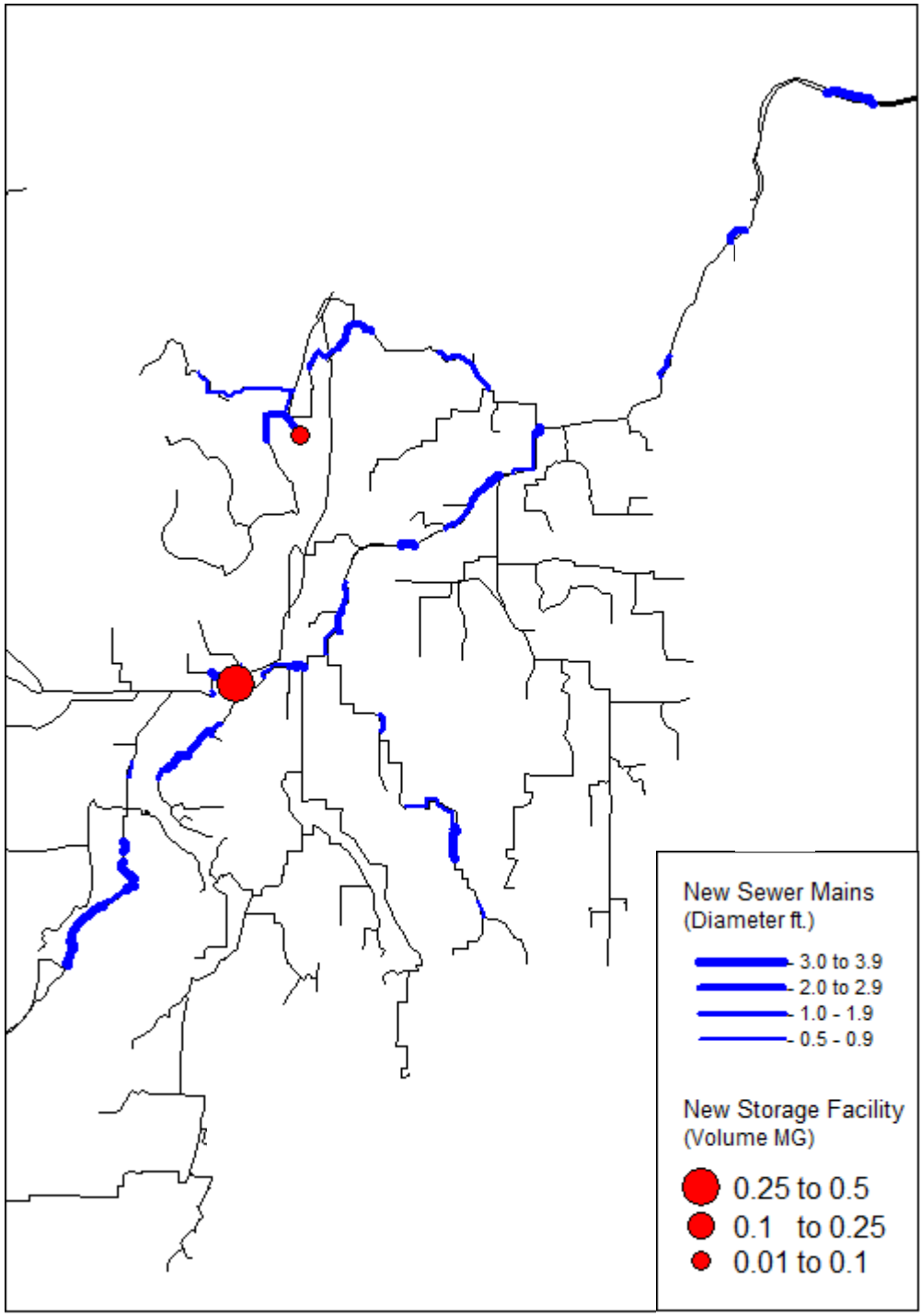
Generation 50 (100,000 Trial Solutions)

Best Solution in 50th Generation

Cost Item	Total Cost ($ Arb) (Including O&M)
Pipes	21.7
Pumps	3.5
Storage	10.1
Total Project Cost	**35.3**



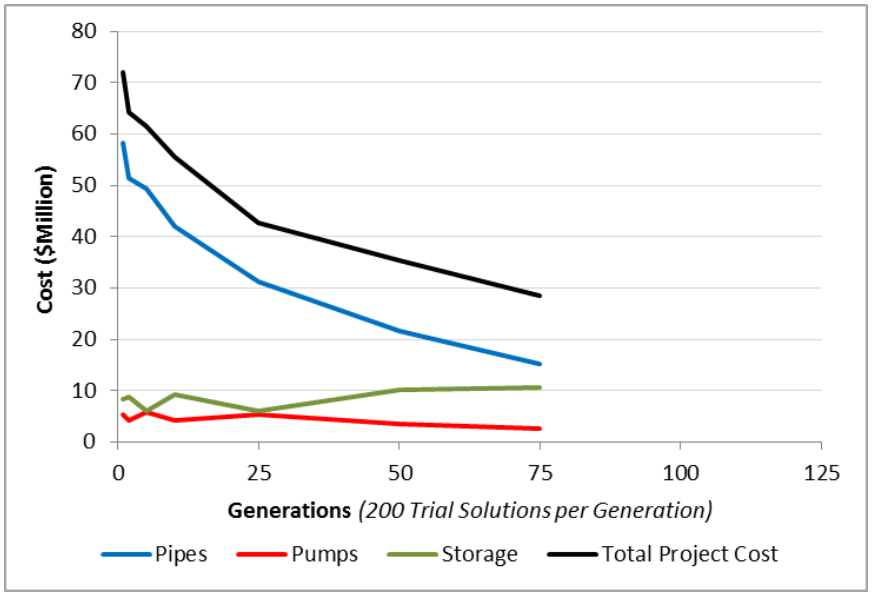
- Actual processing time: 7.50 hours
  (cloud computing using 104 cores in parallel)
- Complete hydraulic analysis of each trial solution
- Detailed life-cycle cost analysis of each trial sol.
- All costs divided by arbitrary value for purpose of demonstration



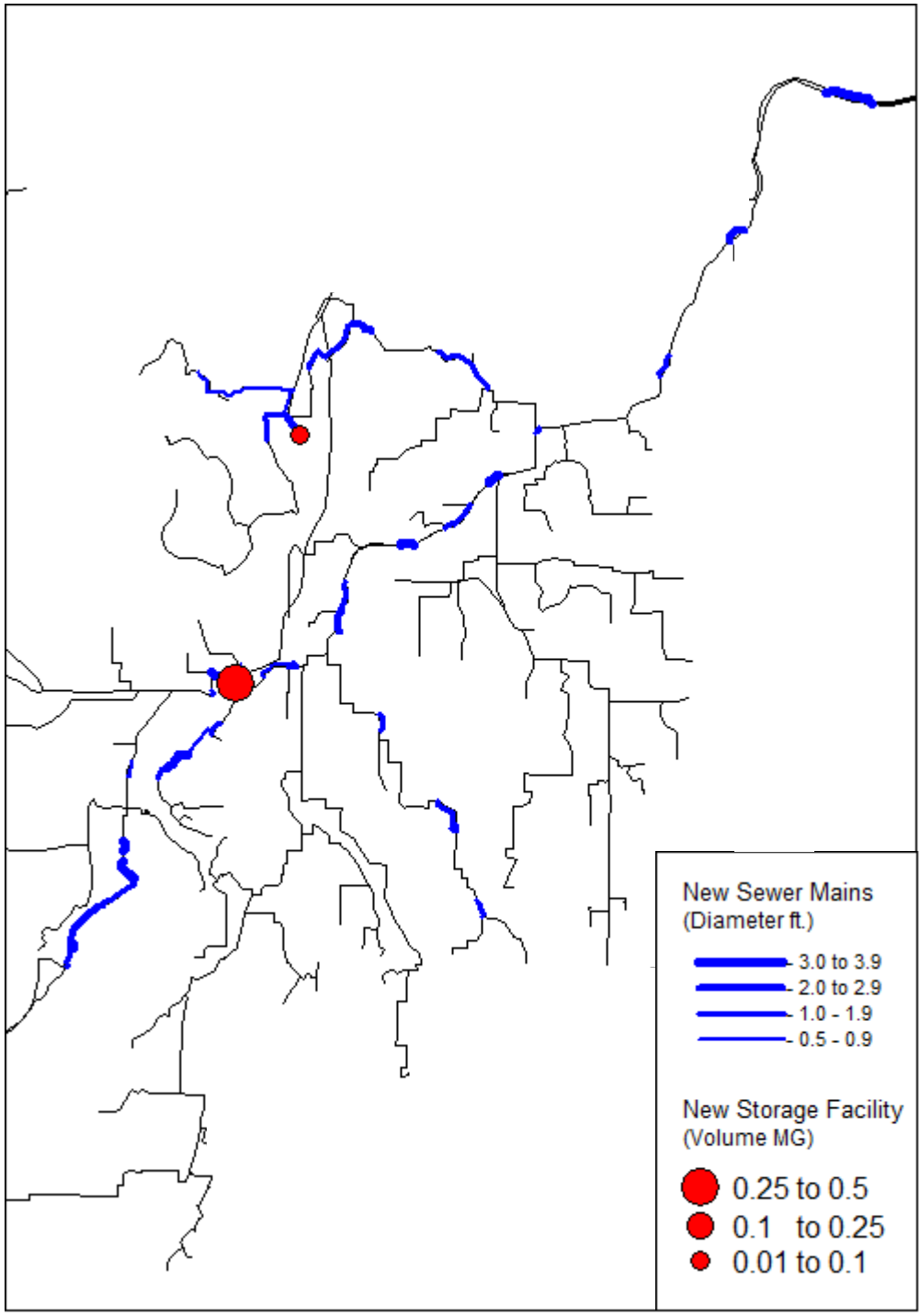
Generation 75 (150,000 Trial Solutions)

Best Solution in 75th Generation

Cost Item	Total Cost ($ Arb) (Including O&M)
Pipes	21.7
Pumps	3.5
Storage	10.1
Total Project Cost	**35.3**



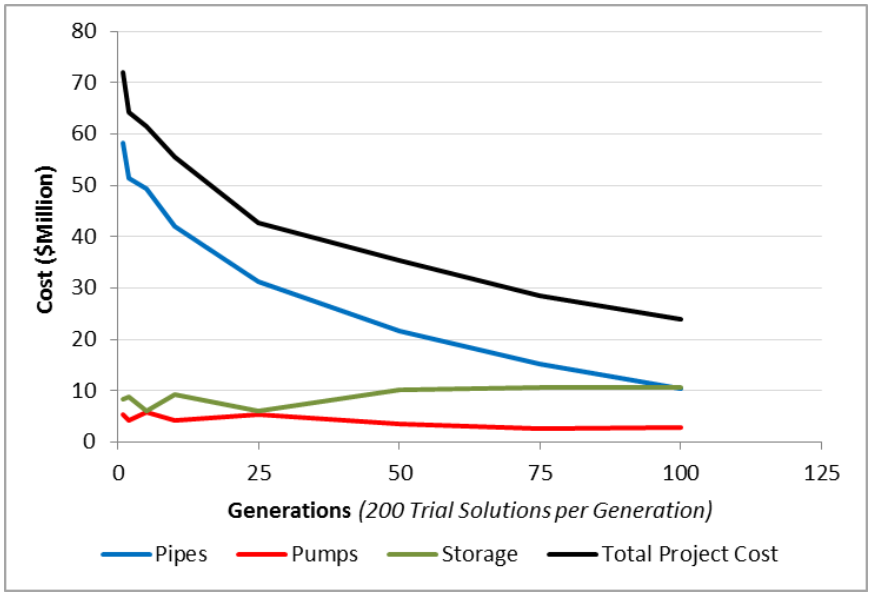
- Actual processing time: 11.25 hours
  (cloud computing using 104 cores in parallel)
- Complete hydraulic analysis of each trial solution
- Detailed life-cycle cost analysis of each trial sol.
- All costs divided by arbitrary value for purpose of demonstration



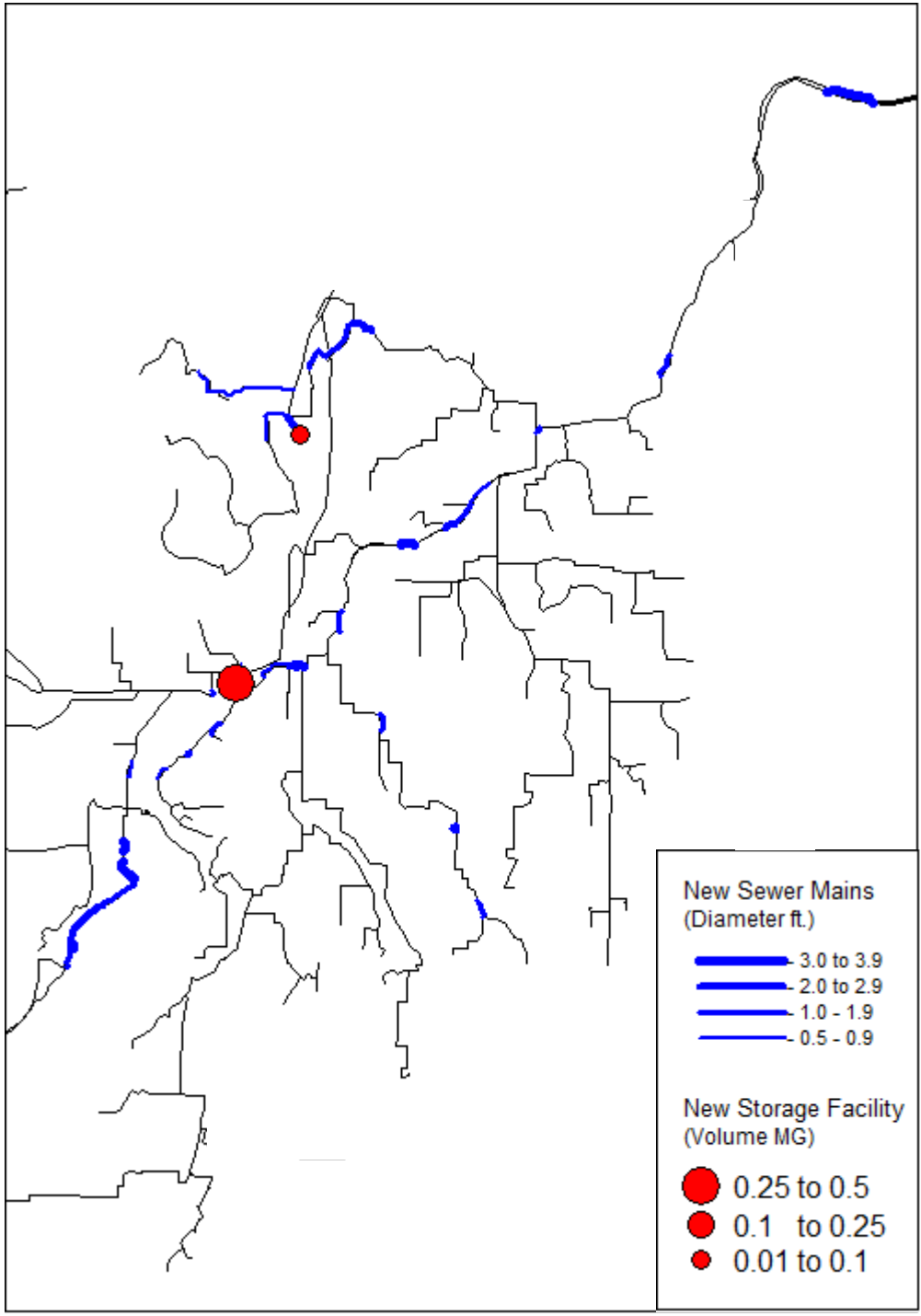
Generation 100 (200,000 Trial Solutions)

Best Solution in 100th Generation

Cost Item	Total Cost ($ Arb) (Including O&M)
Pipes	10.4
Pumps	2.7
Storage	10.7
Total Project Cost	**23.8**



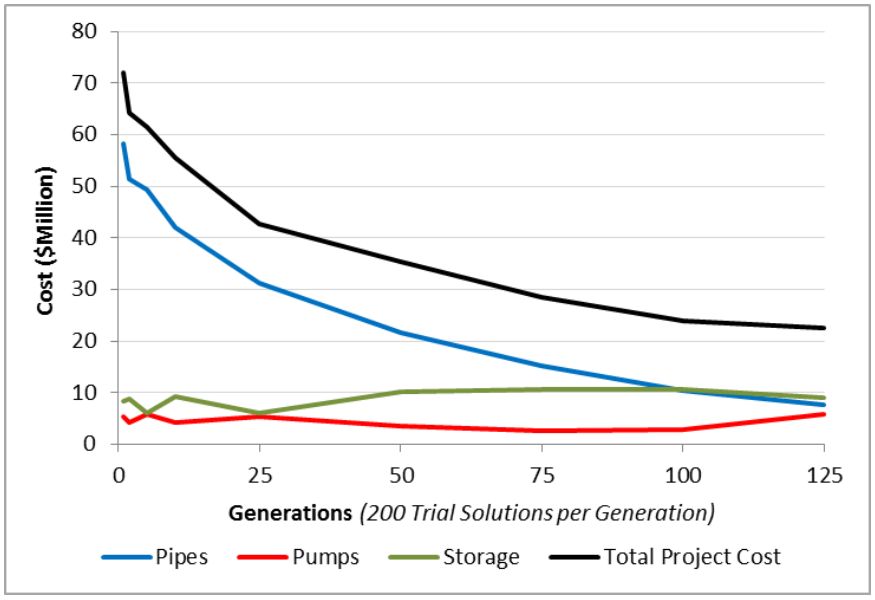
- Actual processing time: 15.00 hours
  (cloud computing using 104 cores in parallel)
- Complete hydraulic analysis of each trial solution
- Detailed life-cycle cost analysis of each trial sol.
- All costs divided by arbitrary value for purpose of demonstration



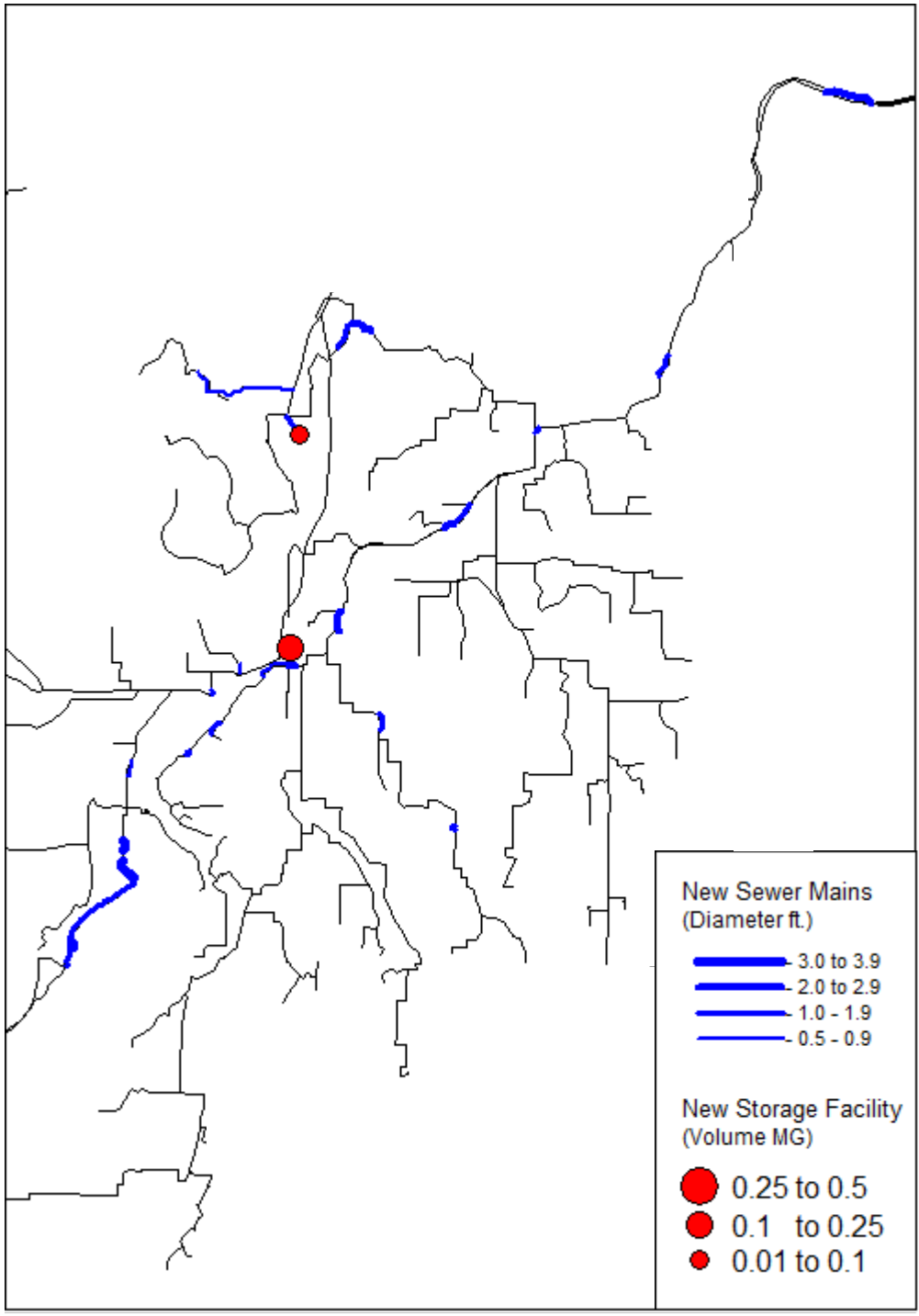
Generation 125 (250,000 Trial Solutions)

Best Solution in 125th Generation

Cost Item	Total Cost ($ Arb) (Including O&M)
Pipes	7.6
Pumps	5.9
Storage	9.1
Total Project Cost	**22.6**

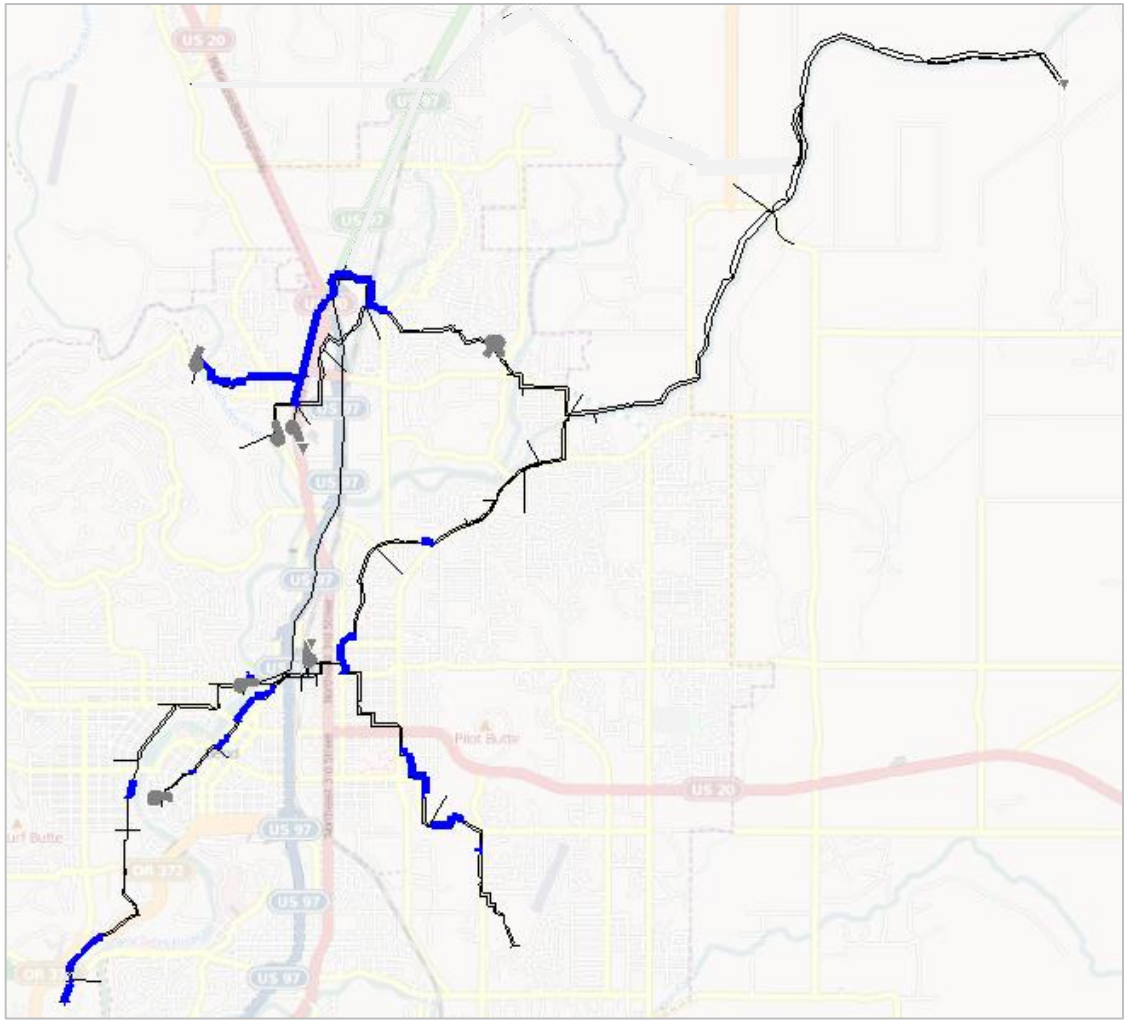


- Actual processing time: 18.75 hours
  (cloud computing using 104 cores in parallel)
- Complete hydraulic analysis of each trial solution
- Detailed life-cycle cost analysis of each trial sol.
- All costs divided by arbitrary value for purpose of demonstration



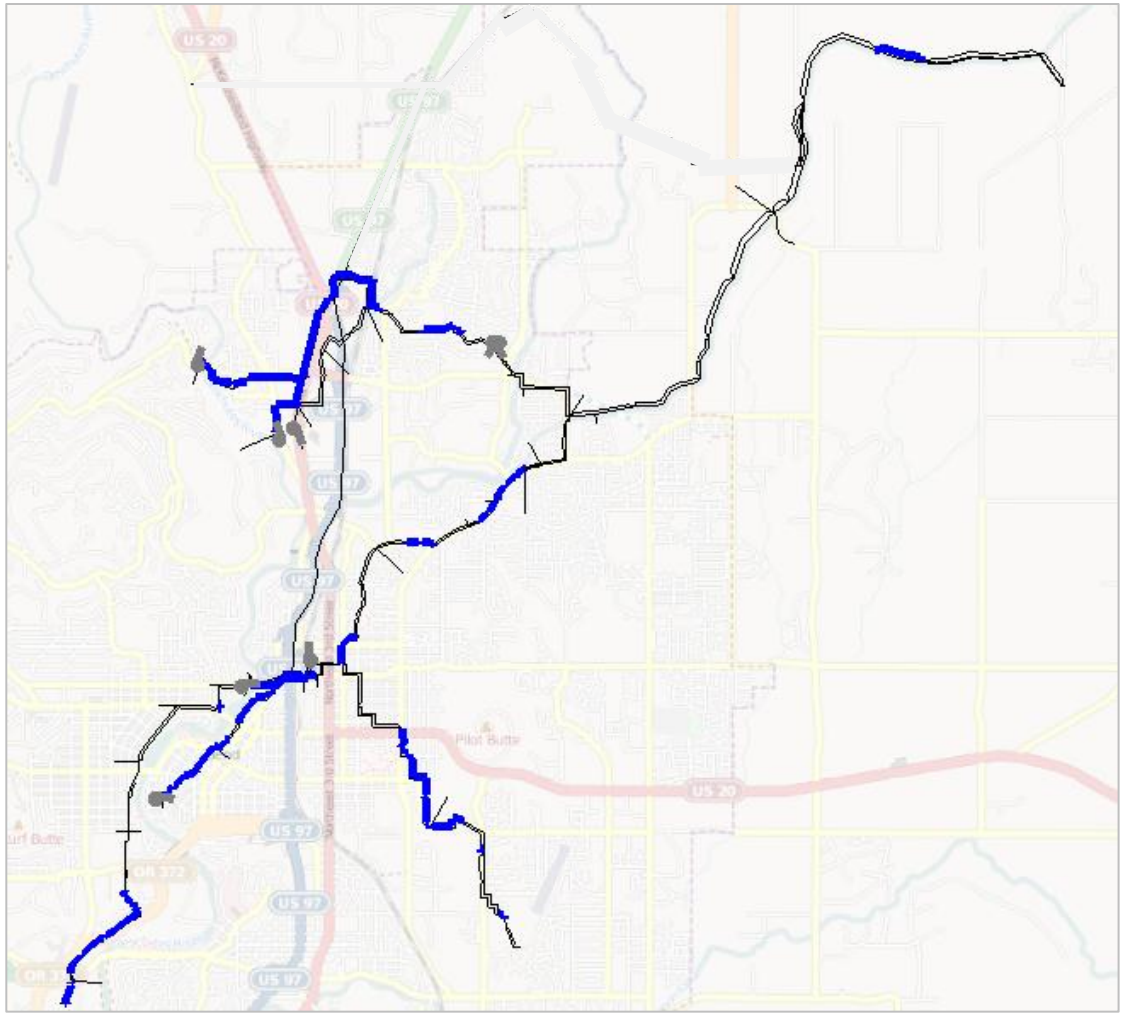
Example Sensitivity Analysis on Loadings

Option 1: $13.7 M in Pipe Improvements
(for Base loading)



Example Sensitivity Analysis on Loadings

Option 2, $20.2 M in Pipe Improvements
(for Base loading + 20%)



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Discussion

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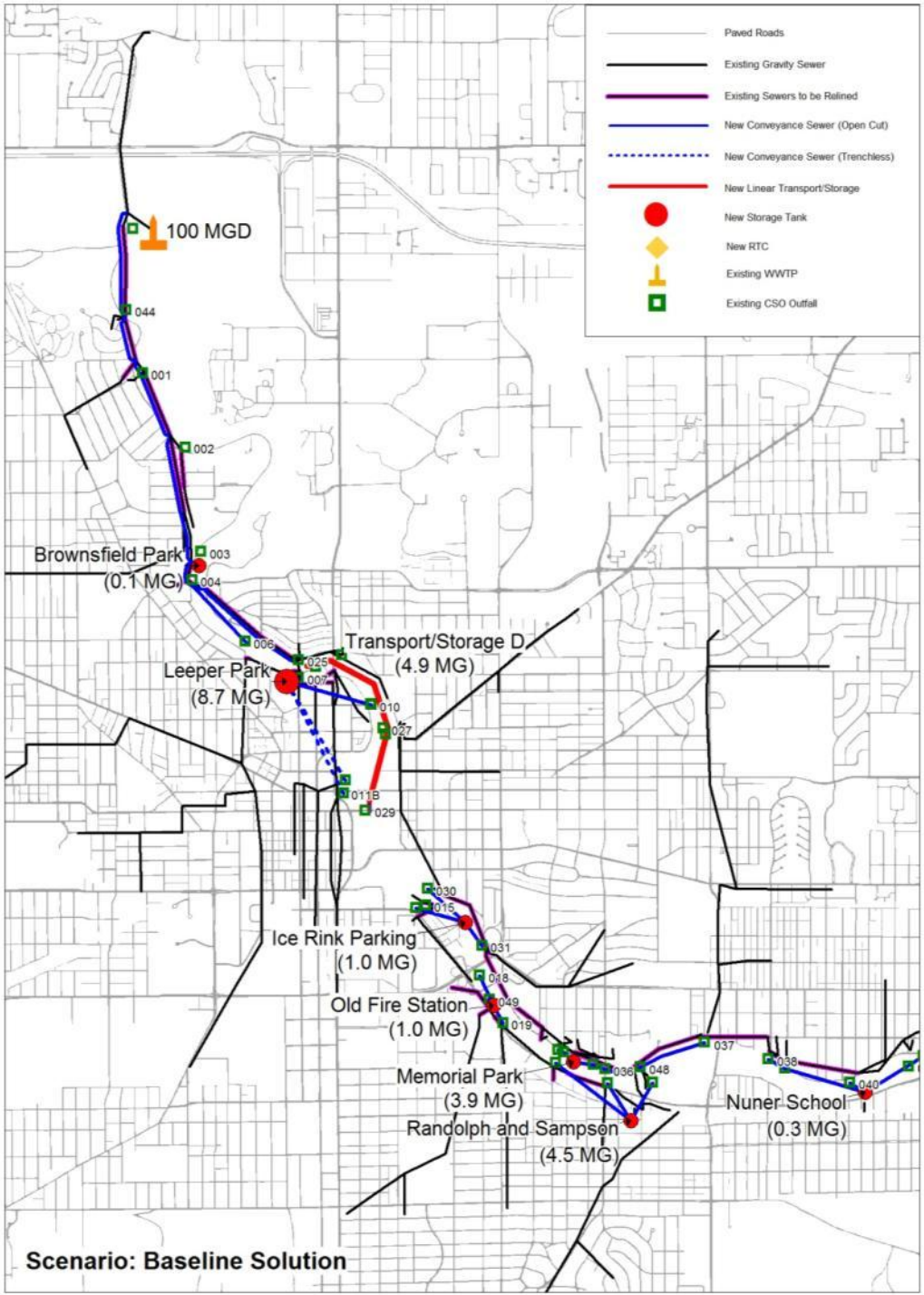
CSO LTCP Optimization for South Bend, Indiana

Baseline LTCP Solution Agreed with EPA

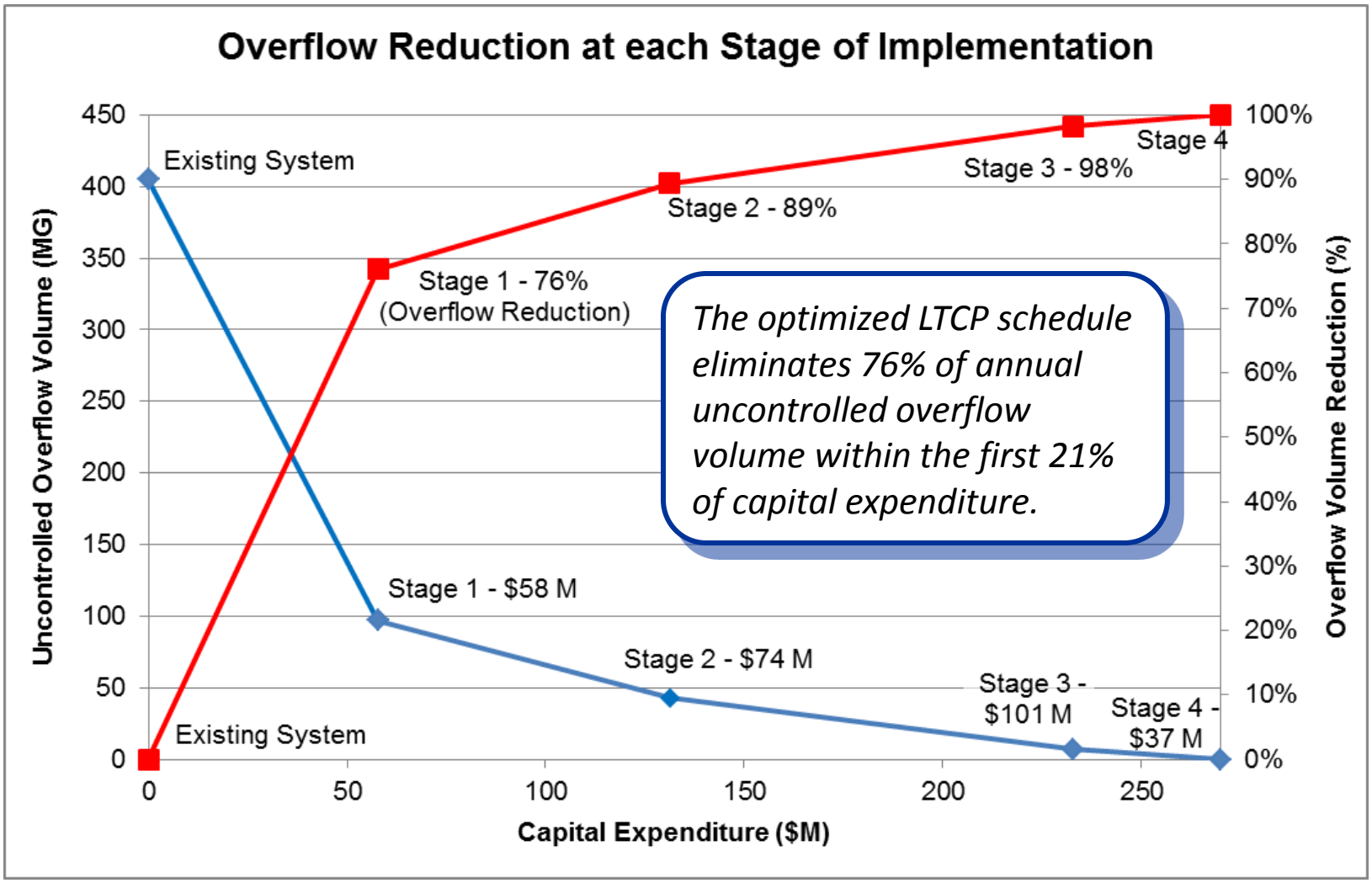
Cost Item	Baseline Solution ($M)
Conveyance	149.83
Pump Station	0.00
Linear Storage	42.66
Storage Tank	99.81
Relining	13.04
RTC	0.00
Green Technology	0.00
Total Construction Cost	305.34
Eng/Leg/Adm. (20%)	61.07
Total Capital Cost	**366.41**
Present Worth O&M	45.61
TOTAL PROJECT COST	**412.02**



Comparison of Baseline and Optimized Solutions

Cost Item	Baseline Solution ($M)	Optimized Solutions				
		Solution 1 ($M)	Solution 2 ($M)	**Solution 3 Optimized Solution**	Solution 4 ($M)	Solution 5 ($M)
Conveyance	149.83	114.40	114.40	114.40	114.40	114.40
Pump Station	-	1.25	1.25	1.25	1.25	1.25
Linear Storage	42.66	13.96	13.96	13.96	13.96	13.96
Storage Tank	99.80	123.62	116.82	63.28	95.81	96.68
Relining	13.04	3.51	3.51	2.18	2.67	2.56
RTC	-	-	2.67	2.67	2.67	2.67
Green Technology	-	-	-	27.39	19.04	15.06
Total Construction Cost	305.34	256.75	252.62	225.13	249.80	246.58
Engineering/Legal/Admin (20%)	61.07	51.35	50.52	45.03	49.96	49.32
Total Capital Cost	**366.40**	**308.10**	**303.14**	**270.16**	**299.76**	**295.90**
Present Worth O&M	45.61	42.02	40.84	29.40	37.45	35.92
TOTAL PROJECT COST	**412.01**	**350.11**	**343.98**	**299.56**	**337.21**	**331.82**
Savings		61.90	68.04	**112.46**	74.80	80.19
		15%	17%	**27%**	18%	19%

Prioritization of Projects for Maximum Impact



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