Reducing wastewater overflows: a pragmatic approach to optimise capital investment in Christchurch

Christchurch City Council

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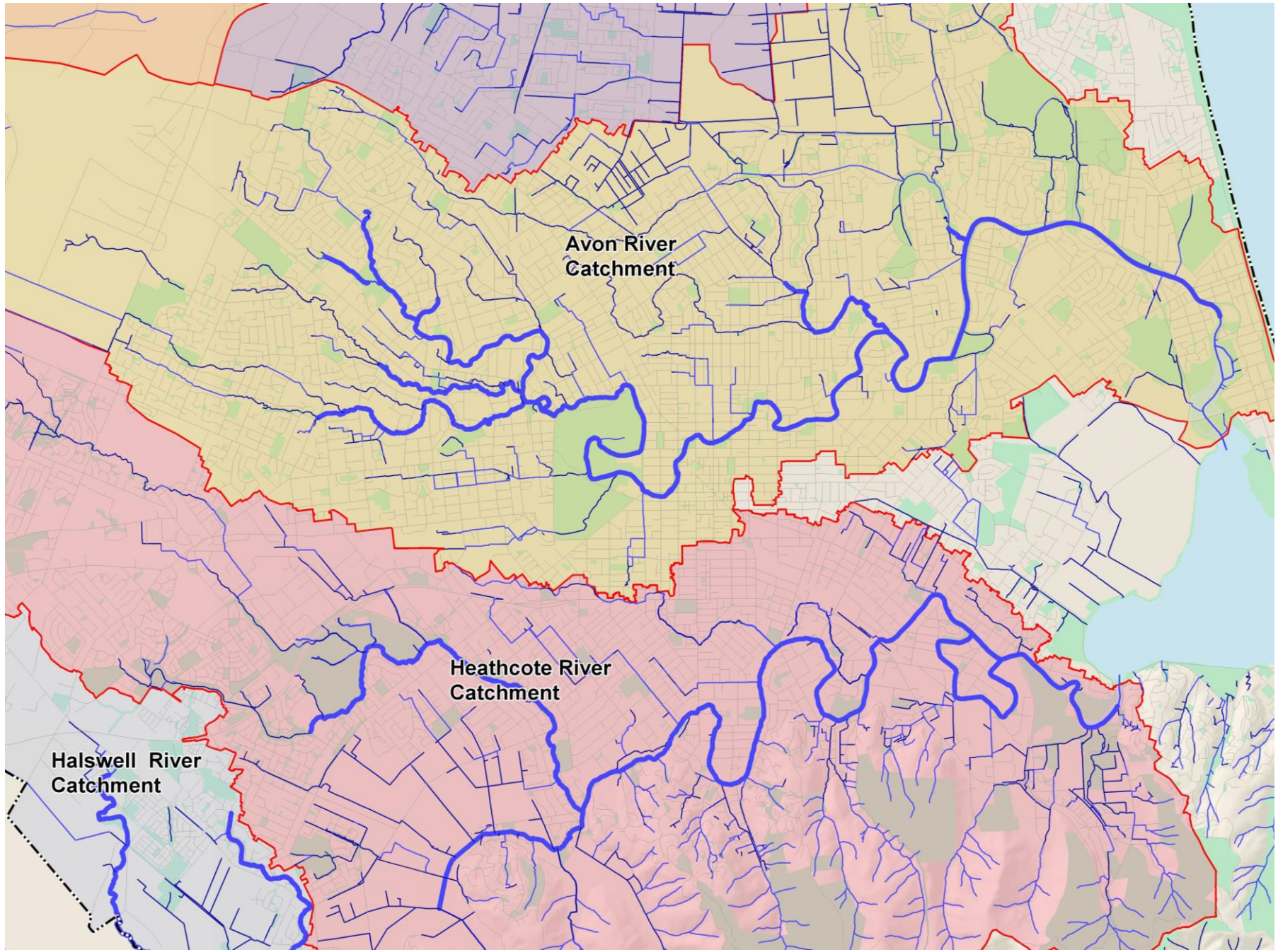
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus
Image IBCAO
Google Earth

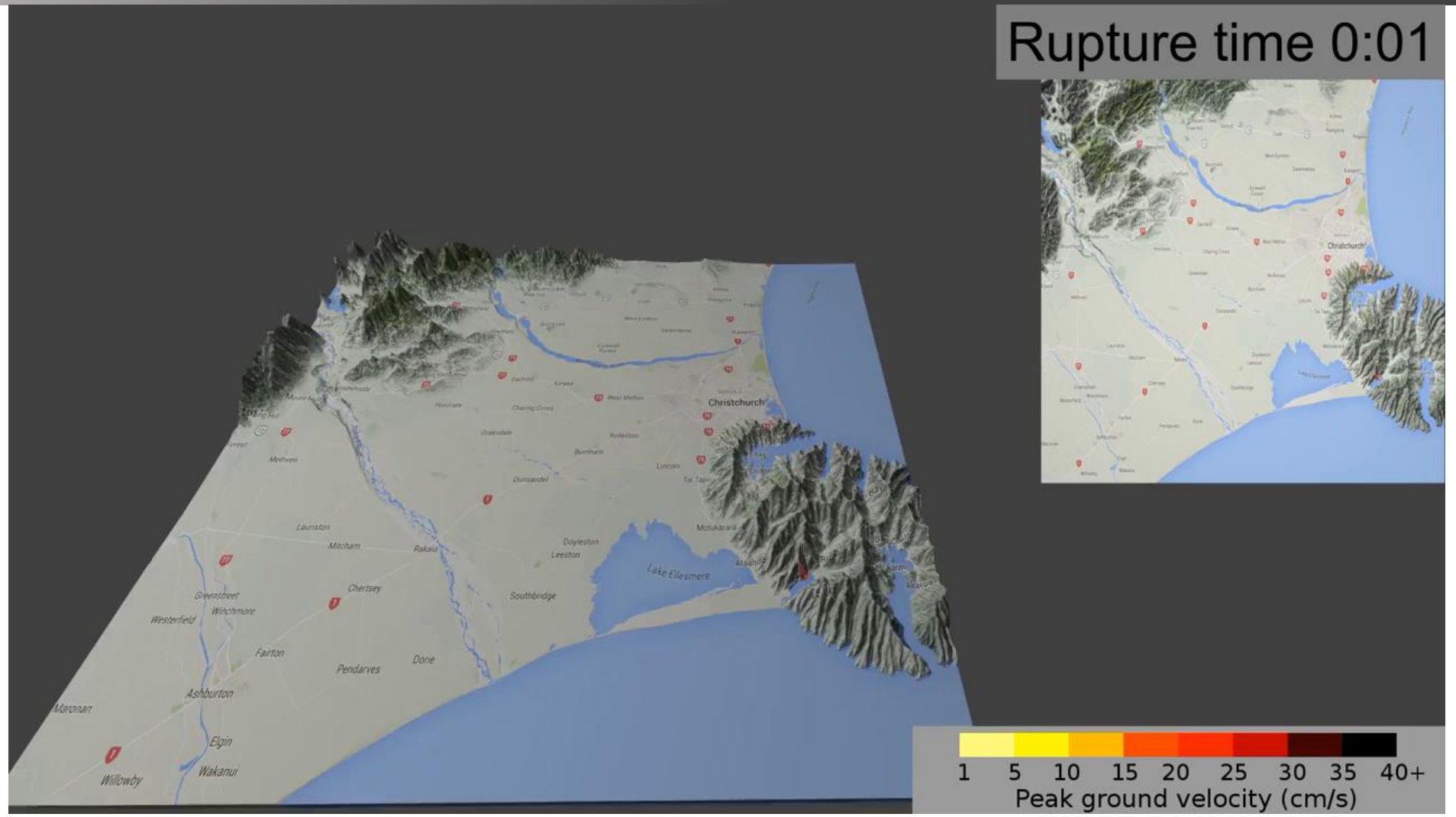
Living where two tectonic plates meet

“Sometimes it does us a power of good to remind ourselves that we live on two volcanic rocks where two tectonic plates meet, in a somewhat lonely stretch of windswept ocean just above the Roaring Forties. If you want drama – you’ve come to the right place.”

Sir Geoffrey Palmer
Former Prime Minister

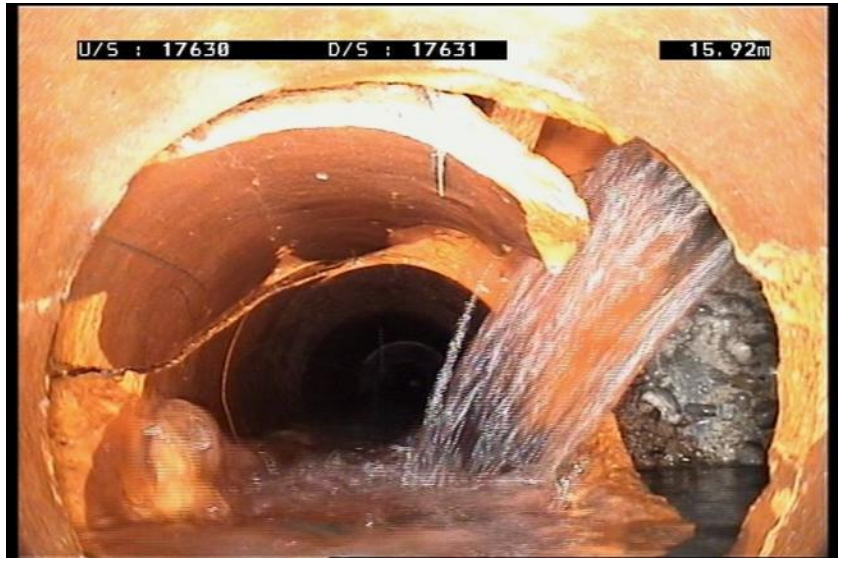

Avon River
Catchment
Heathcote River
Catchment
Halswell River
Catchment

Christchurch earthquake 22 February 2011 – Magnitude 6.4

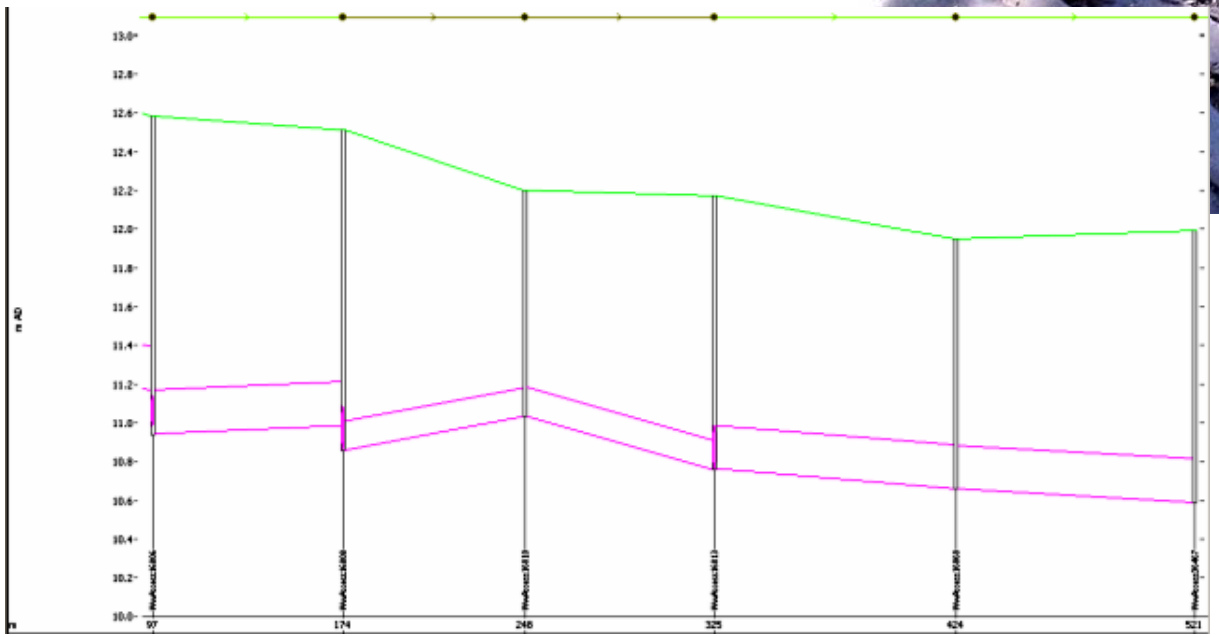


Earthquake damage

- Total cost $26 billion
- Infrastructure repair $1.5 billion

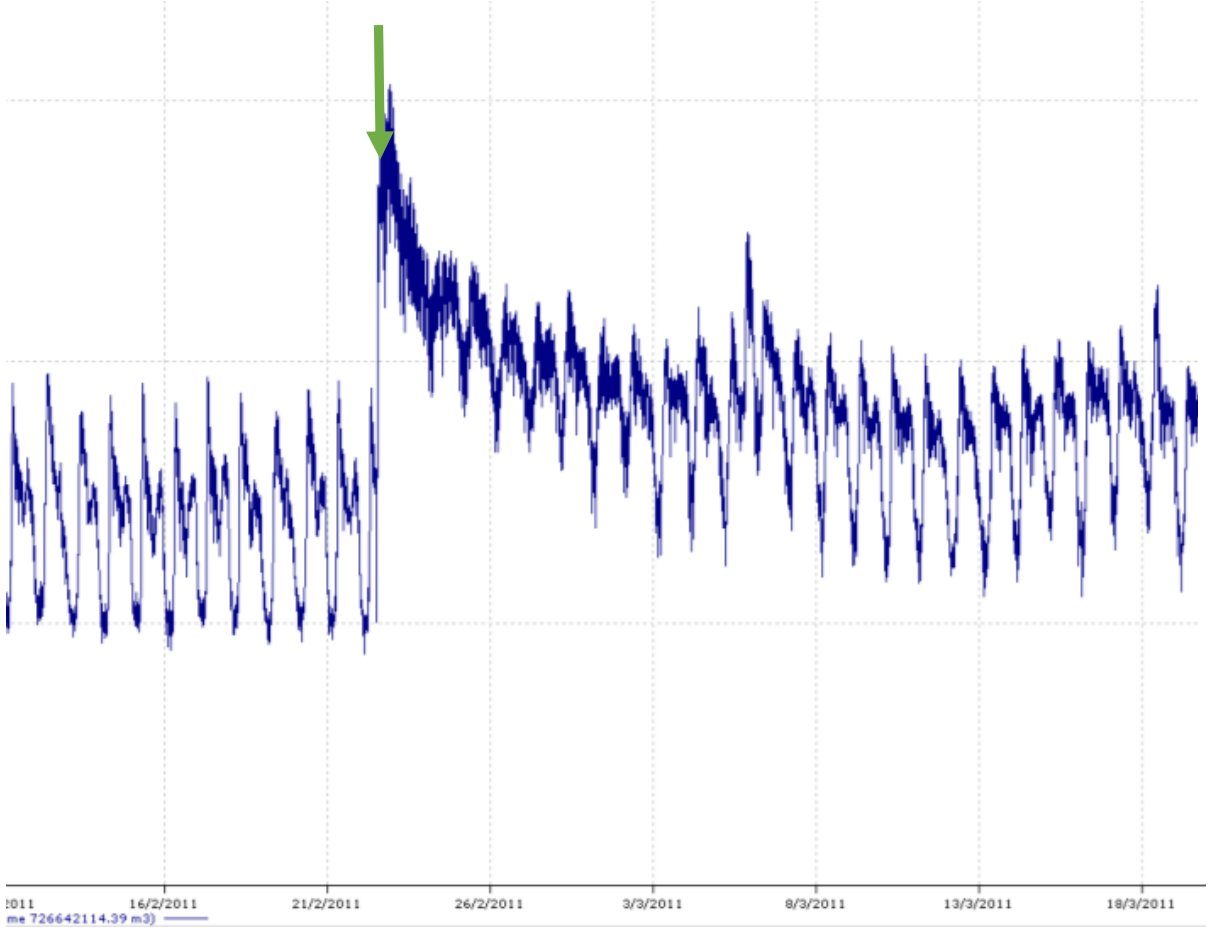


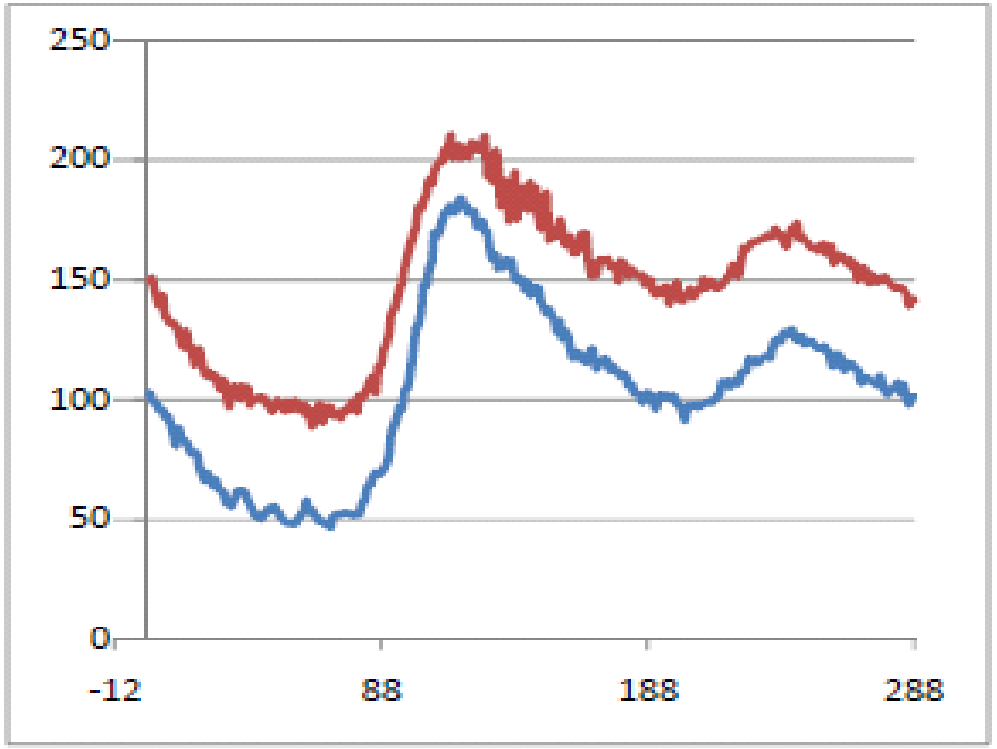

Manhole
Sewer Trench


13.0
12.8
12.6
12.4
12.2
12.0
11.8
11.6
11.4
11.2
11.0
10.8
10.6
10.4
10.2
10.0
97
174
248
325
424
521

Christchurch wastewater flows before and after earthquake

M6.3 earthquake

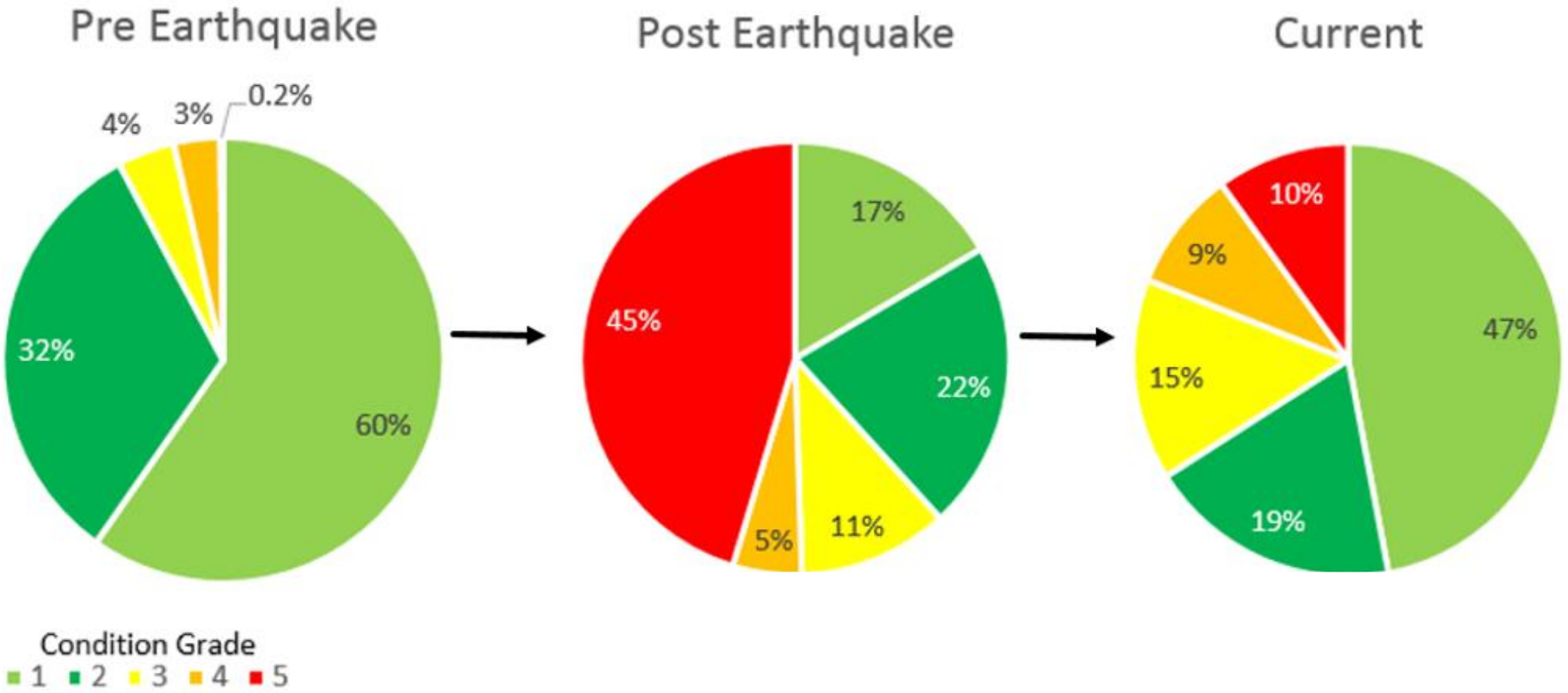




Dry weather flow

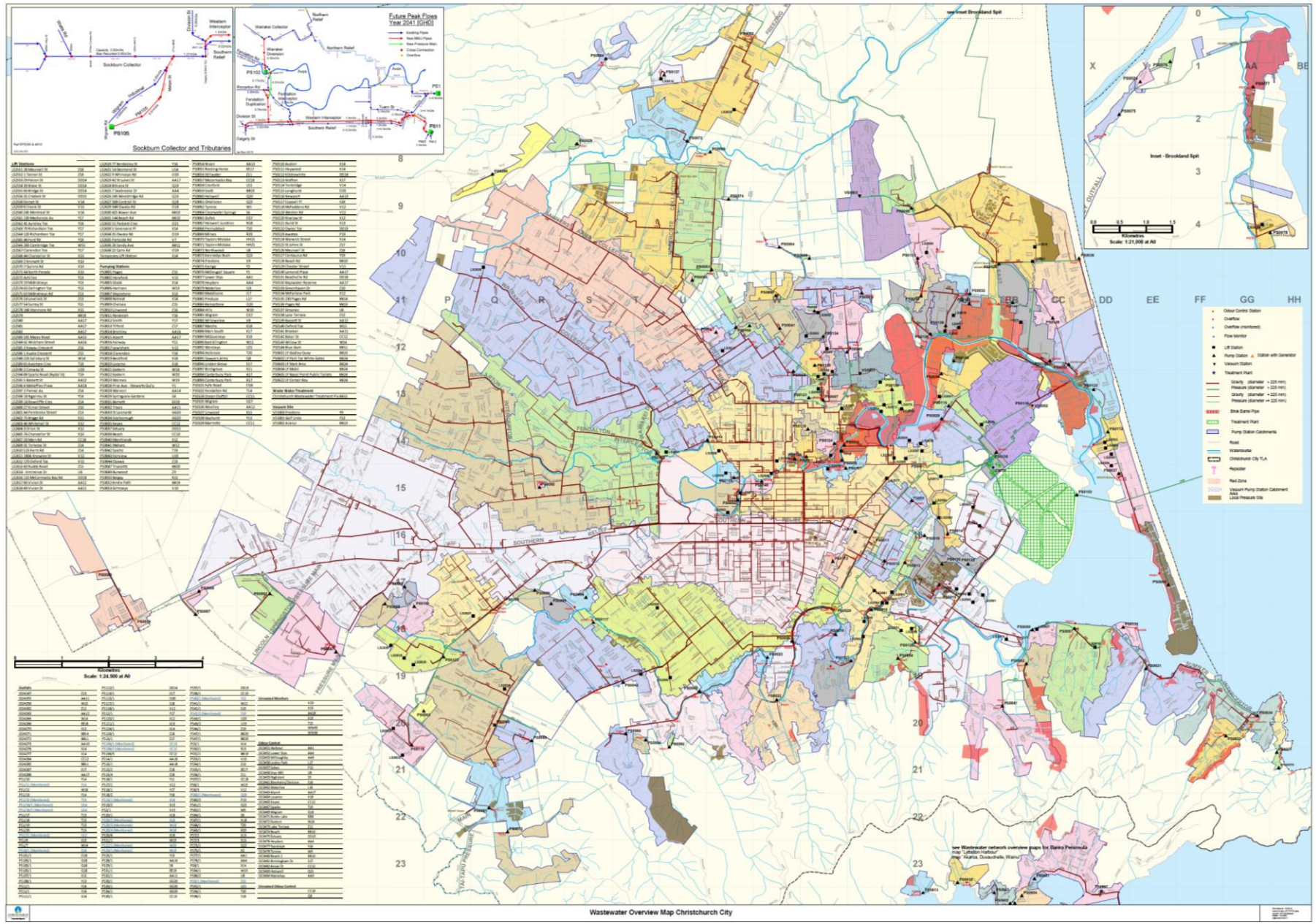
- Before earthquake
- After earthquake

Wastewater pipe condition

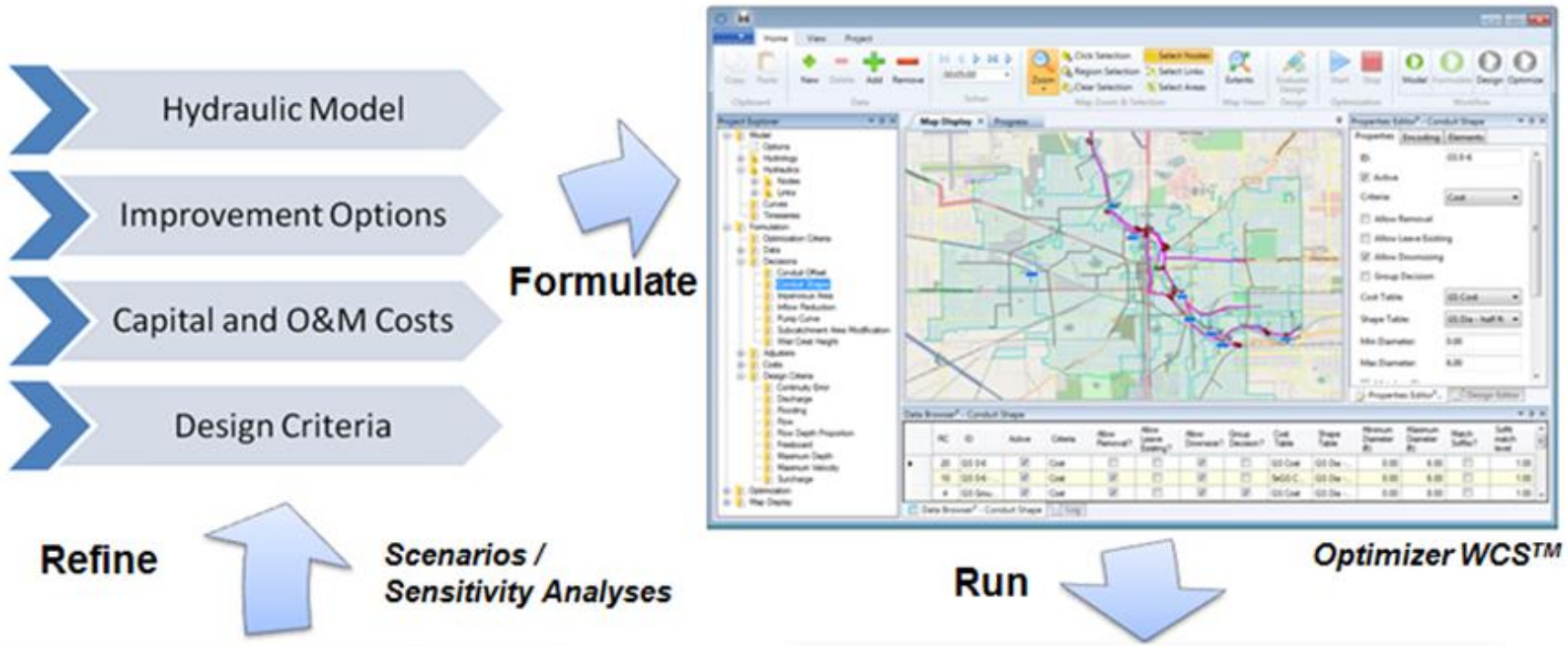


Condition grade 1 = as new

Condition grade 5 = expected to fail within 1-2 years

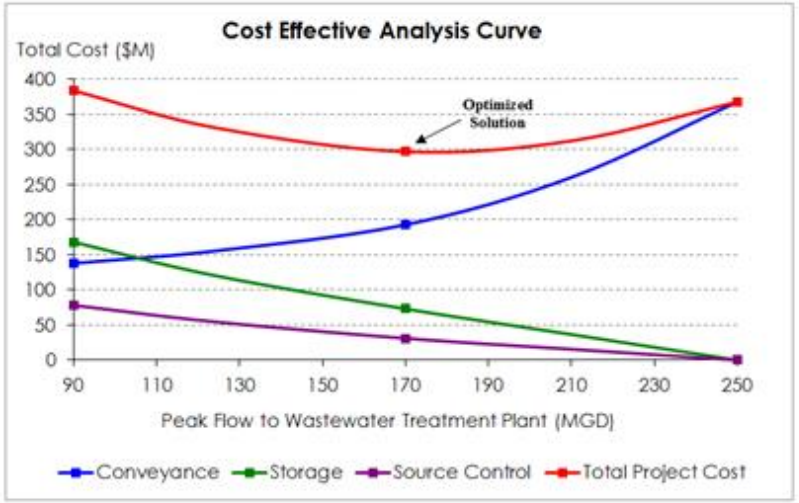

Sockburn Collector and Tributaries
Future Peak Flows Year 2041 [GHD]
Inset - Brookland Spit
Wastewater Overview Map Christchurch City

Overview of Genetic Algorithm Optimisation using Optimizer WCS™



Cost Item	Baseline Solution ($M)	Optimized Solution ($M)
Grey Infrastructure	305.33	195.07
Real Time Control	0.00	2.67
Green Technology	0.00	27.39
Total Construction Cost	305.34	225.13
Eng/Leg/Adm. (20%)	61.07	45.03
Total Capital Cost	366.40	270.16
Present Worth O&M	45.61	29.40
TOTAL PROJECT COST	**412.01**	**299.56**
Saving	112.46	27%

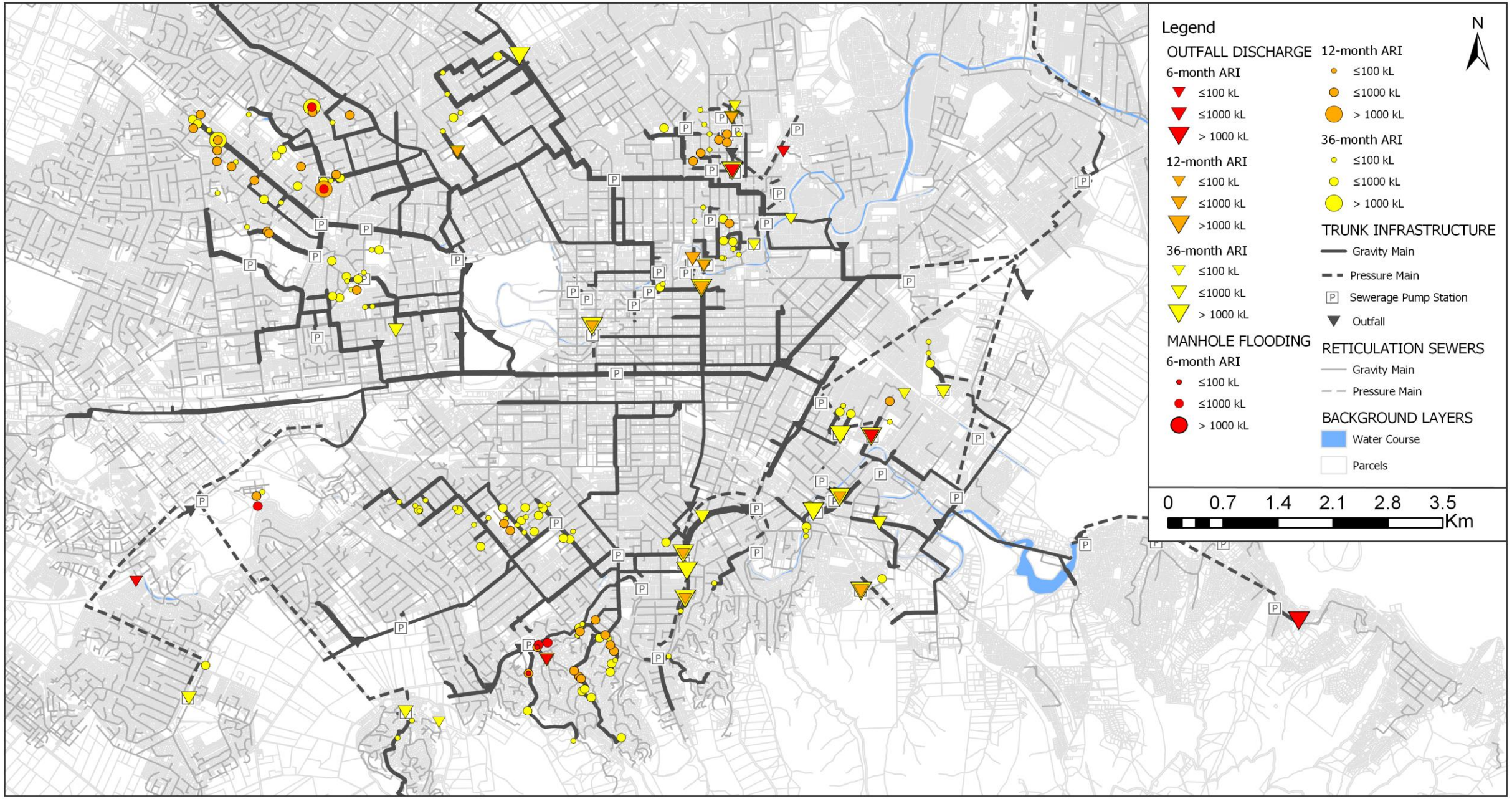
Review



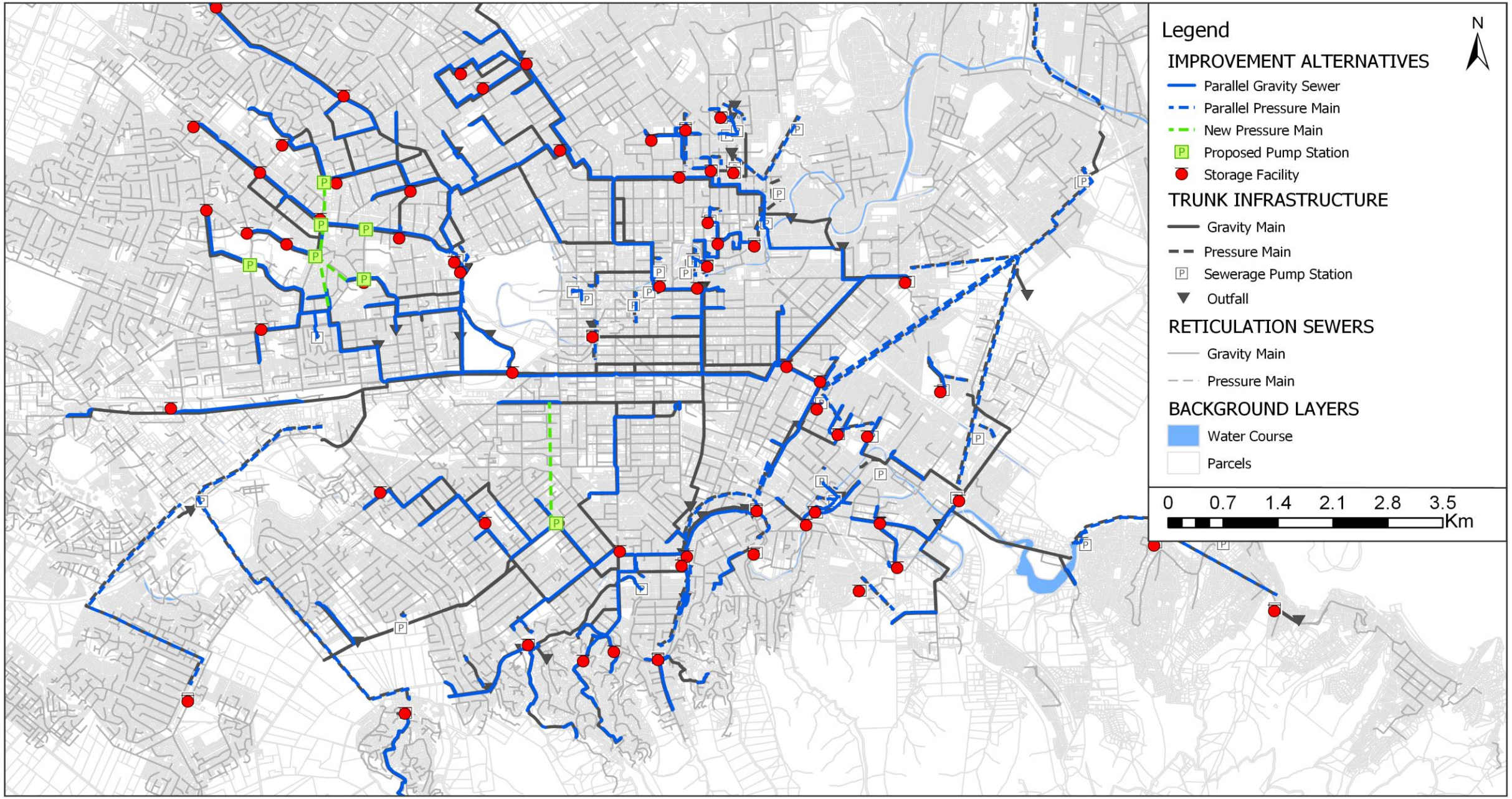
Christchurch Optimisation – Design Data Summary

- 2068 / 50-yr population forecast
- 6-month, 1-year and 3-year ARI design storms considered
- 15-year Long-Term Simulation of Historic Rainfall to verify performance
- Detailed unit cost rates for conveyance, storage and treatment alternatives
- Equivalent uniform annual cost (EUAC) approach used for comparison of alternatives with different life spans
- Solution costs presented based on 50-year total of EUAC

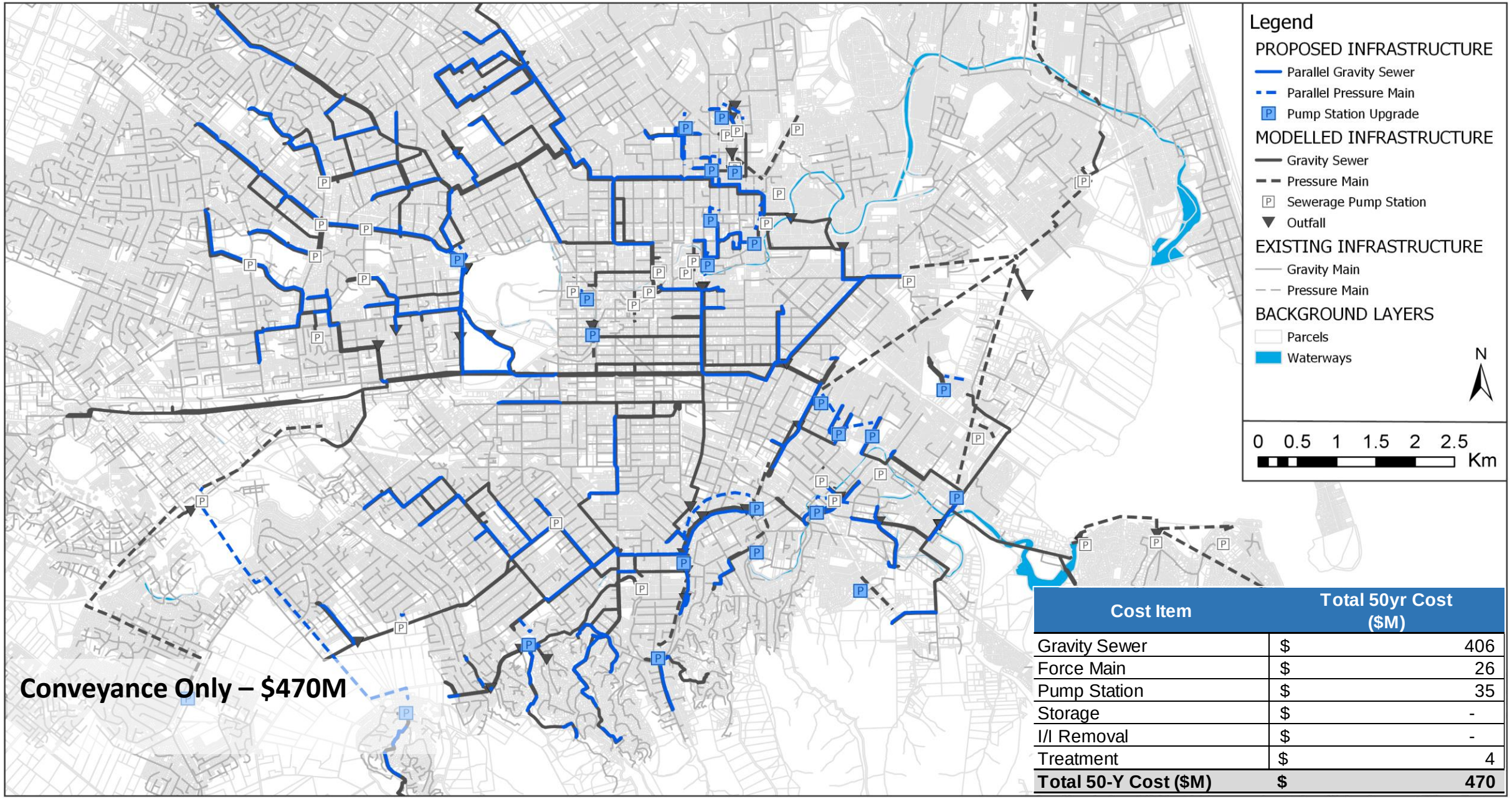
Existing System Performance – Based on 15-Year Time Series Modelling



Sanitary Sewer Overflow Reduction Alternatives

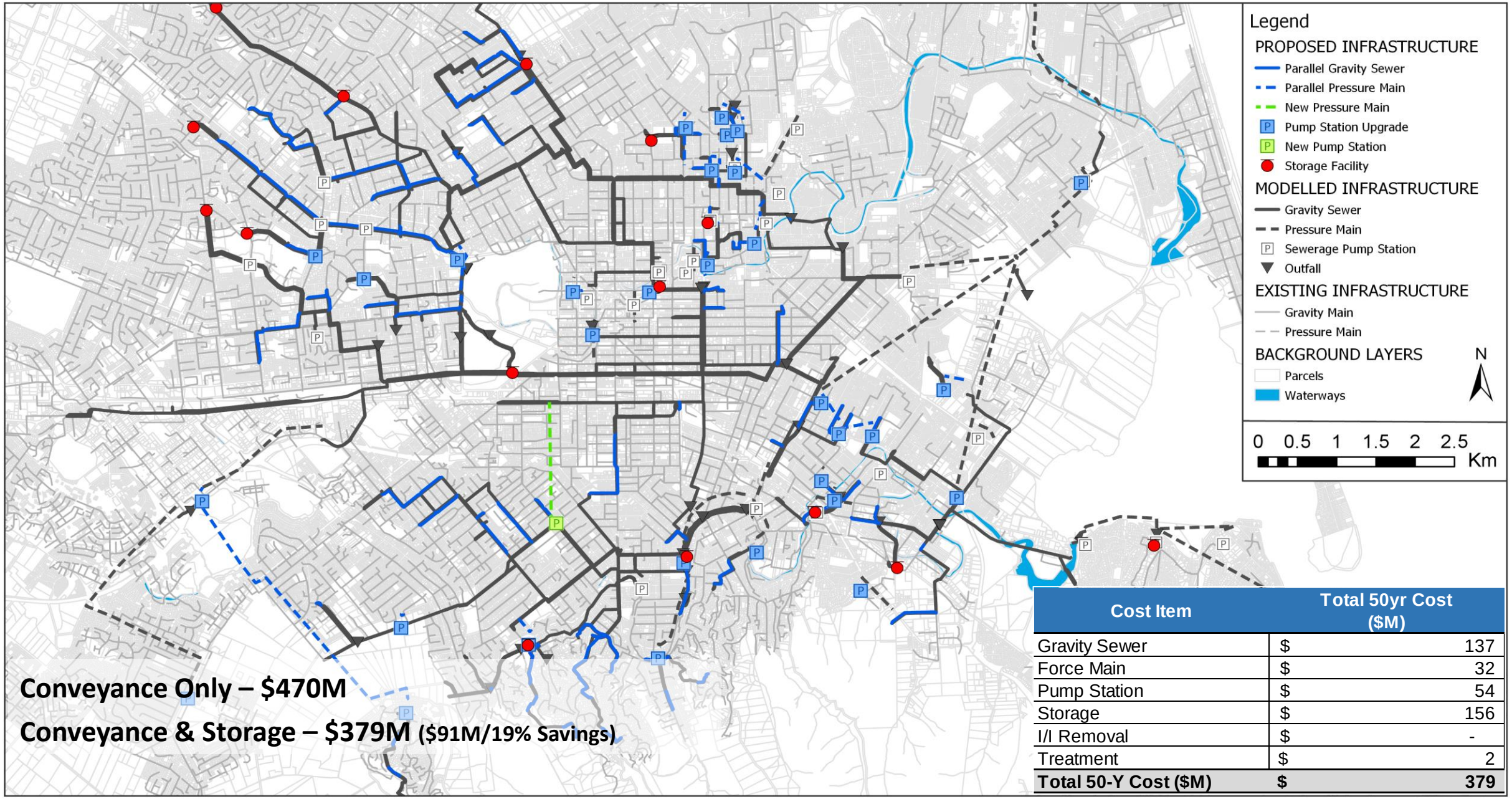


Conveyance-Only Optimised Solution



Cost Item		Total 50yr Cost ($M)
Gravity Sewer	$	406
Force Main	$	26
Pump Station	$	35
Storage	$	-
I/I Removal	$	-
Treatment	$	4
Total 50-Y Cost ($M)	**$**	**470**

Conveyance, Storage & Flow Control Optimised Solution

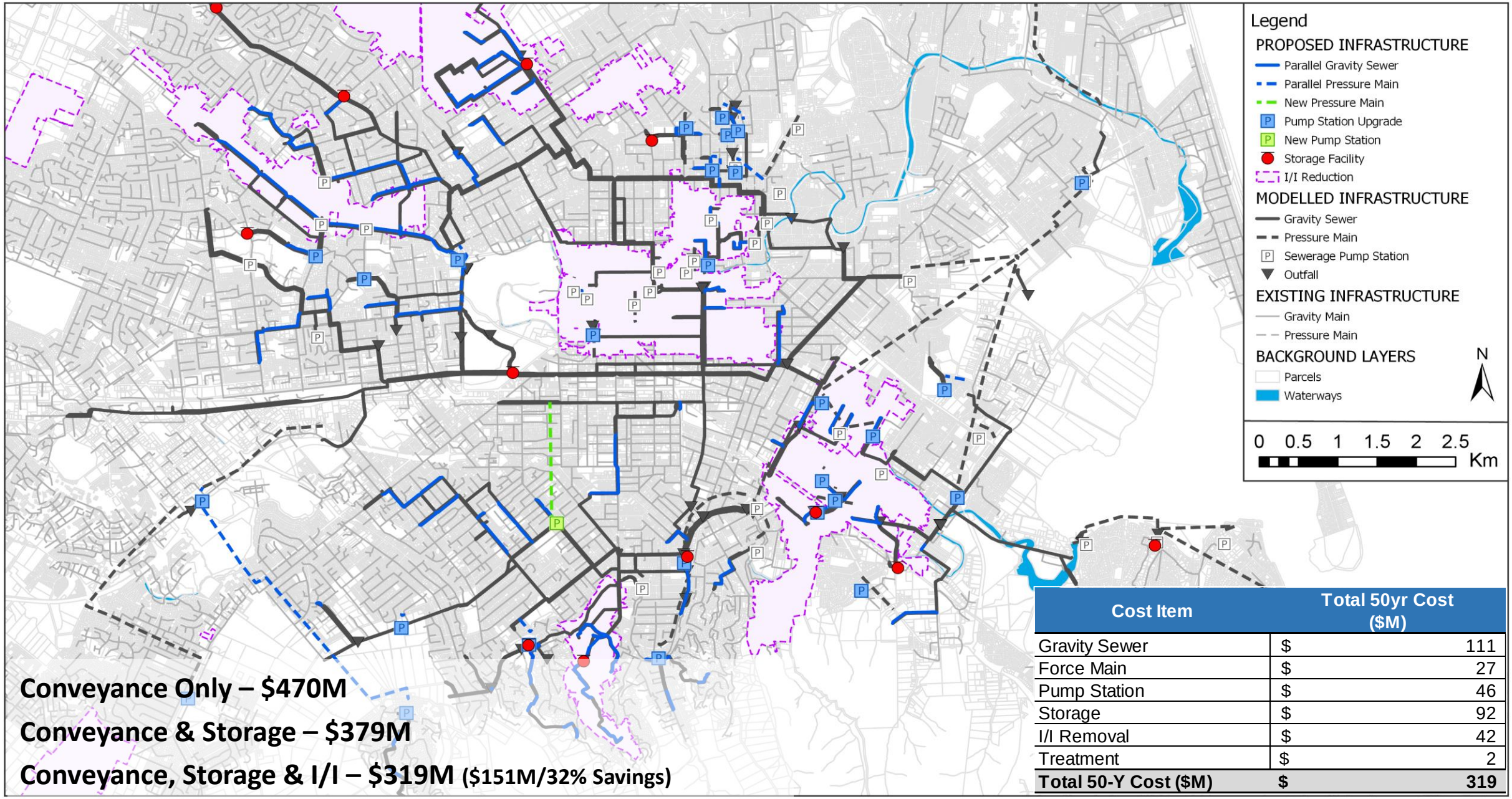


Conveyance Only – $470M

Conveyance & Storage – $379M **($91M/19% Savings)**

Cost Item		Total 50yr Cost ($M)
Gravity Sewer	$	137
Force Main	$	32
Pump Station	$	54
Storage	$	156
I/I Removal	$	-
Treatment	$	2
Total 50-Y Cost ($M)	**$**	**379**

Conveyance, Storage, Flow Control & I/I Reduction Optimised Solution

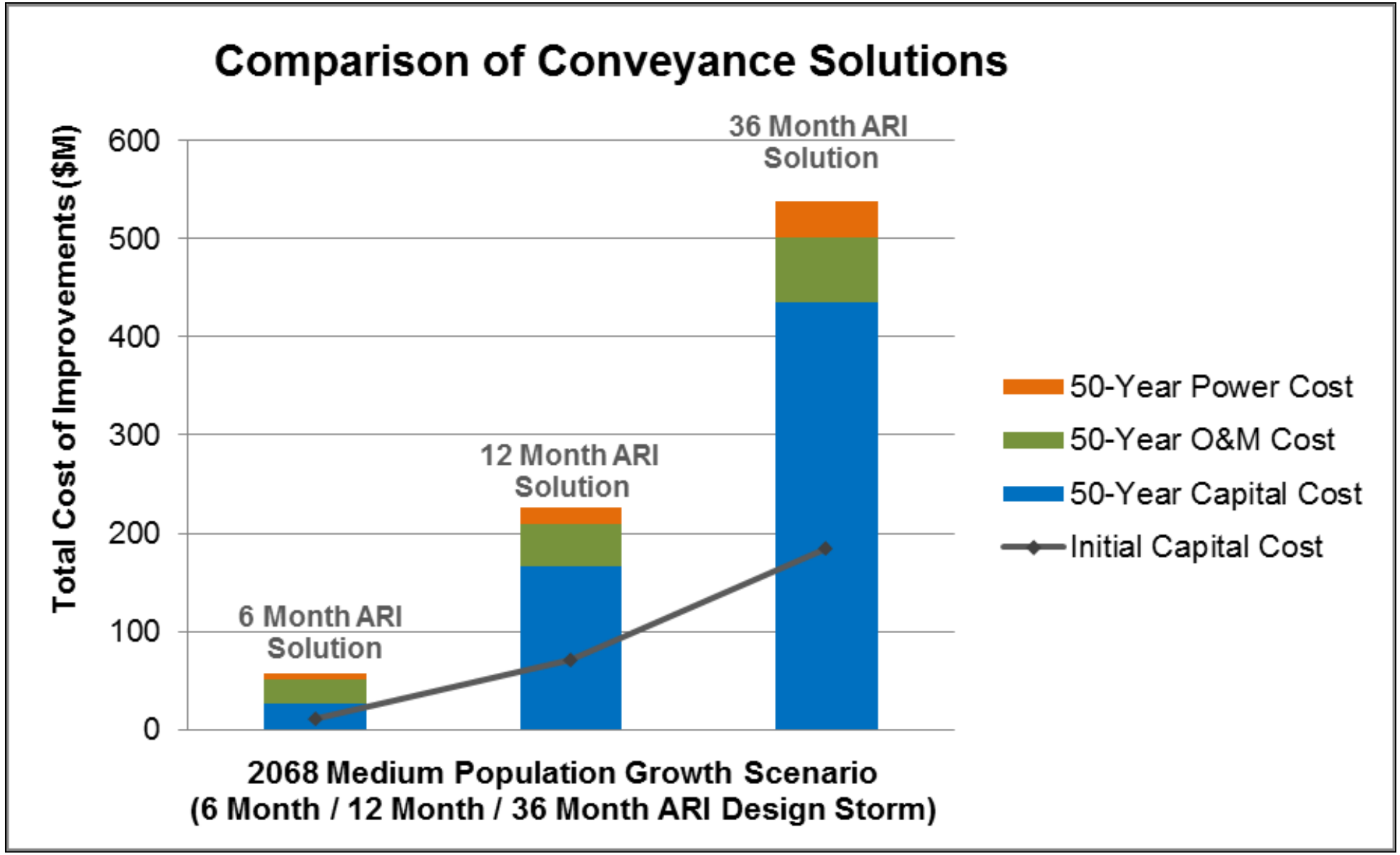


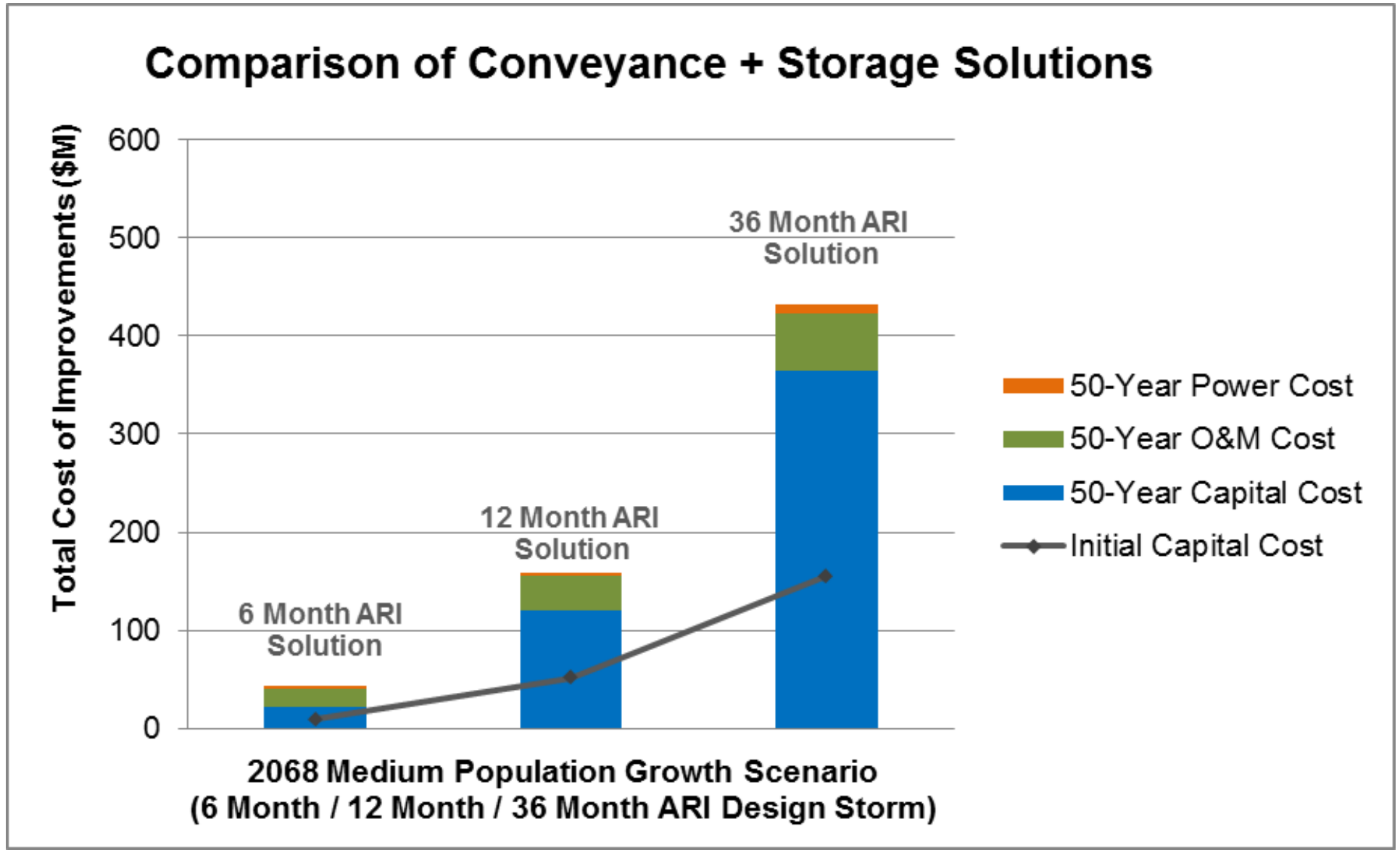
Conveyance Only – $470M

Conveyance & Storage – $379M

Conveyance, Storage & I/I – $319M **($151M/32% Savings)**

Cost Item	Total 50yr Cost ($M)	
Gravity Sewer	$	111
Force Main	$	27
Pump Station	$	46
Storage	$	92
I/I Removal	$	42
Treatment	$	2
Total 50-Y Cost ($M)	**$**	**319**


Comparison of Conveyance Solutions
Total Cost of Improvements ($M)
600
500
400
300
200
100
0
6 Month ARI Solution
12 Month ARI Solution
36 Month ARI Solution
50-Year Power Cost
50-Year O&M Cost
50-Year Capital Cost
Initial Capital Cost
2068 Medium Population Growth Scenario
(6 Month / 12 Month / 36 Month ARI Design Storm)


Comparison of Conveyance + Storage Solutions
Total Cost of Improvements ($M)
600
500
400
300
200
100
0
6 Month ARI Solution
12 Month ARI Solution
36 Month ARI Solution
50-Year Power Cost
50-Year O&M Cost
50-Year Capital Cost
Initial Capital Cost
2068 Medium Population Growth Scenario
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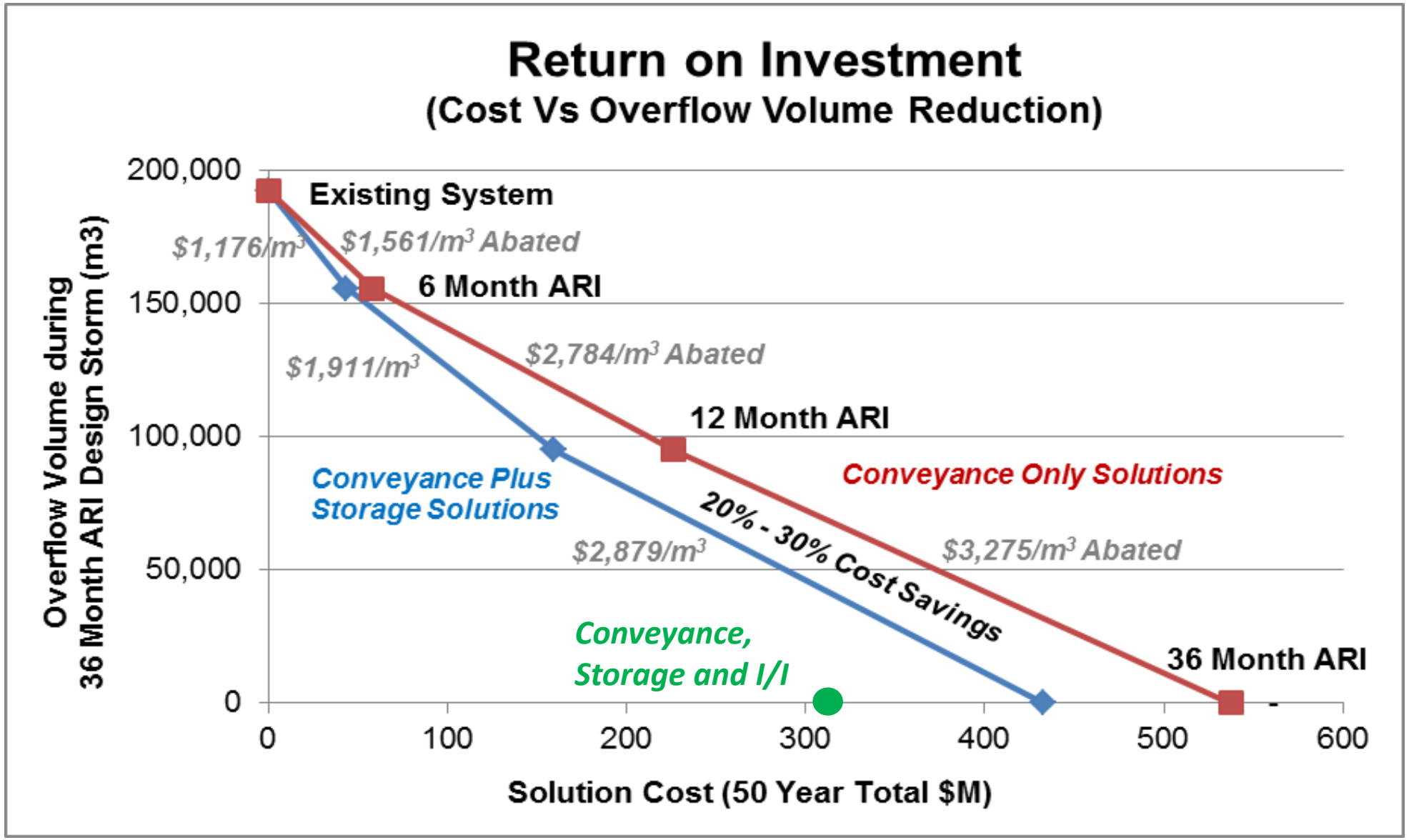
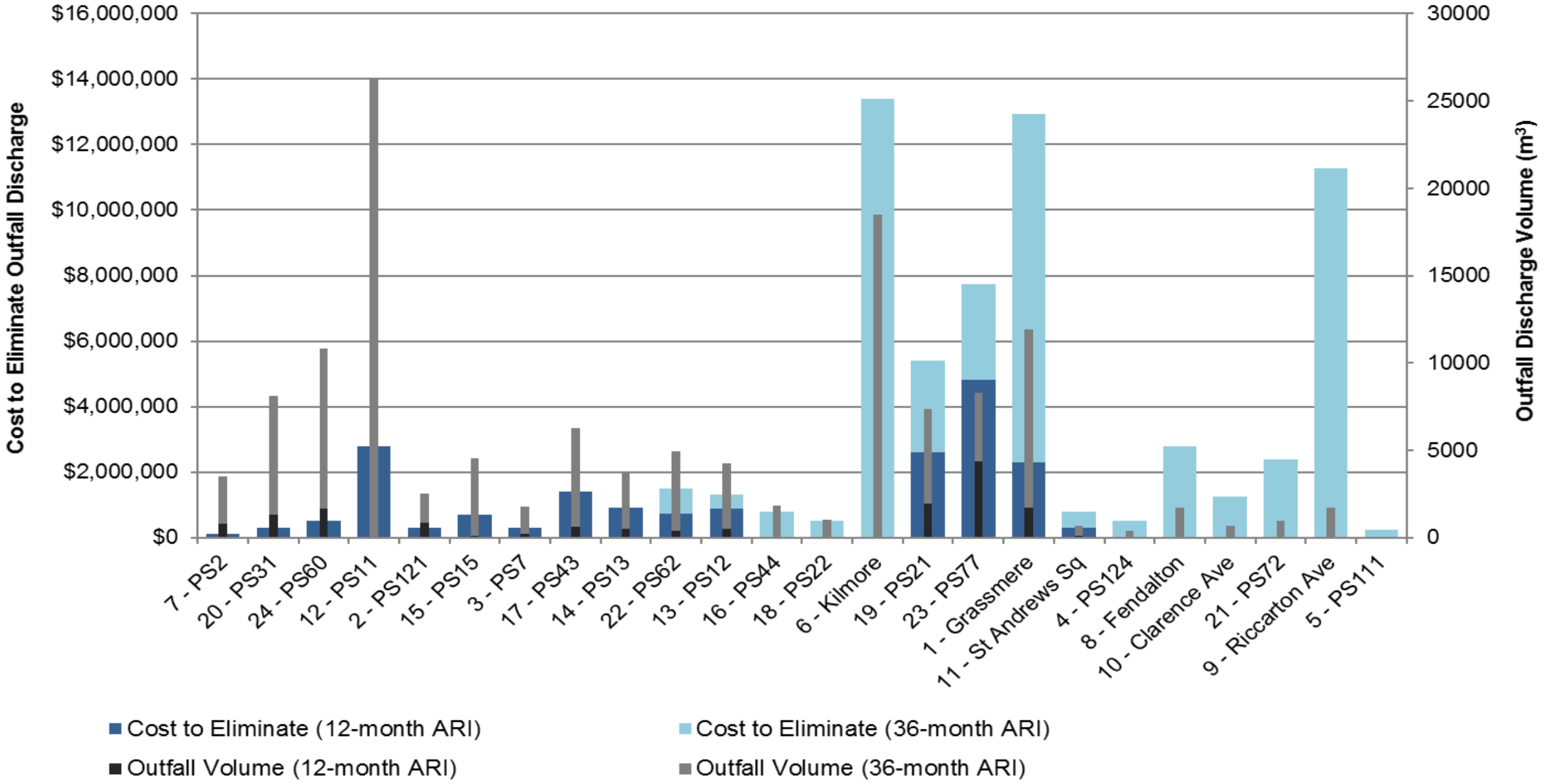
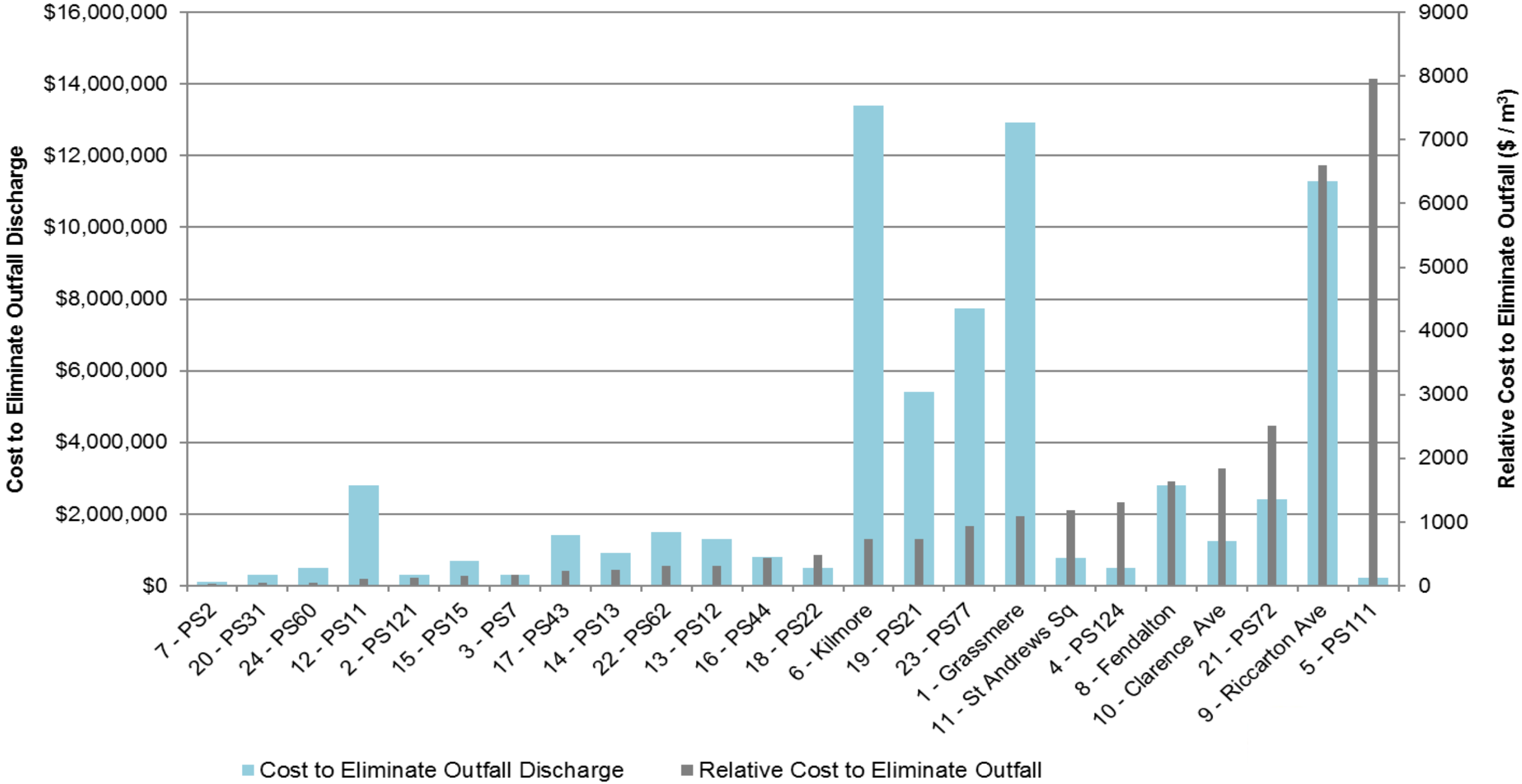
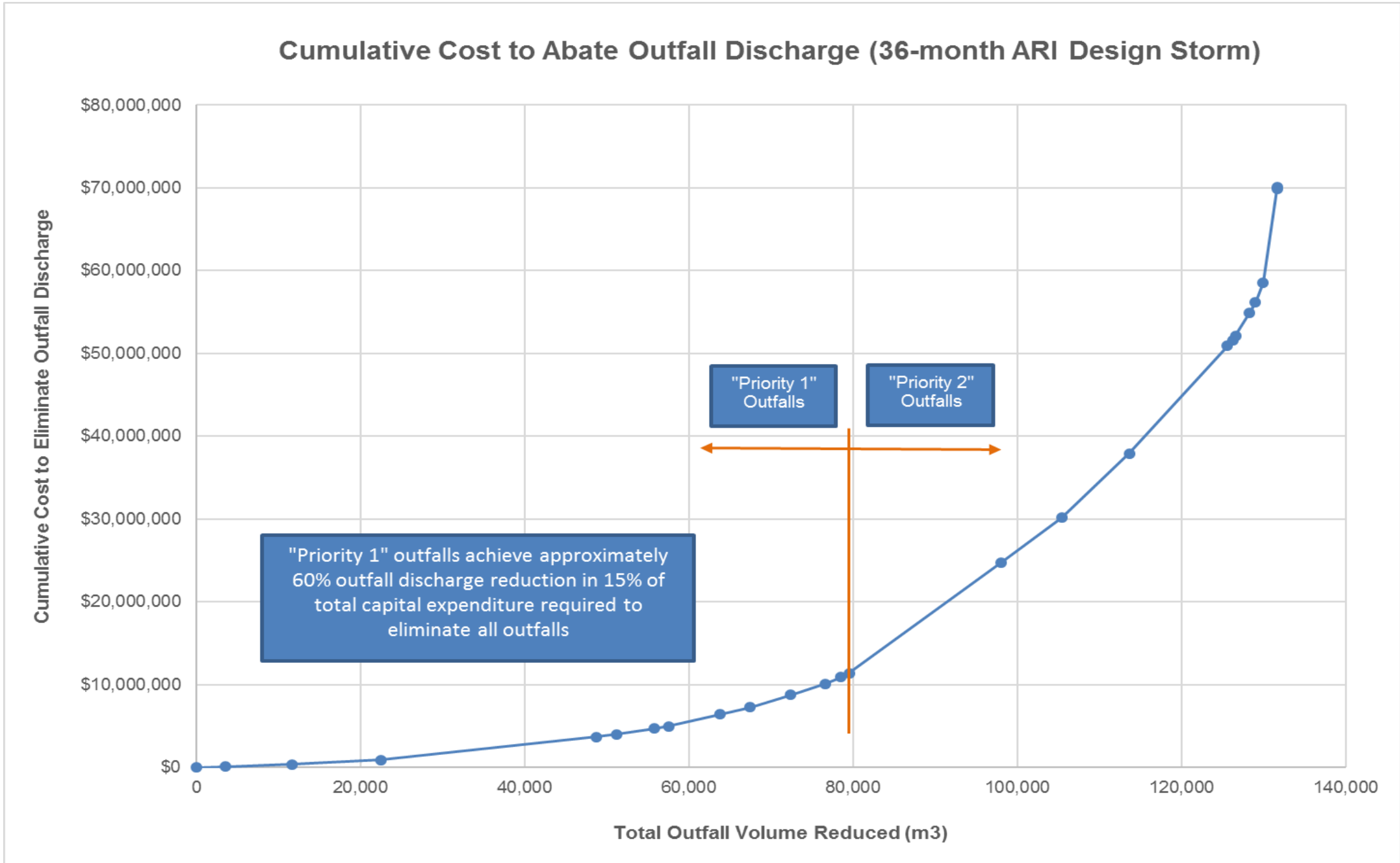

Return on Investment
(Cost Vs Overflow Volume Reduction)
Overflow Volume during
36 Month ARI Design Storm (m3)
200,000
150,000
100,000
50,000
0
Existing System
$1,176/m3
$1,561/m3 Abated
6 Month ARI
$1,911/m3
$2,784/m3 Abated
12 Month ARI
Conveyance Plus
Storage Solutions
Conveyance Only Solutions
20% - 30% Cost Savings
$2,879/m3
$3,275/m3 Abated
Conveyance,
Storage and I/I
36 Month ARI
0
100
200
300
400
500
600
Solution Cost (50 Year Total $M)

Outfall Volume and Cost to Abate



Relative Cost to Abate 36-month ARI Outfall Discharge




Cumulative Cost to Abate Outfall Discharge (36-month ARI Design Storm)
Cumulative Cost to Eliminate Outfall Discharge
$80,000,000
$70,000,000
$60,000,000
$50,000,000
$40,000,000
$30,000,000
$20,000,000
$10,000,000
$0
0
20,000
40,000
60,000
80,000
100,000
120,000
140,000
Total Outfall Volume Reduced (m3)
"Priority 1" Outfalls
"Priority 2" Outfalls
"Priority 1" outfalls achieve approximately 60% outfall discharge reduction in 15% of total capital expenditure required to eliminate all outfalls

Conclusions

1. Optimizer WCS coupled with the wastewater hydraulic model allowed thousands of combinations of solutions to be tested to determine the most cost-effective suite of projects to reduce overflows
2. Much more effective than traditional trial-and-error modelling
3. Savings of up to 32% on total 50-year cost achieved
4. CCC has confidence that budget is being used efficiently in time of constrained funding
5. Applicable to other cities with complex wastewater networks seeking to optimise expenditure

Reducing wastewater overflows: a pragmatic approach to optimise capital investment in Christchurch

Thank you!

Questions?

For additional information, contact:

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