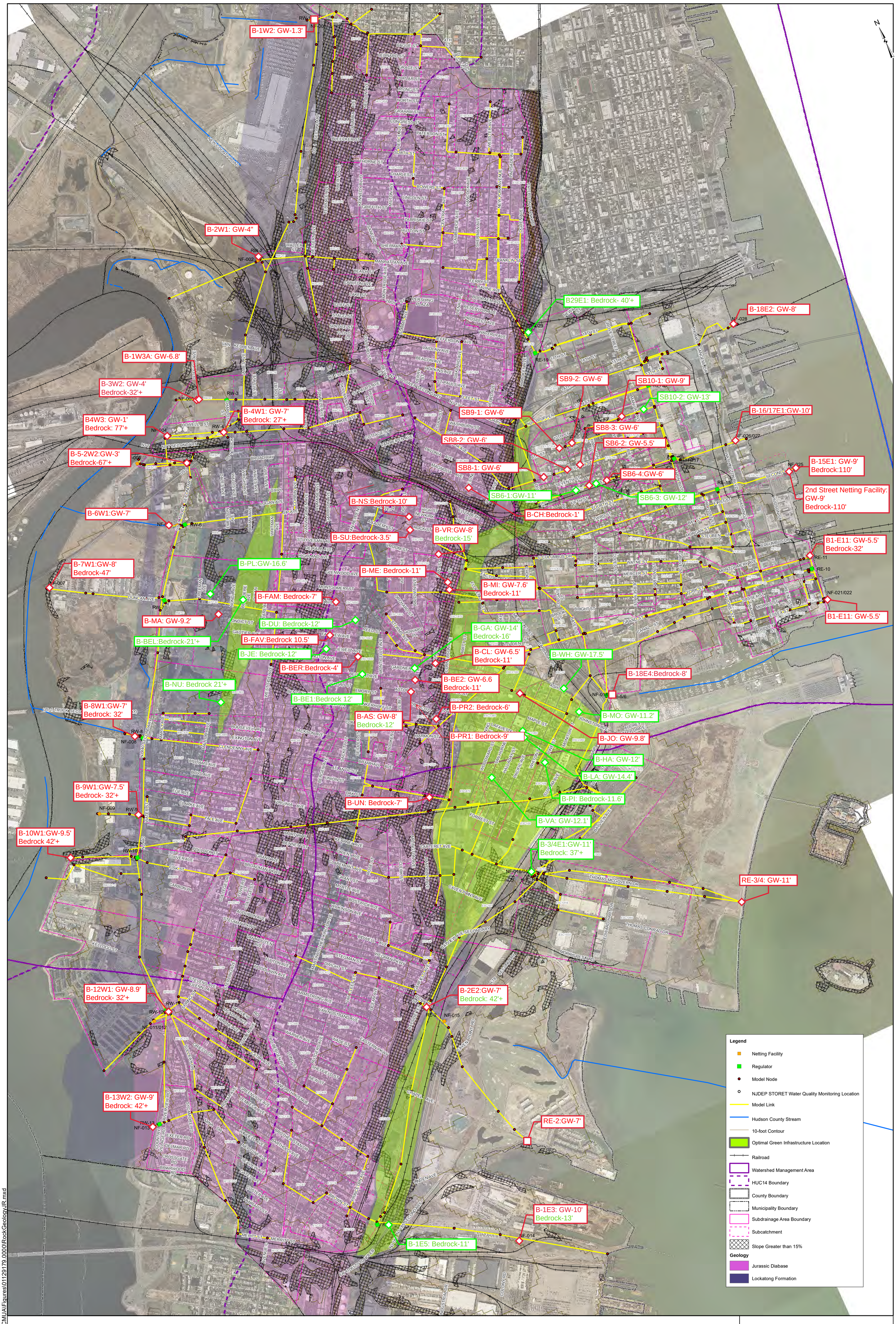

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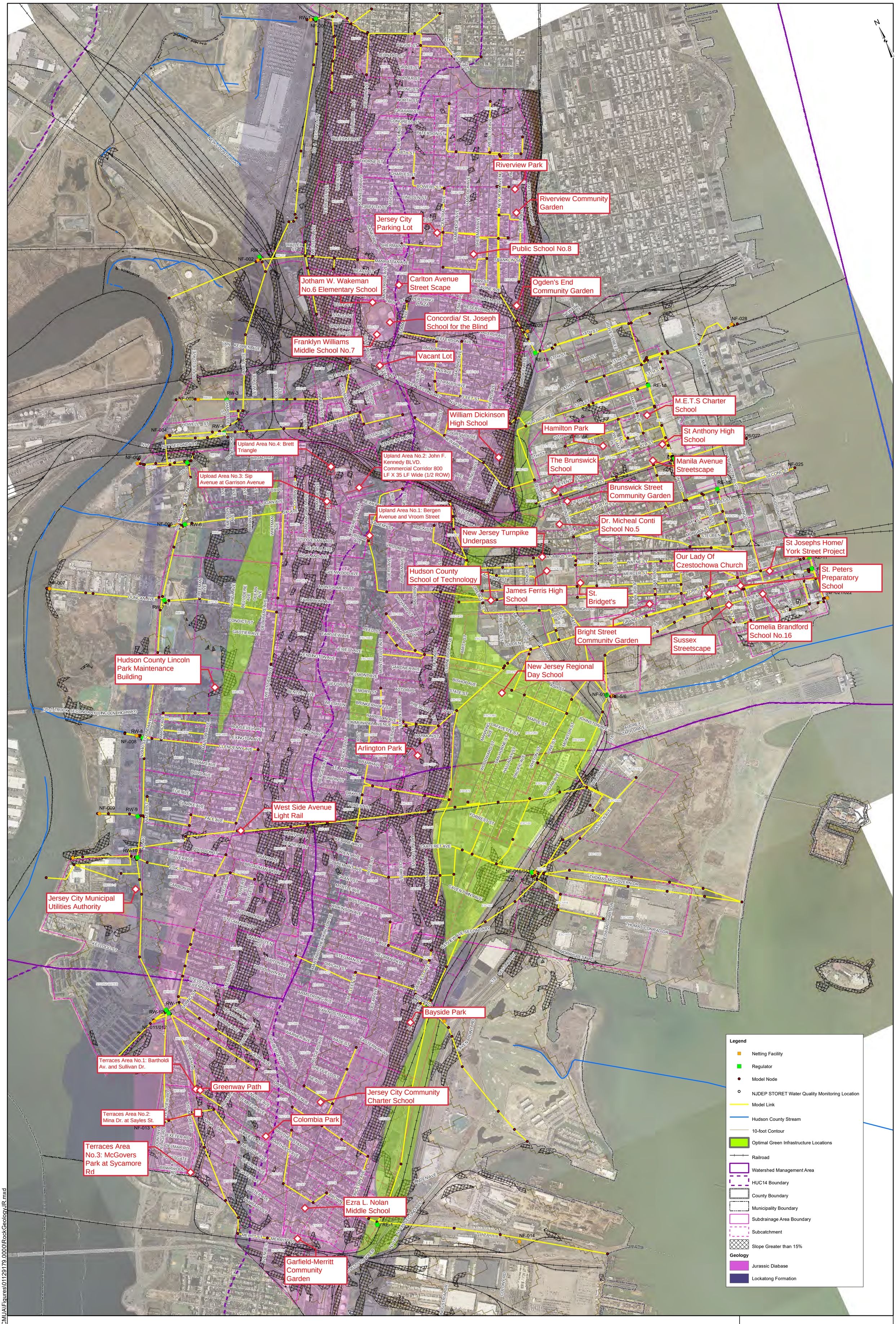
JERSEY CITY MUNICIPAL UTILITIES AUTHORITY

DEVELOPMENT AND EVALUATIONS OF ALTERNATIVESREPORT

OPTIMAL GREEN INFRASTRUCTURE LOCATIONS

FIGURE **D.1-2**



JERSEY CITY MUNICIPAL UTILITIES AUTHORITY

DEVELOPMENT AND EVALUATIONS OF ALTERNATIVES REPORT

ADDITIONAL GREEN INFRASTRUCTURE LOCATIONS

FIGURE **D.1-3**

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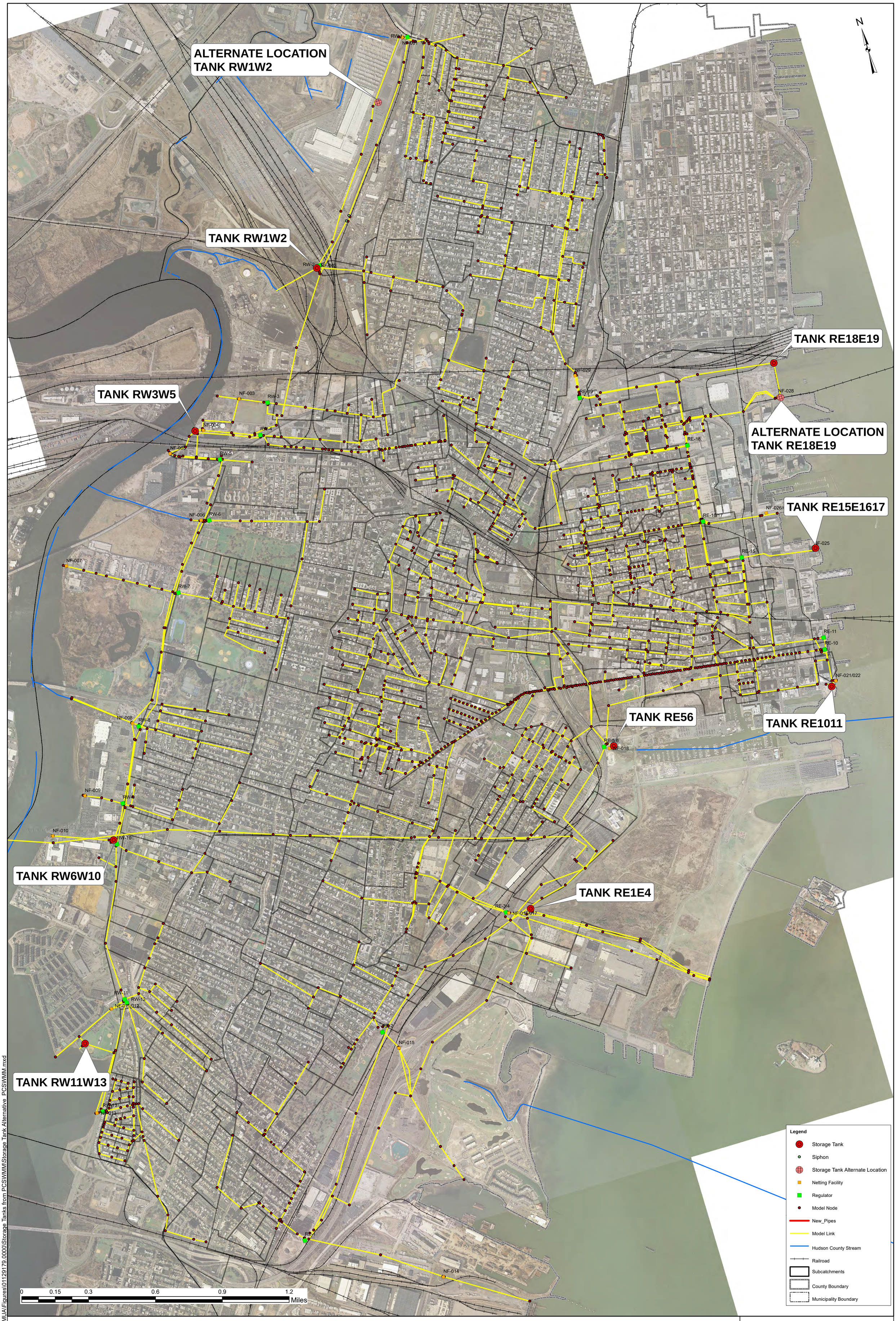
JERSEY CITY MUNICIPAL UTILITIES AUTHORITY
DEVELOPMENT AND EVALUATION OF ALTERNATIVES **REPORT**
PROPOSED JERSEY CITY TUNNEL ALIGNMENT

FIGURE D.**1-4**



JERSEY CITY MUNICIPAL UTILITIES AUTHORITY
DEVELOPMENT AND EVALUATION OF ALTERNATIVES **REPORT**
GROUPED STORAGE TANK LOCATIONS

FIGURE D.1-**5**

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APPENDICES

APPENDIX A

DETAILED TOTAL CAPITAL, O&M, AND PRESENT WORTH COSTS FOR JCMUA ALTERNATIVES

JCMUA Development and Evaluation of Alternatives
Table 1: Grouped Storage Tanks Alternative (4 Overflows)

Construction Phase	Description	Estimated Quantities	Unit Cost	Units	Total
	Grouped Storage Tanks Alternative (4 Overflows)				
	Tank #1: Secaucus / Manhattan (W1W2)				
	Tanks including Installation	5.6	$ 4,230,600	MG.	$ 23,540,000
	Gravity Sewer including Installation (8' x 10')	5,840	$ 2,800	L.F.	$ 16,350,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 40,090,000
	Total Cost with Contingency (25%)				$ 50,110,000
	Overhead and Profit (15%)				$ 7,520,000
TS 1	Legal and Engineering Costs (20%)				$ 10,020,000
	Total Capital Cost				**$ 67,650,000**
	Land Use	**0.33**	**$ 5,123,300**	**AC.**	**$ 1,680,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 710,000
	Annual O & M Cost				**$ 940,000**
	***Present Worth O & M Cost**				**$ 14,330,000**
	***Total Present Worth**				**$ 83,670,000**
	Tank #2: St. Paul's / Van Winkle / Broadway (W3W5)				
	Tanks including Installation	7	$ 3,970,300	MG.	$ 27,990,000
	Gravity Sewer including Installation (6')	1,660	$ 1,600	L.F.	$ 2,620,000
	Gravity Sewer including Installation (4' x 6')	860	$ 1,600	L.F.	$ 1,360,000
	Gravity Sewer including Installation (8')	50	$ 2,100	L.F.	$ 100,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 32,280,000
	Total Cost with Contingency (25%)				$ 40,350,000
TS 2	Overhead and Profit (15%)				$ 6,050,000
	Legal and Engineering Costs (20%)				$ 8,070,000
	Total Capital Cost				**$ 54,470,000**
	Land Use	**0.41**	**$ 5,123,300**	**AC.**	**$ 2,080,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 840,000
	Annual O & M Cost				**$ 1,070,000**
	***Present Worth O & M Cost**				**$ 16,360,000**
	***Total Present Worth**				**$ 72,910,000**
	Tank #3: York/Grand & Essex (E1011)				
	Tanks including Installation	4.5	$ 4,519,000	MG.	$ 20,390,000
	Gravity Sewer including Installation (8' x 10')	230	$ 2,800	L.F.	$ 640,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 21,230,000
	Total Cost with Contingency (25%)				$ 26,540,000
	Overhead and Profit (15%)				$ 3,980,000
TS 3	Legal and Engineering Costs (20%)				$ 5,310,000
	Total Capital Cost				**$ 35,830,000**
	Land Use	**0.3**	**$ 5,123,300**	**AC.**	**$ 1,560,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 610,000
	Annual O & M Cost				**$ 850,000**
	***Present Worth O & M Cost**				**$ 12,890,000**
	***Total Present Worth**				**$ 50,280,000**
	Tank #4: Mill Creek & Pine (E56)				
	Tanks including Installation	15	$ 3,454,200	MG.	$ 51,710,000
	Gravity Sewer including Installation (6')	110	$ 1,600	L.F.	$ 170,000
	Gravity Sewer including Installation (8')	50	$ 2,100	L.F.	$ 100,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 52,180,000
	Total Cost with Contingency (25%)				$ 65,230,000
	Overhead and Profit (15%)				$ 9,780,000
TS 4	Legal and Engineering Costs (20%)				$ 13,050,000
	Total Capital Cost				**$ 88,060,000**
	Land Use	**0.65**	**$ 5,123,300**	**AC.**	**$ 3,330,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 1,550,000
	Annual O & M Cost				**$ 1,790,000**
	***Present Worth O & M Cost**				**$ 27,200,000**
	***Total Present Worth**				**$ 118,590,000**
	Tank #5: Second / Sixth (E15E1617)				
	Tanks including Installation	1.9	$ 6,607,600	MG.	$ 12,580,000
	Gravity Sewer including Installation (8' x 10')	30	$ 2,800	L.F.	$ 80,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 12,860,000
	Total Cost with Contingency (25%)				$ 16,080,000
	Overhead and Profit (15%)				$ 2,410,000
TS 5	Legal and Engineering Costs (20%)				$ 3,220,000
	Total Capital Cost				**$ 21,700,000**
	Land Use	**0.22**	**$ 5,123,300**	**AC.**	**$ 1,120,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 380,000
	Annual O & M Cost				**$ 610,000**
	***Present Worth O & M Cost**				**$ 9,320,000**
	***Total Present Worth**				**$ 32,150,000**

Construction Phase	Description	Estimated Quantities	Unit Cost	Units	Total
	Tank #6: Sip / Duncan / Clendenny / Claremont / Fisk (W6W10)				
	Tanks including Installation	26.4	$ 3,254,900	MG.	$ 86,050,000
	Gravity Sewer including Installation (6' x 10')	1,800	$ 2,300	L.F.	$ 4,160,000
	Gravity Sewer including Installation (8' x 10')	6,180	$ 2,800	L.F.	$ 17,300,000
	Gravity Sewer including Installation (6')	90	$ 1,600	L.F.	$ 140,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 107,850,000
	Total Cost with Contingency (25%)				$ 134,820,000
	Overhead and Profit (15%)				$ 20,220,000
TS 6	Legal and Engineering Costs (20%)				$ 26,960,000
	Total Capital Cost				**$ 182,000,000**
	Land Use	**1**	**$ 5,123,300**	**AC.**	**$ 5,140,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 2,580,000
	Annual O & M Cost				**$ 2,820,000**
	***Present Worth O & M Cost**				**$ 42,890,000**
	***Total Present Worth**				**$ 230,030,000**
	Tank #7: Danforth & Mina (W11W13)				
	Tanks including Installation	8.2	$ 3,830,900	MG.	$ 31,510,000
	Gravity Sewer including Installation (8')	2,210	$ 2,100	L.F.	$ 4,570,000
	Gravity Sewer including Installation (8' x 12')	220	$ 3,000	L.F.	$ 670,000
	Gravity Sewer including Installation (9')	100	$ 2,300	L.F.	$ 230,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 37,180,000
	Total Cost with Contingency (25%)				$ 46,480,000
TS 7	Overhead and Profit (15%)				$ 6,970,000
	Legal and Engineering Costs (20%)				$ 9,300,000
	Total Capital Cost				**$ 62,740,000**
	Land Use	**0.43**	**$ 5,123,300**	**AC.**	**$ 2,190,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 950,000
	Annual O & M Cost				**$ 1,180,000**
	***Present Worth O & M Cost**				**$ 17,970,000**
	***Total Present Worth**				**$ 82,900,000**
	Tank #8: Fourteenth / Eighteenth (E18E19)				
	Tanks including Installation	7	$ 3,970,300	MG.	$ 27,990,000
	Gravity Sewer including Installation (10')	2,640	$ 2,600	L.F.	$ 6,750,000
	Gravity Sewer including Installation (8' x 10')	90	$ 2,800	L.F.	$ 250,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 35,190,000
	Total Cost with Contingency (25%)				$ 43,990,000
	Overhead and Profit (15%)				$ 6,600,000
TS 8	Legal and Engineering Costs (20%)				$ 8,800,000
	Total Capital Cost				**$ 59,380,000**
	Land Use	**0.41**	**$ 5,123,300**	**AC.**	**$ 2,080,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 840,000
	Annual O & M Cost				**$ 1,070,000**
	***Present Worth O & M Cost**				**$ 16,360,000**
	***Total Present Worth**				**$ 77,820,000**
	Tank #9: Brown / Richard / Claremont & Carteret (E1E4)				
	Tanks including Installation	7.3	$ 3,931,200	MG.	$ 28,870,000
	Gravity Sewer including Installation (5')	4,860	$ 1,300	L.F.	$ 6,500,000
	Gravity Sewer including Installation (6')	5,610	$ 1,600	L.F.	$ 8,870,000
	Gravity Sewer including Installation (8')	4,800	$ 2,100	L.F.	$ 9,930,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 54,370,000
	Total Cost with Contingency (25%)				$ 67,960,000
TS 9	Overhead and Profit (15%)				$ 10,190,000
	Legal and Engineering Costs (20%)				$ 13,590,000
	Total Capital Cost				**$ 91,740,000**
	Land Use	**0.41**	**$ 5,123,300**	**AC.**	**$ 2,080,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 870,000
	Annual O & M Cost				**$ 1,100,000**
	***Present Worth O & M Cost**				**$ 16,770,000**
	***Total Present Worth**				**$ 110,590,000**
All Phases	***Total Present Worth**				**$ 858,960,000**

*20 years life cycle costs for operation and maitenance with an interest rate of 2.75% for present value calculation (P/A = 15.227)

JCMUA Development and Evaluation of Alternatives
Table 2: Grouped Storage Tanks Alternative (8 Overflows)

Construction Phase	Description	Estimated Quantities	Unit Cost	Units	Total
	Grouped Storage Tanks Alternative (8 Overflows)				
TS 1	**Tank #1: Secaucus / Manhattan (W1W2)**				
	Tanks including Installation	5.6	$ 4,230,600	MG.	$ 23,540,000
	Gravity Sewer including Installation (8' x 10')	5,840	$ 2,800	L.F.	$ 16,350,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 40,090,000
	Total Cost with Contingency (25%)				$ 50,110,000
	Overhead and Profit (15%)				$ 7,520,000
	Legal and Engineering Costs (20%)				$ 10,020,000
	Total Capital Cost				**$ 67,650,000**
	Land Use	**0.33**	**$ 5,123,300**	**AC.**	**$ 1,680,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 710,000
	Annual O & M Cost				**$ 940,000**
	***Present Worth O & M Cost**				**$ 14,330,000**
	***Total Present Worth**				**$ 83,670,000**
TS 2	**Tank #2: St. Paul's / Van Winkle / Broadway (W3W5)**				
	Tanks including Installation	4.9	$ 4,401,700	MG.	$ 21,510,000
	Gravity Sewer including Installation (6')	1,660	$ 1,600	L.F.	$ 2,620,000
	Gravity Sewer including Installation (4' x 6')	860	$ 1,600	L.F.	$ 1,360,000
	Gravity Sewer including Installation (8')	50	$ 2,100	L.F.	$ 100,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 25,800,000
	Total Cost with Contingency (25%)				$ 32,250,000
	Overhead and Profit (15%)				$ 4,840,000
	Legal and Engineering Costs (20%)				$ 6,450,000
	Total Capital Cost				**$ 43,540,000**
	Land Use	**0.3**	**$ 5,123,300**	**AC.**	**$ 1,560,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 650,000
	Annual O & M Cost				**$ 880,000**
	***Present Worth O & M Cost**				**$ 13,410,000**
	***Total Present Worth**				**$ 58,510,000**
TS 3	**Tank #3: York/Grand & Essex (E1011)**				
	Tanks including Installation	4.5	$ 4,519,000	MG.	$ 20,390,000
	Gravity Sewer including Installation (8' x 10')	230	$ 2,800	L.F.	$ 640,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 21,230,000
	Total Cost with Contingency (25%)				$ 26,540,000
	Overhead and Profit (15%)				$ 3,980,000
	Legal and Engineering Costs (20%)				$ 5,310,000
	Total Capital Cost				**$ 35,830,000**
	Land Use	**0.3**	**$ 5,123,300**	**AC.**	**$ 1,560,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 610,000
	Annual O & M Cost				**$ 850,000**
	***Present Worth O & M Cost**				**$ 12,890,000**
	***Total Present Worth**				**$ 50,280,000**
TS 4	**Tank #4: Mill Creek & Pine (E56)**				
	Tanks including Installation	11.8	$ 3,575,400	MG.	$ 42,350,000
	Gravity Sewer including Installation (6')	110	$ 1,600	L.F.	$ 170,000
	Gravity Sewer including Installation (8')	50	$ 2,100	L.F.	$ 100,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 42,820,000
	Total Cost with Contingency (25%)				$ 53,530,000
	Overhead and Profit (15%)				$ 8,030,000
	Legal and Engineering Costs (20%)				$ 10,710,000
	Total Capital Cost				**$ 72,270,000**
	Land Use	**0.55**	**$ 5,123,300**	**AC.**	**$ 2,830,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 1,270,000
	Annual O & M Cost				**$ 1,510,000**
	***Present Worth O & M Cost**				**$ 22,920,000**
	***Total Present Worth**				**$ 98,020,000**
TS 5	**Tank #5: Second / Sixth (E15E1617)**				
	Tanks including Installation	1.8	$ 6,820,100	MG.	$ 12,260,000
	Gravity Sewer including Installation (8' x 10')	30	$ 2,800	L.F.	$ 80,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 12,550,000
	Total Cost with Contingency (25%)				$ 15,680,000
	Overhead and Profit (15%)				$ 2,350,000
	Legal and Engineering Costs (20%)				$ 3,140,000
	Total Capital Cost				**$ 21,170,000**
	Land Use	**0.22**	**$ 5,123,300**	**AC.**	**$ 1,120,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 370,000
	Annual O & M Cost				**$ 600,000**
	***Present Worth O & M Cost**				**$ 9,180,000**
	***Total Present Worth**				**$ 31,470,000**

Construction Phase	Description	Estimated Quantities	Unit Cost	Units	Total
TS 6	**Tank #6: Sip / Duncan / Clendenny / Claremont / Fisk (W6W10)**				
	Tanks including Installation	25.1	$ 3,268,600	MG.	$ 82,090,000
	Gravity Sewer including Installation (6' x 10')	1,800	$ 2,300	L.F.	$ 4,160,000
	Gravity Sewer including Installation (8' x 10')	6,180	$ 2,800	L.F.	$ 17,300,000
	Gravity Sewer including Installation (6')	90	$ 1,600	L.F.	$ 140,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 103,900,000
	Total Cost with Contingency (25%)				$ 129,870,000
	Overhead and Profit (15%)				$ 19,480,000
	Legal and Engineering Costs (20%)				$ 25,970,000
	Total Capital Cost				**$ 175,320,000**
	Land Use	**0.96**	**$ 5,123,300**	**AC.**	**$ 4,930,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 2,460,000
	Annual O & M Cost				**$ 2,700,000**
	***Present Worth O & M Cost**				**$ 41,080,000**
	***Total Present Worth**				**$ 221,330,000**
TS 7	**Tank #7: Danforth & Mina (W11W13)**				
	Tanks including Installation	8.2	$ 3,830,900	MG.	$ 31,510,000
	Gravity Sewer including Installation (8')	2,210	$ 2,100	L.F.	$ 4,570,000
	Gravity Sewer including Installation (8' x 12')	220	$ 3,000	L.F.	$ 670,000
	Gravity Sewer including Installation (9')	100	$ 2,300	L.F.	$ 230,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 37,180,000
	Total Cost with Contingency (25%)				$ 46,480,000
	Overhead and Profit (15%)				$ 6,970,000
	Legal and Engineering Costs (20%)				$ 9,300,000
	Total Capital Cost				**$ 62,740,000**
	Land Use	**0.43**	**$ 5,123,300**	**AC.**	**$ 2,190,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 950,000
	Annual O & M Cost				**$ 1,180,000**
	***Present Worth O & M Cost**				**$ 17,970,000**
	***Total Present Worth**				**$ 82,900,000**
TS 8	**Tank #8: Fourteenth / Eighteenth (E18E19)**				
	Tanks including Installation	5.9	$ 4,165,400	MG.	$ 24,470,000
	Gravity Sewer including Installation (10')	2,640	$ 2,600	L.F.	$ 6,750,000
	Gravity Sewer including Installation (8' x 10')	90	$ 2,800	L.F.	$ 250,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 31,670,000
	Total Cost with Contingency (25%)				$ 39,590,000
	Overhead and Profit (15%)				$ 5,940,000
	Legal and Engineering Costs (20%)				$ 7,920,000
	Total Capital Cost				**$ 53,440,000**
	Land Use	**0.41**	**$ 5,123,300**	**AC.**	**$ 2,080,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 730,000
	Annual O & M Cost				**$ 970,000**
	***Present Worth O & M Cost**				**$ 14,760,000**
	***Total Present Worth**				**$ 70,280,000**
TS 9	**Tank #9: Brown / Richard / Claremont & Carteret (E1E4)**				
	Tanks including Installation	5.6	$ 4,227,000	MG.	$ 23,590,000
	Gravity Sewer including Installation (5')	4,860	$ 1,300	L.F.	$ 6,500,000
	Gravity Sewer including Installation (6')	5,610	$ 1,600	L.F.	$ 8,870,000
	Gravity Sewer including Installation (8')	4,800	$ 2,100	L.F.	$ 9,930,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 49,090,000
	Total Cost with Contingency (25%)				$ 61,360,000
	Overhead and Profit (15%)				$ 9,200,000
	Legal and Engineering Costs (20%)				$ 12,270,000
	Total Capital Cost				**$ 82,840,000**
	Land Use	**0.41**	**$ 5,123,300**	**AC.**	**$ 2,080,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 710,000
	Annual O & M Cost				**$ 940,000**
	***Present Worth O & M Cost**				**$ 14,350,000**
	***Total Present Worth**				**$ 99,270,000**
All Phases	***Total Present Worth**				**$ 795,730,000**

*20 years life cycle costs for operation and maitenance with an interest rate of 2.75% for present value calculation (P/A = 15.227)

JCMUA Development and Evaluation of Alternatives
Table 3: Grouped Storage Tanks Alternative (12 Overflows)

Construction Phase	Description	Estimated Quantities	Unit Cost	Units	Total
	Grouped Storage Tanks Alternative (12 Overflows)				
TS 1	**Tank #1: Secaucus / Manhattan (W1W2)**				
	Tanks including Installation	4.5	$ 4,519,000	MG.	$ 20,390,000
	Gravity Sewer including Installation (8' x 10')	5,840	$ 2,800	L.F.	$ 16,350,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 36,940,000
	Total Cost with Contingency (25%)				$ 46,170,000
	Overhead and Profit (15%)				$ 6,930,000
	Legal and Engineering Costs (20%)				$ 9,230,000
	Total Capital Cost				**$ 62,330,000**
	Land Use	**0.3**	**$ 5,123,300**	**AC.**	**$ 1,560,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 610,000
	Annual O & M Cost				**$ 850,000**
	***Present Worth O & M Cost**				**$ 12,890,000**
	***Total Present Worth**				**$ 76,790,000**
TS 2	**Tank #2: St. Paul's / Van Winkle / Broadway (W3W5)**				
	Tanks including Installation	4.1	$ 4,657,500	MG.	$ 19,260,000
	Gravity Sewer including Installation (6')	1,660	$ 1,600	L.F.	$ 2,620,000
	Gravity Sewer including Installation (4' x 6')	860	$ 1,600	L.F.	$ 1,360,000
	Gravity Sewer including Installation (8')	50	$ 2,100	L.F.	$ 100,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 23,550,000
	Total Cost with Contingency (25%)				$ 29,440,000
	Overhead and Profit (15%)				$ 4,420,000
	Legal and Engineering Costs (20%)				$ 5,890,000
	Total Capital Cost				**$ 39,740,000**
	Land Use	**0.3**	**$ 5,123,300**	**AC.**	**$ 1,560,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 580,000
	Annual O & M Cost				**$ 810,000**
	***Present Worth O & M Cost**				**$ 12,380,000**
	***Total Present Worth**				**$ 53,680,000**
TS 3	**Tank #3: York/Grand & Essex (E1011)**				
	Tanks including Installation	4.1	$ 4,657,500	MG.	$ 19,260,000
	Gravity Sewer including Installation (8' x 10')	230	$ 2,800	L.F.	$ 640,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 20,110,000
	Total Cost with Contingency (25%)				$ 25,130,000
	Overhead and Profit (15%)				$ 3,770,000
	Legal and Engineering Costs (20%)				$ 5,030,000
	Total Capital Cost				**$ 33,930,000**
	Land Use	**0.3**	**$ 5,123,300**	**AC.**	**$ 1,560,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 580,000
	Annual O & M Cost				**$ 810,000**
	***Present Worth O & M Cost**				**$ 12,380,000**
	***Total Present Worth**				**$ 47,870,000**
TS 4	**Tank #4: Mill Creek & Pine (E56)**				
	Tanks including Installation	11	$ 3,620,100	MG.	$ 39,810,000
	Gravity Sewer including Installation (6')	110	$ 1,600	L.F.	$ 170,000
	Gravity Sewer including Installation (8')	50	$ 2,100	L.F.	$ 100,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 40,290,000
	Total Cost with Contingency (25%)				$ 50,360,000
	Overhead and Profit (15%)				$ 7,550,000
	Legal and Engineering Costs (20%)				$ 10,070,000
	Total Capital Cost				**$ 67,990,000**
	Land Use	**0.52**	**$ 5,123,300**	**AC.**	**$ 2,670,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 1,190,000
	Annual O & M Cost				**$ 1,430,000**
	***Present Worth O & M Cost**				**$ 21,760,000**
	***Total Present Worth**				**$ 92,420,000**
TS 5	**Tank #5: Second / Sixth (E15E1617)**				
	Tanks including Installation	1.6	$ 7,330,200	MG.	$ 11,630,000
	Gravity Sewer including Installation (8' x 10')	30	$ 2,800	L.F.	$ 80,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 11,910,000
	Total Cost with Contingency (25%)				$ 14,890,000
	Overhead and Profit (15%)				$ 2,230,000
	Legal and Engineering Costs (20%)				$ 2,980,000
	Total Capital Cost				**$ 20,100,000**
	Land Use	**0.22**	**$ 5,123,300**	**AC.**	**$ 1,120,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 350,000
	Annual O & M Cost				**$ 580,000**
	***Present Worth O & M Cost**				**$ 8,890,000**
	***Total Present Worth**				**$ 30,110,000**

Construction Phase	Description	Estimated Quantities	Unit Cost	Units	Total
TS 6	**Tank #6: Sip / Duncan / Clendenny / Claremont / Fisk (W6W10)**				
	Tanks including Installation	18	$ 3,377,600	MG.	$ 60,670,000
	Gravity Sewer including Installation (6' x 10')	1,800	$ 2,300	L.F.	$ 4,160,000
	Gravity Sewer including Installation (8' x 10')	6,180	$ 2,800	L.F.	$ 17,300,000
	Gravity Sewer including Installation (6')	90	$ 1,600	L.F.	$ 140,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 82,480,000
	Total Cost with Contingency (25%)				$ 103,100,000
	Overhead and Profit (15%)				$ 15,460,000
	Legal and Engineering Costs (20%)				$ 20,620,000
	Total Capital Cost				**$ 139,180,000**
	Land Use	**0.74**	**$ 5,123,300**	**AC.**	**$ 3,810,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 1,820,000
	Annual O & M Cost				**$ 2,060,000**
	***Present Worth O & M Cost**				**$ 31,290,000**
	***Total Present Worth**				**$ 174,280,000**
TS 7	**Tank #7: Danforth & Mina (W11W13)**				
	Tanks including Installation	7	$ 3,970,300	MG.	$ 27,990,000
	Gravity Sewer including Installation (8')	2,210	$ 2,100	L.F.	$ 4,570,000
	Gravity Sewer including Installation (8' x 12')	220	$ 3,000	L.F.	$ 670,000
	Gravity Sewer including Installation (9')	100	$ 2,300	L.F.	$ 230,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 33,660,000
	Total Cost with Contingency (25%)				$ 42,080,000
	Overhead and Profit (15%)				$ 6,310,000
	Legal and Engineering Costs (20%)				$ 8,420,000
	Total Capital Cost				**$ 56,800,000**
	Land Use	**0.41**	**$ 5,123,300**	**AC.**	**$ 2,080,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 840,000
	Annual O & M Cost				**$ 1,070,000**
	***Present Worth O & M Cost**				**$ 16,360,000**
	***Total Present Worth**				**$ 75,250,000**
TS 8	**Tank #8: Fourteenth / Eighteenth (E18E19)**				
	Tanks including Installation	5.9	$ 4,165,400	MG.	$ 24,470,000
	Gravity Sewer including Installation (10')	2,640	$ 2,600	L.F.	$ 6,750,000
	Gravity Sewer including Installation (8' x 10')	90	$ 2,800	L.F.	$ 250,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 31,670,000
	Total Cost with Contingency (25%)				$ 39,590,000
	Overhead and Profit (15%)				$ 5,940,000
	Legal and Engineering Costs (20%)				$ 7,920,000
	Total Capital Cost				**$ 53,440,000**
	Land Use	**0.41**	**$ 5,123,300**	**AC.**	**$ 2,080,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 730,000
	Annual O & M Cost				**$ 970,000**
	***Present Worth O & M Cost**				**$ 14,760,000**
	***Total Present Worth**				**$ 70,280,000**
TS 9	**Tank #9: Brown / Richard / Claremont & Carteret (E1E4)**				
	Tanks including Installation	5.6	$ 4,227,000	MG.	$ 23,590,000
	Gravity Sewer including Installation (5')	4,860	$ 1,300	L.F.	$ 6,500,000
	Gravity Sewer including Installation (6')	5,610	$ 1,600	L.F.	$ 8,870,000
	Gravity Sewer including Installation (8')	4,800	$ 2,100	L.F.	$ 9,930,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 49,090,000
	Total Cost with Contingency (25%)				$ 61,360,000
	Overhead and Profit (15%)				$ 9,200,000
	Legal and Engineering Costs (20%)				$ 12,270,000
	Total Capital Cost				**$ 82,840,000**
	Land Use	**0.41**	**$ 5,123,300**	**AC.**	**$ 2,080,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 710,000
	Annual O & M Cost				**$ 940,000**
	***Present Worth O & M Cost**				**$ 14,350,000**
	***Total Present Worth**				**$ 99,270,000**
All Phases	***Total Present Worth**				**$ 719,950,000**

*20 years life cycle costs for operation and maitenance with an interest rate of 2.75% for present value calculation (P/A = 15.227)

JCMUA Development and Evaluation of Alternatives
Table 4: Grouped Storage Tanks Alternative (20 Overflows)

Construction Phase	Description	Estimated Quantities	Unit Cost	Units	Total
	Grouped Storage Tanks Alternative (20 Overflows)				
	Tank #1: Secaucus / Manhattan (W1W2)				
	Tanks including Installation	3.7	$ 4,861,100	MG.	$ 17,910,000
	Gravity Sewer including Installation (8' x 10')	5,840	$ 2,800	L.F.	$ 16,350,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 34,460,000
	Total Cost with Contingency (25%)				$ 43,080,000
	Overhead and Profit (15%)				$ 6,460,000
TS 1	Legal and Engineering Costs (20%)				$ 8,620,000
	Total Capital Cost				**$ 58,150,000**
	Land Use	**0.3**	**$ 5,123,300**	**AC.**	**$ 1,560,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 540,000
	Annual O & M Cost				**$ 770,000**
	***Present Worth O & M Cost**				**$ 11,760,000**
	***Total Present Worth**				**$ 71,470,000**
	Tank #2: St. Paul's / Van Winkle / Broadway (W3W5)				
	Tanks including Installation	3	$ 5,281,000	MG.	$ 15,880,000
	Gravity Sewer including Installation (6')	1,660	$ 1,600	L.F.	$ 2,620,000
	Gravity Sewer including Installation (4' x 6')	860	$ 1,600	L.F.	$ 1,360,000
	Gravity Sewer including Installation (8')	50	$ 2,100	L.F.	$ 100,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 20,170,000
	Total Cost with Contingency (25%)				$ 25,220,000
TS 2	Overhead and Profit (15%)				$ 3,780,000
	Legal and Engineering Costs (20%)				$ 5,040,000
	Total Capital Cost				**$ 34,040,000**
	Land Use	**0.3**	**$ 5,123,300**	**AC.**	**$ 1,560,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 480,000
	Annual O & M Cost				**$ 710,000**
	***Present Worth O & M Cost**				**$ 10,830,000**
	***Total Present Worth**				**$ 46,440,000**
	Tank #3: York/Grand & Essex (E1011)				
	Tanks including Installation	1.8	$ 6,805,200	MG.	$ 12,280,000
	Gravity Sewer including Installation (8' x 10')	230	$ 2,800	L.F.	$ 640,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 13,130,000
	Total Cost with Contingency (25%)				$ 16,410,000
	Overhead and Profit (15%)				$ 2,460,000
TS 3	Legal and Engineering Costs (20%)				$ 3,280,000
	Total Capital Cost				**$ 22,150,000**
	Land Use	**0.3**	**$ 5,123,300**	**AC.**	**$ 1,560,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 370,000
	Annual O & M Cost				**$ 600,000**
	***Present Worth O & M Cost**				**$ 9,190,000**
	***Total Present Worth**				**$ 32,900,000**
	Tank #4: Mill Creek & Pine (E56)				
	Tanks including Installation	5.3	$ 4,295,400	MG.	$ 22,710,000
	Gravity Sewer including Installation (6')	110	$ 1,600	L.F.	$ 170,000
	Gravity Sewer including Installation (8')	50	$ 2,100	L.F.	$ 100,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 23,190,000
	Total Cost with Contingency (25%)				$ 28,990,000
	Overhead and Profit (15%)				$ 4,350,000
TS 4	Legal and Engineering Costs (20%)				$ 5,800,000
	Total Capital Cost				**$ 39,130,000**
	Land Use	**0.41**	**$ 5,123,300**	**AC.**	**$ 2,080,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 680,000
	Annual O & M Cost				**$ 920,000**
	***Present Worth O & M Cost**				**$ 13,950,000**
	***Total Present Worth**				**$ 55,160,000**
	Tank #5: Second / Sixth (E15E1617)				
	Tanks including Installation	0.7	$ 12,232,200	MG.	$ 9,110,000
	Gravity Sewer including Installation (8' x 10')	30	$ 2,800	L.F.	$ 80,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 9,390,000
	Total Cost with Contingency (25%)				$ 11,740,000
TS 5	Overhead and Profit (15%)				$ 1,760,000
	Legal and Engineering Costs (20%)				$ 2,350,000
	Total Capital Cost				**$ 15,850,000**
	Land Use	**0.17**	**$ 5,123,300**	**AC.**	**$ 890,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 270,000
	Annual O & M Cost				**$ 510,000**
	***Present Worth O & M Cost**				**$ 7,740,000**
	***Total Present Worth**				**$ 24,470,000**

*20 years life cycle costs for operation and maitenance with an interest rate of 2.75% for present value calculation (P/A = 15.227)

Construction Phase	Description	Estimated Quantities	Unit Cost	Units	Total
	Tank #6: Sip / Duncan / Clendenny / Claremont / Fisk (W6W10)				
	Tanks including Installation	10.2	$ 3,672,200	MG.	$ 37,280,000
	Gravity Sewer including Installation (6' x 10')	1,800	$ 2,300	L.F.	$ 4,160,000
	Gravity Sewer including Installation (8' x 10')	6,180	$ 2,800	L.F.	$ 17,300,000
	Gravity Sewer including Installation (6')	90	$ 1,600	L.F.	$ 140,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 59,080,000
	Total Cost with Contingency (25%)				$ 73,850,000
TS 6	Overhead and Profit (15%)				$ 11,080,000
	Legal and Engineering Costs (20%)				$ 14,770,000
	Total Capital Cost				**$ 99,700,000**
	Land Use	**0.52**	**$ 5,123,300**	**AC.**	**$ 2,670,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 1,120,000
	Annual O & M Cost				**$ 1,350,000**
	***Present Worth O & M Cost**				**$ 20,610,000**
	***Total Present Worth**				**$ 122,980,000**
	Tank #7: Danforth & Mina (W11W13)				
	Tanks including Installation	4.3	$ 4,585,200	MG.	$ 19,830,000
	Gravity Sewer including Installation (8')	2,210	$ 2,100	L.F.	$ 4,570,000
	Gravity Sewer including Installation (8' x 12')	220	$ 3,000	L.F.	$ 670,000
	Gravity Sewer including Installation (9')	100	$ 2,300	L.F.	$ 230,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 25,500,000
	Total Cost with Contingency (25%)				$ 31,870,000
TS 7	Overhead and Profit (15%)				$ 4,780,000
	Legal and Engineering Costs (20%)				$ 6,370,000
	Total Capital Cost				**$ 43,030,000**
	Land Use	**0.3**	**$ 5,123,300**	**AC.**	**$ 1,560,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 590,000
	Annual O & M Cost				**$ 830,000**
	***Present Worth O & M Cost**				**$ 12,630,000**
	***Total Present Worth**				**$ 57,220,000**
	Tank #8: Fourteenth / Eighteenth (E18E19)				
	Tanks including Installation	3.2	$ 5,146,600	MG.	$ 16,450,000
	Gravity Sewer including Installation (10')	2,640	$ 2,600	L.F.	$ 6,750,000
	Gravity Sewer including Installation (8' x 10')	90	$ 2,800	L.F.	$ 250,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 23,650,000
	Total Cost with Contingency (25%)				$ 29,560,000
TS 8	Overhead and Profit (15%)				$ 4,430,000
	Legal and Engineering Costs (20%)				$ 5,910,000
	Total Capital Cost				**$ 39,910,000**
	Land Use	**0.3**	**$ 5,123,300**	**AC.**	**$ 1,560,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 490,000
	Annual O & M Cost				**$ 730,000**
	***Present Worth O & M Cost**				**$ 11,090,000**
	***Total Present Worth**				**$ 52,560,000**
	Tank #9: Brown / Richard / Claremont & Carteret (E1E4)				
	Tanks including Installation	3.2	$ 5,146,600	MG.	$ 16,450,000
	Gravity Sewer including Installation (5')	4,860	$ 1,300	L.F.	$ 6,500,000
	Gravity Sewer including Installation (6')	5,610	$ 1,600	L.F.	$ 8,870,000
	Gravity Sewer including Installation (8')	4,800	$ 2,100	L.F.	$ 9,930,000
	Force Main including Installation	300	$ 700	L.F.	$ 200,000
	Construction Total Cost				$ 41,950,000
	Total Cost with Contingency (25%)				$ 52,430,000
TS 9	Overhead and Profit (15%)				$ 7,860,000
	Legal and Engineering Costs (20%)				$ 10,490,000
	Total Capital Cost				**$ 70,780,000**
	Land Use	**0.3**	**$ 5,123,300**	**AC.**	**$ 1,560,000**
	Operation Storage				$ 240,000
	Maintenance Storage				$ 490,000
	Annual O & M Cost				**$ 730,000**
	***Present Worth O & M Cost**				**$ 11,090,000**
	***Total Present Worth**				**$ 83,440,000**
All Phases	***Total Present Worth**				**$ 546,650,000**

JCMUA Development and Evaluation of Alternatives
Table 5: Tunnel Alternative (4 Overflows)

Description	Estimated Quantities	Unit Price	Units	Total
Tunnel Alternative (4 Overflows)				
West Deep Tunnel				
Tunnel including Installation	27,780	$ 6,000	L.F.	$165,340,000
Tunnel Drop Shaft including Installation	13	$ 2,607,300	EA.	$33,890,000
Storage including Installation	2.9	$ 5,361,500	MG	$15,700,000
Force Main Installation	300	$ 500	L.F.	$150,000
Pumps for Storage Tanks including Installation	1	$ 4,365,500	EA.	$4,370,000
Construction Total Cost				$219,450,000
Total Cost with Contingency (25%)				$274,310,000
Overhead and Profit (15%)				$41,150,000
Legal and Engineering Costs (20%)				$54,860,000
Total Capital Cost				**$370,320,000**
Land Use	**0.96**	**$5,123,300**	**AC.**	**$4,920,000**
Operation Tunnel				$470,000
Operation Storage				$240,000
Maintenance Tunnel				$3,310,000
Maintenance Pump Station				$90,000
Maintenance Storage				$470,000
Annual O & M Cost				**$4,570,000**
***Present Worth O & M Cost**				**$69,590,000**
***Total Present Worth**				**$444,830,000**
East Deep Tunnel				
Tunnel including Installation	27,426	$ 6,000	L.F.	$163,230,000
Tunnel Drop Shaft including Installation	14	$ 2,607,300	EA.	$36,500,000
Storage including Installation	2.9	$ 5,361,500	MG	$15,700,000
Force Main Installation	300	$ 500	L.F.	$150,000
Pumps for Storage Tanks including Installation	1	$ 4,365,500	EA.	$4,370,000
Construction Total Cost				$219,950,000
Total Cost with Contingency (25%)				$274,940,000
Overhead and Profit (15%)				$41,240,000
Legal and Engineering Costs (20%)				$54,990,000
Total Capital Cost				**$371,170,000**
Land Use	**1.03**	**$5,123,300**	**AC.**	**$5,300,000**
Operation Tunnel				$470,000
Operation Storage				$240,000
Maintenance Tunnel				$3,260,000
Maintenance Pump Station				$90,000
Maintenance Storage				$470,000
Annual O & M Cost				**$4,530,000**
***Present Worth O & M Cost**				**$68,950,000**
***Total Present Worth**				**$445,410,000**
***Total Present Worth -- Two Tunnels**				**$890,240,000**

*20 years life cycle costs for operation and maitenance with an interest rate of 2.75% for present value calculation (P/A = 15.227)

JCMUA Development and Evaluation of Alternatives
Table 6: Tunnel Alternative (8 Overflows)

Description	Estimated Quantities	Unit Price	Units	Total
Tunnel Alternative (8 Overflows)				
West Deep Tunnel				
Tunnel including Installation	27,780	$ 5,500	L.F.	$152,460,000
Tunnel Drop Shaft including Installation	13	$ 2,607,300	EA.	$33,890,000
Storage including Installation	2.5	$ 5,769,100	MG	$14,400,000
Force Main Installation	300	$ 500	L.F.	$150,000
Pumps for Storage Tanks including Installation	1	$ 4,365,500	EA.	$4,370,000
Construction Total Cost				$205,260,000
Total Cost with Contingency (25%)				$256,580,000
Overhead and Profit (15%)				$38,490,000
Legal and Engineering Costs (20%)				$51,320,000
Total Capital Cost				**$346,380,000**
Land Use	**0.96**	**$5,123,300**	**AC.**	**$4,920,000**
Operation Tunnel				$470,000
Operation Storage				$240,000
Maintenance Tunnel				$3,050,000
Maintenance Pump Station				$90,000
Maintenance Storage				$430,000
Annual O & M Cost				**$4,270,000**
***Present Worth O & M Cost**				**$65,070,000**
***Total Present Worth**				**$416,370,000**
East Deep Tunnel				
Tunnel including Installation	27,426	$ 5,500	L.F.	$150,510,000
Tunnel Drop Shaft including Installation	14	$ 2,607,300	EA.	$36,500,000
Storage including Installation	2.5	$ 5,769,100	MG	$14,400,000
Force Main Installation	300	$ 500	L.F.	$150,000
Pumps for Storage Tanks including Installation	1	$ 4,365,500	EA.	$4,370,000
Construction Total Cost				$205,930,000
Total Cost with Contingency (25%)				$257,410,000
Overhead and Profit (15%)				$38,610,000
Legal and Engineering Costs (20%)				$51,480,000
Total Capital Cost				**$347,510,000**
Land Use	**1.03**	**$5,123,300**	**AC.**	**$5,300,000**
Operation Tunnel				$470,000
Operation Storage				$240,000
Maintenance Tunnel				$3,010,000
Maintenance Pump Station				$90,000
Maintenance Storage				$430,000
Annual O & M Cost				**$4,230,000**
***Present Worth O & M Cost**				**$64,480,000**
***Total Present Worth**				**$417,280,000**
***Total Present Worth -- Two Tunnels**				**$833,650,000**

*20 years life cycle costs for operation and maitenance with an interest rate of 2.75% for present value calculation (P/A = 15.227)

JCMUA Development and Evaluation of Alternatives
Table 7: Tunnel Alternative (12 Overflows)

Description	Estimated Quantities	Unit Price	Units	Total
Tunnel Alternative (12 Overflows)				
West Deep Tunnel				
Tunnel including Installation	27,780	$ 4,200	L.F.	$ 117,040,000
Tunnel Drop Shaft including Installation	13	$ 2,607,300	EA.	$ 33,890,000
Storage including Installation	2.1	$ 6,292,800	MG	$ 13,200,000
Force Main Installation	300	$ 500	L.F.	$ 150,000
Pumps for Storage Tanks including Installation	1	$ 4,365,500	EA.	$ 4,370,000
Construction Total Cost				$ 168,640,000
Total Cost with Contingency (25%)				$ 210,800,000
Overhead and Profit (15%)				$ 31,620,000
Legal and Engineering Costs (20%)				$ 42,160,000
Total Capital Cost				**$ 284,590,000**
Land Use	**0.96**	**$5,123,300**	**AC.**	**$ 4,920,000**
Operation Tunnel				$ 470,000
Operation Storage				$ 240,000
Maintenance Tunnel				$ 2,340,000
Maintenance Pump Station				$ 90,000
Maintenance Storage				$ 400,000
Annual O & M Cost				**$ 3,530,000**
***Present Worth O & M Cost**				**$ 53,740,000**
***Total Present Worth**				**$ 343,240,000**
East Deep Tunnel				
Tunnel including Installation	27,426	$ 4,200	L.F.	$ 115,550,000
Tunnel Drop Shaft including Installation	14	$ 2,607,300	EA.	$ 36,500,000
Storage including Installation	2.1	$ 6,292,800	MG	$ 13,200,000
Force Main Installation	300	$ 500	L.F.	$ 150,000
Pumps for Storage Tanks including Installation	1	$ 4,365,500	EA.	$ 4,370,000
Construction Total Cost				$ 169,760,000
Total Cost with Contingency (25%)				$ 212,200,000
Overhead and Profit (15%)				$ 31,830,000
Legal and Engineering Costs (20%)				$ 42,440,000
Total Capital Cost				**$ 286,470,000**
Land Use	**1.03**	**$5,123,300**	**AC.**	**$ 5,300,000**
Operation Tunnel				$ 470,000
Operation Storage				$ 240,000
Maintenance Tunnel				$ 2,310,000
Maintenance Pump Station				$ 90,000
Maintenance Storage				$ 400,000
Annual O & M Cost				**$ 3,500,000**
***Present Worth O & M Cost**				**$ 53,280,000**
***Total Present Worth**				**$ 345,050,000**
***Total Present Worth -- Two Tunnels**				**$ 688,290,000**

*20 years life cycle costs for operation and maitenance with an interest rate of 2.75% for present value calculation (P/A = 15.227)

JCMUA Development and Evaluation of Alternatives
Table 8: Tunnel Alternative (20 Overflows)

Description	Estimated Quantities	Unit Price	Units	Total
Tunnel Alternative (20 Overflows)				
West Deep Tunnel				
Tunnel including Installation	27780	$ 3,400	L.F.	$ 94,500,000
Tunnel Drop Shaft including Installation	13	$ 2,607,300	EA.	$ 33,890,000
Storage including Installation	0.9	$10,667,500	MG	$ 9,580,000
Force Main Installation	300	$ 500	L.F.	$ 150,000
Pumps for Storage Tanks including Installation	1	$ 4,365,500	EA.	$ 4,370,000
Construction Total Cost				$ 142,490,000
Total Cost with Contingency (25%)				$ 178,110,000
Overhead and Profit (15%)				$ 26,720,000
Legal and Engineering Costs (20%)				$ 35,620,000
Total Capital Cost				**$ 240,450,000**
Land Use	**0.96**		**AC.**	**$ 4,920,000**
Operation Tunnel				$ 470,000
Operation Storage				$ 240,000
Maintenance Tunnel				$ 1,890,000
Maintenance Pump Station				$ 90,000
Maintenance Storage				$ 290,000
Annual O & M Cost				**$ 2,970,000**
***Present Worth O & M Cost**				**$ 45,220,000**
***Total Present Worth**				**$ 290,590,000**
East Deep Tunnel				
Tunnel including Installation	27426	$ 3,400	L.F.	$ 93,290,000
Tunnel Drop Shaft including Installation	14	$ 2,607,300	EA.	$ 36,500,000
Storage including Installation	0.9	$10,667,500	MG	$ 9,580,000
Force Main Installation	300	$ 500	L.F.	$ 150,000
Pumps for Storage Tanks including Installation	1	$ 4,365,500	EA.	$ 4,370,000
Construction Total Cost				$ 143,890,000
Total Cost with Contingency (25%)				$ 179,870,000
Overhead and Profit (15%)				$ 26,980,000
Legal and Engineering Costs (20%)				$ 35,970,000
Total Capital Cost				**$ 242,820,000**
Land Use	**1.03**	**5123300**	**AC.**	**$ 5,300,000**
Operation Tunnel				$ 470,000
Operation Storage				$ 240,000
Maintenance Tunnel				$ 1,870,000
Maintenance Pump Station				$ 90,000
Maintenance Storage				$ 290,000
Annual O & M Cost				**$ 2,950,000**
***Present Worth O & M Cost**				**$ 44,850,000**
***Total Present Worth**				**$ 292,970,000**
***Total Present Worth -- Two Tunnels**				**$ 583,560,000**

*20 years life cycle costs for operation and maitenance with an interest rate of 2.75% for present value calculation (P/A = 15.227)

JCMUA Development and Evaluation of Alternatives
Table 9: Green Infrastructure Alternative #1: 10% of Impervious Area Controled

Description	Estimated Quantities	Unit Cost	Units	Total
Green Infrastructure Alternative #1: 10% of Impervious Area Controled				
Green Infrastructure Total Construction Cost	270	$ 157,800	AC.	$ 42,610,000
Total Cost with Contingency (25%)				$ 53,270,000
Overhead and Profit (15%)				$ 7,990,000
Legal and Engineering Costs (20%)				$ 10,650,000
Total Capital Cost				**$ 71,910,000**
Maintenance Green Infrastructure				$ 1,620,000
Annual O & M Cost				$ 1,620,000
***Present Worth O & M Cost**				**$ 24,670,000**
***Total Present Worth**				**$ 96,580,000**

*20 years life cycle costs for operation and maitenance with an interest rate of 2.75% for present value calculation (P/A = 15.227)

JCMUA Development and Evaluation of Alternatives
Table 10: Green Infrastructure Alternative #2: 7% of Impervious Area Controled

Description	Estimated Quantities	Unit Cost	Units	Total
Green Infrastructure Alternative #2: 7% of Impervious Area Controled				
Green Infrastructure Total Construction Cost	188	$ 157,800	AC.	$ 29,670,000
Total Cost with Contingency (25%)				$ 37,090,000
Overhead and Profit (15%)				$ 5,560,000
Legal and Engineering Costs (20%)				$ 7,420,000
Total Capital Cost				**$ 50,070,000**
Maintenance Green Infrastructure				$ 1,130,000
Annual O & M Cost				$ 1,130,000
***Present Worth O & M Cost**				**$ 17,180,000**
***Total Present Worth**				**$ 67,250,000**

*20 years life cycle costs for operation and maitenance with an interest rate of 2.75% for present value calculation (P/A = 15.227)

JCMUA Development and Evaluation of Alternatives
Table 11: Bates Street Redevelopment Area- Bright Street Sewer Separation Alternative

Description	Estimated Quantities	Unit Cost	Units	Total
Bates Street Sewer Separation (modeled alternative)				
Sewer Separation Total Construction Cost	2,845	$ 2,800	L.F.	$ 7,880,000
Total Cost with Contingency (25%)				$ 9,850,000
Overhead and Profit (15%)				$ 1,480,000
Legal and Engineering Costs (20%)				$ 1,970,000
Total Capital Cost				**$ 13,290,000**
Annual O & M Cost				$ 160,000
***Present Worth O & M Cost**				**$ 2,400,000**
***Total Present Worth**				**$ 15,690,000**

*20 years life cycle costs for operation and maitenance with an interest rate of 2.75% for present value calculation (P/A = 15.227)

JCMUA Development and Evaluation of Alternatives
Table 12: System-wide Separation (0 overflow)

Description	Estimated Quantities	Unit Cost	Units	Total
System-wide Separation (0 overflow)				
Sewer Separation Total Construction Cost	1,056,000	$ 2,800	L.F.	$ 2,923,840,000
Total Cost with Contingency (25%)				$ 3,654,810,000
Overhead and Profit (15%)				$ 548,220,000
Legal and Engineering Costs (20%)				$ 730,960,000
Total Capital Cost				**$ 4,933,990,000**
Annual O & M Cost				$ 58,480,000
***Present Worth O & M Cost**				**$ 890,430,000**
***Total Present Worth**				**$ 5,824,420,000**

*20 years life cycle costs for operation and maitenance with an interest rate of 2.75% for present value calculation (P/A = 15.227)

JCMUA Development and Evaluation of Alternatives
Table 13: Inflow and Infiltration (I/I) Source Control Pipes Replacement Costs

Description	Estimated Quantities	Unit Cost	Units	Total
Replacement of Existing Sewer with 12 DI Sewer Pipes	2,100	80	L.F.	$ 169,000
Replacement of Existing Sewer with 18 DI Sewer Pipes	32,000	122	L.F.	$ 3,896,000
Replacement of Existing Sewer with 24 DI Sewer Pipes	6,970	164	L.F.	$ 1,140,000
Replacement of Existing Sewer with 30 DI Sewer Pipes	12,460	222	L.F.	$ 2,769,000
Replacement of Existing Sewer with 36 DI Sewer Pipes	6,600	283	L.F.	$ 1,869,000
Replacement of Existing Sewer with 42 DI Sewer Pipes	9,390	335	L.F.	$ 3,145,000
Replacement of Existing Sewer with 48 DI Sewer Pipes	10,360	407	L.F.	$ 4,219,000
Replacement of Existing Sewer with 54 DI Sewer Pipes	2,440	462	L.F.	$ 1,127,000
Replacement of Existing Sewer with 60 DI Sewer Pipes	1,950	573	L.F.	$ 1,117,000
Replacement of Existing Sewer with 66 DI Sewer Pipes	920	657	L.F.	$ 604,000
Replacement of Existing Sewer with 72 DI Sewer Pipes	960	744	L.F.	$ 714,000
Replacement of Existing Sewer with 78 DI Sewer Pipes	590	842	L.F.	$ 497,000
Replacement of Existing Sewer with 84 DI Sewer Pipes	760	929	L.F.	$ 706,000
Replacement of Existing Sewer with 96 DI Sewer Pipes	390	1159	L.F.	$ 452,000
Demolition of Existing Sewer	87,920	$ 120	L.F.	$ 10,550,000
Sheeting and shoring at 10 foot average depth	131,420	$ 120	L.F.	$ 15,770,000
Manholes Replacement with frames and covers	11,920	$ 120	Ea.	$ 1,430,000
Pipe Bedding 10 foot depth	10,000	$ 120	CY	$ 1,200,000
DGA 10 foot depth	54,000	$ 120	CY	$ 6,480,000
Base Course Bituminous Pavement	30,670	$ 120	S.Y.	$ 3,680,000
Surface Course Bituminous Pavement	19,250	$ 120	S.Y.	$ 2,310,000
Testing	17,500	$ 120	L.F.	$ 2,100,000
Load, Haul and Dispose of ID-27 Material	93,670	$ 120	Ton	$ 11,240,000
Construction Total Cost				$ 77,184,000.00
Total Cost with Contingency (25%)				$ 96,480,000.00
Overhead and Profit (15%)				$ 14,472,000.00
Legal and Engineering Costs (20%)				$ 19,296,000.00
Total Capital Cost				**$ 130,248,000**
Sewer Maintenance **(Not Applicable to Replacement of Existing System)****				$ -
Annual O & M Cost				$ -
Total Present Worth O & M Cost				-
***Total Present Worth**				**$ -**
*Total O & M Cost				-
***Total Present Worth**				**$ 130,248,000**

*20 years life cycle costs for operation and maintenance with an interest rate of 2.75% for present value calculation (P/A = 15.227)

**Sewer maintenance is current annual cost that the JCMUA pays not and not a new project cost

JCMUA Development and Evaluation of Alternatives
Table 14: Inflow and Infiltration (I/I) Source Control Pipes Rehabilitation Costs

Description	Estimated Quantities	Unit Cost	Units	Total
CIPPL Rehabilitation of Existing 12 inch Sewer Pipes	2,100	50	L.F.	$ 169,000
CIPPL Rehabilitation of Existing 18 inch Sewer Pipes	32,000	70	L.F.	$ 3,896,000
CIPPL Rehabilitation of Existing 24 inch Sewer Pipes	6,970	95	L.F.	$ 1,140,000
CIPPL Rehabilitation of Existing 30 inch Sewer Pipes	12,460	130	L.F.	$ 2,769,000
CIPPL Rehabilitation of Existing 36 inch Sewer Pipes	6,600	200	L.F.	$ 1,869,000
CIPPL Rehabilitation of Existing 42 inch Sewer Pipes	9,390	260	L.F.	$ 3,145,000
CIPPL Rehabilitation of Existing 48 inch Sewer Pipes	10,360	300	L.F.	$ 4,219,000
CIPPL Rehabilitation of Existing 54 inch Sewer Pipes	2,440	380	L.F.	$ 1,127,000
CIPPL Rehabilitation of Existing 60 inch Sewer Pipes	1,950	450	L.F.	$ 1,117,000
CIPPL Rehabilitation of Existing 66 inch Sewer Pipes	920	540	L.F.	$ 604,000
CIPPL Rehabilitation of Existing 72 inch Sewer Pipes	960	630	L.F.	$ 714,000
CIPPL Rehabilitation of Existing 78 inch Sewer Pipes	590	730	L.F.	$ 497,000
CIPPL Rehabilitation of Existing 84 inch Sewer Pipes	760	830	L.F.	$ 706,000
CIPPL Rehabilitation of Existing 96 inch Sewer Pipes	390	1070	L.F.	$ 452,000
Install layflat hose	500	0.3	L.F.	$ 150
Breakdown/Clean/Load layflat hose	4,000	0.5	L.F.	$ 2,000
6" pump rental	260	650	Wk	$ 169,000
6" pump fuel cost	43,680	18	HR	$ 786,240
Pump operator cost	43,680	50	HR	$ 2,184,000
Construction Total Cost				$ 25,570,000
Total Cost with Contingency (25%)				$ 31,960,000
Overhead and Profit (15%)				$ 4,794,000
Legal and Engineering Costs (20%)				$ 6,392,000
Total Capital Cost				**$ 43,146,000**
Sewer Maintenance **(Not Applicable to Replacement of Existing System)****				$ -
Annual O & M Cost				$ -
Total Present Worth O & M Cost				-
***Total Present Worth**				**$ -**
*Total O & M Cost				-
***Total Present Worth**				**$ 43,146,000**

*20 years life cycle costs for operation and maintenance with an interest rate of 2.75% for present value calculation (P/A = 15.227)

**Sewer maintenance is current annual cost that the JCMUA pays not and not a new project cost

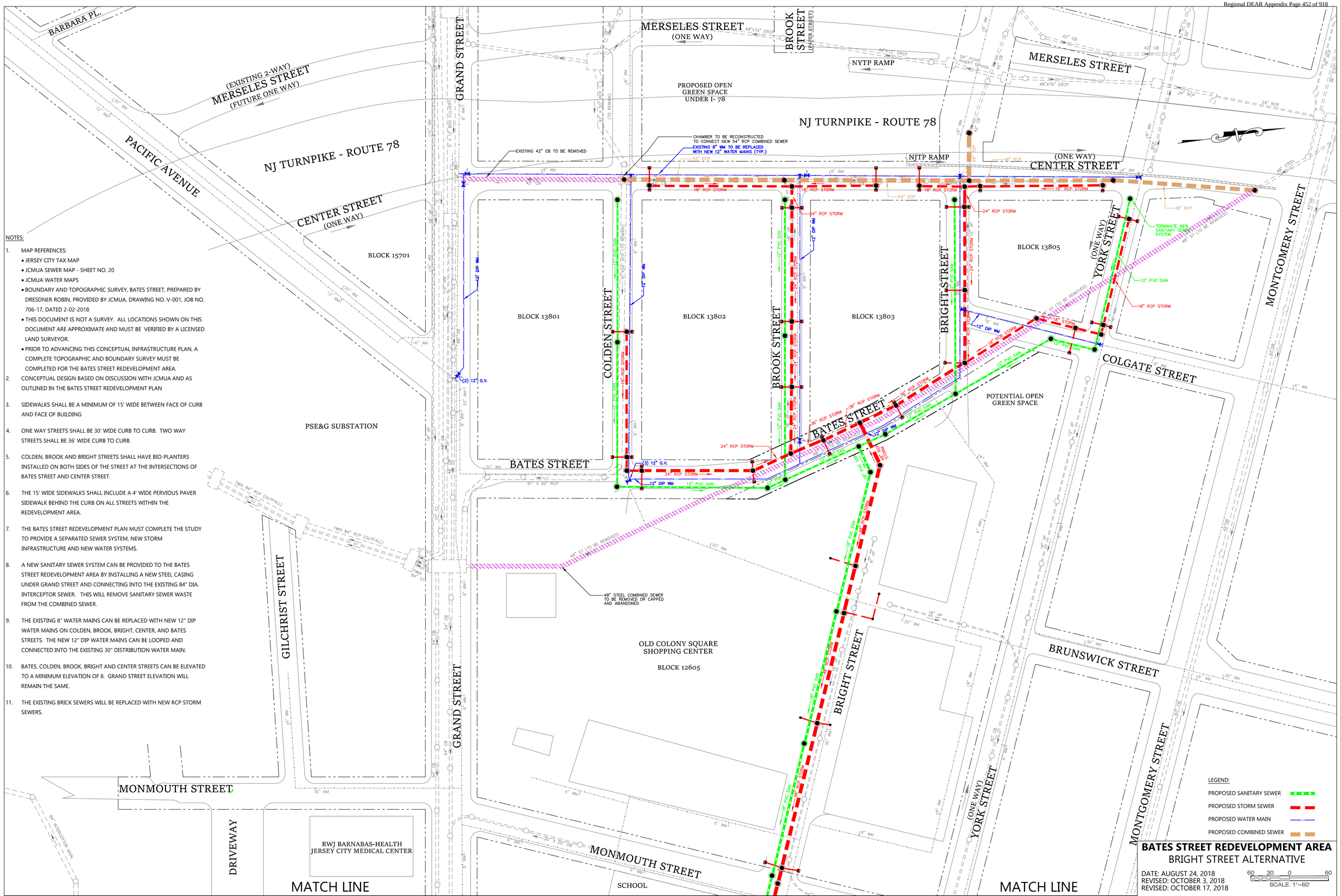
JCMUA Development and Evaluation of Alternatives

Table 15: Disinfection Costs with PAA

Tank	Peak flow (MGD)	Construction Cost	Contingency (25%)	Overhead & Profit (15%)	Legal & Engineering (20%)	Total Capital Cost	Annual O&M Costs	Total Present Worth
W1W2	290.2	$ 3,850,000	$ 960,000	$ 720,000	$ 960,000	$ 6,490,000	$ 524,000	$ 15,400,000
W3W5	97.5	$ 2,210,000	$ 550,000	$ 410,000	$ 550,000	$ 3,730,000	$ 197,000	$ 7,100,000
W6W10	338.5	$ 3,880,000	$ 970,000	$ 730,000	$ 970,000	$ 6,550,000	$ 606,000	$ 16,700,000
W11W13	312.1	$ 3,860,000	$ 970,000	$ 720,000	$ 970,000	$ 6,520,000	$ 561,000	$ 16,000,000
E1E4	140.6	$ 2,640,000	$ 660,000	$ 490,000	$ 660,000	$ 4,450,000	$ 270,000	$ 9,200,000
E56	257.2	$ 3,820,000	$ 960,000	$ 720,000	$ 960,000	$ 6,450,000	$ 468,000	$ 14,500,000
E1011	76.3	$ 2,150,000	$ 540,000	$ 400,000	$ 540,000	$ 3,630,000	$ 161,000	$ 6,500,000
E15E1617	60.1	$ 1,930,000	$ 480,000	$ 360,000	$ 480,000	$ 3,250,000	$ 133,000	$ 5,700,000
E18E19	304.7	$ 3,860,000	$ 960,000	$ 720,000	$ 960,000	$ 6,510,000	$ 548,000	$ 15,800,000
							TOTAL	**$ 106,900,000**

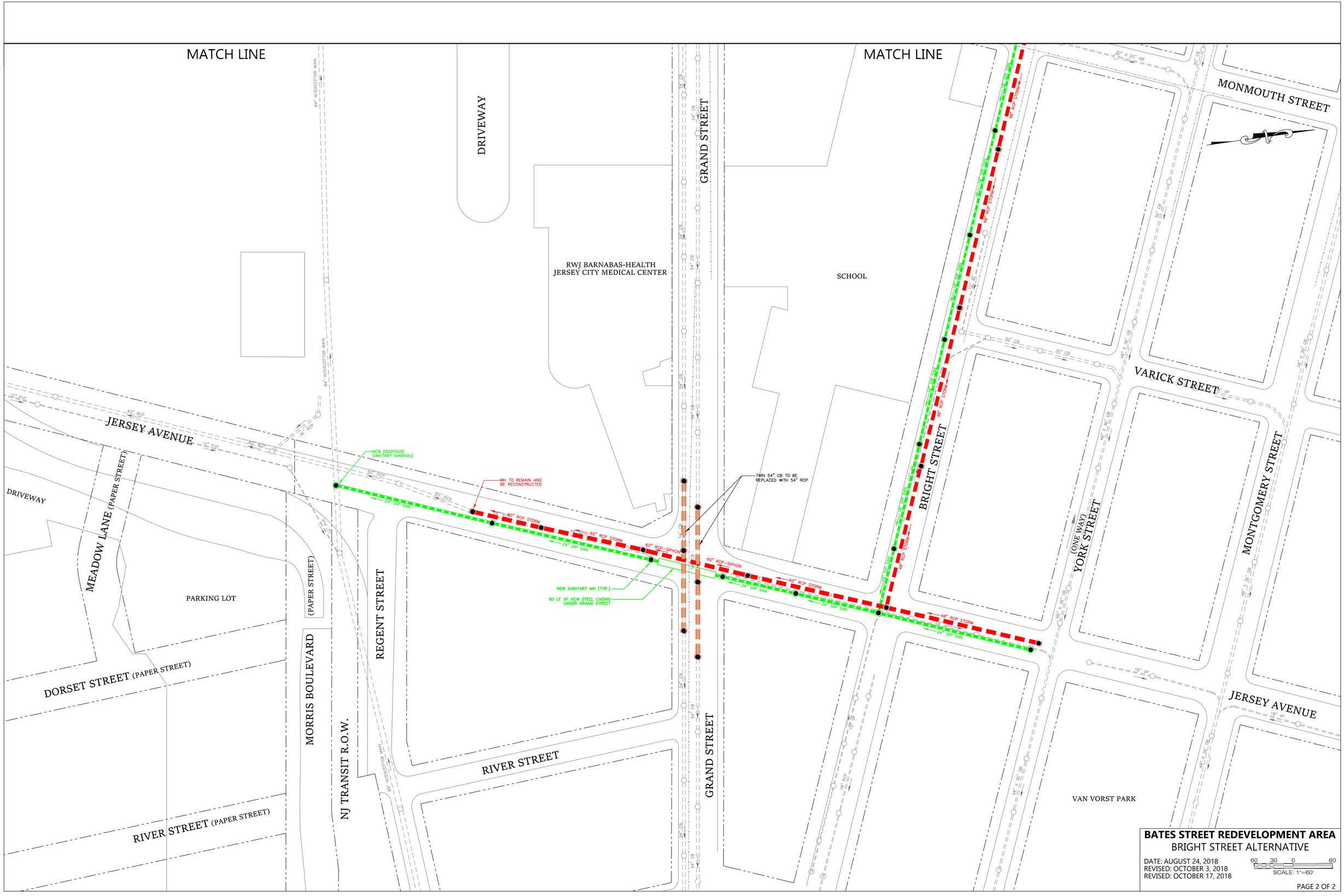
APPENDIX B

PARTIAL SEWER SEPARATION DESIGN DRAWINGS



NOTES:

1. MAP REFERENCES:
   - JERSEY CITY TAX MAP
   - JCMUA SEWER MAP - SHEET NO. 20
   - JCMUA WATER MAPS
   - BOUNDARY AND TOPOGRAPHIC SURVEY, BATES STREET, PREPARED BY DRESDNER ROBIN, PROVIDED BY JCMUA, DRAWING NO. V-001, JOB NO. 706-17, DATED 2-02-2018
   - THIS DOCUMENT IS NOT A SURVEY. ALL LOCATIONS SHOWN ON THIS DOCUMENT ARE APPROXIMATE AND MUST BE VERIFIED BY A LICENSED LAND SURVEYOR.
   - PRIOR TO ADVANCING THIS CONCEPTUAL INFRASTRUCTURE PLAN, A COMPLETE TOPOGRAPHIC AND BOUNDARY SURVEY MUST BE COMPLETED FOR THE BATES STREET REDEVELOPMENT AREA.
2. CONCEPTUAL DESIGN BASED ON DISCUSSION WITH JCMUA AND AS OUTLINED IN THE BATES STREET REDEVELOPMENT PLAN
3. SIDEWALKS SHALL BE A MINIMUM OF 15' WIDE BETWEEN FACE OF CURB AND FACE OF BUILDING
4. ONE WAY STREETS SHALL BE 30' WIDE CURB TO CURB. TWO WAY STREETS SHALL BE 36' WIDE CURB TO CURB.
5. COLDEN, BROOK AND BRIGHT STREETS SHALL HAVE BIO-PLANTERS INSTALLED ON BOTH SIDES OF THE STREET AT THE INTERSECTIONS OF BATES STREET AND CENTER STREET.
6. THE 15' WIDE SIDEWALKS SHALL INCLUDE A 4' WIDE PERVIOUS PAVER SIDEWALK BEHIND THE CURB ON ALL STREETS WITHIN THE REDEVELOPMENT AREA.
7. THE BATES STREET REDEVELOPMENT PLAN MUST COMPLETE THE STUDY TO PROVIDE A SEPARATED SEWER SYSTEM, NEW STORM INFRASTRUCTURE AND NEW WATER SYSTEMS.
8. A NEW SANITARY SEWER SYSTEM CAN BE PROVIDED TO THE BATES STREET REDEVELOPMENT AREA BY INSTALLING A NEW STEEL CASING UNDER GRAND STREET AND CONNECTING INTO THE EXISTING 84" DIA. INTERCEPTOR SEWER. THIS WILL REMOVE SANITARY SEWER WASTE FROM THE COMBINED SEWER.
9. THE EXISTING 8" WATER MAINS CAN BE REPLACED WITH NEW 12" DIP WATER MAINS ON COLDEN, BROOK, BRIGHT, CENTER, AND BATES STREETS. THE NEW 12" DIP WATER MAINS CAN BE LOOPED AND CONNECTED INTO THE EXISTING 30" DISTRIBUTION WATER MAIN.
10. BATES, COLDEN, BROOK, BRIGHT AND CENTER STREETS CAN BE ELEVATED TO A MINIMUM ELEVATION OF 8. GRAND STREET ELEVATION WILL REMAIN THE SAME.
11. THE EXISTING BRICK SEWERS WILL BE REPLACED WITH NEW RCP STORM SEWERS.


MATCH LINE
MATCH LINE
DRIVEWAY
RWJ BARNABAS-HEALTH
JERSEY CITY MEDICAL CENTER
GRAND STREET
SCHOOL
MONMOUTH STREET
VARICK STREET
BRIGHT STREET
YORK STREET
(ONE WAY)
MONTGOMERY STREET
JERSEY AVENUE
JERSEY AVENUE
DRIVEWAY
MEADOW LANE (PAPER STREET)
PARKING LOT
(PAPER STREET)
REGENT STREET
MORRIS BOULEVARD
NJ TRANSIT R.O.W.
DORSET STREET (PAPER STREET)
RIVER STREET
RIVER STREET (PAPER STREET)
GRAND STREET
VAN VORST PARK
84" INTERCEPTOR MAIN
NEW DOGHOUSE SANITARY MANHOLE
MH TO REMAIN AND BE RECONSTRUCTED
TWIN 54" CB TO BE REPLACED WITH 54" RCP
NEW SANITARY MH (TYP.)
90 LF OF NEW STEEL CASING UNDER GRAND STREET
24" DIP SAN
48" RCP STORM
60" RCP STORM
60" RCP-SIPHON
60" RCP
54" CB
30" CB
48" X 36" CB
18" VP
12" PVC
36" RCP
BATES STREET REDEVELOPMENT AREA
BRIGHT STREET ALTERNATIVE
DATE: AUGUST 24, 2018
REVISED: OCTOBER 3, 2018
REVISED: OCTOBER 17, 2018
60 30 0 60
SCALE: 1"=60'
PAGE 2 OF 2

APPENDIX F

Development and Evaluation of Alternatives Report
Town of Kearny

Dated: July 1, 2019

NEW JERSEY DEPARTMENT
OF ENVIRONMENTAL PROTECTION

DEVELOPMENT AND EVALUATION OF ALTERNATIVES REPORT

FOR

TOWN OF KEARNY (NJPDES PERMIT No. NJ0111244)

July 1, 2019

Report Prepared by:

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CERTIFICATE OF AUTHORIZATION (N.J.S.A. 45:8-56) 24GA27927000

with modeling support from:

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1 International Boulevard
10th Floor, Suite 1000
Mahwah, New Jersey 07495
Telephone: (201) 335-9414

Report Disclaimer: The Town of Kearny has completed and participated in the production of this document as required by the Town's individual New Jersey Pollutant Discharge Elimination System (NJPDES) permit (NJPDES Permit No. NJ0111244). At this time, the Town of Kearny is not committing the current governing body of the Town, or future governing bodies, to the allocation of funds based on the costs presented in this report to complete projects related to the control of combined sewer overflows (CSOs).

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Report Disclaimer: The Town of Kearny has completed and participated in the production of this document as required by the Town's individual New Jersey Pollutant Discharge Elimination System (NJPDES) permit (NJPDES Permit No. NJ0111244). At this time, the Town of Kearny is not committing the current governing body of the Town, or future governing bodies, to the allocation of funds based on the costs presented in this report to complete projects related to the control of combined sewer overflows (CSOs).

SECTION A INTRODUCTION

A.1 BACKGROUND

The Town of Kearny, located in Hudson County, owns and operates a combined sewer system (CSS) which conveys all flow to the Passaic Valley Sewerage Commissioners (PVSC) wastewater treatment plant located in Newark, New Jersey. In 2015, Kearny was issued a revised New Jersey Pollutant Discharge Elimination System (NJPDES) permit, No. NJ0111244, Category CSM (Combined Sewer Management), with an effective date of July 1, 2015. Part IV Section D.3.b.vi of the NJPDES permit requires the Town to develop a Long Term Control Plan (LTCP) to reduce the number of Combined Sewer Overflows (CSOs) during wet weather events, to meet the goals set by the Clean Water Act as well as the National CSO Control Policy. The LTCP is required to be submitted to the NJDEP by June 1, 2020. As an interim step toward developing the LTCP, Kearny is required to prepare a Development and Evaluation of Alternatives Report, (Part IV Section D.3.b.v of the NJPDES permit) to investigate cost effective control strategies for reducing CSOs. The findings of this report will be incorporated into the LTCP, which, once approved, will become part of the Town's updated NJPDES permit.

A.2 EXISTING OUTFALLS

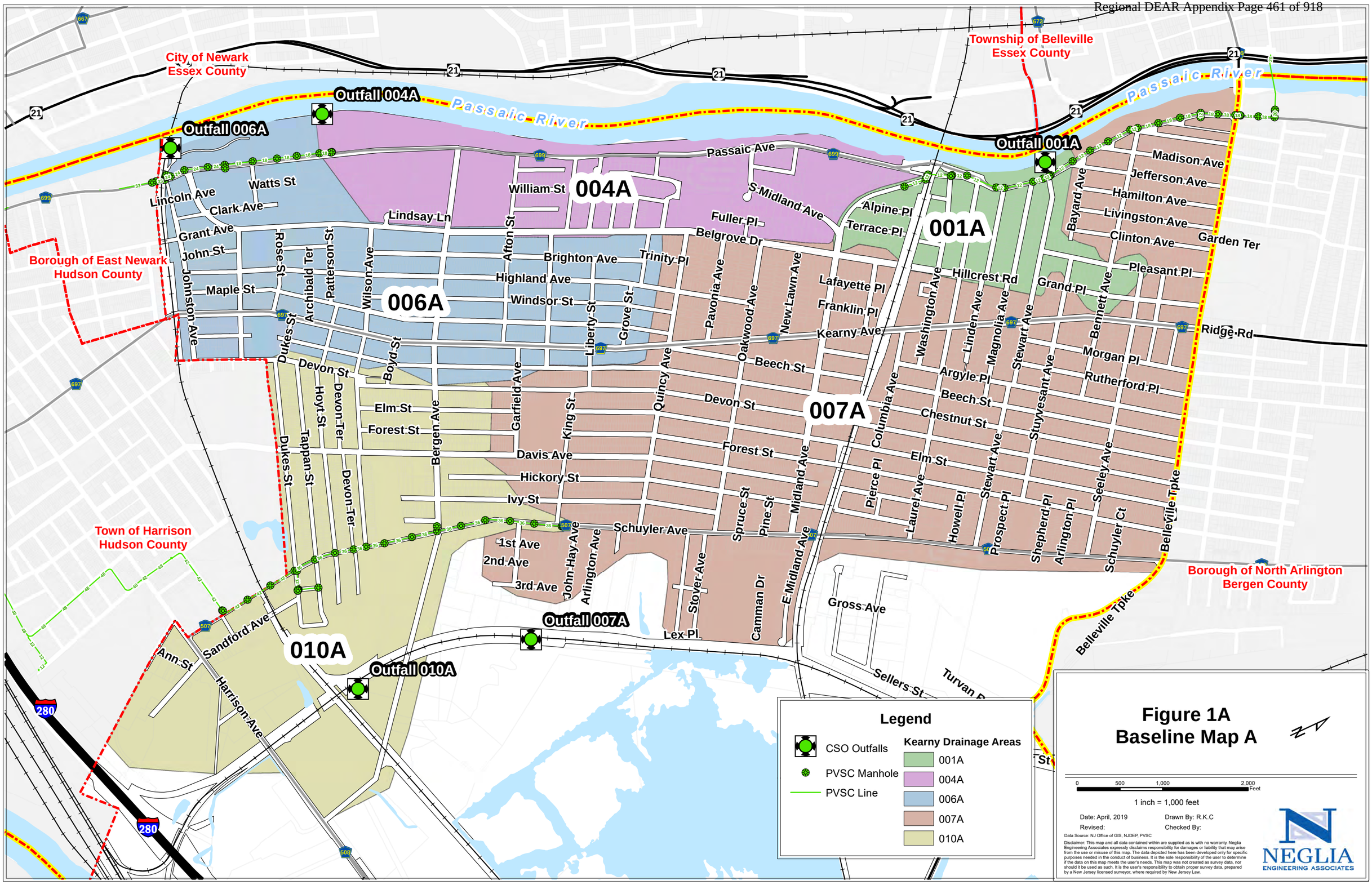
All sewage generated within the Town of Kearny is conveyed to the Passaic Valley Sewerage Commissioners (PVSC) wastewater treatment plant. During certain rainfall events, depending on the magnitude and duration of the event, flow in the conveyance system exceeds the sewer system's capacity, and excess flow is discharged to the adjacent surface water body, through its system of outfall regulator chambers. The Town of Kearny owns and operates five (5) wet weather outfalls, and associated regulator chambers, which are listed below. Refer also to the Town of Kearny Drainage Area Map, Figure 1A, and the individual location maps of the five outfalls, Figures 2A through 2E, shown on the following pages.

TABLE A-1 – EXISTING OUTFALLS		
OUTFALL NO.	LOCATION	RECEIVING STREAM
001A	Stewart Avenue	Passaic River
004A	Nairn Avenue	Passaic River
006A	Johnston Avenue	Passaic River
007A	Ivy Street	Frank's Creek (Tributary to Lower Passaic River)
010A	Dukes Street	Frank's Creek (Tributary to Lower Passaic River)

A.3 WATER QUALITY REQUIREMENTS

Of the five (5) CSO outfalls in Kearny, 001A, 004A, and 006A, discharge to the Passaic River on the western border of the Town. The remaining outfalls, 007A and 010A, discharge to the portion of the Lower Passaic River known as Frank's Creek, on the Town's eastern border. Both bodies of water are classified as SE-3 (C2) or Saline Estuary 3, Category 2. In accordance with N.J.A.C. 7:9B, Surface Water Quality Standards, Subsection 1.12, the designated uses for SE-3(C2) waters are as follows:

- Secondary Contact Recreation;
- Maintenance and Migration of Fish Population;
- Migration of Diadromous Fish;
- Maintenance of Wildlife; and


City of Newark
Essex County
Township of Belleville
Essex County
Borough of East Newark
Hudson County
Town of Harrison
Hudson County
Borough of North Arlington
Bergen County
Passaic River
Outfall 004A
Outfall 006A
Outfall 001A
Outfall 007A
Outfall 010A
004A
006A
001A
007A
010A
Passaic Ave
William St
Lindsay Ln
Lincoln Ave
Watts St
Clark Ave
Grant Ave
John St
Maple St
Johnston Ave
Rose St
Archibald Ter
Patterson St
Wilson Ave
Afton St
Brighton Ave
Highland Ave
Windsor St
Trinity Pl
Fuller Pl
Belgrove Dr
S Midland Ave
Alpine Pl
Terrace Pl
Pavonia Ave
Oakwood Ave
New Lawn Ave
Lafayette Pl
Franklin Pl
Kearny Ave
Washington Ave
Hillcrest Rd
Linden Ave
Magnolia Ave
Stewart Ave
Grand Pl
Bennett Ave
Madison Ave
Jefferson Ave
Hamilton Ave
Livingston Ave
Clinton Ave
Pleasant Pl
Garden Ter
Bayard Ave
Ridge Rd
Morgan Pl
Rutherford Pl
Stuyvesant Ave
Seeley Ave
Belleville Tpke
Dukes St
Devon St
Boyd St
Liberty St
Grove St
Beech St
Argyle Pl
Chestnut St
Elm St
Columbia Ave
Pierce Pl
Laurel Ave
Howell Pl
Prospect Pl
Shepherd Pl
Arlington Pl
Schuyler Ct
Hoyt St
Devon Ter
Tappan St
Elm St
Forest St
Bergen Ave
Garfield Ave
King St
Quincy Ave
Davis Ave
Hickory St
Ivy St
Schuyler Ave
1st Ave
2nd Ave
3rd Ave
John Hay Ave
Arlington Ave
Spruce St
Pine St
Midland Ave
E Midland Ave
Stover Ave
Camman Dr
Lex Pl
Gross Ave
Sellers St
Turvan
Sandford Ave
Ann St
Harrison Ave
280
Legend
CSO Outfalls
PVSC Manhole
PVSC Line
Kearny Drainage Areas
001A
004A
006A
007A
010A
Figure 1A
Baseline Map A
0
500
1,000
2,000
Feet
1 inch = 1,000 feet
Date: April, 2019
Revised:
Drawn By: R.K.C
Checked By:
Data Source: NJ Office of GIS, NJDEP, PVSC
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CERTIFICATE OF AUTHORIZATION (N.J.S.A. 45:8-56) 24GA27927000

0 50 100 200 Feet

1 inch = 100 feet

Stewart Avenue CSO Outfall 001A
Town of Kearny
County of Hudson, New Jersey

CSO Outfalls
PVSC Manhole
PVSC Line
Parcels

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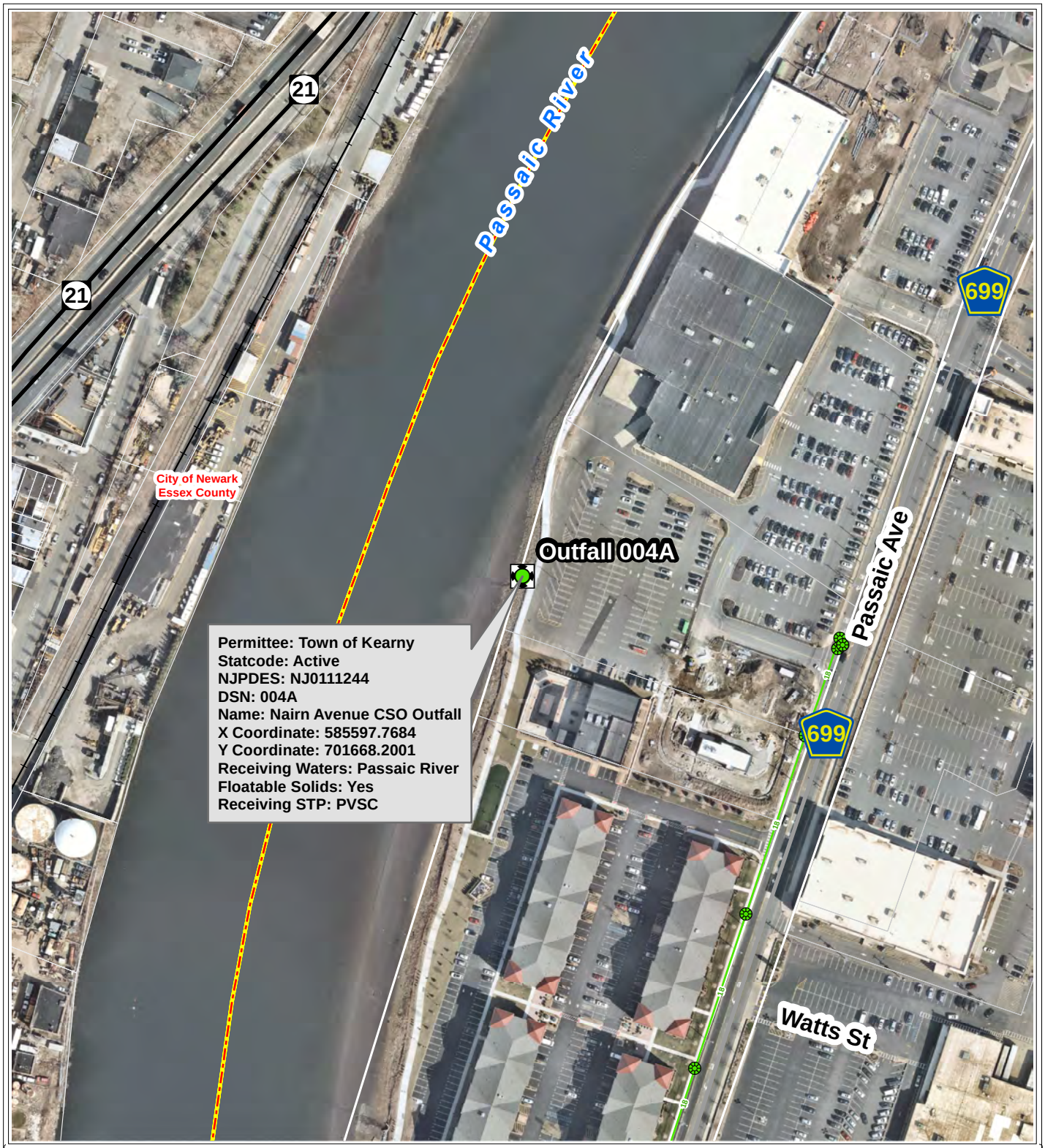
Drawn By: R.K.C.	Checked By: J.R.	Project No:	Sheet No:	Map References:
Designed By: R.K.C.	Page:	KEARMUN18.013	Figure 2A	NJ Office of GIS Nearmap Imagery (March 2019)
Field Book No:	Date: April, 2019			



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0 100 200 400 Feet

1 inch = 200 feet

Nairn Avenue CSO Outfall 004A
Town of Kearny
County of Hudson, New Jersey

CSO Outfalls
PVSC Manhole
PVSC Line
Parcels

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Designed By: R.K.C.	Page:	KEARMUN18.013	Figure 2B	NJ Office of GIS Nearmap Imagery (March 2019)
Field Book No:	Date: April, 2019			

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0 75 150 300 Feet

1 inch = 150 feet

Johnston Avenue CSO Outfall 006A
Town of Kearny
County of Hudson, New Jersey

CSO Outfalls
PVSC Manhole
PVSC Line
Parcels

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Drawn By: R.K.C.	Checked By: J.R.	Project No:	Sheet No:	Map References:
Designed By: R.K.C.	Page:	KEARMUN18.013	Figure 2C	NJ Office of GIS Nearmap Imagery (March 2019)
Field Book No:	Date: April, 2019			

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CERTIFICATE OF AUTHORIZATION (N.J.S.A. 45:8-56) 24GA27927000

0 100 200 400 Feet

1 inch = 200 feet

Ivy Street CSO Outfall 007A
Town of Kearny
County of Hudson, New Jersey

CSO Outfalls
PVSC Manhole
PVSC Line
Parcels

NEGLIA ENGINEERING ASSOCIATES

Drawn By: R.K.C.	Checked By: J.R.	Project No: KEARMUN18.013	Sheet No: Figure 2D	Map References: NJ Office of GIS Nearmap Imagery (March 2019)
Designed By: R.K.C.	Page:			
Field Book No:	Date: April, 2019			

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CERTIFICATE OF AUTHORIZATION (N.J.S.A. 45:8-56) 24GA27927000

0 100 200 400 Feet

1 inch = 200 feet

N

Dukes Street CSO Outfall 010A
Town of Kearny
County of Hudson, New Jersey

CSO Outfalls
PVSC Manhole
PVSC Line
Parcels

NEGLIA ENGINEERING ASSOCIATES

Drawn By: R.K.C.	Checked By: J.R.	Project No:	Sheet No:	Map References:
Designed By: R.K.C.	Page:	KEARMUN18.013	Figure 2E	NJ Office of GIS Nearmap Imagery (March 2019)
Field Book No:	Date: April, 2019			

- Any other reasonable uses.

A.4 MODELING OF THE CSS SYSTEM

The Infoworks ICM hydraulic/hydrologic model was used to calculate the number of CSO events and CSO wastewater volumes, at each outfall, and Citywide, for a one year period. Citywide number of CSO events was calculated based on the hourly time series sum of individual outfall CSO events. A 24 hour inter event time (IET) was used to distinguish between CSO events. That is, if two separate outfalls experienced a discharge within 24 hours, that would be defined as one event. The model was calibrated using available data for the existing 2016/2017 conditions. "Typical year" 2004 rainfall and tides, and average evapotranspiration rates as indicated in the PVSC Technical Guidance Manual, were used with future estimated 2045 population to analyze future conditions and system responses. The Infoworks model was similarly used to calculate preliminary design parameters, such as storage tank volumes, tunnel volume, and design flows for treatment, at each outfall, and for the required 4, 8, 12, and 20 CSO events per year. Zero CSO events per year was not modeled. As will be seen later in the report under alternatives, zero CSO events per year is only considered in conjunction with total sewer separation on a Town wide basis.

A.4.1 Program Requirements

Alternatives considered in this evaluation must satisfy one of the following three (3) criteria:

- Reduction of the number of CSO events to an annual average of four (4) per year;
- 85% capture by volume of the combined sewage collected in the combined sewer system;
- during precipitation events on an annual average basis; and
- Capture of pollutants of concern equivalent to 85% capture.

As required by PVSC, the model looked at target scenarios of 0, 4, 8, 12 and 20 CSO events per year, with 4 CSOs per year being the required target goal, and the remaining scenarios used for cost comparison.

In accordance with NJDEP requirements, alternatives developed in this report are evaluated for the following scenarios:

- 0 CSO events per year (sewer separation only);
- 4 CSO events per year;
- 8 CSO events per year;
- 12 CSO events per year;
- 20 CSO events per year; and
- 85% capture by volume of the combined sewage collected in the combined sewer system during precipitation events on an annual average basis.

SECTION B FUTURE CONDITIONS

B.1 INTRODUCTION

This section presents the population projections used in the modeling effort for Kearny, along with planned projects and future wastewater flows.

B.2 PROJECTIONS FOR POPULATION GROWTH

The current population in Kearny is taken as 52,792. The projected 2045 population is estimated to be 57,415. This is based on the North Jersey Transportation Planning Authority (NJTPA) 2045 population projection and planned new development areas. Typical year 2004 rainfall and tides data, as well as average evapotranspiration rates were used to model future conditions.

B.3 PLANNED PROJECTS

Several residential development projects are planned in Kearny. These are shown on Figure 3, which illustrates the planned developments and their location within the Town.

B.4 PROJECTED FUTURE CSO FREQUENCIES AND VOLUMES

The model calculated the number of CSO events for each outfall, and volume in million gallons (MG). This was done for two distinct scenarios. The first, Scenario A, is based on current conditions.

B.4.1 Baseline A Scenario – Current Conditions

Based on existing conditions, with five CSO outfalls in operation, the model calculated the following number of CSO events and volumes for each outfall:

Table B-1 – CSO Frequency and Volume, Baseline A

Outfall No.	CSO Event Count	Total Volume (MG)
001A	31	3.9
004A	42	12.4
006A	57	121.8
007A	34	90.0
010A	43	26.6
Entire Town	61	254.7

As seen above, the total annual number of CSO events is calculated to be 61. The volume of CSO discharges per year ranges from approximately 4 MG per year at outfall 001A (Stewart Avenue) to 122 MG per year at Outfall 006A at Johnston Street. Total CSO volume is approximately 255 MG.

B.4.2 Baseline B Scenario - Sewer Separation at Outfall 010A

The Town of Kearny has committed to achieving sewer separation for the sewers tributary to Outfall 010A, located in the vicinity of Dukes Street. At the time of this writing, plans and specifications are being finalized for the construction of the sewer separation project, along with an associated pumping station. When completed, the storm water and sanitary sewage in this sub catchment area will be

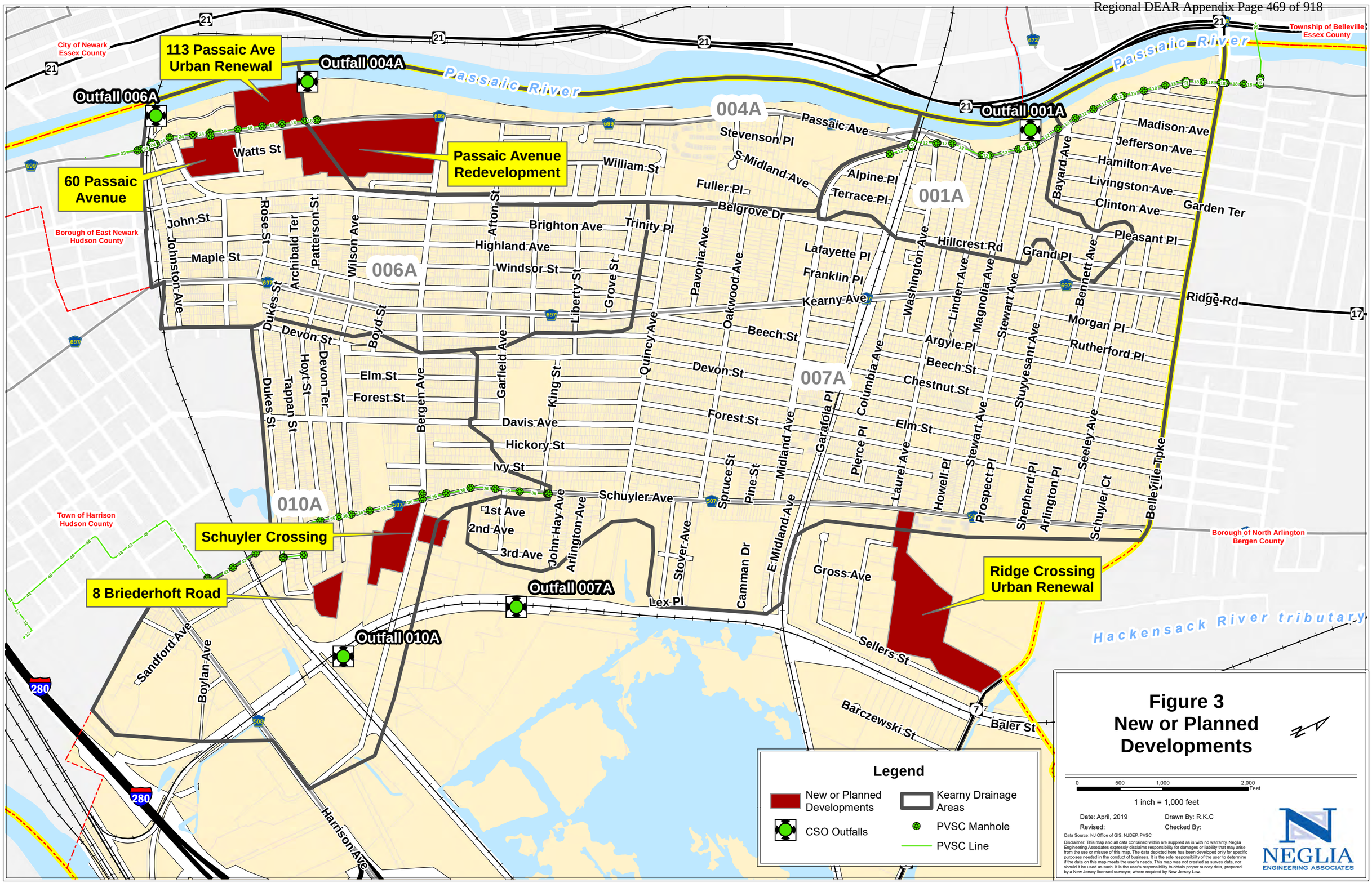


Figure 3
New or Planned Developments

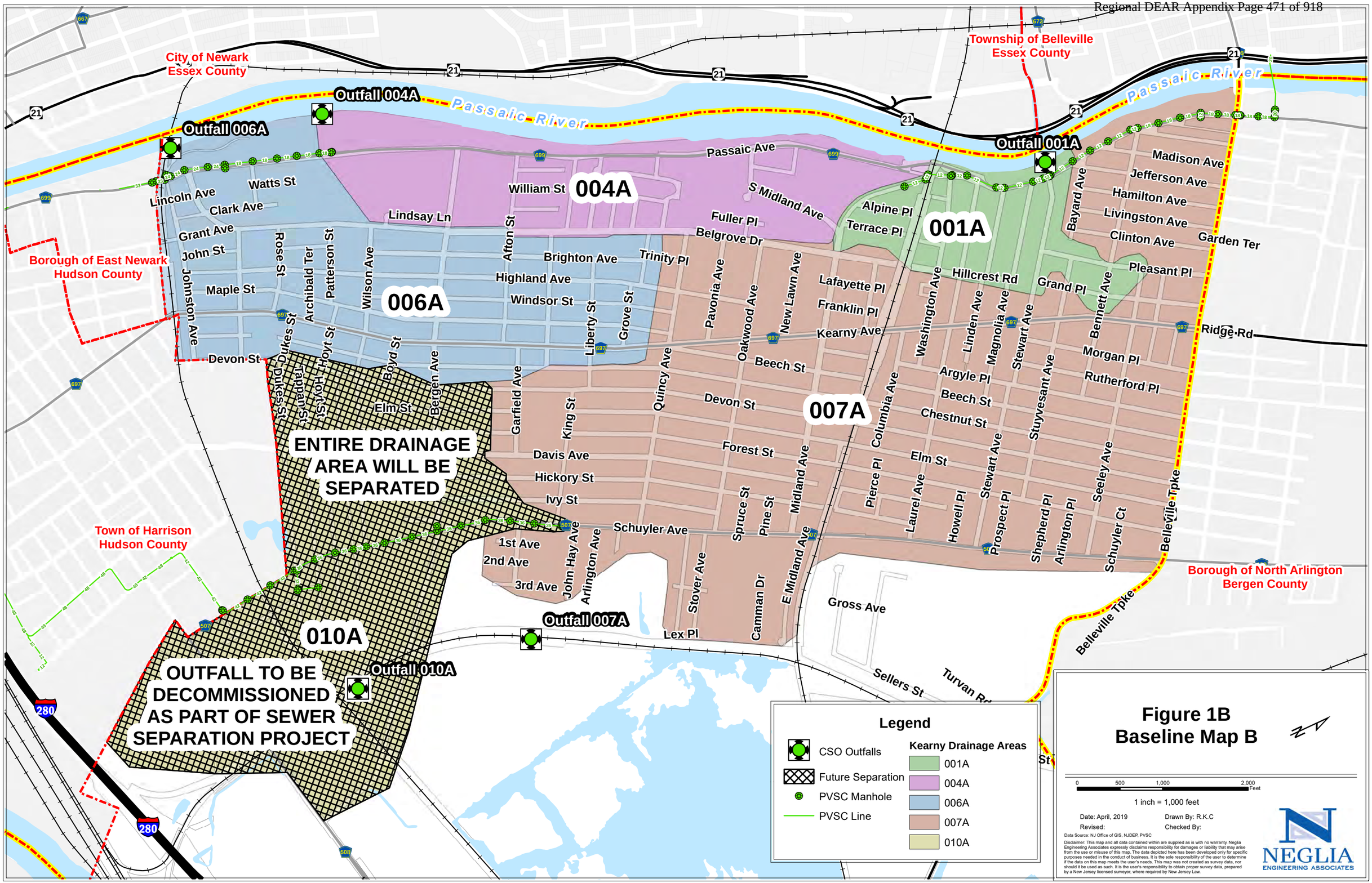
conveyed by separate storm and sanitary sewers. Thus, there will be zero CSO events at Outfall 010A upon completion of the project. This scenario was modeled as Baseline B. All alternatives developed in this report are based on Baseline B – i.e. zero CSO events from Outfall 010A. This is shown on Figure 1B.

Based on the upcoming elimination of CSO events at Outfall 010A, the model calculated the following number of CSO events, and volumes, at each outfall.

Table B-2 – CSO Frequency and Volume, Baseline B

Outfall No.	CSO Event Count	Total Volume (MG)
001A	31	3.9
004A	42	12.4
006A	57	120.2
007A	32	83.8
010A	0	0.0
Town wide	61	220.3

As seen from the above, the total number of CSO events does not change as a result of sewer separation at Outfall 010A. However, the total volume of CSO discharges is reduced from 255 MG to 220 MG, a 13.5% decrease.


City of Newark
Essex County
Township of Belleville
Essex County
Borough of East Newark
Hudson County
Town of Harrison
Hudson County
Borough of North Arlington
Bergen County
Passaic River
Outfall 004A
Outfall 006A
Outfall 001A
Outfall 007A
Outfall 010A
004A
006A
001A
007A
010A
ENTIRE DRAINAGE AREA WILL BE SEPARATED
OUTFALL TO BE DECOMMISSIONED AS PART OF SEWER SEPARATION PROJECT
Passaic Ave
William St
Lindsay Ln
S Midland Ave
Fuller Pl
Belgrove Dr
Alpine Pl
Terrace Pl
Madison Ave
Jefferson Ave
Hamilton Ave
Livingston Ave
Clinton Ave
Garden Ter
Pleasant Pl
Bayard Ave
Lincoln Ave
Watts St
Clark Ave
Grant Ave
John St
Johnston Ave
Maple St
Rose St
Archibald Ter
Patterson St
Wilson Ave
Afton St
Brighton Ave
Highland Ave
Windsor St
Trinity Pl
Liberty St
Grove St
Pavonia Ave
Oakwood Ave
New Lawn Ave
Lafayette Pl
Franklin Pl
Kearny Ave
Hillcrest Rd
Grand Pl
Washington Ave
Linden Ave
Magnolia Ave
Stewart Ave
Bennett Ave
Ridge Rd
Morgan Pl
Rutherford Pl
Devon St
Dukes St
Hoyt St
Boyd St
Bergen Ave
Elm St
Garfield Ave
King St
Quincy Ave
Beech St
Argyle Pl
Chestnut St
Columbia Ave
Stuyvesant Ave
Davis Ave
Hickory St
Ivy St
Forest St
Pierce Pl
Laurel Ave
Howell Pl
Prospect Pl
Shepherd Pl
Arlington Pl
Seeley Ave
Schuyler Ct
Belleville Tpke
1st Ave
2nd Ave
3rd Ave
John Hay Ave
Arlington Ave
Schuyler Ave
Spruce St
Pine St
Midland Ave
Stover Ave
Camman Dr
E Midland Ave
Gross Ave
Lex Pl
Sellers St
Turvan Rd
280
Legend
CSO Outfalls
Future Separation
PVSC Manhole
PVSC Line
Kearny Drainage Areas
001A
004A
006A
007A
010A
Figure 1B
Baseline Map B
0
500
1,000
2,000
Feet
1 inch = 1,000 feet
Date: April, 2019
Drawn By: R.K.C
Revised:
Checked By:
Data Source: NJ Office of GIS, NJDEP, PVSC
Disclaimer: This map and all data contained within are supplied as is with no warranty. Neglia Engineering Associates expressly disclaims responsibility for damages or liability that may arise from the use or misuse of this map. The data depicted here has been developed only for specific purposes needed in the conduct of business. It is the sole responsibility of the user to determine if the data on this map meets the user's needs. This map was not created as survey data, nor should it be used as such. It is the user's responsibility to obtain proper survey data, prepared by a New Jersey licensed surveyor, where required by New Jersey Law.
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ENGINEERING ASSOCIATES

SECTION C SCREENING OF CSO CONTROL TECHNOLOGIES

C.1 INTRODUCTION

A wide range of CSO control technologies were considered for application in the Town of Kearny combined sewer system ("CSS"). The Town of Kearny systematically evaluated various control alternatives using technology categories. The technologies are grouped into the following categories:

- Source Control (Including Green Infrastructure);
- Base Flow Reduction;
- Sewer System Optimization;
- Inline Storage;
- Offline Storage;
- Wastewater Treatment Plant (WWTP) Expansion or Storage at the Plant;
- Sewer Separation; and
- Treatment of CSO Discharge.

The above technologies are described in further detail below and a summary assessment is provided in Table C-7.

C.2 SOURCE CONTROL

As a means of controlling stormwater runoff volumes and pollutants at the source, management technologies can be applied where the subject stormwater runoff and pollutants tend to accumulate. Applicable source technologies are categorized and described below:

C.2.1 Stormwater Management

- Street / Parking Lot Storage (Catch Basin Control): This includes storage of stormwater runoff on streets and/or parking lots to reduce the peak flow during wet weather events. This would be achieved by restricting the occurrence of CSOs and permitting controlled flooding within the streets and parking lots. However, the storage of combined sewage within streets and parking lots would create a public health hazard, would generate considerable public opposition and could potentially create hazardous flooding and freezing problems. It is also noted that this alternative would result in minimal bacteria and volume reduction, which are considered pollutants of concern. Therefore, this alternative has been eliminated from any further consideration.

- Catch Basin Modifications for Floatable Controls: The major objective of catch basin modifications for floatable controls is to capture and restrict the conveyance of floatables to the combined sewer system. This is generally achieved by retrofitting existing catch basins with curb pieces containing openings that do not allow for floatables of certain sizes (greater than 2 inches) to pass through to the combined sewer system. Furthermore, the Town of Kearny ensures that all new catch basin construction, including on private property, contain grates and curb openings that are effective at controlling floatables. While, this is not an effective measure of achieving bacteria and volume reduction associated with CSOs, it is effective at reducing the quantity of floatables that are captured within the combined sewer system. Therefore, the Town of Kearny continues to retrofit existing catch basins with Type N-Eco curb pieces, which typically have narrow, 1-1/2 inch wide openings, during roadway rehabilitation projects to ensure that floatables are less likely to enter. Furthermore, the Department of Public Works is vigilant about cleaning catch basins on a regular basis

(including after significant rainfall events) and clearing the same of all debris. This alternative is considered to be implemented to a satisfactory level.

- Catch Basin Modifications for Leaching: A leaching catch basin is a modified catch basin that is fabricated of barrel and riser sections and permits the infiltration of stormwater runoff into the ground. Furthermore, a leaching catch basin would include an overflow pipe to ensure that excess stormwater runoff that does not infiltrate into the ground is conveyed to the combined sewer system and does not back up, which would result in localized flooding. This application could be utilized on existing street catch basins or can be constructed within new private developments. However, in order to achieve any bacteria or CSO volume reduction, this alternative would need to be implemented on a widespread scale. In addition, the effectiveness of leaching catch basins is contingent upon the permeability of the soil within the Town. Due to its minimal impact on CSO volume and bacteria reduction, as well as the uncertainty of soil permeability rates, this technology is eliminated from further consideration.

C.2.2 Public Education and Outreach

Public education and outreach programs are intended to notify the public of the CSO problem and to provide guidance on measures that community members can undertake to reduce CSO volume and associated bacteria. Generally, public education and outreach programs have minimal impacts on the volume, frequency or duration of CSO overflows. However, these programs tend to be effective at improving the CSO quality by promoting the reduction of floatable debris within the combined sewer system. Public education and outreach is inclusive of the following:

- Water Conservation: Effective water conservation programs would urge the public to reduce water consumption and thereby mitigate the volume of wastewater generated. The inherent benefit would be to reduce dry weather flow in the combined sewer system to create additional storage volume during wet weather events. Water conservation generally has no impact with respect to bacteria reduction and minimal impact on the overall CSO volume reduction. This is discussed further in Section C.4 where a 10% reduction in base flow was modeled and produced a minimal impact in CSO volume. Furthermore, it is noted that the Town does not own the water system. In light of the above factors, and understanding that the precise impact of water conservation on CSO volume and frequency cannot be accurately quantified, this alternative is eliminated from consideration with respect to the LTCP. However, the Town will consider water conservation programs moving forward as a means of general good stewardship, conservation of resources, etc.

- Catch Basin Stenciling: Effective catch basin stenciling includes installation of street pavement markings notifying the general public that waste flow (i.e. floatables) passing through the catch basins may ultimately discharge to a waterbody. While catch basin stenciling would have no impact on bacteria and volume reduction associated with CSOs, it may result in a reduction of floatables encountered within the combined sewer system, which would be beneficial to the overall longevity of the Town's CSO netting facilities at the outfalls. Furthermore, this is an alternative that could be implemented via public volunteers and serves as a significant opportunity to educate the public about CSOs. While the Town will consider reaching out to local volunteer groups to implement stenciling, this item is eliminated from further consideration with respect to the LTCP.

- Community Cleanup Programs: Similar to catch basin stenciling, as described above, community cleanup programs provide an opportunity for the public to engage and may result

in a reduction of floatables entering the combined sewer system. The Town has implemented a community cleanup program.

- Public Outreach Programs: The Town of Kearny has an independent public participation citizens group, Kearny AWAKE (Association of Water, Agriculture and Kearny's Environment), that was formed to provide input of the LTCP process and to educate the public on the CSO issues, along with general environmental issues associated with Kearny. Kearny AWAKE includes a Council member who serves as a liaison and provides updates at Town Council meetings. The Town's Consulting Engineer (NEA) has met with Kearny AWAKE to provide updates on the LTCP progress and to receive input on the same. The Consulting Engineer will continue to meet with Kearny AWAKE and will seek public input accordingly. It is also recommended that the Town engage Kearny AWAKE to participate in water conservation promotion, catch basin stenciling, and community cleanup efforts, as described above. It is noted that two (2) members of Kearny AWAKE participate in the PVSC Group Supplemental CSO Team. Public outreach technologies will be considered in conjunction with other control technologies.
- Fat, Oils and Grease Program: During the site plan review process (i.e. for applications appearing before the Zoning and Planning Boards) in Kearny, certain developments that will produce fats, oils and greases are required to provide grease traps to ensure that the aforementioned substances are not conveyed to the combined sewer system. This alternative has been implemented to a satisfactory level.
- Garbage Disposal Restriction: The Town of Kearny has weekly garbage and recycling collections. Information related to the same is provide on the Town's website. This alternative has been implemented to a satisfactory level.
- Pet Waste Management: The Town of Kearny regularly uses the Town website to notify the public of the requirements established within the Town's Pet Waste Ordinance and will continue to do so. This alternative has been implemented to a satisfactory level.
- Lawn and Garden Maintenance: The Town of Kearny regularly uses the Town website to notify the public of the guidelines for lawn and garden maintenance provided by the United States Environmental Protection Agency (USEPA). This alternative has been implemented to a satisfactory level.
- Hazardous Waste Collection: The Town of Kearny does not currently provide Hazardous Waste collection. However, the Town's website does include guidance as it relates to paint and battery guidance. Hazardous waste dumping is currently illegal in Kearny.

C.2.3 Ordinance Enforcement

The objective of ordinance enforcement as it relates to the occurrence of CSOs is to enact ordinances that may reduce the volume and/or bacteria loading of CSOs. Potential ordinance enforcements alternatives that have been considered for evaluation are further described below:

- Construction Site Erosion & Sediment Control: The Town of Kearny requires that new developments comply with the Standards for Soil Erosion and Sediment Control. The requirements of the same are enforced during the Planning / Zoning Board review process as well as on-site inspections conducted during construction. This alternative is satisfactorily implemented.

- Illegal Dumping Control: The Town of Kearny has ordinances that regulate procedures for disposal of waste and materials. These ordinances outline violations and penalties related to illegal dumping activities. These ordinances, along with the associated violations and penalties, are generally enforced by the Town of Kearny Department of Public Works and Police Department. This control measure has been satisfactorily implemented.
- Pet Waste Control: The Town of Kearny has ordinances that require proper disposal of pet waste. These ordinances contain violations and penalties for pet owners who fail to comply with the same. These ordinances, along with the associated violations and penalties, are generally enforced by the Town of Kearny Department of Public Works and Police Department. This control measure has been satisfactorily implemented.
- Litter Control: The Town of Kearny has an ordinance which requires property owners and/or tenants to keep properties, as well as the sidewalk, curbs and alleyways abutting the properties, free of litter. This ordinance is generally enforced by the Town of Kearny Department of Public Works and Police Department. This control measure has been satisfactorily implemented.
- Illicit Connection Control: The Town of Kearny has an illicit connection ordinance related to connections of domestic sewage, non-contact cooling water, process waste water, or other industrial waste (other than stormwater) to the separate municipal stormwater conveyance system. Overall, illicit connection control is difficult to monitor and is more applicable to separated sewer systems. Due to these factors, this control measure is eliminated from further consideration.

C.2.4 Good Housekeeping

Effective housekeeping is inclusive of practices put in place by the Town to reduce the volume of solids and pollutant loading within the combined sewer system. Overall, the goal of good housekeeping practices is to maximize the storage volume within the conveyance system while ensuring that potential pollutants are treated at the source.

- Street Sweeping/Flushing: The Town of Kearny conducts street sweeping operations on a weekly basis Monday through Thursday. Street signs indicating the hours when parking is prohibited are posted along the sweeping routes. Street sweeping has been implemented to a satisfactory level.

  The intent of combined sewer flushing is to re-suspend settled sewage solids and transmit the same to the wastewater treatment plant during dry weather to prevent stormwater runoff collected during a storm event from flushing these solids to a receiving water body. Overall, the process includes introducing a controlled volume of water over a short duration at key points in the conveyance system. This is done using external water from a tank truck by gravity or pressurized feed or using internal water detained manually or automatically. While the Town of Kearny sometimes uses sewer flushing to alleviate flooding areas, it is generally understood that sewer flushing is more beneficial when applied to flat collection systems. Generally, pipes within the combined system are sufficiently pitched to achieve ample conveyance. Therefore, it is not expected that combined sewer flushing will result in a reduction of CSO volume/events or a reduction in the pollutant loading. Due to the limited benefits of this alternative, it will not be further evaluated.

- Leaf Collection: The Town of Kearny Department of Public Works conducts planned curbside collection of leaves placed within biodegradable bags. The Town does not permit piling of leaves within the street. Leaf collection has been implemented to a satisfactory level.
- Recycling Program: The Town of Kearny has weekly recycling collections. A recycling program has been implemented to a satisfactory level.
- Storage/Loading/Unloading Areas: The Town of Kearny has requirements for storage and loading/unloading areas, as stipulated within the zoning ordinance and site plan review ordinances. These requirements provide the ratio of storage and loading/unloading areas based on the overall size of the proposed development. The requirements are enforced during the Planning/Zoning Board review process. While there are limited benefits to the overall CSO issue that are obtained via the provision of designated storage and loading/unloading areas, the Town of Kearny has implemented this alternative to a satisfactory level.
- Industrial Spill Control: The PVSC has established a pretreatment program for industrial users subject to the Federal Categorical Pretreatment Standards 40 CFR 403.1. This item has been implemented to a satisfactory level.

C.2.5 Green Infrastructure

C.2.5.1 Introduction / Definition of Green Infrastructure

Green Infrastructure (GI) refers to a category of measures that can be used to capture storm water before it enters the sewer system, and conveys that flow into the ground via infiltration, or to the atmosphere via evapotranspiration. GI measures will reduce the quantity of storm flow entering into Kearny's combined sewers, and thereby will play a contributing role in reducing the overall volume of CSOs and the number of CSO events. The 2015 NJPDES permit for the Town of Kearny (and all the PVSC CSS permitees) stipulates that GI measures must be included as a component of the Long Term Control Plan (LTCP), to achieve CSO reduction.

The NJDEP has defined Green Infrastructure as follows:

"Green Infrastructure means methods of stormwater management that reduce wet weather/stormwater volume, flow, or changes the characteristics of the flow into combined or separate sanitary or storm sewers, or surface waters, by allowing the stormwater to infiltrate, to be treated by vegetation or by soils; or to be stored for reuse. Green infrastructure includes, but is not limited to, pervious paving, bioretention basins, vegetated swales, and cisterns".

C.2.5.2 Types of GI Measures

The GI measures considered in the PVSC Public Participation Process Report for Kearny include the following:

- Rain Gardens;
- Tree Pits;
- Harvesting of Rain Water; and
- Porous Pavements.

For detailed descriptions of Green Infrastructure measures, the reader is referred to the 2018 Technical Guidance Manual (TGM) and other NJDEP source material. However, brief descriptions are included below.

- Rain Gardens – consist of a shallow depressed area, with native plants and vegetation, to collect storm water runoff. The collected runoff infiltrates into the ground, or is lost to evaporation, or is transpired by the vegetation. Loading rates are typically 5 to 1 or less; for example, 1 acre of rain garden is needed to capture runoff from a 5 acre area. Porous soil is also needed for the system to perform as intended. Rain gardens have been used in New Jersey and across the country and are considered viable for use in Kearny's LTCP and are therefore retained for further consideration. Rain gardens were included in the modeling effort and costs for rain gardens are included in Tables D-4 and D-5.
- Right-of-Way Bioswales – similar to a rain garden, except that is is constructed along the curb, specifically designed to intercept street runoff, and is deeper than a rain garden, typically 4-1/2 feet deep. R.O.W. bioswales are considered viable for use in Kearny's LTCP and are retained for further consideration. R.O.W. bioswales were included in the modeling effort, and costs for bioswales are included in Tables D-4 and D-5.
- Enhanced Tree Pits – this measure uses an underground system of underdrains, crushed stone and porous soil, designed to infiltrate runoff. Where multiple tree pits are installed, it may be feasible to install permeable pavement between the tree pits. Enhanced tree pits may be feasible for some areas of Kearny and are retained for further consideration in the LTCP.
- Green Roofs – consist of a vegetative layer with porous soil and an underdrain system, all constructed on top of a building roof. The system only collects storm water falling on the roof, and the existing roof may require costly modifications to accept the Green Roof. Green roofs were included in the modeling effort and costs are shown in Tables D-4 and D-5. As seen in Tables D-4 and D-5, green roofs are the most costly of all the GI measures investigated. Therefore, green roofs are eliminated from further consideration.
- Porous Pavements – this measure includes porous asphalt, porous concrete, and porous interlocking concrete pavers (PICP). A stone layer beneath the pavement stores the collected storm water, before it infiltrates into the ground. Of all the types of porous pavements, porous asphalt may have the most potential for use in Kearny, particularly in parking areas. This is shown later in this section, where specific sites in Kearny are evaluated. Porous asphalt lacks the fines included in standard pavement, allowing water to migrate through it. Porous asphalt, porous concrete and porous CICP were modeled, and costs are presented in Tables D-4 and D-5. Porous asphalt is less sturdy than standard pavement, and is not suitable for high traffic areas. In general, porous pavements may be viable for some areas in Kearny, and are retained for further consideration in the LTCP, in conjunction with other technologies.
- Blue Roofs – these are roof systems which are designed to store storm water. Blue roofs can have the potential for leaks, and can be costly. Blue roofs have been installed in New York City. Due to the nature of the properties in Kearny, and proposed new developments, blue roofs are eliminated from further consideration.
- Rainwater Harvesting – for some of the sites investigated in Kearny, discussed below, harvesting of rainwater in cisterns was a measure suggested in the PPP Plan. Harvesting in cisterns is simple, and low maintenance, but may have little overall impact on Town wide CSO frequency and volume. Harvesting may be considered in conjunction with other Green Infrastructure measures.
- Planter Boxes – like rain gardens and right of way bioswales, planter boxes are another means of bioretention. Suitable locations in Kearny for large planter boxes may be limited. However, this control measure will be retained for further consideration in conjunction with other technologies.

C.2.5.3 Public Participation Process Report

In June 2018 PVSC submitted its Public Participation Process (PPP) Report to the NJDEP, on behalf of all of its CSS permittees. The Public Participation Process Report included a discussion of Green Infrastructure measures that could potentially be implemented within each municipality in the Study Area. For Kearny, a total of thirteen (13) Green Infrastructure sites were identified, with recommendations for implementing GI measures presented for each site. These sites, and the recommendations made in the Public Participation Process Report, are now discussed. Also discussed is NEA's field investigations to confirm the PPP findings.

Refer to Figure 4, Map of Green Infrastructure Sites, which illustrates the potential GI sites within the Town of Kearny, as per the PPP Report. Also shown are two additional sites which were suggested by a local citizens' group known as Kearny AWAKE.

C.2.5.4 Field Investigation

In January 2019, Neglia Engineering Associates (NEA) conducted its own field investigation, to evaluate and confirm the feasibility of GI measures at each of the sites listed in the PPP Report. Each listed site was visually inspected, photos were taken, to confirm the most up to date site conditions.

C.2.5.5 Site Evaluation

The thirteen (13) sites identified for Kearny in the Public Participation Process Report are as follows:

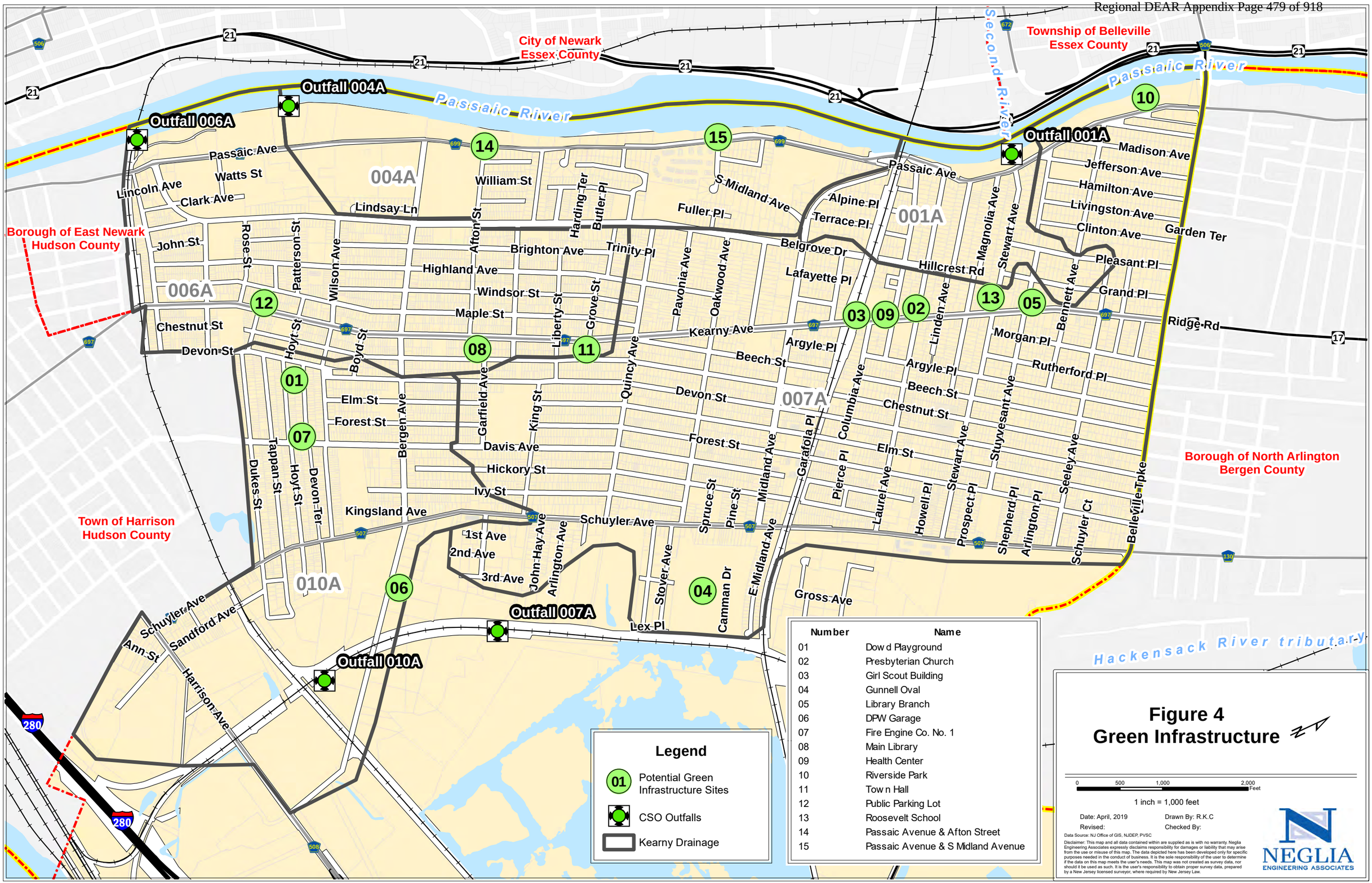
- Dowd Playground – 10 Devon Terrace;
- First Presbyterian Church – 663 Kearny Avenue;
- Girl Scout Building – 635 Kearny Avenue;
- Gunnel Oval – 520 Schuyler Avenue;
- Kearny Branch Public Library – 759 Kearny Avenue;
- Department of Public Works (DPW) Garage – 357 Bergen Avenue;
- Fire Department Engine 1 – 47 Davis Avenue;
- Main Public Library – 318 Kearny Avenue;
- Public Health Center – 645 Kearny Avenue;
- Riverside Park – 925 Passaic Avenue;
- Town Hall – 402 Kearny Avenue;
- Public Parking Lot – 101 Kearny Avenue; and
- Roosevelt School – 733 Kearny Avenue.

Of the above sites, those located on public lands owned by the Town of Kearny are the most desirable, in terms of availability, access and obtaining approval for use. Those sites not owned by the Town of Kearny are eliminated from consideration. These include the First Presbyterian Church and the Roosevelt School.

In addition, the Dowd Playground is located on Devon Terrace, which is on a steep slope. Due to the steepness of the slope, GI measures may prove to be ineffective, as surface runoff would likely predominate, rather than infiltration. Therefore the Dowd Playground site is not considered a desirable site.

Gunnel Oval is a large recreational area which is now undergoing improvements. Additional site features such as Green Infrastructure measures are not included in the current construction. Since much of the area consists of ballfields, the site is not considered amenable to GI measures such as rain gardens, bioswales, etc.

The remaining nine (9) sites are discussed as follows:


City of Newark
Essex County
Township of Belleville
Essex County
Borough of East Newark
Hudson County
Town of Harrison
Hudson County
Borough of North Arlington
Bergen County
Passaic River
Second River
Hackensack River tributary
Outfall 004A
Outfall 006A
Outfall 001A
Outfall 007A
Outfall 010A
004A
006A
001A
007A
010A
Passaic Ave
Watts St
Lincoln Ave
Clark Ave
Lindsay Ln
John St
Rose St
Patterson St
Wilson Ave
Afton St
William St
Harding Ter
Butler Pl
Fuller Pl
S Midland Ave
Alpine Pl
Terrace Pl
Madison Ave
Jefferson Ave
Hamilton Ave
Livingston Ave
Clinton Ave
Garden Ter
Pleasant Pl
Grand Pl
Ridge Rd
Brighton Ave
Trinity Pl
Pavonia Ave
Oakwood Ave
Belgrove Dr
Lafayette Pl
Hillcrest Rd
Magnolia Ave
Stewart Ave
Bennett Ave
Highland Ave
Windsor St
Maple St
Chestnut St
Devon St
Hoyt St
Boyd St
Liberty St
Grove St
Kearny Ave
Argyle Pl
Linden Ave
Morgan Pl
Rutherford Pl
Beech St
Quincy Ave
Elm St
Forest St
Bergen Ave
Garfield Ave
King St
Columbia Ave
Chestnut St
Stuyvesant Ave
Tappan St
Dukes St
Davis Ave
Hickory St
Ivy St
Midland Ave
Garafola Pl
Pierce Pl
Laurel Ave
Howell Pl
Prospect Pl
Shepherd Pl
Arlington Pl
Seeley Ave
Schuyler Ct
Belleville Tpke
Kingsland Ave
Schuyler Ave
Spruce St
Pine St
1st Ave
2nd Ave
3rd Ave
John Hay Ave
Arlington Ave
Stover Ave
Camman Dr
E Midland Ave
Gross Ave
Lex Pl
Sandford Ave
Ann St
Harrison Ave
280
17
21
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
Legend
01 Potential Green Infrastructure Sites
CSO Outfalls
Kearny Drainage
Number Name
01 Dow d Playground
02 Presbyterian Church
03 Girl Scout Building
04 Gunnell Oval
05 Library Branch
06 DPW Garage
07 Fire Engine Co. No. 1
08 Main Library
09 Health Center
10 Riverside Park
11 Tow n Hall
12 Public Parking Lot
13 Roosevelt School
14 Passaic Avenue & Afton Street
15 Passaic Avenue & S Midland Avenue
Figure 4
Green Infrastructure
0 500 1,000 2,000 Feet
1 inch = 1,000 feet
Date: April, 2019
Drawn By: R.K.C
Revised:
Checked By:
Data Source: NJ Office of GIS, NJDEP, PVSC
Disclaimer: This map and all data contained within are supplied as is with no warranty. Neglia Engineering Associates expressly disclaims responsibility for damages or liability that may arise from the use or misuse of this map. The data depicted here has been developed only for specific purposes needed in the conduct of business. It is the sole responsibility of the user to determine if the data on this map meets the user's needs. This map was not created as survey data, nor should it be used as such. It is the user's responsibility to obtain proper survey data, prepared by a New Jersey licensed surveyor, where required by New Jersey Law.
NEGLIA
ENGINEERING ASSOCIATES

- Girl Scout Building (Site No. 3): The Girl Scout Building, located at 635 Kearny Avenue, has a paved parking area on the south side of the building, which could be repaved with porous pavement, to capture and infiltrate storm water. Roof runoff, which currently discharges to the municipal conveyance system, could instead be captured in a cistern, and used onsite for lawn watering. The cistern would be located near the garage at the southeast corner of the building. NEA concurs that this site is feasible for implementing GI. As stated in the Public Participation Process Report, further soil testing is needed to determine the suitability of the existing soil for GI implementation. See photographs No. 1 and 2.

Photo No. 1 – Grassed area in front of Girl Scout Building

Photo No. 2 - Parking Area and Garage at Girl Scout Building

- Kearny Public Health Center (Site No. 9): The Public Health Center is located at 645 Kearney Avenue, adjacent to the Girl Scout Building. The two buildings are separated by a driveway. There are two grassed areas in front of the building on either side of a paved walkway. Rain gardens could be installed in each of these grassed areas to capture, treat and infiltrate roof runoff. NEA concurs that this site is feasible for implementing GI. As stated in the Public Participation Process Report, further soil testing is needed to determine the suitability of the existing soil for GI implementation. See photograph No. 3.

Photo No. 3 – Health Center Building

- Kearny Branch Public Library (Site No. 5): The Kearny Branch Public Library is located at 759 Kearny Avenue at the corner of Stuyvesant Avenue. The side of the building facing Stuyvesant Avenue has a large lawn area. This area has the potential for rain garden installation to capture, treat and infiltrate roof runoff. NEA concurs that this site is feasible for implementing GI. As stated in the Public Participation Process Report, further soil testing is needed to determine the suitability of the existing soil for GI implementation. See Photograph No. 4.

Photo No. 4 - Branch Public Library Side Lawn Area Facing Stuyvesant Avenue

- Kearny Main Public Library (Site No. 8): The Kearny Main Public Library is located at 318 Kearny Avenue, at the corner of Garfield Avenue. A grassed area at the northwest corner of the lot could be the site of a rain garden to capture, treat and infiltrate roof runoff. Additional roof runoff could be collected in a cistern near the garage. NEA concurs that this site is feasible for implementing GI. As stated in the Public Participation Process Report, further soil testing is needed to determine the existing soil's suitability for GI implementation. See Photograph No. 5 below.

Photo No. 5 – Kearny Main Library Side Lawn Area

- Kearny Town Hall (Site No. 11): The Town Hall is located at 402 Kearny Avenue. There is a paved parking lot in the back of the building facing out to Chestnut Street. This area could be repaved with porous pavement. At the front of the building, trees with tree pits could be planted in the sidewalk. NEA concurs that this site is feasible for implementing GI. As stated in the Public Participation Process Report, further soil testing is needed to determine the suitability of the existing soils for GI implementation. See Photograph No. 6.

Photo No. 6 – Kearny Town Hall Rear Parking Lot

- Public Parking Lot (Site No. 12): The Town of Kearny owns and maintains a public parking lot located on Kearny Avenue near the intersection with Dukes Street and in the vicinity of the municipal boundary with the Town of Harrison. Within the parking lot is a concrete island with plantings. A rain garden at this location might be more effective in capturing, treating, and infiltrating parking lot runoff. NEA concurs that this site is feasible for implementing GI. As stated in the Public Participation Process Report, further soil testing is needed to determine the suitability of the existing soils or GI implementation. See Photograph No. 7.

Photo No. 7 – Traffic Island in Public Parking Lot on Kearny Avenue and Dukes Street

- Department of Public Works (DPW) Garage (Site No. 6): The DPW Garage is located at 357 Bergen Avenue near the abandoned railroad tracks. The PPP Report identified this site as amenable to collection of storm water via cisterns, which would be located at a building corner for collection and on-site use. Additionally the parking area could be repaved with porous pavement. NEA concurs that this site is feasible for implementing GI. As stated in the Public Participation Process Report, further soil testing is needed to determine the suitability of existing soils for GI implementation.

- Fire Department Engine No. 1 (Site No. 7): Fire Department Engine No. 1, located at 47 Davis Avenue, was identified in the PPP Report as potentially suitable for collection and storage of rain runoff via on-site cisterns. Additionally the parking area could be repaved with porous pavement. NEA concurs that this site is feasible for implementing GI. As stated in the Public Participation Process Report, further soil testing is needed to determine the suitability of existing soils for GI implementation.

- Riverside Park (Site No. 10): Riverside Park is located at the northwest corner of the Town. The PPP Report recommended porous pavement be installed in the parking area, and a rain garden within the park. The park offers a lot of potential for implementing GI measures as it provides a large, non-paved area. NEA concurs that this site is feasible for implementing GI. As stated in the Public Participation Process Report, further soil testing is needed to determine the suitability of existing soils for GI implementation.

- Additional Green Infrastructure Sites: In February 2019, a meeting was held between NEA and the Kearny AWAKE Group. NEA discussed the overall LTCP process as it relates to Kearny and sought feedback on the same. Kearny AWAKE concern with the inclusion of Green Infrastructure in the LTCP noted two particular areas which have been prone to flooding during and after rainstorms. One such area is located along Passaic Avenue near Afton Street, while the second is located along Passaic Avenue near South Midland Street. These are shown as Site Numbers 14 and 15 on Figure 4. Kearny AWAKE suggested the use of bioswales and eddy basins to help mitigate flooding in those areas.

C.3 COMBINED SEWER SEPARATION

Sewer separation includes the construction of new storm water conveyance pipes which direct storm flow to outfalls at receiving water bodies, while separate sanitary sewers direct sewage flows to the WWTP, thereby eliminating CSO outfalls.

Two levels of sewer separation have been evaluated. The first is total sewer separation for the entire Town of Kearny. The second is partial sewer separation in Drainage Area 010 only. Drainage Area 010 is approximately 93 acres. Sewers have previously been separated in portions of this area, covering approximately 50 acres. For purposes of this study, partial sewer separation refers to separating the sewers in the remaining 43 acres, such that all of Area 010 has separate sewers, and zero CSO events will occur in this drainage area. Refer to Figures 1A and 1B. The Town is committed to achieving complete separation of sewers in all of Drainage Area 010. A project is currently in design and will go into construction in the near future, which will achieve this goal. The development and evaluation of alternatives includes two different baselines, labelled as Baseline A and Baseline B. Baseline A refers to the current infrastructure, including all five drainage areas, while Baseline B accounts for sewer separation in Drainage Area 010, with that area removed from the analysis. All Alternatives shown and evaluated in Section D are based on Baseline B, (i.e. they include sewer separation in Area 010).

- Roof Leader Disconnection: Disconnecting roof leaders and area drains from the storm sewers would need to be coupled with other Green Infrastructure measures, in order to provide an outlet for the discharge of this flow. This measure also requires cooperation from home and business owners. This control measure is eliminated from further consideration.
- Sump Pump Disconnection: This control measure is similar to roof leader disconnection as discussed above. With limited outlets for discharging to pervious areas, sump pump disconnection would need to be combined with other Green Infrastructure measures. This measure also requires cooperation from home and business owners. This control measure is eliminated from further consideration.

C.4 REDUCTION IN BASE FLOW

Reduction in base flow, i.e. dry weather flow, can be achieved through measures such as water conservation or Infiltration/Inflow (I/I) reduction. For separated sanitary sewer systems, I/I reduction has the potential to improve the performance of the sanitary conveyance system by removing storm flow which comes from roof drains, sump pumps, etc, thus alleviating sanitary sewer overflows (SSOs), and excessive flows coming to the wastewater treatment plant. For combined systems, I/I reduction is expected to have little impact on the number and volume of CSOs, as the majority of the CSO volume is not coming through leaks in the sewer piping, but from sanitary flow and precipitation. It was noted in Section C.2 that water conservation will have minimal impact on CSO volume and frequency. Both water conservation and I/I reduction have no impact on pathogen removal.

A 10 percent reduction in base flow was modeled. This reduction is based on a combination of water conservation and I/I reduction. The quantitative impacts resulting from this modeling effort are shown in Tables C-1 and C-2, shown previously in Section C.2.5. A 10 percent reduction in base flow resulted in a 1.6 percent reduction in overall Town wide CSO frequency, and a 1.4 percent reduction in overall Town wide CSO volume.

Based on the above analysis, base flow reduction is eliminated from further consideration.

C.5 COMBINED SEWER OPTIMIZATION

Sewer System Optimization refers to increasing storage and conveyance capacity in the sewers. This can be done via several measures, including additional sewer construction, regulator modifications, outfall consolidation/relocation or real time control.

C.5.1 Additional Sewer Construction

Constructing additional sewers to increase capacity would be costly. In addition, all residential and commercial areas within the Town are served by the municipal sewer system. Therefore, any new sewer construction in Kearny would be part of a sewer separation project. Sewer separation is discussed elsewhere in this report.

C.5.2 Regulator Modifications

Regulator modifications can include adding baffles for floatables capture, or raising the weirs in the chamber to keep more flow in the collection system. Raising the overflow weir in each Regulator Chamber by 6 inches was modeled. The results are tabulated in Tables C-1 and C-2 shown previously in Section C.2.5.

As Tables C-1 and C-2 illustrate, there was a negligible reduction in CSO frequency and volume resulting from this control measure. The model predicted zero percent reduction in Town wide CSO frequency, and 1.2 percent reduction in Town wide CSO volume. In addition, Outfalls 007 and 010 are located in low lying areas which experience flooding on a regular basis. Outfalls 004 and 006 are located in areas where the sewers have a history of surcharging. Thus raising the weirs in the regulators would only serve to intensify an existing problem in Kearny. Based on all of the above factors, increasing storage capacity in the sewers by raising the weirs in the regulator chambers is not considered feasible for Kearny and is eliminated from further consideration.

C.5.3 Outfall Consolidation/Relocation

Consolidation of outfalls reduces the number of discharge locations, thereby reducing O&M requirements and costs. It is also favorable from a regulatory standpoint. In Kearny, there is the potential to consolidate Outfalls 004A (Nairn Avenue) and 006A (Johnston Avenue) due to their close proximity to each other and the relative topography at these locations. Refer to the Town Drainage Area Map, Figure 1A. A single storage or treatment facility to serve both of those outfalls may be feasible. This will be investigated in further detail in the preparation of the 2020 Selection and Implementation Plan document.

C.5.4 Real Time Control

Automating the collection system with flow metering and feedback systems is not considered feasible for Kearny and is not considered for further evaluation. Further, such measures would need to be addressed with PVSC, the entity which owns the interceptor and the regulator chambers.

C.6 STORAGE

C.6.1 Inline Storage (CSO Tunnel)

Inline storage would consist of a single, large diameter tunnel extending from one end of Town to the other. The tunnel would have a single discharge outfall. The overflows from the other existing CSO outfalls KE 001, 004, 006 and 007 in Kearny would be piped to the tunnel. The tunnel would be approximately 10,000 feet in length and has been modeled based on 4, 8, 12, and 20 CSOs per year. A preliminary tunnel route is shown in Figure 5. Tunnel volumes for the target scenarios are shown below in Table C-1. Costs are presented in Section D.

Storage tunnel solutions considered in this evaluation include an analysis to optimize the size of one centralized storage tunnel necessary to achieve each CSO frequency target of 4, 8, 12, and 20 per year. This analysis assumes that the overflows from outfalls KE001, KE004, KE006, and KE007 will be directed to the centralized, deep storage tunnel. The tunnel is assumed to be 10,000 feet long, with varying diameters to achieve the required storage volume. The deep tunnel will store the CSOs generated during wet-weather events and would pump back to PVSC for treatment following the event or when there is available capacity in the system to treat the stored volumes. Required tunnel volumes for each of the target scenarios are shown below in Table C-3. Tunnel costs are included in Table D-3 in Section D. The tunnel option is retained for further consideration in the LTCP.

Table C-1 – Tunnel Storage
(sized to fully capture all CSO for all but number of storms per year indicated)

Outfall No.	Tunnel Volume for 4 CSO events/year (MG)	Tunnel Volume for 8 CSO events/year (MG)	Tunnel Volume for 12 CSO events/year (MG)	Tunnel Volume for 20 CSO events/year (MG)
Total	11.52	10.28	6.47	4.28

C.6.2 Offline Storage (Tanks)

Storage-tank solutions considered in this evaluation included an analysis to optimize the size of storage tanks at each outfall necessary to achieve each CSO-frequency target (4, 8, 12 and 20 per year). CSO is stored in the underground tanks during wet weather events and pumped back to the PVSC treatment plant when there is available capacity in the system. The storage tank would hold the flow for a maximum of three (3) days and then discharge the volume at a rate not to exceed 1.75 times the average dry weather flow when the PVSC treatment plant has the capacity to accept the flow. This analysis assumes that storage tanks will be constructed at locations upstream of the existing outfalls. Specific tank locations have not been identified in this report.

Storage Volumes were computed, for each target scenario, and for each outfall. These are shown below in Table C-2. Costs were estimated, based on the criteria of 4, 8, 12, and 20 CSO events per year. Costs for offline storage tanks are included in the Cost Summary Table in Section D. Offline storage tanks are retained for further consideration in the LTCP.

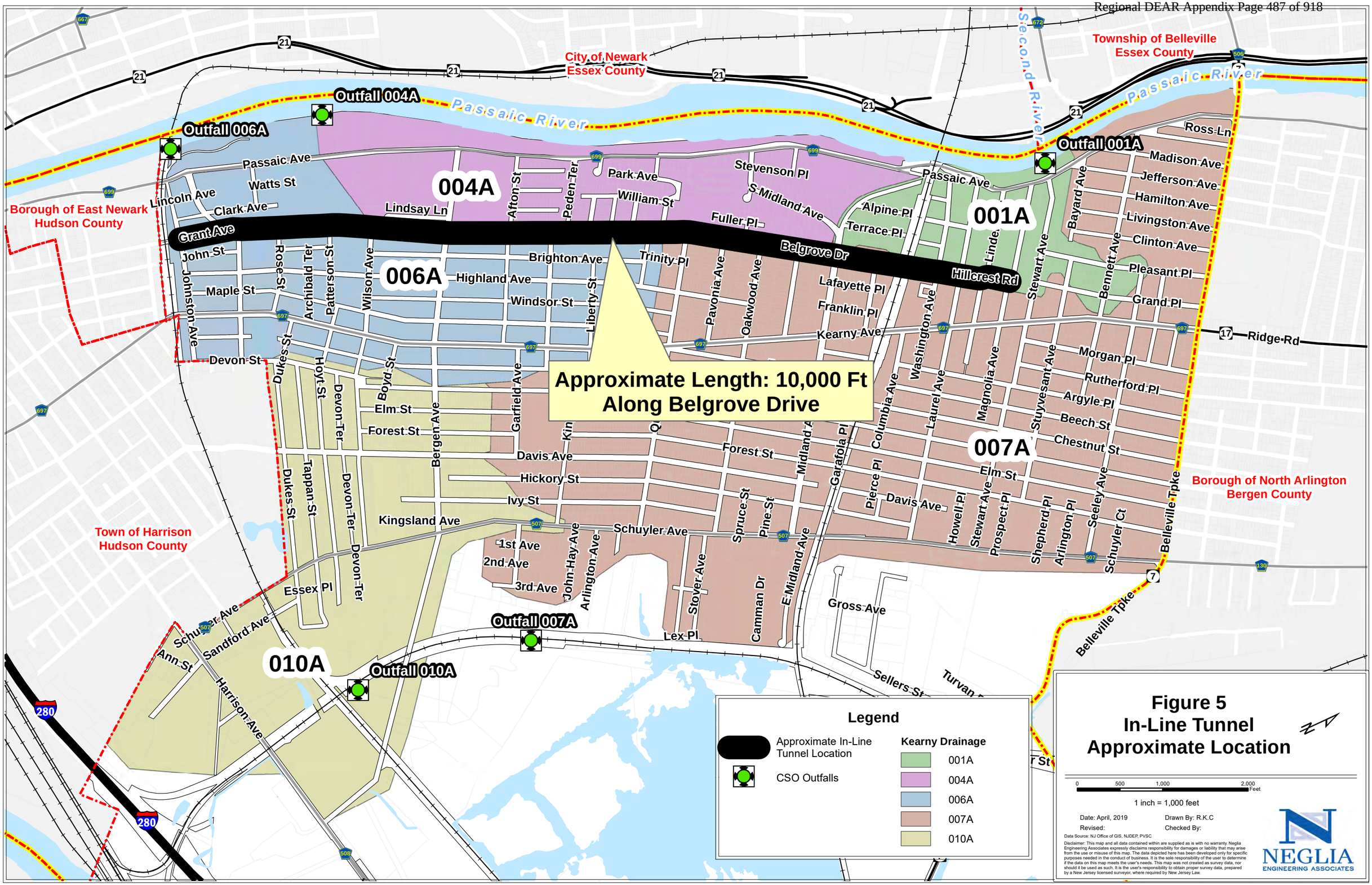

City of Newark
Essex County
Township of Belleville
Essex County
Borough of East Newark
Hudson County
Town of Harrison
Hudson County
Borough of North Arlington
Bergen County
Passaic River
Second River
Outfall 004A
Outfall 006A
Outfall 001A
Outfall 007A
Outfall 010A
004A
006A
001A
007A
010A
Approximate Length: 10,000 Ft
Along Belgrove Drive
Grant Ave
Belgrove Dr
Hillcrest Rd
Passaic Ave
Watts St
Lincoln Ave
Clark Ave
Lindsay Ln
Park Ave
William St
Stevenson Pl
S Midland Ave
Fuller Pl
Alpine Pl
Terrace Pl
John St
Maple St
Johnston Ave
Brighton Ave
Highland Ave
Windsor St
Trinity Pl
Lafayette Pl
Franklin Pl
Kearny Ave
Ridge Rd
Devon St
Elm St
Forest St
Davis Ave
Hickory St
Ivy St
Kingsland Ave
Schuyler Ave
1st Ave
2nd Ave
3rd Ave
Essex Pl
Sandford Ave
Ann St
Harrison Ave
Lex Pl
Gross Ave
Sellers St
Turvan
Belleville Tpke
Madison Ave
Jefferson Ave
Hamilton Ave
Livingston Ave
Clinton Ave
Pleasant Pl
Grand Pl
Morgan Pl
Rutherford Pl
Argyle Pl
Beech St
Chestnut St
Ross Ln
Bayard Ave
Bennett Ave
Stewart Ave
Washington Ave
Magnolia Ave
Stuyvesant Ave
Laurel Ave
Columbia Ave
Pierce Pl
Howell Pl
Prospect Pl
Shepherd Pl
Arlington Pl
Seeley Ave
Schuyler Ct
Afton St
Peden Ter
Liberty St
Pavonia Ave
Oakwood Ave
Garfield Ave
Bergen Ave
Boyd St
Dukes St
Tappan St
Devon Ter
Holy St
Patterson St
Archibald Ter
Wilson Ave
Rosse St
John Hay Ave
Arlington Ave
Spruce St
Pine St
Stover Ave
Camman Dr
E Midland Ave
Garafola Pl
Midland Ave
Kin
Q
Legend
Approximate In-Line Tunnel Location
CSO Outfalls
Kearny Drainage
001A
004A
006A
007A
010A
Figure 5
In-Line Tunnel
Approximate Location
0
500
1,000
2,000
Feet
1 inch = 1,000 feet
Date: April, 2019
Drawn By: R.K.C
Revised:
Checked By:
Data Source: NJ Office of GIS, NJDEP, PVSC
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Table C-2 – Tank Storage (sized to fully capture all CSO for all but number of storms per year indicated)				
Outfall No.	**Tank Volume for 4 CSO events/year (MG)**	**Tank Volume for 8 CSO events/year (MG)**	**Tank Volume for 12 CSO events/year (MG)**	**Tank Volume for 20 CSO events/year (MG)**
KE001	0.25	0.25	0.19	0.15
KE004	0.67	0.51	0.42	0.31
KE006	6.19	5.78	3.94	2.75
KE007	5.01	3.88	2.39	1.38
Total	**12.12**	**10.42**	**6.94**	**4.59**

C.6.3 Industrial Discharge Detention

This would involve storage at the individual industrial users' facilities. PVSC has an Industrial Pretreatment Program (IPP). Therefore this control measure would be addressed by PVSC under its IPP program.

C.7 STP EXPANSION AND SECONDARY BYPASS

PVSC owns and operates the wastewater treatment plant which treats the flow from Kearny. Any modifications to the PVSC treatment plant to mitigate CSO volume and frequency, or any increased treatment capacity, will be addressed by PVSC and its consultants. NEA awaits the results of PVSC's analysis to provide feedback on this issue.

Wet weather blending, which involves bypassing of the secondary treatment process at the PVSC treatment plant, is a measure that is subject to NJDEP approval and, as with capacity expansion discussed in the previous paragraph, is a matter to be addressed by PVSC and its consultants. NEA awaits the results of PVSC's analysis to provide feedback on this issue.

C.8 TREATMENT OF CSO DISCHARGE

C.8.1 Introduction

This section of the report provides a brief discussion of various treatment technologies which are generally considered to be viable for use at CSO outfalls to reduce the pollutant load on the receiving water. Additional details regarding each of the technologies can be found in the earlier sections in the main body of this report. Some of the technologies discussed herein are viable for further consideration and others will be eliminated. Reasons for elimination of a particular technology from further consideration include, but are not limited to: 1) they do not help to meet the water quality goals of the Long Term Control Plan (LTCP); 2) they require a large amount of land which is not available at the CSO outfall sites; 3) they require a significant degree of operator attention due to their complexity, which is not practical at remote, unmanned CSO outfall sites; or 4) they are better suited to continuous flow, as is found at a wastewater treatment plant, then to the intermittent flow experienced at a CSO outfall.

For purposes of the LTCP, the pollutants of concern are bacteria (pathogens). Treatment technologies are discussed in terms of how effective they are in reducing or eliminating these pollutants.

Treatment technologies which have been used to treat CSOs generally consist of three (3) main categories – 1) screening; 2) pretreatment; and 3) disinfection. These broad categories can be further broken down into the subcategories shown below. Certain treatment technologies were identified and discussed in the updated (2015) Technical Guidance Manual (TGM) but were eliminated from further consideration, and therefore are not evaluated in this report. The technologies which were eliminated from consideration in the TGM are as follows:

Screening:
- Band and Belt Screens; and
- Drum Screens.

Pretreatment:
- Fuzzy Filters

Disinfectants:
- Chlorine Dioxide; and
- Ozone.

The following technologies are discussed below:

Screening:
- Mechanical Bar Screens;
- Fine Screens; and
- Netting Chambers.

Pretreatment:
- Vortex swirl separators;
- Ballasted Flocculation;
- Compressible Media Filtration (FlexFilters);
- Disinfection;
- Sodium Hypochlorite;
- Peracetic Acid (PAA); and
- Ultraviolet (UV) Radiation.

C.8.2 Vortex Swirl Separators

Vortex Swirl Separators have been used in CSO pretreatment applications to remove solids and floatables, but not pathogens. The circular motion of the liquid, shown by the arrows in the figure below, produces separation of solids from the liquid stream. The solids settle to the bottom and are discharged to the interceptor system. A more detailed discussion of this technology is given in the Front End of this report. One particular system that has been used in CSO treatment is the Storm King, manufactured by Hydro International. An illustration of the Storm King unit is shown below. Other similar systems are also available.

This system has no moving parts. Suspended solids removal is reported to be in the range of 35% to 50% and BOD removal is 15% to 25%. Performance of these units generally drops off as the hydraulic loading rate increases. The range of hydraulic loading rate is 7 to 44 gallons per minute per square foot of tank area (gpm/sf).

Use of a vortex separator by itself will only remove solids and floatables but not the pollutants of concern such as pathogens. A vortex separator would only be effective if it were used as a solids removal system prior to disinfection. Also, space for the system is limited and deep excavation may be required for installation depending on the elevation of the existing incoming sewers.

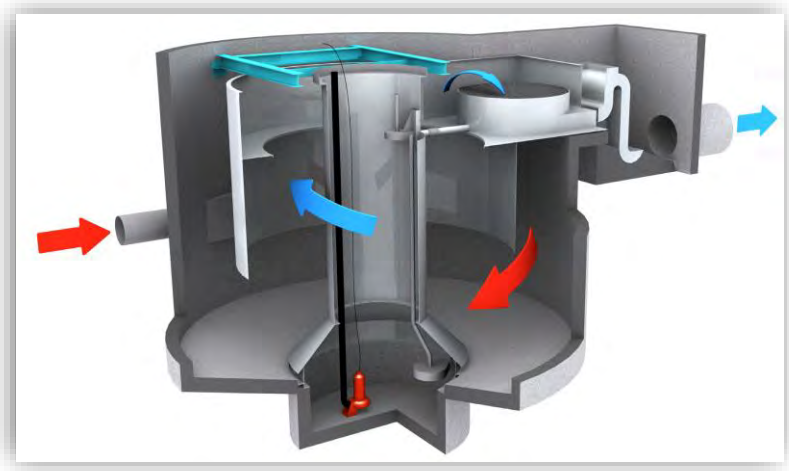

Photo No. 8 – Storm King Vortex Separator

Vortex Swirl Separators are an effective means of solids/liquid separation. However, this technology would be useful only as a pretreatment step prior to disinfection. Kearny currently has Netting Chambers at each CSO outfall site to achieve solids removal. Therefore, vortex separators are eliminated from further consideration.

C.8.3 Screening

- Mechanical Bar Screens: Mechanical Bar Screens are used at both wastewater treatment plants and at CSO pump stations and outfalls. Mechanical Bar Screens are effective for removing large, visible solids, such as rags and floatables from the waste stream, but do not remove significant amounts of BOD, TSS, bacteria, fecal coliforms, or other pollutants. Mechanical screens are generally used at the headworks of wastewater treatment plants to protect downstream plant equipment from damage or clogging. While several types of Mechanical Bar Screens are available, the Climber Screen and the Multi-Rake screen are most commonly used. A Climber Screen uses a mechanically driven rake to remove solids which are trapped on an inclined bar rack. Captured screenings are dumped into a container. In larger installations, where multiple screens are used, a conveyor belt can be used to transport the screenings removed from several bar screens to the container. The screenings container is periodically emptied into a truck which transports the screenings offsite for disposal. While mechanical screens have sometimes been installed outdoors, it is preferable to install the screen inside a building, especially in colder climates, to prevent the equipment, and the captured screenings, from freezing. When mechanical screens are installed outdoors in cold climates, electrical heat tracing with insulation is used for freeze protection.

  The screenings which are dumped into the container contain significant amounts of liquid. This liquid increases the screenings' weight and volume, which in turn adds to the disposal cost. In many installations, a separate screenings washer/compactor is used, which compresses the liquid from the screenings, and results in a dryer product which is less costly to dispose of. The liquid removed by the compactor typically drains back into the sewage channel. Like the bar screen, the compactor is heat traced and insulated when installed outdoors.

For a CSO installation, which has intermittent flow, a level probe would be used to sense flow in the overflow pipe from the regulator and this probe would signal the rake motor to energize. As flow subsides and the level drops, the rake would then be directed to deenergize.

A multi-rake screen operates in a similar manner to a Climber Screen. However, as the name implies, instead of a single rake, a series of rakes, spaced a few feet apart, continually clean the bar rack so that there is less material buildup on the bar rack.

Typical Climber Screen installations and a multi-rake installation are illustrated in the following three photographs.

Photo No. 9 – Single Climber Screen

Photo No. 10 – Multiple Climber Screen Installation

Photo No. 11 – Multi-Rake Mechanical Screen

Use of a mechanical screen at a CSO outfall has certain advantages and disadvantages as follows:

- The Mechanical Screen removes large solids but does not remove pathogens, which are the pollutant of concern, and therefore would only be effective in meeting water quality goals as a pretreatment step prior to disinfection;
- Space for a new channel for the screen and bypass channel may be limited;
- The level of screenings collected in the container must be observed, such that when it is full, a truck is called on to dispose of the screenings. This requires operator attention;
- Access for a disposal truck to pull up to the screen may be limited;
- If not installed in a building, the screenings can be a source of odors to nearby residents;
- The screen depends on power for its operation. Power may not be available at many CSO sites. It can be costly to have the utility provide a new electrical service for the installation; and
- Mechanical screens operate automatically and intermittently, both of which are favorable conditions for CSO applications.

Solids capture at each CSO outfall in Kearny is currently achieved by the existing netting chambers. If additional solids removal is needed, it will be accomplished via FlexFilter systems. This is discussed later in this section, under Disinfection. Based on the above factors, mechanical screens are eliminated from further consideration.

- Fine Screens: The fine screen which has most commonly been used in CSO applications is the ROMAG screen manufactured by WesTech. The screen includes a bar rack with smaller spacing than the mechanical screens previously discussed. Spacing between screen bars is in the range of 0.16 inches to 0.47 inches. The ROMAG screen would be installed either in an existing regulator chamber or, more likely, in a new regulator chamber, as it is doubtful the existing regulator chambers can accommodate the new screen. Unlike the Climber or Multi Rake Screen, the fine screen does not remove solids from the waste stream; rather, it separates the screenings from

the discharge and keeps solids in the waste stream, which ultimately flows to the treatment plant. The following figure illustrates a ROMAG fine screen arrangement.

Photo No. 12 – ROMAG Fine Screen

Fine screens, like mechanical screens, function intermittently to handle the varying and unpredictable nature of flows at a CSO outfall. A level controller would sense the flow when a storm event occurs and energize the rake accordingly. During dry periods, the rake can be energized via a timer.

Fine Screens have many of the same advantages and disadvantages as mechanical screens. Fine screens remove solids and floatables but not organics and pathogens. Fine screens would require major modification of the regulator chambers or construction of new regulator chambers. Fine screens would only be useful as a pretreatment step prior to disinfection. Solids capture at each CSO outfall in Kearny is currently achieved by the existing netting chambers. If additional solids removal is needed, it will be accomplished via FlexFilter systems. This is discussed later in this section, under Disinfection. Based on the above factors, fine screens are eliminated from further consideration.

C.8.4 Netting Chambers

Netting Chambers provide another means of solids removal. All of the CSO outfalls in Kearny are equipped with Netting Chambers. Netting Chambers are effective in removing solids from the waste stream up to ½- inch in size but require operator attention to periodically (approximately monthly) replace the nets. The Town of Kearny DPW maintains the nets, and will continue to do so. The Netting Chambers will remain in service, and therefore are a component of the LTCP. It is not known at this time if additional solids removal will be required as part of the LTCP. This is discussed later in this section.

The Netting Chamber at the Ivy Street Outfall (KE007) is shown below. This is the largest of the Netting Chamber installations in Kearny. Seen in the following photograph are the upper (overflow) nets at this facility.

Photo No. 13 – Netting Chamber at Ivy Street Outfall

C.8.5 Containment Booms

Containment booms can be used to control floatables. These are difficult to maintain, and require personnel and equipment to collect the floatables contained by the boom. The booms can also create unsightly conditions for nearby residents when the floatables become trapped. Containment booms are eliminated from further consideration.

C.8.6 Baffles

Baffles are another means of containing floatables. Baffles are typically installed inside a regulator chamber to trap floatables and permit flows to pass to the receiving water body. The regulator chambers in Kearny are owned by PVSC, who would have to approve any modifications to its regulators. Also, it is not known if the regulator chambers can accommodate installation of a baffle or if such installation would hinder access for maintenance. Baffles would increase head loss and thereby increase the hydraulic grade line (HGL) in the collection system. Furthermore, baffles trap floatables but do not address pathogen removal. Based on the above factors, baffles are eliminated from further consideration.

C.8.7 Disinfection

Disinfection of wastewater is the destruction of pathogens – such as fecal coliforms, E. coli, and Enterococci. Disinfection can be accomplished via chemical addition or radiation. Three methods of disinfection are discussed in this report, as follows:

- Chlorination/Dechlorination;
- Addition of Peracetic Acid (PAA); and
- Ultraviolet (UV) Radiation.

C.8.7.1 Chlorination / Dechlorination

Chlorination is the destruction of pathogens via addition of chlorine compounds. While several chlorine based compounds have been used for water and wastewater disinfection, the most

commonly used chemical is liquid sodium hypochlorite. Other chlorine based compounds have been used for disinfection, including chlorine dioxide and calcium hypochlorite. However, these were eliminated from consideration in the PVSC 2015 Technical Guidance Manual (TGM) as not being practical or feasible for CSO treatment and are therefore not discussed further.

Liquid sodium hypochlorite (NaOCl) is sometimes referred to as chlorine bleach. The typical concentration used is 12% to 15%. NaOCl has proven effective for disinfecting wastewater and is safer than chlorine gas. However, it is highly corrosive, and requires the use of non-corrosive metals or non-metallic materials such as PVC for piping and valves conveying this chemical. The chief drawback to any form of chlorination is the disinfection byproduct, or chlorine residual that results, which is toxic to aquatic life. For this reason, the NJDEP requires that chlorination of wastewater be followed by a dechlorination process, to remove the chlorine residual prior to discharging to surface waters. This is accomplished by adding a sulfur based compound to the chlorinated effluent. The most commonly used dechlorination chemical is liquid sodium bisulfite.

Both sodium hypochlorite and sodium bisulfite are stored in non-metallic tanks, most commonly fiberglass or polyethylene. A 5,000 gallon vertical storage tank, the type that would be used to store hypochlorite or bisulfite, and a chemical metering pump are shown in the following photographs.

Photo No. 14 – Chemical Storage Tank

Photo No. 15 – Chemical Metering Pump

At the CSO outfalls, a chemical feed system would consist of a hypochlorite storage tank, metering pumps, piping and controls, located inside a small building. The tank would need a containment curb around it to contain a spill. A separate storage tank and containment curb, metering pumps, piping and controls are needed for sodium bisulfite addition. A contact basin with a flash mixer is needed to provide a minimum of 3 minutes contact time for the hypochlorite to react with the incoming flow. Sodium bisulfite would be added at the effluent end of the contact tank for dechlorination.

Chlorination is effective in destroying pathogens. However, there are several drawbacks with chlorination at CSO outfalls.

- Dechlorination is required to destroy the chlorine residual prior to discharge.
- Periodic chemical deliveries are needed.

- Sodium hypochlorite has a limited shelf life, so that limited storage can be provided, and frequent chemical deliveries are required.
- Sodium hypochlorite is highly corrosive and safety precautions are needed in the handling of the chemical. Careful selection of pipe materials is necessary, due to the corrosive nature of hypochlorite.

Disinfection with Sodium Hypochlorite will destroy pathogens, which are the primary pollutant of concern. However, chlorination produces a chlorine residual, which is a toxic disinfection byproduct that must be removed. Therefore chlorination must be followed by dechlorination, typically using sodium bisulfite. Thus, additional tankage, pumps, piping and controls are needed for the two separate chemical systems. Sodium hypochlorite has a limited shelf life, only 30 to 60 days, and considering the intermittent nature of CSOs, where long dry periods are possible, this makes hypochlorite impractical, as frequent replenishment of the chemical would be needed. For the above reasons, disinfection with sodium hypochlorite is eliminated from further consideration.

C.8.7.2 Disinfection with Peracetic Acid (PAA)

As discussed earlier, disinfection with sodium hypochlorite leaves a toxic byproduct which must be eliminated via dechlorination.

In recent years, another chemical, peracetic acid (PAA) has been found to be an effective wastewater disinfectant which leaves no toxic residual, yet effectively kills pathogens in wastewater. Peracetic acid is a mixture of hydrogen peroxide, acetic acid and water. It is a clear, colorless liquid with a pH of 2. Solutions of 12%, 15% and 22% are commercially available. PAA has been used as a wastewater disinfectant in Europe and is starting to gain popularity in the U.S. wastewater industry. Various pilot studies and full scale trials have been conducted with PAA with favorable results. These are discussed below.

- Pilot Study at Bayonne MUA: A demonstration project took place at the Bayonne MUA's Oak Street Pump Station, between 2014 and 2016 to demonstrate the effectiveness of various types of solids removal technologies, and disinfection technologies, to treat combined wastewater from CSOs. Included in this project was testing of PAA to evaluate its effectiveness as a wastewater disinfectant. A pilot scale disinfection system was set up on site. For most of the test runs, flows ranged from 50 to 100 gpm. Applied dosage was generally in the range of 1 to 3 ppm. Contact time was in the range of 3 to 6 minutes. The pilot setup is shown on the photograph provided on the following page.

Photo No. 16 – Bayonne MUA Pilot Testing of Peracetic Acid

The study found that PAA proved to be effective in destroying pathogens. A relationship was seen between PAA dosage and influent Chemical Oxygen Demand (COD). When PAA was applied at a dosage of 0.01 mg/L per mg/L of influent COD, a 3 log reduction (99.9%) in fecal coliforms was achieved, with slightly higher effectiveness for E. coli and slightly lower for Enterococci. Influent COD was generally in the range of 250 to 420 mg/L. Increasing the dosage to 0.015 mg/L PAA per mg/L COD achieved a 4 log reduction. Further increase of PAA dosage had limited effect on pathogen reduction. It was concluded that, for satellite facilities, PAA had many desirable characteristics, as follows:

- effective in destroying pathogens;
- six to twelve months shelf life;
- effective with contact times as low as three to six minutes;
- no toxic byproducts; and
- no need for additional processes, such as dechlorination.

- Frankfort, Kentucky WWTP: The Frankfort, Kentucky wastewater treatment plant, having a capacity of 9.9 mgd, selected PAA as a temporary disinfectant while the plant's ozone disinfection system was being upgraded. It was found that:

  - A 12% solution of PAA was effective at controlling fecal coliforms and E. coli at a dose of 0.7 ppm;
  - Effluent treated with PAA passed acute toxicity tests for Ceriodaphnia dubia;
  - Residual PAA in the effluent was less than 1 ppm; and
  - Treatment costs with PAA were competitive with disinfection with sodium hypochlorite and sodium bisulfite.

  The Frankfort, Kentucky plant continues to use PAA as a full scale backup to its ozone disinfection system.

- Steubenville, Ohio WWTP: A one-month trial took place at the Steubenville, Ohio wastewater treatment plant. During that period, plant flow was in the range of 5 to 8 mgd. PAA dosage was 1.5 ppm or less. Residual averaged 0.4 ppm, and never exceeded 1 ppm. Pathogen control was within the plant's permit limits for the length of the trial.

From the case studies discussed above, it is concluded that PAA is a viable disinfection chemical and will be considered further in the Development and Evaluation of Alternatives.

PAA Addition was analyzed for all the Kearny Outfalls, based on a peak flow required for dosing to fully treat all but the number of storms per year indicated. Table C-3 below shows the peak design flow for each of the target frequencies, at each outfall. These flows would be used for sizing the chemical feed pumps required for dosing at the peak flow. Table C-4 below indicates the theoretical maximum chemical usage on an annual basis, at each outfall, assuming complete disinfection for all CSO events. This information would be used for computing storage volumes needed. Computation of pump sizes and storage volumes is beyond the scope of this report, but would be addressed in the 2020 LTCP.

Table C-3 – PAA Treatment (sized based on peak-flow required for dosing to fully treat all but number of storms per year indicated)				
Outfall No.	**Peak Flow for 4 CSO events/year (MGD)**	**Peak Flow for 8 CSO events/year (MGD)**	**Peak Flow for 12 CSO events/year (MGD)**	**Peak Flow for 20 CSO events/year (MGD)**
KE001	12.6	7.5	7.5	3.7
KE004	3.9	3.8	3.7	3.5
KE006	138.3	100.9	64.2	53.9
KE007	75.7	42.2	42.2	29.3

Table C-4 – Maximum Annual Quantity of Chemical Usage				
Outfall No.	**Baseline Total Annual CSO Volume (MG)**	**Annual Amount of PAA needed with dose of 2 mg/L (gal PAA)**	**Annual Amount of PAA needed with dose of 7 mg/L (gal PAA)**	**Annual Amount of PAA needed with dose of 10 mg/L (gal PAA)**
KE001	3.9	46	159	227
KE004	12.4	146	509	727
KE006	121.8	1,430	5,004	7,149
KE007	90.0	1,057	3,697	5,281
Total	**228.1**	**2,679**	**9,369**	**13,384**

Disinfection with Peracetic Acid will destroy pathogens, which are the primary pollutant of concern. In order to achieve the desired frequency targets, disinfection facilities are sized based upon the maximum CSO discharge rate for each event to *fully treat* all but 20, 12, 8, and 4 CSO discharges per year. During CSO events that are not fully treated, disinfection continues but full treatment is achieved only during times that CSO discharges are less than the design-maximum discharge rate. Where full treatment is achieved, disinfection is assumed to remove 99.9% of pathogens, or a 3-log kill. This analysis assumes that PAA disinfection will be implemented at locations between the existing regulators and the existing outfalls.

PAA has a much longer shelf life than hypochlorite, up to one year, which makes it better suited for storage at a CSO site, which is unmanned and remote, than hypochlorite. Further, PAA does not leave a toxic byproduct, and so no additional chemical treatment is required. Although PAA has not been used widely in the U.S., there have been several pilot studies and full scale trials, which have demonstrated that PAA effectively destroys pathogens in wastewater including E. coli, fecal coliforms and Enterococci. PAA has been used in Europe for wastewater disinfection.

From the above, disinfection with PAA is retained for further consideration in the LTCP. PAA treatment costs shown herein include the cost of pretreatment (solids removal) using the FlexFilter system. However, if pretreatment is not necessary, cost savings of approximately 30% to 50%, on both a capital and present value basis would be realized. In addition, the required facility footprint would be

smaller. For these reasons, if PAA disinfection is selected, Kearny will conduct treatability tests to determine if pretreatment is required.

A typical schematic diagram, which illustrates the configuration of a PAA storage and feed system at the CSO outfalls, is shown in Figure 6.

C.8.7.3 UV Radiation

Ultraviolet radiation is an alternative to chlorination that is used at thousands of wastewater treatment plants across the country. UV light bulbs, mounted on stainless steel racks, and housed in quartz sleeves, send UV radiation at a particular wavelength of 254 nm through the wastewater which destroys the reproductive capabilities (DNA) of the bacteria, thus killing the population of pathogens. UV radiation eliminates the need for chemical deliveries, and the dangers of chemical handling, and also eliminates the need for storage tanks and pumps.

UV lamps are installed in an open channel, in which wastewater flows past the lamps, making contact with the radiation. The lamp racks are installed adjacent to each other, in the direction of flow, across the width of the channel, so none of the flow escapes the lamps. A rack may contain 4, 6, or 8 lamps. A typical horizontal lamp rack containing 4 lamps is shown in the following photograph.

Photo No. 17 – Horizontal UV Lamp Rack Assembly

The group of lamp racks spanning the width of the channel is known as a bank. A UV channel may have one bank of lamps, or two or more banks in series. If more than one bank of lamps is installed in a channel, one bank would be energized all of the time, while a second bank might be activated when the flow increases. At wastewater treatment plants, it is common to have two parallel channels, for redundancy and reliability. However, some installations consist of only a single channel. The channel may be concrete, or for smaller installations, prefabricated stainless steel channels can be supplied by the manufacturer. At wastewater plants that previously used chlorine for disinfection, the chlorine contact tanks can be converted to UV channels.

UV lamp assemblies can also be supplied with vertical lamps, as shown in the photograph provided on the following page.

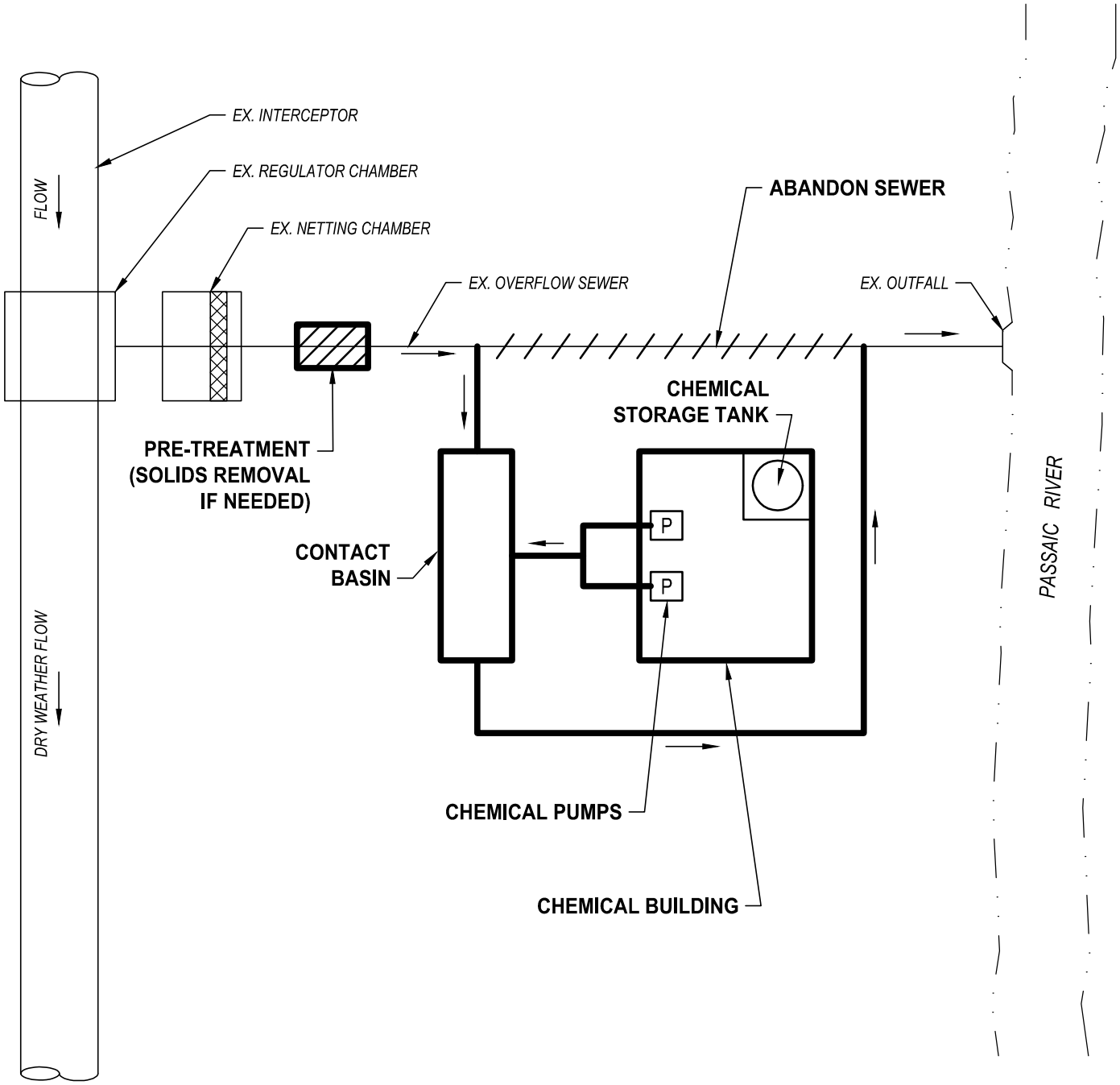

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FIGURE 6 SCHEMATIC: TYP. PAA ADDITION

KEARNY CSO LTCP

TOWN OF KEARNY

HUDSON COUNTY NEW JERSEY

DRAWN BY: M.E.W.	CHECKED BY:	PROJECT NO.: KEARMUN18.013	SHEET NO.: FIG-6
DESIGNED BY: J.R.	SCALE: N.T.S.		
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Photo No. 16 – Verrtical UV Lamp Assemblies

UV controls and alarms include loss of power, individual bulb failure, and loss of lamp intensity. In some systems, the lamp intensity can vary with the incoming flowrate. The lamp rack assemblies can be removed from the wastewater channel for maintenance such as cleaning or replacing a lamp. UV lamps are designed to last approximately one year before needing replacement. Lamps can be cleaned by lifting them out of the channel and submerging them in a chemical cleaning tank. Systems are also available with self-cleaning lamps, in which a mechanical wiper moves across the lamp at preset, timed intervals.

There are several drawbacks to using UV for disinfection at CSO outfalls:

- Due to the variable nature and unpredictability of CSO volumes, it is difficult to properly size a UV system for a CSO application;
- UV systems require more power than chemical feed systems. Availability of power at remote CSO outfall sites is a potential problem. With loss of power, there will be no disinfection;
- UV lamps are designed to be energized and submerged at all times, to avoid building up excessive heat. Thus in dry periods, wastewater must remain in the UV channel to keep the lamps submerged. This could result in septic conditions, and odors; and
- In the 2007 Cost and Performance Report, UV was found to be the least cost effective means of disinfection, of all the methods investigated.

UV disinfection is a proven, effective means of destroying pathogens in wastewater. However, UV disinfection is better suited to use at a wastewater treatment plant where there is continuous flow, and operator attention. During dry periods, the wastewater must remain in the channels to protect the UV bulbs. This could be a source of objectionable odors to the surrounding community. A potential reduction in effectiveness of the UV bulbs can result, after prolonged periods of non -usage. In past studies, UV was found not to be a cost effective means of pathogen removal for CSO treatment. From the above, UV disinfection is eliminated from further consideration.

C.8.8 Ballasted Flocculation

Ballasted flocculation, also referred to as High Rate Clarification, combines chemical coagulation, high rate mixing, flocculation and settling, in a series of tanks, to remove suspended solid particles from

the waste stream. The solids collected at the bottom of the clarifier, are pumped back to the flocculation zone, as ballast, to enhance settling. Polymer is also added to enhance settling. The system can take on a higher hydraulic loading rate, and has a smaller footprint, than a conventional clarifier. The overall system is designed to bring smaller solid particles together to form larger, heavier solids, which settle to the bottom of the clarifier more readily, thereby achieving solids/liquid separation.

The following Figure illustrates the DensaDeg Process, manufactured by Infilco Degremont (now owned by Suez). The Figure shows the different zones which comprise the process, i.e. the rapid mix/coagulation zone, the flocculation zone, etc.

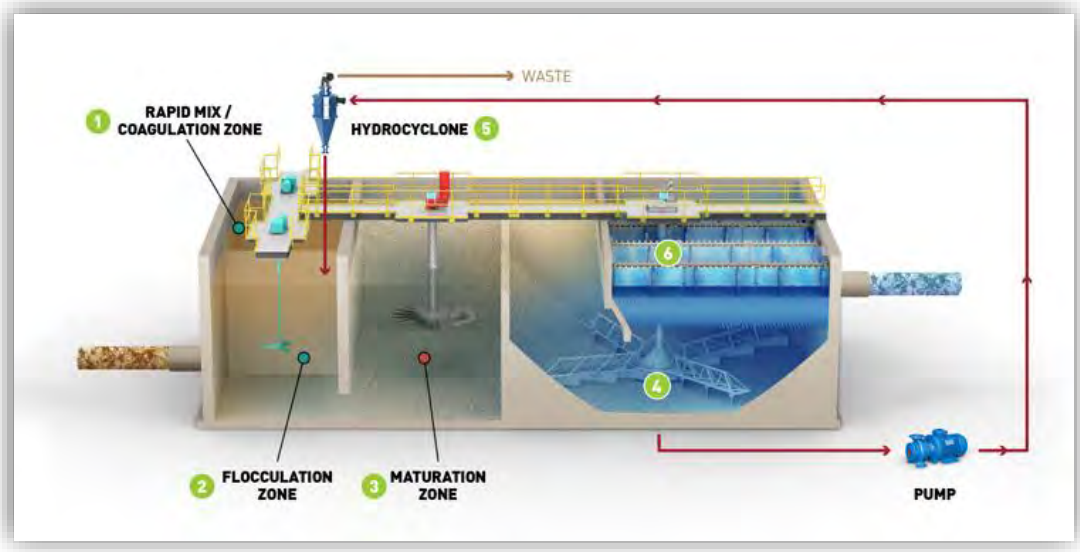

Photo No. 17 – Densa-Deg Ballasted Flocculation System Process

Another system which is commercially available is the ACTIFLO system manufactured by Veolia Water Technologies. The ACTIFLO system uses sand, rather than recycled sludge, as the ballast material to enhance settling.

Refer to the Front End of this report for a more detailed discussion of the Ballasted Flocculation process.

Ballasted Flocculation, or High Rate Clarification, combines chemical mixing, coagulation, flocculation and high rate settling with either sand or recirculated sludge used for ballast to enhance settling, plus polymer addition. This process is complex, requires a high degree of operator attention and therefore is better suited for use at a wastewater treatment plant where there is continuous flow, and onsite operators. Ballasted flocculation does not remove pathogens. It also requires significant space for the required tankage. Based on the above, ballasted flocculation is eliminated from further consideration.

C.8.9 Compressible Media Filters

Compressible Media Filters are another means of removing suspended solids and particulates from the incoming wastewater. Unlike conventional filters which use sand and gravel, or plastic media, the filter media is a synthetic, soft, compressible material.

There are two compressible media filters commercially available. These are the Fuzzy Filter manufactured by Schreiber, Inc. and the FlexFilter manufactured by WesTech. The fuzzy filter was

eliminated from consideration in the Technical Guidance Manual and is therefore not discussed further. The FlexFilter is effective in removing solids, but not pathogens. Thus the FlexFilter would be useful only as a pretreatment step prior to disinfection.

Compressible Media Filters are a means of removing settleable solids, but they do not remove pathogens. Due to the existence of the Netting Chambers at the outfall sites, filtration is not needed, and compressible media filters are eliminated from further consideration.

C. 9 SCREENING OF CONTROL TECHNOLOGIES

In the above sections, the various control technologies are discussed, and either retained for further consideration or eliminated. Reasons given for eliminating a control technology from consideration include: 1) they do not help to meet the water quality goals of the LTCP; 2) they do not significantly impact the computed CSO volumes and frequencies; 3)they require a large amount of land which is not available at the CSO outfall sites; 4) they require a significant degree of operator attention, due to their complexity, which is not practical at remote, unmanned CSO outfall sites; and 5) they are better suited to continuous flow, such as is found at a wastewater treatment plant, then to the intermittent flow experienced at a CSO outfall.

The screening of alternatives is summarized in the matrix table which follows. The format of this report is in line with the matrix, to the extent practicable. However, certain items in the matrix are not applicable to Kearny. This report focuses primarily on the matrix items that are feasible and/or under consideration for the LTCP.

In summary, the control technologies which remain under consideration are as follows:

- Sewer Separation;
- Inline Storage (Tunnel);
- Offline Storage (Tanks);
- Netting Chambers;
- Disinfection With PAA; and
- Green Infrastructure.

The above technologies will be discussed further in Section D, Development and Evaluation of Alternatives.

Source Control Technologies								
Technology Group	Practice	Primary Goals		Community Benefit	Implementation & Operation Factors	Consider Combining w/ Other Technologies	Being Implemented	Recommendation for Alternatives Evaluation
		Bacteria Reduction	Volume Reduction					
Stormwater Management	Street/Parking Lot Storage (Catch Basin Control)	Low	Low	- Reduced surface flooding potential	Flow restrictions to the CSS can cause flooding in lots, yards and buildings; potential for freezing in lots; low operational cost. Effective at reducing peak flows during wet weather events but can cause dangerous conditions for the public if pedestrian areas freeze during flooding.	No	No	No
	Catch Basin Modification (for Floatables Control)	Low	None	- Water quality improvements - Reduced surface flooding potential	Requires periodic catch basin cleaning; requires suitable catch basin configuration; potential for street flooding and increased maintenance efforts. Reduces debris and floatables that can cause operational problems with the mechanical regulators.	No	Yes	Yes
	Catch Basin Modification (Leaching)	Low	Low	- Reduced surface flooding potential - Water quality improvements	Can be installed in new developments or used as replacements for existing catch basins. Require similar maintenance as traditional catch basins. Leaching catch basins have minor effects on the primary CSO control goals.	No	No	Yes
Public Education and Outreach	Water Conservation	None	Low	- Reduced surface flooding potential - Align with goals for a sustainable community	Water purveyor is responsible for the water system and all related programs in the respective City. However, water conservation is a common topic for public education programs. Water conservation can reduce CSO discharge volume, but would have little impact on peak flows.	Yes	No	No
	Catch Basin Stenciling	None	None	- Align with goals for a sustainable community	Inexpensive; easy to implement; public education. Is only as effective as the public's acceptance and understanding of the message. Public outreach programs would have a more effective result.	Yes	No	Yes
	Community Cleanup Programs	None	None	- Water quality improvements - Align with goals for a sustainable community	Inexpensive; sense of community ownership; educational BMP; aesthetic enhancement. Community cleanups are inexpensive and build ownership in the city.	Yes	Yes	Yes
	Public Outreach Programs	Low	None	- Align with goals for a sustainable community	Public education program is ongoing. Permittee should continue its public education program as control measures demonstrate implementation of the NMC.	Yes	Yes	Yes
	FOG Program	Low	None	- Water quality improvements - Improves collection system efficiency	Requires communication with business owners; Permittee may not have enforcement authority. Reduces buildup and maintains flow capacity. Only as effective as business owner cooperation.	Yes	Yes	Yes
	Garbage Disposal Restriction	Low	None	- Water quality improvements	Permittee may not be responsible for Garbage Disposal. This requires an increased allocation of resources for enforcement while providing very little reduction to wet weather CSO events.	Yes	Yes	Yes
	Pet Waste Management	Medium	None	- Water quality improvements	Low cost of implementation and little to no maintenance. This is a low cost technology that can significantly reduce bacteria loading in wet weather CSO's.	Yes	Yes	Yes
	Lawn and Garden Maintenance	Low	Low	- Water quality improvements	Requires communication with business and homeowners. Guidelines are already established per USEPA. Educating the public on proper lawn and garden treatment protocols developed by USEPA will reduce waterway contamination. Since this information is already available to the public it is unlikely to have a significant effect on improving water quality.	Yes	Yes	Yes
	Hazardous Waste Collection	Low	None	- Water quality improvements	The N.J.A.C. prohibits the discharge of hazardous waste to the collection system.	Yes	Yes	Yes
Ordinance Enforcement	Construction Site Erosion & Sediment Control	None	None	- Cost-effective water quality improvements	In building code; reduces sediment and silt loads to waterways; reduces clogging of catch basins; little O&M required; contractor or owner pays for erosion control. A Soil Erosion & Sediment Control Plan Application or 14-day notification (if Permittee covered under permit-by-rule) will be required by NJDEP per the N.J.A.C.	Yes	Yes	Yes
	Illegal Dumping Control	Low	None	- Water quality improvements - Aesthetic benefits	Enforcement of current law requires large number of code enforcement personnel; recycling sites maintained. Local ordinances already in place can be used as needed to address illegal dumping complaints.	Yes	Yes	Yes
	Pet Waste Control	Medium	None	- Water quality improvements - Reduced surface flooding	Requires resources to enforce pet waste ordinances. Public education and outreach is a more efficient use of resources, but this may also provide an alternative to reducing bacterial loads.	Yes	Yes	Yes
	Litter Control	None	None	- Property value uplift - Water quality improvements - Reduced surface flooding	Aesthetic enhancement; labor intensive; City function. Litter control provides an aesthetic and water quality enhancement. It will require city resources to enforce. Public education and outreach is a more efficient use of resources.	Yes	Yes	Yes
	Illicit Connection Control	Low	Low	- Water quality improvements - Align with goals for a sustainable community	Site specific; more applicable to separate sanitary system; new storm sewers may be required; interaction with homeowners required. The primary goal of the LTCP is to meet the NJPDES Permit requirements relative to POCs. Illicit connection control is not particularly effective at any of these goals and is not recommended for further evaluation unless separate sewers are in place.	Yes	Yes	No
Good Housekeeping	Street Sweeping/Flushing	Low	None	- Reduced surface flooding potential	Labor intensive; specialized equipment; doesn't address flow or bacteria; City function. Street sweeping and flushing primarily addresses floatables entering the CSS while offering an aesthetic improvement.	Yes	Yes	Yes
	Leaf Collection	Low	None	- Reduced surface flooding potential - Aesthetic benefits	Requires additional seasonal labor. Leaf collection maximizes flow capacity and removes nutrients from the collection system.	Yes	Yes	Yes
	Recycling Programs	None	None	- Align with goals for a sustainable community	Most Cities have an ongoing recycling program.	Yes	Yes	Yes
	Storage/Loading/Unloading Areas	None	None	- Water quality improvements	Requires industrial & commercial facilities designate and use specific areas for loading/unloading operations. There may be few major commercial or industrial users upstream of CSO regulators.	Yes	Yes	Yes
	Industrial Spill Control	Low	None	- Protect surface waters - Protect public health	PVSC has established a pretreatment program for industrial users subject to the Federal Categorical Pretreatment Standards 40 CFR 403.1.	Yes	Yes	Yes

Technology Group	Practice	Primary Goals		Community Benefit	Implementation & Operation Factors	Consider Combining w/ Other Technologies	Being Implemented	Recommendation for Alternatives Evaluation
		Bacteria Reduction	Volume Reduction					
Green Infrastructure Buildings	Green Roofs	None	Medium	- Improved air quality - Reduced carbon emissions - Reduced heat island effect - Property value uplift - Local jobs - Reduced surface flooding - Reduced basement sewage flooding - Align with goals for a sustainable community	Adds modest cost to new construction; not applicable to all retrofits; low operational resource demand; will require the Permittee or private owners to implement; requires regular cleaning of gutters & pipes; upkeep of roof vegetation. Portions of Cities have densely populated areas, but this technology is limited to rooftops. Can be difficult to require on private properties.	Yes	No	No
	Blue Roofs	None	Medium	- Reduced heat island effect - Property value uplift - Local jobs - Reduced surface flooding - Reduced basement sewage flooding - Align with goals for a sustainable community	Adds modest cost to new construction; not applicable to all retrofits; low operational resource demand; will require the Permittees or private owners to implement; requires regular cleaning of gutters & pipes; upkeep of roof debris. Portions of the Cities have densely populated areas, but this technology is limited to rooftops. Can be difficult to require on private properties.	Yes	No	No
	Rainwater Harvesting	None	Medium	- Reduced surface flooding - Reduced basement sewage flooding - Align with goals for a sustainable community - Water Saving	Simple to install and operate; low operational resource demand; will require the Permittees or private owners to implement; requires regular cleaning of gutters & pipes. Portions of the Cities have densely populated areas, but this technology is limited to capturing rooftop drainage. Capture is limited to available storage, which can vary on rainwater use. Can be difficult to require on private properties.	Yes	No	Yes
Green Infrastructure Impervious Areas	Permeable Pavements	Low	Medium	- Improved air quality - Reduced carbon emissions - Reduced heat island effect - Property value uplift - Cost-effective water quality improvements - Reduced surface flooding - Reduced basement sewage flooding - Align with goals for a sustainable community	Not durable and clogs in winter; oil and grease will clog; significant O&M requirements with vacuuming and replacing deteriorated surfaces; can be very effective in parking lots, lanes and sidewalks. Maintenance requirements could be reduced if located in low-traffic areas, and can utilize underground infiltration beds or detention tanks to increase storage.	Yes	No	Yes
	Planter Boxes	Low	Medium	- Improved air quality - Reduced carbon emissions - Reduced heat island effect - Property value uplift - Reduced surface flooding - Reduced basement sewage flooding - Align with goals for a sustainable community	Site specific; good BMP; minimal vegetation & mulch O&M requirements with regular overflow and underdrain cleaning; effective at containing, infiltration and evapotranspiration of runoff in developed areas. Flexible and can be implemented even on a small-scale to any high-priority drainage areas. Underground infiltration beds or detention tanks can be utilized to increase storage.	Yes	No	Yes

Technology Group	Practice	Primary Goals		Community Benefit	Implementation & Operation Factors	Consider Combining w/ Other Technologies	Being Implemented	Recommendation for Alternatives Evaluation
		Bacteria Reduction	Volume Reduction					
Green Infrastructure Pervious Areas	Bioswales	Low	Low	- Improved air quality - Reduced carbon emissions - Reduced heat island effect - Property value uplift - Local jobs - Passive and active recreational improvements - Reduced surface flooding - Reduced basement sewage flooding - Community aesthetic improvements - Reduced crime - Align with goals for a sustainable community - Increased pedestrian safety through curb retrofits	Site specific; good BMP; minimal vegetation & mulch O&M requirements ; not as flexible or infiltrate as much stormwater as planter boxes. Technology requires open space and is primarily a surface conveyance technology with additional storage & infiltration benefits. Can be modified with check dams to slow water flow. Limited open space in most Cities means land can be utilized in more effective ways with the existing infrastructure.	Yes	No	Yes
	Free-Form Rain Gardens	Low	Medium	- Improved air quality - Reduced carbon emissions - Reduced heat island effect - Property value uplift - Passive and active recreational improvements - Reduced surface flooding - Reduced basement sewage flooding - Community aesthetic improvements - Reduced crime - Align with goals for a sustainable community	Site specific; good BMP; minimal vegetation & mulch O&M requirements with regular overflow and underdrain cleaning; effective at containing, infiltration and evapotranspiration of diverted runoff. Rain Gardens are flexible and can be modified to fit into the previous areas. Underground infiltration beds or detention tanks can be utilized to increase storage.	Yes	No	Yes

Collection System Technologies								
Technology Group	Practice	Primary Goals		Community Benefit	Implementation & Operation Factors	Consider Combining w/ Other Technologies	Being Implemented	Recommendation for Alternatives Evaluation
		Bacteria Reduction	Volume Reduction					
Operation and Maintenance	I/I Reduction	Low	Medium	- Water quality improvements - Reduced basement sewage flooding	Requires labor intensive work; changes to the conveyance system require temporary pumping measures; repairs on private property required by homeowners. Reduces the volume of flow and frequency; Provides additional capacity for future growth; House laterals account for 1/2 the sewer system length and significant sources of I/I in the sanitary sewer.	Yes	No	No
	Advanced System Inspection & Maintenance	Low	Low	- Water quality improvements - Reduced basement sewage flooding	Requires additional resources towards regular inspection and maintenance work. Inspection and maintenance programs can provide detailed information about the condition and future performance of infrastructure. Offers relatively small advances towards goals of the LTCP.	Yes	Yes	Yes
	Combined Sewer Flushing	Low	Low	- Water quality improvements - Reduced basement sewage flooding	Requires inspection after every flush; no changes to the existing conveyance system needed; requires flushing water source. Ongoing: CSO Operational Plan; maximizes existing collection system; reduces first flush effect.	Yes	No	No
	Catch Basin Cleaning	Low	None	- Water quality improvements - Reduced surface flooding	Labor intensive; requires specialized equipment. Catch Basin Cleaning reduces litter and floatables but will have no effect on flow and little effect on bacteria and BOD levels.	Yes	No	Yes
Combined Sewer Separation	Roof Leader Disconnection	Low	Low	- Reduced basement sewage flooding	Site specific; Includes area drains and roof leaders; new storm sewers may be required; requires home and business owner participation. The Cities are densely populated and disconnected roof leaders have limited options for discharge to pervious space. Disconnection may be coupled with other GI technologies but is not considered an effective standalone option.	Yes	Yes	No
	Sump Pump Disconnection	Low	Low	- Reduced basement sewage flooding	Site specific; more applicable to separate sanitary system; new storm sewers may be required; interaction with homeowners required. The Cities are densely populated and disconnected sump pumps have limited options for discharge to pervious space. Disconnection may be coupled with other GI technologies but is not considered an effective standalone option.	Yes	No	No
	Combined Sewer Separation	High	High	- Water quality improvements - Reduced basement sewage flooding - Reduced surface flooding	Very disruptive to affected areas; requires homeowner participation; sewer asset renewal achieved at the same time; labor intensive.	No	No	Yes
Combined Sewer Optimization	Additional Conveyance	High	High	- Water quality improvements - Reduced basement sewage flooding	Additional conveyance can be costly and would require additional maintenance to keep new structures and pipelines operating.	No	No	No
	Regulator Modifications	Medium	Medium	- Water quality improvements	Relatively easy to implement with existing regulators; mechanical controls requires O&M. May increase risk of upstream flooding. Permitees have an ongoing O&M program and system wide replacement program for CSO regulators and tide gates.	Yes	No	No
	Outfall Consolidation/Relocation	High	High	- Water quality improvements - Passive and active recreational improvements	Lower operational requirements; may reduce permitting/monitoring; can be used in conjunction with storage & treatment technologies. Combining and relocating outfalls may lower operating costs and CSO flows. It can also direct flow away from specific areas.	Yes	No	Yes
	Real Time Control	High	High	- Water quality improvements - Reduced basement sewage flooding	Requires periodic inspection of flow elements; highly automated system; increased potential for sewer backups. RTC is only effective if additional storage capacity is present in the system.	Yes	No	No

Storage and Treatment Technologies								
Technology Group	Practice	Primary Goals		Community Benefit	Implementation & Operation Factors	Consider Combining w/ Other Technologies	Being Implemented	Recommendation for Alternatives Evaluation
		Bacteria Reduction	Volume Reduction					
Linear Storage	Pipeline	High	High	- Water quality improvements - Reduced surface flooding potential - Local jobs	Can only be implemented if in-line storage potential exists in the system; increased potential for basement flooding if not properly designed; maximizes use of existing facilities.Pipe storage for a CSS typically requires large diameter pipes to have a significant effect on reducing CSOs. This typically requires large open trenches and temporary closure of streets to install.	No	No	Yes
	Tunnel	High	High	- Water quality improvements - Reduced surface flooding potential	Requires small area at ground level relative to storage basins; disruptive at shaft locations; increased O&M burden.	No	No	Yes
Point Storage	Tank (Above or Below Ground)	High	High	- Water quality improvements - Reduced basement sewage flooding	Storage tanks typically require pumps to return wet weather flow to the system which will require additional O&M; disruptive to affected areas during construction. Several CSO outfalls have space available for tank storage. There may be existing tanks in abandoned commercial and industrial areas to be converted to hold stormwater. Tanks are an effective technology to reduce wet weather CSO's.	No	No	Yes
	Industrial Discharge Detention	Low	Low	- Water quality improvements	Requires cooperation with industrial users; more resources devoted to enforcement; depends on IUs to maintain storage basins. IUs hold stormwater or combined sewage until wet weather flows subside; there may be commercial or industrial users upstream of CSO regulators.	Yes	No	No
Treatment-CSO Facility	Vortex Separators	None	None	- Water quality improvements	Space required; challenging controls for intermittent and highly variable wet weather flows. Vortex separators would remove floatables and suspended solids when installed. It does not address volume, bacteria or BOD.	Yes	No	No
	Screens and Trash Racks	None	None	- Water quality improvements	Prone to clogging; requires manual maintenance; requires suitable physical configuration; increased O&M burden. Screens and trash racks will only address floatables.	Yes	No	No
	Netting	None	None	- Water quality improvements	Easy to implement; labor intensive; potential negative aesthetic impact; requires additional resources for inspection and maintenance. Netting will only address floatables.	Yes	Yes	Yes
	Contaminant Booms	None	None	- Water quality improvements	Difficult to maintain requiring additional resources. Contaminant booms will only address floatables.	Yes	No	No
	Baffles	None	None	- Water quality improvements	Very low maintenance; easy to install; requires proper hydraulic configuration; long lifespan. Baffles will only address floatables.	Yes	No	No
	Disinfection & Satellite Treatment	High	High	- Water quality improvements - Reduced basement sewage flooding	Requires additional flow stabilizing measures; requires additional resources for maintenance; requires additional system analysis. Disinfection is an effective control to reduce bacteria and BOD in CSO's.	Yes	No	Yes
	High Rate Physical/Chemical Treatment (High Rate Clarification Process - ActiFlo)	None	None	- Water quality improvements	Challenging controls for intermittent and highly variable wet weather flows; smaller footprint than conventional methods. This technology primarily focuses on TSS & BOD removal, but does not help reduce the bacteria or CSO discharge volume.	Yes	No	No
	High Rate Physical (Fuzzy Filters)	None	None	- Water quality improvements	Relatively low O&M requirements; smaller footprint than traditional filtration methods. This technology primarily focuses on TSS removal, but does not help reduce the bacteria or CSO discharge volume.	Yes	No	No
Treatment-WRTP	Additional Treatment Capacity	High	High	- Water quality improvements - Reduced surface flooding - Reduced basement sewage flooding	May require additional space; increased O&M burden.	No	No	This alternative is being further evaluated by PVSC as part of the Development and Evaluation of Alternatives Report preparation
	Wet Weather Blending	Low	High	- Water quality improvements - Reduced surface flooding - Reduced basement sewage flooding	Requires upgrading the capacity of influent pumping, primary treatment and disinfection processes; increased O&M burden. Wet weather blending does not address bacteria reduction, as it is a secondary treatment bypass for the POTW. Permittee must demonstrate there are no feasible alternatives to the diversion for this to be implemented.	Yes	No	This alternative is being further evaluated by PVSC as part of the Development and Evaluation of Alternatives Report preparation
Treatment-Industrial	Industrial Pretreatment Program	Low	Low	- Water quality improvements - Align with goals for a sustainable community	Requires cooperation with Industrial User's; more resources devoted to enforcement; depends on IU's to maintain treatment standards. May require Permits.	Yes	No	No

SECTION D ALTERNATIVES ANALYSIS

D.1 DEVELOPMENT AND EVALUATION OF ALTERNATIVES

This section of the report presents the development and evaluation of alternatives, which are based on the screening of technologies presented earlier, in Section C.

To reiterate from Section C.9, the control technologies which remain under consideration are as follows:

- Sewer Separation;
- Inline Storage (Tunnel);
- Offline Storage (Tanks);
- Netting Chambers;
- Disinfection With PAA; and
- Green Infrastructure.

D1.1 CSO Outfalls and Locations

As stated earlier in the report, the Town of Kearny owns and operates five (5) CSO discharge outfalls with their associated regulator chambers. These are listed below in Table D-1. Refer also to the Town Drainage Area Map, Figure 1A.

TABLE D-1 – EXISTING OUTFALLS		
OUTFALL NO.	LOCATION	RECEIVING STREAM
001A	Stewart Avenue	Passaic River
004A	Nairn Avenue	Passaic River
006A	Johnston Avenue	Passaic River
007A	Ivy Street	Frank's Creek (Tributary to Lower Passaic River)
010A	Dukes Street	Frank's Creek (Tributary to Lower Passaic River)

(Note – Outfall No. KE 001 corresponds to No. 001A in the Town's NJPDES permit, etc.)

As discussed in Section C, CSO Outfall 010A (Dukes Street) will be eliminated in the near future. Therefore, the development and evaluation of alternatives considers only the remaining four CSO outfalls listed above, i.e. 001, 004, 006, and 007.

This corresponds to Baseline B in this analysis. All alternatives evaluated are based on Baseline B (i.e. zero CSO events in Drainage Area 010).

Siting and other general issues are now discussed, followed by a listing and discussion of the alternatives under consideration, and summary cost tables which include capital, O&M, and overall present value costs for each of the alternatives.

D.1.2 Siting

D.1.2.1 General

Siting issues at each outfall location include available land area, proximity to residences, land use in adjacent parcels, subsurface conditions, access for operations and maintenance (O&M) (including personnel, vehicles, and chemical deliveries), as well as topography, aesthetics, and impacts to the surrounding area. For example, construction of an underground, offline storage vault requires a large

area to be excavated. However, once constructed, the land at the surface is available for various uses – i.e. park, parking lot, etc. Sewer separation would involve a larger area of town, or possibly multiple areas, with excavations in numerous streets and subsequent disturbances to large numbers of residents and/or businesses. A treatment system, if constructed, would be located at an existing outfall, which is remote from residences, but would be nearer to a water body and, as such, environmental factors must be considered, such as flood hazard elevation, wetlands, minimizing impacts to the water body during construction, etc. A treatment system would also involve chemical deliveries, screenings and sludge disposal. Therefore truck access is needed, which may be difficult to provide at some sites.

The above describes general siting issues. Below, the four Kearny outfall sites are discussed; including specific site concerns and accompanying photographs.

D.1.2.2 Kearny Outfall Sites

Outfall 001A (Stewart Avenue): this site is within a park area off Passaic Avenue, at the northwest corner of Kearny, near its border with North Arlington. The site currently consists of a below ground netting chamber and valve vault. Surrounding properties consist of primarily residential users. As seen in the following photograph, numerous trees exist near the existing structures. Thus potential issues of concern are noise, odors, and disturbance to the park area. This park is not listed on the Green Acres Program Open Space Database and, therefore, is not believed to be within the jurisdiction of NJDEP or associated programs.

Photo No. 18 – Outfall Site KE 001 – Stewart Avenue

Outfall 004A (Nairn Avenue): At this site, the regulator chamber is located within the Passaic Avenue tight-of-way. Nairn Avenue is currently a paper street that has been developed with a parking lot area associated with a commercial development. The area surrounding the regulator chamber has been developed, commercially. Therefore any construction at this site would pose a significant disturbance to adjacent business owners. A residential development is currently under construction on Passaic Avenue, across the street from the regulator. Therefore, noise, truck traffic associated with chemical

deliveries, and temporary disturbance during construction are issues of concern. Refer to the photographs Numbers 18 and 19 below.

Photo No. 19 – Commercial Development in the Vicinity if the Nairn Avenue Outfall

Photo No. 20 – Residential Development in the Vicinity if the Nairn Avenue Outfall

<u>Outfall 006A (Johnston Avenue):</u> this site is located near Passaic Avenue, at the southwest corner of the Town, where it borders East Newark. The site is located near an abandoned railroad bridge. Access

for personnel and vehicles is limited. A stairway provides the only means of direct access to the outfall. There is a large open lot at street level, which is planned to be developed. Once this lot is developed, it may further hinder access to the outfall area. Construction at this outfall site will be difficult. The highest CSO volumes are generated within this drainage area. There is potential for consolidating Outfall 006A with Outfall 004A due to their proximity and existing topography.

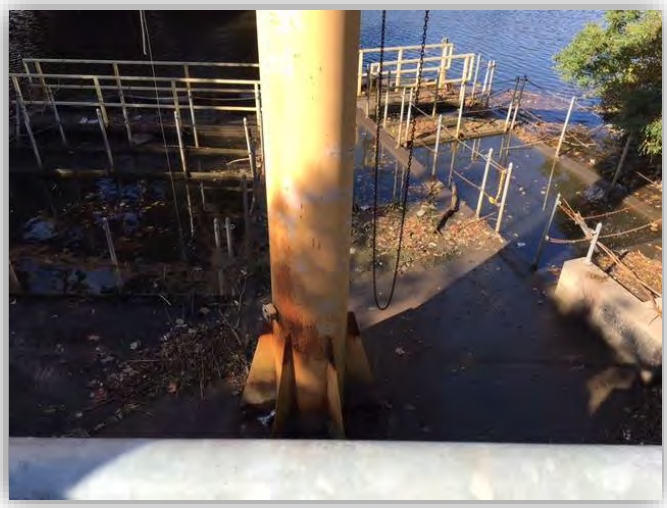

Photo No. 21 – Johnston Avenue Outfall During a Hide-Tide Period

Outfall 007A (Ivy Street): This outfall site is in a low lying residential/commercial area which is prone to flooding. It is surrounded by commercial businesses including a lumber yard, and is surrounded on all sides by existing structures, making access for vehicles difficult. This outfall site is characterized by a large netting chamber, with two rows of nets, and by a long channel going out to the Lower Passaic River. See the two (2) following photographs. There is virtually no space available for construction of any improvements on this site.

Photo No. 22 – Ivy Street Netting Chamber

Photo No. 23 – Ivy Street Outfall Channel

D.1.3 Institutional Issues

Institutional issues may be jurisdictional, regulatory or associated with land acquisition. For example, a potential site for a storage tank or treatment system might be restricted by Green Acres, which could be a significant obstacle to implementing the project (see D.1.4, Implementability). Town acceptance may be a concern, if Town residents or the Town Administration does not want to construct a storage or treatment facility at a particular site. NJDEP approval can also be an obstacle, if construction of a CSO storage or treatment facility is adjacent to wetlands, or in a flood hazard area, or otherwise environmentally sensitive area. The need for easements can also be an obstacle, if a property owner refuses to grant an easement or the cost of the land is prohibitive.

D.1.4 Implementability

Implementability refers to a number of contributing factors such as constructability, obtaining approvals on the local, State, County or Federal level as required, cost effectiveness, and public acceptance which is discussed below. Any of the above listed factors can become an obstacle to implementing a CSO control project.

D.1.5 Public Acceptance

Public acceptance (or resistance) will vary based on the nature of the project. For example, a Town-wide sewer separation project may be met with a high degree of public resistance due to the extent of the disturbance and the number of residents affected. A project at a remote outfall site might see less public resistance but might raise concerns among environmentally concerned citizens. Proposing a below grade storage tank beneath what appears to be an empty parcel might require cooperation from the Town and/or local developer, as the parcel might be planned for development. Public acceptance is also tied to public participation. Public involvement in the overall planning process, through public meetings, is an important step for gaining the public's acceptance. Kearny, through its Engineer, Neglia Engineering Associates, has held public meetings with the Town residents to discuss the CSO project. NEA has met with the Kearny AWAKE (Association of Water, Agriculture, and Kearny's Environment) group, a local citizen's environmental group, to discuss the CSO LTCP project. Kearny

AWAKE has provided NEA with valuable input regarding Green Infrastructure implementation, and specific areas in Town that are of concern.

D.1.6 Performance Considerations

Performance considerations are related to the ability of a proposed project to meet certain established goals. A treatment technology that only removes solids but does not remove pathogens, which are a pollutant of concern, would not satisfy the program water quality goals. Furthermore, a treatment technology which has a high degree of complexity and requires a high degree of operator attention has to be correctly located to facilitate maintenance and access. Use of a new technology that is untested or unproven, or supplied by a manufacturer with a limited number of full scale installations, would raise concerns over performance.

D.2 PRELIMINARY CONTROL PROGRAM ALTERNATIVES

The alternatives considered in this evaluation include the following elements:

- Complete Sewer Separation – this refers to separating the sewers throughout the entire Town of Kearny;
- Partial Sewer Separation – separation of sewers within Drainage Area 010 only. Sewers were previously separated in portions of this drainage area. Sewers in the remaining portions of the drainage area will be separated. Since the Town of Kearny has committed to separation of sewers in Drainage Area 010, this measure is shown as Baseline B, and is a component common to all alternatives;
- Inline Storage via CSO Tunnel (one tunnel to serve the entire Town);
- Offline Storage via Below Grade Tanks, at Each Outfall;
- Disinfection With Peracetic Acid (PAA) at Each Outfall; and
- Green Infrastructure – at various locations throughout Kearny, and Included in all alternatives.

In addition, the alternatives cover all the various levels of control (i.e. 0, 4, 8, 12, and 20 CSO events per year, and the 85% capture goal). The Baseline A and Baseline B are also shown for comparison in order to show the impact of each alternative. The following alternatives are evaluated:

Scenarios Evaluated:

Table D-2 presents the conditions evaluated for this study. The first grouping of alternatives (Group 1) achieve the targeted annual CSO frequencies, and are presented in increasing order (zero, 4, 8, 12, and 20) of untreated discharges per year. Only Alternative 2A, complete Town wide sewer separation considers zero CSO events per year. The second grouping presents other alternatives that cannot alone achieve the targeted annual CSO frequencies. Costs for the "Group 2" alternatives are presented in Tables D-6 and D-7. The alternative identifiers shown in the first column are used to identify each alternative in subsequent tables.

Table D-2 – Listing of Evaluated Scenarios/Alternatives	
Evaluated Scenario	**Description**
Baseline A (Existing Infrastructure)	Existing infrastructure with 2045 population and typical year meteorology (rainfall, evapotranspiration, tide levels)
Baseline B (KE010 Separation)	Baseline A plus separation of the combined sewers draining to outfall KE010 (Kearny has committed to completing sewer separation in this catchment)
Group 1 Alternatives	**Description**
Alt_2A_0_SewerSeparation	Baseline B with complete sewer separation to completely eliminate CSOs

Group 1 Alternatives (cont'd)	Description (cont'd)
Alt_3A_4_PartialSS-Tank	Baseline B with tank storage to control system-wide overflow to 4 events per year
Alt_3B_4_PartialSS-Tunnel	Baseline B with tunnel storage to control system-wide overflow to 4 events per year
Alt_3C_4_PartialSS-PAA	Baseline B with PAA disinfection fully treating all but 4 events annually
Alt_4A_8_PartialSS-Tank	Baseline B with tank storage to control system-wide overflow to 8 events per year
Alt_4B_8_PartialSS-Tunnel	Baseline B with tunnel storage to control system-wide overflow to 8 events per year
Alt_4C_8_PartialSS-PAA	Baseline B with PAA disinfection fully treating all but 8 events annually
Alt_5A_12_PartialSS-Tank	Baseline B with tank storage to control system-wide overflow to 12 events per year
Alt_5B_12_PartialSS-Tunnel	Baseline B with tunnel storage to control system-wide overflow to 12 events per year
Alt_5C_12_PartialSS-PAA	Baseline B with PAA disinfection fully treating all but 12 events annually
Alt_6A_20_PartialSS-Tank	Baseline B with tank storage to control system-wide overflow to 20 events per year
Alt_6B_20_PartialSS-Tunnel	Baseline B with tunnel storage to control system-wide overflow to 20 events per year
Alt_6C_20_PartialSS-PAA	Baseline B with PAA disinfection fully treating all but 20 events annually
Group 2 Alternatives	**Description**
Green Infrastructure	Baseline B with GI to control runoff from 5% of impervious surfaces and 10% of impervious surfaces
In-Line Storage	Baseline B with regulator weir raised to increase "in-line storage"
Base-flow Reduction (Water Conservation/ I/I Reduction)	Baseline B with a 10% reduction in base flow as resulting from water conservation and/or reduction of inflow and infiltration

D.3 REDUCTION OF CSO VOLUME AND FREQUENCY

The above control measures will reduce the number of CSO events experienced annually, at each CSO outfall, and the volume of the overflows. Table D-3 presents the frequency of overflows expected to occur annually at each outfall for each alternative listed above, and the percent reduction from the Baseline B. Table D-4 presents the volume in million gallons (MG) at each outfall for each alternative and the percent reduction from Baseline B.

Table D-3 –Annual Untreated Overflow Frequency by Outfall

Scenario	KE001	KE004	KE006	KE007	KE010	Total	%Reduction from	
							Baseline A	Baseline B
Baseline A (Existing Infrastructure)	31	42	57	34	43	61	N/A	N/A
Baseline B (KE010 Separation)	31	42	57	32	0	61	0.0%	N/A
Alt_2A_0_SewerSeparation	0	0	0	0	0	0	100.0%	100.0%
Alt_3A_4_PartialSS-Tank	4	3	2	4	0	4	93.4%	93.4%
Alt_3B_4_PartialSS-Tunnel	*	*	*	*	*	4	93.4%	93.4%
Alt_3C_4_PartialSS-PAA	**	**	**	**	**	4	93.4%	93.4%

Scenario (cont'd)	KE001 (cont'd)	KE004 (cont'd)	KE006 (cont'd)	KE007 (cont'd)	KE010 (cont'd)	Total (cont'd)	%Reduction from	
							Baseline A (cont'd)	Baseline B (cont'd)
Alt_4A_8_PartialSS-Tank	4	7	5	8	0	8	86.9%	86.9%
Alt_4B_8_PartialSS-Tunnel	*	*	*	*	*	8	86.9%	86.9%
Alt_4C_8_PartialSS-PAA	**	**	**	**	**	8	86.9%	86.9%
Alt_5A_12_PartialSS-Tank	7	10	11	11	0	11	82.0%	82.0%
Alt_5B_12_PartialSS-Tunnel	*	*	*	*	*	11	82.0%	82.0%
Alt_5C_12_PartialSS-PAA	**	**	**	**	**	12	80.0%	80.0%
Alt_6A_20_PartialSS-Tank	9	15	18	18	0	20	67.2%	67.2%
Alt_6B_20_PartialSS-Tunnel	*	*	*	*	*	20	67.2%	67.2%
Alt_6C_20_PartialSS-PAA	**	**	**	**	**	20	67.2%	67.2%

(1) The Baseline B alternative achieves the 85% capture target for PVSC interceptor communities.
(2) %Reduction indicates *frequency reduction* as a percentage from Baseline.
(3) Total and %Reduction values indicate *town-wide* values. Outfalls do not necessarily overflow during the same storms, so the town-wide values do not necessarily equal the highest-frequency outfall.
(4) Overflow frequency does not change from Baseline for disinfection alternatives, but the number of *untreated overflow events* drops to 4, 8, 12, and 20 per year (percent reductions shown).
(5) Partial SS refers to complete separation of the KE010 drainage area.
(6) In this context, a CSO event occurs if the CSO flow rate at any outfall exceeds the design flow rate for 3-log pathogen removal.
(*) Indicates tunnel storage solutions which were modeled as having one outfall to determine citywide overflow volume and frequency.
(**) Disinfection is assessed on a town-wide basis, not by individual outfalls.

Table D-4 – Annual Untreated Overflow Volume (MG) by Outfall

Scenario	KE001	KE004	KE006	KE007	KE010	Total	%Reduction from	
							Baseline A	Baseline B
Baseline A (Existing Infrastructure)	3.9	12.4	121.8	90.0	26.6	254.7	N/A	N/A
Baseline B (KE010 Separation)	3.9	12.4	120.2	83.8	0.0	220.3	13.5%	N/A
Alt_2A_0_SewerSeparation	0.0	0.0	0.0	0.0	0.0	0.0	100.0%	86.5%
Alt_3A_4_PartialSS-Tank	0.4	1.2	8.8	12.3	0.0	22.6	91.1%	77.6%
Alt_3B_4_PartialSS-Tunnel	*	*	*	*	*	25.9	89.8%	76.3%
Alt_3C_4_PartialSS-PAA	**	**	**	**	**	11.0	95.7%	95.0%
Alt_4A_8_PartialSS-Tank	0.4	2.1	11.3	18.9	0.0	32.6	87.2%	73.7%
Alt_4B_8_PartialSS-Tunnel	*	*	*	*	*	34.0	86.7%	73.1%
Alt_4C_8_PartialSS-PAA	**	**	**	**	**	34.0	86.7%	84.6%
Alt_5A_12_PartialSS-Tank	0.8	2.9	26.9	34.7	0.0	65.3	74.3%	60.8%
Alt_5B_12_PartialSS-Tunnel	*	*	*	*	*	70.3	72.4%	58.9%
Alt_5C_12_PartialSS-PAA	**	**	**	**	**	47.0	81.5%	78.7%
Alt_6A_20_PartialSS-Tank	1.11	4.5	44.4	48.9	0.0	98.9	61.2%	47.6%
Alt_6B_20_PartialSS-Tunnel	*	*	*	*	*	100.8	60.4%	46.9%
Alt_6C_20_PartialSS-PAA	**	**	**	**	**	63.0	75.3%	71.4%

(1) The Baseline B alternative achieves the 85% capture target for PVSC interceptor communities.
(2) % Reduction indicates *frequency reduction* as a percentage from Baseline.
(3) Total and % Reduction values indicate *town-wide* values. Outfalls do not necessarily overflow during the same storms, so the town-wide values do not necessarily equal the highest-frequency outfall.
(4) Overflow volume does not change from Baseline for disinfection alternatives, but the *untreated overflow volume* drops for the 4, 8, 12, and 20 per year scenarios (percent reductions shown).
(5) Partial SS refers to complete separation of the KE010 drainage area.
(6) In this context, "Untreated CSO Volume" is defined as the sum of discharged volumes during any 5-minute period that exceed the design flow rate for 3-log pathogen removal.
(*) Indicates tunnel storage solutions which were modeled as having one outfall to determine citywide overflow volume and frequency.
(**)Disinfection is assessed on a town-wide basis, not by individual outfalls.

D.3.1 Quantifying Impacts of GI Through Hydraulic Modeling

Green Infrastructure was modeled, using the Infoworks model, to quantify the impacts of implementing GI measures on CSO volume and frequency. The methodology is based on capturing the first inch of rainfall over an area equal to 5% or 10% of the Town's impervious area. Costs associated with GI are presented in Section D.

In order to evaluate the potential impact of widespread implementation of Green Infrastructure, analyses were performed to quantify the reduction from Baseline of CSO frequency and volume resulting from two different GI-implementation levels. The first level of GI implementation involves elimination of runoff from the first inch of rainfall falling on 10% of the impervious surfaces in Kearny, and the second involves elimination of runoff from the first inch of rainfall on 5% of the impervious surfaces. These two control levels represent what was initially targeted, and more recently found to be reasonably achievable, respectively, given efforts to successfully site and install GI projects in New York City.

Impervious surfaces (including rooftops, streets, sidewalks, parking lots) in Kearny cover approximately 715 acres. When 5% of the impervious area (or about 35.7 acres) are controlled with GI, CSO volumes decrease by about 5 MG (1.9%), and CSO event counts did not decrease at all. When 10% of the impervious area (or about 71.5 acres) are controlled with GI, CSO volumes decrease by about 10 MG (3.9%), and CSO event counts decreased by 2 (3.3%). The quantitative impacts of GI on Town wide CSO frequency and volume, are shown in Tables D-5 and D-6 below. Tables D-5 and D-6 also quantify the impacts of other measures such as base flow reduction and regulator modifications.

Table D-5 – Overflow Frequency by Outfall

Group 2 Alternatives	KE001	KE004	KE006	KE007	KE010	Total	% Reduction from	
							Baseline A	Baseline B
Baseline A (Existing Infrastructure)	31	42	57	34	43	61	N/A	N/A
Baseline B (KE010 Separation)	31	42	57	32	0	61	0.0%	N/A
Baseline B + GI for 5% of Impervious Surfaces	29	42	57	32	0	61	0.0%	0.0%
Baseline B + GI for 10% of Impervious Surfaces	29	42	56	32	0	59	3.3%	3.3%

Group 2 Alternatives (cont'd)	KE001 (cont'd)	KE004 (cont'd)	KE006 (cont'd)	KE007 (cont'd)	KE010 (cont'd)	Total (cont'd)	% Reduction from	
							Baseline A (cont'd)	Baseline B (cont'd)
Baseline B + 6'' Weir Elevation	29	31	57	32	0	61	0.0%	0.0%
Baseline B + 10% Base-Flow Reduction	30	42	56	32	0	60	1.6%	1.6%

(1) % reduction indicates f*requency reduction* as a percentage from Baseline.
(2) Total and % reduction values indicate *city-wide* values. Outfalls do not necessarily overflow during the same storms, so the Town-wide values do not necessarily equal the highest-frequency outfall.
(3) Complete separation of the KE010 drainage area is assumed for all group 2 alternatives.
(4) Baseline A and Baseline B are defined in Section B.

Table D-6 – Annual Overflow Volume (MG) by Outfall								
Group 2 Alternative	KE001	KE004	KE006	KE007	KE010	Total	%Reduction from	
							Baseline A	Baseline B
Baseline A (Existing Infrastructure)	3.9	12.4	121.8	90.0	26.6	254.7	N/A	N/A
Baseline B (KE010 Separation)	3.9	12.4	120.2	83.8	0.0	220.3	13.5%	N/A
Baseline B + GI for 5% of Impervious Surfaces	3.7	11.9	117.1	82.7	0.0	215.4	15.4%	1.9%
Baseline B + GI for 10% of Impervious Surfaces	3.6	11.5	113.9	81.4	0.0	210.3	17.4%	3.9%
Baseline B + 6'' Weir Elevation	3.7	10.8	121.1	81.6	0.0	217.3	14.7%	1.2%
Baseline B + 10% Base-Flow Reduction	3.8	12.3	118.5	81.9	0.0	216.6	15.0%	1.4%

(1) % reduction indicates *volume reduction* as a percentage from Baseline.
(2) Total and % reduction values indicate *city-wide* values.
(3) Complete separation of the KE010 drainage area is assumed for all Group 2 alternatives.
(4) Baseline A and Baseline B are defined in Section B.

Despite the marginal quantitative impacts of GI on CSO frequency and volume, there are numerous benefits to implementing GI. Such benefits include aesthetics, and gaining public and regulatory acceptance. GI measures, regardless of overall impact on CSO's will be included in the final LTCP.

Because of the relatively small impact achievable with GI, all alternatives were evaluated conservatively, without GI, with the assumption that any additional impact of GI, however minor, would be considered in the development of the final selected alternatives.

The capital, O&M, and overall Present Value costs of implementing GI measures, in accordance with the analysis described above, are presented in Section D.5.

D.4 EVALUATION OF COSTS

D.4.1 Capital Costs

Capital costs for storage and treatment are taken from the cost curves presented in the current Technical Guidance Manual (TGM). Based on experience with past projects, the capital costs obtained from the TGM cost curves are multiplied by a factor of 2.5 to account for contractor's installation, electrical, piping, and indirect costs. Costs for sewer separation are taken from the 2007 Cost and

Performance Data and updated using the ENR Construction Cost Index (CCI). Capital costs presented in this report are based on an ENR CCI of 10817. The updated capital cost of sewer separation is multiplied by a factor of 1.5 to account for the ancillary costs not already included in the 2007 cost estimates.

D.4.2 Operation and Maintenance (O&M) Costs

Annual operation and maintenance (O&M) Costs are computed in accordance with the most recent methodology developed by Greeley and Hansen as follows: one continuous operating post (COP) is equivalent to three 8-hour shifts, 365 days per year, at a labor rate of $53.60 per hour, therefore one COP is computed as follows: $53.60/hr x 8 x 3 x 365 = $470,000 per year.

For a CSO tunnel, the operations cost is 1.0 x $470,000 per year. For storage tanks, the operations cost is 0.5 x $470,000 or $235,000 per year.

Maintenance costs are computed as a percentage of the construction cost. For tunnels, the percentage of capital cost is 2%. For storage tanks, the percentage of capital cost is 3%.

O&M costs are converted to present value (PV) costs, based on a 20-year life and an assumed interest rate of 2.75%.

D.4.3 Present Value (Life Cycle) Costs

Capital and O&M costs are added together to compute probable total project cost (PTPC) for a 20-year life cycle as shown in Table D-7.

D.4.4 Cost of Alternatives

From the totality of the previously discussed factor of the Evaluation of Costs, the capital, O&M and overall present value (PV) costs are shown in Table D-7. These costs do not include the estimated costs for implementing GI measures. GI costs are shown in Tables D-8 and D-9 and must be added to the costs shown in Table D-7.

Table D-7 – Total Capital Cost, PTCP Capital Cost, Total 20-yr O&M Cost, and PTPC(1) as 20-yr Present Value of Alternatives to Achieve 0, 4, 8, 12 and 20 CSOs per Year

Annual CSO Count	Alternative ID	Capital Cost ($M)	PTPC Capital Cost ($M)	20-Year O&M Cost ($M)	PTPC 20-Year PV Cost ($M)
61	Baseline B (KE010 Separation)	$30.86	$77.15	$23.49	$100.64
0	Alt_2A_0_SewerSeparation	$414.36	$621.54	$126.19	$747.74
4	Alt_3A_4_PartialSS-Tank	$82.58	$206.45	$61.44	$267.90
4	Alt_3B_4_PartialSS-Tunnel	$107.51	$268.77	$53.99	$322.76
4	Alt_3C_4_PartialSS-PAA-FlexFilter	$90.85	$227.13	$35.27	$262.40
8	Alt_4A_8_PartialSS-Tank	$77.04	$192.60	$58.90	$251.49
8	Alt_4B_8_PartialSS-Tunnel	$104.50	$261.25	$53.08	$314.32
8	Alt_4C_8_PartialSS-PAA-FlexFilter	$72.24	$180.60	$32.03	$212.63
12	Alt_5A_12_PartialSS-Tank	$66.41	$166.03	$54.05	$220.08
12	Alt_5B_12_PartialSS-Tunnel	$93.96	$234.90	$49.87	$284.77
12	Alt_5C_12_PartialSS-PAA-FlexFilter	$63.29	$158.23	$30.46	$188.70

Annual CSO Count (cont'd)	Alternative ID (cont'd)	Capital Cost ($M) (cont'd)	PTPC Capital Cost ($M) (cont'd)	20-Year O&M Cost ($M) (cont'd)	PTPC 20-Year PV Cost ($M) (cont'd)
20	Alt_6A_20_PartialSS-Tank	$59.04	$147.60	$50.68	$198.27
20	Alt_6B_20_PartialSS-Tunnel	$86.83	$217.08	$47.70	$264.78
20	Alt_6C_20_PartialSS-PAA-FlexFilter	$56.45	$141.13	$29.20	$170.32

(1) PTPC (Probable Total Project Costs) reflect a 2.5 escalation factor on capital costs, to account for installation, non-component cost, and indirect costs as described in the Assumptions. For complete sewer separation only, PTPC represents an escalation factor of 1.5 on capital costs to account for ancillary costs not already accounted for in the 2007 cost estimates.
(2) Capital and O&M costs for each alternative include the cost of separating the KE010 drainage area.
(3) The Baseline B alternative achieves the 85% capture goal for PVSC interceptor communities.
(4) Costs shown in Table D-7 do not include costs for Green Infrastructure, which are shown in Tables D-8 and D-9.

D.5 GREEN INFRASTRUCTURE

Capital and O&M costs for GI measures were taken from the recent 2018 G&H Technical Guidance Manual (TGM) and the NJDEP 2018 guidance document. As widespread implementation of GI could involve a variety of GI technologies depending on specific site conditions, a range of costs is provided in the GI cost table. Table D-8 shows the capital costs, O&M costs, and raw total 20-year present value cost for each GI technology for implementation at 5% and 10% of impervious surfaces. Capital costs were multiplied by 2.5 to calculate the probable total project cost (PTPC) of implementing each technology. The PTPC accounts for installation, non-component (electrical, piping, etc.) and indirect costs (freight, permits, etc.) for all storage and disinfection alternatives. An explanation of how the capital cost factor of 2.5 was calculated is shown in the "Assumptions" section. Table D-9 shows the raw and PTPC cost range of green infrastructure reported as $M/MG CSO controlled and $M/impervious acre controlled.

Table D-8 – Capital, 20-Year O&M, and Life-Cycle PV Cost Ranges For Green Infrastructure to Control 5 and 10% of Impervious Cover

Controlled(1) Portion of Impervious Area	Green Infrastructure Technology	Min. Raw(2) Capital Cost ($M)	Max. Raw(2) Capital Cost ($M)	20-Year O&M as PV Cost ($M)	Min. Raw(2) 20-Yr Life-Cycle as PV ($M)	Max. Raw(2) 20-Yr Life-Cycle as PV ($M)
5% (35.7 ac)	Rain Garden	$3.43	$10.90	$4.35	$7.79	$15.26
	Right-of-Way Bioswale	$5.36	$17.87	$4.35	$9.72	$22.23
	Green Roof	$17.16	$87.22	$4.35	$21.51	$91.57
	Porous Asphalt(3)	$9.29	$19.48	$0.68	$9.97	$20.16
	Pervious concrete(3)	$10.90	$21.81	$0.68	$11.58	$22.49
	PICP(3)	$4.65	$13.23	$0.68	$5.33	$13.91
10% (71.5 ac)	Rain Garden	$6.86	$21.81	$8.71	$15.57	$30.51
	Right-of-Way Bioswale	$10.72	$35.75	$8.71	$19.43	$44.46
	Green Roof	$34.32	$174.44	$8.71	$43.03	$183.15
	Porous Asphalt(3)	$18.59	$38.96	$1.36	$23.17	$44.97
	Pervious concrete(3)	$21.81	$43.61	$1.36	$23.17	$44.97
	PICP(3)	$9.29	$26.45	$1.36	$10.65	$27.81

Controlled(1) Portion of Impervious Area	Green Infrastructure Technology	Min. PTPC(4) Capital Cost ($M)	Max. PTPC(4) Capital Cost ($M)	20-Year O&M as PV Cost ($M)	Min PTPC(4) 20-Yr Life-Cycle as PV ($M)	Max PTPC(4) 20-Yr Life-Cycle as PV ($M)
5% (35.7 ac)	Rain Garden	$8.58	$27.26	$4.35	$12.93	$31.61
	Right-of-Way Bioswale	$13.40	$44.68	$4.35	$17.76	$49.04
	Green Roof	$42.90	$218.05	$4.35	$47.25	$222.41
	Porous Asphalt(3)	$23.23	$48.70	$0.68	$23.92	$49.38
	Pervious concrete(3)	$27.26	$54.51	$0.68	$27.94	$55.19
	PICP(3)	$11.62	$33.07	$0.68	$12.30	$33.75
10% (71.5 ac)	Rain Garden	$17.16	$54.51	$8.71	$25.87	$63.22
	Right-of-Way Bioswale	$26.81	$89.37	$8.71	$35.52	$98.07
	Green Roof	$85.79	$436.10	$8.71	$94.50	$444.81
	Porous Asphalt(3)	$46.47	$97.41	$1.36	$55.87	$110.39
	Pervious concrete(3)	$54.51	$109.03	$1.36	$55.87	$110.39
	PICP(3)	$23.23	$66.13	$1.36	$24.60	$67.49

(1) Control eliminates runoff from first inch of rain on controlled portion of impervious area.
(2) Costs based on information provided to NJ CSO Group by PVSC, G&H, except as otherwise noted.
(3) O&M costs for porous asphalt, pervious concrete, and PICP based on information from NJDEP (2018, NJDEP).
(4) PTPC capital costs based on application of an escalation factor of 2.5 times the raw capital cost.
(5) Overall minimum cost is shaded in blue. Overall maximum cost is shaded in red.

Table D-9 – Normalized Green Infrastructure Cost(1) Ranges

Cost Type	Green Infrastructure Technology	Min. 20-Yr Life Cycle Cost as PV, ($M/MG CSO Controlled)	Max. 20-Yr Life Cycle Cost as PV, ($M/MG CSO Controlled)	Min. 20-Yr Life Cycle Cost as PV, ($M/Acre Controlled)	Max. 20-Yr Life Cycle Cost as PV, ($M/Acre Controlled)
Raw Cost(2)	Rain Garden	$1.60	$3.13	$0.22	$0.43
	Right-of-Way Bioswale	$1.99	$4.56	$0.27	$0.62
	Green Roof	$4.41	$18.77	$0.60	$2.57
	Porous Asphalt(3)	$2.04	$4.13	$0.28	$0.56
	Pervious concrete(3)	$2.37	$4.61	$0.32	$0.63
	PICP(3)	$1.09	$2.85	$0.15	$0.39
Probable Total Project Cost(4)	Rain Garden	$2.65	$6.48	$0.36	$0.89
	Right-of-Way Bioswale	$3.64	$10.05	$0.50	$1.37
	Green Roof	$9.69	$45.59	$1.32	$6.23
	Porous Asphalt(3)	$4.90	$10.12	$0.67	$1.38
	Pervious concrete(3)	$5.73	$11.31	$0.78	$1.55
	PICP(3)	$2.52	$6.92	$0.34	$0.95

(1) Costs to eliminate runoff from the first inch of rain from targeted impervious area.
(2) Raw costs based on latest available capital, O&M, and PV (2018, G&H, 2019, G&H) except as noted.

(3) O&M costs for porous asphalt, pervious concrete, and PICP based on information gathered by NJDEP (2018, NJDEP)
(4) PTPC (Probable Total Project Costs) reflect a 2.5 escalation factor on capital costs, to account for installation, non-component cost, and indirect costs as described in Assumption #6.
(5) Costs for each GI technology do not reflect the cost of separating the KE010 drainage area.
(6) Costs in Table D-9 are not included in the costs shown in Table D-7.

Assumptions:

- Sewer Separation Costs
  - Capital costs for complete sewer separation of all combined-sewer drainage areas were modified from prior analyses (2007, HMM) that cited a normalized cost of $235,233 per acre (2006, HMM). To convert to 2018 costs, a ratio of 10817:7630 was applied herein, based on the Engineering News Record (ENR) Construction Cost Index (CCI) values for 2018 and 2006, respectively.
  - O&M costs are assumed to be 2% of the capital cost.
- Treatment Costs
  - Capital and O&M costs for PAA disinfection are based on the latest available guidance for permittees.
- Storage Tank Costs
  - Capital costs for tank-storage solutions are based on the latest available guidance for permittees.
  - O&M costs for tanks are based on operational costs at 0.5*$470,000 and maintenance costs at 3% of the construction cost, in accordance with the latest available guidance for permittees.
- Storage Tunnel Costs
  - Capital costs for tunnel-storage solutions are based on the latest available guidance for permittees.
  - O&M costs for tunnels are based on operational costs at 1.0*$470,000 and maintenance costs at 2% of construction cost, in accordance with the latest available guidance for permittees.
  - The ground type for tunnel cost calculations is assumed to be of the type “unknown”.
  - Construction cost of drop shafts is not included in the cost estimate for tunnel-storage solutions. The construction cost of the tunnel only without the drop shaft is more expensive than the capital cost of tanks therefore the cost of drop shafts were not calculated.
- Green Infrastructure Costs
  - Capital costs for various GI solutions are based on the latest available guidance for permittees.
  - O&M costs for Bioretention GI solutions were provided as $8,000 per managed acre.
  - O&M costs for Porous Pavement GI solutions were assumed to be $1,250 per managed acre.
- Additional Cost Factors
  - Present-value (PV) of life-cycle costs based on a 20-year period and an interest rate of 2.75% in accordance with the latest available guidance for permittees.
  - Based on experience on other similar projects, HDR developed “total probable project costs” using a factor of 2.5 to account for installation costs, non-component costs (electrical, piping, etc.), and indirect costs (freight, permits, etc.) for separation, storage and disinfection. A breakdown of how this factor was calculated is shown below.
    - Installation was estimated at 20% of equipment costs based on historic data experienced by HDR and industry standards for typical plants of similar size and complexity.

- Non-component costs including: electrical (10%), piping (10%), instrumentation and controls ($15,000), and civil site work (25%) were estimated based on factors or percentages of equipment costs. These factors account for standard installation commodities, accessories, steal supports and standard testing support.
- Freight was estimated at a lump sum of $20,000.
- Sales tax was estimates at 8%
- Permits were estimated at $20,000
- Start up, performance testing, operator training and O&M manual were estimated at $50,000
- Contract overhead and profit includes 29% for the following:
- Part time – Project management support, project controls, procurement, quality and safety support.
- Full time – Site construction manager (CM), site administration, standard CM travel pack.
- Engineering, administration and legal fees were estimated at 10%
- A contingency of 10% is included for the remaining equipment items and non-component costs.

- Wastewater Pumping Rate Limits
  - Dewatering of CSO-storage facilities (tanks or tunnels) must be done within 3 days to avoid septic conditions.
  - Dewatering from CSO-storage facilities (tanks or tunnels) cannot cause the total flow rate to exceed 1.75x the total average dry weather flow.

D.6 DISCUSSION OF COSTS

As can be seen from Table D-4 above, the lowest cost alternatives are Alternatives 6C, 5C, 4C, and 3C, all of which are based on Partial Sewer Separation in Area 010 (Baseline B), Plus Disinfection With PAA, for 20, 12, 8, and 4 CSO events per year, respectively. The PV costs for these four alternatives are very close, within 5 percent of each other. The required target frequency is 4 CSO events per year. Alternative 2A, total sewer separation throughout the entire Town, is by far the most costly alternative. In general, the alternatives are ranked from lowest to highest cost as follows:

- Partial Sewer Separation Plus Disinfection
- Partial Sewer Separation Plus Storage Tank
- Partial Sewer Separation Plus CSO Tunnel
- Complete Sewer Separation – Entire Town