Hazen

Environmental Protection

Bowery Bay WWTP Master Facility Plan

NEWEA 2016 Annual Conference & Exhibit
January 27, 2016

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Purpose & Background

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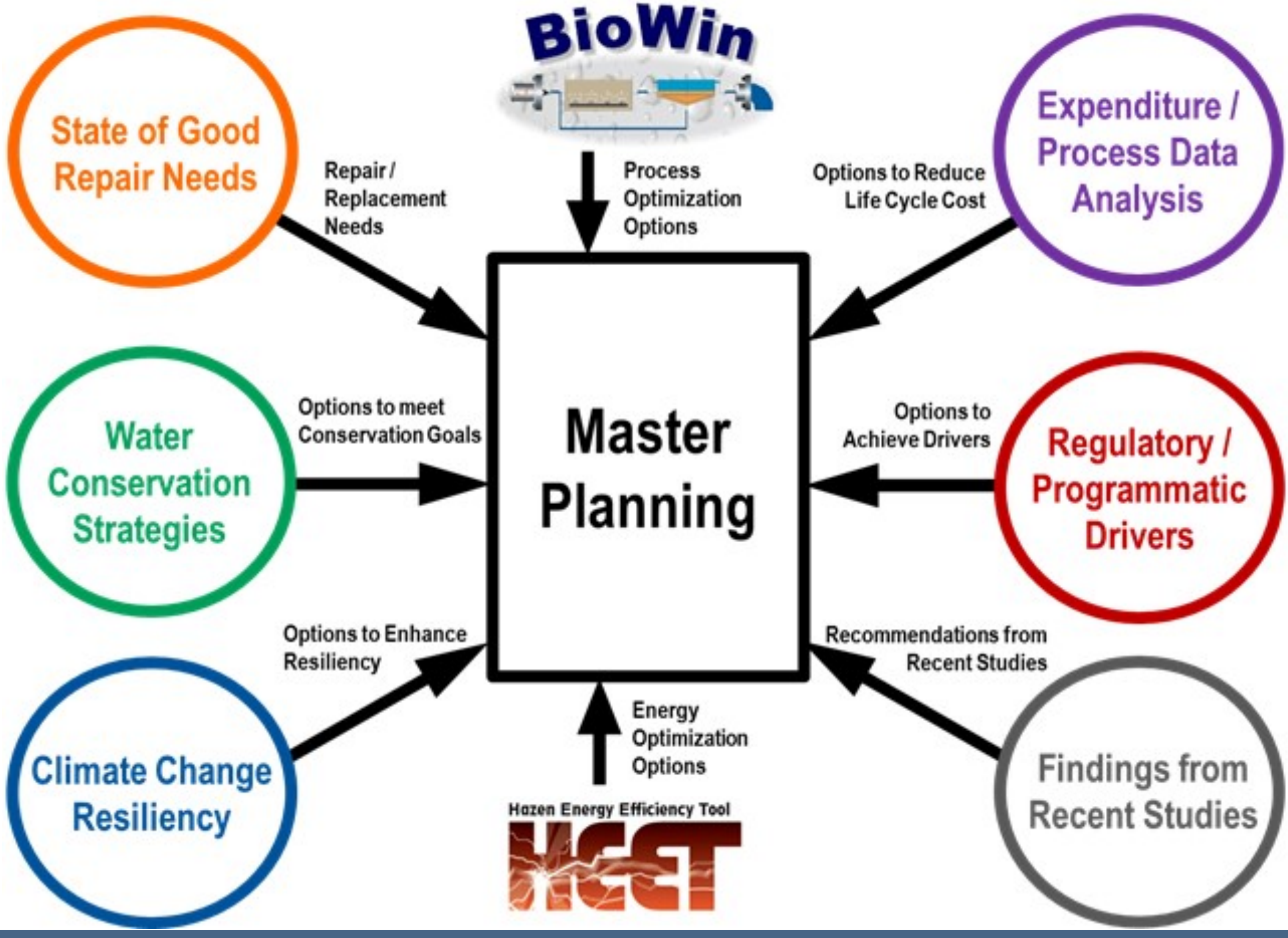
Purpose & Background



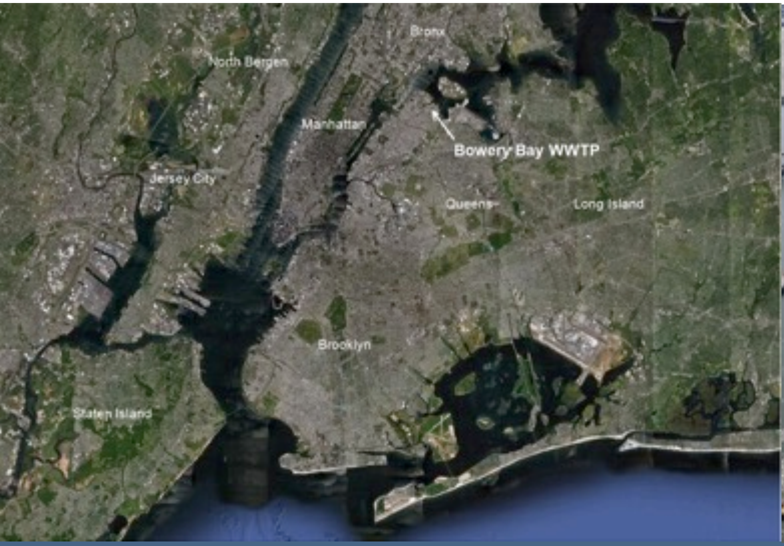
Purpose & Background

Commissioned in 1939

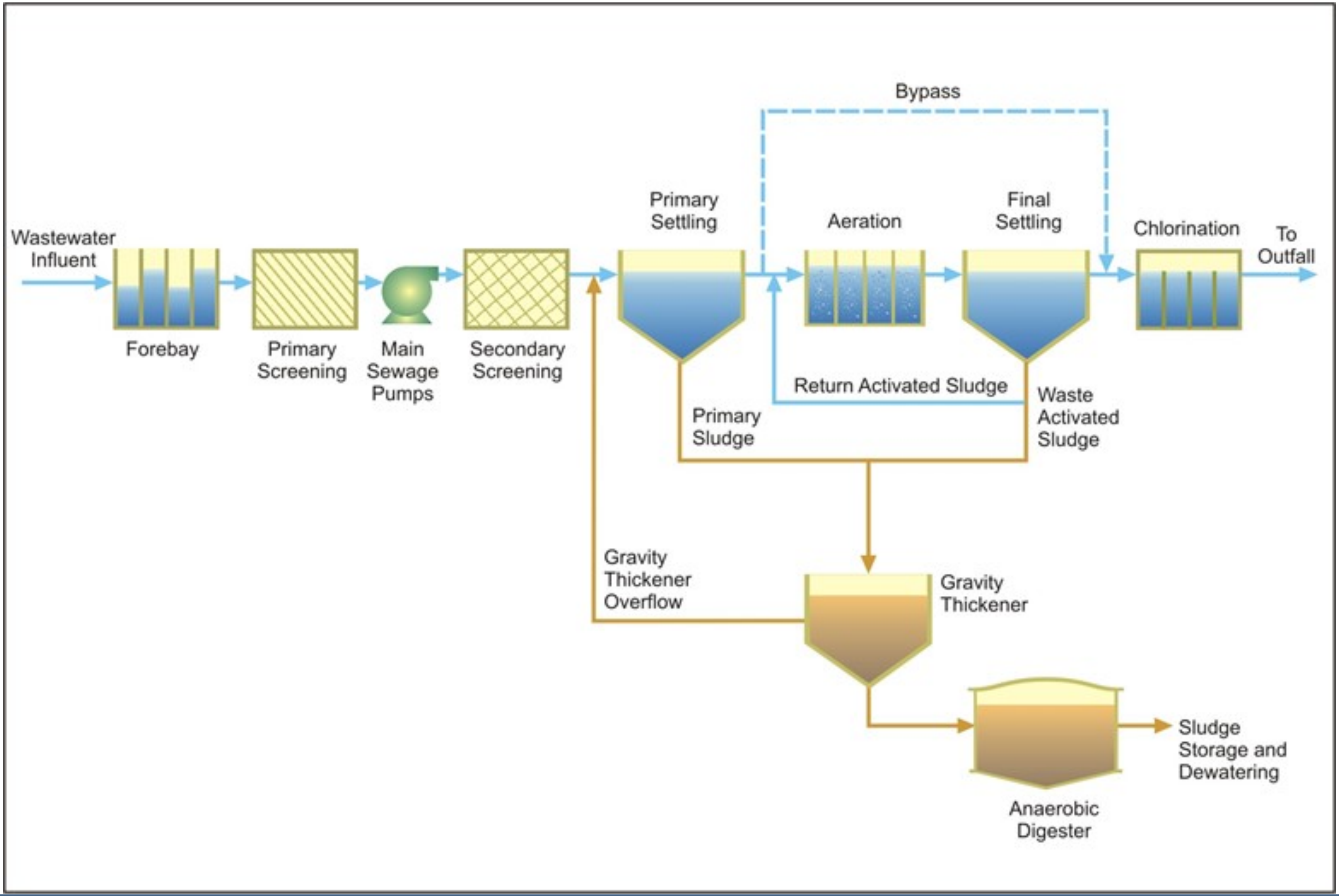
5th largest of NYC's 14 WWTPs – 150 MGD DDWF

Serves ~850,000 residents in 23.8 mi^2 combined sewer drainage area

Part of NYC BNR program



Purpose & Background



Facility Benchmarking

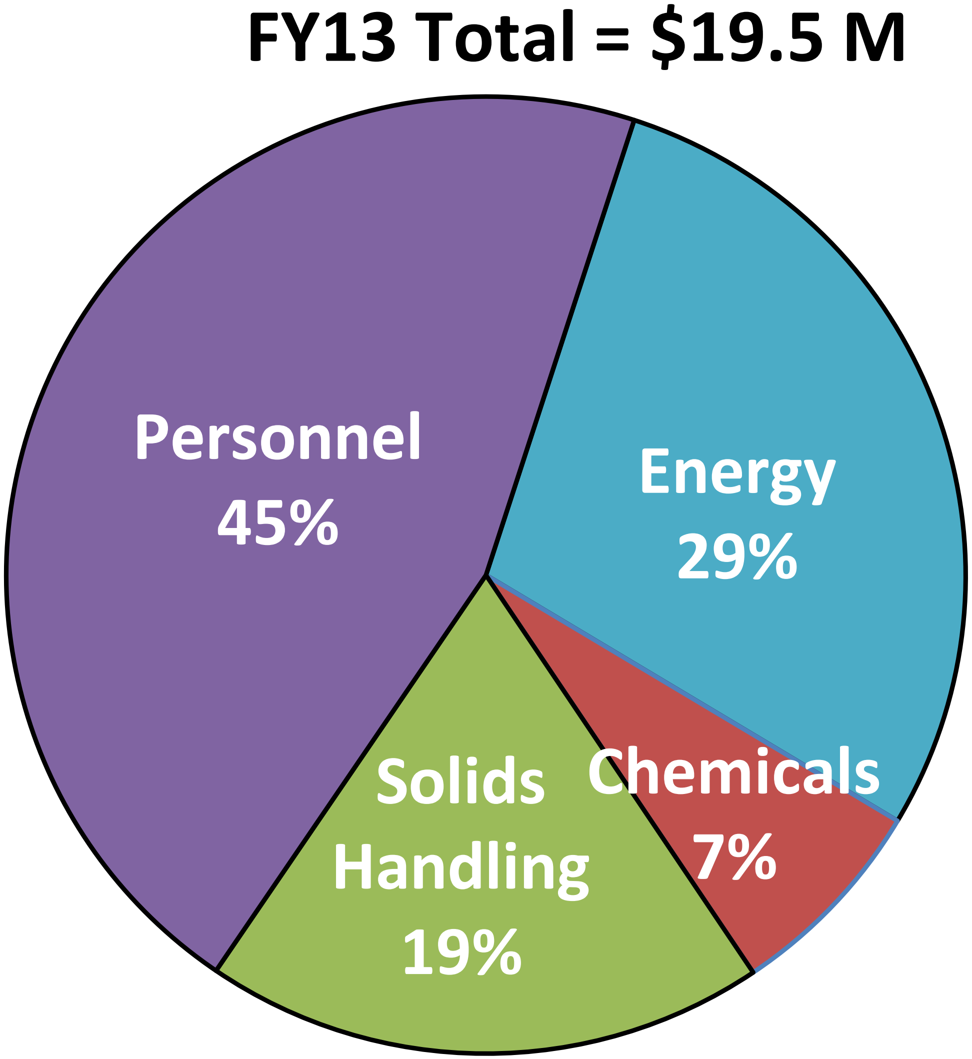
Facility Benchmarking

KEY OBJECTIVES:

Review major expense and operating data

Compare Bowery Bay WWTP with other DEP WWTPs

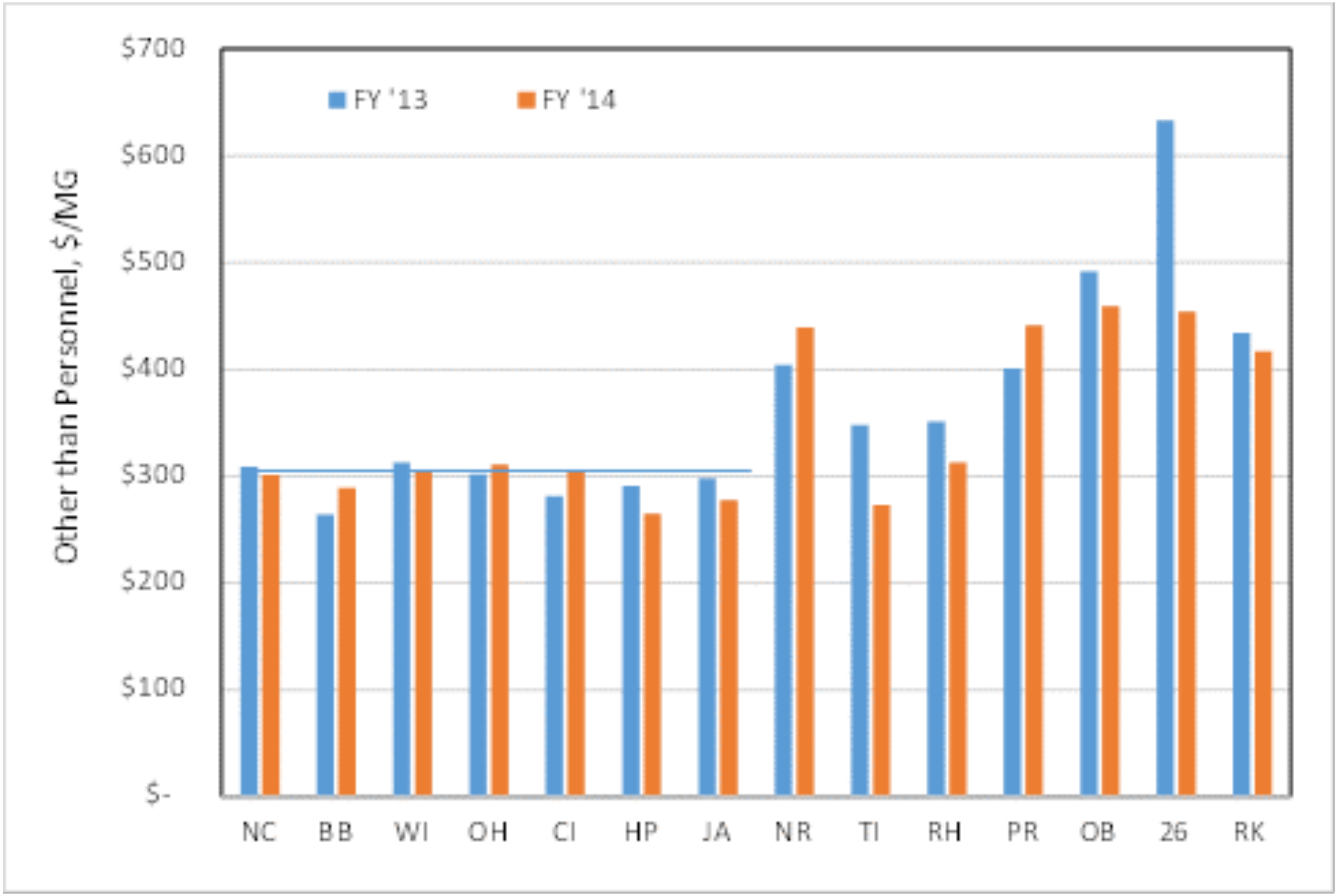
Facility Benchmarking



Facility Benchmarking

WWTP	Design Capacity (MGD)	TOTAL EXPENSE		MAJOR EXPENSE CATEGORIES: Other Than Personnel		Energy & Chemicals		Energy & Solids		Chemicals & Solids	
		Rank	$/MG	Rank	$/MG	Rank	$/MG	Rank	$/MG	Rank	$/MG
NC	310	1	$470	6	$309	7	$235	7	$273	2	$111
BB	**150**	**2**	**$485**	**1**	**$265**	**1**	**$173**	**2**	**$230**	**4**	**$126**
WI	275	3	$501	7	$312	5	$221	6	$242	9	$162
OH	120	4	$506	5	$302	4	$212	1	$226	10	$166
CI	110	5	$523	2	$281	2	$188	4	$238	5	$136
HP	200	6	$524	3	$291	6	$223	3	$237	3	$123
JA	100	7	$532	4	$297	3	$204	5	$240	8	$151
NR	170	8	$662	11	$404	11	$314	10	$321	12	$173
TI	80	9	$704	8	$348	8	$250	9	$307	7	$138
RH	60	10	$881	9	$351	9	$265	8	$300	6	$138
PR	60	11	$894	10	$401	10	$306	11	$329	11	$167
OB	40	12	$1,041	13	$492	12	$366	13	$433	13	$187
26	85	13	$1,171	14	$633	14	$431	14	$495	14	$340
RK	45	14	$1,242	12	$434	13	$397	12	$404	1	$67
Range	40-310	$470 - $1,242		$264 - $633		$173 - $431		$226 - $495		$67 - $340	
Flow-Weighted Average			$591		$333		$242		$274		$149
Bowery Bay			**$485**		**$264**		**$173**		**$230**		**$126**
Difference			$106		$69		$69		$44		$23
% of Difference			**100%**		**65%**		**65%**		**41%**		**22%**

Facility Benchmarking



Facility Benchmarking

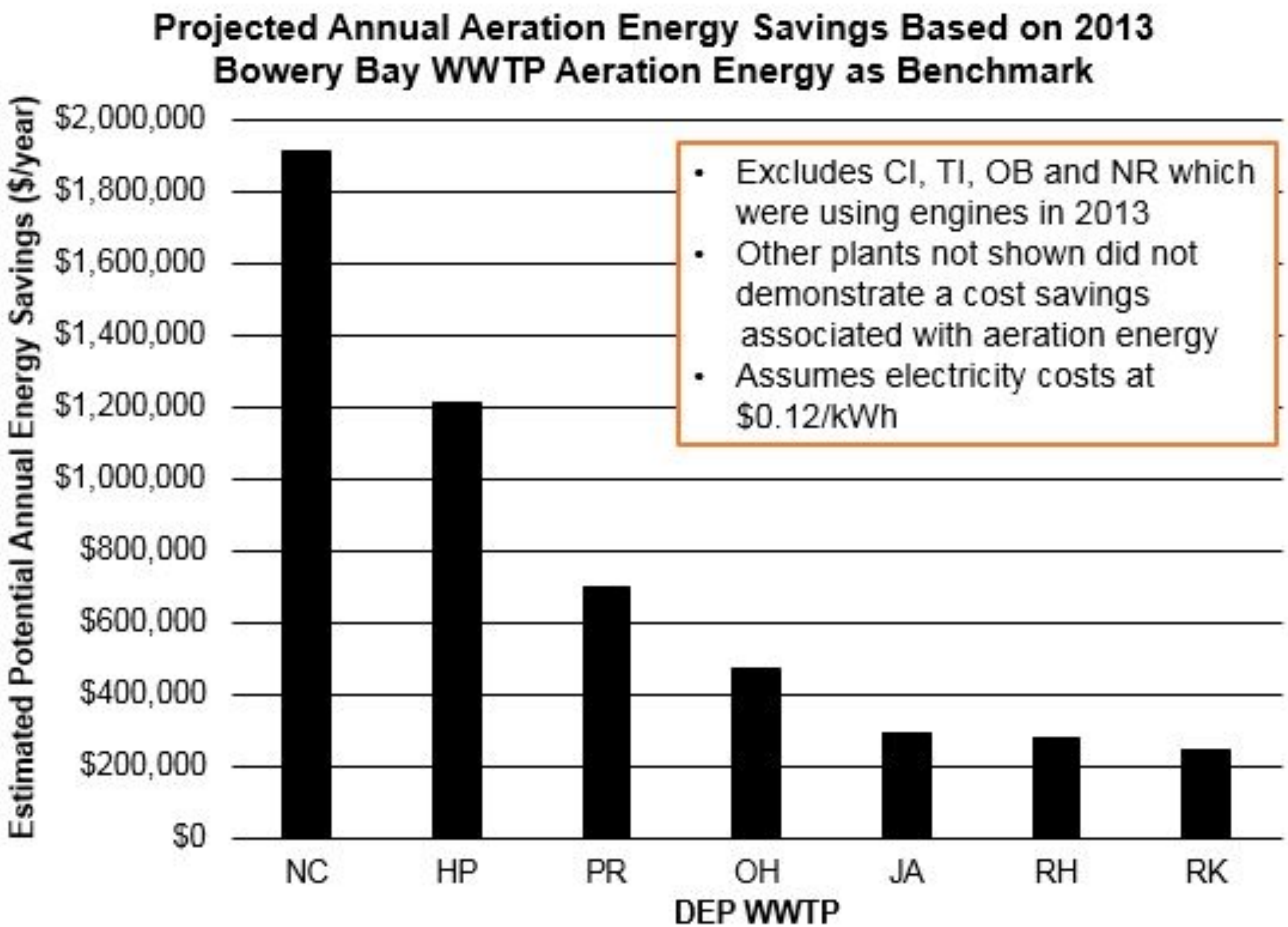
Second lowest operating cost:

- Primary treatment and gravity thickening performance
- Substantial aeration upgrades and automated DO control
- High-level interceptor – low static lift
- Disinfection efficiency (hypo usage, TRC)
- Ferric chloride and polymer usage efficiency

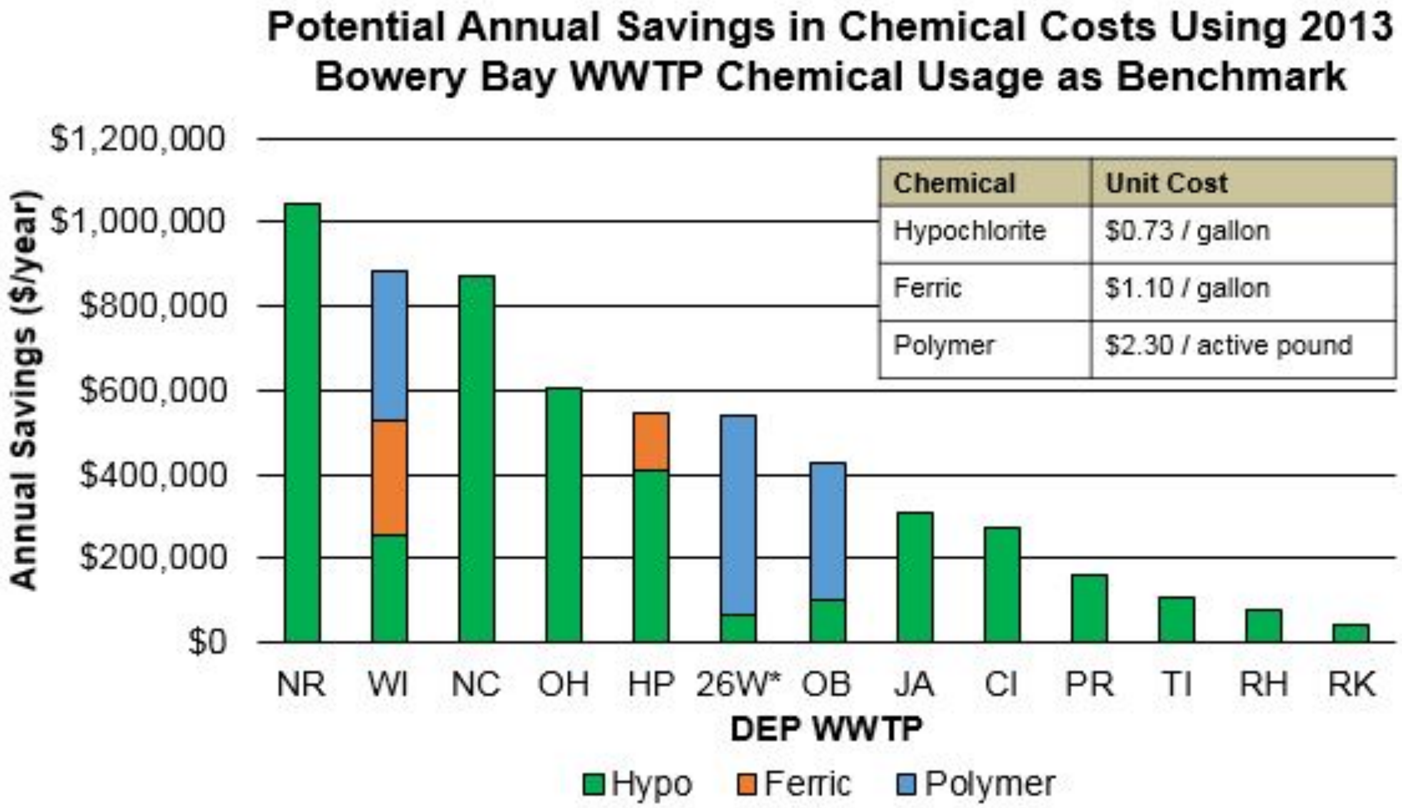
Observations could help drive future upgrades/ design features

Insight into potential savings at other DEP WWTPs

Facility Benchmarking



Facility Benchmarking



Chemical	Unit Cost
Hypochlorite	$0.73 / gallon
Ferric	$1.10 / gallon
Polymer	$2.30 / active pound

- Ferric usage based on 40 lbs ferric / ton dry solids entering dewatering (dewatering plants only)
- Hypo savings based on BB gallons hypo / MG treated ~ 10 gal/MGD
- Polymer savings based on 28 lbs active polymer / ton dry solids entering dewatering

* During benchmarking analysis, it was noted that 26th Ward WWTP is significantly under dosing ferric at about 25% of recommended dose

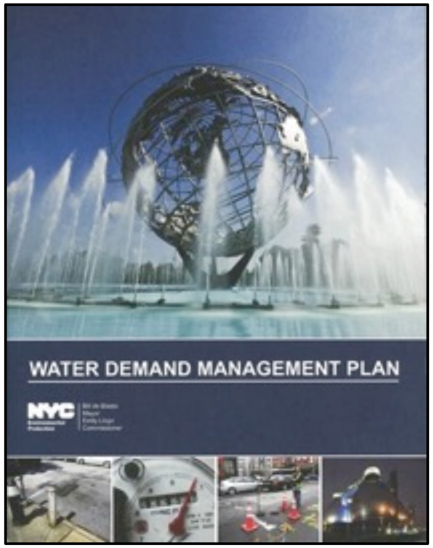
Summary of Recent Work

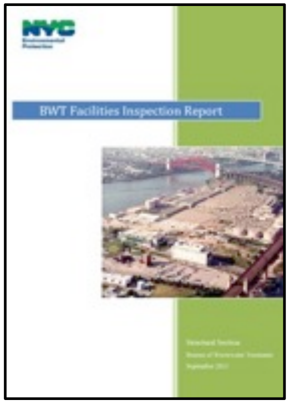
Summary of Recent Work

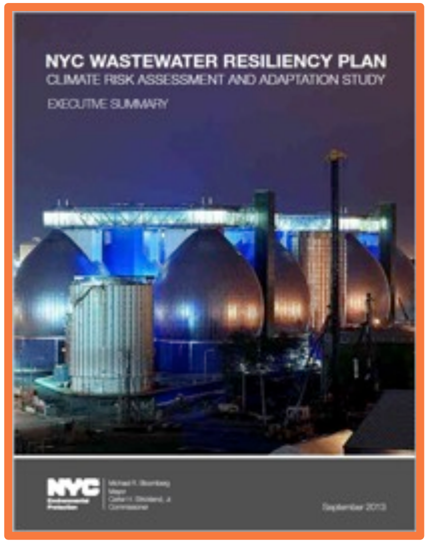
KEY OBJECTIVES:

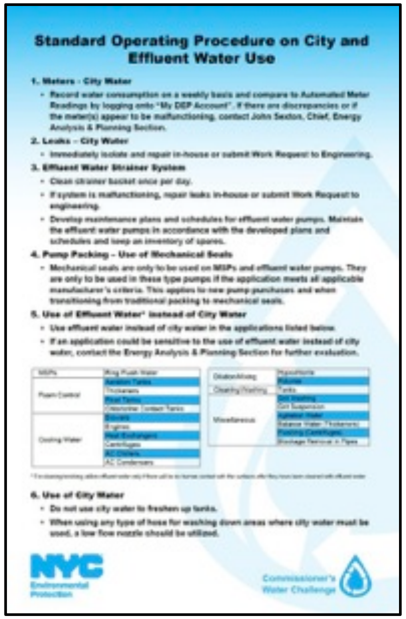
- Summarize major upgrades and capital investments
- Review key findings from recent studies which may impact plant reliability or efficiency
- Correlate findings to inform recommendations for future projects

Summary of Recent Work







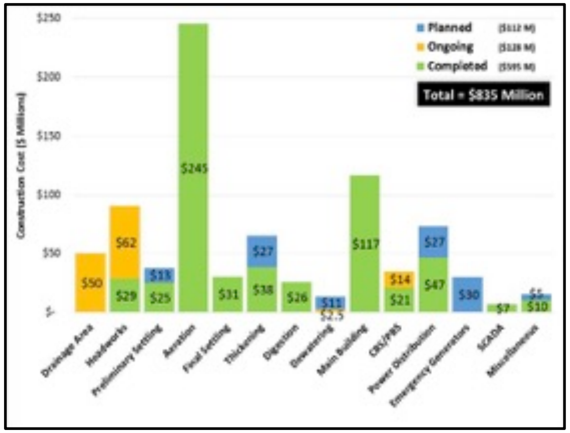


Standard Operating Procedure on City and Effluent Water Use

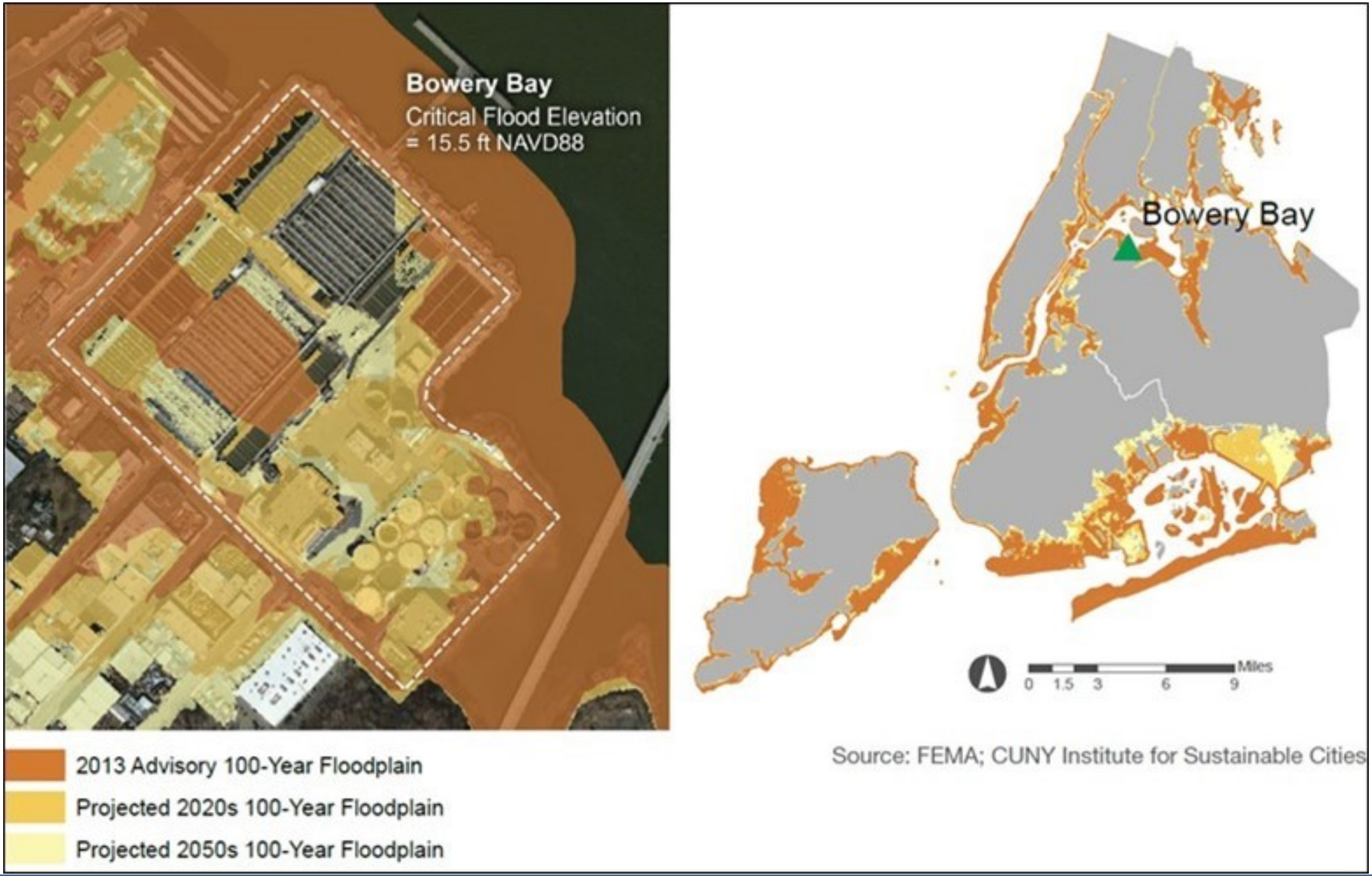
1. Meters - City Water
   - Record water consumption on a weekly basis and compare to Automated Meter Readings by logging onto "My DEP Account". If there are discrepancies or if the meter(s) appear to be malfunctioning, contact John Sexton, Chief, Energy Analysis & Planning Section.
2. Leaks - City Water
   - Immediately isolate and repair in-house or submit Work Request to Engineering.
3. Effluent Water Strainer System
   - Clean strainer basket once per day.
   - If system is malfunctioning, repair leaks in-house or submit Work Request to engineering.
   - Develop maintenance plans and schedules for effluent water pumps. Maintain the effluent water pumps in accordance with the developed plans and schedules and keep an inventory of spares.
4. Pump Packing - Use of Mechanical Seals
   - Mechanical seals are only to be used on MSPs and effluent water pumps. They are only to be used in these type pumps if the application meets all applicable manufacturer's criteria. This applies to new pump purchases and when transitioning from traditional packing to mechanical seals.
5. Use of Effluent Water* instead of City Water
   - Use effluent water instead of city water in the applications listed below.
   - If an application could be sensitive to the use of effluent water instead of city water, contact the Energy Analysis & Planning Section for further evaluation.
6. Use of City Water
   - Do not use city water to freshen up tanks.
   - When using any type of hose for washing down areas where city water must be used, a low flow nozzle should be utilized.

NYC Environmental Protection

Commissioner's Water Challenge



Summary of Recent Work



State of Good Repair (SOGR) Needs

State of Good Repair (SOGR) Needs

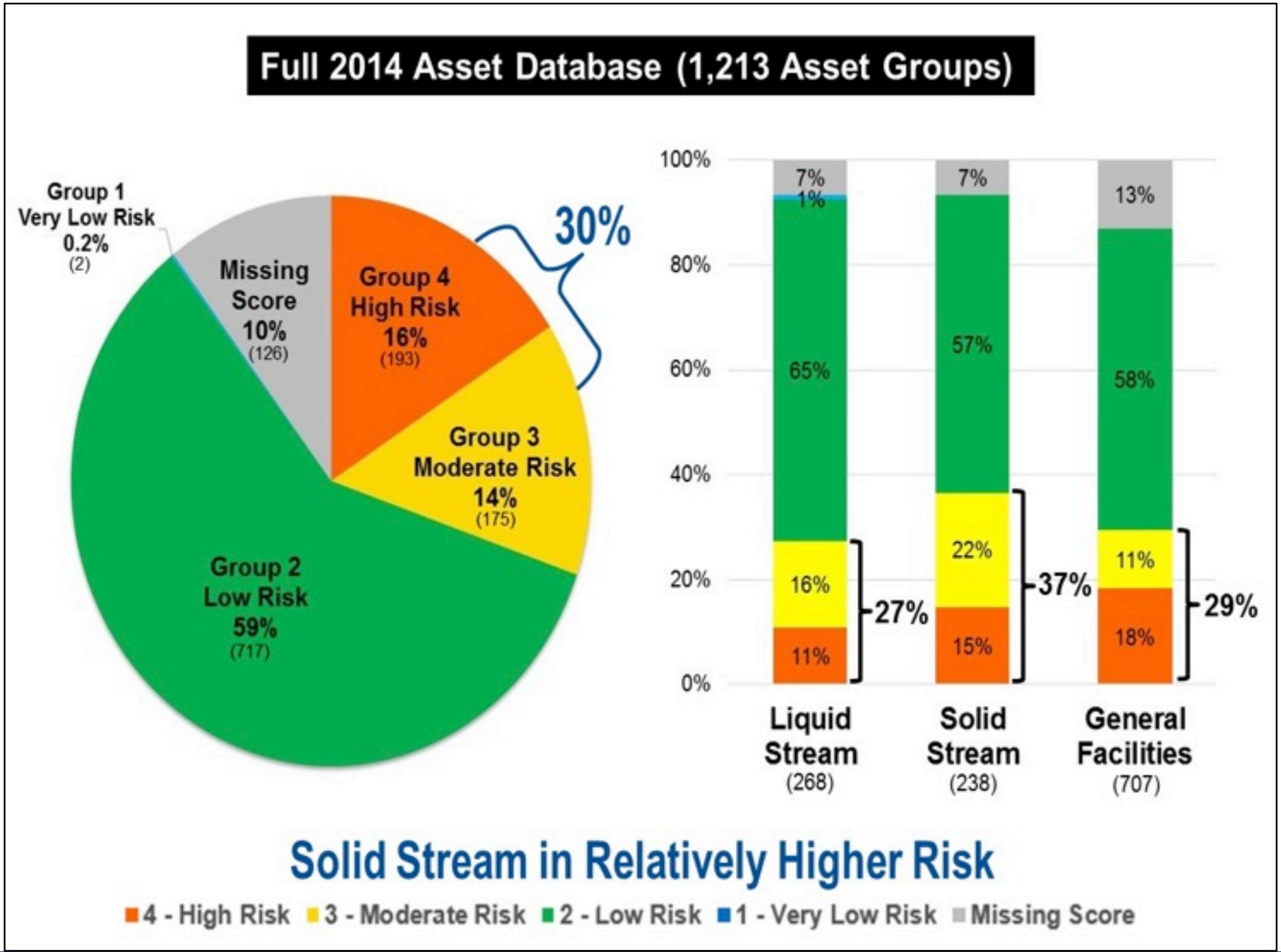
KEY OBJECTIVES:

- Review asset assessment and risk scoring framework
- Summarize 2009 and 2014 results
- Develop candidate list of SOGR projects
- Identify synergies with storm surge resiliency needs
- Correlate findings with previous chapter to inform future capital projects

State of Good Repair (SOGR) Needs

Asset condition assessment and risk scoring framework

State of Good Repair (SOGR) Needs



Regulatory and Programmatic Drivers

Regulatory and Programmatic Drivers

KEY OBJECTIVES:

- Determine impact of near-term and long-term regulations (speculation)
- Assess programmatic drivers for more efficient processes
- Determine buildable envelope
  - Including utilizing land in surrounding area
- Code review of existing buildings
- Determine regulatory and programmatic triggers

Regulatory and Programmatic Drivers

Technology		Limit of Technology		Limit Type
		mg/L	lb/day	
Full-Step BNR w/ Carbon	2017	9-9.5	8,500	TMDL trigger limit
	2040	9-9.5	10,000	TMDL trigger limit
Battery E Effluent TN		6.5	7,000	Assumed numerical limit trigger
Battery E w/ DN Filter or MBBR/DAF		3.5	3,500	Assumed numerical limit trigger

Regulatory and Programmatic Drivers

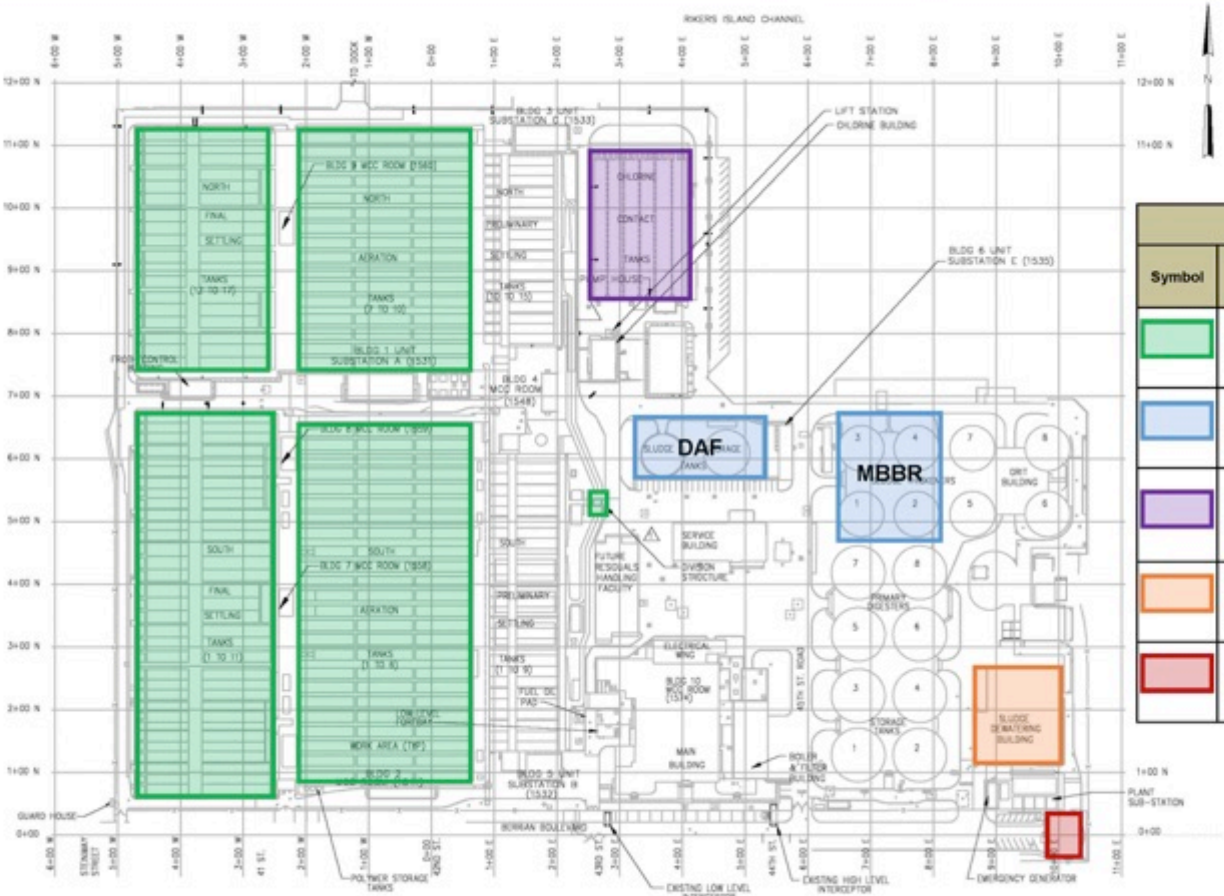
Regulated Effluent	Current Limit	Proposed Limit	Compliance Alternatives	Next Steps
TRC	2.0 mg/L	0.19 mg/L	Chlor/dechlor UV disinfection Ozonation	Continue Integrated Planning Studies
Enterococcus	n/a	130 CFU/100 mL daily 35 CFU/100 mL monthly	Increased chlorination UV disinfection Ozonation	Continue Integrated Planning Studies
Cyanide	75 lb/d	13 lb/d	Application of water effect ratio to increase limit by a factor of 2.7	Collaboration and approval from DEC

Regulatory and Programmatic Drivers

Regulated Effluent	Current Limit	Compliance Alternatives
Class A or B Biosolids	n/a	PSRP or PFRP processes
Superfund	n/a	Increased CSO controls
Nitrous Oxide	n/a	Alternative SCT processes
Trace Organics	n/a	Filtration, activated carbon, and/or AOP
Phosphorus	n/a	Biological, Physical Chemical, Removals/Nutrient Recovery

Regulatory and Programmatic Drivers

Bowery Bay WWTP Long-Term Site Plan
(in Response to Regulatory and Programmatic Drivers)



LEGEND				
Symbol	**Capital Project**	**Process Area**	**Regulatory or Programmatic Trigger**	**Anticipated Term**
	Battery E Level of Treatment	Aeration, Final Settling	Effluent TN Limit < 6.2 mg/L	Mid
	MBBR and DAF	Tertiary Treatment	Effluent TN Limit < 4.5 mg/L; reduced effluent NH_3 limit	Long
	UV Disinfection	Disinfection	Inclusion of coliphage as indicator organism; trouble meeting TRC limit	Long
	Gravity Belt Thickeners (GBT)	Solids Handling and Dewatering	Class B biosolids	Mid
	Main Substation	Power Distribution and Emergency Generation	Implementation of GBTs and/or UV disinfection	Mid-Long

Optimization Evaluations

Optimization Evaluations

KEY OBJECTIVES:

- Identify opportunities to improve performance or efficiency
- Evaluate using process and energy modeling
- Select optimization concepts that are sufficiently beneficial to implement

Optimization Evaluations

Relocate BB sludge to WI for dewatering

Sidestream treatment with ANAMMOX processes

Ammonia-based DO control

Incorporate baffle walls in final settling tanks

Gravity belt thickeners (GBTs) for WAS thickening

Chemically enhanced primary treatment (CEPT)

Sidestream returns

Hydraulic balancing of flow (hydraulic model development)

Optimization Evaluations (Courtesy BWT)

Spare centrifuge capacity at WI

- 2016: from 2.3 MGD to 4.3 MGD[1]

BB sludge flow: 0.53 MGD[2]

Opportunity for cost savings

Proposed:

- Shutdown BB dewatering
- Transship sludge to WI WWTP
- Consider advanced treatment for centrate

Analysis:

1. Impact on BNR and TMDL - **OK**
2. Chemical usage - **REDUCED**
3. Dewatering capacity at WI - **SUFFICIENT**
4. Sludge Storage Capacity at WI and BB - **SUFFICIENT**
5. Sludge Marine Vessel availability– **SUFFICIENT (SOME SCENARIOS)**
6. ANITA-Mox Requirements – **OVERALL SAVINGS**

Notes:
1. 12 out of 16 centrifuges in operation at WI for a 4.3 MGD hydraulic treatment capacity.
2. 0.53 MGD based on data from 7/1/2012 to 4/30/2013.

Optimization Evaluations (Courtesy BWT)

BB dewatering shut down + sludge/centrate to WI with ANITA-Mox:

Item	Capital	O&M
Barge (fuel & crew)	$0	($1.2 M)
Energy for dewatering (elect, fuel oil, gas)	$0	$0.3 M
Energy for new ANITA-Mox pumps/mixer	$0	($0.1)
Chemicals (polymer, glycerol, alkalinity)	$0	$4.7 M
Maintenance of BB dewatering Facility	$0	$0.3 M
Energy for Aeration	$0	$0.3
Planned Capital investments and Repair	$24.5 M	$0 M
Resiliency	$4.0 M	$0.08 M
ANITA-Mox Facilities	($21 M)	$0 M
Subtotal Savings	$7.5 M	$4.4 M

Annualized Projected Savings (over 20 years)* = $3.7 million per year

*Note: For 20-Year NPV Cost Analysis use 3% interest rate

Emerging Technology

Emerging Technology

KEY OBJECTIVES:

Summarize the key emerging and innovative technologies applicable to the Bowery Bay WWTP

Provide insights into creating a resource recovery facility of the future at the Bowery Bay WWTP

Emerging Technology

Nitrogen

- Mainstream Nitritation and Denitritation
- Mainstream deammonification
- Aerobic granular sludge

Disinfection

- UV (Disinfection)
- UV-H_2O_2 (AOP)
- Ozonation (AOP)
- Biological activated carbon

Resource Recovery

- Nutrient Recovery – Struvite harvesting
- Energy Recovery – Boilers
- Energy Recovery - Internal Combustion Engine
- Energy Recovery- Combustion gas turbine/ Microturbine

Wet Weather

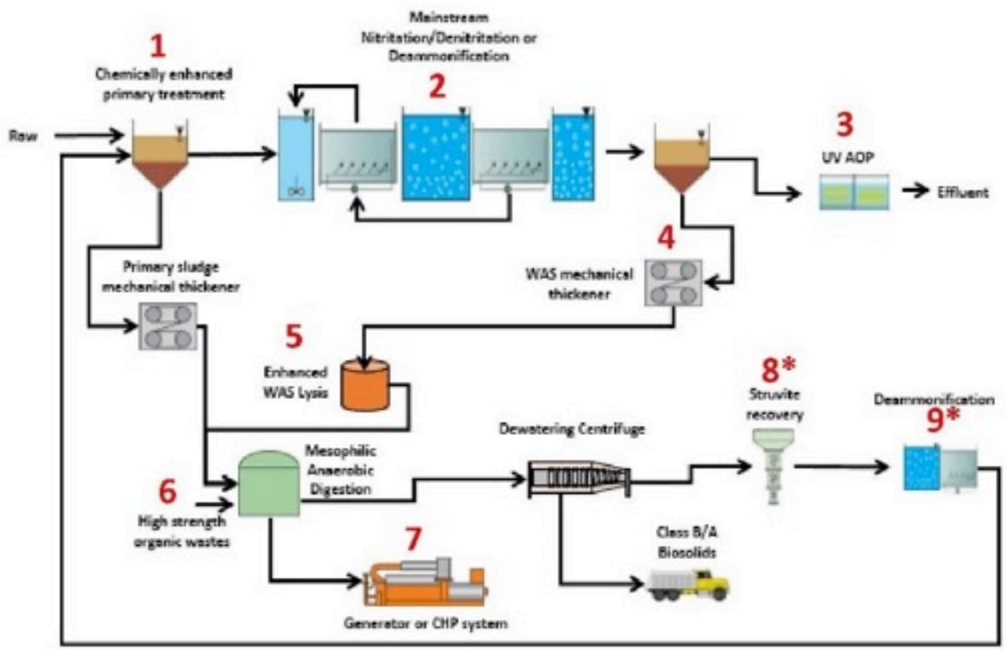
- DensaDeg™ (Ballasted flocculation)
- Actiflo™ (Ballasted flocculation)
- CoMag™ (Ballasted flocculation)
- Microscreens

Class A/B Biosolids

- Co-digestion of high-strength, organic wastes
- Enhanced municipal solids lysis - Thermal hydrolysis
- Enhanced municipal solids lysis – Chemical, mechanical, electrical WAS lysis

Emerging Technology

New York City Plant of the Future



Moving forward, it is recommended that a conceptual level planning estimate and business case evaluations be performed to help prioritize which of these emerging technologies are suited for application at Bowery Bay.

Drivers for Emerging Technology Upgrades

1) **Chemically Enhanced Primary Treatment** to meet future wet weather capacity.
2) **Mainstream Deammonification/SND** to meet lower TN limits and reduce energy & chemical costs (OneNYC).
3) **UV AOP** to remove CECs and inactivate coliphage.
4) **WAS Mechanical Thickening** to reduce sludge production and increase digester capacity to produce Class B biosolids.
5) **Enhanced WAS Lysis** to reduce sludge production and increase biogas/energy production and help meet OneNYC goals
6) **Co-digestion** of source separated organic waste to increase biogas/energy and help meet OneNYC goals.
7) **CHP** – use of high efficiency, low emissions engines to help attain energy neutral operations and meet OneNYC goals.
8) **Struvite Recovery** to reduce O&M costs related to nuisance struvite control/removal and help meet OneNYC goals.
9) **SCT Deammonification** – reduce energy and chemicals costs of current SCT and help meet OneNYC goals.(* Not included at plants without dewatering).

Summary

Summary

KEY OBJECTIVES:

- Summarize and synthesize the insights
- Provide a list of needs to assist NYCDEP decision makers
- Present order-of-magnitude capital costs

Summary

Process Area	Completed and Ongoing: Prior 10 Years Completed Investments ($M)	Completed and Ongoing: Active Work (Ongoing) ($M)	Completed and Ongoing: Total Completed and Ongoing ($M)	Existing Plan: Existing 10-yr CIP ($M)	Existing Plan: Backlogged Work Orders ($M)	Existing Plan: Total Existing 10-yr CIP and Backlogged Work Orders ($M)	Recommended Plan: Short-Term (2015 - 2020) ($M): Description of Investments	Recommended Plan: Short-Term (2015 - 2020) ($M): Investments ($M) (G)	Recommended Plan: Mid-Term (2020 - 2025) ($M): Description of Investments	Recommended Plan: Mid-Term (2020 - 2025) ($M): Investments ($M) (H)	Recommended Plan: Total Revised 10-yr CIP ($M)	Recommended Plan: Long-Term (2025 - 2040) ($M): Description of Investments	Recommended Plan: Long-Term (2025 - 2040) ($M): Investments ($M) (J)	Recommended Plan: Total Revised 25-yr CIP ($M)
	A	B	C=A+B	D	E	F=D+E					I=F+G+H			K=I+J
Aeration	$239 M	$15 M	**$254 M**	$0 M	$0.2 M	**$0.2 M**	(1) Process air improvements for leaking piping and I&C error	$0.2 M	(1) Replace membrane diffusers (further study needed), resulting in expected **energy savings of $0.25 M/yr** (1.3% of annual expense total (FY13))	$6.5 M	**$6.9 M**	(1) Ammonia-based DO control (**O&M savings of $0.06 M/yr** (0.3% of annual expense total (FY13))) (2) MBBR and DAF	$102 M	**$109 M**
Main Building	$116 M	$0.1 M	**$116 M**	$3.9 M	$0.2 M	**$4.1 M**	(1) Storm surge resiliency needs (2) Work orders for broken windows, and egress and monitoring improvements	$1.8 M	(1) Lab and door repairs (2) Defer BB-226 (Pump and Blower Building) to long-term	$0.03 M - $3.9 M	**$2.0 M**	(1) BB-226 (Pump and Blower Building)	$3.94 M	**$5.9 M**
Sludge Handling and Dewatering	$64 M	$13 M	**$77 M**	$30 M	$30 M	**$60 M**	(1) Grit Bldg storm surge resiliency needs (2) SOGR needs for seal water pumps, basement condensate system, and HVAC repairs (3) Decommission Dewatering Bldg (**O&M savings of $0.9 M/yr** (4.6% of annual expense total (FY13))) (4) Decommission Dewatering facility once WI and HP centrifuge upgrades complete, resulting in energy, chemical, SMV, and personnel **savings of $0.9 M/yr** (4.6% of annual expense total (FY13))	$2 M	(1) Implement GBTs under BB-218, resulting in **SMV savings of $0.45 M/yr** (2.1% of annual expense total (FY13)) (2) Eliminate BB-223	$30 M - $3 M	**$89 M**	(1) Sidestream return monitoring (2) CHP (further study needed) (**O&M savings of $2.2 M/yr** (11.3% of annual expense total (FY13))) (3) Phosphorus recovery (4) Codigesting of high-strength waste (further study needed) (5) Enhanced WAS lysis	$174 M	**$263 M**
Power Distribution and Emergency Generation	$46 M	$0.0 M	**$46 M**	$65 M	$0.1 M	**$65 M**	(1) Storm surge resiliency needs (2) Various electrical improvements (MCC 1554A, USS 1534, battery charger for 130V DC system) (3) Generator area repairs (4) Acquire land on dead-end portion of Berrien Blvd to accommodate future electrical work	$7.5 M	(1) Defer BB-220 E-gen work to long-term and combine with potential substation work due to future regulatory drivers	- $30 M	**$43 M**	(1) BB-220 (2) Solar panels (3) New main substation	$67 M	**$110 M**
Plant Facilities	$39 M	$1.2 M	**$40 M**	$5.7 M	$0.8 M	**$6.5 M**	(1) Storm surge resiliency needs (2) Service and Admin Bldg improvements (3) Sea wall and dock work orders (4) Misc galleries and HVAC work orders (5) Misc site upgrades	$38.3 M	(1) Defer BB-221 for exterior lighting to long-term (2) Remaining FY15 capital investment for BB-205 ($0.7 M) considered completed	- $5.7 M	**$39 M**	(1) BB-221	$5 M	**$44 M**
Final Settling	$30 M	$0.6 M	**$31 M**	$5.9 M	$0.9 M	**$6.8 M**	(1) FST gates and scum and WAS pumps (2) Mixers in aerator effluent channel	$1.1 M			**$7.9 M**	(1) FST baffle improvements (**additional O&M of $0.05 M/yr** (0.3% of annual expense total (FY13)))	$3.8 M	**$12 M**
Headworks	$29 M	$50 M	**$79 M**	$59 M	$0.5 M	**$60 M**	(1) Storm surge resiliency needs (2) MSP trolley and HVAC repairs (3) Screen area needs	$2.1 M	(1) Remaining FY15 capital investment for BB-209 ($0.6 M) considered completed	- $0.6 M	**$61 M**			**$61 M**
Primary Treatment	$25 M	$0.0 M	**$25 M**	$20 M	$1.4 M	**$21 M**	(1) PST needs (2) Secondary bypass upgrade	$1.8 M			**$23 M**	(1) Microscreen filters for increased capacity	$41 M	**$64 M**
Disinfection	$0 M	$0 M	**$0 M**	$0 M	$0.1 M	**$0.1 M**	(1) Storm surge resiliency needs (2) Outfall inspection and repair (3) CCT dewatering system	$0.5 M	(1) Chlor / Dechlor improvements	$18 M	**$19 M**	(1) UV disinfection (provisions for AOP) (2) Increased wet-weather capacity (further study needed)	$150 M	**$169 M**
Total	$587 M	$80 M	**$667 M**	$190 M	$34 M	**$224 M**	$55.3 M		$11.3 M		**$291 M**	$547 M		**$838 M**

Acknowledgments

DEP-BWT

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Hazen and Sawyer

Paul Saurer

Ben Levin

Anni Luck

Tom McEnerney

Rob Sharp

Bob Frost

Sarah Galst

Ron Latimer

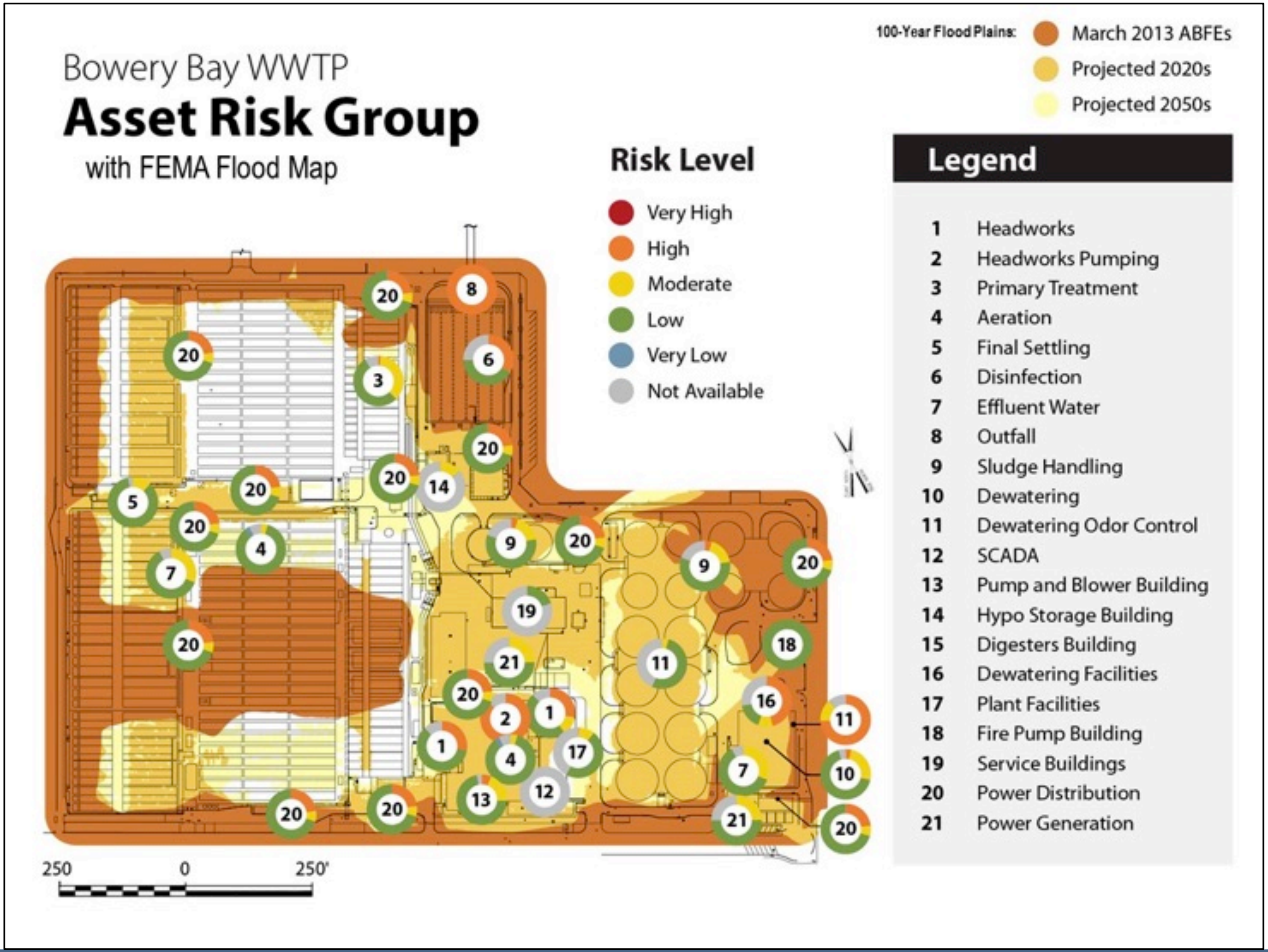
Paul Pitt

Wendell Khunjar

Bullpen

Summary of Recent Work

State of Good Repair (SOGR) Needs



Regulatory and Programmatic Drivers

Enterococcus

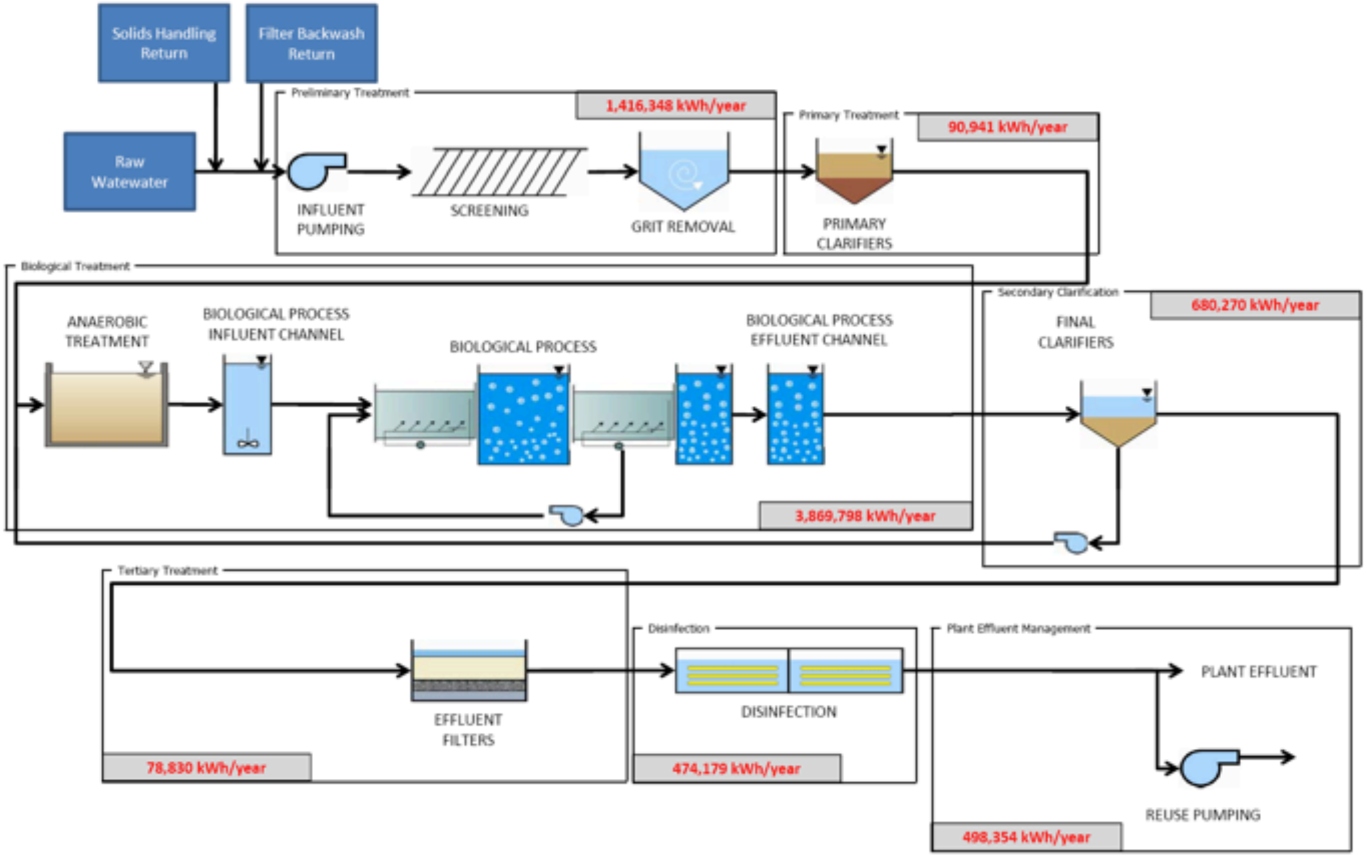
	BAV - daily average	BAV - monthly average
Federal Standard	110-130 CFU/100 mL	N/A
Anticipated Bowery Bay Limit	~130 CFU/100 mL	35 CFU/100 mL

**BAV = Beach Action Value*

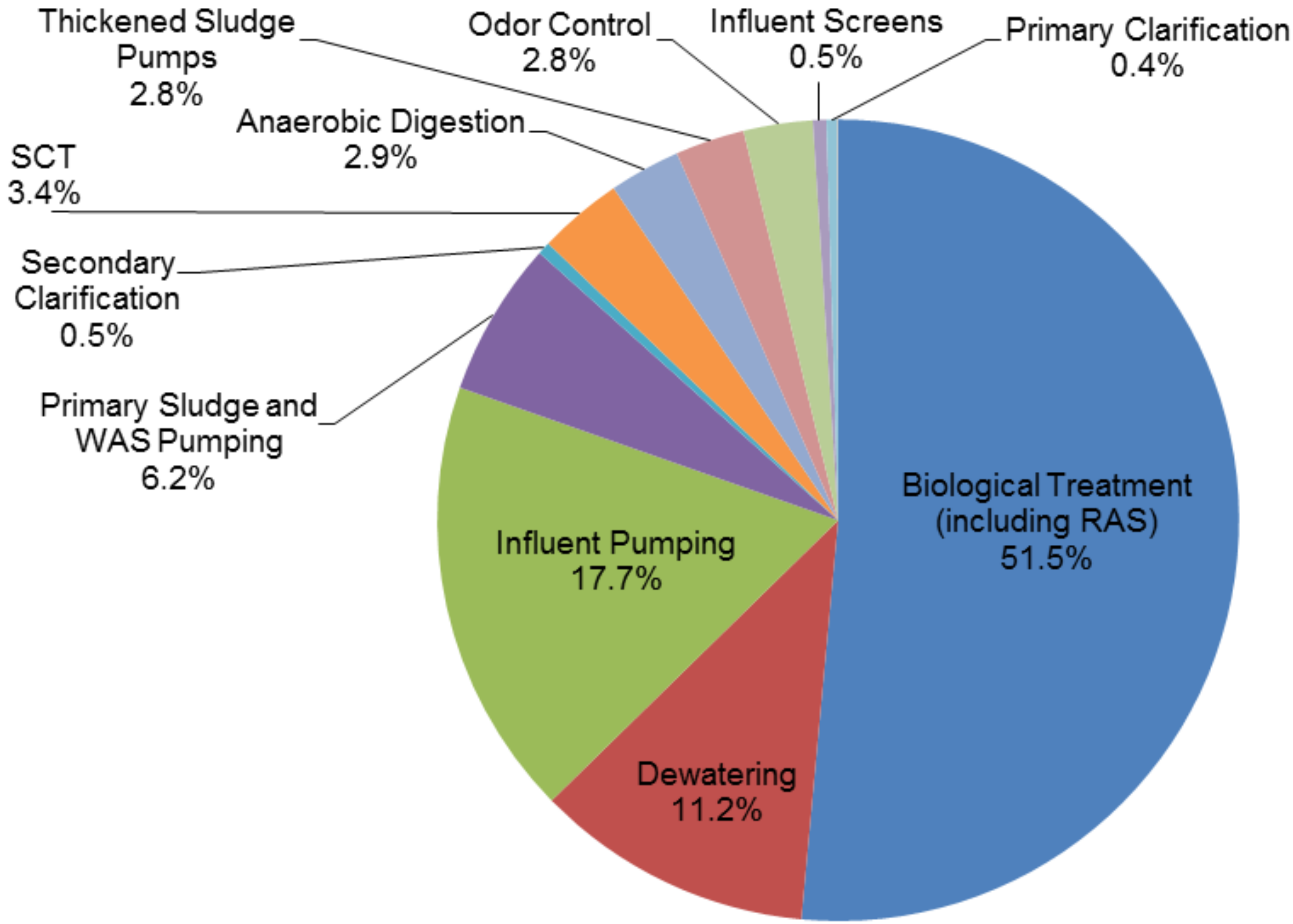
Couple with TRC: dechlor or UV/ozone

Optimization Evaluations

HEET Model:



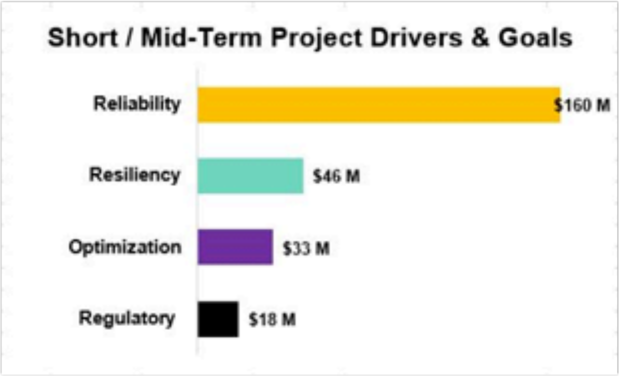
Optimization Evaluations



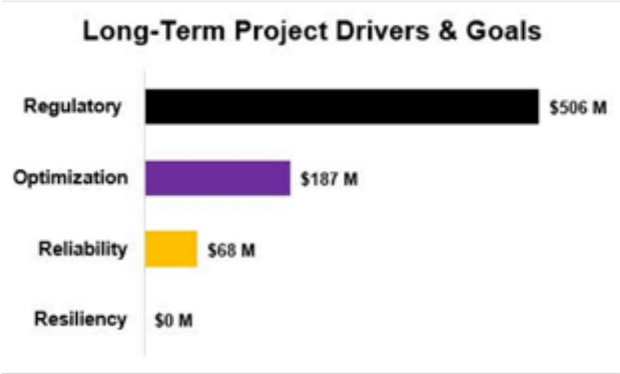
Hazen

Summary

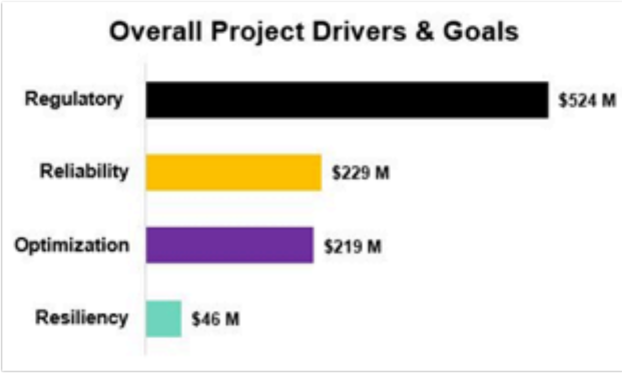

Short-Term
$173 M
Total
$257 M
Mid-Term
$84 M
Recommended 10-Year CIP


Short / Mid-Term Project Drivers & Goals
Reliability
$160 M
Resiliency
$46 M
Optimization
$33 M
Regulatory
$18 M

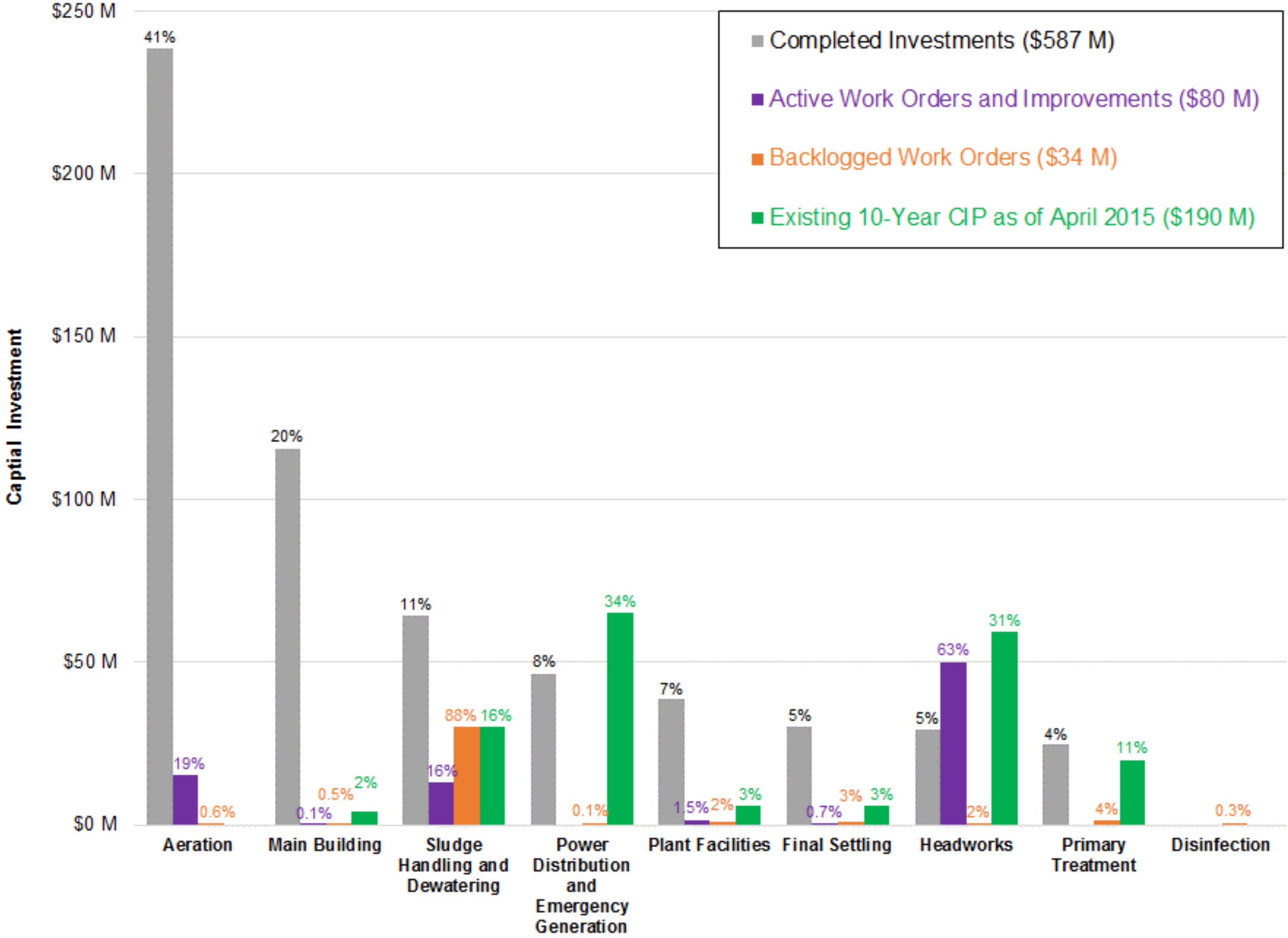

Long-Term
Only
Total
$761 M
25-Year CIP - Long-Term Projects


Long-Term Project Drivers & Goals
Regulatory
$506 M
Optimization
$187 M
Reliability
$68 M
Resiliency
$0 M


Long-Term
$761 M
Total
$1,018 M
Mid-Term
$84 M
Short-Term
$173 M
Proposed 25-Year CIP

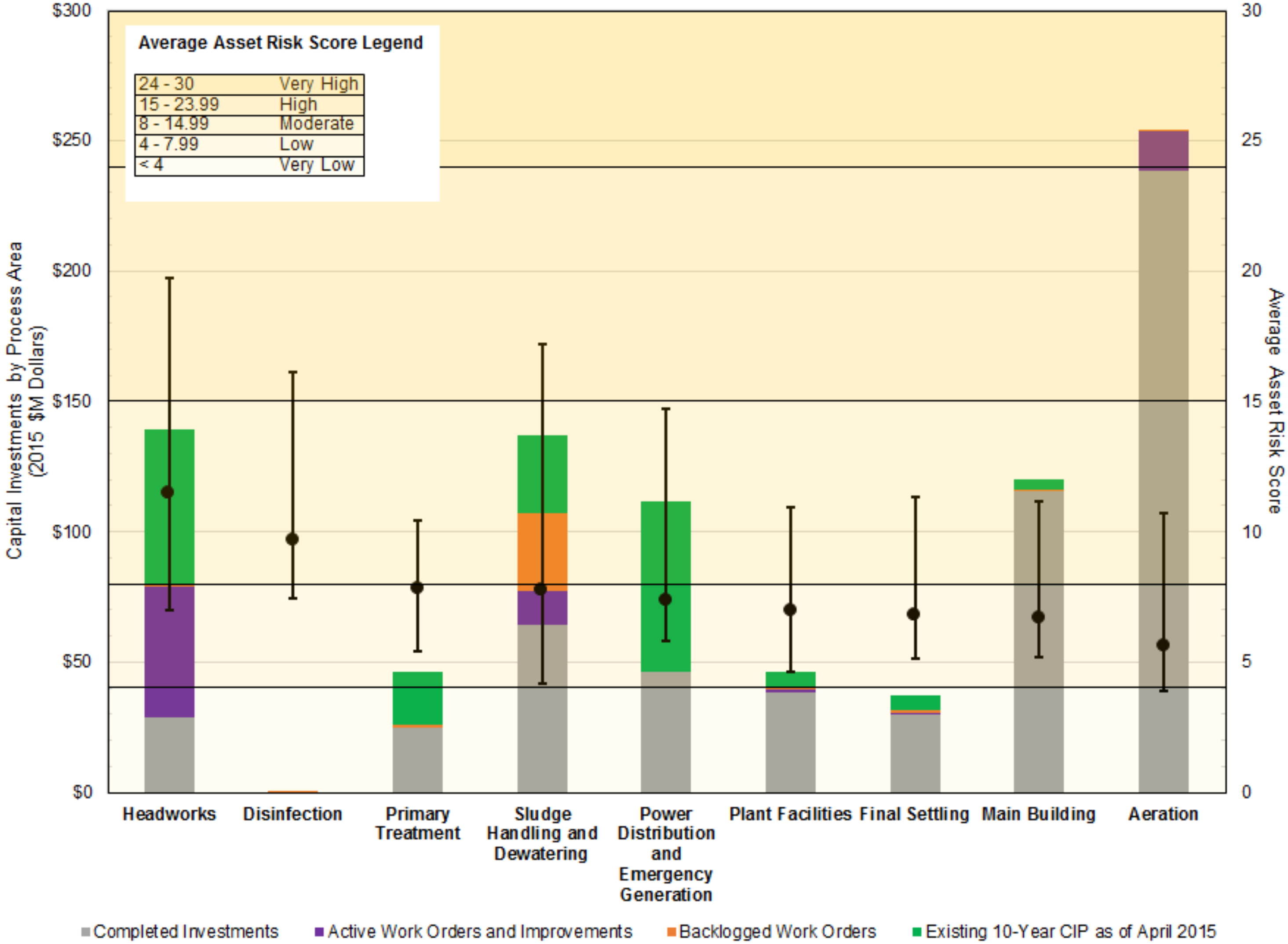

Overall Project Drivers & Goals
Regulatory
$524 M
Reliability
$229 M
Optimization
$219 M
Resiliency
$46 M

Summary



Capital Investment
$250 M
$200 M
$150 M
$100 M
$50 M
$0 M
Completed Investments ($587 M)
Active Work Orders and Improvements ($80 M)
Backlogged Work Orders ($34 M)
Existing 10-Year CIP as of April 2015 ($190 M)
Aeration: 41% 19% 0.6%
Main Building: 20% 0.1% 0.5% 2%
Sludge Handling and Dewatering: 11% 16% 88% 16%
Power Distribution and Emergency Generation: 8% 0.1% 34%
Plant Facilities: 7% 1.5% 2% 3%
Final Settling: 5% 0.7% 3% 3%
Headworks: 5% 63% 2% 31%
Primary Treatment: 4% 4% 11%
Disinfection: 0.3%

Summary



Average Asset Risk Score Legend
24 - 30 Very High
15 - 23.99 High
8 - 14.99 Moderate
4 - 7.99 Low
< 4 Very Low
$300
$250
$200
$150
$100
$50
$0
30
25
20
15
10
5
0
Capital Investments by Process Area (2015 $M Dollars)
Average Asset Risk Score
Headworks
Disinfection
Primary Treatment
Sludge Handling and Dewatering
Power Distribution and Emergency Generation
Plant Facilities
Final Settling
Main Building
Aeration
Completed Investments
Active Work Orders and Improvements
Backlogged Work Orders
Existing 10-Year CIP as of April 2015

Summary

Process Area	Completed and Ongoing		
	Prior 10 Years Completed Investments ($M)	Active Work (Ongoing) ($M)	**Total Completed and Ongoing ($M)**
	A	B	**C=A+B**
Aeration	$239 M	$15 M	**$254 M**
Main Building	$116 M	$0.1 M	**$116 M**
Sludge Handling and Dewatering	$64 M	$13 M	**$77 M**
Power Distribution and Emergency Generation	$46 M	$0.0 M	**$46 M**
Plant Facilities	$39 M	$1.2 M	**$40 M**
Final Settling	$30 M	$0.6 M	**$31 M**
Headworks	$29 M	$50 M	**$79 M**
Primary Treatment	$25 M	$0.0 M	**$25 M**
Disinfection	$0 M	$0 M	**$0 M**
Total	$587 M	$80 M	**$667 M**

Summary

Process Area	Existing Plan		
	Existing 10-yr CIP ($M)	Backlogged Work Orders ($M)	**Total Existing 10-yr CIP and Backlogged Work Orders ($M)**
	D	E	**F=D+E**
Aeration	$0 M	$0.2 M	**$0.2 M**
Main Building	$3.9 M	$0.2 M	**$4.1 M**
Sludge Handling and Dewatering	$30 M	$30 M	**$60 M**
Power Distribution and Emergency Generation	$65 M	$0.1 M	**$65 M**
Plant Facilities	$5.7 M	$0.8 M	**$6.5 M**
Final Settling	$5.9 M	$0.9 M	**$6.8 M**
Headworks	$59 M	$0.5 M	**$60 M**
Primary Treatment	$20 M	$1.4 M	**$21 M**
Disinfection	$0 M	$0.1 M	**$0.1 M**
Total	$190 M	$34 M	**$224 M**

Summary

Process Area	Recommended Plan							
	Short-Term (2015 - 2020) ($M)		Mid-Term (2020 - 2025) ($M)		Total Revised 10-yr CIP ($M)	Long-Term (2025 - 2040) ($M)		Total Revised 25-yr CIP ($M)
	Description of Investments	Investments ($M) (G)	Description of Investments	Investments ($M) (H)	I=F+G+H	Description of Investments	Investments ($M) (J)	K=I+J
Aeration	(1) Process air improvements for leaking piping and I&C error	$0.2 M	(1) Replace membrane diffusers (further study needed), resulting in expected energy savings of $0.25 M/yr (1.3% of annual expense total (FY13))	$6.5 M	$6.9 M	(1) Ammonia-based DO control (O&M savings of $0.06 M/yr (0.3% of annual expense total (FY13))) (2) MBBR and DAF	$77 M	$8.9 M
Main Building	(1) Storm surge resiliency needs (2) Work orders for broken windows, and egress and monitoring improvements	$1.8 M	(1) Lab and door repairs (2) Defer BB-226 (Pump and Blower Building) to long-term	$0.03 M - $3.9 M	$2.0 M	(1) BB-226 (Pump and Blower Building)	$3.94 M	$5.9 M
Sludge Handling and Dewatering	(1) Grit Bldg storm surge resiliency needs (2) SOGR needs for seal water pumps, basement condensate system, and HVAC repairs (3) Decommission Dewatering Bldg (O&M savings of $0.9 M/yr (4.6% of annual expense total (FY13))) (4) Decommission Dewatering facility once WI and HP centrifuge upgrades complete, resulting in energy, chemical, SMV, and personnel savings of $0.9 M/yr (4.6% of annual expense total (FY13))	$2 M	(1) Implement GBTs under BB-218, resulting in SMV savings of $0.45 M/yr (2.1% of annual expense total (FY13)) (2) Eliminate BB-223	$30 M - $3 M	$89 M	(1) Sidestream return monitoring (2) CHP (further study needed) (O&M savings of $2.2 M/yr (11.3% of annual expense total (FY13))) (3) Phosphorus recovery (4) Codigesting of high-strength waste (further study needed) (5) Enhanced WAS lysis	$174 M	$263 M
Power Distribution and Emergency Generation	(1) Storm surge resiliency needs (2) Various electrical improvements (MCC 1554A, USS 1534, battery charger for 130V DC system) (3) Generator area repairs (4) Acquire land on dead end portion of Berrien Blvd to accommodate future electrical work	$7.5 M	(1) Defer BB-220 E-gen work to long-term and combine with potential substation work due to future regulatory drivers	- $30 M	$43 M	(1) BB-220 (2) Solar panels (3) New main substation	$67 M	$110 M
Plant Facilities	(1) Storm surge resiliency needs (2) Service and Admin Bldg improvements (3) Sea wall and dock work orders (4) Misc galleries and HVAC work orders (5) Misc site upgrades	$38.3 M	(1) Defer BB-221 for exterior lighting to long-term (2) Remaining FY15 capital investment for BB-205 ($0.7 M) considered completed	- $5.7 M	$39 M	(1) BB-221	$5 M	$44 M
Final Settling	(1) FST gates and scum and WAS pumps (2) Mixers in aerator effluent channel	$1.1 M			$7.9 M	(1) FST baffle improvements (additional O&M of $0.06 M/yr (0.3% of annual expense total (FY13)))	$3.8 M	$12 M
Headworks	(1) Storm surge resiliency needs (2) MSP trolley and HVAC repairs (3) Screen area needs	$2.1 M	(1) Remaining FY15 capital investment for BB-209 ($0.6 M) considered completed	- $0.6 M	$61 M	(1) Increased wet-weather capacity	$240 M	$301 M
Primary Treatment	(1) PST needs (2) Secondary bypass upgrade	$1.8 M			$23 M	(1) Microscreen filters for increased capacity	$41 M	$64 M
Disinfection	(1) Storm surge resiliency needs (2) Outfall inspection and repair (3) CCT dewatering system	$0.5 M	(1) Chlor / Dechlor improvements	$18 M	$19 M	(1) UV disinfection (provisions for AOP) (2) Increased wet-weather capacity (further study needed)	$150 M	$169 M
Total	$55.3 M		$11.3 M		$291 M	$761 M		$977 M