BACWA Workshop #2: Nutrient Reduction by Treatment Optimization and Upgrades Update

7 June 2017

HDR

Brown AND Caldwell

BACWA BAY AREA CLEAN WATER AGENCIES

Agenda

1. Background
2. Case Studies
3. Draft Findings of Nutrient Removal Reports
   a) Optimization
   b) Sidestream
   c) Upgrades
   d) No Net Load Increase
4. Key Variables that Impact Results
5. Regulatory: N versus P
6. Results of Recycled Water/CIP Surveys
7. Sea Level Rise
8. Next Steps

Project Background

Watershed Permit

CALIFORNIA
Water Boards

EDMUND G. BROWN JR.
GOVERNOR

MATTHEW RODRIQUEZ
SECRETARY FOR
ENVIRONMENTAL PROTECTION

San Francisco Bay Regional Water Quality Control Board

ORDER No. R2-2014-0014
NPDES No. CA0038873

WASTE DISCHARGE REQUIREMENTS FOR NUTRIENTS FROM MUNICIPAL WASTEWATER DISCHARGES TO SAN FRANCISCO BAY

The following dischargers are subject to waste discharge requirements (WDRs) set forth in this Order, for the purpose of regulating nutrient discharges to San Francisco Bay and its contiguous bay segments:

Table 1. Discharger Information

Discharger	Facility Name	Facility Address	Minor/ Major
		151 Mazzotta Court	

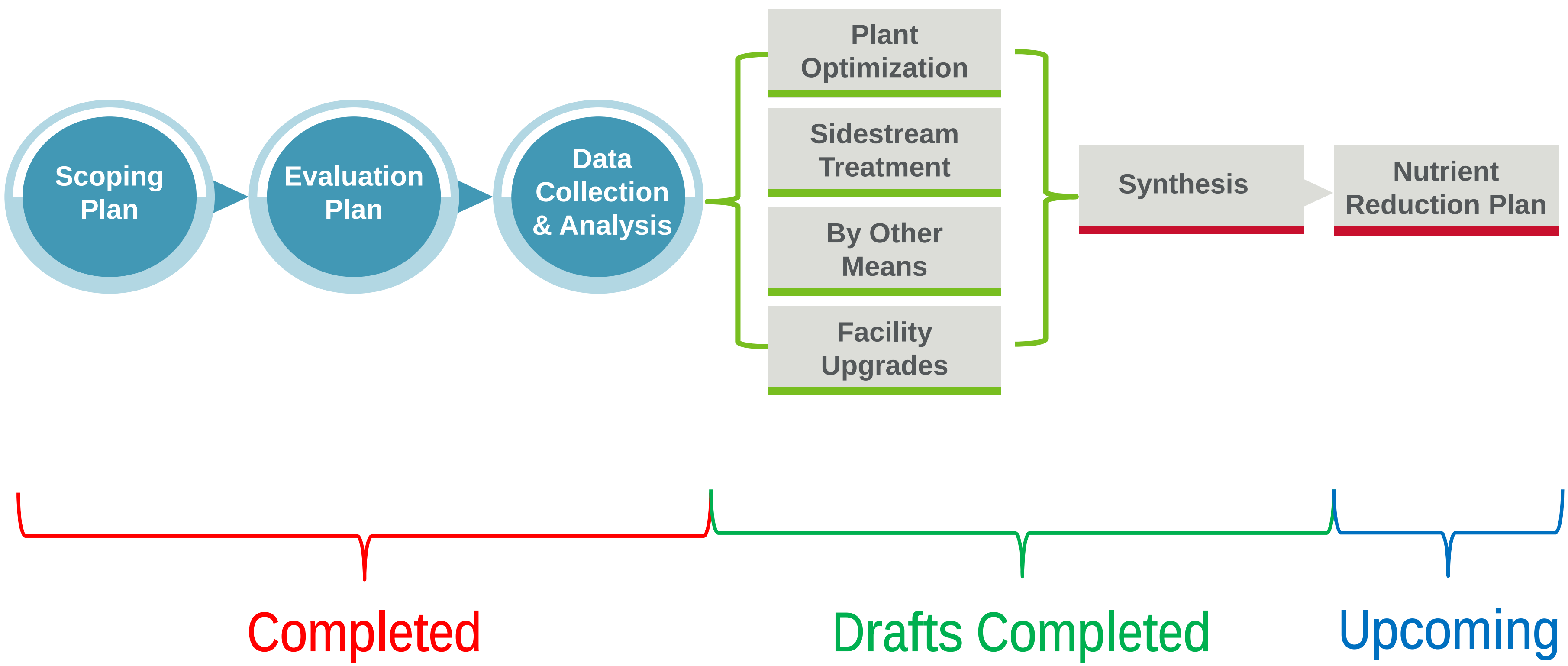
April 9, 2014

Watershed Permit Requirements

- Issued April 9, 2014 – Regional Water Board Order No. R2-2014-0014
- Requirements:
  - Scoping and Evaluation Plan (Accepted first quarter of 2015)
  - July 2018: Task 1 - Conduct treatment plant optimization and sidestream treatment evaluation for nutrient load reductions (Submittal deadline is July 2018)
  - July 2018: Task 2 - Conduct treatment plant upgrades and analysis of removal by other means for nutrient load reductions (Submittal deadline is July 2018)
  - Annual Reporting (Annual submittal in October from 2015 through 2018)

37 Participating Agencies

Overview / Status of Study



Treatment Levels

Level	Study	Ammonia	TN	TP
Level 1 *	Optimization	--	--	--
Level 2 *	Upgrades	2 mg N/L	15 mg N/L	1.0 mg P/L
Level 3 *	Upgrades	2 mg N/L	6 mg N/L	0.3 mg P/L

* The seasonal impacts will be considered for all three treatment levels:

- Dry Season = May 1 to September 30
- Wet Season = October 1 to April 30

Optimization Approach

- Basis of Evaluation
  - Identify no / low cost strategies to reduce effluent nutrients
  - Planning Period: 2025 Horizon
  - Loading: 0% Increase in Flows and 15% Increase in Loads
  - Design Criteria: Aggressive – no permit limits
- Optimization Concepts
  - Use offline tankage
  - Operate in split treatment mode
  - Modify operational mode (e.g., raise SRT)
  - Add chemicals
  - Process control instrumentation
  - Add internal recycle for denitrification

Upgrades Approach

- Basis of Evaluation
  - Identify upgrade strategies to meet effluent targets
  - Planning Period: 30 Years
  - Loading: Design Capacity
  - Design Criteria: Reliability – meet permit limits
- Concepts
  - Sidestream Treatment
  - Design Facilities for Level 2 that could be further upgraded to meet Level 3 – no stranded assets
  - Technology Status: Established Technologies

Treatment Levels

Level	Ammonia	TN	TP
Level 1	--	Optimization	--
Level 2	2 mg N/L	15 mg N/L	1.0 mg P/L
Level 3	2 mg N/L	6 mg N/L	0.3 mg P/L

Case Studies

Pinole

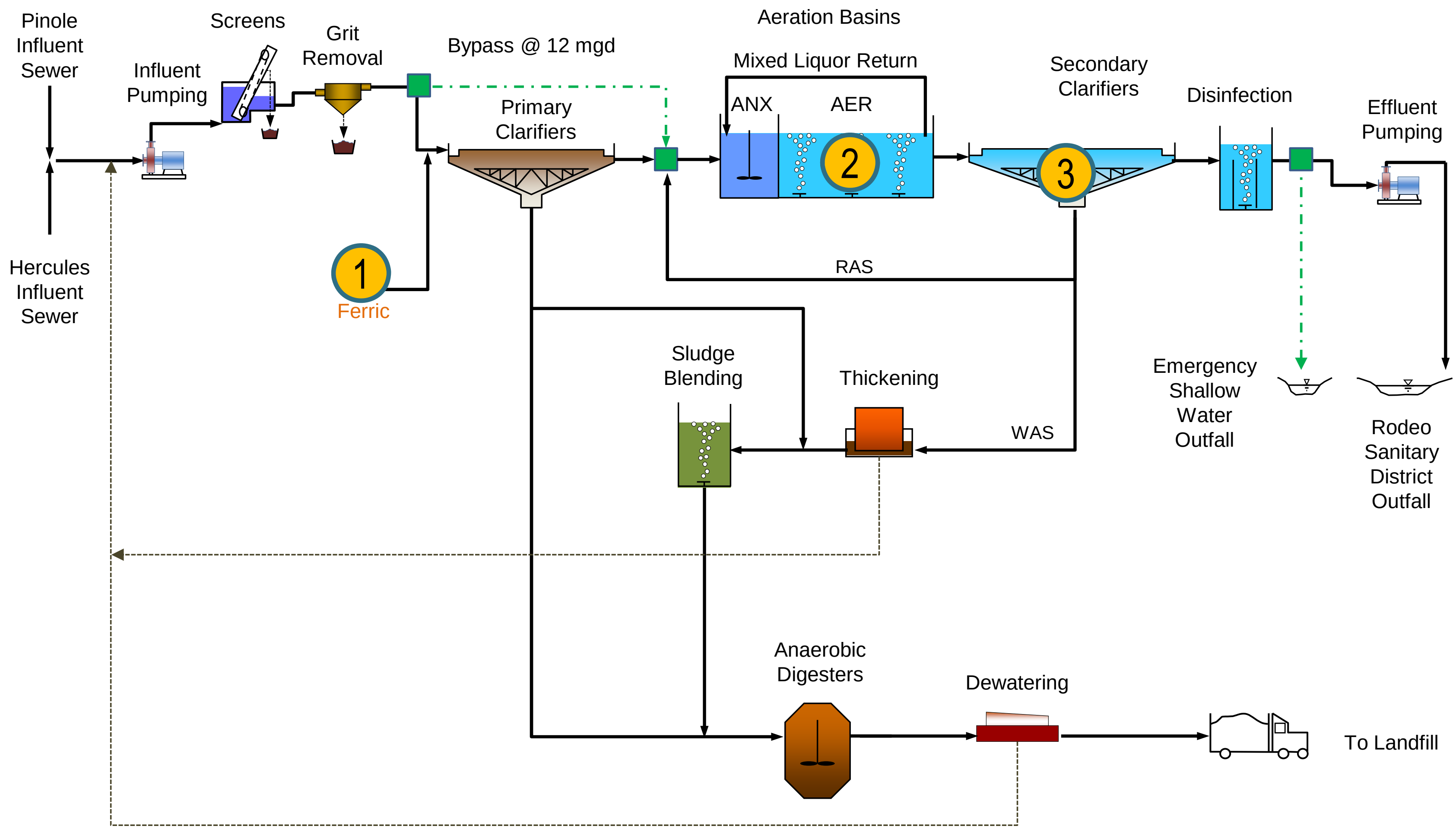
Straight forward, in process of upgrading

Pinole Optimization and Upgrade Concepts

Process	Current	Optimization *	Sidestream	NNLI	Level 2	Level 3
Primaries	Yes	--	-	Yes	CEPT	CEPT
Act Sludge	BOD	--	-	BNR (MLE)	BNR (MLE)	BNR (4-stage)
Sec Clarifier	Yes	--	-	Replace Existing	Replace Existing	Replace Existing
Peak Flow	-	--	-	Contact Stabilization	Contact Stabilization	Contact Stabilization
Filter	-	--	-	-	-	Denite Filter
Carbon	-	--	-	-	-	Yes
Fe/Al/Poly	-	--	-	-	-	Fe/Pol
Sidestream Treatment	-	--	No for NH4 Yes for TN Yes for TP	-	-	-

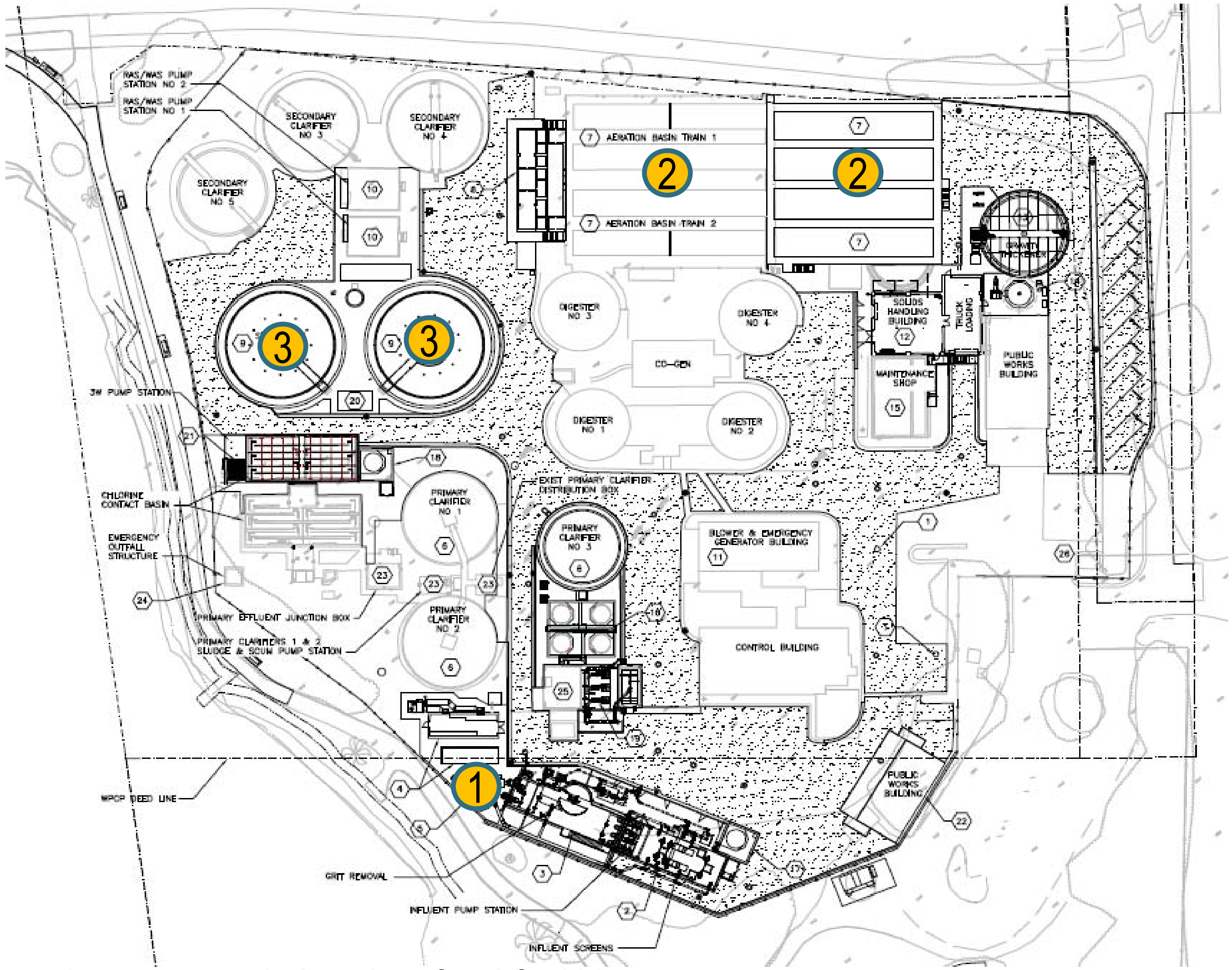
* Plant is under construction for upgrades to meet Level 2

Pinole Level 2



1. **CEPT:** use the recently implemented chemical feed facilities
2. **Nit/Denite:** expand the aeration basins to operate as nitfrication/denitrification (ability to operate in contact stabilization mode during wet season)
3. **Secondary Clarifiers:** replace with new secondary clarifiers

Pinole Level 2 Aerial



1. CEPT: use the recently implemented chemical feed facilities
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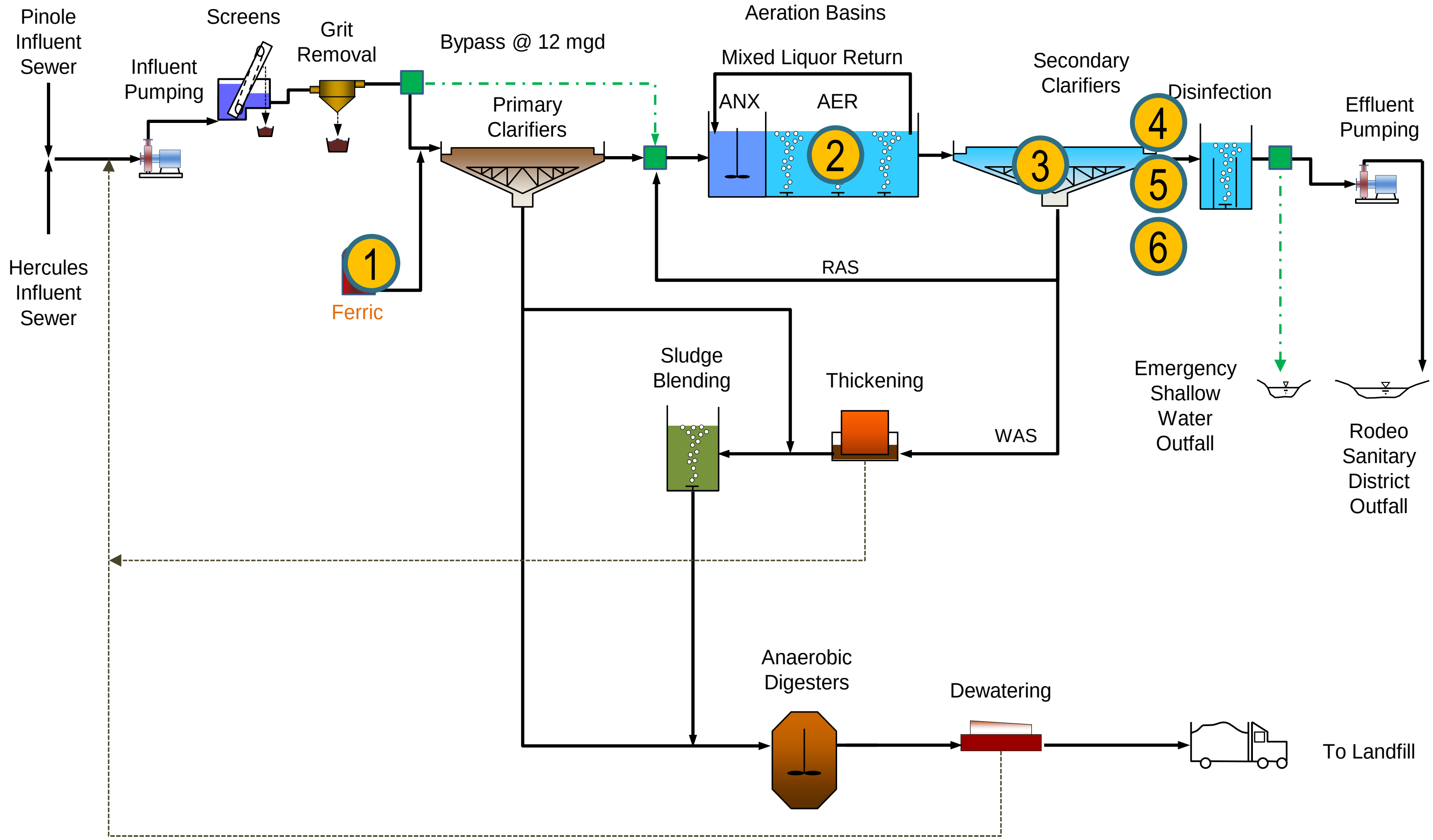
3. Secondary Clarifiers: replace with new secondary clarifiers

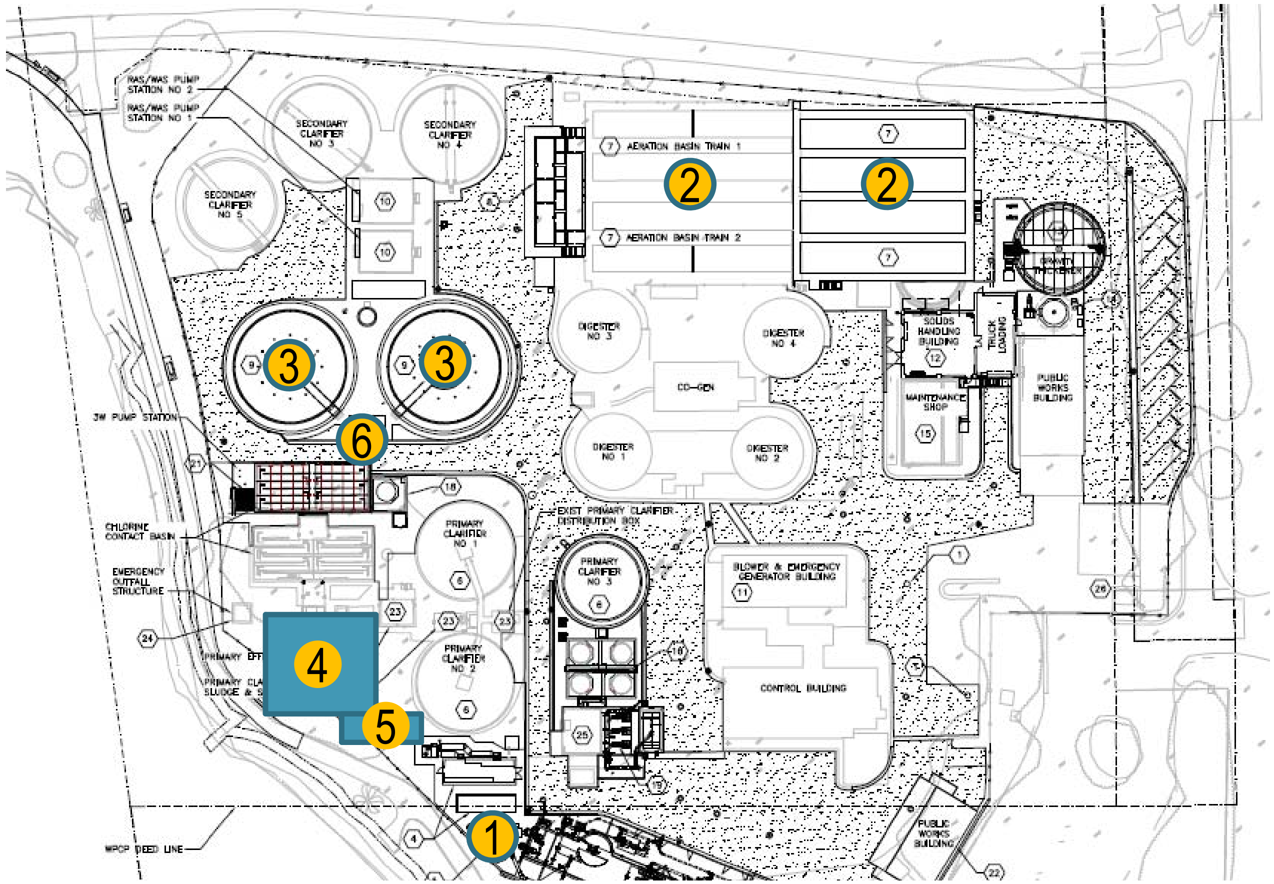

Level 2 Upgrades
Modify
BNR Basin
Pump
Clar
Clar
CEPT
Google

Pinole Level 3



1. CEPT: use the recently implemented chemical feed facilities
2. Nit/Denite: expand the aeration basins to operate as nitfrication/denitrification (ability to operate in contact stabilization mode during wet season)
3. Secondary Clarifiers: replace with new secondary clarifiers
4. Denitrifying Filters: add denitrifying filter complex
5. Carbon: add external carbon source
6. Metal Salt: add metal salt chemical feed facilities

Pinole Level 3 Aerial



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5. Carbon: add external carbon source
6. Metal Salt: add metal salt chemical feed facilities

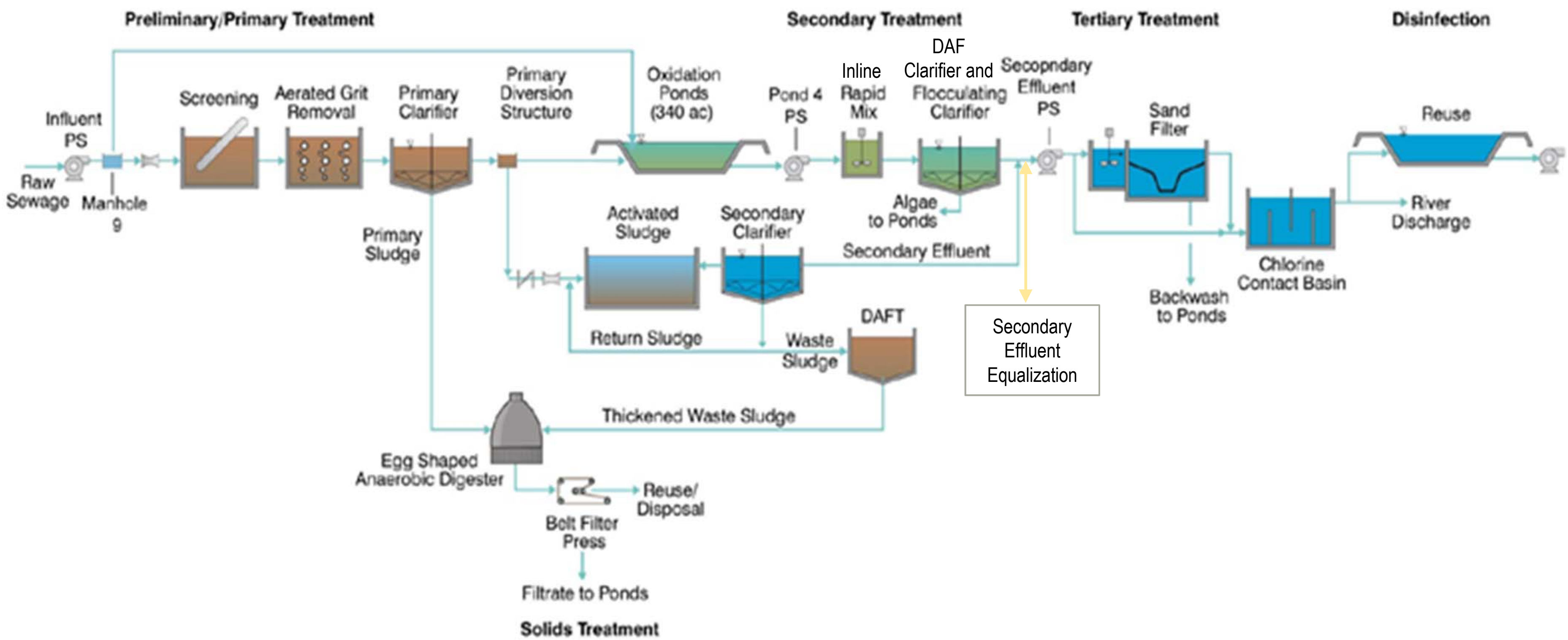
Level 3 Upgrades

Napa

Challenging due to ponds and seasonal flow variations

Challenges at Napa

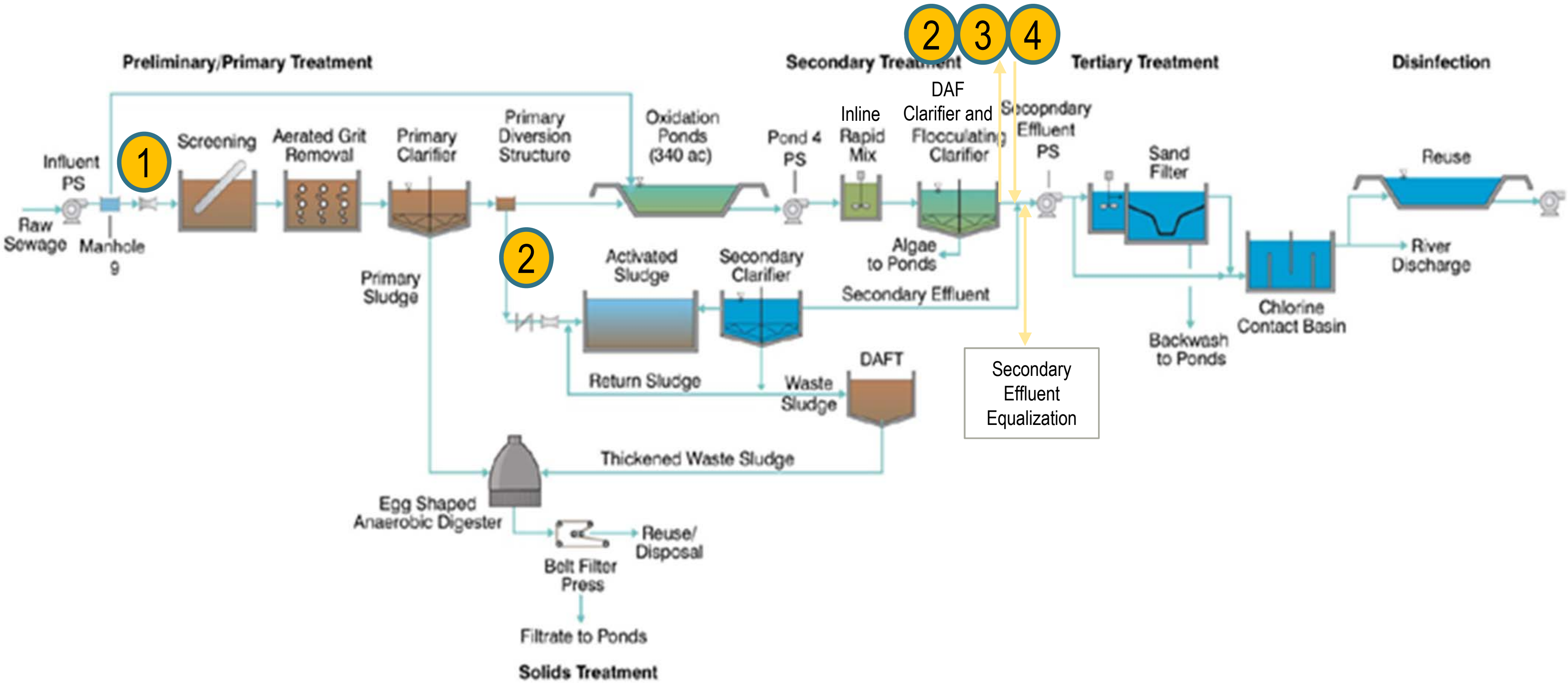
- Split treatment and seasonal storage
- High ammonia in DAF clarifier effluent seasonally
- Not able to reliably meet Level 2 for TN during the winter
- Limited or no discharge in dry season (May through September)



BACWA Upgrades

Process	Current	Optimize	NNLI	Level 2	Level 3
Primaries with Ferric Addition	Yes	Increase winter dose	Increase dose	Increase winter dose	Increase winter dose
Act Sludge	BNR (Step-feed)	BNR (Step-feed)	BNR (Step-feed)	BNR (Step-feed)	BNR (4-stage)
Alkalinity	Yes	Yes	Yes	Yes	Yes
Ponds / DAF Clarifier	High Strength Ammonia (Seasonal)	High Strength Ammonia (Seasonal)	High Strength Ammonia (Seasonal)	High Strength Ammonia (Seasonal)	High Strength Ammonia (Seasonal)
Act Sludge for DAF Clarifier Effluent	-	-	BNR (4-stage / flexible)	BNR (4-stage / flexible)	BNR (4-stage)
Secondary Clarifier	2	2	3	3	3
Filter	Partial	Partial	Partial	Partial	Expand; add ferric chloride
Carbon	-	-	Yes	Yes	Yes

Level 2



(1) Ferric chloride. Use existing chemical facilities (wet season).

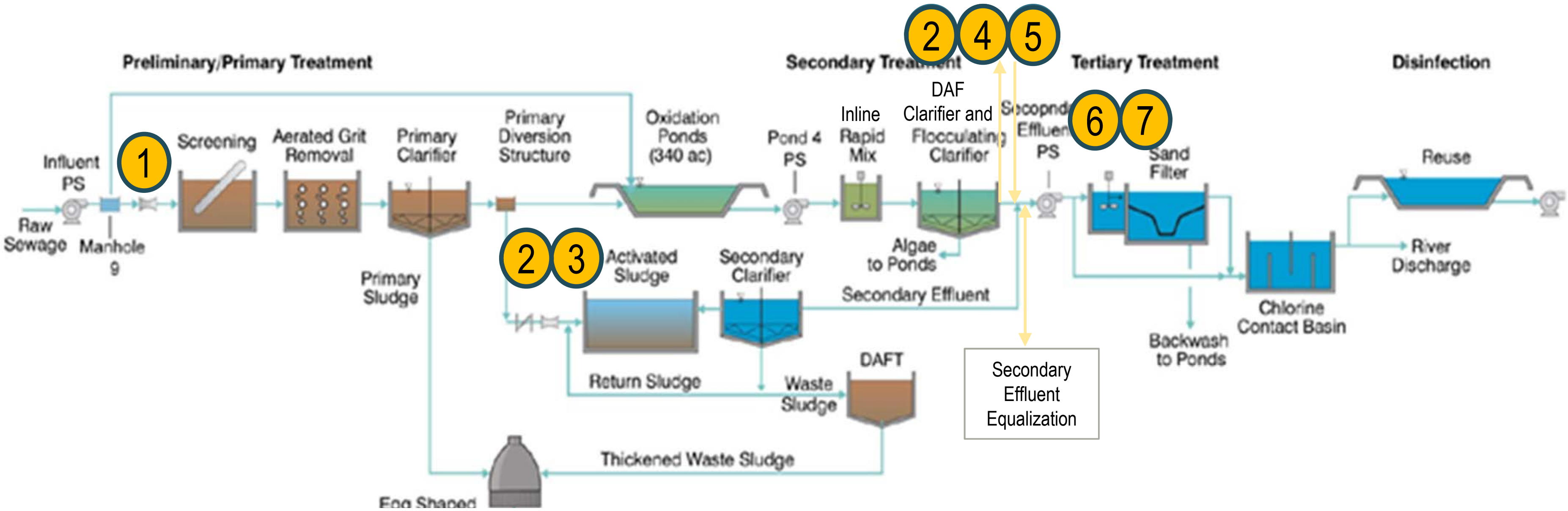
(2) Methanol. Add methanol (or other carbon source) (wet season).

(3) Aeration Basins. Add two (flexible configuration with anoxic zones) for nitrification and denitrification of DAF clarifier effluent (wet season only),

(4) Secondary Clarifier. Add one (wet season only),

Level 2

Level 3



(1) Ferric chloride. Use existing chemical facilities (wet season).

(2) Methanol. Add methanol (or other carbon source) (wet season).

(3) Aeration Basins. Convert to 4-stage BNR and add two basins

(4) Aeration Basins. Add two (flexible configuration with anoxic zones) for nitrification and denitrification of DAF clarifier effluent (wet season only),

(5) Secondary Clarifier. Add one (wet season only),

(6) Ferric Chloride. Before filters.

(7) Filters. Add media to sixth filter cell.

Level 3


(1) Aeration Basins (Upgrade)
(2) Aeration Basins (New)
(3) Aeration Basins (New)
(4) Secondary Clarifier
(5) Filters with Chemical Addition
(6) Methanol
1
2
3
4
5
6

Draft Findings of Nutrient Removal Reports

Preliminary Optimization Results

DRAFT Optimization Findings

Which nutrients are easiest to remove?

- Ammonia load reduction is most difficult
  - Increasing SRT for plants with act sludge
  - Operating Trickling Filter as a Nitrifying Trickling filter
- TN load reduction is possible if ammonia removal implemented
- TP load is easier to remove
  - Most plants already have metal salt chemical feed facilities
  - Some have anaerobic zones
  - Lose TP removal capability by forfeiting anaerobic zone

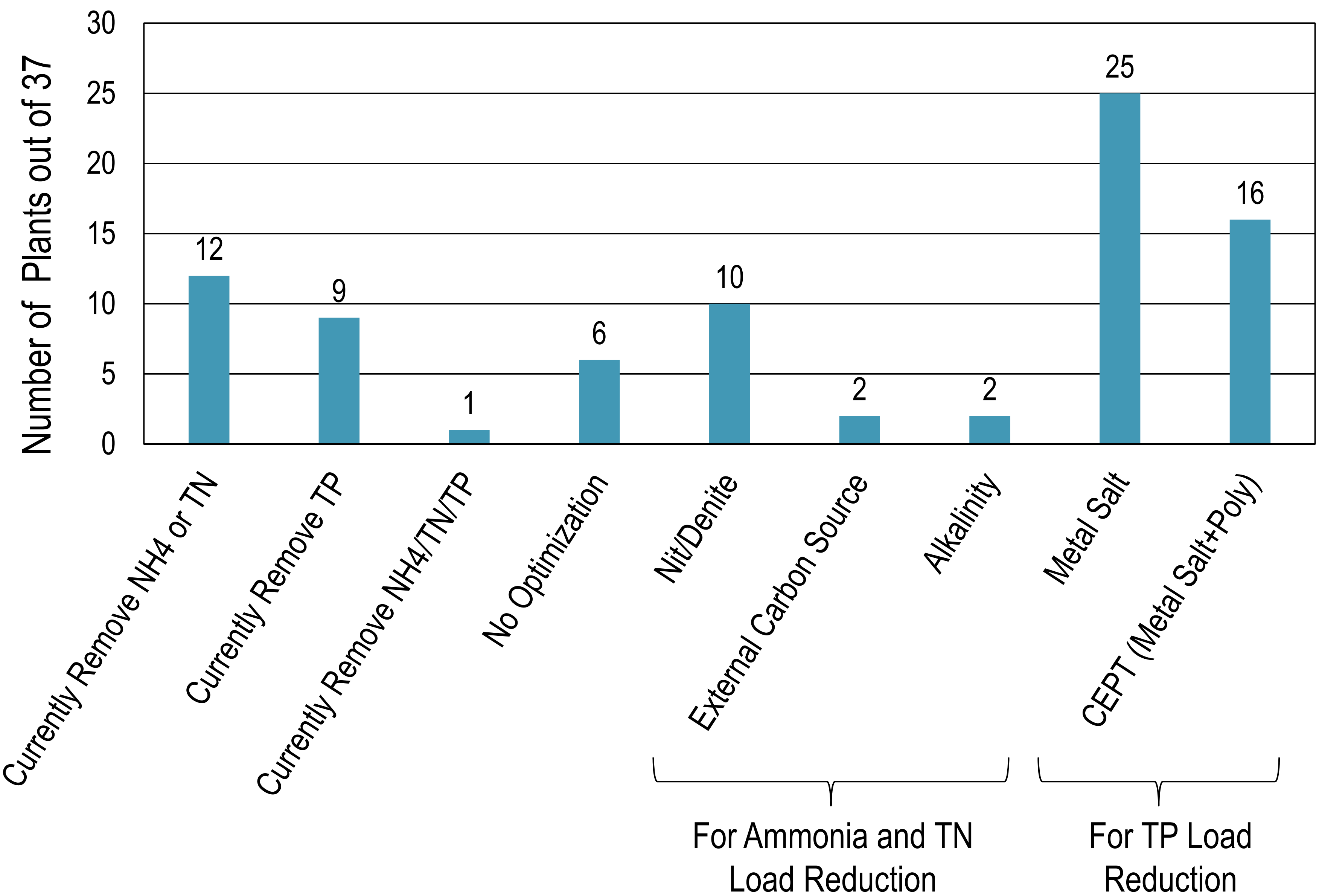
Costs

- Total PV
  - $180M Dry and $223M Wet
  - Ranged from $0.4M to $28M per plant
- Unit Costs
  - Flow-weighted Total PV unit cost = ~$0.4/gpd
  - Flow-weighted Total PV/lb N rem = ~$1.4/lb N
  - Flow-weighted Total PV/lb P rem = ~$12/lb P
- Not all plants can reduce ammonia/TN loads for both dry and wet seasons:
  - 21 of 37 plants for dry season reduction
  - 19 of 37 plants for wet season reduction

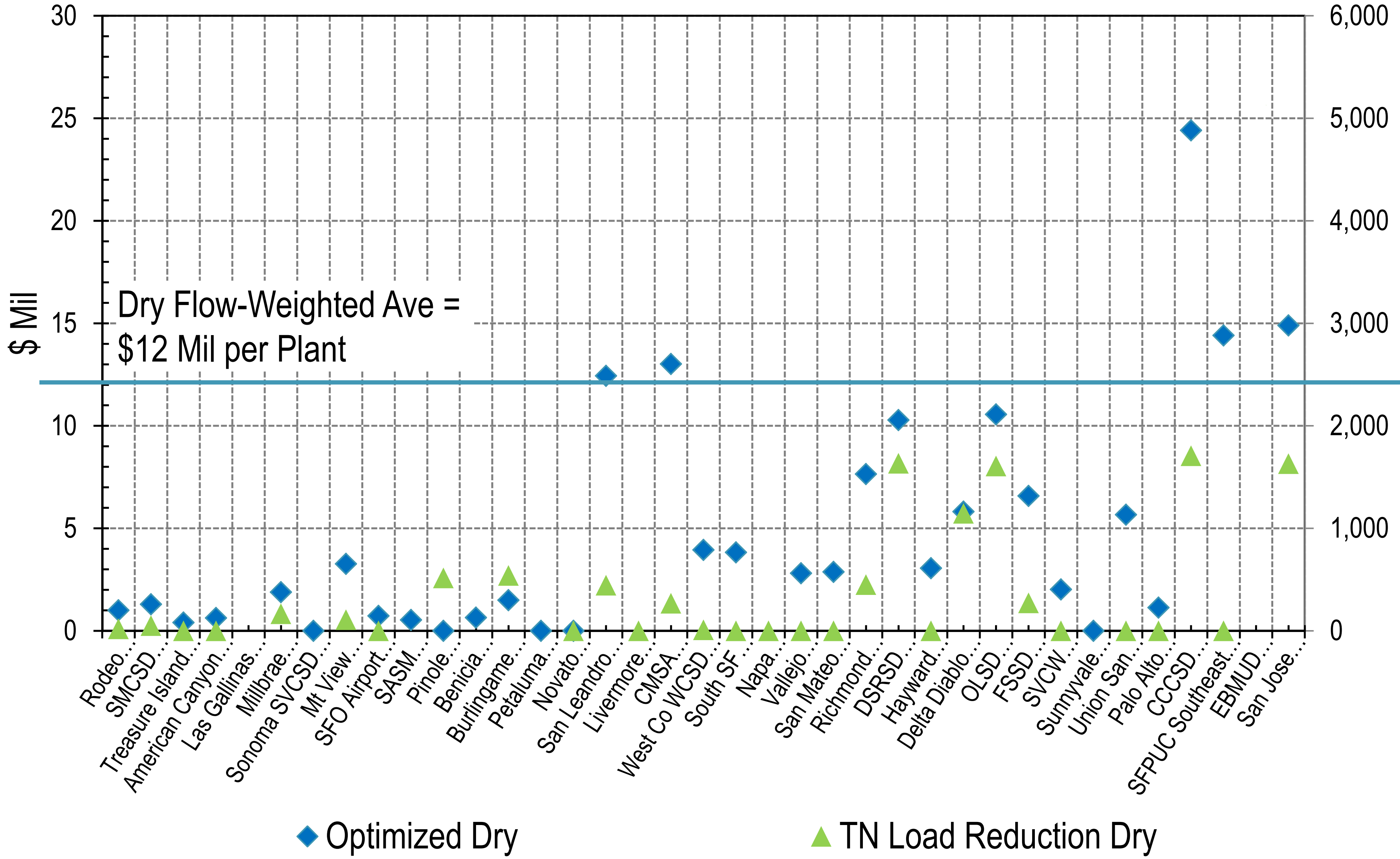
Load Reduction w/Respect to Current Discharge:

- Ammonia load reduction is 18%
- TN load reduction is 10%
- Overall TP load reduction is 44%

Summary of DRAFT Optimization Findings



DRAFT Optimization Total PV Costs



*Draft Results are Sorted by Permitted Capacity

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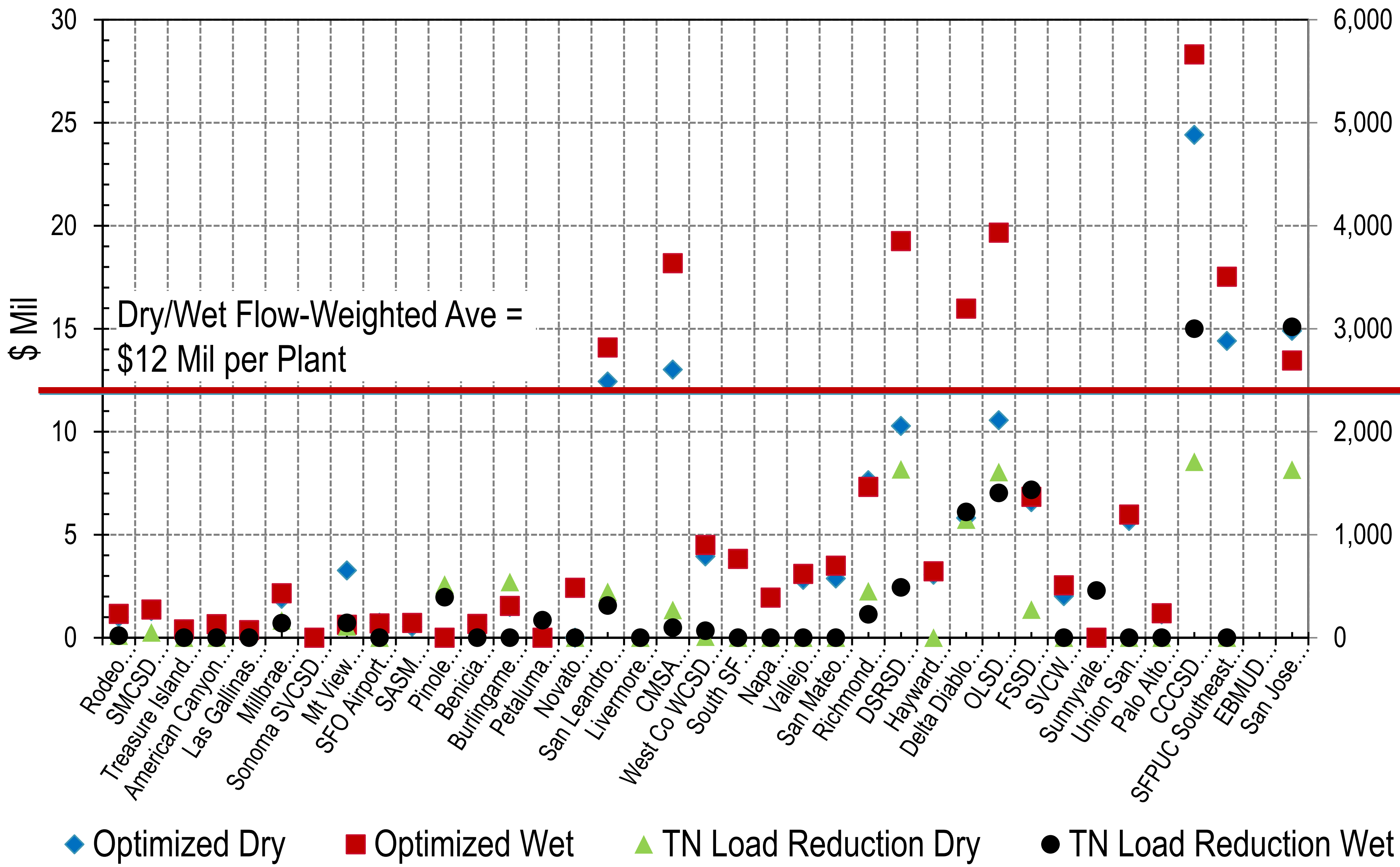

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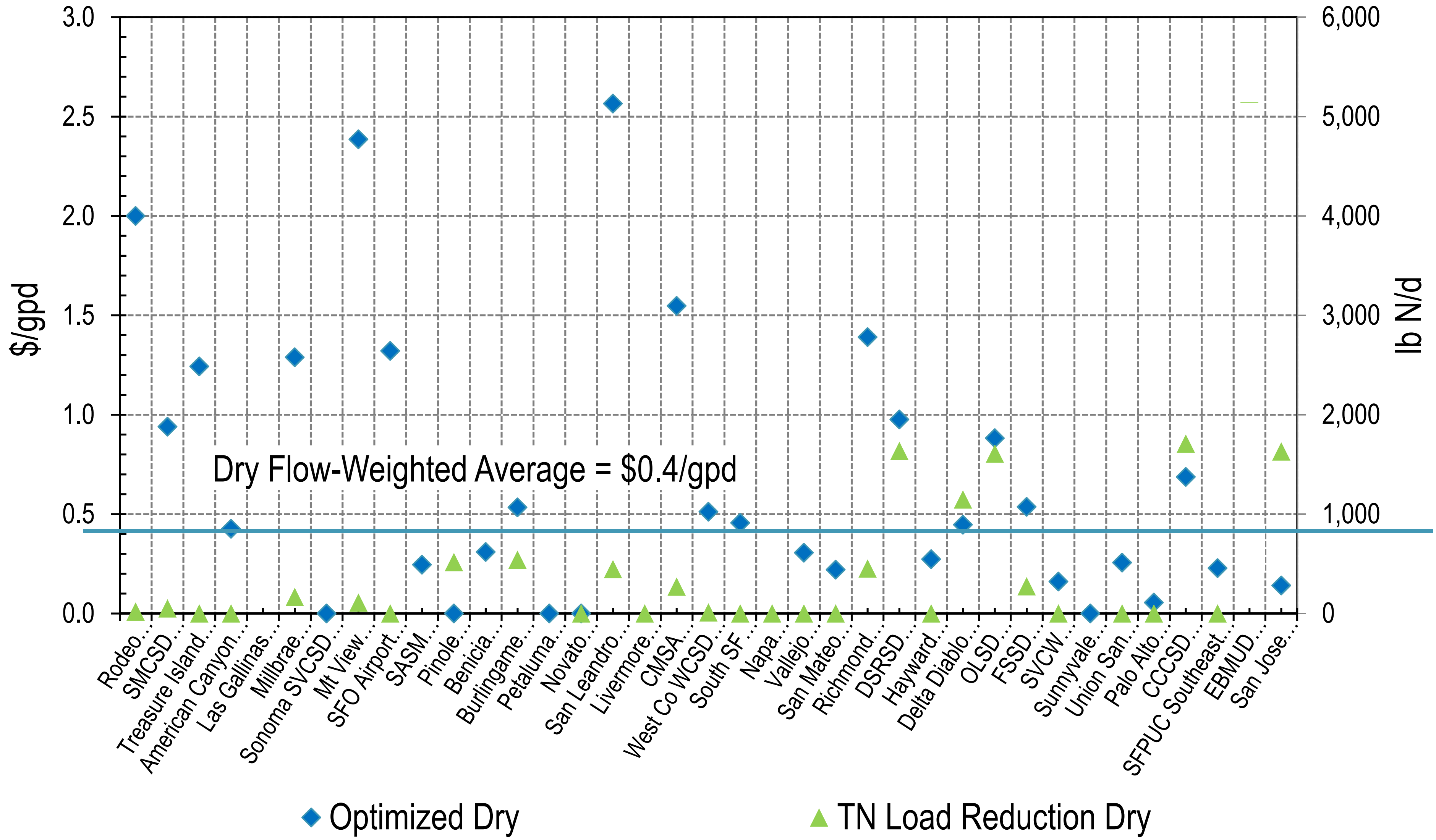
DRAFT Optimization Total PV Unit Costs



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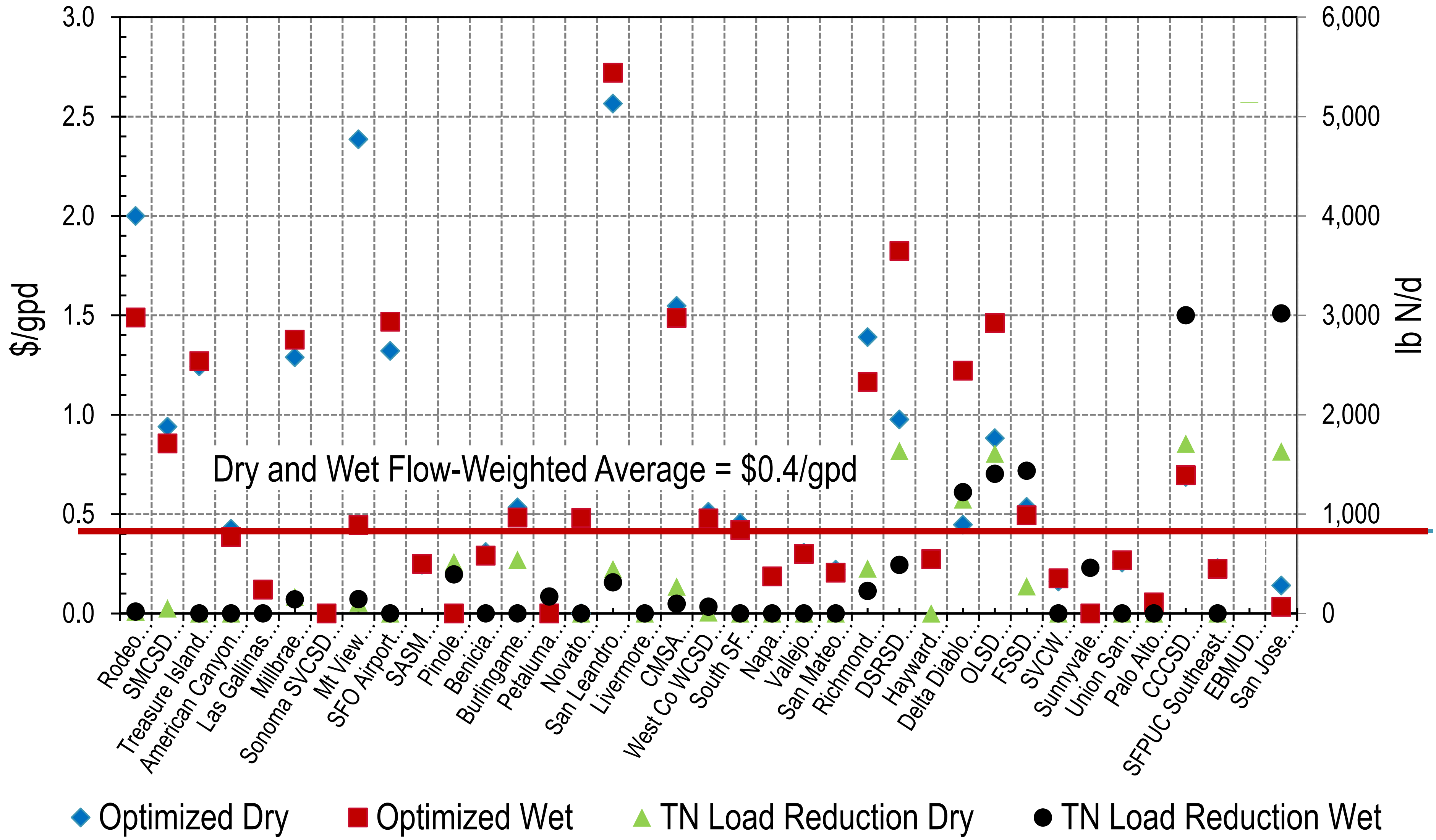

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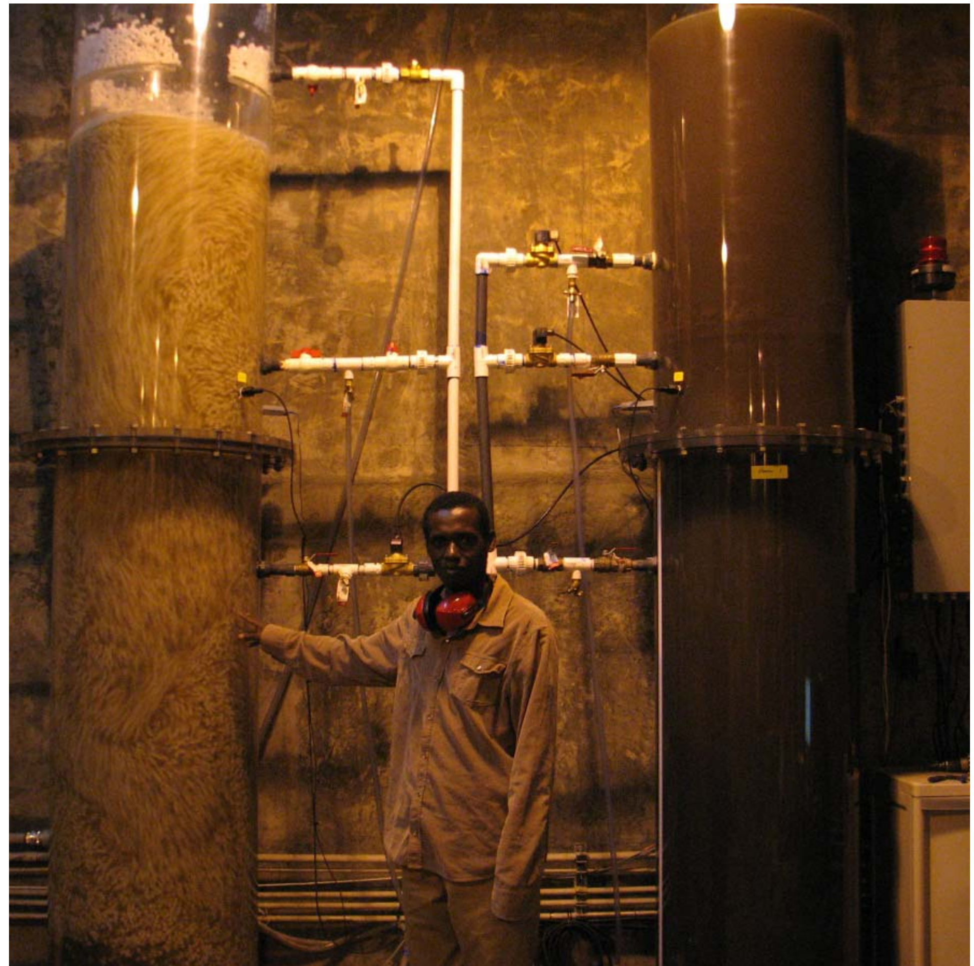
Load Reduction w/Respect to Current Discharge:

- Ammonia load reduction is 18%
- TN load reduction is 10%
- Overall TP load reduction is 44%

Preliminary Sidestream Results

Sidestream Approach

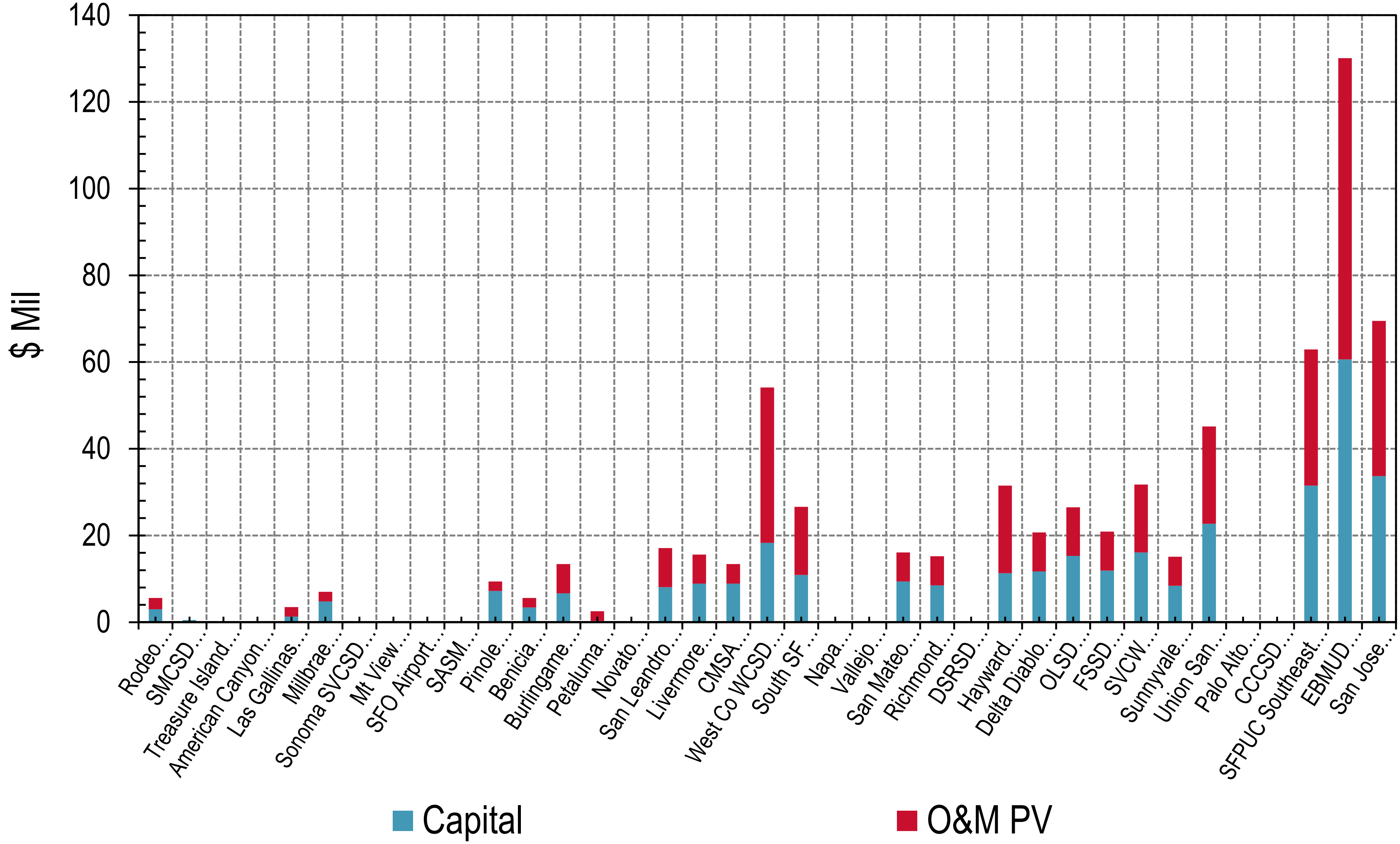
- Basis of Evaluation
  - Identify upgrade strategies to reduce nutrients
  - Planning Period: 30 Years
  - Loading: Design Capacity
  - Design Criteria:
    - Year-round sidestream
    - Sufficient Dewatering Frequency (≥4 days/week)
    - Water temperature governs technology selection
- Concepts
  - Ammonia/TN Removal:
    - Conventional nitrification technology
    - Deammonification technology
  - TP Removal: metal salt precipitation
- Acknowledgements
  - EPA Regional Grant led by EBMUD
  - Agencies that hosted pilots



DRAFT Plants Eligible for Sidestream Treatment by Subembayment

Subembayment	No. Plants Eligible for Ammonia Discharge Reduction to the Bay	No. Plants Eligible for Total Nitrogen Discharge Reduction to the Bay
Suisun Bay	1	3
San Pablo Bay	1	4
Central Bay	4	5
South Bay	10	11
Lower South Bay	0	2
Total	16	25

DRAFT Total PV Costs for Sidestream



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DRAFT Sidestream Findings

- Criteria used for screening:
  - Year-round sidestream
  - Year-round discharge
  - Sufficient dewatering frequency (≥4 days/week)
- Number of candidate plants
  - 16 out of 37 plants if ammonia reduction is the discharge objective
  - 25 out of 37 plants if TN reduction is the discharge objective
- Costs
  - The Total PV costs is $660 Mil
  - Flow-weighted average = $1.7/lb N removed
- The overall Ammonia/TN load reduction from Current Discharge is 21 and 17 percent, respectively

Preliminary Upgrades Results

DRAFT Upgrade Findings

Which nutrients are easiest to remove?

- Ammonia is the most difficult and expensive
  - Bigger basins due to increasing SRT for act sludge plants
  - Expanded aeration system
  - Additional pumping
- TN load reduction requires ammonia removal
  - Level 3 typically require an external carbon source
- TP load reduction is the simplest/most straight forward
  - Level 3 requires tertiary filtration
  - Upgrades use MBR which includes filtration in Level 2
- Number of Plants Already/Planning to Meet Targets:
  - Level 2: 6
  - Level 3: 1

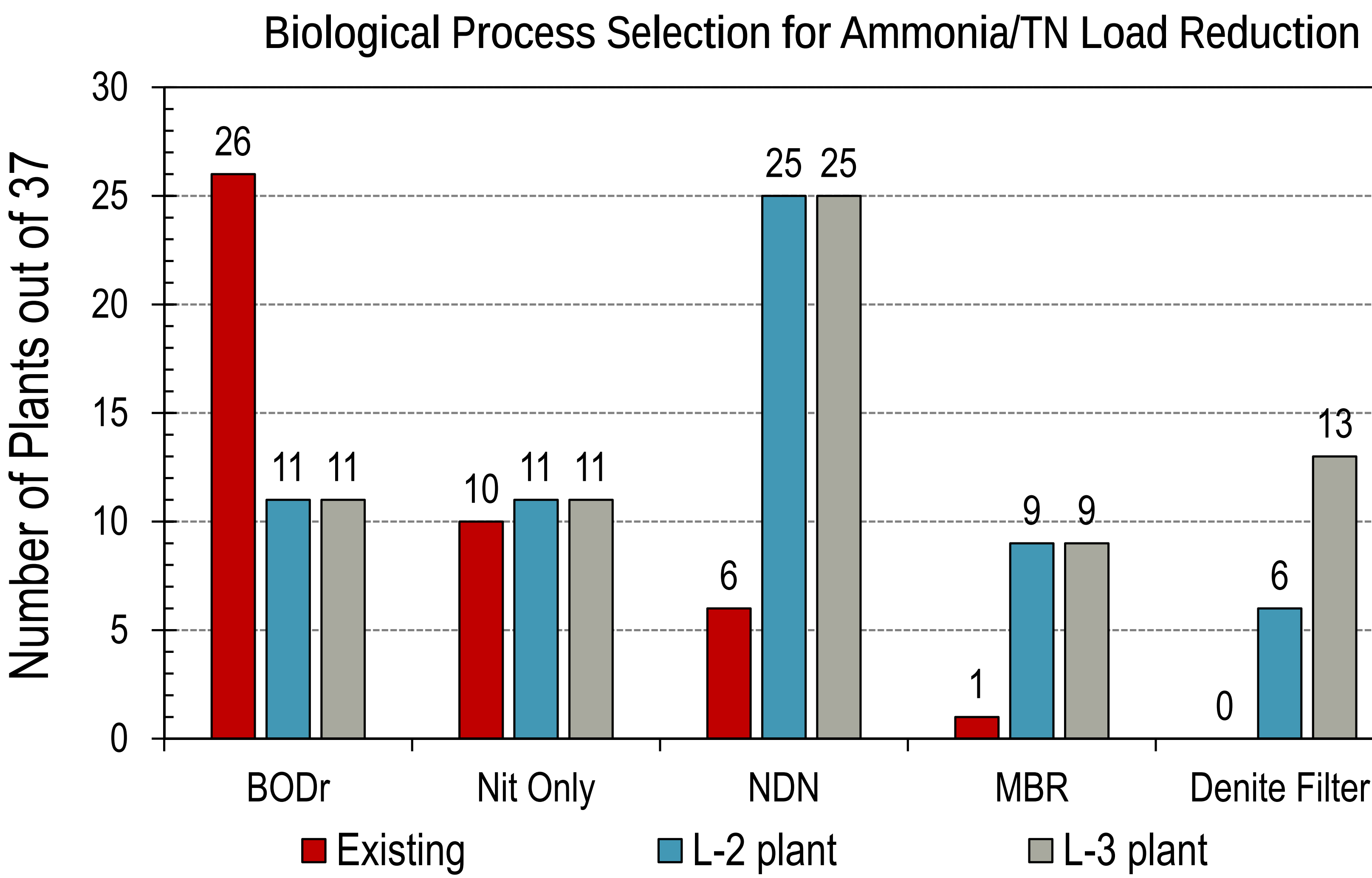
* Excludes San Jose
** Excludes Sunnyvale

Costs

- Total PV Costs
  - Level 2 = $6,430M Dry and $8,050M Wet
  - Level 3 = $8,350M Dry and $10,370M Wet
- Total PV Cost Range per Plant
  - Level 2 = $3.8M to $2,240M per plant
  - Level 3 = $21M to $2,470M per plant
- Unit Costs
  - Level 2: $6/lb N Dry* and $8/lb N Wet
    $34/lb P Dry and $29/lb P Wet
  - Level 3: $12/lb N Dry** and $6/lb N Wet**
    >$60/lb P for Dry or Wet

Parameter	Level 2 Load Reduction	Level 3 Load Reduction
Ammonia	>88%	>88%
Total N	>61%	>84%
Total P	>63%	>89%

Summary of DRAFT Upgrades Findings



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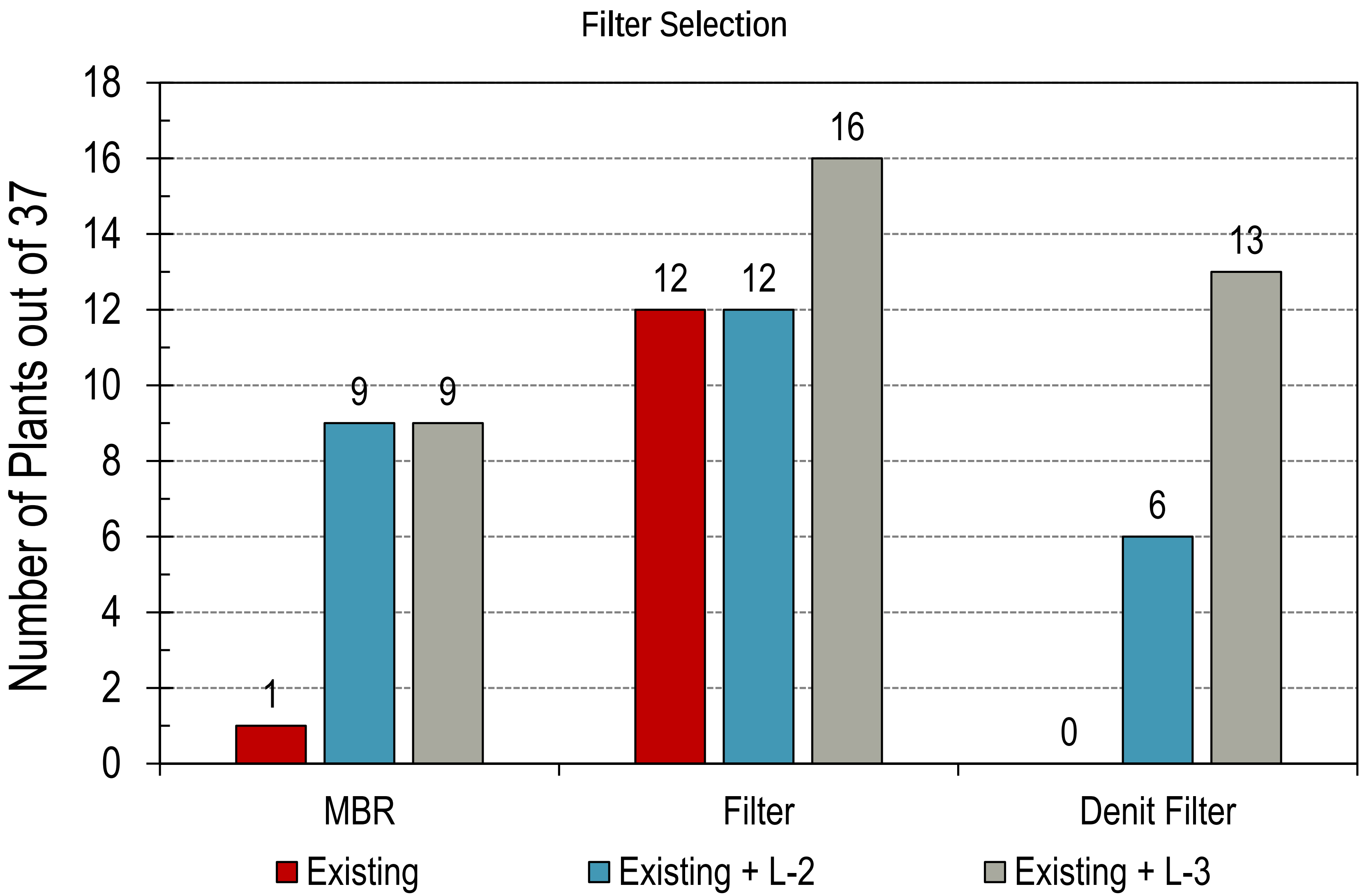

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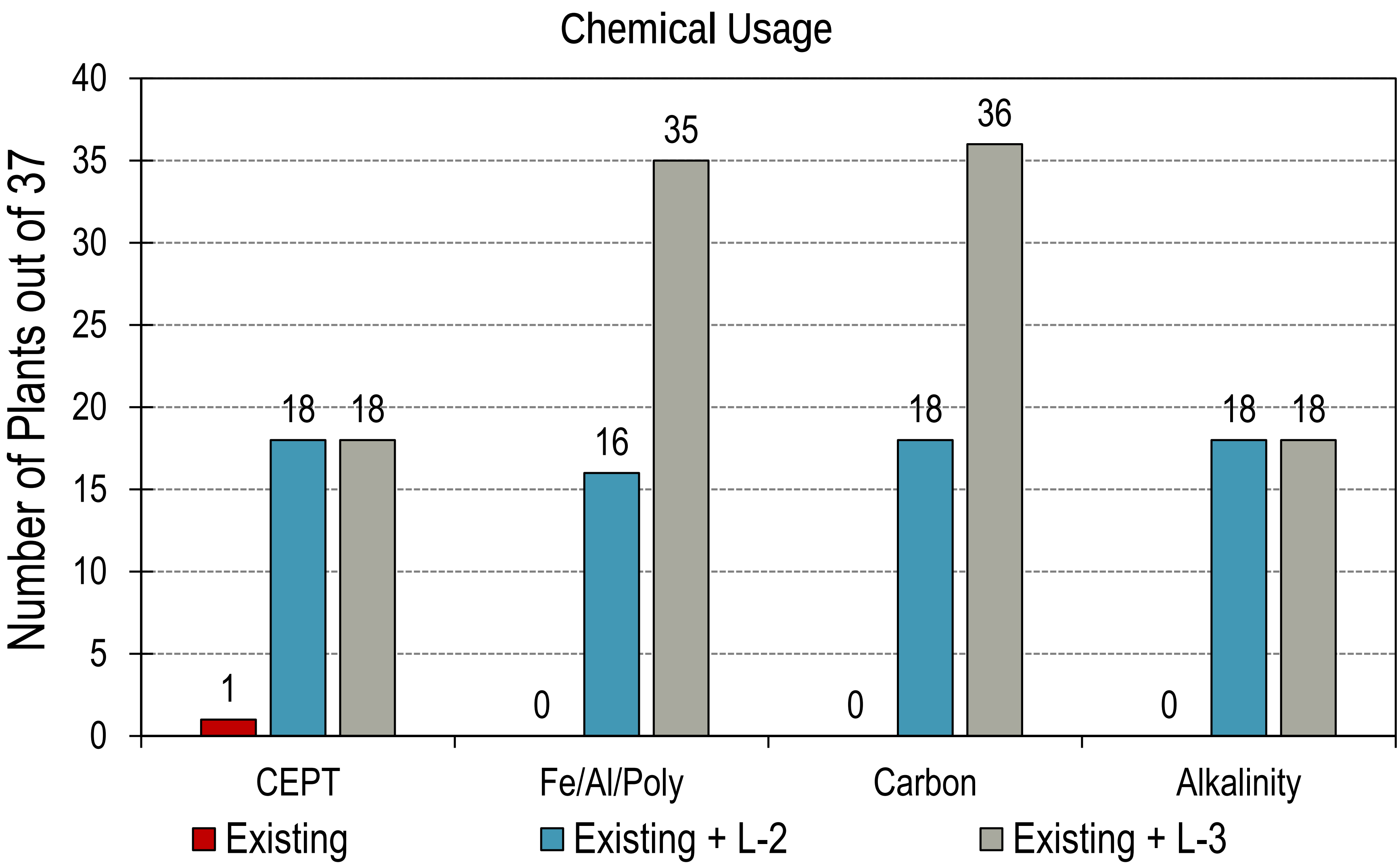
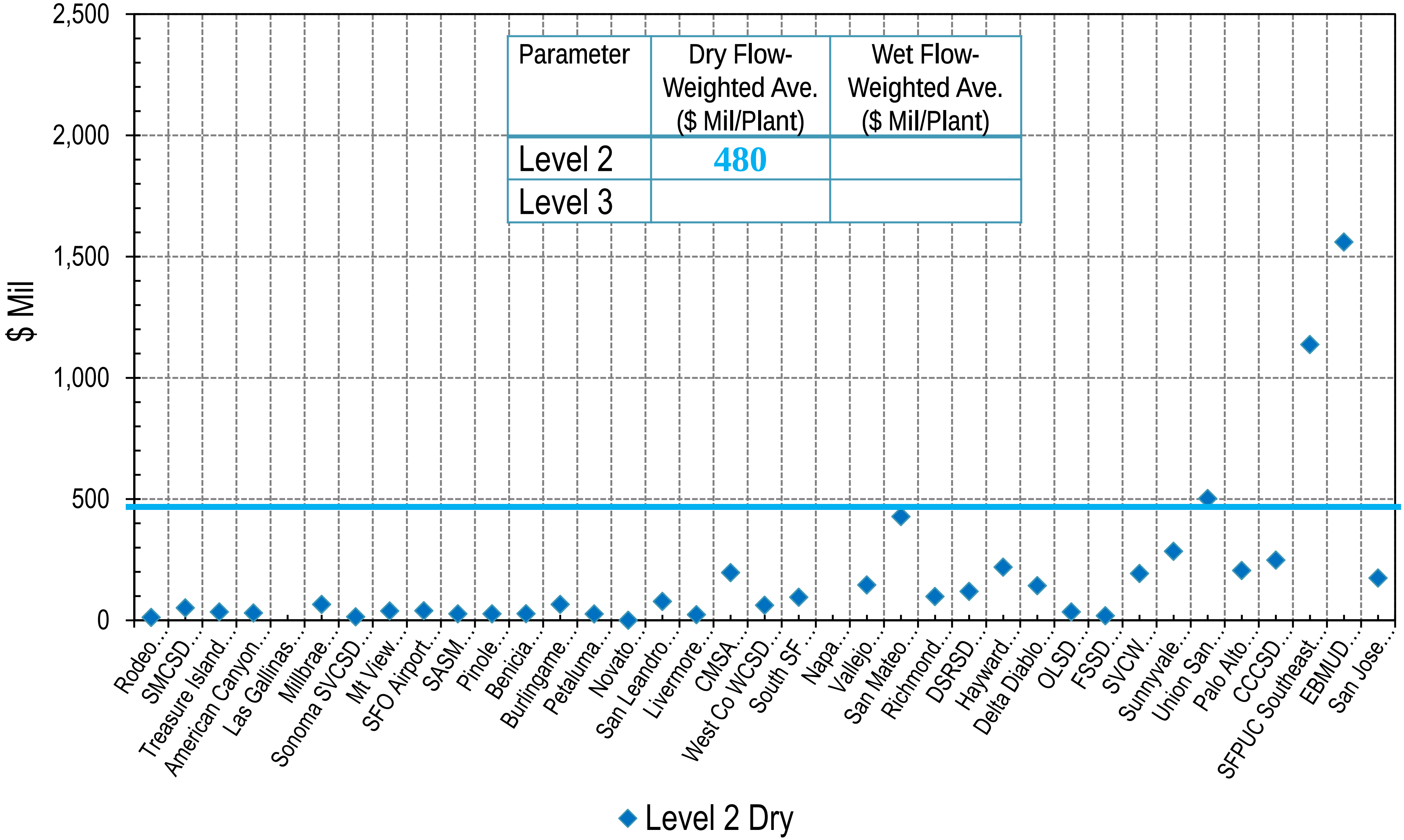


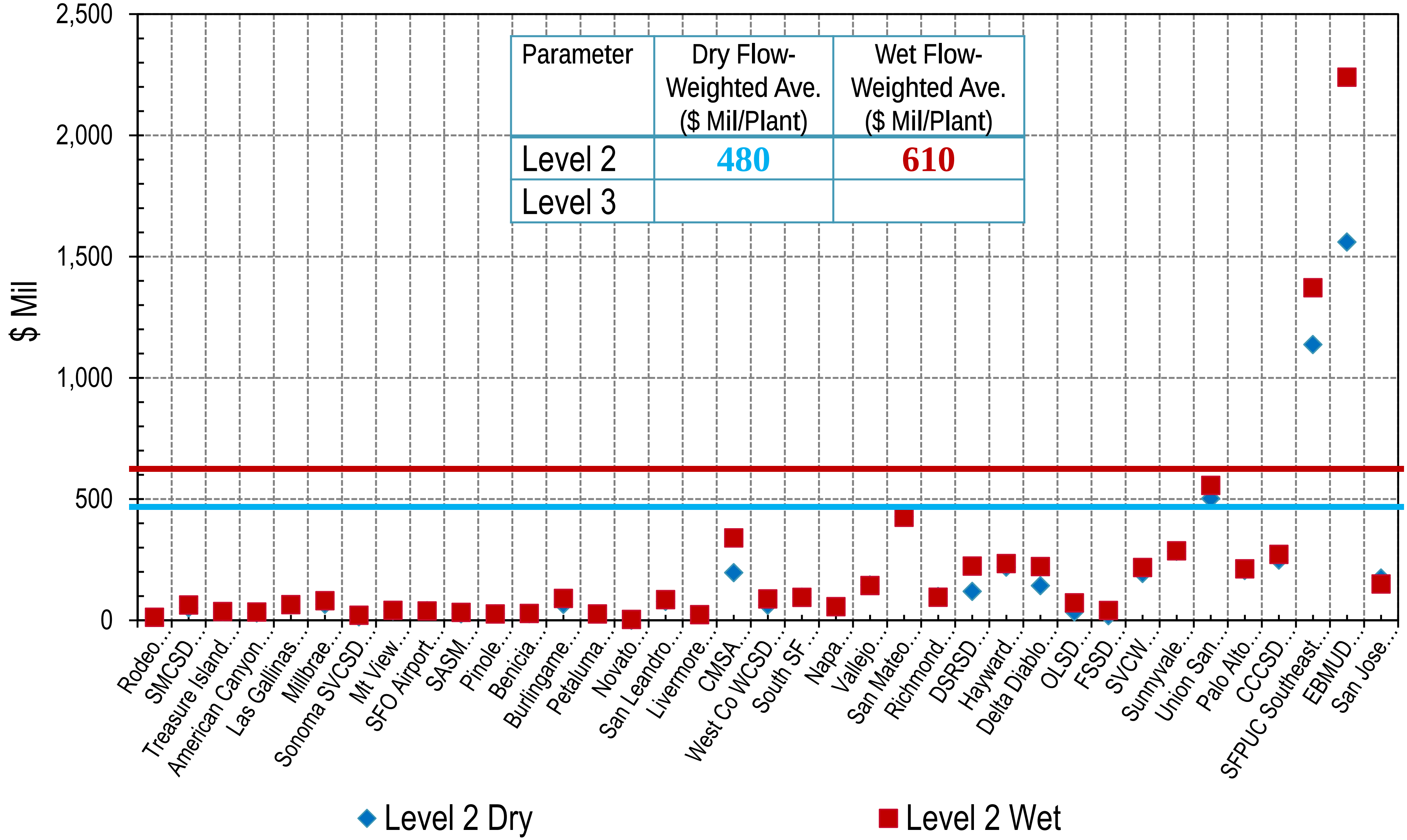
DRAFT Total PV Costs for Upgrades



Parameter	Dry Flow-Weighted Ave. ($ Mil/Plant)	Wet Flow-Weighted Ave. ($ Mil/Plant)
Level 2	480	
Level 3		

*Draft Results are Sorted by Permitted Capacity

DRAFT Total PV Costs for Upgrades



Parameter	Dry Flow-Weighted Ave. ($ Mil/Plant)	Wet Flow-Weighted Ave. ($ Mil/Plant)
Level 2	480	610
Level 3		

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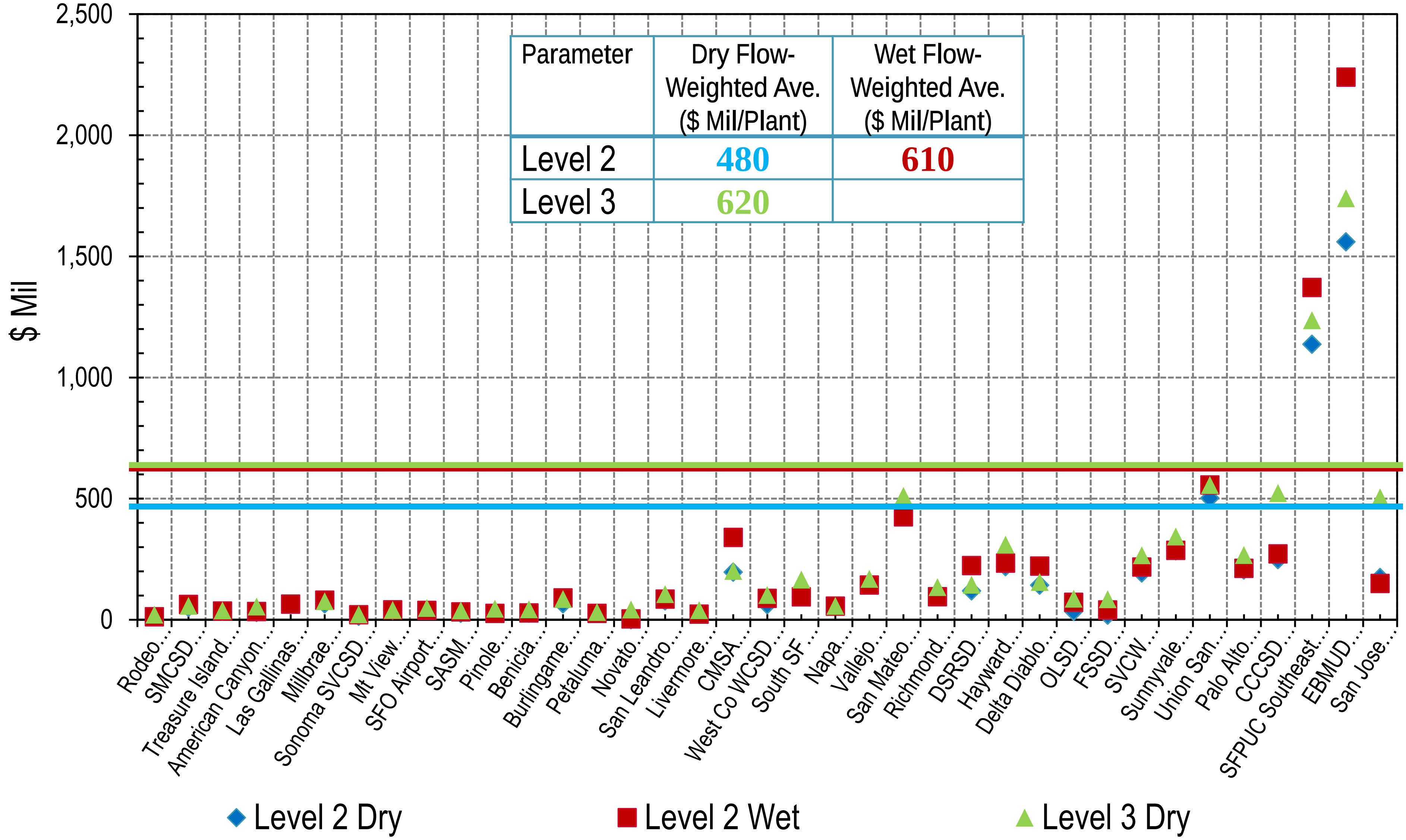
DRAFT Total PV Costs for Upgrades



Parameter	Dry Flow-Weighted Ave. ($ Mil/Plant)	Wet Flow-Weighted Ave. ($ Mil/Plant)
Level 2	480	610
Level 3	620	

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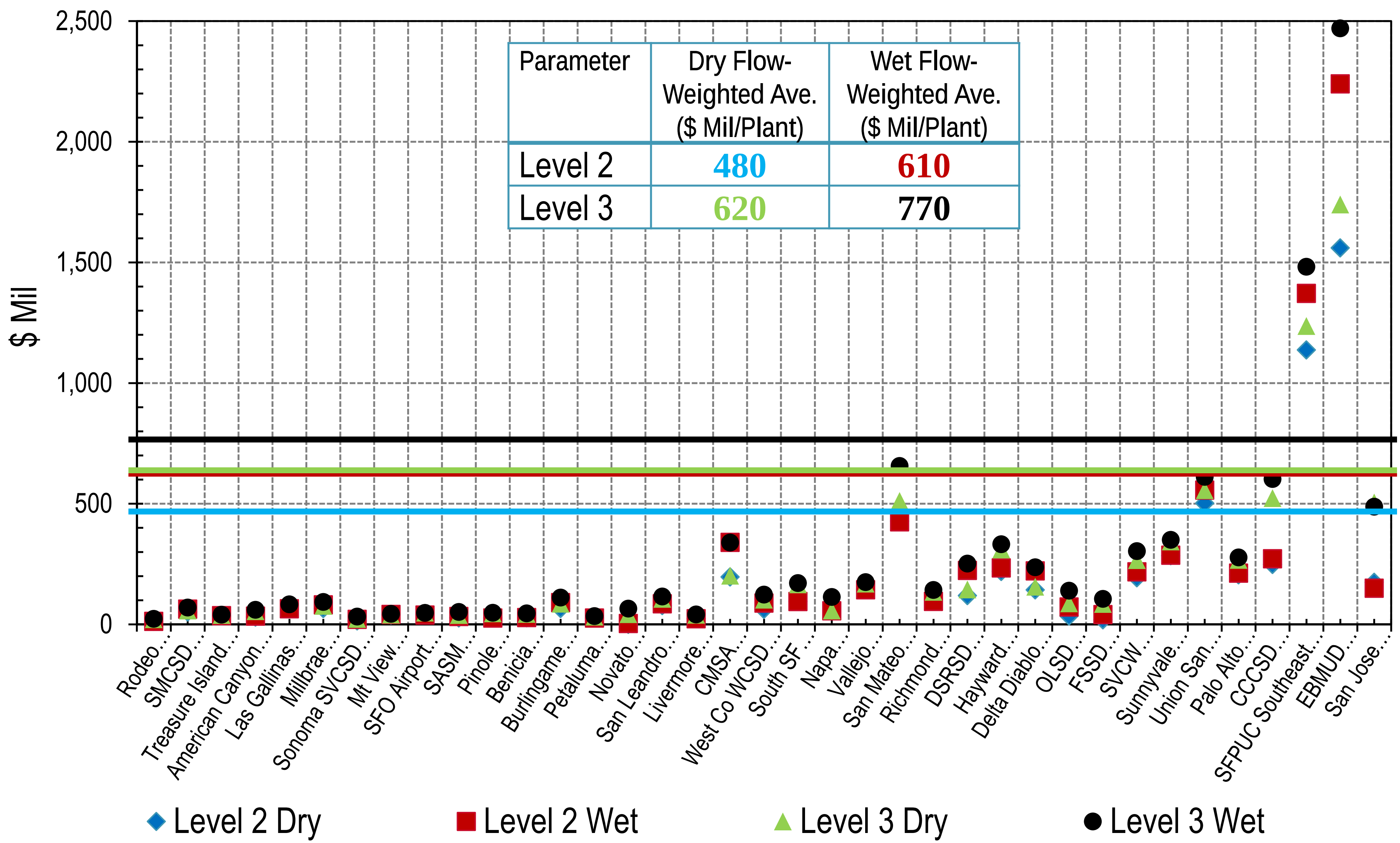
DRAFT Total PV Costs for Upgrades



Parameter	Dry Flow-Weighted Ave. ($ Mil/Plant)	Wet Flow-Weighted Ave. ($ Mil/Plant)
Level 2	480	610
Level 3	620	770

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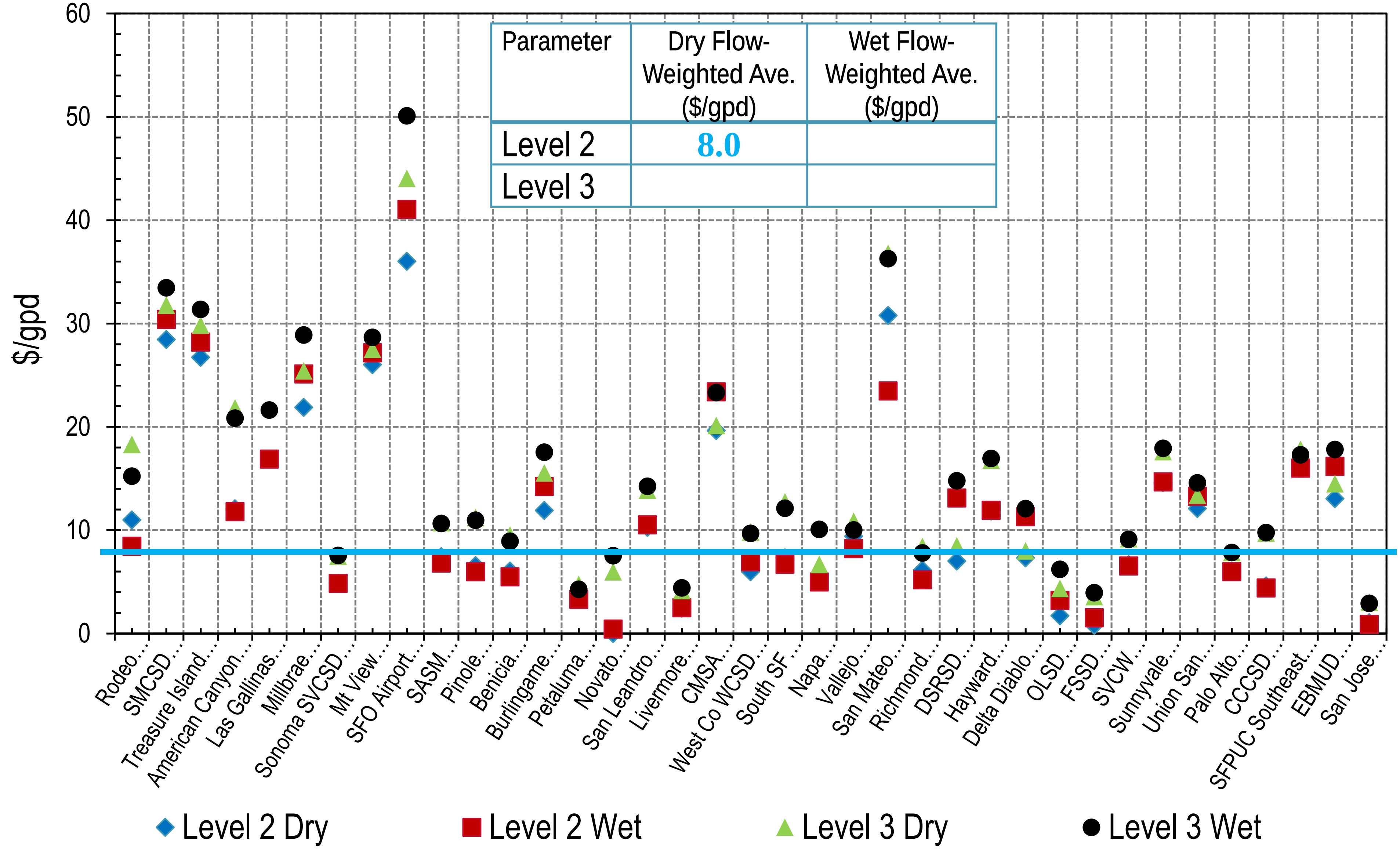
DRAFT Total PV Unit Costs for Upgrades



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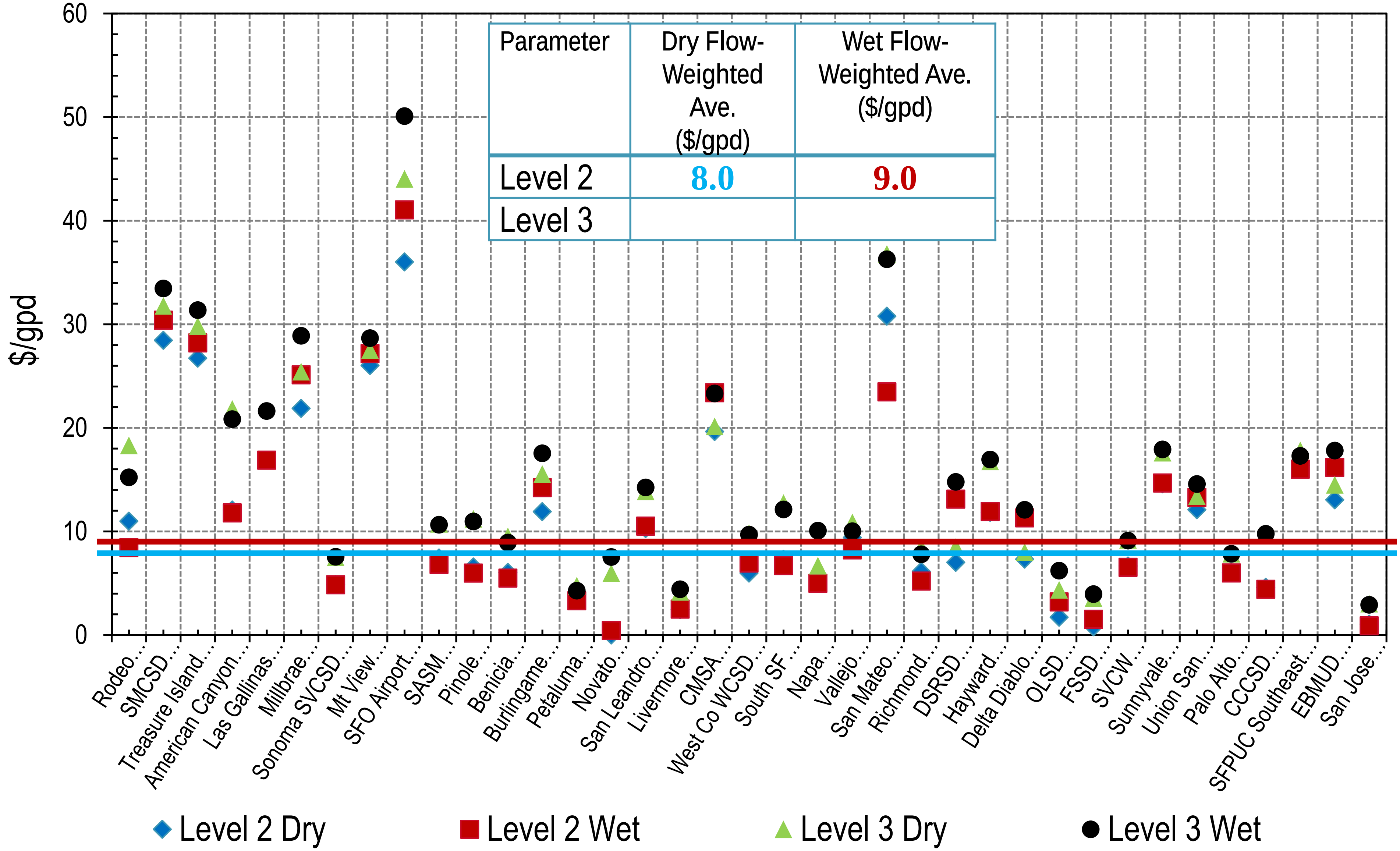

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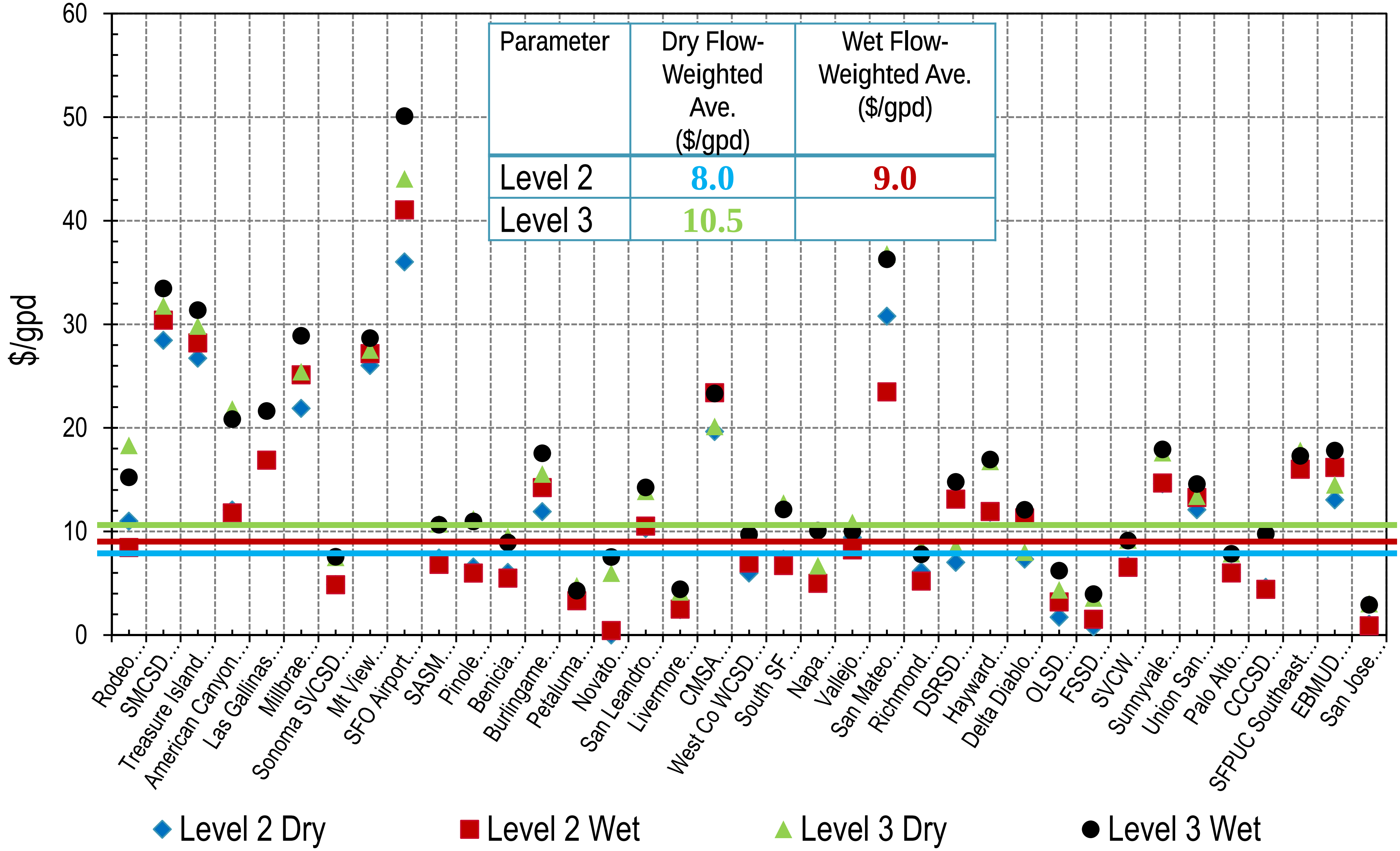
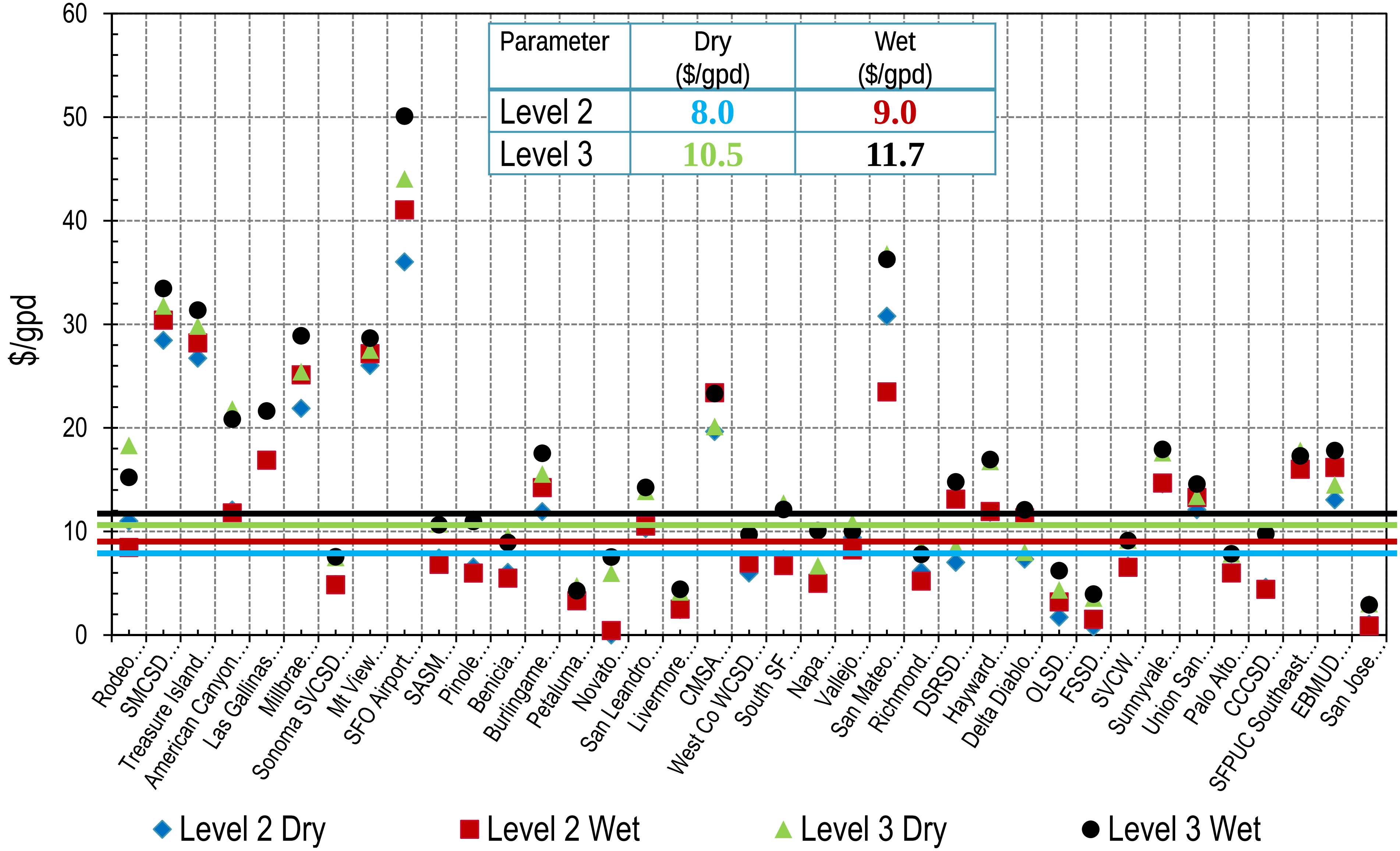


Parameter	Dry Flow-Weighted Ave. ($/gpd)	Wet Flow-Weighted Ave. ($/gpd)
Level 2	8.0	9.0
Level 3	10.5	

*Draft Results are Sorted by Permitted Capacity

DRAFT Total PV Unit Costs for Upgrades



Parameter	Dry ($/gpd)	Wet ($/gpd)
Level 2	8.0	9.0
Level 3	10.5	11.7

*Draft Results are Sorted by Permitted Capacity

DRAFT Upgrade Findings

Which nutrients are easiest to remove?

- Ammonia is the most difficult and expensive
  - Bigger basins due to increasing SRT for act sludge plants
  - Expanded aeration system
  - Additional pumping
- TN load reduction requires ammonia removal
  - Level 3 typically require an external carbon source
- TP load reduction is the simplest/most straight forward
  - Level 3 requires tertiary filtration
  - Upgrades use MBR which includes filtration in Level 2
- Number of Plants Already/Planning to Meet Targets:
  - Level 2: 6
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* Excludes San Jose
** Excludes Sunnyvale

Costs

- Total PV Costs
  - Level 2 = $6,430M Dry and $8,050M Wet
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- Total PV Cost Range per Plant
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- Unit Costs
  - Level 2: $6/lb N Dry* and $8/lb N Wet
    $34/lb P Dry and $29/lb P Wet
  - Level 3: $12/lb N Dry** and $6/lb N Wet**
    >$60/lb P for Dry or Wet

Parameter	Level 2 Load Reduction	Level 3 Load Reduction
Ammonia	>88%	>88%
Total N	>61%	>84%
Total P	>63%	>89%

Preliminary No Net Load Increase (NNLI) Results

DRAFT NNLI Findings

Which nutrients are easiest to remove?

- Ammonia is the most difficult and expensive
  - Bigger basins due to increasing SRT for plants with act sludge
  - Expanded aeration system
  - Additional pumping
- TN load reduction requires ammonia removal
  - An external carbon source occasionally required
- TP load is the simplest and most straight forward to remove
  - Typically CEPT or Biological P removal
  - Tertiary filtration typically not required

PV Costs for 29 Plants

- Total PV = $1.4B Dry and $1.6B Wet
- Total PV ranged from $5.1M to $408M per plant

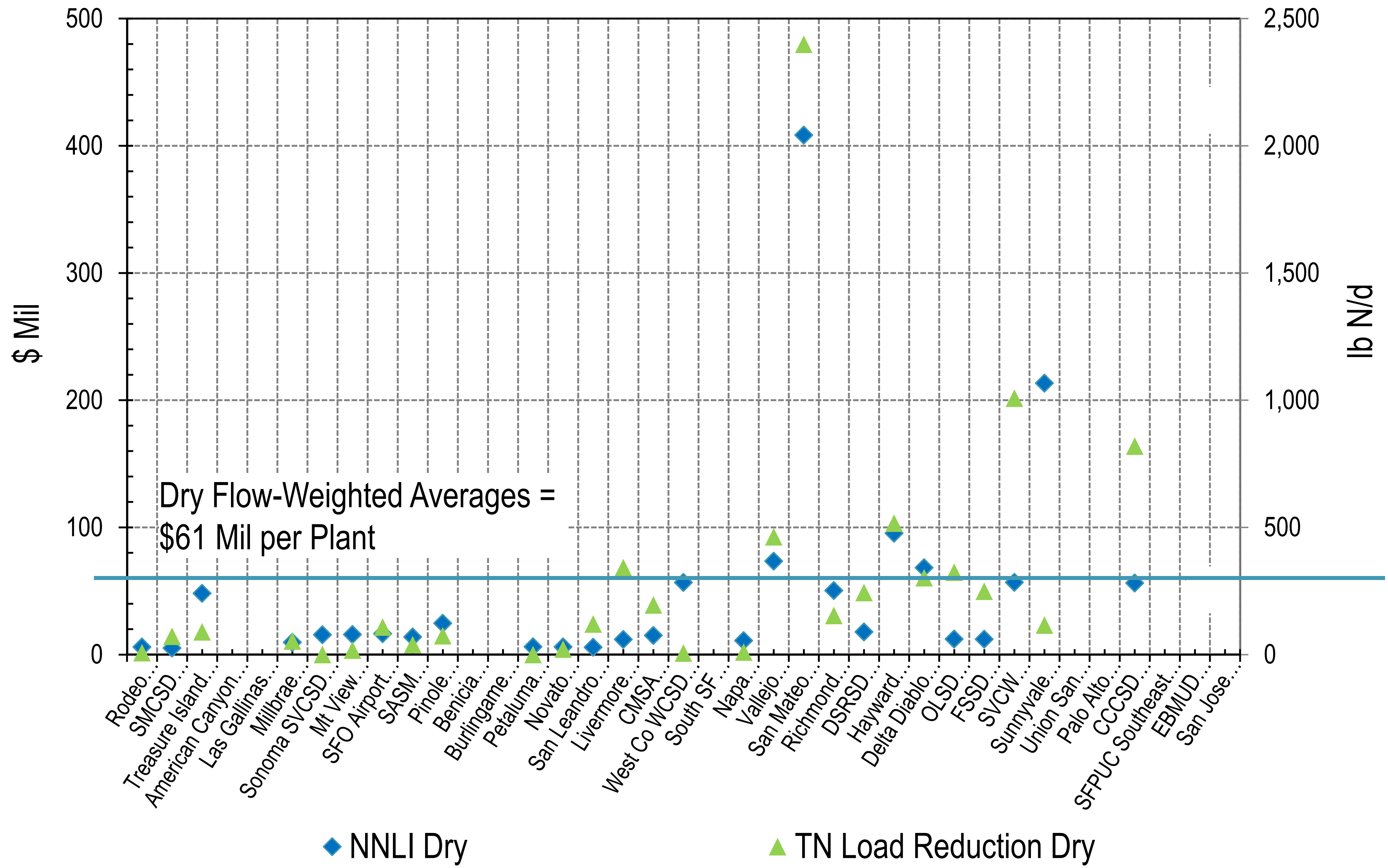
Unit Costs for 29 Plants:

- Flow-weighted Total PV unit cost = $4/gpd for both Dry and Wet
- TN: $42 lb N Dry and $17/lb N Wet
- TP: $88 lb P Dry and $72/lb P Wet

Load Reduction for 29 Plants:

- TN load reduction = 10,700 lb N/d (15% w/respect to 29 Plants Current Discharge)
- TP load reduction = 930 lb P/d (16% w/respect to 29 Plants Current Discharge)

DRAFT NNLI Total PV Costs



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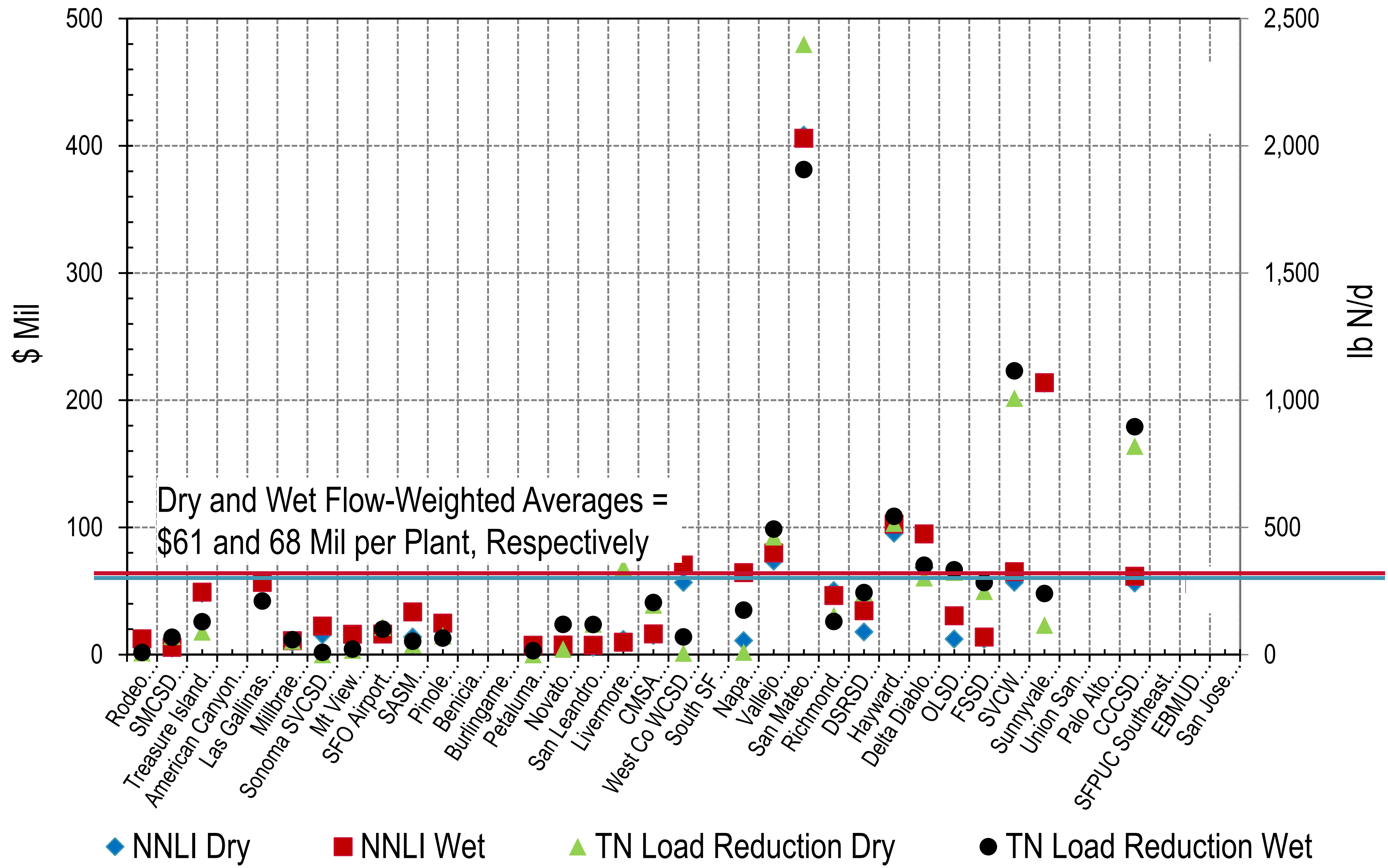
DRAFT NNLI Total PV Costs



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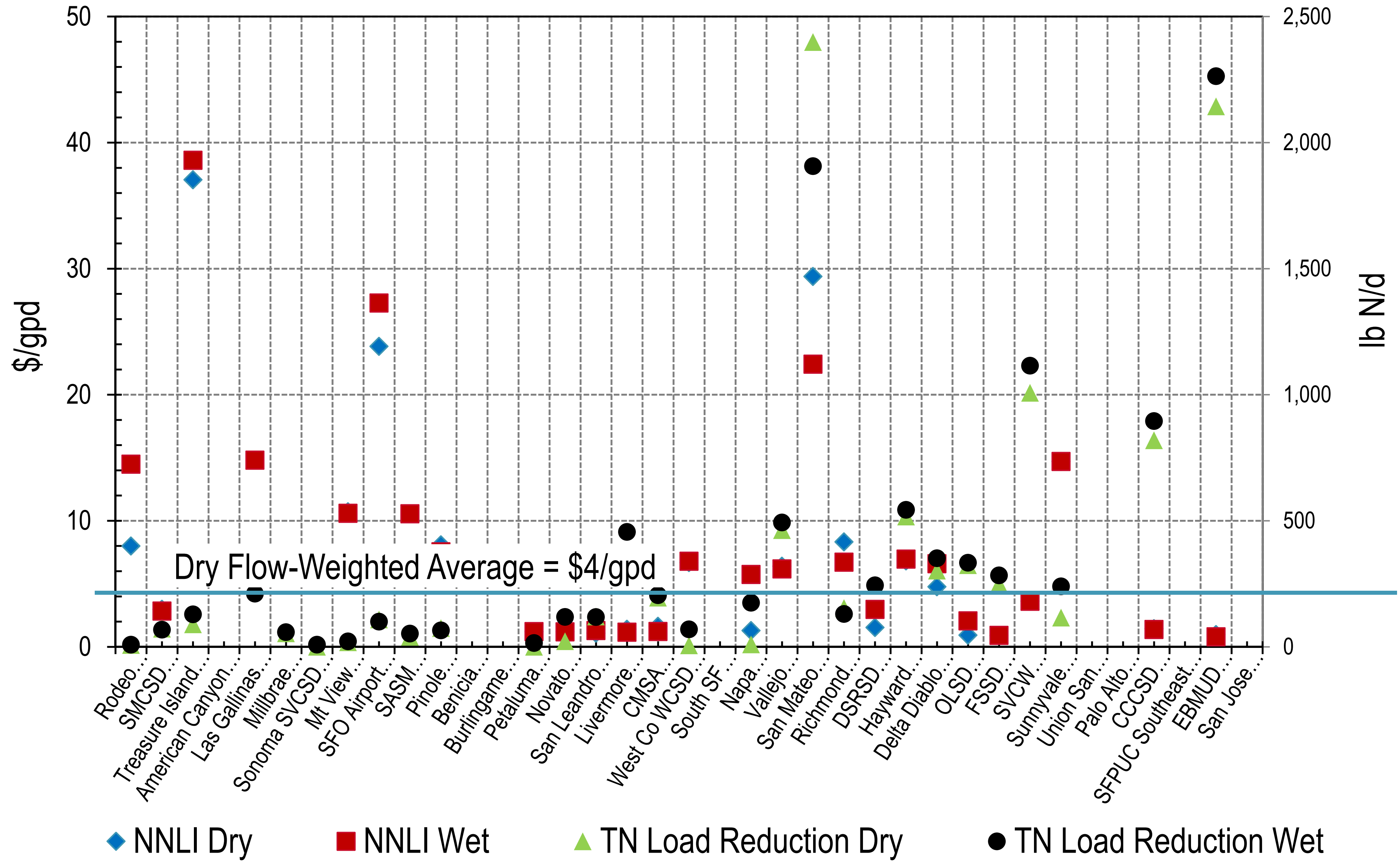
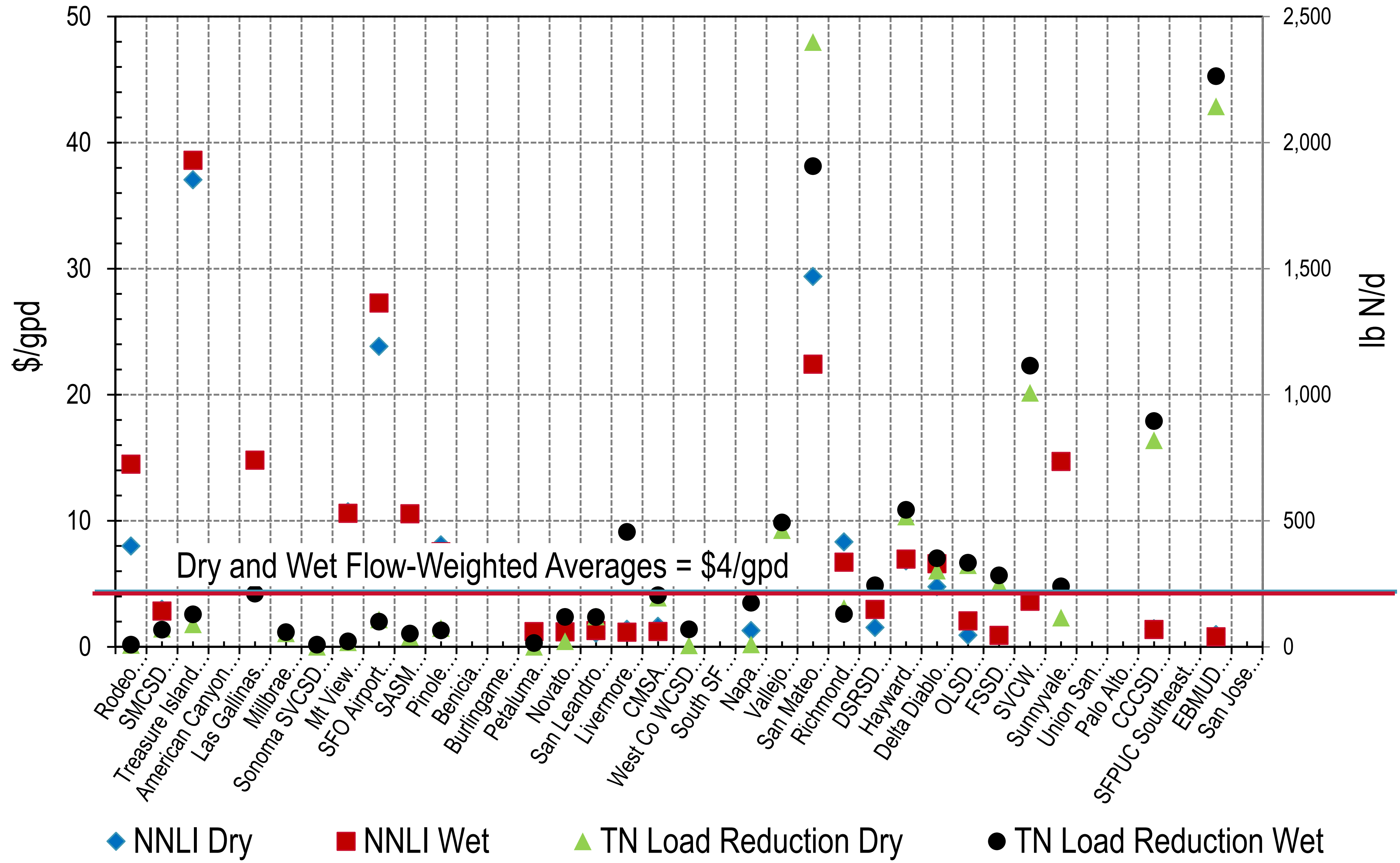
DRAFT NNLI Total PV Unit Costs



*Draft Results are Sorted by Permitted Capacity

DRAFT NNLI Total PV Unit Costs



*Draft Results are Sorted by Permitted Capacity

DRAFT NNLI Findings

Which nutrients are easiest to remove?

- Ammonia is the most difficult and expensive
  - Bigger basins due to increasing SRT for plants with act sludge
  - Expanded aeration system
  - Additional pumping
- TN load reduction requires ammonia removal
  - An external carbon source occasionally required
- TP load is the simplest and most straight forward to remove
  - Typically CEPT or Biological P removal
  - Tertiary filtration typically not required

PV Costs for 29 Plants

- Total PV = $1.4B Dry and $1.6B Wet
- Total PV ranged from $5.1M to $408M per plant

Unit Costs for 29 Plants:

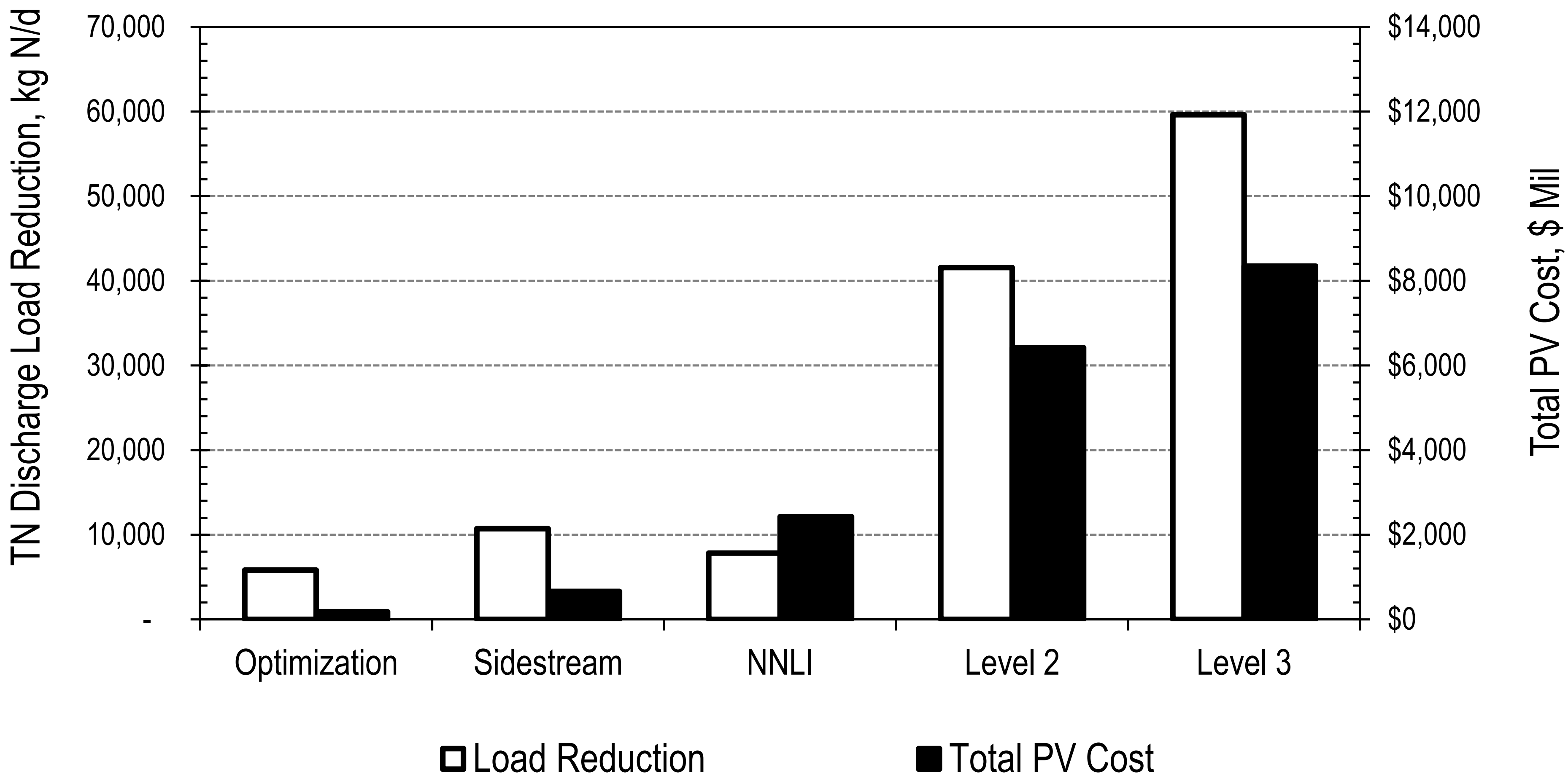
- Flow-weighted Total PV unit cost = $4/gpd for both Dry and Wet
- TN: $42 lb N Dry and $17/lb N Wet
- TP: $88 lb P Dry and $72/lb P Wet

Load Reduction for 29 Plants:

- TN load reduction = 10,700 lb N/d (15% w/respect to 29 Plants Current Discharge)
- TP load reduction = 930 lb P/d (16% w/respect to 29 Plants Current Discharge)

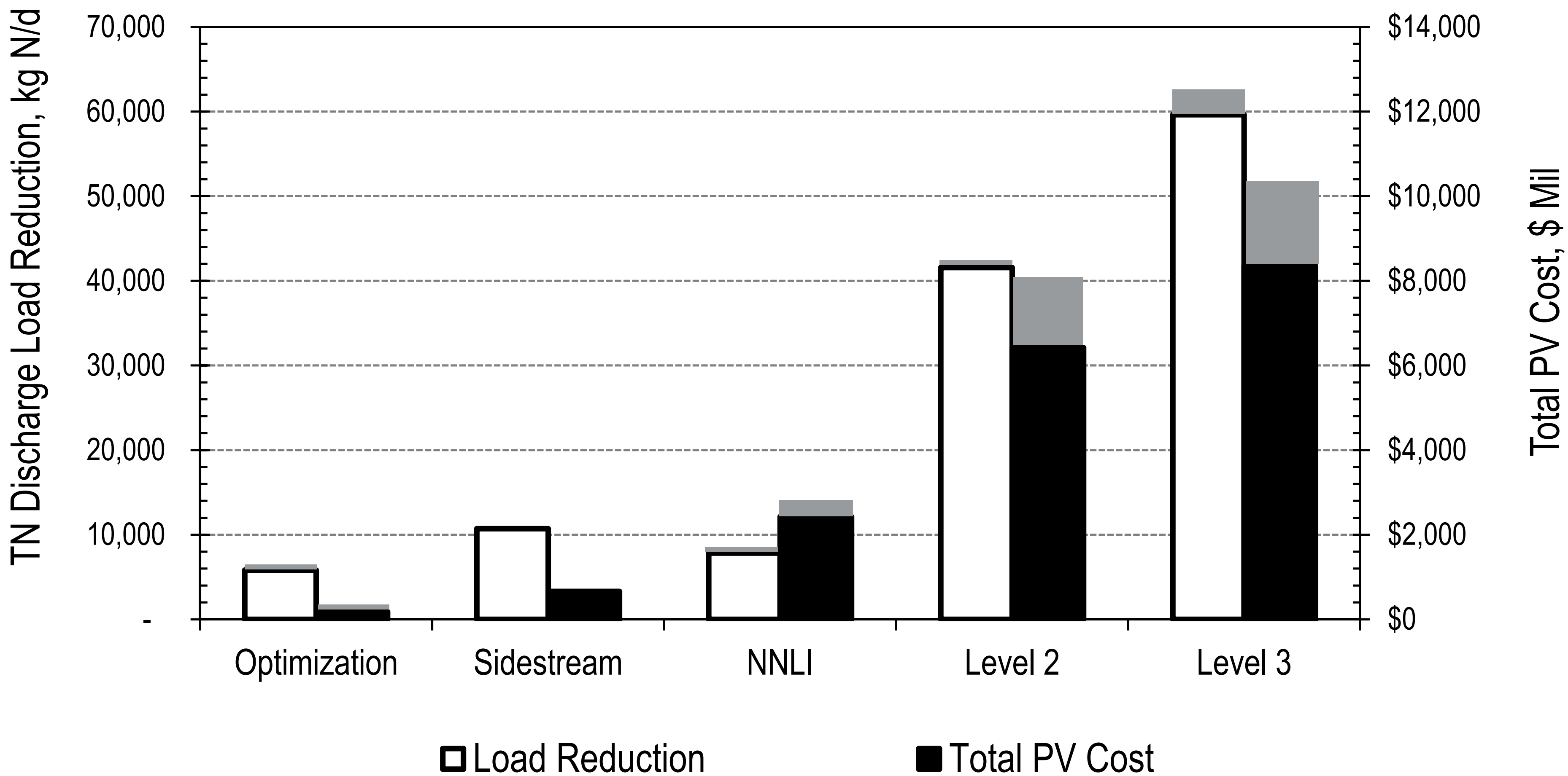
Summary of Results

DRAFT: Total N Discharge Load Reduction and Costs under Various Scenarios (Dry Season)



- Optimization = 10-yr planning horizon
- NNLI = 25-yr planning horizon (Projected to all 37 Plants)
- Sidestream and Upgrades (Level 2 and 3) = 30-yr planning horizon using Permitted Capacity

DRAFT: Total N Discharge Load Reduction and Costs under Various Scenarios (Wet Season)

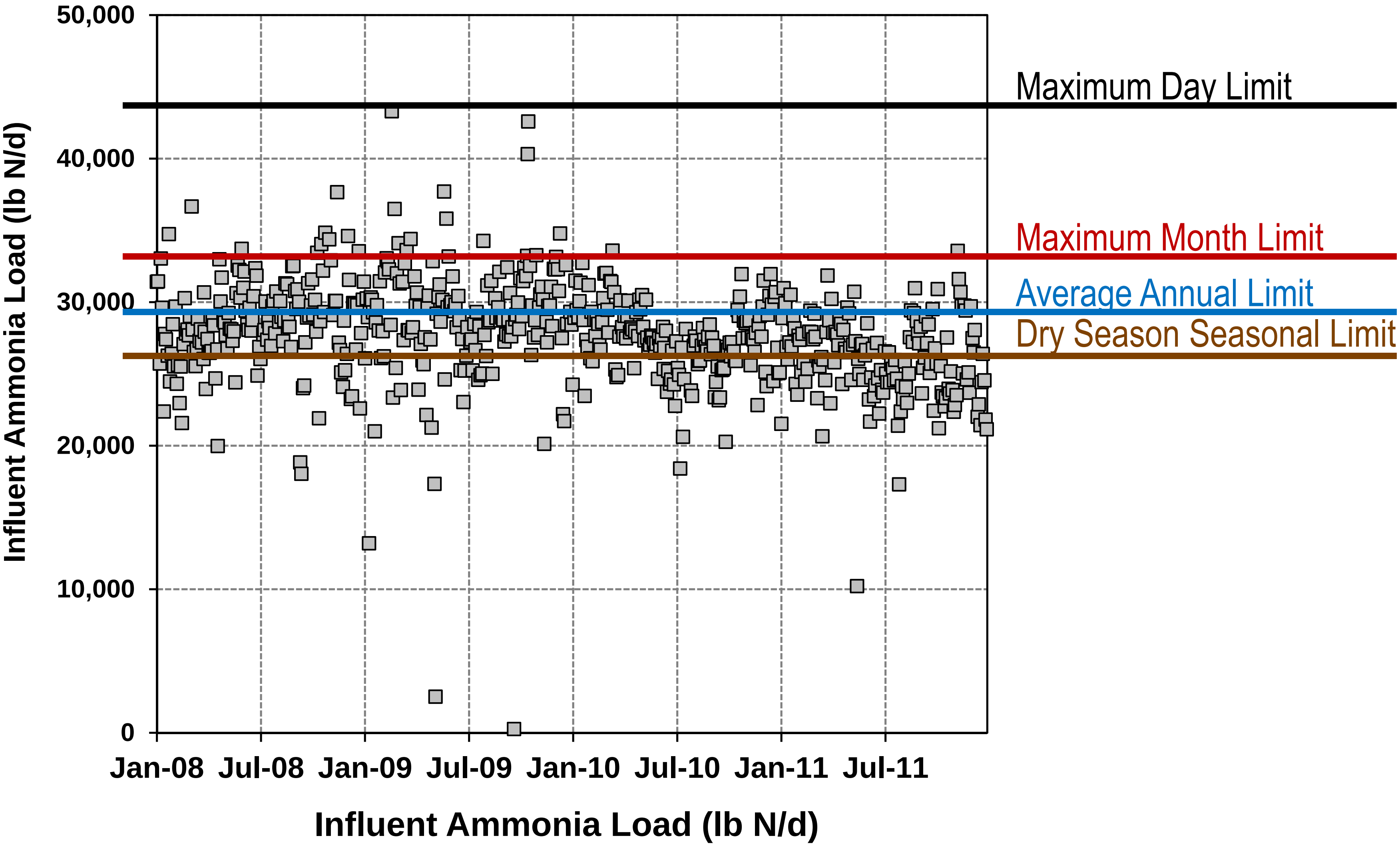


- Optimization = 10-yr planning horizon
- NNLI = 25-yr planning horizon (Projected to all 37 Plants)
- Sidestream and Upgrades (Level 2 and 3) = 30-yr planning horizon using Permitted Capacity

Observations

Role of Averaging Periods

Importance of Averaging Periods



Role of Averaging Periods on SRT and Basin Volume

Averaging Periods Govern the SRT and Overall Basin Volume

Role of Averaging Periods on Cost: Oro Loma for Level 3

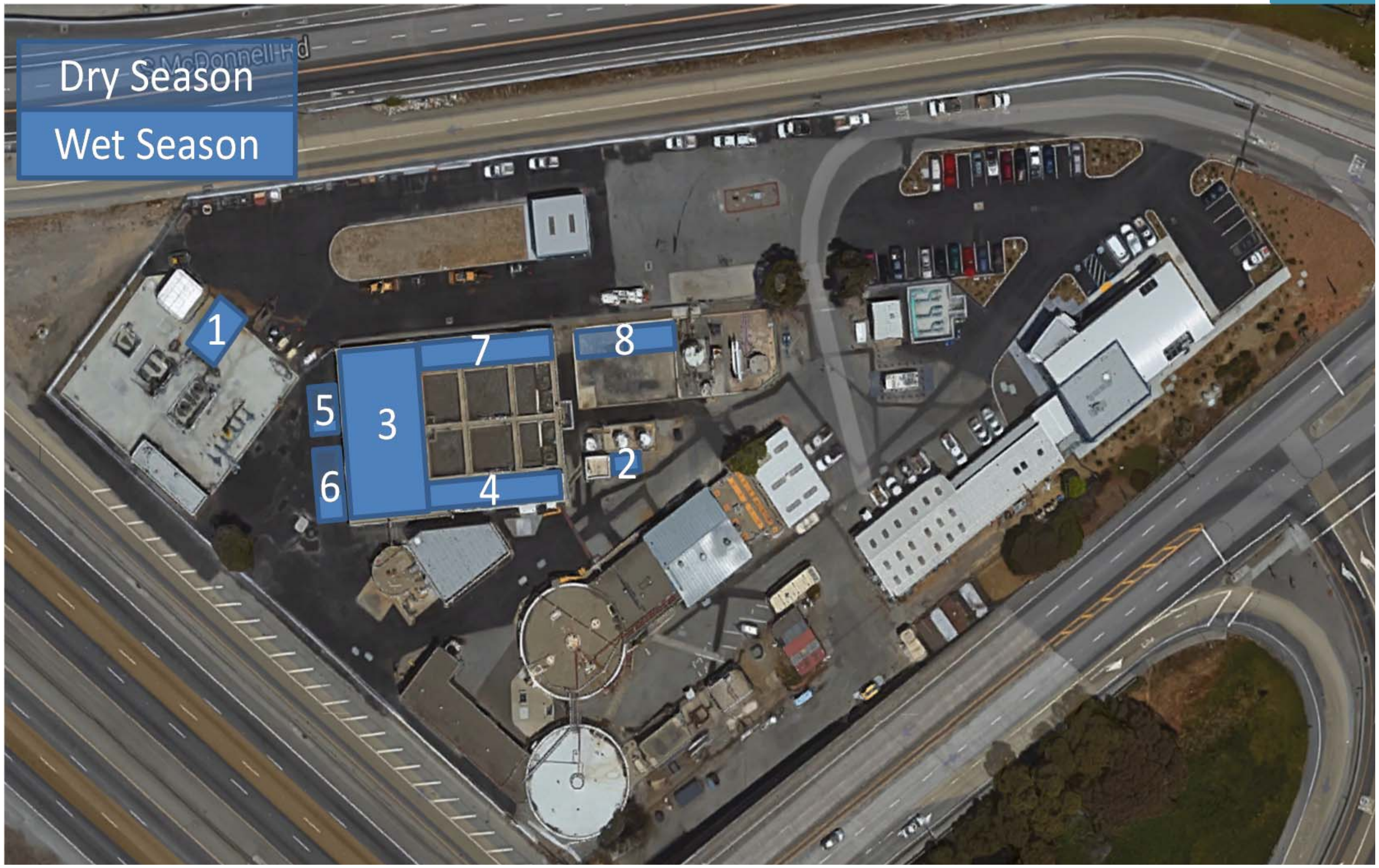
Parameter	Units	Dry Season			Wet Season		
		Ave Annual	Max Month	Max Day	Ave Annual	Max Month	Max Day
Capital PV	$ Mil	60	68	84	66	73	110
O&M	$ Mil /yr	5.7	6.0	6.3	6.1	6.6	7.1
O&M PV	$ Mil	130	134	140	137	147	159
Total PV	$ Mil	190	202	224	203	221	267
NH4 Load Reduction *	%	97	99	>99	92	99	>99

* Based on 6-years historical data from Hampton Roads Sanitation District VIP Plant

Treating all the Flow

Case Study: City of Millbrae

- Permitted Capacity = 3.0 mgd ADWF
- Peak = 9.0 mgd
- Key process:
  - Must be MBR
  - Must move blower building for a train
  - Must move disinfection for a train
  - Add new disinfection
- 8 Plants were pushed to compact footprint technology due to peaks

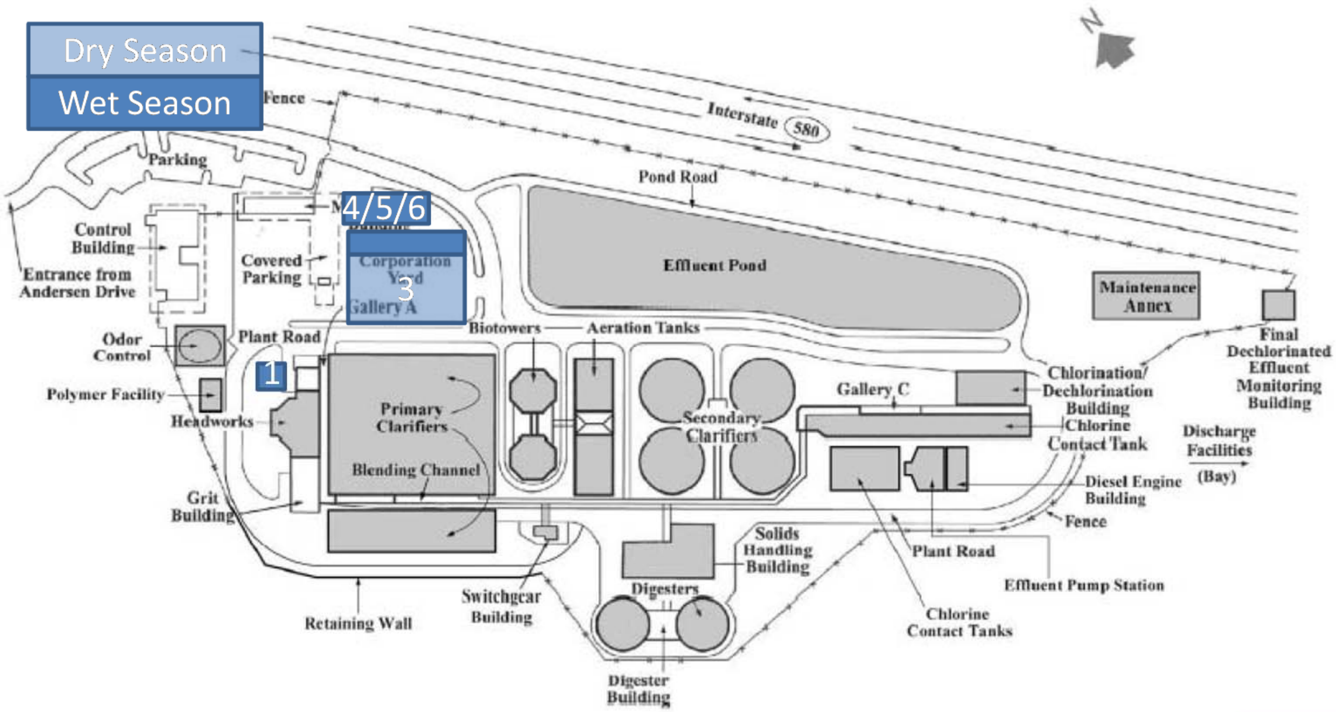


(1) Optimize ferric addition, (2) add polymer, (3) convert act sludge to MBR, (4) expand the aeration basins to create a third train, (5) add alkalinity, (6) add external carbon, (7) decommission the chlorination disinfection system (use for additional aeration basin volume), and (8) add an ultraviolet disinfection system.

Space Constraints

Case Study: CMSA

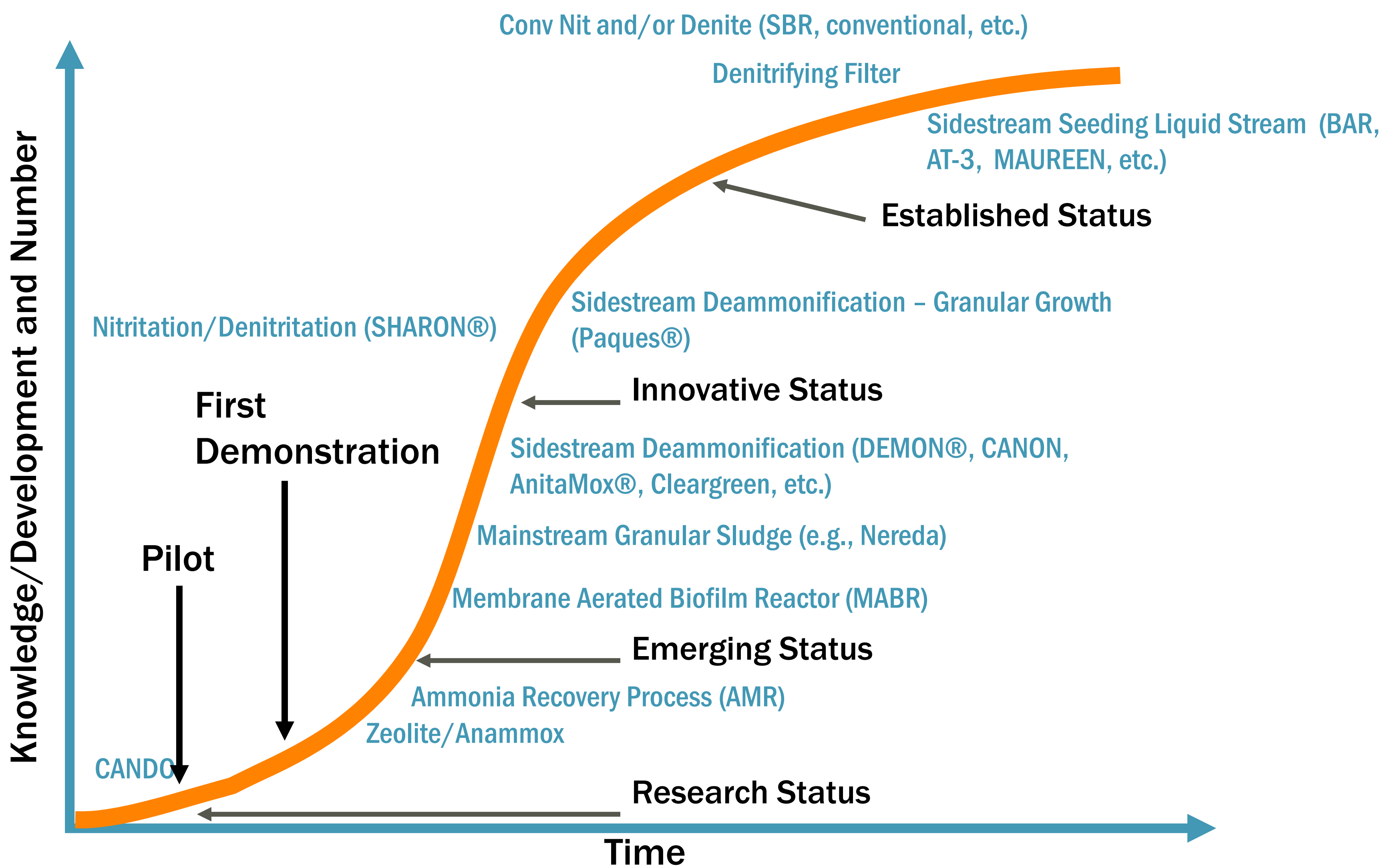
- MBR selected since it's the only option that could meet Level 3 (split treatment with existing facilities would work for Level 2)
- Plant surrounded by highway or steep hills
- 8 Plants were pushed to compact footprint technology due to space constraints



(1) Use existing ferric chloride for CEPT, (3) Add MBR facilities, (4) add an external carbon source, (5) add alkalinity, and (6) add ferric chloride

Role of Emerging Technologies

Technology Status



Adapted from Tetra Tech (2013) and Parker et al. (2011)

Regulatory: Nitrogen versus Phosphorus

Differences in N and P Removal

Nitrogen Removal

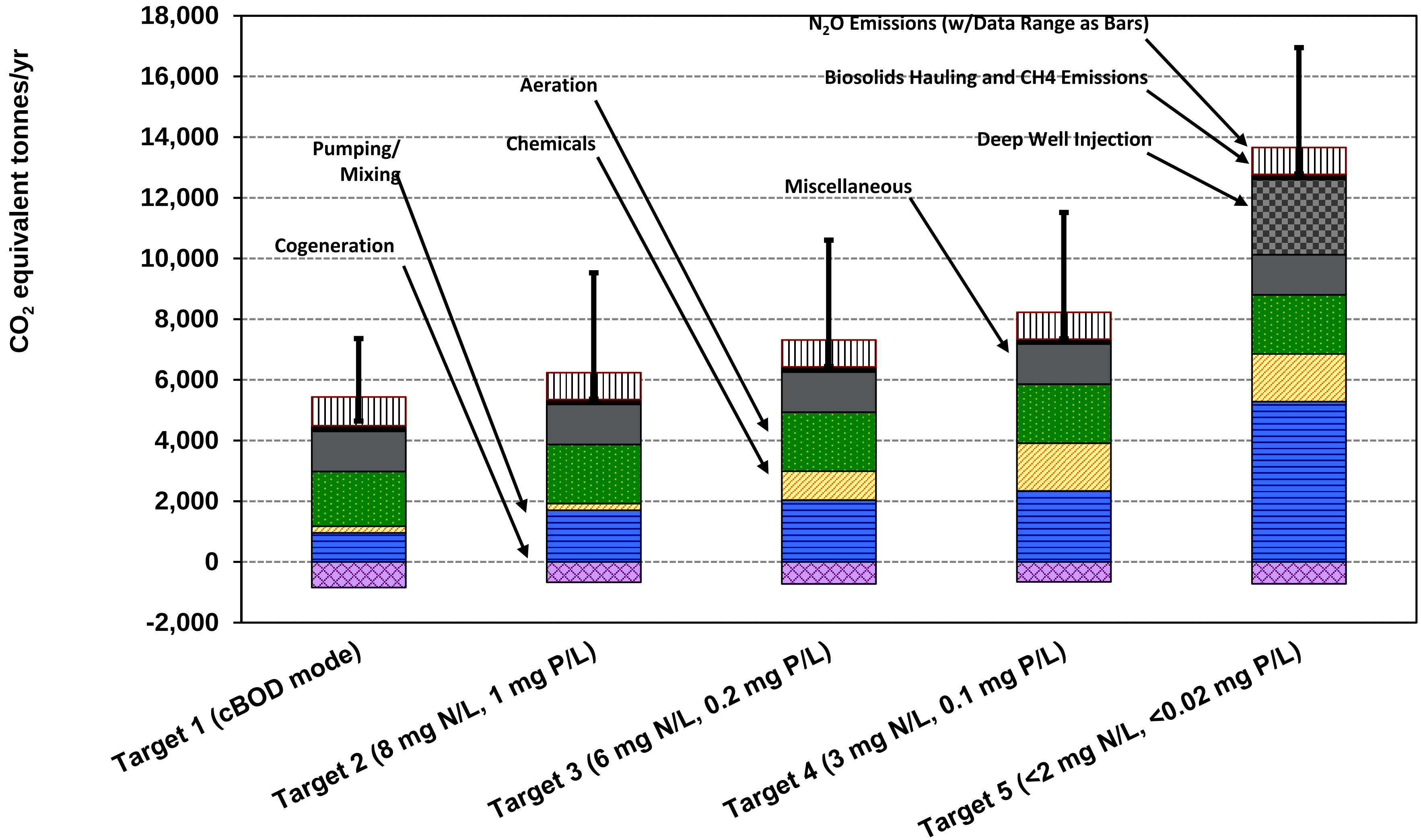
- Challenging to remove with major operational changes
  - Activated Sludge (typical): with longer SRT and intensive mixed liquor returns
  - Biological Filters (to trim): requires large filter footprint plus an external carbon source
- More expensive to remove
- Requires a large footprint
- Energy and chemical intensive (at low targets)
- Can be recovered in the sidestream

Phosphorus Removal

- Straightforward removal
  - Biological P (Act Sludge)
  - Chemical Precipitation: Primaries, Filters, or Sidestream
- Less expensive to remove
- Less additional footprint (extra zone or filters)
- Chemical intensive
- Can be recovered in the sidestream

Greenhouse Gas Emissions

Technology Status



GHG Emissions Distribution for a Nominal 10 mgd Plant at Various Treatment Targets (Adapted from Falk et al., 2013)

Recycled Water and CIP Surveys

BACWA Recycled Water Survey 2015

Agency Name (Recycled Water Producer):

Recycled Water Distributors/Retailers:

CURRENT AND PROJECTED FUTURE AMOUNT OF RECYCLED WATER BY USE CATEGORY (in acre-feet)

	Total Distribute	Confidence (see Note B)	Golf Course Irrigation (See Note C)	Landscape (see Note D)	Commercial (see Note E)	Industrial (see Note F)	Agricultural (see Note G)	Environmental Enhancement (see Note H)	Internal Use (see Note I)	GW Recharge for Indirect Potable Reuse	Surface Water Augmentation	Direct Potable Reuse	Other Non-potable Reuse (See Note J)	RO concentrate or other return	Comments
Type of RW (See Note A):															
Current			0	0	0	0	0	0	0	0	0	0	0	0	
Future															
Future															
Future															
Future															
Future															
Future															

2015 MONTHLY RECYCLED WATER DISTRIBUTION DATA BY USE CATEGORY (in acre-feet)

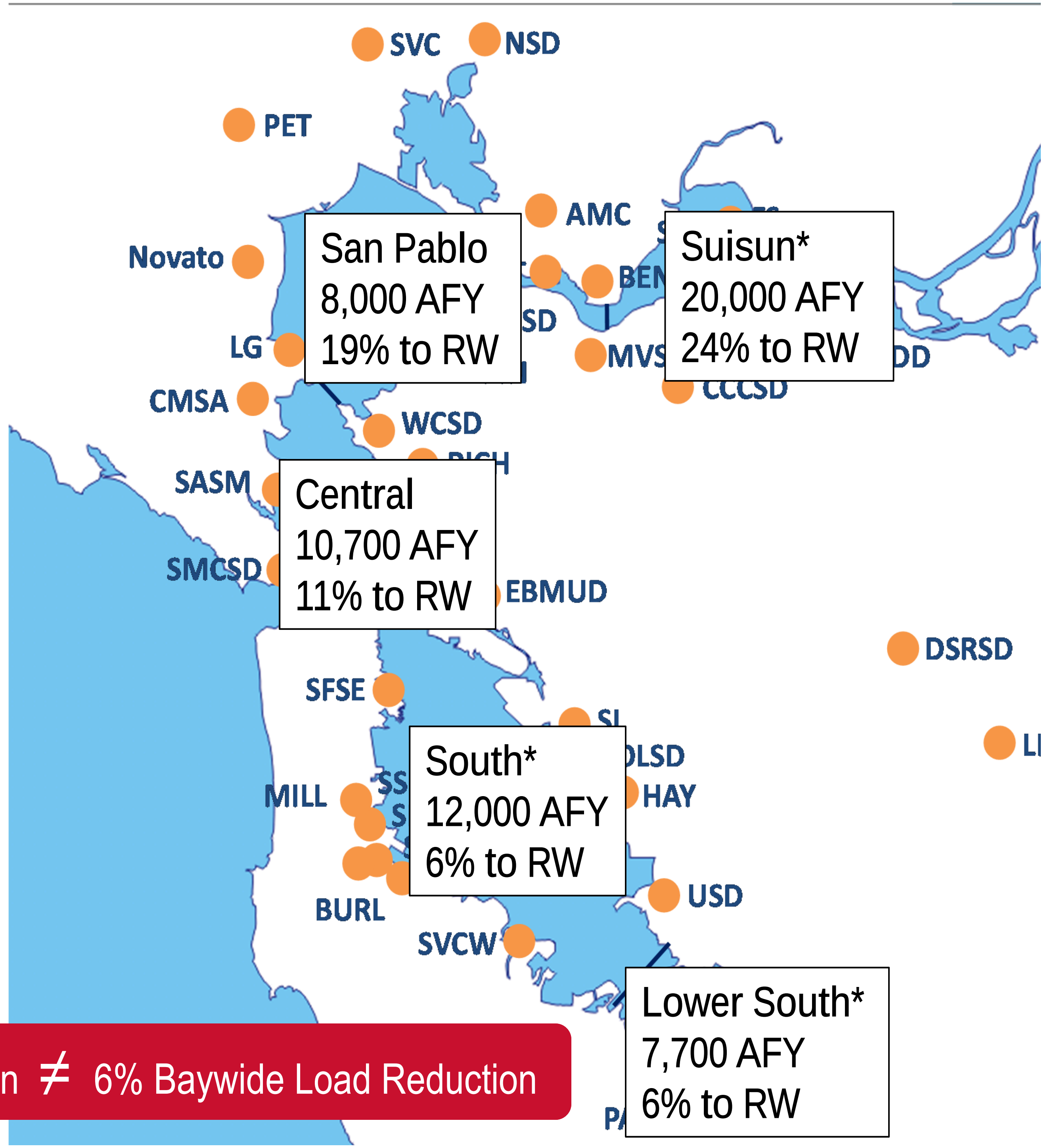
	TOTAL		Golf Course	Landscape	Commercial	Industrial	Agricultural	Environ. Enhance	Internal Use	GW Recharg	Surface Water	Direct Potable	Other Non-	Return Flows	Comments
January															
February															
March															
April															
May															
June															
July															
August															
September															
October															
November															
December															
TOTAL															

Data | README | Potable Reuse Definitions

Recycled Water Survey

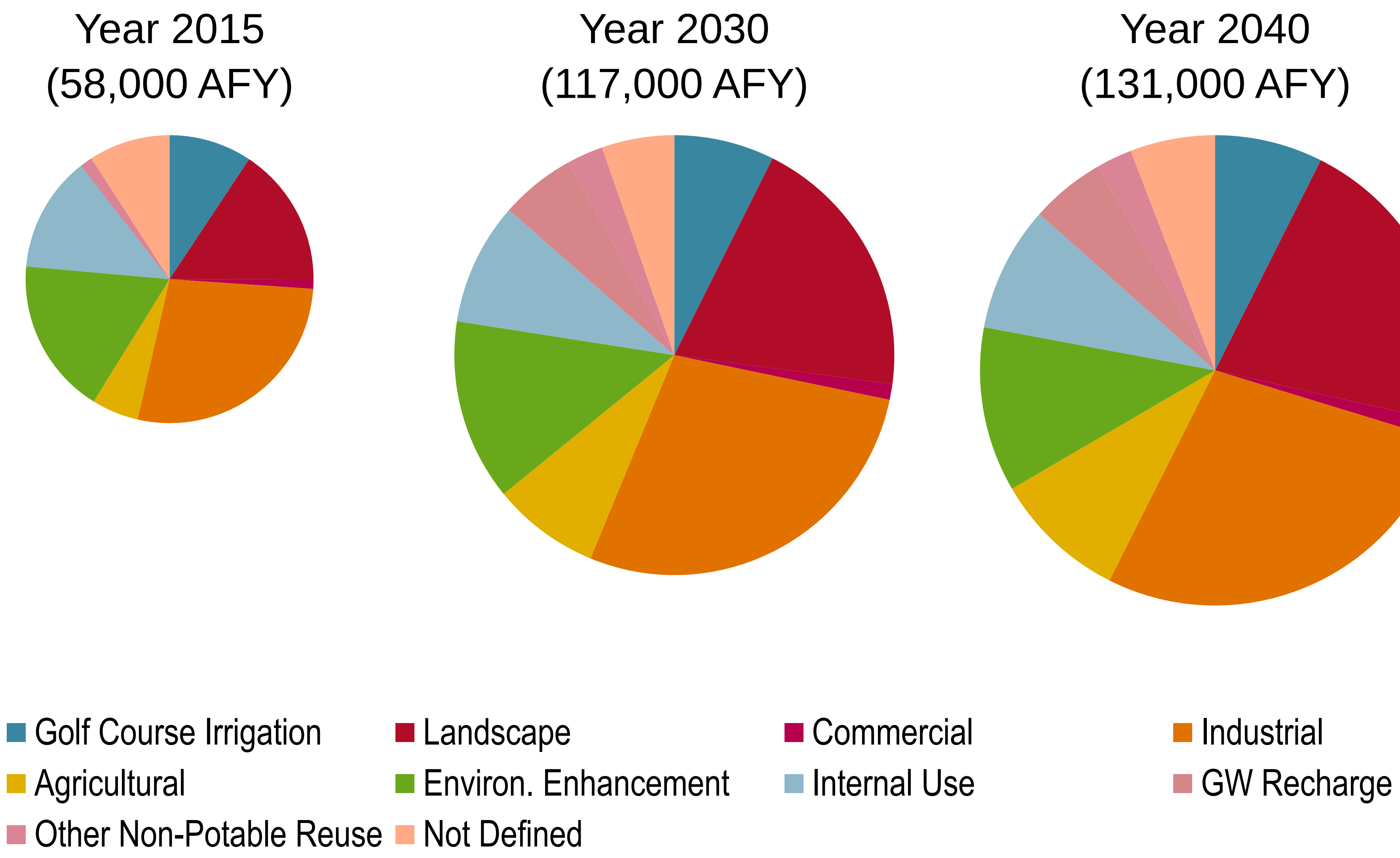
Current Recycled Water Findings

- ~6% of Baywide plant effluent goes to recycled water
- Recycled water is expected to double by 2035
- The primary application is industrial (~40%)

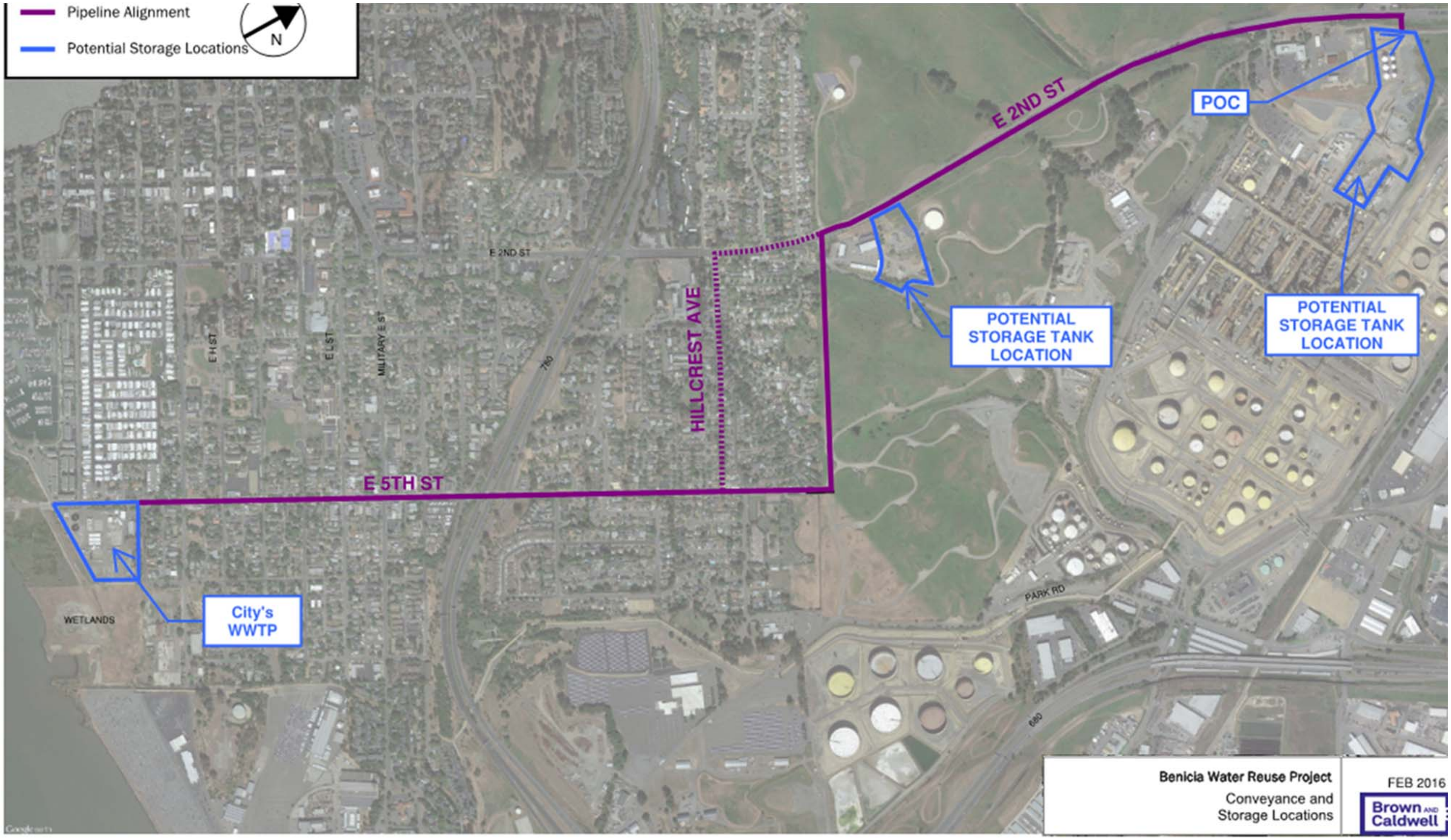


6% Baywide Flow Reduction ≠ 6% Baywide Load Reduction

Recycled Water Distribution over Time



City of Benicia: Recycled Water Project



Produce up to 2,200 AFY (~2mgd) of Title 22 Recycled Water at the City's WWTP for use as cooling tower makeup water at the Valero Benicia Refinery and irrigation water for City customers

Name of Res	<name>
Utility Name	<utility>
Phone Numb	<phone>

Planned CIP Projects that may impact nutrient loads

	Discharger	Permitted ADWDF Capacity (mgd)	Anticipated Year of Completion	Project Description	Estimated Effluent Total Nitrogen (mg N/L)	Estimated Effluent Total Phosphorus (mg P/L)	Capital Cost ($ Mil):	Estimated Annual O&M Cost (if available: $ Mil):	Level of Confidence	Comment
EXAMPLE	ABC	10	2018	1) Membrane Bioreactor (MBR); 2) Modify existing aeration basins to operate as Nit/Denite with anoxic zones and mixed liquor return pumps; 3) replace WAS pumps	6	N/A	$200	$100	100%	The MBR will perform reliable nitrogen removal to 6 mg N/L total nitrogen. The existing aeration basins will be modified to achieve what they can get with nitrogen removal. The anticipated average annual existing aeration basins effluent is 15 mg N/L total nitrogen.

CIP Survey

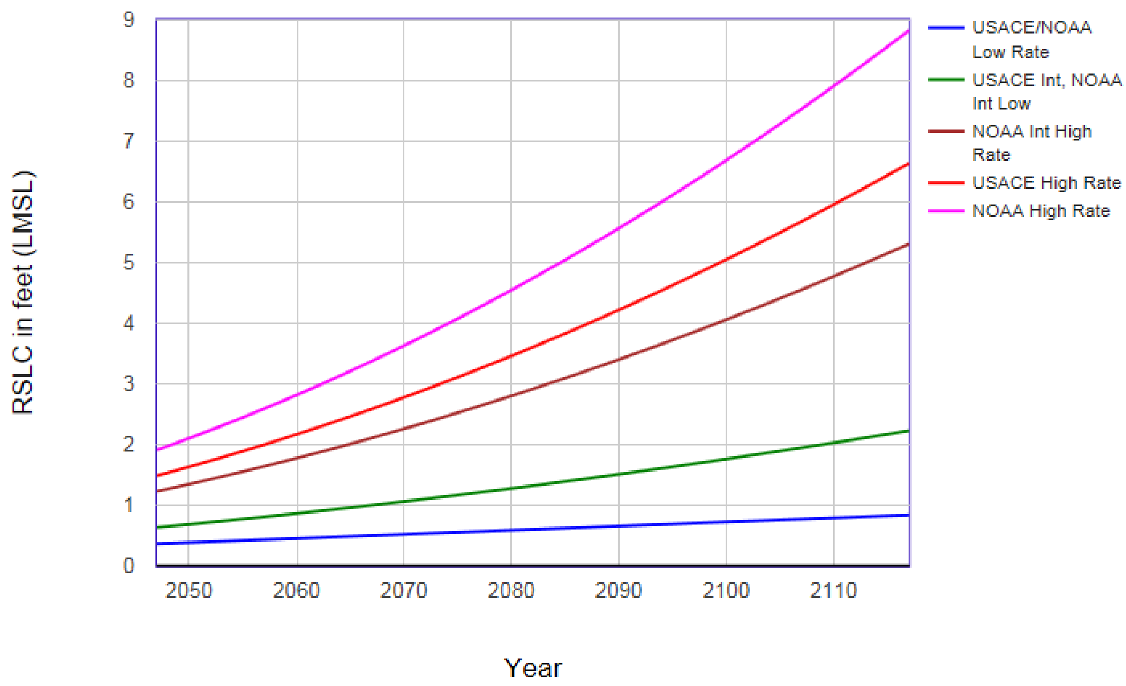
Summary of CIP Survey

- 22 out of 37 plants have either on-going or planned CIP projects for nutrient load reduction
- Total Capital Cost of CIPs = $1.5 Bil
- Example: San Mateo
  - Nutrient Removal and Wet Weather Flow Management Update and Expansion Project
  - New headworks, primary clarifiers, membrane bioreactor with nutrient removal, and disinfection
  - Estimated capital cost = $349-369 Mil

Sea Level Rise

Sea Level Rise Approach and DRAFT Findings

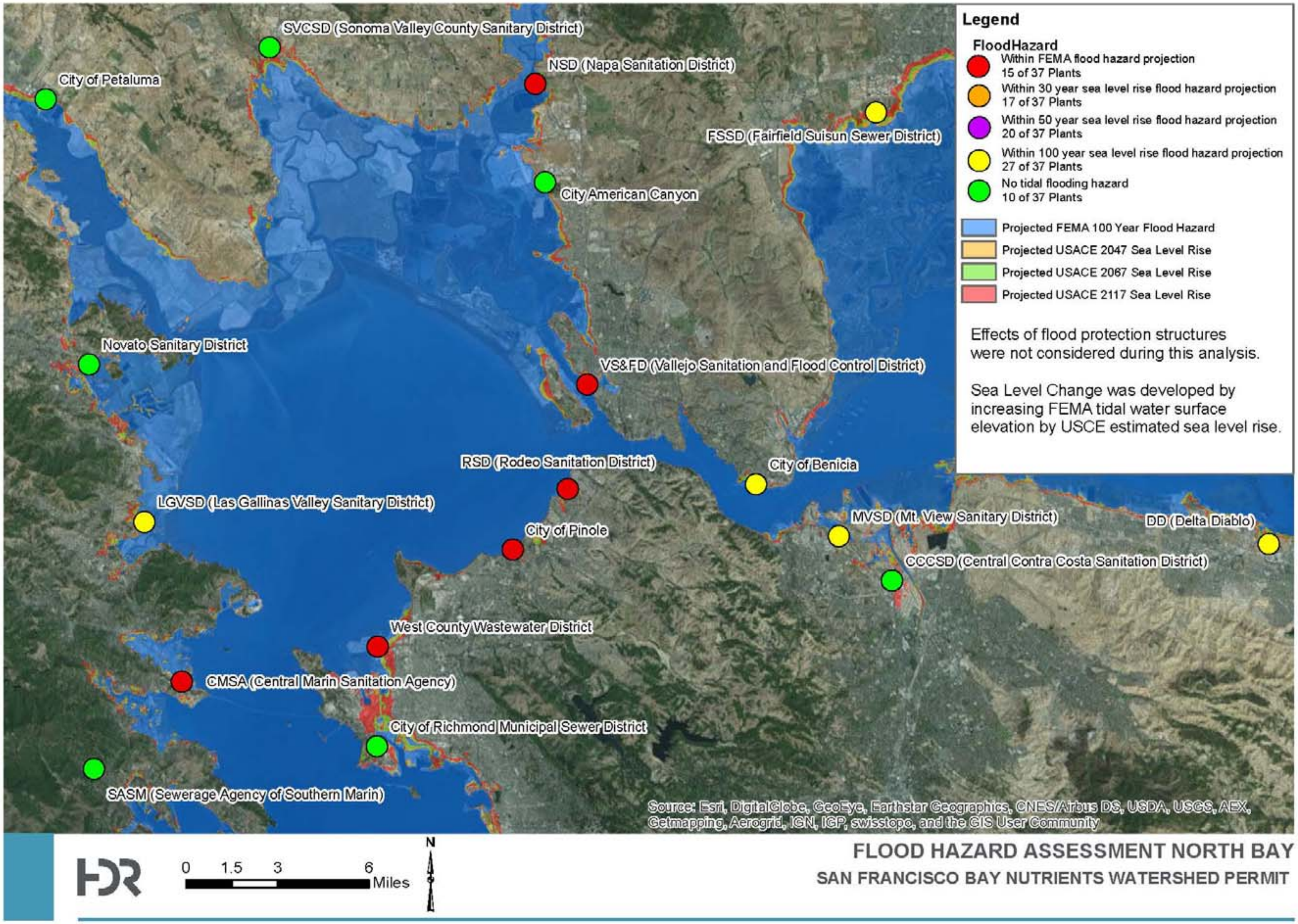
- Models used:
  - FEMA 100-yr flood hazard
  - USACE 2047 sea level rise (30-yr)
  - USACE 2067 sea level rise (50-yr)
  - USACE 2117 sea level rise (100-yr)



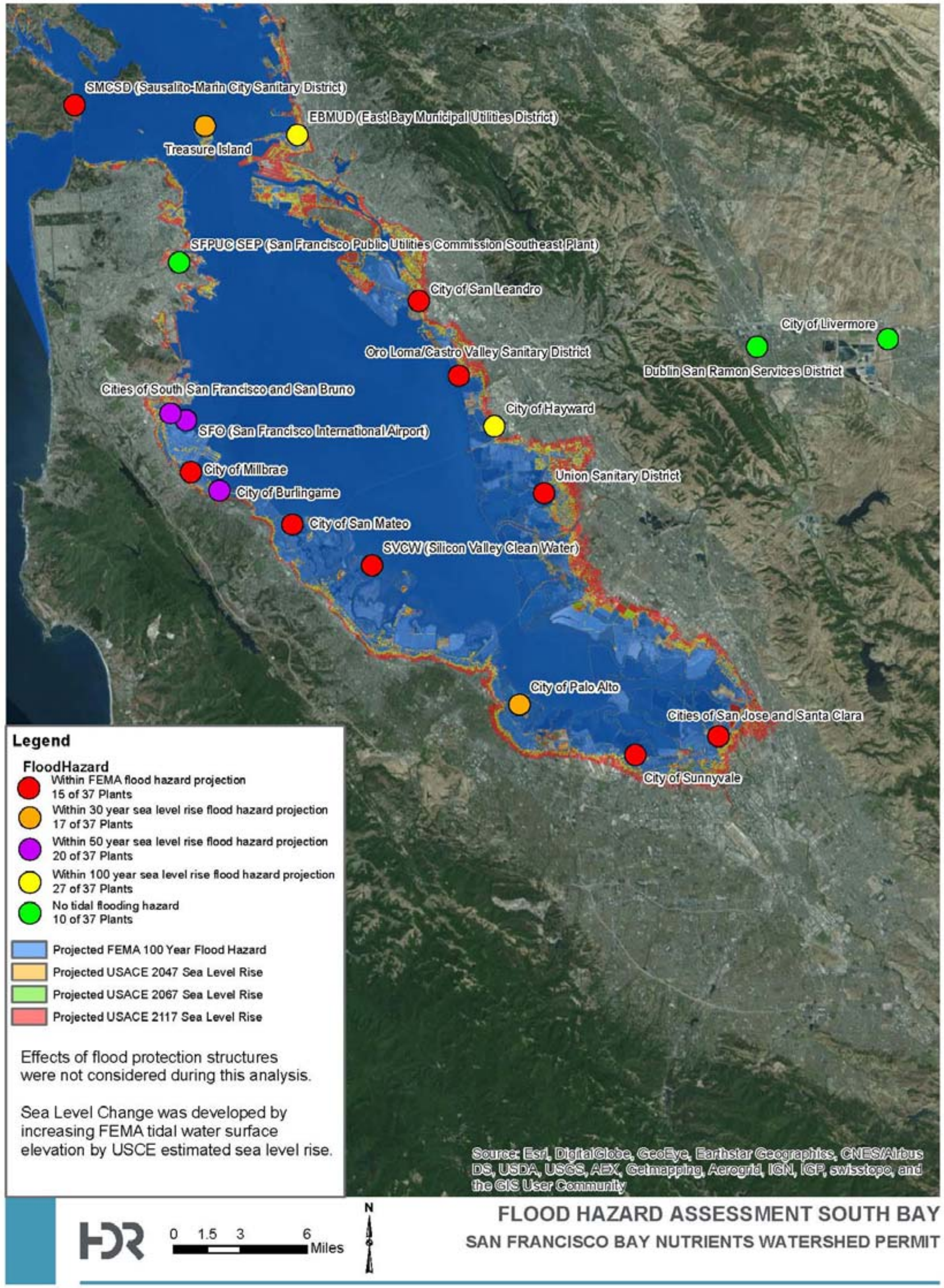
Preliminary Number of Plants (out of 37) that are Potentially at Risk

Plants at Risk for FEMA 100-yr Storm	Plants at Risk for USACE 2047 (30-yr)	Plants at Risk for USACE 2067 (50-yr)	Plants at Risk for USACE 2117 (100-yr)	No Tidal Flooding Hazard
15	17	20	27	10

Northern Portion



Southern Portion



Next Steps

- Draft Report Comments
- Group Annual Report
- Updated Reports
- Others

BACWA Workshop #2: Nutrient Reduction by Treatment Optimization and Upgrades Update

7 June 2017

HDR
Brown AND Caldwell

BACWA
BAY AREA
CLEAN WATER
AGENCIES