No Skeletons in the Closet – Identifying Key Drivers of Methylmercury Reductions in Municipal Wastewater Treatment Facilities in the Delta Region

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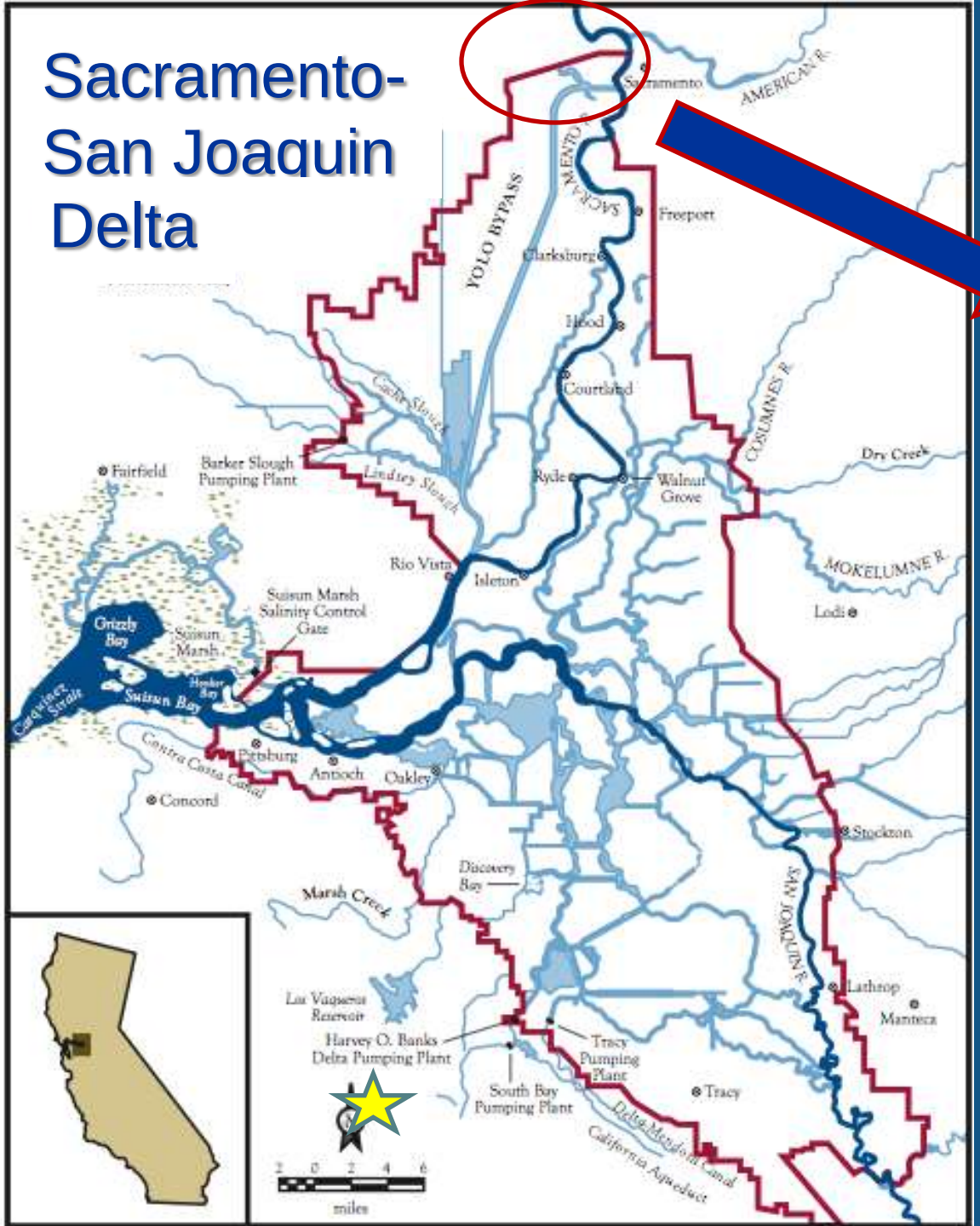
West Yost Associates

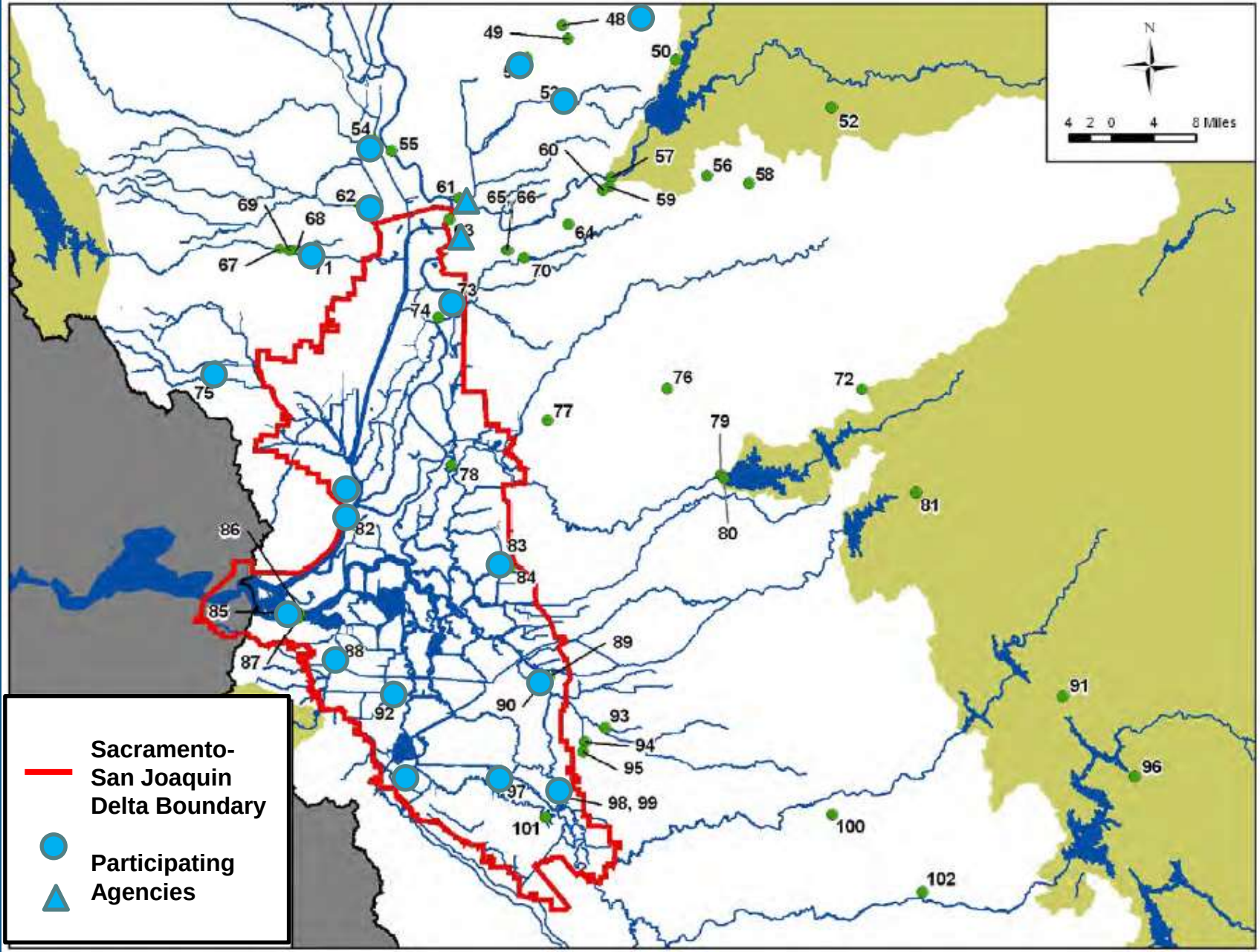
2014 Biennial Bay-Delta Science Conference

October 30, 2014

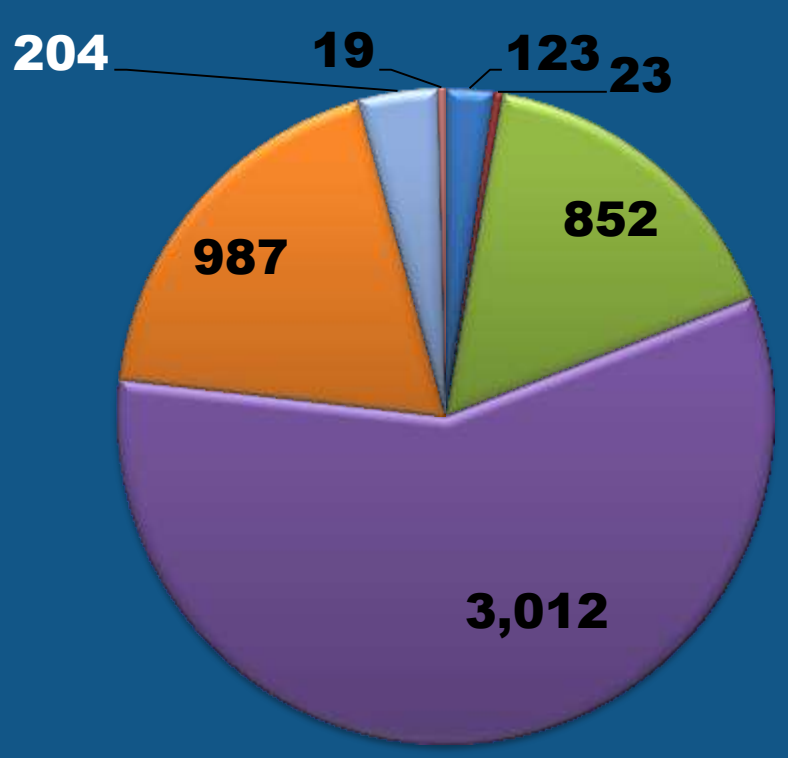
Sacramento-San Joaquin Delta



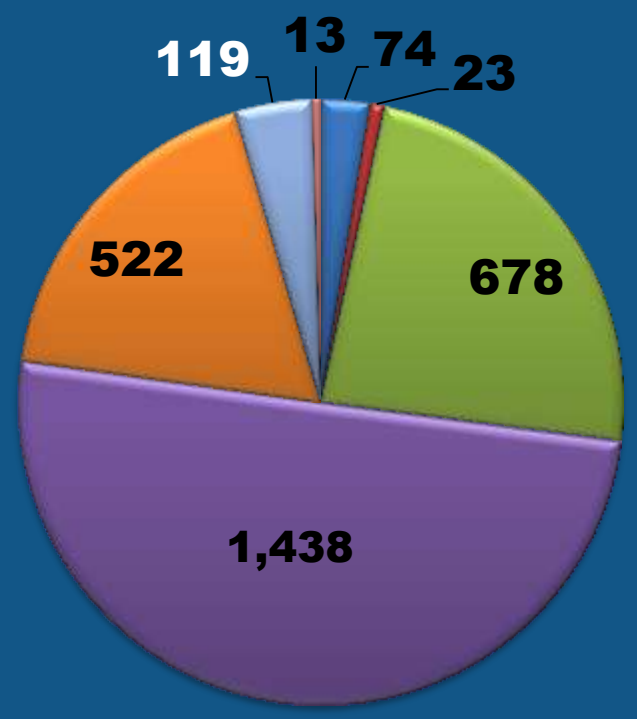
Yolo Bypass and Cache Creek Settling Basin


N
4 2 0 4 8 Miles
Sacramento-San Joaquin Delta Boundary
Participating Agencies

2004-2005 Loads (gram/year)



2030 Allocations (gram/year)



- Agricultural Drainage
- Open Water
- Urban (non-point)
- POTWs
- Atmosphereic Wet Deposit
- Tributary
- Wetlands
- MS4

Delta Methylmercury Control Program

TMDL Adopted 2010

Phase 1 2011-2020

Phase 2 2020-2030

Wasteload Allocations achieved

Presentation Outline

Overview of CVCWA POTW Methylmercury Control Study

Methylmercury Control Mechanisms in POTWs with Biological Nutrient Removal

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Methylmercury Control Mechanisms in POTWs with Biological Nutrient Removal

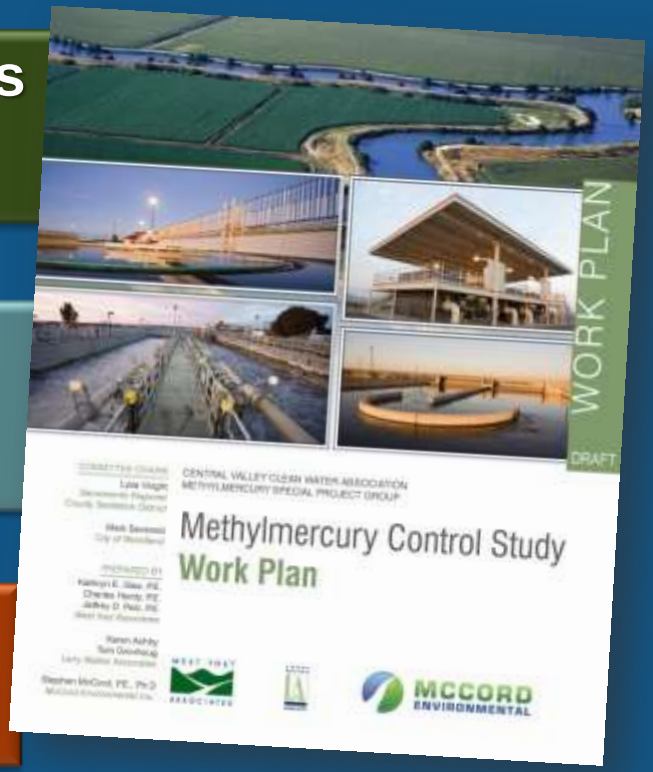
Overall Control Study Approach

Characterize MeHg effluent concentrations at participating POTWs.

Quantify the MeHg effluent concentrations for various levels of treatment.

Extrapolate the water quality to all plants (i.e., what if all plants were upgraded?)

Estimate impacts to the overall POTW MeHg discharge.



Overall Control Study Approach

Characterize MeHg effluent concentrations at participating WWTPs.

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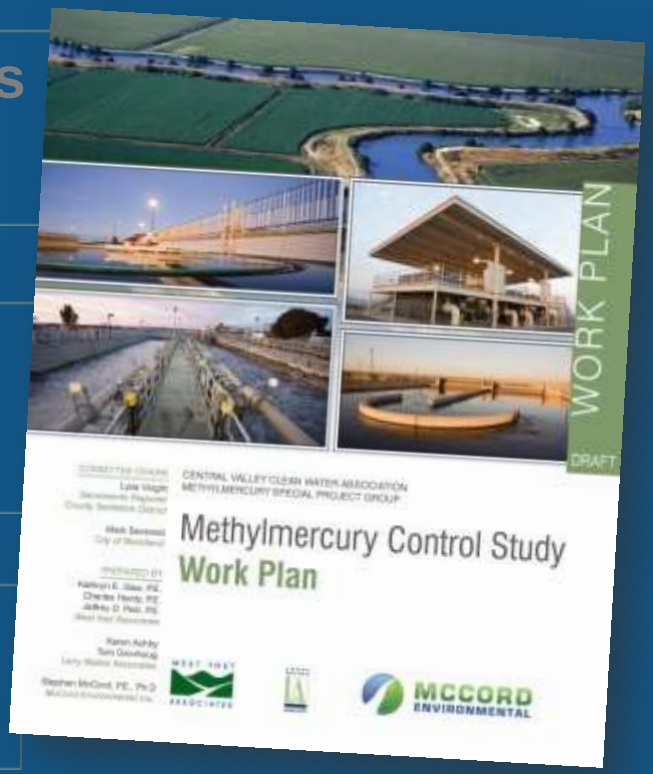
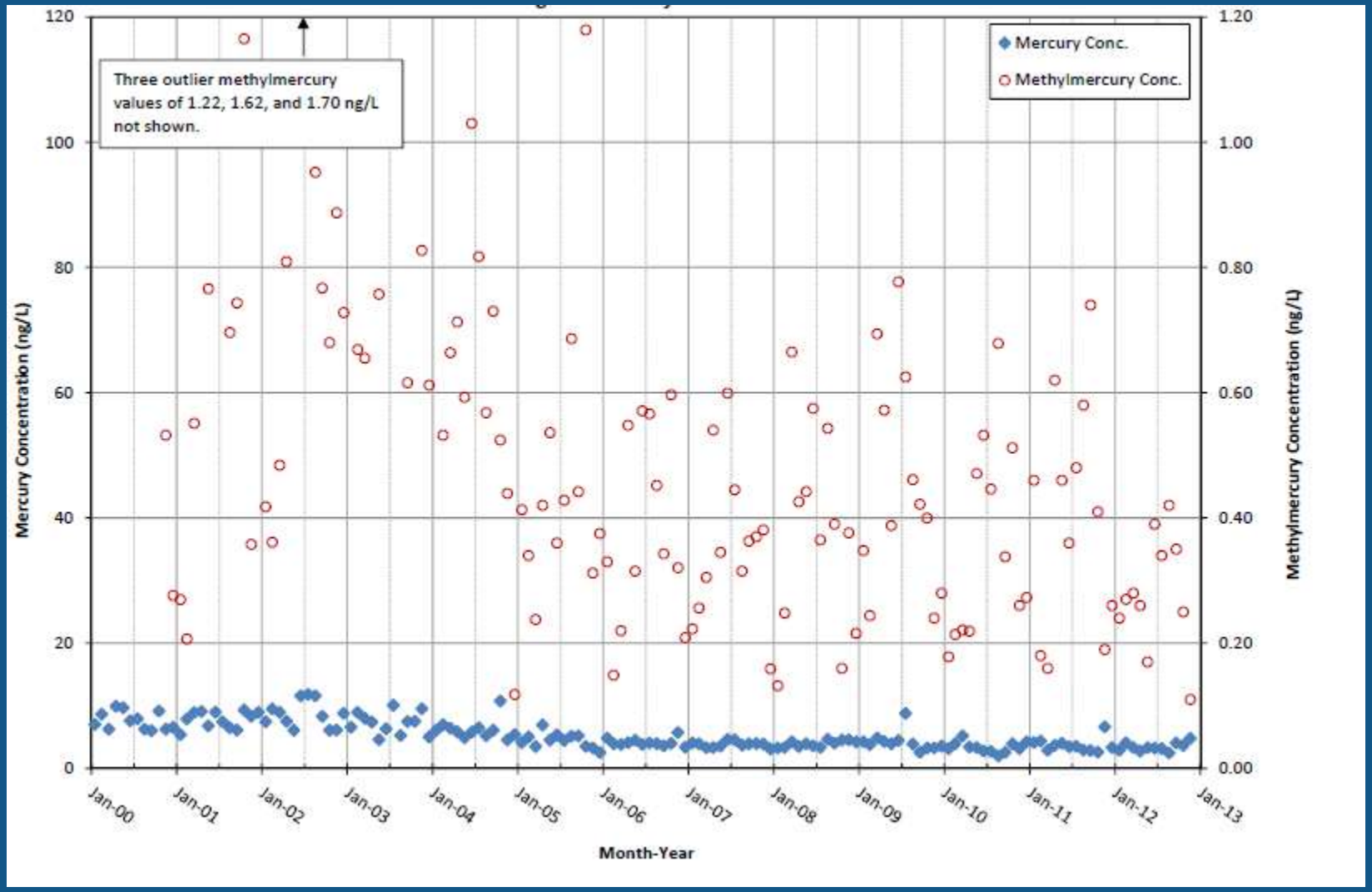
Extrapolate the water quality to all plants (i.e., what if all plants were upgraded?)

Estimate impacts to the overall WWTP MeHg discharge.

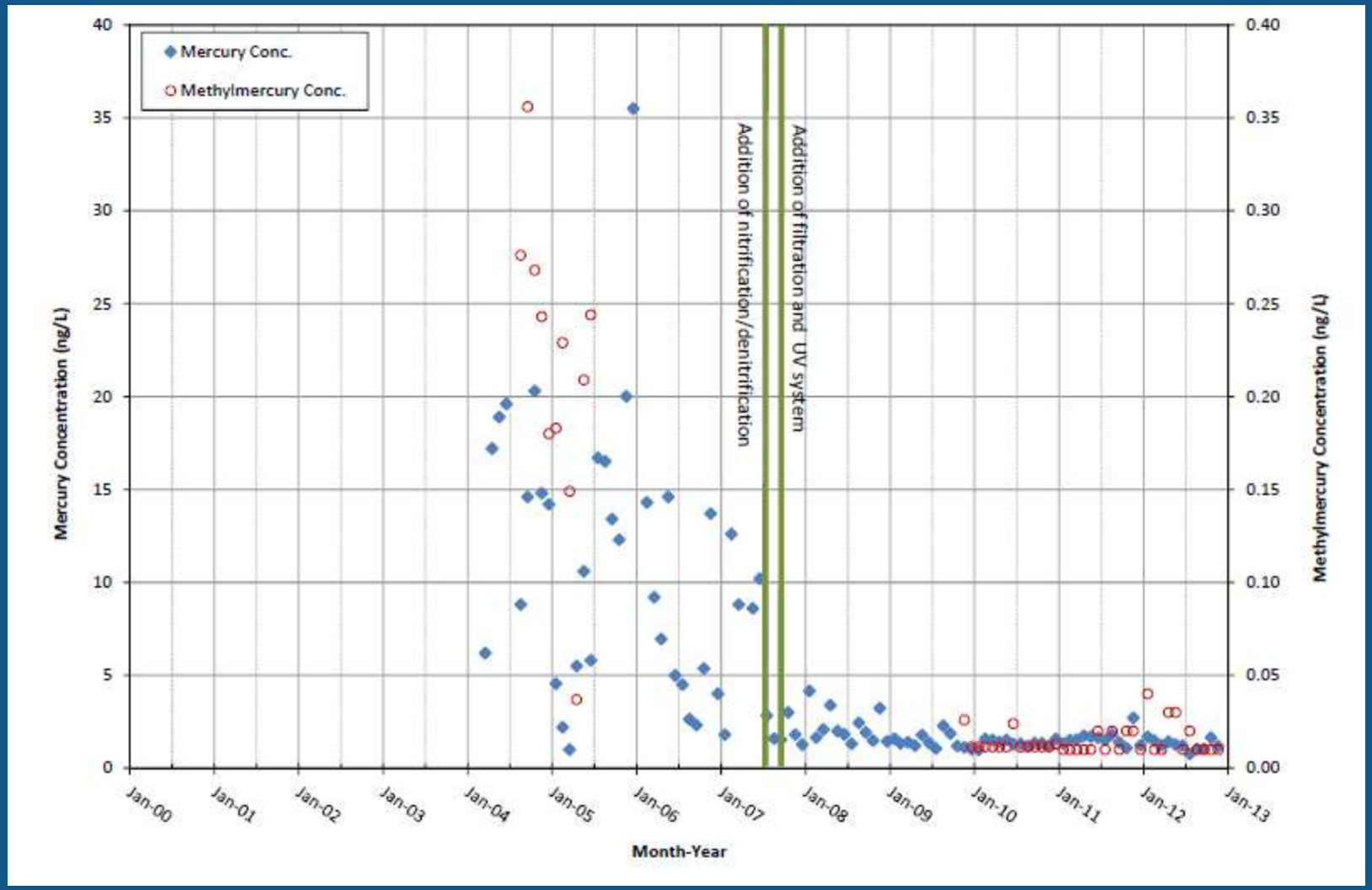


Treatment Level	Secondary Treatment Process	Tertiary Filtration Process	Effluent Water Quality			
			Ammonia as N < 2 mg/L	Nitrate as N < 10 mg/L	TSS < 5 mg/L	Turbidity < 2 NTU
Primary Treatment						
Secondary Treatment	✓					
Secondary Treatment with Nitrification	✓		✓			
Secondary Treatment with Nitrification-Denitrification (NDN)	✓		✓	✓		
Pond Based Secondary Treatment with NDN	✓		✓	✓		
Tertiary Treatment	✓	✓			✓	✓
Tertiary Treatment with Nitrification	✓	✓	✓		✓	✓
Tertiary Treatment with NDN	✓	✓	✓	✓	✓	✓

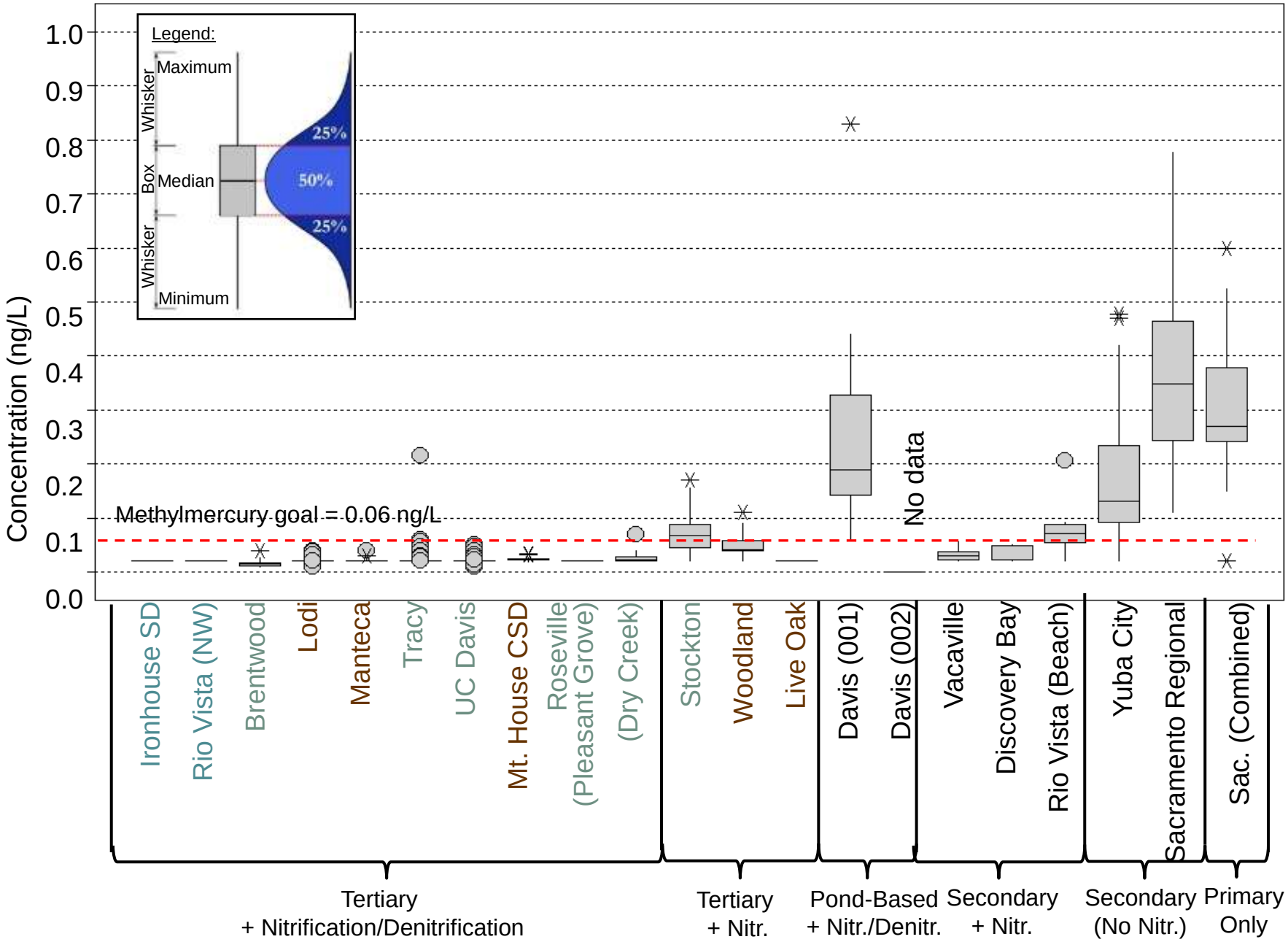
MeHg at a Secondary-Only Facility



MeHg With a Change In Treatment Processes



2009-2012 Effluent MeHg Data by Facility and Treatment Type



Overall Control Study Approach

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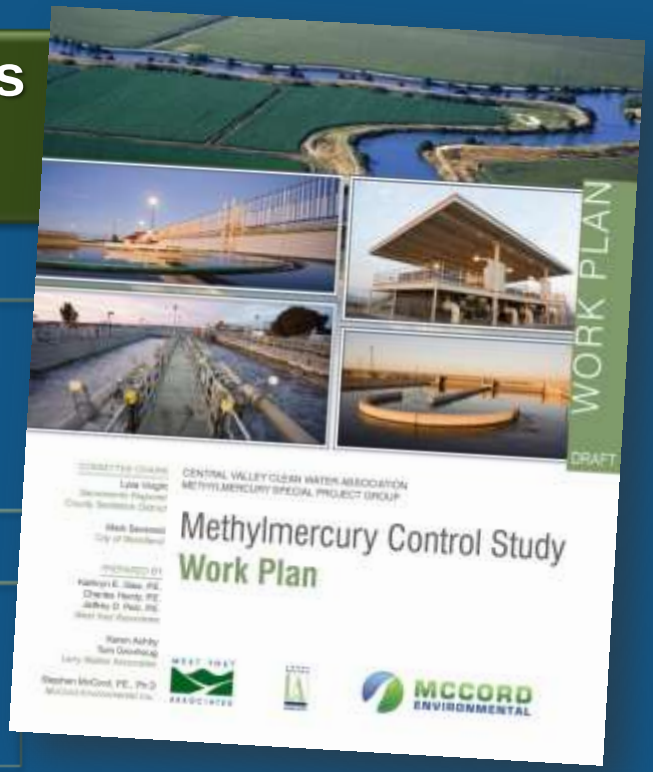


Treatment Level	Count of SPG Faciliites By Treatment Type
Primary Treatment	1
Secondary Treatment	2
Secondary Treatment with Nitrification	3
Secondary Treatment with NDN	1
Pond Based Secondary Treatment with NDN	1
Tertiary Treatment	-
Tertiary Treatment with Nitrification	3
Tertiary Treatment with NDN	10

Treatment Level	Count of SPG Faciliites By Treatment Type
Primary Treatment	1
Secondary Treatment	2
Secondary Treatment with Nitrification	3
Secondary Treatment with NDN	1
Pond Based Secondary Treatment with NDN	1
Tertiary Treatment	-
Tertiary Treatment with Nitrification	3
Tertiary Treatment with NDN	10

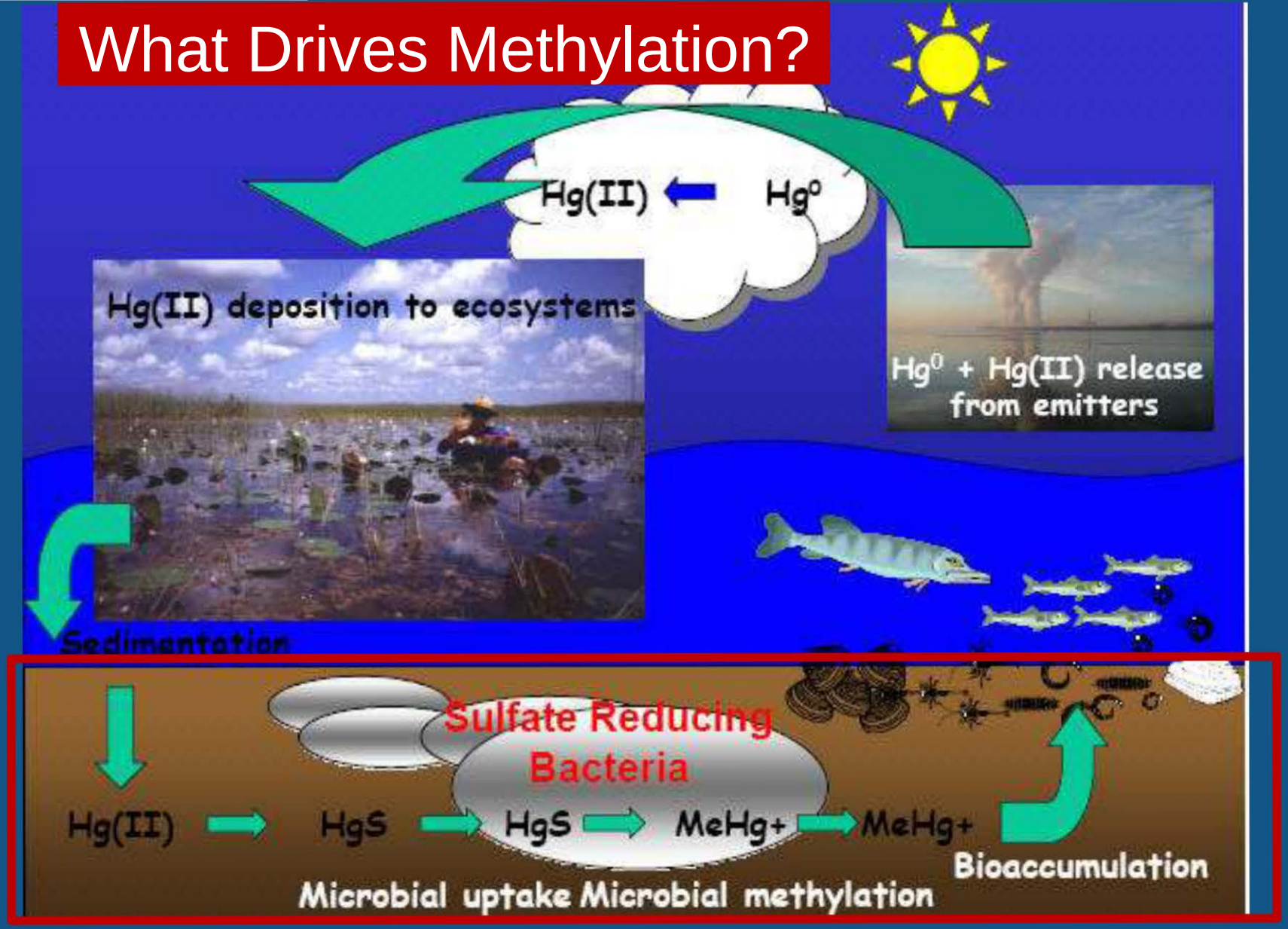
Treatment Level	Count of SPG Faciliites By Treatment Type	Count of SPG Facilities By Treatment Type When Including Inter-Process Data
Primary Treatment	1	
Secondary Treatment	2	
Secondary Treatment with Nitrification	3	6
Secondary Treatment with NDN	1	9
Pond Based Secondary Treatment with NDN	1	
Tertiary Treatment	-	
Tertiary Treatment with Nitrification	3	
Tertiary Treatment with NDN	10	10

Presentation Outline

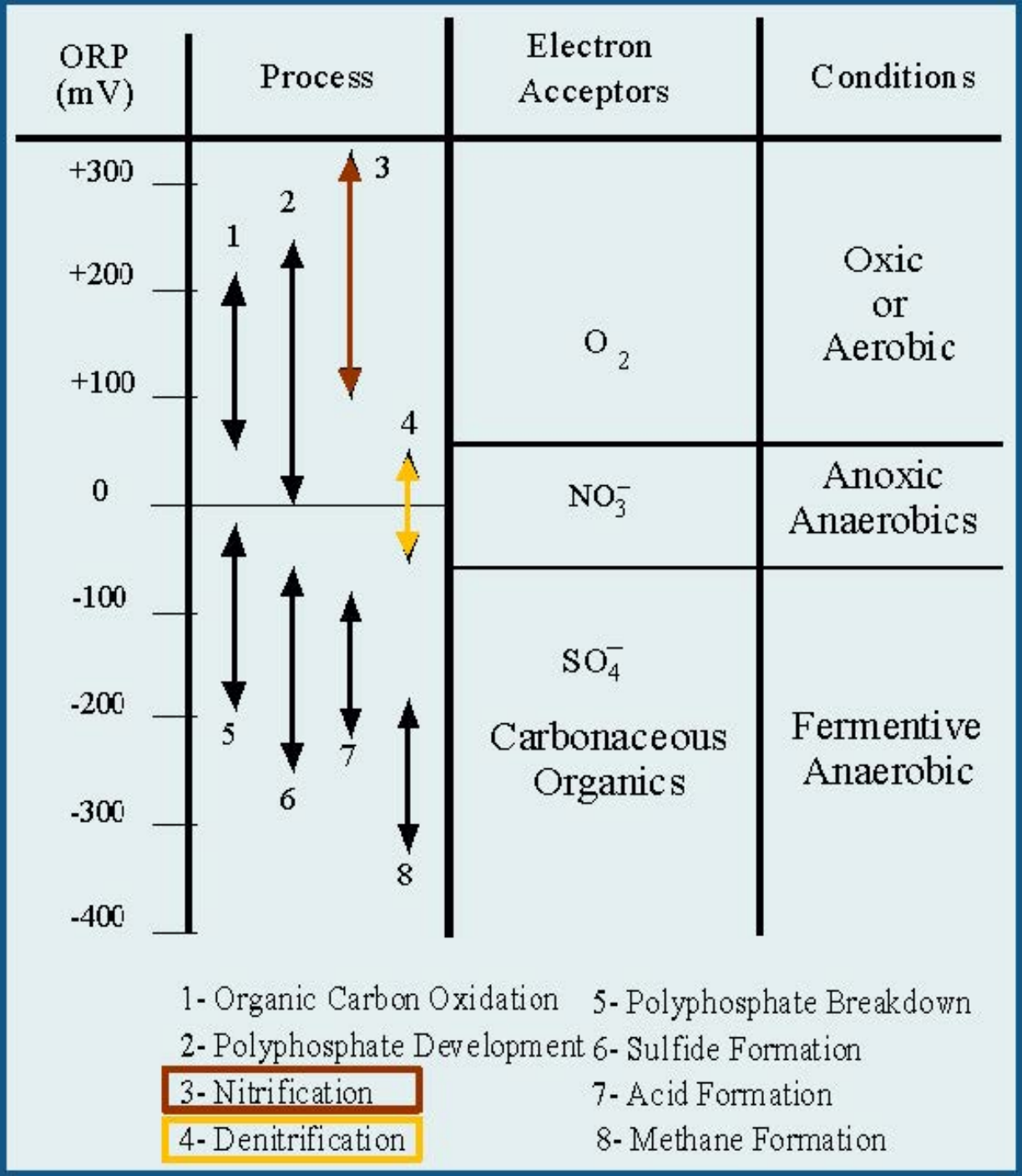
Overview of CVCWA POTW Methylmercury Control Study

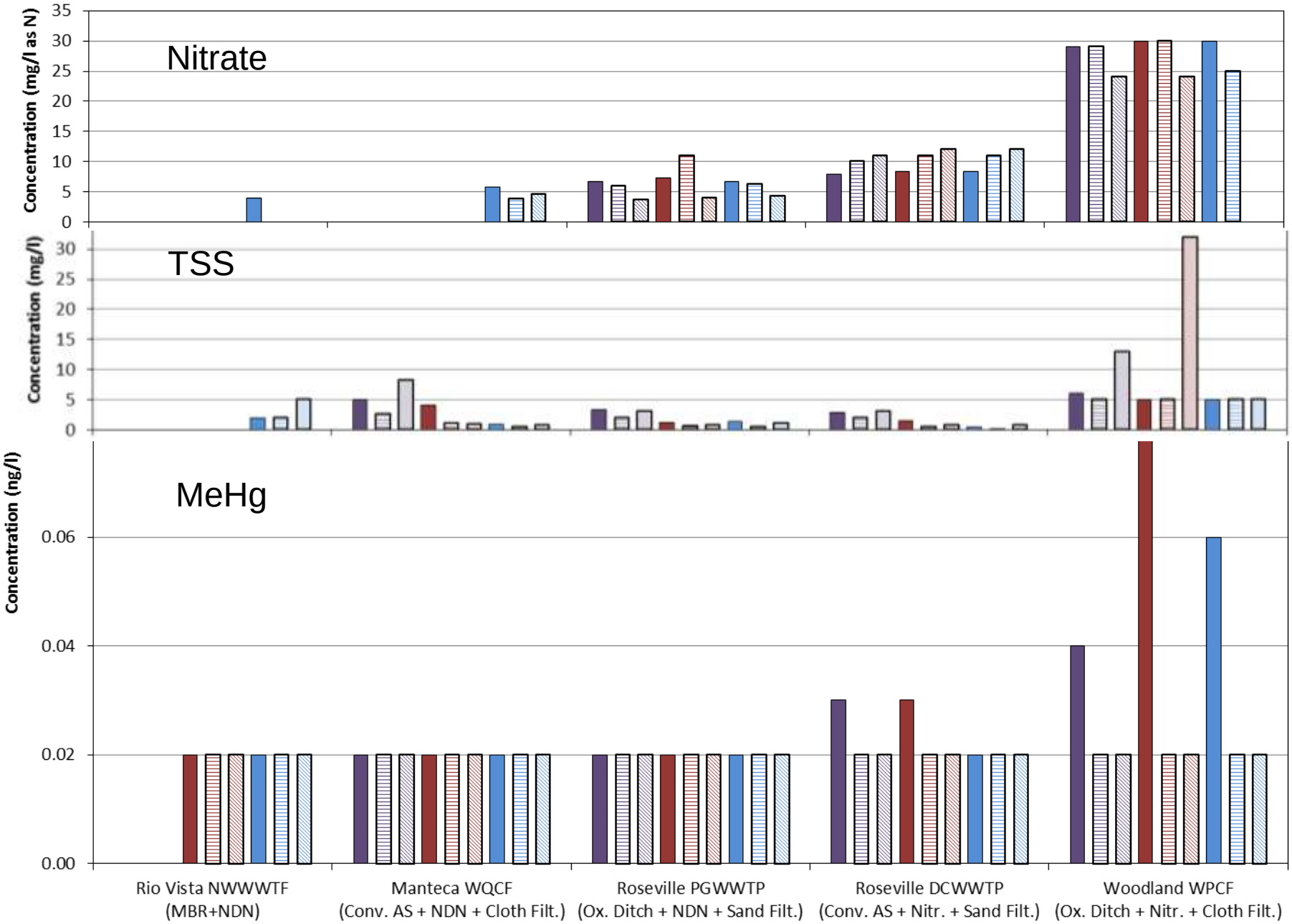
Methylmercury Control Mechanisms in POTWs with Biological Nutrient Removal

What Drives Methylation?



Methylmercury formation is influenced by various environmental factors including temperature, pH, redox potential, activity and structure of bacterial community, and the presence of inorganic and organic complexing agents.


ORP (mV)
Process
Electron Acceptors
Conditions
+300
+200
+100
0
-100
-200
-300
-400
1
2
3
4
5
6
7
8
O_2
Oxic or Aerobic
NO_3^-
Anoxic Anaerobics
SO_4^-
Carbonaceous Organics
Fermentive Anaerobic
1- Organic Carbon Oxidation
2- Polyphosphate Development
3- Nitrification
4- Denitrification
5- Polyphosphate Breakdown
6- Sulfide Formation
7- Acid Formation
8- Methane Formation


Nitrate
Concentration (mg/l as N)
35
30
25
20
15
10
5
0
TSS
Concentration (mg/l)
30
25
20
15
10
5
0
MeHg
Concentration (ng/l)
0.06
0.04
0.02
0.00
Rio Vista NWWWTF (MBR+NDN)
Manteca WQCF (Conv. AS + NDN + Cloth Filt.)
Roseville PGWWTP (Ox. Ditch + NDN + Sand Filt.)
Roseville DCWWTP (Conv. AS + Nitr. + Sand Filt.)
Woodland WPCF (Ox. Ditch + Nitr. + Cloth Filt.)

Questions?

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Extra Slides

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Where Are We Headed?

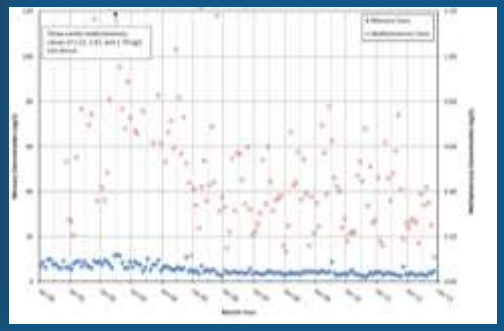
TAC Work Plan Approval
November 2013

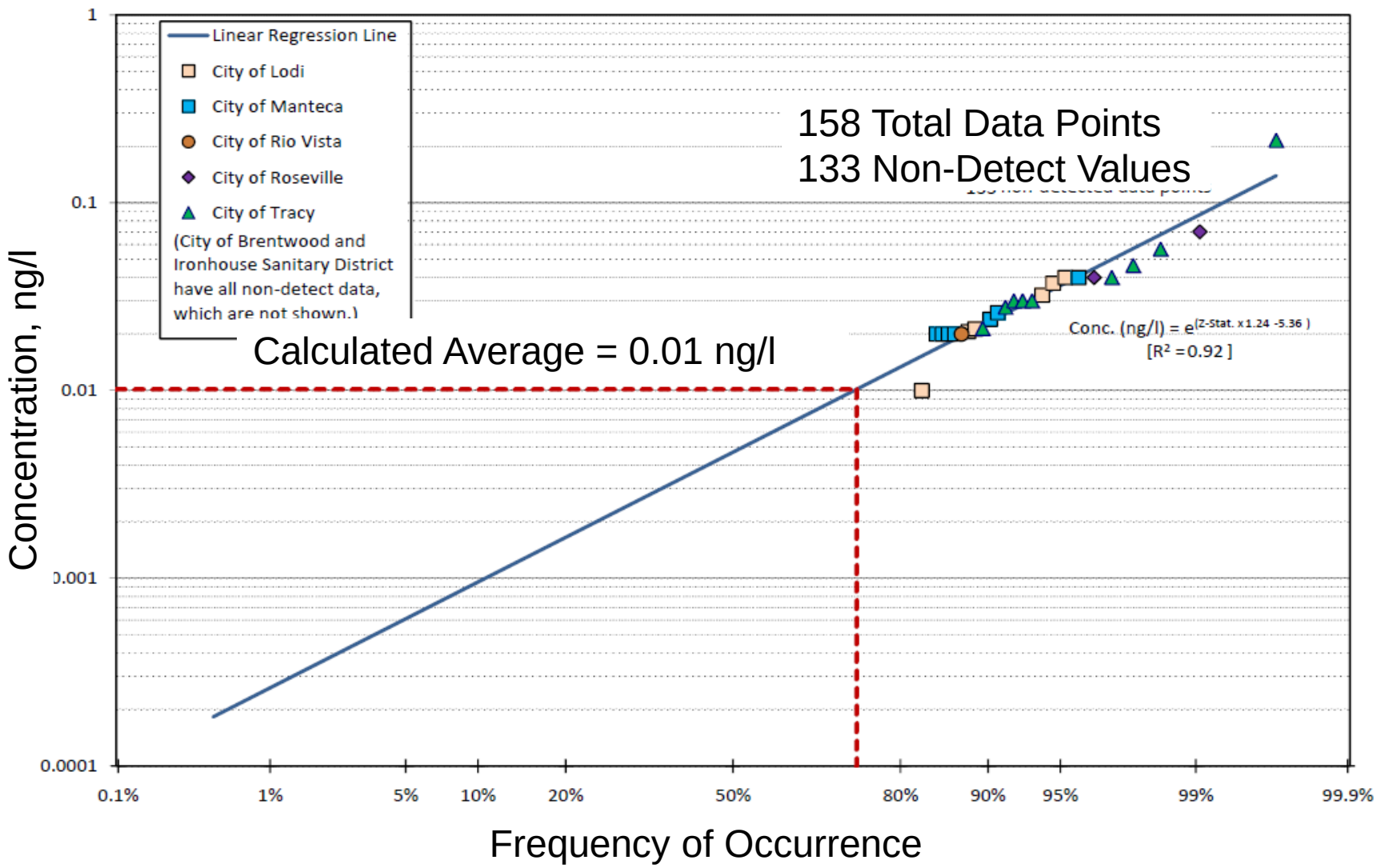
Collect Data
Oct. 2013-Sep. 2014

Complete Evaluation of Load Reductions
Oct. 2014-Apr. 2015

TAC Review and Strategize Next Steps
Apr.-Oct. 2015

Develop Evaluations Needed for Changes to Basin Plan
Oct. 2015-Apr. 2018



Agency	TMDL MeHg WLA, g/year	Current Load, g/year	Planned Changes	Potential Changes
Brentwood	0.14	0.04	Same	Same
Davis	0.43	0.60	5–10 x lower	Same as Planned
Discovery Bay	0.37	0.05	Same	5-10 x lower
Ironhouse SD	0.30	0.02	Same	Same
Lodi	0.94	0.05	Same	Same
Manteca	0.38	0.09	Same	Same
Mountain House CSD	0.37	0.01	Same	Same
Rio Vista Northwest	0.07	0.003	Same	Same
Rio Vista Beach	0.056	0.05	Same	5-10 x lower
Sacramento CSS	0.53	0.21	Same	5-10 x lower
SRCSD	89	75	5–10 x lower	Even Lower?
Stockton	13.0	2.4	Same	Slightly Lower
Tracy	0.77	0.2	Same	Same
Woodland	0.43	0.32	Slightly Lower	Same
Totals	**106.8**	**79.0**	5–10 x lower	Slightly Lower Than Planned

Linear Regression for NDN + Filtration Plants