Desktop Analysis to Inform Pilot Testing of Municipal Operation and Maintenance Enhancements for PCB and Mercury Load Reduction

Prepared for:

Bay Area Storm Water Management Agencies Association

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Background

- This desktop analysis builds upon past/current efforts
  - San Francisco Estuary Institute (SFEI) Proposition 13 grant study of options to better manage PCBs/Hg in urban stormwater.
  - BASMAA Draft Report on preliminary calculation methods/ formulas for quantifying PCB/Hg stormwater load reductions
  - Clean Watersheds for a Clean Bay (CW4CB) – testing a range of pollutant control measures
    - Source property identification
    - Literature Review of Sediment Management Practices

Desktop Analysis Objectives

1. To inform the selection of municipal O&M enhancement pilot studies to be conducted during the current MRP term in order to:
   - Maximize learning benefits in terms of furthering understanding of how to use O&M enhancements to optimize pollutant load reductions
   - Maximize PCB/Hg load reduction opportunity across a larger geographic scale during future permit terms.

2. Develop tools to assist planning of O&M enhancements during future permit terms.

Desktop Analysis Approach

- Focus on areas with high pollutant sediment concentrations and identify potential source properties
- Develop tools to help identify overlap between:
  - Areas where polluted sediment may accumulate in the stormwater conveyance system.
  - Areas where the current level of municipal O&M activities is NOT optimized.
- Estimate pollutant reduction opportunity =
  - hypothetical reduction in pollutant mass associated with implementing pollutant control scenarios.

Municipal Operation and Maintenance Activities

1. Street Sweeping
2. Storm Drain Inlet Cleaning
3. Street Flushing
4. Stormwater Conveyance Pipeline Flushing
5. Pump Station Maintenance

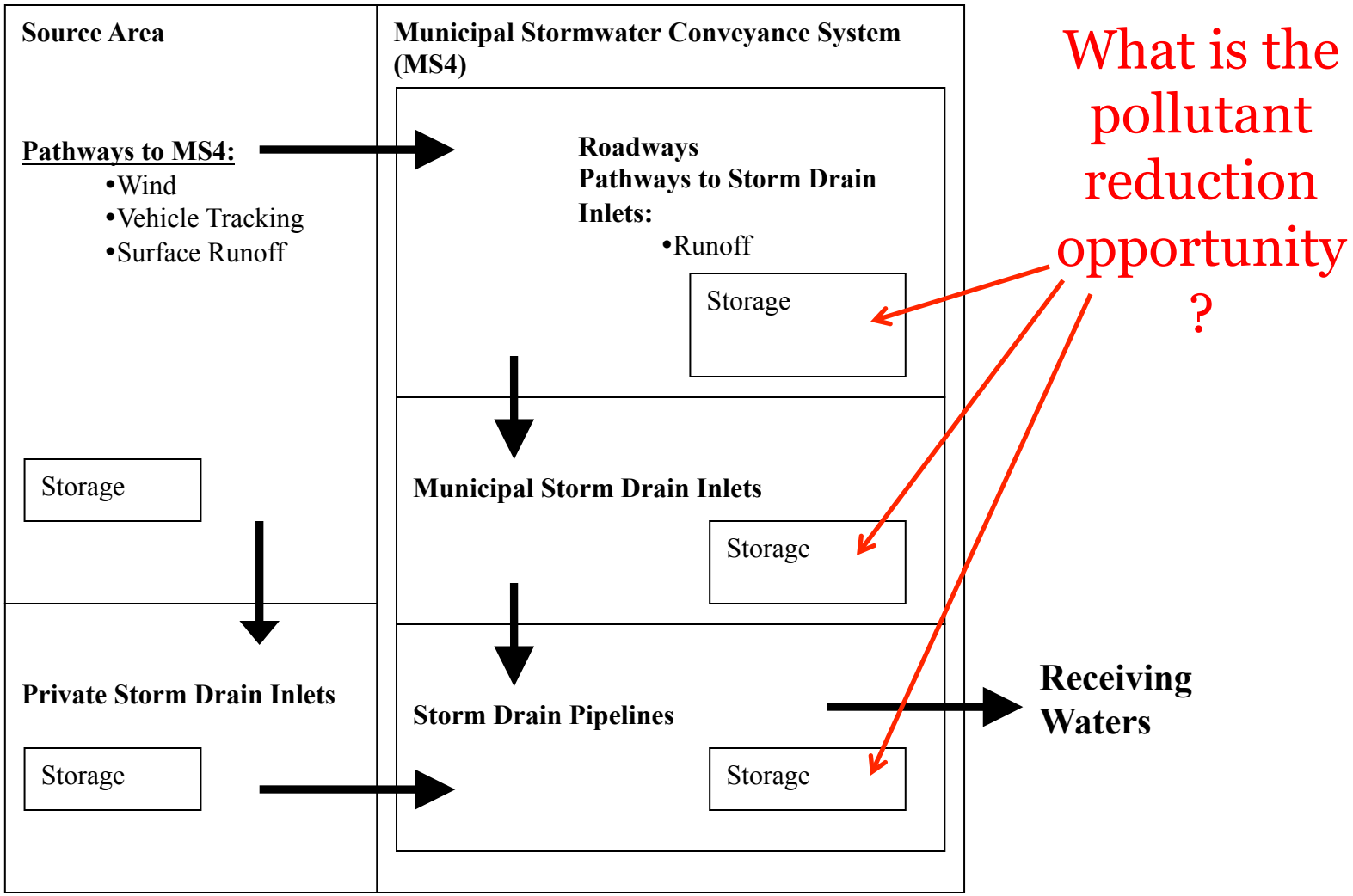
CW4CB Pilot Investigation Watersheds

- This desktop analysis was implemented in the Ettie Street Pump Station, Leo Avenue, and Pulgas Creek Pump Station watersheds

Tools for Evaluating Municipal O&M Activity Enhancements

- Conceptual Model
  - To illustrate movement of polluted sediment from source areas to MS4 and identify areas of accumulation/storage within MS4 where O&M enhancements could be applied to increase sediment removal from system
- Decision Tree
  - To identify O&M enhancements within a watershed where implementation would maximize pollutant reduction opportunity
- Questionnaire
  - To facilitate collection and documentation of watershed data required to apply the decision tree and estimate pollutant reduction opportunity

Conceptual Model of Pollutant Source/Transport/ Storage in an Urban Watershed



Decision Tree

Opportunity Factors	Decision Tree Queries
1. Source areas where sediment pollutant concentrations are elevated 2. Sediment transport from source areas to MS4 3. Sediment accumulation in MS4 4. Current level of sediment removal	• Query 1: Are sediment-bound pollutant concentrations in the watershed elevated? • Query 2: Are there known source areas in the watershed? • Query 3: Is there potential for sediment transport from potential source properties to the MS4 via any of the following pathways: vehicle tracking, wind, or surface runoff? • Query 4: Is there evidence of sediment accumulation from source areas via these pathways in the MS4? If so, identify the MS4 structures which accumulate/store sediment in the watershed: stormwater pipelines; pump stations; storm drain inlets; streets (including curb/gutters). • Query 5: For each MS4 structure, is/are the available O&M activity/ies currently optimized?

Questionnaire

- Designed to gather watershed-specific information
  - Part A: Potential Source Properties/Areas
    - Based on CW4CB source property identification process
  - Part B: Watershed Characteristics
    - Documentation of MS4 infrastructure/sediment transport, accumulation/storage
  - Part C: Current Municipal Operation and Maintenance Activities that remove sediment
  - Part D: General Information

CW4CB – Source Property Identification and Referral Process

1. Records Review
2. Driving/Walking Survey
3. Facility Inspections
4. Sediment/Soil Sampling
5. Referral to Regional Board

- Results from this process (steps 1-3) were used to identify potential source properties.

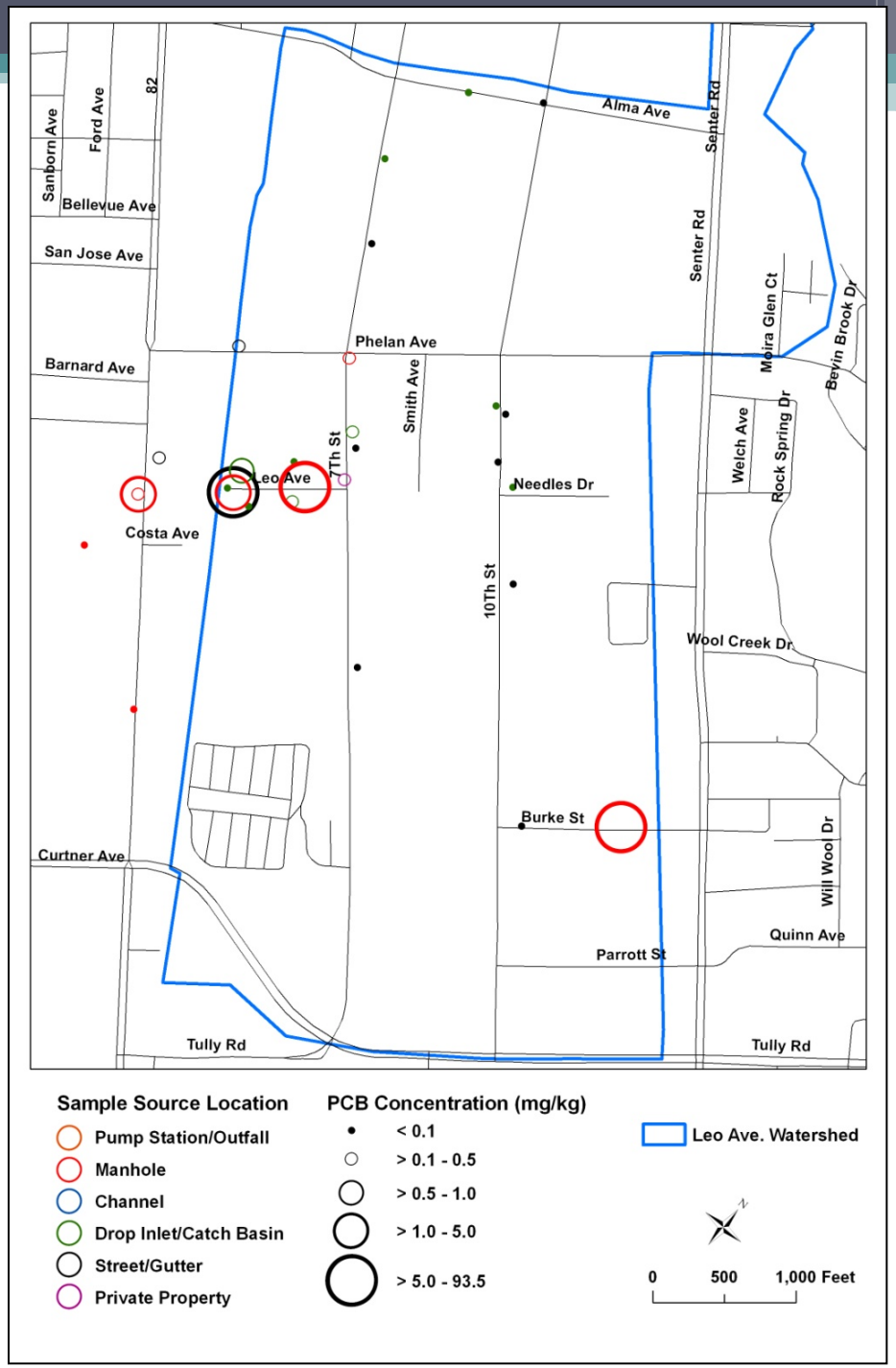
Implementing the Desktop Analysis in the CW4CB Pilot-Investigation Watersheds

- Four steps:
  1. Characterize the watershed
  2. Apply the decision tree
  3. Estimate pollutant load reduction opportunity
  4. Develop initial recommendations for pilot studies

- Example: Leo Avenue Watershed

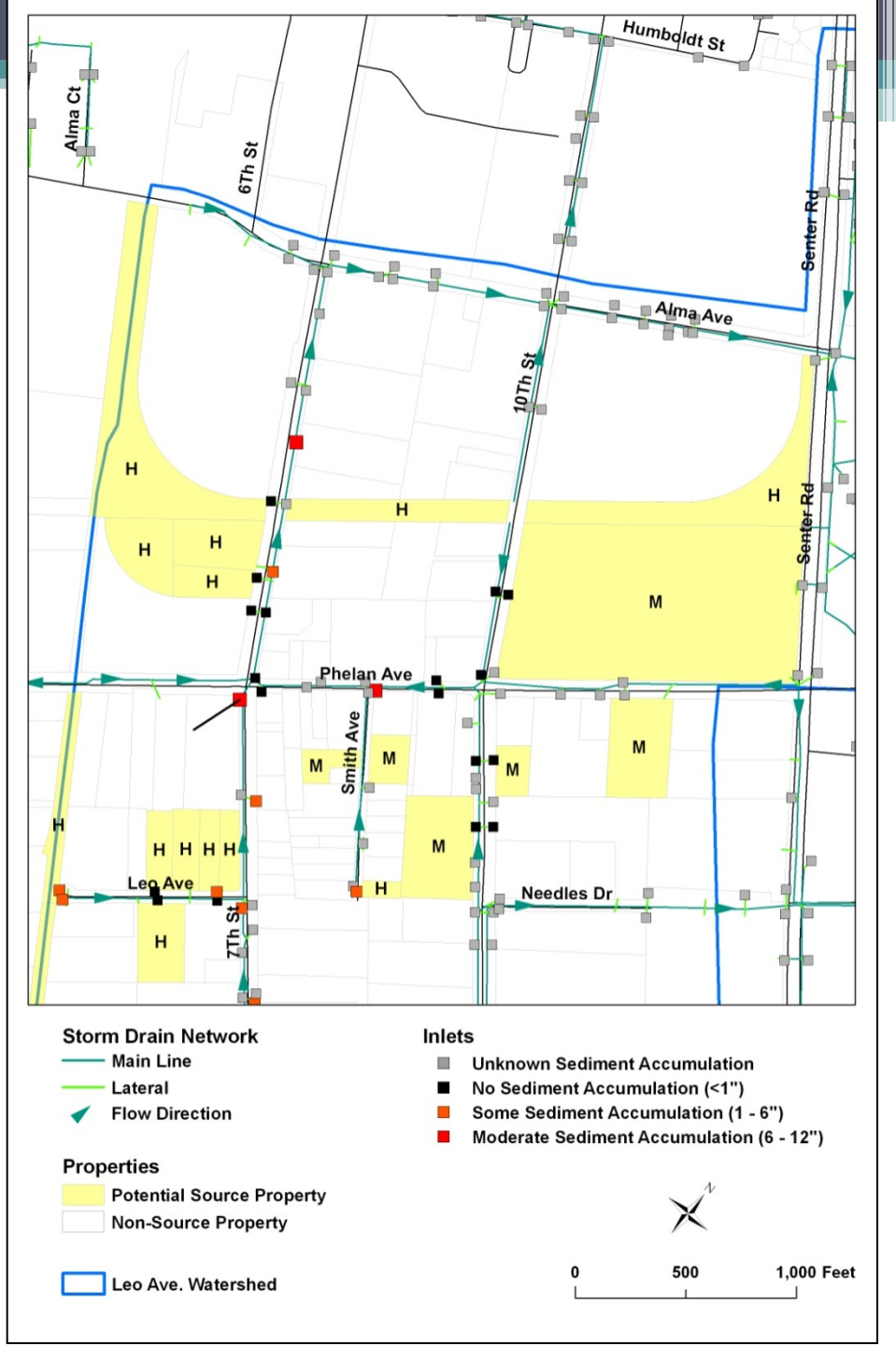
Step 1: Characterize the Watershed

- Leo Avenue Watershed: PCB concentrations in Sediment
  - Range <0.1 – 27 mg/kg



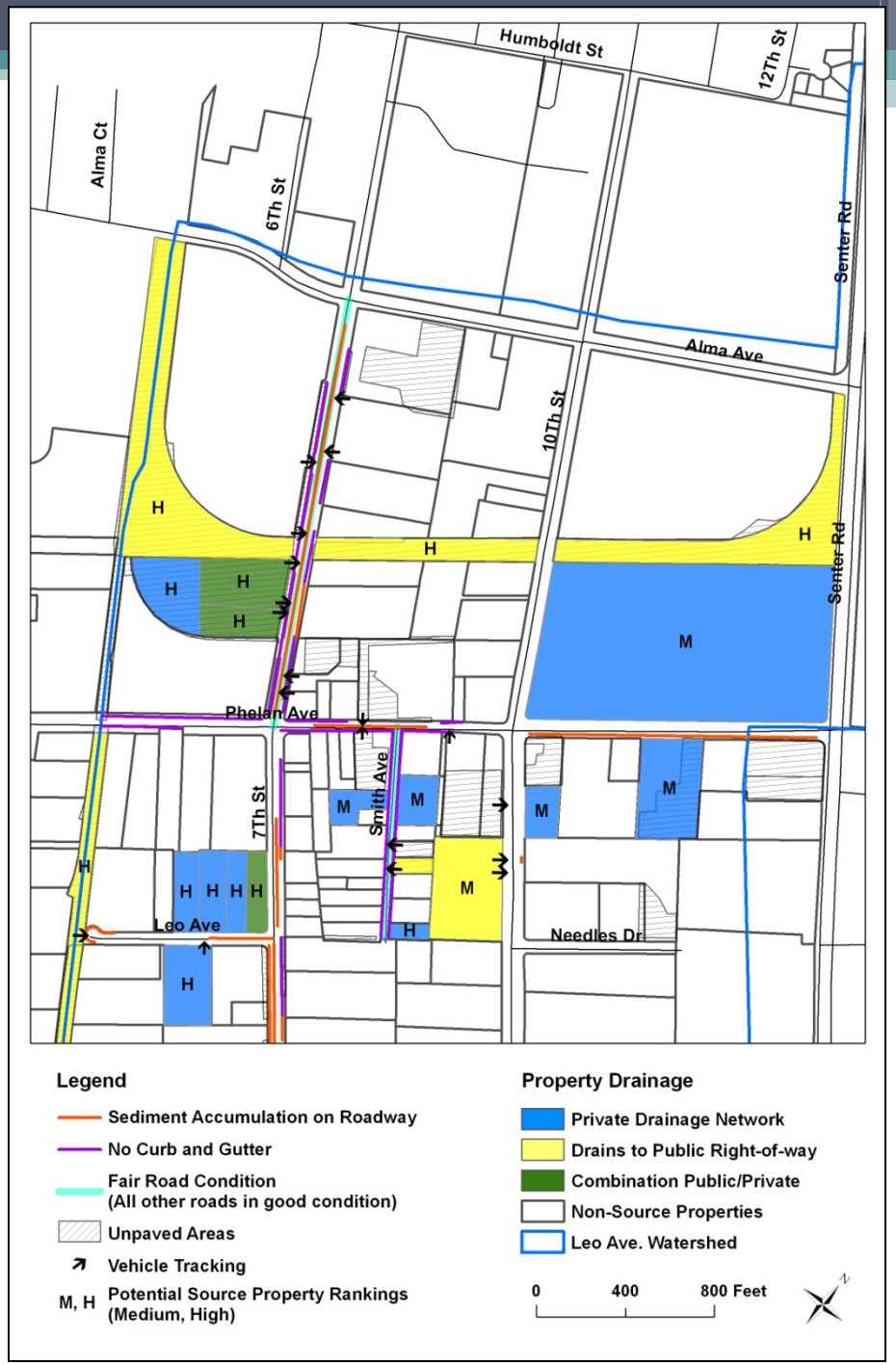
Step 1: Characterize the Watershed (cont.)

- Leo Avenue Watershed: Potential Source Properties and Stormwater Conveyance Infrastructure



Step 1: Characterize the Watershed (cont.)

- Leo Avenue Watershed: Surface sediment transport and storage

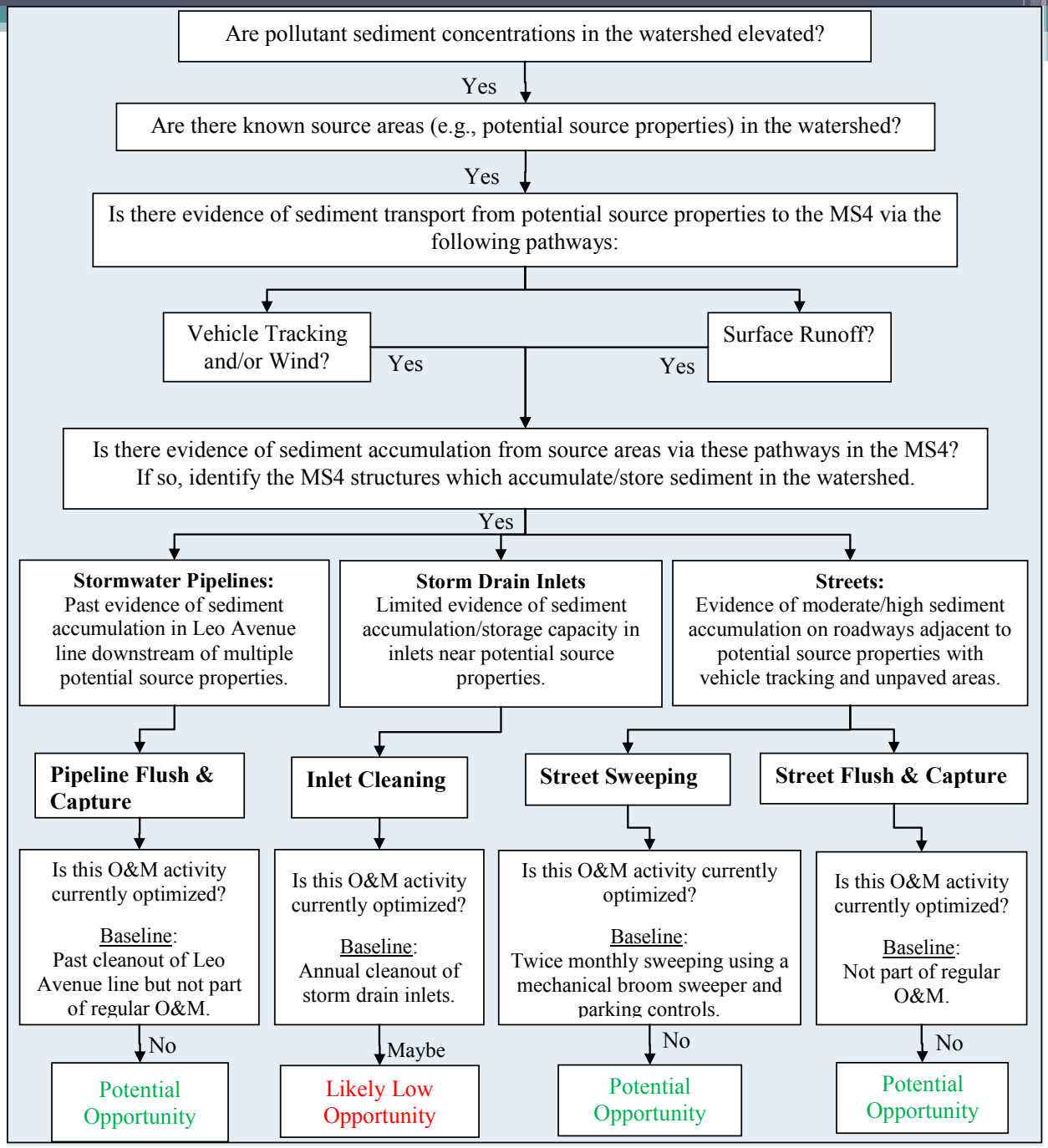


Step 1: Characterize the Watershed (cont.)

- Leo Avenue Watershed – Current O&M Activities
  - Street Sweeping
    - Twice monthly w/ mechanical broom sweeper, 85% curb & gutter
    - Rate: 0.4 CY/curb-mile
    - Annual Volume Collected=155 CY
  - Street Flush & Capture
    - Not part of current O&M practices
  - Storm Drain Inlet Cleaning
    - Annual cleaning w/ vactors or clam shell shovels
    - Rate=0.0084 CY/inlet
    - Annual Volume = 1 CY
  - Stormwater Pipeline Flushing
    - One-time flush of the Leo Avenue line in 2005
    - 2.7 CY of sediment removed
  - Pump Station Maintenance – no pump station in this watershed

Step 2: Apply the Decision Tree

- Leo Avenue Watershed Decision Tree Analysis



Step 3: Estimate Pollutant Reduction Opportunity using Available Data

- Baseline load removed:

$$Red_{Baseline} = V_o \bullet F \bullet P \bullet C_o$$

- Enhanced load removed:

$$Red_{Enhanced} = Red_{Baseline} \bullet F_e$$

- Pollutant reduction opportunity:

$$Red_{Opportunity} = Red_{Enhanced} - Red_{Baseline}$$

Where:

$Red_{Baseline}$=average annual mass of pollutant removed due to a given O&M activity as currently practiced.

V_o =Average annual volume of gross solids collected for a given O&M activity.

F =Volume to mass conversion factor

P =Percent (by mass) of gross solids that are sediment.

C_o =Concentration of mercury or PCBs in sediments (<2 mm in diameter)

$Red_{Enhanced}$=annual mass of pollutant that would be removed due to implementation of an enhanced O&M activity.

F_e =Enhancement factor

Estimated Range of PCB Reduction Opportunity – FOR PLANNING PURPOSES ONLY

O&M Activity	Enhancement Scenario	Annual Pollutant Reduction Opportunity* (g of PCBs)		
		ETTIE	LEO	PULGAS
Street Sweeping	Increase Frequency: 2x monthly? weekly? 2x weekly	1 - 200	2 - 100	0.4 - 40
	Upgrade Equipment		1 - 1,000	
	Both		4 - 2,000	
Street Flush & Capture	1000 Linear Feet	0.09 - 10	0.1 - 5	0.07 - 0.5
	1000 Linear Feet Twice Monthly	2 - 300	2 - 100	2 - 10
Storm Drain Inlet Cleaning	Semi-annual cleanout	0.1 - 7	0.002 - 0.4	0.04 - 1
	Quarterly cleanout	0.2 - 10	0.003 - 0.6	0.05 - 1
	Monthly cleanout	0.8 - 20	0.01 - 1	0.2 - 2
Storm Drain Pipeline Flush	Repeat of one time flush		0.05 - 30	
Pump Station Maintenance	Annual cleanout	10 - 70		
	Semi-annual cleanout			10 - 30

*Calculated using the 10th/90th Percentile concentration & low/high enhancement factor.

Step 4: Develop Recommendations for Pilot Studies

Objectives:

- Consider pollutant reduction opportunity
- Maximize learning benefits
- Potential application beyond pilot studies at a larger spatial scale

Leo Avenue Watershed Summary

O&M Enhancement	*Estimated Pollutant Reduction Opportunity	Learning Benefit (e.g., fill data gap)?	Transferable to larger spatial scale?	Other Issues to Consider
Street Sweeping	High	Yes	Yes	
Pump Station Maintenance	N/A			
Pipeline Flushing	Medium	Limited	Unknown	Learning benefit specific to Leo Avenue pipeline
Street Flush and Capture	High	Yes	Yes	May conflict w/ municipal water usage and conservation policies
Storm Drain Inlet Cleaning	Low	Yes	Yes	

*Ranking for Pollutant Reduction Opportunity is based on the relative magnitude of opportunities calculated within a watershed. On an order-of-magnitude scale, High=largest opportunity; low=lowest opportunity.

Next Steps…

- Continue working with appropriate municipal staff for each watershed to identify logistically feasible pilot study options
- Select suite of pilot studies
- Develop project-specific study designs
  - Study design team and monitoring contractors have been selected and are under contract
- Implement pilot studies
  - Target start date: Spring 2013

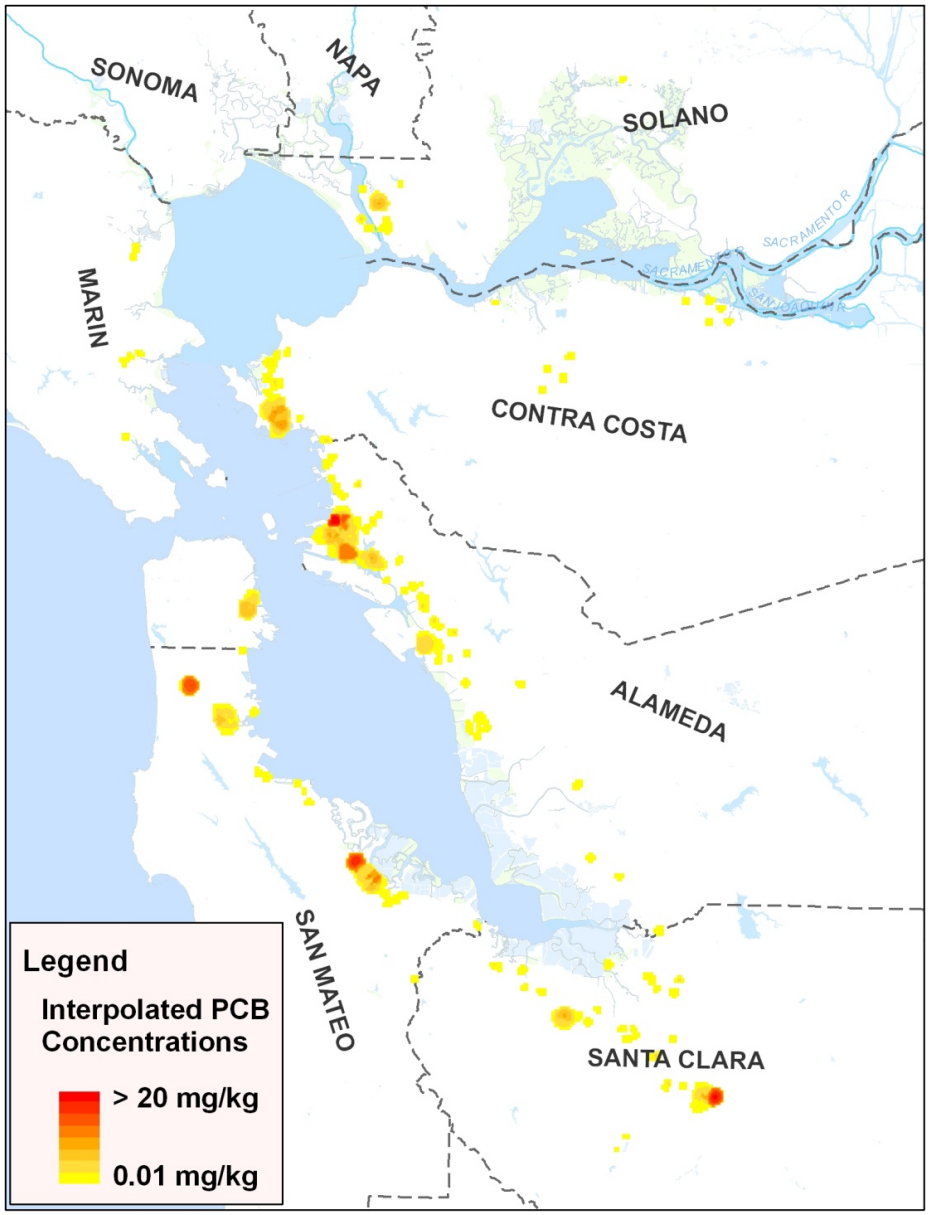
Implications for TMDL Compliance

- TMDL Target Reduction =18 kg of PCBs

- Street Flush & Capture (based on low/high Leo Ave concentrations)

Flush 1000 linear feet twice monthly:

	Low		High
1 site →	0.002	-	0.1 kg
10 sites ~~0.02~~ →	-	1 kg	
100 sites →	0.2	-	10 kg



Questions?

Implications for TMDL Compliance

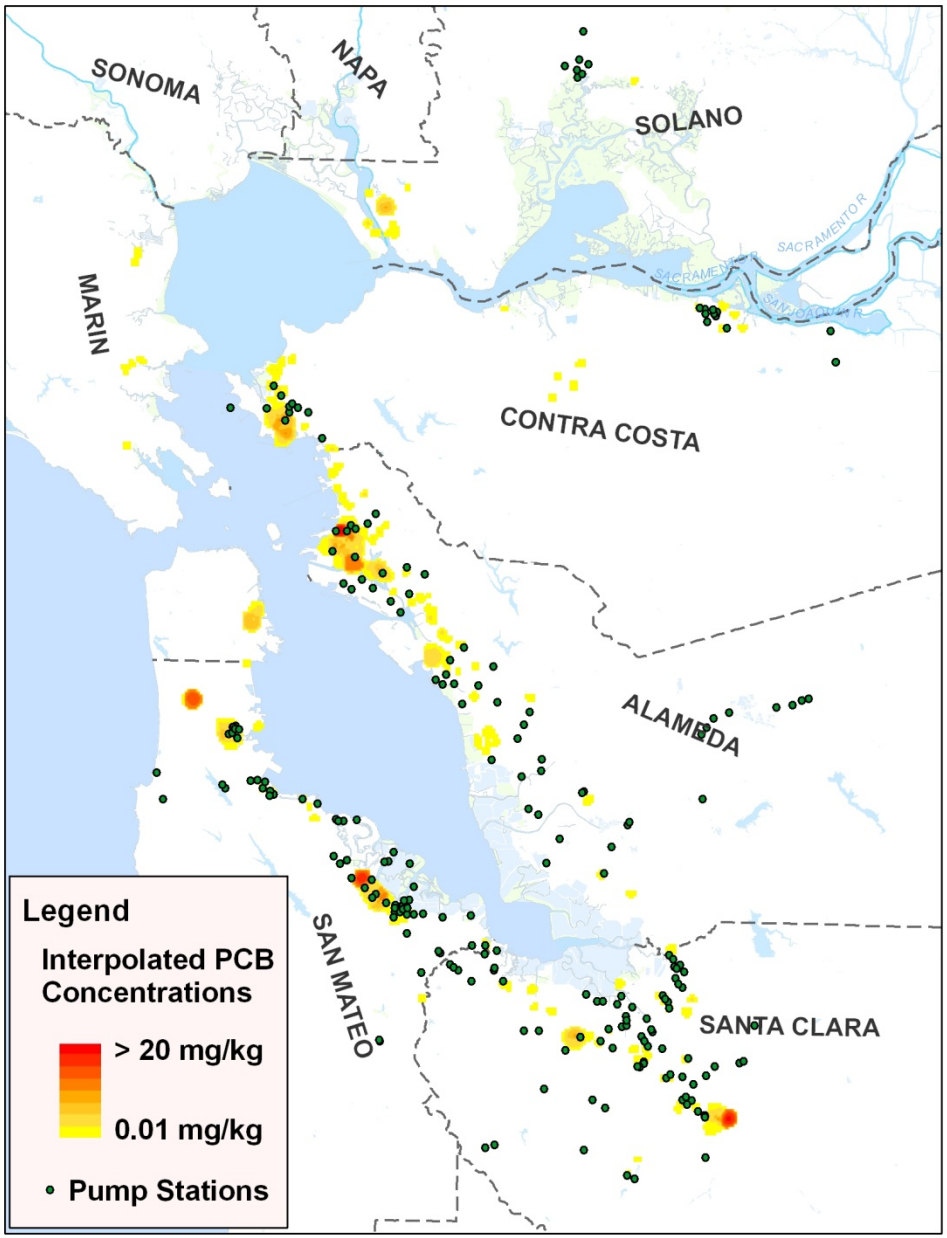
- TMDL Target Reduction =18 kg of PCBs

Pump Station Maintenance

(based on median Pulgas Creek Pump Station concentration)

<u>Increase frequency to semi-annual:</u>

- 1 site → 0.02 kg
- 10 sites → 0.2 kg
- 100 sites → 2 kg



Median Mercury and PCB Concentrations Measured in Sediment Collected From Various MS4 Structures

MS4 Structure	Watershed	PCBs (mg/kg)	Mercury (mg/kg)
Street/Curb	Ettie Street Pump Station	0.80	ND
	Leo Avenue Watershed	0.23	0.17
	Pulgas Creek Pump Station	0.27	0.076
Storm Drain Inlets/Catch Basins	Ettie Street Pump Station	1.0	0.49
	Leo Avenue Watershed	0.069	0.35
	Pulgas Creek Pump Station	0.12	0.15
Manholes	Ettie Street Pump Station	0.70	0.88
	Leo Avenue Watershed	1.2	0.69
	Pulgas Creek Pump Station	11	na
Pump Station	Ettie Street Pump Station	2.0	0.87
	Pulgas Creek Pump Station	4.2	0.32

ND = non detect
na = no measurement data

Presentation Overview

- Project Background and Objectives
- Desktop Analysis Approach
  - Tools for evaluating municipal O&M activities
- Implementing the Desktop Analysis
  - Example – Leo Avenue Watershed
  - Summary of estimated pollutant reduction opportunities
  - Recommendations
- Next Steps…