

## San Mateo County Watershed Data in a GIS

### Introduction

The San Mateo Countywide Water Pollution Prevention Program (Program) performs Watershed Assessment and Monitoring (WAM) component activities in compliance with its municipal stormwater NPDES permit requirements. In the past, a consistent countywide watershed boundary data layer has not been available to meet Program needs for mapping and analyzing watershed-related data. As a result, the Program has previously utilized the best existing available data sets and/or developed new data to meet the objectives of specific individual projects. For example, creek location and watershed boundary data were developed to characterize imperviousness and channel modifications in seventeen watersheds in San Mateo County (STOPPP 2002). In another example, Program staff compiled existing countywide watershed data and developed new data needed to identify watershed areas considered exempt from Hydromodification Management Plan (HMP) requirements (STOPPP 2005).

The Program previously identified two major information gaps in digital watershed boundary data: 1) limited storm drain catchment data were available for urban areas and 2) consistent countywide watershed data layers were not available (STOPPP 2005). Recent development of watershed data in urbanized portions of San Mateo County has provided an opportunity to address these information gaps. This memo describes the methods used by Program staff to create a consistent countywide watershed data layer that includes delineation of storm drain catchments in urban areas. Consistent watershed and creek data set will assist Program staff in watershed characterization and the identification and prioritization of potential future monitoring and watershed assessment activities.

### Background

In 1999, the State of California developed a statewide watershed data layer entitled the California Interagency Watershed Map (Calwater). Watershed delineations were based on a combination of elevation contour data and administrative boundaries used by State and Federal agencies for planning purposes. There were no existing countywide watershed data for San Mateo County available in GIS prior to the development of Calwater. Calwater data were modified in 2005 by the San Francisco Bay Regional Water Quality Control Board (Water Board) to include subwatershed boundary delineations referenced in the Board's Basin Plan and used by Water Board staff for water quality monitoring projects.

One of the major limitations of the Calwater data is the lack of defined drainage boundaries for storm drain catchments in urban areas. Defining surface drainage areas in urban areas require existing data that show storm drain networks, including inlet and

outfall locations. Until recently, these data generally were independently developed by each municipality in San Mateo County in a range of formats (e.g., hard copy maps, CAD files). Standardized countywide storm drain or catchment drainage areas were not available.

During the last two years, William Lettis and Associates (WLA) of Walnut Creek, California has developed digital data layers identifying watersheds, storm drain catchments and creeks within the urbanized portions of San Mateo County and the City of San Francisco (WLA 2005 and 2007). Creek data delineated included natural creeks, engineered channels and underground storm drains and culverts. The data were used to create "Creek and Watershed Maps" for San Mateo County designated "Palo Alto and Vicinity" and "San Francisco Peninsula." These maps were published by the Oakland Museum. The mapped area did not include the entire San Mateo County jurisdiction. Areas not mapped include a portion of San Carlos and Redwood City (i.e., there was a gap between the Peninsula and Palo Alto data sets) and the coastal drainage areas of San Mateo County south of City of Pacifica.

WLA compiled information relevant to storm drains (24 inches or greater), engineered channels, and present-day creeks from city and county data, 2004 aerial photography, and field reconnaissance. Data showing the historical locations of creeks were also identified and mapped. Additional data showing historical tidal marshes and willow groves were compiled from existing data developed by the San Francisco Estuary Institute.

The San Mateo County Public Works Department also developed high resolution countywide GIS data layers relevant to mapping and characterizing watersheds. These layers include topographic contours, streams, lakes, streets jurisdictional boundaries and parcels that match up with the County's existing 200-scale orthophotography base layer. The county did not develop watershed boundary data; however, a digital elevation model (DEM) was developed from high resolution orthophotographs, which can be used to create watershed boundaries.

## **Methods**

Program staff compiled existing creek and watershed data for San Mateo County into a Geographic Information System (GIS) using ArcView<sup>TM</sup> (version 9.2). These data included existing creek and watershed boundaries developed by WLA for urban areas that encompassed the northwest and eastern portion of San Mateo County. Calwater watershed data (version enhanced by Water Board staff) was also obtained to delineate drainage areas in primarily non-urban areas of San Mateo County.

Program staff utilized several spatial analysis tools available in the GIS to append the different data sets and fill existing gaps in the data. The merge and clipping tools were used to combine the Palo Alto and Peninsula Watershed data sets together and then remove portions of data outside of the San Mateo County jurisdiction. Watershed boundaries were then digitized in the area between the two original data sets that was not developed by WLA, which included upper portions of the Belmont, Pulgas and

Cordilleras Creek watersheds. Watershed boundaries along the ridgelines were digitized on the computer screen using 1" : 400' scale topographic contour data developed by the San Mateo County Department of Public Works. The newly created watershed areas were then merged into the existing lower portions using the dissolve tool in GIS.

The Calwater data were clipped to remove all watershed areas that overlapped with the WLA data. The two data sets were not congruent (i.e., the boundaries either overlapped or contained gaps in between). As a result, several spatial analysis tools were used to create a seamless watershed data layer. The intersection tool was used to identify and remove areas of data that overlapped one another. To fill the gaps, a buffer was created along the edge of WLA data, and then the union tool was used to identify the edge of Calwater data set within the buffer area. All the buffer area not filling the gaps was removed and those gaps were then merged and dissolved into the polygons from the WLA data set. The WLA and Calwater watershed data layers were then merged together to create a single watershed data layer for the entire county.

Total creek length for each watershed area was calculated in a GIS. Channel lengths were tabulated into three categories using the WLA data set: unmodified, engineered channel and underground culvert and storm drains ( $\geq 24$  inches diameter). Creek lengths were tabulated for coastal watersheds using a data set obtained from the San Mateo County Public Works Department. Lengths for main stem and tributary creeks were summed for each of the major watersheds.

## Results

The countywide watershed data developed for this project are shown in Figure 1. Surface water (i.e., creeks, engineered channels, reservoirs), underground culverts (24 inches or greater) and reservoirs are shown primarily within the urbanized watershed areas. Watershed boundaries, creeks and reservoirs are also shown in the non-urban portions of the county.

Table 1 provides the name and drainage size for watersheds draining into the San Francisco Bay (n=20), associated channel lengths for unmodified creeks, engineered channels and underground culverts and/or storm drains, and drainage density (i.e., total channel length/total watershed area). Similar information is provided for smaller storm drain catchments and Bay fill areas typically along the shoreline that were unnamed.

Table 2 provides similar information for watersheds draining into the Pacific Ocean (n=20). Lengths for engineered channels and underground culverts and/or storm drains were calculated for six watershed areas that were identified in the WLA data set. Major tributaries and subwatersheds for each of the coastal watersheds are identified in Table 3.

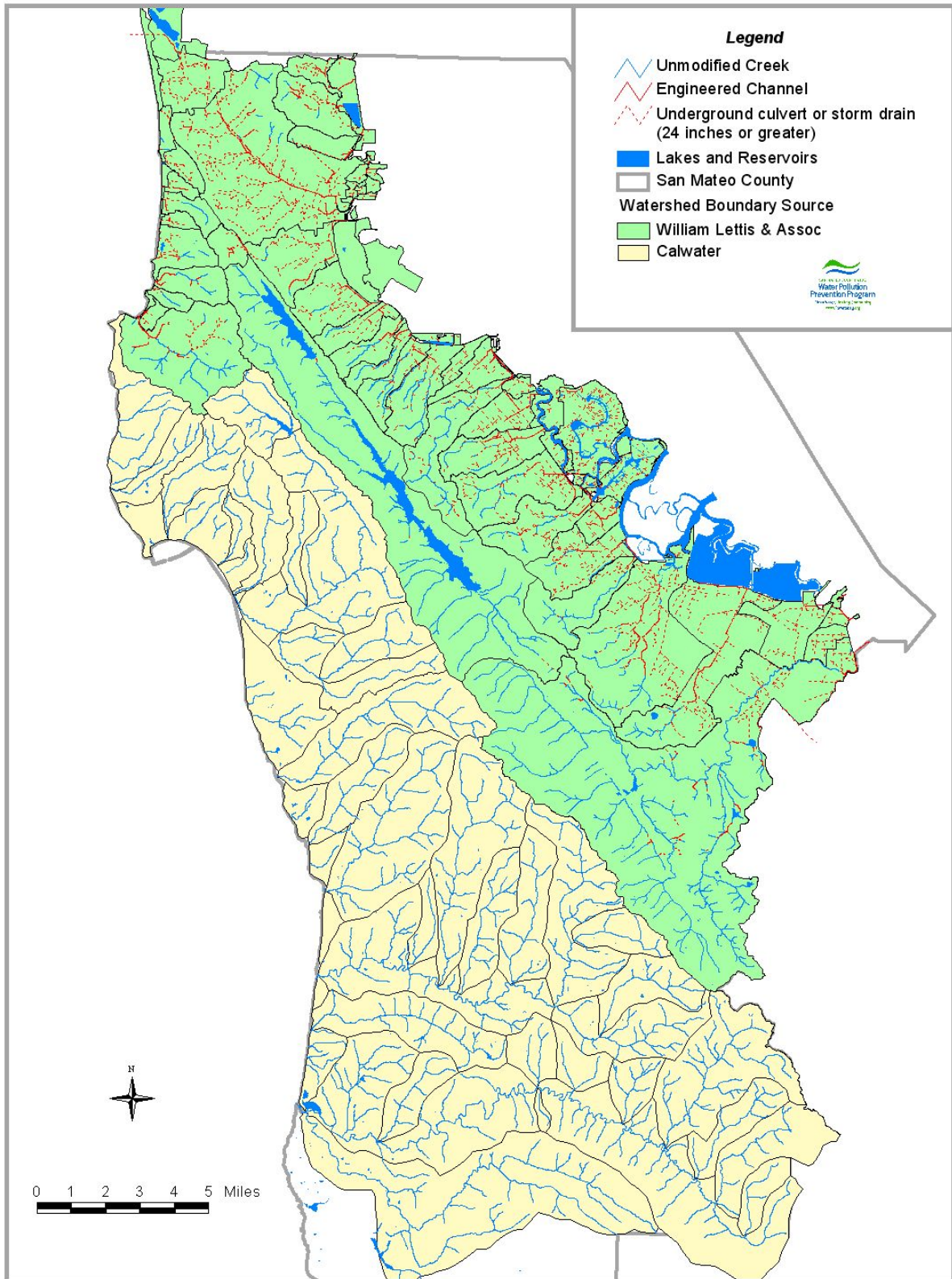


Figure 1. Watershed Boundaries and Channel Type in San Mateo County.



Table 1. Name, area, channel type, length and drainage density of San Mateo County watersheds draining into San Francisco Bay.

Name	Watershed Area (Sq Mi)	Unmodified Channel (Miles)	Engineered Channel (Miles)	Underground Culvert or Storm Drain (Miles)	Total Channel Length (Miles)	Drainage Density (Channel length/area)
16th Avenue Channel	1.9	0.0	2.0	6.7	8.7	4.7
Atherton Creek	8.9	3.6	4.7	22.4	30.7	3.5
Belmont Creek	3.3	2.9	1.1	7.8	11.8	3.6
Borel Creek	3.1	2.5	2.4	7.7	12.6	4.1
Burlingame Creek	3.1	5.9	0.5	5.3	11.7	3.8
Colma Creek	15.7	2.7	7.1	49.9	59.7	3.8
Cordilleras Creek	3.7	5.6	0.5	2.5	8.5	2.3
Easton Creek	1.1	1.7	0.7	1.3	3.7	3.5
Green Hills Creek	2.8	0.5	1.8	7.9	10.2	3.6
Guadalupe Valley Creek	2.7	1.0	1.0	6.1	8.1	3.0
Laurel Creek	4.5	3.7	2.0	12.0	17.7	3.9
Millbrae Creek	1.5	0.7	1.0	3.4	5.1	3.3
Mills Creek	1.6	1.7	0.7	2.3	4.7	2.9
Poplar Creek	1.6	0.0	1.2	4.0	5.3	3.4
Pulgas Creek	3.4	1.9	1.1	14.0	16.9	4.9
Redwood Creek	11.8	8.4	4.0	25.0	37.5	3.2
San Bruno Creek	4.6	0.8	3.9	9.1	13.8	3.0
San Francisquito Creek	45.6	90.6	5.3	22.4	118.3	2.6
San Mateo Creek (Below Dam)	4.64	7.7	0.6	5.7	14.1	3.0
San Mateo Creek (Above Dam)	28.81	47.8	0.2	0.9	48.8	1.7
Sanchez Creek	1.8	3.3	0.8	2.9	7.0	3.9
Unnamed – Watershed (n=34)	18.53	0.1	6.3	57.5	63.8	3.4
Unnamed – Bay Fill	3.78	0.0	1.7	3.1	4.8	1.3

Table 2. Name, area, channel type, length and drainage density of San Mateo County watersheds draining into the Pacific Ocean.

Name	Watershed Area (Sq Mi)	Unmodified Channel (Miles)	Engineered Channel (Miles)	Underground Culvert or Storm Drain (Miles)	Total Channel Length (Miles)	Drainage Density (Channel length/area)
Arroyo Canada Verde	5.7	6.8	0	0	6.8	1.2
Arroyo de en Medio	1.0	3.8	0	0	3.8	3.7
Butano Creek	23.2	55.2	0	0	55.2	2.4
Calera Creek	1.8	1.5	0.1	0	1.6	0.9
Denniston Creek	3.7	13.7	0	0	13.7	3.7
Frenchmans Creek	4.3	11.5	0	0	11.5	2.7
Lobitas Creek	4.1	14.0	0	0	14.0	3.4
Milagra Creek	1.1	0.3	1.1	0	1.4	1.3
Montara Creek	5.1	7.6	0	0	7.6	1.5
Pescadero Creek	59.2	191.2	0	0	191.2	3.2
Pilarcitos Creek	28.5	85.1	0	0	85.1	3.0
Pomponio Creek	6.9	23.5	0	0	23.5	3.4
Purisma Creek	8.4	26.6	0	0	26.6	3.2
Roosevelt Creek	0.8	1.8	0	0	1.8	2.2
San Gregorio Creek	51.8	175.8	0	0	175.8	3.4
San Pedro Creek	7.9	2.5	5.6	0	8.1	1.0
San Vicente Creek	2.5	7.1	0	0	7.1	2.9
Sharp Park Creek	1.9	0.4	3.6	0	4.0	2.1
Tunitas Creek	11.6	35.9	0	0	35.9	3.1
Unnamed - Watersheds (n=17)	12.7	17.0	0	0	17.0	1.3
Vista Grande Canal	4.4	0.0	0.7	12.8	13.5	3.1

Table 3. Subwatersheds of coastal San Mateo County watersheds.

<b>Major Watershed</b>	<b>Subwatershed</b>
Pescadero Creek	Honsinger Creek
	Jones Gulch Creek
	McCormick Creek
	Oil Creek
	Peters Creek
	Slate Creek
	Tar Water Creek
	Waterman Creek
	Unnamed Tributary
	Pilarcitos Creek
Arroyo Leon Creek	
Mills Creek	
Upper Pilarcitos	
San Gregorio Creek	Bogess Creek
	Clear Creek
	El Corte de Madera Creek
	Harrington Creek
	La Honda Creek
	Mindega Creek
	Woodruff Creek

## References

STOPPP 2002. *Characterization of Imperviousness and Creek Channel Modifications for Seventeen Watersheds in San Mateo County*. Prepared for the San Mateo Countywide Stormwater Pollution Prevention Program by EOA, Inc., Oakland, California. January 1, 2002.

STOPPP 2005. *Hydromodification Management Plan*. Prepared for the San Mateo Countywide Stormwater Pollution Prevention Program by EOA, Inc., Oakland, California. May 12, 2005.

WLA 2005. *Creek and Watershed Map of the Santa Clara Basin: A Digital Database*. Version 1.1. Prepared by William Lettis & Associates, Inc., Walnut Creek, California. September, 2005.

WLA 2007. *Creek and Watershed Map of the San Francisco Peninsula: A Digital Database*. Version 1.0. Prepared by William Lettis & Associates, Inc., Walnut Creek, California, May 23, 2007.