Chollas Creek TMDL Source Loading, Best Management Practices, and Monitoring Strategy Assessment

FINAL REPORT

Prepared for:
City of San Diego

Prepared by:
WESTON SOLUTIONS

September 2006

CHOLLAS CREEK TMDL SOURCE LOADING, BEST MANAGEMENT PRACTICES, AND MONITORING STRATEGY ASSESSMENT

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Executive Summary

This report first provides an assessment of the existing water quality data and potential sources relative to the constituents that have been listed in adopted and anticipated future Total Maximum Daily Loads (TMDLs) for Chollas Creek. Available information on watershed characteristics and regulatory issues are then reviewed. These data form the basis for the assessment of the current and potential management actions that will be effective in meeting the current and future TMDL waste load allocations. This assessment takes an integrated approach to the development and implementation of best management practices (BMPs). For the Chollas Creek watershed, the integrated approach discussed in this report is recommended to meet the adopted and anticipated TMDLs for bacteria, dissolved metals and pesticides. An integrated approach uses available resources most cost effectively. This approach results in the implementation of BMPs that address both current and future TMDLs, and therefore will minimize retro-fitting or replacing BMPs to meet future waste load allocations.

An infrastructure intensive approach that requires rapid installation of conservatively designed treatment systems is needed to attain full compliance with because a review of BMP effectiveness indicates that either diversion (e.g. infiltration) or treatment are the only ways to comply with the TMDLs. However, existing data indicates that the majority of the soils in the watershed are not suited to infiltration and because dry weather flows are needed to maintain hydrology and wetland vegetation. Based on the results of the screening assessment of BMPs, two distinct strategies for TMDL implementation are developed. The first strategy is developed to meet the 10-year regulatory timetable for the current dissolved metals TMDL using an integrated approach that includes meeting the goals of other adopted and anticipated TMDLs for bacteria and pesticides. Due to the defined timetable of reduction goals, an infrastructure intensive approach that requires rapid installation of conservatively designed treatment systems is needed to attain full compliance. The compliance schedule requires for example that 50 percent of the approximately 800 outfalls are fully compliant within 7 years. Potentially more cost effective source control and pollution prevention measures can be implemented at the same time, however, these non-structural BMPs are not assured to meet 100% of the reduction goal.

The collection and evaluation of additional soils and hydrological data are also needed to determine the treatment capacity of lower impact technologies that include infiltration, bioretention and low impact development techniques. To assure compliance with the regulatory timetable, treatment BMPs that are not constrained by watershed and regulatory issues requiring additional study are needed for this first strategy. Furthermore, since no guidance has been provided in the current TMDLs for the volume of storm water to be treated, this first strategy has assumed a treatment volume. Development of a design storm is needed as part of the implementation process. A design storm is needed because the feasibility of implementing runoff reduction and treatment BMPs and the cost of implementation depend on the watershed characteristics, required effluent goals and the volume and flow rate of the runoff to be treated.

This first "infrastructure intensive" strategy requires large storage capacity to meet required load reductions in the 10-year timetable. Large storage capacity is required to equalize flows prior to treatment. Based on the conceptual treatment volumes needed to meet the reduction goals and other regulatory requirements on the location of these systems, these storage and treatment systems will require acquisition of private property within the watershed. Due to the built-out condition of the watershed, this strategy will result in impacts to residential communities to meet the reduction timetable. These impacts include the acquisition and condemnation of private property. This process is complicated and will take time to implement. This presents a significant challenge to the City of San Diego to meet the required timetable under the TMDL.

Due to the anticipated impact to residential communities under the first strategy, a recommended second alternative strategy is developed using a tiered or phased approach that reduces the impact to communities and allows for more cost effective implementation of a combination of lower impact BMPs. A tiered or phased approach is recommended that includes three major tiers:

- Tier I – Control of Pollutants at the Source and Prevent Pollutant from Entering Runoff
  - Product Substitution through Legislation
  - Re-evaluation of beneficial uses for the creek
  - Aggressive Implementation of Source Control Measures and Pollution Prevention BMPs Targeted in Areas of Higher Density of Potential Pollutant Sources
  - Effectiveness Monitoring of BMPs and Phasing of Implementation

- Tier II – Conduct Design Studies and Implement Aggressive Street Sweeping and Runoff and Treatment Volume Reduction BMPs
  - Soil and Hydrologic Studies, Source Studies and Determination of Design Storm
  - Aggressive Street Sweeping in Targeted Areas
  - Implementation of Augmented (modification of soils or additional sand layer due to low permeability soils) Infiltration, Bioretention and LID Techniques in Phased Approach
  - Effectiveness Monitoring of BMPs and Phasing of Implementation

- Tier III – Infrastructure Intensive Treatment BMPs
  - Property Acquisition and Easements (where necessary)
  - Implementation of Treatment BMPs in Targeted Areas where Tier I and Tier II BMPs have been shown not to meet full reduction goals
  - Effectiveness Monitoring of BMPs and Phasing of Implementation

This recommended "lower impact" strategy includes implementing Tier I and Tier II activities beginning in year one with the goal of reducing pollutant loads to the maximum extent practical. The strategy emphasizes implementation of potentially more cost effective source control and pollution prevention techniques as well as lower impact augmented infiltration, bioretention and other LID technologies. The use of LID techniques will require site specific geotechnical and hydrological investigations. The goal will be too maximize the effectiveness of Tier I and II activities to meet the reduction goals in a more cost effective and lower impact manner. Where the overall integrated TMDL reduction goals are not being met in certain sub-watersheds, based on effectiveness monitoring of the Tier I and II BMPs, Tier III treatment system BMPs will be implemented.

There may be specific conditions in certain sub-watersheds for which the combined effectiveness of Tier I and Tier II BMPs do not reduce loads down to the TMDL requirement based on effectiveness monitoring. For these conditions, more infrastructure intensive and higher impact Tier III BMPs will be implemented. This integrated and tiered strategy therefore reduces community impacts and allows for the use of targeted effective techniques in meeting the integrated TMDL goals. The tradeoff of both an integrated strategy which considers not just current but future TMDLs, and a lower impact and more cost effective tiered or phased approach, is the need for an extended implementation schedule.

A greater timetable is required for the recommended alternative strategy in order to:

- Meet an integrated TMDL strategy that address both current and anticipated TMDLs;
- Assess the effectiveness of the aggressive implementation of source control and pollution prevention BMPs, measures evaluated as being a reasonably foreseeable means of compliance, in targeted areas to identify which techniques are more effective and to modify approaches and/or extend aggressive activities to other sub-watersheds in a cost effective manner;
- Collect needed data on the soils and hydrological conditions within the watershed to identify where lower impact augmented infiltration and other LID techniques are best suited and what engineering modifications are needed to make these systems most effective;
- Assess the effectiveness of aggressive street sweeping in targeted areas to confirm that the integrated reduction goals are being meet or if additional BMPs are needed along with other Tier I and II activities;
- Work with communities in which these activities will be taking place and changes occurring within their neighborhood; and,
- Acquire property and easements for sub-watersheds that will require retention of storm flows prior to treatment where Tier I and Tier II activities do not achieve the reduction goals.

To address these additional time requirements to implement a lower impact and cost effective program that will meet the integrated TMDL goals, a potential timetable of 20 years should be considered to meet the 100% reduction goals. This is based on meeting the requirements for three integrated TMDLs (metals, bacteria and pesticides). Tier I and II activities should be implemented on an aggressive timetable in targeted areas as part of phase I of these tiers. Effective assessment monitoring should then be implemented as part of this first phase to determine if these BMPs should be extended to other areas or modified to improve effectiveness. The approach on a tiered and phased level is therefore an iterative process of implementation, assessment, and further implementation or improvement.

It is not known to what level of effectiveness source control and pollution prevention (Tier I) BMPs will reach therefore requiring effectiveness monitoring. Effectiveness monitoring is also required to establish a baseline in subwatersheds where existing data in order to verify the required 78-98% load reduction. Actual baseline data may indicate that only a 50% reduction is needed where a combination of Tier I and II BMPs may achieve the needed reduction. Augmented infiltration and other LID techniques may also be limited by site conditions and the storage capacity of these systems. Therefore an iterative approach is also needed for Tier II

BMPs to assess overall effectiveness prior to implementation throughout the watershed. Finally, Tier III infrastructure intensive treatment BMPs should be targeted in a phased manner where Tier I and II BMPs are shown not to have fully met the reduction goals, but have achieved significant reduction in runoff volume and pollutant load. Effective implementation of Tier I and II BMPs will therefore result in the reduction of the treated volume and potential community impacts.

The results of this assessment provide an initial framework from which an implementation plan using an integrated TMDL approach can be developed by the City of San Diego in cooperation with stakeholders and the Regional Water Quality Control Board (RWQCB).

Report Overview

Purpose of Report

The purpose of this report is to first conduct an assessment of available water quality and potential pollutant source data relative to the constituents that have been listed in adopted and anticipated future Total Maximum Daily Loads (TMDLs) for Chollas Creek. These data along with available watershed characteristics and regulatory issues form the basis of the screening assessment of potential BMPs needed to meet the current and future TMDL waste load allocations. This assessment takes an integrated approach to the development and implementation of best management practices (BMPs). For the Chollas Creek watershed, the integrated approach discussed in this report is recommended to meet the adopted and anticipated TMDLs for bacteria, dissolved metals and pesticides. Finally, the BMPs that remain following the screening are used to develop a strategy for TMDL implementation.

Background

The Chollas Creek watershed encompasses approximately 16,270 acres composed predominately of urbanized land. The headwaters of Chollas Creek originate in the Cities of Lemon Grove and La Mesa. The creek then flows through the City of San Diego and empties to the eastern shoreline of San Diego Bay. Chollas Creek was placed on the Section 303(d) list by the State Water Quality Control Board for diazinon, cadmium, lead, copper, zinc and bacterial indicators. Cadmium has been removed from the list based on a re-evaluation of the data. A TMDL for diazinon was adopted in August 2002, and proposed for dissolved copper, lead and zinc in June 2005. TMDLs are currently being developed to address bacterial indicators, benthic community effects, and sediment toxicity at the mouth of Chollas Creek.

The TMDLs for both diazinon and the dissolved metals are concentration-based numeric limits. The TMDL for dissolved metals require attainment upwards of 90% of the California Toxic Rule (CTR) concentration at the discharge point of the municipal storm drain system. The Chollas Creek TMDL for dissolved metals explicitly sets aside the remaining 10% of the CTR concentration as a margin of safety. There are approximately 800 discharge points in the watershed as shown on Figure ES-1, which will require a variety of pollution control activities. In contrast, the implementation plan for addressing diazinon is based on the anticipated reduction of domestic use due to a nationwide ban on the retail sale of this pesticide which became effective January 1, 2005.

The beneficial uses of Chollas Creek are listed as REC-2, WARM, and WILD (RWQCB 1994), with REC-1 as a potential beneficial use. Much of the Creek has been channelized and concrete lined. Approximately 30% of the Creek was channelized prior to 1975, the adoption date of the Basin Plan. Due to the historical channelization of much of the lower portion of the creek and the highly urbanized nature of the watershed, the human recreational beneficial uses do not appear applicable to large portions of the creek and should be considered for amendment of the Basin Plan.

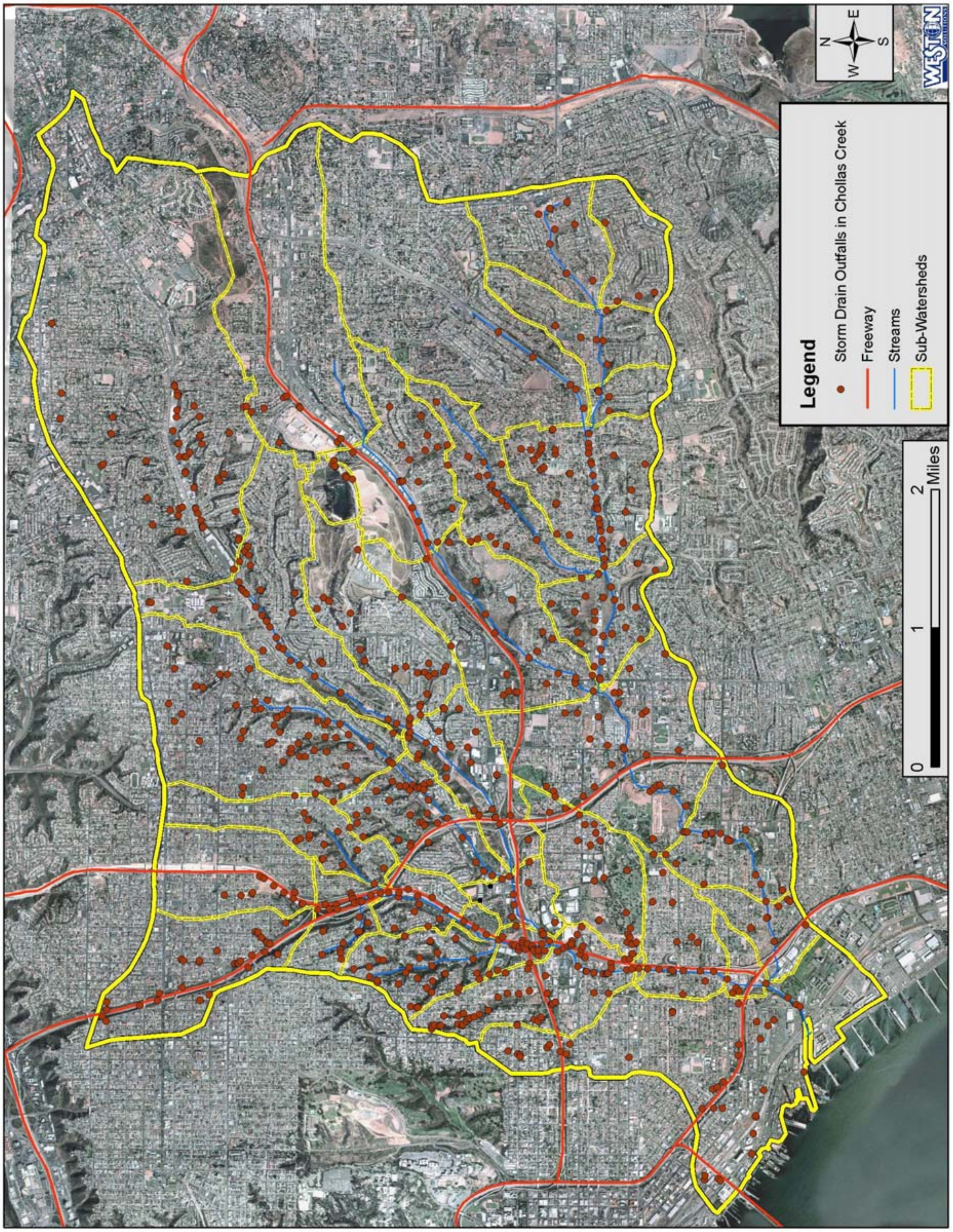

Figure ES-1. Aerial View of Chollas Creek Watershed and Location of Storm Drain Discharges.

Assessment of Water Quality and Source Data

The available water quality data for Chollas Creek includes 12 years of wet weather monitoring at the mass loading station location at the Chollas Creek north fork site SD8(1), and four years of dry weather data collected through the illicit discharge program. The results to date indicate that diazinon concentrations are decreasing in wet weather samples at the mass loading station since 2002, indicating the ban has been effective in addressing the TMDL. The concentration of copper, lead, and zinc in wet weather samples indicates that water quality objectives are frequently exceeded at mass loading stations in both the north fork or south fork of Chollas Creek, yet data gaps exist in the upper watershed limiting the ability to identify problem areas. The concentrations of fecal coliform in wet weather samples at the Chollas Creek north fork site SD8(1) have exceeded the Basin Plan water quality objective in every wet weather sampling event measured since the 2000-2001 wet weather monitoring period. Limited wet weather monitoring data for bacteria exists in the south fork of Chollas Creek. Dry weather sampling results indicate less frequent and less prevalent exceedances of water quality objectives for diazinon, copper, lead, and zinc, but more frequent and wider spread exceedances for bacteria.

Possible pollution sources have been identified and prioritized for bacteria, trace metals and pesticides based on loading potential and the water quality priority ratings presented in the Baseline Long-Term Effectiveness Assessment (Weston et al. 2005). For the San Diego Bay watershed, the identified priority industries which may contribute sources of pollution include: auto mechanical repair, fueling or cleaning; automobile body repair and painting; fabricated metal operations; marinas; corporate yards; motor freight; auto parking and storage, auto wholesale; boat repair; home auto repair and washing; roads, street and highways; eating and drinking establishments; animal facilities; home garden care activities; nurseries; landscaping at public areas; pest control services; and, development subject to SUSMPs. Based on current inventories of these sources, many are located along commercial strips of local highways concentrated along Interstates 5, 15, and 805 and Highway 94 as shown on Figure ES-2 for potential metal sources.

The overall contribution of these priority sources compared to other non-point sources are not known at this time. The potential loading of trace metals from aerial deposition may be a significant portion of the overall total mass of constituents that result in the dissolved metals concentrations that exceed water quality criteria in the receiving waters. An understanding of the contribution (or loads) from each of potential significant sources is needed to develop a TMDL implementation plan to prioritize those management actions that will be most effective at meeting the requirements for the TMDLs. The City is currently conducting an aerial deposition study that includes the Chollas Creek watershed. The goal of the aerial deposition study is to develop a loading estimate from airborne contaminants to compare with the total estimated load from the watershed. The interim findings of the aerial deposition study are consistent with a study performed in Los Angeles, CA which concluded that aerially deposited trace metals may account for 57 – 100% of the total trace metal load in storm water run off (Sabin et al., 2005).

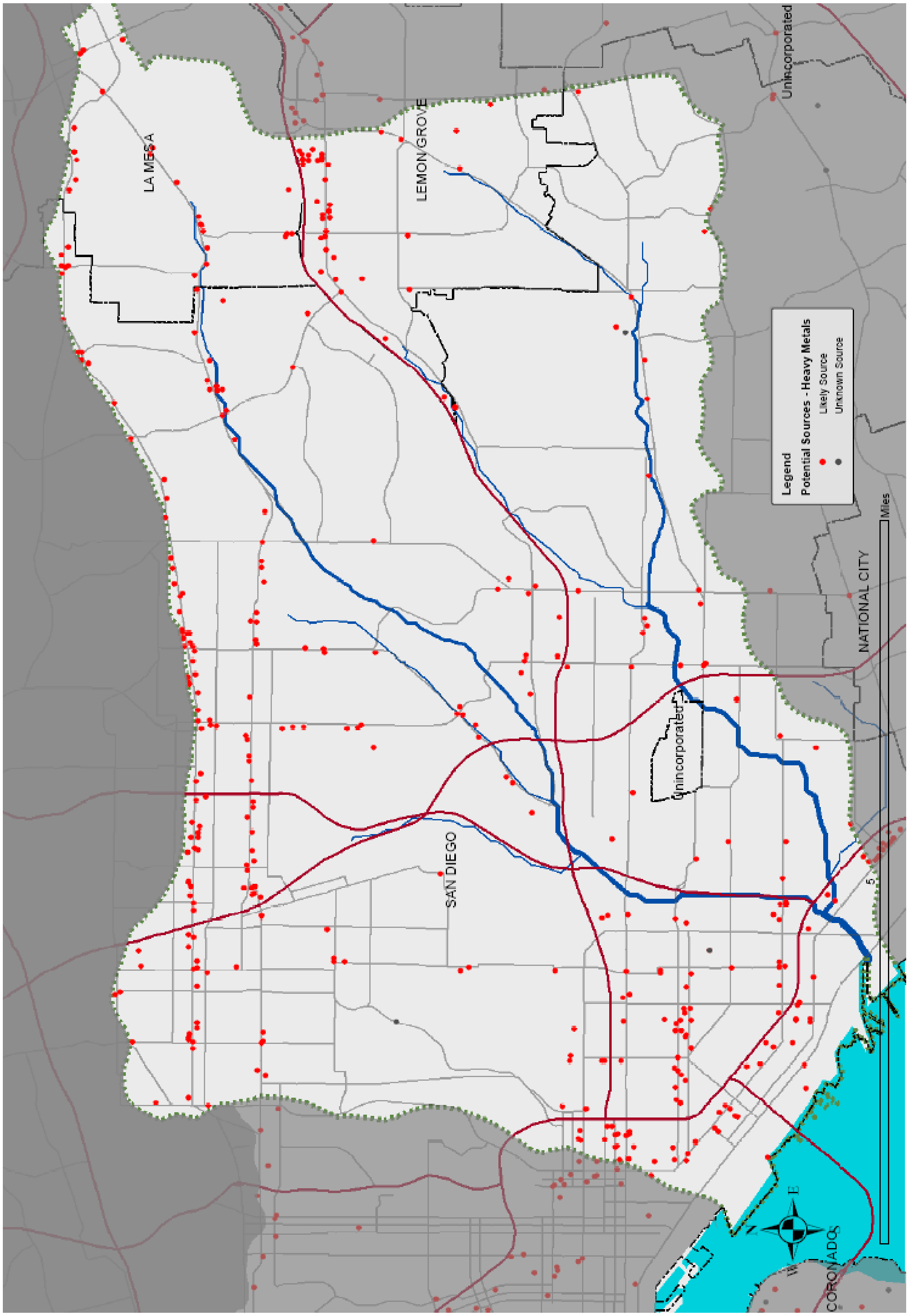

Figure ES-2. Location of Potential Source Types for Metals in the Chollas Creek Watershed (BLTEA 2005)

Watershed Characteristics

The Chollas Creek watershed is characterized by steep slopes along the canyons that drain from the urbanized areas above the creek channel. Storm water is collected in the municipal storm drain system in the urbanized areas and along the major highways and is discharged into natural or lined channels in the canyons that drain to the creek. There are approximately 800 storm drain outlets in the watershed that generally do not drain directly to the creek, but to tributaries further up in the canyon. The watershed is characterized by poorly draining soils and compacted urban lands based on USDA Natural Resources Conservation Service surveys as shown on Figure ES-3. These characteristics limit the application of management measures that require large areas for equalization of storm flows and/or high permeability soils for redirecting runoff back into the ground through infiltration without the acquisition of lands and modification of existing soils. Site specific investigations on the actual infiltration properties of the soils and citing constraints are needed to fully define the implementation constraints.

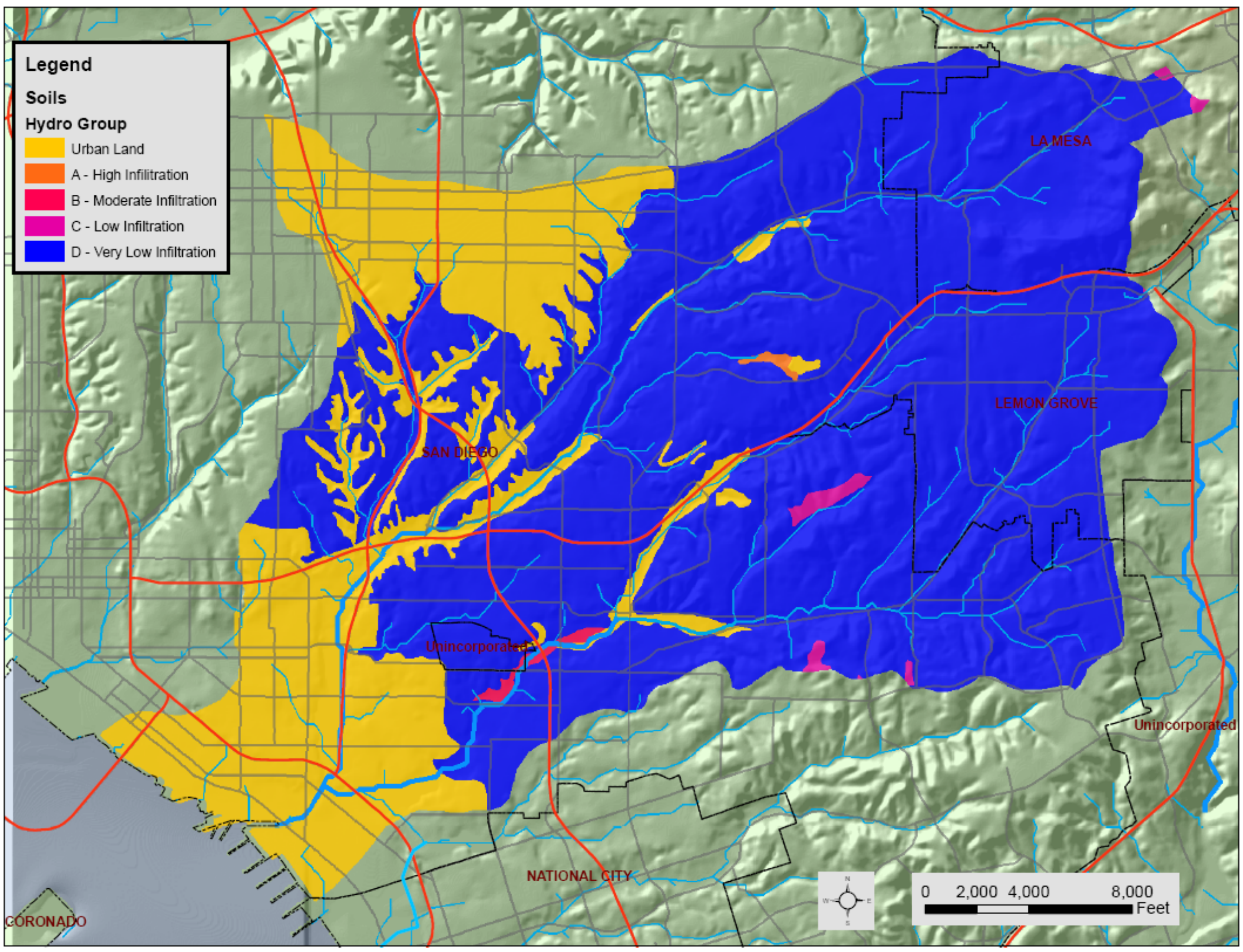

Figure ES-3. Soil Permeability Map for Chollas Creek Watershed.

BMP Assessment

This report presents an integrated approach to the assessment of BMPs for meeting the TMDLs in Chollas Creek. For the Chollas Creek watershed, an integrated approach requires meeting adopted and anticipated TMDLs for bacteria, dissolved metals and pesticides. An integrated approach will require additional time for implementation, but will address all the water quality issues in a more cost effective and environmentally holistic manner. Implementation of management measures that can address multiple constituents under the TMDLs is a more cost effective approach than having to possibly retro-fit or replace existing measures to address additional constituents as future TMDLs are implemented.

Published data on the expected combined removal efficiencies of the recommended baseline non-structural BMPs is limited, but estimates range from 30% to 80%. These baseline source control and pollution prevention measures are not anticipated to fully meet the load allocations of the TMDLs at all discharge locations. Therefore, in addition to non-structural BMPs, treatment BMPs will be needed to meet these limits. However, the non-structural BMPs will provide cost effective reductions in total load and concentrations within drainage areas that are characterized as high loading, reducing the size and number of treatment BMPs required to meet the TMDL. Non-structural BMPs may be less efficient in reducing bacteria loads in the overall watershed due to regrowth prior to discharge to the Bay.

Structural BMPs were selected for assessment in this report based on whether they were rated high to medium for removal efficiencies for all three TMDL constituent groups (dissolved metals, bacteria and pesticides). Those BMPs that were rated low for these constituent groups were not included in the assessment. Pesticides were included in the BMP selection process in anticipation of future pesticide issues that may include synthetic pyrethroids or additional pesticides that may be linked to the toxicity and benthic alteration TMDL at the mouth of Chollas Creek. However, BMPs are not targeted for diazinon which has been addressed through the EPA product ban. The selected treatment technologies were then evaluated based on effectiveness to meet the TMDL concentrations/waste load allocations, regulatory implementation issues, watershed characterization constraints, and relative costs. Based on this evaluation, the following treatment BMPs are recommended for alternative development and conceptual cost estimation:

Alternative Filtration Media Treatment Systems

- Equalization Basin/Chamber, Filter/Screen and Granular Activated Carbon (GAC) Column or Ion Exchange (IX) Media Treatment Train
- GAC or IX Media Mixing Chamber with flow to Sedimentation Basin
- Pretreatment Sedimentation Basin and GAC or IX Treatment Bed Underlain by Sand Filter and Underdrain System – “GAC/IX Sandwich Filter”
- Modified Austin Sand Filter with Activated Alumina or other IX Media

Chemical Precipitation Treatment Systems

- Treatment System Composed of Equalization Basin/Chamber, Chemical Precipitation Process (Sodium Sulfate) and Sand Filter

Runoff Reduction and Treatment Volume Reduction BMPs

- Low Impact Design Technologies – New Development and Retro-fits – Collection, storage and reuse of runoff from roofs; porous pavement; and, bioretention and bio-swales using engineered drainage layers and underdrain systems

- Bioretention Filter for Storm Drain Inlets – Storm water enters inlet and infiltrates through vegetated soil layer and IX Media and then flows to Storm Sewer
- Linear Bioretention Trenches

Selected Flow Diversion Systems

- Dry Weather and First Flush Diversions to Sanitary Sewer

Traditional infiltration technologies were rated the highest for removal efficiencies for all the constituent groups. However, preliminary soils data based on the Soil Conservation Service surveys suggest that the implementation of these BMPs may be restricted in many areas of the Chollas Creek watershed that is characterized by poorly draining soils as shown on Figure ES-3. However, these data may not be fully representative of the underlying soil conditions. Site specific geotechnical investigations are needed to obtain the necessary soil information to determine the actual storage capacity and infiltration rates within targeted areas. The use of infiltration basins and sub-surface galleries to capture and treat a full design storm have not been retained due to predominantly built-out conditions and suggested low permeability soils of this watershed.

The development of Low Impact Design (LID) features such as engineered porous pavement, sunken vegetated islands and sidewalk strips ("Green Streets"), and bioswales were selected as potential BMPs for the Chollas Creek watershed. The Chollas Creek watershed is built-out in most of the sub-watersheds requiring retrofitting for LID applications. LID for new construction can reduce future potential increases in runoff volume and peak flows. Depending on the actual soil conditions and the size of the drainage area, these BMPs can be effective in significantly reducing runoff volumes and ultimately the volume that may require treatment to meet the TMDL goals. LID techniques can be engineered to include additional granular drainage layers and modification of underlying soils to increase storage capacity and permeability. These additional components will increase the cost and space requirements of these systems. For smaller drainage areas, these BMPs can potentially capture close to the design storm eliminating the need for further treatment BMPs. This will depend on the site specific conditions and the defined design storm to be treated.

Results of effectiveness monitoring by Caltrans for a bioswale and a dry detention basin if applied to the Chollas Creek watershed, indicates that these treatment technologies alone will not reduce concentrations of metals to the levels required in the dissolved metals TMDL. These tests were conducted to assess the effectiveness of these BMPs alone. To meet the 10-year dissolved metals TMDL timeline, it will not be possible to phase in treatment train systems after an assessment of the effectiveness of non-structural BMPs and LID techniques to determine the level of reduction achieved. In order to meet the TMDL timetable, treatment BMPs that are assured of achieving full compliance must be implemented under an aggressive timeframe. Therefore, although non-structural BMPs, street sweeping, and LID techniques can be implemented as part of the management activities, treatment train BMPs will also need to be implemented simultaneously to meet the timetable. This approach is the basis for the first strategy developed to meet the 10-year compliance timetable using treatment train type BMPs. To assess the potential impacts and conceptual design costs, required treatment volumes are needed. An assessment of potential design storms and regulatory issues that impact the location of BMPs is presented next.

Runoff Storage/Equalization Requirements and Design Storm Approach

For the structural BMPs that were retained for TMDL implementation, the majority of the recommended treatment system technologies require equalization basins, sedimentation basins, vaults or chambers as part of the treatment process. Exceptions to this requirement are the bioretention technologies, the modified Austin-style sand filter, and the LID techniques that are more applicable for treatment of lower flows. These BMPs can provide significant runoff and/or treatment volume reduction.

Due to the variability of storm water flows, treatment systems will need to be designed for a design flow that is controlled through equalization. These treatment BMPs will therefore require sufficient areas for equalization and/or sedimentation. The City is working with the Southern California Coastal Water Research Project (SCCWRP) on a monitoring program to develop pollutographs (discrete concentrations and flow measurements over a storm event) for Chollas Creek that will provide data to evaluate a design storm approach. The modeling used to develop the TMDLs was based on the 93rd percentile of annual rainfall year (1993) observed over the last 12 years. The modeling was conducted using the dynamic hydrograph from 1993 to drive the build-up/wash-off mechanisms. These modeling parameters do not inform which design storm should be used to size BMPs. In the absence of guidance in the TMDL on the volume to be treated or a “design storm”, a conceptual design storm assessment is presented in this report.

This assessment included the statistical analysis of historical precipitation data to determine the 95 percentile storm duration. This duration was determined to be between 5 and 6 hours. A six-hour duration was therefore selected as the design storm duration. To determine the rainfall total, the total precipitation for a 6-hour duration storm for several return periods were investigated using National Oceanic and Atmospheric Administration (NOAA) data. In the absence of a defined design event, the recommended design storm approach should be based on the 6-hour duration, and a return period that corresponds to the metals TMDL exceedances frequency criteria of approximately 3 years. There is no such allowance for exceedances in the bacteria TMDL. A 3-year return period event would correspond to the requirements of the California Toxics Rules cited in the dissolved metals TMDL which states, “Neither the Aquatic Life Chronic Criteria (CCC) nor the Aquatic Life Acute Criteria (CMC) can be exceeded more than once every three years [40 CFR 131.38 (c)(2)].” Therefore, if an approximate 3-year storm event is used as the design storm, then all storms with a return period of 3 years and less will be collected and treated. However, a better understanding of how concentrations of bacteria, metals, and pesticides (e.g. pyrethroids) change over the course of a storm event and storm season is needed. Pollutograph data from other watersheds in the region indicate that metals are highest during the first flush portion of the storm, while bacteria concentrations tend to remain high through the duration of the storm event. Since an integrated approach is desired and pollutograph data is not yet available at this time, the recommended design storm approach is a 5-year / 6-hour storm event that corresponds to 1.4 inches of total precipitation.

Regulatory Issues that Impact Placement of BMPs

It is the City’s understanding that the RWQCB has interpreted the “tributary rule” to require attainment of the metals TMDL concentration-based limits in all waters of the State that include the conveyance channels (interpreted as “tributaries”) from the point of discharge at the storm drain outlets to the receiving waters (Chollas Creek). This interpretation of the tributary rule is also applied to the bacteria TMDL. The implications of this interpretation in the placement of structural BMPs is that if the BMP is placed between the storm drain outlet and the receiving water, the section of "tributary" between the outlet and the BMP will not be in compliance if the concentrations are above the water quality objective.

There are approximately 800 discharge points in the Chollas Creek Watershed as shown in Figure ES-4. This interpretation of the "tributary rule" limits the location of structural BMPs to be immediately at the storm drain outlet, within the MS4 system or above the outlet. The MS4 system is not designed for storage of storm flows, but rather the rapid discharge of runoff to control flooding. Due to this interpretation and the need for equalization/storage to treat storm flows, treatment BMPs will therefore need to be located above the storm drain outlets on available public lands or currently private property. Because the creek channel and the designated "Waters of the State" are generally located in a canyon valley and down the canyon slope, treatment BMPs will need to be located on the canyon crest and storm water conveyed either downstream to these locations or pumped to these systems. The RWQCB has indicated that application of the "tributary rule" could be considered on a case-by-case basis; however, the RWQCB has applied the tributary rule requirement to this TMDL.

Based on an initial comparison made of the required areas which included an estimation of available public lands (conceptually estimated at 20%) sufficient land may be available in the upper subwatersheds. An evaluation was also performed comparing the location of potentially available public lands to the distance to the storm drain outlets (an assumption of 500 ft maximum was used as a conceptually feasible distance for a conveyance system). Based on this evaluation, approximately 65% of the discharges would be within 500 ft of public lands (see Figure ES-4). However, storm water that is discharged from existing storm drain outlets would need to be conveyed to these potentially available public lands. Further engineering analysis is needed on a drainage area basis to evaluate the feasibility of conveying storm flows to nearby public lands for treatment or infiltration.

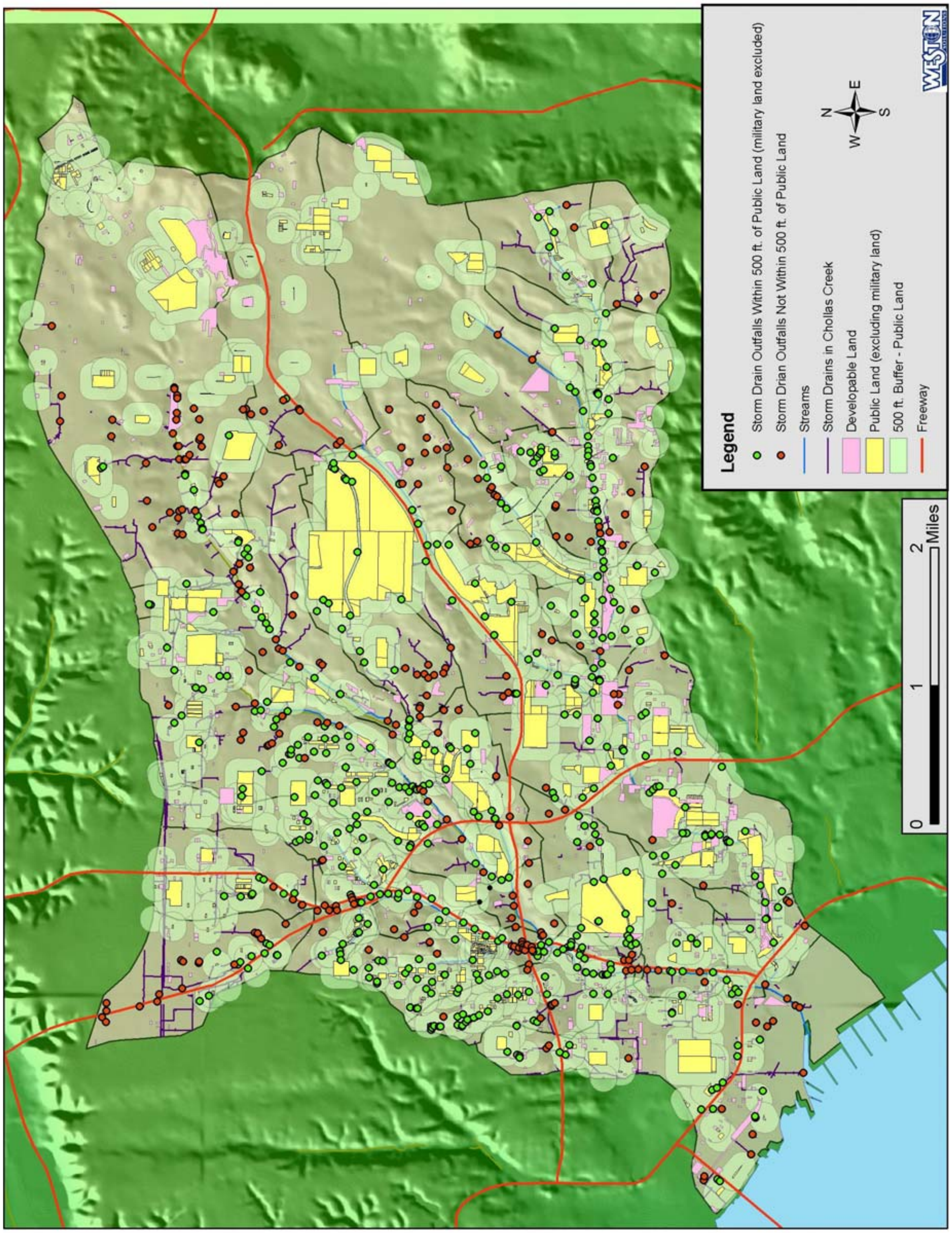

Figure ES-4. Map of Storm Drain Outfalls and Available Public Lands

To accommodate the "tributary rule," storm water will need to be conveyed from the current storm drain outfalls to the closest public lands, or to the top of the canyons that are predominantly residential as illustrated in Figure ES-5. Based on the analysis that limits the length of conveyance systems to 500 ft from outlet to the nearest public lands, approximately 220 acres of urbanized private property would be needed for the installation of the treatment BMPs that would meet the TMDL concentration based load allocations. Acquisition of private lands for the installation of treatment BMPs will create a significant impact to local communities as well as extensive public funds to purchase these properties. With these constraints to implement the level of treatment to meet the dissolved metals TMDL under an integrated TMDL approach, the required implementation schedule of 10 years to attain the CTR concentrations at 100% of the approximately 800 outlets does not appear practically attainable.

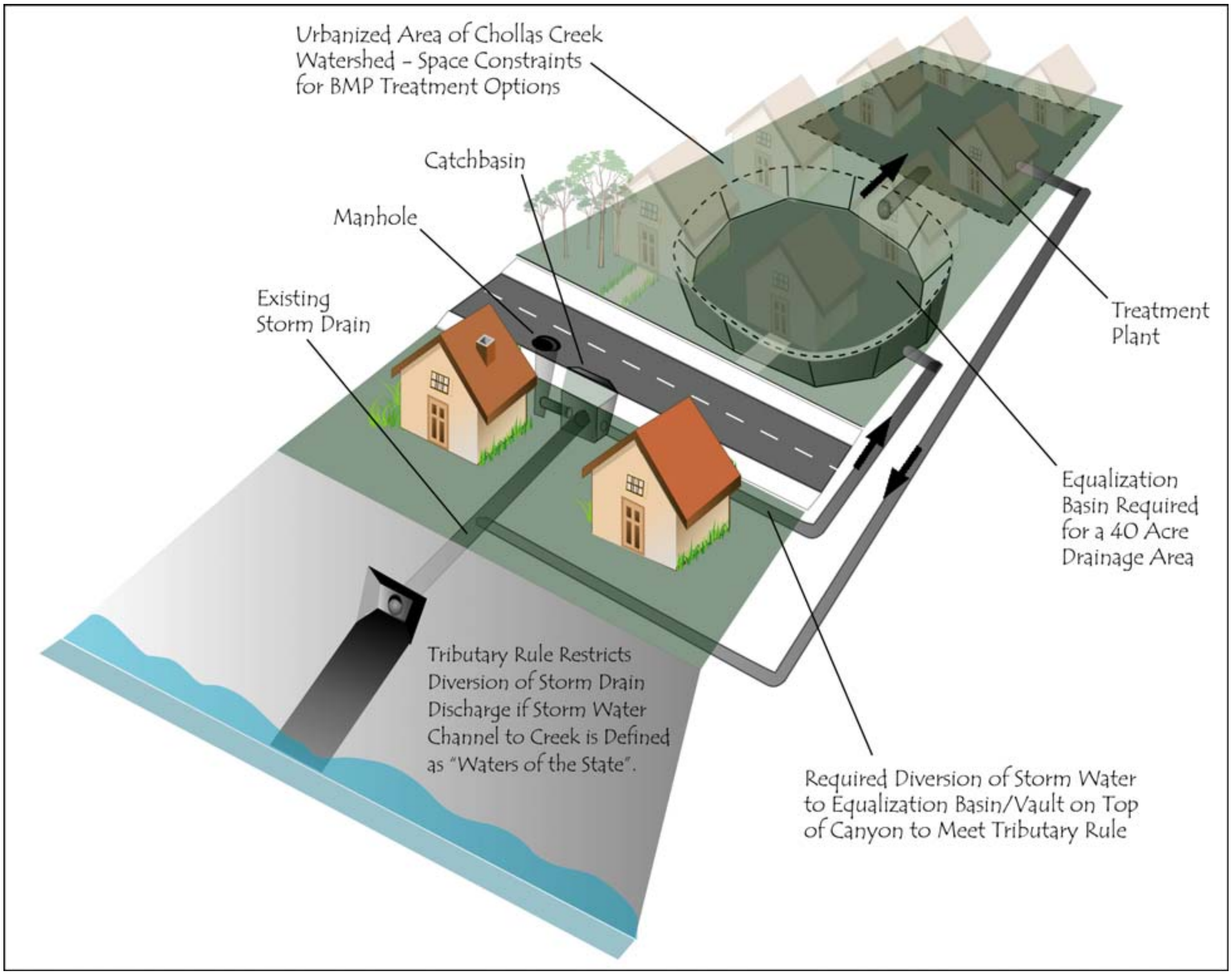

Figure ES-5. Tier III Treatment BMP Placement Constraints – Tributary Rule and Urbanized Watershed

TMDL Implementation Strategies

Two strategies are therefore presented in this report based on the BMP assessment. The first strategy is designed to meet the 10-year timetable. This strategy uses an aggressive implementation of treatment train BMPs that are assured to meet the TMDL requirements by capturing and treating up to the design storm event. The second strategy uses a tiered and phased approach that includes implementing non-structural BMPs, aggressive street sweeping and LID techniques to reduce pollutant loads to the maximum extent practical for these technologies and site conditions. These BMPs will first be implemented in targeted areas of higher loading in the first phase of each tier. These BMPs will then be assessed for effectiveness to determine if these BMPs are to be expanded under Phase II to other areas or modified. Finally, treatment train BMPs will be implemented where the effectiveness of non-structural and LID techniques are determined not to achieved full compliance.

Data gaps remain in water quality data in the upper-watershed, source loading, soil data, hydrological data, contributions from industrial sources, contribution of aerial deposition and overall mass balance from all potential sources. In addition to these data gaps, data within the Chollas Creek watershed on the effectiveness of BMPs to meet the objectives of an integrated strategy is also limited. Given these data gaps, a tiered and iterative implementation strategy may provide the soundest scientific and engineering approach to the implementation of applicable BMPs.

A strategy of a tiered approach is recommended for TMDL implementation given the following:

1. The need for additional time to develop an integrated approach that considers both current and future TMDLs;
2. Limited available public area to fully capture and treat storm flows;
3. Data gaps regarding soils data, hydrogeologic data, industrial source identification and updated inventories;
4. Data gaps on effectiveness of combined non-structural BMP implementation in the Chollas Creek watershed;
5. Pollutographs to develop design storm volume and flow;
6. Data gaps on the effectiveness of runoff and treatment volume reduction BMPs and,
7. Results of phase I (target drainage areas) treatment train system studies on technologies which are effective in meeting the TMDL objectives.

The first strategy that is designed to meet the 10-year compliance schedule is outlined on Figure ES-6. This strategy does not allow for the implementation of BMPs in the recommended tiered approach or time to address the listed data gaps given the number of outfalls to be treated and the conclusions of this assessment. Based on the BMP assessment, an “infrastructure intensive” treatment train approach will be needed to meet the integrated TMDL goals in the absence of data on the effectiveness of source controls, pollution prevention, and infiltration/LID BMPs in the Chollas Creek watershed. The implementation of treatment BMPs in accordance with this schedule will require the immediate acquisition of private land and/or easements on public lands for the installation of treatment BMPs. This will result in significant impact to the communities where acquisition and condemnation of private property is required. This process is complicated and will take time to implement. This presents a significant challenge to the City of San Diego in order to meet the required timetable under the TMDL.

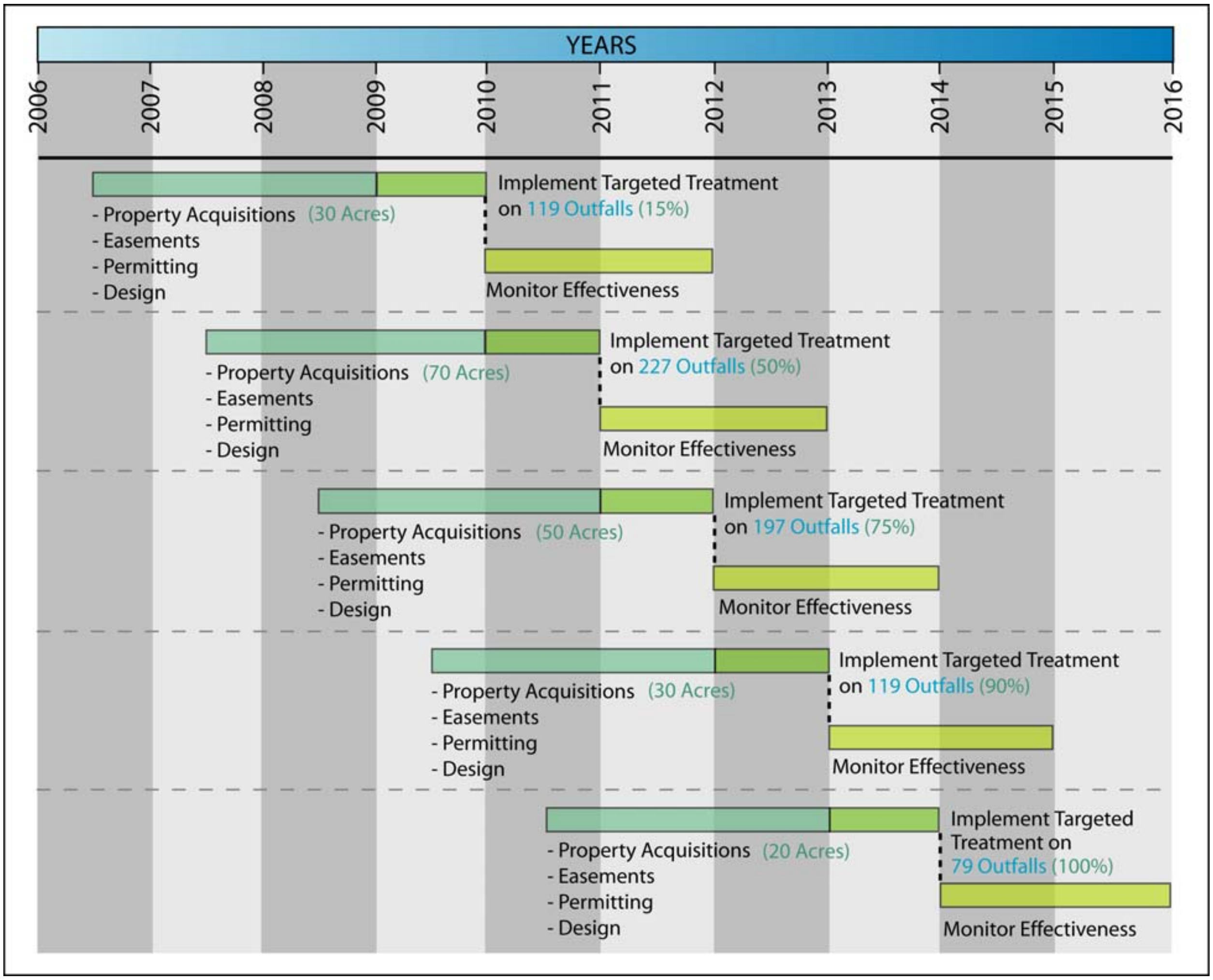

Figure ES-6. Infrastructure Intensive Implementation Strategy – Based on 10-year Dissolved Metals TMDL

An alternative "lower impact" strategy is recommended. This lower impact strategy takes an integrated approach in order to address both current and future TMDLs and uses a tiered approach to the implementation of BMPs as shown in Figure ES-7.

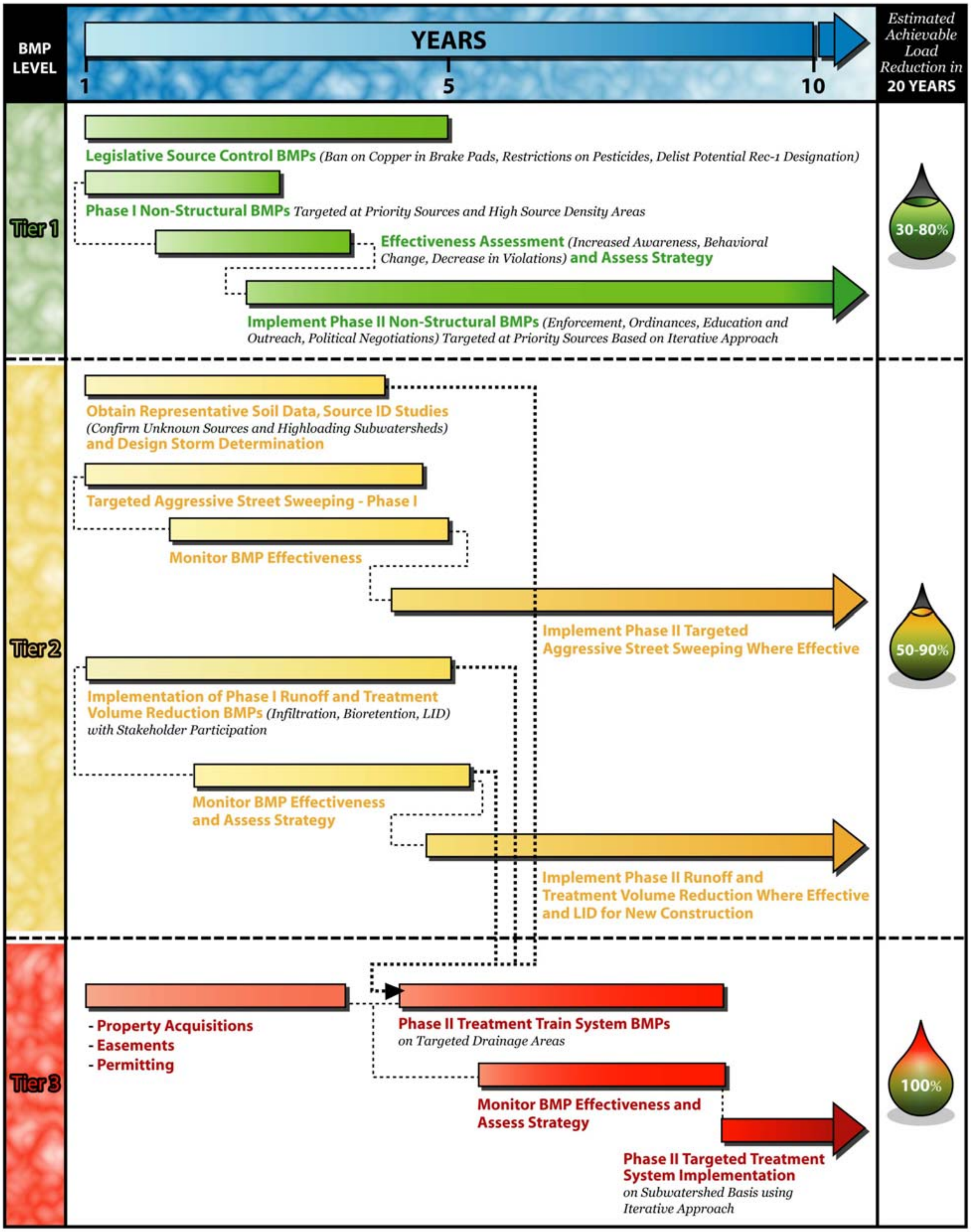

Figure ES-7. Integrated TMDL - Conceptual Alternative Tiered Implementation Schedule

A tiered approach includes three tiers of BMP implementation. Each tier is implemented in an iterative manner that first includes implementation of measures (using a phased approach) that are targeted on known sources or identified high loading drainage areas. These measures are then assessed for effectiveness. Based on the effectiveness assessment, further measures are implemented to meet the TMDL goals. The first tier includes pollution prevention and source control measures that target identified priority sources. The second tier includes further source identification studies, geotechnical investigations, hydrological and pollutant loading modeling and data gaps in order to better target and design more capital intensive BMPs in Tiers II and III. Tier II also includes implementation of more effective street sweeping and runoff and treatment volume reduction BMPs. Runoff and treatment volume reduction BMPs include infiltration, bioretention and other LID techniques.

This recommended "lower impact" strategy includes implementing Tier I and Tier II activities in year one with the goal of reducing pollutant loads to the maximum extent practical and Tier III activities when data indicates that Tier I and II activities will not result in compliance. The strategy emphasizes implementation of potentially more cost effective source control and pollution prevention techniques as well as lower impact augmented infiltration, bioretention and other LID technologies. The use of LID techniques will require site specific geotechnical and hydrological investigations. The goal will be to maximize the effectiveness of Tier I and II activities to meet the reduction goals in a more cost effective and lower impact manner. Where the overall integrated TMDL reduction goals are not being met in certain sub-watersheds, based on effectiveness monitoring of the Tier I and II BMPs, Tier III treatment system BMPs will be implemented.

There may be specific conditions in certain sub-watersheds for which the combined effectiveness of Tier I and Tier II BMPs do not reduce loads down to the TMDL requirement based on effectiveness monitoring. For these conditions, more infrastructure intensive and higher impact Tier III BMPs will be implemented when data indicates that Tier I and II activities will not result in compliance. This integrated and tiered strategy therefore reduces community impacts and allows for the use of targeted effective techniques in meeting the integrated TMDL goals. The tradeoff of both an integrated strategy which considers not just current but future TMDLs, and a lower impact and more cost effective tiered or phased approach, is the need for an extended implementation schedule.

To address additional time requirements to implement a lower impact and cost effective program that will meet the integrated TMDL goals, a potential timetable of 20 years should be considered to meet the 100% reduction goals. Tier I and II activities should be implemented on an aggressive timetable in targeted areas as part of phase I of these tiers. Effectiveness assessment monitoring should then be implemented as part of this first phase to determine if these BMPs should be extended to other areas or modified to improve effectiveness. The approach on a tiered and phased level is therefore an iterative process of implementation, assessment, and further implementation or improvement. The last column in Figure ES-7 depicts the estimated achievable load reductions using the tiered or phased approach in meeting the integrated TMDL goals.

Conceptual Implementation Costs

Although the implementation of non-structural BMPs and runoff reduction BMPs would provide more cost effective first steps, the compliance schedule requires 50% of the outlets to meet the dissolved metals compliance concentrations within the next 7 years. This aggressive schedule will not allow for assessment of the effectiveness of non-structural BMPs within these drainage areas. Therefore, the potential reductions from source control, pollution prevention and runoff reduction measures that may reduce the overall treatment requirements are not considered the first strategy.

For the purpose of developing a conceptual cost estimate for TMDL implementation, it is assumed that treatment BMPs will be required for all the storm drain outlets to meet the infrastructure intensive strategy. This is due to the absence of actual data on the effectiveness of source control and pollution prevention measures, the application of the concentration-based objectives to all waters of the state within the watershed, and that dry weather flows will be treated as necessary to maintain hydrology and wetlands. This interpretation of the tributary rule therefore requires meeting the concentration based objective at the point of discharge of the storm drain outlet.

Conceptual cost estimates were developed for two treatment alternatives. The first alternative consists of the equalization/sedimentation basin followed by the adsorption filtration bed and the second alternative is a chemical precipitation treatment process. The conceptual treatment BMP designs were based on the volume and flow assumptions presented in this document.

For the treatment systems, which include equalization and treatment through a GAC and sand filter bed system as shown in Figure ES-8, the conceptual total construction costs range from $650 to $900 million depending on the design storm used. This range is based on the recommended 5 year/ 6 hour storm to a 25-year / 6-hour storm. This cost estimate assumes that a treatment system will be required for each storm drain outlet to meet the requirements of the Tributary Rule. If the discharges could be consolidated and treated on a subwatershed basis, the cost would be reduced to between $400-$500 million, excluding the cost of private property acquisition and conveyance and pumping systems to public lands. An additional $350-500 million would be needed for private property acquisition. This is based on the analysis presented in this section that estimated approximately 35% of the outlets were not within a reasonable distance (500 ft) from public lands. The total acreages estimated for equalization/sedimentation and treatment for the 1.4 inch and 2-inch / 6-hour storm for a runoff coefficient of 0.75 are 460 and 655 acres, respectively. The cost per acre to acquire private lands is assumed at $1.6 million/acre. Therefore the total cost for consolidated treatment systems and purchase of required lands ranges from approximately $750 million to $1 billion.

The estimated construction cost for the equalization, chemical precipitation, and sand filter process totals ranges from $400 to 500 million for the entire watershed. These costs also do not include the conveyance and pumping systems that would be needed to direct storm water flows from the current storm drain outlets to available public lands. This will increase these costs by potentially 20%. Design and permitting costs are not included and are expected to be 20-30% of the construction costs. These costs are presented for preliminary assessment purposes and more accurate estimates should be developed through a more detailed engineering evaluation on a subwatershed basis and consolidation of flow from several outlets to achieve better economies of scale.

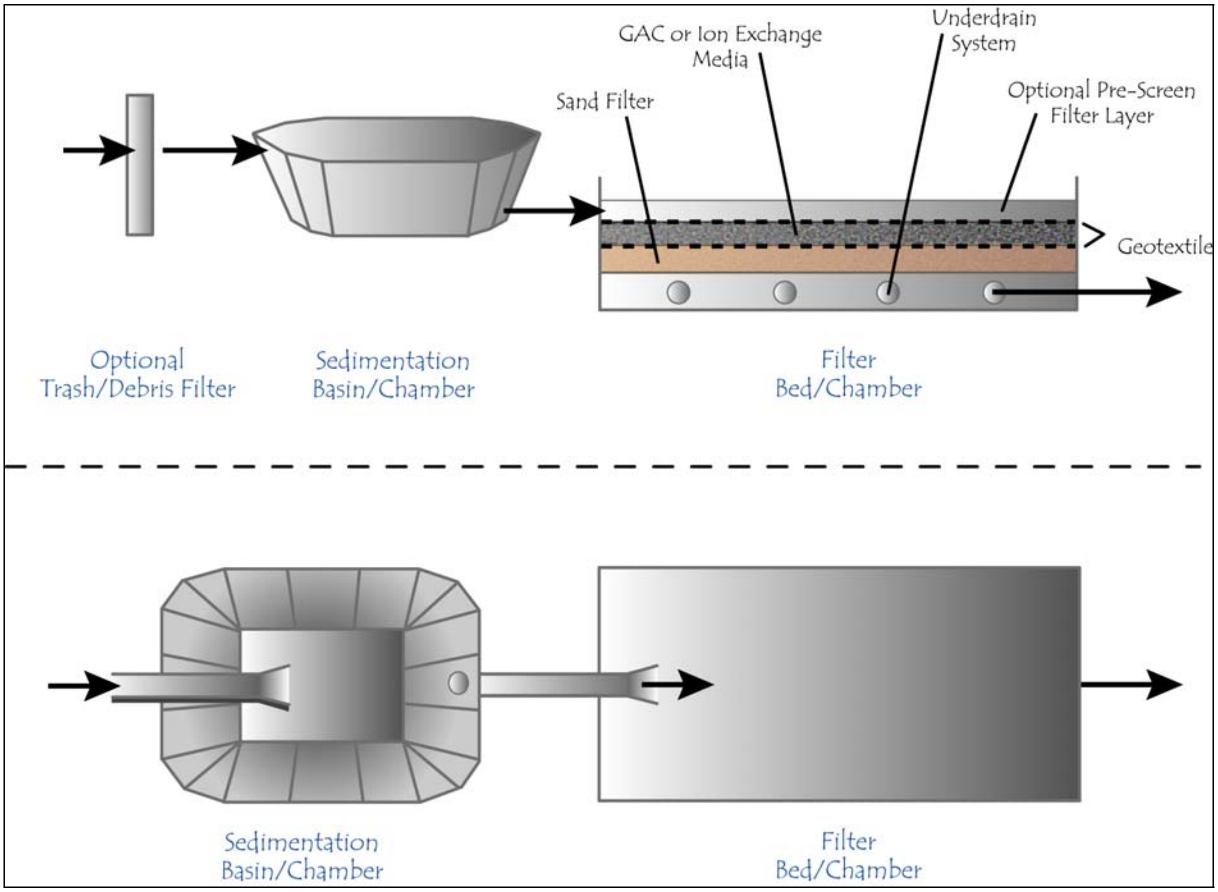

Figure ES-8. Conceptual Layout of Tier III GAC Sandwich Filter and Blanket BMP

In order to assess the cost sensitivity to design storm, the cost for the equalization and treatment media/sand filter system as applied on a subwatershed basis, was factored to various treatment volumes. These treatment volumes are based on the design storm and runoff coefficient selected. This assessment is summarized in Table ES-1. As shown on Table ES-1, the design storm has a significant impact on estimated costs. This analysis highlights the importance of the determination of the design storm criteria, and approval by the RWQCB.

Table ES-1. Cost Sensitivity Analysis for Implementation of Treatment BMP Using Different Design Storms and Runoff Coefficients

Design Storm (yr/6 hr)	Precipitation (in)	Runoff Coefficient (C)	Volume Treated (acre-ft)	Cost for Subbasin Treatment ($Million)
2	1.2	0.75	1173	340
5*	1.4	0.75	1373	350
10	1.6	0.75	1561	380
25	2.0	0.75	1960	490

* Design storm used in report examples

Monitoring Strategy

In order to determine the placement and activities of all BMPs within the watershed, a solid understanding of source contributions to the water quality problem in Chollas Creek is needed. This document identifies areas where further monitoring data is needed to better characterize and identify pollutant sources in order to implement source control BMP measures. A monitoring strategy needs to be implemented in order to fill these data gaps. The recommended monitoring strategy for the Chollas Creek watershed should have three components: (1) Address the data gaps identified (2) Assess the effectiveness of non-structural and treatment BMPs, and (3) Satisfy regulatory monitoring requirements.

Implementation Framework

Finally, an Implementation Plan framework is presented as the next step to this report. It is recommended that this Implementation Plan be developed through a collaborative effort with stakeholders and the RWQCB.

1.0 INTRODUCTION

The purpose of this report is to first provide an assessment of the existing water quality data and potential sources relative to the constituents that have been listed in adopted and anticipated future Total Maximum Daily Loads (TMDLs) for Chollas Creek. Available information on watershed characteristics and regulatory issues are then reviewed. These data form the basis for the assessment of the current and potential management actions (BMPs) that will be effective in meeting the current and future TMDL waste load allocations. This assessment takes an integrated approach to the development and implementation of best management practices (BMPs). For the Chollas Creek watershed, the integrated approach discussed in this report is recommended to meet the adopted and anticipated TMDLs for bacteria, dissolved metals and pesticides. An integrated approach uses available resources most cost effectively. This approach results in the implementation of BMPs that address both current and future TMDLs, and therefore will not require retro-fitting or replacement to meet future waste load allocations.

In addition to the assessments of available source loading and BMPs, the purpose of this report is present a strategy for TMDL implementation. Based on the results of the screening assessment of BMPs, two distinct strategies for TMDL implementation are developed. The first strategy is developed to meet the 10-year regulatory timetable for the current dissolved metals TMDL using an integrated approach. Due to the defined timetable of reduction goals, an infrastructure intensive approach that requires rapid installation of conservatively designed treatment systems is needed to attain full compliance. Potentially more cost effective source control and pollution prevention measures can be implemented at the same time, however, these non-structural BMPs are not assured to meet 100% of the reduction goal.

This first "infrastructure intensive" strategy requires large storage capacity to meet required load reductions in the 10-year timetable. Based on the conceptual treatment volumes needed to meet the reduction goals and other regulatory requirements on the location of these systems, these storage and treatment systems will require acquisition of private property within the watershed. Due to the built-out condition of the watershed, this strategy will result in impacts to residential communities to meet the reduction timetable. Due to the anticipated impact to residential communities under the first strategy, a recommended second "lower impact" strategy is developed using a tiered or phased approach that reduces the impact to communities and allows for more cost effective implementation of a combination of lower impact BMPs.

The report is organized with respect to addressing BMP strategies for the implementation of the Chollas Creek TMDLs as follows:

- Section 1 provides an overview of the existing TMDLs, load allocations, and time schedules for compliance.
- Section 2 is a review of the existing data, monitoring programs, and data gaps.
- Section 3 provides a characterization of the watershed.
- Section 4 discusses the regulatory BMP implementation issues and challenges.
- Section 5 covers the BMP assessment and screening matrix used to define what BMP strategies are best suited to the Chollas Creek watershed.
- Section 6 provides the conclusions and recommendations of the BMP implementation strategy and conceptual costs.

- Section 7 discusses the monitoring strategies needed in order to effectively measure load reductions in order to determine BMP effectiveness.
- Section 8 presents a framework for the development of an Implementation Plan

The results of this assessment provide an initial framework from which a tiered implementation plan using a tiered integrated TMDL approach can be developed by the City of San Diego in cooperation with stakeholders and the Regional Water Quality Control Board (RWQCB).

1.1 Chollas Creek Overview

Chollas Creek is an urban creek located within the County of San Diego (Figure 1-1). The Chollas Creek watershed, which is relatively small and highly urbanized, drains a portion of downtown San Diego and flows into San Diego Bay. Flows in Chollas Creek are highly variable and storm dependent. Much of the creek has been channelized and concrete lined, but some sections of earthen creek bed remain.

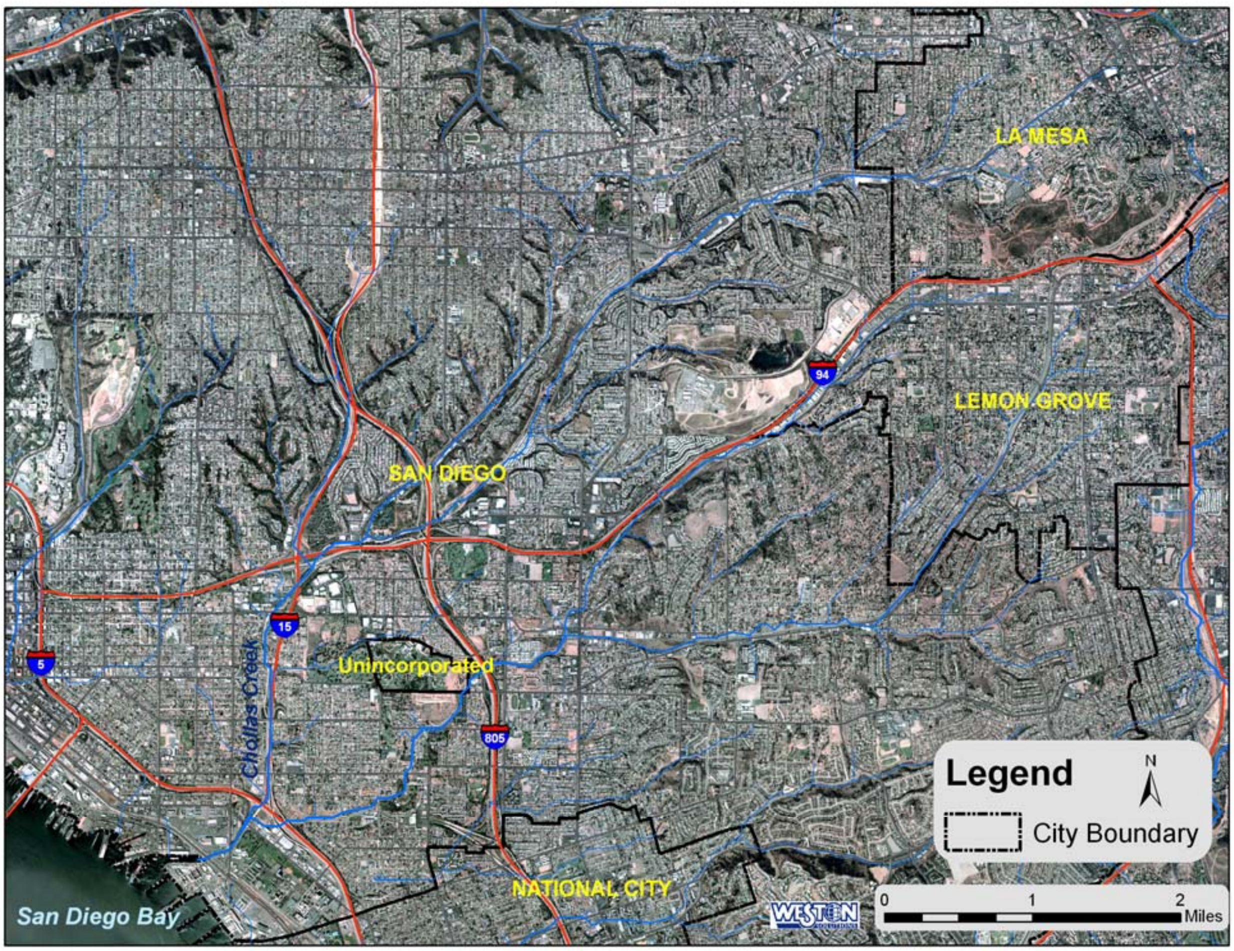

Figure 1-1. Aerial View of the Chollas Creek Watershed

1.2 Problem Statement

Chollas Creek was placed on the Section 303(d) list by the State Water Quality Control Board for diazinon (1996), cadmium, copper, lead, zinc, and bacterial indicators (2002). In addition, the San Diego Bay Shoreline near the mouth of Chollas Creek was listed for benthic community effects and sediment toxicity (2002). The 2006 proposed Section 303(d) list removed cadmium based on a re-evaluation of the data used for the original listing.

Federal law requires the RWQCB to develop a Total Maximum Daily Load (TMDL) for waters on the Section 303(d) list. The purpose of a TMDL is to attain applicable water quality objectives and restore the beneficial uses of "impaired" waters. Due to the listings, a TMDL for diazinon was adopted by the State Board in August 2002. TMDLs for dissolved copper, lead, and zinc were adopted for inclusion in the Basin Plan in June 2005 by the RWQCB. The metals TMDL Basin Plan amendment still requires State Board Office of Administrative Law and USEPA approval for final adoption. TMDLs are currently being finalized for bacterial indicators in Chollas Creek. TMDLs are also being developed for sediment impairments at the mouth of Chollas Creek.

The beneficial uses for Chollas Creek are listed as REC-2, WARM, and WILD (RWQCB, 1994). Chollas Creek also has a potential beneficial use listed for REC-1.

Detections of diazinon have been reported throughout Chollas Creek during storm events. No single reach or area of the creek was found to contain significantly higher concentrations of diazinon than other reaches. Source identification studies have found no identifiable point source of diazinon in the watershed. This is consistent with the land use patterns in the watershed and the documented uses of diazinon. Diazinon concentrations in the watershed have also been found to vary from storm to storm and could be a result of the application process and times of recommended usage (e.g., during dry weather). Diazinon has been detected during dry weather monitoring events.

Monitoring has shown that storm water samples from Chollas Creek have frequently exceeded the Basin Plan narrative water quality objective for toxicity. These samples have also exceeded chronic and acute water quality criteria for metals established in the California Toxics Rule. Specifically, during the period 1994 - 2001, concentrations of copper and zinc during storm events have frequently exceeded acute and chronic criteria, while concentrations of cadmium and lead have frequently exceeded chronic and periodically exceeded acute criteria.

Compliance monitoring is required in the creek to measure the progress of BMP implementation effectiveness and to ensure that the water quality objectives for diazinon, copper, lead, and zinc are being achieved (Order No. R9-2004-0277: Chollas Creek Investigation Order for diazinon and Metals). This Order will be periodically reviewed by the San Diego Regional Water Board (RWQCB), and amended if needed, to require the dischargers to collect additional data necessary to refine the watershed model so that mass loads of dissolved copper, lead, and zinc leaving the Chollas Creek watershed can be more accurately estimated.

1.3 Wasteload Allocations (WLA)

The United States Environmental Protection Agency (EPA) has established policy for establishing wasteload allocations (WLAs) for storm water discharges in approved TMDLs (memorandum from Robert Wayland to EPA Regional Water Division Directors dated November 22, 2002). This policy also addresses the establishment of water quality-based effluent limits (WQBELs) and conditions in National Pollutant Discharge Elimination System (NPDES) permits based on the WLAs for storm water discharges in TMDLs. The policy states that EPA recommends that for NPDES-regulated municipal and small construction storm water discharges effluent limits should be expressed as best management practices (BMPs) or other similar requirements, rather than as numeric effluent limits (see Interim Permitting Approach for Water Quality-Based Effluent Limitations in Storm Water Permits, 61 FR 43761 dated Aug. 26, 1996).

The Interim Permitting Approach Policy recognizes the need for an iterative approach to control pollutants in storm water discharges. Specifically, the policy anticipates that a suite of BMPs will be used in the initial rounds of permits and that these BMPs will be tailored in subsequent rounds. EPA's policy recognizes that because storm water discharges are due to storm events that are highly variable in frequency and duration and are not easily characterized, only in rare cases will it be feasible or appropriate to establish numeric limits for municipal and small construction storm water discharges. The variability in the system and minimal data generally available make it difficult to determine with precision or certainty actual and projected loadings for individual dischargers or groups of dischargers. Therefore, EPA believes that in these situations, permit limits typically can be expressed as BMPs.

In addition, there have been a number of rulings from the federal courts regarding the NPDES Storm Water program. One of the most significant is from the federal court, 9th District Court of Appeals in 1999, where the Court held that MS4 permits need not require strict compliance with water quality standards. Rather, compliance was to be based upon the maximum extent practicable (MEP) standard. The State Water Board through the permit process has stated that compliance with numeric standards can be achieved through the implementation of BMPs in an iterative fashion. Recently, the State Water Board convened a panel of storm water experts to examine the feasibility of developing numeric limits for storm water permits. The panel found that it is not feasible at this time to set enforceable numeric effluent criteria for municipal BMPs and in particular urban discharges (Storm Water Panel on Numeric Limits, 2006). Therefore, although the Basin Plan will be amended to include WLAs, the permits will still be based on the MEP standard.

1.3.1 Diazinon WLA

The WLA for diazinon are concentration-based numeric targets that were derived from the California Department of Fish and Game freshwater Water Quality Criteria. The acute Water Quality Criterion of 0.08 µg/L protects aquatic life from short-term exposure to diazinon, while the chronic criterion of 0.05 µg/L protects aquatic life from long-term diazinon exposure. All allocations were set at 90% of the numeric targets, based on an explicit 10% margin of safety to account for uncertainties in the TMDL analysis. The resulting diazinon WLA is set at 0.072 µg/L for acute exposure conditions and 0.045 µg/L under chronic exposure conditions. The implementation plan for addressing the diazinon TMDL is based on a nationwide ban on the retail sale of the pesticide effective on January 1, 2005. Diazinon concentrations have been steadily declining at the Chollas Creek mass loading station (MLS) site SD8(1) since 2002. There have been no exceedances of the acute or chronic water quality objective for diazinon over the past two wet weather monitoring seasons (Figure 1-2).

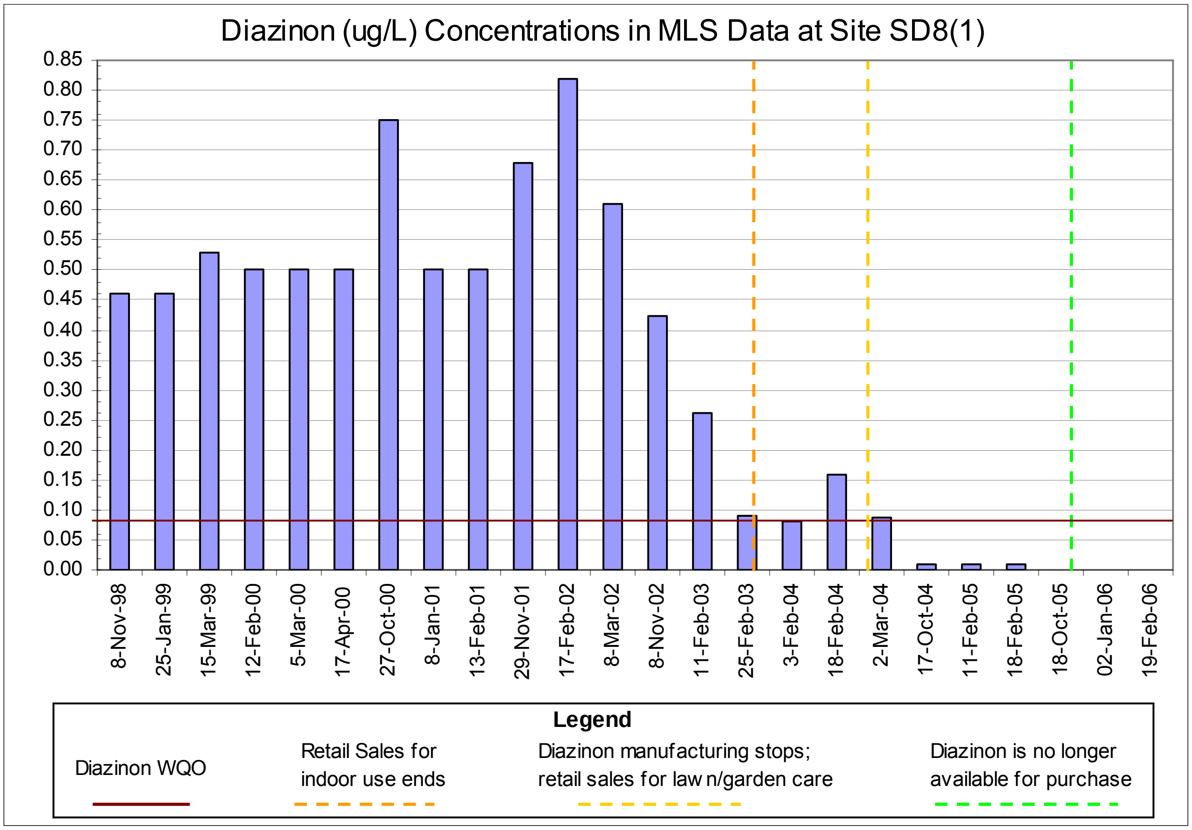

Figure 1-2. Diazinon Concentrations at Chollas Creek MLS Site SD8(1)

1.3.2 Proposed Metals WLAs

EPA established numeric criteria for toxic pollutants which are applicable water quality objectives for dissolved copper, lead, and through promulgation of the California Toxics Rule (CTR). These water quality objectives are applicable to Chollas Creek and are presented below (Table 1-1). The proposed TMDLs for these metals are concentration-based and include an explicit 10 percent margin of safety (MOS) that takes into account any uncertainties in the TMDL calculation. The TMDLs for dissolved copper, lead, and zinc are equal to the WLAs which are 90 percent of the CTR chronic and acute criteria. The TMDL also includes an implicit MOS due to the conservative assumptions used in developing the criteria for the CTR (Stephan et al. 1985). These implicit MOS are not identified in the TMDL. Since the TMDL is concentration based, compliance is not driven by total loads (flow based), but measured concentration in the water body for which the TMDL applies. The application of the "tributary rule" as interpreted by the RWQCB requires compliance throughout the watershed including the conveyance channels (interpreted as tributaries) from the point of discharge at the MS4 storm drain outlets to the recovery waters (Chollas Creek Channel). The RWQCB has indicated that this rule may be reviewed on a case-by-case basis.

Table 1-1. Water Quality Objectives for Specified Metals in Chollas Creek

Metal	Numeric Target for Acute Conditions	Numeric Target for Chronic Conditions
Copper (dissolved)	(0.96) * {e^ [0.9422 * ln (hardness) - 1.700]	(0.96) * {e^[0.8545 * ln (hardness) - 1.702]
Lead (dissolved)	{1.46203 – [0.145712 * ln (hardness)]} * {e^ [1.273 * ln (hardness) - 1.460]}	{1.46203 – [0.145712 * ln (hardness)]} * {e^[1.273 * ln (hardness) - 4.705]}
Zinc (dissolved)	(0.978) * {e^ [0.8473 * ln (hardness) + 0.884]}	(0.986) * {e^[0.8473 * ln (hardness) + 0.884]}

Hardness is expressed as milligrams per liter.
The natural log and exponential functions are represented as “ln” and “e,” respectively.

1.3.3 Proposed Bacterial Indicator WLA

Chollas Creek has also been listed in the TMDL for Indicator Bacteria, Project I - Beaches and Creeks in the San Diego Region (CRWQCB San Diego Region, 2005) (Table 1-2). The RWQCB is considering a Basin Plan amendment to add the TMDL for bacteria. The bacteria TMDL is still in process but should be considered for future BMP development.

Table 1-2. TMDLs for Indicator Bacteria for the Chollas HSA (908.22) Chollas Creek (CRWCB San Diego Region, 2005)

Bacteria	Model Subwatershed[A]	Wet Weather TMDL Results (Billion MPN/year)							Dry Weather TMDL Results (Billion MPN/year)[C]		
		Exisitng Load	Total Maximum Daily Load	Percent[B] Reduction	Wasteload Allocation (Municpal MS4s)	Waste Load Allocation (Caltrans)	Load Allocation (Controllable)	Load Allocation (non-Controllable)	Existing Load	Wasteload Allocation (Municpal MS4s)	Percent Reduction
Total Coliform	1901	15,390,608	13,247,626	13.9%	10,349,391	39,397	0	2,858,838	250,803	19,910	92.1%
Fecal Coliform	1901	603,863	55,516	903.8%	0	0	0	230,139	50,680	3,982	92.1%
Enerococci	1901	1,371,972	1,152,645	16.0%	858,736	1,714	0	292,080	42,826	657	98.5%

A. This number is used in the LSPC model to identify the subwatershed associated with the listed segment(s) within a hydrologic region (see Appendix E). Load-duration curves and TMDL calculation tables for each subwatershed are provided in the Appendices.

B. Percent reduction = [1 – (Total Maximum Daily Load / Existing Load)] x 100%

C. The dry weather TMDLs are only allocated to municipal MS4s because bacteria discharges from Caltrans highways, controllable point sources, and non-controllable point sources are not likely during dry weather.

1.4 TMDL Implementation Schedule

Each TMDL for Chollas Creek provides a compliance schedule for the parameters of concern. Table 1-3 presents the compliance schedule and actions for the Chollas Creek TMDL for Diazinon. The City has been accomplishing these goals through an Integrated Pesticide Management Grant.

Table 1-3. Chollas Creek Diazinon TMDL Compliance Schedule for MS4 Copermittees.

Action	Compliance Date
IPM Workshops	Annually
Monitoring Plan	December 2003
Diazinon Toxicity Control Plan	December 2003
Implement Authorities	May 2003
Compliance with Permit	Ongoing
Submit Reports	Annually

Table 1-4 presents the proposed compliance schedule for the Chollas Creek Metals TMDL. This schedule is considered during the assessment of potential BMPs in this report that may be applied to the Chollas Creek watershed.

Table 1-4. Chollas Creek Metals TMDL Compliance Schedule*

Compliance Year*	Percent Reduction in MS4 outfalls needed to meet TMDL Target
2010	15%
2013	50%
2014	75%
2015	90%
2016	100%

* assumes TMDL is approved by the State Board and USEPA in 2006.

Table 1-5 presents the proposed compliance schedule for the Indicator Bacteria TMDL for beaches and creeks which include Chollas Creek.

Table 1-5. Chollas Creek Pathogen TMDL Compliance Schedule*

Compliance Year	Wet Weather		Dry Weather	
	Fecal Coliform	Enterococcus	Fecal Coliform	Enterococcus
2013	13.8%	16.0%	92.1%	98.5%
2016	90.8%	99.4%	92.1%	98.5%

* assumes TMDL becomes legally established in 2006. Units are in Percent Wasteload Reduction

2.0 EXISTING DATA REVIEW AND ASSESEMENT

2.1 Existing Data

The Chollas Creek Metals TMDL does not provide the sources of the data that were used in the development and evaluation of the TMDL. The RWQCB was contacted and they provided the following reference information that is listed in Table 2-1.

Table 2-1. Chollas Creek Metals TMDL References

Ref.	Source
a	City of San Diego and Co-Permittee Storm water Monitoring Program 1994-1995 (Kinnetic Laboratories)
b	City of San Diego and Co-Permittee NPDES Storm water Monitoring Program 1995-1996 (Woodward-Clyde)
c	City of San Diego and Co-Permittee NPDES Storm water Monitoring Program Report 1997-1998 (Woodward-Clyde)
d	City of San Diego and Co-Permittee NPDES Storm water Monitoring Program Report 1998-1999 (URS Greiner Woodward Clyde)
e	City of San Diego and Co-Permittee NPDES Storm water Monitoring Program Report 1999-2000 (URS Greiner Woodward Clyde)
f	City of San Diego and Co-Permittee NPDES Storm water Monitoring Program Report 2000-2001 (MEC Analytical Systems, Inc.)
g	Chollas Creek Watershed Monitoring Final Report 1999-2001 (MEC Analytical Systems, Inc.)
h	Chollas Creek Water Quality Sampling 1999-2000 Wet-Weather Season (URS)
i	City of San Diego and Co-Permittee NPDES Storm water Monitoring Program Report 1996-1997 (Woodward-Clyde International-Americas)
j	San Diego County Municipal Copermittees 2001-2002 Urban Runoff Monitoring Final Report (MEC Analytical Systems, Inc.)
k	City of San Diego and Co-Permittee NPDES Storm water Monitoring Program 1993-1994 (Kinnetic Laboratories, Inc.)
l	Lab Results/Quality Assurance Laboratory (4 Jun 91)
m	Lab Results/Quality Assurance Laboratory (8 Apr 92)
n	Lab Results/Quality Assurance Laboratory (9 Apr 92)
o	Characterization of Storm water Toxicity in Chollas Creek, San Diego (SCCWRP, 10 Nov 1999)
p	1998-1999 Annual Report for Storm Water Discharges Associated with Industrial Activities: Trolley Auto Parts
q	1998-1999 Annual Report for Storm Water Discharges Associated with Industrial Activities: Mini Trucks and Cars
r	1998-1999 Annual Report for Storm Water Discharges Associated with Industrial Activities: Able Auto Wrecking
s	1998-1999 Annual Report for Storm Water Discharges Associated with Industrial Activities: Allways Recycling
t	Laboratory Results, E.S. Babcock and Sons, Inc., reported 9/26/00
u	Storm water Toxicity in Chollas Creek and San Diego Bay, California. Kenneth Schiff, Steven Bay and Dario Diehl. *Environmental Monitoring and Assessment*, 2003.
v	Storm Water Monitoring and Research Program Annual Data Summary Report 1999/2000. CTSW-RT-00-031. Caltrans, January 2001.
w	2002-2003 Annual Copermittee Annual Storm water Monitoring Report - Preliminary Results

To gain a more thorough understanding of the constituents of concern and loadings to the watershed, additional data beyond that which was provided in the Chollas Creek Metals TMDL were also evaluated. All available monitoring results for diazinon, total suspended solids, copper, lead, zinc, and bacteria were consolidated and is provided in tabular form in Appendix A. The following is a summary of the additional data for the Chollas Creek Watershed:

2.1.1 Chollas Creek PRISM Grant

An Integrated Pest Management (IPM) education program was developed under the Proposition 13 PRISM Grant Agreement No. 04-17-559-0 for the Chollas Creek Watershed. This program is primarily aimed towards the residential and commercial sector, to induce positive changes in attitudes and behaviors regarding pesticide use in urbanized watersheds in order to protect and restore affected beneficial uses of receiving waters of the Chollas Creek Watershed.

Data collected under this program includes results from four mass loading stations during monitoring activities from the 2004-2005 and 2005-2006 wet weather monitoring seasons and sediment samples collected during June 2005. Three of these mass loading stations are located in the south fork of Chollas Creek which allows for spatial analysis. The Chollas Creek PRISM Grant is a three year program that will be completed in March, 2007. This program was also used to provide information to comply with RWQCB Order No. R9-2004-0277.

Statistical evaluations that were performed during the 2005 monitoring submittal included an ANOVA test to determine if there were differences in concentration between water quality monitoring stations. The ANOVA test resulted in a determination of no significant difference between stations. This was due to the large variability in concentrations between storm events. A second ANOVA was performed to determine if there were differences in concentrations between storm events using the four stations as replication. These results showed that the first storm of the season had the highest concentrations of analytes and had significantly higher concentrations for most analytes. Concentrations found during the first storm event were significantly higher for all of the metals, total hardness, and the nutrients. Pesticides (diazinon and malathion) were variable by station as well as storm event, thus significant differences were not found for these two analytes.

Regression analysis indicated that the total metals (cadmium, copper, lead, and zinc) showed the strongest relationships with total suspended solids (TSS) concentrations; all four metals (cadmium, copper, lead, and zinc) regressions had R^2 values above 0.6 indicating a statistically significant correlation with suspended solids. By reducing suspended solids it would be expected that metals concentrations would also be reduced. The dissolved fraction for the metals showed weaker relationships with TSS but likely represents a portion of the total metals; cadmium and lead showed significant correlations, however the R^2 values are much lower than those for total metals. The other nutrients, hardness, and pesticides had no relationship with TSS concentrations.

It is evident that the concentration of diazinon has been decreasing with time. It is expected that residual supply will eventually be exhausted and detections of diazinon should continue to decrease with the EPA ban on the manufacture and retail sale of this product.

2.1.2 Chollas Creek Enhancement Grant

The Chollas Creek Water Quality Protection and Habitat Enhancement project at the Youth Park site was developed under Grant Agreement No. 04-015-559-0 for the Chollas Creek Watershed. This program intends to improve beneficial uses within the Chollas Creek Watershed through a multi-faceted approach that includes outreach, education, stewardship development, and habitat restoration. The REC-2, WARM and WILD beneficial uses will be improved by removing a portion of the concrete channel, widening, and restoring this portion of the channel to natural habitat. Native vegetation will be planted which will provide the foundation for the restoration of the aquatic and terrestrial habitats and biological resources. Channel improvements will result in reduced water velocity which will promote the settling of suspended solids. This will result in water quality improvements as contaminants often bind to suspended solids. Restoration of the creek to natural substrates increases the substrate complexity which promotes invertebrate colonization. In addition, the community will benefit from the aesthetic improvement of the channel and the educational opportunity provided by studying these improvements.

Data collected under this program includes results from two mass loading stations during monitoring activities from the 2005-2006 wet weather monitoring season. The Chollas Creek Enhancement Grant is a two year program that will be completed in January, 2007.

2.1.3 San Diego County Municipal Copermittees Dry Weather Monitoring Program Data (2003-2005 Dry Weather Monitoring Results)

Under RWQCB Order 2001-01, the Cities of San Diego, Lemon Grove, La Mesa, the San Diego Unified Port District, and the County of San Diego perform dry weather monitoring to detect and eliminate illicit discharges and illegal connections to the municipal separate storm sewer system (MS4) during the dry weather period (defined as May 1st through September 30th) each year. Data results are submitted annually in a spreadsheet format from each Copermittee for their jurisdiction to the County of San Diego.

2.1.4 Chollas and Paleta Creek Watershed Monitoring Project (CPCWMP) – San Diego Coastkeeper Progress Report (04/15/03-12/31/05)

The Chollas and Paleta Creek Watershed Monitoring Project was implemented to encourage citizen participation and provide reliable data that would support on-going TMDL efforts as well as assist in the determination of the necessary pollution prevention measures to be implemented in the Chollas and Paleta Creek watersheds. The San Diego Coastkeeper (formerly Baykeeper) worked closely with its grant partners and regional stakeholders to: conduct outreach and education and produce and distribute thousands of copies of bilingual (English and Spanish) watershed pollution prevention educational materials, trained nearly 100 volunteers, and conducted 12 monthly citizen watershed and 5 storm monitoring events. Coastkeeper also worked with its project partner Southwestern College to successfully develop local capacity to analyze water samples for the organophosphate pesticide diazinon.

Monitoring results from six locations in Chollas Creek were reported for metals, diazinon, and other constituents. However, the results were reported as averages and did not provide hardness results for comparison to the California Toxics Rule standards.

2.1.5 File Review of the RWQCB Active Industrial Storm Water Permittees (Chollas Creek Watershed) Analytical Reports

A file review was performed at the San Diego Regional Water Quality Control Board for the existing permitted facilities required to submit metals data based on their SIC Code. Only nine facilities were identified as being required to submit analytical data for the Chollas Creek Watershed. The following is a list of the facilities that had data files available for review:

- Advanced Metal Forming
- Pacific Coast Recycling
- Edco Disposal Corp
- IMS Recycling Main Yard
- IMS Recycling Boston Yard
- San Diego Galvanizing
- Southern California Plating Co

Though some facilities reported results for some metals, there was no consistency between the reported metals and hardness results were not provided in order to calculate the water quality objective. Only one of the nine facilities was located in the upper watershed and that facility did not provide results for metals.

2.1.6 Historical Data Summary

Historical mean wet weather concentrations of total and dissolved copper, lead, and zinc were plotted to show the spatial variability of concentrations (Figure 2-1 through 2-6 respectively) in the Chollas Creek watershed With respect to the potential metals point sources from the BLTEA inventory. It is evident that there are very limited wet weather data points in the upper portions of the watershed or in a number of subwatersheds. Several subwatersheds with multiple potential metals sources from the BLTEA inventory have no metals results. This does not allow for the determination of whether there is a need for BMP implementation or what BMPs may work for these subwatersheds. The figures show only the resulting metal concentrations and were not compared to the WQO due to varying or missing hardness results. In comparison to where the predicted loadings are occurring in the Chollas Creek Metals TMDL model, discussed later in this section, it is evident that additional monitoring needs to occur in the upper watersheds in both the north fork and the northern branch of the south fork of Chollas Creek. Although the metals TMDL is based on the dissolved fraction, targeting total fractions is useful in identifying elevated potential point sources and identifying data gaps. Dissolved metals data were also illustrated though the data is primarily limited to the lower watershed sections and industrial facilities did not provide dissolved metals results.

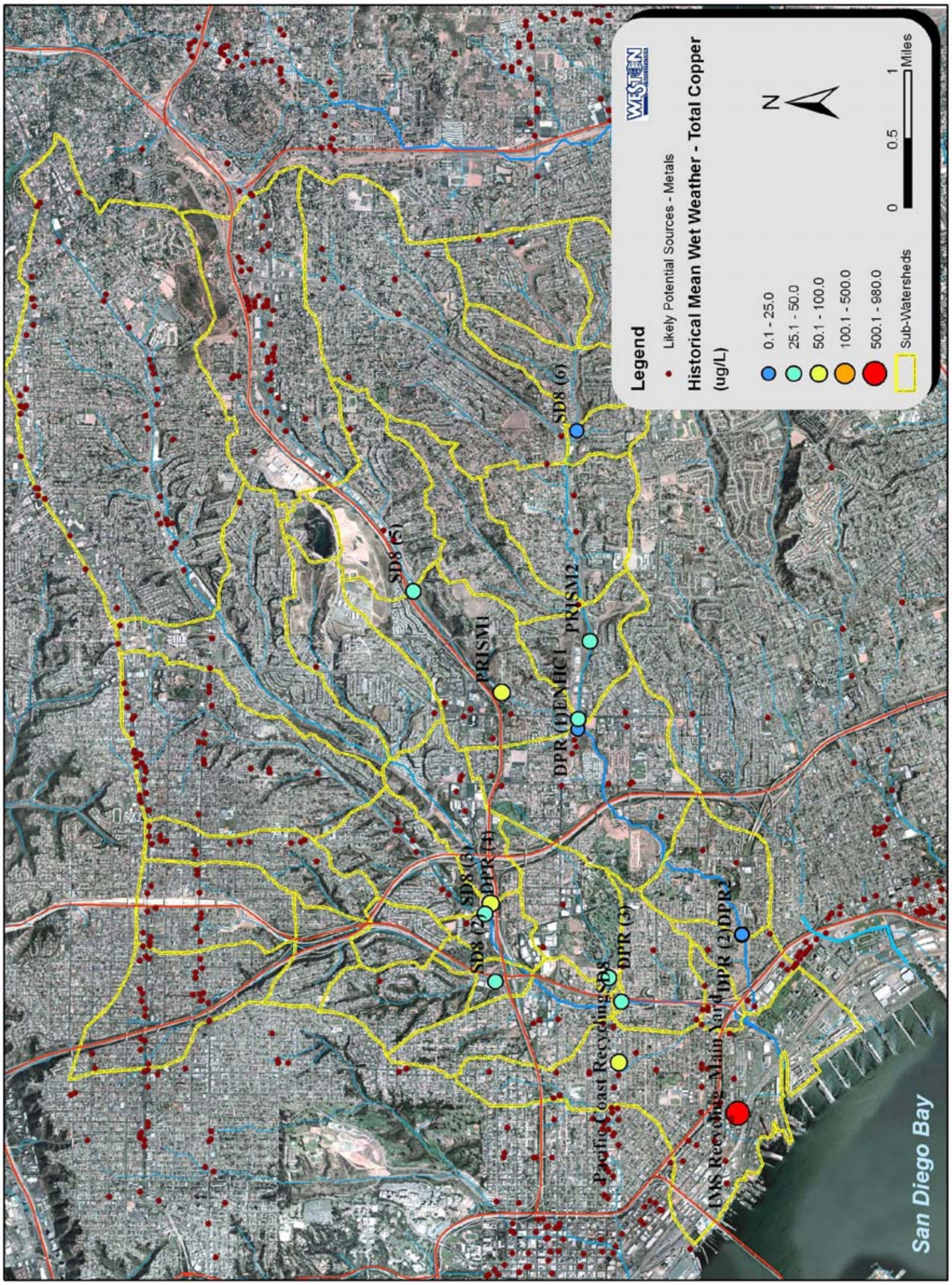

Figure 2-1. Historical (1994-2005) Mean Wet Weather Results for Total Copper in Chollas Creek Including Potential Metals Source Locations from BLTEA

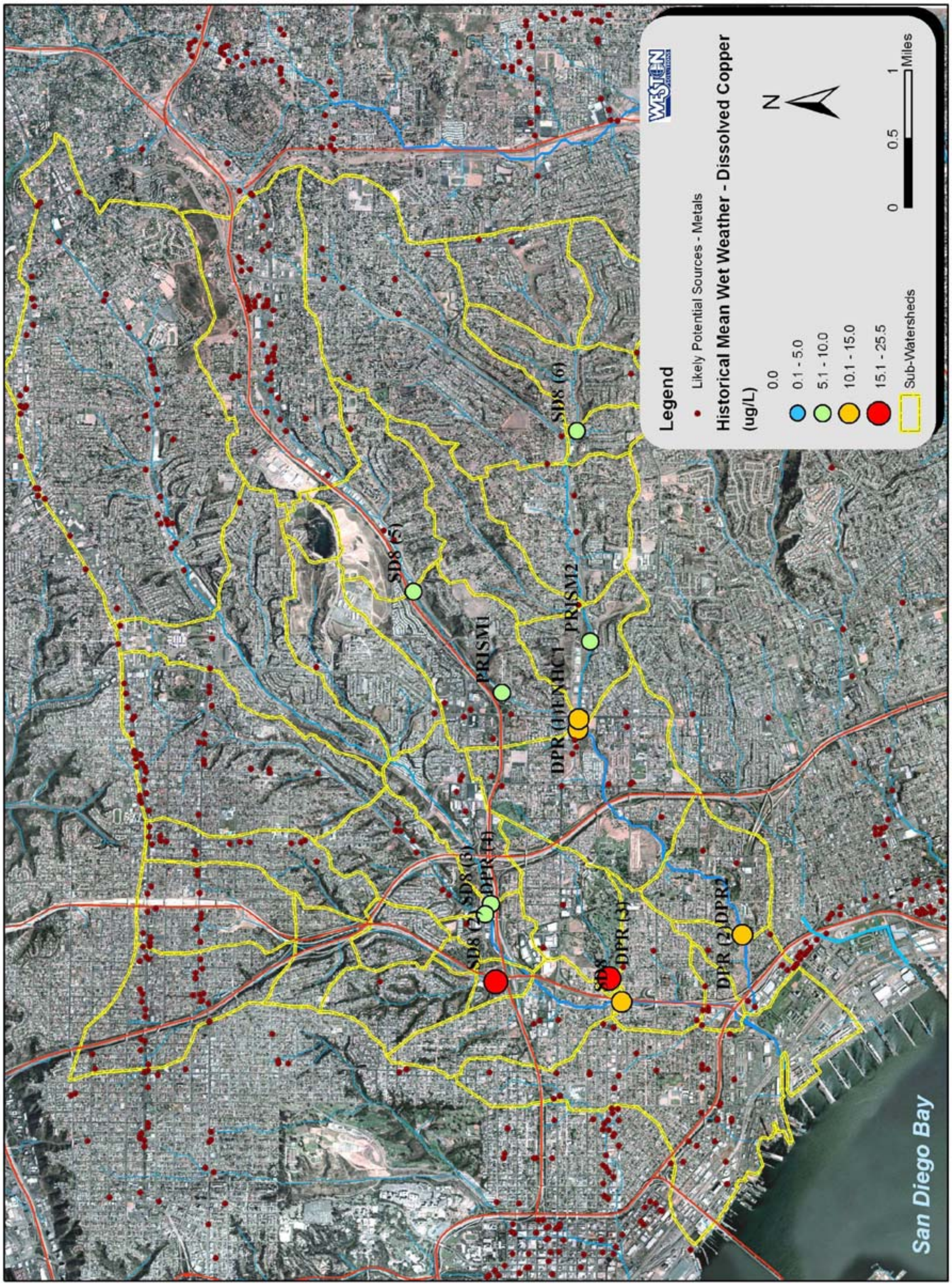

Figure 2-2. Historical (1994-2005) Mean Wet Weather Results for Dissolved Copper in Chollas Creek Including Potential Metals Source Locations from BLTEA

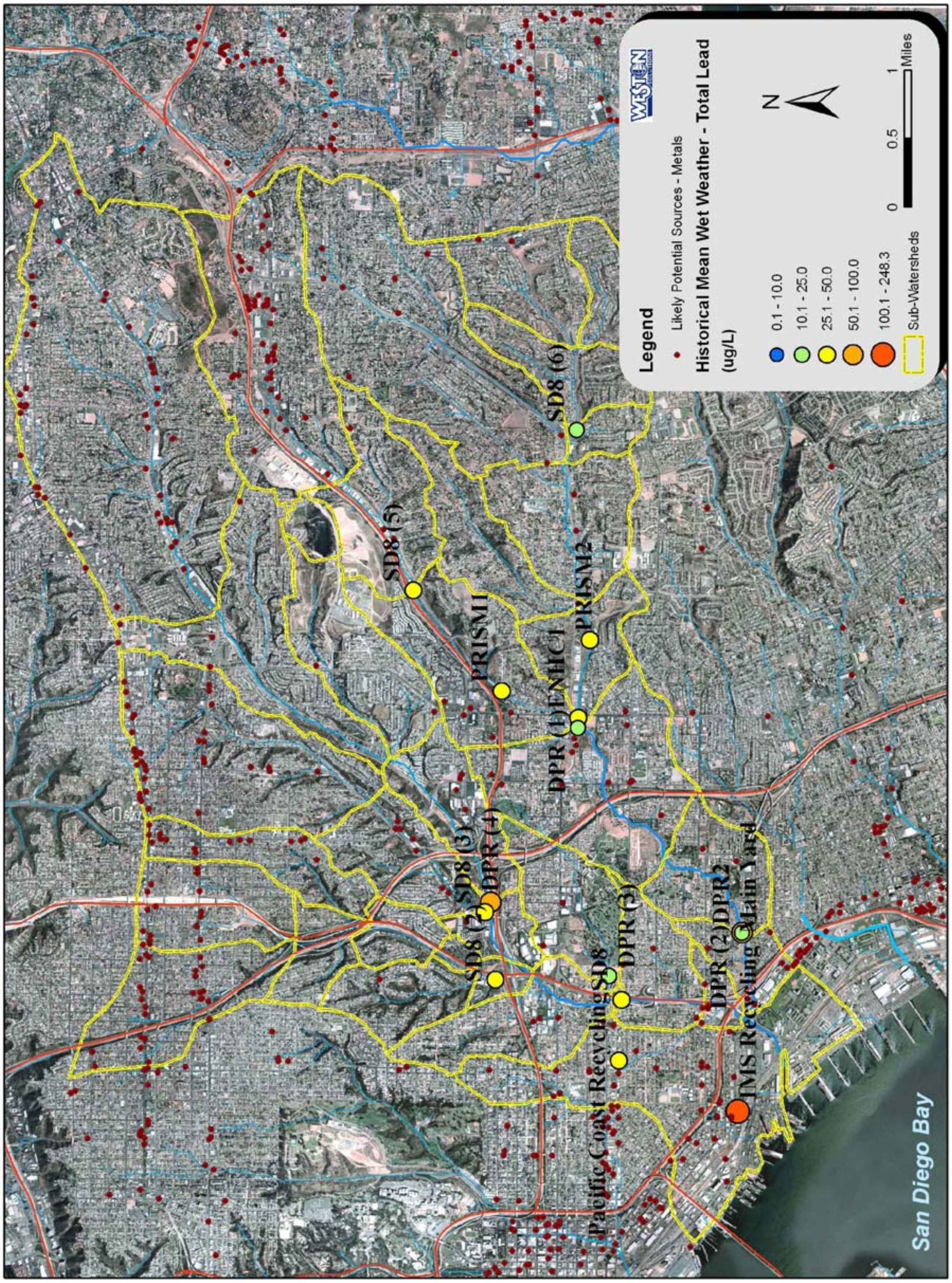

Figure 2-3. Historical (1994-2005) Mean Wet Weather Results for Total Lead in Chollas Creek Including Potential Metals Source Locations from BLTEA

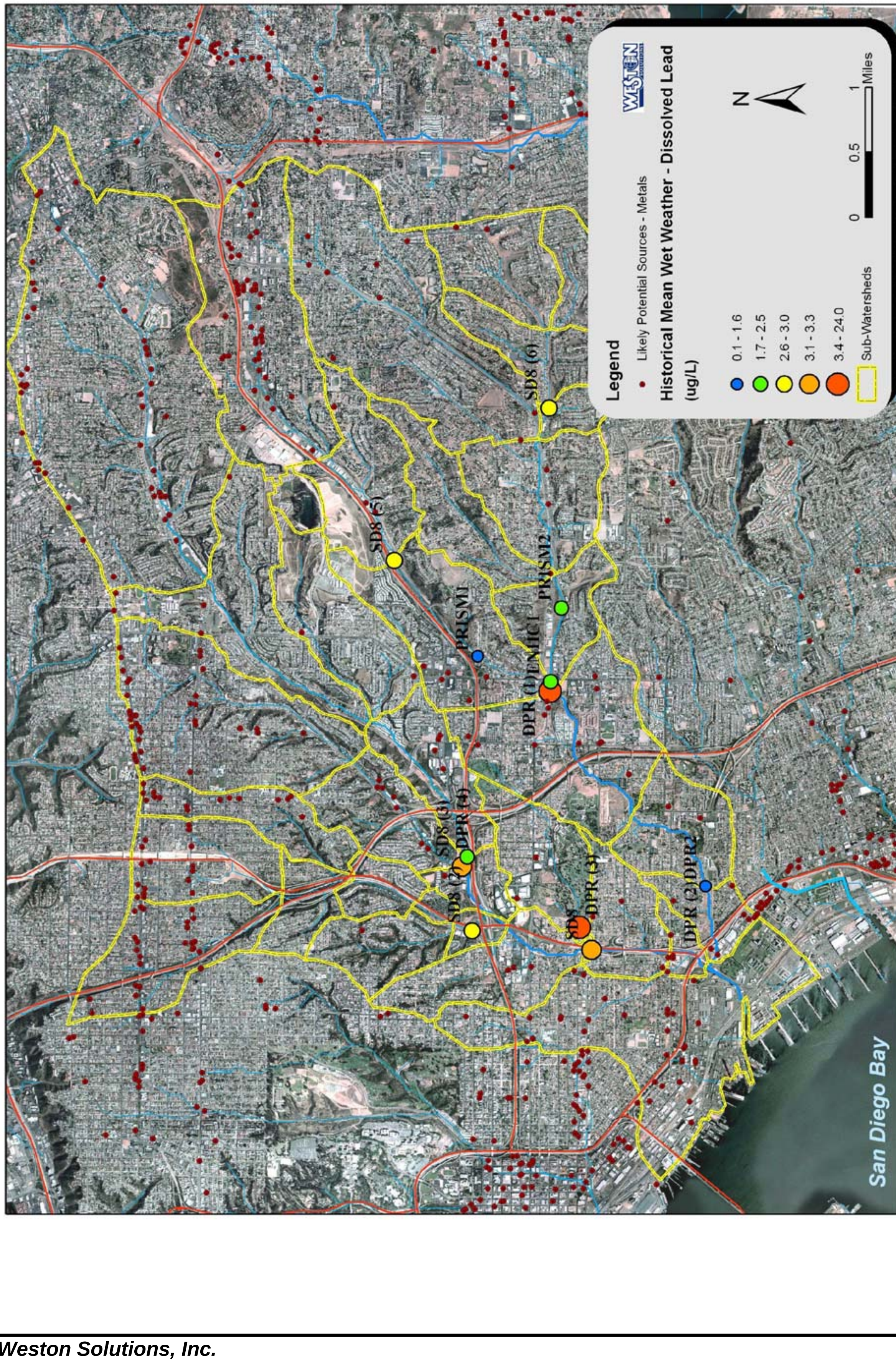

Figure 2-4. Historical (1994-2005) Mean Wet Weather Results for Dissolved Lead in Chollas Creek Including Potential Metals Source Locations from BLTEA

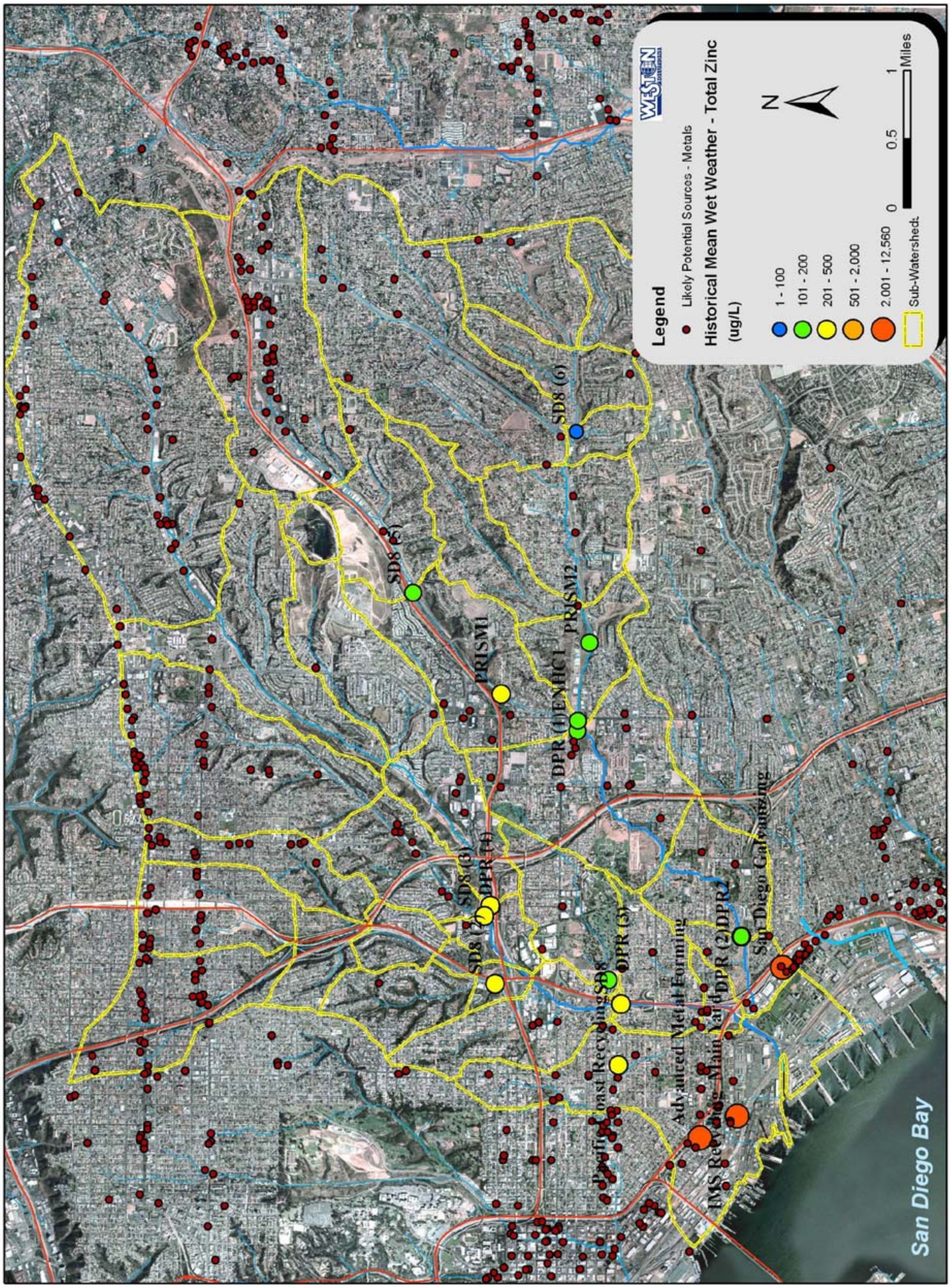

Figure 2-5. Historical (1994-2005) Mean Wet Weather Results for Total Zinc in Chollas Creek Including Potential Metals Source Locations from BLTEA

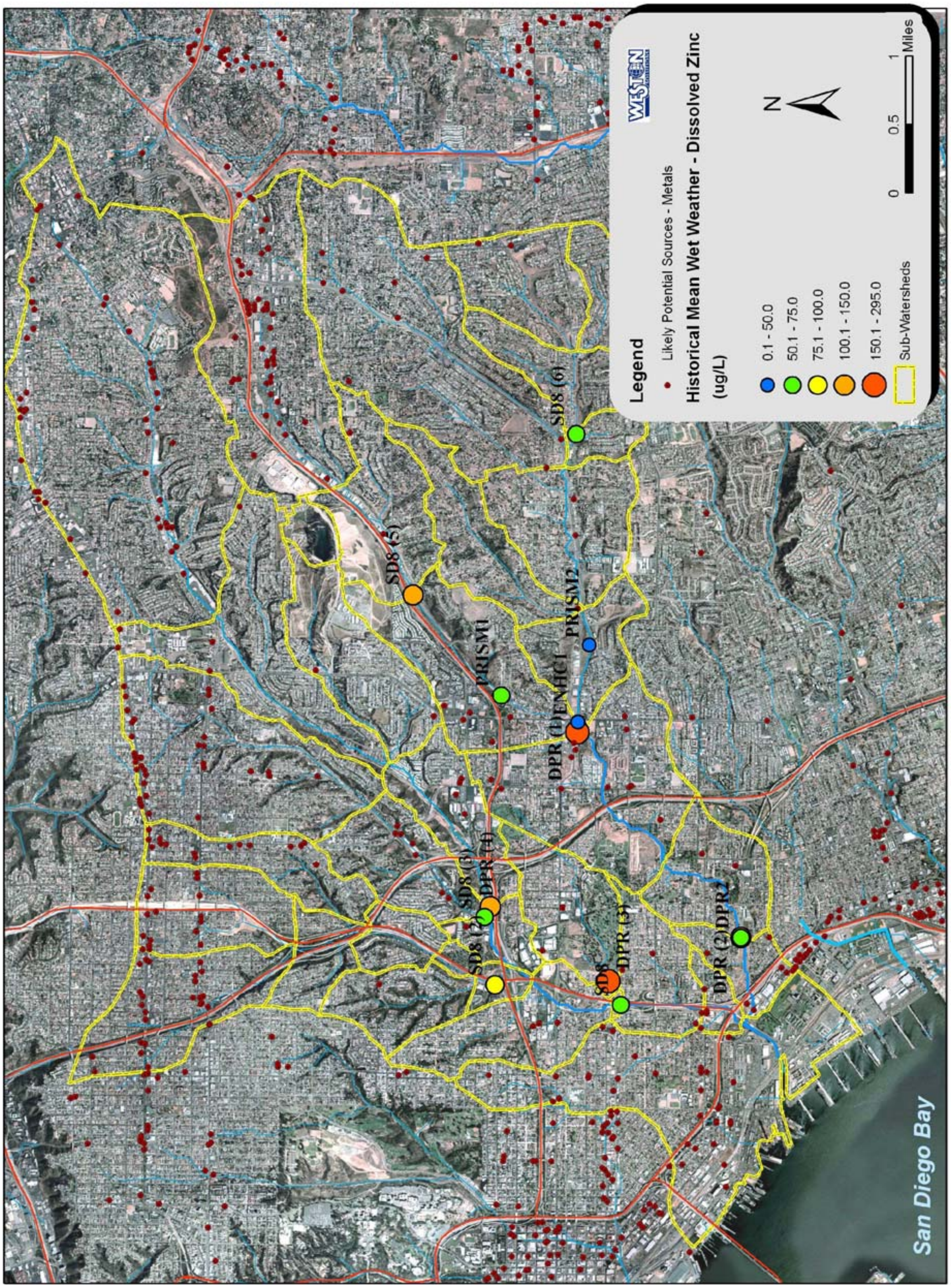

Figure 2-6. Historical (1994-2005) Mean Wet Weather Results for Dissolved Zinc in Chollas Creek Including Potential Metals Source Locations from BLTEA

The dissolved metals TMDL WQO is based on the California Toxics Rule (CTR) but adds an additional 10% margin of safety. The WQO is based on the hardness concentration of each sample. Lower hardness concentrations result in lower WQOs. Shown in Table 2-2 below are the CTR water quality objectives for both total and dissolved metals based on the Chollas Creek watershed wide historical mean wet and dry weather hardness results. The Chollas Creek watershed wide historical mean wet weather concentration was 96 mg $CaCO_3$/l. In contrast, the Chollas Creek watershed wide historical mean dry weather concentration was 599 mg $CaCO_3$/L.

Table 2-2. California Toxics Rule Water Quality Objectives for Copper, Lead, and Zinc Based on Chollas Creek Basin Wide Historical (1994-2005) Mean Wet and Dry Weather Monitoring Results

Analyte	WQO Based on Average Wet Weather Hardness of 96 mg $CaCO_3$/L	*WQO Based on Average Dry Weather Hardness of 400 mg $CaCO_3$/L
Total Copper	9.0	30.5
Dissolved Copper	8.7	29.3
Total Lead	3.0	18.6
Dissolved Lead	2.4	11.0
Total Zinc	116	388
Dissolved Zinc	113	379
*For comparison of the California Toxics Rule, a maximum hardness value of 400 mg $CaCO_3$/L is to be used		

The historical WQO exceedances for dissolved copper, lead, and zinc at the north fork mass loading station site SD8(1) were evaluated to determine the percent reductions needed to be compliant with the TMDL for dissolved metals in Chollas Creek. In order to be compliant with the TMDL, the WLA of 90% of the CTR for each metal was evaluated. Shown below in Table 2-3 are the maximum, minimum, and average percent reduction needed to meet the WLA of 90% of the CTR. When a 50% reduction is applied to the high and low historical concentrations of dissolved zinc, the concentration is below the TMDL WLA requirements. However, based on historic concentrations at the mass loading station, the reductions required to meet the TMDL WLA in any storm event ranged from 3% to 87% for dissolved copper and 14% to 92% for dissolved lead. These requirements are driven by both concentration and hardness of the waters sampled. The reductions needed to meet the TMDL WLA at the mass loading station may not be representative of the reductions needed to be compliant on the subwatershed level. Reductions needed at the subwatersheds will vary based on land use and relative loadings.

Table 2-3. Percent Reductions Needed at Chollas Creek North Fork MLS (SD8(1)) for all Exceedances To Meet the TMDL WLA of 90%

Dissolved Metal	Max	Min	Average
Copper	87%	3%	48%
Lead	92%	14%	60%
Zinc	49%	2%	26%

Chollas Creek has a significant amount of impervious surface coverage and concrete channels, and as a result, the hardness concentrations during storm events have been observed to be lower in comparison to other watersheds with less impervious area and natural creek bottoms. For the first storm events of the year, higher hardness concentrations are observed. The second storm events of the year and those that follow typically have lower hardness concentrations, and hence, lower WQOs. The historical mean wet weather hardness results for Chollas Creek are illustrated in Figure 2-7. It is apparent that the hardness concentrations are lower in the north fork of Chollas Creek than in the south fork of Chollas Creek. Also shown in Figure 2-7 are the lack of hardness results necessary to determine the WQO in several of the subwatersheds. The dry weather results for metals (while not illustrated) tend to have fewer WQO exceedances since hardness concentrations are typically much higher during the dry weather monitoring periods (summer and fall).

Historical bacteria monitoring data that is available for wet weather events was limited to the north fork SD8(1) site. The wet weather bacteria parameters are not illustrated since only this one monitoring station has bacteria results. Also, this site has consistently exceeded the Basin Plan WQO for non-contact recreation (REC-2) of 4000 MPN/100ml for fecal coliform during wet weather events (based on 10% of any samples collected during any 30-day period). Chollas Creek is listed in the Basin Plan as potential for contact recreation (REC-1) but since it is not designated as REC-1 it is compared only to the REC-2 water quality objective. Due to limited wet weather monitoring data as mentioned above, only results from the dry weather monitoring events were plotted to show the spatial variability of concentrations for total coliform, fecal coliform, and enterococcus (Figure 2-8, Figure 2-9, and Figure 2-10 respectively). The dry weather action level for total coliform is 50,000 MPN/100 ml, the fecal coliform is 20,000 MPN/100ml, and enterococcus is 10,000 MPN/100 ml (Dry Weather Monitoring Workgroup, 2005). It is evident that levels above the dry weather action levels for total coliform, fecal coliform and enterococcus occur throughout the watershed, but that some areas indicate more consistently higher bacteria levels. These areas appear to be located in the upper reaches of both the north and south forks of Chollas Creek.

Pesticide analysis has been primarily focused on the organophosphate class of pesticides and primarily on diazinon and chlorpyrifos. The historical mean diazinon concentrations and potential pesticide sources are shown in Figure 2-11. Higher mean concentrations of diazinon are apparent in the south fork of Chollas Creek as compared to the north fork. Diazinon concentrations have significantly decreased at the mass loading station site in the north fork of Chollas Creek and have not been detected above the WQO over the past two wet weather monitoring seasons. Dry weather monitoring results have indicated that diazinon and chlorpyrifos are typically detected below the dry weather action level and do not frequently require follow up investigations. Though the concentrations and use of organophosphate pesticides is decreasing, the increase in use of new synthetic pyrethroids should be expected as indicated in public surveys conducted through the Chollas Creek PRISM Grant.

Statistical trends were evaluated under the San Diego County Copermittee Wet Weather Monitoring Program at the Chollas Creek SD8(1) site in the north fork. Statistically significant increasing trends are evident for turbidity (R^2=0.12). Statistically significant decreasing trends are evident for total lead (R^2=0.14).

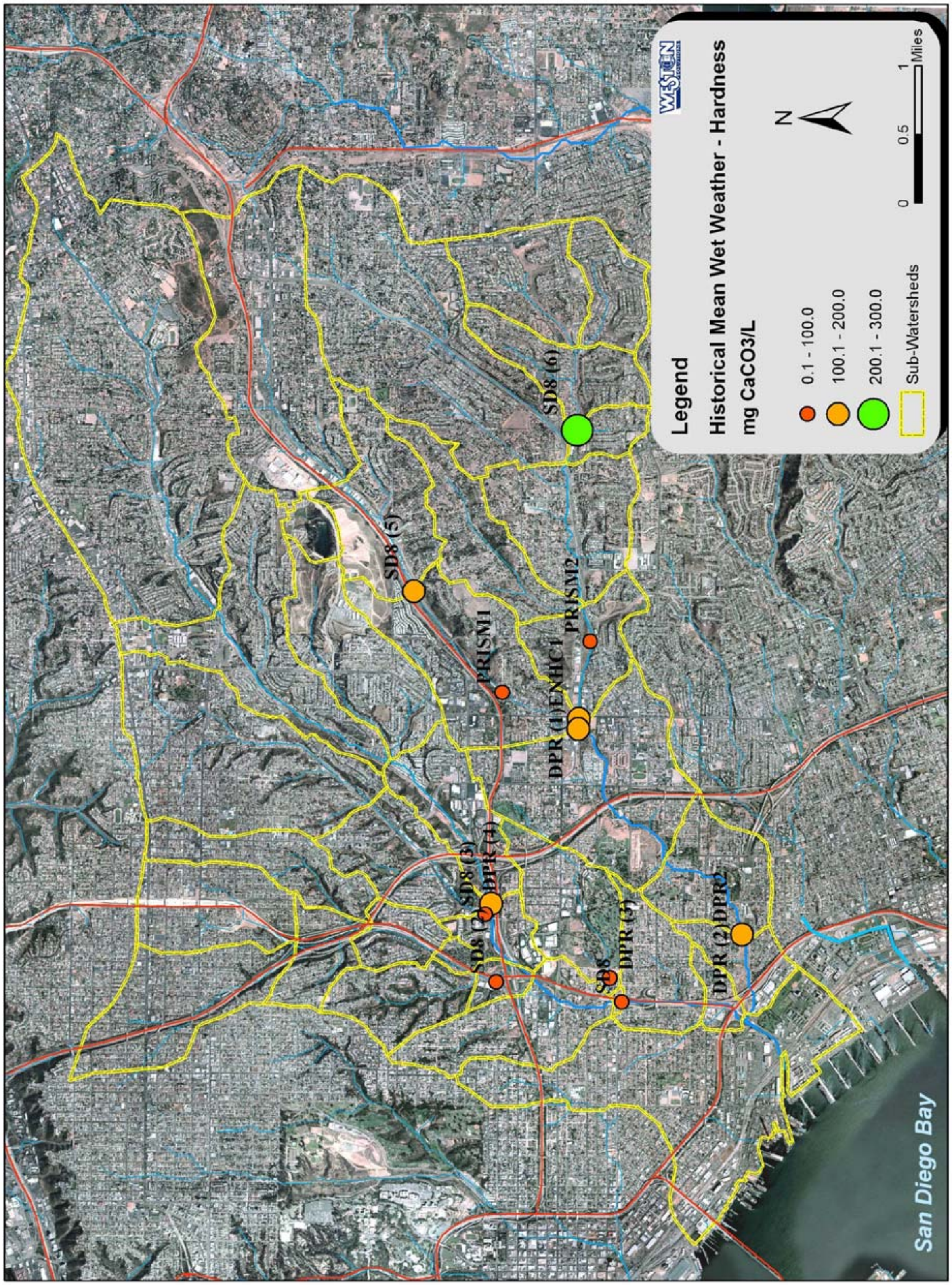

Figure 2-7. Historical (1994-2005) Mean Wet Weather Results Total Hardness in Chollas Creek. Lower Hardness Results in Lower Metals Water Quality Objective

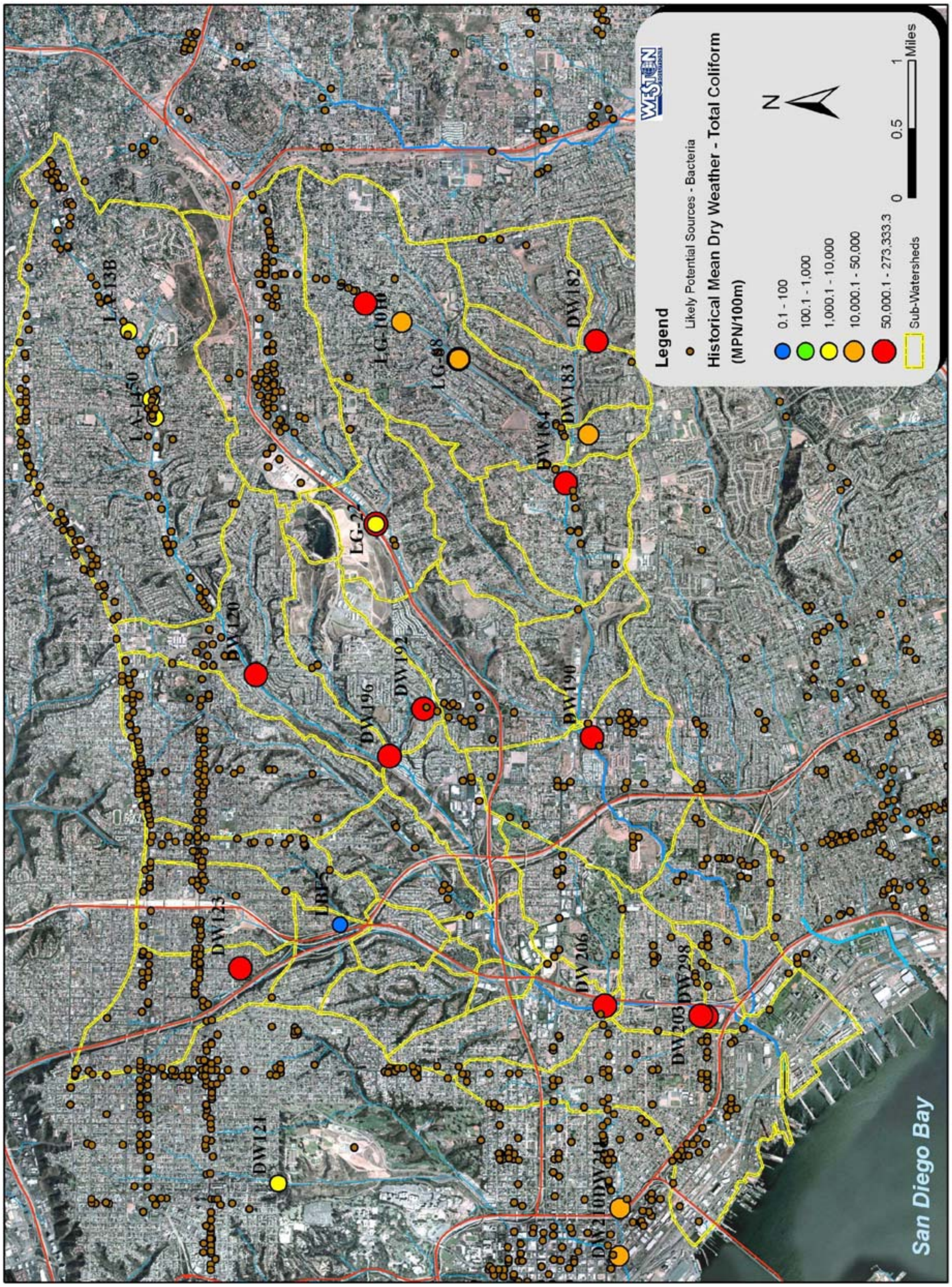

Figure 2-8. Historical (2002-2005) Mean Dry Weather Results for Total Coliform in Chollas Creek Including Potential Bacteria Source Locations from BLTEA

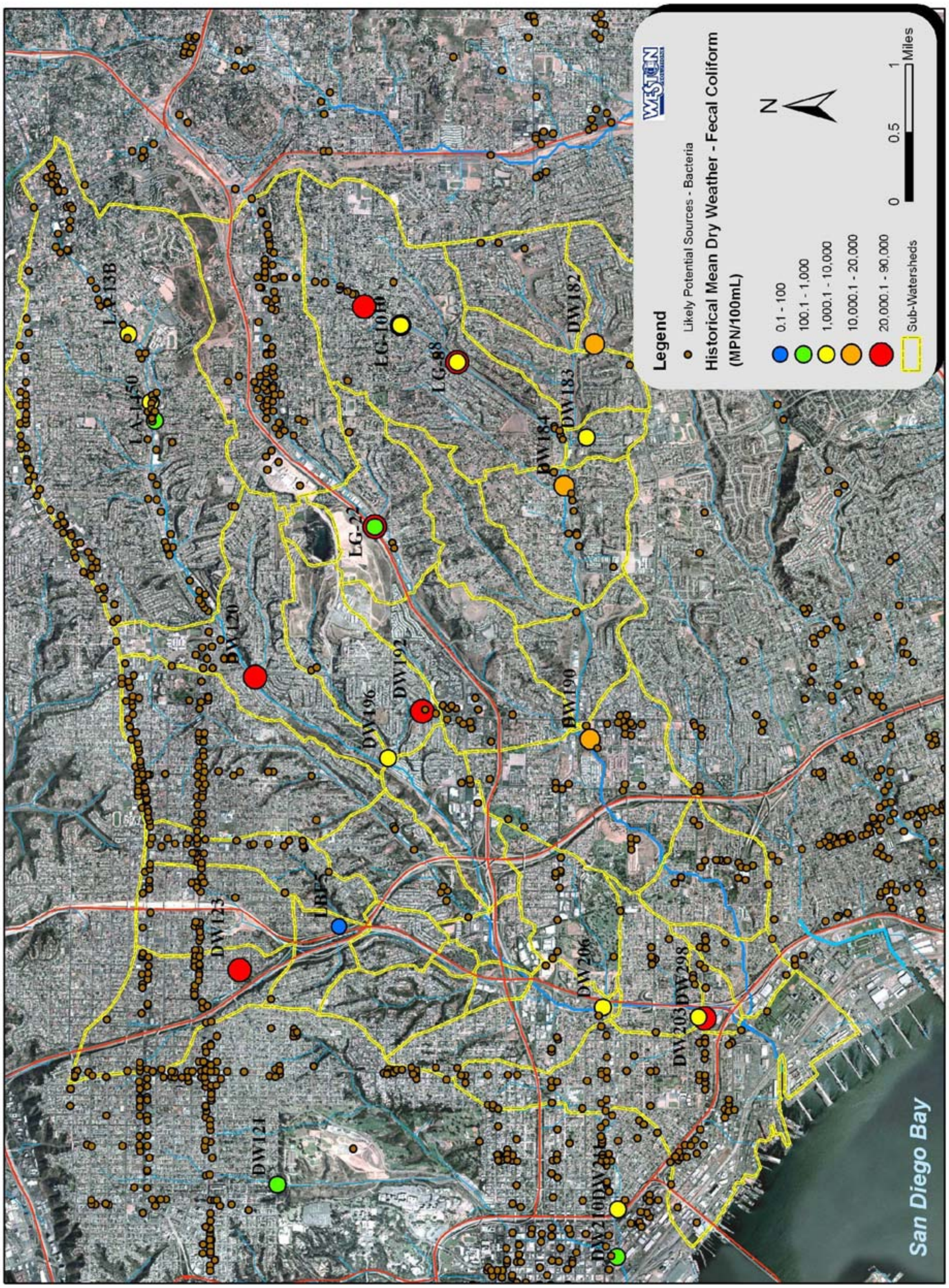

Figure 2-9. Historical (2002-2005) Mean Dry Weather Results for Fecal Coliform in Chollas Creek Including Potential Bacteria Source Locations from BLTEA

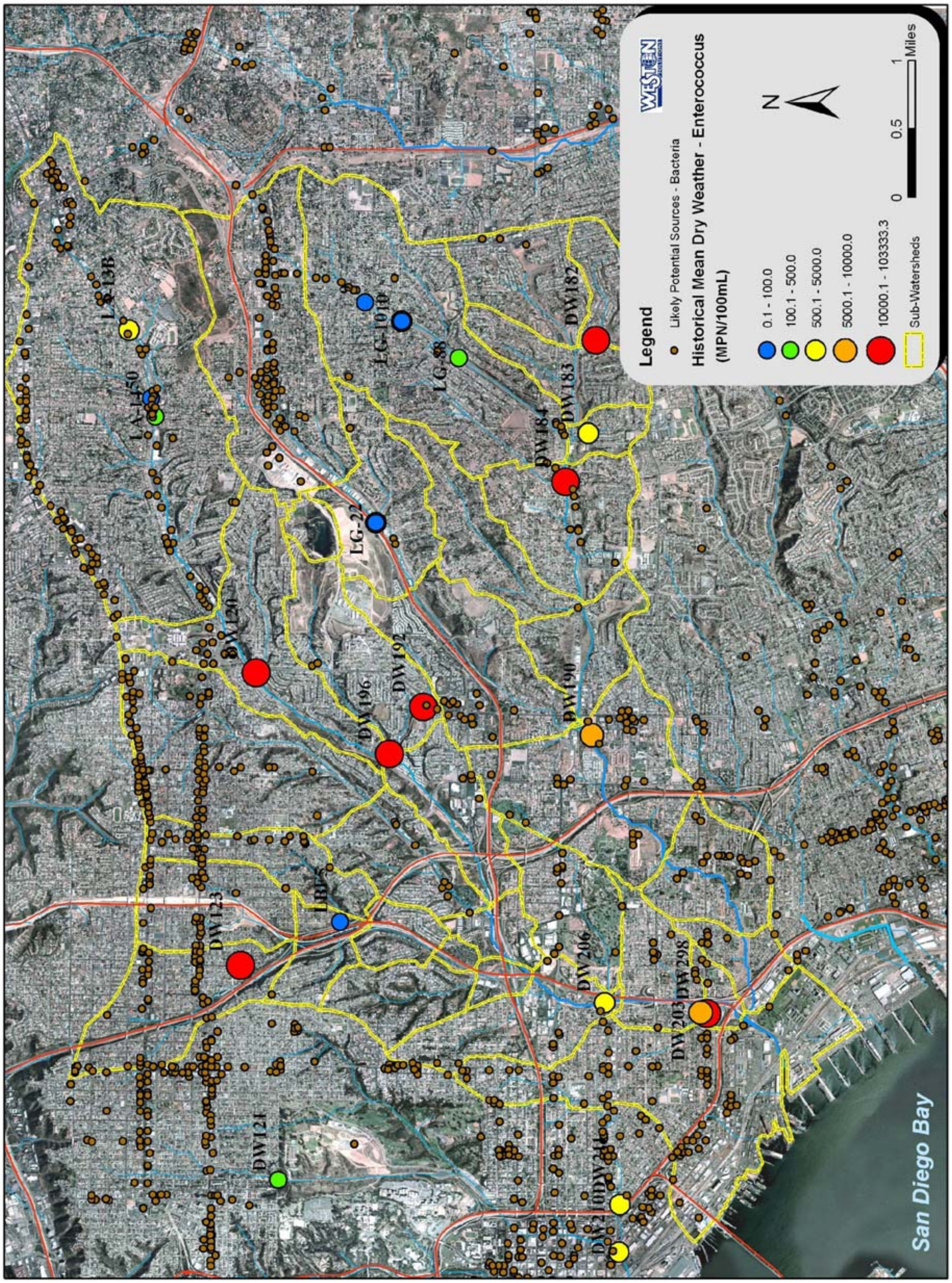

Figure 2-10. Historical (2002-2005) Mean Dry Weather Results for Enterococcus in Chollas Creek Including Potential Bacteria Source Locations from BLTEA

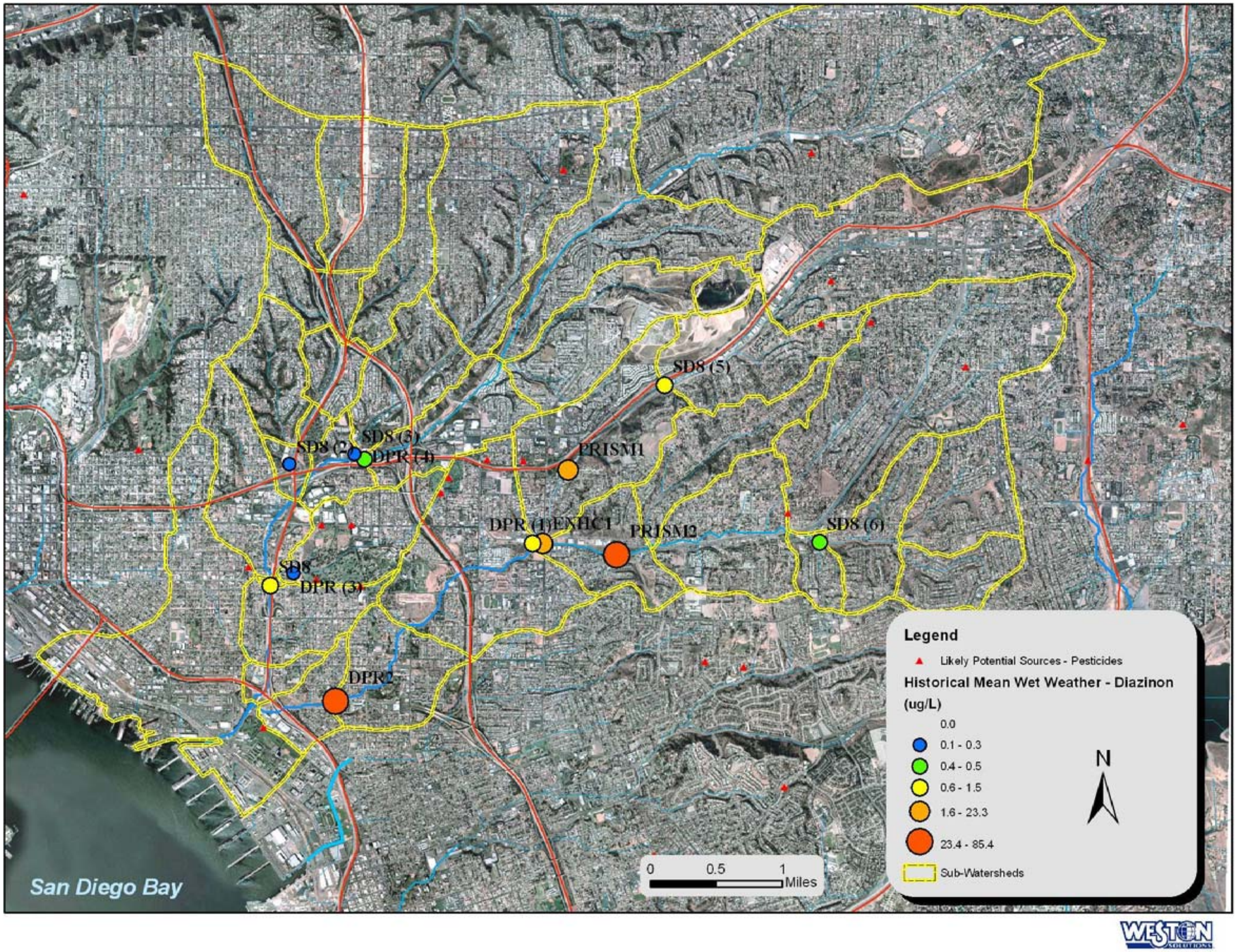

Figure 2-11. Historical (2002-2005) Mean Wet Weather Results Diazinon in Chollas Creek Including Potential Pesticide Source Locations from BLTEA

2.1.7 Baseline Long-Term Effectiveness Report (BLTEA) (Weston Solutions, Inc., Mikhail Ogawa Engineering, Inc., and Larry Walker & Associates, Inc. 2005)

The San Diego Municipal Storm Water Permit NPDES Order No. 2001-01 (Permit) requires that the Copermittees develop and implement a broad array of Jurisdictional Urban Runoff Management Program (JURMP) activities, and that the long-term effectiveness of implementing these program activities be periodically assessed. In October 2003, the Copermittees published a collaboration of efforts developed to address long-term effectiveness assessment strategies entitled, "A Framework for Assessing the Effectiveness of Jurisdictional Urban Runoff Management Programs." The document describes an iterative process of effectiveness assessment involving program planning, program implementation and effectiveness assessment. Through the review of existing water quality data (receiving water and other available data), source profiling and prioritization, and developing load reduction estimates based on program implementation, this document continues the Copermittees development of a long-term strategy for assessing the effectiveness of the JURMPs as described in the Permit.

The current water quality and source data that have been collected by the Copermittees provide a strong basis for the development and establishment of the Long-Term Effectiveness Process. From this solid foundation, the framework developed by the Copermittees in October 2003 is further developed and enhanced in the document to allow for this process to move forward. The report also establishes a prioritization of program efforts through the integration of water quality data to the loading potential of sources on a watershed basis. Recommendations are presented in the report on steps moving forward in the iterative process for program assessment.

The assessment process established in the report that lead to the integrated assessment includes several key steps. This process is outlined in Figure 2-12.

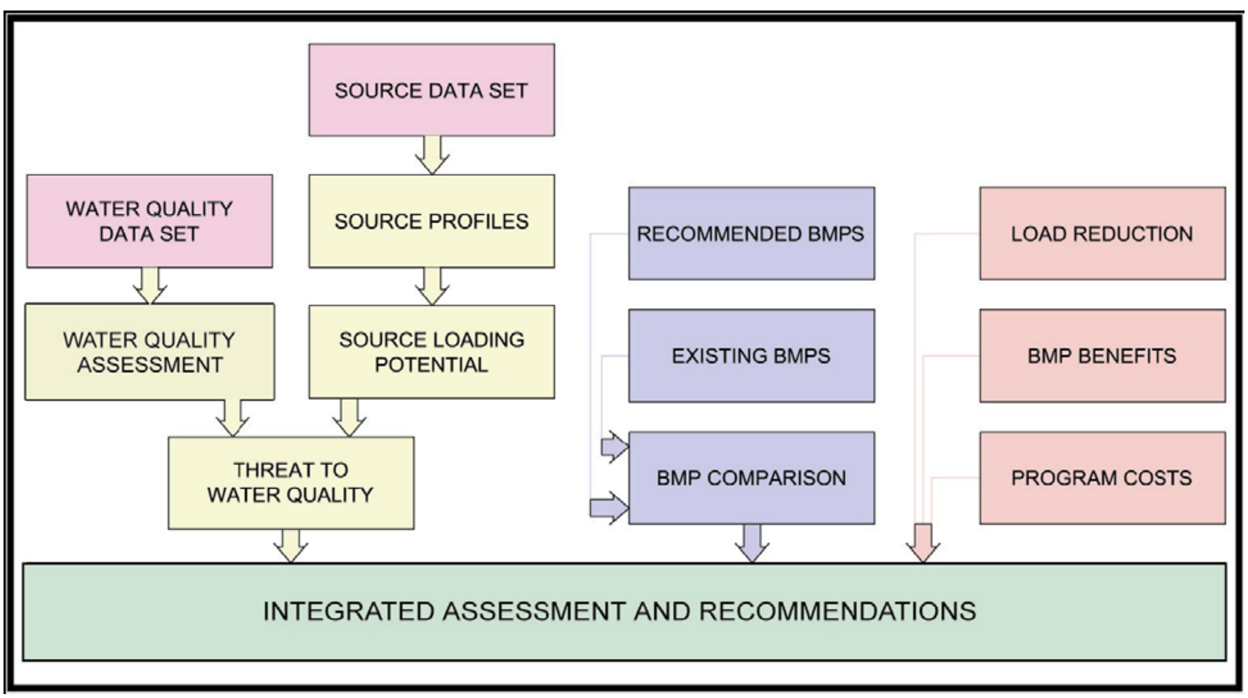

Figure 2-12. Long-Term Effectiveness Process

For the purposes of Chollas Creek TMDL Assessment, the BLTEA report was utilized to focus primarily on the source inventory data set and source profiles in order to develop strategies for BMP implementation and development of monitoring locations. Primarily, the source data set was used to identify locations and potential pollution sources by subwatershed in Chollas Creek and is described further in Section 2.3.

Based on the review of the available data it is evident that more focused sampling needs to occur to better assess the spatial variability of loading throughout the watershed to verify the model predictions. This is needed to help the City in identifying potential point sources and to better refine the potential locations for targeting non structural BMPs and the placement of structural BMPs.

2.2 Chollas Creek Subwatershed Metals Loading Profiles

In the development of the metals TMDLs, the Chollas Creek watershed was divided into subwatersheds as shown on Figure 2-13.

The loadings from each of these subwatersheds were estimated using land use and parameter values calibrated for the watershed model used in the TMDL. Loadings were presented as relative annual loadings (relative to each other) and also normalized loadings per acre for each parameter (Figure 2-14 through Figure 2-19). Each subwatershed was characterized as high, medium, or low.

The relative loadings for copper, lead and zinc as shown on Figure 2-14 through Figure 2-19 indicate that these loadings are not uniform throughout the watershed, and that specific subwatersheds are characterized by higher loads due to land use and modeled loadings. This subwatershed characterization can be used to prioritize the implementation of management measures for those subwatershed's that are designated with relatively high loading. Using a tiered approach to management actions, these higher rated subwatersheds could be targeted for higher tiered actions depending on the watershed characteristics, the proven effectiveness of the measures and regulatory constraints. The BMP Assessment presented in Section 5.0 presents an evaluation of current technologies and evaluates potential measures that can be implemented in an effective manner.

Figure 2-14 and Figure 2-15 present the relative annual and normalized annual loading per acre of copper in Chollas Creek. The highest loadings are indicated in several of the upper subwatersheds of the north fork and south fork, the middle of south fork and at the downstream portion of the confluence that includes the Port and other industrial operations. The relative normalized copper loadings per acre indicate a similar distribution of higher loadings, although limited to the upper most subwatersheds of tributaries of the north and south forks and the downstream drainage areas. The subwatersheds located farther up into the watershed with the higher loadings could be targeted for higher tiered BMPs, where applicable, in order to address these higher loads before the constituents are carried to the downstream sections of the receiving water. The available data as presented in the previous section also indicate higher concentrations of copper that correspond to the higher relative normalized load in the north fork. There is currently not sufficient data in the upper subwatersheds to compare with the relative loadings in these drainage areas which is addressed in the Monitoring Section (7.1.3) of this report.

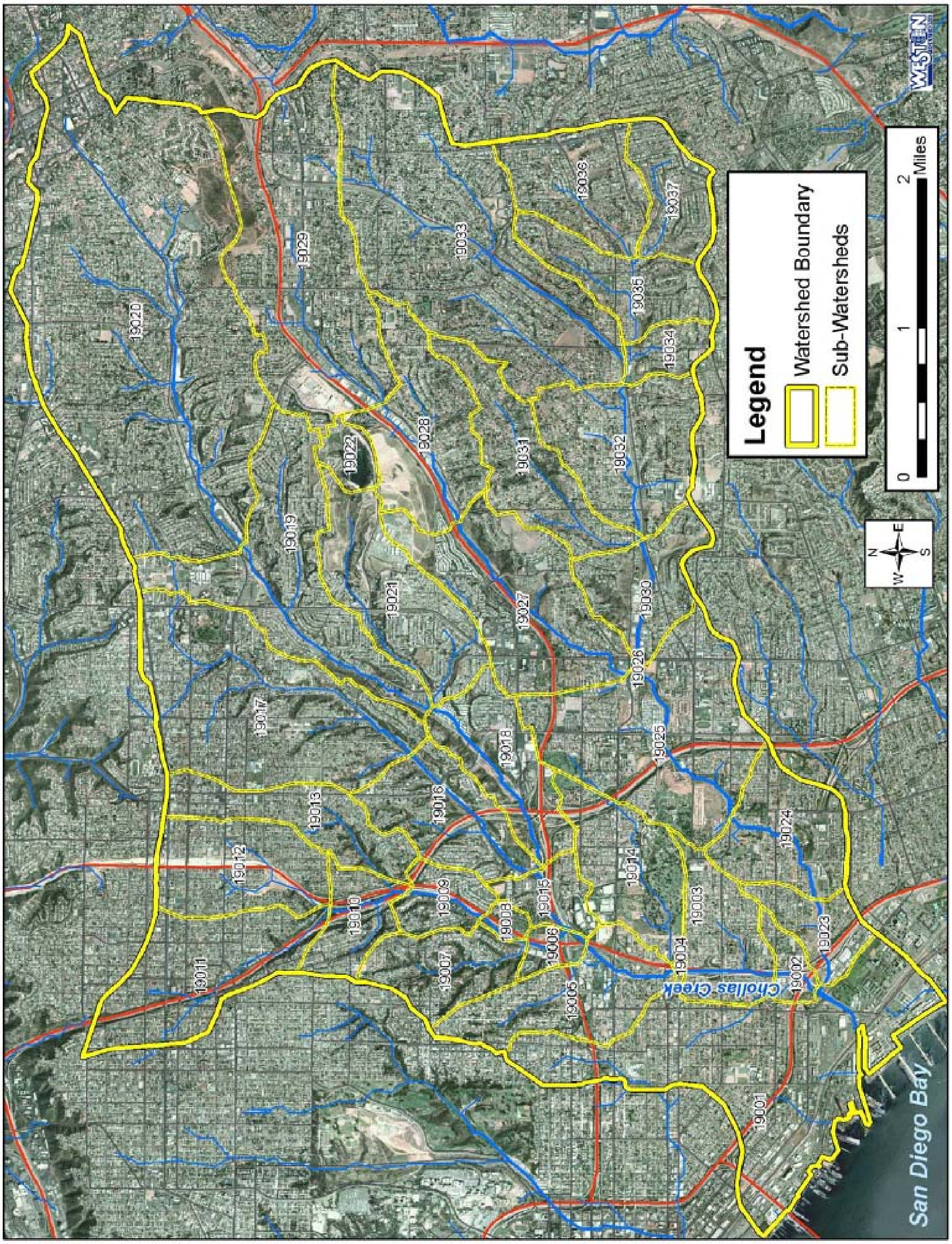

Figure 2-13. Chollas Creek Sub Watershed Boundaries

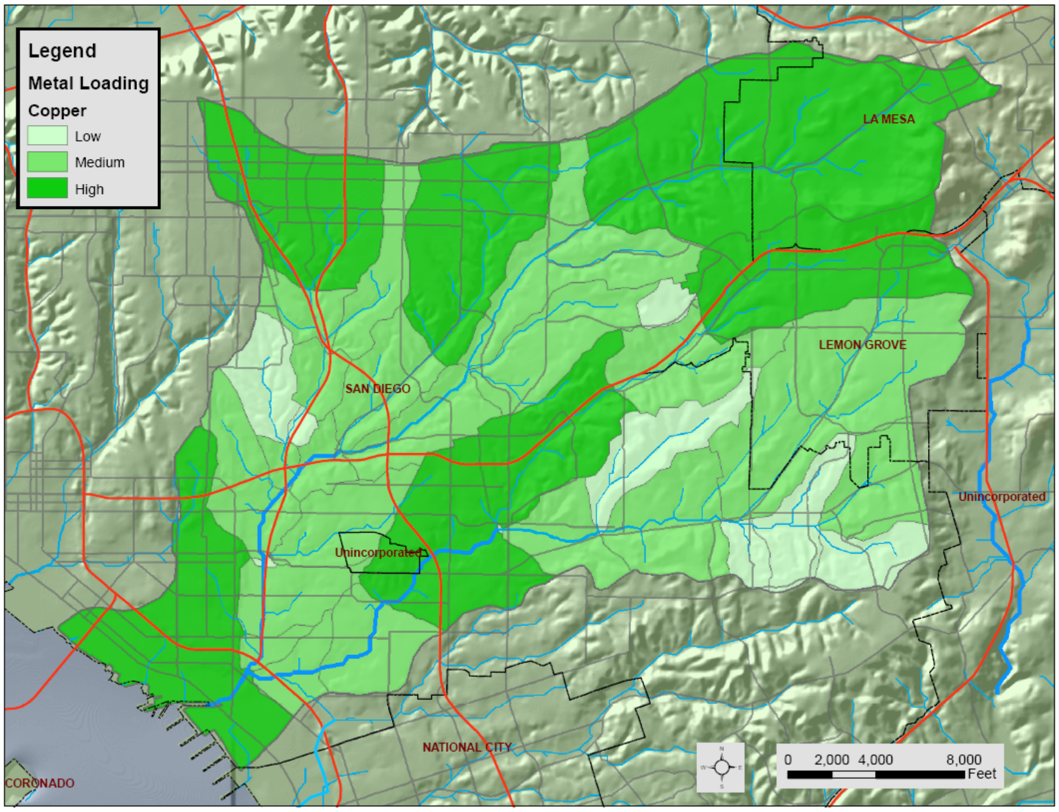

Figure 2-14. Relative Annual Copper Loadings in Chollas Creek

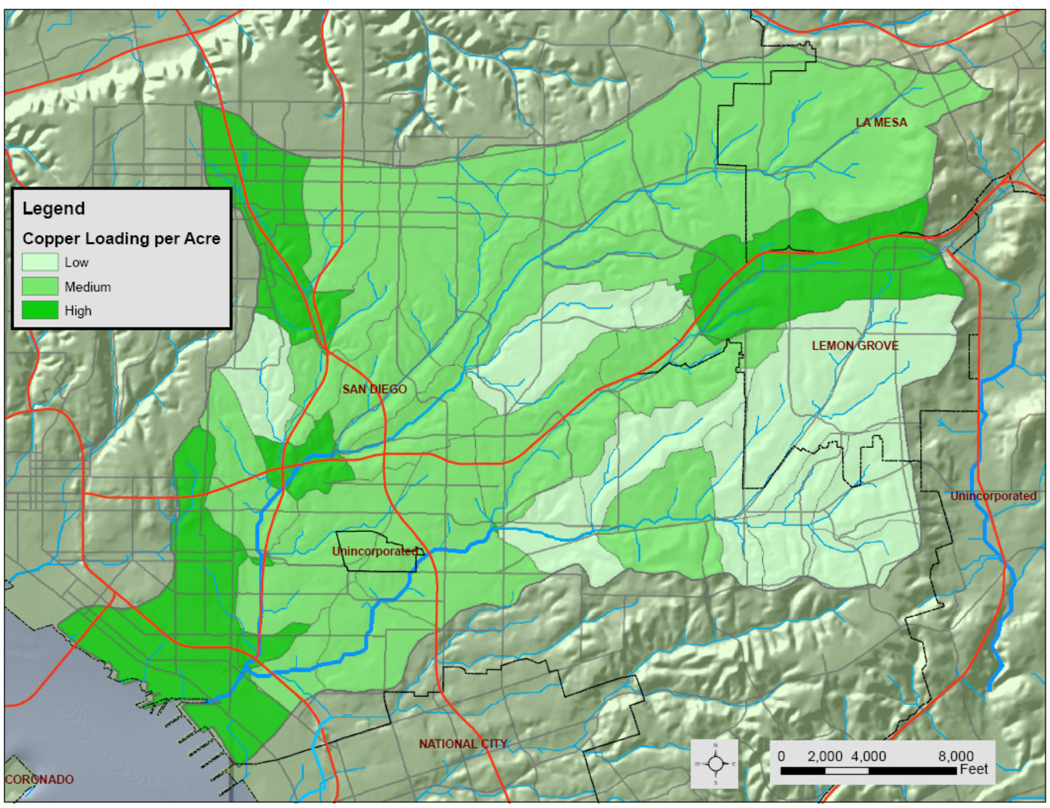

Figure 2-15. Relative Normalized Annual Copper Loading per acre in Chollas Creek Watershed

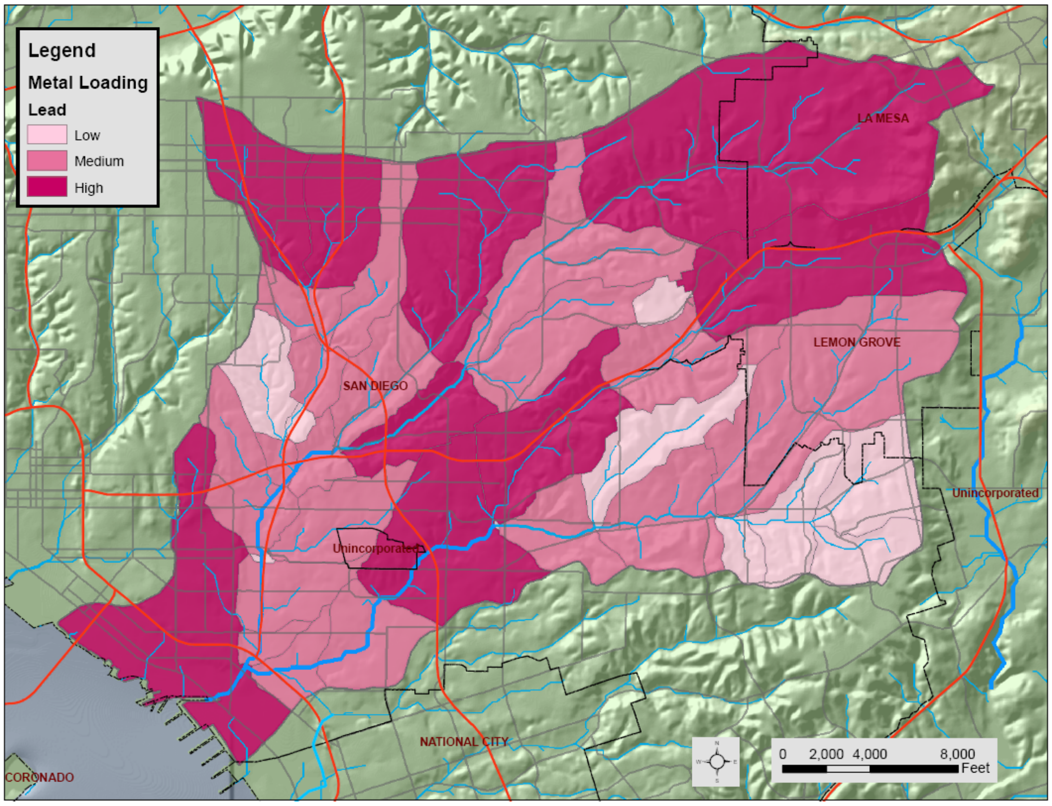

Figure 2-16. Relative Annual Lead Loadings in Chollas Creek

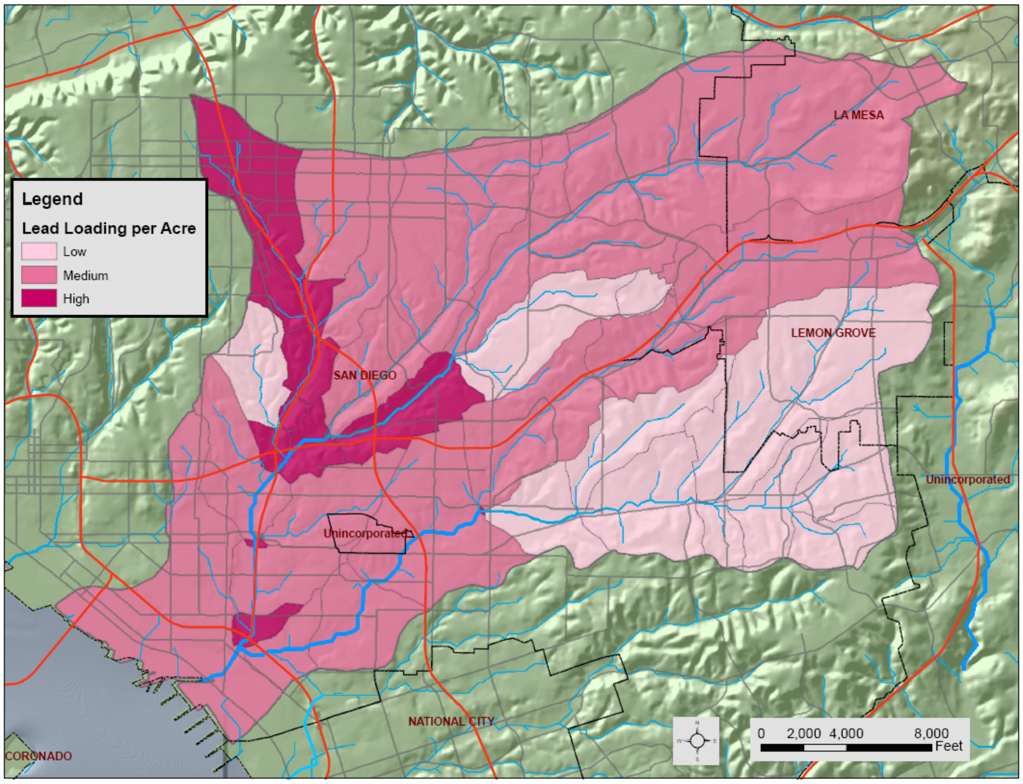

Figure 2-17. Relative Normalized Annual Lead Loading per acre in Chollas Creek Watershed

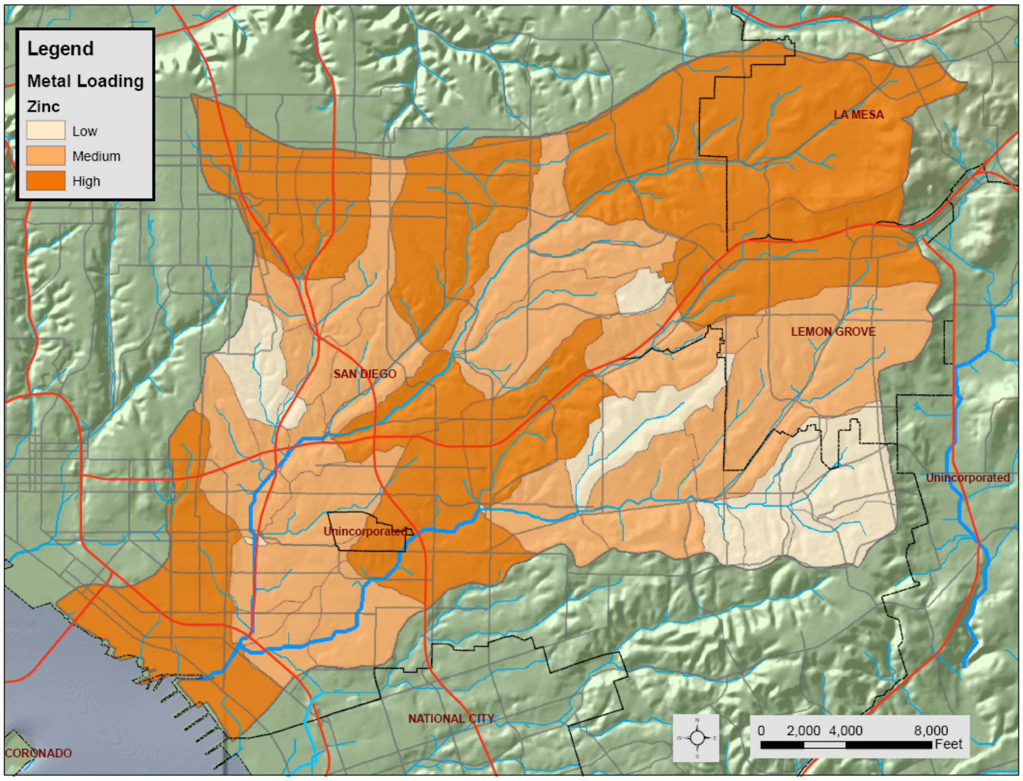

Figure 2-18. Relative Annual Zinc Loading in Chollas Creek

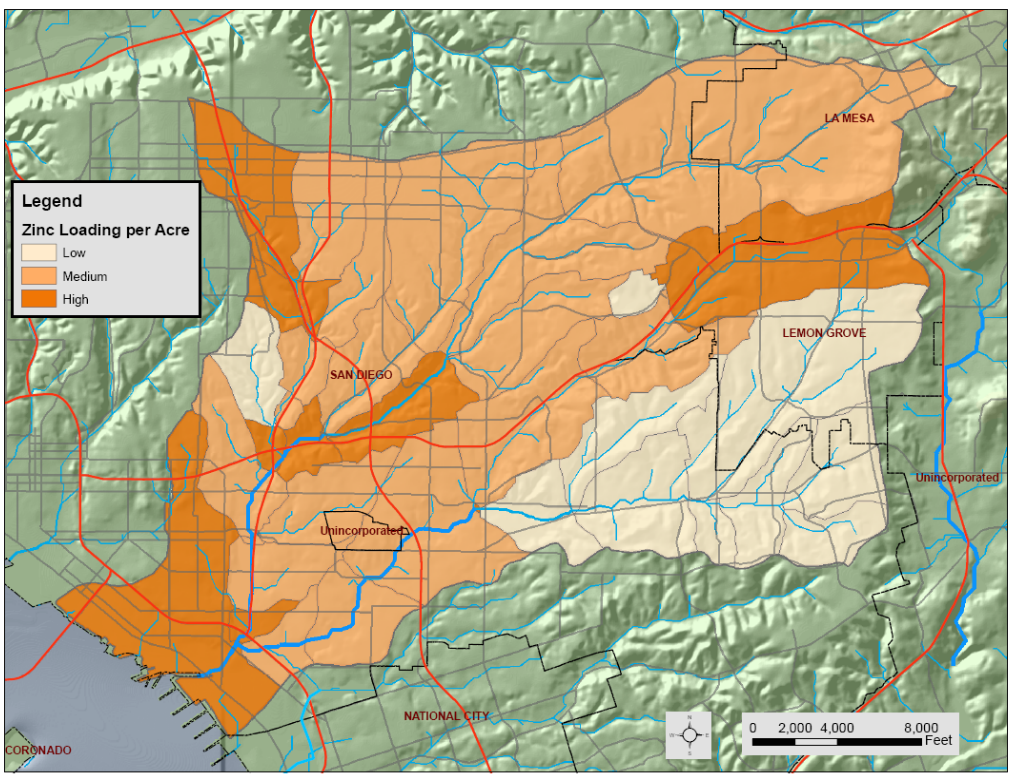

Figure 2-19. Relative Normalized Annual Zinc Loading per acre in Chollas Creek Watershed

The relative annual and normalized annual lead loading per acre presented on Figure 2-16 and Figure 2-17, respectively, indicate similar distribution of higher loading subwatersheds to those of copper. There are less high lead loading subwatersheds for the normalized annual lead loading per acre compared to copper, and these subwatersheds are concentrated on the north fork. The upper subwatershed that drains the northwest tributary of the north fork is identified as being high for both lead and copper. Data is not available in this section of the north branch to verify this characteristic. However, results from sampling in the north fork further downstream indicate higher concentrations compared to the south fork.

Similar distribution of relative and normalized annual loading for zinc compared to the lead and copper loadings are indicated in Figure 2-18 and Figure 2-19. There is a greater similarity in the normalized annual loadings per acre between the three metals than the relative annual loading. Based on the normalized per acre loading for the three metals, the upper northwestern drainage area of the north fork, the middle of the north fork and the lower portion of the watershed that includes the Port are characterized by the highest loading, and therefore should be targeted in the Implementation Plan for higher tiered BMPs to more effectively reduce the metals loading to the overall watershed. The implementation of treatment BMPs as discussed in Section 5.0 is dependent on watershed characteristics, proven effectiveness of the technology for dissolved metals and other regulatory issues (tributary rule, stream encroachment, etc.).

2.3 Source Identification

Priority sources have been identified for bacteria, trace metals and pesticides based on the loading potential of sources and the water quality priority ratings as presented in the Baseline Long-Term Effectiveness Assessment (Weston, MOE & LWA, 2005) For the San Diego Bay watershed, priority sources include: auto mechanical repair, fueling or cleaning; automobile body repair and painting; fabricated metal operations; marinas; corporate yards; motor freight; auto parking and storage, auto wholesale; boat repair; home & auto repair and auto washing; roads, street and highways; eating and drinking establishments; animal facilities; home garden care activities; nurseries; landscaping at public areas; pest control services; and, development subject to SUSMPs. The locations of potential sources that have been geo-coded in the County's database are presented in the following subsection. A more detailed list of sources for each constituent group is provided in Appendix B.

2.3.1 Metals Sources

Chollas Creek TMDL General Sources
The Chollas Creek TMDL for metals focused primarily on three general sources; background, water supply, and anthropogenic. The following data were identified in the Metals TMDL as potential sources for each category:

Background
- Runoff from Natural Open Spaces
- Sediment stored in the Stream Channel

Water Supply

- Groundwater
- Water Supply (Reservoir contributions, treatment plant contributions, and corrosion inhibitors)

Anthropogenic

- Atmospheric Deposition
- Operating and Servicing Automobiles
- Illegal Sources
- Industrial Facilities
- Pesticide Application (Both commercial and residential)
- Wood Preservatives
- Construction
- Galvanized Metals
- Paint
- Landfills

A review of the modeling efforts conducted under the Chollas Creek TMDL for metals indicated that freeways and commercial/institutional land uses account for over 75% of the predicted metals loadings.

Businesses with a potential of discharging pollutants including metals were identified within each watershed (Figure 2-20 and Figure 2-21) from efforts developed under the Baseline Long-Term Effectiveness Assessment (BLTEA) (Weston, MOE & LWA, 2005) prepared for the County of San Diego.

Baseline Long-Term Effectiveness Assessment Source Inventory

Understanding the number and location of the sources is important in the Copermittees' efforts to evaluate their programs. Numerous resources were relied upon in order to obtain as accurate an estimate as possible of the number of sources throughout San Diego County. A summary of the resources is shown below:

- Copermittees developed inventories
- County Department of Environmental Health Hazardous Material Database
- County Agriculture, Weights & Measures Database
- County Department of Environmental Health Food and House Database

A list of the BLTEA source inventory data used to generate Figure 2-21 is provided in Appendix B.

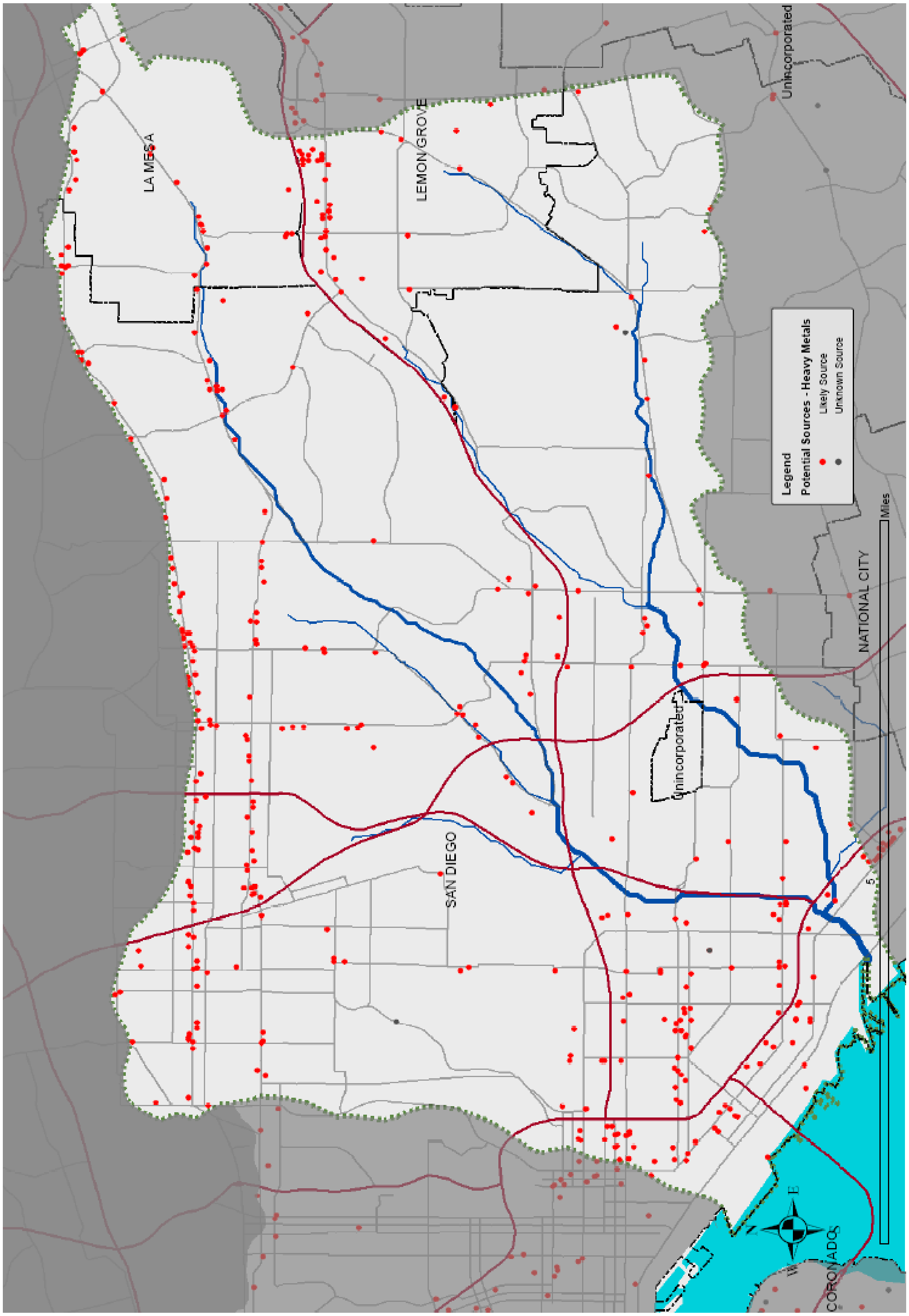

Figure 2-20. Potential Metals Source Locations in the Chollas Creek Watershed (BLTEA 2005)

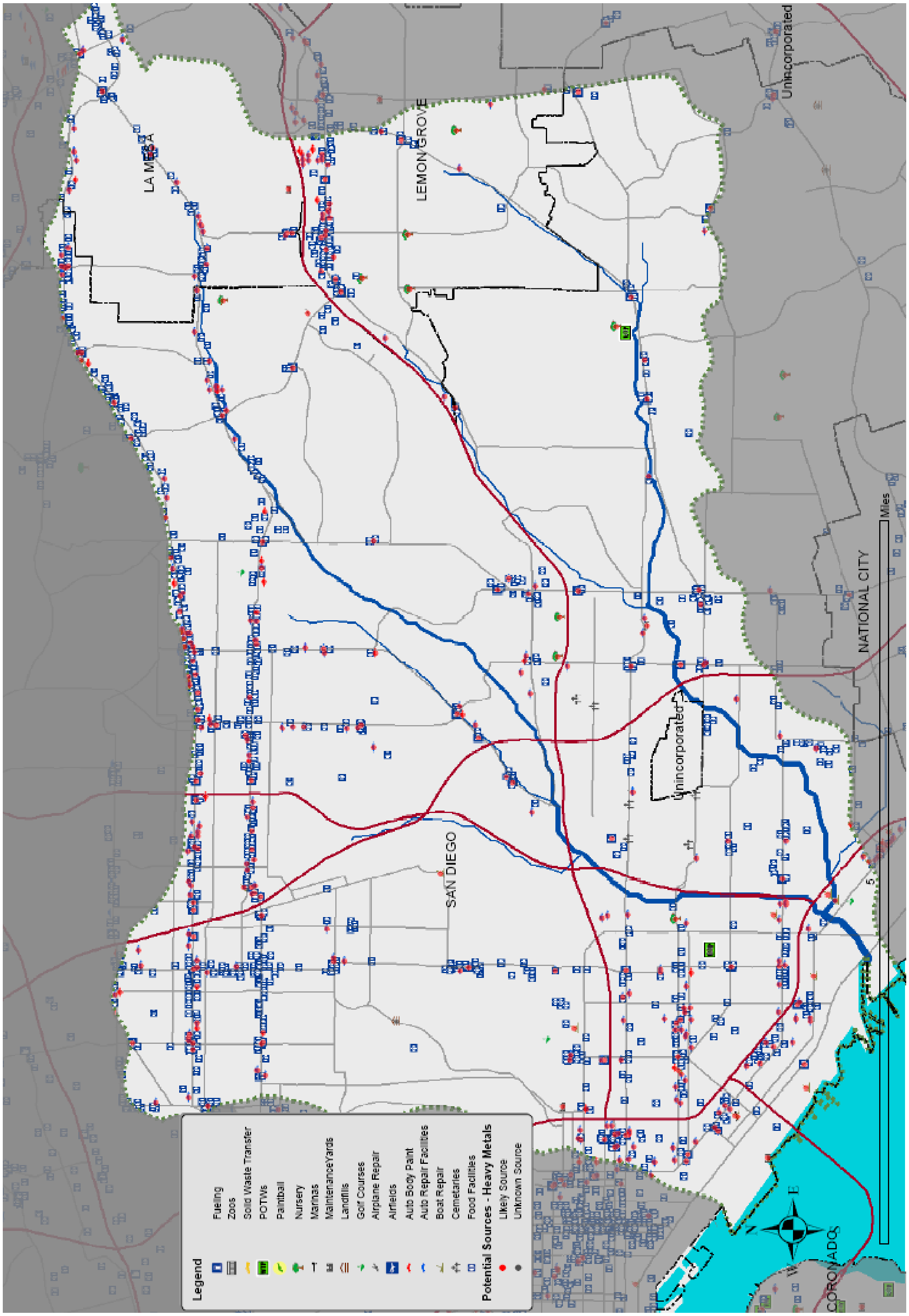

Figure 2-21. Potential Source Types for Metals in the Chollas Creek Watershed (BLTEA, 2005)

As presented on Figure 2-20, potential sources of metals are generally clustered along commercial secondary streets. The location of these clusters of potential sources also correspond to many of the subwatersheds characterized as high for relative annual metals loadings in the upper subwatersheds of the north fork and in the lower portion of the watershed at the confluence of the north and south forks and along the port and industrial areas. Potential management actions to address metals loadings include pollution prevention and source control. Confirmation of the sources of the metals loadings is needed prior to the development of an Implementation Plan that would include source control measures targeted at high loading potential sources. The source data presented in the BLTEA was based on an estimate of loading potential developed from source profiles and available data on these types of establishments, activities and facilities. Data is needed that confirms and quantifies the loading from these sources in order to prioritize the implementation of management actions. The location of these sources along commercial strips limits the type of management controls due to the space constraints and often short distance storm sewer inlets.

RWQCB Active Industrial Storm Water Permit Holders

Businesses with current and active industrial storm water permits that require monitoring of metals were identified by subwatershed (Figure 2-22). A total of nine facilities were identified and are required to collect storm water samples two times per year and are required to submit data reports to the RWQCB. A file review was conducted of these facilities data reports and the data was tabulated for each facility by WDID# and is included in Appendix A. Of the nine active facilities with storm water sampling data, only one of these facilities (WD ID#: 9 37I004665) is located in the upper watershed above the MLS station. This one facility did not have any metals data reported for any storm events. The other eight remaining industrial facilities are located below the MLS station. Only four of these eight facilities submitted metals data. The highest concentration of copper was reported at 2,100 µg/L (WD ID#: 9 37I007237), the highest concentration of lead was reported at 520 µg/L (WD ID#: 9 37I007237), and the highest concentration of zinc was reported at 86,000 µg/L (WD ID#: 9 37I013986). None of these data reports included results for hardness. However, all three of the results listed above exceed the California Toxics Rule (CTR) for both the acute and chronic criteria. To put the above concentrations in perspective, the CTR acute maximum criteria which is higher than the chronic criteria for a hardness of 400 mg/L (the highest hardness allowed for use in the CTR calculation) is 30.5 µg/L for total copper, 18.6 µg/L for total lead, and 388 µg/L for total zinc. It is apparent that the need for increased effort in the permitting and inspection process for these facilities. Sampling should be performed at these and other smaller industrial facilities and is further addressed in the Monitoring Strategy Section (7.0) of this report.

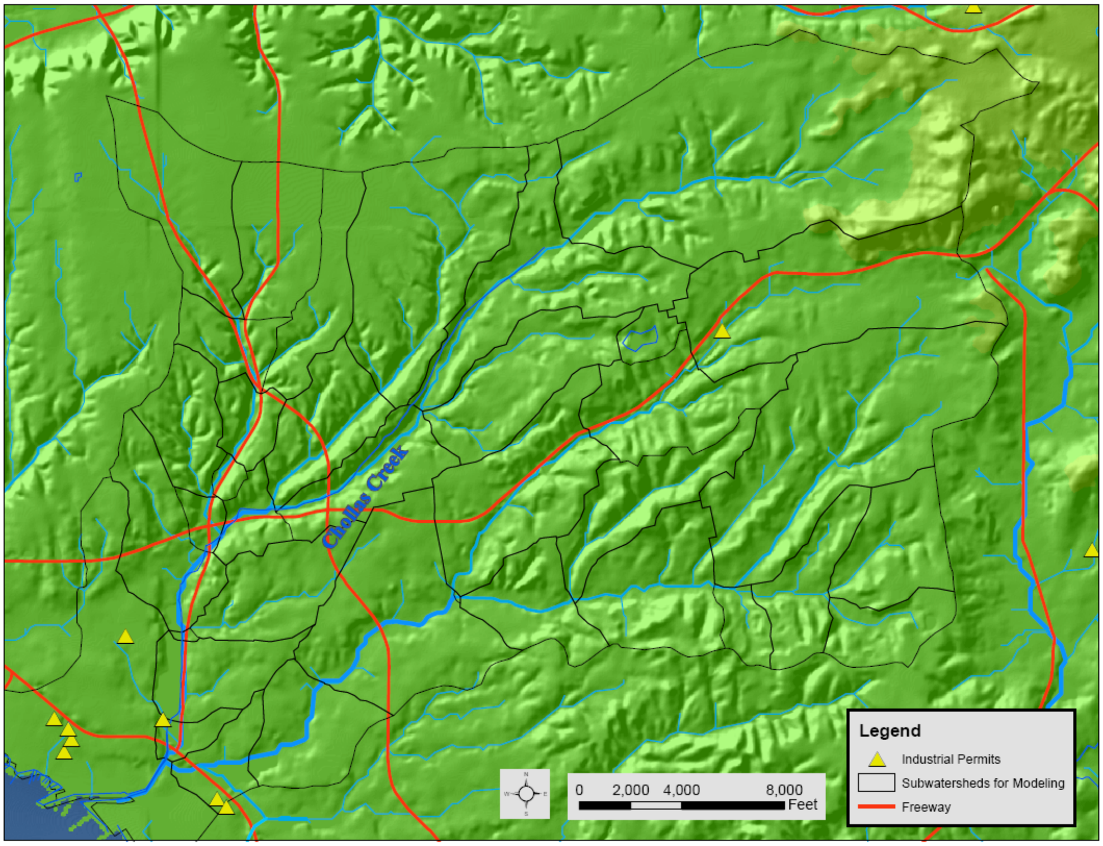

Figure 2-22. Locations of Industrial Permit Holders with Storm Water Sampling Data

2.3.2 Pesticide Sources

Based on the BLTEA inventory discussed earlier, the potential source locations and source location types for pesticides in the Chollas Creek Watershed are presented in Figure 2-23 and Figure 2-24, respectively. It is apparent that the majority of the potential pesticide source types occur in the upper reaches of both forks of the watershed and near the base of the watershed.

A list of the BLTEA source inventory data used to generate Figure 2-24 is provided in Appendix B. The locations of sources shown on Figure 2-23 are based on existing geo-coded sites in the County's inventory database. There may be other sources that have not been geo-coded or entered into the database.

2.3.3 Bacteria Sources

Based on the BLTEA inventory, the potential source locations and source location types for bacteria are presented in Figure 2-25 and Figure 2-26, respectively. It is apparent that the potential bacteria sources occur throughout the watershed but more concentrated densities do occur in the upper watershed reaches and near the base of the watershed.

A list of the BLTEA source inventory data used to generate Figure 2-26 is provided in Appendix B. The locations of sources shown on Figure 2-25 are based on existing geo-coded sites in the County's inventory database. There may be other sources that have not been geo-coded or entered into the database.

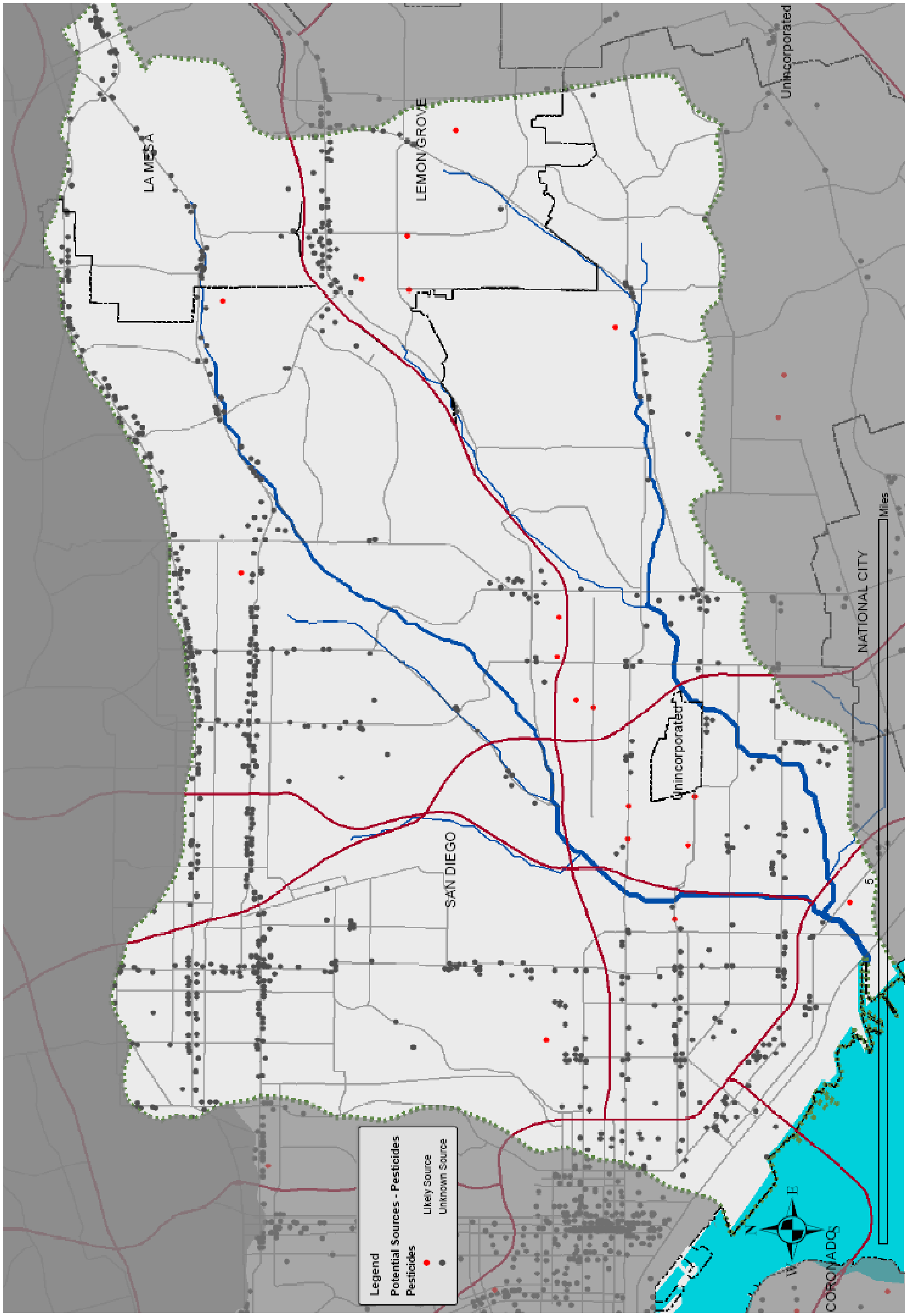

Figure 2-23. Potential Pesticide Source Locations in the Chollas Creek Watershed (BLTEA, 2005)

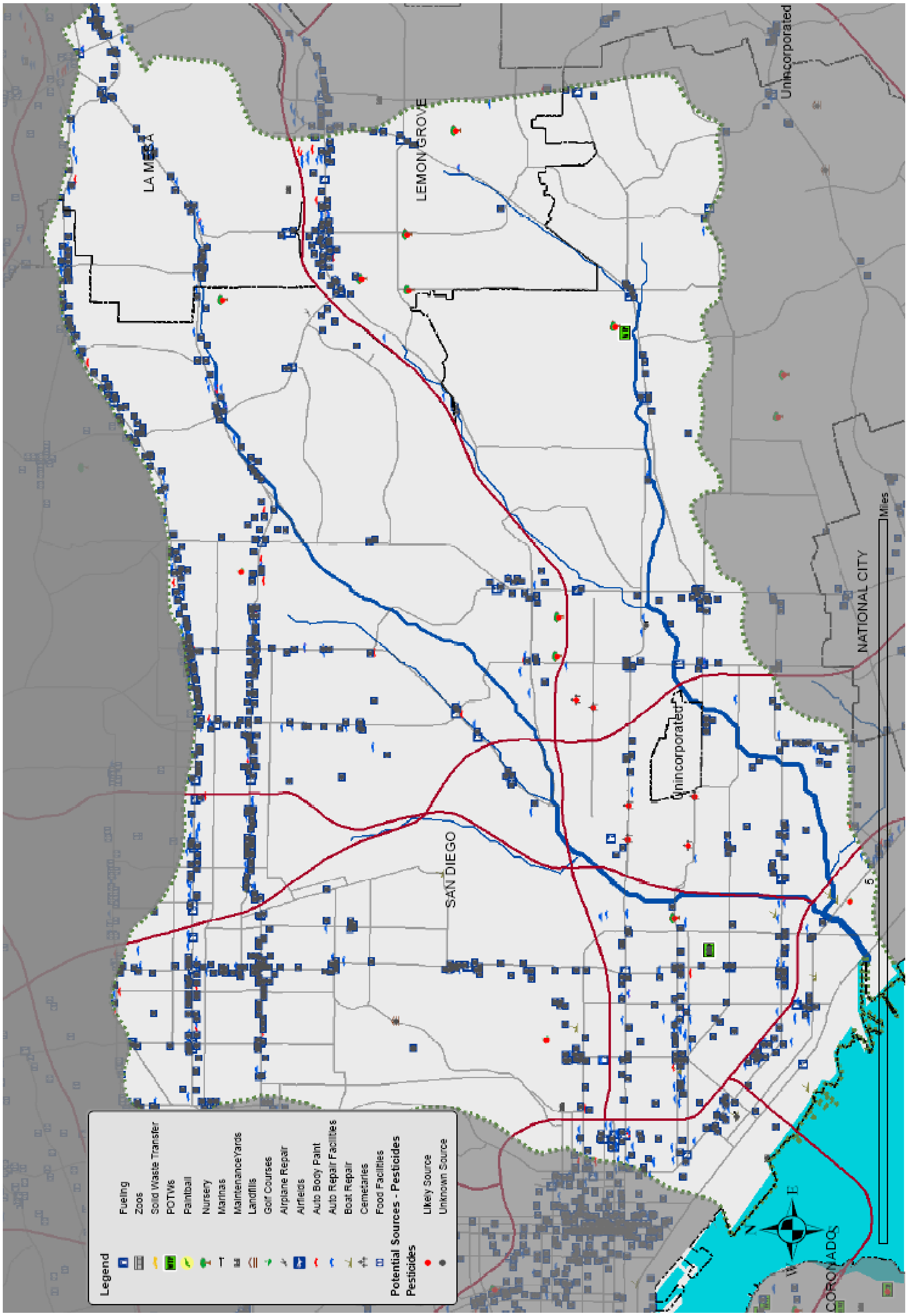

Figure 2-24. Potential Source Types for Pesticides in the Chollas Creek Watershed (BLTEA, 2005)

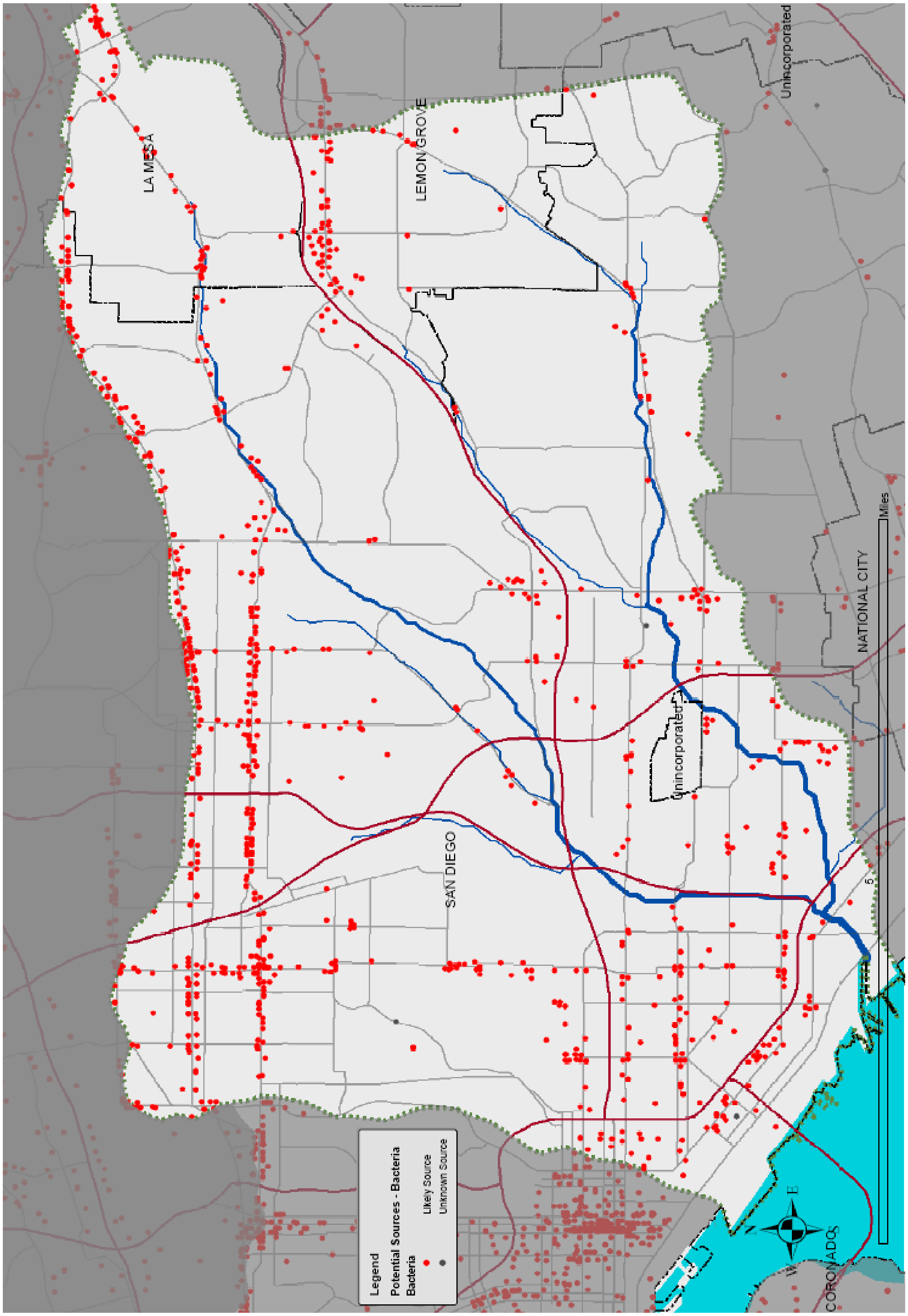

Figure 2-25. Potential Bacteria Source Locations in the Chollas Creek Watershed (BLTEA, 2005)

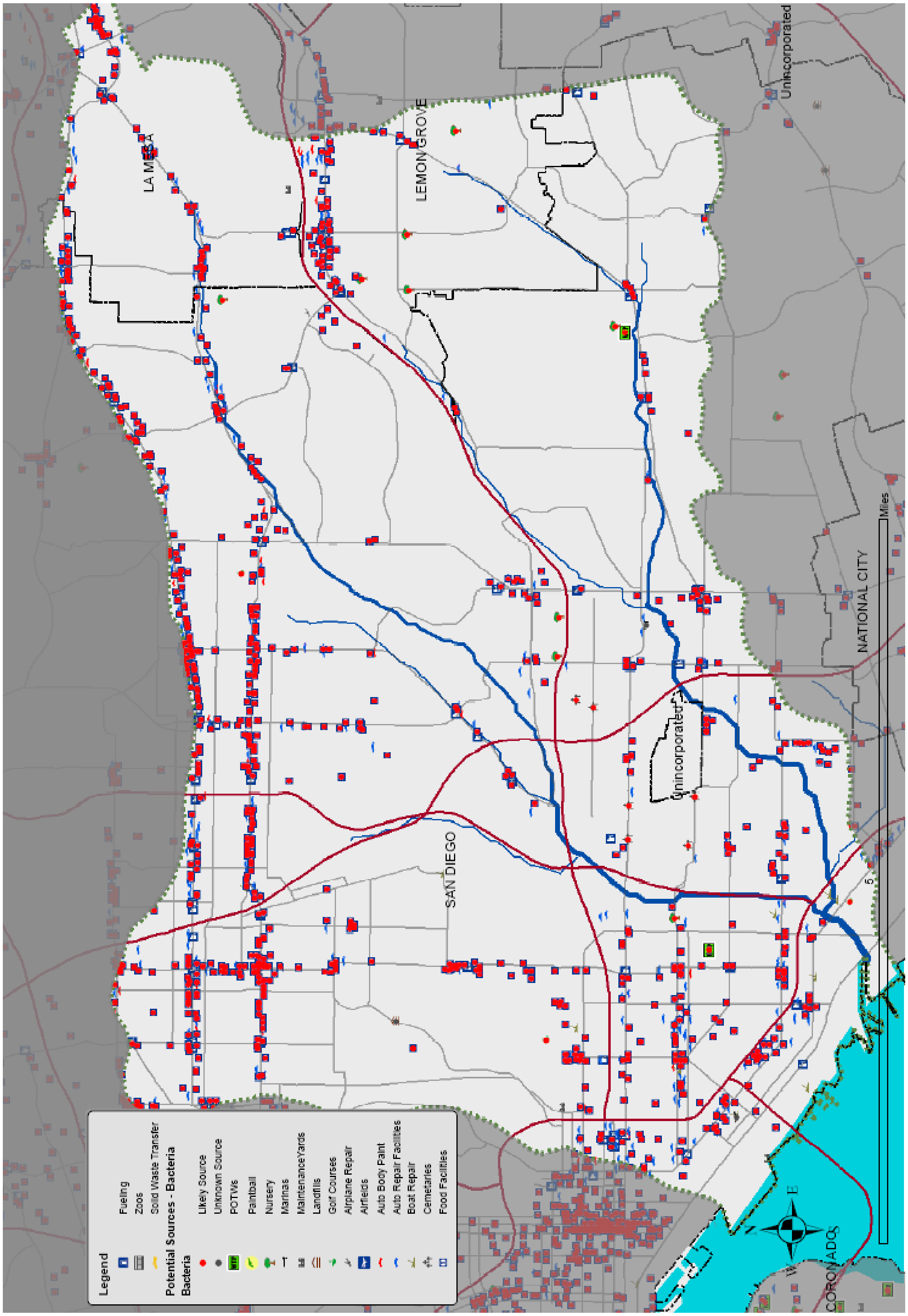

Figure 2-26. Potential Source Types for Bacteria in the Chollas Creek Watershed (BLTEA, 2005)

2.4 Data Gaps

The following data were identified in the TMDL review process as potential sources but due to lack of sufficient data, the sources could not be thoroughly addressed.

- Dry Aerial Deposition Component (wet deposition has not been shown to be a significant contributor to water quality issues for metals).
- Usable Industrial and Commercial Facilities Monitoring Data (these facilities could be significant point sources as illustrated by the few industrial permit holders that have submitted data).
- Confirmation of the metals source data, including BLTEA identified sources, and quantification of loading from these identified sources.
- Confirmation of bacteria source data and contributions from human versus background sources.
- Assess the magnitude of bacteria re-growth within the channel.
- Confirmation that the source of pesticides are from predominantly non-point sources through the application of pesticides.
- Evaluation of the contribution of ponded dry weather flows and first flush phenomenon for bacteria and other constituents.
- Development of an overall mass balance loading estimate for all sources to prioritize management actions and develop effective pollution prevention, source control and treatment control measures.

The data gaps listed above are the basis for the development of a monitoring strategy discussed further in Section 7.0.

3.0 CHOLLAS CREEK WATERSHED CHARACTERIZATION

This section presents an overview of the Chollas Creek watershed characteristics. The successful application of available BMPs in the watershed will depend on the TMDL constituents, the physical characteristics of the watersheds, and the regulatory requirements. The regulatory challenges related to BMP implementation in this watershed are discussed further in Section 4.0. Understanding the watershed characteristics is important in the BMP Assessment and selection process which is discussed in detail in Section 5.0.

3.1 Land Use

The watershed of Chollas Creek encompasses 16,273 acres. The area of the north fork of the watershed (9,276 acres) is larger than that of the south fork (6,997 acres). The watershed is highly urbanized. Land use is predominantly residential, with some commercial and industrial use (Figure 3-1). A significant portion of the remainder of the watershed consists of roadways including several freeways and highways. Caltrans is responsible for the California State Highway System which is legally defined as a Municipal Separate Storm Sewer System (MS4) (CRWQCB San Diego Region, 2005). The remaining land use is open space. Portions of the cities of San Diego, Lemon Grove, and La Mesa are located within the watershed. A small portion of the watershed consists of "tidelands" immediately adjacent to San Diego Bay. Some of this tideland area is under the jurisdiction of the San Diego Unified Port District (Port); the remainder is under the jurisdiction of the U.S. Navy (Navy). The County of San Diego also holds jurisdiction over a small portion of the watershed (<1.0 percent).

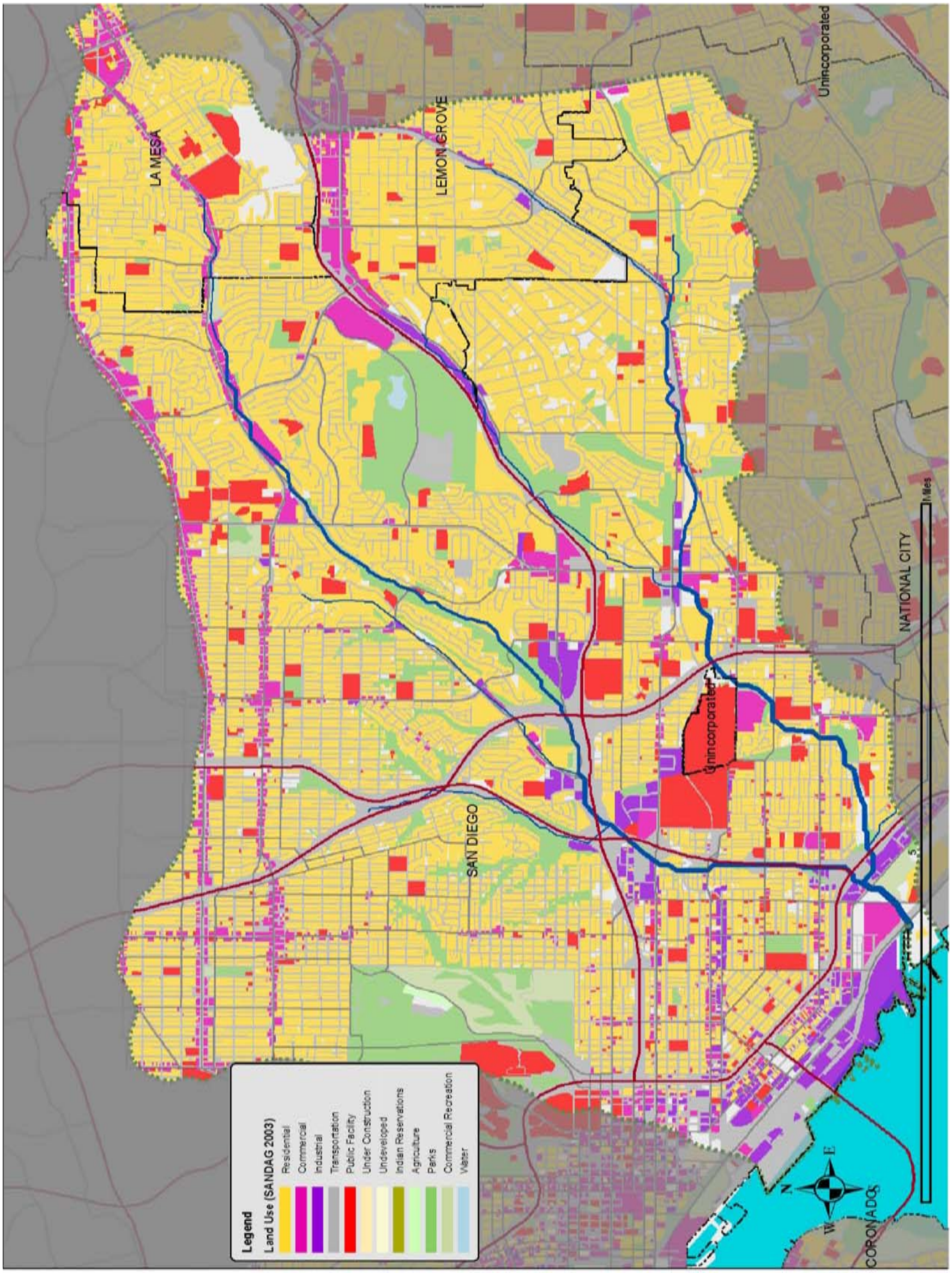

Figure 3-1. Chollas Creek Vicinity and Land Use Map

3.2 Rainfall

Annual rainfall for the Chollas Creek watershed averages 10.5 inches in coastal areas to 13.5 inches in the eastern portion of the watershed. Chollas Creek is a dry channel between storm events with intermittent flows of urban runoff. During rainfall events Chollas Creek flows respond in a relatively short time frame (e.g., within hours). Peak flows occur rapidly (short time of concentration) during the rainfall event and then return back to little or no flow, usually within two days. No guidance has been provided by the RWQCB on a "design" storm event for the current TMDLs. In the absence of this guidance, an assessment of design storm approaches is presented in Section 5. Figure 3-2 and Figure 3-3 present the total runoff on a sub-drainage basis and cumulative runoff, respectively, for a 2-inch storm event in the Chollas Creek Watershed. This size of event was conservatively selected based on the largest storm event in 1993. The modeling used to develop the TMDLs was based on the 93rd percentile of annual rainfall year (1993) observed over the last 12 years. The modeling was conducted using the dynamic hydrograph from 1993 to drive the build-up/wash-off mechanisms. These modeling parameters do not inform which design storm should be used to size BMPs.

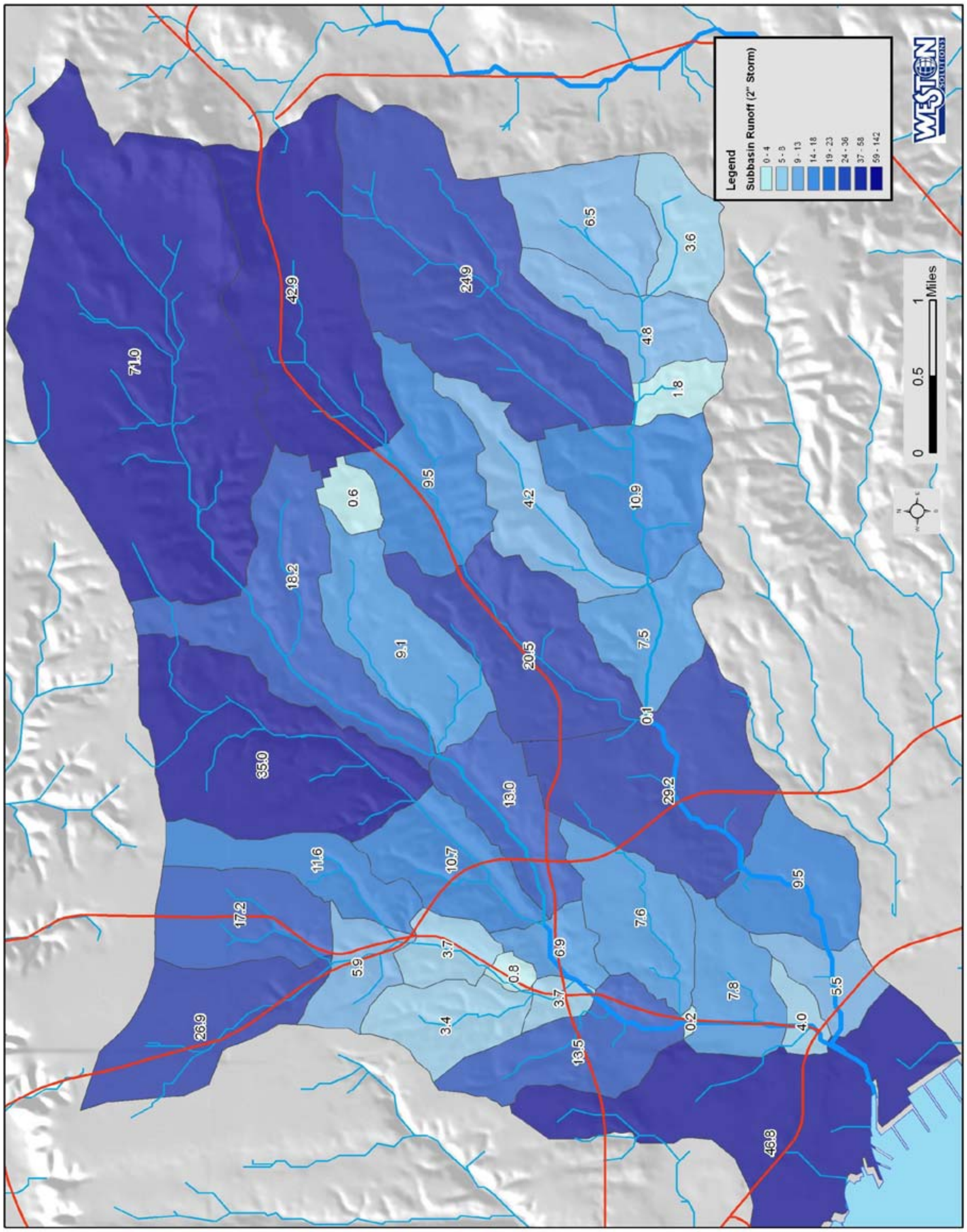

Figure 3-2. Chollas Creek Subbasin Runoff (acre-ft) for a 2" Storm

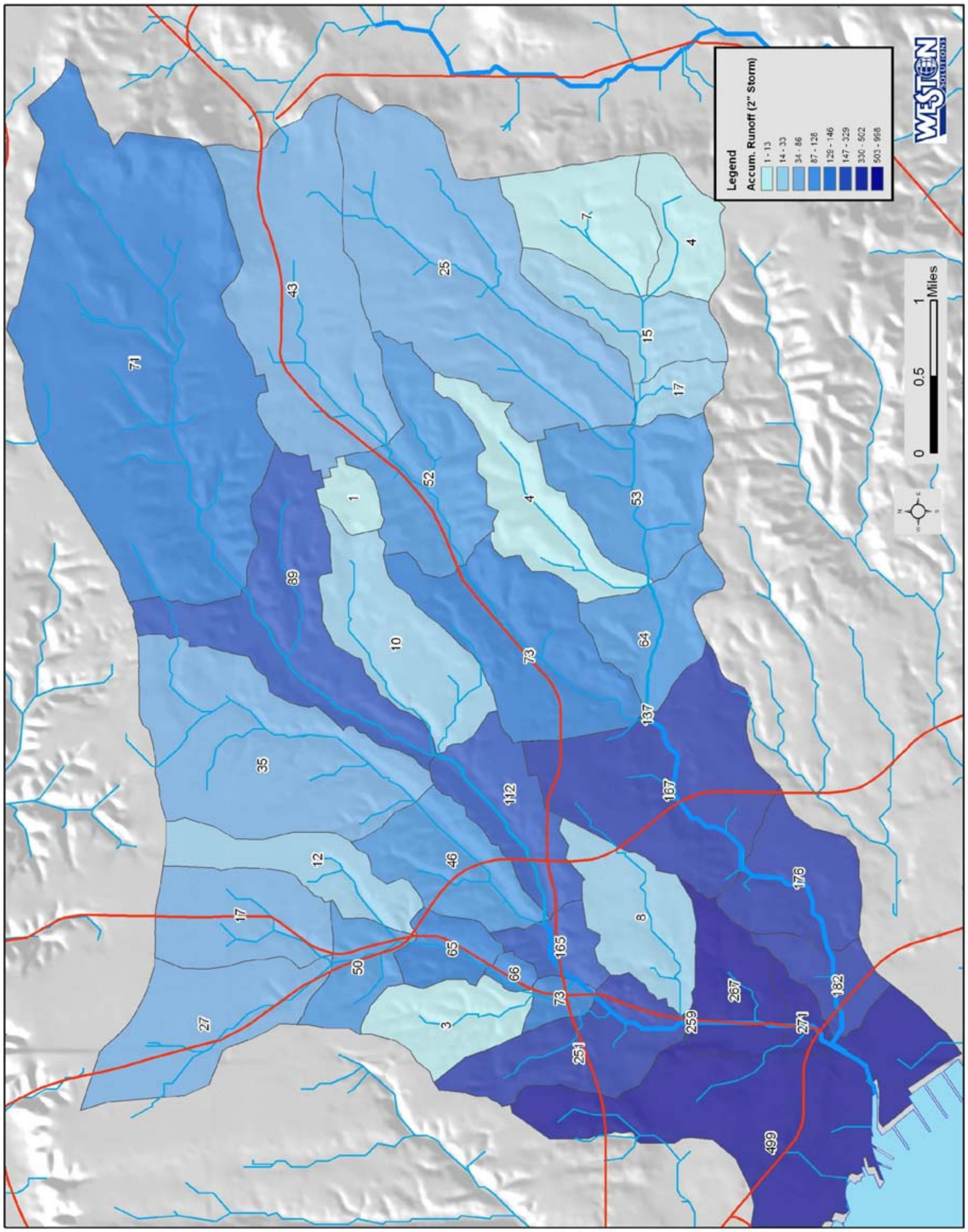

Figure 3-3. Chollas Creek Cumulative Runoff in acre-ft for a 2" Storm

3.3 Chollas Creek Topography

As shown on Figure 3-4 and Figure 3-5, the elevation differences and percent slope in the watershed will limit the placement of treatment BMPs. Areas of steep slopes are predominant in the canyons that are characteristic of these drainage areas. In many cases, freeways (which are the responsibility of Caltrans) pass directly along side Chollas Creek for significant distances. Significant grading and disturbance of areas adjacent to existing tributaries would be needed to install BMPs of sufficient capacities.

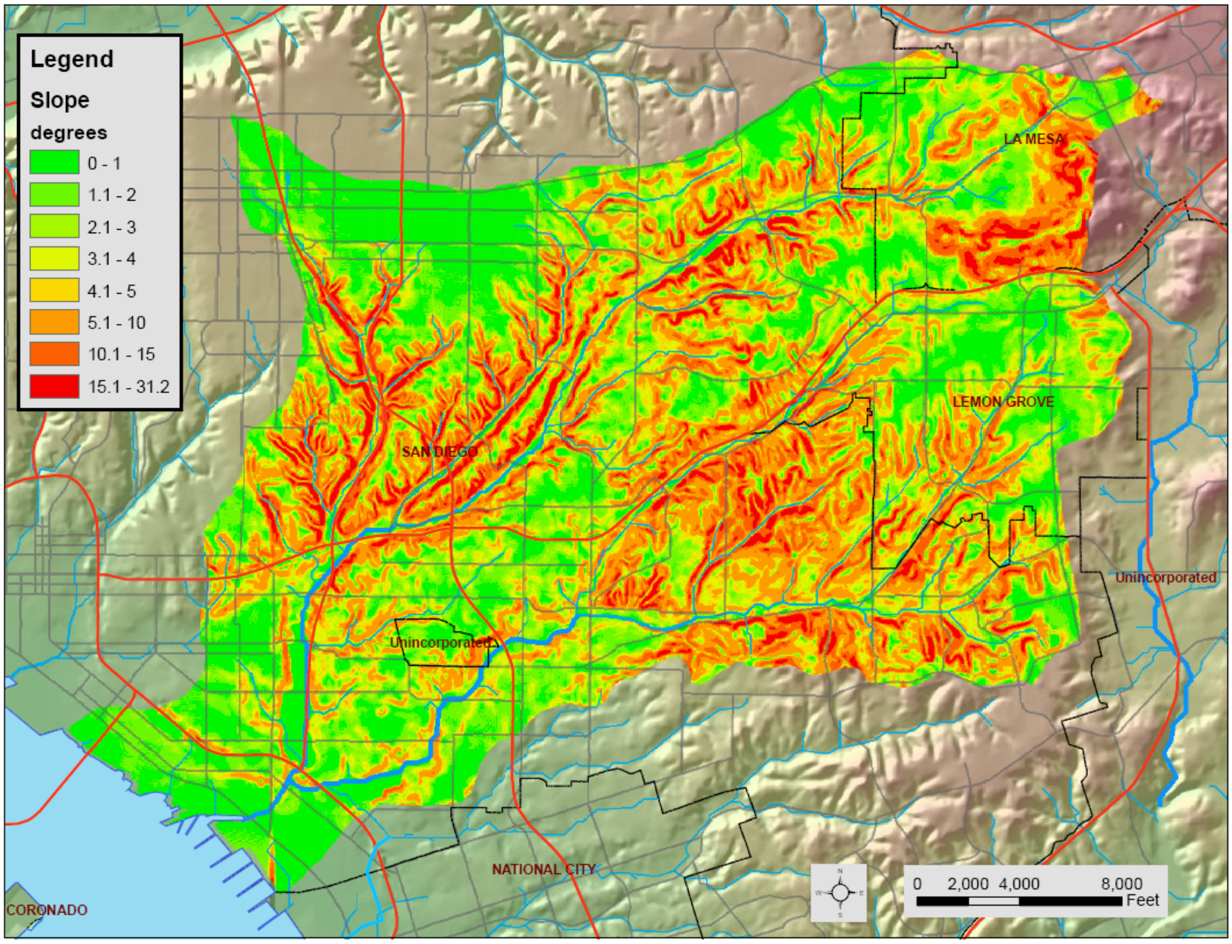

Figure 3-4. Chollas Creek Watershed Slopes

As shown on Figure 3-5, there are numerous drainage areas within the watershed that are characterized by steep slopes along the canyon walls leading down to the creek channel. The highlighted areas represent slopes greater than 16 percent. These slopes may also exist in site specific locations and may restrict placement of structural BMPs within the canyon without major grading.

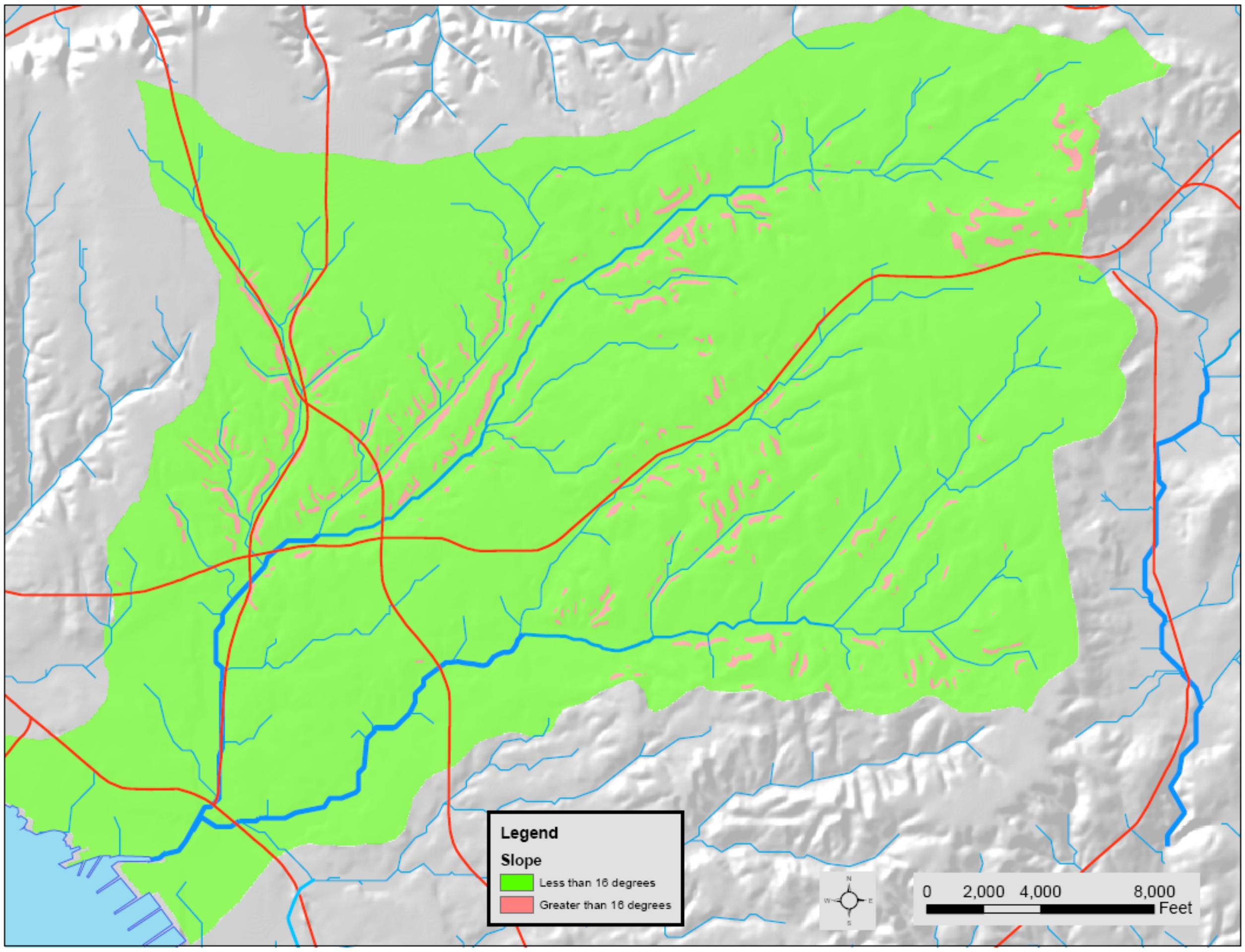

Figure 3-5. Chollas Creek Slopes

3.4 Soil Permeability

The watershed is characterized by poorly draining soils and compacted urban lands based on USDA Natural Resources Conservation Service surveys as shown on Figure 3-6. These characteristics limit the application of management measures that require large areas for equalization of storm flows and/or high permeability soils for redirecting runoff back into the ground through infiltration without the acquisition of lands and modification of existing soils. Site specific investigations on the actual infiltration properties of the soils and citing constraints are needed to fully define the implementation constraints. Alternative approaches may include installing granular drainage layers and soil modification as part of the BMP to provide the necessary storage and prevention of hydraulic head buildup above the low permeability soils. These additional engineering components will increase the cost of these systems, and may preclude the use of these systems for larger storm water volumes and flows. The use of a combination of augmented infiltration (modified soil or addition of sand layer), bioretention, porous pavement and other LID techniques is not precluded, but will require site specific investigations and designs. These treatment system alternatives are discussed and evaluated in Section 5.0.

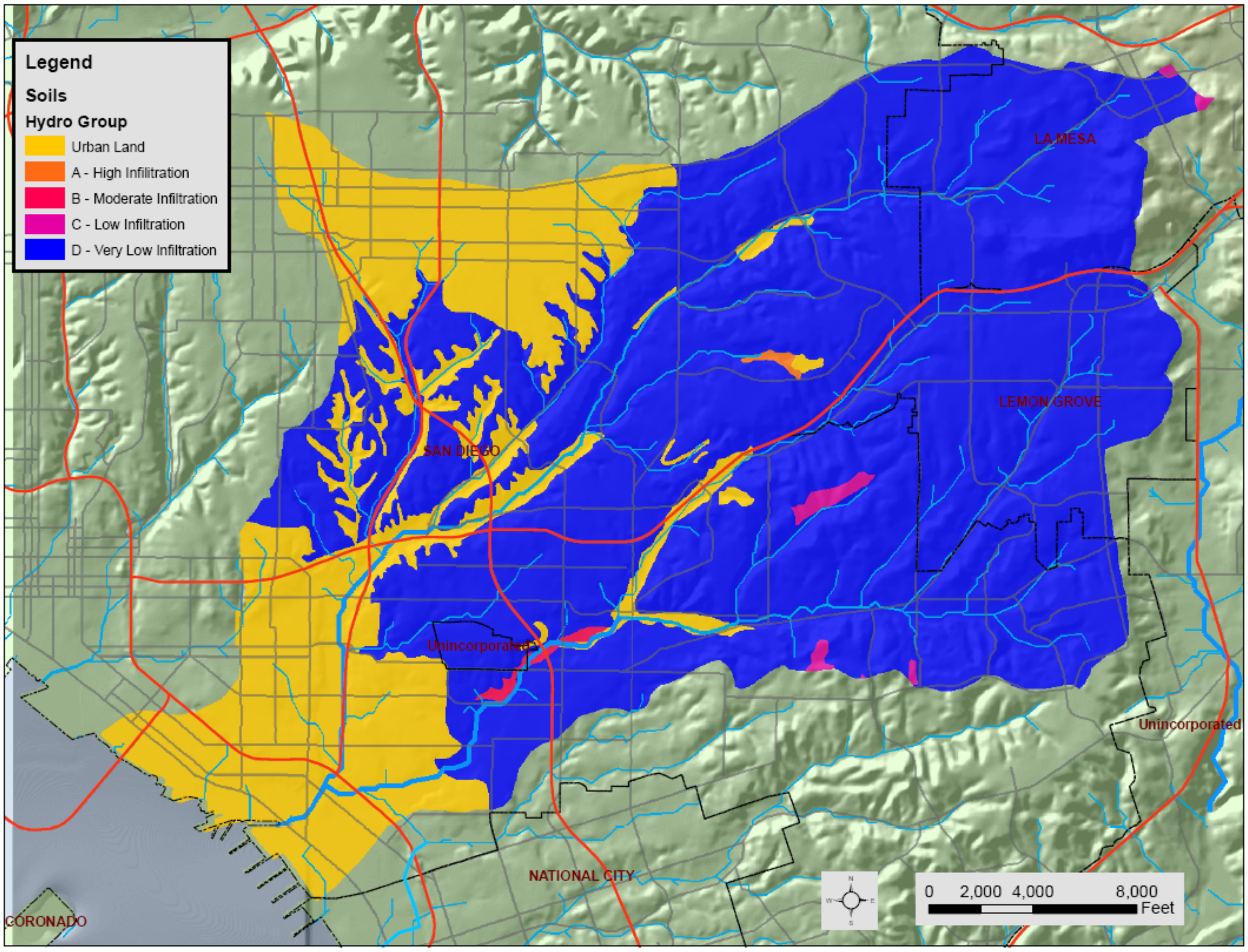

Figure 3-6. Chollas Creek Watershed Soil Permeability

3.5 Chollas Creek Modifications and Channelization

Over the past 68 years, Chollas Creek has been modified, diverted, or channelized in several locations primarily for flood control purposes. Much of the creek has been channelized and concrete lined. Approximately 30% of the creek was channelized prior to the November 28th, 1975 adoption of the Basin Plan as illustrated in Figure 3-7. The most significant alteration is evident in north fork of Chollas Creek in the large scale channel change plans from 1949 depicted in yellow. Depicted in green is the concrete channelization that has occurred over the past 68 years over a significant portion of Chollas Creek. Also shown, are channel re-alignments, slope lining, and box culverts that have been installed. These areas of channel modifications were identified as waters of the U.S. when beneficial uses were first designated in 1975. Currently, the designated beneficial uses of all streams in the Chollas Creek watershed (Hydrologic Unit No. 8.22) are identified in the Basin Plan as Non-Contact Water Recreation (REC-2), Warm Freshwater Habitat (WARM), and Wildlife Habitat (WILD). Contact Water Recreation (REC-1) is a potential beneficial use.

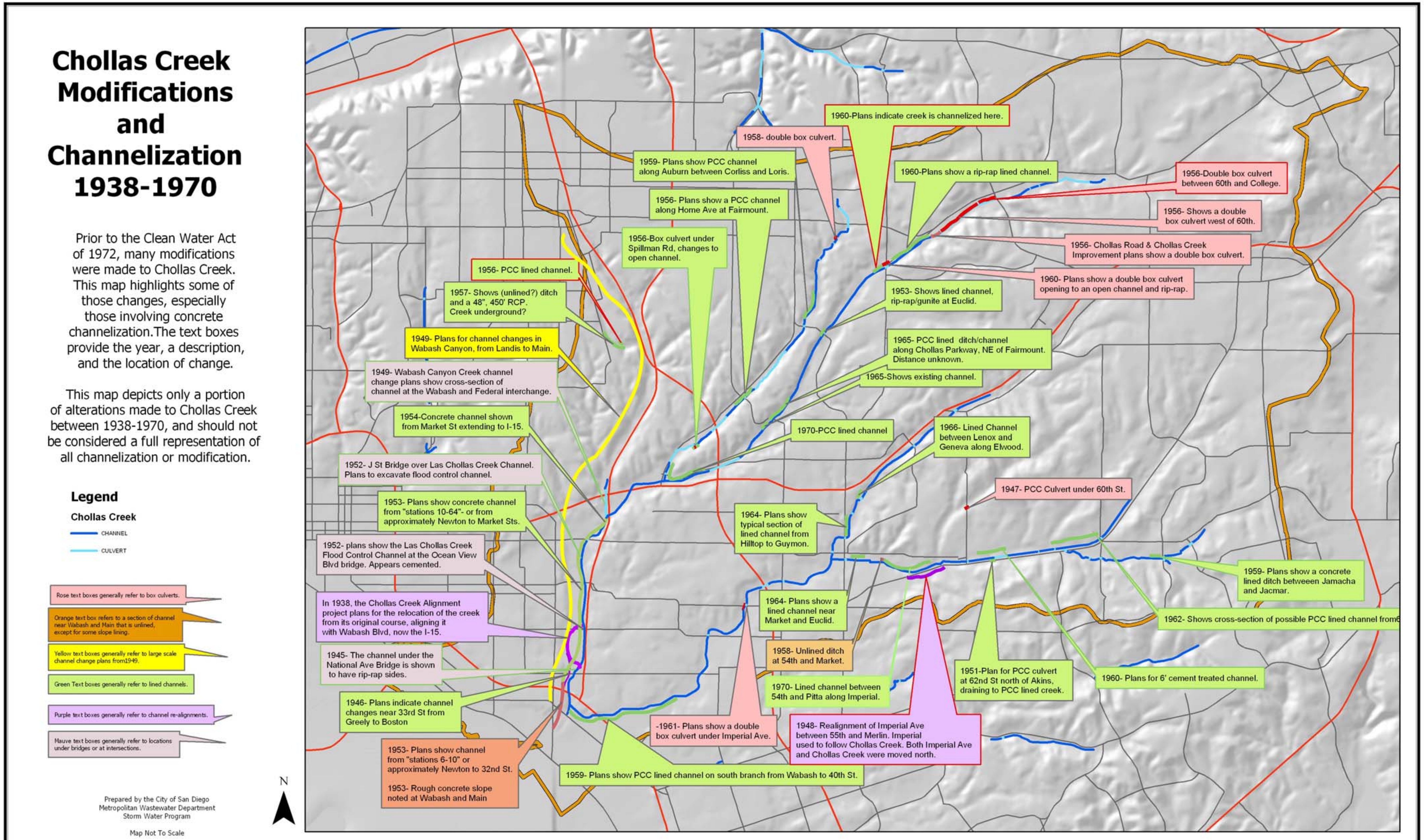

Figure 3-7. Chollas Creek Modifications and Channelization from 1938-1970

4.0 REGULATORY BMP IMPLEMENTATION ISSUES

This section presents an overview of key regulatory issues that are important in the selection of BMPs within the watershed to meet the integrated TMDL requirements. There are two regulatory issues that are important in the evaluation of potential structural BMP implementation. These include the interpretation of the "tributary rule" as outlined in the attached memorandum from the RWQCB to the City (Appendix C), and the potential environmental impact issues regarding diversion of in-channel flows. The "tributary rule" is based on the Federal regulations that require the water quality standards of downstream waters be maintained [40 CFR 131.10(c)]. The dissolved metals TMDL (Technical Report, July 25, 2006) requires that regulated discharges will not be allowed to have dissolved metals concentrations that cause in-stream waters to exceed the water quality criteria. It is the City's understanding that the RWQCB has interpreted the "tributary rule" to require attainment of the metal TMDL limits throughout the watershed in all waters of the State. The waters of the State include the receiving waters and the tributaries that convey waters to these water bodies. These conveyances may include natural channels and those channels/ditches created or constructed from the storm drain outlets to the receiving water. The implications of this interpretation in the placement of structural BMPs is that if the BMP is placed between the storm drain outlet and the receiving water, the section of "tributary" between the outlet and the BMP will not be in compliance if the concentrations are above the water quality objective.

There are approximately 800 discharge points in the Chollas Creek Watershed as shown in Figure 4-1. This interpretation of the "tributary rule" limits the location of structural BMPs to be immediately at the storm drain outlet, within the MS4 system or above the outlet. The MS4 system is not designed for storage of storm flows, but rather the rapid discharge of runoff to control flooding. Due to this interpretation and the need for equalization/storage to treat storm flows, treatment BMPs will therefore need to be located above the storm drain outlets on available public lands or currently private property. Because the creek channel and the designated "Waters of the State" are generally located in a canyon valley and down the canyon slope, treatment BMPs will need to be located on the canyon crest and storm water conveyed either downstream to these locations or pumped to these systems. The RWQCB has indicated that application of the "tributary rule" could be considered on a case-by-case basis; however, the RWQCB has applied the tributary rule requirement to this TMDL.

The placement of potential structural BMPs also needs to consider potential adverse impacts to the habitat, hydrologic flow regime and aesthetics of the creeks and streams. Diversion of receiving water to treatment BMPs will need to consider and address these potential impacts to riparian habitat, in-stream fauna and flow regime.

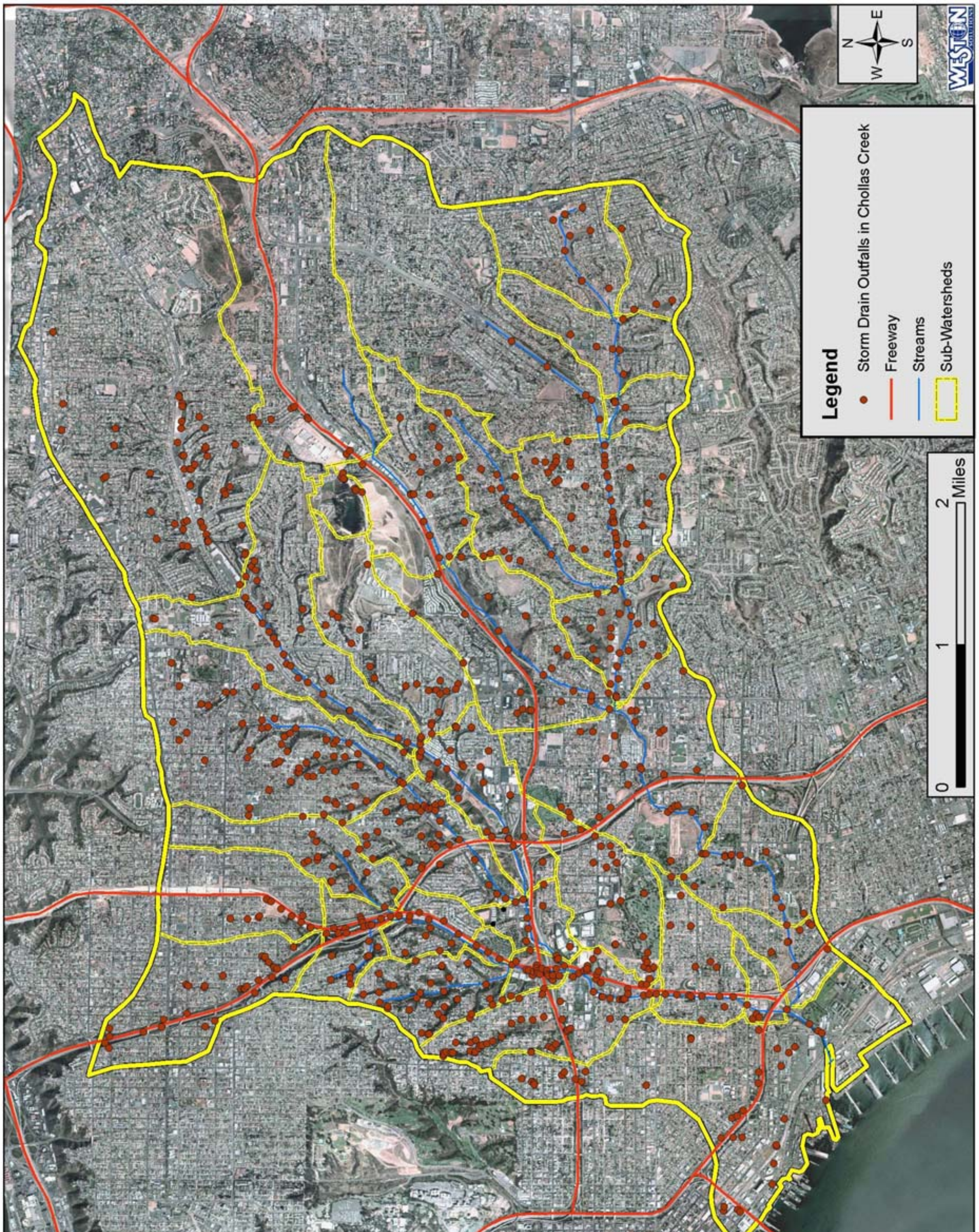

Figure 4-1. Aerial View of Chollas Creek Watershed and Locations of Storm Drain Discharges.

4.1 Waters of the State

As defined under the Porter-Cologne Water Quality Control "Waters of the State" means any surface water or groundwater, including saline waters, within the boundaries of the state. Therefore, discharges from MS4 storm drains apply to both waters of the U.S. and waters of the State. "Waters of the United States" have been re-defined by a recent U.S. Supreme Court ruling. This January 9, 2006 ruling found that certain "isolated" waters of the State are no longer considered waters of the U.S. MS4 permits are regulated under the Clean Water Act (CWA) and California Waste Discharge Requirements. Therefore, discharges from MS4 storm drains apply to both waters of the U.S. and waters of the State. The interpretation by the RWQCB of the application of the tributary rule to waters of the State, would require meeting the water quality objectives in conveyance channels to the receiving waters from the point of discharge of the storm drains. As discussed above, placement of BMPs some distance downstream of the outfall would not meet the rule interpretation between the BMP and the outlet.

Chollas Creek is predominantly channelized and certain portions of the creek only flow during rainfall events or dry weather urban run-off. As a result of the tributary rule, constructed treatment BMPs cannot be placed in waters of the state. Waters of the state are defined by one of the following: bed and bank topography, inundated soils, or wetland vegetation.

4.2 Use Attainability Analysis

A use attainability analysis (UAA) is a structured scientific assessment of the factors affecting the attainment of uses of a water body, such as swimming (i.e. REC-1). A UAA is the tool used to evaluate the potential to remove nonexisting and non-attainable designated uses. Federal regulations guide UAAs [40 CFR 131.3(g)]; the results must be adopted into the water quality objectives and be approved by EPA as meeting CWA. If it is shown that the REC-1 beneficial use is not existing or attainable, then a Basin Plan Amendment can be adopted, removing the potential use from designation. Due to the historical channelization of much of the lower portion of the creek and the highly urbanized nature of the watershed, the human recreational beneficial uses do not appear applicable to large portions of the creek and should be considered for amendment of the Basin Plan.

4.3 Available Public Lands

Land classified as developable or publicly owned lands was developed using GIS layers from SANDAG and are shown in Figure 4-2. Various site specific constraints to BMP placement within these areas are likely present and need to be further researched and verified. Many of the identified public lands are not owned by the City, but are federally controlled as part of the Department of Defense facilities. Public lands shown adjacent to freeways are predominantly right of ways under the responsibility of Caltrans. It is likely only a fraction of these public lands are available for use by the City for BMP placement.

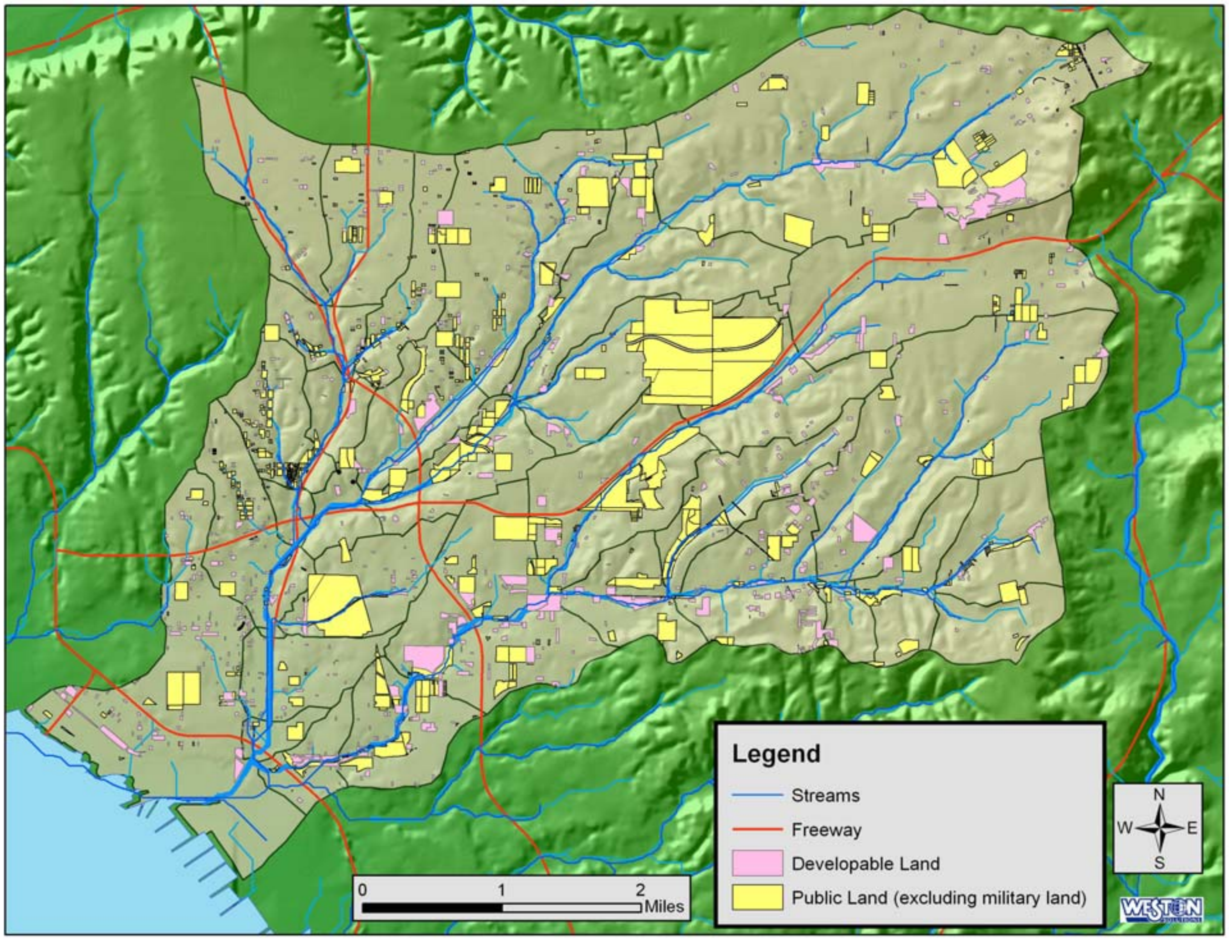

Figure 4-2. Chollas Creek Watershed Publicly Owned and Developable Land

5.0 BEST MANAGEMENT PRACTICES ASSESSMENT AND SCREENING MATRIX

This section presents a feasibility assessment of available BMPs to meet the objectives of the current and future TMDLs for the Chollas Creek watershed. These objectives were presented in Section 1.0 and are summarized in this section. An integrated approach allows for more efficient management in developing BMPs that address multiple TMDLs. An integrated approach will require additional time for implementation, but will address all the water quality issues in a more cost effective and environmentally holistic manner. Implementation of management measures that can address multiple constituents using an integrated approach towards the TMDLs is a more cost effective approach than having to possibly retro-fit or replace existing measures to address additional constituents as future TMDLs are implemented.

As identified in Section 2.4, there are data gaps that need to be filled. These data gaps include water quality data in the upper-watershed, source loading, contributions from industrial sources, contribution of aerial deposition, overall mass balance from all potential sources, soils data and hydrogeological data. In addition to these data gaps, data within the Chollas Creek watershed needed to meet the objectives of an integrated strategy are also limited. Given these data gaps and the associated uncertainty, a tiered and iterative implementation strategy may provide the soundest scientific and engineering approach to the implementation of applicable BMPs. The strategy to implement the TMDLs based on the BMP assessment is presented in Section 6.0. Also discussed in Section 6.0 is the approach needed to meet the defined TMDL schedules. As discussed in Section 6.0, a tiered or phased approach may not be possible under the 10-year dissolved metals TMDL schedule.

The feasibility assessment presented in this section will first include a discussion of non-structural BMPs. Non-structural BMPs include source control and pollution prevention measures. Source control measures include legislative initiatives and building code changes for product substitution. Non-structural BMPs also include cover, containment, prevention, good house keeping and administrative measures. The implementation of recommended baseline or “minimum” non-structural BMPs are targeted at priority sources and are often accomplished through education, code or law changes, and enforcement actions. The importance of confirming priority sources and quantifying the contributions from non-point sources is also discussed.

The combined effectiveness of these non-structural BMPs may range from 30-70%, and can not be accurately determined for the Chollas Creek watershed without conducting effectiveness assessment monitoring. The effectiveness of non-structural BMPs also varies between constituents. In taking an integrated approach to BMP development and assessment, it is reasonably foreseeable that additional management measures will be implemented under a multiple tiered approach. Based on the measured effectiveness of the non-structural BMPs, treatment BMPs will be implemented where appropriate. This will likely be the case within drainage areas with greater loads where non-structural BMPs will not achieve the concentration reductions needed to meet the dissolved metals TMDL. This may also be the case for lower loading subwatersheds where non-structural BMPs have diminishing returns on the removal of incremental levels of constituents at lower concentrations. Furthermore, due to the documented challenges to meet bacteria objectives using only non-structural BMPs, it is reasonably foreseeable that treatment BMPs will be needed to fully meet the Chollas Creek objectives. BMPs will also be needed to address potential future pesticides issues other than diazinon. Treatment BMPs may be needed to address these issues and should be considered in an integrated approach.

Runoff reduction and treatment BMPs that reduce constituent concentrations and loading in storm water flows are also evaluated in this section. This assessment of structural BMPs utilizes the information presented in the Treatment BMP Technology Report (Caltrans, April 2006), ASCE-USEPA Database (ASCE, 2006), and other sources to develop a list of BMP technologies that address the current and future TMDLs in an integrated approach. BMP technologies that address not only dissolved metals, but bacteria and pesticides are selected for further evaluation. An integrated approach to BMP selection provides for cost effective implementation of the TMDLs. The selected treatment BMPs are then evaluated with regard to the specific watershed characteristics, regulatory issues that include the “tributary rule,” and potential environmental impact issues due to diversions of receiving waters. Based on the screening of the treatment BMPs, implementation strategies needed to meet the TMDL goals are developed and presented in Section 6.0.

5.1 BMP Technology Objectives

The objectives of the BMP technologies are to meet the requirements of the TMDLs for Chollas Creek using an integrated approach. Therefore the goals of the BMPs need to address the load allocation and load reduction schedule as stated in the TMDLs. The requirements of the TMDLs presented in Sections 1.3 and 1.4 are the stated objectives of the BMP technologies:

5.2 Non-Structural BMP Assessment

Non-Structural BMPs include source control and pollution prevention measures. These include the proper storage of chemicals, protecting storm drains, good house keeping and administrative measures. Source control measures include legislative initiatives and building code changes resulting in product substitution. Examples include replacement of copper in brake pads and substitution of a less persistent pesticide for synthetic pyrethroids. Non-structural BMPs are targeted at activities that may result in release of constituents into receiving waters through urban runoff or storm water flows. These BMPs are generally more cost effective than treatment BMPs, because they address the sources of pollutants as compared to treating large volumes of storm water to remove these pollutants. However, the effectiveness of non-structural BMPs needed to meet the goals of the TMDLs in the Chollas Creek watershed can not be accurately determined without conducting effectiveness assessment monitoring. Furthermore, as stated previously, additional management measures that include runoff reduction and treatment BMPs will likely be needed to meet the goals of an integrated TMDL strategy.

Published data indicated that the effectiveness of source control and pollution prevention measures can range widely from 30-70%. The effectiveness of these BMPs will vary greatly depending on the level of implementation and enforcement, watershed and regional hydrological characteristics, and constituent type. If the approximate average of this effectiveness range (50%) were assumed for a fully implemented non-structural BMPs program, the reduction in metals concentration would meet the TMDL WLA required concentrations for dissolved zinc, but only the lower exceedances levels for dissolved copper and dissolved lead. Based on historic concentrations, the reductions required to meet the TMDL WLA in any storm event are 87% for dissolved copper, 92% for dissolved lead, and 49% for dissolved zinc.

The effectiveness of non-structural BMPs can not be accurately assessed without actual effectiveness data that compares drainage areas in which these measures are fully implemented compared to a drainage-area where little or no measures are established. Case studies also indicate that source control and pollution prevention measures may have diminishing returns for each incremental reduction at low concentrations in storm water. The non-structural BMPs may only be cost–effective in reducing constituent concentration to a certain level, which may or may not meet the regulatory limit. Published data on these measures addressing bacteria indicates challenges in meeting regulatory limits throughout the regulated channel due to regrowth and a significant number of sources. Source control and pollution prevention measures can be more effective when targeted at sources and activities that have the greatest loading potential for the constituents of concern.

The Baseline Long-Term Effectiveness Assessment (BLTEA) (Weston, MOE, & LWA, August 2005) identified priority sources for each watershed and constituent group in San Diego County using a Threat to Water Quality (TTWQ) rating system. This TTWQ rating is based on the actual water quality data for the watershed and the loading potential of each source for a particular constituent group. The three BLTEA constituent groups of importance for the Chollas Creek watershed are total and dissolved metals, bacteria and pesticides.

Priority sources are those that have a higher TTWQ rating. The higher rated sources correspond to those activities that have a high loading potential for that given constituent group. Sources are also given a high rating if their loading potential is unknown. For the San Diego Bay watershed, priority sources include:

- auto mechanical repair;
- auto fueling or cleaning;
- automobile body repair and painting;
- fabricated metal operations;
- marinas;
- corporate yards;
- motor freight;
- auto parking and storage;
- auto wholesale;
- boat repair;
- home auto repair and washing;
- roads, streets and highways;
- eating and drinking establishments;
- animal facilities;
- home garden care activities;
- nurseries;
- landscaping at public areas;
- pest control services; and,
- developments subject to SUSMPs.

As shown on the figures in Section 2.3, many of these priority commercial activities and transportation sources are concentrated along Interstates 5, 15, 805, and Highway 94.

Based on the TTWQ analysis, the set of high priority sources listed above was used to develop a list of recommended baseline non-structural BMPs. Table 5-1 presents the priority sources and the baseline non-structural BMPs that address these sources. Using an integrated approach that targets these priority sources, the recommended baseline non-structural BMPs are identified in Table 5-1. These BMPs include cover, containment, prevention, good house keeping and administrative measures. Additional non-structural BMPs may be applicable to the Chollas Creek watershed based on updates to the inventory list and a more detailed evaluation of a more comprehensive and current inventory.

The implementation of these recommended baseline BMPs is through education programs, ordinances, and enforcement. Most of the baseline BMPs listed in Table 5-1 are included in the City's Storm Water Pollution Prevention Program fact sheets provided through the "Think Blue" educational program and website (www.thinkbluesd.org). The current San Diego Municipal Code requires the implementation of BMPs where any activity may cause or contribute to storm water pollution or contamination, illegal discharges, or non-storm water discharges in accordance with the BMP guidelines. The guidelines are provided on the fact sheets. The current City Code provides for the greatest amount of flexibility in meeting the pollution control requirement. Specific BMPs are not specified for this purpose.

It is recommended that the City review its ordinances and guidelines to assess if the implementation of the recommended baseline BMPs for the priority sources can be more effective through changes in the City Code. Modifications that may be applicable could include listing the specific priority sources and baseline BMPs in the Code. The Code should also require any additional BMPs needed to prevent storm water pollution, urban runoff and illegal discharges.

As highlighted in Section 2, only a limited number of industrial facilities (9 total) have current and active industrial storm water permits that require monitoring. As part of the non-structural BMPs for the Chollas Creek watershed is a program to prioritize those industries that are identified as high loading potential for the constituents under current and anticipated TMDLs. Prioritized source control and pollution prevention activities should include identifying and determining present practices; review and revise codes accordingly to provide more specific requirements that maximize pollution prevention and source control measures; and conduct regular inspections at these targeted facilities.

In addition to modifying the content of the education and outreach tools to reflect a more strict standard and include specific minimum BMPs, the City's outreach and behavior modification efforts in the Chollas Creek basin and San Diego Bay watershed may benefit from adopting a behavior modification approach with the various target audiences most associated with the generation of the target pollutants.

Table 5-1. Baseline Non-Structural BMPs for Priority Source Categories

		Cover		Containment											Prevention									Good Housekeeping				Administrative	
Source #	Priority Sources	Store/Conduct material/activity Inside	Cover Activity/material	Use designated areas for activity, clean up or loading	Berm activity area or direct run on	Provide secondary containment	Provide drip plans, etc. to collect leaks/spills	Clean floor mats, etc. indoors	Properly dispose of process or wash water.	Immediately clean up spills with dry methods	Keep animals out of creeks	Wash vehicles and equipment in designated areas	Maintain spill clean up material/equipment readily available.	Properly store and dispose of green waste	Properly store and dispose hazardous material/chemicals	Schedule activity in dry weather	Label containers and maintain up-to-date inventory	Drain fluids from automobile	Provide signage for storm drains, materials storage, etc.	Properly manage pesticide/fertilizer use	Provide vegetation cover	Protect Storm drains	Practice water conservation	Inspect activity/storage area regularly	Clean up regularly with dry methods	Clean trash disposal areas	Train employees	Develop & Implement Spill Prevention Plan	Develop & Implement SWPPP
	Commercial Activities																												
1	Auto mechanical repair, maintenance, fueling, or cleaning		√	√	√				√	√		√	√		√		√	√	√					√	√		√		
2	Equipment mechanical repair, maintenance, fueling, or cleaning		√	√	√				√	√		√	√		√		√		√					√	√		√		
3	Automobile and other vehicle body repair and painting		√	√	√				√	√		√	√		√		√		√					√	√		√		
4	Mobile automobile or vehicle washing				√				√			√	√			√						√	√						
5	Auto parking lots and storage facilities	√							√				√		√				√					√	√		√		
6	Retail or wholesale fueling		√		√				√	√			√						√					√	√		√		
7	Pest Control Services	√		√					√				√							√									
8	Eating or drinking establishments		√					√	√	√			√						√	√		√	√	√	√	√	√		
9	Mobile carpet, drape, or furniture cleaning								√				√														√		
10	General contractors for home/commercial improvements (e.g. cement mixing, masonry, painting, etc.)		√	√			√		√	√			√		√	√						√	√	√	√		√		
11	Botanical or zoological gardens and nurseries/greenhouses	√	√		√				√	√			√	√	√		√		√	√	√		√	√	√		√		
12	Landscaping - parks, golf courses, cemeteries, etc.		√		√								√	√	√	√	√		√	√	√		√		√		√		
13	Marinas		√						√	√			√		√		√		√					√	√		√		
14	Animal kennels, horse stables		√	√	x				√		√		√		√				√		√			√	√		√		
	Residential Areas and Activities																												
15	home automobile associated activities, home and garden care activities, waste disposal	√							√	√			√	√	√					√			√	√	√				
	New Development and Significant Redevelopment Projects																												
16	Development subject to SUSMPs - ?	√	√	√	√	√	√	√	√	√		√	√	√	√		√		√	√	√		√	√	√	√	√		

Table 5-1. Baseline Non-Structural BMPs for Priority Source Categories

		Cover		Containment											Prevention									Good Housekeeping				Administrative	
Source #	Priority Sources	Store/Conduct material/activity Inside	Cover Activity/material	Use designated areas for activity, clean up or loading	Berm activity area or direct run on	Provide secondary containment	Provide drip plans, etc. to collect leaks/spills	Clean floor mats, etc. indoors	Properly dispose of process or wash water.	Immediately clean up spills with dry methods	Keep animals out of creeks	Wash vehicles and equipment in designated areas	Maintain spill clean up material/equipment readily available.	Properly store and dispose of green waste	Properly store and dispose hazardous material/chemicals	Schedule activity in dry weather	Label containers and maintain up-to-date inventory	Drain fluids from automobile	Provide signage for storm drains, materials storage, etc.	Properly manage pesticide/fertilizer use	Provide vegetation cover	Protect Storm drains	Practice water conservation	Inspect activity/storage area regularly	Clean up regularly with dry methods	Clean trash disposal areas	Train employees	Develop & Implement Spill Prevention Plan	Develop & Implement SWPPP
	Construction Projects																												
17	Construction sites												√								√	√						√	√
	Municipal Facilities/activities																												
18	Roads, streets, highways, and parking facilities			√			√		√	√			√			√			√			√	√	√	√		√		
19	Corporate yards (incl. maintenance/storage yards)	√	√	√	√	√	√		√	√		√	√		√		√		√	√			√	√	√	√	√	√	√
20	Park and Recreational facilities		√						√				√	√	√	√			√	√	√		√		√		√		
	Industrial Facilities																												
21	Chemical and allied products	√	√	√	√	√			√	√			√		√		√		√					√	√		√	√	√
22	Fabricated metal	√	√	√	√	√			√	√			√		√		√		√					√	√		√	√	√
23	Primary metal		√		√	√			√	√			√		√		√		√					√	√		√	√	√
24	Recycling, junkyards, scrap metal	√	√	√	√	√	√		√	√			√		√		√	√	√					x	√	√	√	√	√
25	Motor Freight	√	√	√	√	√	√		√	√		√	√		√		√	√	√					√	√	√	√	√	√

Most models of community outreach rely on development of large scale education and publicity campaigns to encourage behavior change. Change may be seen in the initial stages of the traditional campaign, but establishing long-term, sustainable behavior change is the key to reducing pollutant loads in the long-term.

The complexity of broad based behavior change by a number of target audiences contributing to high pollutant load requires a more dynamic outreach model. Doug McKenzie-Mohr, Ph.D., Environmental Psychologist, in his guide, "Fostering Sustainable Behavior: An Introduction to Community Based Social Marketing, (1999), outlines four broad steps to achieve a cleaner environment. The steps include:

1. identifying the barriers and benefits to an activity;
2. developing a strategy that uses tools shown to be effective to bring about behavior change;
3. establish pilot education and outreach strategies and gather analytical data; and,
4. evaluate strategy after implementation of selected pilot in the broader community.

This model is a social science based approach. It is based on the premise that behavior change is best achieved through community level initiatives which focus on removing barriers to an activity while simultaneously enhancing the activities benefits. A community based social marketing approach (www.CBSM.com) is recommended for this watershed.

An additional non-structural BMP that can be effective in removal of potential sources of metals and other constituents is street sweeping. The fine-grain and organic materials that accumulate on roadways can be a source of total metals that when carried by storm water can be a source of dissolved metals exceedances depending on the water hardness, valence of the metal species present and water pH. The City currently implements a street sweeping program. These methods can be optimized by using more effective sweeping methods and equipment. These methods include increasing the frequency of the sweeping in targeted areas. More aggressive methods may also include the use of vacuum-assisted and regenerative air sweepers. These sweepers are generally more efficient than mechanical sweepers at removing finer sediments, which often bind a higher proportion of heavy metals. Vacuum street sweeping removes 75% - 85% of total metals compared to a removal efficiency of 35% - 47% for mechanical street sweeping. Initial capital costs are only slightly higher than mechanical street sweeping and overall yearly maintenance cost is estimated to be half of mechanical street sweeping (http://www.fhwa.dot.gov/environment/ultraurb/). Implementation of more effective street sweeping methods should be conducted in targeted subwatersheds and the effectiveness of these methods (use of vacuum assisted sweepers, increased frequency, and ordinances that improve coverage) monitored for a period of several years to determine if these methods are meeting the stated objectives or whether additional measures are needed.

In conclusion, many of these baseline non-structural BMPs are currently being implemented through existing educational programs, ordinances and enforcement programs. Greater effectiveness can be achieved to meet the TMDL goals through a review of these existing programs and by targeting resources on the priority sources. Prioritization of industrial facilities that are identified as high loading potential needs also to be part of the non-structural program. Prioritized source control and pollution prevention activities should include identifying and determining present practices; review and revise codes accordingly to provide more specific requirements that maximize pollution prevention and source control measures; and conduct regular inspections at these targeted facilities. More aggressive street sweeping of targeted areas should also be conducted to reduce the load of source material that is carried by storm water to the receiving water.

These targeted measures and the monitoring of the effectiveness of these measures can provide a cost-effective approach to meeting the TMDL limits. However, there is no current data to determine the estimated reduction in concentration and load to the receiving waters that can be achieved by these non-structural BMPs. In addition to load reduction estimates and effectiveness monitoring, the contribution from these priority sources compared to non-point sources such as air deposition needs to also be quantified in order to assess whether these measures can meet the TMDL limits. Therefore, the total contribution of all sources needs to be quantified. The results of these studies and monitoring could then be used to determine what additional measures are needed to meet the TMDL limits in a cost effective manner.

It is also recommended that the City in collaboration with the Copermittees develop methods to estimate load reductions from these baseline non-structural BMPs, and then measure the actual reductions to determine the effectiveness of the measures. As discussed above, the effectiveness of non-structural BMPs can not be accurately assessed without actual effectiveness data that compares drainage areas in which these measures are fully implemented to drainage areas where little or no measures are established. Published data indicate the effectiveness of these measures vary widely. For example, if a 50% reduction in concentrations of metals could be achieved in currently monitored subwatersheds, the TMDL requirement would likely be met for dissolved zinc, but not for dissolved copper or dissolved lead. Case studies also indicate that source control and pollution prevention measures may have diminishing returns at each incremental reduction for low concentrations in storm water. Non-structural BMPs may only be cost effective in reducing constituent concentration to a certain level, which may or may not still be above the regulatory limit. Furthermore, published data on these measures indicate challenges to meeting regulatory limits for bacteria throughout the regulated receiving waters due to regrowth and significant number of both anthropogenic and background sources. Source control and pollution prevention measures are most effective when targeted to sources and activities that have the greatest loading potential for the constituents of concern. Focused source studies should be conducted to verify the unknown loading potential sources and update current inventories.

5.3 Assessment of Integrated Runoff Reduction and Treatment BMP Technologies

Runoff reduction and treatment BMP technologies that reduce runoff volumes, constituent concentrations and loading in storm water flows are evaluated in this section. This assessment of structural BMPs is based on both a thorough literature search and project experience. Effectiveness of treatment BMPs is based on information presented in the Treatment BMP Technology Report (Caltrans, April 2006), USACE/USEPA BMP Database (USACE, 2006), and other technical publications. The results of this research effort were used to develop a list of BMP technologies that address the current and future TMDLs in an integrated approach. BMP technologies that therefore address not only dissolved metals, but bacteria and pesticides were selected for further evaluation. An integrated approach to BMP selection provides for cost effective implementation of the TMDLs. The selected runoff reduction and treatment BMPs were evaluated with regard to the specific watershed characteristics and the regulatory issues that include the "tributary rule" and potential environmental impact issues due to receiving waters diversions (see Appendix C). Based on the screening of these technologies, recommended technologies were selected to develop treatment alternatives that meet the stated objectives.

Runoff reduction BMPs include technologies that reduce the runoff volumes and peak flows. These BMPs can target both dry and wet weather flows. Through the reduction of runoff volume, these methods can be used to reduce the volume of urban runoff or storm water that requires treatment. These techniques can be combined with treatment BMPs to both reduce volume and treat runoff to meet the TMDL requirements. Runoff reduction measures include non-structural BMPs listed in Table 5-1 such as water conservation measures. The use of weather-based irrigation systems for residential properties and municipal parks can both reduce dry weather flows and the total load for numerous constituents. Structural BMPs that reduce runoff include bioretention, infiltration and low impact development technologies. These BMPs are assessed and screened with other treatment technologies in this section.

Table 5-2 presents the treatment BMPs that have been selected based on the review of published data and design reports. Treatment BMP technologies that have a medium to high rating for effectiveness for each of the constituents of concern (dissolved metals, bacteria and pesticides) were selected for inclusion in this table. There are numerous treatment BMPs that address some of the constituents. However, an integrated approach was taken for this assessment. Only those BMPs that address all the constituents of concern are listed in Table 5-2 for further evaluation. Table 5-2 presents the reported removal efficiency for dissolved metals and whether data is available that indicate that the California Toxics Rule concentrations would be met. The reported removal efficiency for bacteria and pesticides is also provided.

The screening table also presents regulatory issues that may constrain the location, implementation and effectiveness of the BMP technology. These regulatory issues include the RWQCB's interpretation of the "tributary rule" and the potential environmental impact considerations for diversion of waters from the receiving waters, temporary storage and treatment prior to discharge back into the creek. These regulatory issues restrict the placement of treatment BMPs that may require large areas for equalization and sedimentation of storm flows prior to treatment, depending on the drainage area size and required design storm volume to be treated. These issues are discussed further in the following subsection.

Also evaluated in Table 5-2 are the watershed characteristics that will limit the application of BMP technologies. This includes the predominance of low-permeability soils in the watershed which limit the application of infiltration type treatment BMPs. Also presented in Table 5-2 are the relative costs of the BMPs relative to both capital and operations and maintenance costs. Finally, the recommendation whether to retain the BMP for consideration in the TMDL Implementation Plan is presented in the final column of Table 5-2.

Table 5-2. Screening of Selected Integrated Runoff Reduction and Treatment BMP Technologies

Applicable BMP Technologies - Description	Removal Efficiency Rating for Dissolved Metals (1)	Performance Data Indicating CTR Concentrations Will be Achieved	Removal Efficiency Rating for Bacteria (1)	Removal Efficiency Rating for Pesticides (1)	Regulatory Implementation Issues (Interpretation of Tributary Rule and Stream Diversion)	Watershed Characterization Implementation Issues (Low Permeability Soil, Urbanized	Relative Capital Costs	Relative O&M Costs	Retain BMP for TMDL Implementation Plan
1. **Adsorption/Ion Exchange – Granular Activated Carbon – Treatment Train** – Equalization Basin to a Screen or Filter Bag to a Granular Activated Carbon (GAC) column fed by gravity	High	Data on the effectiveness of this technology for storm water applications is limited. Due to potential clogging and interferences from organic material, the efficiency of the GAC column may be reduced and outflow concentration may not meet CTR.	Medium GAC may promote consider-able microbial growth on carbon surface	High	Technology will require equalization of storm water flows in order to provide gravity controlled flow to GAC units. RWQCB interpretation of tributary rule Would limit placement of equalization structures between storm drain outlets and receiving waters. Diversion from the creek to temporary storage and treatment also prohibited. Alternative locations for equalization are above the outlet in urbanized private lands or available public land. Conveyance and possible pumping of storm water may be needed to equalization and treatment structures. RWQCB indicated a case by case review required if the BMP requires an "extension" of the MS4 system.	Highly urbanized setting reduces lower cost opportunities to install this technology. Sufficient Public lands that are close to discharge points are only available in upper watersheds. Interpretation of tributary rule limits installation between the outfall and the Receiving waters. Remaining options are to locate systems within residential and commercial areas requiring buy-out of private property.	High Rated high compared to Retention Basin but provides greater benefit in reducing pollutants	High Spent GAC media may be considered haz waste	Yes Treatment system requires pretreatment and equalization through a retention-sedimentation basin. A smaller "package" treatment system may be applicable for small (>10acres) drainage area and design storm of 0.5 in. Larger drainage areas and storm events will require large areas for equalization and pretreatment. Regulatory issues will restrict placement of these systems to above the outfalls on private lands or available public lands to which the storm flows will need to be conveyed, and potentially pumped. Reduction of flows through Low Impact Development has limited application due to built-out status of the watershed and low permeability soils.
2. **Equalization, Chemical Precipitation Treatment (Sodium Sulfide) and Sand Filter** – This is a chemical treatment process that includes equalization in a basin or vault followed by a treatment process of pH adjustment, precipitation, clarifier, and removal of fine particles using a sand filter prior to discharge into the receiving waters.	High	Data on the effectiveness of this technology for storm water applications is currently not available. This is an effective chemical treatment process that can meet the CTR concentrations for constant flows with consistent characteristics. The high variability of storm water flows and constituent concentrations may limit the effectiveness of this treatment system.	Medium	Medium	Technology will require equalization of storm water flows in order to provide controlled and steady flow to the chemical treatment unit. Same regulatory issues as Technology No. 1 (see above) with regard to location constraints for equalization and treatment systems.	Same issues of urbanized setting as Technology No. 1.	High Not rated in Caltrans Guidance document – Treatment system will be high capital cost	High Sludge may be consider-ed haz waste	Yes Treatment system has not been applied to storm water applications which are infrequent and highly variable. System will require trained operator, although some of the system can be automated. Effectiveness of this process requires continuous operation, which is not the case for periodic and variable storm flows. See Technology No. 1 regarding space constraint issues for equalization and pretreatment.
3. **Adsorption/Ion Exchange – Granular Activated Carbon (GAC) or Ion Exchange (IX) Media w/ Detention Sedimentation BMPs** – Treatment Train – Storm water enters mixing chamber with GAC or IX media and then flows to sedimentation basin and finally filtration chamber	High	The effectiveness of this technology on storm water applications is dependent on volume of flows that are required for treatment. In order to allow sufficient mixing/ contact with GAC or IX, the flow needs to be controlled. This BMP may not meet CTR at higher flows where less contact would occur.	Medium	High	Technology will require sufficient space to construct mixing chamber, sedimentation chamber or basin and filtration chamber /bed. Same regulatory issues as Technology No. 1 (see above) with regard to location constraints for equalization and treatment systems.	Same issues of urbanized setting as Technology No. 1.	High Rated high compared to retention basin but provides greater benefit in reducing pollutants	High	Yes See Technology No. 1 regarding space constraint issues for equalization and pretreatment.
4. **Adsorption/Ion Exchange – GAC Sandwich Filter and Blanket w/ Pretreatment Detention Sedimentation BMPs or Chemically Enhanced Detention Basin (CEDBs)**– Storm water flows to Equalization / Detention	High	The effectiveness of this BMP on storm water flows is in the pilot testing stage. Results reported by Caltrans and the Navy on pilot projects using activated alumina indicate technologies is effective in significantly reducing dissolved	Medium GAC may promote microbial growth	High	Technology will require equalization of storm water flows in order to provide gravity controlled flow to GAC or IX Filter Chamber / Bed. Same regulatory issues as Technology No. 1 (see above) with regard to location constraints for	Same issues of urbanized setting as Technology No. 1.	High Rated high compared to retention basin but provides greater	High Frequent clogging and short bedlife require high O&M	Yes See Technology No. 1 regarding space constraint issues for equalization and pretreatment.

Table 5-2. Screening of Selected Integrated Runoff Reduction and Treatment BMP Technologies

Applicable BMP Technologies - Description	Removal Efficiency Rating for Dissolved Metals (1)	Performance Data Indicating CTR Concentrations Will be Achieved	Removal Efficiency Rating for Bacteria (1)	Removal Efficiency Rating for Pesticides (1)	Regulatory Implementation Issues (Interpretation of Tributary Rule and Stream Diversion)	Watershed Characterization Implementation Issues (Low Permeability Soil, Urbanized	Relative Capital Costs	Relative O&M Costs	Retain BMP for TMDL Implementation Plan
Basin then to Filter Chamber/ Bed composed of GAC or IX underlain by a Sand Filter separated by Geotextile – discharge from Underdrains below Sand Filter. This system can be modified to incorporate these two steps into one CEDB if sufficient larger sediment is removed prior to entering CEDB to reduce clogging of the filter and treatment media.		metals. The effectiveness of the BMP in meeting the CTR concentration will depend on the level of maintenance of the filter system which would be prone to clogging. Use of geotextiles can reduce clogging and O&M but relative O&M costs will be high.			equalization and treatment systems.		benefit in reducing pollutants	Spent GAC / IX may be Haz Waste	
5. **Adsorption/GAC or IX Sandwich Filter and Blanket w/ Pretreatment Detention Sedimentation using Plate and Tube Settlers** - Similar technology to Item #3, but retention/sediment basin can be a vault or chamber that uses parallel plates or inclined tube to can increase sedimentation in smaller space	High	Same as Item #3.	Medium	High	Similar space and implementation issues as Item #3, however, the use of the plates or tubes within the first settlement stage of treatment can reduce the required space for this technology.	Similar implementation issues to Technology # 3, however depending on the amount of storm flow to be treated, the pre-treatment step space requirements are reduced by the use of parallel plates or inclined tubes within the vault or chamber since these reduce velocity and increase retention time using a smaller volume to be retained.	High Rated high compared to retention basin but provides greater benefit in reducing pollutants	High	Yes See Technology No. 1 regarding space constraint issues for equalization and pretreatment. For smaller drainage area, use of an underground vault and treatment/filtration chamber may be possible where sufficient public space is available near the MS4 system.
6. **Adsorption/Ion Exchange – Ion Exchange Column – Treatment Train** – Equalization Basin to a Screen or Filter Bag to a ion exchange (IX) column fed by gravity. IX resin could either be placed in pressure vessels or in a canister at the pond outlet	High	Data on the effectiveness of this technology for storm water applications is limited. Due to potential clogging if pretreatment does not remove enough sediment, and need to re-generate the IX resins, the efficiency of the GAC column may be reduced and outflow concentration may not meet CTR.	Medium	Medium	Technology will require equalization of storm water flows in order to provide gravity controlled flow to IX media columns. Same regulatory issues as Technology No. 1 (see above) with regard to location constraints for equalization and treatment systems.	Same issues of urbanized setting as Technology No. 1.	High Rated high compared to retention basin but provides greater benefit in reducing pollutants	High Spent IX media can be con-sidered Haz Waste	Yes See Technology No. 1 regarding space constraint issues for equalization and pretreatment.
7. **Modified Austin Sand Filter** – This technology is modeled after partial sedimentation type Austin-style sand filters, but with 12-24 inches of IX media overlain by sand rather than typical 18 inches of sand. Media can be activated iron coated alumina or other IX media.	High	The effectiveness of this BMP on storm water flows is in the pilot testing stage. Results reported by Caltrans on pilot projects using activated alumina indicate technologies is effective in significantly reducing dissolved metals. The effectiveness of the BMP in meeting the CTR concentration will depend on the level of maintenance of the filter system which would be prone to clogging.	Medium	Medium	Austin-style Filters may be installed below ground if treatment volume is not large. Therefore, the technology has a limited treatment capacity, but where applicable can potentially avoid the regulatory issues that are applicable to the above ground systems that have greater capacity and subsequent larger area requirements.	Technology is applicable to urbanized watersheds as it can be installed as a retrofit of existing storm drain channels system. *This BMP is undergoing pilot testing by Caltrans, and is limited in its treatment capacity.*	Medium	Medium	Yes This technology has limited treatment capacity because it is contained within a treatment chamber that is generally installed below ground. Therefore, this technology may have only select application to smaller drainage areas and portions of storm flows that through studies have identified a design storm or flow that should be treated to meet the objectives. Furthermore, this technology is in a testing stage. The effectiveness of this option to meeting the CTR and other constituent limits is not known.

Table 5-2. Screening of Selected Integrated Runoff Reduction and Treatment BMP Technologies

Applicable BMP Technologies - Description	Removal Efficiency Rating for Dissolved Metals (1)	Performance Data Indicating CTR Concentrations Will be Achieved	Removal Efficiency Rating for Bacteria (1)	Removal Efficiency Rating for Pesticides (1)	Regulatory Implementation Issues (Interpretation of Tributary Rule and Stream Diversion)	Watershed Characterization Implementation Issues (Low Permeability Soil, Urbanized	Relative Capital Costs	Relative O&M Costs	Retain BMP for TMDL Implementation Plan
8. **Bioretention** – This is manufactured modular bioretention system that is used in urban setting as an alternative to traditional curbside landscaping. There are also non-proprietary systems. Storm water enters curb inlet and infiltrates through soil and engineered media. Infiltration seeps into perforated pipe that flows into storm drain system. Plantings use root system to reduce pollutants and uptake pore water. *This technology is limited to first flush treatment.*	Medium	Pollutant removal efficiency high for limited flow that the system can treat. Capacity of the system is dependent on soil and engineered media permeability and storage capacity. Data on removal of dissolved metals is limited. System is effective in removal of total metals and particulates that may be a source of dissolved metals in the receiving waters. Technology can not treat full storm flows.	High	Medium	This technology can be retrofitted to existing storm drain systems in urban setting where sufficient room is available for plantings. Tributary rule does not limit application since this is applied at the storm drain inlets before the discharge to the canyons or receiving waters.	Technology is applicable to urbanized watersheds as it can be installed as a retrofit of existing storm drain system. There are high space requirements within the right of way to install the system. This includes the plantings, soil and engineering media within the right of way.	High Rated high compared to retention basin but provides greater benefit in reducing pollutants The cost will be high if implemented on a wide scale since the system capacity is relatively small. Construction in right of way may require traffic control.	Medium – Low Planting will require watering during dry season	Yes The technology is best applicable only to treatment of a small portion of storm events and therefore provides a "first flush" treatment option that can reduce particulates and total metals which may reduce dissolved metals concentrations at the storm drain outlets. BMP has limited applications where sufficient right of way is available to retrofit existing storm sewer and curb side plantings.
9. **Chemical Treatment-Alum – Treatment Train** – Alum is added through a chemical feed system to the storm water and then discharged to sedimentation basin where floc is settled out prior to discharge to receiving waters. A minimum of 1 minute retention time required after alum added before discharge to watershed.	Medium	Technology has been successfully used for phosphorus and suspended solids removal, less application for dissolved metals. CTR likely not to be achieved with this technology, although total metals concentrations will be significantly reduced	Medium	Medium	Technology will require large area for sedimentation basin to allow flocculent to settle out prior to discharge. Same regulatory issues as Technology No. 1 (see above) with regard to location constraints for equalization and treatment systems.	Highly urbanized setting significantly reduces opportunities to install this technology. Sufficient Public lands close to discharge points only available in upper watersheds, and tributary rule limits installation to above outfalls in residential and commercial areas	High Rated high compared to retention basin but provides greater benefit in reducing pollutants.	High Manage-ment and disposal costs of sludge Optimiza-tion of alum addition will vary with storm – high technical operational needs	No This treatment technology has relatively high costs and is rated as medium for all the constituents of concern. Application in urbanized setting also limited. Other technologies already listed provided greater efficiencies and greater chance of meeting treatment goals.
10. **Linear Bioretention Trenches** – This is similar to Item #6, but is not a manufactured modular bioretention system rather a French drain type system into which sheet flow enters and infiltrates into a plant/filter medium underlain by a gravel and drain pipe system. The filter media is separated from the drain layer by a geotextile. *This BMP is more of a runoff and treatment volume reduction BMP as it is limited in its capacity.*	Medium	Pollutant removal efficiency high for limited flow that the system can treat. Capacity of the system is dependent on soil and engineered media permeability and storage capacity. Data on removal of dissolved metals is limited. System is effective in removal of total metals and particulates that may be a source of dissolved metals in the receiving waters. Technology can not treat full storm flows. *This BMP is more of a runoff and treatment volume reduction BMP as it is limited in its capacity unless additional*	High	Medium	This technology can be retrofitted to existing concrete swales/ lined channels allowing storm water to infiltrate into the filter media and to the drainage pipe. Tributary rule does not limit application since this is applied to storm water conveyance systems before the discharge to the canyons or receiving waters.	Technology is applicable to urbanized watersheds as it can be installed as a retrofit of existing storm drain channels system. *This BMP is more of a runoff and treatment volume reduction BMP as it is limited in its capacity unless additional storage is provided through installation of larger below ground drainage layers.*	Medium -Low The cost will be high if implemented on a wide scale since the system capacity is relatively small. Construction in right of way may require traffic control.	Medium – Low Planting will require watering during dry season	Yes BMP has limited applications where sufficient right of way is available to retrofit existing storm channels. The technology also is applicable only for *runoff and treatment volume reduction* of a small portion of storm events and therefore provides a "first flush" treatment option that can reduce particulates and total metals which may reduce dissolved metals concentrations at the storm drain outlets.

Table 5-2. Screening of Selected Integrated Runoff Reduction and Treatment BMP Technologies

Applicable BMP Technologies - Description	Removal Efficiency Rating for Dissolved Metals (1)	Performance Data Indicating CTR Concentrations Will be Achieved	Removal Efficiency Rating for Bacteria (1)	Removal Efficiency Rating for Pesticides (1)	Regulatory Implementation Issues (Interpretation of Tributary Rule and Stream Diversion)	Watershed Characterization Implementation Issues (Low Permeability Soil, Urbanized	Relative Capital Costs	Relative O&M Costs	Retain BMP for TMDL Implementation Plan
		storage is provided through installation of larger below ground drainage layers.							
11. **Below Grade Infiltration Chambers** – There are numerous available manufactured systems (Cultec Contractor, Recharger, Matrix, Rainstore, Stormcell, Stormchamber, Stormtech, & VersiCell) that provide temporary storage of storm water flows within sub-surface vaults or chamber that then allow for direct infiltration into the subsoils or first distribute the stored storm water through a seepage drainage bed that is then infiltrated into the sub-soils.	High	This technology has been proven to meet required concentrations since the storm water is completely infiltrated into the sub-soils rather than discharged to the receiving waters.	High	High	Technology has less location constraints associated with the tributary rule than the above ground systems since these underground systems can be installed in urbanized areas and the above ground uses can be maintained for applications such as parking areas. Load and access limitation will restrict location. Highly developed residential areas will have limited space for even underground systems.	The Watershed is characterized by poorly draining soils. The application of BMPs that use infiltration may be limited within the watershed. Site specific geotechnical investigations are needed to determine if subsurface soils provide adequate infiltration rates.	High-Medium Rated high compared to retention basin but provides greater benefit in reducing pollutants	Medium-Low	Not for Widescale Implementation – May be applicable where site specific geotechnical investigations indicate subsurface soils have adequate infiltration rates to accommodate repeated storm events without resulting in flooding. Due to the low permeability of the soils within the watershed, the application of BMPs that use infiltration to treat full design flows is limited to a small percentage of watershed area that is located along the former receiving waters that is precluded from use by the tributary rule.
12. **Porous Pavement** – Allows storm water to infiltrate through the pavement section to a stone "reservoir course" that stores the storm water until it infiltrates into the underlying soils.	High	This technology has been proven to meet required concentrations since the storm water is completely infiltrated into the sub-soils rather than discharged to the receiving waters.	High	High	Technology does not have the same regulatory issues associated with the location of this BMP as those that require equalization and treatment at the storm drain outlet since porous pavement can be installed on roadways and parking areas upstream of the storm drain discharge in urbanized areas.	The Watershed is characterized by poorly draining soils. The application of BMPs that use infiltration is limited within the watershed unless additional storage is provided through engineered below ground drainage layers. Underdrain systems will also be required to prevent built-up of head and potential structural damage. Site specific geotechnical investigations are needed to determine if subsurface soils provide adequate infiltration rates.	High Rated high compared to retention basin but provides greater benefit in reducing pollutants	Medium-Low	Yes – Limited Applications Where Engineered Drainage Layers and Under drain systems provided. Due to the low permeability of the soils within the watershed, the application of BMPs that use infiltration is limited to a small percentage of watershed area that is located along the former receiving waters that is precluded from use by the tributary rule. Technologies that rely on infiltration can be engineered for low permeability soils if sufficient storage is provided through underground drainage layers and under drain systems. These engineered systems will still have finite storage capacity to treat large storm flows requiring by-pass systems to address flooding.
13. **Infiltration Basins** – Basin are installed as an "off line" system that collected and stores a design storm volume and allows the storm water to infiltrate into the sub-soils	High	This technology has been proven to meet required concentrations since the storm water is completely infiltrated into the sub-soils rather than discharged to the receiving waters.	High	High	Same regulatory issues as Technology No. 1 (see above) with regard to location constraints for equalization and treatment systems.	The Watershed is characterized by poorly draining soils. The application of BMPs that use infiltration is limited within the watershed. Site specific geotechnical investigations are needed to determine if subsurface soils provide adequate infiltration rates.	Lower Rated lower compared to retention basin but provides greater benefit in reducing pollutants	Medium-Low	Not for Widescale Implementation – May be applicable where site specific geotechnical investigations indicate subsurface soils have adequate infiltration rates to accommodate repeated storm events without resulting in flooding. Due to the low permeability of the soils within the watershed, the application of these BMPs that uses infiltration is limited to a small percentage of watershed area that is located along the former receiving waters that is precluded from use by the tributary rule. Although technologies that rely on infiltration can be engineered for low permeability soils if sufficient storage is provided through underground drainage

Table 5-2. Screening of Selected Integrated Runoff Reduction and Treatment BMP Technologies

Applicable BMP Technologies - Description	Removal Efficiency Rating for Dissolved Metals (1)	Performance Data Indicating CTR Concentrations Will be Achieved	Removal Efficiency Rating for Bacteria (1)	Removal Efficiency Rating for Pesticides (1)	Regulatory Implementation Issues (Interpretation of Tributary Rule and Stream Diversion)	Watershed Characterization Implementation Issues (Low Permeability Soil, Urbanized	Relative Capital Costs	Relative O&M Costs	Retain BMP for TMDL Implementation Plan
									layers, infiltration basins will require these systems across the basin and therefore function as a sand filter system with under drains. A sand filter alone will not meet the objectives. Therefore, this technology does not provide a cost effective alternative.
14. **Bio-swale with Infiltration** – BMP uses vegetation to reduce transport of sediment and infiltration to treat the remaining flow – Application is limited to pre-treatment or to limited storm water flow or design flow.	High	This technology has been proven to meet required concentrations since the storm water is completely infiltrated into the sub-soils rather than discharged to the receiving waters. This BMP has limited applications due to the limited capacity.	High	High	Technology does not have the same regulatory issues associated with the location of this BMP as those that require equalization and treatment at the storm drain outlet since these systems can be installed in urbanized areas. Trenches can be installed as a retrofit to existing swales.	The Watershed is characterized by poorly draining soils. The application of BMPs that use infiltration is limited within the watershed. Site specific geotechnical investigations are needed to determine if subsurface soils provide adequate infiltration rates.	High-Medium Rated high compared to retention basin but provides greater benefit in reducing pollutants	Medium-Low	Yes – As a runoff and treatment volume reduction technique Due to the low permeability of the soils within the watershed, the application of BMPs that use infiltration is limited to a small percentage of watershed area that is located along the former receiving waters that is precluded from use by the tributary rule. Technologies that rely on infiltration can be engineered for low permeability soils if sufficient storage is provided through underground drainage layers and under drain systems. These engineered systems will still have finite storage capacity to treat large storm flows requiring by-pass systems to address flooding.
15. **Low Impact Site Design (LID) Techniques** – This includes collection, storage and reuse of runoff from roof drains. LID techniques also include porous pavement (#12), bioswales (#13), and bioretention (#8) technologies that use infiltration to reduce runoff flows and thus reduce pollutant loads	High	LID techniques have the potential to meet the CTR concentrations if applied throughout the drainage area resulting in the significant reductions in runoff volumes and thus concentrations at the storm drain outlets. The performance of this technology will therefore depend on the level of implementation, and for infiltration techniques, the capacity of the soils to infiltrate and store runoff volumes. This BMP has limitations to full scale implementation in the Chollas Creek watershed which is built-out and has predominantly low permeability soils. These systems can include modification of existing subgrade soils and replacement of poorly draining soils with sand layers.	High	High	Technology does not have the same regulatory issues associated with the location of this BMP as those that require equalization and treatment at the storm drain outlet since these systems can be installed in urbanized areas.	The Watershed is characterized by poorly draining soils. The application of BMPs that use infiltration is very limited within the watershed unless additional storage is provided through engineered below ground drainage layers. Underdrain systems will also be required to prevent built-up of head and potential structural damage.	Medium	Medium	Yes – As a runoff and treatment volume reduction technique Due to the low permeability of the soils within the watershed, the application of BMPs that use infiltration is limited to a small percentage of watershed area that is located along the former receiving waters that is precluded from use by the tributary rule. Technologies that rely on infiltration can be engineered for low permeability soils if sufficient storage is provided through underground drainage layers and underdrain systems. These engineered systems will still have finite storage capacity to treat large storm flows requiring by-pass systems to address flooding. The Chollas Creek watershed is built-out in most of the sub-watersheds requiring retrofitting for LID applications. LID for new construction can reduce future potential increases in runoff volume and peak flows. This technology will be retained for use as a runoff and treatment volume reduction technique of storm water up to the capacity of the system.
16. **Dry Weather and First Flush Diversion Structures** – This technology would divert dry weather flows from selected storm drain outlets that are observed to pool nuisance flows at the	High	Metals exceedances are not an issue in dry weather flows, but may be accumulated in pools at some outlet structures that then are washed into the channel as part of the first flush. Pollutograph data is	High Same issue as metals removal with regard to whether the	High Same issue as metals removal with regard to whether	No regulatory issues that would constrain location of BMP Diversion of dry weather flows may be limited by the provision in the TMDL that restrict disrupting the hydrology in the creek.	Highly urbanized nature of the watershed will impact implementation of this BMP that will require retro-fitting existing storm drain outlets and construction of conveyance lines to	Medium	Medium	Yes This BMP is applicable only to those outlets where a connection to the sanitary sewer is feasible and where dry weather flows are sufficient and contain constituent concentrations in exceedances of the water quality objectives. The Creek is generally dry

Table 5-2. Screening of Selected Integrated Runoff Reduction and Treatment BMP Technologies

Applicable BMP Technologies - Description	Removal Efficiency Rating for Dissolved Metals (1)	Performance Data Indicating CTR Concentrations Will be Achieved	Removal Efficiency Rating for Bacteria (1)	Removal Efficiency Rating for Pesticides (1)	Regulatory Implementation Issues (Interpretation of Tributary Rule and Stream Diversion)	Watershed Characterization Implementation Issues (Low Permeability Soil, Urbanized	Relative Capital Costs	Relative O&M Costs	Retain BMP for TMDL Implementation Plan
discharge, and convey these flows to the existing sanitary sewer. These diversion structures can also divert a portion of the first flush of a storm event until a design flow is reached and is then bypassed.		needed to assess if metals are a first flush issue that if diverted would reduce the flow weighted concentrations down to CTR values.	bacteria levels are highest in the first flush and can be reduced to meet regulatory objectives	pesticides levels are highest in the first flush and can be reduced to meet regulatory objectives	Further clarification from the Regional Board is needed on this issue which indicates to preserve an anthropogenic created condition.	connect with the sanitary sewer.			during the dry weather period, but outlets are observed to pool nuisance flows near the discharge point. Pollutograph data is needed to assess whether dry weather and first flush diversions would be effective in reducing concentrations in flow weighted storm water samples to below the objectives for all the constituents under current and proposed TMDLs. The capacity of the existing sewer lines and the treatment plant also needs to be verified.

The results of the screening analysis for the runoff reduction and treatment BMP technologies are presented in the final column of Table 5-2. Based on this evaluation, the following treatment BMP technologies were selected for alternative development and conceptual cost estimation:

Alternative Filtration Media Treatment Systems

- Equalization Basin/Chamber, Filter/Screen and Granular Activated Carbon (GAC) Column or Ion Exchange (IX) Media Treatment Train
- GAC or IX Media Mixing Chamber with flow to Sedimentation Basin
- Pretreatment Sedimentation Basin and GAC or IX Treatment Bed Underlain by Sand Filter and Underdrain System – "GAC/IX Sandwich Filter"
- Modified Austin Sand Filter with Activated Alumina or other IX Media

Chemical Precipitation Treatment Systems

- Treatment System Composed of Equalization Basin/Chamber, Chemical Precipitation Process (Sodium Sulfate) and Sand Filter

Runoff Reduction and Treatment Volume Reduction BMPs

- Low Impact Design Technologies – New Development and Retro-fits – Collection, storage and reuse of runoff from roofs; porous pavement; and, bioretention and bio-swales using engineered drainage layers and underdrain systems
- Bioretention Filter for Storm Drain Inlets – Storm water enters inlet and infiltrates through vegetated soil layer and IX Media and then flows to Storm Sewer
- Linear Bioretention Trenches

Selected Flow Diversion Systems

- Dry Weather and First Flush Diversions to Sanitary Sewer

Traditional infiltration technologies were rated the highest for removal efficiencies for all the constituent groups. However, preliminary soils data based on the Natural Resources Conservation Service surveys suggest that the implementation of these BMPs may be restricted in many areas of the Chollas Creek watershed that is characterized by poorly draining soils. These data may however not be fully representative of the underlying soil conditions. Site specific geotechnical investigations are needed to obtain the necessary soil information to determine the actual storage capacity and infiltration rates within targeted areas. The use of infiltration basins and sub-surface galleries to capture and treat a full design storm have not been retained for wide-spread implementation in the watershed due to predominantly built-out conditions and suggested low permeability soils of this watershed. These technologies may be applicable on a site-specific basis where sub-surface soils have adequate infiltration rates to allow for evacuation of these systems between storm events without resulting in flooding of adjacent properties. Site-specific geotechnical studies to assess the application of infiltration technologies should also include an investigation of the depth to groundwater and the potential for downward migration of contaminants. Placement of infiltration technologies is also limited to lower elevations or at locations that will not result in greater slope seepage and potential slope instability. Furthermore, large below ground infiltration vaults would require extensive maintenance and additional engineering backfill to assure they are evacuated in a reasonable time frame to control bacteria growth and vector control. Therefore, widespread infiltration technologies are not recommended, but may be used where site-specific investigations indicate the low permeability soils, groundwater contamination, slope seepage and stability and high maintenance issues can be addressed cost effectively.

The development of Low Impact Design (LID) features such as engineered porous pavement, sunken vegetated islands and sidewalk strips ("Green Streets"), and bioswales have been retained. The Chollas Creek watershed is built-out in most of the sub-watersheds requiring retrofitting for LID applications. LID for new construction can reduce future potential increases in runoff volume and peak flows. Depending on the actual soil conditions and the size of the drainage area, these BMPs can be effective in significantly reducing runoff volumes and ultimately the volume that may require treatment to meet the TMDL goals. LID techniques can be engineered to include additional granular drainage layers and modification of underlying soils to increase storage capacity and permeability. These additional components will increase the cost and space requirements of these systems. For smaller drainage areas, these BMPs can potentially capture close to the design storm eliminating the need for further treatment BMPs. This will depend on the site specific conditions and the defined design storm to be treated.

The potential effectiveness of LID techniques in reducing runoff volumes and associated pollutant load is further discussed in the following sub-sections. Also presented in the following sub-sections is further discussion on the effectiveness of the treatment BMP selected based on available data and operational issues.

5.3.1 Summary of Effectiveness Assessment Monitoring of Treatment BMPs in Chollas Creek Watershed and Emerging Treatment Technologies

This subsection presents the available results on BMP effectiveness within the Chollas Creek watershed and a summary of emerging treatment technologies. This discussion supplements the technology screening summary presented in Table 5-2. This discussion focuses on data and technologies that address the dissolved metals TMDL. An integrated TMDL implementation is recommended, and therefore as data and technologies emerge that address the full constituent list for current and future TMDLs, these data need to be assessed as part of the TMDL Implementation Plan.

The Chollas Creek TMDL for metals is a concentration based TMDL based on the California Toxics Rule (CTR). The water quality criteria are dependant on the hardness concentrations determined at the specific point of sample collection. In Chollas Creek, the high density of impervious surfaces limits the contact of natural earthen soils and materials and as a result, the hardness concentrations are relatively low in comparison to other watersheds in San Diego County. In order to attain compliance with the Chollas Creek Metals TMDL for wet weather flows, the selection of BMPs needs to be based on the ability to meet the CTR criteria rather than on a percent reduction in total constituent loading. As indicated in Table 5-2, the data that is available on treatment BMP effectiveness for dissolved metals is limited. Specific data on the effectiveness of structural BMPs in the Chollas Creek watershed is even more limited.

Data is available from studies conducted by Caltrans and is presented in this section for two BMPs. A comparison of available results from two BMPs (Vegetated Buffer Strips and Dry

Detention Basins) was conducted for application to the Chollas Creek TMDL. These BMPs were targeted to address the dissolved metals TMDL only. As discussed above, the BMP assessment in this report presents an integrated approach. Therefore, the BMPs selected for evaluation in Table 5-2 did not include these BMPs because they were not rated either high or medium for all three constituents of concern (dissolved metals, bacteria, and pesticides). The results presented in this section are provided as additional information on the overall effectiveness data that is available for treatment BMPs targeted at dissolved metals. These results confirm that more complex treatment systems are needed to meet the CTR and provide effectiveness in an integrated approach.

A comparison of mean storm water results from the 2001-02 and 2002-03 monitoring seasons for the Caltrans Roadside Vegetated Treatment Sites (RVTS) Study (Caltrans, 2003) was conducted for application to the Chollas Creek TMDL for metals. In the RVTS study, Caltrans performed two years of water quality monitoring of roadside vegetated buffer strips (biofilter). Biofilters consisted of existing vegetated slopes adjacent to a freeway. Flow weighted composites were collected at the edge of pavement (representative of influent concentrations) and at the effluent of three different lengths of sloped vegetated area. The mean total and dissolved copper results exceeded its respective CTR value based on hardness for both the edge of pavement and the effluent samples. The mean total zinc results exceeded the CTR values for both the edge of pavement and effluent samples. Therefore, the performance of vegetated buffer strips did not meet the concentration based metals TMDL. However, significant reductions in metals concentrations were reported.

A comparison of mean storm water results from the 2004-2005 wet weather monitoring season for the Caltrans San Joaquin Hills Transportation Corridor portion of State Route 73 (SR-73) BMP pilot program was conducted (Caltrans, 2006). In the SR-73 pilot program, eight detention basins were used for water quality purposes and were designed to hold a volume of runoff from a particular subwatershed up to or equal to a prescribed design storm. Each detention basin had results for influent (representative of urban highway runoff), effluent, and bypass concentrations. For the purposes of comparing these results, which are similar in nature to the roadways found in the Chollas Creek Watershed, the mean influent and effluent concentrations were compared to the CTR for copper, lead, and zinc for both total and dissolved fractions. At some sites, the mean effluent concentrations were higher than the mean influent concentrations (i.e., total and dissolved zinc for site 883L). More importantly is that of the eight detention basins evaluated; only one site (1143L) had a mean concentration below the CTR for dissolved copper. All mean total copper results for all sites exceeded the CTR. In all cases where the dissolved zinc concentration exceeded the CTR for the influent, the effluent also exceeded the CTR. Therefore, the performance of detention basins alone did not meet the concentration based metals TMDL.

These results confirm the earlier conclusions of the technologies feasibility assessment that more complex treatment systems are required to collect and treat the complete design storm event to meet the dissolved metals, bacteria and potentially pesticide TMDLs waste load. The technologies that were retained from the screening also include the use of a combination of augmented infiltration, bioretention, porous pavement and other LID techniques that can significantly reduce the volume of runoff and the volume requiring treatment. It is recommended that these augmented infiltration and bioretention BMPs be implemented to maximize the effectiveness of these lower impact techniques. Reductions in runoff and treatment volume from these combined LID measures can significantly reduce the need for more infrastructure intensive treatment train BMPs where applicable. Because there are no data on the effectiveness of the retained treatment BMPs in Chollas Creek, it is recommended that these LID techniques be implemented in a tiered approach that is initiated through phased treatment BMP projects and effectiveness assessment monitoring of these systems. The results of the assessment monitoring will then be used to determine the effectiveness of the technology and informed selection of the most cost effective solutions.

Emerging treatment technologies that are currently undergoing pilot testing and are applicable to meeting dissolved metals TMDL objectives, include the use of activated alumina and similar ion exchange media in sand filter systems, chemically enhanced detention basins (CEDB), and treatment bed systems. Current pilot studies include the "Demonstration of An Advanced Storm Water Runoff Treatment System at the Navy Regional Recycling Center in San Diego" and several studies by Caltrans in the Lake Tahoe region. A summary of these studies is presented in this subsection.

The Navy is conducting a pilot program to develop and test a filtration-adsorption technology for application at its Regional Recycling Center to meet discharge requirements for copper and zinc. The unit has been designed to treat up to a 0.5-inch storm event and a peak runoff rate of 0.56 cubic feet per second. The pilot storm water treatment system was constructed of a $1/20^{th}$ scale model of the planned system that will treat storm water from a 3.25-acre impervious area. The system is designed to be installed below ground and composed of an inlet chamber that allows for the settling out of larger particles before storm water is discharge into the filter chamber. The filter chamber contains a composite filter of sand, bone chare, and activated alumina. The results of the pilot testing indicated copper and zinc removal below the effluent discharge limits and attainment of the toxicity requirements. A full scale treatment system is planned. This system is similar to the modified Austin-type filter system that was retained in the technology screening table (Table 5-2).

Caltrans is conducting a number of pilot study programs in the Lake Tahoe area that include one small-scale test facility that has been in operation for five years and six full-scale pilot media filters. Four chemically enhanced detention basins (CEDBs) are currently being designed for construction and monitoring in 2006 (Caltrans, CTSW-RT-06-167.02.01, April 2006). These pilot studies are using alternative filtration media other than sand to remove dissolved constituents, such as metals, nutrients, and trace organics, that are not removed particularly well by sand. Alternative media may be arranged in either bed or canister configurations. The alternative media used includes activated alumina, expanded shale, and iron-modified activated alumina, granular ferric hydroxide, and a proprietary iron oxide. The results of the pilot testing to date indicate that activated alumina was effective in meeting effluent limits, but sedimentation followed by sand filtration was ineffective. Activated alumina was found to increase effluent pH and aluminum concentrations. A combination of activated alumina and iron-modified activated alumina was also tested to address these issues. The large scale pilot projects focused on nutrient and turbidity removal, and the alternative media were found to be promising in the removal of these constituents to the effluent limits.

In conclusion, the results of treatment BMP tests in Chollas Creek and ongoing pilot studies of alternative technologies to remove dissolved constituents support the conclusions of the technology screening assessment presented in the beginning of this section. In order to meet the integrated TMDL objectives, more complex treatment systems will be required. The use of only bioretention and retention basin technologies will not meet the required dissolved metals TMDL objectives. Technologies that are undergoing pilot studies in San Diego by the Navy and in Lake Tahoe by Caltrans indicate the use of alternative filtration media composed of activated alumina and other ion exchange material as a replacement for or in combination with sand in current filter systems provide a potential effective treatment technology to remove dissolved metals and other constituents. This technology is used in filter beds, media canisters or in CEDBs. These technologies were retained in the screening assessment presented in Table 5-2. However, further engineering evaluation of the specific configurations used for these pilot studies and their application to specific drainage areas in Chollas Creek is needed. As part of the recommended tiered approach to TMDL implementation, phased implementation of these systems in selected drainage areas in the Chollas Creek watershed is recommended to test the actual effectiveness in reducing constituent concentrations in storm water from the subject watershed. Finally, augmented infiltration, bioretention and porous pavement techniques can also be effective in significantly reducing runoff volume and ultimately the volume of storm water requiring more complex treatment. A tiered approach is again recommended to maximize the effectiveness of these lower impact technologies as further discussed in the following sub-section.

5.3.2 Low Impact Site Design and Runoff Reduction Effectiveness

Low Impact site Design (LID) incorporates urban storm water peak flow reduction and water quality improvement techniques with residential and commercial development. These techniques include the use of infiltration galleries, trenches and cisterns that collect storm water from roof down spouts, paved areas and lawns, and redirect it into the ground instead of into the storm drain system. LID uses bioretention techniques to increase infiltration and improve water quality. Porous pavement and other technologies that reduce impervious surfaces are also key aspects of LID. LID is most effective when employed in new developments, but can also be implemented through retrofitting of existing developments. LID has the capacity to reduce total runoff volumes and peak flows.

In the Chollas Creek watershed, the application of LID may be constrained by low permeability soils that restrict the amount of storm water that can be redirected into the sub-surface, and by the near built-out condition of the watershed. LID techniques would therefore consist primarily of retrofit and redevelopment projects which will require the addition of granular material layers and chambers to provide storage of infiltration. These granular layers would have limited capacity, but may provide a viable option for small drainage-areas and smaller storm events. Existing soils can also be modified using compost and other soil additives to increase storage capacity and improve infiltration. Some systems may also require underdrain systems to allow drainage of water above the storage capacity of the system due to the underlying low permeability native soils. Further geotechnical studies are needed to investigate whether sub-surface soils throughout the Chollas Creek watershed have low drainage capacity, or whether underlying more granular soil layers are close enough to the surface to allow for re-directing infiltration to these higher permeability underlying layers. As presented in Table 5-2, LID techniques have been retained as runoff and treatment volume reduction BMPs.

The effectiveness of LID on reducing the runoff volume and constituent loading was assessed for the Chollas Creek watershed using a model developed by Purdue University. The assumptions entered into the model included a conversion of 20% of the existing impervious surfaces to pervious surfaces via retrofit or new development through LID. Two scenarios were then run that assumed that up to 25% and 50% of the residential and commercial land uses could be converted to LID with the assumed 20% reduction in impervious surfaces. A soil type of D (low permeability) was used based on the soil USGS survey results for the Chollas Creek watershed. The results of the model for these two scenarios as summarized in Table 5-3 indicate an approximate 10% reduction in storm water runoff and metals loadings. This is due to the low permeability of the soils as discussed above. Also shown in Table 5-3 is a third scenario that includes the installation of granular drainage layers and underdrains with sufficient storage as part of the LID implementation for the 25% and 50% assumed conversion. The percent reduction under the 25% conversion scenario increases to 17-19% from the less than 6% in Scenario 1. Greater reductions of up to 44% are indicated for the 50% conversion scenario as shown on Table 5-3. These results highlight the need to include well draining sand layers with sufficient storage capacity to achieve more cost effective reductions. The addition of granular layers and potential underdrain systems will add to the overall cost of these LID techniques.

Table 5-3. LID effectiveness analysis

Parameter Affected	Percent Reduction – Scenario 1 – 25% Conversion to LID	Percent Reduction – Scenario 2 – 50% Conversion to LID	Percent Reduction – Scenario 3 – 25% Conversion to LID and Drainage Layer	Percent Reduction – Scenario 4 – 50% Conversion to LID and Drainage Layer
Runoff Volume	4%	8%	18%	43.5%
Lbs. of Copper	5%	9.5%	17.5%	41%
Lbs. of Zinc	5.5%	9.5%	17%	41%
Lbs. of Lead	5.5%	11%	19%	44.5%

LID techniques are retained as potential runoff and treatment volume reduction BMPs that can reduce the size and treatment capacity of treatment BMPs required to meet the integrated TMDL goals. For smaller drainage areas, these BMPs can potentially capture close to the design storm eliminating the need for further treatment BMPs. This will depend on the site specific conditions and the defined design storm to be treated. Implementation of LID techniques should be completed as part of a phased BMP implementation program. This phased approach would include three tiers of BMPs. LID and other runoff and treatment volume reduction BMPs would be implemented as part of Tier II BMPs that can be initiated in the first years of the program. As the effectiveness of these BMPs are assessed, and data on source and design storm determinations are obtained, Tier III treatment train system BMPs can then be implemented. The treatment train system BMPs which will require greater land acquisition and/or easements will require a greater time period to design and implement. Due to the land use constraints for the implementation of treatment BMPs, a phased program is recommended that first reduces concentrations, loads and runoff volumes to the extent practical using more cost effective source control and pollution prevention (Tier I) and runoff reduction (Tier II) measures, prior to implementation of full scale treatment BMPs.

Tier II should also include an assessment of the non-structural BMPs and the runoff and treatment volume reduction BMPs. Data should be collected in Tier II to determine a design storm for treatment BMPs. An engineering evaluation should also be conducted on the feasibility of collection, conveyance and treatment of selected storm drain outlets in high loading drainage areas. A phase I treatment train system BMP project should then be implemented as a first step under Tier III implementation where public space is available and conveyance to these areas is feasible. Results of the effectiveness assessment from this phase I project and further engineering evaluation will provide the basis for an iterative cost-effective approach to BMP implementation.

5.3.3 Further Evaluation of Operation Issues of Chemical Precipitation Treatment Technologies

The most common conventional precipitation process is lime (hydroxide) precipitation. However, the relatively high solubility of most metal hydroxides means this process is generally not effective for very low effluent limitations that are required under the dissolved metal TMDL for Chollas Creek. When limits in the low µg/L range apply, the more reliable process is sulfide precipitation. In this process a soluble sulfide source is fed to the water, and the metals are precipitated as metal sulfide salts, which have extremely low solubility. Following the precipitation step, filtration is generally required to meet low discharge limits because the precipitate particles may be very small and have poor settling characteristics. Sand filtration is often used first, followed by bag filtration with filter bag mesh size suitably small to capture the fine particles. Sand filters may be either fixed bed filters or continuously backwashing moving bed filters (for continuous flow operations) and are generally effective for particles above 10-20 microns. For smaller particles bag filters are often used. Alternative filtration systems, such as disk filtration and cartridge filters, can be considered. Figure 5-1 shows a flow diagram for a chemical precipitation treatment process using sodium sulfide.

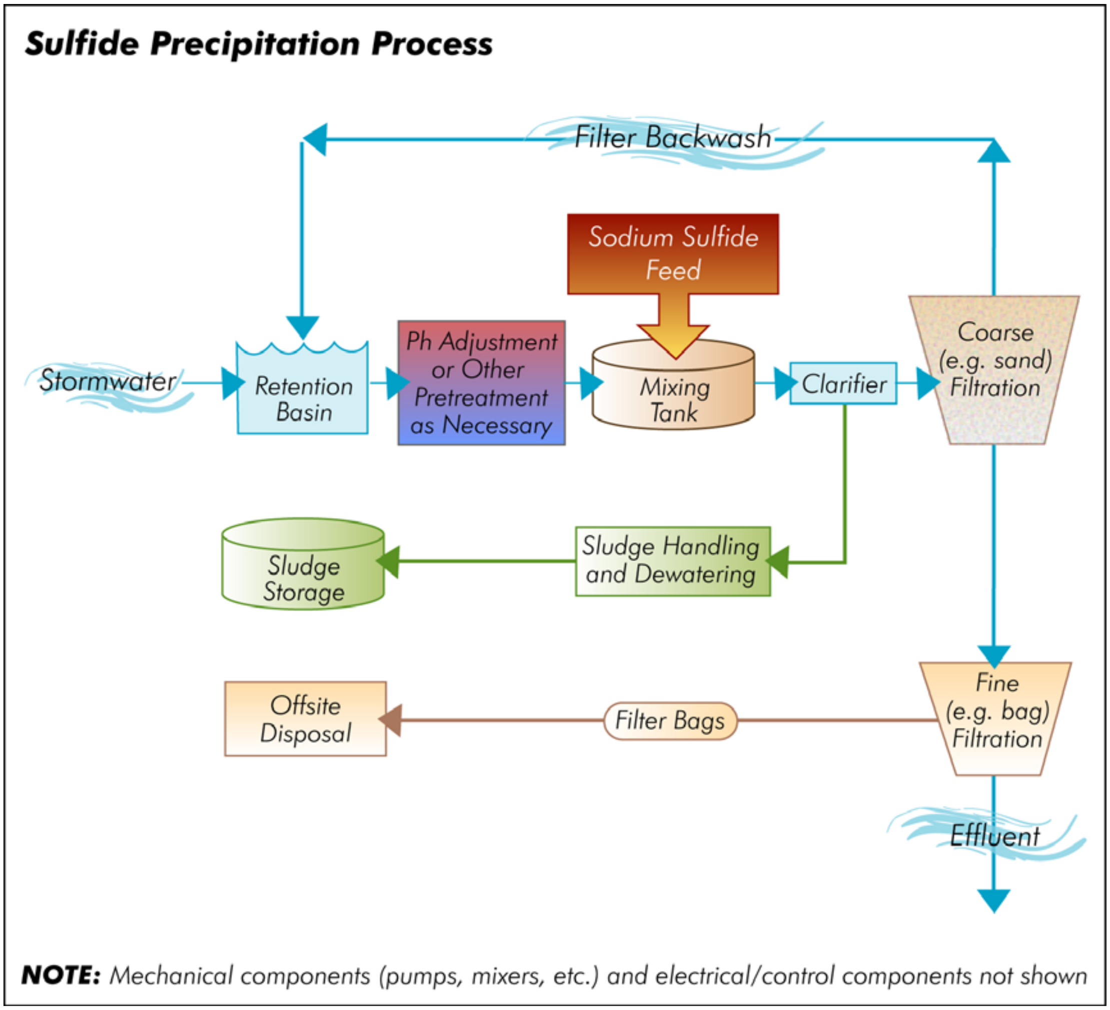

Figure 5-1. Sulfide Precipitation Process

Although this process is well proven in an industrial setting where flow and constituent concentrations are relatively constant, this technology's application to the treatment of highly variable storm water flows is not yet proven. The constraints of this technology as a treatment alternative for the Chollas Creek watershed include the following:

- **Presence of Other Constituents Impacting Precipitation of Target Pollutants** - Possible interference from natural or anthropogenic constituents in the water, which affect the ability to precipitate the metal ions. In particular, significant interferences from chelating agents, which tend to bind and hold metals in solution. This may include chelating agents in commercial and consumer products, such as detergents, a common agent being ethylene diamine tetra acetic acid or EDTA. However, there are also naturally occurring chemicals which may cause the same effect, notably humic acids that are from plant decay and may be present in storm water.

- **Trained Operator Required** - Although not a complicated process, a trained operator is required that is knowledgeable about the chemicals and processes used for this treatment process.

- **Optimization of Process Required Constant Flow and Operation** – This treatment system is generally operated as a continuous flow process, and in this form is not highly amenable to rapid startup and stabilization in response to storm events. Even if configured as a batch operation, very large batch operations would be required to rapidly treat large storm water flows. This will be difficult to mobilize the needed resources on short notice during generally off-hours. Operation of this type of treatment system is less amenable to automation as chemical fed will vary depending on flows and constituent level that will vary between storm events and over the course of storm events.

- **Waste Disposal** - Wastes from the process that require appropriate management and disposal include metals containing sludge and spent filter media (e.g., filter bags). Depending on the sludge volumes and characteristics, an additional pretreatment process to remove water from the sludge may be required, increasing cost and complexity.

Although this treatment alternative will meet the overall technology objectives, there are a number of operational constraints as listed above. Therefore, in order to evaluate performance for a particular application, detailed site specific knowledge of the water chemistry is necessary and treatability testing of the process is required. As recommended previously, a tiered approach to TMDL implementation is recommended. During the implementation of non-structural BMPs targeted at high loading potential sources, further assessment of the selected treatment BMPs should be conducted. This assessment may include batch testing of precipitation treatment technology and comparison of cost effectiveness to the alternative filtration technologies discussed in Section 5.3.4. Based on this more detailed engineering analysis, phase I treatment train system BMP projects should then be implemented where public space is available and conveyance to these areas feasible.

5.3.4 Further Evaluation of Operation Issues of Alternative Filtration Media Treatment Technologies

All of the alternative filtration media treatment systems retained from the screening assessment use constituent adsorption media as an alternative to sand filters in filtration beds, media canisters, and sand filter chamber applications. This treatment media includes granular activated carbon (GAC) or ion exchange materials that can also achieve low effluent metals levels under favorable conditions. These conditions include controlled steady gravity flow with low turbidity. The filtration media act to adsorb the dissolved constituent in the storm flows that are passed through a horizontal filter layer, canister or vertical filter berm.

In conventional water treatment applications, the filter media is a manufactured product consisting of, for example, polystyrene beads with charged surface sites or GAC. However, some natural materials are being used in storm water treatment applications that can be more cost effective. As discussed in this section, activated alumina and iron-modified activated alumina is showing promise as a filter adsorption material to address dissolved constituents. Other filter adsorption media include zeolites, granular ferric hydroxide, and other proprietary materials. As applied to treatment of metals, for example, a cationic resin for metals removal would have negatively charged surface sites to which innocuous cations (e.g., sodium) are attached. When metals containing water pass over the resin, the metal ions replace the sodium, which is released into the water. When the capacity of the resin is exhausted it is either replaced or in some cases regenerated. A related process is the use of activated alumina as the treatment medium. This technology is most applicable to metals which are present as oxyanions in water such as arsenic or selenium. However, pilot testing by the Navy and Caltrans using activated alumina as discussed previously is being applied to the removal of dissolved copper and zinc.

All four retained alternative filtration technologies are applicable as BMP treatment alternatives. A conceptual layout of the pretreatment sedimentation basin and "GAC/IX Sandwich Filter" bed system is presented in Figure 5-2. Further, a more detailed engineering analysis of the specific conditions and design parameters is needed to determine the most cost-effective treatment BMP for implementation in selected drainage areas.

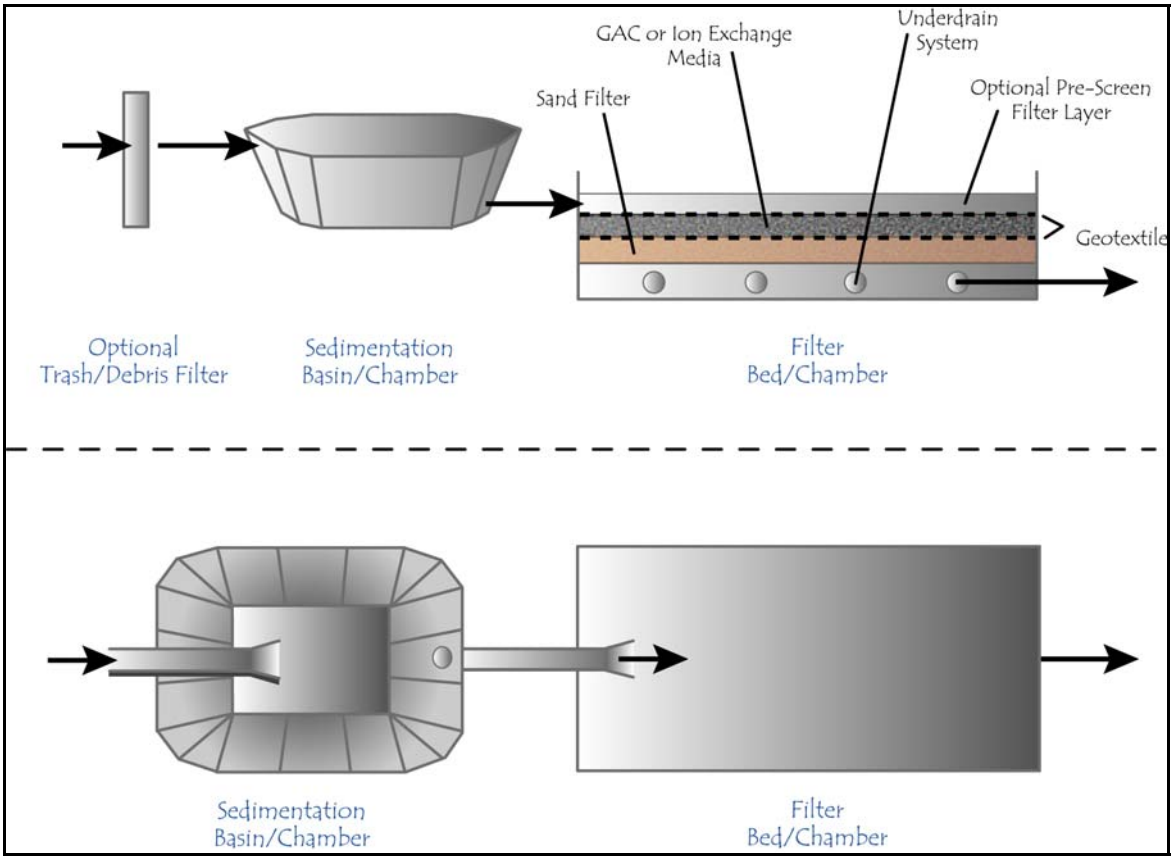

Figure 5-2. Conceptual Layout of GAC Sandwich Filter and Blanket

Although adsorption filter technology has been proven in ongoing pilot studies to be highly effective in removal of dissolved constituents, there are several operational issues associated with its application in an integrated TMDL approach for the Chollas Creek watershed:

- **Competition with Other Charged Particles** - Other cations in solution will compete for the filter media capacity with the target ions and, depending on specificity, may be preferentially removed in lieu of the metal ions. Ion exchange is not often used on "raw" water without pretreatment.

- **Pre-Treatment Required to Remove Suspended and Dissolved Solids** - The process is generally not cost effective when high levels of TDS or other contaminants are present. Pretreatment is needed to remove other materials. This can be accomplished through the use of pre-treatment steps such as detention basins and bioretention technologies.

- **Filter Material Fouling** - Influent suspended solids, oil and grease, and certain organics may foul the adsorption filter material surface or plug the filter bed and prevent effective treatment. In some cases the plugging can be relieved by backwashing, but irreversible damage to the media may also occur. Additional steps would be needed to pretreat and remove problematical constituents to protect the filter bed, canister or treatment berm.

- **Bacteria Removal Effectiveness and Bio-Fouling** – The effectiveness of these treatment systems in the removal of bacteria is not well documented. Of the current pilot programs, the reduction of bacteria is not identified as an objective of the treatment systems. As with sand filters, bio-solids can accumulate on the surface of these filters and cause the growth of bacteria. Periodic maintenance of the system will be needed to control bacteria growth that could increase the concentration of bacteria in the effluent, particularly between storm events.

- **Required Maintenance to Replace Spent Adsorption Media** – The capacity of any adsorption material is finite and will need periodic replacement. Further engineering analysis is needed on the performance of various adsorption media. The results of ongoing pilot program and bench scale studies using storm water from Chollas Creek can be used to assess long-term performance and maintenance requirements. These systems therefore require periodic maintenance to maintain performance.

- **Disposal of Wastes** - Wastes from the process that require disposal include spent adsorption filter materials or regeneration brine containing the metals, as well as filter media (e.g., filter bags) or wastes from pretreatment processes used to protect the resin bed.

Because these treatment technologies have already been applied to the treatment of storm water, they provide a more applicable alternative compared to the chemical precipitation alternative. Ongoing pilot testing using these technologies as discussed in this section indicate promising results in the reduction of dissolved constituent concentrations. This alternative's effectiveness in reducing pesticide and bacteria concentrations to the required levels needs further study. As previously stated, a tiered approach to TMDL implementation is recommended that includes implementing focused non-structural and run-off reduction BMPs and assessing their effectiveness. Data should be collected to determine a design storm for treatment BMPs and engineering evaluations conducted on the feasibility of collection, conveyance, and treatment of selected storm drain outlets in high loading drainage areas. Bench scale testing should be performed during this initial step to determine technology effectiveness using storm water collected from Chollas Creek in order to select the most cost effective technology. A phase I (targeted drainage area) treatment train system BMP project should then be implemented where public space is available and conveyance to these areas is feasible. Results of the effectiveness assessment from this phase I project and further engineering evaluation will provide the basis for an adaptive management approach to BMP implementation.

5.4 Design Storm, Volume and Space Requirements and Regulatory Constraints

5.4.1 Design Storm

The feasibility of implementing runoff reduction and treatment BMPs and the cost of implementation depends on watershed characteristics, required effluent goals and the volume and flow rate of the runoff to be treated. The size of the treatment system will depend on the volume and flow rate that requires treatment. The sizing of these treatment systems to meet the TMDL objectives requires a design storm. The current TMDLs do not specify a design storm event. Assumptions that are used in this assessment for the design storm are discussed in this subsection.

For the structural BMPs that were retained for TMDL implementation, the majority of the recommended treatment system technologies require equalization basins, sedimentation basins, vaults or chambers as part of the treatment process. Due to the variability of storm water flows, treatment systems will need to be designed for a design flow that is controlled through equalization. These treatment BMPs will therefore require sufficient areas for equalization and/or sedimentation. Exceptions to this requirement are the bioretention technologies, the modified Austin-style sand filter, and the LID techniques that are more applicable for treatment of lower flows and volumes. These BMPs can provide significant runoff and/or treatment volume reduction.

The modeling used to develop the TMDLs was based on the 93^{rd} percentile of annual rainfall year (1993) observed over the last 12 years. The modeling was conducted using the dynamic hydrograph from 1993 to drive the build-up/wash-off mechanisms. These modeling parameters do not inform which design storm should be used to size BMPs.

The use of pollutograph data to determine the portion of the storm that contains the highest concentrations of the constituents of concern is also needed to develop the design storm and flow requirements. Pollutants that are carried by storm flows may be mobilized during the initial portion of the storm or first flush resulting in the highest concentrations occurring during this period. Other pollutants may not be mobilized until the intensity of the rainfall reaches a certain level. Pollutographs are developed based on discrete samples collected at set times over the storm event. The City is working with the Southern California Coastal Water Research Project (SCCWRP) on a monitoring program to develop pollutographs (discrete concentrations and flow measurements over a storm event) for Chollas Creek that will provide data to evaluate a design storm approach. The results of this project can be used to assess if the overall integrated TMDL objectives can be met by capturing and treating a portion of the total storm flows. This evaluation would be conducted with the design storm event evaluation. If objectives could be met by treating a portion of a larger storm event, then the volume and flow requirements could be reduced including the subsequent space needed for equalization.

In the absence of guidance in the TMDL on the volume to be treated or a "design storm", a conceptual design storm assessment is presented. This assessment included the statistical analysis of historical precipitation data to determine the 95th percentile storm duration. The results of this analysis are provided in Appendix D. This duration was determined to be between 5 and 6 hours. A 6-hour duration was therefore selected as the design storm duration.

To determine the rainfall total, the total precipitation for a six hour duration storm for several return periods were investigated using National Oceanic and Atmospheric Administration (NOAA) data. Table 5-4 presents a list of storm events and the corresponding total precipitation based on NOAA isopluvial charts.

Table 5-4. Return Period and Total Precipitation

Return Period / Storm Event (yr/6 hr)	Total Precipitation (in)
2	1.2
3	1.3
5*	1.4
10	1.6
25	2.0
**Recommended Design Storm*	

In the absence of a defined design event, the recommended design storm approach should be based on the 6-hour duration, and a return period that corresponds to the metals TMDL exceedances frequency criteria of approximately 3 years. The A 3-year return period event would correspond to the requirements of the California Toxics Rules cited in the dissolved metals TMDL which states, "Neither the Aquatic Life Chronic Criteria (CCC) nor the Aquatic Life Acute Criteria (CMC) can be exceeded more than once every three years [40 CFR 131.38 (c)(2)]." Therefore, if an approximate 3-year storm event is used as the design storm, then all storms with a return period of 3 years and less will be collected and treated. Larger storm events with a less frequent return period may occur during this period, but are of lower probability. The TMDL requirements would still be met if one exceedance occurred during the 3-year period due to a larger storm flow that would be by-passed by the treatment system. There is no such allowance for the bacteria TMDL.

Since an integrated approach is desired and pollutograph data is not yet available at this time, the recommended design storm approach to use for the sizing of BMPs at this time is a 5-year / 6-hour storm event that corresponds to 1.4 inches of total precipitation. The City should negotiate with the RWQCB on the recommended design storm that meets the TMDL objectives.

In order to develop a conceptual runoff volume, a runoff coefficient was developed based on a weighted average of land use types and acreage for the watershed. This runoff coefficient was then multiplied by the total precipitation totals presented above for the 6-hour duration storms. It is understood that more robust and accurate methods are available to estimate runoff volumes from large drainage areas. As more detailed hydrogeological and land use data is made available, a runoff model can be performed that more accurately determines the runoff volumes for design purposes. The purpose of this estimate is to determine order of magnitude costs to demonstrate the sensitively of the design storm and to provide a preliminary estimate of the cost of TMDL implementation.

In order to assess the sensitivity of the design storm, an analysis of the total required volume and area was performed. The results of this analysis are shown in Table 5-5. The results indicate that the design storm significantly influences the size of the equalization and treatment systems.

Table 5-5. Sensitivity Analysis of Design Storm and *C* on Required Volume and Storage Area

Design Storm (yr/6 hr)	Precipitation (in)	Runoff Coefficient (C)	Volume Treated (acre-ft)	Required Equalization/ Storage Area (acres)
2	1.2	0.75	1173	390
3	1.3	0.75	1273	425
5	1.4	0.75	1373	460
10	1.6	0.75	1561	520
25*	2.0	0.75	1960	655

* conservative storm used in report figure examples
Shaded row is the recommended design storm

This analysis highlights the importance of the design storm and the need to obtain the data to develop these design criteria. The challenge for the design of treatment systems for the Chollas Creek watershed is the dissolved metals concentration based TMDL requirements. Although large storm events may result in overall dilution of surface flows thereby reducing constituent concentrations, the portion of the larger storm that is not treated by a smaller sized system may not meet the concentration based objectives. The development of a design storm and maximum flow (flow that occurs during the greatest intensity of the design storm) should be conducted as part of a more detailed engineering evaluation based on further statistical evaluation of rain data for the Chollas Creek watershed and pollutograph data from Chollas Creek.

The storm events listed in Table 5-5 are based on a 6-hour duration. The recommended design storm to be used to size BMPs is a 5-year / 6-hour storm which corresponds to 1.4 inches of total precipitation. The current SUSMP design storm requirements are based on an 85th percentile total precipitation based on historical total annual precipitation. This could be a possible alternative approach that should be further evaluated and discussed with the RWQCB. An analysis of the historical rainfall for San Diego indicates that over 90% of the rain occurs as storms of 0.5 inches or less (US Navy RRC, 2006).

5.4.2 Assessment of Space Requirements

In order to assess the required land needs to implement treatment BMPs compared to the space available; a preliminary assessment was performed using the following conservative assumptions:

- A conservative 2-inch event was assumed for this preliminary analysis of land needs to account for potential set-back requirements and potential other factors. The 2-inch storm is not the recommended design storm event, but is used for this conceptual analysis of land requirements. The 2-inch storm corresponds to the maximum event in 1993 and the 25-year/6-hour event;

- A runoff coefficient of 0.75. Land use data was obtained from SANDAG;
- The equalization basins that contain the storm flows and control the flow to the treatment unit are above ground structures that hold up to 3 ft of water and have 5 ft berms to allow for 2 ft of freeboard;
- the basins must drain all the stored storm water within a 72-hour period to address vector control issues;
- the treatment system that receives the controlled flow from the equalization/ sedimentation basin is composed of a multi-media sand filter bed of ion-exchange media covered with a sand layer that has an underdrain system to discharge the treated storm water to a conveyance channel or pipe; and,
- 20% of the identified public lands are available for installation of the treatment BMP system.

The results of this preliminary evaluation of space requirements compared to available public lands using the above listed assumptions are presented on Figure 5-3 through Figure 5-6. Figure 5-3 first presents the required area need for the equalization basin and filter system for each drainage area using runoff coefficients specific to each sub-watershed based on land use types. Figure 5-4, Figure 5-5, and Figure 5-6 show a comparison between the land areas required for BMP treatment (equalization and treatment systems) compared to the area consisting of 20% of public lands. The estimate of 20% of public lands that may be available is based on the assumption that most of these lands contain existing structures, have designated usage, and consist of lands under the jurisdiction of the Federal government (Department of Defense) and State government (Caltrans).

The total volume required for the equalization basin used for Figure 5-3 to Figure 5-5 is based on a cumulative runoff approach. Volume requirements therefore increase as accumulated runoff quantities increase in downstream subwatersheds. If treatment systems are installed to collect and treat runoff from each sub-drainage area separately, then the total volumes would be less than those shown for the downstream areas. The total required storage area for equalization/sedimentation is estimated at 655 acres without consideration for surrounding buffer zones. The land required for conceptual sand and activated media filter systems is approximately 130 acres. These areas are based on the 2 inch storm and a coefficient of 0.75. Also shown on Figure 5-4, Figure 5-5, and Figure 5-6 are the determined relative loading for each sub-basin for copper, lead, and zinc, respectively. This loading is based on the water quality model used in the Chollas Metals TMDL technical report.

As indicated on Figure 5-4, Figure 5-5, and Figure 5-6, there appears to be sufficient publicly owned space for the treatment BMPs (equalization and treatment systems) in the upper subwatersheds. However, the actual space available may be heavily restricted by current use of the public land, existing steep grades and regulatory issues that include the RWQCB's interpretation of the "tributary rule."

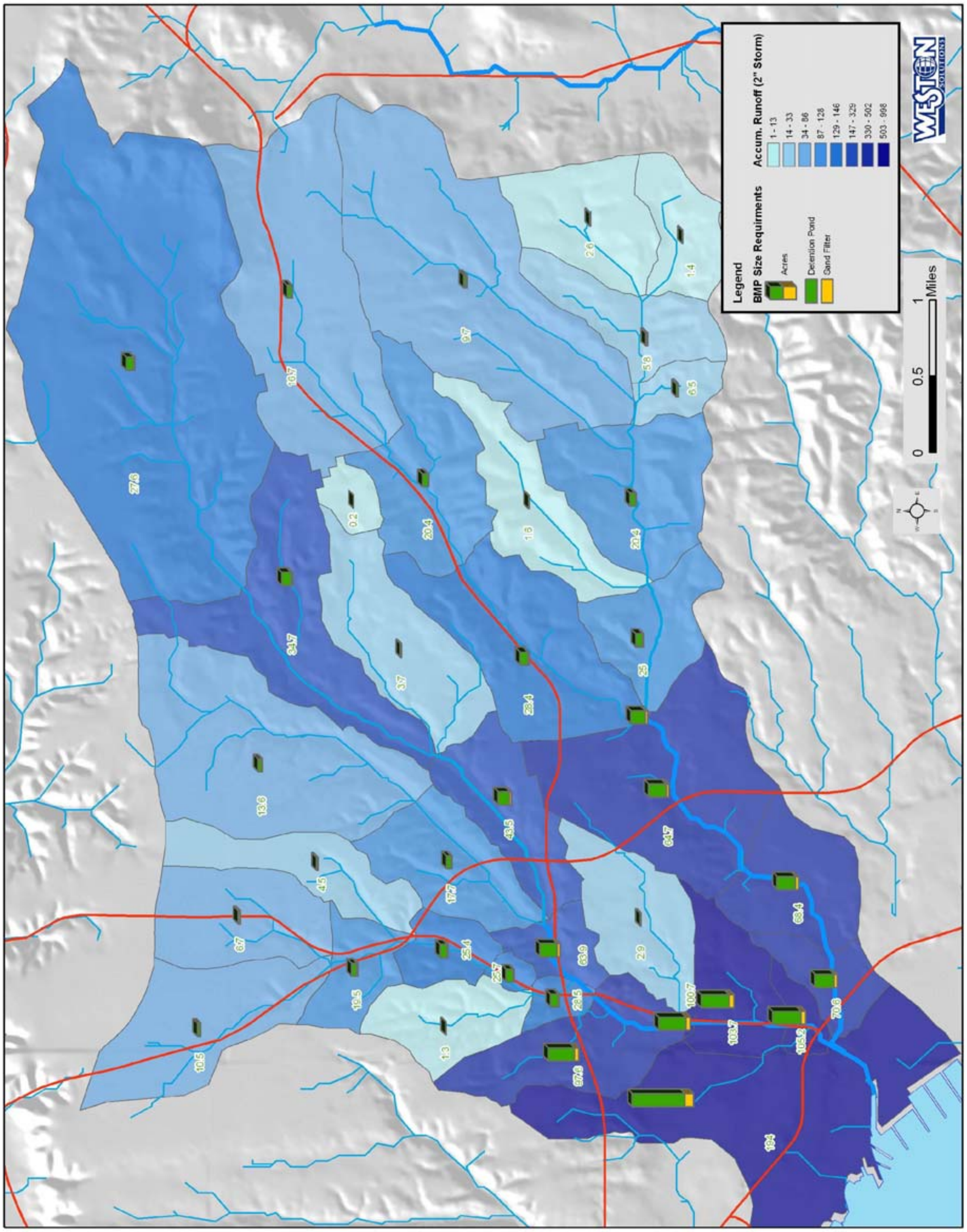

Figure 5-3. Chollas Creek BMP Size Requirements for Detention Basins and Sand Filters for a 2" Storm

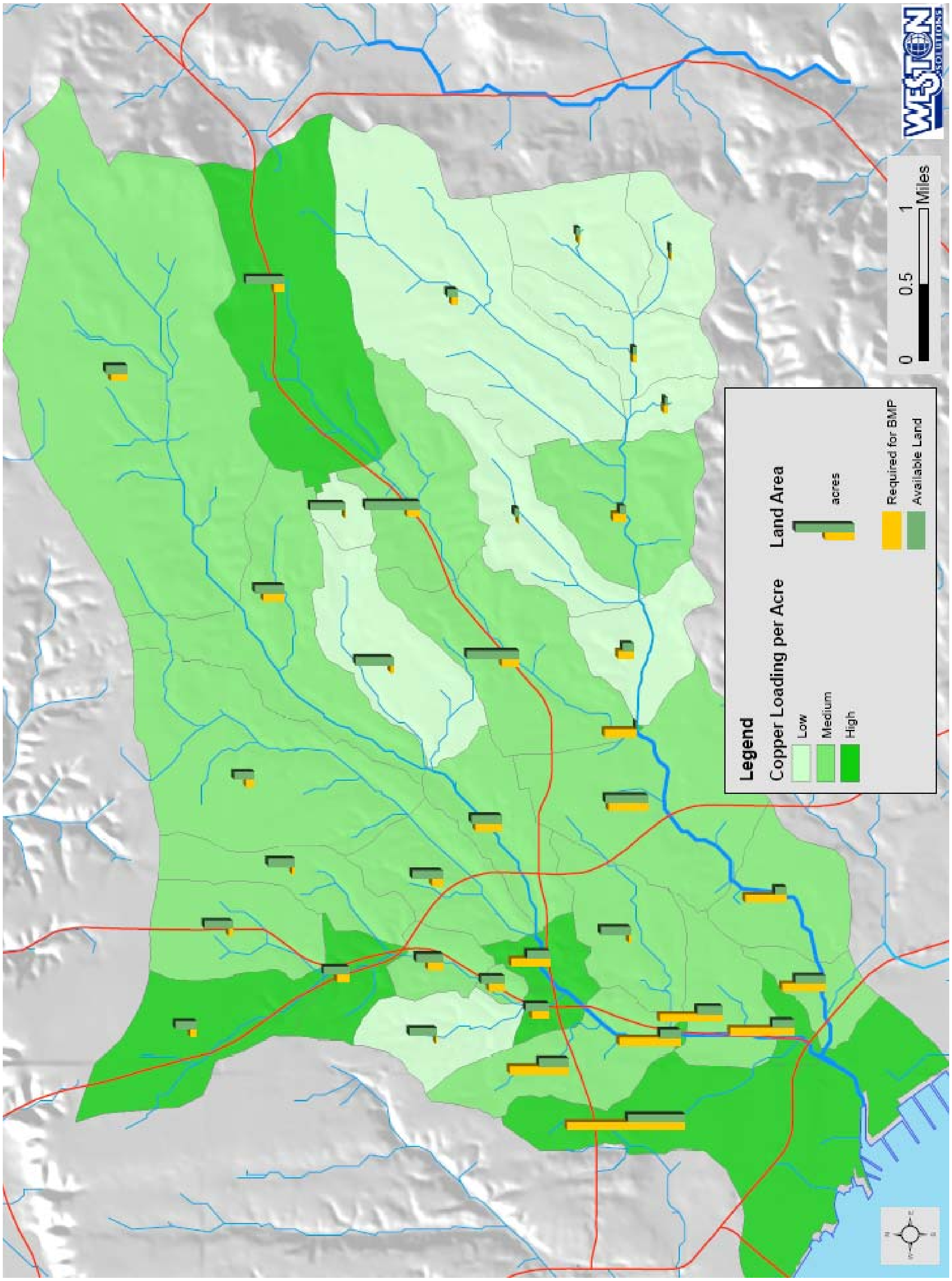

Figure 5-4. Copper Loading and BMP Land Requirements in Chollas Creek (2” Storm)

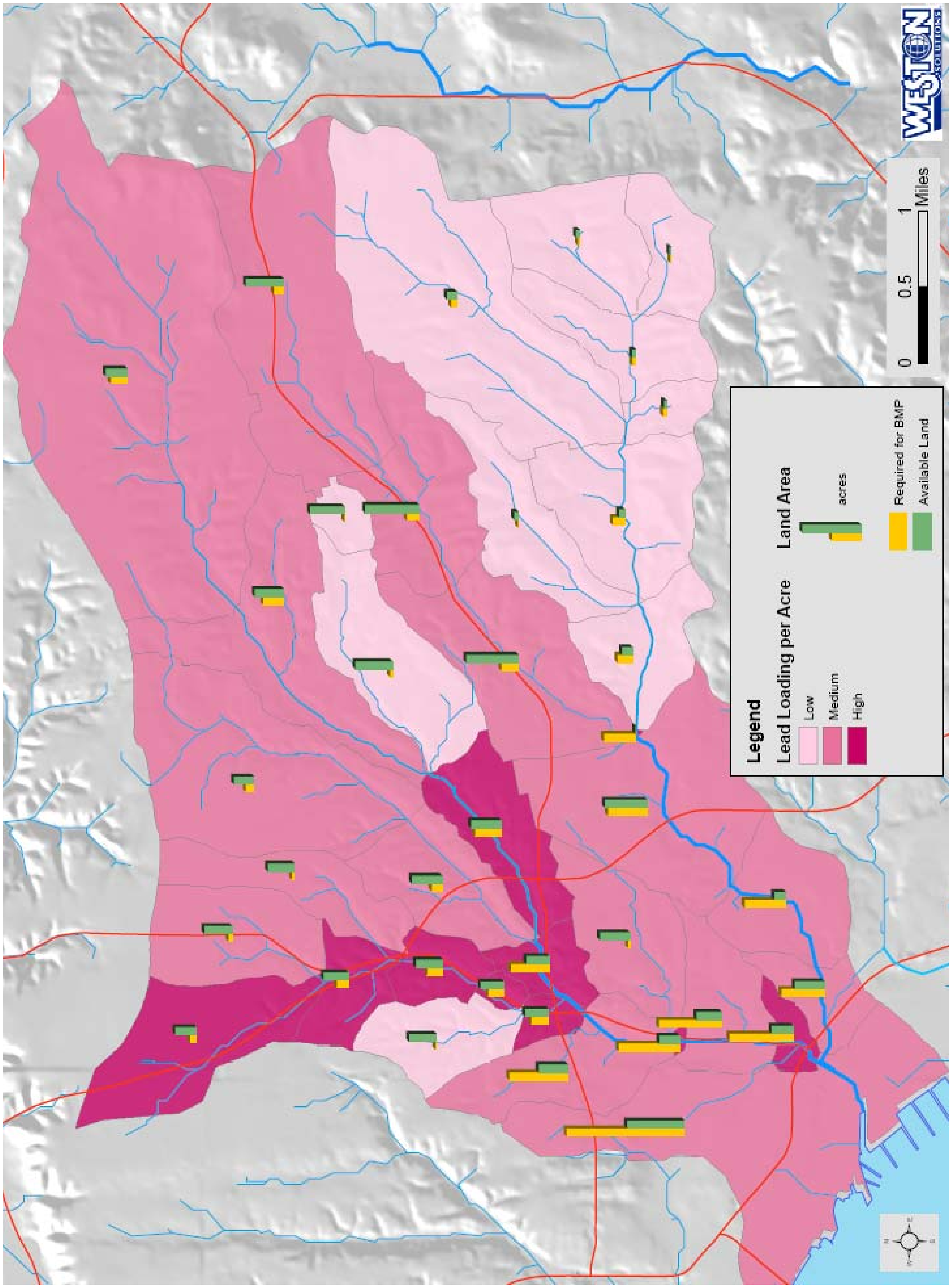

Figure 5-5. Lead Loading and BMP Land Requirements in Chollas Creek (2" Storm)

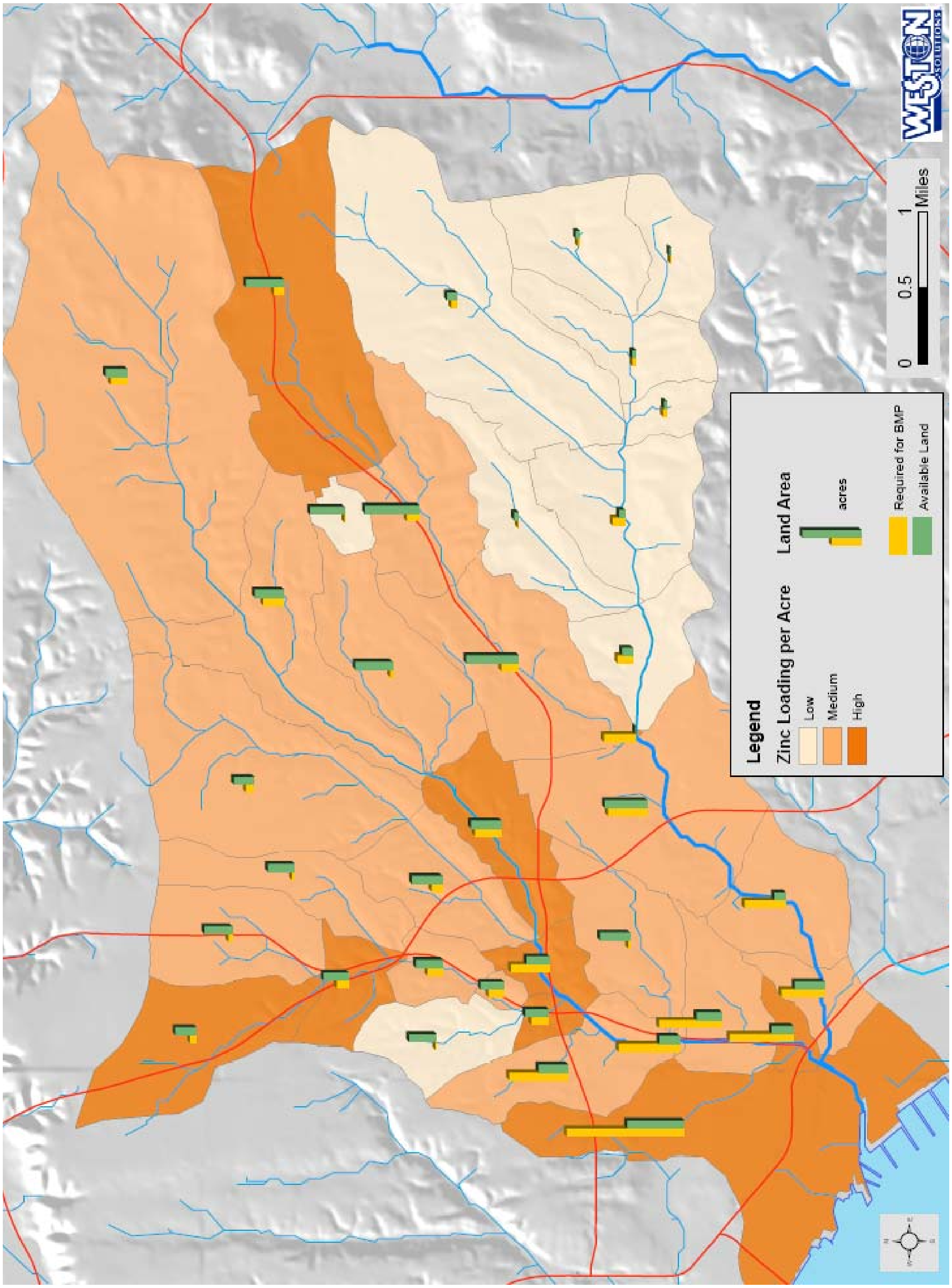

Figure 5-6. Zinc Loading and BMP Land Requirements in Chollas Creek (2" Storm)

As discussed in Section 4.0, it is the City's understanding that the RWQCB has interpreted the "tributary rule" to require attainment of the metals TMDL concentration-based limits throughout the waters of State including the conveyance channels (interpreted as "tributaries") from the point of discharge at the storm drain outlets to the receiving waters. This interpretation of the "tributary rule" would result in non-compliance with the TMDL in the section of the "tributary" between the storm drain outlet and the BMP. The treatment BMPs will therefore need to be located immediately at the outlet, within the MS4, above the storm drain outlets on available public lands or currently private property. The MS4 system is not designed to store storm flows, but to convey them as rapidly as possible to the outlets for flood control purposes. The RWQCB has indicated that application of the "tributary rule" could be considered on a case-by-case basis. The application of the tributary rule to the dissolved metals concentration-based TMDL will also require meeting the concentration-based objectives in all "Waters of the State." This will restrict the flexibility of implementing a treatment BMP farther downstream in the watershed that would collect accumulated storm water from several drainage areas for treatment. In addition, there may be locations where BMPs are effective in reducing metals, bacteria, and pesticide concentrations at the point of discharge but bacterial regrowth in stormdrains and sediments in the receiving waters as a result of natural processes downstream of the BMPs may result in non-compliance with the bacteria TMDL.

Considering these regulatory issues, required land area for BMP installation needs to be considered at the individual storm drain outlet level or at least to a sub-drainage area level. This is the case due to the requirement of meeting the concentration based objective at the storm drain outlet, and the restriction on placing BMPs or conveyances between the outlet and the receiving water. Figure 5-7 presents the location of all known storm drain outlets in the watershed and public lands that are within an assumed 500 ft distance from the outfall. The 500-ft assumption is based on possible maximum distance that conveyance systems may be practically and cost-effectively implemented. This distance may be significantly less where outlets are located in canyons well below the elevation of public areas. For this analysis, developed public lands and properties under the jurisdiction of the Department of Defense were excluded. Based on this conceptual evaluation of public lands, approximately 65% of the discharges would be within 500 ft of public lands. However, storm water that is discharged from existing storm drain outlets would need to be conveyed to these potentially available public lands. Further engineering analysis is needed on a drainage area basis to evaluate the feasibility of conveying storm flows to nearby public lands.

Other options will need to be pursued for the estimated 35% of the total drainage areas with outfalls that are either not within 500 feet of public lands or conveyance to public lands is not possible due to existing infrastructure and topography. These options must include locating these systems close to the storm drain outfalls. This interpretation of the "tributary rule" as discussed above would limit the construction of BMPs between the existing storm drain outlet and the receiving waters, which are defined as waters of the state. This regulatory issue would require installation of BMPs above the MS4 outlets that are generally located above the receiving waters in the canyons immediately below the residential and commercial development on the top of the canyons. Because many of the storm drain discharges in the upper watershed are located in canyons below highly urbanized areas, implementation of an applicable BMP sized to treat the storm flows would require construction of treatment systems in developed residential or commercial areas in many cases. The cost of implementing these systems will therefore need to consider the purchase of private property and demolition of residential and commercial structures in built-out areas as illustrated conceptually on Figure 5-8.

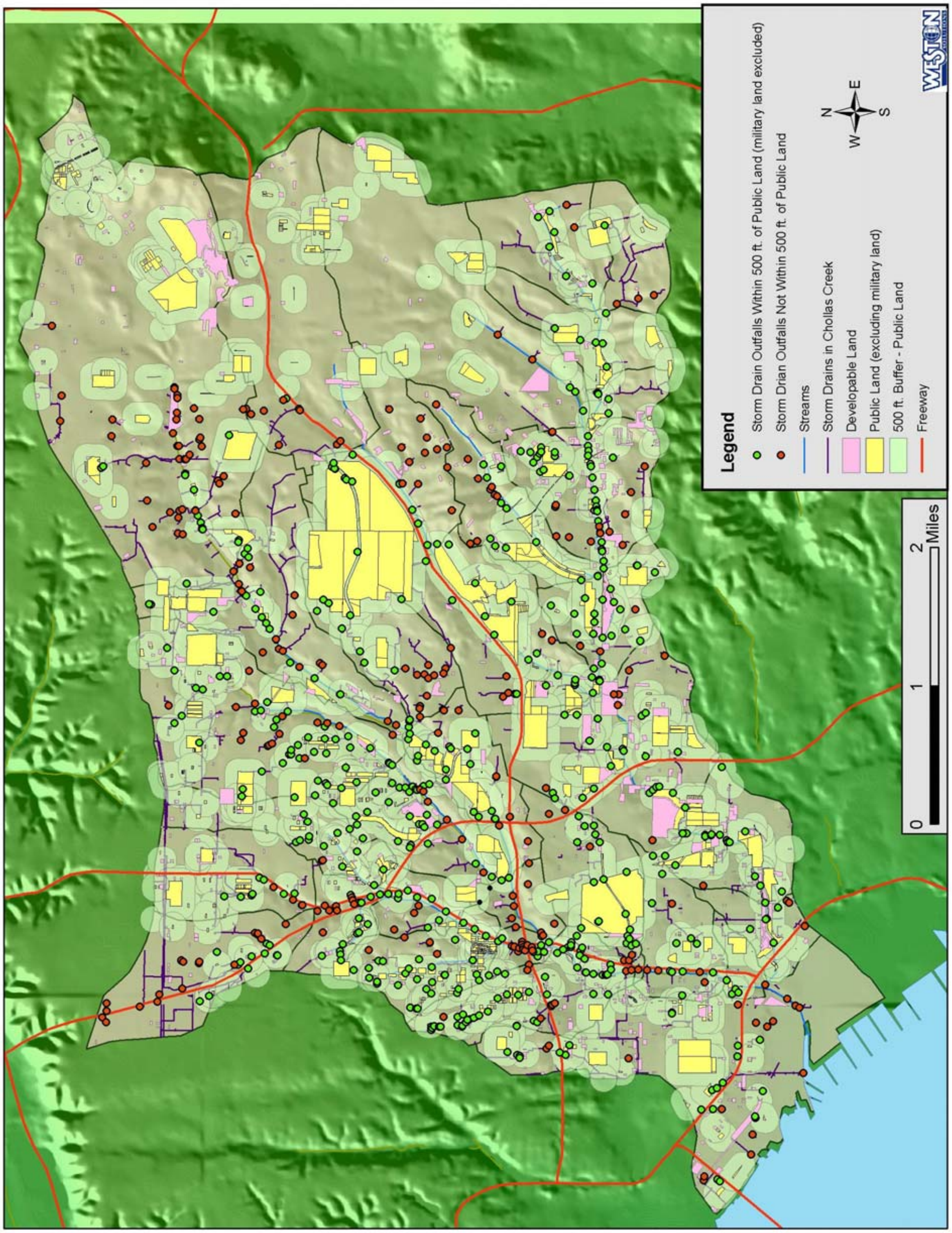

Figure 5-7. Map of Storm Drain Outfalls and Available Public Lands.

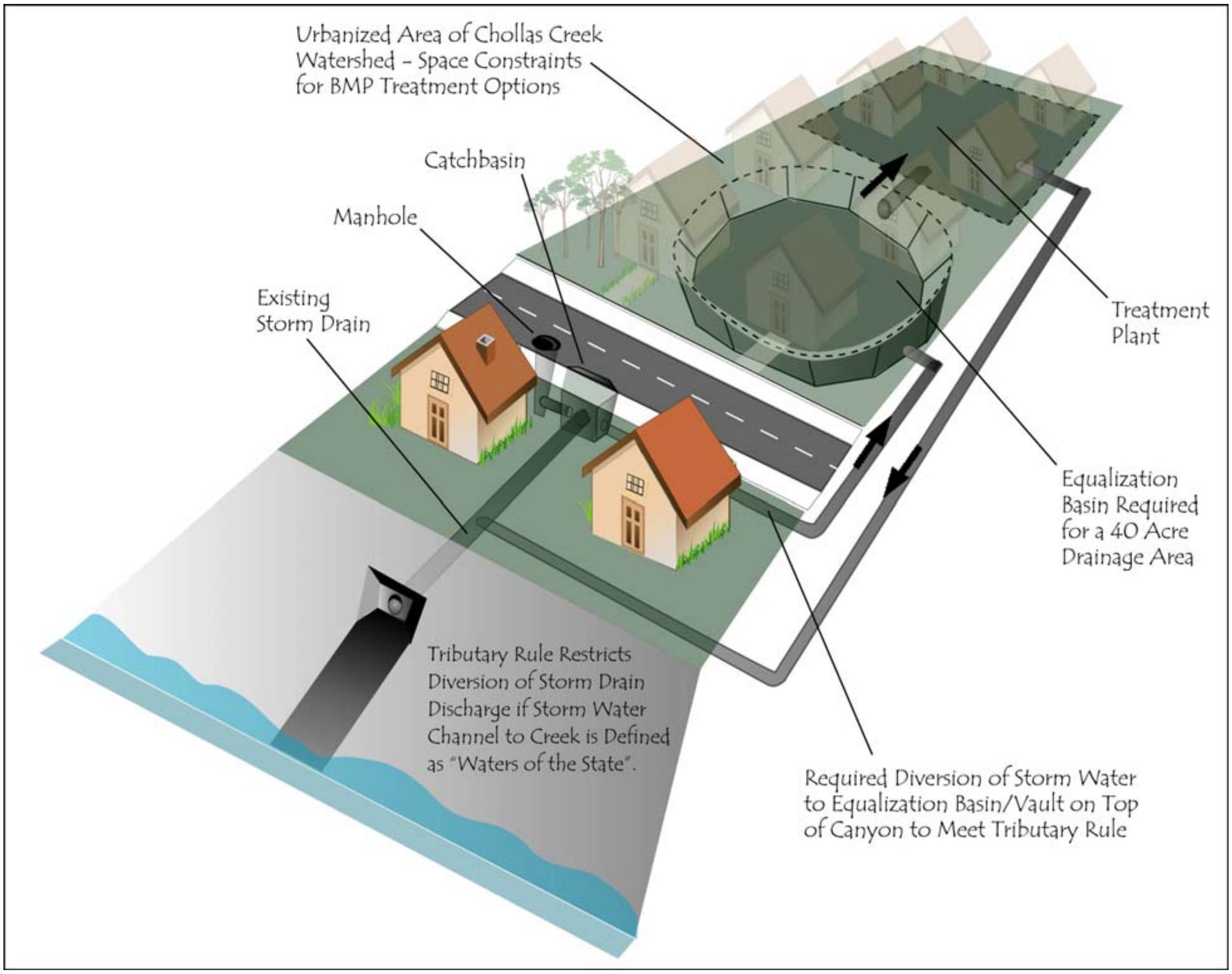

Figure 5-8. Treatment BMP Placement Constraints – Tributary Rule and Urbanized Watershed

The estimates for required storage volume and maximum flow requirements for the retained treatment systems were developed for conceptual cost estimating of the treatment alternatives. A conservative total precipitation total was used for this conceptual estimate. Through a more detailed engineering design analysis and evaluation of the conditions within each drainage area, reductions in the required "footprint" of the treatment systems may be achieved based on the actual runoff coefficient, design storm and runoff reduction technologies (LID, bioretention, etc.).

6.0 TMDL IMPLEMENTATION STRATEGIES AND COST ESTIMATES

Based on the results of the screening assessment of BMPs, two distinct strategies for TMDL implementation are developed. The first strategy is developed to meet the 10-year regulatory timetable for the current dissolved metals TMDL using an integrated approach that includes meeting the goals of other adopted and anticipated TMDLs for bacteria and pesticides. Due to the defined timetable of reduction goals, an infrastructure intensive approach that requires rapid installation of conservatively designed treatment train BMPs that are assured to meet the TMDL requirements by capturing and treating up to the design storm event. The first "infrastructure intensive" strategy is illustrated on Figure 6-1. As shown on Figure 6-1, the compliance schedule requires that 50 percent of the approximately 800 outfalls are fully compliant within 7 years. Potentially more cost effective source control and pollution prevention measures can be implemented at the same time, however, these non-structural BMPs are not assured to meet 100% of the reduction goal.

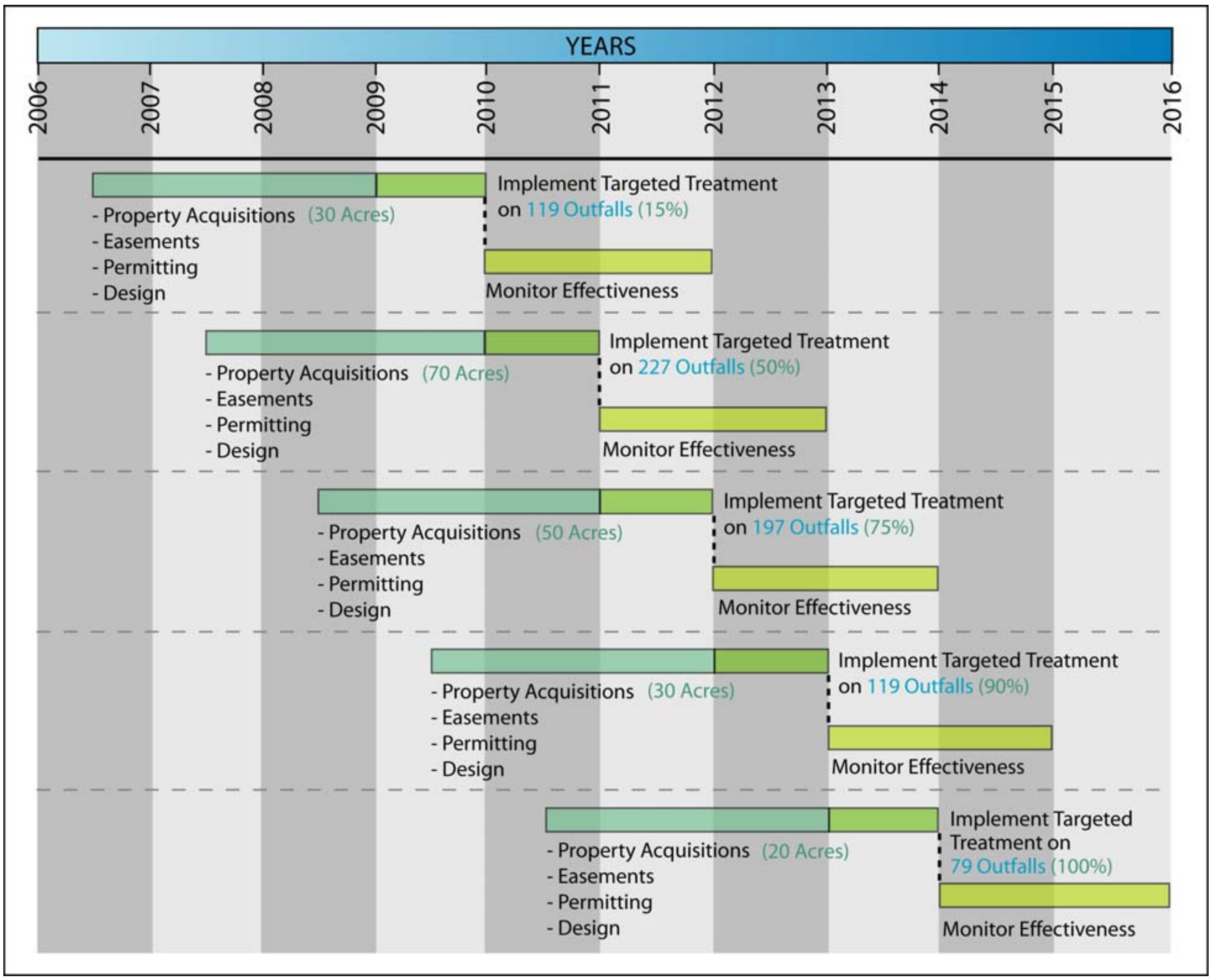

Figure 6-1. Infrastructure Intensive Implementation Strategy – Based on 10 year Dissolved Metals TMDL

The collection and evaluation of additional soils and hydrological data are also needed to determine the treatment capacity of lower impact technologies that include infiltration, bioretention and low impact development techniques. To assure compliance with the regulatory timetable, treatment BMPs that are not constrained by watershed and regulatory issues requiring additional study are needed for this first strategy. Furthermore, since no guidance has been provided in the current TMDLs for the volume of storm water to be treated, this first strategy has assumed a treatment volume. Finalization of a design storm is needed as part of the implementation process.

This first "infrastructure intensive" strategy requires large storage capacity to meet required load reductions in the 10-year timetable. Based on the conceptual treatment volumes needed to meet the reduction goals and other regulatory requirements on the location of these systems, these storage and treatment systems will require acquisition of private property within the watershed. As shown on Figure 6-1, property acquisition will need to begin in the first year. The estimated acreage of property shown on Figure 6-1 is based on the design storm recommended in Section 5.4.1 which results in a total area needed for equalization and treatment of approximately 460 acres. The total acreage for acquisition is then estimated based on the available public land assessment presented in Section 5.4.2 which assumed 65% of the total land available is public and 35% is private. These estimates will vary depending on the final design storm negotiated with the RWQCB as demonstrated in Section 5, and on the site specific actual public lands available and economically accessible.

This infrastructure intensive strategy does not allow for the implementation of BMPs in the recommended tiered approach or time to address data gaps given the number of outfalls to be treated and the conclusions of this assessment. Based on the BMP assessment, an "infrastructure intensive" treatment train approach will be needed to meet the integrated TMDL goals in the absence of data on the effectiveness of source controls, pollution prevention, and infiltration/LID BMPs in the Chollas Creek watershed. The implementation of treatment BMPs in accordance with this schedule will require the immediate acquisition of private land and/or easements on public lands for the installation of treatment BMPs. This will result in significant impact to the communities where acquisition and condemnation of private property is required. This process is complicated and will take time to implement. This presents a significant challenge to the City of San Diego to meet the required timetable under the TMDL.

Due to the anticipated impact to residential communities under the first strategy, a recommended second alternative "lower impact" strategy was developed using a tiered or phased approach that reduces the impact to communities and allows for more cost effective implementation of a combination of lower impact BMPs. This lower impact strategy uses an integrated approach in order to address both current and future TMDLs and uses a tiered approach in the implementation of BMPs as shown in Figure 6-2.

The recommended tiered or phased approach includes the following three major tiers:

- Tier I – Control of Pollutants at the Source and Prevent Pollutant from Entering Runoff
    - Product Substitution through Legislation
    - Aggressive Implementation of Source Control Measures and Pollution Prevention BMPs Targeted in Areas of Higher Density of Potential Pollutant Sources
    - Effectiveness Monitoring of BMPs and Phasing of Implementation

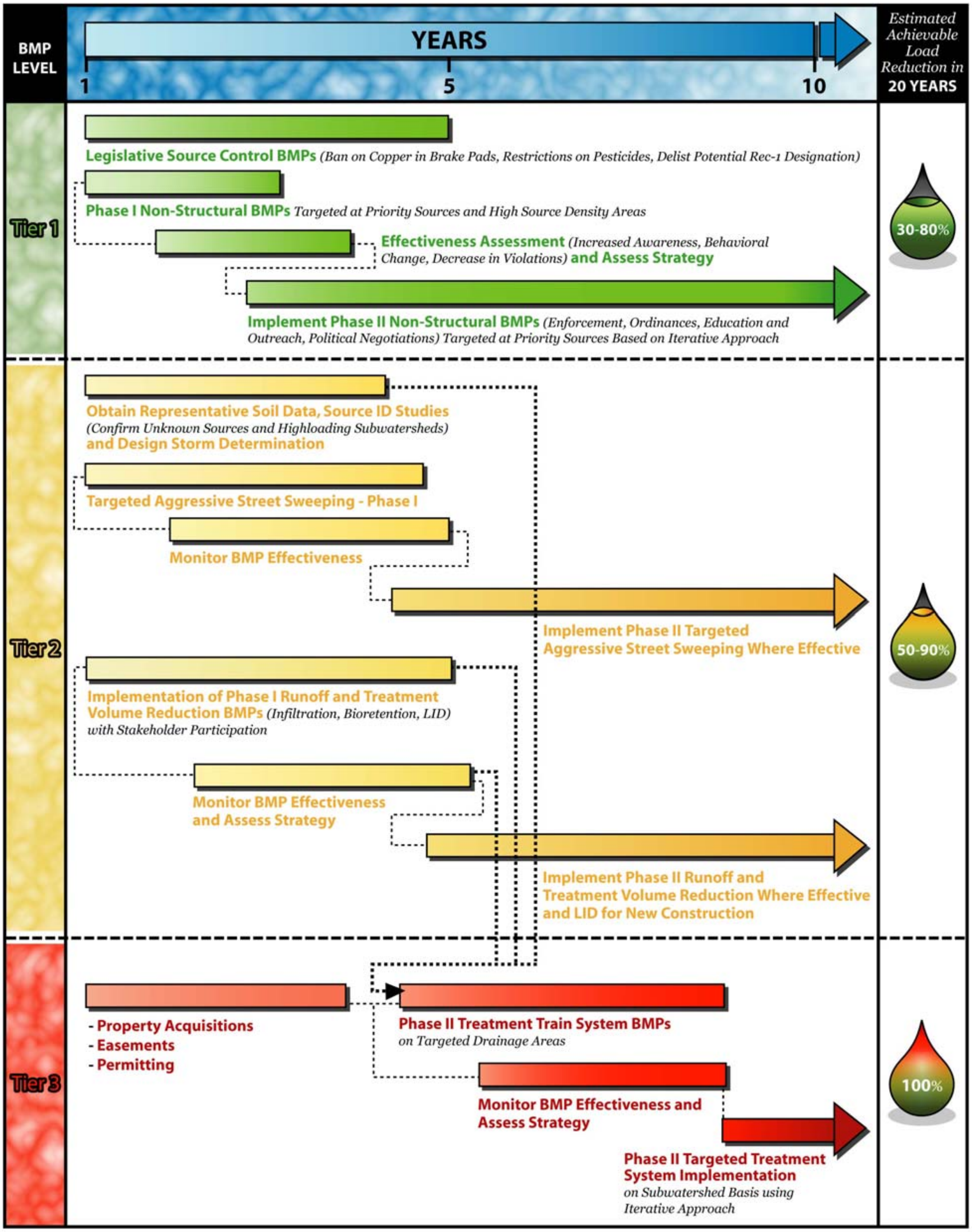

Figure 6-2. Integrated TMDL - Alternative "Lower Impact" Tiered TMDL Strategy

Implementation of Phase I and Phase II Non-Structural BMPs – These BMPs include the recommended "Baseline" source control BMPs that are targeted at priority sources and high density areas. These BMPs are implemented through legislative source controls, education, ordinances and enforcement. Legislative source controls should be pursued in partnership with stakeholders to ban the use of copper in brake pads, place restrictions on pesticide use, and delist the potential REC-1 designation of Chollas Creek. The City should review existing code and enforcement programs and focus resources to address source control and pollution prevention measures for priority sources. This includes prioritizing the permitting and inspection of high loading potential industries in the watershed that are currently not under a monitoring program. Effectiveness assessment monitoring will also be performed to determine the success of these activities and provide input on their implementation in other areas of the watershed.

- Tier II – Conduct Design Studies and Implement Aggressive Street Sweeping and Runoff and Treatment Volume Reduction BMPs
    - Soil and Hydrologic Studies, Source Studies and Determination of Design Storm
    - Aggressive Street Sweeping in Targeted Areas
    - Implementation of Augmented (modification of soils or additional sand layer due to low permeability soils) Infiltration, Bioretention and LID Techniques in Phased Approach
    - Effectiveness Monitoring of BMPs and Phasing of Implementation

  Site specific soil data will be needed to determine if infiltration rates are conducive for implementing infiltration BMPs in targeted subwatersheds. Implement a program for selected lower and higher loading subwatersheds in cooperation with Stakeholders to use more effective vacuum street sweepers and higher frequency sweeping to reduce the loading of metals and other constituents that can contribute to dissolved metals exceedances. Also implement phase I runoff and treatment volume reduction BMPs that include infiltration technologies, bioswales, linear bioretention trenches and LID technologies in targeted communities. The effectiveness of these projects would be monitored and an adaptive approach used to implement additional or modified measures to further reduce the constituent loading and concentrations. Tier II also includes the completion of priority source verification, mass contribution from non-point sources, pollutograph design storm studies and determination, and BMP design studies.

- Tier III – Infrastructure Intensive Treatment BMPs
    - Property Acquisition and Easements (where necessary)
    - Implementation of Treatment BMPs in Targeted Areas where Tier I and Tier II BMPs have been shown not to meet full reduction goals
    - Effectiveness Monitoring of BMPs and Phasing of Implementation

  Phase I treatment train system BMPs would be focused in an identified drainage area adjacent to available public lands within a high loading subwatershed using selected treatment BMPs. Effectiveness monitoring would be conducted to assess if treatment is meeting the TMDL requirements and evaluate methods to improve the efficiency of the system. Based on the results of the effectiveness monitoring, phase II treatment train system BMPs would be implemented on targeted subwatershed that have been identified as high loading and where the systems can be located using available public lands. This tier will need to include the acquisition of lands, where needed, easements to build on public lands, engineering designs, and permitting.

Under this recommended tiered approach to BMP implementation, each tier is implemented in an iterative manner that first includes implementation of measures (using a phased approach) that are targeted on known sources or identified high loading drainage areas. These measures are then assessed for effectiveness. Based on the effectiveness assessment, further measures are implemented to meet the TMDL goals. The first tier includes pollution prevention and source control measures that target identified priority sources. The second tier includes further source identification studies, geotechnical investigations, hydrological and pollutant loading modeling and addressing data gaps in order to better target and design more capital intensive BMPs in the second and third tiers. The second tier also includes implementation of more effective street sweeping and runoff and treatment volume reduction BMPs. Runoff and treatment volume reduction BMPs include infiltration, bioretention and other LID techniques.

This recommended "lower impact" strategy includes implementing Tier I and Tier II activities in year one with the goal of reducing pollutant loads to the maximum extent practical. The strategy emphasizes implementation of potentially more cost effective source control and pollution prevention techniques as well as lower impact augmented infiltration, bioretention and other LID technologies. The use of LID techniques will require site specific geotechnical and hydrological investigations. The goal will be to maximize the effectiveness of Tier I and II activities to meet the reduction goals in a more cost effective and lower impact manner. Where the overall integrated TMDL reduction goals are not being met in certain sub-watersheds, based on effectiveness monitoring of the Tier I and II BMPs, Tier III treatment system BMPs will be implemented.

There may be specific conditions in certain sub-watersheds for which the combined effectiveness of Tier I and Tier II BMPs do not reduce loads down to the TMDL requirement based on effectiveness monitoring. For these conditions, more infrastructure intensive and higher impact Tier III BMPs will be implemented. This integrated and tiered strategy therefore reduces community impacts and allows for the use of targeted effective techniques in meeting the integrated TMDL goals. The tradeoff of both an integrated strategy which considers not just current but future TMDLs, and a lower impact and more cost effective tiered or phased approach, is the need for an extended implementation schedule.

To address additional time requirements to implement a lower impact and cost effective program that will meet the integrated TMDL goals, a potential timetable of 20 years should be considered to meet the 100% reduction goals. Tier I and II activities should be implemented on an aggressive timetable in targeted areas as part of phase I of these tiers. Effective assessment monitoring should then be implemented as part of this first phase to determine if these BMPs should be extended to other areas or modified to improve effectiveness. The approach on a tiered and phased level is therefore an iterative process of implementation, assessment, and further implementation or improvement. The last column in Figure 6-2 depicts the estimated achievable load reductions using the tiered or phased approach in meeting the integrated TMDL goals.

A greater timetable is required for the recommended alternative strategy in order to:

- Meet an integrated TMDL strategy that address both current and anticipated TMDLs;
- Assess the effectiveness of the aggressive implementation of source control and pollution prevention BMPs in targeted areas to identify which techniques are more effective and to modify approaches and/or extend aggressive activities to other sub-watersheds in a cost effective manner;
- Collect needed data on the soils and hydrological conditions within the watershed to identify where lower impact augmented infiltration and other LID techniques are best suited and what engineering modifications are needed to make these systems most effective;
- Assess the effectiveness of aggressive street sweeping in targeted areas to confirm that the integrated reduction goals are being meet or if additional BMPs are needed along with other Tier I and II activities;
- Work with communities in which these activities will be taking place and changes occurring within their neighborhood; and,
- Acquire property and easements for sub-watersheds that will require retention of storm flows prior to treatment where Tier I and Tier II activities do not achieve the reduction goals.

6.1.1 Estimated Conceptual Costs for Treatment Alternatives – Compliant with TMDL Schedule Scenario

As previously stated, a strategy of a tiered approach is recommended for TMDL implementation given the following:

1. The need for additional time to develop an integrated approach that considers both current and future TMDLs;
2. Limited available public area to fully capture and treat storm flows;
3. Data gaps regarding site specific soil data, source identification and updated inventories;
4. Data gaps on effectiveness of combined non-structural BMP implementation in the Chollas Creek watershed;
5. Pollutographs to develop design storm volume and flow;
6. Data gaps on the effectiveness of runoff and treatment volume reduction BMPs and,
7. Results of phase I (target drainage areas) treatment train system BMP studies on technologies which are effective in meeting the TMDL objectives.

However, the TMDL adopted by the RWQCB for inclusion in the Basin Plan for dissolved metals requires meeting the concentration based objectives at 100% of the approximately 800 storm drain outlets by 2016. This 10-year schedule will not allow for the implementation of BMPs in the recommended tiered approach given the number of outlets to be treated and the conclusions of this assessment. Based on the BMP assessment, a treatment train approach will be needed to meet the integrated TMDL goals in the absence of data on the effectiveness of source controls, pollution prevention, runoff and treatment volume reduction BMPs in the Chollas Creek watershed. The implementation of treatment BMPs in accordance with this schedule will require the immediate acquisition of private land and/or easements on public lands for approximately, and the installation of treatment BMPs.

Although the implementation of non-structural BMPs and runoff reduction BMPs would provide more cost effective first steps, the compliance schedule requires 50% of the outlets to meet the dissolved metals compliance concentrations within the next 7 years. This aggressive schedule will not allow for assessment of the effectiveness of non-structural BMPs within these drainage areas. Therefore, the potential reductions from source control, pollution prevention and runoff reduction measures that may reduce the overall treatment requirements are not considered in this compliance schedule scenario.

For the purpose of developing a conceptual cost estimate for TMDL implementation, it is therefore assumed that treatment BMPs will be required for all the storm drain outlets to meet the compliance schedule scenario in the absence of actual data on the effectiveness of source control and pollution prevention measures, and the application of the concentration-based objectives to all waters of the state within the watershed. This interpretation of the tributary rule therefore requires meeting the concentration based objective at the point of discharge of the storm drain outlet.

Conceptual costs estimated were developed for two treatment alternatives presented in this section. The first alternative consists of the equalization/sedimentation basin followed by the adsorption filtration bed as illustrated on Figure 5-2. The second alternative for which a conceptual cost was developed included the chemical precipitation treatment process illustrated on Figure 5-1. The conceptual treatment BMP designs were based on the volume and flow assumptions listed in Subsection 5.3.1. As discussed in this previous subsection, design storm greatly influences the cost of the treatment BMPs. Therefore, a cost sensitivity analysis is presented for these parameters.

Conceptual cost summary tables are provided in Appendix E for both treatment alternatives. The volume and flow requirements for each subwatershed were estimated using the previously listed assumptions. The totals for each of the drainage areas were then divided by the number of storm drain outfalls to obtain an average volume and flow requirement for each outlet within the drainage area. These quantities were then categorized within a defined range. Cost estimates were then developed for these ranges and applied to the specific outfall. In order to assess the potential economies of scale, it was also assumed that outlet discharges could be combined within a drainage area and stored and treated in a single treatment unit rather than for each storm drain outlet. These cost estimates are provided in Appendix E. These estimated costs are 2006 dollars and do not include present worth factors. These costs do not include operation and maintenance costs.

For the treatment systems, which include equalization and treatment through a GAC and sand filter bed system as shown in Figure 5-2, the conceptual total construction costs range from $650 to $900 million depending on the design storm used. This range is based on the recommended 5-year / 6-hour storm to a 25-year / 6-hour storm. This cost estimate assumes that a treatment system will be required for each storm drain outlets to meet the requirements of the Tributary

Rule. If the discharges could be consolidated and treated on a subwatershed basis, the cost would be reduced to between $400-$500 million, excluding the cost of private property acquisition and conveyance and pumping systems to public lands. An additional $350-500 million would be needed for private property acquisition. This is based on the analysis presented in this section that estimated approximately 35% of the outlets were not within a reasonable distance (500 ft) from public lands. The total acreages estimated for equalization/sedimentation and treatment for the 1.4-inch and 2-inch / 6-hour storm for a runoff coefficient of 0.75 are 460 and 655 acres, respectively. The cost per acre to acquire private lands is assumed at $1.6 million/acre. Therefore the total cost for consolidated treatment systems and purchase of required lands ranges from approximately $750 million to $1 billion.

The estimated construction cost for the equalization, chemical precipitation, and sand filter process totals ranges from $400 to 500 million for the entire watershed. These costs also do not include the conveyance and pumping systems that would be needed to direct storm water flows from the current storm drain outlets to available public lands. This will increase these costs by potentially 20%. Design and permitting costs are not included and are expected to be 20-30% of the construction costs. These costs are presented for preliminary assessment purposes and more accurate estimates should be developed through a more detailed engineering evaluation on a subwatershed basis and consolidation of flow from several outlets to achieve better economies of scale.

In order to assess the cost sensitivity to design storm, the cost for the equalization and treatment media/sand filter system as applied on a subwatershed basis, was factored to various treatment volumes. These treatment volumes are based on the design storm and runoff coefficient selected. This assessment is summarized in Table 6-1. As shown on Table 6-1, design storm has a significant impact on estimated costs. This analysis highlights the importance of the determination of the design storm criteria, and approval by the RWQCB.

Table 6-1. Cost Sensitivity Analysis for Implementation of Treatment BMP Using Different Design Storms and Runoff Coefficients

Design Storm (yr/6 hr)	Precipitation (in)	Runoff Coefficient (C)	Volume Treated (acre-ft)	Cost for Subbasin Treatment ($Million)
2	1.2	0.75	1173	340
5*	1.4	0.75	1373	350
10	1.6	0.75	1561	380
25	2.0	0.75	1960	490

* Design storm used in report examples

6.1.2 Conceptual Costs for Treatment Alternatives – Recommended Tiered Approach

An alternative implementation strategy is recommended that is adaptive and based on sound science and engineering. This strategy takes into account an integrated approach that addresses current and future TMDL, and uses a tiered approach. This approach consists of three tiers. The first tier includes aggressive implementation of source control and pollution prevention measures that are targeted at priority sources. These non-structural BMPs vary in effectiveness, but when prioritized to known higher loading sources can be more cost effective than treating pollutants that have already entered into the storm water flows. As discussed, the efficiency of these BMPs ranges widely from 30-70%. There is no current data within the Chollas Creek watershed on the effectiveness of source control and pollution prevention measures, and therefore the impact on the reduction of required treatment cost estimates can not be estimated at this time.

A potential reduction can be conceptually estimated using an average efficiency of 50% and the available wet weather data from the mass loading station. When a 50% reduction is applied to the high and low historical concentrations of dissolved zinc, the concentration is below the TMDL WLA requirements. However, based on historic concentrations at the mass loading station, the reductions required to meet the TMDL WLA in any storm event ranged from 3% to 87% for dissolved copper and 14% to 92% for dissolved lead. These requirements are driven by both concentration and hardness of the waters sampled. This analysis indicates that non-structural BMPs when targeted at priority sources will achieve the TMDL objectives for dissolved metals within sub-watersheds where exceedances concentrations are on the lower end of range, and could therefore reduce the number of treatment systems. Actual effectiveness data is needed to determine an estimate of the reductions that could be achieved, particularly regarding meeting bacteria removal requirements and future pesticide issues.

The same approach should be taken for the implementation of aggressive street sweeping in targeted sub-watersheds. The reported removal effectiveness for metals by vacuum street sweeping ranges from 75%-85%. Aggressive street sweeping should be initiated within the first two years in targeted drainage areas with varying loading to verify these efficiencies and determine if additional treatment BMPs are required. This measure would be part of Tier II and also include source data collection, design storm determination, and effectiveness monitoring. In addition, Tier II includes the collection of site specific soil data and implementation of runoff and treatment volume reduction BMPs that include infiltration technologies where practical, bioretention, bioswales and other LID techniques.

The cost of the Tier I and II implementation depends on the evaluation of priority sources and water quality data in order to target these BMPs, and monitoring needs to address the identified data gaps. The cost for the implementation is however well below the estimated costs for treatment BMPs, and therefore provides a cost effective approach where these measures reduce the volume to be treated in the watershed.

Tier III includes the implementation of phase I treatment train system BMPs in the initial steps of the program. These phase I BMPs will be placed in targeted drainage areas where baseline data indicates high loading. The purpose of the phase I BMPs is to obtain data on the effectiveness of the treatment technologies that have been retained from this assessment in meeting the integrated TMDL objectives cost-effectively. As effectiveness data is obtained through the monitoring of these BMPs, additional drainage areas can be identified for implementation of those treatment BMPs that are shown to be cost-effective in meeting the integrated objectives.

This tiered and iterative approach will require more time to implement than the compliance schedule allowed under the dissolved metals TMDL, but is more practically attainable and based on sound science and engineering. The overall goals of the TMDLs will be met, but in a manner that allows for the implementation and assessment of the effectiveness of BMPs on meeting these integrated objectives. This approach also considers available municipal resources, and using these resources in a more cost effective manner. Less effective measures are discontinued and proven measures are implemented in more targeted areas. BMPs are implemented to target priority sources and high loading areas to maximize resource efficiency.

The City is currently working on a five year priority activity implementation plan for the Chollas Creek watershed. This implementation plan will use the approach outlined in this strategy to identify priority activities that will include both non-structural BMPs and runoff reduction and treatment BMPs. The City will be meeting with community stakeholders to obtain their input on priority activities. The plan will also include a framework for effectiveness monitoring of these measures that will be used to assess their efficiency and identify more effective BMPs and the need for additional measures. Cost estimates for the activities will be provided in this 5 year plan.

7.0 MONITORING STRATEGY

Sampling of each of the TMDL pollutants will require somewhat different sampling designs. It is simply not possible to monitor the quantity of all waters using a "census" approach (e.g., monitoring every surface water flow). A "sample survey" approach is often used to conduct comprehensive watershed assessments. A sample survey approach allows for the estimation of the conditions of waters watershed-wide by making inferences from a defined set of monitoring locations. The level of certainty for these estimates can be described.

Sample surveys are intended to produce assessments of the condition of the entire watershed when that resource cannot be subject to a complete census. Sample surveys rely on the selection of monitoring sites that are representative of the resource. EPA (1997) describes two different sample survey designs: probability-based and judgmental. Both designs use a stratified sampling method so inferences can be made about other waters the samples represent.

The *probability-based design* uses monitoring stations that are selected in a statistically random method. Randomization in the site selection process is the way to assure that sites are selected without bias. This approach is used to select stations for EPA's Environmental Monitoring and Assessment Program.

The random selection of stations provides:

- Every possible station (population) has a known probability of being selected for monitoring (sample).
- The set of stations monitored (sample) is drawn by some method of random selection or a systematic selection with a random start.
- Estimates are made about the population from the sample.

The use of a probability-based design has several drawbacks for use in the water quality assessment. The most significant is the need to establish a new sampling network based on random selection. With this design, one cannot use data collected by an existing sampling network. Also, there are much higher costs associated with traveling to remote stations that may have limited access. This site selection approach will only work for natural run-of-river systems with no withdrawals.

Judgmental design is the other sample survey approach recommended by EPA (1997). Selection of monitoring locations is based on the best professional judgment that the sites are representative of the target resource (i.e., a subpopulation of surface waters). This method assumes that the stations selected represent all waters in a particular subpopulation. Monitoring station locations from an existing sampling network are periodically reviewed individually to determine the reasons why the location was selected.

The judgmental design has several advantages:

- All stations selected are accessible.
- All sites are suitable for sampling.
- Allows estimates to be made with a known precision and confidence.
- Data collected by existing and historical stream monitoring sites can be used.

However, there are some deficiencies in the judgmental design:

- Assumes those stations selected by judgment represent all waters in the watershed.
- Watershed estimates may still be biased due to factors unknown when selecting sites using best professional judgment.

Both probability-based and judgmental designs are recommended for assessing pollutants and sources within Chollas Creek Watershed.

Measuring pollutant concentrations and quantifying pollutant loads from multiple sources can be cost prohibitive. Monitoring designs are always constrained by available staff and financial resources. These constraints often determine the location and frequency of sampling. To address these constraints, monitoring designs often use synoptic monitoring to locate problem areas, followed by intensive monitoring to adequately quantify the water quality condition.

- *Synoptic Monitoring* focuses on screening water quality characteristics to provide a *spatial* assessment at a large number of sampling sites with minimal estimation of overall variability.
- *Intensive Monitoring* employs more frequent sampling at fewer locations to provide more detailed water quality information for a smaller number of selected waters. Intensive monitoring is focused on improving the accuracy and precision of constituent quantities.

The recommended monitoring strategy for the Chollas Creek watershed should have three components: (1) Address the data gaps identified in Section 2.4, (2) Assess the effectiveness of non-structural and treatment BMPs, and (3) Satisfy regulatory monitoring requirements. These monitoring components are discussed below.

7.1 Address Identified Data Gaps

In Section 2.4, several data gaps were identified. These data gaps were identified in the TMDL review process as potential sources but due to lack of sufficient data, the sources could not be thoroughly assessed. Table 7-1 lists these data gaps and the recommended monitoring approach for each. Further details of the recommended monitoring approach are discussed below.

Table 7-1. Monitoring Approaches for Identified Data Gaps

Identified Data Gap	Monitoring Approach
Dry Aerial Deposition Monitoring	Judgmental, Intensive
Industrial and Commercial Facility Monitoring	Probability-based, Synoptic
Metals Source Loading Confirmation	Judgmental, Synoptic & Intensive
Evaluation of Human vs. Background Bacteria Sources	Judgmental, Intensive
Evaluation of Channel Bacterial Re-growth	Judgmental, Intensive
Pesticide Reduction Assessment	Probability-based, Synoptic
Evaluate Dry-weather and First-flush Contributions	Judgmental, Intensive
Develop Source Mass Balance Loading Estimates	Judgmental, Intensive
Design Storm Data / Pollutograph Monitoring	Judgmental, Intensive

7.1.1 Dry Aerial Deposition Monitoring

Indirect and direct aerial deposition of pollutants is thought to be a significant contributor to the pollutant load in this highly urbanized setting. The City of San Diego is currently conducting an aerial deposition study across the City of San Diego with focus in the Chollas Creek Watershed. The study is being conducted during the summer and fall of 2006.

The key questions the City will seek to provide information for are as follows:

1. What are the aerial contributions of pollutants and are they associated with different sources?
2. What particle size and load of pollutants is deposited directly to a water body vs. what particle size and load is deposited on roadways and impervious areas and washed off?
3. Where is pollutant loading from aerial deposition occurring in the watersheds?

The preliminary findings of the aerial deposition study are consistent with a study performed in Los Angeles, CA which concluded that aerially deposited trace metals may account for 57 – 100% of the total trace metal load in storm water run off (Sabin et al., 2005).

7.1.2 Industrial and Commercial Facility Monitoring

The Industrial Storm Water General Permit Order 97-03-DWQ is an NPDES permit that regulates discharges associated with 10 broad categories of industrial activities. The General Industrial Permit requires the implementation of management measures that will achieve the performance standard of best available technology economically achievable (BAT) and best conventional pollutant control technology (BCT). The General Industrial Permit also requires the development of a Storm Water Pollution Prevention Plan (SWPPP) and a monitoring plan. Through the SWPPP, sources of pollutants are to be identified and the means to manage the sources to reduce storm water pollution are described. The General Industrial Permit requires that an annual report be submitted each July 1.

The Chollas Creek TMDL is a watershed specific issue, however, the most recent draft industrial permit also lists the SIC codes and additional parameters to be monitored for but does not provide for all of the metals listed as potential sources in the Chollas Creek metals TMDL to be considered.

In lieu of the current and new draft industrial permit, the City may need to implement jurisdictional policies and controls to deal with the monitoring gaps that exist in the industrial and commercial facilities that discharge storm water to Chollas Creek. A comprehensive inventory and inspection process should be conducted to thoroughly identify potential pollution sources.

7.1.3 Metals Source Loading Confirmation

In the development of the TMDLs for metals, the Chollas Creek watershed was parsed into subwatersheds (Figure 2-13). The loadings from each of these subwatersheds were estimated using land use and parameter values calibrated for the watershed model used in the TMDL. In addition, businesses with a possibility of discharging these metals were identified within each watershed through the BLTEA source inventory. Those businesses with industrial storm water permits that require monitoring of these metals were identified by subwatershed. The information on estimated loadings and potential discharges was used to select sampling locations based on judgment of where the highest loadings are expected.

The recommended monitoring plan for assessing the magnitude of different source loads of metals to Chollas Creek should use both synoptic and intensive monitoring. This adaptive monitoring approach will allow financial resources to be focused on areas with the largest metals loadings to help identify where BMPs should be sited.

During the first year of monitoring, storm water grab samples should be collected at the downstream location of each stream segments within the subwatersheds with the highest loads predicted from the land use model. An example of this strategy is presented in Figure 7-1.

A coordinated effort would be required to collect samples during the first two hours of significant flow (e.g., during the rise of the hydrograph) where the highest metals concentrations are predicted. The higher the flow the greater the expected mobility, but prior to the peak or tail end of the storm event. The data collected from these sites will identify those stream segments within the subwatersheds with the greatest metals loading. During the second year, additional wet and dry weather samples will be collected at the subwatershed with the largest loadings and continuous flow measured to allow estimation of annual loads. Flow-weighted composite water samples will be collected to assess total storm loading during the same storm events as the grab sampling. From these data, estimates of loading from storm events not sampled can be made. In addition, this approach allows for an adaptive approach to the prioritization of subwatersheds. This approach could then be applied to the medium priority and low priority watersheds until the metals TMDL objectives are achieved.

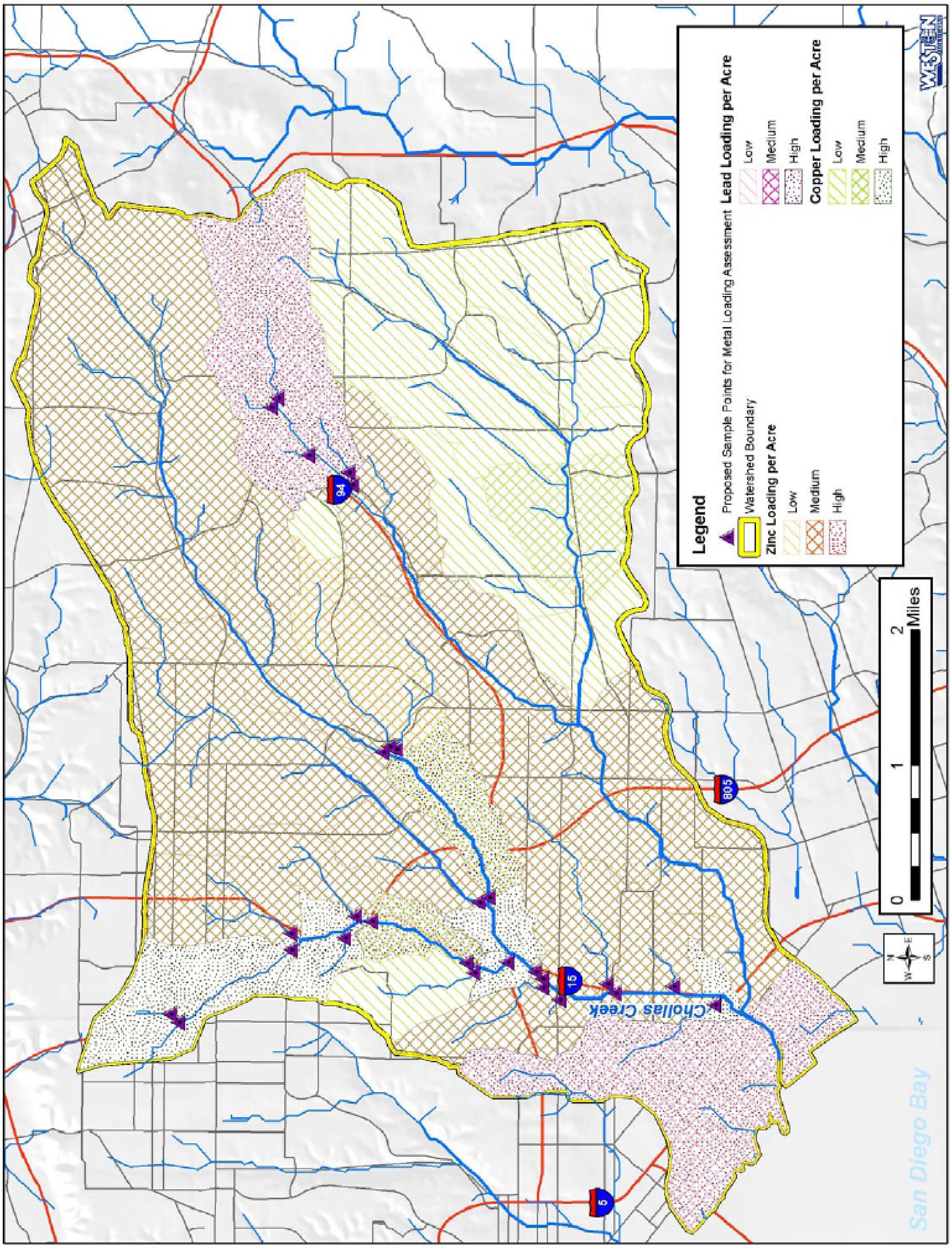

Figure 7-1. Proposed Sample Locations for Assessing High Priority Subwatersheds for Metals Loading

7.1.4 Evaluation of Human vs. Background Bacteria Sources

The polymerase chain reaction (PCR) technique is often used to determine if bacteria found in the environment originated from human or non-human sources. The PCR technique is used to amplify the DNA of a bacterium (*Bacteroides*) found in the fecal material of warm blooded animals. The technique utilizes specific molecular probes that allow one to determine if the bacteria in the sample originated from human or non-human sources. Currently, this technique can not be used to determine any other non-human host (bird, dog, etc.) and can not be used to determine load estimates. The techniques can be used determine the presence of bacteria from human origin. Samples for PCR analysis should be collected from each of the MLS wet weather sites via grab sampling for each storm event sampled.

7.1.5 Evaluation of Channel Bacteria Re-Growth

Bacterial re-growth has been shown to occur in areas receiving flows to shallow ponded areas or where percolation of groundwater re-surfaces through channels containing organic debris including trash. Identification of these areas should be targeted to assess the contribution of bacteria that may multiply exponentially between wet weather events or during contributions from dry weather flows. These sites may also contribute to dry weather exceedances in the event that urban run-off or nuisance flows exceed the ponded areas capacity and result in mobilization of the ponded bacteria laden water.

A monitoring plan for assessing areas of bacterial re-growth could incorporate the identification and cataloging of ponded areas, percolation, and seepage from storm drains during dry weather monitoring events and inspections. The collection of grab samples will be used to identify where re-growth is occurring. These sites can then be addressed in a methodical order using best management practices.

7.1.6 Pesticide Reduction Assessment

The EPA Office of Pesticide Programs initiated a phase-out and elimination program for the insecticide diazinon. The phase-out of diazinon is expected to significantly reduce current source loadings of diazinon, and the resulting aquatic toxicity, to negligible levels over time. The phase-out is designed to reduce diazinon use, sales and availability, and to increase proper disposal. As a result of the phase-out, EPA expects, on a national basis, that these actions will end over 90% of current diazinon uses. In the Chollas Creek watershed, since agricultural use is negligible, the phase-out should reduce current source loadings of diazinon, and the resulting aquatic toxicity, to negligible levels over time. There have been no exceedances of the acute or chronic water quality objective for diazinon over the past two wet weather monitoring seasons as was mentioned earlier (Figure 1-2). However, there is concern that synthetic pyrethroids may be used in place of diazinon. Increased use of synthetic pyrethroids may also result in impairment of aquatic life uses through toxicity.

Since the primary implementation activity will be applied watershed-wide, a probabilistic monitoring design is the best approach for assessing overall improvement. This statistically based approach utilizes the scientific methodology developed for surveys to provide quantitative answers and uncertainty measures for the sampled resource. The target population is a description of the aquatic resource that information is needed about. Streams may be thought of as a linear network, such as is generally used to represent streams on maps and in geographic information systems (GIS). The elements of the target population are all the points within the linear stream network representing an infinite number of elements. To avoid this, the linear features of the stream are often divided into reaches based on an overlying grid or based on points of stream confluences. These elements are randomly selected to identify sampling locations.

The objective of a stream survey is to estimate the proportion of the target population that meets a specific measure of condition. For example, what proportion of the stream miles in Chollas Creek watershed exceeds the water quality objective for diazinon? Given that a statistical probability survey design is used to select a sample of stream reaches from the entire population within the watershed, the estimate will have uncertainty associated with it. One measure of the uncertainty is the precision of the estimate. The precision of the estimate is directly related to the sample size. With a sample size of 50, the precision will be +/-12% with 90% confidence (assuming half the stream reaches exceed the criterion). If only 25 units are sampled, then the precision changes to +/-17% respectively.

Precision will be important when determining whether the proportion meeting the criterion differs between two different years. If the true proportion changes by 10%, e.g., from 20% to 30%, then what is the chance that the monitoring will detect this change? The better the precision the more likely the change will be detected. Decreasing the sample size decreases the ability to detect the difference.

The recommended monitoring plan for assessing the magnitude of different source loads of diazinon and pyrethroids in the Chollas Creek watershed should use a probabilistic monitoring design. GIS information identifying the waters of the state in the Chollas Creek watershed should be segmented using a grid. The resulting stream reaches should then be randomly selected for monitoring. These sites need to be surveyed before sampling to determine if access is available for sampling. Since the diazinon criterion is exceeded only during wet weather, samples should be collected at the randomly selected sites during storm events. EPA recommends 50 locations be sampled to obtain adequate precision to detect trends. These 50 samples can be collected throughout the wet season and from different storm events to represent both the spatial and seasonal variability. All data collected during a year can be combined for a single watershed-wide assessment of condition. After the first year of sampling, the variability of the data collected can be used to determine the annual sampling frequency needed to detect a trend.

7.1.7 Evaluate Dry-Weather Ponding and First-Flush Contributions

The current monitoring at the mass loading stations collect event mean concentrations of each storm measured. The event mean concentration (EMC) is the total storm load (mass) divided by the total runoff volume. EMC estimates are obtained from a flow-weighted composite of concentration samples taken during a storm. Although this is useful information for determining total relative loads in wet weather, the data cannot be used to determine the magnitude of the first flush phenomenon observed in storm events. The instantaneous concentration during a storm can be higher or lower than the EMC. A plot of concentration versus time is often called a pollutograph. The pollutograph frequently exhibits considerably higher concentrations near the beginning of the storm. The first flush phenomenon is thought to be due to greater availability of pollutants that have built up on urban surfaces during dry weather. The wash-off of these pollutants is thus greater nearer the beginning of a storm. In addition, information is lacking on water that accumulates within the channel during dry weather. This ponded water is directly related to the pollutants found in the first flush.

A monitoring program should be established during dry weather to collect samples of this accumulated water for analyzing pollutant concentrations. In addition, grab samples should be collected frequently over the course of the first storm event of the wet season to assess the significance of the first flush.

7.1.8 Develop Source Mass Balance Loading Estimates

The monitoring data collected in the monitoring programs described above can be compiled to produce an inventory of all source loads for each pollutant. This inventory will serve to provide a overall mass balance loading estimate for all sources to prioritize management actions and develop effective pollution prevention, source control and treatment control measures. The inventory can also be used to provide information for future updates to existing TMDLs or help establish defensible allocations for future TMDLs.

7.1.9 Design Storm Data and Pollutograph Monitoring

Pollutograph monitoring was performed by the Southern California Coastal Water Research Project (SCCWRP) during February and March of 2006 at the north fork mass loading station SD8(1) and the south fork mass loading station DPR2. This monitoring was performed in coordination with the TMDL modeling being performed for the mouth of Chollas Creek. The pollutograph monitoring analyzed only metals and PAHs. This data has not yet been published.

Development of a design storm utilizes the concentration data collected during different flow conditions of a storm event. A design storm will be developed by the City but will require additional pollutograph monitoring for metals, pesticides, and bacteria in order to characterize and identify high loading subwatersheds.

7.2 BMP Effectiveness Monitoring

BMPs have been identified for implementation to address the TMDLs in Chollas Creek watershed. These BMPs are both structural and non-structural method(s) recommended that have a demonstrated success for addressing or preventing water quality degradation. Monitoring BMPs typically involves inspecting the results or performance of the practice. BMP monitoring also involves scheduling of inspections to ensure that the outcomes of BMPs meet expectations.

BMP effectiveness assessments are used by managers to evaluate whether their programs are resulting in desired outcomes. Stormwater managers use a number of different approaches to assess the effectiveness of their activities and programs. This involves the evaluation and measurement of various types of programmatic and environmental outcomes. The California

Stormwater Quality Association describes six levels of outcomes ranging from activity-based (implementation) outputs to water quality-based outcomes:

Level 1: Compliance with Permit Implementation Requirements
Level 2: Public and Management Changes in Awareness
Level 3: Changes in Behavior & BMP Implementation
Level 4: Reduction in Pollutant Loads
Level 5: Improvements in Discharge Quantity and Quality
Level 6: Improvements in Receiving Water Quality

This report presents a feasibility assessment of available BMPs to meet the objectives of the current and future TMDLs in the Chollas Creek watershed. The report recommends implementation of non-structural BMPs be targeted at identified priorities sources. Since the identified non-structural BMPs are not likely to meet the TMDL requirements alone, additional management measures that include treatment BMPs are expected to be needed. Several treatment BMPs that reduce constituent concentrations and loading in storm water flows were also evaluated and only a few were determined to be adequate for the specific Chollas Creek watershed TMDL objectives.

Monitoring the effectiveness of the BMPs that can help meet TMDL objective should occur at all outcome levels. Table 7-2 lists the recommended BMPs, the type of effectiveness monitoring that should be conducted, and the outcome level.

Table 7-2. BMP Effectiveness Monitoring

Recommended BMP	Monitoring Approach	Outcome Levels (#)
Education	Public Survey	Awareness (2) & Behavioral (3)
Ordinances	Compliance Reports	Permit Implementation (1)
Enforcement	Increased Inspections	Behavioral (3)
Vacuum Street Sweeping	Monitor Runoff Water Quality	Discharge Water Quality (5)
Bioswales	Monitor Runoff Water Quantity & Quality	Load Reduction (4) & Discharge Water Quality (5)
Linear Bioretention Trenches	Monitor Runoff Water Quantity & Quality	Load Reduction (4) & Discharge Water Quality (5)
Treatment BMPs (GAC & Sulfide Precipitation)	Monitor Runoff Water Quantity & Quality	Load Reduction (4) & Discharge Water Quality (5)

7.3 Regulatory Monitoring Requirements

Tentative Order No. R9-2006-0011 details the receiving water monitoring that will be required by the Copermittees. The order includes monitoring requirements for compliance with existing TMDLs and other pollutants of concern. The pollutants of concern for Chollas Creek include, but are not limited to, diazinon, pyrethroids, copper, lead, zinc, bacterial indicators, and trash. A monitoring strategy is described below that provides further details.

- Chollas Creek currently has a TMDL for diazinon. The Tentative Order requires that water column diazinon be sampled during three storm events annually. These samples are to be flow-weighted composites. Samples are to be collected at two locations specifically identified in the Tentative Order which references compliance with RWQCB Order R9-2004-0277. One sample location is in the North Fork (SD8-1) and one location is in the South Fork (DPR-2) as illustrated in Figure 7-2. These sites were selected to represent the cumulative loading at downstream sites for both the north and south forks.

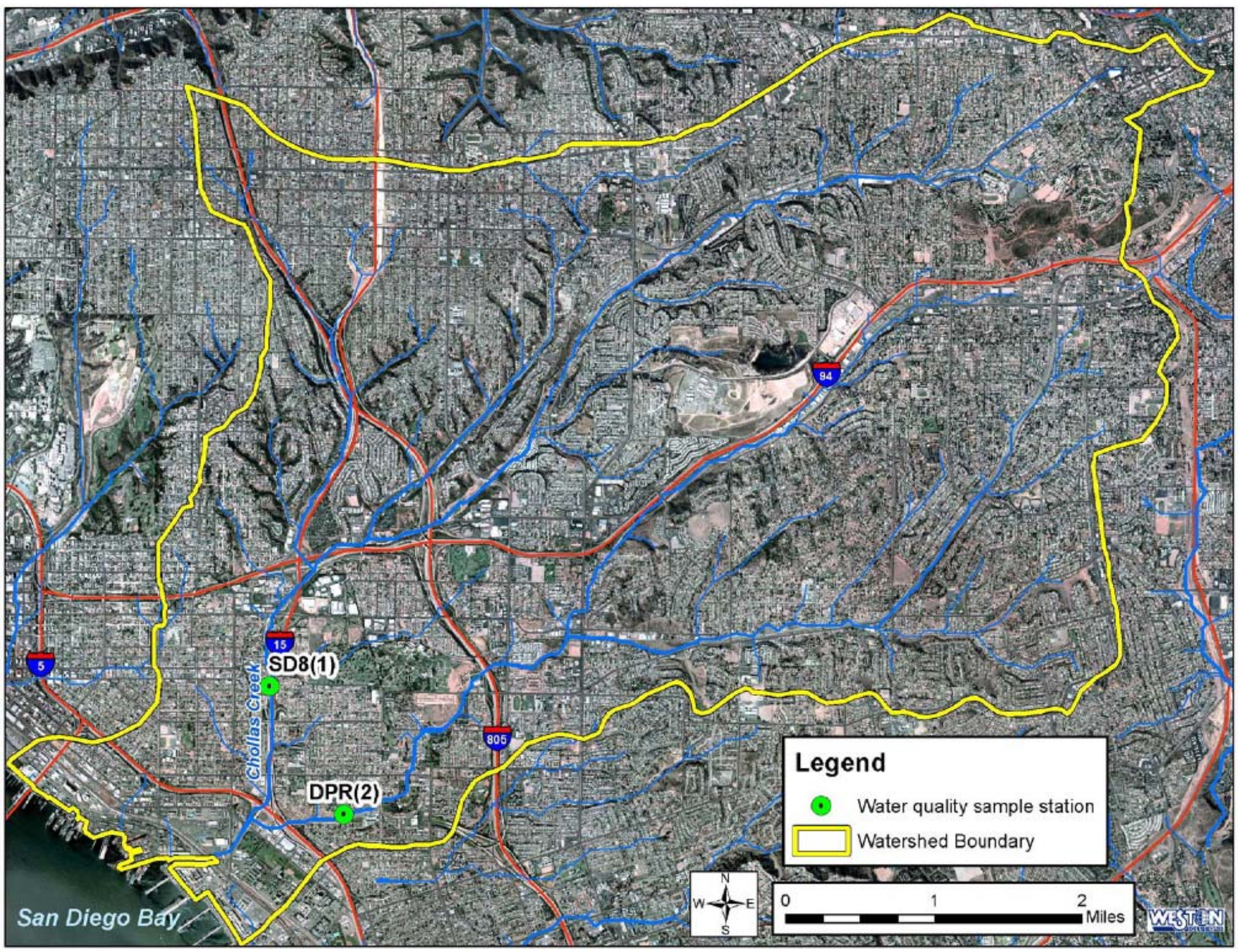

Figure 7-2. Sample locations required under RWQCB Order R9-2004-0277

- Sediment sampling was also required under RWQCB Order R9-2004-0277. The sediment sampling was a one time requirement and was performed in June 2005 under the PRISM Grant mentioned earlier. Sediment sampling will occur again during June 2006 at the same locations as part of the PRISM Grant requirements. These samples will be analyzed for organophosphorus pesticides, pyrethroids, and total copper, lead, and zinc.

- TMDLs for copper, lead, and zinc have been developed. Tentative Order R9-2006-0011 references compliance with RWQCB Order R9-2004-0277 which requires that water column concentrations and hardness be sampled during three storm events annually. These samples are to be flow-weighted composites. Samples are to be collected at the two locations identified in Figure 7-2.

- The RWQCB is also currently developing a TMDL for indicator bacteria (Project I – Beaches Creeks in the San Diego Region and Project II - San Diego Bay and Dana Point Harbor Shorelines). The Tentative Order R9-2006-0011 requires sampling of total coliform, fecal coliform, and enterococcus at the same locations in Figure 7-2.

- The Tentative Order R9-2006-0011 also requires the Copermittees develop a monitoring program for monitoring both pyrethroids and trash. Through the current public comment period for the Tentative Order, it is understood that the RWQCB will add the pyrethroid monitoring as part of the standard analyte list rather than a separate program. The RWQCB has also indicated that the trash monitoring program will be given flexibility in how the Copermittees develop their program, the RWQCB is not opposed to a semi-quantitative visual assessment as long as the monitoring occurs in the receiving waters and there is a process to mitigate or prevent trash from reaching the receiving waters.

8.0 RECOMMENDED STEPS FORWARD

A conceptual layout of the recommended “lower impact” TMDL implementation strategy is presented in Figure 8-1. It is anticipated that Tier I source control and pollution prevention BMPs would be implemented in the first year since many of these measures are currently being conducted by the City through its education and enforcement programs. Evaluation of existing City codes and more aggressive targeting of priority sources would be initiated in the first year as well. Effectiveness monitoring of these targeted programs would be conducted beginning in year two in accordance with the recommendations presented in the Monitoring Strategy section of this report.

Tier II activities beginning in year one with phase I programs would be conducted over the next five years and include more aggressive targeted street sweeping and implementation of runoff and treatment volume reduction BMPs (infiltration, bioretention, and LID technologies). Effectiveness monitoring will also be conducted as part of this adaptive approach. The completion of soil surveys, source ID, and design storm studies will also be performed during the first five years and the results used to design more cost effective treatment train technologies and non-structural BMP programs under Tiers Three and One, respectively. An iterative and phased approach is necessary for Tier I and Tier II BMPs to meet the maximum achievable reductions possible. This will result in lower impacts to the community, be more cost effective, but will require more time to achieve the maximum reduction potential. As illustrated to the right of Figure 8-1, Tier I and Tier II BMPs are expected to reach more than 50 percent of the load reductions needed. However, more costly treatment train BMPs shown in Tier III will be needed to achieve the maximum load reductions possible. While Tier I and Tier II BMPs are only expected to reach some fraction of the reductions needed, more costly treatment train BMPs will be needed to achieve the maximum reduction possible. Tier III BMPs including phase I and phase II treatment train system BMP projects would begin around year two following necessary land acquisition, easement, design, and permitting activities. These phased treatment train projects would be targeted for storm drain outlets in subwatersheds that are rated as high loading. Effectiveness monitoring would be conducted after these phased treatment systems are installed to evaluate the need for system modification or evaluation of alternative technologies that may become available in the near future that are cost effective. Full-scale treatment systems will be implemented following effective assessment monitoring of phase I treatment train projects by year 7-8.

The City of San Diego has already taken the first step in the implementation process by coordinating with stakeholders. The City met with representatives from the Sierra Club and San Diego Coastkeeper at the Regional Water Quality Control Board on May 26, 2006. Two additional meetings were held with stakeholders at the City of San Diego offices on August 22, 2006 and September 15, 2006. By continuing to meet with the stakeholders and developing a clear and concise implementation strategy, the stakeholders should be able to achieve the intended goals of reducing storm water pollution to the maximum extent practicable or to achieve each TMDLs water quality standards.

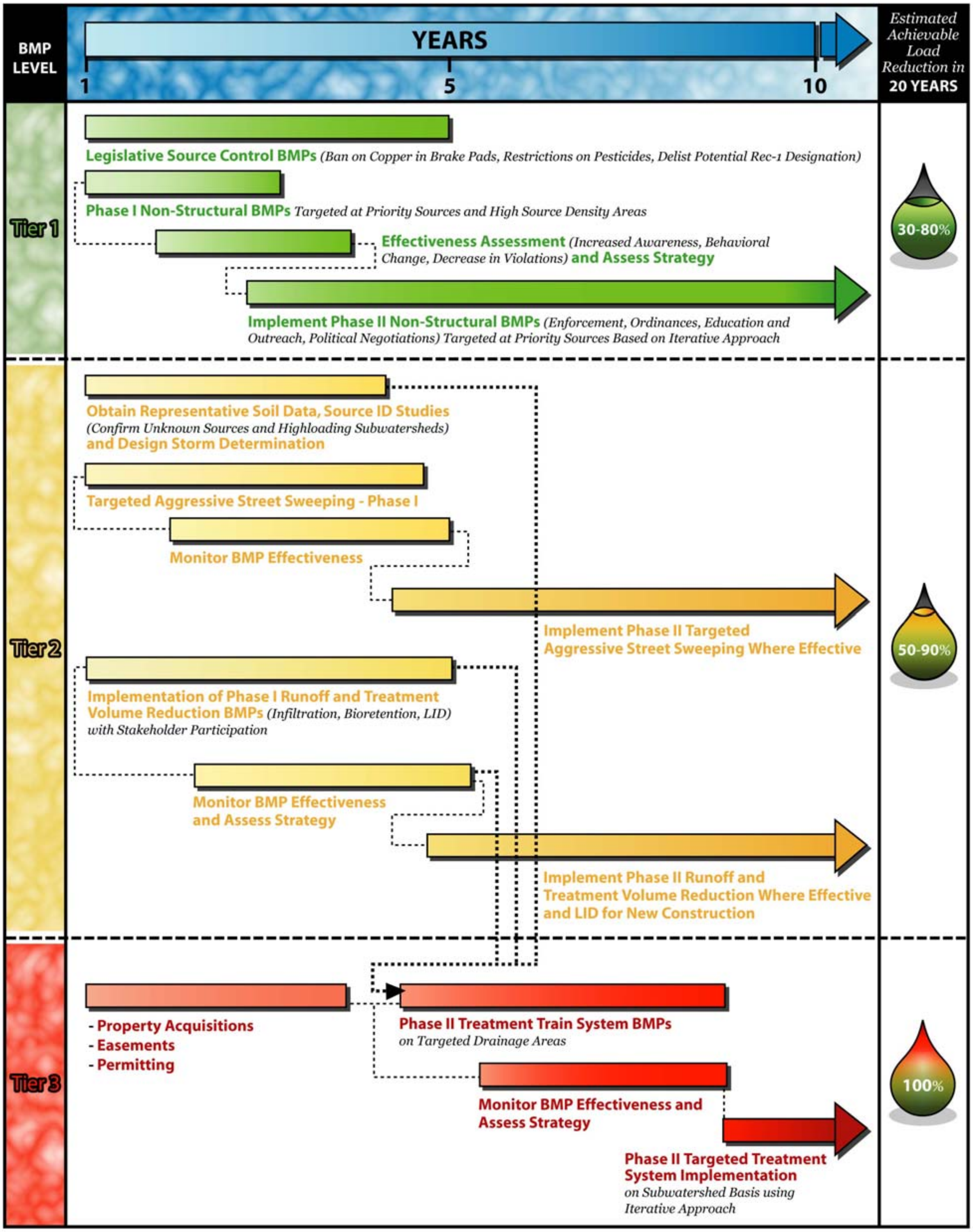

Figure 8-1. Integrated TMDL - Conceptual Alternative Tiered Implementation Schedule

The City is currently working on a five year priority activity implementation plan for the Chollas Creek watershed. This implementation plan will use the approach outlined in this strategy to identify priority activities that will include both non-structural BMPs and runoff reduction and treatment BMPs. The City will be meeting with community stakeholders to obtain their input on priority activities. The plan will also include a framework for effectiveness monitoring of these measures that will be used to assess their efficiency and identify more effective BMPs and the need for additional measures. Cost estimates for the activities will be provided in this 5 year plan.

Finally, an Implementation Plan framework is presented as the next step to this report. It is recommended that this Implementation Plan be developed through a collaborative effort with stakeholders and the RWQCB. An Implementation Plan is often prepared following development, and approval of a TMDL. Implementation plans are not necessarily pollutant specific and should be designed to address multiple water quality problems within a watershed. The Chollas Creek watershed stakeholders will benefit from a coordinated implementation plan that addresses all TMDL pollutants of concern. The Regional Water Quality Control Board has described implementation plans for each TMDL, but with little detail on how to execute them. As such, the Chollas Creek watershed implementation plan should be developed by the interested and involved stakeholders. The Chollas Creek watershed implementation plan should be prepared as a formal "living" document that can be changed over time as new information is collected.

It is recommended that the Chollas Creek TMDL implementation plan should contain the following elements:

- Introduction
- Summary of TMDL development
- Stakeholder's roles and responsibilities
- Public participation process
- Implementation actions
- Potential funding sources
- Measurable goals and milestones

The implementation plan should provide an **Introduction** that includes information on the following:

- Describe the purpose, content, and scope to answer:
- What beneficial uses are impaired?
- What pollutants cause the impairments?
- What is the geographical extent of impairment?
- What are applicable Water Quality Objectives?

The implementation plan should include a **Summary of the TMDL Development**. This description should include a brief description of the following:

- Describe watershed characteristics
- Describe water quality data used
- Describe water quality modeling

- Describe water quality sensitivity analysis
- Describe pollution sources evaluated
- Describe allocations
- Describe needed load reductions

Stakeholders are individuals who live or have land management responsibilities in the watershed, including government agencies, businesses, private individuals, and special interest groups. Stakeholder participation and support is essential for achieving the goals of this TMDL effort. This section of the implementation plan should identify and define **Stakeholders' Roles and Responsibilities** by describing who will work together to develop and execute the implementation plan.

- Who are the stakeholders identified in TMDL Development?
- Which stakeholders have not yet engaged in the process?
- Which stakeholders will assist in implementing the implementation plan?
- What are the specific roles and responsibilities of involved stakeholders?
- What resources can these stakeholders provide toward implementation?
- Which stakeholders are involved in voluntary controls?
- Which stakeholders are involved in regulatory controls?

The primary use of this section of the implementation plan is to specify how the stakeholders will be organized. The implementation plan will describe the formal agreement between existing stakeholders (i.e., MOU). The structure of the stakeholder organization will depend on the set of ground rules to be used for collaboration. The decision making process must be inclusive, transparent, effective, and broadly representative of the watershed community. The following factors should be considered:

- *Consensus*. The definition of consensus is important -- whether everyone has to agree, whether everyone simply has to be able to live with it, or whether just no one says "no." The group needs to decide what to do if there is deadlock. Will some form of super majority vote be required? Will they use "parking lots" to place issues until agreement can be reached, or will they just not act if disagreement exists?

- *Who is considered a member*. This involves deciding what interests need to be at the table, who picks the representatives of those interests, whether the group will allow alternates for members, and whether all members will be expected to have authority to speak for and commit their organizations.

- *How information is to be generated, shared, and legitimized*. Unless all group members are comfortable with the information being used, disagreements may result over whose information is "right," what the real on-the-ground needs are or which system of monitoring and evaluation is to be used.

- *Commitment*. Individual members of the group should agree to invest the time, energy, and resources necessary to work to implement consensus decisions.

The implementation plan should also include a section summarizing the **Community Participation** process that will help guide development of the implementation plan. This section should recognize the citizens and agencies that provided input for the implementation plan. This section should briefly describe how the public will be involved in the implementation plan. The plan should use a community based social marketing approach that includes the following steps:

1. Identifying the barriers and benefits to an activity,
2. Developing a strategy that uses tools shown to be effective to bring about behavior change,
3. Establish pilot education and outreach strategies and gather analytical data, and
4. Evaluation of strategy after implementation of selected pilot in the broader community.

The implementation plan should also address the following questions:

- What are the target public audiences in the watershed?
- What are the concerns and priorities of the target audiences?
- Will public meetings be held?
- Will the public receive mailings?
- Will there be a website for the activities?
- Will there be media contacts?

The largest section of the implementation plan should describe the **Implementation Actions** that will be conducted. The implementation plan should:

- Identify specific types of corrective actions that may be applied (i.e., BMPs)
- Identify the degree of detail needed to conduct each corrective action (feasibility studies, engineering plans)
- Identify technical assistance needed to implement each corrective action
- Estimate cost and benefit of each corrective action

The IP should describe how the implementation actions will be funded. The implementation plan should:

- Identify all **Possible Funding Sources**
- Identify which stakeholders will apply for which funds

Finally, the implementation plan should have a section describing the **Measurable Goals and Milestones**. The lead agencies agreeing to be responsible for overseeing implementation should be identified, as well as the milestones and goals set for implementation. This section of the implementation plan should address the following questions:

- Will implementation be conducted in phases?
- Who is responsible for tracking control measure installations?
- What are the timelines for installing control measures?
- What type of water quality monitoring will be conducted during implementation?
- What are the annual goals to be achieved (both installation and water quality goals)?
- What methods will be used for evaluating progress?
- What actions will be taken if goals are not met (both installation and water quality goals)?

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