Guidance Document for Effectiveness Assessment – Source Contribution Tools and Methodologies Information Database

Effectiveness Assessment Subcommittee

California Stormwater Quality Association

Version 1.1

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CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION®

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California Stormwater Quality Association

Guidance Document
for
Effectiveness Assessment -
Source Contribution Tools and Methodologies
Information Database (Version 1.1)

Prepared By:

July 2018

1 Purpose

The California Stormwater Quality Association (CASQA) conducted a comprehensive review of existing approaches and tools for use in evaluating source contributions (outcome level 4) from key source categories and target audiences. This work effort was and will continue to be coordinated amongst three CASQA subcommittees (Effectiveness Assessment, Best Management Practices, and Watershed and Impaired Waters). The work effort consisted of the following tasks:

1) Conduct surveys/literature reviews to identify existing approaches and tools used for evaluating source contributions as well as key materials for further evaluation (completed in November 2017);
2) Evaluate the tools and methodologies identified as part of Task 1, determine the applicability based on pollutant type, sources, and target audiences, phase of program planning/implementation and identify how the tools may be used by the municipalities; and
3) Update the CASQA effectiveness assessment web portal to provide an online interface and access to the database.

This guidance document and accompanying Source Contribution Tools and Methodologies Information Database (Database) provides the information identified in Task 2. The Database is comprised of the tools and methodologies[1] currently used to assess source contributions and reductions and is structured to allow the user to search for information from three perspectives: Pollutant/Condition of Concern (POC/COC); Best Management Practices (BMPs); or Source. The Database was developed in Microsoft Access format.

The structure and content of the information within the Database was primarily driven by the questions and results from the survey distributed to CASQA members (Task 1) as well as feedback received by the three CASQA subcommittees involved in this work effort. Results of this survey are presented in *Summary of the CASQA Source Contribution Tools and Methodologies Survey Memorandum* dated November 5, 2017.

For the online interface, the information from the Database will be incorporated into the CASQA website so that the information may be broadly distributed and updated as needed.

2 Background

Stormwater program managers and practitioners rely on an array of tools and methodologies to try to determine source loadings and reductions. Approaches fall within three distinct categories: modeling, direct measurement, and utilization of literature values. Many of these tools may also be used to assist municipalities who are required to conduct reasonable assurance analyses (RAAs) to demonstrate that their management program will have the intended effect on discharge and/or receiving water quality.

Table 1 presents five types of tools and methodologies and how they may be used by stormwater programs when trying to determine source loadings and reductions.

[1] Tools and methodologies available at the time of writing were reviewed and are presented in the Database. It is anticipated that the Database will be updated over time as additional tools or methodologies are developed and/or further discretization is desired within the Database.

Table 1. Application of Tools and Methodologies by Type

Tool or Methodology Type	Application
Modeling	
"Complex" Models	Complex models utilize data (e.g., default data or user-provided data) to simulate hydrologic and water quality transport processes and evaluate the effects of BMP implementation within the study area, watershed, or drainage area. Some models are designed for direct use by stormwater program staff, whereas others require modeling specialized expertise to use them.
"Simple Spreadsheet" Models	Similar to complex models, simple spreadsheet models can estimate baseline source contributions and evaluate the pollutant removal effects of BMPs for a given study area. Simple spreadsheet models are typically intended for direct use by stormwater program staff. Compared to complex models, simple spreadsheet models generally do not perform robust computations (e.g., on an event basis) or require significant data input (comparatively). Simple spreadsheet models are typically easier to use than complex models and rely on general assumptions that can have multiple or wide-ranging applications.
Direct Measurement	
	Direct measurement is the actual measurement of the influent and effluent of a BMP to determine the amount of a pollutant removed. This methodology typically involves the planning and staging of equipment and personnel to sample land-based runoff for water quality parameters and requires a project plan or standard operating procedures (SOP) as well as a quality assurance project plan (QAPP). Special studies use direct measurement to attain data to answer specific questions related to source contributions or pollutant load removal occurring within the watershed. Types of special studies may include, but are not limited to, bacterial source investigations or monitoring specific project sites.
Literature Values	
	Stormwater program managers may utilize estimations and/or loading factors from literature to characterize the source contributions and/or pollutant load removal within their jurisdictions. Literature values are representative of actual conditions and the values are typically based on data observed and measured in similar regions or with similar watershed conditions.

Throughout the State of California, various source contribution tools and methodologies have been used during the planning and implementation phases of stormwater programs. Below are a few examples of how specific tools and methodologies have been utilized.

Models (Complex)

The Reasonable Assurance Analysis (RAA) in the Ballona Creek Enhanced Watershed Management Plan (EWMP) was performed utilizing the Watershed Management Modeling System (WMMS). WMMS is a comprehensive watershed model of the entire Los Angeles County area that characterizes water quality loading, fate, and transport for several water quality constituents (i.e., pollutants). This modeling system consists of two other modeling tools, Loading Simulation Program C+ (LSPC) and System for Urban Stormwater Treatment Analysis and Integration (SUSTAIN), to predict the baseline hydrology and pollutant loading conditions and evaluate BMP performance.

Direct Measure

Special studies and direct measurement techniques were employed by the City of San Diego to further understand and evaluate the water quality benefits of street sweeping. Five phases of this pilot study were conducted over a five-year period to explore various aspects of street sweeping including effectiveness of vacuum and mechanical sweepers and sweeping frequency, water quality benefits from and feasibility of median sweeping, optimal sweeper speed, and the water quality benefits and cost-effectiveness of implementing parking restrictions. Pollutant removal efficiencies and street sweeping debris compositions determined through these studies have been used for planning decisions related to operational modifications to optimize program, developing implementation strategies for water quality improvement plans, and determining compliance feasibility with the California Statewide Trash Amendments.

Literature Values

Several Water Quality Improvement Plans (WQIPs) developed for Water Management Areas (WMAs) in southern California relied on pollutant load estimations to account for the pollutant load removal achieved collectively by nonstructural or programmatic activities. In 2014 the City of San Diego researched pollutant load reduction for nonstructural activities and presented the findings in the *Nonstructural Non-Modeled Activity Pollutant Load Reduction Research Technical Memorandum*. The study determined that 10 percent is an average percent removal that can be used for all nonstructural activities for all pollutants. San Diego Region copermittees who elected to utilize water quality models in the development of WQIPs referred to this estimation for nonstructural activities that were not modeled. Pollutant load removals achieved by structural BMP implementation were accounted by the model and load removals achieved through nonstructural activities were assumed to amount to 10 percent of source load, based on the findings from this study.

3 Database Overview

Based on the results of the survey conducted as part of Task 1, the tools and methodologies summarized within the Database are listed in **Table 2**. It is anticipated that this list will be expanded on in the future as new tools and methodologies are identified and developed.

Table 2. Tools and Methodologies Compiled

Tool and Methodologies
Modeling
"Complex" Models • Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) • Hydrological Simulation Program - FORTRAN (HSPF) • Loading Simulation Program in C++ (LSPC) • Pollutant Load Reduction Model (PLRM) • Structural BMP Prioritization and Analysis Tool (SBPAT) • System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN) • Stormwater Management Model (SWMM) • Stormwater Tool to Estimate Load Reduction (swTELR) • Source Loading and Management Model for Windows (WinSLAMM) • Watershed Management Modeling System (WMMS) • Watershed Management Optimization Support Tool (WMOST) *"Simple Spreadsheet" Models* • Watershed Treatment Model (WTM) • Parcel Best Management Practice (BMP) Calculator
Direct Measurement
• Special Studies, Monitoring ○ Street sweeping pilot studies (City of San Diego, 2010a; 2010b; 2011; 2015) ○ Catch basin inlet cleaning pilot studies (City of San Diego, 2013a; 2013b) ○ Guidance manuals for monitoring (USEPA, 1997; USEPA, 2002; Meals et al., 2013; County of San Diego, 2001; USGS, 2006) ○ CalTrans BMP retrofit pilot program (CalTrans, 2004)
Literature Values
• Estimations/Loading Factors *Land-based pollutant generation references:* ○ Interim Accounting Methodology for TMDL Loads Reduced (BASMAA, 2017) ○ Hydrological Simulation Program—FORTRAN, Version 12, User's Manual (Bicknell, 2001) ○ Stormwater Effects Handbook (Burton and Pitt, 2002) ○ 1994-2000 Integrated Receiving Water Impacts Report (LA County DPW, 2000) ○ National Stormwater Quality Database ○ Sources, Patterns and Mechanisms of Storm Water Pollutant Loading from Watersheds and Land Uses of the Greater Los Angeles Area, California, USA. (Stein et al. 2007) ○ Watershed Hydrologic Modeling and Sediment and Nutrient Loading Estimation for the Lake Tahoe Total Maximum Daily Load (Tetra Tech, 2007) ○ Los Angeles County Watershed Model Configuration and Calibration – Part I (Tetra Tech, 2009)

Tool and Methodologies
○ Results of the Nationwide Urban Runoff Program, Volume I Final Report. (USEPA, 1983) *BMP pollutant removal references:* ○ Stormwater Best Management Practice Handbook: New Development and Redevelopment (CASQA, 2003) ○ Effectiveness Evaluation of Best Management Practices for Stormwater Management in Portland, Oregon (City of Portland, 2006) ○ BMP Design Manual for Permanent Site Design (County of San Diego, 2016) ○ Nonstructural Non-Modeled Activity Pollutant Load Reduction Research – Addendum (HDR, 2014) ○ BMP Modeling Concepts and Simulation (Huber et al., 2006) ○ SWMM4 User's Manual (James, et al. 2002) ○ Demonstration of Nonpoint Pollution Abatement through Improved Street Cleaning Practices (Pitt, 1979) ○ Best Management Practice Rapid Assessment Methodology (BMP RAM) (2nd Nature, 2016) ○ Long-Term Performance and Life-Cycle Costs of Stormwater Best Management Practices (NCHRP, 2014)

The Database, developed as an Access Database file, is designed to identify tools and methodologies through three, unique query pathways. Depending on the user's focus of interest, a query pathway may begin with a selection of a pollutant/condition of concern, source, or BMP. Each query pathway allows the user to further refine results by selecting the combination of conditions that they are interested in. The Database queries are designed to assist the user in making relationship-based selections. For instance, a pollutant/condition of concern selection of metals would limit sources and BMP selections to those that contribute to metal contributions and pollutant reduction. It should be noted that, for the initial development of this Database, many of the categories are representative of a number of sub-categories that could be included in the future. For example, one of the pollutants/conditions of concern that is included is metals, which is representative of a number of metals such as copper, cadmium, lead, zinc, etc. Although this may be further refined in the future, for the purposes of this Database and the current abilities of the tools and methodologies, it was determined that a categorical approach would be used.

These relationships are defined in **Attachment 1** and **Attachment 2**. Selections for each category are presented in **Table 3** and model concepts of each query pathway are presented in **Figure 1**.

Table 3. Pollutant/Condition of Concern, Source, and BMP selections

Pollutant/Condition of Concern	Source	BMP[1,2]
• Dissolved oxygen (DO) • Metals • Nutrients • Pathogen indicators/bacteria • Pesticides • Runoff volume and flow • Sediment/Total suspended solids (TSS) • Trash • Waste material[3]	• Agricultural • Commercial • Construction • Industrial • Undeveloped Areas • Residential • Transportation	• SC - Catch basin cleaning • SC - Education • SC - Street sweeping • SC - All source controls (collective)[4] • SC-/TC- Roof runoff controls[5] • TC - Bioretention • TC - Constructed wetland • TC - Extended detention basin • TC - Infiltration basin • TC - Infiltration trench • TC - Media filter • TC - Pervious pavement • TC - Vegetated buffer strip • TC - Vegetated swale • TC - Vortex separator • TC - Wet pond

[1] "SC" indicates source control, "TC" indicates treatment control

[2] BMP names are based on BMPs identified in the 2003 CASQA BMP Handbooks – New Development and Redevelopment; Municipal, and Industrial and Commercial (CASQA 2003a; 2003b; 2003c).

[3] Waste material refers to yard waste, fertilizer, used oils, paint, recyclable waste and other miscellaneous waste products. Presently there are no models to evaluate the fate and transport of waste materials, however, direct measurement (e.g., special studies) can be used to further evaluate waste material contributions and removal.

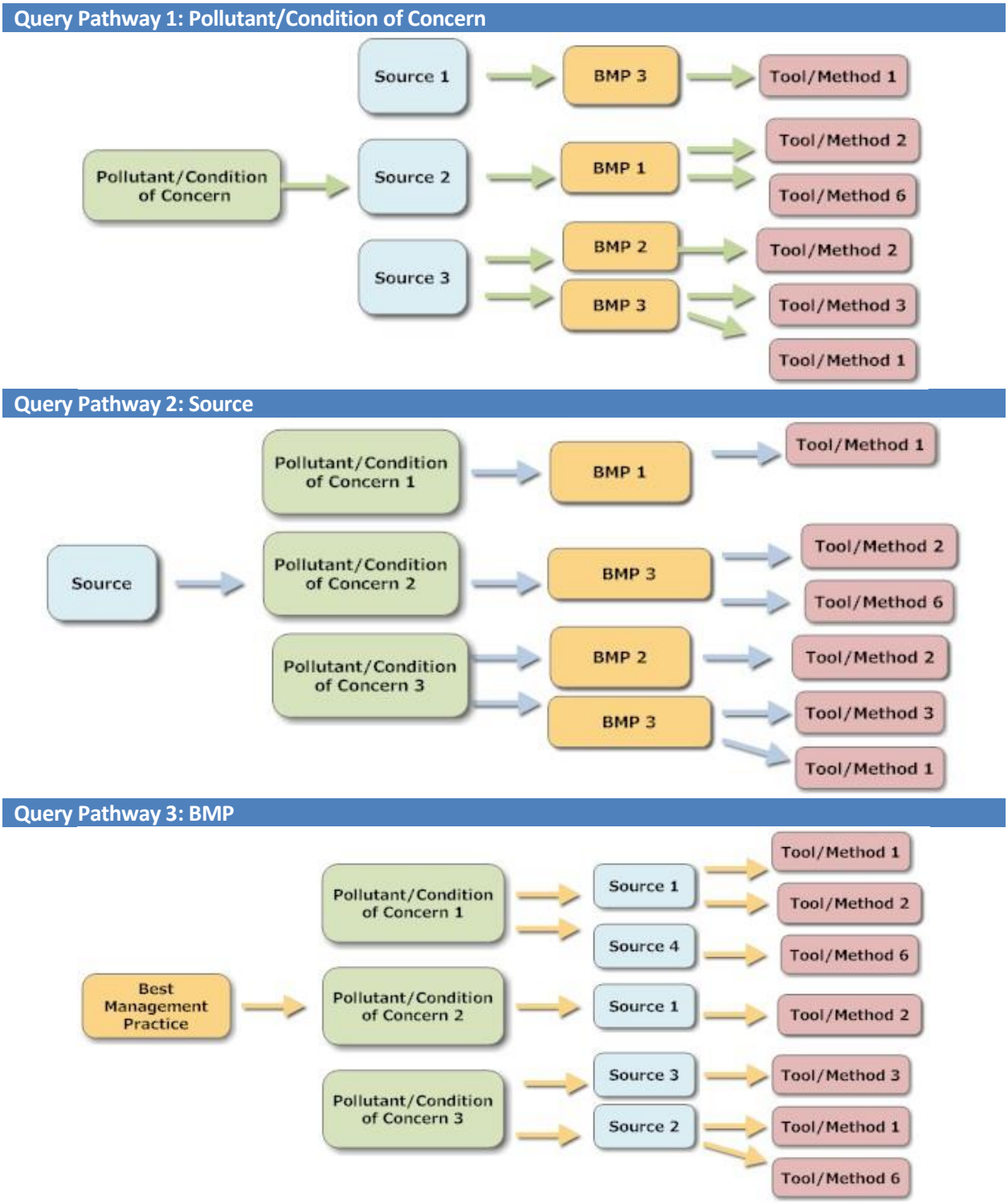
[4] This BMP selection is a non-specific source control selection. Users interested in evaluating the collective water quality benefit of several source controls can select this option.

[5] Roof runoff controls include source control and treatment controls such as downspout disconnections, cisterns, rain barrels, and green roofs.

After the user selects the query pathway and selections of interest, the Database generates a report. The report includes a series of summaries for the tools and methodologies applicable to the user selections. The type of content that is provided generally includes the following:

- Type of tool/methodology (e.g., modeling, direct measurement, literature values)
- Brief description of the tool/methodology
- Intended user
- Geographic focus
- Scale
- Developer
- Website
- How are source contributions estimated?
- How is pollutant load removal estimated?
- What does the user need to input?
- What can the user expect as outputs?
- Considerations
- Additional features

Figure 1. Query Pathways



4 Limitations and Future Considerations

The Database contains information available at the time of writing. Selection options in the Database are derived from the capabilities of tools and methodologies compiled. It is anticipated that these selections will grow in the future as capabilities for models expand and more research is conducted. Relationships built into the Database to assist the query selections are from the CASQA Stormwater BMP Handbooks (CASQA 2003a; 2003b; 2003c) and other recent literature reviews (Tetra Tech, 2012). The Development and Redevelopment CASQA Stormwater BMP Handbook is currently being updated and was not available for consideration at the time of this writing. Relationships built into this Database may be modified as new research and publications are made available.

The Database serves as a central repository with flexibility to expand as additional resources are collected. Future considerations for the enhancement of this Database include:

- Updating content as tools are modified and new tools and methodologies become available
- Updating selection options as appropriate; and
- Updating query relationships, defined in **Attachment 1** and **Attachment 2**, as the CASQA Stormwater BMP Handbooks are updated and/or other sources are used.

5 Online Interface

The information in the Database and the queries may be accessed at www.casqa.org through the Effectiveness Assessment page.

6 References

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ATTACHMENT 1

Pollutant/Condition of Concern to BMP Relationships

BMP	Pollutant/Condition of Concern									Reference
	Dissolved oxygen (DO)[1]	Metals	Nutrients	Pathogen indicator/ bacteria	Pesticides[1]	Runoff volume and flow[1]	Sediment/Total suspended solids (TSS)	Trash[2]	Waste material[1]	
SC - All source controls (collective)	x	x	x	x	x	x	x	x	x	CASQA Stormwater BMP Handbook - Municipal (2003)
SC - Catch basin cleaning	x	x	x	x	x	x	x	x	x	CASQA Stormwater BMP Handbook - Municipal (2003)
SC - Education	x	x	x	x	x	x	x	x	x	CASQA Stormwater BMP Handbook - Municipal (2003)
SC - Street sweeping	x	x			x	x	x	x	x	CASQA Stormwater BMP Handbook - Municipal (2003)
SC-/TC - Roof runoff controls	x	x	x	x	x	x	x	x	x	CASQA Stormwater BMP Handbook - Development (2003)
TC - Bioretention	x	x		x	x	x	x	x	x	CASQA Stormwater BMP Handbook - Industrial and Commercial (2003)[3]
TC - Constructed wetland	x	x		x	x	x	x	x	x	CASQA Stormwater BMP Handbook - Industrial and Commercial (2003)[3]
TC - Extended detention basin	x				x	x		x	x	CASQA Stormwater BMP Handbook - Industrial and Commercial (2003)[3]
TC – Infiltration basin	x	x	x	x	x	x	x	x	x	CASQA Stormwater BMP Handbook - Industrial and Commercial (2003)[3]
TC - Infiltration trench	x	x	x	x	x	x	x	x	x	CASQA Stormwater BMP Handbook - Industrial and Commercial (2003)[3]
TC - Media filter	x	x			x	x	x	x	x	CASQA Stormwater BMP Handbook - Industrial and Commercial (2003)[3]
TC - Pervious pavement	x	x	x	x	x	x	x	x	x	CASQA Stormwater BMP Handbook - Development (2003)
TC - Vegetated buffer strip	x	x			x	x	x	x	x	CASQA Stormwater BMP Handbook - Industrial and Commercial (2003)[3]
TC - Vegetated swale	x				x	x		x	x	CASQA Stormwater BMP Handbook - Industrial and Commercial (2003)[3]
TC - Vortex separator	x	x	x	x	x	x	x	x	x	CASQA Stormwater BMP Handbook - Industrial and Commercial (2003)[3]
TC - Wet pond	x	x			x	x	x	x	x	CASQA Stormwater BMP Handbook - Industrial and Commercial (2003)[3]

[1] BMP removal efficiencies for dissolved oxygen, pesticides, runoff volume and flow, and waste material are not defined in the CASQA Stormwater BMP Handbooks. For the purposes of this Database and selection queries, these pollutants and conditions of concerns will have a relationship with all BMPs so as to not limit the number of outputs.

[2] All BMPs are assumed to address trash for the purposes of this information database.

[3] Targeted constituents are based on "high pollutant removal" denoted in the CASQA BMP manual.

ATTACHMENT 2

Pollutant/Condition of Concern to Source Relationships

Source	Pollutant/Condition of Concern									Reference
	Dissolved oxygen (DO)[1]	Metals	Nutrients	Pathogen indicator/ bacteria	Pesticides[1]	Runoff volume and flow[1]	Sediment/Total suspended solids (TSS)	Trash[2]	Waste material[1]	
Agriculture	x		x	x	x	x	x		x	County of Los Angeles 2010; City of San Diego 2010a; USEPA 2011d; Appendix A; County of Los Angeles 2010; USEPA 2011d
Commercial	x	x	x	x	x	x	x	x	x	County of Los Angeles 2010; SDRWQCB 2010; SWRCB 2011d; Stein and Tiefenthaler 2005; Appendix A
Construction	x	x	x	x	x	x	x	x	x	County of Los Angeles 2010; USEPA 2011d
Industrial	x	x	x	x	x	x	x	x	x	County of Los Angeles 2010; SDRWQCB 2010; SWRCB 2011d; Stein and Tiefenthaler 2005; Appendix A, Gregorio and Moore 2004; Tiefenthaler et al. 2007; Lattin et. al 2004; Appendix A
Undeveloped	x	x	x	x	x	x	x		x	County of Los Angeles 2010; LARWQCB 2002; Appendix A
Residential	x	x	x	x	x	x	x	x	x	County of Los Angeles 2010; SDRWQCB 2010; SWRCB 2011d; Stein and Tiefenthaler 2005; Appendix A, City of San Diego 2009a; Appendix A
Transportation	x	x			x	x	x	x	x	County of Los Angeles 2010; USEPA 2011d; Schueler and Holland 2000; Stein et al. 2006, Sabin and Schiff 2007; Sabin et al. 2005, Caltrans 2003a

Source: Tetra Tech. 2012. Chollas Watershed Comprehensive Load Reduction Plan. Available at: https://www.sandiego.gov/stormwater/plansreports

[1] Source activity and pollutant/condition of concern relationships were not defined for dissolved oxygen, pesticides, runoff flow and volume, and waste material in the source for this table (Tetra Tech, 2012). For the purposes of this Database and selection queries, these pollutants and conditions of concerns will have a relationship with all land use sources.

[2] All land uses are assumed to be a source of trash, except Agriculture and Undeveloped land uses, for the purposes of this information database.