

# **Attachment B**

## **Sources and Activities Profile Sheets**

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Construction Sources and Activities

Industrial & Commercial Sources and Activities

Municipal Operations Sources and Activities

Planning and Land Development Sources and Activities

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# Construction Sources and Activities

*This fact sheet has been developed to assist stormwater program managers in understanding why these sources and activities can be problematic in stormwater and urban runoff, what the potential pollutants of concern are, and how effectiveness assessment goals and metrics can be established to assist program managers in answering specific management questions in order to adaptively manage their programs.*



The approach and methods described herein provide a “toolbox” for stormwater program managers so that they can select the program assessment methods and metrics that are most meaningful to their overall stormwater program.

## INTRODUCTION

The Construction activities can alter natural drainage patterns and affect runoff quality and/or quantity, adding pollutants to the receiving waters.

Excessive erosion and sedimentation are perhaps the most visible water quality impacts due to construction activities. However, there are other, less visible impacts associated with construction sites, such as the potential to discharge other on-site pollutants including cement waste, oil & grease, metals, nutrients, soil additives, pesticides, construction-related chemicals, and other construction waste such as trash. Construction activities can also impact a construction site’s runoff sediment supply and transport characteristics. These modifications, which can occur both during and after the construction phase, are a cause of concern and may contribute to adverse impacts in the receiving waters.

The magnitude of the potential impacts from construction sites depends on the construction phase, climatic conditions, and site conditions (i.e., amount of area cleared) as well as the actions taken by the target audience involved at the site. The target audience—the key personnel involved in the activities at these sites—includes contractors, skilled workers, and laborers. Controlling the potential impact(s) of

Each stormwater program may also wish to refer to the following constituent-specific profiles for additional, example program activities, management questions, goals, and metrics that may apply to this program element:

- Bacteria
- Mercury
- ✓ Nutrients
- ✓ Pesticides
- ✓ Sediment
- ✓ Trash

# Construction Sources and Activities

construction site activities requires that the target audience have a basic understanding of the impacts, pollutant sources, and other contributing factors, as well as implementation of the Best Management Practices (BMPs) necessary to eliminate or reduce the discharge of pollutants.

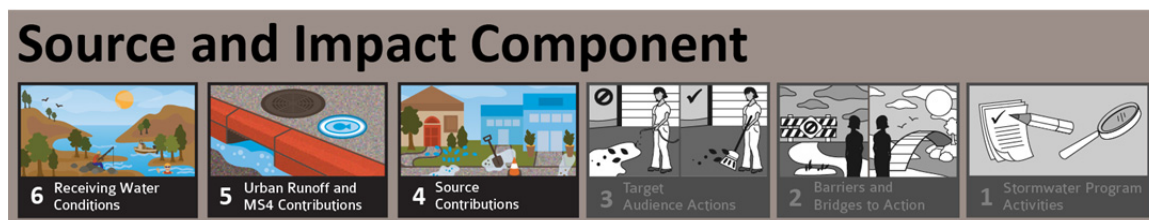
## ASSESSMENT OF WATER QUALITY ISSUES AND SOURCES

This section assumes that the following has been determined as a part of the stormwater program planning and assessment process:

- The receiving water quality and/or conditions warrant addressing the constituents associated with these sites, and/or flow as a high priority; AND
- The urban runoff quality and hydrology have been identified as a primary source of the receiving water quality and/or conditions; AND
- These sites have been potentially identified as a major source of the constituents/conditions of concern.

Depending on the stormwater program, the receiving water/urban discharge assessment may be completed by evaluating a local urban discharge/receiving water monitoring program, or it may be completed by assessing other available data and information sources, such as total maximum daily loads (TMDLs), 303(d) lists, special studies, and/or other research and literature.

*Note: The terminology OL6, OL5, etc. used herein refers to the CASQA outcome levels (OL) as defined in Section 2.*



## Receiving Water Conditions (OL6) and Urban Runoff and MS4 Contributions (OL5)

The primary constituent of concern at construction sites is excess sediment.

- Sediment - can be detrimental to aquatic life (primary producers, benthic invertebrates, and fish) by interfering with photosynthesis, respiration, growth, reproduction, and oxygen exchange in water bodies. In addition, sediment particles can transport other constituents that are attached to them, including nutrients, trace metals, and hydrocarbons.

In addition to the impacts directly associated with sedimentation, various constituents can also be transported along with sediment particles leaving construction sites. Such constituents may

# Construction Sources and Activities

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include oil and grease, metals, nutrients, and pesticides. These constituents often originate from on-site activities as well as through organic components, plant residues, and nutrient elements within soils on the construction site, and are thus mobilized by erosion and later deposited downstream during sedimentation.

- Oil & grease - may enter surface water bodies through leaks, spills, automotive cleaning or repair, and waste oil disposal.
- Metals - including lead, zinc, cadmium, copper, chromium, and nickel are commonly found in stormwater. Many of the artificial surfaces of the urban environment (e.g., galvanized metal, paint, automobiles) contain metals, which enter stormwater as the surfaces corrode, flake, dissolve, decay, or leach. Over half the trace metal load carried in stormwater is associated with sediments.
- Nutrients - excess nutrients including nitrogen and phosphorous can lead to excessive vegetation or algal growth which may correspond to aesthetic or aquatic life impairment in surface water.
- Pesticides - used to kill a wide variety of insects, weeds, and other pests can be highly toxic to birds, honeybees, and aquatic life.
- Trash<sup>1</sup> - can cause aesthetic and recreational impacts, inhibit aquatic habitat and vegetation growth, and harm aquatic organisms that ingest or become entangled in the debris. Trash can transport other constituents that are attached to it, including nutrients, bacteria, trace metals, and hydrocarbons.

## Source Contributions (OL4)

If, through the planning and assessment process, construction sites are identified as a potential source, then the various activities that occur on-site that may contribute to the discharge of the constituents of concern should be identified and prioritized. Although a stormwater program may address multiple sources concurrently, those sources most likely to be attributed to the constituent(s) of concern should be addressed as high priority.

Although erosion and sedimentation discharges are the most visible and significant sources of constituents associated with construction sites, other constituents such as pH, oil and grease, nutrients, metals, organics, pesticides, and gross constituents may also be considered. The potential sources of the constituents of concern from construction sites are summarized in **Table 1**.

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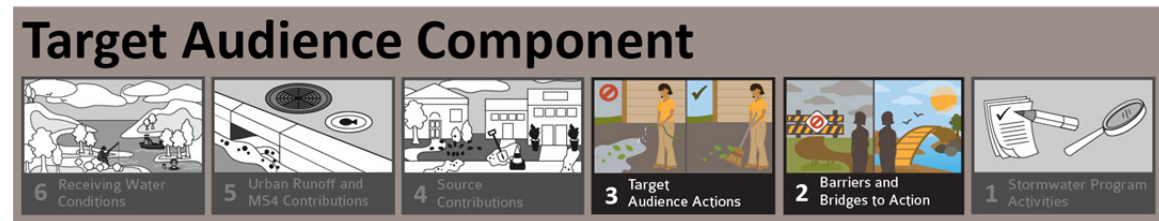
<sup>1</sup> Any debris that does not pass through a 5 mm sieve or preproduction plastic pellets

# Construction Sources and Activities

**Table 1.** Potential Construction Sources of Constituents of Concern

Construction Sources	Constituents of Concern							
	Sediment	pH	Oil, Grease, Fuels	Pesticides	Metals	Other Toxic Chemicals	Trash	Misc. Waste
<b>Construction Practices</b>								
Grading Operations	X						X	
Dewatering Operations	X					X		
Pre-Construction Termiticide Applications				X				
Paving Operations	X	X	X	X		X	X	X
Structure Construction/Painting		X			X	X	X	X
Weed Control				X				
<b>Materials Management</b>								
Material Use and Storage	X	X	X	X	X	X	X	
<b>Waste Management</b>								
Solid Waste	X						X	X
Hazardous Waste						X		
Contaminated Spills	X					X		
Concrete Waste		X					X	X
Sanitary/Septic Waste							X	X
<b>Vehicle/Equipment Management</b>								
Fueling			X			X		X
Maintenance & Washing			X			X		X

# Construction Sources and Activities



## Target Audience Actions and Barriers and Bridges to Action (OL3, OL2)

The target audiences most involved with construction sites include:

- Contractors;
- Skilled workers; and
- Laborers.

Once the priority sources at the construction sites are identified, the target audience(s) most involved with those sources can also be identified and evaluated to assess their behaviors, as well as the potential barriers to the implementation of the “correct” behaviors. Some of the barriers may include miscommunication between workers, a lack of training, a lack of oversight at the construction site, and/or language barriers. The outreach to the target audiences should be evaluated and prioritized so that the high priority target audiences and sources are addressed using the most effective means of outreach.



## Stormwater Program Activities (OL1)

The implementation activities for construction programs typically include the following:

- Reviewing and revising municipal code, as needed;
- Review and revising the plan review and approval process, as needed;
- Developing and updating a construction site inventory;
- Providing outreach to construction site owners/operators;
- Providing training to key staff who are involved in the construction program;

# Construction Sources and Activities

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- Conducting site inspections and follow up inspections to verify BMP implementation; and
- Pursuing progressive enforcement actions for those sites that do not comply with the stormwater requirements.

For the purposes of program effectiveness assessment, the OL1 activities simply demonstrate that the program is being implemented pursuant to the municipal stormwater permit. The assessment at this outcome level does not indicate the effect that the program is having (i.e., are the objectives/goals of the program being met?). For that reason, the goals and metrics identified for the program will primarily focus on OL2-OL6.

## MANAGEMENT QUESTIONS, GOAL SETTING, AND METRIC IDENTIFICATION

A large portion of the construction program is typically focused on site inspections which can serve as the basis for establishing baselines regarding how the sites are operating, what constituents are of concern, and the level of BMP implementation and maintenance that is required in order to address the constituents. In turn, follow-up inspections can be used to track changes and ensure that the sites are properly implementing and maintaining their BMPs. For programs that have existing data, these data can be used to determine the appropriate baseline factors by which future reductions can be measured. Some potential goals for existing programs may include:

- An increase in BMPs that are effective at removing constituents of concern (e.g., TMDLs), and are suitable to site constraints; and/or
- A reduction in the number of violations.

Another important aspect of this program element is educating the target audiences at the construction sites—the construction site owners/operators and their sub-contractors. Survey results may serve as a way to establish baseline information on current knowledge and practices. Some example goals, targets (where applicable) and projected timeframes are identified below. The targets and goals/metrics in **Table 2** below are examples. Each stormwater program will need to decide what numbers are most applicable to their program.



# Construction Sources and Activities

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## Example Management Questions and Goals

The following questions may also be used to assist in identifying/ establishing goals:

Outcome Level	Management Question
<b>1</b>	Is the program element/control measure/activity being implemented in accordance with the Permit Provisions, SWMP control measures and performance standards?
<b>2</b>	Does the program element/control measure/activity raise the target audience's awareness of an issue?
<b>3</b>	Does the program element/control measure/activity change a target audience's behavior which will result in the proper design and implementation of recommended BMPs?
<b>4</b>	Does the program element/control measure/activity reduce the load of constituents from the sources to the storm drain system?

# Construction Sources and Activities

**Table 2.** Example Management Questions, Goals, and Metrics

Program Activity	Management Question	Goal/Metric <sup>2</sup>	Data/Information to be Collected
<b>Outcome Level 4</b>			
Inspections	Are BMPs in place to prevent debris from leaving site?	<ul style="list-style-type: none"> <li>90% -100% of debris is captured and not released to the environment.</li> </ul>	Track quantities diverted to trash, other disposal streams  Track BMPs in place to prevent materials (e.g., sediment, trash, scrap metal) from leaving site and whether they are properly maintained.
<b>Outcome Level 3</b>			
Inspections	Did inspections change behavior?	<ul style="list-style-type: none"> <li>Increase percent of people responding to surveys that they are implementing BMPs to 90%</li> <li>Increase sites in compliance upon inspection to 75% within 2 years</li> <li>Increase sites in compliance upon inspection to 90% within 5 years</li> <li>Enforcement actions are required at &lt;10% of the sites and of those, &lt;5% are repeat offenders</li> </ul>	Track BMP implementation survey results.  Track initial site inspection results.  Track all sites and number and types of enforcement actions issued.
Inspections	Are key staff at the construction sites maintaining the BMPs?	<ul style="list-style-type: none"> <li>Based on the site inspections, &gt; 90% of the sites have BMPs that are maintained correctly.</li> <li>Enforcement actions are required at &lt;10% of the sites and of those, &lt;5% are repeat offenders</li> </ul>	Track all site inspection results.  Track all sites and number and types of enforcement actions issued.

<sup>2</sup> It should be recognized that goals and metrics may be limited to TMDL requirements.

# Construction Sources and Activities

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Program Activity	Management Question	Goal/Metric <sup>2</sup>	Data/Information to be Collected
<b>Outcome Level 2</b>			
Training	Was training effective for construction staff?	<ul style="list-style-type: none"> <li>• For each training module, increase number of attendees ranking the training as effective to 95% within 5 years</li> <li>• For each training module, increase post-training survey percent of answers correct to 95% within 5 years</li> </ul>	Track training evaluation results. Track pre- and post-training survey results.

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# Industrial & Commercial Sources and Activities

*This fact sheet has been developed to assist stormwater program managers in understanding why these sources and activities can be problematic in stormwater and urban runoff, what the potential pollutants of concern are, and how effectiveness assessment goals and metrics can be established to assist program managers in answering specific management questions in order to adaptively manage their programs.*



The approach and methods described herein provide a “toolbox” for stormwater program managers so that they can select the program assessment methods and metrics that are most meaningful to their overall stormwater program.

## INTRODUCTION

The Construction activities can alter natural drainage patterns and affect runoff quality and/or quantity, adding pollutants to the receiving waters.

Activities conducted at industrial and commercial facilities can adversely affect runoff quality, adding pollutants to the receiving waters. Water quality impacts from industrial and commercial facilities can include runoff associated with vehicle and equipment maintenance and cleaning, trash and debris in outdoor areas, and runoff associated with landscape maintenance.

The magnitude of the potential impacts from industrial and commercial facilities depends on the type of business or facility, climatic conditions, and site conditions as well as the actions taken by the target audience involved at the facility. The target audience—the key personnel involved in the activities at these sites—includes the owners and operators, as well as the skilled workers, and laborers. Controlling the potential impact(s) of industrial/commercial facilities requires a basic understanding of the activities that are conducted on site, the potential pollutant sources, and the Best Management Practices (BMPs) necessary to

Each stormwater program may also wish to refer to the following constituent-specific profiles for additional, example program activities, management questions, goals, and metrics that may apply to this program element:

- ✓ Bacteria
- ✓ Mercury
- ✓ Nutrients
- ✓ Pesticides
- ✓ Sediment
- ✓ Trash

# Industrial & Commercial Sources and Activities

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eliminate or reduce the discharge of pollutants.

The approach and methods described herein provide a “toolbox” for stormwater program managers so that they can select the methods and metrics that are most meaningful to their overall stormwater program.

## ASSESSMENT OF WATER QUALITY ISSUES AND SOURCES

This section assumes that the following has been determined as a part of the stormwater program planning and assessment process:

- The receiving water quality and/or conditions warrant addressing the constituents associated with these sites, and/or flow as a high priority; AND
- The urban runoff quality and hydrology have been identified as a primary source of the receiving water quality and/or conditions; AND
- These sites have been potentially identified as a major source of the constituents/conditions of concern.

Depending on the stormwater program, the receiving water/urban discharge assessment may be completed by evaluating a local urban discharge/receiving water monitoring program, or it may be completed by assessing other available data and information sources, such as total maximum daily loads (TMDLs), 303(d) lists, special studies, and/or other research and literature.

*Note: The terminology OL6, OL5, etc. used herein refers to the CASQA outcome levels (OL) as defined in Section 2.*



## Receiving Water Conditions (OL6) and Urban Runoff and MS4 Contributions (OL5)

The primary constituents of concern at industrial and commercial sites will vary depending on the type of business and facility and the extent and type of activities conducted outside. Constituents of concern may include metals, mercury, organics and toxicants, oil and grease, and pesticides.

# Industrial & Commercial Sources and Activities

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- Metals - including lead, zinc, cadmium, copper, chromium, and nickel are commonly found in stormwater. Many of the artificial surfaces of the urban environment (e.g., galvanized metal, paint, automobiles) contain metals, which enter stormwater as the surfaces corrode, flake, dissolve, decay, or leach. Over half the trace metal load carried in stormwater is associated with sediments.
- Mercury - has useful properties which have been applied in many products and chemical applications historically, and it is still widely used. Improper disposal of these products or mercury compounds can contribute mercury directly to wastewater, stormwater, and the atmosphere.
- Organics and toxicants - are widely used as cleaners, solvents, or sealers and may be improperly stored, disposed of, or dumped into storm drains and inlets.
- Oil & grease - may enter surface water bodies through leaks, spills, automotive cleaning or repair, and waste oil disposal.
- Pesticides - used to kill a wide variety of insects, weeds, and other pests can be highly toxic to birds, honeybees, and aquatic life.

Other constituents of concern that may originate from industrial and commercial sites include nutrients, sediment and trash.

- Nutrients - excess nutrients including nitrogen and phosphorous can lead to excessive vegetation or algal growth which may correspond to aesthetic or aquatic life impairment in surface water.
- Sediment - can be detrimental to aquatic life (primary producers, benthic invertebrates, and fish) by interfering with photosynthesis, respiration, growth, reproduction, and oxygen exchange in water bodies. In addition, sediment particles can transport other constituents that are attached to them including nutrients, bacteria, trace metals, and hydrocarbons.
- Trash<sup>1</sup> - can cause aesthetic and recreational impacts, inhibit aquatic habitat and vegetation growth, and harm aquatic organisms that ingest or become entangled in the debris. Trash can transport other constituents that are attached to it, including nutrients, bacteria, trace metals, and hydrocarbons.

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<sup>1</sup> Any debris that does not pass through a 5 mm sieve or preproduction plastic pellets

# Industrial & Commercial Sources and Activities

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## Source Contributions (OL4)

The potential sources of constituents from industrial and commercial sites include the following categories of activities (see also **Table 1**):

- Vehicle and Equipment Fueling: Spills and leaks that occur during vehicle and equipment fueling can contribute hydrocarbons, oil and grease, as well as heavy metals to stormwater runoff.
- Vehicle and Equipment Washing and Steam Cleaning: Washwater, if not properly contained, can runoff the site to the storm drain carrying sediment, and constituents on site (metals, trash, nutrients, etc.) to the storm drain or receiving water.
- Vehicle and Equipment Maintenance and Repair: Engine repair and service (e.g. parts cleaning), replacement of fluids (e.g. oil change), and outdoor equipment storage and parking (dripping engines) can impact water quality if stormwater runoff from areas with these activities occurring on them becomes polluted by a variety of contaminants.
- Outdoor Loading and Unloading of Materials: The loading/unloading of materials usually takes place outside on docks or terminals; therefore, materials spilled, leaked, or lost during loading/unloading may collect in the soil or on other surfaces and have the potential to be carried away by stormwater runoff or when the area is cleaned.
- Outdoor Container Storage of Liquids: Accidental releases of materials from above ground liquid storage tanks, drums, and dumpsters present the potential for contaminating stormwater with many different constituents. Tanks may store many potential stormwater runoff constituents, such as gasoline, aviation gas, diesel fuel, ammonia, solvents, syrups, etc.
- Outdoor Process Equipment: Outside process equipment operations and maintenance can contaminate stormwater runoff. Activities, such as grinding, painting, coating, sanding, degreasing or parts cleaning, landfills and waste piles, solid waste treatment and disposal, are examples of process operations that can lead to contamination of stormwater runoff.
- Outdoor Storage of Raw Materials: Raw materials, by-products, finished products, containers, and material storage areas exposed to rain and/or runoff can pollute stormwater. Improper storage of these materials can result in accidental spills and the release of materials.
- Waste Handling and Disposal: Improper storage and handling of solid wastes can allow toxic compounds, oils and greases, heavy metals, nutrients, suspended solids, and other constituents to enter stormwater runoff.



# Industrial & Commercial Sources and Activities

- **Building and Grounds Maintenance and Repair:** Activities may include landscaping, building repair, and graffiti removal. Landscaping can disturb soil and create a source of sediment. In addition, fertilizers, which are a source of nutrients, and pesticides may be used. If disturbed soil is not stabilized or the area is over irrigated these constituents can reach the storm drain or receiving waters
- **Parking/Storage Area Maintenance:** These areas consist of a high percentage of impervious cover and automobile exposure contributes to constituents of concern such as oil and grease, trash, and metals.

**Table 1.** Potential Industrial & Commercial Sources of Constituents of Concern

Activity or Facility Type	Constituents of Concern								
	Metals	Mercury	Organics and Toxicants	Oil & Grease	Nutrients	Sediment	Trash	Bacteria	Pesticides
Vehicle & Equipment Fueling	X		X	X					
Vehicle & Equipment Washing and Steam Cleaning	X		X	X	X	X			
Vehicle & Equipment Maintenance and Repair	X	X	X	X					
Outdoor Loading and Unloading of Materials	X		X	X	X	X	X		
Outdoor Container Storage of Liquids	X		X	X	X				X
Outdoor Process Equipment Operations and Maintenance	X		X	X		X			
Outdoor Storage of Raw Materials, Products and Byproducts	X		X	X	X	X	X		
Waste Handling and Disposal	X	X	X	X			X	X	
Building and Grounds Maintenance	X				X	X	X	X	X
Parking/Storage Area Maintenance	X		X	X			X	X	

# Industrial & Commercial Sources and Activities



## Target Audience Actions and Barriers and Bridges to Action (OL3, OL2)

The target audiences most involved with industrial/commercial sites include:

- Facility owners/operators; and
- Municipal inspectors.

Once the priority sources at industrial/commercial sites are identified, the target audience(s) most involved with those sources can also be identified and evaluated to assess their behaviors, as well as the potential barriers to the implementation of the “correct” behaviors. Some of the barriers may include miscommunication between workers, a lack of training, a lack of oversight at a facility, and/or language barriers. The outreach to the target audiences should be evaluated and prioritized so that the high priority target audiences and sources are addressed using the most effective means of outreach.

## MANAGEMENT QUESTIONS, GOAL SETTING, AND METRIC IDENTIFICATION

A large portion of the industrial/commercial program is typically focused on identifying activities of concern and associated BMPs that address potential sources of constituents to the storm drain system. Training and inspections can be used to track changes and ensure that the sites are properly implementing and maintaining their BMPs. For programs that have existing data, these data can be used to determine the appropriate baseline factors by which future reductions can be measured. Some potential goals for existing programs may include:

- An increase in BMP implementation and maintenance at industrial/commercial sites;
- A reduction in the number of violations; and/or
- A reduction in constituent concentrations in stormwater runoff.

Another important aspect of this program element is educating the target audiences associated with industrial/commercial requirements –the facility owners and operators and municipal inspectors. Survey results may serve as a way to establish baseline information on current knowledge and practices.

Some example goals, targets (where applicable) and projected timeframes are identified below. The targets and goals in **Table 2** are examples. Each stormwater program will need to decide what numbers are most applicable to their program.

# Industrial & Commercial Sources and Activities

## Example Management Questions and Goals

*The following questions may also be used to assist in identifying/ establishing goals:*

Outcome Level	Management Question
<b>1</b>	Is the program element/control measure/activity being implemented in accordance with the Permit Provisions, SWMP control measures and performance standards?
<b>2</b>	Does the program element/control measure/activity raise the target audience's awareness of an issue?
<b>3</b>	Does the program element/control measure/activity change a target audience's behavior which will result in the proper design and implementation of recommended BMPs?
<b>4</b>	Does the program element/control measure/activity reduce the load of constituents from the sources to the storm drain system?

# Industrial & Commercial Sources and Activities

**Table 2.** Example Management Questions, Goals, and Metrics

Program Activity	Management Question	Goal/Metric <sup>2</sup>	Data/Information to be Collected
<b>Outcome Level 4</b>			
Inspections	Was the amount of trash from commercial/industrial areas to the storm drain reduced?	<ul style="list-style-type: none"> <li>Reduce amount from major commercial/industrial areas by 50% in 5-10 years.</li> </ul>	Track amount of trash removed from trash capture devices that receive runoff from commercial/industrial areas.
<b>Outcome Level 3</b>			
Inspections	Did inspections change behavior?	<ul style="list-style-type: none"> <li>Increase percent of staff responding to surveys that they are implementing BMPs to 90%</li> <li>Increase sites in compliance upon inspection to 75% within 2 years</li> <li>Increase sites in compliance upon inspection to 90% within 5 years</li> </ul>	Track BMP implementation survey results.  Track initial site inspection results.
Inspections	Did enforcement actions change behavior?	<ul style="list-style-type: none"> <li>Reduce percent of sites receiving enforcement actions by 10% each year</li> <li>Reduce number of notice of violations by 10% each year</li> <li>For each training module, increase post-training survey % of answers correct to 95% within 5 years</li> </ul>	Track all sites and number and types of enforcement actions issued.  Track pre- and post-training survey results.

<sup>2</sup> It should be recognized that goals and metrics may be limited to TMDL requirements.

# Industrial & Commercial Sources and Activities

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Program Activity	Management Question	Goal/Metric <sup>2</sup>	Data/Information to be Collected
<b>Outcome Level 2</b>			
Inspections	Did inspections increase awareness?	<ul style="list-style-type: none"> <li>Increase number of sites incorporating minimum required BMPs to 75% in 2 years and 90% in 5 years</li> </ul>	Track initial and follow-up site inspection results.
Training	Was inspector training effective?	<ul style="list-style-type: none"> <li>For each training module, increase number of attendees ranking the training as effective to 95% within 5 years</li> <li>For each training module, increase post-training survey percent of answers correct to 95% within 5 years</li> </ul>	Track training evaluation results.  Track pre- and post-training survey results.

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# Municipal Operations Sources and Activities

*This fact sheet has been developed to assist stormwater program managers in understanding why these sources and activities can be problematic in stormwater and urban runoff, what the potential pollutants of concern are, and how effectiveness assessment goals and metrics can be established to assist program managers in answering specific management questions in order to adaptively manage their programs.*



The approach and methods described herein provide a “toolbox” for stormwater program managers so that they can select the program assessment methods and metrics that are most meaningful to their overall stormwater program.

## INTRODUCTION

Municipal operations can adversely affect runoff quality, adding pollutants to the receiving waters. Water quality impacts from municipal operations can include runoff associated with vehicle and equipment maintenance and cleaning, trash and debris in outdoor areas, and runoff associated with landscape maintenance.

The magnitude of the potential impacts from municipal operations depends on the type of activities that are being conducted, climatic conditions, and site conditions, as well as the actions taken by the target audience involved at the site. The target audience—the key personnel involved in the activities at these sites—includes contractors as well as the municipal staff. Controlling the potential impact(s) of municipal operations requires a basic understanding of the activities that are conducted on site as well as in the field, the potential pollutant sources and the Best Management Practices (BMPs) necessary to eliminate or reduce the discharge of pollutants.

Each stormwater program may also wish to refer to the following constituent-specific profiles for additional, example program activities, management questions, goals, and metrics that may apply to this program element:

- ✓ Bacteria
- Mercury
- ✓ Nutrients
- ✓ Pesticides
- ✓ Sediment
- ✓ Trash

# Municipal Operations Sources and Activities

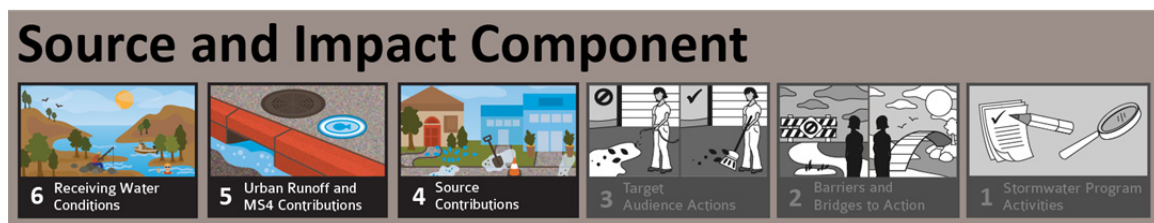
## ASSESSMENT OF WATER QUALITY ISSUES AND SOURCES

This section assumes that the following has been determined as a part of the stormwater program planning and assessment process:

- The receiving water quality and/or conditions warrant addressing the constituents associated with these sites, and/or flow as a high priority; AND
- The urban runoff quality and hydrology have been identified as a primary source of the receiving water quality and/or conditions; AND
- These sites have been potentially identified as a major source of the constituents/conditions of concern.

Depending on the stormwater program, the receiving water/urban discharge assessment may be completed by evaluating a local urban discharge/receiving water monitoring program, or it may be completed by assessing other available data and information sources, such as total maximum daily loads (TMDLs), 303(d) lists, special studies, and/or other research and literature.

*Note: The terminology OL6, OL5, etc. used herein refers to the CASQA outcome levels (OL) as defined in Section 2.*



## Receiving Water Conditions (OL6) and Urban Runoff and MS4 Contributions (OL5)

The constituents of concern associated with municipal operations will vary depending on the land use and activities occurring onsite. Constituents of concern can include trash, metals, nutrients, pesticides, sediment, oil & grease, and organics and toxicants.

- Trash<sup>1</sup> - can cause aesthetic and recreational impacts, inhibit aquatic habitat and vegetation growth, and harm aquatic organisms that ingest or become entangled in the debris. Trash can transport other constituents that are attached to it, including nutrients, bacteria, trace metals, and hydrocarbons.

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1 Any debris that does not pass through a 5 mm sieve or preproduction plastic pellets



# Municipal Operations Sources and Activities

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- Metals - including lead, zinc, cadmium, copper, chromium, and nickel are commonly found in stormwater. Many of the artificial surfaces of the urban environment (e.g., galvanized metal, paint, automobiles) contain metals, which enter stormwater as the surfaces corrode, flake, dissolve, decay, or leach. Over half the trace metal load carried in stormwater is associated with sediments.
- Nutrients - excess nutrients including nitrogen and phosphorous can lead to excessive vegetation or algal growth which may correspond to aesthetic or aquatic life impairment in surface water.
- Pesticides - used to kill a wide variety of insects, weeds, and other pests can be highly toxic to birds, honeybees, and aquatic life.
- Sediment - can be detrimental to aquatic life (primary producers, benthic invertebrates, and fish) by interfering with photosynthesis, respiration, growth, reproduction, and oxygen exchange in water bodies. In addition, sediment particles can transport other constituents that are attached to them including nutrients, trace metals, and hydrocarbons.
- Oil & grease - may enter surface water bodies through leaks, spills, automotive cleaning or repair, and waste oil disposal.
- Organics and toxicants - are widely used as cleaners, solvents, or sealers and may be improperly stored, disposed of, or dumped into storm drains and inlets.

## Source Contributions (OL4)

If, through the planning and assessment process, municipal operations and/or sites are identified as a potential source, then the various activities that occur on site that may contribute to the discharge of the constituents of concern should be identified and prioritized. Although a stormwater program may address multiple sources concurrently, those sources most likely to be attributed to the constituent(s) of concern should be addressed as high priority.

The potential sources of constituents from municipal operations include the following categories of activities:

- Building and Grounds Maintenance and Repair: Activities may include landscaping, building repair, and graffiti removal.
- Parking/Storage Area Maintenance: These areas consist of a high percentage of impervious cover and automobile exposure contributes to constituents of concern such as oil and grease, trash, and metals.

# Municipal Operations Sources and Activities

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- Waste Handling and Disposal: Improper storage and handling of solid wastes can allow toxic compounds, oils and greases, heavy metals, nutrients, pathogens, suspended solids, and other constituents to enter stormwater runoff.
- Vehicle and Equipment Fueling: Spills and leaks that occur during vehicle and equipment fueling can contribute hydrocarbons, oil and grease, as well as heavy metals to stormwater runoff.
- Vehicle and Equipment Maintenance and Repair: Engine repair and service (e.g. parts cleaning), replacement of fluids (e.g. oil change), and outdoor equipment storage and parking (dripping engines) can impact water quality if stormwater runoff from areas with these activities occurring on them becomes polluted by a variety of contaminants.
- Vehicle and Equipment Washing and Steam Cleaning: Wash water, if not properly contained, can runoff the site to the storm drain carrying sediment, and constituents on site (metals, trash, nutrients, etc.) to the storm drain or receiving water.
- Outdoor Loading and Unloading of Materials: The loading/unloading of materials usually takes place outside on docks or terminals; therefore, materials spilled, leaked, or lost during loading/unloading may collect in the soil or on other surfaces and have the potential to be carried away by stormwater runoff or when the area is cleaned.
- Outdoor Container Storage of Liquids: Accidental releases of materials from above ground liquid storage tanks, drums, and dumpsters present the potential for contaminating stormwater with many different constituents. Tanks may store many potential stormwater runoff constituents, such as gasoline, aviation gas, diesel fuel, ammonia, solvents, syrups, etc.
- Outdoor Storage of Raw Materials: Raw materials, by-products, finished products, containers, and material storage areas exposed to rain and/or runoff can pollute stormwater. Improper storage of these materials can result in accidental spills and the release of materials.
- Outdoor Process Equipment: Outside process equipment operations and maintenance can contaminate stormwater runoff. Activities, such as grinding, painting, coating, sanding, degreasing or parts cleaning, landfills and waste piles, solid waste treatment and disposal, are examples of process operations that can lead to contamination of stormwater runoff.
- Over-Water Activities: Over-water activities occur at boat and ship repair yards, marinas, and yacht clubs.

# Municipal Operations Sources and Activities

- Landscape Maintenance: Landscaping can disturb soil and create a source of sediment. In addition, fertilizers, which are a source of nutrients, and pesticides may be used. If disturbed soil is not stabilized or the area is over-irrigated, these constituents can reach the storm drain or receiving waters
- Sanitary Sewer Overflows: Sanitary Sewer Overflows (SSOs) may reach the storm drain and are a source of pathogens and bacteria.



## Target Audience Actions and Barriers and Bridges to Action (OL3, OL2)

The target audiences most involved with municipal operations include:

- Maintenance crews;
- Roads crews;
- Park and recreation crews;
- Street sweepers;
- Waste pickup; and
- Contract/lease staff.

Once the priority sources at the municipal operations are identified, the target audience(s) most involved with those sources can also be identified and evaluated to assess their behaviors, as well as the potential barriers to the implementation of the “correct” behaviors. Some of the barriers may include miscommunication between workers, a lack of training, a lack of oversight at a facility, and/or language barriers. The outreach to the target audiences should be evaluated and prioritized so that the high priority target audiences and sources are addressed using the most effective means of outreach.

## MANAGEMENT QUESTIONS, GOAL SETTING, AND METRIC IDENTIFICATION

A large portion of the municipal operations program is typically focused on identifying activities of concern and associated BMPs that address potential sources of constituents to the storm drain system. Training and inspections can be used to track changes and ensure that the sites are properly implementing and maintaining their BMPs. It is important that the Permittees develop management questions (both environmental and programmatic), as well as

# Municipal Operations Sources and Activities

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measurable, achievable goals that are consistent with the program’s priorities. Some potential goals for existing programs may include:

- An increase in BMP implementation and maintenance at municipal facilities;
- A reduction in constituent concentrations in stormwater runoff;
- Increase knowledge/understanding of program impacts by target audiences (i.e., the maintenance, roads and parks and recreation crews, street sweepers, and waste pickup staff).

Some example goals, targets (where applicable) and projected timeframes are identified below. The targets and goals in **Table 1** are examples. Each stormwater program will need to decide what numbers are most applicable to their program.

## Example Management Questions and Goals

*The following questions may also be used to assist in identifying/ establishing goals:*

Outcome Level	Management Question
<b>1</b>	Is the program element/control measure/activity being implemented in accordance with the Permit Provisions, SWMP control measures and performance standards?
<b>2</b>	Does the program element/control measure/activity raise the target audience’s awareness of an issue?
<b>3</b>	Does the program element/control measure/activity change a target audience’s behavior which will result in the proper design and implementation of recommended BMPs?
<b>4</b>	Does the program element/control measure/activity reduce the load of constituents from the sources to the storm drain system?

# Municipal Operations Sources and Activities

**Table 1.** Example Management Questions, Goals, and Metrics

Program Activity	Management Question	Goal/Metric <sup>2</sup>	Data/Information to be Collected
<b>Outcome Level 4</b>			
Street Sweeping	Did street sweeping remove sediment and other debris?	<ul style="list-style-type: none"> <li>Street sweeping conducted for 90% of streets on a <i>[insert stormwater program’s schedule—e.g., weekly, monthly]</i> basis.</li> </ul>	Track amount of debris and sediment collected via street sweeping.
<b>Outcome Level 3</b>			
Inspections	Did inspections change behavior?	<ul style="list-style-type: none"> <li>Increase percent of catch basins with screens or covers to 90%</li> <li>Increase use of secondary containment and/or trash booms for outdoor areas to 90-100%</li> <li>Reduce improper lateral connections by 50%</li> </ul>	<p>Track number of catch basins with screens/covers.</p> <p>Track implementation of secondary containment/trash booms at municipal sites.</p> <p>Track number of improper lateral connections observed/eliminated during inspections.</p>
Inspections	Did enforcement actions change behavior?	<ul style="list-style-type: none"> <li>Reduce percent of sites receiving enforcement actions by 10% each year</li> <li>Reduce number of notice of violations by 10% each year</li> <li>For each training module, increase post-training survey % of answers correct to 95% within 5 years</li> </ul>	<p>Track all sites and number and types of enforcement actions issued.</p> <p>Track pre- and post-training survey results.</p>

<sup>2</sup> It should be recognized that goals and metrics may be limited to TMDL requirements.

# Municipal Operations Sources and Activities

Program Activity	Management Question	Goal/Metric <sup>2</sup>	Data/Information to be Collected
<b>Outcome Level 2</b>			
Training	Did street sweeper operators modify operation of street sweepers?	<ul style="list-style-type: none"> <li>Increase number of staff with knowledge of guidelines for street sweeping operations that improve water quality to 95% within 2 years</li> </ul>	Track pre- and post-training survey results.
Training	Was training effective for street sweeper operators?	<ul style="list-style-type: none"> <li>For each training module, increase number of attendees ranking the training as effective to 95% within 5 years</li> <li>For each training module, increase post-training survey percent of answers correct to 95% within 5 years</li> </ul>	Track training evaluation results.  Track pre- and post-training survey results.

# Planning and Land Development Sources and Activities

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*This fact sheet has been developed to assist stormwater program managers in understanding why these sources and activities can be problematic in stormwater and urban runoff, what the potential pollutants of concern are, and how effectiveness assessment goals and metrics can be established to assist program managers in answering specific management questions in order to adaptively manage their programs.*



The approach and methods described herein provide a “toolbox” for stormwater program managers so that they can select the program assessment methods and metrics that are most meaningful to their overall stormwater program.

## INTRODUCTION

Land development can alter natural drainage patterns and affect runoff quality and/or quantity, adding pollutants to the receiving waters. Water quality impacts from new or re-development can include the generation of dry-weather runoff, increases in the rates and volume of stormwater runoff that may increase the downstream erosion potential, and increased discharges of pollutants in wet weather (stormwater) runoff.

The magnitude of the potential impacts depends on the site conditions, layout and design of the site, and climatic conditions.

The target audience—the key personnel involved in the activities at these sites—includes the planners, engineers, developers, as well as BMP owners and building and construction inspectors. Controlling the potential impact(s) of land development requires a basic understanding of the activities that are conducted as a part of the planning process as well as on-site, the potential pollutant sources, and the Best Management Practices (BMPs) necessary to eliminate or reduce the discharge of pollutants.

# Planning and Land Development Sources and Activities

## ASSESSMENT OF WATER QUALITY ISSUES AND SOURCES

This section assumes that the following has been determined as a part of the stormwater program planning and assessment process:

- The receiving water quality and/or conditions warrant addressing the constituents associated with these sites, and/or flow as a high priority; AND
- The urban runoff quality and hydrology have been identified as a primary source of the receiving water quality and/or conditions; AND
- These sites have been potentially identified as a major source of the constituents/conditions of concern.

Depending on the stormwater program, the receiving water/urban discharge assessment may be completed by evaluating a local urban discharge/receiving water monitoring program, or it may be completed by assessing other available data and information sources, such as total maximum daily loads (TMDLs), 303(d) lists, special studies, and/or other research and literature.

*Note: The terminology OL6, OL5, etc. used herein refers to the CASQA outcome levels (OL) as defined in Section 2.*



## Receiving Water Conditions (OL6) and Urban Runoff and MS4 Contributions (OL5)

The constituents of concern associated with land development will vary depending on the land use and activities occurring onsite. Constituents of concern can include flow, sediment, nutrients, pathogens, oil and grease, metals, organics, pesticides, and trash.

- Flow - new development typically results in more runoff volume and higher rate of runoff (flow). Problems include washing out in-stream habitat, eroding streambeds and banks, and changing downstream ecosystems.
- Sediment - can be detrimental to aquatic life (primary producers, benthic invertebrates, and fish) by interfering with photosynthesis, respiration, growth, reproduction, and oxygen exchange in water bodies. In addition, sediment particles can transport other



# Planning and Land Development Sources and Activities

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- constituents that are attached to them, including nutrients, trace metals, and hydrocarbons.
- Nutrients - excess nutrients, including nitrogen and phosphorous, can lead to excessive vegetation or algal growth, which may correspond to aesthetic or aquatic life impairment in surface water.
  - Pathogens (bacteria and viruses) - are common contaminants of stormwater. Sources of these contaminants include animal excrement (e.g., pet waste) and sanitary sewer overflows.
  - Oil & grease - may enter surface water bodies through leaks, spills, automotive cleaning or repair, and waste oil disposal.
  - Metals - including lead, zinc, cadmium, copper, chromium, and nickel are commonly found in stormwater. Many of the artificial surfaces of the urban environment (e.g., galvanized metal, paint, automobiles) contain metals, which enter stormwater as the surfaces corrode, flake, dissolve, decay, or leach. Over half the trace metal load carried in stormwater is associated with sediments.
  - Organics and toxicants - are widely used as cleaners, solvents, or sealers and may be improperly stored, disposed of, or dumped into storm drains and inlets.
  - Pesticides - used to kill a wide variety of insects, weeds, and other pests can be highly toxic to birds, honeybees, and aquatic life.
  - Trash<sup>1</sup> - can cause aesthetic and recreational impacts, inhibit aquatic habitat and vegetation growth, and harm aquatic organisms that ingest or become entangled in the debris. Trash can transport other constituents that are attached to it, including nutrients, bacteria, trace metals, and hydrocarbons.

## Source Contributions (OL4)

If, through the planning and assessment process, new development and redevelopment sites are identified as a potential source, then the various activities that occur on-site that may contribute to the discharge of the constituents of concern should be identified and prioritized. Although a stormwater program may address multiple sources concurrently, those sources most likely to be attributed to the constituent(s) of concern should be addressed as high priority.

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<sup>1</sup> Any debris that does not pass through a 5 mm sieve or preproduction plastic pellets

# Planning and Land Development Sources and Activities

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The potential sources of the constituents of concern from new development and redevelopment sites are outlined below. The constituents of concern for each site are activity and land use dependent.

- Residential: Residential development results in the creation of impervious cover, landscaped areas, and lawns which increases runoff volume and flow. Additionally, rainfall washes sediment and constituents off impervious surfaces and into nearby storm drains. Landscaping can disturb soil and create a source of sediment. In addition, fertilizers (which are a source of nutrients) and pesticides may be washed into storm drains when inappropriately applied or over applied.
- Commercial: Commercial areas tend to have a high percentage of impervious cover and, therefore, can increase stormwater runoff flow and volume. Commercial areas usually incorporate some landscaping which may result in fertilizers and pesticides in stormwater runoff.
- Industrial: Development of industrial areas can result in the creation of parcels with a high percentage of impervious cover. The constituents of concern associated with industrial development are dependent on the types of activities occurring on-site but are likely to include oil and grease and trash.
- Retail Gasoline Outlets: A high percentage of impervious cover combined with automotive exposure and the potential for gas spills results in the potential contribution of oil and grease and trash.
- Automotive Repair Shops: Automotive repair shop activities usually include storage of inoperable vehicles, changing fluids, and replacing auto parts. These activities can directly or indirectly contribute to oil and grease, metals, organics and trash in stormwater runoff.
- Restaurants: Waste or wash water generated by restaurants often contain materials such as food wastes, oil and grease, and cleaning agents. Restaurants may also have some landscaping located onsite which can contribute to pesticides and fertilizers in stormwater runoff.
- Parking Lots: Parking lots largely consist of impervious surface with some landscaping. Cars and other motor vehicles in parking lots can contribute to oil and grease, metals and other constituents of concern that wash off pavement and into storm drains. Parking lots usually incorporate some landscaping which may result in fertilizers and pesticides in stormwater runoff.
- Streets, Highways, and Freeways: Similar to parking lots, streets, highways and freeways largely consist of impervious surfaces with the landscaping included in the right-of-way. Cars and other motor vehicles contribute to oil and grease, metals, and other constituents of concern that wash off pavement and into storm drains.

# Planning and Land Development Sources and Activities

For Planning and Land Development, pollutants will be linked to the ultimate land use.



## Target Audience Actions and Barriers and Bridges to Action (OL3, OL2)

The target audiences most involved with new development and redevelopment sites include:

- Plan checkers;
- Engineers;
- Developers;
- BMP owners/responsible parties; and
- Building and construction inspectors.

Once the priority sources at the new development and redevelopment sites are identified, the target audience(s) most involved with those sources can be identified and evaluated to assess their behaviors, as well as the potential barriers to the implementation of the “correct” behaviors. Some of the barriers may include lack of consistency between plan checkers, miscommunication between workers, lack of training, lack of oversight at the new development and redevelopment site, and/or language barriers. The outreach to the target audiences should be evaluated and prioritized so that the high priority target audiences and sources are addressed using the most effective means of outreach.

## MANAGEMENT QUESTIONS, GOAL SETTING, AND METRIC IDENTIFICATION

A large portion of the land development program is typically focused on implementation of land development requirements which can serve as the basis for establishing baselines regarding the level of BMP implementation required in order to address the constituents of concern. In turn, follow-up inspections can be used to track changes and ensure that the sites are properly designing, implementing, and maintaining BMPs. For programs that have existing data, these data can be used to determine the appropriate baseline factors by which future reductions can be measured. Some potential goals for existing programs may include:

- An increase in BMPs that are effective at removing constituents of concern (e.g., TMDLs), and are suitable to site constraints; and/or
- A reduction in the number of violations.

# Planning and Land Development Sources and Activities

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Another important aspect of this program element is educating the target audiences associated with the land development requirements – the plan reviewers, engineers, developers, inspectors and BMP owners.

Some example goals, targets (where applicable) and projected timeframes are identified below. The targets and goals in **Table 1** are examples. Each stormwater program will need to decide what numbers are most applicable to their program.

## Example Management Questions and Goals

*The following questions may also be used to assist in identifying/ establishing goals:*

Outcome Level	Management Question
<b>1</b>	Is the program element/control measure/activity being implemented in accordance with the Permit Provisions, SWMP control measures and performance standards?
<b>2</b>	Does the program element/control measure/activity raise the target audience's awareness of an issue?
<b>3</b>	Does the program element/control measure/activity change a target audience's behavior which will result in the proper design and implementation of recommended BMPs?
<b>4</b>	Does the program element/control measure/activity reduce the load of constituents from the sources to the storm drain system?

# Planning and Land Development Sources and Activities

**Table 1.** Example Management Questions, Goals, and Metrics

Program Activity	Management Question	Goal/Metric <sup>2</sup>	Data/Information to be Collected
<b>Outcome Level 4</b>			
Inspections during/after storm events	Was the volume of runoff retained at new development sites?	<ul style="list-style-type: none"> <li>100% of new developments retained the 85<sup>th</sup> percentile 24-hour storm event, where technically feasible</li> </ul>	Track runoff volumes/flows during storm events.
<b>Outcome Level 3</b>			
Inspections	Did inspections change behavior?	<ul style="list-style-type: none"> <li>Increase percent of people responding to surveys that they are implementing BMPs to 90%</li> <li>Increase sites in compliance upon inspection to 75% within 2 years</li> <li>Increase sites in compliance upon inspection to 90% within 5 years</li> </ul>	Track BMP implementation survey results. Track initial site inspection results.
<b>Outcome Level 2</b>			
Plan Review	Did plan review and approval process increase awareness?	<ul style="list-style-type: none"> <li>Reduce number of plans that had to make revisions related to land development requirements to &lt;5% within 4 years</li> </ul>	Track initial plan review results and required revisions
Training	Was training effective for plan review staff?	<ul style="list-style-type: none"> <li>For each training module, increase number of attendees ranking the training as effective to 95% within 5 years</li> <li>For each training module, increase post-training survey percent of answers correct to 95% within 5 years</li> </ul>	Track training evaluation results Track pre- and post-training survey results

<sup>2</sup> It should be recognized that goals and metrics may be limited to TMDL requirements.