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# Usage of Storm Water Best Management Practices in Southern California

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**Abstract.** Severe economic recessionary times beginning in 1990 in southern California and the concurrent introduction of National Pollution Discharge Elimination System permit requirements provided a backdrop to evaluate Best Management Practices (BMP) cost effectiveness. This study analyzes municipal Best Management Practices for municipalities in five southern California counties; Los Angeles, Orange, Riverside, San Bernardino, and San Diego. The hypothesis of this study is that due to the severe economic recessionary times, the BMPs implemented with the greatest frequency (by cities in the five counties studied) are the most cost-beneficial for cities to implement. Each city located in the five counties studied is identified as a coastal, valley, or mountain city. The number of cities that have implemented each BMP are categorized to determine which BMPs are most frequently implemented on a regional basis, and are therefore the most cost-beneficial.

**Key words:** best management practices, National Pollution Discharge Elimination System, Southern California, storm water management

## 1. Introduction

In 1972, the Clean Water Act was amended to provide that discharge of pollutants to waters of the United States from storm water is effectively prohibited, unless the discharge is in compliance with a NPDES (National Pollutant Discharge Elimination System) permit. This amendment focused on improving water quality by focusing on industrial process waste water and municipal waste water treatment plants. Once these measures were developed, it became evident that more diffuse sources of water pollution, such as urban runoff, were contributing to water pollution problems. So in 1987, amendments were made to the Clean Water Act which added section 402(p) which established a framework for regulating municipalities, industrial, and construction storm-water discharges under the NPDES permit process.

In November of 1990, federal regulations were enacted that detailed the information that was required for a municipality to prepare a NPDES permit application.

There are two parts to the NPDES permit application. 'Part 1, basically, requires the discharger to collect existing information regarding storm-water dischargers, receiving waters, management programs, fiscal resources, and associated elements' (Camp Desser and McKee, 1993).

The second part of the NPDES permit process, which is the focus of this study, requires a municipality to take the information from Part 1 of the application and, '... formulate a storm-water management program designed to reduce the discharge of pollutants to the maximum extent practical' (Camp Desser and McKee, 1993). Municipalities are expected to implement Best Management Practices (BMPs) that will effectively reduce the discharges of pollutants into storm water.

'Maximum extent practical' is defined as, '... to the maximum extent possible, taking into account equitable considerations of synergistic, additive, and competing factors, including but not limited to, gravity of the problem, fiscal feasibility, public health risks, societal concern, and social benefits' (Orange, 1993).

The NPDES permitting process, enacted in November 1990, is relatively new. This regulation came about at a time when cities were facing severe cutbacks in their budgets due to a recession that has affected southern California since 1990. This study focuses on analyzing BMPs that cities have implemented since 1990 to determine which BMPs are most cost-beneficial. This study observes the results of dozens of economically challenged cities in meeting the NPDES permitting requirements. The focus of this study is the area of southern California, including the counties of Los Angeles, San Bernardino, Orange, Riverside, and San Diego.

In this study, BMPs that have already been implemented, or BMPs that are planned by a city in the future are considered. It is assumed that the cities surveyed have each closely examined the costs of implementing their selected BMPs due to recent budget cuts initiated by recessionary times. They have determined what BMPs will be the most efficient for the amount of dollars spent. It can therefore be assumed that these BMPs are the most cost-beneficial for cities to implement.

In December of 1994, Orange County, California, filed for federal bankruptcy protection. It is important to note that the ramifications of this fiscal crisis are independent of the results of this study. BMPs were committed to by the 31 cities of Orange County prior to the crisis.

Cities that were studied were categorized into coastal, valley, and mountain areas so that any differences between the three areas could be examined. Cities in the three different areas may implement different BMPs because of different hydrologic responses in their region. For example, a coastal city lies directly along a water body while a valley city is generally a flatter area with less water bodies. Originally mountain areas were going to be analyzed, but since only one city out of the total 162 for all five counties was classified as a mountain city, the results for mountain areas would be insignificant.

Coastal cities include those along the Pacific coast as well as cities that directly affect storm water quality because of their close proximity to a river or channel draining to the coast. For example, although the city of Bellflower is not along

the coast, it lies along the Los Angeles River, which drains into the Pacific Ocean. Valley cities lie in an area that is typically flat and generally not surrounded by water bodies.

BMPs for each city in the five counties studied were obtained from the following sources: a city's yearly report on the NPDES program to the county, through a county's Drainage Area Management Plan (DAMP), or through a survey sent to a city's Public Works Department.

Once all of the information about each city's BMPs was obtained, the BMPs that each city was implementing or considering were entered onto a spread sheet data base and statistically analyzed. Not all BMPs were fully implemented; some BMPs had a pilot program, some BMPs were partially implemented, and some BMPs were planned for the future. All of the BMP programs were lumped together in the statistical database. Although not all BMP programs were fully implemented, cities committed to the programs sometime in the future, and therefore determined the programs to be cost-beneficial.

Once the data were tabulated, the BMPs were ranked according to the percent of cities that have implemented them. The ranking was done with respect to clusters as opposed to individual ranking. This was done because many BMPs were implemented with the same frequency, therefore making up a cluster. With respect to a cluster, no one BMP included in the cluster is recommended for a city to implement above another in that cluster; that is, those BMPs are recommended equally.

## 2. Description of Best Management Practices

Below is a brief description of the Best Management Practices identified in the survey portion of this study, and the identification number linked to each particular BMP (note that the numbers below do not indicate any priority or ranking).

1. **Street Sweeping**
   Street sweeping can be effective for removing sediment, heavy metals, and nutrients from street surfaces therefore eliminating pollutants from storm water.
2. **Yard Clearing**
   Removing pine needles, leaves, and other materials from yards eliminates potentially large amounts of organics from entry into the storm water runoff system.
3. **Roadway Maintenance/Litter Control**
   A few techniques for roadway maintenance include; appropriate paving techniques, proper chemical/raw material handling procedures, minimizing of impervious surface areas, maintenance of a clean construction site and employee training.
4. **Public Education**
   Cities in the five counties studied have implemented the following public education BMPs:

- educate and demonstrate the proper way to dispose of used motor oil and toxic waste;
- classroom presentations;
- public services staff training;
- video presentations;
- publish information in newsletters and/or newspapers;
- distribute information about NPDES permits on residents, door hangers;
- pollution prevention week;
- TV stations used to educate people about stormwater;
- one day collection season and advertising through PSAs and/or newspaper ads.;
- give information about nonpoint source pollution;
- distribute flyers/brochures;
- distribute information about storm water through utility bill inserts.

5. **Household Hazardous Waste**
   Hazardous waste collection centers give the public a safe and convenient way to dispose of their household hazardous products avoiding the possibility that they will be disposed of in storm drains.
6. **Used Oil/Oil Filter Collection**
   This program educates the public as to the negative impacts of improper disposal of oil and helps to avoid the decision to disposing of hazardous materials improperly.
7. **Storm Drain System Maintenance**
   Cleaning out storm drain inlets, catchbasins, and lines on a regular or as-needed basis reduces the debris and sediment loads in the drainage system.
8. **Storm Drain Design Standards**
   The city of Coronado in San Diego County has implemented this BMP. All of the city's storm drains terminate on the shoreline of either the San Diego Bay or the Pacific Ocean. The pipe outfalls are highly visible making it easier to monitor the outfall for pollutants.
9. **Stenciling**
   Stenciling storm drain systems (inlets, catch basins, channels, and creeks) is a very visible way of discouraging the dumping of improper materials into the storm drain system.
10. **Spill Prevention, Containment and Response**
    A city will use their emergency response section or will contract out to respond to spills resulting from chemicals being transported across streets and highways.
11. **Pesticide Use Enforcement (Pesticide/Fertilizer Management)**
    A Pesticide/Fertilizer Management plan is developed to address both acute and toxicity concerns and chronic exposure concerns associated with all insecticides, rodenticides and herbicides.

12. **Code Enforcement**
    The purpose of these codes is to prevent illegal discharges into the storm water drainage system.
13. **Inspections**
    Inspections for construction, building and business/fire are required to determine compliance with city codes and regulations.
14) **Illicit Connection/Illegal Dumping**
    (A) *Illicit Connection*
    This BMP prevents the unwarranted physical connections to the storm drain system from overflow cross-connects from sanitary sewers, and floor drains from businesses through regulation, regular inspection, testing, education.
    (B) *Illegal dumping*
    Implement measures to detect, correct and enforce against illegal dumping into storm drains, creeks and streets.
15. **Grading and Erosion Control**
    Grading plans are approved through various departments depending on the city, and erosion control for existing developments is monitored by various departments.
16. **Materials Handling, Storage and Recycling**
    This BMP is the regulation and control of hazardous materials use, storage, and disposal as a means of preventing these materials from coming into contact with storm water.
17. **New Developments**
    (A) *Infiltration Devices:*
    Infiltration devices capture storm water runoff and allow percolation through the soil column.
    (B) *Biofilters*
    There are two types of biofilters, swale and strip. A swale is a vegetated channel that treats concentrated flow. A strip treats sheet flow and is placed parallel to the contributing surface.
18. **Revisions to General Plan**
    General plans are a very good place to detail a municipality's goals for storm water pollution control and watershed protection.
19. **Aboveground Tank Spill Controls**
    Cities can prevent or reduce the discharge of pollutants to storm water from aboveground storage tanks by installing safeguards against accidental releases, installing secondary containment, conducting regular inspections, and training employees in standard operating procedures and spill cleanup techniques.
20. **Dry Weather Monitoring**
    Storm water monitoring is an effective way of analyzing the pollutants in storm water runoff. Constituents monitored during dry weather conditions include biostimulatory substances (nutrients) which tend to be found in the dissolved form.

21. **Wet Weather Monitoring**
    Wet weather monitoring consists of monitoring storm water during rain storms.
22. **Pretreatment inspections of commercial and industrial facilities**
    Pretreatment inspections of commercial and industrial facilities are done to inform business owners of BMPs and to assure that all hazardous materials are covered and containment areas are in place.
23. **Drainage Ordinance**
    Many cities have municipal codes that contain chapters related to Stormwater Discharge and Collection, Flood Hazard Prevention, and Grading and Erosion Control. These ordinances comprise the enforcement and regulation authority of the city regarding storm water flows and runoff.
24. **Recycling**
    In 1989, the California Integrated Waste Management Act was passed in an effort to reduce the amount of trash in landfills. Community programs for collection and recycling of non-hazardous solid wastes are initiated statewide.
25. **Landscape Requirements**
    Under this BMP, developments or projects are encouraged to incorporate landscape controls for drainage and runoff.
26. **Wind Born Dust Control**
    For cities with dust control problems, this BMP is useful and can be regulated by appropriate departments.
27. **Dechlorination Program**
    A city's Water Department cleans water after pipelines have been disinfected.
28. **Site Inspection/Enforcement**
    Some variation of a code enforcement team enforces the provisions of a City's Municipal Code. Part of the inspection process includes inspecting for proper procedures relative to protecting storm water quality.
29. **Watershed Protection Ordinance**
    A Watershed Protection Ordinance is a management measure that can be used to protect storm water quality along with potential land uses within a watershed. The ordinance can be used to determine what types of activities occur in the watershed, where the activities can occur, and what types of storm water control measures are implemented and enforced.
30. **Natural Channels alternative to Concrete Channels**
    Maximum use of natural drainage ways and/or grass-lined channels are to be used when feasible in new development.
31. **Construction Site Inspections**
    Cities inspection crews constantly monitor new construction to ensure connections to the sanitary sewer where appropriate. They also monitor to ensure that no illicit connections are made to the storm drain system.
32. **Trash Removal in Lined and Unlined Channels preceding Rain**
    This BMP is effective in curbing the amount of pollutants entering storm water by removing trash and weeds before storms.

33. **Use of Detention/Retention Basins**
    These facilities trap sediment in the drainage system and reduce the sediment and heavy metal load in the storm water runoff.
34. **Wetlands Conservation**
    Storm water management can can be accomplished while protecting wetland areas by utilizing a few practices; flow routing, water level maintenance, inflow/outflow regulations, seasonal application of storm waters, and by routing waters to areas of high soil permeability for maximum infiltration.
35. **Hazardous Materials Management**
    Municipalities review and where appropriate implement improvements to hazardous materials practices.
36. **Spill Prevention and Clean Up**
    Cities enforce Uniform Building Codes and Uniform Plumbing Code which address spill prevention and clean up.
37. **Adopt Runoff Ordinance**
    A city can use a runoff ordinance as a management measure to protect runoff water quality.
38. **Increase Roadside Trash Receptacle Usage**
    Done through the city or county.
39. **Discourage Improper Disposal of Litter, Lawn Clippings, Pet Feces**
    Educate the public and business owners as to negative effects from dumping these materials.
40. **Inspect Automobile Uses and Restaurants**
    Various departments can inspect these establishments for illegal dumping and disposal practices.
41. **Encourage Removal of Dirt, Rubbish, and Debris from Sidewalks, Alleys**
    Educate the public and business owners about the proper way to remove debris.
42. **Encourage Conservation of Water**
    Business owners, the public and municipalities are all encouraged to conserve water.
43. **Emergency Response**
    This BMP includes a planned response for a hazardous materials emergency.
44. **Hazardous Materials Disposal**
    This BMP includes disposing of hazardous materials in a safe manner.
45. **Structural Controls**
    Structural Controls include detention/retention basins, infiltration trenches/basins, first flush diversion, porous pavement, oil/grease separators, grass swales, swirl concentrators, and engineering and design modification of existing structures.
46. **Local Ordinances**
    Some cities in Orange County have adopted Uniform Fire Code Articles for pollution control, others operate under county codes and policies and some have an Industrial Waste Ordinance specific to controlling hazardous material/waste dumping into surface waters.

47. **Composting**

Composting programs reduce the amount of green waste entering into the drainage system and reduce the amount of pollutants with oxygen demand and levels of coliform in storm water runoff.

## 3. Approach

Economic recessionary times beginning in 1990 in southern California and the introduction of NPDES permit requirements in 1990 provided a means to evaluate BMP efficiency with respect to their cost. Cities consider the financial impact that implementing a particular BMP will have on the city. Therefore by studying BMPs that have already been implemented by cities and those that are being considered by cities, one can find cost-beneficial BMPs for cities to implement by analyzing a particular BMP's frequency of use.

There are three analysis in this study. Coastal and valley cities' BMPs were analyzed separately, and coastal and valley cities' BMPs were analyzed together. Due to sparsity of data, the mountain area (1 city) was not partitioned from the data set.

The following pages show the percentage of all cities in the five counties studied that are implementing BMPs or have a program started. The number of cities that have fully implemented BMPs, partially implemented BMPs, have BMPs in the planning stages or are running a pilot program are divided by the total number of cities in all five counties to give a percentage.

The percentage of BMPs implemented and the ranking of the implemented BMPs are detailed in the following pages. The BMP analysis shows the number of BMPs implemented, partially implemented, in the planning stages and the number of cities running a pilot program divided by the total number of coastal, valley and mountain cities. The BMPs located in a cluster are implemented equally.

In another analysis, the BMPs for all five counties were combined to determine whether there was a significant difference between BMPs being implemented in coastal and valley areas. These results were also ranked with the highest percentage of implemented BMPs ranked highest and the lowest percentage of implemented BMPs listed lowest. There are clusters in these data as well.

Table I gives the percentage for coastal, valley, and mountain cities of BMPs that are fully implemented, partially implemented, are in the planning stages, or are running a pilot program. All of the various stages are lumped together to give one percentage.

## 4. Ranking of Combined BMPs

In Table III BMPs are ranked from high to low percentage of implementation. Those BMPs with bold lettering, and grouped together, are clusters. Clustered BMPs are implemented with equal frequency.

Table I. Analysis of BMPs

| BMP no. | Coastal | Valley | Mountain |
|---|---|---|---|
| 1 | 0.9347 | 0.9391 | 1 |
| 2 | 0.0434 | 0.1217 | 0 |
| 3 | 0.0652 | 0.3565 | 0 |
| 4 | 0.913 | 0.826 | 1 |
| 5 | 0.8913 | 0.8434 | 1 |
| 6 | 0.2173 | 0.2347 | 0 |
| 7 | 0.9565 | 0.9043 | 1 |
| 8 | 0.0869 | 0.0521 | 0 |
| 9 | 0.6739 | 0.5478 | 0 |
| 10 | 0.0869 | 0.1478 | 0 |
| 11 | 0.2826 | 0.2521 | 0 |
| 12 | 0.1304 | 0.1739 | 1 |
| 13 | 0.1086 | 0.1565 | 1 |
| 14 | 0.7391 | 0.6434 | 0 |
| 15 | 0.3043 | 0.3391 | 1 |
| 16 | 0.1086 | 0.0521 | 0 |
| 17 | 0.0869 | 0.0521 | 0 |
| 18 | 0.0434 | 0.0173 | 0 |
| 19 | 0.0869 | 0.026 | 0 |
| 20 | 0.1304 | 0.1565 | 0 |
| 21 | 0.1304 | 0.0782 | 0 |
| 22 | 0.0217 | 0.026 | 0 |
| 23 | 0.1086 | 0.0695 | 0 |
| 24 | 0.8478 | 0.7826 | 0 |
| 25 | 0.1304 | 0.0434 | 0 |
| 26 | 0.0434 | 0.026 | 0 |
| 27 | 0.0217 | 0.0086 | 0 |
| 28 | 0.1086 | 0.0608 | 0 |
| 29 | 0.0652 | 0.026 | 0 |
| 30 | 0.0869 | 0.0347 | 0 |
| 31 | 0.1304 | 0.0695 | 0 |
| 32 | 0.0869 | 0.0521 | 0 |
| 33 | 0.0869 | 0.0434 | 0 |
| 34 | 0.3043 | 0.226 | 0 |
| 35 | 0.1086 | 0.0608 | 0 |
| 36 | 0.1304 | 0.0434 | 0 |
| 37 | 0.6086 | 0.4347 | 0 |
| 38 | 0.6086 | 0.4173 | 0 |
| 39 | 0.3695 | 0.4434 | 0 |
| 40 | 0.5652 | 0.4347 | 0 |
| 41 | 0.5652 | 0.3565 | 0 |
| 42 | 0.6304 | 0.4434 | 0 |
| 43 | 0.326 | 0.2173 | 0 |
| 44 | 0.3043 | 0.1826 | 0 |
| 45 | 0.3695 | 0.1304 | 0 |
| 46 | 0.326 | 0.1739 | 0 |
| 47 | 0.1086 | 0 | 0 |

Table II. BMP frequency of usage: Total data set

| BMP number | Frequency of usage | BMP number | Frequency of usage |
|---|---|---|---|
| 1 | 93.82% | 24 | 79.62% |
| 2 | 9.87% | 25 | 6.79% |
| 3 | 27.16% | 26 | 3.08% |
| 4 | 85.18% | 27 | 1.23% |
| 5 | 85.80% | 28 | 7.40% |
| 6 | 22.83% | 29 | 3.70% |
| 7 | 91.97% | 30 | 4.93% |
| 8 | 6.17% | 31 | 8.64% |
| 9 | 58.02% | 32 | 6.17% |
| 10 | 12.96% | 33 | 5.55% |
| 11 | 25.92% | 34 | 24.69% |
| 12 | 16.66% | 35 | 7.40% |
| 13 | 14.81% | 36 | 6.79% |
| 14 | 66.66% | 37 | 48.14% |
| 15 | 33.33% | 38 | 46.91% |
| 16 | 6.79% | 39 | 41.97% |
| 17 | 6.17% | 40 | 46.91% |
| 18 | 2.46% | 41 | 41.35% |
| 19 | 4.32% | 42 | 49.38% |
| 20 | 14.81% | 43 | 24.69% |
| 21 | 9.25% | 44 | 21.60% |
| 22 | 2.46% | 45 | 19.75% |
| 23 | 8.02% | 46 | 21.60% |
| | | 47 | 3.08% |

### 4.1. STATISTICAL ANALYSIS OF TOTAL BMP DATA SET

The frequency of usage for BMPs in coastal and valley areas with a 50% implementation rate and above was found to be similar to the frequency of usage of BMPs for the entire data set. It is therefore determined that, for the five southern California counties studied, there is not a significant difference between BMPs implemented in coastal cities versus valley cities.

Table IV presents a listing of BMPs with a greater than 50% implementation rate for Coastal, Valley and Combined BMPs. The top six recommended BMPs for all categories are included in all three groups.

When every coastal BMP implemented and every combined BMP implemented were compared, there were nine BMPs that had a greater than 5% difference of implementation between the two groups.

There is no particular order to the BMPs listed in Table V. The (+) marking identifies the group that has the highest percentage of implemented BMPs.

Table III. BMP ranking: Frequency of usage for total data set

| BMP number | Frequency of use | BMP number | Frequency of use |
|---|---|---|---|
| 1 | 93.82% | 10 | 12.96% |
| 7 | 91.97% | 2 | 9.87% |
| 5 | 85.80% | 21 | 9.25% |
| 4 | 85.18% | 31 | 8.64% |
| 24 | 79.62% | 23 | 8.02% |
| 14 | 66.66% | | |
| 9 | 58.02% | **16** | **6.79%** |
| 42 | 49.38% | **25** | **6.79%** |
| 37 | 48.14% | | |
| | | **28** | **7.40%** |
| **38** | **46.91%** | **35** | **7.40%** |
| **40** | **46.91%** | | |
| | | 36 | 6.79% |
| 39 | 41.97% | | |
| 41 | 41.35% | **8** | **6.17%** |
| 6 | 22.83% | **17** | **6.17%** |
| 15 | 33.33% | **32** | **6.17%** |
| 3 | 27.16% | | |
| 11 | 25.92% | 33 | 5.55% |
| | | 30 | 4.93% |
| **34** | **24.69%** | 19 | 4.32% |
| **43** | **24.69%** | 29 | 3.70% |
| **44** | **21.60%** | **26** | **3.08%** |
| **46** | **21.60%** | **47** | **3.08%** |
| 45 | 19.75% | **18** | **2.46%** |
| 12 | 16.66% | **22** | **2.46%** |
| **13** | **14.81%** | 27 | 1.23% |
| **20** | **14.81%** | | |

When every valley BMP implemented and every combined BMP implemented were compared, there were two BMPs (see Table VI) that had a greater than 5% difference of implementation between the two groups. The (+) marking on Table VI identifies the group that has the highest percentage of implemented BMPs.

## 5. Conclusions

BMPs with a greater than 50% implementation rate for all five counties studied are recommended for implementation. Those BMPs are considered to be the most

Table IV. Most frequently used BMPs

| Combined BMPs ranked 50% and above (BMP number) | Coastal BMPs ranked 50% and above (BMP number) | Valley BMPs ranked 50% and above (BMP number) |
|---|---|---|
| 1 | 7 | 1 |
| 7 | 1 | 7 |
| 5 | 4 | 5 |
| 4 | 5 | 4 |
| 24 | 24 | 24 |
| 14 | 14 | 14 |
| | 9 | 9 |
| | 42 | |
| | 37 | |
| | 38 | |
| | 40 | |
| | 41 | |

Table V. BMPs with significant difference in usage between total data set and coastal areas

| BMP number | Coastal BMPs | Combined coastal and valley BMPs |
|---|---|---|
| 3 | 6.52% | 27.16%+ |
| 43 | 32.60%+ | 24.69% |
| 44 | 30.43%+ | 21.60% |
| 46 | 32.60%+ | 21.60% |
| 45 | 36.95%+ | 19.75% |
| 2 | 4.34% | 9.87%+ |
| 25 | 13.04%+ | 6.79% |
| 36 | 13.04%+ | 6.79% |
| 47 | 10.86%+ | 3.08% |

Table VI. BMPs with significant difference in usage between total data set and valley areas

| BMP number | Valley BMPs | Combined valley and coastal BMPs |
|---|---|---|
| 3 | 35.65%+ | 27.16% |
| 45 | 13.04% | 19.75%+ |

Table VII. BMPs with highest frequency of usage[a] in coastal areas

| BMP no. | BMP description | Implementation rate |
|---|---|---|
| 7 | Storm drain system maintenance | 80–100% implementation rate |
| 1 | Street sweeping | |
| 4 | Public education[b] | |
| 5 | Household hazardous waste collection | |
| 24 | Recycling | |
| 14 | Illicit connection/Illegal dumping | 60–75% implementation rate |
| 9 | Stenciling | |
| 42 | Encourage conservation of water | |
| **37** | **Adopt runoff ordinance** | **60.86%** |
| **38** | **Increase roadside trash receptacle usage** | **60.86%** |
| **40** | **Inspect automobile uses and restaurants** | 50–60% implementation rate **56.52%** |
| **41** | **Encourage removal of dirt, rubbish and debris from sidewalks, alleys** | **56.52%** |

[a] All other implemented BMPs for Coastal areas are below 50%. Refer to ranking sheet on page 000 for detailed ranking order.

[b] Under the Public Education BMP there are twelve (A–L) different public education programs that cities implement. Below is the ranking order for the public education programs. The ranking is determined by dividing the total number of coastal cities implementing the particular program by the total number of coastal cities for all five counties that implement the public information BMP. The most popular program is listed first and the least popular is listed last. The bold highlighting indicates that two programs are implemented with the same frequency. Since these programs are implemented by an equal number of cities, one program is not recommended over another.

(J). 23.80% of cities distribute information about nonpoint source pollution.

(E). 21.42% of cities publish information in newsletters and/or newspapers.

(A). 11.90% of cities educate and demonstrate the proper way to dispose of used motor oil and toxic waste.

(K). 9.52% of cities distribute flyers/brochures.

**(B). 4.76%** of cities give classroom presentations.

**(C). 4.76%** of cities hold public services staff training.

**(D). 2.38%** of cities give video presentations.

**(G). 2.38%** of cities hold a pollution prevention week.

cost-beneficial for coastal and valley cities to implement. The BMPs with a 50% and higher implementation rate are listed on Tables VII and VIII.

In addition to a city using the results of this study to lower the costs of implementing BMPs, there are other ways that a city can reduce costs. One method would be for a city to build on its existing programs. For example, if a city currently has a hazardous waste facility, it could easily add the collection of used motor oil and

Table VIII. BMPs with highest frequency of usage[a] in valley areas

| BMP no. | BMP description | Implementation rate |
|---|---|---|
| 1 | Street sweeping | 80–100% implementation rate |
| 7 | Storm drain maintenance | |
| 5 | Household hazardous waste collection | |
| 4 | Public education[b] | |
| 24 | Recycling | 50–80% implementation rate |
| 14 | Illicit connection/Illegal dumping | |
| 9 | Stenciling | |

[a] All other implemented BMPs for Valley areas are below 50%. Refer to ranking sheet on page 000 for detailed ranking order.

[b] Under Public Education BMPs there are twelve (A–L) different aspects of implementing this BMP listed. Here they are ranked with the most popular listed first and the least popular listed last. The ranking is determined by dividing the total number of valley cities implementing the particular program by the total number of valley cities for all five counties that implement the public information BMP. The most popular program is listed first and the least popular is listed last. The bold highlighting indicates that two programs are implemented with the same frequency. Since these programs are implemented by an equal number of cities, one program is not recommended over another.

(E). 24.21% of cities publish information in newsletters and/or newspapers.

(J). 20.00% of cities distribute information about nonpoint source pollution.

(K). 17.89% of cities distribute flyers/brochures.

(B). 11.57% of cities give classroom presentations.

(A). 9.47% of cities educate and demonstrate the proper way to dispose of used motor oil and toxic waste.

(H). 6.31% of cities use TV stations to educate about stormwater.

(C). 5.26% of cities hold public services staff training.

(L). 2.10% of cities use utility bill inserts to educate the public.

**(G). 1.05%** of cities hold a pollution prevention week.

**(F). 1.05%** of cities distribute information about NPDES on residents doorhangers.

**(I). 1.05%** of cities hold a one day collection season-advertising with PSA's and newspaper ads.

oil filters (BMP 36) to the collection facility. Another cost saving measure would be to have an environmental group start a storm drain stenciling program (BMP no. 7) which would alleviate that responsibility and cost from the city.

Because NPDES permits are relatively new, BMPs have been implemented by cities for only a short period of time. To date, there have been little or no studies done on how effective BMPs have been in reducing storm water pollution. Studies should be done in order for cities to have the knowledge that will allow them to implement the BMPs that will be the most beneficial for curbing water pollution. This information would also help cities cut costs since they would not spend money to implement those BMPs that are deemed ineffective.

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