Best Management Practices (BMP) Selection Guidelines

Description

Selecting BMPs can be a straightforward process. Below are five (5) suggested steps for BMP designers to get the most out of their BMP selection, installation and maintenance. There are Tables and Graphs throughout this section that help assess the likely pollutants of a site and the proper BMPs or combination of BMPs needed to keep the pollutants on-site and out of the local streams, lakes and water bodies.

Overall Flow and/or Volume Design Criteria

Overall flow and/or volume design considerations vary for temporary BMPs and permanent or post-construction BMPs. Temporary BMPs used during construction should be designed to function adequately during peak flows from a 2-year, 24-hour storm event. If impacting high quality or impaired streams, other requirements such as a 5-year, 24-hour storm event design, sediment basins and buffer zones may apply (see 3.6 Discharges in Impaired or High Quality Watersheds). Designing BMPS to function effectively for a 5-year, 24-hour storm event is recommended as storms of shorter duration may surpass anticipated levels of peak flow. Larger storm events may also be considered. Permanent or Post-Construction BMPs shall be designed to treat the 'first flush' of stormwater runoff (see 3.3 1st Flush/Water Quality Requirement). The first flush volume is defined as the first ¾ inch of direct stormwater runoff over the entire contributing drainage area. First flush volume is released over a period of up to 96 hours.

The annual storm events for Hamilton County computed by NOAA are as follows:

- 2-year storm event 3.75 inches
- 5-year storm event 4.57 inches
- 10-year storm event 5.21 inches
- 25-year storm event 6.10 inches
- 50-year storm event 6.80 inches
- 100-year storm event 7.52 inches

As a supplement to on-site rain-gauges, see NOAA's website for Chattanooga area weather at:

NOAA Weather Observations for the Past Three Days – Chattanooga, Lovell Field: http://www.srh.noaa.gov/data/obhistory/KCHA.html

NOAA National Weather Service Enhanced Radar Image – Storm Total Precipitation and other maps, Huntsville Radar (shows Chattanooga):
http://radar.weather.gov/radar.php?rid=htx&product=N0R&overlay=1110111 1&loop=no
Other weather websites can also help keep up with anticipated rain events and plan inspections.

Identify Objectives

The objectives in pollution prevention for each property can vary widely. Therefore, a specific understanding of pollution risks for each activity is essential for selecting and implementing BMPs. See Tables 1-3 for pollutants to be expected from construction sites and urban land uses. Defining these risks requires review of the characteristics of the site and the nature of the construction process or industrial activity. This information should be carefully assembled and reviewed early in the design process. Once these pollution risks are defined, then BMP objectives are developed and specific BMPs can be selected. The BMP objectives for a typical construction project are as follows:

- **Preventing Pollution Runoff/Good Housekeeping**: Perform activities in a manner, which keeps potential pollutants from either draining or being transported offsite by managing pollutant sources and modifying construction activities. Dispose of waste materials in designated areas and in designated containers away from rainfall and stormwater runoff.
- **Minimize Disturbed Areas**: Only clear land that will be actively under construction in the near term (within the next 3 months). Minimize new land disturbance, and do not clear or disturb sensitive areas (e.g., steep slopes, buffers and natural watercourses).
- **Stabilize Disturbed Areas**: Provide temporary stabilization of disturbed soils whenever active construction is not occurring on that portion of the site. Provide permanent stabilization during the final grading process and carefully landscape the site.
- **Protect Slopes and Channels**: Avoid disturbing steep or unstable slopes. Safely convey runoff from the top of the slope and stabilize disturbed slopes as quickly as possible. Avoid disturbing natural channels. Stabilize temporary and permanent channel crossings as quickly as possible and ensure that increases in runoff velocity caused by the project do not erode the channel.
- **Control Site Perimeter**: Upstream runoff should be diverted around or safely conveyed through the construction project, and must not cause downstream property damage. Runoff from project site should be free of excessive sediment and other constituents.
- **Control Internal Erosion and Drainage:** Detain sediment-laden waters from actively disturbed areas within the site to minimize the risk that sediment will have the opportunity to leave the site.
- **Set Up Self Inspections and Maintenance Schedule**: In selecting BMPs, consider the required weekly inspection of outfalls, steep slopes and other areas of high erosion potential. A rainfall gauge on-site is necessary. Inspections will be conducted weekly after a ¼ inch or more rainfall. Maintenance considerations for BMPs as checked during weekly inspections should be a central part of planning and BMP selection. As conditions change, BMPs may need to be reconfigured. Refer to permits for inspection and maintenance requirements.

Site characteristics and proposed contractor activities will affect the potential for site erosion and contamination by other constituents used on the construction site. It is important to plan the project to fit the topography and drainage patterns of the site.

Before defining BMP objectives, these factors should be carefully considered:

1. Site conditions that affect erosion and sedimentation, which include:
    a. Soil type, including underlying soil strata that are likely to be exposed
    b. Natural terrain and slope
    c. Final slopes and grades
    d. Location of outfalls, concentrated flows, storm drains, and streams
2. Climatic factors, which include:
    a. Seasonal rainfall patterns
    b. Appropriate design storm (quantity, intensity, duration)
    c. Existing vegetation and ground cover
3. Proximity to Sensitive Water Environment
    a. Floodplain
    b. Floodway
    c. Sensitive receiving waters (impaired or high quality, 303(b), 303(d) listed streams, etc.,) and buffer requirements

Select BMPs

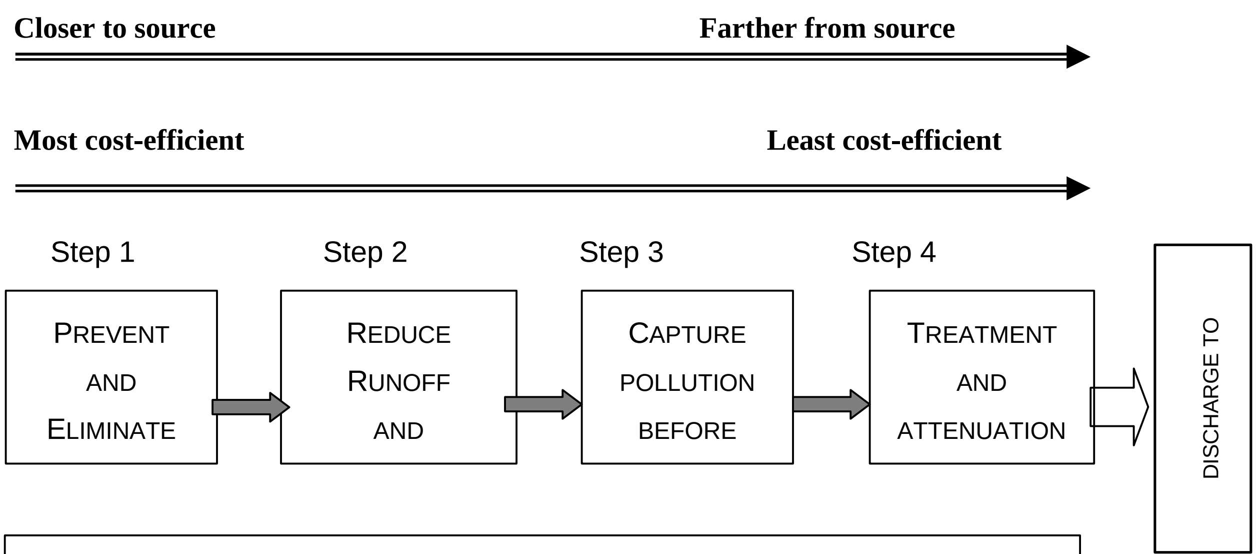
Once the BMP objectives are defined, it is necessary to identify the BMPs that are best suited to meet each objective. To determine where to place BMPs, a map of the project site can be prepared with sufficient topographic detail to show existing and proposed drainage patterns and existing and proposed permanent stormwater control structures.

The project site map should identify the following:

1. Locations where stormwater enters and exits (outfalls) the site. Include both sheet and channel flow for the existing and final grading contours.
2. Identify topographic lines clearly
3. Identify locations subject to high rates of erosion such as steep slopes and unlined channels. Long, steep slopes are considered as areas high erosion potential.
4. Categorize and identify slopes as: low erosion potential (0 to 5 percent slope), moderate erosion potential (5 to 10 percent slope), or higher erosion potential (slope greater than 10 percent).
5. Identify wetlands, springs, sinkholes, floodplains, floodways, sensitive areas, or buffers, which must not be disturbed, as well as other areas where site improvements will not be constructed. Establish clearing limits around these areas to prevent disturbance by the construction activity. Obtain all applicable federal and state permits.
6. Identify the total drainage area/basin for each outfall location. Then calculate the approximate area drainage area/basin. Define areas where various contractor activities have a likely risk of causing a runoff or pollutant discharge.

With the site map in hand, categories of BMPs can be selected and located. Detailed planning before construction begins and phasing construction activities achieve erosion and pollution prevention most cost-effectively. It is more cost-effective to prevent erosion and pollution than it is to remove sediment and pollutants. This is demonstrated in Figure 1 by first attempting to eliminate the generation of erosion and pollution (step 1) prior to reviewing the other alternatives in steps 2 through 4.

Figure 1
BMP Treatment Options



Examples of BMPs for each step			
• Employee training • Public awareness • Minimize paved areas • Material storage • Spill Prevention • Recycling	• Waste handling • Permanent seeding • Protect existing trees • Filter Strips and Swales • Riprap	• Inlet protection • Compost Filter Sock • Silt fence • Sediment trap • Check dams • Tire washing	• Dry Detention Basin • Wet Detention Basin • Floatables Skimmer • Constructed Wetlands

BMPs that can achieve multiple BMP objectives should be utilized to achieve cost-effective solutions. For instance, it is not always necessary to install extensive sediment trapping controls during initial grading. In fact, sediment trapping should be used only as a short-term measure for active construction areas and replaced by permanent stabilization measures as soon as possible. A permanent detention pond may be built first and used as temporary sediment control by placing a filter on the outlet. After construction is complete and the drainage area is stabilized, the permanent outlet configuration can be reestablished.

Considerations for Construction Sites

Certain contractor activities may cause pollution if not properly managed. Not all BMPs will apply to every construction site, however, all of the suggested BMPs should be evaluated. Considerations for selecting BMPs for contractor activities include the following:

- Is it expected to rain? BMPs may be different on rainy days versus dry days, winter versus summer, etc. For instance, a material storage area may be covered with a tarp during the rainy season, but not in the summer. However, it should be noted that plans should be made for some amount of rain even if it is not expected to generate a flooding event.
- How much material is used? Less-intensive BMP implementation may be necessary if a “small” amount of pollutant containing material is used. However, remember that some materials may be more dangerous or have the potential to cause widespread pollution.
- How much water is used? The more water used and wastewater generated, the more likely that pollutants transported by this water will reach the stormwater system or be transported offsite. Washing out one concrete truck on a flat area of the site may be sufficient (as long as the concrete is safely removed later), but a pit should be constructed if several trucks will be washed out at the same site.
- What are the site conditions? BMPs selected will differ depending on whether the activity is conducted on a slope or flat ground, near a stormwater structure or watercourse, etc. Anticipating problems and conducting activities away from environmentally sensitive areas will reduce the cost and inconvenience of performing certain BMPs.
- In general, establishing a BMP for each conceivable pollutant discharge may be very costly and significantly disrupt construction. As a rule of thumb, establish controls for common (daily or weekly) activities and be prepared to respond quickly to accidents. This rule of thumb only applies to contractors handling unusual materials that are not usually at the project site. Industries and commercial facilities are expected to have contingency plans and spill measures for every material that is used regularly.

Therefore, keep in mind that the BMPs for contractor activities are suggested practices, which may or may not apply in every case. Construction personnel should be instructed to develop additional or alternative BMPs, which are more cost-effective for a particular project. The best BMP is a construction work force aware of the pollution potential of their activities and committed to a clean worksite.

Temporary vs Permanent BMPs

A temporary BMP differs from a permanent BMP in that the former is usually used to control sediment and other runoff during construction only. After construction is complete these BMPs are usually removed from the site or their function is altered.

However, care should be taken in selecting temporary BMPs as well as permanent BMPs. Care should also be taken in installing and maintaining temporary BMPs. The only difference is in the intended lifespan of the BMP. It is good to remember that, in the world of construction and industry, a temporary solution may be in place for years due to oversight, neglect, good performance, etc. In general, temporary BMPs are intended to address construction activities; while permanent BMPs address long-term stormwater management objectives.

Temporary BMPs may include a variety of "good housekeeping" measures and short-term erosion and sediment control activities. An appropriate professional such as construction site operator and/or licensed professional civil engineer should utilize temporary BMPs. A licensed professional engineer must design some of the more complicated BMPs. The temporary management practices should be designed and submitted to the plan review process with the applicable local Engineering Departments. The contractor is responsible for properly constructing/implementing and maintaining the temporary practices and/or seeking guidance when the measures do not appear to be meeting the stormwater management objectives (namely that sediment and other pollutants do not leave the construction site).

Permanent BMPs, which are designed to control long-term stormwater pollution, are the final improvements and lay out of the project. Permanent BMPs are selected by licensed professional civil engineers, incorporated into the plans and specifications for the project, and have long-term maintenance responsibilities identified. The contractor is responsible for properly constructing the permanent controls. Permanent BMPs are normally selected in the planning phase in conjunction with the approval of the tentative map designed during the design phase of a project and completed to the satisfaction of the local Engineering Department. Occasionally, unforeseen natural or manmade factors may require revisions to or additions of permanent BMPs during the construction phase. These revisions or additions must also be approved by the local Engineering Department.

Stormwater Treatment Removal Goals

Various BMPs will have different rates of effectiveness. For most BMPs, the goal is to discharge clear stormwater with no visible pollutants and no known sources of man-made pollution (such as toxic substances, oils, chemicals or fertilizers). The objective of this section is to establish a baseline for pollution removal goals for various stormwater treatment BMPs.

There is essentially a three-step approach to achieving water quality (simplified from the 4-steps shown in Figure 1). The first step is large-scale prevention of sediment pollution from entering or even contacting stormwater runoff. The second step is removal of the visible components of stormwater runoff pollution, such as coarse sediment, oil and grease, bulk materials, and floating debris. The third step is the treatment and removal of the less obvious pollutants in stormwater runoff, such as fine sediment, nutrients, and heavy metals from automotive emissions.

Local governments require that the "first flush" volume be treated in some manner (see Sections 3 & 4). The first flush represents the early stages of a storm event, which usually delivers a large amount of accumulated pollutants and sediments that have been deposited since the last storm event. The first flush may be a steady drizzle that slowly dissolves oil, grease or other automotive combustion byproducts from the streets, or it may be a heavy downpour that really does flush all sediments and accumulated particulates down the storm drain. The first flush is defined as the first ¾ inch of direct runoff over the entire contributing drainage area.

2-year to 25-year storm events should be considered in design of BMPs. The 50-year and 100-year storm events should be considered in analysis only for the possibility of special design considerations on a case by case basis. As noted earlier, treatment of the more polluted 'first flush' should be considered in permanent BMP design. For specific first flush requirements, see Section 2 – Local Requirements and Section 3.3 First Flush/Water Quality Requirements. There are space saving devices providing first flush treatment alternatives to the usual detainment options (see Section 10 – Limited Space Devices.

Pollutant Removal Efficiencies

The overall basis for evaluating pollution removal efficiencies for various stormwater treatment BMPs is shown in Table 6. These six categories represent some of the common pollutants found in an urban environment, with the principal category considered to be the total suspended sediments (TSS).

Pollutant removal rates for a 24-hour detention time in Table 4 are used to evaluate other stormwater treatment methods, since stormwater detention and first flush volumes are required for most new construction and redevelopment projects (see Section 2 Local Requirements). An approximate 75% removal rate is indicated for suspended sediment at a detention time of 24 hours. Dissolved nutrients (phosphorous and nitrogen) are much harder to remove from stormwater runoff, and a removal rate of 30% to 40% is reasonable for a detention time of 24 hours. A closer look shows that even 2 hours of detention time will accomplish a great deal of stormwater treatment.

Typical pollutants from areas that carry automobile traffic (such as highways, streets and parking lots) are shown in Table 1. Toxic pollutants such as polychlorinated biphenyls (PCBs) may also be present. Heavy metals, oil and grease, and coarse sediments can be removed efficiently through the use of oil/water separators or by media filtration inlets, provided that these manufactured systems are carefully chosen for each application.

Tables below show expected pollutant concentrations for different land uses (Table 2), how some common BMPs protect different types of watersheds that may be near the site (Table 3), and controls and strategies for different types of physical impacts caused by your site work (Table 4). See National Pollutant Removal Performance Database (2007).

Table 1 Typical Urban Areas and Pollutant Yields

Pollutant	LAND USE (lb/acre/yr)[a]								
	Commercial	Parking Lot	Residential - Density			Highways	Industry	Parks	Shop-ping Center
			High	Medium	Low[b]				
Total Solids	2100	1300	670	450	65	1700	670	N/A[c]	720
SS	1000	400	420	250	10	880	500	3	440
Cl	420	300	54	30	9	470	25	N/A	36
TP	1.5	0.7	1	0.3	0	0.9	1.3	0.03	0.5
TKN	6.7	5.1	4.2	2.5	0.3	7.9	3.4	N/A	3.1
NH_3	1.9	2	0.8	0.5	0	1.5	0.2	N/A	0.5
$NO_3 + NO_2$	3.1	2.9	2	1.4	0.1	4.2	1.3	N/A	0.5
BOD_5	62	47	27	13	1	N/A	N/A	N/A	N/A
COD	420	270	170	50	7	N/A	200	N/A	N/A
Pb	2.7	0.8	0.8	0.1	0	4.5	0.2	0	1.1
Zn	2.1	0.8	0.7	0.1	0	2.1	0.4	N/A	0.6
Cr	0.15	N/A	N/A	0	0	0.09	0.6	N/A	0.04
Cd	0.03	0.01	0	0	0	0.02	0	N/A	0.01
As	0.02	N/A	N/A	0	0	0.02	0	N/A	0.02

a The difference between lb/acre/yr and kg/ha/yr is less than 15%, and the accuracy of the values shown in this table cannot differentiate between such close values

b The monitored low-density residential areas were drained by grass swales

c NA = Not available

USEPA (2004)

Table 2 Median Event Mean Concentrations for All Sites by Land Use

Constituents	Land Uses							
	Residential		Mixed Land Use		Commercial		Open/Non-urban	
	Median	Cov[a]	Median	COV	Median	COV	Median	COV
BOD5, mg/L	10	0.41	7.8	0.52	9.3	0.3	-	-
COD, mg/L	73	0.55	65	0.58	57	0.4	40	0.78
TSS, mg/L	101	.96	67	1.14	69	0.9	70	2.92
Total Pb, µg/L	144	0.75	114	1.35	104	0.7	30	1.52
Total Cu, µg/L	33	0.99	27	1.32	29	0.8	-	-
Total Zn, µg/L	135	0.84	154	0.78	226	1.1	195	0.66
TKN, µg/L	1900	0.73	1289	0.5	1179	0.4	965	1
No2+NO3(asN), µg/L	736	0.83	558	0.67	572	0.5	543	0.91
TP, µg/L	383	0.69	263	0.75	201	0.7	121	1.66
Soluble P, µg/L	143	0.46	56	0.75	80	0.7	26	2.11

[a]COV: coefficient of variation = standard deviation/mean

(USEPA 2004)

Table 3 Treatment BMPs for Specific Watershed Factors

BMPs	**Cold Water**	**Sensitive Stream**	**Aquifer Protection**	**Reservoir Protection**	**Shellfish/Beach**
Ponds and Wetlands	Restricted due to thermal impacts, offline design recommended	May be limited or require additional volume for channel erosion impacts	May require liner if HSG A soils are present, pre-treat hot spots	May be limited due to channel erosion and may require additional volume control	May require use of permanent pools to increase bacteria removal
Infiltration	Yes, if site has suitable soils	Yes, if site has suitable soils	Requires safe distance from wells and water table, pre-treat hot spots	Requires safe distance from bedrock and water table	Yes, but needs safe distance to water table
Vegetative Biofilters	OK	OK, if channel protection volume is met	OK	OK	OK, but wet swale has poor bacteria removal
Filters (Sand, Perimeter, Underground)	OK for small volumes	Ok for water quality, no channel protection	OK for water quality, no recharge	OK for water quality	OK, moderate to high bacteria

Table 4 Quantitative Assessment of Water Quality Control Strategies in the Physical Impact Category

Physical Impact Category	Control	Strategy Assessment
Increased flooding	Not a water quality control strategy	Not applicable
Channel instability and erosion	Not a water quality control strategy	Not applicable
Reduction in groundwater recharge and related issues	Capture and treat first flush, or 1-yr, 2-yr or larger design storm volumes using infiltration practices	Generally designed for groundwater or peak discharge control, but can be effective in removal of phosphorus, particulate matter, some pathogens and other pollutants.
Increased sediment transport	Percentage load reduction or maximum effluent limits	Effectively reduces sediment loads of overland flow, with effectiveness decreasing as finer particle loads increase.
Thermal impacts	Capture and treat first flush, or 1-yr, 2-yr or larger design storm volumes	Increased exposure to warm, impervious surfaces and solar radiation of retained stormwater increases water temperatures.

(USEPA 2004)

Table 5 BMP Selection for Specific Terrain Factors Quantitative Assessment of Water Quality Control

BMPs	Terrain Factor		
	Low Relief	Karst	Mountainous
Ponds	Maybe limited by depth to groundwater	Geotechnical testing required, may require liner, ponding depth may be limited	Embankments heights restricted
Wetlands	OK	Geotechnical testing required, may require liner, ponding depth may be limited	Embankments heights restricted
Infiltration	Minimum distance to water table of 2 ft* depending on soil type	May be prohibited by local authority	Maximum terrain slope 15%
Vegetative Biofilter	OK	OK	Swales may be limited by steep slopes
Filter	Some designs limited by head required	Liner required	OK

USEPA (2004)

Table 6 Comparative Pollutant Removal Percentages of Urban BMP Designs*

BMP DESIGN	TSS	Total P	Total N	Oxygen demand	Trace metals
	(expressed in percentages)				
Dry detention basin, First flush held for 6 to 12 hours	60 – 80	20 – 40	20 – 40	20 – 40	40 – 60
Dry detention basin, 1” runoff volume held for 24 hours	80 - 100	40 – 60	20 – 40	40 – 60	60 – 80
Dry detention basin with shallow marsh and forebay, 1” runoff volume held for 24 hours	80 - 100	60 – 80	40 – 60	40 – 60	60 – 80
Wet detention basin, Permanent pool = 0.5” per impervious acre	60 – 80	40 – 60	20 – 40	20 – 40	20 – 40
Wet detention basin, Permanent pool = 2.5 x mean storm runoff	60 – 80	40 – 60	20 – 40	20 – 40	60 – 80
Wet detention basin, Permanent pool = 4.0 x mean storm runoff	80 - 100	60 – 80	40 – 60	40 – 60	60 – 80
Infiltration basin, Exfiltrates 0.5” per impervious acre	60 – 80	40 – 60	40 – 60	60 – 80	40 – 60
Infiltration basin, Exfiltrates 1” per impervious acre	80 - 100	40 – 60	40 – 60	60 – 80	80 - 100
Infiltration basin, Exfiltrates all runoff from 2-year design storm	80 - 100	60 – 80	60 – 80	80 - 100	80 - 100
Filter strip, 20’ wide turf strip	20 – 40	0 - 20	0 - 20	0 - 20	20 – 40
Filter strip, 100’ wide forested buffer with level spreader	80 - 100	40 – 60	40 – 60	60 – 80	80 - 100
Grass swale, Moderate slopes with no check dams	0 - 20	0 - 20	0 - 20	0 - 20	0 - 20
Grass swale, Low slopes with check dams	20 – 40	20 – 40	20 – 40	20 – 40	0 - 20
Water quality inlet or oil/water separator, (consult manufacturer)	Varies	Varies	Varies	Varies	Varies

Figure 2 Pollutant Removal for Dry Basins

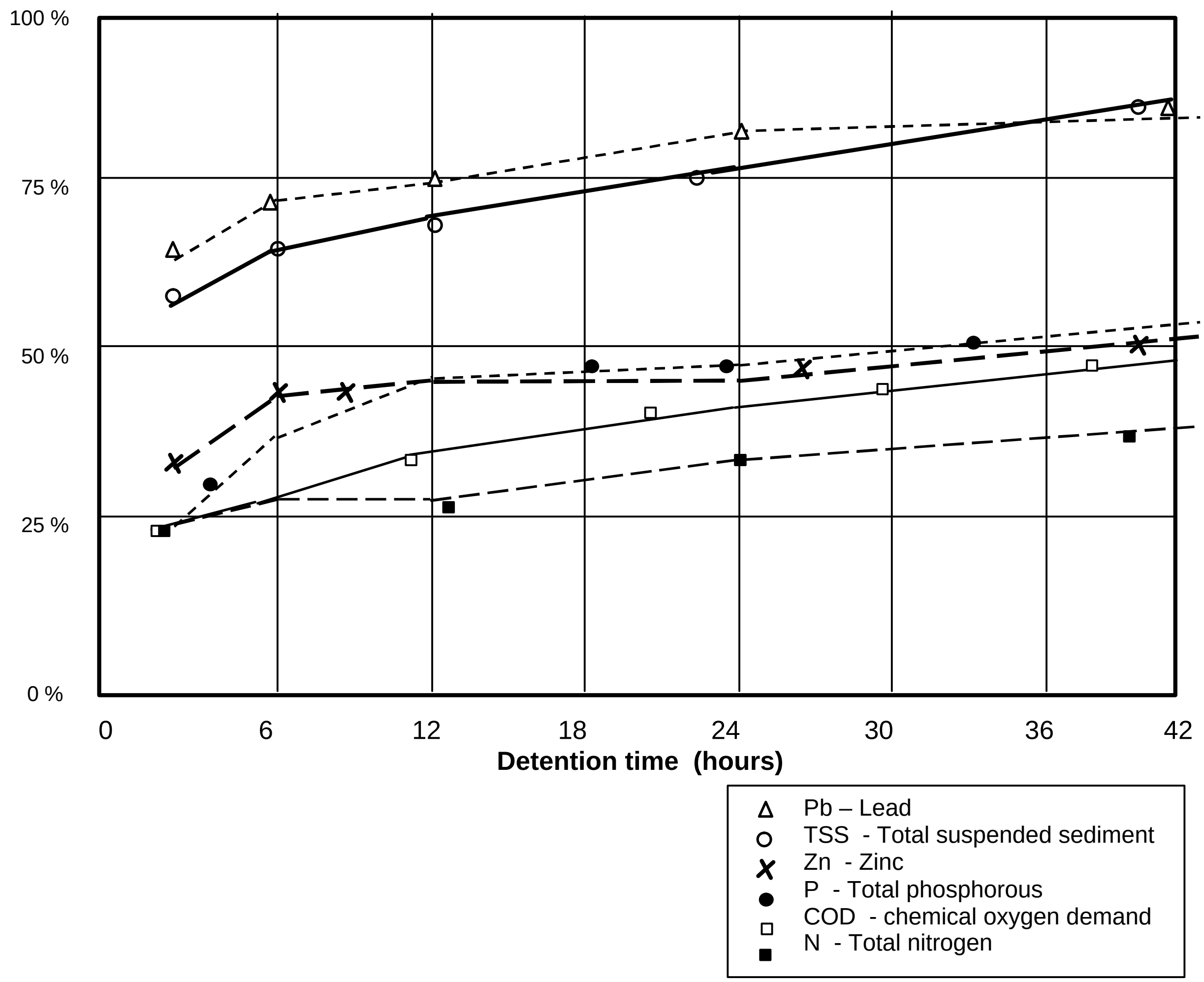


Table 7
Construction Site Pollutants

Construction Site Pollutants									
	Primary Pollutant	Other Pollutants							
Areas of Consideration	Sediment	Nutrients	Heavy Metals	pH (acids & bases)	Pesticides & Herbicides	Oil & grease	Bacteria & Viruses	Trash, debris, solids	Other toxic chemicals
Clearing, grading, excavating, and unstabilized areas	√							√	
Paving operations	√							√	
Concrete washout and waste			√	√				√	
Structure construction/ painting / cleaning		√		√				√	√
Demolition and debris removal	√							√	
Dewatering operations	√	√							
Drilling and blasting operations	√			√				√	
Material delivery and storage	√	√	√	√	√	√		√	√
Material use during building process		√	√	√	√	√		√	√
Solid Waste (trash and debris)								√	√
Hazardous waste			√	√	√	√			√
Contaminated spills		√	√	√	√	√			√
Sanitary/septic waste		√		√			√		√
Vehicle/equipment fueling and maintenance						√			√
Vehicle/equipment use and storage						√			√
Landscaping operations	√	√						√	

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