EVALUATING POTENTIAL FOR HAZARDOUS SEDIMENTS IN STORMWATER QUALITY TREATMENT FACILITIES

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1.0 EXECUTIVE SUMMARY

Urban stormwater quality treatment facilities—also referred to as best management practices, or BMPs—are designed to maximize the removal of sediment and other solids. Such solids have an affinity for a host of pollutants commonly found in urban runoff, such as heavy metals, solvents and other chemicals. The disposal of these pollutants may be regulated under federal law by the Resource Conservation and Recovery Act (RCRA) and under the companion Colorado state law, Colo. Rev. Stat. § 25-15-301 *et seq.* These laws define the compounds regulated as hazardous wastes, and the circumstances in which those compounds are regulated.

Accumulated sediments must periodically be removed to assure proper facility function. If the sediment is classified as a hazardous waste due to the presence of certain regulated pollutants, special (and often expensive) treatment and/or disposal requirements may be applicable.

This report (1) describes circumstances under which stormwater BMP sediments can be classified as hazardous wastes; (2) briefly addresses major legal and regulatory considerations and initially assesses how this issue is being addressed in other locations; (3) presents sediment chemistry data for ten representative BMPs in the UDFCD region, including an evaluation of whether or not the sediments in these BMPs could be classified as hazardous wastes; and (4) provides recommendations for managing this potential issue.

This assessment began with a review of the major provisions of RCRA and Colorado hazardous waste regulations and the applicable technical literature, and interviews were conducted with other municipalities around the United States. A field monitoring program was established in which sediment samples were collected from ten representative extended detention basins and retention ponds located throughout the UDFCD region. Samples were collected from multiple locations within each BMP, composited and analyzed at a certified laboratory. The laboratory results were then compared against applicable standards to determine if a sample would be classified as a hazardous waste and subject to special disposal requirements. Most of the chemical constituents tested for at the ten sampling locations were undetected. None of the tested constituents returned concentrations above the hazardous thresholds as defined by RCRA. The same conclusion applies to the thresholds in Colorado's hazardous waste laws.

Although the ten stormwater BMPs that were sampled did not have exceedances of applicable hazardous thresholds under RCRA (a finding which is consistent with most other studies of "standard" [typical] urban stormwater facilities in the United States) facility owners, designers and maintenance staff should be aware of this issue and are advised to consider the following steps to best manage sediment removal and reduce the probability that sediments will be classified as hazardous waste under RCRA or the Colorado statutes for hazardous waste:

1. Take reasonable steps to reduce the likelihood that chemicals listed as hazardous waste under RCRA will come into contact with precipitation or stormwater.
2. In small drainage areas where there are relatively few property owners, control the kinds of chemicals that come into contact with precipitation and enter the drainage system. In small drainage areas, the prospects for strictly controlling the kinds of chemicals that enter the drainage system are better than those in larger areas with multiple property owners.
3. To localize the problem, stormwater pretreatment facilities should be considered. For example, immediately upstream from a stormwater wetland, it may be feasible to install a sedimentation basin.
4. Adopt measures throughout the watershed to reduce the quantity of sediment that will enter the BMP over time.
5. Designers are well advised to discuss the potential problem of sediment disposal with regulators and their clients in advance of an assignment.
6. Intentionally oversize the sediment storage volume in the BMP.

When confronted with the knowledge that BMP sediments may potentially contain RCRA-listed wastes, the facility owner and the designer should consider the following steps:

1. Conduct additional sampling to confirm the concentration of the contaminants.
2. If the drainage area is small, thoroughly search the area for potential distinct sources of chemicals that have been detected in the sediments. If there are distinct sources that could be transported by stormwater to the BMPs, take immediate action to assure that the chemical will not continue to be discharged into the stormwater drainage system.
3. In many cases, a risk assessment will demonstrate that no practical risk is posed to the public or other life forms by constituent levels within the sediments. This is important information to provide to the regulators because they can exercise some judgment or discretion in evaluating regulatory options. For example, if volatile or semi-volatile compounds are in the sediments, the risk assessment should account for sediment dredging and disposal processes, thereby reducing the risk.
4. Evaluate modifications to the stormwater facility that will avoid the need to excavate the contaminated sediments. For example, it may be reasonable to retrofit a detention basin with a micropool or increase the size of an existing micropool, thereby increasing sediment storage space.
5. Consider seeking advice from qualified attorneys, engineers and scientists on how to proceed, and become knowledgeable on the issues involved.

2.0 INTRODUCTION AND PURPOSE

Urban stormwater quality treatment facilities—also referred to as best management practices, or BMPs—are designed to maximize the removal of sediment and other solids. Such solids have an affinity for a host of pollutants commonly found in urban runoff, such as heavy metals, solvents and other chemicals. The disposal of these pollutants may be regulated under the federal hazardous waste law, the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. § 6901 *et seq.*, as well as the companion Colorado state law, Colo. Rev. Stat. § 25-15-301 *et seq.* RCRA and the Colorado hazardous waste regulations define the compounds regulated as hazardous wastes, and the circumstances in which those compounds are regulated. The RCRA definitions of hazardous wastes are found at 40 CFR Part 261, and the related Colorado regulations are found at 6 Colo. Code Reg. 1007-3, Part 261.

Accumulated sediments must periodically be removed to assure proper facility function. If the sediment is classified as a hazardous waste due to the presence of certain regulated pollutants, special treatment and/or disposal requirements may be applicable. The additional regulatory compliance measures are typically expensive and consume significant time to address. Consequently, an understanding of this subject is important for stormwater facility owners, designers, and maintenance staff.

This report was prepared by Wright Water Engineers, Inc. (WWE) with limited legal review by Hogan & Lovells for the Urban Drainage and Flood Control District (UDFCD). The purposes of this report are to:

1. Describe circumstances under which stormwater BMP sediments can be classified as hazardous wastes under RCRA.

2. Briefly review major legal and regulatory considerations, and through literature review and interviews, initially assess how this issue is being addressed in other locations around the United States.

3. Present sediment chemistry data for ten representative BMPs in the UDFCD region, encompassing a wide range of land uses, including an evaluation of whether or not the sediment in these BMPs could be classified as hazardous wastes under RCRA and

Colorado hazardous waste regulations, based on laboratory analysis. For the purpose of this study, the sites selected were limited to extended detention basins and retention ponds.

4. Provide recommendations for managing this potential issue for public and private stormwater facility owners, engineers and maintenance staff.

The report is organized as follows:

- Section 2.0 Approach
- Section 3.0 Legal and Regulatory Background
- Section 4.0 Technical Literature Review and Interviews
- Section 5.0 Sediment Sampling, Laboratory Analysis and Interpretation
- Section 6.0 Recommendations to Reduce the Potential Problem

3.0 APPROACH

This assessment began with a review of the major provisions of RCRA and the Colorado hazardous waste regulations. The applicable technical literature was then reviewed, and interviews were conducted with other municipalities around the United States. A field monitoring program was established in which samples were collected from ten representative extended detention basins and retention ponds located throughout the UDFCD region. Sediment samples were collected from multiple locations within each of these BMPs, composited and then analyzed at a certified laboratory to determine whether or not the samples would be classified as hazardous. The laboratory results were then compared against applicable standards with the resulting determination of whether or not the sample would be a hazardous waste and subject to special disposal requirements. After these tasks were conducted, conclusions and recommendations were prepared.

This report should be viewed as an initial study that provides an overview of a complex topic. The question of whether or not sediments that accumulate in stormwater impoundments (and other best management practices) will be hazardous is watershed specific and involves technical and legal questions. Stormwater practitioners are encouraged to obtain assistance from regulators, engineers/scientists and attorneys with specific training on federal and state requirements where appropriate.

4.0 LEGAL AND REGULATORY BACKGROUND

4.1 Resource Conservation and Recovery Act

4.1.1 Legal Background

The Resource Conservation and Recovery Act of 1976 (RCRA) addresses issues surrounding the production of municipal and industrial wastes. RCRA has four goals:

1. Protect human health and the natural environment from potential hazards associated with waste disposal.
2. Promote the conservation of energy and natural resources.
3. Reduce the amount of waste generated through source reduction and recycling.
4. Ensure the management of waste in an environmentally sound manner.

In the 38 years since its enactment, RCRA has served as the basis for most of the hazardous waste classification and disposal regulations in the United States. RCRA regulates the disposal of solid waste in general, and provides a "cradle to grave" regulatory program for the subset of solid waste that is defined as "hazardous" in 40 CFR Part 261. The United States Environmental Protection Agency (EPA) administers the federal RCRA program. The State of Colorado has adopted its own "cradle to grave" regulatory program for hazardous waste that largely parallels the federal program.

4.1.2. What Is Hazardous Waste?

A hazardous waste under RCRA is any solid waste that is not specifically excluded from the hazardous waste regulations, and that:

- Exhibits one or more of four characteristics identified at 40 CFR 261.21-24—*ignitability, corrosivity*, *reactivity* and *toxicity* (*i.e.,* a *characteristic* waste); and/or

- Is listed in one of four lists developed by EPA and contained in the *Code of Federal Regulations* (CFR) at 40 CFR 261.31-33 (*i.e.*, a *listed* waste).

Characteristic hazardous wastes include those that are:

- Ignitable—Liquids with flashpoint <140° F, spontaneously combustible materials, strong oxidizers or ignitable compressed gases (*e.g.*, gasoline).
- Corrosive—Aqueous solutions of pH ≤ 2 or ≥ 12.5, or a liquid that corrodes steel at a specified rate (*e.g.*, sulfuric acid).
- Reactive—Normally unstable or explosive, reacts violently with water, or may release a toxic gas on contact with water (*e.g.*, certain cyanide or sulfide-containing compounds).
- Toxic—Exceeds concentration limits for specified organic and inorganic contaminants when sample is analyzed using a specific laboratory protocol known as the "Toxicity Characteristic Leaching Procedure" (TCLP). Common examples include lead (5 mg/L), mercury (0.2 mg/L), cadmium (1 mg/L), benzene (0.5 mg/L) and silver (5 mg/L).

It would be highly unusual for sediment that accumulates in a typical BMP to be classified as hazardous because the sediment is ignitable, corrosive, or reactive. Instead, the designation of "hazardous" would more likely be due to concentrations of *listed* chemical compounds that exceed numeric limits specified in RCRA.

Hazardous chemicals present in a watershed may *mix with* sediment in sufficient quantities to render the mixture a hazardous waste. Mixtures of listed hazardous wastes with non-hazardous solid wastes are considered to be RCRA hazardous wastes [40 CFR 261.3(a)(2)(iv)]. Solid wastes mixed with waste exhibiting the hazardous characteristic of toxicity also remain subject to the mixture rule. [40 CFR 261.3(a)(2)(iii)]. However, mixtures of a solid waste and a hazardous waste which is listed solely because the mixture exhibits one or more of the characteristics of ignitability, corrosivity or reactivity, are not hazardous wastes when the resultant mixture no longer exhibits those particular characteristics.

4.1.3 Categories of Hazardous Wastes

The primary RCRA listed hazardous wastes are those included in the F-list, the K-list and the P- and U-lists. Each listed waste is given a four-character alphanumeric classification. The first character is a broad classification and the next three digits specifically identify the listed waste.

For example, F007 refers to spent cyanide solutions from electroplating baths. A complete list of RCRA listed wastes can be found in the document *RCRA Hazardous Waste Codes*. A summary is listed below:

1. F-list wastes
    a. From nonspecific sources—Used across a wide variety of industries, these wastes are among the most common hazardous wastes found in deposited urban sediments.
    b. Spent solvent wastes.
        i. Must be spent.
        ii. Must meet a specific before-use concentration.
        iii. For mixtures of F001, F002, F004 and F005, if the before-use concentration of all of the solvents present in a given product is ≤ 10 percent by volume, all solvents present in any concentration apply to the spent product.
        iv. Mixtures containing F003 solvents are listed only under two conditions:
            - The mixture contains only F003 constituents.
            - The mixture contains F003 and at least 10 percent of other solvent constituents.
    c. Electroplating and other metal finishing wastes.
    d. Dioxin-containing wastes.
    e. Chlorinated aliphatic hydrocarbons production wastes.
    f. Wood preserving wastes.
    g. Petroleum refinery wastewater treatment sludges.
    h. Multisource leachate.
2. K-list wastes
    a. Industry specific wastes, e.g., specific chemicals related to wood preservation, lead smelting, etc.
3. P- and U-list wastes
    a. Discarded commercial chemicals.
    b. Hazardous waste when discarded unused.

c. Identified as hazardous waste because they are either toxic or have another hazardous characteristic (such as ignitability).

If any of the hazardous compounds in the lists above are present in sediment that needs to be removed from a stormwater facility at greater than specified concentrations (typically micrograms or milligrams of chemical per kilograms of sediment or milligrams per liter if a leaching test is performed[1]), then the "mixture" of sediment and the applicable chemical(s) is hazardous and must be treated as such. The applicable limits that were used for the ten BMPs that were sampled as part of this project are provided in Section 5.

4.1.4 Land Disposal Requirements

Land disposal facilities may require testing prior to acceptance of sediments to ensure that those sediments are not hazardous. Required testing is a response to the RCRA Land Disposal Restrictions (LDR) program, which regulates hazardous wastes by helping to ensure that wastes are properly treated prior to land disposal through the immobilization of harmful constituents or by destroying or removing those constituents. The LDR program is an additional layer or regulation, supplemental to the regulation of hazardous wastes defined in the federal and state Part 261 regulations.

Soils (or sediment deposits in BMPs) are subject to RCRA LDR requirements, including treatment requirements, when (1) the soil is *generated*, and (2) the soil contains a hazardous waste regulated by RCRA. Soil is considered to be generated when it is excavated and collected in containers, treated *in situ* or removed from the area of contamination. Soils are also considered generated if they are placed within an area of contamination.

If soils/sediment in BMPs are not removed from an area of contamination, they are not subject to RCRA requirements; however, when a BMP is cleaned out for maintenance and sediments are

[1] If a sediment sample is tested as a solid and a laboratory reports the total concentration limit in mg/kg, dividing mg/kg by 20 (which reflects the 20-1 ratio of extraction fluid to the solid used in a TCLP test) will result in a mg/L value (reflecting the maximum theoretical leachate concentration) that can be compared to regulatory limits. If the value (in mg/L) equals or exceeds the regulatory limit, then a landfill may require a TCLP test be conducted to determine actual leachate concentration levels prior to allowing disposal.

collected and removed, *i.e.*, generated, those sediments may need to be tested for hazardous wastes (as defined by RCRA) prior to acceptance by a landfill.

RCRA lists hundreds of hazardous wastes, so how does one determine what parameters to test for to ascertain land disposal requirements? Different land disposal facilities have different requirements for the testing and disposal of sediments, so it is prudent to confer with the disposal site that is planned for use prior to collecting and testing. Although landfills have a list of basic criteria that must be fulfilled, they do allow for generator discretion and determination regarding the potential contents of the sediments that are collected. Determination of the potential contents of sediment can guide what parameters are tested for prior to disposal. Landfills rely on generators'/contractors' knowledge of the characteristics of the watershed draining into sediment collection facilities. If, for example, a contractor is aware of runoff potentially containing petroleum products from upstream areas in the watershed, then that contractor would possess the knowledge that could result in a decision to require a test for BTEX. Additionally, if odors or other signs of contamination are identified, a landfill may require lab analysis.

Oftentimes, testing laboratories require paperwork submittals to assure that the generator has used the best available information to determine that hazardous wastes are not present. Most landfills require a full Toxicity Characteristic Leaching Procedure (TCLP) test, which includes testing for herbicides, pesticides, semi-volatiles, volatiles, metals and other parameters. Also, a Paint Filter test is typically required to test for free liquids, since free liquids are forbidden from landfill disposal.

Landfills (such as the ones consulted by WWE as part of this project) have lists of basic criteria that must be fulfilled. However, they allow for a large amount of generator discretion/ determination as to the content of the wastes that they receive. They require paperwork submittals to assure that the generator has used the best available information to determine that hazardous wastes are not present, and some of their testing criteria are absolute (for instance, they all require TCLP). However, they do not test for, nor do they require, anything approaching a full RCRA list.

In addition to the mixture rule, discussed above, urban stormwater practitioners may encounter other RCRA and Colorado state program rules, such as the "Derived from Rule" and the "Contained in Policy." The application of these rules to the nature of the source material and exceptions to the definition of hazardous waste are provided in Appendix A.

4.1.5 EPA Interviews

WWE interviewed EPA staff experienced with RCRA and asked for their recommendations regarding testing and managing accumulated sediment in stormwater facilities. Highlights of the interviews include:

1. There is no federal standardized list of hazardous materials that are required to be sampled and tested for in order for sediment from a BMP to be deemed hazardous waste. There is a complete list of hazardous wastes; however, it covers over 1,000 compounds and would represent an unduly onerous burden on those seeking to dispose of wastes. Therefore, substantial latitude is given to hazardous waste "generators" (the owners and operators of BMPs) who test for contaminants. That is, "generators" have the freedom to choose which contaminants to test for according to the best available information for a specific facility and drainage area, as discussed above.

2. Lists of potential constituents to be tested for that are provided by testing laboratories must be carefully reviewed. It would be common to amend or revise the lists that have been provided in accordance with site-specific conditions.

3. Land disposal sites have their own lists for hazardous wastes and their own requirements for what needs to be done in order to allow for disposal of sediments/solids. Consulting directly with individual disposal sites is a good option for building a suitable list.

5.0 TECHNICAL LITERATURE REVIEW AND INTERVIEWS

5.1 Technical Literature Review

WWE conducted a review of the applicable technical literature and had telephone interviews with various municipal officials to ascertain the experiences that others have had regarding whether BMP sediments can be classified as hazardous wastes. There is limited literature on this subject, and many of the articles are older. A brief synopsis of some of the key documents reviewed and interviews conducted follows:

1. A thorough discussion of the subject is found in Chapter 9 of the reference *Operation, Maintenance, & Management of Stormwater Management,* prepared by Livingston *et al.* and published by the Watershed Management Institute and EPA (undated). Chapter 9 is attached as Appendix B. Some of the key quotations and paraphrased statements from this reference include:
   - "A growing concern, as more and more stormwater treatment systems are constructed, is how should the sediments that accumulate in them be disposed? The stormwater pollutants that accumulate in the sediments are highly variable, but they often include several contaminants such as heavy metals, petroleum hydrocarbons, and other organic compounds, such as pesticides or solvents, which may be considered hazardous wastes.

     "This chapter will discuss the applicability of federal and state solid and hazardous waste laws which may affect the proper disposal of stormwater sediments. It will also summarize data on stormwater sediments from the few studies which have been conducted to characterize them. Finally, recommendations will be provided on whether stormwater sediments need to be characterized before disposal and what type of tests need to be conducted… Recommendations will be made on how stormwater sediments should be safely disposed."
   - "Unfortunately, few state or local governments have established clear policies, guidance, or rules on disposal of stormwater sediments or the applicability of federal, state, or local laws and rules. Seldom do current laws, ordinances, rules, or guidelines governing solid waste handling and disposal address waste removed from stormwater systems. This ambiguity makes it difficult for public and private operators to comply with relevant laws and regulations in their stormwater management system maintenance programs. As a result of these unanswered handling and disposal questions, many stormwater management agencies have been discouraged from performing routine maintenance of stormwater systems."

- Examples of comprehensive solid waste regulations that apply to stormwater sediments are presented for the states of Washington and Florida. Regarding data from the state of Washington, "A study by Herrera Environmental Consultants (1991) found that vactor truck sediments generally exceeded the Washington Model Toxics Control Act criteria for polyaromatic hydrocarbons (PAHs) and total petroleum hydrocarbons (TPH). Concentrations of the most often detected compounds were greater in wastes from industrial areas than from residential and commercial areas."

  A paper by the Center for Urban Water Resources Management at the University of Washington authored by Jacobson, 1993, was summarized as follows: "The Jacobson study concluded that stormwater system solids must be disposed of with caution because of high TPH concentrations. Similar results were found in a 1995 analysis of vactor sediments that had been stockpiled at a maintenance yard in Bellevue, Washington. Although such wastes are probably not so contaminated that they require hazardous waste landfilling, they are too polluted for some standard landfills."

- With regard to sediment data collected in Florida, the following summary statement was provided: "A key question that must be addressed is whether sediments taken from stormwater BMPs are a 'hazardous waste' because of their toxicity? Based on Florida data, stormwater sediments generally are not toxic based on the results of toxic compound leaching procedure (TCLP) tests. Not a single sample in the database exceeded the TCLP limits. Follow-up testing confirmed this finding. Specifically, in 1996, the Florida Department of Environmental Protection collected sediment samples at 44 sites in 1996 and found that only about 10 percent of the 15,506 laboratory analyses for constituents such as total organic carbon, heavy metals, chlorinated pesticides and PCBs, and volatile and semivolatile organic compounds resulted in levels above the laboratory minimum detection levels."

2. In the mid 1990s, Jones *et al*. published four papers on this subject entitled: "BMPs and Hazardous Sediments," "Beware the Sediment Scare," "Can Sediments That Accumulate

in Stormwater BMPs Be Classified as Hazardous Wastes under RCRA?" and "Stormwater Best Management Practices—When Is Sediment Considered Hazardous?" These papers are provided in Appendix C. The major findings from these four papers can be summarized as follows:

- Under certain circumstances, sediments that accumulate in either municipal or industrial facilities, when discarded, may be classified as hazardous waste.
- Under current RCRA regulations, the "mixture" rule and "derived from" rule can cause sediments with extremely low concentrations (barely above the detection limit) of one or more listed hazardous wastes to be classified as hazardous waste when those sediments are discarded. Perhaps of greater significance, under EPA's "contained in" policy, environmental media (like water, soil, and sediment) that contain a listed hazardous waste must be handled as if a hazardous waste.
- Many of the compounds specifically listed as hazardous waste under RCRA have been detected in municipal and industrial stormwater runoff. For example, chemical compounds that are commonly used for automobile maintenance (certain solvents, degreasers, hydraulic fluids, etc.) and yard care (selected herbicides, insecticides, fungicides and other pesticides) have been detected in stormwater runoff samples throughout the United States.
- The chemicals of concern will mix with total suspended solids ("TSS") in the stormwater and a certain portion of these solids will "settle out" (be deposited) in the BMP. Such sediments can potentially be considered a solid waste regulated under RCRA.
- Simply because a chemical regulated by RCRA is detected in BMP sediments, the sediments are not necessarily hazardous. If, for example, a spent halogenated solvent listed as hazardous waste is detected in detention basin sediments, those sediments would be hazardous waste under the mixture rule only if the source of the spent solvent contained more than 10 percent of that solvent by volume (40 CFR §261.31 [F001 wastes]). If a potential source is located, there must also be a way for precipitation/runoff to come into contact with the chemical. If no product containing

greater than 10 percent of the listed solvent is found, or if contact with precipitation/runoff (including via spills) is unlikely, the BMP sediments would not be classified as hazardous waste per RCRA.

- Municipal and industrial stormwater designers should specify an array of source control techniques to reduce the probability that RCRA-listed wastes will enter BMPs.
- Despite aggressive source control efforts, in most municipal and industrial settings, pollutants that are "listed" under RCRA will inevitably find their way into BMPs on occasion. Further, most BMPs will cause some sediment/pollutant deposition. Thus, the owners of the BMPs should have a plan to address this potential problem. It is not feasible to design facilities to allow listed hazardous compounds to assuredly pass through, nor would this be desirable from a receiving water impact perspective.

3. Chapter 11, "Maintenance of Stormwater Controls" from *Design of Urban Stormwater Controls*, published by the Water Environment Federation and American Society of Civil Engineers/Environmental and Water Resources Institute/McGraw–Hill in 2012, provides the following discussion regarding sediment disposal:

   "Sediment disposal is often a concern for agencies and others responsible for stormwater control maintenance. There are conflicting perceptions as to the degree of contamination in sediments in stormwater systems, and there is also concern among operators that there will be high costs associated with disposal of contaminated sediments. Sediment quality datasets from around the country generally do not support the concern that these materials are hazardous based on the mass of metals contained in the sediment. Maximum concentrations from controls constructed in the United States by the California Department of Transportation (Caltrans) (2004) for transportation facilities are presented in Table 11.1 (Table 1, below). The concentrations of the samples are compared with concentrations for U.S. hazardous waste thresholds. The results indicate that sediment pollutant concentrations from stormwater controls are generally well below thresholds for concentrations as hazardous waste in the United States, and could be disposed of in a municipal landfill as a "special waste" or used as fill for another project. However, it is important to note that controls treating runoff from "hot spots" or where spills of hazardous materials have occurred in the watershed may have substantially higher contaminant concentrations than shown here; in these instances, the sediment may need to be tested to determine the proper disposal methods."

Table 1. Maximum Concentrations of Selected Constituents in Sediments from Various Sources
***Design of Urban Stormwater Controls* (Table 11.1) (WERF)**

		Maximum Concentration (mg/kg)						
Site Name	**Structure**	**As**	**Cd**	**Cu**	**Pb**	**Zn**	**Ni**	**Hg**
605 / 91 (U.S.)	Biofiltration strips	2.9	1.2	60	144	337	13	0.05
Alameda (U.S.)	Oil and water separator	5	1.7	106	189	702	27	0.07
Termination P&R (U.S.)	Sand filter	0.76	0.3	11	11	70	3.4	0.04
Eastern regional middle states (U.S.)	Sand filter	1.2	0.3	8	25	61	3.1	0.04
Foothill middle states (U.S.)	Sand filter	1.7	0.2	7	16	77	2.4	0.04
Via Verde P&R (U.S.)	Sand filter treatment train	3.1	1.5	41	54	535	22	0.05
Kearny Mesa (U.S.)	Compost filter	1.7	5	120	110	670	18	0.5
Escondido (U.S.)	Sand filter	1.1	5	10	10	140	10	0.5
U.S. threshold values for hazardous waste		5000	1000	25,000	5000	250,000	20,000	

4. Relevant statements from an article entitled "Are Rain Gardens Mini Toxic Cleanup Sites?" in *Sightline Daily: News and Views for a Sustainable Northwest* (Sightline Institute) by Lisa Stiffler, January 22, 2013, include:

   - "One of the most prevalent categories of runoff pollution is oil and grease from leaking cars and spills at gas pumps, vehicle exhaust, and burning wood and fossil fuels. The contaminants include petroleum hydrocarbons, and a category of environmentally hazardous chemicals called polycyclic aromatic hydrocarbons, or PAHs."

     "Scientists from the University of Minnesota recently performed experiments in the field and the lab to track PAHs in stormwater systems. They collected more than 70 soil samples from more than 50 rain gardens and bioretention infrastructures in the Twin Cities. The rain gardens were capturing water from various types of land use, including parking lots, roofs, and streets. The researchers found much higher levels of petroleum hydrocarbons in the rain garden versus the non-rain garden soils, but the levels were essentially safe in both: "all soil concentrations were about one thousand times less than regulatory action levels," the scientists reported.

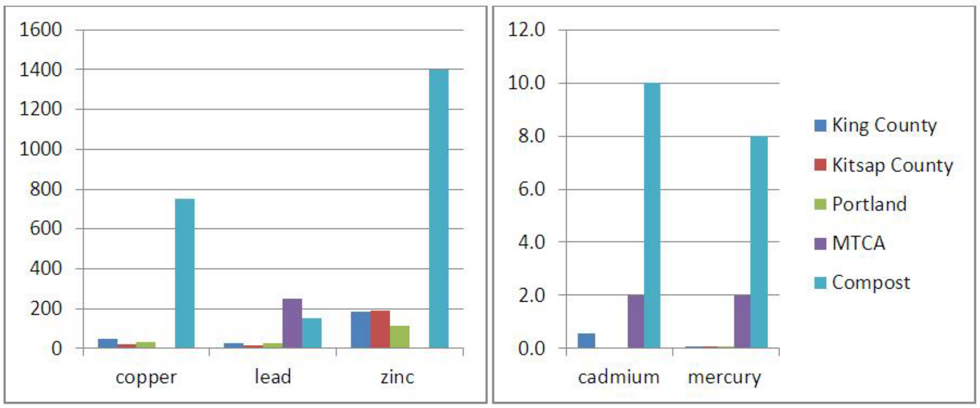
"The City of Portland's (Oregon) Bureau of Environmental Services has been doing its own testing of rain gardens and other green infrastructure to track pollutants. The Bureau detected PAHs at all of the rain garden facilities it tested, "but typically at concentrations well below human health guidelines."

- Heavy metals found in stormwater include copper, cadmium, lead, mercury, and zinc. A 2007 study published in *Chemosphere* using faux stormwater contaminated with copper, lead, cadmium, and zinc in a lab simulation found that between 88 to 97 percent of the metals were captured in the soil media and up to 3 percent was trapped by plants. But even if all the metals are being held in the rain garden, this is still not a large volume of toxics. A 2003 study concluded that it would take about 20 years for rain garden soils soaking up runoff to reach EPA limits for the amount of heavy metals allowed in recycled sewage waste used as compost. Recent research from the University of Minnesota concluded that it would take 76 years or more for rain garden soils to reach saturation, depending on the heavy metal.

  The City of Portland has (metals) data from actual rain gardens and swales around the city. King and Kitsap counties in the Puget Sound region have data from the sediment scooped out of stormwater ponds.

  Table 2 (below) compares the metals concentrations in stormwater pond sediment to Washington's cleanup standard under the Model Toxics Control Act, which defines Washington's maximum contamination limits allowed for cleanup sites appropriate for "unrestricted use" (as opposed to industrial use). Table 2 demonstrates that metal concentrations in the stormwater pond and rain garden sediment samples were well below the applicable state safety standards.

Table 2. Metals in Sediment from Northwest Stormwater Ponds or Rain Gardens, as Compared to Washington Safety Standards for Soil Clean Up and Compost
(mg/kg dry weight)



King County data are average values from samples taken from four different stormwater ponds in 2011.
Kitsap County data are average values from multiple stormwater ponds sampled in 2009, 2010, and 2012.
Portland data are average values from 37 samples taken from the top 0 to 6 inches of soil in rain gardens and similar structures around Portland in 2010 (these values are approximate as they were extrapolated from a chart).
MTCA (Model Toxics Control Act) standards are Washington's contamination limits allowed for cleanup sites appropriate for "unrestricted use" (as opposed to industrial use).
Compost standards are limits allowed for manure used as compost in Washington under the WSDA International Organic Program.

5. Selbig, Bannerman and Corsi provide excellent discussion regarding sediment toxicity to aquatic life and the importance of source controls relative to the kinds and concentrations of toxic compounds that may be found in urban stormwater sediments, in their article entitled "From Streets to Streams: Assessing the Toxicity Potential of Urban Sediment by Particle Size" (*Science of the Total Environment* 444 [2013] 381 – 391). The authors state that "Concentrations of urban contaminants in sediments, such as heavy metals and hydrocarbons, have been reported to increase with decreasing particle size, yet the majority of mass lies in coarse particles. In bed sediment and in the water column, the majority of contaminants from urban sources are associated with particulate matter. Studies suggest that treatment options for urban stormwater should include specific plans for targeting both fine and coarse sediment as the primary source of contamination to receiving water bodies." (The authors cite multiple references to substantiate their statements.)

   Selbig *et al.* note that the toxic effect of sediment entrained in stormwater has been studied by many different researchers. For example, they cite the research of Pitt *et al.* in

1995, who measured toxicants in stormwater and who found that parking areas had high concentrations of organic toxicants with metal toxicants being present in all samples analyzed. They also note that Marsalek *et al*. in 2004 found sediments in stormwater ponds to be highly toxic in direct testing with bioluminescent bacteria, in comparison to guidelines that apply in Canada. In their concluding paragraph, the authors state, "Understanding the potential toxicity of urban sediment by particle size can help environmental managers assess the most effective way to limit their source or delivery to receiving water bodies." The paper also discusses the significance of source controls that are found in any drainage area of interest, by focusing on polycyclic aromatic hydrocarbons (PAHs). The paper states, "A ban of coal-tar sealants was enacted throughout Dane County, Wisconsin, in 2009, the year many of the samples used in this study were collected. If coal-tar sealants are the primary cause of toxicity found in urban sediment, future research could determine the effectiveness of the ban. In the meantime, efforts to mitigate potential toxic effects of contaminated sediment would need to focus on removal of both silt and sand fractions through either source control or removal prior to reaching a receiving water body. BMPs that use settling as the primary method of sediment removal may be less likely to remove contaminants associated with smaller particle sizes before discharging to the receiving water body. In order to treat the full range of sediments transported in stormwater, a combination of filter media and settling may be needed."

The last statement regarding the value of utilizing a "treatment train" of BMPs that will remove a wide range of particle sizes is important—the implication being that the issue of the potential classification of sediments as hazardous will not be limited to stormwater impoundments, but can extend to other BMPs, including those with filter media.

6. Another paper that addresses PAHs is entitled "The Fate of Polycyclic Aromatic Hydrocarbons Bound to Stormwater Pond Sediment during Composting," by Scott James Kyser. This paper was a thesis submitted to the faculty of the Graduate School of the University of Minnesota in March 2010. The author states that "Recently, concentrations of PAHs that are above the Minnesota Control Agency's recommended limits for

unrestricted use have been detected in stormwater pond sediments. Effective treatment methods are needed to mediate these PAH contaminated sediments to allow for unrestricted use in cost-effective disposal options." The author's research focused on using compost to biodegrade the PAH concentrations. The bottom-line finding was that "Despite significant microbiological activity, only the three-ring PAH phenanthrene was found to be significantly degraded in all experiments and no PAH with four or more rings was found to be significantly degraded during the extent of the composting."

For context, the author found that the rate of sediment accumulation in retention ponds in the Minneapolis–St. Paul, Minnesota area ranged from 200 to 1,450 kg/ha/year, depending on pond trap efficiency and watershed sediment yield. The author notes that retention ponds in Minnesota are typically designed with a 25-year design life, and the Minnesota Pollution Control Agency recommends that the ponds be inspected every two to seven years. Many of the retention ponds are now reaching the end of their design life and thus have sediment deposits that require dredging. Mr. Kyser states: "The management of dredged material in Minnesota is subject to regulatory control. In order to determine appropriate reuse and disposal, all sediments must be tested for pollutants prior to the initiation of any dredging activity. Municipal pond sediments are tested for common parameters such as heavy metals, nitrogen, phosphorus, organic content and sieve size. In addition, based on the reasonable likelihood of their occurrence, the sediments could be tested for other contaminants. The Minnesota Pollution Control Agency (MPCA) has developed dredged material soil reference toxicity values that categorize sediments into different management tiers, depending on their potential for toxicity, including those that are either: (1) safe for residential use, (2) safe for industrial reuse or (3) having significant contamination that might require regulation under the Toxic Substances Control Act."

5.2 Interviews Conducted by WWE

WWE interviewed engineers in San Diego, Seattle, Minneapolis and Austin, and brief summaries follow:

- Jim Nabong, City of San Diego, California

- Generally, sediment can be taken to the landfill and does not tend to fit the hazardous waste definition. However, if in doubt (such as at certain industrial sites), then sediment may be tested. City of San Diego does not routinely monitor sediment. Ultimately, it is the landfill's decision and subject to the landfill's policies.

- Tracy Tackett, Seattle Public Utilities, Seattle, Washington
  - See article at http://daily.sightline.org/2013/01/22/are-rain-gardens-mini-toxic-cleanup-sites/
  - Sediment generally not found to be of concern.
  - Some industrial sites on the Duwamish River may have some data, particularly industrial storm sewer pipes that have been cleaned.

- Andy Erickson, University of Minnesota
  - Some wet ponds have recently required sediment removal and have been maintained. These ponds did have elevated PAHs; however, not all PAHs are toxic.

- Leila Gosselink, City of Austin, Texas
  - Bottom line is that testing has indicated that the toxic pollutants tend not to be leachable, which is the key criterion for disposal in a landfill.
  - The Texas Commission on Environmental Quality has generally agreed with the non-leachable/non-mobile findings, so sediment disposal at landfills is generally allowed.

6.0 SEDIMENT SAMPLING, LABORATORY ANALYSIS AND INTERPRETATION

6.1 Sample Sites and Testing Parameters

To develop a general understanding of the chemistry characteristics of the sediment collected in stormwater BMPs in the UDFCD region and the potential for sediments to be defined as hazardous waste by RCRA and Colorado state law, samples were collected at ten publicly owned retention ponds and detention basins. The BMPs are located in Denver, Lakewood, Westminster, Broomfield, Golden and Aurora (see Figures 1 through 11). Sampling locations were chosen based on land use characteristics specific to each BMP, the type of BMP (*i.e.*, retention or detention), and accessibility. The BMPs that were sampled range in size (as measured by surface area) from 1,000 square feet (less than 0.1 acre) to over 12 acres, and receive direct runoff from watersheds that have at least one of the following land uses: (1) Residential, (2) Recreational/Open Space and (3) Commercial. Table 3 lists each site, the type of BMP and associated land use(s). At each facility, the removal of sediment has not occurred for over 10 years. Six of the ten BMPs are detention basins and four of the ten are retention ponds. All samples were tested by ALS Environmental in Fort Collins, Colorado. The sites are listed by land use.

Table 3. Sample Locations and Land Uses

Site*	Type of Facility	Location	Primary Land Use(s) in Drainage Area
1	Detention	Lakewood	Residential
10	Detention	Denver	Residential
5	Retention	Westminster	Recreational/Open Space
6	Retention	Westminster	Recreational/Residential
2	Retention	Broomfield	Commercial/Open Space
4	Detention	Broomfield	Commercial (Airport)
7	Retention	Denver	Commercial
9	Detention	Aurora	Commercial (Military)
11	Detention	Golden	Commercial
12	Detention	Denver	Commercial

*See Figures 1 to 11 for aerial views of sampling sites.

The tested parameters were chosen based on landfill testing requirements for the disposal of BMP sediment and general knowledge of watershed characteristics. All ten locations were sampled for a full toxicity characteristic leaching procedure (TCLP), the testing methodology that simulates leaching through a landfill. A TCLP includes testing for volatile and semi-volatile compounds, pesticides, herbicides and metals. When interviewing four landfill representatives, WWE found that three of the four required a full TCLP and a Paint Filter test in order to dispose of sediment at their sites. The fourth landfill required a full TCLP and Paint Filter test, plus additional testing. A Paint Filter test determines if samples contain free liquids, which are liquids that are capable of migrating to groundwater. Wastes containing free liquids cannot be disposed of in landfills.

In addition to the TCLP and Paint Filter tests, which were conducted on samples collected at all ten sites, five sites were chosen (from three detention basins and two retention ponds encompassing each land use) to be tested for ignitability, reactivity, and corrosivity. Four sites were chosen to sample for BTEX; all four sites were recipients of commercial runoff, including a detention basin for an airport and a detention basin adjacent to a former military site. Finally, polycyclic aromatic hydrocarbons, PAHs, were tested for at four detention basins and one retention pond. All but one of the detention basins sampled and tested for PAHs receive runoff from commercial areas. Although coal-tar sealants are not typically used in the UDFCD region, they have been found nationally to be typical contributors of PAHs, which prompted the decision to sample for this family of compounds.

Table 4 shows the matrix of testing parameters for each site, along with type of stormwater pond and primary land use characteristic(s).

Table 4. Sampling Sites and Testing Parameters

Site	BMP	Test Parameter									Location	Primary Land Use(s)
		Paint Filter	RCRA Metals	Herbicides	Pesticides	Semi-volatiles	Volatiles	Reactivity/ Ignitability/ Corrosivity	BTEX	PAHs		
1	Detention	X	X	X	X	X	X				Lakewood	Residential
10	Detention	X	X	X	X	X	X	X		X	Denver	Residential
5	Retention	X	X	X	X	X	X				Westminster	Recreational/Open Space
6	Retention	X	X	X	X	X	X	X			Westminster	Recreational/Residential
2	Retention	X	X	X	X	X	X			X	Broomfield	Commercial/Open Space
4	Detention	X	X	X	X	X	X	X	X	X	Broomfield	Commercial (Airport)
7	Retention	X	X	X	X	X	X	X	X		Denver	Commercial
9	Detention	X	X	X	X	X	X		X		Aurora	Commercial (Military)
11	Detention	X	X	X	X	X	X	X	X	X	Golden	Commercial
12	Detention	X	X	X	X	X	X			X	Denver	Commercial

6.2 Sampling Protocol

A sampling procedure and Quality Assurance/Quality Control (QA/QC) Plan were prepared to aid in proper collection of samples and proper care of sampling tools before the sampling program began. The sampling protocol is included in Appendix D. At each sample site, samples were collected in at least two locations: (1) adjacent to the inlet and (2) adjacent to the outlet. Whenever feasible, samples were collected in the middle of the detention/retention areas and other locations. If forebays and/or micropools were accessible, samples were also collected in these areas. Each "grab" sample was taken from the surface (top 1 inch to 3 inches) of the sediment deposits. All of the samples taken from each BMP were then mixed to form a homogenous composite mixture suitable for testing and then placed in laboratory-provided containers. The sampling protocol was adhered to at all ten sampling sites. Site and sample characteristics such as color and odor were recorded at each sample site. These records are in Appendix E.

6.3 Sample Results

Most of the chemical constituents tested for were undetected. The Paint Filter test detected free liquids in three samples.

Regulatory concentration levels for TCLP hazardous wastes are listed in Table 5. The laboratory test results are given in Appendix F. For each constituent tested for, the laboratory reporting and detection limits were lower than the regulatory thresholds defined by RCRA. None of the tested constituents returned concentrations above the hazardous thresholds as defined by RCRA. The same conclusion applies to the thresholds in Colorado's hazardous waste laws.

Table 5. TCLP Regulatory Concentration Levels (mg/L)

Compounds	mg/L
Metals	
Arsenic	5.0
Barium	100.0
Cadmium	1.0
Chromium	5.0
Lead	5.0
Mercury	0.2
Selenium	1.0
Silver	5.0
Volatile Organics	
1,1-Dichloroethylene	0.7
1,2-Dichloroethane	0.5
1,4-Dichlorobenzene	7.5
Benzene	0.5
Carbon Tetrachloride	0.5
Chlorobenzene	100.0
Chloroform	6.0
Methyl Ethyl Ketone (MEK) (2-Butanone)	200.0
Tetrachloroethylene	0.7
Trichloroethylene	0.5
Vinyl Chloride	0.2
Semi-Volatile Organics	
2,4,5-Trichlorophenol	400.0
2,4,6-Trichlorophenol	2.0
2,4-Dinitrotoluene	0.13
Cresol	200.0
Hexachloro-1,3-butadiene	0.5
Hexachlorobenzene	0.13
Hexachloroethane	3.0
m-Cresol	200.0
Nitrobenzene	2.0
o-Cresol	200.0
p-Cresol	200.0
Pentachlorophenol	100.0
Pyridine (Azobenzene)	5.0
Pesticides	
Toxaphene	0.5
Methoxychlor	10.0
Lindane	0.4
Endrin	0.02
Heptachlor	0.008
Chlordane	0.03
Herbicides	
2,4-D	10.0
2,4,5-TP (Silvex)	1.0

Herbicides, pesticides, semi-volatiles, volatiles, reactivity, ignitability and BTEX were all undetected during testing. All five samples collected and tested for corrosivity were acceptable because pH values fell within the acceptable pH range. The corrosivity characteristic applies to wastes that have a pH of less than or equal to 2.0 and greater than or equal to 12.5.

The laboratory reported that four out of the ten site samples had concentrations for metals that were above detection limits; however, all four of these samples were substantially below levels that are considered hazardous by RCRA. Table 6[2] shows the sites where metals were detected and compares regulatory levels with the test results.

Table 6. Detected Metal Concentrations
(all values expressed as mg/L)

Detected Metals	Detection Limit	Site 5 (Residential runoff)	Site 10 (Recreational runoff)	Site 7 (Commercial runoff)	Site 11 (Commercial runoff)	Regulatory Level
Barium	1.0	1.6	n/d	n/d	1.0	100
Lead	0.03	n/d	0.12	0.21	n/d	5
Selenium	0.05	0.1	0.05	n/d	n/d	1

n/d = nondetect.

Sites 6, 10, and 12 failed the Paint Filter test. All three sites have different drainage area characteristics, as shown in Table 4. Of the samples that did not pass the Paint Filter test, two of the three sites are detention basins (which are normally dry) and one site is a retention pond. A substantial rain event did occur in the UDFCD region on the night before samples were collected, which may have contributed to the presence of free liquids; however, even samples collected in retention ponds (on the previous day) passed the Paint Filter test. Landfills will not accept the disposal of solids that do not pass the Paint Filter test.

PAHs were detected at two sites, Site 10 (residential runoff) and Site 11 (commercial runoff). Concentration levels are presented in Table 7. Although the landfills interviewed for this

[2] Table 6 (Detected Metal Concentrations) and Table 7 (Detected PAH Concentrations) are the only test results tabulated in this report because test results indicated concentration levels greater than laboratory detection limits for these constituents. All other constituents were not detected; laboratory results for all of the constituents can be found in Appendix F.

evaluation do not normally require testing for PAHs, if generators have knowledge of the potential for PAHs to be found in sediments to be disposed of, then the landfills may require those sediments to be tested for PAHs.

Table 7. Detected Polycyclic Aromatic Hydrocarbon (PAH) Concentrations (all values expressed as µg/kg)

Detected PAHs	Site 10 (Residential runoff)		Site 11 (Commercial runoff)	
	Detection Limit	Concentration Level	Detection Limit	Concentration Level
fluoranthene	680	1900	490	n/d*
pyrene	680	1900	490	790
benzo(a)anthracene	680	800	490	n/d
chrysene	680	1000	490	n/d
benzo(b)fluoranthene	680	2000	490	770
benzo(k)fluoranthene	680	810	490	n/d
benzo(a)pyrene	680	950	490	n/d

*n/d = nondetect.

7.0 RECOMMENDATIONS TO REDUCE THE POTENTIAL PROBLEM

The following recommendations are based on the paper entitled "BMPs and Hazardous Sediment" by Jones *et al.* in the May 1995 edition of *Public Works* magazine, with additions and edits by the authors of this report.

Although the ten stormwater BMPs that were sampled did not have exceedances of applicable hazardous thresholds under RCRA (a finding which is consistent with most other studies of "standard" [typical] urban stormwater facilities in the United States) facility owners, designers and maintenance staff should be aware of this issue and are advised to consider the following steps to best manage sediment removal and reduce the probability that sediments will be classified as hazardous waste under RCRA or the Colorado statutes for hazardous waste (for simplicity, the recommendations below reference RCRA, but they apply to Colorado state law as well).

1. Take reasonable steps to reduce the likelihood that chemicals listed as hazardous waste under RCRA will come into contact with precipitation or stormwater. These measures are well documented in contemporary literature on stormwater quality and include:
    - Educate workers and the public.
    - Place hazardous materials indoors or under cover.
    - Connect floor drains and sumps to the sanitary sewer rather than to the drainage system.
    - Inventory hazardous chemicals on a regular basis and track their usage.
    - Discourage the use of hazardous chemicals and emphasize replacement compounds that are not listed by RCRA.
    - Formulate, implement and regularly monitor pursuant to an aggressive spill control program.

2. In small drainage areas, the prospects for strictly controlling the kinds of chemicals that enter the drainage system are better than those in larger areas with multiple property owners. Although this point states the obvious, it merits emphasis. To provide an example, a vehicle maintenance facility that is three acres in size, and which receives no runoff from adjoining properties, should be able to implement rigorous source controls without difficulty. All work on vehicles can occur indoors. Floor drains and sumps should be connected to pretreatment facilities, which in turn would discharge into the sanitary sewer.

   Thoughtful drainage design decisions can be made. For example, where feasible, disconnect vehicle parking with vegetated buffers and use grass swales for conveyance. These practices will promote the interaction of chemicals of concern with vegetation and soils, and will also encourage infiltration.

3. To localize the problem, stormwater pretreatment facilities should be considered. For example, immediately upstream from a stormwater wetland, it may be feasible to install a sedimentation basin. Even with a retention time of as little as 15 minutes (where soil conditions are favorable), a significant fraction of the total sediment load can be removed from the stormwater before discharge into the wetland. This not only localizes sediments

and the pollutants that adsorb them, but also benefits the wetland and results in decreased long-term maintenance costs.

4. Adopt measures throughout the watershed to reduce the quantity of sediment that will enter the BMP over time. The smaller the sediment load that accumulates, the less frequently the sediment has to be removed. This is important because RCRA in most instances becomes relevant only when sediments actually need to be removed.

   Rigorous erosion and sediment control practices, both during and after construction, are mandatory. Judicious use of sand during the winter months is necessary.

5. Designers are well advised to discuss potential problems with regulators and their clients in advance of an assignment. By discussing potential problems with the BMP facility owner, professional liability is reduced and the owner and engineer can agree, in advance, on mitigation measures.

   Discussions with regulators are equally important. Generally, the authors recommend that the design engineer do the following: (a) cite regulations that are forcing the implementation of stormwater BMPs in the first place (typically municipal or industrial NPDES regulations); (b) delineate the full range of functions that the BMP will fulfill (flood hazard reduction, stormwater quality management and others specific to the given facility); (c) describe structural and nonstructural measures that will be taken to reduce the probability that hazardous chemicals will enter the BMP; and (d) where applicable, suggest a regulatory agreement, in advance, that will address the issue in a reasonable, cost-effective manner if and when the sediments must be removed, under the assumption that they contain one or more RCRA-listed chemicals.

   Discussions with the BMP owner and regulators will undoubtedly be highly specific to the circumstances involved.

6. Intentionally oversize the sediment storage volume in the BMP. Instead of assuming that the BMP should have its sediments removed once every 5 to 10 years, assume that sediment removal should occur no more frequently than once every 20 to 30 years. This

will be impractical and excessively expensive in certain instances, but in situations where additional sediment storage can be achieved economically, this step should be taken.

It is essential to recognize that in most instances, RCRA will not be triggered until sediments need to be removed from the BMP. Therefore, every reasonable step should be taken to avoid the need to remove sediments from stormwater facilities.

It will not always be feasible to avoid RCRA regulations by implementing the measures listed above. Furthermore, existing BMPs may currently contain sediments that have RCRA-listed chemicals in them. When confronted with the knowledge that BMP sediments could potentially contain RCRA-listed wastes, the facility owner and the designer should consider the following steps:

1. Conduct additional sampling to confirm the concentration of the contaminants. Also, sample at multiple locations to assure adequate horizontal and vertical coverage.

2. Take immediate action to assure that the chemical will not continue to be discharged into the stormwater drainage system.

   If no distinct source with the requisite characteristics (as defined by RCRA) is located, this is very important information to be conveyed to the regulators. All other things being equal, RCRA regulators may be less inclined to rigorously control contaminated sediments that have been affected by diffused sources as opposed to sediments affected by distinct sources with the requisite characteristics.

   The ideal outcome is to identify probable sources that do not comply with RCRA requirements. For example, if the trichlorethylene sources in the watershed that are in contact with precipitation/runoff are less than 10 percent pure, the sediments should not be classified as hazardous wastes.

3. In many cases, a risk assessment will demonstrate that no practical risk is posed to the public or other life forms by constituent levels within the sediments. This is important information to provide to the regulators because they can exercise some judgment or discretion in evaluating regulatory options. If volatile or semi-volatile compounds are in

the sediments, the risk assessment should account for sediment dredging and disposal processes, thereby reducing the risk.

4. Evaluate modifications to the stormwater facility that will avoid the need to excavate the contaminated sediments. For example, it may be reasonable to retrofit a detention basin with a micropool or increase the size of an existing micropool, thereby increasing sediment storage space.

5. Consider seeking advice from qualified attorneys, engineers and scientists on how to proceed, and become knowledgeable on the issues involved.

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