PROCEDURES FOR WASTE MANAGEMENT FROM STREET SWEEPING AND STORMWATER SYSTEMS

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16. Abstract		
Street sweeping and storm water system cleaning activities are conducted regularly by ODOT to comply with NPDES permit requirements and to ensure roadway safety. Once collected, these materials are classified as solid waste and require cost-effective and sustainable management. This research report summarizes tools for tracking and quantifying the volume of material collected and associated management costs, comprehensive analytical testing of solid waste materials from multiple locations, design and construction of a prototype decanting facility, metal adsorption media testing at the prototype decanting facility, and the development of standard operating procedures to operate the new facility. Detailed analysis shows the solid waste disposal cost is less than 5% of the management activity and management priorities should focus on cost-effective collection and management versus disposal cost. Multiple factors were utilized to rank decanting facility location options for each District in Ohio. Metal adsorption media testing showed significant removal of many heavy metals and operational observations at the new prototype facility showed promise for effectively managing these waste materials.		
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Customary Unit	SI Unit	Factor	SI Unit	Customary Unit	Factor
Length			Length		
inches	millimeters	25.4	millimeters	inches	0.039
inches	centimeters	2.54	centimeters	inches	0.394
feet	meters	0.305	meters	feet	3.281
yards	meters	0.914	meters	yards	1.094
miles	kilometers	1.61	kilometers	miles	0.621
Area			Area		
square inches	square millimeters	645.1	square millimeters	square inches	0.00155
square feet	square meters	0.093	square meters	square feet	10.764
square yards	square meters	0.836	square meters	square yards	1.196
acres	hectares	0.405	hectares	acres	2.471
square miles	square kilometers	2.59	square kilometers	square miles	0.386
Volume			Volume		
gallons	liters	3.785	liters	gallons	0.264
cubic feet	cubic meters	0.028	cubic meters	cubic feet	35.314
cubic yards	cubic meters	0.765	cubic meters	cubic yards	1.308
Mass			Mass		
ounces	grams	28.35	grams	ounces	0.035
pounds	kilograms	0.454	kilograms	pounds	2.205
short tons	megagrams	0.907	megagrams	short tons	1.102

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ADC—Alternate Daily Cover

BMP—Best Management Practice

BUD—Beneficial Use Determination

CalTrans—California Department of Transportation

CFR—Code of Federal Regulations

DEP—Department of Environmental Protection

DEQ—Department of Environmental Quality

DOT—Department of Transportation

EPA—Environmental Protection Agency

ETOS—Eductor Truck Offload System

FHWA—Federal Highway Administration

GIS—Geographic Information System

GWCTL—Groundwater Cleanup Target Levels

MassHighway—Massachusetts Highway Department

MEP—Maximum Extent Practicable

MnDOT—Minnesota Department of Transportation

MS4—Municipal Separate Storm Sewer System

NPDES—National Pollutant Discharge Elimination System

OAC—Ohio Administrative Code

Ohio EPA – Ohio Environmental Protection Agency

ODOT—Ohio Department of Transportation

PAHs—Polycyclic Aromatic Hydrocarbons

PCA—Pollution Control Agency

RCRA—Resource Conservation and Recovery Act

RFP—Request for proposal

SPLP—Synthetic Precipitation Leaching Procedure

SVOCs—Semi-Volatile Organic Compounds

TCLP—Toxicity Characteristic Leaching Procedure

TEPH—Total Extractable Petroleum Hydrocarbons

TIMS—Transportation Information Mapping System

TPH—Total Petroleum Hydrocarbons

USEPA—United States Environmental Protection Agency

VOCs—Volatile Organic Compounds

CHAPTER I INTRODUCTION

As a regulated Municipal Separate Storm Sewer System (MS4), the Ohio Department of Transportation (ODOT) is required to implement a storm water management program designed to reduce pollutant concentrations entering the storm sewer system to the maximum extent practicable (MEP). Because street sweeping can remove sediments containing heavy metals or petroleum from the road way before they enter the storm sewer system, it is an effective non-structural best management practice (BMP) for reducing the impact of contaminated runoff on surface water. Street sweeping and storm water system cleaning activities are conducted regularly by ODOT to comply with permit requirements and to ensure roadway safety. The material collected from these maintenance activities is currently defined as waste material and is therefore required to be handled and disposed of in accordance to Federal and State regulations. The regulatory definitions for this type of material can be found under the Ohio EPA's Division of Materials and Waste Management (OAC 3745-27 and particularly the definition found in OAC 3745-27-01((S)23). The storm water regulations are found in OAC 3745-39 with the definition found in OAC 3745-39-01((B)8) and the waste water rules found under OAC3745-34 with the specific definition for waste water listed under OAC 3745-34-01. To reduce disposal costs and prevent reusable materials from entering landfills, other state DOT and municipalities have begun reusing storm water sediments for traction and fill material, slope flattening, and as concrete aggregate. Some states require that heavy metals and petroleum contaminant concentrations be assessed prior to reusing these materials, while other states do not require ongoing sampling of storm water sediments that are not visibly contaminated. The overall purpose of this project is to provide procedures and engineering solutions for the effective management of wastes generated by ODOT street sweeping and storm water management activities.

1.1 Purpose and Objectives

This research team proposed eight objectives that must be met for this project. These included:

1. Determine state of current procedures and practices by Ohio DOT, other state DOTs, and local municipalities including material classification, handling, and tracking.

2. Identify existing decanting practices and review available decanting equipment for potential regional implementation of equipment at ODOT facilities.

3. Develop a tracking tool for operational activity and conduct analysis of existing data.

4. Develop Construction Plan Set and Specifications for Decanting Facility

5. Perform analytical testing of waste material generated by maintenance activities to classify the material and determine how it may be beneficially reused in Ohio in accordance with Ohio EPA (OEPA) regulations.

6. Evaluate Adsorption Media Testing at "New" Decanting Facility

7. Develop Standard Operating Procedures for Handling Street Sweepings and Sewer Cleanout Material

8. Develop Final Design Report, Plans and Recommendations

1.2 Organization of this Report

This report is divided into seven chapters. Chapter 1 introduces the research topic and includes a list of the research objectives. Chapter 2 presents background research into the current practice for managing street sweeping and storm water system waste materials, as well as survey information collected from other transportation departments. Operational tracking and management activity analysis is presented in Chapter 3. Chapter 4 presents the rationale and approach to design a prototype decanting facility for construction in Ohio and Chapter 5 presents state-wide analysis of waste materials, comparison to beneficial reuse limits, as well as media testing for reduction of heavy metals in the decant liquid. Based on earlier chapter analysis, as well as testing results, Chapter 6 presents preliminary standard operating procedures (SOPs) for the decant facility. Lastly, Chapter 7 summarizes the research conclusions and recommendations for ODOT continuing to move forward in their endeavor to cost-effectively manage wastes generated from street sweeping and storm water system activities.

CHAPTER II CURRENT STREET SWEEPING AND STORM WATER SYSTEMS WASTE MANAGEMENT PRACTICES

Background research into the current state of practice for street sweeping and storm water systems waste management practices are presented in this chapter. The research for this chapter was conducted during 2012 and 2013 and formed a foundation for the later chapters. This chapter is divided into two sections:

- Section One - Evaluate Available Data and Reports on the Management Procedures and Practices of Other State DOTs and Municipalities Including Material Classification, Handling, and Beneficial Use
- Section Two – Evaluate Available Data and Reports for Ohio on the Management Procedures and Practices Including Material Classification, Handling, and Beneficial Use

2.1 Evaluate Available Data and Reports on the Management Procedures and Practices of Other State DOTs and Municipalities Including Material Classification, Handling, and Beneficial Use

This section includes results from three activities: 1.) a literature review, 2.) an online survey, and 3.) telephone interviews with other state DOT and public works personnel. The purpose of the literature review was to identify potential contaminants of concern, their expected concentrations in storm water sediments, factors influencing contaminant concentrations, and viable options for the beneficial reuse of these materials.

The online survey was developed using Survey Monkey (surveymonkey.com) and distributed through five separate American Public Works Association (APWA) infoNOW message boards, which are designed for information sharing among public works employees. The survey, which specifically addressed storm water sediment management, reuse, quantification, and tracking, was sent to members of the Environment, Sustainability, Canadian Public Works, Management, Administration and Finance, and Transportation message boards on December 7, 2012. The majority of survey responses were received from municipalities. To ensure feedback from both municipalities and state Departments of Transportation, a request for information regarding best management practices for stormwater sediments was sent via email to DOT personnel from states other than Ohio on December 14, 2012.

Based on the results of the survey and information request, telephone interviews were conducted to collect detailed information regarding current best management practices. The purpose of these interviews was to determine current reuse options being practiced in other states, as well as monitoring requirements, and available technologies for tracking stormwater sediments.

2.1.1 Literature Review

The literature review focused on two specific areas: 1.) the identification of contaminants of concern, their expected concentrations, and factors influencing contaminant concentrations in street sweeping and catch basin sediments, and 2.) potential options for the beneficial reuse of these materials. Details are below.

2.1.1.1 Contaminants of Concern

Street sweeping and catch basin sediments may contain elevated levels of Total Petroleum Hydrocarbons (TPH), Polycyclic Aromatic Hydrocarbons (PAHs), and heavy metals (Liebens, 2001, Breault et al, 2005, Sutherland, 2003, Depree, 2008, Karlsson and Viklander, 2008) as a result of asphalt wear, motor oil, gasoline, brake and tire wear, atmospheric deposition, or automobile fluid and emissions (Sadiq, 1989, Breault et al, 2005, Sutherland, 2012). Because these contaminants are known to be toxic to human health and aquatic life (Sadiq, 1989, Breault, 2005, USEPA, 2008, USEPA, 2011, Sutherland, 2012) their concentrations and mobility dictate viable reuse options in Ohio.

Contaminant concentrations in street sweeping and catch basin sediments are impacted by factors such as land use, average daily traffic count, roadway characteristics, frequency of sweeping, and the type of street sweeper used (Liebens, 2001, Walch, 2006, Jang, 2010, Seattle, 2012). One potential management strategy is to use these factors to characterize storm water sediments and segregate materials for reuse based on their anticipated contaminant levels. The characterization of materials in this way could lead to reduced costs for the collection of analytical data (Oregon DOT, 2001) and allow less impacted sediments to be targeted for reuse (Depree, 2008).

In urban areas with high traffic counts, higher concentrations of heavy metals, TPH, and PAHs are expected in collected sweepings (Washington Department of Ecology, 2005). Irvine, et al, 2009 confirmed that heavy metals concentrations are elevated in street sweepings collected from urban roads with high traffic counts and in industrialized areas. Both zinc and copper concentrations were higher in areas with high traffic counts, while manganese and iron concentrations were higher in industrialized areas (Irvine, et al, 2009). Depree, 2008 found that PAH concentrations in street sweepings collected from arterial streets were approximately two times higher than those collected from non-arterial roads, while copper and lead concentrations were three times higher on high traffic volume roads than low traffic volume roads (Depree, 2008).

Regardless of land use or traffic count, the smallest grain size fractions of street sweepings and catch basin sediments are consistently found to be the most impacted (Stone and Marsalek, 1996, Sutherland, 2003, Breault et al, 2005, Depree, 2008, Karlsson and Viklander, 2008). While vacuum type sweepers are able to remove all grain sizes from the roadway, the smallest, most contaminated sediments (<250 microns) are not effectively removed from the roadway by mechanical broom type sweepers (Breault et al, 2005). In areas where these sweepers are used, the smallest sediments remain on the roadway until they are washed into the catch basin, leading to higher contaminant concentrations in the catch basins, and lower contaminant concentrations in the collected sweepings (Seattle, 2012). Because the type of street sweeper used affects the grain size distribution of the collected sediments, the type of sweeper could be used as a means of characterizing the level of contamination in the collected sweepings. In addition to the type of sweeper used, the frequency of street sweeping also influences contaminant concentrations, with frequent street sweeping resulting in lower contaminant concentrations in the collected sweepings (Liebens, 2001).

Contaminant concentrations in storm water sediments are expected to vary based on land use, traffic count, and sweeper type and frequency, as well as the type of sediment collected. Research has shown that catch basin sediments are generally more impacted than street sweepings collected in the same area (Liebens, 2001, Sengupta, 2007). Potential reasons for this trend include: catch basin sediments have a longer time of exposure to contaminant sources than roadway sediments, mechanical broom sweepers leave the most impacted sediments on the roadway until they are washed into a nearby catch basin, and catch basins have a higher concentration of organic material, which adsorbs hydrophobic PAHs, than street sweepings (Liebens, 2001, Sengupta, 2007). Because catch basin sediments are expected to have higher contaminant concentrations than street sweepings, it may be desirable to separate these materials for reuse purposes.

Tables 1 and 2 summarize available data on heavy metals concentrations found in street sweepings and catch basin sediments and compare them with the proposed Ohio EPA beneficial reuse standards (Ohio EPA, 2011). As shown in the tables, the reported ranges of metals concentrations in street sweepings are below the Ohio EPA beneficial reuse guidelines for traction, fill, or aggregate. Tables 3 and 4 show the reported range of concentrations of TPH and PAHs found in street sweepings and catch basin sediments collected under a wide range of circumstances. Table 3 shows that the heavier range TPH fractions are most likely to be present in excess of Ohio's proposed reuse standards, with oil range hydrocarbons reported as high as 10,000 mg/kg. Table 4 shows that reported PAH concentrations appear to fall below the levels required for reuse as fill or aggregate, but may exceed appropriate levels for reuse as traction materials. While these data are useful for illustrating which contaminants are potentially problematic for reuse purposes, they may not be representative of Ohio's roadways.

Table 1: Summary of reported analytical data on heavy metals concentrations in street sweepings. Data are compared with the proposed Ohio EPA maximum limit for beneficial reuse as abrasive, fill, or aggregate.

Metal	Units	Mean	Range	Reference	Source	Ohio EPA Maximum Limit for Beneficial Use (mg/kg) Winter Traction Abrasive Fill Aggregate
Street Sweepings						
As	mg/kg	0.69 +/- 1.12	<0.50-13.6	Jang, et al 2009	Mixed land use	41
	mg/kg		2.1-6.1	Sengupta, 2007	Mixed land use	
	mg/kg	2.5		Liebens, 2001	Residential	
	mg/kg	1.03		Liebens, 2001	Commercial	
	mg/kg	6.14 +/- 1.29		Walch, 2006	Mixed land use	
Cd	mg/kg	0.7		Liebens, 2001	Residential	35
	mg/kg	0.29		Liebens, 2001	Commercial	
	mg/kg	2.2		Irvine, et al, 2009	Industrial	
	mg/kg	2		Irvine, et al, 2009	Commercial/Residential 13,560-70,137 vpd	
	mg/kg	1.5		Irvine, et al, 2009	Commercial/Residential <13,560 vpd	
	mg/kg	0.396 +/- .060		Walch, 2006	Mixed land use	
Cu	mg/kg	16.5 +/- 31.5	<1.84-3,721	Jang, et al 2009	Mixed land use	1,500
	mg/kg	10.19		Liebens, 2001	Residential	
	mg/kg	8.6		Liebens, 2001	Commercial	
	mg/kg	171		Irvine, et al, 2009	Industrial	
	mg/kg	164		Irvine, et al, 2009	Commercial/Residential 13,560-70,137 vpd	
	mg/kg	73.5		Irvine, et al, 2009	Commercial/Residential <13,560 vpd	
	mg/kg	58.08 +/- 8.17		Walch, 2006	Mixed land use	
Pb	mg/kg	18.3 +/- 32.5	<1.43-386	Jang, et al 2009	Mixed land use	300
	mg/kg		19-120	Sengupta, 2007	Mixed land use	
	mg/kg	19.86		Liebens, 2001	Residential	
	mg/kg	19.33		Liebens, 2001	Commercial	
	mg/kg	276		Irvine, et al, 2009	Industrial	
	mg/kg	165		Irvine, et al, 2009	Commercial/Residential 13,560-70,137 vpd	
	mg/kg	84.9		Irvine, et al, 2009	Commercial/Residential <13,560 vpd	
	mg/kg	83.02 +/- 20.41		Walch, 2006	Mixed land use	
Hg	mg/kg	0.0135		Liebens, 2001	Residential	7.8
	mg/kg	0.0286		Liebens, 2001	Commercial	
	mg/kg	0.168 +/- 0.0408		Walch, 2006	Mixed land use	
Ni	mg/kg	8.69 +/- 7.83	<1.72-69.9	Jang, et al 2009	Mixed land use	420
	mg/kg	6.42		Liebens, 2001	Residential	
	mg/kg	5.81		Liebens, 2001	Commercial	
	mg/kg	56.02 +/- 8.24		Walch, 2006	Mixed land use	
Se	mg/kg		1.7	Sengupta, 2007	Mixed land use	100
	mg/kg	2.36 +/- 0.39		Walch, 2006	Mixed land use	
Zn	mg/kg	65.1 +/- 86.5	4.3-80	Jang, et al 2009	Mixed land use	2,800
	mg/kg	28.95		Liebens, 2001	Residential	
	mg/kg	55.94		Liebens, 2001	Commercial	
	mg/kg	390		Irvine, et al, 2009	Industrial	
	mg/kg	544		Irvine, et al, 2009	Commercial/Residential 13,560-70,137 vpd	
	mg/kg	413		Irvine, et al, 2009	Commercial/Residential <13,560 vpd	
	mg/kg	213.4 +/- 28.9		Walch, 2006	Mixed land use	

*Shaded cells exceed one or more of the Ohio EPA Beneficial Reuse Standards

Table 2: Summary of reported analytical data on heavy metals concentrations in catch basin sediments. Data are compared with the proposed Ohio EPA maximum limit for beneficial reuse as abrasive, fill, or aggregate.

Metal	Units	Mean	Range	Reference	Source	Ohio EPA Maximum Limit for Beneficial Use (mg/kg) Winter Traction Abrasive Fill Aggregate
Catch Basins						
As	mg/kg	0.58 +/- 0.99	0.5-12.7	Jang, et al. 2010	mixed land use	41
	mg/kg	5 +/- 2		Karlsson and Viklander, 2008	500 v/d	
	mg/kg	7 +/- 1.3		Karlsson and Viklander, 2008	25,500 v/d	
	mg/kg	3.86	1.97-9.31	Caltrans, 2003	mixed land use	
	mg/kg		1.9-6.5	Sengupta, 2007		
Cd	mg/kg	0.1 +/- 0.07		Karlsson and Viklander, 2008	500 v/d	35
	mg/kg	0.1 +/- 0.04		Karlsson and Viklander, 2008	25,500 v/d	
	mg/kg	0.583	0.133-1.64	Caltrans, 2003		
	mg/kg		ND-0.73	Sengupta, 2007		
Cu	mg/kg	19.3 +/- 0.83	5.5-398	Jang, et al. 2010	mixed land use	1500
	mg/kg	24 +/- 13		Karlsson and Viklander, 2008	500 v/d	
	mg/kg	53 +/- 17		Karlsson and Viklander, 2008	25,500 v/d	
	mg/kg	41.2	19.2-94.1	Caltrans, 2003		
Pb	mg/kg	9.73 +/- 2.01	6.4-1,060	Jang, et al. 2010	mixed land use	300
	mg/kg	34 +/- 24		Karlsson and Viklander, 2008	500 v/d	
	mg/kg	30 +/- 16		Karlsson and Viklander, 2008	25,500 v/d	
	mg/kg	167	16.1-611	Caltrans, 2003		
	mg/kg		9.5-120	Sengupta, 2007		
Hg	mg/kg	0.5 +/- 0.04		Karlsson and Viklander, 2008	500 v/d	7.8
	mg/kg	0.6 +/- 0.08		Karlsson and Viklander, 2008	25,500 v/d	
	mg/kg	0.295	0.021-3.96	Caltrans, 2003		
Ni	mg/kg	9.29 +/- 0.37	2.5-30.7	Jang, et al. 2010	mixed land use	420
	mg/kg	8 +/- 2.4		Karlsson and Viklander, 2008	500 v/d	
	mg/kg	19 +/- 1.7		Karlsson and Viklander, 2008	25,500 v/d	
	mg/kg	71.8	21.3-406	Caltrans, 2003		
Se	mg/kg	0.28	<0.1-1.08	Caltrans, 2003		100
Zn	mg/kg	98 +/- 0.98	9.1-956	Jang, et al. 2010	mixed land use	2800
	mg/kg	60 +/- 20		Karlsson and Viklander, 2008	500 v/d	
	mg/kg	111 +/- 8.5		Karlsson and Viklander, 2008	25,500 v/d	
	mg/kg	244	51.2-614	Caltrans, 2003		

*Shaded cells exceed one or more of the Ohio EPA Beneficial Reuse Standards

Table 3: Summary of reported analytical data on TPH concentrations in street sweepings and catch basin sediments. Data are compared with the proposed Ohio EPA maximum limit for beneficial reuse as abrasive, fill, or aggregate.

Parameter	Units	Mean	Range	Reference	Source	Ohio EPA Maximum Limit for Beneficial Use (mg/kg) Winter Traction Abrasive Fill Aggregate
Street Sweeping						
TPH	mg/kg		3410-8020	Walch, 2006	Mixed land use	
GRO	mg/kg					1,000
DRO	mg/kg		190-760	Seattle, 2009	Residential, swept	2,000
	mg/kg		320-470	Seattle, 2009	Industrial, swept	
	mg/kg		37-980	Sengupta, 2007	Mixed land use	
ORO	mg/kg		1,200-6,000	Seattle, 2009	Residential, swept	5,000
	mg/kg		1,900-3,800	Seattle, 2009	Industrial, swept	
Catch Basin						
TPH	mg/kg					
GRO	mg/kg		5.9-16	Sengupta, 2007		1,000
DRO	mg/kg		84-980	Sengupta, 2007		2,000
			760-880	Seattle, 2009	Residential, swept	
	mg/kg		980-2,600	Seattle, 2009	Industrial, swept	
	mg/kg	141	<10-450	Caltrans, 2003		
ORO	mg/kg		3,500-5,400	Seattle, 2009	Residential, swept	5,000
	mg/kg		4,200-10,000	Seattle, 2009	Industrial, swept	
	mg/kg	683	<20-1500	Caltrans, 2003		

*Shaded cells exceed one or more of the Ohio EPA Beneficial Reuse Standards

Table 4: Summary reported analytical data on PAH concentrations in street sweepings and catch basin sediments. Data are compared with the proposed Ohio EPA maximum limit for beneficial reuse as abrasive, fill, or aggregate.

PAH	Units	Mean	Range	Reference	Source	Ohio EPA Maximum Limit for Beneficial Use (ug/kg)	
						Winter Traction	Fill/Aggregate
Street Sweeping							
Benzo(a)anthracene	ug/kg		14.5	Jang, et al 2009	Mixed land use	2,200	63,000
	ug/kg		290-780	Sengupta, 2007	Mixed land use		
Benzo(b)fluoranthene	ug/kg		13.2	Jang, et al 2009	Mixed land use	5,530	63,000
	ug/kg		370-2,100	Sengupta, 2007	Mixed land use		
	ug/kg	434 +/- 156		Walch, 2006	Mixed land use		
Benzo(k)fluoranthene	ug/kg		410-1,100	Sengupta, 2007	Mixed land use	1,970	630,000
	ug/kg	366 +/- 124		Walch, 2006	Mixed land use		
Benzo(a)pyrene	ug/kg		9.2	Jang, et al 2009	Mixed land use	1,100	6,300
	ug/kg		330-1,100	Sengupta, 2007	Mixed land use		
	ug/kg	374 +/- 131		Walch, 2006	Mixed land use		
Chrysene	ug/kg		400-1,300	Sengupta, 2007	Mixed land use	1,270	6,700,000
	ug/kg	451 +/- 157		Walch, 2006	Mixed land use		
Dibenz(a,h)anthracene	ug/kg		110-210	Sengupta, 2007	Mixed land use	940	6,700
Indeno(1,2,3-cd)pyrene	ug/kg		280-750	Sengupta, 2007	Mixed land use	150	67,000
Naphthalene	ug/kg					3,980	530,000
Catch Basin							
Benzo(a)anthracene	ug/kg		39,900	Jang, et al 2010	mixed land use	2,200	63,000
	ug/kg		89-4,200	Sengupta, 2007			
Benzo(b)fluoranthene	ug/kg		140-7,000	Sengupta, 2007		5,530	63,000
Benzo(k)fluoranthene	ug/kg		120-5,100	Sengupta, 2007		1,970	630,000
Benzo(a)pyrene	ug/kg		34,300	Jang, et al 2010	mixed land use	1,100	6,300
	ug/kg		97-5,200	Sengupta, 2007			
Chrysene	ug/kg		110-5,400	Sengupta, 2007		1,270	6,700,000
Dibenz(a,h)anthracene	ug/kg		55-820	Sengupta, 2007		940	6,700
Indeno(1,2,3-cd)pyrene	ug/kg		81-3,600	Sengupta, 2007		940	6,700
Naphthalene	ug/kg		ND-24	Sengupta, 2007		3,980	530,000

* Shaded cells exceed one or more of the Ohio EPA Beneficial Reuse Standards

2.1.1.2 Treatment and Beneficial Reuse

To reduce costs associated with the disposal of street sweeping and catch basin sediments, several states and researchers have investigated potential beneficial reuse strategies for these materials. One potential option is to reuse these materials for traction, either directly or mixed with clean sand (Sengupta, 2007). According to the State of Connecticut Department of Environmental Protection (DEP), anywhere from one-third to one-half of the sand applied in the winter will be collected when the streets are swept in the spring (Connecticut DEP, 2007). Collecting this material immediately after spring snow melt begins maximizes the reuse potential by minimizing the high silt content that results from extended time on the road (Oregon DOT, 2001). Sengupta, 2007 showed that the geotechnical characteristics of street sweepings collected by MassHighway are similar to clean sand, making traction a viable reuse for these materials and further recommended that these materials be stockpiled and made available statewide for use as part of winter maintenance operations to reduce costs (Sengupta, 2007).

One potential concern with reusing stormwater sediments is that contaminants will become mobile and contaminate nearby groundwater sources. Researchers in Florida used the synthetic precipitation leaching procedure (SPLP) to evaluate the potential leachability of contaminants in street sweepings and catch basin sediments. Results showed that leachable metals and organic compound concentrations were below the Florida Groundwater Cleanup Target Levels (GWCTL) for most samples (Jang, 2010). Among the heavy metals, zinc has been shown to be the most leachable (Jang, 2010, 2012, Depree, 2008). Using the Toxicity Characteristic Leaching Procedure (TCLP), Depree, 2008 found zinc to be ten times more mobile than copper or lead.

One beneficial reuse strategy that would minimize concerns with contaminant leaching is to incorporate stormwater sediments into bituminous concrete or asphalt (Sengupta, 2007, Depree, 2008). Geotechnical tests conducted by researchers for MassHighway showed that street sweepings and catch basin sediments are suitable for use as aggregate in bituminous concrete (Sengupta, 2007). The use of these materials as compost additives may also be a means of reducing contaminant mobility. Laboratory experiments by Depree, 2008 showed that the addition of 10% compost material to road sediments resulted in a 14-fold decrease in zinc leachability (Depree, 2008).

In general, street sweepings are able to be reused after processing to remove trash and litter. However, due to the high water content of catch basin sediments, the additional step of liquid/solid separation is required prior to reuse. Decant facilities can be used for this purpose, but are typically expensive to construct and may not be effective in treating loads with differing liquid/solid ratios (Oregon DOT, 2001). During a series of field trials, Oregon DOT was able to identify a flocculant that could be used to separate liquids and solids inside an eductor truck. After flocculation, the liquid portion could be returned directly to a sanitary sewer. Oregon DOT also investigated the use of mobile dewatering boxes and concluded that these mobile systems could yield significant cost savings when used in areas that conduct minimal catch basin cleaning activities or could be combined with flocculants to improve dewatering efficiency (Oregon DOT, 2001). However, neither flocculants nor mobile dewatering boxes are currently being used by Oregon DOT because it is more efficient for them to partner with municipalities for the management of these materials.

Based on the information provided above, the following viable options for the reuse of street sweepings have been identified through a review of relevant literature. In general, most states only allow reuse of materials that are not visibly contaminated after trash and litter have been removed by screening.

- As aggregate in concrete and asphalt (Sengupta, 2007, Connecticut DEP, 2007, Depree, 2008)
- Blended with clean material to reduce chemical concentrations by dilution; could be used as an additive in compost or topsoil (Sengupta, 2007, Depree, 2008)
- Directly for traction (Sengupta, 2007)

- Mixed with new salt or sand for traction (Connecticut DEP, 2007)
- As daily cover on an active permitted lined or unlined landfill (Connecticut DEP, 2007)
- Sub-grade for municipal roads or parking lots—sweepings covered by asphalt (Connecticut DEP, 2007)
- For filling potholes—sweepings covered by asphalt (Connecticut DEP, 2007)
- Median fill in divided highway (Connecticut DEP, 2007)
- Fill along a road shoulder in a municipally owned public right-of-way; requires sweepings to be covered with:
    - asphalt or
    - a minimum of four feet of clean soil.
    - Fill locations must be more than 100 feet from a wetland, watercourse, or water supply well (Connecticut DEP, 2007)
- Fill on commercial or industrial properties (with testing for VOCs and SVOCs) (Connecticut DEP, 2007)
- Spill Cleanup (with testing for VOCs and SVOCs) (Connecticut DEP, 2007)

Potential options for the reuse of catch basin materials include:

- Directly as traction material on roads (Sengupta, 2007)
- As a compost additive (Sengupta, 2007)
- As an aggregate in concrete pavement (Sengupta, 2007, Depree, 2008)
- Sub grade materials below paved roadways or parking lots, with appropriate analytical testing (New Hampshire DEP, 2009)

2.1.2 Email Survey

The online survey received a total of 47 responses, and an additional seven responses were received by email from other state DOT personnel. The majority of respondents to the online survey indicated that like Ohio, they do not have official programs for the beneficial reuse of stormwater sediments, nor do they track the volume of material collected. Of those that reported reusing these sediments, beneficial reuses included: as subgrade below parking lots, as traction material, as fill in medians, as a compost additive, and as clean cover. The results of the street sweeping survey are provided in Appendix A.

Responses to the information request sent by email indicated that Washington, Maine, Minnesota, and Vermont have programs for the beneficial reuse of storm water sediments, while Iowa, North Dakota, and Rhode Island reported that they either do not collect or do not reuse these materials. Beneficial uses of these materials by other state DOT include: as fill along the right of way, as fill in gravel pits, and blended with clean sand and gravel for highway construction and maintenance projects.

2.1.3 Telephone Interviews

Telephone interviews were conducted with a total of ten DOT and Public Works personnel. Details are provided below.

Due to limitations on landfill space, public works entities in Washington State aggressively pursue the reuse of storm water sediments. After screening material to remove litter, Washington DOT is able to reuse these materials for slope flattening, berm construction, and as fill material in publicly owned right-of-ways. The biggest concern for Washington DOT in reusing these materials is that there are not currently regulations for the reuse of these materials, and if regulations are developed at a later date, sites where these materials have been placed may become cleanup sites.

King County in Washington State also strives for complete reuse of storm water sediments. King County utilizes a central location for storage and processing of all stormwater sediments, and opens this facility to contractors and other municipalities. The solid waste fraction (trash, litter) is screened out and disposed of as solid waste and the remaining materials are stockpiled until they are needed for reuse. King County has conducted extensive sampling of these materials since 1996, and has eliminated the need to test for heavy metals, as the material is considered adequately characterized for reuse purposes. They are currently reusing storm water sediments as fill material for the reclamation of gravel pits.

The Oregon DOT currently reuses street sweepings for shoulder building, traction, and patching. Only materials collected shortly after sand is applied to the roadway meet the grain size criteria for reuse as traction. Oregon DOT is working with the Department of Environmental Quality (DEQ) to establish guidelines for reusing materials based on the locations where materials are collected. Oregon DOT anticipates less stringent requirements for reusing materials collected in rural areas than those collected in urban areas.

Minnesota DOT (MnDOT) has developed a program for the reuse of storm water sediments. Historically, TPH and heavy metals testing was required for reuse, but monitoring is no longer required as part of the reuse program. Minnesota DOT worked with the Minnesota Pollution Control Agency (PCA) to develop a Beneficial Use Determination (BUD) for reuse of these materials. MnDOT estimates an annual cost savings of approximately $350,000 as a result of reusing these materials. Street sweepings and catch basin sediments are screened using a portable screen that is shared by all districts and stored on-site until they are reused for road projects or in concrete.

The Cedar Rapids, Iowa Department of Public Works aims to reuse a minimum of 95% of the street sweepings collected annually. Approximately 5,000-6,000 tons of sweepings are collected annually in Cedar Rapids, and the disposal cost is $37/ton. To maximize reuse potential, sweepings are segregated based on the time of year collected. Sweepings collected in spring and early summer consist mostly of sand and can be mixed with new sand for traction control or as a sand seal prior to chip and seal. Sweepings collected through the summer are used as general fill material for road projects, although this material is not always the best fill. Sweepings collected in the fall consist mostly of leaves, which are not easily disposed of when mixed with grit. Cedar Rapids is moving to discontinue fall sweeping.

Maine DOT also has a beneficial reuse program for street sweeping and catch basin sediments. Historically, analytical data regarding VOC, SVOC, TPH, and heavy metals concentrations have been collected. However, Maine DOT has discontinued sampling for VOC, SVOC, and heavy metals as a result of consistently low concentrations of these contaminants. Catch basin sediments in Maine have been characterized as poorly sorted sands, which are ideal for blending with other sands for use in highway maintenance and construction projects. Maine DOT is required to sample stockpiles annually for analysis of Total Extractable Petroleum Hydrocarbons (TEPH). TEPH concentrations must be less than 500 mg/kg for reuse.

Vermont DOT is also able to successfully reuse street sweepings as fill material. Vermont DOT requires that street sweepings and catch basin sediments be stored separately, and does not require sampling for reuse of street sweepings that are not visibly contaminated. In order to reuse catch basin materials, analysis of VOCs is required. Catch basin materials are stored on-site, where water is allowed to drain to vegetated areas or evaporate.

The Bismarck, North Dakota Department of Public Works stockpiles sweepings collected in the spring for use the following fall. Sweepings are screened and reused for traction control. Monitoring of storm water sediments is not required. When catch basins are cleaned, dry material is hauled directly to a landfill. Wet material is dried on-site then mixed with compost.

The Missouri DOT currently reuses street sweeping and catch basin sediment as structural fill, road base, or soil amendment. As part of the reuse policy, samples must be collected for analysis of BTEX, heavy metals, TPH, and SVOCs. One sample is required for every 500 cubic yards of soil. Contaminant concentrations must be below the Missouri Risk-Based Corrective Action for Underground Storage Tank Guidance Default Target Levels.

The City of Ann Arbor, Michigan does not reuse any storm water sediments because they are concerned about the potential future liability of placing these materials on the roadway. The Michigan solid waste standards do not allow for reuse of any materials designated as solid waste. All of the materials collected as part of the storm water management program are disposed in a landfill.

2.1.4 Summary

Table 5 summarizes the beneficial uses identified through telephone interviews with other state DOT and municipalities as well as the monitoring requirements for reusing storm water sediments. General conclusions that can be drawn from the interviews with personnel from states other than Ohio are as follows:

- Many states have less stringent requirements for the reuse of street sweepings than catch basins;
- Some states do not require analytical testing for the reuse of street sweepings that are not visibly contaminated, while others require the analysis of TPH, BTEX, heavy metals, and PAHs prior to approving the reuse of these materials;
- The primary reuses for street sweepings are traction control, construction fill, and slope flattening;
- Some states mix catch basin sediments with street sweepings, while in other states, they are separated because of the differing requirements for reuse;
- Many states reported that the catch basin sediments are allowed to dewater on the ground, while others have specific decanting stations for liquid/solid separation;
- Only Washington State reported the widespread construction of decanting facilities; and
- None of the states interviewed reported tracking the volume of materials collected.

Table 5: Summary of beneficial reuses and sampling requirements identified through interviews with other state DOT and municipalities.

	Reuse		Sampling Requirements for Reuse		
Organization	**Street Sweepings**	**Catch Basin Sediments**	**Street Sweepings**	**Catch Basin Sediments**	**Other Comments**
Washington DOT	Slope flattening, berms, fill	Slope flattening, berms, fill	None--there are no regulations; 1 composite sample is collected annually for documentation purposes	None	Jointly co-locate statewide decanting facilities using grants provided by Dept. of Ecology
King County, Washington DOT	Gravel pit reclamation	Gravel pit reclamation	None--there are no regulations; use own internal standards and test for TPH, PAHs	None	Operate decanting facility jointly with Washington DOT; it is open to contractors; currently has 32 customers; metals concentrations have been relatively low, the area is rural.
Oregon DOT	For shoulder building, patching, traction	None	None	On a case by case basis; sampling requirements depend on desired reuse	Right now they are working with DEQ to develop standard approvals for reuse depending on location of material collection (e.g. if it is from a rural location); they do not use flocculants or mobile dewatering boxes; some locations have makeshift decant facilities, others partner with cities that have decant facilities; considering investigating a state of the art system that is being utilized in Tacoma, Washington
Minnesota DOT	Road construction or in concrete	Road construction or in concrete	None	None	Treat catch basin and sweepings the same; materials are mixed, screened, reused. One portable trommel screen for use in whole district. Estimate savings of $350,000/year by reusing these materials
Cedar Rapids, IA Public Works	Traction, Chip and seal, fill for road projects, shoulder building, flood control	Don't reuse; typically comingled with sanitary sewer clean out	None	N/A	Try to reuse at least 95% of sweepings because landfills are now charging the city $38/ton for disposal; city generates 5,000-6,000 tons in a typical year. Process includes separating materials for reuse by time of year collected; spring sweepings are mostly sand, summer sweepings mostly grit, fall sweepings mostly leaves.
Maine DOT	Unknown	Blend with sands for highway maintenance and construction	Unknown	TEPH <500mg/kg	Found catch basin sediments to be relatively clean with respect to VOCs and SVOCs; primary concern is TPH; no decanting facilities, materials dewater on-site.
Vermont DOT	Fill	Currently contracting catch basin cleanout	None	VOCs	
Bismarck, ND	Traction	Compost	None	None	
Missouri DOT	Structural fill, road base, or soil amendment	Structural fill, road base, or soil amendment	1 sample per 500 cubic yards for BTEX, TPH, Heavy metals, SVOCs	1 sample per 500 cubic yards for BTEX, TPH, Heavy metals, SVOCs	Sweepings and catch basin sediments treated the same
Ann Arbor, MI	None	None	N/A	N/A	Concerned about the potential liability or reusing these materials, so they just landfill them
Rhode Island DOT	None	None	N/A	N/A	They have an agreement to take these materials to a landfill for use as daily cover
Iowa DOT	Do not collect	Do not collect	N/A	N/A	
North Dakota DOT	Do not collect	Do not collect	N/A	N/A	
Bloomington, MN	Previously reused street sweepings for traction, but they discontinued the use of sand for traction, now sweepings are landfilled	Unknown	N/A	N/A	

2.2 Evaluate Available Data and Reports for Ohio on the Management Procedures and Practices Including Material Classification, Handling, and Beneficial Use

This section includes results from six different activities: 1.) the compilation and analysis of existing ODOT data regarding best management practices and sediment quality monitoring, 2.) telephone interviews with personnel in each District, 3.) the selection of five facilities for detailed evaluation 4.) telephone interviews with entities in Ohio that are involved in stormwater sediment management, 5.) the identification of new technologies for the management of storm water sediments, and 6.) the preliminary identification of a process for tracking and quantifying the volume of stormwater sediment collected and the associated management costs.

Existing information regarding storm water sediment management and monitoring was provided by ODOT Central Office personnel. Analytical data was available for street sweeping and catch basin sediments collected in Districts 2, 6, 10, and 12 and included results of the analysis of TPH, VOCs, SVOCs, and heavy metals. To determine whether the collected materials would be classified as hazardous waste, the Toxicity Characteristic Leaching Procedure (TCLP) was also run on several of the samples. Although the data were not collected to assess potential reuse options, they can be used to identify potential contaminants of concern in street sweeping and catch basin sediments collected by ODOT.

To determine current management practices for street sweeping and catch basin sediments in each District, the Roadway Services Manager or Highway Management Administrator in each District was contacted by telephone to discuss current management practices, the locations of decanting facilities, the volume of material collected, and the cost of managing these materials. Details were tabulated and evaluated to identify potential improvements to current management practices. Based on the results of the assessment of current management practices at ODOT maintenance facilities, five locations were chosen for comprehensive evaluation of stormwater sediment management during the next phase of the project.

To determine current management practices for street sweeping and catch basin sediments among non-ODOT entities, responsible personnel were identified and contacted by telephone with a broad background including large and small governmental bodies responsible for street sweeping and storm sewer maintenance. Similarly, several leading manufacturers of storm and sanitary sewer equipment manufacturers have been identified and contacted by telephone to help determine the state of the practice in this area.

2.2.1 Existing ODOT Data

2.2.1.1 Best Management Practices

Information regarding current management of street sweeping and catch basin sediments at ODOT maintenance facilities was provided by ODOT Central Office Personnel. As shown in Figure 2-1 and Table 6, a total of 65 garages reported some form of street sweeping management strategy, with the majority of respondents indicating that street sweepings are stored on-site uncovered. Figure 2-2 and

Table 6 show that 81 garages reported a management strategy for catch basin sediments, with the majority indicating that materials are stored on open ground.

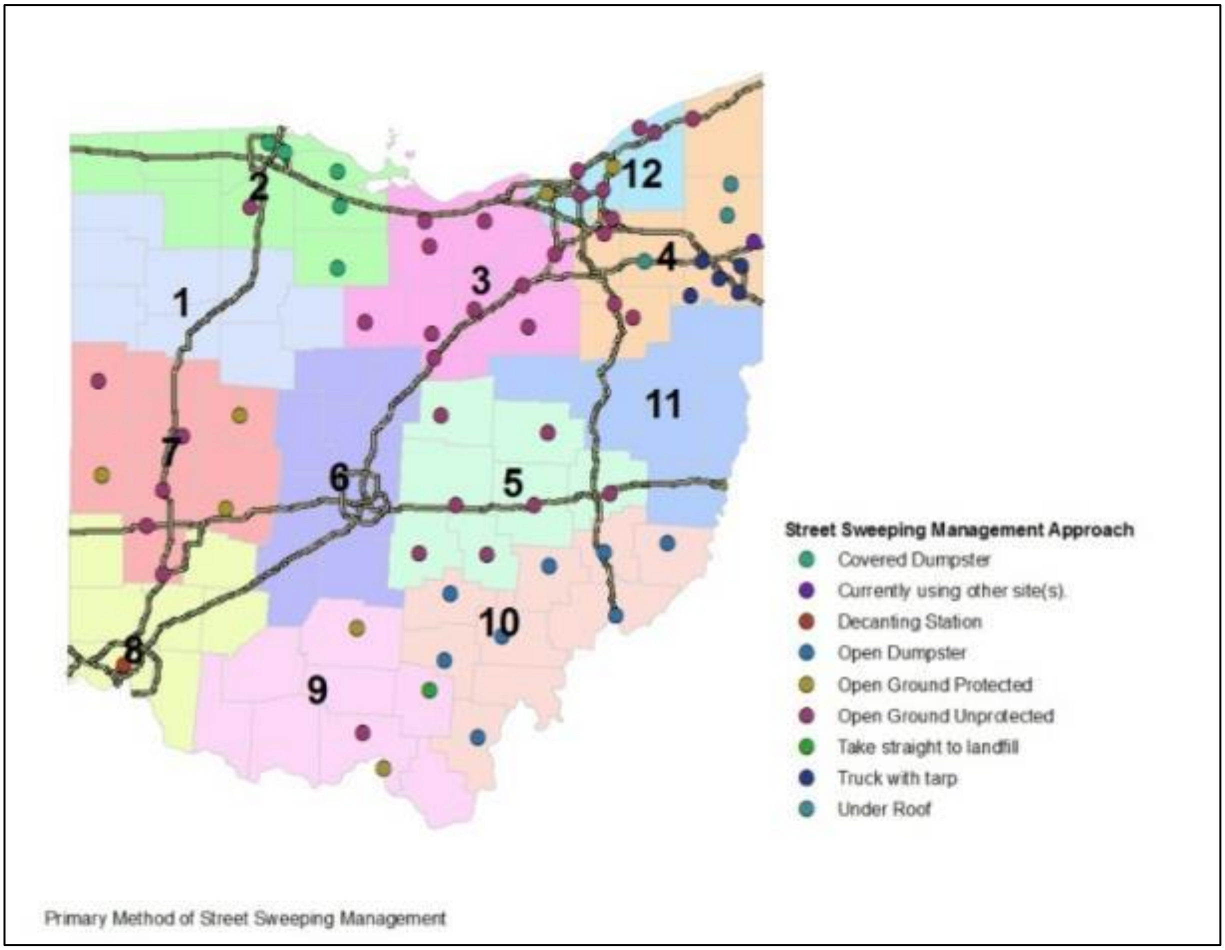


Figure 2.1: Reported approaches to managing street sweepings by Ohio DOT maintenance facilities. Data was provided by Central Office personnel.

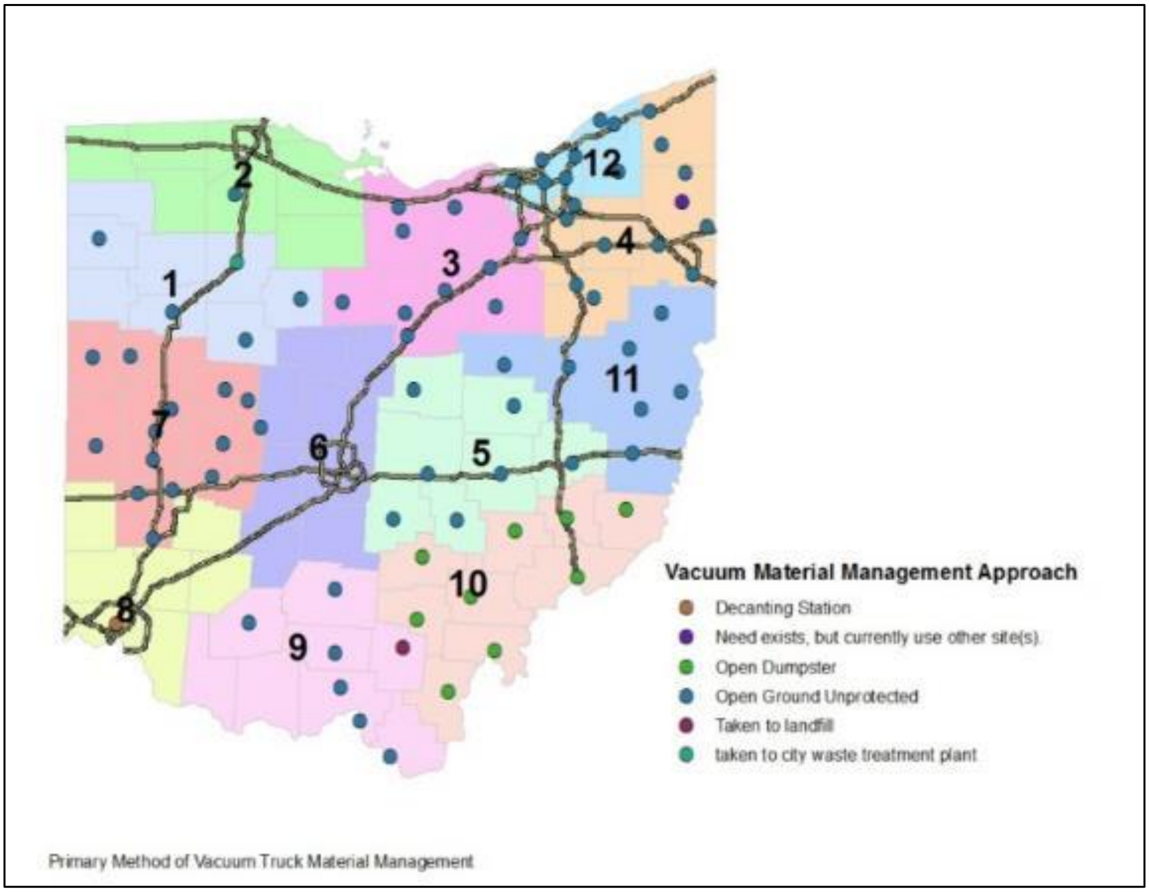


Figure 2.2: Reported approaches to managing catch basin sediments at Ohio DOT maintenance facilities. Data was provided by Central Office personnel.

Table 6: Summary of the number of garages reporting street sweeping and catch basin sediment management strategies at Ohio DOT maintenance facilities. Data provided by Central Office personnel.

		Vacuum Truck Material Management	Street Sweeping Management
Garage Breakdown	Total	81	65
	County Garages	56	43
	District Garages	1	1
	Outpost Garages	24	21
Management Approach	Open Ground Unprotected	68	34
	taken to city waste treatment plant	1	
	Need exists, but currently use other site(s).	1	
	Decanting Station	1	1
	Taken to landfill	1	1
	Open Dumpster	9	8
	Covered Dumpster		5
	Truck with tarp		5
	Under Roof		3
	Open Ground Protected		7
	Currently using other site(s).		1

2.2.1.2 Analytical Data

In the past, ODOT has collected analytical data regarding contaminant concentrations in street sweepings and catch basin sediments in Districts 2, 6, 7, 10, and 12. Sediment samples have been analyzed for TCLP metals, RCRA metals, SVOCs, and VOCs. An assessment of catch basin water quality, including metals and SVOCs, was also conducted in District 2. The results of these sampling efforts are tabulated below with the exception of District 7, because the source of materials was unknown. The results are compared with the appropriate regulatory guidelines for beneficial reuse and the identification of a hazardous waste (Ohio EPA, 2011, 40 CFR 261.24).

As shown in Tables 7 through 12, PAH concentrations in both road dirt and catch basin sediment samples collected from Districts 2, 6, and 10 were found in excess of the proposed Ohio EPA beneficial reuse guidelines for the use of these materials for traction. However, PAH results did not exceed the proposed guidelines for reuse as fill or aggregate. Because these data were not collected to assess the viability of reusing these materials in accordance with the proposed Ohio EPA guidelines, conclusions regarding the suitability of these materials for reuse purposes cannot be drawn at this time.

Table 7: District 2 comparison of the concentrations of TCLP metals, VOCs, and SVOCs in street sweeping sediments collected with appropriate regulatory standards for the identification of hazardous waste and the proposed regulatory standards for beneficial reuse of street sweepings. TCLP standards for the identification of hazardous waste taken from 40 CFR 261.24. This table only includes contaminants reported at concentrations greater than the detection limit. Shaded cells exceed one or more of the applicable standards.

		Analytical Results								Standards		
		Street Sweepings (?)						Type Unknown		TCLP Limits	Maximum Limit for Beneficial Use (mg/kg)	
											PAHs	
Constituent	Units	LUC-SS-10-01	LUC-SS-10-02	LUC-SS-10-03	LUC-SS-11-01	LUC-SS-11-02	LUC-SS-11-03	WOOTS-US-11-01	WOOTS-US-11-02	from 40 CFR 261.24	Winter Traction	Fill/Aggregate
Metals (TCLP)												
Silver	mg/L	N/A	N/A	N/A	BDL	BDL	BDL	BDL	BDL	5		
Arsenic	mg/L	N/A	N/A	N/A	BDL	BDL	BDL	BDL	BDL	100		
Barium	mg/L	N/A	N/A	N/A	0.736	0.717	0.537	0.758	0.704	1		
Cadmium	mg/L	N/A	N/A	N/A	BDL	BDL	BDL	0.0122	0.0119	5		
Chromium	mg/L	N/A	N/A	N/A	0.0112	0.0145	BDL	BDL	BDL	5		
Lead	mg/L	N/A	N/A	N/A	BDL	0.0979	BDL	0.15	0.0835	0.2		
Selenium	mg/L	N/A	N/A	N/A	BDL	BDL	BDL	BDL	BDL	1		
Mercury	mg/L	N/A	N/A	N/A	BDL	BDL	BDL	BDL	BDL	5		
VOCs												
Methylene Chloride	mg/kg dry	0.0209	BDL	BDL	N/A	N/A	N/A	BDL	BDL			
Tetrachloroethene	mg/kg dry	BDL	BDL	BDL	N/A	N/A	N/A	0.0824	0.0258			
SVOCs												
Benzo(b)fluoranthene	mg/kg dry	BDL	BDL	BDL	N/A	N/A	N/A	2.89	BDL		5.53	63
Chrysene	mg/kg dry	BDL	BDL	BDL	N/A	N/A	N/A	2.73	BDL		1.27	6700
Fluoranthene	mg/kg dry	BDL	BDL	BDL	N/A	N/A	N/A	7.55	3.37			
Indeno(1,2,3-cd)pyrene	mg/kg dry	BDL	BDL	BDL	N/A	N/A	N/A	BDL	BDL		0.15	67
Pyrene	mg/kg dry	BDL	BDL	BDL	N/A	N/A	N/A	5.22	BDL			
Benz(a)anthracene	mg/kg dry	BDL	BDL	BDL	N/A	N/A	N/A	2.73	BDL		2.2	63
Dimethyl phthalate	mg/kg dry	BDL	BDL	BDL	N/A	N/A	N/A	BDL	BDL			
Benzo(a)pyrene	mg/kg dry	BDL	BDL	BDL	N/A	N/A	N/A	2.69	BDL		1.1	6.3
Benzo(g,h,i)perylene	mg/kg dry	BDL	BDL	BDL	N/A	N/A	N/A	BDL	BDL			
Phenanthrene	mg/kg dry	BDL	BDL	BDL	N/A	N/A	N/A	4.18	BDL			
Benzo(k)fluoranthene	mg/kg dry	BDL	BDL	BDL	N/A	N/A	N/A	BDL	BDL		1.97	630

Table 8: District 2 comparison of concentrations of RCRA metals in street sweepings collected with the proposed regulatory standards for beneficial reuse of street sweepings. This table only includes contaminants reported at concentrations greater than the detection limit. Shaded cells exceed one or more of the applicable standards.

		Analytical Results						Beneficial Reuse Limits (Metals)
RCRA Metals	Units	LUC-SS-10-01	LUC-SS-10-02	LUC-SS-10-03	LUC-SS-11-01	LUC-SS-11-02	LUC-SS-11-03	Winter Traction Abrasive Fill Aggregate
Silver	mg/kg dry	BDL	BDL	BDL	BDL	BDL	BDL	
Arsenic	mg/kg dry	2.32	4.22	8.85	3.98	5.47	BDL	41
Barium	mg/kg dry	124	107	319	86.2	77.1	15.2	
Cadmium	mg/kg dry	0.996	1.71	3.33	1.13	1.28	BDL	35
Chromium	mg/kg dry	162	131	254	30.2	60.6	3.38	
Lead	mg/kg dry	120	43.2	778	9.44	9.07	2.72	300
Selenium	mg/kg dry	BDL	BDL	BDL	BDL	BDL	BDL	
Mercury	mg/kg dry	BDL	BDL	BDL	BDL	BDL	BDL	7.8
Not Tested								
Copper	mg/kg dry							1500
Nickel	mg/kg dry							420
Selenium	mg/kg dry							100
Zinc	mg/kg dry							2800

Table 9: District 2 comparison of the concentrations of metals and SVOCs in the water collected from a catch basin with the water quality standards for the protection of aquatic life (OAC 3745-1-07) and the water quality criteria for the Ohio River drainage basin non-drinking standards (OAC 3745-1-34). Some standards are hardness dependent. This table only includes contaminants reported at concentrations greater than the detection limit. Shaded cells exceed one or more of the applicable standards.

		Analytical Results			Standards		
Water Quality Parameter	Units	LUC-CB-10-01	LUC-CB-10-02	LUC-CB-10-03	Water Quality Standards for Protection of Aquatic Life (OMZA) (Total Recoverable)		
Hardness					200 mg/L as CaCO3	300 mg/L as CaCO3	Not Hardness Dependent
Silver	ug/L	BDL	0.61	BDL			
Arsenic	ug/L	14.3	25.1	13.5			150
Barium	ug/L	320	688	584			
Cadmium	ug/L	1.54	6.21	1.85	4.2	5.8	
Chromium	ug/L	12.1	142	49.9	150	210	
Lead	ug/L	34.3	219	40.2	16	26	
Selenium	ug/L	BDL	BDL	BDL			5
Mercury	ug/L	BDL	0.31	BDL			0.91
					Water Quality Standards for Ohio River Basin Human Health Non-Drinking (OMZA) (Total)		
Benzo(b)fluoranthene	ug/L	BDL	3.47	BDL			0.49
Chrysene	ug/L	BDL	BDL	BDL			0.49
Fluoranthene	ug/L	BDL	BDL	BDL			370
Indeno(1,2,3-cd)pyrene	ug/L	BDL	2.15	BDL			0.49
Pyrene	ug/L	BDL	BDL	BDL			11,000
Benz(a)anthracene	ug/L	BDL	1.69	0.46			0.49
Dimethyl phthalate	ug/L	BDL	BDL	BDL			2,900,000
Benzo(a)pyrene	ug/L	BDL	2.03	0.61			0.49
Benzo(g,h,i)perylene	ug/L	BDL	BDL	BDL			
Phenanthrene	ug/L	BDL	BDL	BDL			
Benzo(k)fluoranthene	ug/L	BDL	3.64	BDL			0.49
2,6-Dinitrotoluene	ug/L	BDL	BDL	16.4			
Dibenz(a,h)anthracene	ug/L	BDL	BDL	0.66			0.49

Table 10: District 6 comparison of the concentrations of TCLP metals, VOCs, and SVOCs in street sweeping and catch basin sediments collected with appropriate regulatory standards for the identification of hazardous waste and the proposed regulatory standards for beneficial reuse of street sweepings. TCLP standards for the identification of hazardous waste taken from 40 CFR 261.24. This table only includes contaminants reported at concentrations greater than the detection limit. Shaded cells exceed one or more of the applicable standards.

		Analytic Results						Standards		
		Catch Basin			Curb			TCLP Limits	Maximum Limit for Beneficial Use (mg/kg)	
									PAHs	
Constituent	Units	LOC 1 Inside CB	LOC 2 Inside CB	LOC 3 Inside CB	LOC 1 Curb Line	LOC 2 Curb Line	LOC 3 Curb Line	from 40 CFR 261.24	Winter Traction	Fill/Aggregate
Metals (TCLP)										
Silver	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	5		
Arsenic	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	100		
Barium	mg/L	0.989	1.35	1.26	0.902	0.939	1.26	1		
Cadmium	mg/L	BDL	BDL	0.0112	BDL	BDL	0.0137	5		
Chromium	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	5		
Lead	mg/L	BDL	0.0578	BDL	BDL	BDL	0.166	0.2		
Selenium	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	1		
Mercury	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	5		
VOCs										
Methylene Chloride	mg/kg dry	BDL	BDL	BDL	BDL	BDL	BDL			
SVOCs										
Anthracene	mg/kg dry	BDL	BDL	5.96	BDL	6.01	4.36			
Benzo(b)fluoranthene	mg/kg dry	0.742	7.97	7.46	1.29	9.04	5.92		5.53	63
Chrysene	mg/kg dry	BDL	BDL	6.15	0.803	6.95	4.79		1.27	6700
Fluoranthene	mg/kg dry	0.66	5.51	13.7	1.03	14.9	9.39			
Indeno(1,2,3-cd)pyrene	mg/kg dry	BDL	8.48	10.4	1.17	11.3	6.66		0.15	67
Pyrene	mg/kg dry	BDL	6.61	9.42	1.07	12	7.27			
Benz(a)anthracene	mg/kg dry	BDL	BDL	5.21	0.611	6.08	4.21		2.2	63
Dimethyl phthalate	mg/kg dry	BDL	BDL	BDL	BDL	BDL	BDL			
Benzo(a)pyrene	mg/kg dry	BDL	4.74	7.77	0.792	8.67	5.04		1.1	6.3
Benzo(g,h,i)perylene	mg/kg dry	BDL	5.28	8.63	0.925	9.29	4.5			
Phenanthrene	mg/kg dry	BDL	BDL	BDL	BDL	BDL	BDL			
Benzo(k)fluoranthene	mg/kg dry	BDL	BDL	8.45	BDL	7.32	4.96		1.97	630

Table 11: District 10 comparison of the concentrations of TCLP metals, VOCs, and SVOCs in street sweeping and catch basin sediments collected with appropriate regulatory standards for the identification of hazardous waste and the proposed regulatory standards for beneficial reuse of street sweepings. TCLP standards for the identification of hazardous waste taken from 40 CFR 261.24. This table only includes contaminants reported at concentrations greater than the detection limit. Shaded cells exceed one or more of the applicable standards.

		Analytical Results						Standards		
		Catch Basin			Road Sediment			TCLP Limits	Maximum Limit for Beneficial Use (mg/kg)	
									PAHs	
Constituent	Units	WAS-10 (was new mat CB)	WAS-12 (was Par Mor CB)	ATH-10 (ath Plains CB)	WAS-11 (was new mat CURB)	WAS-13 (was Par Mor CURB)	ATH-11 (ath Plains CURB)	from 40 CFR 261.24	Winter Traction	Fill/Aggregate
Metals (TCLP)										
Silver	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	5		
Arsenic	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	100		
Barium	mg/L	0.757	1.01	0.671	0.663	1.03	0.681	1		
Cadmium	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	5		
Chromium	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	5		
Lead	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	0.2		
Selenium	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	1		
Mercury	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	5		
VOCs										
Methylene Chloride	mg/kg dry	BDL	BDL	BDL	0.0272	0.0681	BDL			
SVOCs										
Anthracene	mg/kg dry	0.818	BDL	BDL	BDL	BDL	BDL			
Benzo(b)fluoranthene	mg/kg dry	0.98	BDL	0.149	1.21	BDL	1.01		5.53	63
Chrysene	mg/kg dry	0.607	BDL	BDL	4.21	BDL	0.626		1.27	6700
Fluoranthene	mg/kg dry	1.54	BDL	0.142	BDL	BDL	0.896			
Indeno(1,2,3-cd)pyrene	mg/kg dry	0.718	BDL	BDL	BDL	BDL	BDL		0.15	67
Pyrene	mg/kg dry	1.1	BDL	BDL	BDL	BDL	0.813			
Benz(a)anthracene	mg/kg dry	BDL	BDL	BDL	4.79	BDL	BDL		2.2	63
Dimethyl phthalate	mg/kg dry	BDL	0.898	BDL	BDL	BDL	BDL			
Benzo(a)pyrene	mg/kg dry	BDL	BDL	BDL	BDL	BDL	0.622		1.1	6.3
Benzo(g,h,i)perylene	mg/kg dry	BDL	BDL	BDL	BDL	BDL	0.576			

Table 12: District 12 comparison of the concentrations of TCLP metals, VOCs, and SVOCs in street sweeping and catch basin sediments collected with appropriate regulatory standards for TCLP and proposed regulatory standards for beneficial reuse of street sweepings. TCLP standards for the identification of hazardous waste taken from 40 CFR 261.24. This table only includes contaminants reported at concentrations greater than the detection limits. Shaded cells exceed one or more of the applicable standards.

		Analytical Results								Standards		
		Catch Basins				Gutter				TCLP Limits	Maximum Limit for Beneficial Use (mg/kg)	
											PAHs	
Constituent	Units	Cuy71 238.5 CB	Cuy 176 13.6 CB	Cuy 90 176.2 CB	Lake 44 5.61 CB	Cuy71 238.5 Gutter	Cuy 176 13.6 Gutter	Cuy 90 176.2 Gutter	Lake 44 5.61 Gutter	from 40 CFR 261.24	Winter Traction	Fill/Aggregate
Metals (TCLP)												
Silver	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5		
Arsenic	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100		
Barium	mg/L	0.864	0.527	1.93	0.52	0.36	0.518	0.761	0.523	1		
Cadmium	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5		
Chromium	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5		
Lead	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.2		
Selenium	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1		
Mercury	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5		
VOCs												
Methylene Chloride	mg/kg dry											
SVOCs												
Anthracene	mg/kg dry	BDL	0.42	BDL	BDL	BDL	BDL	BDL	BDL			
Benzo(b)fluoranthene	mg/kg dry	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL		5.53	63
Chrysene	mg/kg dry	BDL	1.2	BDL	BDL	0.31	BDL	BDL	BDL		1.27	6700
Fluoranthene	mg/kg dry	BDL	2.3	2.1	BDL	0.36	BDL	BDL	BDL			
Indeno(1,2,3-cd)pyrene	mg/kg dry	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL		0.15	67
Pyrene	mg/kg dry	BDL	1.9	1.6	BDL	BDL	BDL	BDL	BDL			
Benz(a)anthracene	mg/kg dry	BDL	1.4	BDL	BDL	BDL	BDL	BDL	BDL		2.2	63
Dimethyl phthalate	mg/kg dry	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL			
Benzo(a)pyrene	mg/kg dry	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL		1.1	6.3
Benzo(g,h,i)perylene	mg/kg dry	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL			
Phenanthrene	mg/kg dry	BDL	1.5	BDL	BDL	BDL	BDL	BDL	BDL			

2.2.2 ODOT District Interviews

The results of telephone interviews with ODOT personnel in each District are summarized in Table 13. Most Districts reported minimal street sweeping activities, and three Districts reported that catch basin materials are not collected. In general, street sweeping and catch basin sediments are disposed of in a landfill. However, Districts 1 and 2 reported problems with some disposal locations no longer wanting to accept catch basin materials. Detailed cost and volume estimates were not readily available in many Districts. Districts 1 and 6 reported that they do not currently have costs associated with the disposal of storm water sediments. District 8 reported the use of a decanting station in Hamilton County for liquid/solid separation. Similar decanting stations are currently under construction in Districts 1, 3, and 11. Districts 1 and 3 anticipate that these facilities will be operational by spring 2013, while District 11 anticipated completion of their facility by spring 2014.

Table 13: Summary of current Best Management Practices for managing street sweeping and catch basin sediments in each of ODOT's 12 Districts.

District	Current BMP			
	Street Sweepings	Catch Basins	Volume/Cost	Decant stations
1	Sweeping only done in Allen and Hancock Counties; don't own sweeper, borrow one from the city and the city takes the material for disposal at no charge	A new outpost with a decant bay (like a fourth wash bay) is under construction at Forest Outpost; will be using it in the spring; the addition of decant stations to the Van Wert and Allen County Garages have been proposed for the next 2 years; these two decant stations can be used by the entire District; currently no cost for disposal of catch basin sediments, but anticipate reusing dried material as fill	Do not currently have any disposal costs	Forest Outpost; in the future Van Wert and Allen Counties possibly
2	Sweepings stored at Northwood Garage, disposed in landfill	Catch basins sediment stored at Wood Co. Garage; allowed to dewater on-site (do not have constructed decant);	5 years of catch basin material was 285 tons; disposal cost was $12,273.77	
3	Not a lot of street sweeping in this district; Sweeper is rented for 2 months in spring; Street sweepings are collected in dumpsters and then taken to landfill;	Catch basin cleaning has been contracted in the past; New facility is currently under construction--will include a decant station (Wayne County); ODOT will take over facility in spring	Unknown	Wayne County
4	Street sweeping only done in Stark and Mahoning counties; Street Sweepings are landfilled	Decant liquids back into catch basin; mix catch basin and street sweepings when possible for disposal	FY 2012: $8,526 for 343 tons of sweepings; no info on cost for catch basin sediments	
5	Almost no street sweeping in this district; only in Zanesville and Licking County (once per year); collected with broom truck brought back to yard and mixed with other material; volume unknown	Do not collect catch basin sediments; Material is flushed through catch basins, rather than collected. Leaves are collected from catch basins as needed		
6	Street sweepings taken directly to landfill for disposal; volume unknown	Catch basins are cleaned using vactor and material is hauled directly to the City of Columbus, where it is managed. City does not currently charge District 6 for disposal	Currently no disposal costs	
7	Street sweeping done in Montgomery County, Clark County, and Miami County; not stored, taken directly to landfill for disposal	Material disposed of at appropriate location		
8	Only sweep in Butler and Warren Counties on I-75; not a lot of volume in this district, but no numbers; tried reuse, but it was cost prohibitive to separate trash	Catch basin sediments are stored in decant station; Hamilton County has decant station; solids go to landfill		Hamilton County
9	Only collect sweepings from bridge decks; these materials are reused in berms; sweeping done in fall to promote drainage on bridges	Not currently cleaning out catch basins		
10	sweep 120 lane miles annually; rent sweeper at cost of $20,000/year; dispose of approximately 150 tons of material annually	Do not actively clean catch basins	Total cost for sweeping (truck rental, labor, disposal) ~ $40,000/year.	
11	Previously contracted this out, but will begin sweeping in the next FY due to lack of funding for contract	Previously contracted this out, but will begin cleaning catch basins next FY due to lack of funding for contracting. Decant station being constructed in Jefferson County (Winters Garage) that will be used to manage materials for entire district; hope to reuse the dried materials	Budget of $150,000 annually for contract	Jefferson County--will not be constructed until next FY
12	Street sweepings disposed in landfill	Catch Basin sediments disposed in landfill	Budget $180,000/year; will provide detailed cost info	

2.2.3 Locations for Detailed Investigation - Preliminary

As stated in the project proposal, a maximum of five locations, with varying conditions (geographic and traffic volume), were selected for detailed investigation of stormwater sediments. The following results of interviews with ODOT Districts were used to narrow the list of potential candidates:

- Districts 1, 2, 3, 5, 7, 8, 10 reported that only minimal street sweeping is conducted. District 3 and 10 do not own street sweepers, but rent them.
- Four districts reported that they do not collect catch basin sediments; District 3 has previously contracted this work out and Districts 5, 9, and 10 routinely clean catch basins.
- Districts 1 and 2 reportedly have problems finding disposal locations for catch basin materials.

- District 8 currently operates a decanting station, while Districts 1 and 3 anticipate beginning operation of decanting stations in spring 2013.

- District 6 collects a large volume of material, but it is not stockpiled.

Based on the above, we determined facilities in Districts 1, 2, 4, 6, and 12 should be considered for detailed analysis. The final selection of sample locations was dependent on input from ODOT personnel and is discussed later in Chapter 5

2.2.4 Stormwater Sediment Management in Ohio (non-ODOT)

Five non-ODOT entities have been identified who are responsible for managing street sweepings. These are the Ohio Turnpike, City of Akron, the Northeast Regional Sewer District, the City of Columbus, and the City of Defiance. With the exception of the City of Columbus, representatives for each entity have been identified, contacted and interviewed preliminarily. Current practice among these entities is similar to ODOT management practices and varies between flushing the debris further down the line, deposition and decanting at a centralized location, deposition at the local waste water treatment plant, and landfilling. Deposition on the land for dewatering followed up with landfilling the solid debris is the most common practice among the entities contacted. Although the City of Defiance and the City of Columbus currently have decanting facilities, none of these entities have a facility specifically constructed to recover material for beneficial reuse although in at least one case, some of the solid material has been used in the past for use in aiding traction for winter driving. Descriptions of quantities generated were generally qualitative in nature and generally small amounts where several years of material might be stored before hauling to a landfill or otherwise disposed. None of these entities currently have plans to manage the solids for beneficial use other than potentially use as alternate daily cover at landfills which would still require OEPA authorization-approval.

2.2.5 Identification of New Technologies

For this research project, the primary purpose of identifying new technology is to recognize a process or procedure capable of separating the solids from the liquids contained in street sweepings and sewer catch basin debris. Depending on the desire and purpose for beneficial reuse of the solids, other concerns related to the characteristics of the material are the amount of litter and concentration of pollutants.

The most significant difference between street sweepings and storm sewer catch basin debris is street sweepings are typically generated via the sweeping machine's broom and conveyor directly from the street and are usually low in moisture in comparison to material retrieved from catch basins. Some street sweepers add moisture to the street to control dust and in some cases are designed to loosen debris, but this material is typically still low in moisture. Storm sewer debris is usually collected via vacuum trucks that remove solids and liquids at the same time and consequently has a much higher liquid content and normally includes free liquid. In addition, catch basins tend to have a larger percentage of litter than street sweepings. Both materials are reported to contain a significant amount of fine or colloidal particles that tend to adsorb pollutants.

These differences in characteristics, particularly moisture content, dictate the methods for management of these two waste streams. Prevention of additional moisture via precipitation or mixing with other waste and keeping the material segregated after it is collected will minimize the application of further treatment. The degree of management is commensurate with the final use of the material. Disposal of the solid material in a landfill only requires decanting of the liquid. Beneficial reuse requires the materials to be further refined to segregate the solids based on the final use.

Based on a review of available literature and discussions with equipment manufacturers, equipment and procedures used for managing street sweepings and storm sewer debris used in practice varies across the US. In general, management of street sweepings in accordance with best management practices has received more attention along the west coast where the potential for pollution of surface water and sensitive areas from storm runoff has been of greater concern than in the Midwest. Technology in current use typically applies existing procedures and machinery developed for other purposes and applies it toward management of these materials. This includes technology to decant excess water, separation of organics and floatables, and segregation of the finer material as desired for beneficial reuse. No technology identified is able to separate the debris to achieve recycling of 100% of the material meaning some portion will always need landfilled. Some technologies not currently used at ODOTs existing decanting facilities that may possibly be used in future facilities are described in more detail below.

Standard storm water BMP equipment can be used as part of a treatment train to manage mixed media waste generated from street sweepings and sewer catch basin cleanout materials. Proven technologies that could be part of a regionalized location to manage these materials are as follows.

Filtration – Several manufacturers have utilized filtration as part of an overall design solution to prevent fine particles from entering the environment for storm water runoff. Ohio EPA has expressed concerns based on findings in other states that very fine particles (less than 300 micron) may contain proportionally higher concentrations of toxic materials. Filtration consists of passing the effluent (decant water) through a single or series of media filters designed to target a specific size particle or particles such that they are retained while allowing the effluent to pass through. Filter technologies on the market can be obtained in various forms and installed in different configurations based on the need of a specific site/area, to achieve removal of pollutants and sediments from the effluent. Particles much smaller than 300 microns can be targets for removal. Today, this technology is most often installed in conjunction with catch basins, curb inlets, and other downstream treatment arrangements and is typically one of the final measures for treatment of storm water. This technology is well established and some products have proven to be very efficient at removal. It is however, moderately expensive and requires maintenance and upkeep for the filters as they become clogged over time.

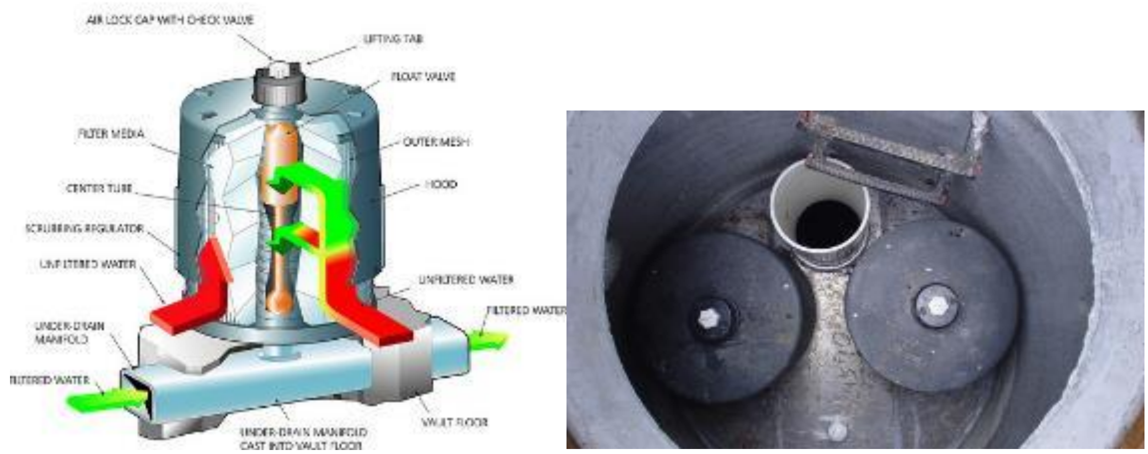


Figure 2.3: Storm Filter media filtration system (Contech Engineered Solutions).

Figure 2.4: Storm Clean catch basin filtration inserts (CleanWay Environmental Partners).

- **Hydrodynamic Separation -** Hydrodynamic separators are flow-through structures with a settling or separation unit to remove sediments and other pollutants also widely used in storm water treatment. The energy of the flowing water allows the sediments to efficiently separate without the need for an outside power source. Separation may be by means of swirl action or indirect filtration depending on the type of unit. Hydrodynamic separators come in a wide size range and some are small enough to fit in conventional manholes. Depending on the type of separator, removal efficiencies typically range between 80 and 90 percent including large particles and floatables though they are less efficient at removal of very small particles (i.e. <300µm). They are also relatively expensive depending on the size installed but require lower maintenance.

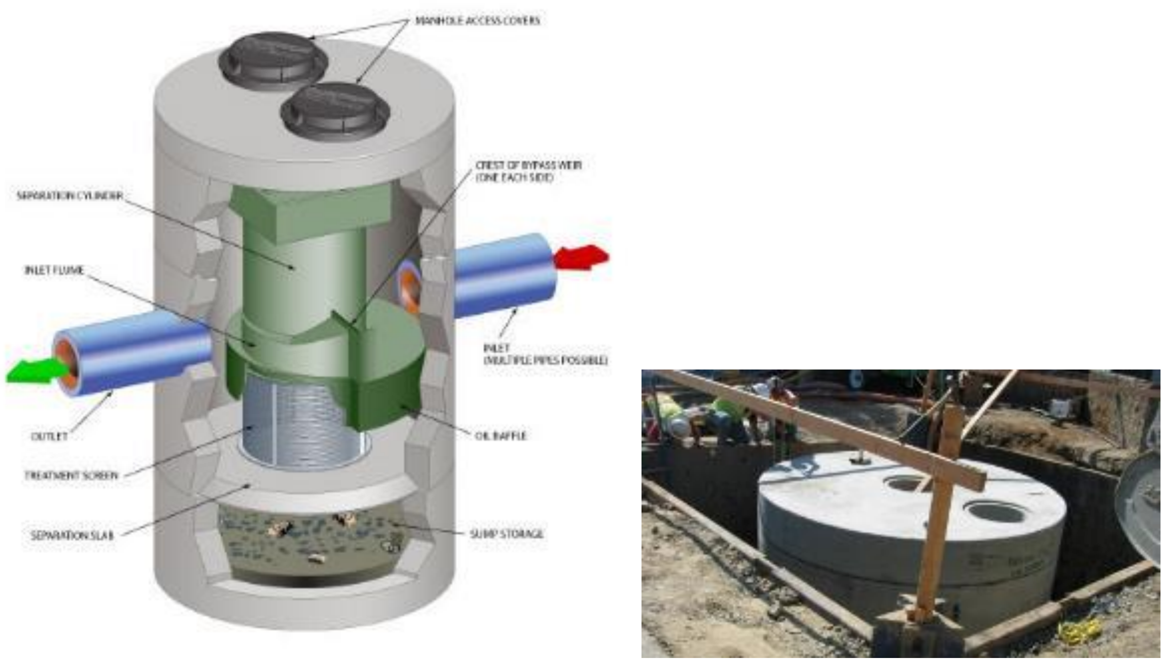


Figure 2.5: CDS Hydrodynamic Separator (Contech Engineered Solutions).

Figure 2.6: Downstream Defender Hydrodynamic Separator (HRD Technologies).

Water and waste water treatment methods can also be applied as part of a treatment train to manage mixed media waste generated from street sweepings and sewer catch basin cleanout materials. Well-developed technologies that could be part of a portable solution to manage these materials are as follows.

- **Flocculants Technology -** Flocculants are designed to separate solids from liquid slurry. Because pollutants are thought to concentrate on the fine particles, if fine soils can be settled or separated from the mixed media, many of the attached pollutants will also be captured or removed. When an appropriate flocculant is matched with the target media, high removal efficiency can be obtained well below 300µm. This technology is well developed in the water/waste water treatment industry and although many commercially produced flocculants are available, it is likely trial and error will be necessary to find an appropriate material based on the characteristics of the catch basin or street sweeping material. However, this technology does hold the promise of being portable. In the best case scenario, flocculants could be added to the individual vactor trucks and after treatment, safely discharge the effluent directly back into a sanitary sewer or possibly a storm sewer. Cost for flocculant can vary depending on the necessary quantities and characteristics and maintenance of equipment could be a significant concern for this method.

- **Dewatering Box** – Dewatering boxes are similar to roll off boxes used to haul industrial trash but are designed to hold and drain wet materials through a metal screen at the bottom. They can be outfitted with wheels and towed or can otherwise be hauled and located as needed reducing haul time and increasing waste disposal efficiencies. The wet waste can be dumped into this box, the liquids drained to a sanitary sewer, and remaining solids hauled to a solid waste facility. These boxes are relatively expensive compared to the amount of material that can be treated at one time and at least one trial reports decanting can take three or more weeks (Oregon DOT, 2001) due to clogging of the screen. There are logistics of dumping the waste material into the box also requires some planning.

Figure 2.7: Dewatering boxes (Baker and Flo Tec respectively).

AWS technologies of Tacoma, Washington have developed what probably represents the state of the art in managing street sweepings, the Viking Eductor Truck Offload System (ETOS). Their process is composed of a reasonably sophisticated treatment train meant to be a start to finish procedure requiring a single operator to turn street sweeping and catch basin debris into a product for reuse. Vactor or Eductor trucks dump directly into a receiving pit where it is conveyed through a series of trommels, screens, and a filter that separates and segregates the materials into its component products.

- 3 inch minus to 3/16 plus recovered as ADC, top cover or fill
- 3/16 minus material recovered in sand phase for re-use recycle
- Dewatered fines recovered from press cake reduce landfill costs
- Complete water phase recovery available for treatment
- Free oil phase removed and collected as product

The developer also claims that no additives are required.

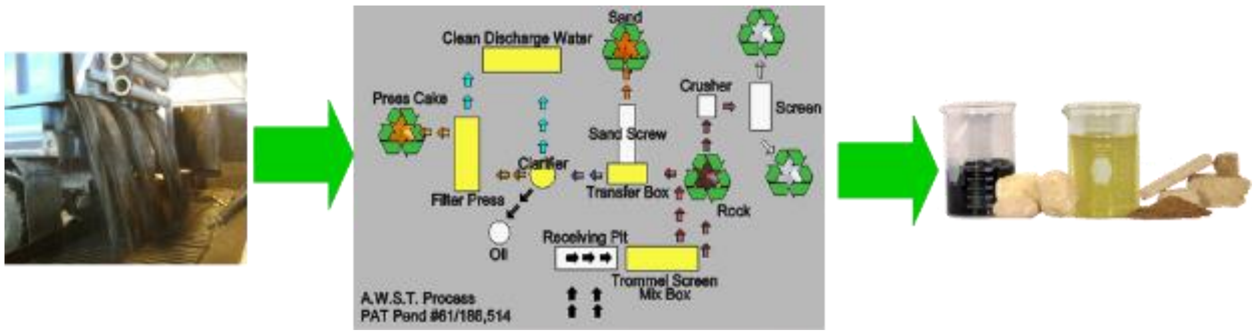


Figure 2.8: ETOS decanting and separation process (AWS Technologies).

2.2.6 *Tracking and Quantification of Sediments*

To evaluate the use of centralized locations for the treatment and/or reuse of stormwater sediments and to optimize the locations of these facilities, it is necessary to track the volume of material collected by each garage and the cost of material disposal and management. It would also be advantageous to classify the materials by location (e.g. urban, rural, industrial, etc.), as some materials may be more suited for reuse. We have identified several options for tracking and quantifying stormwater sediments. These options, which range from paper data entry and estimation to fully automated data collection by means of in-truck GPS units, are as follows:

1. Data would be entered on paper forms at individual garages, and could then be input to a spreadsheet locally, or into an existing ODOT database (like ODOT's Transportation Information Mapping System – TIMS) with the addition of appropriate data collection fields. Tables 14 and 15 show the information that would be collected on a paper form during each stormwater cleaning event. These same fields could be used for collection in a spreadsheet or database. The volume of material collected can be estimated from a weight ticket, if the material is taken to a landfill for disposal, or from the number of lane miles swept or days since the last catch basin cleanout event. The Connecticut DEP uses an average volume of 20.25 tons of material per street mile to estimate the volume of sweepings collected in urban areas, and a value of 0.1 pounds per calendar day to estimate the volume of material in a catch basin in an urban area (Connecticut DEP, 2007). Other information that would be collected includes the location of the material, which refers to whether the material is stockpiled onsite or disposed, whether the material has

been sampled for reuse, the classification of material (urban, rural), and the management cost, which would include disposal and analytical costs.

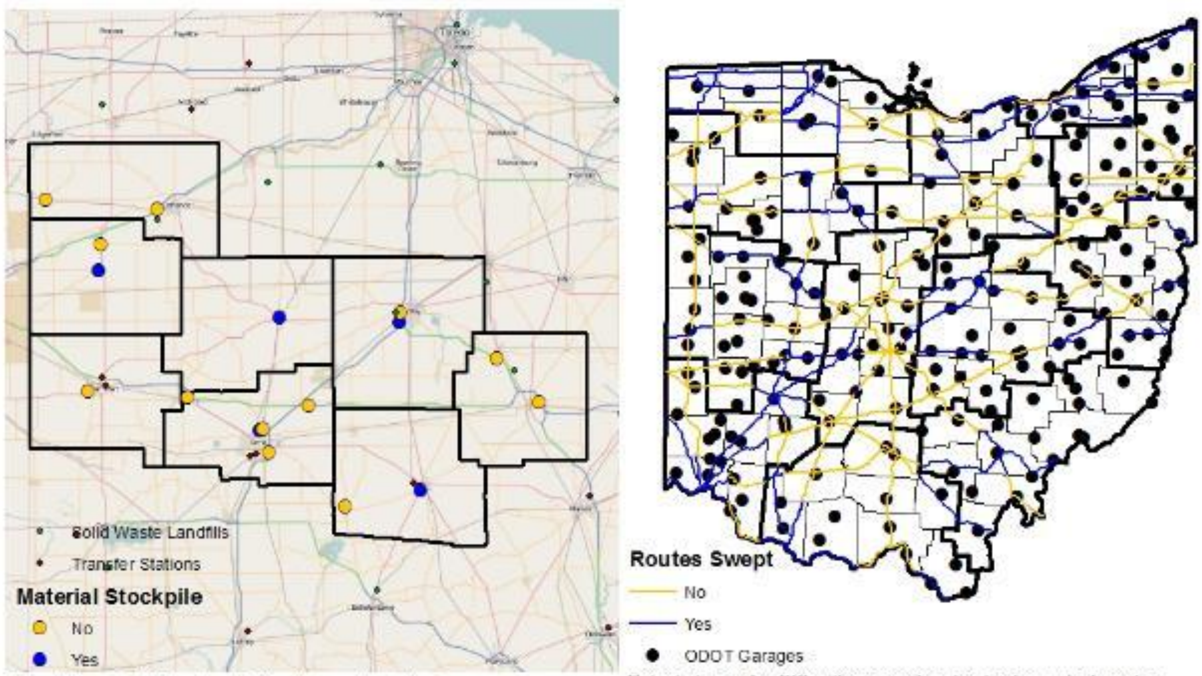
Table 14: Preliminary identification of data that could be collected for street sweeping routes.

Date	Route	Volume/Weight	Location	Sampled	Miles Swept	Classification	Cost

Table 15: Preliminary identification of data that could be collected for catch basin cleanout activities.

Date	Catch Basin	Volume/Weight	Location	Sampled	Classification	Cost

After this data is collected in a database or spreadsheet, ODOT users could connect to the TMS database or import the Excel® data into ArcMap® and display any of the street sweeping data spatially. This format would allow users to run queries to identify which routes or catch basins have been cleaned this year, dates of sweeping events, and locations that have material stockpiles that have been assessed for reuse. In this way, existing stockpiles could be used by multiple facilities to maximize reuse potential. This GIS system could also be used to identify nearby disposal locations. Examples of these uses are shown in Figure 2-9. These figures do not depict actual conditions, but are showing instead the potential applications of GIS software to stormwater sediment tracking. This option would require that the end user have access to GIS software.



Potential use of GIS to identify locations with stockpiles for use across a District; this is just an example, real data was not used

Potential use of a GIS with mapped routes to show which routes have been completed in a given year. Real data regarding actual sweeping routes was not available. This example was generated to show the potential application of GIS.

Figure 2.9: Potential uses for data collected during street sweeping and catch basin cleaning activities.

2. The second option identified for tracking stormwater sediments is through the use of a web application that can be accessed through a browser on the ODOT intranet. A user would enter stormwater cleaning data directly into the application by typing the URL into the browser and then pointing and clicking on the applicable feature (route, catch basin, and garage) and entering the data into the pop-up window. Only fields that have been made accessible in the browser are able to be edited. Edits can be tracked by the user name and date to ensure the integrity of the data. Figures 2-10 and 2-11 show an example of the use of the web application to track stormwater sediments. This option would require the use of an enterprise database for data collection, an ArcGIS server, and a web server.

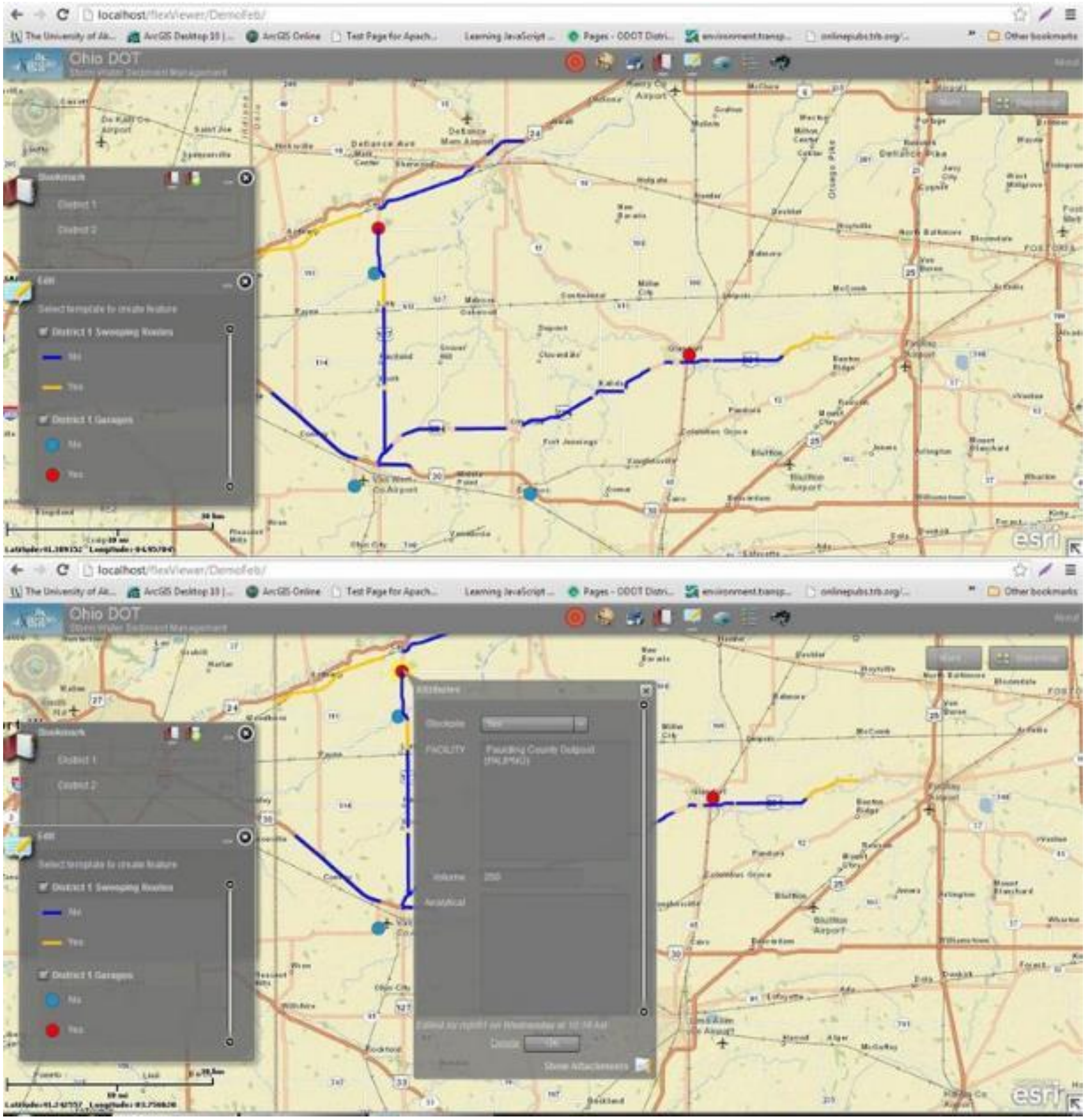


Figure 2.10: Example web application for stormwater sediment data input. The top figure shows example garages and routes in District 1, while the lower figure shows the pop-up window that displays when the garage is clicked. The user can enter information directly in to the pop-up window.

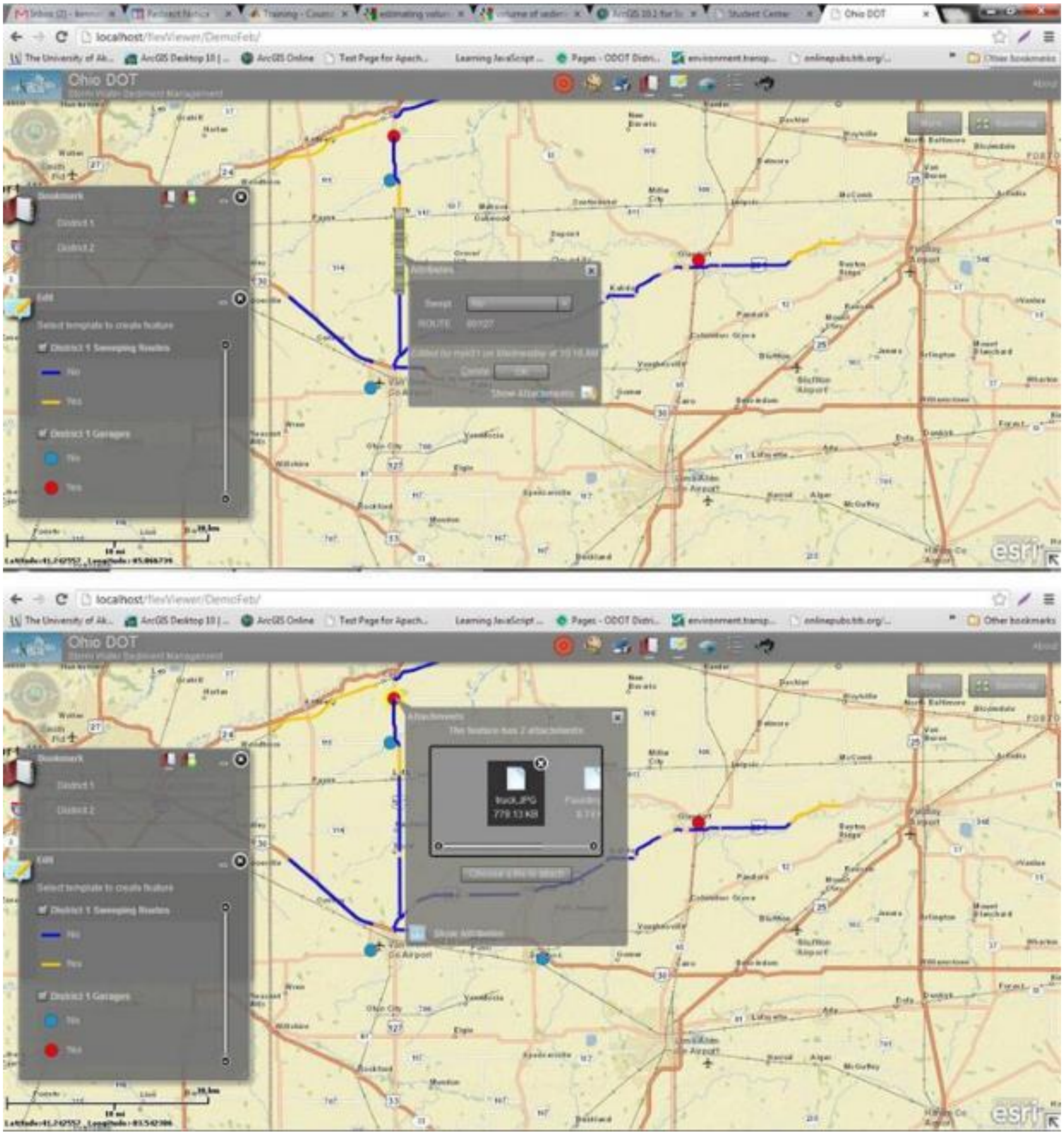


Figure 2.11: Example web application. The top figure shows that different data can be entered for different features. Here the road information is being edited. The lower figure shows that images or spreadsheet tables can be attached to garage locations. All users would be able to view the photograph or table after it is uploaded.

3. To eliminate the requirement of data entry by an end user and to improve the accuracy of the data, the last option requires the use of GPS units installed on individual trucks to collect information. The city of Tacoma, Washington, and Maricopa County, Arizona use in-truck GPS units to track street sweepers in real time (Akuoko, 2011, Talend, 2012). They are able to track the time of contact between the broom and the roadway to determine the duration of street sweeping activities. These data are uploaded directly to a city database and can then be used to map the routes that have been swept and to ensure that sweeping requirements, such as speed limits, are being met. These units could be used to estimate the volume of sweepings from the number of lane miles swept, but would likely be costly to implement.

A draft standard operating procedure (SOP) is provided in Chapter 6 with recommendation for material tracking that is consistent with current (i.e. 2016) ODOT database and GIS maps.

2.2.7 Background Data (2012 and 2013) Review Summary

During telephone interviews with ODOT District personnel, most Districts reported only minimal street sweeping activities. While widespread volume and cost information was not available, District 4 reported that 383 tons of sweepings were collected during fiscal year 2012, Medina County Garage collected six tons, and Huron County Garage collected four tons. These materials were disposed in a landfill.

Information regarding the volume of catch basin sediments collected was only available from District 2, where 285 tons of catch basin material was collected over a five year period. Material had to be stored on-site for five years due to the unwillingness of the local landfill to accept the material. Both Districts 1 and 2 reported that this is a problem for them. To manage catch basin sediments, some districts are using centralized decanting stations for liquid/solid separation. District 8 currently has a decanting station in Hamilton County, and similar decanting stations are currently under construction in Districts 1, 3, and 11. Based on the results of interviews with ODOT District personnel, facilities in Districts 1, 2, 4, 6, and 12 should be considered for detailed analysis during the next phase of the project along with the Forest Outpost in District 1, the Wayne County Garage in District 3, and the Hamilton County Garage in District 8.

Preliminary analytical data collected in Districts 2, 6, 7, 10, and 12 indicated that PAH concentrations in road and catch basin sediments may exceed the proposed Ohio EPA beneficial reuse guidelines for the use of these materials for traction, but did not for reuse as fill or aggregate. However, because these data were not collected to assess the viability of reusing these materials in accordance with the proposed Ohio EPA guidelines, definitive conclusions regarding the suitability of these materials for reuse purposes cannot be drawn at this time.

Interviews with officials representing non-ODOT entities (i.e. representatives from five agencies were contacted) revealed that none of them manage their street sweepings and sewer clean-out material differently than ODOT currently does. The cities of Columbus and Defiance both have decanting facilities that are similar in design, at least conceptually, to the ones currently operated and under design consideration at ODOTs various garages. None of the entities identified currently beneficially reuse the solid material after decanting.

CHAPTER III OPERATIONAL TRACKING AND ACTIVITY EVALUATION

The research presented in this chapter focuses on the operational tracking and activity evaluation of ODOT street sweeping and catch basin cleanout activities, as well as developing decision support tools for decanting activity monitoring and facility location selection. This chapter is divided into three sections:

- Section One - Organize Available ODOT Data of Street Sweepings and Catch Basin Cleanout Activity
- Section Two – Activity and Cost Tool Development and Analysis
- Section Three – Decanting Facility Location Selection Process and Ranking

3.1 Organize Available ODOT Data of Street Sweepings and Catch Basin Cleanout Activity

In 2013, data regarding street sweeping and drainage structure cleaning activities were collect from TMS with the support of ODOT personnel. Data regarding the number of accomplishments, equipment miles, labor hours, and costs for activities related to stormwater sediment management over the last five years were made available to the research team.

Because material is not always hauled directly to a landfill and weighed immediately after collection, material weights are an unknown quantity that must be estimated. In District 4, tons of sweepings disposed are recorded in TMS when material is hauled to a landfill. The material quantities often represent the accumulation of material over a period of weeks or months. Figure 3.1 shows the reported tonnage of sweeping material disposed from Mahoning, Stark, and Portage Counties from 2010 through 2012. Figure 3.2 shows the sweepings accomplishments (miles swept) for the garages of District 4 from 2010-2012.

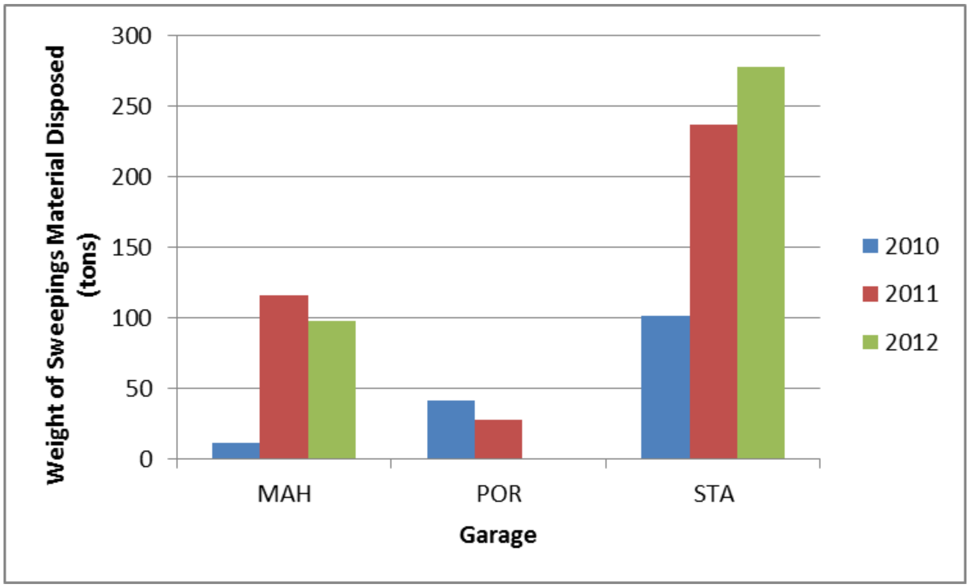


Figure 3.1: Weight of sweepings (tons) disposed from the Mahoning, Portage, and Stark County garages in District 4 in 2010, 2011, and 2012. Data from TMS.

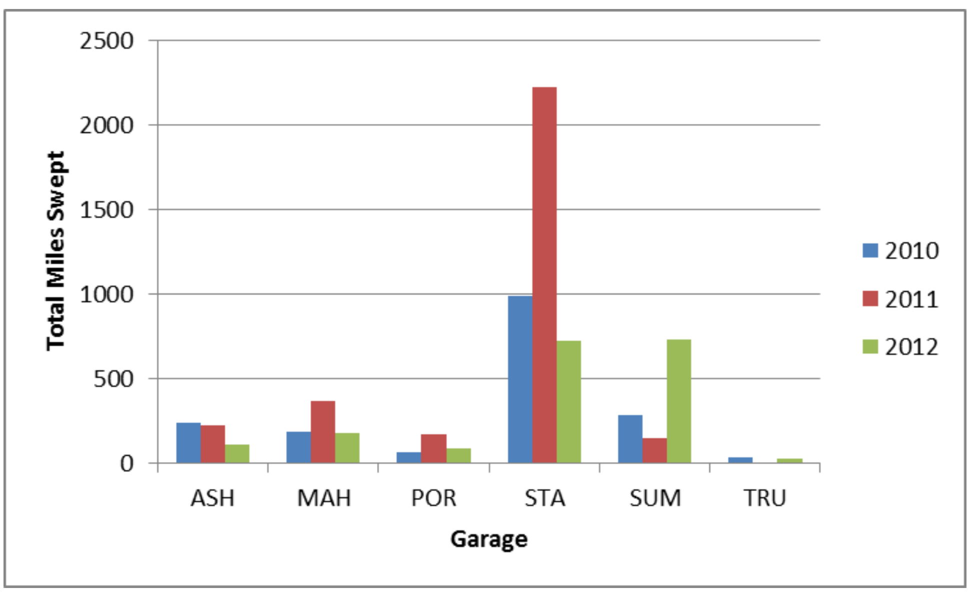


Figure 3.2: Sweepings accomplishments (miles swept) from 2010 through 2012 for District 4. Data from TMS.

The data summarized in Figures 3.1 and 3.2 were used to estimate a unit rate of material collected per mile swept, assuming that all sweeping accomplishments between disposal dates contributed to the material stockpile. These data may overestimate the actual amount of material collected because sweeping activity is not currently differentiated by whether material is collected or brushed off the roadway. Table 16 shows the calculated collection rate for Stark, Mahoning and Portage Counties from 2010 through 2012. As shown, median collection rates ranged from 332 lbs./mile in Stark County to 938 lbs./mile in Portage County. Literature reported unit collection rates ranged from 37 to 157 lbs./mile (San Diego, 2010). Factors influencing the collection rate include the type of sweeper, traffic count, precipitation, frequency of sweeping, and surrounding land use.

Table 16: Calculated unit material collection rates for Stark, Mahoning, and Portage Counties in District 4.

Unit Collection Rate; Based on data from 2010-June 2012						
	tons/mile			lbs/mile		
	Stark	Mahoning	Portage	Stark	Mahoning	Portage
Min	0.022	0.075	0.282	44	151	565
Max	2.189	3.775	0.656	4378	7550	1311
Median	0.166	0.401	0.469	332	802	938

The material collection rates are used as part of the activity and cost development tool discussed in the next section.

3.2 Activity and Cost Tool Development and Analysis

The activity tracking and cost tool developed for this project is an interactive, Excel-based tool that summarizes cost data from TMS and estimates material weights based on reported accomplishments. Given the fluid nature of databases managed by ODOT, it is important to note that this tool was developed primarily during 2012-2013, reviewed by ODOT technical liaisons, and presented at OTEC in October 2013. Figure 3.3 shows a snap shot of the main screen. Developing the tool in a Microsoft Excel environment suggests the tool will be accessible to a wide range of users. The tool summarizes District-specific cost and material weight information using a dashboard format to improve the user experience. The summary graphs can be viewed from the dashboard, but detailed cost information can be viewed by selecting the cost and material details buttons at the top of the screen. The purpose of the tracking tool is to provide a manager with an intuitive visual summary of estimated material quantities and costs for stormwater systems material collection activities within their District. As new data are recorded in TMS, the dashboard can be updated by importing data from TMS.

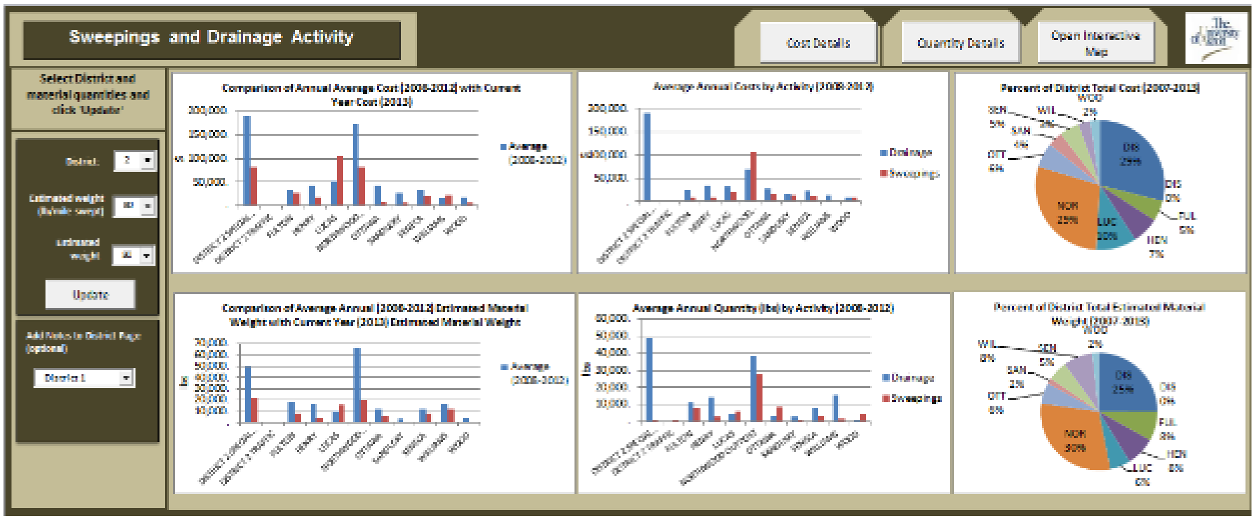


Figure 3.3: Sweepings and Drainage Activity Tracker Dashboard.

To display the material costs and estimated quantities for a given district, the District number is selected from a dropdown menu on the left side of the tool, as well as the sweepings collection rate (lbs./lane mile), and catch basin material weight (lbs./drainage activity recorded) (see Figure 3.4). Once the District is selected, all graphs automatically update. The ‘Add Notes’ dropdown menu at the left side of the screen can be used by individual garage managers to track pertinent information regarding stormwater cleaning activities and create an archive of this information for future use.

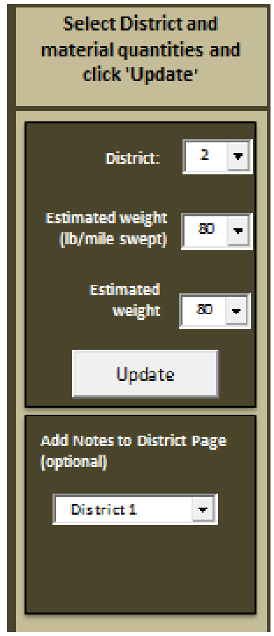


Figure 3.4: Menu for beginning to use the material tracking tool for a specific District.

Material collection costs are summarized in the three graphs at the top of the tool. These data were obtained directly from the ODOT Transportation Management System (TMS) Database. From left to right, the graphs show: 1.) A comparison of the average annual cost for the collection of all materials with the current year collection cost (Figure 3.5); 2.) The breakdown of average annual costs by activity (Figure 3.6); and 3.) Each garage's percentage of the district total cost for material collection (Figure 3.7). The average costs are calculated based on the activity information within the tool, which currently includes cost data from 2008-2013. However, the tool can also be updated as new information becomes available, either by obtaining data from TMS and copying it into the tool, or establishing a database connection between the tool and the TMS database.

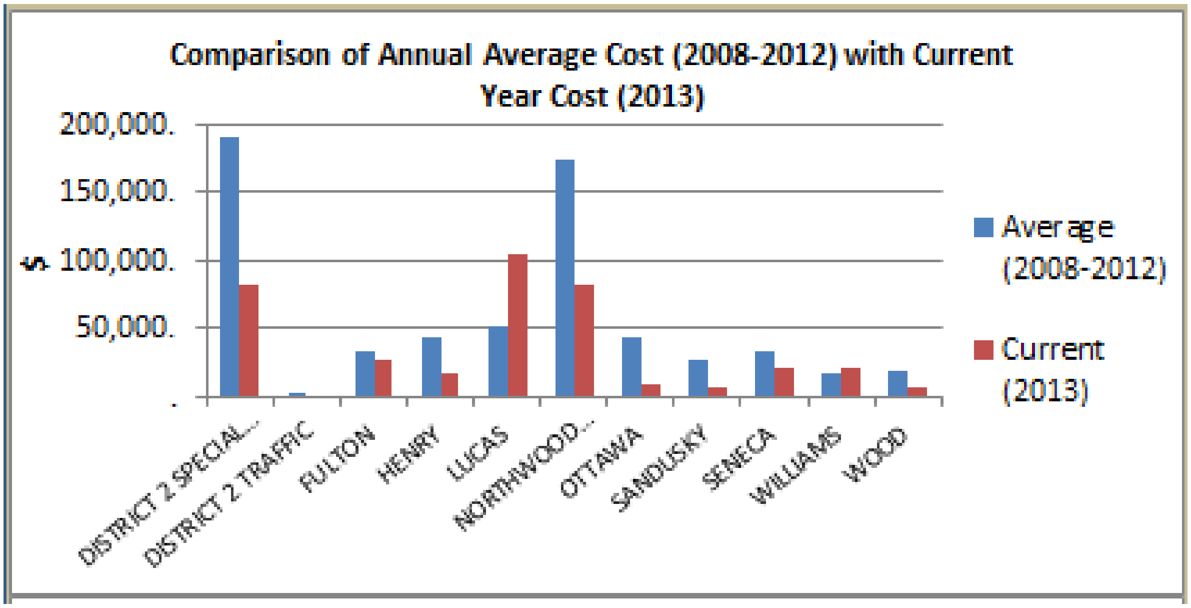


Figure 3.5: Comparison of the annual average material collection cost with the 2013 year cost; figure is a screenshot from the material tracking tool.

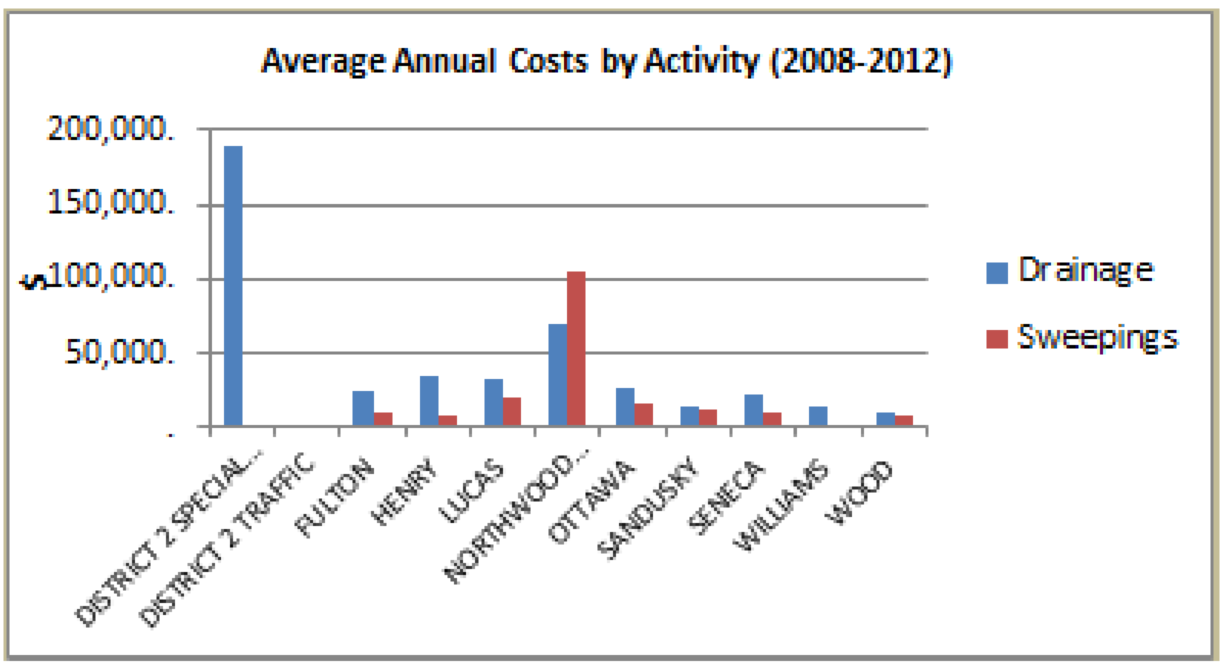


Figure 3.6: Breakdown of average annual costs by activity (2008-2012); figure is a screenshot from the material tracking tool.

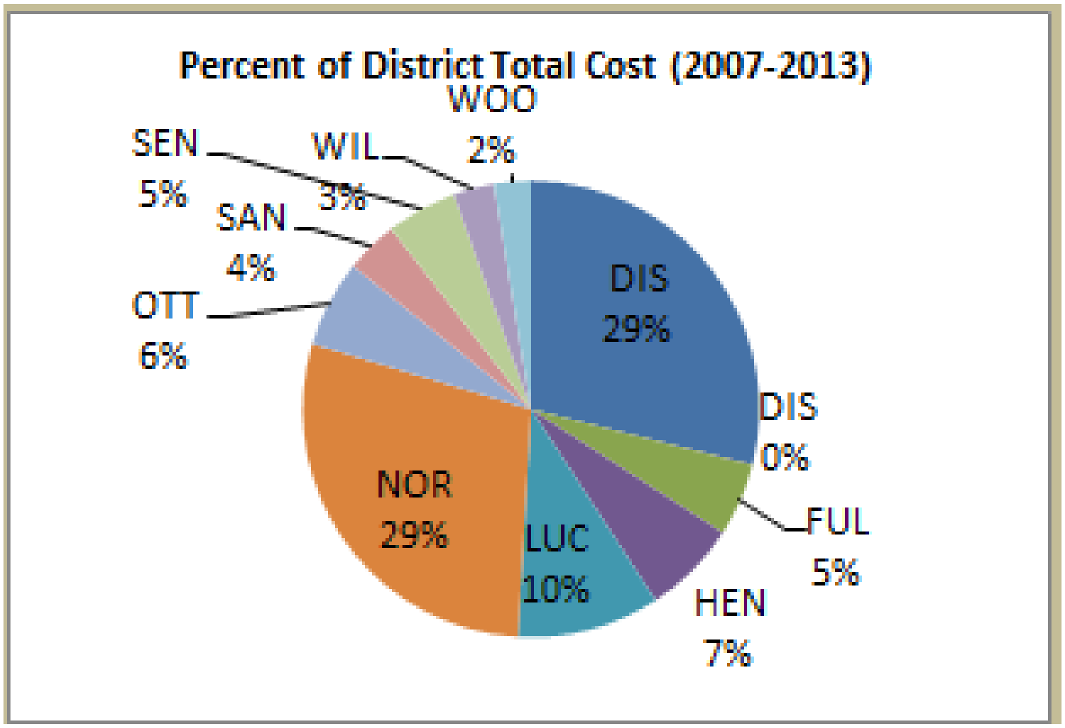


Figure 3.7: Percent of district total cost; figure is a screenshot from the material tracking tool.

The three graphs in the bottom row of the tool summarize material quantity estimates. The material quantity estimates were based on reported quantities from Wood County Garage in ODOT District 2 and literature reported collection rates and accomplishments from TMS discussed earlier in this chapter. From left to right in the dashboard, the bottom row of graphs shows 1.) A comparison of the average annual estimated material weight with the current year estimated material weight (Figure 3.8); 2.) The breakdown of the average estimated material quantity by activity (Figure 3.9); and 3.) Each garage's contribution to the district total estimated material quantity (Figure 3.10).

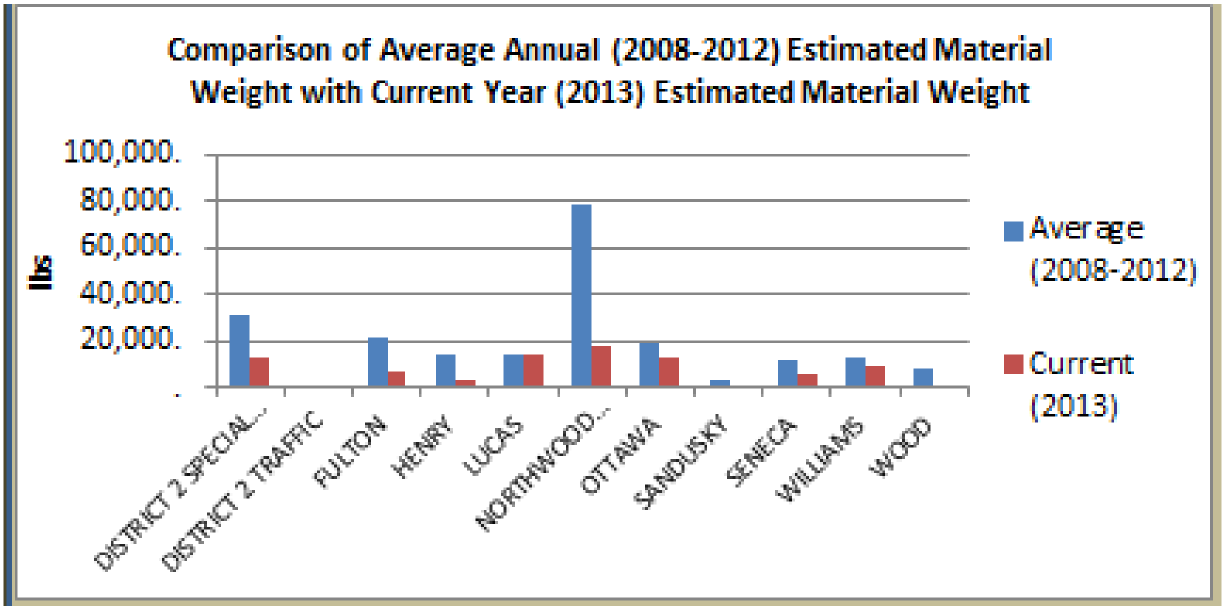


Figure 3.8: Comparison of the average annual estimated material weight with the 2013 estimated material weight.

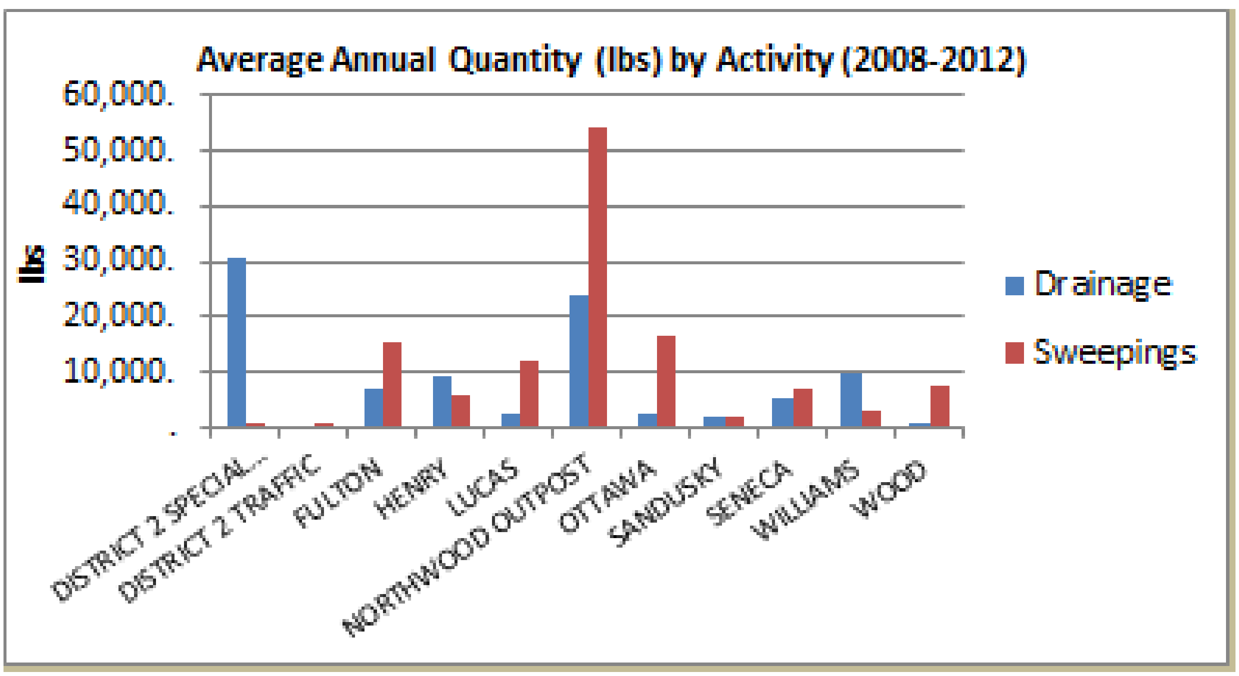


Figure 3.9: Breakdown of the average annual quantity of material collected by activity.

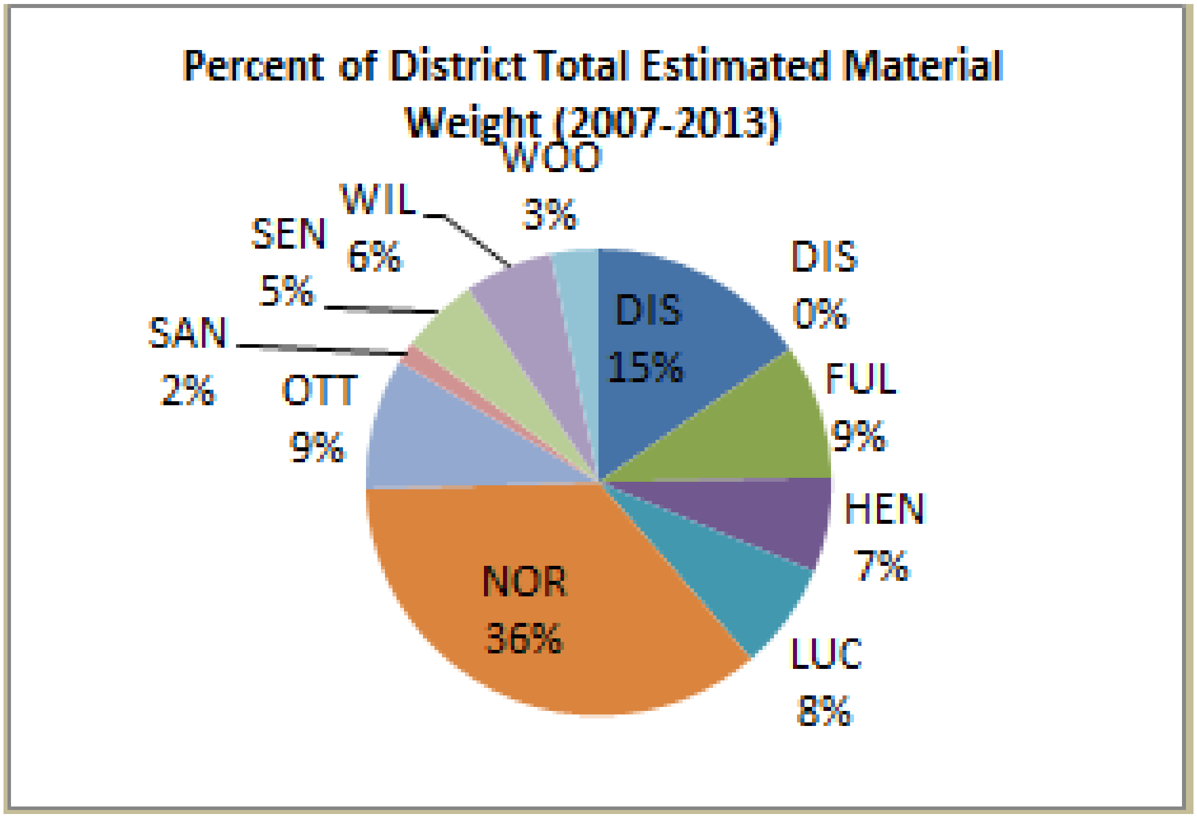


Figure 3.10: Percentage breakdown of the district total estimated material weight.

The menu at the top right of the dashboard includes navigation buttons that can be used to move between the dashboard and tabulated costs and quantity estimates (Figure 3.11). At the far right is a button placeholder (i.e. currently inactive) that could be used to open a locally stored map document that includes data specified by geographic location.

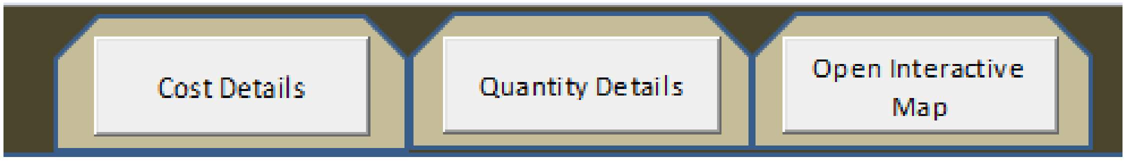


Figure 3.11: Menu showing links to detailed information on collection costs and material quantities.

3.3 Decanting Facility Location Selection Process and Ranking

This section includes an assessment of costs associated with stormwater material management, as well as ranking of decanting facility locations within a District based on multiple criteria. While costs for material collection (labor hours, equipment miles, equipment hours) are currently recorded in TMS, costs for material disposal are not. Based on the material quantity estimates developed earlier in this chapter, disposal costs were estimated at $25/ton (unit disposal cost in ODOT District 4) and $40/ton (unit disposal cost in ODOT District 2) to determine a range of costs that could be expected for disposing of these materials. As shown in Figure 3.12, within each District, the disposal costs represent less than 5% of the overall cost for collecting and disposing of these materials (i.e. disposal cost bar is barely visible in figure). To determine how this distribution of costs between disposal and collection would shift if the quantity estimates previously developed were underestimating the actual quantity of material, the disposal costs for 10 times the estimated material weight were calculated at the same disposal cost values of $25/ton and $40/ton. As shown in Figure 3.13, disposal costs would still be only a fraction of the collection costs. Therefore, the dominant cost factor associated with sweeping and drainage activities is the collection cost which includes labor hours, equipment miles, and equipment hours.

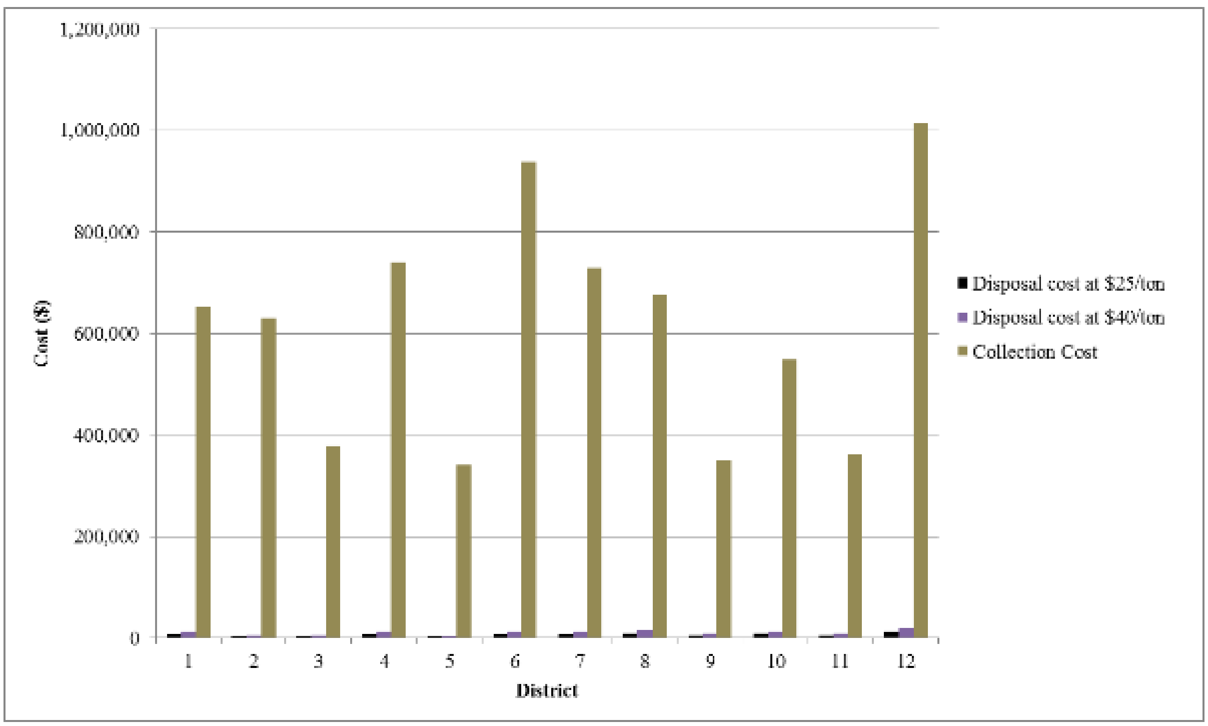


Figure 3.12: Comparison of the estimated range of disposal cost with the cost of material collection within each District. Disposal costs were calculated using the estimated material quantities; collection costs were reported in TMS.

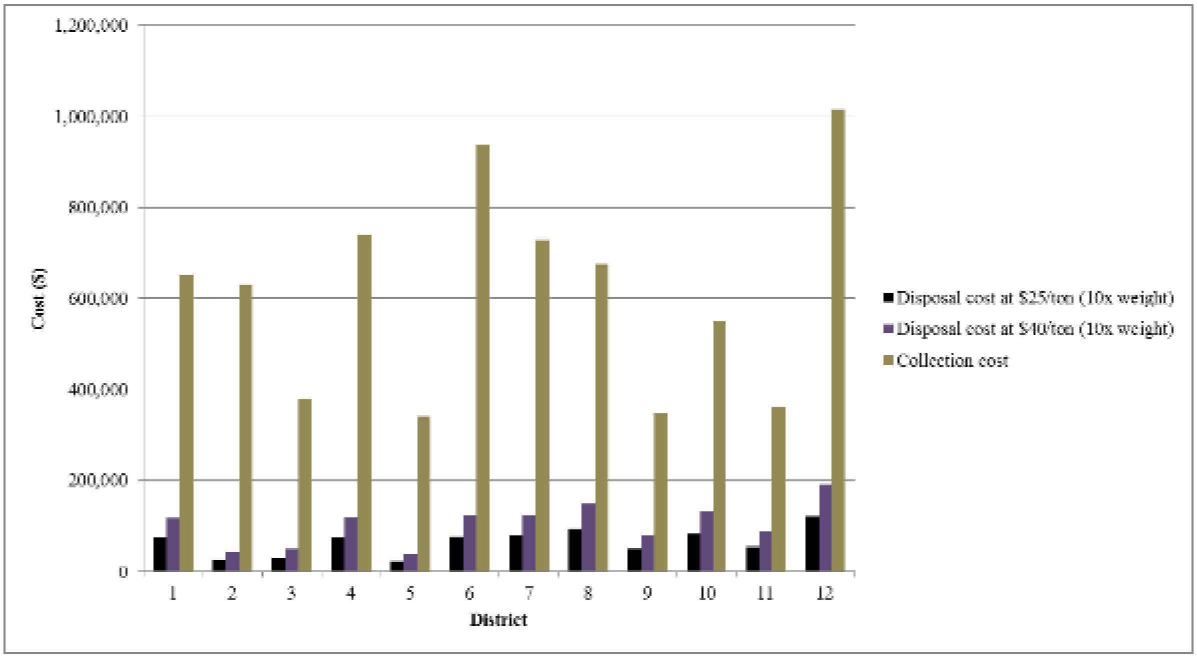


Figure 3.13: Comparison of the estimated range of disposal cost with the cost of material collection within each District. Disposal costs were calculated using ten times the estimated material quantities; collection costs were reported in TMS.

The next task was to utilize the activity and cost tool to rank locations or facilities within each District. To determine the optimal locations for decanting stations, all facilities within each District were ranked based on multiple factors including estimated material quantity, total annual cost, total annual labor hours, total annual equipment miles, and total annual equipment hours. The rankings were assigned using the five year average value for each factor from TMS, with higher rankings being assigned for higher levels of activity or cost. The rankings were then added to determine a score, and this score was used in conjunction with availability of sanitary sewer access to evaluate the suitability of each facility for decanting stations. By locating decanting stations at facilities with the most activity, hauling costs are minimized. Figures 3.14 to 3.16 show the ranking for every District. Varying the weighting of different factors (data not shown here for brevity) did not change the ranking order for the suitable facilities as all key cost factors are associated with activity.

			Criteria Scores				
Location	Suitability for Decant Station	Sanitary Sewer	Material Quantity	Total Annual Cost (excluding disposal)	Total Annual Labor Hours	Total Annual Equip. Miles	Total Annual Equip. Hours
1							
ALLEN COUNTY GARAGE	✓	Yes	9	8	8	6	9
WYANDOT COUNTY GARAGE	✓	Yes	6	9	9	9	7
HANCOCK COUNTY GARAGE	✓	Yes	5	6	7	7	8
HARDIN COUNTY GARAGE	✓	Yes	8	7	6	8	3
DEFIANCE COUNTY GARAGE	!	Yes	7	5	5	4	4
PAULDING COUNTY GARAGE	!	Yes	2	4	4	5	6
VAN WERT COUNTY GARAGE	!	Yes	4	3	3	3	2
PUTNAM COUNTY GARAGE	!	Yes	3	2	2	2	5
DISTRICT 1 BRIDGE	✗	#N/A	1	1	1	1	1
Weight			**0.3**	**0.2**	**0.2**	**0.2**	**0.1**
2							
NORTHWOOD OUTPOST	✓	Yes	11	10	11	11	11
LUCAS COUNTY GARAGE	✓	Yes	7	9	9	8	9
FULTON COUNTY GARAGE	✓	Yes	9	6	7	9	6
OTTAWA COUNTY GARAGE	✓	Yes	8	8	8	5	8
SENECA COUNTY GARAGE	!	Yes	4	5	5	6	3
SANDUSKY COUNTY GARAGE	!	Yes	2	4	4	3	7
WOOD COUNTY GARAGE	!	Yes	3	3	3	4	5
WILLIAMS COUNTY GARAGE	✗	Yes	5	2	2	2	2
DISTRICT 2 SPECIAL PROJS	✗	#N/A	10	11	10	10	10
HENRY COUNTY GARAGE	✗	No	6	7	6	7	4
DISTRICT 2 TRAFFIC	✗	#N/A	1	1	1	1	1
3							
DISTRICT 3 GARAGE	✓	Yes	9	10	10	10	10
ERIE COUNTY GARAGE	✓	Yes	8	9	9	9	9
RICHLAND COUNTY GARAGE	✓	Yes	10	7	8	8	8
MEDINA COUNTY GARAGE	✓	Yes	7	8	7	7	7
LORAIN COUNTY GARAGE	!	Yes	3	6	6	3	6
WAYNE COUNTY GARAGE	!	Yes	6	4	4	2	4
ASHLAND COUNTY GARAGE	!	Yes	5	2	2	4	5
CRAWFORD COUNTY GARAGE	!	Yes	4	3	3	5	2
AVON OUTPOST	✗	Yes	1	1	1	1	1
HURON COUNTY GARAGE	✗	No	2	5	5	6	3
4							
STARK COUNTY GARAGE	✓	Yes	7	6	7	7	6
MAHONING COUNTY GARAGE	✓	Yes	4	5	5	5	4
PORTAGE COUNTY GARAGE	!	Yes	2	3	2	3	5
ASHTABULA COUNTY GARAGE	!	Yes	3	2	3	4	2
TRUMBULL COUNTY GARAGE	✗	Yes	1	1	1	2	1
DISTRICT 4 BRIDGE/CULVERT	✗	#N/A	5	7	6	1	7
SUMMIT COUNTY GARAGE	✗	No	6	4	4	6	3

Figure 3.14: Decanting facility location rankings for Districts 1-4 and suitability analysis (based on sanitary sewer availability). Material quantities and collection costs were reported in TMS.

Location	Suitability for Decant Station	Sanitary Sewer	Criteria Scores: Material Quantity	Total Annual Cost (excluding disposal)	Total Annual Labor Hours	Total Annual Equip. Miles	Total Annual Equip. Hours
5							
PERRY COUNTY GARAGE	✓	Yes	7	7	8	8	6
COSHOCTON COUNTY GARAGE	✓	Yes	9	5	5	7	8
GUERNSEY COUNTY GARAGE	✓	Yes	5	6	7	6	4
KNOX COUNTY GARAGE	!	Yes	4	4	4	3	5
FAIRFIELD COUNTY GARAGE	!	Yes	6	3	3	4	3
DISTRICT 5 BRIDGE	✗	#N/A	2	2	2	2	2
DISTRICT 5 SPECIAL PROJS	✗	#N/A	3	9	6	5	10
DISTRICT 5 TRAFFIC	✗	#N/A	1	1	1	1	1
LICKING COUNTY GARAGE	✗	No	10	10	10	10	9
MUSKINGUM COUNTY GARAGE	✗	No	8	8	9	9	7
6							
UNION COUNTY GARAGE	✓	Yes	15	16	16	17	8
DELAWARE COUNTY GARAGE	✓	Yes	16	10	11	10	17
MARION COUNTY GARAGE	✓	Yes	14	11	12	14	11
CHESTERVILLE OUTPOST	✗	No	1	1	1	1	1
DIST 6 BRIDGE	✗	#N/A	4	6	6	4	16
DIST 6 HWY MGMT	✗	#N/A	2	2	2	1	3
DIST 6 SPECIAL PROJECTS	✗	#N/A	5	15	10	5	19
FAYETTE COUNTY GARAGE	✗	No	8	7	7	8	6
FIRST RESPONSE TEAM	✗	#N/A	3	3	3	3	1
FRANKLIN COUNTY GARAGE	✗	No	20	20	20	20	20
GROVE CITY OUTPOST	✗	No	12	14	15	18	9
HILLIARD OUTPOST	✗	No	10	8	8	9	10
JEFFERSONVILLE OUTPOST	✗	No	7	5	5	7	5
MADISON COUNTY GARAGE	✗	No	18	19	19	19	14
MORROW COUNTY GARAGE	✗	No	11	12	13	15	15
MOUNT STERLING OUTPOST	✗	No	19	18	18	12	7
PICKAWAY COUNTY GARAGE	✗	No	13	13	14	16	13
WEST JEFFERSON OUTPOST	✗	No	17	17	17	13	18
WESTERVILLE OUTPOST	✗	#N/A	9	9	9	11	12
WORTHINGTON OUTPOST	✗	No	6	4	4	6	4
7							
MONTGOMERY COUNTY GARAGE	✓	Yes	11	12	12	12	12
CLARK COUNTY GARAGE	✓	Yes	7	10	10	10	11
MIAMI COUNTY GARAGE	✓	Yes	5	11	11	11	10
LOGAN COUNTY GARAGE	!	Yes	9	8	9	7	4
CHAMPAIGN COUNTY GARAGE	!	Yes	12	4	6	9	5
AUGLAIZE COUNTY GARAGE	!	Yes	8	6	7	6	7
DARKE COUNTY GARAGE	!	Yes	10	3	5	8	6
MERCER COUNTY GARAGE	!	Yes	6	7	8	3	3
SHELBY COUNTY GARAGE	✗	Yes	2	2	2	2	2
DIST 7 SPECIAL PROJECCTS	✗	#N/A	4	9	4	5	9
DISTRICT 7 BRIDGE	✗	#N/A	1	1	1	1	1
DISTRICT 7 M & R	✗	#N/A	3	5	3	4	8
8							
HAMILTON COUNTY GARAGE	✓	Yes	11	11	11	11	11
BLUE ASH OUTPOST	✓	Yes	10	10	10	10	10
CLERMONT COUNTY GARAGE	✓	Yes	8	9	9	9	9
BUTLER COUNTY GARAGE	✓	Yes	9	8	8	8	8
GREENE COUNTY GARAGE	!	Yes	7	6	7	7	6
CLINTON COUNTY GARAGE	!	Yes	6	7	6	6	3
WARREN COUNTY GARAGE	!	Yes	4	5	5	5	7
DISTRICT 8 HWY MGMT	✗	#N/A	2	2	2	2	1
DISTRICT 8 TRAFFIC	✗	#N/A	1	1	1	1	1
MIAMITOWN OUTPOST	✗	No	5	4	4	3	4
PREBLE COUNTY GARAGE	✗	No	3	3	3	4	5

Figure 3.15: Decanting facility location rankings for Districts 5-8 and suitability analysis (based on sanitary sewer availability). Material quantities and collection costs were reported in TMS.

Location	Suitability for Decant Station	Sanitary Sewer	Criteria Scores: Material Quantity	Criteria Scores: Total Annual Cost (excluding disposal)	Criteria Scores: Total Annual Labor Hours	Criteria Scores: Total Annual Equip. Miles	Criteria Scores: Total Annual Equip. Hours
9							
PIKE COUNTY GARAGE	✓	Yes	6	8	8	7	8
SCIOTO COUNTY GARAGE	✓	Yes	7	7	7	8	7
BROWN COUNTY GARAGE	✓	Yes	5	6	6	5	5
LAWRENCE COUNTY GARAGE	!	Yes	2	4	5	4	4
HIGHLAND COUNTY GARAGE	!	Yes	3	3	3	3	1
ROSS COUNTY GARAGE	!	Yes	4	2	2	2	3
ADAMS COUNTY GARAGE	✗	No	8	5	4	6	6
JACKSON COUNTY GARAGE	✗	No	1	1	1	1	2
10							
WASHINGTON COUNTY GARAGE	✓	Yes	12	12	12	12	12
HOCKING COUNTY GARAGE	✓	Yes	9	9	10	9	10
ATHENS COUNTY GARAGE	✓	Yes	10	10	9	10	7
NOBLE COUNTY GARAGE	!	Yes	5	8	8	8	5
MONROE COUNTY GARAGE	!	Yes	4	6	6	7	6
NOBLE COUNTY GARRAGE	!	Yes	6	4	5	6	4
GALLIA COUNTY GARAGE	✗	Yes	3	3	3	3	3
DISTRICT 10 GARAGE	✗	Yes	1	1	1	2	1
DISTRICT 10 BRIDGE	✗	#N/A	2	2	2	1	1
MEIGS COUNTY GARAGE	✗	No	8	5	4	4	11
MORGAN COUNTY GARAGE	✗	No	7	7	7	5	8
VINTON COUNTY GARAGE	✗	No	11	11	11	11	9
11							
BELMONT COUNTY GARAGE	✓	Yes	10	10	10	10	10
JEFFERSON COUNTY GARAGE	✓	Yes	7	9	9	8	7
CARROLL COUNTY GARAGE	✓	Yes	8	7	6	7	8
HARRISON COUNTY GARAGE	!	Yes	5	5	5	5	3
HOLMES COUNTY GARAGE	!	Yes	6	4	4	4	5
COLUMBIANA COUNTY GARAGE	✗	No	4	6	8	6	6
DISTRICT 11 ROADWAY SVC	✗	#N/A	3	3	3	3	4
SAINT CLAIRSVILLE OUTPOST	✗	No	1	2	1	1	1
TORONTO OUTPOST	✗	No	1	1	1	1	1
TUSCARAWAS COUNTY GARAGE	✗	No	9	8	7	9	9
12							
INDEPENDENCE OUTPOST	✓	Yes	10	10	10	10	9
LAKE COUNTY GARAGE	✓	Yes	8	7	7	8	5
MAYFIELD OUTPOST	!	Yes	6	5	4	6	4
CLEVELAND OUTPOST	✗	No	5	8	8	7	8
DISTRICT 12 BRIDGE INSPEC	✗	#N/A	1	2	2	1	1
DISTRICT 12 HWY MGMT	✗	#N/A	3	4	5	3	6
DISTRICT 12 LIGHTING	✗	#N/A	1	1	1	1	2
GEAUGA COUNTY GARAGE	✗	No	4	3	3	5	3
RIVEREDGE OUTPOST	✗	No	9	9	9	9	10
WARRENSVILLE OUTPOST	✗	No	7	6	6	4	7

Figure 3.16: Decanting facility location rankings for Districts 9-12 and suitability analysis (based on sanitary sewer availability). Material quantities and collection costs were reported in TMS.

In addition to summarizing historical data, the activity tool could be linked to a spatial analysis tool designed to select optimal locations for decanting stations based on minimizing the distance traveled between facilities. It is anticipated that this tool could be used in conjunction with the historical cost and accomplishment data to determine the best location(s) for decanting stations within each District to minimize total management costs. We ran a spatial analysis model for two different scenarios in District 1: 1.) select one location; and 2.) select two locations. Figure 3.17 shows the results of this analysis for District 1. If only one location is desired, the best location in District 1 is the Allen County Garage. However, if two locations are desired, the Paulding and Hardin County Garages become the optimal choices based solely on distance. The model results include the travel distances, which can then be used to calculate the total cost of hauling for each trip for different scenarios (see Table 17).

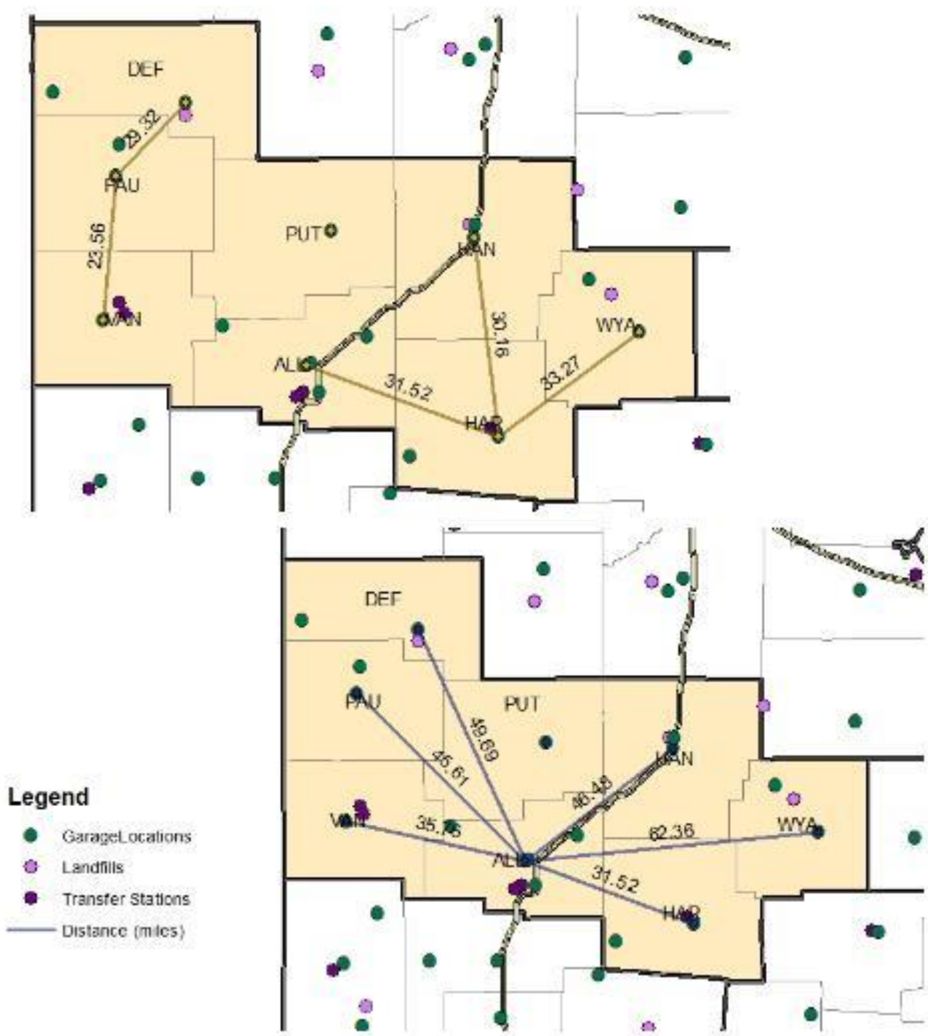


Figure 3.17: Results of spatial analysis for District 1. In the top figure, it was specified that two locations be selected, while in the bottom figure, it was specified that only one central location be selected. Distances shown as straight lines represent actual travel distances along the roadways.

Table 17: Estimated hauling cost per trip based on the location analysis shown in Figure 3.17. Hauling cost estimate assumes an average cost of $1.12/mile.

One Decanting Station			Two Decanting Stations		
Route	One Way Distance	Hauling Cost	Route	One Way Distance	Hauling Cost
Allen County Garage (ALLCG) - Allen County Garage (ALLCG)	0.00	0.00	Allen County Garage (ALLCG) - Hardin County Garage (HARCG)	31.52	70.60
Defiance County Garage (DEFCG) - Allen County Garage (ALLCG)	49.69	111.32	Hancock County Garage (HANCG) - Hardin County Garage (HARCG)	30.16	67.56
Hancock County Garage (HANCG) - Allen County Garage (ALLCG)	46.48	104.11	Hardin County Garage (HARCG) - Hardin County Garage (HARCG)	0.00	0.00
Hardin County Garage (HARCG) - Allen County Garage (ALLCG)	31.52	70.60	Wyandot County Garage (WYACG) - Hardin County Garage (HARCG)	33.27	74.53
Paulding County Garage (PAUCG) - Allen County Garage (ALLCG)	45.61	102.17	Defiance County Garage (DEFCG) - Paulding County Garage (PAUCG)	29.32	65.67
Van Wert County Garage (VANCG) - Allen County Garage (ALLCG)	35.76	80.09	Paulding County Garage (PAUCG) - Paulding County Garage (PAUCG)	0.00	0.00
Wyandot County Garage (WYACG) - Allen County Garage (ALLCG)	62.36	139.69	Van Wert County Garage (VANCG) - Paulding County Garage (PAUCG)	23.56	52.78
Total Hauling Cost		**607.98**			**331.15**

The District level ranking and site identification provides an excellent starting point for the planning and budgeting process. We recommend additional confirmation analysis once a budgeting process and directive is considered or issued for decanting facility requirements for each District.

CHAPTER IV DECANTING FACILITY DESIGN AND CONSTRUCTION

This chapter presents the research activities associated with the design and construction of the decanting facility at the Lucas County (Ohio) garage. The chapter is divided into two sections:

- Section One – Decanting Site Visits and Facility Planning Activities
- Section Two – Decanting Facility Design and Construction

4.1 Decanting Site Visits and Facility Planning Activities

This section summarizes decanting site visits and facility planning activities prior to the design and construction of the decanting facility.

4.1.1 Existing Decanting Facility Site Visits

Site visits in 2013 and earlier at ODOT facilities showed both uncovered material storage (Figure 4.1 and 4.2) and covered material storage (Figure 4.3).

Figure 4.1: Hamilton County (District 8) material storage area.

Figure 4.2: Wood County (District 2) material storage area.

Figure 4.3: Forest Outpost (District 1) material storage area.

Improvements to the uncovered facility design implemented in District 4 include grates for trash separation and connection to sanitary sewer (Figure 4.4).

Figure 4.4: District 4 decanting facility with grates to separate trash and prevent solids from entering sewer.

After presenting at the Ohio Transportation Engineering Conference in October 2013 (Columbus, Ohio), representatives from the City of Solon (Ohio) approached the research team about visiting their decanting facility. A visit to their facility took place in March 2014 and site visit pictures are shown in Figure 4.5 and Figure 4.6. The facility is operated by the City Service Department at 6600 Cochran Road, and receives all the City's street sweeping and sewer cleanout material for decanting. Air drying is the last step before being transported to a landfill.

Figure 4.5: Aerial view of Solon, Ohio decanting facility.

Figure 4.6: Solon, Ohio decanting facility: general layout and catch basins.

The facility is relatively basic and consists of a slab on grade concrete pad surrounded on three sides by cast in place concrete walls approximately 4 feet high. The facility is approximately 40 ft. by 40 ft. and has no roof. The floor is gently sloped to the back wall which has a series of five catch basins that allow drainage into a subsurface channel which leads to an underground storage tank. The tank is pumped and discharged to a sanitary sewer periodically as needed. A hydrant is located adjacent to the facility to provide high pressure water for cleaning out equipment and washing down the facility when necessary.

The facility manages material by directly dumping from the City's street sweepers and vactor trucks onto the floor of the facility. After the free water drains, a 14 ton wheel loader is used to manage the material by pushing and stacking the semi-dry material to one side of the facility for additional drying time. Once enough material had accumulated, it is loaded into a tandem axle dump truck and transported to a landfill. During peak periods in the spring when the City is actively sweeping and cleaning out sewers, the facility can process up to approximately 70 tons of material a week.

Managers of the facility have discussed the possibility of constructing a cover to prevent reinfiltration of water into the cleanout material. The City is also looking at improving operations by adding a raised portion of the floor to facilitate drainage and managing the material to provide an extended drainage path between the longer term deposition area and the catch basins to reduce the frequency of cleanout of the catch basins.

4.1.2 Facility Planning Activities (Key Meetings and Facility Sizing Tool)

The research team had several key meetings prior to the meetings associated with the design and construction phase described in the next section of this chapter (section 4.2). One of the first comprehensive meetings involved the entire research team and all ODOT technical liaison members on May 7, 2013. The meeting included site visits to the decanting operations at the Wood County and Lucas County facilities (see Figure 4.2). A major focus of the meeting was documenting the best practices and lessons learned from the Wood County and Lucas County facilities. Key points from this meeting will be presented in section 4.2, as they formed the initial basis for the design of the new facility.

On June 20, 2013, the research team participated in a conference call with ODOT and OEPA. The purpose of this meeting was to determine how to proceed with gaining OEPA approval for the reuse of sweepings and drainage structure cleanout material as alternate daily cover at a landfill and to obtain feedback on the proposed project sampling and analysis plan. Two general options were outlined: 1) Approve the material through a director's letter in accordance with the current landfill operational rules and 2.) Pursue approval through Ohio EPA's beneficial use program.

The first option represents the current method of approval. It has the advantage of being an existing, well understood process by Ohio EPA staff. However, historically this process can be tedious and would require director's letters for each landfill where the material could be used. Based on the meeting with Ohio EPA, they appear to be open to developing a procedure to help reduce the time and effort involved with a reasonably robust analytical dataset to rely on.

The second option is attractive because Ohio EPA is currently reviewing their beneficial use rules and ODOT is positioned to provide input and direction on how these materials are regulated in the future. Although rule revisions are in their preliminary stages, three categories for obtaining approval for the reuse of stormwater sediments were discussed: 1.) exclusion, 2.) general permit, 3.) individual permit. If the materials can be regulated in either category 1 or 2, no further authorizations from Ohio EPA would be necessary. To be regulated in this manner, a robust analytical dataset would also be necessary. Because Ohio EPA is in the preliminary stages of rulemaking, the duration for final rulemaking is uncertain as is the result. However, OEPA staff indicated that they would be open to the possibility of allowing the reuse of material collected from drainage structures as well as sweepings for alternate daily cover as a category 1 or 2, if analytical data support it. OEPA indicated they would look further into this option and were also open to using street sweepings as a "test case" for a draft general permit.

OEPA also provided preliminary feedback on our solid waste and decanting liquid sampling plan, indicating it was comprehensive. The sampling plan for the solid waste included TCLP metals, total metals, SVOCs, and TPH-GRO/DRO/ORO. Liquid samples will also be collected directly from the eductor truck or the decanting bay and analyzed for total metals to assess the potential risk of the decant water. Chapter 5 will present the sampling results for characterizing street sweeping and drainage structure materials from five geographically distinct locations in Ohio, as well as results from the "prototype" facility.

As a result of concerns expressed by wastewater treatment plants (i.e. utilities receiving the decant water from ODOT facilities), the research team was involved in several meetings in mid-2014 with both the utility, consulting engineers, and ODOT facility personnel. The details of these meetings cannot be disclosed in this report; however, they highlighted the need to be proactive and forward thinking regarding the needs of sanitary sewer systems receiving decant water. Chapter 5 will address this further as decant water metal analysis and metal adsorption media testing results will be presented.

In addition to the activity and material tracking tool presented in Chapter 3, the research team developed a tool for estimating the area or footprint needed to manage stormwater system cleanout materials.

As shown in Figure 4.7, it is anticipated that the sizing tool will be used in conjunction with the material tracking tool to size facilities based on material quantities. Estimated material quantities within each district or at individual garage locations, which are generated based on activity reports obtained from TMS, can be reviewed in the material tracking tool. These estimates can then be used in the decanting station sizing tool to estimate the number of standard size bays needed.

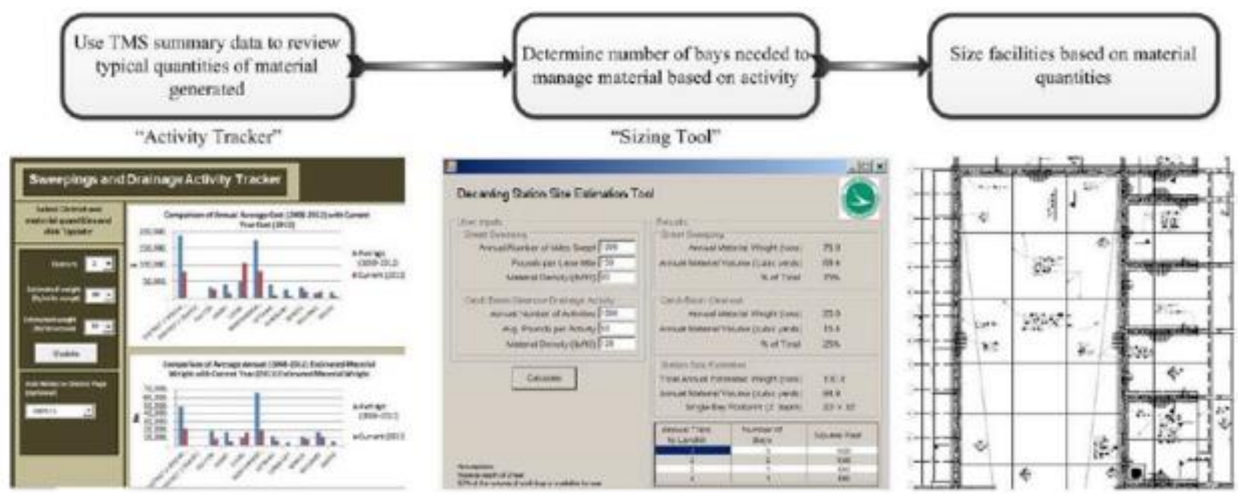


Figure 4.7: Expected workflow for sizing decanting facilities.

The tool was developed in Visual Basic as a stand-alone application that can be installed and run on any computer with a Windows platform. The tool requires user input values for the annual number of miles swept, the annual number of basins cleaned, the unit collection rates, and the material densities. Default values for the unit collection rates and material densities will be provided by the tool, but can be modified by the user. The tool converts these user input values to an estimate of the weight and volume of material collected annually and will calculate the number of standard size bays required to manage this material dependent on the number of times material will be collected and hauled off-site for disposal. Fewer trips may save on hauling costs, but will require a larger area for managing material.

Figure 4.8 summarizes the conversion of user inputs to an estimate of the number of bays required in the facility sizing tool. Material weights and volumes are calculated separately for sweeping material and catch basin material depending on user input values for activity, unit collection rates, and material densities and then summed to determine the total annual weight and volume of material. The amount stored on site at any given time is then calculated based on the annual number of trips to the landfill. To determine the number of bays required, the amount of material stored on-site is divided by the volume that a standard size bay (measuring 20 feet by 32 feet) would accommodate at a material depth of two feet. For calculation purposes, it is assumed that only 80% of this volume would be used. Detailed equations are provided in Table 18 and a screenshot of the tool is shown in Figure 4.9.

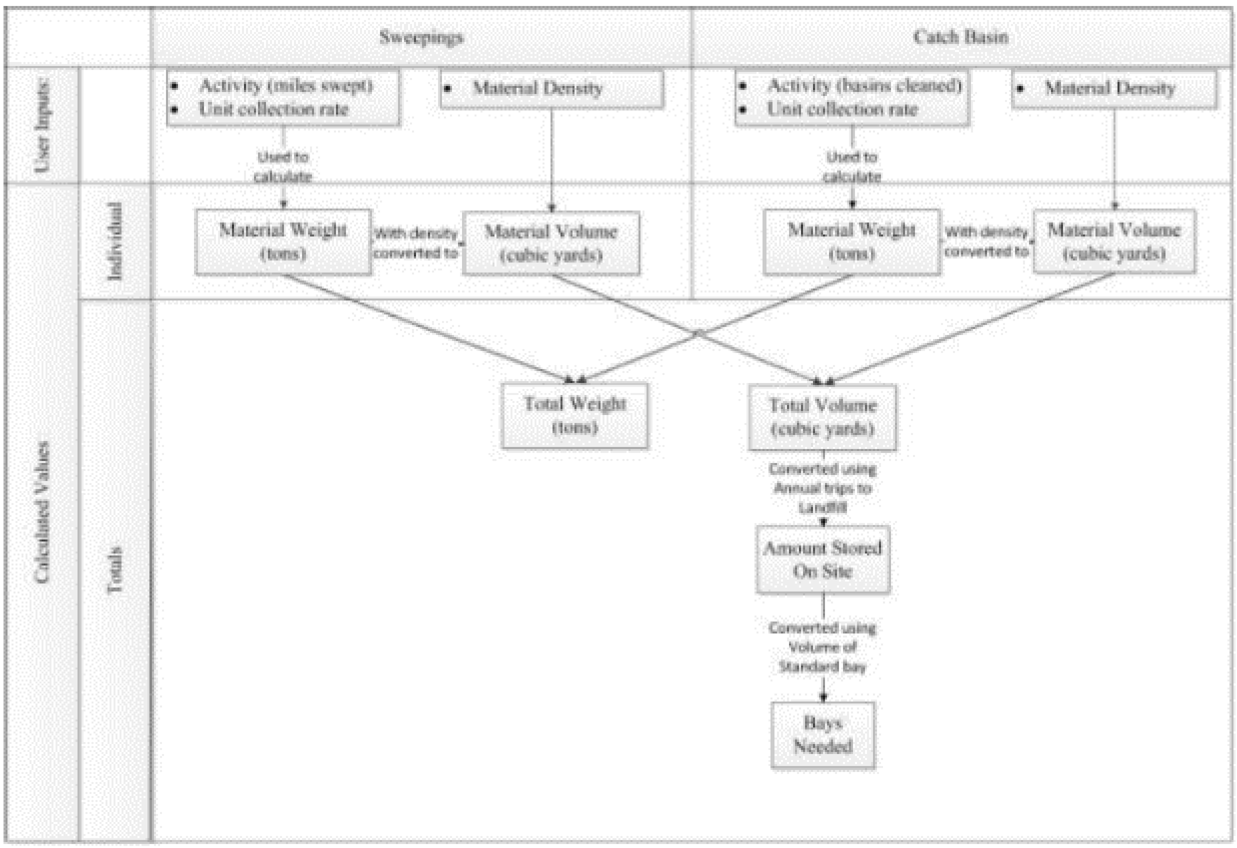


Figure 4.8: Summary of calculations used in the decanting sizing tool.

Table 18: Equations used to calculate values in the decant station sizing tool. Parameters in orange-lightly shaded are user specified values.

$$\textit{Material Weight (tons)} = \textit{Miles Swept} * \textit{Unit Rate}\left(\frac{lb}{\textit{miles swept}}\right) * \frac{1\ ton}{2{,}000\ lb}$$

$$\textit{Material Volume (cubic yards)} = \textit{Miles Swept} * \textit{Unit Rate}\left(\frac{lb}{\textit{miles swept}}\right) * \left(\frac{1}{\textit{density}\left(\frac{lb}{ft^3}\right)}\right) * \left(\frac{1\ yd^3}{27\ ft^3}\right)$$

$$\textit{Total Weight (tons)} = \textit{Sweepings Weight (tons)} + \textit{Catch Basin Weight (tons)}$$

$$\textit{Total Volume (cubic yards)} = \textit{Sweepings Volume (cubic yards)} + \textit{Catch Basin Volume (cubic yards)}$$

$$\%\ \textit{of Total} = \frac{\textit{Sweepings Weight (tons)}}{\textit{Total Weight (tons)}} * 100$$

$$\textit{Usable Volume of Single Bay (cubic feet)} = (20\ feet) * (32\ feet) * (2\ feet) * 0.8$$

Where 0.8 is the percentage of the bay used

$$\textit{Amount of Material Stored (cubic feet)} = \frac{\textit{Total Material Volume (cubic yards)} * \left(27\frac{ft^3}{1yd^3}\right)}{\textit{Annual Trips to Landfill}}$$

$$\textit{Number of Bays Needed} = \frac{\textit{Amount of Material Stored (cubic feet)}}{\textit{Volume of Standard Bay (cubic feet)}}$$

Notes:

1. Single bay dimensions of 20x32x2 feet are based on the current design
2. Final bay design for working versus storage areas is still to be determined
3. The 0.8 factor in the usable volume calculation above assumes only 80% of a bay will be utilized

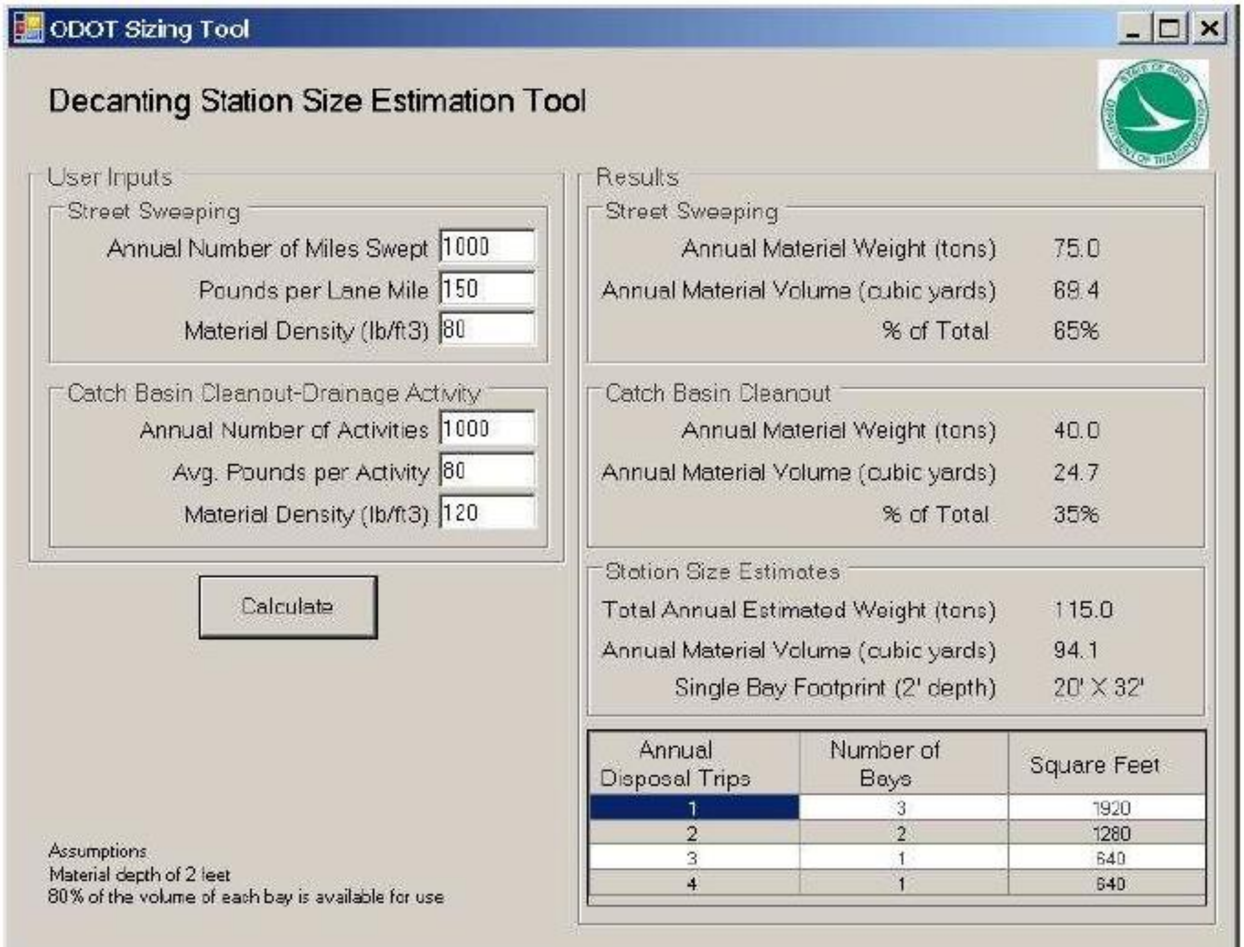


Figure 4.9: Decanting station sizing tool screenshot.

Table 19 summarizes the street sweeping and drainage structure cleaning accomplishments for District 2 from 2007 through 2013. ODOT District 2 cleaned an average of 1,988 drainage structures and swept 733 lane miles annually from 2008 through 2013. Because data from 2007 were not complete, they were not included in the calculation of the annual average. A review of individual garage data (included in the activity tracking tool) reveals the drainage activity was the highest at the Northwood Outpost Garage in 2012 and 2013, where almost 1,100 drainage structures were cleaned. In addition, approximately 117 lane miles were swept by the Northwood Outpost Garage in 2013 and 279 lane miles were swept in 2012 (Prior to 2013, sweeping accomplishments were the sum of three activities: Clean Curbs Gutters and Along Medians, Cleaning/Sweeping, and Cleaning Pavement and/or Berm).

Table 19: Summary of activity in District 2 from 2007 through 2013. Note: data were collected from June 2007 through November 2013; annual data are summed based on calendar year, not fiscal year. The average was calculated from 2008-2013 because 2007 only represents a half year.

Year	Cleaning Drainage Structures	Clean Curbs Gutters and Along Medians	Cleaning Sweeping	Cleaning Pavement and/or Berm (Acc)	Sweeping Total
2007	784	206.1		187.83	393.93
2008	2237	378.03		434.23	812.26
2009	1921	260.14		294.1	554.24
2010	834	612.09		804	1416.09
2011	2238.6	109.96		544.42	654.38
2012	2009	127.52	198.36	185.2	511.08
2013	2684		448		448
Avg.	1987.27	297.55	323.18	452.39	732.68

Management activity values were input to the size estimation tool (Figure 4.10) along with the default values for material density and unit collection rates. This analysis indicated the Northwood Outpost Garage may collect approximately 65 tons of material each year and that to manage this volume of material at one location, two single bays would be required if the material were collected and disposed one time each year. In some cases, it may be desirable to centralize decanting stations within a county. The Northwood Outpost Garage in ODOT District 2 is located in Lucas County. In 2013, 160 lane miles were swept and 1,424 catch basins cleaned by these two garages. Using these values as inputs to the decanting station sizing tool, it is recommended that two bays be used to manage this material (Figure 4.11). In summary, these activities formed a solid foundation for the design process discussed in the next section of this report.

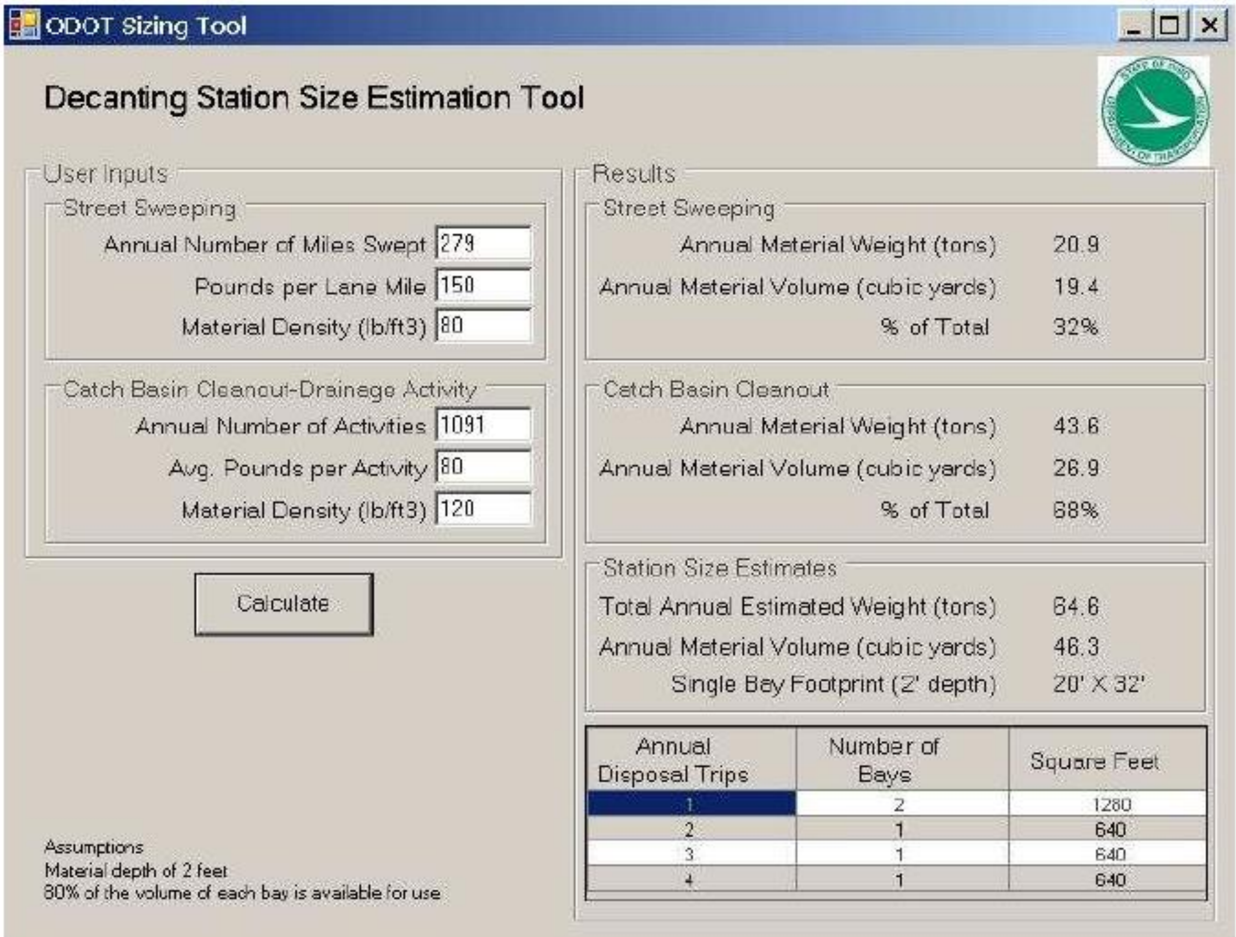


Figure 4.10: Example using decanting station sizing tool for material collected at one location in ODOT District 2 (Data used were from Northwood Outpost Garage for activities conducted from 2012 through 2013).

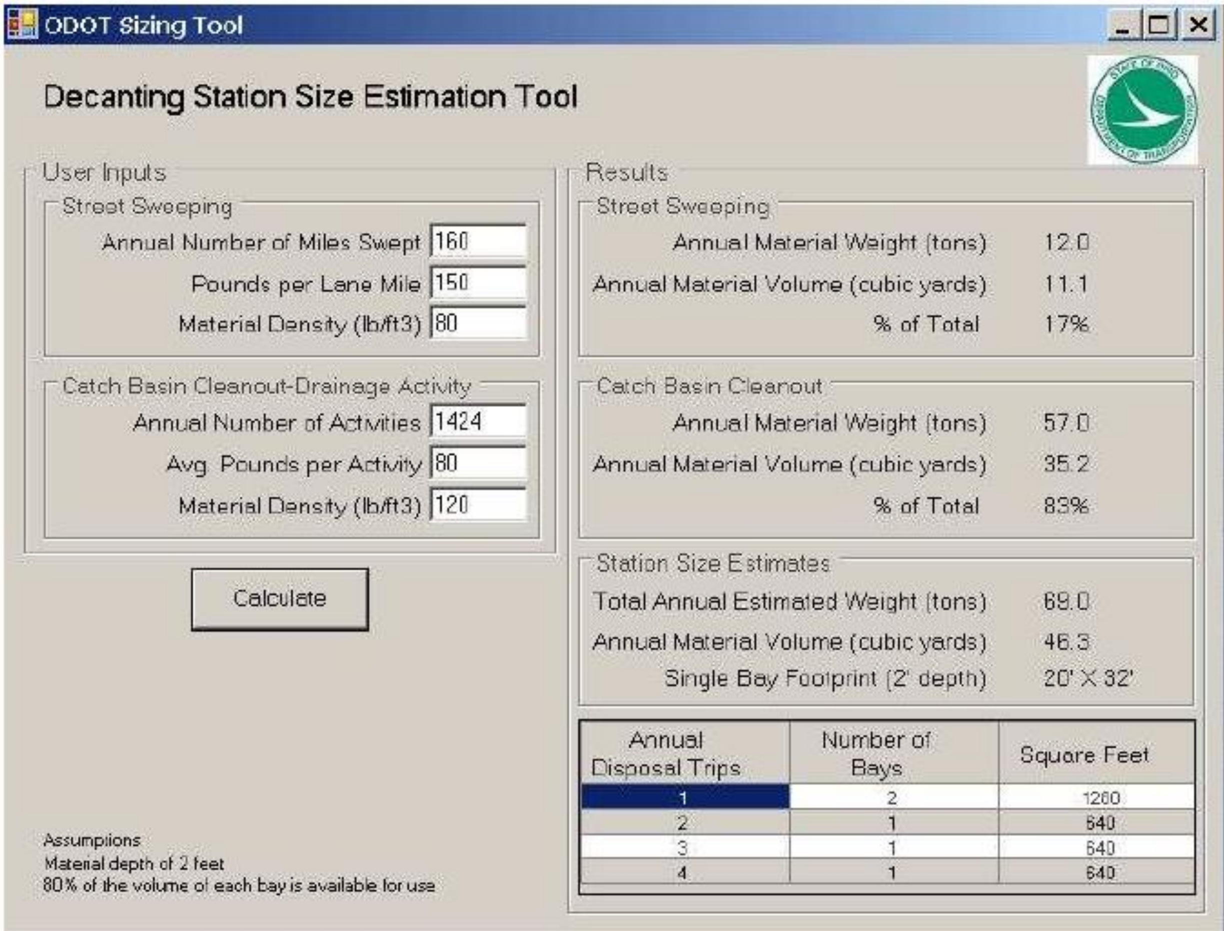


Figure 4.11: Example using decanting station sizing tool for material collected at two locations in ODOT District 2 (Data used were from Northwood Outpost Garage and Lucas County Garage for activities conducted in 2013).

4.2 Decanting Facility Design and Construction

This section summarizes decanting facility design process and construction activity observations.

4.2.1 Decanting Facility Design Process

An interim progress report for this project was submitted in January 2014 and listed the following key findings for handling residual street sweepings and sewer cleanout materials using a decanting facility:

- Other than the amount of material being collected, the design of the facility and material handling procedures have the greatest effect on the minimum size and minimum number of drying bays required for the facility.
- Designing the bays with a roof, sloped floor, and where the materials are deposited away from the drain are key in drying and promoting drainage.
- The ability to turn over, transfer, and segregate materials more easily is also important in providing operational flexibility so that older drier materials do not get mixed with more recently collected material.

The report went on to list a number of other proposed design recommendations for a proposed decant facility. As part of their ongoing facilities planning, ODOT had recently constructed several decant facilities with various designs parameters and some of these facilities were discussed earlier in Chapter 4. Some facilities appear to be operating adequately, while others have significant operational concerns. Two municipalities rejected disposal of eductor truck water into their sanitary sewer system based on concerns related to the heavy metals concentrations in this water. We reviewed the local limits (i.e. discharge limits that the permit must adhere to) for several metals (e.g. copper and zinc) and compared them to the concentrations measured previously in educator water (also see Chapter 5) and the water has concentrations exceeding the local limits. These concerns and data suggested a need for metal reduction strategies are needed in addition to facility modifications.

After review of the interim report, ODOT recognized an excellent opportunity to construct a prototype decant facility to test and refine earlier design recommendations for the decant facility and test solutions to address regulatory concerns. Such a facility would assist in providing "real world" experience concerning the optimum sizing of the decant pad, typical drying time, and best management practices to better quantify the effects each of the variables noted above have on the design and discharged water quality.

A project addendum with AECOM as the design engineering firm (formerly URS Corporation and the same key personnel selected to work on the original project) was approved during the second quarter of 2014 and listed the following tasks (note: each chapter reference after a task is the corresponding chapter in this report where the research results are documented in addition to this chapter):

Task 1. Site Visit and Existing Information Review

Task 2. Establish Existing Site Plans

Task 3. Develop Construction Plan Set and Specifications

Task 4. Construction Monitoring

Task 5. Develop SOPS for Material Handling (Chapter 6)

Task 6. Evaluate Adsorption Media (Chapter 5)

Task 7. Develop Final Design Report (Chapter 6)

After reviewing the available options with ODOT and considering the relatively small amounts of waste material being generated, the high costs of separation technology, and limited opportunities for beneficial reuse, ODOT elected to make beneficial use options at solid waste landfills as a goal for alternatives to disposal. The focus of intended use for the ODOT material at landfills is for alternate daily cover (ADC). Therefore, the design of the decanting facility is focused on the use of the waste materials as ADC.

As described earlier in this report, ODOT uses decanting as the primary method for separating liquids from the waste materials. Methods currently used for decanting vary by location, but primarily involve placing the bulk waste materials at a designated location and allowing them to drain and dry out over time via gravity flow. Subsequently, the dry material would presumably be disposed at a landfill. As part of this project, ODOT requested that their current decanting practice be reviewed in relation to a preferred decanting facility design alternative. Although methods for decanting vary widely and in some cases are crude, one benchmark for this review is represented by the plans for the Wayne County ODOT facility.

Once ODOT elected to focus their goal on the beneficial use of the waste material at landfills, the need for more complex decanting technology than what is already represented by the Wayne County Facility was eliminated. The street sweepings and sewer cleanout material generally have similar characteristics to soil; therefore, the applicable “treatment” necessary to facilitate its use as ADC is to separate the solids from the liquids. This is required because landfills in Ohio are prohibited from accepting free liquids at the facility. This indicates that the current technology being utilized by ODOT to decant water from the solid material is generally sufficient to alter the material to meet the physical requirements for using the solids at a landfill because no additional physical or chemical treatment methods are necessary. Note this alone is not sufficient to allow beneficial use of the material at landfills. A written authorization from the director of Ohio EPA is also currently required to be able to use a solid waste as ADC at a landfill. Gaining authorization typically requires additional analytical testing and likely a demonstration by the landfill manager at the chosen facility that the material will perform in a manner similar to soil cover at the facility.

AECOM reviewed the existing benchmark drawings for the planned Wayne County facility. Given the anticipated waste generation rate, the cost for implementation, and the end use, the basic and most reasonable technology necessary for separation of the phases for generating a solid material from the slurry is straightforward. It involves placement of the material in an area conducive to drainage such as a hard surface where the surrounding area is sloped away from the bulk material and allowing enough time for the material to drain via gravity. In general, ODOT's existing design standard meets this general criteria and is constructed similarly to other dedicated decant pads for street sweepings waste we are aware of in Ohio and other parts of the country.

Therefore, the minimum necessary requirements for proper design include the following:

- Sloped impermeable floor surface to promote drainage
- Drain(s) to collect runoff from the street sweepings/sewer cleanout material
- Access areas for large equipment to both dump and pick up bulk material
- Barriers to control storm water run-on
- A roof (with adequate clearance) to prevent direct rain reinfiltration
- Access to sanitary sewer discharge for the decant water
- A modular design that can be scaled to different locations based on regional material generation rates but that must still have bays large enough to accommodate heavy equipment

Additional enhancements may include the following:

- Drainage can be better facilitated with increases to the minimum floor grades and locations of floor drains.

- The location of the floor drains and partitions could be strategically relocated to minimize handling of the materials and allow equipment access to older/drier portions of the bulk materials.
- The structural components of the walls could be designed to act as a "push-wall" to aid loading equipment.
- Depending on the type of material, the entire drainage area could be lowered relative to the truck entrance such that the trucks could dump directly into roll off boxes placed below the truck entrance. The roll off boxes could be configured to facilitate drainage and function as dewatering vessels. When dewatered, the boxes and waste materials in their entirety could be transferred to the landfill without the need for additional handling.

The first design scoping meeting was held at ODOT District 2 headquarters in Bowling Green, Ohio on October 3, 2014 with AECOM to discuss the research purpose, benefits, site locations, work scope, roles and responsibilities, conduct a visit of possible sites in Toledo and at the Lucas County Garage for the decanting facility, and plan a schedule for the remaining months of the project (attendees included: Hussein Abounaaj, Rick Puderbaugh, Sulaiman Bah, and Jill Martindale). Following the meeting at District 2, AECOM visited the current sweepings site storage areas as well as a possible decant facility location on Berdan Avenue in Toledo, Ohio. Following the meeting, it was determined that the current Lucas County Garage location represents the optimal location for the prototype facility as it has the best combination of proximity to existing facilities, room for construction, and convenient location.

After selecting the Lucas County Garage location for the decanting facility design, an additional site visit was conducted on December 19, 2014 to locate existing site features in relation to the site plan provided by ODOT. Both water and sewer were located and ground truthed in relation to the existing survey. AECOM also met with District 2 representatives Hussein Abounaaj, Greg Strausbaugh, and Dale Calcamuggio to discuss the preliminary design alternatives and evaluate the issues with the existing decant facility at this location. AECOM presented design concepts and discussed District 2 needs. From this point onward, project progress meetings were held every two weeks (with the exception of the holidays) by the joint project team on Wednesdays to discuss the facility design, project schedule, budget, and other project details. Updates to the design were presented at each meeting and the 90% design plans were submitted to ODOT in March 2015 for review and comment before going to bid.

4.2.2 Decanting Facility Construction Observations

The research team via AECOM performed site visits during the construction and fulfilled all proposal tasks. The construction resulted in a finished, usable facility that far exceeds the capabilities of the previous adjacent area. Enhanced capabilities include:

- The capacity for treatment and storage has been upgraded to allow for more than five times the previously available storage volume.
- With addition of multiple bins for storage, the garage now has the ability to segregate different materials and/or materials of different moisture contents. The size of the storage areas also promotes evaporation the ability of the stored materials to evaporate.
- The tiered drainage system with the large drainage bay allows the sewer material decant water to be quickly separated from the offloaded materials. The large drainage bay also allows for the option of utilizing evaporation versus discharge to the sewer if that is desired.
- The roof structure keeps the solids dry during inclement weather and the louvered windows allow airflow to promote drying.
- Initial use of the facility has demonstrated that each load of storm sewer cleanout material can be dried and processed within a week or less and the materials can either be stored long term in one of the adjacent bins or offloaded into a roll off box for transfer to a landfill.

The construction also encountered a number of unforeseen challenges, many of which were related to Contractor capabilities and expectations. For example, the construction schedule ran more than two months longer than originally anticipated. The original proposal timeline called for construction to occur during the April through June 2015 time frame with operations monitoring and testing to be conducted immediately following through August 2015. Because of construction delays, operations could not begin in earnest until November 20, 2015 following inspection by the Lucas County Building Regulations Department. This delayed the time for occupation and use of the facility past the date that street sweepings and sewer cleanout operations activity is at a high level. This also severely compressed the time the research team had for completing their work. Further, due in part to the purpose for the structure being for an uncommon use, it became apparent that the Contractor would have benefitted from more information at the start of the construction as to what portions of the structure were critical. They also would have benefitted from additional day to day oversight and direction than they were provided initially.

Aside from the Contractor issues, a number of unforeseen items related to design became apparent during construction. Based on the observations during construction, the following items should be considered for future design and construction:

- The weir gate operation can be improved with use of a motor. This was not included in the final design due to cost, but operating the gate manually is labor intensive. A motor would greatly enhance the operations of the gate.
- Because the weir gate is intended to move down so that the decant water can flow over top of the weir, ensuring that the minimum length of travel to the bottom of the concrete control vault is of critical importance to allow the weir to be lowered fully for cleanout of the sediment from the drainage bay. Not all contractors may be familiar with the application of the weir gate specified and should be made aware of the intent and the importance of maintaining the minimum depth for travel of the gate.
- The screens within the drainage bay were intended to provide a modular filtering solution based on trial and error for the prototype facility. The screen perforations, number, sequence and placement were intended to allow for adjustments during operations. Therefore, all the screens were fabricated similarly with the largest holes being based on Ohio EPA guidance for beneficial use. This allows for the maximum diameter of the screens to be reduced with additional screen overlays and/or fabrication of additional aluminum panels to improving the filtering capability of the screens. Future users may consider modifying the screen design to use fewer panels, blinding off portions of the panels to create a more tortuous path through the screen series, and/or progressively reducing the maximum diameter of the screens.
- The screens could be fitted with rings to facilitate hoisting and moving the panel screens.
- The drain between the unloading bay and the concrete apron outside the facility where the roll off boxes are stored can be fitted with a solid plate constructed similarly to the perforated screens in each bay. This will minimize spillover during unloading of sewer cleanout materials.
- Installation and removal of the supplementary filter media could be improved with fabrication of an additional insert either in the drainage bay in front of the weir gate or in

the control box following the weir gate. The insert could be fabricated of wood or metal and lined with the geotextile fabric that allows flow but retains the media.

CHAPTER V WASTE MATERIAL ANALYSIS AND MEDIA TESTING

This chapter summarizes the solid waste material analysis conducted at representative ODOT facilities from 2014-2016, as well as metal adsorption media testing at the Lucas County decanting facility in 2015-2016. This chapter is divided into three sections:

- Section One – Solid Waste Material Sampling at Five Representative ODOT Facilities
- Section Two – Solid Waste Material Sampling at Lucas County Decanting Facility
- Section Three – Metal Adsorption Media Testing at Lucas County Decanting Facility

5.1 Solid Waste Material Sampling at Five Representative ODOT Facilities

In addition to testing results compiled earlier in this report (see Chapter 2), five county garages were selected for solid waste material sampling in 2014. The five county garages and their locations are shown on Figure 5.1. Samples were collected in May 2014. Comprehensive testing results are summarized in Table 20 and show that only one sample constituent exceeded the beneficial use draft levels for fill/aggregate. A diesel concentration of 2,400 mg/kg was measured at the Forest outpost (District 1), slightly higher than the 2,000 mg/kg beneficial use level for fill/aggregate. This should not be problematic, however, as diesel is relatively volatile (note all other locations were well below 2,000 mg/kg) and adequate drying of solid waste material will lower the diesel concentration.

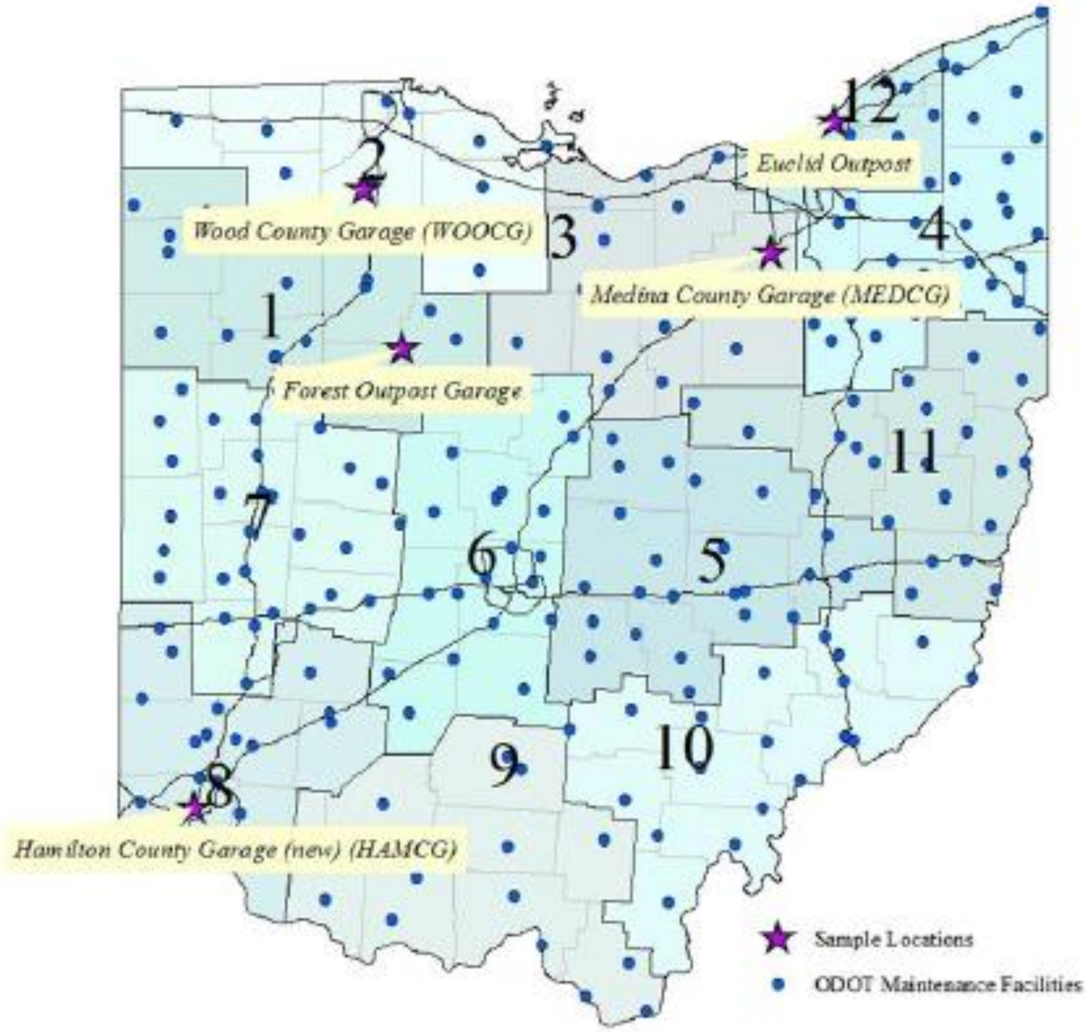


Figure 5.1: 2014 Sampling Sites for Solid Waste Testing.

Table 20: Solid Waste Testing Results for ODOT Garages Sampled in 2014 (see Figure 5.1 for locations). Shaded cell indicates value exceeding Beneficial Use limit.

			OHIO ODOT Districts Sampling					OHIO EPA PROGRAMS Divisions of Surface Water and Materials Waste Management — Ohio EPA Proposed Max. Limit for Beneficial Use of Street Sweepings (DRAFT Policy)	
			Medina	Hamilton	Wood	Euclid	Forest	Traction	Fill/Aggr
	CASRN	Contaminant	Metals (mg/kg)					(mg/kg)	(mg/kg)
Heavy Metals	7440-22-4	Silver	-	-	-	-	-	N/A	N/A
	7440-38-2	Arsenic	4.5	4.6	6.7	11	5.1	41	41
	7440-39-3	Barium	55	59	81	53	92	-	-
	7440-43-9	Cadmium	0.39	0.43	0.43	2.2	0.55	35	35
	18540-29-9	Chromium	28	57	31	41	23	-	-
	7440-50-8	Copper	91	67	54	42	40	1500	1500
	7439-92-1	Lead	11	19	52	80	19	300	300
	-	Nickel	16	17	18	24	18	420	420
	7782-49-2	Selenium	0.76	-	0.58	1.2	-	100	100
	7439-97-6	Mercury	-	-	0.23	-	-	7.8	7.8
	7440-66-6	Zinc	180	220	230	230	200	2800	2800
	-	Aluminum	2100	2600	3600	4800	4200	-	-
	-	Calcium	150000	130000	72000	52000	100000	-	-
	-	Iron	25000	18000	17000	19000	19000	-	-
	-	Potassium	-	-	540	800	960	-	-
	-	Magnesium	32000	40000	29000	11000	46000	-	-
	-	Manganese	540	300	310	420	190	-	-
	-	Sodium	-	-	990	610	12000	-	-
	-	Vanadium	11	7.7	12	19	11	-	-
General Chemistry		Total Phosphorus	86	300	550	190	360	-	-
		Nitrogen, Total Organic	290	1700	530	470	720	-	-
		Nitrogen, Kjeldahl	290	1700	530	470	720	-	-
		Orthophosphate as P	7.5	15	-	7.2	24	-	-
			mg/kg						
VOC's	75-09-2	Methylene Chloride	-	-	-	-	-	-	-
	127-18-4	Tetrachloroethene	-	-	-	-	-	-	-
SVOC's	120-12-7	Anthracene	0.043	0.41	0.65	0.49	0.2	-	-
	205-99-2	Benzo (b) fluoranthene	0.42	3.8	3.1	1.9	0.64	5.53	63
	218-01-9	Chrysene	0.31	2.8	2.7	1.4	0.71	1.27	6700
	206-44-0	Fluoranthene	0.5	5.8	5.7	2.5	1.2	-	-
	193-39-5	Indeno (1,2,3 - cd)pyrene	0.094	1.1	1.4	0.36	0.33	0.15	67
	129-00-0	Pyrene	0.46	4.5	5.2	1.9	1.2	-	-
	56-55-3	Benz (a) anthracene	0.18	1.8	2.1	1.2	0.44	2.2	63
	131-11-3	Dimethyl phthalate	-	-	-	-	-	-	-
	50-32-8	Benzo (a) pyrene	0.2	2.2	2.1	0.96	0.5	1.1	6.3
	191-24-2	Benzo(g,h,i)perylene	0.13	1.2	1.7	0.34	0.55	-	-
	85-01-8	Phenanthrene	0.25	3	3	1.7	1	-	-
	207-08-9	Benzo (k) fluoranthene	0.13	1.1	1.1	0.71	0.35	1.97	630
	-	2-Methylnaphthalene	-	0.049	1.9	0.52	0.31	-	-
	-	Acenaphthene	-	0.14	0.46	0.16	-	-	-
	-	Acenaphthylene	-	-	-	0.26	-	-	-
	-	Bis(2-ethylhexyl) phthalate	0.57	2.2	1.8	0.63	7.9	-	-
	-	Carbazole	-	0.51	-	-	-	-	-
	-	Butyl benzyl phthalate	-	-	-	0.3	-	-	-
	-	Di-n-butyl phthalate	-	0.28	0.35	-	2.5	-	-
	-	Dibenz(a,h)anthracene	-	-	-	0.12	-	-	-
	-	Dibenzofuran	-	-	-	0.27	-	-	-
	-	Fluorene	-	0.17	0.32	0.2	0.25	-	-
	-	Naphthalene	-	0.053	0.86	0.36	0.51	-	-
TPH	8006-61-9	Gasoline (C6 - C12)	-	-	-	-	1.4	1000	1000
	-	Diesel (C10 - C20)	300	450	1500	220	2400	2000	2000
	-	Oil (C10 - C20)	-	-	-	-	-	5000	5000

5.2 Solid Waste Material Sampling at Lucas County Decanting Facility

In addition to testing results compiled in the previous section, solid waste material from the newly-constructed decanting facility was sampled on 12/3/15. Comprehensive testing results are summarized in Table 21 and compared to Wood County Garage results from 2014. Only show that only one sample constituent exceeded the beneficial use draft levels for fill/aggregate. The diesel concentration was 3,000 mg/kg, slightly higher than the 2,000 mg/kg beneficial use level for fill/aggregate. This should not be problematic; however, as diesel is relatively volatile and adequate drying of solid waste material will lower the diesel concentration.

Table 21: Solid waste testing results for Lucas County Decanting Facility (2015) and Wood County Garage (2014) solid waste sample. Shaded cell indicates value exceeding Beneficial Use limit.

			ODOT Sampling		OHIO EPA PROGRAMS Divisions of Surface Water and Materials Waste Management: Ohio EPA Proposed Max. Limit for Beneficial Use of Street Sweepings (DRAFT Policy)	
			Lucas (2015)	Wood (2014)	Traction	Fill/Aggr
	CASRN	Contaminant	Metals (mg/kg)		(mg/kg)	(mg/kg)
Heavy Metals	7440-22-4	Silver	-	-	N/A	N/A
	7440-38-2	Arsenic	3.1	6.7	41	41
	7440-39-3	Barium	110	81	-	-
	7440-43-9	Cadmium	0.66	0.43	35	35
	18540-29-9	Chromium	31	31	-	-
	7440-50-8	Copper	50	54	1500	1500
	7439-92-1	Lead	24	52	300	300
	-	Nickel	20	18	420	420
	7782-49-2	Selenium	-	0.58	100	100
	7439-97-6	Mercury	-	0.23	7.8	7.8
	7440-66-6	Zinc	220	230	2800	2800
	-	Aluminum	5100	3600	-	-
	-	Calcium	64000	72000	-	-
	-	Iron	13000	17000	-	-
	-	Potassium	700	540	-	-
	-	Magnesium	25000	29000	-	-
	-	Manganese	210	310	-	-
	-	Sodium	1200	990	-	-
	-	Vanadium	11	12	-	-
General Chemistry		Total Phosphorus	290	550	-	-
		Nitrogen, Total Organic	-	530	-	-
		Nitrogen, Kjeldahl	170	530	-	-
		Orthophosphate as P	290	-	-	-
			mg/kg			
VOC's	75-09-2	Methylene Chloride	-	-	-	-
	127-18-4	Tetrachloroethene	-	-	-	-
SVOC's	120-12-7	Anthracene	-	0.65	-	-
	205-99-2	Benzo (b) fluoranthene	-	3.1	5.53	63
	218-01-9	Chrysene	330	2.7	1.27	6700
	206-44-0	Fluoranthene	640	5.7	-	-
	193-39-5	Indeno (1,2,3 - cd)pyrene	86	1.4	0.15	67
	129-00-0	Pyrene	530	5.2	-	-
	56-55-3	Benz (a) anthracene	270	2.1	2.2	63
	131-11-3	Dimethyl phthalate	-	-	-	-
	50-32-8	Benzo (a) pyrene	280	2.1	1.1	6.3
	191-24-2	Benzo(g,h,i)perylene	100	1.7	-	-
	85-01-8	Phenanthrene	230	3	-	-
	207-08-9	Benzo (k) fluoranthene	190	1.1	1.97	630
	-	2-Methylnaphthalene	-	1.9	-	-
	-	Acenaphthene	-	0.46	-	-
	-	Acenaphthylene	-	-	-	-
	-	Bis(2-ethylhexyl) phthalate	1600	1.8	-	-
	-	Carbazole	-	-	-	-
	-	Butyl benzyl phthalate	-	-	-	-
	-	Di-n-butyl phthalate	-	0.35	-	-
	-	Dibenz(a,h)anthracene	-	-	-	-
	-	Dibenzofuran	-	-	-	-
	-	Fluorene	-	0.32	-	-
	-	Naphthalene	-	0.86	-	-
TPH	8006-61-9	Gasoline (C6 - C12)	-	-	1000	1000
	-	Diesel (C10 - C20)	3300	1500	2000	2000
	-	Oil (C10 - C20)	-	-	5000	5000

5.3 Metal Adsorption Media Testing at Lucas County Decanting Facility

Most of the focus on the waste pertains to its solid phase, however, there is growing concern regarding heavy metal concentrations in the decanting water. During the second quarter 2013, water samples were collected during storm sewer cleaning operations in ODOT District 2. A total of five water samples were collected from the eductor truck in Wood and Putnam Counties. Water samples were stored in 1 L high density polyethylene bottles and refrigerated. Using Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES), the samples were analyzed for heavy metals: aluminum (Al), arsenic(As), boron (B), beryllium (Be), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), lithium (Li), manganese (Mn), molybdenum (Mo), nickel (Ni), lead (Pb), selenium (Se), vanadium (V), and zinc (Zn). The results of this analysis are shown in Table 22.

Table 22: Water samples metal analysis collected from the eductor truck during summer 2013.

	Metal (ppb)																
Garage I.D	Mn	Al	As	B	Be	Cd	Co	Cr	Cu	Fe	Li	Mo	Ni	Pb	Se	V	Zn
Woods Rt65 1130	1,333	37,073	124	264	4	4	1	70	182	56,277	38	7	215	309	BD	54	1,221
Woods Rt65 1015	743	25,137	60	218	2	2	2	49	137	38,582	15	5	161	219	BD	40	857
Ottawa 915	5,254	171,864	24	441	15	14	BD	229	478	145,070	328	BD	473	1,295	1	144	3,305
Ottawa 120P	6,253	205,785	29	702	18	22	BD	315	1,500	175,956	362	BD	780	969	BD	304	9,834
Ottawa 930	2,494	7,211	29	129	0	BD	BD	11	71	12,957	6	12	56	85	4	12	166

As noted in Chapter 2, potential metals of concern include copper and zinc. The copper concentration from these samples ranged from 71-1,500 ppb and zinc ranged from 166-9,834 ppb. Depending on local discharge requirements, the higher range concentrations could require some level of pre-treatment before discharge to the sanitary sewer. Therefore, this research investigated the use of a metal adsorption media to be incorporated into the basic design of the facility. The back channel of the decanting facility was designed to accommodate the media, as well as after the weir gate at the end of the channel. It is very important to note per the proposal that the metal adsorption media was to:

1. Emphasize dissolved zinc and copper removal and
2. Must involve low maintenance implementation.

A research paper was published in 2015 by Ernst et al. examining the removal of dissolved copper and zinc from highway runoff via adsorption. The study was conducted for the Texas Department of Transportation and developed a column testing protocol for which five different media (iron oxide, manganese dioxide, crab shell, concrete, and bone meal) were evaluated. Their results indicated that the iron oxide media is the most effective adsorptive technique copper and zinc removal from highway runoff. Given the time constraints created by the construction schedule, the successful treatment results from this comprehensive study, and an emphasis on low maintenance, the iron oxide media was selected for testing in this research. The media was ordered in September 2015 (see Figure 5.2 below):

AdEdge water technologies

Quotation

5152 Belle Wood Court
Buford, GA 30518
www.adedgetechnologies.com

Phone: 678-730-6517 (Doug Emerick)
Fax: 678-835-0057
Email: demerick@adedgetechnologies.com

Quote # DE-8.28.15

Date 8/28/15

Terms See Below

Prices FOB Buford, GA

Delivery 1 week

To: Dr. Christopher M. Miller, Ph.D., PE
Associate Professor
Department of Civil Engineering
University of Akron
162B Schrank Hall North
Akron, OH 44325-3905
(330)-972-5915
cmmiller@uakron.edu

Ship To Address
Ohio Department of Transportation
ATTN: Mike Fountain
4080 Technology Drive
Maumee, OH 43537

Phone # 678-730-6517

Fax # 678-835-0057

Reference # Email 8.28.15

Project: Media Replacement for Ohio Department of Transportation
Fife Way

Item	Quantity	Description	Unit Price	Total
A	6	**Media** Bayoxide E33 GFO Media (6 cuft x 30 lbs/cuft = 180 lbs) for arsenic removal Packaged in (1-Ea) 55 gallon barrel with 180 lbs Note: Order will be billed and shipped in lbs.	$300	$1,800
B	1	**Project Coordination** Provided by Others and not included in this quotation	Not Included	
C	1	**Transportation and Disposal** Provided by Others and not included in this quotation	Not Included	
D	1	**Estimated Shipping Freight for Media** *Shipping costs are estimated, actual costs to be invoiced upon shipment.	$250	$250

Figure 5.2: Iron oxide adsorption media cost quotation.

Physical properties of the iron oxide media are summarized in Figure 5.3. Preliminary testing results are summarized in Table 23 and confirm the Texas study results with copper removal greater than 98% and zinc removal of 24%.

Physical Properties	E33 Media
Matrix	Iron Oxide Composite
Physical Form	Dry granular media
Color	Amber
Particle Size Distribution	10x35 mesh
Moisture Content	< 15% by wt.
Packaged	Dry

Figure 5.3: Physical properties of iron oxide media selected for water treatment testing.

Table 23: Iron oxide media metal removal results on decanting water from the Lucas County Decanting facility (collected 11/2/15) before and after adsorption to the media. The water was placed in contact with the water for a period of 30 minutes.

Analyte	Before (ppb)	After (ppb)	% Removal
Arsenic	99	< 15	> 84.8%
Cadmium	18	< 5	> 72.2%
Chromium	680	< 10	> 98.5%
Copper	1500	< 25	> 98.3%
Nickel	550	< 40	> 92.7%
Lead	1200	1100	8.3%
Zinc	10000	7600	24.0%

A siltsack (used frequently to capture solids particles entering drainage structures) was selected to contain the media (see Figure 5.4). Details regarding its use and implementation are discussed in Chapter 6 and additional information for the media and siltsack are included in Appendix B and Appendix C.

SPECIFICATIONS:

Siltsack Regular Flow

PROPERTY	TEST METHOD	MINIMUM AVERAGE ROLL VALUE
Grab Tensile Strength	ASTM D4632	315 lbs
Grab Tensile Elongation	ASTM D4632	15%
Puncture Strength	ASTM D4833	140 lbs
Mullen Burst	ASTM D3786	800 psi
Trapezoid Tear	ASTM D4533	125 x 115 lbs
UV Resistance @ 500 hrs	ASTMD4355	80%
AOS	ASTM D4751	40 Sieve
Permittivity (sec-1)	ASTM D4491	0.70 (sec-1)
Flow Rate	ASTM D4491	50 gpm/ft2

Figure 5.4: Siltsack specifications and frame for holding the iron oxide media.

CHAPTER VI STANDARD OPERATING PROCEDURES FOR DECANT FACILITIES

After design and construction of the decanting facility, the next portion of the research focused on developing and drafting standard operating procedures (SOPs) for decant facilities management of solid waste and decant water. This chapter is divided into four sections which address developing standard operating procedures for decant facilities, as well as recommendations for future facility design:

- Section One – Decanting Facility Operational Goals
- Section Two – Lucas County Decanting Facility Operations Monitoring
- Section Three – Draft Standard Operating Procedures
- Section Four – Develop Final Design Report and Plans

It is important to note that the SOPs presented here are based primarily on the decanting facility constructed at Lucas County as part of this project. Any modifications to this design will require review of the SOPs and potential modification.

6.1 Decanting Facility Operational Goals

In order to prepare standard operating procedures for the new facility it is important to first summarize the decanting facility operational goals. The overall objective is to meet the state and local requirements for landfill disposal without additional treatment and potentially use the material as alternate daily cover (ADC) which might translate in a cost savings to ODOT and provide a beneficial use for the material.

Based on our assessment of the solid waste testing results, there are no analytes that would generally preclude disposal of the street sweeping derived solids at a licensed and lined landfill in Ohio. State requirements are a mix of prescriptive and descriptive requirements. In Ohio, solid waste is an unwanted material that cannot be hazardous or infectious or contain free liquids and specifically defines street sweepings as a regulated material. However, there are no specific analytical testing requirements in the Ohio Administrative Code. Because landfill owner/operators are required by Ohio EPA to ensure no unauthorized materials are accepted at the landfill, many owner/operators have implemented their own requirements for acceptance of non-municipal waste that often involves analytical testing. The Solid Waste Authority of Ohio who operates the Franklin County Sanitary Landfill near Columbus utilizes what is likely the most comprehensive such special waste program in Ohio. Their requirements are summarized as listed in Appendix D and note SWACO explicitly does not require any additional testing for street sweepings. Republic Services (the operator of Hoffman Road in Toledo, Ohio) also has a special waste program in place and those requirements are also summarized in Appendix D. Republic also does not generally require analytical testing for street sweeping derived material. The Hoffman Road Landfill is the most likely destination for the Lucas County Decanting Facility waste. In short, although it is possible additional analytical testing may be required at any given disposal facility, it is generally recognized that these materials do not warrant significant concern on the part of the Ohio EPA and the regulated community.

If ODOT would like to facilitate an agreement with a nearby landfill to use the material as alternate daily cover (ADC) and give some relief to ODOT for the disposal fees, two requirements must be met:

1. Ohio EPA will have to approve that use of the material. At a minimum, OEPA will only approve of the material if it will function similar to a soil (i.e. the material promotes drainage, minimizes odors, etc.) and it does not contain chemical constituents such that runoff might lead to contamination of surface water. There may also be other non-technical issues related to local politics, etc.
2. The landfill manager will find it useful. The material will have to benefit the landfill operations in some way by saving on borrow materials, or cost for tarping at the end of the day etc. If the material is hard to handle or they can't afford to lower the tipping fee, or for other reasons, the landfill may refuse to accept it for ADC. Even if the Ohio EPA approves of its use, the landfill operator is not compelled to use the material as ADC.

The draft OEPA guidance document for beneficial use of street sweepings has analytical testing requirements for beneficial use of the material including landfill ADC. One of the key requirements in the document states "SCREENED sweepings aren't required to be tested at all for ADC". However, screened in this context currently means removal of greater than 3/4" material (which the Lucas County Decanting Facility screens are sized for) and removal of finer than 300 microns material. The small, 300 microns material management will be discussed in the standard operating procedures.

For future reference, the process flow for getting a material approved for ADC from Ohio EPA is:

1. Generate a waste profile with TCLP testing (what is tested is not standardized, that's generally determined by the generator and negotiated for acceptance with OEPA).
2. Send a letter to the director of OEPA/copy district office where it will be used.

3. In the letter, outline the requested use and state the use in accordance with OAC 3745-27-19(F)(3)(a).

If alternate daily cover is not an objective, then further analytical testing would likely only be required if the local landfill owner/operator has site specific testing requirements. Aside from those, the decanting facility operational goals can be summarized as follows:

1. Low moisture content solid waste
2. High solid material capture efficiency (i.e. minimize solids going into the oil-water separator)
3. Safe operations

As discussed earlier in this report, site-specific situations may arise in which the treatment facility receiving the decant water requires additional reduction of specific contaminants (e.g. heavy metals), then other measures utilizing filter media and increased attention to particulate removal will be required (note: the Lucas County garage does not require additional treatment as of the writing of this report).   An SOP for these situations in presented later in this chapter (section 6.3.3).

6.2 Lucas County Decanting Facility Operations Monitoring

Per the proposal, "During operations, representatives of the UofA/AECOM team will visit the site to review the material handling techniques. Site visits will be conducted to document the utility of the SOPs and to gather field data for improvement and establishment of final recommendations. Times for these site visits will also be mutually agreed on prior to arrival by the UofA/AECOM Team and ODOT and are planned to occur during peak use times which are generally anticipated to occur during the spring and summer. Two site visits are planned per this proposal." As stated earlier in this report, the construction delays prevented monitoring during peak use times of spring and summer. The research team, however, was on site three times between November 2, 2015 and February 4, 2016. In addition to the site visits, the research team was in frequent communication with Lucas County Garage managers and the equipment operators (note: due to inclement weather, activities were scheduled as weather allowed). For all of Chapter 6, we will refer to Figure 6.1 for identifying specific locations within the decanting facility.

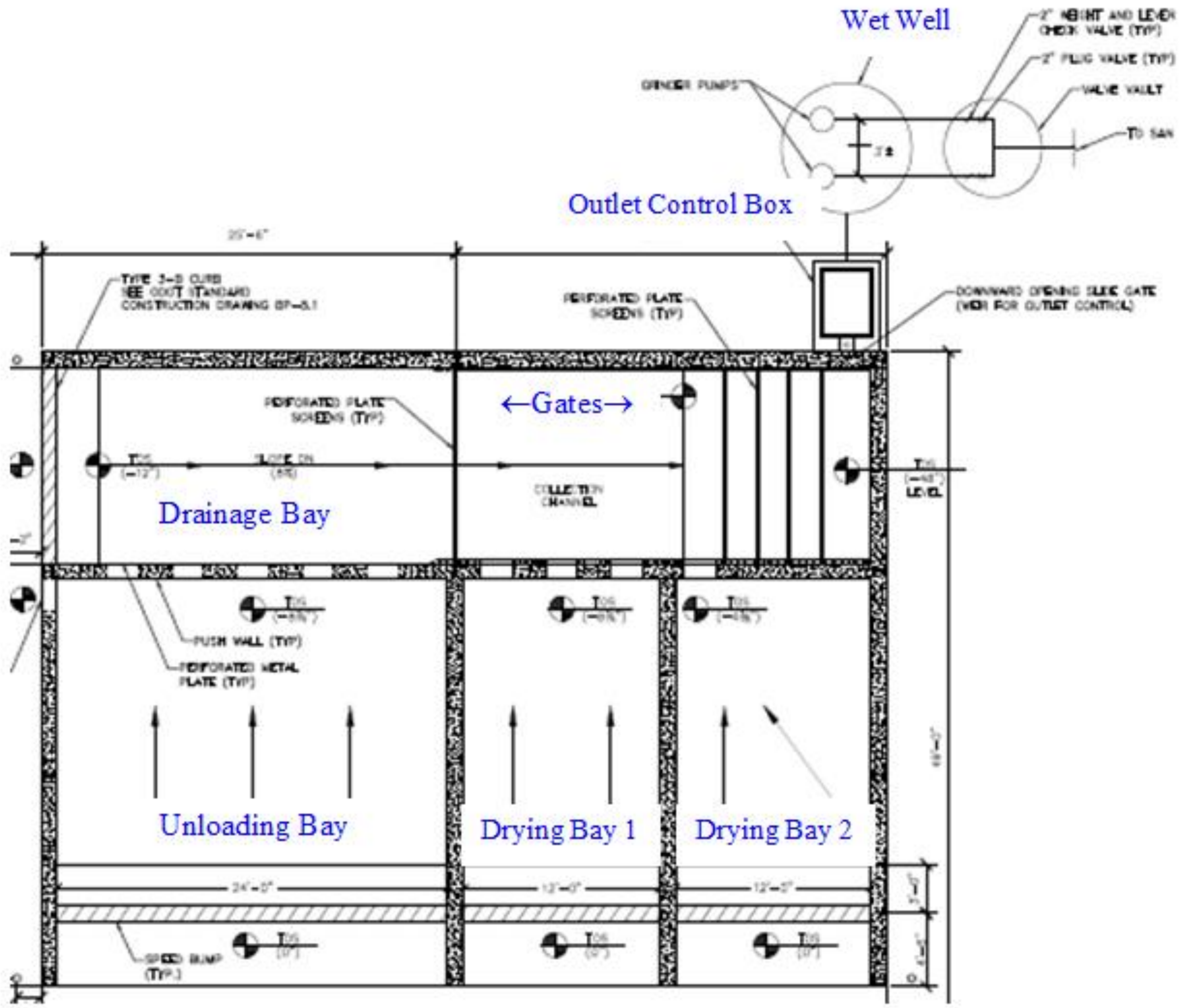


Figure 6.1: Plan view (sheet 9 of 23 in Appendix E) of the decanting facility.

A summary of important observations made by ODOT personnel and the research team at the facility during this operations period include:

- The solid material from a single load of a "full" vactor truck load does not occupy much space in the Unloading Bay (see Figure 6.2), but does contain large debris and trash.
- The perforated plate screens used to separate and keep debris-trash in the unloading bay do experience partial plugging after every load (see Figure 6.3) and the water can be quite turbid-dirty (see Figure 6.4).
- Tamping of perforated plate screens with a rake or shovel was used during the unloading process, to allow water to more readily pass through the screens.

- Initially the floats in the pumps station did not work. After contacting the contractor, the pump station was set up so that floats were operating properly and automatically turning the pumps on and off as water was discharged through the Outlet Control Box. This
- In the future after multiple loads, the large screens in the Drainage Bay may need to be lifted-moved. They do note currently have a ring or angle attached to the frame to lift. These screens need to be fitted with two rings or angles that will allow an end loader or back hoe to hook onto them either with a chain or strap to lift and move them as needed. This was not included in the original design.
- The water flow over the top of the gate could be easily controlled by slowly lowering the gate until water started to flow (see Figure 6.5). However, the gate could only be lowered to a point such that 4-6 inches of water still remained inside the Drainage Bay. The gate must be raised to allow this water to be released from the Drainage Bay.
- A full vactor truck load of water did not occupy much volume in the Drainage Bay (see Figure 6.6), allowing for multiple loads before water discharge would be needed.
- After observing the nature of the solids making it through the perforated plate screens between the Unloading Bay and Drainage Bay, the research team decided to overlay the perforated plate gate screen with standard window screen (see Figure 6.7). The addition of the screens assisted with retaining sediment at the first perforated plate gate screen in the Drainage Bay (see Figure 6.8).
- After unloading material from the vactor truck, it was readily moved from the Unloading Bay (see Figure 6.9 after removing debris from Unloading Bay) to the Drying Bay (see Figure 6.10).
- The additional screen placed over the gates in the Drainage Bay resulted in an accumulation of solids-sludge in the Drainage Bay (see Figure 6.11).
- Even with additional screen on the first large gate in the Drainage Bay, there was some solids-sludge accumulation near the Drainage Bay outlet-gate after allowing the water to completely drain from the bay (see Figure 6.12).
- The iron oxide media and silt sack described in section 5.3 of this report (see Figure 6.13) was successfully placed in the Drainage Bay and used to treat water flowing through the gate (see Figure 6.14). The results of the test were previously reported in section 5.3.
- The outside drain opening on the west side of the building allowed waste material onto the apron (see Figure 6.15 for opening on west side of building). This behavior was unintended. There should be a much smaller screen on this end to allow some water flow during dumping, but minimal solids. The screen should be able to be removed similar to the others as needed to drain water from the apron. This was not included in the original design.

- After communication with Elytus (the contractor selected by District 2 for the disposal of the solids from the decanting facility, they required additional testing before disposal. They required Dry Solids and BETX testing at a total cost of $106 per sample (see Figure 6.16 for copy of email communication). Testing results for all bays (see Figure 6.17) showed the material was acceptable for landfill disposal.

Figure 6.2: Unloading Bay after vactor trump unloading (November 2016).

Figure 6.3: Perforated plate screen between Unloading Bay and Drainage Bay after vactor truck unloading and visibly showing clogging.

Figure 6.4: Water flowing through perforated plate screen between Unloading Bay and Drainage Bay during vactor truck unloading.

Figure 6.5: Water flowing over the top of the gate in the Outlet Control Box.

Figure 6.6: Drainage Bay with gate closed retaining water.

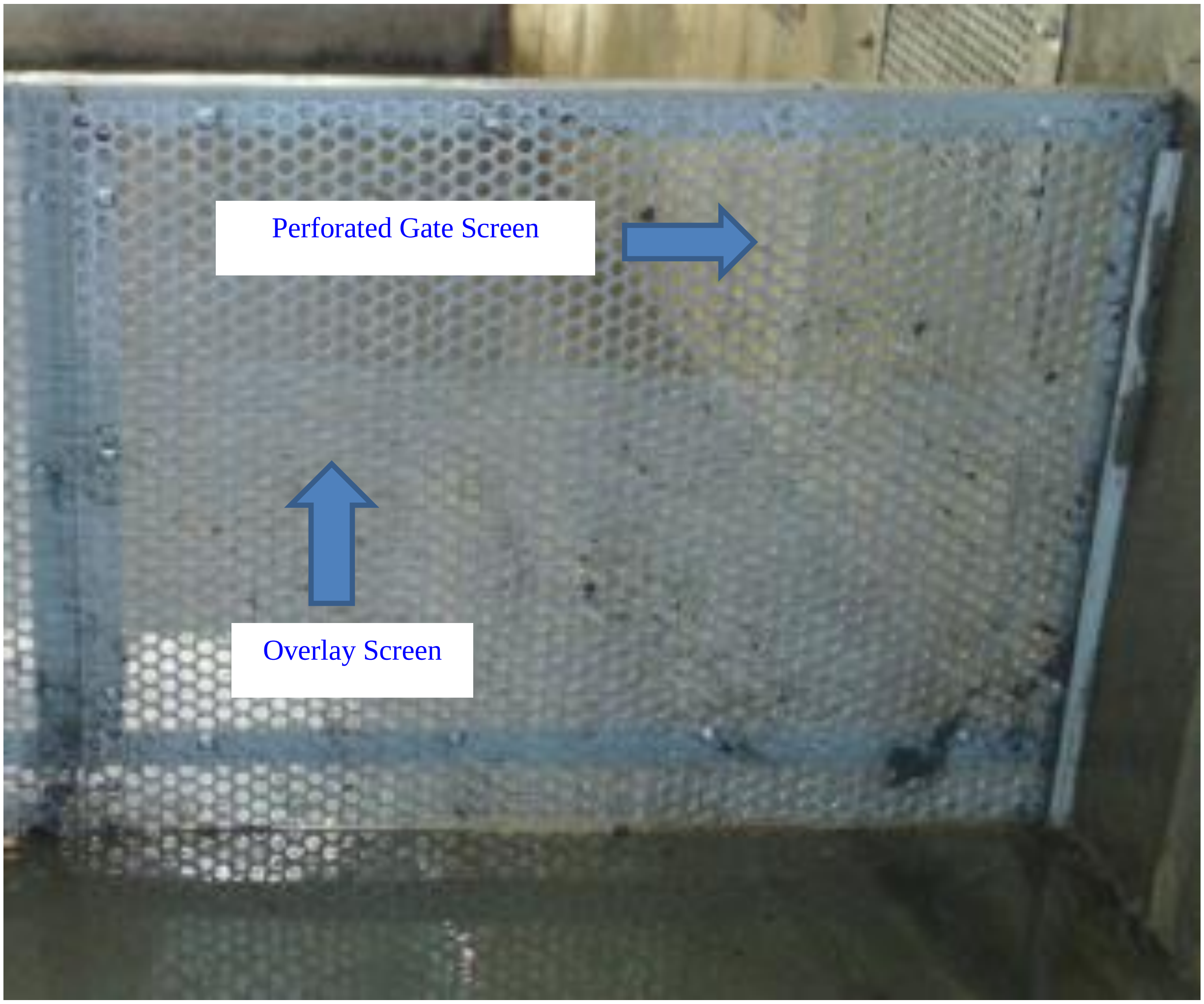


Figure 6.7: Close up of perforated plate gate screen in Drainage Bay showing standard window screen overlay to enhance solids removal.

Figure 6.8: Drainage Bay after discharging water and showing sediment accumulation in front of perforated plate screen that was overlaid with standard window screen.

Figure 6.9: Unloading Bay cleaned after one load of vactor truck.

Figure 6.10: Drying Bay 1 containing one load of vactor truck material.

Figure 6.11: Solids-sludge accumulation in front of gate in Drainage Bay and visible clogging of overlaid screen (see discoloration of screen above the solids and staining of concrete wall at same level).

Figure 6.12: Solids-sludge accumulation near the Drainage Bay outlet-gate after allowing the water to complete drain from the bay.

Figure 6.13: Silt sack containing iron oxide media placed at gate outlet inside Drainage Bay used to treat decant water prior to discharge to the Wet Well.

Figure 6.14: Water flowing under the gate in the Outlet Control Box.

Figure 6.15: Opening on west end of building with perforated screen.

From: Abounaaj, Hussein
Sent: Wednesday, February 03, 2016 8:20 AM
To: Martindale, Jacquelin
Subject: Additional Testing for Decanting Material

FYI Jill;

D02 was in communication with Elytus who handles our dumpster contract to get rid of the material at the decanting station. We gave them the test results done as part of the research study and they asked for an additional test called BETX.

Jones & Henry Laboratories, Inc. is pleased to offer our quotation for analytical testing services. The test parameters and fees are as follows:

Lucas County Garage

Test Parameter		Unit Cost	# samples	Total
Dry Solids		$11.00	5	55.00
BETX		$80.00	5	400.00
	Sub Total			$455.00
Sampling		$75.00	_	75.00
				$530.00

Hussein Abounaaj, P.E.
Roadway Services Manager
ODOT District 2
(419) 373-4483

Figure 6.16: Email communication regarding testing requirements from Elytus and analytical cost estimate provided by Jones & Henry Laboratories ($106 per sample).

Sample I.D. AH14522 | Location Description: Bay #1 soil
Sample Collector: RR | Collection Date: 2/1/2016 | Collection Time: 10:45
Lab Submittal Date: 2/01/2016 | Submittal Time: 11:55 | Received by: CF
Location code: ODOT | Validated by: CF | Validation date: 2/04/2016

TEST PARAMETER	RESULT	UNITS	PQL	AN DATE	AN	REF METHOD
SOLIDS, DRY, 104 DEG C	91.7	%	0.01	02/02/16	AJP	SM 2540 G
BETX by GC/MS		mg/kg		02/03/16	ND	EPA 8260
BENZENE	Not detected	mg/kg	0.09	02/03/16	ND	EPA 8260
ETHYLBENZENE	Not detected	mg/kg	0.09	02/03/16	ND	EPA 8260
TOLUENE	Not detected	mg/kg	0.09	02/03/16	ND	EPA 8260
m+p-XYLENE	Not detected	mg/kg	0.09	02/03/16	ND	EPA 8260
o-XYLENE	Not detected	mg/kg	0.09	02/03/16	ND	EPA 8260
S 0.812 mg/kg Dibromofluoromethane	0.685	mg/kg	0.	02/03/16	ND	EPA 8260
S 0.812 mg/kg Toluene-D8	0.695	mg/kg	0.	02/03/16	ND	EPA 8260
S 0.812 mg/kg Bromofluorobenzene	0.772	mg/kg	0.	02/03/16	ND	EPA 8260

Sample I.D. AH14523 | Location Description: Bay #2 soil
Sample Collector: RR | Collection Date: 2/1/2016 | Collection Time: 10:55
Lab Submittal Date: 2/01/2016 | Submittal Time: 11:55 | Received by: CF
Location code: ODOT | Validated by: CF | Validation date: 2/04/2016

TEST PARAMETER	RESULT	UNITS	PQL	AN DATE	AN	REF METHOD
SOLIDS, DRY, 104 DEG C	86.3	%	0.01	02/02/16	AJP	SM 2540 G
BETX by GC/MS		mg/kg		02/03/16	ND	EPA 8260
BENZENE	Not detected	mg/kg	0.10	02/03/16	ND	EPA 8260
ETHYLBENZENE	Not detected	mg/kg	0.10	02/03/16	ND	EPA 8260
TOLUENE	Not detected	mg/kg	0.10	02/03/16	ND	EPA 8260
m+p-XYLENE	Not detected	mg/kg	0.10	02/03/16	ND	EPA 8260
o-XYLENE	Not detected	mg/kg	0.10	02/03/16	ND	EPA 8260
S 1.00 mg/kg Dibromofluoromethane	0.900	mg/kg	0.	02/03/16	ND	EPA 8260
S 1.00 mg/kg Toluene-D8	0.839	mg/kg	0.	02/03/16	ND	EPA 8260
S 1.00 mg/kg Bromofluorobenzene	0.918	mg/kg	0.	02/03/16	ND	EPA 8260

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Sample I.D. AH14524 | Location Description: Bay #3 soil
Sample Collector: RR | Collection Date: 2/1/2016 | Collection Time: 11:00
Lab Submittal Date: 2/01/2016 | Submittal Time: 11:55 | Received by: CF
Location code: ODOT | Validated by: CF | Validation date: 2/04/2016

TEST PARAMETER	RESULT	UNITS	PQL	AN DATE	AN	REF METHOD
SOLIDS, DRY, 104 DEG C	89.1	%	0.01	02/02/16	AJP	SM 2540 G
BETX by GC/MS		mg/kg		02/03/16	ND	EPA 8260
BENZENE	Not detected	mg/kg	0.11	02/03/16	ND	EPA 8260
ETHYLBENZENE	Not detected	mg/kg	0.11	02/03/16	ND	EPA 8260
TOLUENE	Not detected	mg/kg	0.11	02/03/16	ND	EPA 8260
m+p-XYLENE	Not detected	mg/kg	0.11	02/03/16	ND	EPA 8260
o-XYLENE	Not detected	mg/kg	0.11	02/03/16	ND	EPA 8260
S 1.00 mg/kg Dibromofluoromethane	0.909	mg/kg	0.	02/03/16	ND	EPA 8260
S 1.00 mg/kg Toluene-D8	0.837	mg/kg	0.	02/03/16	ND	EPA 8260
S 1.00 mg/kg Bromofluorobenzene	0.937	mg/kg	0.	02/03/16	ND	EPA 8260

Figure 6.17: Lucas County garage solid material testing results (February 1, 2016) from Jones & Henry Laboratories.

6.3 Draft Standard Operating Procedures (SOPs)

This section will present separate draft SOPs for the following:

- Street Sweepings
- Catch Basin and Sewer Cleanout Material
- Decanting Facility Water (primarily from eductor truck-decant water)
- Material tracking utilizing 2016 ODOT TIMS mapping

The SOPs will focus on achieving the following operational objectives:

1. Low moisture content solid waste
2. High solid material capture efficiency (i.e. minimize solids going into the oil-water separator)
3. Safe operations

The SOP's for facility operations will differentiate three operational phases for each SOP. The three phases are (1) before new material is placed at the facility, (2) material loading activity at the facility, and (3) after the material is loaded at the facility.

6.3.1 Street Sweepings SOP

The SOP for this section is focused on managing the material collected from street sweeping equipment and reference should be made to Figure 6.1 regarding designated locations and areas within the decanting facility. Detailed guidance for the SOP is as follows:

<u>Before Placing New Material at Facility:</u>

1. Proper equipment safety and best practices documented by ODOT must be followed at all times during the operation of sweepings or material moving equipment at the facility.
2. Confirm with decanting facility at least 2 days ahead that there is capacity in Drying Bay 1 or Drying Bay 2 for the expected street sweepings activity material. Under most circumstances this will not be an issue as the Unloading Bay can also be used to unload sweepings in the event that both Drying Bay 1 and Drying Bay 2 are full.

3. As necessary prior to arrival, make room in the receiving bay (Drying Bay 1 or Drying Bay 2) for the incoming material to avoid introducing additional moisture from the new material to the emplaced material that is already dry or in process of drying. This can be accomplished by moving material from Drying Bay 1 to Drying Bay 2. All material should remain undisturbed for a minimum of 24 hours before moving to another bay. Monitor periodically to observe any water drainage in the bays. If there is any significant drainage, let material remain in place for at least another 24 hours until the drainage has dissipated. If the material in Drying Bay 1 has been drying for more than 72 hours, then all of it should be moved to Drying Bay 2.
4. Ensure there is a clear path to the drain-perforated screen at the rear of the bays for any water that drains from the newly-unloaded material.
5. If the load will contain substantial amounts of water, confirm there is capacity for drainage in the Drainage Bay area behind the drying bays and unloading area. Under most circumstances this will NOT be an issue, but should still be checked as a precaution. Make sure the depth of water does not exceed the level of the bottom of the perforated screens in the storage bays.
6. Ensure the perforated gates in the Drainage Bay area, as well as the perforated screens along the bottom of the back walls of the Unloading Bay and Drying Bays are fully in place, freely draining, and are not damaged. In the event that a screen is damaged and a replacement is not readily available, the screen in Drying Bay 2 can be used with concrete blocks used to prevent materials from entering the Drainage Bay area.
7. If filter media-silt sacks are being used at the weir gate for additional solids capture and water treatment, be sure to mix-displace the media in the silt sack by pushing on the outside of the silt sack. If the media appears to have solidified or the water does not readily pass through the silt sack, then the media must be replaced.
8. At least once a month, ensure the on-site dewatering pumps are in good operating order and are readily available should they be needed in the event the Wet Well pumps are not working.
9. Make sure the weir gate in the Outlet Control Box is raised to prevent water from flowing out of the Drainage Bay area.

<u>Material Loading Activity at Facility:</u>

1. Proper equipment safety and best practices documented by ODOT must be followed at all times during the operation of sweepings or material moving equipment at the facility.
2. If water content is expected to be minor in the street sweepings material, place the material in Drying Bay 1 (preferred) or Drying Bay 2. If water content is expected to be higher than is typical in the street sweepings material or is unknown, unload material into the Unloading Bay.

3. Observe drainage into the Drainage Bay and note the perforated and additional overlay screens are operating properly and retaining silt and sediment particles behind the screen while allowing any decant water to continue to flow. Note the presence of any unusual odors, colors, or consistency of drainage.
4. The screens along the back walls of the Unloading Bay and Drying Bays may clog during decanting operations, therefore, clear and tamp the perforated screens with a rake as necessary to allow free water to continue to collect in the Drainage Bay area.

<u>After Material Loading Activity at Facility:</u>

1. Proper equipment safety and best practices documented by ODOT must be followed at all times during the operation of sweepings or material moving equipment at the facility.
2. Let ALL material remain in place for a minimum of 24 hours before moving to another bay and monitor periodically to observe any water drainage present. If there is any significant drainage, let material remain in place for at least another 24 hours until the drainage has dissipated.
3. The general priority for managing material at the facility is to follow all of the guidelines listed previously in the SOP (e.g. minimum 24 hour drain time), while striving to move as much material as possible to Drying Bay 2 for disposal. Maximizing the material storage in Drying Bay 2 will keep the facility operating efficiently and reduce accumulation of material at the facility.
4. Preparing material from Drying Bay 2 for landfill disposal and/or utilization of a roll off box located on the apron can only be accomplished if ALL of the following conditions are met: (a) no "free" water is visible, (b) all material has been in Drying Bay 2 for a minimum of 72 hours, and (c) ensure that any special analytical testing required by the landfill owner/operator is performed that is necessary prior to disposal. Once the material testing has been completed (if required) and the analytical results are satisfactory for the disposal contractor and/or landfill owner/operator, the materials should be disposed of as soon as reasonably possible.
5. Electronic record of activity. Depending on operator and garage preference, a GPS tracking device should record the latitude and longitude of the start of the sweepings activity location and the end of the sweepings segment. Additional information should include the date the material was collected, the miles swept, and any observations-notes regarding the material after being unloaded at the decanting facility. This information needs to be recorded in an Excel file (see Material Tracking SOP for additional details).

6.3.2 Catch Basin and Sewer Cleanout Material SOP

The SOP for this section is focused on managing the material collected from catch basin and sewer cleanout material and reference should be made to Figure 6.1 regarding designated locations and areas within the decanting facility. Detailed guidance for the SOP is as follows:

<u>Before Placing New Material at Facility:</u>

1. Proper equipment safety and best practices documented by ODOT must be followed at all times during the operation of sweepings or material moving equipment at the facility.
2. Confirm with decanting facility at least 1 day ahead that all Unloading Bay material has been moved to Drying Bay 1 or that there is sufficient capacity in the Unloading Area for the expected catch basin activity material. Under most circumstances the Unloading Bay can be used for multiple loads as long as the perforated screens are clear of debris before unloading.
3. Ensure there is a clear path to the drain-perforated screen at the rear of the bays for water that drains from the newly-unloaded material.
4. Confirm there is capacity for water from the catch basin material in the Drainage Bay area behind the drying bays and unloading area. Under most circumstances this will NOT be an issue, but should still be checked as a precaution. Make sure the depth of water does not exceed the level of the bottom of the perforated screens in the storage bays.
5. Ensure the perforated gates in the Drainage Bay area, as well as the perforated screens along the bottom of the back walls of the Unloading Bay are fully in place, freely draining, and are not damaged. In the event that a screen is damaged and a replacement is not readily available, the screen in Drying Bay 2 can be used with concrete blocks used to prevent materials from entering the Drainage Bay area.
6. If filter media-silt sacks are being used at the weir gate for additional solids capture and water treatment, be sure to mix-displace the media in the silt sack by pushing on the outside of the silt sack. If the media appears to have solidified or the water does not readily pass through the silt sack, then the media must be replaced.
7. At least once a month, ensure the on-site dewatering pumps are in good operating order and are readily available should they be needed in the event the Wet Well pumps are not working.
8. Make sure the weir gate in the Outlet Control Box is raised to prevent water from flowing out of the Drainage Bay area.

Material Loading Activity at Facility:

1. Proper equipment safety and best practices documented by ODOT must be followed at all times during the operation of sweepings or material moving equipment at the facility.
2. Unload material into the Unloading Bay.
3. Observe water drainage into the Drainage Bay and note the perforated and additional overlay screens are operating properly and retaining silt and sediment particles behind the screen while allowing any decant water to continue to flow. Note the presence of any unusual odors, colors, or consistency of drainage.
4. The screens along the back walls of the Unloading Bay may clog during decanting operations, therefore, clear and tamp the perforated screens with a rake as necessary to allow free water to continue to collect in the Drainage Bay area.

After Material Loading Activity at Facility:

1. Proper equipment safety and best practices documented by ODOT must be followed at all times during the operation of sweepings or material moving equipment at the facility.
2. Let ALL material remain in place for a minimum of 24 hours before moving to another bay and monitor periodically to observe any water drainage present. If there is any significant drainage, let material remain in place for at least another 24 hours until the drainage has dissipated.
3. The general priority for managing material at the facility is to follow all of the guidelines listed previously in the SOP (e.g. minimum 24 hour drain time), while striving to move as much material as possible to Drying Bay 2 for disposal. Maximizing the material storage in Drying Bay 2 will keep the facility operating efficiently and reduce accumulation of material at the facility.
4. Preparing material from Drying Bay 2 for landfill disposal and/or utilization of a roll off box located on the apron can only be accomplished if ALL of the following conditions are met: (a) no "free" water is visible, (b) all material has been in Drying Bay 2 for a minimum of 72 hours, and (c) ensure that any special analytical testing required by the landfill owner/operator is performed that is necessary prior to disposal. Once the material testing has been completed (if required) and the analytical results are satisfactory for the disposal contractor and/or landfill owner/operator, the materials should be disposed of as soon as reasonably possible.
5. Electronic record of activity. Depending on operator and garage preference, a GPS tracking device should record the latitude and longitude of catch basin-cleanout location. Additional information should include the date the material was collected and any observations-notes

regarding (a) the catch basin and (b) the material after being unloaded at the decanting facility. This information needs to be recorded in an Excel file (see Material Tracking SOP for additional details).

6.3.3 Decanting Facility Water SOP

The SOP for this section is focused on managing the decanting facility water collected in the Drainage Bay and reference should be made to Figure 6.1 regarding designated locations and areas within the decanting facility. Detailed guidance for the SOP is as follows:

<u>Releasing Water from the Drainage Bay:</u>

1. Proper equipment safety and best practices documented by ODOT must be followed at all times
2. Confirm the weir gate is closed and no leaks are present. Eliminate any leaks and repair as necessary.
3. Prior to releasing any water, confirm water has been stored a minimum of 48 hours in the Drainage Area to allow settlement of fine particles to occur.
4. If filter media-silt sacks are being used at the weir gate for additional solids capture and water treatment, be sure to mix-displace the media in the silt sack (see Figure 6.18) by pushing on the outside of the silt sack. If the media appears to have solidified or the water does not readily pass through the silt sack, then the media must be replaced. Place the silt sack-filter media and holder within the Drainage Bay area next to the weir gate or in the Control Box outside the weir gate.
5. At least once a month, ensure the on-site dewatering pumps are in good operating order and are readily available should they be needed in the event the Wet Well pumps are not working.
6. Release water by slowly lowering the weir gate down so as to allow flow over the weir gate. Do this in increments of approximately 2 inches until approximately six inches of water remains on the Drainage Area floor. Listen to make sure that the Wet Well pumps turn on when sufficient water has drained into the Wet Well. In the event the pumps do not turn on, immediately close the gate and determine the reason the pumps are not working. Do not release any more water until these pumps are functional.
7. Release the remainder of the water by slowly raising the weir gate until water flows slowly under the gate. There should be minimal solids being released into the Outlet Control Box. If solids are observed, then immediately close the gate and follow the Drainage bay material cleanout procedures.

Drainage Bay Material Cleanout and Maintenance:

1. Proper equipment safety and best practices documented by ODOT must be followed at all times.
2. After all water has been released from the Drainage Bay, the depth of material-sludge in the channel nearest the weir gate should be estimated. Once it is approximately 4-6 inches, all material from the Drainage Bay needs to be removed and placed in Drying Bay 1. Material removal from the Drainage Area can be either by hand work (near the last few gates) and/or with mechanical equipment appropriate for the job (see Figure 6.19). Note the filter screens may be left in place if shovels are used to remove the sediment.

Figure 6.18: Iron oxide media in silt sack.

Figure 6.19: End loader used to remove material from the Drainage Bay.

6.3.4 Material Tracking

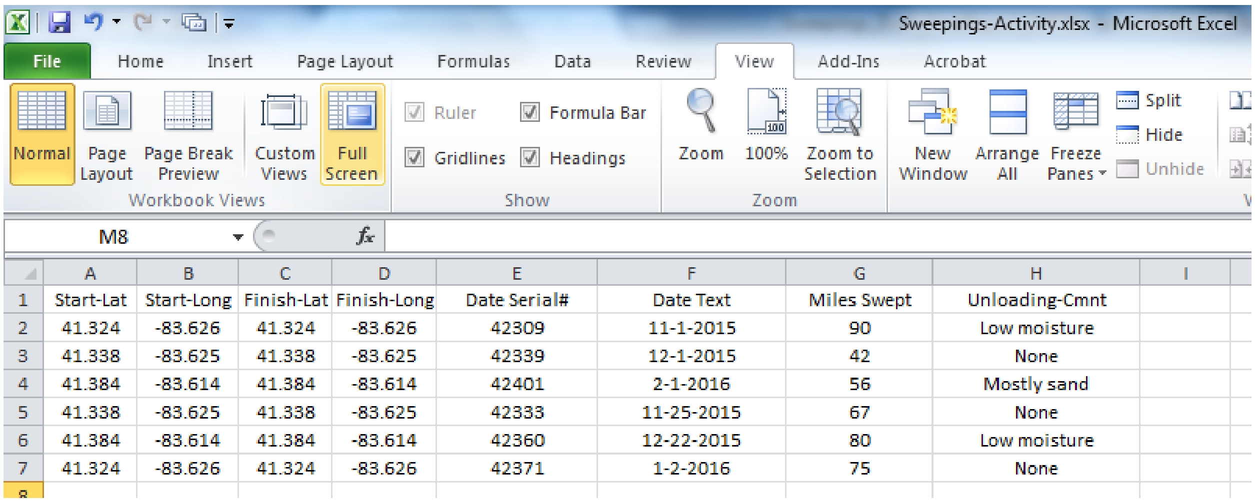
The SOP for this section is focused on tracking sweepings and catch basin material activity for the purpose of identifying potentially problematic drainage or street areas, as well as the quantity of material generated at a facility. The important elements for this SOP include (1) a GPS-enabled device to record latitude and longitude (or geospatial coordinates) where activity was performed, (2) a spreadsheet (e.g. Excel or Google documents), and (3) access to ODOT TIMS. Detailed guidance for the SOP is as follows:

<u>Street Sweeping Tracking:</u>

1. Electronic record of activity. Depending on operator and garage preference, a GPS tracking device should record the latitude and longitude of the start of the sweepings activity location and the end of the sweepings segment. Additional information should include the date the material was collected, the miles swept, and any observations-notes regarding the material after being

unloaded at the decanting facility. This information needs to be recorded in an Excel file (see Figure 6.20 for screenshot example).

2. Viewing activity can be accomplished using TIMS as follows (a) go to TIMS website, (b) create a map, (c) load Excel file (see Figure 6.20), and (d) view map. See subsequent pages for screen shots of this process.



	A	B	C	D	E	F	G	H
1	Start-Lat	Start-Long	Finish-Lat	Finish-Long	Date Serial#	Date Text	Miles Swept	Unloading-Cmnt
2	41.324	-83.626	41.324	-83.626	42309	11-1-2015	90	Low moisture
3	41.338	-83.625	41.338	-83.625	42339	12-1-2015	42	None
4	41.384	-83.614	41.384	-83.614	42401	2-1-2016	56	Mostly sand
5	41.338	-83.625	41.338	-83.625	42333	11-25-2015	67	None
6	41.384	-83.614	41.384	-83.614	42360	12-22-2015	80	Low moisture
7	41.324	-83.626	41.324	-83.626	42371	1-2-2016	75	None

Figure 6.20: Excel screenshot of example file used to track street sweeping activity.

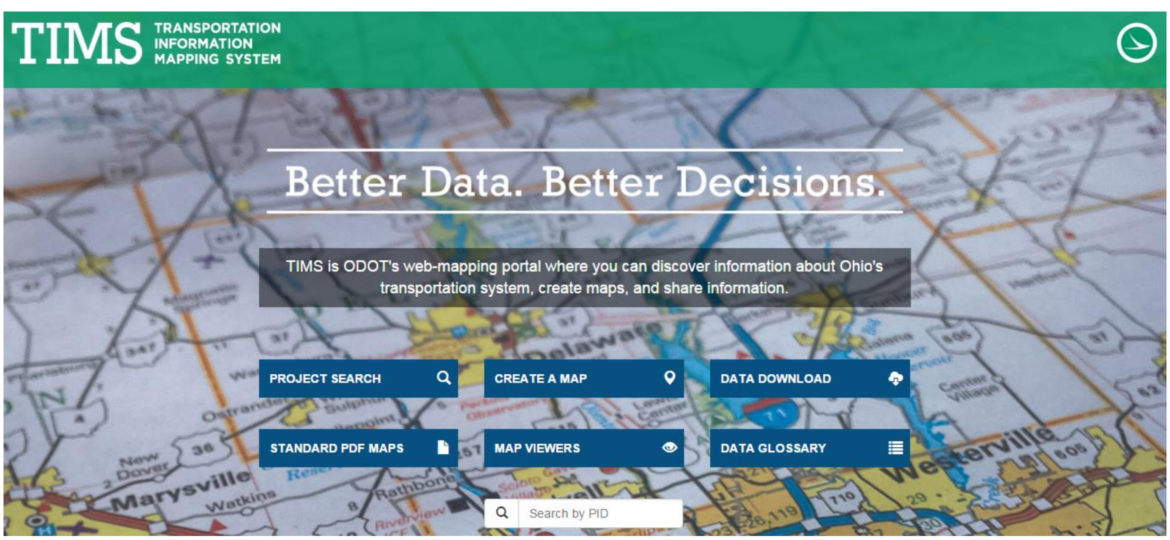


Figure 6.21: ODOT Transportation Information Mapping System (TIMS) screen shot (http://gis.dot.state.oh.us/tims).

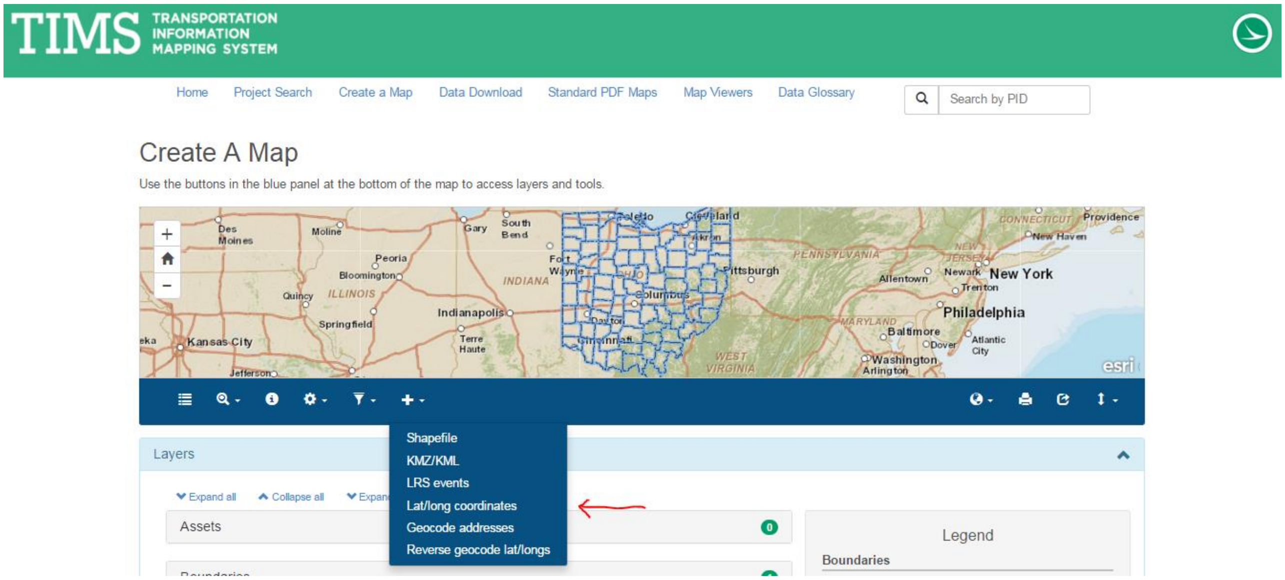


Figure 6.22: ODOT TIMS Create a Map functionality and drop down menu (shown with red arrow) to select Lat/long coordinates.

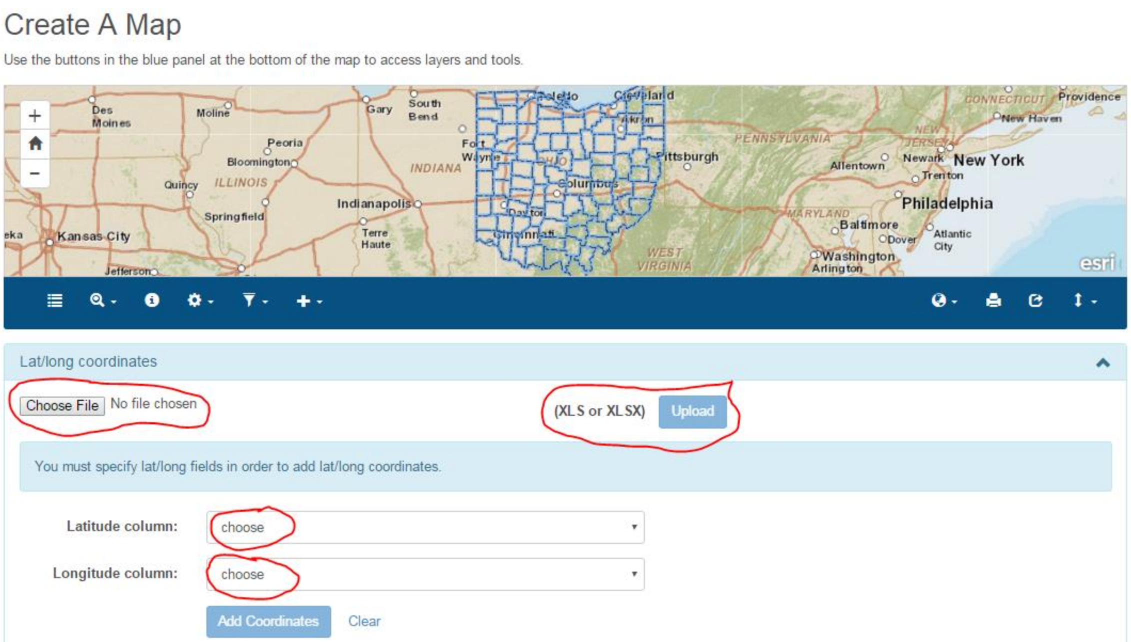


Figure 6.23: ODOT TIMS Create a Map functionality and choosing a file (red circles showing Choose File and Upload Excel buttons to select file) with Lat/long coordinates.

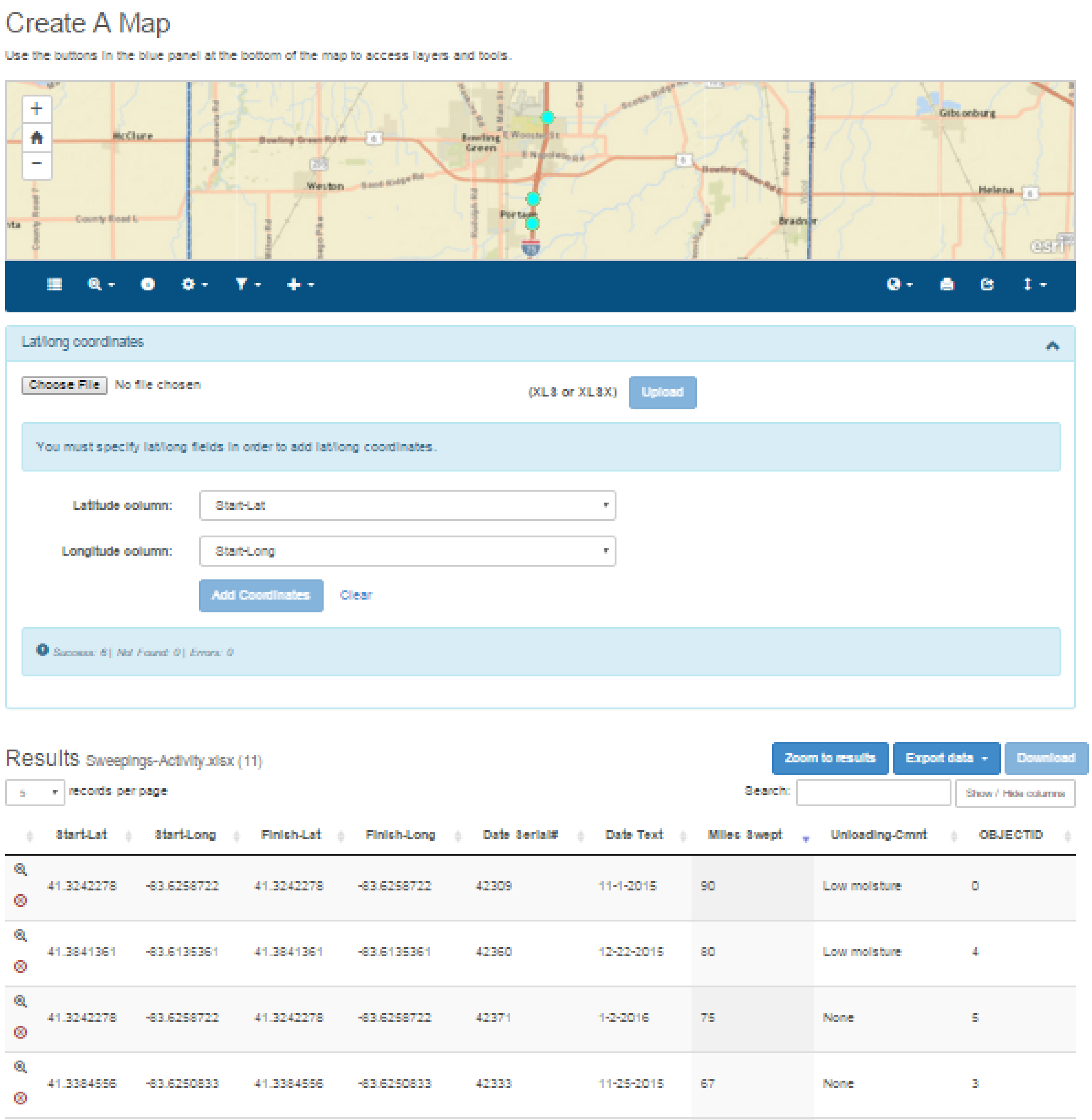


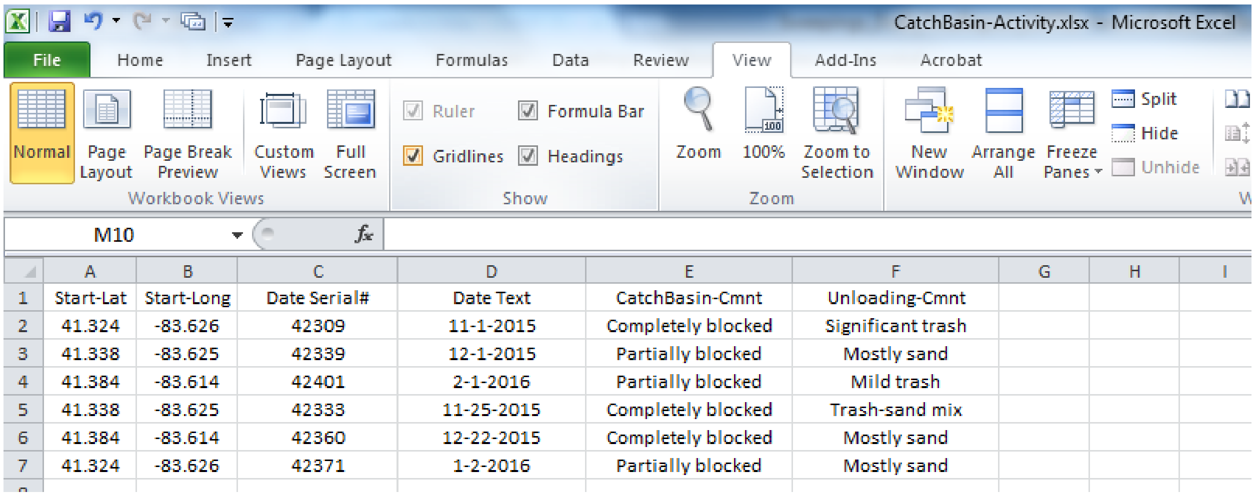
Figure 6.24: ODOT TIMS Create a Map output functionality showing map locations (dots on maps) and location data stored in spreadsheet file.

Catch Basin Tracking:

1. Electronic record of activity. Depending on operator and garage preference, a GPS tracking device should record the latitude and longitude of catch basin-cleanout location. Additional information should include the date the material was collected and any observations-notes regarding (a) the catch basin and (b) the material after being unloaded at the decanting facility. This information needs to be recorded in an Excel file (see Figure 6.21 for screenshot example).

In conversations with ODOT personnel, they stated that a maximum work activity day would result in cleaning 3-4 catch basins which is a manageable number to record.

2. Viewing activity can be accomplished using TIMS as follows (a) go to TIMS website, (b) create a map, (c) load Excel file (see Figure 6.21 for screenshot example), and (d) view map.



	A	B	C	D	E	F	G	H	I
1	Start-Lat	Start-Long	Date Serial#	Date Text	CatchBasin-Cmnt	Unloading-Cmnt			
2	41.324	-83.626	42309	11-1-2015	Completely blocked	Significant trash			
3	41.338	-83.625	42339	12-1-2015	Partially blocked	Mostly sand			
4	41.384	-83.614	42401	2-1-2016	Partially blocked	Mild trash			
5	41.338	-83.625	42333	11-25-2015	Completely blocked	Trash-sand mix			
6	41.384	-83.614	42360	12-22-2015	Completely blocked	Mostly sand			
7	41.324	-83.626	42371	1-2-2016	Partially blocked	Mostly sand			

Figure 6.25: Excel screenshot of example file used to track catch basin activity.

<u>Material Disposal Tracking:</u>

The most accurate way to record the total quantity of material managed by a facility is to record the landfill-contractor ticket quantities in a spreadsheet. This can be as simple as the date of disposal and the quantity of material. This will allow cross-referencing material activity to quantity of material generated by simply calculating the quantity of material generated between disposal dates.

Note: All Material Disposing Tracking activities could be recorded in one spreadsheet file with three tabs, one tab for each type of data.

6.4 Develop Final Design Report and Plans

The final task for the research project as stated in the proposal was:

"After completing the field monitoring activities, the enhancements and recommendations identified in the field during construction and operations will be incorporated into the plan set, construction specifications, and the SOPs in conjunction with any additional recommendations provided by ODOT. These documents will be incorporated into appropriate appendices of the final project report documenting the decant facility construction, operations, observations, and final recommendations at the new site."

Section 6.2 provided significant detail on operations observations from the newly-constructed decanting facility. After reviewing a draft of this report and meeting with ODOT personnel on March 11, 2016, modifications to the perforated gates in the Drainage bay were recommended to include placing solid aluminum across the first 12-18 inches of the Drainage Bay gates in a manner to create a tortuous path for the water to travel and the solids to settle before the water is released from the weir gate (see Figure 6.26 and Figure 6.27)

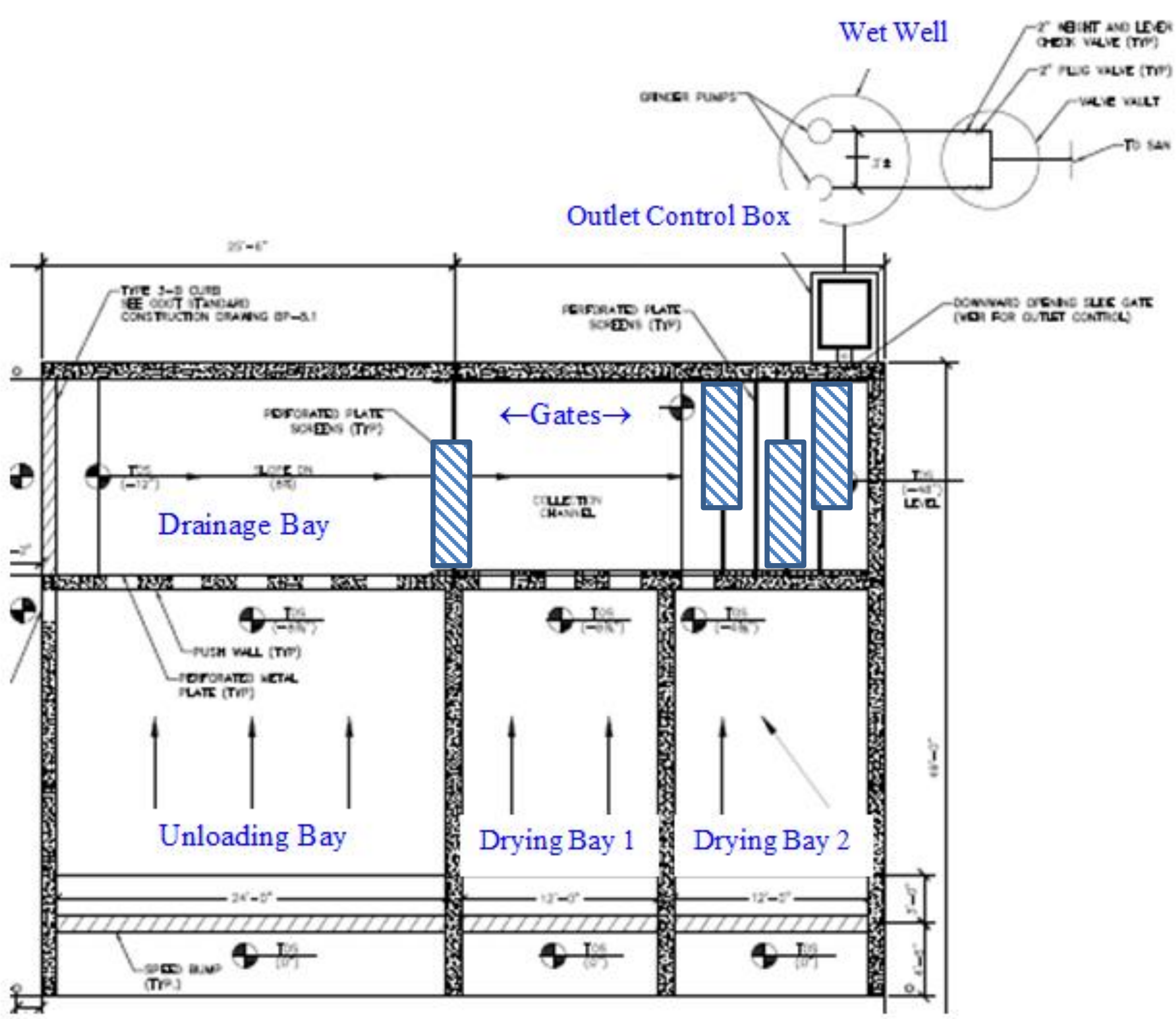


Figure 6.26: Plan view of the decanting facility showing gate modifications (crosshatched areas on figure) to create tortuous path for water and aid particle settling.

Figure 6.27: Drainage bay view (March 2016) showing gate modifications (i.e. solid aluminum) to create tortuous path for water and aid particle settling.

These modifications should reduce particle settling near the gate opening into the control box.

The Final Design drawings are included in Appendix E. Recommendations for improving the operations at the facility are listed in Chapter 7 - Recommendations.

CHAPTER VII CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

This research team proposed eight objectives for this project. These included:

1. Determine state of current procedures and practices by Ohio DOT, other state DOTs, and local municipalities including material classification, handling, and tracking.
2. Identify existing decanting practices and review available decanting equipment for potential regional implementation of equipment at ODOT facilities.
3. Develop a tracking tool for operational activity and conduct analysis of existing data.
4. Develop Construction Plan Set and Specifications for Decanting Facility
5. Perform analytical testing of waste material generated by maintenance activities to classify the material and determine how it may be beneficially reused in Ohio in accordance with Ohio EPA (OEPA) regulations.
6. Evaluate Adsorption Media Testing at "New" Decanting Facility
7. Develop Standard Operating Procedures for Handling Street Sweepings and Sewer Cleanout Material
8. Develop Final Design Report, Plans and Recommendations

We believe that these research objectives have been met and have the following conclusions:

- Surveys and interviews were used to determine state of current procedures and practices by Ohio DOT, other state DOTs, and local municipalities including material classification, handling, and tracking. The survey results indicate that ODOT is using the best available management practices for managing these materials (Chapter 2.1 and 2.2).
- Review of existing decanting practices and available decanting equipment for potential regional implementation of equipment at ODOT facilities revealed simply managing the solids and the water would be more cost-effective than expensive and complicated equipment (Chapter 2.2).
- Several material tracking tools were developed and evaluated for operational activity monitoring using existing ODOT data (complete annual data sets for 2008-2012). Cost analysis showed that labor and equipment costs comprise greater than 90-95% of the cost associated with material management, indicating disposal costs (varied from $25/ton to

$40/ton) to be insignificant compared to the collection cost which includes labor hours, equipment miles, and equipment hours (Chapter 3.1 and 3.2).

- The activity tool, data analysis, and multi-weighted criteria were used to assign a priority of potential decanting facility locations in each ODOT District (Chapter 3.3 – see Figures 3.14 - 3.16). All ODOT Districts have at least two locations that are suitable for a decanting facility, scoring high based on historical material quantity and activity costs.
- A prototype design was created for ODOT for construction of a decanting facility at the Lucas County (District 2) garage that incorporated the minimum necessary requirements determined after visiting many other material-handling facilities (see Chapter 4) and included:
    - a) Sloped impermeable floor surface to promote drainage
    - b) Drain(s) to collect runoff from the street sweepings/sewer cleanout material
    - c) Access areas for large equipment to both dump and pick up bulk material
    - d) Barriers to control storm water run-on
    - e) A roof (with adequate clearance) to prevent direct rain reinfiltration
    - f) Access to sanitary sewer discharge for the decant water
    - g) A modular design that can be scaled to different locations based on regional material generation rates but that must still have bays large enough to accommodate heavy equipment
- Analytical testing of waste material generated by maintenance activities in Ohio at five ODOT locations (2014) was used to assess beneficial reuse in Ohio in accordance with Ohio EPA (OEPA) regulations. The material was generally acceptable as a fill material with all constituents below recommended concentrations except for diesel (Chapter 5.1 and 5.2 – see Table 20 and Table 21).
- Analytical testing of waste material generated by maintenance activities at the "new" Lucas County facility (2016) showed the material to be acceptable for disposal (Figure 6.17).
- Metal adsorption media testing at the newly-constructed decanting facility showed promise, with many heavy metals reduced by a significant percentage. Testing with iron oxide media and decanting water from the facility showed the following removals (Chapter 5.3 – see Table 23): arsenic (>84.8%), cadmium (>72.2%), chromium (>98.5%), copper (>98.3%), nickel (>92.7%), were reduced the most, followed by zinc (24.0%) and lead (8.3%).
- Standard operating procedures (SOPs) for the Lucas County facility were drafted for managing street sweepings (Chapter 6.3.1), catch basin material (Chapter 6.3.2), decanting facility water (Chapter 6.3.3), and material tracking incorporating the latest GIS technology

supported by ODOT (Chapter 6.3.4). These procedures were developed as to be easily transferable to accommodate operations in all ODOT Districts.

7.2 Recommendations

We believe there are several recommendations for ODOT consideration to continue to increase their capacity and effectiveness to manage street sweeping and catch basin materials. These include:

1. Install a motor on the weir gate to facilitate raising and lowering of the gate. It currently takes at least 5-15 minutes to manually raise and lower the gate.
2. Consider slots or a means to support the silt sack support or design a new support for the silt sack to contain metal adsorption media for metal removal from the water. This would make it easier to maintain the media and potentially enhance removal.
3. Start actively tracking material activities and disposal using the SOP drafted as part of this project.
4. Update SOPs for all activities at the Lucas County garage decanting facility as new operational efficiencies are observed.

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APPENDIX A: ONLINE SURVEY RESULTS

Street Sweepings

7. 9. How are street sweeping sediments classified?

		Response Percent	Response Count
Solid Waste		67.5%	27
Hazardous Waste		15.0%	6
Other		17.5%	7
	Other (please specify)		7
	answered question		40
	skipped question		7

8. 10. Does your organization track the volume of street sweepings collected?

		Response Percent	Response Count
Yes		59.0%	23
No		41.0%	16
	answered question		39
	skipped question		8

Page 4, Q9. 11. How are these materials quantified and tracked?		
1	loads are tracked as they are hualed to the landfill - approx 4 tons per load	Dec 18, 2012 1:59 PM
2	cubic yards	Dec 11, 2012 12:08 PM
3	Loaded into a dumpster and weighed at the landfill	Dec 11, 2012 10:55 AM
4	By cubic yards through a work order system	Dec 10, 2012 5:50 PM
5	By truck load dumped at the sanitary landfill we own and operate.	Dec 10, 2012 3:37 PM
6	The units hold a given yardage. The operator gives a dayly measurement of how many yard dumped	Dec 10, 2012 12:50 PM
7	The sweeper operator gives the info to the MS4 cooridinator.	Dec 10, 2012 12:49 PM
8	we keep track in tonnage.	Dec 10, 2012 10:53 AM
9	Estimated by driver and recorded daily	Dec 10, 2012 10:29 AM
10	Cubic Yard	Dec 10, 2012 9:11 AM
11	cubic yard at collection and at disposal	Dec 10, 2012 9:07 AM
12	by the Yard	Dec 10, 2012 8:37 AM
13	Truck weight tickets.	Dec 10, 2012 7:48 AM
14	By cubic yards	Dec 7, 2012 5:47 PM
15	Cubic yards of debris is reported daily by operators	Dec 7, 2012 3:49 PM
16	By Cubic Yard	Dec 7, 2012 3:13 PM
17	Weighed at transfer station	Dec 7, 2012 2:09 PM
18	by truck load cubic yards	Dec 7, 2012 2:02 PM
19	Estimated amount screened	Dec 7, 2012 1:10 PM
20	Loads are weighed at scales from our landfill site	Dec 7, 2012 12:22 PM
21	as they are trucked to the landfill	Dec 7, 2012 12:21 PM

14. 16. Does your organization have a beneficial reuse program for street sweepings?

	Response Percent	Response Count
Yes	14.7%	5
No	85.3%	29
	answered question	34
	skipped question	13

15. 17. How are street sweepings reused by your organization? Please check all that apply

	Response Percent	Response Count
Clean cover	66.7%	4
Aggregate in asphalt or concrete	0.0%	0
Winter Traction Abrasive	33.3%	2
Subgrade below parking lots	66.7%	4
Fill in median strip of ROW	16.7%	1
Other	33.3%	2
Other (please specify)		3
answered question		6
skipped question		41

Page 6, Q15. 17. How are street sweepings reused by your organization? Please check all that apply		
1	Part of the sweeping is clean up after chip seal operations. That rock is reused for gravel areas.	Dec 10, 2012 12:53 PM
2	mixed with compost	Dec 7, 2012 5:49 PM
3	reused to mix with new sand for traction on streets on icy streets	Dec 7, 2012 4:18 PM

Page 4, Q11. 13. How are these street sweepings managed? Please check all that apply		
1	Spoils are screened, non organics go to the landfill, organics are used in gravel pit reclamation	Dec 10, 2012 5:50 PM
2	Leaves are used as compost if possible.	Dec 10, 2012 12:50 PM
3	Trucked to landfill when stock pile reaches capacity of storage area.	Dec 10, 2012 9:07 AM
4	they hauled in dumpsters	Dec 10, 2012 8:37 AM
5	Stored on site hauled away as needed. Onsite storage provided for approx 500 tons	Dec 10, 2012 7:48 AM
6	Taken to transfer station/landfill once quantity is sufficient	Dec 7, 2012 2:09 PM

Page 5, Q12. 14. Please describe how street sweepings are treated		
1	segregated from excavation spoils and landfilled	Dec 10, 2012 7:50 AM

Page 5, Q13. 15. What is the approximate annual budget for street sweepings management?		
1	There is not a seperate budget for street sweeping, but costs are approx. $480,000 annually	Dec 18, 2012 2:00 PM
2	There is no budget, we haul to our landfill	Dec 11, 2012 12:30 PM
3	150000	Dec 11, 2012 12:27 PM
4	$24,000	Dec 11, 2012 10:55 AM
5	$20,800	Dec 10, 2012 5:51 PM
6	Not sure	Dec 10, 2012 3:10 PM
7	$12,000	Dec 10, 2012 12:52 PM
8	$30,000.00	Dec 10, 2012 12:49 PM
9	530,000.	Dec 10, 2012 11:11 AM
10	$83,000	Dec 10, 2012 10:48 AM
11	$90,000	Dec 10, 2012 10:29 AM
12	$175,000	Dec 10, 2012 9:11 AM
13	budget is not broken out specific to sweeping	Dec 10, 2012 9:08 AM
14	$40,000	Dec 10, 2012 8:38 AM
15	$42,400.00	Dec 10, 2012 7:50 AM
16	3.6 million	Dec 7, 2012 5:48 PM
17	0	Dec 7, 2012 4:25 PM
18	200,000	Dec 7, 2012 4:10 PM
19	125,000	Dec 7, 2012 3:16 PM
20	0	Dec 7, 2012 2:10 PM
21	30000	Dec 7, 2012 2:02 PM
22	$88,000	Dec 7, 2012 1:12 PM
23	10000	Dec 7, 2012 1:00 PM
24	300,000	Dec 7, 2012 12:56 PM
25	300,000	Dec 7, 2012 12:50 PM

Catch Basins

17. 9. How are catch basin, storm water pond, and swale cleanout sediments classified?

		Response Percent	Response Count
Solid Waste		59.4%	19
Hazardous Waste		18.8%	6
Other		21.9%	7
		Other (please specify)	7
		answered question	32
		skipped question	15

21. 23. Is the volume of clean out material quantified and tracked?

		Response Percent	Response Count
Yes		25.8%	8
No		74.2%	23
		answered question	31
		skipped question	16

25. 27. Are these materials designated for any beneficial uses?

		Response Percent	Response Count
Yes		6.7%	2
No		93.3%	28
		answered question	30
		skipped question	17

Page 7, Q19. 21. How are the materials collected by the vacuum truck managed?		
1	decanted and stored until haul out.	Dec 10, 2012 7:51 AM
2	Cleaned by spoon and manpower.	Dec 7, 2012 4:27 PM
3	Stored in roll-off, covered.	Dec 7, 2012 3:22 PM
4	wastewater	Dec 7, 2012 12:48 PM

Page 8, Q20. 14. Please describe how these materials are treated		
1	treated at the waste water treatment plant.	Dec 10, 2012 11:13 AM
2	decanted with sump cleaning debris and hauled out as needed.	Dec 10, 2012 7:51 AM
3	they are not treated	Dec 7, 2012 4:27 PM
4	wastewater treatment plant	Dec 7, 2012 12:48 PM

Page 9, Q22. 24. How are these materials quantified and tracked?		
1	cubic yard	Dec 11, 2012 12:40 PM
2	Hauled with sweeper debris to landfill.	Dec 11, 2012 10:57 AM
3	Operators track loads and reported daily	Dec 10, 2012 12:57 PM
4	not sure	Dec 10, 2012 11:14 AM
5	segrated and stored, weight tickets from trucks	Dec 10, 2012 7:53 AM
6	Cubic yards are reported by operators	Dec 7, 2012 3:54 PM
7	truck load, cubic yard	Dec 7, 2012 2:04 PM
8	Weighed at landfill	Dec 7, 2012 12:24 PM

Page 9, Q24. 26. What is the approximate annual budget for the management of catch basin, stormwater pond, and swale clean out materials?		
1	$250K	Dec 17, 2012 4:36 PM
2	unknown	Dec 11, 2012 12:40 PM
3	75000	Dec 11, 2012 12:28 PM
4	alloted with the $24,000 for weeper debris	Dec 11, 2012 10:57 AM
5	not sure	Dec 10, 2012 3:11 PM
6	$3,500	Dec 10, 2012 12:57 PM
7	not sure	Dec 10, 2012 11:14 AM
8	$130,000	Dec 10, 2012 10:50 AM
9	$50,000	Dec 10, 2012 10:32 AM
10	$50,000	Dec 10, 2012 9:28 AM
11	no specific budget for this operation	Dec 10, 2012 9:10 AM
12	$30,000	Dec 10, 2012 8:39 AM
13	$25000.00	Dec 10, 2012 7:53 AM
14	1 million	Dec 7, 2012 6:00 PM
15	unknown as it is included with other work in the land drainage systems.	Dec 7, 2012 4:28 PM
16	No designated budget	Dec 7, 2012 3:23 PM
17	500	Dec 7, 2012 2:11 PM
18	40000	Dec 7, 2012 2:04 PM
19	UNKNOWN	Dec 7, 2012 1:16 PM
20	200,000	Dec 7, 2012 12:57 PM
21	unknown	Dec 7, 2012 12:48 PM
22	no budget	Dec 7, 2012 12:46 PM
23	unknown as it is included in larger overall stormwater maintenance budget	Dec 7, 2012 12:38 PM
24	60000	Dec 7, 2012 12:24 PM
25	No specific budget amount	Dec 7, 2012 12:23 PM

Page 10, Q26. 28. Please describe how these materials are reused		
1	Landfill Cover	Dec 17, 2012 4:36 PM
2	fill material	Dec 10, 2012 9:10 AM
3	As cover for the landfill	Dec 7, 2012 12:24 PM

Decanting Facilities

28. 30. Does your organization use decanting facilities as part of the storm water sediment management program?

	Response Percent	Response Count
Yes	21.9%	7
No	78.1%	25
answered question		32
skipped question		15

29. 31. Do you use portable or fixed decanting facilities?

	Response Percent	Response Count
Portable	0.0%	0
Fixed	100.0%	7
Both	0.0%	0
answered question		7
skipped question		40

APPENDIX B: METAL ADSORPTION MEDIA BROCHURE

Bayoxide® E33 Adsorption Media – Arsenic Reduction

AdEdge Technologies' Bayoxide® E33 media is the industry standard for arsenic reduction that reduces up to 99% of total arsenic, including both arsenic (III) and arsenic (V). This revolutionary new iron-based granular adsorption media has 4 to 10 times the capacity of many adsorption medias. AdEdge's product is specifically designed for commercial and residential POE and small systems to meet the EPA arsenic standard of 10 ppb. Developed in the mid-nineties, this ferric oxide-based product has been successfully used in large-scale drinking water applications since 1999. The new E33 media can be discarded when spent and requires no chemicals or regeneration. It has become the premier product of choice for POE whole-house drinking water treatment systems for reliable, cost-effective, proven reduction of arsenic.

✓ Removal of up to 99% of total Arsenic in water, including As (III) & As (V) with no wasting of water.	✓ NSF 61 product listing (see AdEdge for listing site/product details) ✓ Effective over broad water chemistry.
✓ Spent media discarded as non-hazardous household waste.	✓ Simple application for whole house POE applications for arsenic removal.
✓ Reliable performance, low maintenance ✓ Adaptable add-on to water softening or other existing equipment.	✓ 2 - 2.5 times lighter than other iron-based media; easily backwashable; arsenic not released or discharged in backwash water.
✓ No salt, chemicals or regeneration needed	✓ Imparts no harmful chemicals into the treated product water.

TECHNICAL SPECIFICATIONS

E33 provides cost effective centralized arsenic treatment with a typical life of 2-3+ years before replacement. The media exhibits high operating capacity across a wide range of pH, influent arsenic concentrations and flow rates. It is simple to apply in standard POE vessels with typical flow rates of 2-10 gallons per minute. Once the media is exhausted, E33 can be discarded as a non-hazardous waste (specific state requirements should be consulted). Media is easy to handle and can be stored and shipped dry.

Physical Properties	E33 Media
Matrix	Iron Oxide Composite
Physical Form	Dry granular media
Color	Amber
Particle Size Distribution	10x35 mesh
Moisture Content	< 15% by wt.
Packaged	Dry

AdEdge Technologies, Inc.,
5152 Belle Wood Court, Suite A,
Buford, GA 30518 (866) 823-3343 (678) 835-0057 Fax
www.advantedgewater.com

AdvantEdge 0311

Arsenic Removal Performance (POE)	
Arsenic concentration range [1,2]	10 – 100+ ppb
Arsenic species reduced	As (III) and As (V)
Removal efficiency	Up to 99%
Estimated media life	2 to 3+ years
Expected life bed volumes [3]	15,000 to 125,000
Spent media disposal [4]	Non-hazardous waste
Empty bed contact time	3 minutes typical

Notes:
1. Typical arsenic contamination in U.S. < 50 ppb.
2. Capable of removing higher As concentrations. Consult AdVantEdge for applications above 100 ppb.
3. Actual bed volumes based on water quality.
4. Reference US EPA TCLP protocol

Use of E33 media in typical point-of-entry system installation. Picture courtesy of Aquamerck, Inc.

WATER QUALITY CRITERIA

Parameter	Value [1]
pH range [2]	5.5 - 8.5
Arsenic [3]	< 100 ug/L
Iron	< 0.3 mg/L
Manganese	< 0.05 mg/L
Phosphate	< 0.5 mg/L
Silica	< 30 mg/L
Sulfate	< 100 mg/L
Sulfides	< detect mg/L
TSS	< 5 mg/L
Fluoride	< 1 mg/L
Hardness	< 300 mg/L
Turbidity	5 NTU

Notes:
1. Recommendations for best performance.
2. Water > 8.5 pH may require pH adjustment for best results. Contact AdVantEdge for technical support.
3. For all applications, complete AdVantEdge POE profile sheet to pre-qualify site for proper use; consult AdVantEdge Authorized dealer or distributor for details
4. Pretreat for tannins if present prior to adsorption

RESIDENTIAL SIZING PARAMETERS

System Design Parameters	5 GPM dual tank	6 GPM single tank	10 GPM single tank
Typical Tank size (inches)	10 x 42	12 x 52	14 x 65
Media Volume (cubic feet)	(2) 1-ft³ ea	2 ft³	4 ft³
Operation mode	2 in series	Single tank	Single tank
Media Type	E33S	E33S	E33S
Underbedding	gravel	gravel	gravel
Typical Freeboard (%)	40	40	40
Backwash flow rate (gpm/ft²)	4	5	10
Backwash cycles (per month)	2x	2x	2x
Est. gallons per day [4]	300	300	500
Est. gallons to breakthrough [1]	374,000	374,000	561,000
Estimated time to media changeout [1]	2-3+ years	2-3+ years	2-3+ years
Max flow rate (gpm)	5	6	10

Notes:
1. Media life based on gallon usage and water profile (Above is example only; example assumes 40 ppb
2. arsenic, 25,000 bed volumes); will vary by individual site based on water quality and usage
3. AdVantEdge recommends effluent testing and monitoring program to determine media breakthrough.
4. Average gallons per day will be site and usage specific.

AdEdge Technologies, Inc.,
5152 Belle Wood Court, Suite A,
Buford, GA 30518 (866) 823-3343 (678) 835-0057 Fax
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APPENDIX C: SILTSACK DATA SHEET

SILTSACK
SEDIMENT CAPTURE DEVICE

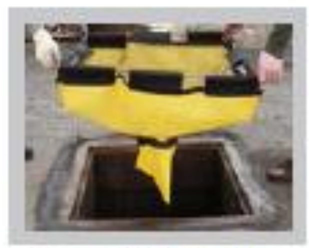
INLET PROTECTION

Are you looking for a cost-effective, easy way to stop silt and sediment from entering catch basins on construction site? Siltsack is the simple and economical solution to prevent clogging of catch basins.

Type A - Installed.

Siltsack is a sediment control device used to prevent silt and sediment from entering your drainage system by catching the silt and sediment while allowing water to pass through freely. Siltsack can be used as a primary or secondary sediment control device to prevent failure of your drainage system due to clogging. It must be maintained on a regular basis to function properly.

Siltsack is available in both high-flow or regular flow. A modified Siltsack is also available with a curb opening deflector attached to prevent sediment and debris from entering through curb openings. Siltsack is a quality product designed to save time and money.



Type C - Adjustable hanging frame.

Routine inspection of a Siltsack's collected sediment level is important to prevent "ponding" around storm drains. We recommend the following maintenance schedule:

- Each Siltsack should be inspected after every major rain event.
- If there have been no major events, Siltsack should be inspected every 2-3 weeks.
- The yellow restraint cord should be visible at all times. If the cord is covered with sediment, the Siltsack should be emptied.

Adjustable frame installed.
Adjusts from 16x24 to 24x36.

ADVANTAGES:

- Made to fit any size inlet
- Easy to install and economical
- US Patented
- Undergrate design so it is not easily disturbed
- Type B, Type C Adjustable Frame, and Floc Model available

For more information about Inlet Protection, contact Inside Sales at 800.448.3636
email at info@acfenv.com

INSTALLATION

LET'S GET IT DONE

SPECIFICATIONS:

Siltsack Regular Flow

PROPERTY	TEST METHOD	MINIMUM AVERAGE ROLL VALUE
Grab Tensile Strength	ASTM D4632	315 lbs
Grab Tensile Elongation	ASTM D4632	15%
Puncture Strength	ASTM D4833	140 lbs
Mullen Burst	ASTM D3786	800 psi
Trapezoid Tear	ASTM D4533	125 x 115 lbs
UV Resistance @ 500 hrs	ASTMD4355	80%
AOS	ASTM D4751	40 Sieve
Permittivity (sec-1)	ASTM D4491	0.70 (sec-1)
Flow Rate	ASTM D4491	50 gpm/ft2

Siltsack High Flow

PROPERTY	TEST METHOD	MINIMUM AVERAGE ROLL VALUE
Grab Tensile Strength	ASTM D4632	255x275 lbs
Grab Tensile Elongation	ASTM D4632	20x15%
Puncture Strength	ASTM D4833	135 lbs
Mullen Burst	ASTM D3786	420 psi
Trapezoid Tear	ASTM D4533	40x50 lbs
UV Resistance	ASTMD4355	90%
AOS	ASTM D4751	20 Sieve
Permittivity (sec-1)	ASTM D4491	1.50 (sec-1)
Flow Rate	ASTM D4491	200 gpm/ft2

All properties are Minimum Average Roll Values (MARV)

SIMILAR PRODUCTS IN THIS FAMILY:

PRODUCT PRODUCT PRODUCT

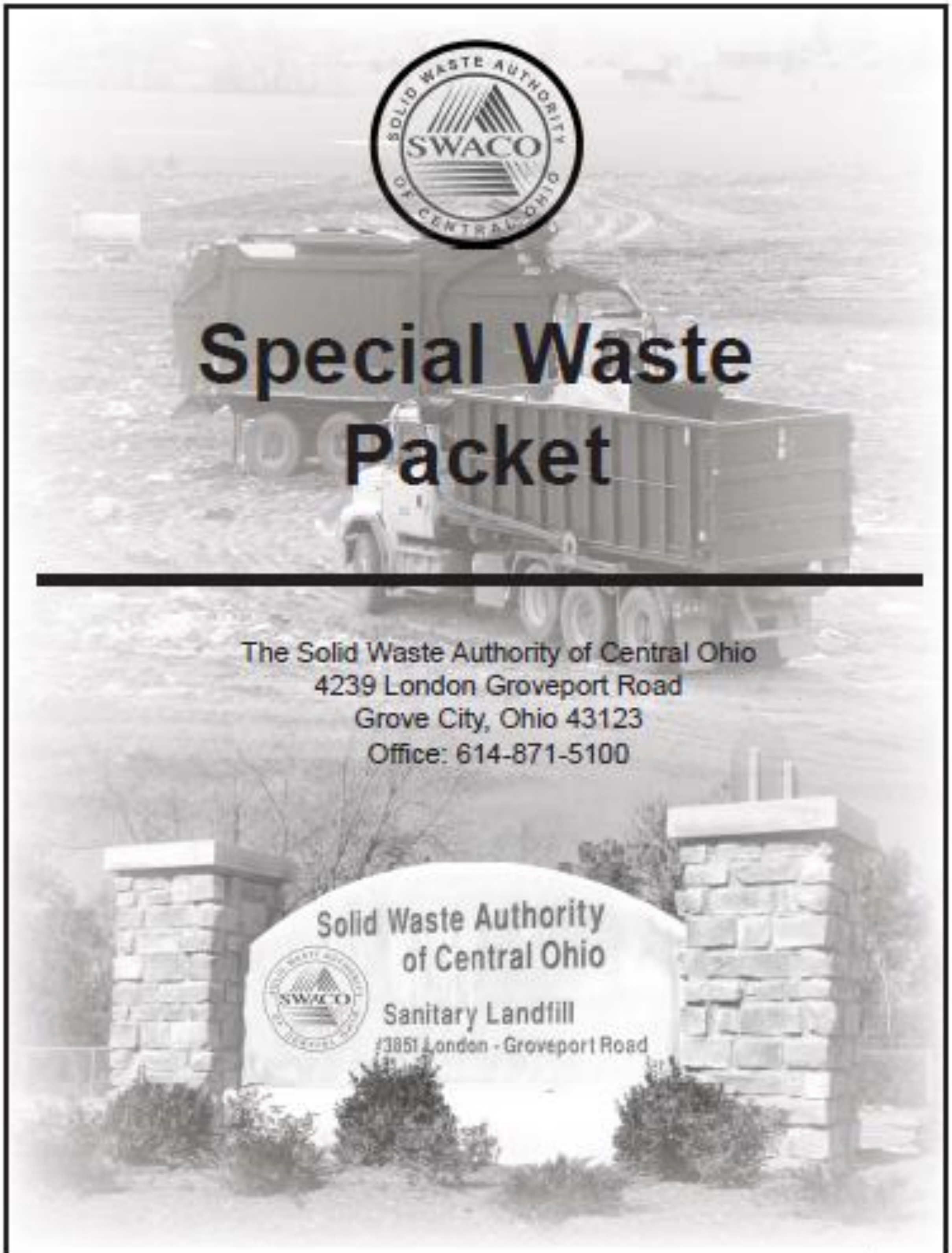
ACF ENVIRONMENTAL
LET'S GET IT DONE
800.448.3636
acfenvironmental.com

APPENDIX D: SOLID WASTE AUTHORITY OF OHIO SPECIAL WASTE PACKET

Complete, updated packet can be requested at contact information on cover

Special Waste Packet

The Solid Waste Authority of Central Ohio
4239 London Groveport Road
Grove City, Ohio 43123
Office: 614-871-5100



APPENDIX E: DECANTING FACILITY PLAN DRAWING SET

Electronic plan set files may be available upon request.