ATTACHMENT A

Alameda Countywide Storm Drain Trash Monitoring and Characterization Project

Technical Report

Prepared for:

Alameda Countywide Clean Water Program

Alameda County Waste Management Authority

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LIST OF ABBREVIATIONS

ACCWP	Alameda County Clean Water Program
ARS	Automated Retractable Screen
Authority	Alameda County Waste Management Authority
BASMAA	Bay Area Stormwater Management Agencies Association
CRV	California Redemption Value
EPS	Expanded Polystyrene
gal	Gallon
MDL	Method detection limit
mL	milliliter
mm	millimeter
MRP	San Francisco Bay Area Municipal Regional Stormwater NPDES Permit
MS4s	Municipal Separate Storm Sewer Systems
NPDES	National Pollutant Discharge Elimination System
SAP	Sampling and Analysis Plan
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
TMDL	Total Maximum Daily Load
USEPA	United States Environmental Protection Agency
QA/QC	Quality Assurance/Quality Control
yr	Year

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1.0 INTRODUCTION

High levels of trash (i.e., litter, floatables, gross pollutants, or solid waste) in local watersheds can present an aesthetic nuisance to communities, and pose a serious threat to surface water quality if transported to local creeks, the San Francisco Bay, or the Pacific Ocean. Data suggest that plastic trash in particular persists for hundreds of years in the environment and can pose a threat to wildlife through ingestion, entrapment, as well as harboring chemicals potentially harmful to the aquatic environment (Bjorndal et al. 1994; Islam and Tanaka 2004; Moore 2008; von Saal et al. 2008). Types of trash commonly observed in watersheds and water bodies include food and beverage containers (e.g., plastic bags and bottles) and packaging, cigarette butts, food waste, construction and landscaping materials, furniture, electronics, tires, and hazardous materials (e.g., paint and batteries).

In response to concerns about urban trash impacts on receiving water bodies in the San Francisco Bay area, the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB or Water Board) included trash reduction requirements in the Municipal Regional Stormwater NPDES Permit for Phase I communities in the Bay Area (Order R2-2009-0074), also known as the Municipal Regional Permit (MRP). These provisions require applicable Bay Area municipalities (Permittees) to reduce trash from their Municipal Separate Storm Sewer Systems (MS4s) by 40 percent before July 1, 2014, 70 percent by 2017, and to a point of "no adverse impacts" to water bodies by 2022 (SFBRWQCB 2009). To establish a baseline, each Permittee was also required to develop an estimate of the amount of trash discharged from its stormwater conveyance system circa 2011, and develop and implement an assessment strategy used to account for trash load reduction actions and to demonstrate progress and attainment of trash load reduction targets.

Permittees participated in a regional trash characterization and generation rate study through Bay Area Stormwater Management Agencies Association (BASMAA), with the goal developing first-order estimates of trash generation in Bay Area urban areas. As part of this study, at total of 154 trash full-capture devices located in Bay Area storm drain inlets were monitored for trash. Trash and debris was intercepted and collected during four different time periods, and subsequently sorted and characterized. Monitoring sites represented seven different land use classes and a range of household income levels. Of the 154 inlets, 45 were located in Alameda County.

The regional study resulted in trash generation rates for each inlet monitored in the Bay area. Best estimates for trash generation in the Bay Area ranged from 0.5 to 150 gallons/acre per year, depending on the land use and the median household income level in the area surrounding monitored sites. These rates along with additional field observations were used to develop maps illustrating trash generation for each Permittee. Additionally, data generated from the study included the number and volume of single-use plastic bags and expanded polystyrene foam (EPS) food service ware. This information was collected prior to the implementation of many trash control measures, including most product-related ordinances in Alameda County. The results of the project are presented in the *San Francisco Area Stormwater Trash Generation Rates* Final Technical Report (BASMAA 2014).

The assessment strategy used by Permittees in Alameda County to demonstrate progress and attainment of trash reduction targets is described in Permittee *Long-Term Trash Load Reduction Plans* (Long-Term Plans) and the *Pilot Assessment Strategy* (Strategy) developed by the Alameda Countywide Clean Water Program (ACCWP 2014). ACCWP includes fifteen population-based Permittees within Alameda County (14 cities and the unincorporated area) that collaborate to protect water quality in Alameda County creeks, wetlands and the San Francisco Bay. With regard to trash reduction, each population-based Permittee was required by provision C.10 of the

Municipal Regional Stormwater NPDES Permit (MRP) to submit a Long-Term Plan by February 1, 2014. The Long-Term Plans outline how each will achieve MRP trash reduction goals. Trash control measures and implementation schedules are described in each Long-Term Plan. In their Long-Term Plans, all Permittees included the adoption of ordinances that prohibit the distribution of litter-prone products (e.g., single-use plastic bags and expanded polystyrene foam food ware) in their jurisdictions. Section 4.0 of the Long-Term Plan describes each Permittee's approach to assessment and includes a reference to the Strategy, which was submitted on behalf of the Permittees and describes a number of indicators that Permittees plan to use to assess progress towards trash reduction goals. These indicators are either outcome-based or output-based. Outcome-based indicators measure the results or environmental outcomes of litter reduction efforts and are used to assess the effectiveness of trash control measures.

This report describes the results of *Alameda Countywide Storm Drain Trash Monitoring and Characterization Project* (Project), which was designed and funded through ACCWP and the Alameda County Waste Management Authority (Authority), a public agency that includes the County of Alameda, each of the fourteen cities within the county, and two sanitary districts and is responsible for increasing recycling and reducing waste in Alameda County. The main goal of this study was to measure trends in one outcome-based indicator described in the Strategy, the amount of litter-prone products (i.e., single-use plastic bags and expanded polystyrene foam food ware) and other litter in storm drains.

1.1 Trash Control Measures

1.1.2 Product-based Ordinances

In an effort to reduce the environmental impacts of single-use bags, the Authority adopted Ordinance 2012-2 (Ordinance) to reduce the use of single-use bags and promote the use of reusable bags at the point of sale in Alameda County. The Ordinance went into effect on January 1, 2013 in unincorporated Alameda County and its fourteen incorporated cities. On or before January 1, 2013, stores within Alameda County are required to make available for sale to a customer a recycled paper bag or a reusable bag for a minimum price of ten cents ($0.10). The price of a recycled paper bag or a reusable bag is scheduled to increase to a minimum price of twenty-five cents ($0.25) on or after January 1, 2015, unless the Authority finds, after January 1, 2014, that the Ordinance has achieved its goal of substantially reducing the environmental impacts of single-use bags, in which case the minimum price will remain ten cents ($0.10). The results of this study will be one data point that the Authority will use to assess the attainment of this goal.

In addition to adopting a single-use bag ordinance, ten incorporated cities in Alameda County have also prohibited the distribution of Expanded Polystyrene (EPS) food service ware by food vendors. A list of cities with EPS food service ware ordinances (with their effective date) are provided within Table 1.1. Ordinances were developed due to potential impacts of EPS to aquatic life and wildlife and the persistence of this material within the environment. Four cites (i.e., cities of Dublin, Piedmont, Newark and Union City) and unincorporated Alameda County do not have EPS food service ware ordinances.

Table 1.1. Effective dates of EPS food service ware ordiances in Alameda County.

City	Effective Date
Alameda	7/1/08
Albany	9/1/08
Berkeley	1988
Emeryville	1/1/08
Fremont	1/1/11
Hayward	7/1/11
Livermore	2010
Oakland	2007
Pleasanton	7/1/13
San Leandro	11/1/12

1.1.3 Other Trash Control Measures

Enhanced or new trash control measures presented within the Long-Term Plan are based on the Permittees' current understanding of trash problems within its jurisdiction and the effectiveness of control measures designed to reduce trash impacts associated with MS4 discharges. The Long-Term Plans build upon trash control measures implemented by Permittees prior to the adoption of the MRP and during the implementation of Short-Term Trash Load Reduction Plans submitted to the Water Board on February 1, 2012. With the implementation of the Long-Term Plan, trash reductions should be observable on streets, public right-of-ways, and in stormwater conveyances. Trash control measures that may be implemented by Permittees include, but not limited to the following:

- Enhanced Street Sweeping
- Public Education and Outreach Programs
- Anti-Littering and Illegal Dumping Enforcement Activities
- Improved Trash Bin/Container Management
- Enhanced On-land Trash Cleanups
- Curb Inlet Screens
- Enhanced Storm Drain Inlet Maintenance
- Full-Capture Treatment Devices
- Creek/Channel/Shoreline Cleanups

1.2 Management Questions

With increased levels of control measures implementation, Permittees are poised to begin assessing progress toward trash reduction goals and evaluating the effectiveness of specific control measures that are designed to reduce the generation of trash. In particular, ACCWP and the Authority were interested in determining whether the effects of municipal product-based ordinances that prohibit litter-prone items are detectable in stormwater conveyances or in other locations in the environment. Additionally, ACCWP was interested in evaluating whether reductions in the overall level of trash in stormwater conveyances in Alameda County were observable using methods similar to those employed by BASMAA as part of the SF Bay Trash Generation Rates project.

The following management questions were developed by ACCWP and the Authority to evaluate environmental outcomes associated with product-based ordinances and trash levels in Alameda County:

1. Has the Alameda County Waste Management Authority single use bag ordinance achieved its intended goal of substantially reducing the level of bags observed in the environment and associated adverse environmental impacts?
2. What levels of expanded polystyrene (EPS) foam food ware items are observed in the environment and have municipal ordinances achieved their intended goal of substantially reducing the level of EPS foam food ware found in the environment?
3. Are trash control measures implemented by Permittees effectively reducing trash in municipal stormwater conveyances in Alameda County?

This Project was managed by both ACCWP and the Authority and conducted by EOA, Inc.

2.0 MONITORING DESIGN AND METHODS

Site selection and monitoring procedures used during the Project are fully described in the project's Sampling and Analysis Plan (SAP). The SAP describes the assessment methods outlined in Long-Term Plans and the Strategy that ACCWP Permittees are using to evaluate progress towards overall trash reduction goals and assist the Authority in assessing the effects of specific trash control measures designed to reduce the generation and impacts of litter-prone products and materials (see Appendix A).

The monitoring design employed during this Project consisted of re-sampling most of the storm drain inlets in Alameda County monitored during the BASMAA SF Bay Area Trash Generation Rates Project (BASMAA Study), in addition to other previously unmonitored inlets in Alameda County Permittee jurisdictional areas. Data on single-use bags and EPS food service ware, which were collected during the BASMAA Study and prior to the implementation of many product-related ordinances in Alameda County, were compared to data collected via this Project. Additionally, data generated through monitoring of previously unmonitored sites located in high and medium trash generating areas throughout Alameda County were compared to data from similar sites previously sampled in other Bay Area locations during the BASMAA Study. This Project was designed in January/February 2014 and conducted between March and June 2014.

2.1 Monitoring Sites

2.1.1 Site Selection Criteria

In an effort to select previously unmonitored sites and assess the level of specific trash items potentially present in different land uses, data generated via the BASMAA Study were compiled and evaluated. Based on the analysis of single-use plastic bag data specific to different land uses, the current and planned locations of many enhanced control measures, and experience in conducting trash characterization studies; monitoring sites included in this study met the following selection criteria, which were applied in the following order:

1. Sites (inlets) that are equipped with properly functioning small trash full-capture[1] devices or systems meeting the full-capture standard;
2. Sites that are not equipped with curb inlet screens that block trash from entering the storm drain inlet;
3. Sites with properly functioning devices that were previously sampled during the BASMAA Study were selected;
4. Previously unmonitored sites that drain predominately retail land use areas associated with moderate, high or very high trash generation rates; and,
5. A minimum of three[2] monitoring sites were selected within each Permittee's jurisdiction.

Small full-capture devices were selected because they typically drain smaller areas that are depictive of a homogeneous land use (e.g., retail) and are relatively easy to clean/maintain.

2.1.2 Selected Monitoring Sites

A total of 100 monitoring sites (Figure 2.1) were selected from a pool of nearly 1,400 available sites equipped with small full-capture devices. Prior to commencing the study, each monitoring site was visited to ensure that each full-capture device was operational and met the site selection criteria described above. A total of 40 of the 45 sites previously monitored during the BASMAA Study were determined to be properly functioning and were re-sampled during the study. Of the five sites not re-sampled, two in the City of Oakland had Automatic Retractable Screens (ARS) installed, two sites in the City of Dublin were located in a parking lot with very limited volume of trash observed during previous monitoring events, and one site in the City of Livermore was not selected due to its current condition.

Table 2.1 summarizes the sites available in Alameda County and the 100 selected monitoring sites. The selected sites provide a broad representation of land use and trash generation in Alameda County. The land uses associated with the selected monitoring sites are provided in Table 2.2. All selected monitoring sites are described in Appendix B.

Specific types and associated manufacturers of small trash capture devices used during the study included: Connector Pipe Screens (West Coast Storm, Inc and United Stormwater, Inc.); and Triton Bioflex Drop Inlet Trash Guard (Revel Environmental Manufacturing, Inc.). An example small trash capture device used as a monitoring site is provided as Figure 2.2.

[1] A full capture system or device has the ability to trap all particles retained by a 5 mm mesh screen and has a design treatment capacity of at least the peak flow rate resulting from a one-year, one-hour, storm in the sub-drainage area.

[2] With the except of the City of Pleasanton, which did not have three sites that met the other selection criteria.

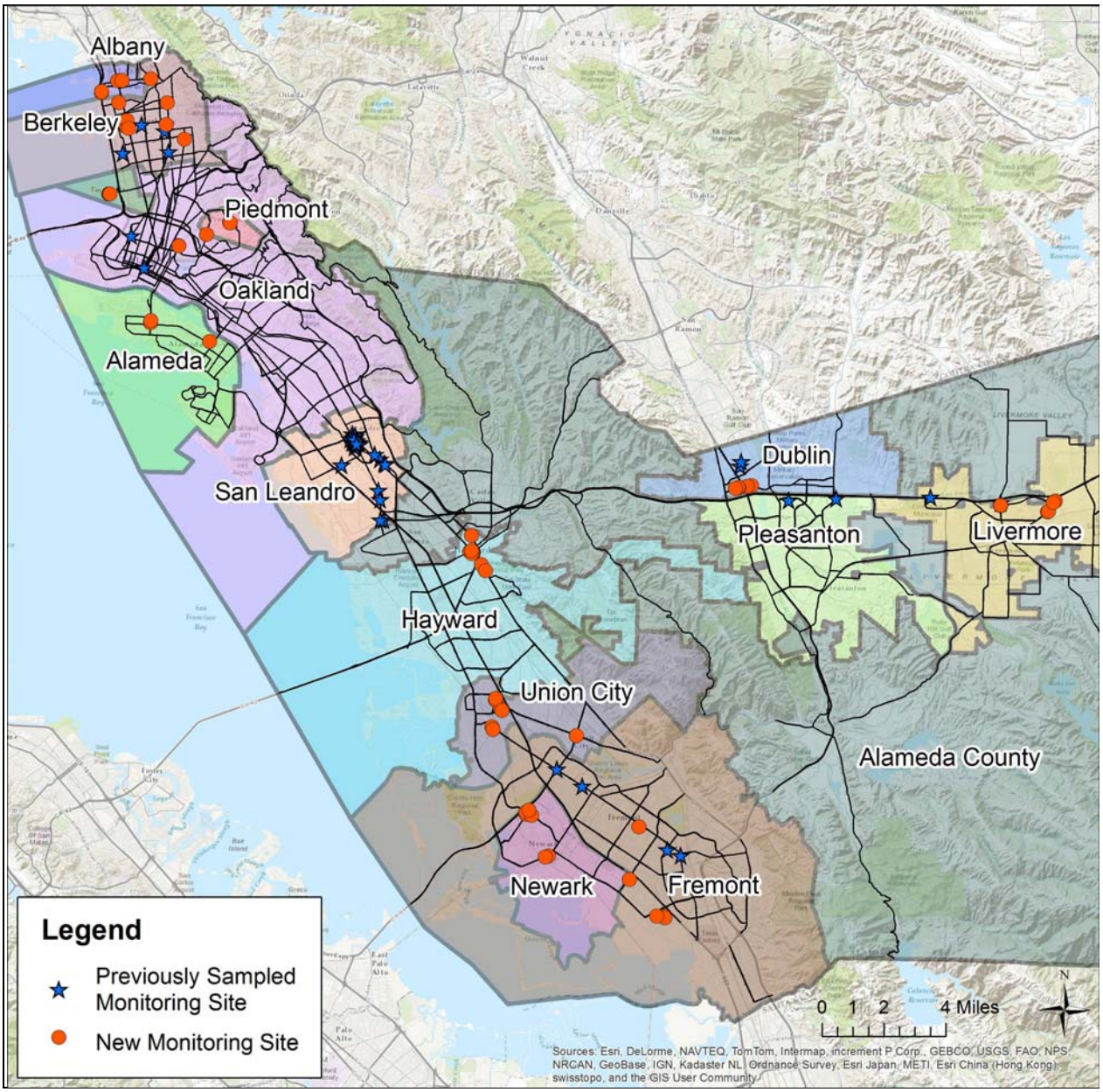

Figure 2.1. Monitoring sites included in the Alameda Countywide Storm Drain Trash Monitoring and Characterization Project.

Table 2.1. Summary of available and selected monitoring sites by Permittee.

Permittee	# Available Sites[1]	# Previously Monitored Sites	# Previously Monitored Sites Selected	# Previously Unmonitored Sites Selected	Total # Sites Selected
Alameda	16	0	0	3	**3**
Albany	17	0	0	4	**4**
Berkeley	104	4	4	8	**12**
Dublin	76	4	2	5	**7**
Emeryville	3	0	0	3	**3**
Fremont	346	4	4	5	**9**
Hayward	79	0	0	7	**7**
Livermore	174	2	1	7	**8**
Newark	127	0	0	6	**6**
Oakland	11	4	2	2	**4**
Piedmont	14	0	0	3	**3**
Pleasanton	2	2	2	0	**2**
San Leandro	273	25	25	0	**25**
Union City	147	0	0	7	**7**
Alameda County	0	0	0	0	**0**
Total	**1,389**	**45**	**40**	**60**	**100**

[1] Includes those inlets equipped with storm drain insert full capture devices that are owned and operated by Permittees. Many Permittees have additional devices within their jurisdictional boundaries that are owned and operated by Private entities.

Table 2.2. Land uses associated with selected monitoring sites.

Land Use	# of Sites
Commercial	6
Industrial	2
Schools	7
Residential	6
Retail	79
Urban Parks	0
Total	**100**

Figure 2.2. Example small trash capture device used as a monitoring site.

2.2 Sampling and Characterization Methodology

2.2.1 Sampling Procedure

Prior to the start of the Project in March 2014, each of the 100 monitoring sites was cleaned to provide a specific start date for the trash accumulation period. The cleanout date for each site was recorded to track the number of days of accumulation. All trash and debris was removed during the March 2014 clean outs and the screens of the devices were cleaned to provide for proper device operation. Sites were again cleaned in June 2014 and all trash and debris (e.g., sediment, vegetation, rocks, bugs, etc.) were removed from each inlet and placed in large, plastic garbage bags and transported to the central site located at the Alameda County Public Works Agency's Corporation Yard. Both cleaning events were done by a contractor that has extensive experience with small capture device maintenance (i.e., Revel Environmental Manufacturing) that was hired specifically for the project. The contractor followed procedures in accordance with the *Standard Operating Procedure for Storm Drain Insert Trash Removal* (see Project SAP in Appendix A).

Site information was recorded by the contractor on field forms, including exact cleanout dates and any issues associated with the devices (e.g., damaged screens, observations of flows bypassing devices) that were observed. To ensure monitoring occurred during similar timeframes, all sites were cleaned during the same weeks for both the March and the June 2014 cleanout events, with the exception of one site that was cleaned the following week due to access issues. The total accumulation period for all monitoring sites was between 82 and 94 days (11-13 weeks).

2.2.2 Characterization Procedure

Trash Classification System

Once the material cleaned from monitoring sites was received at the centralized characterization location, trash was separated from other debris using procedures described in the *Standard Operating Procedure for Trash and Debris Evaluation* (see Appendix A). EOA conducted all trash characterization activities using the trash classification system presented in Table 2.3.

Table 2.3. Trash characterization classification system used during the study.

Main Categories	Subcategories	Description and Examples
Plastic	Recyclable beverage containers	Recyclable beverage containers labeled with a California Redemption Value (CRV). Includes all plastic and glass redeemable water, soda and juice bottles.
	Single-use plastic bags	Includes all single use plastic bags that have handles and are typically distributed at point-of-sale. Single use plastic bags used to distribute or hold produce, newspapers, sandwiches and parking tickets were not included in this category.
	Expanded polystyrene foam food ware	Expanded polystyrene (EPS) foam food and beverage ware includes all disposable containers, bowls, plates, trays, cartons, cups, and other items made of expanded polystyrene designated for one-time use for prepared foods. Food and beverage ware includes service ware distributed for takeout foods and leftovers from partially consumed meals prepared by food providers.
	Rigid plastic disposable food and beverage ware	Rigid plastic disposable food and beverage ware includes non-EPS plastic, fiber-based, and compostable plastic containers, bowls, plates, trays, cartons, cups, and other items designated for one-time use for prepared foods. These products are typically distributed by food vendors in jurisdictions with EPS prohibitions.
	Other plastic materials/items	Includes all other trash items made of any type of plastic, including but not limited to food and candy packaging, straws, lids, and bottle tops. Includes hard plastic and plastic film.
Cigarette Butts	Cigarette Butts	Cellulose cigarette butts
All Other Trash	All Other Trash	Any other item or fragment of an item that does not fit into one of the categories listed above. Includes but is not limited to, paper, metal, and items made of rubber, fabric or other hybrid materials.
Debris	NA	All material not characterized as trash. Includes sand, sediment and vegetation.

Trash Measurement

Trash and debris removed from each storm drain inlet during the June 2014 cleanout event was sorted based on the project's trash classification system and placed into containers between 50 milliliters (mL) and 5 gallons in size (depending on the volume of the material). All item identified as recyclable beverage containers, single-use plastic bags, EPS foam food ware, rigid plastic disposable food and beverage ware, and cigarette butts were also counted and recorded. Measurements procedures generally included the following steps:

- **Volume**: The appropriate size of container was used to measure and record the total uncompacted volume of each of the trash categories and debris for each site. If a bucket of trash or debris was partially full, a tape measure, ruler or meter stick was used to measure the total volume. The lowest reporting limit for total volume determination for trash or debris was 5 mL for samples less than 50 mL but greater than zero. Sites that did not contain one or more trash categories or debris were recorded as zero.

- **Item Count**: The number of recyclable beverage containers, single-use plastic bags, polystyrene foam food ware items, rigid plastic disposable food and beverage ware and cigarette butts were counted and recorded.
- **Disposal**: After all measurements and records were completed, all trash and debris was placed in plastic trash bags and properly disposed.

All data recorded on field data sheets were transferred into spreadsheet project database. To ensure that all data were transferred correctly, quality assurance and control checks were performed during and following data entry.

3.0 MONITORING RESULTS AND DISCUSSION

3.1 Statement of Data Quality

A comprehensive quality assurance and control (QA/QC) program was implemented, covering all aspects of trash monitoring and characterization. All data and associated information on trash captured via monitored full capture treatment devices at sampling sites were compiled into a project database. Data underwent quality assurance checks prior to being used to calculate total volumes or numbers of specific items (i.e., single-use bags or EPS foam food ware).

With regard to assessing the precision of the trash characterization methods that were used as part of the study, trash and debris samples from 11 sites/events were re-measured. In comparison to the volume of samples originally measured, all samples that were re-measured were within 10% of original results. The level of precision was considered adequate for the characterization of this material and therefore, no samples characterized during the Project were discarded. The mean relative percent differences (<MDL = ½ MDL) between trash volumes measured in samples and duplicates collected at the 11 monitoring sites was 0.67%. All results of QA/QC assessments used to evaluate precision are included in Appendix C.

3.2 Overview of Results

3.2.1 Summary of Characterization Results

A total of 100 small full-capture devices throughout Alameda County were sampled as part of the Project. The period of trash accumulation occurred from March 2014 to June 2014 and ranged from 82 to 94 days for the sites monitored. Approximately 808 gallons of material (i.e., trash and debris) was collected and characterized. A total of 683 gallons (84.5%) was debris (i.e., sediment and vegetation), with the remainder (15.5%) identified as trash (Table 3.1 and Figure 3.1). Trash volumes for each monitoring site are provided in Appendix D.

Trash characterization results observed during this Project are similar to the BASMAA Study which found that by volume, 17% of the material characterized in the study was trash (BASMAA 2014). Additionally, of all the trash characterized during the ACCWP/Authority's Project, roughly 59% (by volume) was plastic (Table 3.1), compared to roughly 70% observed during the BASMAA study.

A total of 13 single-use plastic bags were observed in 100 sites located in 8 cities (i.e., Alameda, Albany, Berkeley, Dublin, Emeryville, Oakland, San Leandro and Union City) during the Project, compared to 365 single-use bags observed in 154 sites during the BASMAA Study. No single-use plastic bags observed during the ACCWP/Authority Project could clearly be identified as originating from food vendors. Specifically, all single-use plastic bags identified were either clearly associated with (i.e., branded) non-food vendors (e.g., Target™) or very small bags (e.g., ~6"x9") that are

typically distributed by convenience stores or non-food vendor types of retail businesses. A total of 2.3 gallons of expanded polystyrene (EPS) foam food service ware was also observed during the Project. A total of 4,037 cigarette butts (2.9 gallons) were observed during the Project. Similar to the BASMAA study, cigarette butts were the most frequent trash type observed. The total count of cigarette butts for each monitoring site is provided in Appendix E.

CRV-labeled plastic and glass containers accounted for nearly 4.5% of trash characterized. Approximately 49% of the trash characterized was other plastic and 41% was all other trash (e.g. paper, rubber, metal, mixed materials). No disposable rigid or paper food or beverage ware products were observed at the 100 monitoring sites, indicating that EPS replacement products are not consistently observed in the storm drain conveyance system in Alameda County. A possible explanation may be that either these products are littered at a lower frequency than other items, or that they are too large to easily fit in the curb opening or grate of a storm drain inlet.

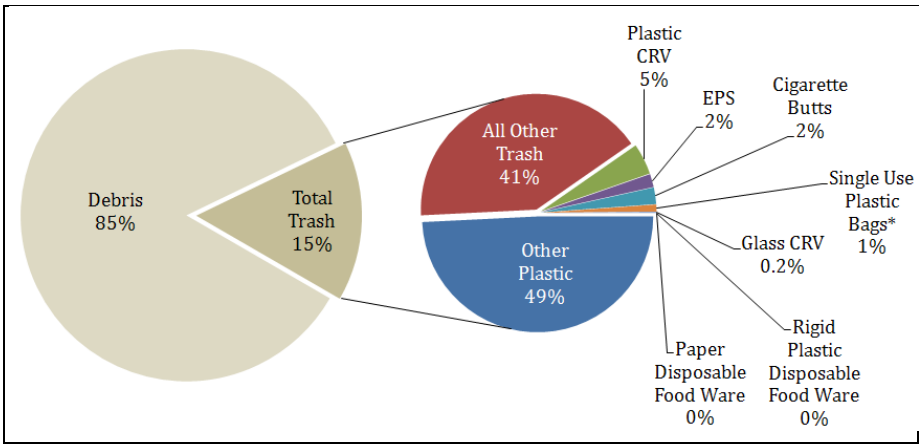

Figure 3.1. Percent of trash and debris (by volume) that was characterized during the ACCWP/Authority Project (*Assumes an average volume of 12 ounces per bag).

Table 3.1. Total amount and percentage of material removed and characterized from ACCWP/Authority monitoring sites.

Material Type	# Counted	Volume (gallons)	% of All Material Type	% of Trash
Debris (e.g., Sediment, sand and vegetation)	--	**683**	**84.5%**	--
Trash	--	**125**	**15.5%**	--
1. Plastic - Recyclable Beverage Containers (CRV-labeled)	41	5.4	0.7%	4.3%
2. Glass - Recyclable Beverage Containers (CRV labeled)	3	0.2	0.0%	0.2%
3. Single Use Plastic Bags*	13	1.2	0.2%	1.8%
4. EPS Disposable Food & Beverage Ware	74	2.3	0.3%	0.0%
5. Rigid Plastic Disposable Food and Beverage Ware	0	0	0.0%	0.0%
6. Paper Disposable Food and Beverage Ware	0	0	0.0%	2.3%
7. Cigarette Butts	4037	2.9	0.4%	49.2%
8. Other Plastic	--	61.6	7.6%	41.1%
9. All Other Trash	--	51.5	6.4%	
Total	**--**	**808**	**--**	--

*Assumes12 oz/bag

3.2.2 Trash Volumes and Rates by Land Use

The results of the BASMAA Study are presented as annual trash rates (gallons/year). The accumulation period during the ACCWP/Authority Project, however, was roughly three months. For comparison purposes, normalizing the volumes of trash removed and characterized from the 100 ACCWP/Authority Project monitoring sites during the three months into annual rates was therefore necessary. For each Project site, normalization was done by multiplying the daily trash rates observed during the Project (i.e., volume of trash observed divided by the number of accumulation days) by 365 days.

As in the BAASMA study, Project monitoring sites were also classified by land use to determine if trash rates varied among land use types. In each study, the six land use categories included commercial, industrial, schools (kindergarten through 12th grade), residential, retail and urban parks. Calculated annual average trash rates for each land use class monitored during the BASMAA Study and ACCWP/Authority Project are presented in Table 3.2.

Table 3.2. Average trash rates (gallons/year) by land use for BASMAA Study and ACCWP/Authority Project sites.

Land Use	BASMAA Study (2011-12)		ACCWP/Authority Project (2014)	
	# of Sites	Average Trash Rate (gallons/year)[a]	# of Sites	Average Trash Rate (gallons/year)[a]
Commercial	18	1.33	6	0.73
Industrial	13	7.41	2	3.02
Residential	49	4.66	6	2.88
Retail	61	8.66	79	5.49
School	10	5.08	7	9.64
Urban Park	3	1.27	0	--
All Land Uses	**154**	**6.13**	**100**	**5.29**

[a] Trash rates presented in the table were not normalized for the effects of existing trash control measures (e.g., street sweeping) or area draining to each monitoring site as was done to develop trash generation rates presented in BASMAA (2014).

Based on the comparison of average annual trash volumes observed during the Project and Study, sites with the most trash were located in retail, industrial and school land uses. Trash rates were lowest in residential and commercial (primarily office building) land uses. One important observation of the ACCWP/Authority Project data – some schools may have higher rates than previously documented by BASMAA. Specifically, trash rates at Berkeley High School and the Westlake Middle School in the City of Oakland were much higher than those observed during the BASMAA Study.

3.3 Evaluation of Management Questions

This Project was designed to answer the three management questions listed in Section 1.3. These questions were evaluated using the data collected during the Project and the BASMAA Study. A discussion of the preliminary results of the evaluations is presented for each management questions in the following sections.

3.3.1 Effectiveness of the Single-Use Bag Ordinance

The first management question relates to the effectiveness of the Alameda County single-use bag ordinance that went into effect in 2013. The goal of the ordinance is to substantially reduce the level of bags observed in the environment and associated adverse environmental impacts. Of the 100 monitoring sites included in the Project, 40 sites were also part of the BASMAA Study and were therefore used to evaluate the rate at which bags were observed prior to, and after the ordinance went into effect.

Single-use plastic bags removed from each monitoring site were counted during both the ACCWP/Authority and BASMAA studies. The numbers of bags observed at the 40 sites common to both the Study and Project are presented in Table 3.3.

Table 3.3. Number of single-use plastic bags observed pre-ordinance (BASMAA Study) and post-ordinance (ACCWP Study) at 40 monitoring sites in Alameda County.

Permittee	Site ID	Land Use	BASMAA Study (2011-12)		ACCWP/Authority Project (2014)	
			Accumulation Period (Days)	# Single-Use Plastic Bags	Accumulation Period (Days)	# Single-Use Plastic Bags
Berkeley	BK04	Industrial	407	2	83	1
	BK02	K-12 School	407	3	83	0
	BK01	Retail	407	0	83	0
	BK03	Retail	404	0	83	0
Dublin	DN03	Residential	477	1	89	0
	DN04	Residential	477	1	89	0
Fremont	FR01	Commercial	407	1	85	0
	FR02	K-12 School	407	1	85	0
	FR03	Retail	407	3	85	0
	FR04	Retail	407	1	85	0
Livermore	LV01	Commercial	408	0	88	0
Oakland	OK03	Industrial	126	1	83	0
	OK04	Retail	315	3	83	1
Plesanton	PL02	Commercial	408	0	89	0
	PL01	Retail	315	0	89	0
San Leandro	SL16	Commercial	295	1	86	0
	SL17	Commercial	274	0	86	0
	SL19	K-12 School	311	0	86	0
	SL20	K-12 School	308	2	86	0
	SL22	K-12 School	296	0	86	0
	SL05	Residential	300	1	86	0
	SL08	Residential	302	0	86	0
	SL21	Residential	310	0	86	0
	SL01	Retail	408	1	86	0
	SL02	Retail	408	2	86	0
	SL03	Retail	408	2	86	2
	SL04	Retail	408	2	86	0
	SL06	Retail	300	2	86	0
	SL07	Retail	300	2	86	0
	SL09	Retail	294	1	86	0
	SL10	Retail	274	0	86	0
	SL11	Retail	297	2	86	0
	SL12	Retail	302	1	86	0
	SL13	Retail	274	0	86	0
	SL14	Retail	301	1	86	0
	SL15	Retail	274	1	86	0
	SL18	Retail	294	1	94	0
	SL23	Retail	307	0	86	1
	SL24	Retail	314	1	86	0
	SL25	Retail	301	2	86	1
Totals			**-**	**42**	**-**	**6**

Using similar methods to those described for calculating annual trash rates by volume, the number of bags observed and the associated accumulation period for each of the 40 sites were used to calculate the average annual number of single use plastic bags in the stormwater conveyance system during the BASMAA Study (pre-ordinance) and the ACCWP/Authority Project (post-ordinance). The average (mean) number of single-use plastic bags for each study is shown in Table 3.4. Average rates for the 17 non-retail sites and the 23 retail sites monitored are also presented.

Table 3.4. Average annual number[a] of single-use plastic bags pre-ordinance (BASMAA Study) and post-ordinance (ACCWP Study) at 40 monitoring sites in Alameda County.

Land Use	# Sites	BASMAA Study (Pre-Ordinance)	ACCWP/Authority Project (Post-Ordinance)
Retail Sites	23	1.32	0.93
Non-Retail Sites	17	0.91	0.26
All Sites	**40**	**1.15**	**0.64**

[a] Because there were different accumulation periods during the BASMAA Study and ACCWP/Authority Project, the numbers of bags observed in storm drains during each study/project were normalized to an average annual rate for comparison purposes.

Average (and median) rates were significantly lower during the ACCWP/Authority Project compared to the BASMAA study. For the 40 monitoring sites, the reduction in the average number of single use plastic bags decreased by 44%, compared to pre-ordinance data from the 2011 BASMAA study. Average rates for plastic bags in retail land use sites decreased by 30% and non-retail by 65%. Although the dataset is limited, these results appear to indicate that the level of single-use plastic bags observed in stormwater conveyances has decreased in Alameda County, regardless of land use.

A statistical comparison[3] of single-use plastic bags annual rates for the BASMAA and ACCWP/Authority studies was performed to further evaluate the potential reduction. The results indicate that there is greater than a 95% chance that a statistically significant difference ($p = 0.023$, $\alpha = 0.05$) exists between the data collected at the 40 sites pre- and post-ordinance adoption.[4]

3.3.2 Prevalence of Expanded Polystyrene in the Environment

The second trash management question relates to the level of EPS foam food ware observed in the environment, and whether municipal ordinances have achieved their intended goal of substantially reducing the level of EPS foam food ware observed. Ten of the fourteen Permittees in Alameda County have adopted ordinances prohibiting the distribution of EPS food service ware by food vendors. For those Permittees with ordinances, the year of the adoption (see Table 1.1) and scope of the ordinance vary. Some ordinances were adopted prior to the BASMAA Study, while others occurred after the Study was completed. Therefore, unlike the comparison of pre- and post-ordinance datasets for single use bags, comparisons presented in this section are not linked to EPS

[3] The two data sets were first assessed for normality using the Shapiro-Wilk test and found not to follow a normal distribution. A Wilcoxon Signed-Rank Test was therefore used rather than a paired t-test.

[4] Although these results indicate that a reduction in the number of single-use bags observed in storm drains pre-ordinance versus post-ordinance is evident, they should be interpreted cautiously due to the low number of data points in the two sets (40), and the shorter accumulation period in the ACCWP/Authority Project (approximately three months) compared to the BASMAA study (approximately 10-12 months). It is possible that there are other variables affecting the results.

ordinance adoption timeframes. Information presented is only focused on evaluating the extent and magnitude of EPS food ware observed in the environment over time. That said, a case study using data collected via this Project in the City of San Leandro is described in the next section in an attempt to evaluate the effectiveness of an EPS ordinance for a specific Permittee.

To assess potential trends in the presence of EPS food ware in the environment over time, the volumes of EPS foam food ware removed from the 40 monitoring sites in both the ACCWP/Authority Project and the BASMAA Study were compared. Using similar methods to those described for calculating annual rates (by volume) for all trash, annual rates of EPS food service ware were calculated for the 40 sites. Volume was used to compare the EPS foam food ware data rather than item count because EPS commonly breaks into smaller pieces, making item counts difficult to interpret.

Average EPS food ware rates observed during both projects/studies are shown in Table 3.5. Average rates for the 17 non-retail sites and the 23 retail sites monitored are also presented.

Table 3.5. Average annual volume (gallons/yr) of expanded polystyrene food service ware based on data collected during the BASMAA Study and ACCWP/Authority Project at 40 monitoring sites in Alameda County.

Land Use	# Sites	BASMAA Study (Pre-Ordinance)	ACCWP/Authority Project (Post-Ordinance)
Retail Sites	23	0.26	0.11
Non-Retail Sites	17	0.09	0.12
All Sites	**40**	**0.19**	**0.11**

Out of the 40 monitoring sites common to both the BASMAA Study and ACCWP/Authority Project, EPS food ware was observed at 36 and 12 sites, respectively. For these sites, results indicate that there is greater than a 95% chance that the average annual rates of EPS food ware were significantly less ($p=0.017$, $\alpha = 0.05$) during the ACCWP/Authority Project than the BASMAA study.[5] Additionally, average (and median) rates at retail sites (n=23) decreased. For non-retail sites, the mean during the ACCWP/Authority Project was slightly higher than the rate observed during the BASMAA Study due to the relatively large volume of EPS observed at a site near Berkeley High School.

3.3.3 Effectiveness of an EPS Food Ware Ordinance - City of San Leandro Case Study

The City of San Leandro had not yet adopted an EPS food ware ordinance prior to the BASMAA Study. Subsequently, the City adopted an ordinance that went into effect in November 2012. Data collected post-ordinance adoption via the ACCWP/Authority Project therefore provides a post-ordinance perspective of the level of EPS observed in the environment.

A total of 25 sites in San Leandro were monitored during the BASMAA Study and the ACCWP/Authority Project (Table 3.6). During the pre-ordinance study, EPS food ware was observed at all but two (92%) of the sites. During the post-ordinance project, EPS was found at 8 (32%) of the 25 sites.

[5] Like the reduction found in single-use plastic bags, these results should be interpreted with caution due to the low number of data points and short monitoring period in the ACCWP/Authority Project (approximately three months) compared to the BASMAA study (approximately 10-12 months).

Table 3.6. Voume of expanded polystyrene (EPS) food ware observed pre-ordinance (BASMAA Study) and post-ordinance (ACCWP Study) at 25 monitoring sites in the City of San Leandro (Alameda County).

Site ID	Land Use	BASMAA Study (2011-12)		ACCWP/Authority Project (2014)	
		Accumulation Period (Days)	EPS Food Ware (gal)	Accumulation Period (Days)	EPS Food Ware (gal)
SL16	Commercial	295	0.19	86	0.00
SL17	Commercial	274	0.70	86	0.00
SL19	K-12 School	311	0.48	86	0.23
SL20	K-12 School	308	0.22	86	0.00
SL22	K-12 School	296	0.56	86	0.06
SL05	Residential	300	0.05	86	0.00
SL08	Residential	302	0.00	86	0.00
SL21	Residential	310	0.00	86	0.00
SL01	Retail	408	0.44	86	0.03
SL02	Retail	408	<0.02	86	0.00
SL03	Retail	408	0.11	86	0.00
SL04	Retail	408	0.11	86	0.00
SL06	Retail	300	0.03	86	0.00
SL07	Retail	300	0.05	86	0.00
SL09	Retail	294	0.11	86	0.09
SL10	Retail	274	0.06	86	0.00
SL11	Retail	297	0.11	86	0.00
SL12	Retail	302	0.44	86	0.00
SL13	Retail	274	0.05	86	0.03
SL14	Retail	301	0.11	86	0.06
SL15	Retail	274	<0.02	86	0.00
SL18	Retail	294	0.03	94	0.00
SL23	Retail	307	0.09	86	0.04
SL24	Retail	314	0.14	86	0.00
SL25	Retail	301	1.23	86	0.00
Total		**-**	**5.32**	**-**	**0.55**

After normalizing the volumes of EPS food ware observed during the Study and the Project into annual averages, a comparison between the two datasets was made. The average annual volume of EPS food ware during the post-ordinance adoption (i.e., 2.32 gal/yr) was 61% less than the pre-ordinance volume (i.e., 6.04 gal/yr). Furthermore, statistical analyses indicates that there is a 95% chance ($p<0.001$, $\alpha = 0.05$)[6] that the annual volume of EPS food ware has decreased in the City of San Leandro since the adoption of the ordinance. These results suggest that although the ordinance has not eliminated EPS food ware from the environment, it is having a significant effect on the volume of this material observed.

3.4 Effectiveness of All Trash Control Measures

The third trash management question (Are trash control measures implemented by Permittees effectively reducing the overall level of trash in municipal stormwater conveyances in Alameda County?) was addressed by comparing trash rates measured during the ACCWP/Authority Project to those measured during the BASMAA Study. As a first step trash volumes observed during the

[6] The Shapiro-Wilk test determined that the two groups did not follow a normal distribution, resulting in the use of the Mann-Whitney Rank Sum Test to evaluate statistical differences between the two datasets.

Study and Project were normalized to annual rates (gal/yr) using methods described in Section 3.2.2. Annual rates were then used to develop box plots, which illustrate the range and distribution of annual trash rates for both the BASMAA Study and ACCWP/Authority Project (Figure 3.2). Box plots are typically used to visualize and compare datasets to better understand the level of data variability within and between categories (e.g., land use). Box plots have three parts: 1) the "box", which represents the 25th percentile (lower edge), 50th percentile (horizontal line), and 75th percentile (upper edge) of the dataset; 2) the "whiskers", which represent the upper and lower bounds of the dataset; and 3) the "dots", which represent the statistical outliers in the dataset.

Visual observations of the box plots suggest that trash rates observed in different land uses during the ACCWP/Authority Study are similar to those observed by BASMAA (i.e., 50th percentiles and lengths of the boxes and whiskers are relatively similar).

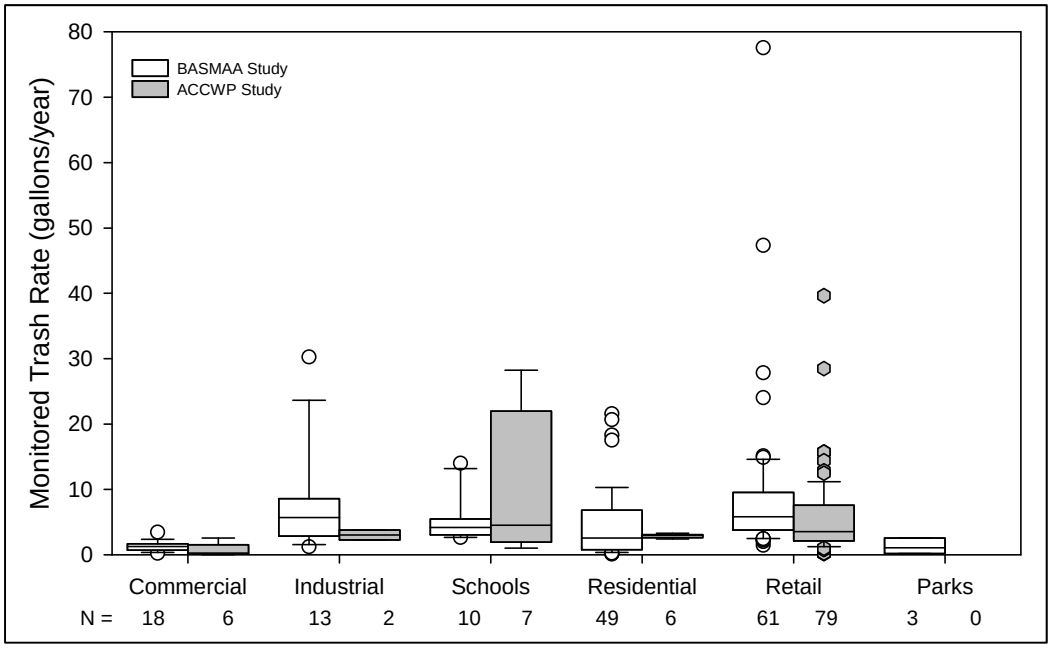

Figure 3.2. Comparison of trash rates by land use obesrved during the BASMAA Study (n= 154) and ACCWP/Authority Project (n= 100).

Statistical comparisons[7] were made to further evaluate whether there are significant differences between the BASMAA and ACCWP/Authority datasets, possibly indicating a reduction in trash between 2011/12 and 2014. The results presented in Table 3.7 indicate that statistically significant differences are only observable between the datasets representing retail land uses. Trash rates for all other land uses and all sites combined were not observed when comparing the BASMAA and ACCWP/Authority datasets. That said, due to the significant variability in rates within land uses classes and the fact that other non-land use factors such as income levels and proximity to trash generating areas/businesses can significantly influence trash rates (BASMAA 2014), detecting differences in rates overtime by comparing datasets collected at the regional and county levels is challenging.

[7] A Shapiro-Wilk test of normality determined that none of the data sets were normally distributed and therefore a Mann-Whitney Rank Sum Test (non-parametric) test was used.

Table 3.7. Results of the nonparametric Mann-Whitney Rank Sum Tests comparing annual trash rates observed in the BASMAA Study and ACCWP/Authority Project.

Land Use	Number of Sites		Statistically Significant Difference?	P-value ($\alpha = 0.05$)
	BASMAA Study	ACCWP/ Authority Project		
Commercial	18	6	No	0.057
Industrial	13	2	No	0.270
Schools	10	7	No	0.884
Residential	49	6	No	0.617
Retail	61	79	**Yes**	**<0.050**
All Sites	154	100	No	0.408

In an effort to account for the potential influence that factors other than land use may have on the amount of trash observed at monitoring sites, data from the 40 sites common to both the ACCWP/Authority Project and BASMAA Study were compared. Average annual trash rates observed during each project/study are shown in Table 3.8. Average trash rates for the 17 non-retail sites and the 23 retail sites monitored are also presented.

Table 3.8. Average annual volume (gallons/yr) of trash based on data collected during the BASMAA Study and ACCWP/Authority Project at 40 monitoring sites in Alameda County..

Land Use	# Sites	BASMAA Study (2011/12)	ACCWP/Authority Project (2014)
Retail Sites	23	6.73	5.63
Non-Retail Sites	17	3.70	3.56
All Sites	**40**	**5.44**	**4.75**

For all sites, retail sites, and non-retail sites, average (and median) annual trash rates were 13% lower during the ACCWP/Authority Project than the BASMAA Study. However, average trash rates for the two studies were not statistically different ($p=0.208$, $\alpha = 0.05$)[8], and therefore the possibility that the difference in the two datasets was due to chance cannot be excluded.

The lack of reduction in trash rates observed between the two studies may be attributable to the lack of enhanced trash control measure implemented at the monitoring sites, with the exception of product-based ordinances and other jurisdictional-wide actions (e.g., public education and outreach programs). Each site monitored is equipped with a full capture device achieves the regulatory standard for stormwater trash control for the area draining to the site. Therefore permittees may have foregone implementing other types of enhanced actions that reduce trash in these areas. If enhanced actions other than product bans and other jurisdictional-wide actions have not been

[8] A Shapiro-Wilk test was performed to test for normality and it was determined that the two data sets followed a normal distribution ($p=0.449$). Therefore a parametric two-tailed paired t-test was used to compare the datasets.

implemented near the sites monitored, then differences in trash rates observed would not be expected.

4.0 CONCLUSIONS AND UNCERTAINTIES

Data collected as part of the *Alameda Countywide Storm Drain Trash Monitoring and Characterization Project* and the previously conducted BASMAA Study assisted in beginning to answer questions related to reductions in single-use plastic bags, expanded polystyrene (EPS) foam food ware, and overall levels of trash observed in stormwater conveyance systems in Alameda county. The 100 sites monitored during the study (including 40 previously monitored BASMAA sites) served as sites representative of high and moderate trash generation in the County of Alameda. Based on the limited data available as part of the ACCWP/Authority Project and the BASMAA Study, the following preliminary conclusions can be made with reference to the three management questions developed to guide this Project:

- **Trash Characteristics** – Similar to the BASMAA Study, roughly 15% (by volume) of the material removed and characterized from storm drain inlets meets the definition of trash. The types of trash observed is dominated by plastic film, food and candy packaging, straws, lids, and bottle tops (i.e., Other Plastic Category); and paper napkins, newspapers, cardboard, sports balls, and other non-plastic trash (i.e., All Other Trash Category). CRV-labeled plastic and glass recyclable bottles, cigarette butts, single use plastic bags, and EPS food ware comprises a smaller portion of the trash characterized (~10% combined). Rigid plastic and paper disposable food and beverage ware are not consistently observed in material removed from storm drains.

- **Single-Use Plastic Bags** – The number of single-use plastic bags observed in Alameda County storm drains appears to be decreasing over time. The number of bags observed during this study was significantly less than the number observed in the 2011 BASMAA Study, decreasing by roughly 44% during this time frame. This decrease coincides with the adoption and implementation of Alameda County's ordinance prohibiting the distribution of single-use plastic bags at many stores/businesses.

- **EPS Foam Food Ware** – When comparing the annual average volume of EPS food ware monitored at 154 sites during the BASMAA Study and 100 sites during the ACCWP/Authority Project, the volumes were significantly less during the Project. The relationship between this decrease and the adoption and implementation of Permittee ordinances prohibiting the distribution of EPS food ware by food vendors is currently unclear due to the varying ordinance adoption timeframes and scopes. Using one Permittee (i.e., City of San Leandro) as a case study, however, indicates that there were significant reductions (~61%) in the average volume of EPS food ware in storm drains after the City's EPS ordinance became effective. These results suggest that although the ordinance has not eliminated EPS food ware in the environment, it is having a significant effect on the volume of this type of trash observed.

- **Effectiveness of All Control Measures** - The overall trash rate observed during the ACCWP/Authority Project is similar to the rate observed during the BASMAA Study in 2011. Although average rates have decreased during this timeframe, the differences are not significantly different from those calculated via the BASMAA Study. This conclusion is not intended to suggest the lack of trash reduction in the County, rather the lack of reduction in

levels of trash generated within the areas draining to monitoring sites equipped with full capture devices that effectively removing trash prior to entering local surface waters.

Due to the limited amount of data available to make comparisons and the inherent temporal and spatial variability in trash generation and processes that transport trash into stormwater conveyance systems, the conclusions provided above should be considered preliminary. Additional data collection and observations, and potentially alternative approaches are needed to more fully answer the management questions posed.

5.0 REFERENCES

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APPENDIX B

ACCWP/AUTHORITY PROJECT
SAMPLING AND ANALYSIS PLAN (SAP)

APPENDIX B

MONITORING SITE DESCRIPTIONS

Appendix B. Summary information for each Alameda Countywide Storm Drain Trash Monitoring and Characterization Project monitoring site.

Permittee	Site ID	Latitude	Longitude	Land Use	Accumulation Period (days)	Trash Rate (gal/year)	Single Use Plastic Bags		Expanded Polystyrene Foam		BASMAA Study Monitoring Site	Previously Unmonitored Site
							# of Bags Observed	Bag Rate (bags/yr)	Volume of EPS (gallons)	EPS Rate (gal/yr)		
Albany	AB01	-122.2987	37.89021	Retail	82	6.52	0	0	0	0		X
Albany	AB02	-122.30812	37.88445	Retail	82	2.77	1	4.5	0	0		X
Albany	AB03	-122.29609	37.89051	Retail	82	2.06	0	0	0.0013	0.0059		X
Albany	AB04	-122.3081	37.88508	Retail	82	1.92	0	0	0	0		X
Alameda	AL01	-122.27634	37.77717	Retail	89	9.96	2	8.2	0.040	0.16		X
Alameda	AL02	-122.27632	37.77816	Retail	89	4.32	0	0	0.14	0.59		X
Alameda	AL03	-122.24144	37.76881	Residential	89	3.28	0	0	0	0		X
Berkeley	BK01	-122.26772	37.85756	Retail	83	0.79	0	0	0	0	X	
Berkeley	BK02	-122.27033	37.86734	K-12 School	83	21.96	0	0	0.31	1.4	X	
Berkeley	BK03	-122.28412	37.87002	Retail	83	0.18	0	0	0	0	X	
Berkeley	BK04	-122.29489	37.85653	Industrial	83	2.27	1	4.4	0	0	X	
Berkeley	BK05	-122.27915	37.89147	Retail	83	2.18	0	0	0	0		X
Berkeley	BK06	-122.29906	37.87988	Retail	83	3.61	0	0	0	0		X
Berkeley	BK07	-122.26906	37.8803	Retail	83	2.02	0	0	0	0		X
Berkeley	BK08	-122.26948	37.87021	Retail	83	3.37	0	0	0	0		X
Berkeley	BK10	-122.2916	37.868132	Retail	83	4.95	0	0	0	0	X	
Berkeley	BK11	-122.2931	37.868796	Retail	83	3.9	0	0	0	0	X	
Berkeley	BK13	-122.2586	37.863402	Retail	83	2.08	0	0	0.013	0.058		X
Berkeley	BK15	-122.2928	37.871767	Retail	83	15.7	1	4.4	0.23	1.00		X
Dublin	DN03	-121.92666	37.71684	Residential	89	3.02	0	0	0	0		X
Dublin	DN04	-121.9272	37.71482	Residential	89	2.41	0	0	0	0		X
Dublin	DN05	-121.92029	37.70555	Retail	89	0.85	0	0	0	0		X
Dublin	DN06	-121.92303	37.70528	Retail	89	14.39	1	4.1	0.0066	0.027		X
Dublin	DN07	-121.92804	37.70448	Retail	89	4.6	0	0	0	0		X

ATTACHMENT A

Permittee	Site ID	Latitude	Longitude	Land Use	Accumulation Period (days)	Trash Rate (gal/year)	Single Use Plastic Bags		Expanded Polystyrene Foam		BASMAA Study Monitoring Site	Previously Unmonitored Site
							# of Bags Observed	Bag Rate (bags/yr)	Volume of EPS (gallons)	EPS Rate (gal/yr)		
Dublin	DN08	-121.92814	37.70469	Retail	89	1.24	0	0	0	0		X
Dublin	DN09	-121.92978	37.70418	Retail	89	3.47	0	0	0	0	X	
Emeryville	EM01	-122.30269	37.83722	Retail	82	1.01	0	0	0	0	X	
Emeryville	EM02	-122.30229	37.83723	Retail	82	3.04	0	0	0	0	X	
Emeryville	EM03	-122.30203	37.83722	Retail	82	2.54	1	4.5	0	0	X	
Fremont	FR01	-122.03228	37.57133	Commercial	85	0.01	0	0	0	0		X
Fremont	FR02	-122.01732	37.56358	K-12 School	85	1.03	0	0	0	0		X
Fremont	FR03	-121.96658	37.53444	Retail	85	3.94	0	0	0	0		X
Fremont	FR04	-121.95881	37.53173	Retail	85	7.72	0	0	0.094	0.40		X
Fremont	FR05	-121.96778	37.50292	Retail	85	2.46	0	0	0	0		X
Fremont	FR06	-121.96744	37.50239	Retail	85	2.41	0	0	0	0		X
Fremont	FR07	-121.9835	37.54473	Retail	85	12.85	0	0	0	0		X
Fremont	FR08	-121.97232	37.50307	Retail	85	0.22	0	0	0	0		X
Fremont	FR09	-121.98869	37.51993	Retail	85	1.68	0	0	0	0		X
Hayward	HW01	-122.085	37.68006	Retail	85	1.29	0	0	0.016	0.067		X
Hayward	HW02	-122.07886	37.66655	Retail	85	8.54	0	0	0.079	0.34		X
Hayward	HW03	-122.08579	37.67257	Retail	85	0.26	0	0	0	0		X
Hayward	HW04	-122.08395	37.67196	Retail	85	7.15	0	0	0.0013	0.0057	X	
Hayward	HW05	-122.08438	37.67178	Retail	85	2.12	0	0	0	0		X
Hayward	HW07	-122.08478	37.67303	Retail	85	11.17	0	0	0.0078	0.034		X
Hayward	HW08	-122.08192	37.67816	Retail	85	0.26	0	0	0	0		X
Livermore	LV01	-121.8146	37.7015	Commercial	88	0.19	0	0	0	0		X
Livermore	LV03	-121.77317	37.6978	Retail	88	2.31	0	0	0	0		X
Livermore	LV04	-121.77333	37.69791	Retail	88	2.1	0	0	0	0		X
Livermore	LV05	-121.74558	37.69523	Retail	88	2.42	0	0	0	0		X
Livermore	LV06	-121.74495	37.69562	Retail	88	2.44	0	0	0	0		X

ATTACHMENT A

Permittee	Site ID	Latitude	Longitude	Land Use	Accumulation Period (days)	Trash Rate (gal/year)	Single Use Plastic Bags		Expanded Polystyrene Foam		BASMAA Study Monitoring Site	Previously Unmonitored Site
							# of Bags Observed	Bag Rate (bags/yr)	Volume of EPS (gallons)	EPS Rate (gal/yr)		
Livermore	LV07	-121.74101	37.70047	Retail	88	2.36	0	0	0	0		X
Livermore	LV08	-121.74223	37.69961	Retail	88	15.72	0	0	0	0		X
Livermore	LV10	-121.81233	37.70136	Retail	88	2.78	0	0	0	0		X
Newark	NW01	-122.05006	37.54976	Retail	86	2.16	0	0	0	0		X
Newark	NW02	-122.05032	37.55075	Retail	86	2.82	0	0	0	0		X
Newark	NW03	-122.04688	37.54937	Retail	86	1.35	0	0	0.0053	0.022	X	
Newark	NW04	-122.04837	37.5518	Retail	86	1.75	0	0	0	0	X	
Newark	NW05	-122.03661	37.53044	Retail	86	8.5	0	0	0.063	0.27		X
Newark	NW06	-122.03828	37.52989	Retail	86	39.64	0	0	0.078	0.33		X
Oakland	OK03	-122.2888	37.81783	Industrial	83	3.77	0	0	0	0		X
Oakland	OK04	-122.28091	37.80312	Retail	83	7.74	1	4.4	0.023	0.10		X
Oakland	OK05	-122.26078	37.81346	Retail	83	4.33	0	0	0.013	0.058		X
Oakland	OK11	-122.26085	37.81365	K-12 School	82	28.23	0	0	0.17	0.76		X
Piedmont	PD01	-122.2445	37.81908	Retail	83	2.56	0	0	0.0026	0.012		X
Piedmont	PD07	-122.23306	37.82371	Commercial	83	0.35	0	0	0	0		X
Piedmont	PD08	-122.23414	37.82289	K-12 School	83	2.76	0	0	0	0		X
Plesanton	PL01	-121.87022	37.70028	Retail	89	3.39	0	0	0.091	0.37	X	
Plesanton	PL02	-121.89833	37.69915	Commercial	89	0.11	0	0	0	0	X	
San Leandro	SL01	-122.15454	37.72223	Retail	86	1.83	0	0	0	0	X	
San Leandro	SL02	-122.15628	37.72279	Retail	86	10.85	0	0	0	0	X	
San Leandro	SL03	-122.14023	37.70067	Retail	86	12.47	2	8.5	0.23	0.96	X	
San Leandro	SL04	-122.13912	37.69638	Retail	86	4.3	0	0	0	0	X	
San Leandro	SL05	-122.1549	37.72064	Residential	86	3.01	0	0	0.063	0.27	X	
San Leandro	SL06	-122.15378	37.72235	Retail	86	2.25	0	0	0	0	X	
San Leandro	SL07	-122.15362	37.72223	Retail	86	3.6	0	0	0	0	X	
San Leandro	SL08	-122.15188	37.72215	Residential	86	2.93	0	0	0	0	X	

ATTACHMENT A

Permittee	Site ID	Latitude	Longitude	Land Use	Accumulation Period (days)	Trash Rate (gal/year)	Single Use Plastic Bags		Expanded Polystyrene Foam		BASMAA Study Monitoring Site	Previously Unmonitored Site
							# of Bags Observed	Bag Rate (bags/yr)	Volume of EPS (gallons)	EPS Rate (gal/yr)		
San Leandro	SL09	-122.15264	37.72271	Retail	86	9.64	0	0	0.033	0.14	X	
San Leandro	SL10	-122.15287	37.72288	Retail	86	1.94	0	0	0	0	X	
San Leandro	SL11	-122.1538	37.72361	Retail	86	7.57	0	0	0	0	X	
San Leandro	SL12	-122.1549	37.72303	Retail	86	3.63	0	0	0	0	X	
San Leandro	SL13	-122.15505	37.72433	Retail	86	10.05	0	0	0	0	X	
San Leandro	SL14	-122.1574	37.72449	Retail	86	2.99	0	0	0	0	X	
San Leandro	SL15	-122.15565	37.72501	Retail	86	4.48	0	0	0.094	0.40	X	
San Leandro	SL16	-122.15455	37.72543	Commercial	86	1.19	0	0	0	0	X	
San Leandro	SL17	-122.15452	37.72615	Commercial	86	2.56	0	0	0	0	X	
San Leandro	SL18	-122.15609	37.72692	Retail	94	6.7	0	0	0	0	X	
San Leandro	SL19	-122.14295	37.71749	K-12 School	86	7.05	0	0	0.026	0.11	X	
San Leandro	SL20	-122.1398	37.71524	K-12 School	86	4.52	0	0	0.063	0.27	X	
San Leandro	SL21	-122.13727	37.7134	Residential	86	2.66	0	0	0	0	X	
San Leandro	SL22	-122.13644	37.71282	K-12 School	86	1.91	0	0	0	0	X	
San Leandro	SL23	-122.16221	37.71211	Retail	86	7.63	1	4.2	0.040	0.17	X	
San Leandro	SL24	-122.13875	37.68676	Retail	86	10.09	0	0	0.0026	0.011	X	
San Leandro	SL25	-122.13703	37.68673	Retail	86	5.64	1	4.2	0	0	X	
Union City	UC01	-122.06638	37.5995	Retail	86	6.97	0	0	0	0		X
Union City	UC02	-122.06933	37.60308	Retail	86	3.55	0	0	0.040	0.17		X
Union City	UC03	-122.06906	37.60395	Retail	86	5.4	0	0	0.14	0.58		X
Union City	UC04	-122.06534	37.59837	Retail	86	4.18	0	0	0	0		X
Union City	UC05	-122.07091	37.59059	Retail	86	9.02	0	0	0.19	0.80		X
Union City	UC06	-122.0703	37.58921	Retail	86	28.48	1	4.2	0	0		X
Union City	UC07	-122.02127	37.58704	Retail	86	6.36	0	0	0.0013	0.0056		X

APPENDIX C

QUALITY ASSURANCE

RELATIVE PERCENT REDUCTION CALCULATIONS

Appendix C. Relative Percent Differences (<MDL = ½ MDL) between trash volumes measured in samples and duplicates collected at applicable sampling sites.

Site ID	Sample Volume (gallons)	Duplicate Volume (gallons)	Relative Percent Difference
BK02	11.27	11.18	-0.81%
BK15	13.93	13.82	-0.80%
OK04	8.21	8.21	0.00%
OK11	16.34	16.11	-1.45%
SL03	15.57	15.43	-0.94%
SL08	8.42	8.05	-4.32%
SL10	16.00	15.87	-0.83%
SL14	4.89	5.09	4.14%
SL22	4.18	4.32	3.36%
UC05	20.40	19.67	-3.57%
UC07	14.04	13.74	-2.19%
		Average:	**-0.67%**

APPENDIX D

TRASH VOLUMES BY MONITORING SITE

Appendix D. Trash Volumes (Gallons) by Monitoring Site.

Site ID	Total Debris	Total Trash	Trash Types									Grand Total (All Material)
			Plastic - Recyclable Beverage Containers (CRV-labeled)	Glass - Recyclable Beverage Containers (CRV labeled)	Single Use Plastic Bags	EPS Disposable Food & Beverage Ware	Rigid Plastic Disposable Food and Beverage Ware	Paper Disposable Food and Beverage Ware	Cigarette Butts	Other Plastic	All Other Trash	
AB01	1.64	1.46	0	0	0	0	0	0	0.02	0.56	0.89	3.10
AB02	0.63	0.72	0	0	0.09	0	0	0	0.01	0.44	0.17	1.34
AB03	5.73	0.46	0	0	0	0.001	0	0	0.01	0.40	0.06	6.19
AB04	2.00	0.43	0.16	0	0	0	0	0	0.01	0.23	0.04	2.43
AL01	1.45	2.62	0	0	0.19	0.04	0	0	0.01	2.18	0.20	4.07
AL02	0.36	1.05	0	0	0	0.14	0	0	0.02	0.44	0.44	1.42
AL03	2.18	0.80	0	0	0	0	0	0	0.04	0.20	0.56	2.98
BK01	0.73	0.18	0	0	0	0	0	0	0.00	0.17	0.01	0.91
BK02	6.27	4.99	0.31	0	0	0.31	0	0	0.01	2.55	1.82	11.27
BK03	1.44	0.04	0	0	0	0	0	0	0.002	0.02	0.02	1.48
BK04	2.45	0.61	0	0	0.09	0	0	0	0.02	0.14	0.36	3.06
BK05	0.91	0.49	0	0	0	0	0	0	0.01	0.23	0.26	1.40
BK06	2.18	0.82	0	0	0	0	0	0	0.01	0.61	0.20	3.00
BK07	1.82	0.46	0	0	0	0	0	0	0.01	0.17	0.28	2.28
BK08	1.45	0.77	0	0	0	0	0	0	0.04	0.56	0.17	2.22
BK10	10.00	1.13	0	0	0	0	0	0	0.02	0.56	0.56	11.13
BK11	1.27	0.89	0	0.09	0	0	0	0	0.01	0.56	0.23	2.16
BK13	3.91	0.47	0	0	0	0.01	0	0	0.04	0.28	0.14	4.38
BK15	10.36	3.66	0.32	0	0.09	0.23	0	0	0.08	1.56	1.39	14.03
DN03	7.91	0.74	0.16	0	0	0	0	0	0.01	0.28	0.28	8.65
DN04	15.00	0.59	0.13	0	0	0	0	0	0.08	0.28	0.09	15.59
DN05	11.45	0.21	0	0	0	0	0	0	0.03	0.15	0.03	11.66
DN06	8.27	3.60	0.26	0	0.09	0.01	0	0	0.01	0.78	2.45	11.88
DN07	16.73	1.12	0.19	0	0	0	0	0	0.05	0.57	0.31	17.85
DN08	8.91	0.30	0	0	0	0	0	0	0.02	0.08	0.20	9.21
DN09	15.55	0.85	0	0	0	0	0	0	0.01	0.47	0.37	16.39
EM01	0.50	0.23	0	0	0	0	0	0	0.01	0.08	0.14	0.73
EM02	1.82	0.68	0	0	0	0	0	0	0.01	0.28	0.39	2.50
EM03	2.55	0.67	0	0	0.09	0	0	0	0.02	0.16	0.39	3.21
FR01	0.63	0.00	0	0	0	0	0	0	0	0.001	0.001	0.63

ATTACHMENT A

Site ID	Total Debris	Total Trash	Trash Types									Grand Total (All Material)
			Plastic - Recyclable Beverage Containers (CRV-labeled)	Glass - Recyclable Beverage Containers (CRV labeled)	Single Use Plastic Bags	EPS Disposable Food & Beverage Ware	Rigid Plastic Disposable Food and Beverage Ware	Paper Disposable Food and Beverage Ware	Cigarette Butts	Other Plastic	All Other Trash	
FR02	0.39	0.24	0	0	0	0	0	0	0.001	0.04	0.20	0.63
FR03	2.89	0.92	0	0	0	0	0	0	0.02	0.34	0.56	3.81
FR04	8.64	1.80	0	0	0	0.09	0	0	0.03	1.22	0.45	10.43
FR05	4.00	0.57	0	0	0	0	0	0	0.02	0.44	0.11	4.57
FR06	1.45	0.56	0	0	0	0	0	0	0.001	0.39	0.17	2.02
FR07	2.91	2.99	0.13	0	0	0	0	0	0.03	1.33	1.50	5.90
FR08	3.27	0.05	0	0	0	0	0	0	0.001	0.03	0.02	3.32
FR09	2.91	0.39	0	0	0	0	0	0	0.03	0.08	0.28	3.30
HW01	1.36	0.30	0	0	0	0.02	0	0	0.02	0.15	0.11	1.66
HW02	4.00	1.99	0.20	0	0	0.08	0	0	0.11	1.27	0.33	5.99
HW03	5.09	0.06	0	0	0	0	0	0	0.01	0.02	0.04	5.15
HW04	7.18	1.66	0.26	0	0	0.001	0	0	0.07	0.67	0.67	8.85
HW05	1.09	0.49	0	0	0	0	0	0	0.01	0.26	0.23	1.59
HW07	2.91	2.60	0	0	0	0.01	0	0	0.08	1.63	0.89	5.51
HW08	3.45	0.06	0	0	0	0	0	0	0.01	0.02	0.03	3.52
LV01	6.00	0.04	0	0	0	0	0	0	0.01	0.02	0.02	6.04
LV03	3.18	0.56	0	0	0	0	0	0	0.01	0.50	0.05	3.74
LV04	3.91	0.51	0	0	0	0	0	0	0.03	0.33	0.14	4.42
LV05	2.55	0.58	0	0	0	0	0	0	0.04	0.28	0.26	3.13
LV06	2.73	0.59	0	0	0	0	0	0	0.02	0.28	0.28	3.31
LV07	3.09	0.57	0	0	0	0	0	0	0.07	0.33	0.17	3.66
LV08	2.55	3.79	0.13	0	0	0	0	0	0.03	2.91	0.72	6.34
LV10	5.64	0.67	0.09	0	0	0	0	0	0.01	0.23	0.34	6.31
NW01	5.45	0.51	0	0	0	0	0	0	0.01	0.44	0.06	5.96
NW02	8.91	0.66	0	0	0	0	0	0	0.04	0.28	0.34	9.57
NW03	3.55	0.32	0	0	0	0.01	0	0	0.01	0.26	0.05	3.86
NW04	4.18	0.41	0	0	0	0	0	0	0.01	0.33	0.07	4.59
NW05	16.45	2.00	0	0	0	0.06	0	0	0.05	0.94	0.94	18.46
NW06	20.64	9.34	0.13	0.07	0	0.08	0	0	0.05	4.00	5.00	29.98
OK03	2.18	0.86	0.23	0	0	0	0	0	0.02	0.39	0.23	3.04
OK04	6.45	1.85	0	0	0.09	0.02	0	0	0.02	1.27	0.44	8.31

ATTACHMENT A

Site ID	Total Debris	Total Trash	Trash Types									Grand Total (All Material)
			Plastic - Recyclable Beverage Containers (CRV-labeled)	Glass - Recyclable Beverage Containers (CRV labeled)	Single Use Plastic Bags	EPS Disposable Food & Beverage Ware	Rigid Plastic Disposable Food and Beverage Ware	Paper Disposable Food and Beverage Ware	Cigarette Butts	Other Plastic	All Other Trash	
OK05	9.09	0.98	0	0	0	0.01	0	0	0.03	0.61	0.33	10.08
OK11	10.00	6.34	0	0	0	0.17	0	0	0.03	4.36	1.78	16.34
PD01	3.27	0.58	0	0	0	0.003	0	0	0.01	0.11	0.45	3.86
PD07	14.27	0.08	0	0	0	0	0	0	0	0.07	0.01	14.35
PD08	2.91	0.63	0	0	0	0	0	0	0.003	0.28	0.34	3.54
PL01	11.18	0.83	0.16	0	0	0.09	0	0	0.01	0.37	0.20	12.01
PL02	8.27	0.03	0	0	0	0	0	0	0	0.02	0.01	8.30
SL01	1.73	0.43	0	0	0	0	0	0	0.004	0.26	0.17	2.16
SL02	2.55	2.56	0.16	0	0	0	0	0	0.01	1.33	1.06	5.10
SL03	12.64	3.13	0.13	0	0.19	0.23	0	0	0.02	1.22	1.33	15.76
SL04	5.45	1.01	0	0	0	0	0	0	0.12	0.61	0.28	6.47
SL05	3.45	0.71	0.16	0	0	0.06	0	0	0.04	0.17	0.28	4.16
SL06	5.64	0.53	0	0	0	0	0	0	0.02	0.40	0.11	6.17
SL07	6.45	0.85	0	0	0	0	0	0	0.02	0.44	0.39	7.30
SL08	7.73	0.69	0.07	0	0	0	0	0	0.01	0.17	0.44	8.42
SL09	16.64	2.27	0	0	0	0.03	0	0	0.02	0.83	1.39	18.91
SL10	15.55	0.46	0	0	0	0	0	0	0.03	0.20	0.23	16.00
SL11	13.64	1.78	0	0.05	0	0	0	0	0.01	0.56	1.17	15.42
SL12	5.73	0.86	0	0	0	0	0	0	0.02	0.56	0.28	6.58
SL13	47.45	2.37	0	0	0	0	0	0	0.03	1.26	1.08	49.82
SL14	4.18	0.70	0	0	0	0	0	0	0.03	0.39	0.28	4.89
SL15	11.82	1.05	0	0	0	0.09	0	0	0.02	0.31	0.63	12.87
SL16	2.73	0.28	0	0	0	0	0	0	0.001	0.02	0.26	3.01
SL17	3.45	0.60	0	0	0	0	0	0	0.01	0.20	0.40	4.06
SL18	8.82	1.73	0	0	0	0	0	0	0.004	0.44	1.28	10.54
SL19	5.73	1.66	0.25	0	0	0.03	0	0	0.02	1.00	0.37	7.39
SL20	11.82	1.06	0	0	0	0.06	0	0	0.00	0.67	0.33	12.88
SL21	2.91	0.63	0.16	0	0	0	0	0	0.02	0.17	0.28	3.54
SL22	3.73	0.45	0	0	0	0	0	0	0.05	0.26	0.14	4.18
SL23	12.91	1.89	0.16	0	0.09	0.04	0	0	0.16	1.00	0.44	14.80
SL24	10.00	2.38	0.13	0	0	0.003	0	0	0.13	1.11	1.00	12.38

ATTACHMENT A

Site ID	Total Debris	Total Trash	Trash Types									Grand Total (All Material)
			Plastic - Recyclable Beverage Containers (CRV-labeled)	Glass - Recyclable Beverage Containers (CRV labeled)	Single Use Plastic Bags	EPS Disposable Food & Beverage Ware	Rigid Plastic Disposable Food and Beverage Ware	Paper Disposable Food and Beverage Ware	Cigarette Butts	Other Plastic	All Other Trash	
SL25	20.36	1.42	0	0	0.09	0	0	0	0.11	0.89	0.33	21.79
UC01	2.55	1.64	0	0	0	0	0	0	0.02	1.22	0.40	4.19
UC02	12.73	0.84	0.13	0	0	0.04	0	0	0.05	0.33	0.28	13.56
UC03	33.36	1.27	0	0	0	0.14	0	0	0.08	0.56	0.50	34.64
UC04	5.34	0.98	0.26	0	0	0	0	0	0.11	0.17	0.44	6.32
UC05	18.27	2.13	0.15	0	0	0.19	0	0	0.07	1.00	0.72	20.40
UC06	1.09	6.80	0.83	0	0.09	0	0	0	0.11	1.78	4.00	7.89
UC07	12.55	1.50	0	0	0	0.001	0	0	0.05	0.56	0.89	14.04

APPENDIX E

TOTAL COUNT OF CIGARETTE BUTTS

Appendix E. Total Count of Cigarette Butts

Permittee	BASMAA ID	Number of Cigarette Butts
Albany	AB01	29
Albany	AB02	10
Albany	AB03	7
Albany	AB04	10
Alameda	AL01	13
Alameda	AL02	30
Alameda	AL03	42
Berkeley	BK01	1
Berkeley	BK02	8
Berkeley	BK03	4
Berkeley	BK04	23
Berkeley	BK05	14
Berkeley	BK06	13
Berkeley	BK07	8
Berkeley	BK08	59
Berkeley	BK10	24
Berkeley	BK11	13
Berkeley	BK13	59
Berkeley	BK15	122
Dublin	DN03	14
Dublin	DN04	2
Dublin	DN05	46
Dublin	DN06	11
Dublin	DN07	83
Dublin	DN08	29
Dublin	DN09	12
Emeryville	EM01	4
Emeryville	EM02	11
Emeryville	EM03	37
Fremont	FR01	0
Fremont	FR02	1
Fremont	FR03	30
Fremont	FR04	38
Fremont	FR05	19
Fremont	FR06	1
Fremont	FR07	15
Fremont	FR08	1
Fremont	FR09	39
Hayward	HW01	27
Hayward	HW02	164
Hayward	HW03	12

ATTACHMENT A

Permittee	BASMAA ID	Number of Cigarette Butts
Hayward	HW04	91
Hayward	HW05	15
Hayward	HW07	107
Hayward	HW08	8
Livermore	LV01	14
Livermore	LV03	20
Livermore	LV04	40
Livermore	LV05	66
Livermore	LV06	29
Livermore	LV07	116
Livermore	LV08	38
Livermore	LV10	11
Newark	NW01	10
Newark	NW02	63
Newark	NW03	15
Newark	NW04	15
Newark	NW05	73
Newark	NW06	68
Oakland	OK03	22
Oakland	OK04	33
Oakland	OK05	32
Oakland	OK11	49
Piedmont	PD01	13
Piedmont	PD07	0
Piedmont	PD08	2
Plesanton	PL01	15
Plesanton	PL02	0
San Leandro	SL01	4
San Leandro	SL02	12
San Leandro	SL03	39
San Leandro	SL04	183
San Leandro	SL05	46
San Leandro	SL06	24
San Leandro	SL07	21
San Leandro	SL08	15
San Leandro	SL09	19
San Leandro	SL10	42
San Leandro	SL11	10
San Leandro	SL12	14
San Leandro	SL13	46
San Leandro	SL14	36
San Leandro	SL15	26
San Leandro	SL16	1

ATTACHMENT A

Permittee	BASMAA ID	Number of Cigarette Butts
San Leandro	SL17	5
San Leandro	SL18	5
San Leandro	SL19	24
San Leandro	SL20	4
San Leandro	SL21	23
San Leandro	SL22	68
San Leandro	SL23	306
San Leandro	SL24	197
San Leandro	SL25	148
Union City	UC01	35
Union City	UC02	94
Union City	UC03	104
Union City	UC04	143
Union City	UC05	82
Union City	UC06	131
Union City	UC07	80