Appendix I3: Implementation and Monitoring Plan for Kaneohe Stream, 2015

IMPLEMENTATION AND MONITORING PLAN FOR KANEOHE STREAM WASTELOAD ALLOCATION FOR THE CITY AND COUNTY OF HONOLULU MUNICIPAL SEPARATE STORM SEWER SYSTEM NPDES PERMIT NO. HI S000002

June 2015

Prepared by
City and County of Honolulu
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E Mālama I Ka Wai Ola
Protect our waters...
FOR LIFE

Transmittal Letter

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Acronyms

BMP	Best Management Practice
City/CCH	City and County of Honolulu
CSM	City and County of Honolulu, Department of Environmental Services, Collection System Maintenance
CY	Calendar Year
DDC	City and County of Honolulu, Department of Design and Construction
DFM	City and County of Honolulu, Department of Facility Maintenance
DOH	State of Hawaii, Department of Health
EMC	Event Mean Concentration
ENV	City and County of Honolulu, Department of Environmental Services
EPA	United States Environmental Protection Agency
FY	Fiscal Year
GH	Good Housekeeping
I&M Plan	Implementation and Monitoring Plan
MS4	Municipal Separate Storm Sewer System
NCDC	National Climatic Data Center
NPDES	National Pollutant Discharge Elimination System
NTE	Not-to-Exceed
OM	Organic Matter
Permit	NPDES Permit No. HI S000002
PM	Particulate Matter
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
USLE	Universal Soil Loss Equation
WLA	Wasteload Allocation
WQS	Water Quality Standards

Executive Summary

This implementation and monitoring plan was developed to comply with the terms of the National Pollutant Discharge Elimination System Permit No. HI S000002 (Permit) for the City's municipal separate storm sewer system (MS4).

The State of Hawaii, Department of Health (DOH) developed and established Total Maximum Daily Loads (TMDLs) for Kaneohe Stream. The DOH TMDL report further defined Wasteload Allocations (WLAs) for point dischargers including the City and County of Honolulu (City or CCH) and calculated reduction goals based on the City's MS4 coverage area which includes parks, golf courses, residential neighborhoods, commercial areas, curbed streets, and swales.

Based on discussions with DOH representatives, it was determined that the City's load reduction goals shall be based on the seasonal 2% and 10% Not-to-Exceed (NTE) criteria, as defined by the TMDL report. In addition, adjustments were made for long-term storm runoff and residential land use pollutant runoff concentrations to better represent local conditions. Based on this methodology, the resulting load reduction goals for Total Suspended Solids (TSS), Total Nitrogen (TN), and Total Phosphorus (TP) for the City and County of Honolulu are as follows:

Table ES-1: TSS, Total Nitrogen, and Total Phosphorus Load Reduction Summary

	TSS		TN		TP	
	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season
CCH Reductions Required (lb/season)	0	0	28.2	19.0	52.6	27.0

Based on this analysis, the City will implement Best Management Practices (BMPs) targeted at removing 28.2 lbs of TN and 52.6 lbs of TP in the wet season and 19 lbs of TN and 27 lbs of TP in the dry season. Reduction goals for TSS are not applicable.

The City will implement a variety of BMPs to reduce pollutant loads in the watershed. These activities include:

- Public outreach efforts to inform homeowners of how their actions affect water quality in the Kaneohe Stream;
- Public outreach efforts targeted to specific homeowners who could make improvements around their homes such as disconnecting roof drains;
- Refining street sweeping routes and tracking/sampling procedures;
- Continued inspection and maintenance of recently constructed stabilized stream banks; and
- Inspection and cleaning of drainage structures and conveyances as necessary.

The combination of these efforts is expected to remove nutrients, namely TN and TP, from the waste stream and ultimately achieve the targeted WLA. Based on historical collections, it is anticipated that street sweeping once or twice during the dry season and three to four times during the wet season, in addition to continued maintenance of the Kaneohe Stream bank will collect or treat sediment and organic matter in sufficient quantity to meet the TN and TP seasonal reduction goals. If additional activities (ex. additional street sweeping cycles, drain cleaning, and/or permanent BMPs, etc.) are required to meet the target reductions, the City will implement them in increments as described in Section 5.0. The following table provides a summary of the estimated pollutant load reductions for each of the City's BMPs.

Table ES-2: Summary of BMP Activities and Quantitative Reductions

	TN Reduction (lbs/season)		TP Reduction (lbs/season)	
	Wet Season	Dry Season	Wet Season	Dry Season
Downspout Disconnect	*	*	*	*
Homeowner Outreach/Volunteer Cleanup	*	*	*	*
Street Sweeping	75.2	32.8	49.6	27.4
Water Quality Improvement Projects	7.6	2.7	3.6	1.3
Storm Drain Maintenance	**	**	**	**
TOTAL REMOVED	82.8	35.5	53.2	28.7
REDUCTIONS REQUIRED	28.2	19.0	52.6	27.0

* The City will conduct a public education and outreach program to all homeowners within the watershed; however, due to difficulty in quantifying pollutant load reductions due to behavior changes, no homeowner contribution is assumed for accounting purposes at this time.

**Cleaning of storm drains and drainage structures will be implemented only if collections from other activities are less than anticipated and the City needs additional reductions to meet the load reduction goals for a particular season. Storm drain cleaning may also be done in lieu of additional street sweeping activities based on scheduling and equipment availability.

The final compliance deadline is December 31, 2018.

1.0 Introduction

The National Pollutant Discharge Elimination System (NPDES) Permit No. HI S000002 (Permit) issued by the State of Hawaii, Department of Health (DOH) to the City and County of Honolulu (City for CCH) for their municipal separate storm sewer system (MS4) became effective February 16, 2015. It stipulates that the City develop a Wasteload Allocation (WLA) implementation and monitoring plan (I&M Plan) for Kaneohe Stream by the end of Fiscal Year 2015 (FY15). For the purpose of complying with the foregoing requirement, the City is submitting this I&M Plan for Kaneohe Stream.

The DOH developed and established Total Maximum Daily Loads (TMDLs) for the Kaneohe Stream in its technical report *Total Maximum Daily Loads (TMDLs) for Total Suspended Solids, Nitrogen, and Phosphorus in Kaneohe Stream, Kaneohe, Hawaii* (DOH, September 2009). This I&M Plan will address specific City activities targeted to reducing Total Nitrogen and Total Phosphorus discharges in the Kaneohe Stream watershed as necessary to comply with the TMDLs and the City's WLA. The monitoring plan specifies activity tracking necessary to demonstrate efforts by the City to comply with the urban source WLAs.

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2.0 Kaneohe Stream Watershed

The Kaneohe Stream watershed, located on the windward side of Oahu, encompasses an area of approximately 5.7 square miles (3,686 acres). It is bordered by Keaahala watershed to the North; Kawa and Kawainui watersheds to the East; and the peak of the Koolau Mountain range to the south (see Figure 1). Kaneohe Stream and its tributaries (Luluku Stream, Kapunahala Stream, and Kamooalii Stream) discharge north to Kaneohe Bay. The nearshore waters of Kaneohe Bay are currently listed under the Clean Water Act §303(d) list of impaired water bodies for excessive nutrients, turbidity, and suspended solids.

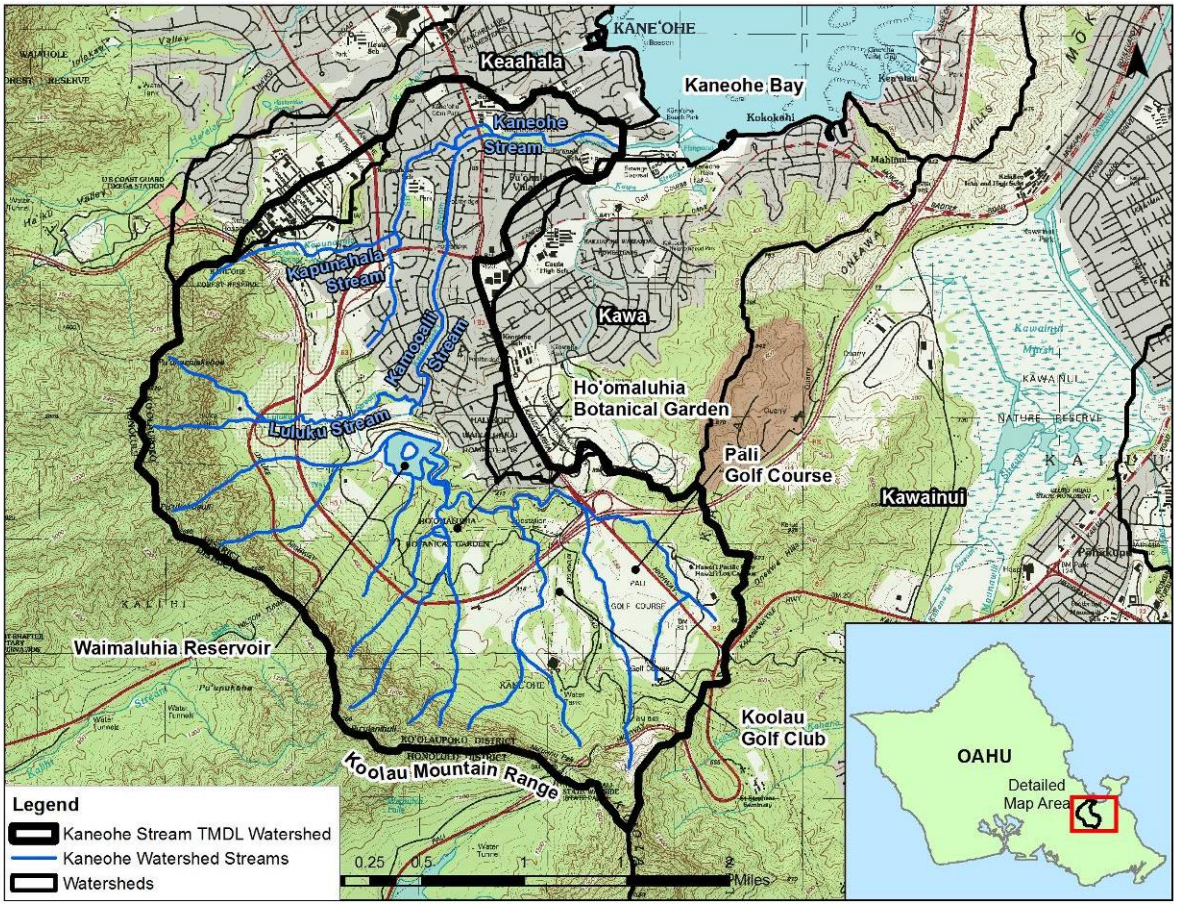

Figure 1: Kaneohe Stream Watershed

For the purposes of TMDL and WLA development, the DOH further delineated the watershed into six sub-basins as shown in Figure 2.

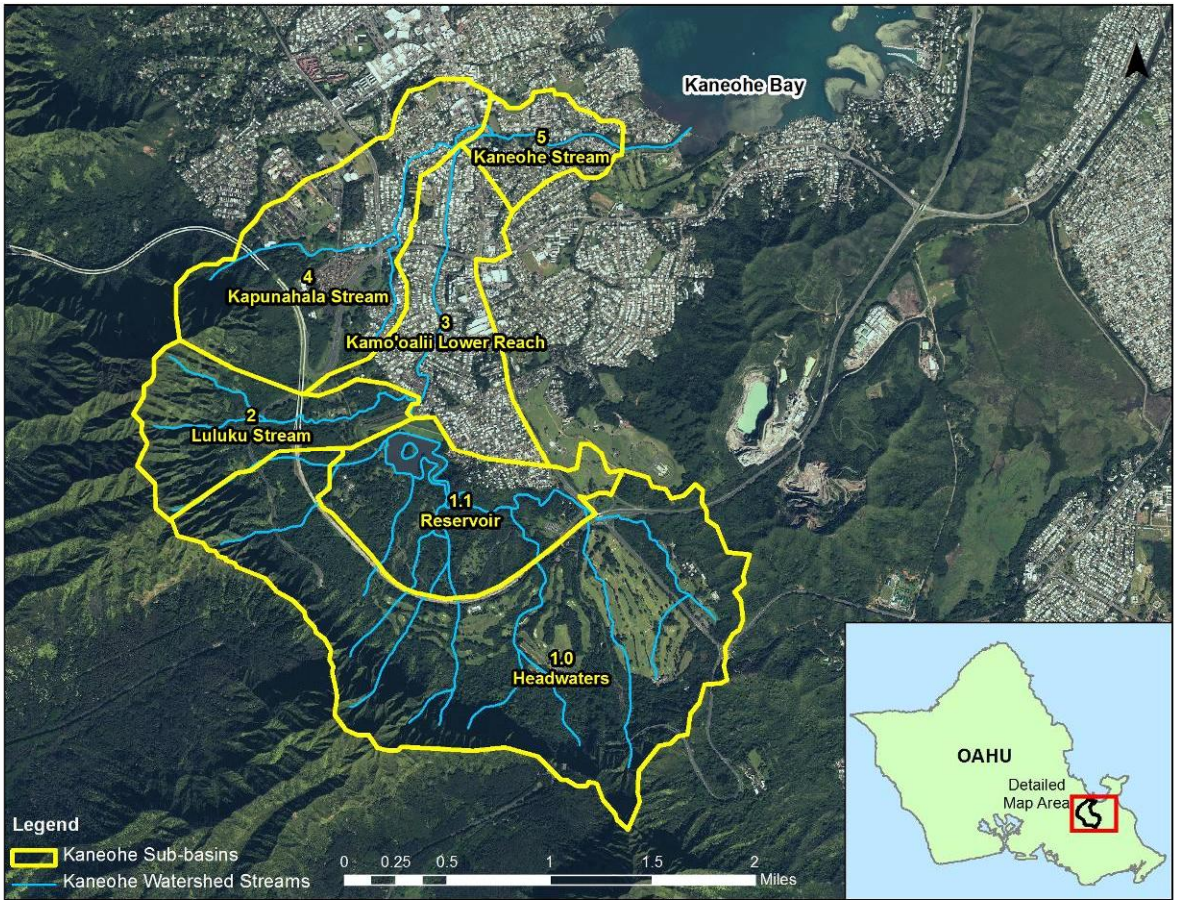

Figure 2: Kaneohe Stream Aerial Photo

Primary land uses in the Kaneohe watershed included preservation areas, golf courses, a banana plantation, a botanical garden, residential neighborhoods, and agricultural lands.

Within the Kaneohe Stream Watershed, the City's MS4 covers 1,482 acres (40%) of the total 3,686 acres. The single largest land use is preservation area/forested land (~42%) as summarized in Table 1 below.

Table 1: Land Use within the Kaneohe Sub-basins[1]

Sub-basin	Forest (ac)	Agr. (ac)	Cem. (ac)	Inst. (ac)	Koolau Golf Course (ac)	City and County of Honolulu (ac)						DOT Highways (ac)		Total (ac)
						Parks	Pali Golf Course	Resid.	Comm.	Curbs	Swales	Curbs	Swales	
1.0	994	60	20	35	143	0	216	0	0	0	0	0	60	1527
1.1	10	0	25	36	0	382	0	37	0	2	6	0	0	498
2	271	93	0	0	0	0	0	0	0	0	0	0	8	372
3	14	5	0	10	0	4	0	343	29	25	7	7	0	444
4	250	82	0	47	0	30	0	208	15	11	9	10	17	678
5	0	0	0	7	0	22	0	118	1	7	12	1	0	168
Total (ac)[2] Total (%)[2]	1,538 42%	241 7%	45 1%	135 4%	143 4%	1,482 40%						103 3%		3,686 100%

[1]Modified from DOH TMDL Report, Table 4.1 (September 2009)
[2]Values have been rounded to the nearest acre or percent, thus totals may differ from the sum of their parts

3.0 TMDLs and WLAs for Kaneohe Stream Watershed

TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards and is an allocation of that load among the various sources of that pollutant. In 2009, the DOH published and the United States Environmental Protection Agency (EPA) approved TMDLs and WLAs for Kaneohe Stream for Total Suspended Solids (TSS), Total Nitrogen (TN), and Total Phosphorus (TP). These TMDLs/WLAs were allocated between the wet and dry seasons for three intervals: 2% Not-to-Exceed (NTE), 10% NTE, and baseflow (non-runoff) conditions. The TMDLs/WLAs were calculated based on flow contributions from various land uses and the state water quality standards (WQS) for the 2% NTE and the 10% NTE and the geometric mean WQS for baseflow conditions. The TMDL report further established existing loading rates for point source discharges including the City and County of Honolulu for the same intervals. The DOH defined the CCH MS4 coverage area as including parks, Pali Golf Course, residential and commercial areas, curbed streets, and roadside swales. The following sections summarize the DOH TMDL calculations and describe the modifications made to those calculations to determine the City's seasonal reduction goals.

3.1 Existing Storm Runoff Pollutant Loads

The DOH TMDL report assigned existing load concentrations for various land uses draining to the City's MS4 based on the Event Mean Concentration (EMC) data derived from EPA's Nationwide Urban Runoff Program (1983) and other estimates of nonpoint source pollutant loading rates (Shannon and Brezonik, 1972, Uttermark et al. 1974). These estimates were based on mainland U.S. data and are likely not representative of conditions on Oahu, not only due to Hawaii's locational isolation, but also due to changing characteristics of urban runoff over the past 30+ years.

Upon review of the data used by DOH to derive the CCH's existing pollutant loads (DOH Table 4.3, 2009) and comparing it to locally collected event mean concentration (EMC) data, it became evident that the values used in the DOH TMDL report were not consistent with the local data. In particular, the residential land use pollutant load for TN appeared to be greatly over-estimated. The following table summarizes the pollutant loading rates for residential land use sites around Oahu:

Table 2: Storm Runoff Pollutant Loading Rates for TN and TP at Residential Sites on Oahu

Location	Annual Ave. Precipitation (in/yr)	TN (mg/l)	TP (mg/l)	Source
Kaneohe TMDL Watershed	67.5[1]	2	0.5	DOH TMDL Report (2009)
Kawa TMDL Watershed	62.5[2]	0.9	0.25	DOH TMDL Report (2005)
Upper Kaukonahua	73.1[2]	1.04	n/a	Upper Kaukonahua WLA I&M Plan (2013)
Waialae Iki	30.4[3]	0.486	0.106	Oceanit (1994)

[1]Annual average precipitation calculated for sub-basins with City MS4 coverage based on the 1971-2000 PRISM dataset.

[2]Average annual precipitation estimated to approximate centroid of the residential land use area based on rainfall isohyetals from the Hawaii Rainfall Atlas, Report R-76 (1986)

[3]Average Annual Precipitation provided in Oceanit's report (1994)

The following graph is a depiction of the data presented in Table 2. It indicates a very strong correlation (R = 1) between average annual precipitation and TN runoff concentrations based on the Kawa DOH TMDL report and the measured EMC data collected in Upper Kaukonahua and Waialae Iki. It also indicates that the TN pollutant concentration assumed in the DOH TMDL report is clearly an outlier

(purple square). Based on a linear regression of the 3 locally collected TN data points, the storm runoff concentration should be 0.97 mg/l.

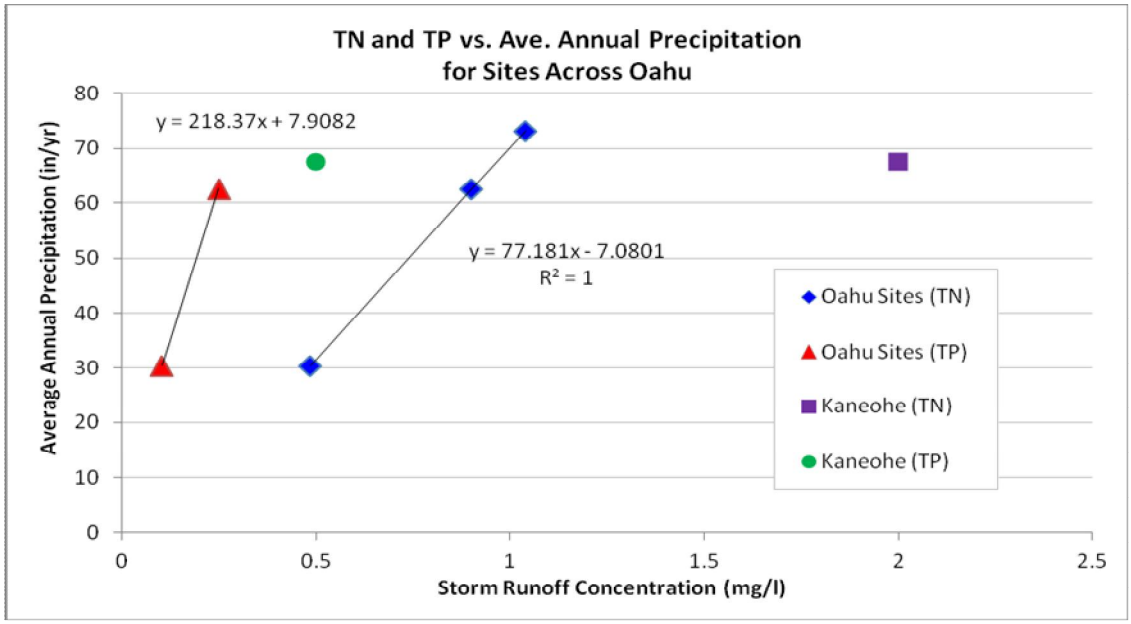

Figure 3: Graph of TN and TP Runoff Concentrations vs. Annual Precipitation at Sites Across Oahu

Only two TP monitoring locations were sampled on Oahu (Kawa DOH TMDL report and Waialae Iki), but it was assumed to be representative of local residential land use conditions based on the very strong correlation noted in the TN trendline (coefficient of determination = 1) for the same locations. It also indicates that the TP pollutant concentration assumed in the DOH Kaneohe TMDL report is an outlier (green circle). Based on a linear regression of the 2 locally collected TP data points, the storm runoff concentration should be 0.27 mg/l.

It should also be noted that the Kawa TMDL watershed is immediately adjacent to the Kaneohe TMDL watershed and is very similar in character and meteorological conditions. This methodology is consistent with 40 CFR 130.7(c)(1)(i) which states, "site specific information should be used wherever possible" in developing TMDLs.

A distinction was not made between the wet season and dry season storm runoff pollutant loads nor between the 2% and 10% NTE intervals. This is consistent with the original calculations presented in the Kaneohe DOH TMDL report.

Storm runoff pollutant loads for other land uses (parks, golf courses, cemetery, institutions, commercial, and street) that drain to the City MS4 also appeared to be over-estimated, but due to lack of EMC data, adjustments to these values could not be made.

3.2 Adjustment for Storm Precipitation Data (PRISM 30-Yr Normals)

The City also evaluated the “30-year Normals” data for the 1971-2000 PRISM dataset, which is an update of the 1961-1990 dataset. Based on the City’s independent calculations, the precipitation values assumed in the DOH TMDL report warranted adjustment to reflect the current conditions. Overlaying the precipitation grid with the sub-basin boundaries, a weighted average precipitation value was calculated for each sub-basin by month. Monthly averages for May through October were summed to determine the

total dry season rainfall. Similarly, monthly averages for November through April were summed to determine the total wet season rainfall. Based on this analysis, most point precipitation values were adjusted 14% higher or lower, on average, in the dry season and 6% higher or lower, on average, in the wet season.

3.3 Revised CCH Seasonal WLA, Existing Loads, and Reduction Goals

Based on discussions with DOH representatives, it was determined that the City's load reduction goals shall be based on the seasonal 2% and 10% NTE criteria, as defined by the TMDL report.

The modified seasonal rainfall totals and storm runoff pollutant concentrations for TN and TP for the residential land use were used to re-calculate the existing loads in the same manner the original calculations were prepared by DOH. The following table summarizes the City's seasonal WLAs, revised existing loads, and load reductions for the storm runoff condition (from Tables 5.10 and 5.11, DOH, 2009 with modifications noted in Sections 3.1 and 3.2 above). For the following scenarios, it is assumed that a 2% NTE event occurs each day for 2% of the days in the season and a 10% NTE event occurs for 8% of the days in the season (i.e., the 10% NTE events include the 2% NTE events). The wet season is defined as the period between November 1st and April 30th for a total of 181 days. The dry season is defined as the period between May 1st and October 31st for a total of 184 days.

Table 3: Seasonal CCH WLA, Existing Loads, and Reduction Goals

	TSS				TN				TP			
	Wet Season		Dry Season		Wet Season		Dry Season		Wet Season		Dry Season	
Interval (% NTE)	2%	10%	2%	10%	2%	10%	2%	10%	2%	10%	2%	10%
WLA (kg/event)	11,856	593	2,732	135	91.1	6.0	19.4	2.0	22.5	1.9	4.2	0.6
# of events per season	3.6	14.5	3.7	14.7	3.6	14.5	3.7	14.7	3.6	14.5	3.7	14.7
WLA Load (kg/season)	42,682	8,597	10,109	1,978	328	86.3	72	29.3	81	27.4	15.7	8.8
Existing Load (kg/season)	36,052	7,093	8,502	1,744	324	99	81	28	98	35	27	9
Reduction Required (kg/season)	0	0	0	0	0	13	9	0	17	7	12	1
Reduction Required (lb/season)	0		0		28.2		19.0		52.6		27.0	

Based on the above computations, the City's implementation plan will target reductions in TN loadings by 28.2 lbs during the wet season and 19 lbs during the dry season and TP loadings by 52.6 lbs during the wet season and 27 lbs during the dry season. TSS reductions are not applicable.

It should be noted that the City is preparing to appeal to the State Department of Health to revise the TMDL/WLA calculations to (1) reflect current conditions as new information has become available, (2) incorporate site-specific information where appropriate per 40 CFR 130.7(c)(1)(i), and (3) correct apparent calculation errors and omissions in the DOH TMDL report in accordance with the modifications described in this section.

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4.0 Proposed Best Management Practice Implementation and Monitoring Plan

The City will implement various Best Management Practices (BMPs) to reduce pollutants, particularly TN and TP, from entering the stream. The aggregate effect of these individual activities is expected to reduce the pollutants in the City's stormwater discharge to below the target WLA. This TMDL Implementation Plan identifies specific activities with the goal of reducing pollutants, improving water quality, and increasing the stream's ability to support aquatic habitat. While ultimately the attainment of the Kaneohe Stream TMDL requires all stakeholders, including major landowners and land operators, to participate in pollution reduction efforts, the City proposes to implement the following BMPs to reduce point source loads from the City's streets and facilities.

- Community Involvement and Outreach/Education
- Pollution Prevention and Good Housekeeping
- Water Quality Improvement Projects

4.1 Community Involvement and Outreach/Education

Outreach efforts which educate the general public to effect changes in their behavior can result in significant reductions of pollutants that would otherwise enter the storm drain system and receiving waters.

4.1.1 Downspout Disconnection

Building rooftops are impervious surfaces, similar to paved streets and parking lots that accumulate debris, chemicals, fine sediment, nutrients or other pollutants that could adversely affect water quality if the runoff is discharged untreated. Connected downspouts discharge rooftop runoff either directly to the storm drain system or to impervious surfaces. In both cases, there is little to no treatment of storm water runoff before it reaches the stream system. Most of the nitrogen contained in storm water is in the form of dissolved nitrate. Since the nitrogen is not in solid form, removal through plant uptake has been shown to be much more effective than filtration methods.

Downspout disconnection can help reduce runoff volume, rate, and accumulated rooftop pollutants introduced to local streams by allowing runoff water to pass through the initial plant uptake process as well as the secondary infiltration process rather than discharging directly to the storm drainage system. Disconnected downspouts typically drain to pervious areas such as yards and lawns, rain barrels, or rain gardens, all of which allow rooftop runoff to enter treatment prior to discharge.

Literature data suggests that for each 1 acre of impervious rooftop that is disconnected, 7.9 lbs of TN in the wet season and 4.8 lbs in the dry season are diverted from directly entering the storm drainage system. In addition, an additional 0.25 lbs of TP during the wet season and 0.15 lbs during the dry season are similarly diverted. This estimation is based on the following equation:

Load Reduction [lb/yr] $= LR * A_{IMP} * P * RE * C$, where:

LR = Loading rate for urban land use (NY State Stormwater Management Design Manual) (1.5 mg/L for TN and 0.11 mg/L for TP)

A_{IMP} = impervious rooftop drainage area recommended for disconnection (1 acre)

P = Seasonal average precipitation totals for residential land use based on the PRISM dataset of 30-yr Normals for 1971-2000 (41.5 in/wet season; 25.3 in/dry season)

RE = Removal Efficiency for Specific BMP Type (open channel removal rate: 56% for TN and 24% for TP per National Pollutant Removal Performance Database, Center of Watershed Protection [CWP], 2007)

C = Conversion Factor, 0.2266

While downspout disconnection is a meaningful and tangible homeowner contribution to reducing pollutants in the waste stream, this activity has not been included in the accounting of TN or TP load reductions from the City's MS4 due to uncertainty in the participation rate. While a significant portion of the TN loading has the potential to be reduced by downspout disconnection, the process is much less effective for treating TP. Therefore, a survey of the potential rooftop area suitable for disconnection was not conducted in Kaneohe, however, the City will prepare an informational mailer to educate homeowners on the benefits of downspout disconnection and include resources for additional information.

4.1.2 Homeowner Outreach/Volunteer Cleanup

Raising awareness among homeowners about some of the common activities around their homes that can negatively affect water quality can invoke a behavior change. This shift in behavior is a primary citizen-based strategy that can yield significant positive results and water quality improvements.

In the past, the City has partnered with local community groups and schools to educate and engage the community in clean up events. Recent events include storm drain stenciling projects, adopt-a-stream events, and Make a Difference Day.

Since the effects of education/outreach and public participation on storm water discharges is often unreliable and difficult to quantify, the anticipated removal rates from this activity have not been included in the calculations to quantify TN or TP load reductions. However, if a methodology is developed to quantify the homeowner/volunteer group contribution in removal of TN and TP (i.e., volume of material removed and debris composition), it will be applied to waste load reduction in a manner identical to that of street sweeping described below.

4.2 Pollution Prevention and Good Housekeeping

The City currently implements a host of pollution prevention and good housekeeping (GH) practices across the island. Collectively, these programs are a key element in the diversion of trash, sediment, and nutrients from entering the storm drain system and discharging to receiving waters. The City will implement the following plan to expand its maintenance operations in the Kaneohe Stream watershed for the upcoming 2016 fiscal year (FY16).

4.2.1 Street Sweeping

The Kaneohe Corporation Yard of the City Department of Facility Maintenance (DFM) currently maintains the City's streets and facilities within the Kaneohe Stream Watershed. The current street sweeping schedule is not entirely consistent and is conducted based on the availability of staff and operability of the equipment. The baseyard currently uses a vacuum street sweeper (Allianz Johnston VT560) for its street sweeping operations.

A street sweeping pilot study was initiated in September 2013 to determine baseline conditions in the wet and dry seasons. During the baseline study, the total volume of debris removed from the roadside area

was estimated by spreading the collected material into a rectangle of uniform thickness and measuring the dimensions to calculate the volume. In addition, the percent composition of the debris collected (gravel + sand + sediment, green waste, and trash) was visually estimated. The raw data summarizing the estimated removal quantity and debris composition are presented in Table 4 below.

Table 4: Summary of Street Sweeping Baseline Data Collection

Date	Season	Quantity Collected (CY) [1]	Debris Composition (%)[2]		
			Trash	Gravel/Sand/ Sediment	Green Waste
9/25-27/13	Dry	5.26	0	80	20
10/1/13	Dry	3.80	0	85	15
11/12-22/13	Dry	7.55	0-1	70-95	5-30
1/28/14	Wet	0.81	0	85	15
4/1-2/14	Wet	10.51	0-1	70-90	10-29
5/19-22/14	Dry	5.49	0-1	50-95	5-50
7/25-28/14	Dry	3.30	0	60-80	20-40
9/9-11/14	Dry	6.44	0-1	50-89	10-50
12/8-12/14	Wet	1.76	0	60-98	2-40
12/16-18/14	Wet	2.94	0	60-100	1-40
1/28-30/15	Wet	4.98	0	75-99	1-25

[1]Quantity estimated by spreading out the material collected into a uniform thickness and measuring length x width x depth
[2]Debris composition percentages estimated based on visual assessment

Particulate matter (PM) consisting of road sediment/sand/gravel were randomly sampled from the material collected and taken to the University of Hawaii at Manoa Agricultural Diagnostic Service Center for nitrogen and phosphorus analysis. The nitrogen content of the samples varied from 0.001% to 1.99% of total weight with an average concentration of 0.0017 lb-N/lb-PM. The phosphorus content of the samples varied from 0.07% to 0.16% with an average concentration of 0.0012 lb-P/lb-PM, respectively.

Organic matter (OM) was also extracted from the material collected and taken to the University of Hawaii at Manoa Agricultural Diagnostic Service Center for nitrogen and phosphorus analysis. The nitrogen content of the samples varied from 0.22% to 2.40% of the total weight. The average nitrogen content of all OM collected was 0.0102 lb-N/lb-OM. The phosphorus content of the samples varied from 0.04% to 0.34% of the total weight. The average phosphorus content of all OM collected was 0.0013 lb-P/lb-OM.

EPA bulk density conversion factors were determined for “gravel” + “sand” + “soil” (for sediment) and “compost” (for green waste) (www.epa.gov/osw/conserve/smm/wastewise/pubs/conversions.pdf).

TN and TP load reductions were estimated from the measured concentrations along with the bulk density conversion factors according to the following equations:

TN Load Reduction [lb/sweep] = $(V_{TOTAL} * F_{G+S+S} * W_{G+S+S} * N_{PM}) + (V_{TOTAL} * F_{OM} * W_{COMPOST} * N_{OM})$, where:

V_{TOTAL} = Total volume of material collected (CY)

F_{G+S+S} = Estimated fraction of gravel + sand + sediment by volume based on visual assessment (%)

F_{OM} = Estimated fraction of organic material by volume based on visual assessment (%)

W_{G+S+S} = Average bulk density conversion factor for gravel, sand, and sediment (2,466 lbs/CY)

$W_{COMPOST}$ = Bulk density conversion factor for green waste (360 lbs/CY)

N_{PM} = Nitrogen content of particulate matter (gravel, sand, and sediment) (lb-N/lb-PM)

N_{OM} = Nitrogen content of organic matter (green waste) (lb-N/lb-OM)

TP Load Reduction [lb/sweep] = $(V_{TOTAL} * F_{G+S+S} * W_{G+S+S} * P_{PM}) + (V_{TOTAL} * F_{OM} * W_{COMPOST} * P_{OM})$, where:

V_{TOTAL} = Total volume of material collected (CY)

F_{G+S+S} = Estimated fraction of gravel + sand + sediment by volume based on visual assessment (%)

F_{OM} = Estimated fraction of organic material by volume based on visual assessment (%)

W_{G+S+S} = Average bulk density conversion factor for gravel, sand, and sediment (2,466 lbs/CY)

$W_{COMPOST}$ = Bulk density conversion factor for green waste (360 lbs/CY)

P_{PM} = Phosphorus content of particulate matter (gravel, sand, and sediment) (lb-P/lb-PM)

P_{OM} = Phosphorus content of organic matter (green waste) (lb-P/lb-OM)

A summary of the computations is provided in Table 5.

Table 5: Summary of Street Sweeping Pilot Study Load Reductions

Date	Qty (CY)	Material Collected	Bulk Density (lb/CY)	Concentration (lb/lb)		Qty Removed (lb/sweep)	
				TN	TP	TN	TP
9/25-27/13	5.26	Gravel+Sand+Sediment	2,466	0.0015	0.0011-0.0012	20.74	12.36
		Green Waste	360	0.0085-0.0187	0.0010-0.0013		
10/1/13	3.80	Gravel+Sand+Sediment	2,466	0.0005	0.0015	5.61	12.24
		Green Waste	360	0.0079	0.0014		
11/12-22/13	7.55	Gravel+Sand+Sediment	2,466	0.0003-0.0023	0.0012-0.0014	15.74	20.67
		Green Waste	360	0.0057-0.0176	0.0011-0.0016		
1/28/14	0.81	Gravel+Sand+Sediment	2,466	0.0199	0.0012	34.20	2.10
		Green Waste	360	0.0048	0.0011		
4/1-2/14	10.51	Gravel+Sand+Sediment	2,466	0.0001-0.0009	0.0011-0.0016	17.39	28.61
		Green Waste	360	0.0068-0.0240	0.0009-0.0012		
5/19-22/14	5.49	Gravel+Sand+Sediment	2,466	0.0004-0.0020	0.0008-0.0011	15.03	8.83
		Green Waste	360	0.0053-0.108	0.0004-0.0012		
7/25-28/14	3.30	Gravel+Sand+Sediment	2,466	0-0.0002	0.0012-0.0014	5.15	8.52
		Green Waste	360	0.0079-0.0207	0.0010-0.0018		
9/9-11/14	6.44	Gravel+Sand+Sediment	2,466	0.0002-0.0012	0.0009-0.0013	19.18	12.86
		Green Waste	360	0.0080-0.0173	0.0008-0.0014		
12/8-12/14	1.76	Gravel+Sand+Sediment	2,466	0.0004-0.0015	0.0011-0.0014	4.64	3.81
		Green Waste	360	0.0103-0.0153	0.0013-0.0026		
12/16-18/14	2.94	Gravel+Sand+Sediment	2,466	0.0014-0.0049	0.0014-0.0016	20.58	8.85
		Green Waste	360	0.0035-0.0185	0.0011-0.0019		
1/28-30/15	4.98	Gravel+Sand+Sediment	2,466	0.0005-0.0022	0.0007-0.0011	20.50	10.65
		Green Waste	360	0.0022-0.0061	0.0007-0.0013		

[1]Kaneohe Routes 2A and 2B (Halekauwila, Kapuna Hala, Keapuka, Hale Kou) are typically swept on Tuesdays; Route 5 (Puohala Village) is typically swept on Fridays

The street sweeping pilot study will continue through the end of calendar year 2016 (CY16). Throughout this period, the total volume of material collected and the estimated debris composition will be tracked for each street sweeping cycle. In addition, laboratory analysis for the nutrient content of the particulate fraction and organic fraction of the material collected from street sweeping will be conducted.

Based on the data collected thus far, it is estimated that each monthly street sweeping cycle is anticipated to reduce TN loadings by 16-19 lbs and TP loadings by 12-14 lbs. On average, 3-4 lbs of TN and 2-3 lbs of TP are removed per cubic yard of street sweeping debris collected.

This activity will occur approximately three to four times during the wet season and once or twice during the dry season. In the event the street sweeping equipment is out of commission for an extended period of time, the baseyard will borrow equipment from another baseyard to ensure the removal from this activity is sufficient to meet the City's WLA.

The seasonal removal quantity will be measured based on the City's fiscal year which begins on July 1st of each year. Data collected from each street sweeping cycle will be tallied and the running total will be measured against seasonal metrics to determine if collections are on target to meet the TN and TP reduction goals for the season. If, at any time, the actual collections fall short of the estimates and it appears that routine street sweeping operations scheduled for the remainder of the season are not sufficient to meet the reduction goals, additional activities including drain cleaning will be conducted.

4.2.2 Pump Station Maintenance

There are two Collection System Maintenance (CSM) Division pump stations within the Kaneohe watershed that pump sewage to the Kailua Wastewater Treatment Plant. The Waikalua Pump Station, located at 45-044 Holowai Place (0.12 acres), and the Halekou Pump Station, located at 45-309 Kahiko Street (0.15 acres) are operated and maintained by the CSM Division of the ENV. The sites are unmanned and closed at all times except during routine inspection which occurs daily, seven days a week. Routine maintenance operations occur once a week. Each site is gated and consists of a pump station building, fuel storage tanks, a driveway, and paved parking areas.

The City currently has a landscape maintenance contractor perform regular monthly maintenance on the property grounds. However, maintenance records detailing the specific composition of the debris removed from the site were not available, and therefore estimations regarding pollutant removal cannot be made at this time.

4.2.3 Maintenance of Storm Drainage System

Within the Kaneohe Stream watershed, the City currently owns approximately 425 inlets (catch basins and grated inlets), 160 manholes, and nearly 54,000 linear feet of ditches, drainage pipes, and box culverts. The City routinely inspects its drainage facilities once every five years (once per permit term) and cleans all structures that are at least 50% full. Cleaning is performed more frequently if complaints are received. The City will continue this routine maintenance through the end of the permit term (2020).

It is not anticipated that annual or seasonal drain cleaning will be required to meet the City's TN or TP reduction goals. However, if it is determined that additional reductions are required, the City will implement drain cleaning on an as needed basis to supplement the regularly scheduled good housekeeping activities. The methodology to estimate pollutant removals will be similar to that presented for street sweeping. Consequently, similar data will be tracked, including total volume of material collected and debris composition.

The City also owns over 160 outfalls within the watershed boundary. Most outfalls discharge to hardened channels with little or no potential for erosion prevention improvement. Therefore, outfall improvements were not evaluated for this I&M Plan, but may be considered for future projects.

4.3 Water Quality Improvement Projects

4.3.1 Kaneohe Stream Bank Repair (DDC-CD Job No. 37-10)

An evaluation of erosion prone areas conducted by the City ENV in 2011 identified an erosion problem along Kaneohe Stream fronting a residence at 45-185 Wena Street (adjacent to Bay View Golf Course) (see Figure 4). The existing rock revetment was undermined and a portion had collapsed into the stream. The City Department of Design and Construction (DDC) sought emergency funds to replace the bank lining with a gabion mattress (see Figure 5). Had the slope protection not been restored, the bare slope would have continued to erode.

Figure 4: Before Condition – Erosion Damage at Kaneohe Stream

Figure 5: After Condition with Gabion Mattress

Estimated pollutant reductions from this project are based on the soil erosion prevention applied to the area. The Universal Soil Loss Equation (USLE)(DPP, 1999) used to estimate soil losses and runoff from the Kaneohe Stream bank in the vicinity of Wena Street is expressed as follows:

Long-term average annual soil loss, A [lbs/acre/season] = R * % cum * K * LS * C * P * 2000, where:

R = Rainfall Erosivity Factor (375)

% cum = Percent of Erosive Rainfall Accumulation for Windward Oahu (0.261 for dry season, 0.739 for wet season)

K = Soil Erodibility Factor (0.17)

LS = Slope-Length/Slope-Gradient Factor (9.06)

C = Cover and Management Factor (0.15)

P = Erosion Control Practice Factor (1.0)

The nutrient content of the estimated annual soil loss is based on laboratory analysis of sediment and dirt samples collected in the project vicinity.

TN Load Reduction [lb] = A * A_{TOTAL} * $N_{SEDIMENT}$, where:

A = Long-term Average Annual Soil Loss (lbs/acre/season)

A_{TOTAL} = Project Area (0.026 acre)

$N_{SEDIMENT}$ = Nitrogen content of gravel and sediment (0.00227 lb-N/lb-PM)

TP Load Reduction [lb] = A * A_{TOTAL} * $P_{SEDIMENT}$, where:

A = Long-term Average Annual Soil Loss (lbs/acre/season)

A_{TOTAL} = Project Area (0.026 acre)

$P_{SEDIMENT}$ = Phosphorus content of gravel and sediment (0.00108 lb-N/lb-PM)

A summary of the computations is provided in Table 6.

Table 6: Summary of Kaneohe Stream Bank Repair Load Reduction Computations

Season	Annual Soil Loss, A (lbs/ac/season)	Sediment Concentration		Area (acre)	Qty Removed	
		(lb-N/lb-PM)	(lb-P/lb-PM)		TN (lb/season)	TP (lb/season)
Wet	128,048	0.00227	0.00108	0.026	7.6	3.6
Dry	45,224	0.00227	0.00108	0.026	2.7	1.3
Annual Total					10.3	4.9

The City will conduct routine inspections to ensure that the site is properly stabilized and the gabion structure is properly maintained to prevent soil loss along the stream bank. This will enable the City to continue to account for the on-going TN and TP pollutant reductions at this.

4.3.2 Kaneohe Stream Bank Restoration

The City DDC is considering implementing mitigation measures to repair eroding stream bank segments along Kaneohe Stream adjacent to Keneke Street between Kamehameha Highway and Likelike Highway (see Figures 6 and 7). The project may also include restoring damaged areas of the stream invert and/or lining troubled areas of the stream bank. The project is currently under discussion between DDC and DOH. At the time of this writing, details on the specific improvements to be implemented were not available, and therefore, an erosion mitigation quantity could not be estimated.

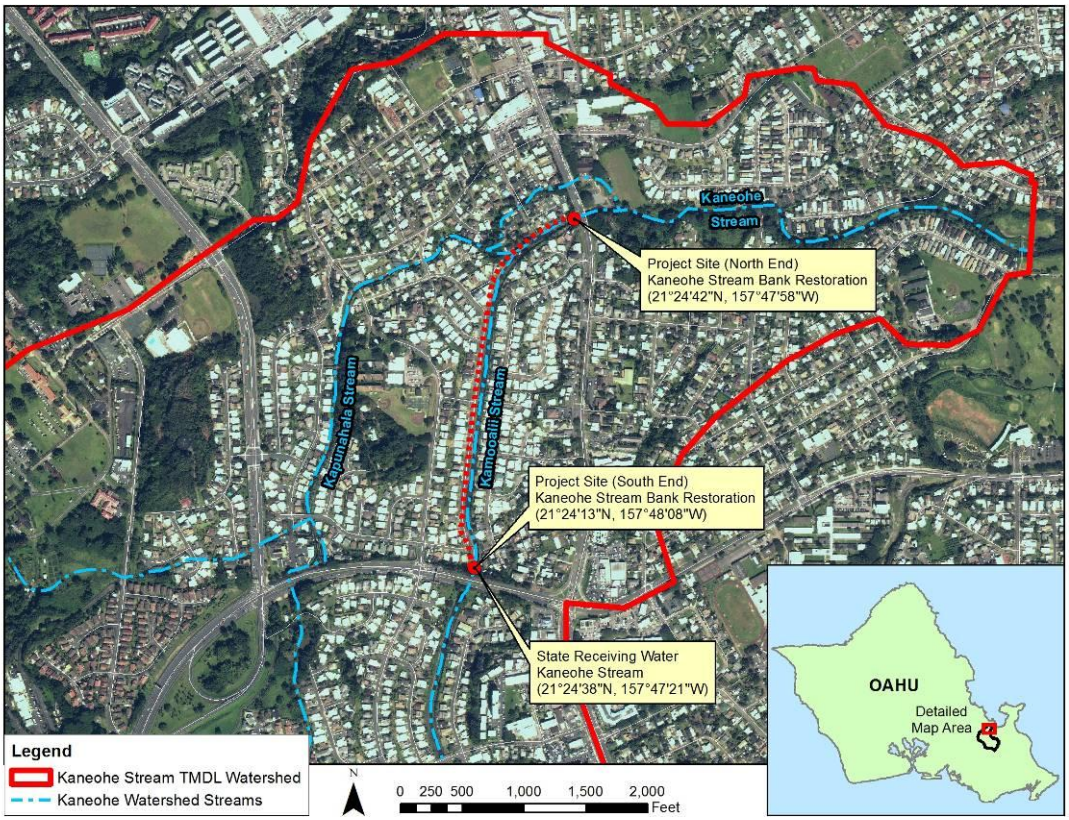

Figure 6: Kaneohe Stream Bank Restoration Project Limits

Figure 7: Typical Erosion Areas along Kaneohe Stream Bank

4.4 Permanent BMP

It is not anticipated that permanent BMPs will be required to meet the nutrient load reductions; however, if it becomes necessary to further reduce pollutant loads, the City will consider permanent BMP options which include retrofitting outfalls with sediment capture devices and/or installing catch basin inserts in strategic locations. The decision to implement permanent BMPs will be made after the results of FY17 debris collection data is compiled and analyzed. If required, a revised I&M Plan will be submitted to the DOH by the end of FY18. Additional details on the implementation timeline are provided in Section 5.0.

4.5 Summary of BMP Activities

The following table summarizes the estimated effectiveness of the various BMP activities to be implemented by the City.

Table 7: Summary of BMP Activities and Quantitative Reductions

	TN Reduction (lbs/season)		**TP Reduction (lbs/season)**	
	Wet Season	Dry Season	Wet Season	Dry Season
Downspout Disconnect	*	*	*	*
Homeowner Outreach/Volunteer Cleanup	*	*	*	*
Street Sweeping	75.2	32.8	49.6	27.4
Water Quality Improvement Projects	7.6	2.7	3.6	1.3
Storm Drain Maintenance	**	**	**	**
TOTAL REMOVED	82.8	35.5	53.2	28.7
REDUCTIONS REQUIRED	28.2	19.0	52.6	27.0

* The City will conduct a public education and outreach program to all homeowners within the watershed; however, due to difficulty in quantifying pollutant load reductions due to behavior changes, no homeowner contribution is assumed for accounting purposes at this time.

** Cleaning of storm drains and drainage structures will be implemented only if collections from other activities are less than anticipated and the City needs additional reductions to meet the load reduction goals for a particular season. Storm drain cleaning may also be done in lieu of additional street sweeping activities based on scheduling and equipment availability.

4.6 Summary of Activities to be Tracked

The City will meet the TN and TP load reduction goals during the wet and dry seasons by employing a combination of street sweeping and on-going maintenance at erosion control stabilization sites.

The City intends to continue routine street sweeping within the residential areas of the Kaneohe Stream watershed indefinitely. The quantity of material collected, the debris composition, and the laboratory analysis of the particulate and organic matter will continue through the end of the street sweeping pilot study (December 2016). At the conclusion of the pilot study, laboratory analysis for the nutrient content of the collected material will cease and the three years of data will be averaged to determine estimated removal rates going forward. The quantification of the material removed and estimation of debris composition will continue until the end of FY17. After that date, the City will utilize the historical data to determine the basic level of street sweeping activities necessary to meet the pollutant load reduction goal and ultimately the City's WLA.

The City will also continue to maintain the Kaneohe Stream Bank gabion mattress site. Maintenance activities will include periodic inspections to verify the integrity of the gabion baskets and filter fabric and clear debris. The site will also be inspected for damage following periods of heavy rainfall. If repairs are required, they will be conducted at that time.

If the combination of all of the proposed activities results in less collections than required, the City will reevaluate the program. Depending on the findings, this may result in implementing additional program elements, including identifying opportunities for permanent BMP development.

5.0 Compliance Schedule

The achievement of the City's WLA for the Kaneohe Stream will occur over a period of three and a half years with a final compliance deadline of December 31, 2018. Based on historical collections, it is anticipated that a combination of street sweeping and continued maintenance of the Kaneohe Stream bank will collect or prevent the discharge of sediment and organic matter in sufficient quantity to meet the seasonal TN and TP reduction goals.

If it is determined that significantly more activities are required to meet the target reductions and the City is unable to meet the WLA by the compliance deadline, the City will work with the appropriate agency to reevaluate the program. Depending on the findings, this may result in implementing additional program elements or reevaluating the current conditions to determine if the characteristics of the MS4 discharges have changed. In accordance with these modifications, the City will submit a revised I&M Plan in FY18 and request a modification to the final compliance deadline. The revised plan will outline the additional activities the City plans to implement to achieve the WLA and include a timeline for implementation. The proposed implementation schedule is shown in the following table.

Table 8: Schedule of Compliance

Due No Later Than:	Milestone / Deliverable
June 30, 2015	• Submit I&M Plan per Part F.3.a • Continue 3-yr street sweeping pilot study (quantity of material collected, debris composition, and TN/TP analysis)
June 30, 2016	• Continue 3-yr street sweeping pilot study (quantity of material collected, debris composition, and TN/TP analysis)
December 31, 2016	• Complete street sweeping pilot study (TN/TP analysis) • Continue numerical tracking of GH activities (quantity of material collected and debris composition)
June 30, 2017	• Complete numerical tracking of GH activities (quantity of material collected and debris composition)
December 31, 2017	• Submit street sweeping pilot study report and provide summary of street sweeping material analyzed during pilot study
June 30, 2018	• Complete analysis of GH numerical tracking data to determine basic level of activities necessary, and • If additional activities are required, submit revised I&M Plan which outlines additional activities to be implemented[1]
December 31, 2018	FINAL COMPLIANCE DEADLINE • Submit final report detailing how compliance with WLA reductions was achieved and will be maintained

[1]Other activities are defined as other municipal and public participation maintenance activities such as drain cleaning, volunteer cleanups, regulatory compliance and enforcement policies, homeowner involvement, downspout disconnections, structural retrofits and other structural BMP measures

After the final compliance deadline, the City's compliance will be based on fulfilling the basic level of activities determined to be necessary to meet the pollutant load reduction.

Ultimately, it is the City's goal to contribute to good stewardship of the land and ensure that water quality in and around the island of Oahu is safe and useable for all intended purposes. These activities are proposed to aid in achieving this goal.

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