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Waste Load Allocation Completion Report for the North Fork of Kaukonahua Stream, Monitoring for Mid-May 2015 through December 2015

Joint Base Pearl Harbor-Hickam, Wahiawa Annex Wahiawa, Oahu, Hawaii

Note: Portions of this Plan have been redacted due to National Security concerns

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Table of Contents

Section **Page**

1 Introduction 1-1

1.1 Project Objective 1-1
1.2 Site Location 1-1
1.3 Land Use and Existing BMPs 1-2
1.4 Background of Upper Kaukonahua Stream TMDLs 1-3
1.5 Summary of Previous Monitoring Work 1-6

2 Installation of Monitoring Equipment 2-1

2.1 Installation of Cutthroat Flume and Pressure Transducers 2-1
2.2 Installation of Automated Samplers 2-2
2.3 Installation of Tipping Rain Gauges 2-2

3 Sample Collection and Analysis 3-1

3.1 Sample Collection Method 3-1
3.2 Field Equipment 3-1
3.3 Field Logbook and Chain-of-Custody Forms 3-2
3.4 Sample Handling and Shipping 3-2
3.5 Laboratory Analysis 3-3

4 Monitoring Results 4-1

4.1 Rainfall Monitoring Data 4-1
4.2 Water Quality Monitoring Data 4-1
4.3 Stormwater Runoff Flow Volume Monitoring Data 4-3

5 Turbidity and Total Nitrogen Load Calculation 5-1

5.1 TMDL Calculation Methodology 5-1
5.2 Flow Calculations 5-1
5.3 Load Calculations 5-1

6 Conclusions and Recommendations 6-1

6.1 Conclusions 6-1
6.2 Recommendations 6-1

7 References 7-1

List of Tables

Table 1-1: Land Use Categories for North Fork of Kaukonahua Stream Watershed (DOH 2009) 1-4
Table 1-2: Numeric WLAs for Total Nitrogen (lbs/day) Based on Flow Curve Intervals 1-5
Table 1-3: Numeric WLAs for Turbidity (NTU-tons/day) Based on Flow Curve Intervals ... 1-5
Table 1-4: JBPHH-Wahiawa Annex MS4 – Summary of Numeric WLAs Based on Flow Curve Intervals 1-6
Table 1-5: Summary of Measured and Sampled Flow Events in 2011 1-7
Table 1-6: Summary of Results of Measured and Sampled Flow Events in 2011 1-7
Table 3-1: Analytical Methods Information 3-3
Table 4-1: Monthly Rainfall Measured at JBPHH Wahiawa Annex 4-1
Table 4-2: Turbidity and Total Nitrogen Levels Measured in NSW-1 and NSW-2 in 2015 .. 4-2
Table 6-1: Total Monitored Mass of Sediment and Nitrogen Leaving JBPHH Wahiawa Annex in 2015 6-1

List of Figures

Figure 1-1: Site Location [Redacted due to national security concerns]..... 1-8
Figure 1-2: JBPHH Wahiawa Annex Overall Drainage Map [Redacted due to national security concerns]..... 1-10
Figure 1-3: Location of JBPHH Wahiawa Annex and USGS North Fork Kaukonahua Monitoring Station 1-12
Figure 1-4: JBPHH Wahiawa Annex Drainage Area to North Fork of Kaukonahua Stream [Redacted due to national security concerns]..... 1-14

List of Appendices

Appendix A: Summary of Site Visits to JBPHH-Wahiawa Annex in 2015
Appendix B: Rating Table for Cutthroat Flume
Appendix C: Summary of Monitored Stormwater Runoff Events
Appendix D: Field Logbook
Appendix E: Hourly Rainfall Amounts (Hundredth of Inches) and Runoff Tracker for JBPHH-Wahiawa Annex
Appendix F: Field and Laboratory Water Quality Parameters
Appendix G: Daily Turbidity and Total Nitrogen Loads Calculated for Days of Measurable Runoff Compared to Kaukonahua TMDL Criteria

List of Acronyms

BMP	best management practice
^{o}C	degrees Celsius
CCH	City and County of Honolulu
cfs	cubic feet per second
COC	chain-of-custody
CTO	Contract Task Order
DL	detection limit
DO	dissolved oxygen
DOH	State of Hawaii Department of Health
E2	Element Environmental, LLC
EPA	Environmental Protection Agency, United States
ERDC	Engineer Research and Development Center
gpm	gallons per minute
H_2SO_4	sulfuric acid
JBPHH	Joint Base Pearl Harbor-Hickam
LLC	Limited Liability Company
mg/L	milligrams per liter
mL	milliliter
mS/cm	millisiemens per centimeter
MS4	Municipal Separate Storm Sewer System
NAVFAC	Naval Facilities Engineering Command
NCTAMS	Naval Computer and Telecommunications Area Master Station
ND	non-detect
NSW	NCTAMS Stormwater
NTU	Nephelometric Turbidity Unit
ppm	parts per million
PPV	public-private venture
PVC	polyvinyl chloride
SIC	Standard Industrial Classification
SOW	Statement of Work
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TSS	Total Suspended Solids
US	United States
USGS	United States Geological Survey
WLA	waste load allocation
WP	Work Plan
WQLS	water quality limited segment

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Executive Summary

This report summarizes the stormwater monitoring results collected at the Joint Base Pearl Harbor-Hickam (JBPHH)-Wahiawa Annex from mid-May to the end of December 2015. The monitoring work was conducted to comply with terms of National Pollutant Discharge Elimination System (NPDES) Permit No. HI S000257 for the Navy's municipal separate storm sewer system (MS4). The JBPHH-Wahiawa Annex was formerly known as Naval Computer and Telecommunications Area Master Station Pacific (NCTAMS PAC).

This permit requires compliance with Total Maximum Daily Loads (TMDLs) developed by the State of Hawaii, Department of Health (DOH) for the 3,651-acre watershed that contributes to the North Fork of Kaukonahua Stream (DOH, 2009). Stormwater runoff from approximately 55-acres of land within the JBPHH-Wahiawa Annex that flows towards the North Fork of Kaukonahua Stream. The DOH further defined Waste Load Allocations (WLAs) for the Navy lands that contribute runoff to the North Fork of Kaukonahua Stream with the goal of waste load reductions for turbidity in the wet and dry seasons and total nitrogen (TN) in the wet season. The Permit also requires that the Navy identify specific activities targeted to reducing turbidity and TN discharges to Kaukonahua Stream.

The Navy submitted an Implementation Plan to DOH in January 2011 that described the extent of the sampling program and the type of flow, sediment, and nutrient data to be collected to measure compliance with the TMDL load reductions developed by DOH (ERDC 2011). During the current effort, the Navy conducted water quality monitoring for TN, turbidity and Total Suspended Solids (TSS) (turbidity is used for a surrogate for TSS) from mid-May to the end of December 2015 at two monitoring locations (NSW-1 and NSW-2). The monitoring collected representative runoff generated from residential and undeveloped sub-catchments within the approximately 55-acre portion of the JBPHH-Wahiawa Annex that potentially contributes runoff to the North Fork of Kaukonahua Stream. A total of 85 stormwater samples were collected from these two monitoring sites during this 7.5-month time period.

The volume of runoff at the two monitoring locations was measured using pressure transducers installed in a cutthroat flume and drainage culvert. Rainfall falling within the contributory watersheds was monitored with two tipping rain gauges located near to the two monitoring locations. The results from the 2015 stormwater monitoring were used to calculate the existing pollutant and nutrient loads from the JBPHH-Wahiawa Annex during both the wet and dry seasons.

During the May to December 2015 monitoring period, the following general observations were made:

1) The current monitoring period was anomalously wet compared to historic rainfall averages (157% of normal rainfall, see Table 1) due to El Niño conditions.

2) Measurable runoff occurred during 5.7% of the time (315 hours) at the residential monitoring site NSW-1 and 2.8% of the time (156 hours) at the undeveloped area monitoring site NSW-2.

3) The residential monitoring site (NSW-1) captures runoff from approximately 6-acres of the residential areas within JBPHH-Wahiawa Annex that potentially contribute runoff to the North Fork of Kaukonahua Stream. It is estimated that this monitoring site records

approximately 33% of the total runoff from residential areas within JBPHH-Wahiawa Annex.

4) The undeveloped monitoring site (NSW-2) captures runoff from approximately 4-acres of the undeveloped areas within JBPHH-Wahiawa Annex that potentially contribute runoff to the North Fork of Kaukonahua Stream. It is estimated that this monitoring site records approximately 33% of the total runoff from undeveloped areas within JBPHH-Wahiawa Annex.

5) The total estimated volume of stormwater leaving JBPHH-Wahiawa Annex to the North Fork Kaukonahua stream (~4.2 million gallons (MG)) is about 0.069% of the total stream flow (6,183 MG) measured at the United States Geological Survey (USGS) gauging station on the North Fork of Kaukonahua Stream (162000000) during the monitoring period.

6) Measurable runoff occurred on 62 days during the 231-day long monitoring period. The daily turbidity TMDL was exceeded on 17 of these days, mostly related to large Kona storm events that occurred during the anomalously wet summer months of 2015. The total nitrogen TMDL was not exceeded during the 2015 monitoring period

The mass of nitrogen that was transported by stormwater from the 55-acre JBPHH-Wahiawa Annex facility is insignificant (~3.3 kilogram over the 7.5-month monitoring period) and implementation of additional BMPs is not required. The total mass of sediments leaving the installation is also quite low (~245 kilogram over the 7.5-month monitoring period) but could be further reduced by implementation of the following two Best Management Practices (BMPs):

1) Establish additional grass in the eastern portion of the installation on bare or poorly grassed areas where erosion is apparent and/or indicated by the watershed model, particularly where the antennas are located.

2) Install synthetic erosion control material (such as Curlex) or staple geotextile fabric material at locations where storm drain outlet pipes or concentrated overland flow discharge to land surface at the top of the bluff on the edge of the forested area.

1 Introduction

The following waste load allocation (WLA) completion report presents the results of stormwater monitoring conducted at the Joint Base Pearl Harbor-Hickam (JBPHH) Wahiawa Annex on the island of Oahu, Hawaii, from mid-May 2015 to the end of December 2015. Stormwater that leaves a 55-acre portion of JBPHH Wahiawa Annex reaches the North Fork of Kaukonahua Stream. The technical approach used by the Navy to evaluate compliance with the Total Maximum Daily Loads (TMDLs) established by the State of Hawaii Department of Health (DOH) for the former Naval Computer and Telecommunications Area Master Station (NCTAMs), located at the JBPHH Wahiawa Annex (DOH 2009) are utilized in this report. The work was conducted in accordance with the Amendment 24 Statement of Work (SOW) entitled "*2014-2015 TMDL Storm Water Monitoring at North Fork of Upper Kaukonahua Stream, Navy Region Hawaii, JBPHH Wahiawa Annex*" dated 3 May 2014, of Contract Number N62742-12-D-1820, Contract Task Order (CTO) 0018.

1.1 Project Objective

The objective of this WLA completion report was to evaluate whether pollutant and nutrient loads within stormwater runoff exiting the JBPHH Wahiawa Annex installation comply with the TMDLs established by DOH for the North Fork of Upper Kaukonahua Stream (DOH 2009). These specific TMDLs establish the maximum rate at which the Upper Kaukonahua Stream can receive nutrients or sediments from various permitted entities located in the watershed without exceeding the State's water quality standards. The general methodology employed by the Navy for monitoring TMDL compliance at the JBPHH Wahiawa Annex was described in an implementation work plan (WP) that was submitted to DOH in January 2011 (Engineer Research and Development Center [ERDC] 2011). This document detailed the Navy's general approach for collection of stormwater flow and water quality data that would allow evaluation of compliance with the TMDL load reductions developed by DOH from the small acreage of land (~55 acres) within the JBPHH Wahiawa Annex that contributes runoff to the North Fork of Upper Kaukonahua Stream.

1.2 Site Location

The project site is located in central Oahu (Figure 1-1[Redacted due to national security concerns]). The JBPHH Wahiawa Annex is located approximately one-half mile north of the mauka portion of the town of Wahiawa and one mile northeast of the town of Whitmore Village. This study evaluated stormwater runoff generated from approximately 55-acres of residential and undeveloped land located within the southeastern corner of the JBPHH Wahiawa Annex that is located within the watershed for the North Fork of Kaukonahua Stream (Figure 1-2[Redacted due to national security concerns]). Figure 1-2 [Redacted due to national security concerns] shows the locations of the two stormwater runoff monitoring sites and the two tipping rain gauges installed and utilized during this study. Monitoring station NSW-1 [Coordinates redacted due to national security concerns] is located at the largest storm drain outlet serving the nearby residential houses and streets and was deemed representative of discharges from residential areas within JBPHH Wahiawa Annex that flow towards the north fork of Kaukonahua Stream. Monitoring station NSW-2 [Coordinates redacted due to national security concerns] is located in the drainage swale at the beginning of the culvert draining the antennae field on the undeveloped southeastern

side of JBPHH Wahiawa Annex, and is representative of discharges from undeveloped lands within the installation that flow towards the north fork of Kaukonahua Stream.

The Kaukonahua Stream watershed is bordered by the Poamoho watershed to the north, to which runoff generated from the remaining 650 acres of the JBPHH Wahiawa Annex facility flows. The eastern fringes of the Kaukonahua Stream watershed drain the leeward face of the Koolau Mountain Range towards central Oahu where it enters Lake Wilson and ultimately flows to Kaiaka Bay on the North Shore of Oahu. Kaiaka Bay has long been identified as a WQLS and is currently listed under the State's Section 303(d) as a water body in which water quality is impaired by excessive nutrients and turbidity. In addition, there have been numerous public complaints regarding nuisance odors, poor agricultural water quality, and overall concern for water quality in Kaiaka Bay. Figure 1-3 shows the location of the United States Geological Survey gauging station (USGS Gauge 16200000) on the North Fork of Kaukonahua Stream that was used by DOH to establish the TMDLs. The data from this station was used in this study to characterize individual flow events at monitoring locations NSW-1 and NSW-2 as being associated with either High, Elevated, or Stable Flow for the purpose of assessing compliance with the TMDL.

Figure 1-4 [Redacted due to national security concerns] shows the various drainage watersheds, storm drains and the few industrial locations within JBPHH Wahiawa Annex.

1.3 Land Use and Existing BMPs

The portion of the JBPHH Wahiawa Annex installation evaluated in this study is dominated by two land uses: residential housing and undeveloped areas, which covers approximately 25 acres and 30 acres of the study area, respectively. The residential housing is a combination of relatively new, townhouse-type housing units (less than 10 years old) and associated streets and sidewalks that were constructed by Forest City in the middle of the project site, and older, more sparse military single-family housing units located near the western end of the project site. The public-private venture (PPV) manager of the residential units at the JBPHH Wahiawa Annex facility, Hunt MH Property Managers, LLC, currently performs the day-to-day management of the residential properties within the project site. Monitoring site NSW-1 collects runoff from the rooftops, roadways, and sidewalks of the new housing units and is considered representative of runoff generated from residential sections of the project site.

The remainder of the project site is comprised of relatively undeveloped land that is both covered in grass and trees in the vicinity of the residential areas and bare in the vicinity of the antennae field located at the eastern, mauka portion of the project site. A few minor industrial activities are located in this largely undeveloped portion of the project site, including Building 466, the Wahiawa Fire Station, and a cluster of three buildings (Buildings 393, 423, and 439) associated with the automotive hobby shop (Figure 1-4 [Redacted due to national security concerns]). The primary Standard Industrial Classification (SIC) code for the auto hobby shop buildings are considered to be recreational, though the facility does have limited industrial-type activities. The majority of the activities occur under cover, with some runoff generating from a paved area to the north of the facility and a small corner of the roofed area to the south of the facility. Some vehicle maintenance and washing may occur at the fire station. The majority of the runoff will most likely saturate into the ground in the vicinity of the buildings; however, if it rains very hard, runoff may also reach behind the building.

Facility 403 is an antenna rosette, which consists of a series of wooden poles that support suspended wiring and is located adjacent to the drainage area for monitoring site NSW-2. Due to the low density of buildings and activities in the eastern portion of the project site, these areas are considered undeveloped in this report and the water quality data collected from NSW-2 reflects the aggregate water quality generated from these largely undeveloped lands.

Hunt MH Property Managers, LLC currently utilizes the following best management practices (BMPs) to minimize the pollutant loads leaving the residential properties they manage.

1. Quarterly street sweeping of the residential portions of the installation
2. Educational programs for residents (e.g., community handbooks, newsletters, stormwater brochures, etc.)
3. Installing dog park signage and providing bags for pet waste collection
4. Fertilizer use on lawns in residential area is maintained by Navy personnel and residents
5. Stenciling of storm drain inlets in the new residential section of the installation
6. Controlling feral animal populations

1.4 Background of Upper Kaukonahua Stream TMDLs

A 1996 water quality assessment conducted by DOH identified the entire Kiikii Stream System, which includes the lower and upper sections of Kaukonahua Stream, Wahiawa Reservoir, and Poamoho Stream, as well as the adjacent Paukauila Stream System, as being impaired by excessive nutrients and turbidity. The streams in these watersheds drain into Kaiaka Bay, previously identified by the State as a water quality limited segment (WQLS), leading to this marine water body being listed under Section 303(d) as a water body in which water quality is impaired by excessive nutrients and turbidity. The Clean Water Act requires that once a state identifies a WQLS, it must promulgate TMDLs for each water body on the Section 303(d) list. A TMDL is the maximum amount of a given pollutant (Total Nitrogen [TN] and turbidity, in this case) that may be discharged or “loaded” into a WQLS without violating State water quality standards.

The DOH conducted an analysis of pollutant load distributions and resulting water quality in the North and South Forks of Upper Kaukonahua Stream (DOH 2009). A total of 58 baseline stream sampling events were conducted from the streams in the watershed between 2004 and 2008, and storm event samples were collected from the streams from 2007 to 2008 using automated samplers. The TMDL included calculations of water body pollutant loadings and their allocations to identified pollutant sources such that water quality standards for TN and turbidity in these two stream segments would be achieved. The TMDL designated load reductions for landowners in the watershed that have a Municipal Separate Storm Sewer System (MS4) permit. For the North Fork of Kaukonahua Stream, the only landowners identified by DOH were 43 acres of urban land owned by the Navy (JBPHH Wahiawa Annex) and 77 acres of urban land under the jurisdiction of the City and County of Honolulu (CCH). The CCH developed an implementation plan for the small portion of land covered by their MS4 permit, which comprises approximately 2.11% of the 3,651-acre North Fork of the Kaukonahua Stream watershed (CCH 2012). The portion of the JBPHH Wahiawa Annex facility located within the North Fork of Kaukonahua Stream watershed covers approximately 1.18% of this watershed. The vast majority of the watershed that contributes runoff to the North Fork of Kaukonahua Stream (93.84%) consists of conservation

land (DOH 2009). Figure 1-3 and Table 1-1 below shows the various land use categories assigned within the watershed.

Table 1-1: Land Use Categories for North Fork of Kaukonahua Stream Watershed (DOH 2009)

Land Use Category	North Fork of Kaukonahua Stream Watershed	
	Acres	Percentage of Land Area
Urban Navy	43	1.18%
Urban CCH	77	2.11%
Urban Subtotal	*120*	*3.29%*
Restricted Agriculture	85	2.33%
Military Reserve	20	0.55%
Agriculture Subtotal	*105*	*2.88%*
Conservation Subtotal	*3,426*	*93.84%*
Total	**3,651**	**100%**

DOH established a total of four TMDLs for the North and South Forks of Upper Kaukonahua Stream. The WLAs for TN and turbidity developed by DOH based on Receiving Water Flow Curve Intervals during the Wet and Dry Seasons, as applicable, established for the North Fork of Kaukonahua Stream are compiled in Tables 1-2 and 1-3, respectively. The WLAs determined by DOH for the JBPHH Wahiawa Annex MS4 are summarized in Table 1-4.

Table 1-2: Numeric WLAs for Total Nitrogen (lbs/day) Based on Flow Curve Intervals

Receiving Water Flow Curve Intervals[1, 2]	Wet Season			Dry Season		
	High	Elevated	Stable	High	Elevated	Stable
TMDL	1,043	136	10.6	No TMDLs Required		
Existing Load	1,139	234	14.2			
Load Reduction Required	76	99	3.6			
Percent Reduction	6.7%	42.4%	25.4%			
Waste Load Allocation – Navy MS4	195	24.6	1.0	No TMDLs Required		
Waste Load Allocation – CCH MS4	349	44	1.8			
Load Allocation	520	65.8	7.8			
Margin of Safety	0	0	0			

[1]Wet Season is from November through April; Dry Season is from May through October.
[2]Flow Curve Intervals are 0-4% flow duration (High), 4-20% flow duration (Elevated), and 20-100% flow duration (Stable).

Table 1-3: Numeric WLAs for Turbidity (NTU-tons/day) Based on Flow Curve Intervals

Receiving Water Flow Curve Intervals[1, 2]	Wet Season			Dry Season		
	High	Elevated	Stable	High	Elevated	Stable
TMDL	13.1	2.29	0.094	2.53	0.84	0.029
Existing Load	64.4	4.57	0.164	9.15	2.09	0.035
Load Reduction Required	51.3	2.28	0.07	6.62	1.25	0.0059
Percent Reduction	79.7%	49.8%	42.9%	72.3%	59.8%	17.1%
Waste Load Allocation – Navy MS4	0.219	0.039	0.0011	0.043	0.014	0.0003
Waste Load Allocation – CCH MS4	0.39	0.07	0.002	0.076	0.025	0.0006
Load Allocation	12.47	2.18	0.091	2.41	0.80	0.0281
Margin of Safety	0	0	0	0	0	0

[1]Wet Season is from November through April; Dry Season is from May through October.
[2]Flow Curve Intervals are 0-4% flow duration (High), 4-20% flow duration (Elevated), and 20-100% flow duration (Stable).

Table 1-4: JBPHH-Wahiawa Annex MS4 – Summary of Numeric WLAs Based on Flow Curve Intervals

Parameter	Units	Receiving Water Flow Curve Intervals[1, 2]					
		Wet Season			Dry Season		
		High	Elevated	Stable	High	Elevated	Stable
Turbidity	NTU-tons/ day	0.219	0.039	0.0011	0.043	0.014	0.0003
Total Nitrogen	lbs/day	195	24.6	1.0	No TMDLs Required		

[1]Wet Season is from November through April; Dry Season is from May through October.
[2]Flow Curve Intervals are 0-4% flow duration (High), 4-20% flow duration (Elevated), and 20-100% flow duration (Stable).

1.5 Summary of Previous Monitoring Work

As part of this study, a series of stormwater samples were collected from monitoring locations NSW-1 and NSW-2 between February 2011 and December 2011. Stormwater samples were collected after seven storm events generating between 0.47 and 9.5 inches of rainfall. The stormwater samples collected were associated with a total of 24.3 inches of rainfall. It is estimated that a total of around 80 inches of precipitation fell on the JBPHH Wahiawa Annex installation during 2011 (ERDC and WES 2014).

A total of 87 and 73 one-liter stormwater samples were collected from NSW-1 and NSW-2, respectively, during 2011. The automated samplers were programmed to collect stormwater samples at 5- to 10-minute intervals. Turbidity measurements were made in the field using an Oakton T-11 turbidity meter. The samples were then transported to the TestAmerica laboratory located in Aiea, Hawaii for additional packing and shipment to their mainland laboratory where the samples were analyzed for nutrients and Total Suspended Solids (TSS).

Table 1-5 provides information on the storm events and the number of samples that were collected during the 2011 sampling activities. Table 1-6 provides a summary of the field results (turbidity) and laboratory results (TSS, TN, nitrate/nitrite as nitrogen, and organic nitrogen as Total Kjeldahl Nitrogen [TKN]) obtained on these samples. Ammonia was also analyzed by the laboratory, but was only detected in a single stormwater sample collected from both NSW-1 and NSW-2 during the 2011 monitoring at trace levels.

Table 1-5: Summary of Measured and Sampled Flow Events in 2011

Duration of Flow Event	Size of Storm (Inches of Rainfall)	Number of TN Samples Collected	Number of TSS and Turbidity Samples Collected
2/6/2011 14:00 to 2/7/2011 12:00	2.1	13	13
2/22/2011 0:00 to 2/23/2011 15:00	0.6	3	2
3/3/2011 10:00 to 3/8/2011 3:00	3.5	3	2
4/6/2011 10:00 to 4/9/2011 8:00	3.4	16	18
5/2/2011 22:00 to 5/10/2011 1:00	9.5	39	34
5/10/2011 21:00 to 5/11/2011 9:00	0.47	1	1
12/10/2011 0:00 to 12/11/2011 12:00	4.73	7	8

Table 1-6: Summary of Results of Measured and Sampled Flow Events in 2011

Water Quality Statistic	Turbidity (NTU)	TSS (mg/L)	TN (mg/L)	Nitrate/Nitrite (mg/L)	TKN (mg/L)
NSW-1 Wet Season (November to April)					
Geomean Concentration	14.3	12.4	0.25	0.19	0.11
Concentration Range	3.9 – 149	< 1 – 85	< 0.0892 – 7.3	< 0.008 – 0.73	< 0.075 – 6.5
Number of Samples	26	23	26	26	26
NSW-2 Wet Season (November to April)					
Geomean Concentration	208	40.8	0.15	< 0.008	0.13
Concentration Range	66 – 578	10.8 – 144	< 0.0892 – 1.29	< 0.008 – 0.244	< 0.075 – 1.05
Number of Samples	16	8	16	16	16
NSW-1 Dry Season (May to October)					
Geomean Concentration	11.1	6.1	0.30	0.023	0.28
Concentration Range	6.3 – 964	< 1 – 54	< 0.075 – 1.12	< 0.008 – 0.36	< 0.075 – 0.76
Number of Samples	19	19	19	19	19
NSW-2 Dry Season (May to October)					
Geomean Concentration	320	-	0.15	< 0.008	0.14
Concentration Range	176 – 484	-	< 0.075 – 0.769	< 0.081 – 0.051	< 0.075 – 0.769
Number of Samples	21	0	21	21	21

Figure 1-1: Site Location

Note: Figure 1-1 has been Redacted due to National Security Concerns

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Figure 1-2: JBPHH Wahiawa Annex Overall Drainage Map

Note: Figure 1-2 has been Redacted due to National Security Concerns

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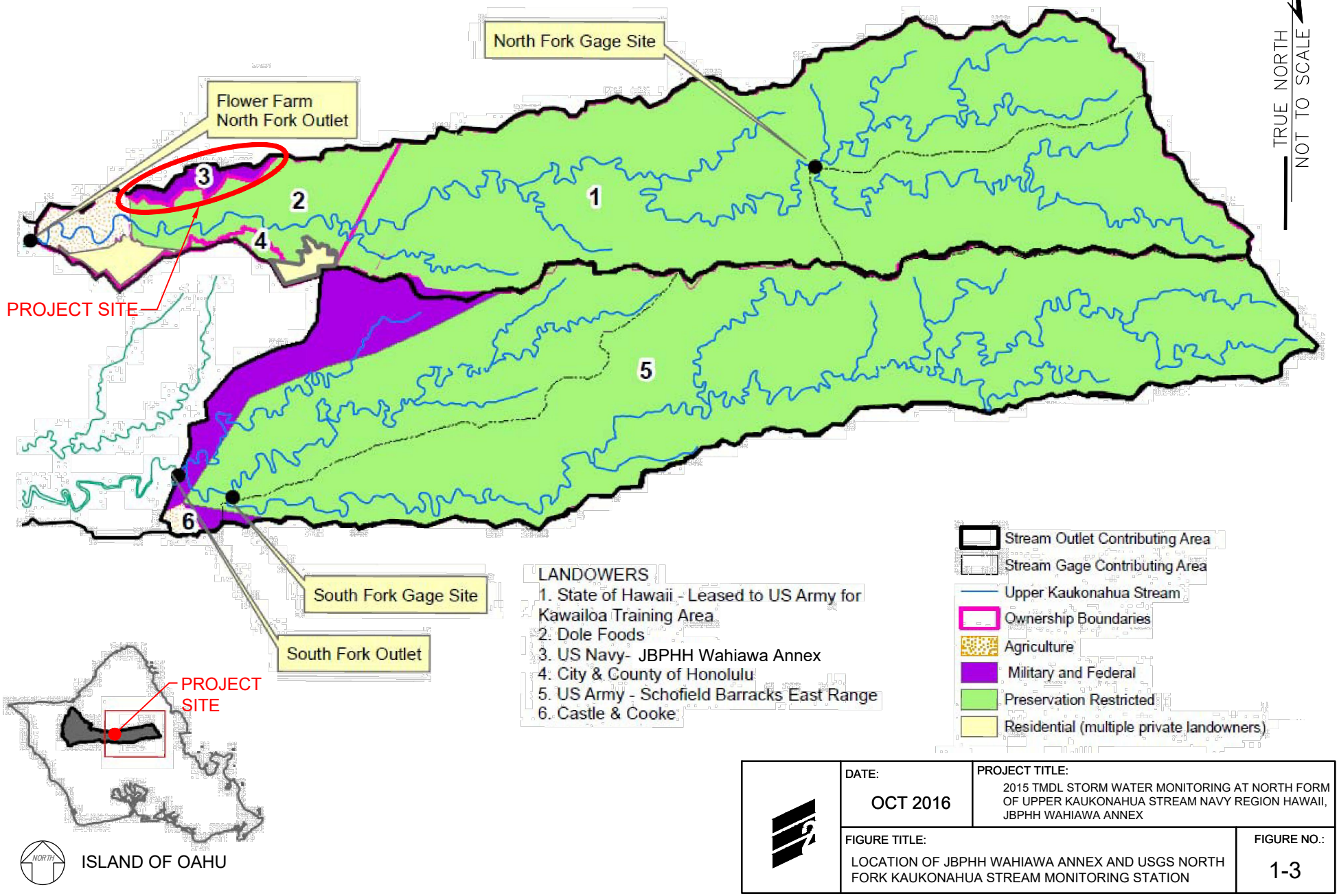

DATE:	PROJECT TITLE:
OCT 2016	2015 TMDL STORM WATER MONITORING AT NORTH FORM OF UPPER KAUKONAHUA STREAM NAVY REGION HAWAII, JBPHH WAHIAWA ANNEX
FIGURE TITLE: LOCATION OF JBPHH WAHIAWA ANNEX AND USGS NORTH FORK KAUKONAHUA STREAM MONITORING STATION	FIGURE NO.: 1-3

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Figure 1-4: JBPHH Wahiawa Annex Drainage Area to North Fork of Kaukonahua Stream

Note: Figure 1-4 has been Redacted due to National Security Concerns

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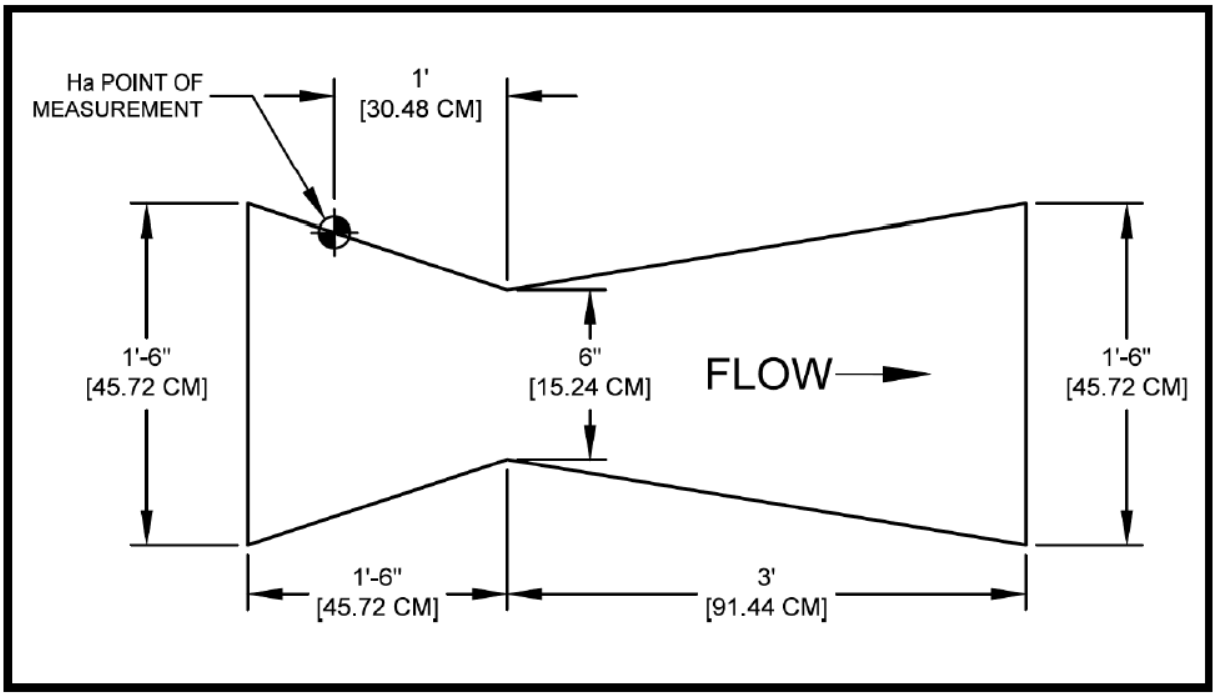
2 Installation of Monitoring Equipment

This section describes the monitoring equipment that was installed at JBPHH Wahiawa Annex to monitor rainfall and stormwater runoff volume, and to collect stormwater samples. All required approvals were obtained from the Navy and installation personnel in early 2015 prior to installation of the monitoring equipment for this project. Monitoring site NSW-1 was installed in the largest storm drain outlet that services the residential areas on the installation. Monitoring site NSW-2 was installed in the drainage swale in front of the culvert that receives stormwater runoff from the undeveloped land that surrounds the antennae field in the southeastern portion of the installation. Appendix A is a summary of the daily site visits conducted by field personnel to JBPHH Wahiawa Annex during 2015.

2.1 Installation of Cutthroat Flume and Pressure Transducers

A wooden Cutthroat Flume (depicted in the graphic below) was installed at monitoring location NSW-2 on May 13, 2015. The flume was installed in the drainage swale in front of the culvert under the adjacent dirt road that travels around the perimeter of the antennae field. Plywood sidewalls were constructed at angles at the entrance to the flume in order to route all of the water flowing in the swale into the flume. An In-Situ brand pressure transducer was installed in a stilling well placed adjacent to the flume and was connected to the floor of the flume at H_a, the point of measurement depicted in the graphic.



The Cutthroat Flume's simple design allows it to be constructed and installed easier than a Parshall Flume while still obtaining a flow rate measurement accuracy of ±3%. Previous monitoring conducted at NSW-2 prior to construction measured a range of peak flows from 0.9

cubic feet per second (cfs) to 2.7 cfs (ERDC and WES 2014). With the installation of a 54-inch long by 6-inch wide Cutthroat Flume, flow rates between 0.08 cfs to 3.9 cfs can be accurately measured at NSW-2.

The transducer was programmed to measure water levels within the stilling well at 10-minute intervals. The table in Appendix B shows the conversion calculations of the water height measured by the transducer in the stilling well at NSW-2 during storm events to corresponding estimated water flow volumes (cubic feet per second [cfs]). The transducers store data which was regularly downloaded to a field computer.

The transducer for NSW-1 was located in a small stilling well that was constructed of a 2-inch diameter polyvinyl chloride (PVC) pipe installed flush with the ground surface just downstream of the end of the concrete culvert at this location. A power equation was developed based upon the relationship observed between water height in the stilling well and estimated water flow volumes. The power equation that was developed for the NSW-1 monitoring site to convert the water height measured by the transducer into a water flow volume value is as follows:

$$y = 16.17e^{3.658x}$$

where y is the flow volume (in gallons per minute [gpm]) and x is the water height (in feet).

2.2 Installation of Automated Samplers

Stormwater runoff samples were collected using Global Water brand WS750 water samplers. The samplers were programmed to collect the first flush (within 15 minutes of runoff) and three subsequent samples every 15 minutes within the first hour of stormwater runoff at each monitoring site.

The tubing for the automated sampler at NSW-1 was installed at the outlet of the storm drain that drains a portion of three residential streets. The sample collection container is located within a shed adjacent to the culvert. The tubing for the automated sampler at NSW-2 was installed on the downstream portion of the Cutthroat Flume close to the entrance of the culvert that drains the antennae field. The sample collection container is located within a shed adjacent to the flume. The Global samplers are programmed to initiate sampling through the use of an external trigger, which detects the presence of stormwater flow through the culvert at NSW-1 and the flume at NSW-2.

2.3 Installation of Tipping Rain Gauges

Two Onset Hobo brand tipping rain gauges were installed at separate locations within JBPHH Wahiawa Annex. A tipping rain gauge consists of a funnel that collects and channels the precipitation into a small seesaw-like container. After a pre-set amount of precipitation falls, the lever tips, dumping the collected water and sending an electrical signal. One rain gauge is attached to a driven fence post in the antennae field adjacent to monitoring site NSW-2, and the other rain gauge is attached to a driven fence post in a large open field adjacent to the new residential area within JBPHH Wahiawa Annex. The tipping rain gauges are designed to measure rainfall at 0.01-inch intervals. Each rain gauge has a data logger, which can be downloaded using a field computer to retrieve the collected rainfall data. A manual rain gauge is

also located adjacent to the tipping rain gauge at NSW-2 which was read and downloaded during each site visit.

3 Sample Collection and Analysis

This section describes the sampling and analysis methodologies followed during the monitoring period for this study (mid-May 2015 to December 2015). Measurable runoff occurred on 62 days during the 231-day monitoring period, enabling the collection of a total of 85 stormwater samples from the two monitoring sites (NSW-1 and NSW-2) at JBPHH Wahiawa Annex. Appendix C is a summary of the monitored runoff events in 2015.

3.1 Field Equipment

The following field equipment was used during field activities for sampling, monitoring, and documentation purposes:

- Global Water WS750 Automated Samplers
- Hydrolab Quanta D Water Quality Instrument
- Onset Hobo Tipping Rain Gauges
- In Situ Pressure Transducers
- Field Computer (to download transducers and rain gauges)
- Digital Camera

Preventive maintenance of field equipment was performed throughout the monitoring period in accordance with the requirements of the specified manufacturer. Monitoring and sampling equipment was periodically cleaned, checked for operability, and repaired as necessary. The batteries in the automated samplers were replaced on a weekly basis to assure that the samplers would trigger during storm events. Maintenance activities were recorded in the field log book.

All field personnel were trained on the proper operation, calibration, and maintenance of the Hydrolab Quanta. Field personnel ensured that the manufacturer's guidelines were available in the field with the equipment and that the equipment was tested, calibrated, and found to be in good working condition prior to use in the field. Field personnel also ensured that the instruments were stored properly and protected against excess heat, dust, and moisture.

Parameters that were measured in the field using the water quality meter included temperature ($^{\circ}$C), pH (pH units), electrical conductivity (mS/cm), DO (mg/L), and turbidity (NTU). Prior to measurement in the field, the meter was first calibrated using known standard pH buffers (usually pH 4 and 7), a conductivity standard (1.412 mS/cm), and a turbidity standard (12.7 NTU), which were kept with the water quality meter. The meter was calibrated to these known standards to verify the meter was operating within an acceptable range ($\pm$5% of standard values) prior to collection of the stormwater samples in the field.

3.2 Sample Collection Method

Samples were collected in accordance with the procedures detailed in the project WP utilizing industry standard stormwater sample collection procedures (E2 2015). Stormwater samples were collected from each monitoring site using a pair of Global WS750 automated samplers, which allowed the collection of four discrete, one-gallon samples per runoff event. Once the individual sample containers were filled by the automated samplers, the field personnel recovered

the individual stormwater samples from each automated sampler as quickly as possible (typically within 24 hours of the flow event). Water quality parameters of a representative aliquot from each collected sample were then measured in the field for temperature (°C), pH (pH units), electrical conductivity (millisiemens per centimeter [mS/cm]), dissolved oxygen (DO, milligrams per liter [mg/L]), and turbidity (NTU) using a portable Hydrolab Quanta D brand water quality meter. The remaining sample was then poured into properly labelled sample containers and immediately placed on ice to ensure a temperature of 4 degrees Celsius (°C) ± 2°C during transport to the analytical laboratory. TestAmerica analytical laboratory was used to measure nutrients and TSS in the samples.

The stormwater flow and volume data for each sampled runoff event was collected through the use of a Cutthroat Flume (at NSW-2) and a stilling well below a culvert (at NSW-1) with pressure transducers. After samples were collected, field personnel downloaded the pressure transducer data using a field computer and related software.

Rainfall amounts were measured with two Onset Hobo brand tipping rain gauges installed at relatively unobstructed areas near both monitoring points. The data loggers associated with each rain gauge were downloaded shortly after the collection of the samples.

3.3 Field Logbook and Chain-of-Custody Forms

A project-dedicated bound, waterproof field logbook was maintained by field personnel throughout the duration of the monitoring period (copies of pages from the logbook are included in Appendix D).

Strict chain-of-custody (COC) protocol was adhered to in order to ensure that the integrity of the samples was not jeopardized through unauthorized or careless handling. The COC forms were placed in sealable plastic storage bags and accompanied the samples during transport to the local laboratory. The COC forms were properly signed during the transfer of the samples from the field to the laboratory. The field personnel retained a copy of the COC form upon relinquishing the samples to the laboratory, and filed them in the E2 project file. The COC forms are included in the analytical laboratory reports generated during this monitoring period (included in the companion CD to this report).

3.4 Sample Handling and Shipping

The samples were transferred into laboratory-provided containers immediately after the field parameters had been measured. The containers were then immediately placed in a cooler with ice and the COC forms, and transported by car to the TestAmerica receiving center in Aiea, where laboratory personnel then repackaged the samples for shipment to the U.S. mainland for analysis. TestAmerica is an ISO17025 compliant laboratory, as required by Section 7-3.3 of Navy Environmental Readiness Program Manual OPNAV M-5090.1 (10 January 2014).

3.5 Laboratory Analysis

The stormwater samples were analyzed by TestAmerica located in Tacoma Washington. Although the TMDL specifies only standards for turbidity and TN, the samples were also analyzed for TSS, nitrate/nitrate, ammonium nitrogen, and organic nitrogen as TKN. The TSS data allowed the actual mass of sediment leaving the installation via stormwater to be monitored. The individual components of TN were analyzed to determine whether inorganic or organic nitrogen is leaving the project site. Table 3-1 lists the analytical method, holding time, type and size of container, and preservative utilized for the various parameters analyzed by the laboratory.

Table 3-1: Analytical Methods Information

Analyte	Analytical Method	Holding Time	Container Type/Size	Preservative
Nitrate/Nitrite	EPA 353.2-SDB	28 days	500-mL plastic	none
Ammonium Nitrogen	EPA 350.1	14 days	500-mL plastic	H_2SO_4
TKN (Organic Nitrogen)	EPA 351.2	28 days	500-mL plastic	H_2SO_4
TSS	SM2540D	7 days	1,000-mL plastic	none

H_2SO_4 = sulfuric acid

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4 Monitoring Results

This section describes the monitoring results obtained at the JBPHH Wahiawa Annex during the monitoring period for this study (mid-May to December 2015).

4.1 Rainfall Monitoring Data

The average annual rainfall at the project site is approximately 70 inches/year based upon rainfall data collected at the Upper Wahiawa Station since 1954. The measured rainfall during the monitoring period for this study was anomalously high with several large Kona storms impacting the project site in August and September. As a result of the abundant summer rainfall during 2015, the normally Dry Season for the TMDL that extends from May to October had approximately 163% more rain than normal, which led to elevated volumes of stormwater runoff during the monitoring period. Table 4-1 summarizes the monthly rainfall measured at the rain gauge station established at NSW-2. Appendix E contains tables depicting the hourly rainfall that fell during the monitoring period, along with information on when stormwater runoff was observed at monitoring sites NSW-1 and NSW-2.

Table 4-1: Monthly Rainfall Measured at JBPHH Wahiawa Annex

Month	Measured Rainfall	Long-Term Historical Average Rainfall[1]	Percentage Difference
May-15[2]	0.68[2]	4.63	14.7%
Jun-15	1.43	4.62	36.4%
Jul-15	4.55	4.86	93.6%
Aug-15	17.26	3.76	459.0%
Sep-15	11.07	4.03	274.7%
Oct-15	3.32	5.85	56.8%
Nov-15	19.49	6.98	279.2%
Dec-15	9.61	8.12	118.3%
Monitoring Period:	67.41	42.85	157.3%

[1]*Average rainfall based upon data collected at Upper Wahiawa Station, SKN 874.3, Elevation 1,115 feet since 1954.*
[2]*Measurements started on May 15, 2015.*

4.2 Water Quality Monitoring Data

The field and laboratory water quality monitoring data obtained from the stormwater samples collected during the monitoring period for this study are compiled in Appendix F. Temperature, pH, electrical conductivity, DO, and turbidity were measured in the field using a Hydrolab Quanta D. Samples for TN, nitrate-nitrite, ammonia, TKN, and TSS were sent to TestAmerica for analysis. Measurable runoff occurred on 62 days during the 231-day monitoring period.

Table 4-2 summarizes the turbidity and TN concentrations measured in stormwater runoff at the two monitoring sites, and compares the measured geometric mean concentration observed during the wet and dry seasons of 2015 with the concentrations measured in 2011.

Table 4-2: Turbidity and Total Nitrogen Levels Measured in NSW-1 and NSW-2 in 2015

Sample Order	Dry Season Water Quality Statistics (May to October 2015)			
	NSW-1		NSW-2	
	Turbidity (NTU)	Total Nitrogen (mg/L)	Turbidity (NTU)	Total Nitrogen (mg/L)
1	15.6 ± 10.6	2.0 ± 2.3	192 ± 128	0.21 ± 0.27
2	18.5 ± 26.3	1.3 ± 2.4	165 ± 89	0.24 ± 0.20
3	6.7 ± 4.1	0.6 ± 0.9	153 ± 69	0.14 ± 0.22
4	5.8 ± 3.2	0.4 ± 0.4	177 ± 83	0.09 ± 0.09
2015 Mean Data	12.0 ± 14.3	1.1 ± 1.8	177 ± 83	0.17 ± 0.21
2015 Geometric Mean	8.1	0.38	160	0.10
2011 Geometric Mean	11.1	0.30	320	0.15
Sample Order	**Wet Season Water Quality Statistics (November to December 2015)**			
	NSW-1		**NSW-2**	
	Turbidity (NTU)	**Total Nitrogen (mg/L)**	**Turbidity (NTU)**	**Total Nitrogen (mg/L)**
1	16.7 ± 6.7	0.74 ± 0.52	167 ± 50	0.17 ± 0.12
2	21.5 ± 2.0	0.05 ± 0.0	162 ± 69	0.18 ± 0.0
3	14.9 ± 1.9	0.05 ± 0.0	181 ± 73	0.05 ± 0.0
4	21.0 ± 0.0	0.05 ± 0.0	157 ± 81	0.05 ± 0.0
2015 Mean Data	18.2 ± 11.4	0.31 ± 0.43	167 ± 57	0.13 ± 0.10
2015 Geometric Mean	16.2	0.13	157	0.10
2011 Geometric Mean	14.3	0.25	208	0.15

The Sample Order in Table 4-2 indicates the partition of flow from the initial flow or first flush in bottle 1 and subsequent flow segments in bottles 2 through 4 of the Global autosampler. At both monitoring sites NSW-1 and NSW-2, TN concentrations are highest at first and rapidly decline as a flow event proceeds. Turbidity values do not necessarily appear to be related to flow duration, but perhaps are a function of flow intensity.

The TN concentrations measured in stormwater runoff at both sites is quite low (geometric mean between 0.13 to 0.38 mg/L). The turbidity concentrations at the residential monitoring location (NSW-1) are also quite low (geometric means of 8.1 and 16.2 NTU), while the undeveloped monitoring location (NSW-2) has substantially higher turbidity concentrations (geometric means of 160 and 157 NTU) due to the presence of reddish colloidal fines in the stormwater runoff at this

site. Geometric mean data from 2011 compares well to data from 2015 with the exception of dry season turbidity levels, which were twice as high during the 2011 monitoring.

The TMDL only specified standards for turbidity and TN; these quantities alone do not provide sufficient information to understand the possible source of TN in the watershed or to design BMPs, as needed. However, nitrate/nitrite, ammonium nitrogen, and organic nitrogen as TKN, were evaluated to assess inorganic versus organic nitrogen. Since TN did not exceed the TMDL during the year, the nitrogen breakdown was not calculated for 2015 but the vast majority (>80%) of the nitrogen leaving the site is inorganic nitrogen

4.3 Stormwater Runoff Flow Volume Monitoring Data

The volume of stormwater runoff was monitored using pressure transducers installed in a stilling well downstream of the concrete culvert at NSW-1 and in a stilling well attached to the cutthroat flume installed at NSW-2. The transducers were programmed to measure water levels at 10-minute intervals.

At the NSW-1 monitoring site, the following power equation was developed to estimate flow volumes from the transducer readings:

$$y = 16.17e^{3.658x}$$

where y is the flow volume (in gpm) and x is the water height in the culvert (in feet). The table in Appendix B shows the conversion calculations of the water height measured by the transducer in the stilling well at NSW-2 during storm events to corresponding estimated water flow volumes (cfs). The date, time, and estimated volumes of the various monitored storm events at NSW-1 and NSW-2 are compiled in Appendix C.

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5 Turbidity and Total Nitrogen Load Calculation

This section discusses the methodology used to calculate the daily loads generated at the JBPHH Wahiawa Annex during the monitoring period for this study (mid-May to December 2015).

5.1 TMDL Calculation Methodology

The waste loads were calculated using equations provided in the September 2009 TMDL report prepared for the North and South Forks of the Upper Kaukonahua Stream (DOH 2009). This report served as the basis for the target WLAs established in the Navy's NPDES permit that covers JBPHH Wahiawa Annex (Permit No. HI S000257). The waste loads were calculated as described in Section 5.3 using flow data obtained as described in Section 5.2 below.

5.2 Flow Calculations

Flow calculations are required to calculate loading of TN and TSS/turbidity. Depth measurements for the different flow events were made using pressure transducers, which provided the hydraulic head within the monitoring points. Site-specific formulas were used to calculate the flow at stations NSW-1 and NSW-2 based on the measured depths. Data from the pressure transducers were downloaded and the units were reset approximately every three months. Continuous readings were obtained at 10-minute intervals with the pressure transducers.

The transducer for NSW-1 was located in a small stilling well that was constructed of a 2-inch diameter PVC pipe installed flush with the ground surface just downstream of the culvert. A flow relationship was obtained by taking manual flow measurements over varying depths and comparing them to depth data recorded by the transducer. The power equation that was developed for the NSW-1 monitoring site is as follows:

$$y = 16.17e^{3.658x}$$

A plywood cutthroat flume with a stilling well was constructed at the NSW-2 monitoring point. The cutthroat flume is designed to relate the depth of water flowing through the flume to flows using tabulated values (see Appendix B).

Flow values were calculated by applying the formula for each monitoring point to each 10-minute depth reading throughout a flow event. The sum of individual 10-minute segments throughout a flow event was calculated to obtain the total flow volume per event. The volume of water flow measured at NSW-1 and NSW-2 during the current monitoring period is presented in Appendix C.

5.3 Load Calculations

The pollutant loads leaving JBPHH-Wahiawa Annex during the monitoring period were calculated as follows:

1) The 2009 TMDL report utilized the flow characteristics measured over a five-year time interval at the North Fork of Kaukonahua Stream to develop the TMDLs. The TMDL

methodology determined a weighted geometric mean of the monitored water quality parameters for both the wet (November to April) and dry (May to October) seasons, with the data separated into three categories based on the volume of stream flow at the time the sample was collected from the stream: high (0-4%), elevated (4-20%), and stable (20-100%) flows.

2) The flow recurrence interval for the Dry Season on the North Fork of Kaukonahua Stream was determined to be: High Flow >55.4 cfs, Elevated Flow <55.4 and >15.2 cfs, and Stable Flow <15.2 cfs. The flow occurrence interval for the Wet Season on the North Fork of Kaukonahua Stream was determined to be: High Flow >69.3 cfs, Elevated Flow <69.3 and >17 cfs, and Stable Flow <17 cfs.

3) Because the TMDLs were generated based upon the flow characteristics of Kaukonahua Stream, the flow measured at the United States Geological Survey (USGS) gauging station on the North Fork of Kaukonahua Stream (USGS Gauge 16200000; see Figure 1-3 for location) was used to characterize individual flow events at monitoring points NSW-1 and NSW-2 as being associated with High, Elevated, or Stable Flow for the purpose of assessing compliance with the TMDLs.

4) Each monitored runoff event was characterized as being associated with High, Elevated or Stable Flow by determining the maximum flow measured at the USGS gauge on the North Fork of Kaukonahua Stream during the duration of the runoff event, including up to an hour before and after the end of the event (to account for lag times between flows measured at the USGS Gauge and JBPHH Wahiawa Annex during both normal and Kona storm conditions). The five-minute stream flow data for Kaukonahua Stream was obtained from the online USGS National Water Information System Web Interface.

5) The geometric mean of the turbidity and TN values obtained on stormwater samples collected from JBPHH Wahiawa Annex at NSW-1 and NSW-2 during the dry (May to October 2015) and wet (November and December 2015) season was then calculated. Non-detect (ND) values for TN were assigned a value equal to the detection limit (DL) when calculating the geometric mean value, as was done in the 2009 TMDL report.

6) The NPDES permit requires a WLA for turbidity. Turbidity is a method-defined parameter that expresses the tendency of a liquid to deflect light. Turbidity is reported in NTUs, which does not incorporate mass. Since WLAs are based on a mass per time measurement, turbidity must be converted to a mass unit. Because turbidity is standardized against formazin, the 2009 TMDL report viewed NTUs as equivalent to other concentration factors, such as parts per million (ppm). The waste load for turbidity (TL), expressed as NTU-tons/day, was calculated using the following equation:

$$TL = 0.002695 * T * Q * I$$

T = geometric mean of turbidity (NTU) measurements
Q = flow (cfs)
I = flow interval (fraction of the day that stormwater flowed)

The flow value (Q) used in the equation was calculated by dividing the total volume of stormwater runoff measured during each discrete runoff event by the duration of the runoff event based upon the pressure transducer data (I). The turbidity value (T) used was the

geometric mean of all of the turbidity measurements made at the monitoring points (NSW-1 and NSW-2) during the dry and wet seasons (see Table 4-2).

7) The waste load for total nitrogen (NL), expressed as pounds/day (lbs/day), was calculated using the following equation provided in the 2009 TMDL report:

$$NL = 5.39 * N * Q * I$$

5.39 is a constant that converts units from mg/L of nitrogen to pounds per day of nitrogen, i.e., mg / 1,000,000 Kg * 2.2 lbs/Kg * 3.79 L/gal * 7.48 gal/cfs * 3,600 seconds/hr * 24 hr/day

N = geometric mean of Nitrogen measurements (mg/L)

Q = flow (cfs)

I = flow interval (fraction of the day that stormwater flowed)

8) The waste load for each of the pollutants TN and turbidity exiting the two monitoring sites (NSW-1 and NSW-2) on a daily basis was calculated by multiplying the geometric mean of the pollutant levels in samples collected during the dry (May to October) and wet (November and December) seasons by the volume of stormwater flow for each discrete runoff event. In the case when multiple discrete runoff events occurred during a single day, the sum of the nitrogen load and the sum of the turbidity load from each event were calculated. Since the equation developed for the 2009 report was designed for a constant flowing stream, while flow from the monitoring sites was intermittent, a flow interval conversion was included in the equation. The sum of the nitrogen load and the sum of the turbidity loads at both NSW-1 and NSW-2 were compared to the TMDLs.

9) Monitoring site NSW-1 represents runoff from the residential portions of the JBPHH-Wahiawa Annex while monitoring site NSW-2 represents runoff from the undeveloped portions of the installation. Taking infiltration into account, monitoring of runoff at the site during 2015 and 2016 indicates that the flow leaving NSW-1 represents approximately 33% of the total stormwater flow leaving residential portions of the installation while the flow leaving NSW-2 represents approximately 33% of the total stormwater flow leaving undeveloped portions of the installation. The total estimated loads leaving the JBPHH-Wahiawa Annex were calculated during individual storm events using the following formula:

$$\text{Total Load} = (\text{Calculated NSW-1 Load}) * 3.0 + (\text{Calculated NSW-2 Load}) * 3.0$$

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6 Conclusions and Recommendations

6.1 Conclusions

The monitoring period from mid-May to December 2015 was anomalously wet compared to average historic rainfall due to El Nino-related weather conditions during this time. Despite the wet conditions, the volume of stormwater flow from the small portion of JBPHH Wahiawa Annex that flows towards the North Fork of Kaukonahua Stream is small and the occurrence of runoff infrequent. Measurable runoff occurred on 62 days during the 231-day monitoring period, specifically during 5.7% of the time (315 hours) at the residential monitoring site (NSW-1) and 2.8% of the time (156 hours) at the undeveloped area monitoring site (NSW-2) (see Table 6-1). The total flow was obtained by proportioning the measured representative flows by a factor of the total area of the permit area. The estimated total volume of stormwater thought to have left the JBPHH Wahiawa Annex (~4.2 million gallons) is about 0.069% of the total stream flow (6,183 million gallons) measured at the USGS gauging station (16200000) on the North Fork of Kaukonahua Stream during the roughly 7.5-month monitoring period.

The TN concentrations measured in stormwater runoff at both monitoring points is quite low (geometric mean between 0.10 to 0.38 mg/L). At both monitoring points, the sources of the detected nitrogen is predominately (>80%) organic in origin. The turbidity concentrations at the residential monitoring location (NSW-1) are also quite low (geometric means of 8.1 and 16.2 NTU), while the undeveloped monitoring location (NSW-2) has substantially higher turbidity concentrations (geometric means of 160 and 157 NTU) due to the presence of reddish colloidal fines in the stormwater runoff at this location (see Table 4-2). The daily turbidity TMDL was exceeded on 17 days during the monitoring period, while there were no exceedances for TN (see Appendix F). The monitoring data indicates that the majority of the TMDL load originates from the relatively undeveloped portions of the installation that contain sparsely vegetated open areas surrounding the antennae field.

Table 6-1: Total Monitored Mass of Sediment and Nitrogen Leaving JBPHH Wahiawa Annex in 2015

TMDL Season	Parameter (mg/L)	Geometric Mean Measured		Volume of Storm Water (Gallons)		Total Mass Discharged (kg)
		NSW-1	NSW-2	NSW-1	NSW-2	
Dry Season	TN	0.38	0.10	484,878	453,970	0.87
	TSS	8.12	25.3			61.33
Wet Season	TN	0.13	0.10	246,494	207,577	0.20
	TSS	7.57	25.6			20.11

6.2 Recommendations

The estimated mass of total nitrogen that was transported from the 55-acre JBPHH Wahiawa Annex during the monitoring period in 2015 was insignificant (~3.3 kilograms) and implementation

of additional BMPs is not recommended. The mass of sediments leaving the installation is also quite low (~245 kilograms over the 7.5-month monitoring period), but could be further reduced by implementation of BMPs.

The turbidity load contributing to the flow monitored at NSW-2 into the North Fork of Kaukonahua Stream from the JBPHH Wahiawa Annex is primarily from two locations, the bluff bordering the forested area of the property and unvegetated areas surrounding the antennae field in the eastern portion of the installation. The monitoring results indicate that BMPs implemented in the residential portions of the installation are achieving their goals, but that additional BMPs are required for some of the undeveloped portions of the installation to ensure that the entire installation is within compliance.

BMPs that could be implemented to lower the turbidity load exiting the installation include revegetation of the poorly vegetated areas surrounding the antennae field in the eastern portion of the facility and installation of geotextile fabric material in order to reduce erosion in areas along the southern boundary of the installation where outlet pipes concentrate stormwater runoff onto steep sections of the hillside in the area.

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APPENDIX A

Summary of Site Visits to JBPHH-Wahiawa Annex in 2015

Visit #	Date	Purpose	Manual Rainfall Amount (inches)
DRY SEASON			
1	5/12/2015	Constructed and installed cutthroat flume at NSW-1	
2	5/13/2015	Installed monitoring station at NSW-2	
3	5/18/2016	Reconfigure Globals and sampling inlets	> 2" (excess water dumped)
4	5/20/2015	Install 1st tipping gauge rain bucket	0.15
5	5/27/2015	Install 2nd tipping gauge rain bucket	0.16
6	6/3/2015	Replace batteries, one sampler triggered with small amount	0.4
7	6/13/2015	Replace NSW-1 rain gauge	0.2
8	6/17/2015	Download hobo rain gauge	-
9	6/23/2015	Replaced batteries. Collected sample from NSW-1 from runoff event occurring on 6/23.	0.85 @ 10:40
10	6/26/2015	Download transducer data	0.28 @ 9:00 am
11	7/7/2015	Replaced batteries	0.2 @10:20
12	7/11/2015	Samplers did not trigger with storm event	0.76 @ 16:00
13	7/14/2015	Site visit with A.Hong and J.Chang from NAVFAC Hawaii. All four samples collected at NSW-1. Samples acquired from runoff event occurring on 7/14	-
14	7/16/2015	Collected samples from NSW-1, NSW-2 did not trigger. Samples acquired from runoff event occurring on 7/16	1.0 @20:30
15	7/29/2015	Collected sample from NSW-1 (2 bottles), not analyzed due to a professional judgement call based on insufficient transducer data.	0.68 @ 13:17
16	8/5/2015	Check pumps and batteries, no trigger	0.47 @9:55
17	8/6/2015	Download the HOBO at NSW-1	-
18	8/7/2015	Download the HOBO at NSW-2. Disconnect battery from ISCO	0.14 @ 15:00
19	8/11/2015	Reconnected battery @ ISCO Site. No runoff at NSW-1 or -2.	0.46 @ 10:00
20	8/17/2015	Download HOBO at NSW-2, remove NSW-1 HOBO (malfunctioning), No runoff	0.29 @ 14:40
21	8/18/2015	Storm runoff began at NSW-1 ~11:15, Collected samples from three bottles (1, 3 and 4). Runoff lasted ~45 minutes. No runoff at NSW-2. Additional runoff at NSW-1 occurred later in afternoon.	0.53 @13:40
22	8/19/2015	Replaced batteries at NSW-2. Reinstall NSW-1 HOBO. Collected 4 samples from NSW-1, however, were discarded because they had refilled during the same storm event during 8/18. No evidence of runoff at NSW-2 from yesterday's storm event.	0.45 @ 11:30
23	8/21/2015	Collected two stormwater samples from NSW-2. Runoff acquired from event occurring on 8/20. Three stormwater samples (bottles 1, 3 and 4) from NSW-1. Runoff likely occurred on 8/20, late afternoon.	0.77 @ 12:30
24	8/22/2015	Replace batteries at NSW-2, small amount of runoff observed at NSW-1 ~ 15:15, flow measured at 15:30 was 5 sec/2 gal.	0.13 @ 15:00
25	8/24/2015	Collected four runoff samples from the Antennae Field (NSW-2-01-082315, -02, -03, -04), very turbid and red color. Samples acquired from runoff event occurring on 8/23.	6.98 @ 11:30

Visit #	Date	Purpose	Manual Rainfall Amount (inches)
26	8/25/2015	Collected four runoff samples from the Antennae Field (NSW-2-01-082515, -02, -03, -04), very turbid and red color and four from residential area (NSW-1-01-082515, -02, -03, -04). Manual flow measurements 5 gal per 2 sec at NSW-1 @15:02, 2 gal/6 sec at NSW-2 @15:15 and ~5 gal/min at NSW-2 @16:00.	2.02 @ 16:00
27	8/27/2015	Collected four runoff samples from the Antennae Field (NSW-2-01-082715, -02, -03, -04), very turbid and red color. Manual flow measurement at NSW-1 @14:20 is 2 gal/sec and between 6 to 8 gal/sec at 14:40.	Raining, not measured
28	8/28/2015	Downloaded pressure transducers, reinstalled Hobo rain gauge near residential area, replaced batteries.	6.20 @ 11:30
29	9/1/2015	Reset the samplers at NSW-1 and NSW-2. Visual evidence for a small flow event at NSW-1 (green ball moved).	0.17 @ 12:20
30	9/3/2015	Collected three samples from the auto sampler at the residential area (NSW-1-01-90315, -02, -03) which were probably from the runoff event during 9/1. Collected four manual runoff samples from the Antennae Field (NSW-2-01-90315, -02, -03, -04), very turbid and red color. Manual flow measurements 2.5 gal per sec at NSW-2 @14:35, 1 gal/ sec at NSW-2 @14:50 and ~0.5 gal/sec at NSW-2 @15:20.	0.39 @ 13:40
31	9/8/2015	Collected four runoff samples from the Antennae Field (NSW-2-01-090815, -02, -03, -04), turbid and red color. Runoff event may have occurred on 9/5. Download pressure transducers and HOBOs.	2.68 @ 8:40
32	9/12/2015	Collected four runoff samples from the Antennae Field (NSW-2-01-091215, -02, -03, -04), turbid and red color. Runoff event occurred on 9/11 between 13:25 and 15:15. Collected two samples from residential area (NSW-1-01-091215 and NSW-1-02-091215). Runoff event occurred on 9/11 between 02:25 and 03:55.Turned off samplers.	1.85 @ 8:50
33	9/14/2015	Turned on samplers. Downloaded pressure transducers and HOBOs.	0.40 @ 9:00
34	9/16/2015	Collected three runoff samples from Residential Area (NSW-1-01-91615, NSW-1-02-91615, and NSW-1-02-91615). Samples acquired from runoff event during 9/14. No samples triggered at NSW-2. Turned off sampler at NSW-1 but left on sampler at NSW-2. Downloaded transducers and HOBOs.	1.49 @ 9:40
35	9/30/2015	Download NSW-1 and NSW-2 transducers. Download both HOBO rain gauges. Replace batteries in Globals at NSW-2. Disabled sampler until November 1 due to the high number of samples taken thus far and to ensure the collection of “wet season” samples within the maximum number of permitted samples.	4.24 @10:00
36	10/13/2015	No samples collected at NSW-2.	1.11 @10:45
37	10/29/2015	Downloaded transducer at NSW-2, reactivated NSW-1. Visited site with NAVFAC personnel (A. Hong, R. Mohandie, C. Esaki)	2.56 @ 12:00

WET SEASON			
Visit #	**Date**	**Purpose**	**Manual Rainfall Amount (inches)**
38	11/4/2015	Runoff occurred at both NSW-1 and NSW-2 during a rainfall event that occurred during the middle of the day on 10/31/15. Downloaded transducers and measured water quality of collected samples in Globals. Samples were not submitted for analysis due to a professional judgement call based on previous date sampled and the extended time between sampled date and actual arrival to site.	1.61 @13:15
39	11/5/2015	Collected single sample from NSW-2 manually. Replaced batteries at NSW-1 and NSW-2. Small flow at NSW-1 which had ponded to form a pool. No sample collected.	1.48 @11:45
40	11/10/2015	Collected three samples from NSW-2 and two samples from NSW-1 generated from rainfall during 11/9. The pressure transducer and tipping rain gauge was downloaded from NSW-2	3.13 @14:00
41	11/13/2015	Collected two samples from NSW-01 which likely were generated during a rain event on 11/11. Downloaded transducer at NSW-1 and both rain gauges.	1.00 @ 13:00
42	11/16/2015	Collected a single sample from NSW-02 and three samples from NSW-01 which were likely generated during heavy rain on the evening of 11/13 and the early morning of 11/14. Installed new batteries in all four samplers.	1.23 @9:35
43	11/20/2015	Collected three samples from NSW-1 and three samples from NSW-2. Samples acquired from runoff event during 11/19. Pulled batteries for the Thanksgiving Weekend.	2.94 @9:45
44	12/2/2015	Installed batteries and downloaded the rain gauge.	9.39 @8:00
45	12/4/2015	Downloaded the pressure transducer data	0.33 @12:30
46	12/10/2015	Collected two samples from NSW-1 and four samples from NSW-2. Samples acquired from the runoff event during 12/10. Pulled batteries for the remainder of the year as the maximum permitted samples within the contract were acquired.	1.25 @ 12:00
47	1/4/2016	Download transducers and rain gauges.	8.07 @ 10:00

Site visits during which storm water samples were collected are highlighted in yellow

APPENDIX B
Rating Table for Cutthroat Flume

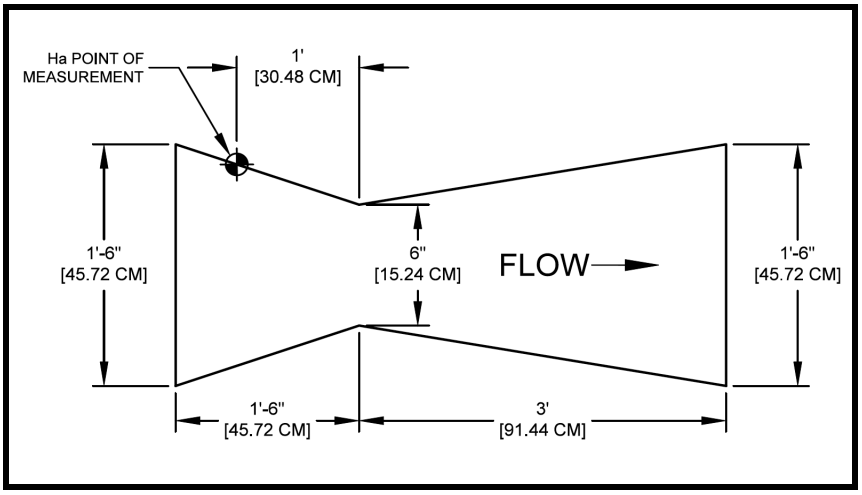
54-Inch L x 6-Inch W Cutthroat Flume Discharge Table

70% Submergence Transition ±3% Accuracy

Formulas (H in feet): CFS = 1.96 $H_{ft.}^{1.72}$ GPM = 879.6 $H_{ft.}^{1.72}$ MGD = 1.267 $H_{ft.}^{1.72}$

Formulas (H in meters): L/S = 428.2 $H_m^{1.72}$ M3/HR = 1541 $H_m^{1.72}$

FEET	INCHES	METERS	CFS	GPM	MGD	L/S	M3/HR
0.01	0.12	0.0030	Excessive error due to fluid-flow properties and boundary conditions				
0.02	0.24	0.0061					
0.03	0.36	0.0091					
0.04	0.48	0.0122					
0.05	0.60	0.0152					
0.06	0.72	0.0183					
0.07	0.84	0.0213					
0.08	0.96	0.0244					
0.09	1.08	0.0274					
0.10	1.20	0.0305	0.0373	16.76	0.0241	1.058	3.806
0.11	1.32	0.0335	0.0440	19.75	0.0284	1.246	4.484
0.12	1.44	0.0366	0.0511	22.94	0.0330	1.447	5.207
0.13	1.56	0.0396	0.0586	26.32	0.0379	1.661	5.976
0.14	1.68	0.0427	0.0666	29.90	0.0431	1.887	6.788
0.15	1.80	0.0457	0.0750	33.67	0.0485	2.124	7.644
0.16	1.92	0.0488	0.0838	37.62	0.0542	2.374	8.541
0.17	2.04	0.0518	0.0930	41.75	0.0601	2.635	9.480
0.18	2.16	0.0549	0.1026	46.07	0.0663	2.907	10.46
0.19	2.28	0.0579	0.1126	50.56	0.0728	3.190	11.48
0.20	2.40	0.0610	0.1230	55.22	0.0795	3.484	12.54
0.21	2.52	0.0640	0.1338	60.05	0.0865	3.789	13.63
0.22	2.64	0.0671	0.1450	65.05	0.0937	4.105	14.77
0.23	2.76	0.0701	0.1565	70.22	0.1011	4.431	15.94
0.24	2.88	0.0732	0.1684	75.56	0.1088	4.768	17.16
0.25	3.00	0.0762	0.1806	81.05	0.1167	5.115	18.40
0.26	3.12	0.0792	0.1932	86.71	0.1249	5.471	19.69
0.27	3.24	0.0823	0.2062	92.52	0.1332	5.838	21.01
0.28	3.36	0.0853	0.2195	98.50	0.1418	6.215	22.36
0.29	3.48	0.0884	0.2331	104.6	0.1507	6.602	23.75
0.30	3.60	0.0914	0.2471	110.9	0.1597	6.998	25.18



Note: Discharge is calculated to top of flume

Sources: Cutthroat Flume Discharge Relations, Water Management Technical Paper No. 16, Colorado State University, AER71-72RSB6, March 1972
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Formulas (H in meters): L/S = 428.2 $H_m^{1.72}$ M3/HR = 1541 $H_m^{1.72}$

FEET	INCHES	METERS	CFS	GPM	MGD	L/S	M3/HR
0.31	3.72	0.0945	0.2615	117.3	0.1690	7.404	26.64
0.32	3.84	0.0975	0.2761	123.9	0.1785	7.820	28.14
0.33	3.96	0.1006	0.2911	130.7	0.1882	8.245	29.67
0.34	4.08	0.1036	0.3065	137.5	0.1981	8.679	31.23
0.35	4.20	0.1067	0.3221	144.6	0.2082	9.123	32.83
0.36	4.32	0.1097	0.3381	151.8	0.2185	9.576	34.46
0.37	4.44	0.1128	0.3545	159.1	0.2291	10.04	36.12
0.38	4.56	0.1158	0.3711	166.5	0.2398	10.51	37.81
0.39	4.68	0.1189	0.3880	174.2	0.2508	10.99	39.54
0.40	4.80	0.1219	0.4053	181.9	0.2620	11.48	41.30
0.41	4.92	0.1250	0.4229	189.8	0.2733	11.98	43.09
0.42	5.04	0.1280	0.4408	197.8	0.2849	12.48	44.92
0.43	5.16	0.1311	0.4590	206.0	0.2967	13.00	46.77
0.44	5.28	0.1341	0.4775	214.3	0.3086	13.52	48.66
0.45	5.40	0.1372	0.4963	222.8	0.3208	14.06	50.58
0.46	5.52	0.1402	0.5155	231.3	0.3331	14.60	52.53
0.47	5.64	0.1433	0.5349	240.1	0.3457	15.15	54.51
0.48	5.76	0.1463	0.5546	248.9	0.3584	15.71	56.52
0.49	5.88	0.1494	0.5746	257.9	0.3714	16.27	58.56
0.50	6.00	0.1524	0.5950	267.0	0.3845	16.85	60.63
0.51	6.12	0.1554	0.6156	276.3	0.3978	17.43	62.73
0.52	6.24	0.1585	0.6365	285.7	0.4114	18.02	64.86
0.53	6.36	0.1615	0.6577	295.2	0.4251	18.63	67.02
0.54	6.48	0.1646	0.6792	304.8	0.4389	19.23	69.21
0.55	6.60	0.1676	0.7009	314.6	0.4530	19.85	71.43
0.56	6.72	0.1707	0.7230	324.5	0.4673	20.48	73.67
0.57	6.84	0.1737	0.7454	334.5	0.4817	21.11	75.95
0.58	6.96	0.1768	0.7680	344.7	0.4963	21.75	78.26
0.59	7.08	0.1798	0.7909	355.0	0.5112	22.40	80.59
0.60	7.20	0.1829	0.8141	365.4	0.5262	23.06	82.96
0.61	7.32	0.1859	0.8376	375.9	0.5413	23.72	85.35
0.62	7.44	0.1890	0.8613	386.6	0.5567	24.39	87.77
0.63	7.56	0.1920	0.8854	397.4	0.5722	25.07	90.22
0.64	7.68	0.1951	0.9097	408.3	0.5879	25.76	92.70
0.65	7.80	0.1981	0.9343	419.3	0.6038	26.46	95.20
0.66	7.92	0.2012	0.9591	430.5	0.6199	27.16	97.73
0.67	8.04	0.2042	0.9842	441.7	0.6361	27.87	100.3
0.68	8.16	0.2073	1.010	453.1	0.6525	28.59	102.9
0.69	8.28	0.2103	1.035	464.7	0.6691	29.32	105.5
0.70	8.40	0.2134	1.061	476.3	0.6859	30.06	108.1
0.71	8.52	0.2164	1.087	488.1	0.7028	30.80	110.8
0.72	8.64	0.2195	1.114	499.9	0.7199	31.55	113.5
0.73	8.76	0.2225	1.141	511.9	0.7372	32.30	116.2
0.74	8.88	0.2256	1.168	524.1	0.7547	33.07	119.0
0.75	9.00	0.2286	1.195	536.3	0.7723	33.84	121.8
0.76	9.12	0.2316	1.223	548.7	0.7901	34.62	124.6
0.77	9.24	0.2347	1.250	561.1	0.8081	35.41	127.4
0.78	9.36	0.2377	1.278	573.7	0.8262	36.20	130.3
0.79	9.48	0.2408	1.307	586.4	0.8445	37.01	133.2
0.80	9.60	0.2438	1.335	599.3	0.8630	37.81	136.1

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Formulas (H in meters): L/S = 428.2 $H_m^{1.72}$ M3/HR = 1541 $H_m^{1.72}$

FEET	INCHES	METERS	CFS	GPM	MGD	L/S	M3/HR
0.81	9.72	0.2469	1.364	612.2	0.8816	38.63	139.0
0.82	9.84	0.2499	1.393	625.3	0.9004	39.46	142.0
0.83	9.96	0.2530	1.423	638.4	0.9194	40.29	145.0
0.84	10.08	0.2560	1.452	651.7	0.9385	41.13	148.0
0.85	10.20	0.2591	1.482	665.1	0.9578	41.97	151.0
0.86	10.32	0.2621	1.512	678.7	0.9773	42.82	154.1
0.87	10.44	0.2652	1.543	692.3	0.9969	43.68	157.2
0.88	10.56	0.2682	1.573	706.0	1.017	44.55	160.3
0.89	10.68	0.2713	1.604	719.9	1.037	45.43	163.4
0.90	10.80	0.2743	1.635	733.8	1.057	46.31	166.6
0.91	10.92	0.2774	1.667	747.9	1.077	47.20	169.8
0.92	11.04	0.2804	1.698	762.1	1.098	48.09	173.0
0.93	11.16	0.2835	1.730	776.4	1.118	48.99	176.3
0.94	11.28	0.2865	1.762	790.8	1.139	49.90	179.6
0.95	11.40	0.2896	1.794	805.4	1.160	50.82	182.9
0.96	11.52	0.2926	1.827	820.0	1.181	51.74	186.2
0.97	11.64	0.2957	1.860	834.7	1.202	52.67	189.5
0.98	11.76	0.2987	1.893	849.6	1.223	53.61	192.9
0.99	11.88	0.3018	1.926	864.6	1.245	54.56	196.3
1.00	12.00	0.3048	1.960	879.6	1.267	55.51	199.7
1.01	12.12	0.3078	1.994	894.8	1.289	56.47	203.2
1.02	12.24	0.3109	2.028	910.1	1.311	57.43	206.6
1.03	12.36	0.3139	2.062	925.5	1.333	58.40	210.1
1.04	12.48	0.3170	2.097	941.0	1.355	59.38	213.7
1.05	12.60	0.3200	2.132	956.7	1.378	60.37	217.2
1.06	12.72	0.3231	2.167	972.4	1.400	61.36	220.8
1.07	12.84	0.3261	2.202	988.2	1.423	62.36	224.4
1.08	12.96	0.3292	2.237	1004	1.446	63.36	228.0
1.09	13.08	0.3322	2.273	1020	1.469	64.38	231.6
1.10	13.20	0.3353	2.309	1036	1.492	65.40	235.3
1.11	13.32	0.3383	2.345	1053	1.516	66.42	239.0
1.12	13.44	0.3414	2.382	1069	1.539	67.45	242.7
1.13	13.56	0.3444	2.419	1085	1.563	68.49	246.4
1.14	13.68	0.3475	2.455	1102	1.587	69.54	250.2
1.15	13.80	0.3505	2.493	1119	1.611	70.59	254.0
1.16	13.92	0.3536	2.530	1135	1.635	71.65	257.8
1.17	14.04	0.3566	2.568	1152	1.659	72.72	261.6
1.18	14.16	0.3597	2.606	1169	1.684	73.79	265.5
1.19	14.28	0.3627	2.644	1186	1.709	74.87	269.4
1.20	14.40	0.3658	2.682	1204	1.733	75.95	273.3
1.21	14.52	0.3688	2.720	1221	1.758	77.04	277.2
1.22	14.64	0.3719	2.759	1238	1.783	78.14	281.2
1.23	14.76	0.3749	2.798	1256	1.809	79.25	285.1
1.24	14.88	0.3780	2.838	1273	1.834	80.36	289.1
1.25	15.00	0.3810	2.877	1291	1.859	81.48	293.2
1.26	15.12	0.3840	2.917	1309	1.885	82.60	297.2
1.27	15.24	0.3871	2.957	1327	1.911	83.73	301.3
1.28	15.36	0.3901	2.997	1345	1.937	84.87	305.4
1.29	15.48	0.3932	3.037	1363	1.963	86.01	309.5
1.30	15.60	0.3962	3.078	1381	1.989	87.16	313.6

Sources: Cutthroat Flume Discharge Relations, Water Management Technical Paper No. 16, Colorado State University, AER71-72RSB6, March 1972
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FEET	INCHES	METERS	CFS	GPM	MGD	L/S	M3/HR
1.31	15.72	0.3993	3.119	1400	2.016	88.32	317.8
1.32	15.84	0.4023	3.160	1418	2.042	89.48	322.0
1.33	15.96	0.4054	3.201	1437	2.069	90.65	326.2
1.34	16.08	0.4084	3.242	1455	2.096	91.83	330.4
1.35	16.20	0.4115	3.284	1474	2.123	93.01	334.7
1.36	16.32	0.4145	3.326	1493	2.150	94.20	338.9
1.37	16.44	0.4176	3.368	1512	2.177	95.39	343.2
1.38	16.56	0.4206	3.411	1531	2.204	96.59	347.6
1.39	16.68	0.4237	3.453	1550	2.232	97.80	351.9
1.40	16.80	0.4267	3.496	1569	2.260	99.01	356.3
1.41	16.92	0.4298	3.539	1588	2.287	100.2	360.7
1.42	17.04	0.4328	3.583	1608	2.315	101.5	365.1
1.43	17.16	0.4359	3.626	1627	2.344	102.7	369.5
1.44	17.28	0.4389	3.670	1647	2.372	103.9	374.0
1.45	17.40	0.4420	3.714	1667	2.400	105.2	378.4
1.46	17.52	0.4450	3.758	1687	2.429	106.4	382.9
1.47	17.64	0.4481	3.802	1706	2.457	107.7	387.5
1.48	17.76	0.4511	3.847	1726	2.486	108.9	392.0
1.49	17.88	0.4542	3.892	1747	2.515	110.2	396.6
1.50	18.00	0.4572	3.937	1767	2.544	111.5	401.2

Sources: Cutthroat Flume Discharge Relations, Water Management Technical Paper No. 16, Colorado State University, AER71-72RSB6, March 1972
Generalized Discharge Relations for Cutthroat Flumes, Journal of the Irrigation and Drainage Division, ASCE, Vol. 98, No. IR4, December 1974

APPENDIX C
Summary of Monitored Stormwater Runoff Events

NSW-1

Date	Runoff Start	Runoff End	Max Stage (Feet)	Total Stormwater Volume (Gal)	Samples Collected	# of Samples
DRY SEASON						
5/14/2015	7:12	7:35	0.053	NM		
5/14/2015	8:13	9:26	0.34	NM		
5/14/2015	9:31	10:27	0.116	NM		
5/14/2015	10:32	12:24	0.567	NM		
5/22/2015	19:06	19:22	0.019	201		
5/28/2015	14:12	14:39	0.435	48		
5/31/2015	3:49	4:36	0.396	1941		
6/1/2015	2:40	2:54	0.112	201		
6/23/2015	8:55	9:07	0.075	259	NSW1-3-01-062315, NSW1-4-01-062315	2
7/12/2015	12:45	13:30	0.364	404		
7/13/2015	7:10	7:20	0.061	36		
7/14/2015	4:00	4:10	0.027	377		
7/14/2015	4:45	5:00	0.128	592	NSW1-1-01-071415, NSW1-2-01-071415, NSW1-3-01-071415, NSW-4-01-071415	4
7/14/2015	7:15	7:45	0.163	395		
7/14/2015	9:15	9:35	0.161	539		
7/15/2015	0:15	0:45	0.027	539		
7/16/2015	20:55	21:25	0.099	628	NSW1-03-01-071615, NSW1-04-01-071615	2
8/18/2015	11:15	12:05	0.677	7755	NSW1-1, NSW-1-3, NSW1-4	3
8/18/2015	13:25	15:25	0.693	2011		
8/20/2015	13:35	14:45	0.877	10735	NSW-1-1-821, NSW-1-3-821, NSW-1-4-821	3
8/20/2015	15:35	17:45	0.709	251		
8/21/2015	3:55	4:15	0.07	377		
8/22/2015	15:05	15:40	0.044	72		
8/22/2015	22:35	22:45	0.034	43731		
8/23/2015	14:45	17:10	0.978	17808		
8/23/2015	22:05	0:40	0.828	4775		
8/24/2015	1:55	3:05	0.159	121014		

Date	Runoff Start	Runoff End	Max Stage (Feet)	Total Stormwater Volume (Gal)	Samples Collected	# of Samples
8/24/2015	3:45	9:00	1.068	8563		
8/24/2015	21:25	22:55	0.778	32385		
8/25/2015	12:55	16:20	0.848	1293	NSW-1-01-82515, NSW-1-02-82515, NSW-1-03-82515, NSW-1-04-82515	4
8/26/2015	12:35	17:20	1.096	84931		
8/27/2015	13:05	16:30	0.739	44898		
9/1/2015	4:25	4:55	0.132	539	NSW-1-01-9315, NSW-1-02-9315, NSW-1-03-9315	3
9/1/2015	18:50	20:00	0.365	1759		
9/3/2015	14:15	15:20	0.559	7585		
9/5/2015	15:05	17:20	1.028	31021		
9/7/2015	11:55	12:40	0.344	1939		
9/7/2015	15:55	16:30	0.154	691		
9/11/2005	2:25	3:55	0.421	1939	NSW-01-01-91215, NSW-01-02-91215	2
9/11/2015	6:45	9:40	0.378	4398		
9/11/2015	13:25	15:05	0.633	13105		
9/13/2015	13:15	14:15	0.341	1293		
9/14/2015	18:45	19:10	0.06	449	NSW-01-01-91615, NSW-01-02-91615, NSW-01-03-91615	3
9/14/2015	22:25	23:10	0.254	1131		
9/15/2015	0:15	3:15	0.315	5170		
9/18/2015	5:55	8:05	0.532	4250		
9/18/2015	14:15	14:55	0.028	200		
9/26/2015	3:15	4:05	0.292	1000		
9/30/2015	2:05	2:50	0.148	275		
10/13/2015	6:30	8:00	0.524	4300		
10/14/2015	9:20	10:30	0.332	960		
10/17/2015	22:10	23:30	0.127	490		
10/20/2015	8:10	9:30	0.101	340		
10/31/2015	10:20	12:20	1.019	15285		
WET SEASON						
11/4/2015	6:30	7:40	0.062	125		
11/4/2015	20:00	12:50	0.348	7700		

Date	Runoff Start	Runoff End	Max Stage (Feet)	Total Stormwater Volume (Gal)	Samples Collected	# of Samples
11/7/2015	7:30	12:40	0.514	9150		
11/9/2015	23:10	5:40	0.536	7600	NSW-01-03-111015, NSW-01-04-111015	2
11/10/2015	8:30	11:00	0.345	3150		
11/11/2015	13:40	15:40	0.215	510	NSW-01-01-111315, NSW-01-02-111315	2
11/11/2015	18:30	19:40	0.404	2800		
11/13/2015	21:10	2:00	0.389	2960	NSW-01-01-111615, NSW-01-02-111615, NSW-01-03-111615	3
11/17/2015	19:40	22:00	0.128	366		
11/19/2015	18:50	22:40	0.784	17675	NSW-01-01-112015, NSW-01-02-112015, NSW-01-03-112015	3
11/20/2015	1:00	8:20	0.451	11400		
11/20/2015	16:50	21:10	0.489	9900		
11/21/2015	1:00	15:00	0.821	47800		
11/22/2015	4:00	6:40	0.291	830		
11/22/2015	9:00	12:40	0.298	2100		
11/22/2015	17:30	18:50	0.47	3625		
11/23/2015	4:10	10:40	0.806	30185		
11/26/2015	9:00	22:30	0.518	28300		
11/27/2015	2:30	4:00	0.119	420		
12/10/2015	7:10	10:00	0.479	3630	NSW-01-01-121015, NSW-01-02-121015	2
12/11/2015	12:10	14:50	0.072	263		
12/18/2015	8:30	11:20	0.28	1600		
12/18/2015	12:10	14:40	0.357	1945		
12/18/2015	16:30	19:40	0.495	4140		
12/18/2015	20:00	21:40	0.343	1943		
12/19/2015	2:10	3:30	0.197	451		
12/19/2015	18:40	23:30	0.421	5436		
12/20/2015	18:50	20:30	0.07	227		
12/21/2015	3:50	5:10	0.311	1182		
12/21/2015	6:20	23:40	0.481	25500		
12/22/2015	5:50	7:20	0.184	418		
12/22/2015	1:30	3:00	0.271	1154		

Date	Runoff Start	Runoff End	Max Stage (Feet)	Total Stormwater Volume (Gal)	Samples Collected	# of Samples
12/22/2015	14:40	22:00	0.419	7310		
12/26/2015	4:40	12:20	0.424	4553		
12/28/2015	2:10	3:30	0.076	146		

Total # of Samples Collected at NSW-1 in 2015 **38**

NSW-2

Date	Runoff Start	Runoff End	Max Stage (Feet)	Total Stormwater Volume (Gal)	Samples Collected	# of Samples
DRY SEASON						
5/14/2015					Start Monitoring	
8/18/2015	14:25	14:35	0.029	20		
8/20/2015	15:55	16:25	0.052	86	NSW2-1-82115, NSW-2-2-82115	2
8/23/2015	14:55	17:20	0.963	43231	NSW2-1-082315, NSW-2-2-082315, NSW-2-3-082315, NSW-2-4-082315 (Samples collected on 08/24)	4
8/23/2015	22:05	0:40	0.745	19797		
8/24/2015	3:55	8:25	1.309	115674		
8/24/2015	21:35	22:55	0.35	5037		
8/25/2015	13:00	16:20	0.674	23733	NSW-2-01-82515, NSW-2-02-82515, NSW-2-03-82515, NSW-2-04-82515	4
8/26/2015	12:45	17:10	1.272	122817		
8/27/2015	13:15	16:30	1.029	79728	NSW-2-01-82715, NSW-2-02-82715, NSW-2-03-82715, NSW-2-04-82715	4
9/3/2015	14:15	15:50	0.354	5121	NSW-2-01-9315, NSW-2-02-9315, NSW-2-03-9315, NSW-2-04-9315	4
9/5/2015	15:15	17:20	0.809	18896	NSW-2-01-9815, NSW-2-02-9815, NSW-2-03-9815, NSW-2-04-9815	4
9/11/2015	13:25	15:15	0.536	11231	NSW-2-01-91215, NSW-2-02-91215, NSW-2-03-91215, NSW-2-04-91215	4
9/11/2015	18:45	19:25	0.16	30		
9/15/2015	1:05	3:15	0.041	224		
9/18/2015	6:25	7:55	1.008	870		
10/31/2015	10:40	11:50	0.527	7475		
WET SEASON						
11/5/2015	2:30	6:20	0.119	1500	NSW-2-01-11515	1
11/7/2015	8:10	13:20	0.202	6150		
11/9/2015	0:30	5:40	0.235	3700	NSW-2-01-111015, NSW-2-02-111015, NSW-2-03-111015	3
11/11/2015	18:40	19:40	0.036	45		
11/13/2015	23:40	1:20	0.066	335	NSW-2-01-111615	1
11/19/2015	19:00	23:00	1.062	39210	NSW-2-01-112015, NSW-2-03-112015, NSW-2-04-112015	3
11/20/2015	1:30	4:40	0.146	2715		
11/20/2015	17:00	19:00	0.033	90		
11/21/2015	0:50	15:20	0.88	58190		

Date	Runoff Start	Runoff End	Max Stage (Feet)	Total Stormwater Volume (Gal)	Samples Collected	# of Samples
11/23/2015	5:20	10:30	1.083	67452		
11/26/2015	9:00	23:00	0.256	18215		
12/10/2015	8:00	10:30	0.224	3312	NSW-2-01-121015, NSW-2-02-121015, NSW-2-03-121015, NSW-2-04-121015	4
12/18/2015	12:30	13:20	0.027	50		
12/18/2015	16:50	19:20	0.114	943		
12/19/2015	20:40	22:40	0.132	1230		
12/21/2015	6:00	23:50	0.082	2260		
12/22/2015	15:00	22:10	0.13	1800		
12/26/2015	11:00	12:30	0.079	380		

Total # of Samples Collected at NSW-2 in 2015 **38**

APPENDIX D
Field Logbook

5/12/2015

8:30 Meet Matt Neal, Marvin Heskett in office

9:15 Head to Home Depot to purchase equipment and supplies for the stormwater collection site installation

10:45 Arrive at NCJAMS

10:45-15:30 Install a 54 inch length by 6 inch wide cutthroat flume at NSW-2. Flume was constructed of 3/4" thick plywood. In addition, we installed a 3" diameter stilling well adjacent to the flume and placed the plastic Navy supplied equipment shed adjacent to the wooden flume.

15:30-15:45 Briefly inspected the NSW-1 monitoring site

15:55 Exit Site

Rite in the Rain

5/13/2015

7:00 meet in Office

8:15-9:00 Get additional field supplies from Home Depot

9:15 M Hoskett M McNeal arrive at site

9:30 S. Speyer Arrive at Site

9:35 Conduct Tailgate Safety Briefing

9:45 Extend wing wall of flume structure, install rain gauge, install Global samplers, pH probe, pressure transducer install

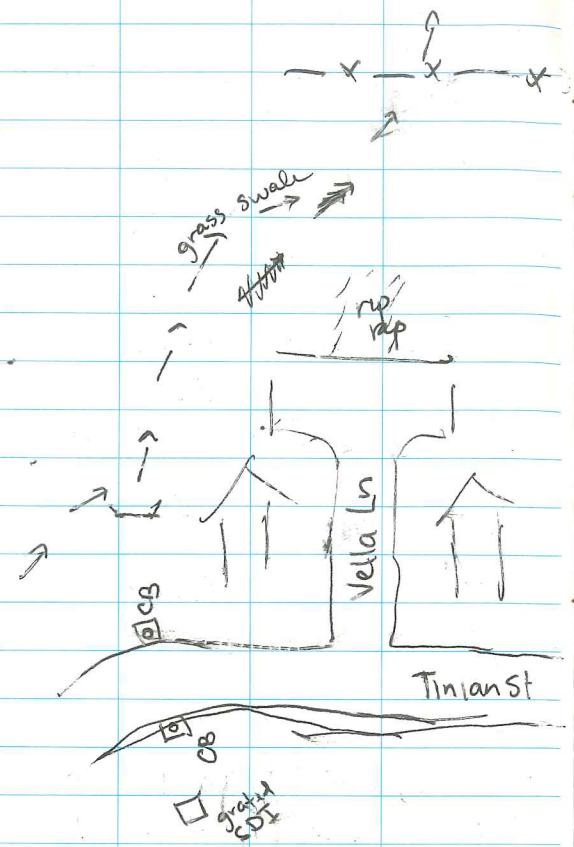
10:30 S. Speyer talked to the two police officers at the installation to let them know that we were going to be jumping the fence at the dog park area to install equipment at monitoring site NSW-1

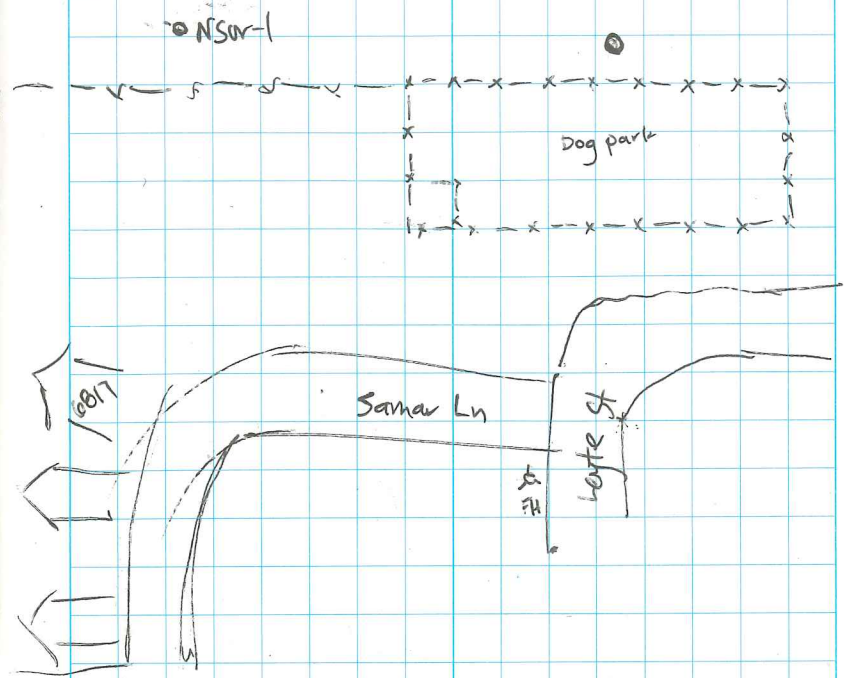
10:45 C Borges arrive on site

11:00 Begin veg clearing @ NSW-1. N 021° 30.858'
(WGS 84) W 157° 59.987'

Other SD outlet @ extension of Leyte
(lower end of dog park) N 021° 30.838'
W 158° 00.018'

Rite in the Rain





@ NSW-1, install stormwater sample collection system. "Henry" and "Rosanne"
Tested batteries – need new battery for Rosanne

Near antenna field and above Bldg 393, concrete swale across asphalt road diverts water runoff toward the bushes

Rite in the Rain

grate SD1 @ top of main road below the jogging track. Piped to headwall outlet @ CDC Bldg B477. Second culvert under sidewalks to CDC. Final outlet to grassy field (slight slope)
Uncertain whether discharge will reach Kaukonahua Stream or infiltrate prior to reaching the steep slope to the gulch.
*Note: swale to top SD1 is unlined earthen swale - scoured / eroding

15:50 E2 demob from site

5/18/15 11:30 am
NCTAMS Antenna Field NSW-2
evidence of rain. scour marks on weir @ 6"

Sampler Lucille did not trigger as wire harness was partly detached. Totalizer reads 524 gal
wire harness repaired & tested

Sampler Alfred triggered but bottles did not fill, small amt of liquid in pump l. indicates a small rain event likely triggered pump, utilized battery before larger rain event. Consider raising sensor & using larger battery.
Battery replaced.

11:50 am - rain gauge filled >> 1.00"
tipping rain gauge installed.

12:17 - pH probe & transducer inspected ✓ ok

Rite in the Rain

5/18/15 cont.

12:23 global logger info uploaded

12:35 NSW-1 Sampler Henry inspected. 2 samples taken, data downloaded & battery replaced

12:45 Rosanne inspected. 2 samples taken. 72,000 gallons of water sampled. Data uploaded. Battery replaced.

12:53 left site.

5/20/15 MDH, SS arrive 12:20.
Rain gauge @ NSW-2 read 0.15"
no samples taken @ any site.
Rain gauge post installed in open field East of Housing, North of Basketball court.
transducer data uploaded for all sites.

5/27/15

9:45 ARRIVED AT SITE
MANUAL RAIN GAUGE.
@ NSW2 · 0.16" RAIN

WAITING FOR FLOW MONITORING UNIT ON ONE OF GLOBALS.

RESET FLOW MONITOR.

pH 7.04

~~2ND GLOBAL WATER SENSOR~~

DIMENSIONS OF ENCLOSURE FOR SHELF:
W 31.5" × D 20".

- INSTALLED TIPPING GAGE, RAIN BUCKET. NEAR CHILDCARE CENTER

10:54 LEFT SITE.

Rite in the Rain

11:00 ARRIVED AT NSW1

~~RECHARGE~~ REPLACED BATTERY IN PUMPY TOTALIZER., REMOVED TOTALIZER FROM BATTERY

11:13 LEFT SITE.

6/23/15

~~ARR~~

9:57 ARRIVED AT NSW 1: CB, RY & JT
WEATHER: CLOUDY, LIGHT ~~SHOWERS~~ RAIN

REPLACED BATTERIES.
* COLLECTED SAMPLE FROM BOTTLE 3, & PARTIAL SAMPLE FROM 4

10:35 LEFT SITE.

10:40 ARRIVED AT NSW 2
MANUAL RAIN GAGE = 0.85
WEATHER: OVERCAST, NO RAIN

NO SAMPLES COLLECTED
BATTERIES WERE STILL GOOD.

11:09 LEFT SITE

* SAMPLE FROM BOTTLE 3 INCLUDED 3 BOTTLES TOTAL. (2 - SULPHURIC ACID PRESERVED, 1 - NOT PRESERVED)
COLLECTED AT 10:00

SAMPLE FROM BOTTLE 4 (PARTIALLY FILLED 3 BOTTLES, - 2 × SULPHURIC ACID, 1 - NOT PRESERVED)
COLLECTED AT 10:15

— JCAT

OUT OF ORDER

6/3/15 RAINFALL @ NSW-2 = 0.4"
Appeared to have fell on 5/31 and 6/1. Did not trigger the sampler @ NSW-2
NSW-1 raingauge malfunctioned. One of the two samplers triggered and sputtered a few 100 mls of sample.

6/13/15 Rainfall @ NSW-2 = 0.2" Samplers did not trigger Replaced NSW-1 raingauges

6/17/15 Downloaded the hobo raingags. Samplers did not trigger

Rite in the Rain

6/26/15 Arrived at Site at 9:00 Am
Rain Gauge = 0.28
Downloaded data from transducer at NSW-1
HAD DIFFICULTY DOWNLOADING THE TRANSDUCER
AT NSW-2. INSTALLED A NEW TRANSDUCER
THAT STARTED @ 11:00 AM AND MEASURED
WATER LEVELS @ 10 MIN INTERVALS
ALSO RESET THE EXISTING TRANSDUCER @
NSW-1 TO START @ 11:00 AM

7/7/15 Arrived at Site @ 10:20
RAIN GAUGE = 0.20"
The roads were wet upon arrival at the site
Replaced the batteries at the two monitoring
sites (all 4)
Left site @ 11:10 under slight drizzle

Rite in the Rain

7/11/15 16:00 RY and CB arrive @ NCTAMS
Rain gauge = 0.76
16:15 NSW 1 Samplers did not trigger
tested all pumps
16:35 NSW 2 Samplers did not trigger
tested all pumps

7/14/15 10:30 arrive on site MH, RY, CB
+ Anne Hong & Ravi M (NAVFAC HI)
NSW 1 Samplers triggered - all 4 bottles

7/16/15 RY & CB arrive @ NSW-1 19:20
Green ball moved
NSW1 - Samplers 1 and 2 did not trigger
* Replaced battery and tested pumps
NSW1 - Samplers 3 and 4 collected (full bottles)

	pH	temp	turb	time
NSW1-3	6.77	24.1	1.80 NTU	20:00
NSW1-4	6.61	24.3	1.24 NTU	19:58

* Replaced battery and tested pumps

RAIN GAUGE: 1.00 in 2030

NSW2 Samplers did not trigger
Tested pumps - did not replace batteries

7/29/15 MH SS @ NSW-2 @ 13:17
Rain gauge 0.68" since 7/16/15

pump timing test
1 - start to full trigger working
2 - not triggered
3 - start t=0 to full
4 - start t=0 to full
pH meter and buffer @ NSW-2

Rite in the Rain

7/29/15 onsite batteries inspected
rain gauge & flow data uploaded
no flow events.

13:39 NSW-1
samplers triggered. 3:4 full
1 empty 2 partial.
transducer data shows
flow @ 7/17 last samples
discarded.

pump flow schema
1 10 min delay then full
2 10 min delay 600ml/5m
3 start to fill
4 5min delay 600ml
trigger in water sensor
rain sensor plugged

user name
sprens0001

8/5/2015 Rain had passed through the site between 7:30-9:00. It was still drizzling upon arrival at the site. Brush fire and helicopter water dumps were occurring during the site visit.
No evidence of runoff at either NSW-1 or NSW-2

Manual Rain Gauge Measurement = 0.47 inch at ontanne field @ 9:55AM

8/6/2015 MARVIN Downloaded the HOBO Rain Gauge in the open field NSW-1

8/7/2015
MANUAL RAIN GAUGE = 0.14" @ 15:00
Downloaded Rain gauge in the open field @ NSW-2
Disconnected Battery @ ISCO site
8/11/2015 MANUAL RAIN GAUGE = 0.46" @ 10:00
No visual evidence of runoff @ NSW-2 or NSW-1
Checked batteries at both sites, Still Good
Reconnected Battery @ ISCO site
8/17/2015 MANUAL RAIN GAUGE = 0.29 @ 14:40
No runoff at NSW-1 or NSW-2
Downloaded the HOBO at NSW-2. Could not download the HOBO at NSW-3.

Rite in the Rain

8/21/15 Likely runoff from rain that fell the afternoon of 8/20/15

NSW-2-2 DO = 4.51

Turb = 55.3 pH = 6.84

Sal = 0.03

Temp = 25.45

Spc = 0.057

8/18/15 Storm Event started ~ 11:20

Collected sample from NCTAM's Annual Stormwater Site ~ 12:30

Collected three samples from NSW-1 - Sample Bottles 1, 3 and 4 were collected

No flow @ NSW-2, despite MANUAL RAIN - 0.53" @ 13:40

Bottle 1 = 0.211 mS/cm

Bottle 2 = 0.055 mS/cm

Bottle 3 = 0.048 mS/cm

8/19/15 MANUAL RAIN GAUGE = 0.45" @ 11:30

Replaced batteries @ NSW-2 Antennas Tuned @ 12:00 All 4 water Bottles had refilled during yesterday's storm after we had collected our initial 3 samples. Samples were not saved for analysis

Re-installed tipping rain gauge in open field at NSW-1

8/21/15 MANUAL RAIN GAUGE = 0.77" @ 12:30

Pump still on @ NSW-2 upon arrival Filled up 1.5 Bottles - 2 SAMPLES NSW-2-1 / NSW-2-2

Temp = 24.74 pH = 6.96

Spc = 0.054 mS/cm Sal = 0.03

DO = 4.33 mg/L Turb = 67.4

NSW-2-4

Rite in the Rain

8/21/15 13:30

Collected runoff samples from NSW-1. Measured water quality parameters

PARAMETER	NSW-1-1	NSW-1-3	NSW-1-4
Temperature	24.65	24.35	24.33
SpC (mS/cm)	0.042	0.036	0.025
Dissolved Oxygen	4.92	4.41	4.45
pH	5.95	6.08	6.16
Salinity	0.03	0.02	0.02
DO %	51.2	51.8	51.7
Turbidity (NTU)	12.1	5.0	3.8

8/22/15

MANUAL RAIN GAUGE = 0.13" @ 15:00

Runoff visually observed @ NSW-1 to begin ~ 15:15

NSW-1 @ 15:30 Flow Measured @ 5 sec/2 Gallon

Short duration rainfall event.

Replaced two batteries @ NSW-2 Gauge.

Left batteries unconnected @ NSW-1 since it was flowing during site visit

Download NSW-2 Hobo ~ 15:10

" NSW-1 Hobo ~ 16:05

Download transducer data at NSW-1 ~ 15:10

Download transducer data at NSW-2 ~ 16:00

Rite in the Rain

NSW-1

82515	Temp	SpC	DO	pH	Turb
NSW-01	24.97	0.074	5.02	6.45	21.9
-02	24.55	0.038	6.35	6.46	6.4
-03	24.07	0.018	6.54	6.43	3.1
-04	24.14	0.034	6.78	6.37	7.9

NSW-2

		0.019	5.06	6.60	
NSW-02-1	24.53	0.019	~~6.28~~	~~6.12~~	148
02-2	24.52	0.018	5.25	6.43	139
02-3	24.59	0.018	5.10	6.39	103
02-4	24.62	.022	5.14	6.34	165

Grab @ 15:55 → 26.08 0.030 4.90 6.36 145

8/27/15
Antonio Field - Downloaded the HOBO. Large Runoff event
MANUAL RAINGAUGE = 6.98 inches

Collected 4 stormwater samples from the antonio field
NSW-2-01-082315
-02
-03
-04
] very turbid colored in color

~~8/28/15~~ Arrive @ 14:00 Recent Rain
Runoff @ NSW-1 still occurring @ 14:10 2 gal/sec
Collected for Samples
MANUAL RAIN = 2.02" @ 16:00

NSW-1-01082315	Temp	SpC	DO	pH	Turb
-02					
-03					
-04					

@ 15:02 5 gal/2sec at NSW-1

@ 15:15 2 gal/6sec @ NSW-2

@ 16:00 ~5 gal/min @ NSW-2

Rite in the Rain

8/27/15
Arrival at Site @ 13:40 heavy runoff @ NSW-2

NSW-02-01-82715 @ 13:40
T=25.77 SpC=0.014 pH=6.01 Turb=358

NSW-02-02-82715 @ 13:55

T=25.37 SpC=0.017 pH=6.02 Turb=345

NSW-02-03-82715 @ 14:10

T=25.10 SpC=0.015 pH=6.04 Turb 228

NSW-02-04-82715 @ 14:40
T=24.71 SpC=0.017 pH=6.05 Turb 204

NSW-1 @ 14:20 Manual Flow
~ 2 gal/sec
14:40 6-8 gal/sec

Rite in the Rain

8/28/15 Arrived Site @ 11:30

MANUAL RAINFALL
@ 11:30 = 6.2"

Downloaded NSW-2 transducer
replaced batteries @ NSW-2

Installed Hobo rain gauge near
residential area @ 12:00

Replaced batteries @ NSW-1

9/1/15 Arrived @ Site @ 12:20

MANUAL RAINFALL = 0.17"

Reset the samplers at NSW-1
and NSW-2

Rite in the Rain

9/3/15 Arrival @ Site @ 13:40

Manual Rainfall = 0.39"

No runoff @ NSW-2

3 Sample Bottles @ NSW-1

NSW-01-01-090315

T=24.55 SpC= 0.056 ms/cm pH= 7.28 Turb= 7.4

NSW-01-02-090315

T=24.29 SpC= 0.046 pH= 7.15 Turb= 7.7

NSW-01-03-090315

T=24.38 SpC= 0.030 pH= 7.07 Turb= 5.2

Collect Sample @ 14:00

Heavy rain started @ ~1410 manually collected sample at NSW-2

Rite in the Rain

Visual flow →
@ 14:35 ~ 2.5 gal/sec

manual rain
= 0.71"
@ 14:50

@ 14:50 ~ 1 gal/sec

@ 15:20 ~ 0.5 gal/sec

9/3/15

NSW-02-01-90315 @ 14:20

T=25.85 SpC=0.029 pH=6.93 Turb=380

NSW-02-02-90315 @ 14:35

T=25.08 SpC=0.021 pH=6.89 Turb=174

NSW-02-03-90315 @ 14:50

T=25.55 SpC=0.022 pH=6.17 Turb=251

NSW-02-04-90315 @ 15:20

T=26.48 SpC=0.032 pH=6.52 Turb=179

9/8/15 Arrive @ 8:30

MANUAL RAIN GAUGE = 2.68"

Download Transducer data at NSW-1 and NSW-2

Rite in the Rain

9/8/15

NSW-02-01-90815 @ 9:00

T=23.28 SpC=0.023 pH=6.02 Tur.b=103

NSW-02-02-090815 @ 9:00

T=23.10 SpC=0.020 pH=5.93 Tur.b=120

NSW-02-03-90815 @ 9:00

T=23.16 SpC=0.022 pH=5.78 Tur.b=94.7

NSW-02-04-90815 @ 9:00

T=23.20 SpC=0.022 pH=5.76 Tur.b=140

~~NSW-01-01-90815 @ 10:15~~

Rite in the Rain

runoff occurred
on 9/11 13:25-15:15 →

9/12 @ 3:50
Manual rainfall = 1.85"

NSW-02-01-91215 @ 9:00
T=23.43 SpC=0.047 pH=6.6 Turb=195
NSW-02-02-91215 @ 9:00
T=23.34 SpC=0.022 pH=6.30 Turb=143
NSW-02-03-91215 @ 9:00
T=23.38 SpC=0.022 pH=6.01 Turb=122
NSW-02-04-91215 @ 9:00
T=23.36 SpC=0.023 pH=5.98 Turb=159

NSW-01-01-91215 @ 10:15
T=23.78 SpC=0.066 pH=6.23 Turb=20.5

NSW-01-02-91215 @ 10:15
T=23.92 SpC=0.045 pH=6.1 Turb=8.0

9/14/15
manual RAINFALL = 0.40"
@ 9 Am
1) Download pressure transducers
2) Turn on samplers
3) HOBO in residential area is not downloading

Rite in the Rain

9/16/15

MANUAL RAINFALL = 1.49 @ 9:40

NSW-2 - NO SAMPLES COLLECTED

NSW-1-01-91615 @ 10:45

T=23.83 SpC=.107 pH=6.38 Turb=12.3

NSW-1-02-91615 @ 10:45

T=23.56 SpC=0.047 pH=6.34 Turb=13.0

NSW-1-03-91615 @ 10:45

T=23.46 SpC=0.027 pH=6.27 Turb=9.1

Turned off sampler @ NSW-1, left sampler at NSW-2 ON.

9/30/15 Manual Rainfall = 4.24" @ 10:00

Downloaded NSW-2 transducer

Downloaded NSW-1 "

Downloaded both HOBO rain gauge

Replace batteries in Globals @ NSW-2

NSW - disabled samplers until November!

Rite in the Rain

10/13/15

Manual Rainfall @ NSW2@ 10:45 = 1.11"
No samples @ NSW-2

10/29/15 2.56" manual rainfall
Conducted transducer @ NSW-2, reactivated NSW-1. Visit with NAVFAC personnel

~~10/4~~ 11/4/15 1.61" manual rainfall
runoff occurred middle of day on 10/31

		Temp	Sp C	DO	pH	Turb
NSW-02	-1	22.68	0.054	2.71	7.17	125
	-2	22.10	0.045	3.34	7.10	102
	-3	21.90	0.033	4.10	7.03	80.5
-3/4 Full	-4	22.52	0.030	4.47	6.62	111

NSW-01	-1	22.63	0.044	3.18	7.32	23.5
	-2	22.48	0.065	4.06	6.62	18.3
	-3	22.27	0.021	4.37	6.39	22.4
	-4	22.20	0.047	4.58	6.16	21.7

Replaced batt. →

Rite in the Rain

11/5/15 NSW-2 raining, low flow through flume. ~ 0.25" no sample collected but aliquots were triggered. Guess that flow level was too low for suction hose. 1 manual sample collected @ 11:45

temp = 24.52
cond = 0.090 ms/cm
D.O = 5.30 / 63.4%
turb = 136 NTU
pH = 6.70

rainfall uploaded & measured @ 1.48" manually. Batteries reset

12:10 NSW-1 small flow. pool Almost full. no samples. Batteries replaced. trigger cleared

11/10/15 MANUAL RAINFALL = 3.13"

	Temp	SpC	DO	pH	Turbidity
NSW-02-1	22.66	0.097	4.64	7.07	115
02-2	21.94	0.063	4.47	6.60	113
02-3	21.87	0.047	4.27½	6.46	100
02-4	22.03	0.043	4.55	6.46	77

Submitted Samples for 02-1, 02-02, 02-3 for analysis.
Insufficient volume of water in 02-4 bottle for analysis

NSW-01-03	22.77	0.030	5.75	7.72	14
-01-04	22.78	0.035	5.49	7.27	21

Samples for 01-01 and 01-02 did not activate

11/13/15 MANUAL RAINFALL = 1.00" @ 13:00

Download Rain Gauges — Runoff likely occurred on 11/11

NSW-01-01	22.83	0.146	4.43	6.65	14.2
NSW-01-02	22.20	0.103	4.76	6.65	10.9

Downloaded transducer @ NSW-1 and both rain gauges

11/16/15 Manual Rainfall = 1.23" @ 9:35

NSW-02-01	20.83	0.124	5.46	6.33	145
NSW-01-01	21.99	0.137	4.49	6.52	9.6
NSW-01-02	21.19	0.113	4.88	6.16	12.5
NSW-01-03	21.99	0.102	5.25	6.05	13.6

11/20/15 MANUAL RAINFALL = 2.94" @ 9:45

NSW-01-01	21.68	0.135	3.85	6.74	17.5
NSW-01-02	21.56	0.083	4.25	6.34	11.1
NSW-01-03	21.74	0.042	4.70	6.23	17.1

@ 9:45

Rite in the Rain

11/20/15 @10:00

	Temp	SpC	DO	pH	Turbidity
NSW-02-01	21.62	0.059	4.86	6.56	220
NSW-02-03	21.66	0.050	4.82	6.42	241
NSW-02-04	21.67	0.029	4.59	6.26	239

SAMPLER NSW-02-02 only partially filled - no sample

12/2/15 MANUAL RAINFALL = 1.39" @8:00am

Installed batteries and downloaded the rain gauges.

12/4/15 MANUAL RAINFALL = 0.33" @12:30

12/10/15 It had just rained prior to arrival at Hesto

Manual Rainfall = 1.25"

	Temp	SpC	DO	pH	Turbidity
NSW-01-01	21.41	0.094	3.33	6.70	25.5
NSW-01-03	21.72	0.038	5.25	6.69	51.5

SMALL Amount of stream flow at NSW-2 @ 12:00

NSW-02-01	21.56	0.056	5.54	6.30	221
NSW-02-02	21.50	0.055	5.84	6.26	210
NSW-02-03	21.51	0.051	5.85	6.25	203
NSW-02-04	21.57	0.047	5.87	6.25	154

1/4/16 @10:00 MANUAL RAINFALL = 8.07"

Download transducers

1/6/16 @11:00 manual Rainfall = 0.66"

Transported Housing Unit for Nay to the Site

Rite in the Rain

APPENDIX E

Hourly Rainfall Amount (Hundredth of Inches) and Runoff Tracker for JBPHH-Wahiawa Annex

May-15	HOURLY RAINFALL TOTALS: MAY 2015																							
DAY	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00
15													Start	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	5	2	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	1
20	2	2	2	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	5	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	1	0	23	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Runoff detected at NSW-1 but not at NSW-2
	Runoff detected at NSW-1 and NSW-2

Jun-15	HOURLY RAINFALL TOTALS: JUNE 2015																							
DAY	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00
1	0	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	1	2	2	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	5	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	1	5	3	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	1	0	2	2	1	3	6
22	1	2	5	1	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
23	0	0	0	8	2	2	4	12	3	0	1	0	0	0	1	0	0	3	0	1	0	0	2	0
24	1	0	0	4	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
25	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	1	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	5	5
29	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Runoff detected at NSW-1 but not at NSW-2
	Runoff detected at NSW-1 and NSW-2

Jul-15	HOURLY RAINFALL TOTALS: JULY 2015																							
DAY	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
7	0	0	0	0	1	1	0	3	2	0	0	0	0	0	0	0	0	0	0	3	5	3	0	1
8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	3	4	7	3	2	3
10	2	0	3	3	3	3	5	4	2	1	2	2	0	0	0	1	0	0	0	0	0	0	0	0
11	0	0	0	0	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
12	0	0	0	0	0	0	0	0	0	0	1	42	1	0	0	0	0	1	1	5	12	8	2	2
13	1	3	4	6	8	10	9	7	2	1	0	0	0	0	0	0	0	0	0	1	0	0	0	3
14	7	14	9	11	3	10	11	9	6	0	5	3	0	0	0	0	1	0	0	1	2	7	13	13
15	5	1	4	6	1	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	3	9	4	1
16	1	0	2	0	0	0	0	0	2	1	0	0	0	0	0	0	8	5	0	7	10	0	0	0
17	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	1	5
19	2	4	1	3	5	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	1	0	0	0	0	0	4	1	1	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	0	0

	Runoff detected at NSW-1 but not at NSW-2
	Runoff detected at NSW-1 and NSW-2

Aug-15	HOURLY RAINFALL TOTALS: AUGUST 2015																							
DAY	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	3	4
5	0	1	5	7	3	1	1	5	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
6	0	0	0	1	2	1	2	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	7	36	1	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	16	3	46	3	0	0	0	0	0	0	0	0
21	0	0	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	1	3	6	1	5	0	0	0	1	4	0	1	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	40	168	7	0	0	0	0	20	64	21	0
24	6	7	38	214	87	27	8	1	0	0	0	0	0	0	0	0	0	1	5	2	53	1	0	0
25	0	0	1	0	0	0	0	0	0	0	3	31	88	9	12	1	3	12	0	0	0	0	0	0
26	0	0	1	0	0	0	0	0	0	0	0	102	85	166	23	0	0	0	0	0	0	0	1	0
27	0	0	0	0	0	0	0	0	0	0	0	9	122	94	3	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0

	Runoff detected at NSW-1 but not at NSW-2
	Runoff detected at NSW-1 and NSW-2

Sep-15	HOURLY RAINFALL TOTALS: SEPTEMBER 2015																							
DAY	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00
1	0	0	0	10	0	0	0	1	0	1	0	0	0	0	0	0	0	14	0	0	0	0	0	0
2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3	0	9	2	0	0	0	0	0	4	2	3	3	0	65	0	1	0	0	0	0	0	0	0	1
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	128	1	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	4	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	1	0	24	12	5	2	11	0	1	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	1	14	1	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	12	6	0	1	8	14	2	3	0	0	1	73	9	7	8	4	13	1	2	3	0	0	5
12	3	0	0	0	0	0	0	1	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
13	0	0	0	0	0	1	3	2	5	1	0	4	12	3	1	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	4	4	10	3	6	8	14	3	13
15	16	9	5	6	5	2	5	10	5	1	0	1	0	0	0	0	8	3	1	2	1	2	2	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	12	8
18	5	1	0	2	6	28	9	1	3	1	2	1	2	10	1	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	6	3	0	0	0	0	0	0	0	1	0	0	1	7	2	1	0	1	0
20	0	0	0	0	0	0	0	0	0	0	0	0	6	8	0	0	0	0	0	1	0	0	1	0
21	0	0	0	1	3	7	6	6	5	0	0	6	0	0	0	0	0	0	0	1	0	0	0	0
22	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	1	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
24	0	4	1	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	8	2
25	0	1	0	0	1	1	1	2	3	1	0	0	1	0	1	1	0	0	0	1	8	6	3	5
26	12	2	13	2	0	1	1	0	0	0	0	2	0	1	0	0	0	1	0	0	0	0	0	0
27	0	1	0	0	1	3	2	10	5	3	6	0	1	2	0	2	4	1	2	1	1	0	1	0
28	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1
29	4	1	0	0	0	1	5	2	0	0	0	0	0	0	4	1	1	1	7	8	5	4	8	7
30	9	6	1	0	0	4	1	0	0	0	0	0	0	0	0	2	0	1	1	3	0	0	1	3

	Runoff detected at NSW-1 but not at NSW-2
	Runoff detected at NSW-1 and NSW-2

Oct-15	HOURLY RAINFALL TOTALS: OCTOBER 2015																							
DAY	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00
1	2	0	0	0	0	0	2	2	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	7	0	2
7	2	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	3	8	1	0	0	0	0	6	0	1	0	3	2	0	0	0	0	0	0	0	0
13	0	0	0	0	0	27	24	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
14	0	0	0	0	0	0	15	14	12	6	3	2	0	0	1	5	2	0	4	0	0	0	2	2
15	0	0	1	0	0	0	0	6	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
17	1	1	0	1	0	0	0	0	0	0	0	1	4	2	3	2	4	3	4	8	7	7	0	1
18	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	1
20	1	0	6	0	1	6	9	12	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	5	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5	4	4	3	2	3
27	3	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	1	0	0	0	172	0	0	0	0	0	0	0	0	0	0	1	2	1	0

	Runoff detected at NSW-1 but not at NSW-2
	Runoff detected at NSW-1 and NSW-2

Nov-15	HOURLY RAINFALL TOTALS: NOVEMBER 2015																							
DAY	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00
1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
3	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	2	0	1
4	0	0	0	3	3	17	5	5	2	0	0	0	0	0	0	0	0	0	9	12	5	2	7	13
5	8	17	14	9	8	7	7	8	8	4	9	2	3	0	2	0	0	0	2	5	1	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0
7	0	2	0	2	7	9	13	20	26	8	21	2	1	0	0	0	0	0	0	0	0	0	0	1
8	3	2	3	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	9	18	21
9	7	1	10	18	1	0	0	0	0	0	0	0	0	0	0	1	1	0	2	3	6	0	1	1
10	0	0	1	0	1	0	7	11	13	10	5	2	1	0	0	0	0	0	0	0	0	0	0	0
11	0	0	1	0	1	2	3	0	1	0	2	11	7	10	0	1	0	18	4	6	0	1	1	0
12	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	1	0	0	3	2	2	3	2	2
13	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	7	2	4	5	7	11	0	13	13
14	7	2	4	2	2	6	1	1	0	0	0	0	0	0	0	0	3	5	8	0	1	4	1	0
15	0	0	2	1	0	0	0	0	0	0	0	0	0	0	1	1	3	2	8	1	0	0	0	0
16	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	5	0	0	2	0	1	0	12	14	9	2	4	1
18	0	0	0	0	0	0	4	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	6	1	21	15	96	15	1	0	9
20	18	15	6	6	7	13	7	1	1	0	1	2	5	0	4	10	11	8	6	10	0	2	1	21
21	83	11	22	16	18	18	8	11	2	18	4	13	36	2	0	0	0	0	0	0	0	0	0	0
22	1	0	1	12	3	2	0	4	8	7	1	4	0	0	4	5	14	2	2	0	5	6	3	1
23	5	3	3	7	95	53	33	18	4	1	2	0	0	0	1	1	0	1	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	1	3	4	2	3	3	1
26	4	3	2	1	2	4	3	7	30	7	8	13	18	17	14	12	17	12	12	11	11	0	1	2
27	3	10	5	2	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	1	1	4	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	4	9	1	1	3
29	0	1	2	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Runoff detected at NSW-1 but not at NSW-2
	Runoff detected at NSW-1 and NSW-2

Dec-15	HOURLY RAINFALL TOTALS: DECEMBER 2015																							
DAY	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00
1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
2	0	0	1	0	0	0	0	0	3	2	0	1	2	0	1	0	0	0	0	4	1	3	1	3
3	5	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	1	0	0	0	2	2	5	2	2	2	0	0	0	0	0	0	0	0	0	0	2
6	1	2	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	3	0	0	2	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2	5	2	1	0	0	0	0	0
10	0	0	0	3	9	7	15	31	7	3	1	0	0	1	0	0	0	0	0	3	2	3	5	0
11	0	0	0	0	0	0	1	1	0	1	4	4	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
15	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	3	3	9	2	0	1	0	0	2	0	0	0	0	0	0	0	2	1	7	4	14	1	0	0
17	0	0	0	0	6	12	4	0	0	1	3	1	0	0	4	8	6	3	5	3	0	1	0	2
18	1	0	0	0	1	4	3	8	4	5	1	14	3	2	1	14	16	3	5	9	0	2	4	1
19	0	9	0	0	0	0	0	0	0	0	0	0	2	2	1	1	0	10	13	16	14	0	2	1
20	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	2	4	0	3	0	0
21	2	0	12	4	7	6	15	9	11	7	11	5	12	2	12	12	12	6	6	14	9	6	2	0
22	9	4	1	2	10	5	3	1	0	0	0	0	1	12	8	20	4	3	8	11	3	0	0	0
23	2	2	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	3	1	4	4	2
25	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	4	0	0	7	0	0	0
26	0	0	5	8	2	2	7	16	4	9	11	0	0	0	0	0	2	10	8	2	4	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	2	1	3	6	4
28	6	8	6	7	1	2	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	2	0	3	3	1	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Runoff detected at NSW-1 but not at NSW-2
	Runoff detected at NSW-1 and NSW-2

APPENDIX F
2015 Field and Laboratory Water Quality Monitoring Data

Sample ID	Date Sample Retrieved	Date Sample Captured	pH	Temp	Turbidity	Specific Conductance	Total N	Kaukonahua Stream Flow		
				(°C)	(NTU)	(mS/cm)	(mg/L)	Stable	Elevated	High
Dry Season 2015 Data: NSW-1										
NSW-1-1-062315	6/23/2015	6/23/2015	6.88	22.2	3.45	NM	6	x		
NSW-1-2-062315	6/23/2015	6/23/2015	7.01	22.9	4.13	NM	6.16	x		
NSW-1-1-071415	7/14/2015	7/14/2015	6.87	22.6	36.9	NM	0.72		x	
NSW-1-2-071415	7/14/2015	7/14/2015	7.03	22.6	71.9	NM	0.71		x	
NSW-1-3-071415	7/14/2015	7/14/2015	6.92	22.6	13.4	NM	2.26		x	
NSW-1-4-071415	7/14/2015	7/14/2015	7.02	22.7	9.1	NM	1.01		x	
NSW-1-3-071615	7/16/2015	7/16/2015	6.77	24.1	1.8	NM	1.46			x
NSW-1-4-071615	7/16/2015	7/16/2015	6.61	24.3	1.2	NM	0.55			x
NSW-1-1-081815	8/18/2015	8/18/2016	6.79	24.05	10.3	0.211	5.1	x		
NSW-1-3-081815	8/18/2015	8/18/2015	6.9	25.69	9.5	0.055	0.24	x		
NSW-1-4-081815	8/18/2015	8/18/2015	6.86	26.08	6.9	0.048	0.28	x		
NSW-1-1-082115	8/21/2015	8/20/2015	5.95	24.65	12.1	0.042	1.1	x		
NSW-1-3-082115	8/21/2015	8/20/2015	6.08	24.35	5	0.036	0.22	x		
NSW-1-4-082115	8/21/2015	8/20/2015	6.16	24.33	3.8	0.025	0.2	x		
NSW-1-1-082515	8/25/2015	8/25/2015	6.45	24.97	21.9	0.074	0.66	x		
NSW-1-2-082515	8/25/2015	8/25/2015	6.46	24.55	6.4	0.038	0.1	x		
NSW-1-3-082515	8/25/2015	8/25/2015	6.43	24.07	3.1	0.018	0.05	x		
NSW-1-4-082515	8/25/2015	8/25/2015	6.37	24.14	7.9	0.034	0.05	x		
NSW-1-1-09315	9/3/2015	9/1/2015	7.28	24.59	7.4	0.056	0.76	x		
NSW-1-2-09315	9/3/2015	9/1/2015	7.15	24.29	7.7	0.046	0.19	x		
NSW-1-3-09315	9/3/2015	9/1/2015	7.07	24.38	5.2	0.03	0.12	x		
NSW-1-1-91215	9/12/2015	9/11/2015	6.23	23.78	20.5	0.066	1.1	x		
NSW-1-2-91215	9/12/2015	9/11/2015	6.1	23.92	8	0.045	0.23	x		
NSW-1-1-91615	9/16/2015	9/14/2015	6.38	23.83	12.3	0.107	0.18			x
NSW-1-2-91615	9/16/2015	9/14/2015	6.34	23.56	13	0.047	0.38			x
NSW-1-3-91615	9/16/2015	9/14/2015	6.27	23.46	9.1	0.027	0.05			x
Wet Season 2015 Data: NSW-1										
NSW-01-03-111015	11/10/2015	11/9/2015	7.72	22.77	14	0.030	0.05		x	
NSW-01-04-111015	11/10/2015	11/9/2015	7.27	22.78	21	0.035	0.05		x	
NSW-01-01-111315	11/13/2015	11/11/2015	6.65	22.83	14.2	0.146	0.67	x		
NSW-01-02-111315	11/13/2015	11/11/2015	6.65	22.2	10.9	0.103	0.05	x		
NSW-01-01-111615	11/16/2015	11/13/2015	6.52	21.99	9.6	0.137	0.14		x	
NSW-01-02-111615	11/16/2015	11/13/2015	6.16	21.19	12.5	0.113	0.05		x	
NSW-01-03-111615	11/16/2015	11/13/2015	6.05	21.99	13.6	0.102	0.05		x	
NSW-01-01-112015	11/20/2015	11/19/2015	6.74	21.68	17.5	0.135	0.75			x
NSW-01-02-112015	11/20/2015	11/19/2015	6.34	21.56	11.1	0.083	0.05			x
NSW-01-03-112015	11/20/2015	11/19/2015	6.23	21.74	17.1	0.042	0.05			x
NSW-01-01-121015	12/10/2015	12/10/2015	6.7	21.41	25.5	0.094	1.4			x
NSW-01-02-121015	12/10/2015	12/10/2015	6.68	21.72	51.5	0.038	0.05			x

Sample ID	Date Sample Retrieved	Date Sample Captured	pH	Temp (^oC)	Turbidity (NTU)	Specific Conductance (mS/cm)	Total N (mg/L)	Kaukonahua Stream Flow		
								Stable	High	Elevated
Dry Season 2015 Data: NSW-2										
NSW-2-1-82115	8/21/2015	8/20/2015	6.96	24.74	64.4	0.054	0.25	x		
NSW-2-2-82115	8/21/2015	8/20/2015	6.84	25.45	55.3	0.057	0.36	x		
NSW-2-1-82315	8/24/2015	8/23/2015	5.03	23.45	95.7	0.016	0.05		x	
NSW-2-2-82315	8/24/2015	8/23/2015	4.91	23.48	181	0.018	0.18		x	
NSW-2-3-82315	8/24/2015	8/23/2015	5.05	23.44	116	0.017	0.05		x	
NSW-2-4-82315	8/24/2015	8/23/2015	4.95	23.56	213	0.019	0.05		x	
NSW-2-01-82515	8/25/2015	8/25/2015	6.6	24.53	148	0.019	0.05		x	
NSW-2-02-82515	8/25/2015	8/25/2015	6.43	24.52	139	0.018	0.54		x	
NSW-2-03-82515	8/25/2015	8/25/2015	6.39	24.59	103	0.018	0.05		x	
NSW-2-04-82515	8/25/2015	8/25/2015	6.36	24.62	165	0.022	0.26		x	
NSW-2-01-82715	8/27/2015	8/27/2015	6.01	25.77	358	0.014	0.05		x	
NSW-2-02-82715	8/27/2015	8/27/2015	6.02	25.37	345	0.017	0.05		x	
NSW-2-03-82715	8/27/2015	8/27/2015	6.14	25.1	228	0.015	0.05		x	
NSW-2-04-82715	8/27/2015	8/27/2015	6.05	24.71	204	0.017	0.05		x	
NSW-2-01-9315	9/3/2015	9/3/2015	6.93	25.25	380	0.029	0.19		x	
NSW-2-02-9315	9/3/2015	9/3/2015	6.89	25.08	174	0.021	0.42		x	
NSW-2-03-9315	9/3/2015	9/3/2015	6.67	25.55	251	0.022	0.05		x	
NSW-2-04-9315	9/3/2015	9/3/2015	6.52	26.48	179	0.032	0.05		x	
NSW-2-01-9815	9/8/2015	9/5/2015	6.02	23.28	103	0.023	0.8		x	
NSW-2-02-9815	9/8/2015	9/5/2015	5.93	23.1	120	0.02	0.05		x	
NSW-2-03-9815	9/8/2015	9/5/2015	5.78	23.16	94.7	0.022	0.59		x	
NSW-2-04-9815	9/8/2015	9/5/2015	5.76	23.2	140	0.022	0.05		x	
NSW-2-01-91215	9/12/2015	9/11/2015	6.6	23.4	195	0.047	0.05			x
NSW-2-02-91215	9/12/2015	9/11/2015	6.3	23.34	143	0.022	0.05			x
NSW-2-03-91215	9/12/2015	9/11/2015	6.01	23.38	122	0.022	0.05			x
NSW-2-04-91215	9/12/2015	9/11/2015	5.98	23.36	159	0.023	0.05			x
Wet Season 2015 Data: NSW-2										
NSW-2-01-110515	11/5/2015	11/5/2015	6.7	24.52	136	0.09	0.05		x	
NSW-2-01-111015	11/10/2015	11/9/2015	7.07	22.66	115	0.097	0.26			x
NSW-2-02-111015	11/10/2015	11/9/2015	6.6	21.94	113	0.063	0.18			x
NSW-2-03-111015	11/10/2015	11/9/2015	6.46	21.87	100	0.047	0.05			x
NSW-2-04-111015	11/10/2015	11/9/2015	6.46	22.03	77	0.043	NM			x
NSW-02-01-111615	11/16/2015	11/13/2015	6.33	20.83	145	0.124	0.05			x
NSW-2-01-112015	11/20/2015	11/19/2015	6.56	21.62	220	0.059	0.18		x	
NSW-2-03-112015	11/20/2015	11/19/2015	6.42	21.66	241	0.05	0.05		x	
NSW-2-04-112015	11/20/2015	11/19/2015	6.26	21.67	239	0.029	0.05		x	
NSW-2-01-121015	12/10/2015	12/10/2015	6.3	21.56	221	0.056	0.32		x	
NSW-2-02-121015	12/10/2015	12/10/2015	6.26	21.5	210	0.055	0.18		x	
NSW-2-03-121015	12/10/2015	12/10/2015	6.25	21.51	203	0.051	0.05		x	
NSW-2-04-121015	12/10/2015	12/10/2015	6.25	21.57	154	0.047	0.05		x	

APPENDIX G

Daily Turbidity and Total Nitrogen Loads Calculated for Days of Measurable Runoff Compared to Kaukonahua TMDL Criteria

Date	Runoff Start	Runoff End	NSW-1 + NSW-2 (NTU tons/day)	NSW-1 + NSW-2 (Nitrogen pounds/day)	High, Elevated, Stable Flow in Receiving Water	TMDL Criteria for Turbidity (NTU tons/day)	TMDL Criteria for Total Nitrogen (Pounds/day)
5/22/2015	19:06	19:22	0.0000020	0.0001901	Elevated	0.014	None
5/28/2015	14:12	14:39	0.0000822	0.0077103	Elevated	0.014	None
5/31/2015	3:49	4:36	0.0001212	0.0113705	High	0.043	None
6/1/2015	2:40	2:54	0.0000043	0.0003993	Elevated	0.014	None
6/23/2015	8:55	9:07	0.0000025	0.0002377	Stable	0.0003	None
7/12/2015	12:45	13:30	0.0000704	0.0066075	Stable	0.0003	None
7/13/2015	7:10	7:20	0.0000051	0.0004754	High	0.043	None
7/14/2015	4:00	4:10	0.0001077	0.0101060	Elevated	0.014	None
7/14/2015	4:45	5:00					
7/14/2015	7:15	7:45					
7/14/2015	9:15	9:35					
7/15/2015	0:15	0:45	0.0000010	0.0000951	Elevated	0.014	None
7/16/2015	20:55	21:25	0.0000637	0.0059735	High	0.043	None
8/18/2015	11:15	12:05	0.0010296	0.0928956	Stable	0.0003	None
8/18/2015	13:25	15:25			High	0.043	None
8/18/2015	14:25	14:35					
8/20/2015	13:35	14:45	0.0012854	0.1046665	Stable	0.0003	None
8/20/2015	15:35	17:45			High	0.043	None
8/20/2015	15:55	16:25					
8/21/2015	3:55	4:15	0.0000382	0.0035841	Stable	0.0003	None
8/22/2015	15:05	15:40	0.0044384	0.4164398	High	0.043	None
8/22/2015	22:35	22:45					
8/23/2015	14:45	17:10	0.1284317	0.4197070	High	0.043	None
8/23/2015	14:55	17:20					
8/23/2015	22:05	0:00			Elevated	0.014	None
8/23/2015	22:05	0:00					
8/24/2015	1:55	3:05	0.2580143	1.8418073	Elevated	0.014	None
8/24/2015	3:45	9:00			High	0.043	None
8/24/2015	3:55	8:25					
8/24/2015	21:25	22:55			Elevated	0.014	None
8/24/2015	21:35	22:55					
8/25/2015	12:55	16:20	0.0476326	0.0716654	High	0.043	None
8/25/2015	13:00	16:20					
8/26/2015	12:35	17:20	0.2544241	1.1147225	High	0.043	None
8/26/2015	12:45	17:10					
8/27/2015	13:05	16:30	0.1641251	0.6263204	High	0.043	None
8/27/2015	13:15	16:30					
9/1/2015	4:25	4:55	0.0002328	0.0218460	Stable	0.0003	None
9/1/2015	18:50	20:00					
9/3/2015	14:15	15:20	0.0110182	0.0849211	High	0.043	None
9/3/2015	14:15	15:50					
9/5/2015	15:05	17:20	0.0409636	0.3421968	Stable	0.0003	None
9/5/2015	15:15	17:20					
9/7/2015	11:55	12:40	0.0002665	0.0250035	Stable	0.0003	None
9/7/2015	15:55	16:30					
9/11/2005	2:25	3:55	0.0245089	0.2130115	Stable	0.0003	None
9/11/2015	6:45	9:40					
9/11/2015	13:25	15:05			Elevated	0.014	None
9/11/2015	13:25	15:15					
9/11/2015	18:45	19:25					
9/13/2015	13:15	14:15	0.0001310	0.0122884	High	0.043	None
9/14/2015	18:45	19:10	0.0001601	0.0150191	High	0.043	None
9/14/2015	22:25	23:10					
9/15/2015	0:15	3:15	0.0009722	0.0497140	High	0.043	None
9/15/2015	1:05	3:15					
9/18/2015	5:55	8:05	0.0021922	0.0444834	High	0.043	None
9/18/2015	6:25	7:55					
9/18/2015	14:15	14:55			Elevated	0.014	None
9/26/2015	3:20	4:00	0.0001013	0.0095071	High	0.043	None
9/30/2015	2:00	2:40	0.0000279	0.0026145	High	0.043	None
10/13/2015	6:30	8:00	0.0004357	0.0408807	Stable	0.0003	None
10/14/2015	9:20	10:30	0.0000973	0.0091268	High	0.043	None

Date	Runoff Start	Runoff End	NSW-1 + NSW-2 (NTU tons/day)	NSW-1 + NSW-2 (Nitrogen pounds/day)	High, Elevated, Stable Flow in Receiving Water	TMDL Criteria for Turbidity (NTU tons/day)	TMDL Criteria for Total Nitrogen (Pounds/day)
10/17/2015	22:10	23:30	0.0000496	0.0046585	High	0.043	None
10/20/2015	8:10	9:30	0.0000345	0.0032324	High	0.043	None
10/31/2015	10:20	12:20	0.0165100	0.1640181	Elevated	0.014	None
10/31/2015	10:40	11:50					
11/4/2015	6:30	7:40	0.0000628	0.0010083	Stable	0.0011	1
11/4/2015	20:00	21:20			High	0.219	195
11/5/2015	0:00	12:50	0.0044594	0.0280420	High	0.219	195
11/5/2015	2:30	6:20					
11/7/2015	7:30	12:40	0.0139327	0.0451464	High	0.219	195
11/7/2015	8:10	13:20					
11/8/2015	23:10	0:00	0.0002857	0.0045859	Elevated	0.039	24.6
11/9/2015	0:00	5:40	0.0085854	0.0304206	Elevated	0.039	24.6
11/9/2015	0:30	5:40					
11/10/2015	8:30	11:00	0.0006384	0.0102452	Stable	0.0011	1
11/11/2015	13:40	15:40	0.0013091	0.0210108	Stable	0.0011	1
11/11/2015	18:30	19:40					
11/11/2015	18:40	19:40					1
11/13/2015	21:10	0:00	0.0002493	0.0040050	Elevated	0.039	24.6
11/14/2015	0:00	2:00	0.0010371	0.0072139	Elevated	0.039	24.6
11/14/2015	0:00	1:20					
11/17/2015	19:40	22:00	0.0000742	0.0011904	Elevated	0.039	24.6
11/19/2015	18:50	22:40	0.0805893	0.1555855	High	0.219	195
11/19/2015	19:00	23:00					
11/20/2015	1:00	8:20	0.0846498	0.1419690	High	0.219	195
11/20/2015	1:30	4:40					
11/20/2015	16:50	21:10			Elevated	0.039	24.6
11/21/2015	11:00	15:00	0.1239704	0.3010509	Elevated	0.039	24.6
11/21/2015	0:50	15:20					
11/22/2015	4:00	6:40	0.1148774	0.1551139	Stable	0.0011	1
11/22/2015	9:00	12:40			Elevated	0.039	24.6
11/22/2015	17:30	18:50					
11/23/2015	4:10	10:40	0.1385910	0.2669315	High	0.219	195
11/23/2015	5:20	10:30					
11/26/2015	9:00	22:30	0.0415088	0.1376157	High	0.219	195
11/26/2015	9:00	23:00					
11/27/2015	2:30	4:00	0.0000851	0.0013660	High	0.219	195
12/10/2015	7:10	10:00	0.0072403	0.0200926	High	0.219	195
12/10/2015	8:00	10:30					
12/11/2015	12:10	14:50	0.0000533	0.0008554	Stable	0.0011	1
12/18/2015	8:30	11:20	0.0039014	0.0337989	Stable	0.0011	1
12/18/2015	12:10	14:40					
12/18/2015	12:30	13:20					
12/18/2015	16:30	19:40					
12/18/2015	16:50	19:20					
12/18/2015	20:00	21:40					
12/19/2015	2:10	3:30	0.0015868	0.0254660	Elevated	0.039	24.6
12/19/2015	18:40	23:30					
12/19/2015	20:40	22:40					
12/20/2015	18:50	20:30	0.0000460	0.0007383	Stable	0.0011	1
12/21/2015	3:50	5:10	0.0545320	0.0875199	Stable	0.0011	1
12/21/2015	6:20	23:40					
12/21/2015	6:00	23:50					
12/22/2015	5:50	7:20	0.0053351	0.0333916	High	0.219	195
12/22/2015	1:30	3:00			Stable	0.0011	1
12/22/2015	14:40	22:00			High	0.219	195
12/22/2015	15:00	22:10					
12/26/2015	4:40	12:20	0.0016690	0.0157591	High	0.219	195
12/26/2015	11:00	12:30					
12/28/2015	2:10	3:30	0.0000296	0.0004749	Elevated	0.039	24.6

	Day when Turbidity TMDL Criteria was Exceeded.
	Measured Daily Turbidity Load that Exceeded Associated TMDL Criteria
	Numerical Value of TMDL Criteria Exceeded