STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT
P.O. BOX 621
HONOLULU, HAWAII 96809

November 7, 2016

Introduction

This serves as the written testimony summarizing the supplemental data requested from the Commission on Water Resource Management (CWRM) by the Hearings Officer, Dr. Lawrence Miike, for the re-opened contested-case hearing (CCH-MA13-01) addressing the 27 Petitions to Amend the Interim Instream Flow Standards in East Maui, filed by Native Hawaiian Legal Corporation (NHLC) on behalf of Na Moku ʻAupuni o Koolau Hui (Na Moku), Beatrice Kepani Kekahuna, and Marjorie Wallet. The Hearings Officer wanted CWRM staff to identify how much of the natural stream flow and/or regulated stream flow above certain diversions in each hydrologic unit was being diverted before establishment of an interim instream flow standard (IIFS), how much stream flow occurred below the diversion before establishment of an IIFS, how much stream flow was being diverted at the identified diversion, the percent of habitat at the regulated flow relative to the natural median baseflow (BFQ_{50}), and the flow value which restored 90% of habitat (H_{90}) below the diversion. These values are based on US Geological Survey (USGS) Scientific Investigations Reports (2004-5262 and 2005-5213) by Gingerich (2004) and Gingerich and Wolff (2005)

Further, additional data are included which update the continuous monitoring efforts made by CWRM staff to verify the previously established IIFS values. Previous (2010-2014) monitoring datasets were included in the original staff testimony in December 2014 and only data from 2015 and 2016 (to date) are included here. The DLNR server (and its backup) were corrupted on October 28, 2016 (and continues to not be accessible), which has the extent to which the 2016 data were analyzed.

Overview of Results

Results were organized by location as identified as IIFS sites by previous Decision & Orders (D&O) and the draft 2016 D&O produced by the Hearings Officer prior to the re-opening of the CHH. Other than in the Honopou (6034) and Hanehoi (6037) hydrologic units, only a single IIFS point was considered in this supplemental, located below the lowest diversion. Since many hydrologic units have multiple ditch systems diverting water, flow above a diversion with additional diversions upstream is considered "regulated", meaning it is not natural.

Data presented in Table 1 are derived from Gingerich (2004) utilizing locations as close upstream and downstream to the diversion of interest as possible. Gingerich (2004) estimated the "natural" BFQ_{50} at particular sites in many of the hydrologic units (Column A) as well as estimated the regulated BFQ_{50} at these same points (column B). The amount diverted at this location is equal to the natural BFQ_{50} (if there are no upstream diversions) or the regulated BFQ_{50} (if additional diversions are located upstream). In most cases, diversions were designed to take 100% of the baseflow. Similarly, Gingerich (2004) provided estimates of natural (column D) and regulated (column E) BFQ_{50} values below the diversion of interest. These sites were often much farther downstream, such as near the Hana Highway or coastline. The difference between natural and regulated flow below each diversion (column F) provides a reference for how much restored flow is needed to return the stream to "normal". The ratio of regulated flow to natural flow (column G) is used in a habitat model to estimate the percent of habitat available under regulated flow conditions compared to natural flow conditions for oʻopū (column H) and ʻopae (column I) based on

Gingerich and Wolff (2005). The H_{90} flow value (64% of natural BFQ_{50}) is provided in column J as the estimated flow that provides 90% of the habitat available at BFQ_{50}. Lastly, the latest (2016) proposed IIFS values in cubic feet per second (column K) and million gallons per day (column L) are provided for comparison. A summary of the total amount of flow diverted and restored by each phase is provided at the top. Note that this does not include diversions not part of the CCH nor does it include changes to previously established IIFS values proposed in the 2016 draft D&O. Only new IIFS values at each phase.

Complete restoration to streams occurred immediately following the termination of revocable permits to East Maui Irrigation in January 2016. Overall, 2016 was wetter than 2015, resulting in greater flow duration metrics, but both years had greater flows than long-term flow metrics provided by Cheng (2016). Table 2 provides a summary of flow duration values for USGS long-term gaging stations monitoring natural stream flow in East Maui for 2015 and 2016.

Monitoring data are presented for calendar years 2015 and 2016, up to October 26, 2016 in the following section. Measurements made from station installation to present by USGS and CWRM staff are presented in relation to staff gage heights and plotted as the reference rating curve. A description of the stream channel control for the station is also provided. Mean daily flow was calculated and graphed out for 2015 and 2016 with the IIFS as a reference line for each station. Mean daily flow data for nearby USGS stations are also provided. Median flow values from mean daily flows for 2015 and 2016 for annual IIFS and/or for wet/dry seasonal IIFS values are provided. The number of days each IIFS was met is also provided. Despite 2016 being a wet year overall, January and February were much drier than normal resulting in many stations not meeting the IIFS.

Because of its location and the wet conditions during 2015 and 2016, the site on Hanehoi above Lowrie Ditch was only visited once and the range of data presented is limited. Data for East Wailuaiki (CWRM ID 6-66) and Waiohue (CWRM ID 6-64) were graphed but no summary statistics have been calculated due to the malfunctioning DLNR server.

This report was prepared by Dr. Ayron M. Strauch, Hydrologic Program Manager for CWRM's Stream Protection and Management Branch. Should you have any questions, please contact Ayron Strauch by email at ayron.m.strauch@hawaii.gov

Table 1

Of the streams addressed in each phase, the total amount diverted and total amount restored by phase →	BFQ50 (cfs)	2008 IIFS	2010 IIFS	2016 IIFS	total
	diverted	27.6	38.4	2.4	68.4
	restored	19.4	19.9	4.5	43.8

		A	B	C		D	E	F	G	H	I	J	K	L
		above lowest diversion				below lowest diversion				oopu[a]	opae[a]			
Stream	Site	location*	USGS estimated natural flow BFQ50 (cfs)	USGS estimated regulated flow BFQ50 (cfs)	amount diverted by ditch (cfs)	location*	USGS estimated natural flow BFQ50 (cfs)	USGS estimated regulated flow Q50 (cfs)	difference in BFQ50 (cfs)	regulated flow relative to natural flow	Percent habitat at regulated relative to natural BFQ50	Percent habitat at regulated relative to natural BFQ50	Flow value of H90 (64% of BFQ50)	2016 proposed IIFS (cfs)	2016 proposed IIFS (mgd)
Honopou[1]	Site A: Downstream of Haiku Ditch		6.5	0.7	0.7		6.5	1.2	5.3	18.5	46.87	64.41	4.2	3.6	2.31
Honopou[2]	Site B: At 40ft (ds of taro)						12.6	no data	no data	no data	no data	no data	no data	2.3	1.49
Huelo (Puolua)[2]	Downstream of Haiku Ditch		1.5	1.1	1.1		1.5	no data	no data	no data	no data	no data	no data	0.1	0.09
Hanehoi[3]	Site B: Downstream of Haiku Ditch		3.9	no data	no data		3.9	no data	no data	no data	no data	no data	no data	1.1	0.69
Hanehoi[4]	Site C: Upstream of Lowrie Ditch		2.5	no data			2.5	no data	no data	no data	no data	no data	no data	1.1	0.74
Hanehoi	Site D: Above terminal waterfall		5.4	no data			5.4	no data	no data	no data	no data	no data	no data	3.4	2.21
Waikamoi	Above Hana Hwy at 550ft	MU	6.6	1.6	1.6	ML	6.7	0.2	6.5	3.0	28.17	51.31	4.3	2.8	1.81
Wahinepee	Above Hana Hwy at 575ft	M	0.9	0.9	0	L	1.8	0.9	0.9	50.0	76.17	84.77	1.2	0.5	0.32
Puohokamoa	Above Hana Hwy at 565ft	MU	8.4	2	2	ML	10	1.1	8.9	11.0	38.21	58.35	6.4	0.4	0.26
Haipuaena	Above Hana Hwy at 510ft	MU	4.3	0.8	0.8	ML	4.9	0.5	4.4	10.2	37.25	57.67	3.1	0.1	0.06
Punalau/Kolea	Above Hana Hwy at 40ft	M	no data	no data	no data	L	4.5	0.6	3.9	13.3	40.99	60.29	2.9	0.2	0.13
Honomanu	Above Hana Hwy at 20ft	U	2.8		2.8	L	9	5.8	3.2	64.4	85.63	91.26	5.8	0.0	0
Nuaailua	Above Hana Hwy at 110ft (below Koolau Ditch)	U	0.28		0.28	L	7.4	7.1	0.3	95.9			4.7	3.1	2
Piinaau	Above Hana Hwy at 110ft	U	14		14	L	28	no data	no data	no data	no data	no data	no data	none	none
Palauhulu	Above Hana Hwy at 80ft (upstream of confluence v	U	3.43		3.43	L	11	4.8	6.2	43.6	no data	no data	no data	4.8	3.1
Ohia (Waianu)	Above Hana Hwy at 195ft	M	4.7											4.6	2.97
Waiokamilo	Below Koolau Ditch above confluence with Kualani	U	3.9		3.9	L	8.7	no data	no data	no data	no data	no data	no data	4.9	3.17
Kualani (Hamau)	Before tributary enters Waiokamilo	M	no data		no data		no data	no data	no data	no data	no data	no data	no data	none	none
West Wailuanui	At 620ft (blw conf of E&W Branches)	U	2		2	M	6.1	1	5.1	16.4	44.54	62.78	4.8	4.9	3.17
East Wailuanui		U	2.5		2.5										
West Wailuaiki	Above Hana Hwy at 1235ft (below Koolau Ditch)	U	6		6	M	6.8	0.8	6.0	11.8	39.13	58.99	4.4	3.8	2.46
East Wailuaiki	Above Hana Hwy at 1235ft (below Koolau Ditch)	U	5.8		5.8	M	6.8	1	5.8	14.7	42.60	61.42	4.4	3.7	2.39
Kopiliula	Above Hana Hwy at 1270ft (below Koolau Ditch)	U	5		5	M	6.5	1.2	5.3	18.5	46.87	64.41	4.2	3.2	2.07
Puakaa	Above Hana Hwy at 1235ft (below Koolau Ditch)	U	1.1		1.1	M	2.2	1.1	1.1	50.0	76.17	84.77	1.4	0.7	0.45
Waiohue	Above Hana Hwy at 1195ft (below Koolau Ditch)	U	5		5	M	6	1	5.0	16.7	44.85	62.99	3.8	3.2	2.07
Paakea	Above Hana Hwy at 1265ft (below Koolau Ditch)	U	0.9		0.9	M	4.7	3.8	0.9	80.9	93.37	96.48	3.0	1.5	0.97
Waiaaka	Above Hana Hwy at 1235ft (below Koolau Ditch)	M	0.77		0.77	M	0.77	0.77	0.0	100.0	98.34	99.66	0.5	0.0	0
Kapaula	Above Hana Hwy at 1194ft (below Koolau Ditch)	U	2.8		2.8	M	5.1	2.1	3.0	41.2	69.17	79.93	3.3	0.2	0.13
Hanawi	Above Hana Hwy at 1300ft (below Koolau Ditch)	U	4.6		4.6	M	21	19	2.0	90.5	96.41	98.47	15.0	0.1	0.06
Makapipi	Above Hana Hwy at 935ft (below Koolau Ditch)	U	1.3		1.3									0.9	0.6

all values directly from Gingerich (2005) except where noted by superscript number

[1]USGS records and regression model

[2]regression models, no field verification

[3]difference between HaneO and HuelL; no GW interaction

[4]no data, but assumed same as HaneM site in IFSAR

*location based on Gingerich (2005) reach locations labeled Upper (U), Middle Upper (MU), Middle (M), Lower Middle (LM), Lower (L)

[a]calculated based on formula provided by Gingerich & Wolff (2005) using regulated flow relative to natural flow

not applicable

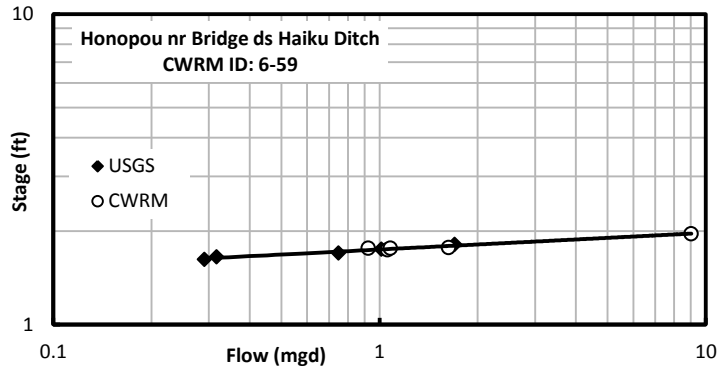
Table 2. Flow duration statistics (millions of gallons per day, mgd) for USGS gaging stations in East Maui for years 1984-2013 (from Cheng, 2016) and calendar years 2015 and 2016 (up to October 26, 2016).

	Q_{50}			Q_{70}			Q_{90}			Q_{95}		
USGS station	1984-2013	2015	2016	1984-2013	2015	2016	1984-2013	2015	2016	1984-2013	2015	2016
16587000 Honopou	1.29	2.33	2.46	0.78	1.49	1.87	0.39	0.84	0.84	0.30	0.71	0.65
16518000 West Wailuaiki	5.75	9.05	10.34	3.36	4.61	5.80	1.81	2.22	2.06	1.42	1.49	1.55
16508000 Hanawi	4.01	5.75	7.76	2.52	2.91	5.36	1.68	1.75	2.07	1.42	1.50	1.87

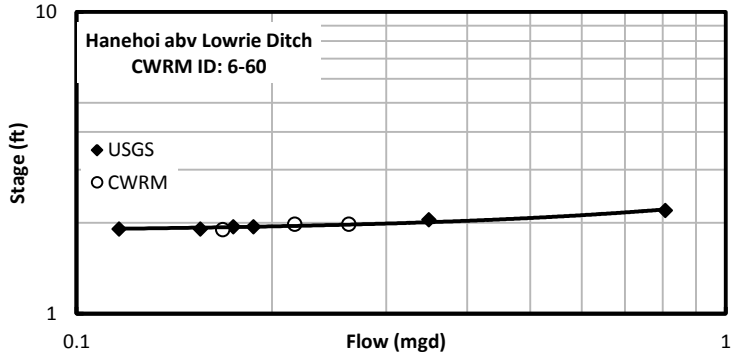
Summary of IIFS monitoring stations

6-59 Honopou nr Bridge ds Haiku Ditch
Gage 6-59 monitors stream flow below Haiku Ditch on Honopou Stream where an IIFS of 1.29 mgd was established in 2010. Because this is the last control point on Haiku Ditch before it enters the HC&S distribution system, during periods of rainfall, excess ditch flow is dumped at this stream. This results in extremely flashy hydrographs that are not usually representative of the actual amount of water flowing in the stream channel. In addition to the five measurements made by the USGS during rating curve development from 2009-2010, CWRM staff have measured flow an additional five times from 2011-2016 which have confirmed that the rating curve is still accurate. The control at this location is a former weir used by the USGS which improves the reliability of the data.

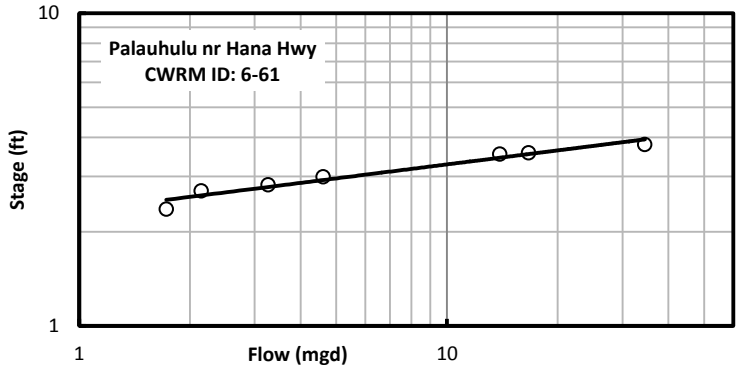
In 2015, the median flow at 6-59 was 6.42 mgd, and the IIFS met on 336 of 365 days (92.1%). In 2016 (through October 25), the median flow was 22.54 mgd, and the IIFS was met on 262 of 299 days (87.6%).



6-60 Hanehoi abv Lowrie Ditch
Gage 6-60 monitors stream flow in Hanehoi Stream above the Lowrie Ditch. The USGS made six measurements at this location from 2009-2010. The streambed is dominated by bedrock in this reach and the control is maintained by bedrock before water spills over a waterfall. From 2011-2015, CWRM staff made three measurements verify that the rating curve is still accurate. Gage 6-60 is challenging to get to and data are infrequently downloaded.



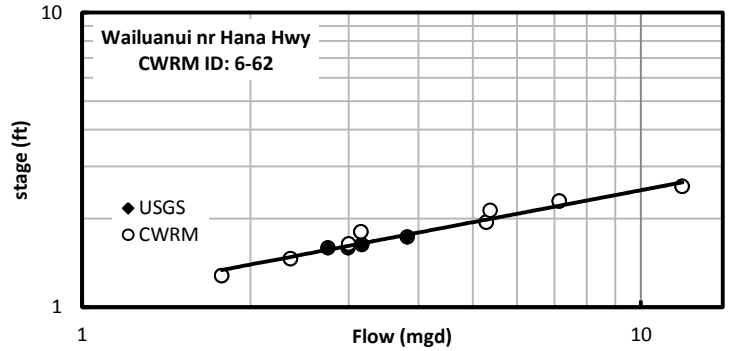
6-61 Palauhulu nr Hana Hwy
Gage 6-61 monitors stream flow in Palauhulu Stream at Hana Highway above the confluence with Piinaau Stream. The USGS made seven measurements at this location from 2009-2011, but the control that was partially maintained by a large tree wedged into the bedrock, shifted when this tree was carried further downstream during a storm event. From 2011-2015, CWRM staff made seven measurements to establish a new rating curve. Gage 6-61 was washed away during a storm flow likely in March 2016.



6-62 Wailuanui nr Hana Hwy

Gage 6-62 monitors stream flow in Wailuanui Stream at Hana Highway below the confluence of the east and west branches. Diversions on both streams take water for the Koolau Ditch. The USGS made four measurements at this location from 2009-2010. The control is maintained by bedrock and some large boulders in the stream channel below the bridge. From 2011-2015, CWRM staff made nine additional measurements to improve the rating curve.

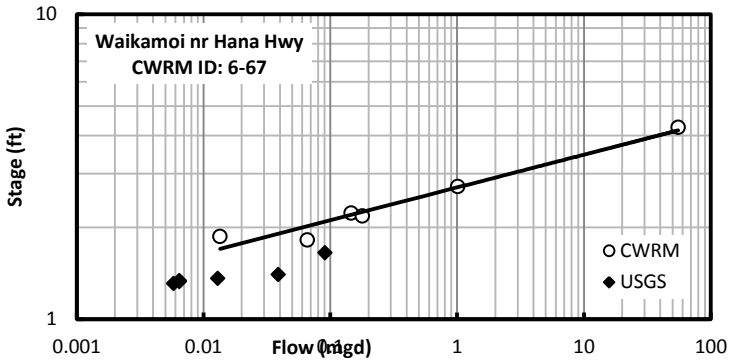
In 2015, the median flow at 6-62 was 4.17 mgd, and the IIFS met on 279 of 365 days (76.4%). In 2016 (through October 25), the median flow was 8.33 mgd, and the IIFS was met on 259 of 299 days (86.6%).



6-67 Waikamoi nr Hana Hwy

Gage 6-67 monitors stream flow in Waikamoi Stream at Hana Highway below the Center Ditch diversion. The USGS made six measurements at this location from 2010-2011. The control is maintained by boulders at the edge of a plunge pool which are subject to move during high flow events. From 2014-2016, CWRM staff made nine measurements to improve the rating curve. There is currently a seasonal IIFS of 1.81 mgd during the wet season and 0 mgd during the dry season.

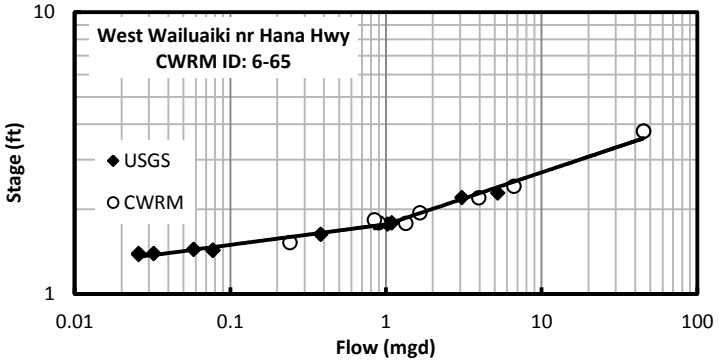
In 2015, the median flow at 6-62 was 0.11 mgd, and the IIFS met on 184 of 365 days (65.9%). During the wet season, the median flow was 0.53 mgd and the IIFS was met on 49 of 144 days (34.0%) in 2015 (gage malfunction led to lost data). In 2016 (through October 25), the median flow was 1.73 mgd, and the IIFS was met on 198 of 301 days (65.8%). During the wet season, the median flow was 0.19 mgd and the IIFS was met 18 of 121 days (14.9%) in 2016.



6-65 West Wailuaiki nr Hana Hwy

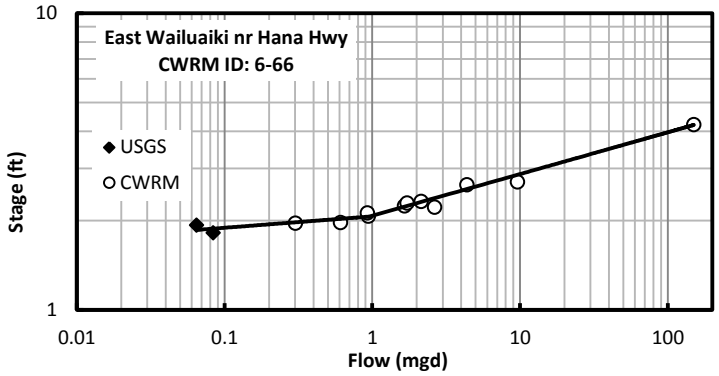
Gage 6-65 monitors stream flow in West Wailuaiki Stream at Hana Highway below the Koolau Ditch diversion. The USGS made nine measurements at this location from 2009-2011. The control is maintained by bedrock and boulders at the highway bridge pier. From 2011-2016, CWRM staff made eight measurements to improve the rating curve. There is currently a seasonal IIFS of 2.46 mgd during the wet season and 0.26 mgd during the dry season.

In 2015, the median flow at 6-62 was 1.29 mgd, and the IIFS met on 180 of 365 days (49.3%). During the wet season in 2015, the median flow was 1.44 mgd and the IIFS was met on 83 of 181 days (45.9%). During the dry season in 2015, the median flow was 0.59 mgd and the IIFS was met on 97 of 184 days (52.7%). In 2016 (through October 25), the median flow was 1.73 mgd, and the IIFS was met on 198 of 301 days (65.8%). During the wet season, the median flow was 0.19 mgd and the IIFS was met 18 of 121 days (14.9%) in 2016.



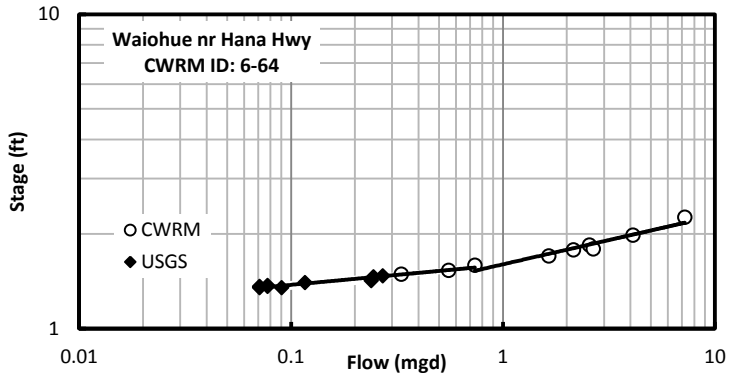
6-66 East Wailuaiki nr Hana Hwy

Gage 6-66 monitors stream flow in East Wailuaiki Stream at Hana Highway below the Koolau Ditch diversion. The USGS made two measurements at this location from 2010-2011. The control is maintained by boulders at the highway bridge pier. From 2014-2016, CWRM staff made 11 measurements to improve the rating curve.



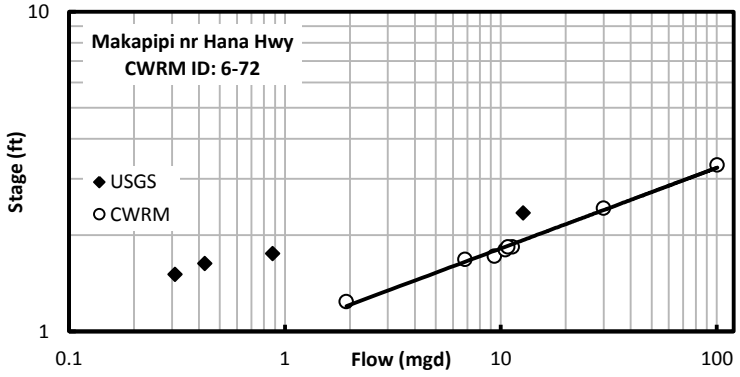
6-64 Waiohue nr Hana Hwy

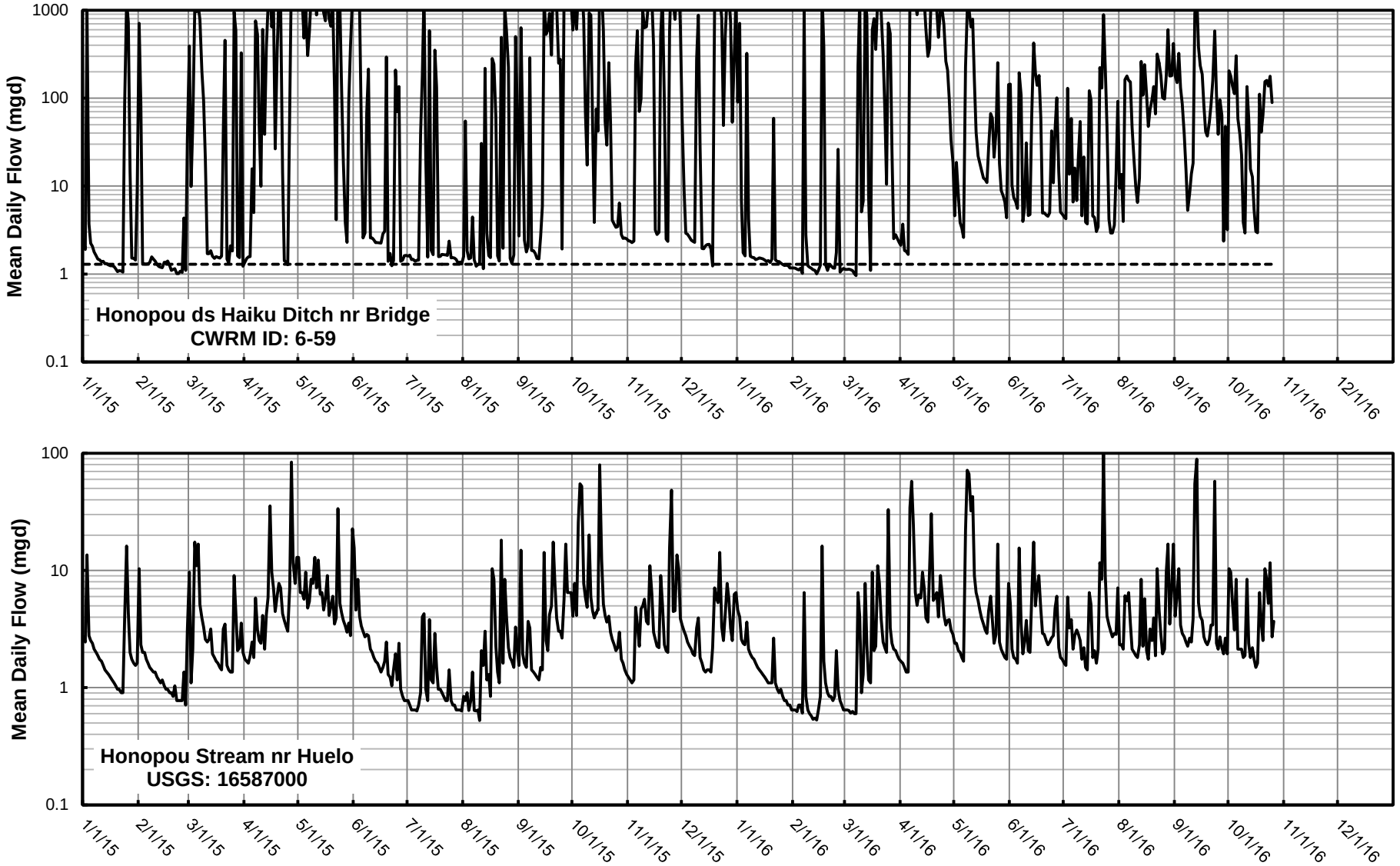
Gage 6-64 monitors stream flow in Waiohue Stream at Hana Highway below the Koolau Ditch. The USGS made nine measurements at this location from 2009-2011. The control is maintained by bedrock and the highway bridge pier. From 2011-2016, CWRM staff made nine measurements to improve the rating curve.



6-72 Makapipi nr Hana Hwy

Gage 6-72 monitors stream flow in Makapipi Stream at Hana Highway below the Koolau Ditch diversion. The USGS made four measurements at this location from 2010-2011 but the control changed following a series of storm events which redistributed the boulders in the stream channel. The control is maintained by bedrock and a few boulders in the channel but is not very stable. In 2016, CWRM staff installed a pressure transducer to begin monitoring flow in Makapipi and have made eight measurements to update the rating curve.




Mean Daily Flow (mgd)
1000
100
10
1
0.1
Honopou ds Haiku Ditch nr Bridge
CWRM ID: 6-59
1/1/15
2/1/15
3/1/15
4/1/15
5/1/15
6/1/15
7/1/15
8/1/15
9/1/15
10/1/15
11/1/15
12/1/15
1/1/16
2/1/16
3/1/16
4/1/16
5/1/16
6/1/16
7/1/16
8/1/16
9/1/16
10/1/16
11/1/16
12/1/16
Mean Daily Flow (mgd)
100
10
1
0.1
Honopou Stream nr Huelo
USGS: 16587000
1/1/15
2/1/15
3/1/15
4/1/15
5/1/15
6/1/15
7/1/15
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10/1/15
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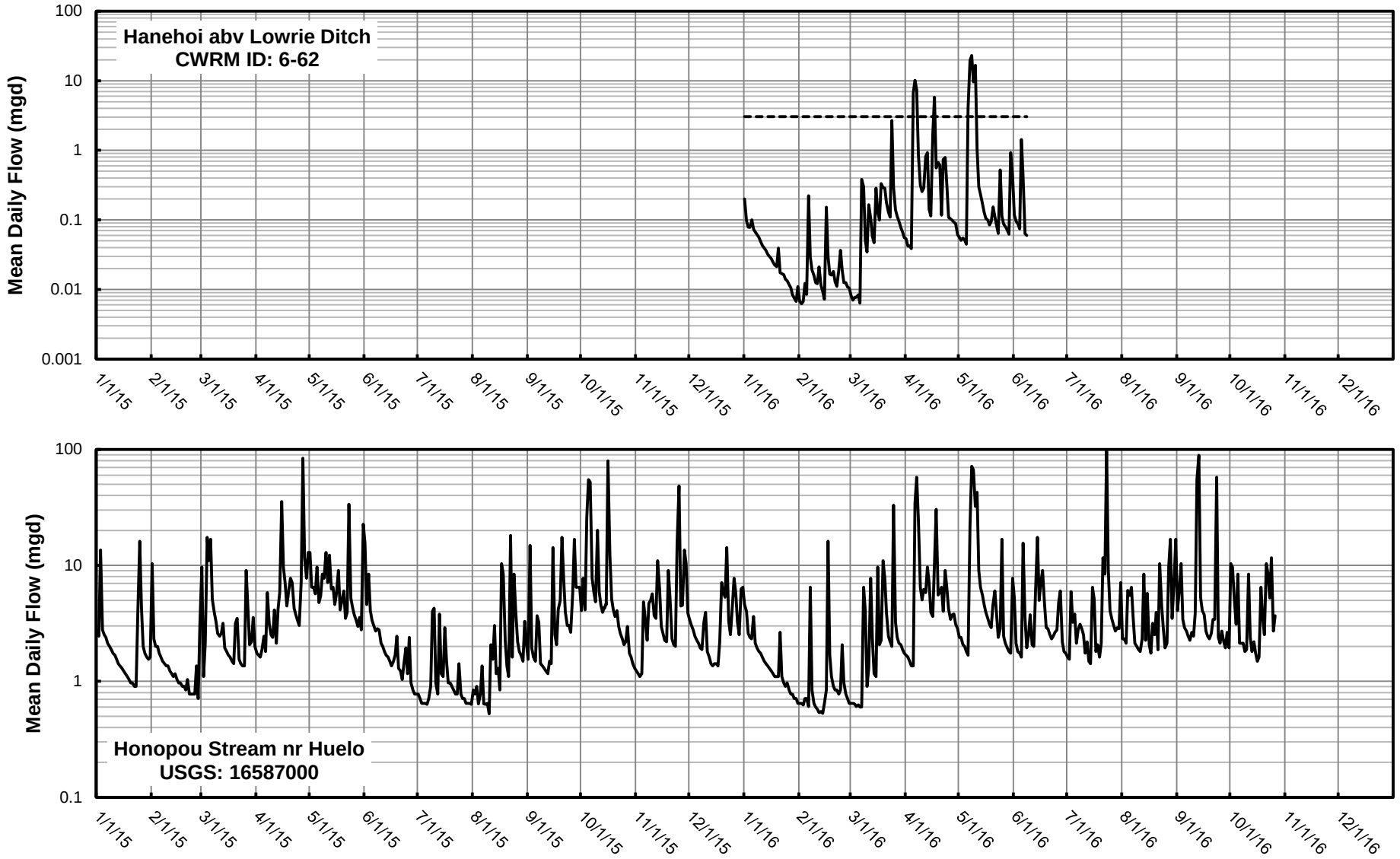
12/1/16


Hanehoi abv Lowrie Ditch
CWRM ID: 6-62
Mean Daily Flow (mgd)
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10
1
0.1
0.01
0.001
1/1/15
2/1/15
3/1/15
4/1/15
5/1/15
6/1/15
7/1/15
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9/1/15
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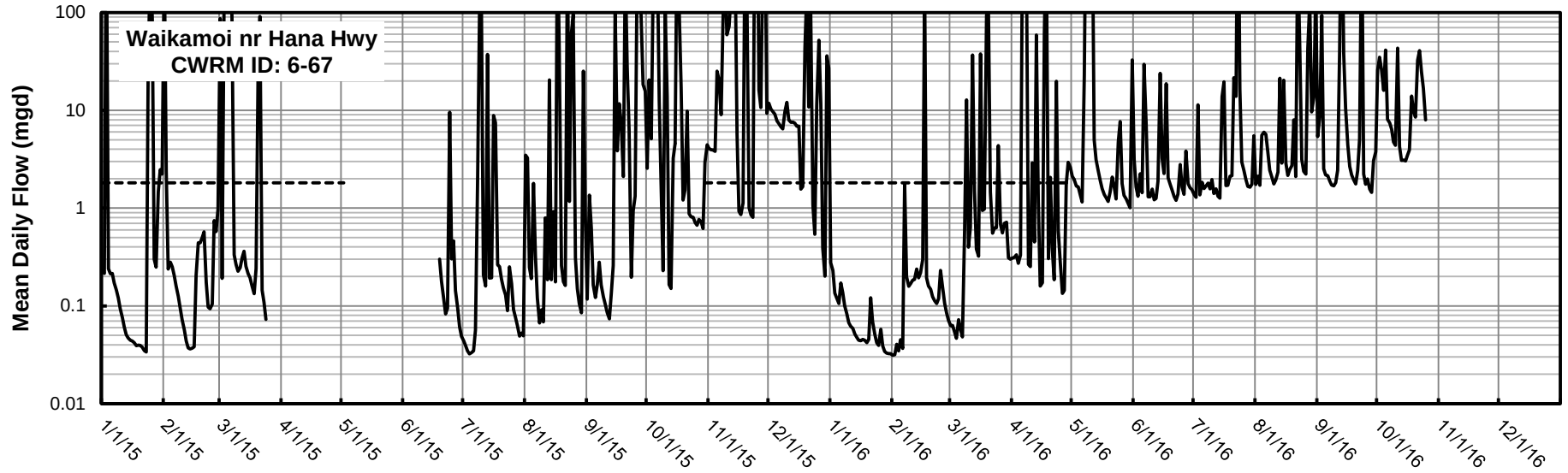
Honopou Stream nr Huelo
USGS: 16587000
Mean Daily Flow (mgd)
100
10
1
0.1


Waikamoi nr Hana Hwy
CWRM ID: 6-67
Mean Daily Flow (mgd)
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1
0.1
0.01
1/1/15
2/1/15
3/1/15
4/1/15
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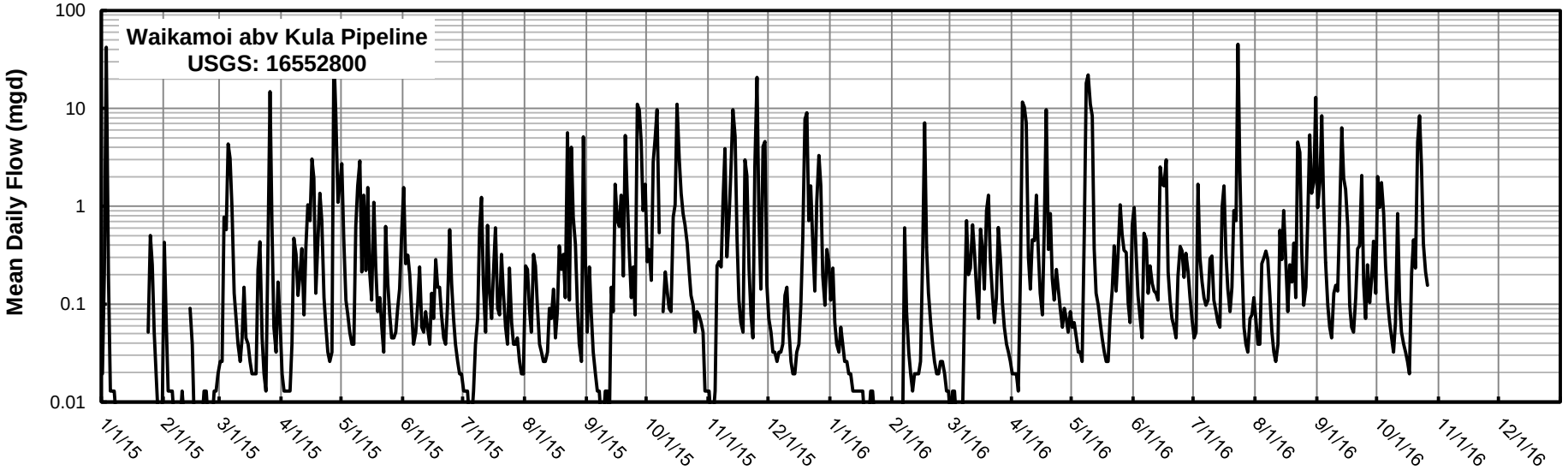

Waikamoi abv Kula Pipeline
USGS: 16552800
Mean Daily Flow (mgd)
100
10
1
0.1
0.01
1/1/15
2/1/15
3/1/15
4/1/15
5/1/15
6/1/15
7/1/15
8/1/15
9/1/15
10/1/15
11/1/15
12/1/15
1/1/16
2/1/16
3/1/16
4/1/16
5/1/16
6/1/16
7/1/16
8/1/16
9/1/16
10/1/16
11/1/16
12/1/16

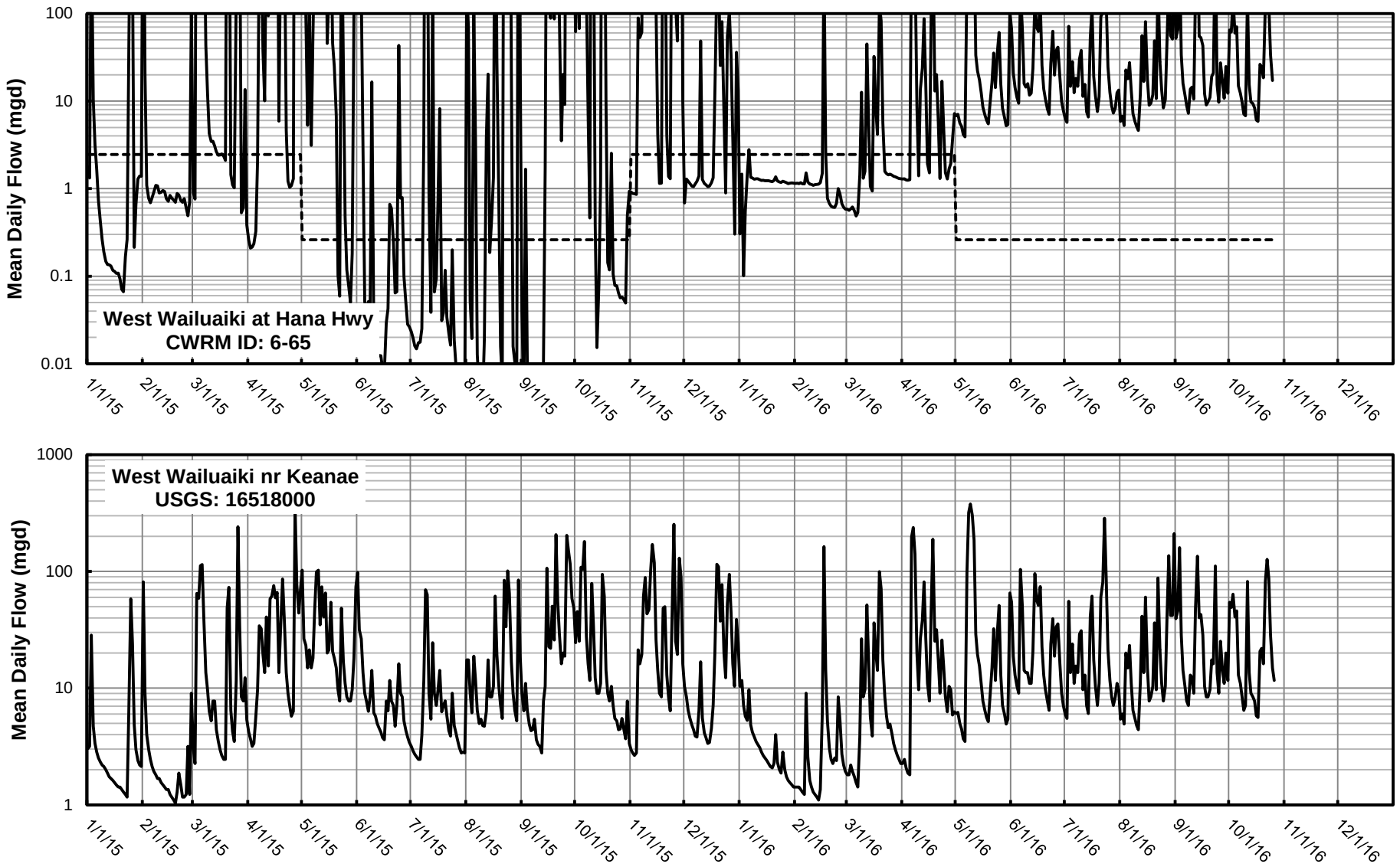
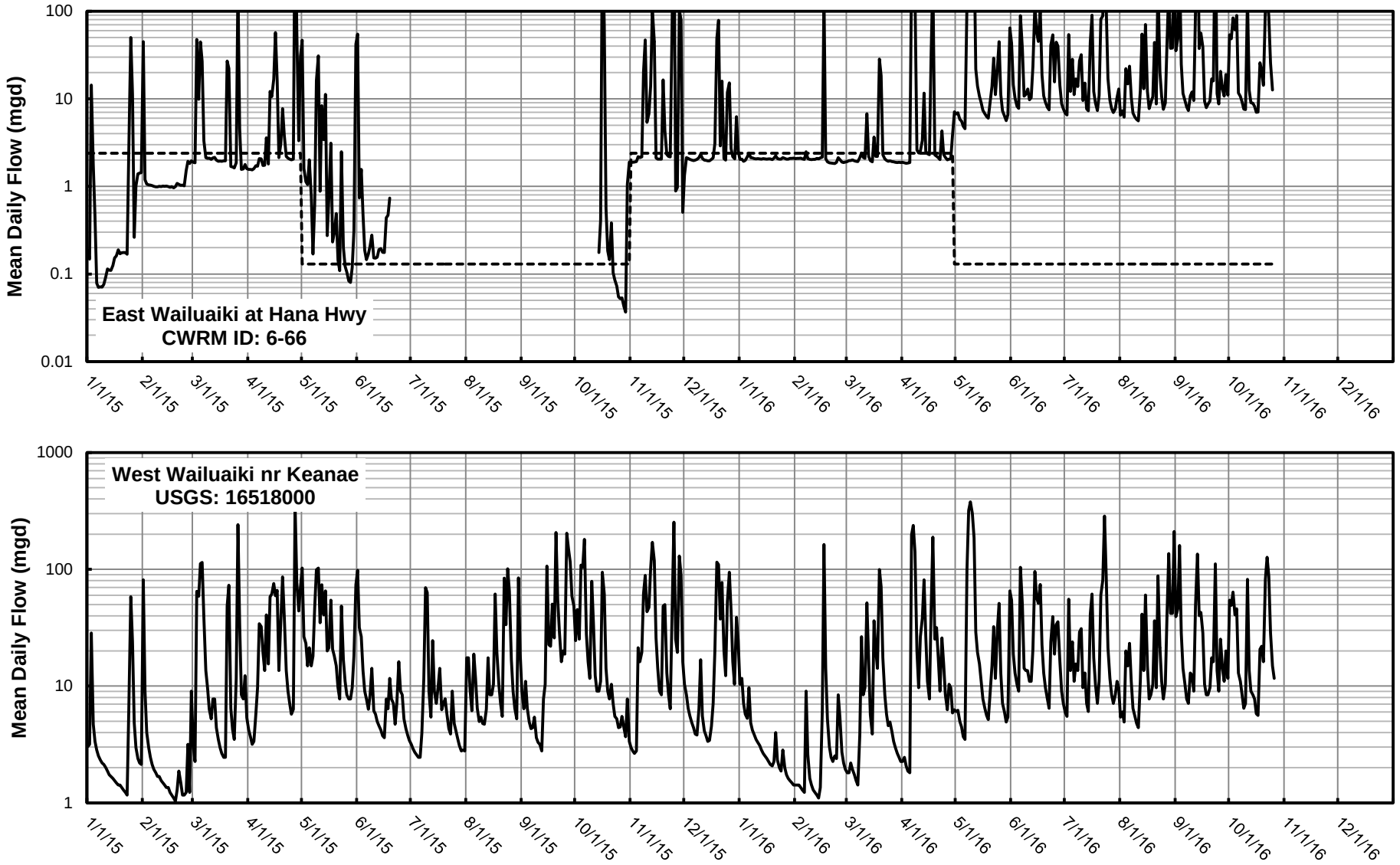
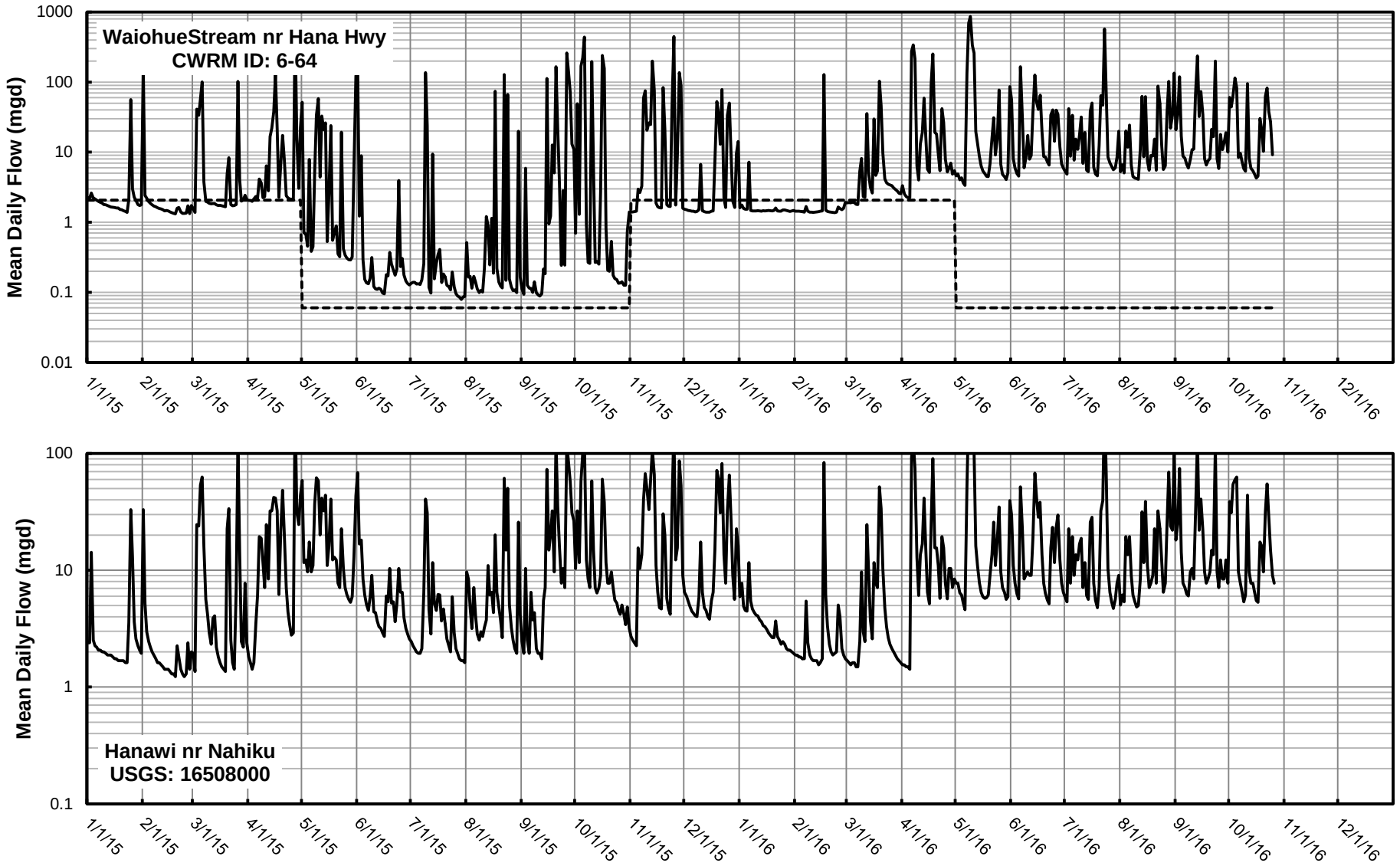
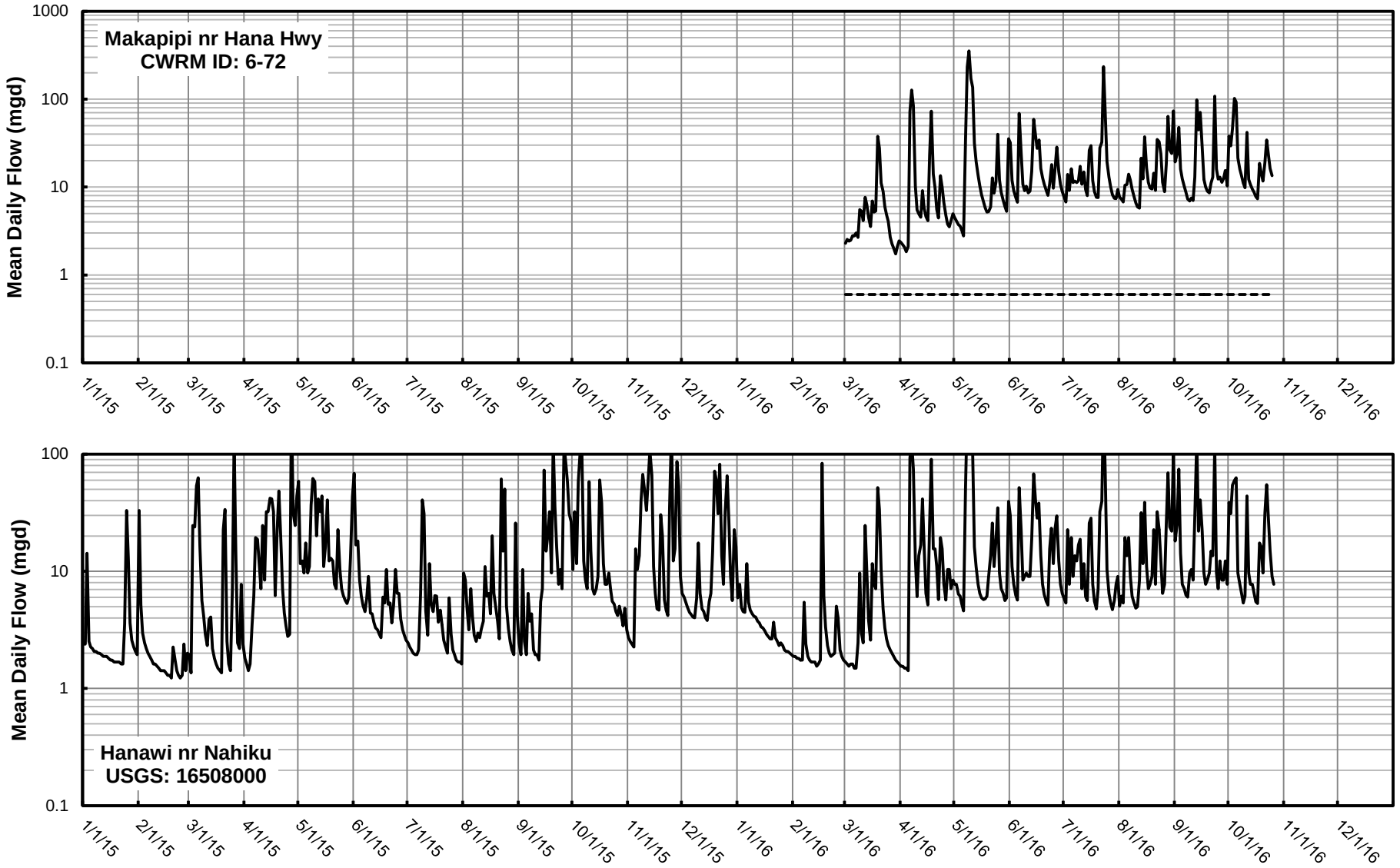

Mean Daily Flow (mgd)
100
10
1
0.1
0.01
West Wailuaiki at Hana Hwy
CWRM ID: 6-65
1/1/15
2/1/15
3/1/15
4/1/15
5/1/15
6/1/15
7/1/15
8/1/15
9/1/15
10/1/15
11/1/15
12/1/15
1/1/16
2/1/16
3/1/16
4/1/16
5/1/16
6/1/16
7/1/16
8/1/16
9/1/16
10/1/16
11/1/16
12/1/16
Mean Daily Flow (mgd)
1000
100
10
1
West Wailuaiki nr Keanae
USGS: 16518000
1/1/15
2/1/15
3/1/15
4/1/15
5/1/15
6/1/15
7/1/15
8/1/15
9/1/15
10/1/15
11/1/15
12/1/15
1/1/16
2/1/16
3/1/16
4/1/16
5/1/16
6/1/16
7/1/16
8/1/16
9/1/16
10/1/16
11/1/16
12/1/16

Figure --.


Mean Daily Flow (mgd)
100
10
1
0.1
0.01
East Wailuaiki at Hana Hwy
CWRM ID: 6-66
1/1/15
2/1/15
3/1/15
4/1/15
5/1/15
6/1/15
7/1/15
8/1/15
9/1/15
10/1/15
11/1/15
12/1/15
1/1/16
2/1/16
3/1/16
4/1/16
5/1/16
6/1/16
7/1/16
8/1/16
9/1/16
10/1/16
11/1/16
12/1/16
Mean Daily Flow (mgd)
1000
100
10
1
West Wailuaiki nr Keanae
USGS: 16518000
1/1/15
2/1/15
3/1/15
4/1/15
5/1/15
6/1/15
7/1/15
8/1/15
9/1/15
10/1/15
11/1/15
12/1/15
1/1/16
2/1/16
3/1/16
4/1/16
5/1/16
6/1/16
7/1/16
8/1/16
9/1/16
10/1/16
11/1/16
12/1/16


WaiohueStream nr Hana Hwy
CWRM ID: 6-64
Mean Daily Flow (mgd)
1000
100
10
1
0.1
0.01
1/1/15
2/1/15
3/1/15
4/1/15
5/1/15
6/1/15
7/1/15
8/1/15
9/1/15
10/1/15
11/1/15
12/1/15
1/1/16
2/1/16
3/1/16
4/1/16
5/1/16
6/1/16
7/1/16
8/1/16
9/1/16
10/1/16
11/1/16
12/1/16
Hanawi nr Nahiku
USGS: 16508000
Mean Daily Flow (mgd)
100
10
1
0.1


Makapipi nr Hana Hwy
CWRM ID: 6-72
Mean Daily Flow (mgd)
1000
100
10
1
0.1
1/1/15
2/1/15
3/1/15
4/1/15
5/1/15
6/1/15
7/1/15
8/1/15
9/1/15
10/1/15
11/1/15
12/1/15
1/1/16
2/1/16
3/1/16
4/1/16
5/1/16
6/1/16
7/1/16
8/1/16
9/1/16
10/1/16
11/1/16
12/1/16
Hanawi nr Nahiku
USGS: 16508000
Mean Daily Flow (mgd)
100
10
1
0.1