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COMMISSION ON WATER RESOURCE MANAGEMENT

OF THE STATE OF HAWAII

PETITION TO AMEND INTERIM INSTREAM FLOW STANDARDS FOR HONOPOU, HUELO (PUOLUA), HANEHOI, WAIKAMOI, ALO, WAHINEPEE, PUOHOKAMOA, HAIPUAENA, PUNALAU/KOLEA, HONOMANU, NUAAILUA, PIINAAU, PALAUHULU, OHIA (WAIANU), WAIOKAMILO, KUALANI, WAILUANUI, WEST WAILUAIKI, EAST WAILUAIKI, KOPILIULA, PUAKAA, WAIOHUE, PAAKEA, WAIAAKA, KAPAULA, HANAWI, AND MAKAPIPI STREAMS	Case No. CCH-MA-13-01 HAWAIIAN COMMERCIAL AND SUGAR COMPANY’S SUBMISSION OF AMENDED PROPOSED FINDINGS OF FACT AND CONCLUSIONS OF LAW; CERTIFICATE OF SERVICE Hearing Officer: Dr. Lawrence Miike

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HAWAIIAN COMMERCIAL AND SUGAR COMPANY'S SUBMISSION OF AMENDED PROPOSED FINDINGS OF FACT <u>AND CONCLUSIONS OF LAW</u>

Pursuant to Minute Order 24, Hawaiian Commercial and Sugar Company ("***HC&S***") submits its Amended Proposed Findings of Fact and Conclusions of Law ("***HC&S' Amended Proposed FOF/COL***"). Given that the Hearings Officer issued his Proposed Findings of Fact, Conclusions of Law, and Decision and Order on January 15, 2016 (the "***1/15/16 Proposed Decision***"), HC&S submits its amended proposed findings and conclusions in the form of proposed revisions to the 1/15/16 Proposed Decision. Attached hereto is a redline version of the 1/15/16 Proposed Decision showing proposed revisions of the decision. Additional proposed revisions that are of a more global nature are addressed in the brief accompanying HC&S' Amended Proposed FOF/COL.

DATED: Honolulu, Hawai'i, June 7, 2017.

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Hearings Officer's Proposed Findings of Fact,

Conclusions of Law, and Decision and Order

The Hearings Officer makes the following Findings of Fact ("FOF"), Conclusions of Law ("COL"), and Decision and Order ("D&O"), based on the records maintained by the Commission on Water Resource Management, Department of Land and Natural Resources ("Commission") on contested case number CCH-MA13-01, Petition to Amend Interim Instream Flow Standards for Honopou, Hanehoi/Puolua (Huelo), Waikamoi, Alo, Wahinepee, Puohokamoa, Haipuaena, Punalau/Kolea, Honomanu, Nuaailua, Piinau, Palauhulu, Ohia (Waianu), Waiokamilo, Kualani (Hamau), Wailuanui, Waikani, West Wailuaiki, East Wailuaiki, Kopiliula, Puakaa, Waiohue, Paakea, Waiaaka, Kapaula, Hanawi, and Makapipi Streams, and the witness testimonies and exhibits presented and accepted into evidence.

If any statement denominated a COL is more properly considered a FOF, then it should be treated as an FOF; and conversely, if any statement denominated as a FOF is more properly considered a COL, then it should be treated as a COL.

Proposed FOF not incorporated in this D&Or have been excluded because they may be duplicative, not relevant, not material, taken out of context, contrary (in whole or in part) to the found facts, an opinion (in whole or in part), contradicted by other evidence, or contrary to law. Proposed FOF that have been incorporated may have minor modifications or corrections that do not substantially alter the meaning of the original findings.

I. FINDINGS OF FACT[1]

A. Sequence of Events Leading to the Contested Case

1. On May 24, 2001, the Native Hawaiian Legal Corporation ("NHLC") filed 27 Petitions to Amend the IIFS for 27 East Maui streams on behalf of Nā Moku `Aupuni `O Ko`olau Hui

[1] References to the record are enclosed in parentheses, followed by a party's proposed Finding of Fact ("FOF"), if accepted. "Exh." refers to exhibits accompanying written or oral testimony, followed by the exhibit number and page or table number, if necessary. Written testimony is referred to as follows: name of the witness, the type of written testimony, and the page number or paragraph of that testimony. "WDT" means written direct testimony or witness statement; and "WRT" means written responsive testimony or the written rebuttal testimony to the written responsive testimony. Oral testimony is referred to as follows: name of the witness, the date of the transcript ("Tr."), and the page number.

("Nā Moku"), Beatrice Kepani Kekahuna, Marjorie Wallett, and Elizabeth Lehua Lapenia[2]. The petitions were accepted on July 13, 2001. (Commission meeting of August 28, 2008, p. 1.)

2. By a letter dated July 26, 2001, NHLC memorialized its conversation with Commission staff and reiterated its request for the Commission to focus its efforts to restore streamflow to Honopou, Hanehoi, Kualani, Piinau, Palauhulu, Waiokamilo, and Wailuanui streams. (*Id.*)

3. Including the addition of Puolua (Huelo) Stream, these eight streams were eventually organized into five surface water hydrologic units: 1) Honopou (6034) surface water hydrologic unit contains Honopou Stream; 2) Hanehoi (6037) contains Hanehoi and Puolua (Huelo) Streams; 3) Piinaau (6053) contains Piinaau and Palauhulu Streams; 4) Waiokamilo (6055) contains Waiokamilo and Kualani Streams; and 5) Wailuanui (6056) contains Wailuanui Stream.[3] (Exh. C-85, pp. 1-2.)

4. From July 2001, there were meetings, site visits, and discussions among the interested parties regarding the possibility of a collaborative effort to carry out stream studies for the area. On March 20, 2002, the Commission approved a cooperative agreement between the United States Geological Survey ("USGS") and the Commission for the Water Resources Investigations for Northeast Maui streams. The Study was to run from October 2, 2002 to September 30, 2005. The study was completed in January 2006. (*Id.*)

5. On May 29, 2008, NHLC filed a complaint on behalf of Nā Moku, Beatrice Kekahuna, Marjorie Wallet, and Maui Tomorrow Foundation, Inc. ("MTF"), alleging that HC&S was wasting water, based on testimony of an HC&S employee who testified at the Board of Land and Natural Resources ("BLNR") contested case hearing on November 15, 2005. The waste complaint was resolved after staff corresponded with the parties. (Staff Submittal to Clarify the Scope of the Proceedings for the Contested Case Hearing on Remand from the Intermediate Court of Appeals No. CAAP-10-0000161, August 20, 2014, p. 2.)

6. On August 18, 2008, HC&S filed a Motion to Consolidate Petitions to Amend Interim Instream Flow Standards for East Maui Streams and Complaint Relating Thereto Filed May 29, 2008. In the motion, HC&S requested that the Commission consolidate all 27 previously filed petitions into one and to consider amending the IIFS for all 27 streams in one unified proceeding. (Staff submittal, August 28, 2008, p. 2.)

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[2] The Commission was notified by letter on May 10, 2007, that NHLC no longer represented Ms. Lapenia.

[3] The petition to amend the IIFS for Waikani Waterfall (Stream) was consolidated with and addressed as part of the petition to amend the IIFS for East and West Wailuanui Streams, hereinafter referred to as "Wailuanui Stream." (Staff submittal, September 24, 2008, p. 2.)

7. On September 24, 2008, the Commission denied HC&S's motion . (Exh. C-89, p. 9.)

8. On September 25, 2008, the Commission voted to accept staff's recommendation to accept the Petition to Amend the Interim Instream Flow Standards for the Surface Water Hydrologic Units of Honopou (6034), Hanehoi (6037), Piinaau (6053), Waiokamilo (6055), and Wailuanui (6056), Maui. (*Ibid.*, p. 30.)

9. Six of the eight streams in these five surface water hydrologic units had some diverted water restored, for a total of 4.5 mgd (7 cfs)[4]: 1) Honopou Stream; 2) Hanehoi Stream; 3) Puolua (Huelo) Stream; 4) Palauhulu Stream; 5) Waiokamilo Stream; and 6) Wailuanui Stream. Two streams, Piinaau and Kualani Streams, were not restored. (Exh. C-85, pp. 60-62; Exh. C-103, p. 4.)

10. In accepting staff's recommendation, the Commission added three amendments, the first of which was that "(m)oving forward on the staff's recommendation is the first step in (an) integrated approach to all 27 (twenty-seven) streams that are the subject of these petitions." Then Chair Thielen had stated in the preceding discussion that "if people are not happy at the end of the year, when the Commission makes any decisions, they would have the ability to request a contested case hearing at that time. Cooperation now is not a waiver of any body's rights to contest that at a later date." After the vote to accept staff's recommendation with amendments, Chair Thielen stated that "the main thing that was passed today is setting minimum instream flow standards that require some infrastructure change, require some evaluation, cooperation and then coming back to the Commission and making final recommendations for the entire 27 stream units." (Exhs. C-89, pp. 27, 30-31.)

11. On December 16-17, 2009, the Commission met to consider staff's recommendations for the remaining 19 streams. Additional information was requested before the Commission would make its decision, including a focus on seasonal IIFS—i.e., different IIFS for wet versus dry seasons. (Exhs. C-90, C-106.)

12. On May 25, 2010, the Commission voted to amend the IIFS through a seasonal approach to address habitat availability for native stream animals for six of the remaining 19 streams, with winter total restorative amounts of 9.45 mgd, and summer restoration reduced to 1.11 mgd. (Exh. HO-1.).)

13. Together with the additions for the first eight streams (six of which were amended) that totaled 4.5 mgd (*supra,*FOF 9), total stream restorations for the 27 streams were as follows: 12 of

[4] But see FOF 183, *infra*, where the total is 4.65 mgd.

27 streams restored by a total of 13.95 mgd in the wet season, reduced to 5.61 mgd in the dry season.

14. Commission staff had estimated total diversions by East Maui Irrigation (EMI) as ranging from 134 mgd in the winter months to 268 mgd in the summer months, averaging about 167 mgd. (Exh. C-85, p. 22; Exh. C-103, p. 18, table 4.)

15. Increasing the IIFS for 12 of the 27 streams by 13.95 mgd in the wet (winter) season, and reducing the total for these 12 streams to 5.61 mgd in the dry (summer) season, resulted in: 1) winter months: 13.95 mgd returned to the streams, leaving 120.05 (134 – 13.95) mgd to continue to be diverted; and 2) summer months: 5.61 mgd returned to the streams, leaving 262.39 (268 – 5.61) mgd to continue to be diverted. Thus, in the winter months, 10.4 (13.95/134) percent of diversions would be returned to the streams, and in the summer months, 2.1 (5.61/268) percent would be returned.

16. HC&S had submitted a consultant's paper on September 12, 2008, Importance of the Hawaiian Commercial & Sugar Company to the Hawaii Economy and Conditions for Its Survival: A consultant Paper by Leroy O. Laney, Ph.D. Commission staff stated that "HC&S plays an important role in Maui's economy…however, the paper fails to provide any data with regards to water usage by HC&S or any data that demonstrates the impacts of specific reductions in water availability." (Exh. C-85, p.4.)

17. HC&S had calculated its water usage as 5,064 gallons per acre per day (gad) in the winter months and 10,128 gad in the summer months, but Commission staff found this to be high and had calculated average irrigation needs for sugarcane to range from 1,400 to 6, 000 gad. (Exh. C-85, p. 8.)

18. Despite these earlier conclusions by Commission staff (*supra*, COL 16-17), in its May 25, 2010 submittal, staff stated the following, based on additional information provided by HC&S: "On average, streamflow provides 167 mgd of water to the plantation with an additional 72 mgd from ground water sources. Evidently, the plantation's water needs greatly exceed surface water sources otherwise HC&S would not expend the cost to pump water from its brackish water wells to supplement surface water sources. Pumping costs can range from $32 to $290 per million gallons (*citation omitted*). With decreasing trends in streamflow, east Maui streams will continue to be an insufficient supply of surface water needs for the plantation regardless of interim IFS adoption (*footnote omitted*). (Exh. C-103, p. 14-15.)

19. Staff did not attempt to reconcile its May 25, 2010 opinion with its earlier September 24, 2008 opinion, nor did the Commission discuss this issue before reaching its decision on the remaining 19 streams. (Exhs. C-91, E-60.)

20. At the end of the May 25, 2010 meeting, petitioners requested a contested case. (Exhs. C-91, E-60, p. 50.)

21. On June 3, 2010, Nā Moku filed a Petition for a Contested Case for "(p)etitioners right to sufficient stream flow to support the exercise of their traditional and customary native Hawaiian rights to growing kalo and gathering in, among, and around East Maui streams and estuaries and the exercise of other rights for religious, cultural and subsistence purposes. Specifically, the rights of members to engage in such practices in, on, and near Waikamoi, Puohokamoa, Haipuaena, Punalau/Kolea, Honomanu, West Wailuaiki, East Wailuaiki, Kopiliula and Puakaa, Waiohue, Paakea, Kapaula, Hanawi streams from HRS § 1-1 and HRS § 7-1 and protected under HRS § 174-101." (Exh. C-92, p. 3.)

22. Petitioner's request for a contested case identified five of the six streams that had their IIFS amended, and eight of the 13 streams that had been left at their status quo IIFS in the Commission's May 25, 2010 decision. (Staff Submittal on the request for a contested case hearing, October 18, 2010, p. 4, table 1.)

23. On June 3, 2010, County of Maui, Department of Water Supply ("MDWS"), also had filed a contested case petition, citing as its reasons that: 1) "any decision will directly affect MDWS's ability to provide water to homes, farms, schools, hospitals, churches, and businesses in Upcountry Maui, as MDWS's Upcountry System relies heavily on surface water"; and 2) "MDWS is the public water supplier for the County. MDWS is in the best position to represent the public's interest in continued use of these resources for the Upcountry Maui public water supply." (Application to be a Party in a Contested Case Hearing Before the Commission on Water Resource Management, June3, 2010, p. 2.)

24. On October 18, 2010, the Commission voted to deny the petition on the basis that "(n)either petitioner has a property interest in the determination of the public's interest in stream flows," and "(t)he amendment of the interim IFS for the subject streams was couched in terms of flows required at a particular point in the stream. The Commission's decision did not give any party any rights or privileges in the stream flows." Therefore, "it is clear there was no requirement for the Commission to hold a contested case hearing prior to making a decision on

the amendment of interim IFS for the 16 hydrologic units in east Maui." (Exh. C-93, p. 5, pp. 3-4.)

25. On November 17, 2010, Nā Moku filed a timely notice of appeal, contending that the Commission erred in: 1) concluding that Nā Moku had no right to a contested case hearing; and 2) reaching its underlying decision regarding IIFS amendment for the nineteen streams at issue. (*In Re Petition to Amend Interim Instream Flow Standardsfor Waikamoi, Puohokamoa, Haipuaena, Punalau/Kolea, Honomanu, West Wailuaiki, East Wailuaiki, Kopiliula, Puakaa, Waiohue, Paakea, Kapaula and Hanawi Streams*, Hawai`i Intermediate Court of Appeals, CAAP-10-0000161, November 30, 2012, pp. 2-3.)

26. On November 30, 2012, the Intermediate Court of Appeals vacated the Commission's October 18, 2010 denial of Nā Moku's Petition for Hearing and remanded the matter to the Commission with instructions to grant Nā Moku's Petition for Hearing and to conduct a contested case hearing pursuant to HRS Chapter 91 and in accordance with state law. (*Ibid.*, p. 8.)

27. In its ruling, the Intermediate Court Appeals concluded that "(t)he May 25, 2010 meeting, at which the Commission reached an IIFS determination for the nineteen streams, did not comply with the adjudicatory procedures of HAPA (Hawai`i Administrative Procedures Act). Among other things, the Commission did not produce a written decision accompanied by findings of fact and conclusions of law. We consequently decline Nā Moku's invitation to address the merits of whether the Commission erred in reaching its determination on the petitions to amend the IIFS for the nineteen streams, as argued in the parties' briefs. This matter is to be properly presented, argued, and decided pursuant to an HRS chapter 91 contested case hearing conducted by the Commission, the body statutorily empowered to make this determination." (*Ibid.*, pp. 7-8.)

28. On January 29, 2014, Lawrence Miike was appointed Hearings Officer.[5]

29. On March 4, 2014, a prehearing conference was held to establish timetables for the contested case proceedings. (Minute Order #1, February 25, 2014.)

30. On April 21, 2014, Nā Moku, MDWS, HC&S,[6] Hawaii Farm Bureau Federation, and MTF, were granted standing. (Minute Order #2, April 21, 2014.)

[5] Dr. Miike was a member of the Commission from 1994 to 1998 and from 2004 to 2012. He was a member of the Commission at the time of its September 24, 2008 decision on the first eight streams, the May 25, 2010 decision on the remaining 19 streams, and the October 18, 2010 decision to deny standing to Nā Moku. Dr. Miike voted to approve the staff recommendation (with amendments) on the first eight streams, dissented from the majority's approval of the remaining 19 streams, and did not attend the meeting where the Commission denied standing to Nā Moku.

31. On May 13, 2014, MTF withdrew as a party to the contested case, without prejudice to the ability of its supporters, Neola Caveny and Ernest Shupp, to continue as parties. (Letter of May 13, 2014, from Isaac Hall, attorney for Maui Tomorrow Foundation, Inc.; Minute Order #6, May 28, 2014.)

32. On June 6, 2014, MTF requested that it be reinstated as a party to the contested case, and the request was granted on June 9, 2014. (Minute Order #8, June 9, 2014.)

33. On June 30, 2014, a hearing was held to address the Hearings Officer's proposal that the contested case must address all 27 streams in an integrative approach and not just the thirteen streams named in the request for the contested case. (Minute Order #7, May 30, 2014; Transcript of due process hearing, June 30, 2014.)

34. At the June 30, 2014 hearing, the Hearings Officer ruled that all 27 streams would be addressed in the contested case, because:

a. the Commission's decision on the first eight streams amended the staff recommendation to state that "(m)oving forward on the staff's recommendation is the first step in (an) integrated approach to all 27 (twenty-seven) streams that are the subject of these petitions," FOF 10, *supra*;

b. the Intermediate Court of Appeals had ruled that "(t)he May 25, 2010 meeting, at which the Commission reached an IIFS determination for the nineteen streams, did not comply with the adjudicatory procedures of HAPA (Hawai`i Administrative Procedures Act). Among other things, the Commission did not produce a written decision accompanied by findings of fact and conclusions of law. We consequently decline Nā Moku's invitation to address the merits of whether the Commission erred in reaching its determination on the petitions to amend the IIFS for the nineteen streams, as argued in the parties' briefs. This matter is to be properly presented, argued, and decided pursuant to an HRS chapter 91 contested case hearing conducted by the Commission, the body statutorily empowered to make this determination," FOF 27, *supra*;

c. neither the Commission's decision on the first eight streams nor its decision on the remaining 19 streams met the legal requirements for establishing IIFS, as those decisions did not "weigh the importance of the present or potential instream values with the importance of the present or potential uses of water for noninstream purposes, including the economic impact of restricting such uses," H.R.S. § 174C-71(2)(D); and

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[6] Alexander and Baldwin, Inc./EMI/HC&S.

d. the Commission cannot evaluate the cumulative impact of existing and proposed diversions on trust purposes without assessing the impacts of diversions on all 27 streams. (Transcript of due process hearing, June 30, 2013, pp. 28-41.)

35. On July 16, 2014, the Commission met to discuss a Proposed Procedural Order to conduct a Contested Case Hearing for all twenty-seven (27) streams. (Proposed Procedural Order to clarify the scope of the proceeding and Contested Case Hearing, July 16, 2014.)

36. On August 20, 2014, the Commission voted to authorize, order, delegate, and direct the Hearings Officer to conduct a Contested Case Hearing on Petitions to Amend the Interim Instream Flow Standards for all twenty seven (27) Petitions and streams filed by NHLC. (Minutes of the Commission Meeting of August 20, 2014, pp. 9-10.)

37. On September 9, 2014, the Hearings Officer issued a revised schedule for the Contested Case Hearing. (Minute Order # 9, September 9, 2014.)

38. On September 8, 2014, a notice was published, announcing that the Contested Case Hearing would address all twenty seven (27) petitions. (Maui News, September 8, 2014.)

39. On November 13, 2014, a standing hearing was held to address three applications to be additional parties in the Contested Case Hearing. (Minute Order # 10, October 28, 2014.)

40. At the standing hearing, Jeffrey Paisner was granted standing. John Blumer-Buell and Nikhilananda were denied standing but could testify at the hearing. (Minute Order # 11, December 4, 2014.)

41. On January 7, 2015, a minute order was issued, standardizing the captions for the contested case hearing, because differing versions had been used by the parties and the Commission staff. (Minute Order # 13, January 7, 2015.)

42. On February 19, 2015, a prehearing conference was held to discuss the order of witnesses. (Minute Order # 14, February 9, 2015.)

43. Between March 2, 2015 and April 2, 2015, 15 days of hearings were held, during which 36 witnesses testified and an additional 16 witness statements and approximately 550 exhibits were introduced into evidence.

44. On October 2, 2015, Nā Moku and MTF jointly, HC&S, and MDWS submitted their FOF, COL, and D&O to the hearings officer. Jeffrey Paisner and Hawaii Farm Bureau Federation did not submit any FOF, COL, and D&O.

45. On January 6, 2016, A&B announced that HC&S was transitioning from a business model based on sugarcane cultivation to a diversified farm model.

46. On January 15, 2016, the hearings officer submitted his FOF, COL, and D&O (the "1/15/16 Proposed Decision") to the Commission and the parties.

47. On February 29, 2016, the parties submitted their exceptions to the hearings officer's Proposed Decision. On March 10, 2016, CWRM issued Minute Order 18 directing the Hearings Officer to "reopen the hearing to address A&B's decision of January 6, 2016 to change HC&S' business operations from farming sugar to a diversified agricultural model."

48. On April 1, 2016, the Hearings Officer issued Minute Order 19 in which he recommended that the scope of the re-opened hearing include the following areas:

a. HC&S/A&B's current and future use of surface waters and the impact on the groundwater sources for its central Maui fields of HC&S's cessation of sugar operations;

b. the impact of HC&S' cessation of sugar operations on MDWS' use of surface water; and

c. Maui County's position on the future use of the central Maui fields; and

d. how EMI is managing the decrease in diversions, how it would manage the interim restorations, and any issues concerning the integrity of the EMI ditch system with the current and any future changes in offstream diversions

49. On April 20, 2016, A&B announced that it had decided to fully and permanently restore the East Maui streams identified in 2001 by CWRM and the Native Hawaiian Legal Corporation on behalf of its clients. On April 22, 2016, A&B sent a letter to CWRM confirming this. These streams are: Honopou, Hanehoi (including Puolua), Waiokamilo, Kualani, P`ina`au, Palauhulu, and East and West Wailuanui. (Volner WDT 10/17/16, ¶ 8; Exhibit C-154.)

50. On August 18, 2016, CWRM issued an Order Regarding the Scope of the Re-Opened Hearing to Address the Cessation of Sugar Operations by HC&S (the ***"Scope Order"***). The Scope Order approved the listing of issues set forth in Minute Order 19.

~~45.~~51. The Hearings Officer conducted re-opened evidentiary hearings on February 6, 8, and 9, 2016.

B. The EMI-State Watershed Leases

~~46.~~52. "Since the 1930s, the Territory and then the State issued water permits to Alexander & Baldwin, Inc., Hawaiian Commercial & Sugar Co, and East Maui Irrigation Company, Ltd. (EMI) for the diversion of water from streams in East Maui. The collection system consist(ed) of 388 separate intakes, 24 miles of ditches, and fifty miles of tunnels, as well as numerous small dams, intakes, pipes, and flumes (*citation omitted*). With few exceptions, the diversions capture all of the base flow, which represents the ground-water contribution to total stream flow, and an unknown percentage of total stream flow[7] at each crossing...The source of diverted water is a watershed with an area of about 56,000 acres, about two-thirds of which is owned by the State (*citation omitted*) and managed by the State Department of Land and Natural Resources." (Gingerich, S.B., 2005, "Median and Low-Flow Characteristics for Streams under Natural and Diverted Conditions, Northeast Maui, Hawaii: Honolulu, HI, U.S. Geological Survey, Scientific Investigation Report 2004-5262, 72 pp., at p. 1, referenced by Stephen B. Gingerich, Transcript, March 3, 2015, p. 49 [*hereinafter*, "2005 Flow Study"].)

~~47.~~53. The leases cover four watersheds of approximately 50,000 acres, of which 33,000 acres are owned by the State, and 17,000 acres are owned by EMI. (Garrett Hew, WDT, ¶ 4.)

~~48.~~54. The lease between the State and EMI traces back to a September 13, 1876 agreement. Construction of the ditch system began in the 1870's. (Exh. C-2; Garrett Hew, WDT, ¶ 5.)

~~49.~~55. Since 1938, the leases have been governed by an agreement dated March 18, 1938 between the Territory of Hawaii and EMI. The last long-term licenses were issued in the 1950s and 1960s, and following their expiration, annual revocable licenses were issued by the Board of Land and Natural Resources ("BLNR"). The licenses are currently in holdover status due to the contested case hearing that is pending before BLNR. (Exhs. C-3 to C-11; Garrett Hew, WDT, ¶¶ 6, 8-11.)

~~50.~~56. Prior to 1985-86, the State contracted with the U.S. Geological Survey ("USGS.") to operate gaging stations in various locations in the Ditch system to measure the volume of water collected in each license area from State lands. Beginning with fiscal year 1985-1986, the State no longer contracted with USGS for this service, and EMI took over the operation of the ditch gages and reports the license yields directly to the State. Since 1988 EMI reports a single annual yield to the State, aggregating the readings at the western end of the license areas at Honopou Stream and applying a single factor of 70 percent, based on a comparison of average yields reported by USGS in prior years and a series of studies from 1949 to 1985. (Garrett Hew, WDT, ¶ 12, 13, 15; Exh. C-16.)

~~51.~~57. EMI pays the State $160,000 a year for the right to divert stream waters from the approximately 33,000 acres it leases. (Garrett Hew, Tr., March 17, 2015, pp. 198-200.)

~~52.~~58. From east to west, the watersheds are:

[7] ground water, plus freshet ("normal" rainfall) and storm waters.

a. Nahiku: between the Nahiku Homesteads and the easterly boundary of the Keanae license area. (Exh. C-10, p. 2.)

b. Keanae: between and including the easterly watershed of Waiaaka Stream and the westerly watershed of Piinau Stream. (Exh. C-8, p. 2.)

c. Honomanu: between and including Nuaailua and Haipuena Streams and tributaries. (Exh. C-6, ¶ 4.)

d. Huelo: between and including Puohokamoa and Honopou Streams and their tributaries. (Exh. C-4, p. 2.)

~~53.~~59. From east to west, the State leases begin at Nahiku and end at Honopou Stream, and the East Maui Ditch System continues to collect stream waters between Honopou Stream and Maliko Gulch on EMI's and other private landowners' lands. The sugar cane fields of HC&S begin west of Maliko Gulch. (*See* Exh. C-1, attached.)

~~54.~~60. Streams in the lands leased from the State not only traverse EMI lands on their way to the ocean, but also traverse other private landowners' lands, particularly as the streams near the ocean. (*See* Exh. C-1, attached.)

~~55.~~61. The 1876 agreement between the State and EMI recognized the existence of other property owners, stating that "existing rights or present tenants of said lands or occupiers along said streams shall in no wise be lessened or affected injuriously by reason of anything hereinbefore granted or covenanted." (Exhibit C-2, pp. 2-3; Garrett Hew, Tr., March 17, 2015, pp, 161-169.)

~~56.~~62. Each of the four leases continues to recognize the rights of other property owners "for domestic purposes and the irrigation of kuleanas entitled to the same." (Exh. C-4, ¶ 6; Exh. C-6, ¶ 6; Exh. C-8, p. 2; Exh. C-10, p. 2.)

C. The East Maui Streams

~~57.~~63. There are 25, not 27, streams that are the subject of this contested case:

a) Waikani is not a stream but a waterfall on Wailuanui Stream. (Garrett Hew, WDT, ¶ 36.)

b) Alo is a tributary of Waikamoi Stream. (*See* Exh. C-1, attached.)

~~58.~~64. EMI and MDWS have diverted 23 of these 25 streams:

a) Kualani (also known as "Hamau") and Ohia (also known as "Waianu") Streams are both below the EMI ditch system and have never been diverted. (Garrett Hew, WDT, ¶ 36.)

~~59.~~65. EMI's and MDWS's ditches divert more streams than these 23 streams. (*See* Exhs. C-1 and C-33, attached.) From east to west, the streams that are in each of the state watershed leases are as follows. Streams subject to this contested case are underlined and identified with an asterisk:

a) Nahiku lease area:

1. Makapipi Stream*
2. Hanawi Stream*
3. Kapaula Stream*

b) Keanae lease area:

4. Waiaaka Stream*
5. Paakea Stream*
6. Waiohue Stream*
7. Puakaa Stream*[8]
8. Kopiliula Stream*
9. East Wailuaiki Stream*
10. West Wailuaiki Stream*
11. Wailuanui Stream* (Waikani waterfall, *supra*, FOF 57)
12. Kualani (or Hamau) Stream* (below ditch system, *supra*, FOF 58)
13. Waiokamilo Stream*
14. Ohia (or Waianu) Stream* (below ditch system, *supra*, FOF 58)
15. Palauhulu Stream* (Hauoli Wahine and Kano tributaries)
16. Piinau Stream*

c) Honomanu lease area:

17. Nuaailua Stream*
18. Honomanu Stream*
19. Punalau Stream* (Kolea and Ulunui tributaries)
20. Haipuaena Stream*

d) Huelo lease area:

[8] Puakaa Stream is listed as a independent stream in the Petition, but on the map (*see* Exh. C-1, attached), it is a tributary of Kopiliula Stream.

21. Puohokamoa Stream*

22. Wahinepee Stream*

23. Waikamoi Stream* (Alo tributary)

24. Kolea Stream

25. Punaluu Stream

26. Kaaiea Stream

27. Oopuola Stream (Makanali tributary)

28. Puehu Stream

29. Nailiilihaele Stream

30. Kailua Stream

31. Hanahana Stream (Ohanui tributary)

32. Hoalua Stream

33. Hanehoi Stream* (Huelo [also known as Puolua] tributary)

34. Waipio Stream

35. Mokupapa Stream

36. Hoolawa Stream (Hoolawa ili and Hoolawa nui tributaries)

37. Honopou Stream* (Puniawa tributary)

~~60.~~66. Additional streams between Honopou Stream and Maliko Gulch (*See* Exhs. C-1 and C-33, attached) include:

38. Kapalaalaea Stream (Piilo`i tributary)

39. Halehaku Stream (Waihee, Makaa, Kaulu, Palama, Opana tributaries)

40. Keali Stream

41. Manawaiianu Stream

42. Opaepilau Gulch (labeled as a stream in Exh. C-33)

43. Lilikoi Gulch (labeled as a stream in Exh. C-33)

~~61.~~67. Exhibit C-33 needs explanation in that:

a) In the Nahiku lease area, Kapaula Stream is not depicted.

b) In the Keanae lease area, Paakea, Waiohue, Puakaa, East Wailuaiki, West Wailuaiki, Wailuanui, Waiakamilo, and Palauhulu Streams are not depicted. Of these, EMI has stated that it no longer diverts Waiakamilo. (Garrett Hew, WDT, ¶ 33; Garrett Hew, Tr., March 17, 2015, pp. 125, 128.)

c) In the Honomanu lease area, Kolea Stream is a branch of Punalau Stream, *supra*, FOF 65~~59~~ (stream # 19).

d. In the Huelo lease area:

1. Alo Stream is a tributary of Waikamoi Stream.
2. Ohanui Stream is a tributary of Hanahana Stream.
3. Huelo Stream is a tributary of Hanehoi Stream.
4. Kolea Stream is not depicted, but there is a Kolea reservoir.
5. Wahinepee, Punaluu, Puehu, and Mokupapa Streams are not depicted.
6. Hoolawa ili and Hoolawa nui are tributaries of Hoolawa Stream.

e. In the area between Honopou Stream and Maliko Gulch:

1. There is no Kapalaalaea Stream, but an unidentified stream flows into Kapalaalaea Reservoir.
2. Opana Stream is one of the tributaries of Halehaku Stream.
3. EMI states that Opana, Opaepilau, and Lilikoi Streams are not diverted at the Wailoa Ditch (but are diverted at the lower ditches). (Garrett Hew, Tr., March 18, 2015, p. 176.)
4. Keali and Manawaiianu Streams are below the Wailoa Ditch and not depicted, *see* Exh. C-1, attached.

D. Stream Diversions

1. EMI's Ditch System

~~62.~~68. The Ditch system was constructed in phases, beginning in the 1870s and extending to the completion of the current system in 1923. (Garrett Hew, WDT, ¶ 5.)

~~63.~~69. From mauka to makai, the major ditches that cross Honopou Stream (the western boundary of the state lease areas) are the Wailoa Ditch, the New Hamakua Ditch, the Lowrie Ditch, and the Haiku Ditch. The major ditches that cross Maliko Gulch, the border between EMI's ditch system and HC&S's sugarcane fields, are the Wailoa Ditch, the Kauhikoa Ditch, the Lowrie Ditch, and the Haiku Ditch. (*See* Exh. C-33, attached.)

~~64.~~70. Water sold to MDWS from EMI's Haiku Uka watershed (collected through MDWS's Waikamoi Upper Flume and Waikamoi Lower Pipeline, *see* Exh. C-33, and described, *infra*, at FOF 91~~71~~, is removed east of Honopou Stream and is therefore not captured by the gages at Honopou and need to be added to the amounts measured at Honopou for total license area yields. (Garrett Hew, WDT, ¶ 12.)

~~65.~~71. EMI records the amount of water delivered to HC&S at gages in the four ditches that cross Maliko Gulch. Most of the recorded flows are from the four license areas, which end at Honopou Stream, but some water is collected in streams between Honopou Stream and Maliko Gulch. (Garrett Hew, WDT, ¶ 24.)

~~66.~~72. The delivery capacity of the EMI system is 450 mgd. The long-term average delivery by EMI to HC&S has been 165 mgd, but since 1999, deliveries have decreased significantly, and in the ten year period from 2004-2013, the average delivery was 126 mgd. (Garrett Hew, WDT, ¶ 23, 30.)

~~67.~~73. The HC&S irrigation system is designed to operate at the maximum extent possible on gravity flow from higher to lower elevations, so it is critical that the maximum amount of water possible is taken into the HC&S system at the Wailoa Ditch, the ditch at the highest elevation, which has a capacity of 195 mgd. (Garrett Hew, WDT, ¶ 28.)

~~68.~~74. When the Wailoa Ditch is filled to capacity, it overflows into the New Hamakua Ditch via the streams. Once the New Hamakua has reached capacity, it overflows via the streams into the Lowrie Ditch. And if the Lowrie is filled to capacity, it overflows into the Haiku Ditch via the streams. (Garrett Hew, Tr., March 18, 2015, p. 144.)

~~69.~~75. Surface water flows from East Maui can fluctuate tremendously from day to day and cannot be relied on at times to meet the irrigation requirements of HC&S. When the Wailoa ditch flow is extremely low, the lower ditches have little or no water. (Garrett Hew, WDT, ¶ 29.)

~~70.~~76. At Honopou:

a. for the Wailoa Ditch from 1922 to 1987, daily flows ranged from 1.8 to 328 cubic feet per second (cfs), or 1.16 to 212 mgd,[9] averaging 108.8 mgd, with flows less than 42.46 mgd for five days out of a year;

b. for the New Hamakua Ditch from 1918 to 1985, daily flows ranged from zero to 120.2 mgd, averaging 2.89 mgd, with flows less than 0.27 mgd for four days out of a year;

c. for the Old Hamakua Ditch from 1918 to 1965, daily flows ranged from zero to 39.43 mgd, averaging 0.05 mgd, with flows lowest in June and averaging 0.03 mgd;

[9] 1 cfs equals 0.6463 mgd.

d. for the Lowrie Ditch from 1910 to 1985, daily flows ranged from zero to 74.97 mgd, averaging 16.23 mgd, with flows less than 2.72 mgd for five days out of a year; and

e. for the Haiku Ditch from 1910-1985, daily flows ranged from zero to135.1 mgd, averaging 2.84 mgd, with flows less than 0.36 mgd three days out of a year.(Exh. C-101, pp. 74-77.)

77. EMI has reduced its diversions as a result of the cessation of sugar operations. In addition, on April 20, 2016, A&B announced its decision to fully and permanently restore the following streams: Honopou, Hanehoi (including Puolua), Waiokamilo, Kualani, Pi`ina`au, Palauhulu, and East and West Wailuanui. (Volner WDT 10/16/17, ¶¶ 8, 11; Hew WDT 10/16/17, ¶ 9.)

78. There are primarily four ways to reduce the amount of water that is collected and transported in the EMI ditch system: 1) on streams that have controlled diversions, by closing or reducing the diversion intake gate openings; 2) on stream diversions that have sluice gates, by partially or completely opening the sluice gates; 3) on streams that have radial gates between the diversions and the ditch, by completely closing the radial gates; and 4) by partially or completely closing the gates on the main control points on the ditches themselves to limit the amount of water that can pass each control point, the effect of which is to redirect any excess water into the stream crossed by the ditch where the control point is located. (Hew WDT 10/16/17, ¶ 3.)

79. The streams that have controlled diversions are Hanawi, Kapaula, Paakea, Puakea, Waiohue, East Kopiliula, East Wailua-iki, West Wailua-iki, East Wailuanui, West Wailuanui, Haipuaena and Kolea. The intake gates are openings, which are typically constructed with wooden boards or metal plates, used to regulate how much water can flow from the stream into the diversion structure. The controlled diversions for the above streams are all at the Koolau Ditch level of the EMI ditch system with the exception of Haipuaena and Kolea, where the diversions are at the Spreckels Ditch, which at that point is located at a higher elevation than the Koolau Ditch. (Hew WDT 10/16/17, ¶ 4.)

80. The streams that have diversion structures with sluice gates are Makapipi, Hanawi, Kapaula, Paakea, Puakea, Waiohue, East and West Kopiliula, East Wailua-iki, West Wailua-iki, East Wailuanui, West Wailuanui, Palauhulu, Nuaailua, Honomanu, Kolea, Alo, Waikamoi, Kaaiea, Oopuola, Nailiilihaele, Kailua, Ohanui, Hoalua, Hanehoi, Waipio, Mokupapa, Hoolawa-liili, Hoolawa-nui, and Honopou. These include diversions located on the Ko'olau Ditch, the

Wailoa Ditch, the Spreckels Ditch, the Center/Manuel Luis Ditch, the New Hamakua Ditch, the Lowrie Ditch and the Haiku Ditch. Sluice gates are openings within the basin of the diversions that can be opened to discharge the water collected in the diversion back into the stream. Periodically opening sluice gates to flush out silt, gravel and other debris that collects in the diversion structures is one of the normal means of maintaining the proper functioning of the ditch system. The effect of opening a sluice gate is to return water to the stream after it has entered the diversion structure. It may not always cause 100% of the water that entered the diversion to be discharged back into the stream, however, because during periods of heavy rainfall, water may back up in the diversion faster than it can be discharged through the sluice gate, in which case some water will still enter the ditch. During most flow conditions, however, completely opening the sluice gate will return practically all of the water to the stream. (Hew WDT 10/16/17, ¶ 5.)

81. The streams that have radial gates between the diversions and the ditch are Puohokamoa, Alo, Waikamoi, Kaaiea, Oopuola, Nailiilihaele, Kailua, Ohanui, Hoalua, Hoolawa-liili, Hoolawa-nui, and Honopou. These gates are located along the tunnel reaches of the ditch and were designed to automatically open or close in relation to the water level in the tunnel. The gates are controlled by a float located in a float chamber in the tunnel that is connected to a cable that lifts or lowers the radial gate depending on the water level in the tunnel. The operation of the gates can be adjusted by piping water to the float chamber and closing the drain valve on the chamber to raise the float to maintain the gate in the closed position. (Hew WDT 10/16/17, ¶ 6.)

82. The main ditch control points on the Koʻolau Ditch are located near where the ditch crosses Waiaaka (the #3 gatehouse), Hanawi (Awaimakaino), Waiaaka sluice basin, Kopiliʻula, East Wailua-iki (# 6 gatehouse) and Piʻinaʻau Streams. The main ditch control points on the Spreckels ditch are located near where ditch crosses Uluini, Kolea, Haipuaʻena and Puohokamoa Streams. The main ditch control points on the Manuel Luis / Center Ditch are located near where ditch crosses Haipuaena, Puohokamoa and Waikamoi Streams. The main ditch control points on the Wailoa ditch / tunnel are located near where ditch crosses Kolea and Honopou Streams. The main ditch control points on the New Hamakua Ditch are located near where ditch crosses Alo, Nailiilhaele, Hoolawa and Honopou Streams. The main ditch control point on the Lowrie Ditch is located near where ditch crosses Kailua, Hoalua and Hoolawa Stream. The main ditch control points on the Haiku Ditch are located near where ditch crosses Hoolawa and Honopou Streams. (Hew WDT 10/16/17, ¶ 7.)

83. EMI manages the reduction in diversions by implementing a combination of measures that involve adjusting the intake control gates on the streams with controlled diversions, opening the sluice gates at the diversion on streams that have sluice gates, adjusting the operation of radial gates on the streams that have radial gates, and partially or completely closing the gates on main ditch control points. The precise combination of measures implemented by EMI at any given point in time depends on the amount of water sought to be brought in to serve the needs of HC&S and the County of Maui, and the amount of rainfall that is occurring among the watershed areas that span the ditch system. (Hew WDT 10/16/17, ¶ 8.)

~~84.~~ Currently, EMI has closed the intakes on all of the streams with controlled diversions, has opened the sluice gates on the majority of diversions that have sluice gates, has closed the radial gates on a couple of streams with radial gates, and has closed the main ditch control points on the Koʻolau Ditch where it crosses Waiaaka (the #3 gatehouse), Hanawi (Awaimakaino), Waiaaka sluice basin, Kopiliula, East Wailua-iki (# 6 gatehouse) and Pi'ina'au Streams. EMI has opened the sluice gates on Nuaʻailua stream, Alo stream, and Waikamoi stream on the Center Ditch. The sluice gates on three of the four main intakes on Honomanū stream are open. One of the sluice gates on Honomanū stream cannot be opened because it is inoperable, but water is released into Uluwini stream (the west tributary of Honomanū stream) further down at a control gate in the Spreckels Ditch. The effect of these measures is to rely principally on water entering the ditch system west of Piʻinaʻau stream to meet the current level of reduced needs of HC&S and the County of Maui. With these measures in place, water flows in the Wailoa ditch at Maliko Gulch have been reduced to 20 to 25 mgd, which is enough to serve the County and HC&S' current level of reduced water needs. (Hew WDT 10/16/17, ¶ 9; Hew, Tr., 2/6/17, p. 94 ll. 11-23, p. 95 ll. 19 to p. 96, l. 12.)

85. Under drought conditions, EMI would be implementing a different set of gate adjustments because it would not be possible to meet even the lowered needs of HC&S and the County without importing water from further east, in the Nahiku and Keʻanae area, where base flows are more reliable and there is a ground water contribution to the Koʻolau Ditch, in order to maintain a consistent flow in the Wailoa Ditch. (Hew WDT 10/16/17, ¶ 10.)

86. As irrigation requirements increase due to the ongoing implementation of the Diversified Agricultural Plan, EMI expects to implement a selective opening of board gates, readjusting the opening of sluice gates, resetting of radial gates, and readjusting of main ditch control gates to increase the amount of water brought into the ditch system and delivered to HC&S and the

County. These measures will be dictated by the flow levels needed at Maliko Gulch and the rainfall patterns throughout the East Maui watersheds. (Hew WDT 10/16/17, ¶ 11.)

87. With regard to the implementation of the restoration of the streams that EMI has agree to fully and permanently restore, EMI has done all it can without pursuing permitting. It has 1) closed the intakes and opened the sluice gates on the diversions on East and West Wailuanui Streams on the Koʻolau Ditch; 2) has opened the sluice gate on Palauhulu Stream on the Koʻolau Ditch; 3) has opened the sluice gates on the diversions on Hanehoi and Puolua on the Haiku Ditch; and 5) has opened the sluice gate and closed the radial gate on the Wailoa Ditch, made modifications to the intake on the New Hamakua Ditch, opened the sluice gate and closed the intake diversion on the Lowrie Ditch and modified the diversion on the Haiku Ditch on Honopou Stream. (Hew WDT 10/16/17, ¶ 12.)

88. Further measures to achieve the full and permanent restoration of these streams cannot be taken until EMI obtains all necessary permits and government approvals. On September 16, 2016, EMI submitted to CWRM its applications to abandon the following stream diversions: Honopou, Hanehoi (Puolua), Waiokamilo, Kualani, Pi'ina'au, Palauhulu and Wailuanui (East and West). Other pending approvals and concurrences will be needed from the County, Office of Conservation and Coastal Lands and the United States Army Corps of Engineers. (Hew WDT 10/16/17, ¶¶ 13, 14; Exhibit C-158.)

89. HC&S is currently diverting approximately 20 mgd. Approximately 6-8 mgd of the water being diverted is used by for the County of Maui for its Kula Agriculture Park and Kamole Treatment Plant; 1 mgd is used for HC&S' cattle operation; 2 mgd is used for HC&S' bioenergy crops; and 6 mgd is used for maintenance of HC&S' reservoirs for fire protection. Seepage loss accounts for the balance of approximately 4 mgd. (Hew, Tr., 2/6/17, p. 107, ll. 11-20.)

90. The reduction in diversion amounts does not by itself compromise the structural integrity of the EMI ditch system so long as the complete system, including the open ditches and roadways, continues to be maintained as a single, coordinated system. Consistently reduced flows will increase the amount of maintenance required of the open ditches in the system, because it will increase the surface areas that will need to be periodically cleared of vegetation. (Hew WDT 10/16/17, ¶ 15.)

2. MDWS

~~71.~~91. MDWS receives water from EMI through:

a. groundwater from a development tunnel in the Ko`olau Ditch for the Nahiku community;

b. streams in EMI's Haiku Uka watershed through the upper and lower Waikamoi flumes that MDWS maintains to serve its Olinda/Upper Kula and Piiholo water treatment plants;

c. water from the Wailoa Ditch after it enters HC&S's lands to serve its Kamole water treatment plant; and

d. non-potable water from HC&S's Hamakua Ditch[10] at Reservoir 40 to serve the Kula Agricultural Park. (Garrett Hew, WDT, ¶ 20;Garrett Hew, Tr., March 18, 2015, pp. 192-193; David Taylor, WDT, ¶ 7; Exh. C-33.)

~~72.~~92. MDWS diverts stream water directly through its upper and lower Waikamoi flumes, and receives stream waters from EMI's Wailoa Ditch and its continuation as HC&S's Hamakua Ditch, *see* Exh. C-33, attached.

~~73.~~93. The upper Waikamoi flume diverts water from the Waikamoi, Puohokamoa, and Haipuena Streams to the Olinda/Upper Kula water treatment facility. Water for this facility is stored in the 30-million gallon Waikamoi reservoirs and the 100-million gallon Kahakapao reservoirs, *see* Exh. C-33, attached. The Olinda facility's average daily production is 1.6 mgd, with a capacity of 2 mgd. (David Taylor, WDT, ¶ 11; Exh. B-3, p. 25; David Taylor, Tr., March 11, 2015, pp. 47, 140.) [MDWS FOF 25.]

~~74.~~94. The lower Waikamoi flume diverts water from the Waikamoi, Puohokamoa, Haipuaena and Honomanu Streams to the Piiholo water treatment facility. Water for this facility is store in the 50-million gallon Piiholo Reservoir, *see* Exh. C-33, attached. The Piiholo facility's average daily production is 2.5 mgd, with a capacity of 5 mgd. (David Taylor, WDT, ¶ 10; Eh. B-3, p. 25; David Taylor, Tr., March 11, 2015, p. 47.) [MDWS FOF 24.]

~~75.~~95. The stream flows are variable, so the reservoirs provide storage so that there is a relatively constant amount of water available to the treatment facilities, regardless of streamflow. (David Taylor, Tr., March 11, 2015, p. 49.)

~~76.~~96. There are no gages on the Waikamoi flumes, so there is no way to measure the amount of water being diverted from the streams. Because the new upper Waikamoi flume isn't going to be leaking, MDWS assumes that everything that goes in will come out. MDWS measures the reservoir levels every day, so once the new flume is functional, MDWS will be able

[10] The source for the Hamakua Ditch is the Wailoa Ditch. *See* Exh. C-33, attached.

to calculate how much water is coming from the flume on days when the main intake from the dam is dry, which is most of the days. All of the water coming in will be from the flume. (David Taylor, Tr.,March 11, 2015, pp. 59-60.)

~~77.~~97. EMI's Wailoa ditch, which diverts multiple streams (*see* Exh. C-33 and FOF 61, *supra*), is the source of water for MDWS's Kamole water treatment facility. The Kamole facility's average daily production is 3.6 mgd, with a capacity of 6 mgd. (David Taylor, WDT, ¶ 9; Exh. B-3, p. 24; David Taylor, Tr., March 11, 2015, p. 47.) [MDWS FOF 23.]

~~78.~~98. MDWS owns the upper and lower Waikamoi flumes and has a contract with EMI to service the diversions to keep them clear. MDWS takes water directly from the Wailoa ditch. (David Taylor, Tr., March 11, 2015, p. 53.)

~~79.~~99. HC&S's Hamakua ditch (the western extension of the Wailoa ditch), at reservoir 40 (*see* Exh. C-33, attached), is the source of water for Kula Agricultural Park, where two reservoirs have a total capacity of 5.4 million gallons. The Park consists of 31 farm lots which range in size from 7 to 29 acres, and which are owned by the County of Maui. Individual lots are metered and billed by MDWS. (David Taylor, WDT, ¶ 13; Exh. B-4.) [MDWS FOF 27.]

~~80.~~100. MDWS pays EMI $0.06 per thousand gallons ($60/million gallons). (Garrett Hew, WDT, ¶ 21.)

~~81.~~101. The original contract between MDWS and EMI was entered into in 1961, which was replaced by a 1973 "Memorandum of Understanding" with a term of 20 years. Since its expiration, there have been a total of 8 extensions. After the lapse of the most recent extension, EMI has continued to provide water to MDWS through a memorandum dated April 13, 2000. (David Taylor, WDT, ¶ 15; Exhs. B-5-15.) [MDWS FOF 29.]

~~82.~~102. The memorandum provides that MDWS will receive 12 mgd from the Wailoa ditch with an option for an additional 4 mgd. During periods of low flow, no water will be diverted to lower-elevation ditches, and MDWS will receive a minimum allotment of 8.2 mgd and HC&S will also receive 8.2 mgd. If these minimum amounts cannot be delivered, MDWS and HC&S will receive prorated shares of the water available. (David Taylor, WDT, ¶ 15; Exh. B-5; David Taylor, Tr., March 11, 2015, pp. 53-54; Garrett Hew, Tr., March 18, 2015, pp. 146-147.) [MDWS FOF 30.]

~~83.~~103. Average daily use by MDWS from the Wailoa ditch is 7.1 mgd, which includes water for the Kamole facility, averaging 3.6 mgd (*see* FOF 97~~77~~, *supra*), and the Kula Agricultural Park. (David Taylor, Tr., March 11, 2015, pp. 81-83.)

E. Estimates of Stream Flows

~~84.~~104. Prior to the partial restorations of twelve streams in 2008 and 2010, *supra*, FOF 9, 11, and subsequent installation of gages in these streams, there were only four active gages, one each in Hanawi Stream, West Wailuaiki Stream, Waiokamilo Stream, and Honopou Stream (which is outside the study area to be described, *infra*). (2005 Flow Study, p.4 and Table 1; Exh. C-101, p. 28; Exh. C-85, 47.)

~~85.~~105. Gages had been previously installed on a number of streams for various periods of time and for various years. For example, Makapipi Stream had a gage at 920 feet elevation between 1932-1945; Hanawi Stream had gages at 500 feet elevation between 1932-1947 and again between 1992-1995, and at 1,318 feet elevation between 1914-1915 and again between 1921-Present; and West Wailuaiki Stream had a gage at 1343 feet elevation between 1914-1917 and again between 1921-Present. (2005 Flow Study, Table 1.)

~~86.~~106. In 2002 to 2005, USGS conducted studies to: 1) assess the effects of existing diversions on flows of perennial streams in northeast Maui, 2) characterize the effects of diversions on instream temperature variations, and 3) estimate the effects that streamflow restoration (full or partial) would have on the availability of habitat for native stream fauna (fish, shrimp and mollusks) in northeast Maui. The study area contained 22 named streams from the drainage basins of Makapipi Stream in the east to Kolea Stream to the west (Streams # 1 and #24 in FOF 65~~59~~, *supra*). (2005 Flow Study, p. 3.) The first study is summarized in this section. The second and third studies are summarized in the next section.

~~87.~~107. Stream flows under natural (undiverted) and diverted conditions were estimated for 21[11] streams, using a combination of continuous-record gaging-station data, low-flow measurements, and values determined from regression equations developed for the study. For the drainage basin for each continuous-record gaged site and selected ungaged sites, morphometric, geologic, soil, and rainfall characteristics were quantified. Regression equations relating the non-diverted streamflow statistics to basin characteristics of the gaged basins were developed. Regression equations were also used to estimate stream flow at selected ungaged diverted and undiverted sites. (2005 Flow Study, p. 1.)

[11] No estimates were made for Piinau Stream because the regression equations were not valid for this stream and reliable flow measurements were lacking (2004 Flow Study, p. 63.)

~~88.~~108. Estimates were made for 50 percent and 95 percent duration total flow (TFQ) and base flow (BFQ).[12] (2005 Flow Study, p. 1.)

~~89.~~109. A 50 percent duration flow (median streamflow; Q_{50}) means that, for a specific period of time, half of the measured stream flow was greater than the Q_{50} value, and half was less. For example, for measurements of total flows in a particular stream for the specified period of time: 1) if TFQ_{50} = 25 mgd, then total stream flow was above 25 mgd half of the time and below 25 mgd half of the time,; and 2) if TFQ_{95} = 2 mgd, total stream flow was above 2 mgd 95 percent of the time and below 2 mgd 5 percent of the time. (2004 Flow Study, p. 4.) [HC&S FOF 2.]

~~90.~~110. Relative errors between observed and estimated flows ranged from 10 to 20 percent for the 50-percent duration total flow and base flow, and from 29 to 56 percent for the 95-percent duration total flow and base flow. (2004 Flow Study, p. 1.) Errors are higher for lower flows because, for the same absolute error in flow, the relative error in percent increases as the actual flow decreases. (2005 Flow Study, p. 43.) [HC&S FOF 11.]

~~91.~~111. East of Keanae Valley, the 95-percent duration discharge equation generally underestimated total flow (TFQ_{95}), due to gains in flow from groundwater discharge, and within and west of Keanae Valley, the equation generally overestimated total flow, due to loss of water at lower elevations. (2005 Flow Study, pp. 1, 58.) [HC&S FOF 6.B.]

~~92.~~112. An extreme example of the limitations of the model is Piinau Stream:

> Estimates of flow-duration statistics for Piinau Stream determined from the regression equations are the highest of any sites in the study area...yet the flow observations, although scarce, indicate that flows are much lower than estimated. The stream channel was dry between 1,200 ft and 600 ft altitude...and only a trickle of flow was observed upstream of the 1,300-ft diversion. A recent (2001) large landslide, which covered the stream at about 1,000 ft altitude and filled most of the stream channel downstream to 600 ft altitude with gravel, cobbles, and boulders, complicates flow in the stream. This basin has the highest rainfall and MAXELEV (maximum elevation) in the study area and both are above the range of characteristics used to develop the flow-duration equations. Because the regression equations are not valid for this stream and reliable flow measurements are lacking, no estimates of stream statistics were made for Piinau Stream. (2005 Flow Study, p. 63.)

~~93.~~113. Reduction in 50- and 95-percent flows in stream reaches affected by the diversions throughout the study area averaged 58-60 percent. (2005 Flow Study, p. 1.) Average

[12] Base flow is the groundwater contribution to flow; total flow includes all sources; i.e., ground, freshet ("normal" rainfall) and storm waters.

reduction in the low flow of streams due to diversions ranged from 55 to 60 percent. (2005 Flow Study, p. 70; Stephen B. Gingerich, WDT, p. 2.) [Nā Moku/MTF FOF 235.]

F. Restoration Potential

1. The 2005 Habitat Study

~~94.~~114. The purposes of the second and third studies in 2002 to 2005, *supra*, FOF 86, were to characterize the effects of diversions on instream temperature variations, and to estimate the effects that streamflow restoration (full or partial) would have on the availability of habitat for native stream fauna (fish, shrimp and mollusks). (Exh. E-69: Gingerich, S.B. and Wolff, R.H., 2005, "Effects of Surface-Water Diversions on Habitat Availability for Native Macro-Fauna, Northeast Maui," Hawaii: U.S. Geological Survey Scientific Investigations Report 2005-5213, 93 pp., referenced by Stephen B. Gingerich, Transcript, March 3, 2015, p. 49 [*hereinafter*, "2005 Habitat Study"].)

~~95.~~115. In general, the stream temperatures measured at any of the monitoring sites were not elevated enough to adversely affect the growth or mortality of native fish, shrimp, and mollusks or to cause wetland taro to be susceptible to fungi and associated rotting diseases. (2005 Habitat Study, p. 1.)

~~96.~~116. The Physical Habitat Simulation System (PHABSIM), which incorporates hydrology, stream morphology and microhabitat preferences, was used to simulate habitat/discharge relations for various species and life stages, and to provide quantitative habitat comparisons at different streamflows of interest. Estimates were made of the availability of aquatic habitat for diverted and undiverted conditions and to produce a relation between discharge and habitat availability. Habitat-duration curves show the percentage of time that indicated habitat conditions would be equaled or exceeded and are based on the available estimates of flow duration at each stream reach developed in the 2005 Flow Study for Q_{50} and Q_{95} of total and base flows. (2005 Habitat Study, pp. 1, 51-52.)

~~97.~~117. The area of usable bed habitat was estimated over a range of streamflows that includes the diverted and natural base-flow estimates. The results are also presented as habitat relative to natural conditions with 100 percent of natural habitat at natural median base flow (BFQ_{50}) and 0 percent of habitat at 0 streamflow. In general, the models show a decrease in habitat for all species as streamflow is decreased from natural conditions. (2005 Habitat Study, pp. 51-52.) [Nā Moku/MTF FOF 250.]

~~98.~~118. The relative amount of expected natural habitat (H) expected at 50 percent of natural median base flow ranges from 70 to 92 percent (H_{70-92}), and maintaining 90 percent of natural median base flow results in 94 to 101 percent of expected natural habitat (H_{94-101}) in the stream reaches. (2005 Habitat Study, p. 52.)

~~99.~~119. For East Maui streams, it is estimated that 64 percent of natural median base flow ($0.64xBFQ_{50}$) is required to provide 90 percent of the natural habitat (H_{90}). The flow requirements for each stream reach were provided by the USGS in terms of cubic feet per second (cfs) for all petitioned streams except for Piinaau, Honopou, and Hanehoi streams. (Stephen B. Gingerich, WDT, Summary Table.) [Nā Moku/MTF FOF 258.]

~~100.~~120. Many factors that affect the presence of native aquatic species in northeast Maui were beyond the scope of the USGS study and were not addressed, including:

a. What is the effect of alien species on the migration and living conditions of the native species?

b. What is the fate of animals upon reaching a dry stream reach during upstream migration?

c. At what rate and at what locations will native species populations return to natural levels if diversions were removed?

d. Why were opae seen in abundance above the major diversions but oopu alamoo were not observed at all?

e. To what extent do native and alien species use the diversion ditches and tunnels for migration between streams?

f. What is the effect of taro lo`i on the migration and life cycles of native species?

g. What are the effects of stream diversions on native aquatic insect species?

(Stephen B. Gingerich, WDT, pp. 4-5.) [Nā Moku/MTF FOF 256.]

2. The 2009 Habitat Availability Study

~~101.~~121. After release of the two USGS reports, USGS provided Commission staff with relative estimates of the change in aquatic habitat due to surface-water diversions. (Stephen B. Gingerich, WDT, October 31, 2014, p. 4.)

~~102.~~122. The resulting "2009 Habitat Availability Study" (Glenn R. Higashi, WDT, Appendix A: Parham, J.E. *et al.*, "The Use of Hawaiian Stream Habitat Evaluation Procedure to Provide Biological Resource Assessment in Support of Instream Flow Standards for East Maui

Streams," Bishop Museum and Division of Aquatic Resources, Department of Land and Natural Resources, November 20, 2009) had four goals:

1. explain the influence of stream diversions on the distribution and habitat availability of native stream animals;
2. provide documentation of the model's design, underlying data structure, and application;
3. show changes in habitat availability for native amphidromous animals on a stream-by-stream basis; and
4. prioritize habitat and passage restoration actions among the streams of concern in East Maui. (Glen R. Higashi, WDT, ¶ 3.) [Nā Moku/MTF FOF 269.]

~~103.~~123. Of the 27 streams that were the subject of this contested case, the 2009 Habitat Availability Study addressed only the 19 streams remaining after the Commission's September 25, 2008 order amending the IIFS for 6 of 8 streams, where instream flow for taro cultivation was the main concern, *supra*, FOF 9. (Glen R. Higashi, WDT, ¶ 19.) [Nā Moku/MTF FOF 271.]

~~104.~~124. The Study stated that the 19 streams comprised 16 distinct streams and their tributaries, but only explained that Waiaaka Stream was left out because it was not in DAR's stream codes, database, or GIS coverages. Puakaa Stream is a tributary of Kopiliula Stream, *supra*, FOF 65~~59~~. Wahinepee Stream was left out without explanation. (2009 Habitat Availability Study, Table 1.)

~~105.~~125. Minimum viable habitat flow (H_{min}) for the maintenance of suitable instream habitat was defined as 64% of Median Base Flow ($0.64xBFQ_{50}$) (also defined as H_{90} by USGS studies, *supra*, FOF 99), which was expected to produce suitable conditions for growth, reproduction, and recruitment of native stream animals. (Glen R. Higashi, WDT, Appendix D, p. 4.)

~~106.~~126. Habitat less than H_{90} was not expected to result in viable flow rates for the protection of native aquatic biota. There is no linear relationship between the amount of habitat and the number of animals. H_{70}, or twenty percent less habitat than H_{90}, would not result in only 20 percent less animals; nor would H_{50}, which is twenty percent less than H_{70}, result in only an additional 20 percent less animals. (Glen R. Higashi, WDT, Appendix D, p. 2.)

~~107.~~127. The 16 streams in the study, with their corresponding numbers in FOF 59, *supra*, were:

a. Makapipi Stream,[1]

b. Hanawi Stream,[2]

c. Kapaula Stream,[3]

d. Paakea Stream,[5]

e. Waiohue Stream,[6]

f. Kopiliula Stream[8] (and its tributary, Puakaa Stream[7])

g. East Wailuaiki Stream,[9]

h. West Wailuaiki Stream,[10]

i. Ohia Stream,[14]

j. Nuaailua Stream,[17]

k. Honomanu Stream,[18]

l. Punalau Stream,[19]

m. Haipuaena Stream,[20]

n. Puohokamoa Stream,[21]

o. Waikamoi Stream,[23]

p. Kolea Stream.[24] (Glen R. Higashi, WDT, Appendix A, Table 1.)

~~108.~~128. The Division of Aquatic Resources ("DAR"), recommended the restoration of the following eight streams, in descending order of habitat units restored:

a. Honomanu Stream: 11.6 kilometers (km) of Habitat Units;

b. Puohokamoa Stream: 7.6 km of Habitat Units;

c. Waikamoi Stream: 5.8 km of Habitat Units;

d. Kopiliula Stream (and its tributary, Puakaa Stream): 5.1 km of Habitat Units;

e. East Wailuaiki Stream: 4.4 km of Habitat Units;

f. West Wailuaiki Stream: 4.0 km of Habitat Units;

g. Makapipi Stream: 3.8 km of Habitat Units; and

h. Hanawi Stream: 3.5 km of Habitat Units.

(Glen R. Higashi, WDT, Appendix B, pp. 3-4.)

~~109.~~129. Flow restoration for these eight streams would result in 45.8 km out of a total of 67.3 km, or 68 percent of the 16 streams. (Glen R. Higashi, WDT, Appendix B, p. 4.)

~~110.~~130. Restoration of fish passage and restoration of suitable habitat forming flows at a small number of key locations can result in large amounts of potential habitat to become available for native animals. (Glen R. Higashi, WDT, Appendix A, p. 77.)

~~111.~~131. Restoration of an upstream diversion is not useful without first improving diversions downstream. (*Ibid*.)

~~112.~~132. DAR recommended that all existing diversions on these eight streams be modified to increase suitable instream habitat, minimize the entrainment of larvae, and to allow for animal passage for the recruiting post-larvae. (Glen R. Higashi, WDT, ¶ 8.) [Na Moku, FOF 278.]

~~113.~~133. DAR also commented that:

a. The restoration of suitable flows to a single stream is more appropriate than the return of inadequate flows to multiple streams.

b. Restoration of streams should be spread out in a geographic sense. This will provide greater protection against localized habitat disruptions, a wider benefit to estuarine and nursery habitat for nearshore marine species, and result in more comprehensive ecosystem function across the entire east Maui sector. (Glen R. Higashi, WDT, Appendix D, p. 3.)

~~114.~~134. DAR later reconsidered its initial list of 8 streams on the basis of:

a. the amount of habitat currently lost to diversions;

b. seasonality (wet versus dry seasons) was considered by setting minimum connectivity flows in the dry season and minimum habitat flow in the wet season;

c. issues relating to losing reaches, which eliminated Honomanu and Makapipi streams;

d. streams most biologically impacted by dewatering;

e. the number and difficulty of modifying diversions;

f. the efficient use of water in terms of habitat units restored per cfs of water returned;

g. whether restoration of stream flow along a given segment of a stream involved the comingling of stream and ditch waters; and

h. to geographically distribute the streams proposed for restoration across the entire East Maui ecosystem. (Glen R. Higashi, WDT, Appendix C, p. 2.)

~~115.~~135. Honomanu and Makapipi streams were eliminated after consultation with CWRM, USGS and Bishop Museum on the basis of concerns over losing reaches and replaced with Waiohue and Haipuena streams. DAR's estimates of the undiverted BFQ_{50} flows and 64 percent of BFQ_{50} (H_{90}) flows for the revised list of eight streams were as follows, in order of DAR's priority ranking:[13]

	Median undiverted base stream flow below lower most diversion (Undiverted BFQ_{50})	64 percent of BFQ_{50}, or H_{90} flows
East Wailuaiki Stream	4.52 mgd (7.0 cfs)	2.91 mgd (4.5 cfs)
West Wailuaiki Stream	4.52 mgd (7.0 cfs)	2.91 mgd (4.5 cfs)
Puohokamoa Stream	6.79 mgd (10.5 cfs)	4.33 mgd (6.7 cfs)
Waikamoi Stream	4.46 mgd (6.9 cfs)	2.84 mgd (4.4 cfs)
Kopiliula Stream	5.17 mgd (8.0 cfs)	3.30 mgd (5.1 cfs)
Haipuaena Stream	3.36 mgd (5.2 cfs)	2.13 mgd (3.3 cfs)
Waiohue Stream	4.39 mgd (6.8 cfs)	2.78 mgd (4.3 cfs)
Hanawi Stream	no flow recommended, only modification of diversion for passage	

(Glen R. Higashi, WDT, Appendix D, p. 5.)

~~116.~~136. For these eight streams, the amounts that would be needed to bring stream flows under diverted conditions to 64 percent of BFQ_{50}, or the minimum habitat needed for growth, reproduction, and recruitment of native stream animals, were as follows:

East Wailuaiki Stream:	2.07 mgd (3.2 cfs)
West Wailuiki Stream:	2.26 mgd (3.5 cfs)
Puohokamoa Stream:	3.49 mgd (5.4 cfs)
Waikamoi Stream:	1.68 mgd (2.6 cfs)
Kopiliula Stream:	1.94 mgd (3.0 cfs)
Haipuaena Stream:	1.62 mgd (2.5 cfs)
Waiohue Stream:	1.75 mgd (2.7 cfs)
Hanawi Stream:	modification only of diversion for passage
Total:	14.81 mgd (22.9 cfs)

(Glenn R. Higashi, WDT, Appendix C, Table 1.)

G. The September 25, 2008 Commission Order

~~117.~~137. On September 25, 2008, the Commission voted to accept staff's recommendation to restore six of eight streams for a total of 4.5 mgd: 1) Honopou Stream; 2) Hanehoi Stream; 3)

[13] cfs converted to mgd: 1 cfs = 0.6463 mgd.

Puolua (Huelo) Stream; 4) Palauhulu Stream; 5) Waiokamilo Stream; and 6) Wailuanui Stream. Two streams, Piinaau and Kualani Streams, were not restored, *supra*, FOF 8~~8~~-9~~9~~.

1. Honopou Stream

~~118.~~138. The Wailoa, New Hamakua, Lowrie, and Haiku ditches have historically diverted water from Honopou Stream. HC&S plans to no longer divert Honopou Stream. There is one active gaging station above the Wailoa ditch, and there were three other now-inactive stations below the New Hamakua, Lowrie, and Haiku ditches, respectively. Data from these gages were used instead of the estimates from the 2004 Stream Flow study. Furthermore, Honopou Stream is outside the study area, which would have made the use of the 2005 Stream Flow study for Honopou Stream questionable. (Exh. C-85, pp. 10, 16.)

~~119.~~139. Honopou is a gaining stream, and the average annual groundwater contribution from the stretch from the Wailoa ditch to the Haiku ditch (1.78 cfs, or 1.15 mgd) equals the groundwater (base flow) contribution above the Wailoa ditch (1.78 cfs, or 1.15 mgd), so under undiverted conditions, the base flow below the Haiku ditch would be twice that above the Wailoa ditch. Despite this doubling of base flow as measured by gages above the Wailoa ditch and below the Haiku ditch, the four ditches reduce total stream flow (Q_{50}) by 50 percent, from 2.4 cfs (1.55 mgd) above the Wailoa ditch to 1.2 cfs (0.775 mgd). below the Haiku ditch. (Exh. C-85, pp. 10, 16.)

~~120.~~140. The 2005 Flow Study had comparable percentages of reduced stream flows due to the diversions: 1) reduction in 50- and 95-percent flows in stream reaches affected by the diversions throughout the study area averaged 58-60 percent; and 2) average reduction in the low flow of streams due to diversions ranged from 55 to 60 percent, *supra*, FOF 93.

~~121.~~141. The 2008 Commission decision allowed the continued diversion at Wailoa ditch but minimal or no diversions of low flows (base flows) at the lower ditches; leaving an estimated 1.78 cfs (1.15 mgd) just below the Haiku ditch. Since Honopou Stream continues to gain an unknown amount of water below the Haiku ditch, the IIFS just below the Haiku ditch was set at 2.00 cfs, or 1.29 mgd. (Exh. C-85, pp. 14, 16.)

~~122.~~142. A second IIFS was established downstream of taro and domestic diversions below the Haiku ditch, to prevent drying of the stream and increase the continuity of flow to enhance biological integrity in the stream. This IIFS was established at the Q_{90} above the Wailoa ditch, or 0.47mgd (0.72 cfs). This resulted in 0.82 mgd (1.29 - 0.47 mgd) available to the taro and domestic diversions, and 0.47 mgd to increase continuity of flow to the ocean. There was no explanation of why 0.82 mgd would meet the needs of domestic and taro users, nor why the downstream IIFS of 0.47 mgd was for only continuity of flow to establish biological connectivity instead of a larger IIFS to increase stream habitat to enable reproduction. (Exh. C-85, pp. 14-16.)

~~123.~~143. Even though both total and base flows were reduced by about 50 percent by the diversions, using base flow to amend the IIFS was justified by the conclusion that "(g)round water contribution estimates instead of total flow estimates are used because major diversion structures are generally assumed to capture the majority of the base flow, which is assumed to be mostly ground water flow." (Exh. C-85, p. 14.)

~~124.~~144. In setting the first IIFS at 2.00 cfs, the amendment added 0.22 cfs to 1.78 cfs to account for an unknown gain in the amount of water below the Haiku ditch, *supra*, FOF 141~~121~~. But base flows below the Haiku ditch were available, with Q_{90} at 0.51 cfs, so the amended IIFS should have been increased to 2.29 instead of to 2.00 cfs, or 1.48 mgd instead of 1.29 mgd. (Exh. C-85, p. 16.)

~~125.~~145. This would have increased the available water for domestic and taro users from 0.82 mgd to 1.01 mgd.

~~126.~~146. Base flow was defined as the Q_{70} to Q_{90} flows. In using the base flows instead of total flows, the amended IIFS also chose the lower number of base flow, while recognizing that "the median base flow could also be as high as Q_{70} or 70 percent of total flow." (Exh. C-85, p. 14.)

~~127.~~147. Using Q_{90}, the first IIFS was increased from 0.51 cfs to 2.00 cfs. Using Q_{70}, the increase would have added 0.87 to 1.78 cfs, or 2.65 cfs (1.71 mgd), compared with 1.48 mgd for Q_{90}, *supra*, FOF ~~124~~144. (C-85, pp. 14-16.)

~~128.~~148. Using Q_{90}, the second IIFS was established at 0.72 151cfs (0.47 mgd), the Q_{90} above the Wailoa ditch, *supra*, FOF 122, replacing the measured Q_{90} of 0.51 cfs at the site. Using Q_{70}, the measurement at the site was 0.87 cfs, and would have been replaced by the Q_{70} above the Wailoa ditch, or 1.4 cfs (0.90 mgd). (C-85, p. 16.)

~~129.~~149. Therefore, adding the measured Q_{90} and Q_{70} values at the first IIFS site instead of hypothesizing what those numbers might be, and using Q_{70} instead of Q_{90} values for base flow:

a. The IIFS at the first site could have been 1.71 mgd instead of 1.48 mgd or 1.29 mgd, *supra*, FOF 144~~124~~, 147~~127~~; and

b. The IIFS at the second site could have been 0.90 mgd instead of 0.47 mgd, *supra*, FOF 148~~128~~.

~~130.~~150. Under the assumptions underlying FOF 129, *supra*, the amount of water available to domestic and taro users below the Haiku ditch would have increased from 0.82 (1.29 - 0.47) mgd to 1.01 (1.48 - 0.47) mgd under the Q_{90} flows, and would have decreased slightly from 0.82 mgd to 0.81 (1.71 - 0.9) mgd under the Q_{70} flows; however, under the Q_{70} flows, water at the second IIFS site to increase stream flow to enhance biological integrity would have increased from 0.47 mgd to 0.90 mgd.

~~131.~~151. The total flow restored to Honopou Stream was 1.29 mgd, with 0.82 mgd available to the taro and domestic diversions, and 0.47 mgd for enhancing continuity of flow to the ocean, *supra*, FOF 141~~121~~-142~~122~~.

~~132.~~152. Commission staff noted that there was an estimated 35 acres cultivable for taro, and that Honopou residents do not receive water from a county water system. (Exh. C-85, pp. 11, 13.) There was no explanation on how the 0.82 mgd for taro and domestic diversions would meet these needs.

~~133.~~153. Nā Moku members claim 6.17 acres for taro cultivation and an additional 17.82 acres for cultivable agriculture, for a total of 23.99 acres fed by Honopou Stream, claiming either appurtenant or traditional and customary native Hawaiian rights to a sufficient amount of stream water to irrigate the taro lo`i contained within this acreage. (Exh. A-173.) [Nā Moku FOF 554-556.]

~~134.~~154. Teri Gomes, Nā Moku's expert witness, was not able to quantify the portion of a parcel that was actually farmed in taro nor the percentage of each parcel actually contained in lo`i or farmed in taro at the time of the Mahele and put the entire parcel in taro when she couldn't tell what portion was in taro. (Teri Gomes, Tr., March 4, 2015, p. 137; Tr., April 1, 2015, pp. 18, 40.)

~~135.~~155. Gomes also placed the parcel in the cultivable agriculture category when land was awarded without specificity of use. (Teri Gomes, Tr., April 1, 2015, pp. 19, 32.)

156. On the other hand, HC&S contends that specific locations for properties currently being used or planned to be used for taro cultivation amounts to only two acres . The total of 23.99 acres that Nā Moku members claim is simply the parcels that Lurlyn Scott describes in her Declaration as parcels in which her family has an interest, and are the same properties that her

cousins referenced in their Declarations. (Lurlyn Scott, WDT, ¶ 30; Tr., March 4, 2015, p. 193.) [HC&S FOF 111-112.] 137

~~136.~~157. As a result of A&B's decision to restore the seven priority taro streams, EMI has opened the sluice gate and closed the radial gate on the Wailoa Ditch, made modifications to the intake on the New Hamakua Ditch, opened the sluice gate and closed the intake diversion on the Lowrie Ditch and modified the diversion on the Haiku Ditch on Honopou Stream. EMI is obtaining the necessary approvals to permanently abandon the diversions on Honopou Stream. (Hew WDT 10/16/17, ¶ 12; Hew, Tr., 2/6/17, p. 99, l. 12 to p. 101, l. 16.)

2. Hanehoi Stream and its tributary Puolua (also known as "Huelo")

158. The Wailoa, New Hamakua, Lowrie, and Haiku Ditches have historically diverted water from Hanehoi Stream, and the Lowrie and Haiku Ditches have historically diverted water from the Puolua tributary. HC&S plans to no longer divert Hanehoi and Pulua (Huelo) Streams.

~~137.~~159. Measured stream flow data are limited for Hanehoi/Puolua Streams, so flow statistics were estimated with regression equations. The estimated BFQ_{50} undiverted flow of Hanehoi Stream is 2.54 cfs (1.64 mgd) below the Lowrie Ditch and above the Haiku Ditch. The estimated BFQ_{50} undiverted flow of Puolua (Huelo) Stream is 1.07 cfs (0.69 mgd) below the Lowrie Ditch and above the Haiku Ditch and 1.47 cfs (0.95 mgd) below the Haiku Ditch. The estimated BFQ_{50} undiverted flow at the mouth of Hanehoi Stream is 5.35 cfs (3.46 mgd). (Exhibit C-85, p. 26.)~~Furthermore,~~ Hanehoi/Puolua are outside the 2005 Flow Study area in which the regression equations were developed, so the estimated flow statistics may not be representative of the flow conditions in Hanehoi and Puolua (Huelo) Streams. (Exh. C-85, p. 20, 26.)

~~138.~~160. There are no data on whether Hanehoi and Puolua Streams are losing or gaining flow from groundwater. There is currently very little flow in Hanehoi Stream, but residents reported that the streams had continuously flow before the 1960s except in times of drought, and archaeological evidence of extensive taro lo`i along the lower reaches of the streams suggests that water was once readily available . Streamflow data from long-term gaging stations around the islands indicate that monthly mean total and base flows have generally decreased from the 1940s to 2002, which is consistent with decreasing rainfall trends statewide. (C-85, p. 20.)

~~139.~~161. A diversion for domestic purposes serves approximately 30 families, or approximately 100 people in the Huelo community. There is rarely water available in residents' sections of the streams under present conditions, so they are not using stream water for their crops. (Exh. C-85, pp. 21-22.)

~~140.~~162. As in the case of Honopou Stream, base flow was defined as the Q_{70} to Q_{90} flows. For Honopou Stream, the lower flow of Q_{90} was used instead of the Q_{70}, *supra*, FOF 126-127. For Hanehoi and Puolua Streams, the regression equation estimates were made for TFQ_{50} and TFQ_{95} and BFQ_{50} and BFQ_{95} (TF is total flow, and BF is base flow). TFQ is the same as Q. For Hanehoi Stream, the lower flow (BFQ_{95} instead of the BFQ_{50}) was again used, as it had been for Honopou Stream. But note that TFQ_{95} is lower than the definition of base flow (Q_{70} to Q_{90} flows), and BFQ_{95} is lower than TFQ_{95}. For example, between the Lowrie and Haiku Ditches, for Hanehoi Stream, the estimated TFQ_{95} was 0.81 mgd (1.26 cfs) and BFQ_{95} was 0.74 mgd (1.15 cfs).(Exh. C-85, pp. 24, 26.)

~~141.~~163. Two IIFS were established below the Haiku Ditch and above the confluence of the two streams: 1) for Hanehoi Stream, 0.41 mgd (0.63 cfs); and 2) for the Puolua Stream tributary, 0.57 mgd (0.89 cfs). (C-85, p. 24.)

~~142.~~164. Theses two IIFS were arrived at in the following way:

a. The natural, undiverted BFQ_{95} just above the terminal waterfall at the mouth of Hanehoi Stream was estimated at 1.96 mgd (3.04 cfs). Half, or 0.98 mgd (1.52 cfs), was assumed to maintain biological integrity of the stream. (In the 2005 Habitat Availability Study, when 50 percent of natural base flow [BFQ_{50}, not the smaller BFQ_{95} as used for these two streams] is present in the stream, potentially 80 to 90 percent of the natural habitat for selected native aquatic species is available. Although Hanehoi Stream was not part of the study area, the Study was the best information available.)

b. Since there is no information available on whether Hanehoi Stream is losing or gaining groundwater, the assumption was made that Hanehoi Stream and its tributary, Puolua Stream, contribute to the natural, undiverted flow just above the terminal waterfall. (Exh. C-85, p. 24.)

~~143.~~165. For the Puolua tributary, the IIFS was set at 0.57 mgd (0.89 cfs), the estimated, natural, undiverted flow at that site. For Hanehoi Stream, the IIFS would be 0.41 mgd (0.63 cfs, the remainder after subtracting 0.57 mgd (0.89 cfs) from 0.98 mgd (1.52 cfs). (Exh. C-85, p. 24.)

~~144.~~166. A third IIFS of 0.74 mgd (1.15 cfs) was established further upstream on Hanehoi Stream above the Lowrie Ditch, the estimated undiverted BFQ_{95} below the Lowrie Ditch. (Exh. C-85, p. 25.)

~~145.~~167. No IIFS was proposed for the stream mouth because of the small number of registered surface water users below the confluence of the streams, and because of the terminal waterfall. (Exh. C-85, p. 25.)

~~146.~~168. The purpose of the first two IIFS, *supra*, FOF 141, was to ensure that an adequate amount of surface water reaches users downstream of the Haiku Ditch. (Exh. C-85, p. 24.)

~~147.~~169. The purpose of the third IIFS was to provide adequate surface water for domestic use of the Huelo community. (Exh. C-85, p. 25.)

~~148.~~170. Note that there is a conflict between how the first two IIFS were arrived at and the stated purpose of those IIFS. The sum of the two IIFS, 0.98 mgd (1.52 cfs), *supra*, FOF 165~~143~~, was based on maintaining the biological integrity of the stream, but the purpose of those IIFS was to ensure that an adequate amount of surface water reaches users downstream of the Haiku Ditch, *supra*, FOF 168~~146~~. Moreover, no IIFS was proposed for the stream mouth, which means that all of the water at the IIFS on Hanehoi Stream and its Puolua tributary could be diverted from the streams below those locations, so there would be no improvement in the biological integrity of the stream.

~~149.~~171. As a consequence, although the sum of the first two IIFS was to improve the biological integrity of the stream, operatively, the flows could be completely diverted for offstream uses, leading to no biological enhancement of the streams. Furthermore, as with Honopou Stream, *supra*, FOF 142~~122~~, there is no explanation on how the quantities chosen would provide an adequate amount of surface water for users downstream of the Haiku Ditch, *supra*, FOF 168~~146~~.

~~150.~~172. While not identifying specific acres, Nā Moku contends that insufficient water and lands that have either appurtenant or riparian rights require that both Hanehoi and Puolua Streams be returned to their natural base flows (BFQ_{50}): 1) for Hanehoi Stream, 1.64 mgd (2.54 cfs) at the selected ungaged site between the Lowrie and Haiku Ditch; and 2) 0.95 mgd (1.47 cfs) at the selected ungaged site below the Haiku Ditch for Puolua Stream. This would increase the IIFS for Hanehoi Stream from 0.74 mgd to 1.64 mgd, and for Puolua Stream, from 0.57 mgd to 0.95 mgd. (Exh. C-85, p. 26.) [Nā Moku/MTF FOF 783-784, 806, 810, 819, 840.]

173. On the other hand, HC&S noted that CWRM identified an estimated cultivable area of 2.3 acres, and identified two parties who are or who would like to cultivate taro on four acres, as well as one person who has a parcel adjacent to Hanehoi Stream and would like to exercise her

riparian rights. (Exh. C-85, p. 21; Ernest Schupp, WDT, ¶¶ 3, 9, 13; *see generally,* Neola Caveny, WDT; *see generally*, Solomon Lee, WDT.) [HC&S FOF 154-161.]

~~151.~~174. As a result of A&B's decision to restore the seven priority taro streams, EMI has opened the sluice gates on Hanehoi and Puolua Streams on the Haiku Ditch. EMI has not opened the sluice gate on Hanehoi Stream on the Wailoa Ditch because water released back into the stream at that point would not make it past the New Hamakua Ditch or Lowrie Ditch below until the diversions on those ditches are modified, as those diversions presently have no sluice gates. EMI is obtaining the necessary approvals to permanently abandon the diversions on Hanehoi and Puolua Streams. (Hew WDT 10/16/17, ¶ 12; Hew, Tr., 2/6/17, p. 92, ll. 3-23, p. 99, l. 12 to p. 101, l. 16.)

3. Piinaau and Palauhulu Streams

~~152.~~175. Piinaau and Palauhulu Streams have ~~are~~ historically been diverted by the Ko`olau Ditch (east of and flowing into the Wailoa Ditch; *see* Exhs. C-1 and C-33, attached:

a. Piinaau Stream is dry immediately downstream of the Koolau Ditch, possibly from infiltration losses and diversions at the Ditch. Actual flow measurements are not available because of geographic inaccessibility and a major landslide in 2001.

b. Palauhulu Stream gains flow (averaging 2.7 mgd) from Plunkett Spring below the Ditch. The lower reach is dry from infiltration losses above Store Spring, below which the stream gains an unknown amount of flow from the spring.

c. There was one now-inactive gaging station on Palauhulu Stream just before its confluence with Piinaau Stream. Streamflow statistics were estimated with regression equations from the 2005 Flow Study and low-flow (diverted conditions) measurements.

(Exh. C-85, pp. 30, 36.) HC&S plans to no longer divert Piinaau and Palauhulu Streams.

~~153.~~176. For Piinaau Stream, the Commission kept the status quo IIFS at its lower reach at 40 feet elevation, upstream from its confluence with Palauhulu Stream. A flow value could not be determined due to the large uncertainty in the hydrological data. Moreover, with the current flow, the stream exhibited a rich native species diversity, offered a variety of recreational and aesthetic opportunities, and the two registered diversions had not indicated a lack of water availability. (Exh. C-85, p. 33.)

~~154.~~177. For Palauhulu Stream, a IIFS was established at 3.56 mgd (5.50 cfs) near 80 feet elevation, upstream of its confluence with Piinaau Stream, to ensure that the proposed flow reaches downstream users in Keanae peninsula. This was half of the estimated undiverted base flow at the site, which is 7.12 mgd (11 cfs). Since estimated diverted flow was 3.10 mgd (11 cfs), there was a net addition of 0.46 mgd (0.71 cfs). A second IIFS was not proposed at the stream mouth, because the amount of water flowing from both streams into the estuary, Waialohe Pond, was deemed adequate. (Exh. C-85, pp. 34-35, 36.)

~~155.~~178. 155. Median base flow (BFQ_{50}) was used to establish the IIFS, in contrast with Honopou Stream, where Q_{90} was used, *supra*, FOF 146~~126~~, 147~~127~~, and Hanehoi and Puolua Streams, where BFQ_{95} was used, *supra*, FOF 162~~140~~. (Exh. C-85, p. 34.) Part of the reason was that "(m)edian base flow is used as a standard to determine the relative native species habitat availability in a USGS study, which will be important for future comparisons," and that "(i)f flow is restored to 50 percent of natural base flow, potentially 80 to 90 percent of native habitat is available in Palauhulu Stream upstream of the confluence." (Exh. C-85, p. 34.) It was not explained why BFQ_{50} was not used for the previously described streams, nor why habitat availability was the basis for the amended IIFS, when taro cultivation was the focus.

~~156.~~179. 156. Commission staff identified eight diversions for domestic use, irrigation of taro and other crops and for livestock, for an estimated cultivable area of 106 acres. The Keanae complex, with about 107 lo`i, which has decreased by half since 1903, is fed by Palauhulu Stream. The Keanae Arboretum complex, with 14 lo`i, is fed by Piinaau Stream. (Exh. C-85, p. 31.)

~~157.~~180. Nā Moku claimed that Palauhulu Stream was the water source for 27.195 acres, 24.595 for taro in Keanae, and an addditional 2.6 acres in cultivable acreage. (Exh. A-173, Teri Gomes, Tr., April 1, 2015, p. 7.) [Na Moku/MTF FOF 571-573.]

181. HC&S contends that no person came forth to assert a claim for water from Piinaau Stream, and that the entire Keanae lo`i complex comprises only 10.53 acres. (Garret Hew, WDT, ¶ 29; Exh. C-108, figure 3, p. 57.; Exh. C-109; Exh. C-110.) [HC&S FOF 318-320.]

~~158.~~182. As a result of A&B's decision to restore the seven priority taro streams, EMI has opened the sluice gate on Palauhulu Stream on the Koʻolau Ditch. EMI is obtaining the necessary approvals to permanently abandon the diversions on Palauhulu Stream. (Hew WDT 10/16/17, ¶ 12; Hew, Tr., 2/6/17, p. 99, l. 12 to p. 101, l. 16.)

4. Waiokamilo Stream

~~159.~~183. Waiokamilo Stream is diverted by the Ko`olau Ditch. It is generally a losing stream. The 2005 Flow Study indicated that it is dry immediately downstream of the Ditch, then gains about 3.8 mgd from Akeke (Banana) Spring. Thereafter, the stream loses flow to ground water, minor diversions, and a known losing reach near Dams 2 and 3. (Exh. C-85, p. 40.)

~~160.~~184. In March 2007, the Board of Land and Natural Resources' ("BLNR") issued an interim order to release 6 mgd into Waiokamilo Stream below Dam 3. (Exh. C-83, p. 46.)

~~161.~~185. In July 2007, as a result of the interim order, a USGS gaging station was installed near Dam 3. Streamflow statistics at ungaged sites were estimated with regression equations and low-flow measurements. (Exh. C-85, pp. 40, 47.)

~~162.~~186. In the September 25, 2008 Commission order, an IIFS of 3.17 mgd (4.9 cfs) was established near Dam 3 at the site of the USGS gage. This was the median total flow (T_{50}, also described as TFQ_{50}), or the total flow in the stream without diversions at the Ko`olau Ditch. The estimate of the total undiverted flow: 1) just below the Ko`olau Ditch was TFQ_{50} = 4.52 mgd (7 cfs); 2) below Akeke (Banana) Spring, TFQ_{50} was estimated at 6.46 mgd (10 cfs); but 3) TFQ_{50} was measured at the USGS gaging station at 3.17 mgd (4.9 cfs), likely due to losing reaches between the Spring and Dam 3, *supra*, FOF 183~~159~~. (Exh. C-85, pp. 43-44, 47.)

~~163.~~187. Below the IIFS established at 3.17 mgd (4.9 cfs) near Dam 3 at the site of the USGS gage, Waiokamilo Stream gains flows at 250 feet elevation from what was thought was Kualani Stream and at 240 feet from an unnamed spring, so that just above the terminal waterfall, TFQ_{50} without diversions was estimated at 5.62 mgd (8.7 cfs). (Exh. C-85, p. 47.)

~~164.~~188. What was thought to be Kualani Stream served as a conduit for the Lakini auwai system. Water from Waiokamilo Stream was diverted into the Lakini system and joined Kualani Stream before reaching Dam 1, after which it is diverted for taro cultivation in the Lakini taro patches and in Wailua Valley further downstream. (Exh. C-85, pp. 45, 47.)

~~165.~~189. After investigation, what was thought to be Kualani Stream was actually the most eastern tributary of Waiokamilo Stream. (Garrett Hew, Tr., April 1, 2015, p. 126; Dean Ueno, Tr. March 2, 2015, p. 43.).)

~~166.~~190. The IIFS at Dam 3 was the total flow in the stream without diversions at the Ko`olau Ditch, yet the TFQ_{50} of 3.17 mgd was only half of the 6 mgd that BLNR had ordered released at the same point in March 2007, *supra*, FOF 160.

~~167.~~191. EMI claimed that it had sealed up all its diversions on Waiokamilo Stream, including the intake on what was thought was Kualani Stream, and thereby was no longer diverting any water from Waiokamilo Stream. Dean Uyeno of the Commission staff also stated that what was thought was Kualani Stream, but now is known as East Waiokamilo Stream, was not being diverted. (Garrett Hew, Tr., March 17, 2015, pp. 125, 128-129; Dean Uyeno, Tr., March 2, 2015, pp. 41-43.)

~~168.~~192. Commission staff estimated that there were 515 cultivable acres with Waiokamilo Stream as its source. (Exh. C-85, p. 41.)

~~169.~~193. The Wailuanui lo`i complex relies on three different sources of water, two of which are associated with Waiokamilo Stream and one with Wailuanui Stream. (Exh. cC-85, p. 52.)

~~170. Nā Moku claimed that 60.767 acres, 44.474 acres in taro and 16.293 cultivable acres, are fed by Waiokamilo and Kualani Streams, 22.448 cultivable taro acres are fed by Wailuanui and Kualani Streams, and 5 acres in Waianu Valley, between Wailuanui and Keanae, are fed by Waiokamilo Stream. (Exh. A-173; Isaac Kanoa, WDT, ¶ 6.) [Nā Moku/MTF FOF 595, 606.]~~

~~171. 171. Because what was thought was Kualani Stream is actually the east branch of Waiokamilo Stream, Nā Moku's revised claim is that 65.767 acres are fed by Waiokamilo Stream, and 22.448 acres are fed by Wailuanui and Waiokamilo Streams.~~

~~172.~~194. HC&S states that EMI is no longer diverting Waiokamilo Stream. (Garrett Hew, WDT, ¶ 35; Tr., March 17, 2015, pp. 128-129; Exh. C-52, pp. 56-67; Exh. C-147, pp. 84-96.) [HC&S FOF 365.]

5. Wailuanui Stream

~~173.~~195. Streamflow statistics were estimated by regression equations, estimating that Wailuanui Stream gains flow from the lower reaches of its tributaries to the coast. Average annual groundwater gains upstream of Ko`olau Ditch for East and West Wailuanui are 1.7 mgd and 2.2 mgd, respectively. Between the Ditch and the lowest USGS ungaged site, Wailuanui Stream gains an average of 0.8 mgd. (Exh. C-85, p. 51.)

~~174.~~196. Ko`olau Ditch is the only diversion capturing base flow and could reduce natural total flow by 84 percent. A number of other diversions between the lowest stream gage and the coast could reduce natural total flow by 85 percent. (Exh. C-85, p. 51.)

~~175.~~197. The IIFS was established at 1.97 mgd (3.05 cfs) at 620 feet elevation, downstream of the Ko`olau Ditch and below the confluence of East and West Wailuanui Streams. ~~Estimated diverted flow at this site was 0.65 mgd (1.0 cfs), so there would be a net addition of 1.32 mgd~~

~~(2.05 cfs)~~The estimated BFQ_{50} of undiverted flow at this location is 3.94 mgd (6.1 cfs). (Exh. C-85, pp. 54, 56.)

~~176. The IIFS is half of the BFQ_{50} of 3.94 mgd (6.1 cfs) and was established on the rationale that with half of median base flow, potentially 80 to 90 percent of natural habitat will be available, as well as providing more surface water to the downstream users, the majority of whom are downstream of the IIFS location. (Exh. C-85, p. 55.)~~

~~177.~~198. The IIFS of 0.71 mgd (1.1 cfs), BFQ_{50} of diverted flow, was kept at the status quo further downstream below Waikani Falls. At this location, the estimated BFQ_{50} of undiverted flow is 4.33 mgd (6.7 cfs), and 64 percent of BFQ_{50}~~, or H_{90}, would be 2.77mgd (4.33 cfs). Therefore, the status quo IIFS would be less than that needed for growth, reproduction, and recruitment of native stream animals~~. (Exh. C-85, p. 56.)

~~178. There are two declared diversions for taro cultivation with an estimated cultivable area of 350 acres, but the Wailuanui lo`i complex relies on water from both Waiokamilo and Wailuanui Streams, and Commission staff had estimated that there were 515 cultivable acres with Waiokamilo Stream as its source, *supra*, FOF 168. Therefore, these two areas have undetermined overlaps, and the total would be less than the sum of the two. (Exh. C-85, p. 52.)~~

~~179. As noted earlier, *supra*, FOF 170, Nā Moku contends that 22.448 acres are fed by Wailuanui and Waiokamilo Streams.~~

~~180.~~199. 180. HC&S contends that "the Wailua (Waikani) complex" is the lo`i system that is irrigated solely with water from Wailuanui Stream, and as of the summer of 2006, it comprised 2.80 acres. Furthermore, HC&S contends that it is now substantially, if not entirely, removed from taro production despite an increased, consistent flow of 2 to 3 mgd since the Commission's 2008 decision. (Garret Hew, WDT, ¶¶ 36-38; Exh. C-108; Norman "Bush" Martin, Tr., March 9, 2015, pp. 185-189; Dan Clark, Tr., March 10, 2015, pp. 113-117; Uyeno, December 18, 2014 written report, p. 30.) [HC&S FOF 387-389, 393.]

200. HC&S further contends that the record does not include an adequate breakdown of the parcels and acreage that Nā Moku has identified as owned by its members in the vicinity of Wailuanui Stream that may have been previously irrigated with Wailuanui Stream water. [HC&S FOF 391.]

~~181.~~201. As a result of A&B’s decision to restore the seven priority taro streams, EMI has closed the intakes and opened the sluice gates on the diversions on East and West Wailuanui Streams on the Ko‘olau Ditch. EMI is obtaining the necessary approvals to permanently abandon the diversions on East and West Wailuanui Streams. (Hew WDT 10/16/17, ¶ 12; Hew, Tr., 2/6/17, p. 99, l. 12 to p. 101, l. 16.)

6. Summary and Analysis

a. Use of Different Reference Flows

~~182.~~202. The September 25, 2008 Commission order was said to have restored 4.5 mgd (7 cfs) to six of the eight streams, *supra*, FOF 9. If there were estimated diverted flows at the IIFS sites, those would be subtracted from the IIFS to compute net restorations. If there were only estimated undiverted flows at the IIFS sites, then the IIFS were assumed to be the net restorations:

Honopou Stream:	1.29 - 0.14 =	1.15 mgd	(based on TFQ_{90} flows)
Hanehoi Stream:		0.74 mgd	(based on BFQ_{95} flows)
		0.41 mgd	(based on BFQ_{95} flows)
Puolua Stream:		0.57 mgd	(based on BFQ_{95} flows)
Palauhulu Stream:	3.56 - 3.10 =	0.46 mgd	(based on BFQ_{50} flows)
Waiokamilo Stream:		3.17 mgd	(based on TFQ_{50} flows)
Wailuanui Stream:	1.97 - 0.65 =	1.32 mgd	(based on BFQ_{50} flows)
Total:		7.82 mgd	

~~183.~~203. If the 3.17 mgd for Waiokamilo Stream is left out because BLNR had previously ordered that the flow be increased to 6 mgd at the IIFS site, *supra*, FOF 184~~160~~, the total restorations would be 4.65 mgd (7.19 cfs).

~~184.~~204. The summary table provided by Commission staff are nearly identical to the numbers (without Waiokamilo Stream) in FOF 202~~182~~, *supra*, except that Honopou is listed at 1.21 mgd instead of 1.15 mgd, and Palauhulu Stream is listed at 0.45 mgd instead of 0.46 mgd. That table summarizes the restoration amounts at 4.7 mgd instead of 4.65 mgd. This discrepancy may be due to the Commission staff's use of BFQ_{50} or TFQ_{70} in arriving at their numbers. (Exh. HO-1, footnote 1.) Commission staff also stated that the restoration amounts did not consider Honopou, Hanehoi, and Puolua Streams, but they are in fact included, with the IIFS assumed to be the net restoration, *supra*, FOF 202~~182~~. (Exh. HO-1, footnote 2 and column titled "Restoration Amount, Wet Season.")

~~185.~~205. There was also no uniformity in that four different reference flows (TFQ_{90}, BFQ_{95}, BFQ_{50}, and TFQ_{50}) were used to calculate restoration amounts, *supra*, FOF 202~~182~~.

Commission staff had defined base flow (BFQ) as the Q_{70} to Q_{90} flows, *supra*, FOF 146~~126~~; but for Honopou Stream, they had chosen the low end (Q_{90}), and for Hanehoi and Puolua Streams, had chosen an even smaller reference flow, BFQ_{95}. Furthermore, in the summary table, staff "assumed that Q_{70} and BFQ_{50} represent median base flow in the streams." (Exh. HO-1, footnote 1.)

~~186.~~206. Therefore, for Honopou, Hanehoi and Puolua Streams, less than median base flows formed the basis for restoration amounts, *supra*, FOF 202~~182~~, and for Palauhulu and Wailuanui Streams, *supra*, FOF 155, 176, only half of the median base flows were restored.

~~187.~~207. The choice of reference flows makes a significant difference in the amount of flow restored. For example, restorations for both Hanehoi and Puolua Streams used BFQ_{95} instead of BFQ_{50} flows, *supra*, FOF 202~~182~~. Had BFQ_{50} been used, the restoration amounts for Hanehoi Stream would have increased from 0.74 mgd to 1.64 mgd, and from 0.41 mgd to 0.78 mgd, respectively; and for Puolua Stream, the restoration would have increased from 0.57 mgd to 0.95 mgd. (Exh. C-85, pp. 24-26.)

~~188.~~208. Finally, the use of TFQ_{50} flows for Waiokamilo Stream is explained by the fact that it was no longer being diverted, *supra*, FOF 191~~167~~, and TFQ_{50} should represent median undiverted total flow. However, the TFQ_{50} of 3.17 mgd, which represents all of the total flow, is substantially less than the 6 mgd that BLNR had ordered in March 2007 to be restored, *supra*, FOF 184~~160~~.

~~189.~~209. In the 2007 BLNR order, it had conservatively estimated that the flow above Dams 2 and 3 was 3 mgd, and that EMI had measured it at 3.57 mgd and 3.85 mgd on July 26, 2005, comparable to flows measured by EMI in 1981. It ordered that current diversions be decreased so that flows below Dam 3 increased to 6 mgd on a monthly moving average on an annual basis. (Exh. C-83, pp. 28, 31, 46.)

~~190.~~210. However, total flows after diversions were sealed only averaged 3.17 mgd (4.9 cfs) over 8 months of measurements beginning on September 1, 2007. (Exh. C-85, p. 44.)

b. Taro Water Requirements

~~191.~~211. Paul Reppun, a taro farmer who testified as an expert on taro cultivation in the Nā Wai `Ehā proceeding as well as in the instant proceeding, had opined that the water requirements of kalo lo`i ranges from 100,000 to 300,000 gad. (Paul Reppun, WDT, Exh. A, p. 5; Tr., March 4, 2015, p. 43.) [HC&S FOF 84.]

~~192.~~212. In the contested case hearing on petitions to amend the IIFS for Nā Wai `Ehā streams, the Commission had concluded that on kuleana lands, 130,000 to 150,000 gad of flow-through water was sufficient for proper kalo cultivation, with 15,000 to 40,000 gad of net loss between lo`i inflow and outflow from evaporation, transpiration, and percolation through the bottoms and leakage through the banks, with most of the loss through percolation and leakage. (Exh. C-120, p. 120, COL 54-56; p. 168, COL 219 (citations omitted).) [HC&S FOF 83.]

~~193.~~213. The Commission's estimate was based on its finding that the kuleana lands in the Nā Wai `Ehā case receive more than 130,000 to 150,000 gad for their kalo lo`i, including the 50 percent of time that no water is needed to flow into the lo`i. This would be equivalent to 260,000 to 300,000 gad for the 50 percent of the time that water is flowing, amounts that would be sufficient to meet even Reppun's estimate of 100,000 to 300,000 gad for sufficient flow. (Exh. C-120, p. 120, COL 56.)

~~194.~~214. In the instant proceeding, Reppun stated that his estimate of 100,000 to 300,000 gad took into account the 50 percent of time that no water is needed (but *see* FOF 216~~196~~, 291~~271~~, *infra*) and that any figure can be assumed to be an average resulting from such parameters as percolation rates, weather, season, location on the stream relative to other diversions, initial water temperature, and rate of dilution of used water. (Paul Reppun, Tr., March 4, 2015, p. 43; WDT, Exh. A, p. 6.)

~~195.~~215. However, the utility of using a general water requirement is questionable, as even Reppun opined, "there is no one definitive answer." (Paul Reppun, Tr., March 4, 2015, p.19.)

~~196.~~216. Reppun's use of the 100,000 to 300,000 gad figure is predicated on when the taro needs the most water, not an average over the course of the entire crop cycle, which he had claimed: "but the important thing is that when it does need the most water, it can be severely--the crop can be severely damaged if it doesn't get that. And so it's that peak period of time, which during the summer months, during the hottest times, the longest days, also happens to be the time that everybody else needs the most water, and also the stream needs the most water." (Paul Reppun, Tr., March 4, 2015, p. 19.)

~~197.~~217. The temperature of 27^{0}C (80.6^{0}F) is the threshold point at which wetland kalo becomes more susceptible to fungi and rotting diseases. (Paul Reppun, Tr., March 4, 2015, p. 27; Exh. C-108, p. 1.) [HC&S FOF 86.]

~~198.~~218. Water temperature in a lo`i complex is dependent on variables such as the amount and temperature of the inflow, the amount of foliage cover, and the size of the complex, and different factors in a lo`i can contribute to how soon and how quickly taro rot occurs. (Paul Reppun, Tr., March 4, 2015, pp. 31-33.) [HC&S FOF 88-89.]

~~199.~~219. Reppun participated in a 2007 USGS study designed to collect baseline flow--what the farmers were actually using--and temperature data from kalo cultivation areas on Kauai, Oahu, Maui, and Hawaii. "All we did was look at quantities of water and correlate that to temperature." (Paul Reppun, Tr., March 4, 2015, p. 26; Exh. C-108.)

~~200.~~220. The area of a lo`i complex included the cultivated and fallow lo`i banks, pathways, and auwai inside the perimeter of each complex. (Exh. C-108, pp. 5-6.)

~~201.~~221. Water need for kalo cultivation depends on the crop stage, and in order to assure consistency of the data collected at the various sites, only lo`i with crops near the harvesting stage (continuous flooding of the mature crop) were selected for water-temperature data collection. Data was collected in the dry season (June - October), when water requirements for cooling kalo approach upper limits. Flow measurements generally were made during the warmest part of the day, and temperature measurements were made every 15 minutes at each site for about a 2-month period. (Exh. C-108, p. 1.)

~~202.~~222. The Maui part of the study measured three areas, all on the windward side: 1) Waihee, 2) Wailua, and 3) Keanae. (Exh. C-108, p. 43.)

~~203.~~223. Three lo`i complexes in Wailua were studied: Lakini, Wailua, and Waikani. Lakini and Wailua receive diverted water from Waiokamilo Stream, and Waikani receives diverted water from Wailuanui Stream. All the active lo`i in Keanae were treated as one complex, which receives diverted water from Palauhulu Stream. (Exh. C-108, p. 43.)

~~204.~~224. The acreage for these complexes were:

Lakini:	0.74 acres
Wailua:	3.32 acres
Waikani:	2.80 acres
Keanae:	10.53 acres (Exh. C-108, p. 44, Table 5.)

~~205.~~225. The average inflow value for the 19 lo`i complexes across the four islands that were studied was 260,000 gad, and the median inflow value was 150,000 gad. The average inflow value for the 17 windward lo`i complexes was 270,000 gad, and the median inflow value was 150,000 gad. (Exh. C-108, p. 1.)

~~206.~~226. Inflow measurements on July 30, 2006 and on September 21, 2006 were:

Lakini: 750,000 gad and 550,000 gad (for 0.74 acres)

Wailua: 180,000 gad and 140,000 gad (for 3.32 acres)

Waikani: 190,000 and 93,000 gad (for 2.80 acres)

Keanae: 180,000 gad and 150,000 gad (for 10.53 acres) (Exh. C-108, p. 44.)

~~207.~~227. Of the 17 (of 19) lo`i complexes where water inflow values were measured, only three had inflow temperatures that rose above 27^0C. (Exh. C-108, pp. 1.)

~~208.~~228. Lakini, Wailua, Waikani, and Keanae had inflow temperatures well below 27^0C, with Keanae having the lowest inflow temperature of all lo`i complexes in the study at 20.0^0C. (Exh. C-108, pp. 1, 51, 53, 56, 58.)

~~209.~~229. Outflow temperature was not measured for Wailua, and there was an equipment malfunction at Keanae. For Lakini, temperatures exceeded 27^0C 16.9 percent of the time, with the earliest time of day at 1015 hours and the latest, at 1800 hours; peak temperatures occurred between 1300 and 1815 hours. For Waikani, temperatures exceeded 27^0C 29.1 percent of the time, with the earliest time of day at 0000 hours and the latest, at 2345 hours; peak temperatures occurred between 1400 and 2045 hours. (Exh. C-108, p. 45.)

~~210.~~230. The time that 27^0C was exceeded did not occur every day. Although the study did not summarize these data, the graphs indicate that one-half to two-thirds of the time, temperatures exceeded 27^0C for several hours a day. (Exh. C-108, pp. 51, 56.)

~~211.~~231. Reppun is of the opinion that 77^0F is the point at which rot begins to accelerate, and as rot begins to accelerate, it doesn't necessarily reach unacceptable levels until a little bit higher temperature, and he is of the opinion that 27^0C (80.6^0F) is about that point where it starts to really climb. (Paul Reppun, Tr., March 4, 2015, pp. 27-28.)

~~212.~~232. Reppun is of the opinion that the percent of the time that outflows exceed 27^0C is the most important factor. (Paul Reppun, Tr., March 4, 2015, p. 69.)

~~213.~~233. Reppun also opines that the cooler the water that comes into the lo`i, the better, and the water flowing out of the lo`i should be 77^0F or less. (Paul Reppun, Tr., March 4, 2015, pp. 51, 62.)

~~214.~~234. Aside from such things as the stage of the crop, temperature of the inflows, the amount of sunlight, etc., there are management practices that the farmer can engage in to maximize the cooling effect of the water. The main one is to increase the depth of the water, which would increase the cooling capacity of the water. That takes more water. (Paul Reppun, Tr., March 4, 2015, p. 59.)

~~215.~~235. If you begin to have rot, then you rest your field and change it from a wetland ecosystem to a dry land ecosystem. (Paul Reppun, Tr., March 4, 2015, p. 33.)

~~216.~~236. Questioned on the 0.74-acre Lakini lo`i complex using 550,000 to 750,000 gad, *supra*, FOF 204, 206, Reppun was of the opinion that the capacity of that amount of water was enormous relative to the size of the area, that the water was not going to heat up very much at all, and that the amount was more than adequate. (Paul Reppun, Tr., March 4, 2015, p. 73.)

~~217.~~237. Reppun's opinion that taro water requirements are approximately 100,000 to 300,000 gad does not mean that these amounts are daily averages during a crop cycle, but an approximation of the amount required when maximum inflow is required to prevent rot. Nor is 100,000 to 300,000 gad the maximum of the amount so required. Reppun's principal point is that when lo`i waters are most susceptible to reach temperatures that accelerate rot, sufficient inflow waters need to be available to keep water temperatures below the threshold for rot.

c. Acreage in Taro

~~218.~~238. In total, the acreage claimed by Nā Moku as being either in taro or cultivable agriculture was 136.18 acres for Honopou, Palauhulu, Waiokamilo, and Wailuanui Streams, *supra*, FOF 153~~133~~, 180~~157, 170, 171~~.[14] (Teri Gomes, Tr., April 1, 2015, p. 11, 13.)

~~219.~~239. Nā Moku identified no acreage for Hanehoi and Puolua Streams, but contended that insufficient water and lands that have either appurtenant or riparian rights require that both Hanehoi and Puolua Streams be returned to their natural base flows (BFQ_{50}), *supra*, FOF 150; while HC&S noted that the Commission identified an estimated cultivable area of 2.3 acres, and identified two parties who are or who would like to cultivate taro on four acres, as well as one person who has a parcel adjacent to Hanehoi Stream and would like to exercise her riparian rights, *supra*, FOF 174~~151~~.

~~220.~~240. Teri Gomes, Na Moku's expert witness, put the entire parcel in taro when she couldn't tell what portion was in taro. In her previous testimony before BLNR, she had reduced the acreage by 10 percent, but was not instructed to do so in the present contested case. (Teri Gomes, Tr., April 1, 2015, pp. 14, 18, 40.)

~~221.~~241. Gomes also placed the parcel in the cultivable agriculture category when land was awarded without specificity of use, because most parcels awarded at the time of the Mahele were

[14] The total acreage under FOF 153~~133~~, 180~~157, 170, and 171~~ is 139.4 acres, but there is some overlap because some acres are fed by both Waokamilo and Wailuanui Streams~~, *supra*, FOF 170-171~~.

used for agricultural purposes and she had already eliminated house lots, cemeteries, and churches. (Teri Gomes, Tr., April 1, 2015, pp. 19, 32.)

~~222.~~242. Therefore, Na Moku's own expert witness conceded that these acreages are overstated by an unknown amount for taro cultivation and cultivable agriculture.

d. Revised IIFS to Meet Taro Water Needs

~~223.~~243. The Commission's order identified the acreage of taro for each stream through the undocumented declarations of registered diverters, with a total of 1006 acres plus water for domestic needs, *supra*, FOF 152~~132~~, 161~~139~~, 179~~156~~, 192~~168, 178~~, but did not attempt to evaluate these claims nor relate these acres to the amount of water added to the streams in the revised IIFS.

~~224.~~244. It has further been noted that different reference flows were used to amend the IIFS, *supra*, FOF 202~~182~~-209~~189~~.

~~225.~~245. Commission staff stated that their efforts were based on looking at the lower Q values, the low flow values, in order to make sure that it would always be met, to make sure that the downstream users would always have a set amount of water, and conceded that such an approach could amend the IIFS lower than what taro farmers might need. (Dean Uyeno, Tr., March 2, 2015, p. 122.)

e. Habitat Improvement

~~226.~~246. For East Maui streams, it is estimated that 64 percent of natural median base flow ($0.64xBFQ_{50}$) would be required to provide 90 percent of the natural habitat (H_{90}), *supra*, FOF 99, which is expected to produce suitable conditions for growth, reproduction, and recruitment of native stream animals, *supra*, FOF 125~~105~~.

~~227.~~247. Habitat less than H_{90} would not result in viable flow rates for the protection of native aquatic biota. There is no linear relationship between the amount of habitat and the number of animals. H_{70}, or twenty percent less habitat than H_{90}, would not result in only 20 percent less animals; nor would H_{50}, which is twenty percent less than H_{70}, result in only an additional 20 percent less animals, *supra*, FOF 126~~106~~.

~~228.~~248. The 2008 Commission decision restored only enough water to Honopou Stream for continuity of flow, not growth, reproduction, and recruitment of native stream animals, *supra*, FOF 142~~122~~.

~~229.~~249. For Hanehoi Stream, half of the BFQ_{95} (not the much larger BFQ_{50}) flow, or $0.50xBFQ_{95}$ was restored, *supra*, FOF 164~~142~~. Thus, not only was the smaller base flow used as a reference, but the percent of such flow was only 50 percent, not 64 percent. Furthermore, although the amended IIFS was to improve the biological integrity of the stream, operatively, the flows could be completely diverted for offstream uses, *supra*, FOF 171~~149~~.

~~230.~~250. For Palauhulu Stream, restoration was for half of BFQ_{50}, or $0.50xBFQ_{50}$, less than the $0.64xBFQ_{50}$, and flow at the mouth was deemed adequate, although it is unclear if that flow met the $0.64BFQ_{50}$ requirement, *supra*, FOF 177~~154~~-178~~155~~.

~~231.~~251. For Waiokamilo Stream, the total flow of 3.17 mgd was restored (TFQ_{50}), which cannot meet the BLNR order to have a total of 6 mgd flowing in the stream, supra, FOF 186~~162~~, 190~~166~~. If this total flow is really equivalent to H_{100}, however, the principal purpose of BLNR's order and the cessation of diversions were to increase the availability of stream water for taro growing. So how much of the stream water is used by the taro farmers will determine whether habitat restoration takes place.

~~232.~~252. Finally, for Wailuanui Stream, restoration was for half of BFQ_{50}, or $0.50xBFQ_{50}$, less than the $0.64xBFQ_{50}$ needed for habitat restoration, *supra*, FOF 176. Furthermore, the increased flows can be diverted by downstream users, further compromising habitat improvement, *supra*, FOF 198~~177~~.

H. The May 25, 2010 Commission Order

~~233.~~253. On May 25, 2010, the Commission voted to amend the IIFS through a seasonal approach for six of the remaining 19 streams, with winter total restorative amounts of 9.45 mgd, and summer restoration reduced to 1.11 mgd, *supra*, FOF 12.

~~234.~~254. Winter restorative flows were established at 64 percent of BFQ_{50} (H_{90} or $H_{minimum}$) to maintain minimum viable habitat for native stream animals, while summer restorative flows were established at 20 percent of BFQ_{50} ($C_{minimum}$) to maintain minimum connectivity for animals to survive in shallow pools without suitable long-term growth or reproduction of native stream animals. (Exh. C-103, pp. 9, 11.)

~~235.~~255. A comparison between annual and seasonal approaches is summarized as follows:

	Annual approach	Seasonal approach
Instream uses	helps restore streams to their natural flow pattern for the full year	helps restore streams to their natural flow pattern for part of the year

	greater biological benefit as the higher flows support annual growth and reproduction of native stream animals	results in semi-annual growth and reproduction with recruitment and survival during the alternate six months
<u>noninstream uses</u>	less stream water available for agricultural and domestic needs in the summer when demands are high	streamflows provide more water for agricultural and domestic needs in the summer season when demands are higher than in winter
	one-time diversion modification needed for stable IIFS	more complex diversion modification needed for flexible IIFS and oversight of semi-annual modifications required

(Exh. C-103, p. 14.)

~~236.~~<u>256.</u> Together with the additions for the first eight streams (six of which were amended) that totaled 4.5 mgd (*supra,* FOF 9), total stream restorations for the 27 streams were as follows: 12 of 27 streams restored by a total of 13.76 mgd in the wet season, reduced to 5.61 mgd in the dry season, *supra*, FOF 13.

~~237.~~<u>257.</u> By comparison, Commission staff had estimated total diversions by East Maui Irrigation (EMI) as ranging from 134 mgd in the winter months to 268 mgd in the summer months, averaging about 167 mgd, *supra*, FOF 14.

~~238.~~<u>258.</u> Of the eight (nine, counting Puakaa Stream as separate from Kopiliula Stream, *supra*, FOF 108) streams recommended by DAR for restoration, *supra*, FOF <u>135</u>~~115~~, Commission staff recommended five--Waikamoi, East Wailuaiki, West Wailuaiki, Waiohue, and Hanawi Streams--and added one, Makapipi Stream. (Exh. C-103. p. 19.)

~~239.~~<u>259.</u> The flow rates for H_{90} or $H_{minimum}$ calculated by Commission staff were similar but not the same as DAR's recommended flows in the wet season, because DAR calculated IIFS for the lower and middle reaches of the streams, while Commission staff calculated IIFS near potential monitoring stations. (Exh. C-103, p. 17.)

~~240.~~<u>260.</u> Commission staff's recommendations, which were accepted by the Commission, were as follows:

a. <u>Waikamoi Stream</u>: "supports DAR's position of a geographic approach to flow restoration. A geographic approach means restoring flow to streams both east and west of Keanae Valley. Benefits of this approach include biological diversity in the East Maui area, and regional diversity in traditional gathering opportunities...(I)t is the only stream out of the three recommended DAR streams located west of Keanae Valley that is not used for conveyance along its main reach. Many area residents also expressed interests in gathering native animals from this stream." (Exh. C-103, p. 19.)

b. West Wailuaiki and East Wailuaiki Streams: flow restoration in these streams "will result in the most biological return from additional flow. The presence of an estuary in both streams further enhances the biological diversity of the stream. In addition, flow restoration provides increased opportunities for traditional gathering that area residents currently want to practice." (Exh. C-103, p. 19.)

c. Waiohue Stream: "is also proposed for flow restoration for similar reasons that East and West Wailuaiki Streams were selected. The presence of an estuary further enhances the biological diversity of the stream...(R)esidents testified to gathering vegetation and stream animals in Waiohue Stream." (Exh. C-103, p. 19.)

d. Hanawi Stream: "minimal flow is needed to achieve the desired biological diversity and impacts to HC&S would be negligible. Modification of the diversion would serve mainly to create a wetted pathway for stream animal connectivity from the diversion to the ocean. The interim IFS for Hanawi Stream is an exception to the staff"s approach to calculating the interim IFS because the stream has adequate flow to sustain a viable biota population. As recommended by DAR, the biological health of the stream could be further improved simply by providing connectivity in the dry reach immediately below the diversion. For this reason, staff established the monitoring site directly below the ditch at an interim IFS of 0.1 cfs to ensure a wetted pathway." (Exh. C-103, p. 19.)

e. Makapipi Stream: "Apart from DAR's priority streams, staff recommends restoration for Makapipi Stream because the Nahiku community relies heavily on the stream for cultural practices, recreation, and other instream uses. With the uncertainty of gaining and losing reaches along most of the stream's course to the ocean, it is not known whether restored flow will result in continuous stream flow from the headwaters to the stream mouth. A coordinated study of a short-term release of water past the one major EMI diversion should be sufficient to determine the sustainability of the proposed standard (0.60 mgd [0.93 cfs], which is TFQ_{70}, or BFQ_{50}, just upstream of Hana Highway)." (Exh. C-103, pp. 19-20.)

~~241.~~261. Commission staff did not recommend DAR's selection of Puohokamoa, Haipuaena, and Kopiliula Streams, reasoning that these streams are used for conveyance, more water may exist in the portion of the stream used for conveyance than would naturally occur, and any interim IFS should be based on the surface water available within the given hydrological unit. (Exh. C-103, p. 20.)

a. For Kopiliula Stream, conveyance was described as "ditch," and DAR had recommended bypassing the area of commingling of the ditch and stream water with a box flume. (Glenn Higashi, Tr., March 16, 2015, p. 171. [Nā Moku/MTF FOF 362.]

b. For Puohokamoa Stream, conveyance was described as "overflow" at the Spreckels Ditch and "??" at the Manuel Luis Ditch. (Exh. C-103, p. 1-5.)

c. For Haipuaena Stream, conveyance was described as "S-7, Punalau" at the Spreckels Ditch. ("S-7, Punalau" refers to the Spreckels Ditch intake on Punalau Stream, which is immediately east of Haipuaena Stream. S-8 is the Spreckels Ditch intake for Haipuaena Stream.) (Exh. C-103, p. 1-7.)

~~242.~~262. However, during the contested case hearing, Garrett Hew of EMI agreed that there's no identification of particular conveyance streams. If storm waters overflow a ditch, the water goes into the stream and then hits the next ditch downstream. There are no actual conveyance ditches or designated conveyance streams in the system. (Garrett Hew, Tr., March 18, 2015, pp. 144-145.)

~~243.~~263. For Puakaa Stream, minimum connectivity as for Hanawi Stream, *supra*, FOF 260~~240~~(d), was not recommended, because the habitat unit gain would be only 300 meters compared to over 1300 meters for Hanawi Stream, and the cost and effort to modify the diversion to allow for connectivity was better spent in Hanawi Stream. (Exh. C-103, p. 20.)

~~244.~~264. For the remaining nine streams--Alo (a tributary of Waikamoi Stream), Wahinepee, Punalau, Honomanu, Nuaailua, Ohia, Paakea, Waiaaka, and Kapaula Streams--flow restoration was not recommended because these streams would not result in significant biological return from additional flow. Instead, staff recommended establishing measurable status quo flows at specific locations along each stream." (Exh. C-103, p. 20.)

~~245.~~265. The revised IIFS for these six streams were as follows:

	Wet season (winter)	Dry season (summer)
Waikamoi Stream	1.81 mgd (2.80 cfs)	0
West Wailuaiki Stream	2.46 mgd (3.80 cfs)	0.26 mgd (0.40 cfs)
East Wailuaiki Stream	2.39 mgd (3.70 cfs)	0.13 mgd (0.20 cfs)
Waiohue Stream	2.07 mgd (3.20 cfs)	0.06 mgd (0.10 cfs)

Hanawi Stream (annual)	0.06 mgd (0.10 cfs)	0.06 mgd (0.10 cfs)
Makapipi Stream (annual)	0.60 mgd (0.93 cfs)	0.60 mgd (0.93 cfs)
Total:	9.39 mgd (14.53 cfs)	0.57 mgd (1.73 cfs)

~~246.~~266. The total restoration amounts for the wet season are slightly less than the sum of the IIFS by 0.13 mgd (0.20 cfs), because Waikamoi Stream was restored by 1.68 mgd (2.60 cfs) to bring its IIFS to 1.81 mgd (2.80 cfs), while the other streams' revised IIFS are equal to the restoration amounts. (Exh. HO-1.)

~~247.~~267. Thus, total wet season restoration for these six streams was 9.26 mgd (14.33 cfs), and total dry season restoration was 0.57 mgd (1.73 cfs).

~~248.~~268. Together with the six streams whose IIFS were increased 4.7 mgd (7.27 cfs) on an annual basis in September 2008 primarily for taro growing and domestic uses, *supra*, FOF 204~~184~~, total wet season and dry season restorations for these twelve streams were:

Wet season: 13.96 mgd (21.60 cfs)

Dry season: 5.27 mgd (8.15 cfs)

~~249.~~269. There are small inconsistencies in the totals for the first six streams in 2008 and for the six streams in 2010, *supra*, FOF 9, 12, 13, 15, 204~~184~~, as well in the summary table provided by Commission staff at the contested case hearing (Exh. HO-1). For example, the summary table prepared by Commission staff identified wet season total restoration as 13.97 mgd (21.62 cfs), and dry season total restoration of 5.83 mgd (9.02 cfs). (Exh. HO-1.) However, these differences are insignificant when contrasted to the total amounts diverted for offstream uses by East Maui Irrigation (EMI); namely, from 134 mgd in the winter months to 268 mgd in the summer months, averaging about 167 mgd, *supra*, FOF 14, 257~~237~~.

I. Impact of the Commission's Orders

1. Adequacy of Increased Flows from the 2008 Order for Taro Growing and Domestic Uses

~~250.~~270. In amending the IIFS, different reference flows were used, and the choice of reference flow significantly affected the amount of water restored, *supra*, FOF 206~~186~~-207~~187~~.

~~251.~~271. At the contested case hearing, Commission staff confirmed that the intent of the IIFS meant there would always be that amount of flow in the stream, and that "(w)hat we're trying to do is in using the low flow BF values was to insure that there would always be (that) amount of water in the stream;" "our efforts were based on looking at the lower Q values, the low flow values, in order to make sure that it would always be met;" "we wanted to go with the lower number to assure that the amount would be there for the majority of the time." (Dean Uyeno, Tr., March 2, 2015, pp. 91, 121-122, 128-129, 153.)

~~252.~~272. Staff also confirmed that complaints of taro farmers that they were not getting enough water was not material to whether or not they would have changed their decision to recommend higher releases into the stream: "No. The point was to make sure that the IFS was being met at the IFS point." (Dean Uyeno, Tr., March 2, 2015, p. 64.)

~~253.~~273. Nā Moku didn't provide data on their needs for water, and the documentation for the amended IIFS were addressed by Commission staff. (Exchange between the Hearings Officer and Alan Murakami, attorney for Nā Moku, Tr., March 2, 2015, pp. 45-48.)

~~254.~~274. However, at the conclusion of the Commission's meeting on the September 25, 2008 order, then Chair Thielen stated that: "We recognize that the numbers for the minimum amount of stream flow standard that is in the staff's recommendations for each of the streams(s) may not be the number that the taro farmers and the community want, but on the other hand you've been taking after the diversion. Under this transition the stream would get that amount first and it may be found over the course of the year some requirements may be met or not." (Exh. C-89, p. 31.)

~~255.~~275. The recommended IIFS were for increased water for taro growing and domestic use, and improving habitat for native stream animals, *supra*, FOF 142~~122~~, 151~~131~~, 164~~142~~, 168~~146~~, 169~~147~~, 177~~154~~, 178~~155~~, 184~~160, 176~~.

~~256.~~276. In the implementation, among other things, Commission staff has learned that: 1) the regression estimates used for flows had, in many cases, overstated what those flows would be, so if the sluice gates on the ditches are opened, there still may not be enough flow to meet the amended IIFS; and 2) in Wailuanui and Keanae, the Ko`olau Ditch has only been taking, for the most part, water generated by rainfall, and spring water below the Ditch is what the taro farmers have access to. (Dean Ueno, Tr., March 2, 2015, pp. 30-31.)

~~257.~~277. Whatever basis is used to amend the IIFS, there is a natural variability in stream flow which may dip below the IIFS, generally due to periods of low rainfall, so guaranteeing that a specific flow is always in the stream and still meet the objective of the IIFS is not possible. (Dean Ueno, Tr., March 2, 2015, p. 87, 92-94.)

~~258.~~278. At the time of the 2008 Commission Order, the 2005 Habitat Study was available, but the 2009 Habitat Availability Study was not. (FOF 114~~94~~-136~~116~~.) Therefore, Commission staff did not know that the minimum flow level necessary for suitable habitat availability (H_{90}) for growth, reproduction, and recruitment of native stream animals was 64 percent of BFQ_{50}.

2. Adequacy of Increased Flows from the 2010 Order for Increases in Native Stream Animals

a. Impact of Seasonal Flows

~~259.~~279. To detect if seasonal flow changes mandated by the 2010 Commission resulted in positive changes in a stream over time, monitoring stations were established in three of the four streams for which seasonal IIFS (winter versus summer flows) had been established--East Wailuaiki, West Wailuaiki, and Waiohue Streams, *supra*, FOF 265~~245~~. Surveys began prior to the water restoration and continued for two years after flow restoration commenced.(Glenn Higashi, WDT, Appendix E, pp. 5, 7.)

~~260.~~280. The monitoring effort did not include an assessment of whether or not the winter flows, based on 64 percent of estimated BFQ_{50}, had in fact achieved the minimum habitat of H_{90} necessary for growth, reproduction, and recruitment of native stream animals. (*Ibid.*, pp. 4-49.) Moreover, it is possible that the 64 percent level set by USGS may not be sufficient. (Glenn Higashi, Tr., March 16, 2015, pp. 223-224.)

~~261.~~281. The focus of the monitoring effort was to determine if the return of water had an effect on the habitat and abundance of stream animals and focused on three broad areas: 1) changes in the quantity of physical habitat; 2) changes to the population structure of native stream animals; and 3) changes in connectivity between the lower and upper stream areas. (*Ibid.*, pp. 1, 4, 11.)

~~262.~~282. The correlation between return flows, habitat, and biota was weak. This may have been due to a number of factors including: changing environmental conditions (e.g., rainfall, drought, flash flooding), short monitoring period (< 4 years), and/or that summer flows were detrimental to gains in habitat and biota from the winter flows. (*Ibid.*, p. 2.)

~~263.~~283. While not definitive, some general conclusions were suggested by the study:

> Some changes to instream habitat at the upper survey stations were observed in response to the higher wintertime flow releases. In general, dry, disconnected or slow-water habitats were replaced by more connected swift-water habitats. These improvements to instream habitat reflected a change to a more stream-like environment. Based on our knowledge of stream animals found in mid to upper stream reaches, these changes should result in more suitable instream habitat. In contrast to the improvements observed at upper stations during the wintertime flow releases, the lower summer flows showed little or no habitat improvement.

> In the upper stations of all streams, stream animal assemblages did not show the healthy characteristics. In general, we did not see consistent patterns of occurrence, growth in numbers, or increases in size classes of the animals. As expected based on its habitat and range distribution, *Atyoida bisulcata*[15] was the most common species and some recruitment and growth were observed in East and West Wailua Iki streams.While conditions may have been suitable for *A. bisulcata*, few *Lentipes concolor*, *Sicyopterus stimpsoni*, and *Neritina granosa*[16] were observed in the upper stations suggesting poor quality habitat for these species over time.
>
> At the lower monitoring stations, little change was observed to instream habitat with respect to either winter or summer flow releases. This was not an unexpected result. The lower stations were just upstream from the stream mouth and had perennial flow prior to the flow restorations. In the lower stations of all streams, the stream animal assemblages appear healthy and diverse with good recruitment from the ocean and display composition structure typical of Hawaiian streams. A range of size classes for most stream animals were observed and this pattern likely reflects that suitable conditions existed for feeding, growth, courtship and reproduction.
>
> In our assessment of connectivity, we only observed consistent recruitment of small individuals for *Atyoida bisulcata* to the upper stations over time suggesting that adequate connectivity flows were present. While the upper sites showed some connectivity for *A. bisulcata*, we did not observe increases in recruitment numbers comparing post-release periods to pre-release periods for *Lentipes concolor*, *Sicyopterus stimpsoni*, or *Neritina granosa*. This result suggests that flows for connectivity may have been insufficient for these species. (*Ibid.*, pp. 1-2.)

~~264.~~284. There is no evidence that the summertime flows were advantageous to the animals. The concept of varying flow over times is well supported in fisheries, but in this case it was not. For example, if the wintertime flows had been returned during the summer and complete flow restoration had been done in the winter, that would have been a seasonal flow approach, and we might have seen completely different results. (James Parham, Tr., March 16, 2015, pp. 62-63.)

~~265.~~285. "Overall, the seasonal flow hypothesis (higher winter flows and lower summer flows) was conceptually coherent, yet not supported by the data. The lack of support for the seasonal flow hypothesis may reflect that the prescribed flow amounts were insufficient (i.e. needed higher flows in summer) or that a year round minimum flow is more appropriate for East Maui streams." (Glenn Higashi, WDT, Appendix E, p. 2.)

b. Makapipi Stream

[15] A small shrimp or opae.
[16] two fish or o'opu, and a mollusk or hihiwai.

~~266.~~286. The other three streams whose IIFS were amended were Waikamoi, Hanawi, and Makapipi. Waikamoi Stream's IIFS was amended for seasonal flows but was not selected for the evaluation. Hanawi Stream's IIFS was amended to provide connectivity to the ocean, because the stream has adequate flow to sustain a viable biota population, and only minimal flow was needed to create a wetted pathway for stream animal connectivity from the diversion to the ocean, *supra*, FOF 260~~240~~(d).

~~267.~~287. Makapipi Stream was preliminarily selected for restoration, because the Nahiku community relies heavily on the stream for cultural practices, recreation, and other instream uses. However, with the uncertainty of gaining and losing reaches along most of the stream's course to the ocean, it is not known whether restored flow will result in continuous stream flow from the headwaters to the stream mouth. Therefore, a short-term release of water past the one major EMI diversion was ordered to determine the sustainability of the proposed standard of 0.60 mgd (0.93 cfs), TFQ_{70} or BFQ_{50}, just upstream of Hana Highway, *supra*, FOF 260~~240~~(e).

~~268.~~288. When the sluice gates on the Koolau Ditch were partially opened to allow the majority of the water in Makapipi Stream to flow downstream of the diversion, flows ranged from 0.87 mgd (1.35 cfs) on September 14, 2010 to 0.76 mgd (1.18 cfs) on September 17, 2010. Daily site visits during September 13-17, 2010, indicated zero flow at the Hana Highway Bridge, located about two-thirds of a mile downstream of the diversion. A 1,000-foot reach upstream of the Hana Highway Bridge was dry, with the exception of a few isolated pools of water, and there was no indication of recent streamflow. The precise location where the stream went dry farther upstream was not determined, because it could not be safely accessed on foot. Much of the lower sections of the stream below the highway was largely dry, with isolated reaches with pools of water. (Exh. C-54, p. 1; Dean Uyeno, Tr., March 3, 2015, p. 48.) [HC&S FOF 573.]

J. Neither the 2008 nor 2010 Commission Orders Balanced Instream versus Noninstream Uses

1. The 2008 Order was Intended to be Provisional

~~269.~~289. The 2008 Order addressing eight streams was intended to be provisional and revisited for a final determine for these eight streams when the IIFS for the remaining nineteen streams were addressed:

> In accepting staff's recommendation, the Commission added three amendments, the first of which was that "(m)oving forward on the staff's recommendation is the first step in (an) integrated approach to all 27 (twenty-seven) streams that are the subject of

these petitions." Then Chair Thielen had stated in the preceding discussion that "if people are not happy at the end of the year, when the Commission makes any decisions, they would have the ability to request a contested case hearing at that time. Cooperation now is not a waiver of any body's rights to contest that at a later date." After the vote to accept staff's recommendation with amendments, Chair Thielen stated that "the main thing that was passed today is setting minimum instream flow standards that require some infrastructure change, require some evaluation, cooperation and then coming back to the Commission and making final recommendations for the entire 27 stream units," *supra*, FOF 10.

~~270.~~290. However, Commission staff operated on the premise that complaints of taro farmers that they were not getting enough water was not material to whether or not they would have recommended higher releases into the stream, *supra*, FOF 273~~253~~.

~~271.~~291. Thus, there was no evaluation on which to base an integrated approach to make final recommendations for all 27 streams.

2. The 2010 Order Did not Revisit the 2008 Order nor Balance Instream versus Noninstream Uses

~~272.~~292. The 2010 order focused only on amending the IIFS for the remaining 19 streams, *supra*, FOF 12.

~~273.~~293. More specifically, the Commission focused only on native stream animals and did not balance instream versus noninstream uses, *supra*, FOF 12, 19, 253~~233~~.

~~274.~~294. On Nā Moku's appeal of the Commission's denial of its request for a contested case hearing, the Intermediate Court of Appeals vacated the Commission's denial and remanded the matter to the Commission with instructions to grant Nā Moku's Petition for Hearing and to conduct a contested case hearing pursuant to HRS Chapter 91 and in accordance with state law, *supra*, FOF 26.

~~275.~~295. The Intermediate Court of Appeals declined to address the merits of whether the Commission erred in reaching its determination on the petitions to amend the IIFS for the nineteen streams and stated that the matter would be properly presented, argued, and decided pursuant to an HRS chapter 91 contested case hearing conducted by the Commission, *supra*, FOF 27.

~~276.~~296. The Hearings Officer subsequently proposed, and the Commission accepted and so ordered, that the Contested Case Hearing address all twenty-seven petitions and streams filed by Nā Moku, *supra*, FOF 33-36.

K. Instream Uses

~~277.~~297. Beneficial instream uses for significant purposes are located in the stream and achieved by leaving the water in the stream. They include, but are not limited to:

a. maintenance of fish and wildlife habitats

b. outdoor recreational activities;

c. maintenance of ecosystems such as estuaries, wetlands, and stream vegetation;

d. aesthetic values such as waterfalls and scenic waterways;

e. navigation;

f. instream hydropower generation;

g. maintenance of water quality;

h. the conveyance of irrigation and domestic water supplies to downstream points of diversion; and

i. the protection of traditional and customary Hawaiian rights. (HRS § 174C-3.)

~~278.~~298. "Navigation" and "instream hydropower generation (*emphasis added*)" are not relevant to the East Maui streams.

~~279.~~299. "Maintenance of fish and wildlife habitats" has been addressed, *supra*, in section I.F, habitat restoration potential; section I.H, the Commission's 2010 order; and section I.I, the impact of that order. Further analysis on stream habitat is provided, *infra*, on the exercise of traditional and customary Hawaiian rights.

~~280.~~300. That portion of stream flows to satisfy appurtenant rights is included in "the conveyance of irrigation and domestic water supplies to downstream points of diversion," and is an instream use. The exercise of appurtenant rights is a noninstream use, because it is carried out on appurtenant lands and not within the streams from which those appurtenant rights are derived.

~~281.~~301. The adequacy of the increased flows to meet taro grower and domestic uses was addressed in section I.I.i, *supra*. Further analysis on taro growing and domestic uses is provided, *infra*, on the exercise of traditional and customary Hawaiian rights.

~~282.~~302. "Outdoor Recreational Activities":

From east to west, Makapipi, Hanawi, Waiohue, East Wailuaiki, West Wailuaiki, Wailuanui, Waiokamilo, Ohia, Honomanu, Waikamoi, Hanehoi, and Honopou streams have significant outdoor recreational activities, including in some cases swimming and/or fishing, and nearly all including scenic views for recreational and sometimes for educational purposes. (Makapipi IFSAR § 5.0, p. 50; Exh. A-1; Hanawi IFSAR § 5.0, p. 54; Lucien De Naie, WDT;

East Wailuaiki IFSAR § 5.0, p. 52; West Wailuaiki IFSAR § 7.0, p. 56; Wailuanui IFSAR § 5.0, pp. 43-44; Waiokamilo IFSAR § 5.0, p. 40; Ohia IFSAR § 5.0, p. 43; Honomanu IFSAR § 5.0, p. 56; Camp, WDT; Exh. E-71; Neola Caveny, WDT; Exh. E-24; Lurlyn Scott, WDT, ¶¶ 24-25; Julien P. Allen Jaccintho, WDT ¶ 9. [HC&S FOF 264, 334, 354, 378, 406, 427, 553, 576; Na Moku FOF 387, 396, 404, 405, 414, 416, 420-423, 428, 435, 438, 440.]

~~283.~~303. "Maintenance of Ecosystems Such as Estuaries, Wetlands, and Stream Vegetation":

From east to west, all of the streams except Waiaaka and Ohia Streams have seasonal, non-tidal palustrine wetlands, in the upper watershed of the hydrologic unit. East Wailuaiki, West Wailuaiki, and Waiohue Streams also have estuaries. (Waiaaka IFSAR § 6.0, pp. 51-53; Ohia IFSAR § 6.0, pp. 46-48; Exh. C-103, p. 19.) [HC&S FOF 421, 433, 466, 513.)

~~284.~~304. "Aesthetic Values Such as Waterfalls and Scenic Waterways":

Waterfalls, some including plunge pools at their base, and to a lesser extent, springs, constitute the principal aesthetic values in the East Maui streams. From east to west, the streams include Makapipi, Hanawi, Kapaula, Waiaaka, Paakea, Waiohue, Kopiliula, West Wailuaiki, East Wailuaiki, Wailuanui, Waiokamilo, Palauhulu, Piinaau, Honomanu, Punalau, Haipuaena, Puohokamoa, Waikamoi, and Honopou. (Makapipi IFSAR § 7.0, p. 62; Hanawi IFSAR § 7.0, p. 61; Kapaula IFSAR § 7.0, p. 62; Waiaaka IFSAR § 7.0, p. 59; Paakea IFSAR § 7.0, p.64; Waiohue IFSAR § 7.0, p. 64; Kopiliula IFSAR § 7.0, p. 67; East Wailuaiki IFSAR § 7.0, p. 64; West Wailuaiki IFSAR § 7.0, p. 63; Wailuanui IFSAR § 7.0, p. 56; Waiokamil~~59~~;o IFSAR § 7.0, p. 52; Palauhulu IFSAR § 7.0, p. 55; Honomanu IFSAR § 7.0, p. 69; Punalau IFSAR § 7.0, p. 59; Haipuaena IFSAR § 7.0, p. 65; Puohokamoa IFSAR § 7.0, p. 66; Waikamoi IFSAR § 7.0, p. 72; Exh. C-101, p. 48.) [HC&S FOF 103, 182, 203, 226, 246, 266, 309, 356, 380, 408, 429, 453, 474, 494, 514, 535, 555, 578.]

~~285.~~305. "Maintenance of Water Quality":

Streams that appear on the 2006 List of Impaired Waters in Hawaii, Clean Water Act § 303(d), include, from east to west, Hanawi, Puakaa, East Wailuaiki, West Wailuaiki, Ohia, Honomanu, Punalau, Haipuaena, Puohokamoa, and Waikamoi streams. (Hanawi IFSAR § 10.0, pp. 74-75; Puakaa IFSAR § 10.0, pp. 75-76; East Wailuaiki IFSAR § 10.0, pp. 71-72;West Wailuaiki IFSAR § 10.0,pp. 70-71; Ohia IFSAR § 10.0, pp. 57-58; Honomanu IFSAR § 10.0, pp. 76-78; Punalau IFSAR § 10.0, pp. 65-66, 74; Haipuaena IFSAR § 10.0, pp. 72-74;

Puohokamoa IFSAR § 10.0, p. 4; Waikamoi IFSAR § 10, pp. 80-81.) [HC&S FOF 185, 206, 229, 249, 269, 339, 411, 432, 456, 558.]

1. Protection of Traditional and Customary Hawaiian Rights

~~286.~~306. Maintenance of fish and wildlife habitats to enable gathering of stream animals and increased flows to enable the exercise of appurtenant rights constitute the instream exercise of "traditional and customary Hawaiian rights."

a. Gathering of Stream Animals

~~287.~~307. Both the 2008 and 2010 Commission orders did not result in increased populations of stream animals, nor any signs of growth, reproduction, and recruitment.

~~288.~~308. In the 2008 Commission order, except for Waiokamilo Stream, which had been returned to full natural flow by a previous order of BLNR, all of the other streams' flow levels were established below 64 percent of BFQ_{50}, the minimum flow level necessary for suitable habitat availability (H_{90}) for growth, reproduction, and recruitment of native stream animals, *supra*, FOF 278~~258~~.

~~289.~~309. In the 2010 Commission order, evaluation of the seasonal flows ordered for four of the six streams resulted in: 1) no evidence that the summertime flows were advantageous to the animals, *supra*, FOF 284~~264~~; 2) the lack of support for the seasonal flow hypothesis may reflect that the prescribed flow amounts were insufficient (i.e. needed higher flows in summer) or that a year round minimum flow is more appropriate for East Maui streams, *supra*, FOF 285~~265~~; and 3) the monitoring effort did not include an assessment of whether or not the winter flows, based on 64 percent of estimated BFQ_{50}, had in fact achieved the minimum habitat of H_{90} necessary for growth, reproduction, and recruitment of native stream animals; moreover, it is possible that the 64 percent level set by USGS may not be sufficient, *supra*, FOF 280~~260~~.

~~290.~~310. In the 2010 Commission order, Hanawi Stream was only modified to provide connectivity in the dry reach immediately below the diversion, because it had been concluded that the stream had adequate flow to sustain a viable biota population, *supra*, FOF 260~~240~~.d. No evaluation was conducted to confirm that the expected results had been achieved in both connectivity and sustaining viable stream animal populations.

b. Exercise of Appurtenant Rights

~~291.~~311. In total, the acreage claimed by Nā Moku as being either in taro or cultivable agriculture was 136.18 acres for Honopou, Palauhulu, Waiokamilo, and Wailuanui Streams, *supra*, FOF 238~~218~~.

~~292.~~312. Nā Moku identified no acreage for Hanehoi and Puolua Streams, but contended that insufficient water and lands that have either appurtenant or riparian rights require that both Hanehoi and Puolua Streams be returned to their natural base flows (BFQ_{50}), *supra*, FOF 239~~219~~.

~~293.~~313. Teri Gomes, Nā Moku's expert witness, conceded that these acreages are overstated by an unknown amount for taro cultivation and cultivable agriculture, *supra*, FOF 222. She put the entire parcel in taro when she couldn't tell what portion was in taro. In her previous testimony before BLNR, she had reduced the acreage by 10 percent, but was not instructed to do so in the present contested case, *supra*, FOF 240~~220~~. She also placed the parcel in the cultivable agriculture category when land was awarded without specificity of use, because most parcels awarded at the time of the Mahele were used for agricultural purposes and she had already eliminated house lots, cemeteries, and churches, *supra*, FOF 241~~221~~.

~~294.~~314. The 136.18 acres claimed by Nā Moku for Honopou, Palauhulu, Waiokamilo, and Wailuanui Streams were comprised of the following areas:

a.	Keanae (Palauhulu Stream):	27.195 acres;
b.	Wailua: (Waiokamilo and	27.73 acres
	Wailuanui Streams)	33.035 acres
		24.227 acres
c.	Honopou: (Honopou Stream)	23.99 acres
	Total:	136.18 acres

(Teri Gomes, WDT, pp. 3-36, 38-39.)

~~295.~~315. Nā Moku had claimed that 60.767 acres, 44.474 acres in taro and 16.293 cultivable acres, are fed by Waiokamilo and Kualani Streams, 22.448 cultivable taro acres are fed by Wailuanui and Kualani Streams, and 5 acres in Waianu Valley, between Wailuanui and Keanae, are fed by Waiokamilo Stream.~~ *supra*, FOF 170~~. Because what was thought was Kualani Stream is actually the east branch of Waiokamilo Stream, Nā Moku's revised claim is that 65.767 acres are fed by Waiokamilo Stream, and 22.448 acres are fed by Wailuanui and Waiokamilo

Streams, *supra*, ~~FOF 171~~. The total of 88.22 acres (65.767 plus 22.448 acres) is slightly larger than the total of the three Wailua areas of 84.99 acres (27.73 + 33.035 + 24.227), *supra*, FOF 294, which is likely due to some overlap of acres ascribed to both Wailuanui and Waiokamilo Streams.

~~296.~~316. The breakdown of each of the four groups in FOF 314~~294~~, *supra*, is:

Keanae:	22 taro lots:	13.475 acres	(0.07 to 2.27[17] acres in size)
	4 agriculture lots	7.00 acres	
	5 ili (land area)	5.49 acres	
	1 conservation	0.18 acres	
	1 wetland	1.05 acres	
Total	33 parcels	27.195 acres	
Wailua:	10 taro lots:	8.02 acres	(0.125 to 2.75[18] acres in size)
	7 agriculture lots	11.86 acres	
	1 ili (land area)	0.42 acres	
	4 mo`o (narrow strip of land)	7.43 acres	
Total	22 parcels	27.73 acres	
Wailua:	10 taro lots	9.22 acres	(0.162 to 2.67[19] acres)
	9 agriculture lots	11.23 acres	
	5 mo`o (narrow strip of land)	12.03 acres	
	1 kula (plain) and home lot	0.216 acres	
	1 pond	0.338 acres	
Total:	26 parcels	33.035 acres	
Wailua:	24 taro lots	12.92 acres	(0.08 to 0.83[20] acres in size)
	9 agriculture lots	5.006 acres	
	4 mo`o (narrow strip of land)	4.98 acres	
	1 ili (land area)	1.32 acres	

[17] described as a poalima, or chief's terraced plantation, with 6 lo`i.
[18] described s containing 26 lo`i.
[19] described as containing 10 lo`i.
[20] described as a taro lot.

Total:	38 parcels	24.227 acres

Honopou:	1 lot, consisting of 22.81 acres that included:		
		taro lot	3.32 acres
		unspecified	8 acres
		poalima (chief's terraced plantation)	1.67 acres[21]
		land along three streams	9.82 acres
	poalima (chief's terraced plantation)		0.08 acres
	taro lot and kula		1.10 acres
Total:	3 parcels		23.99 acres

(Teri Gomes, WDT, pp. 3-36, 38-39.)

~~297.~~317. The lots, whether for taro, agriculture, ili, or mo`o, are relatively small. The largest of the taro lots was 3.32 acres, and the great majority of the taro lots were less than one acre in size.

~~298.~~318. Teri Gomes, Nā Moku's expert witness, had placed the entire parcel in taro when she couldn't tell what portion was in taro. In her previous testimony before BLNR, she had reduced the acreage by 10 percent, but was not instructed to do so in the present contested case, *supra*, FOF 240~~220~~, 313~~293~~.

~~299.~~319. Counting only the taro lots and the poalima:

Keanae:	13.475 out of 27.195 acres	less 10%:	12.13 acres
Wailua:	8.02 out of 27.73 acres	less 10%:	7.22 acres
Wailua:	9.22 out of 33.035 acres	less 10%:	8.30 acres
Wailua:	12.92 out of 24.227 acres	less 10%:	11.63 acres
Honopou:	6.17 out of 23.99 acres	less 10%:	5.55 acres

~~300.~~320. However, all except one of these 69 parcels were identified as only taro lots, with the exception being 1.10 acres in Honopou, described as a taro lot and kula, *supra*, FOF 316~~296~~.

~~301.~~321. Gomes also placed the parcel in the cultivable agriculture category when land was awarded without specificity of use, because most parcels awarded at the time of the Mahele were

[21] quantity arrived at as being the remainder, because lot sizes were identified for only 3 of the 4 lots in the grant.

used for agricultural purposes and she had already eliminated house lots, cemeteries, and churches, *supra*, FOF 241~~221~~, 313~~293~~.

~~302.~~322. However, cultivable agriculture is not equivalent to wetland taro: 1) taro lots were specified as so; and 2) there were other types of agriculture at the time of the Mahele, which used much less water for growing crops. Therefore, while the cultivable agriculture category was entitled to water from the time of the Mahele, that amount would be much less than for taro.

~~303.~~323. Counting the agricultural lots:

Keanae: 7.00 acres
Wailua: 11.86 acres
Wailua: 11.23 acres
Wailua: 5.006 acres

~~304.~~324. The Honopou acreage of 23.99 acres also included 9.82 acres along three streams, *supra*, FOF 316~~296~~, which were probably agricultural, as it ran along streams (*See, infra*, FOF 325~~305~~).

~~305.~~325. Nā Moku also submitted other exhibits for:

Keanae, consisting of 397.41 acres:
Taro and house lot along Hamau (Kualani) Stream: 9.20 acres
Agricultural lot running along Palauhulu Stream: 13.70 acres
Agricultural lot running along Wailua(nui) Stream: 103.82 acres
Agricultural lot running along the Ditch of Wailua: 151.65 acres

Waianu, consisting of 160.50 acres:
Agricultural lot running from the mountain to the sea: 107 acres
Agricultural lot running from the government road to the sea: 53.50 acres

Honopou, consisting of 2.07 acres, although the total of the parcels is 0.624 acres:
Taro and pasture: 0.154 acres
Taro and pasture: 0.47 acres

Makapipi, consisting of 4.17 acres:
Agricultural lot running along Haiha Stream: 4.17 acres

(Teri Gomes, WDT, pp. 36-40.)

~~306.~~326. For Keanae, HC&S contends that there are only 10.53 acres, supra, FOF 182~~158~~, referring to the USGS study, *supra*, FOF 184~~204~~, compared to the 13.475 acres as estimated in FOF 319~~299~~, *supra*.

~~307.~~327. For Wailua, HC&S contends that it no longer diverts Waiokamilo Stream, *supra*, FOF 194~~172~~, that Wailuanui Stream is the sole water source for only 2.80 acres, *supra*, FOF 199~~180~~, but does not address the acreage that is watered by both streams.

~~308.~~328. For Honopou, HC&S contends that there are only 2 acres in taro, *supra*, FOF 157~~136~~, compared to 6.17 acres as estimated in FOF 319~~299~~, *supra*.

~~309.~~329. Nā Moku had identified no acreage for Hanehoi and Puolua Streams, but contended that insufficient water and lands that have either appurtenant or riparian rights require that both Hanehoi and Puolua Streams be returned to their natural base flows (BFQ_{50}), *supra*, FOF 239~~219~~. HC&S noted that CWRM identified an estimated cultivable area of 2.3 acres, and identified two parties who are or who would like to cultivate taro on four acres, as well as one person who has a parcel adjacent to Hanehoi Stream and would like to exercise her riparian rights, *supra*, FOF 174~~151~~.

~~310.~~330. Nā Moku submitted one exhibit for Makapipi Stream on a 4.17-acre lot for agricultural purposes running along Haiha Stream, *supra*, FOF 305. HC&S noted that CWRM had records for two diversions for taro cultivation, and that Jeffrey Paisner owns property that abuts Makapipi Stream but has no firsthand knowledge that taro was cultivated on his property. (Makapipi IFSAR § 12.0, p. 84; Jeffrey Paisner, WDT, §§ 5-6.) [HC&S FOF 584-586.]

L. Noninstream Uses

1. HC&S

a. Irrigation Requirements

~~311.~~331. Approximately 30,000 acres (the "East Maui Fields") of HC&S's 35,000-acre sugarcane plantation can be serviced by surface water from EMI or brackish groundwater pumped from within the boundaries of the plantation, but not water from the West Maui ditch system. From 2008-2013, HC&S actively cultivated sugarcane on an average of 28,941 acres of its East Maui Fields. (Rick Volner, WDT, ¶ 2; Garret Hew, WDT, ¶ 25; Rick Volner, Tr., March 23, 2015, p. 27; Exhs. C-35 and C-137.) [HC&S FOF 590-592.]

~~312.~~332. From 2008 to 2013, HC&S received 113.71mgd[22] from surface water deliveries and 69.90 mgd in pumped groundwater for a combined total of 183.61 mgd, 62 percent from

[22] HC&S reports its water deliveries and usage in millions of gallons per year, and those numbers have been divided by 365 to arrive at daily totals. For example, the 113.71 mgd in surface water deliveries was reported as 41,505 million gallons per year.

surface water and 38 percent from groundwater. (Exh. C-137, columns B and C.) [HC&S FOF 629.A.]

~~313.~~333. The use of those waters as reported by HC&S were as follows:

a.	Sugarcane irrigation:	132.45 mgd
b.	MDWS:	2.83 mgd
c.	HC&S Industrial:	6.25 mgd
d.	Other:	0.41 mgd
	Total:	141.94 mgd
	Remainder:	41.67 mgd (183.61 - 141.94 mgd)

(Exh. C-137; Rich Volner, Tr., March 23, 2015, pp. 23-30.)

~~314.~~334. MDWS's usage is at the Kamole Weir and Kula Agricultural Park. Industrial usage at HC&S is used in the factory, power plant, mixing fertilizer solutions, and anything else to support the farming and factory operations, one of the largest uses being cane cleaning. "Other" is water for tenants that are on the HC&S property, such as Ameron and for a period of time, Monsanto. (Rich Volner, Tr., March 23, 2015, pp. 23-26.))

~~315.~~335. After these three user categories, all of the remaining water ~~is~~was used for sugarcane irrigation. The unaccounted remainder is ascribed to system losses, consisting of seepage, evaporation, and miscellaneous losses, such as back-flushing of filters, drip tube ruptures or breaks, animal damage, pipeline breaks, misreported irrigation (if they are not applying the correct hours to the amount that they ran), testing of systems prior to planting, or where water is taken out of the system but not accounted for in daily irrigation. (Rick Volner,Tr., March 23, 2015, pp. 26, 30-31, 140.) [HC&S FOF 637.]

~~316. The 132.45 mgd for sugarcane irrigation, divided by the 28,941 irrigated acres, *supra*, FOF 311, is the gallons per acre per day, or 4,577 gad. (Exh. C-137.)~~

~~317. Compared to the actual irrigation of 4,577 gad that HC&S was able to deliver to its fields, it contends that irrigation requirements were 5,146 gpad, resulting in 89 percent of irrigation requirements being met from 2008 to 2013. (Exh. C-137.)~~

~~318. HC&S determines its irrigation requirements of each field on a day-to-day basis employing a computerized water balance model, which essentially calculates a water budget that accounts for "deposits" of water in the form of rainfall and irrigation and "withdrawals" in the form of evapotranspiration (losses from evaporation and transpiration from the sugarcane plant). HC&S uses the water balance model as a managerial tool to determine what fields need to be~~

irrigated. The model prioritizes field needs, indicating which field should receive water next, based on the estimated soil moisture status of each field. (Exh. C-67, pp. 5-6.) [HC&S FOF 626.]

319. HC&S does not include rainfall data in the calculation of water availability, because it contends that light rains lower evapotranspiration by raising humidity and lowering exposure to sunlight, and that during heavy rains, surface runoff is not taken up by the plants. Therefore, HC&S contends that while sometimes rain does fall in sufficient amounts over a period of time to be effective for plant and soil absorption, dividing total annual rainfall by 365 days and assuming that this amount was applied on a daily basis is erroneous. (Rick Volner, WDT, ¶ 60.)

320. However, by totally excluding rainfall data from its calculation of water availability, it also ignores its own description of a water balance model that accounts for "deposits" in the form of rainfall and irrigation, *supra*, FOF 318, therefore overestimating by an unknown amount the amount needed from irrigation with surface water.

321. Under the foregoing assumptions, HC&S calculates its percent actual irrigation of required irrigation as 89 percent from 2008 to 2013, *supra*, FOF 317.

322. HC&S also introduced data on average water need and availability from 1986, the year HC&S converted from furrow irrigation to drip irrigation, to 2009, and from 1986 to 2013:

a. 1986 to 2009: HC&S contends that 85 percent of total water requirements[23] were met; and average total requirements were 270 mgd versus available water of 230 mgd, with requirements not met 10 months of the year and only the winter months of November and December in which requirements were met. Total requirements were estimated at 9,019 gad, which included system losses, irrigation inefficiencies, and industry (factory) needs. (Exh. C-71, Appendix G, p. G-3; Exh. C-103, pp. 14-15.) [HC&S FOF 624, 628.]

b. 1986 to 2013: HC&S contends that 89 percent of total requirements[24] were met; and average total requirements were 251 mgd versus available water of 224 mgd, with requirements not met 10 months of the year and only the winter months of November and December in which requirements were met. Irrigation requirements were estimated at 7,396 gad. (Exh. C-74.)

[23] includes system losses, irrigation efficiencies, and industry (factory) needs. MDWS usage not mentioned. (Exh. C-71. p. G-3.)

[24] includes boiler and factory operations and seepage and evaporation in transportation and storage systems. MDWS usage not mentioned. (Exh. C-74.)

323. HC&S's figures for 2008 to 2013 addressed irrigation, not total requirements, with irrigation requirements of 5,146 gad versus available water of 4,577 gad; and average irrigation requirements of 149 mgd versus available water of 132.15 mgd, with 89 percent of irrigation requirements met, *supra*, FOF 313, 316-317. Assuming the total 51.16 mgd for other uses, including 41.67 mgd of seepage and evaporation losses, *supra*, FOF 312-315, were required, then 92 percent of total requirements were met.

324. To summarized the data from these three time periods:

a. 1986 to 2009:

i. 230 mgd of available water, meeting 85 percent of total requirements of 270 mgd;

ii. no specific number for irrigation requirements separated from other uses;

b. 1986-2013:

i. 224 mgd of available water, meeting 89 percent of total requirements of 251 mgd;

ii. 7,396 gad irrigation requirements;

c. 2008-2013:

i. 184 mgd of available water, meeting 92 percent of total requirements of 200 mgd;

ii. 4,577 gad of irrigation water available, meeting 89 percent of 5,146 gad irrigation requirements.

From HC&S's own data, from1986-2009 to 2008-2013, average available water decreased from 230 mgd to 184 mgd, or by 20 percent, but irrigation requirements decreased from 9,019 gad to 5,146 gad, or by 43 percent, thereby increasing the percent of irrigation requirements met from 85 percent to 89 percent.

325. HC&S observed that the water requirements of 5,146 gad for the East Maui fields are less than that which CWRM found to be reasonable in the Nā Wai `Ehā contested case hearing: 5,958 gad for the Waihee-Hopoi Fields and 5,408 gad for the `Īao-Waikapū Fields. (Exh. C-120, p. 128 [COL 91].) [HC&S FOF 630.]

326. The West Maui fields have less rainfall, lower elevation, higher winds, and higher evapotranspiration, so on average, irrigation requirements are lower for the East Maui than for the West Maui fields. (Rick Volner, Tr., March 23, 2015, p. 154.)

327. However, for 1986-2013, HC&S had calculated its water requirements for 30,000 acres (versus 28,941 irrigated acres in its calculations for 2008 to 2013) as 7,396 gad; not only significantly higher than the 5,146 gad it had calculated for 2008 to 2013, but also significantly higher than the 5,958 gad and 5,408 gad for the two West Maui fields. (Exh. C-74.)

328. Morever, in the Nā Wai `Ehā contested case hearing, HC&S had used an 80 percent efficiency factor, while the method adopted by the Commission used an 85 percent efficiency factor. (Exh. C-120, p. 126 [COL 83].)

329. For the period 1986 to 2013, HC&S had used an 80 percent efficiency factor to arrive at its water requirement of 7,396 gad--the same efficiency factor used by HC&S in the Nā Wai `Ehā contested case hearing, where the Commission adopted an 85 percent efficiency factor. (Exh. C-74.)

330. Applying an efficiency factor of 85 instead of 80 percent, water requirements for 1986 to 2013 would have decreased to 7,251 gad from 7,396 gad, but still much higher than the West Maui Fields, *supra*, FOF 327. (Exh. C-74.)

331. For the period 2008 to 2013, no "gross water needed" is provided, nor an explanation of how the 5,146 mgd requirement was derived, nor why the 5,146 mgd requirement was much lower than the 7,251 gad or 7,396 gad requirements for 1986 to 2013. (Exh. C-137.)

332. Assuming that the 5,146 mgd requirement was derived in the same way that the 1986 to 2013 requirement of 7,396 gad was derived, the 5,146 gad requirement must have applied an efficiency factor of 80 percent, with irrigation requirements of 4,117 gad plus system losses of 1,029 gad. Applying an efficiency factor of 85 percent, the revised irrigation requirement would be 4,117 gad plus system losses of 727 gad, or a requirement of 4,844 gad, including system losses.

333. Given that the East Maui fields were expected to use less water than the West Maui fields and that the 1986 to 2013 requirement would be much higher at 7,251 gad than the 5,958 gad and 5,408 gad requirements for the West Maui fields, the 2008 to 2013 revised estimate of 4,844 gad, using an 85 percent instead of 80 percent efficiency factor, is more in line with those expectations.

334. Commission staff had estimated irrigation requirements to be 1,400 gad to 6,000 gad, based on a newly developed Irrigation Water Requirement Estimation Decision Support System (IWREDSS) model. (Exh. C-85, p. 9.) [Na Moku FOF 1019.]

~~335. The Commission staff's estimated requirements did not explain how the model was applied and what the range from 1,400 gad to 6,000 gad represented, although it might be inferred that the range represented winter versus summer requirements. (Exh. C-5, p. 9.)~~

~~336. On the other hand, the expert who developed the model adopted by the Commission in the Nā Wai `Ehā contested case had concluded that the principal difference that resulted in his model calculating lower optimal irrigation requirements than HC&S's was the choice of irrigation efficiency. He had selected 85 percent because it is the irrigation industry standard and the minimum efficiency for which drip irrigation systems are designed. HC&S's use of 80 percent had been used before either of HC&S's two experts started with HC&S and neither were aware of any actual measurements or studies conducted by HC&S to verify that assumption. (Exh. C-120, FOF 488-489, pp. 82-83.)~~

~~337. Thus, 4,844 gad, the irrigation requirement calculated by HC&S for the years 2008 to 2013, adjusted for 85 percent efficiency instead of 80 percent, is a reasonable estimate of irrigation requirements for HC&S's East Maui fields.~~

~~338. Therefore, for 2008 to 2013, total irrigation requirements would have been 140.19 mgd (4,844 gad x 28,941 irrigated acres) versus 132.45 mgd of actual irrigation, *supra*, FOF 311-312, or 94 percent of irrigation requirements having been met.~~

~~339. Left unexplained, however, is the drastic difference in both available irrigation and requirements between 1986-2013 and the subset years of 2008-2013. For 1986 to 2013, HC&S contends that 6,163 gad was the irrigation requirement, increased to 7,396 gad when applying their 80 percent efficiency factor. Multiplying 7,396 gad by the 30,000 acres HC&S used as its irrigated acres, the total irrigation requirement would be 221.9 mgd.[25] ((Exh. C-74.)~~

~~340. Adjusting H&S's 7,396 gad for 85 percent instead of 80 percent efficiency would result in 7,250 gad, or a total irrigation requirement for 30,000 acres of 217.9 mgd.~~

~~341. Comparable data for 2008-2013 were 5,146 gad adjusted to 4,844 gad for irrigation requirements, and a total irrigation requirement for 28,941 acres of 140.19 mgd. Adjusting the 1986-2013 data from 30,000 acres to 28,941 acres would reduce 217.9 mgd to 209.82 mgd, still 50 percent higher than the 140.19 mgd for 2008-2013.~~

~~342. For 1986-2013, there was 223.6 mgd available, 152.6 mgd from surface water and 71 mgd from ground water. 6.5 mgd was for industrial usage and an allocation of 22.4 mgd (10 percent for seepage and evaporation losses), leaving 194.7 mgd for irrigation. (Exh. C-74.)~~

~~[25] There is a small error in HC&S's calculations, because 6,163 gad is 83 percent of 7,396 gad, so 7,396 gad should have been 7,703 gad. Multiplying 7,703 gad by 30,000 acres is 231.1 mgd.~~

~~343. If HC&S's irrigation water requirements for 1986-2013, adjusted for 85 percent instead of 80 percent efficiency, were 7,250 gad or a total irrigation requirement of 217.9 mgd for 30,000 acres, *supra*, FOF 340, then 89 percent of irrigation requirements would have been met. Applied to 28,941 acres, irrigation requirements would be reduced from 217.9 mgd to 209.82 mgd, *supra*, FOF 341, and 93 percent of irrigation requirements would have been met.~~

~~344. If HC&S's irrigation water requirements for 1986-2013 were 4,844 gad or 140.19 mgd, the total for 2008-2013, HC&S's irrigation requirements would have been more than met by the 194.7 mgd available for irrigation. Even using an 80 percent efficiency factor, or 5,146 gad, as HC&S did, over 28,941 acres, the total requirement would have been 148.93 mgd, and over 30,000 acres, the total requirement would have been 154.38 mgd. In either scenario, the total irrigation requirement would have been more than met by the 194.7 mgd available for irrigation.~~

~~345. Similar conclusions could probably be made for 1986-2009, with even more "surplus" water, because the available water was 230 mgd for 1986-2009 versus 224 for 1986-2013, *supra*, FOF 324.~~

~~346. Given the expected lower irrigation requirements for HC&S's East Maui versus West Maui fields and the use of an 85 percent versus 80 percent efficiency factor, it is reasonable to conclude that HC&S's irrigation requirements for its East Maui fields should be 4,844 gad, *supra*, FOF 333, 337.~~

~~347. Based on this irrigation requirement of 4,844 gad, between 1986 and 2013, HC&S's irrigation requirements would not only have been met, but also would have left a surplus, *supra*, FOF 343. For 2008 to 2013, with its lower water deliveries than for the overall 1986 to 2013 period, 94 percent of irrigation requirements would have been met, supra, FOF 338.~~

~~348. HC&S states that the sugarcane plant can survive, but not thrive, with less than optimal water. Sugar yields increase as water application to the cane plant increases. The determination of HC&S's water needs for sugarcane cultivation is thus based on the amount of water required to produce yields at levels that enable HC&S to remain economically viable. (Rich Volner, WDT, ¶ 55; Exh. C-71, Appendix G, p. G-3.) [HC&S FOF 631.]~~

~~349. Sugar production is influenced by two main variables: yield per acre and acreage harvested. Of the two, yield per acre, measured in Tons of Sugar per Acre ("TSA"), is more critical than acreage harvested. The single most important variable affecting yields per acre is the amount of irrigation water available. (Rick Volner, WDT, ¶ 7, 17; Rick Volner, Tr., March 23, 2015, pp. 58, 66; Exh. C-65, Appendix I, p. 20.) [HC&S FOF 672-674.]~~

350. HC&S has determined that, on a long-term basis, sustainable yields should be between 12 and 14 TSA per crop cycle, which translates into over 200,000 tons of sugar per year given the acreage that HC&S has in cultivation. Yields in this range generate sufficient revenues to carry its fixed and variable costs and return a reasonable profit to its shareholders. (Rick Volner, WDT, ¶ 17; Rick Volner, Tr., March 23, 2015, p. 58.) [HC&S FOF 673.]

351. The market price of commodity sugar is a direct factor influencing sugar revenues. However, HC&S has no control over the sugar market and at most can attempt to time the market well and take advantages of spikes in sugar pricing. (Rick Volner, Tr. March 23, 2015, p. 66; Exh. C-65, Appendix I, p. 20.) [HC&S FOF 675.]

352. From 2008 to 2013, production improvements accounted for about half of the increases in revenues, with dramatically improved sugar prices accounting for the other half. (Rick Volner, WDT, ¶ 22.) [HC&S FOF 690.]

353. HC&S implemented various measures to improve its agronomic practices in an effort to reverse the declining sugar yields experienced from 2006 through 2009, with severe drought in 2007 and 2008 and reduced water deliveries resulting from the amended IIFS determinations previously issued by the Commission in this proceeding and in the separate Nā Wai `Ehā proceeding. The measures included a one-time harvest delay in 2009 to increase average crop age, increased deep tilling of fields before planting, improved fertilization, and improved ripening practices. HC&S also shifted some of its available power generation capacity from power sales to increased well pumping for irrigation. (Rick Volner, WDT, ¶ 20.) [HC&S FOF 688-689.]

354. HC&S reported the following improvements, following the severe drought years of 2007 and 2008:

	Sugar Production	TSA	Agribusiness Profit
2008	145,000 tons	8.6	(-)$12.9 million
2009	126,000 tons	8.4	(-)$27.8 million
2010	171,800 tons	11.1	(+)$6.1 million[26]
2011	182,800 tons	12.1	(+) $22.2 million
2012	178,300 tons	11.3	(+)$20.8 million
2013	191,500 tons	12.4	(+)$10.7 million

[26] included $4.9 million in disaster relief funds.

2014 162,100 tons 11.4 (-)$11.8 million

336. (Rick Volner, WDT, ¶¶ 12-17; Rick Volner, Tr., March 23, 2015, p. 9; Exh. C-57, pp. 4, 13; Exh. C-58, pp. 6,7, 17; Exh. C-59, pp. 6, 17; Exh. C-60, pp. 6, 17; Exh. C-61, pp. 6, 15; Exh. C-62, pp. 4, 10; Exh. C-150, p. 2.) [HC&S FOF 680-686.]

355. The September 25, 2008 Commission order restored 4.5 mgd to five East Maui streams, *supra*, FOF 117, and the May 25, 2010 order restored an additional 9.45 mgd in the winter and 1.11 mgd in the summer for six more streams, *supra*, FOF 233, for a reduction of stream waters to HC&S of 13.95 mgd in the winter and 5.61 mgd in the summer.

356. From 2008 to 2013, HC&S received an average of 183.61 mgd, 113.71 mgd from East Maui streams and 69.90 mgd from ground water, *supra*, FOF 312, compared to a reduction beginning in late 2008 of 4.5 mgd and in mid-2010 of 13.95 mgd in the winter and 5.61 mgd in the summer, *supra*, FOF 355. Thus, from late 2008, water for the East Maui fields was reduced by 2.5 percent, and from mid-2010 reduced by 7.6 percent in the winter and 3.1 percent in the summer.

357. Thus, from late 2008, assuming these reductions all had to be absorbed by crop irrigation, irrigation requirements would have been 140.19 mgd, *supra*, FOF 338, while available irrigation water would have been reduced from 132.45 mgd to 127.95 mgd, and from mid-2010, available irrigation water would have been 118.5 mgd in the winter and 126.84 mgd in the summer. These reductions would have resulted in 94 percent of irrigation requirements met decreasing to 91 percent, starting in late 2008, and to 85 to 90 percent, beginning in mid-2010, *supra*, FOF 356.

358. For the West Maui fields, the Commission order of June 10, 2010 restored 12.5 mgd to the Nā Wai `Ehā streams but also found that ground water could offset 9.5 mgd, for a net reduction of 3 mgd. On remand from the Hawai`i Supreme Court, the April 17, 2014 Commission-approved Mediated Agreement restored an additional 12.9 mgd to the streams, for a total of 25.4 mgd. The ground water source was increased from 9.5 mgd to 18.5 mgd, the increase of 9 mgd resulting in a net reduction of water to HC&S of 3.9 mgd. (Iao Ground Water Management Area High-Level Source Water Use Permit Applications and Petition to Amend Interim Instream Flow Standards of Waihe`e, Waiehu, `Īao, and Waikapū Streams Contested Case Hearing No. CCH-MA06-01, "Commission on Water Resource Management Order Adopting: 1) Hearings Officer's Recommendation on the Mediated Agreement between the Parties; and 2) Stipulation Re Mediator's Report of Joint Proposed Findings of Fact, Conclusions of Law, Decision and Order," April 17, 2014, pp.1-3 ("2014 Mediated Agreement".)

~~359. To summarize, for HC&S's West Maui (Nā Wai `Ehā) fields, stream water sources were reduced by 25.4 mgd, but ground water sources was increased by 18.5 mgd, for a net reduction of 6.9 mgd, 3 mgd in 2010 and a further 3.9 mgd in 2014, *supra*, FOF 358.~~

~~360. Prior to the restoration order of June 10, 2010, HC&S used 50.09 mgd in 2005 and 41.92 mgd in 2006 from the Nā Wai `Ehā streams, averaging 46.01 mgd. (`Iao Ground Water Management Area High-Level Source Water Use Permit Applications and Petition to Amend Interim Instream Flow Standards of Waihe`e, Waiehu, `Iao, and Waikapū Streams Contested Case Hearing No. CCH-MA06-01, "Findings of Fact, Conclusions of Law, and Decision and Order," June 10, 2010, p. 210, table 7.)~~

~~361. Thus, for its West Maui fields, the 2010 Commission order reduced HC&S's water by 6.5 percent, increasing reductions in 2014 to 15 percent. Based on the 2005-2006 use rates, *supra*, FOF 360, available water after 2010 would have been reduced from 46.01 mgd to 43.01 mgd, and reduced to 39.11 mgd after 2014.~~

~~362. Compared to East Maui's 28,941 irrigated acres, *supra*, FOF 311, West Maui has only 4,770 acres in irrigation. Water requirements for these 4,770 acres had been found to be 27.81 mgd, and system losses to be 2.15-4.20 mgd by the Commission. ("2014 Mediated Agreement," p. 3 and Exhibit 1, p. 13.) Thus, even with the 15 percent reduction in water for its West Maui fields, supplies were still greater than irrigation requirements and reasonable losses, 39.11 mgd versus 29.96 mgd to 32.01 mgd.~~

~~363. To summarize, for the 28,941 irrigated acres in the East Maui fields, water available as a percent of irrigation requirements decreased from 94 percent to 91 percent in 2008, and to 85-90 percent in 2010, *supra*, FOF 357. For the 4,770 irrigated acres in West Maui, more water was available both before and after the Commission's actions in 2010 and 2014, *supra*, FOF 362.~~

~~364. Comparing these reductions of irrigation water to HC&S's East Maui and West Maui fields with sugar production and agribusiness profits from 2008 to 2014, *supra*, FOF 354, there does not appear to be any relationship between the two. The rebound from the severe drought years of 2007 and 2008 has been ascribed by HC&S to production improvements, *supra*, FOF 353, which accounted for about half of the increases in revenues, with dramatically improved sugar prices accounting for the other half, *supra*, FOF 352.~~

~~365. HC&S has also contended that, on a long-term basis, sustainable yields should be between 12 and 14 TSA per crop cycle, which translates into over 200,000 tons of sugar per year given the acreage that HC&S has in cultivation. Yields in this range generate sufficient revenues~~

~~to carry its fixed and variable costs and return a reasonable profit to its shareholders, *supra*, FOF 350.~~

~~366. However, HC&S met that level of production only once between 2003 and 2013, when in 2003 it generated 205,700 tons of sugar, and conceded that it did not have a minimum sugar production number to remain viable, because its bottom line is dependent on many variables contribute to economic success, including sugar pricing, other revenue streams including specialty sugar, energy, molasses, and other things like that. (Exh. C-77; Rick Volner, Tr., March 23, 2015, pp. 59-60, 67-69.) [Nā Moku/MTF FOF 1037, 1043.]~~

~~367. HC&S also conceded that 200,000 tons of sugar a year is a production goal, not a minimum water need to remain viable. (Rick Volner, Tr., March 23, 2015, p. 68.) [Na Moku/MTF FOF1044.]~~

~~368. Between 2008 and 2014, only 2011 and 2013 had TSAs over 12, and the higher profit resulted from a smaller production: $22.2 million on a production of 12.1 TSA (182,800 tons) and $10.7 million on a production of 12.4 TSA (191,500 tons), *supra*, FOF 354.~~

~~369. HC&S states that the sugarcane plant can survive, but not thrive, with less than optimal water. Sugar yields increase as water application to the cane plant increases, *supra*, FOF 348.~~

~~370. Because of the Commission's 2008 and 2010 orders, for the 28,941 irrigated acres in the East Maui fields, water available as a percent of irrigation requirements decreased from 94 percent to 91 percent in 2008, and to 85-90 percent in 2010, *supra*, FOF 357, 363. For the 4,770 irrigated acres in West Maui, more water was available both before and after the Commission's actions in 2010 and 2014, *supra*, FOF 362.~~

~~371. In the Nā Wai `Ehā contested case hearing, the Commission had found that reasonable irrigation requirements were 5,958 gad for the Waihee-Hopoi Fields and 5,408 gad for the Iao-Waikapu Fields, *supra*, FOF 325. (Exh. C-120, p. 128 [COL 91].) [HC&S FOF 630.]~~

~~372. The estimates adopted by the Commission in the Nā Wai `Ehā contested case hearing adopted an 80 percent probability for satisfying the crop's irrigation requirements (80% of the time, or four out of five years), because it is the industry standard for calculating crop water duties in both the government and private sectors, including the Hawai`i Natural Resource Conservation Service of USDA. (Exh. C-120, COL 457, pp. 73-74.)~~

~~373. Irrigation requirements (gad) in Nā Wai `Ehā were as follows, with the 80 percent probability in bold:~~

	~~Median~~	~~Minimum~~	~~50%~~	~~**80%**~~	~~90%~~	~~95%~~	~~Maximum~~

~~Waihe`e-Hopoi~~	~~5589~~	~~4422~~	~~5583~~	~~**5958**~~	~~6126~~	~~6251~~	~~6305~~
~~`Īao-Waikapū~~	~~4993~~	~~3830~~	~~4990~~	~~**5408**~~	~~5597~~	~~5739~~	~~5836~~

~~(Exh. C-120, Table 11, p. 214.)~~

~~374. For the Waihe`e-Hopoi fields, 5958 gad would satisfy irrigation requirements 80 percent of the time. At 5583 gad, irrigation requirements would be satisfied 50 percent of the time. So 5958 gad at the 80 percent rate would be at least 375 gad or more than needed for 50 percent of the time. Similarly, 6305 gad would satisfy irrigation requirements 100 percent of the time, and at the 80 percent rate of 5958 gad, up to 347 gad would be needed to satisfy the irrigation requirements for the remaining 20 percent of the time. Finally, at the 100 percent rate, even though all acres would receive sufficient water all of the time, more water than needed would be applied nearly all the time. The Commission monitors water use on a 12-month moving average (12-MAV), and at an average rate of 5958 gad, daily irrigation requirements of 6305 gad could be applied and be offset by days when the requirements were less than 5958 gad, as long as the 12-MAV stays within the range of 5958 gad. (Exh. C-120, footnote 5, p. 74.)~~

~~375. After the Commission's 2008 and 2010 orders, for the 28,941 irrigated acres in the East Maui fields, water available as a percent of irrigation requirements decreased from 94 percent to 91 percent in 2008, and to 85-90 percent in 2010. For the 4,770 irrigated acres in West Maui, more water was available both before and after the Commission's actions in 2010 and 2014, *supra*, FOF 370.~~

~~376. At 85-90 percent of irrigation requirements, water available for irrigation for the East Maui fields would be greater than the 80 percent probability for satisfying irrigation requirements that the Commission had adopted in the Nā Wai `Ehā contested case hearing for the West Maui fields.~~

337. On January 6, 2016, A&B announced its decision to cease sugar cultivation upon completion of the 2016 harvest that it is transitioning HC&S to a diversified farm model, a true and correct copy of which is attached hereto as Exhibit C-153 As explained in the press release, the economics of continuing to operate HC&S as a sugarcane plantation were recognized as being unsustainable and the decision was made to and transition to a diversified farm model, the goal of which is to retain as much of the plantation in agricultural use as possible with a mix of crops and agricultural activities that will be economically viable. (Volner, WDT 10/17/16; Ex. C-153.)

338. The sugar plantation ceased operations as of December 30, 2016. (Volner, Tr., 2/8/17, p. 245, ll. 6-9.)

339. HC&S is actively engaged in furthering of a plan to transition the former sugarcane lands to the cultivation of diversified agriculture by A&B and others that would be sustainable and economically viable (the "***Diversified Agricultural Plan***"). (Volner, WDT 10/17/16, ¶ 13.)

340. HC&S is endeavoring to identify productive, economically viable agricultural uses for as much of the 36,000 acres of former sugar lands as possible. In line with this goal, HC&S is strategically seeking large-scale agricultural uses for its lands as well as smaller agricultural uses, and considering how the various uses impact one another rather than putting relatively small amounts of acreage into use in an ad hoc fashion simply for purposes of expediency. (Volner, Tr., 2/6/17, p. 210 l. 14-18 and p. 214, l. 15, to p. 215, l. 5.)

341. The mix of uses currently envisioned by the Diversified Agricultural Plan are listed on Exhibit C-153-A and color-coded as follows:

Irrigated pastures for livestock	Light Green
Unirrigated pastures for livestock	Light Yellow
Forestry Crops	Light Purple
Mechanically harvested row crops	Light Pink
Agricultural Parks	Dark Pink
Large Diversified Farm leases	Orange
Orchard crops	Light Blue
Pongamia Orchards	Dark Purple
Beverage crops (coffee/cacao)	Dark Green
Dairy operations	Dark Blue
Biogas feedstock crop	Red

The Diversified Agricultural Plan is constantly evolving. (Ex. C-153-A; Tr., 2/6/17, p. 160, l. 15 to p. 161, l. 2.)

342. The projects currently planned by A&B for 2017 in pursuit of the Diversified Agricultural Plan at the time of the reopened hearing include:

A. A pasturing agreement with Maui Cattle Co. to populate the 4,000 acres of former sugar lands that HC&S is in the process of converting to grazing pasture by fencing, seeding with signal grass, and – in certain areas – installing supplemental irrigation;

B. Responding to a utility-issued RFI designating lands that are suitable for renewable energy development (solar, wind, bioenergy), and making those lands available in any subsequent RFPs for the siting of renewable generating assets on Maui;

C. The sale of approximately 850 acres of land to the County for an ag park;

D. The establishment of approximately 100 acres of oilseed orchards – the first phase of a planned 250 acres; and

E. The execution of a commercial feedstock agreement for anaerobic digestion crop feedstocks and the associated use of innovative farming techniques to expand HC&S' bioenergy and grain crop rotation on up to 500 acres.

(Written Direct Testimony of Jerrod M. Schreck ("***Schreck WRT***")) 1/20/17, ¶ 6.)

343. In siting the differing uses throughout the former sugar lands, HC&S considered, among other things, varying soil types, rainfall, solar radiation, elevation, and the relative tolerance of the different crops to irrigation with brackish water. Thus, in general, crops with a lower tolerance for irrigation with brackish water are sited in the higher elevations which do not have access to well water. On the other hand, grasses, bioenergy crops, and crops raised for animal feed, which have a suspected relatively higher tolerance for irrigation that is supplemented with brackish water, are sited in the lower elevations where HC&S has historically used its brackish water wells to supplement surface water imported from EMI, in the east, and the Na Wai Eha streams, in the west, to meet the irrigation needs of approximately 35,000 acres of sugar cultivation. (Volner WDT 10/17/16, ¶ 16; Volner, Tr., 2/6/17, p. 181, ll.15-21.)

344. Excluding the Waihe'e-Hopoi fields, which have never been served with water from the EMI ditch system, the Diversified Agricultural Plan envisions the use of 26,996 acres of former sugar fields that were previously irrigated with a combination of surface water delivered by EMI and brackish water pumped from HC&S' brackish water wells. Of these 26,996 acres, 3,954 acres are planned for unirrigated livestock pastures on the eastern edge of the plantation where there it is anticipated that there is sufficient rainfall to support this use. This leaves 23,042 acres that will need to be irrigated. (Ex. C-156-A; Volner WDT 10/17/16, ¶ 17.)

345. HC&S' forecast of the irrigation requirements for the 26,996 acres is as follows:

Use	Acres	GPAD Required	Annual Requirement	% of Total Water

			(MG)	Requirement
Pasture – Unirrigated	3,954	--	--	0.0%
Pasture – Irrigated (surface only)	--	1,704	--	0.0%
Pasture – Irrigated	3,037	1,704	1,890	5.8%
Dairy – Irrigated (surface only)	2,483	1,384	1,255	3.9%
Dairy – Irrigated	1,972	2,297	1,655	5.1%
Forestry – Unirrigated	227	--	--	0.0%
Agricultural Park (surface only)	717	2,448	641	2.0%
Diversified Ag (surface only)	2,830	2,510	2,594	8.0%
Diversified Ag	2,000	2,753	2,011	6.2%
Orchard Crops (surface only)	2,212	51,54	4,164	12.8%
Orchard Crops	1,554	5,765	3,272	10.0%
Beverage Crops (surface only)	901	5,096	1,677	5.1%
Pongamia	2,113	4,478	3,456	10.6%
Biogass feedstock area	820	3,565	1,068	3.3%
Mechanically harvested row crops	6,357	3,835	8,904	27.3%
	26,996	3,307	32,587	100%

The irrigation requirement for each crop is determined by applying the appropriate crop co-efficient to the average daily evapotranspiration rates for the fields in question, crediting average rainfall, and expressing the remaining requirement in gallons per acre per day ("***GPAD***"). The data used to calculate the water requirements for the crops is drawn from 14 weather stations strategically located throughout the plantation by representative region that have been consistently operated for many years. (Exhibit C-156-A at 1; Exhibit C-157-A; Volner WDT 10/17/16, ¶ 18; Volner WRT 1/20/17, ¶ 8.)

346. The aggregate irrigation requirement for the 26,996 acres is 3,307 GPAD, which amounts to 32,587 million gallons per year, or an average daily requirement of 89.28 mgd. Accounting for estimated losses of 22.7% due to seepage, evaporation and other system losses, the gross amount of water needed to yield the net irrigation requirement of 89.28 mgd is 115.49 mgd. (Exhibit C-137; Exhibit C-156-A; Volner WDT 10/17/16, ¶ 19.)

347. The gross irrigation requirement for acreage that is 100% dependent on surface water breaks down as follows:

Agricultural Park 717 acres @ 2448 GPAD 1.75 mgd

Dairy	2483 acres @ 1384 GPAD	3.44 mgd
Diversified Ag	2830 acres @ 2510 GPAD	7.10 mgd
Orchard Crops	2212 acres @ 5765 GPAD	11.40 mgd
Beverage Crops	901 acres @ 5096 GPAD	4.59 mgd
Total irrigation requirement		28.28 mgd
Gross irrigation requirement (1.294 x 28.28 mgd)		36.59 mgd

(Exhibit C-156-A; Exhibit C-157-A.)

348. The gross irrigation requirement for acreage with access to well water breaks down as follows:

Pasture irrigated	3037 acres @ 1704 GPAD	5.17 mgd
Dairy irrigated	1972 acres @ 2297 GPAD	4.53 mgd
Diversified Ag	2000 acres @ 2753 GPAD	5.51 mgd
Orchard crops	1554 acres @ 5765 GPAD	8.96 mgd
Pongamia	2113 acres @ 4478 GPAD	9.46 mgd
Biogas Feedstock	820 acres @ 3565 GPAD	2.92 mgd
Row Crops	6357 acres @ 3835 GPAD	24.38 mgd
Total irrigation requirement		60.93 mgd

Gross irrigation requirement (1.294 x 60.93 mgd) 78.84 mgd

(Exhibit C-156-A; Exhibit C-157-A.)

349. The Diversified Agricultural Plan is broken down loosely into uses that A&B plans to self-perform and uses that A&B is hoping to partner with others to perform. (Schreck, Tr., 2/8/17, p. 289, ll. 5-9.)

350. A&B has performed a high level analysis of potential markets available for Hawai‘i farmers. A&B focused on markets for Hawai‘i-produced products that are imported widely and the general farming community in Hawai‘i and production markets. (Schreck, Tr., 2/8/17, p. 289, l. 12 to p. 290, l. 4.)

351. HC&S has received approximately 250 inquiries about leasing former sugar lands for agricultural activity since the cessation of sugar cultivation. Of these 250 inquiries, HC&S is investigating over 60 that it has determined to be possible prospects meriting further review. If

all of the possible lease prospects were successfully sited on former sugar lands and mutual agreements were reached on lease terms, the aggregate acreage required would roughly total 19,500 acres. (Schreck WRT 1/20/17, ¶ 8.)

352. Virtually every prospective lessee of the former sugar lands has raised the topic of water for irrigation with A&B. A&B's current inability to provide assurances regarding whether and how much irrigation water can be made available to lessees from the EMI Ditch System is a major obstacle to procuring commitments from prospective lessees who need such assurance in order to justify committing the necessary capital to develop a new agricultural operation. No farmers have been willing to commit to cultivation on HC&S lands absent some assurance as to the quantity and quality of water and cost. (Schreck WRT 1/20/17, ¶ 9; Volner, Tr., 2/8/17, p. 268, l. 25 to p. 269, l. 20; Schreck, Tr., 2/8/17, p. 295, l. 20 to p. 296, l. 5.)

353. HC&S' goal is to put as much of the former cane lands into viable, sustainable diversified ag operations. At this time, HC&S' water use is limited to irrigation of diversified agricultural test crops, irrigation of cover crops to minimize soil erosion and miscellaneous uses such as industrial wash water, firefighting and dust control. Water usage will be limited until full implementation of the Diversified Agricultural Plan. (Volner, WDT 10/17/16, ¶¶ 3, 11; Volner, Tr., 2/6/17, p. 182, l. 21 to p. 183, l. 1 and p. 201, ll. 21 to p. 202, l. 202.)

354. As part of the Diversified Agricultural Plan, HC&S is currently cultivating test crops, has completed harvesting of over 180 acres of bioenergy crops, and is preparing for the cultivation of approximately 500 acres for large scale row testing. (Volner, Tr., 2/6/17, p. 168, ll. 8-23.)

355. HC&S is engaged in efforts to move the cultivation of bioenergy crops into the commercialization phase. For example, HC&S has entered into a commercial feedstock agreement to provide biogas feedstock to a company that is under contract with the County of Maui to provide power for the Kahukui Wastewater Treatment Facility. The expansion to 500 acres of row crop testing supports this commercialization initiative. (Volner, Tr., 2/6/17, p. 179, l. 25 to p. 180, l. 6; Volner, Tr., 2/8/17, p. 265, l. 14 to p. 267, l. 11.)

b. Losses

1. EMI

~~377.~~356. From March to October 2011, USGS conducted a field study of the EMI ditch system to document the location of tunnels and open-ditch sections and to determine seepage losses and gains along selected reaches. (Cheng, C.L., 2012, "Measurements of Seepage Losses and Gains, East Maui Irrigation Diversion System, Maui, Hawaii," US Geological Survey Open-File Report 2012-1115, 23 p. ("USGS 2012 Seepage Report"), presented at the CWRM meeting of January 23, 2013. ("USGS 2013 Presentation") [Nā Moku/MTF FOF 1064.]

~~378.~~357. The EMI diversion system begins at Makapipi Stream in the east and ends at Maliko Gulch in the west. It consists of four primary ditches known as the Wailoa, New Hamakua, Lowrie, and Haiku ditches. Additional ditches that connect to the four primary ditches include the Ko`olau, Spreckels, Kauhikoa, Spreckels at Papaaea, Manuel Luis, and Center ditches. (USGS 2012 Seepage Report, p. 1.)

~~379.~~358. Ditch characteristics for about 63 miles of the EMI system, excluding abandoned ditches and stream conveyances, were characterized. About 46 miles (73%) of the surveyed diversion system are tunnels, and 17 miles (27%) are open ditches, of which 3.5 miles (6%)are lined, 2.5 miles (4%) are partially lined (4%), and 11 miles (17%) are unlined. (*Id.*)

~~380.~~359. Tunnels, covered and/or underground, include culverts, siphons and pipes. Lined ditches have concrete ditch bottom and walls, steel ditch bottoms and walls, or concrete ditch bottoms and armored cut-stone walls. Partially lined ditches have earthen material on the ditch bottom and one wall and lined on the other wall; earthen material on the ditch bottom and lined on both walls; or a lined ditch bottom and earthen material on both walls. Unlined ditches have earthen material on bottom and both walls. (USGS 2013 Presentation.)

~~381.~~360. The Wailoa, Kauhikoa, and Haiku ditches have greater than 96 percent of their total length as tunnels, whereas more than half of the Lowrie ditch and Spreckels ditch at Papaaea are open ditches. About 70 percent of the total length of lined open ditches in the EMI diversion system is located along the Ko`olau ditch, whereas about 67 percent of the total length of unlined open ditches is located along the Lowrie ditch. Less than 4 percent is partially lined open ditches, and about half is in the Spreckels ditch. (USGS 2012 Seepage Report, p. 1.)

~~382.~~361. Discharge measurements were made along 26 seepage-run measurement reaches that are about a total of 15 miles in length. The seepage run measurement reaches represent 23 percent of the total length of ditches in the EMI system. (*Id.*)

~~383.~~362. The results were as follows:

Range of ditch flows (mgd)	seepage losses and gains (mgd)	seepage losses and gains, in percentage of ditch flows
>19	-0.39 to 2	-1.6% to 4%
9.7 to 19	-0.26 to 1.4	-3.7% to 11%

1.3 to 5.2	-0.78 to 0.17	-20% to 8%
0 to 1.3	-0.13 to 0.21	-71% to 41%

Measurement reach lengths range from 0.15 to 2.23 miles. (USGS 2013 Presentation.)

~~384.~~363. Ko`olau and Spreckels ditches generally had seepage losses. Wailoa, Kauhikoa, and New Hamakua ditches had seepage gains. The Manuel Luis, Center, Lowrie, and Haiku ditches had variable seepage losses and gains. Open ditch measurement reaches generally had seepage losses that ranged from 0.1 cfs (0.06 mgd) per mile at the Lowrie ditch to 3.0 cfs (1.94 mgd) per mile at the Ko`olau ditch. Tunnel measurement reaches generally had seepage gains that ranged from 0.1 cfs (0.06 mgd) per mile at the Manuel Luis ditch to 5.2 cfs (3.36 mgd) per mile at the Wailoa ditch. (USGS 2012 Seepage Report, p. 1.)

~~385.~~364. Thus, because both open ditches and tunnels in the EMI diversion system not only incur seepage losses but also gains from groundwater, especially in the tunnels, it is not clear whether net seepage losses even occur in the EMI diversion system. At low flows, the USGS study results show that losses are greater than gains, but at higher flows, gains are greater than losses, *supra*, FOF 362~~383~~.

2. HC&S

~~386.~~365. For 1986 to 2013, HC&S accounted for "system inefficiencies, installation, and terrain inconsistencies" separately from "system losses due to seepage and evaporation of transportation and storage system." "System inefficiencies, etc." assumed that "effective water needed" was 80 percent of "gross water needed" and were incorporated into HC&S's irrigation requirements, which uses a 80 percent efficiency factor in calculating its water requirements. (Exh. C-74.) The preceding analysis had concluded that, for purposes of estimating HC&S's irrigation needs, an 85 percent efficiency factor should be used instead~~, *supra*, FOF 328-337~~. "System losses, etc." was estimated at 10 percent of the water needed to irrigate 30,000 acres, but no analysis was provided for this estimate. (Exh. C-74.)

~~387.~~366. Based on this information, *supra*, FOF 365~~386~~, system losses would be 10 percent of the water required to irrigate 28,941 acres, or 4,844 gad x 28,941 acres x 0.1 = 14.02 mgd. (The information provided by HC&S identified water requirements as 7,396 gad and acreage as 30,000, but reasonable water requirements have been found to be 4,844 gad and irrigated acres--as opposed to the total East Maui fields of 30,000 acres--are assumed to be the 28,941 acres identified by HC&S in its 2008 to 2013 data.)

~~388.~~367. For 1986 to 2009, all water needs were lumped together in a single number of 9,019 gad, not only including irrigation requirements but also system losses, irrigation inefficiencies, and industry (factory) needs, ~~*supra*, FOF 322,~~ so system losses cannot be estimated.

~~389.~~368. For 2008 to 2013, HC&D characterized all water that could not be accounted as "seepage, evaporation and miscellaneous system losses." Total surface and ground water deliveries were 183.61 mgd and unaccounted water was 41.67 mgd, or 22.7 percent of surface water delivered and ground water pumped, *supra*, FOF 332~~312~~-333~~313~~, 335~~315~~. (Exh. C-137.)

~~390.~~369. Estimating seepage and evaporation losses by way of direct measurement would require closing sections of the ditches and reservoirs, allowing the water to remain in those structures for a period of time, and taking before and after readings. This is impractical to do on a large scale because it would interrupt plantation operations. (Garret Hew, WDT, ¶ 10; Garret Hew, Tr., March 17, 215, pp. 184, 186.) [HC&S FOF 636.]

~~391.~~370. As an alternative to direct measurement, HC&S calculated the amount of water that cannot be accounted for, *supra*, FOF 368~~389~~.

~~392.~~371. To obtain a benchmark against which the estimated 22.7 percent loss rate could be compared, HC&S consulted the National Engineering Handbook published by the Soil Conservation Service of the U.S. Department of Agriculture ("USDA"), which provides seepage rate factors that can be applied to various sections of HC&S's system. HC&S calculated the average surface area under water for each type of material that holds or conveys the water (i.e., lined or unlined ditches or reservoirs). For each type of material, HC&S selected a relatively low seepage factor along with a relatively high seepage factor from the USDA Handbook and applied each factor to the estimated surface area under water to calculate what would represent low seepage loss and high seepage loss in the HC&S system per USDA's standards. Based on the foregoing calculations, a low seepage loss per day was estimated to be 30.75 mgd, or 16.76 percent of average daily water deliveries of surface and ground water of 183.61 mgd; a high seepage loss per day was estimated to be 65.06 mgd, or 35.46 percent of average daily water deliveries. (Garret Hew, WDT, ¶¶ 11-12; Exh. C-138, Figure 2-50; Exh. C-139.) [HC&S FOF 638.]

~~393.~~372. To account for loss due to evaporation, HC&S estimated the average daily amount of evaporation from the surface of the water contained in the same ditches and reservoirs as those considered in estimating the seepage losses. The average daily evaporation rate of 0.40

acre-inches was multiplied by the average daily surface area of the water in the system (243.48 acres), which yielded an average daily evaporation loss rate of 2.64 mgd. Added to the high and low seepage calculations, an estimated range of losses from both seepage and evaporation was 33.40 mgd, or 18.20 percent of average daily water deliveries, to 67.70 percent, or 36.90 percent of average daily water deliveries. (Garret Hew, WDT, ¶ 13; Exh. C-139.) [HC&S FOF 639.]

~~394.~~373. The average of the high and low estimated losses from seepage and evaporation is 27.55 percent, and HC&S's losses of 22.7 percent falls below this average. (Exh. C-139.) [HC&S FOF 640.]

~~395.~~374. HC&S's losses of 22.7 percent include not only seepage and evaporation losses, but also miscellaneous losses such as back-flushing of filters, drip tube ruptures or breaks, animal damage, pipeline breaks, misreported irrigation (if they are not applying the correct hours to the amount that they ran), testing of systems prior to planting, or where water is taken out of the system but not accounted for in daily irrigation, *supra*, FOF 335~~315~~.

~~396.~~375. In the Nā Wai `Ehā contested case hearing, the Commission identified a number of other factors that could contribute to miscellaneous losses, describing such losses in HC&S's field operations as "plausible and reasonable factors that would significantly increase their actual irrigation requirements" and ascribing such losses as the equivalent of 5 percent of irrigation requirements. (Exh. C-120, COL 79, 90-91.)

~~397.~~376. Five percent of irrigation requirements would be 7.01 mgd (4,844 gad x 28,941 acres x 0.05 = 7.01) mgd, losses that are plausible and reasonable."

~~398.~~377. Of HC&S's unaccounted water of 41.67 mgd, or 22.7 percent of surface water delivered and ground water pumped, *supra*, FOF 389, 34.66 mgd (41.67 mgd minus 7.01 mgd), or 18.9 percent, would be ascribed to seepage and evaporation losses. This percentage is nearly equal to the low seepage rate of 18.20 percent as calculated under USDA's standards, *supra*, FOF 393.

~~399.~~378. Thus, HC&S's system losses of 22.7 percent (41.67 mgd of 183.61 mgd of surface water delivered and ground water pumped) are reasonable losses.

c. Alternate Sources

1. Ground Water

~~400.~~379. HC&S's irrigation structure includes 15 brackish water wells and associated pumps with a total pumping capacity of 228 mgd, which may be used to supplement surface water to irrigate 17,200 acres of the approximately 30,000 acres serviced by waters from the EMI Ditch system. (Exh. C-33; Exh. C-35; Exh. E-76 at 3 (PDF); Garret Hew WDT, ¶ 25.) [HC&S FOF 606; Nā Moku/MTF FOF 997.]

~~401.~~380. The remaining 12,800 acres cannot be serviced by pumped ground water on a consistent basis. Ground water can be delivered to 7,000 acres via a shared pipeline that serves as a penstock line for a hydroelectric unit for the majority of the year. This pump system was designed and built to be an emergency water source for high-elevation fields in the event of extreme drought, rather than a primary source of water. The system consists of a booster pump system that diverts primary ground water at the Lowrie Ditch level to a higher elevation. (Rick Volner, WDT, ¶ 19.) [HC&S FOF 645.]

~~402.~~381. The maximum instantaneous pumping capacity of wells that can service the East Maui fields is 215 mgd. However, the true instantaneous pumping capacity of the wells--i.e., the most HC&S can pump over 3 to 5 days--is 115 mgd to 120 mgd. Sump levels in the wells start to drop when pumping reaches 115 mgd to 120 mgd, especially in the summer months where there is little recharge. Further lowering of the sump levels could cause severe mechanical damage to the pumps. (Rick Volner, Tr., March 23, 2015, pp. 16-19.) [HC&S FOF 611.]

~~403. In contrast, by 1931, HC&S had been able to pump 144 mgd, and in dry times, pumps supplied up to 45 percent of the irrigation water. And as late as a 1996 Memorandum of Understanding between EMI, MDWS, and others, ground water was described as supplying 45 percent of HC&S's irrigation needs. (Exh. E-92, p. 121; Exh. E-110, p. 1.) [Nā Moku/MTF FOF 1126, 1129.]~~

382. ~~403.~~ From 2008 to 2013, HC&S pumped an annual average of 25,512 million gallons, or 69.90 mgd, for use on the East Maui fields, including mill use. (Exh. C-137, Column C.) [HC&S FOF 619.]

383. ~~404.~~ From 1986 to 2009, HC&S pumped an average of 72 mgd; and from 1986 to 2013, an average of 71 mgd. Compared to service water deliveries during these times, the amounts and percentage of totals were as follows:

	Total	Surface water/percent	Ground water/percent
1986-2013:	224 mgd	153 mgd (68%)	71 mgd (32%)
1986-2009:	239 mgd	167 mgd (70%)	72 mgd (30%)
2008-2013:	184 mgd	114 mgd (62%)	70 mgd (38%)

(Exhs. C-74, C-103, pp. 14-15, C-137.)

405. Ground water contributions to total irrigation uses have remained constant at or near 70 mgd, or about half of the 1931 capacity, and about 60 percent of what HC&S claims is the present capacity, *supra*, FOF 402-403. The percent of total rose from 30 percent in 1986 to 2009 to 38 percent in 2008 to 2013, because surface water contributions decreased from 167 mgd to 114 mgd, while ground water contributions remained the same, even though ground water contributions could have been increased by another 45 mgd to 50 mgd *supra*, FOF 402, 404.

406. In its 2013 annual report, A&B, HC&S's parent company, made the following statement:

(A) change in A&B's power sales contracts may adversely affect power revenue and provide less protection against internal power generation costs in a rising oil price market. As a result, A&B may consider decreasing or eliminating power sales on Maui in future years, and, instead, use its power for field irrigation purposes, which would be expected to increase sugar yields. (Exh. E-112, p. 29.) [Nā Moku/MTF FOF 1134.]

384. 407. Thus, it can be inferred that HC&S has not increased ground water for irrigation, because revenues from selling electricity from its hydropower operations have outweighed revenues from increased sugar production, which would require using electricity to operate its ground water pumps, *supra*, FOF 406.

385. 408. While HC&S was engaged in sugarcane cultivation, Furthermore, by using about 70 mgd of a ground-water usable capacity of 115 mgd to 120 mgd, HC&S hashad an alternative ground water source of 45 to 50 mgd, *supra*, FOF 383383405.

386. 409. This potential capacity may be less, because a reduction in surface water importation coupled with an increase in ground water pumping will likely increase aquifer salinity levels, especially in the summer months when pumping is highest. (Exh. C-71, Appendix A, p. E-2 and exhibit E-3.) [HC&S FOF 646.]

387. It is unclear what the direct relationship of recharge from surface water importation to the underlying groundwater aquifer is, but historical groundwater pumping levels were higher than published sustainable yields. (Volner, WDT 10/17/16, ¶ 23; Volner, Tr., 2/6/17, p. 161, ll. 13-21.)

388. The transition to diversified agriculture will bring with it several key changes that will impact the utility and reliability of brackish groundwater resources in the future—reduced recharge from lower levels of irrigation of the overlying lands, uncertain tolerance of diversified agriculture crops to heavy reliance on brackish water, and the higher costs associated with well

water versus surface water, and the higher economic hurdles related to higher levels of investment in new agricultural ventures versus ongoing sugar operations where the major investments were already made. (Volner, WDT 10/17/16, ¶ 22.)

389. Although the crops conceptually planned for the area that can access groundwater are known to be tolerant to some levels of brackish water irrigation, the precise tolerance levels and the impacts of prolonged uses of brackish water on these crops are presently unknown. When these fields were planted with sugarcane, well water was periodically being applied during dry periods to a crop with a twenty four month crop cycle. The crops currently planned for those acres will generally have much shorter crop cycles than sugarcane, and so they will have less time to recover from sustained periods of reliance upon brackish water during dry periods, and will thus be generally more vulnerable to the negative impacts on crop growth associated with prolonged exposure to brackish water. As with sugarcane cultivation, the prolonged or primary use of brackish water could have additional negative impacts on soil health with the buildup of minerals and salts without adequate surface water to flush these constituents. (Volner, WDT 10/17/16, ¶ 24; Volner, Tr., 2/6/17, p. 162 ll. 8-14.)

390. There are increased costs associated with utilizing well water rather than surface water. It is unknown at this time if the economics of the diversified agriculture uses envisioned for these lands can support the increased costs associated with utilizing well water. Unlike sugar, where the major investments necessary to support operations had previously been made, new diversified agriculture ventures will require significant new investments in farming and processing equipment. (Volner, WDT 10/17/16, ¶ 25.)

391. With the end of sugar operations, HC&S would need to purchase electricity from Maui Electric Company at commercial rates to operate the groundwater pumps. (Volner, Tr., 2/6/17, p. 190, ll. 5-10.)

392. The cost to pump groundwater could deter those who are interested in farming on HC&S land from making the investments necessary to support diversified agriculture. (Volner, WDT 10/17/16, ¶ 25.)

393. Groundwater wells were designed to be operated as an integrated irrigation system. Therefore, HC&S is unable to commit to using well water to provide the water needs of a small plot farmer even if the field in question has access to groundwater. (Schreck, Tr., 2/8/17, p. 304, ll. 15-24.)

394. Historically, HC&S supplemented the surface water imported from East Maui with pumped groundwater to irrigate its sugarcane fields. This was done seasonally more than anything else and, on an aggregate basis, constituted between 20 to 30 percent of total water use when HC&S was cultivating sugarcane. The amount of groundwater historically used was far in excess of what the published sustainable yields of the underlying aquifers are, which was made possible by the large volumes of surface water being imported from East Maui. (Volner, Tr., 2/6/17, p. 161. ll. 9-12; 163 ll. 16-21.)

395. Given that the crops cultivated under the Diversified Agricultural Plan will generally be less tolerant to brackish water than sugarcane, and that the amount of surface water imported from East Maui is expected to be reduced to satisfy the amended IIFS, ~~,~~it is not ~~un~~reasonable to assume that use of groundwater under the Diversified Agricultural Plan will be within the historical range of 20 to 30 percent of total water use. HC&S believes that a sustainable level of ~~G~~groundwater usage will more likely~~probably~~ be within the range of 0 to 20 percent of total water use. (Volner, Tr., 2/6/17, p. 163, l. 21 to p. 164, l.1.)

2. Additional Reservoirs

396. ~~410.~~ Reservoirs would be most valuable as a water source in the summer months, when it's dry and HC&S's daily irrigation needs are at their maximum. (Rick Volner, Tr., March 23, 2015, p. 33.)

397. ~~411.~~ Storing water in the existing reservoirs or lining them to reduce or eliminate seepage would not provide large amounts of new water, because in the summer months the water is not being put in the reservoirs, and if it is, it's put in and taken out relatively quickly. (Rick Volner, Tr., March 23, 2015, p. 35.)

398. ~~412.~~ The 36 reservoirs located throughout the plantation range in size from 4 million gallons to 80 million gallons, which are a total of 862 million gallons at full capacity, only a five- to ten-day supply for the approximately 12,800 acres that are serviced by these reservoirs. The reservoirs are primarily holding ponds where water is collected and distributed for irrigation or other uses on a daily basis. Only when ditch flows are high do they have the ability to store additional water. (Exh. C-68, pp. 5-6.)

399. ~~413.~~ A reservoir would need to have an extremely large storage capacity to meet demands for a prolonged period of time during the summer months when water would be the most valuable. To be of most value, a large reservoir would need to be located at the highest

elevation at the head of the Wailoa Ditch, above Paia or Haliimaile, which supplies the greatest amount of water to HC&S, so as to maximize the ability of the reservoir to supply water to various parts of the plantation during dry periods. (Rick Volner, Tr., March 23, 2015, pp. 32-33.) [HC&S FOF 659.

400. ~~414.~~ In the 1960s, HC&S internally considered building such a large reservoir, but decided not to pursue it after a study indicated that a billion-gallon reservoir would provide only a 10-day supply of water. HC&S's daily water needs were in the range of 200 mgd to 300 mgd, and even a billion-gallon reservoir would provide 200 mgd for only five days. (Garret Hew, Tr., March 18, 2015, p. 236; Rick Volner, Tr., March 23, 2015, P. 33.) [HC&S FOF 658.]

401. ~~415.~~ Assuming that there is a reduction of stream water, not a total cessation, smaller deficits would mean that a billion-gallon reservoir could provide, for example, 40 mgd for 25 days.

402. ~~416.~~ However, there are some complexities with how you would fill such a large reservoir,. Even if the Wailoa Ditch were flowing at capacity in the summertime, it would make more sense to apply that water as quickly as possible to the fields to avoid having system losses or to reduce system losses instead of trying to store it and meter it out. (Rick Volner, Tr., March 23, 2105, pp. 34-35.)

403. ~~417.~~ Ever since the Kaloko Dam incident on Kauai, all dam structures are highly scrutinized by the state. Constructing a large dam today will require much more scrutiny, much more oversight, than previously constructed reservoirs, and community opposition would also be expected. Any dam that would be sited would be at the highest elevation possible, and that would be above either Paia or Haliimaile. (Rick Volner, Tr., March 23, 2015, p. 34.)

404. ~~418.~~ A billion-gallon reservoir is approximately 3,800 acre-feet. If the reservoir is 10 feet deep, it would occupy approximately 30 acres. It would be very difficult to site a reservoir that large at the highest elevation on the plantation. (Garret Hew, Tr. March 18, 2015, p. 98; Rick Volner, Tr., March 23, 2015, p. 33.) [HC&S FOF 660.]

405. ~~419.~~ The cost of building a billion-gallon reservoir would depend on a number of factors, including terrain, acquisition of land, and permitting. In 2009, HC&S estimated that building a billion-gallon reservoir on Maui would cost well in excess of $150 million. (Exh. C-68, p. 6.) [HC&S FOF 663.]

406. ~~420.~~ HC&S has not considered building a large number of small reservoirs at the top of the plantation, because they wouldn't have the benefit that a large reservoir at the highest

elevation, the most eastward end of the plantation, would have. This would be where the largest supply comes in, the Wailoa ditch. (Rick Volner, Tr., March 23, 2015, pp. 142-143.)

3. Recycled Wastewater

407. ~~421.~~ Nā Moku/MTF proposed a number of FOF on the use of wastewater for sugarcane irrigation, based on the December 20, 2010, Central Maui Recycled Water Verification Study. (Nā Moku/MTF Proposed FOF 973-985.)

408. ~~422.~~ Nā Moku/MTF contends that "(f)unds in the County budget have been set aside for an R-1 upgrade and transmission lines at the Kahului plant. What remains to be decided is where these lines would be placed." (Nā Moku/MTF Proposed FOF 974.) No reference accompanies this proposed FOF. What is in the record is the response of Irene Bowie, Executive Director of MTF:

> A. There has been ongoing conversation, and I've talked with staff in the Department of Environmental Management about funding for that, and the county has looked to put money into the budget. I believe in the 2015 budget there is money set aside.
>
> And also Department of Transportation Airports Division was willing to put money into a line that would go to the airport.
>
> (Irene Bowie, Tr., March 23, 2015, p. 167.)
>
> "Funding for the distribution system could come jointly from Hawaii Department of Transportation, Airports Division, HC&S and others." (Irene Bowie, WDT, ¶ 14.) [Nā Moku/MTF FOF 976.]

409. ~~423.~~ Irene Bowie, Executive Director of MTF, makes a number of statements that do not distinguish the use of wastewater from the Kahului Wastewater Reclamation Facility ("WWRF") on HC&S's West Maui versus East Maui fields, *infra*, FOF 409~~423~~-413~~427~~.

410. ~~424.~~ Nā Moku/MTF contends that "Option 2 on page 8 of the Central Maui Recycled Water Verification Study proposes a distribution system from the Kahului WWRF to Kanaha Beach Park and Kahului Airport that could be extended to HC&S fields north of the airport." (Exhs. E-88, E-88-A, E-126.) (Na Moku/MTF FOF 975.]

411. ~~425.~~ However, the study proposal was for a distribution system to Kanaha Beach Park and Kahului Airport, and it was Irene Bowie's suggestion "that it could conceivably go on out to the fields in the north side of HC&S's plantation." (Irene Bowie, Tr., March 23, 2015, p. 166.)

412. ~~426.~~ The HC&S fields immediately north of the airport are irrigated by either EMI ditch water or HC&S wells. (Exh. C-35.)

413. ~~427.~~ The other options identified by Irene Bowie pertain to HC&S's West Maui fields: 1) a proposed pipeline along Kaahumanu Avenue to reach existing Maui Land and Pine ("ML&P") pipe lines that used to carry wastewater from its cannery operations to HC&S's seed cane fields; and 2) pumping R-1 water from the WWRF directly to HC&S's reservoir, are all in the West Maui fields. (Exh. C-120, FOF 506, p. 86; Exh. C-119, p. 36.)

414. ~~428.~~ In order to realize the use of WWRF R-1 water on HC&S's East Maui fields immediately north of Kahului Airport: 1) upgrade of the Kahului WWRF to R-1 water capability , with an estimated cost in December 2010 of $4,965,000 (Exh. E-88, p.6); 2) the pipeline to Kahului Airport must be completed, and 3) a dedicated HC&S pipeline from that point to its East Maui fields above the airport must be completed.

415. ~~429.~~ Furthermore, there is presently only 2.95 mgd to 4.2 mgd of R-2 available on a consistent basis, and the current dry-weather flow capacity of the WWRF is 7.9 mgd. (Exh. C-119, p. 36; Exh. E-88, pp. 2, 6.)

4. Maui Land and Pine

416. ~~430.~~ Nā Moku/MTF contends that Maui Land and Pine (MLP) relied on EMI for irrigation water for 2,800 acres of its 6,000 acres, or approximately 4.5 mgd, and that 4.5 mg can be deducted from any determination of actual need for HC&S because MLP has gone out of business. (Exh. C-85, p. 32.) [Nā Moku/MTF FOF 1108-1113.]

417. ~~431.~~ However, MLP and HC&S had a transportation agreement, and not a water-use agreement, for use of the EMI transmission system to transport water MLP pumped into the EMI ditch at Nahiku for use on its pineapple fields. Furthermore, EMI/HC&S does not intend to use water from the well in the future, because the pump is small, and the cost of electricity outweighs the use of that water. (Exh. E-107; Garret Hew, Tr., March 18, 2015, pp. 165-166.) [Nā Moku/MTF FOF 1109-1110, 113.]

~~**5. Green Harvesting**~~

~~432. Irene Bowie does not consider herself an expert in cultivation of sugarcane but considers her position as Executive Director of MTF as capable of researching issues and reaching out to different entities and organizations that have the expertise. (Irene Bowie, Tr., March 23, 2015, p. 193.) As such, she is no more qualified as an expert than a layperson who has formed an opinion after becoming interested in a particular subject.~~

433. Bowie states that the replacement of pre-harvest burning by the adoption of green cane harvesting and trash blanketing has worked well on a large scale in Australia and does not reduce productivity or efficiency. Trash blanketing is the spreading of leaves and other plant residue in a thick layer of mulch over the ground. Because trash blankets help to prevent evaporation of water from the soil surface and allows better water infiltration, Bowie contends that the practice reduces irrigation requirements and produces higher cane yields in drier areas. However, one of her references, Exh. E-127, a study in South Africa, concludes that a trash blanket could also inhibit crop growth. Bowie also claims that HC&S currently green harvests between 4 percent and 6 percent of their fields, and have publicly stated that they could increase that amount to possibly 20 percent. (Exhs. E-91, E-127; Irene Bowie, WDT, ¶¶ 28-29.) [Nā Moku/MTF FOF 1116-1123.]

434. The water savings that could theoretically be realized from green harvesting are due to the green trash blanket on the ground reducing evaporation from the soil surface. However, HC&S installs drip irrigation tubing below the ground. As a result, soil surface evaporation is very low, and the fields generally are not irrigated to the to the point that the surface becomes wet. (Rick Volner, WDT, ¶ 7; Rick Volner, Tr., March 23, 2015, pp. 38-39.) [HC&S FOF 665.]

435. In regions where green harvesting reportedly is practice, sugar is not a two-year crop as is uniquely the case in Hawaii. Sugarcane that is green harvested in a one-year crop cycle is ratooned (i.e., cut and allowed to regrow) multiple times over a four- to five-year period. Every time the crop is ratooned, it must be irrigated the next day to prevent damage to the stock core. Green harvesting sugarcane also has a shorter ripening and drying off stage (which uses little or not water), and thus it is very likely that green harvesting would increase annual water usage as compared to the current two-year crop cycle. Rick Volner, WDT, ¶ 7; Rick Volner, Tr., March 23, 2015, pp. 37, 39-40; Irene Bowie, Tr., March 23,2015, pp. 193-196.) [HC&S FOF 666.]

436. HC&S previously considered adopting a green harvesting approach and determined that it would not achieve economies of scale. Mechanical harvesting requires that the fields be free of rocks. Based on that limitation, approximately 12,000 acres could effectively be green harvested if HC&S were to purchase the equipment. There are probably an additional 4,000 acres to 5,000 acres that would require extensive rock-clearing in order to be green

harvested. The remaining 13,000 acres to 14,000 acres cannot be green harvested. (Rick Volner, Tr., March 23, 2015, p. 39.) [HC&S FOF 667.]

437. The desert-like climate where most of the plantation is situated does not promote good trash breakdown over a four to five-year period. Consequently, after a crop is ratooned, the trash must be disposed of either by burning or plowing. (Rick Volner, Tr., March 23, 2015, pp. 40-41.) [HC&S FOF 668.]

d. Economic Impacts

438. HC&S provided two analyses on the economic impact of reduced water for its sugarcane operations: 1) the incremental impacts to HC&S of reductions in East Maui surface water diversions; and 2) the impact on Maui County and the State of Hawaii of the termination of HC&S's sugar operations. (HC&S's Proposed FOF 695-715.)

439. On the impact of terminating HC&S's sugar operations, HC&S provided no information on when and how reduced surface water availability would reach the point that HC&S would cease operations. HC&S only stated in broad terms that it was in the public interest to continue HC&S's operation, because cessation of its sugar operations would affect the County of Maui and the State, MDWS and its customers, renewable energy benefits, and agricultural benefits. (HC&S Proposed FOF 698-715.)

440. On the incremental impacts to HC&S of reductions in deliveries from the EMI ditch system, HC&S created a model for assessing the economic impact of reducing the amount of EMI ditch water, separately assessing reductions of deliveries to the two upper ditches (the Wailoa Ditch and the Kauhikoa Ditch) and reduction of deliveries to the two lower ditches (the Lowrie Ditch and the Haiku Ditch). (Exhs. C-76, C-77, C-78.)[HC&S FOF 695.]

441. Reduced deliveries to the Wailoa Ditch and Kauhikoa Ditch result in reduced water availability to irrigate the 12,800 acres of sugarcane that cannot be irrigated with ground water. The financial impact is therefore calculated in terms of HC&S's anticipated loss in sugar yields due to the average decrease in available water. According to the model, the estimated value to HC&S of the average yield per million gallons per day of available water is $1,390. Therefore, the estimated average annual financial impact to HC&S per million gallons of reduced deliveries to either the Wailoa Ditch or the Kauhikoa Ditch would be $507,858. (Rick Volner, WDT, ¶ 69; Rick Volner, Tr., March 23, 2015, pp. 20-22; Exhs. C-76, C-78.) [HC&S FOF 696.]

~~442. Reduced deliveries to the Lowrie Ditch and Haiku Ditch are assumed to be compensated for by increased pumping of brackish ground water. The financial impact is therefore calculated in terms of the average cost of this pumping; $439 per million gallons per day for the Lowrie Ditch and $205 per million gallons per day for the Haiku Ditch. Therefore, the estimated average annual financial impact to HC&S per million gallons per day of reduced deliveries to either the Lowrie Ditch or the Haiku Ditch would be $160,250 and $74,825, respectively. (Rick Volner WDT, ¶ 69; Rick Volner, Tr., March 23, 2015, p. 22; Exhs. C-76, C-78.) [HC&S FOF 697.]~~

~~443. For the Wailoa Ditch and Kauhikoa Ditch, total water delivered and tons of sugar produced for the years 2003 to 2013 were used to arrive at "tons sugar/million gallons of water," with the yearly average at 2.19 tons sugar/million gallons of water. Dollars per ton of sugar is calculated at $520 (at $0.26 per pound,), dollars per ton of molasses at $85, dollars per ton of bagasse at $50, and various factory costs at $60 per ton of sugar. A ton of molasses is calculated at 0.32 per ton of sugar, and a ton of bagasse is calculated at 2.97 per ton of sugar. Adding the dollars per ton of sugar, the tons of molasses and bagasse adjusted to a ton of sugar, and subtracting the factory costs, the average value of water would be $1,390/mgd, which, when multipled by 365 days, equals the annual financial impact of $587, 858 per million gallons per day of reduced deliveries to either the Wailoa Ditch or the Kauhikoa Ditch, *supra*, FOF 441.~~

~~444. The $520 per ton of sugar is based on a price of $0.26 per pound, while the prevailing price per pound was $0.2382 in 2014. (Rick Volner, Tr., March 23, 2015, pp. 52-53.)~~

~~445. While the yearly average for 2003 to 2013 is 2.19 tons sugar/million gallons of water, the yearly averages ranged from 1.55 for 2009, when total water deliveries were 82,003 million gallons (224.67 mgd) and tons of sugar were 126,800, to 2.51 for 2003, when total water deliveries were 81,913 million gallons (224.42 mgd) and tons of sugar were 205,700. (Exh. C-77.)~~

~~446. For the year 2003, 82,003 million gallons (224.67 mgd) produced 205,700 tons of sugar, while for 2009, a nearly identical supply of water, 81,913 million gallons (224.42 mgd), produced only 126,800 tons of sugar. (Exh. C-77.)~~

~~447. Given this large difference between tons of sugar produced by nearly identical amounts of water (a ratio of 1.55 for 2009 versus 2.51 for 2003), a consistent relationship between tons of sugar produced and amount of irrigation water is questionable.~~

~~448. For the increased pumping costs for the Lowrie and Haiku ditches, a direct relationship between pumping costs and increased pumping is logical.~~

~~449. In Exh. C-76, HC&S estimates a total economic impact of $1,250,775, but this is the sum of costs for each of the four ditches; i.e., $507,858 for both the Wailoa Ditch and Kauhikoa Ditch, $160,250 for the Lowrie Ditch, and $74,825 for the Haiku Ditch. Therefore, the sum is actually HC&S's estimated costs of reducing EMI ditch system water by 1 mgd at each of the four ditches, or the cost of reducing EMI ditch system water by 4 mgd, spread equally across the four ditches.~~

~~450. According to HC&S's own model and calculations, the economic impact of a 1 mgd reduction in EMI ditch system water would range from $74,825 at the Haiku Ditch, to $160,250 at the Lowrie Ditch, to $507,858 at either the Wailoa Ditch or Kauhikoa Ditch.~~

~~451. Given these large differences in impact, if faced with shortages of EMI ditch system water, to minimize costs and to the extent possible, HC&S should serve those fields irrigated from the Wailoa and Kauhikoa ditches first, then the fields irrigated from the Lowrie Ditch, and lastly, the fields irrigated from the Haiku Ditch.~~

~~452. However, the estimated costs for the Wailoa and Kauhikoa ditches, which are based on tons of sugar per million gallons of water per day, are based on a questionable assumption that there is a consistent relationship between amounts of irrigation water and tons of sugar produced, *supra*, FOF 447.~~

~~453. Finally, HC&S's model is based on a reduction of surface water delivered through the EMI ditch system. Such costs have to be predicated on reductions of water that are necessary for irrigation, not on reductions of water that are currently delivered. As previously analyzed, even after the reductions of the Commission's 2008 and 2010 orders, more water than is required is still being delivered, *supra*, FOF 375-376.~~

418. The County of Maui has expressed that it "is in strong support of keeping the lands used by HC&S/A&B in agriculture." The County's position "is largely premised on the policies set forth in Maui Island Plan/General Plan 2030, the Countywide Policy Plan, and the various Community Plans, which promote a variety of interests including economic diversity, maintenance of view planes, open space and fire protection." (MDWS Opening Brief at 5; MDWS Rebuttal Brief at 6; Exhibit B-063, pp. 7-2 to 7-10, Exhibit B-064, pp. 46, 60, 61, 75.)

419. MTF supports commercial agriculture in Central Maui. (Albert Perez, Tr., 2/8/17, p. 435, ll. 13-14, p. 437 ll. 1-11.) MTF's report, *Mālama ʻĀina: A Conversation About Maui's Farming Future* notes that "[t]he closure of the HC&S sugarcane enterprise is an opening to the next generation of diversified farm businesses," and that HC&S's "large, consolidated 35,000-acre

block of central Maui farmland can be used to generate multiple income streams while growing food and fuel profitably for local consumption and value-added export." (Exhibit E-160, *preface* and p. 1.) MTF supports the use of East Maui stream water for "true agriculture."

420. Nā Moku agrees that the former sugar lands should be kept in agriculture.

421. Accordingly, the parties to this contested case do not dispute that keeping HC&S' former sugar lands in agriculture is in the public's best interest.

422. Keeping HC&S' former sugar lands in agriculture would promote the Countywide Policy Plan's core principle of maintaining open space and protecting scenic views. (Kathleen Ross Aoki Written Direct Testimony 10/17/16, ¶ 6.)

423. 22,254 acres of land irrigated with EMI water are designated as Important Agricultural Lands ("IAL") pursuant to HRS Chapter 205, Part III. The IAL designation "is a commitment to keep these lands in productive agriculture over the long term." (Volner WDT 10/17/16, ¶ 12.)

2. MDWS

a. Uses

424. ~~454.~~ MDWS is the sole municipal water provider for the County of Maui. The MDWS Upcountry Water System serves the communities of Kula, Haiku, Makawao, Pukalani, Haliimaile, Waiakoa, Keokea, Waiohuli, Ulupalakua, Kanaio, Olinda, Omaopio, Kula Kai, and Pulehu. (David Taylor, WDT, David Taylor, Tr., March 11, 2015, p. 41.) [MDWS FOF 13.]

425. ~~455.~~ The population served by the MDWS upcountry system is projected at 35,251 people and includes several businesses, churches, Kamehameha Schools, Hawaiian Homelands, and government facilities. By 2030, the population is anticipated to grow by about 8,424 to a total of 43,675. (Michele McLean, WDT, ¶5; Exh. B- David Taylor, WDT, ¶ 6; David Taylor, Tr., March 11, 2015, p. 41; Michele McLean, Tr., March 12, 2015, pp. 120-127; Exhs. B-1, B-18, B-58.) [MDWS FOF 15, 34.]

426. ~~456.~~ Approximately 60 percent of MDWS's system is used domestically, and the remaining 40 percent for agricultural purposes. (David Taylor, WDT, ¶ 17; Exh. B-2, pp. 1-2; David Taylor, Tr., March 11, 2015, pp. 44-47.) [MDWS FOF 21.]

427. ~~457.~~ Approximately 80 to 90 percent of the water delivered within the upcountry system comes from surface water sources, either directly or by way of various raw water storage facilities. (David Taylor, WDT, ¶¶ 7-8, 18; Exh. B-2, Table 2; David Taylor, Tr., March 11, 2015, p. 44.) [MDWS FOF 20.]

428. ~~458.~~ MDWS relies on three surface water sources, one of which is delivered by EMI through the Wailoa Ditch, and the other two through two MDWS higher-elevation aqueducts maintained by EMI that transport water to Olinda and Kula, under a contractual agreement originated under the 193 East Maui Water Agreement and subsequent agreements. (Exhs. B-5, B-6, B-7, C-3.) [Na Moku/MTF FOF 844.]

429. ~~459.~~

Water Treatment Plant ("WTP")	Elevation	Conveyance System	Production Capacity	Average Production
Olinda	4,200 feet	Upper Kula Flume	2.0 mgd	1.6 mgd
Piiholo	2,900 feet	Lower Kula Flume	5.0 mgd	2.5 mgd
Kamole-Weir	1,120 feet	Wailoa Ditch	6.0 mgd	3.6 mgd

(David Taylor, WDT, ¶ 9-11; David Taylor, Tr., March 11, 2015, p. 47; Exh. B-3, pp. 24-25; Exh. B-16, pp. 6-7.) [MDWS FOF 23-25; Nā Moku/MTF FOF 844.]

430. ~~460.~~ The Olinda facility diverts water from the Waikamoi, Puohokamoa, and Haipuaena streams. Water is stored in the 30-million gallon Waikamoi Reservoirs (two, at 15 million gallons each) and the 100-million gallon Kahakapao Reservoir. (David Taylor, WDT, ¶ 11; Exh. B-3, p. 25; David Taylor, Tr., March 11, 2015, p. 47.) [MDWS FOF 25.]

431. ~~461.~~ The Piiholo facility diverts water from the Waikamoi, Puohokamoa, Haipuaena, and Honomanu streams into the 50-million gallon Piiholo Reservoir. (David Taylor, WDT, ¶ 10; David Taylor, Tr., March 11, 2015, p. 47; Exh. B-3, p. 25.) [MDWS FOF 24.]

432. ~~462.~~ The Kamole-Weir facility, which has no reservoir, relies on water from the Wailoa Ditch, which diverts water from Honopou, Hanehoi, Puolua, Alo, Waikamoi, Puohokamoa, Haipuaena, Kolea, Punalau, Honomanu, Nuaailua, Piinaau, Paluhulu, East and West Wailuanui, West Wailuaiki, East Wailuaiki, Kopiliula, Puakaa, Waiohue, Paakea, Waiaaka, Kapaula, Hanawi, and Makapipi streams. (David Taylor, WDT, ¶ 9; David Taylor, Tr., March 11, 205, p. 47; Exh. B-3, p. 24.) [MDWS FOF 23.]

433. ~~463.~~ Besides its customers on the Upcountry Water System, *supra*, FOF 454, MDWS also provides non-potable water to the Kula Agricultural Park ("KAP") through diversions from the same streams which serve the Kamole-Weir WTP through the Wailoa Ditch. Water is stored in two reservoirs with a total capacity of 5.4 million gallons. KAP consists of 31 farm lots ranging in size from 7 to 29 acres, and which are owned by the County of Maui. The individual lots are metered and billed by MDWS. (David Taylor, WDT, ¶ 13; Exh. B-4.) [MDWS FOF 27.]

434. ~~464.~~ MDWS receives its surface water under a series of contracts with EMI. The original contract was entered into in 1961, and the "Master Water Agreement" was replaced by a 1973 "Memorandum of Understanding" as the primary contract, which had a term of 20 years. Since its expiration, there have been a total of 8 extensions, and after the lapse of the most recent extension, water has continued to be provided through a "Memorandum of Understanding Concerning Settlement of Water and Related Issues" dated April 13, 2000 ("MOU"). (David Taylor, WDT, ¶15; Exhs. B-5 to B-15.) [MDWS FOF 29.]

435. ~~465.~~ The MOU provides that MDWS will receive 12 mgd with an option for an additional 4 mgd. During low-flow periods, the County and HC&S will both receive a minimum allotment of 8.2 mgd. If these minimum amounts cannot be delivered, MDWS and HC&S will receive prorated shares of the water that is available. (David Taylor, WDT, ¶ 15; David Taylor, Tr., March 11, 2015, pp. 53-54; Exh. B-15.) [MDWS FOF 30.]

436. ~~466.~~ Approximately 80 to 90 percent of the water delivered within the upcountry system comes from surface water sources, *supra*, FOF 457, with the remaining 10 to 20 percent coming from a series of basal aquifer wells. The Haiku Well can produce 0.5 mgd, the Pookela Well, 1.3 mgd, and the two Kaupakalua wells, 1.6 mgd, for a total of 3.4 mgd. (Exh. B-16, p. 8.) [Na Moku/MTF FOF 850.]

437. ~~467.~~ In times of emergency, MDWS may also draw 1.5 mgd from the Hamakuapoko Wells. This water, however, is only available during times of emergency due to concerns over pesticides from former pineapple production. (David Taylor, Tr., March 11, 2015, pp. 61-62.)

438. ~~468.~~ The combined surface and ground water sources have a production capacity of 17.9 mgd: 13.0 mgd from surface water, *supra*, FOF 459, and 4.9 mgd from ground water (including 1.5 mgd in emergencies from the Hamakuapoko wells), *supra*, FOF 436~~466~~-437~~467~~.

439. ~~469.~~ However, due to occasional maintenance requirements and limitations on the use of the Hamakuapoko Wells, reliable capacity stands at 9.1 mgd. This is premised on the following sources not being available: 1) the largest surface-water facility, the Kamole-Weir at 6.0 mgd production capacity; 2) the Pookela Well at 1.3 mgd production capacity; and 3) Hamakuapoko Wells at 1.5 mgd, which is only available at times of emergency. These three sources total 8.8 mgd, potentially reducing total production capacity of 17.9 mgd to 9.1 mgd. (David Taylor, Tr., March 12, 2015, pp. 68-69.)

440. ~~470.~~ Customer usage based on meter readings between 2004 and 2013 average 7.9 mgd, varying between 6 mgd and 10 mgd. (Exhs. B-2; B-16, p. 3, table 3; B-21, p. 14, figure 1.) [MDWS FOF 33.]

441. ~~471.~~ There are currently 9,865 water connections to the Upcountry System. As of June 30, 2014, there were 1,852 applicants on the County's waiting list for new water connections. MDWS contends that if all were connected to the Upcountry System, water demand would increase by approximately 7.5 mgd, or 95 percent of current usage of 7.9 mgd, *supra*, FOF 440~~470~~. However, because of the high cost of these connections, approximately half of the applicants who have been offered new meters have declined, and MDWS anticipates that this trend will continue, leaving demand at about 3.75 mgd. (David Taylor, WDT, ¶¶ 20-23.)

442. ~~472.~~ MDWS explained that its current 9,865 water connections use an average of 7.9 mgd, and it expects that the additional 1,852 applicants, if meters are granted, would increase usage by 7.5 mgd, or 95 percent, because some of those applicants are asking for multiple meters for subdivisions. Therefore, 1,852 applicants represent many, many more actual meters. Staff engineers went through each of the applications, did an estimate for each one, and came up with the increased usage of 7.5 mgd. (David Taylor, Tr., March 11, 2015, p. 67-69.)

443. ~~473.~~ MDWS also expects that by 2030 the population of the area served by the Upcountry System is anticipated to grow by about 8,424, from 35,251 to 43, 675, with a predicted additional need for water of 1.65 mgd. (Michele McLean, WDT, ¶ 5; Michele McLean, Tr., March 12, 2015, pp. 120-127; David Taylor, WDT, ¶ 24; David Taylor, Tr., March 11, 2015, pp. 76-78; Exhs. B-1; B-2, amended table 5; B-16, table 3;B-18; B-58.) [MDWS FOF 34-35.]

444. ~~474.~~ MDWS anticipates that it will need to develop between 4.2 mgd and 7.95 mgd to meet demands through 2030, including present use, expected increased demand due to population growth, and a percentage of new connections from the current priority list for meters. (David Taylor, WDT, ¶ 25.)

b. Losses

445. ~~475.~~ The 1.1-mile Waikamoi Flume transports surface water from the intakes at Waikamoi, Puohokamoa, and Haipuaena streams to the Olinda WTP. Water is stored in the 30-million gallon Waikamoi Reservoirs (two, at 15 million gallons each) and the 100-million gallon Kahakapao Reservoir, *supra*, FOF 430~~460~~.

446. ~~476.~~ Over the years, the Waikamoi Flume became so leaky that MDWS estimated it lost as much as 40 percent of total flow through cracks and holes along its whole length. (Exh. B-54, pp. 27-29; Exh. E-114, p. 8.) [Nā Moku/MTF FOF 907-908.]

447. ~~477.~~ MDWS could not measure actual losses, because it had no mechanism for quantifying water levels at either the intake or discharge sites of the Waikamoi Flume. (David Taylor, First Supplemental Declaration, ¶ 5.) [Nā Moku/MTF FOF 911.]

448. ~~478.~~ If the reliable capacity of the Olinda WTP is the reported 1.6 mgd, *supra*, FOF 429~~459~~, then the flume could have wasted as much as 0.64 mgd (1.6 mgd x 0.40) at that level of operation. (Nā Moku/MTF FOF 910.)

449. ~~479.~~ MDWS has just completed replacing the entire Waikamoi Flume. (David Taylor, Tr., March 11, 2015, pp. 55-59.)

450. ~~480.~~ Because the new flume isn't going to be leaking, MDWS assumes that everything going in will come out. They measure the reservoir levels every day, and also know how much water is taken out to the water treatment plant. So MDWS will be able to calculate how much water is coming from the flume on days when the main intake from the dam is dry, which is most of the days. All of the water coming in wil be from the flume, so MDWS will be able to quantify how much water comes in from the flume most of the time. (David Taylor, Tr., March 11, 2015, p. 60.)

451. ~~481.~~ There is no way to accurately compare intake versus outtake of the Waikamoi Flume prior to versus completion of the replacement flume. (David Taylor, Tr., March 11, 2015, p. 60.)

452. ~~482.~~ Further, the two 15 million-gallon Waikamoi reservoirs as well as the 2 million-gallon on-site basin at the Olinda WTP have just been relined. (David Taylor, Tr., March 11, 2015, p. 54-55.)

c. Alternate Sources

453. ~~483.~~ MDWS has no plans to drill new production wells to serve the Upcountry areas at the present time. They are very expensive, use a lot of energy, and there are some legal and procedural difficulties:

1. Water is very heavy, so moving it to higher elevations takes a lot of energy. Because a lot of the Upcountry System is at 1,000 to 4,000 feet and the basal aquifer is roughly at sea level, moving water is projected to cost $1.64 per thousand gallons for

distribution from the Kamole-Weir WTP, $4.07 per thousand gallons at the Piiholo WTP, and $5.93 per thousand gallons at the Olinda WTP. On top of pumping costs, increased reliance on ground water sources would require substantial initial capital expenditures and on-going maintenance. Ground water development also involves risks due to the uncertainty of the quantity and quality of water that will be presentt. MDWS's current charges for water only average about $4 per thousand gallons, so just the electrical costs is more than what MDWS charges overall for its entire operation. (David Taylor, Tr., March 11, 2015, pp. 62-65; David Taylor, Tr., March 12, 2015, pp. 17-19, 52; Exh. B-16, pp. 10, 14, 16.) [MDWS FOF 39-43.]

2. MDWS has entered into a Consent Decree in the case of Coalition to Protect East Maui Water Resources v. Board of Water Supply, County of Maui, Civil No. 03-1-0008(3), December 2003, which requires that MDWS conduct vigorous cost/benefit analyses of other water source options before developing ground water in the East Maui region. On several occasions, MDWS has tried but been unsuccessful in working within the framework of the consent decree to develop new ground water sources. (David Taylor, WDT, ¶¶ 29-30; David Taylor, Second Supplemental Declaration, ¶¶ 26-28; David Taylor, Tr., March 11, 2015, pp. 64-65; Exhs. B-19, B-20, B-52.

454. ~~484.~~ New raw water storage facilities, which would be fed by streams in times of water surplus for use during times of low flows, are an additional means by which MDWS could mitigate the effects of stream flow restoration:

1. Currently, MDWS is considering construction of a 100- to 200-million gallon reservoir at the Kamole-Weir WTP, which has no reservoir, *supra*, FOF 462, and has allocated $1.5 million in its FY2015 budget toward land acquisition for a possible reservoir. The total six-year estimated cost for the project is $25.25 million. No money has been allocated for design or construction. (David Taylor, First Supplemental Declaration, ¶¶ 10-11; David Taylor, Second Supplemental Declaration, ¶ 24; David Taylor, Tr., March 11, 2015, pp. 50-53; Exhs. B-16, p. 13 table 13; E-124.) [MDWS FOF 45-46.]

2. Like new basal groundwater source development, development of new raw water storage would require significant initial capital expenditures and on-going maintenance costs. (David Taylor, Tr., March 12, 2015, pp. 19-24; Exh. B-16, pp. 14, 16 table 4.) [MDWS FOF 47.]

455. ~~485.~~ Raw water storage at the Kamole WTP is more cost-effective than providing backup capacity by extensive additions of basal groundwater wells, which require high long-term energy expenditures. (Exh. E-147, p. 48.) [Nā Moku/MTF FOF 952-953.]

456. ~~486.~~ Reservoirs mitigate fluctuations in both stream flow and consumer demand, and mitigations in fluctuations in stream flow allow more of it to be used at the proper time; i.e., during drier times when it is most needed for irrigation, by making more water available without simultaneously taking directly from the water source being protected. (David Taylor, WDT, ¶ 10; Richard Mayer, Supplemental Declaration, ¶¶ 13-14.) [Nā Moku/MTF FOF 949-950.]

d. Economic Impact

457. ~~487.~~ A study conducted for the Draft "Maui Water Use and Development Plan ("WUDP") Upcountry Final Strategies Report" (July 25, 2009) examined the impacts of amended IIFS on drought period reliable capacity at the Kamole-Weir water treatment plant. (Exh. E-130.)

458. ~~488.~~ In 2014, MDWS also commissioned an engineering analysis of the impact to MDWS if the County's use of East Maui surface water were reduced or eliminated, based on documents provided by MDWS, including the July 25, 2009 Draft WUDP for MDWS's Upcountry System. (Exh. B-16.)

459. ~~489.~~ The 2014 review and analysis compared new groundwater sources versus construction of raw water storage reservoirs to mitigate Upcountry drought conditions. New reservoirs carry high capital costs but have lower operation and maintenance costs compared to groundwater wells. New wells carry relatively lower capital costs but also require transmission and storage improvements to be integrated into the existing water delivery systems, have risks associated with the uncertainty of the quantity and quality of water that will be present, and have higher operational costs due to the costs of pumping ground water from basal aquifers at sea level to the Upcountry system. (Exh. B-16, p. 14.)

460. ~~490.~~ Life-cycle cost comparisons were made, with new ground water sources and construction of storage reservoirs carrying similar life-cycle costs. Life-cycle costs incorporate capital, operating, and maintenance costs over a defined planning period and include inflationary effects. Over a 25-year period, both new ground water wells and reservoirs would cost about \$33-\$35/thousand gallons, for a total of \$250 to \$260 million for each strategy. (Exh. B-16, p. 15.)

461. ~~491.~~ The Kamole-Weir WTP has no storage reservoir, while both the Olinda and Piiholo WTPs have reservoirs, *supra*, FOF 430~~460~~-432~~462~~. The Kamole-Weir WTP has a production capacity of 6 mgd and an average production of 3.6 mgd, *supra*, FOF 429~~459~~.

462. ~~492.~~ Under the MOU between EMI and MDWS, MDWS can receive 12 mgd with an option for an additional 4 mgd. During low-flow periods when ditch flows are greater than 16.4 mgd, both will receive a minimum allotment of 8.2 mgd. If these minimum amounts cannot be delivered, both will receive prorated shares of the water that is available, *supra*, FOF 434~~464~~-435~~465~~. In recent periods of low Wailoa Ditch flow, EMI has not restricted the allotment of water to MDWS according to the terms of the agreement, and MDWS withdrawals have been limited only by the amounts of water available in the ditch and the physical limitations of the existing Kamole-Weir WTP intake structures. During drought conditions, MDWS may withdraw 6 mgd, and what remains is used by HC&S for irrigation. (Exhs. E-130, p. 4; Exh. B-16, p. 10.)

463. ~~493.~~ For the period 1922 to 1987, flows in the Wailoa Ditch exceeded 40 mgd more than 90 percent of the time and exceeded 20 mgd more than 99 percent of the time. (Exh. E-130, p. 4.)

464. ~~494.~~ Assuming a drought period exists if water available to MDWS is less than the 6 mgd capacity of the Kamole-Weir WTP, recent existing reliability was 4.5 mgd drought period yield, with raw water requirements assumed to be 5.0 mgd to provide 4.5 mgd of potable water capacity.[27] (Exh. E-130, p.6.)

465. ~~495.~~ For the 23,680-day period of record from 1922 to 1987, assuming a daily withdrawal of 5.0 mgd from the Wailoa Ditch, there was deficient water on 54 days (0.23 percent of the time) with a maximum of 16 consecutive days of deficiency. (Exh. E-130, p. 7.)

466. ~~496.~~ For the ten-year period 2001 to 2011, the number of days when the Wailoa Ditch flow was less than 20 mgd was 50 days, and the longest continuous span of no flow was 5 days. (Exh. B-16, p. 11 table 12.)

467. ~~497.~~ There would be little or no impact if Wailoa Ditch flows were reduced 15 mgd. MDWS would not have full access to the 6 mgd capacity of the Kamole-Weir WTP for 5 days, the same as for the period 2001 to 2011, *supra*, FOF 466~~496~~, and less than the maximum of 16 days for the period 1922 to 1987, *supra*, FOF495. (David Taylor, Tr., March 11, 2015, pp. 145-146; Exh. B-16, p. 16.)

[27] The study uses 4.5 mgd or 4.6 mgd for various reasons. 4.6 mgd will be used to simplify the discussion.

468. ~~498.~~ With a 20 mgd reduction in Wailoa Ditch flow and assuming a daily drought period withdrawal of 5.0 mgd, *supra*, FOF 464~~494~~, there would not be sufficient water to provide reliable drought period capacity without some mitigating actions. For a 23,680 day period, *supra*, FOF 465~~495~~, 5.0 mgd would not be able to be withdrawn for 822 days or 3.47 percent, with 54 consecutive days of deficiency. (Exh. E-130, p. 9.)

469. ~~499.~~ Note, however, that the deficiency only means that 5 mgd could not be withdrawn. Lesser amounts could still be withdrawn from the Wailoa Ditch. Furthermore, while the study defined drought period deficiency as being less than 4.6 mgd of a total capacity of 6 mgd, actual use from the Kamole-Weir WTP has been 3.6 mgd out of the total capacity of 6 mgd, *supra*, FOF 429~~459~~.

470. ~~500.~~ With the addition of a 100-million gallon reservoir at the Kamole-Weir WTP, the drought period reliable yield with the 20 mgd reduction in Wailoa Ditch flow would be 4.6 mgd, approximately equal to the existing WTP reliable yield without reductions in ditch flows. (Exh. E-130, p. 10.)

471. ~~501.~~ With a 200-million gallon reservoir, the drought period reliable yield with the 20 mgd reduction in Wailoa Ditch flow increases to 7.1 mgd, an increase of 2.4 mgd compared to a 100-million gallon reservoir and greater than the total capacity of 6 mgd of the Kamole-Weir WTP. (Exh. E-130, p. 10.)

472. ~~502.~~ Estimated costs of a 100- to 200-million reservoir at the Kamole-Weir WTP are $25.25 million, *supra*, FOF 454~~484~~, and life-cycle costs over 25 years are estimated at $33 per thousand gallons or $250 million, *supra*, FOF 460~~490~~. (Exh. B-16, p. 15.)

II. CONCLUSIONS OF LAW

A. Applicable Laws

1. Interim Instream Flow Standards (IIFS)

1. "'Instream flow standard' means a quantity or flow of water or depth of water which is required to be present at a specific location in a stream system at certain specified times of the year to protect fishery, wildlife, recreational, aesthetic, scenic, and other beneficial instream uses." (HRS § 174C-3.)

2. "A petition to adopt an interim instream flow standard under this section shall set forth data and information concerning the need to protect and conserve beneficial instream uses of

water and any other relevant and reasonable information required by the commission." (HRS §174C-71(2)(C).)

3. "In considering a petition to adopt an interim instream flow standard, the commission shall weigh the importance of the present or potential instream values with the importance of the present or potential uses of water for noninstream purposes, including the economic impact of restricting such uses." (HRS § 174C-71(2)(D).)

4. The value of water that is diverted, only to be lost due to avoidable or unreasonable circumstances, is unlikely to outweigh the value of retaining the water for instream uses. Therefore, the Commission should consider whether system losses experienced by diverters are unreasonable, and whether reduction of such losses is reasonably practicable. (*Nā Wai `Ehā*, 128 Haw. at 257-258; 287 P.3d at 158-159.)

5. The availability of alternative water sources is a consideration in the weighing of instream values with noninstream purposes when establishing IIFS, because the availability of alternative sources diminishes the "importance" of diverting stream water for noninstream use. (*Nā Wai `Ehā*, 128 Haw. at 259; 287 P.3d at 160.)

6. "'Instream use' means beneficial uses of stream water for significant purposes which are located in the stream and which are achieved by leaving the water in the stream (*Emphasis added*). Instream use include, but are not limited to:

1. Maintenance of fish and wildlife habitats;
2. Outdoor recreational activities;
3. Maintenance of ecosystems such as estuaries, wetlands, and stream vegetation;
4. Aesthetic values such as waterfalls and scenic waterways;
5. Navigation;
6. Instream hydropower generation;
7. Maintenance of water quality;
8. The conveyance of irrigation and domestic water supplies to downstream points of diversion; and
9. The protection of traditional and customary Hawaiian rights." (HRS § 174C-3.)

7. 7. "'Noninstream use' means the use of stream water that is diverted or removed from its stream channel and includes the use of stream water outside the channel for domestic, agricultural, and industrial purposes." (HRS § 174C-3.)

8. "Interim instream flow standards may be adopted on a stream-by-stream basis or may consist of a general instream flow standard applicable to all streams within a specified area." (HRS § 174C-71(2)(F).)

2. The Public Trust Doctrine

9. Under Articles XI, sections 1 and 7 of the Hawaii State Constitution, the public trust doctrine applies to all waters of the State without exception or distinction. (*In re Water Use Permit Applications* ["*Waiāhole I*"], 94 Haw. 97, 133; 9 P.3d 409, 445 [2000].)

10. The state water resources trust embodies a dual mandate of protection and maximum reasonable and beneficial use. The object is not maximum consumptive use but the most equitable, reasonable, and beneficial allocation of state water resources, with full recognition that resource protection also constitutes use. (*Waiāhole I*, 94 Haw. at 139-140; 9 P.3d at 451-452.)

11. The purposes of the water resources trust are: 1) maintenance of waters in their natural state; 2) domestic water uses of the general public, particularly drinking; 3) native Hawaiian and traditional and customary rights, including appurtenant rights; and 4) reservations of water, particularly for Hawaiian home lands. (*Waiāhole I*, 94 Haw. at 136-138; 9 P.3d at 448-450. *In re Wai`ola o Moloka`i, Inc.*("*Wai`ola*"), 103 Haw. 401, 429, 431; 83 P.3d 664, 692, 694 [2004].)

12. There are no absolute priorities among trust purposes, and resource protection is not a "categorical imperative." The Commission must weigh competing public and private water uses on a case-by-case basis, according to any appropriate standards provided by law. (*Waiāhole I*, 94 Haw. at 142; 9 P.3d. at 454.)

13. Any balancing between public and private purposes must begin with a presumption in favor of public use, access, and enjoyment. Use consistent with trust purposes is the norm or "default" condition, which effectively prescribes a higher level of scrutiny for private commercial uses. (*Waiāhole I*, 94 Haw. at 142; 9 P.3d at 454.)

14. Reason and necessity dictate that the public trust may have to accommodate offstream diversions inconsistent with the mandate of protection, to the unavoidable impairment of public instream uses and values. (*Waiāhole I*, 94 Haw. at 141; 9 P.3d at 453.)

15. When scientific evidence is preliminary and not yet conclusive regarding the management of fresh water resources which are part of the public trust, it is prudent to adopt "precautionary principles" in protecting the resource. Lack of full scientific certainty should not be a basis for postponing effective measures to prevent environmental degradation. (*Waiāhole I*, 94 Haw. 154-155, 159; 9 P.3d 466-467, 471.)

16. Uncertainty regarding the exact level of protection necessary justifies neither the least protection feasible nor the absence of protection. Although interim standards are merely stopgap measures, they must still protect instream values to the extent practicable. The Commission may still act when public benefits and risks are not capable of exact quantification. (*Waiāhole I*, 94 Haw. at 159; 9 P.3d at 471.)

17. "In requiring the Commission to establish instream flow standards at an early planning stage, the Code contemplates the designation of the standards based not only on scientifically proven facts, but also on future predictions, generalized assumptions, and policy judgments." (*Waiāhole I*, 94 Haw. at 155; 9 P.3d at 467.)

18. "(I)n the interest of precaution, the Commission should consider providing reasonable 'margins of safety' for instream trust purposes when establishing instream flow standards." (*Waiāhole I*, 94 Haw. at 156; 9 P.3d at 468.)

3. Appurtenant Rights and Riparian Rights

19. There are no designated surface water management areas under HRS §§ 174C-45 and 174C-46 in the East Maui region from which the EMI Ditch System diverts water.

20. Water rights in non-designated areas are governed by the common law. (*Ko`olau Agr. Co. v. Commission on Water Resource Management* ["*Ko`olau*"], 83 Haw. 484, 491; 927 P.2d 1367, 1374 [1996]).

21. Appurtenant rights and riparian rights are the common law surface water rights.

22. Appurtenant rights are rights to the use of water utilized by parcels of land at the time of their original conversion into fee simple land, when title was confirmed by the Land Commission Award and title conveyed by the issuance of a Royal Patent. (*Reppun v. Board of Water Supply* ["*Reppun*"], 65 Haw. 531, 551; 656 P.2d 57, 71 [1982].)

23. When "the same parcel of land is being utilized to cultivate traditional products by means approximating those utilized at the time of the Mahele, there is sufficient evidence to give rise to a presumption that the amount of water diverted for such cultivation sufficiently approximates the quantity of the appurtenant water rights to which that land is entitled." (*Reppun*, 65 Haw. at 554; 656 P.2d at 72.)

24. Appurtenant rights are superior to riparian rights as they constituted an easement in favor of the property with the appurtenant right as the dominant estate. (*Reppun*, 65 Haw. at 551; 656 P.2d at 71; *Peck v. Bailey*, 8 Haw. 658, 662 [1867].)

25. Under riparian rights, owners of land adjacent to a natural watercourse are entitled to its use, no one owns the water, and the rights of one owner is not superior to another's. (*McBryde v. Robinson* ("*McBryde"*), 54 Haw. 174, at 198; 504 P.2d 1330, at 1344 [1973]; *aff'd on rehearing*, 55 Haw. 260; 517 P.2d [1973]; *appeal dismissed for want of jurisdiction and cert. denied*, 417 U.S. 962 [1974].)

26. Surface water rights are limited to the base flows. "(T)itle to water was reserved to the State for the common good when parcels of land were allotted to the awardee under the mahele. Thus 'storm and freshet' water is the property of the State." (*McBryde*, 54 Haw at 199-200; 504 P.2d at 1345.)

27. The exclusive purpose of the statutory imposition of riparian rights in this jurisdiction was to enable tenants of ahupuaa to make productive use of their lands. (*Reppun*, 65 Haw. at 553; 656 P.2d at 72.)

28. There is no right to divert water by non-riparian landowners, but such diversions are permissible if they are reasonable and beneficial. (*Robinson v. Ariyoshi*, 65 Haw. 641, 648-650; 658 P.2d 287, 294-295 [1982].)

29. The continuing use of the waters of the stream by non-riparian landowners is contingent on a demonstration that such use will not harm the established rights of others. (*Reppun*, 65 Haw. at 554; 656 P.2d at 72.)

30. Such non-riparian diversions will be restrained only if a riparian owner can demonstrate actual harm to his/her own reasonable use of those waters. (*Reppun*, 65 Haw. at 553; 656 P.2d at 72.)

31. Where water has been improperly diverted by a public entity for actual public use, a complainant may not obtain injunctive relief against the diversion to which a public use has attached at the time suit is filed, unless the court finds that another public interest of substantially the same magnitude as that of the public's interest in adequate water will be advanced by injunctive relief. A public use attaches at the time the water is actually used by the public and only to the extent of such actual use. In the case of prior attachment, damages rather than injunctive relief would be the preferred solution. In the case of gradually increasing water diversion, the point at which the public use doctrine becomes operational is when the diversion causes harm to the complainants, and not when the complaint is filed. (*Reppun*, 65 Haw. at 565; 656 P.2d at 79.)

32. Since the 1982 *Reppun* decision, "domestic use of the general public" has been identified as a public trust purpose, *supra*, COL 9~~9~~, thereby conflicting with the rights of riparian and appurtenant rightsholders to seek injunctive relief or damages under the public use doctrine, *supra*, COL 30~~30~~.

33. For non-public-entity diverters, riparian and appurtenant rightsholders are entitled to waters sufficient to cultivate their crops in the manner in which they were accustomed prior to the diversions that led to a damaging of their crops. (*Reppun*, 65 Haw. at 553; 656 P.2d at 72.)

B. Burden of Proof in Amendments to the IIFS

34. "In the context of IIFS petitions, the water code does not place a burden of proof on any particular party; instead, the water code and our case law interpreting the code have affirmed the Commission's duty to establish IIFS that 'protect instream values to the extent practicable' and 'protect the public interest.'" (*In re Water Use Permit Applications ["Waiāhole II"]*, 105 Haw. 1, 11, 93 P. 3d 643, 653 [2004].)

35. In the IIFS-setting context, the Commission "need only reasonably estimate instream and offstream demands."(In re `Īao Ground Water Management Area High-Level Surface Water Use Permit Applications and Petition to Amend Interim Instream Flow Standards of Waihe`e River and Waiehu, `Īao, and Waikapu Streams Contested Case Hearing ["Nā Wai `Ehā"], 128 Haw. 228, 258; 287 P.3d 129, 159 (2012); Waiāhole I, 94 Haw. at 155 n. 60; 9 P.3d at 467 n. 60.)

36. "In requiring the Commission to establish instream flow standards at an early planning stage, the Code contemplates the designation of the standards based not only on scientifically proven facts, but also on future predictions, generalized assumptions, and policy judgments," *supra*, COL 17~~17~~.

37. Legal conclusions made in this proceeding pertaining to a particular party's water rights, traditional and customary rights, water use requirements, alternative water sources, and system losses are made without prejudice to the rights of any party and the Commission to revisit these issues in any proceeding involving the use of water from any of the East Maui streams that are the subject of this contested case hearing. The burden of proof with respect to such issues will be upon the petitioner rather than upon the Commission. (*See* 2014 Mediated Agreement, pp. 3-4 and Exhibit 1, p. 25.)

C. The EMI Ditch System is a "Hydrologically Controllable Area"

38. In *Waiāhole I*, the Court concluded that consolidated regulation of separate water management areas was not precluded when a water delivery system draws water from several different water management areas. "HRS § 174C-50(h) addresses competition arising between existing uses when 'they draw water from the same hydrologically controllable area and the aggregate quantity of water consumed by the users exceeds the appropriate sustainable yield or instream flow standards established pursuant to law for the area (*emphasis in original*).' The Code defines 'hydrologic unit' as 'a surface drainage area or a ground water basin or a combination of the two,' HRS § 174C-3, but does not define a 'hydrologically controllable area.' The plain reading of the latter term indicates that the area 'controlled' by the ditch system qualifies, irrespective of 'hydrologic units.'" (*Waiāhole I*, 94 Haw. at 174; 9 P.3d at 486.)

39. In the context of amendments to the IIFS, the same logic applies: the East Maui streams "controlled" by the EMI ditch system qualifies as a "hydrologically controllable area," and consolidated amendments to the IIFS of the East Maui streams are not precluded.

D. Instream Uses

40. Of the instream uses identified in COL 6~~6~~, *supra*, the principal uses in the East Maui streams are the exercise of appurtenant and riparian water rights; gathering of fish, mollusks, and crustaceans; and the exercise of traditional and customary Hawaiian rights. Gathering of stream animals and stream flows to enable the downstream exercise of appurtenant and riparian rights constitute the instream exercise of traditional and customary Hawaiian rights. (FOF 306~~286~~.)

41. Petitioners' use of water for growing wetland taro, for other agricultural uses, and for domestic household uses are also noninstream uses but are addressed as instream uses because their uses are met by "the conveyance of irrigation and domestic water supplies to downstream points of diversion," supra, COL 6~~6~~. Furthermore, in the weighing of instream values versus noninstream values, the Commission must consider the economic impact of restricting noninstream uses, *supra*, COL 3~~3~~, and petitioners' are asking for more water for their agricultural and domestic household uses.

1. Conveyance of Water for Appurtenant and Riparian rights

a. Water Requirements

42. Approximately 94.721 acres have appurtenant rights, 49.805 acres for taro lo`i and 44.916 acres for other types of agricultural uses. (FOF 319~~299~~-324~~304~~.)

43. These acres are located in the following areas and watered by the following streams:

	Taro Lo`i	Other Agriculture	Source of Stream Water
Keanae	13.475 acres	7.00 acres	Palauhulu Stream
Wailua	30.160 acres	28.096 acres	Waiokamilo & Wailuanui Streams
Honopou	6.17 acres	9.82 acres	Honopou Stream

(FOF 294-304.)

44. In addition, the following areas and streams have some acreage identified with use of stream waters:

	Taro Lo`i	Other Agriculture	Source of Stream Water
Hanehoi	2.3 acres	?	Hanehoi & Puolua Streams
Makapipi	4.17 acres	3.25 acres	Makapipi Stream

The "other agriculture" category is for riparian rights: 1) a parcel adjacent to Hanehoi Stream for which the owner would like to exercise her riparian rights, and 2) for Jeffrey Paisner's property adjacent to Makapipi Stream.

(FOF 174~~151~~, 239~~219~~, 325~~305~~, 330~~310~~.)

45. The acres have not been reduced by 10 percent, as Na Moku's expert witness had done in a previous proceeding. (FOF 312~~292~~, 319~~299~~.) Instead, when accounting for water for the "other agriculture" category, the water assigned to "taro lo`i" is assumed to be more than enough to meet the irrigation requirements of the "other agriculture" category, *infra*, COL 58~~58~~-59~~59~~.

46. In the Nā Wai `Ehā contested case, the Commission had adopted a water budget of 130,000 to 150,000 gad for taro lo`i, which the Commission reaffirms here for East Maui. (FOF 212~~192~~.)

47. Given the approximately half of the crop cycle that no water is needed to flow into the lo`i, the Commission's water budget means that average flow requirements for the half of the time that flow is needed would be 260,000 to 300,000 gad. On the other hand, Reppun contends that the water budget should be 100,000 to 300,000 gad, even when taking into consideration the 50 percent of time that no water is flowing into the lo`i. Reppun's requirements would translate into an average of 200,000 to 600,000 gad when inflow is needed. (FOF 214~~194~~.)

48. On the other hand, Reppun also concludes that any general water requirement is questionable, because there is no definitive answer, and that the average is a result of such parameters as percolation rates, weather, season, location on the stream relative to other

diversions, initial water temperature, and rate of dilution of used water. Reppun's use of the 100,000 to 300,000 gad figure is predicated on when the taro needs the most water: the summer months, the hottest times, the longest days. (FOF 214~~194~~-216~~196~~.)

49. The temperature of 27°C (80.6°F) is the threshold point at which wetland kalo beccomes more susceptible to fungi and rotting diseases. (FOF 217~~197~~.)

50. Reppun participated in a 2007 USGS study of what farmers were actually using, which looked at quantities of water and correlated that to temperature. To assure consistency of data, only lo`i with crops near harvesting (continuous flooding of the mature crop) was studied in the dry season (June to October), when water requirements for cooling kalo approach upper limits. (FOF 219~~199~~-221~~201~~.)

51. Keanae and Wailua (Lakini, Wailua, and Waikani) in East Maui were part of the areas studied. Keanae receives water from Palauhulu Stream, Lakini and Wailua receive water from Waiokamilo Stream, and Waikani receives water from Wailuanui Stream. (FOF 223~~203~~.)

52. Inflow measurements on July 30, 2006 and September 21, 2006 were as follows:

Keanae: 180,000 gad and 150,000 gad (for 10.53 acres)
Waikani: 190,000 gad and 93,000 gad (for 2.80 acres)
Wailua: 180,000 gad and 140,000 gad (for 3.32 acres)
Lakini: 750,000 gad and 550,000 gad (for 0.74 acres)

(FOF 226~~206~~.)

53. All taro complexes had inflow temperatures well below 27°C. (FOF 228~~208~~.)

54. Outflow temperatures were not measured at Wailua, and there was an equipment malfunction at Keanae. (FOF 229~~209~~.)

55. For Lakini and Waikani, temperatures exceeded 27°C for several hours a day for one-half to two-thirds of the time: 16.9 percent of the time for Lakini and 29.1 percent of the time for Waikani. Reppun is of the opinion that percent of time that outflows exceed 27°C is the most important factor. (FOF 229~~209~~, 232~~212~~.)

56. For Lakini, Reppun was of the opinion that the water was not going to heat up very much at all, given the enormous amount of water relative to the size of the area, and that the amount was more than adequate. (FOF 236~~216~~.)

57. The Commission's water budget of 130,000 to 150,000 gad translates to an average of 260,000 to 300,000 gad for the time when water is needed to flow into the lo`i, *supra*, COL 46~~46~~-47~~47~~. The USGS study focused on the times when water requirements were at their

maximum, and for which much more water than 260,000 to 300,000 gad would be available without exceeding the limits of the water budget. Thus, there would likely have been sufficient water to significantly reduce the percent of time that temperatures for these taro complexes exceeded 27^{o}C and still stay within the limits of an overall water budget of 130,000 to 150,000 gad for a crop cycle.

58. Applying a water budget of 130,000 to 150,000 gad to the acreage in COL 43~~43~~-44~~44~~, *supra*, results in the following water requirements from the identified streams.

Palauhulu:	13.475 acres x (130,000 to 150,000 gad) = 1.75 mgd - 2.02 mgd
Waiokamilo & Wailuanui:	30.160 acres x (130,000 to 150,000 gad) = 3.92 mgd - 4.52 mgd
Honopou:	6.17 acres x (130,000 to 150,000 gad) = 0.80 mgd - 0.93 mgd
Hanehoi/Puoloa:	2.3 acres x (130,000 to 150,000 gad) = 0.30 mgd - 0.35 mgd
Makapipi:	4.17 acres x (130,000 to 150,000 gad) = 0.54 mgd - 0.63 mgd

59. These requirements should also meet the requirements for acres in "other agriculture," because the acreage has not been reduced by 10 percent, which Na Moku's expert did not do for this contested case, *supra*, COL 45~~45~~, and water requirements for "other agriculture" are far less than for taro lo`i. For example, for Palauhulu Stream, 10 percent of 13.475 acres is 1.348 acres, and multiplying by 130,000 to 150,000 gad, 0.18 mgd to 0.20 mgd would be available for 7.00 acres for "other agriculture," or 25,714 gad to 28,571 gad. For Waiokamilo and Wailuanui Streams, the comparable water available for other agricultural uses would be 13,880 to 16,728 gad; for Honopou Stream, available water would be 8,168 to 9,425 gad; and for Makapipi Stream, available water would be 16,680 to 19,246 gad, all far in excess of any agricultural requirements other than taro lo`i (*see*, COL 43~~43~~, *supra*, for other agriculture acreage).

60. Furthermore, the taro lo`i water requirements are for flow-through amounts, most of which will exit the lo`i complex and then may either flow into another lo`i complex or back into the stream. Thus, much of the 130,000 to 150,000 taro lo`i water requirements will be available for use by others such as for downstream lo`i complexes and other agricultural uses, or for increased stream flow for improved stream animal habitat.

61. The 2008 Commission order made the following amounts of water available in these streams:

Palauhulu:	3.56 mgd (for taro)
Waiokamilo & Wailuanui:	Waiokamilo: 3.17 mgd for taro and domestic Wailuanui: 1.26 mgd for taro and habitat

Honopou:	1.29 mgd[28]: 0.82 mgd for taro and domestic; 0.47 mgd for habitat
Hanehoi/Puoloa:	1.72 mgd: 0.98 mgd for taro; 0.74 mgd for Huelo community
Makapipi Stream:	not included in 2008 Commission order

(FOF 141~~121~~-142~~122~~, 163~~141~~-169~~147~~, 177~~154~~, 186~~162~~, 197~~175~~-198~~177~~.)

62. However, the existing stream flows at these locations were either unknown or estimates from the modeling effort, *supra*, FOF 104~~84~~-113~~93~~, 202~~182~~, and were to be confirmed after initial implementation, but, as described earlier, *supra*, FOF 270~~250~~-278~~258~~, no evaluation of whether or not the purposes of the amended IIFS were met have been conducted.

63. As can be seen by comparing COLs 58~~58~~ and 61~~61~~, *supra*, had the 2008 Commission order been able to be implemented, the water requirements would have been met with waters from Honopou and Waiokamilo/Wailuanui Streams, and exceeded for irrigation from Palauhulu and Hanehoi/Puolua Streams. However, in the implementation, Commission staff has learned that: 1) the regression estimates used for flows had, in many cases, overstated what those flows would be, so if the sluice gates on the ditches are opened, there still may not be enough flow to meet the amended IIFS; 2) there is a natural variability in stream flow which may dip below the IIFS, generally due to periods of low rainfall, so guaranteeing that a specific flow is always in the stream and still meet the objective of the IIFS is not possible; and 3) in Wailuanui and Keanae, the Ko`olau Ditch has only been taking, for the most part, water generated by rainfall, and spring water below the Ditch is what the taro farmers have access to. (FOF 276~~256~~-277~~257~~.)

b. Appurtenant and Riparian Uses

64. Appurtenant and riparian rights are limited to the base flows, and storm and freshet water is the property of the State, *supra*, COL 26~~26~~, which the State may assign or apportion among users that is in the public interest.

65. Appurtenant rights are superior to riparian rights, *supra*, COL 24~~24~~.

66. The amount of water accompanying the appurtenant right is determined by its use on the property at the time of the Mahele, while a riparian right is not superior to the rights of other riparian landowners and the amount of water is determined by whether its use is reasonable and beneficial, *supra*, COL 22~~22~~-23~~23~~, 25~~25~~.

[28] In actuality, 1.15 mgd (1.7 cfs) was added just below the Haiku Ditch, then the IIFS was raised to 1.29 mgd (2.00 cfs) because Honopou Stream gains an unknown amount below the Haiku Ditch. (FOF 141~~121~~.)

67. The continuing use of stream waters by non-riparian landowners is permissible if the use is reasonable and beneficial and will not harm the established rights of appurtenant and riparian landowners, *supra,* COL 28~~28~~-29~~29~~.

68. Such non-riparian diversions will be restrained only if a riparian landowner can demonstrate actual harm to his/her own reasonable use of those waters, *supra*, COL 30~~30~~.

~~69. Appurtenant and riparian rightsholders have demonstrated actual harm to their reasonable use of the waters of Palauhulu, Waiokamilo, Wailuanui, Honopou, Hanehoi, and Makapipi Streams. (FOF 93, 185-187, 225, 250-257.)~~

2. Maintenance of Fish and Wildlife habitats

~~70.~~69. Incorporating hydrology, stream morphology, and microhabitat preferences, a model of stream systems was used to simulate habitat/discharge relationships for various species and their life stages, and to provide quantitative habitat comparisions at different streamflows. (FOF 116~~96~~.)

~~71.~~70. For East Maui streams, 64 percent of natural median base flow ($0.64xBFQ_{50}$) is required to provide 90 percent of the natural habitat (H_{90}), or the minimum viable habitat flow (H_{min}) expected to produce suitable conditions for growth, reproduction, and recruitment of native stream animals. (FOF 119~~99~~, 125~~105~~.)

~~72.~~71. Habitat less than H_{90} would not result in viable flow rates for growth, reproduction, and recruitment. There is no linear relationship between the amount of habitat and the number of animals. H_{70}, or twenty percent less habitat than H_{90}, would not result in only 20 percent less animals; nor would H_{50}, which is twenty percent less than H_{70}, result in only an additional 20 percent less animals. (FOF 126~~106~~.)

~~73.~~72. A geographic approach to stream restoration was taken in the Commission's 2010 order, meaning that flows were restored in selected streams both east and west of Keanae Valley. Benefits of this approach included biological diversity in the East Maui area, and regional diversity in traditional gathering opportunities. (FOF 260~~240~~a.)

~~74.~~73. A geographic approach to stream restoration is in compliance with the Code:

a. "Interim instream flow standards may be adopted on a stream-by-stream basis or may consist of a general instream flow standard applicable to all streams within a specified area," HRS § 174C-71(2)(F), *supra*, COL 8.

b. Each of the streams in this contested case has been and will be addressed on a stream-by-stream basis, and the Code does not prohibit evaluating each stream's contribution to a geographic approach to stream restoration in amending (or not) its IIFS.

~~75.~~74. A geographic approach is the most feasible method of restoring streams that are collectively diverted by EMI's Ditch System:

a. The EMI Ditch System qualifies as a "hydrologically controllable area," and a geographic approach, or consolidated amendments to the IIFS, of the East Maui streams are not precluded, *supra*, COL 38-39.

~~76.~~75. Streams were selected which would result in the most biological return from additional flow. (FOF 260~~240~~b.)

~~77.~~76. Final selections were as follows, with the Commission adopting its staff selections:

Division of Aquatic Resources (DAR)	Commission Staff
East Wailuaiki Stream	East Wailuaiki Stream
West Wailuaiki Stream	West Wailuaiki Stream
Puohokamoa Stream	
Waikamoi Stream	Waikamoi Stream
Kopiliula Stream	
Haipuaena Stream	
Waiohue Stream	Waiohue Stream
Hanawi Stream	Hanawi Stream
	Makapipi Stream

(FOF 135~~115~~, 258~~238~~.)

~~78.~~77. Puohokamoa, Haipuaena, and Kopiliula Streams were not selected by Commission staff, reasoning that these streams are used for conveyance, more water may exist in the portion of the stream used for conveyance than would naturally occur, and any interim IFS should be based on the surface water available within the given hydrological unit. (FOF 261~~241~~.)

a. However, during the contested case hearing, Garrett Hew of EMI agreed that there's no identification of particular conveyance streams. If storm waters overflow a ditch, the water goes into the stream and then hits the next ditch downstream. There are no actual conveyance ditches or designated conveyance streams in the system. (FOF 262~~242~~.)

~~79.~~78. For Hanawi Stream modification of the diversion would serve mainly to create a wetted pathway for stream animal connectivity from the diversion to the ocean. The stream already had adequate flow to sustain a viable biota population, but the biological health of the stream could be further improved simply by providing connectivity through a wetted pathway in the dry reach immediately below the diversion. (FOF 260~~240~~d.)

~~80.~~79. Makapipi Stream was selected by the Commission staff because the Nahiku community relies heavily on the stream for cultural practices, recreation, and other instream uses. But with the uncertainty of gaining and losing reaches along most of the stream's course to the ocean, it was not known whether restored flow will result in continuous stream flow from the headwaters to the stream mouth. Thus, a short-term release of water past the one major EMI diversion was made to determine the sustainability of the proposed IIFS of 0.60 mgd (BFQ_{50}), just upstream of Hana Highway. (FOF 260~~240~~e.)

a. Flows ranging from 0.76 mgd to 0.87 mgd were released from the Ko`olau Ditch in September 2010, but no flow was observed at the Hana Highway Bridge located about two-thirds of a mile downstream of the diversion. A 1,000-foot reach upstream of the Hana Highway Bridge was dry, with the exception of a few isolated pools of water, and there was no indication of recent streamflow. The precise location where the stream went dry farther upstream was not determined, because it could not be safely accessed on foot. Much of the lower sections of the stream below the highway was largely dry, with isolated reaches with pools of water. (FOF 288~~268~~.)

~~81.~~80. The seasonal approach of the Commission's 2010 order established winter flows at 64 percent of BFQ_{50} (H_{90}) and summer flows at 20 percent of BFQ_{50} for the remaining four streams: East Wailuaiki, West Wailuaiki, Waiohue, and Waikamoi Streams. Although flow rates less than 64 percent of BFQ_{50} would not result in habitat sufficient for growth, reproduction, and recruitment, *supra*, COL 72, the rationale was that it would provide minimum connectivity for native stream animals to survive in shallow pools without long-term growth or reproduction. (FOF 254~~234~~.)

~~82.~~81. Three of these streams, with the exception of Waikamoi Stream, were studied, with the following results:

a. There was no evidence that the summertime flows were advantageous to the animals. The concept of varying flow over times is well supported in fisheries, but in this case it was not. For example, if the wintertime flows had been returned during the summer and complete flow restoration had been done in the winter, that would have been a seasonal flow approach, and completely different results might have been seen. (FOF 284~~264~~.)

b. Overall, the seasonal flow hypothesis (higher winter flows and lower summer flows) was conceptually coherent but not supported by the data. The lack of support for the seasonal flow hypothesis may reflect that the prescribed flow amounts were insufficient (i.e. needed higher flows in summer) or that a year round minimum flow is more appropriate for East Maui streams. (FOF 285~~265~~.)

~~83.~~82. Finally, of the six streams addressed in the Commission's 2008 order, besides increases in the IIFS for taro and/or domestic uses, improvements in stream habitat was among the objectives, but none of the amended IIFS reached the level of 64 percent of BFQ_{50} (H_{90}). (FOF 278~~258~~.)

a. Waiakamilo Stream was restored to its non-diverted state, but the focus was on taro and domestic uses, and the IIFS at the lowest reach was left at the status quo, diverted state. (Exh. C-85, p. 44-45.)

3. Protection of Traditional and Customary Hawaiian Rights

~~84.~~83. In the context of amendments to the IIFS for the East Maui streams that are the subject of this contested case, instream exercise of traditional and customary Hawaiian rights are at issue, and not all such rights that may be exercised in the East Maui watersheds and nearshore ocean, *supra*, COL 3~~3~~, 6~~6~~.

~~85.~~84. One of the public trust purposes is native Hawaiian and traditional and customary rights, including appurtenant rights, supra, COL 11~~11~~.

a. Appurtenant rights are property rights to the use of water utilized by parcels of land at the time of their original conversion into fee simple land, when title was confirmed by the Land Commission Award and title conveyed by the issuance of a Royal Patent, *supra*, COL 22.

b. Traditional and customary Hawaiian rights are personal rights "customarily and traditionally exercised for subsistence, cultural and religious purposes and possessed by ahupua`a tenants who are descendants of native Hawaiians who inhabited the Hawaiian Islands prior to 1778, subject to the right of the State to regulate such rights." (Haw. State Constitution, Article XII, § 7.)

~~86.~~85. In order to qualify as traditional and customary Hawaiian rights, gathering of stream animals and the exercise of appurtenant rights must meet the following criteria:

a. it is being exercised by descendants of native Hawaiians who inhabited the Hawaiian Islands prior to 1778 (Haw. State Constitution, Article XII, § 7);

b. there are six elements essential to traditional and customary native Hawaiian practices: 1) the purpose is to fulfill a responsibility related to subsistence, cultural, or religious needs of the practitioner's family; 2) the practitioner learned the practice from an elder; 3) the practitioner is connected to the location of practice, either through a family tradition or because that was the location of the practitioner's education; 4) the practitioner has taken responsibility for the care of the location; 5) the practice is not for a commercial purpose; and 6) the practice is consistent with custom. (*State v Pratt["Pratt"]*, 127 Haw. 206, at 209; 277 P.3d 300, at 303 [2012].)

c. There is an adequate foundation connecting the claimed right to a firmly rooted traditional or customary native Hawaiian practice traceable to at least November 25, 1892, when the State adopted English common law with exceptions that included "established by Hawaiian usage." (HRS Ch. 1, § 1-1; *State v Zimring [I]*, 52 Haw. 472, at 475; 479 P.2d 202, at 204 [1970]; *Public Access Shoreline Hawaii v Hawaii County Planning Commission ["PASH"]*, 79 Haw. 425, at 447; 903 P.2d 1246, at 1268 [1995]; *cert. denied* 517 U.S. 1163; 116 S.Ct. 1559; 134 L.Ed. 660 [1996].)

1. "(I)t is established that the application of a custom has continued in a particular area (*emphasis added*)." (*PASH*, 79 Haw. 525, at 442; P. 2d 1246, at 1263.)

2. Through expert testimony and kama`āina witness testimony, claimants can personally trace their practices in the subject area to a period prior to November 25, 1892. (*State of Hawaii v Hanapi*, 89 Haw. 177, at186-187 n.12; 970 P.2d 485, at 495 n. 12 [1998].)

~~87.~~86. Therefore, not all appurtenant rightsholders have traditional and customary Hawaiian rights, because appurtenant rights are property rights held by any owner of the appurtenant lands, while traditional and customary Hawaiian rights are personal rights.

~~88.~~87. The record is not clear whether any person holds traditional and customary Hawaiian rights in the East Maui area, whether for gathering rights or for farming in traditional and customary ways. There was testimony that at least some Nā Moku members gathered for subsistence and cultural purposes in the East Maui area, and wetland taro was being grown or attempted to be grown with traditional and customary practices, sometimes by members who have lived in the area for generations. (*See*, Edward Wendt, WDT, ¶ 2; Edward Wendt, Tr., March 9, 2015, p. 8; Terrance Akuna, Tr., March 10, 2015, pp. 17-19; Norman Martin, Tr., March 9, 2015, pp. 113-114; Jerome Kekiwi, Tr., March 9, 2015, p. 202; Joseph Young, Tr., March 9, 2015, pp. 222-223.)

~~89.~~88. For the purposes of this contested case to amend the IIFS, it will be assumed that at least some persons have traditional and customary Hawaiian rights to gather stream animals and farm wetland taro in the East Maui area.

~~90.~~89. Therefore, the Commission must make specific findings and conclusions on:

a. the identity and scope of valued cultural, historical, or natural resources in the area, including the extent to which traditional and customary native Hawaiian rights are exercised in the petition area;

b. the extent to which those resources will be affected or impaired by the proposed action; and

c. the feasible[29] action, if any, to be taken to reasonably protect native Hawaiian rights if they are found to exist. (*Ka Pa`akai O Ka`aina v Land Use Commission***,** 94 Haw. 31, at 47; 7 P.3d 1068, at 1084 [2000].)

~~91.~~90. The petition area covers four watersheds of approximately 50,000 acres, of which 33,000 acres are owned by the State, and 17,000 acres are owned by EMI. (FOF 53~~47~~.) Traditional and customary native Hawaiian rights are exercised in the streams in the form of subsistence gathering of native fish, mollusks, and crustaceans, and stream flows are diverted for the cultivation of wetland taro, other agricultural uses, and domestic uses that can be traced back to the Mahele. (FOF 306~~286~~.)

~~92.~~91. The proposed actions will not impair these resources but instead they will be improved by increasing stream flows. (*See* the September 25, 2008 Commission Order, FOF 137~~117~~-252~~232~~, and the May 25, 2010 Commission Order, FOF 253~~233~~-288~~268~~, and the Decision and Order, *infra*.)

~~93.~~92. The feasible actions, or a balancing of benefits and costs, that are being undertaken in this contested case are "to weigh the importance of the present or potential instream values with the

[29] "Feasible" is defined as a "balancing of benefits and costs," and not whether the action is "capable of achievement." *Waiahole I*, 94 Haw. at 141 n. 39; 9 P.3d 409, at 453 n. 39.

importance of the present or potential uses of water for noninstream purposes, including the economic impact of restricting such uses." (HRS § 174C-71[2][D].)

4. Estuaries and Wetlands; Recreational Activities; Waterfalls; Water Quality

~~94.~~93. Navigation and instream hydropower generation are not uses in the East Maui streams. (FOF 298~~278~~.)

~~95.~~94. Maintenance of ecosystems such as estuaries, wetlands, and stream vegetation:

a. East Wailuaiki, West Wailuaiki, and Waiohue streams have estuaries; and

b. from east to west, all of the streams except Waiaaka and Ohia Streams have seasonal, non-tidal palustrine wetlands. (FOF 303~~283~~.)

~~96.~~95. Outdoor recreational activities:

a. from east to west, Makapipi, Hanawi, Waiohue, East Wailuaiki, West Wailuaiki, Wailuanui, Waiokamilo, Ohia, Honomanu, Waikamoi, Hanehoi, and Honopou streams have outdoor recreational activities, and nearly all include scenic views. (FOF 302~~282~~.)

~~97.~~96. Aesthetic values such as waterfalls and scenic waterways:

a. Waterfalls, some including plunge pools at their base, and to a lesser extent, springs, constitute the principal aesthetic values in the East Maui streams. From east to west, the streams include Makapipi, Hanawi, Kapaula, Waiaaka, Paakea, Waiohue, Kopiliula, West Wailuaiki, East Wailuaiki, Wailuanui, Waiokamilo, Palauhulu, Piinaau, Honomanu, Punalau, Haipuaena, Puohokamoa, Waikamoi, and Honopou. (FOF 304~~284~~.)

~~98.~~97. Maintenance of water quality:

a. Streams that appear on the 2006 List of Impaired Waters in Hawaii, Clean Water Act § 303(d), include, from east to west, Hanawi, Puakaa, East Wailuaiki, West Wailuaiki, Ohia, Honomanu, Punalau, Haipuaena, Puohokamoa, and Waikamoi streams. (FOF 305~~285~~.)

~~99.~~98. Streams that have had their IIFS increased to address wetland taro and domestic uses and/or habitat improvement for native stream animals include (FOF 117-181, 233-249):

a. Honopou: also on the list for palustrine wetlands, aesthetic values and outdoor recreation.

b. Hanehoi/Puolua: also on the list for palustrine wetlands and outdoor recreation.

c. Palauhulu: also on the list for palustrine wetlands and aesthetic values.

d. Waiokamilo: also on the list for palustrine wetlands, outdoor recreation, and aesthetic values.

e. Wailuanui: also on the list for palustrine wetlands, outdoor recreation, and aesthetic values.

f. Waikamoi: also on the list for palustrine wetlands, outdoor recreation, aesthetic values, and impaired water quality.

g. East Wailuaiki: also on the list for estuaries, palustrine wetlands, outdoor recreation, aesthetic values, and impaired water quality.

h. West Wailuaiki: also on the list for estuaries, palustrine wetlands, outdoor recreation, aesthetic values, and impaired water quality.

i. Waiohue: also on the list for estuaries, palustrine wetlands, outdoor recreation, and aesthetic values.

j. Hanawi: also on the list for palustrine wetlands, aesthetic values, and impaired water quality.

k. Makapipi: palustrine wetlands, outdoor recreation, and aesthetic values.

~~100.~~99. Therefore, these other instream uses are substantially represented by the streams that have had their IIFS increased by the two previous Commission decisions in 2008 and 2010.

E. Noninstream Uses

1. HC&S

a. Requirements

~~101.~~100. HC&S' estimate of future use of 3,307 gad to enable 26,996 acres of diversified agriculture, or 115.49 mgd of East Maui stream water, is reasonable and beneficial. (FOF 346~~346~~344.)~~Reasonable and beneficial irrigation requirements are 4,844 gad for its 28,941 acres in sugarcane cultivation, or 140.19 mgd. (FOF 346.)~~

b. Losses

101. The hearings officer previously concluded that ~~R~~reasonable and beneficial system losses are 22.7 percent of total water uses, which consist of HC&S irrigation, deliveries to MDWS, and HC&S industrial and other uses. (FOF 332~~312~~-335~~315~~, 378~~399~~.) A&B anticipates using the same HC&S ditches and reservoirs, where appropriate, under the Diversified Agricultural Plan.

Therefore, a 22.7% system loss rate continues to be a reasonable proxy for future system losses. (Hew WRT 1/20/17, ¶ 10.)

102. Based on requirements of 3,307 gpad for 26,996 acres of diversified agriculture, HC&S has total irrigation requirements of 89.28 mgd. To calculate the gross irrigation requirement, the total irrigation requirement of 89.21 mgd is multiplied by 1.294 (the inverse of 22.7%), which results in total gross irrigation requirement of 115.43 mgd. That is, 26.22 mgd of the total gross irrigation requirement of 115.43 mgd, reasonably consists of system losses. (Exhibit C-156-A at 2; Volner, Tr., 2/8/17, p. 240, l. 20 to p. 242, l. 15.)

c. Alternative Sources

103. Brackish ground-water usable pump capacity is 115 mgd to 120 mgd, limited by a likely increase in aquifer salinity levels, especially in the summer months when pumping is highest. (FOF 385~~408~~-386~~409~~.)

~~103.~~ Historically, pumped groundwater constituted between 20 to 30 percent of total use when HC&S was cultivating sugarcane. (FOF 394~~394~~.) Because of the Diversified Agricultural Plan's ~~will result in~~ reduced recharge of the groundwater aquifer due to lower levels of irrigation of overlying lands, the uncertain tolerance of diversified agricultural crops to heavy reliance on brackish water, and the higher costs of pumping groundwater, a sustainable level of groundwater usage is expected to ~~will~~ be within the range of 0 to 20 percent of total water use. (FOF 388~~388~~-390~~390~~, 395~~395~~.) ~~Between 2008 to 2013, HC&S' average total water use was 184 mgd.~~ Therefore, while the amount would vary seasonally based on its current Diversified Agricultural Plan, no more than ~~approximately 0 to~~ 23~~36.8~~ mgd of groundwater would be available as a reasonably practicable alternative source for HC&S.

~~104. The brackish water wells can be used to irrigate 17,200 acres of the approximately 30,000 acres serviced by waters from the EMI Ditch System (FOF 400), or about 83.32 mgd (4,844 gad x 17,200 acres) of the 115 mgd to 120 mgd usable capacity.~~

~~105.~~104. ~~From 2008 to 2013, HC&S received 113.71mgd from surface water deliveries and 69.90 mgd in pumped groundwater for a combined total of 183.61 mgd, 62 percent from surface water and 38 percent from groundwater. (FOF 312.) Under those conditions, an additional 13.42 mgd (83.32 - 69.90 mgd) of groundwater would be available as an alternative source. 83.32 mgd of pumped groundwater would be 69 to 72 percent of usable capacity, *supra*, COL 103, which would likely not increase aquifer salinity levels significantly.~~

106.105. Additional reservoirs, recycled wastewater, and water from Maui Land and Pine, and green harvesting are not reasonable alternatives based on analyses of costs, technology, and logistics. (FOF 396410-437.)

d. Economic Impact

107. On the impact of terminating HC&S's sugar operations, HC&S provided no information on when and how reduced surface water availability would reach the point that HC&S would cease operations. HC&S only stated in broad terms that it was in the public interest to continue HC&S's operation, because cessation of its sugar operations would affect the County of Maui and the State, MDWS and its customers, renewable energy benefits, and agricultural benefits. (FOF 439.)

108. On the incremental impacts to HC&S of reductions in deliveries from the EMI ditch system, HC&S created a model for assessing the economic impact of reducing the amount of EMI ditch water, separately assessing reductions of deliveries to the two upper ditches (the Wailoa Ditch and the Kauhikoa Ditch) and reduction of deliveries to the two lower ditches (the Lowrie Ditch and the Haiku Ditch). (FOF 440.)

109. Reduced deliveries to the Wailoa Ditch and Kauhikoa Ditch result in reduced water availability to irrigate the 12,800 acres of sugarcane that cannot be irrigated with ground water. The financial impact is therefore calculated in terms of HC&S's anticipated loss in sugar yields due to the average decrease in available water. (FOF 441.)

110. Reduced deliveries to the Lowrie Ditch and Haiku Ditch are assumed to be compensated for by increased pumping of brackish ground water. The financial impact is therefore calculated in terms of the average cost of this pumping. (FOF 442.)

111. Given the large difference between tons of sugar produced by nearly identical amounts of water (a ratio of 1.55 for 2009 versus 2.51 for 2003), a consistent relationship between tons of sugar produced and amount of irrigation water is questionable. (FOF 443-447.)

112. For the increased pumping costs for the Lowrie and Haiku ditches, a direct relationship between pumping costs and increased pumping is logical. (FOF 448.)

a. HC&S estimates a total economic impact of $1,250,775, but this is the sum of costs for each of the four ditches; i.e., $507,858 for both the Wailoa Ditch and Kauhikoa Ditch, $160,250 for the Lowrie Ditch, and $74,825 for the Haiku Ditch. Therefore, the sum is actually HC&S's estimated costs of reducing EMI ditch system water by 1 mgd at

~~each of the four ditches, or the cost of reducing EMI ditch system water by 4 mgd, spread equally across the four ditches. (FOF 449.)~~

~~b. According to HC&S's own model and calculations, the economic impact of a 1 mgd reduction in EMI ditch system water would range from $74,825 at the Haiku Ditch, to $160,250 at the Lowrie Ditch, to $507,858 at either the Wailoa Ditch or Kauhikoa Ditch. (FOF 450.)~~

~~c. Given these large differences in impact, if faced with shortages of EMI ditch system water, to minimize costs and to the extent possible, HC&S should serve those fields irrigated from the Wailoa and Kauhikoa ditches first, then the fields irrigated from the Lowrie Ditch, and lastly, the fields irrigated from the Haiku Ditch. (FOF 451.)~~

~~d. However, the estimated costs for the Wailoa and Kauhikoa ditches, which are based on tons of sugar per million gallons of water per day, are based on a questionable assumption that there is a consistent relationship between amounts of irrigation water and tons of sugar produced. (FOF 447, 452.).~~

~~113. Finally, HC&S's model is based on a reduction of surface water delivered through the EMI ditch system. Such costs have to be predicated on reductions of water that are necessary for irrigation, not on reductions of water that are currently delivered. As previously analyzed, even after the reductions of the Commission's 2008 and 2010 orders, more water than is required was still being delivered. (FOF 375-376, 453.)~~

106. The parties in this contested case do not dispute that keeping HC&S' former sugar lands in agriculture is in the public interest. Maintaining agricultural activity on these lands is consistent with the County of Maui's land use planning policies, and could generate multiple income streams, strengthen the State of Hawaii's food security, and create alternative energy sources. Keeping HC&S' former sugar lands in agriculture would maintain open space and protect scenic views. (FOFs 418~~418420~~, 419~~419421~~, 421~~421423~~, 422~~422424~~.)

107. The County of Maui has expressed strong support of keeping HC&S' former sugar lands in agriculture. (FOF 418~~418420~~.)

108. A&B's Diversified Agricultural Plan entails partnering with others who are interested in farming on the former sugar lands. (FOF 349~~349~~.)

109. A&B's inability to provide assurances regarding whether and how much irrigation can be made available to prospective lessees from the EMI Ditch System is a major obstacle to procuring commitments from prospective lessees who need such assurance in order to justify

committing the necessary capital to develop a new agricultural operation. No farmers have been willing to commit to cultivation on HC&S lands absent some assurance as to the quantity and quality of water and cost. (FOF 352~~352~~.)

2. MDWS

a. Uses

~~114.~~110. MDWS provides two types of surface water to its users: 1) potable water from its Olinda, Piiholo, and Kamole WTPs, with a combined capacity of 13 mgd and an average daily production of 7.7 mgd; and 2) non-potable water from HC&S's Hamakua Ditch at Reservoir 40 for the Kula Agricultural Park, with two reservoirs with a total capacity of 5.4 million gallons and average daily use of 3.5 mgd. (FOF 91~~71~~, 93~~73~~-94~~74~~, 97~~77~~, 99~~79~~, 103~~83~~.)

~~115.~~111. Current unmet demand is approximately 3.75 mgd, and by 2030, there is a predicted additional need for 1.65 mgd. MDWS anticipates it will need to develop between 4.2 mgd and 7.95 mgd to meet demands through 2030. (FOF 441~~471~~, 443~~473~~-444~~474~~.)

~~116.~~112. MDWS is a purveyor of domestic water uses of the general public, particularly drinking. In this capacity, MDWS serves one of the purposes of the public trust, *supra*, COL 11~~11~~.

~~117.~~113. "Domestic use" as defined in the Code is distinct from "domestic uses of the general public." In the Code, "'(d)omestic use' means any use of water for individual personal needs and for household purposes such as drinking, bathing, heating, cooking, noncommercial gardening, and sanitation (*emphasis added*)." (HRS § 174C-3.) The purpose of this definition in the Code is to exempt individual users from the permit provisions of the Code: "(N)o permit shall be required for domestic consumption of water by individual users..." (HRS § 174C-48(a).) On the other hand, "domestic uses of the general public" acknowledges "the general public's need for water," and "the public trust applies with equal impact upon the control of drinking water reserves (*quotation marks in original deleted*) ." (*Waiāhole I*, 94 Haw. at 136-138; 9 P.3d at 448-450.)

~~118.~~114. MDWS is also a non-riparian diverter of East Maui stream waters, and under the common law, its continuing use of stream waters is permissible if the use is reasonable and beneficial and will not actually harm the established rights of appurtenant and riparian landowners. (COL 67~~67~~-68~~68~~.)

~~119.~~115. For MDWS's use of East Maui stream waters, there is a potential conflict between the public trust doctrine and the common law. Under the public trust doctrine, there is a presumptive in favor of trust purposes, and competing water uses must be weighed on a case-by-case basis. Under the common law, MDWS's use must not actually harm the established rights of appurtenant and riparian landowners. While some appurtenant rightsholders are also likely to have traditional and customary Hawaiian rights in their exercise of appurtenant rights, *supra*, COL 88~~89~~, and also have a presumption in their favor, they do not have priority over MDWS as a purveyor of domestic water uses of the general public, and competing uses must still be weighed on a case-by-case basis according to any appropriate standards provided by law.

~~120.~~116. The Public Trust Doctrine applies in all situations, whether or not in a water management area, and whether or not the common law applies.

~~121.~~117. The appropriate standard is a cost-benefit analysis in weighing appurtenant and riparian uses with MDWS as a purveyor of domestic water uses of the general public.

~~122.~~118. Finally, MDWS is a public entity for actual public use. If MDWS's diversions are ruled improper, appurtenant and riparian rightsholders cannot obtain injunctive relief (but may seek damages) against MDWS because of the public use doctrine, *supra*, COL 31~~31~~.

b. Losses

~~123.~~119. The 1.1-mile Upper Waikamoi Flume, which serves the Olinda WTP, was estimated to lose as much as 40 percent of total flow through cracks and holes along its whole length. Actual losses could not be measured, because MDWS had no mechanism for quantifying water levels at either the intake or discharge sites of the flume. If reliable capacity of the Olinda WTP is the reported 1.6 mgd, then the flume could have lost as much as 0.64mgd (1.6 mgd x 0.40) at that level of operation. (FOF 445~~475~~-448478.)

~~124.~~120. MDWS has just completed replacing the entire flume, as well a completely relining the two 15 million-gallon Waikamoi reservoirs and the 2 million-gallon on-site basin a the Olinda WTP. (FOF 449~~479~~, 452~~482~~.)

~~125.~~121. With the new flume, MDWS will be able to calculate how much water is coming from the flume on days when the main intake from the dam is dry, which is most of the days. (FOF 447~~480~~.)

c. Alternative Sources

~~126.~~122. New reservoirs, which would be fed by streams in times of water surplus for use during times of low flows, are not alternatives to using stream waters but a means of mitigating the impacts of reduced availability of stream waters. Reservoirs mitigate fluctuations in both stream flow and consumer demand, and mitigations in fluctuations in stream flow allow more of it to be used at the proper time. (FOF 454~~484~~, 456~~486~~.)

~~127.~~123. New production wells are not an alternative to serve the Upcountry areas in the immediate and intermediate future. Water is heavy, so moving it to higher elevations such as where much of the Upcountry System is located, at 1000 to 4000 feet, from basal aquifers at sea level is projected to cost $1.64 per thousand gallons for distribution from the Kamole-Weir WTP, $4.07 per thousand gallons at the Piiholo WTP, and $593 per thousand gallons at the Olinda WTP. MDWS's current charges for water only average about $4 per thousand gallons, so just the electrical costs to pump the water is more than what MDWS charges overall for its entire operation. On top of pumping costs, there would be substantial initial capital expenditures and on-going maintenance. (FOF 453~~483~~.)

~~128.~~124. MDWS has also entered into a Consent Decree, which requires that MDWS conduct vigorous cost/benefit analyses of other water source options before developing ground water in the East Maui region, and has tried unsuccessfully on several occasions to work within the framework of the consent decree to develop new ground water sources. (FOF 453~~483~~.)

d. Economic Impact

~~129.~~125. Under the MOU between EMI and MDWS, MDWS can receive 12 mgd with an option for an additional 4 mgd. During low-flow periods when ditch flows are greater than 16.4 mgd, both will receive a minimum allotment of 8.2 mgd. If these minimum amounts cannot be delivered, both will receive prorated shares of the water that is available. In recent periods of low Wailoa Ditch flow, EMI has not restricted the allotment of water to MDWS according to the terms of the agreement, and MDWS withdrawals have been limited only by the amounts of water available in the ditch and the physical limitations of the existing Kamole-Weir WTP intake structures. During drought conditions, MDWS may withdraw 6 mgd, and what remains is used by HC&S for irrigation. (FOF 462~~492~~.)

~~130.~~126. There would be little or no impact if Wailoa Ditch flows were reduced 15 mgd. MDWS would not have full access to the 6 mgd capacity of the Kamole-Weir WTP for 5 days, the same as for the period 2001 to 2011, and less than the maximum of 16 days for the period 1922 to 1987. (FOF 467~~497~~.)

~~131.~~127. With a 20 mgd reduction in Wailoa Ditch flow and assuming a daily drought period withdrawal of 5.0 mgd, there would not be sufficient water to provide reliable drought period capacity without some mitigating actions. For a 23,680 day period, *supra*, FOF 495, 5.0 mgd would not be able to be withdrawn for 822 days or 3.47 percent, with 54 consecutive days of deficiency. (FOF 468~~498~~.)

~~132.~~128. The deficiency only means that 5 mgd could not be withdrawn. Lesser amounts could still be withdrawn from the Wailoa Ditch. Furthermore, while the study defined drought period deficiency as being less than 4.6 mgd of a total capacity of 6 mgd, actual use from the Kamole-Weir WTP has been 3.6 mgd out of the total capacity of 6 mgd. (FOF 469~~499~~.)

~~133.~~129. With the addition of a 100-million gallon reservoir at the Kamole-Weir WTP, the drought period reliable yield with the 20 mgd reduction in Wailoa Ditch flow would be 4.6 mgd, approximately equal to the existing WTP reliable yield without reductions in ditch flows. (FOF 470~~500~~.)

~~134.~~130. With a 200-million gallon reservoir, the drought period reliable yield with the 20 mgd reduction in Wailoa Ditch flow increases to 7.1 mgd, an increase of 2.4 mgd compared to a 100-million gallon reservoir and greater than the total capacity of 6 mgd of the Kamole-Weir WTP. (FOF 471~~501~~.)

~~135.~~131. Estimated costs of a 100- to 200-million reservoir at the Kamole-Weir WTP are $25.25 million, and life-cycle costs over 25 years are estimated at $33 per thousand gallons or $250 million. (FOF 472~~502~~.)

F. Streams That Have Been Amended

~~136.~~132. Stream restoration for appurtenant rights was the focus of the September 25, 2008 Commission Order and done on a stream-by-stream basis for water rights associated with specific streams. (FOF 2~~2~~, 3~~3~~, 8~~8~~-9~~9~~.)

~~137.~~133. A geographic approach to stream restoration was taken in the Commission's 2010 order, meaning that flows were restored in selected streams both east and west of Keanae Valley. Benefits of this approach included biological diversity in the East Maui area, and regional diversity in traditional gathering opportunities, *supra*, COL 72~~73~~.

~~138.~~134. The East Maui streams diverted by EMI's Ditch System are in a hydrologically controllable area, and consolidated amendments to their IIFS are not precluded, *supra*, COL 38~~38~~-39~~39~~.

~~139.~~135. A geographic approach to stream restoration is in compliance with the Code, *supra*, COL 73~~74~~.

~~140.~~136. A geographic approach is the most feasible method of restoring streams that are collectively diverted by EMI's Ditch System, *supra*, COL 74~~75~~; and streams were selected which would result in the most biological return from additional flow. (FOF 260~~240~~b.)

1. Stream-by-Stream Amendments

~~141.~~137. The streams in the September 25, 2008 Commission Order addressed the taro and domestic water needs of Nā Moku members, and were done on a stream-by-stream basis. There were eight streams addressed: Honopou, Hanehoi and its tributary Puolua (Huelo), Piinau, Palauhulu, Waiokamilo, Kualani, and Wailuanui Streams, *supra*, FOF 3~~3~~.

~~142.~~138. Six of the eight streams had some diverted water restored, for a net restoration of 4.65 mgd (7.19 cfs), *supra*, FOF 202~~182~~-203~~183~~. Because estimates of flows under diverted conditions were available for some streams, after adding the restored amounts to existing flows, available stream water was 11.71 mgd (18.12 cfs). Water would be available for the following streams, along with estimated requirements, *supra*, COL 58~~58~~, 61~~61~~:

	Available water	Requirements
Palauhulu:	3.56 mgd	1.75-2.02 mgd for taro
Waiokamilo &	3.17 mgd	3.92-4.52 mgd for taro
Wailuanui:	1.97 mgd	
Honopou:	1.29 mgd	0.80-0.93 mgd for taro
	(0.82 mgd for taro and domestic; 0.47 mgd for habitat)	
Hanehoi/Puoloa:	1.72 mgd:	0.30-0.35 mgd for taro
	(0.98 mgd for taro; 0.74 mgd for Huelo community)	

~~143.~~139. For Palauhulu and Hanehoi/Puoloa Streams, taro water requirements are greatly exceeded. Moreover, the taro lo`i water requirements are for flow-through amounts, most of which will exit the lo`i complex and then may either flow into another lo`i complex or back into the stream. Thus, much of the 130,000 to 150,000 taro lo`i water requirements will be available for use by others such as for downstream lo`i complexes and other agricultural uses, or for increased stream flow for improved stream animal habitat, *supra*, COL 60~~60~~.

a. There are 15,000 to 40,000 gad of net loss between lo`i inflow and outflow from evaporation, transpiration, and percolation through the bottoms and leakage through the banks, with most of the loss through percolation and leakage. (FOF 212~~192~~.) Of the 130,000 to 150,000 gad of in-flow water, a minimum of 90,000 to 110,000 gad to a maximum of 115,000 to 135,000 gad will out-flow, with much if not most available to downstream lo`i or returned to the stream.

~~144.~~140. However, it is unclear whether or not these amended IIFS were achieved. Commission staff concentrated on making sure that a specific amount of water was always present in the stream, and that the complaints of taro farmers that they were not getting enough water was not material to whether or not staff would have changed their decision to recommend higher releases into the stream. Therefore, most of the amended IIFS were based on low-flow values, *supra*, FOF 202~~182~~. However, even at the flow values used by Commission staff, the comparision with water requirements has found that such quantities would have been sufficient and even excessive for Palauhulu and Hanehoi/Puolua Streams, *supra*, COL 138~~142~~. Therefore, it is most likely that the amended IIFS were never fully implemented: either through Commission staff striving to achieve constant IIFS and therefore setting them lower than intended, or to insufficient water in the ditches to restore the streams to the levels intended.

~~145.~~141. Of the two remaining streams, Kualani Stream was first thought to be the easternmost tributary of Waiokamilo Stream and had its IIFS kept at the status quo, but it was subsequently determined to be a separate stream that is below the EMI Ditch System and has never been diverted. (FOF 64~~58~~, 189~~165~~.)

~~146.~~142. Piinaau Stream was kept at its status quo IIFS at its lower reach at 40 feet elevation, upstream from its confluence with Palauhulu Stream. Piinaau Stream is dry immediately downstream of the Koolau Ditch, possibly from infiltration losses and diversions at the Ditch. Actual flow measurements are not available because of geographic inaccessibility and a major landslide in 2001. A flow value could not be determined due to the large uncertainty in the hydrological data. Moreover, even with the current flow, the stream exhibited a rich native species diversity, offered a variety of recreational and aesthetic opportunities, and the two registered diversions had not indicated a lack of water availability. (FOF 175~~152~~-176~~153~~.)

2. Amendments through the Geographic Approach

~~147.~~143. Five streams were partially restored to increase habitat availability, and a short-term release of water into Makapipi Stream was conducted to see if a continuous flow from the headwaters to the stream mouth could be achieved. (FOF 260~~240~~.)

a. The short-term release into Makapipi Stream was unsuccessful in achieving continuous flow. (FOF 288~~268~~.)

b. For Hanawi Stream, it had adequate flow to sustain native animal populations, but there was a dry reach immediately below the Ko`olau Ditch, so 0.06 mgd (0.1 cfs) was released to create a wetted pathway from the Ditch to the ocean. (FOF 260~~240~~.)

c. For Waikamoi, East Wailuaiki, West Wailuaiki, and Waiohue Streams, seasonal restorations were implemented, with wet season (winter) flows set at 64 percent of BFQ_{50} to achieve H_{90} and dry season (summer) flows reduced 20 percent of BFQ_{50} to maintain minimum connectivity for native stream animals to survive in shallow pools without suitable long-term growth or reproduction. (FOF 214~~234~~.)

~~148.~~144. The results of the evaluation of the seasonal approach were as follows:

a. There was no evidence that the summertime flows were advantageous to the animals. The concept of varying flow over times is well supported in fisheries, but in this case it was not. For example, if the wintertime flows had been returned during the summer and complete flow restoration had been done in the winter, that would have been a seasonal flow approach, and the results might have been completely different. (FOF 284~~264~~.)

b. Overall, the seasonal flow hypothesis (higher winter flows and lower summer flows) was conceptually coherent, yet not supported by the data. The lack of support for the seasonal flow hypothesis may reflect that the prescribed flow amounts were insufficient (i.e. needed higher flows in summer) or that a year round minimum flow is more appropriate for East Maui streams. (FOF 285~~265~~.)

3. Reliability of the Estimated Stream Flows

~~149.~~145. Prior to the partial restorations of twelve streams in 2008 and 2010 and subsequent installation of gages in these streams, there were only four active gages, one each in Hanawi Stream, West Wailuaiki Stream, Waiokamilo Stream, and Honopou Stream (which is outside the study area to be described, *infra*). (FOF 104~~84~~.) Gages had been previously installed on a number of streams for various periods of time and for various years. For example, Makapipi Stream had a gage at 920 feet elevation between 1932-1945; Hanawi Stream had gages at 500 feet elevation between 1932-1947 and again between 1992-1995, and at 1,318 feet elevation between 1914-1915 and again between 1921-Present; and West Wailuaiki Stream had a gage at 1343 feet elevation between 1914-1917 and again between 1921-Present. (FOF 105~~85~~.)

~~150.~~146. USGS's 2005 Stream Flow Study estimated stream flows under natural (undiverted) and diverted conditions for 21 streams, using a combination of continuous-record gaging-station data, low-flow measurements, and values determined from regression equations developed for the study. For the drainage basin for each continuous-record gaged site and selected ungaged sites, morphometric, geologic, soil, and rainfall characteristics were quantified. Regression equations relating the non-diverted streamflow statistics to basin characteristics of the gaged basins were developed. Regression equations were also used to estimate stream flow at selected ungaged diverted and undiverted sites. (FOF 106~~86~~107-~~87~~.)

~~151.~~147. Estimates were made for 50 percent and 95 percent duration total flow (TFQ) and base flow (BFQ). Base flow is the groundwater contribution to flow. Total flow includes all sources; i.e., ground, freshet ("normal" rainfall) and storm waters. A 50 percent duration flow (median streamflow; Q_{50}) means that, for a specific period of time, half of the measured stream flow was greater than the Q_{50} value, and half was less. For example, for measurements of total flows in a particular stream for the specified period of time: 1) if TFQ_{50} = 25 mgd, then total stream flow was above 25 mgd half of the time and below 25 mgd half of the time,; and 2) if TFQ_{95} = 2 mgd, total stream flow was above 2 mgd 95 percent of the time and below 2 mgd 5 percent of the time. (FOF 108~~88~~-109~~89~~.)

~~152.~~148. Relative errors between observed and estimated flows ranged from 10 to 20 percent for the 50-percent duration total flow and base flow, and from 29 to 56 percent for the 95-percent duration total flow and base flow. Errors are higher for lower flows because, for the same absolute error in flow, the relative error in percent increases as the actual flow decreases. (FOF 110~~90~~.)

~~153.~~149. East of Keanae Valley, the 95-percent duration discharge equation generally underestimated total flow (TFQ_{95}), due to gains in flow from groundwater discharge, and within and west of Keanae Valley, the equation generally overestimated total flow, due to loss of water at lower elevations. (FOF 111~~91~~.)

~~154.~~150. Therefore, when the amended IIFS for both the 2008 and 2010 Commission Orders were approved, it was intended that streamflows be monitored at the proposed IIFS locations, and the IIFS be revised if necessary. (Exh. C-85, p. 63; Exh. C-103, p. 26.)

~~155.~~151. Commission staff has since learned that: 1) the regression estimates used for flows had, in many cases, overstated what those flows would be, so if the sluice gates on the ditches are opened, there still may not be enough flow to meet the amended IIFS; 2) there is a natural variability in stream flow which may dip below the IIFS, generally due to periods of low rainfall, so guaranteeing that a specific flow is always in the stream and still meet the objective of the IIFS is not possible; and 3) in Wailuanui and Keanae, the Ko`olau Ditch has only been taking, for the most part, water generated by rainfall, and spring water below the Ditch is what the taro farmers have access to, *supra*, COL 63~~63~~.

4. Implementation of the Amended IIFS

In addition to whether or not the amended IIFS were achieved, *supra*, COL 159~~155~~, there are implementation issues that have to be clarified and resolved:

~~156.~~152. Meeting the amended IIFS:

a. "'Instream flow standard' means a quantity or flow of water or depth of water which is required to be present at a specific location in a stream system at certain specified times of the year to protect fishery, wildlife, recreational, aesthetic, scenic, and other beneficial instream uses," *supra*, COL 1.

b. This definition does not limit "a quantity or flow of water or depth of water" to a specific quantity that must be present at the specific location at all times. In fact, the very definitions of "base flow (BFQ)" and "total flow (TFQ or Q)" recognize that stream flows vary, even base flows. BFQ and TFQ are expressed in terms of the percent of time the referenced quantity was present in the stream, *see* COL 148~~152~~, *supra*. Thus, when all diversions onWaiokamilo Stream were closed, total undiverted flow was expressed as TFQ_{50} or Q_{50}, meaning that the median flow, or the Q_{50}, was 3.17 mgd. (FOF 186~~162~~.) It does not mean that

3.17 mgd was present at the IIFS location at all times. It means that half the time, the amount was greater than 3.17 mgd, and the other half of the time, less than 3.17 mgd. As a further example of variations in stream flow, for the Wailoa Ditch, which diverts multiple streams, daily flows between 1922 to 1987 ranged from only 1.16 mgd to as much as 212 mgd. (FOF 67~~61~~, 76~~70~~.)

c. Thus, to have a specific quantity in a specific location in a stream cannot be achieved, and an IIFS must be achieved by an average of multiple measurements at the specified location. Furthermore, it would be technically difficult to adjust releases so that the median (half of measurements greater, and half, less)is achieved. Instead, it would probably be easier that the amended IIFS equal the mean or average of all readings. This would be similar to the quantities under water-use permits, in which 12-month moving averages are used to monitor water use, instead of the permitted amount being the maximum amount that could be used under the permit. In the latter instance, over a defined period of time, permit holders would always be limited to using less than what was allowed under their permits.

~~157.~~153. Release of water to meet the amended IIFS.

a. A similar situation would exist to that which was just immediately discussed, *supra*, if the release of water was capped at the quantity needed to meet the IIFS. For example, suppose an IIFS is established at 2.0 mgd immediately downstream of a diversion, and the stream is dry at that point. If the diversion from the stream into a ditch were modified to allow the first 2.0 mgd to continue downstream, stream flows 2.0 mgd or less would remain in the stream. However, when the stream flow is greater than 2.0 mgd, flows over 2.0 mgd would be diverted into the ditch. Thus, the stream flow at the IIFS location would always be 2.0 mgd or less, and the mean and median would always be less than 2.0 mgd, because there would be no flows higher than 2.0 mgd to balance against the flows less than 2.0 mgd.

b. Thus, amended IIFS cannot be met unless there are continual adjustments to the ditch modifications, or if the amount allowed to continue downstream is higher than the target IIFS. Either approach presents operational difficulties.

~~158.~~154. Almost all of the stream flows on which the amended IIFS are based are estimates and not observed measurements. (FOF 104~~84~~-113~~93~~.) Therefore:

a. In some cases, actual flows may be insufficient to meet the amended IIFS.

b. Values assigned to TFQ and BFQ flows have relative errors ranging from 10 to 20 percent for TFQ_{50} and BFQ_{50} and from 29 to 56 percent for TFQ_{95} and BFQ_{95}. (FOF 110~~90~~.) The use of BFQ_{50} in determining viable stream habitat (64 percent of BFQ_{50} = H_{90}) may result in inaccurate habitat values, and in the evaluation of the effect of increased stream flows from the 2010 Commission Order, the monitoring effort did not include an assessment of whether or not the winter flows, based on 64 percent of BFQ_{50}, had in fact achieved the minimum habitat of H_{90} necessary for growth, reproduction, and recruitment of native stream animals. (FOF 280~~260~~.)

G. Amended IIFS

~~159.~~155. The Commission affirms its choice of the streams which had their IIFS amended in either the 2008 or 2010 Commission order, subject to modifications of the IIFS as described, *infra*. The Commission also modifies its prior decisions for Kopiliula Stream and its tributary, Puakaa Stream, also described, *infra*.

~~160.~~156. Stream-flow restorations for taro lo`i complexes are based on flow-through requirements, which in turn are allocated the full amount of 130,000 to 150,000 gad for each acre, *supra*, COL 58~~58~~. However, each acre of taro lo`i complexes consumes only 15,000 to 40,000 gad, *supra*, COL 139~~143~~, leaving a minimum of 90,000 to 110,000 gad and a maximum of 115,000 to 135,000 gad that exits the lo`i complex and potentially available to downstream lo`i or to be returned to the stream.

~~161.~~157. Neither stream restorations nor the exercise of appurtenant and riparian rights can depend on the unpredictability of storm and freshet ("normal" rainfall) waters. Both are based on base flows, or the ground-water contribution to stream flow. (FOF 118~~98~~, 105; COL 22~~22~~, 25~~25~~-26~~26~~.) In Wailuanui and Keanae, the Ko`olau Ditch has only been taking, for the most part, water generated by rainfall, *supra*, COL 63~~63~~, 151~~155~~.

~~162.~~158. The exercise of appurtenant and riparian rights require diversions of water from the stream and therefore will compete with stream restoration if the sum of their requirements exceeds the amount of available base flow.

~~163.~~159. Hawaii`s stream flows are highly variable in nature, and flows are expressed in the percent of the time that a certain amount of water is flowing in the stream in a given time period. For example, a stream's total flow ("Q" or "TFQ") and base flow ("BFQ") in a given time period are expressed as the median flow (TFQ_{50} and BFQ_{50}), where half of the measured flows was greater and half was less. (FOF 109~~89~~.)

~~164.~~160. The expectation that an IIFS requires that a specific amount of water must be present in the stream at all times will be at odds with the objective of the amended IIFS. For example, if an IIFS is amended to provide the flow (64 percent of BFQ_{50}) equivalent to H_{90} and that flow were 10 cfs, there will be times when the entire flow in the stream will be less than 10 cfs. If the flow that would be in the stream 100 percent of the time (BFQ_{100}) were less than 10 cfs or even zero, establishing the amended IIFS at BFQ_{100} would obviously not meet the H_{90} objective.

~~165.~~161. On the other hand, monitoring amended IIFS through median flows would require adjusting flows so that the IIFS would be at the median, a monitoring approach that is unlikely to be achieved on an ongoing basis. Monitoring the IIFS through mean (average) flows is likely the most achievable approach and has its counterpart in monitoring water-use permits, where 12-month moving averages are used.

~~166.~~162. When the IIFS were amended to provide water to taro farmers in the 2008 Commission order, the 2009 Habitat Availability Study, with its conclusions that there was a threshold for viable habitat and that H_{90} was equal to a flow of 64 percent of BFQ_{50}, was not yet available. Thus, the 2005 Habitat Study was used when addressing habitat availability for Palauhulu, Wailuanui, Honopou, and Hanehoi/Puolua Streams.

~~167.~~163. Despite the use of low reference flows in order to assure that the IIFS would always be meet, the comparision with water requirements has found that such quantities would have been sufficient and even excessive for Palauhulu and Hanehoi/Puolua Streams, *supra*, COL 138~~142~~, 140~~144~~, but Commission staff has since learned that the regression estimates used for flows had, in many cases, overstated what those flows would be, so if the sluice gates on the ditches are opened, there still may not be enough flow to meet the amended IIFS, *supra*, COL 151~~155~~.

1. Palauhulu and Piinaau Streams

~~168.~~164. The major diversion on Palauhulu and Piinaau Streams was~~is~~ the Ko`olau Ditch (east of and flowing into the Wailoa Ditch). (FOF 175~~152~~.) HC&S will no longer divert Palauhulu and Piinaau Streams. ~~In Wailuanui and Keanae, the Ko`olau Ditch has only been taking, for the most part, water generated by rainfall, and spring water below the Ditch is what the taro farmers have access to, *supra*, COL 63, 155~~.

~~169.~~165. For Piinaau Stream, the Commission kept the status quo IIFS at its lower reach at 40 feet elevation, upstream from its confluence with Palauhulu Stream. A flow value could not be determined due to the large uncertainty in the hydrological data. Moreover, with the current flow, the stream exhibited a rich native species diversity, offered a variety of recreational and aesthetic opportunities, and the two registered diversions had not indicated a lack of water availability. (FOF 176~~153~~.)

~~170.~~166. The IIFS for Palauhulu Stream was based on BFQ_{50} and established at 3.56 mgd (5.50 cfs) near 80 feet elevation, upstream with its confluence with Piinaau Stream, to ensure that the proposed flow reaches downstream users in Keanae peninsula. Estimated diverted flow at that point was BFQ_{50} = 3.10 mgd (4.80 cfs), so the net addition was estimated at 0.46 mgd (0.71 cfs). (FOF 177~~177182~~.)

~~171.~~167. ~~3.56 mgd (5.50 cfs) was half of the estimated undiverted base flow at the site, and part of the rationale was that if flow were restored to 50 percent of natural base flow, potentially 80 to 90 percent of native habitat would be available in Palauhulu Stream upstream of its confluence with Piinaau Stream. (FOF 155.)~~ The estimated undiverted BFQ_{50} on Palauhulu Stream near 80 feet elevation, upstream of its confluence with Piinaau Stream, is 7.12 mgd (11 cfs). (FOF 177~~177~~.)

~~172.~~168. Above the confluence with Piinaau Stream and Store Spring, Palauhulu Stream is dry from infiltration losses, losing the estimated flow of 2.7 mgd from Plunkett Spring below the Ko`olau Ditch. (FOF 175~~152~~.) So it is questionable whether or not releases from the Ko`olau Ditch would reach the IIFS site.

~~173.~~169. No IIFS was proposed for the stream mouth because the amount of water flowing from both streams into the estuary, Waiahole Pond, was deemed adequate. (FOF 177~~154~~.)

~~174. Irrigation requirements from Palauhulu Stream was estimated at 1.75 mgd to 2.02 mgd, *supra*, COL 58. Thus, even without the addition of 0.46 mgd, the 3.10 mgd of diverted flow estimated to already be present in the stream was more than sufficient to meet irrigation requirements.~~

~~175. If increasing flow to meet both irrigation and H_{90} requirements were the objectives, then the IIFS should be an estimated 6.30 mgd to 6.57 mgd (9.75 cfs to 10.17 cfs), rather than 3.56 mgd (5.50 cfs). The estimated flow with diversions at the Ko`olau Ditch is BFQ_{50} = 7.11 mgd (11 cfs). 64% of 7.11 mgd (11 cfs) = 4.55 mgd (7.04 cfs). Irrigation requirements are 1.75 mgd to 2.02 mgd, so total requirements would be 4.55 mgd + 1.75 mgd to 2.02 mgd, or 6.30 mgd to 6.57 mgd (9.75 cfs to 10.17 cfs).~~

~~176. The estimated flow already present under diverted conditions is 3.10 mgd (4.80 cfs), so 3.20 mgd to 3.47 mgd would have to be added from the Ko`olau Ditch diversion instead of the current 0.46 mgd (0.71 cfs). However, as noted earlier, in Wailuanui and Keanae, the Ko`olau Ditch has only been taking, for the most part, water generated by rainfall, and spring water below the Ditch is what the taro farmers have access to, *supra*, COL 63, 155.~~

~~177. It is also questionable whether or not releases from the Ko`olau Ditch would reach the IIFS site because of the dry reach in-between from infiltration losses. Moreover, the gain in habitat would be small, extending only from the IIFS site to the dry reach.~~

~~178.~~170. ~~The estimated flow under diverted conditions of 3.10 mgd (4.80 cfs) should be more than sufficient to meet estimated irrigation requirements of 1.75 mgd to 2.02 mgd without the additional 0.46 mgd (0.71 cf).~~

~~179.~~171. Subject to the grant of necessary government approvals for the permanent abandonment of all EMI diversion structures on Palauhulu and Pi‘ina‘au Streams and completion of work to effectuate such abandonment, the ~~Therefore, the current amended~~ IIFS for Palauhulu Stream and the IIFS for Pi‘ina‘au Stream shall be amended to be the natural flow of the respective streams immediately below the EMI diversions on those streams at the Ko‘olau Ditch.~~established at 3.56 mgd (5.50 cfs) near 80 feet elevation, upstream with its confluence with Piinaau Stream, should be amended back to its former diverted flow, estimated at 3.10 mgd (4.80 cfs).~~

2. Waiokamilo Stream

~~180.~~172. The major diversion on Waiokamilo Stream is the Ko`olau Ditch. (FOF 183~~159~~.) In Wailuanui and Keanae, the Ko`olau Ditch has ~~only been taking~~historically taken, for the most part, water generated by rainfall, and spring water below the Ditch is what the taro farmers have access to, *supra*, COL 63~~63~~, 151~~155~~.

181.173. With no diversions, the measured IIFS near Dam 3 is TFQ_{50} = 3.17 mgd (4.9 cfs), just above the diversion to the Lakini taro patches. (FOF 186162.) Together with Wailuanui Stream, *infra*, irrigation requirements are 3.92 mgd to 4.52 mgd, with amendments to Wailuanui Stream's IIFS contributing 1.26 mgd (FOF 198177), *supra*, COL 6161.Thus, the amended IIFS of both streams total 4.43 mgd, approximately equal to irrigation requirements. However, the division of irrigation requirements between Waiokamilo and Wailuanui Streams is not clear. (FOF 274294-275295.)

182.174. With existing flows needed to meet irrigation requirements, there would not be additional flows that could be applied to meet H_{90} for habitat improvements. Furthermore, there is no data on which to calculate flows needed to meet H_{90}.

3. Wailuanui Stream

183.175. The major diversion on Wailuanui Stream is the Ko`olau Ditch. (FOF 196174.) A&B will no longer divert Wailuanui Stream. (FOF 201201.)In Wailuanui and Keanae, the Ko`olau Ditch has only been taking, for the most part, water generated by rainfall, and spring water below the Ditch is what the taro farmers have access to, *supra*, COL 63, 155.

184. The IIFS for Wailuanui Stream was established at 1.97 mgd (3.05 cfs) at 620 feet elevation, downstream of the Ko`olau Ditch and below the confluence of East and West Wailuanui Streams. Estimated diverted flow at this site was 0.65 mgd (1.0 cfs), so there would be a net addition of 1.32 mgd (2.05 cfs). (FOF 175.)

185. The IIFS is half of the BFQ_{50} of 3.94 mgd (6.1 cfs) and was established on the rationale that with half of median base flow, potentially 80 to 90 percent of natural habitat will be available, as well as providing more surface water to the downstream users, the majority of whom are downstream of the IIFS location. (FOF 176.)

186.176. The IIFS of 0.71 mgd (1.1 cfs), BFQ_{50} of diverted flow, was kept at the status quo further downstream below Waikani Falls. Therefore, 1.26 mgd (1.95 cfs) of the 1.97 mgd up above at 620 feet elevation would be available for irrigation, *supra*, COL 61.

187.177. At the location below Waikani Falls, BFQ_{50} of undiverted flow is 4.33 mgd (6.7 cfs), and 64 percent of BFQ_{50}, or H_{90}, would be 2.77 mgd (4.29 cfs). Therefore, the status quo IIFS of 0.71 mgd (1.1 cfs) would be less than that needed for growth, reproduction, and recruitment of native stream animals, and an additional 2.06 mgd (3.19 cfs) would be needed to meet both irrigation and habitat requirements. (FOF 177198198.)

~~188. Therefore, to meet both irrigation and habitat requirements, the IIFS at 620 feet elevation, downstream of the Ko`olau Ditch, would have to be increased by 3.38 mgd (5.23 cfs) instead of by 1.32 mgd (2.05 cfs), bringing the IIFS from 1.97 mgd (3.05 cfs) to 4.03 mgd (6.23 cfs) when added to the 0.65 mgd (1.0 cfs) of flow already estimated to be present.~~

178. ~~189.~~ The estimated undiverted flow at 620 feet elevation is BFQ_{50} = 3.94 mgd (6.1 cfs). ~~If this estimate is accurate, the 3.38 mgd (5.23 cfs) required to be left in Wailuanui Stream should be available from the Ko`olau Ditch. However, as noted earlier, in Wailuanui and Keanae, the Ko`olau Ditch has only been taking, for the most part, water generated by rainfall, and spring water below the Ditch is what the taro farmers have access to, *supra*, COL 63, 155.~~ (FOF 197~~197~~.)

~~189.~~179. Subject to the grant of necessary government approvals for the permanent abandonment of all EMI diversion structures on East and West Wailuanui Streams and completion of work to effectuate such abandonment, the amended IIFS for Wailuanui Stream shall be the natural flow of East Wailuanui and West Wailuanui Streams immediately below the EMI diversions on those streams at the Ko‘olau Ditch.

4. Honopou Stream

~~190.~~180. The major diversions on Honopou Stream are the Wailoa, New Hamakua, Lowrie, and Haiku Ditches. (FOF 138~~118~~.) HC&S will no longer divert Honopou Stream. (FOF 157~~157~~.)

~~191.~~181. The 2008 Commission decision established the amended IIFS just below the Haiku ditch at 1.29 mgd (2.00 cfs). (FOF 141~~121~~.)

~~192.~~182. A second IIFS of 0.47 mgd (0.72 cfs) was established downstream of taro and domestic diversions below the Haiku ditch, to prevent drying of the stream and increase the continuity of flow to enhance biological integrity in the stream. This resulted in 0.82 mgd (1.29 - 0.47 mgd) available to the taro and domestic diversions, and 0.47 mgd to increase continuity of flow to the ocean. (FOF 142~~122~~.)

~~193. Taro water requirements were estimated at 0.80-0.93 mgd, essentially matching the available water of 0.82 mgd for taro, *supra*, COL 142.~~

~~194.~~183. ~~Available water for habitat restoration was 0.47 mgd, *supra*, COL 142, but flows for habitat restoration (H_{90}) are not known,~~ Estimated undiverted flows for Honopou are because

Honopou Stream was not included in the 2004 Stream Flow study~~2009 Habitat Availability Study~~. (FOF ~~103~~138~~138~~.)

~~195.~~184. Subject to the grant of necessary government approvals for the permanent abandonment of the EMI diversion structure on Honopou Stream and completion of work to effectuate such abandonment, the amended IIFS for Honopou Stream shall be the natural flow of the stream immediately below the EMI diversions on the stream at the Haiku Ditch.~~However, total ground water gain to a point just below the Haiku Ditch is estimated at 2.3 mgd (3.6 cfs). (Exh. C-85, p. 16.) If it is assumed that this is BFQ_{50}, then H_{90} or 64 percent of BFQ_{50} would be 1.49 mgd (2.3 cfs). With the amended IIFS at the lower IIFS location at 0.47 mgd (0.72 cfs), an additional 1.02 mgd (1.58 cfs) would be needed to reach flows equivalent to H_{90}. Thus the lower IIFS would be amended to 1.49 mgd (2.3 cfs), and the upper IIFS would be amended to 2.31 mgd (3.58 cfs) to keep 0.82 mgd available for taro~~.

5. Hanehoi/Puolua (Huelo) Streams

~~196.~~185. Major diversions on Hanehoi Stream were~~are~~ the Wailoa, New Hamakua, Lowrie, and Haiku Ditches. Its tributary, Puolua Stream, is diverted by the Lowrie and Haiku Ditches. HC&S will no longer divert Hanehoi and Puolua (Huelo) Streams. (FOF 158~~158~~, 174~~174~~~~137~~.)

~~197.~~186. One amended IIFS of 0.74 mgd (1.15 cfs) was established on Hanehoi Stream above the Lowrie Ditch to provide water for domestic use in the Huelo community. (FOF 166~~144~~, 169~~147~~.)

~~198.~~187. Two other amended IIFS were established on Hanehoi Stream and Puolua Stream below the Haiku Ditch and above the confluence of the two streams to serve users downstream of the Haiku Ditch: 0.57 mgd (0.89 cfs) for Puolua Stream and 0.41 mgd (0.63 cfs) for Hanehoi Stream. (FOF 165~~143~~, 168~~146~~.)

~~199.~~188. Part of the purpose of the two amended IIFS below the Haiku Ditch was to improve stream habitat. (FOF 164~~142~~.) But the IIFS at the stream mouth was not amended because of the small number of registered users below the confluence of the two streams, and because of a terminal waterfall. (FOF 167~~145~~.)

~~200.~~ As with Honopou Stream, Hanehoi/Puolua Streams were not included in the 2009 Habitat Availability Study (FOF 103), so flow statistics were estimated with regression equations. The estimated BFQ_{50} undiverted flow of Hanehoi Stream is 2.54 cfs (1.64 mgd) below the Lowrie Ditch and above the Haiku Ditch. The estimated BFQ_{50} undiverted flow of Puolua (Huelo)

Stream is 1.07 cfs (0.69 mgd) below the Lowrie Ditch and above the Haiku Ditch and 1.47 cfs (0.95 mgd) below the Haiku Ditch. The estimated BFQ_{50} undiverted flow at the mouth of Hanehoi Stream is 5.35 cfs (3.46 mgd). (FOF 158~~158.~~)~~, so flows for habitat restoration (H_{90}) are not known.~~

~~201.~~189. 201. However, estimates of undiverted flow at the stream mouth are available, with BFQ_{50} estimated at 3.46 mgd (5.35 cfs). (Exh. C-85, p. 26.) Estimated H_{90} flows would therefore be 64 percent of BFQ_{50}, or 2.21 mgd (3.42 cfs).

~~202.~~190. Requirements for taro are estimated at 0.30-0.35 mgd, *supra*, COL 138~~142~~, while a total of 0.98 mgd have been made available, 0.57 mgd from Puolua Stream and 0.41 mgd from Hanehoi Stream. Therefore, about 0.63 mgd (0.97 cfs) would remain below the confluence of the two streams at the stream mouth.

~~203.~~191. To increase flow at the stream mouth to H_{90} or 2.21 mgd (3.42 cfs), an additional 1.58 mgd (2.45 cfs) would need to reach the mouth from the amended IIFS locations on Puolua and Hanehoi Streams.

~~204.~~192. The current amended IIFS for Puolua Stream of 0.57 mgd (0.89 cfs) is the estimated natural, undiverted BFQ_{95} flow. The BFQ_{50} at that location below the Haiku Ditch is estimated at 0.95 mgd (1.47 cfs), but BFQ_{50} above the Haiku Ditch is estimated at a lower 0.69 mgd (1.07 cfs).

~~205.~~193. Using the BFQ_{50} above the Haiku Ditch for Puolua Stream, the amended IIFS below the Haiku Ditch would be increased by ~~0.12~~____ mgd (~~0.18~~____ cfs), from 0.57 mgd (0.89 cfs) to ~~0.69~~____ mgd (~~1.07~~____ cfs), and the remainder of the increase, ~~1.46~~____ mgd (~~2.27~~____ cfs), would be added to the amended IIFS on Hanehoi Stream, increasing it from ~~0.41~~____ mgd (~~0.63~~____ cfs) to ~~1.87~~____ mgd (~~2.90~~____ cfs).

~~206.~~194. Subject to the grant of necessary government approvals for the permanent abandonment of all EMI diversion structures on Hanehoi and Puolua (Huelo) Streams and completion of work to effectuate such abandonment, ~~T~~the revised IIFS are~~would be~~ as follows:

a. The natural flow of Hanehoi Stream immediately below the Wailoa Ditch.

b. The natural flow of Hanehoi Stream immediately below the New Hamakua Ditch.

~~a.~~c. <An amount necessary to accommodate the needs of the Huelo community> on Hanehoi Stream above the Lowrie Ditch.~~The amended IIFS of 0.74 mgd (1.15 cfs) on Hanehoi Stream above the Lowrie Ditch to provide water for domestic use in the Huelo community would remain unchanged.~~

~~b.~~d. The IIFS on Puolua Stream below the Haiku Ditch would be amended from 0.57 mgd (0.89 cfs) to ~~0.69 mgd (1.07 cfs)~~<an amount necessary to improve stream habitat and accommodate the needs of users downstream of the Haiku Ditch>.

~~c.~~e. The IIFS on Hanehoi Stream below the Haiku Ditch would be amended from 0.41 mgd (0.63 cfs) to ~~1.87 mgd (2.90 cfs)~~ <an amount necessary to improve stream habitat and accommodate the needs of users downstream of the Haiku Ditch>.

~~d.~~f. A new IIFS of <an amount necessary to improve habitat at the stream mouth>~~2.21 mgd (3.42 cfs)~~ would be established just above the terminal waterfall at the mouth of Hanehoi Stream.

~~0.74~~____ mgd (~~1.15~~____ cfs) would ~~continue to~~ be available to the Huelo community, ~~0.35~~ mgd would meet the taro requirements of ~~0.30 0.35~~____ mgd, and the flow at the mouth of Hanehoi Stream of 2.21 mgd (3.42 cfs) would be the H_{90} flow for native stream animals.

195. Assuming no flows at the amended IIFS sites before the 2008 Commission Order, that order restored a total of 1.72 mgd (2.67 cfs) at three sites. The proposed amended IIFS and additional IIFS restores an additional ~~1.58~~____ mgd (~~2.45~~____ cfs), for a total restoration of ~~3.3~~____ mgd (~~5.12~~ ____cfs) to meet domestic uses for the Huelo community, water requirements for taro, and habitat requirements for native stream animals.

~~207.~~

6. East Wailuaiki, West Wailuaiki, Waikamoi, and Waiohue Streams

~~208.~~196. The IIFS of these four streams should be amended to annual, year-round flows in the amounts they were previously amended only for wet season (winter) flows. (FOF 265~~245~~.)

~~209.~~197. East Wailuaiki Stream: The interim IIFS below all EMI diversions and just above Hana Highway, near an altitude of 1,235 feet, shall be an estimated flow of 2.39 mgd (3.70 cfs). (Exh. HO-1; Exh. C-103, p. 22.)

~~210.~~198. West Wailuaiki Stream: The interim IIFS below all EMI diversions and just above Hana Highway, near an altitude of 1,235 feet, shall be an estimated flow of 2.46 mgd (3.80 cfs). (Exh. HO-1; Exh. C-103, p. 22.)

~~211.~~199. Waikamoi Stream: The interim IIFS below the confluence with its tributary, Alo Stream, below all EMI diversions and just above Hana Highway, near an altitude of 550 feet, shall be an estimated flow of 1.81 mgd (2.80 cfs). (Exh. HO-1; Exh. C-103, p. 21.)

~~212.~~200. Waiohue Stream: The interim IIFS below all EMI diversions and just above Hana Highway, near an altitude of 1,195 feet, shall be an estimated flow of 2.07 mgd (3.20 cfs). (Exh. HO-1; Exh. C-103, p. 23.)

7. Hanawi Stream

~~213.~~201. The purpose of the amended IIFS in the 2010 Commission Order was to create a wetted pathway to provide connectivity from the Ko`olau Ditch diversion to the ocean for native stream animals. (FOF 260~~240~~.)

~~214.~~202. The interim IIFS below all EMI diversions and just above Hana Highway, near an altitude of 1,300 feet, shall remain at an estimated flow of 0.06 mgd (0.10 cfs). (Exh. HO-1; Exh. C-103, p. 23.)

8. Makapipi Stream

~~215.~~203. The major diversion on Makapipi Stream is the Ko`olau Ditch. (FOF 287~~267~~-288~~268~~.)

~~216.~~204. Makapipi Stream was preliminarily selected for restoration, because the Nahiku community relies heavily on the stream for cultural practices, recreation, and other instream uses. However, with the uncertainty of gaining and losing reaches along most of the stream's course to the ocean, it was not known whether restored flow will result in continuous stream flow from the headwaters to the stream mouth. Therefore, a short-term release of water from the Ko`olau Ditch was ordered to determine the sustainability of the proposed standard of 0.60 mgd (0.93 cfs), TFQ_{70} or BFQ_{50}, just upstream of Hana Highway. (FOF 260~~240~~, 287~~267~~.)

~~217.~~205. When the sluice gates on the Koolau Ditch were partially opened to allow the majority of the water in Makapipi Stream to flow downstream of the diversion, flows ranged from 0.87 mgd (1.35 cfs) on September 14, 2010 to 0.76 mgd (1.18 cfs) on September 17, 2010. Daily site visits during September 13-17, 2010, indicated zero flow at the Hana Highway Bridge, located about two-thirds of a mile downstream of the diversion. A 1,000-foot reach upstream of the Hana Highway Bridge was dry, with the exception of a few isolated pools of water, and there was no indication of recent streamflow. The precise location where the stream went dry farther upstream was not determined, because it could not be safely accessed on foot. Much of the lower sections of the stream below the highway was largely dry, with isolated reaches with pools of water. (FOF 288~~268~~.)

~~218.~~206. Five days of releases is not a definitive test of whether infiltration losses would be permanent. There was enough water to be released from the Ko`olau Ditch to meet the proposed amended IIFS of 0.60 mgd (0.93 cfs), because only partially opening the sluice gates resulted in flows ranging from 0.76 mgd (1.18 cfs) to 0.87 mgd (1.35 cfs) over four days in September 2010.

~~219.~~207. Irrigation requirements for Makapipi Stream are 0.54 mgd - 0.63 mgd, *supra*, COL 58~~58~~, so an amended IIFS of 0.60 mgd (0.93 cfs), if achievable, would be sufficient to meet irrigation needs.

9. Kopiliula Stream and its Tributary, Puakaa Stream

~~220.~~208. The major diversion on Kopiliula Stream and its tributary Puakaa Stream is the Ko`olau Ditch. (Exh. C-103, p. 1-21.)

~~221.~~209. Kopiliula Stream and its tributary, Puakaa Stream, was ranked fourth in DAR's initial top eight streams for restoration in its 2009 Habitat Availability Study (FOF 128~~108~~), was ranked number fifth in DAR's revised priority ranking (FOF 115), but was one of three streams in DAR's top eight ranking that was not recommended by Commission staff because the streams were used for conveyance. However, in the case of Kopiliula Stream, DAR had also recommended that the area of commingling of the ditch and stream water could be bypassed with a box flume. (FOF 261~~241~~.)

~~222.~~210. Below the Ko`olau Ditch, natural $BFQ_{50}$ would be 3.23 mgd (5.00 cfs), so $H_{90}$ (64 percent of $BFQ_{50}$) would be 2.07 mgd (3.20 cfs). Diverted $BFQ_{50}$ is 0.32 mgd (0.5 cfs), so 1.75 mgd (2.70 cfs) would have to be added from the Ko`olau Ditch to reach an amended IIFS of 2.07 mgd (3.20 cfs). (Exh. HO-1.)

~~223.~~211. For Puakaa Stream, as in the case of Hanawi Stream, habitat could be restored through minimal flow restoration for connectivity, but Commission staff concluded that there would be only 300 meters of habitat unit gain, compared to over 1300 meters for Hanawi Stream, and that the cost and effort to modify the Ko`olau Ditch diversion was better spent on Hanawi Stream. (FOF 263~~243~~.)

~~224.~~212. Flow below the Ko`olau Ditch under diverted conditions is an estimated 0.39 mgd (0.50 cfs), which provides minimal connectivity in the wet season. In the dry season, an additional 0.06 mgd (0.1 cfs) would have to be added to the existing 0.39 mgd (0.60 cfs) of flow to achieve minimal connectivity. Thus, the amended IIFS for Puakaa Stream would be 0.45 mgd (0.70 cfs). (Exh. HO-1.)

10. Kualani (Hamau) and Ohia (Waianu) Streams

~~225.~~213. Kualani (Hamau) and Ohia (Waianu) Streams are both below the EMI Ditch System and have never been diverted by EMI. (FOF 64~~58~~.)

~~226.~~214. Kualani (Hamau) Stream: The interim IIFS shall remain as designated on October 8, 1988. The estimated flow is unknown. (Exh. HO-1.)

~~227.~~215. Ohia (Waianu) Stream: The interim IIFS just above Hana Highway, near an altitude of 195 feet, shall remain as designated on October 8, 1988. This is equivalent to an estimated flow of 2.97 mgd (4.60 cfs). (Exh. HO-1; Exh. C-103, p. 22.)

11. Alo, Kapaula, Waiaaka, Paakea, Puakaa, Nuaailua, Honomanu, Punalau/Kolea, Haipuaena, Puohokamoa, and Wahinepee Streams

~~228.~~216. The IIFS of the remaining streams shall remain at their status quo flows as designated on October 8, 1988.

~~229.~~217. Alo Stream (tributary of Waikamoi Stream): The interim IIFS shall remain as designated on October 8, 1988. (The interim IIFS of Waikamoi Stream has been set below its confluence with Alo Stream.) (Exh. HO-1.)

~~230.~~218. Kapaula Stream: The interim IIFS below all EMI diversions and just above Hana Highway, near an altitude of 1,194 feet, shall remain as designated on October 8, 1988. This is equivalent to an estimated flow of 0.13 mgd (0.2 cfs). (Exh. HO-1; Exh. C-103, p. 23.)

~~231.~~219. Waiaaka Stream: The interim IIFS below all EMI diversions and just above Hana Highway, near an altitude of 1,235 feet, shall remain as designated on October 8, 1988. This is equivalent to an estimated flow of 0. (Exh. HO-1; Exh. C-103, p. 23.)

~~232.~~220. Paakea Stream: The interim IIFS below all EMI diversions and just above Hana Highway, near an altitude of 1,265 feet, shall remain as designated on October 8, 1988. This is equivalent to an estimated flow of 0.97 mgd (1.50 cfs). (Exh. HO-1; Exh. C-103, p. 23.)

~~233.~~221. Nuaailua Stream: The interim IIFS below all EMI diversions and just above Hana Highway, near an altitude of 110 feet, shall remain as designated on October 8, 1988. This is equivalent to an estimated flow of 2.0 mgd (3.1 cfs). (Exh. HO-1; Exh. C-103, p. 22.)

~~234.~~222. Honomanu Stream: The interim IIFS below all EMI diversions and just above Hana Highway, near an altitude of 20 feet, shall remain as designated on October 8, 1988. This is equivalent to an estimated flow of 0. (Exh. HO-1; Exh. C-103, p. 21.)

~~235.~~223. Punalau/Kolea Stream: The interim IIFS below all EMI diversions and just above Hana Highway, near an altitude of 40 feet, shall remain as designated on October 8, 1988. This is equivalent to an estimated flow of 0.13 mgd (0.20 cfs). (Exh. HO-1; Exh. C-103, p. 1-9.)

~~236.~~224. Haipuaena Stream: The interim IIFS below all EMI diversions and just above Hana Highway, near an altitude of 510 feet, shall remain as designated on October 8, 1988. This is equivalent to an estimated flow of 0.06 mgd (0.1 cfs). (Exh. HO-1; Exh. C-103, p. 21.)

~~237.~~225. Puohokamoa Stream: The interim IIFS below all EMI diversions and just above Hana Highway, near an altitude of 565 feet, shall remain as designated on October 8, 1988. This is equivalent to an estimated flow of 0.26 mgd (0.4 cfs). (Exh. HO-1; Exh. C-103, p. 21.)

~~238.~~226. Wahinepee Stream: The interim IIFS below all EMI diversions and just above Hana Highway, near an altitude of 575 feet, shall remain as designated on October 8, 1988. This is equivalent to an estimated flow of 0.32 mgd (0.5 cfs). (Exh. HO-1; Exh. C-103, p. 21.)

H. Balancing of Instream versus Noninstream Uses

~~239.~~227. "In considering a petition to adopt an interim instream flow standard, the commission shall weigh the importance of the present or potential instream values with the importance of the present or potential uses of water for noninstream purposes, including the economic impact of restricting such uses." (HRS § 174C-71(2)(D).)

1. Instream Values

~~240.~~228. The primary instream values are the conveyance of irrigation and domestic water supplies to downstream points of diversion for appurtenant/riparian and domestic uses, and the maintenance of fish and wildlife habitats, which protect the traditional and customary Hawaiian rights of growing wetland taro and gathering of native stream animals. The stream-by-stream IIFS amendments have addressed appurtenant/riparian and domestic uses, and the geographic approach has addressed the maintenance of fish and wildlife habitats.

~~241.~~229. Waiokamilo Stream no longer is diverted, and Kualani (Hamau) Stream and Ohia (Waianu) Streams are below, and therefore have never been diverted by, the EMI Ditch System.

Moreover, Piinaau, Palauhuku, East and West Wailuanui, Honopou, Hanehoi, and Puolua (Huelo) Streams are no longer diverted.

~~242.~~230. The proposed amended IIFS would restore the following amounts of flow **[Note: The chart below would need to be revised to reflect new IIFS recommendations]**:

	Amended IIFS	Amount Restored
Palauhulu Stream	3.10 mgd (4.80 cfs)	0[30]
Waiokamilo Stream	3.17 mgd (4.90 cfs)	0[31]
Wailuanui Stream	4.03 mgd (6.23 cfs)	
		2.06 mgd (3.19 cfs)[32]
	2.77 mgd (4.29 cfs)	
Honopou Stream	2.31 mgd (3.58 cfs)	
		2.17 mgd (3.36 cfs)[33]
	1.49 mgd (2.30 cfs)	
Hanehoi/Puolua Streams	0.74 mgd (1.15 cfs)	
	1.87 mgd (2.90 cfs)	3.30 mgd (5.12 cfs)[34]
	0.69 mgd (1.07 cfs)	
East Wailuaiki Stream	2.39 mgd (3.70 cfs)	2.39 mgd (3.70 cfs)[35]
West Wailuaiki Stream	2.46 mgd (3.80 cfs)	2.46 mgd (3.80 cfs)[36]
Waikamoi Stream	1.81 mgd (2.80 cfs)	1.68 mgd (2.60 cfs)[37]
Waiohue Stream	2.07 mgd (3.20 cfs)	2.07 mgd (3.20 cfs)[38]
Hanawi Stream	0.06 mgd (0.10 cfs)	0.06 mgd (0.10 cfs)[39]
Kopiliula/Puakaa Streams	2.07 mgd (3.20 cfs)	1.75 mgd (2.70 cfs)[40]
	0.45 mgd (0.70 cfs)	0.06 mgd (0.1 cfs)[41]
Makapipi Stream	0.60 mgd (0.93 cfs)--**test**	0.60 mgd (0.93 cfs)--**test**[42]

[30] 2008 amendment to 3.56 mgd (5.50 cfs) reduced back to status quo, *supra*, COL 170~~178~~-171~~179~~.
[31] No longer diverted due to BLNR ordering 6 mgd to be restored, but without diversions, flow is only 3.17 mgd (4.90 cfs). (FOF 184~~160~~, 186~~162~~.)
[32] COL 177~~187~~-178~~188~~.
[33] FOF 141~~121~~, 144~~124~~, 202~~182~~; COL 184~~195~~.
[34] FOF 202~~182~~; COL 187~~197~~-188~~198~~, 194~~206~~.
[35] Exh. HO-1.
[36] Exh. HO-1.
[37] Exh. HO-1.
[38] Exh. HO-1.
[39] Exh. HO-1.
[40] COL 190~~222~~.
[41] COL 212~~224~~.

Total (with Makapipi Stream):	18.60 mgd (28.80 cfs)
Total (without Makapipi Stream)	18.00 mgd (27.87 cfs)

~~243.~~231. The amended IIFS for Palauhulu, Waiokamilo, Wailuanui, Honopou, and Hanehoi/Puolua Streams would provide sufficient flows for irrigation and domestic uses.

~~244.~~232. Whether flows can be increased to serve irrigation requirements from Makapipi Stream are to be determined by a longer test period than initially conducted.

~~245.~~233. Flows sufficient to enable growth, reproduction, and recruitment of native stream animals would be restored for Piinaau, Palauhulu, Wailuanui, Honopou, Hanehoi/Puolua, East Wailuaiki, West Wailuaiki, Waikamoi, Waiohue, Hanawi, and Kopiliula/Puakaa Streams.

~~246.~~234. Commission staff estimates that approximately 43.82 mgd (67.83 cfs) of groundwater (base flows, BFQ_{50}) were previously ~~have been~~ diverted by EMI from the streams that are the subject of this contested case, and the total amount diverted by EMI should be calculated from total median flow (TFQ_{50}) to include the contribution of rainfall. (Exh. HO-1, footnotes 3-4.)

~~247.~~235. Based on the foregoing premises, the amended IIFS would restore about (18.00 - 18.60)/43.82, or 41 to 42 percent of base flows that EMI had previously diverted from the 23 of 27 streams that are the subject of this contested case. (FOF 63~~57~~-65~~59~~.)

~~248.~~236. The amount of total flows diverted from these streams could be calculated but was not presented in this contested case. Moreover, the EMI Ditch System formerly diverted~~s~~ a total of at least 43 streams (FOF 65~~59~~.)

~~249.~~237. ~~On average, the total amount of stream flows diverted by EMI's Ditch System has been 114 mgd to 167 mgd. (FOF 14, 312.) Therefore, the proposed amendments' total of 18 mgd would represent 11 to 16 percent of EMI's diversions. Diversions also vary greatly, averaging 134 mgd in the winter months and 268 in the summer months. (FOF 14.) The proposed IIFS amendments would therefore represent a 13 percent reduction in the winter and a 7 percent reduction in the summer of EMI's diversions.~~

[42] The five days of test releases were not enough to determine if infiltration losses could be overcome with a constant flow. Therefore, it is proposed that a longer test period be conducted before concluding whether or not continuous flow to the ocean from the Ko`olau Ditch can be achieved with a flow of 0.60 mgd (0.93 cfs) to provide 0.54 to 0.63 mgd for irrigation requirements. (COL 205~~217~~-207~~219~~.)

~~250.~~238. Finally, the never-diverted flows of Kualani and Ohia Streams continue to provide their natural habitats, and any restoration of habitat for Waiokamilo Stream will depend on how much of the fully restored flows remain, if any, after diversions for irrigation.

2. Noninstream Values

a. HC&S

~~251.~~239. HC&S's reasonable and beneficial irrigation requirements for potential use are 3,307~~4,844~~ gad for its 26,996~~28,941~~ acres of diversified agriculture~~in sugarcane cultivation~~, or 89.21 mgd of total irrigation excluding system losses~~140.19 mgd~~. (FOF 346~~346~~346.)

~~252.~~240. Reasonable and beneficial system losses are 22.7 percent of total water uses, which consist of HC&S irrigation, deliveries to MDWS, and HC&S industrial and other uses. Based on a 22.7 percent loss rate, 26.22 mgd of the total gross irrigation requirement of 115.43 mgd reasonably constitutes system losses. (FOF 332~~312~~-335~~315~~, 378~~399~~.)

~~253.~~241. Brackish ground-water usable pump capacity is 115 mgd to 120 mgd, limited by a likely increase in aquifer salinity levels, especially in the summer months when pumping is highest. (FOF 385~~408~~-386~~409~~.)

242. The brackish water wells can be used to irrigate 17,200 acres of the approximately 30,000 acres serviced by waters from the EMI Ditch System (FOF 400)~~, or about 83.32 mgd (4,844 gad x 17,200 acres) of the 115 mgd to 120 mgd usable capacity~~.

~~254.~~243. It is estimated that pumped groundwater in an amount of between 0 to 20 percent of total water use would be available to HC&S for use on 17,200 acres, or from 0 to 23 mgd.

~~255.~~244. After adding total water uses and system losses and subtracting between ~~about~~ 0--23~~36.8~~ ~~83~~ -mgd from brackish ground~~-~~water wells, between ~~the remainder of 104~~92.43-115.43 mgd would be the reasonable and beneficial future use by HC&S of EMI ditch system surface waters for diversified agriculture.

~~256. Assuming the following:~~

~~a. sugarcane irrigation requirements at 4,844 gad for its 28,941 acres in sugarcane cultivation, or 140.19 mgd, *supra*, COL 251;~~

~~b. average use by MDWS from the Wailoa Ditch at 7.1 mgd for the Kamole WTP and Kula Agricultural Park (FOF 83); and~~

~~c. HC&S industrial and other uses at 6.66 mgd (FOF 313); and~~

cd. reasonable losses at 22.7 percent, *supra*, COL 252, of 153.95 mgd (140.19 + 7.1 + 6.66 = 153.95), or 34.95 mgd.

Total reasonable and beneficial use would be 188.9 mgd.

257. Water from brackish groundwater wells could provide a maximum of 83.32 mgd, *supra* COL 254, leaving a total of 105.58 mgd to be provided from surface water from EMI's Ditch System.

249. On average, the total amount of stream flows diverted by EMI's Ditch System has been 114 mgd to 167 mgd, and the proposed amendments, *supra* COL 249, would reduce that amount to 96 to 149 mgd, compared to a need of 105.58 mgd of stream waters, *supra*, COL 257.

250. HC&S provided estimates of costs related to:

a. reduced deliveries to the Wailoa Ditch and Kauhikoa Ditch, which result in reduced water availability to irrigate the 12,800 acres of sugarcane that cannot be irrigated with ground water. The financial impact was therefore calculated in terms of HC&S's anticipated loss in sugar yields due to the average decrease in available water, with an average annual financial impact to HC&S per million gallons of reduced deliveries to either the Wailoa Ditch or Kauhikoa Ditch estimated at $507,858. (FOF 441.)

b. reduced deliveries to the Lowrie Ditch and Haiku Ditch, assumed to be compensated for by increased pumping of brackish ground water. The financial impact was therefore calculated in terms of the average cost of this pumping. (FOF 442.)

251. However, given the large difference between tons of sugar produced by nearly identical amounts of water (a ratio of 1.55 for 2009 versus 2.51 for 2003), a consistent relationship between tons of sugar produced and amount of irrigation water was questionable. (FOF 443-447.)

252. For the increased pumping costs for the Lowrie and Haiku ditches, a direct relationship between pumping costs and increased pumping was logical (FOF 448), but no more ground water could be pumped than the maximum of 83.32 mgd, *supra* COL 254, assumed to being already pumped before use of surface water was necessary.

253. Compared to a need of 105.58 mgd of stream waters, there would be 96 mgd to 149 mgd available, *supra*, COL 249. Therefore, there would be no more than a 10 mgd or 9 percent shortfall some of the time, and still more surface water than needed most of the time.

b. MDWS

245. ~~254.~~ MDWS diverts water:

a. at its upper Waikamoi Flume from the Waikamoi, Puohokamoa, and Haipuena Streams (FOF 93~~73~~);

b. at its lower Waikamoi Flume from the Waikamoi, Puohokamoa, Haipuaena, and Honomanu Streams (FOF 94~~74~~); and

c. draws water from EMI's Wailoa Ditch, which diverts multiple streams, including all the streams for which amended IIFS are being proposed, except that Waiokamilo Stream is reported as no longer being diverted (FOF 167).

246. ~~255.~~ The Upper Waikamoi Flume diverts an average of 1.6 mgd from Waikamoi, Puohokamoa, and Haipuaena Streams for treatment into potable water at the Olinda WTP. (FOF 93~~73~~.)

247. ~~256.~~ The 1.6 mgd represents 21 percent of the 7.7 mgd average daily potable water production for MDWS's Upcountry System. (FOF 93~~73~~-94~~74~~, 97~~77~~.)

248. ~~257.~~ From upstream to below the Upper Waikamoi Flume, no habitat has been lost from either flow diversions or barriers on Waikamoi, Puohokamoa, or Haipuaena Streams. (2009 Habitat Availability Study (*see* FOF 102), p. 97, Table 13.)

249. ~~258.~~ The Lower Waikamoi Flume diverts an average of 2.5 mgd from Waikamoi, Puohokamoa, Haipuaena, and Honomanu Streams. (FOF 94~~74~~.)

250. ~~259.~~ The 2.5 mgd represents 32 percent of the 7.7 mgd average daily potable water production for MDWS's Upcountry System. (FOF 93~~73~~-94~~74~~, 97~~77~~.)

251. ~~260.~~ From below the Upper Waikamoi Flume to below the Lower Waikamoi Flume, Waikamoi Stream has lost 1.8 percent of total habitat units from flow diversion and 3.6 percent from a barrier. (2009 Habitat Availability Study, p. 96-97, Table 13.)

252. ~~261.~~ For restoration of flows to 64 percent of BFQ_{50}, or H_{90}, DAR had recommended no change at the Upper and Lower Kula Flumes except to address the barriers, recommending instead that flows be restored at the Wailoa Ditch or its counterparts (Ko'olau and Spreckels ditches) and lower for Waikamoi Stream. (C-103, p. 1-1.)

253. ~~262.~~ Thus, there are no competing costs and benefits between restoring Waikamoi Stream and continued diversions by MDWS at its Upper and Lower Waikamoi Flumes. MDWS could continue to divert 53 percent of potable water supplies for its Upcountry System, and Waikamoi Stream could be restored to H_{90}.

254. ~~263.~~ EMI's Wailoa ditch, which diverts multiple streams, including all of the streams for which increased IIFS are being proposed, is the source of water for MDWS's Kamole water treatment facility. The Kamole facility's average daily production is 3.6 mgd, with a capacity of 6 mgd. (FOF 97~~77~~.)

255. ~~264.~~ HC&S's Hamakua ditch (the western extension of the Wailoa ditch), at reservoir 40, is the source of water for Kula Agricultural Park. (FOF 99~~79~~.)

256. ~~265.~~ Average daily use by MDWS from the Wailoa ditch is 7.1 mgd, which includes water for the Kamole facility and Kula Agricultural Park. (FOF 103~~83~~.)

257. ~~266.~~ The impact on MDWS's provision of water for upcountry Kula would be a potential loss of up to 47 percent (3.6 mgd/7.7 mgd) of its average daily potable water production, and loss of the only source of water for Kula Agricultural Park.

258. ~~267.~~ The proposed amended IIFS restoring 18 mgd would come mostly from the Ko`olau Ditch, which becomes the Wailoa Ditch as water flows westerly toward HC&S's fields. (*See* Exh. C-1, attached.)

259. ~~268.~~ MDWS's agreement with EMI provides that MDWS will receive 12 mgd from the Wailoa ditch with an option for an additional 4 mgd. During periods of low flow, no water will be diverted to lower-elevation ditches, and MDWS will receive a minimum allotment of 8.2 mgd and HC&S will also receive 8.2 mgd. If these minimum amounts cannot be delivered, MDWS and HC&S will receive prorated shares of the water available. (FOF 102~~82~~.)

260. ~~269.~~ Therefore, the 18 mgd in proposed restored flows will come from HC&S's share of the water until Wailoa Ditch flows begin to drop below 34.4 mgd (18 mgd + 8.2 mgd + 8.2 mgd = 34.4 mgd). Average Wailoa Ditch flow from 1922 to 1987 has been 108.8 mgd, with flows less than 42.46 mgd for five days out of a year. (FOF 90~~70~~.)

261. ~~270.~~ Therefore, MDWS's use of 7.1 mgd of water from the Wailoa Ditch would seldom compete with the amended IIFS's increased needs for 18 mgd, and if such competition occurs, it would be for only a few days a year, *supra*, COL 260~~269~~.

262. ~~271.~~ Furthermore, while MDWS's needs would be at least 3.6 million gallons daily for potable water (the Kula Agricultural Park use of 3.5 mgd could be met for a few days by its 5.4 million gallon reservoirs [FOF 99~~79~~]), the 18 mgd for the amended IIFS would be spread among 9 streams, *supra*, COL 230~~242~~, and temporary, modest decreases in flow for irrigation and habitat would be better tolerated than decreases in available potable water for Upper Kula residents.

263. 272. Finally, resource protection--i.e., instream uses--is not a categorical imperative; there are no absolute priorities among trust purposes--e.g., between stream restoration and domestic uses of the general public, particularly drinking, *supra*, COL 1212.

264. 273. Thus, the weighing of costs and benefits is in favor of MDWS's continued use of its share of Wailoa Ditch diversions.

III. DECISION AND ORDER

The Commission bears the burden of establishing IIFS that protect instream values to the extent practicable and to protect the public interest, need only to reasonably estimate instream and offstream demands, and may base the IIFS not only on scientific proven facts but also on future predictions, generalized assumptions, and policy judgments. (COL 34-36.)

Legal conclusions made in this proceeding pertaining to a particular party's water rights, traditional and customary Hawaiian rights, water-use requirements, alternative water sources, and system losses are made without prejudice to the rights of any party and the Commission to revisit these issues in any proceeding involving the use of water from any of the East Maui streams that are the subject of this contested case hearing. The burden of proof with respect to such issues will be upon the petitioner rather than upon the Commission. (COL 37.)

When scientific evidence is preliminary and not yet conclusive regarding the management of fresh water resources which are part of the public trust, it is prudent to adopt "precautionary principles" in protecting the resource. Lack of full scientific certainty should not be a basis for postponing effective measures to prevent environmental degradation. (COL 15.)

Uncertainty regarding the exact level of protection necessary justifies neither the least protection feasible nor the absence of protection. Although interim standards are merely stopgap measures, they must still protect instream values to the extent practicable. The Commission may still act when public benefits and risks are not capable of exact quantification. (COL 16.)

However, reason and necessity dictate that the public trust may have to accommodate offstream diversions inconsistent with the mandate of protection, to the unavoidable impairment of public instream uses and values. (COL 14.)

A. Amended IIFS

The regression estimates have, in many cases, overstated stream flows, so if the sluice gates on the ditches are opened, there still may not be enough flow to meet the amended IIFS. *See* COL 145~~149~~-151~~155~~.

If actual flows are insufficient to meet the amended IIFS which were based on the regression estimates, flows up to actual BFQ_{50} shall be released for irrigation and domestic uses.

a. Surface water rights apply only to groundwater or base flows; rainfall and storm waters are the property of the State. *See* COL 26. 13.

b. The estimates of wetland taro and other agricultural requirements, including those that would also qualify for traditional and customary Hawaiian rights, were based on a subset of acreage that Nā Moku claimed for appurtenant and riparian rights. *See* COL 291-310. ~~These acres were demonstrated as suffering actual harm to their owners' reasonable use. *See* COL 30.~~

c. The continued use of the waters by diverters HC&S and MDWS is contingent on a demonstration that such use will not harm the established rights of appurtenant and riparian landowners, and that has been demonstrated, either through no harm, or requiring reduced use by the diverter if there is insufficient water for both rightsholders and diverters. *See* COL 237~~249~~, 241~~253~~, 253~~262~~, 261~~270~~-264~~273~~.

Subject to the grant of necessary government approvals for the permanent abandonment of all EMI diversion structures on Palauhulu Stream, Pi‘ina‘au Stream, Wailuanui Stream, Honopou Stream, and Hanehoi/Puolua Stream and completion of work to effectuate such abandonment, ~~T~~the IIFS of the following streams are amended from their previous IIFS, at the approximate locations specified, with final locations approved by the Commission, if necessary, after implementation by Commission staff:

Palauhulu and Pi‘ina‘au Streams:

Amended IIFS: ~~The lesser of 3.10 mgd (4.80 cfs) or the estimated BFQ_{50} flow at the site as derived from actual flows.~~The natural flow of Pi‘ina‘au Stream and Palauhulu Stream immediately below the EMI diversions of those streams on Ko‘olau Ditch.

Location: Just below the Ko‘olau Ditch diversion~~Near 80 feet elevation, upstream with its confluence with Piinaau Stream~~ (*See* COL 171~~171~~~~179~~).

Waiokamilo Stream:

Amended IIFS: 3.17 mgd (4.90 cfs)

Location: Near Dam 3, just above the diversion to the Lakini taro patches *(See* COL 181).

<u>Wailuanui Stream</u>:

Amended IIFS: ~~The lesser of 4.03 mgd (6.23 cfs) or the estimated BFQ_{50} flow at the site as derived from actual flows.~~<u>The natural flow of Wailuanui Stream immediately below the EMI diversion on Ko'olau Ditch.</u>

Location: Near 620 feet elevation, downstream of the Koolau Ditch and below the confluence of East and West Wailuanui Streams (*See* COL <u>179</u>~~179184, 188~~).

Amended IIFS: The lesser of ~~2.77~~<u>4.33</u> mgd (~~4.29~~<u>6.70</u> cfs) or the estimated 64 percent of BFQ_{50} flow (H_{90}) at the site as derived from actual flows.

Location: Below Waikani Falls (*See* COL <u>179</u>~~179187~~).

<u>Honopou Stream</u>:

Amended IIFS: ~~The lesser of 2.31 mgd (3.58 cfs) or the estimated BFQ_{50} flow at the site as derived from actual flows.~~<u>The natural flow of Honopou Stream immediately below the EMI diversion on Haiku Ditch.</u>

Location: Just below the Haiku ditch (*See* COL <u>184</u>~~184191~~).

Amended IIFS: The estimated 64 percent of BFQ_{50} flow (H_{90}) at the site as derived from actual flows, currently estimated as 1.49 mgd (2.30 cfs).

Location: Downstream of taro and domestic diversions below the Haiku ditch, (*See* COL <u>182</u>~~192~~).

<u>Hanehoi/Puolua Streams</u>:

<u>Amended IIFS: The natural flow of Hanehoi Stream immediately below the Wailoa Ditch</u>

<u>Location: On Hanehoi Stream below the Wailoa Ditch (*See* COL 194).</u>

<u>Amended IIFS: The natural flow of Hanehoi Stream immediately below the New Hamakua Ditch</u>

<u>Location: On Hanehoi Stream below the New Hamakua Ditch (*See* COL 194).</u>

Amended IIFS: The lesser of <an amount necessary to accommodate the needs of the Huelo community upstream of the Lowrie Ditch> ~~0.74 mgd (1.15 cfs)~~ or the estimated BFQ$_{50}$ flow at the site as derived from actual flows~~.~~

Location: On Hanehoi Stream above the Lowrie Ditch *(See* COL 194~~190~~~~206~~).

Amended IIFS: <An amount necessary to improve stream habitat at the mouth of Hanehoi Stream>~~The estimated 64 percent of BFQ$_{50}$ flow (H$_{90}$) at the site as derived from actual flows, currently estimated as 2.21 mgd (3.42 cfs).~~

Location: Just above the terminal waterfall at the mouth of Hanehoi Stream (*See* COL 194~~190~~~~206~~).

Amended IIFS: <An amount necessary to improve stream habitat and accommodate the needs of users downstream of the Haiku Ditch>~~0.69 mgd (1.07 cfs)~~ or the estimated BFQ$_{50}$ flow at the site as derived from actual flows. (*See* COL 194).

Location: On Puolua Stream below the Haiku Ditch (*See* COL 194~~206~~).

Amended IIFS: <An amount necessary to improve stream habitat and accommodate the needs of users downstream of the Haiku Ditch>~~1.87 mgd (2.90 cfs)~~ or as explained below. (*See* COL 194).

Location: On Hanehoi Stream below the Haiku Ditch (*See* COL 194~~206~~).

The purpose of the two IIFS below the Haiku Ditch, one on Hanehoi Stream and the other on Puolua Stream, is to provide ~~0.35~~___ mgd to meet the taro irrigation requirements, *supra*, COL 183~~142~~, 190~~202~~. The sum of both IIFS, ~~2.56~~___ mgd (~~0.69~~___ mgd plus ~~1.87~~___ mgd), is ~~0.35~~___ mgd greater than the IIFS of ~~2.21~~___ mgd for habitat restoration located downstream. Thus, if the estimated IIFS cannot be achieved, ~~T~~the IIFS on Puoloa Stream would be established as the BFQ$_{50}$ flow at the site as derived from actual flows, and the IIFS on Hanehoi Stream would be established such that flows from both streams contribute to the ___~~0.35~~ mgd to meet the taro irrigation requirements, and the remaining combined flows equal 64 percent of BFQ$_{50}$ flow (H$_{90}$) at the lowest site as derived from actual flows.

East Wailuaiki Stream:

Amended IIFS: The estimated 64 percent of BFQ_{50} flow (H_{90}) at the site as derived from actual flows, currently estimated as 2.39 mgd (3.70 cfs).

Location: Below all EMI diversions and just above Hana Highway, near an altitude of 1,235 feet (*See* COL 197~~209~~).

West Wailuaiki Stream:

Amended IIFS: The estimated 64 percent of BFQ_{50} flow (H_{90}) at the site as derived from actual flows, currently estimated as 2.46 mgd (3.80 cfs).

Location: Below all EMI diversions and just above Hana Highway, near an altitude of 1,235 feet (*See* COL 198~~210~~).

Waikamoi Stream:

Amended IIFS: The estimated 64 percent of BFQ_{50} flow (H_{90}) at the site as derived from actual flows, currently estimated as 1.81 mgd (2.80 cfs).

Location: below all EMI diversions and just above Hana Highway, near an altitude of 550 feet (*See* COL 199~~211~~).

Waiohue Stream:

Amended IIFS: The estimated 64 percent of BFQ_{50} flow (H_{90}) at the site as derived from actual flows, currently estimated as 2.07 mgd (3.20 cfs).

Location: Below all EMI diversions and just above Hana Highway, near an altitude of 1,195 feet (*See* COL 200~~212~~).

Hanawi Stream:

Amended IIFS: 0.06 mgd (0.10 cfs) (to create a wetted pathway)

Location: Below all EMI diversions and just above Hana Highway, near an altitude of 1,300 feet (*See* COL 202~~214~~).

Kopiliula/Puakaa Streams:

Amended IIFS: The estimated 64 percent of BFQ_{50} flow (H_{90}) at the site as derived from actual flows, currently estimated as 2.07 mgd (3.20 cfs).

Location: On Kopiliula Stream, below the Ko`olau Ditch (*See* COL 210~~222~~).

Amended IIFS: Flow necessary to create a wetted pathway for an annual IIFS, estimated at 0.45 mgd (0.70 cfs) in the dry season (*See* COL 212~~224~~).

Location: On Puakaa Stream, below the Ko`olau Ditch (*See* COL 212~~224~~).

Makapipi Stream[43]:

Amended IIFS: 0.60 mgd (0.93 cfs) (achieved during test release, *supra* FOF 259~~268~~.)

Location: Below the Ko`olau Ditch (*See* COL 228~~216~~).

IIFS is subject to a continuous flow being established.

B. Status Quo IIFS

The remaining streams shall continue with their status quo IIFS as of October 8, 1988 (*See* COL 212~~226~~-238~~238~~).

C. Method of Monitoring

Monitoring of the IIFS will be through 12-month moving averages. This method recognizes that requiring a specific amount of flow at all times at a specific location is incompatible with the objectives of providing sufficient flow to meet irrigation and domestic requirements and/or providing sufficient habitat for growth, reproduction, and recruitment of native stream animals. *See* COL 151~~155~~-152~~156~~.

D. Reporting

Approximately one year from the date of this Order, the following information shall be provided:

a. Commission staff shall report on:

1. Whether or not continuous flow could be established in Makapipi Stream.
2. All other aspects of the implementation of the amended IIFS.

b. DAR shall report on:

1. Whether or not the flows implemented for East Wailuaiki, West Wailuaiki, Waikamoi, and Waiohue Streams that were estimated at 64 percent of BFQ_{50} did in fact result in H_{90} habitat.

[43] Makapipi Stream's amended IIFS is subject to a continuous flow being established.

2. Whether or not the assumptions that there is a treshold and that it is H_{90} are inconclusive or conclusive.

3. A reconnaissance of Kualani (Hamau) and Ohia (Waianu) Streams, which have never been diverted by the EMI Ditch System (FOF 64~~58~~), for a qualitative assessment of the abundance of native stream animals.

c. Nā Moku shall report on:

1. Adequacy of water deliveries in terms of inflow quantity and outflow water temperatures from Pauluhu Stream, Waiokamilo and Wailuanui Streams, Honopou Stream, and Hanehoi/Puolua Streams.

2. Taro loi from which outflows continue to lower loi or return to the stream; and loi from which outflows are not reused or returned.

3. Actual and potential maintenance, irrigation and farming practices for more efficient use of stream waters.

4. Nā Moku members as "konohiki" for the streams that they use for irrigation and/or domestic uses, including managing their uses so that the downstream IIFS for habitat restoration are met.

d. EMI shall report on:

1. Modifications to diversions to meet the amended IIFS.

2. Water deliveries at Honopou Stream and Maliko Gulch, and any changes EMI ascribes to the amended IIFS.

e. HC&S shall report on:

1. Surface, pumped, and total water usage.

f. MDWS shall report on:

1. Water deliveries at the Upper Waikamoi Flume, including any amounts ascribed to reduced losses from replacing the flume.

2. The status of plans for a 100-million or 200-million gallon reservoir at the Kamole WTP.

COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII

PETITION TO AMEND INTERIM INSTREAM FLOW STANDARDS FOR HONOPOU, HUELO (PUOLUA), HANEHOI, WAIKAMOI, ALO, WAHINEPEE, PUOHOKAMOA, HAIPUAENA, PUNALAU/KOLEA, HONOMANU, NUAAILUA, PIINAAU, PALAUHULU, OHIA (WAIANU), WAIOKAMILO, KUALANI, WAILUANUI, WEST WAILUAIKI, EAST WAILUAIKI, KOPILIULA, PUAKAA, WAIOHUE, PAAKEA, WAIAAKA, KAPAULA, HANAWI, AND MAKAPIPI STREAMS	Case No. CCH-MA13-01 **CERTIFICATE OF SERVICE**

CERTIFICATE OF SERVICE

The undersigned hereby certifies that, on this date, a true and correct copy of the foregoing document was duly served on the following parties as stated below:

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