HUI O PIKOILOA, an unincorporated association,
LIANNE CHING, BETTYE HARRIS, RICHARD MCCREEDY,
JULIANNE MCCREEDY, JESSE REAVIS, and
GRANT YOSHIMORI
c/o 45-464 Lipalu Street
Kaneohe, HI 96744
Telephone No.: (808) 236-0502

INTERVENORS PRO SE

BEFORE THE LAND USE COMMISSION

OF THE STATE OF HAWAII

IN THE MATTER OF:	) DOCKET NO. A17-804
HAWAIIAN MEMORIAL LIFE PLAN, LTD., a Hawaii Corporation	) WITNESS LIST AND) WITNESS WRITTEN DIRECT TESTIMONY;
To Amend The Conservation Land Use District Boundary Into The Urban Land Use District For Approximately 53.449 Acres Of Land At Kāne'ohe, Island of Oahu, State of Hawai'i, Tax Map Key: (1) 4-5-003:por.001	) CERTIFICATE OF SERVICE

LIST OF WITNESSES

WITNESS WRITTEN DIRECT TESTIMONY

CERTIFICATE OF SERVICE

I hereby certify that due service of a copy of the within document was made by depositing the same with the U. S. mail, postage prepaid, or by hand delivery, on December __, 2019, addressed to:

MARY ALICE EVANS — BY HAND DELIVERY
Director
Office of Planning, State of Hawaii
235 S. Beretania St. 6th Floor
Honolulu, Hawaii 96813

DAWN TAKEUCHI-APANA, ESQ. — BY HAND DELIVERY
Deputy Attorney General
Department of the Attorney General
425 Queen Street
Honolulu, Hawaii 96813

KATHY K. SOKUGAWA — BY HAND DELIVERY
Acting Director
City and County of Honolulu
Department of Planning and Permitting
650 South King Street
Honolulu, Hawaii 96813

CHAIR, PLANNING COMMISSION — BY HAND DELIVERY
City and County of Honolulu
650 South King Street,7th Floor
Honolulu, Hawaii 96804-2359

PAUL S. AOKI, ESQ. — BY HAND DELIVERY
Acting Corporation Counsel
Office of the Corporation Counsel
City and County of Honolulu
530 South King Street, Room 110
Honolulu, Hawaii 96813

JAY MORFORD — BY HAND DELIVERY
Hawaiian Memorial Life Plan, Ltd.
1330 Maunakea Street
Honolulu, Hawaii 96817

BENJAMIN MATSUBARA, ESQ
Matsubara, Kotake & Tabata
888 Mililani Street, Suite 308
Honolulu, Hawaii 96813

BY HAND DELIVERY

DATED: Honolulu, Hawaii, December 23, 2019.

GRANT YOSHIMORI, ET. AL.

Intervenors

DOCKET NO./PETITIONER: A17-804/ HAWAIIAN MEMORIAL LIFE PLAN, LTD

PARTY: GRANT YOSHIMORI ET. AL.

LIST OF WITNESSES AND DIRECT TESTIMONY

NAME/ORGANIZATION/POSITION (List in Order of Appearance)	TO BE QUALIFIED AS AN EXPERT IN:	SUBJECT MATTER	WRITTEN TESTIMONY (Yes or No)	TESTIMONY NUMBER (S)	LENGTH OF DIRECT
WINSTON WELCH Outdoor Circle Executive Director	Outdoor Circle Position	Outdoor Circle Position on Forest Conservation and Environment	No		.5 hour
NATHAN YUEN Sierra Club	Sierra Club Position and Endangered and Rare Plants and Animals	Sierra Club Position on Forest Conservation and Environment	Yes	1	.5 hour
KEN MIDDLETON Hawaii Ash Scatterings	Ash Scattering	Funeral and Burial Practices	Yes	2	.15 hour
M. LEE GOFF, PH.D University of Hawaii Professor	Entomology	Blackline Damselfly	Yes	3	.5 hour
JOHN HIGHAM Retired Civil Engineer	Civil Engineering	Development plan	Yes	4	.5 hour
STEVEN BUSINGER, PH.D University of Hawaii Professor	Meteorology	Meteorology	Yes	5	1.0 hour

Testimony 1

SIERRA CLUB OF HAWAI'I
O'AHU GROUP

October 23, 2018

HHF Planners
Attn: Ron Sato
733 Bishop St., Suite 2590
Honolulu, Hawaii 96813

State of Hawaii
Land use Commission
Department of Business, Economic Development & Tourism
Attn: Scott Derrickson
PO Box 2359
Honolulu, Hawaii 96804

RE: Response to Draft Environmental Impact Statement for
Hawaiian Memorial Park Cemetery Expansion Project
Kaneohe District, Oahu, Hawaii, Tax Map Key: (1) 4-5-033: por. 001

Dear Land Use Commissioners and Administrators:

The O'ahu Group of the Sierra Club of Hawai'i is concerned that the proposed cemetery expansion at Hawaiian Memorial Park will adversely affect the survival of a population of endangered Blackline Hawaiian Damselflies that live in a mini-wetland on conservation land on the slopes of Oneawa Hills.

Figure 1: Blackline Hawaiian Damselfly -- Most common male morph at recently discovered in Kāne'ohe

CONSERVTION STATUS

The Blackline Hawaiian Damselfly – Megalagrion nigrohamatum nigrolineatum -- was first described by RCL Perkins in 1899. It used to be widespread on O'ahu from sea level to the mountain tops, but their numbers crashed since the 1960's due to loss of habitat and invasive species. The damselflies were placed on the federal list of endangered species by Dan Polhemus in 2012. Today they are only found on O'ahu – at high elevations around 2,000 feet -- except for this newly found low elevation population in Kāne'ohe discovered by Liam Gray in 2016. See Exhibit A for an account of the discovery of the endangered damselflies and more close-up photos of the damselflies in Kāne'ohe.

PINAO IN HAWAIIAN CULTURE

Pinao is the Hawaiian word for dragonflies and damselflies. Pinao are specifically mentioned in the Kumulipo, the Hawaiian creation chant, on line 290 of the chant.

> *Puka kana keiki he Pinao, lele*
> *Out came its child a dragonfly, and flew*

Pinao was the name of the heiau where the Naha Stone – a huge heavy stone -- was located. It was prophesized that whoever overturned the Naha Stone would conquer all the islands. High ranking chiefs watched a young Kamehameha over turn the Naha Stone in 1775. There was a pillar at the entrance to the Pinao Heiau that was called the Pinao Stone. Both the Naha Stone and the Pinao Stone were moved to the Hilo Public Library in 1916 where they reside today.

Pinao is the name of a bay at Kalae – South Point – on Hawaii Island where a fishing village once stood. Both the bay and fishing village were named Pinao.

Pinapinao ānuenue -- is in the Pukui/Elbert Hawaiian Dictionary -- © 2003 edition. Pinapinao ānuenue is rainbow-eye damselfly (Megalagrion nigrohamatum nigrolineatum). Lit., rainbow damselfly.

DAMSELFIES IN POAMOHO STREAM

Since the damselfly population in Kāne'ohe is small – I never saw more than 8 individuals at a time, I ventured high into the Ko'olau Mountains see a more robust population of Blackline Hawaiian Damselflies at about 2,000 feet elevation. My goal was to get a better idea of the range colors and patterns the damselfly can assume.

I was pleased to find an actively breeding colony at Poamoho Stream. I was amazed to see that the thoraxes of Blackline Hawaiian Damselflies can assume a wide range of colors: red, orange, yellow, green, blue, and purple. Their eyes are colored independently from the body and can be bi-colored or tri-colored. The name pinapinao ānuenue – rainbow eye damselfly – is a most appropriate name for these beautifully colored damselflies.

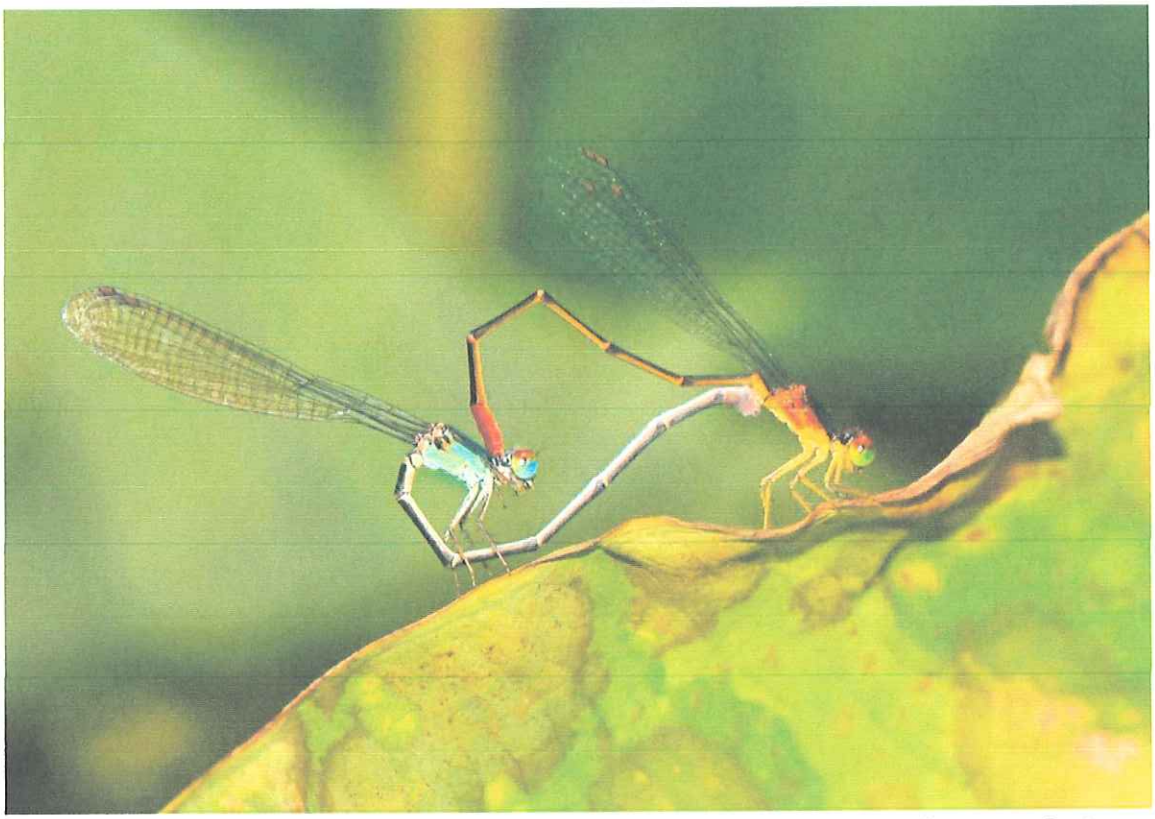

Figure 2: The most common male morph mates with a less common blue female morph at Poamoho Stream

Figure 3: The male has blue eyes in this pair and the female is green at Poamoho Stream

Figure 4: The male has tri-colored rainbow-eye while the female is purple at Poamoho Stream

Figure 5: The male's thorax is deep crimson while female' thorax is a yellow-orange at Poamoho Stream

DAMSELFLY HABITAT

The endangered Blackline Hawaiian Damselflies survive on the slopes of Oneawa Hills in Kāne'ohe because ground water seeps to the surface and creates a miniature wetland about 150 feet long by 15 feet wide. The damselflies lay their eggs in the water which hatch into nymphs and molt several times before becoming adults and completing their life cycle. Without this miniature wetland the population of damselflies would cease to exist.

The hydrological analysis indicates that the well at the head of the seep does not get its water from a deep underground aquifer. Instead the seep gets its water from the movement of shallow ground water that converge at the spot beneath the well from several directions.

WETLANDS DESIGNATION

According to the U.S. Army Corps of Engineers (Corps) and the U.S. Environmental Protection Agency (EPA), *"Wetlands are areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."*

The 1987 Corps of Engineers Wetlands Delineation Manual and Regional Supplements defines criteria for determining whether an area is a wetland. Wetland hydrology, hydric soil, and hydrophytic vegetation indicators are used to determine whether an area is a wetland. Has the U.S. Army Corps of Engineers evaluated the damselfly habitat to determine whether the miniature wetland is a wetland as defined by the Corps and EPA?

GRADING

The proposed expansion involves grading the slopes of the Oneawa Hills on the western end of the site. Much of the western hillside would be excavated up to 40 feet in height and areas near the top of the hillside would be reduced up to 100 feet in height. The earth will be moved to fill low spots and to establish a consistent grade. A large volume of earth (57,287 cubic yards of soil and rocks) will be taken from high areas and moved into low areas and compacted to create the desired grade.

Since the seep is fed by the movement of shallow ground water, grading Oneawa Hills is likely to affect ground water supplies to the seep. Removing steep slopes and compacting the soil to build up low areas will undoubtedly affect the movement of shallow ground water when the slopes are redefined.

DEFORESTATION

The proposed expansion involves cutting down thousands of the trees on Oneawa Hills in the Kāwā Watershed. A significant part of the hillside will no longer be forested. Removal of trees will reduce the moisture transpired by the trees into the atmosphere which promotes cloud formation and rainfall.

Olelo Noe'au	Hahai no ka ua i ka ulu la'au
Traditional Hawaiian Proverb	The rain follows the forest

Hawaiians knew that forested slopes were crucial to attracting clouds and rain and memorialized that knowledge in a proverb.

Over the past 50 years rainfall on Oahu shows a declining trend. Deforestation of the trees on Oneawa Hills is likely to exacerbate this trend. It can be reasonably anticipated that reduced rainfall and decreased ground water supplies to the seep is a likely scenario when trees are cut down from the site.

RUN-OFF

The proposed expansion involves cutting down trees on the hillside and the planting lawn grass over about an 18-month period. A large volume of earth (57,287 cubic yards of soil and rocks) will be relocated in the process. Heavy rain during this period could send tons of mud and rocks flowing downslope to cover and destroy the damselfly habitat.

The mud and rocks would do further damage as they flowed into the Kāwā Stream and into Kāne'ohe Bay. Many coral reefs in Kaneohe Bay were killed in the 1950-60s when mud and silt from construction sites flowed into the bay and smothered the coral.

Even after the slope is established and grass grows on the lawn, muddy run-off would continue to threaten the site especially with extreme rain events happening at greater frequency and intensity. The 49 inches of rain of torrential rain on Kauai over a 24-hour period in April 2018 wasn't even a hurricane – just a big rain storm. Muddy run-off threatens to inundate, destroy or degrade the damselfly habitat. The retention ponds should be increased in size to accommodate more severe rainstorm.

RETAINING WALLS, RUN-OFF, and CANOPY

Figure 2.3 Preliminary Grading Cut and Fill Plan shows the location of three proposed retaining walls. The lowest of the three walls "Proposed Wall A" appears to be just 10-20 feet away from the miniature wetland.

The walls are crucial to holding back soil relocated from grading the hill side. With "Proposed Wall A" being just 10-20 feet away there is zero margin of error to avert disaster should the system fail under extreme rainfall conditions and/or when plans go awry. With freak rain events becoming increasingly prevalent, it is reasonably foreseeable that a larger buffer is needed to preserve the miniature wetland.

The damselfly habitat is dark – many trees -- schefflera, strawberry guava, java plum and other introduced trees -- provide shade over the seep which keeps light levels low, prevents evaporation, and keeps humidity levels high. Under the existing plan "Proposed Wall A" is just 10-20 feet away with no tree canopy over that part of the habitat. There needs to be a canopy of trees for at least 100 feet (but preferably more) to maintain the low-light and high-humidity conditions at the miniature wetland.

GROUND WATER CONTAMINATION

The proposed expansion calls for conservation land in the Kāwā Watershed to be zoned urban so the land can be used as a cemetery. Cemeteries adversely affect ground water.

Modern human burials introduce formaldehyde and other toxic elements and chemicals into the environment. Mercury in dental fillings, pacemakers, esophageal tubes, and other medical products, can leach into groundwater as they decay. Unlike formaldehyde which breaks down more readily, mercury is stable and persists in the environment for long periods of time.

Toxic chemicals from coffins are also released into the groundwater including varnishes, sealers and preservatives and metal handles and ornaments used on wooden coffins. Many paints still contain lead, mercury, cadmium, and chromium. Arsenic is sometimes used as a pigment, a wood preservative and anti-fouling agent. Barium is sometimes used as a pigment and corrosion inhibitor.

All of these toxic chemicals, including pesticides, fertilizers, and weed killers used to maintain the lawn and shrubbery, soak into the earth and contaminate the ground water. Some of these compounds are toxic and known carcinogens to humans and wildlife.

Since shallow ground water emerges at the miniature wetland, it is foreseeable that toxic chemicals from the burial of humans will appear in the damselfly habitat. Additionally, there are 19 permits for wells in the area with a total permitted use of 10.312 mgd some of which are possibly used for drinking water by the community. The accumulation of tens of thousands of bodies and caskets has the potential to contaminate ground water resources for those who tap the Ko'olaupoko aquifer.

ADDITIONAL MEASURES TO MITIGATE ADVERSE AFFECTS

The Sierra Club commends Hawaiian Memorial Park for adjusting the original expansion plan to accommodate the damselfly habitat. The footprint of the expansion has been moved back to avoid grading the miniature wetland. However, the Sierra Club sees additional measures that could be implemented to enhance the ability of the damselflies to survive.

The damselflies chances for survival will be greatly improved if the landowner could install a long hose to artificially supply the habitat with clean water should something happen to disrupt the water flow or if the ground water became contaminated. A long hose is relatively inexpensive and can be deployed in under half a day to provide water. This would provide additional security to the habitat that water will always flow in the miniature wetland.

We do not completely understand or appreciate all the factors that resulted in the survival of this remnant population of endangered damselflies at this spot. In order to give the best chances for survival the goal should be to alter the habitat as little as possible. A canopy of trees shades the wetland, reduces evaporation, and keeps humidity levels high. Their chances for survival will be enhanced if the landowner left the canopy of trees intact over the wetland and for at least another 100 feet beyond the habitat before the trees are cut down.

There is increasing consciousness about green burials -- ways of caring for the dead that lessen the environmental impact, reduce impact on water quality, and reduce carbon emissions. Green burials involve the use of non-toxic and biodegradable materials, for caskets, shrouds, and urns, and the use of

fungi to breakdown toxic chemicals in the human body before releasing them into the environment. It would be ideal if green burials could be offered to reduce adverse impacts to water quality. Green burials are still in its infancy and the Sierra Club would like to see Hawaiian Memorial Park become a pioneer and leader in promoting green burials to the public.

CLOSING

The Sierra Club places high priority on the survival of this population of Blackline Hawaiian Damselflies into the future. Pinapinao ānuenue -- rainbow-eye damselflies – are beautiful insects that come in a spectacular array of colors and patterns. These damselflies are unique to the natural and cultural history of the Hawaiian Islands and are found only on O'ahu. These damselflies are biological treasures that deserve to be preserved for future generations. Please consider these special creatures as you decide this matter.

Sincerely,

Nathan Yuen
Conservation Chair
Sierra Club of Hawaii

EXHIBIT A

Discovery of
Blackline Hawaiian Damselflies
in Kaneohe

January 22, 2018

Nathan Yuen
91-233 Hanapouli Cir #29T
Ewa Beach, Hawaii 96706
Email: 808nateyuen@gmail.com

HHF Planners
733 Bishop Street #2590
Honolulu, HI 96813

Ronald A. Sato, AICP, Senior Associate
email: rsato@hhf.com
457-3172

With a copy to:

Mr. Scott Derrickson
State of Hawaii
Land Use Commission
Department of Business, Economic Development and Tourism
PO Box 2359
Honolulu, HI 96804

Project: Docket Number: A17-804
Hawaiian Memorial Park Cemetery Project
Kane'ohe District, O'ahu, Hawaii
(1) 4-5-033: por.001 (Private Property)

Dear Sir or Madam:

I am responding to the Environmental Impact Statement Preparation Notice by Hawaiian Memorial Park.

I work as an accountant for an engineering consulting firm during the week but on the weekends I become an amateur naturalist, hiker, and photographer. For the past 20 years I have been venturing to remote parts of our islands to photograph the native plants and animals of the Hawaiian Islands many of which are rare or endangered. I have a blog – HawaiianForest.Com – which documents some of the rarest species on the planet.

I served as a commissioner for the State of Hawaii's Natural Area Reserves System (NARS) Commission administered by the Department of Land and Natural Resources from 2013 to 2017. I currently serve as Conservation Chair for the Sierra Club of Hawaii Executive Committee. I am also a member of the Hawaiian Entomological Society.

In this matter, I am acting on my personal behalf as a private citizen. I was involved in the initial discovery and confirmation of the population of Blackline Hawaiian Damselflies — Megalagrion nigrohamatum nigrolineatum – on conservation land owned by Hawaiian Memorial Park.

My friend Patrick Shea was a candidate for State House of Representatives District 49 in the 2016 election. In June 2016, Patrick met Liam Gray while canvassing the homes on Ohaha Street. Liam told Patrick that he discovered a previously unknown population of endangered Blackline Hawaiian Damselflies in the backyard of Ernest and Bettye Harris on Ohaha Place who live adjacent to the land owned by Hawaiian Memorial Park. Patrick asked whether I could confirm the find and made arrangements for Liam to take us to the site.

On June 26, 2016, Liam Gray took me and several windward residents – Patrick Shea, Grant Yoshimori, Caitlyn Yoshimori, Rich McCreedy, and Julie McCreedy – to see the endangered damselflies. I was surprised to see these damselflies in Kāne'ohe. I had previously only seen this species of damselflies in native forests and streams above 2,000 feet elevation in the Ko'olau Mountain. I did not expect to see them at this low elevation in Kāne'ohe under alien trees – scheflera, albezia, strawberry guava, and other non-native vegetation.

The Pukui/ Elbert Hawaiian dictionary has an intriguing entry for this damselfly — pinapinao ānuenue — the rainbow-eye damselfly.

This is the most common morph for males — it has big round eyes that are red, green, and yellow, a orange-yellow-black thorax, and a segmented abdomen with a red tip.

I have taken many photos of these damselflies at the low elevation site in Kāne'ohe. There are multiple morphs (color patterns) for both male and female damselflies. One of the morphs has a

three colored-eye. The name pinapinao ānuenue — the rainbow-eye damselfly – is appropriate for this colorful insect.

This is the most common female morph – the eyes are red on top and blue on the bottom.

I contacted Hawaiian damselfly expert Dan Polhemus at the US Fish & Wildlife Service and brought him to the site. He did the research to get this and several other damselfly species listed as endangered species. Dan Polhemus confirmed that this was a previously unknown population of Blackline Hawaiian Damselflies — Megalagrion nigrohamatum nigrolineatum. Dan was also surprised to see these damselflies at this low elevation. He said that this species is endemic only to O'ahu and once inhabited the streams and wetlands throughout the island at all elevations. But they are rare today with less than 1,000 estimated to remain.

Blackline Hawaiian Damselflies are on the federal list of endangered species. Loss of habitat and predation by invasive species are the biggest reasons for their decline. Today they are found at high elevations in the Ko'olau Mountains except for this population in Kāne'ohe. For some reason this population managed to survive at low elevation.

This population of damselflies exists because of a seep – a small fresh water spring – that trickles down a shallow ravine and creates a miniature wetland where they breed. This habitat is crucial to the survival of this remnant population of low-elevation rainbow-eye damselflies. If the habitat is destroyed or otherwise adversely affected, this population of damselflies will likely cease to exist.

A rival male darts in to interrupt a pair of mating rainbow-eye damselflies.

The proposed cemetery expansion is likely to adversely affect this population of damselflies. It is my understanding that Hawaiian Memorial Park is required to develop a habitat conservation plan to protect these endangered insects. The plan would need to address several issues important to the continuation of this unique population of damselflies.

Of greatest concern is that the proposed cemetery expansion could disrupt the ground water hydrology of the area and cause the seep to stop flowing. The damselfly population cannot survive without water flowing in their habitat.

Another big concern is run-off from the construction or operation of the expanded cemetery could destroy the habitat or introduce fertilizers/pesticides that harm the damselflies. Also studies have shown that the decomposition of human bodies could introduce arsenic and other toxins into the ground water adversely affecting water quality in the seep.

It is also important to establish a sufficient buffer between the expanded cemetery and the damselfly habitat so they continue to exist and breed at the seep without disruption and interference by humans.

After the female is fertilized the pair fly to water where she curls her abdomen and lays eggs in the seep.

The discovery of this previously unknown population of low elevation Blackline Hawaiian Damselflies in Kāne'ohe is a remarkable and significant find. Rainbow damselflies are an endangered species found only on O'ahu and are unique to the natural history and heritage of Kāne'ohe. The low elevation habitat for these damselflies needs to be protected to ensure their survival into the future.

Thank you for this opportunity to protect these damselflies. I would appreciate being places on your distribution list so I can participate in this proceeding though the various stages of the process.

Sincerely,

Nathan Yuen

Nathan Yuen

EXHIBIT B

Sources

EXHIBIT B
SOURCES

Kumulipo A Hawaiian Creation Chant
Edited and translated by Martha Warren Beckwith (University of Chicago Press, 1951)
Interlinearization by David Stampe
http://www.kauainenehcp.com/uploads/8/1/8/0/81802884/kumulipo-text.pdf

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The Story of the Naha Stone
HokuLoa Blog, Posted on December 13, 2015
https://nupepa-hawaii.com/2015/12/13/on-the-moving-of-the-na-ha-stone-to-hilo-library-100-years-ago-and-its-history-5-of-6-1915/#more-20162

Naha Stone is Moved
http://ulukau.org/elib/collect/elibrary/index/assoc/D0.dir/doc112.pdf

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Pinao Bay and Fishing Village at Kalae, South Point, Hawaii Island
South Point Resources Management
https://dhhl.hawaii.gov/wp-content/uploads/2015/07/South-Point-Pre-Final-Plan_092916_w-cover-app_low-res.pdf

---

Rainfall Changes in Hawai During the Last Century
Henry F. Diaz1, Pao-Shin Chu, and Jon K. Eischeid1
Climate Diagnostics Center, NOAA, Boulder, CO
Department of Meteorology, University of Hawaii at Manoa, Honolulu, HI
https://ams.confex.com/ams/pdfpapers/84210.pdf

Changes in Precipitation Extremes in the Hawaiian Islands in a Warming Climate
Pao-Shin Chu, Ying Ruan Chen, and Thoas A. Schroeder
Department of Meteorology, School of Ocean and Earth Science and Technology, University of Hawaii at Manoa, Honolulu, Hawai
http://www.soest.hawaii.edu/MET/Hsco/Paper/2010JCLI3484.pdf

Is a Green Burial Right for You?
By Chris Raymond, VeryWellHealth
https://www.verywellhealth.com/what-is-a-green-burial-1131911

What is Green Burial?
Green Burial Council
https://greenburialcouncil.org/home/what-is-green-burial/

Testimony 2

Written Testimony of Kenneth Middleton

Background Questions

1. Please state your name and address for the record.

   My name is Kenneth Middleton, and my address is 796 Kalanipu'u Street, Honolulu, HI 96825

2. Please state some recent positions which you've held related to memorial services at sea.

   I have a private company, Tradewind Charters, and memorial services have been part of our offerings since the company has started.

Cremation and Sea Burials

1. How many sea-based ash scatterings have you performed in 2019?

   I will have done over 600 ash scatterings.

2. Of those 600 services, how many were for Hawaii Residents?

   Half of our clientele is from Hawaii.

3. What are the reasons people give for having their ashes scattered at sea?

   The answer varies by customer but these are the reasons I hear most often, in order of frequency:
   - Deceased requested ash scattering
   - Its uplifting and positive engagement with the natural environment
   - Affordable pricing
   - Environmentally friendly

4. How are your prices compared to traditional burials?

   Our offering are a good cost alternative to traditional burials. Our lowest package starts at $500.

5. Hawaiian Memorial had commissioned CBRE to do a Market Study for the Hawaiian Memorial Expansion. In their study, they estimated that Oahu would see 1048 ash scatterings in 2019. Do you think that is an accurate estimate?

   I suspect if that number is low. For Oahu, I estimate I've done almost half of that estimate (450 this year), so it seems low.

6. Do you have the capacity to handle more at-sea services? And if yes, how many more would you personally be able to handle?

   Yes. I can handle 1000% more.

7. The CBRE Market Study assumes that ash-scatterings will remain at 18% of all cremations. Do you think that is correct?

   I think this number is inaccurate. Ash-sea scatterings definitely is a growing trend. There are more people who are opting to do cremations, and I believe that percentage will increase.

Testimony 3

Written Testimony of
M. Lee Goff, Ph.D.

Background Questions

1. Please state your name and address for the record.

   My name is Madison Lee Goff, and my address is 45-187 Namoku Street, Kaneohe, Hawaii

2. What is your educational background?

   I received a:
   B.S. in Zoology (1966) from the University of Hawaii at Manoa;
   M.S. in Biology (1974) from California State University, Long Beach; and
   Ph.D. in Entomology (1977) from the University of Hawaii at Manoa

3. Please state some relevant positions which you've held related to the field of entomology

1983 - 2001	Department of Entomology, University of Hawaii at Manoa, Honolulu. Professor of Entomology.
1986 – present	Department of the Medical Examiner, City & County of Honolulu. Consultant in forensic entomology.
1986 - 1993	State of Hawaii, Natural Area Reserves System Commission. Commissioner and Chair of Commission.
1993 - 1996	Forensic Entomology Working Group, American Academy of Forensic Sciences, Chair.
1993 - 2001	Curator, Entomology Museum, Department of Entomology, University of Hawaii at Manoa
1994 – 1998	Chair of Entomology Graduate Field, Department of Entomology, University of Hawaii at Manoa.
1994 - present	Avian Disease Recovery Working Group, U.S. Fish and Wildlife Service, Pacific Islands Office, Honolulu, Hawaii.
1996 -1997	Chair Pathology/Biology Section, American Academy of Forensic Sciences.
1996 – 1999	American Board of Forensic Entomology, Chair, Board of Directors.
1997- present	Editorial Board, Journal of Forensic Sciences

2000- 2008	National Disaster Medical System, D-MORT Region 9, U.S. Dept. of Health and Human Services. Team member.
2001 -2013	Professor of Forensic Sciences and Director of Forensic Sciences Program , Chaminade University of Honolulu.
2001 – 2015	Consultant in Entomology for episodes of CSI on CBS.
2001 - present	Professor Emeritus, University of Hawaii at Manoa, Honolulu, HI.
2002 - 2003	Subject Editor, Forensic Entomology and Myiasis, Journal of Medical Entomology
2003 –2014	Curator, Crime Scene Insects. ExhibitQ, Inc. Long, Beach, California. Exhibit appeared at: St. Paul, MN; Roanoke, WV; Norfolk, VA; New York, NY; Chicago, IL; Berkeley, CA; Memphis, TN; Indianapolis, IN, Phoenix, AZ; Bozeman, MT, Miami, FL
2005 – 2007	Interim Dean, Division of Natural Sciences and Mathematics, Chaminade University of Honolulu
2013 - present	Retired, 31 July 2013, Professor Emeritus, Chaminade University of Honolulu

4. What aspects of your career can you draw upon to comment on the Blackline Damselfly and the EIS Appendix G: Survey of Native Invertebrate Resources in proposed expansion of Hawaiian Memorial Park – July 2017

   My comments are based on my PhD in Entomology and teaching experience at the university-level while at University of Hawaii, Manoa, and Chaminade University of Honolulu in the field of entomology combined with my relevant experience in dealing with insects and other invertebrates in Hawaii through my work with agencies such as the Natural Areas Reserves System Commission.

Recommendations for Damselfly Protection

1. Are you aware that the Blackline Damselfly is listed as an endangered species on the Federal Register?

   Yes

2. The Federal Register states that "the blackline ... damselflies are vulnerable to extinction" (page 57677). The Register states threats include stream diversion (pg. 57674), dewatering of aquifers (57674), predation by non-native fish (57678), Flooding and drought (pg. 57673), and climate change (pg. 57675). Do you agree the population is at risk due to these factors?

   Yes

3. Do you think the survey is sufficient in identification of invertebrate species?

   No. The survey is stated to be designed to determine the presence of any endemic or indigenous terrestrial invertebrates, although some species are included in the report that are not either (Mollusca, Heteropodidae, Coleoptera, Culicidae, Hymenoptera). The bulk of the survey concentrates on the endangered Blackline Hawaiian Damselfly, *Megalagrion nigrohamatum nigrohamatum*. This document is not a complete inventory of invertebrates present in the area under consideration. With only 37 species listed, the total seems low, even for a disturbed area. It appears no attempt was made to look at the soil fauna, including significant annelids and other groups. A more complete survey should be made.

4. Do you think the mitigations recommended in the survey are sufficient to protect the habitat?

   No

5. Do you believe the Damselflies forage and extend into the proposed development area?

   As adults, these damselflies will potentially forage into the proposed development area.

6. If the surface water flow increased on the damselfly habitat, would that threaten the damselfly survival?

   Increased surface water flow has the potential to interfere with activities of damselfly immatures and completion of development to the adult stage. Much depends on the amount and rate of the increased flow.

7. Ms. Kristi Young from the Federal Fish and Wildlife Service wrote a letter dated 10/23/2018 to HMP (in EIS Appendix-A2) which asked HMP to "analyze an alternative under which no cemetery development or major land disturbance would occur on any directly above or draining into the damselfly habitat." Do you agree with that assessment?

   Yes

8. Mr. David Smith from the State Division of Forestry and Wildlife wrote a letter dated 10/31/2018 (which Petitioner has not submitted to the LUC; submitted as Intervenors' Exhibit 8). Mr. Smith states "DOFAW does not agree that the proposed solution is sufficient to maintain the essential flow characteristics that support the endangered blackline damselfly habitat and there is unlikely to be any solution under the existing plan and site layout with the proposed extensive cut and fill and retaining walls that can provide the degree of certainty necessary that there would be no impacts to the damselfly habitat." Do you agree with that assessment?

   Yes

9. Do you have other recommendations for projection of the damselfly?

   At present, the habitat appears to be allowing for the population of the damselfly. Given this, I would suggest the best approach is for the area remain as it is.

Mosquito Threats of Retention Ponds

1. HMP is planning to build retention/detention ponds which are supposed to drain in 48 hours from when full. Do you think this is a risk for infectious mosquito breeding?

   The effectiveness of the retention basins to deter mosquito breeding depends on the period of time required for the pools to become full and drain, as well as the definition of "drain .completely" The species of concern here is C. quinquefasciatus which is a pool breeder and completes development in 5-8 days, depending on temperature. Time periods greater than this 5-8 day period may actually have the effect of increasing potential breeding sites for this species. Other species listed are not pool breeders, but are container breeders.

2. Would we face increased risk for Dengue, Zika, West Nile?

   The survey lists 3 species of mosquitoes in the area: *Culex quinquefasciatus, Aedes albopictus* and *Toxorhynchites ambonensis.* Two additional species may be present in the area but not recovered, *Aedes vexans* and *Wyeomyia mitchelli.* C.*quinquefasciatus,* as noted above, is a pool breeder and completes development in 5-8 days, depending on temperature. This species has been implicated in transmission of Zika and West Nile Virus, as well as dog heart worm and appears to be the major vector for avian malaria in Hawaii, a leading cause of the decline in endemic Hawaiian land birds. Species in the genus Aedes are know vectors of a number of diseases, including Dengue, Yellow Fever (Aedes aegypti), and various encephalides. The *Toxorhynchites* and *Wyeomyia* species are not considered vectors of human diseases.

Additional Comment.

1. Do you have any other comments?

   Landscaping with native plants is mentioned in the survey. This presumes that non-native plants will have been removed and that action has not inadvertently eradicated the damselfly population. How is this to be accomplished? What native plants are to be used for the landscaping? Keep in mind that the introduced plants are typically more aggressive than the native plants. Otherwise we would not have the problem. Have the native plants in the area suddenly become more aggressive and thus capable of overcoming/resisting invasion by introduced species?

Testimony 4

Written Testimony of John Higham

Background Questions

1. Please state your name and address for the record.

   My name is John Higham. My address is 44-048 Kaimalu Place, Kaneohe, Hawaii.

2. What is your educational background?

   I received a B.S. in Civil Engineering from the University of Hawaii in 1973.

3. Please summarize some of your experience related to the field of Engineering:

   I have a Professional Civil Engineering License, and have held the following positions:
   - Vice President, Construction & Engineering Aina Nui Corporation from August 2008 to November 2018
   - Chief Operating Officer, Community Planning and Engineering, Inc. from September 2007 to July 2008
   - Chief Engineer, Waiawa Ridge Development, LLC from January 2004 to September 2007

   - Director of Development – Amfac/JMB Hawaii from August 1990 to January 2004.

Water Retention/Detention During Construction

1. Do you have any concerns with the conclusions/proposed drainage improvements of the Preliminary Engineering Report (PER) attached as Appendix D to the EIS as it relates to the proposed grading and drainage improvements?

   Yes. The PER (Page 20) states that during construction, sediment basins designed for a 2-year 24 hour storm event will be used., which would be insufficient should a storm of greater intensity occur during the 12-16 month construction period.

   There is not enough detail in the PER regarding the capacity of the sedimentation basins that are being proposed during construction. The developer is required to have a capacity of 3,600 cubic feet per acre of area to be drained, but the PER does not show if, or how, that requirement will be met. At a minimum, a conceptual grading plan for each of the sedimentation basins should have been provided as part of the Petition documents.

2. Are there risks for homeowners during the construction period?

   Yes. The proposed project appears to do the bare minimum for drainage improvements, based on the conclusion that there will be a "slight" reduction in flows for the 10-year, one-hour storm post-development condition, which may not actually be the case.

But given that the EIS identifies a limitation of capacity in the downstream improvements, the proposed project does little, if anything, to improve the situation. It adds potential risks (especially during construction) due to the amount of grading but it does not identify any benefits (or reduction of risks) to the downstream homeowners.

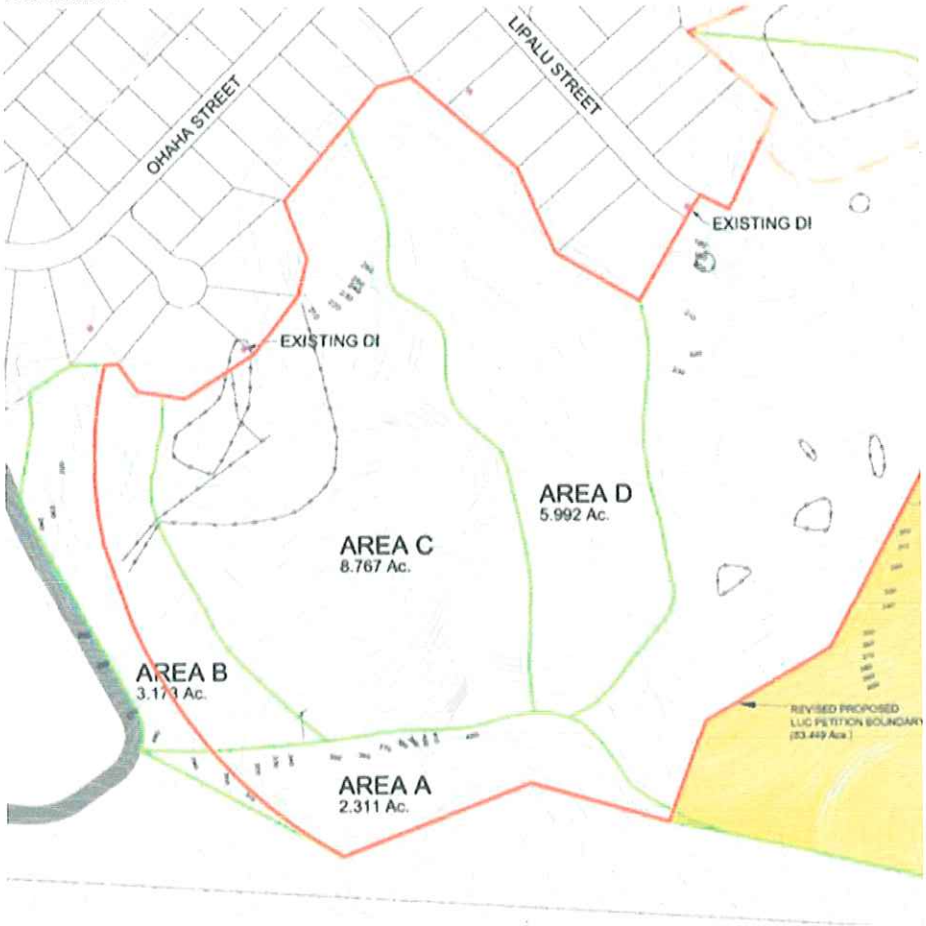
Retention/Detention Basins

1. Do you have concerns with the current runoff estimations in the Preliminary Engineering Report, potentially risking homeowners downslope?

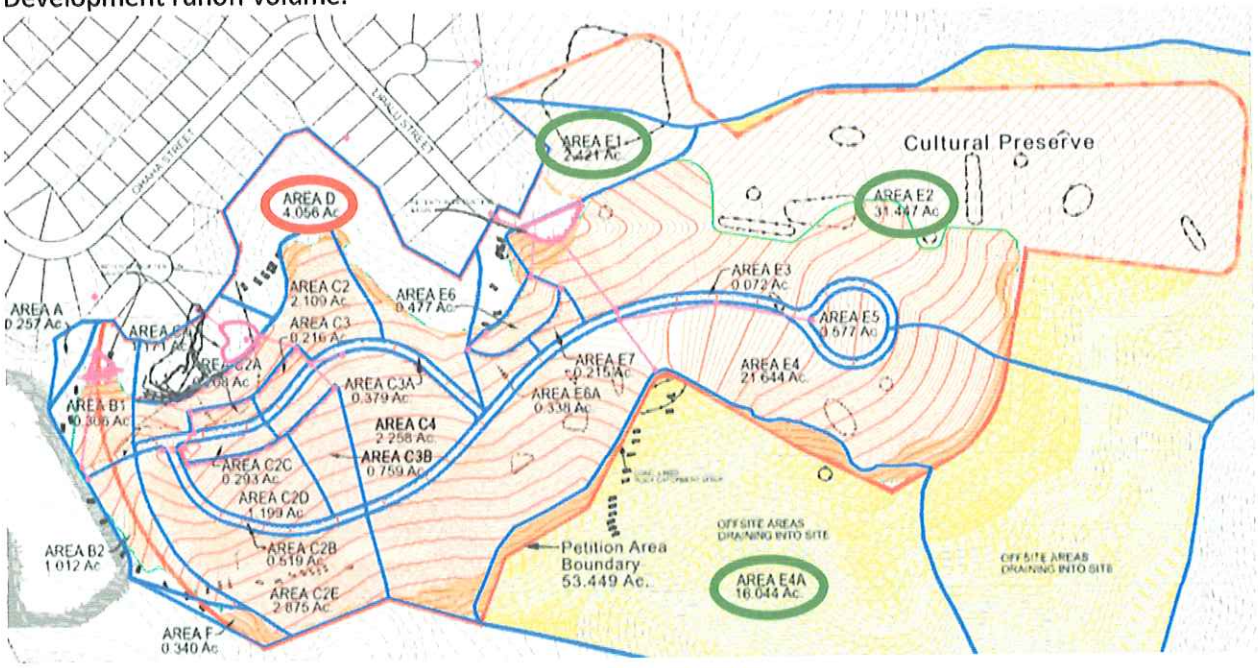
   Yes. There are two major concerns which may negate any reduction and, in fact, may result in an increase in runoff in the post development condition.

   1) We note that the EIS projects a 4% reduction in the runoff rates (cfs) (EIS Appendix D Page Page 22) and a 5.5% reduction in the volume of runoff (EIS Appendix D Page 23). However, in Figure 2.4 and Table 1 & 2 in Appendix A of the Engineering Report, Drainage Area A (2.3 acres) is assumed to flow into the tributary area in its existing condition which we think is incorrect.

   The error increases the "starting" volume benchmark and artificially increases post development reduction.



2). The amount of undisturbed area in Table 2 of Appendix A of the Engineering Report is incorrect. The table shows 49.9 acres of undisturbed area (EIS Figure 5.2 - Areas E1, E2 and E4A – highlighted in green below). However, there should be another 9.7 acres of undisturbed area, which is in buffer area (Area D – highlighted in red) and, I assume, partly near the cultural preserve (Area E2) If the additional 9.7 acres are corrected as undisturbed, it increases the Post Development runoff volume.



In summary, when you correct for both of the above issues, 1) removing runoff from Area A, and 2) correcting for undeveloped areas, it may well negate any reduction and, in fact, may result in an increase in runoff in the post development condition.

2. Do you have other concerns with the drainage calculations?

It should be noted that the drainage tributary is reported to have an area of 93.2 acres. If it was seven acres larger, the City Standards would require the engineer to use the City and County's Rules Relating to Storm Drain Standards "Plate 6" graph to determine the runoff; and the runoff from Plate 6 would be 1,000 cubic feet per second. For comparison, on Page 5-12 of the EIS the runoff (even for the 100 year, 1-hr storm is less than 200 cubic feet per second).

If the drainage area was 7 acres bigger the "calculated" runoff would be five times higher than what was calculated via the 100-yr 1 hour storm as shown in the EIS.

The Storm Drainage Standards are not an exact science. They are estimates based on assumptions made by engineers. Clearly seven additional acres will not cause the runoff to go

up five times, but it does raise questions on the appropriateness of using the much less stringent runoff standards near the upper end of the spectrum instead of the more conservative "Plate 6" standards. If the drainage area was 99 acres, wouldn't it be more appropriate to use the "Plate 6" standards even though "technically" the much less stringent standards could be used?

3. Does the Engineering Report provide enough information for you to make an assessment of the retention/detention basis?

   No. In Appendix D (page 20) there is a statement that "a portion of the basins will be converted to retention/detention basins as a permanent BMP after construction is completed. A similar statement occurs on page 2-40 of the EIS. Neither reference provides any detail what portion (or volume) would remain. Is it a large portion or just a small "token" amount? The Petitioner should be required to provide specifics on what is being provided as permanent detention/retention basins (and where they will be).

Testimony 5

Written Testimony of Steven Businger Ph.D.

Background Questions

1. Please state your name and address for the record.

   My name is Steven Businger, and my address is 4837 Sierra Drive, Honolulu, Hawaii

2. What is your educational background?

   I received a:
   Ph.D., Atmospheric Sciences, from University of Washington, in 1986,
   M.S., Astro-Geophysics, from University of Colorado, in 1978, and
   B.S., Atmospheric Sciences, from University of Washington, 1975 cum laude

3. Please state some recent positions which you've held related to the field of entomology

1999 – Current	Professor and Chair, Department of Atmospheric Sciences, University of Hawaii
1993-98	Associate Professor, Department of Atmospheric Sciences, University of Hawaii
1992-93	Associate Professor, Department of Marine, Earth and Atmospheric Sciences, North Carolina State University (NCSU)
1986-92	Assistant Professor, Department of Marine, Earth and Atmospheric Sciences, North Carolina State University (NCSU)
1982-86	Research Assistant, University of Washington 1980-85 Meteorology Instructor, University of Washington and Bellevue Community College
1978-82	Avalanche/Mountain Weather Forecaster, U. S. Forest Service

Climate Impact

1. Hawaiian Memorial is designing "retention/detention basins capturing and treating runoff generated from the cemetery would be designed for a 100-year frequency, one-hour duration storm event (4.5 inches per hour)." (EIS page 3-95). How often does a 100-year one-hour duration event occur?

   The probability that a 100-year one-hour duration event will occur in a given year is 1/100 or 1%. That said, a 100-yr flood can happen two years in a row. And there is an 0.2% probability that a 500-yr flood will occur. These probabilities are calculated with reference to past data for Oahu. As I will elaborate on later, recurrence intervals for heaving rainfall are shifting and the values are increasing with global warming as sea-surface temperature (SST) increases in the vicinity of Hawaii.

2. Have there been occurrences in Hawaii, where the amount of rain has exceeded 4.5 inches in an hour?

   Yes. Here's a summary of major rain events exceeding 4.5 inches in one or more consecutive hours:

   June 25, 2019 – "At 9:00 p.m., radar indicated persistent torrential rain and thunderstorms affecting south and east Oahu, with rainfall rates up to 4 inches per hour affecting a wide swath of urban Honolulu, causing significant flooding impacts," - https://www.staradvertiser.com/2019/06/25/breaking-news/flood-advisory-in-effect-for-oahu-9/

   October 29, 2018 – "Rain rates up to 2 to 4+ inches per hour were observed this morning on both islands, with additional heavy rainfall expected over the next couple of hours. ... On Oahu, locations in the warning include, but are not limited to, Honolulu, Ahuimanu, Punaluu, Hauula, Waimanalo, Kailua, Manoa, Maunawili, Kaneohe, Kalihi and Waikane." - https://www.staradvertiser.com/2018/10/29/breaking-news/heavy-rain-expected-for-state-before-halloween/

   April 13 thru 15 2018– "The area of intense rainfall with rates greater than 4+ inches per hour moved across east Oahu between 7:00 PM and 9:00 PM HST on April 13. Although the affected area was localized, the intensity of the rainfall produced tremendous amounts of runoff which produced substantial damage to communities from Maunawili to Waimanalo over the windward slopes of the Koolau Range." During this event the all time US record for 24-hr rainfall was smashed on Kauai with 50" of rainfall confirmed over Hanalei on 4/15/18 - https://www.weather.gov/hfo/RecordKauaiandOahuRainfallAndFlooding-April2018

   March 9, 2012 – "Kauai was hardest hit with rainfall totals on the north shore of Kauai in excess of 30 inches in a 4 day period" - https://www.weather.gov/hfo/SVA20120309

   June 4, 2011 – "Flash floods from 5 to 10 inches of rain in a 3-hour period inundated roads and homes and severely damaged agricultural properties from Punaluu to Kailua." - https://www.weather.gov/hfo/HeavyRain20110604

   Halloween flood 2004, 9+" fell over Manoa Valley in under 6 hrs causing $60 million in damage.

   New Years flood of 1987 – 25 inches fell over East Oahu in 24 hours causing $50 million in damage

3. Do you believe the planned retention/detention volumes are sufficient given the physical circumstance of the site?

   No. The planned retention does not adequately take into account the changes in the grounds ability to absorb rainfall, thus increase in runoff associated with the development. The prior

moisture content of the soils, depth of the soils, and steepness of the terrain in the requisite basin were not adequately modeled in the application.

4. Do you anticipate that the frequency and intensity of events with rainfall exceeding 4.5 inches in one hour will increase?

   Yes. Extreme rainfall events are on the rise over Hawaii, as outlined in the response to question 2 above. Moreover, it has been documented in peer reviewed literature as summarized in the IPCC report that extreme rainfall events have been increasing in frequency across the US and the world. This is consistent with the observation of warming global sea-surface temperatures (SSTs). There is a non-linear relationship between saturation vapor pressure and temperature. An SST increase of only 3.5° C from 26.5 to 30°C results in a 25% increase in vapor pressure, fueling the difference between a category 1 and 5 hurricane! It has been documented that tropical cyclones are increasing in intensity, producing higher winds and greater flooding, and their tracks are shifting poleward while their speeds are slowing, placing Hawaii at increasing risk for extreme flooding from tropical cyclones.

5. Do you believe the planned retention/detention volumes are sufficient given trends in weather?

   Clearly no, see answer to question 4.

Climate Change

1. What is the evidence of global warming?

   Multiple studies published in peer-reviewed scientific journals show that 97 percent or more of actively publishing climate scientists agree*: Climate-warming trends over the past century are extremely likely due to human activities. (https://climate.nasa.gov/scientific-consensus/)

   Carbon dioxide that accumulates in the atmosphere insulates the surface of the Earth. It's like a warming blanket that holds in heat. This energy increases the Earth's surface average temperature, heats the oceans and melts polar ice. As consequences, sea level rises and weather changes.

   If all green house gas emissions stopped today, the Earth's temperature would rise about another 1.1F (0.6C). Scientists refer to this as committed warming. Ice, also responding to increasing heat in the ocean, will continue to melt. (https://www.iflscience.com/environment/what-would-happen-climate-if-we-stopped-emitting-greenhouse-gases-today/)

   A United Nations Intergovernmental Panel on Climate Changed issued a report saying , humanity has just 12 years to roll back carbon dioxide emissions if there is any hope of keeping global temperatures from rising above 2.7°F.

2. What can the State and City do to help alleviate Climate change?

   Very pertinent to the decision we are debating today, an acre of trees can sequester roughly 5 tons of CO2 per year. (https://www.botany.org/PlantTalkingPoints/CO2andTrees.php)

   By protecting the existing forests designated in the conservation district, we can ensure no additional loss of CO2 sequestration capabilities.

3. Other reasons to keep hillside undeveloped?
   Hawaii has the most endangered plants and animals of any state in the US, making it critically important for us to maintain as much undeveloped habitat as possible on our crowded Island of Oahu.

NOAA Atlas 14, Volume 4, Version 3
Location name: Kaneohe, Hawaii, USA*
Latitude: 21.3969°, Longitude: -157.7839°
Elevation: 284.76 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

S. Perica, D. Martin, B. Lin, T. Parzybok, D. Riley, M. Yekta, L. Hiner, L.-C. Chen, D. Brewer, F. Yan, K. Maitaria, C. Trypaluk, G. M. Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.449 (0.394-0.498)	0.556 (0.485-0.625)	0.724 (0.630-0.817)	0.858 (0.740-0.973)	1.04 (0.884-1.20)	1.19 (0.993-1.38)	1.34 (1.10-1.57)	1.51 (1.20-1.78)	1.73 (1.33-2.08)	1.91 (1.42-2.34)
10-min	0.666 (0.585-0.739)	0.825 (0.720-0.927)	1.07 (0.934-1.21)	1.27 (1.10-1.44)	1.55 (1.31-1.77)	1.77 (1.47-2.04)	1.99 (1.63-2.33)	2.23 (1.78-2.64)	2.56 (1.97-3.09)	2.83 (2.10-3.46)
15-min	0.836 (0.734-0.928)	1.04 (0.904-1.16)	1.35 (1.17-1.52)	1.60 (1.38-1.81)	1.94 (1.65-2.22)	2.22 (1.85-2.56)	2.50 (2.04-2.92)	2.80 (2.24-3.31)	3.22 (2.47-3.88)	3.55 (2.64-4.35)
30-min	1.18 (1.03-1.31)	1.46 (1.27-1.64)	1.90 (1.65-2.14)	2.25 (1.94-2.55)	2.73 (2.32-3.13)	3.12 (2.60-3.61)	3.52 (2.88-4.11)	3.94 (3.15-4.66)	4.53 (3.48-5.46)	4.99 (3.71-6.12)
60-min	1.55 (1.36-1.72)	1.92 (1.67-2.16)	2.50 (2.17-2.82)	2.96 (2.55-3.36)	3.60 (3.05-4.12)	4.11 (3.42-4.75)	4.63 (3.78-5.41)	5.19 (4.14-6.14)	5.96 (4.58-7.18)	6.57 (4.88-8.05)
2-hr	2.14 (1.87-2.36)	2.68 (2.35-3.02)	3.49 (3.03-3.94)	4.13 (3.56-4.69)	5.01 (4.25-5.75)	5.71 (4.76-6.60)	6.42 (5.25-7.51)	7.16 (5.71-8.49)	8.18 (6.28-9.89)	9.00 (6.68-11.1)
3-hr	2.45 (2.15-2.70)	3.14 (2.74-3.53)	4.09 (3.56-4.62)	4.85 (4.18-5.51)	5.89 (4.99-6.75)	6.70 (5.59-7.76)	7.55 (6.16-8.83)	8.42 (6.71-9.98)	9.63 (7.39-11.6)	10.6 (7.85-13.0)
6-hr	3.12 (2.73-3.45)	3.97 (3.48-4.47)	5.22 (4.54-5.90)	6.21 (5.35-7.05)	7.55 (6.40-8.66)	8.62 (7.18-9.97)	9.72 (7.93-11.4)	10.9 (8.66-12.9)	12.5 (9.55-15.1)	13.7 (10.2-16.9)
12-hr	3.83 (3.34-4.23)	4.92 (4.29-5.55)	6.49 (5.64-7.35)	7.73 (6.65-8.79)	9.41 (7.97-10.8)	10.7 (8.94-12.4)	12.1 (9.86-14.2)	13.5 (10.7-16.0)	15.4 (11.8-18.6)	16.9 (12.5-20.8)
24-hr	4.52 (4.02-5.07)	5.98 (5.32-6.71)	7.97 (7.05-8.98)	9.52 (8.38-10.8)	11.6 (10.1-13.3)	13.3 (11.4-15.3)	14.9 (12.7-17.4)	16.7 (14.0-19.7)	19.0 (15.6-22.9)	20.9 (16.8-25.6)
2-day	5.15 (4.59-5.76)	6.83 (6.07-7.65)	9.14 (8.08-10.3)	10.9 (9.63-12.4)	13.4 (11.7-15.3)	15.3 (13.2-17.7)	17.3 (14.8-20.2)	19.4 (16.3-22.9)	22.2 (18.3-26.7)	24.4 (19.7-29.8)
3-day	5.66 (5.03-6.33)	7.50 (6.66-8.41)	10.0 (8.85-11.3)	12.0 (10.5-13.5)	14.6 (12.7-16.7)	16.7 (14.4-19.2)	18.7 (16.0-21.9)	20.9 (17.5-24.7)	23.8 (19.5-28.7)	26.1 (21.0-31.9)
4-day	6.16 (5.48-6.90)	8.18 (7.24-9.16)	10.9 (9.62-12.3)	13.0 (11.4-14.7)	15.8 (13.7-18.1)	18.0 (15.5-20.7)	20.2 (17.1-23.5)	22.4 (18.8-26.5)	25.4 (20.8-30.6)	27.7 (22.3-34.0)
7-day	7.26 (6.44-8.14)	9.57 (8.47-10.7)	12.7 (11.2-14.3)	15.0 (13.2-17.1)	18.2 (15.8-20.8)	20.7 (17.8-23.9)	23.1 (19.6-27.0)	25.6 (21.4-30.3)	28.9 (23.6-34.8)	31.4 (25.2-38.5)
10-day	8.17 (7.25-9.16)	10.7 (9.47-12.0)	14.1 (12.4-15.9)	16.7 (14.6-18.9)	20.2 (17.5-23.1)	22.8 (19.6-26.4)	25.5 (21.7-29.8)	28.2 (23.6-33.4)	31.8 (26.0-38.4)	34.5 (27.7-42.3)
20-day	10.5 (9.30-11.8)	13.5 (12.0-15.2)	17.6 (15.5-19.9)	20.7 (18.2-23.5)	24.9 (21.7-28.5)	28.1 (24.2-32.5)	31.4 (26.7-36.7)	34.7 (29.0-41.0)	39.0 (32.0-47.1)	42.4 (34.0-52.0)
30-day	12.5 (11.1-14.0)	16.0 (14.1-17.9)	20.6 (18.2-23.3)	24.2 (21.2-27.4)	28.9 (25.1-33.1)	32.6 (28.0-37.7)	36.2 (30.7-42.3)	39.9 (33.4-47.3)	44.8 (36.7-54.2)	48.6 (39.0-59.7)
45-day	15.3 (13.5-17.1)	19.3 (17.1-21.7)	24.7 (21.8-27.8)	28.8 (25.2-32.6)	34.2 (29.7-39.1)	38.3 (32.9-44.2)	42.4 (36.0-49.5)	46.6 (38.9-55.0)	52.0 (42.5-62.7)	56.2 (45.0-68.8)
60-day	17.6 (15.6-19.8)	22.1 (19.6-24.9)	28.1 (24.8-31.7)	32.6 (28.6-36.9)	38.5 (33.4-44.0)	42.9 (36.9-49.5)	47.3 (40.2-55.2)	51.7 (43.3-61.2)	57.6 (47.1-69.4)	61.9 (49.7-75.9)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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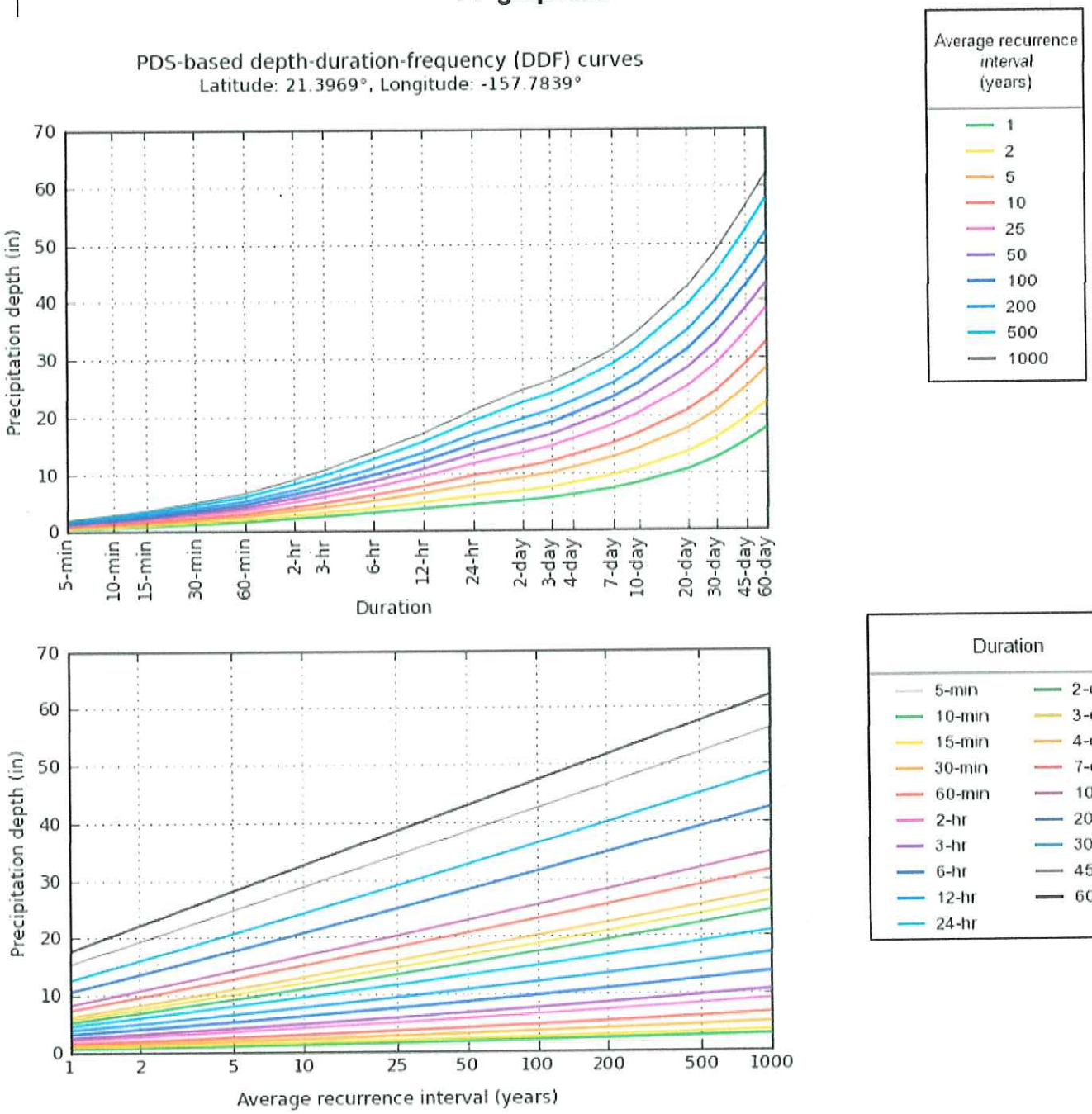
PF graphical



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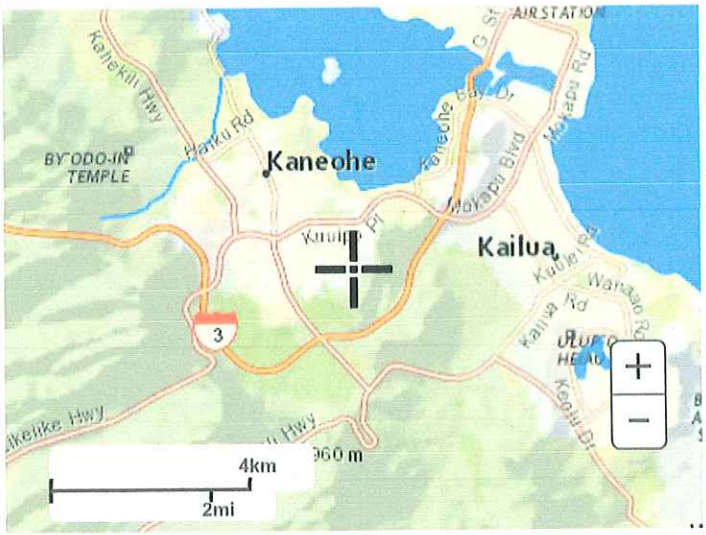
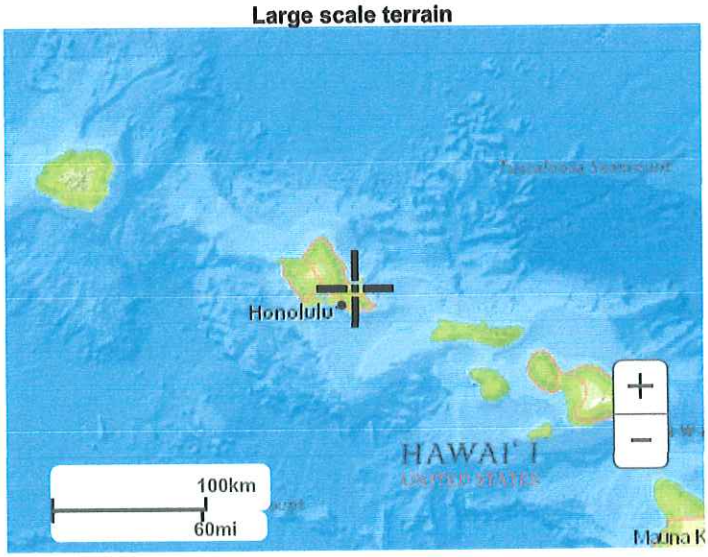
Maps & aerials

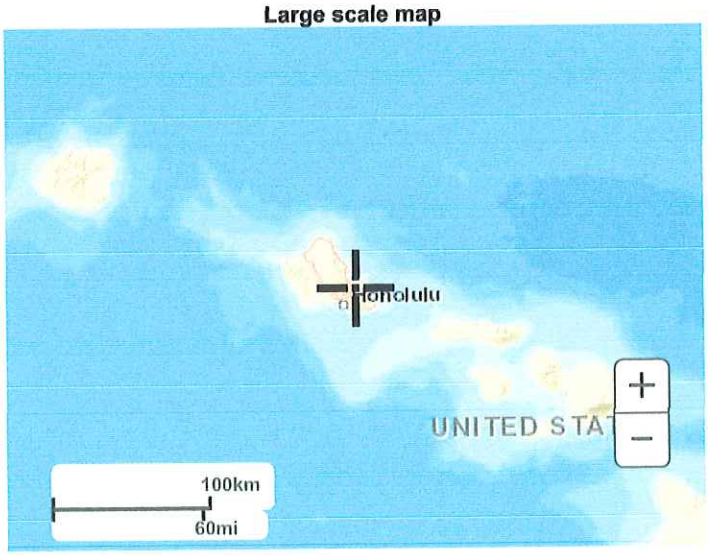
Small scale terrain



Large scale terrain



Large scale map



Large scale aerial

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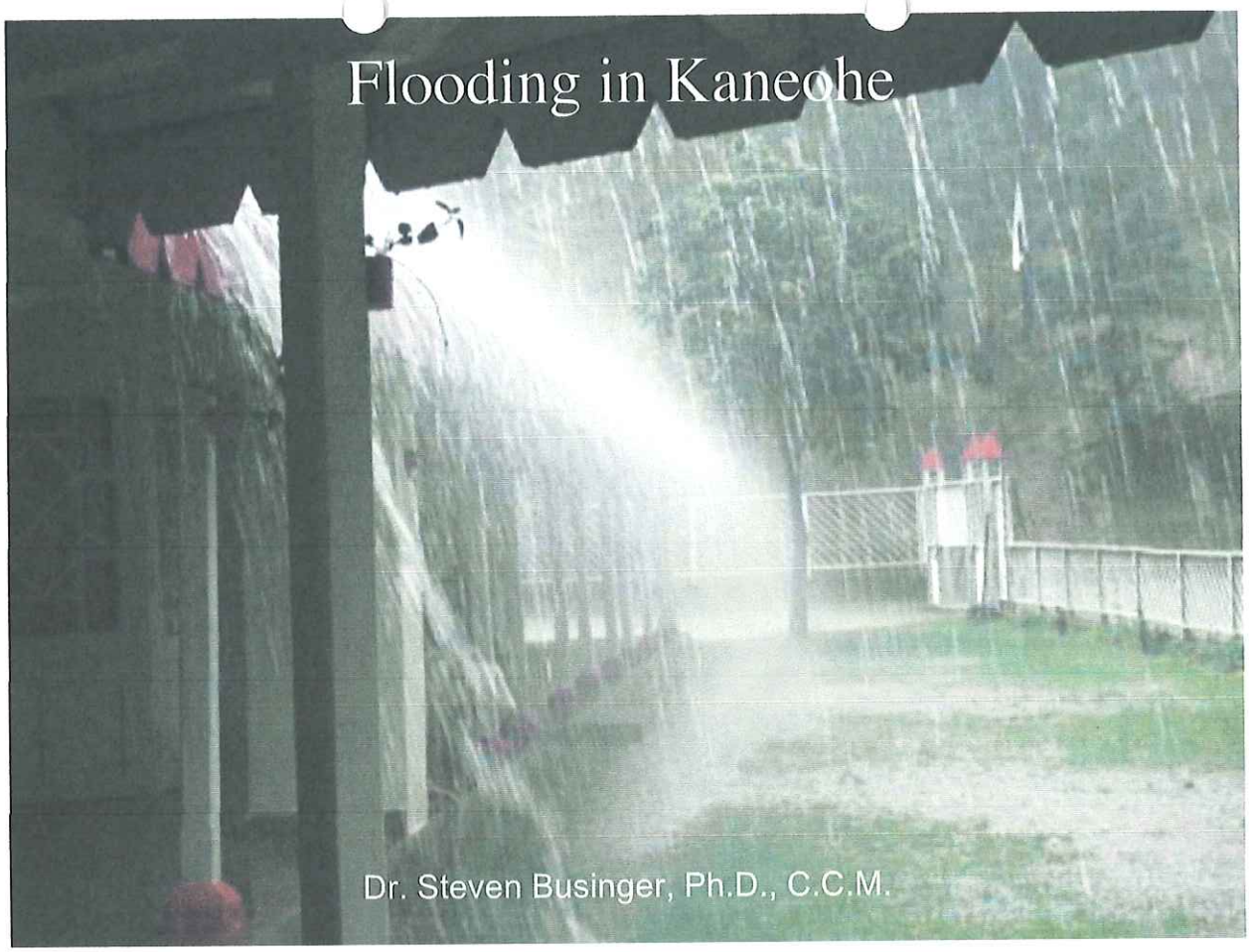
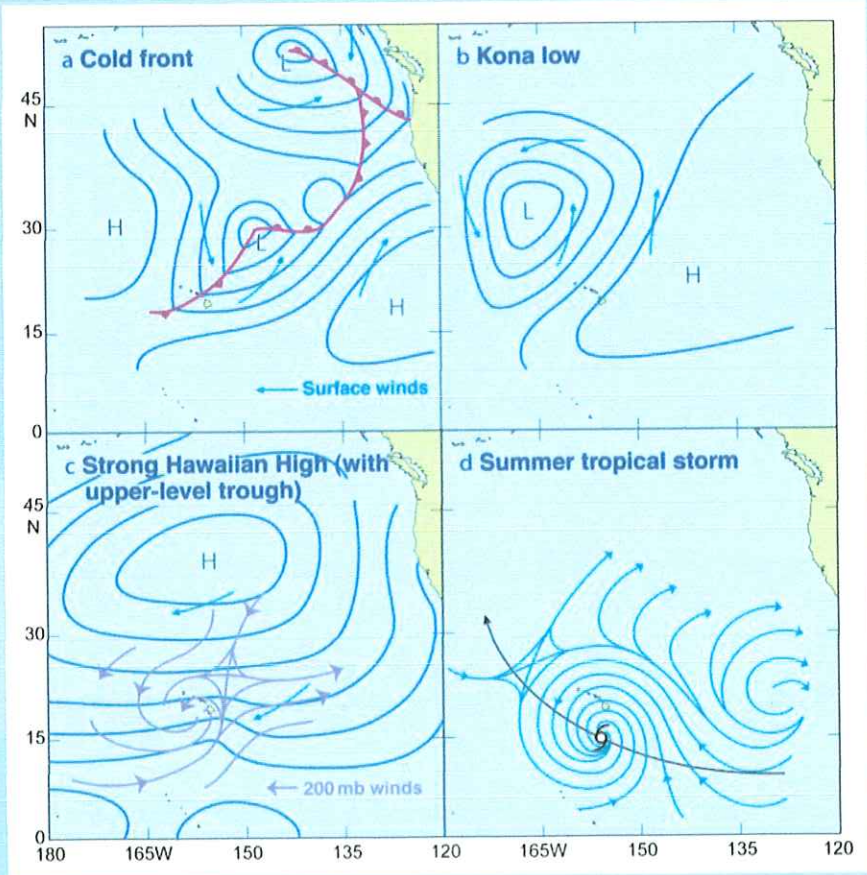
Questions?: HDSC.Questions@noaa.gov

Disclaimer

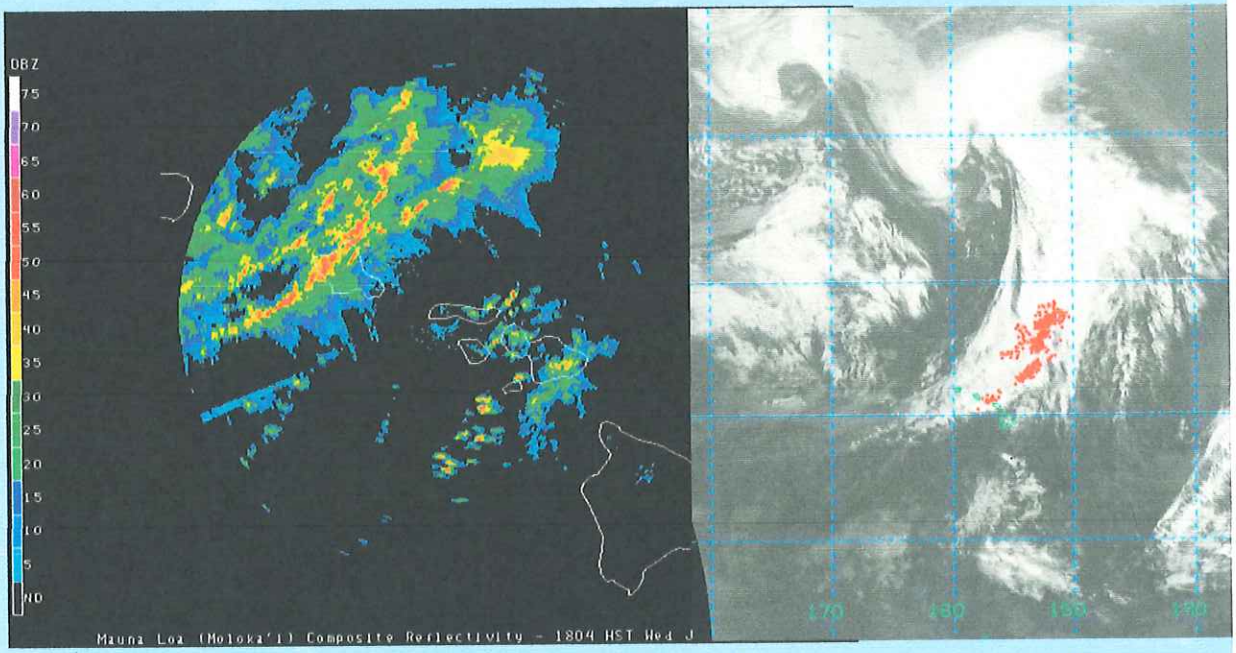


Four Heavy Rain Patterns in Hawaii



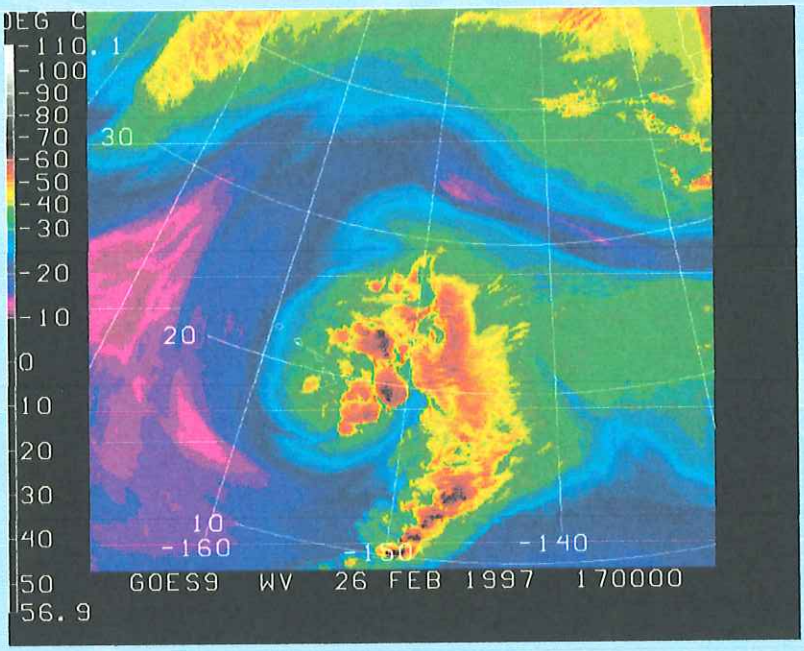
Winter Storm, Cold Front, and Kona Low

Radar Loop of Passing Cold Front



Wednesday 1/12/11. Slow movement of front causes training of heavy showers over Oahu. Landfill waste washes up between Ko Olina and Kahe Power Plant. High winds down power lines.

Kona Low



Kona lows cause more flash floods in Hawaii than any other storm system. They form south of 30°N latitude and are cut off from the polar jet stream.

Kona Low

- Kona lows all have an upper-level low aloft.
- The upper-level low is cold and it is cut off from the polar jet stream.
- New convection forms near and east of upper level low center.

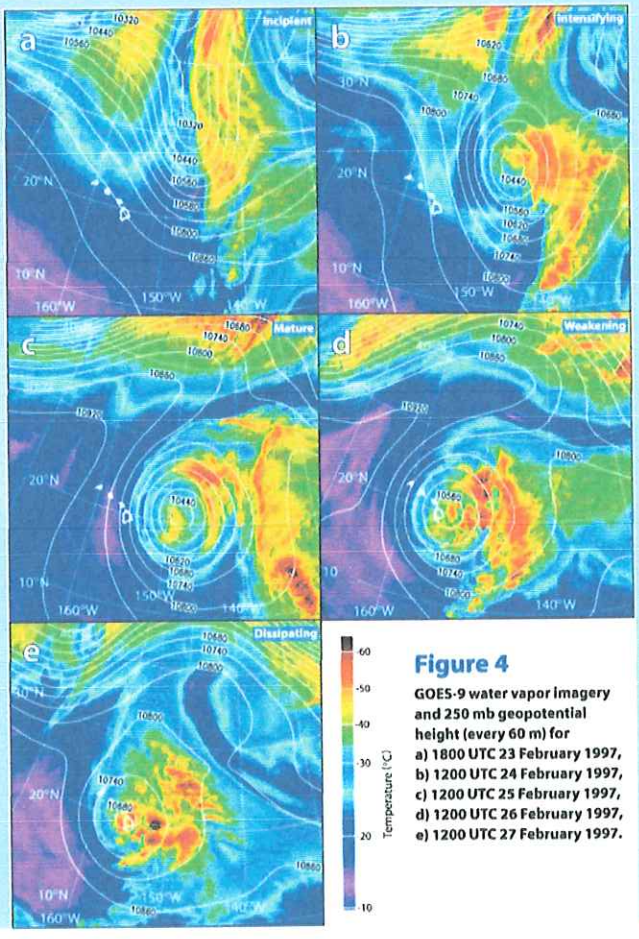


Figure 4

GOES-9 water vapor imagery and 250 mb geopotential height (every 60 m) for a) 1800 UTC 23 February 1997, b) 1200 UTC 24 February 1997, c) 1200 UTC 25 February 1997, d) 1200 UTC 26 February 1997, e) 1200 UTC 27 February 1997.

Kona Low

- The surface low moves southward as it deepens.
- The surface low moves westward as it dissipates.
- Thunderstorms form on the east side of the surface low.
- The strongest winds are on the north side and in rainbands.

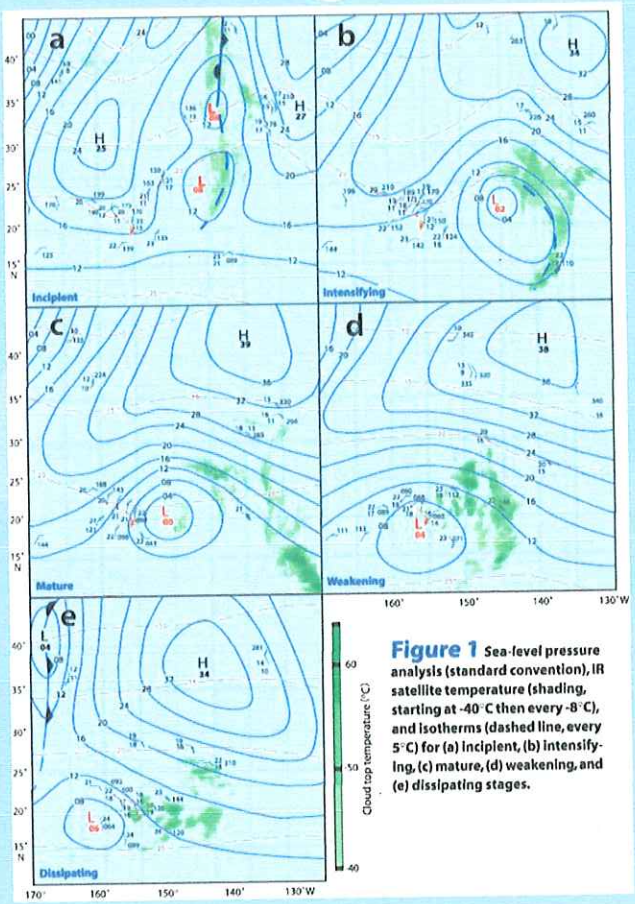
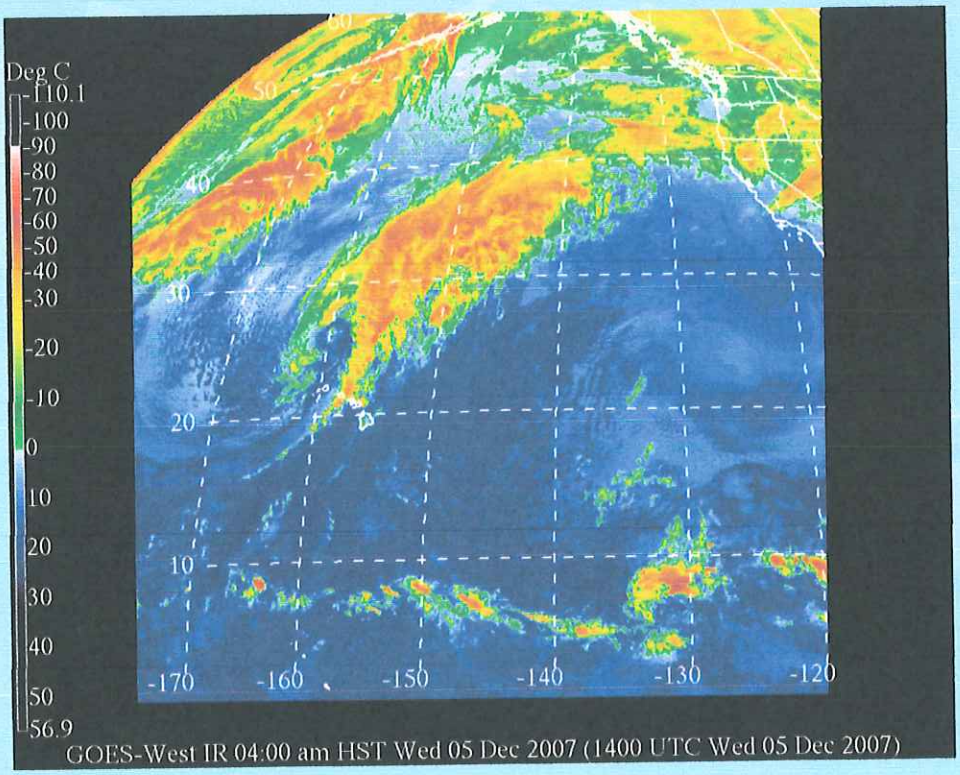
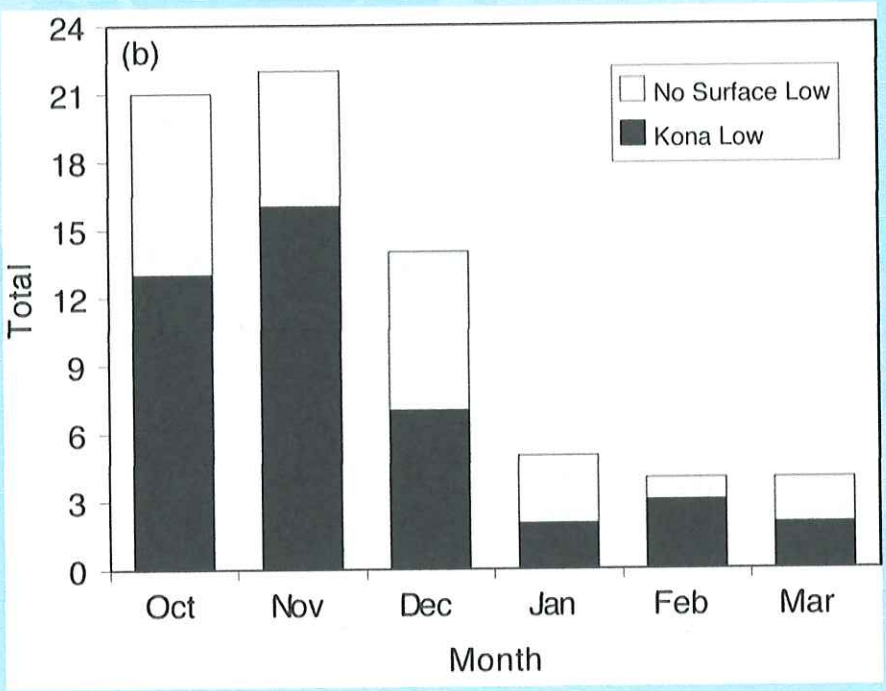


Figure 1 Sea-level pressure analysis (standard convention), IR satellite temperature (shading, starting at -40°C then every -8°C), and isotherms (dashed line, every 5°C) for (a) incipient, (b) intensifying, (c) mature, (d) weakening, and (e) dissipating stages.

Kona Low



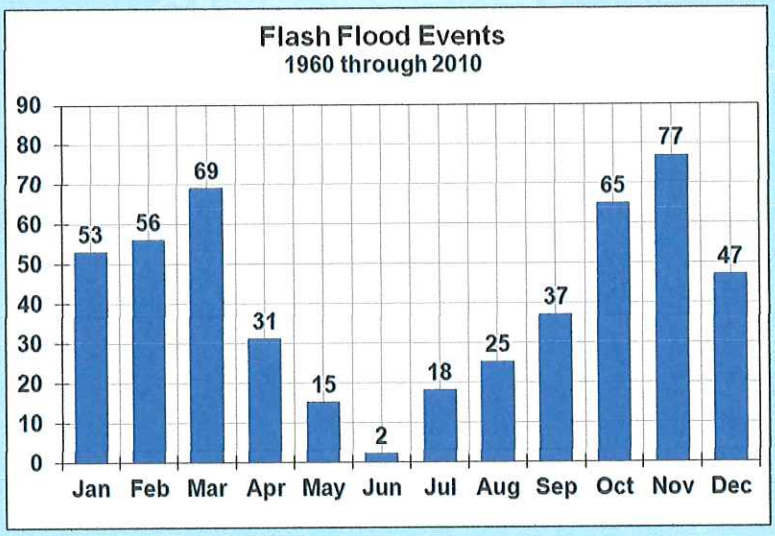
Monthly Distribution of Kona Lows



Kona Low – Flooding

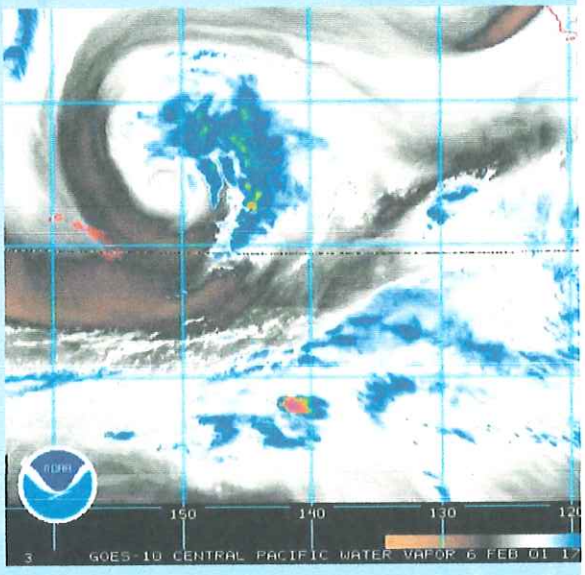
Flash Flood Climatology in Hawaii

- Is the second leading cause of wx-related fatalities, after surf
- 495 events in 41-year period
- ~12 per year
- November is the worst month for storms (~2 flash floods)
- June has the best weather



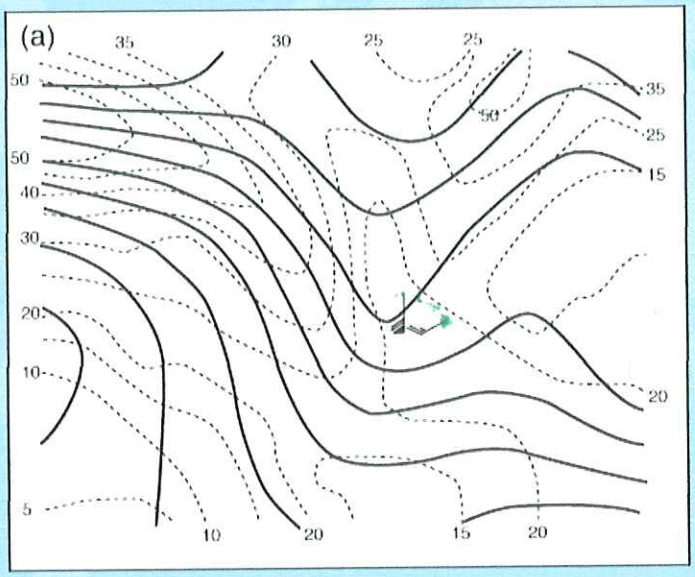
Ingredients for Heavy Rain

- Moisture – lots of water vapor
  - Large amounts of moisture results in unstable air and more rainfall
- Large upward motion
  - Low level convergence & upper level divergence needed for heavy rainfall.
- Slow storm motion (i.e. long duration)
  - Increases total rainfall over basin
  - Terrain anchoring



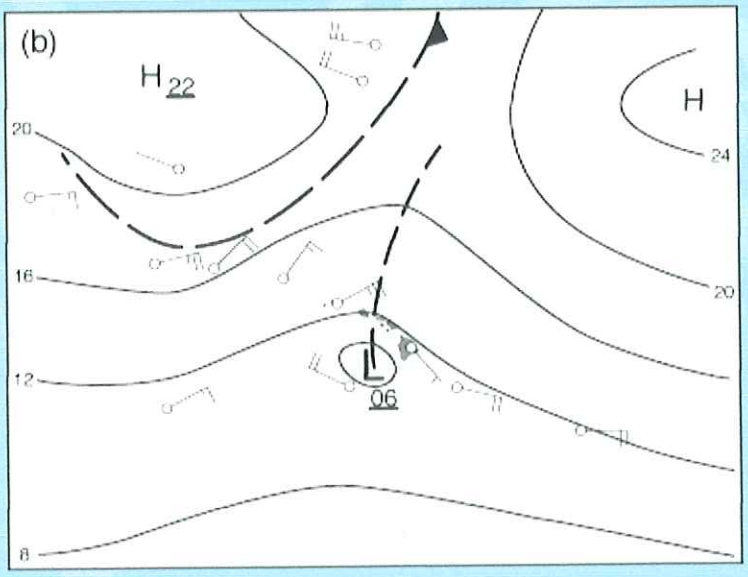
Enhanced IR image during peak rainfall period of the Nov. 2000 Big Island flood event.

Upper Level Divergence of Winds



Analysis for 1200 UTC 25 January 1996 of 250 mb streamlines and isotachs (every 5 m/s).

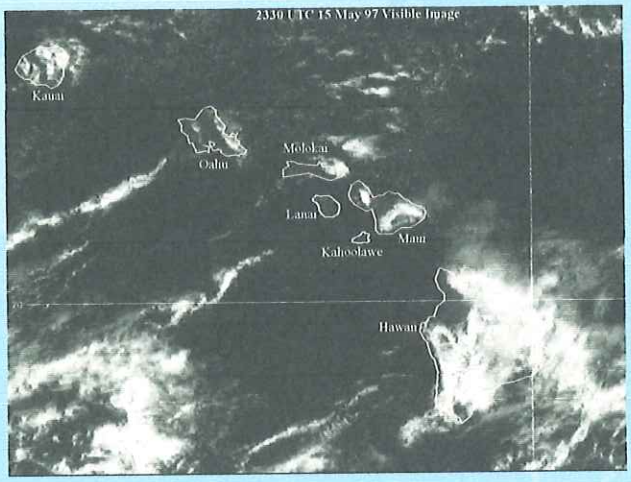
Low Level Convergence of Winds



Analysis for 1200 UTC 25 January 1996 of sea-level pressure (mb).

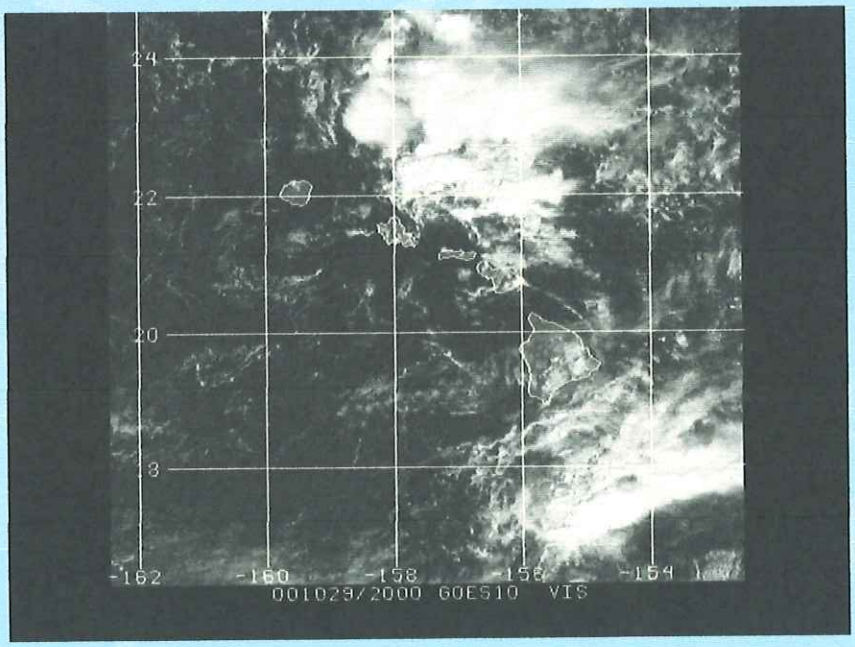
Terrain Affects

- Terrain lifting and anchoring
  - Ideal lifting mechanism for prolonged heavy rains
  - Rain maxima often over slopes exposed to low level flow
- Lee-side convergence zones (a.k.a. "plumes")
  - Enhanced low level convergence.
  - Southeasterly flow causes "plume" to drift over downstream islands



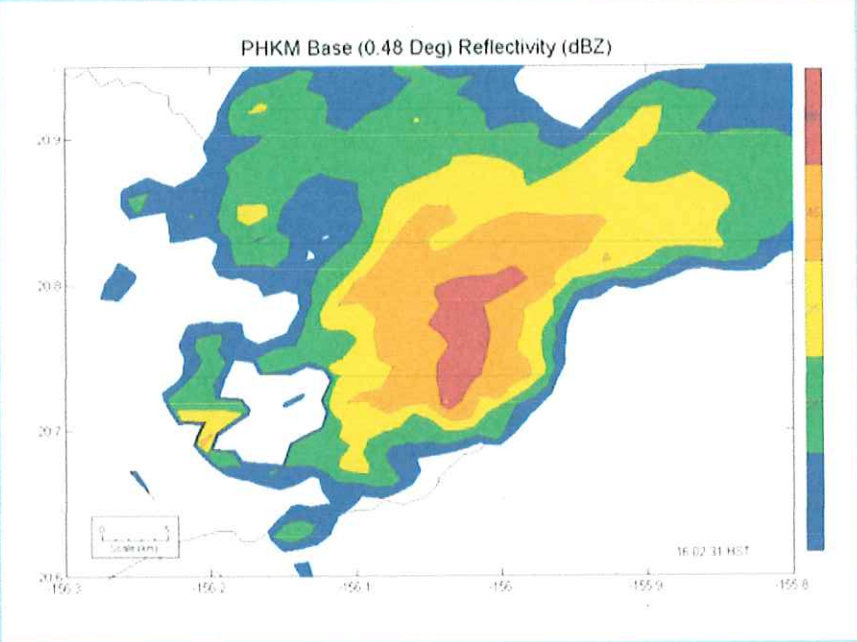
Visible image showing plumes

Hana Flood - Visible Imagery



Big Island Plume and Terrain Anchoring

Hana Flood - Radar View

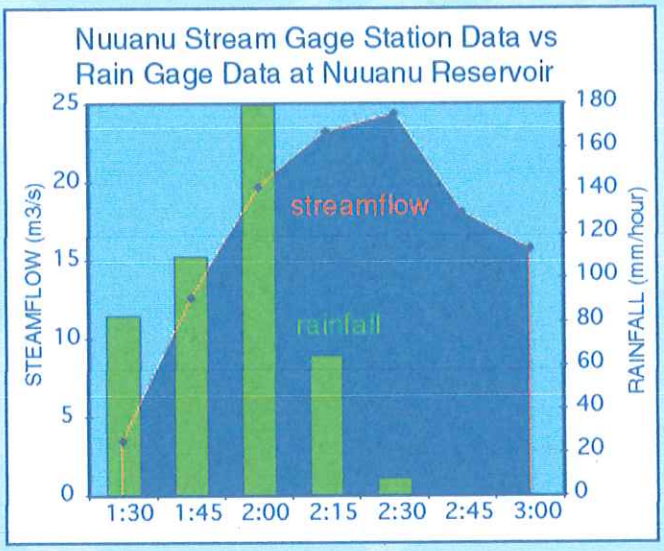


Big Island Plume and Terrain Anchoring

Factors that Contribute to Flood Problem

1. Small Watersheds result in short response time.
   - Steep slopes increase speed of runoff
   - Shallow soils quickly become saturated
2. Urbanization increases runoff.
   - debris dams commonly form in urban culverts
   - storm water and sewers share plumbing - result is sewage spills.

Small Basins mean Short Response Time



Small basins with steep slopes and shallow soils make the time between peak rain and peak discharge short, as little as 15 minutes. Half of the State is within 5 miles of the shore, therefore lead time for a response is very short.

Contributing Factor - Saturated Soil

Paauau Stream overtopping Belt Highway at Pahala during Nov. 2000 Big Island flood event.

- Soil moisture content from previous rains
- Previous Rainfall: Rate, duration, pattern
- Soil type, depth and stratification: determines infiltration rate & flow type

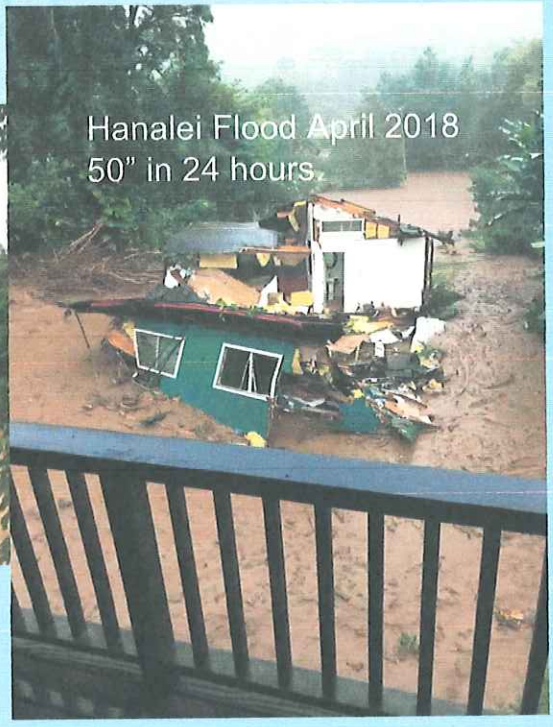
Contributing Factors - Land Use

- Land use affects basin response
  - Agriculture
  - Natural forest
  - Urbanized
- Basin slope & size
  - Small, steep, shallow soils: < 1 hr response time
- Channel condition
  - Debris dams?

Aerial view of Kaneohe, Oahu. Note encroachment of urban areas within small, steep-walled basins.

Notable Recent Flood Events

Lane induced Hilo Flooding
August 2018. 42" in 36 hours



Some Notable Flood Events

- April 2018
  - Oahu and Kauai
  - $200 Mil.
  - 50 inches/24-hrs
- Halloween Flood UH Manoa 2004
  - $50 Million
  - 9 inches in 6 hours
- February & March 2006
  - >80 inches of rain on Oahu
  - Kaloko Dam Break - seven deaths
- New Years Flood 1987 Hawaii Kai
  - 25 inches/24-hrs
  - $34 Million

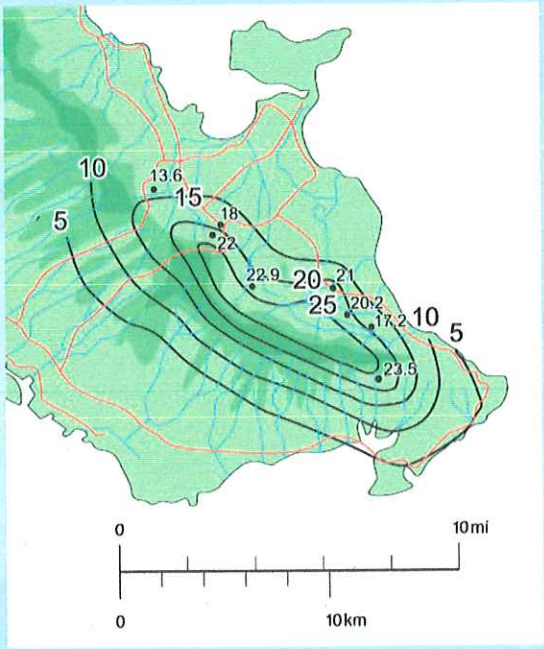
Manoa Valley flood, Halloween 2004

Oahu New Year's Eve Flood

New Years Flood 1987 Hawaii Kai

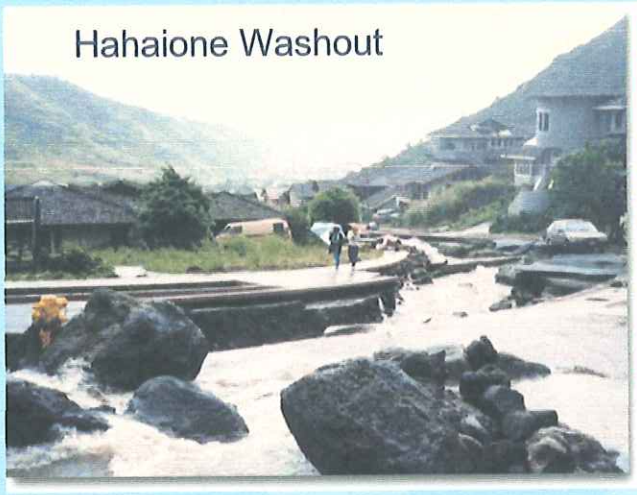
- 25 inches/24-hrs
- $34 Million

Kahena Street, Hahaione Valley on January 2, 1988. Flood waters gouged a 10–20 ft channel in the roadway. (Photo courtesy of T. Giambelluca).

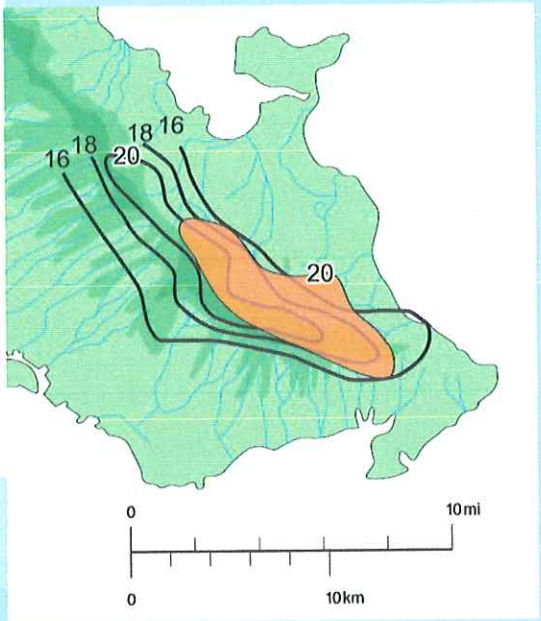


24-hour rainfall in inches. Distribution determined by the terrain.

Rainfall Distribution: New Year's Storm



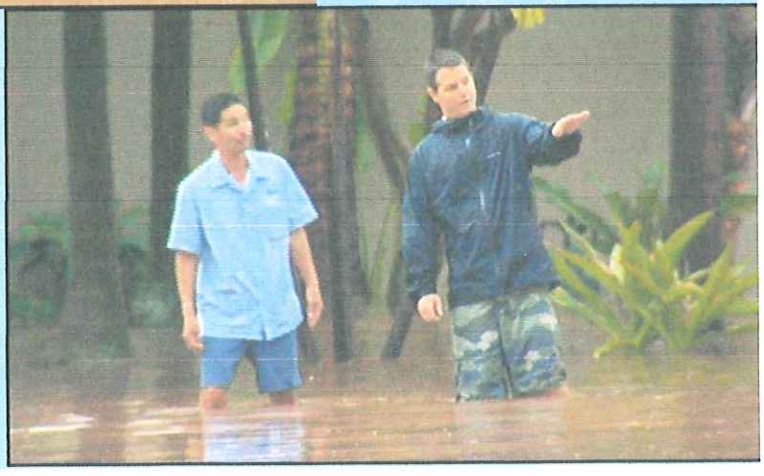
Our islands have narrow coastal transportation corridors that can have large sections isolated by debris flows. This occurred on Oahu on New Years Eve, 1987 when all transport to East Oahu was severed.



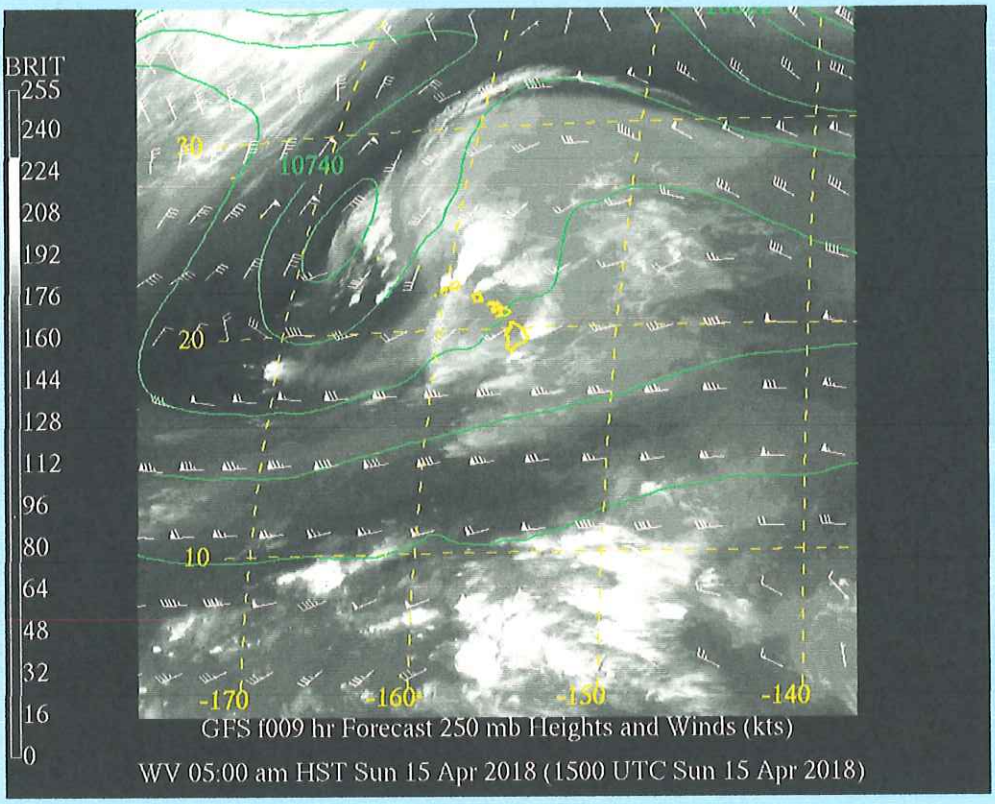
Contours for a 100-yr rainfall event with overlay of 20" rainfall contour.

East Oahu Flood
4/13/18

Niu Valley – 5.57"
Maunawili – 5.03"
Waimanalo – 4.79"
Manoa's Lyon Arboretum – 4.42"



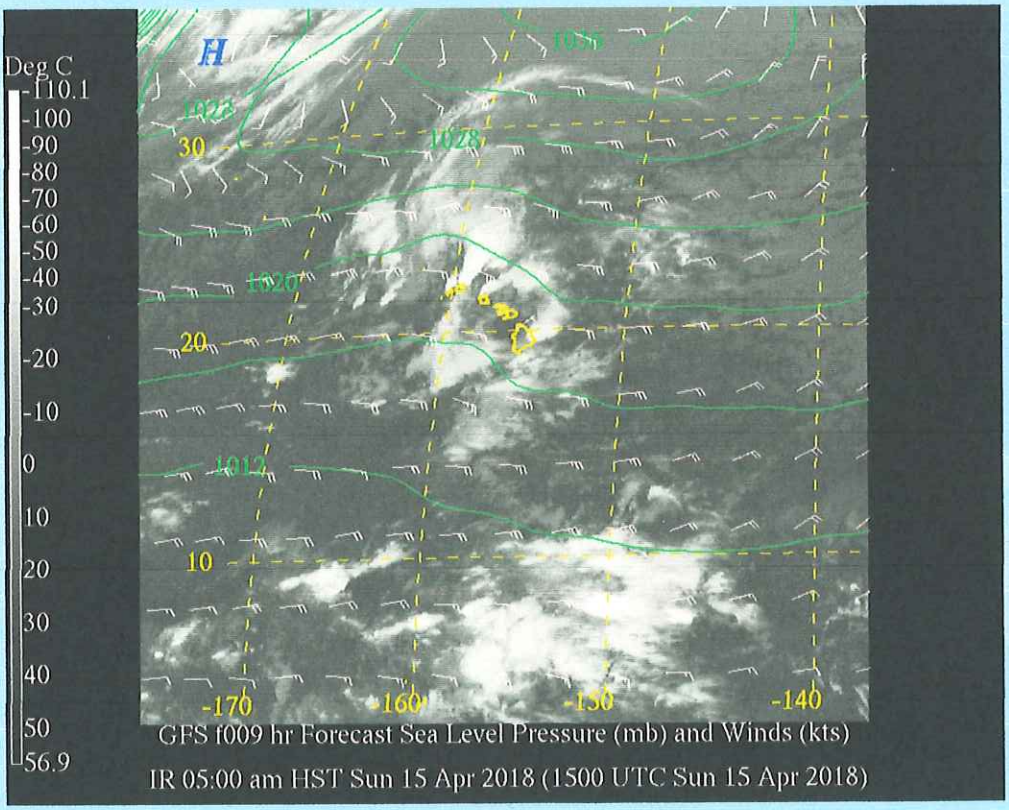
Upper Level Winds Diverge



GFS f009 hr Forecast 250 mb Heights and Winds (kts)

WV 05:00 am HST Sun 15 Apr 2018 (1500 UTC Sun 15 Apr 2018)

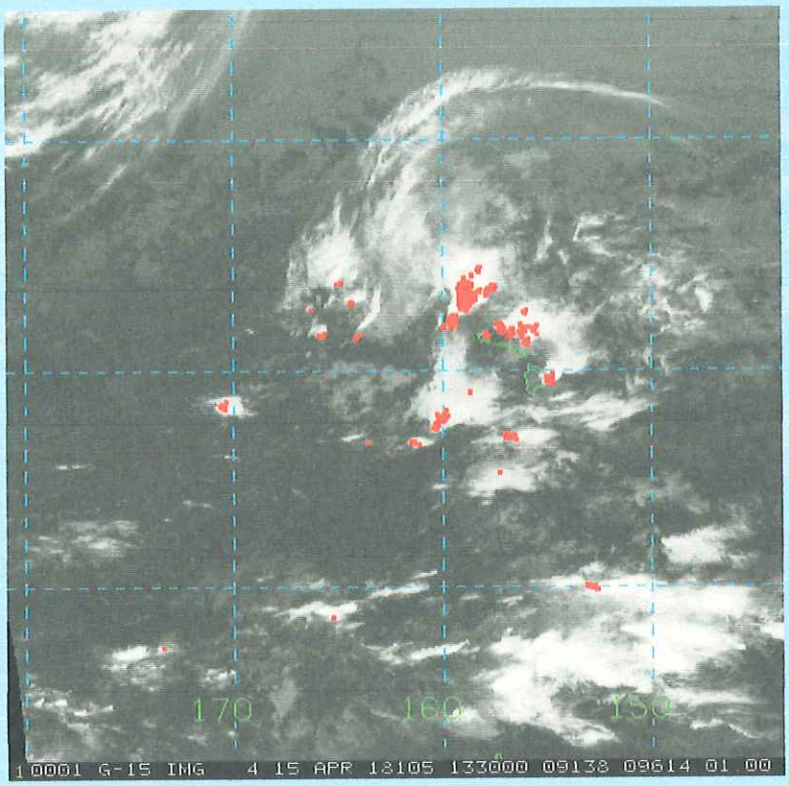
Low Level Winds Converge

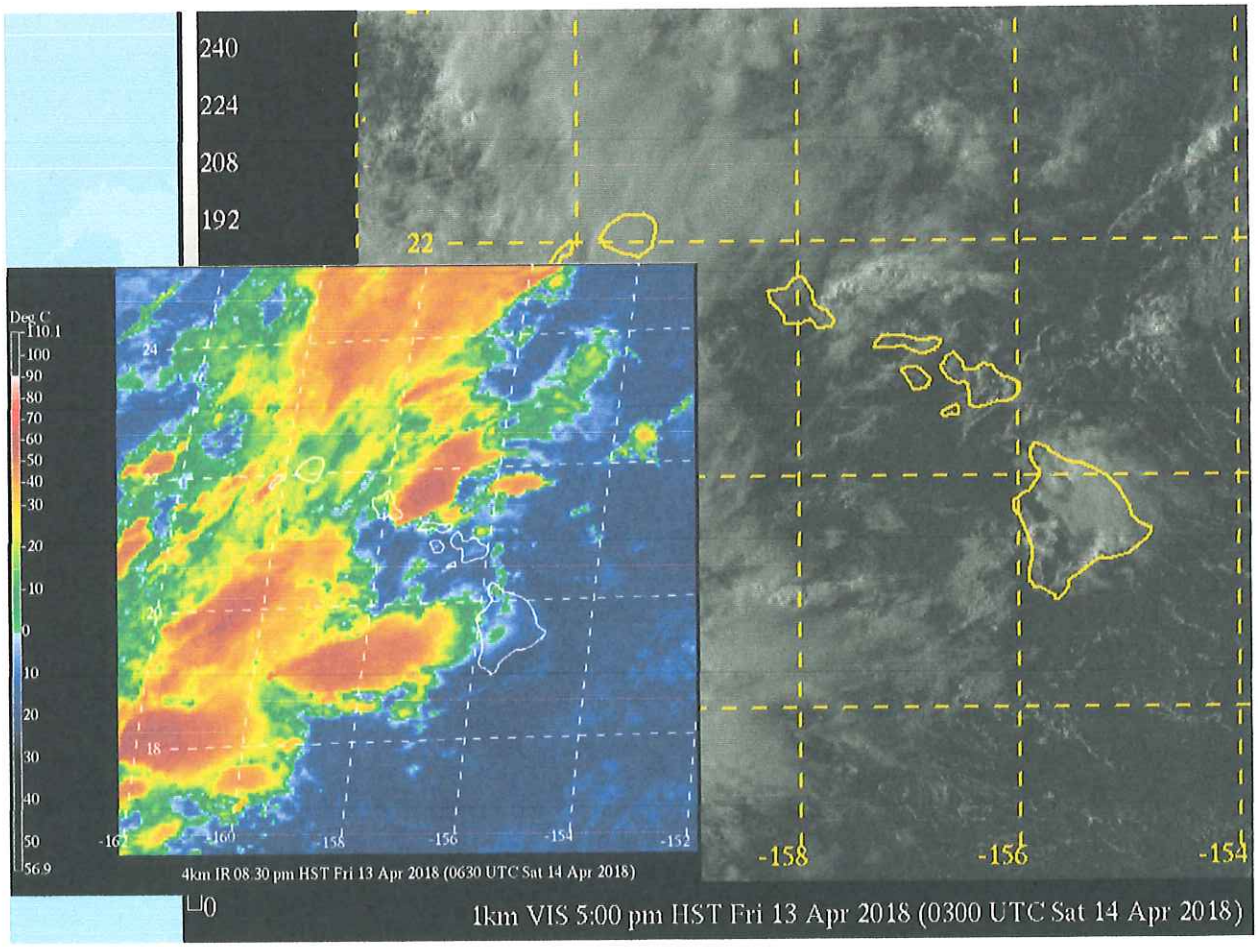


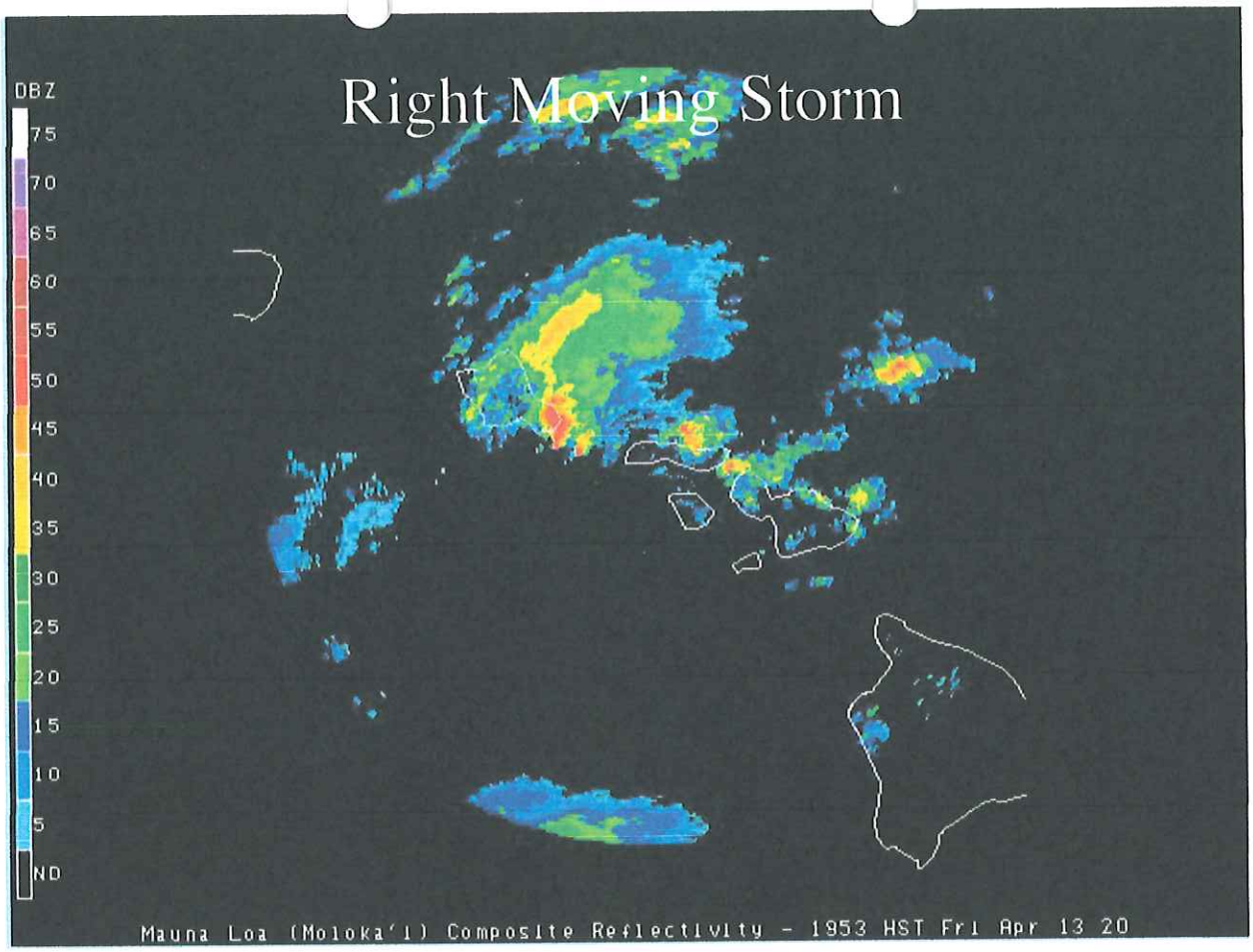
GFS f009 hr Forecast Sea Level Pressure (mb) and Winds (kts)

IR 05:00 am HST Sun 15 Apr 2018 (1500 UTC Sun 15 Apr 2018)

Thunderstorms - Deep Convection






Right Moving Storm
DBZ
75
70
65
60
55
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40
35
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25
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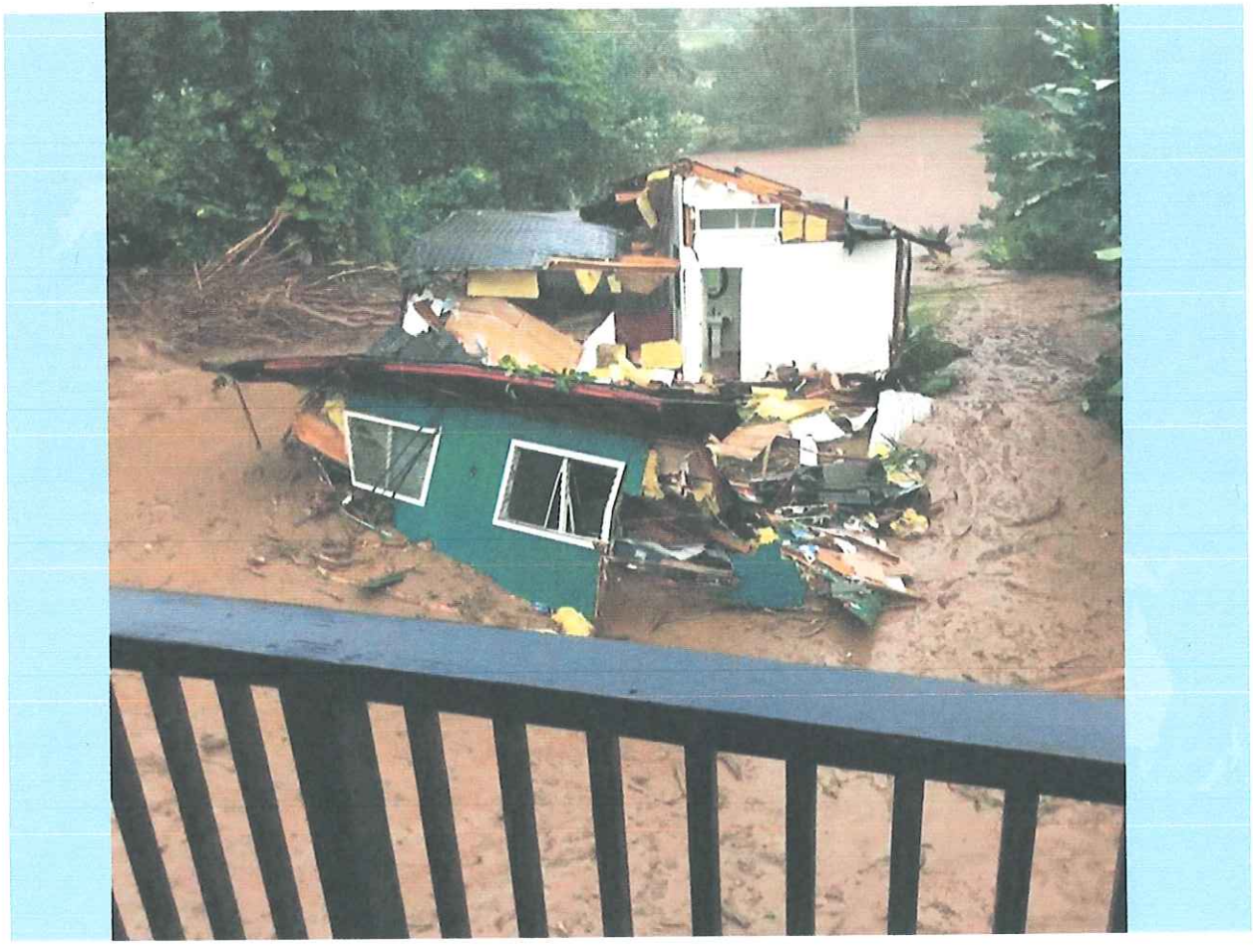
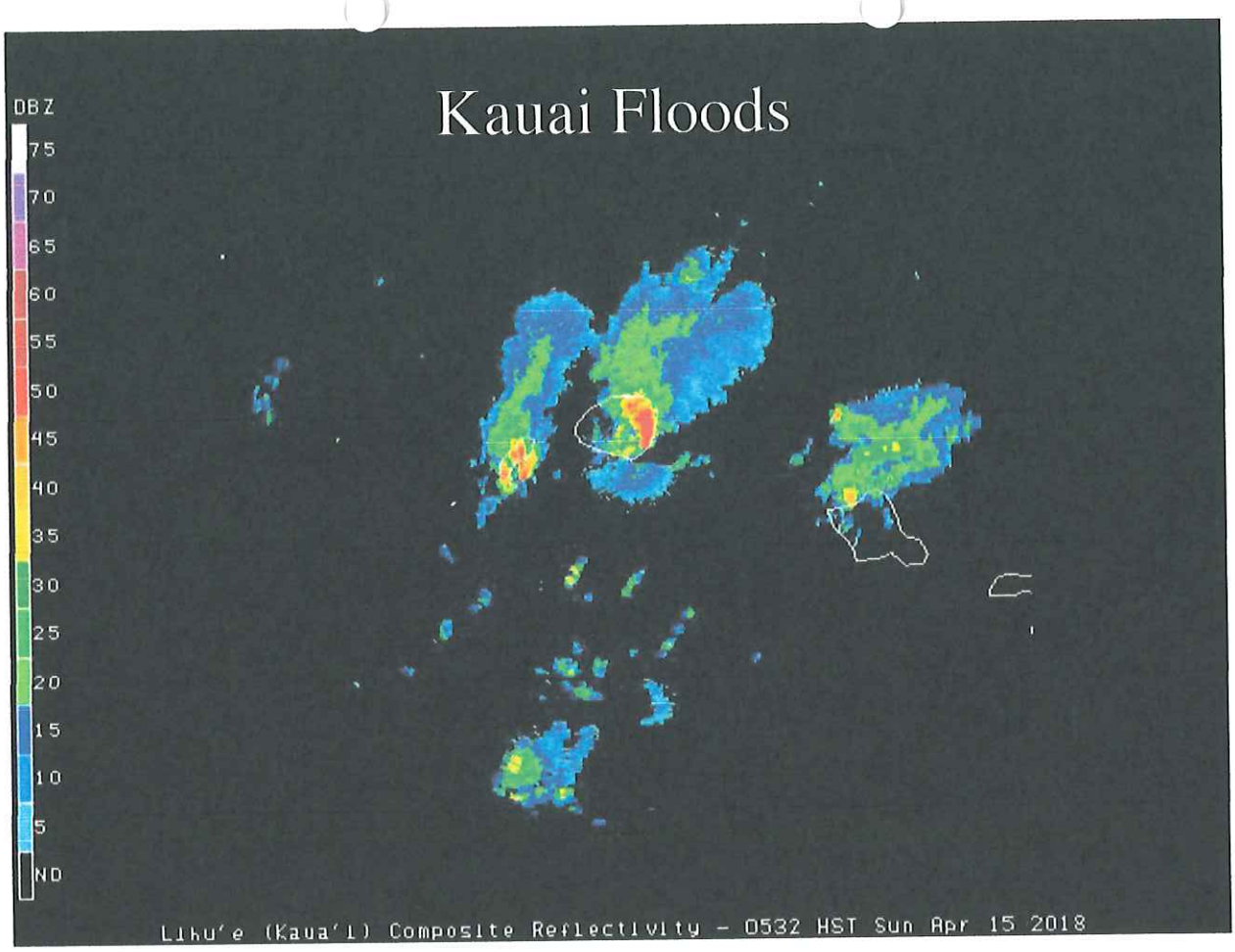
15
10
5
ND
Mauna Loa (Moloka'i) Composite Reflectivity - 1953 HST Fri Apr 13 20




Kauai Floods
DBZ
75
70
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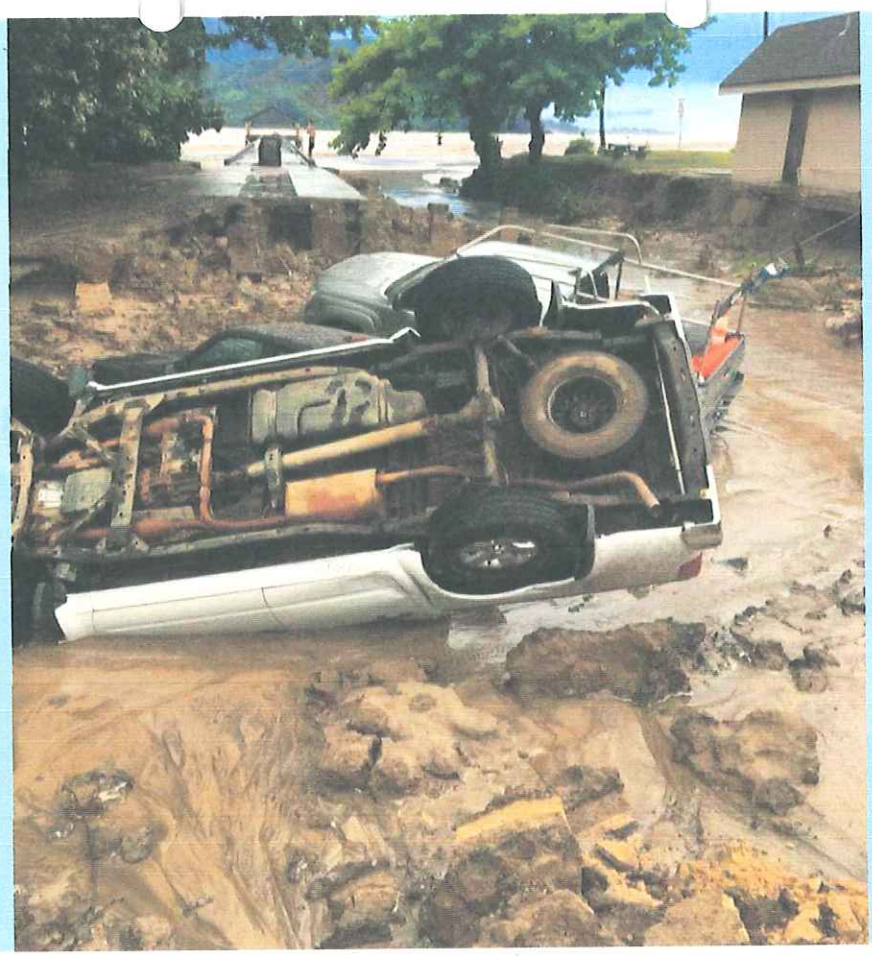
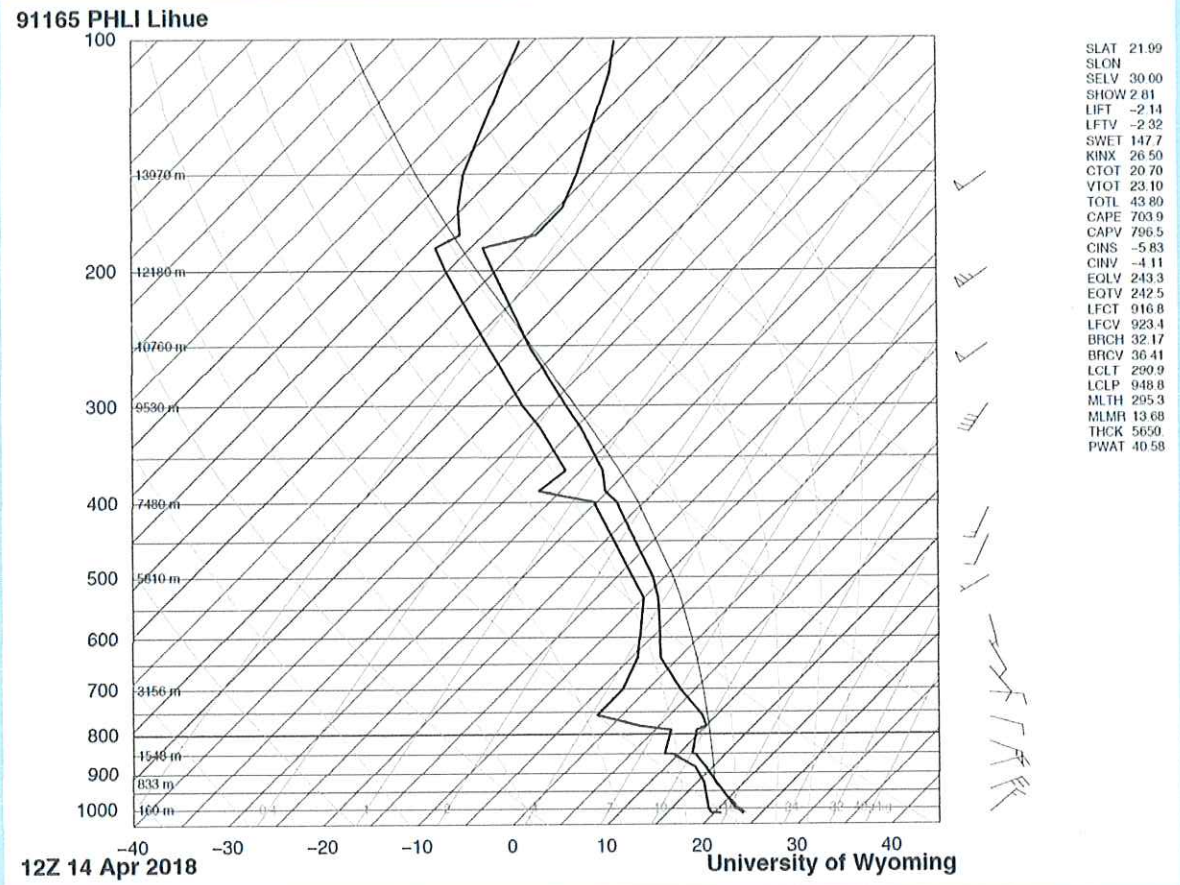
ND
Lihu'e (Kaua'i) Composite Reflectivity - 0532 HST Sun Apr 15 2018

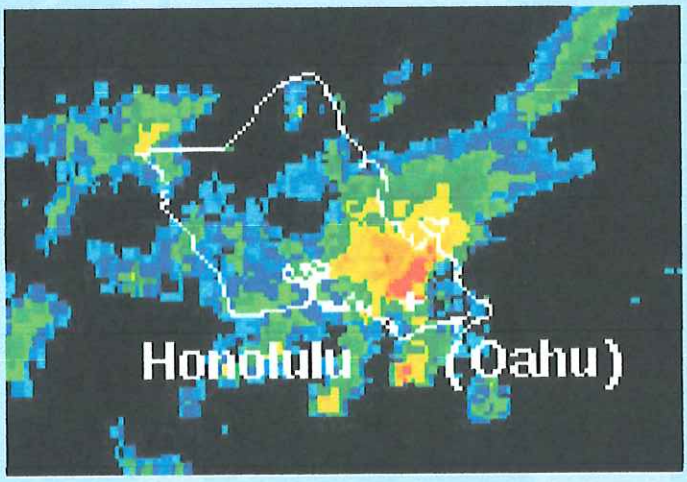

YIELD





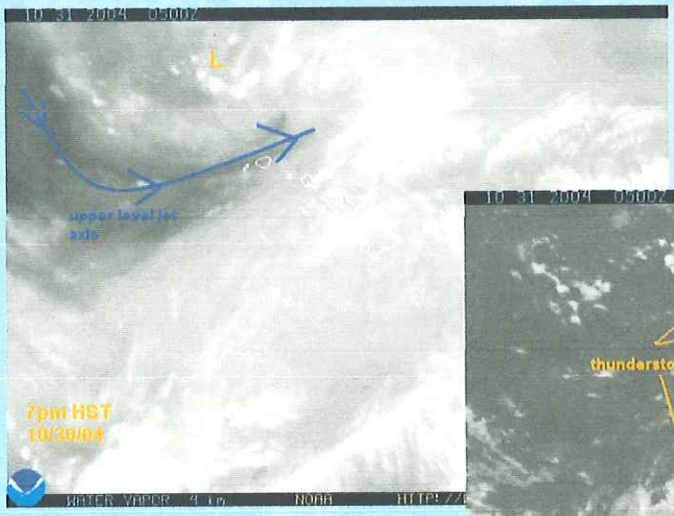
Manoa Halloween Flood 2004

Rainfall Rates
15min: 1.29 inches
1-hr: 3.72 inches
2-hr: 4.38 inches
3-hr: 5.73 inches
6-hr: 8.71 inches
A once in 50-yr storm

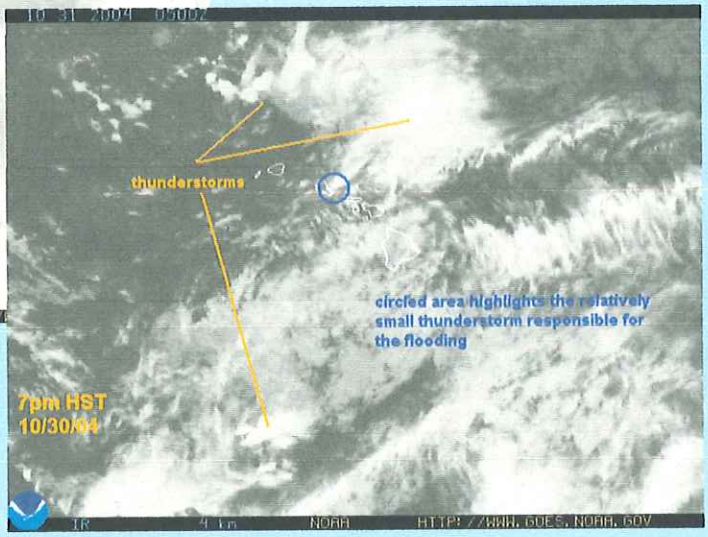


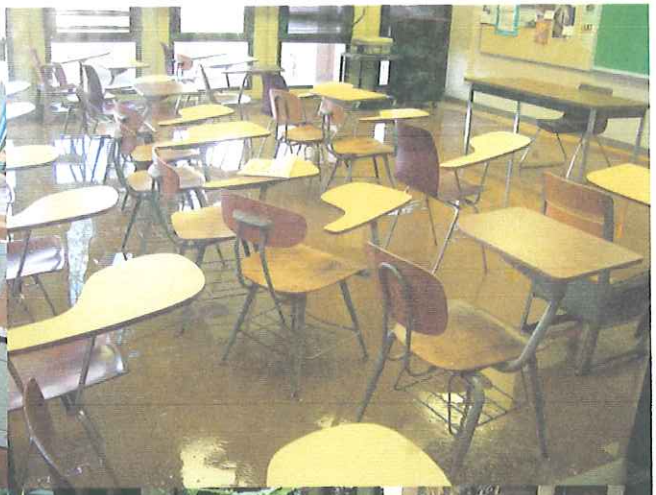
Halloween Flood caused more than $50 million in damage at UH Manoa.

Manoa Halloween Flood 2004

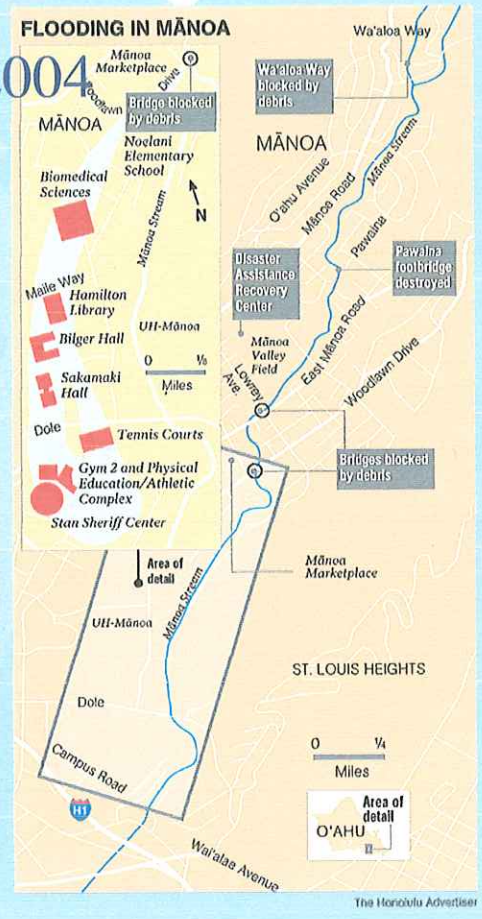


Upper-level divergence over converging NE trade winds.



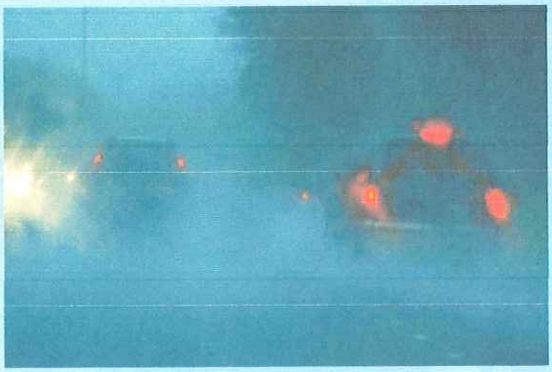


Manoa Halloween Flood 2004



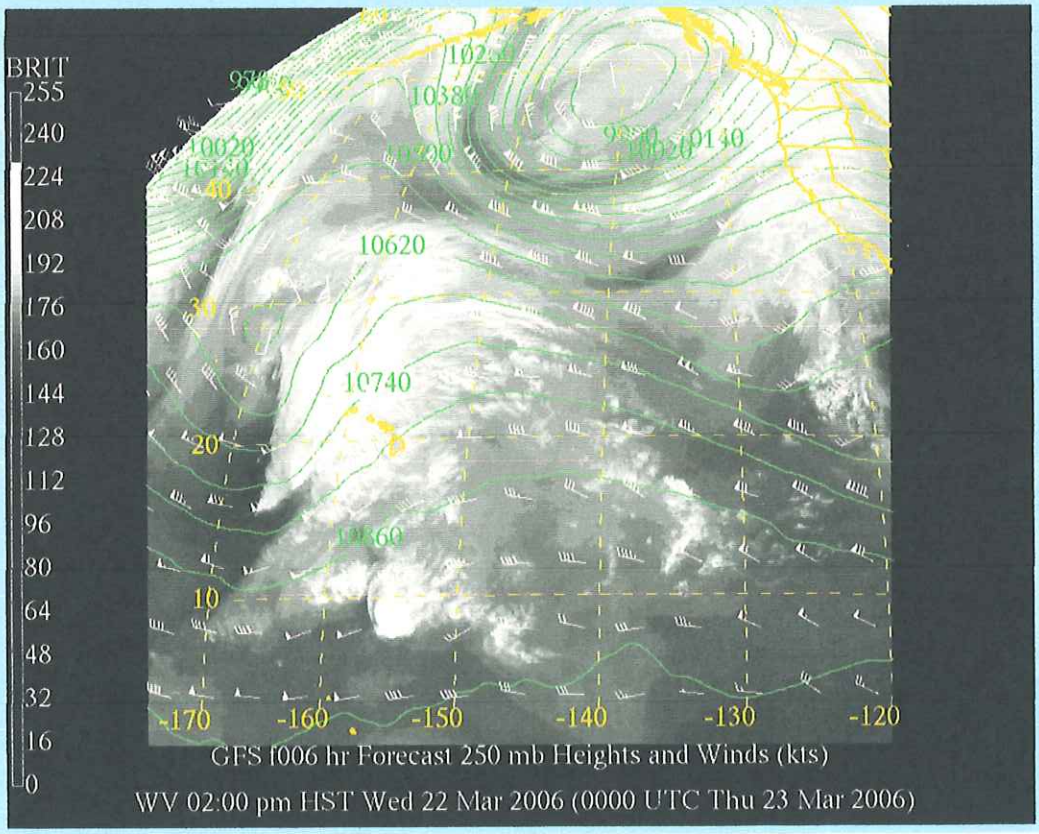
Oahu Floods February and March 2006

Laie Flood

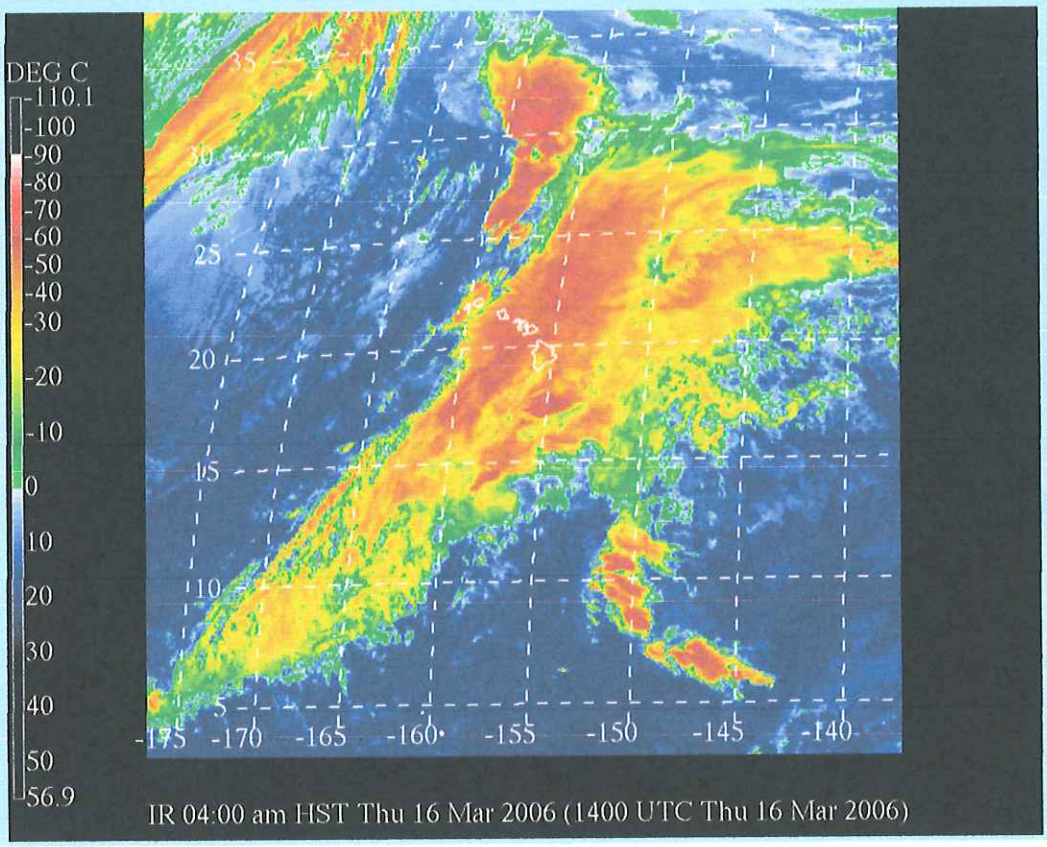


The Deja Vu Kona Low

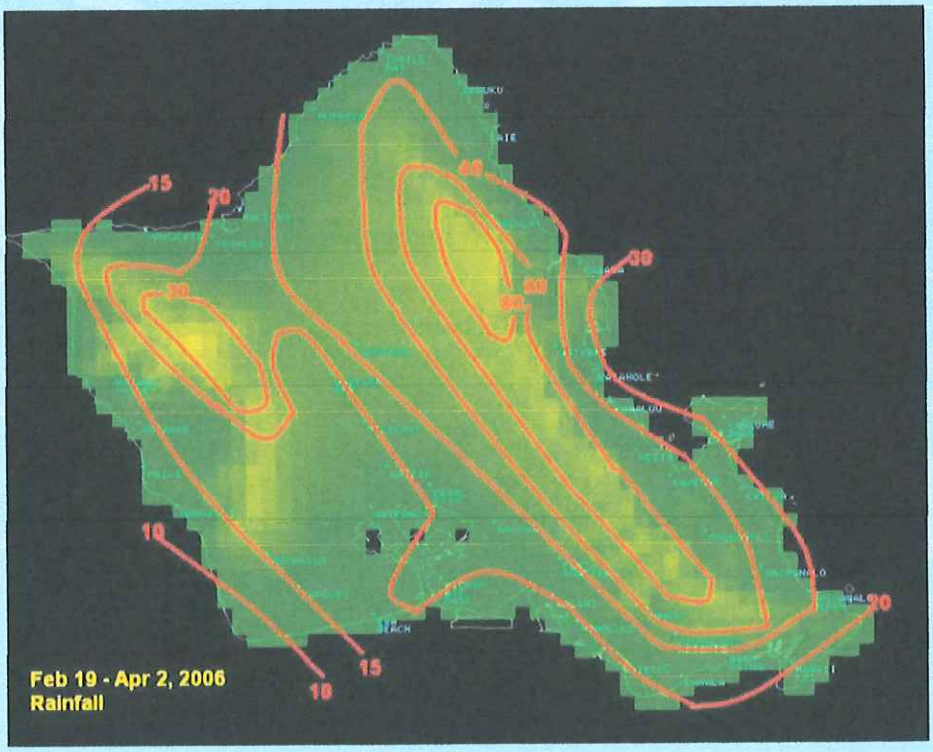
The Deja vu Kona Low



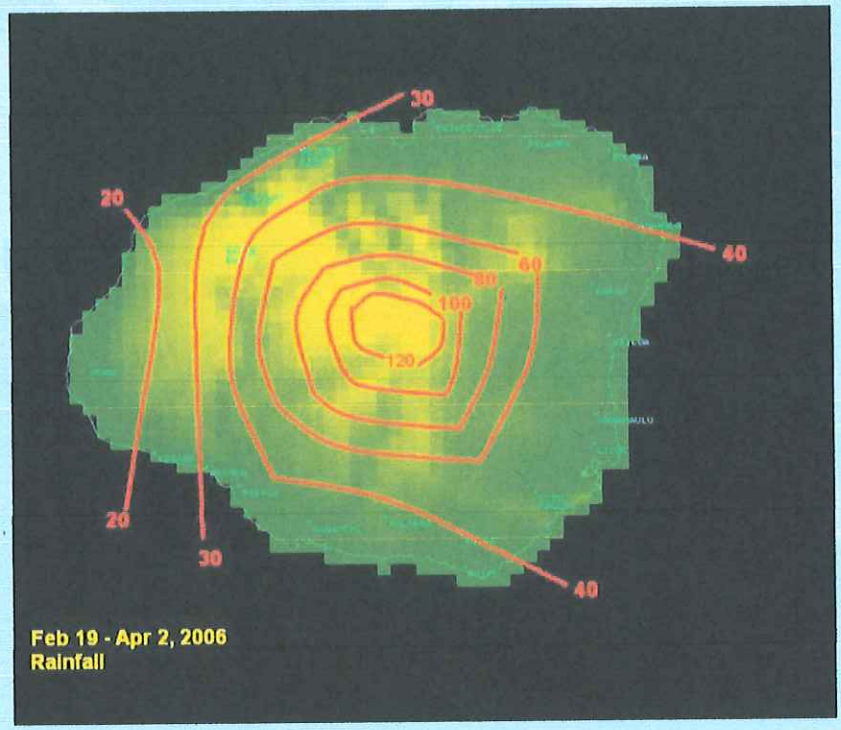
The Deja Vu Kona Low



The Deja Vu Kona Low



The Deja Vu Kona Low

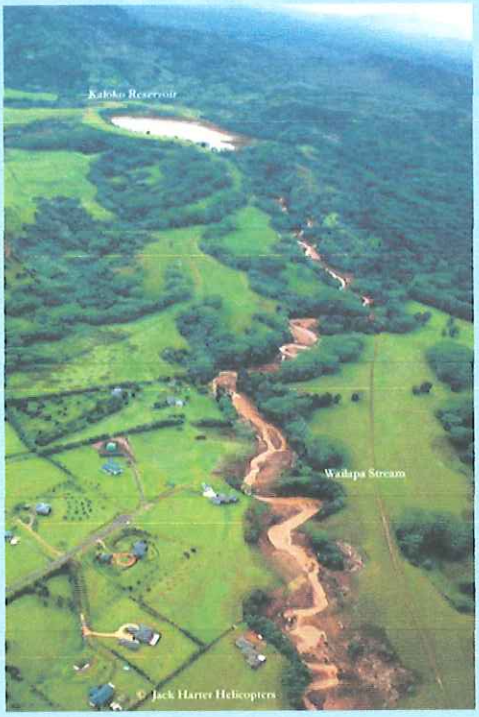


Kaloko Dam Break

- Prolonged period of heavy rainfall during February and March of 2006 filled the reservoir to capacity.
- Dam failure caused seven deaths.

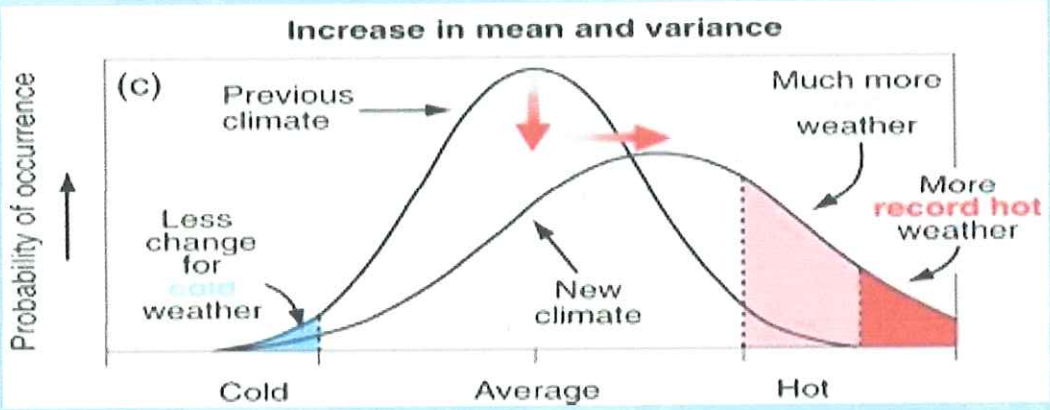
Kaloko Reservoir, Kauai

Kaloko Dam Break



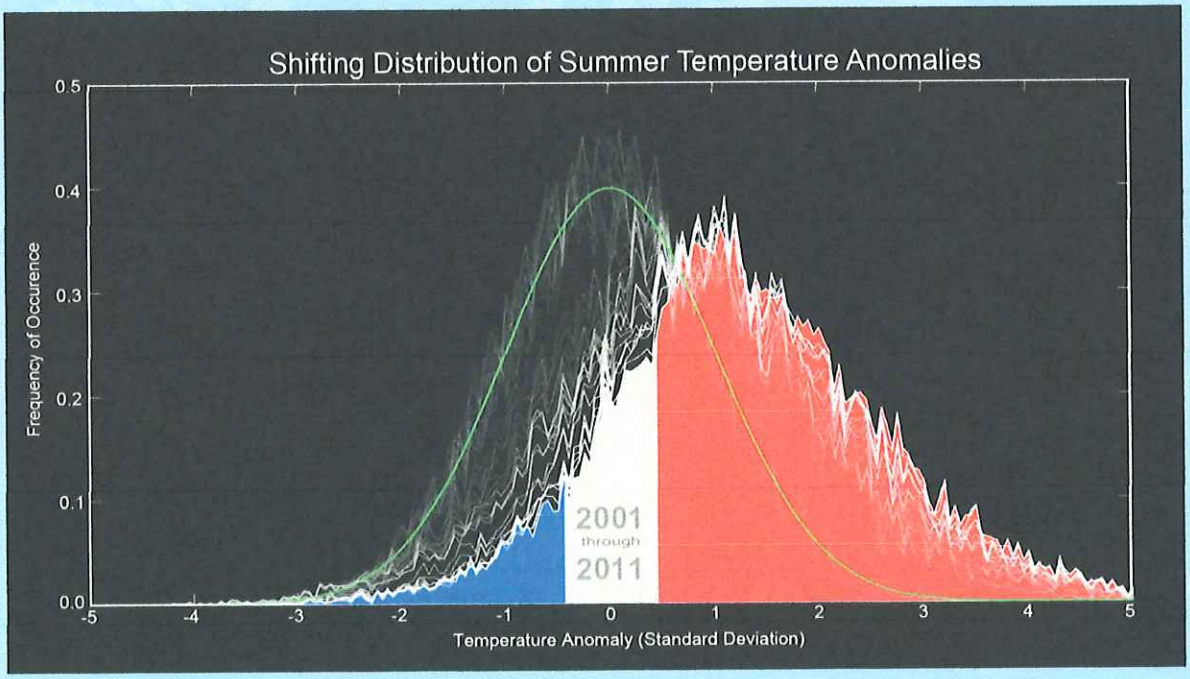
Kaloko Dam Break

Extreme Weather Events

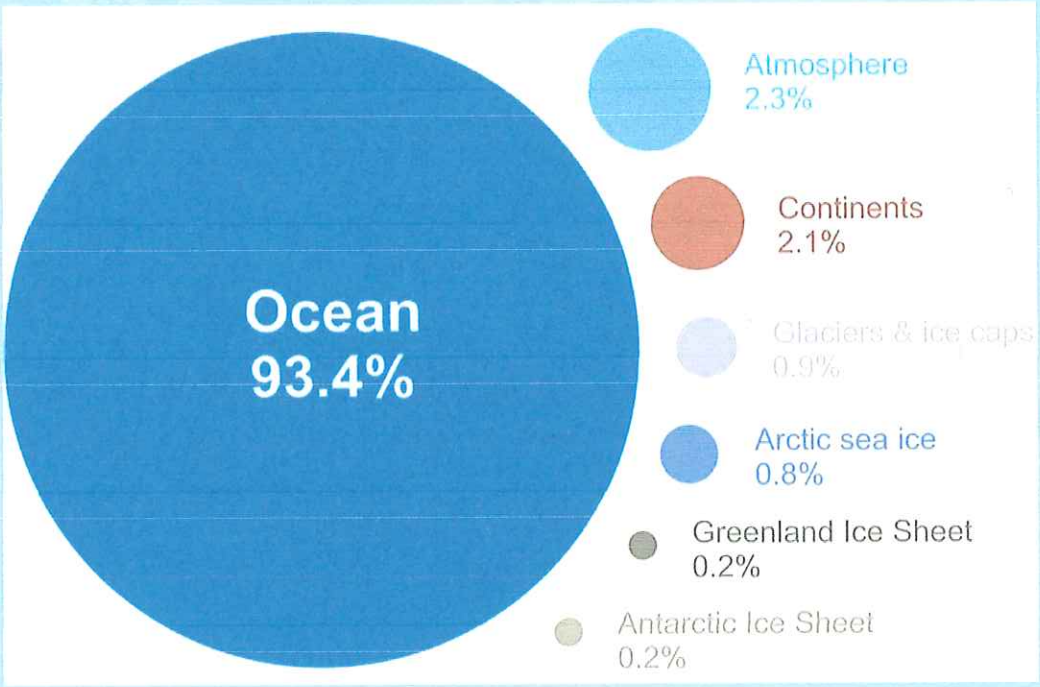


Schematic showing the effect on extreme temperatures when the mean temperature and the variance increases, for a normal temperature distribution.

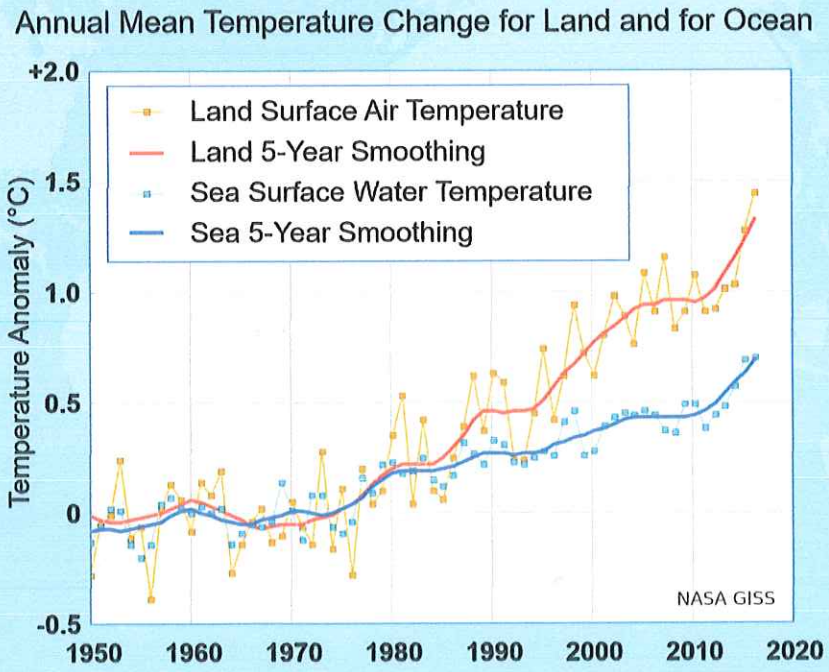
Our "Normal" Weather is Shifting



Where is the Heating Going?

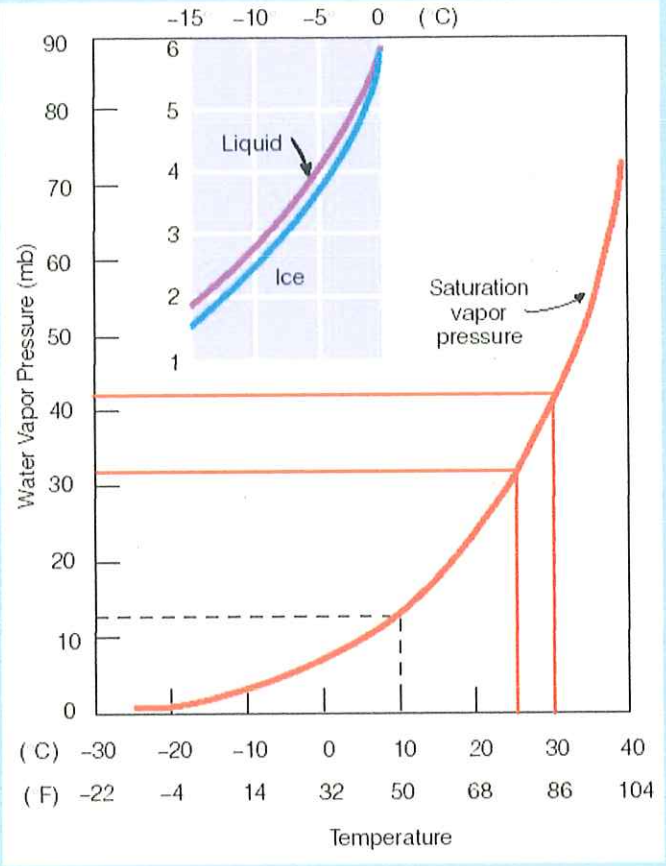


Sea-Surface Temperature Trend

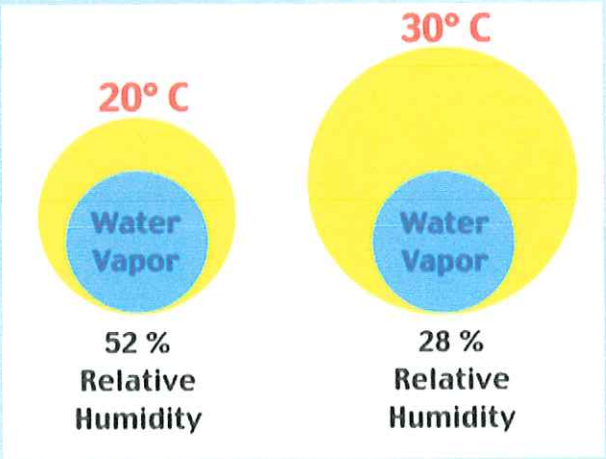


Saturation Vapor Pressure

An SST increase of only 3.5° C from 26.5 to 30°C results in a 25% increase in vapor pressure, fueling the difference between a category 1 and 5 hurricane!

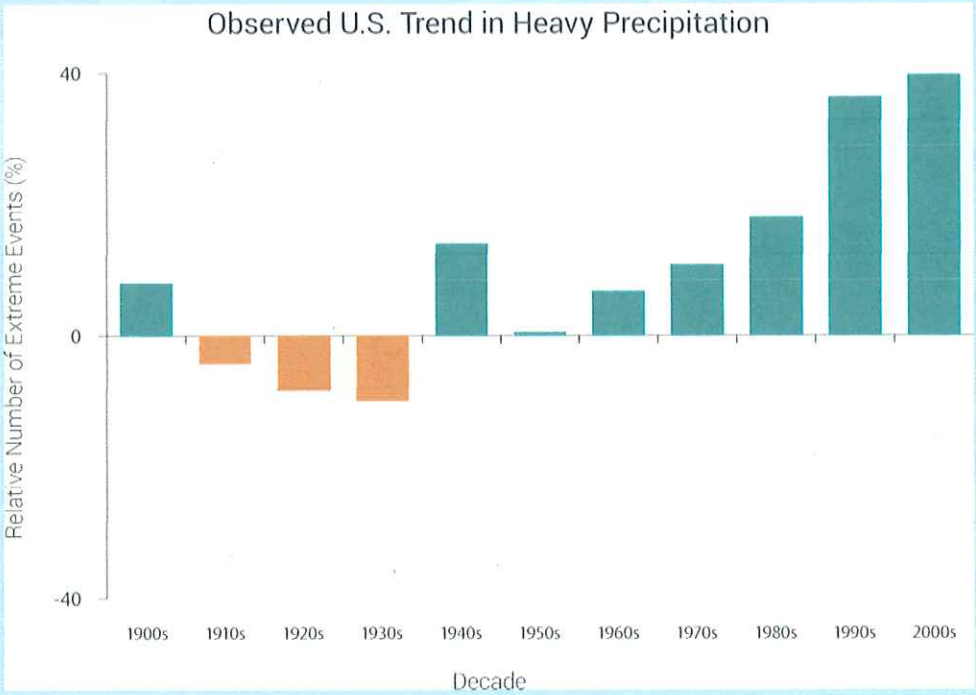


More Intense Hydrological Cycle

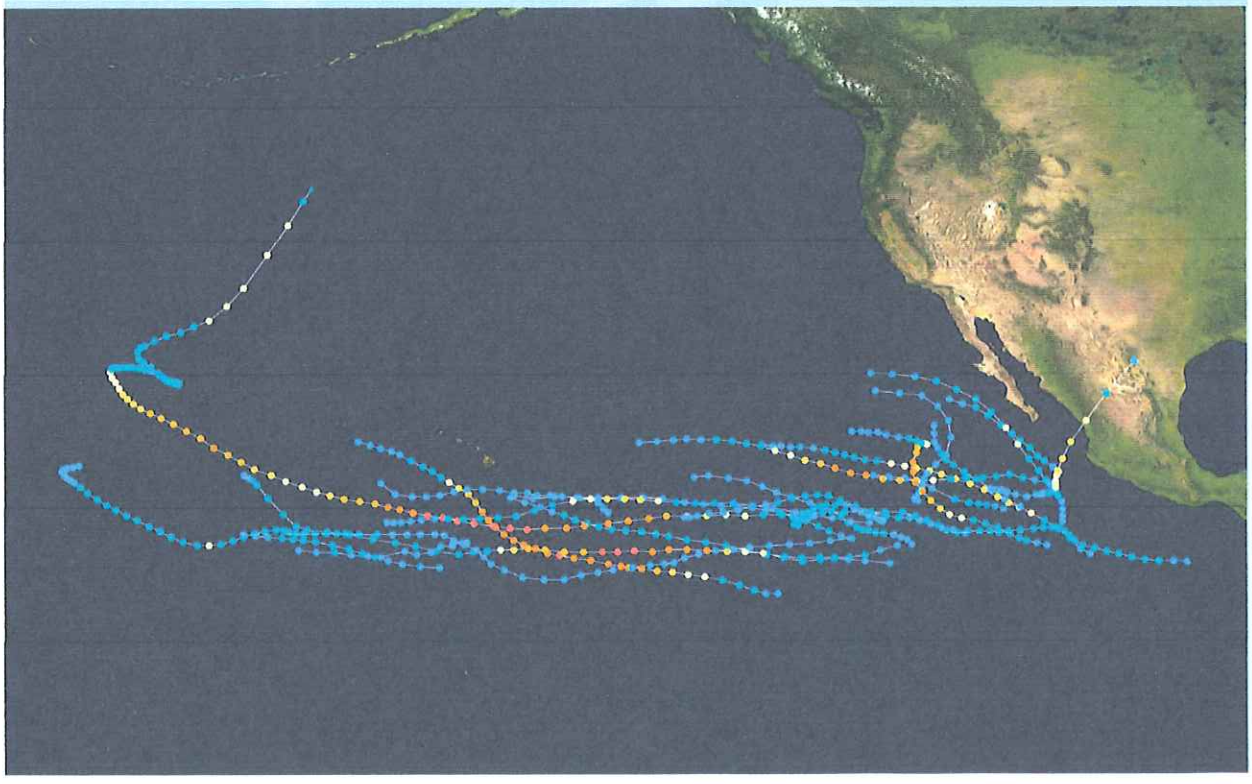


If the amount of water in the air is limited as it is over inland areas, but the air temperature increases, then the relative humidity drops. Lower relative humidity means drier conditions are experienced, e.g., droughts.

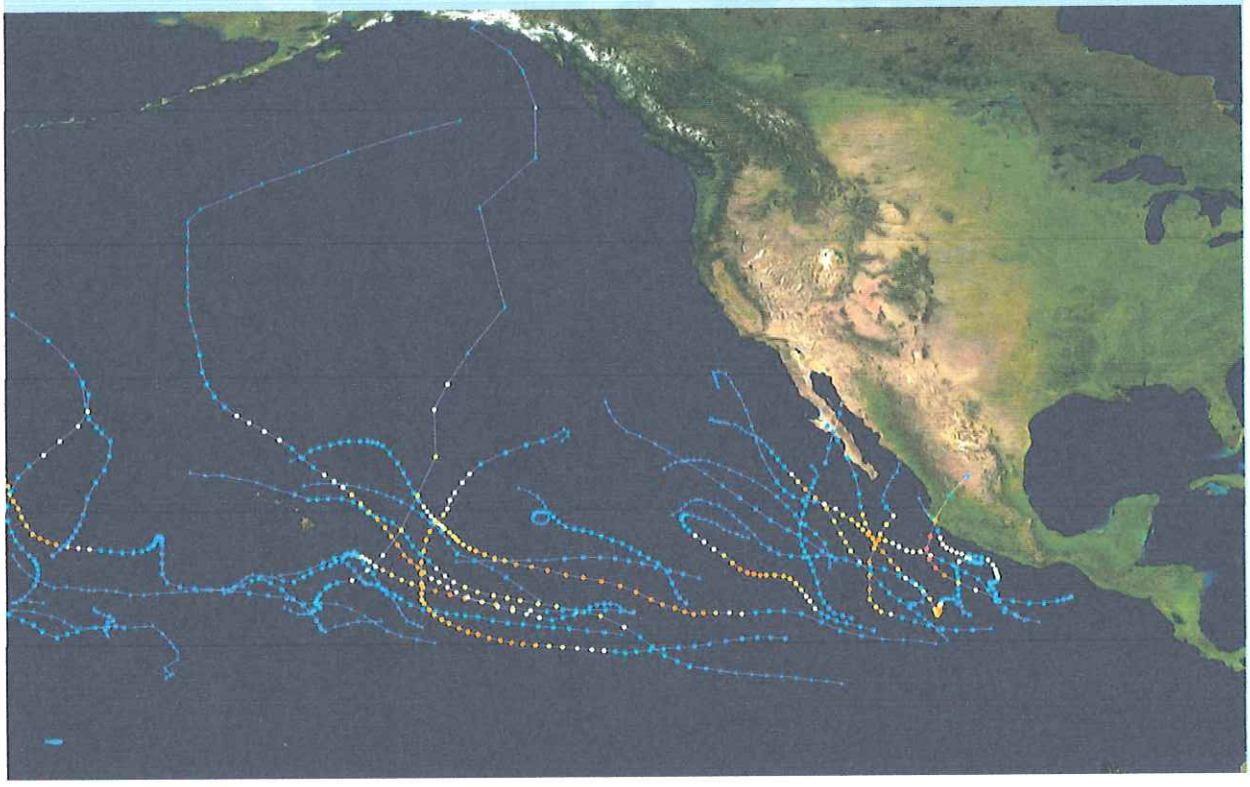
Days with Heavy Rain Increasing



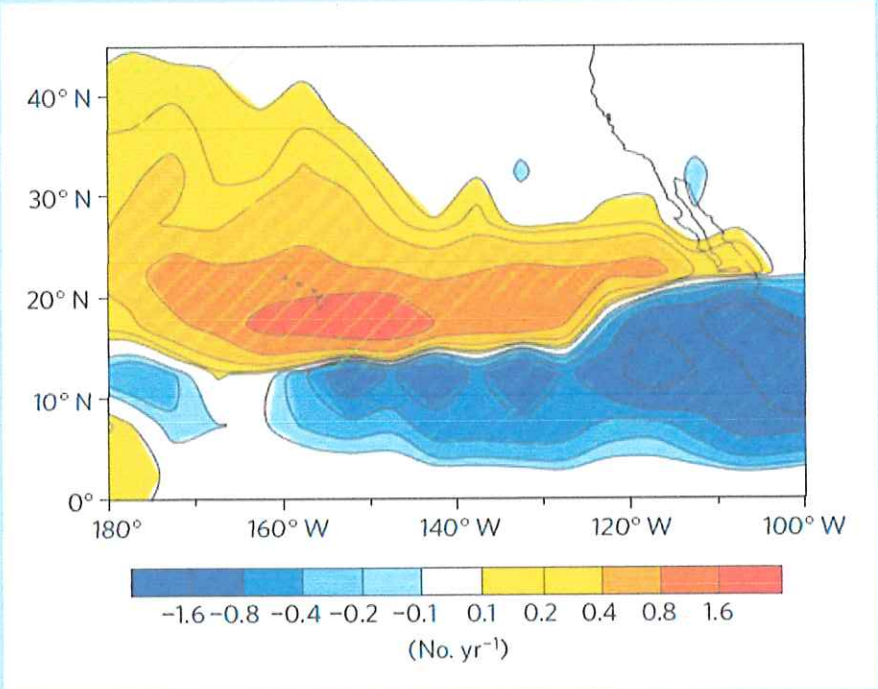
Central Pacific Hurricane Tracks for 1994



Central Pacific Hurricane Tracks for 2015



Hurricanes under Global Warming



The projected future change for 2075. Track shifts northward.