Final Report
Tsunami Observer Program
and the Tsunami of March 11, 2011

Award Number NA09NWS4670016
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Prepared for
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Tsunami Observer Program and the Tsunami of March 11, 2011
Jacquelin Miller, PhD, Statewide Coordinator for Tsunami Observer Program
Volker Roeber, PhD, Oahu Team Leader, Tsunami Observer Program and
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The Tohoku-oki great earthquake of $M_w$ 9.0 ruptured the mega-thrust fault offshore of Miyagi and Fukushima in Northeastern Honshu at 5:46 am Coordinated Universal Time (UTC) on March 11, 2011. This event generated strong shaking across the region and a large tsunami that devastated the coastal communities with run-up heights of more than 10 m. The tsunami, which registered 6.7 m amplitude at a coastal Global Positioning System (GPS) buoy and 1.75 m at an open-ocean Deep-Ocean Assessment and Reporting of Tsunamis (DART) buoy, triggered warnings across the Pacific. The tsunami reached Hawaii at 3:00 am HST, 7 hours after the earthquake, and caused localized impacts across the island chain. The Pacific Tsunami Warning Center finally cancelled the warning at 8:36 am on March 12, 2011 when the amplitude of water-level oscillations decreased to less than 1 m around all islands.

The mission of the Tsunami Observer Program (TOP) is to obtain accurate measurements of water run-up (elevation above mean sea level) and inundation distances resulting from tsunami waves for use in preparing emergency response and evacuation maps for the State of Hawaii. Hence, the March 11, 2011 earthquake and tsunami triggered the initiation of a statewide alert to all TOP volunteers in the Program. The Statewide Program Manager for the TOP first learned of the event through a special news announcement on TV but shortly thereafter received the official telephone call from State Civil Defense. Immediately thereafter, the TOP manager initiated calls to Volker Roeber, Oahu Team Leader, and George Curtis and Dan Walker, Technical Directors. Calls to Team Leaders Pete Hendricks and Tom Daniels, West Hawaii; David Grooms, Maui; and Chuck Blay, leader for Kauai; were also made as soon as possible. Despite many attempts, the TOP manager was not able to reach any TOP observers on the East side of the Big Island. However, each of the island team leaders in turn initiated their appropriate island phone tree tsunami notification calls to their respective observers. (Figs. 1-4). Since the arrival time for Hawaii was not expected until approximately 2:30 am, there was sufficient time to notify most of the Observers. Given the magnitude of the quake and images of the destructive tsunami that were widely disseminated on the TV news, all of our Observers were cautioned to wait until daylight before trying to make any measurements or photographs. The TOP manager spent the evening making dozens of phone calls and e-mails to confirm what coastal areas statewide would be covered and making modifications where observers could not be reached or were otherwise determined to be off island. At approximately 2:00 am the Program Manager chose to evacuate her house (marina front with approximately 5 feet elevation) for higher ground. She returned to the house about 4:30 am and shortly thereafter began communications again with the Observers statewide to see how their preparations for observations were progressing. All island coordinators and their teams were able to make measurements of run-up and inundation data points throughout the state on each of the four main islands. We were also aided on the Big Island by Jim Kauahikaua, Scientist-in-Charge, U.S. Geological Survey, Hawaiian Volcano Observatory, Tyler Paikuli-Campbell, Archaeologist, Kaloko-Honokohau National Historical Park, National Park Service and Frank A. Trusdell, U.S.
Tsunami Observers

Approximately 20 observers participated in the Tsunami Observer Program and recorded measurements of run-up and inundation at statewide locations. The majority of these observers were on the island of Oahu but measurements were obtained from all major islands except Lanai and Molokai.

Results of the Run-up and Inundation Measurements

The locations and results of our measurements and the observers responsible for collecting the data are shown in tables 1-4. The geographic locations for each measurement were entered into Google Earth by Roeber and this in turn provided the data set used by Moravcik for the site locations illustrated in Figures 5-8. It should be noted that more run-up values were obtained for this tsunami than all other tsunamis of record.

After the March 11th tsunami event the TOP observers measured local run-up heights as well as inundation limits over several days and at many times. Our convention is to use Mean Sea Level (MSL) as a baseline. Therefore, the data were corrected to MSL for tidal elevations at the time of our measurements. This is also the reference for bathymetry and topography data used by many researchers, e.g. the Tsunami Mapping Project at the Department of Ocean and Resources Engineering of the University of Hawaii. Detailed tidal information from the main tide gauges in Hawaii, such as Honolulu, Kahului, Kawaihae, or Nawiliwili, is shown in 1 min increments (http://tidesandcurrents.noaa.gov/tsunami/). The data show predicted as well as observed tidal signals with residuals. For the correction the tidal elevation at the particular date and time was selected from the tide table. We assumed that the tidal elevation is uniform for locations near the gauge. The difference between MSL and the actual tide level was then added to or subtracted from the observed run-up height depending on whether the observation was taken during a tide level above or below MSL. The run-up observations from Oahu's North shore were corrected by using a chart from Haleiwa (http://tidesandcurrents.noaa.gov/noaatidepredictions), since there is a significant time lag between the North and the South shores of that island. Because of the difficulty of accurately determining mean sea level at the time of the measurements, all run-up values were rounded to the nearest whole number with a break at 5" being rounded down and 6 inches rounded up.

The observed inundation limits were NOT corrected for tides because it is difficult to estimate the local beach slope. Depending on the applied methodology the accuracy of the run-ups is approximately ±0.5 ft. The inundation limits probably contain an error of several feet.

Oahu

Highest run-up on the Island of Oahu was measured at about 17 feet just NW of Camp Erdman on the north shore (ONS2) by Dan Walker and his team. The entire north shore experienced higher run-up values than any of the other shorelines (table 1). The Mader/Miller team reported about 10 feet just seaward of the traffic signal at the intersection of Hawaii Kai Drive and Kalanianaole near Sandy Beach (OSS13). The Keating/Helsley team reported an estimated (not measured) run-up of 13 feet at the far eastern end of Queens Beach near the inlet (east of OSS19). Other high values were recorded at Baby Makapu'u (OSS17) by the Miller/Yamada team of 8 feet, and the Donelle and Bill Lennan team measured a run-up of about 13 feet at Sandy Beach (OSS21). Run-ups along most of the southern coast along the Maunalua Bay to Kahala beach area were made by Volker and Schloesser and Miller and Watkins and ranged from 5-6 feet (OSS7-OSS9). Run-up
and Inundation limits along the western shore of Oahu were diligently recorded by Mark Suiso. Maximum run-up on this western shore was measured at about 10 feet at Hakimo (OWS12), Mailiili (OWS10), Makua North (OWS3), and Makaha (OWS7). Several other areas along this shoreline had run-ups of 7 and 9 feet with a mean value of 8 feet (OWS4, OWS6, OWS8, OWS13, OWS15).

Inundation limits were more difficult to measure accurately due to the slopes of the beaches. In addition, conspicuous 5 to 10 minute period oscillations of sea level were observed for several days following the quake adding to the difficulty in estimating sea levels at the time of the measurements. Inundation limits ranged widely from the 27-67 feet inundations measured off Kahala beach areas (OSS2, OSS9) to almost 250 feet at the parking area adjacent to Maunalua Bay (OSS18, again a reflection of the relatively flat slope of the shoreline.

**Damage**

No significant damages along the eastern-Sandy Beach shoreline were noted by our observers. In some cases minor damage to the beach Naupaka was visible (especially at Baby Makapuu) (OSS17) and in the case of Queens Beach-Ermas a number of large (1x2 feet by about 4 inch thick) concretions were tossed up on the beach (Erik Miller, personal communication). Damage on Oahu was limited to its harbors primarily due to seiches. According to the Coast Guard, 200 boats at Keehi Small Boat Harbor near Sand Island were affected after docks broke free from their moorings with the boats still attached. Many of the boats floated aimlessly in the lagoon, colliding with each other and in one instance, slamming into the Sand Island Bridge. The damage was estimated at $3.3 million. At Haleiwa harbor the “tsunami resistant” dock buckled and snapped away from the embankment.

**Molokai**

We did not receive any tsunami observer data from the island of Molokai however we did hear that substantial damage to several small boats occurred especially on the east side of the island. According to Hawaii News Now, KGMB, “On Molokai at least six houses have been flooded, damaged or knocked off their foundation including one where an SUV washed into the house. Most of the damage came on the east side of the island.”

**Maui**

David Grooms, the TOP leader for Maui, was able to guide his team of observers to make measurements of run-up and inundation at several locations on Maui. They recorded maximum run-up at La Perousse Bay of 8 ft 3 inches (MES8) and maximum inundation inland of 156 feet.

Joseph Fell-McDonald reported a run-up height at Kanahena cove Ahihi Bay at 6 feet with 22 feet inland inundation (MES9) and a run-up height of 4 feet 4 inches occurred with an inundation distance of 18 feet at 7299 Makena Alanui Drive (MES10). On March 16, 2011 he also reported that wave run-up height reached a maximum at La Perouse Bay of 8 ft 3 inches. Maximum inland inundation was measured at 156 feet (MES8).

Frannie Coopersmith reported wave damage at Baldwin Beach Park (MES1) just west of Paia town. Waves damaged the beach area and lifeguard stations. Water reached into the parking lot. No measurements were made but estimated run up was 5-7 feet. The parking lot was closed for a few days.

According to observer Jeannie Pezzoli, water washed over North Kihei road in the condominium residential area south of Sugar Beach (MES2). No run-up measurements or damage
to condominiums were reported; however, damage could have occurred had the water not funneled up a dry river channel just adjacent to the residential property. She also reported that water from the tsunami extended approximately 600 feet eastward along W. Lipoa Road and reached St. Teresa church on the south side of Lipoa road just west of South Kihei road (MES5). Water extended approximately 1000 feet inland from the shoreline along Kulanihakoi road in Kihei (MES6). This east-west road is also near a dry river channel that empties into the ocean. At Kalepolepo Park, (north Kihei), south of Kaonoulu St., water extended approximately 500 feet inland (MES7). This location is also up a dry river channel that empties into the ocean.

In addition to the individual measurements and reports cited above, informal observations were reported by Maui TOP leader David Grooms for Kahului Harbor and nearby coastal areas. Runup was 5 feet along Puunene ave (MES3). Inundation along Puunene ave was approximately 0.2 miles from the coast line at the Hideaway restaurant (Latitude 20° 53.513' N; Longitude 156° 28.094' W.) to the McDonalds (MES4) across from the Puunene Post Office just south of Kamehameha Ave. Some damage was experienced by the Hideaway restaurant and the east-west trending fence was torn apart, along the northern border of the parking area of the old site for the Superferry. Some cars within the lot were moved and banged against each other. Water entered the parking areas of both the Hideaway restaurant and 1st Hawaiian Bank just to the south. He found no other noticeable locations of inundation around Kahului Harbor. David Grooms also reported that most boats left Maalaea harbor in response to the tsunami warning from Civil Defense. Some damage was experienced by those that remained. Water washed over the breakwater at Maalaea Harbor and left debris scattered along the roadway. Some boulders and wood structures were moved as much as 30 feet (MES11).

Kauai

Run-ups on the east side of Kauai reported by the team of Blay and Siemers were substantially higher than those observed at most areas on Oahu, and ranged from a high of 17+ feet at Moloaa Bay (KES1, KES2) to about 9 feet at the Anahola Beach near the lifeguard station (KES5). The few observations from the South side gave values of from 3-8 feet (KSS1, KSS2, KES9, KES8).

Hawaii (The Big Island)

Run-up values recorded by the team of Daniel and Hendricks for the Big Island were generally high ranging from 6-10 feet along the west shore. Highest value in this area was measured at the north northwest corner of the new Kawaihae Small Boat Harbor (HNWS8) where a run-up of 10 feet was recorded. Significant damage was experienced along the Kona coast with damages to houses, businesses, hotels and roads fronting the ocean when waves overtopped the shoreline breakwater/wall and flooded Alii Drive. For example, an outrigger canoe was washed into the lobby of the King Kamehameha Hotel. Estimates of losses on the Big Island were in the tens of millions of dollars. One of the most dramatic losses and the highest measured run-up on the Big Island of 16 feet was measured by Walker at Napoopoo where a vacant two story house was washed into Kealakekua Bay (HWS17). It floated in the bay for several days with just the roof exposed above the water surface but eventually broke apart and was lost completely. Measurements along the eastern most side of the Big Island were made by Walker and included run-ups of 4 to 6 feet in the Hilo to Apua point area (HES10, HES11, HES12, HSES13, HSES14, HSES15). The Punaluu beach run-up was measured at 7 feet (HSS16).
Conclusions/Recommendations

Based on our experiences in responding to the March 11, 2011 Japanese Tsunami event we have the following recommendations for future actions by the Tsunami Observer Program:

1. We must insure that back-up coordinators are available when key island coordinators are off island. This became a real problem on the island of Hawaii when we were unable to reach many of the observers on the Hilo side. Fortunately, in the months that have followed since the March 11, 2011 event, we have been able to significantly expand our Observer team on the Big Island and we are much better prepared now. The newly revised and expanded phone key for Big Island Observers is shown in Figure 4. Future training sessions will emphasize the need to notify other members of your island observer group and your phone tree when you plan to be off island.

2. Additional efforts need to be made to insure that sufficient observers will be trained and available on all islands and for all shorelines. It became obvious that more observers are needed particularly on the outer islands so that we will still have sufficient observers to cover those that are off island at any given time.

3. We have found that relying on GPS data alone to locate measurement sites can be very inaccurate. It appears that there can be considerable variation in GPS readings from one instrument to another and furthermore that the readings may be influenced by local weather and power lines. There also was an inconsistency in the reporting of the coordinates. Some were reported in degrees, minutes, and seconds, some in degrees and decimal minutes, and others in decimal degrees. Since the modeling programs being used by the University use decimal degrees, we will instruct our observers in the future to set their GPS units to report all coordinates in decimal degrees. Subsequent efforts to rectify the GPS values have been very time consuming. A much closer approximation of the “real” location of the data measurements can be achieved using Google Earth and detailed descriptions of the locations, particularly proximity to any definitive land marks that will appear on Google Earth, combined with a photographic record of the run-up and site. In the future, we will urge our observers to record the GPS values and then verify the locations with Google earth. Future training will emphasize the use of Google Earth, physical in-hand maps that can be marked in the field of the areas being measured, and photographs along with GPS coordinates in decimal degrees as procedures for mapping our measurements.

4. All our observers reported that they had difficulty in determining “mean sea level” i.e. where to place the “seaward” pole. When we first began the measurements in the afternoon of March 12th, there was a continuous oscillation of sea level of about a 5 to 7 minute period. It also appeared that the lowering of the sea level was more prominent or observable than the following rise of water. The seiches were still observable on the late afternoon of March 12th and the next day. Determining where to place the “seaward” pole is likely a primary source of error in our run-up measurements.

5. Photographic records of the debris line or other evidence of run-up have been shown to be essential. In several cases, excellent photographic records of the debris lines were made immediately after the tsunami even though actual measurements could not be made for several days or even weeks later. With the photographic records, observers...
were able to return to exact locations and make excellent measurements at a much later time. We intend to emphasize the need for photographic records at all sites in all subsequent trainings.

6. Inundation measurements are of limited value in calculations of flood limits since inundation is so dependent on beach slope. However, given accurate locations of the observations with GPS and Google Earth, specific inundation limits will be of use in estimating flood limits in specific coastal areas.

7. At the time of the March 11, 2011 event we were seriously deficient in the number of Observers for the Hilo and Hamakua sides of the Big Island. Since then we have added two additional observers on the Hilo side and one new Observer for the Kona side. Our Big Island team leaders are actively working on obtaining more Observers for Hawaii Island.

8. We are also deficient in the number of observers for Maui. Our team leader on Maui, David Grooms, is actively soliciting new observers through the University of Maui to expand his pool.

9. Lastly, we were unable to obtain any actual measurements for the islands of Molokai, Lanai, or Ni‘ihau. Again, our team leaders on Maui and Kauai are actively working to enlist volunteer tsunami observers on these islands to resolve this problem. We now have a couple new observers on the island of Molokai.

10. The data gathered for this report will be incorporated into the work being carried out to update the tsunami inundation and evacuation maps for the State of Hawaii by Volker Roeber and Kwok Fai Cheung of the University of Hawaii, Department of Ocean and Resources Engineering in cooperation with State Civil Defense.

Acknowledgments

It is important to give proper credit to the volunteer Tsunami Observers who diligently carried out their measurements and reported their observations to us then helped in reviewing the data to insure that the measurements and their locations were accurately recorded. And finally, Philip Moravcik of the UH Manoa Water Resources Research Center, contributed immeasurably to the development of this report including preparation of the site maps and assisting in the review and editing of the data and text during final compilation of the report. In addition the efforts of George Curtis and Dan Walker in providing guidance and support in all aspects of this work also need to be acknowledged. The following is a list of the Tsunami Observers, Team Leaders and others, for each island, that contributed data to this report:

Statewide Personnel
George Curtis, Technical Director
Dan Walker, Technical Director
Jackie Miller, Tsunami Observer Program Manager

Oahu
Volker Roeber, Oahu Team Leader and Data Manager for March 11, 2011 Event
Susan Fite
Chuck and Barbara Helsley (Observations only)
Bill and Donelle Lennan
Charles Mader
Erik Miller (Observations only and Video recordings)
Fabian Schloesser
Mark Suiso
Dan Walker
Anna Marie Watkins
Su Yamada

Hawaii (Big Island)
Tom Daniel, Co-Team Leader, Kona side
Pete Hendricks, Co-Team Leader, Kona side
Dan Walker

Others who Contributed to the Measurements on the Big Island:
Jim Kauahikaua, Scientist-in-Charge
Volcano National Park:
USGS Hawaiian Volcano Observatory
PO Box 51, 1 Crater Rim Road
Hawaii National Park, HI 96718
Frank A. Trusdell,
Hawaii National Park, HI
Tyler Paikuli-Campbell, Archaeologist,
Kaloko-Honokohau National Historical Park, National Park Service

Maui
David Grooms, Team Leader
Ann (Frannie) Coopersmith (Observations only)
Joe Fell-McDonald
Jeannie Pezzoli (Observations only)

Kauai
Chuck Blay, Team Leader
David Burney
Rob Siemers
Fig. 1  Oahu TOP Phone Tree
Fig. 2  Kauai TOP Phone Tree
Fig. 3  Maui TOP Phone Tree
Fig. 4  Hawaii TOP Phone Tree
Fig. 5,  Oahu, Tsunami Run-up Measurement Sites
Fig. 6,  Hawaii (Big Island), Tsunami Run-up Measurement Sites
Fig. 7,  Maui, Tsunami Run-up Measurement Sites
Fig. 8,  Kauai, Tsunami Run-up Measurement Sites
Table 1,  Oahu Run-up and Inundation Data, March 11, 2011
Table 2,  Hawaii (Big Island) Run-up and Inundation Data, March 11, 2011
Table 3,  Maui Run-up and Inundation Data, March 11, 2011
Table 4,  Kauai Run-up and Inundation Data, March 11, 2011
MARCH 11, 2011 TSUNAMI RUN-UP AND INUNDATION MEASUREMENTS IN HAWAII
TSUNAMI OBSERVER PROGRAM

Table 1, Oahu Run-up and Inundation Data, March 11, 2011

<table>
<thead>
<tr>
<th>Data ID</th>
<th>Site No.</th>
<th>Location</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Date</th>
<th>Time</th>
<th>Inundation [feet]</th>
<th>Tide Corrected Run-ups (rounded) [ft]</th>
<th>Observer</th>
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</thead>
<tbody>
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<td>1</td>
<td>ONS1</td>
<td>End of Road</td>
<td>21.579967</td>
<td>-158.23745</td>
<td>14-Mar-11</td>
<td>10:35</td>
<td>84</td>
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<td>2</td>
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<td>11:04</td>
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<td>8:54</td>
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<td>6</td>
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<td>12:49</td>
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<td>Laniakea</td>
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<td>Log Cabins</td>
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<td>NW Branch Maalekahana</td>
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<td>17:12</td>
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NA = No Data
### Table 1, Oahu Run-up and Inundation Data, March 11, 2011

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<tr>
<th>Data ID</th>
<th>Site No.</th>
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<th>Latitude</th>
<th>Longitude</th>
<th>Date</th>
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<th>Inundation [feet]</th>
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<td>Seaward of Puame St, No of Waimanalo Bay Beach Park</td>
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<td>OSS16</td>
<td>Erma's, near Sandy Beach</td>
<td>21.291008</td>
<td>-157.664063</td>
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<td>164</td>
<td>8</td>
<td>Charles Mader, Jackie Miller</td>
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</tbody>
</table>
# MARCH 11, 2011 TSUNAMI RUN-UP AND INUNDATION MEASUREMENTS IN HAWAII
## TSUNAMI OBSERVER PROGRAM

<table>
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<tr>
<th>Data ID</th>
<th>Site No.</th>
<th>Location</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Date</th>
<th>Time</th>
<th>Inundation [feet]</th>
<th>Tide Corrected Run-ups (rounded) [ft]</th>
<th>Observer</th>
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<tbody>
<tr>
<td>36</td>
<td>OSS17</td>
<td>Baby Makapu'u Beach</td>
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<td>OSS19</td>
<td>Alan Davis</td>
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<td>Sandy Beach Life Guard Tower 4B</td>
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<td>Keawauna N</td>
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<td>Makua S</td>
<td>21.506117</td>
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<td>OWS5</td>
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<td>OWS7</td>
<td>Makaha</td>
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NA = No Data
### Table 1, Oahu Run-up and Inundation Data, March 11, 2011

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<th>Longitude</th>
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<th>Time</th>
<th>Inundation [feet]</th>
<th>Tide Corrected Run-ups (rounded) [ft]</th>
<th>Observer</th>
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<td>Hakimo</td>
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NA = No Data
### MARCH 11, 2011 TSUNAMI RUN-UP AND INUNDATION MEASUREMENTS IN HAWAII
#### TSUNAMI OBSERVER PROGRAM

#### Table 2, Hawaii (Big Island) Run-up and Inundation Data, March 11, 2011

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<th>Longitude</th>
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<th>Time</th>
<th>Inundation [feet]</th>
<th>Tide Corrected Run-ups (rounded) [ft]</th>
<th>Observer</th>
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<tr>
<td>3</td>
<td>2011_B13</td>
<td>HWS3</td>
<td>South of Wawalolo Beach</td>
<td>19.712667</td>
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<td>26-Mar</td>
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<tr>
<td>7</td>
<td>2011_B17</td>
<td>HNWS7</td>
<td>Kawaihale Main Harbor, SE corner</td>
<td>20.031833</td>
<td>-155.8255</td>
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<td>2011_B19</td>
<td>HNWS9</td>
<td>SE of Kawaihale Small Boat Harbor</td>
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<td>28-Mar</td>
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<td>10</td>
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<td>HES10</td>
<td>Hilo - Pauahi St.</td>
<td>19.723150</td>
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<td>2011_B21</td>
<td>HES11</td>
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<td>Apua Point</td>
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ND = No Data
### Table 3, Maui Run-up and Inundation Data, March 11, 2011

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<th>Data ID</th>
<th>Site No.</th>
<th>Location Description</th>
<th>Latitude</th>
<th>Longitude</th>
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<th>Time</th>
<th>Inundation [feet]</th>
<th>Tide Corrected Run-ups (rounded) [ft]</th>
<th>Observer</th>
</tr>
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<tr>
<td>1</td>
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<td>MES1 Baldwin Beach Park</td>
<td>20.914170</td>
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<td>ND</td>
<td>Frannie Coopersmith</td>
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<tr>
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<td>2011_M2</td>
<td>MES2 No. Kihei road south of Sugar Beach</td>
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<td>-156.467000</td>
<td>12-Mar-11</td>
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<td>Jeannie Pezzoli</td>
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<tr>
<td>3</td>
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<td>MES3 Puunane Ave.</td>
<td>20.891883</td>
<td>-156.468233</td>
<td>12-Mar-11</td>
<td>10:00</td>
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<td>ND</td>
<td>David Grooms</td>
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<tr>
<td>4</td>
<td>2011_M4</td>
<td>MES4 McDonalds just So. Of Kamehameha Ave.</td>
<td>20.887917</td>
<td>-156.463900</td>
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<td>10:00</td>
<td>1900</td>
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<tr>
<td>5</td>
<td>2011_M5</td>
<td>MES5 W. Lipoa Rd south side just west of So. Kihei Rd.</td>
<td>20.747600</td>
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<td>6</td>
<td>2011_M6</td>
<td>MES6 Kulanihakoi Rd in Kihei</td>
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<td>3/12/2011</td>
<td>13:00</td>
<td>000</td>
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<tr>
<td>7</td>
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<td>MES7 Kalepolepo Park (No. Kihei) south of Kaanuloa St.</td>
<td>20.765450</td>
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<tr>
<td>8</td>
<td>2011_M8</td>
<td>MES8 La Perouse</td>
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<td>6:15</td>
<td>156</td>
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<tr>
<td>10</td>
<td>2011_MA10</td>
<td>MES10 7299 Makena Alanui Dr.</td>
<td>20.651900</td>
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<td>MES11 Maalaea Harbor</td>
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<td>13:00</td>
<td>ND</td>
<td>2</td>
<td>David Grooms</td>
</tr>
</tbody>
</table>

ND = No Data
Figure 1
O’AHU PHONE TREE

Note: If you cannot reach the person below you, please move down and make their calls
All telephone numbers are area code (808) unless otherwise shown
Figure 2, KAUAI PHONE TREE

George Curtis
963-6670 (h)
895-9339 (c)

Jackie Miller
396-0033 (h)
429-1934 (c)

Dan Walker
638-7336 (h)

Chuck Blay
742-8305 (h)
639-6436 (c)

Rob Siemers
822-2308 (h)
635-2905 (c)

Jana Rothenberg
822-2660 (h)
651-7224 (c)

Charlie Fox
722-2200 (c)

Mike Mitchell
826-9151 (h)
828-1413 (w)
635-0922 (c)

Don Thornburg
212-1016 (h)
635-7502 (c)

Rob Anderson
823-9353 (h)
742-8760 ext. 300
691-6349 (c)
332-5131 (h)
635-2479 (c)

Mike French
742-7975 (h)
482-1009 (c)

Jana Rothenberg
822-2660 (h)
651-7224 (c)

Jay French
634-8060 (c)

Roan Burney
332-5131 (h)
482-1059 (c)

Lida Pigott Burney
332-5131 (h)
482-1059 (c)

Megan Juran
826-1985 (h)

Mike Mitchell
826-9151 (h)
828-1413 (w)
635-0922 (c)

Matt Rosener
826-1985 (h)
639-2640 (c)

Note: If you cannot reach the person below you, please move down and make their calls. All telephone numbers are area code (808) unless otherwise shown.
Figure 3, MAUI PHONE TREE

George Curtis
963-6670 (h)
895-9339 (c)

Jackie Miller
396-0033 (h)
429-1934 (c)

Dan Walker
638-7336

Joe Fell-McDonald
298-6868
875-0099
264-2326

David Grooms
(808) 984-3376 (w)
(808) 283-4684 (c)

John Pye
984-3206 (w)
283-9714 (c)

Donna Brown
661-5380

Ann Coopersmith
579-8577 (h)
205-8577 (c)

Note: If you cannot reach the person below you, please move down and make their calls.
All telephone numbers are area code (808) unless otherwise shown.
Figure 4, HAWAI'I (BIG ISLAND) PHONE TREE

Note: If you cannot reach the person below you, please move down the list and make their calls. All telephone numbers are area code (808) unless otherwise shown.
Figure 5
Oahu, Hawaii. Location and height of run-ups measured by Tsunami Observers with the Statewide Tsunami Observer Program following the March 11, 2011 Japanese tsunami
Figure 6
Hawaii Island. Location and height of run-ups measured by Tsunami Observers with the Statewide Tsunami Observer Program following the March 11, 2011 Japanese tsunami.
Figure 7

Maui, Hawaii. Location and height of run-ups measured by Tsunami Observers with the Statewide Tsunami Observer Program following the March 11, 2011 Japanese tsunami.
Kauai, Hawaii. Location and height of run-ups measured by Tsunami Observers with the Statewide Tsunami Observer Program following the March 11, 2011 Japanese tsunami.