



# NOAA Technical Report NOS NGS 73

## Primary and Secondary Adjustments of Leveling Observations to Establish a Consistent Vertical Datum Tied to Local Mean Sea Level for Oahu, HI

Daniel R. Roman  
Silver Spring, MD  
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## Introduction

This report summarizes work related to the adjustment of leveling data for the island of Oahu, Hawaii. This is a part of a larger effort on the part of Hawaii Department of Transportation (HI DOT) for reconnaissance, mark setting, descriptions, leveling observations following Federal Geodetic Control Subcommittee (FGCS) specifications and procedures for Second Order Class I digital leveling, data processing following NGS guidelines, and submitting data to NGS county by county. The state of Hawaii will contract the leveling work for the islands of Oahu, Maui, Molokai, Lanai, Kauai, and Hawaii for a total of 1,001.3 miles. These six islands are part of four counties, and the state is planning on performing the leveling county by county. This report represents the culmination of the work on the first of these islands.

This effort was originally envisioned as a project in the NGS Project Review Board (PRB) process. However, it is no longer tracked by the PRB, because it is primarily a data collection and processing effort by a large customer — HI DOT. As subsequent island collection efforts are finalized, additional technical reports will be issued.

## Local Mean Sea Level (LMSL) Datum for Oahu

It should be noted that each island will have its own Local Mean Sea Level (LMSL) datum established from available tidal bench marks. As suggested by the NOAA Center for Operational Oceanographic Products and Services (CO-OPS), this project was adjusted holding only one mark, designated 161 2340 TIDAL 21 (TU0291) on the National Tidal Datum Epoch (NTDE) 1983–2001, with an elevation of 2.042 m.



Figure 1. Local Mean Sea Level (LMSL) datum for Oahu is Station 161 2340 TIDAL 21 (PID TU0291) at a height of 2.042 m.

In the next few years, a new NTDE will be realized (2002–2020). That might normally impact the control for the vertical datum, because the height of LMSL may change. However, by the time it is implemented the North America Pacific Geospatial Datum of 2022 (NAPGD 2022) should be realized everywhere including in Oahu. If not, then this may need to be reassessed at that time.

# Primary Adjustment

The primary adjustment of this Island was made using the latest 2017 data (L28404) (Figure 2). The main line length of this project is 182 km with 218 km of spur line length. A total of 414 bench marks were observed, and their elevations were published.

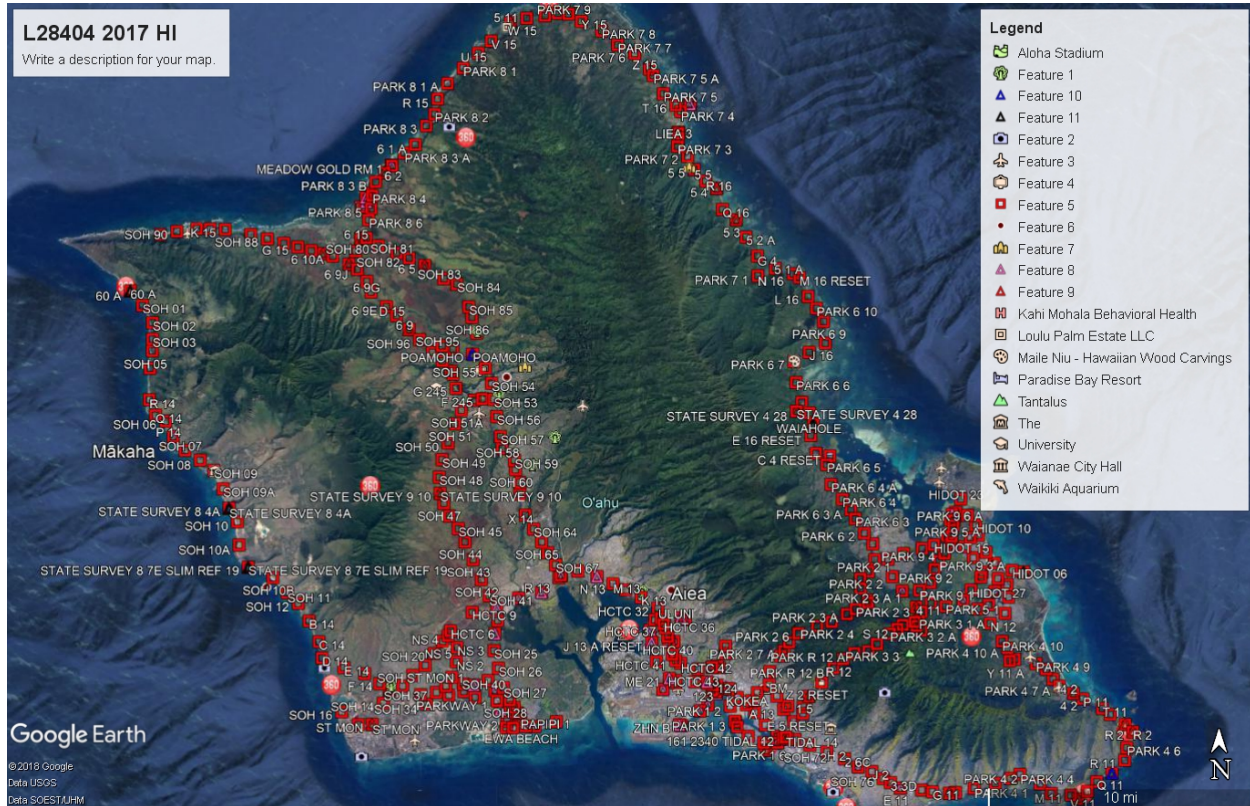


Figure 2. Graphic depiction of 2017 leveling survey around the island of Oahu, Hawaii. TIDAL 21 (TU0291) with an elevation of 2.042 m (NTDE 1983–2001) served as the Local Mean Sea Level (LMSL) datum and the basis for vertical control.

# Secondary Adjustment

L28404 is only the latest campaign on Oahu. There are 19 previous projects loaded into the NGS Integrated Database (IDB). The descriptions and observations were loaded but never adjusted. These projects are all first order projects. The following projects were used in this Secondary Adjustment:

L21923/1	L15/1	L20925	L20798
L21923/2	L15/2	L20939	L21203
L21923/3	L15/3	82674/1	L23065
L21923/4	L15/4	82674/2	L18771
L21923/5		82674/3	L25532

Of these previous surveys, two went around the entire island in 1969 (L21923/1) and 1927 (82674/1). See Figures 3 and 4, respectively. However, not all these marks were surveyed in the new project.

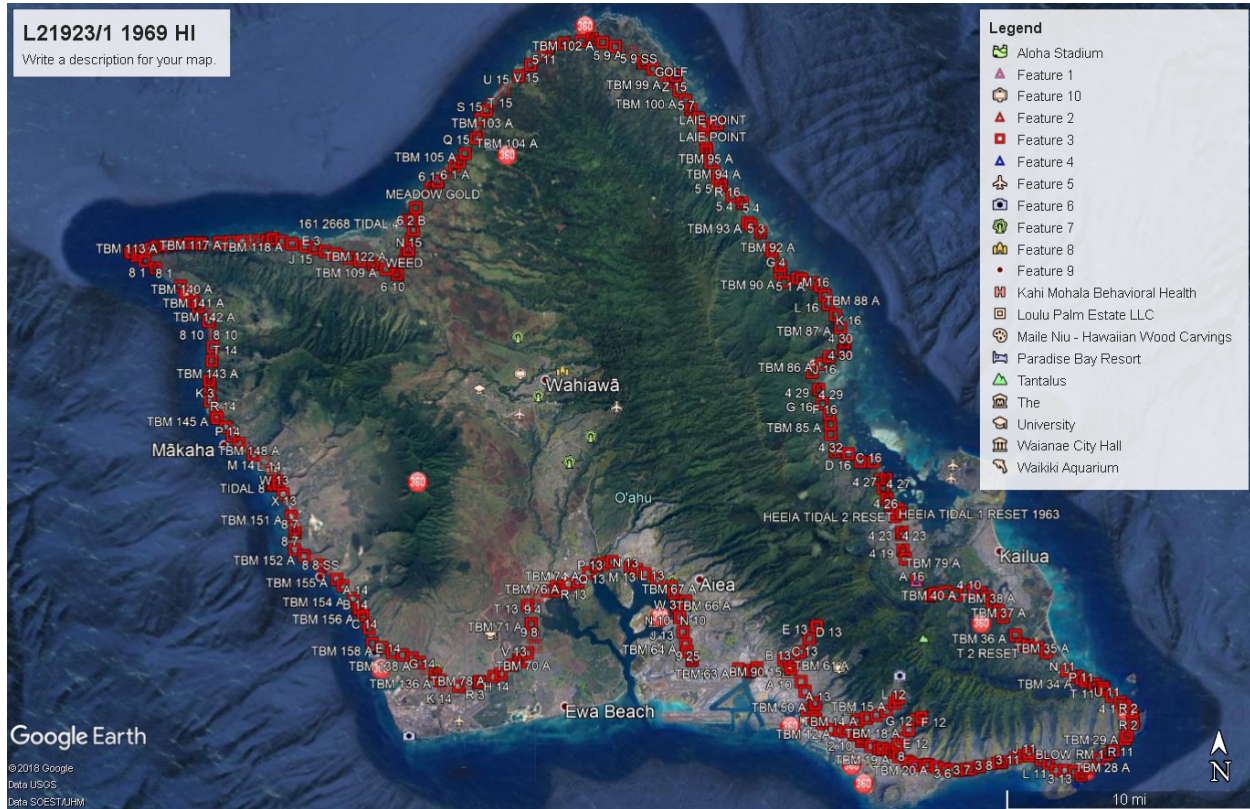


Figure 3. Graphic depiction of leveling collected in 1969 and loaded into the NGS IDB. Datum was different than the current NTDE LMSL value.

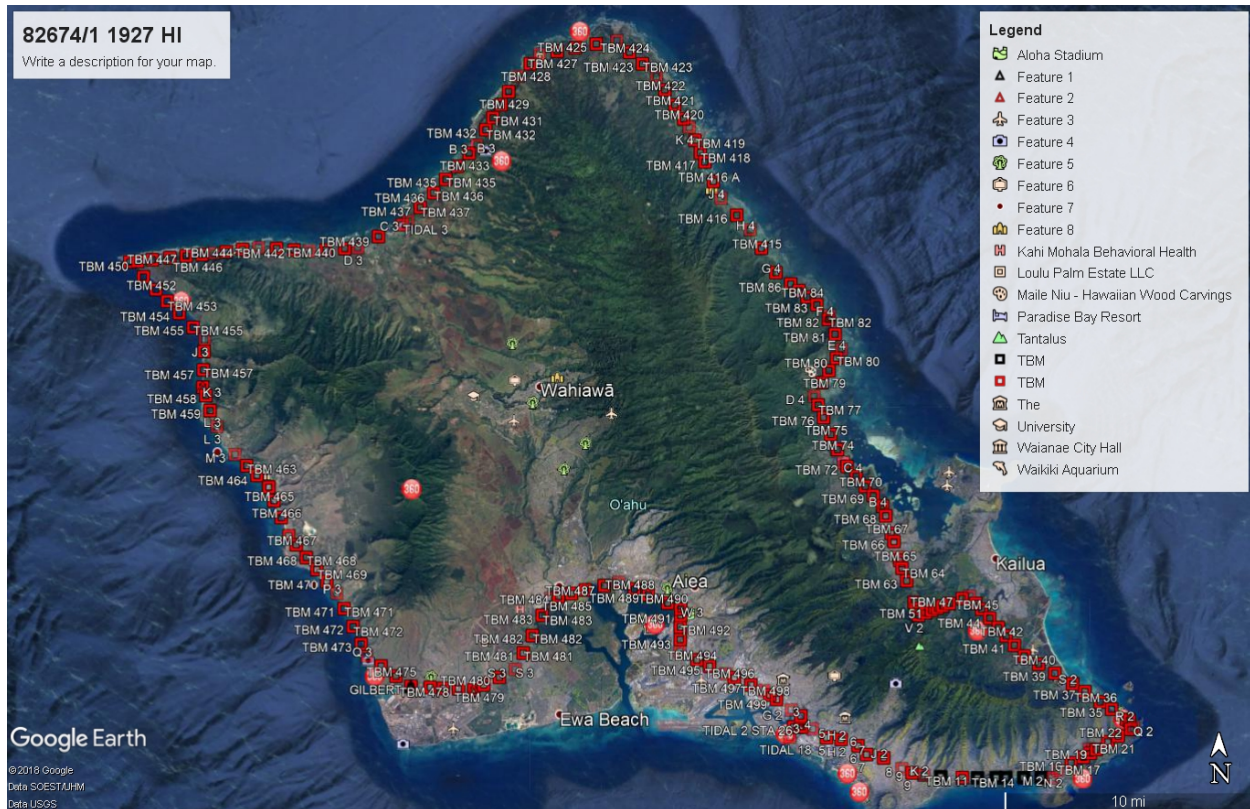


Figure 4. Graphic depiction of leveling collected in 1927 and loaded into the NGS IDB. Datum was different than the current NTDE LMSL value.

While the data from the previous surveys were already loaded into the database, they had a different datum and different epoch dates. It was necessary to adjust all this data to the latest datum, which was established in the primary adjustment.

The secondary adjustment was performed holding all 414 published heights from the primary adjustment of the latest project. About 740 heights were published from this secondary adjustment. Because the latest 2017 project was a 2/1 project, all these heights had to be published as 2/1, but the observations will remain as 1/2.

The appropriate text below will be added to the datasheets for the Permanent Identifiers (PIDs) in this adjustment:

- A. The datum point 161 2340 TIDAL 21 (TU0291) should have the following:  
“This bench mark was chosen by the National Geodetic Survey (NGS) to serve as the datum origin point for the island of Oahu leveling done between February 2016 and March 2017. The height of this point was adopted by NGS to be exactly 2.042 meters which is identical to the LMSL height of this benchmark for the National Tidal Datum 1983–2001 as determined by the Center for Operational Oceanographic Products and Services (CO-OPS) in December 2017.”
- B. Project L28404 (which is the new leveling network) should have the following:  
“The orthometric height was determined by differential leveling and adjusted by the National Geodetic Survey in June 2019 holding the tidal station 161 2340 TIDAL 21 to the 1983/2001 tidal epoch value 2.042 meters.”
- C. All the other projects that were adjusted to L28404 should have the following done:  
“The orthometric height was determined by differential leveling and adjusted by the National Geodetic Survey in September 2019 holding the tidal station 161 2340 TIDAL 21 to the 1983/2001 tidal epoch value 2.042 meters.”