

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
Engineering Division
Honolulu, Hawaii 96813

June 9, 2022

Board of Land and Natural Resources
State of Hawaii
Honolulu, Hawaii

**Request Approval of Variance for Keaīwa Reservoir (HA-0049) of Hawaii
Administrative Rules Section 13-190.1-21(b)(2), and allow more than 5 feet of Water depth
to remain in the Breached Dam**

Dam Owner: Edmund C. Olson Trust No. II
P.O. Box 280
Pahala, HI 96777

Location: Middle & Lower Moaula Camp, Pahala, Hawai'i County

Tax Map Key: (3) 9-6-007:001, (3) 9-6-007:002

SUMMARY

The Keaīwa Reservoir owner, Edmund C. Olson Trust No. II (Owner), is requesting a variance on Hawaii Administrative Rules (HAR) §13-190.1-21(b)(2), which limits the amount of water remaining in the reservoir, after the dam has been breached, to a depth of five feet or less during or following a 100-year storm event. The intent of this provision in the HAR was to minimize residual risk to the downstream community after a dam has been removed from DLNR oversight.

The Owner plans to submit a Dam Safety permit application to breach the dam and remove it from DLNR jurisdiction. The Owner desires to retain a small volume of water to serve the Pahala farming community with irrigation water and to provide a water source for future hydro-electric power. The Department of Land and Natural Resources (Department) recommends approval of the variance request based on safety measures taken and the size of the residual pool remaining, which will pose minimal risk to visitors on the Owner's property and to the public outside the property should a dam break occur.

BACKGROUND

The Keaīwa Reservoir is located in Pahala on the island of Hawai'i. (See Figure 1 for aerial photo.) The structure receives water from the Ka'ala'ala and Noguchi Tunnels and is used for agricultural irrigation purposes for local farmers. The dam was constructed in 1920 and has a concrete lined earth embankment with a concrete parapet wall extension on the crest. This dam is 32 feet high and has the capacity to impound 48 acre-feet (16 million gallons), though it

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currently remains empty. The dam is considered “off-line” as it is not constructed in a drainageway but is instead supplied by a valve-controlled pipeline.

The Trust is proposing to deregulate the Keaīwa Reservoir by breaching a portion of the embankment (see Figure 1) to lower the effective dam height and storage volume. For the reservoir to be removed from DLNR regulatory oversight, it must fall below a volume and depth threshold as defined in the HAR. The chart in Figure 2 shows the volume and dam height thresholds as defined by the Department, as well as the new planned dam height and volume.

The intent of the modification is to “partially remove” the dam to bring it below jurisdictional thresholds, while still storing a smaller volume of water to serve the Pahala farming community’s irrigation needs as well as to provide a sustainable renewable energy source for future hydro-electric power.

On April 9, 2021, the Board of Land and Natural Resources (Board) fined the Owner \$7,500 for failing to submit technical studies and for failing to install a water level monitoring system. The Owner paid the fine, installed a water level monitoring system, completed a Hydrology and Spillway Analysis, and submitted a conceptual design and project timeline to partially remove the dam. The Board also ordered the Owner to submit a permit application by June 1, 2022, submit proof of contract award for construction by April 1, 2023, and start construction by June 1, 2023.

The Keaīwa Reservoir is currently classified as a Low Hazard Potential Dam with an Unsatisfactory overall condition rating. "Low hazard" means a dam's or reservoir's failure will result in no probable loss of human life and low economic loss or environmental loss, or both, and economic losses are principally limited to the owner's property. “Unsatisfactory” is defined as having dam safety deficiencies that require immediate or emergency remedial action for problem resolution. The Unsatisfactory condition prompted the Department to issue a Notice of Deficiency in 2016 to drain the reservoir to a fully drawdown state with no impoundment. The primary safety issues at this facility are (1) risk of embankment instability, (2) a potentially undersized spillway, (3) damaged concrete liner, and (4) possible damaged outlet works.

DISCUSSION

Variances

In accordance with HAR §13-190.1-9, the Board may grant a variance on any provision of the HAR chapter 13-190.1 governing dams and reservoirs.

Proposed Modifications

The Owner is proposing to modify the dam by creating a trapezoidal shaped channel through a portion of the southwest embankment wall (see Figure 3), which will lower the effective height and storage capacity of the dam. The intent is to partially remove the dam to bring it below the jurisdictional thresholds. The effective height of the dam structure will be reduced from 32-ft to 23-ft and the storage volume is greatly reduced from 48 acre-ft (16 million gallons) to 18.5 acre-ft (6 million gallons). The engineered breach is conservatively designed, having several times the capacity to pass a Probable Maximum Flood (PMF) event.

Breached Dam / Reduced Reservoir Risk

During a 100-year flood, the remaining pool in the reservoir will be 23-ft deep¹, which exceeds the five feet maximum depth in HAR §13-190.1-21(b)(2):

Results of analyses demonstrating the 100-year, 24-hour flood can be safely passed within the breached section while maintaining five feet or less of water in the remaining reservoir shall be submitted for review.

This rule is a requirement for dam structures to be removed, or partially removed, and is intended to reduce the risk and impact of a dam break by limiting the amount of water remaining in the reservoir.

	Existing Dam	Proposed Breached Dam	HAR Requirement
Reservoir depth (ft)	32	23	5-ft or less
Dam volume (acre-ft)	48	18.5	Less than 50
Dam volume (million gallons)	16	6	Less than 16

A dam breach (failure) analysis was performed with the reduced reservoir storage volume and determined the modified dam's failure would generate a peak water flow rate of 1 foot per second at a depth of 1-2 feet and is primarily contained within existing drainageways. The flow route is displayed on the inundation map maximum depth and maximum velocity plots on Figures 4 and 5, respectively. With the modified dam holding close to three times less water in the reservoir, the downstream flow is greatly reduced.

Residual Risk Evaluation

After the proposed breach modification to the Keaīwa Reservoir, the risk to the downstream population will be greatly reduced and is anticipated to be minimal. The smaller pool of water from a dam potential dam break greatly reduces the depth and velocity of the water flowing from the reservoir, which translates to low risk to the public. Several other factors contribute to this reduction in risk.

First, the engineered breach is conservatively sized and will have more than enough capacity to pass the probable maximum flood event, which reduces the risk of failure by overtopping the modified dam. Second, a portion of the original reservoir was constructed by excavating below natural ground level, which typically has a reduced risk of failure. The majority of the above grade storage of the reservoir will be eliminated by the proposed improvements. Finally, a dam failure analysis that modeled the flood caused by the release of the residual pool remaining in the reservoir will pose a low risk to the public should a dam break occur, based on the anticipated depth and speed of water flowing from the reservoir to the ocean.

¹ The 23-ft pool depth is based on the difference between the breach channel invert elevation of 3,031 feet and the low point of the reservoir, which is the outlet works at the toe of the embankment at 3,008 feet elevation.

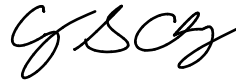
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It should be noted, however, by allowing more than 5 feet of water depth to remain in the reservoir, the breached dam facility will retain a certain amount of flood risk. Approval of the variance and the dam safety permit will allow the structure to become an unregulated dam and reservoir facility. Unregulated dams are solely the Owner's responsibility to inspect, maintain, operate, and remediate. However, prior to the Department recommending approval of the dam safety permit, existing dam deficiencies noted in previous inspections will be evaluated and addressed based on the modified dam loadings.

RECOMMENDATION

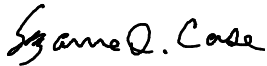
The Department recommends the Board to authorize a variance of HAR §13-190.1-21(b)(2), to allow a breach of the Keaīwa Reservoir (HA-0049) that will have a reservoir depth of not more than 23 feet of water and the maximum reservoir storage will not exceed 18.5 Acre-Feet.

Respectfully submitted,



CARTY S. CHANG
Chief Engineer

APPROVED:



SUZANNE D. CASE, Chairperson
Board of Land and Natural Resources

ATTACHMENT A

Figures of Photos, Diagrams, and Maps



Figure 1. Keaīwa Reservoir (2011).

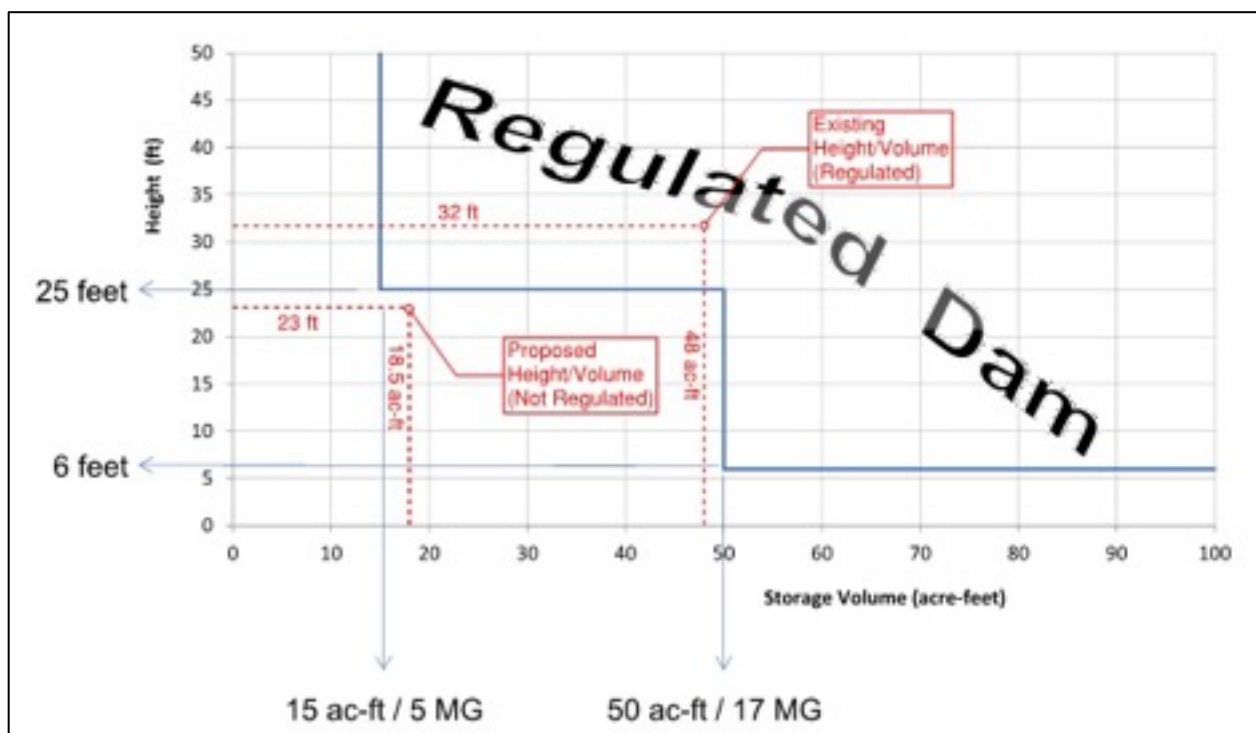


Figure 2. Jurisdictional size limits for dam regulation.

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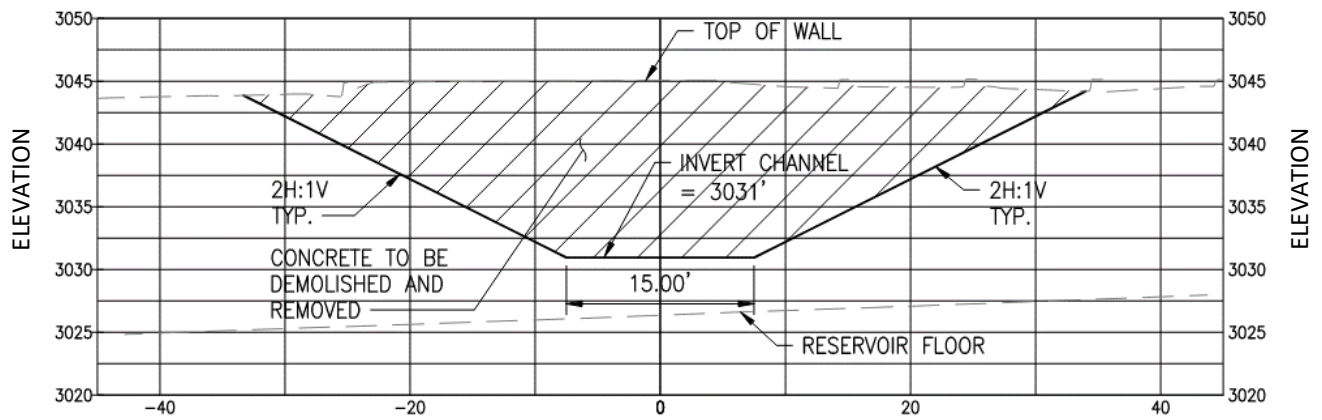


Figure 3. Typical section of proposed dam breach.

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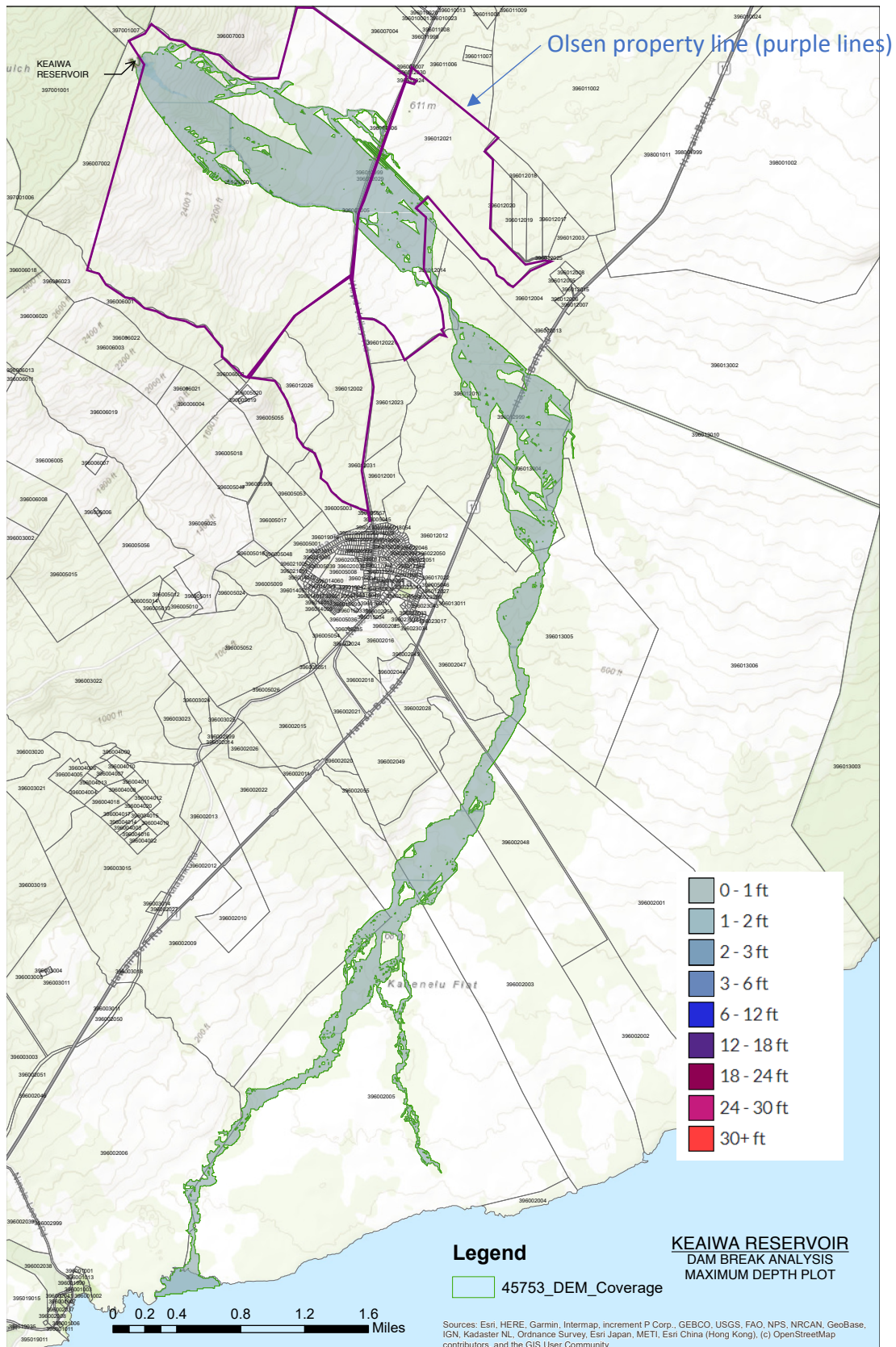


Figure 4. Dam breach inundation map, maximum depth plot.

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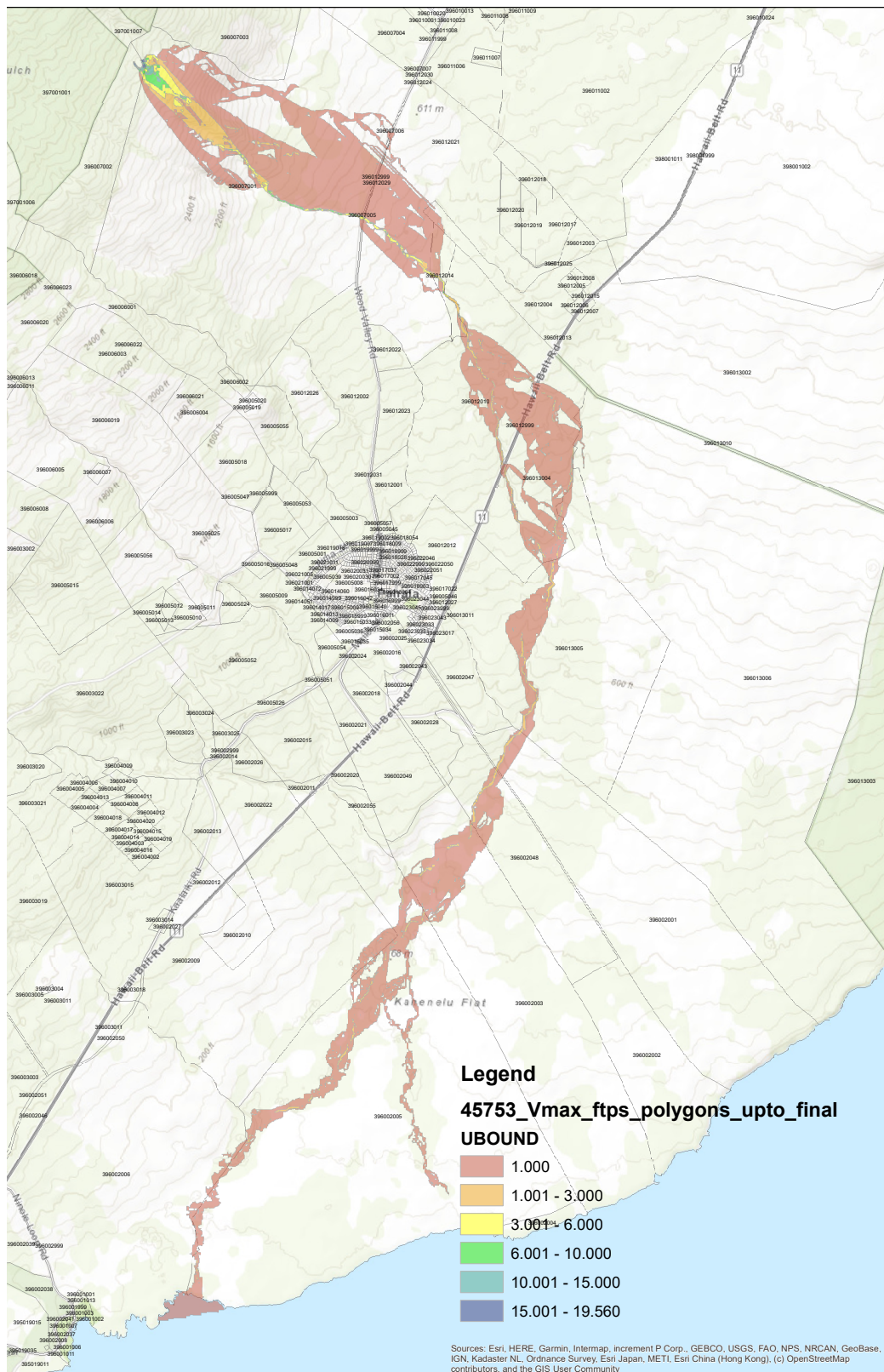


Figure 5. Dam breach inundation map, maximum velocity plot.