FY 2025-2027 Budget Requests Detail

Ops Requests:

Project	Description	FY26	FY27
Funding for United States Geological Survey Joint Funding Agreements	Funding for cooperative joint funding agreements with United States Geological Survey to carry out hydrologic data collection, analyses, and investigations tied to court orders and responses to water resource management challenges on Maui. An additional $400,000 is requested to implement a robust monitoring program for East Maui, Central Maui, and Lahaina. Currently, discretionary funding has been used to expand the USGS network, diverting resources from other essential programs. The requested funding would support the monitoring program for Maui Island: Central Maui (3): Waihee River, Wailuku River, Waikapu Stream; West Maui (4): Honokohau Stream, Kahoma Stream, Kauaula Stream, Ukumehame Stream; East Maui (9): Honopou Stream, Naiiliilihaele Stream, Kaaiea Stream, Puohokamoa Stream, Honomanu Stream, Kopiliula Stream, Hanawi Stream, Halehaku Stream, Awalau Stream. (16 streams x $25K each = $400,000) Three members of CWRM's SPAM Branch staff currently dedicate the vast majority of their time to maintaining stream gages in the field, which limits their capacity to carry out other critical duties. For East Maui streams alone, data collection takes six staff days per month. Stakeholders and community members have expressed the need for effective, timely, and accurate monitoring. Expanding streamflow monitoring and replacing certain CWRM stations with USGS stations would address these concerns.	$400,000	$400,000

	The total funding requirement for the 2025 USGS cooperative joint funding agreement (JFA) is $1,277,633, with CWRM funding 80-percent of the JFA at $1,021,806. The current JFA supports 44 streamflow stations, 6 groundwater stations, and 17 rainfall stations statewide. The JFA accounts for CWRM's single largest expense and consumes approximately two-thirds of CWRM's discretionary funds. USGS gaging costs have continued to rise due to inflation (now $25,000/gage), while the USGS' budget allocation has remained relatively stagnant. USGS maintains very high-quality assurance and quality control standards, providing very high-quality, scientifically defensible data. Maintaining such standards can be challenging for the Commission to replicate with limited staffing and infrastructure and takes away from Commission staff's primary duties regarding the analysis of hydrological data, development and implementation of management recommendations, and issuance of water use permits. Real-time USGS monitoring provides data transparency to the public and unparalleled assurances of compliance with Commission actions. Maintaining, and even expanding, ground- and surface-water monitoring statewide is central to Hawai'i's comprehensive hydrological monitoring network and therefore critical to characterizing the consequences of climate change on water availability, while supporting the regulation and management of Hawai'i's water resources. Stations re-established in locations with previous long-term streamflow monitoring can also be used to help track shifts in water availability or hydrological processes associated over time. This funding would ensure adequate resources for maintaining a comprehensive monitoring program and free up funding for other CWRM initiatives such as sustainable yield analyses, instream flow standard development, and planning efforts, which have languished due to limited funding in the past. If this request is not approved, CWRM will be delayed in the amendment and implementation of instream flow standards in Na Wai Eha, assessment		

	of water availability for long-term water leases in East Maui, and the allocation of surface water to meet public trust water uses in Lahaina.		
Funding for Central Maui Hydrologic Study	Funding for Central Maui Hydrologic Study to analyze existing groundwater data and assess accuracy of hydrologic boundaries for aquifer systems in Central Maui. Current data suggests that groundwater withdrawals from aquifer systems in Central Maui are at 590% (Kahului) and 110% (Paia) of their respective sustainable yields. If the current Aquifer Boundaries were considered accurate, those aquifer system areas would meet one criterion for designation as ground water management areas. However, water levels and salinity observed don't support the notion that water is overwithdrawn. A more accurate management approach would consider redrawing aquifer boundary lines that match groundwater flow direction, rather than defining aquifer boundaries lateral to groundwater flow. At present, given the proportion of ground water withdrawals to sustainable yield, it is very difficult to obtain permits to drill/outfit new wells or install larger pumps in existing wells within the Central Maui area. By assessing the accuracy of the currently drawn hydrologic boundaries for these aquifer systems, the proposed study will increase CWRM's understanding of the availability of ground water in these areas, including ground water recharge and discharge to shoreline ecosystems. This, in turn, will allow CWRM to fill substantial gaps in CWRM's understanding of ground water availability in Central Maui, and would allow better management of ground water resources in Central Maui. If this request is not approved, CWRM will not be able to adequately manage the Central Maui aquifer sector because groundwater data for the hydrologic units in Central Maui, as currently defined, shows that pumpage exceeds the sustainable yield for Kahului and Paia.	$250,000	$150,000

Funding for Sustainable Yield Hydrologic Investigations	Funding for hydrologic investigations of existing groundwater data and modelling to revise sustainable yields, with priority given to the Lahaina Aquifer System. Sustainable Yields (SYs) establish the availability of groundwater from an aquifer system. Over 90% of the State's drinking water comes from groundwater. SY estimates for aquifers statewide were last updated in 2019 and need to be revised to more accurately reflect climate change impacts on groundwater recharge and groundwater availability. New 2023 estimated recharge data from the U.S. Geological Survey presents an opportunity to not only consider the impacts of climate change on recharge, but also an opportunity to reevaluate CWRM's approach to calculating SYs. The current methodology used by CWRM to estimate SY is simple and has limitations; CWRM would like to explore other, more complex methods to estimate SYs. As such, funding is needed to hire consultants to help CWRM evaluate other methodologies for calculating SYs, such as numerical computer models, and to also conduct public outreach and consultation with a variety of stakeholders. This funding would prioritize reevaluating SYs in the Lahaina Aquifer Sector. This is a recommended before CWRM provides recommendations on new and existing Ground Water Use Permit applications in the Lahaina Aquifer Sector. If this request is not approved, water use permitting may be delayed and could result in the delay of new affordable housing development in Lahaina and potential over-pumping of Lahaina aquifers. This would also create uncertainty in the availability of water in Lahaina and may hinder investment in infrastructure and other related projects.	$200,000	$200,000
Funding for Hawai'i Mesonet Network	Funding for Hawai'i Mesonet network of telemetered climate stations in cooperation with the University of Hawai'i Water Resources Research Center to carry out hydrologic data collection, analyses, management, and dissemination	$350,000	$350,000

	CWRM is an active partner with the University of Hawaiʻi, Water Resources Research Center (UH-WRRC) who administers the Hawaiʻi Mesonet Network project. CWRM benefits from the data collected by the Mesonet climate stations, which can be used to inform water management decisions and will assist in determining water availability. CWRM advocates for funding on behalf of the Mesonet project and has received both State (FY25, $237,500 – a portion will go to Mesonet) and federal funding (FY24 Congressionally Directed Spending $350,000) to support the expansion of the Mesonet network. Mesonet's ongoing maintenance costs are approximately $600,000 annually. Of that $600,000, 40% or $240,000 is paid for with federal funds through the National Science Foundation (NSF). CWRM has agreed to pay the remaining $360,000 through its operating budget, as the data collected by Mesonet climate stations is of high utility to CWRM (as well as other agencies within DLNR and beyond).		

CIP Requests:

Project	Description	FY26	FY27
Deep Monitor Wells, Statewide	Design and construction funds to construct and/or repair priority deep monitor wells, statewide to monitor the health of drinking water aquifers This project will construct and/or repair Commission on Water Resource Management (CWRM) deep monitor wells (DMWs) statewide, with a focus on areas that are experiencing an increased demand on water resources or targeted for increased development, to monitor the health of the drinking water aquifers. This project is part of an ongoing effort to monitor aquifer health statewide. Data collected from DMWs is essential for observing long-term changes in the thickness of the aquifer’s freshwater lens, which provides an indicator of drought conditions and expected impacts on groundwater supplies. The current State DMW network has limited geographic coverage with only 12 wells statewide and 3 in progress. Based on factors such as pumpage proportionate to sustainable yield, estimated recharge decline, and projected population growth rate, Commission staff have identified the aquifers of Waimea (Hāpuna), Pāʻia/Central Maui, Launiupoko, Waiʻanae, Kīholo, Kamaʻole, Honolua, Kōloa, and Mokulēʻia as being of the highest priority for construction of deep monitor wells. The cost of developing a deep monitor well is roughly $2 million ($200K design, $1,800K construction). CWRM has 12 DMWs statewide (6 on Oʻahu, 4 on Maui, 2 on Hawaiʻi Island), and 3 in progress. Ideally, there should be 3 DMWs in each aquifer system area (over 300 DMWs statewide). CIP funding for new DMWs statewide is about $2 million each year, or enough to construct one well. CWRM’s WRPP contemplates $5M/year for construction of deep monitor wells, plus one FTE. There are only a handful of qualified drillers who can drill DMWs, and it also takes time to identify a suitable location for the wells given the constraints (e.g., on state or county land; not near other operating wells, at a specific elevation). CWRM is assessing whether dedicating a FTE to the DMW initiative would help CWRM to reach its goals.	$2,000,000	$2,000,000

Analysis of Groundwater Flow in the Central Aquifer Sector, Maui, Hawaiʻi

U.S. Geological Survey
Pacific Islands Water Science Center
January 2025

SUMMARY

Demand for water from Maui's Central aquifer sector, which contains the Kahului, Pāʻia, Makawao, and Kamaʻole aquifer systems, is expected to increase in the future. Sustainable groundwater development in the Central aquifer sector, however, is poorly understood. For example, the Hawaiʻi Commission on Water Resource Management (CWRM) has established a sustainable yield of 1 million gallons per day for the Kahului aquifer system, from which more than 5 million gallons of water per day was reportedly developed during 2023. The aquifer systems within the Central aquifer sector were delineated using selected topographic, geographic, political, surface-ditch, and geologic features (Mink and Lau, 1990). Because many of the aquifer-system lines do not correspond to features that control groundwater flow, withdrawal from one aquifer system will affect groundwater flow in other aquifer systems. For example, long-term withdrawal from the Makawao aquifer system, which is a land-locked aquifer system, will reduce groundwater flow to adjacent aquifer systems or induce groundwater inflow into the Makawao aquifer system from adjacent aquifer systems. Thus, management of groundwater in the aquifer systems of the Central aquifer sector can be challenging within the current management framework. A better understanding of groundwater flow in the Central aquifer sector is critical for (1) management of coastal, groundwater-dependent habitat for endangered native waterbirds, (2) evaluation of sustainable groundwater development, and (3) balancing of beneficial uses of groundwater.

This U.S. Geological Survey (USGS) study of groundwater in Maui's Central aquifer sector will address uncertainties in groundwater flow that are affected by changes in recharge and withdrawals. The objective of this study is to provide information needed to evaluate the validity of existing aquifer-system boundaries and potentially revise existing boundaries. Although delineating new boundaries is beyond the scope of this study, the information generated by this study is expected to be useful for this purpose. The approach for this study will be to use an existing island-wide groundwater-flow model of Maui to simulate conditions for selected recharge and withdrawal scenarios to be developed in consultation with CWRM. The scenarios will provide insight into how groundwater-flow directions and the north-south groundwater divide, which represent potential aquifer-system separators, might shift in response to different hydrologic conditions.

Results of this study will be documented in a USGS Scientific Investigations Report and related data release of model files. Regular virtual and in-person meetings, every 3–4 months, are anticipated to develop model scenarios and discuss study progress and results. Estimated cost for this 3-year study is $442,000. The USGS anticipates contributing approximately 10 percent of the total cost through available Federal matching funds.

PROBLEM

The resident population on the island of Maui, Hawaiʻi, increased from 38,691 in 1970 to 154,100 in 2020, which represents an increase of almost 300 percent (State of Hawaiʻi, 2023). Because of the increase in population, the groundwater demand for public water supply also has increased and groundwater withdrawals likely will continue to increase in the future.

In a typical freshwater-lens system, increased groundwater withdrawals will, in the long term, result in a decline in water levels, a rise in the transition zone between freshwater and saltwater, and a reduction of natural groundwater discharge to the ocean, springs, and streams, or in nearby groundwater areas. Coastal wetlands can be reduced in area or disappear if groundwater withdrawals cause water levels to decline in the vicinity of the wetlands. Furthermore, the wetland water quality, in terms of salinity, can be affected by groundwater withdrawals, which could affect habitat for wetland flora and fauna. Changes in future rainfall and groundwater recharge can also affect the availability of fresh water.

Maui's Central aquifer sector is formed by the Kahului, Pāʻia, Makawao, and Kamaʻole aquifer systems. The boundaries separating these aquifer systems were not drawn on the basis of known hydrogeologic boundaries. Instead, many of the aquifer-system boundaries were based on selected topographic, geographic, political, and surface-ditch features (Mink and Lau, 1990). The Hawaiʻi Commission on Water Resource Management (CWRM) has established a sustainable yield of 1 million gallons per day for the Kahului aquifer system, from which more than 5 million gallons of water per day was reportedly developed during 2023 (Robert Chenet, Hawaiʻi Commission on Water Resource Management, written commun., 2024). Simulated groundwater flow (Izuka and others, 2021) crosses the north-south-oriented boundary separating the Kahului and Pāʻia aquifer systems, which suggests that recharge and withdrawal from one aquifer system can affect conditions in other aquifer systems. Thus, management of groundwater in the aquifer systems of the Central aquifer sector can be challenging within the current management framework. A better understanding of groundwater flow in the Central aquifer sector is critical for (1) management of coastal, groundwater-dependent habitat for endangered native waterbirds, (2) evaluation of sustainable groundwater development, and (3) balancing of beneficial uses of groundwater.

This U.S. Geological Survey (USGS) study of groundwater in Maui's Central aquifer sector will address uncertainties in groundwater flow that are affected by changes in recharge and withdrawals. The objective of this study is to provide information needed to evaluate the validity of existing aquifer-system boundaries and potentially revise existing boundaries. Although delineating new boundaries is beyond the scope of this study, the information generated by this study is expected to be useful for this purpose. Results of this study will provide insight into how groundwater-flow directions and the north-south groundwater divide, which represent potential aquifer-system separators, might shift in response to different hydrologic conditions.

DESCRIPTION OF STUDY AREA

The main study area is the Central aquifer sector (fig. 1), Maui, Hawaiʻi, as defined by CWRM, although nearby areas that are hydrologically connected to the Central aquifer sector are also relevant and included in the analysis for this study. The Central aquifer sector is divided into the Kahului, Pāʻia, Makawao, and Kamaʻole aquifer systems by CWRM. The lines separating these four aquifer systems do not correspond to any known geologic structures and therefore neither impede flow from one aquifer system to another, nor exert a control on the effects of withdrawal from one aquifer system on groundwater conditions in other aquifer systems. The northeastern and southeastern boundaries of the Central aquifer sector generally are aligned with rift zones of Haleakalā, and these boundaries are expected to affect groundwater flow. CWRM manages groundwater withdrawals statewide by establishing sustainable-yield estimates for each aquifer system. For the Central aquifer sector of Maui, CWRM has estimated sustainable-yield values of 1, 7, 7, and 11 million gallons per day (Mgal/d) for the Kahului, Pāʻia, Makawao, and Kamaʻole aquifer systems, respectively.

The study area covers about 230 mi^2 and is bounded by the coast on the north, by Māliko Gulch and a line extending to Puʻu Nianiau and Kalahaku overlook on the northeast, the southwest rift zone of Haleakalā on the southeast, the coast on the southwest and south, and a line extending from Māʻalaea Bay to Kahului Bay on the west (fig. 1). The study area lies on the western flank of Haleakalā, which forms the eastern part of the island of Maui, the second largest island in the Hawaiian archipelago. The Island of Maui located between longitude 155º55′ W and 156º45′ W and between latitude 20º30′ N and 21º05′ N, is composed of two shield volcanoes, the older West Maui volcano that rises to an altitude of 5,788 feet (ft) at Puʻukukui, and the younger Haleakalā that rises to an altitude of 10,023 ft. The two volcanoes are separated by an isthmus, generally at altitudes less than 300 ft, which is covered with terrestrial and marine sedimentary deposits that are as much as 5 miles wide (Stearns and Macdonald, 1942).

Between the late 1800s to 2016, sugarcane was grown extensively on the western slopes of Haleakalā, including within the study area, typically below an altitude of about 1,000 ft. Areas inland of sugarcane cultivation were used for grazing or pineapple cultivation or were forested (Territorial Planning Board, 1939; Harland Bartholomew and Associates, 1957; U.S. Department of Agriculture, 1983; Engott and Vana, 2007; Melrose, 2016). Following the 2016 cessation of sugarcane cultivation in the area, much of the former lands that were cultivated remained largely unused. This land-use change also altered the water budget of the area by eliminating substantial areas of cultivated sugarcane that previously contributed to groundwater recharge. The study area also contains developed areas including those at Kahului, Makawao, Pukalani, and Kīhei (fig. 1).

Mean annual rainfall in the study area ranges from less than 15 in. at low altitudes in the southwest to greater than 100 in. above an altitude of 2,500 ft toward the northeast (Giambelluca and others, 2013). The prevailing trade-wind direction is from the northeast and controls the distribution of rainfall throughout much of the Hawaiian Islands. Rainfall is generally greatest where the prevailing northeasterly trade winds encounter the flank of a volcano, forcing warm, moist air into the cool, higher altitudes. The study area lies mainly on the drier, leeward side of Haleakalā.

Geology.—The geology of Maui was described in detail by Stearns and Macdonald (1942), and some of the geologic units were subsequently reclassified by Langenheim and Clague (1987) and Sherrod and others (2021). Haleakalā is formed mainly by lava flows of tholeiitic and alkalic basalt of the shield-stage Honomanū Basalt, which is almost entirely covered by post-shield-stage Kula and Hana Volcanics. The Kula Volcanics and the Hana Volcanics are the most widespread geologic units exposed at the land surface on Haleakalā.

The shield stage represents the most voluminous phase of eruptive activity of Haleakalā, during which more than 95 percent of the volcano was formed, mainly by thousands of relatively thin basalt lava flows. These flows emanated from fissures and vents near and radiating outward from the central summit area. The lavas of the Honomanū Basalt have typical dips of 2° to 22° with the flatter dips near the isthmus where flows approached the West Maui volcano. The basalts were laid down as very vesicular pāhoehoe and ʻaʻā flows with an average thickness of about 15 ft (Stearns and Macdonald, 1942, p. 61). Contrary to typical observations of shield-stage formations in which pāhoehoe is found in greater abundance near volcanic vents, pāhoehoe flows are abundant throughout the Honomanū Basalt even at the periphery of the volcano. In the study area, exposures of Honomanū Basalt are found in Māliko Gulch and in narrow areas along the coast to the west of Māliko Gulch (Stearns and Macdonald, 1942). Exposures are identified as Honomanū Basalt in the field where they are thin bedded, porphyritic, and often show characteristics typical of pāhoehoe flows. Field reconnaissance has shown that exposures of Honomanū Basalt can be found nearly 4 mi from the coast at an altitude of about 600 ft in Māliko Gulch and almost 1 mi from the coast in Kākipi Gulch at an altitude of about 100 ft (Gingerich, 1999). These exposures are much more extensive than those shown on existing geologic maps (Stearns and Macdonald, 1942; Sherrod and others, 2021), which show the Honomanū Basalt exposed in Māliko Gulch for less than a mile from the coast and no exposures in Kākipi Gulch.

The Kula Volcanics, which overlies the Honomanū Basalt, consists of post-shield stage lava flows of mainly alkalic basalt, hawaiite, mugearite, benmoreite, and basanite and associated intrusive rocks and pyroclastic and sedimentary deposits (Langenheim and Clague, 1987; Sherrod and others, 2021). In some places, Honomanū Basalt and Kula Volcanics are separated by a thin red soil layer that has been altered by the weight and heat of the overlying flows. The Kula Volcanics covers large areas of the underlying Honomanū Basalt and exposures range from 2,500 ft thick near the summit to 50 to 200 ft thick near the coast. Individual flows average about 20 ft in thickness near the summit and 50 ft near the periphery but flows as much as 200 ft thick are not rare (Stearns and Macdonald, 1942, p. 75). The usual dip of the flows is about 10°. The flows are generally thicker and narrower than the Honomanū Basalt and have more lenticular bedding due to the filling of swales and valleys eroded into the underlying rocks. Flows of the Kula Volcanics cover the surface of almost the entire study area.

The most recent eruptions produced lavas of mainly alkalic basalt and basanite, named the Hana Volcanics. The Hana Volcanics includes lava flows and associated intrusive rocks and pyroclastic and sedimentary deposits (Langenheim and Clague, 1987; Sherrod and others, 2021). Within the study area, the Hana Volcanics are mapped mainly in the southeastern part and probably are less important hydrologically than the Honomanū Basalt and Kula Volcanics.

Haleakalā has three primary rift zones (Stearns and Macdonald, 1942; Langenheim and Clague, 1987) and the study-area boundary is partly related to two of these, the northwest and southwest rift zones that extend from the central summit area. The two rift zones are marked by numerous volcanic vents, commonly related to cinder, spatter, and pumice cones visible at the surface (Stearns and Macdonald, 1942; Macdonald and others, 1983; Sherrod and others, 2021). The trends of these two rift zones are generally consistent with measured gravity anomalies (Kinoshita and Okamura, 1965). Dikes associated with rift zones are the dominant intrusive rocks in Hawaiian volcanoes. Due to the relative youth of Haleakalā, exposures of dikes are scarce and limited to the walls of the summit and the larger valleys (Stearns and Macdonald, 1942). A few dikes are mapped near the eastern corner of the Kamaʻole aquifer system near the summit area. Thousands of dikes are inferred to exist within the rift zones, with the number of dikes increasing toward the caldera and with depth.

The dikes and the rocks they intrude are commonly referred to as dike complexes. In Hawaiian volcanoes, dike complexes range in width from 1.5 to 3 mi and average about 1.9 mi (Macdonald and others, 1983). The dike complex associated with the northwest rift zone of

Haleakalā appears to be about 3 mi wide near the coast and may be greater than 5 mi wide at an altitude of 4,000 ft on the basis of the locations of the cinder and spatter cones that are in two parallel and roughly linear patterns. The vents of the southwest rift zone indicate a rift-zone width less than a mile wide. Dikes in a dike complex number about 100 to 200 per mile of width (Macdonald and others, 1983) and compose 10 percent or more of the rock volume (Takasaki and Mink, 1985). Downward, the number of dikes in the dike complex is expected to increase and may average 500 to 600 per mile of width of the complex (Macdonald and others, 1983). The dike complexes are hydrologically important because dikes have low permeability and tend to impound groundwater to high altitudes within inter-dike compartments. Also, dikes associated with rift zones tend to impede groundwater flow from groundwater areas on either side of the rift zone.

Within the study area, sedimentary deposits of recent alluvium, older alluvium and dune deposits are found in coastal areas and almost cover the entire surface of the Kahului aquifer system that forms the western part of the Central aquifer sector. The sedimentary deposits likely impede groundwater flow between West Maui volcano and Haleakalā.

Surface Water.—The drainage pattern of the stream valleys on Haleakalā is generally radial from the summit of area to the ocean. The streams originating on Haleakalā in the study area drain to the northwest and southwest. A few streams originating on West Maui volcano drain to the east and south within the study area. Streams in the study area are mostly ephemeral, except in places where groundwater discharge might locally sustain perennial flow.

Streamflow consists of direct runoff, base flow, and possibly flow added to some streams from the network of irrigation ditches in and near the study area. Base flow is presumed to represent groundwater discharge and is limited in the study area. As of 2024, the USGS does not maintain any continuous-record streamgaging stations within the study area, although one stream originating on the West Maui volcano that ultimately drains into the study area does have a streamgaging station. The USGS has also historically maintained other streamgaging stations in the area, although mainly for monitoring peak flows related to flooding (Fontaine, 1996; Mitchell and others, 2023).

Groundwater.— Groundwater recharge by direct infiltration of rainfall occurs over nearly the entire study area. Estimates of groundwater recharge in Maui for selected periods, land-cover conditions, and climate conditions have been published in recent years (Johnson and others, 2018; Izuka and others, 2018; Mair and others, 2019; Kāne and others, 2024; Mair and others, 2024). Groundwater recharge in the study area is generally greatest in wet mountainous areas and least in drier coastal areas, although irrigation can greatly enhance recharge in dry areas. Estimated groundwater recharge for recent land-cover conditions without sugarcane in the Central aquifer sector is greatest in the Makawao aquifer system and least in the Kahului aquifer system. Estimated groundwater recharge (recent land-cover conditions without sugarcane) in the Central aquifer-sector area ranges from 40.30 million gallons per day (Mgal/d) for a future drought condition with 100 percent of shrubland and forest areas within the cloud zone converted to grassland (Mair and others, 2024) to 107.53 Mgal/d for 1978–2007 rainfall and 2020 land-cover conditions (Kāne and others, 2024).

On the basis of available information, groundwater in the study area occurs in two main forms: (1) as dike-impounded groundwater associated with the rift zones near the northeastern and southeastern boundaries of the Central aquifer sector, and (2) as a freshwater lens floating on denser, underlying saltwater in dike-free (or mainly dike-free) areas (Gingerich, 2008). The freshwater-lens system is mainly dike free. However, numerous volcanic vents or vent-related features in some areas where a freshwater lens is expected were fed through dikes that could affect groundwater conditions.

Dike-Impounded Groundwater.—Within the study area, volcanic dikes are inferred to exist near the northeastern and southeastern boundaries where volcanic vents at the surface indicate the presence of subsurface dikes. Dikes are hydrologically important because they have low permeability and can compartmentalize and impound groundwater to higher altitudes than would exist in the absence of dikes. Groundwater recharge to the dike-impounded area is mainly in the form of infiltration of rainfall. Groundwater flows from the dike-impounded groundwater area towards the coast and contributes subsurface flow to the freshwater-lens system.

Freshwater Lens.—Within the high-permeability rocks of the Honomanū Basalt, a lens of freshwater floats on denser underlying saltwater. Where the Kula Volcanics exists near and below sea level, expected mainly near the coast, the freshwater lens will exist within that formation as well. The source of freshwater in the lens is groundwater recharge from infiltration of rainfall, irrigation water, and streamflow, inflow from the dike-impounded groundwater in the rift zones near the northeastern and southeastern boundaries of the study area, and possibly inflow across the western boundary of the study area from groundwater originating in the West Maui volcano. Fresh groundwater flows generally from inland recharge areas to the coast where it discharges at springs and by diffuse seepage at and near sea level.

In coastal aquifers of Hawaiʻi, a saltwater-circulation system exists beneath the freshwater lens (Souza and Voss, 1987). Saltwater flows landward in the deeper parts of the aquifer, rises, and then mixes with seaward flowing freshwater. This mixing creates a freshwater-saltwater transition zone. No wells are currently available in the study area to characterize the thicknesses of freshwater or the transition zone, although such deep monitor wells are available in the West Maui volcano.

Existing Groundwater Withdrawals.—Reported groundwater withdrawals (Robert Chenet, Hawaiʻi Commission on Water Resource Management, written commun., 2024) in the Central aquifer sector varied over time in response to changing irrigation demand and drinking-water needs. Since 1990, reported withdrawals from all groundwater sources in the Central aquifer sector peaked in 1996 at 120 Mgal/d and then, following the cessation of sugarcane cultivation on Maui in 2016, was between 8 and 17 Mgal/d during 2017–23. During 2023, reported withdrawals from the Central aquifer sector were 16.7 Mgal/d, and were greatest in the Pāʻia aquifer system (6.8 Mgal/d) and least in the Makawao aquifer system (1.0 Mgal/d). Reported 2023 withdrawals from the Kahului aquifer system totaled 5.2 Mgal/d, whereas CWRM has estimated a sustainable yield of 1 Mgal/d for this aquifer system.

OBJECTIVES

The objective of this study is to provide information needed to evaluate the validity of existing aquifer-system boundaries and potentially revise existing boundaries. Although developing new boundaries is beyond the scope of this study, the information generated by this study is expected to be useful for this purpose.

APPROACH

To meet the objectives of this study, an existing island-wide groundwater-flow model of Maui will be used to simulate steady-state conditions for selected recharge and withdrawal scenarios. The selected scenarios will be developed in consultation with CWRM. The existing numerical groundwater-flow model incorporates the latest conceptual understanding of hydrogeologic conditions on Maui (Izuka and others, 2021). Known or inferred geologic structures related to dikes and low-permeability weathered rocks and sedimentary deposits are represented in the model. The model was constructed using available groundwater-level, -withdrawal, and -discharge information. CWRM aquifer-system boundaries that are related to topographic, surface, geographic, or political features that do not affect groundwater flow are not represented in the model framework, although flow across these aquifer-system boundary lines can be quantified by the model.

The recharge and withdrawal scenarios will provide insight into groundwater-flow directions and how the north-south groundwater divide and generalized flow lines, which represent potential aquifer-system separators, might shift in response to different hydrologic conditions. The model will also be used to quantify groundwater discharge to coastal wetland areas within the Central aquifer sector in northern and southern Maui near Kanahā and Keālia Ponds, respectively. These wetlands provide habitat for endangered native waterbirds and changes in groundwater discharge to these wetlands can affect available habitat.

Existing recharge estimates based on recent land-cover and climate conditions and a range of future climate projections will be considered as input to the groundwater-flow model. If deemed appropriate, land-cover conditions that reflect plausible changes in agriculture or development can be incorporated in new water-budget computations. A range of recent, proposed, or hypothetical withdrawals scenarios can be incorporated in the groundwater-flow model.

DELIVERABLES

The anticipated products of this study are (1) a published USGS report in the Scientific Investigations Report series; (2) a data release documenting groundwater-flow model files; and (3) meetings (virtual and in person) to discuss model scenarios, study progress, and results.

BUDGET

The total cost for this 3-year study is estimated to be $399,000 for CWRM. The USGS will contribute $43,000 in matching funds The cost includes salary and overhead. No supply or equipment purchases are anticipated for this study.

Table 1: Budget

	Year 1	Year 2	Year 3	**Total**
USGS	25,000	18,000		43,000
CWRM	229,000	160,000	10,000	399,000
Total	254,000	178,000	10,000	**442,000**

WORK PLAN

The major tasks and associated periods of activity for this 3-year study are summarized in table 1. Work will begin as soon as funding becomes available. Preliminary results and meeting will be held throughout the duration of the study.

	Quarter											
Task	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Develop model scenarios	x	x										
Create model files		x										
Run model scenarios			x									
Analyze model results				x								
Document results					x							
Scientific Investigations Report												
Write draft			x	x	x	x	x					
Review								x				
Approve								x				
Publish									x	x	x	x
Data release												
Write draft							x					
Review							x					
Approve								x				
Publish												x
Meetings	x		x		x		x		x			

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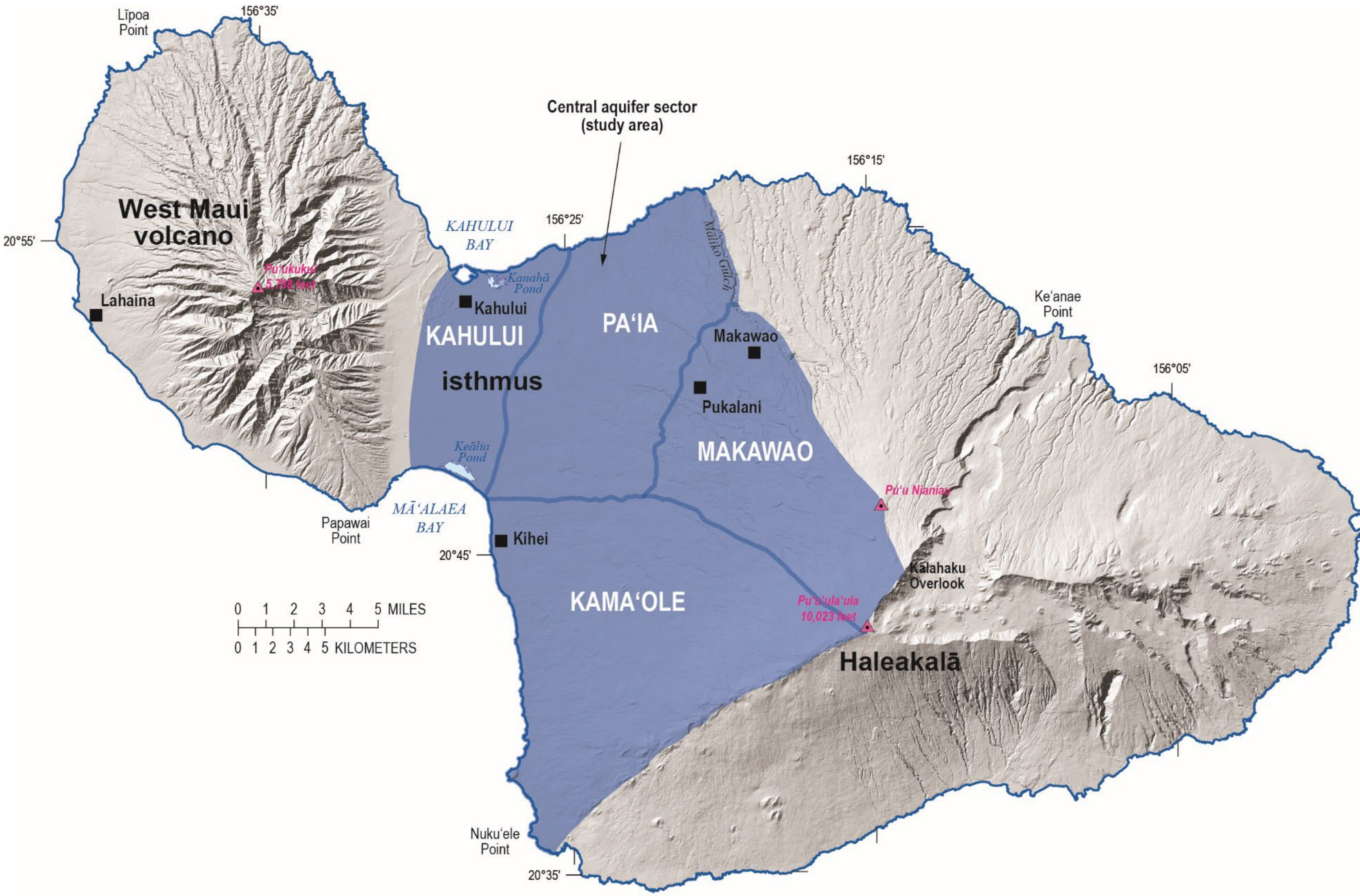

Figure 1. State of Hawai'i Central aquifer sector study area, Island of Maui, Hawai'i.