Christopher K. Shuler
Aly I. El-Kadi

University of Hawaii Water Resources Research Center
UNIVERSITY OF HAWAI'I AT MĀNOA
Honolulu, Hawai'i 96822

CONTACTS
cshuler@hawaii.edu
elkadi@hawaii.edu

Management Summary

Provisional Hydrogeologic Data and Recommendations for Sustainable Groundwater Management, Tutuila American Samoa

EPA Region 9

Special Report SR-2018-03
Prepared in cooperation with American Samoa Environmental Protection Agency through a US EPA Region IX Making a Visible Difference Project
Project No. C00543

Summary

THE PURPOSE OF THIS REORT IS TO SUPPORT GROUNDWATER RESOURCE MANAGERS SEEKING TO DEVELOP A GROUNDWATER SUSTAINABILITY PLAN FOR THE ISLAND OF TUTUILA.

The main report provides a comprehensive summary of the currently available hydrogeologic information and data for American Samoa and then details and prioritizes the existing knowledge gaps that hinder progress towards a more water sustainable future. The report provides necessary background by covering the conceptual hydrogeologic model of the island and by presenting available recharge estimates. All available groundwater well data including average chloride concentrations (Cl-), drilling water levels, pumping water levels, well pump-rates, and values of aquifer specific capacity, transmissivity (T) and hydraulic conductivity (K) from aquifer tests is organized by wellfield and presented for all known current and historical wells on Tutuila. The report concludes by providing water management recommendations for groundwater use and development, aquifer testing, and for filling hydrogeologic data gaps.

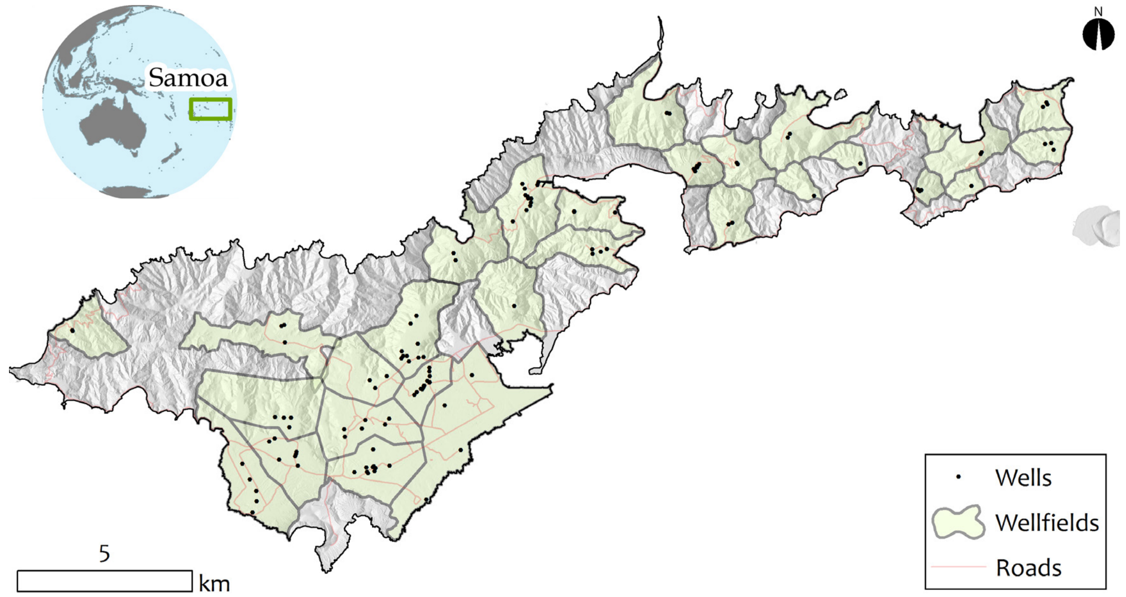

Figure 1: Map of Tutuila island showing defined wellfield boundaries examined by this report (shaded in green), and locations of every known well on Tutuila (as black dots). In the full report, groundwater data from every well is consolidated and hydrogeologic information is summarized at the wellfield level for each groundwater development region on Tutuila.

The Importance of Groundwater

Tutuila Island in American Samoa is almost completely dependent on groundwater resources and therefore faces very real consequences due to overexploitation of their limited water supplies.

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Conceptual Hydrogeologic Model

On Tutuila, like other oceanic islands, the primary groundwater resource is contained in a basal freshwater lens residing near sea level and supported by underlying seawater within saturated rock.

Geology Controls Hydrology

Observations of Tutuila's geologic structure from outcrops and borehole logs show a heterogeneous distribution of lavas, breccia, debris flows, cinders, and intrusive bodies yielding a complex and difficult to predict subsurface geology. However, existing data do not allow for detailed characterization this complexity, and only regional scale distinctions can be made. What is discernable are stark differences between the water bearing properties of the younger Tafuna-Leone Plain Region and those of the older portion of the island. The Tafuna-Leone Plain displays higher K values, a thinner freshwater lens, and has been found to be more susceptible to surface water contamination. On the other hand, the Pleistocene Shield Region of Tutuila, generally has lower K values, and shows high water levels as can be seen by the plentiful but small spring discharge that feeds perennial streams in the unit's steep sided watersheds.

Two different conceptual models of groundwater occurrence on Tutuila have been previously proposed, the Hawaiian Model (Lau and Mink, 2006) consisting of two disconnected groundwater systems (high-level and basal) and the Canary Island Model (Join et al., 2016) where both elevated groundwater and basal groundwater are hydraulically connected as a single system contained in low-permeability rock (Fig. 2). While neither of these models has proven to be definitively correct, it is likely that different regions may be better represented by different models, thus emphasizing the importance of interpreting data from different aquifers or hydrogeologic units on an individual basis, as done in this work.

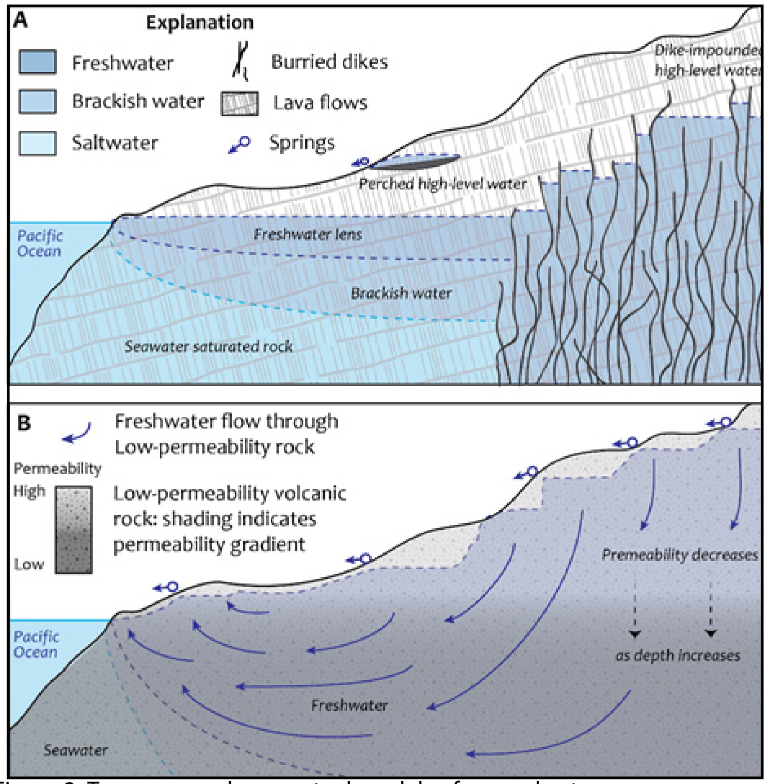

Figure 2: Two proposed conceptual models of groundwater occurrence on Tutuila: (A) the Hawaiian Model and (B) the Canary Island Model.

Existing Recharge Estimates

Tutuila's drinking water supply is primarily derived from groundwater, which is fed by the infiltration of rainfall into the land.

In general, the spatial distribution of recharge on Tutuila seems to follow a similar pattern as rainfall, where higher elevations contribute more water to the subsurface than lower elevations. Existing recharge estimates indicate that the eastern part of the island receives significantly lower amounts of recharge than the west. Recharge on the Tafuna-Leone Plain is enhanced by the process of mountain front recharge (MFR) where runoff from mountain streams infiltrates into the streambed once water reaches more permeable geologic formations. As of December 2018 there are three existing recharge estimates for Tutuila, as detailed in Eyre and Walker (1991), Izuka et al. (2007), and ASPA (2013). In this report, these results were summarized by producing maps of total regional recharge in million gallons per day (Mgal/d) for each of the three estimates (Fig. 3).

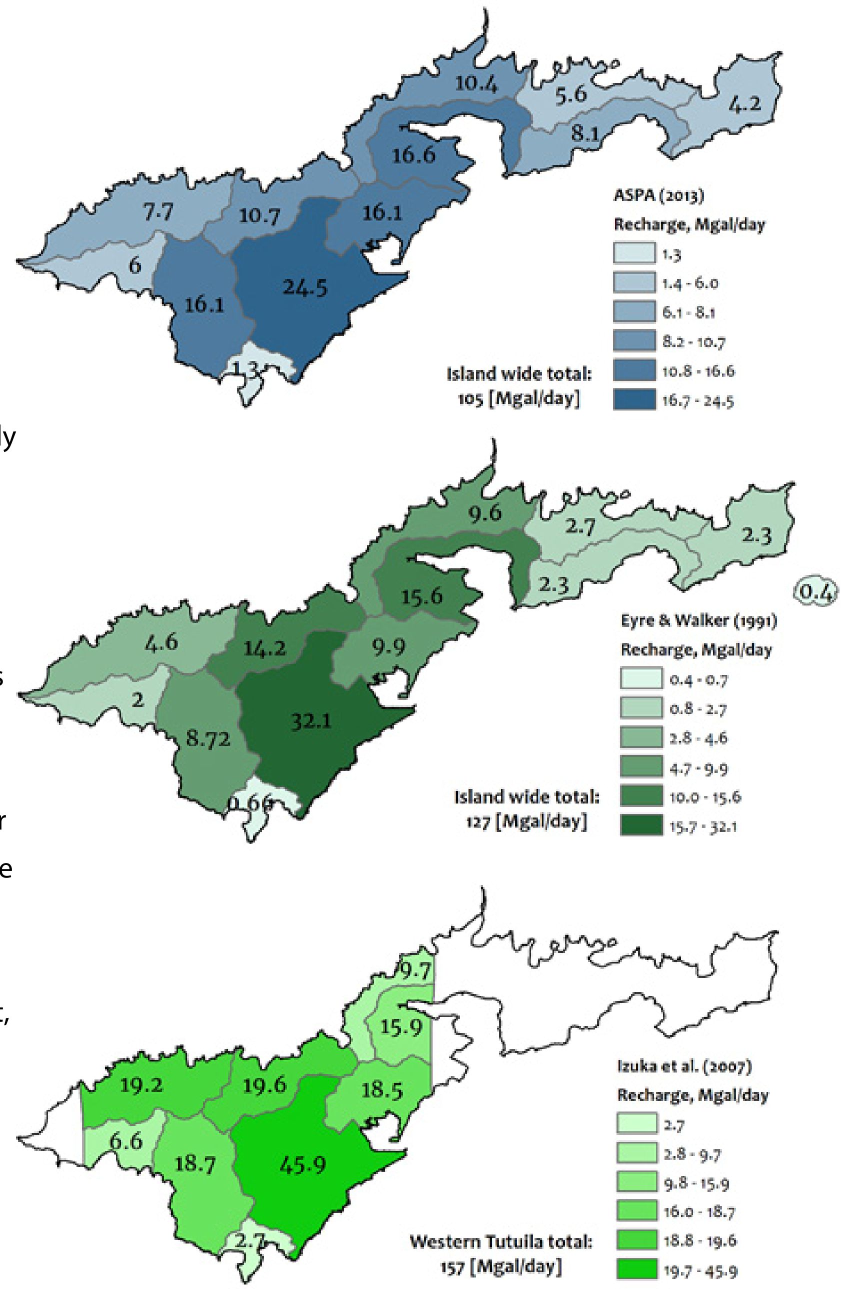

Figure 3: Comparison of Tutuila's recharge estimates by ASPA (2013), Eyre and Walker (1991), and Izuka et al. (2007). Each estimate was converted to a region-standardized format.

Consolidated Well Data

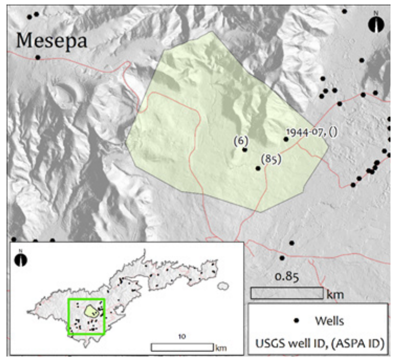

Figure 4: Location map of the Mesepa wellfield with locations of active and abandoned wells. Green shading denotes wellfield boundary, which does not necessarily delineate aquifer extent. Labels indicate well ID numbers.

Data obtained from existing wells is a key resource for understanding the condition of aquifers and assessing future groundwater development potential. In this report all available well data from Tutuila are organized by wellfields defined by existing groupings of wells, watersheds or, geologic units, on Tutuila. Each wellfield is also classified into one of three development stress categories based on current aquifer conditions and viability of future development. These categories include a) areas with a minimal amount of groundwater development in comparison to likely potential for development capacity, b) areas where moderate to extensive groundwater resources are currently developed, yet data does not indicate withdrawal rates are unsustainable and c) heavily developed wellfields with water level and chloride trends suggesting groundwater withdrawals may already exceed the aquifer's capacity to sustainably supply water. The locations of all wells and wellfields are shown on figure x. Currently available groundwater datasets include: well locations and elevations, pumping rates, pre-production and pumping water levels, chloride (Cl-) concentrations, specific capacity values, and transmissivity (T) and hydraulic conductivity (K) values from aquifer tests. Although not all wells have records available for each of these parameters, every effort was made to compile as much of this information from as many sources as possible

Example Datasets

Below are examples of the types of tables and figures presented in the full report for each of the wellfields on the island

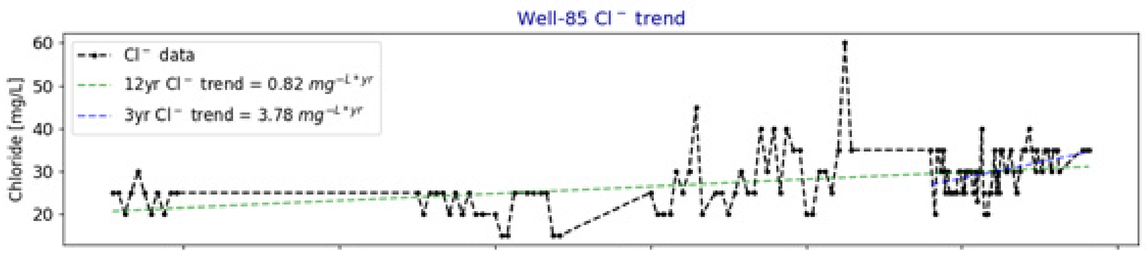

Figure 5: Averaged Cl- concentrations for most recent 3-year period, 2015-2017 at Well 85. Green dashed line shows the linear regression trend line for all data, generally about 12 years, and blue dashed line shows the linear regression trend line for 2015-2017.shading denotes wellfield boundary, which does not necessarily delineate aquifer extent. Labels indicate well ID numbers. (example dataset)

Table 1: Mesepa Wellfield aquifer parameters. (example)

Well # [USGS ID]	Well # [ASPA ID]	Drilling WL [m]	Pumping WL [m]	Pump rate [GPM]	Specific capacity [GPM/m]	T [m^2/day]	K [m/d]	Avg. Cl^- [mg/L]	Cl^- trend [mg/L/yr.]
1944-07	-	3.0	-	-	-	-	-	23	
-	**85**	**-**	**0.8**	**280**	**1244**	**9195**	**647**	**28**	**↑, 4**
-	6	0.0	-43.9	130	3	3810	18	25	

Groundwater Use and Development Recommendations

1. Wells in the Pleistocene Volcanics should be expected to yield only low quantities of water (<30–50 gpm).

2. Saltwater intrusion risk can be minimized by drilling production wells as far from the coast as possible.

3. Careful assessment of aquifer parameters during and/or after drilling with step-drawdown, constant-rate , and recovery tests will help to set appropriate pumping rates and better understand the aquifer.

4. If chronic static water level declines or substantial increases in Cl^- concentrations are detected, pumping rates may be reduced to allow aquifer recovery.

5. Successfully developing high-level reservoirs on Tutuila will probably necessitate use of geophysical exploration and drilling multiple wells to find high-yielding zones.

6. Targeting high-elevation (above sea level) perched, dike-impounded, or semi-perched water "pockets" is a riskier strategy than targeting basal water supplies, though elevated water often has a lower contamination potential.

Conclusions and Directions for Future Study

The collection of hydrologic data presented in this report is foundational for developing numerical groundwater models, which are generally considered to be the most reliable tools for quantifying groundwater availability. While a large amount of data has been consolodated here, there remain a number of significant data gaps needing to be filled. These gaps include: 1) an updated, high-temporal, and spatial resolution recharge distribution, 2) an assessment of mountain front recharge (MFR) runoff to infiltration ratio, 3) conceptual model testing and validation, 4) higher resolution Cl- information from production wells, 5) aquifer testing for existing wells with no existing test records, 6) improved assessment of aquifer boundaries, and 7) development of sustainable yield criteria. Filling these gaps should be a key goal for water managers and researchers seeking to continue making progress in developing data-driven management strategies that ensure the sustainability of Tutuila's water resources for future generations.

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W.R.R.C.

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