

Commission On Water Resource Management Meeting Honolulu, Oʻahu, Hawaiʻi August 18, 2020

Ke Kahunas Pono "The trustee who oversees the rightful sharing of water."

Briefing Outline

Deep Monitoring Well (DMW) purpose

Number and Location of DMWs currently monitored by CWRM in the Pearl Harbor Aquifer

Data collection and how the data is used

- Deep monitor wells penetrate the freshwater basal aquifer into the underlying brackish and salt water. DMWs are used to measure the thickness of the freshwater part of the aquifer (freshwater lens) and the freshwater-saltwater transition zone.
- The vertical profile is divided into four parts:
 - the upper fresh water zone (less than 2% sea water)
 - the transition zone (2% to 50% sea water)
 - into the saline zone (greater than 50% sea water)
 - and where encountered, the sea water interface.



Number and Location of DMWs currently monitored by CWRM in the Pearl Harbor Aquifer

CWRM currently monitors six (6) DMWs on O'ahu, all located in the Pearl Harbor aquifer:

- Waipahu DMW was the earliest of the six DMWs drilled. Originally installed as a municipal supply well in 1926, it was deepened to 1,108 feet in 1980; data collection began in November 1986. This DMW is owned by BWS.
- 2. Waipio Mauka DMW was installed in 1987.
- Halawa DMW was installed near the Halawa Correctional Facility in 2000.

Number and Location of DMWs currently monitored by CWRM in the Pearl Harbor Aquifer

- 4. Kunia Middle DMW was installed in 2002.
- 5. Kunia Mauka DMW was installed in 2004.
- 6. The most recent CWRM DMW, Waimalu DMW, was installed in April 2005.
- The following map shows the locations of the six DMWs.

3-2503-003 Kunia Mauka 2 Deep Monitor

3-2403-002 Kunia Middle Deep Monitor

3-2659-001 Waipio Mauka DMW

3-2456-005 Waimalu Deep Monitor

3-2300-018 Waipahu Deep Monitor

3-2253-003 Halawa Deep Monitor

Data collection and how the data is used

- Electronic data recorders (or pressure transducers) have been installed in all six DMWs to measure pressure (i.e., water level), and temperature on an hourly schedule.
- During each quarterly visit, the data recorder is retrieved from the well and downloaded to a field laptop for processing. An electronic water level meter is then used to measure the elevation of the water surface in the well.



Data collection and how the data is used

- An electronic logger that measures conductivity, temperature, and depth (CTD) is then deployed using a winch, to record water quality data throughout the water column.
- The CTD logger collects data at a rate of three data points per second as it is lowered through the water column.
- Upon retrieval of the CTD, the data is downloaded to a field laptop for transfer to the CWRM server, where it is processed and plotted as a profile of conductivity and temperature vs depth.



Typical CTD Profile (Waipahu DMW 4-28-2020)



Data collection and how the data is used

- CWRM plots time-series graphs showing the changes in elevation (relative to mean sea level) for the following data:
- Water level
- **Top of transition zone TTZ** (2% seawater, or 1,000 μS/cm or 250 mg/l cl⁻)
- Midpoint of transition zone MPTZ (50% seawater, or 25,000 µS/cm or 9,500 mg/l cl⁻)
- Sea water interface (100% seawater , or 45,000 μS/cm or 19,000 mg/l cl⁻)

These time-series plots are posted to our website: *https://dlnr.hawaii.gov/cwrm/groundwater/monitoring/*



WEBSITE UPDATES

As of June 20, 2018

- · CCH-MA13-01: Commission issues Findings of Fact, Conclusions of Law, & Decision and Order (News Release)
- · June 2018 Water Resource Bulletin
- Meet Commissioner Dr. Bruce S. Anderson

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MONITORING DATA

The Commission on Water Resource Management's Survey Branch is responsible for collecting basic hydrologic data and conducting water availability and sustainable yield analyses statewide. The information presented below highlights some of the Commission's monitoring activities essential to the protection of Hawaii's water resources. The <u>U.S. Geological</u> <u>Survey</u> also collects water level and deep monitor well data through cooperative agreements with CWRM and other government agencies. The <u>Honolulu Board of Water Supply</u> also has a network of water level and deep monitor wells on Oahu.

Deep Monitor Well Data

A deep monitor well penetrates the freshwater basal aquifer into the underlying brackish and salt water. It is used to estimate the thickness of the freshwater part of the aquifer (freshwater lens) and the freshwater-saltwater transition zone. For convenience, the vertical profile is divided into three parts: the upper fresh water zone (less than 2% sea water), the transition zone (2% to 50% sea water), and into the saline zone (greater than 50% sea water). The data are



presented as graphs of the changes in elevation (feet, mean sea level) of the top of the transition zone (2% seawater) and the midpoint of the transition zone (50% seawater) over time.

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OAHU WELLS

- <u>Halawa</u>
- Kunia Mauka
- <u>Kunia Middle</u>
- <u>Waimalu</u>
- <u>Waipahu</u>
- <u>Waipio Mauka</u>

Halawa Deep Monitor Well, Oahu (3-2253-003)

Fluctuations in the Water Table, Top of Transition Zone (TTZ), and Midpoint of Transition Zone (MPTZ) From August 2000 through July 2020 100 From August 2000 to July 2020 the Water Table rose 3.70 feet to 19.75 feet above msl n Fresh Water -100From August 2000 to July 2020 the TTZ declined 29.35 feet to an elevation of 96.78 feet below msl -200 -300 -400 Brackish Water Elevation (feet msl) -500 -600 790 feet below msl -700 From August 2000 to July 2020 the MPTZ rose 77.86 feet to an elevation of 850.85 feet below msl -800 -900 0-0-0-0-0 -1000 From August 2000 to July 2020 Sea Water rose 45.88 feet to an elevation of 962.12 feet below msl -1100 Sea Water 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020

Notes: : (1) TTZ = 1,000 µS/cm (~ 220 mg/L Cl⁻); MPTZ = 25,000 µS/cm (~ 8,500 mg/L Cl⁻) (2) Fresh Water < 220 mg/L Cl⁻, Brackish Water 220 mg/L Cl⁻ to 16,999 mg/L Cl⁻, Sea Water >= 17,000 mg/L Cl⁻; (3) OS 421/425 = Ocean Sensors CTD (absolute conductivity); (4) RBR 12895 = RBR Global CTD (Specific Conductivity); (5) msl = mean sea level.

* Since the year 2000, the MPTZ has risen 77.86 feet, rising toward a calculated Ghyben-Herzberg equilibrium elevation of approximately 790 feet below msl (relative to the Water Table, measured at 19.75 feet above msl). Note the relatively thick mixing zone, resulting from upward borehole flow of an influx of brackish water.

Waimalu Deep Monitor Well, Oahu (3-2456-005)

Fluctuations in the Water Table, Top of Transition Zone (TTZ), and Midpoint of Transition Zone (MPTZ) from May 2005 through July 2020



Notes: : (1) TTZ = 1,000 µS/cm (~ 220 mg/L Cl⁻); MPTZ = 25,000 µS/cm (~ 8,500 mg/L Cl⁻) (2) Fresh Water < 220 mg/L Cl⁻, Brackish Water 220 mg/L Cl⁻ to 16,999 mg/L Cl⁻, Sea Water >= 17,000 mg/L Cl⁻; (3) OS 421/425 = Ocean Sensors CTD (absolute conductivity); (4) RBR 12895 = RBR Global CTD (Specific Conductivity); (5) msl = mean sea level.

* Since the year 2005, the MPTZ has declined 89.27 feet toward a calculated Ghyben-Herzberg equilibrium elevation of approximately 788 feet below msl, relative to the Water Table measured at 19.86 feet above msl.

Fluctuations in the Water Table, Top of Transition Zone (TTZ), and Midpoint of Transition Zone (MPTZ) March 1987 through April 2020 100 0 From March 1987 to April 2020, the Water Table rose 1.16 feet to 20.69 feet above msl -100 -200 Fresh Water -300 -400 From March 1987 to April 2020, the TTZ rose 94.32 feet to 606.68 feet below msl Elevation (feet msl) -500 -600 * 827.6 feet below msl -700 From March 1987 to April 2020, the MPTZ rose 114.07 feet to 854.93 feet below msl -800 Brackish Water -900 -1000 From February 2003 through April 2020, Sea Water rose 108.94 feet to an elevation of -1111.94 feet below msl -1100 -1200 (Sea Water interface not measured prior to February 2003) -1300 Sea Water -1400^{Jan} 1989 ^{Jan} 1991 ^{Jan} 1993 ^{Jan} 1997 Jan 2001 ^{Jan} 2003 ^{Jan} 2005 Jan 2007 ^{Jan} 2009 Jan 2011 ^{Jan} 2017 ^{Jan} 1987 ^{Jan} 1995 ^{Jan} 1999 Jan 2013 ^{Jan} 2015 ^{Jan} 2019 TTZ - OS 421/425 MPTZ - OS 421/425 TTZ - RBR 12895 MPTZ - RBR 12895 Water Table Sea Water Notes: (1) TTZ = 1,000 µS/cm (~ 220 mg/L Cl-); MPTZ = 25,000 µS/cm (~ 8,500 mg/L Cl-) (2) Fresh Water < 220 mg/L Cl-, Brackish Water 220 mg/L CL- to 16,999 mg/L Cl-, Sea Water >= 17,000 mg/L CI; (3) OS 421/425 = Ocean Sensors CTD (absolute conductivity); (4) RBR 12895 = RBR Global CTD (Specific Conductivity); (5) msl = mean sea level

Waipio Mauka Deep Monitor Well, Oahu (3-2659-001)

* Since the year 1987, the MPTZ has risen 114.07 feet, to below a calculated Ghyben-Herzberg equilibrium elevation of approximately 827.6 feet below msl, relative to the Water Table measured at 20.69 feet above msl.

Elevation (feet msl)

Waipahu Deep Monitor Well, Oahu (3-2300-018)

Fluctuations of the Water Level, Top of Tranzition Zone (TTZ), and Midpoint of Transition Zone (MPTZ) From November 1986 through July 2020



Notes: (1) TTZ = 1,000 µS/cm (~ 220 mg/L Cl⁻); MPTZ = 25,000 µS/cm (~ 8,500 mg/L Cl⁻) (2) Fresh Water < 220 mg/L Cl⁻, Brackish Water 220 mg/L Cl⁻ to 16,999 mg/L Cl⁻, Sea Water >= 17,000 mg/L Cl⁻; (3) OS 421/425 = Ocean Sensors CTD (absolute conductivity); (4) RBR 12895 = RBR Global CTD (Specific Conductivity); (5) msl = mean sea level. * The MPTZ at 708.64 feet below msl, is above a calculated Gyben-Herzberg elevation of 741.2 feet below msl, relative to the Water Table measured at 18.53 feet msl.

Kunia Mauka Deep Monitor Well, Oahu (3-2503-003)

Fluctuations in the Water Table, Top of Transition Zone (TTZ), and Midpoint of Transition Zone (MPTZ) From December of 2004 through July 2020



Notes: : (1) TTZ = 1,000 µS/cm (~ 220 mg/L CF); MPTZ = 25,000 µS/cm (~ 8,500 mg/L CF) (2) Fresh Water < 220 mg/L CF, Brackish Water 220 mg/L CL⁻ to 16,999 mg/L CF, Sea Water >= 17,000 mg/L CF; (3) OS 421/425 = Ocean Sensors CTD (absolute conductivity); (4) RBR 12895 = RBR Global CTD (Specific Conductivity); (5) msl = mean sea level.

* Since the year 2004, the MPTZ has risen 46 feet to an elevation of 641.31 feet below msl, where it is above a calculated Ghyben-Herzberg equilibrium elevation of 674 feet below msl, relative to the Water Table measured at 16.85 feet above msl.

Elevation (ft msl)

Kunia Middle Deep Monitor Well, Oahu (3-2403-002)

Fluctuations in the Water Table, Top of Transition Zone (TTZ), and Midpoint of Tranzition Zone (MPTZ) October 2002 through July 2020



Notes: (1) TTZ = 1,000 µS/cm (~ 220 mg/L CF); MPTZ = 25,000 µS/cm (~ 8,500 mg/L CF) (2) Fresh Water < 220 mg/L CF, Brackish Water 220 mg/L CF to 16,999 mg/L CF, Sea Water >= 17,000 mg/L CF; (3) OS 421/425 = Ocean Sensors CTD (absolute conductivity); (4) RBR 12895 = RBR Global CTD (Specific Conductivity); (5) msl = mean sea level.

* Since the year 2002, the MPTZ has risen 32.72 feet to an elevation of 602.45 feet msl, where it is higher than the calculated Ghyben-Herzberg elevation of 640.4 feet below msl, relative to the Water Table measured at 16.01 feet above msl.

Data collection and how the data is used

In summary, the data collected to date in the six DMWs have measured rising water levels in all six wells, indicating a general thickening of the fresh water aquifer, likely due to reduced pumpage from O'ahu Sugar closing operations in 1995.

- Halawa DMW +3.70 feet from August 2000 to July 2020
- Waimalu DMW +1.32 feet from May 2005 to July 2020
- Waipahu DMW +3.07 feet from November 1986 to July 2020
- Waipio Mauka DMW +1.11 feet from March 1987 to Aug 2020
- Kunia Mauka DMW +0.21 feet from December 2004 to Aug 2020
- Kunia Middle DMW +0.91 feet from October 2002 to Aug 2020

The top of transition zone (TTZ) borders in the Halawa and Waimalu DMWs show a gentle downward (thickening) trend, as does the MPTZ in Waimalu DMW. The remaining four DMWs show a gentle rise in both TTZ and MPTZ over the history of data collection.

Data collection and how the data is used

In addition, given the generally remote locations of the DMWs, away from pumping wells, the water level data collected to date in the six DMWs has been evaluated for statistical criteria, to be used as aquifer condition indicators for the proposed Pearl Harbor Water Shortage Plan (PHWSP).

The mean water level was calculated for all six DMWs. Standard Deviations (SD) were then calculated. The -1, -2, and -3 SD have been incorporated into the PHWSP as water shortage triggers.

O'ahu Deep Monitoring Well Briefing Data collection and how the data is used





http://hawaii.gov/dlnr/cwrm/

