Monitoring and Management of Hawaii's Water Resources

AEM Project
West Maui

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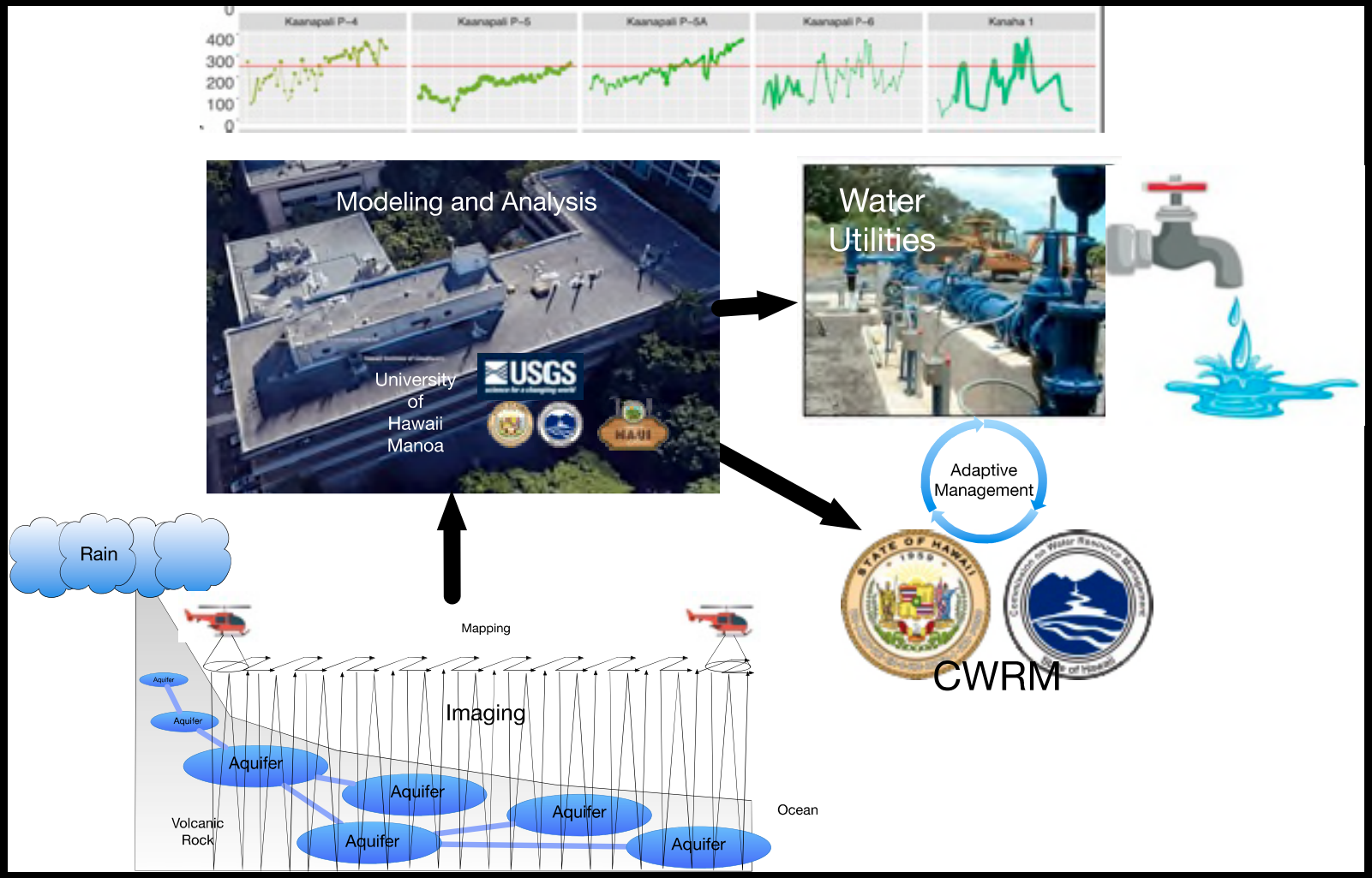
Project Purpose

- Develop new water resource monitoring and management framework
  - Characterize aquifers
  - Expand current modeling capabilities (UH, USGS, Counties, State)
  - Support adaptive management of water resources
- Standardize
  - Stand-up long-term operations providing decision-support to partners
  - Establish training program for professional staff and students

Big Picture


Kaanapali P-4
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Kanaha 1
400
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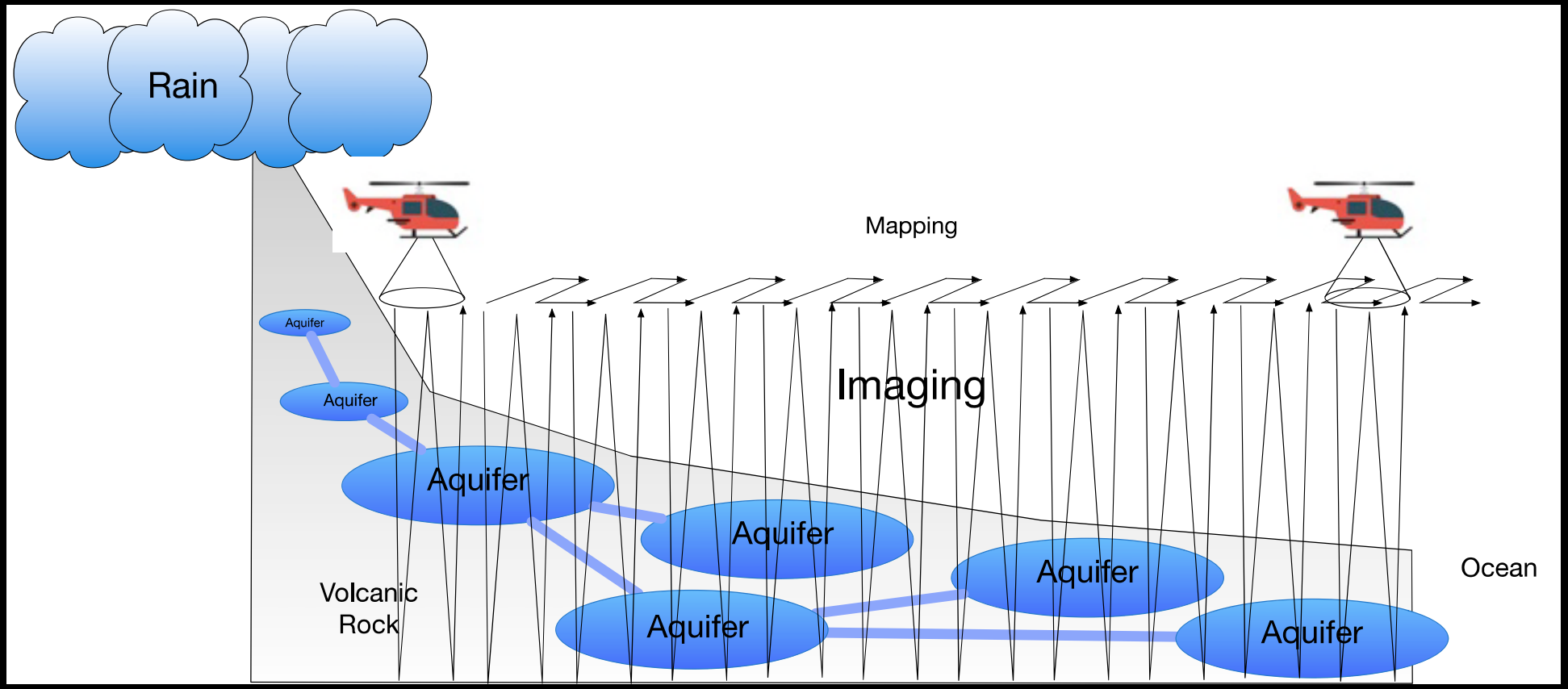
Modeling and Analysis
University of Hawaii Manoa
USGS
Water Utilities
Adaptive Management
CWRM
Rain
Mapping
Imaging
Aquifer
Aquifer
Aquifer
Aquifer
Aquifer
Aquifer
Aquifer
Volcanic Rock
Ocean

Aquifer Characterization: Airborne Electromagnetic Imaging



Project Partners

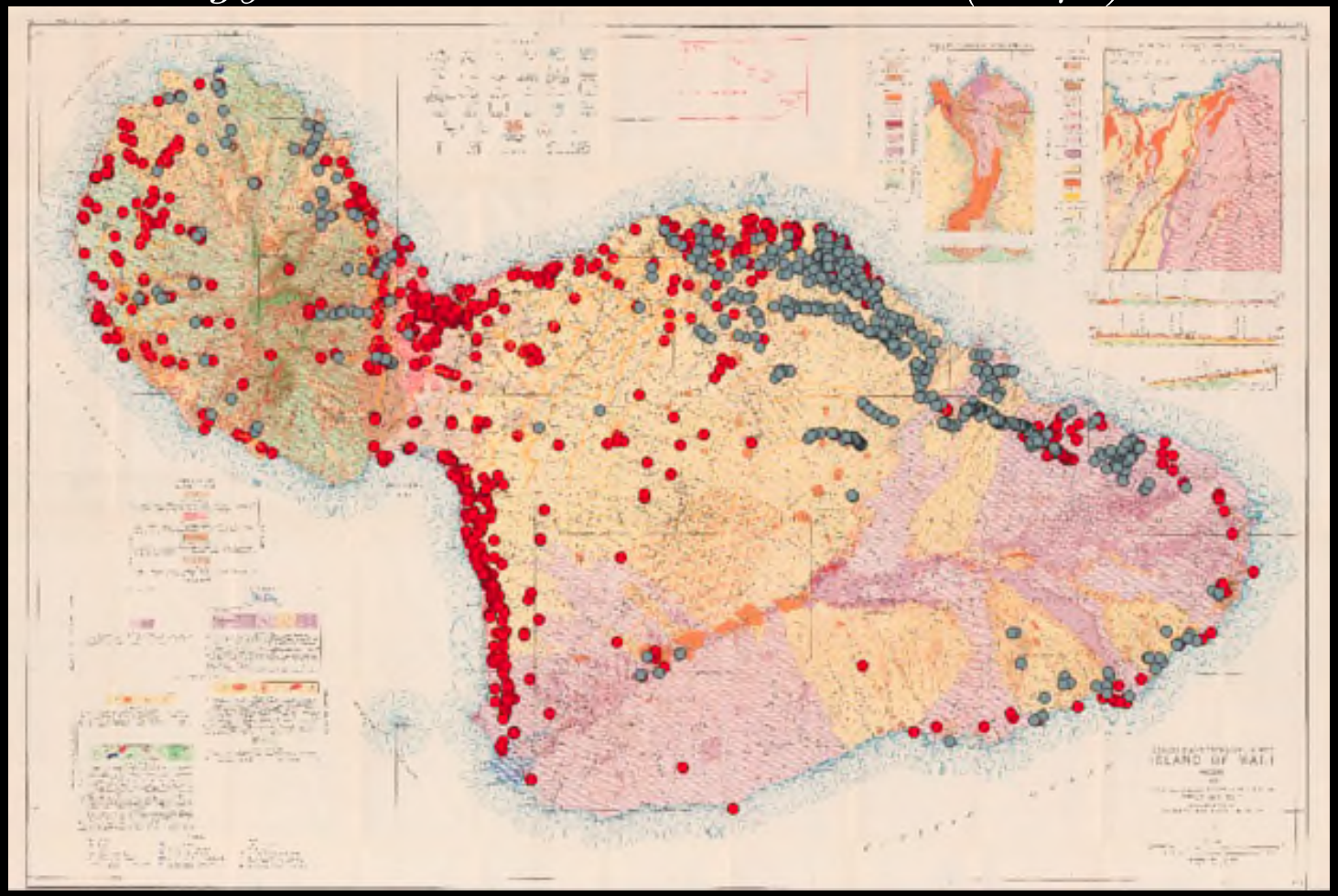
- ’Aina Ho’okupu O Kīlauea (AHK): Sabrina Day, Jeremy Burns, Yoshito L’Hote
- CWRM: Deputy Director Ciara Kahahane, Hydrologic Pgm. Mgr. Ryan Imata
- Maui Department of Water Supply: Director John Stufflebean
- UH Manoa: Dr. Amir Haroon, Dr. Xiaolong (Leo) Geng
- USGS Pacific Islands Water Science Center: Director, Dr. Stephen Zahniser
- Industry: Blue Rock LLC, Eric Eldred

Problem Statement (Westside Maui)

- We are heavily dependent on over-pumped groundwater on Westside
  - Precipitation decreasing
  - Supplemental surface water erratic, diminishing
- Leads to declining
  - Water quantity
  - Water quality
- No new housing without water
- No additional potable water without more (1) rain, (2) desalination, or (3) R0
  - Re-allocation only recourse in short-term
  - Re-allocation decisions and sustainability limits need information
- How do you make these decisions without understanding aquifer conditions?

Permitted Diversions and Wells

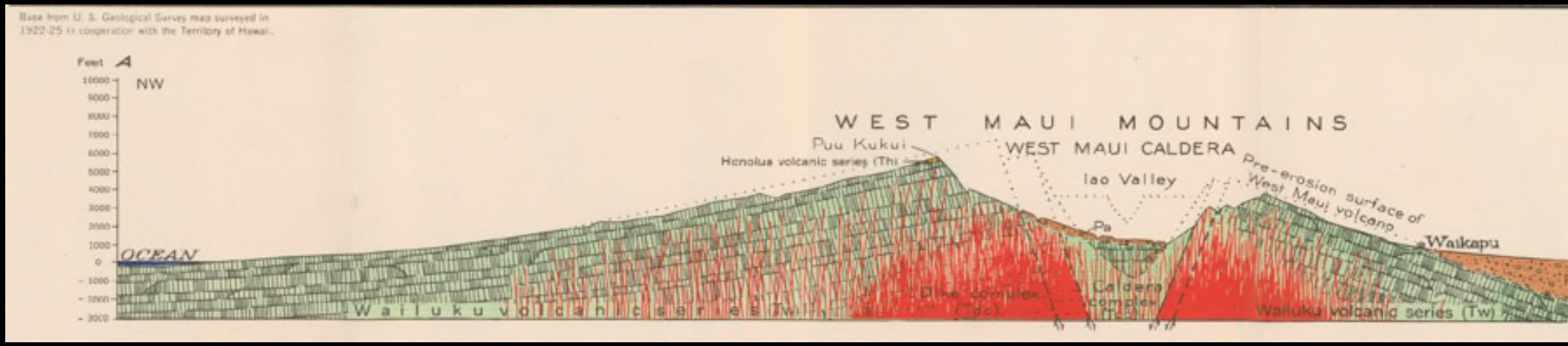
Geology: Stearns and MacDonald (1942) + Data: CWRM



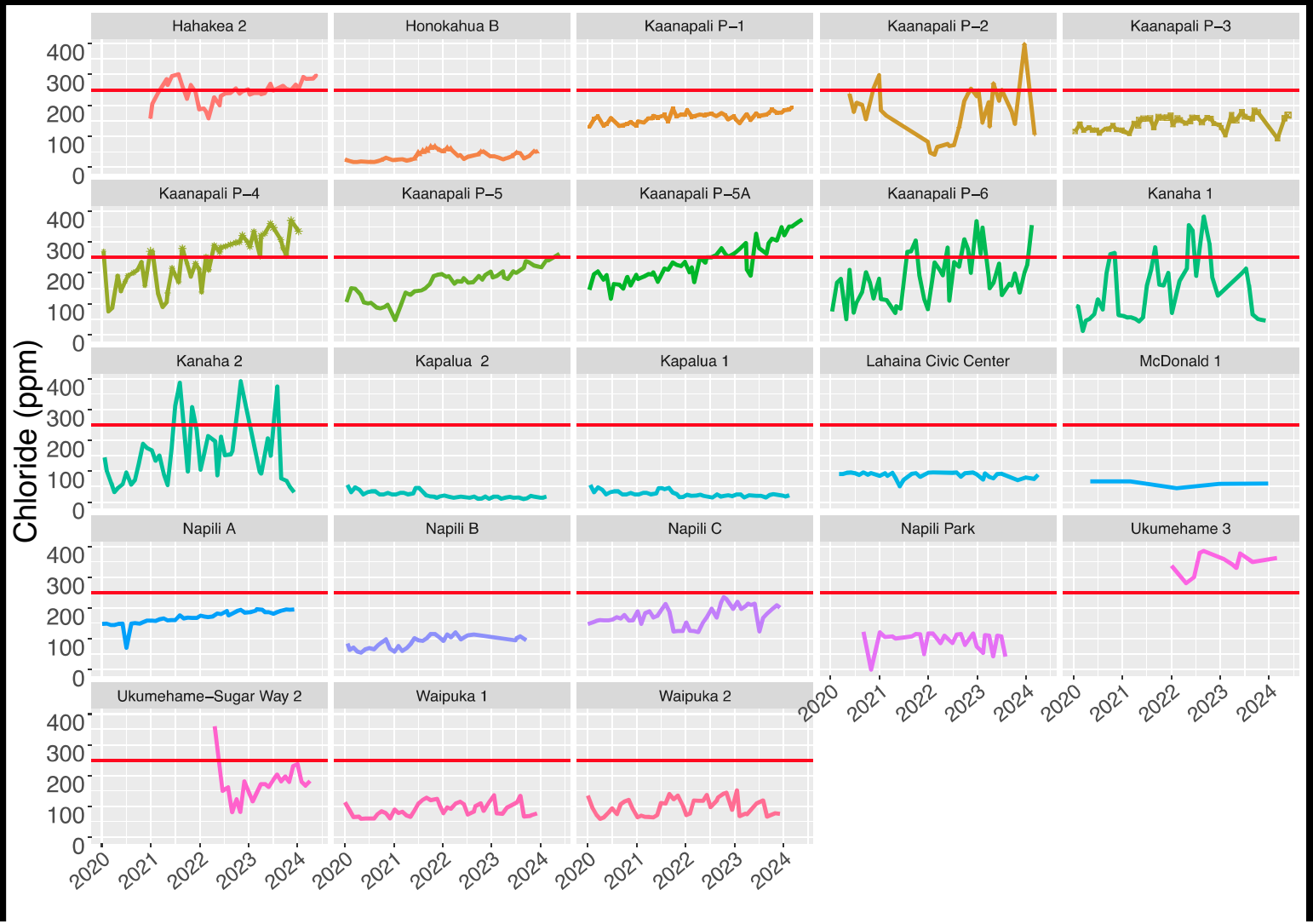
Limits of Present Knowledge

Cross-sectional Geologic Setting for LASEA

- Stearns and MacDonald (1942) is still the primary reference



West Maui Water Crisis: Overpumping

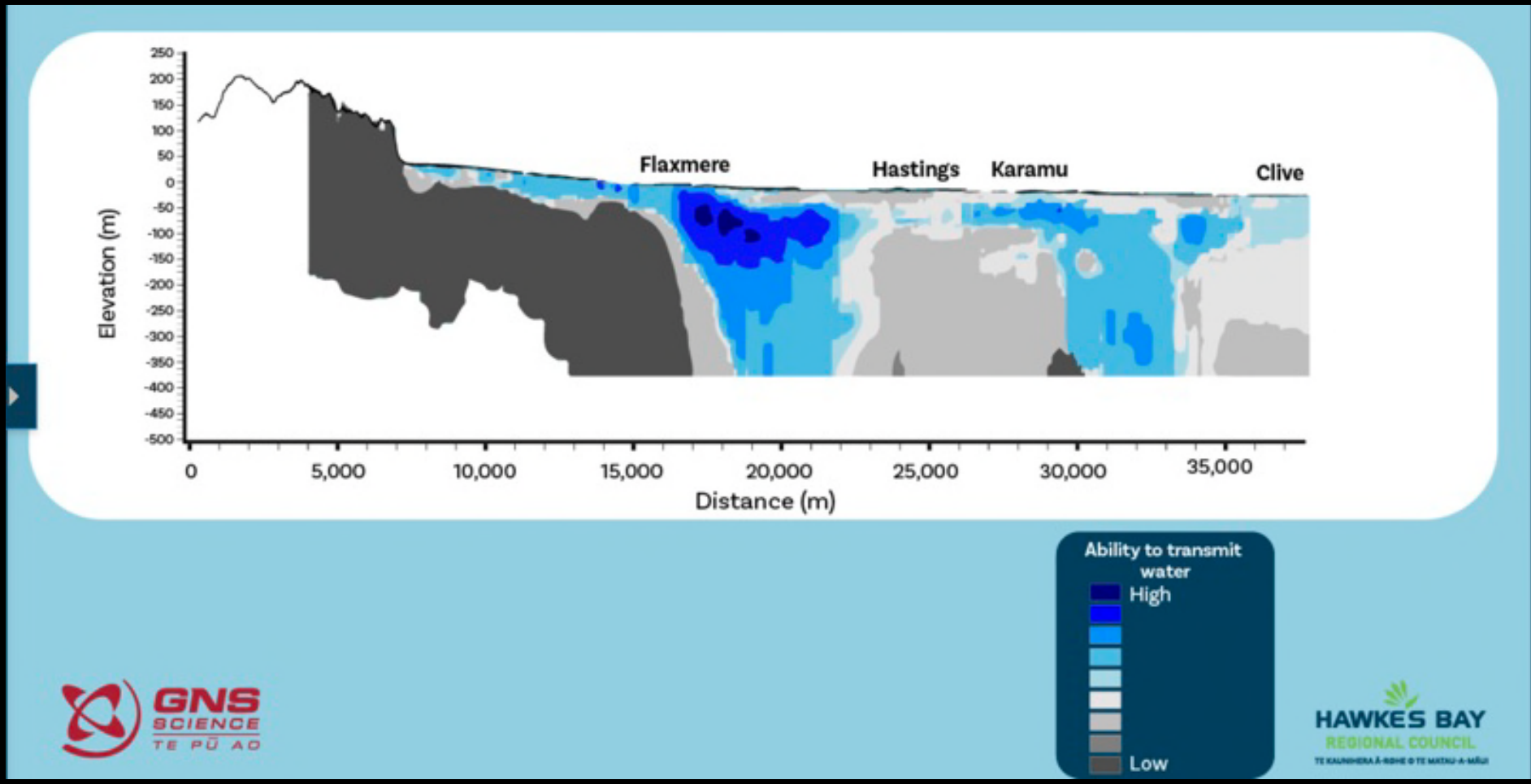


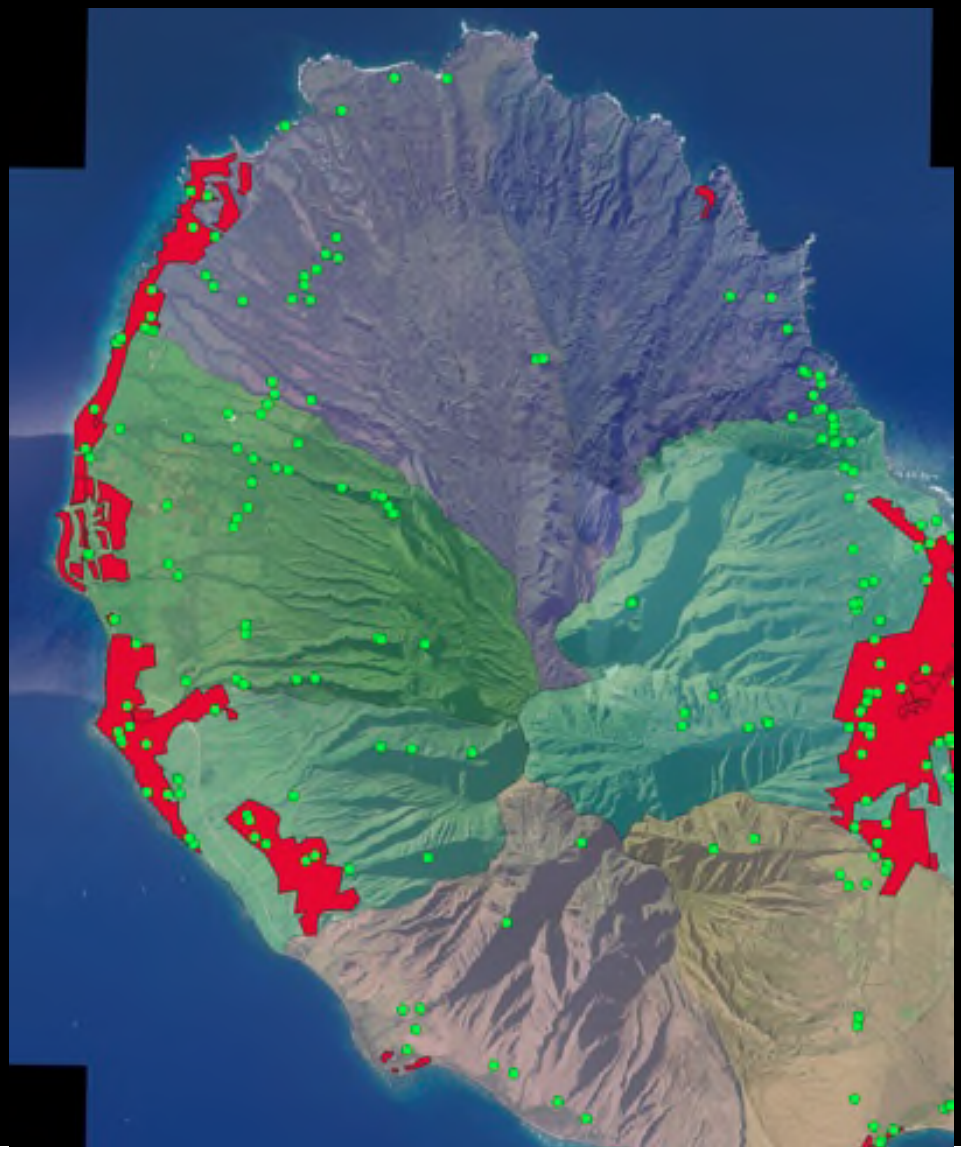
What Can We Do About Water Scarcity?

- We Need to Know More About Our Water Supply
  - How much, where is it, what's sustainable?
  - Maui Needs a Long-term Water Monitoring Program to determine sustainable groundwater and surface water availability

- Current methods are inadequate and lack sufficient data
  - Well-data essential to long-term management
    - More needed but cannot build enough
  - Airborne Electromagnetic (AEM) imaging provides key missing information
- Well data + AEM-based modeling = Best Solution

Example AEM + Modeling: Hawkes Bay New Zealand (2022)

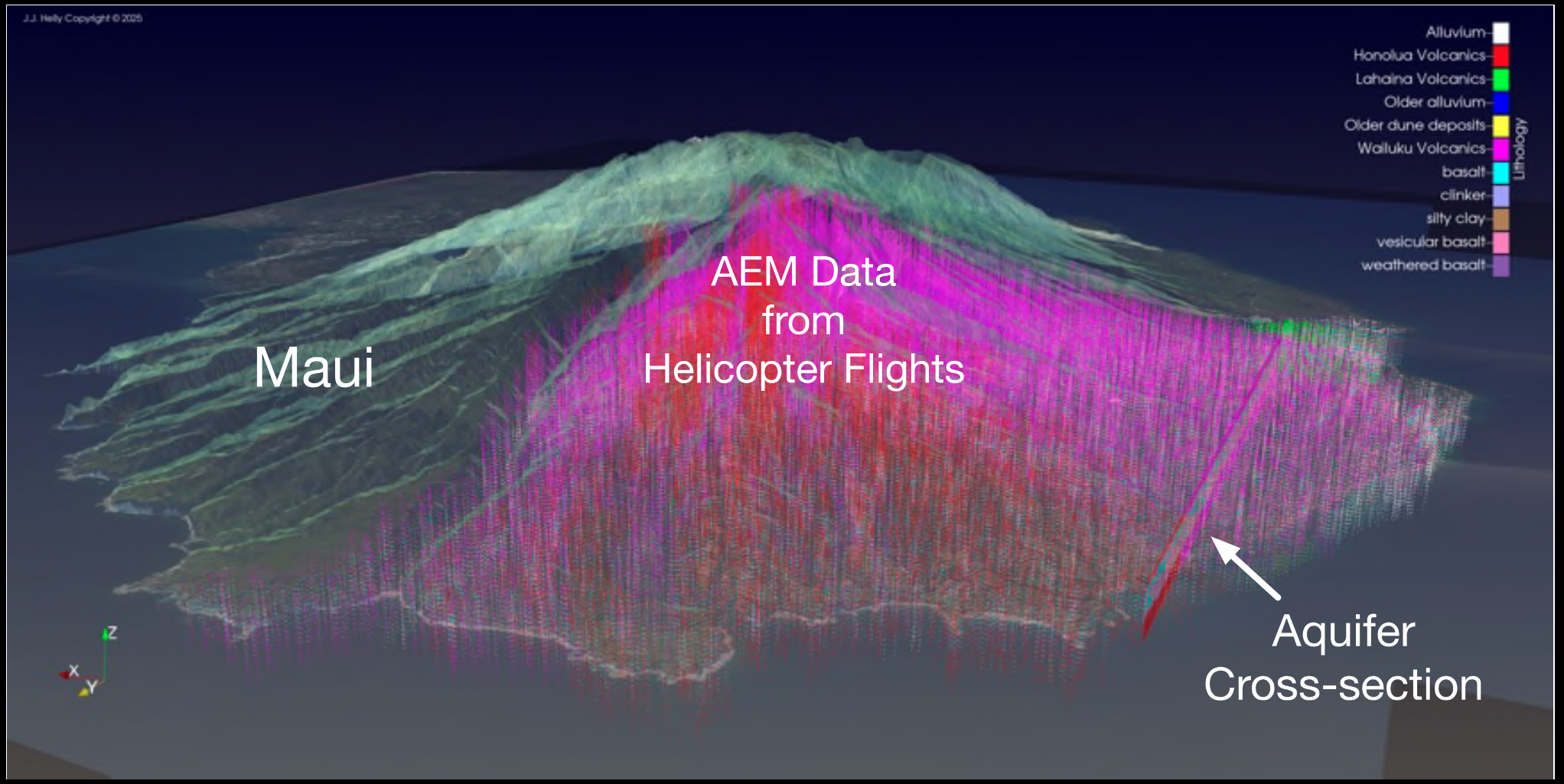




Scope, Budget and Schedule

- Current Project Scope: West Maui
  - 'Connect the dots' (groundwater wells)
  - Entirety of West Maui (subject to flight restrictions)
- Preliminary budget estimate
  - Non-recurring cost $\sim$ \$2.5M
  - Recurring cost $\sim$ \$0.5M/year

West Maui Animation: Aquifer Characterization Using AEM



Working Schedule

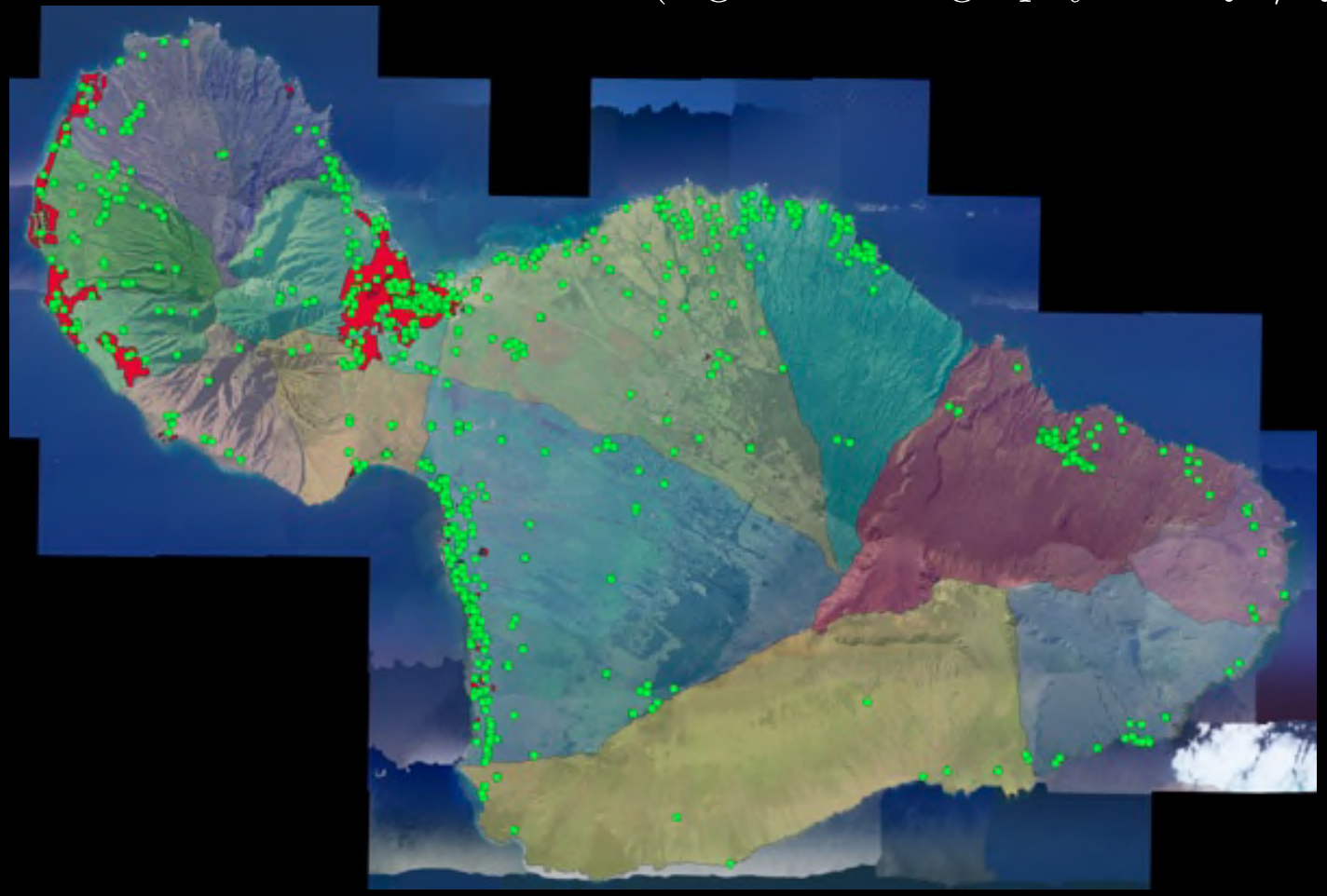
WBS	Component	Item	OPR	2026				2027				2028				2029			
				1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
A100	Data Acquisition	Flights / Maui	MDWS	X	X	X													
A200	Data Acquisition	Flights / Kauai	AHK	X	X	X													
A300	Data Acquisition	SkyTEM Deliverables	MDWS/AHK				X	X											
A400	Data Acquisition	QA/QC + Data Analysis	UH/Haroon	X	X	X	X	X	X	X	X	X	X						
B100	Modeling	Development	USGS	X	X	X	X	X	X	X	X	X	X	X	X				
B200	Modeling	Development	UH/Geng	X	X	X	X	X	X	X	X	X	X	X	X				
B300	Modeling	Verification and Validation	USGS/UH						X	X	X	X	X	X	X				
B400	Modeling	Operations & Maintnenance	UH/USGS									X	X	X	X	X	X	X	X
C100	Monitoring	Operations	CWRM									X	X	X	X	X	X	X	X
C200	Monitoring	Operations	MDWS									X	X	X	X	X	X	X	X
C300	Monitoring	Operations	AHK									X	X	X	X	X	X	X	X
C400	Monitoring	Operations	USGS									X	X	X	X	X	X	X	X

Expected Results

- Sustainable, adaptive pumping limits
- Best (and worst) places for future wells
- On-going monitoring, modeling, and decision-making
- Professional opportunities for future generations (Education, Training, Employment)

Potential Island-wide Scope

~$2M additional for rest of Maui (flight time + geophysical QA/QC)



Summary: Project Purpose

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Backup

What Are Benefits of Airborne Electromagnetic Surveys for Reliable 3D Modeling?

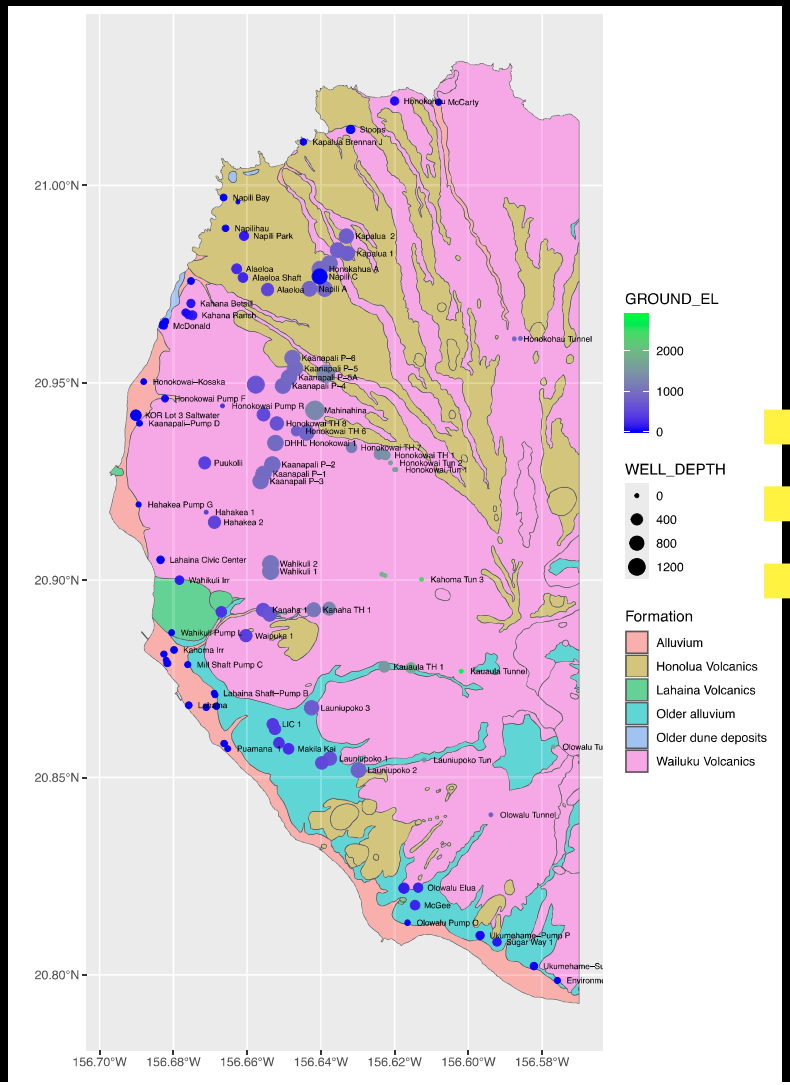
- Large area characterization of aquifers
  - Fine spatial resolution (40 m pixels, 100 m inter-line spacing, 5-10s m vertically, 500 m depth)
  - Point-in-time estimate of groundwater volume, distribution, connectivity
  - Proximity of existing wells to water (fresh, brackish, seawater)

- Model projections can be compared to wells for accuracy
  - on-going operations (water supply production)
  - change detection (seasonal, inter-annual, climate-scale)
  - regulatory decision-making (land-use, water allocation)

Westside Groundwater Well Salt-levels

- Red line = potable salt limit
- CWRM data shows
  - Wells not the same
  - Some are over-pumped
  - Others trending high
- *Increasingly frequent exceedances*

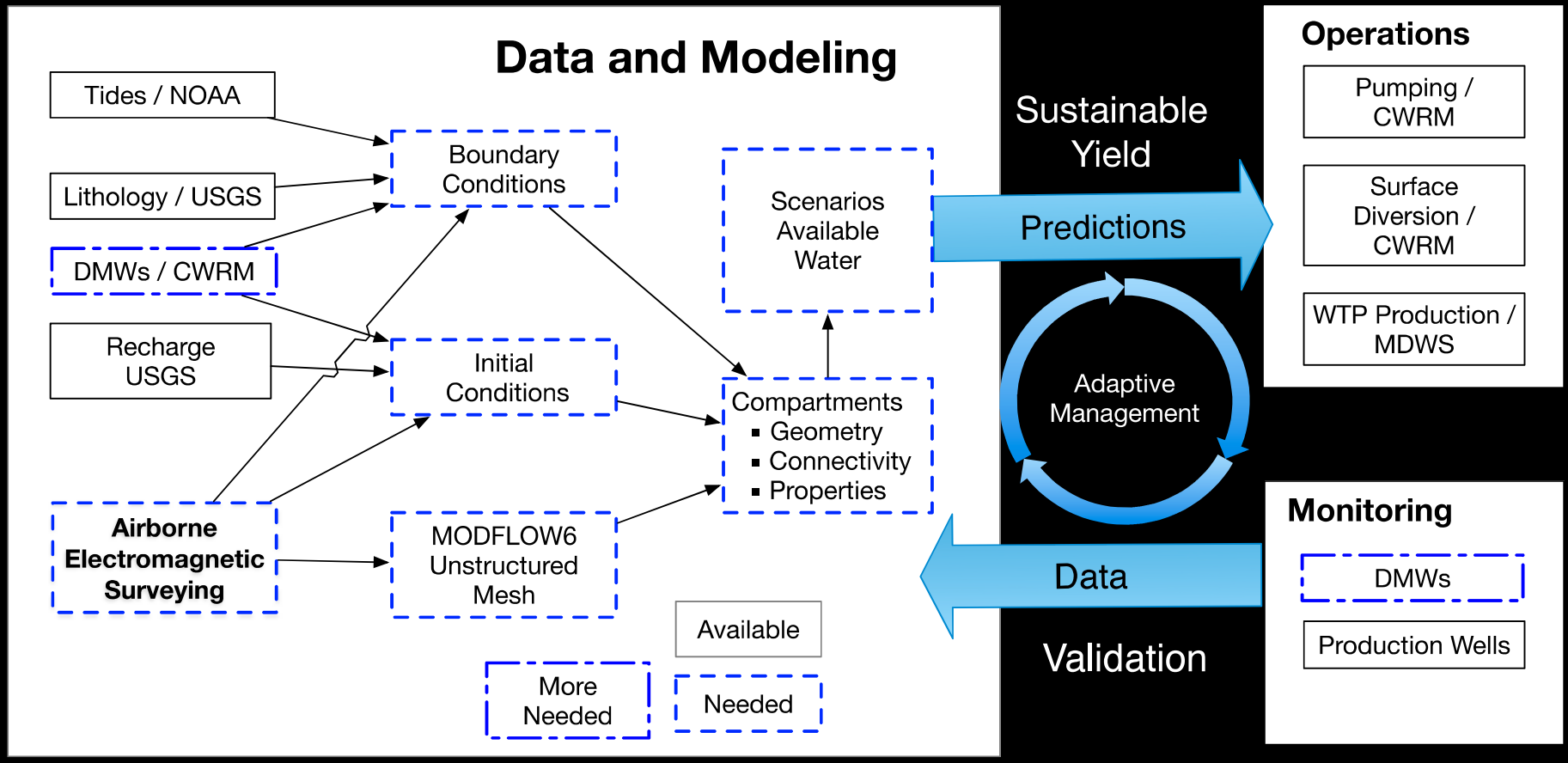
Not Homogeneous (Westside)



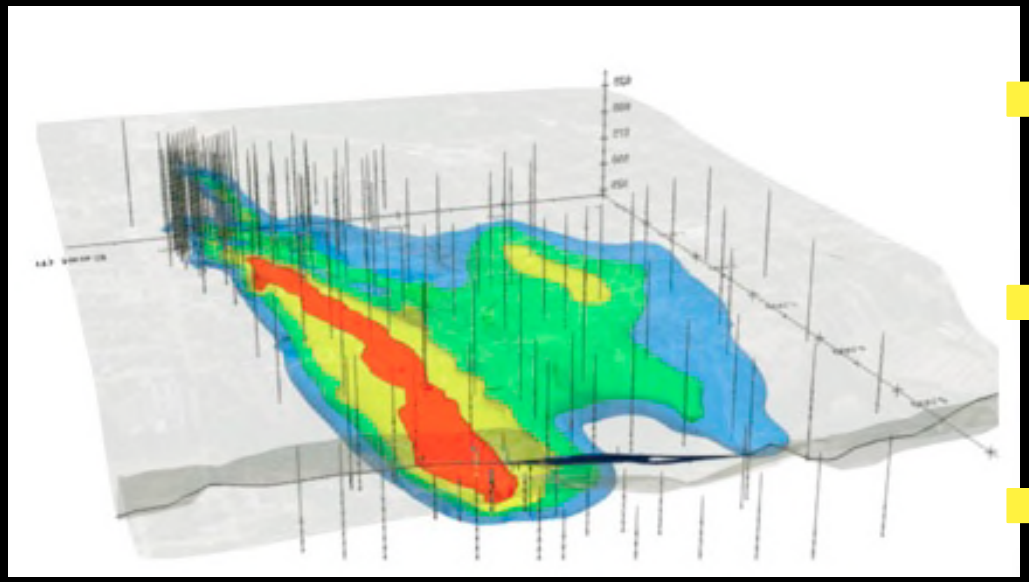
- Same information, same sources
- Not geologically homogeneous
- Not geographically homogeneous
  - land-use
  - water-use

Operate pumping at sustainable levels

Requires Better Understanding of Aquifers



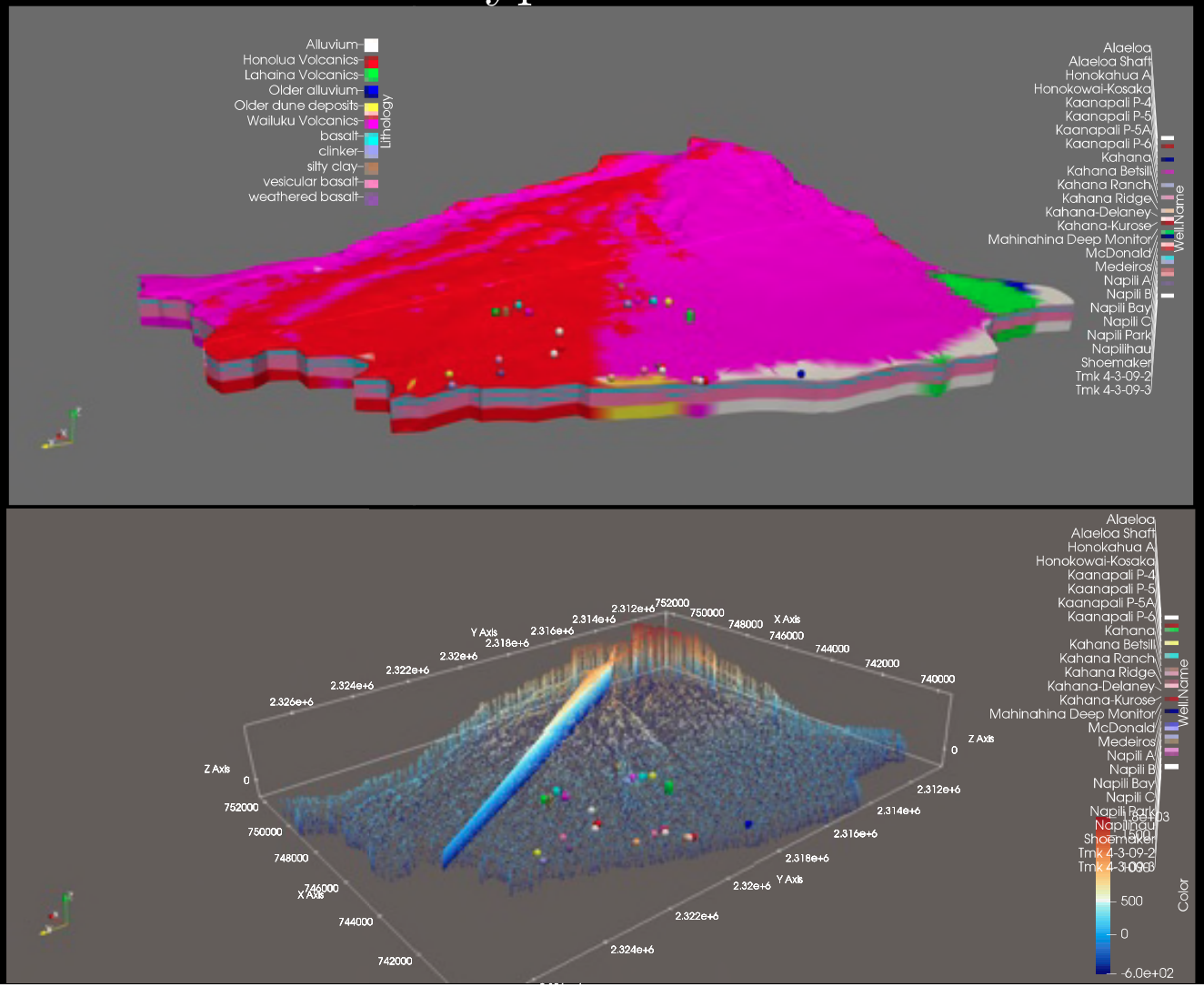
What Good Is A 3D Model of Groundwater?



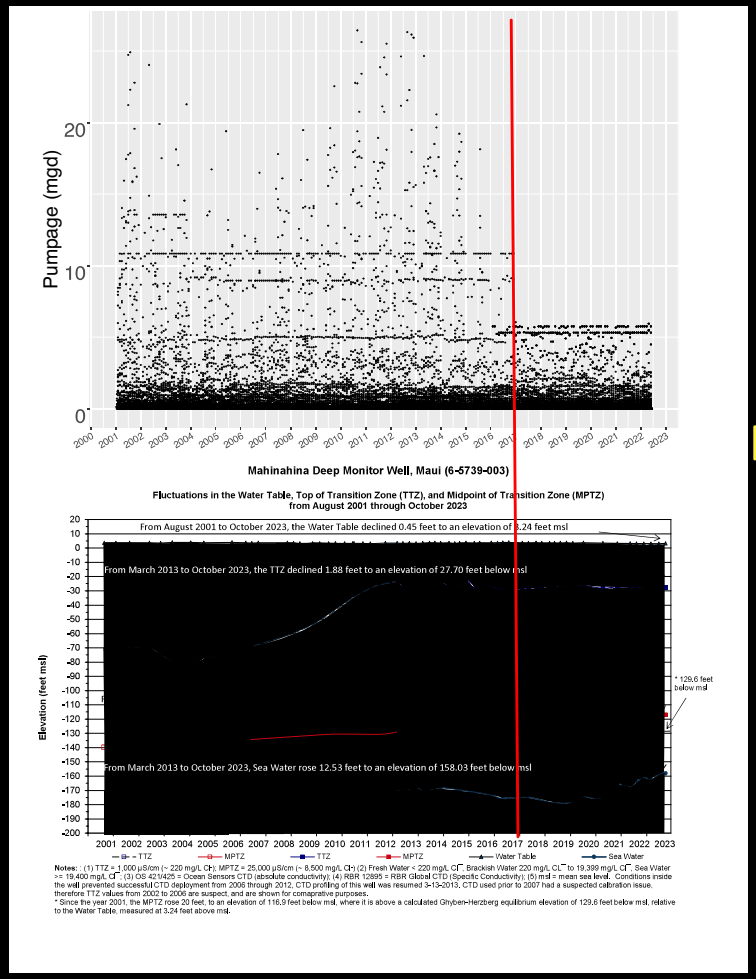
- Quantify volumes and distribution of groundwater horizontally and vertically
- Provide testable estimates of recharge; therefore sustainable yield
- Inform site selection for Deep Monitor Wells

https://sketchfab.com/3d-models/groundwater-plume-example-13-r-priority-e2d54ec8511c49969cfd0c1a3ea8e7e2

Prototype 3D Model Honokowai Area + Wells

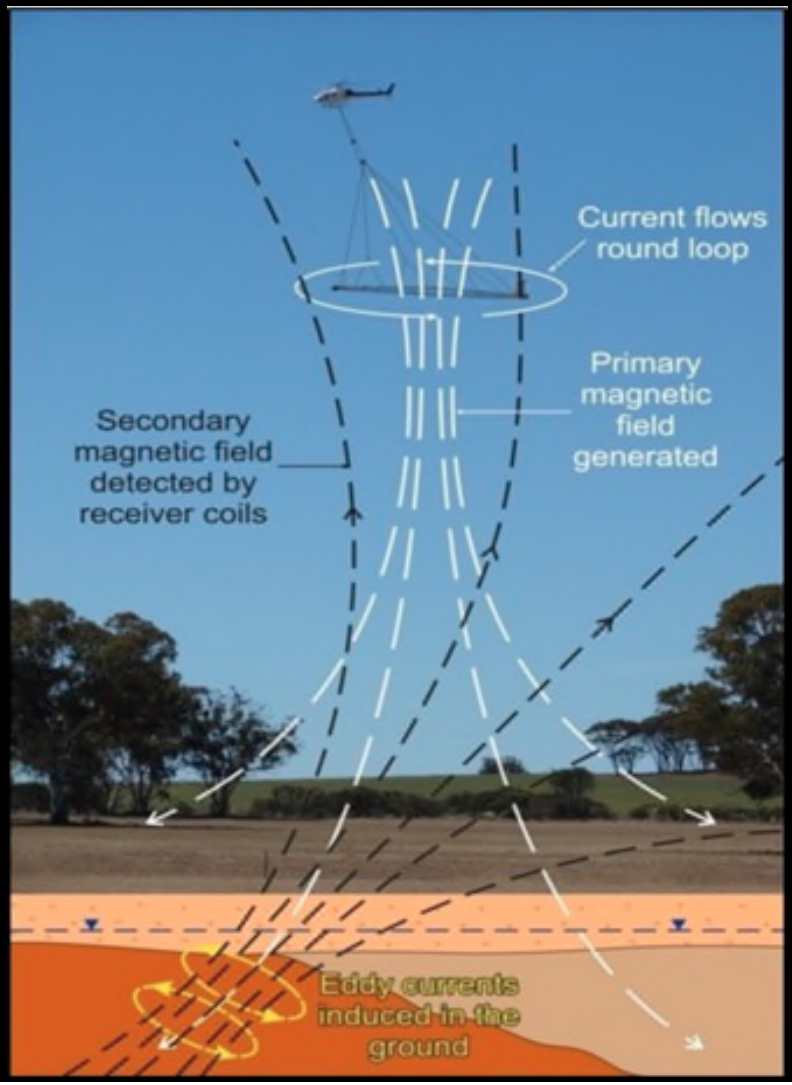


What Do We Know About Water Quantity and Quality?



- We know aquifer with *only* Deep Monitor Well shows disturbing trends and possibly unexpected behaviors

AEM: What Is Airborne Electromagnetic Imaging?



- Flown by helicopter
  - Non-invasive (∼25 Hz)
  - FAA-approved operations
- Produces 3D data for mapping and modeling
- Non-recurring, one-time cost

ADEPT Committee

From: Helly, John <hellyj@ucsd.edu>
Sent: Sunday, November 16, 2025 3:20 PM
To: Ellen B. McKinley
Cc: Helly, John; Kate Griffiths; Axel I. Beers; Shelly K. Espeleta; Criselda R. Paranada; Kasie M. Takayama; Megan K. Moniz; ADEPT Committee
Subject: UPDATE: ADEPT Committee presentation on December 4, 2025 - Revised Briefing
Attachments: LongTermMonitoring-ADEPT.pdf

Aloha.

Please replace the prior PDF with this one. I have embedded the animation in the PDF and made some other edits.

J.

John Helly / San Diego Supercomputer Center / Scripps Institution of Oceanography
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