

EPSCOR Merging the Data  
Needs of the State  
Agencies with those of the  
Scientific Community

A Proposal for a  
Collaborative Resource  
(Re-)Analysis

Don Thomas  
&  
The EPSCOR Team

(To State the Obvious)

- The quality of Hawai'i's ground-water resources is among the best in the world
- We all recognize these resources as critical assets for our communities
- For most communities, the available resource is adequate to meet current needs.... BUT

The resource is under varying degrees and urgencies of threat from multiple stressors:

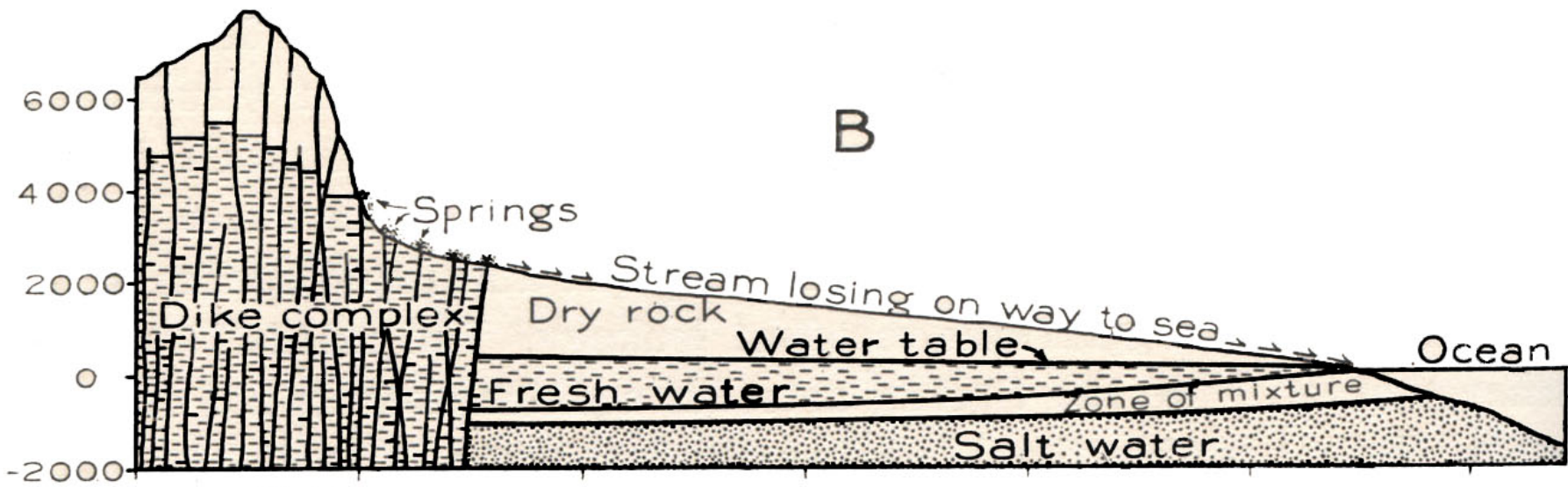
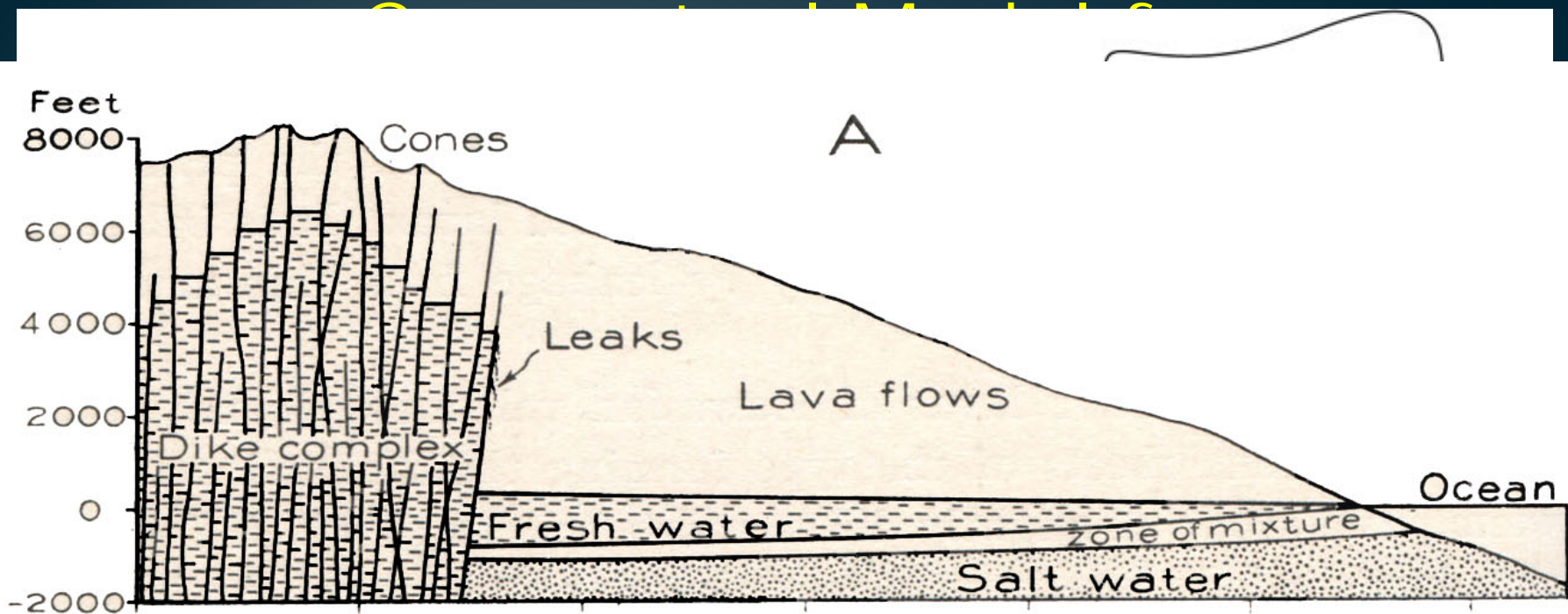
- Over production in some locations
- Contamination
  - Red Hill (headlines)
  - Pesticide use - (headlines)
  - Wastewater spills - (headlines)
  - OSDS - (no headlines????)
- Climate Change
  - Manmade - or Not - headlines (see Anasazi & overproduction...)

- These threats are managed by
  - CWRM – overproduction, protection of the resource
  - DOH – Point and Non-Point source contamination
  - DWS - quality delivered to the user

All over committed and under-resourced to fully manage the complete spectrum of threats that the resource is subject to...

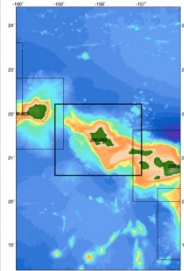
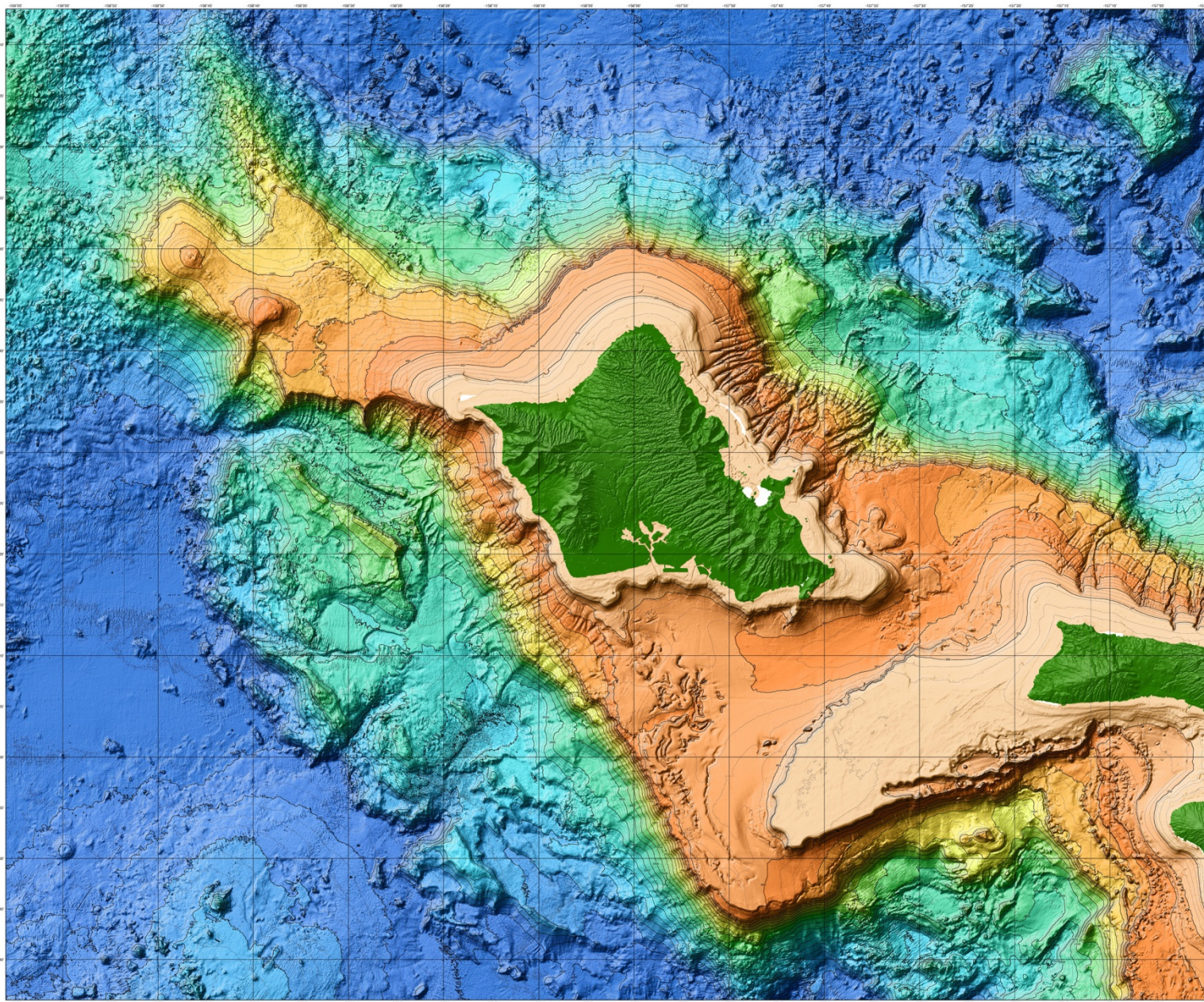
There is a further threat that compounds all the others:

We don't yet fully understand how water flows, or how it is stored, inside Hawai'i's volcanoes



← Generalized Direction of Ground Water Movement

# Hydrologic Units



LOCATION MAP  
Location of the chart outlined in black

## Main Hawaiian Islands Chart 200-003

Multibeam Bathymetry  
Data Synthesis

School of Ocean & Earth  
Science & Technology

University of Hawaii at Manoa

Charted By  
Hawaii Mapping Research Group

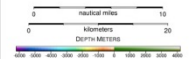


SCHOOL OF OCEAN AND EARTH  
SCIENCE AND TECHNOLOGY



SCALE 1:200,000

MERCATOR PROJECTION

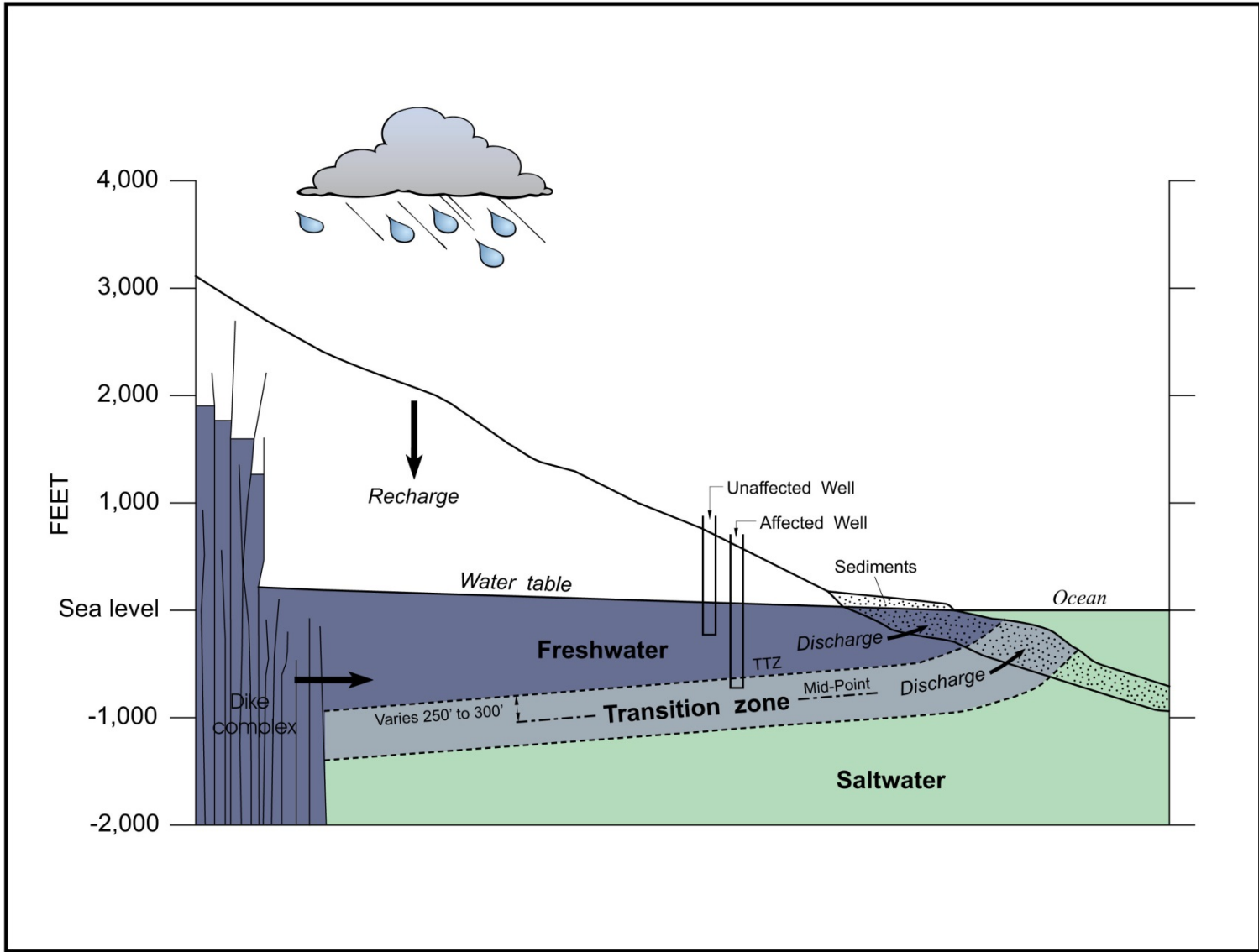


Horizontal Datum: WGS 84  
Vertical Datum: WGS 84  
Projection: Mercator  
Coordinate System: UTM

- NOTES
1. Bathymetry is derived from multibeam data synthesis.
  2. Bathymetry is based on the 200 m scale.
  3. Bathymetry is based on the 200 m scale.
  4. Bathymetry is based on the 200 m scale.
  5. Bathymetry is based on the 200 m scale.
  6. Bathymetry is based on the 200 m scale.
  7. Bathymetry is based on the 200 m scale.
  8. Bathymetry is based on the 200 m scale.
  9. Bathymetry is based on the 200 m scale.
  10. Bathymetry is based on the 200 m scale.

**Not for navigation**  
For information contact  
Dr. Brian Taylor, SOEST

Author	Editor	Project Manager	Project	Date
Dr. Brian Taylor	Dr. Brian Taylor	Dr. Brian Taylor	Chart 200-003	27 Jan 2011

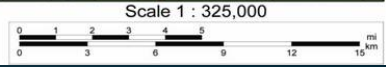
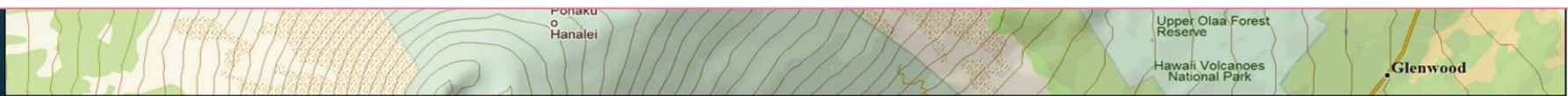
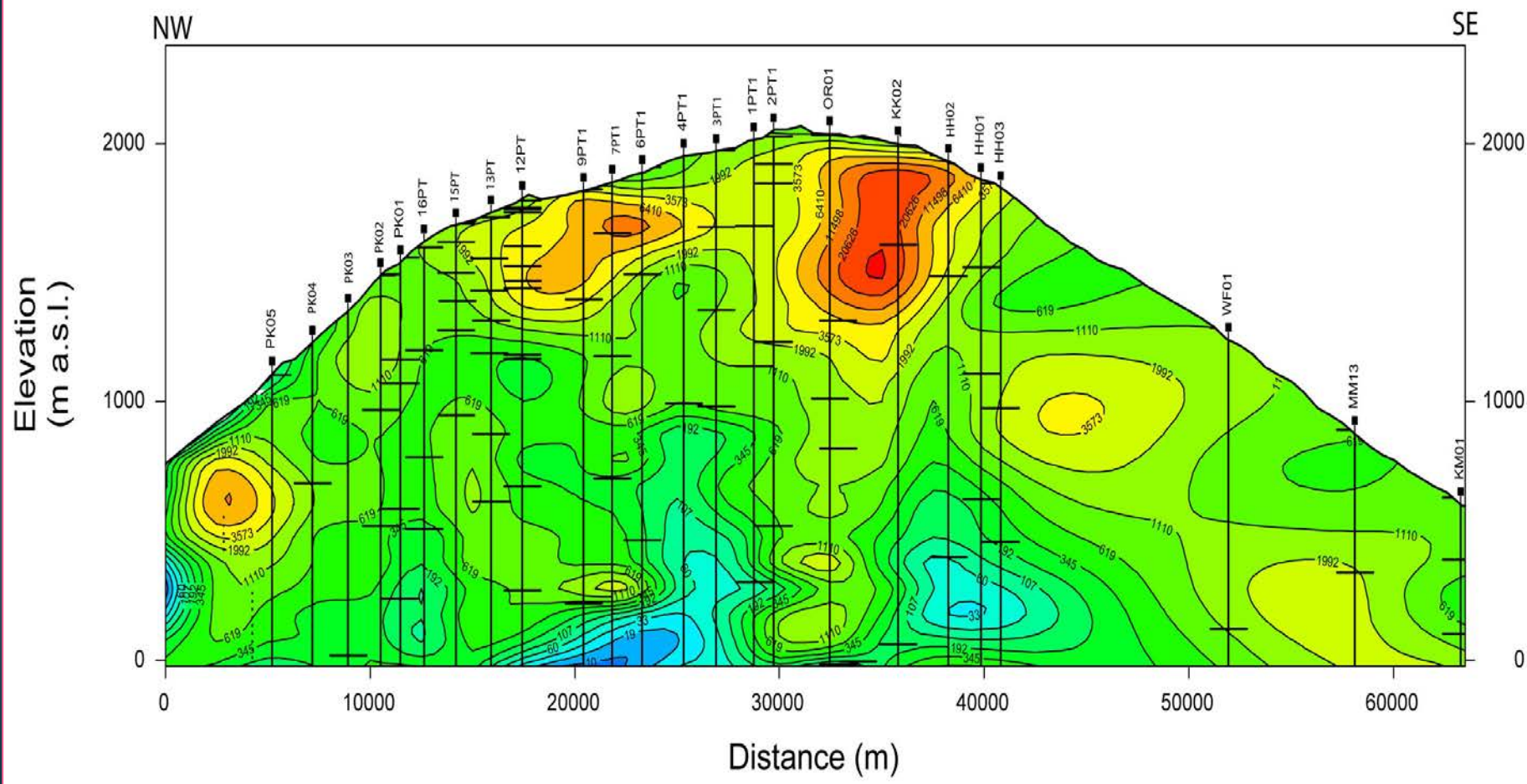


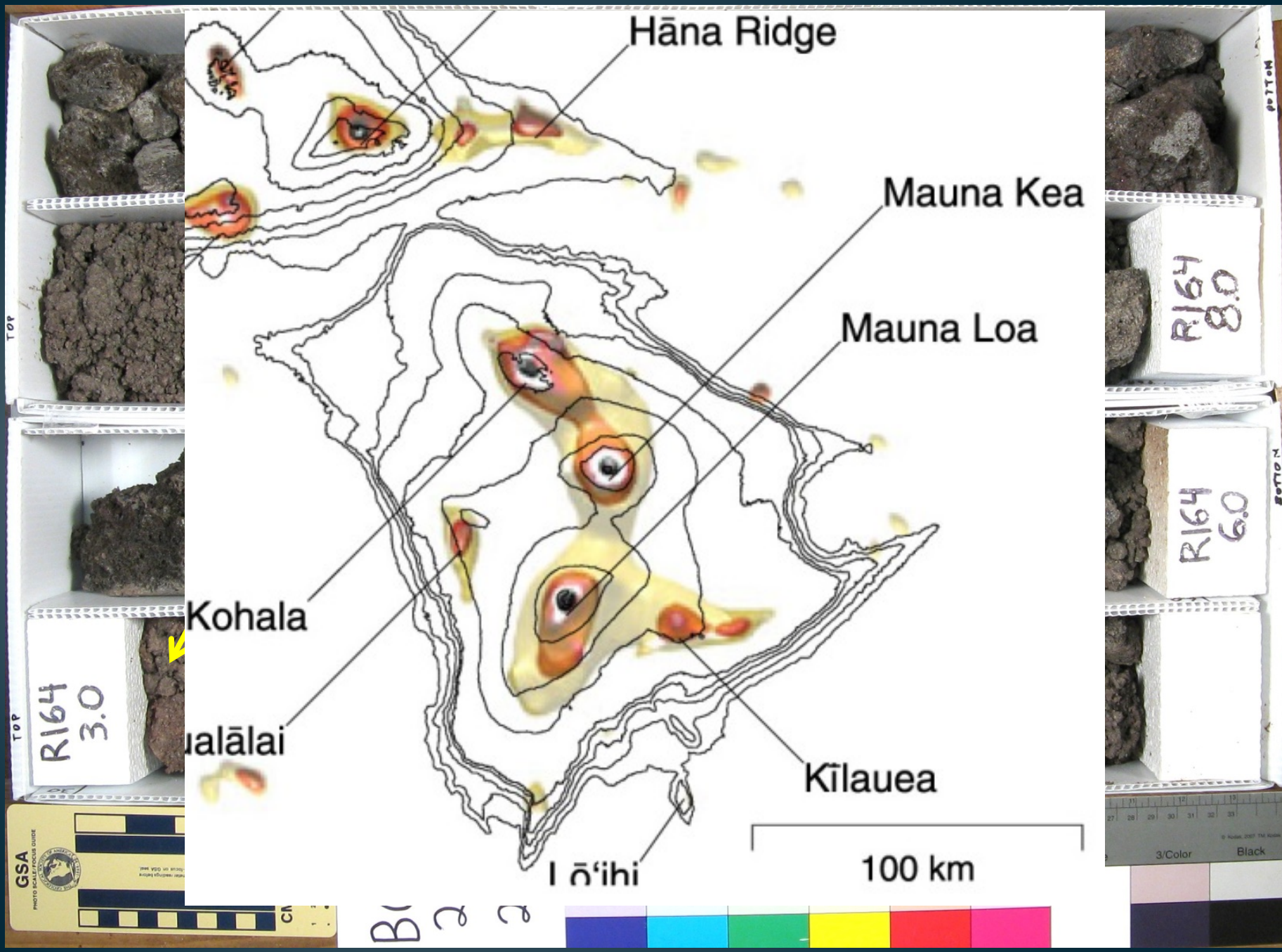




Later drilling, in the Keauhou aquifer, on Hualalai, found a system similar to that found in Hilo

- The Kamakana Well encountered a thin basal lens, underlain by salt water saturated rock down to ~1000' below sea level and then a second freshwater saturated interval below that
- We believe that the Keopu Deep Monitor Well farther south in Kona may have encountered a similar aquifer





Hāna Ridge

Mauna Kea

Mauna Loa

Kohala

Kīlauea

Iō'ihī

100 km

TOP

BOTTOM

R164  
8.0

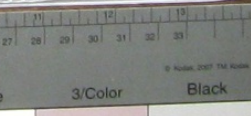
R164  
6.0

BOTTOM

TOP

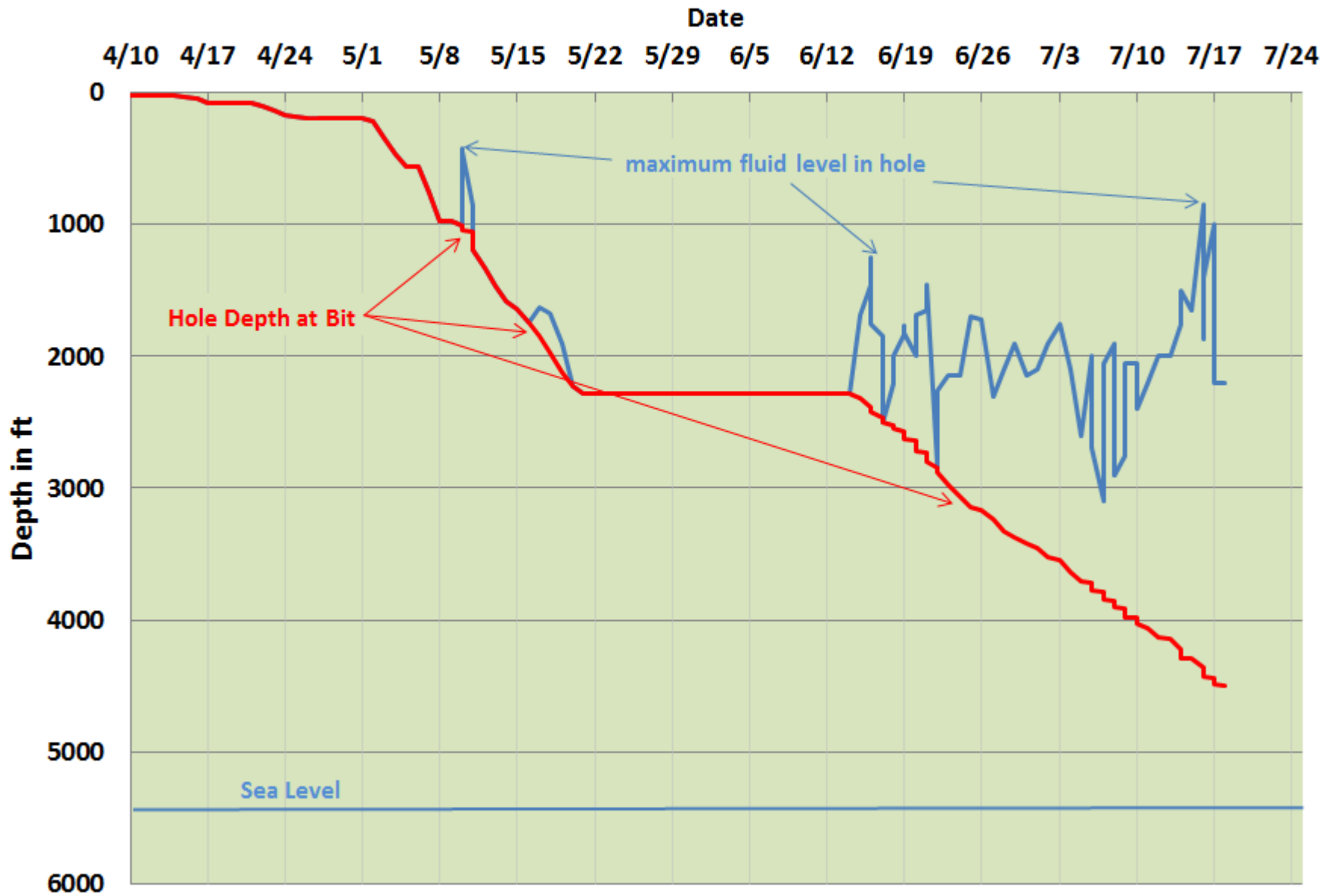
R164  
3.0

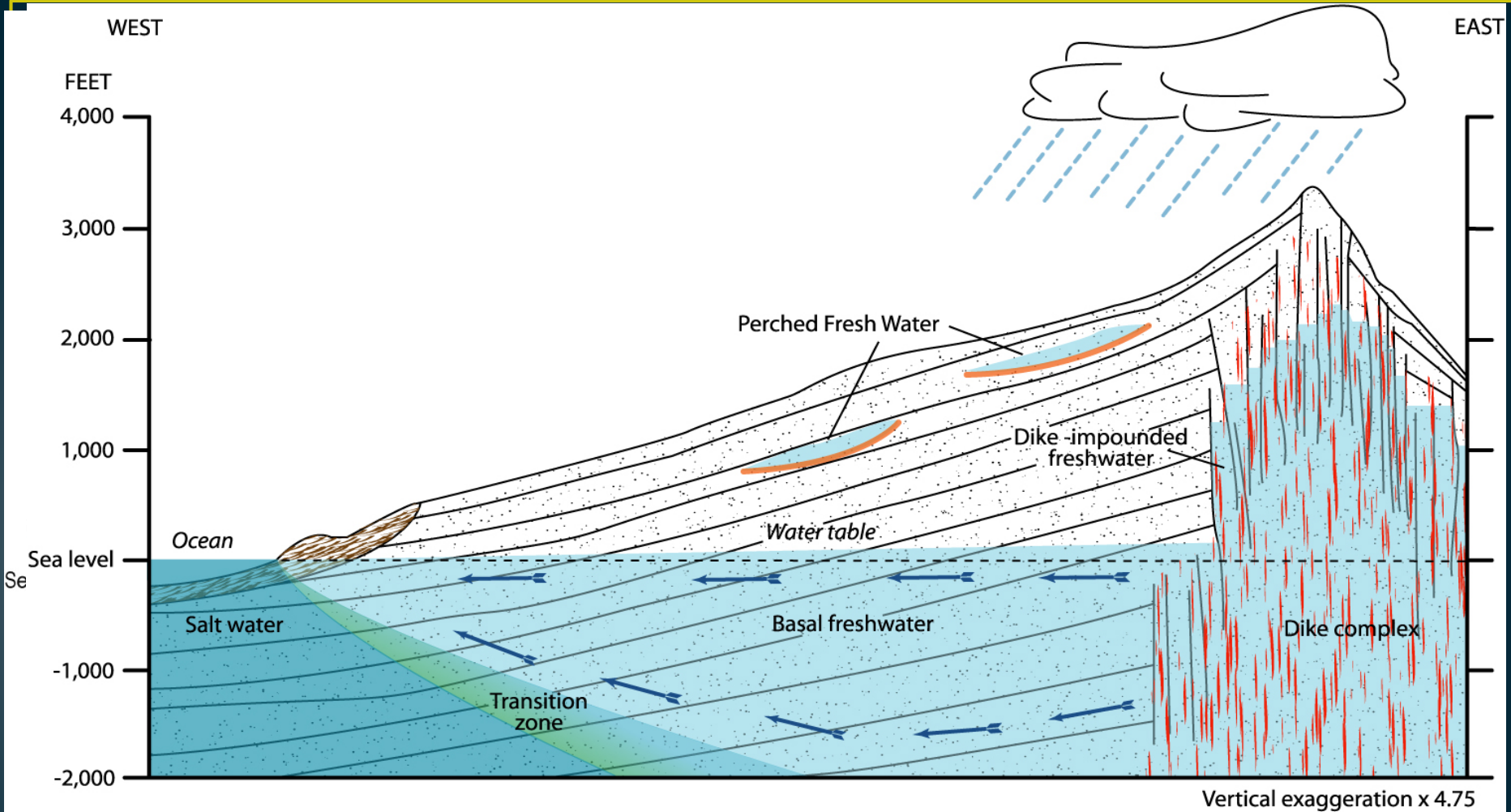
GSA



B  
2  
2

# Depth versus Time



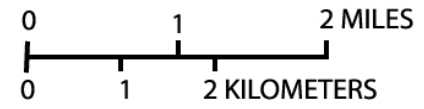


**EXPLANATION**

 Sedimentary Deposits (Caprock)  
Consists of saprolite and overlying coastal-plain sediments

 Basalt

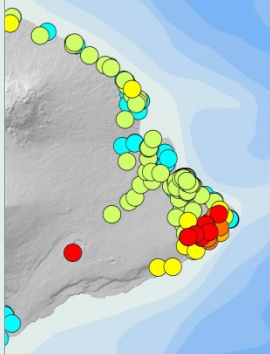
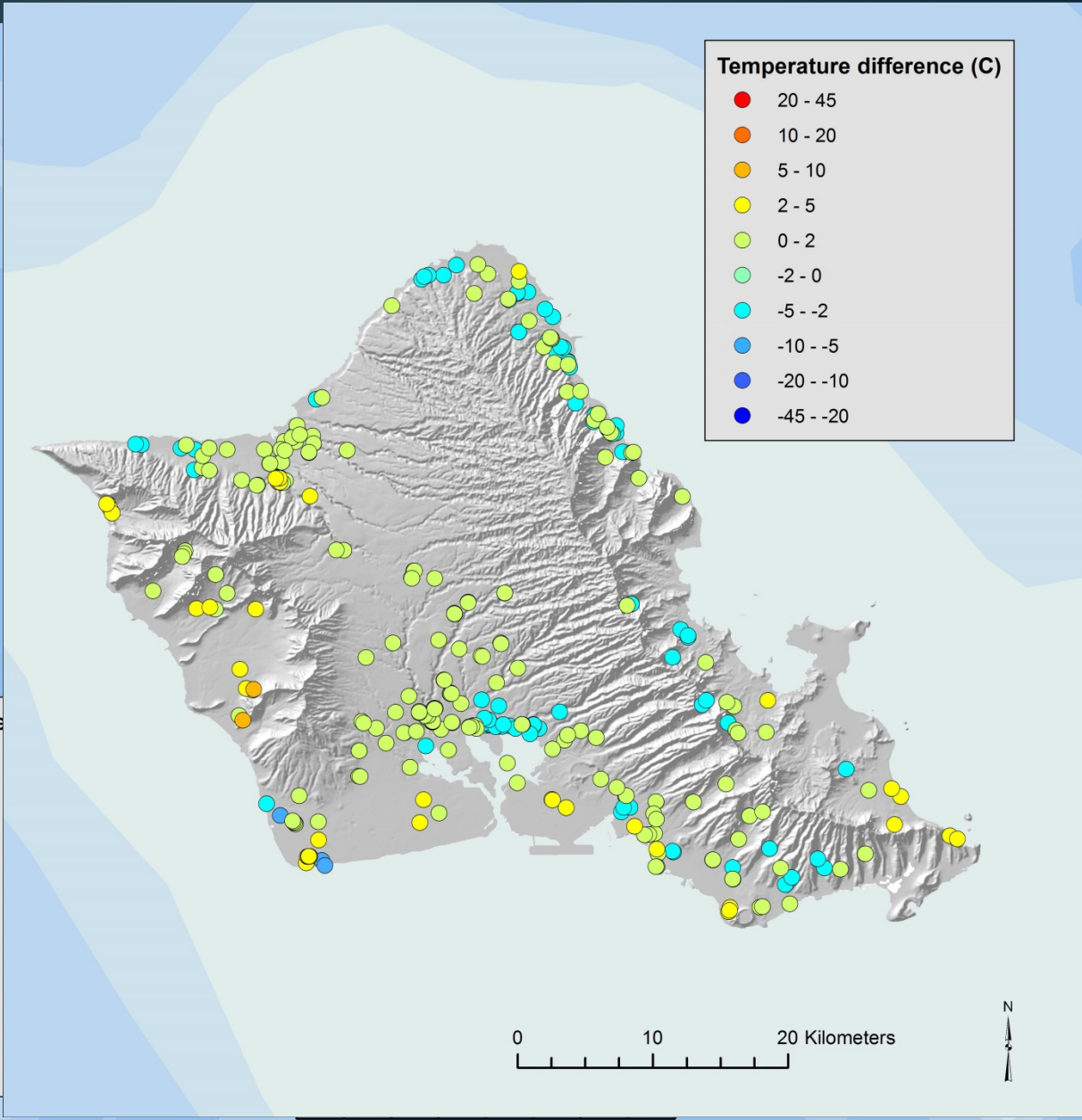
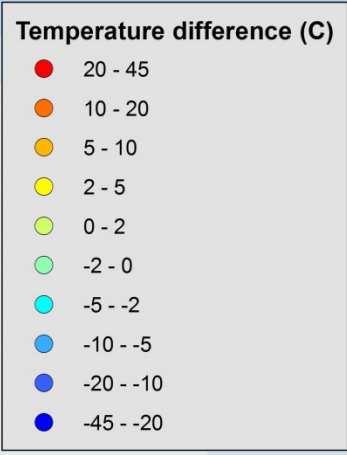
 Generalized Direction of Ground Water Movement



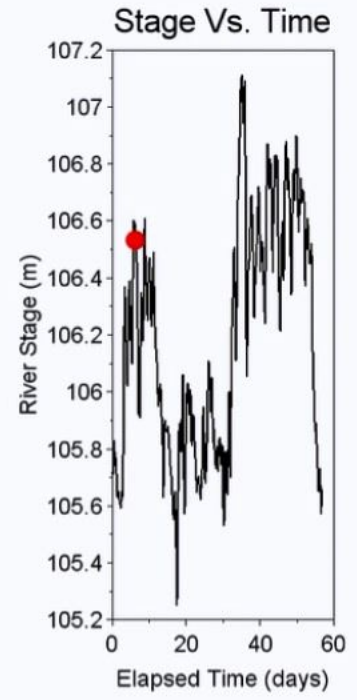
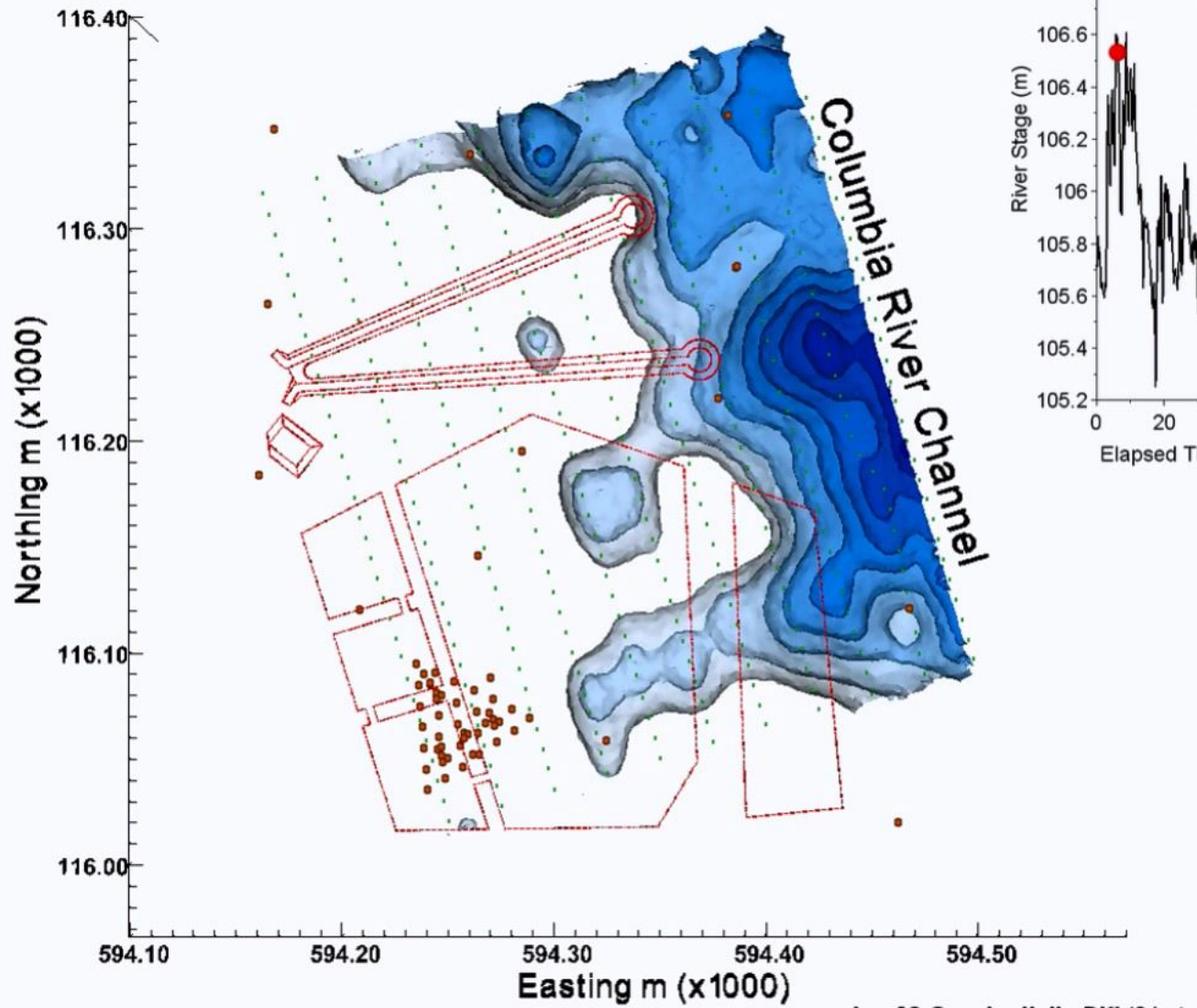
# Proposal

- A collaborative effort among the UH and CWRM, DOH, and county DWS to:
- Better define the distribution and extent of groundwater aquifers (in 3-Dimensions) on each of the islands
- Develop better models for groundwater flow that can more reliably project the rates and direction of flow of the groundwater (and potential contaminants)

# Temperature







# How Do We Propose To Do This

- Develop innovative downhole monitoring instruments that can provide better, more timely, and more robust water level and chemistry data for selected monitoring and production wells
- Develop better estimates of coastal discharge of groundwater that can help us constrain the overall disposition of the recharge into the islands
- Use these legacy and new data sets to test and refine existing conceptual and numerical models for groundwater storage and flow inside the islands

# How Do We Propose To Do Thi\$\$\$

- We currently have a proposal submitted to National Science Foundation that would allow us to cover the costs of conducting a targeted effort to accomplish our goals in the Keauhou/Kiholo and Pearl Harbor/Honolulu aquifers
- Provide funding for interns, field work, development of the visualization software, development of the monitoring tools, model development etc.
- Now working on development of a proposal to DOD for site specific work in the Pearl Harbor area

# Cooperation from our Collaborators

- Provide access to the legacy data and clear guidance on (C.I.) access restrictions
- Provide guidance on the types of monitoring that would be most beneficial to operating needs and access to a subset of wells that can be monitored
- Provide guidance on what mapping or sorting capabilities would be most useful to potential users (e.g. highest chlorides; greatest change in chloride, hits on criteria pollutants, greatest deviation from prior set point, etc.
- Provide us with feedback on areas of interest for conducting active or passive geophysical surveys and tests

# What is the Desired End State

- A better understanding of the groundwater flow and storage inside the islands
- A suite of useful, user-friendly tools for agency staff to monitor the condition, and highlight significant changes, in groundwater quality and availability
- A set of tools that can allow the agencies to better convey the condition of our groundwater resources (and the threats thereto) to the public and decision-makers
- More robust modeling capabilities that can reliably reflect storage and transport processes and can support agency needs (e.g. SWAP, contaminant plume definition)

# What is the Desired End State

- Guidance on how to best access the needed water resources – sustainably – while minimizing costs and adverse impacts on natural hydrologic processes

Old Joke – With A (sharp) Point

I've got good news and bad news:

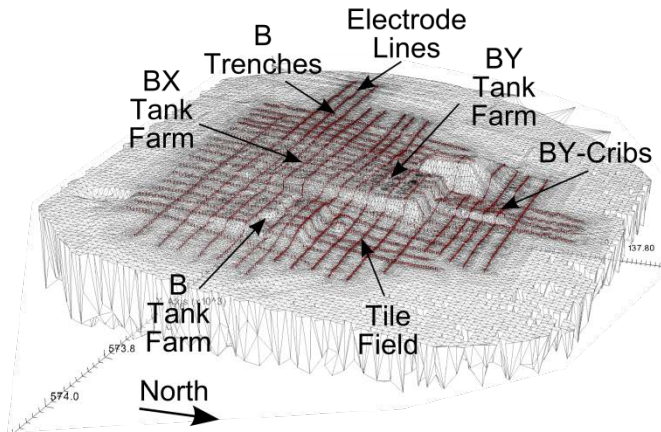
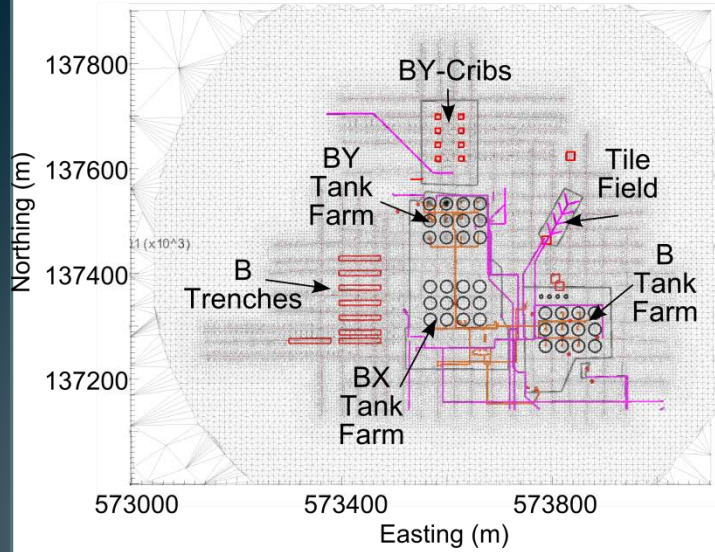
The good news: In 20 years we'll all be drinking recycled wastewater

The bad news: There's not going to be enough to go around

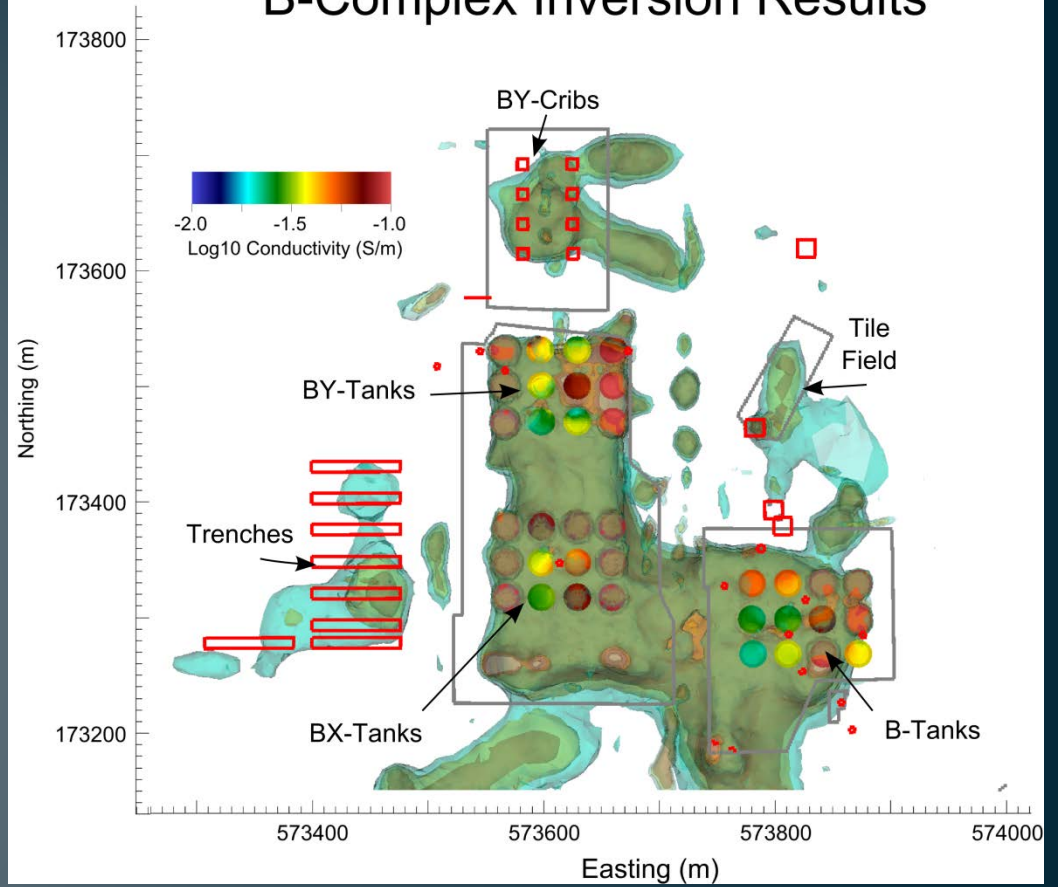


Pau

## B-Complex Computational Mesh

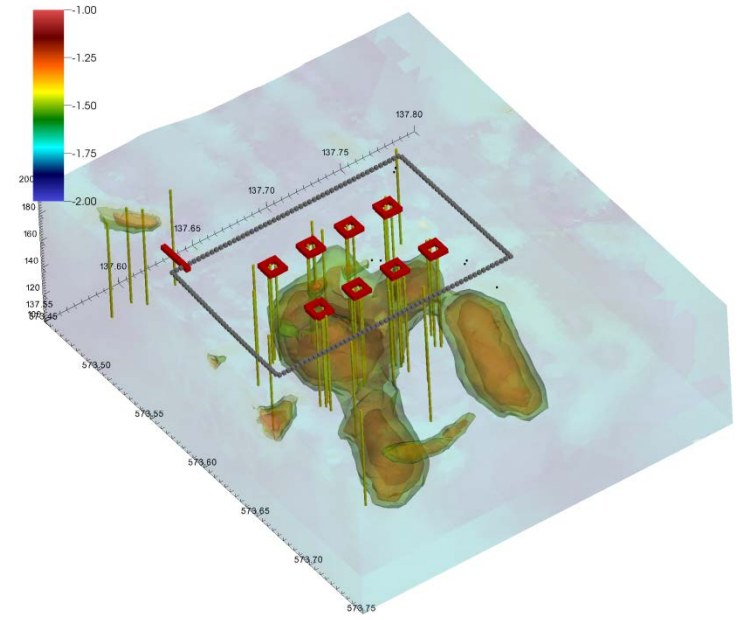
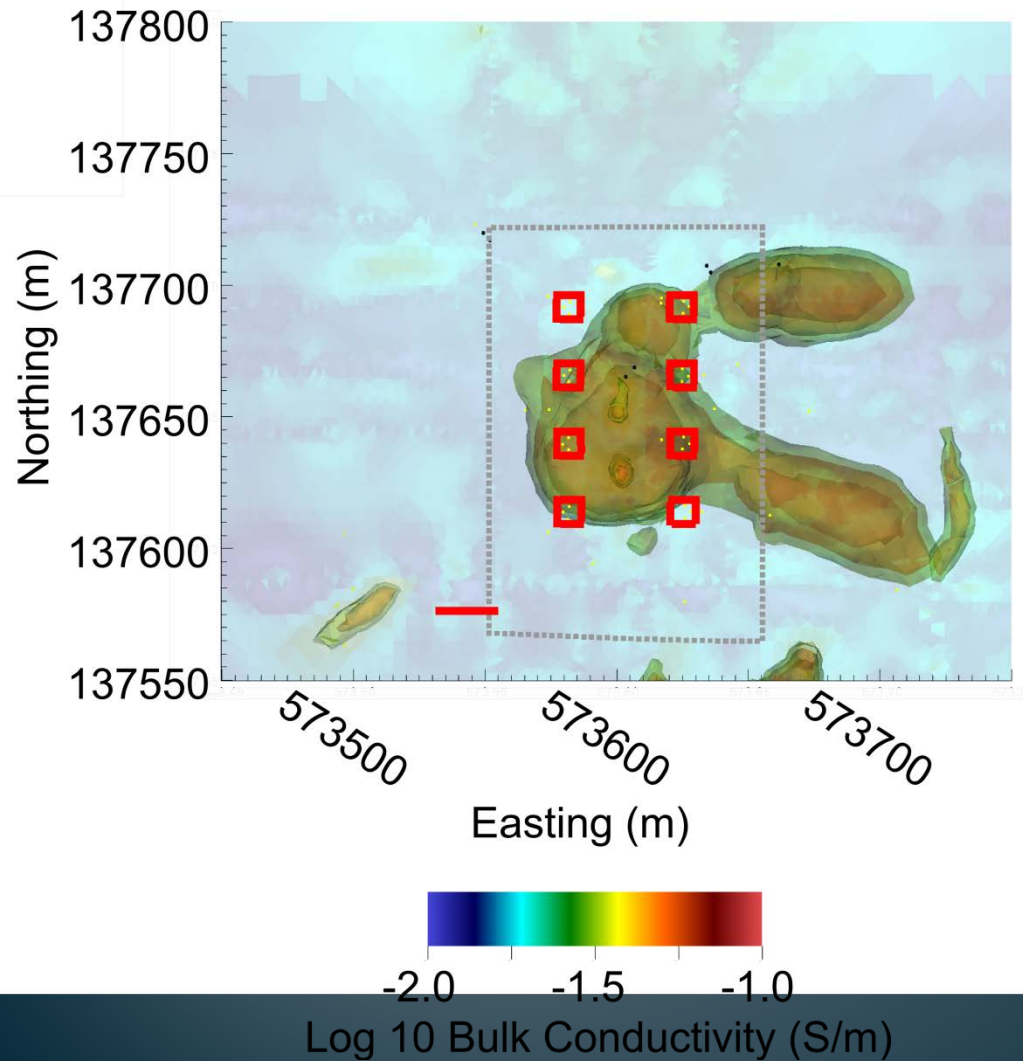


## B-Complex Inversion Results



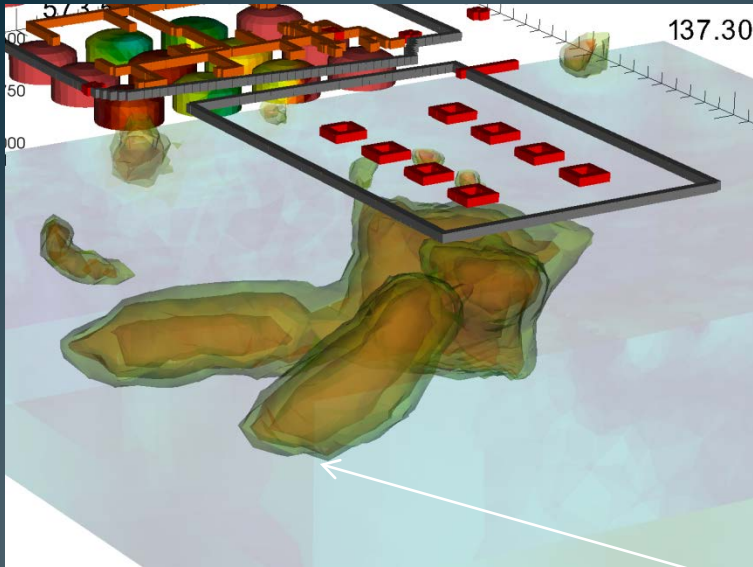


# By-Cribs Results

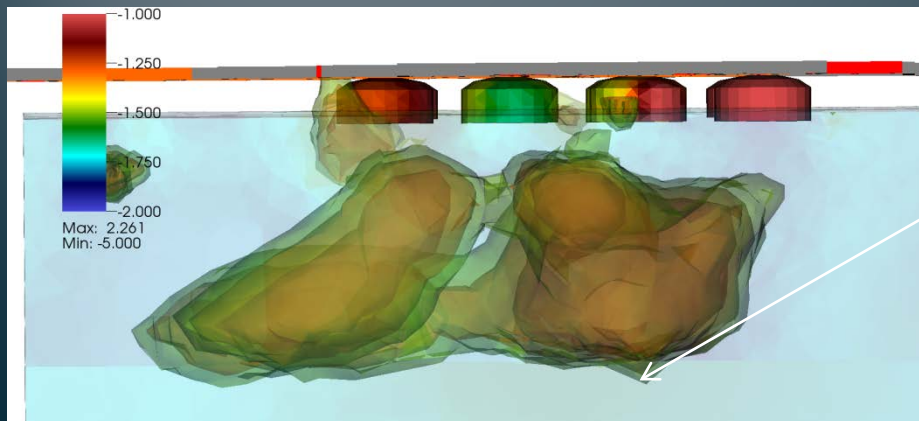


# BY-Cribs

Oblique View

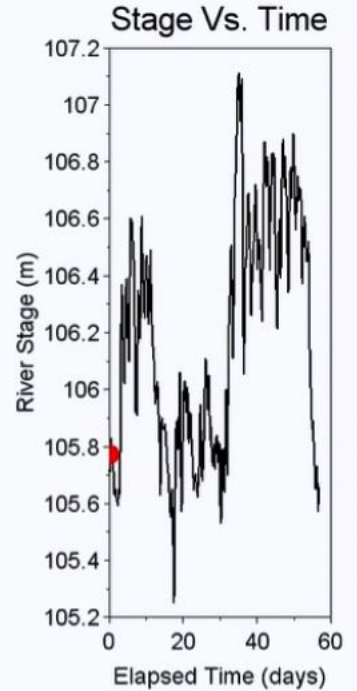
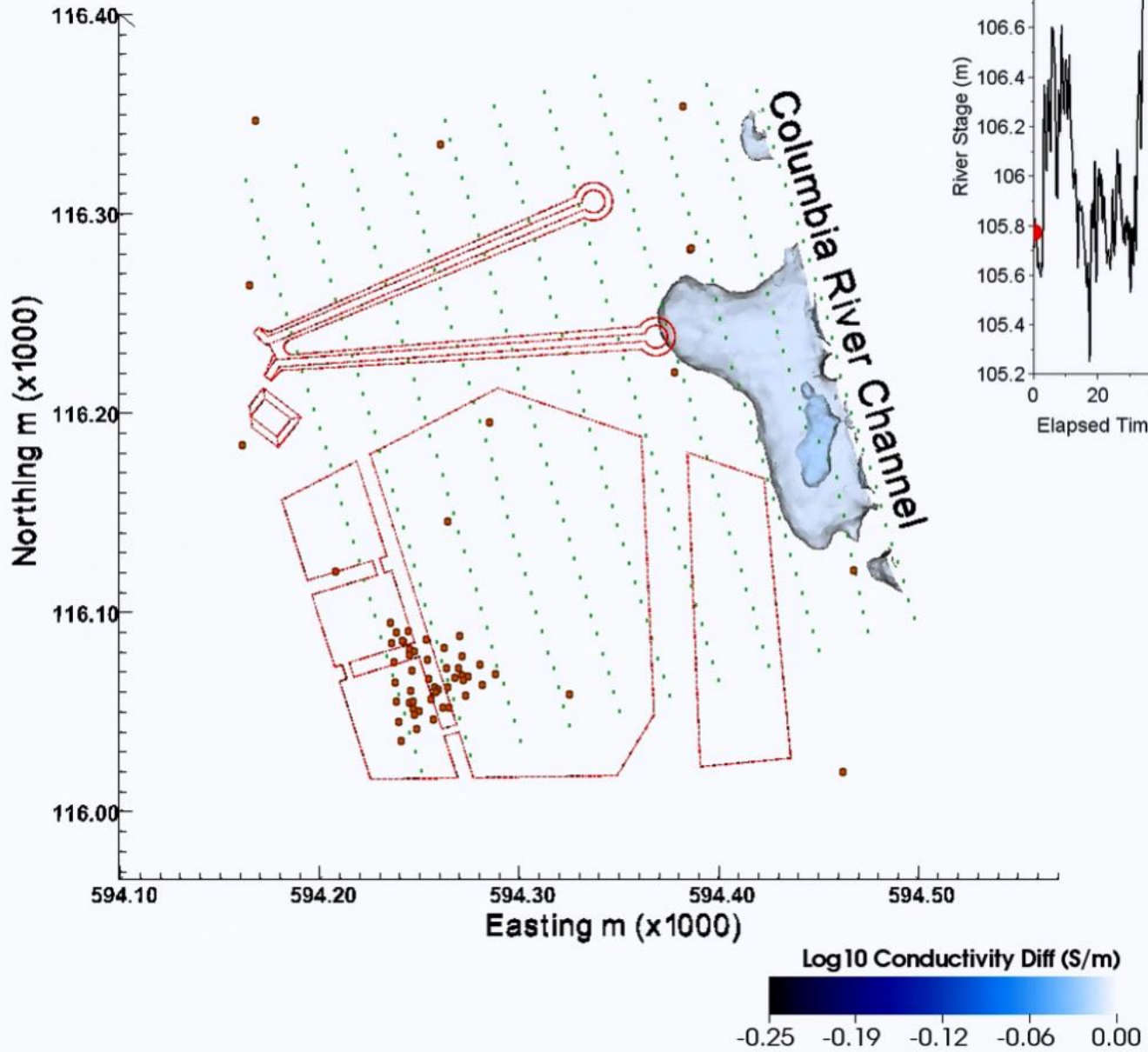


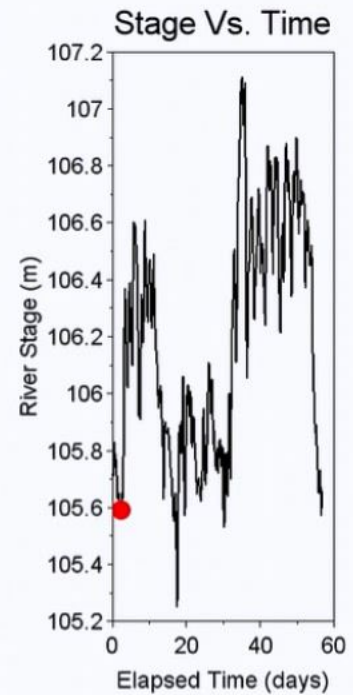
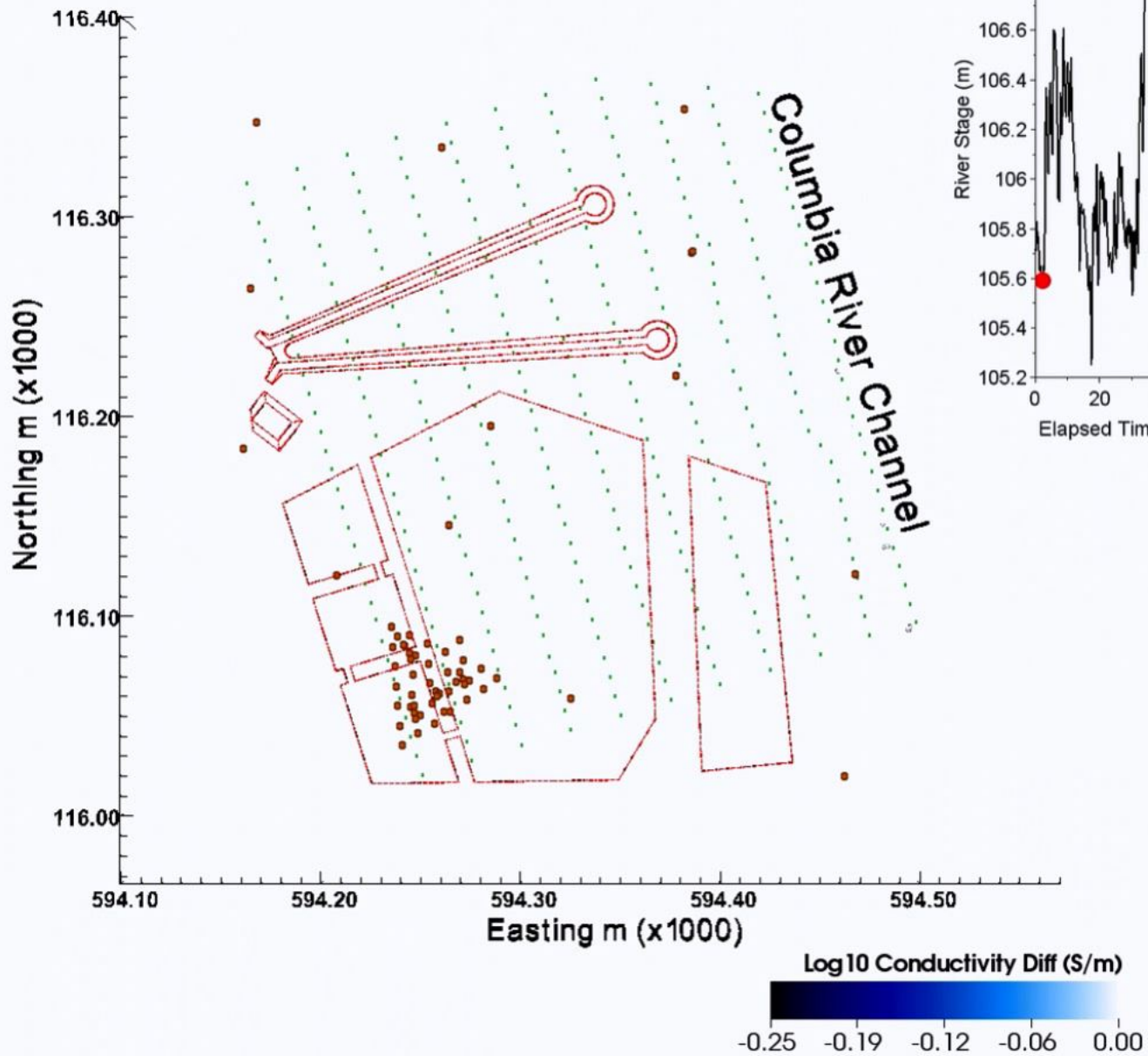
Plan View

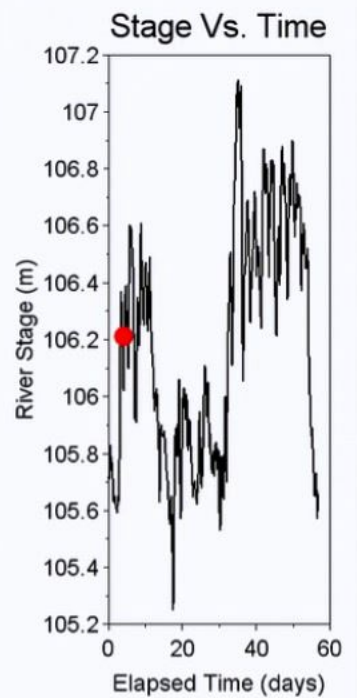
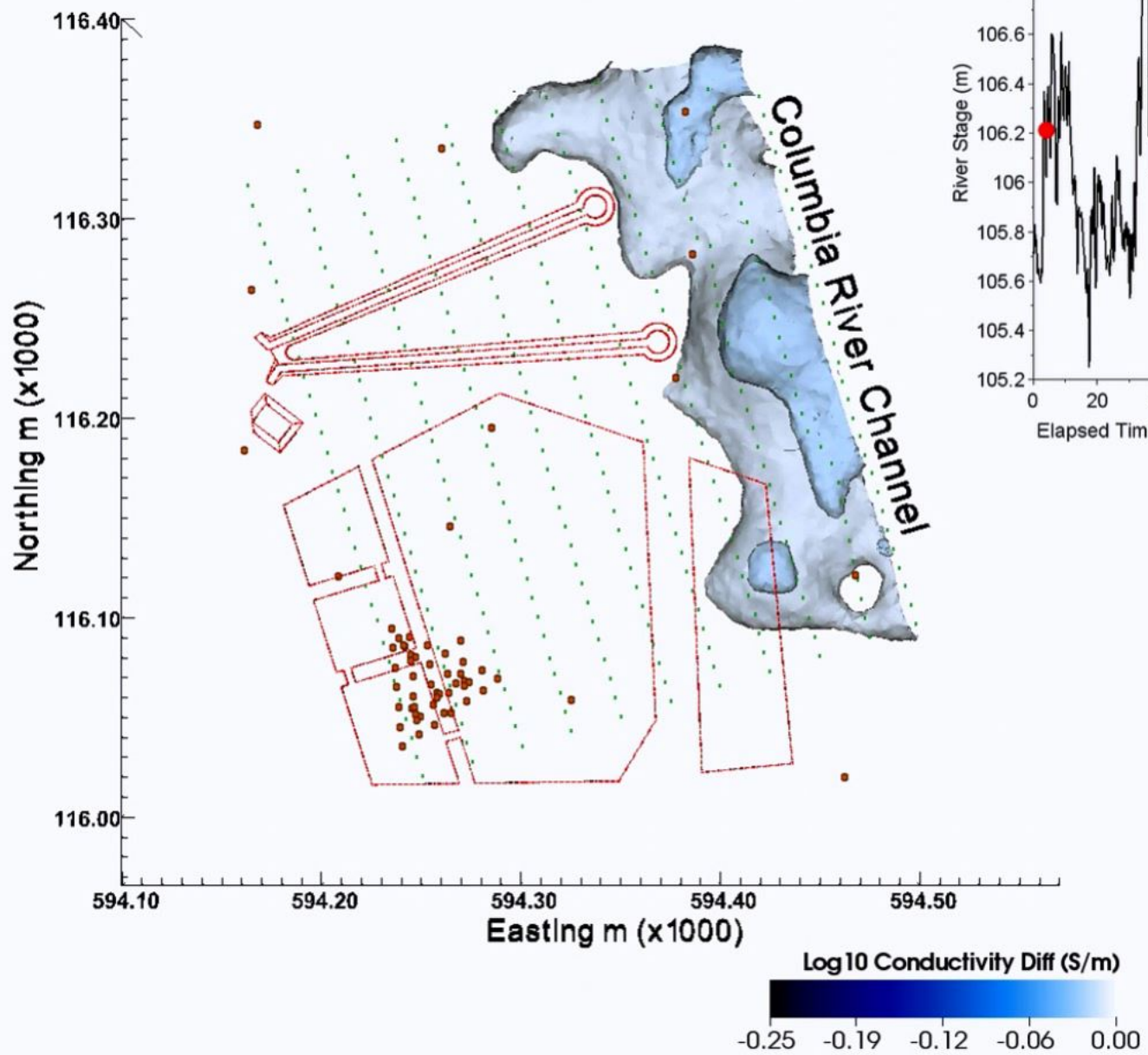


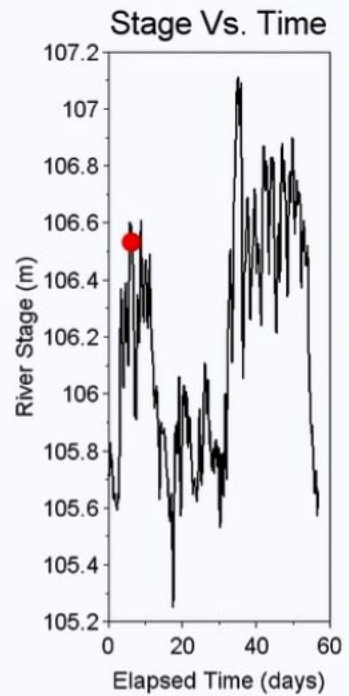
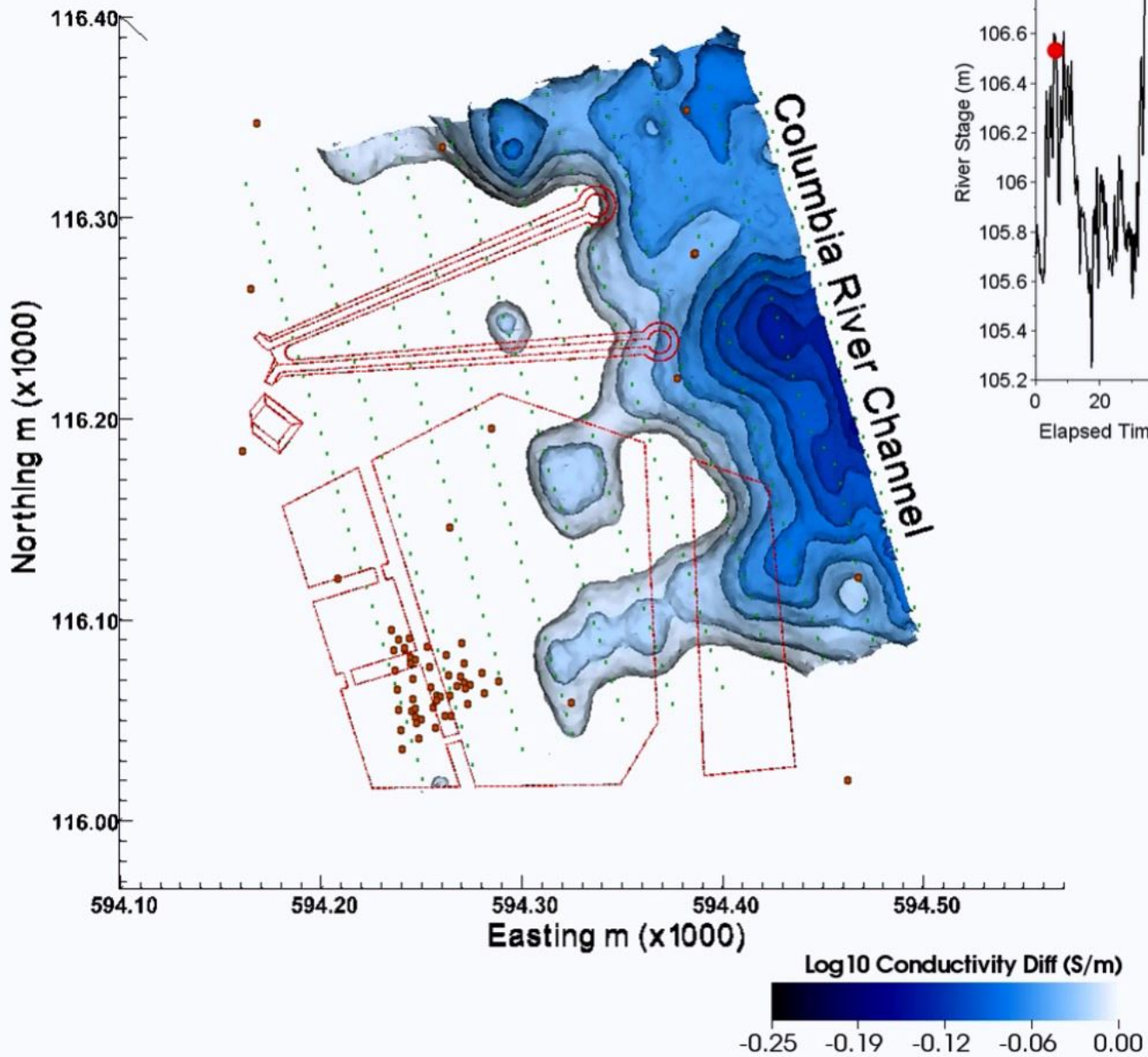
water table

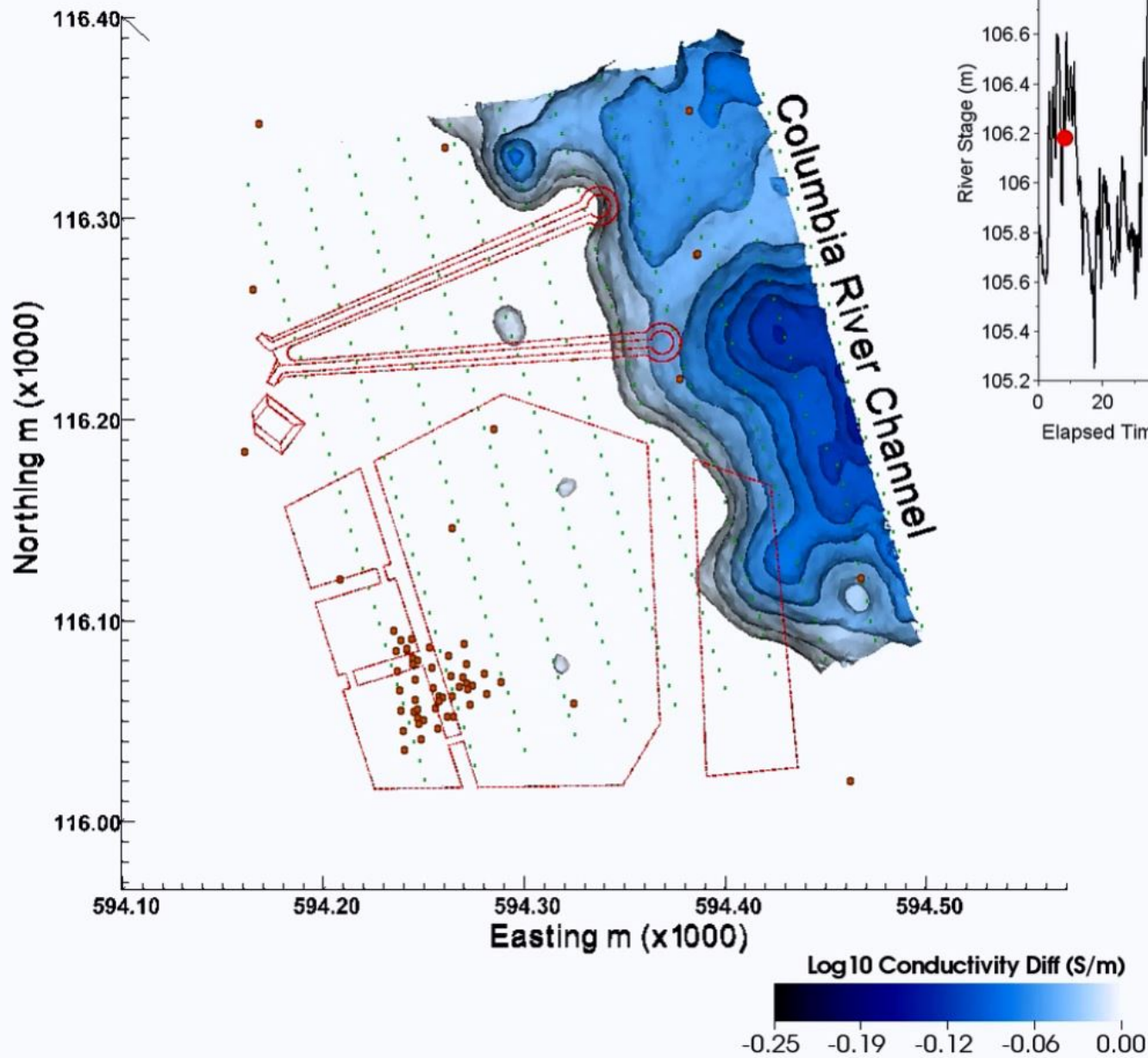
One primary plume with two lobes that appear to settle (on cold creek?) at depth and extend eastward.



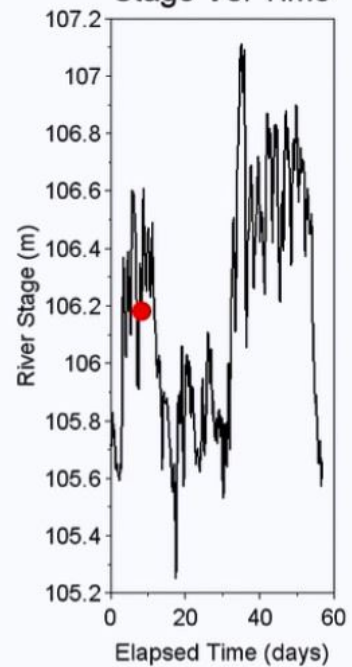


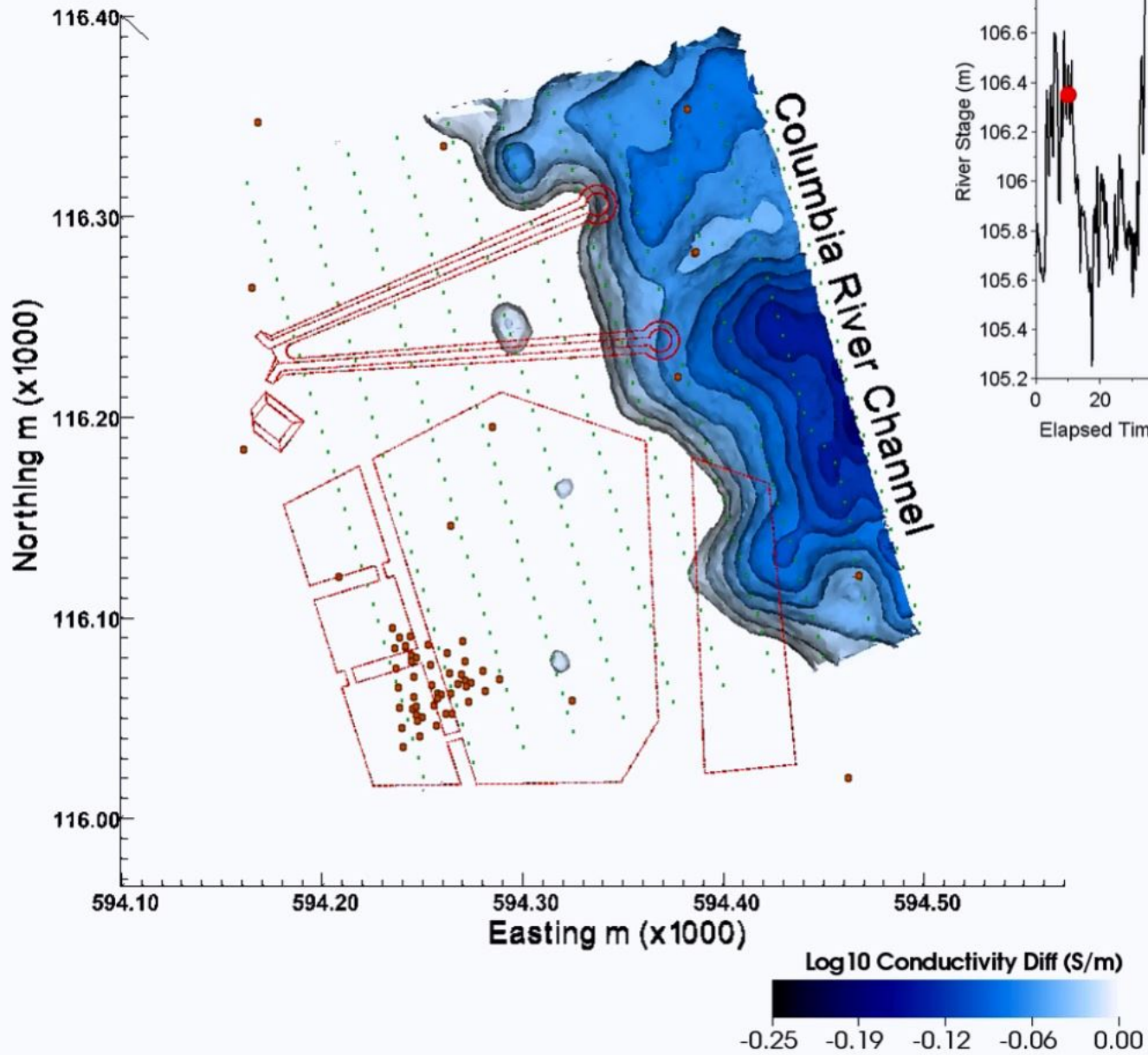




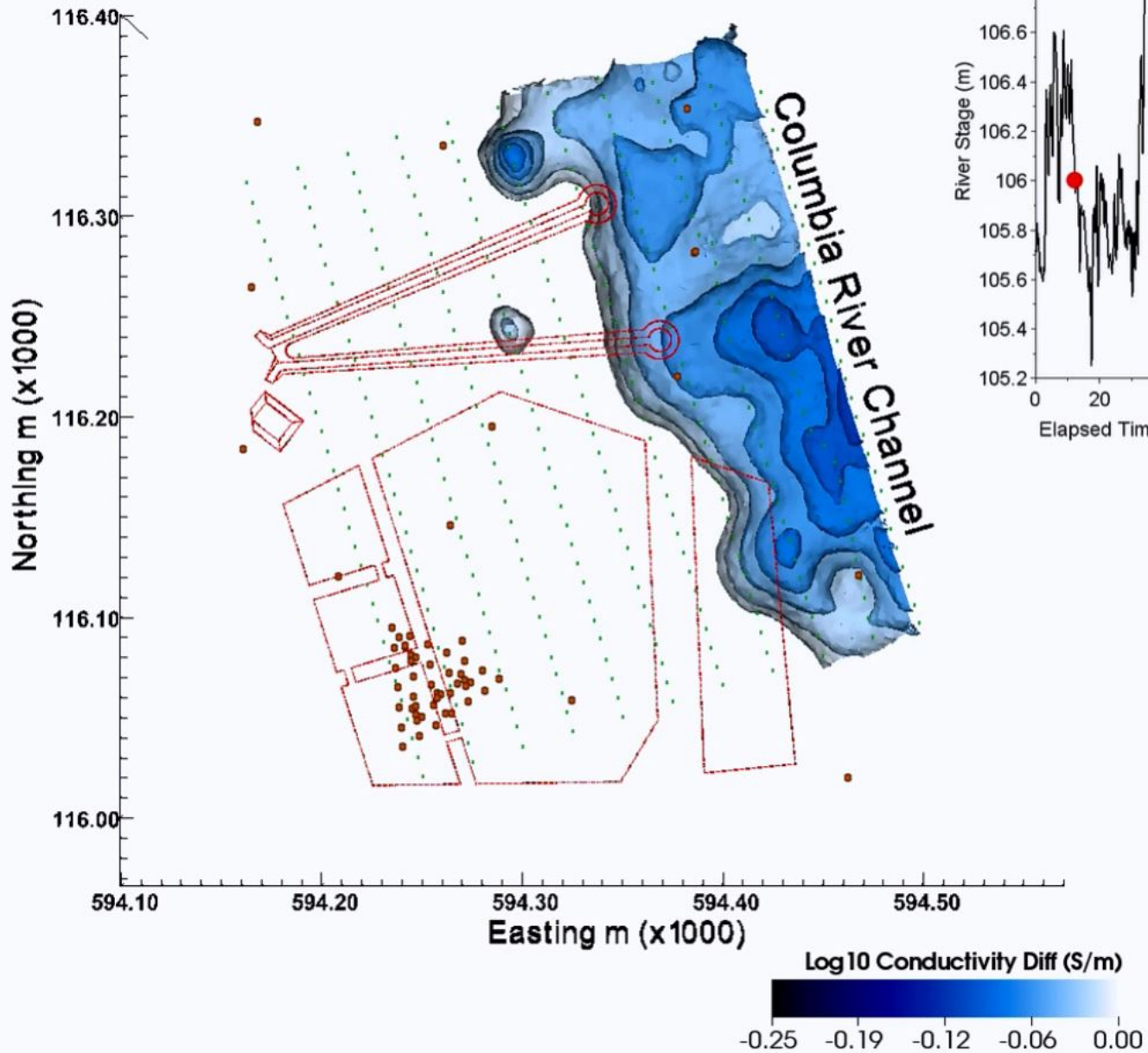


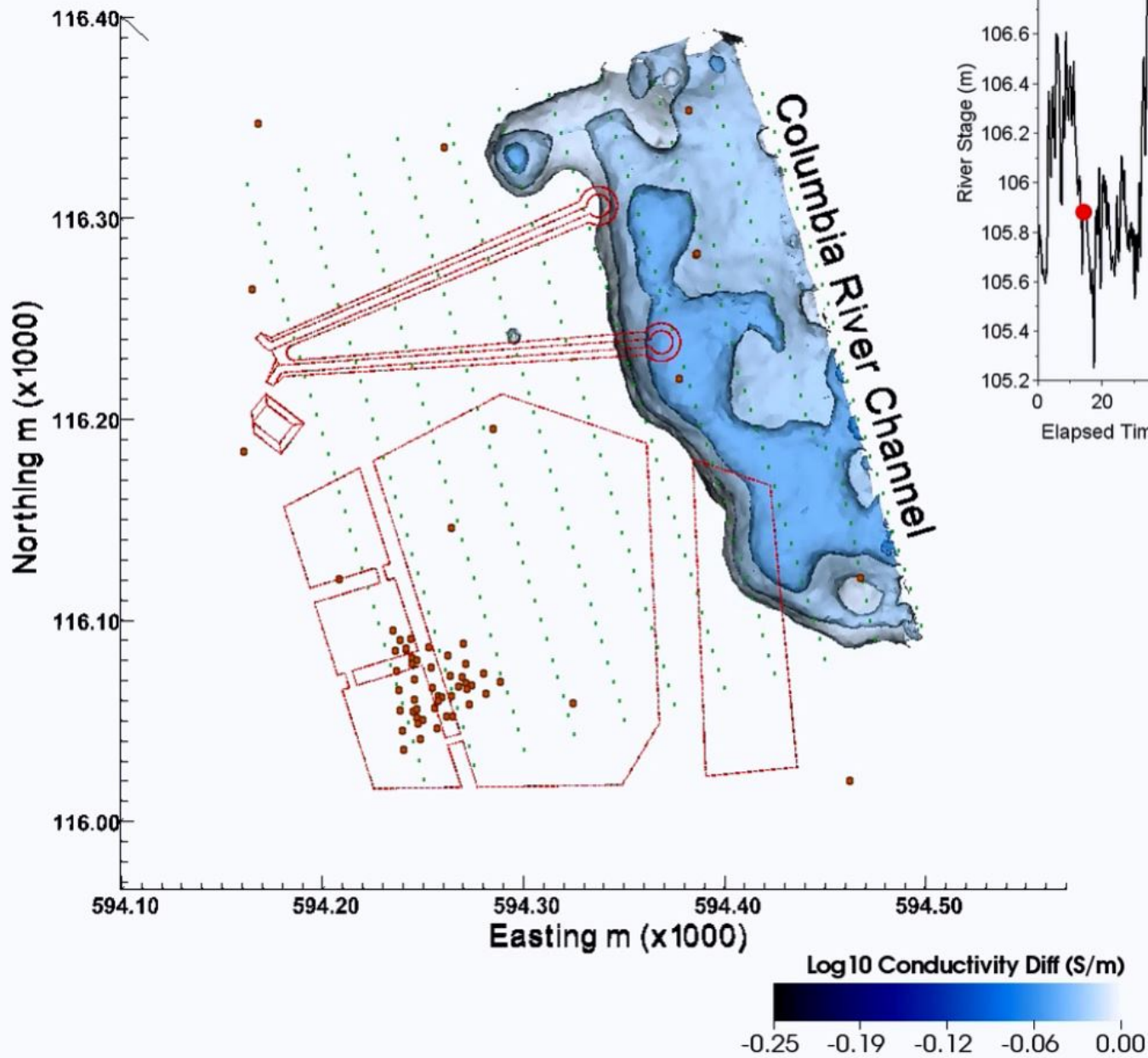
Stage Vs. Time

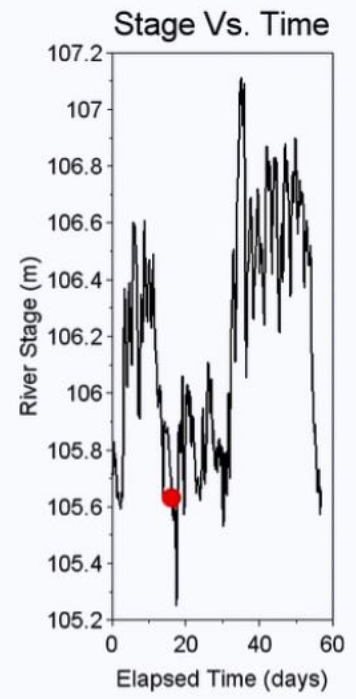
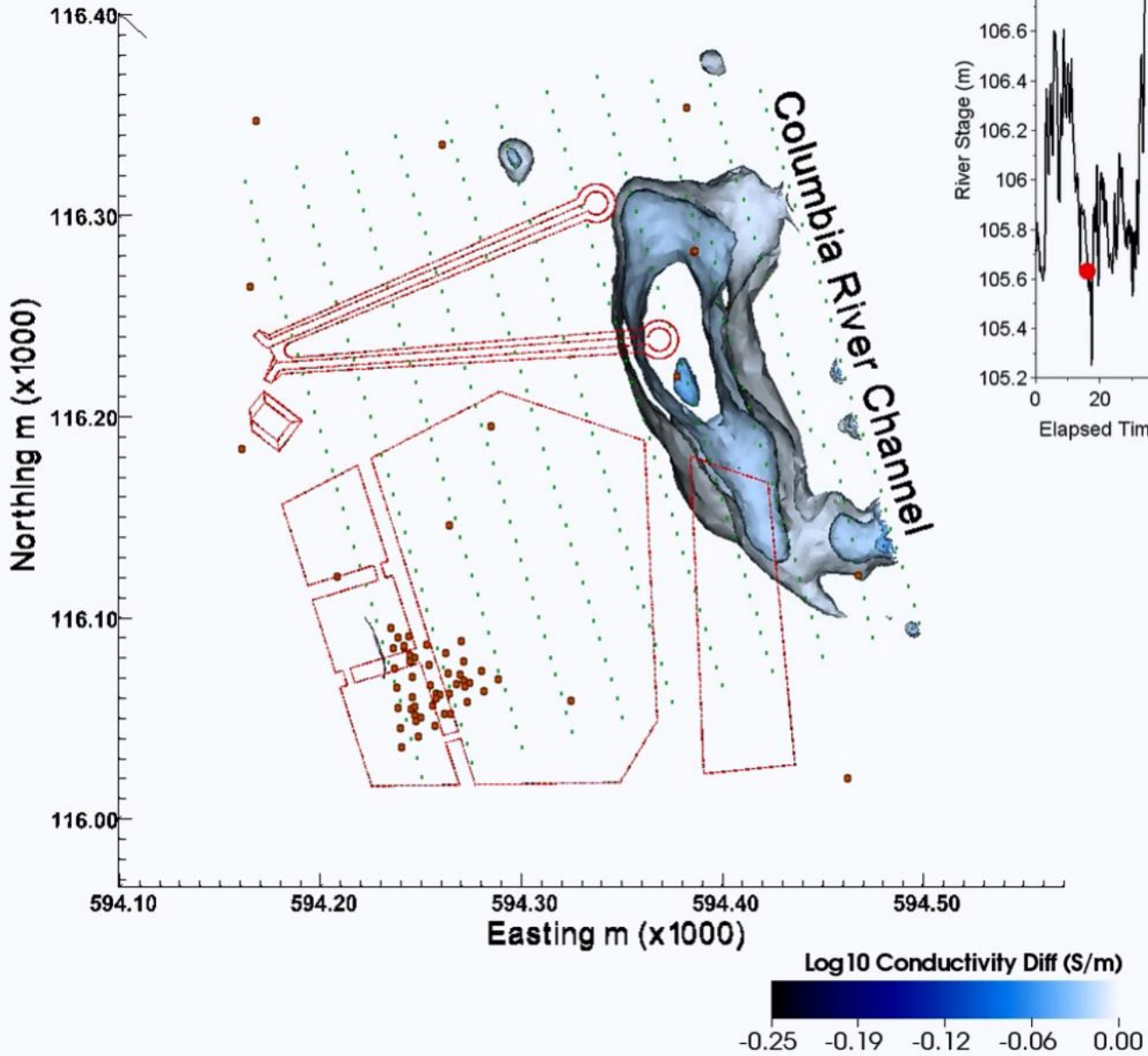


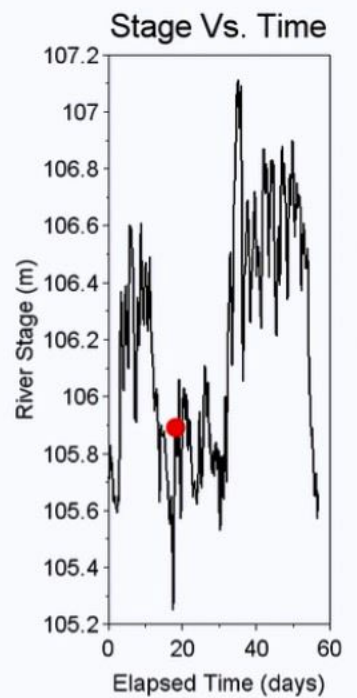
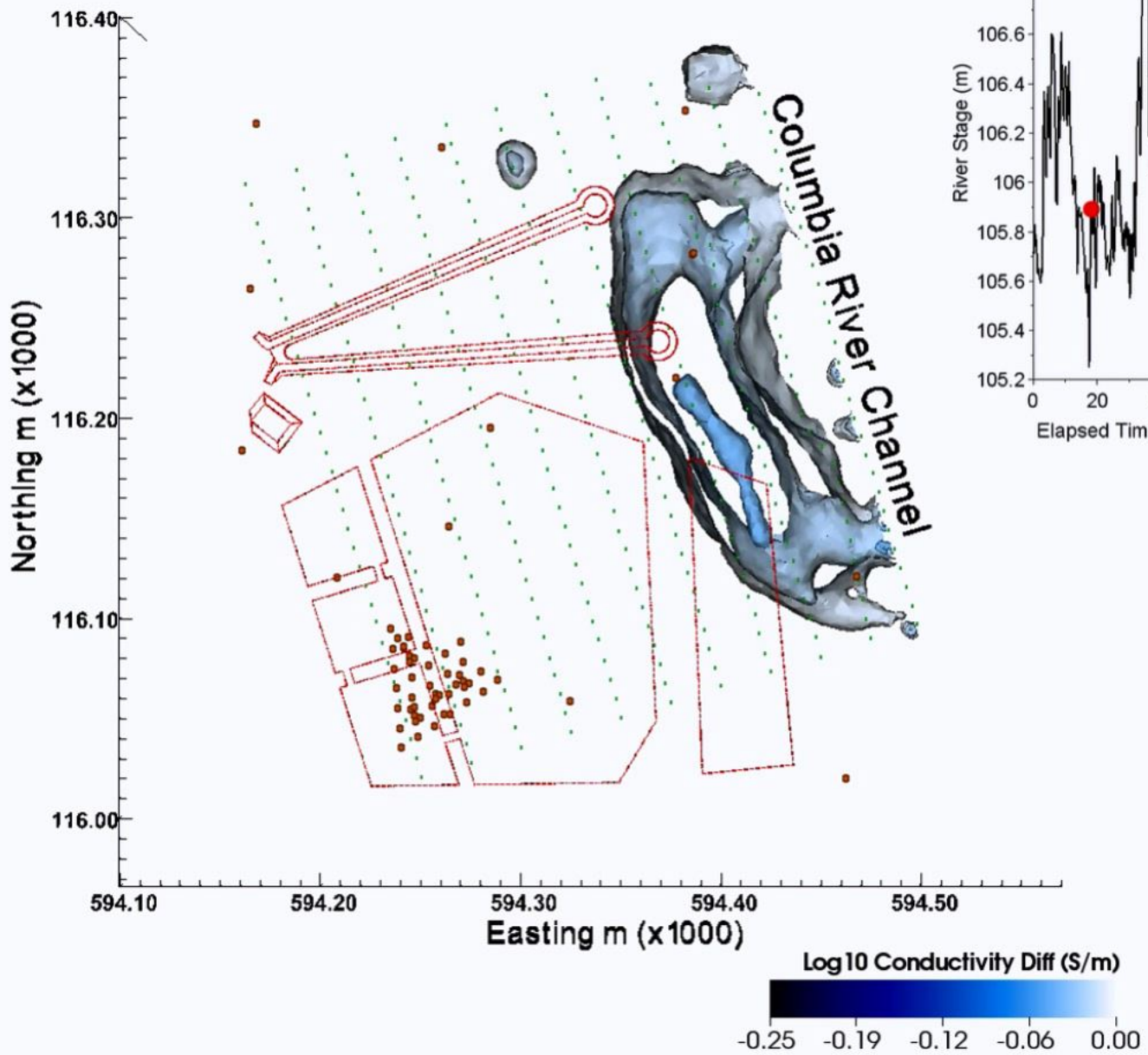


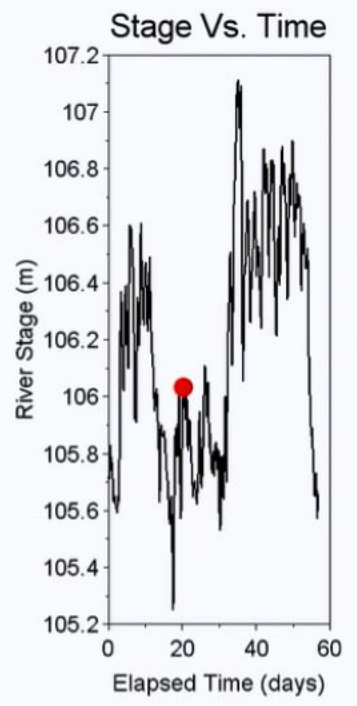
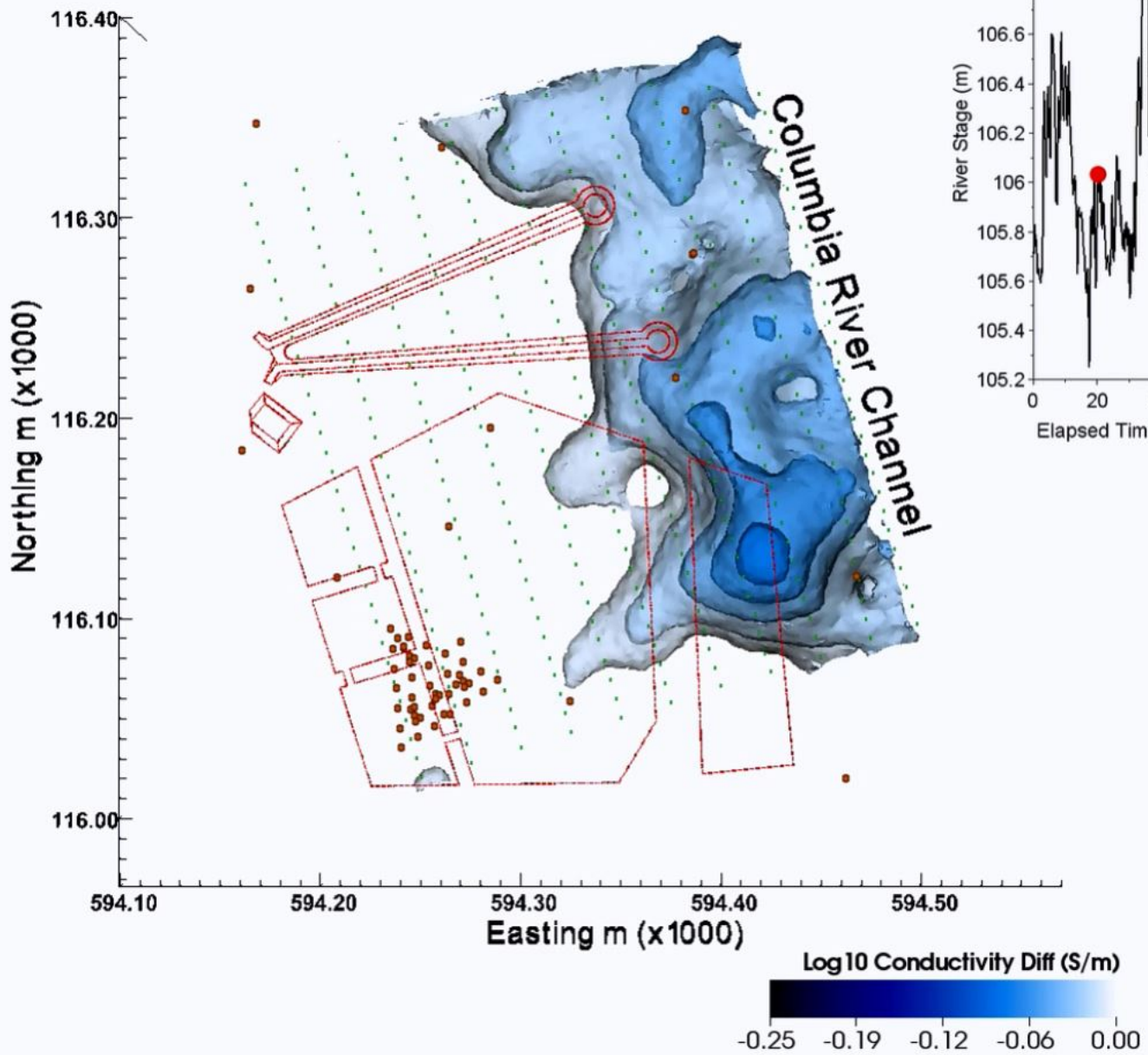


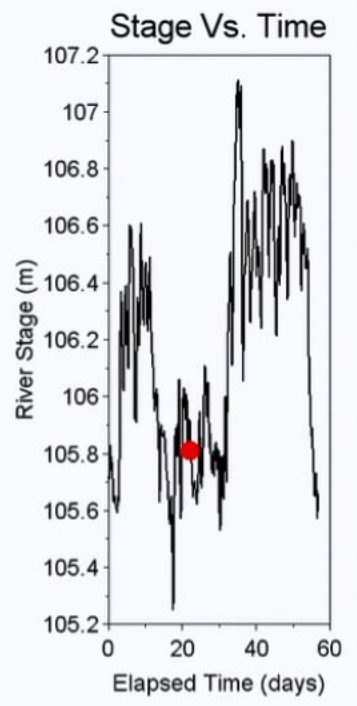
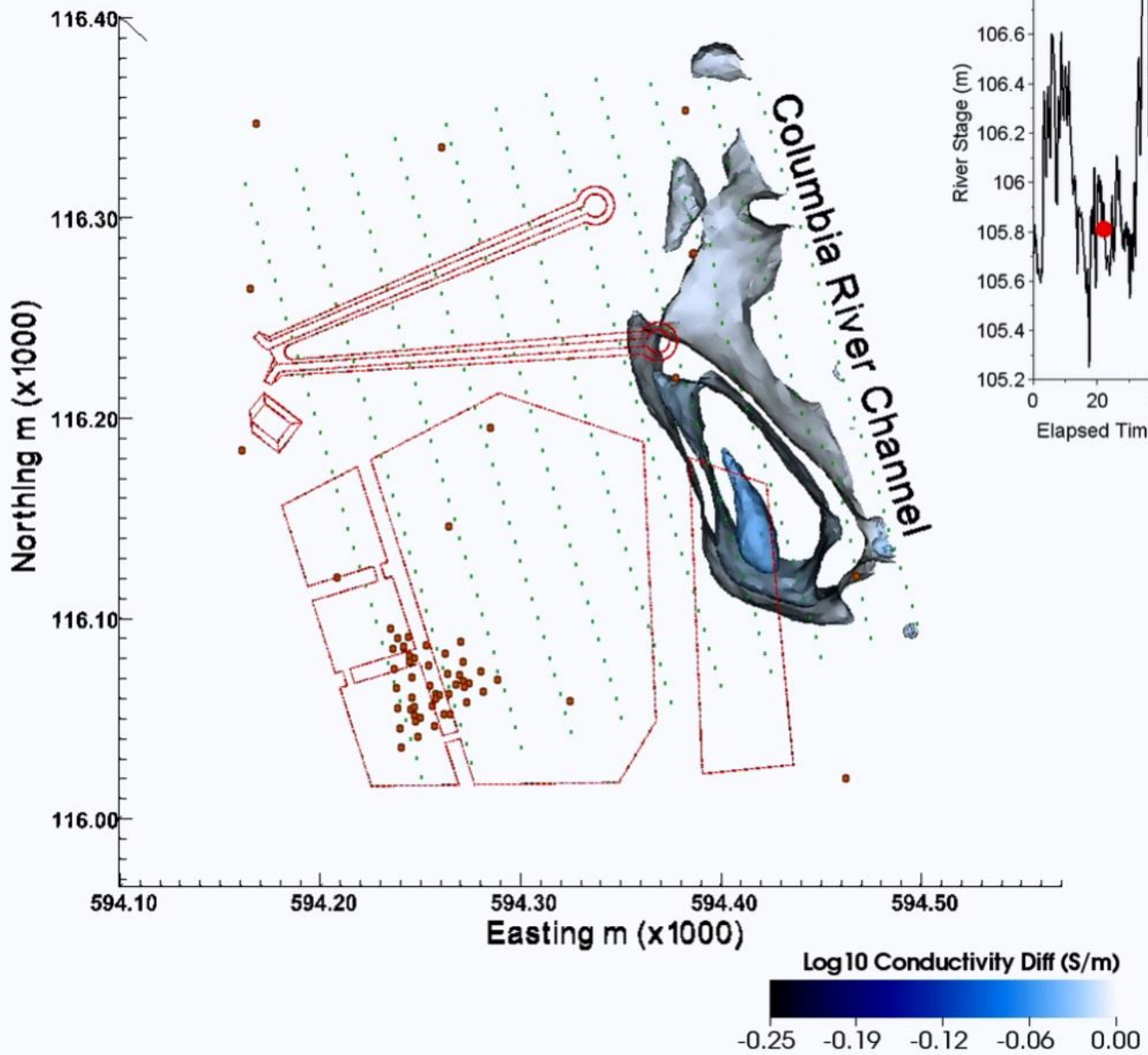


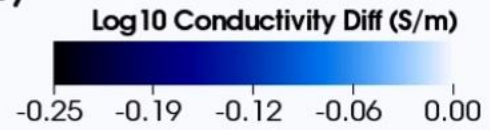
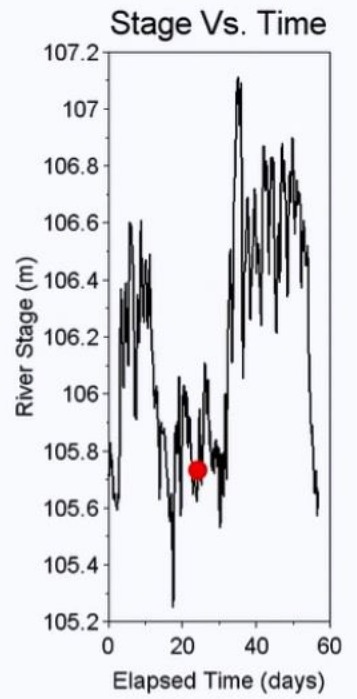
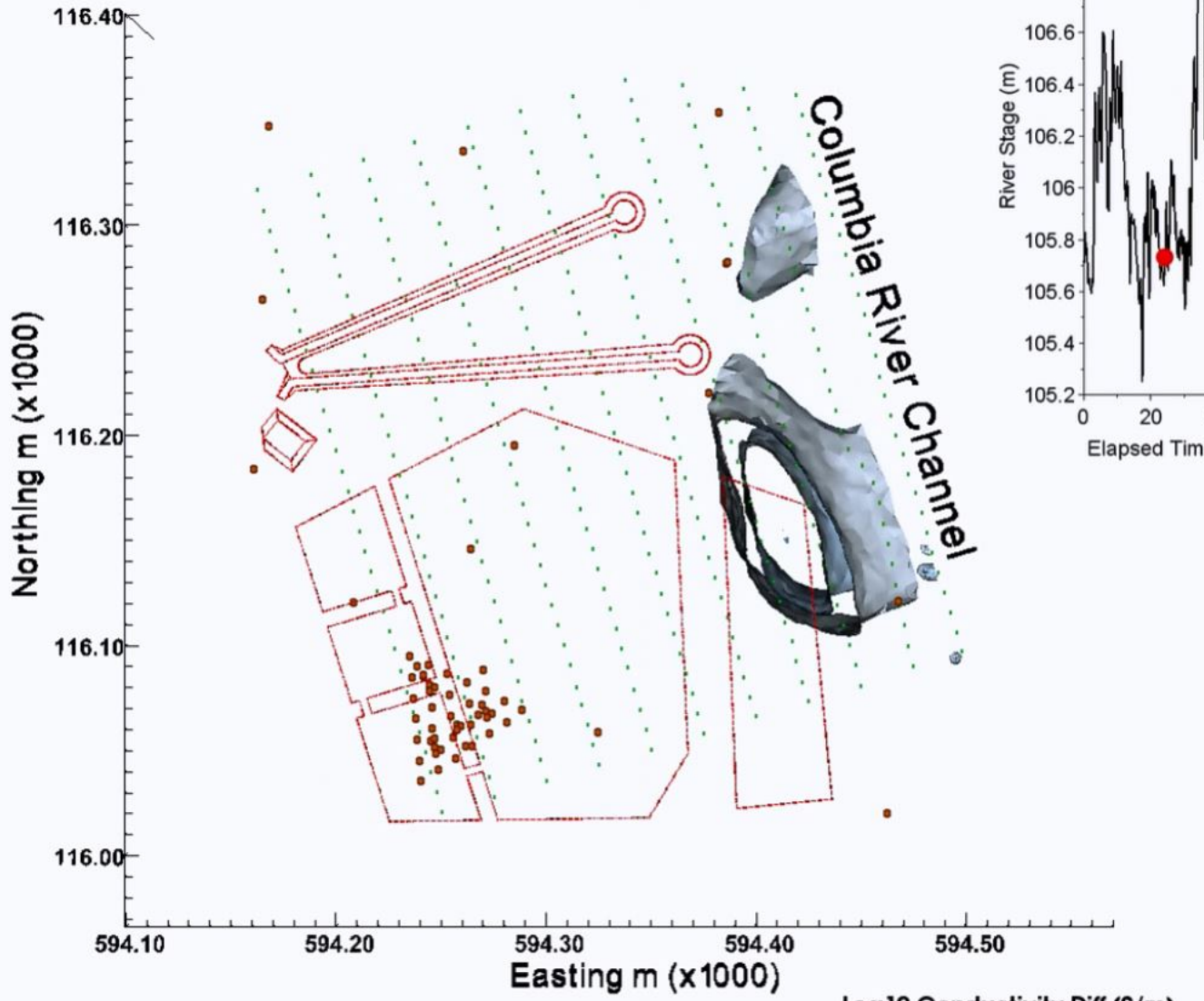


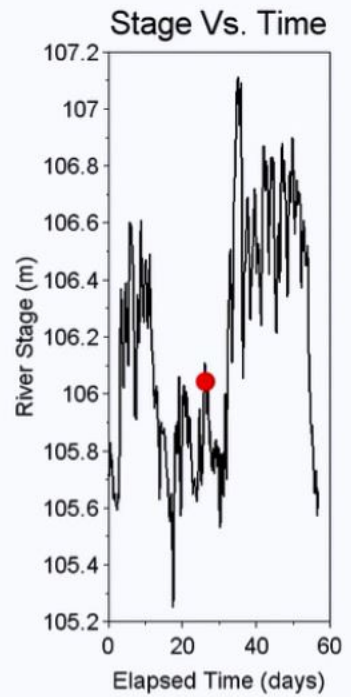
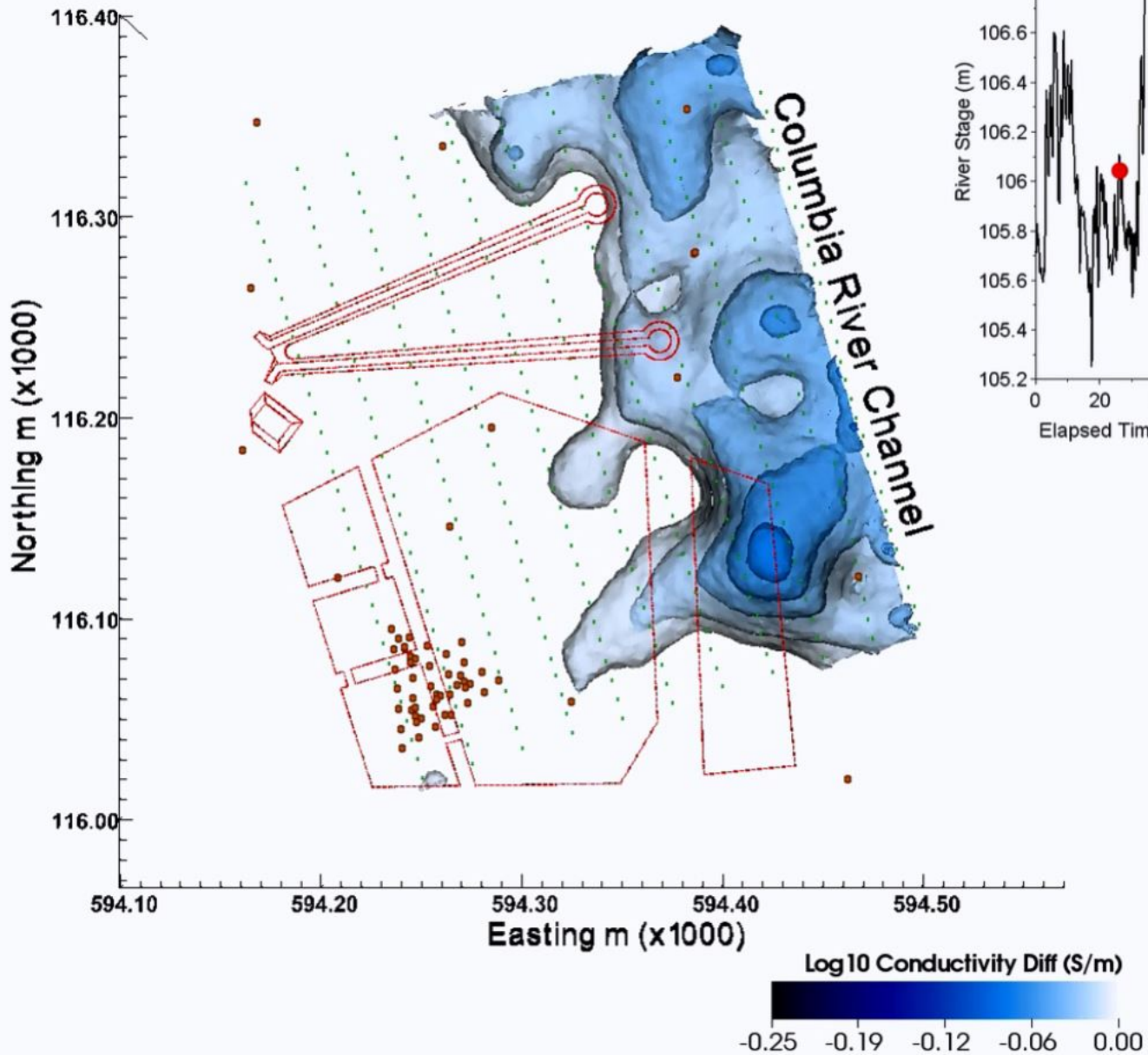




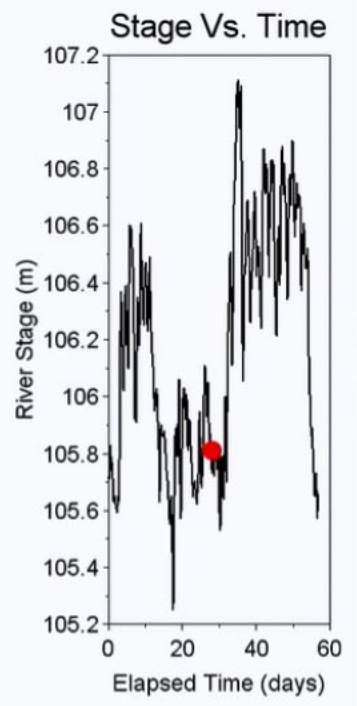
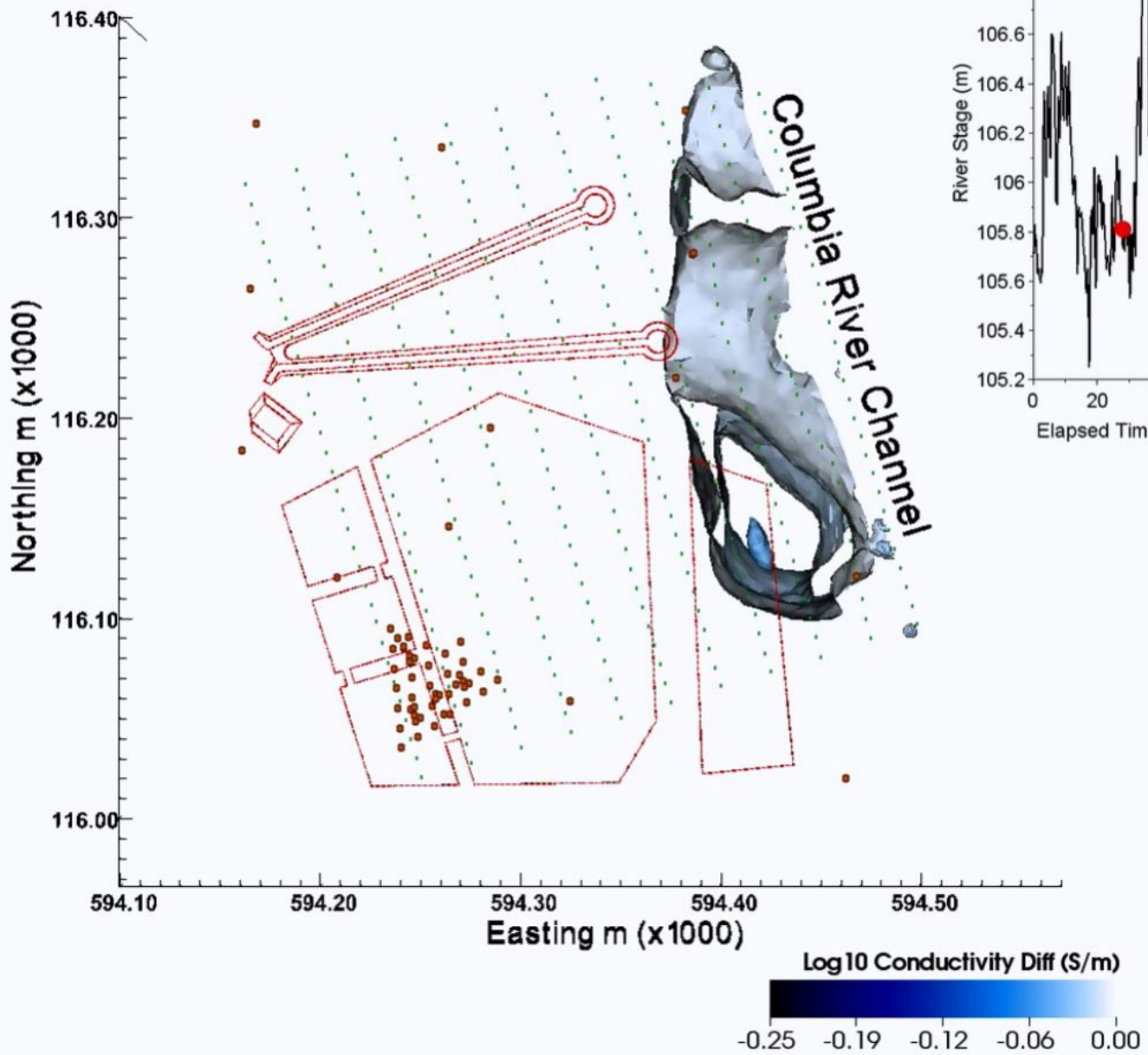


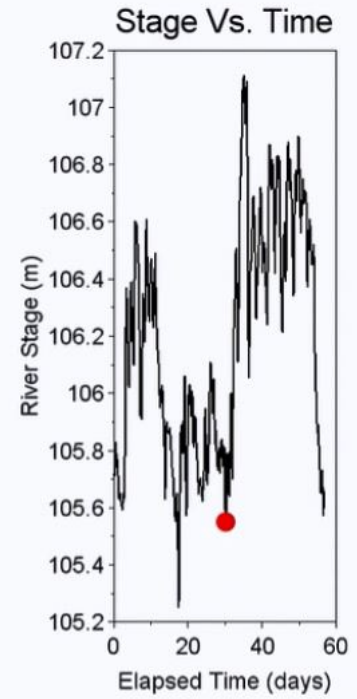
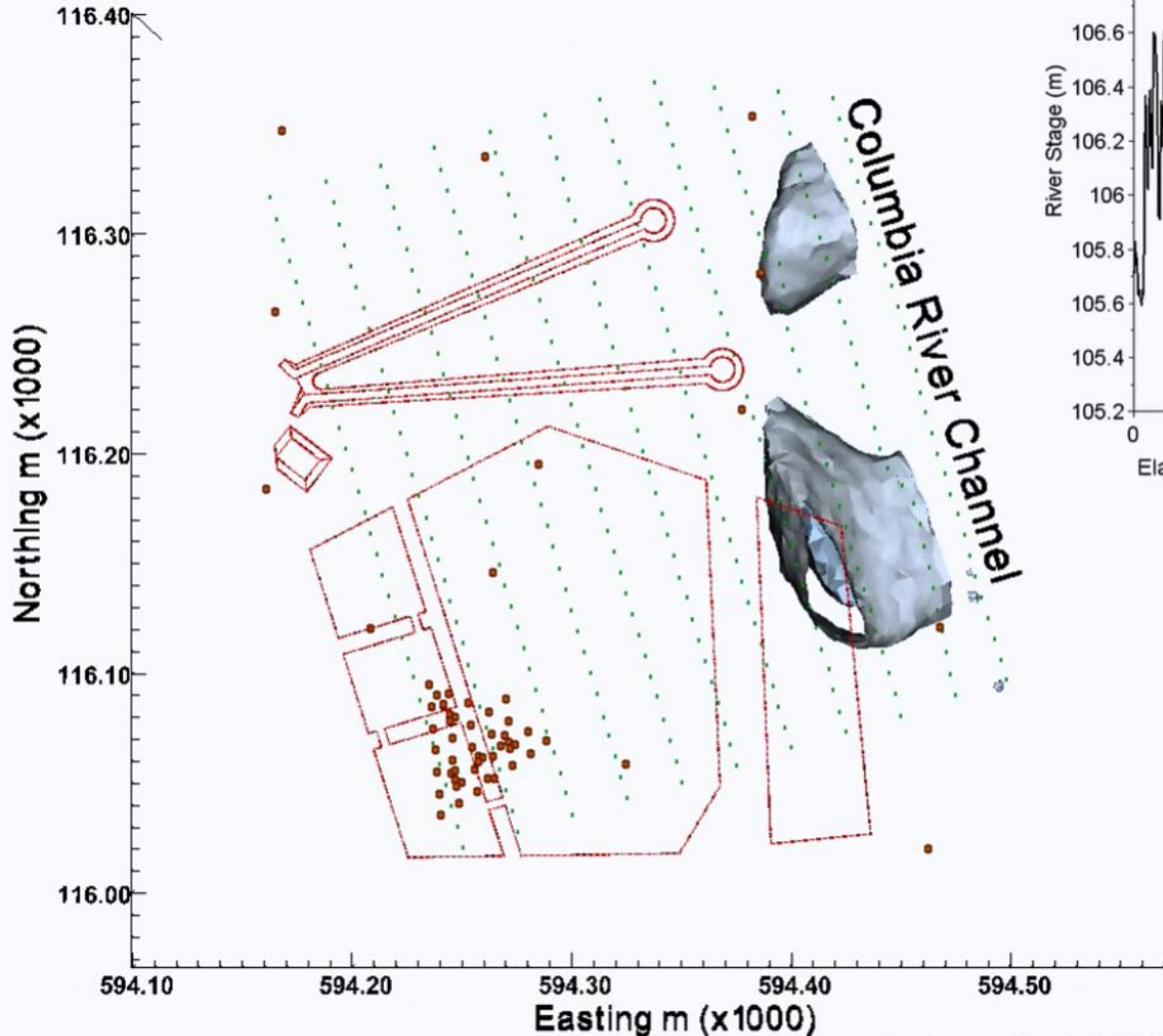


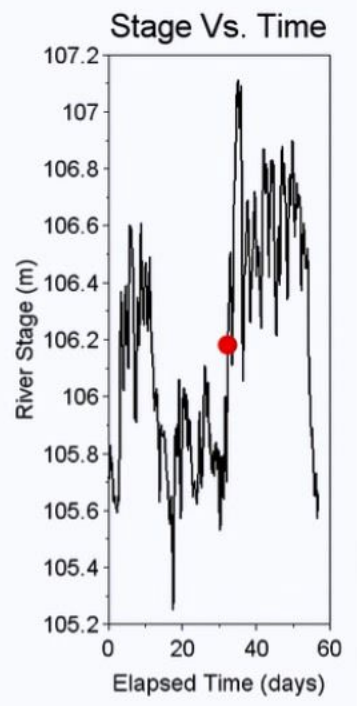
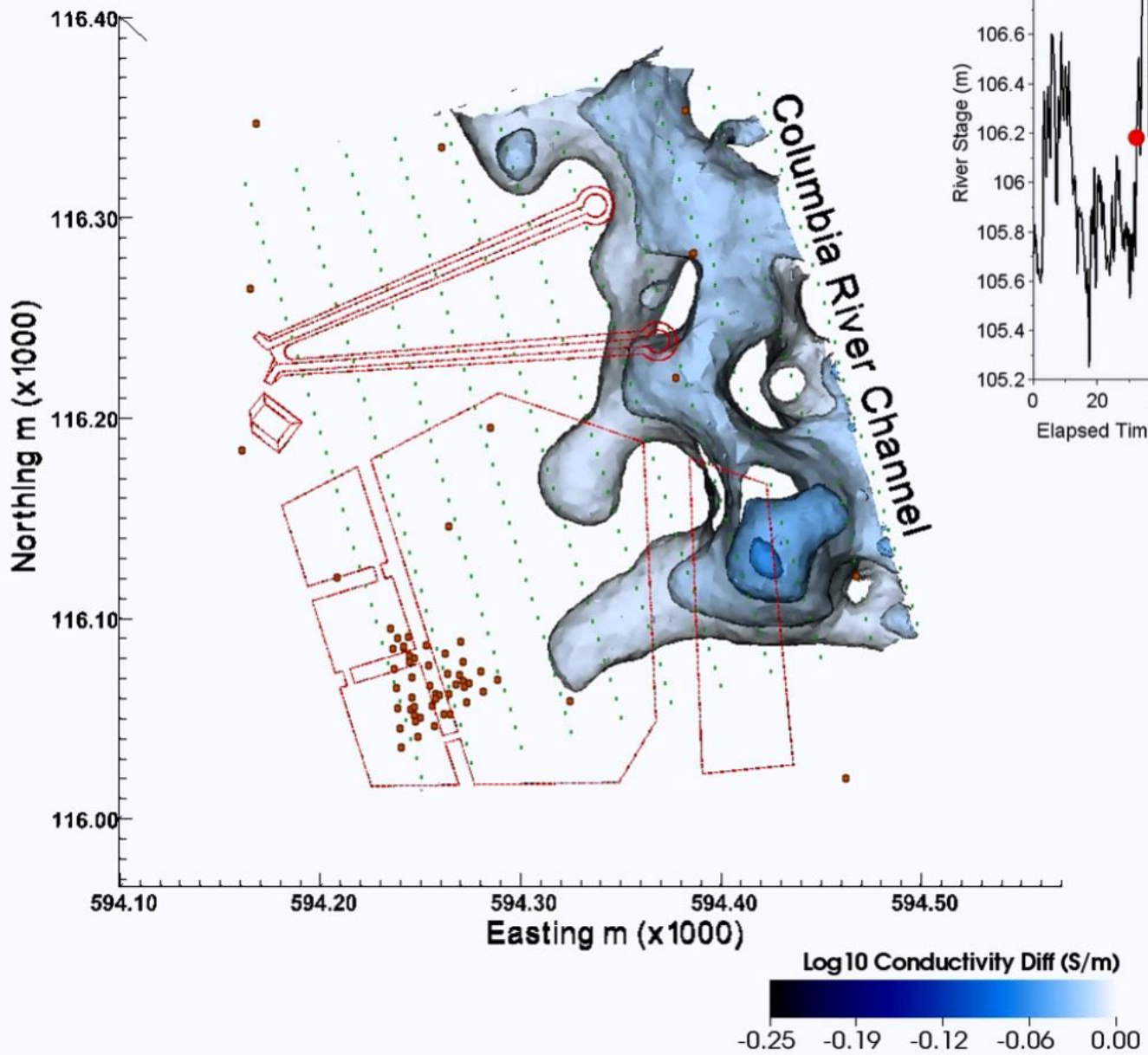


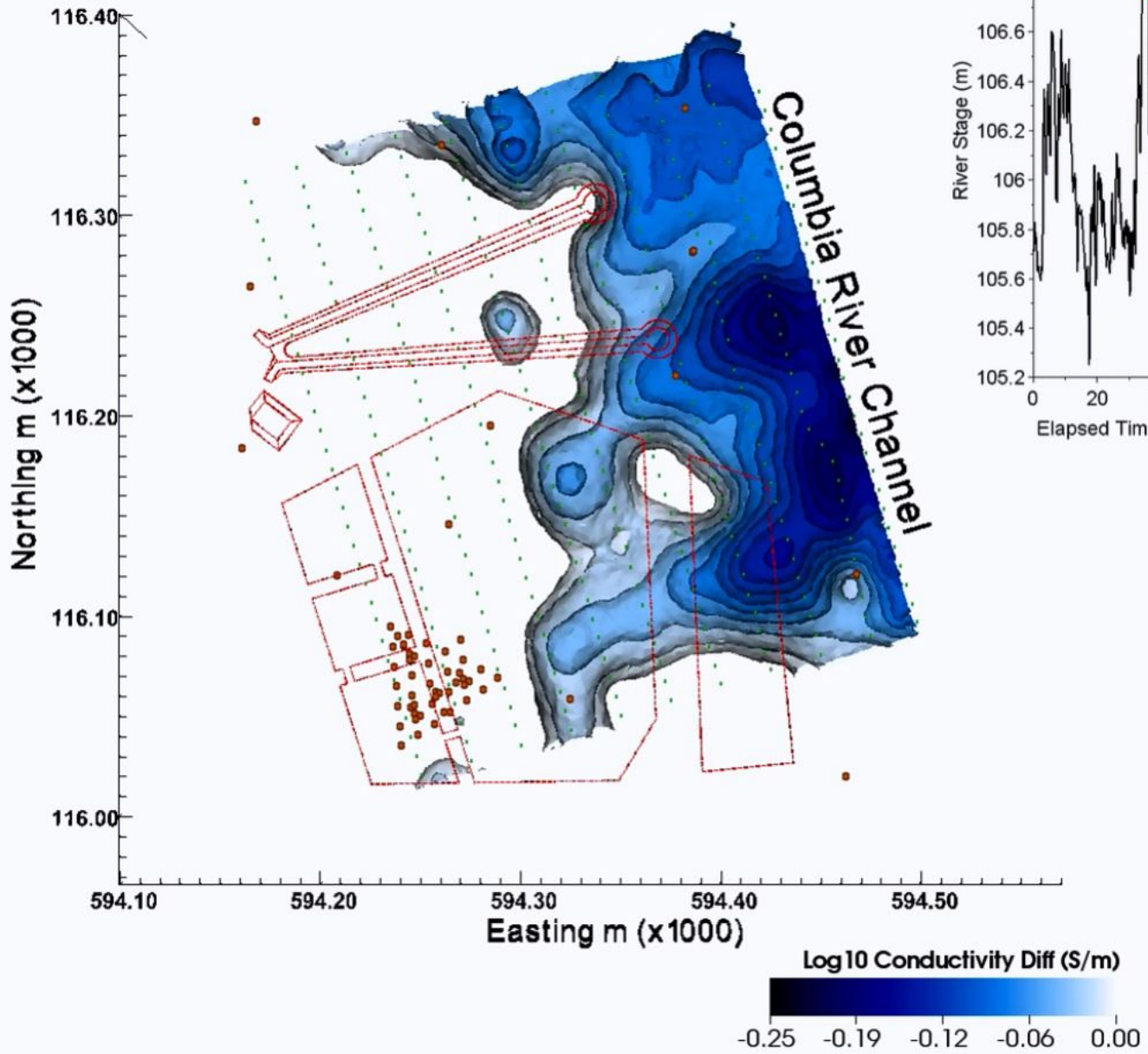




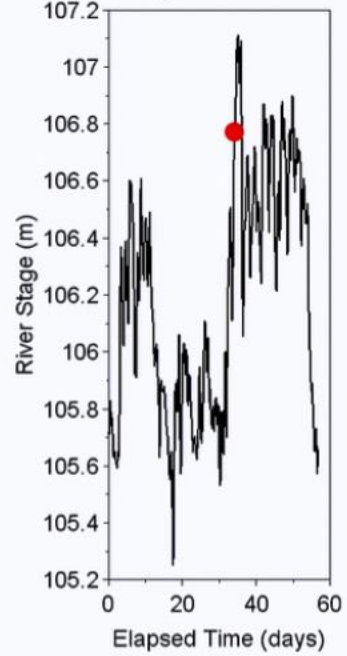


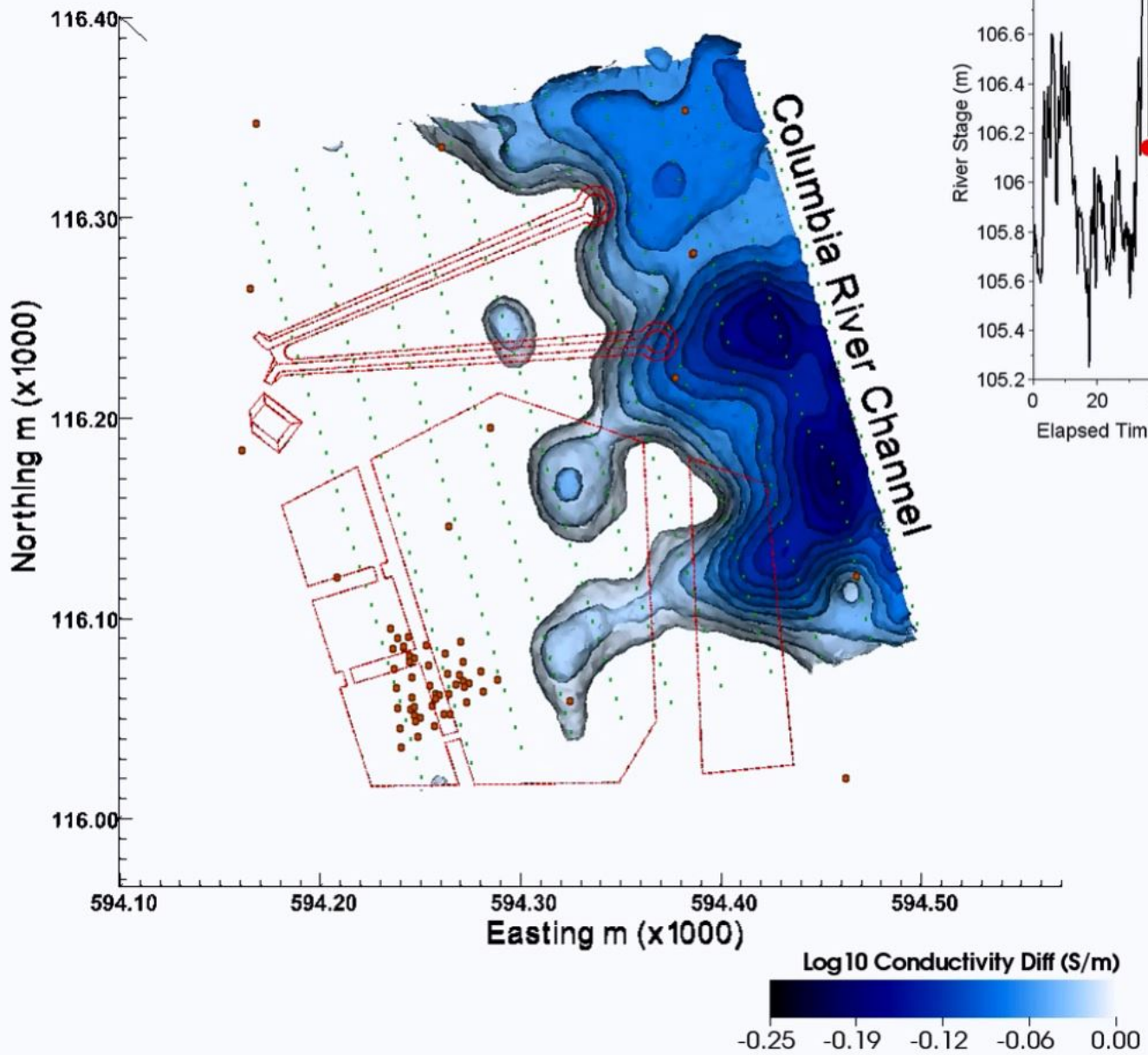


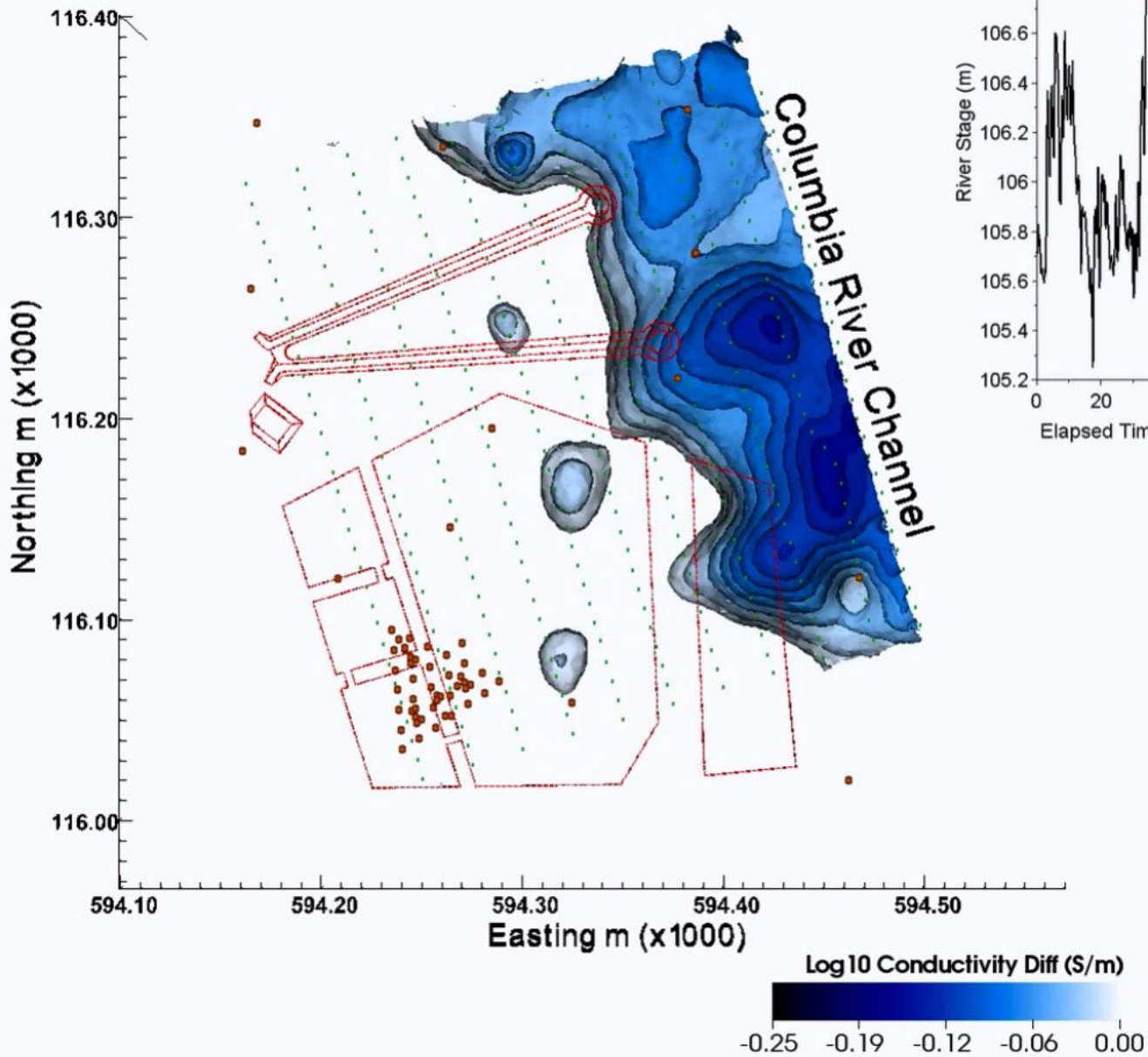


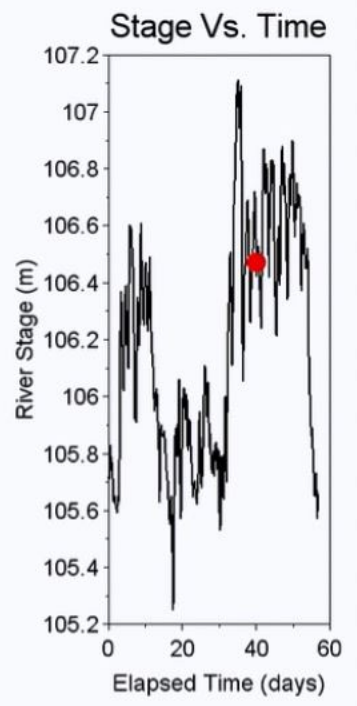
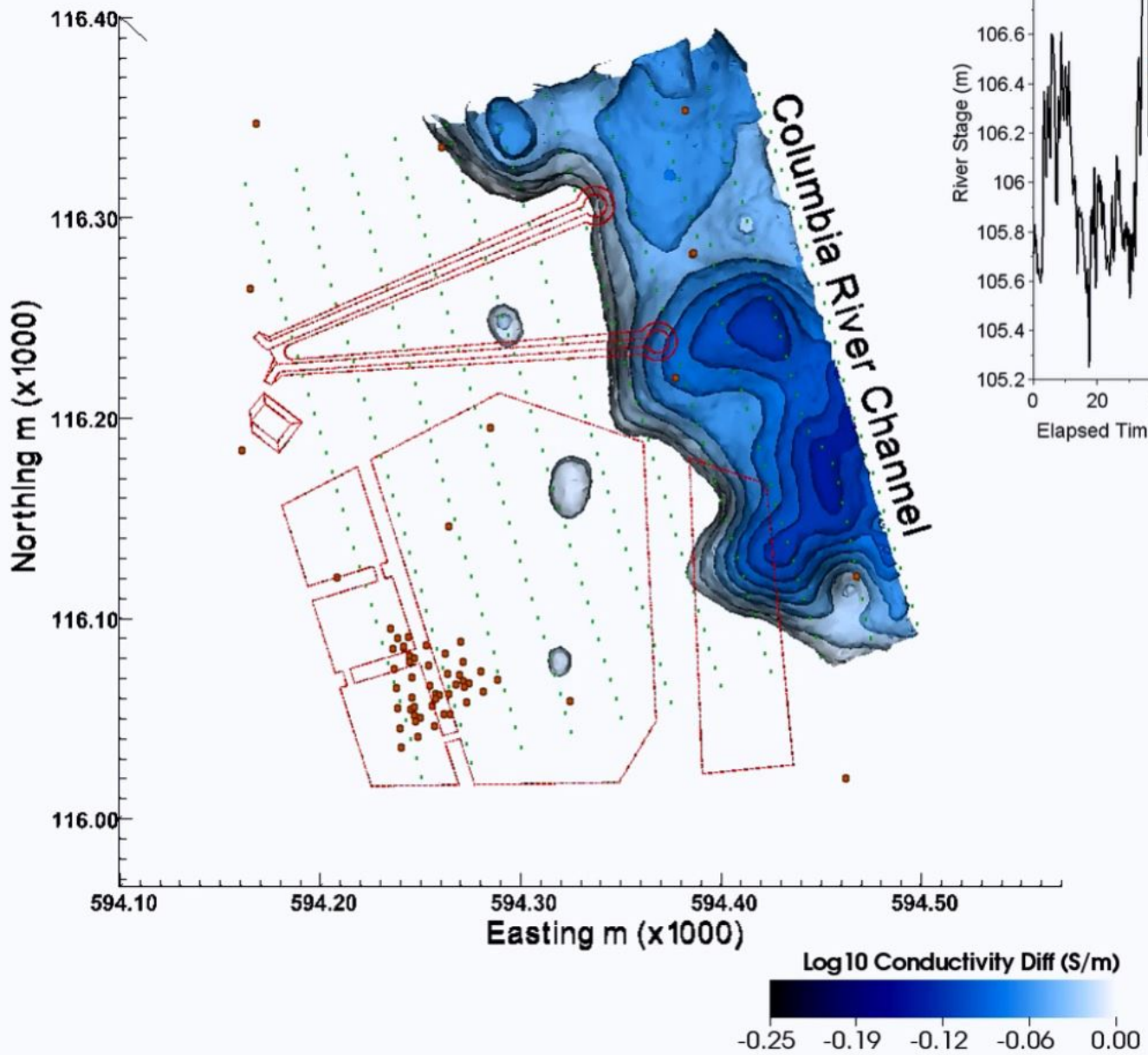


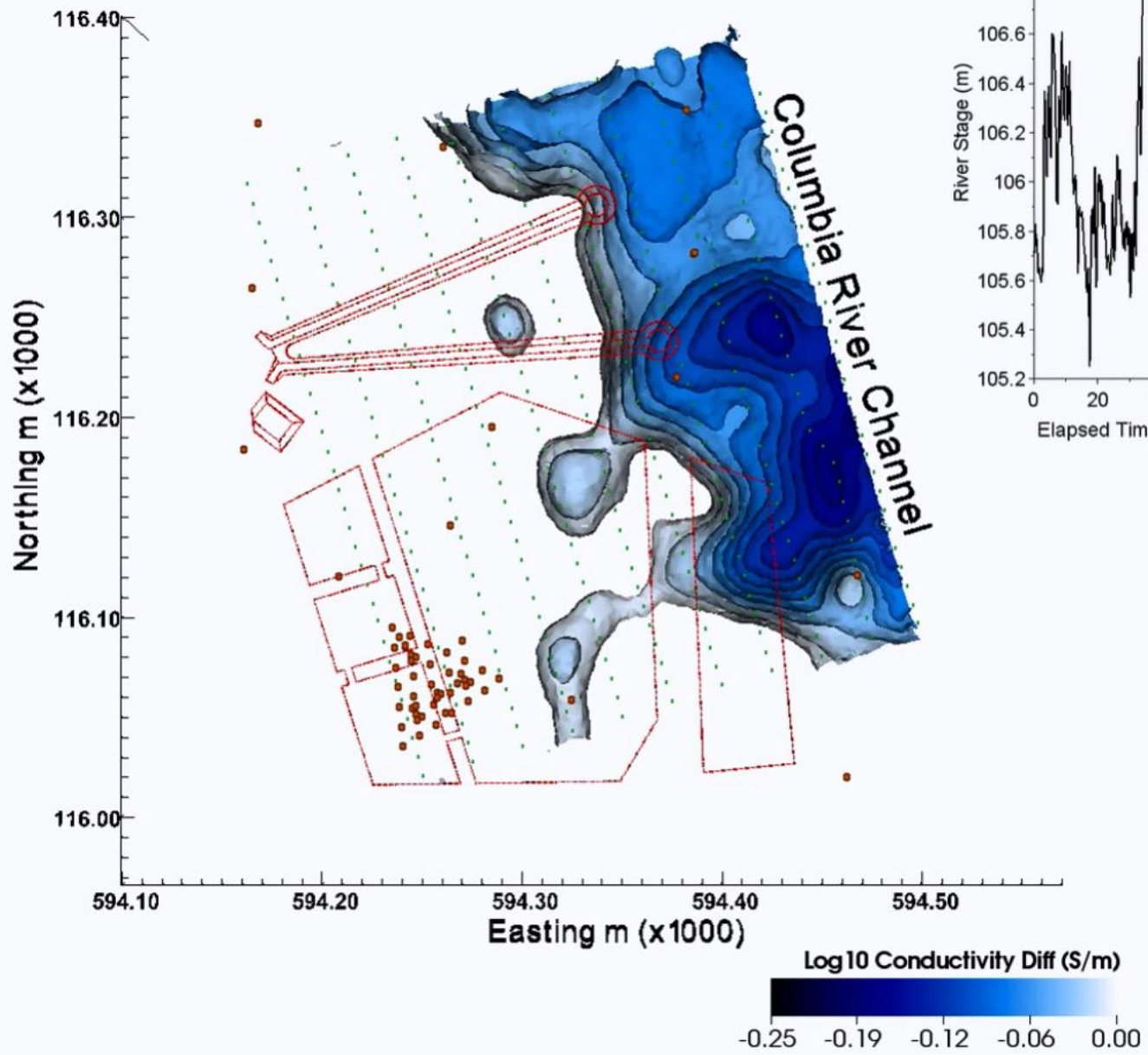
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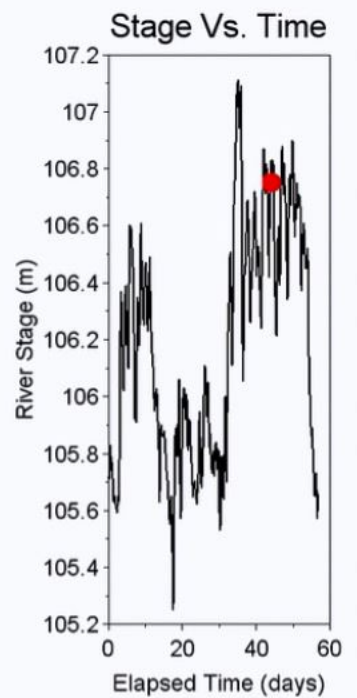
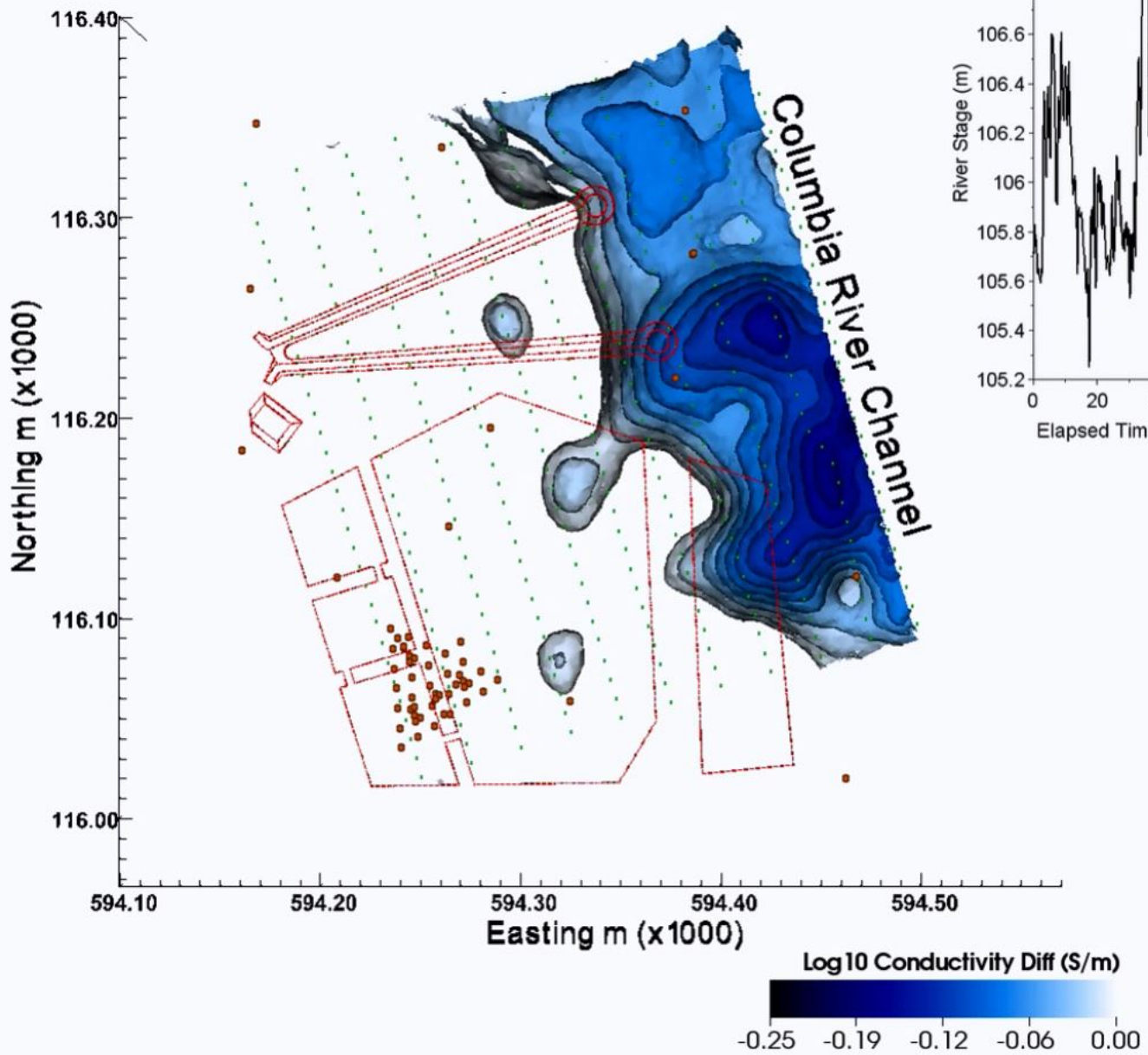


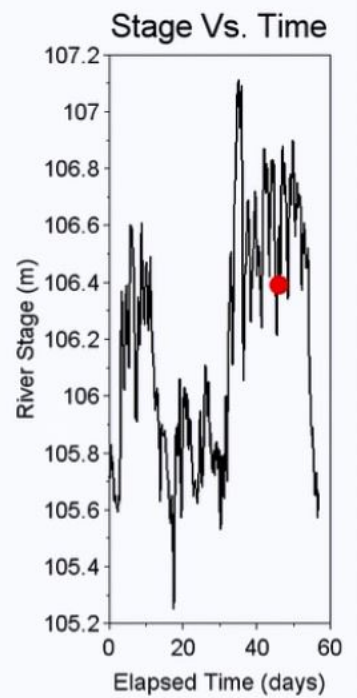
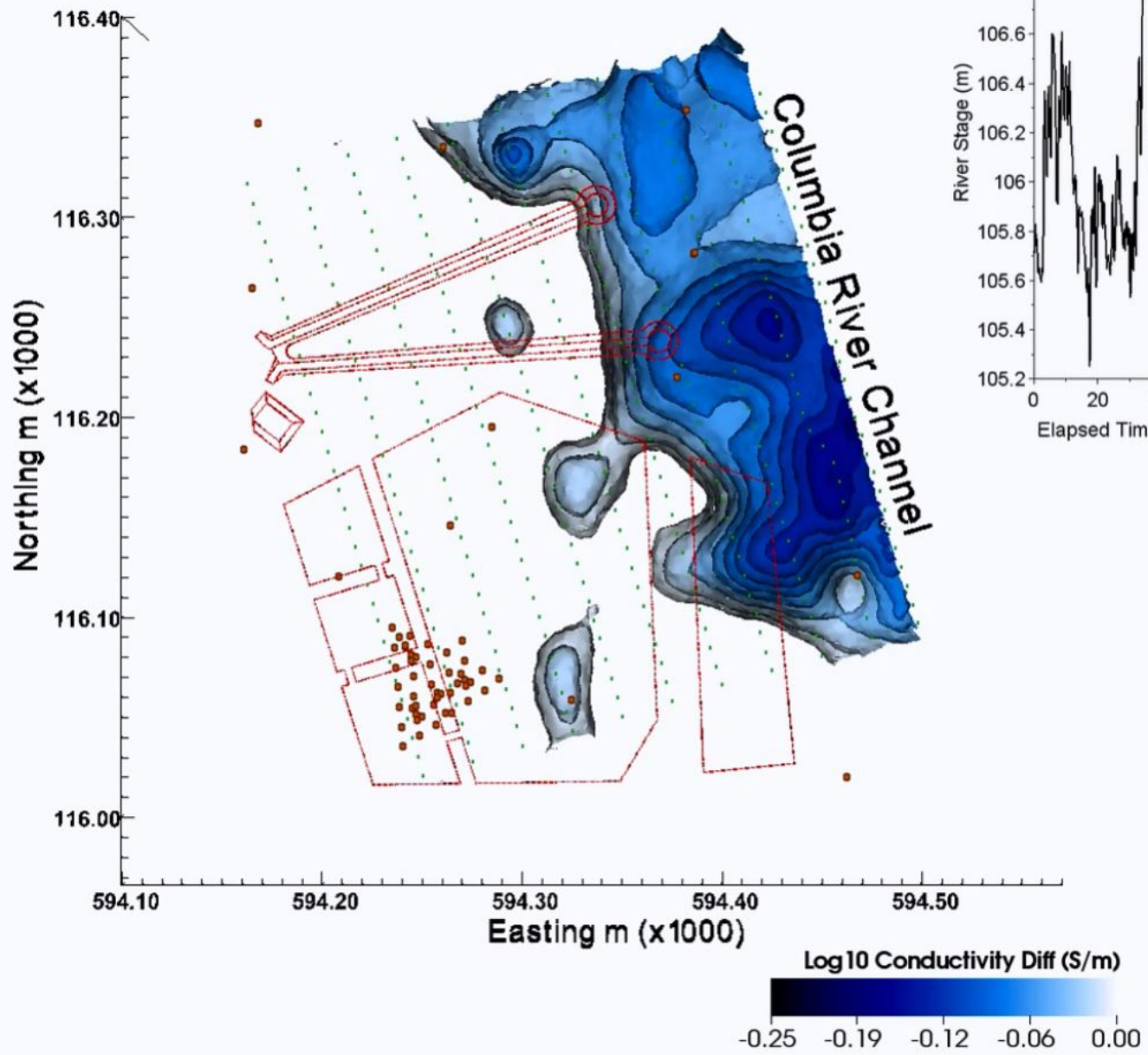


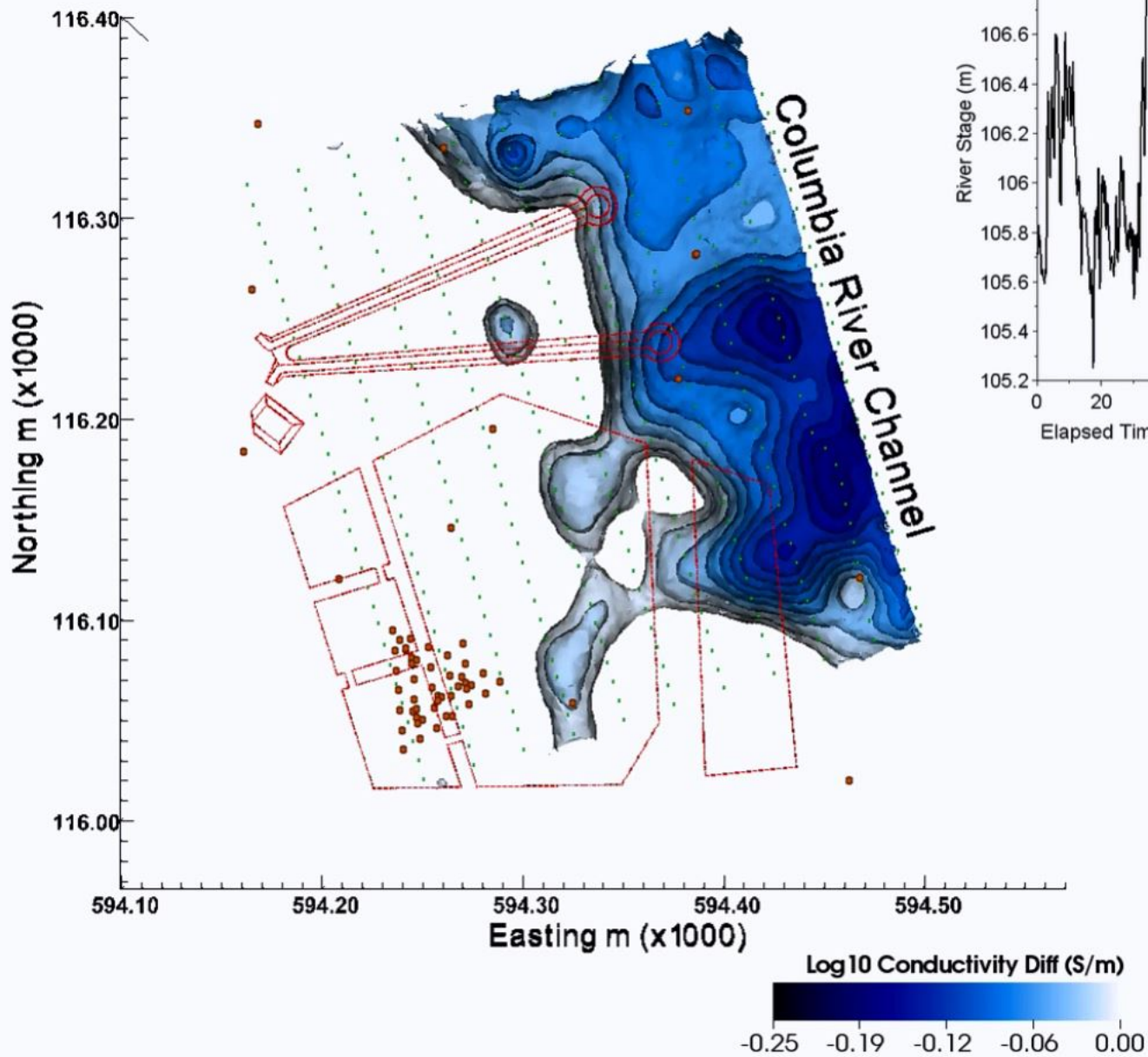


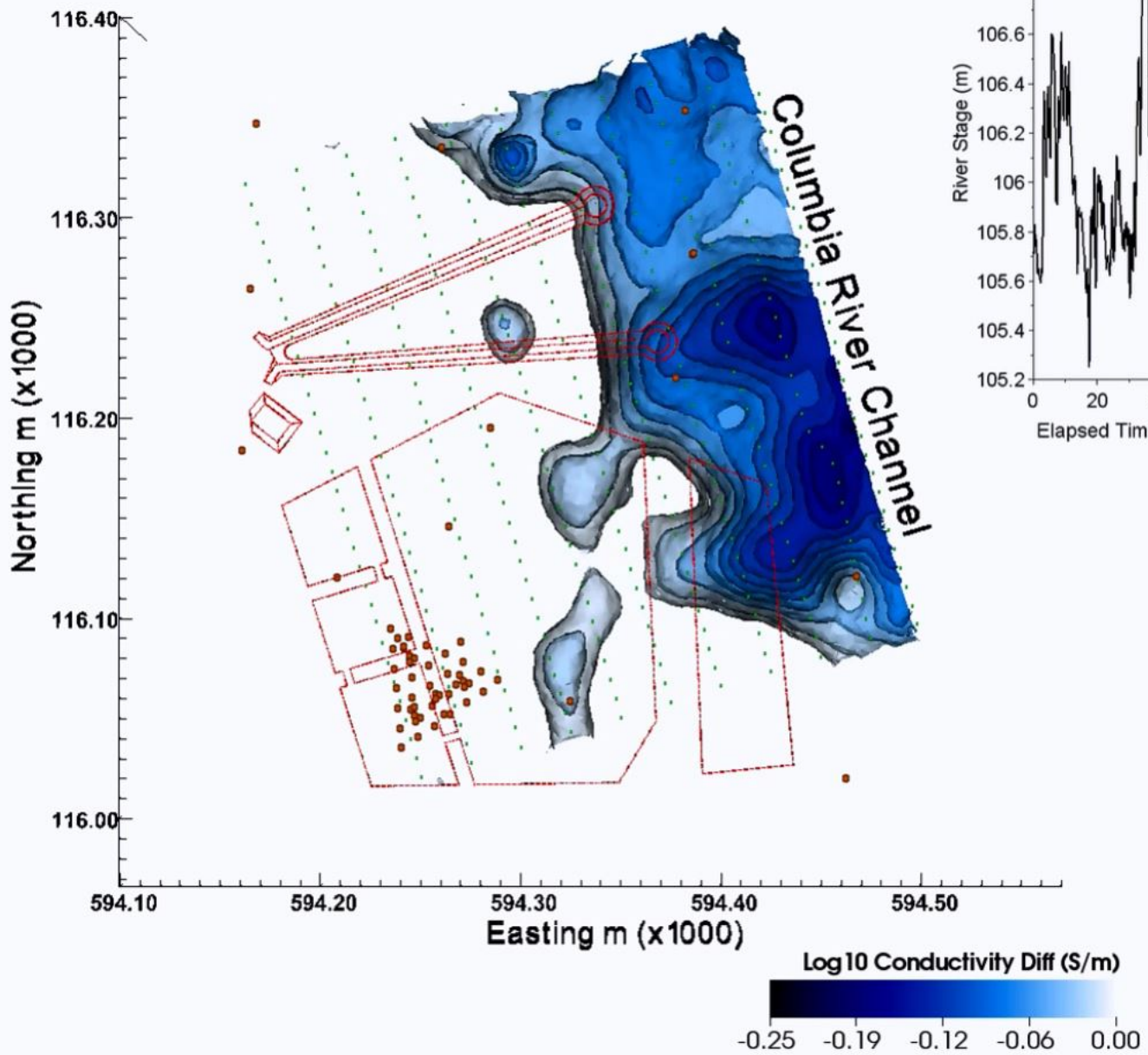


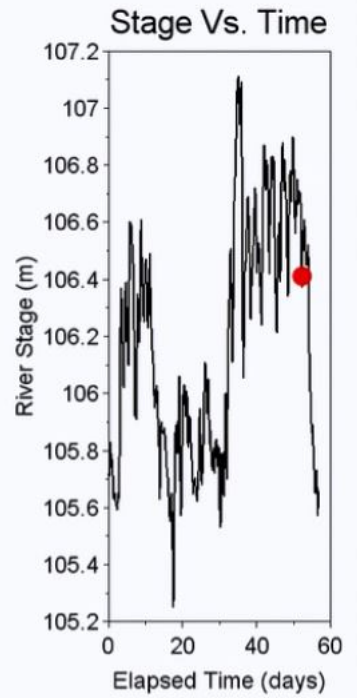
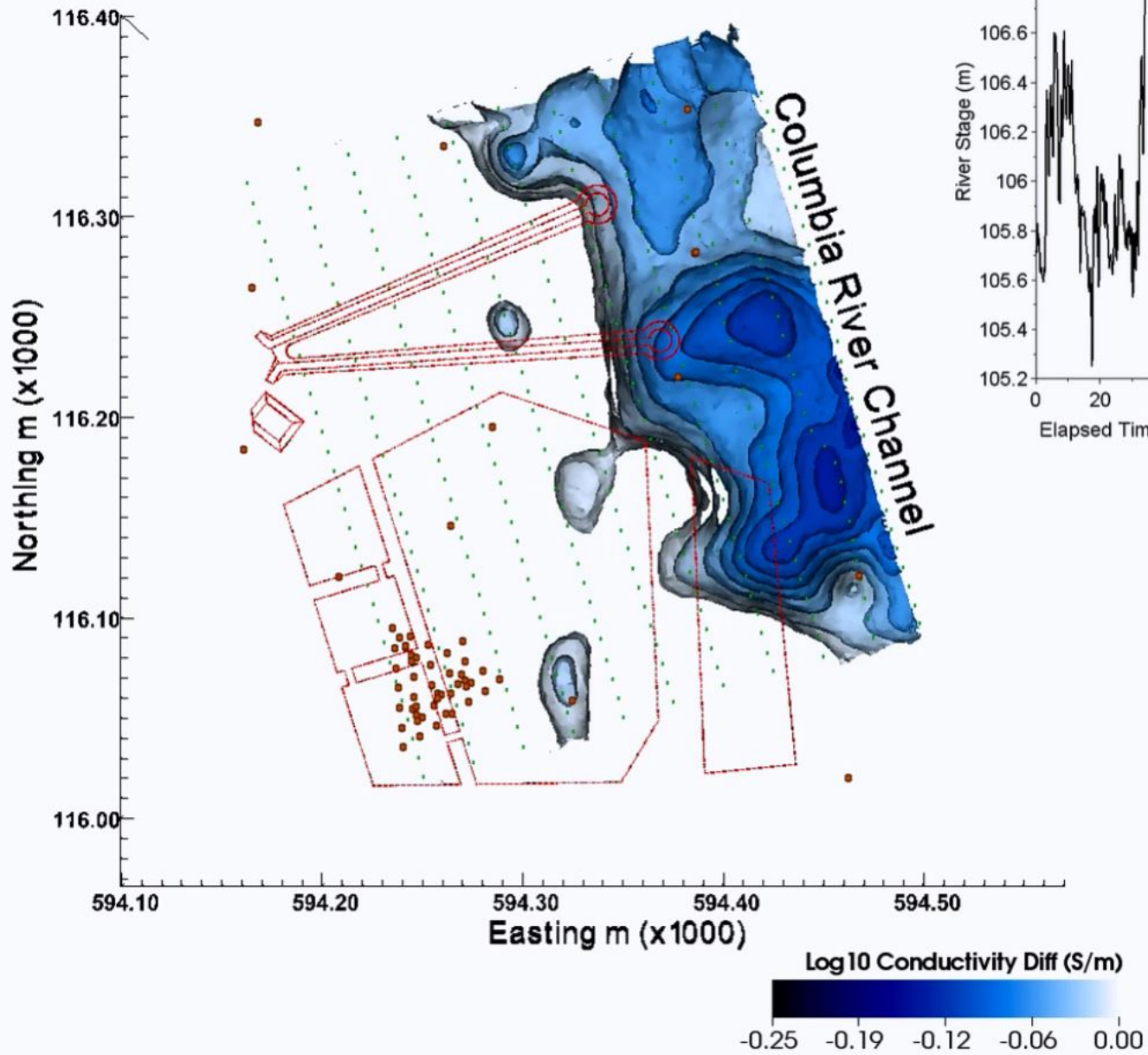


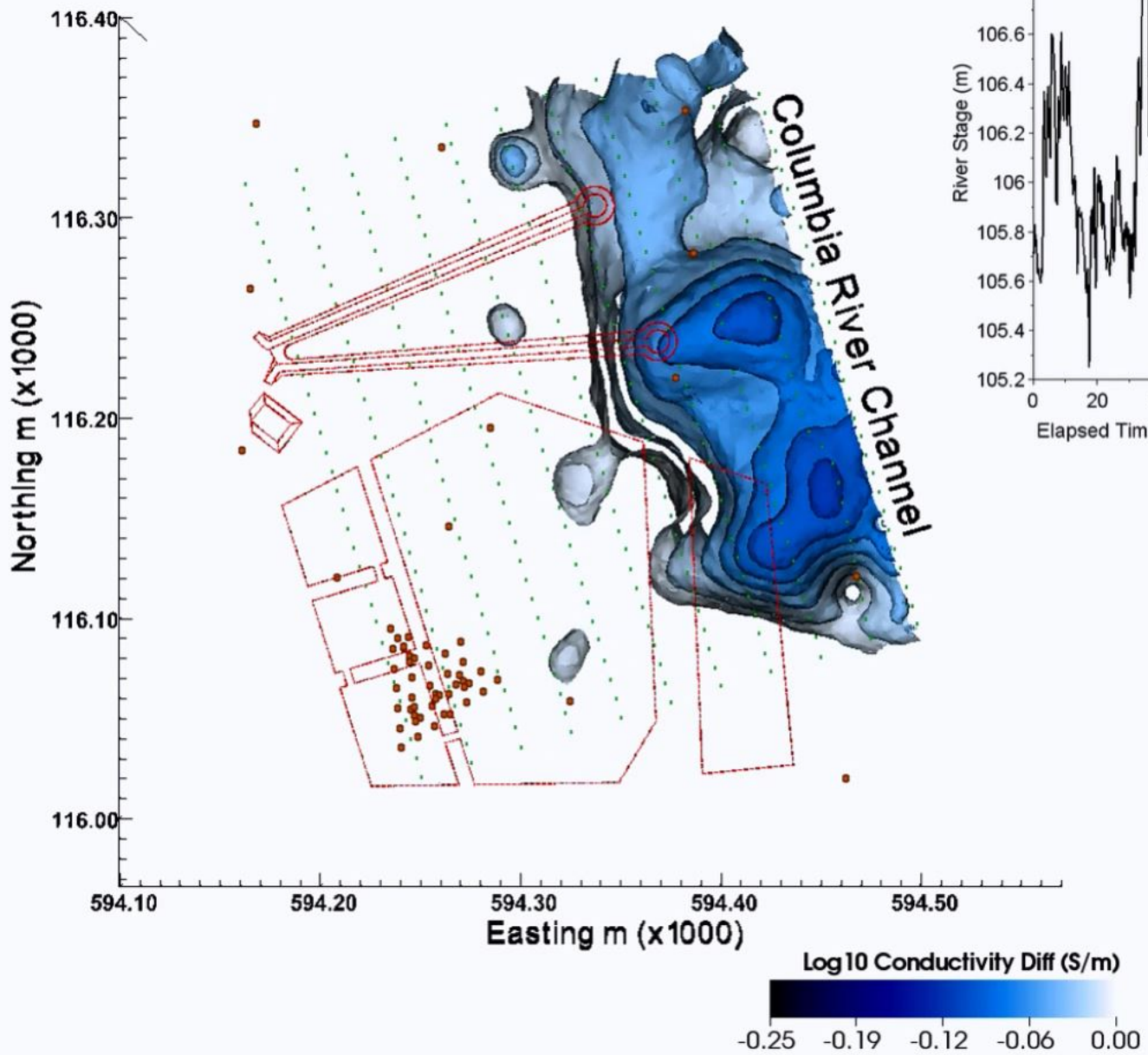


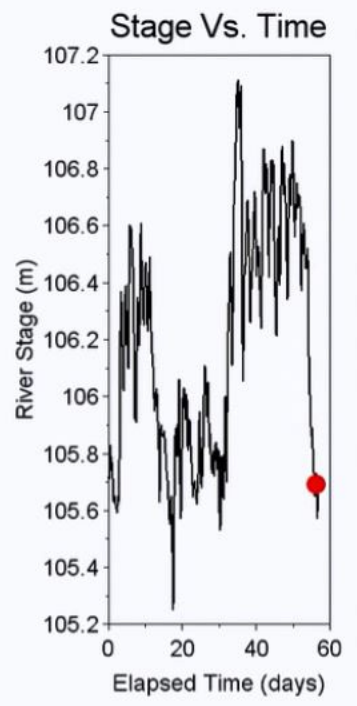
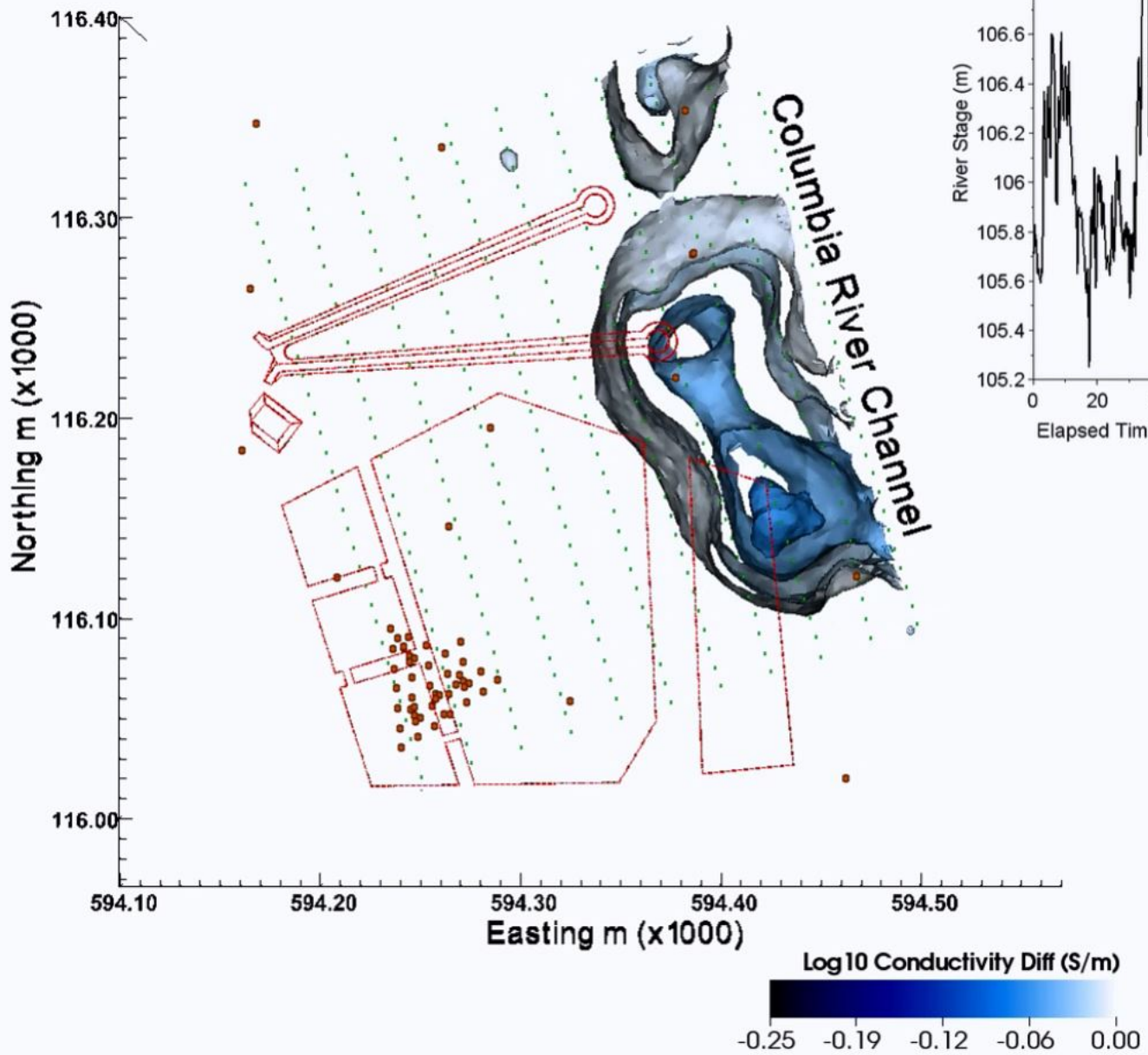




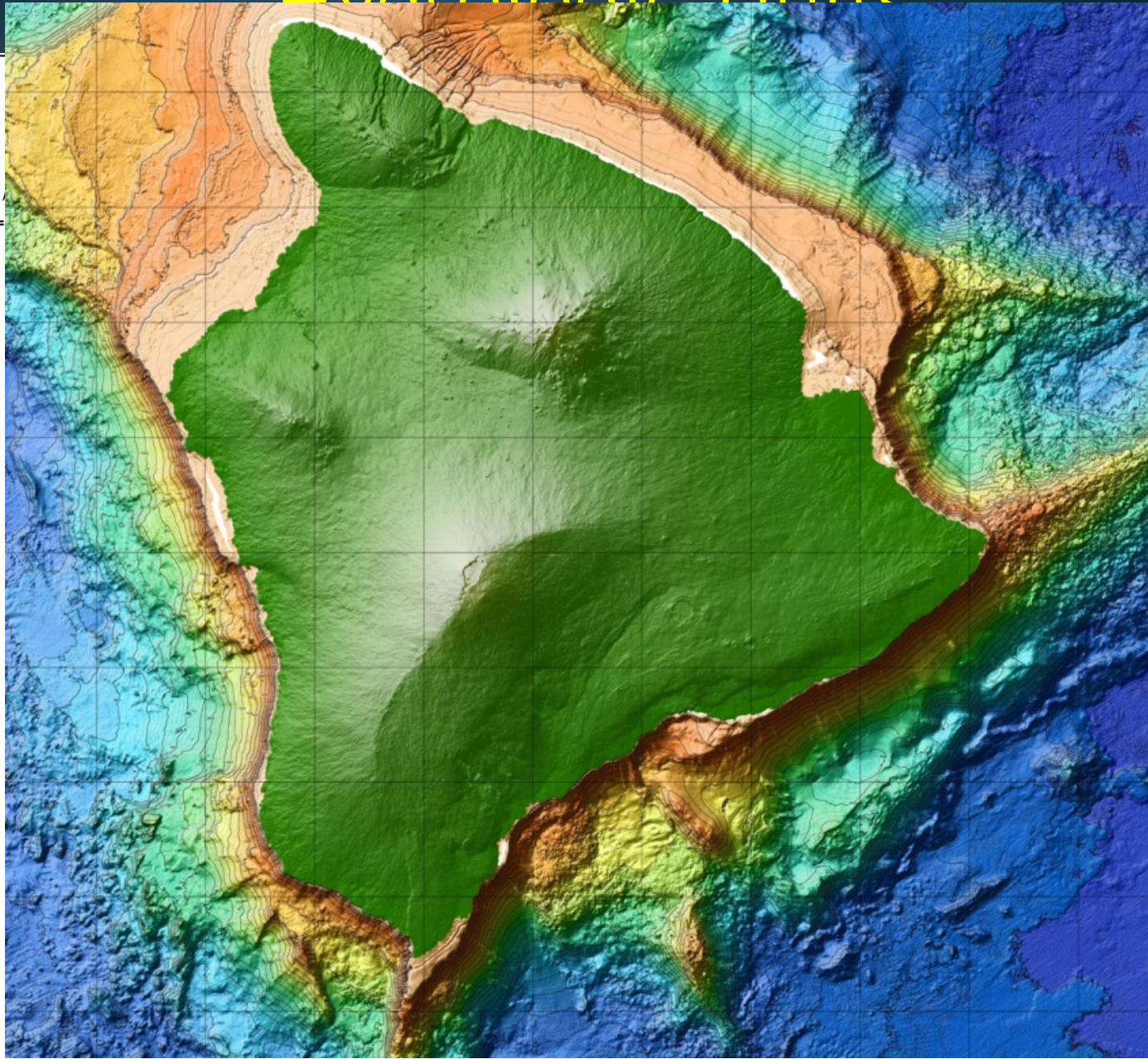








# Hydrologic Units



NT  
All  
code

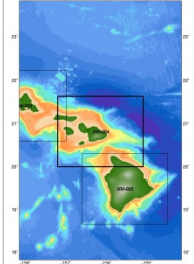
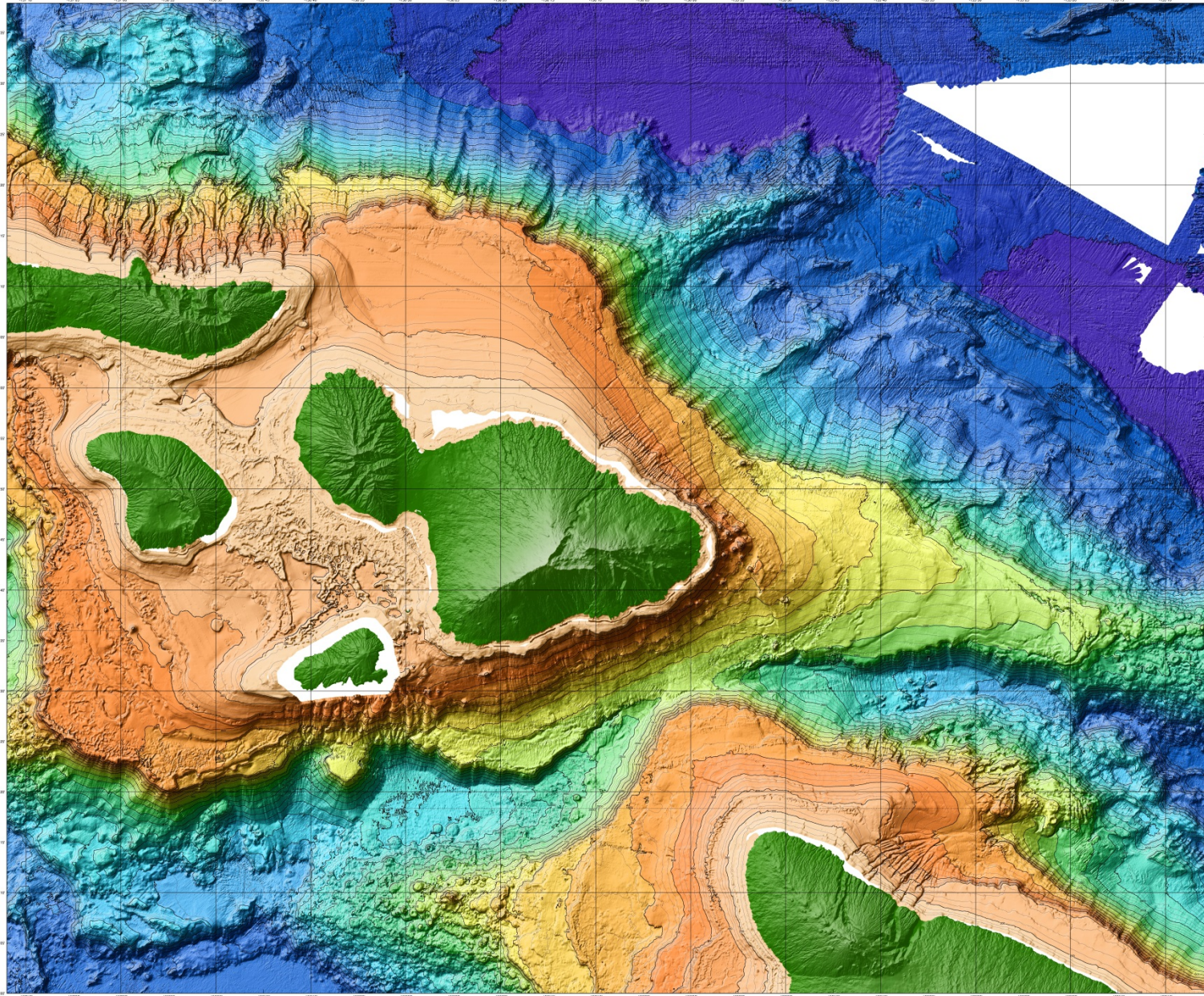
Map ID: 1010

08/28/2008

Map Projection: Universal Transverse Mercator



# Hydrologic Units



LOCATION MAP  
Number of the National Oceanic and Atmospheric Administration Chart 200-004

## Main Hawaiian Islands Chart 200-004

Multibeam Bathymetry  
Data Synthesis

School of Ocean & Earth  
Science & Technology  
University of Hawaii at Manoa

Charted By  
Hawaii Mapping Research Group

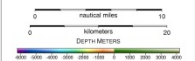


SCHOOL OF OCEAN AND EARTH  
SCIENCE AND TECHNOLOGY



SCALE 1:200,000

MERCATOR PROJECTION



Horizontal Datum: WGS84  
Vertical Datum: WGS84

Geographic Projection: UTM  
Map Datum: WGS84  
Coordinate System: UTM

### NOTES

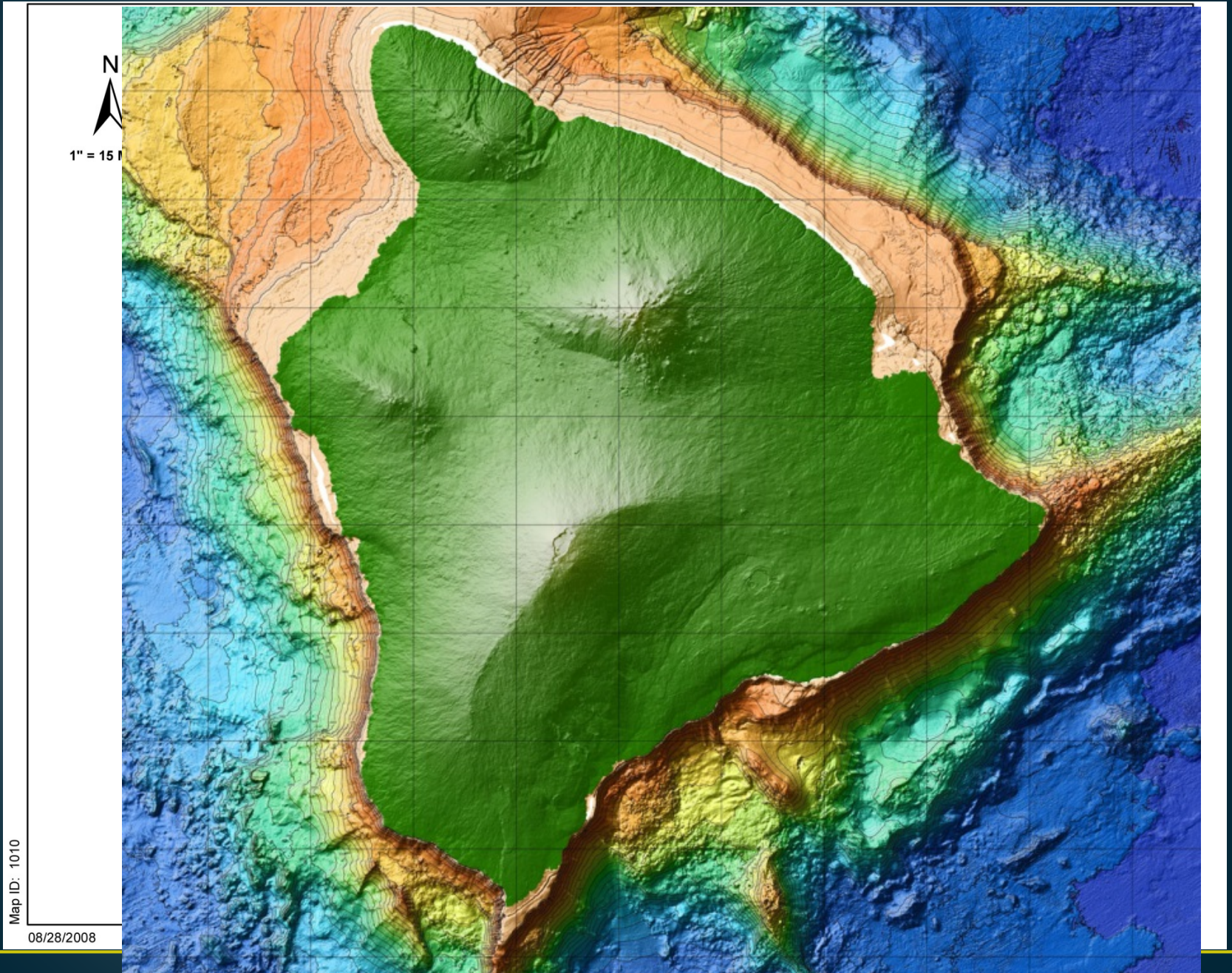
1. Main Hawaiian Islands Multibeam Bathymetry
2. Derived from the Hawaiian Islands Bathymetry Survey (HIBS) data
3. All elevations are relative to Mean Sea Level (MSL)
4. Contours are shown at 100m intervals
5. Contours are shown in locations of adjacent contours
6. Contours are shown in locations of adjacent contours
7. Refer to the chart for navigation

### Not for navigation

For information contact  
Dr. Brian Taylor, SOEST

UNIVERSITY OF HAWAII  
SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY  
1680 ALLOA DRIVE, MANOA, HAWAII 96822 USA  
TEL: 808 955 2771 FAX: 808 955 2839  
WWW: WWW.SOEST.HAWAII.EDU  
DATE: 08/28/2008  
BY: B. TAYLOR  
CHECKED BY: B. TAYLOR  
APPROVED BY: B. TAYLOR  
DATE: 08/28/2008

# Hydrologic Units





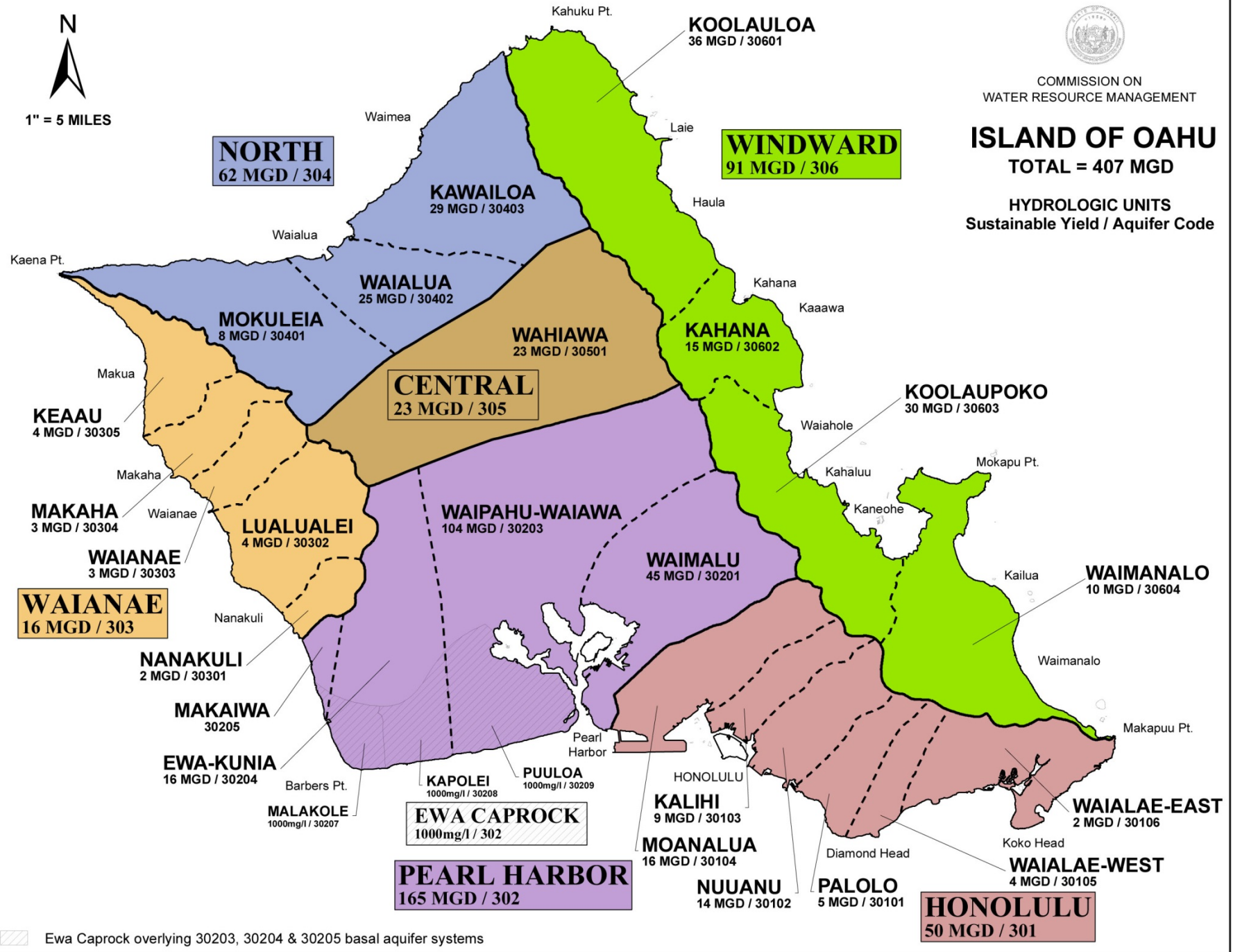
COMMISSION ON  
WATER RESOURCE MANAGEMENT

# ISLAND OF OAHU

TOTAL = 407 MGD

HYDROLOGIC UNITS  
Sustainable Yield / Aquifer Code

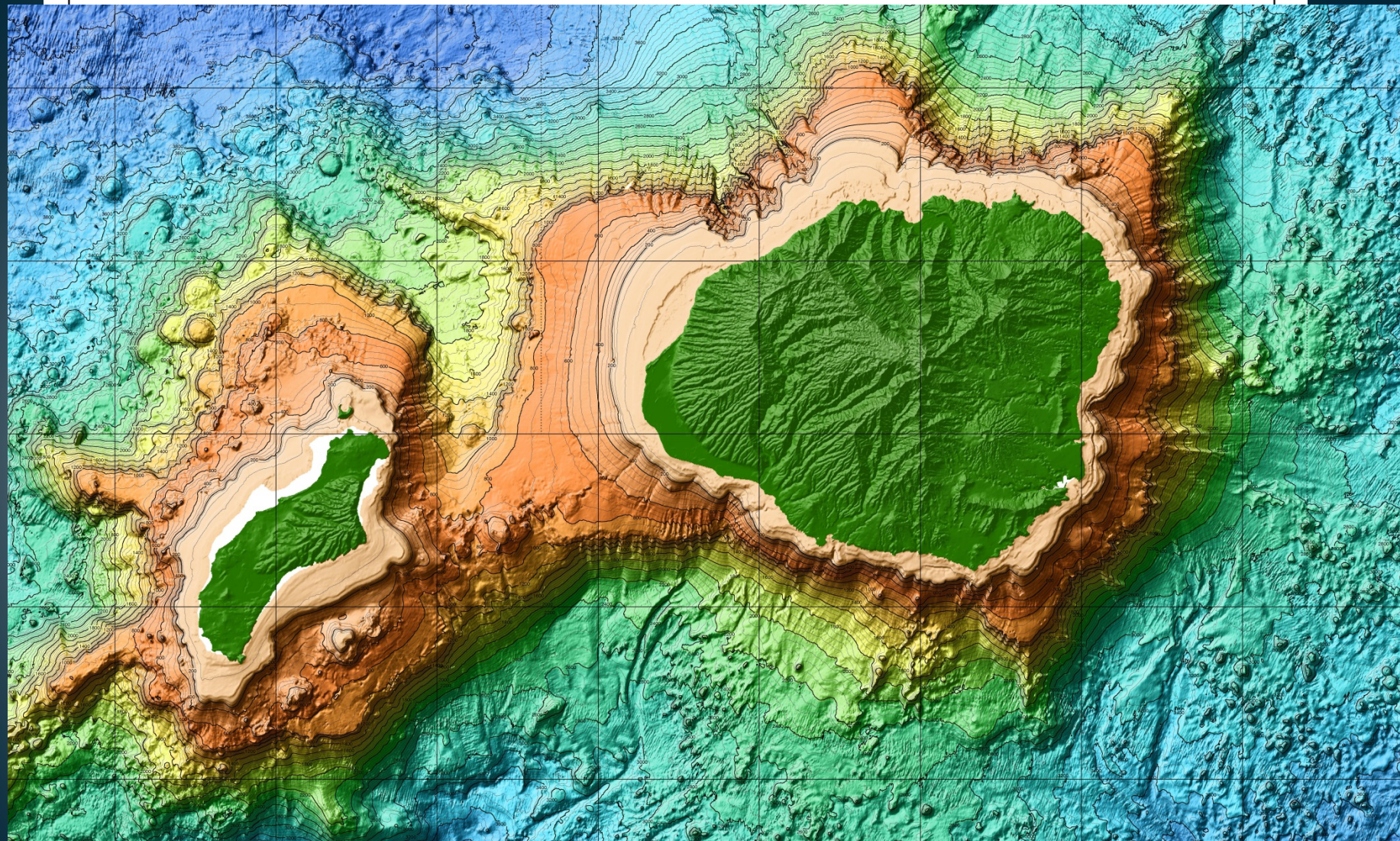
N  
1" = 5 MILES



Legend: Ewa Caprock overlying 30203, 30204 & 30205 basal aquifer systems

Map ID: 1026

# Hydrologic Units



Map ID: 1012

**HANAPEPE**  
22 MGD / 20304

Makahuena Pt.

08/28/2008

Map Projection: Universal Transverse Mercator

EPSCOR Merging the Data  
Needs of the State  
Agencies with those of the  
Scientific Community

A Proposal for a  
Collaborative Resource  
(Re-)Analysis

Don Thomas  
&  
The EPSCOR Team

(To State the Obvious)

- The quality of Hawai'i's ground-water resources is among the best in the world
- We all recognize these resources as critical assets for our communities
- For most communities, the available resource is adequate to meet current needs.... BUT

The resource is under varying degrees and urgencies of threat from multiple stressors:

- Over production in some locations
- Contamination
  - Red Hill (headlines)
  - Pesticide use - (headlines)
  - Wastewater spills - (headlines)
  - OSDS - (no headlines????)
- Climate Change
  - Manmade - or Not - headlines (see Anasazi & overproduction...)

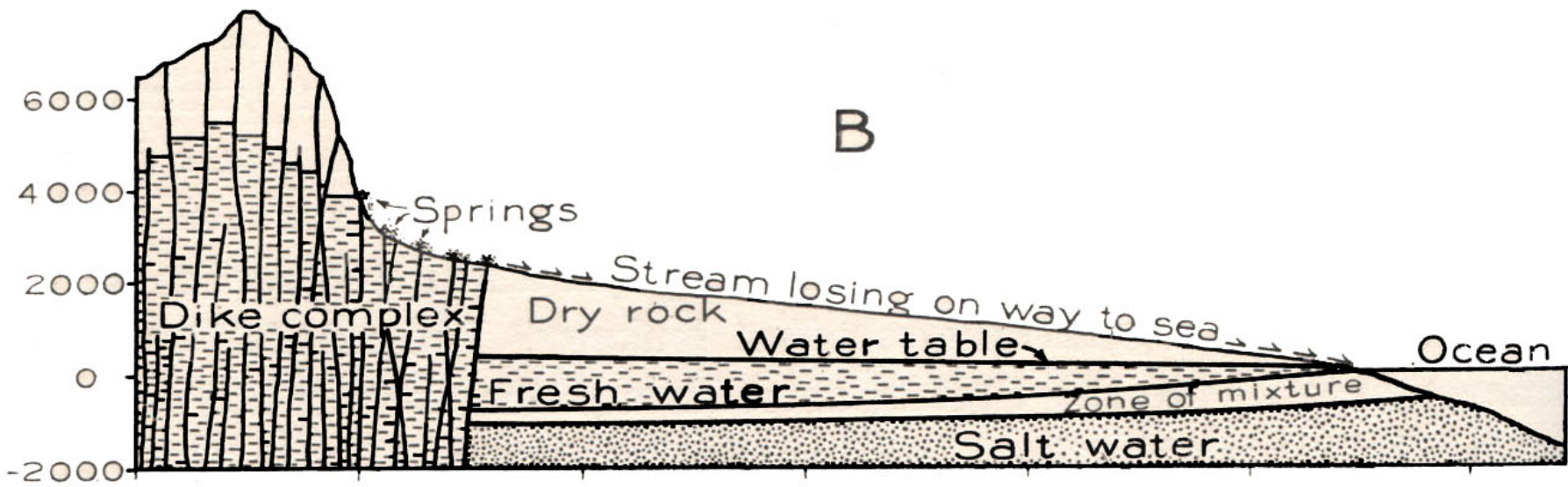
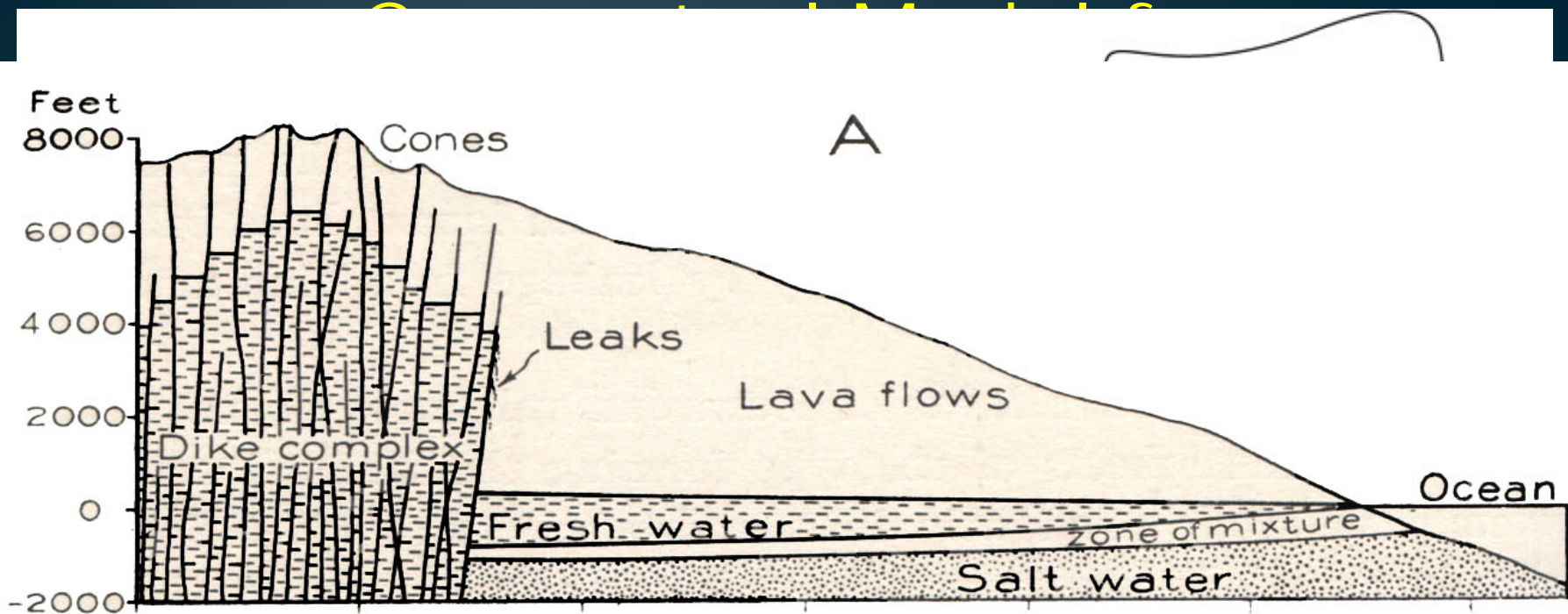
- These threats are managed by
  - CWRM – overproduction, protection of the resource
  - DOH – Point and Non-Point source contamination
  - DWS - quality delivered to the user

All over committed and under-resourced to fully manage the complete spectrum of threats that the resource is subject to...



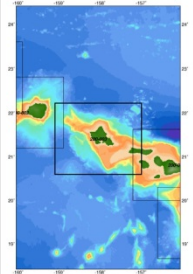
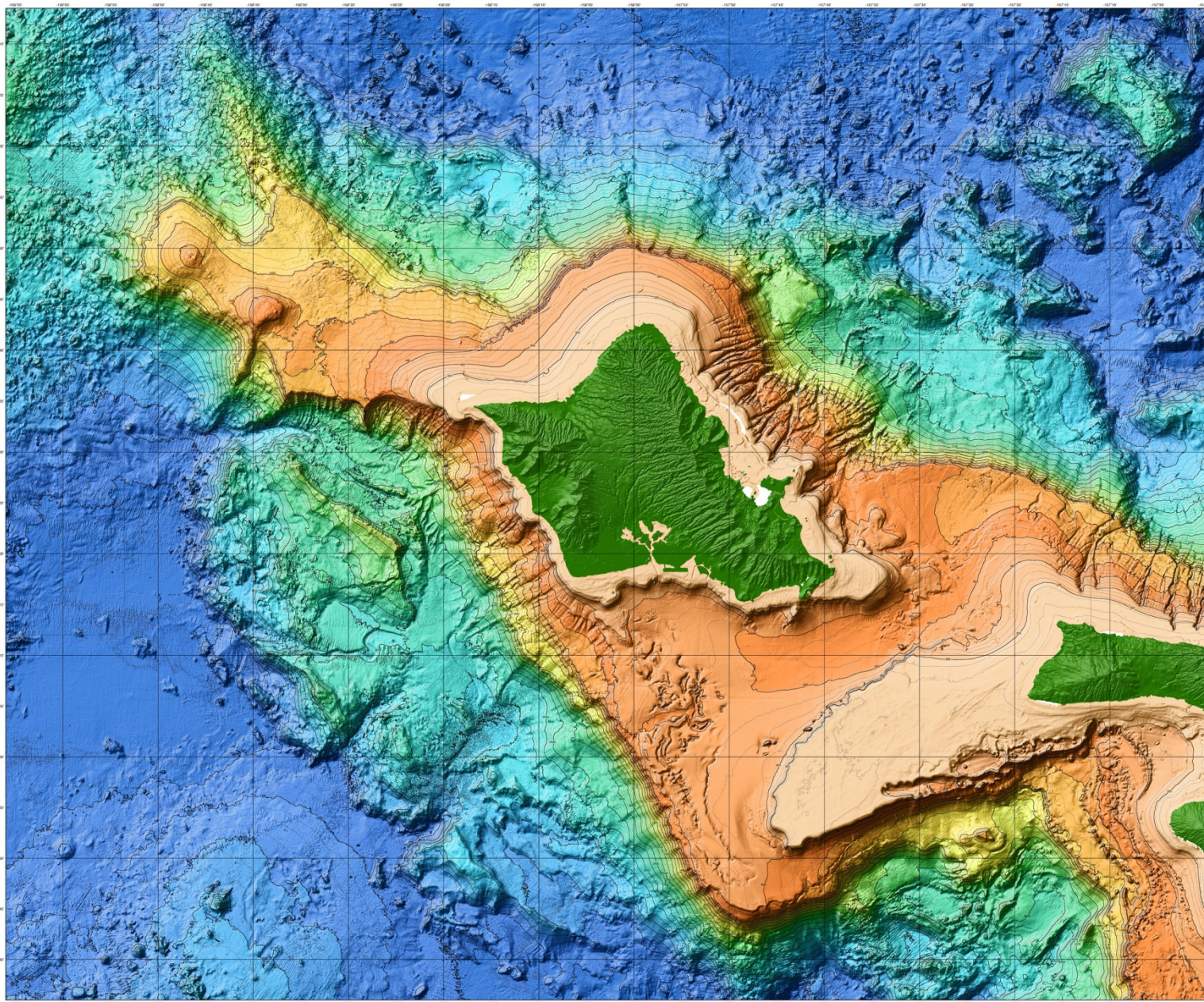
There is a further threat that compounds all the others:

We don't yet fully understand how water flows, or how it is stored, inside Hawai'i's volcanoes



← Generalized Direction of Ground Water Movement

# Hydrologic Units



LOCATION MAP  
Location of the chart outlined in black

Main Hawaiian Islands  
Chart 200-003

Multibeam Bathymetry  
Data Synthesis

School of Ocean & Earth  
Science & Technology

University of Hawaii at Manoa

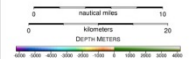
Charted By  
Hawaii Mapping Research Group



SCHOOL OF OCEAN AND EARTH  
SCIENCE AND TECHNOLOGY



SCALE 1:200,000  
MERCAITOR PROJECTION



Horizontal Datum: WGS 84  
Vertical Datum: WGS 84

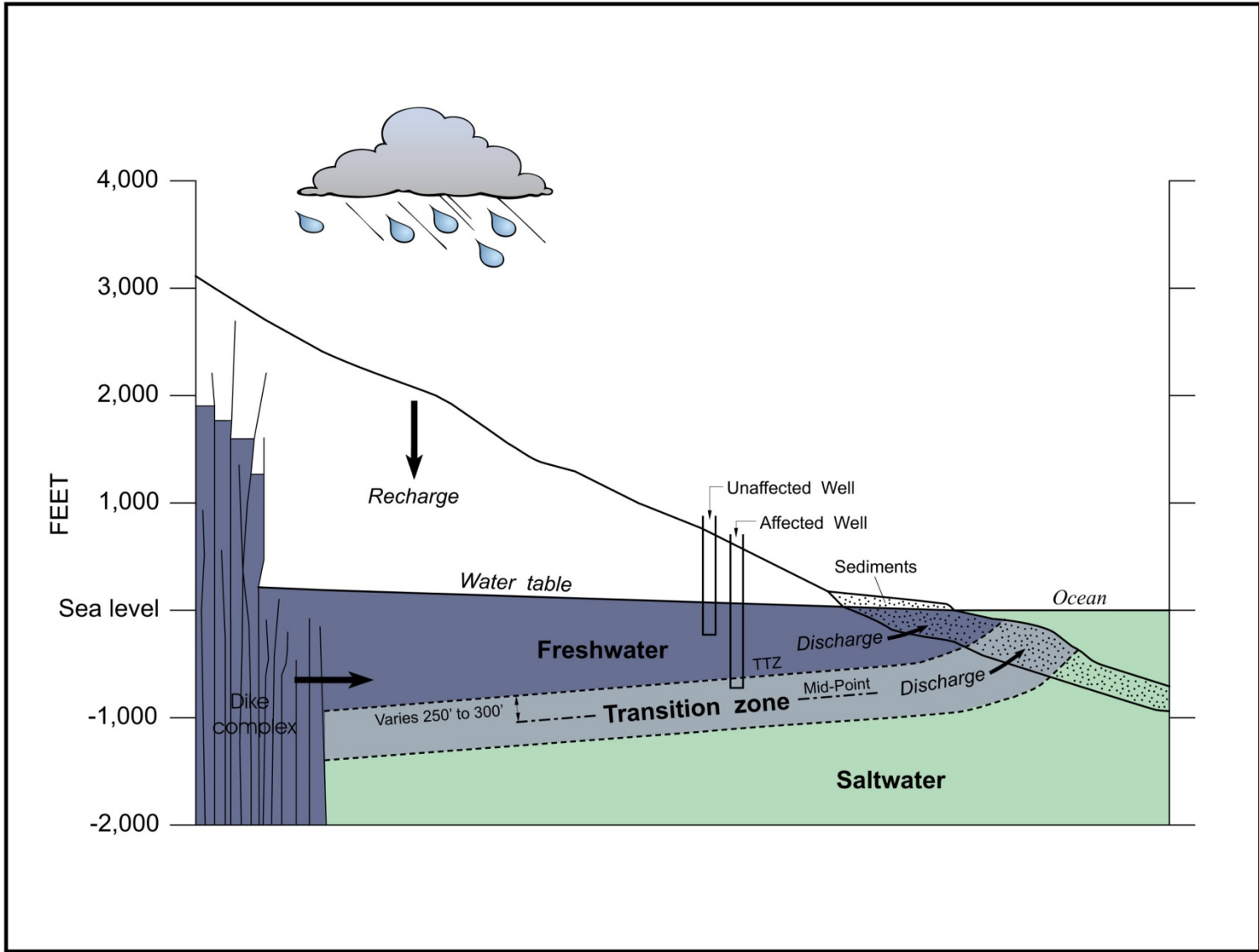
Geoid: IGS09  
Projection: Mercator  
Coordinate System: UTM

- NOTES
1. Bathymetry is derived from multibeam data synthesis.
  2. Bathymetry is based on the 200 m scale.
  3. Bathymetry is based on the 200 m scale.
  4. Bathymetry is based on the 200 m scale.
  5. Bathymetry is based on the 200 m scale.
  6. Bathymetry is based on the 200 m scale.
  7. Bathymetry is based on the 200 m scale.
  8. Bathymetry is based on the 200 m scale.
  9. Bathymetry is based on the 200 m scale.
  10. Bathymetry is based on the 200 m scale.

**Not for navigation**

For information contact  
Dr. Brian Taylor, SOEST

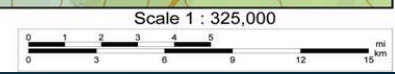
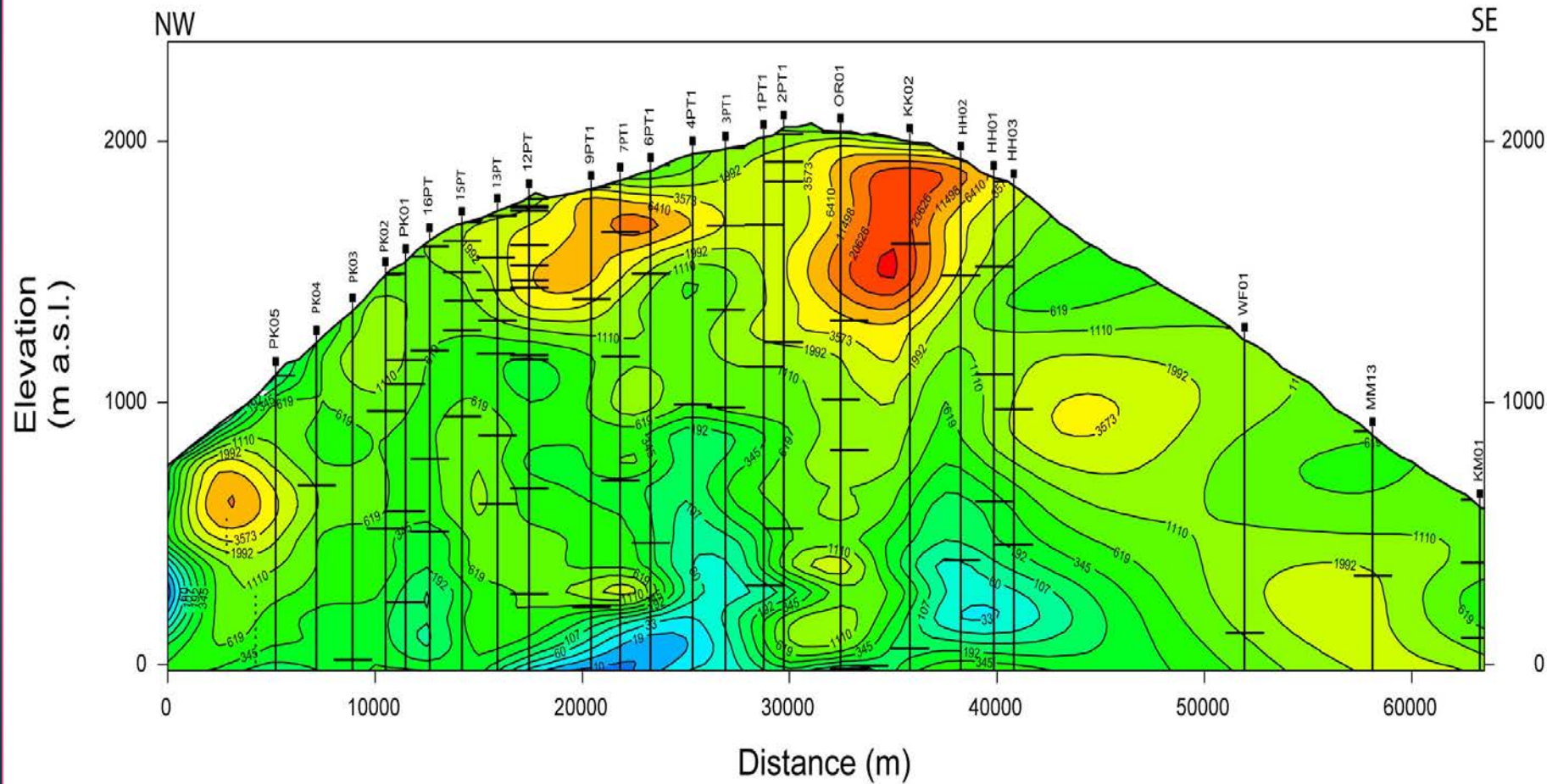
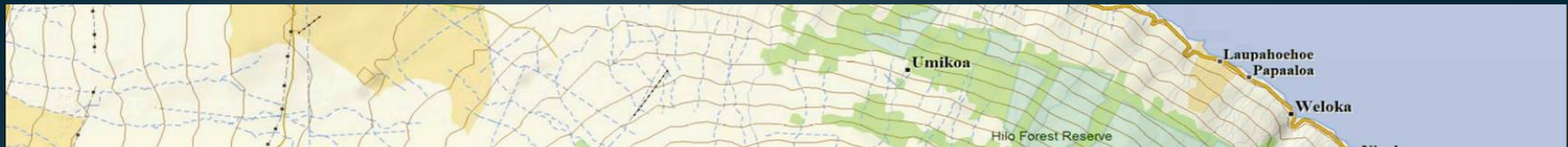
Chart No. 200-003	Scale 1:200,000	Projection: Mercator	Date: 07/20/2011
Chart No. 200-003	Scale 1:200,000	Projection: Mercator	Date: 07/20/2011
Chart No. 200-003	Scale 1:200,000	Projection: Mercator	Date: 07/20/2011

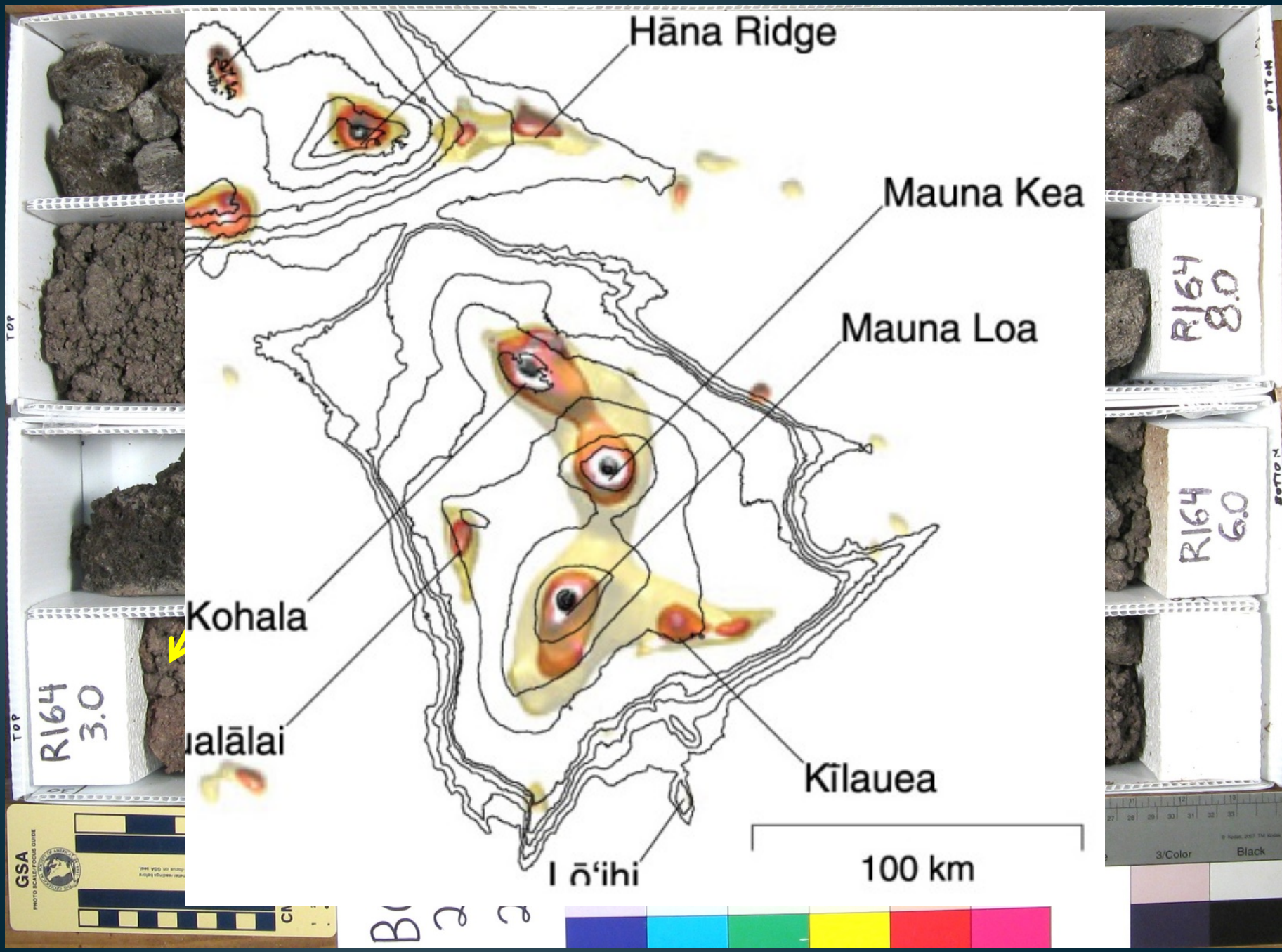




Later drilling, in the Keauhou aquifer, on Hualalai, found a system similar to that found in Hilo

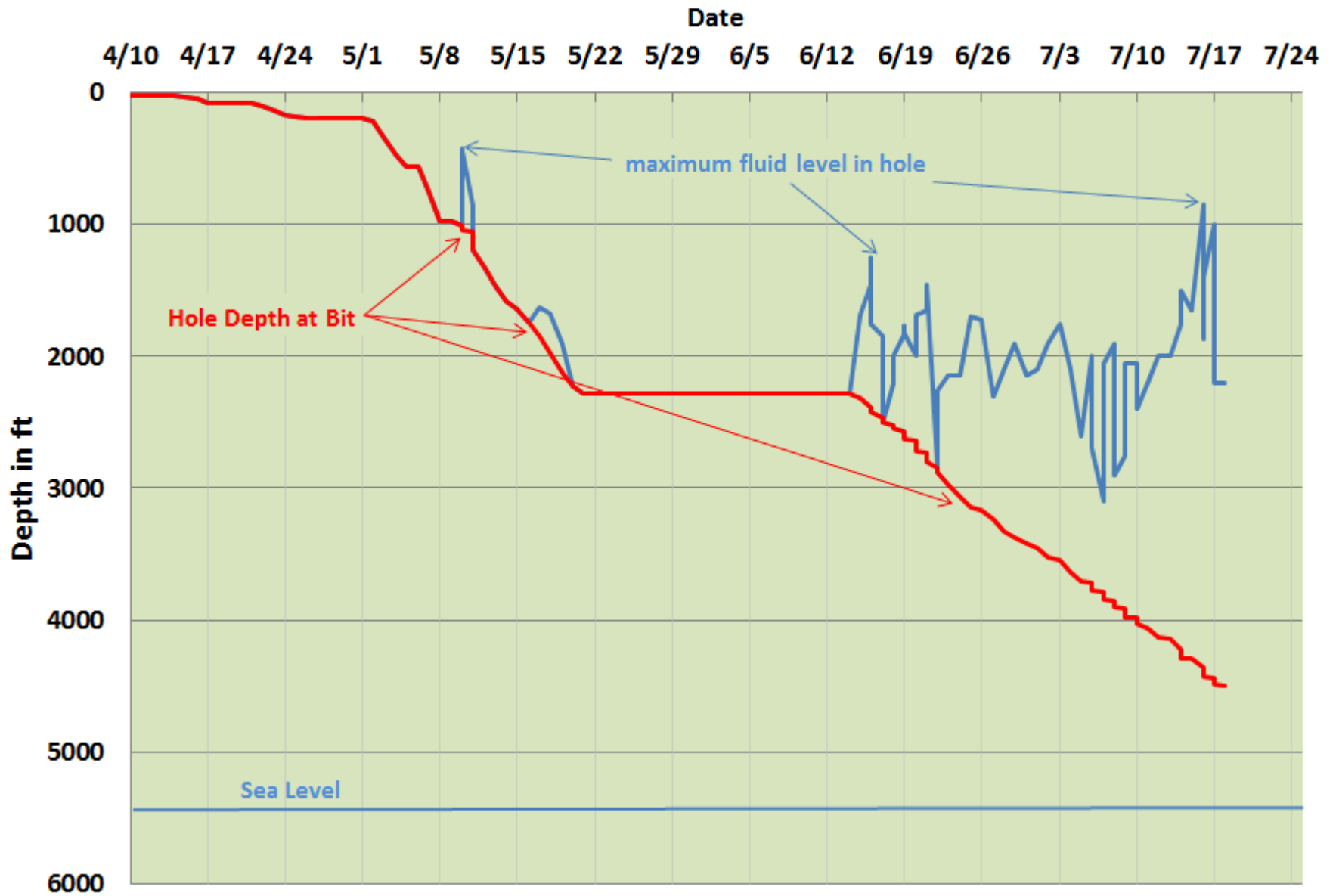
- The Kamakana Well encountered a thin basal lens, underlain by salt water saturated rock down to ~1000' below sea level and then a second freshwater saturated interval below that
- We believe that the Keopu Deep Monitor Well farther south in Kona may have encountered a similar aquifer

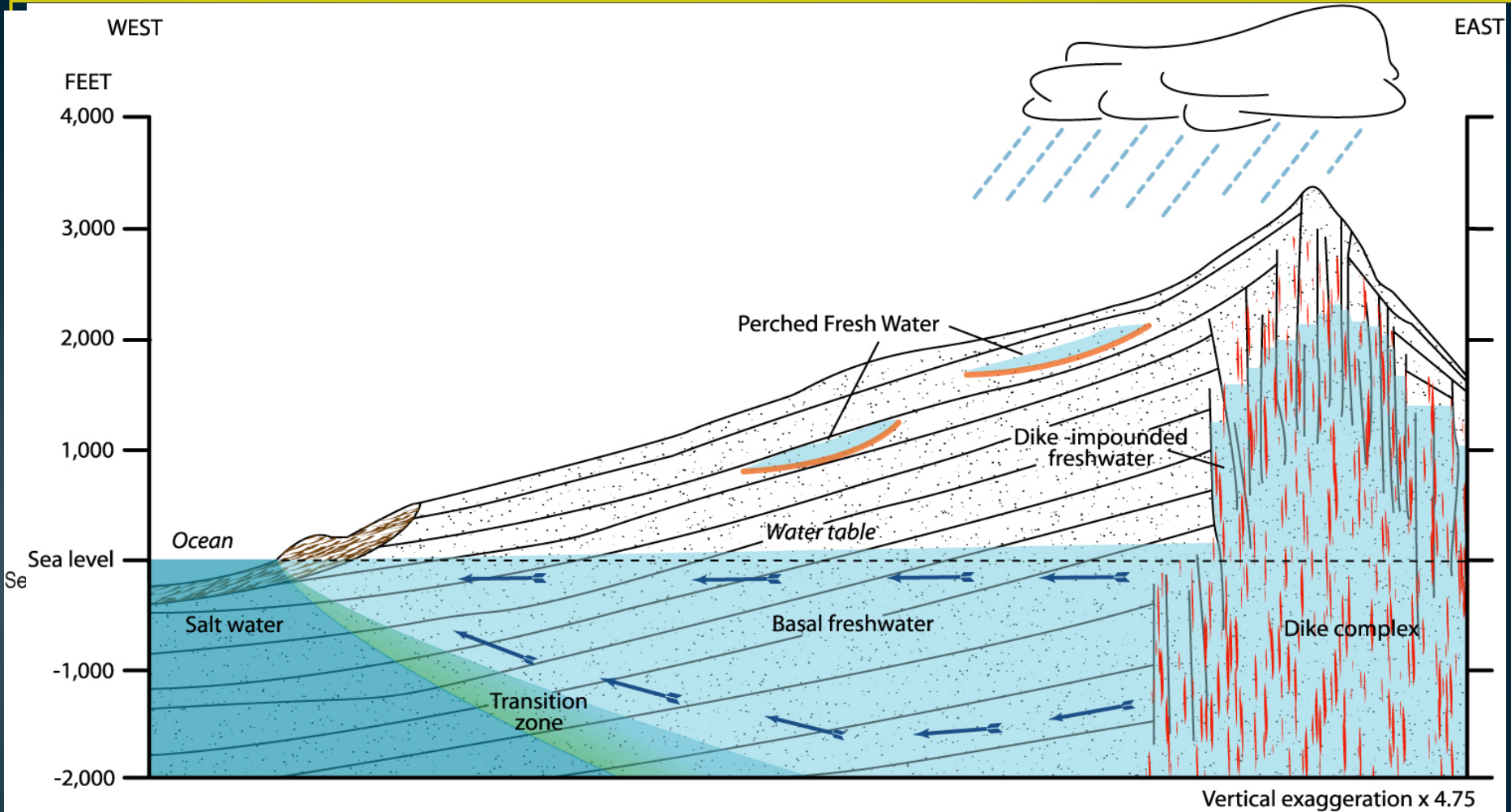







# Depth versus Time



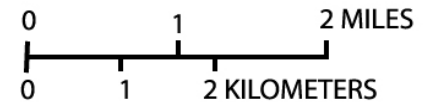


**EXPLANATION**

 Sedimentary Deposits (Caprock)  
Consists of saprolite and overlying coastal-plain sediments

 Basalt

 Generalized Direction of Ground Water Movement

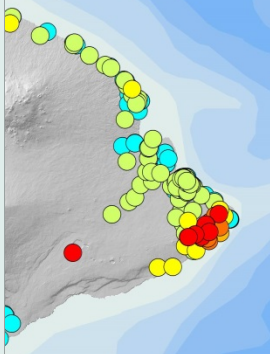
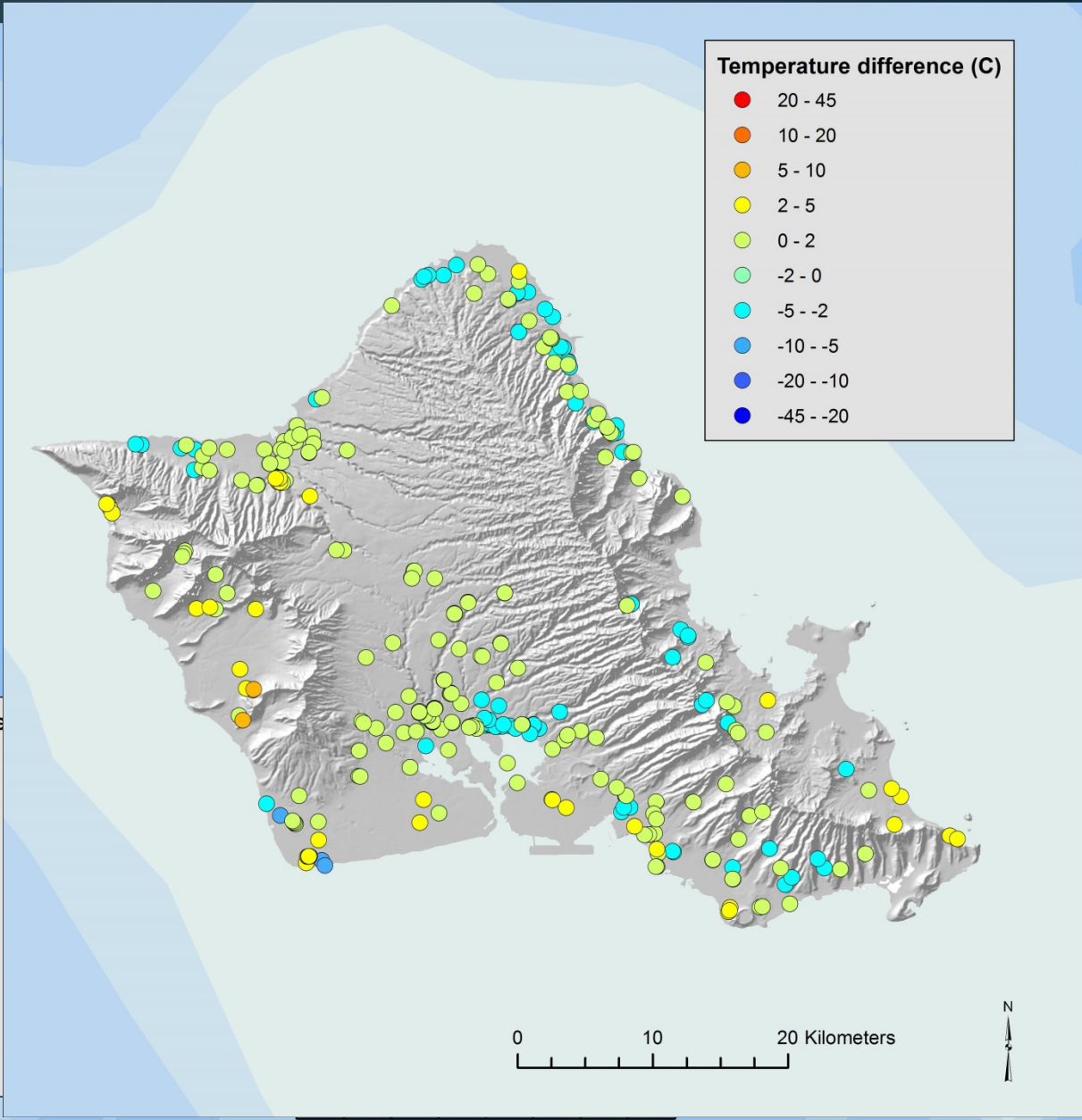
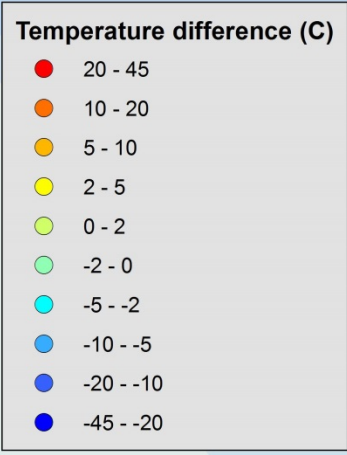


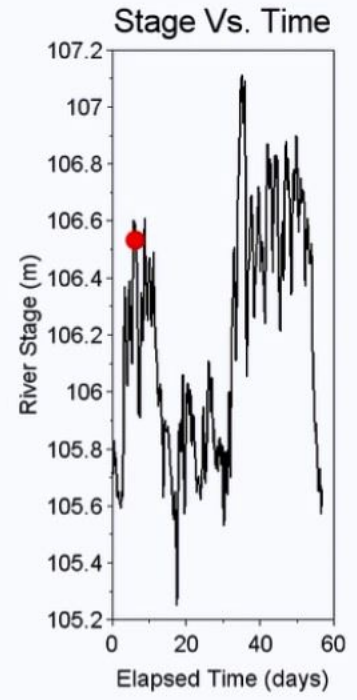
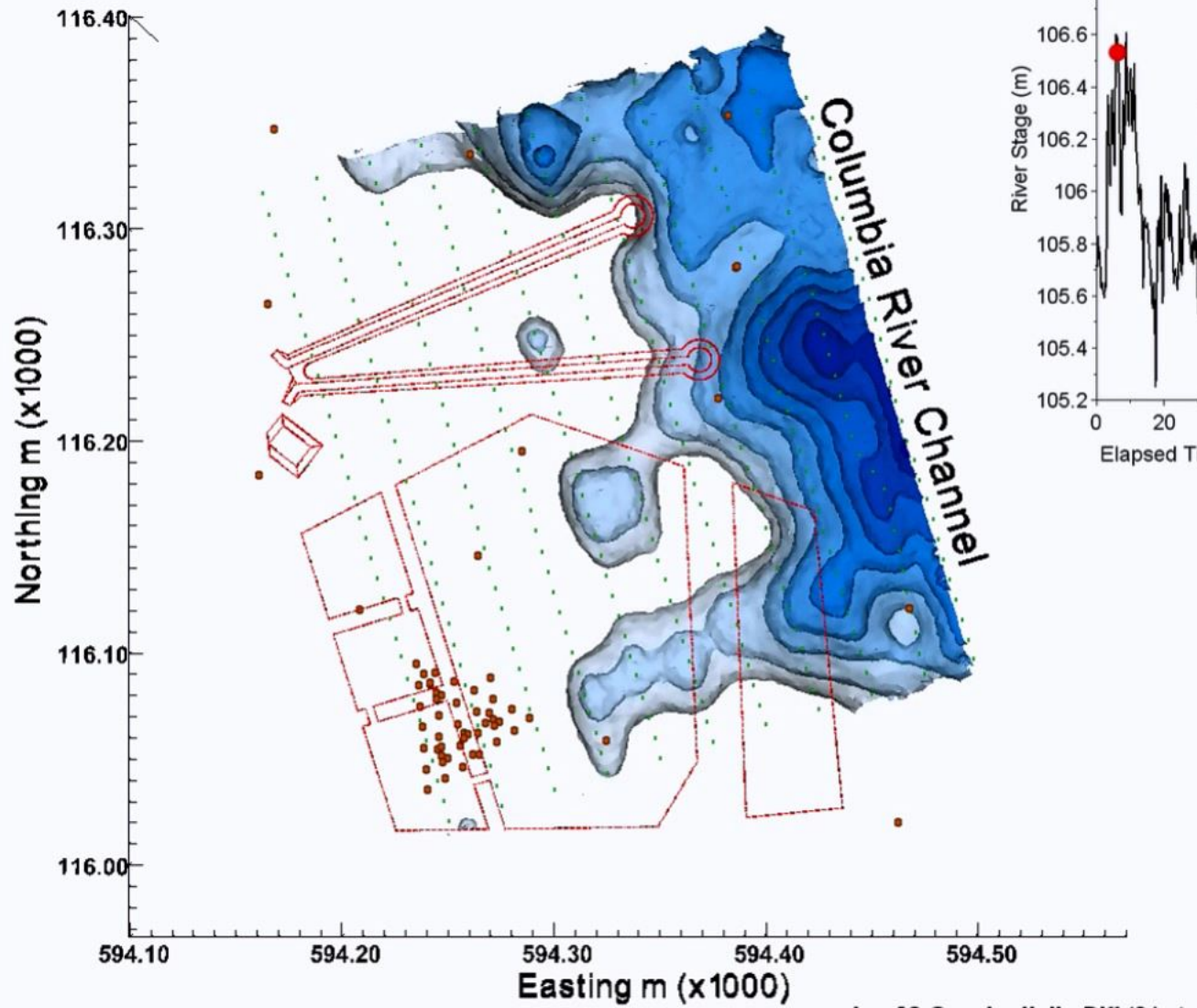
Vertical exaggeration x 4.75

# Proposal

- A collaborative effort among the UH and CWRM, DOH, and county DWS to:
- Better define the distribution and extent of groundwater aquifers (in 3-Dimensions) on each of the islands
- Develop better models for groundwater flow that can more reliably project the rates and direction of flow of the groundwater (and potential contaminants)

# Temperature





# How Do We Propose To Do This

- Develop innovative downhole monitoring instruments that can provide better, more timely, and more robust water level and chemistry data for selected monitoring and production wells
- Develop better estimates of coastal discharge of groundwater that can help us constrain the overall disposition of the recharge into the islands
- Use these legacy and new data sets to test and refine existing conceptual and numerical models for groundwater storage and flow inside the islands

# How Do We Propose To Do Thi\$\$\$

- We currently have a proposal submitted to National Science Foundation that would allow us to cover the costs of conducting a targeted effort to accomplish our goals in the Keauhou/Kiholo and Pearl Harbor/Honolulu aquifers
- Provide funding for interns, field work, development of the visualization software, development of the monitoring tools, model development etc.
- Now working on development of a proposal to DOD for site specific work in the Pearl Harbor area

# Cooperation from our Collaborators

- Provide access to the legacy data and clear guidance on (C.I.) access restrictions
- Provide guidance on the types of monitoring that would be most beneficial to operating needs and access to a subset of wells that can be monitored
- Provide guidance on what mapping or sorting capabilities would be most useful to potential users (e.g. highest chlorides; greatest change in chloride, hits on criteria pollutants, greatest deviation from prior set point, etc.
- Provide us with feedback on areas of interest for conducting active or passive geophysical surveys and tests



# What is the Desired End State

- A better understanding of the groundwater flow and storage inside the islands
- A suite of useful, user-friendly tools for agency staff to monitor the condition, and highlight significant changes, in groundwater quality and availability
- A set of tools that can allow the agencies to better convey the condition of our groundwater resources (and the threats thereto) to the public and decision-makers
- More robust modeling capabilities that can reliably reflect storage and transport processes and can support agency needs (e.g. SWAP, contaminant plume definition)

# What is the Desired End State

- Guidance on how to best access the needed water resources – sustainably – while minimizing costs and adverse impacts on natural hydrologic processes

Old Joke – With A (sharp) Point

I've got good news and bad news:

The good news: In 20 years we'll all be drinking recycled wastewater

The bad news: There's not going to be enough to go around



Pau