Guam Groundwater-Availability Study: Technical Working Group Meeting

September 11, 2013

University of Guam

Marine Laboratory Lecture Room

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Outline of Meeting

- **Overview of USGS water programs in Guam**
- Proposal for rehabilitation and expansion of water-resource monitoring in northern Guam
- Results from the USMC funded study on groundwater availability in northern Guam
- Plans for the DoD funded study on impacts of climate change on water resources in Guam
- Next steps

Mission of the USGS Pacific Islands Water Science Center

- Provide information to manage, protect, and enhance water resources
- Address water-related hazards
- Non-regulatory role
- Provide information that is reliable, impartial, and timely to all stakeholders

Most USGS Water Programs are conducted in cooperation with federal, state, and local agencies. USGS can provide up to 50% of the funds for programs with State and local agencies (including territories and freely associated nations). Other Federal agencies provide 100% of the funds.

USGS Pacific Islands Water Science Center Core Capabilities

Hydrologic Data Collection

- Climate
- Streamflow and suspended sediment
- Groundwater levels and salinity
- Water quality

Research and Assessments

- Statistical analysis
- Hydraulic modeling
- Watershed modeling
- Groundwater flow and solute transport modeling

Information Services

- Flood-alert systems
- WaterWatch web pages
- NWISWeb database
- Publications and presentations

History of USGS Water Programs in Guam

1951	USGS installed stream gages at Pago, Lonfit, and Tolaeyuus Streams, and a rain gage near Fena dam.
1970s	Cooperative Water Program with GovGuam and U.S. Navy expands.
1990	Monitoring program was downsized over the next few years because matching support from GEPA was reduced and then discontinued.
1995	USGS closed its field office at Navy Public Works and continued limited monitoring for the Navy from Saipan and then Honolulu.
1998	Governor Gutierrez signed PL 24-247 which resulted in refurbishment of deep monitoring wells and renewed USGS monitoring in cooperation with WERI. Several water-related studies have been conducted in cooperation with GEPA and WERI over the last decade.

USGS Water-Resource Monitoring, FY2014

Funding

• USGS	$84K
• WERI	$145K
• U.S. Navy	$142K
Total	$371K

Monitoring stations

8 Rainfall

6 Streamflow

1 Reservoir water level

8 Groundwater levels

7 Groundwater-salinity profiles

U.S. Navy Public Works:

2 rainfall, 3 streamflow, and 1 reservoir water-level monitoring station

Semi-annual surveys of Fena Dam settlement markers

Quarterly reports of projected water storage in Fena Valley Reservoir

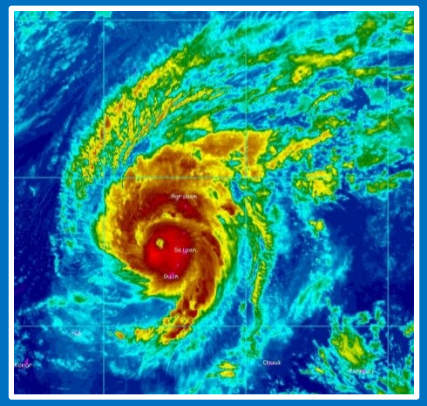
Rainfall and Streamgages for Water Availability and Flood Planning in Southern Guam

Fena watershed monitoring: rainfall (2), streamflow (3), reservoir stage (1) and dam settlement marks for U.S. Navy

Rainfall / runoff model is used to provide quarterly predictions of reservoir storage based on 6-month ENSO rainfall forecast

USGS
science for a changing world

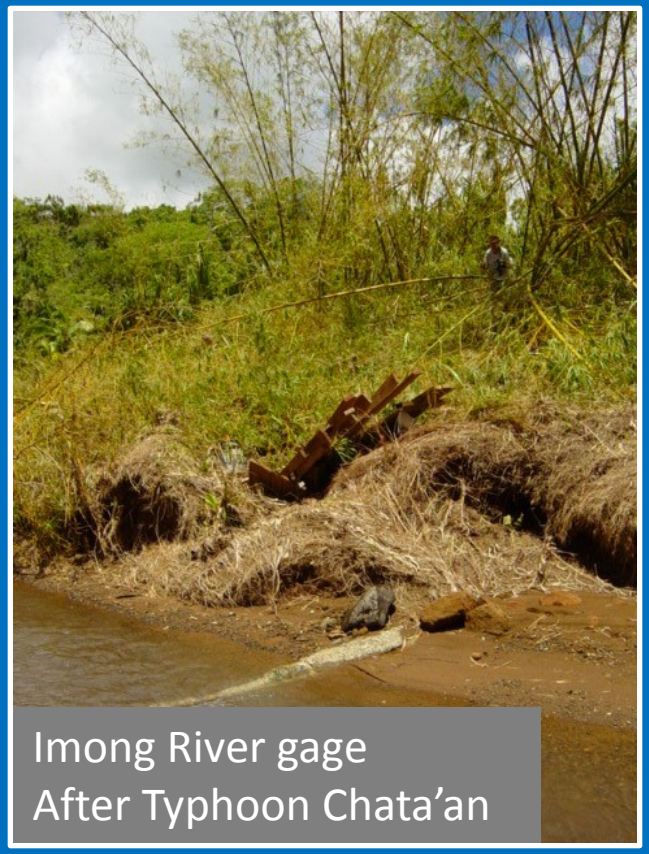
Typhoon Chata'an, 2002



Rainfall and streamflow gages are needed to document extreme events for flood planning

- 20 inches of rain (15" in 3 hours}
- Peak flows for period of record (20-50 years)
- 100+ year recurrence interval
- All 11 stream gages flooded, 5 destroyed

Imong River gage
Before Typhoon Chata'an



Imong River gage
After Typhoon Chata'an

Rainfall Data to Estimate Water-Supply Recharge and Flood-Water Distribution

- Rainfall is measured continuously at 8 locations in cooperation with WERI and for the U.S. Navy
- Data are essential for:
  - Determining how much freshwater infiltrates past the ground surface to reach the water table
  - Evaluating extent of drought events and severity of flooding from typhoons and high intensity rainfall events

Well Monitoring in Northern Guam

- Water levels are measured continuously in 8 wells
- Salinity profiles are collected quarterly to measure the thickness of the freshwater lens in 7 wells
- Salinity was measured continuously at multiple depths in cooperation with GEPA, 2004
- Information needed to understand how current withdrawals are affecting the resource and how future changes in climate and withdrawals may affect the long-term availability of groundwater

Well monitoring is conducted in cooperation with WERI

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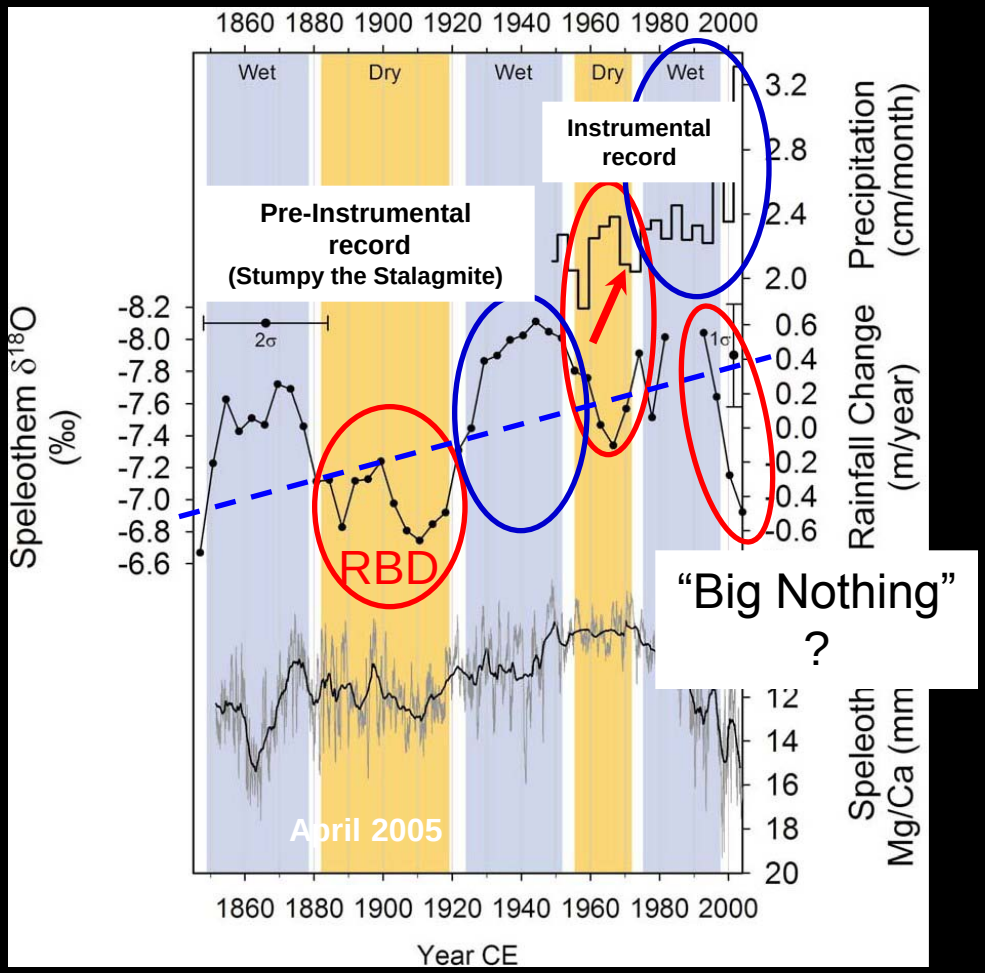
Reasons for Expanded Monitoring

1. Sustainable groundwater development requires accurate and detailed data on aquifer hydrology and geology
   - Water levels and salinity
2. Existing network inadequate to support proposed groundwater development
   - Track responses to development & natural changes
3. Evaluate model predictions & improve future models
   - Models are only as good as the data that go into them

Record of Rainfall History

Jinapsan Cave Stalagmites: Past 160 years

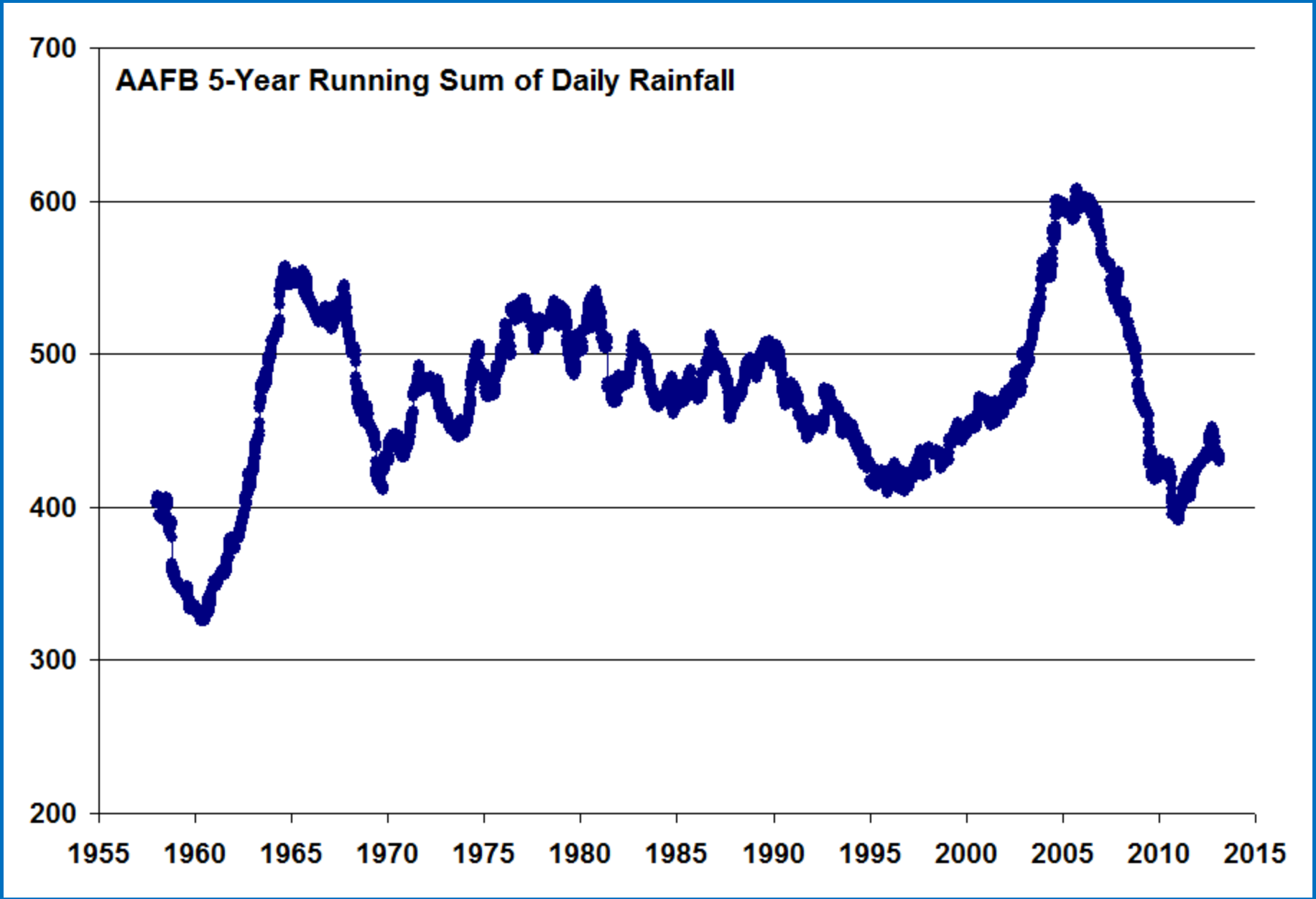


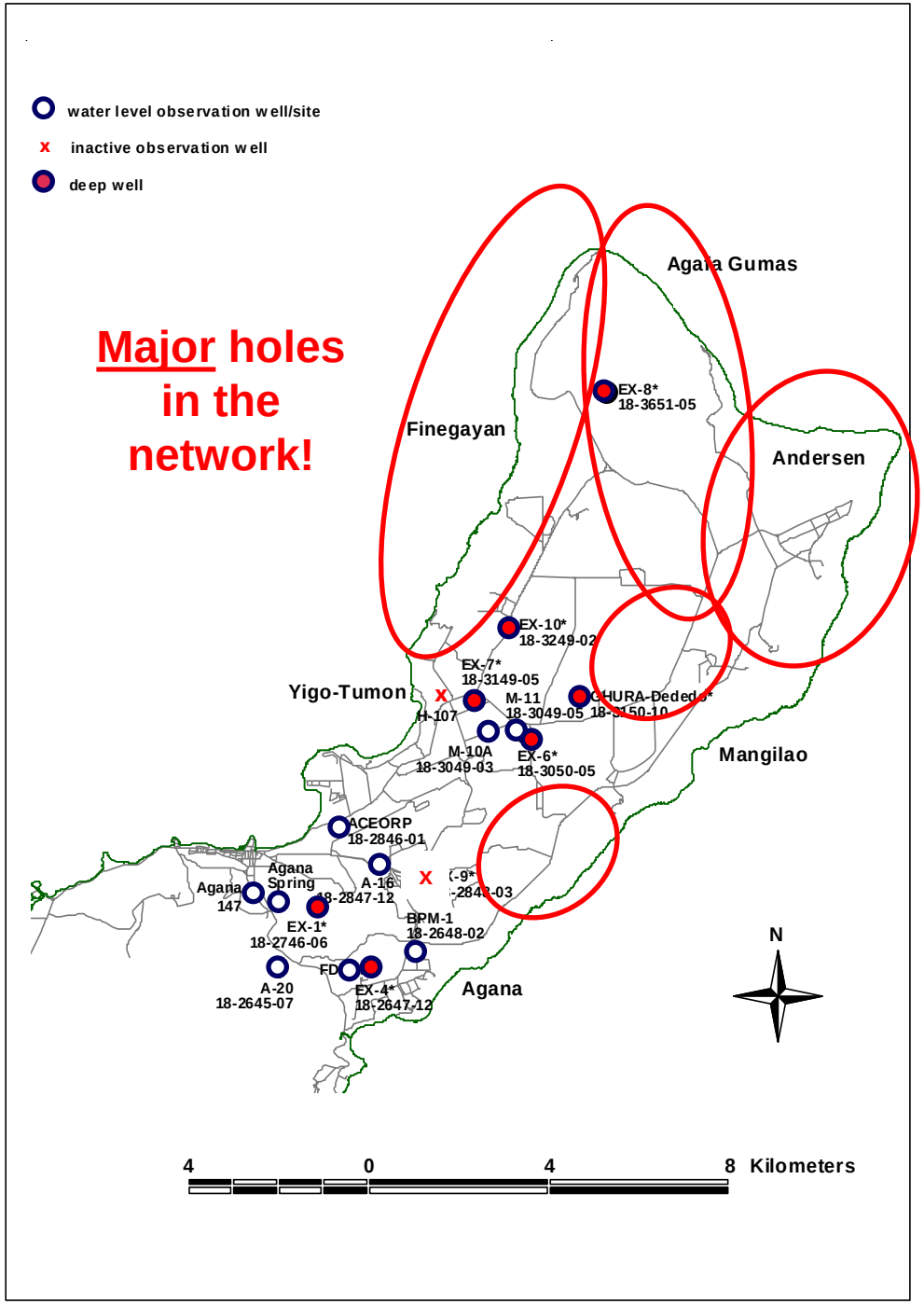
"Big Nothing" ?

Partin, Jenson & Banner et al., 2012

Decadal Oscillations

1. Wetter since the 1970s
   - Current conditions not the norm
2. `50s & `60s much drier
   - 1969-1973 drought (simulated)
3. `20s-`40s wetter than 19th century
4. The Really Big Drought (RBD)
   - 1880-1900: long, hard dry seasons
   - 1900-1920: drier wet seasons
5. Middle 19th Century was "wet"…
   - But not as wet as the middle of the 20th
6. Good news: overall trend for past 160 years is wetter…but only the past 160 years
7. Bad news: The "Big Nothing"
   - Downward limb of the PDO

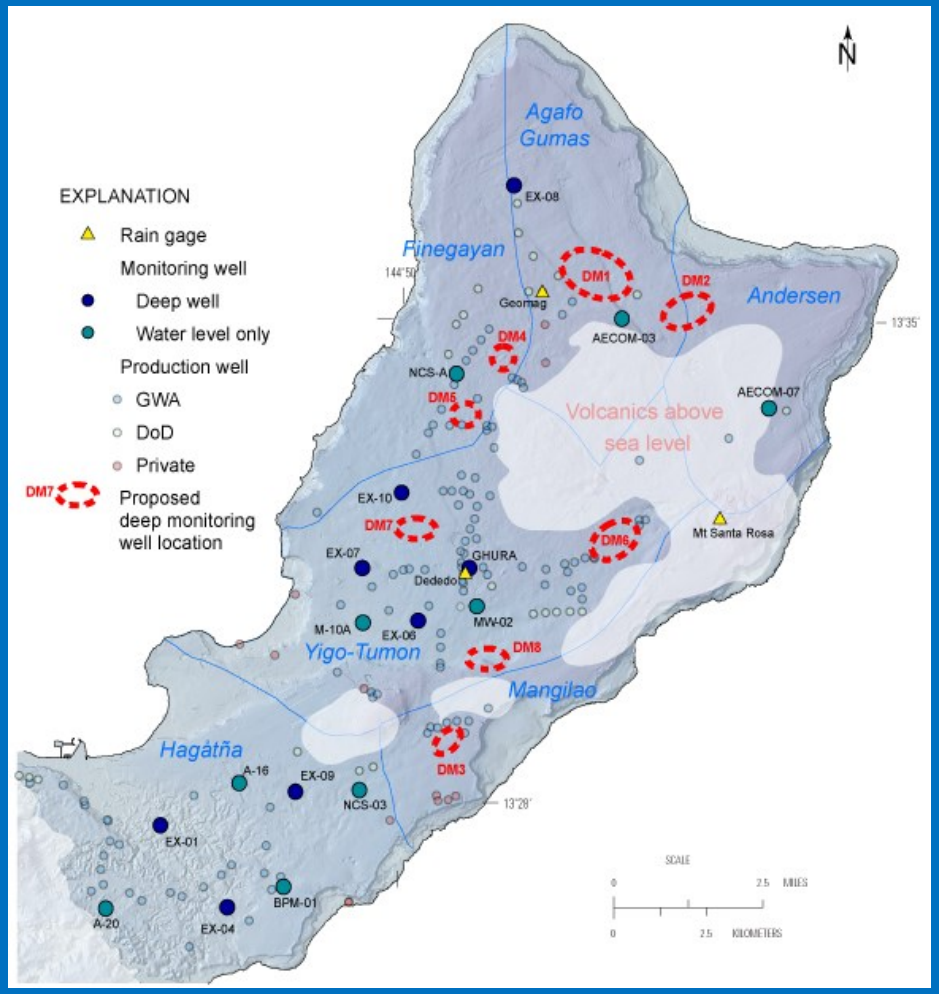

AAFB 5-Year Running Sum of Daily Rainfall
700
600
500
400
300
200
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015



Aquifer Monitoring

- Little/no coverage
  - 4 of 6 basins
- Most especially least developed ones
- Installed 1982
  - Excluded DOD land
- Last rehab 1998
- WERI-USGS Proposal
  1. Rehab existing wells
  2. Upgrade instruments
  3. Expand network to full coverage
  4. Periodic maintenance program

Expansion of Monitoring in Northern Guam



Groundwater Monitoring Wells

- Existing network of 7 deep wells is limited to 2 of the 6 groundwater basins
- 8 new deep wells are needed in areas with little/no coverage (4 of 6 basins)
  - Agafo Gumas/Andersen (DM1, DM2)
  - Finegayan (DM4, DM5)
  - Yigo-Tumon (DM6, DM7, DM8)
  - Mangilao (DM3)

Groundwater Monitoring Strategy

- Water levels, continuous
  - 15 long-term index sites
  - 8 additional sites (7 days every 5 years)
- Salinity
  - Continuous monitoring at 2 fixed depths
    - Above and below mid-point of transition zone
    - Long-term: 2 index sites
    - Short-term: 2 deep wells, rotated for 1-yr periods
  - Semi-annual monitoring of vertical profile of salinity in the water column (all deep wells)

Proposed Funding Breakdown for Monitoring in Northern Guam

Agency	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
DoD	57,000	73,000	63,000	63,000	95,000
GovGuam	196,000	190,000	226,000	221,000	216,000
USGS	70,000	70,000	70,000	70,000	70,000
Total	**323,000**	**333,000**	**359,000**	**354,000**	**381,000**

Additional cost for rehabilitation of existing wells, and design, construction, and testing of new deep monitor wells is estimated to be $2-3M

- 15 existing monitoring wells need to be rehabilitated
- 8 new deep monitor wells are needed for areas that lack a deep monitor well but are either already developed or planned for groundwater development
- Office of Economic Adjustments is possible funding source

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- Overview of USGS water programs in Guam
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Groundwater-Availability Study

- **Project goals, products, timeline**
- Review of project products
- Numerical modeling – final scenarios
  - Calibration to baseline condition
  - Coastal discharge
  - Drought condition (driest 5-year period)
  - Future pumping scenarios

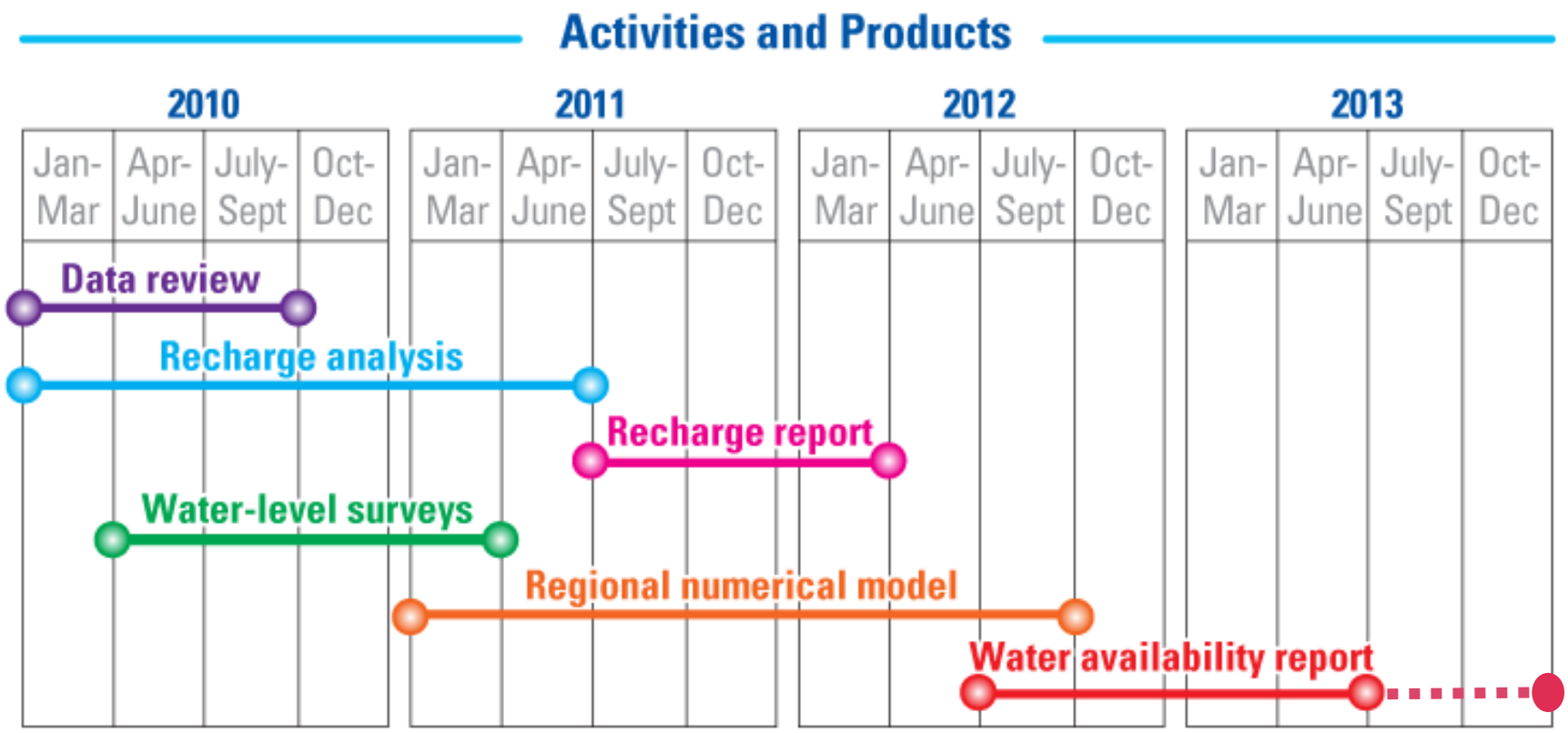
Study Objectives

- Obtain a better understanding of the regional groundwater flow system in northern Guam
- Update estimates of groundwater recharge for the entire island
- Estimate effects of selected withdrawal scenarios within northern Guam, using a numerical groundwater flow and transport model, on water levels and the transition zone between freshwater and saltwater

Study Approach

1. Compile, review, and analyze existing data
2. Collect additional groundwater data in northern Guam
3. Develop daily water budget to estimate groundwater recharge rates
4. Develop numerical groundwater flow and salinity model for northern Guam

Timelines



Planned schedule for the various activities and products of the groundwater-availability study of northern Guam.

Groundwater-Availability Study

- Project goals, products, timeline
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Project Products

- Study overview – USGS Fact Sheet
- Water budget – USGS Scientific Investigations Report
- Hydraulic characteristics – Hydrogeology Journal
- Well database – WERI Tech Report (in prep)
- Volcanic basement map – WERI Tech Report (in prep)
- Groundwater availability/model – USGS Scientific Investigations Report (in USGS editorial review)

Published Reports

Study overview
USGS Fact Sheet

USGS
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WERI

Groundwater Availability Study for Guam—Goals, Approach, Products, and Schedule of Activities

An expected significant population increase on Guam has raised concern about the sustainability of groundwater resources. In response, the U.S. Geological Survey (USGS), in collaboration with the University of Guam's Water and Environmental Research Institute of the Western Pacific (WERI) and with funding from the U.S. Marine Corps (USMC), is conducting a 3.5-year study to advance understanding of regional groundwater dynamics in the Northern Guam Lens Aquifer, provide a new estimate of groundwater recharge, and develop a numerical groundwater flow and transport model for northern Guam. Results of the study, including two USGS reports and a well database, will provide more reliable evaluations of the potential effects of groundwater production and help guide sustainable management of this critical resource.

Introduction

The population of Guam is expected to increase substantially over the next decade during a proposed military forces relocation, which includes a major realignment of U.S. Marine Corps (USMC) personnel and their families to northern Guam. Groundwater production from the Northern Guam Lens Aquifer, currently about 40 million gallons per day, could significantly increase as a result. This prospective increase has prompted concerns over the sustainability of additional groundwater development on the island. Recognizing these concerns, Headquarters, USMC, has provided $1.2 million for the U.S. Geological Survey (USGS) to conduct a 3.5-year groundwater availability study that will provide information and tools to more effectively manage Guam's groundwater resources. The USGS has in turn engaged the University of Guam's Water and Environmental Research Institute of the Western Pacific (WERI), with whom it has had a long-standing collaborative relationship, to provide local scientific expertise and coordinate with local cooperating agencies in developing a well database.

The island of Guam, in the western Pacific Ocean, has a freshwater-lens system in the productive limestone aquifer (Northern Guam Lens Aquifer) underlying the island's northern half, where most of the population resides and where population is expected to increase substantially as a result of military expansion. A groundwater-availability study will help guide sustainable management of this critical and increasingly used resource. The darker "window" in the middle of the aquifer is the extent of the volcanic basement rock above sea level, where groundwater pumping is precluded by the very low permeability of the rock. (Image from U.S. Department of Agriculture, Natural Resources Conservation Service, 20060714, Orthophoto Mosaic for Guam).

U.S. Department of the Interior
U.S. Geological Survey

Fact Sheet 2010–3084
2010

USGS
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Prepared in cooperation with the United States Marine Corps

A Water-Budget Model and Estimates of Groundwater Recharge for Guam

Scientific Investigations Report 2012–5028

U.S. Department of the Interior
U.S. Geological Survey

Recharge estimate
USGS SIR

Aquifer characteristics
Hydrogeology Journal

Springer Link

Hydrogeology Journal
Official Journal of the International Association of Hydrogeologists
© Springer-Verlag Berlin Heidelberg 2013
10.1007/s10040-012-0949-9

Report

Estimating hydraulic properties from tidal attenuation in the Northern Guam Lens Aquifer, territory of Guam, USA

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(2) US Geological Survey, Pacific Islands Water Science Center, 677 Ala Moana Blvd, No. 415, Honolulu, HI 96813, USA
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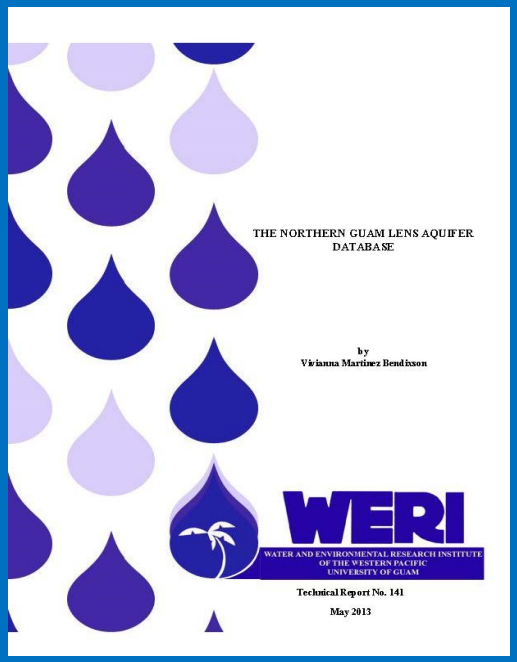
Received: 29 May 2012
Accepted: 18 December 2012
Published online: 15 January 2013

Abstract

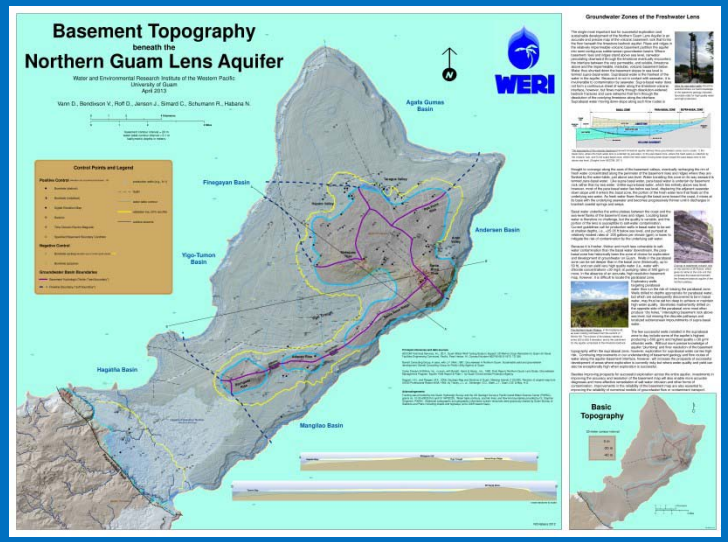
Tidal-signal attenuations are analyzed to compute hydraulic diffusivities and estimate regional hydraulic conductivities of the Northern Guam Lens Aquifer, Territory of Guam (Pacific Ocean), USA. The results indicate a significant tidal-damping effect at the coastal boundary. Hydraulic diffusivities computed using a simple analytical solution for well responses to tidal forcings near the periphery of the island are two orders of magnitude lower than for wells in the island's interior. Based on assigned specific yields of ~0.01–0.4, estimated hydraulic conductivities are ~20–800 m/day for peripheral wells, and ~2,000–90,000 m/day for interior wells. The lower conductivity of the peripheral rocks relative to the interior rocks may best be explained by the effects of karst evolution: (1) dissolutional enhancement of horizontal hydraulic conductivity in the interior; (2) case-hardening and concurrent reduction of local hydraulic conductivity in the cliffs and steeply inclined rocks of the periphery; and (3) the stronger influence of higher-conductivity regional-scale

Reports in preparation

Well database
WERI Tech Report

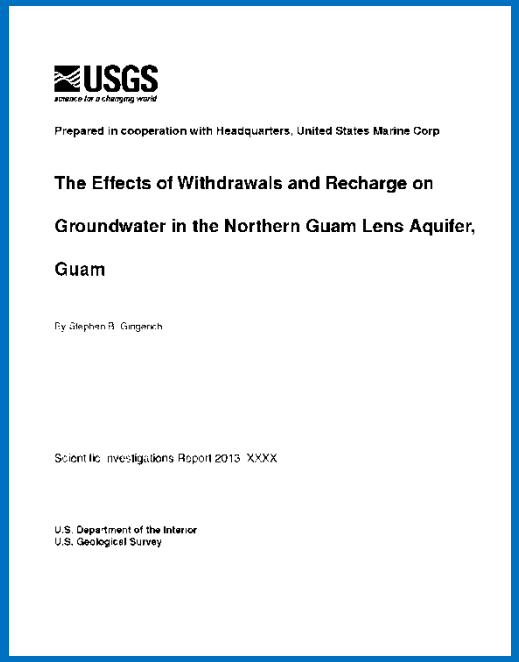


Basement map
WERI Tech Report



Volcanic basement
WERI Tech Report

Groundwater availability
USGS SIR



Groundwater-Availability Study

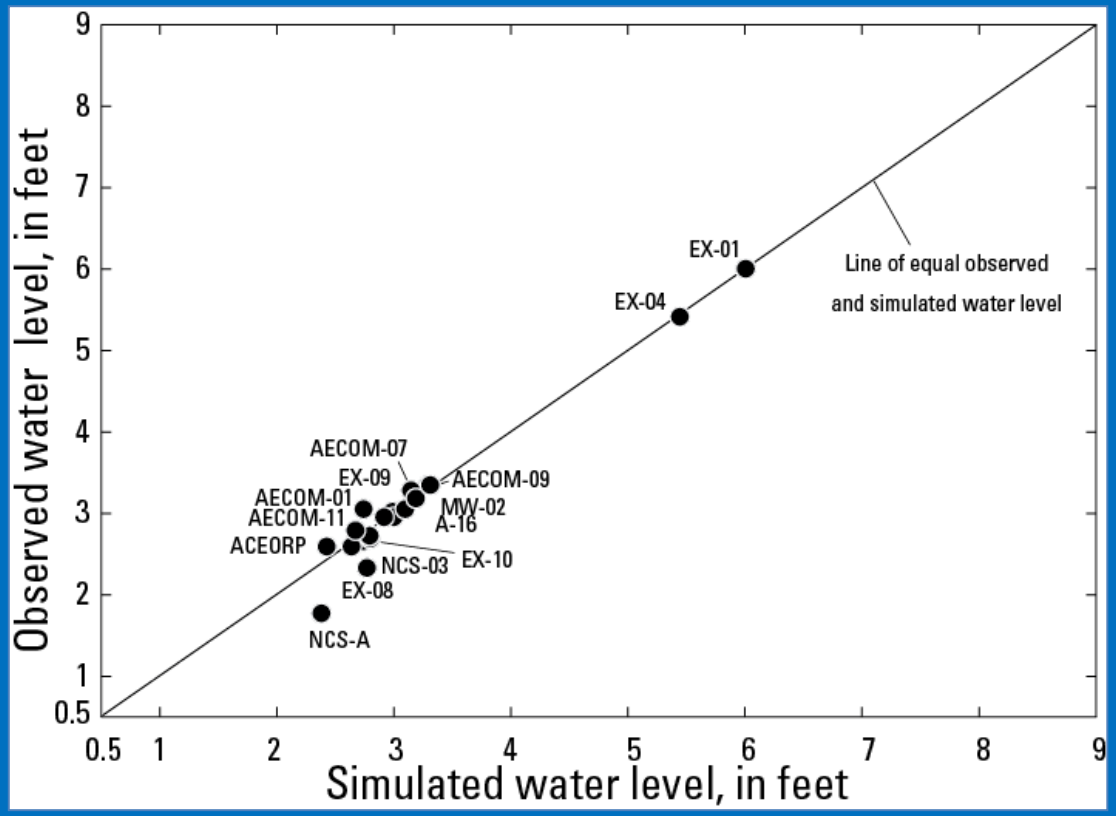
- Project goals, products, timeline
- Review of project products
- **Numerical modeling – final scenarios**
  - Calibration to baseline condition
  - Coastal discharge
  - Drought condition (driest 5-year period)
  - Future pumping scenarios

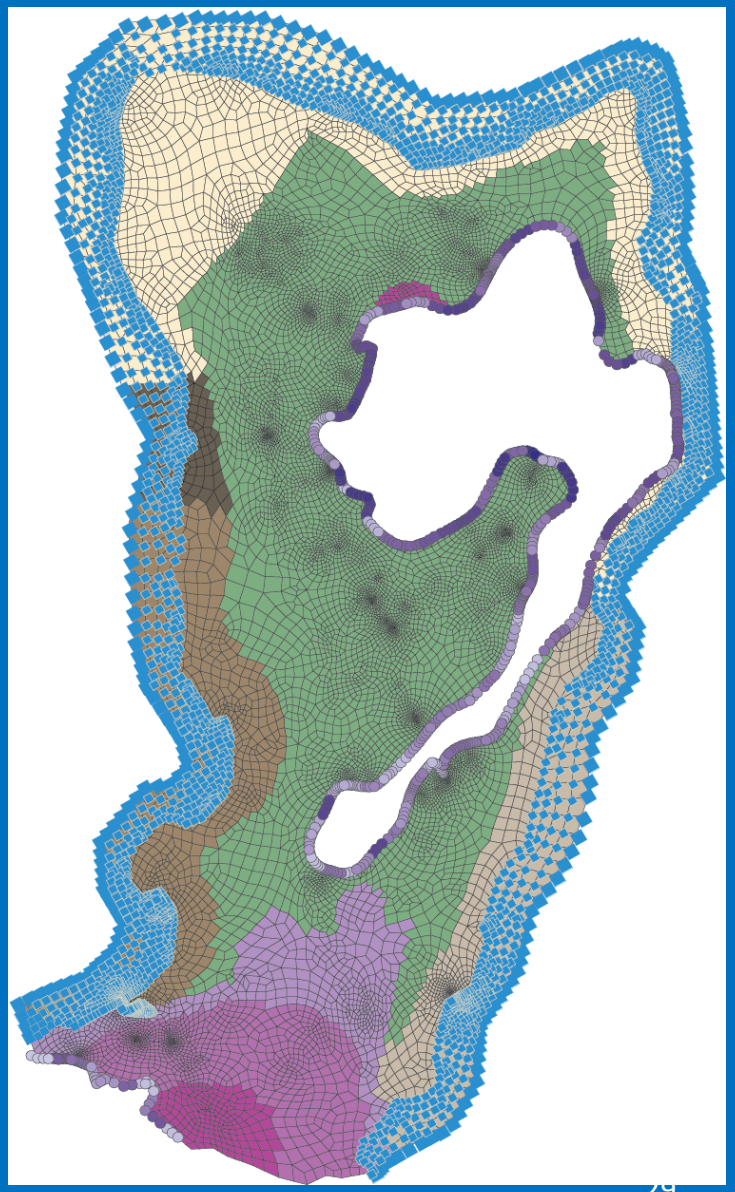
Model Calibration-Baseline Condition

- Hydrologic conditions
  - Long-term average recharge (1961-2005 rainfall; 2004 land cover)
  - 2010 pumping rates

- Calibration targets
  - Average 2010 water levels and tidal fluctuations
  - December 2009 salinity profiles

Observed and Simulated Water Levels





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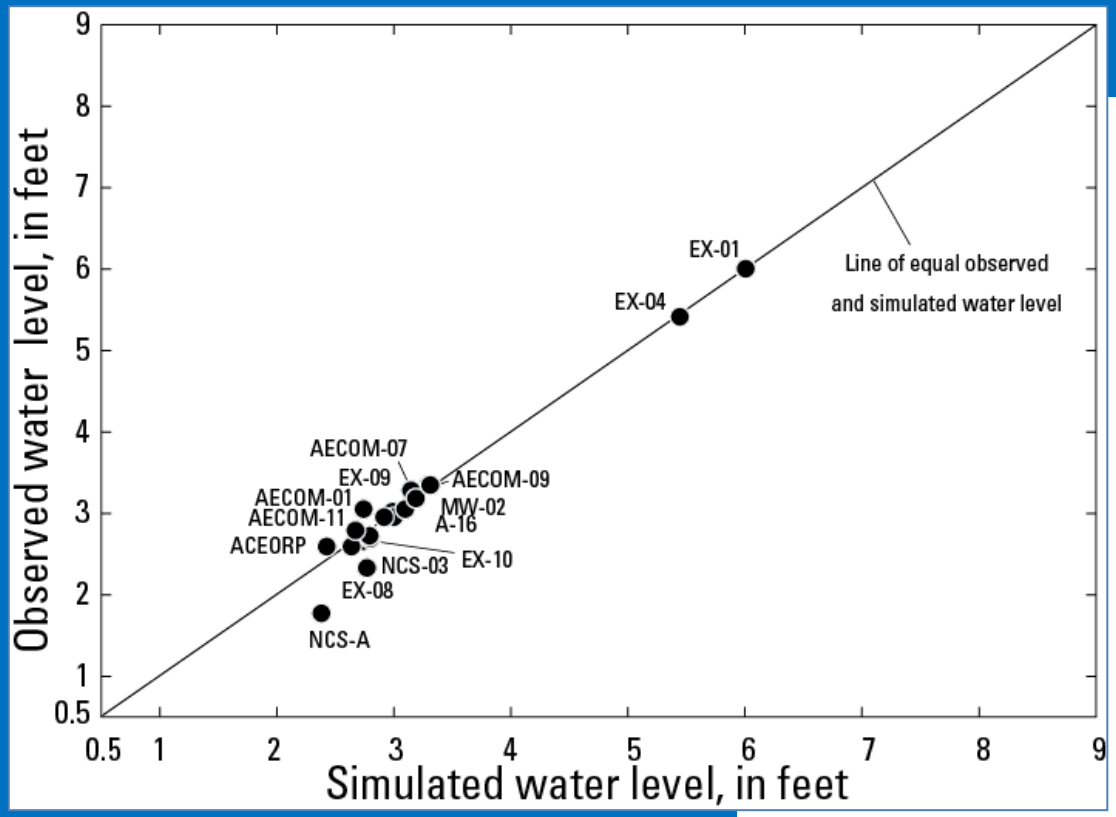
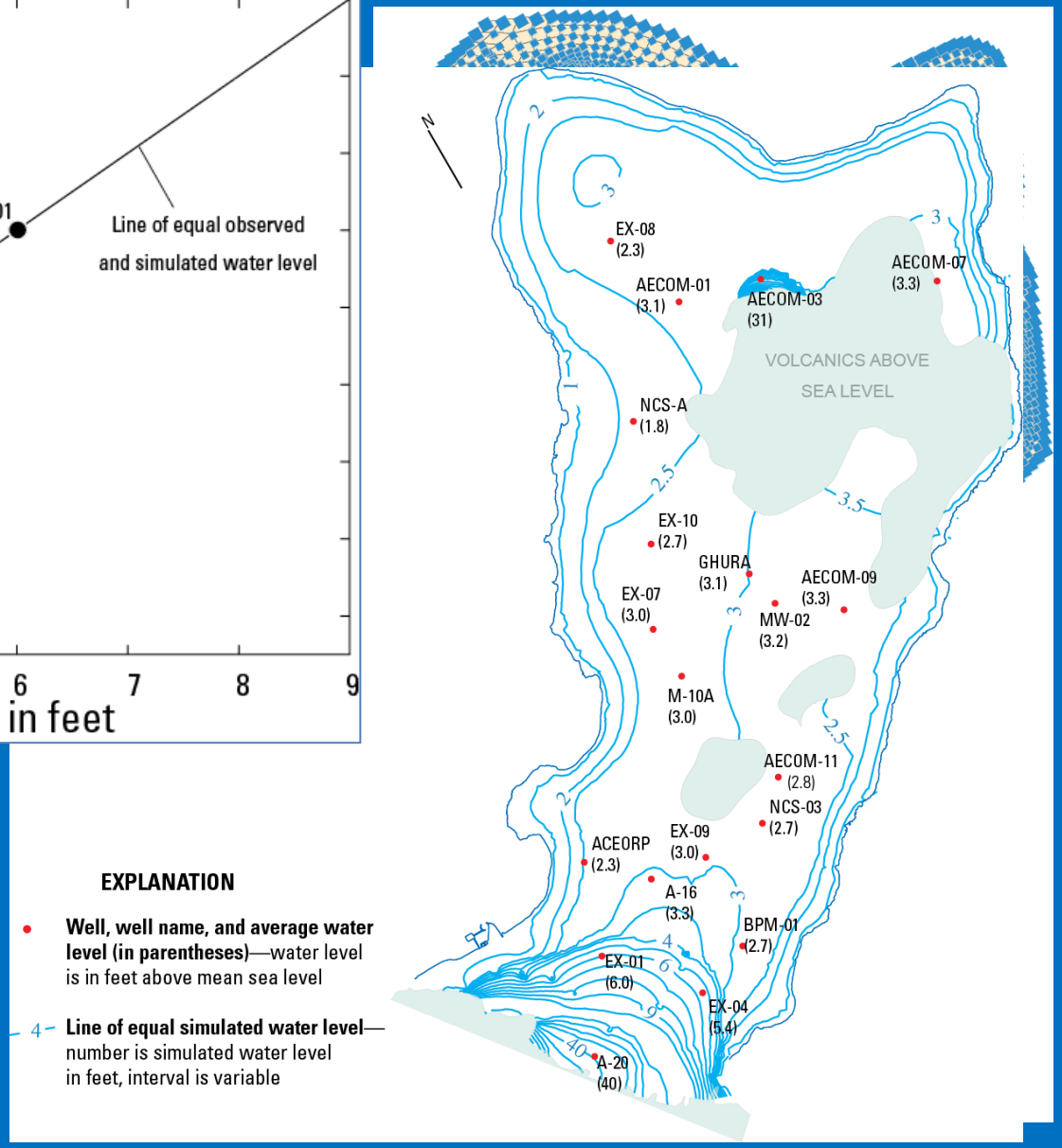
Observed and Simulated Water Levels





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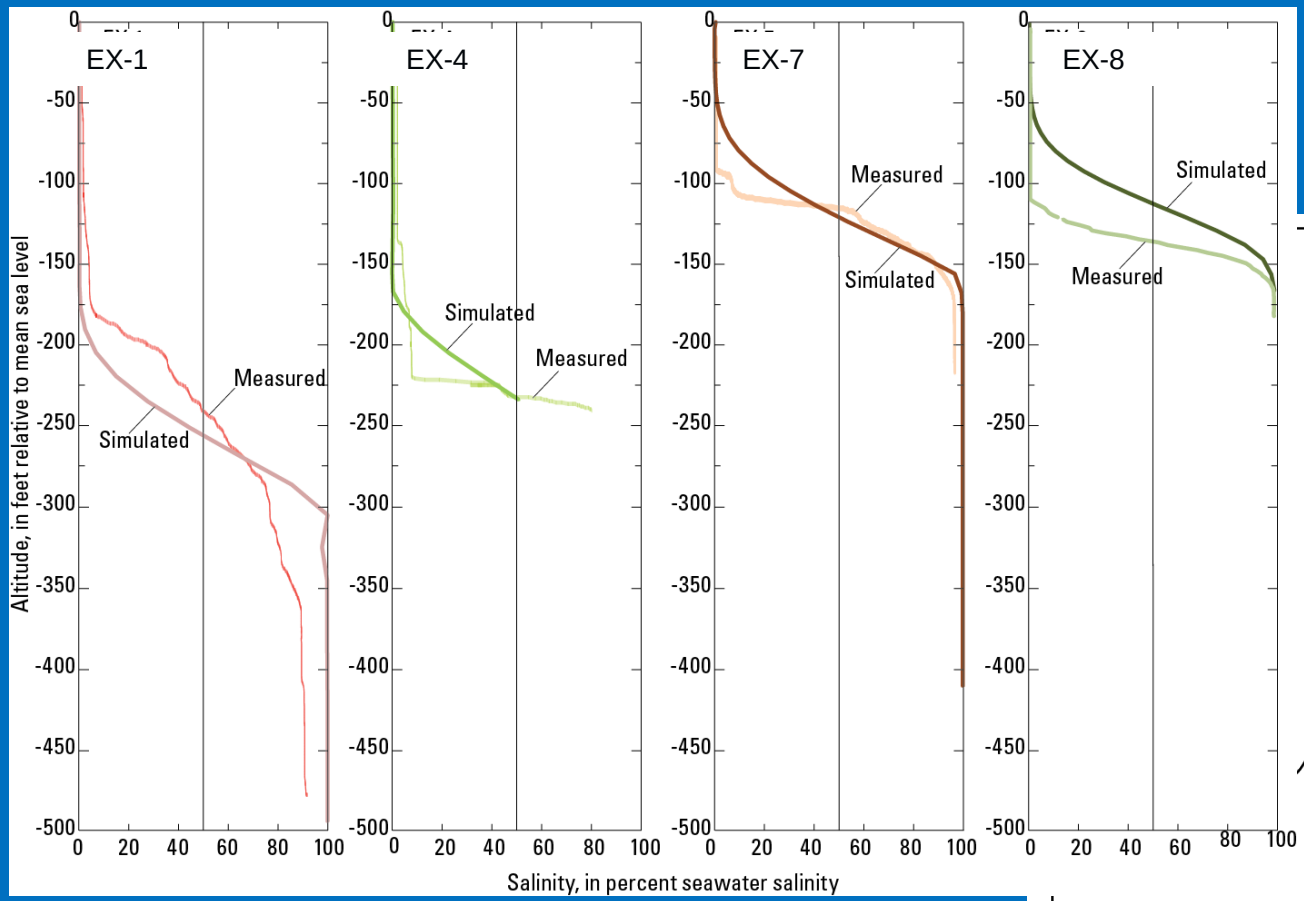
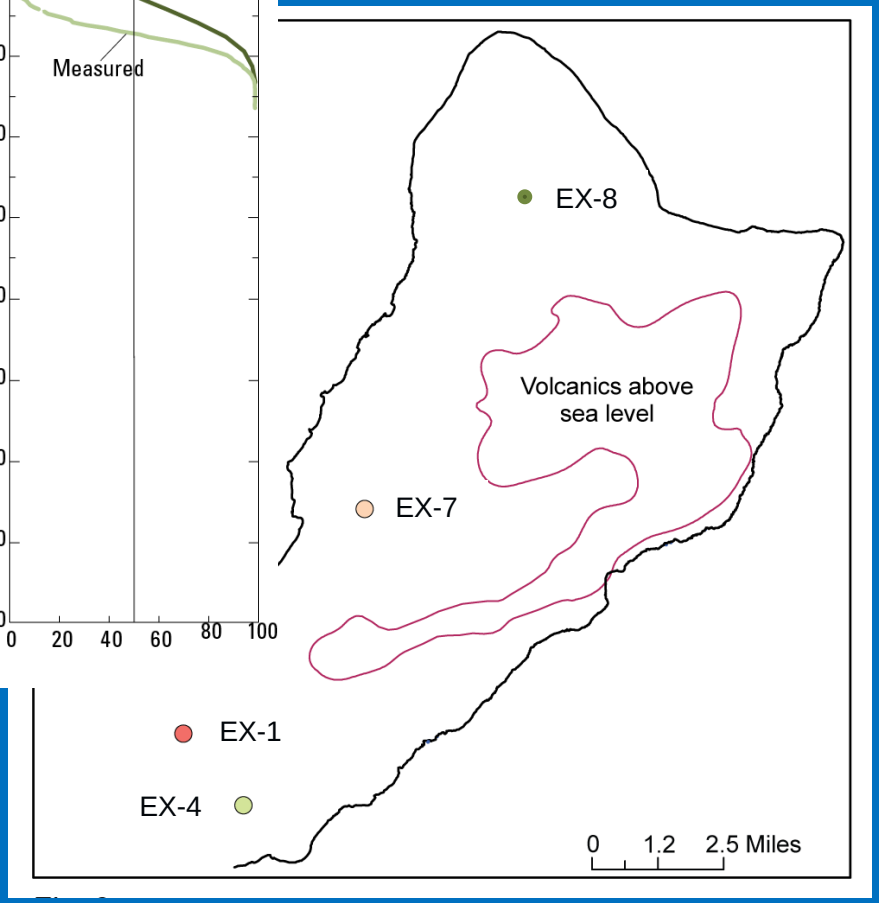
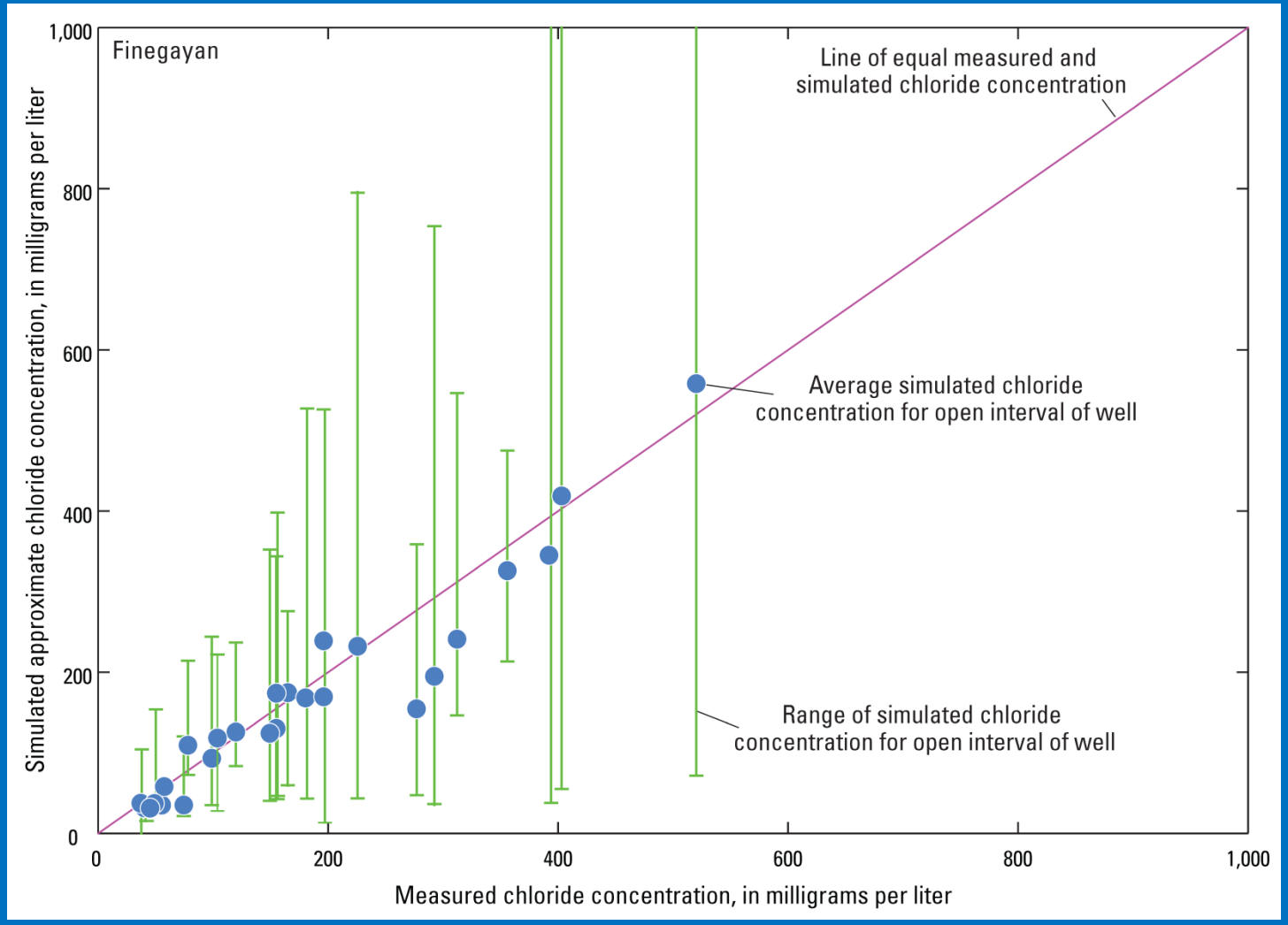
Observed and Modeled Salinity Profiles

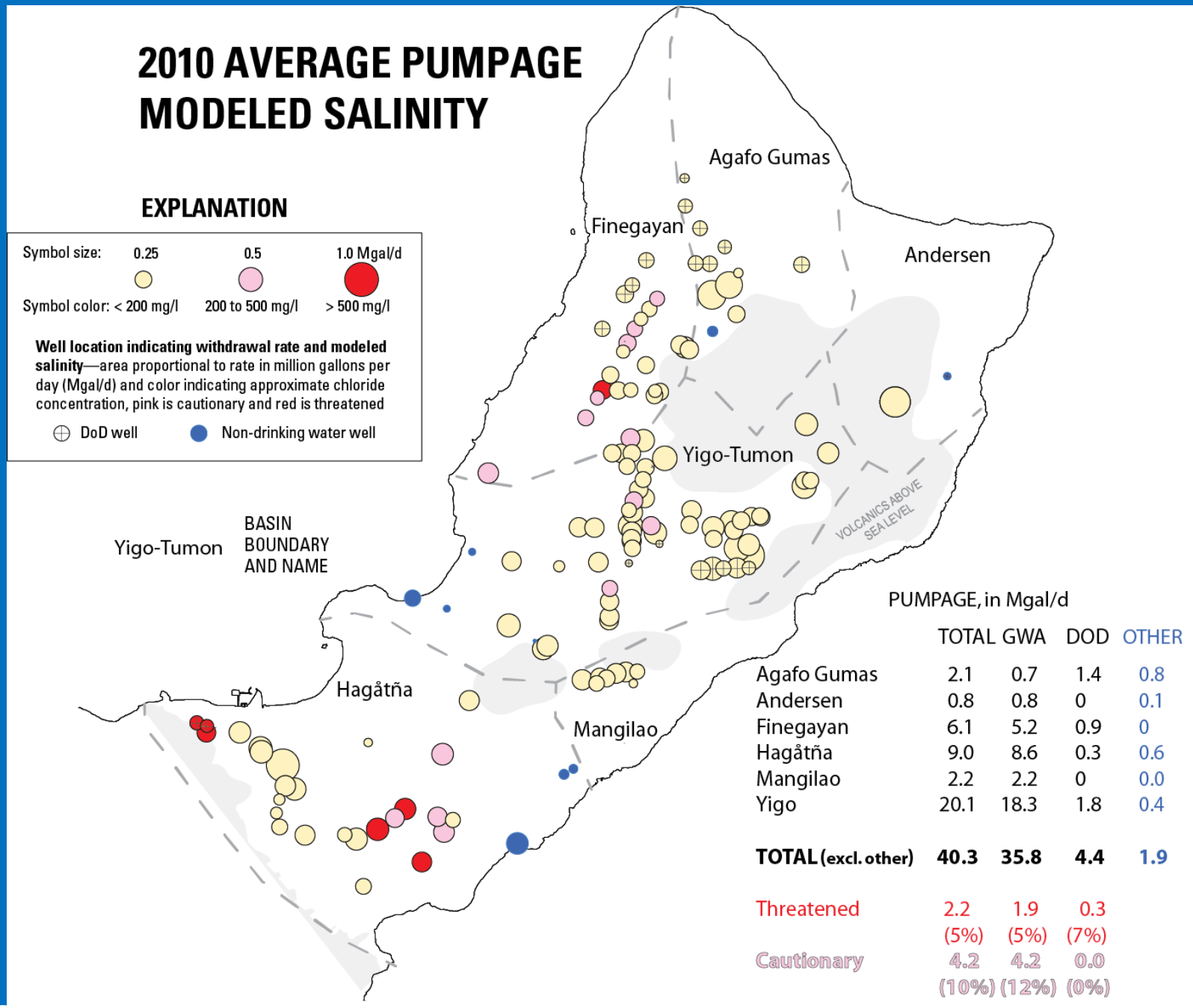




Observed and Modeled Pumped Salinity

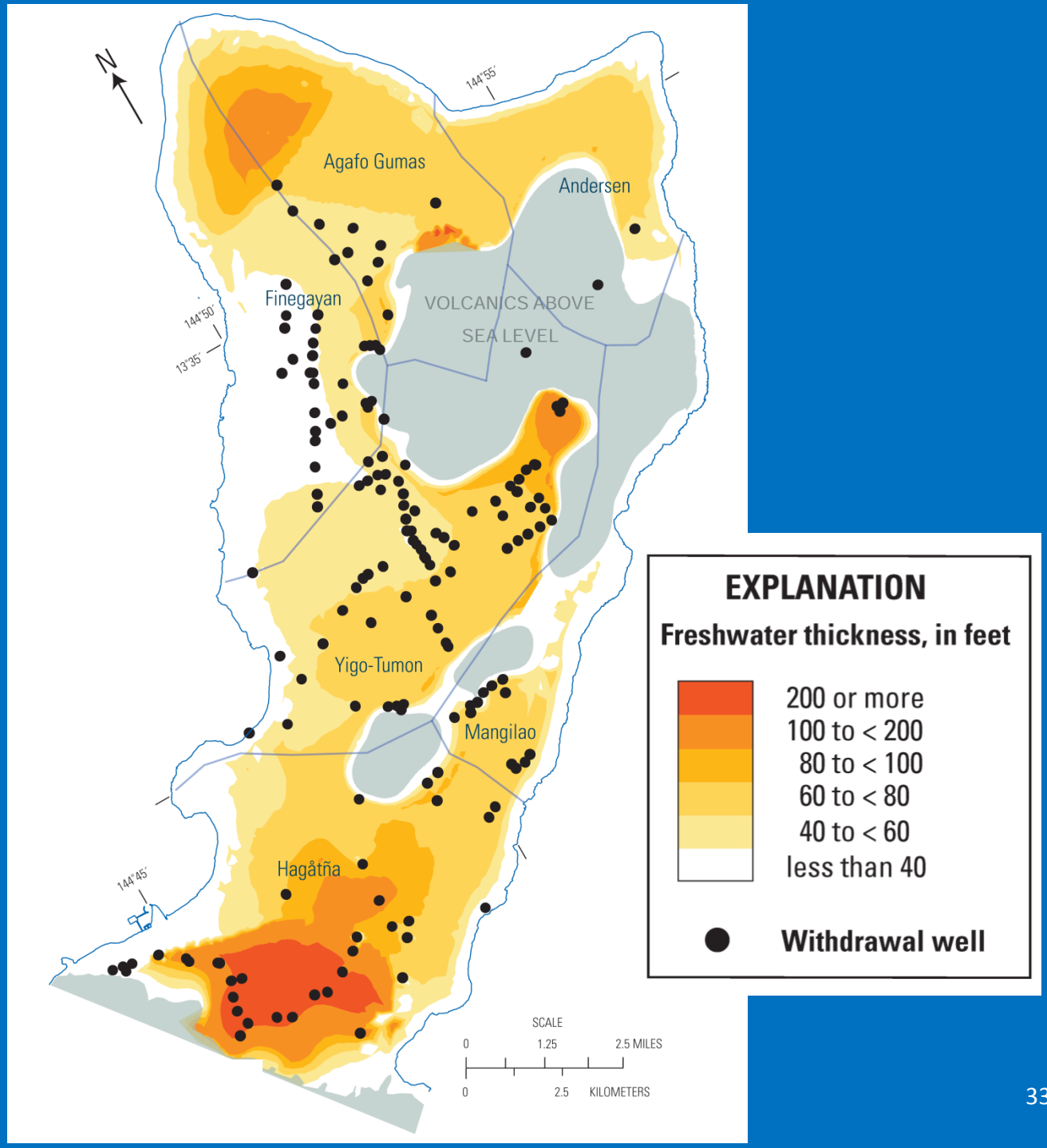


2010 AVERAGE PUMPAGE MODELED SALINITY

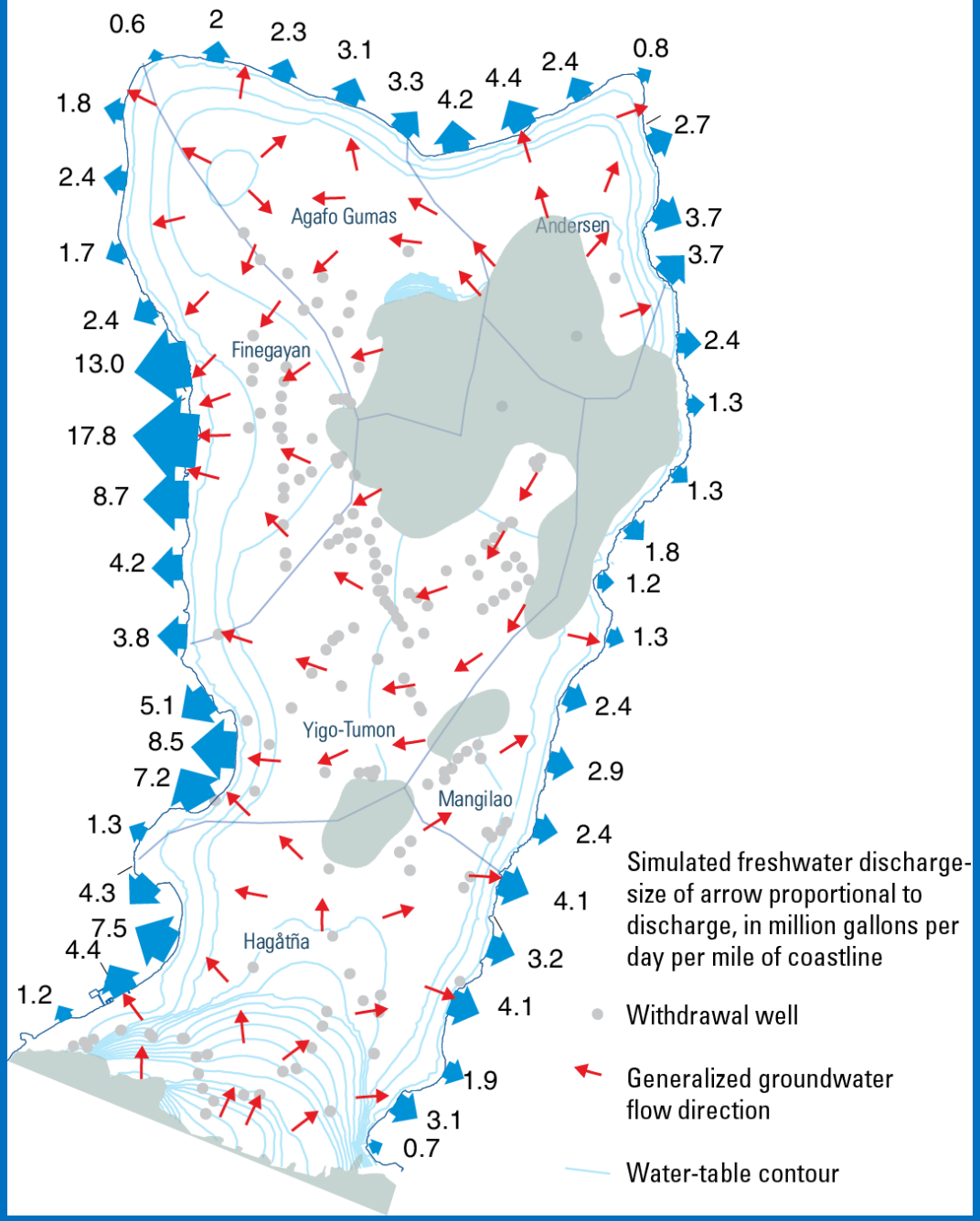


PUMPAGE, in Mgal/d

	TOTAL	GWA	DOD	OTHER
Agafo Gumas	2.1	0.7	1.4	0.8
Andersen	0.8	0.8	0	0.1
Finegayan	6.1	5.2	0.9	0
Hagåtña	9.0	8.6	0.3	0.6
Mangilao	2.2	2.2	0	0.0
Yigo	20.1	18.3	1.8	0.4
TOTAL (excl. other)	**40.3**	**35.8**	**4.4**	**1.9**
Threatened	2.2 (5%)	1.9 (5%)	0.3 (7%)	
Cautionary	4.2 (10%)	4.2 (12%)	0.0 (0%)	


N
144°55'
Agafo Gumas
Andersen
Finegayan
VOLCANICS ABOVE
SEA LEVEL
144°50'
13°35'
Yigo-Tumon
Mangilao
Hagåtña
144°45'
SCALE
0
1.25
2.5 MILES
0
2.5
KILOMETERS
EXPLANATION
Freshwater thickness, in feet
200 or more
100 to < 200
80 to < 100
60 to < 80
40 to < 60
less than 40
Withdrawal well

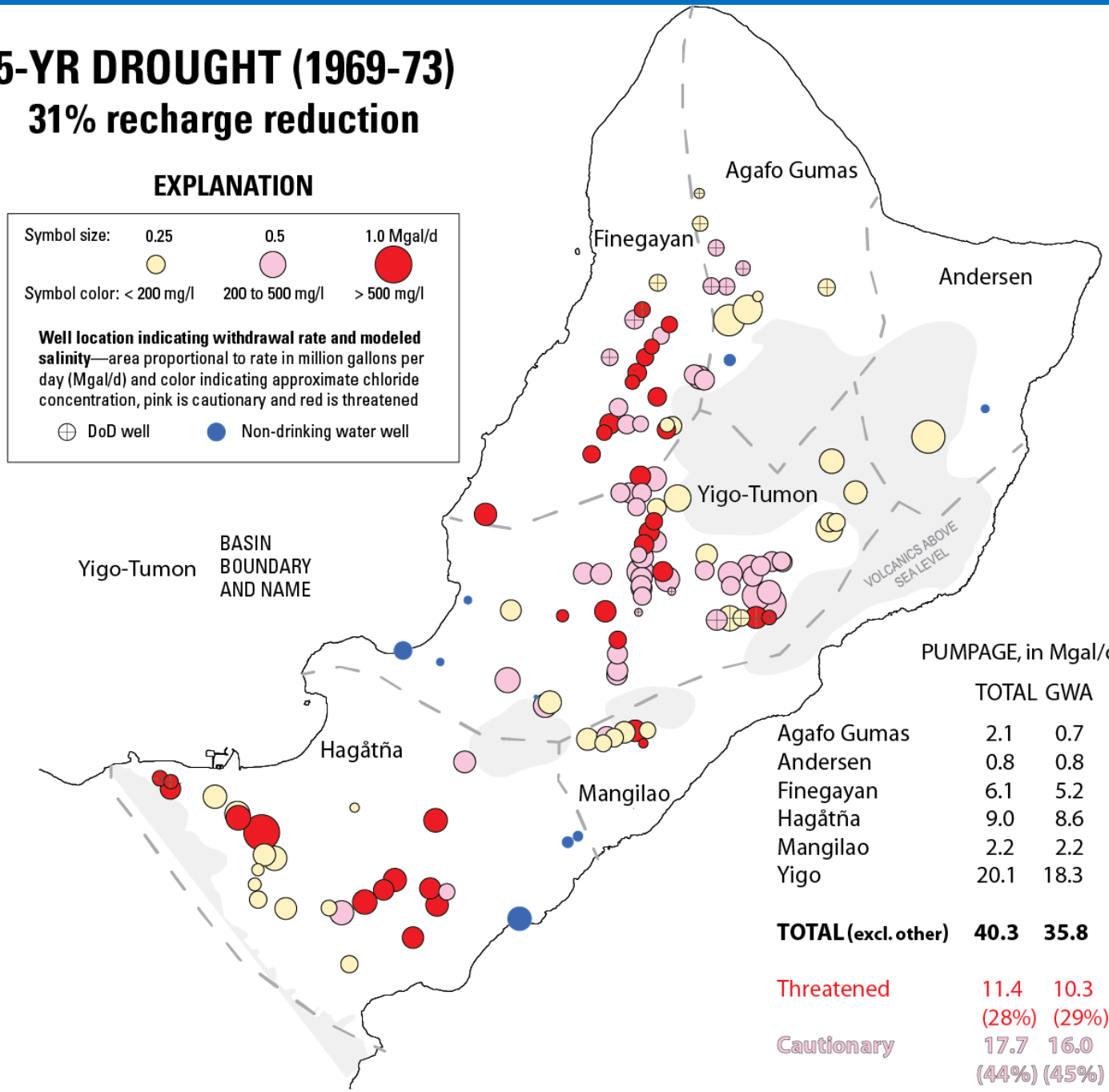
Simulated coastal freshwater discharge



Drought Condition

- Hydrologic conditions
  - Driest 5-yr period (31% reduction in recharge)
    - 1969-73 rainfall
    - 2004 land cover
  - 2010 pumping rates
- Results after 5 years of pumping at steady rates

5-YR DROUGHT (1969-73)
31% recharge reduction



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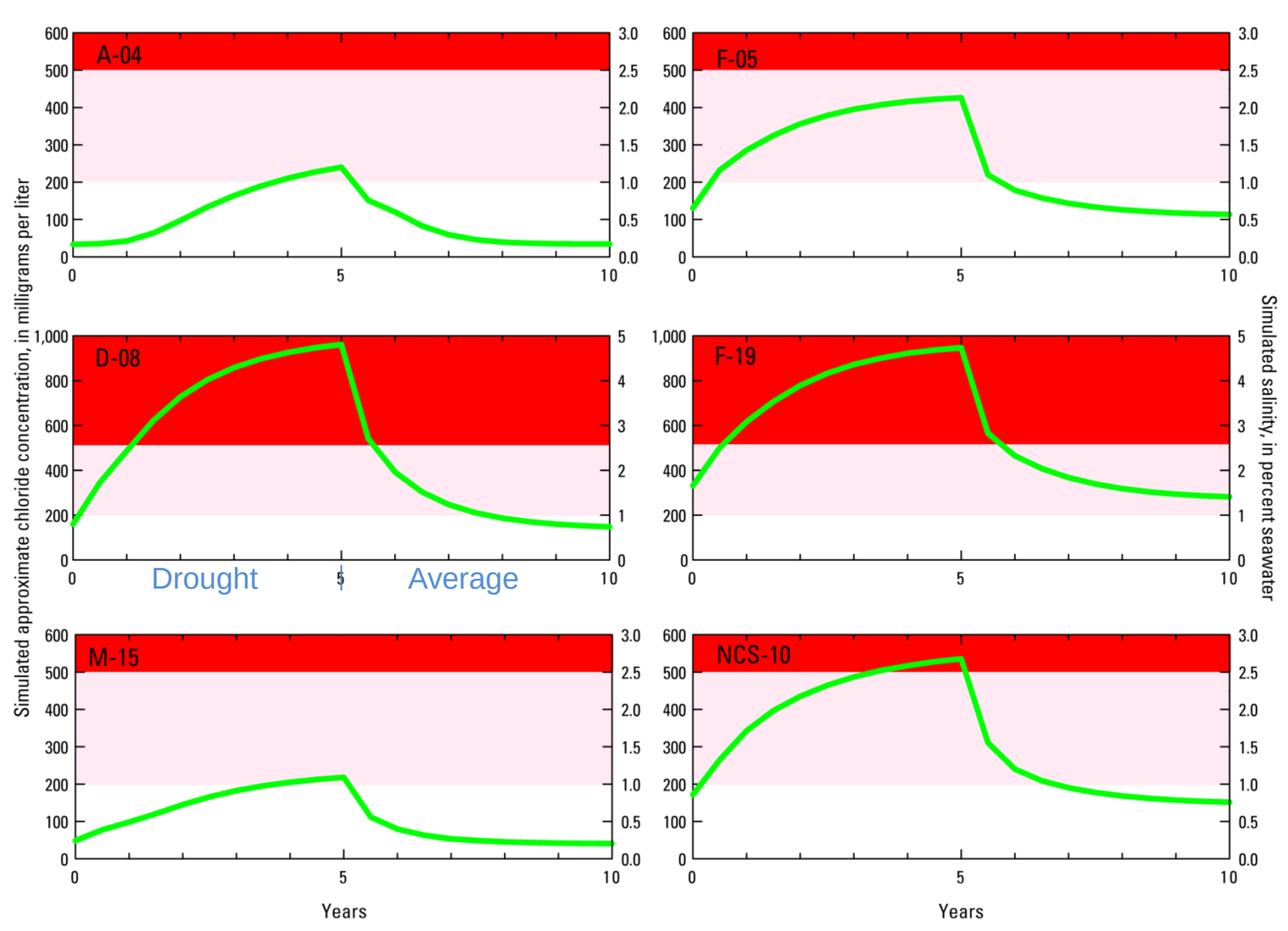
Hagåtña	9.0	8.6	0.3	0.6
Mangilao	2.2	2.2	0	0.0
Yigo	20.1	18.3	1.8	0.4
TOTAL (excl. other)	**40.3**	**35.8**	**4.4**	**1.9**
Threatened	11.4 (28%)	10.3 (29%)	1.1 (25%)	
Cautionary	17.7 (44%)	16.0 (45%)	1.7 (39%)	

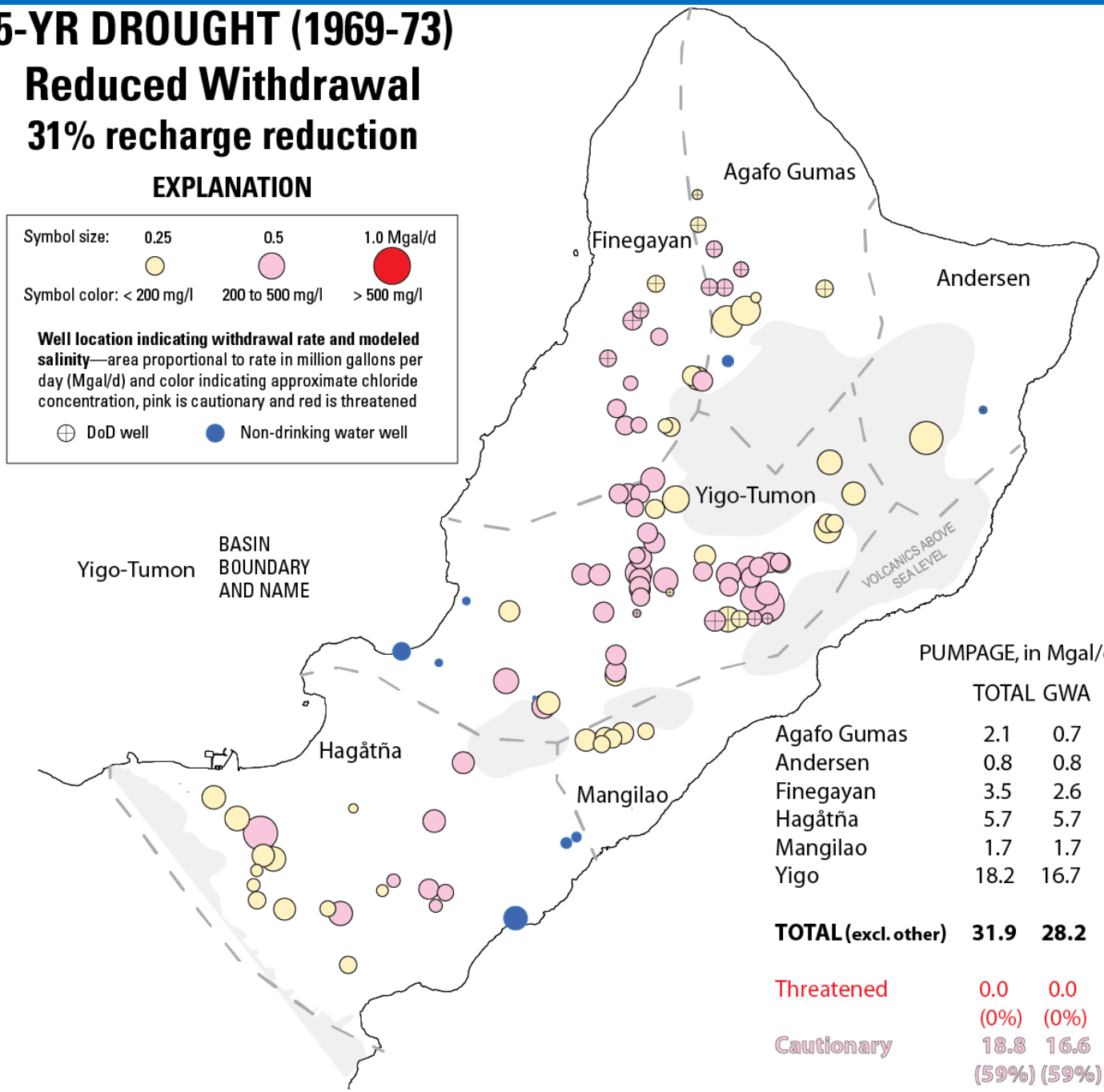
Drought Condition



Drought Condition-Reduced Withdrawal

- Hydrologic conditions
  - Driest 5-yr period (31% reduction in recharge)
    - 1969-73 rainfall
    - 2004 land cover
  - Reduced pumping rates to eliminate threatened wells
- Results after 5 years of pumping at steady rates

5-YR DROUGHT (1969-73)
Reduced Withdrawal
31% recharge reduction



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Mangilao	1.7	1.7	0	0.0
Yigo	18.2	16.7	1.4	0.4
TOTAL (excl. other)	**31.9**	**28.2**	**3.7**	**1.9**
Threatened	0.0 (0%)	0.0 (0%)	0.0 (0%)	
Cautionary	18.8 (59%)	16.6 (59%)	2.2 (59%)	

Groundwater-Availability Study

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- Numerical modeling – final scenarios
  - Calibration to baseline condition
  - Coastal discharge
  - Drought condition (driest 5-year period)
  - **Future pumping scenarios**

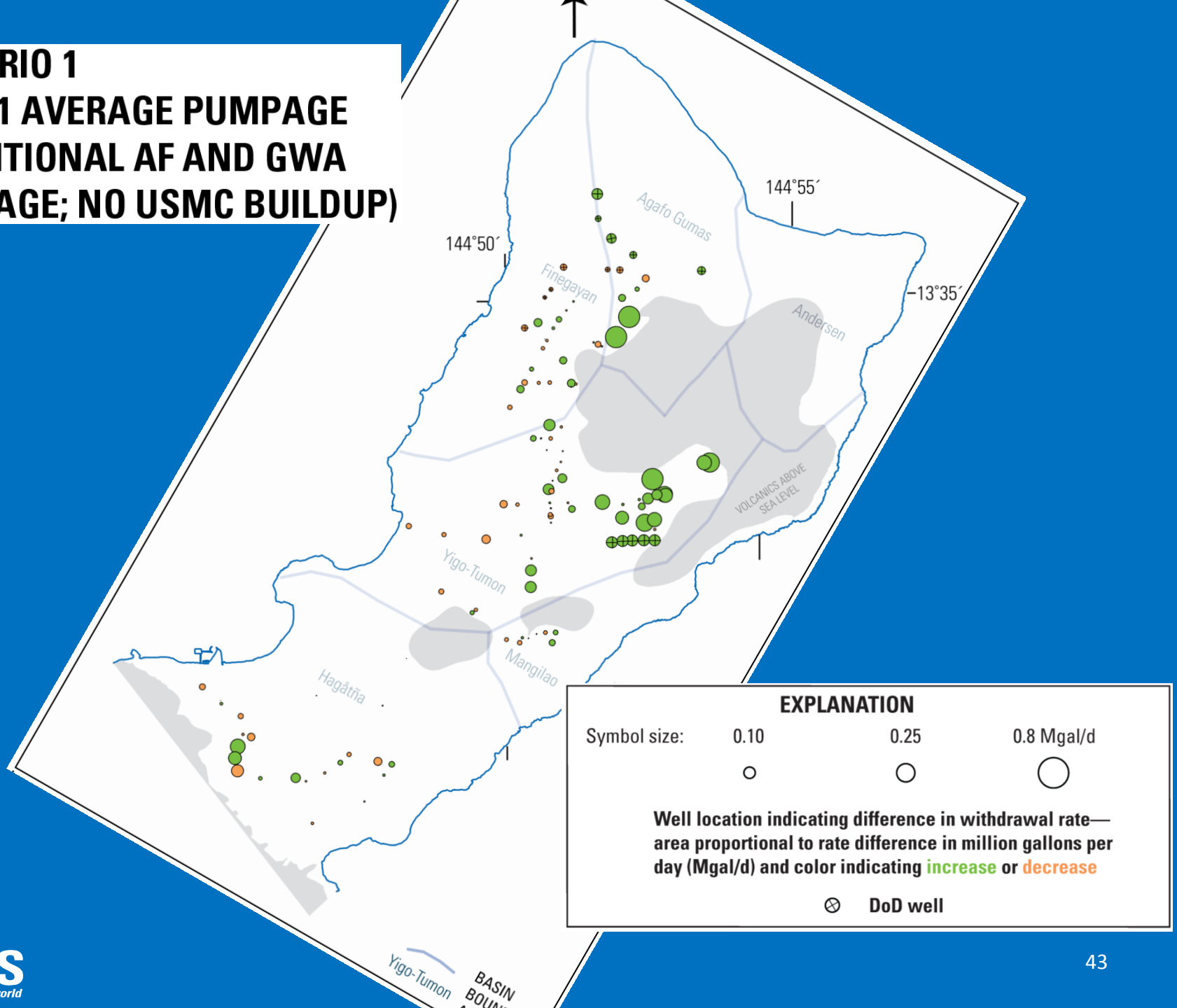
Future Scenarios

1. Expected GWA/DoD growth with no USMC buildup
2. Expected GWA/DoD growth plus USMC buildup
3. Expected GWA/DoD growth plus redistributed USMC buildup
4. Redistributed USMC buildup w/drought
5. Scenario 3 with redistributed GWA/DoD

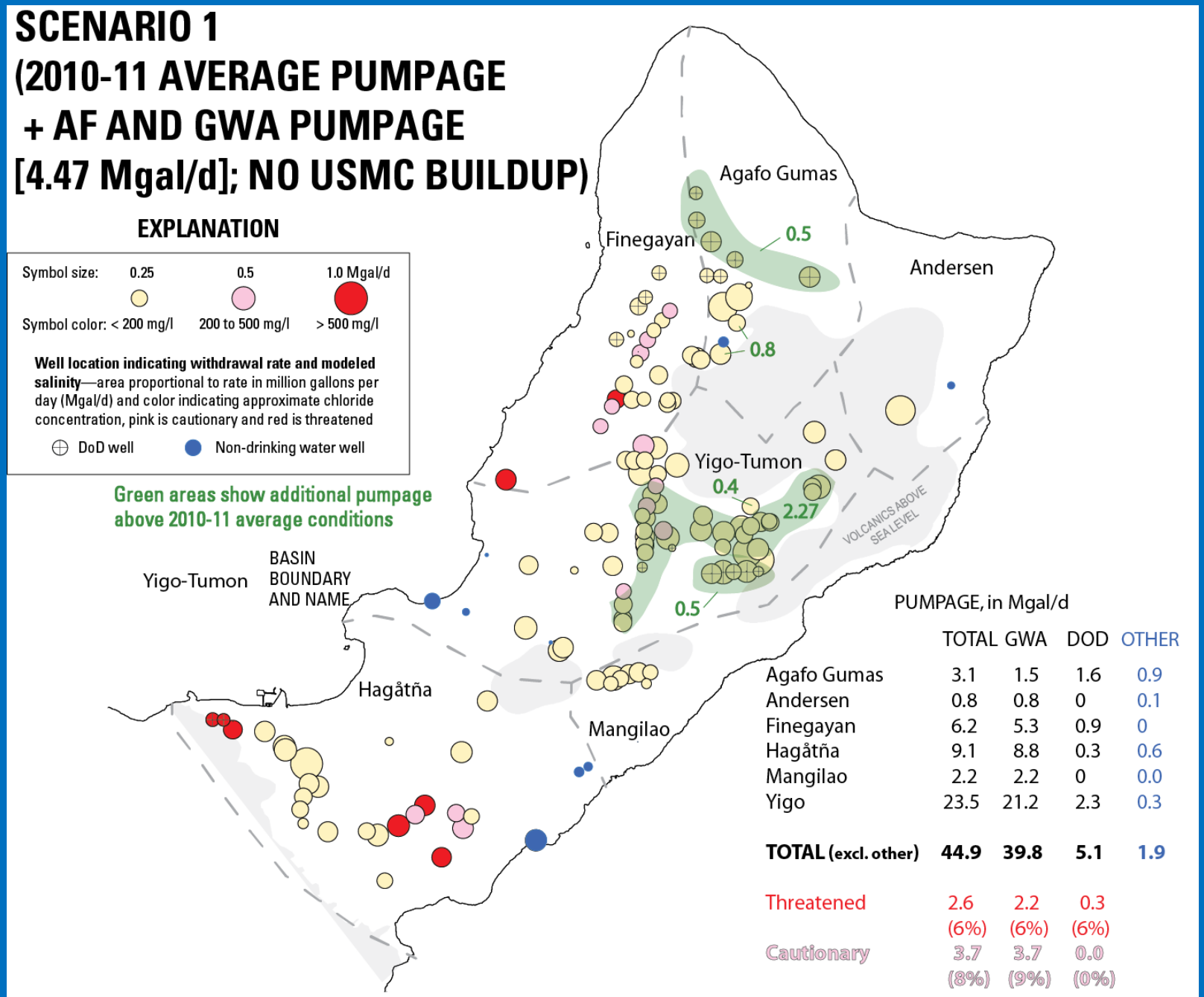
Scenario 1
Expected Growth with No USMC buildup

- Hydrologic conditions
  - Average long-term recharge
  - 2010-11 pumping rates (GWA, DoD, private wells)
  - GWA 3 new wells (AG10, Site 08, Site 12)
    - Additional 1.2 Mgal/d
  - GWA Yigo-Tumon wells
    - Additional 2.27 Mgal/d
  - Air Force 10 existing wells (AF01–05, MW05–09)
    - Additional 0.97 Mgal/d

SCENARIO 1
(2010-11 AVERAGE PUMPAGE + ADDITIONAL AF AND GWA PUMPAGE; NO USMC BUILDUP)



SCENARIO 1
(2010-11 AVERAGE PUMPAGE + AF AND GWA PUMPAGE [4.47 Mgal/d]; NO USMC BUILDUP)



PUMPAGE, in Mgal/d

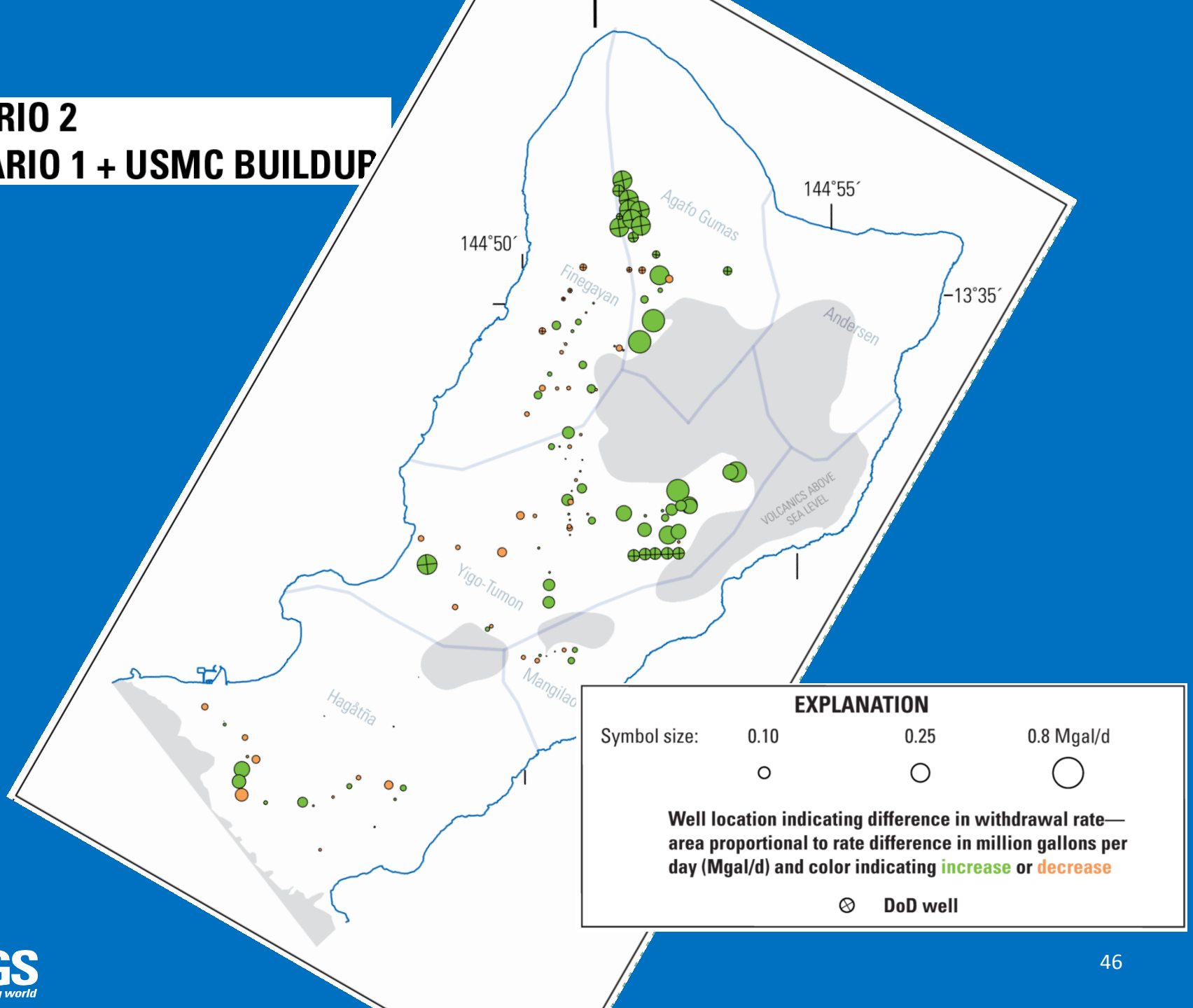
	TOTAL	GWA	DOD	OTHER
Agafo Gumas	3.1	1.5	1.6	0.9
Andersen	0.8	0.8	0	0.1
Finegayan	6.2	5.3	0.9	0
Hagåtña	9.1	8.8	0.3	0.6
Mangilao	2.2	2.2	0	0.0
Yigo	23.5	21.2	2.3	0.3
TOTAL (excl. other)	**44.9**	**39.8**	**5.1**	**1.9**
Threatened	2.6 (6%)	2.2 (6%)	0.3 (6%)	
Cautionary	3.7 (8%)	3.7 (9%)	0.0 (0%)	

Scenario 2

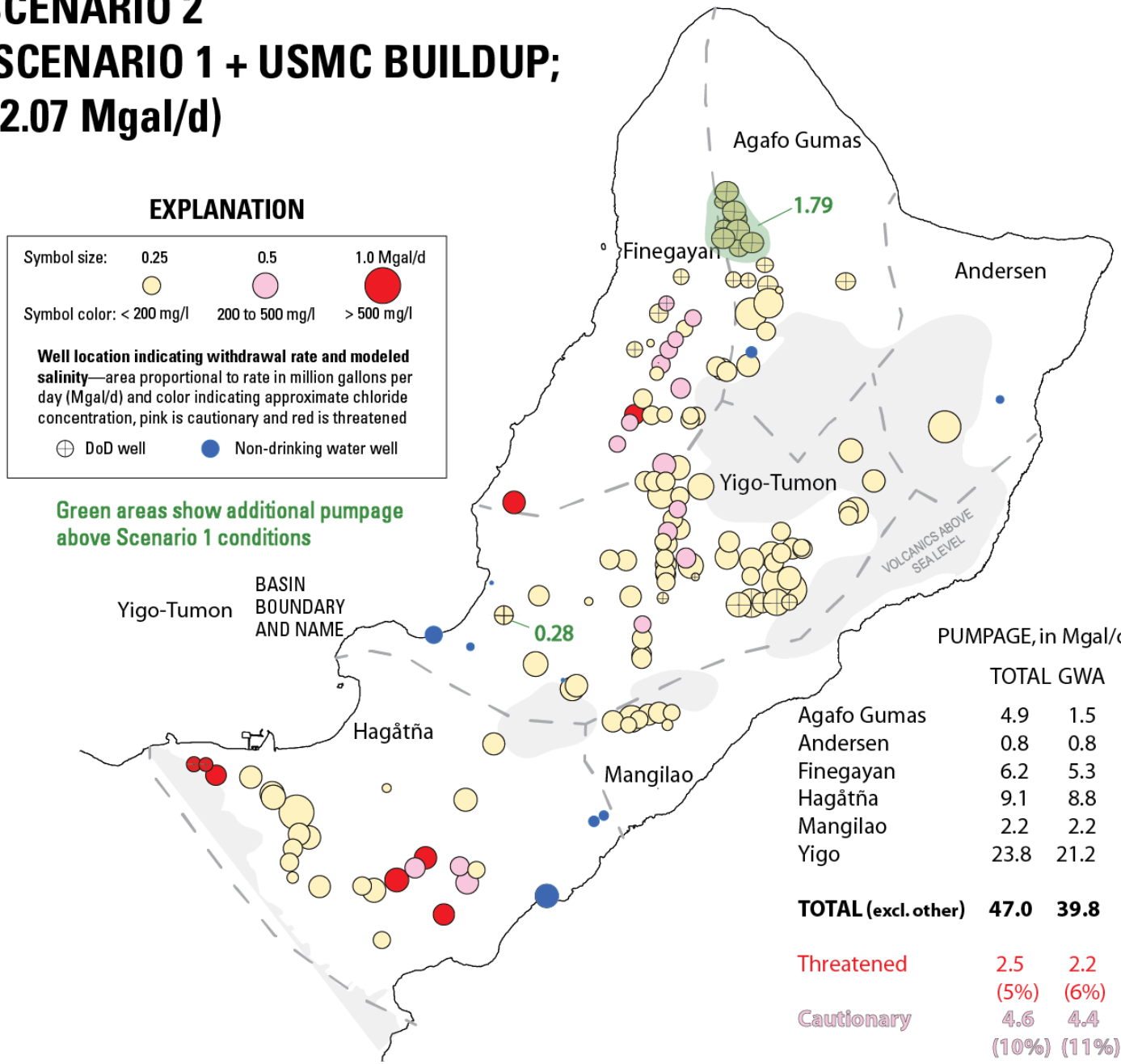
Scenario 1 plus USMC buildup

- Hydrologic conditions
  - Average long-term recharge
  - 2010-11 pumping rates (GWA, DoD, private wells)
  - GWA 3 new wells (AG10, Site 08, Site 12)
    - Additional 1.2 Mgal/d
  - GWA Yigo-Tumon wells
    - Additional 2.27 Mgal/d
  - Air Force 10 existing wells (AF01–05, MW05–09)
    - Additional 0.97 Mgal/d
  - USMC Tumon well - 0.28 Mgal/d
  - USMC new wells - 1.79 Mgal/d in Agafo Gumas

SCENARIO 2
(SCENARIO 1 + USMC BUILDUP



SCENARIO 2 (SCENARIO 1 + USMC BUILDUP; +2.07 Mgal/d)



PUMPAGE, in Mgal/d

	TOTAL	GWA	DOD	OTHER
Agafo Gumas	4.9	1.5	3.4	0.9
Andersen	0.8	0.8	0	0.1
Finegayan	6.2	5.3	0.9	0
Hagåtña	9.1	8.8	0.3	0.6
Mangilao	2.2	2.2	0	0.0
Yigo	23.8	21.2	2.6	0.3
TOTAL (excl. other)	**47.0**	**39.8**	**7.2**	**1.9**
Threatened	2.5 (5%)	2.2 (6%)	0.3 (4%)	
Cautionary	4.6 (10%)	4.4 (11%)	0.2 (3%)	

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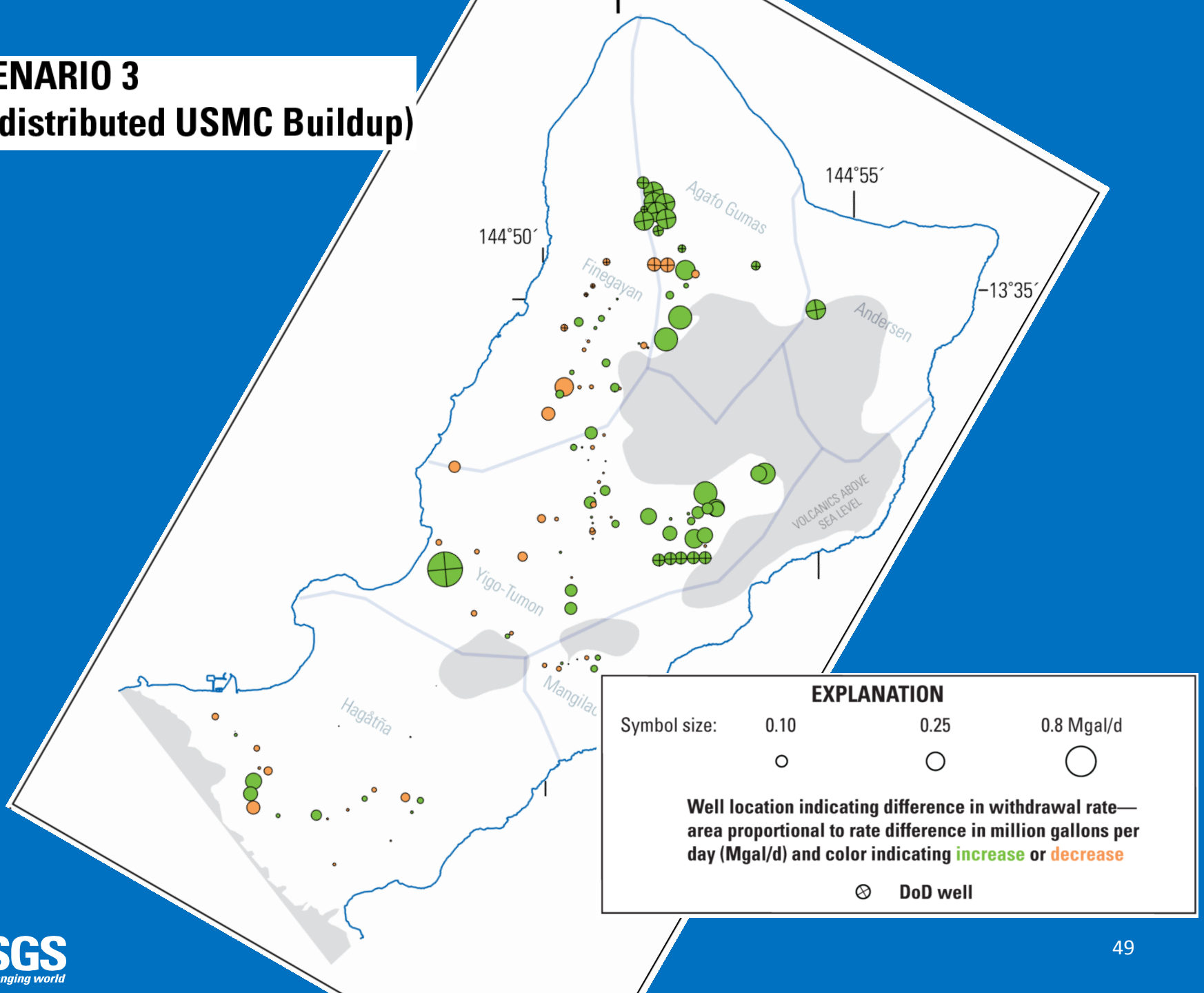
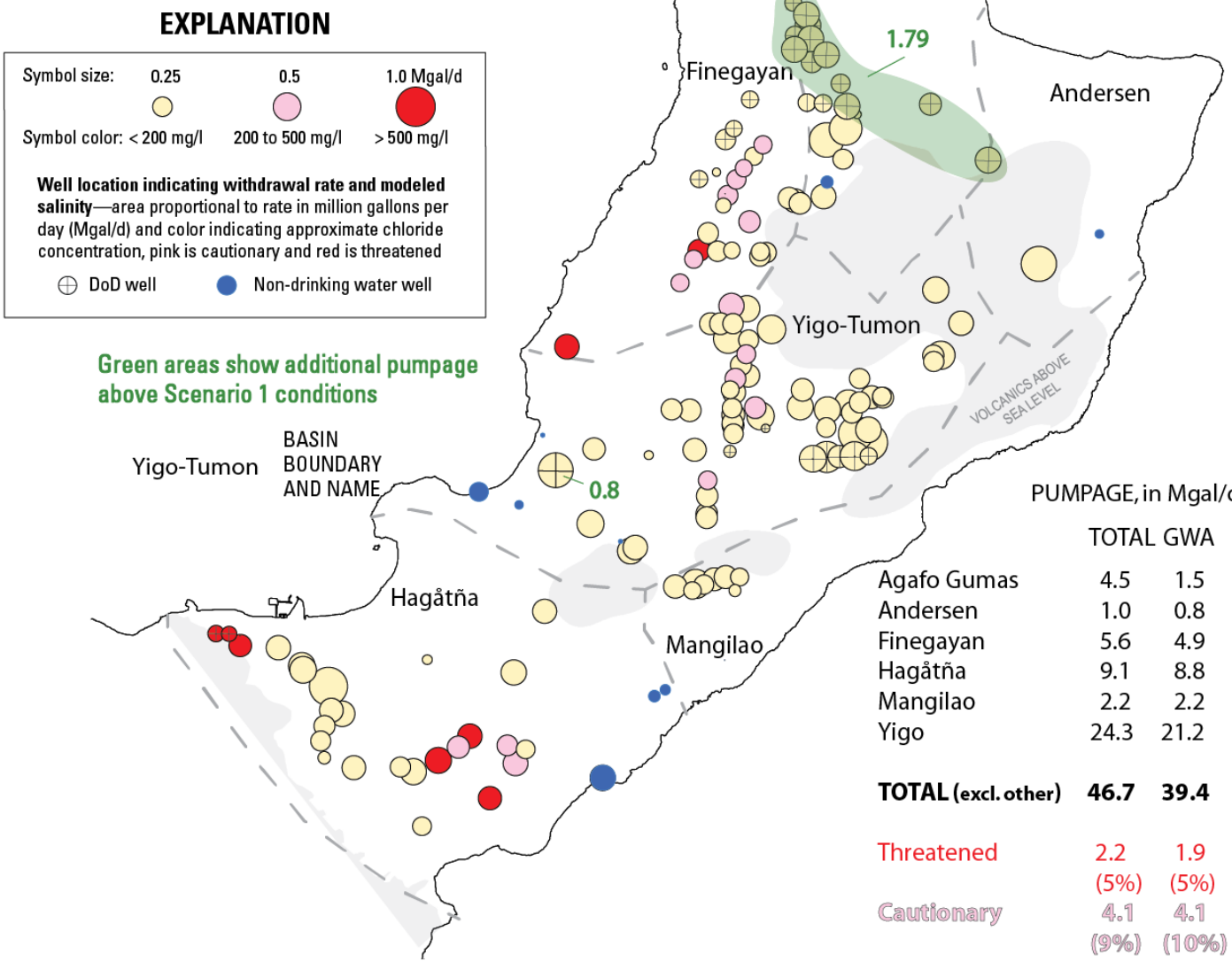
Scenario 3
USMC buildup (redistributed)

- Hydrologic conditions
  - Average long-term recharge
  - 2010-11 pumping rates (GWA, DoD, private wells)
  - GWA 3 new wells (AG10, Site 08, Site 12)
    - Additional 1.2 Mgal/d
  - GWA Yigo-Tumon wells
    - Additional 2.27 Mgal/d
  - Air Force 10 existing wells (AF01–05, MW05–09)
    - Additional 0.97 Mgal/d
  - USMC Tumon well - 0.8 Mgal/d (DoD:GWA; 50:50 split)
  - USMC new wells - 1.79 Mgal/d in Agafo Gumas and Andersen

SCENARIO 3
(Redistributed USMC Buildup)



SCENARIO 3
(Redistributed USMC Buildup; +2.59 Mgal/d)



PUMPAGE, in Mgal/d

	TOTAL	GWA	DOD	OTHER
Agafo Gumas	4.5	1.5	3.0	0.9
Andersen	1.0	0.8	0.3	0.1
Finegayan	5.6	4.9	0.7	0
Hagåtña	9.1	8.8	0.3	0.6
Mangilao	2.2	2.2	0	0.0
Yigo	24.3	21.2	3.1	0.3
TOTAL (excl. other)	**46.7**	**39.4**	**7.4**	**1.9**
Threatened	2.2 (5%)	1.9 (5%)	0.3 (4%)	
Cautionary	4.1 (9%)	4.1 (10%)	0.0 (0%)	

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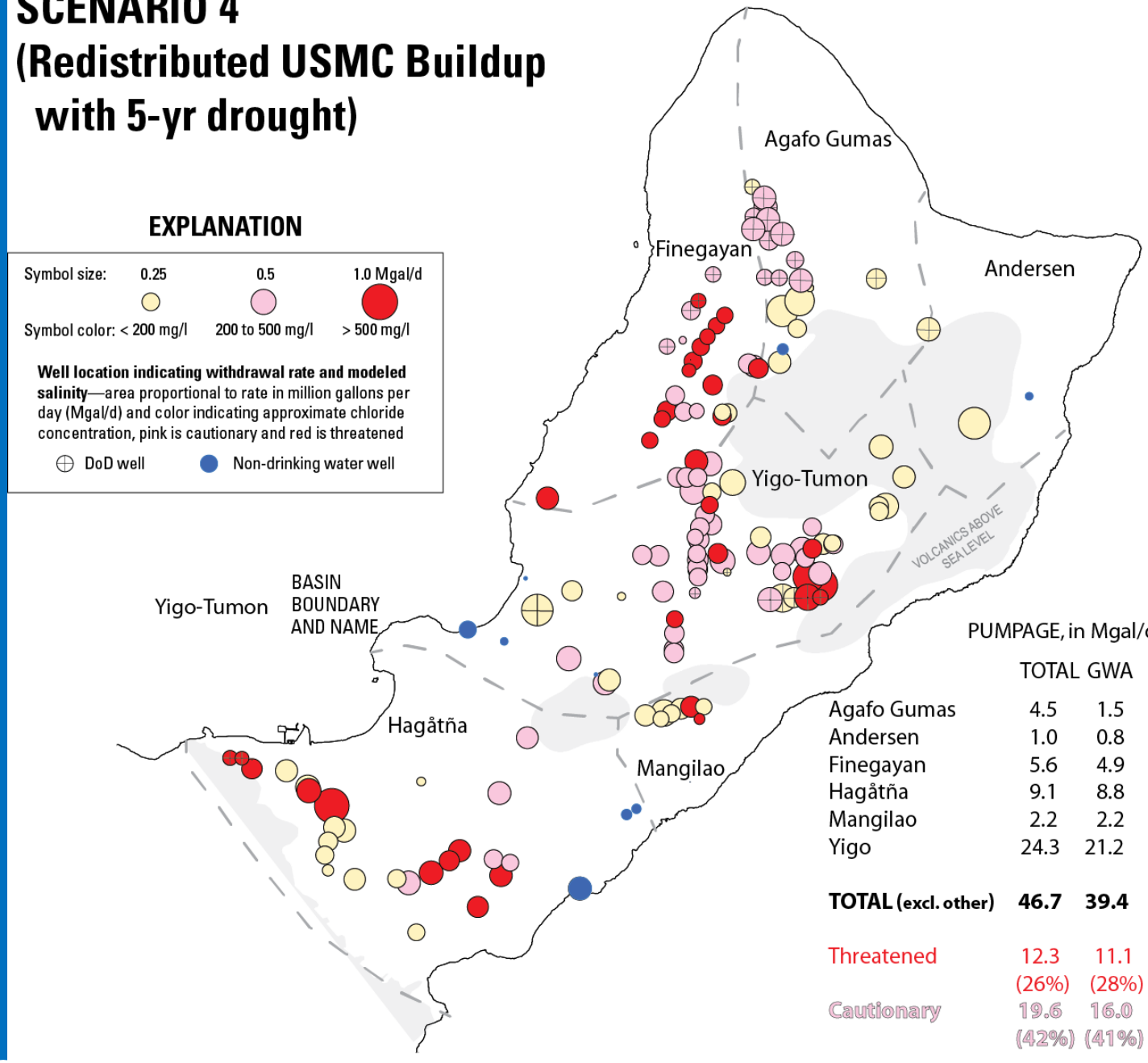
Scenario 4
Redistributed USMC buildup w/Drought

- Hydrologic conditions
  - 1969-73 drought recharge
  - 2010-11 pumping rates (GWA, DoD, private wells)
  - GWA 3 new wells (AG10, Site 08, Site 12)
    - Additional 1.2 Mgal/d
  - GWA Yigo-Tumon wells
    - Additional 2.27 Mgal/d
  - Air Force 10 existing wells (AF01–05, MW05–09)
    - Additional 0.97 Mgal/d
  - USMC Tumon well - 0.8 Mgal/d (DoD:GWA; 50:50 split)
  - USMC new wells - 1.79 Mgal/d in Agafo Gumas and Andersen

SCENARIO 4
(Redistributed USMC Buildup with 5-yr drought)



PUMPAGE, in Mgal/d

	TOTAL	GWA	DOD	OTHER
Agafo Gumas	4.5	1.5	3.0	0.9
Andersen	1.0	0.8	0.3	0.1
Finegayan	5.6	4.9	0.7	0
Hagåtña	9.1	8.8	0.3	0.6
Mangilao	2.2	2.2	0	0.0
Yigo	24.3	21.2	3.1	0.3
TOTAL (excl. other)	**46.7**	**39.4**	**7.4**	**1.9**
Threatened	12.3 (26%)	11.1 (28%)	1.2 (16%)	
Cautionary	19.6 (42%)	16.0 (41%)	3.6 (49%)	

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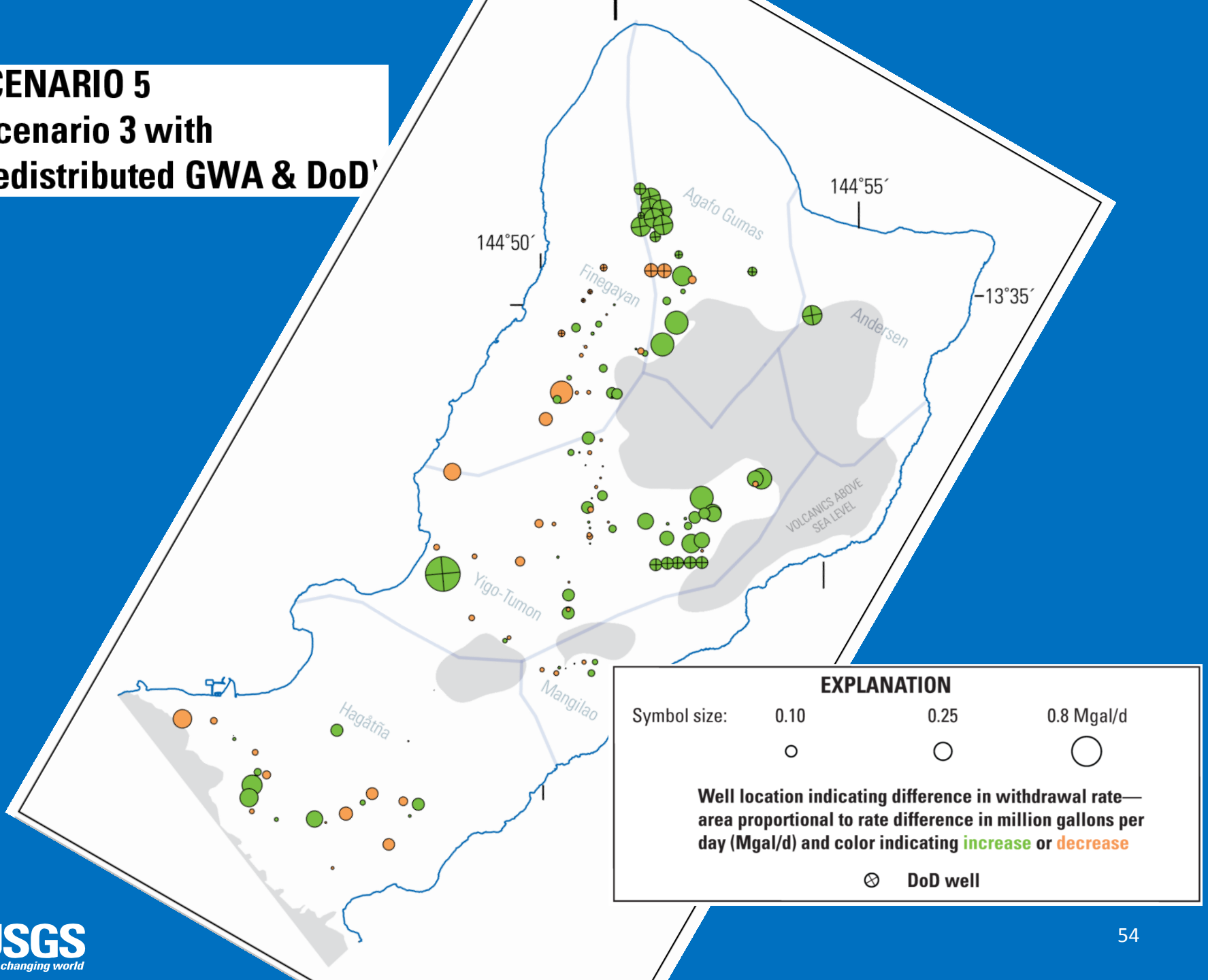
Scenario 5

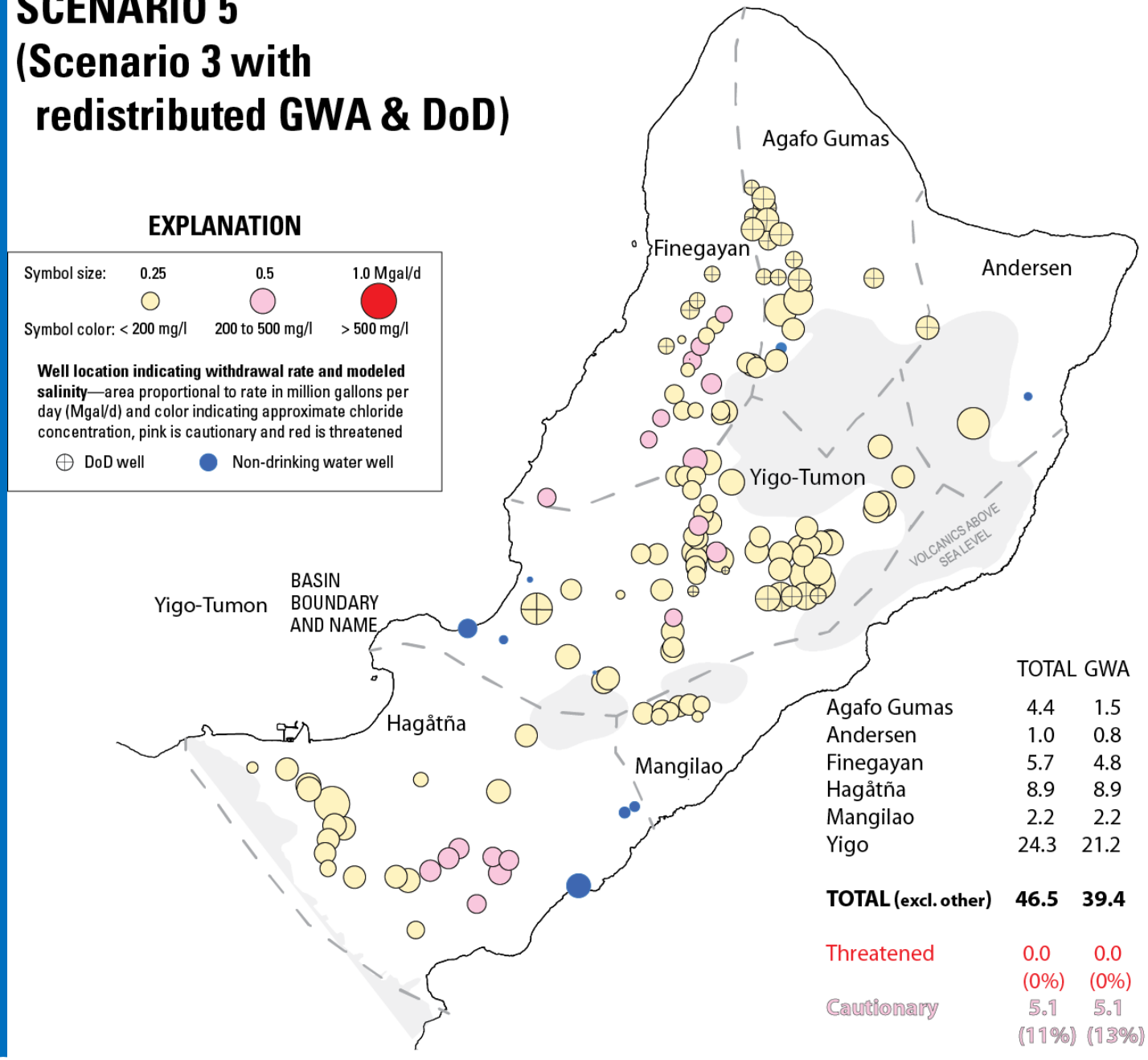
Scenario 3 with Redistributed DoD and GWA

- Hydrologic conditions
  - Average long-term recharge
  - 2010-11 pumping rates (GWA, DoD, private wells)
  - GWA 3 new wells (AG10, Site 08, Site 12)
    - Additional 1.2 Mgal/d
  - GWA Yigo-Tumon wells
    - Additional 2.27 Mgal/d
  - Air Force 10 existing wells (AF01–05, MW05–09)
    - Additional 0.97 Mgal/d
  - USMC Tumon well - 0.8 Mgal/d (DoD:GWA; 50:50 split)
  - USMC new wells - 1.79 Mgal/d in Agafo Gumas and Andersen

SCENARIO 5
(Scenario 3 with redistributed GWA & DoD)



SCENARIO 5 (Scenario 3 with redistributed GWA & DoD)



	TOTAL	GWA	DOD	OTHER
Agafo Gumas	4.4	1.5	2.9	0.9
Andersen	1.0	0.8	0.3	0.1
Finegayan	5.7	4.8	0.9	0
Hagåtña	8.9	8.9	0	0.6
Mangilao	2.2	2.2	0	0.0
Yigo	24.3	21.2	3.1	0.3
TOTAL (excl. other)	**46.5**	**39.4**	**7.2**	**1.9**
Threatened	0.0 (0%)	0.0 (0%)	0.0 (0%)	
Cautionary	5.1 (11%)	5.1 (13%)	0.0 (0%)	

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Scenario Summary

- Impact to GWA and DoD groundwater sources, in Mgal/d:

Condition	Total	Threatened	Cautionary
Baseline	40.3	2.2	4.2
Drought	40.3	11.4	17.7
Drought-minimized	31.9	0.0	18.8
Scenario 1	44.9	2.6	3.7
Scenario 2	47.0	2.5	4.6
Scenario 3	46.7	2.2	4.1
Scenario 4	46.7	12.3	19.6
Scenario 5	46.5	0.0	5.1

Availability Study Wrap-up

- Acceptable yield (total minus threatened and cautionary) reduced from 33.9 Mgal/d to 11.5 Mgal/d during 5-yr drought
- Future growth + buildup leads to increased salinity, mainly in Finegayan and Agafo Gumas basins
- Basins cannot be managed independently; for example, withdrawal from Agafo Gumas causes salinity increase in Finegayan
- Redistribution of withdrawal can improve overall pumped-water salinity and provide 46.5 Mgal/d
- Groundwater model and expanded monitoring needed for sustainable management of NGLA
- Database, basement map, and groundwater model should be periodically updated as new hydrologic data is obtained

Outline of Meeting

- Overview of USGS water programs in Guam
- Proposal for rehabilitation and expansion of water-resource monitoring in northern Guam
- Results from the USMC-funded study on groundwater availability in northern Guam
- **Plans for the DoD-funded study on impacts of climate change Guam's water resources**
- Next steps

Strategic Environmental Research and Development Program

Water Resources on Guam: Potential Impacts and Adaptive Response to Climate Change for Department of Defense Installations

RC-2340

SERDP Objectives

- How will streamflow, sediment loads, and turbidity be modified and how will this affect surface water availability?
- How will groundwater recharge and salinity be modified?
- What are climate-change impacts to DoD infrastructure supplying surface water and groundwater and what are the adaptive strategies to maximize the water resources?
- How will information about potential climate-change impacts be communicated to water managers evaluating and implementing adaptive strategies?

SERDP 2014 PLANS

- Future climate simulations
  - Develop regional climate model to predict future weather
  - Evaluate changes in typhoon patterns
- Fena Valley Reservoir bathymetric survey
  - Planned for Jan-Mar 2014
  - Ten days of field work on the Reservoir
  - Differential GPS; survey-grade echo sounder
  - Sediment coring
- Geochemical recharge study
  - Use geochemical tracers to reveal groundwater flow paths & residence times (fast vs. slow pathways)
  - Begin to sample rain, cave drip water, wells, springs, & rocks across northern Guam for cations, anions, Sr & water isotopes
- Stakeholder engagement
  - Begin in-depth interviews

SERDP SCHEDULE

	TASK	FY 2014	FY 2015	FY 2016	FY 2017
1	Regional Climate Projections				
2	Watershed Model				
3	Reservoir Capacity				
4	Groundwater Geochemistry and Water Budget				
5	Numerical Groundwater Model				
6	Adaptive Strategies				
7	Communicating Impacts				
	SERDP Reports				

Next Steps

- Groundwater-Availability Study
  - Publish final report – December 31, 2013
- Begin DoD Strategic Environmental Research Development Program (SERDP) study of climate-change impacts on Guam's water resources
- Topics for consideration by DoD and GovGuam
  - Proposal for rehabilitation and expansion of water-resource monitoring in northern Guam
  - Interagency agreement (DoD, GWA, GEPA, WERI, USGS) to ensure long-term funding for water-resource monitoring
  - Groundwater modeling training