Protecting the Health and Sustainable Yield of Northern Guam Lens Aquifer (NGLA)

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My Statement

Guam has sufficient water resources to serve as a source of drinking water.

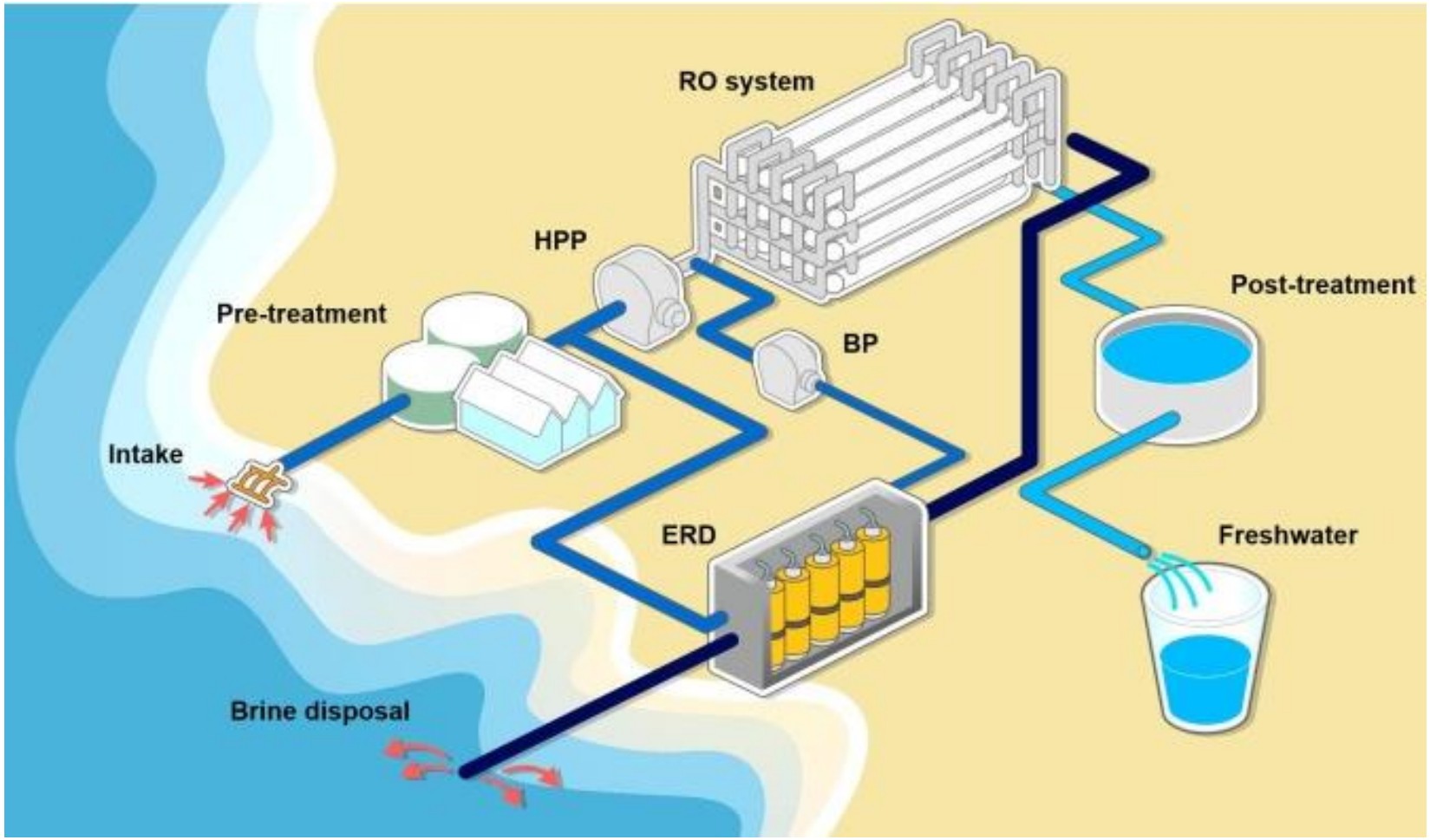
Do you agree or disagree?

My Answer

If Guam is wealthy enough to treat any polluted water without charging residents, then it currently has no big issues related to drinking water resources.

Example. Seawater Desalination Plant

In general, producing water through desalination costs 2 to 4 times more than producing water with conventional treatment methods.



https://watermanaustralia.com/desalination-plant/

Unfortunately, Guam does not have sufficient funding to treat polluted water.

How should we define the meaning of a water budget in relation to drinking water resources on Guam?

Guam's water budget can be defined as the total volume of water that can be supplied in a safe and cost-effective manner, while also complying with the Safe Drinking Water Act.

Today's Topics – Guam's Water Budget

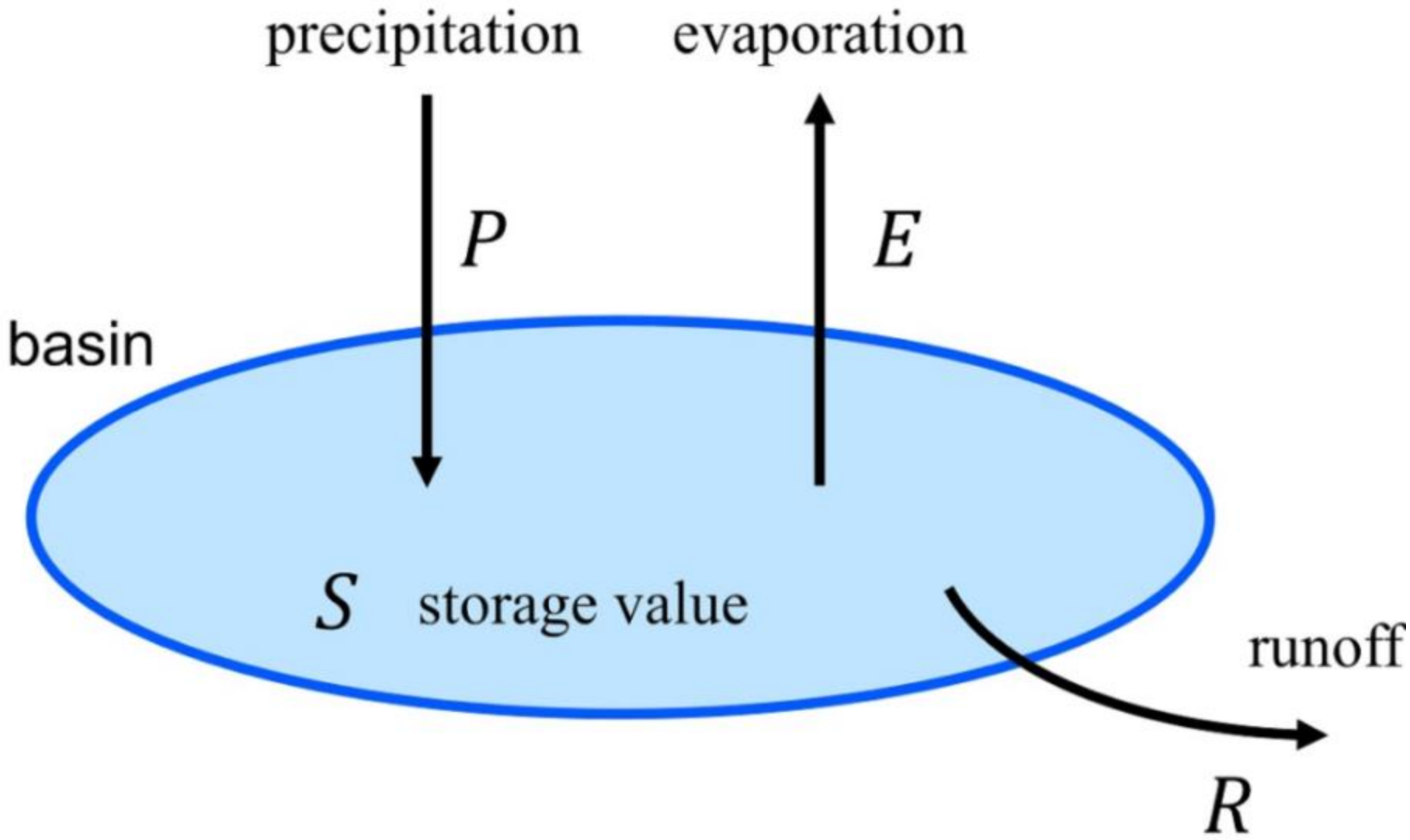
1. **Water Quantity:** NGLA
2. **Water Quality I:** Chloride (derived from seawater)
3. **Water Quality II:** Other water pollutants (from human activities, such as PFAS and nitrate)
4. **Applicable Water Resource Management Methods for Guam**

Topic 1- Guam's Water Budget

Water Quantity

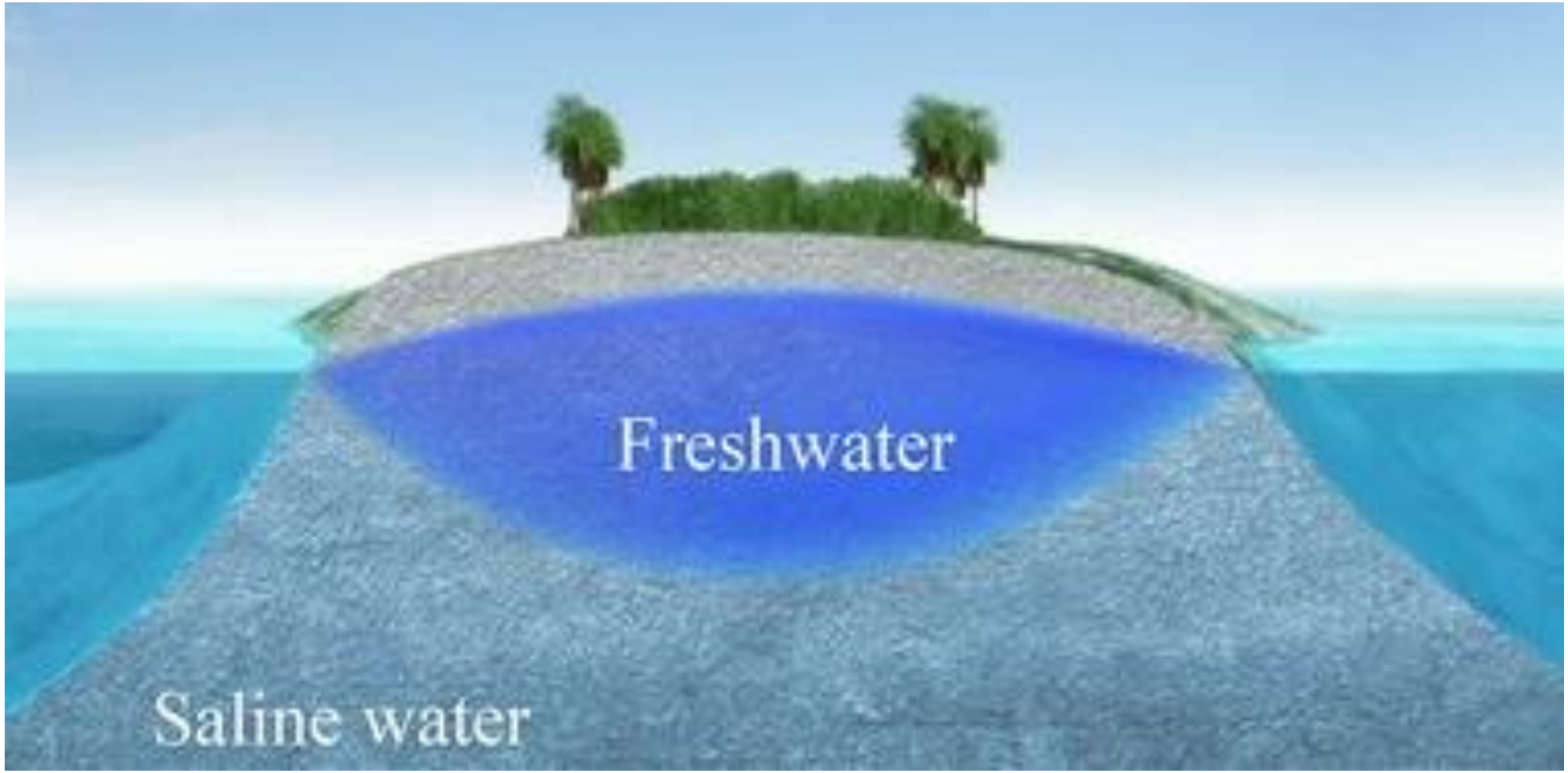
Northern Guam Lens Aquifer (NGLA)

Basic concept of water budget



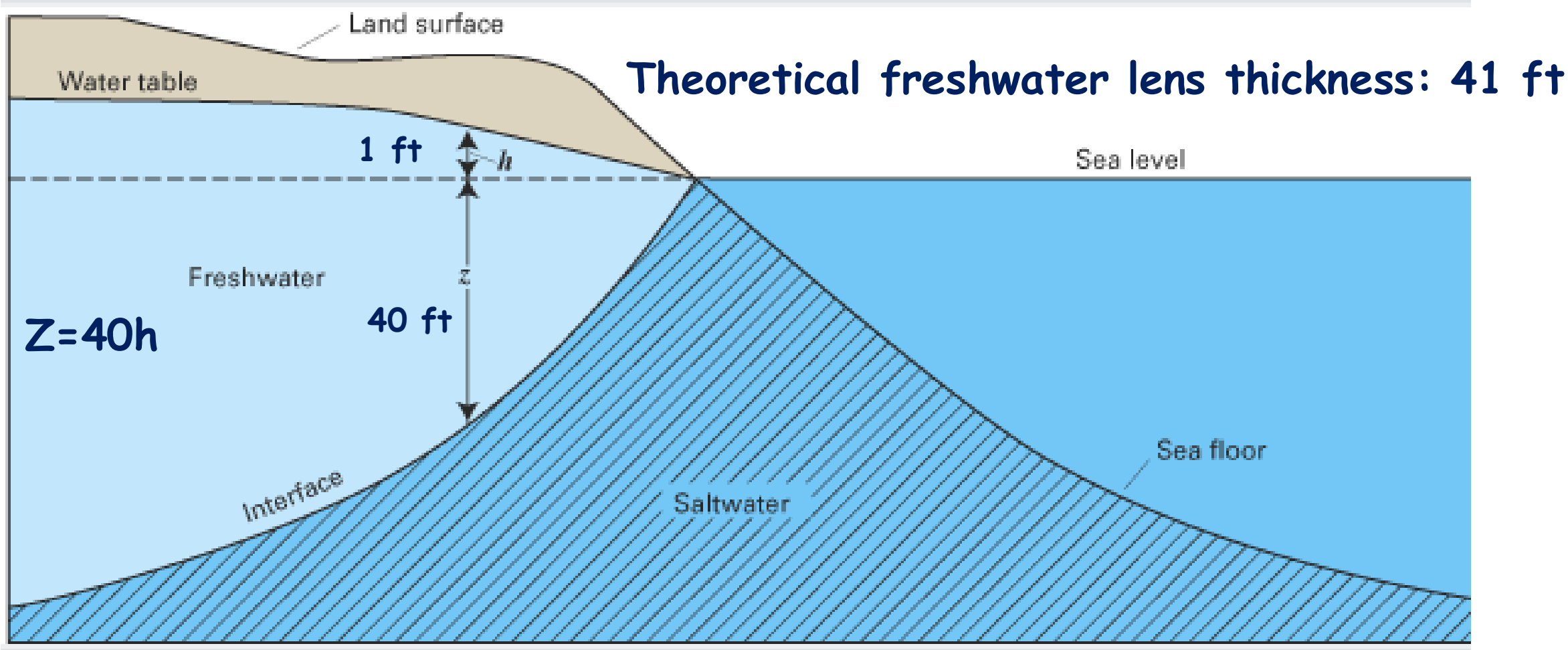
https://trenchlesspedia.com/definition/3144/water-budget

Freshwater Lens (groundwater)



https://www.researchgate.net/journal/Rock-Mechanics-and-Rock-Engineering-1434-453X

Ghyben-Herzberg relation

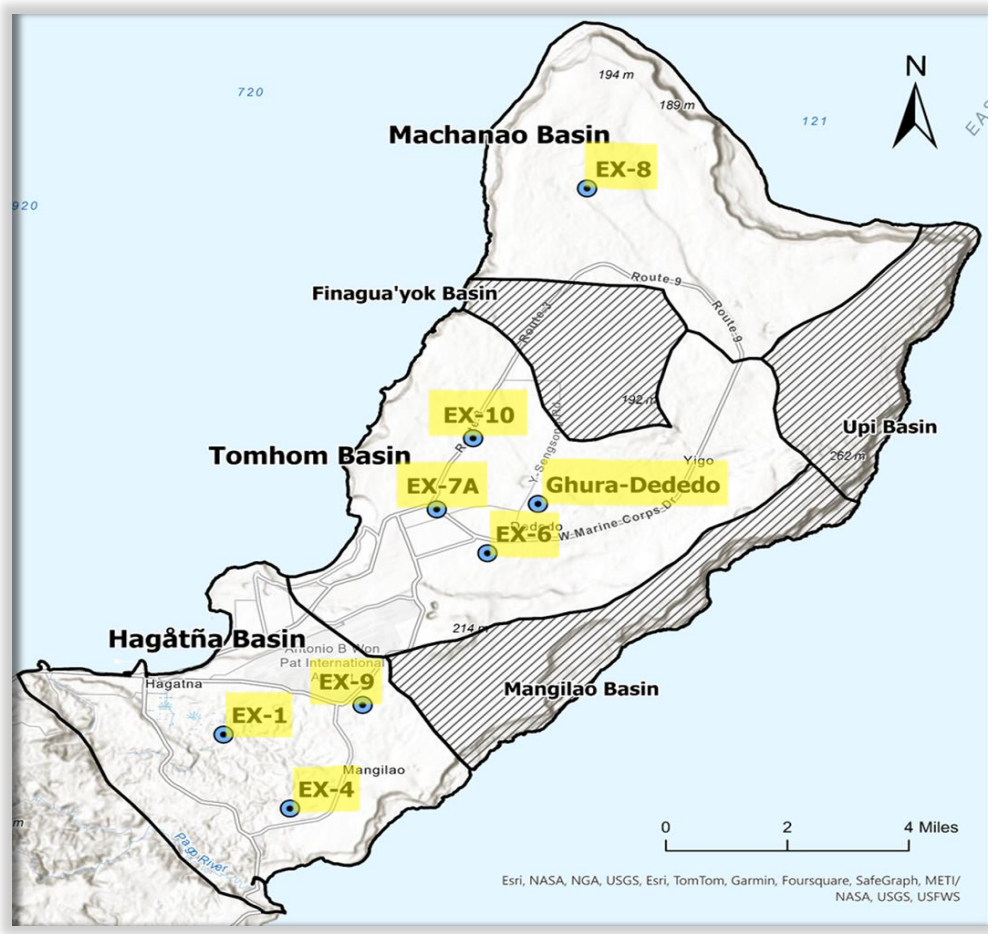


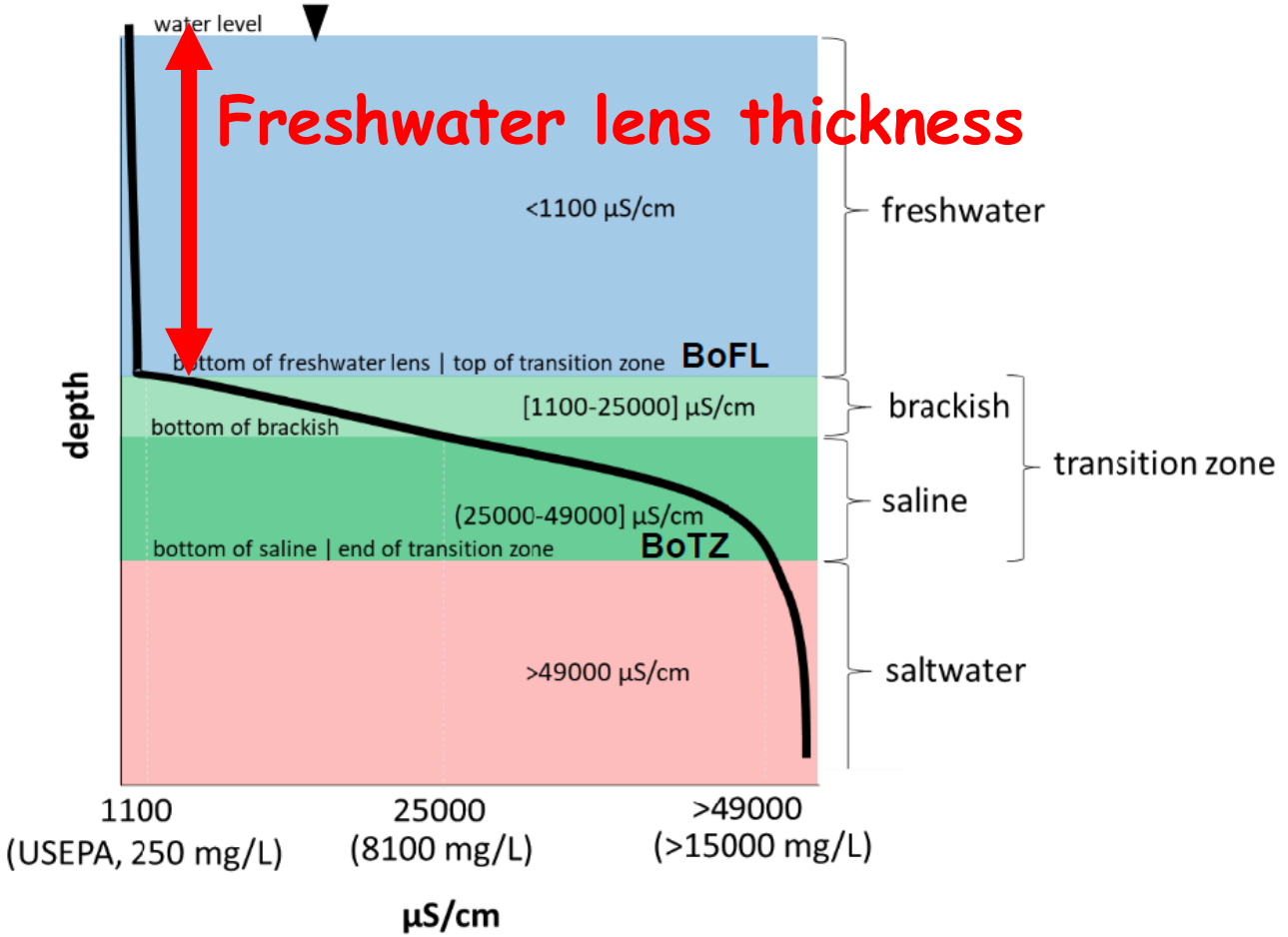
Theoretical freshwater lens thickness: 41 ft

https://www.vcalc.com/wiki/EmilyB/Ghyben-Herzberg+Relation+%28Saltwater+Intrusion%29

How to estimate the water budget of the NGLA (Quantity)

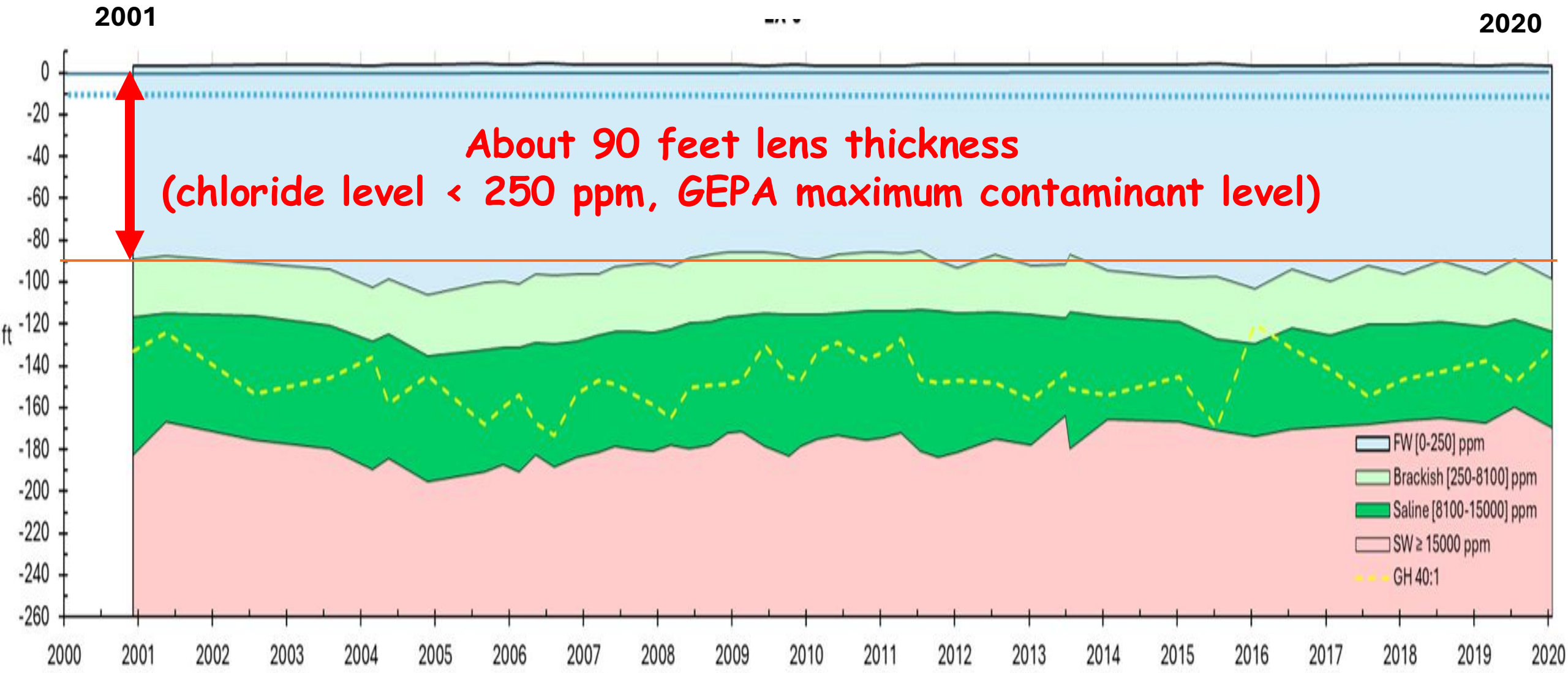
Measurement of chloride levels at monitoring wells





A slide From Ms. Mary Snare's presentation

Example. EX-9 monitoring well (near the happy mart)



A slide From Ms. Mary Snare's presentation

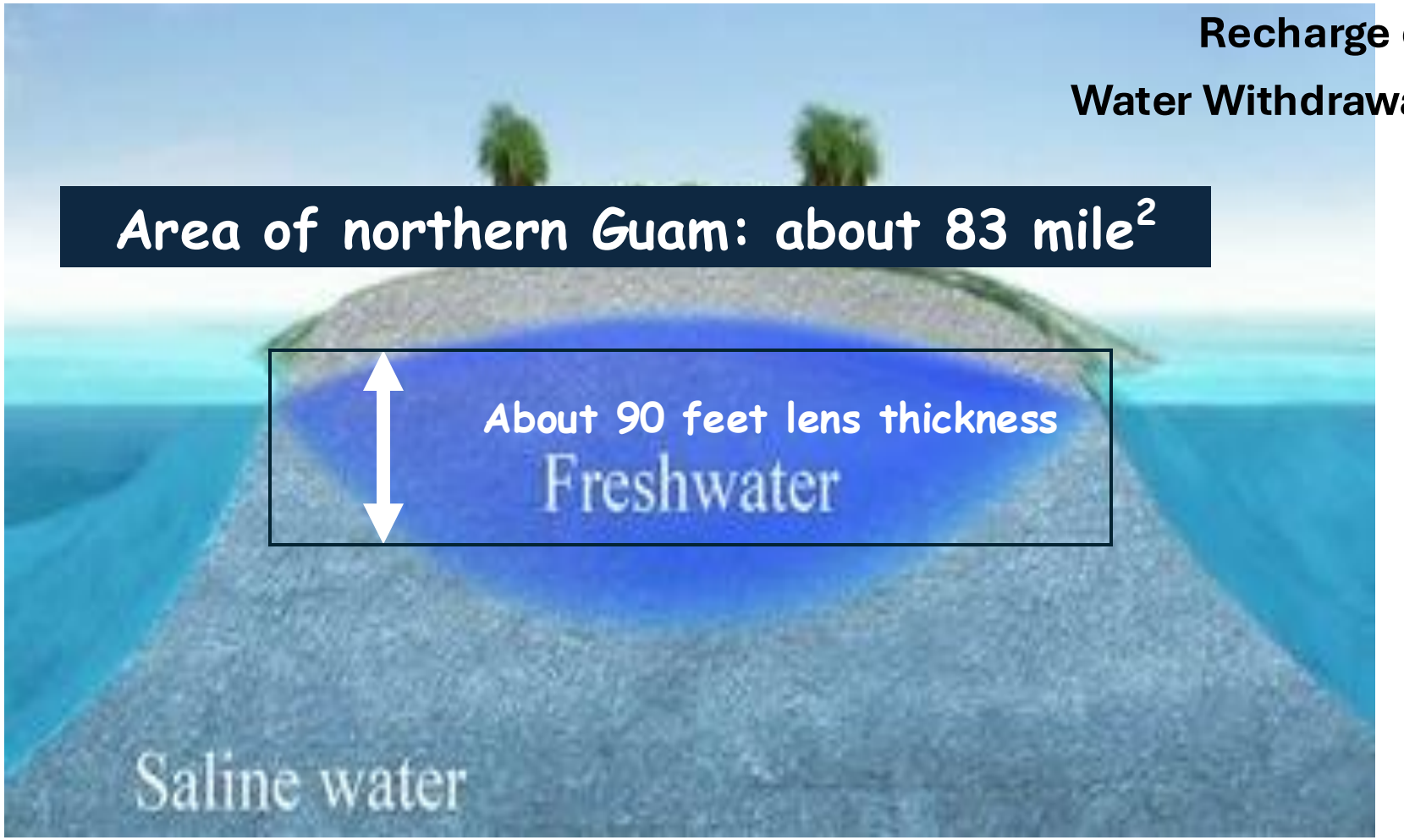
Rough calculation of the NGLA water budget

1,500 Billion Gallon of freshwater

Annual rainfall: ~ 100 inches/year

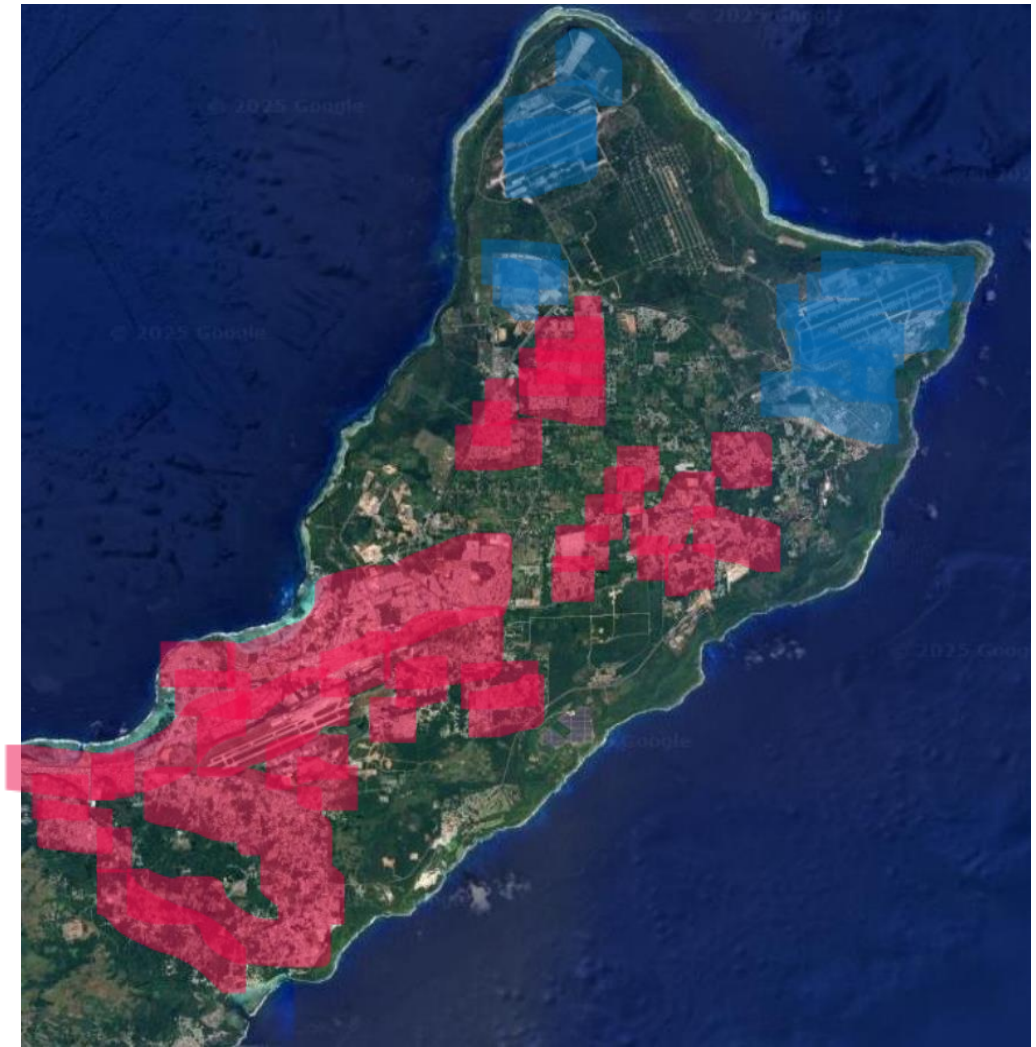
Recharge of freshwater : 467 MGD

Water Withdrawal from the Wells: 35 – 40 MGD



Another Factor: Decrease in Vegetated Land Cover

Continuous land development and military buildup reduce the infiltration rate of rainwater, ultimately leading to a decrease in groundwater recharge.



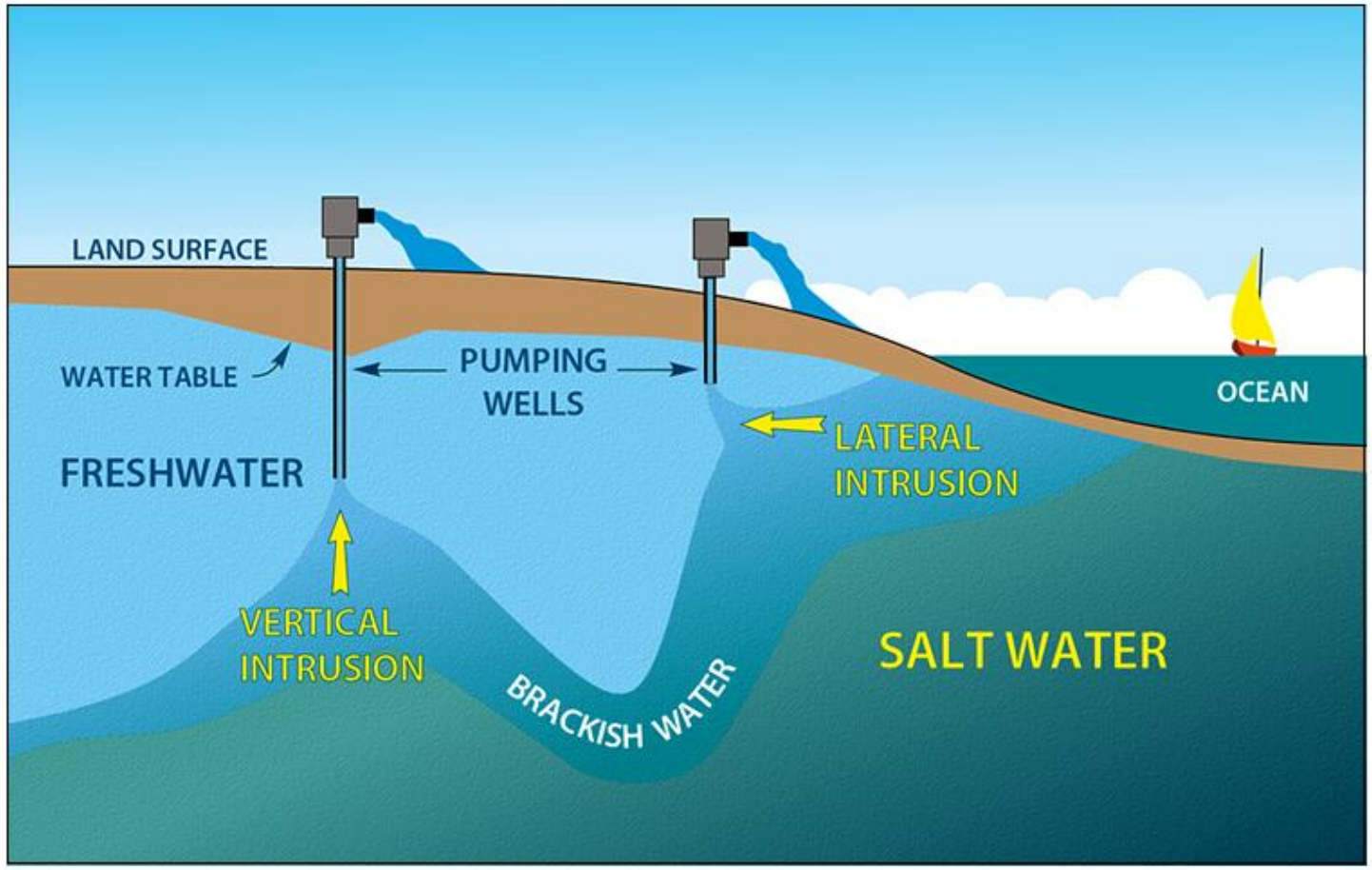
Topic 2 - Guam's Water Budget

Water Quality I

Chloride levels (< 250 ppm)

Well hydraulics

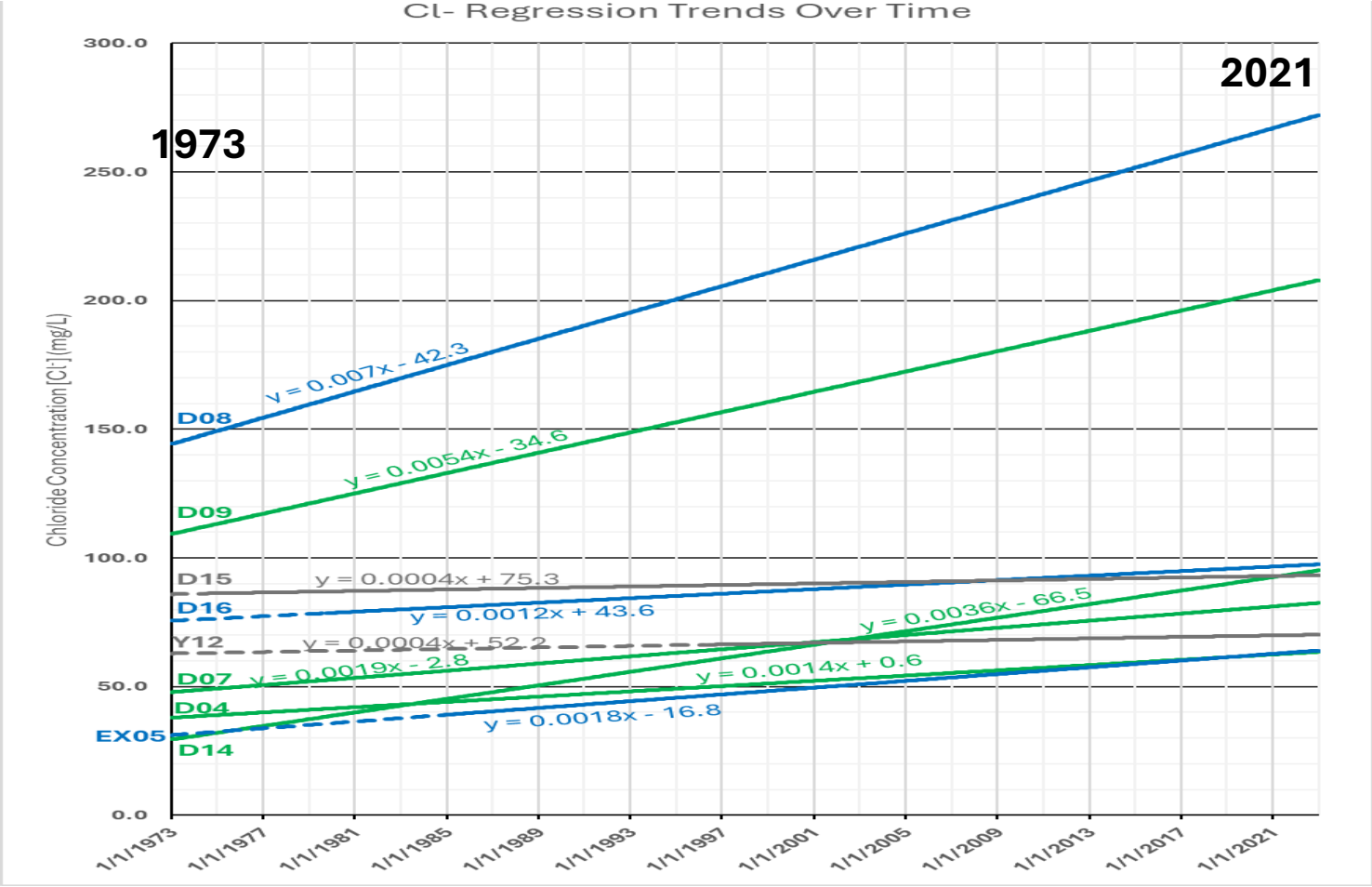
The impact of well pumping depends on the well's location, but it generally accelerates saltwater intrusion.



https://floridacoastaleverglades.blogspot.com/2016/08/the-peril-of-peatsea-level-rise-in_22.html

Example. Chloride Concentrations Over Time

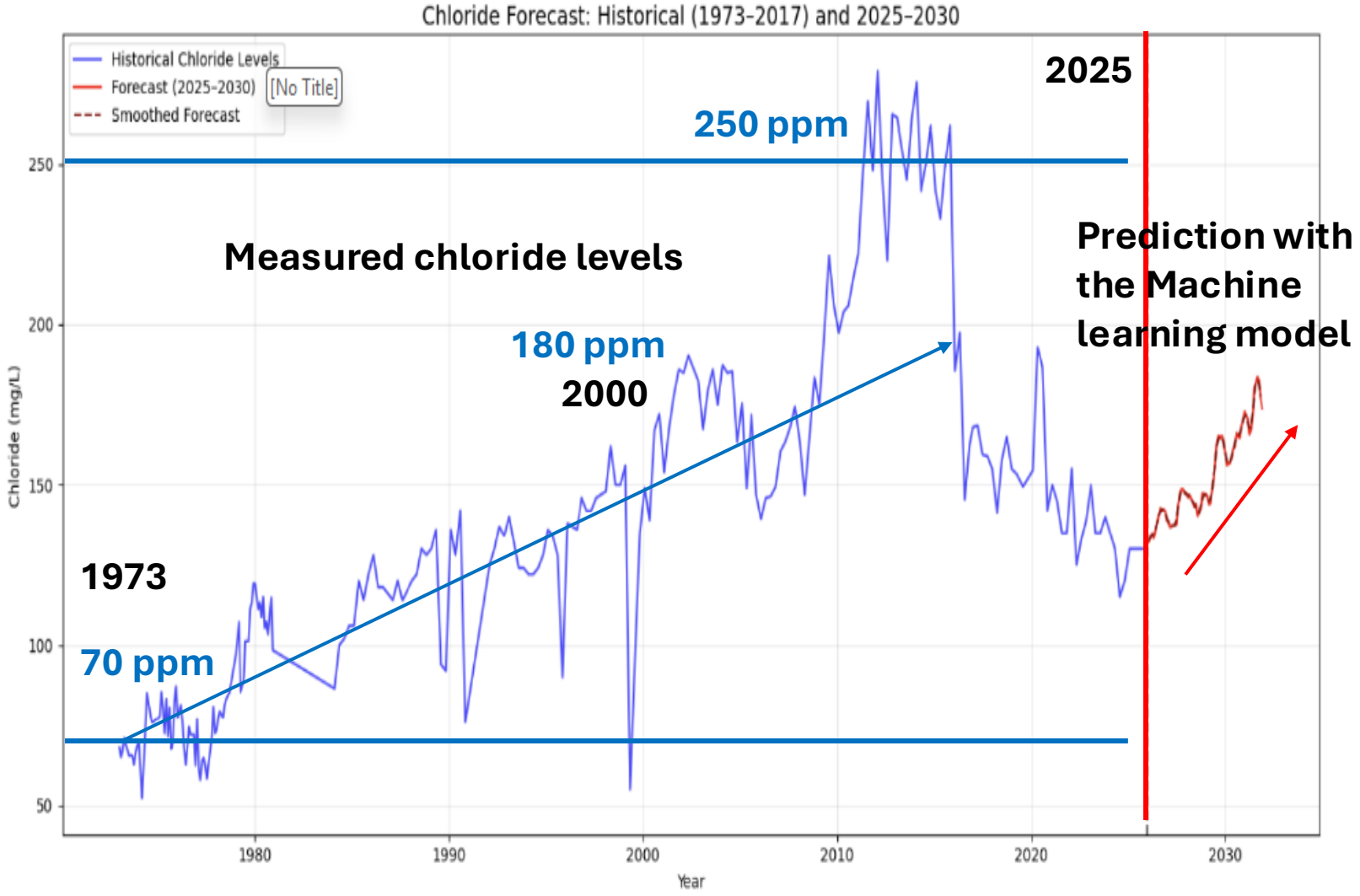
Wells D04, D09, D07, D08 have 50-year records (1973-2022), Increasing trend over time

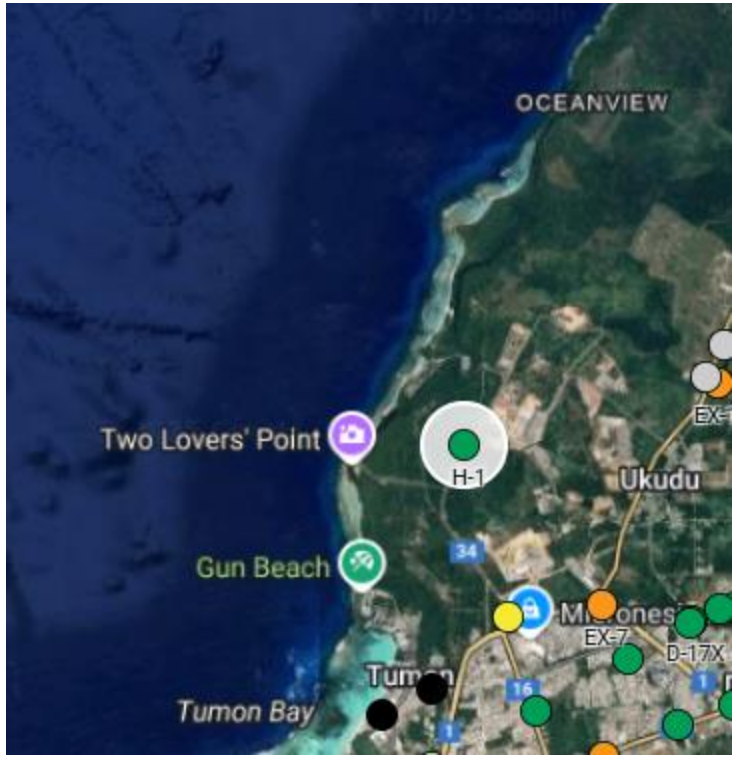


A slide From Ms. Hazelle Ko's presentation

Example. Well H-1, the well closest to the shoreline

Machine Learning Approach to predict the chloride level





Preliminary Conclusion

- **The operation of 150 wells in the NGLA will drive a continuous increase in chloride levels.**
- **From my perspective, there are already more wells than the safe limit, causing saltwater intrusion.**
- **But if wells should be further installed, when planning new well installation, it’s crucial to choose areas that reduce the risk of saltwater intrusion.**

Topic 3 - Guam's Water Budget

Water Quality II

Other water pollutants, such as PFAS and nitrate

Chloride contaminates freshwater due to saltwater intrusion.

Fortunately, groundwater containing chloride that discharges into the ocean does not harm marine water quality.

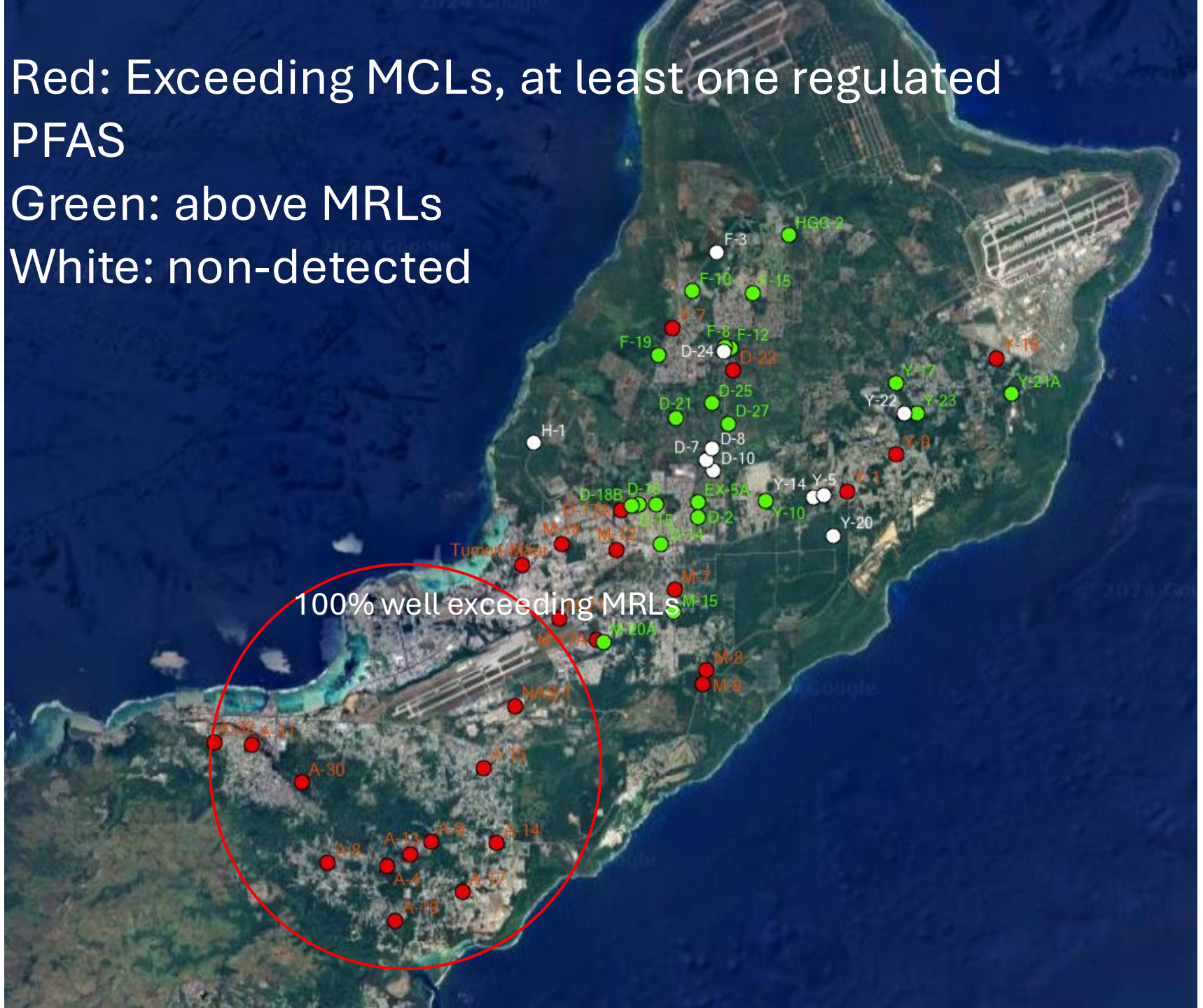
Aside from chloride, the majority of water pollutants come from human activities, with some caused by natural disasters (turbidity). As a result, the origin of most pollutants is closely linked to human activities and waste management.

PFAS

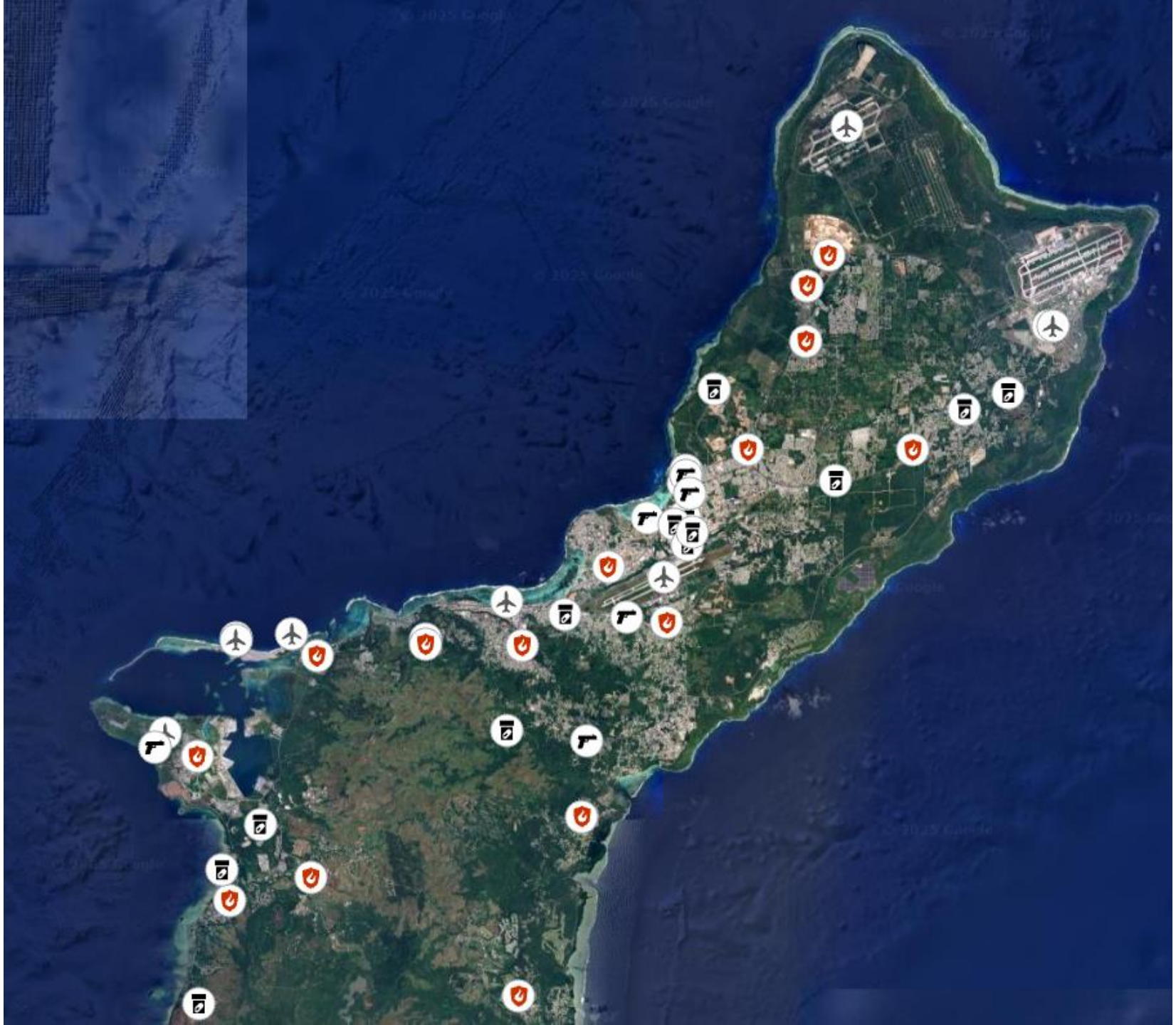
Red: Exceeding MCLs, at least one regulated PFAS

Green: above MRLs

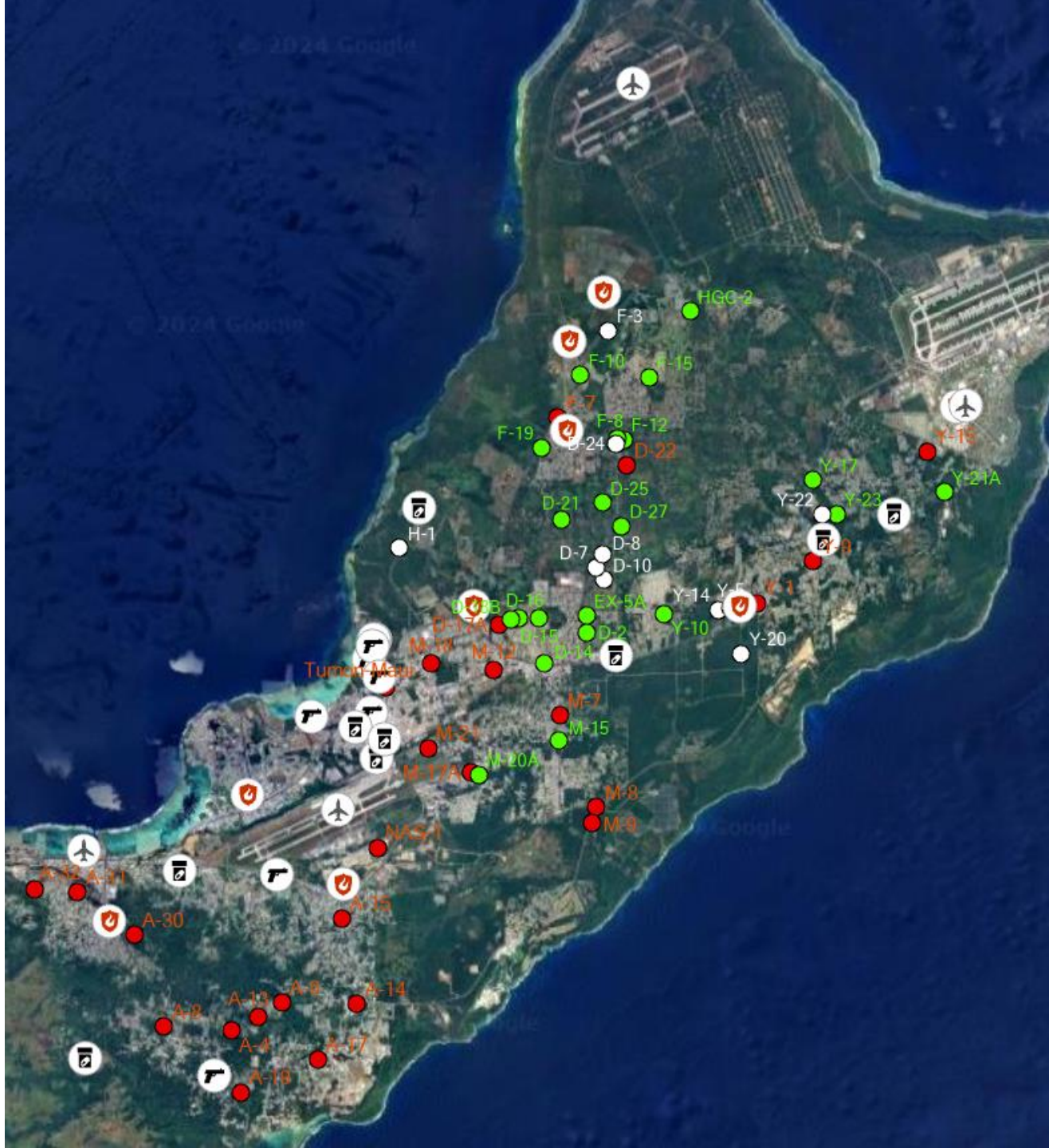
White: non-detected



Potential contamination sources



PFAS


HGC-2
F-3
F-10
F-15
F-7
F-8
F-12
F-19
D-24
D-22
Y-15
Y-17
Y-21A
D-25
D-21
D-27
Y-22
Y-23
H-1
D-8
D-7
D-10
Y-14
Y-5
Y-1
D-16
EX-5A
D-2
Y-10
Y-20
D-14
M-12
Tumon-Maui
M-7
M-15
M-21
M-20A
M-17A
M-8
M-9
NAS-1
A-31
A-30
A-15
A-13
A-9
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A-4
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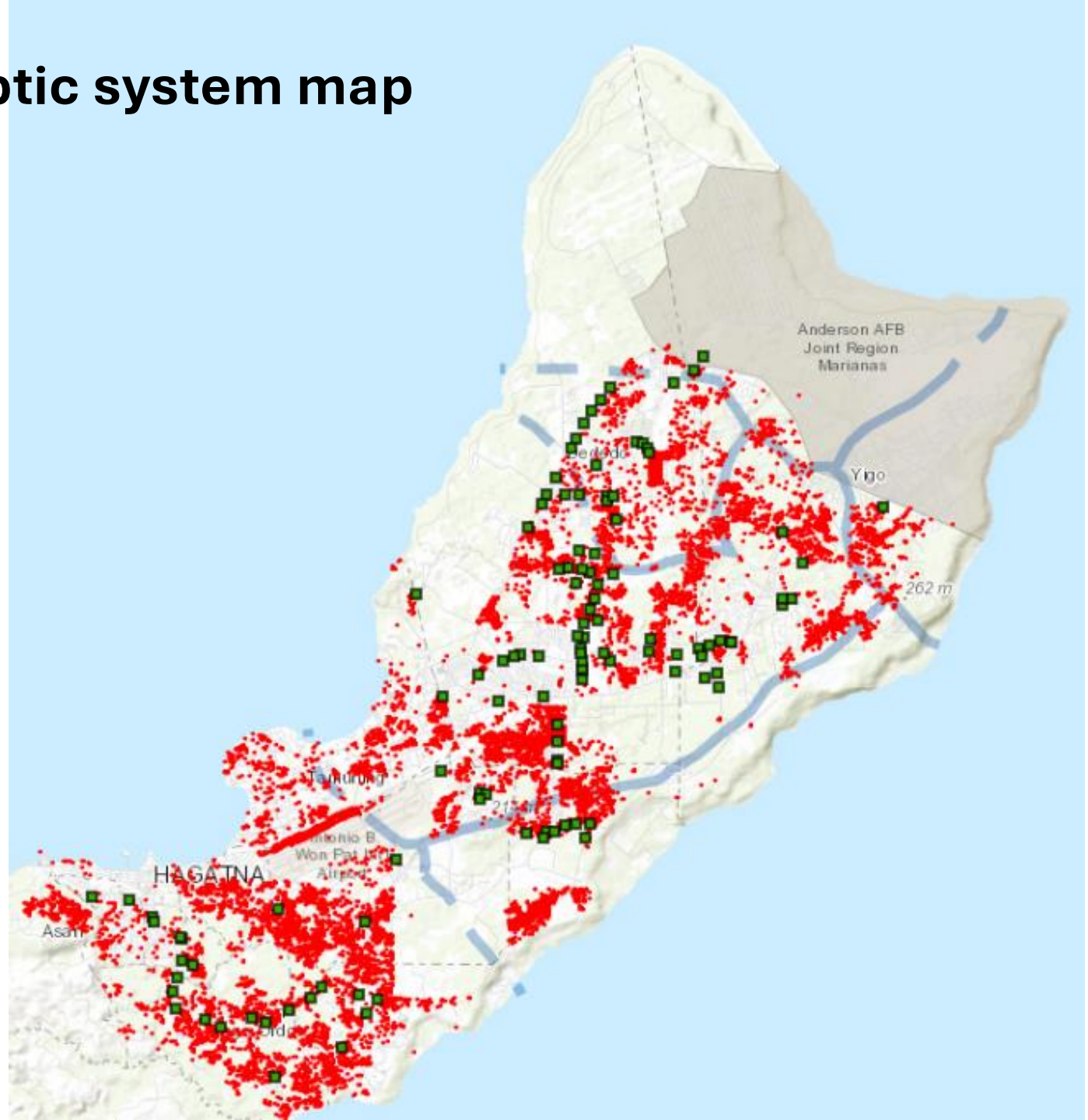
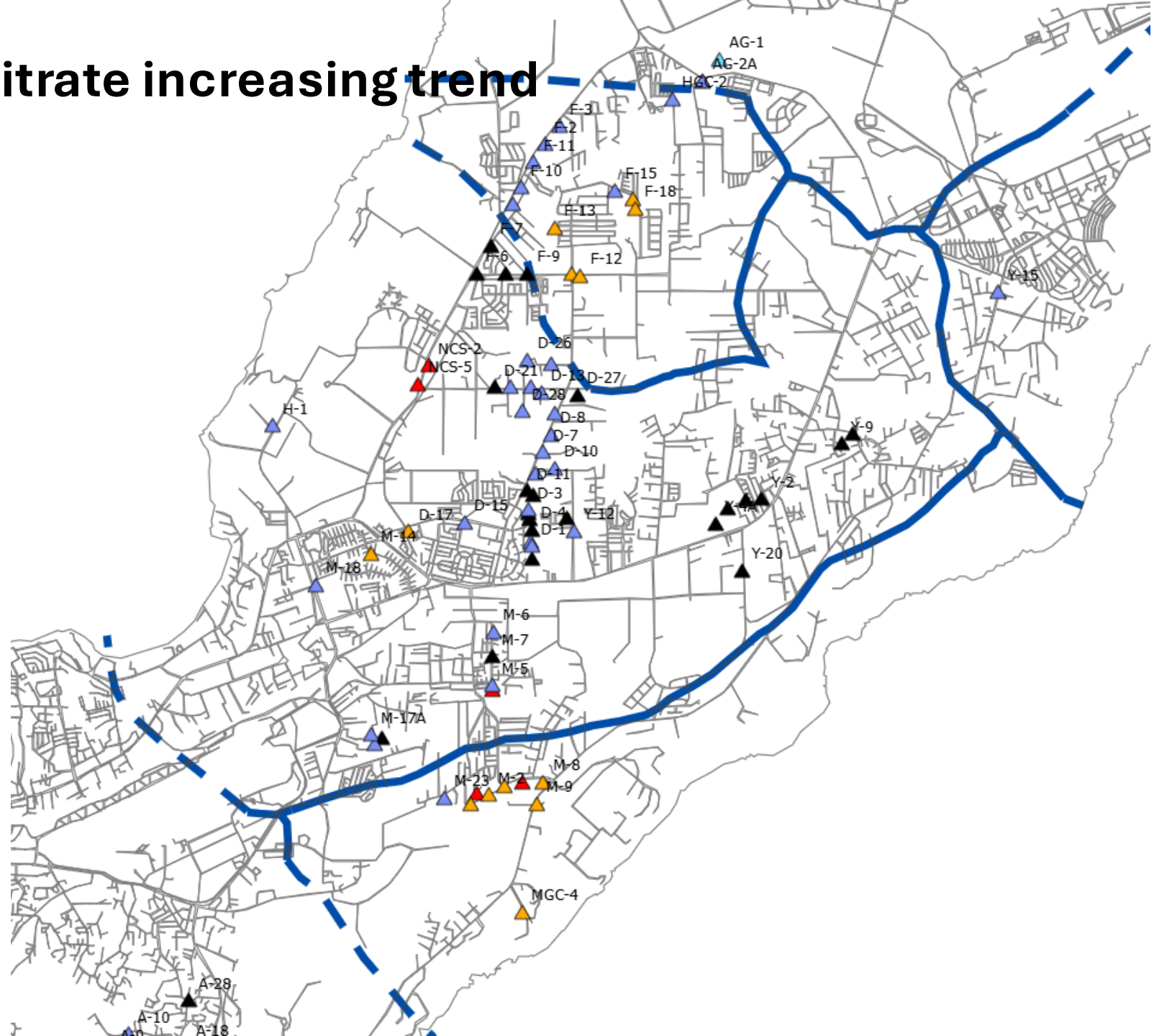
A-18

Production wells and septic system map



Red dots indicate septic tanks
Green boxes represent GWA production wells

Wells showing nitrate increasing trend



https://guamhydrologicsurvey.uog.edu/

The fundamental problem of Guam's water budget is water pollution caused by human activities,

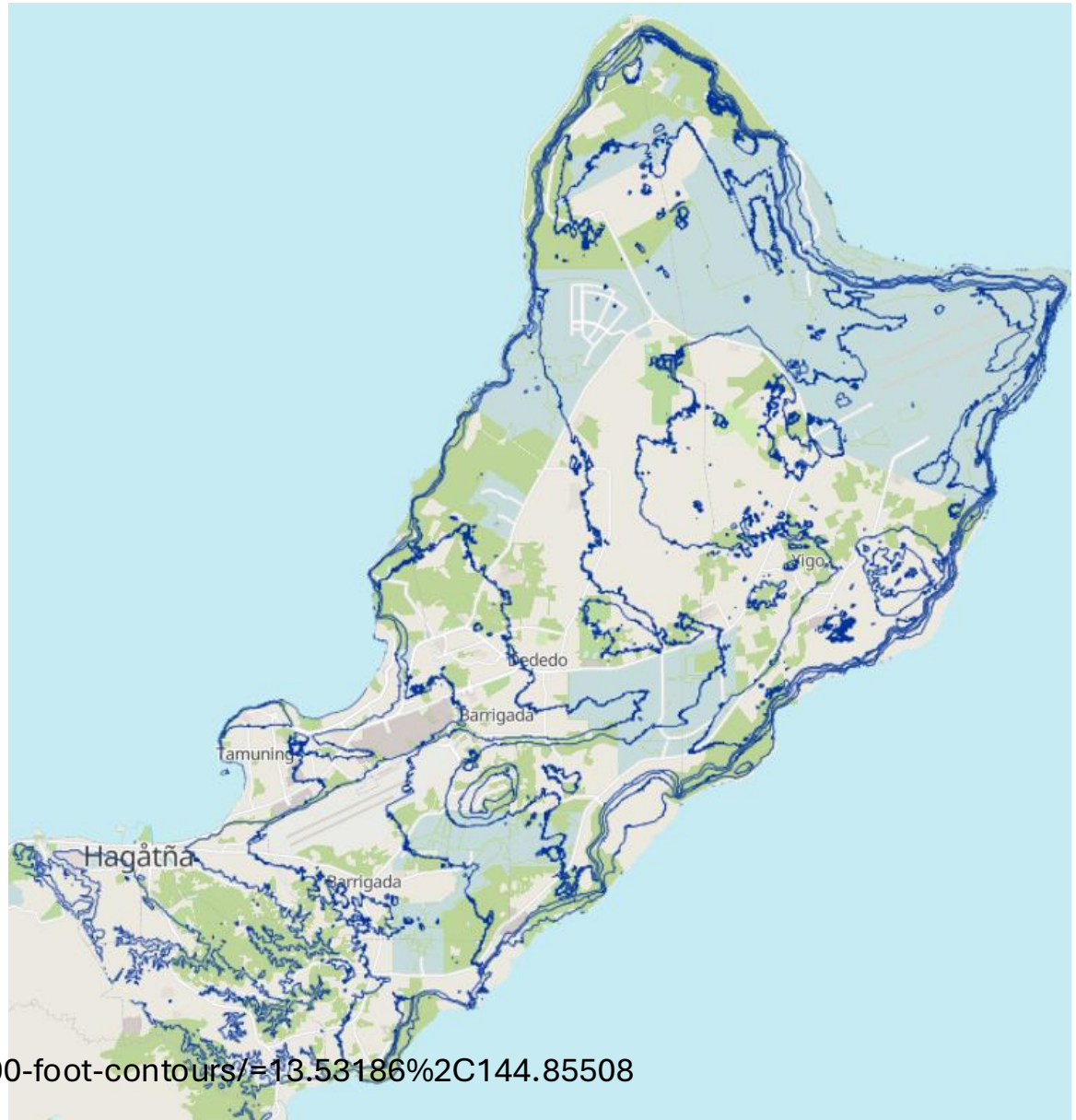
and this issue will create a tremendous financial burden for water treatment in the future.

Topic 4

Applicable Water Resource Management Methods for Guam

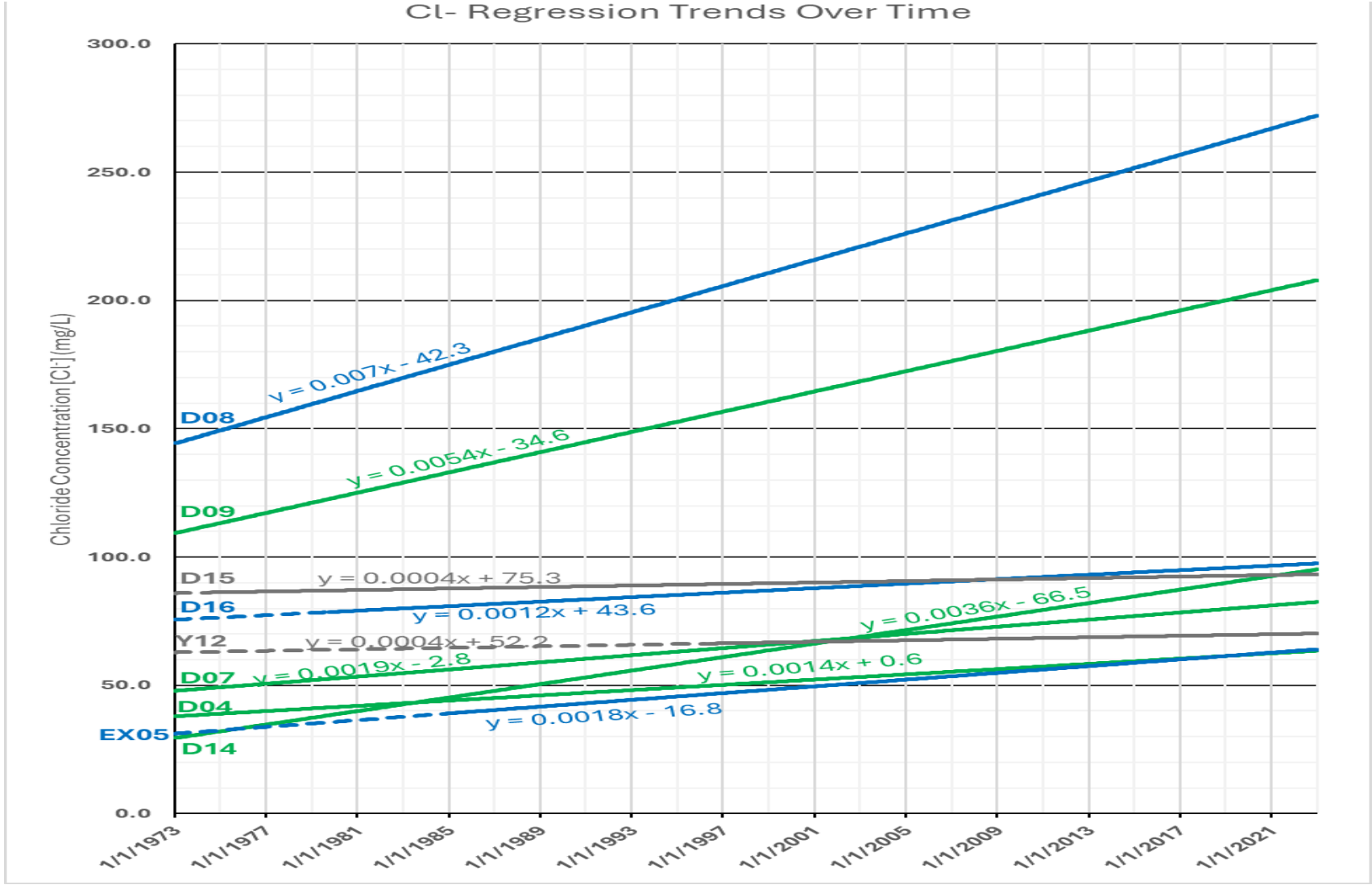
A. New wells should be drilled in locations where chloride levels are relatively low and water availability is relatively high.

New well drilling – Required Chloride level contour map

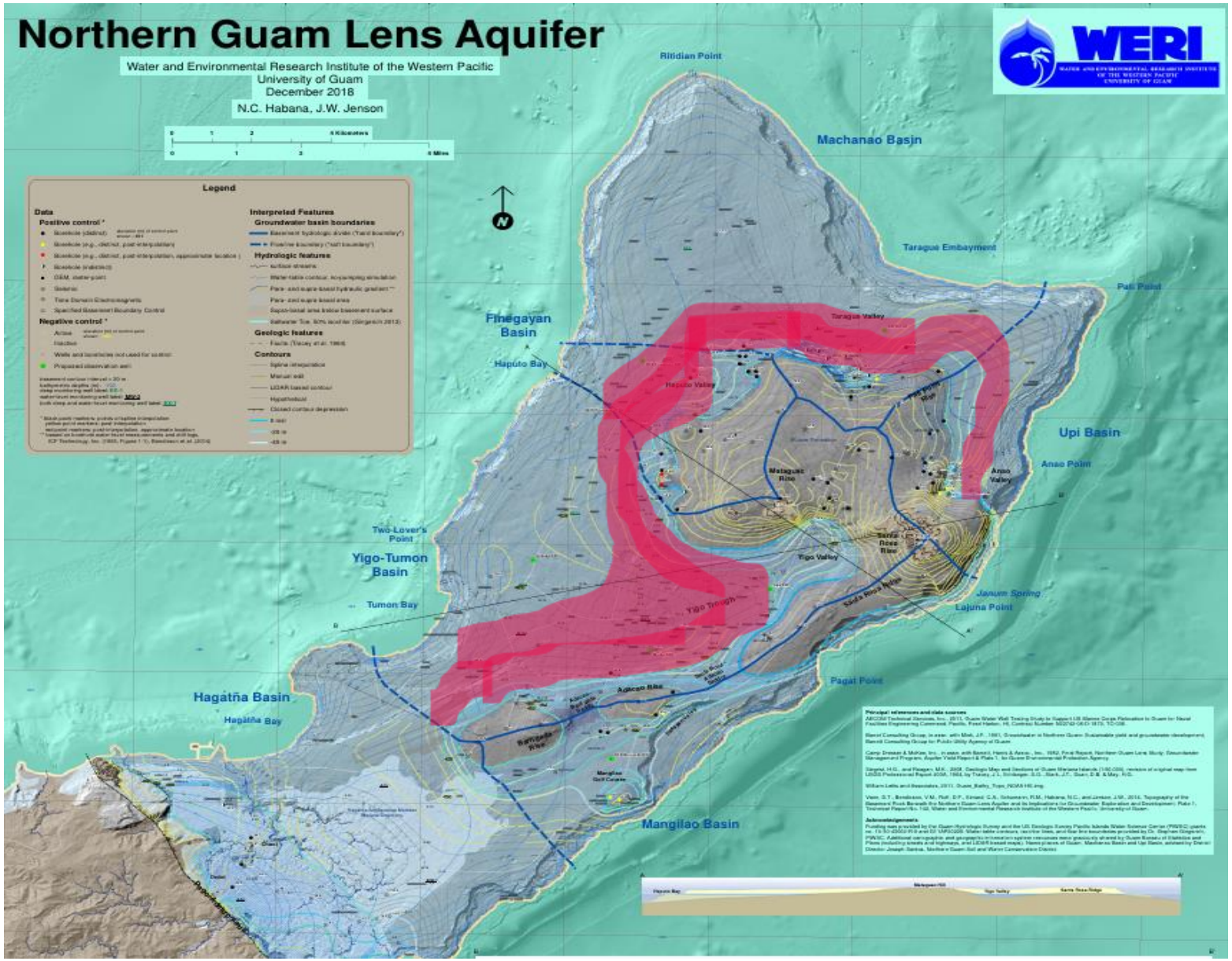


https://koordinates.com/layer/111348-guam-100-foot-contours/=13.53186%2C144.85508

New well drilling – Historical chloride level trend data



New well drilling – Chloride and water production related

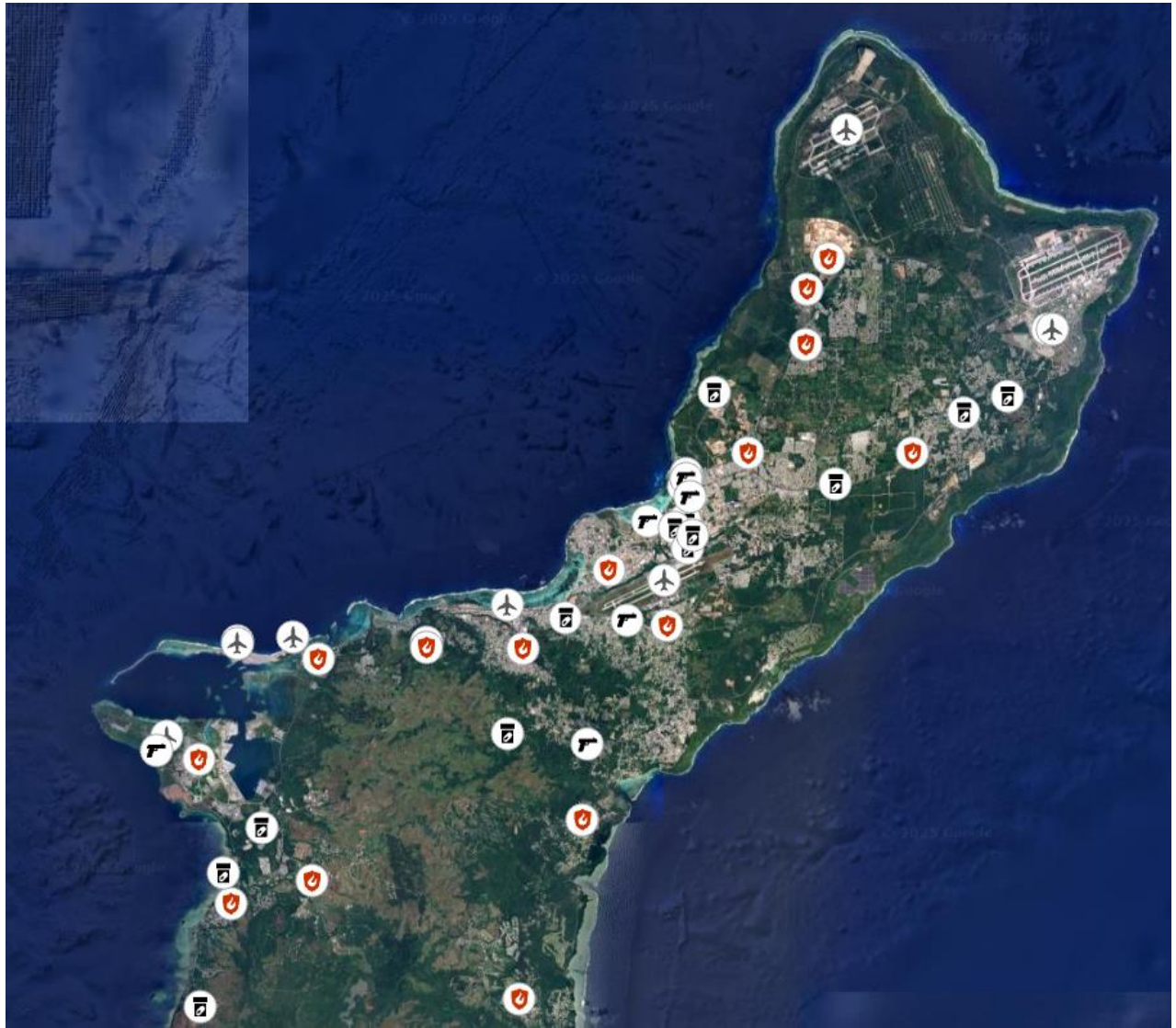


B. Potential contamination sites should be avoided.

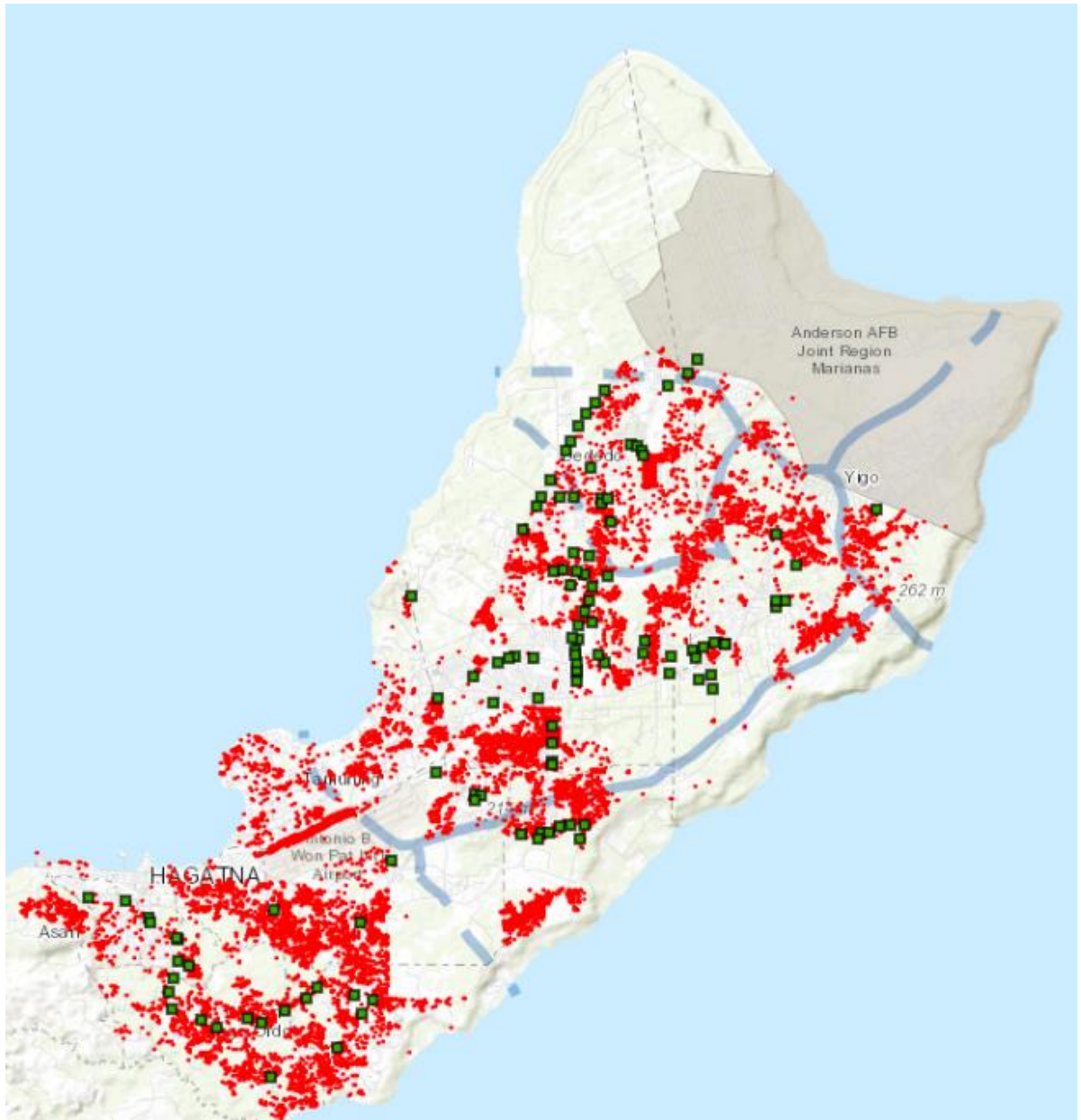
Ensuring safe water quality in a cost-effective and efficient manner starts with public education and strong waste management policies.

Development of a Potential Pollution Area Map

Sinkholes, groundwater injection wells, fire stations, chemical storages, hardfill sites, solid waste sites, landfill sites, munition sites…

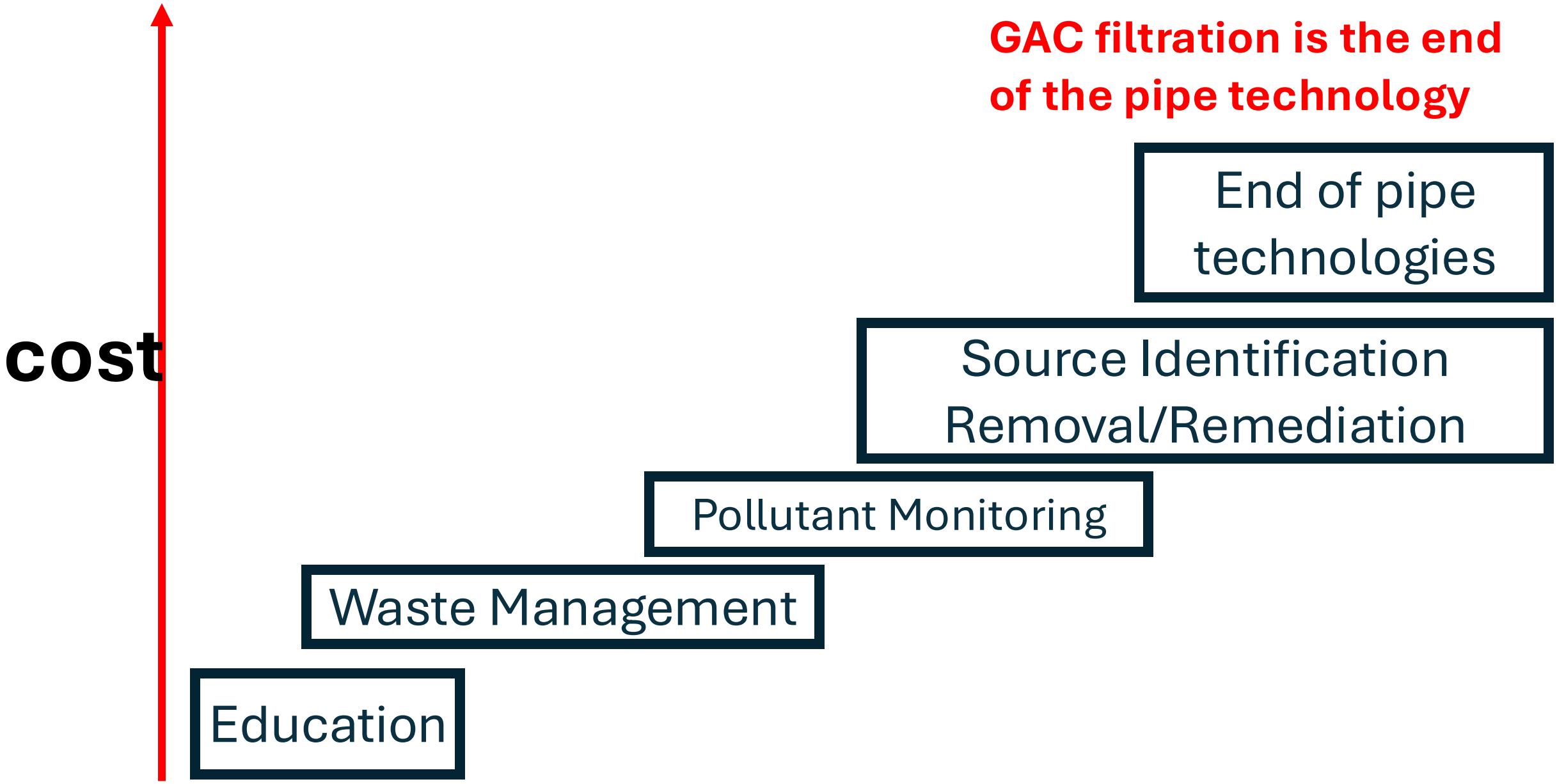


Extension of sewer lines to minimize pollution from septic systems



Red dots indicate septic tanks
Green boxes represent GWA production wells

Stronger waste management policies



C. Various water supply strategies must be developed to ensure sustainable water provision.

Return on Investment (ROI) Analysis and Development of Alternative Water Resource Plans

- The Development of Freshwater Resources in Southern Guam
- Desalination Systems
- Water Pollution Treatment Technologies
- New Water Supply Strategies – Pipes, Tanks, and Well Connections

Thank you for listening!

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