Remote Environmental Monitors (REM)

Arizona Department of Environmental Quality (AZDEQ)

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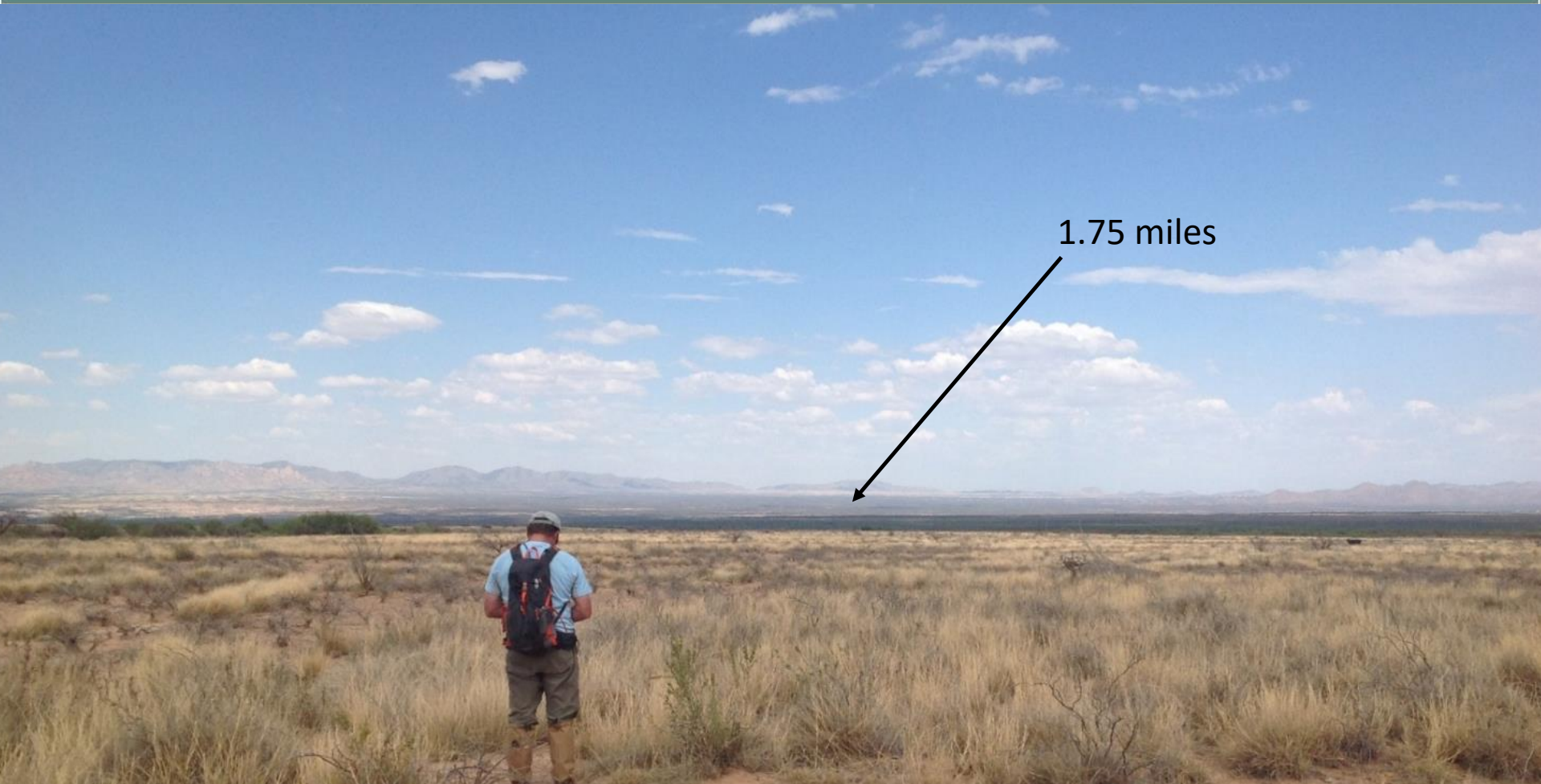
February 5th, 2019

Current State, or “How did we do it yesterday?”



Current State, or “Where was the waste?”

Average retrieval run requires 1.2 hours/site/employee.
Ratio of hit/miss = 48% (n = 32/67)
Conservative Estimate of Waste: ~1.2*2*35 = 84 hours
Unnecessary Risks and wear/tear (snakes, heat, equipment)

Exploring Open Source Alternatives for Doing More with Less

Arduino Prototype for Remote Environmental Monitoring

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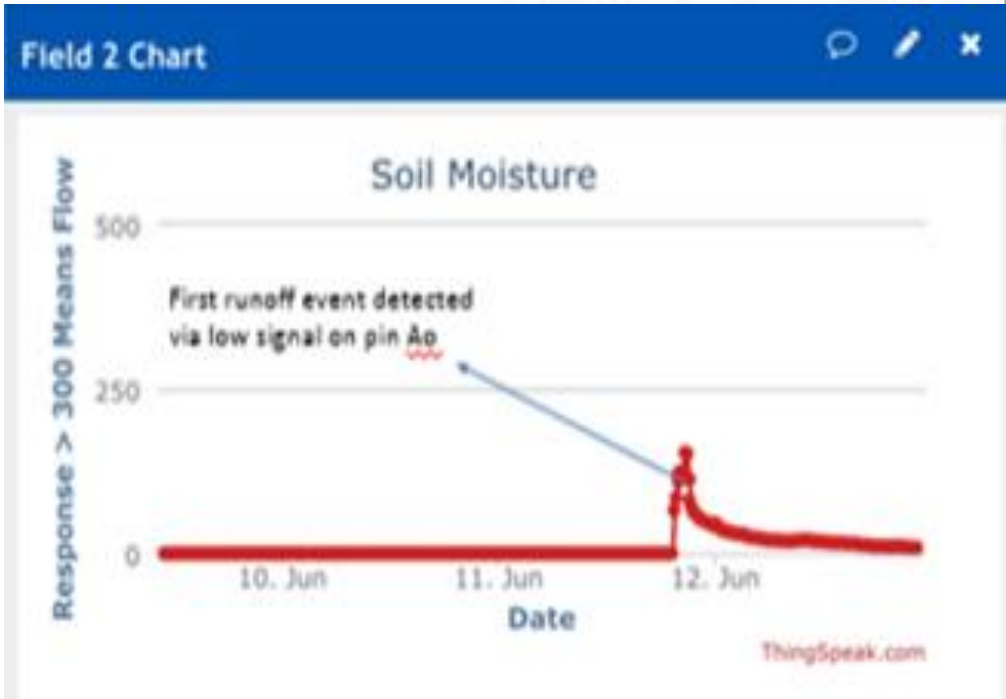
March 28, 2016

Arduino community logo used with permission

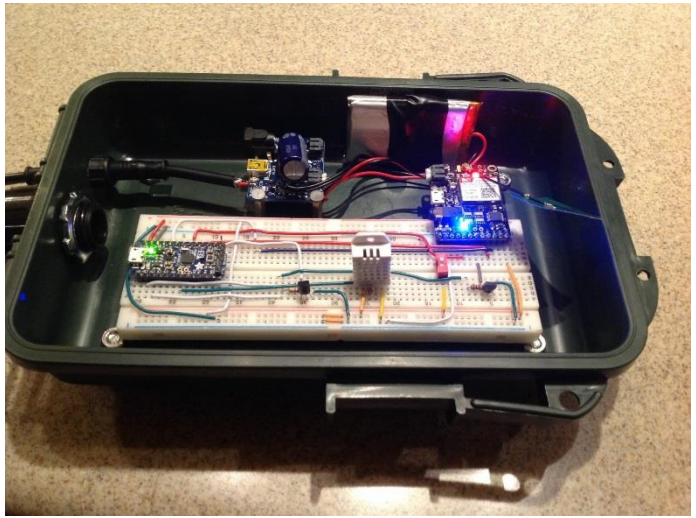
Field Installation
May 8, 2016

Success!
First Detect
June 11, 2016



Performance

Adafruit FONA Breakout (2G)



Parameter	Result
Time Period	May 3, 2016 – February 12, 2017
Days in Service	285
Records Collected	30,506
Frequency	1 record / 12.5 minutes
Max Down Time (DT)	59 minutes
Events > 50 min. DT	51 (2 days total; < 1% of 285)
Bat. Charge/Discharge	~285 cycles

- Employed non-strategic high frequency reporting
- Tolerated one season of temperature extremes w/ no maintenance
- Successful Beta
- *Revisit design and improve*

T-Mobile 2G Problem

Most of state is unserviced by T-Mobile's 2G network.

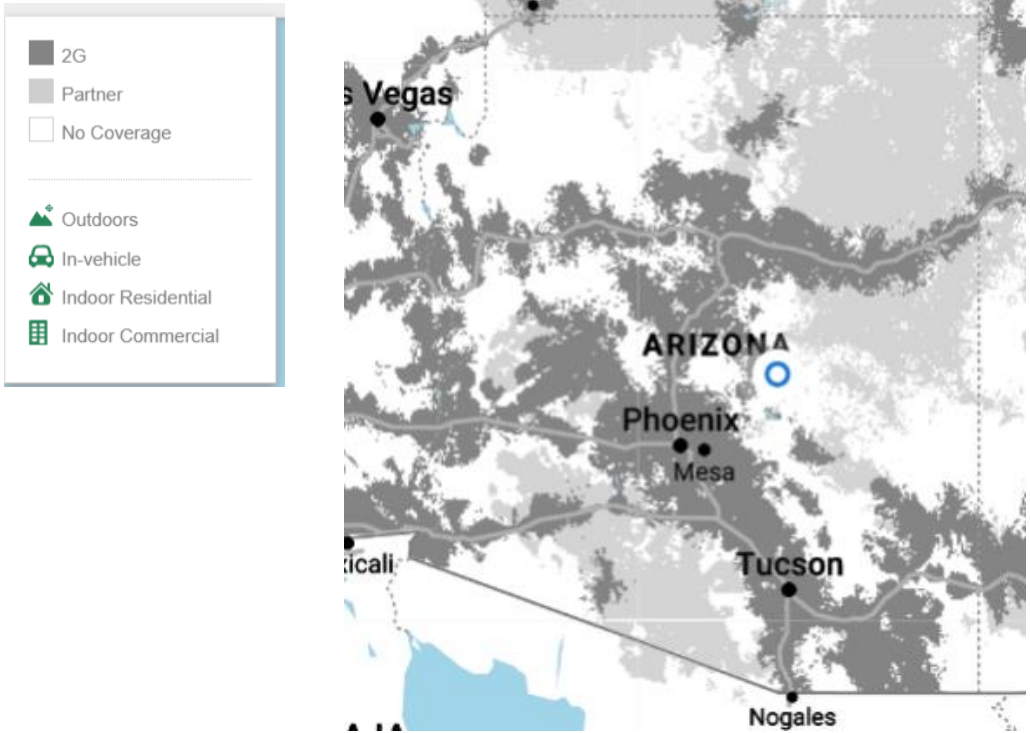
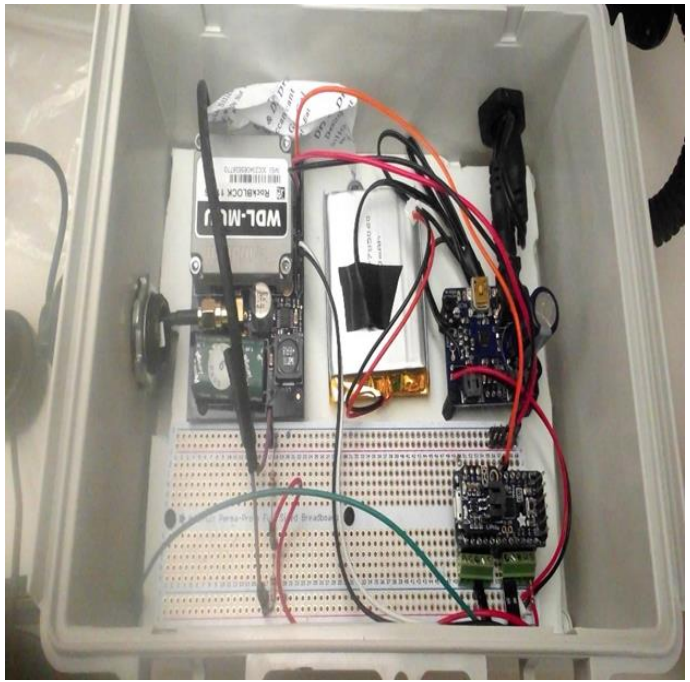


Figure 1: T-Mobile 2g Coverage. https://orion.freeus.com/coverage-map.aspx

Updated REM Design

Upgraded to Rockblock (Iridium) Satellite Modem

Service everywhere the sky is visible

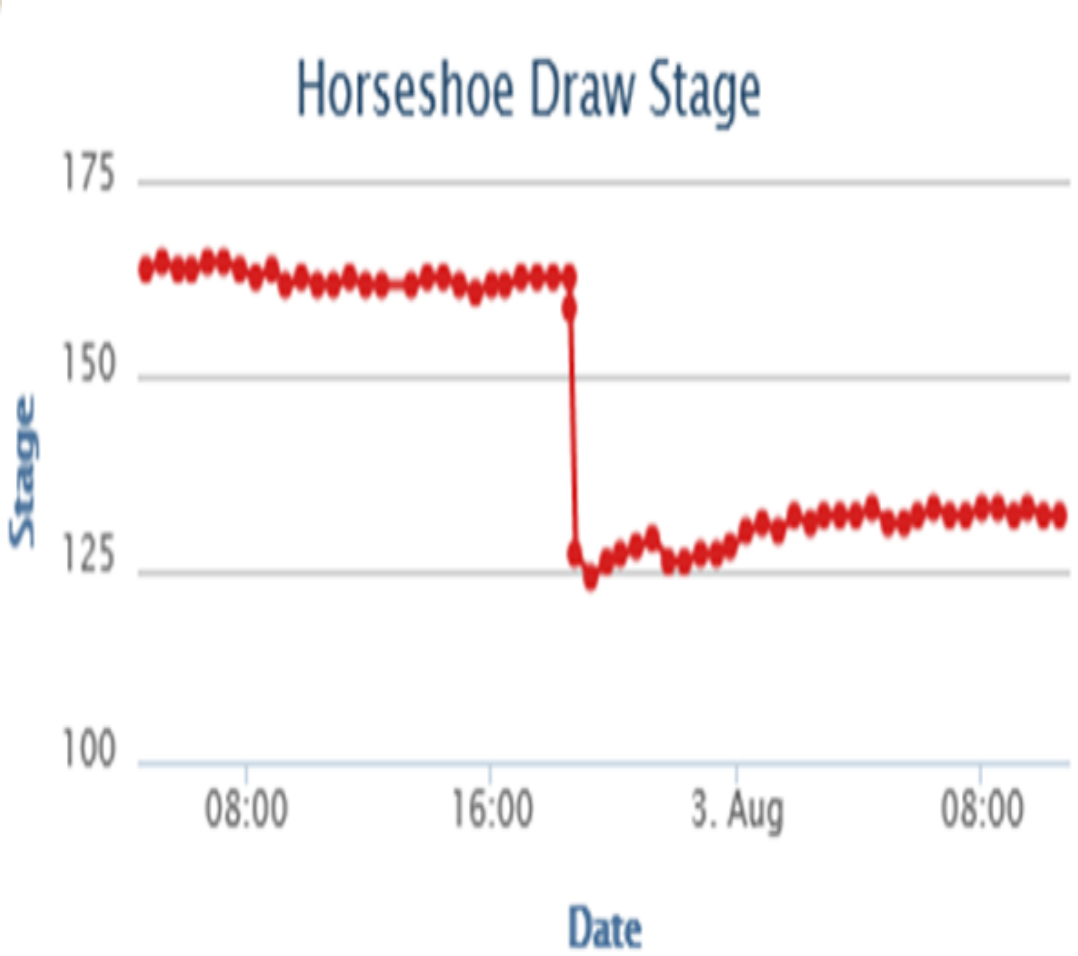


Updated Box Design, Added Satellite Modem

Detect Flow at Horseshoe Draw August 2, 2018

https://thingspeak.com/channels/540564

Between 6:33 – 6:44pm on 8/2/2018 the updated REM captured the 1st flow event.



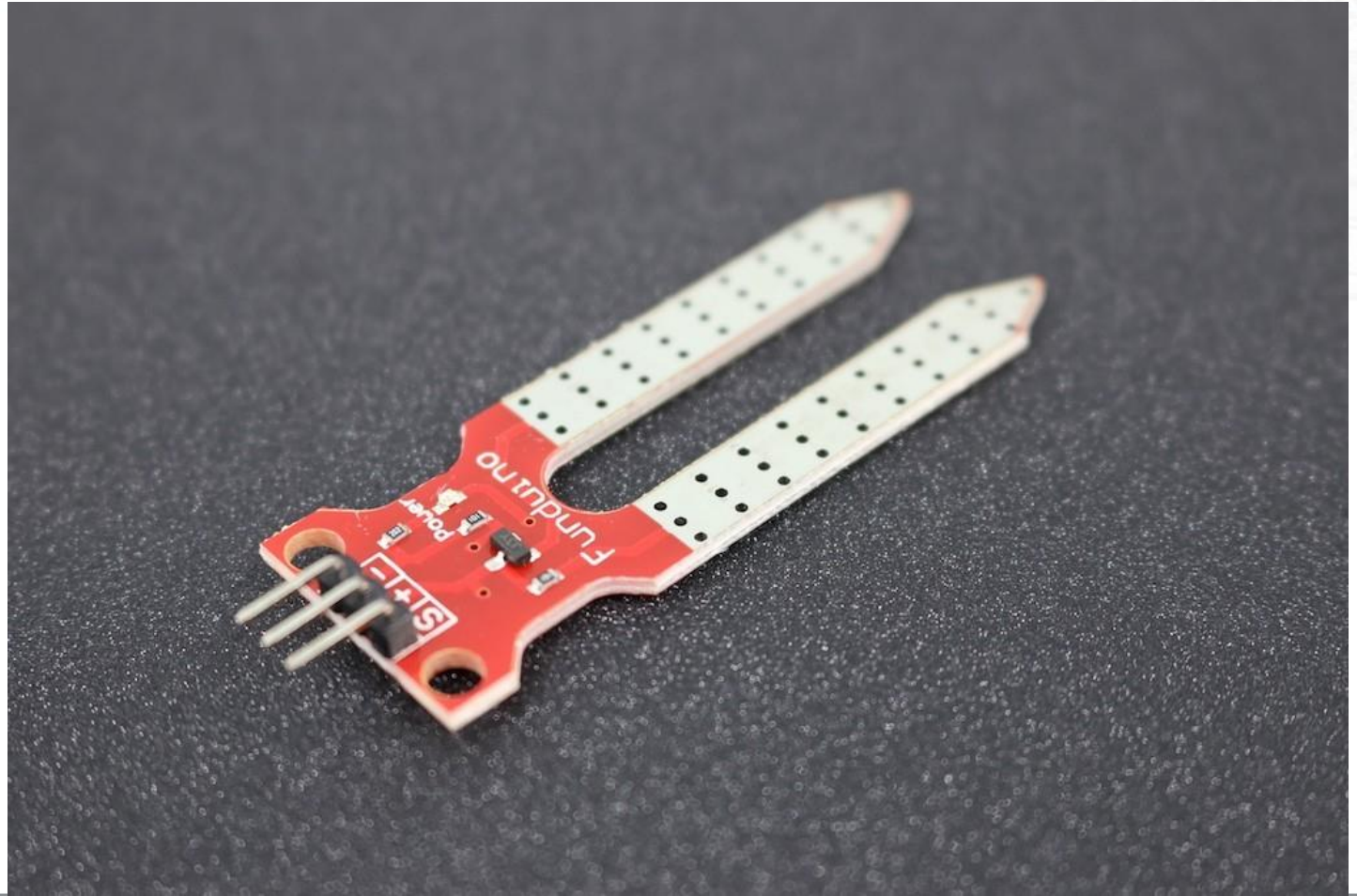
Integration with Hach AS950 Auto Sampler

Integrated with Auto Sampler at Big Bug Creek near Prescott.

Integrated with Auto Sampler at Green Bush Draw near Naco.

Flow Switch For Auto Sampler

Low Cost Switch



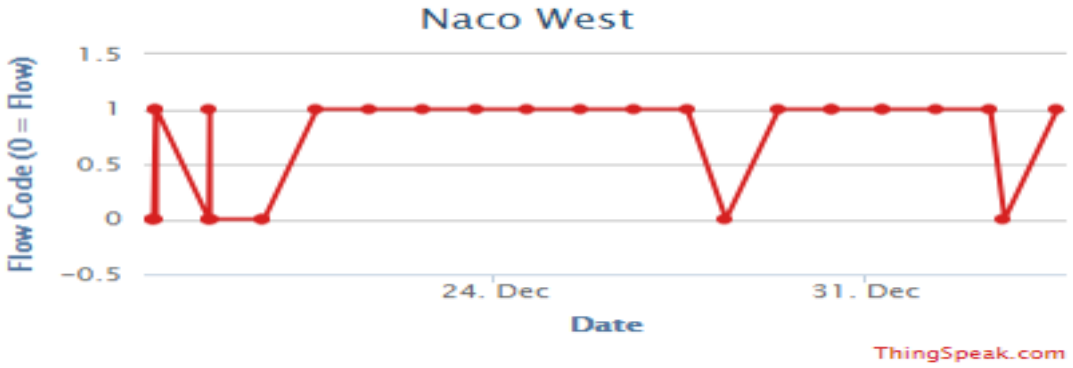
West Naco Installation

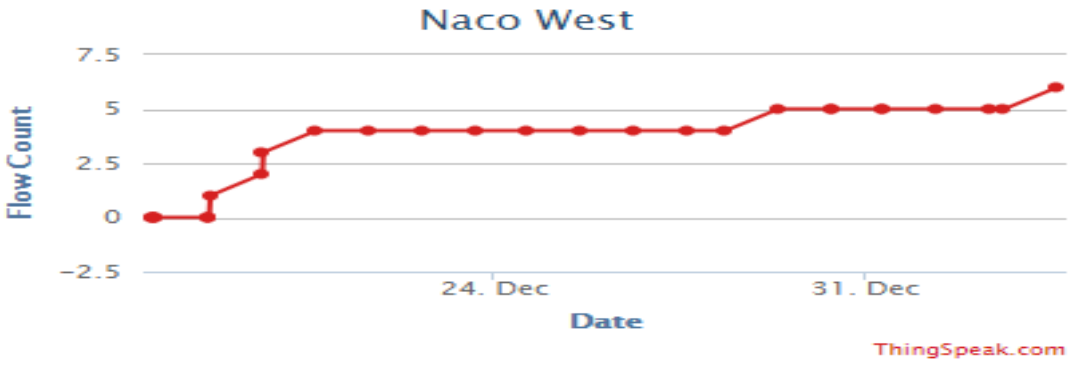
Detect Cross Border Flow in Naco

Similar Flow Switch to Auto Sampler

East Naco Installation

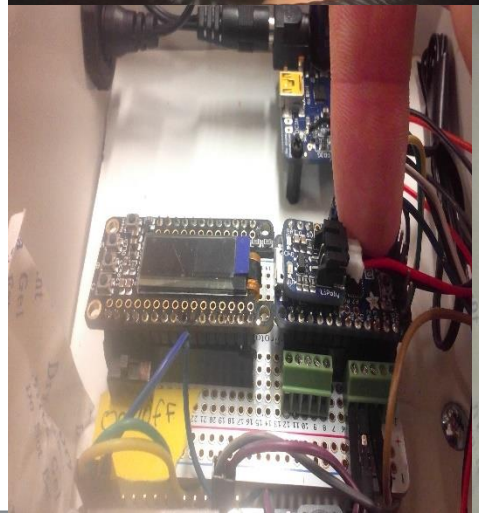
Example of Thingspeak Channel For Naco

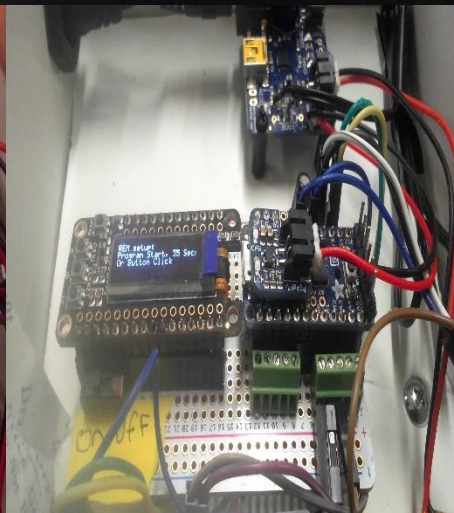




Stock Tank Installation

Help a Grantee Install a satellite REM at their remote Stock Tank.





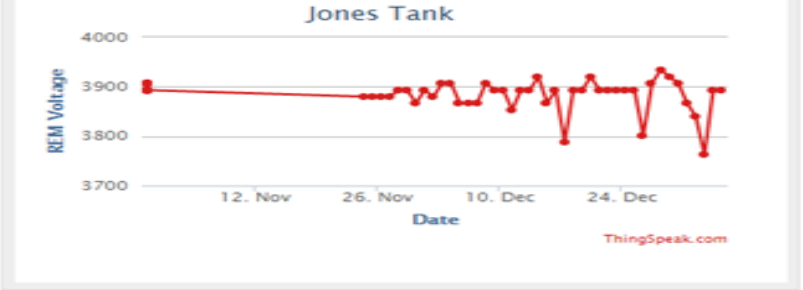
Their Thingspeak Page

ADEQ Arizona Department of Environmental Quality

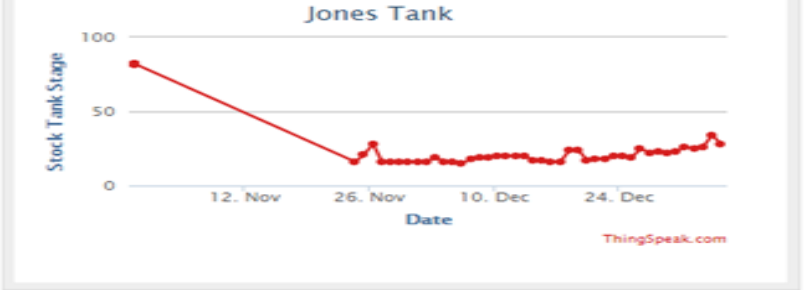
ThingSpeak™ | Channels | Apps | Community | Support | Commercial Use | How to Buy | Account

ated: 2 months ago
entry: about an hour ago
es: 332

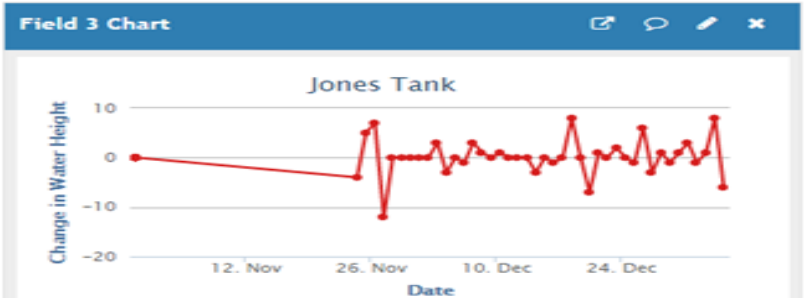
Field 1 Chart



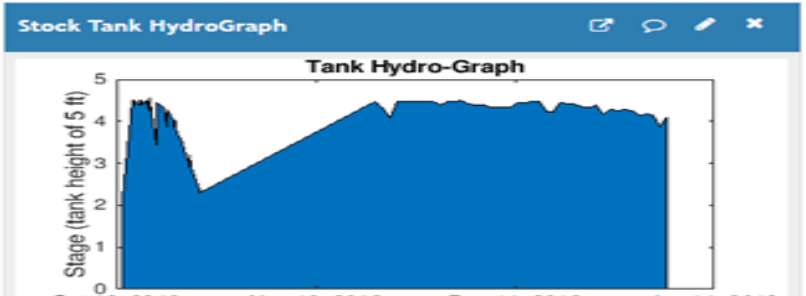
Field 2 Chart



Field 3 Chart



Stock Tank HydroGraph



Cost

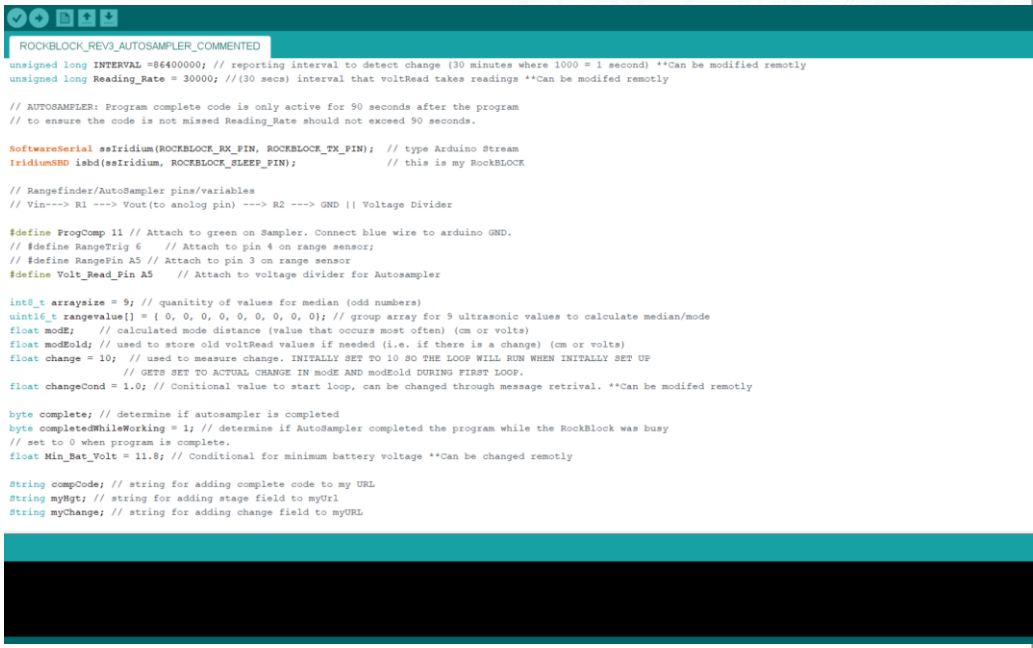
REM Type:	Equipment Cost	Modem Cost	Total Equipment Cost	Monthly Cost	Cost per Message
2G- Fona	150	44.95	$194.95	$6	100Mb $3
Satellite-RockBlock Modem	150	253.00	$403.00	$13	$0.13 (<270 bytes)

Benefits

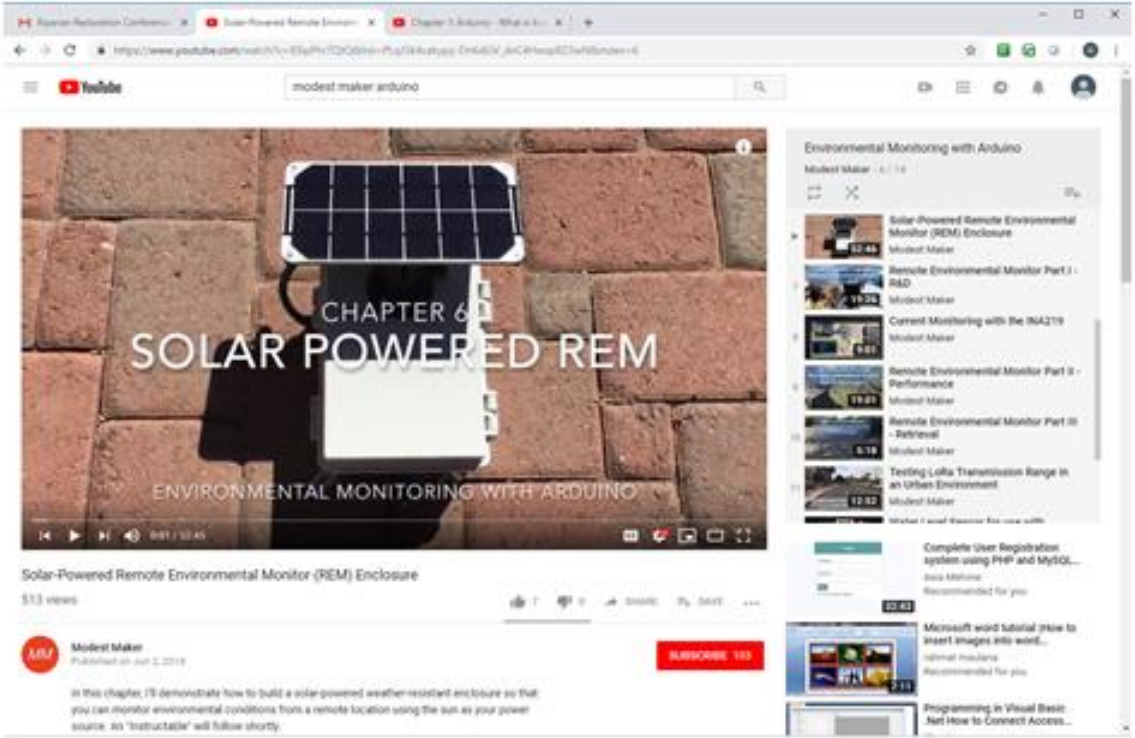
- Flexibility
- Relatively low cost
- Low maintenance
- Open source
- Low power, durable

Drawbacks

- Learning curve
- Knowledge of hardware
- Programming
- Open source libraries
- Testing (trial and error)



Homebrew your own open source hardware!



https://www.youtube.com/playlist?list=PLqJ5k4cakypy-Dn6dGV_dvC4Hwxp8Z3wN

https://www.youtube.com/playlist?list=PLqJ5k4cakypwMUFxZ1ckiiUfp1Ngf6o29

http://www.biod101.com

… or search "modest maker arduino" on YouTube

Thank You!

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February 5th, 2019

"Everything around you that you call life was made up by people that were no smarter than you."
- Steve Jobs