

Piggery Management Assessment and Water Quality Impacts Pohnpei, FSM

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FOOD AND ENVIRONMENT SUMMIT
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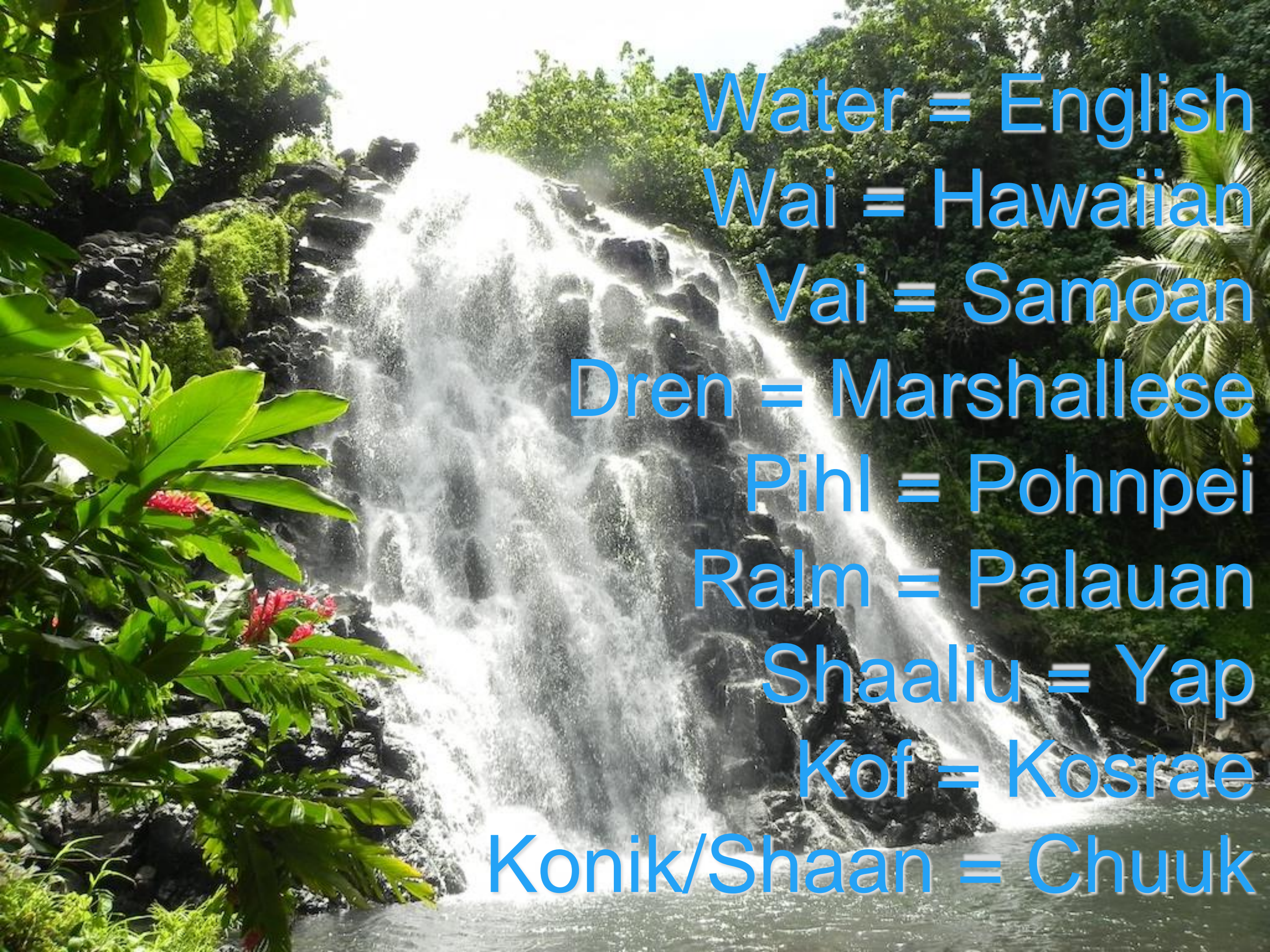


Some thoughts before we start ...

- *Everyone needs to take responsibility for the quality of our water resources*
- *We are all part of the solution*
- *Encourage environmental stewardship to strengthen our Island communities*

*Remember to teach your children
... they are the future !!*





Water = English

Wai = Hawaiian

Vai = Samoan

Dren = Marshallese

Pihl = Pohnpei

Ralm = Palauan

Shaaliu = Yap

Kof = Kosrae

Konik/Shaan = Chuuk

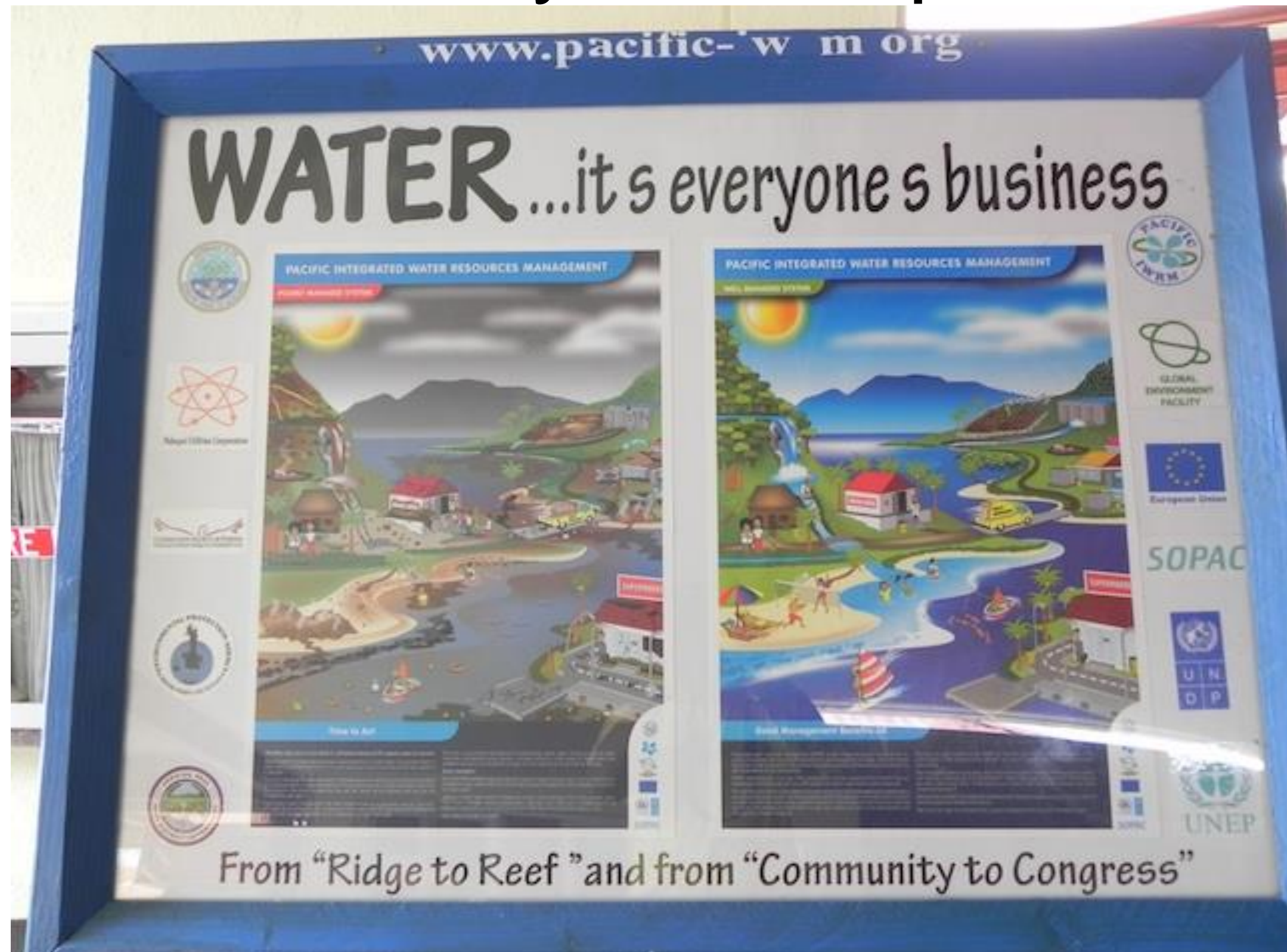








Community Awareness of Water Quality in Pohnpei



SOURCES OF WATER POLLUTION



Pigpen

Pigpens must be more than 50 feet from the shoreline or anybody of water (Rivers, Streams, etc.). Diseases found in Pig waste can cause serious illnesses in human health such as:

- *Leptospirosis*
- *Diarrheal Diseases*
- *Parasitic Infections & many more...*



Toilet facility

Exposure to runoff from toilets can cause serious diseases such as;

- | | | |
|--------------------|------|---|
| CHOLERA | ———— | <i>Bacteria found in human waste</i> |
| HEPATITIS A | ———— | <i>Can cause permanent liver damage</i> |
| AMOEBAS | ———— | <i>Protozoan found in both human and animal waste</i> |



Illegal waste disposal is prohibited by the Pohnpei State Government. Waste disposal on shorelines can cause problems to:

- *Mangroves*
- *Corals*
- *Fish*
- *Birds*
- *Recreational areas & etc.*

WE ALL HAVE WORK TOGETHER IN PROTECTING AND PRESERVING OUR ENVIROMENT

Piggery Assessments

June 2011

- USDA, NIFA, National Water Program
- Thanks to COM CRE, P-EPA, USDA-NRCS, Students
- 15 piggeries
- GPS, Water use, Number of pigs, pig weight estimates, calculated manure generation
- Potential compost production and revenue



PNI #7

PNI #6

PNI #3

PNI #2

PNI #1

PNI #5

PNI #4

PNI #11

PNI #15

PNI #9

PNI #8

PNI #10

PNI #14

PNI #12

PNI #13

5.02 mi

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Summary: Piggery Size

- Average number: 15.2 pigs
 - Range: 3 – 31 pigs
- Animal Units: Average 2.2
 - Range: 0.8 – 6.2 A.U.

Summary: Manure Generation

- Average: 135.0 gallons/farm/year
 - Range = 40.6 – 357.0 gal/farm/year
- 15.2 tons/farm/year
- 18.1 yd³/farm/year

Summary: Wastewater Generation

- Wash time: Average 36.4 min/wash
 - range 0 – 60 min/wash
- Frequency: Average 2 times/day
 - range 0 to 3 times/day
- Effluent: Average = 85,798 gal/farm/year
 - range = 146.9 – 162,417 gal/farm/year

Summary: Nutrients Produced

- Average
 - Nitrogen = 277 pound/farm/year
 - Phosphorus = 93 pounds/farm/year
 - Potassium = 168 pounds/farm/year
- Can we capture these nutrients for beneficial?
- Recapture dollars spent on feed cost.
- Can we reduce pathogen release to the environment?

Summary: Composting Potential

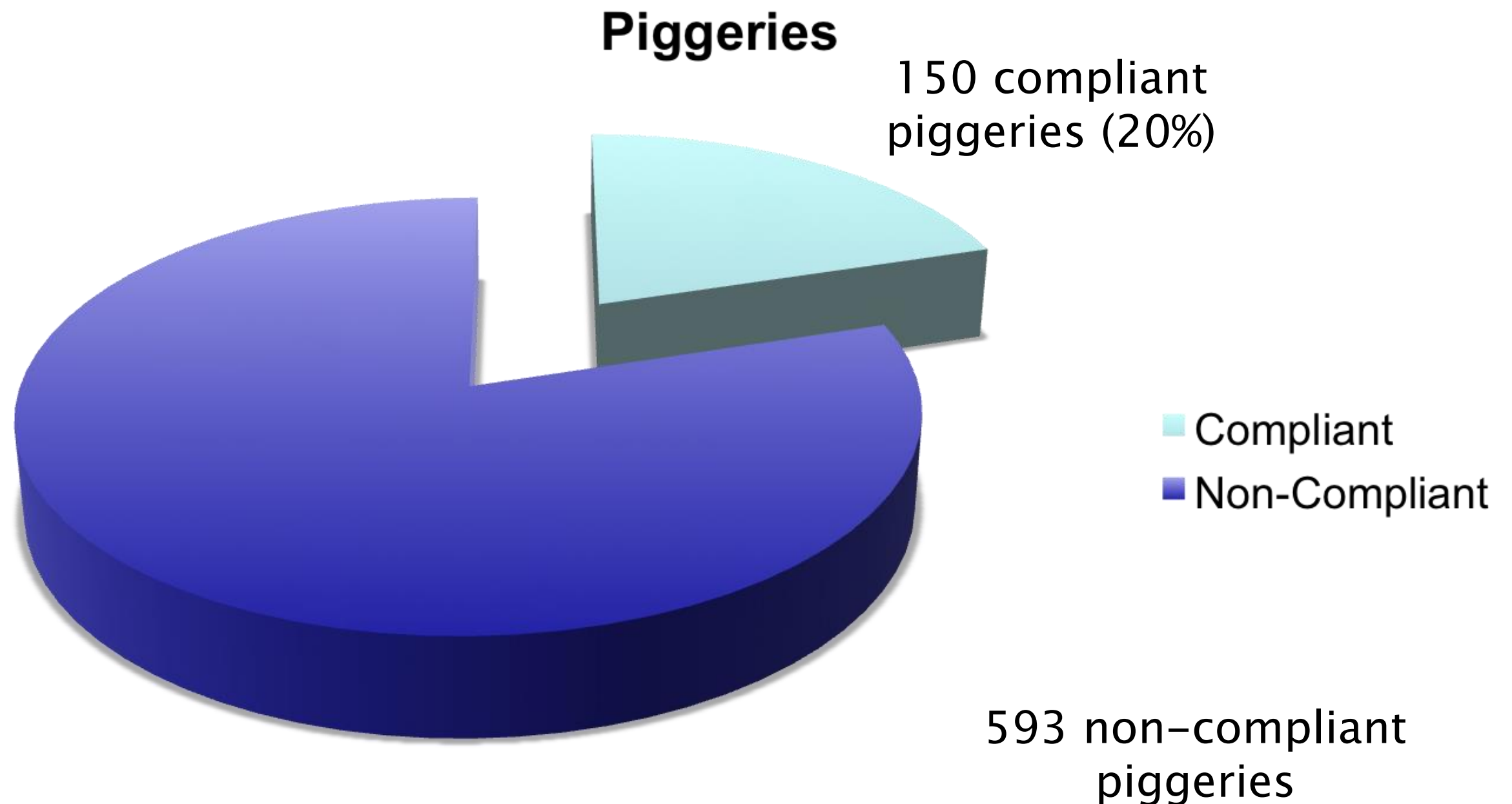
- Carbon Required: 54 yd²/farm/year
- Compost Produced: 25 yd²/farm/year
- Value of Compost: \$1,012/farm
(@\$3.00/feed bag)

How many pig pens are there in Pohnpei?



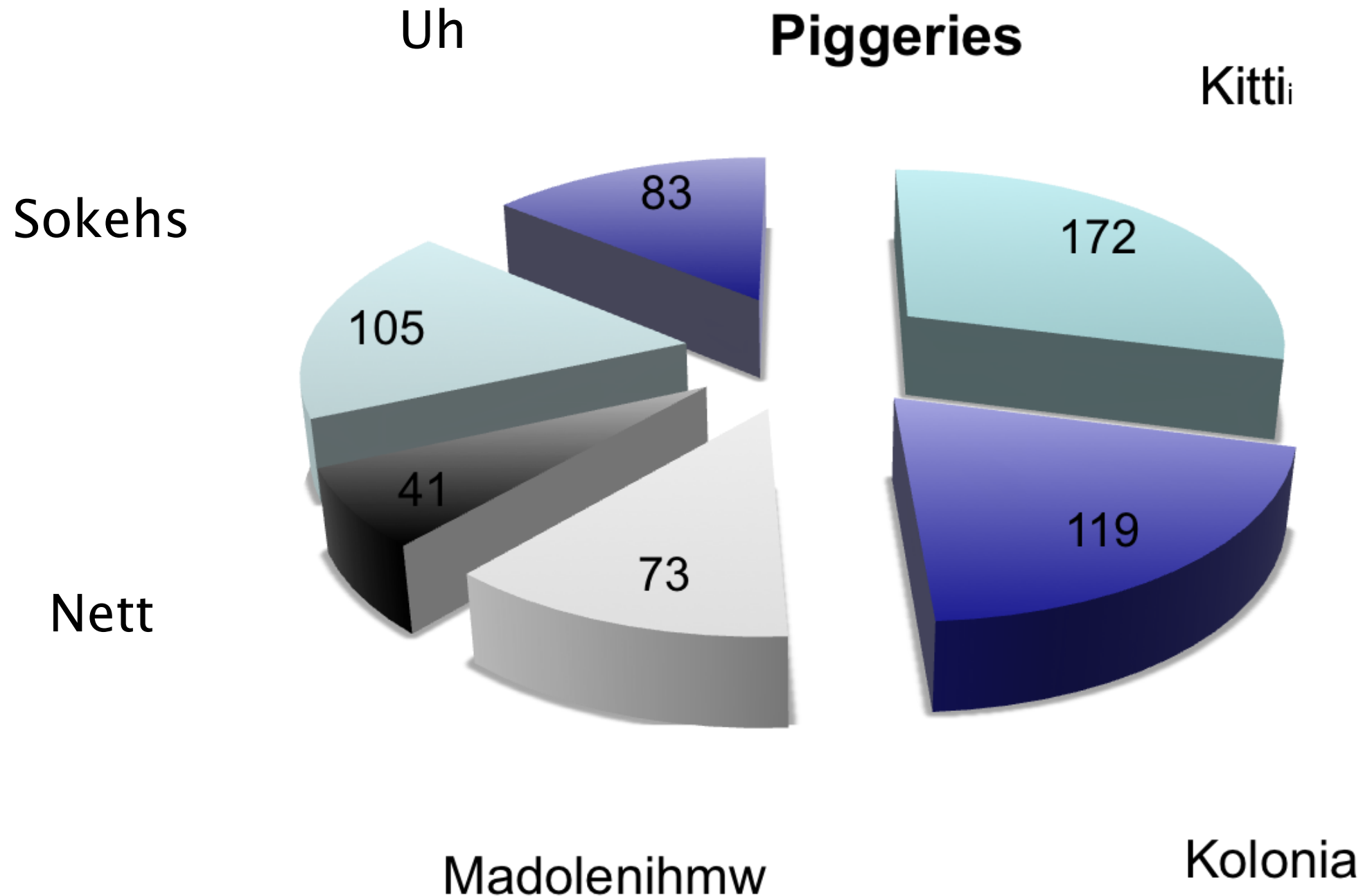
Pohnpei EPA (2011)

Streambank and Coastal Piggery Survey

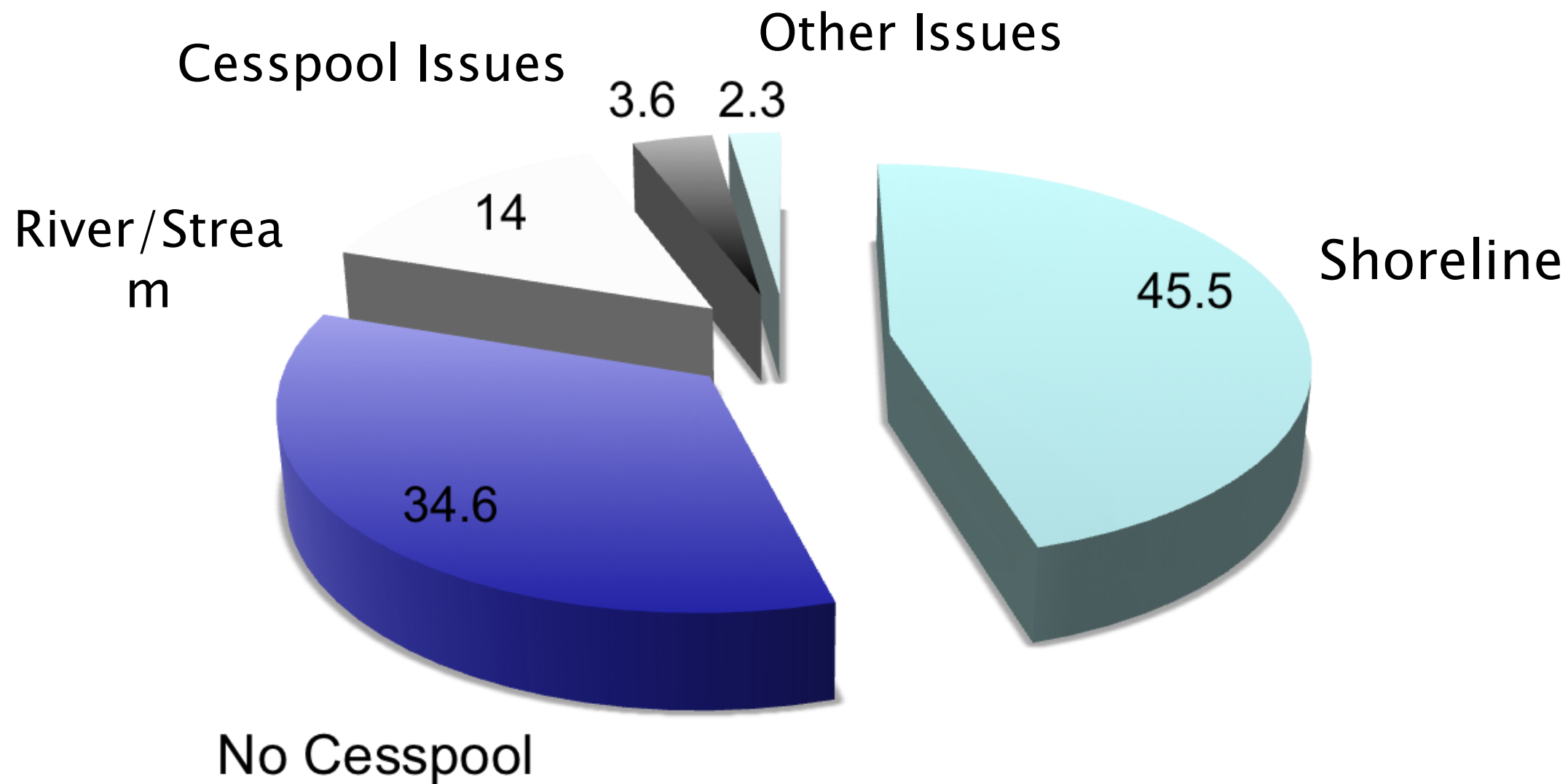


Municipalities

Non-Compliant Piggeries, n = 593



Reasons for Non-Compliance





Water Quality Standards

Pohnpei Environmental Protection Agency

- Drinking Water
- 0 mpn/100 ml E. coli



Water Quality Standards

Pohnpei Environmental Protection Agency

- Recreational Standard for Fresh Water
- $< 576 \text{ mpn}/100 \text{ ml E. coli}$



mpn = most probable number

Piggery Impacts on Water Quality

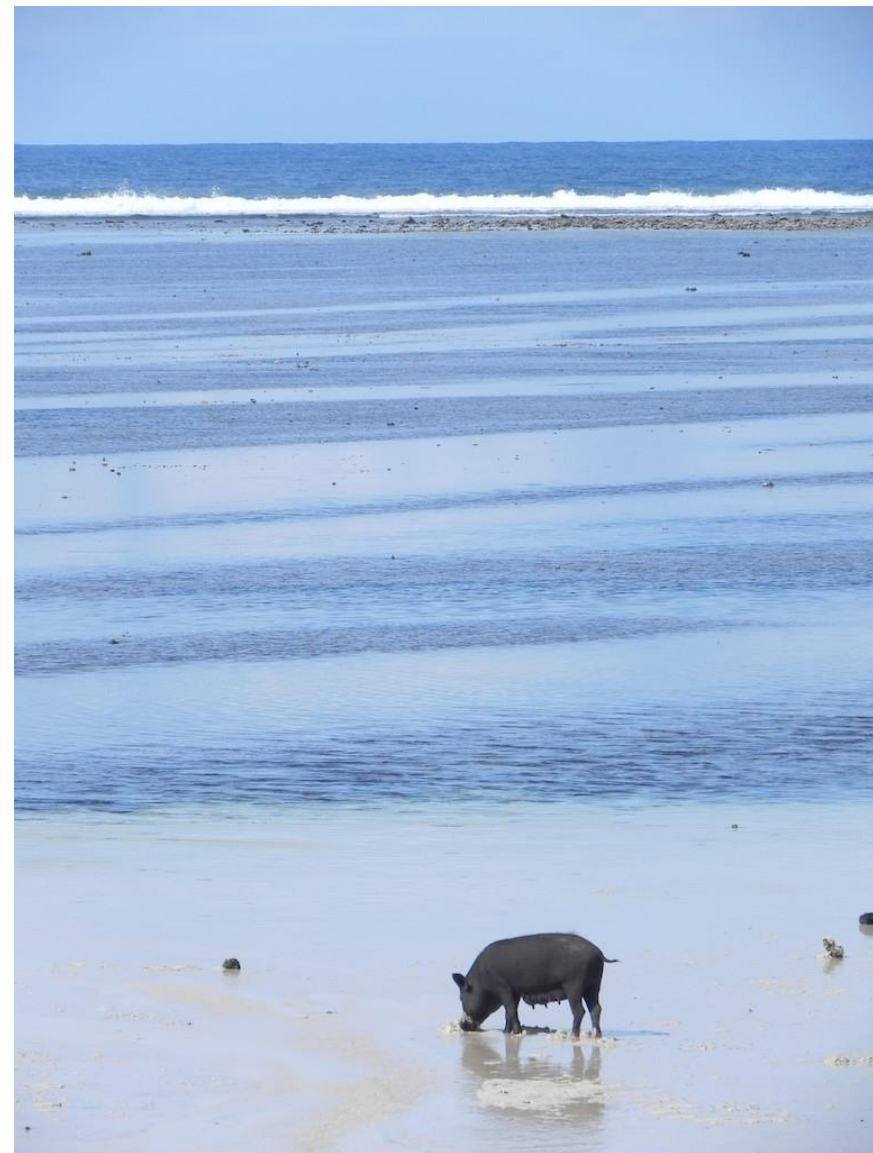
- Nutrients
- Pathogens

E. coli

Leptospirosis

Salmonella

Cholera



Can you see contamination in water?



E. coli at 10,000 magnification



Water Sampling and Testing Acknowledgements

- **Pohnepi State EPA** Director Albert Roby, Clayton Santos, Quinton Lawrence, Fermin Scaliem, Jefferson Saul, Rusty Cerlus, Alfred David, Jay Carter
- **College of Micronesia, CRE** Mark Kostka
- **Municipalities and Villages**
- **UHM UROP**, Ms. Marta Hura

Study #1

Profile Sampling

March and October 2012

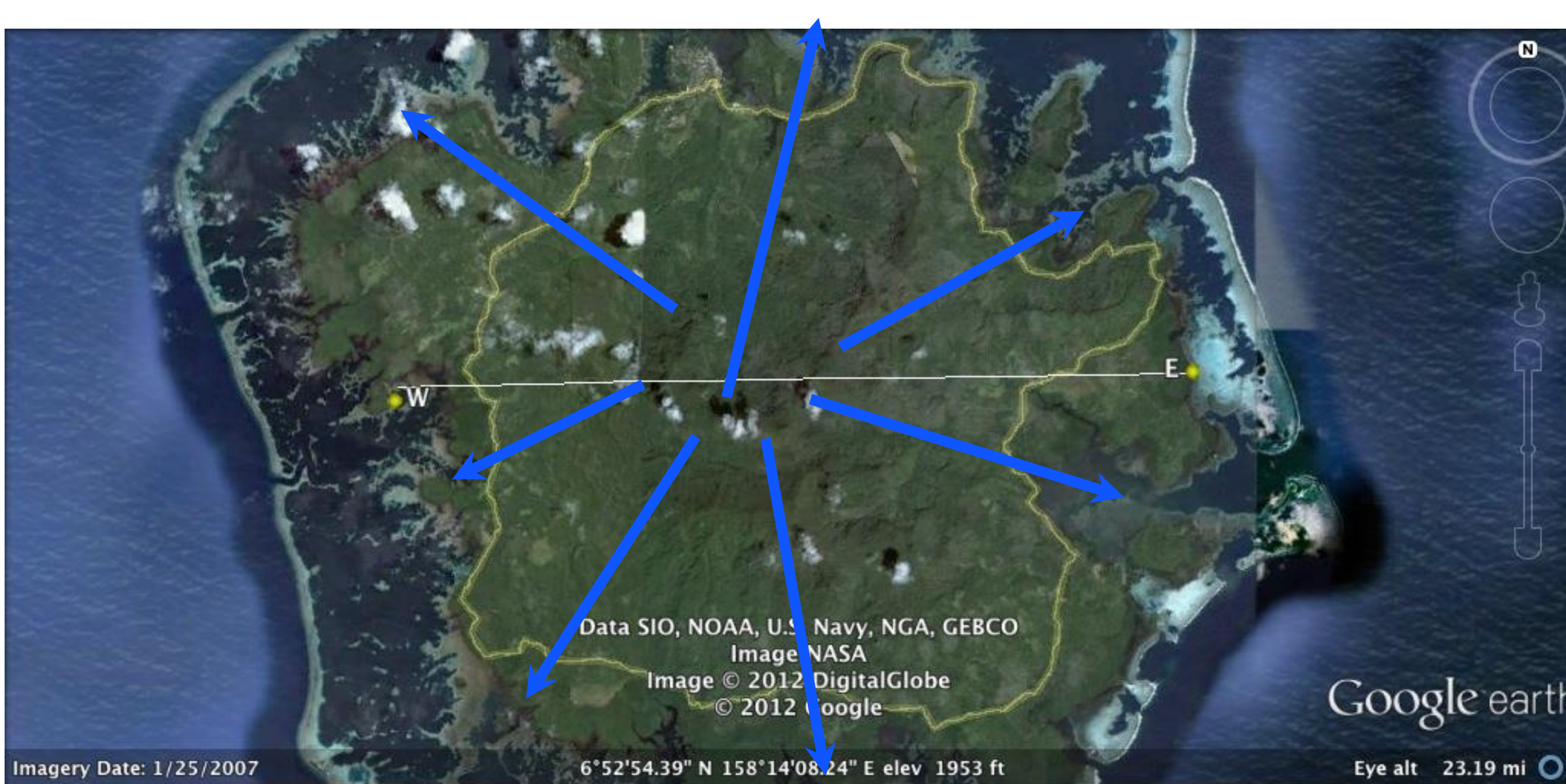
Sample from strategic locations in the watershed.

Sampling sites:

A - upper watershed, above the contamination zone

C - contamination zone

B - lower watershed, bottom of stream system



Stream sampling







Certified Laboratory Analyses



Water Quality Criteria

Data Sets

GPS location

Turbidity (ntu)

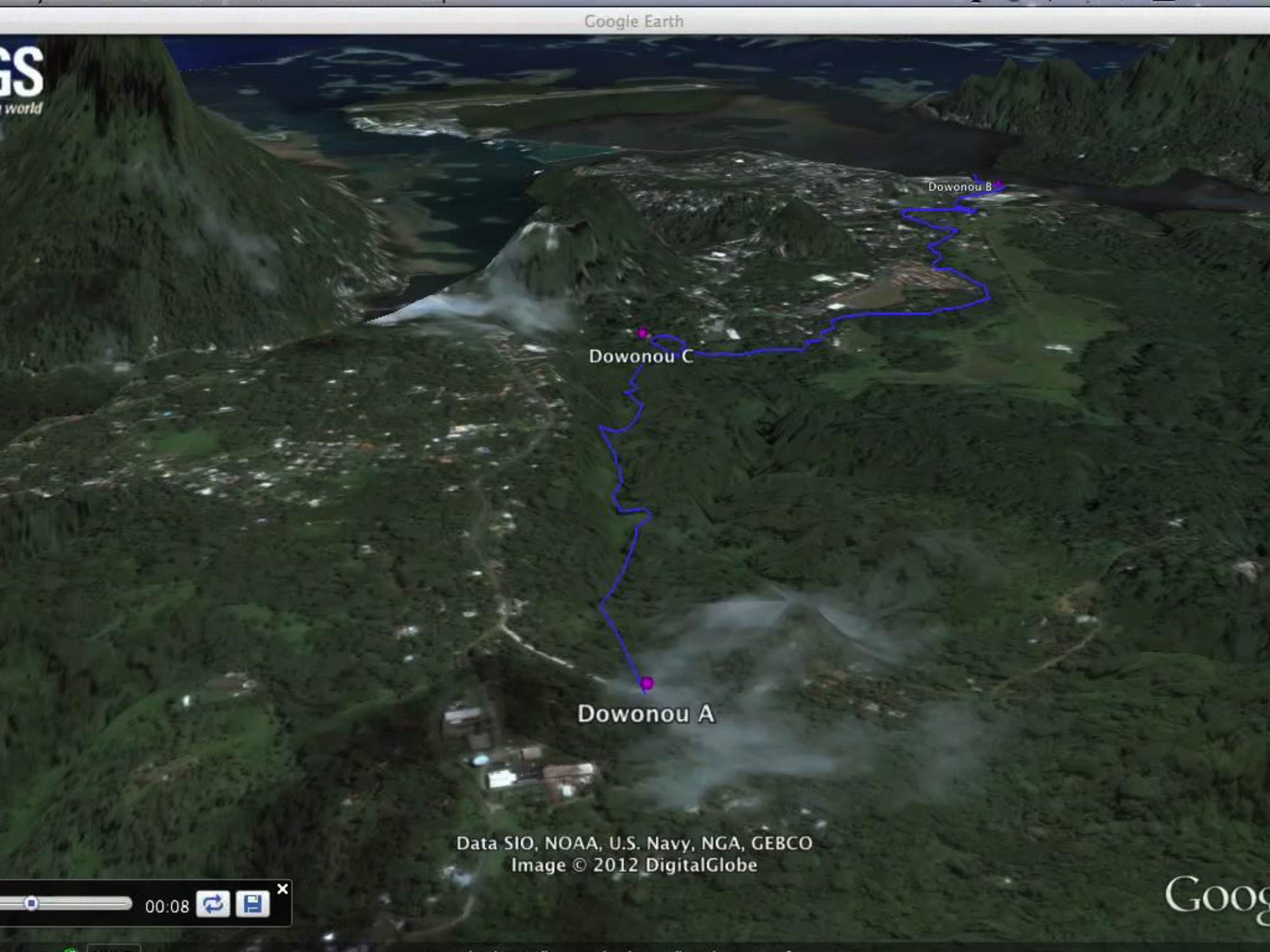
Surface Flow rate

E. coli (mpn/100 ml)

Stream Sampling and Results

March & October 2012

- Mand River (Kepirohi Falls), repeated
- Awak Stream
- Kipar Stream
- Nintu (Seidonokawa) & Dauen Neu
- Soukirouhn
- Nanpil



Dowonou C

Dowonou B

Dowonou A

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2012 DigitalGlobe

Mand River, Madolenihmw

Water flow

Sample Sites

Distance A to B: 1.2 mi.

B1

B2

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Image © 2012 DigitalGlobe

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Mand River Madolenihmw

Length: 1.43 miles
Flow: 1.68 mph

Mand A

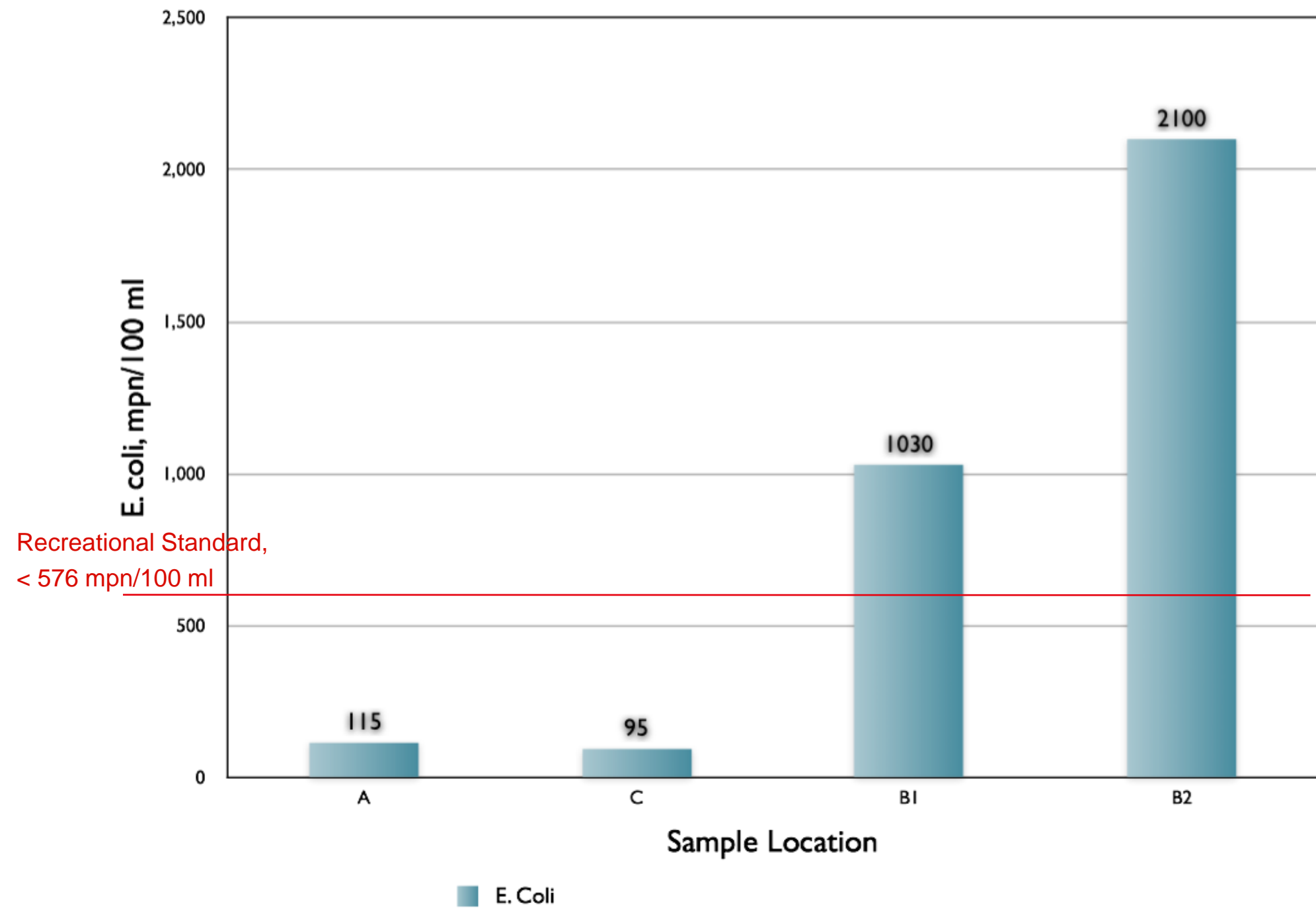
Mand C

Kepirohi Falls

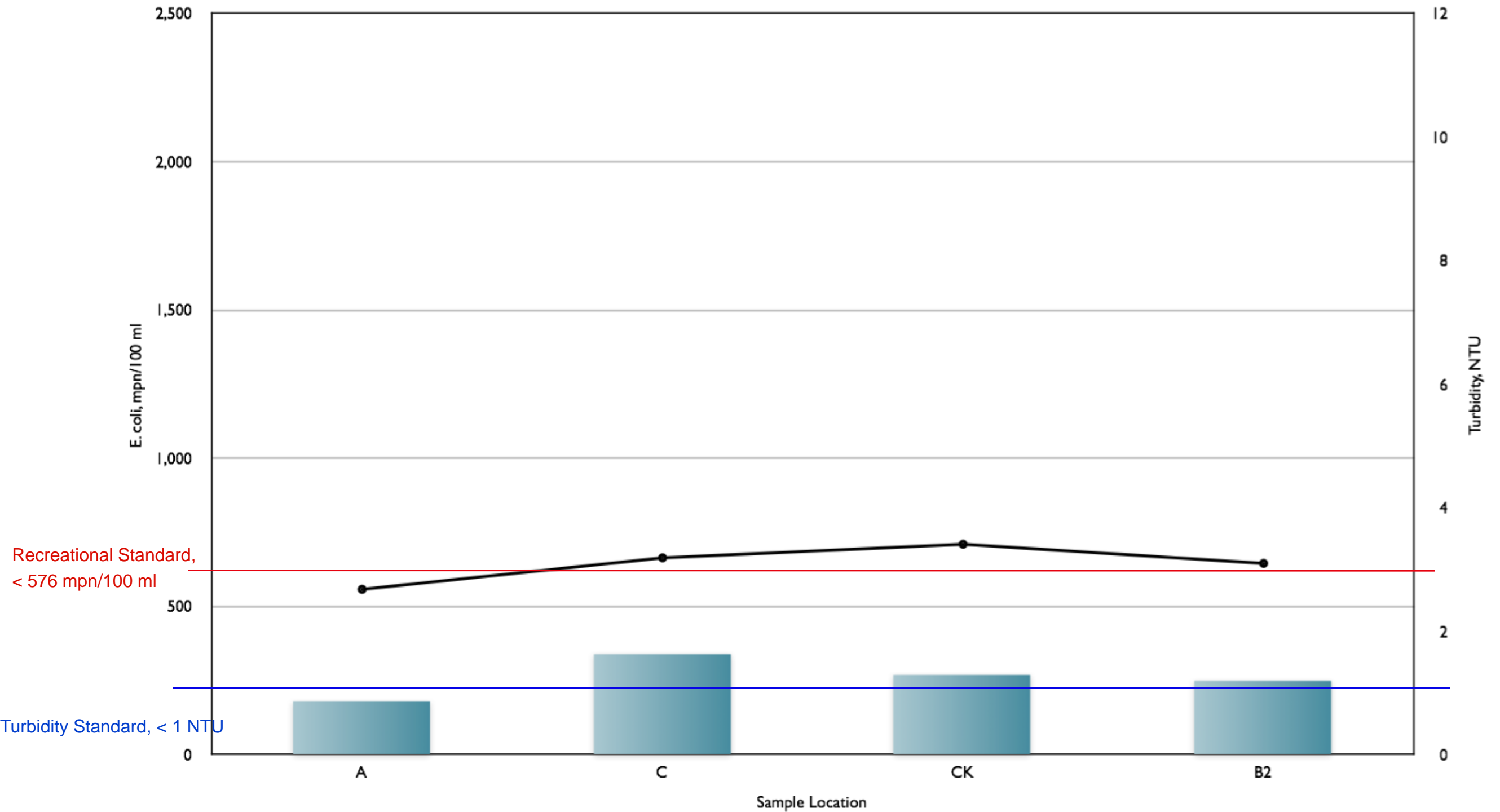
Mand B

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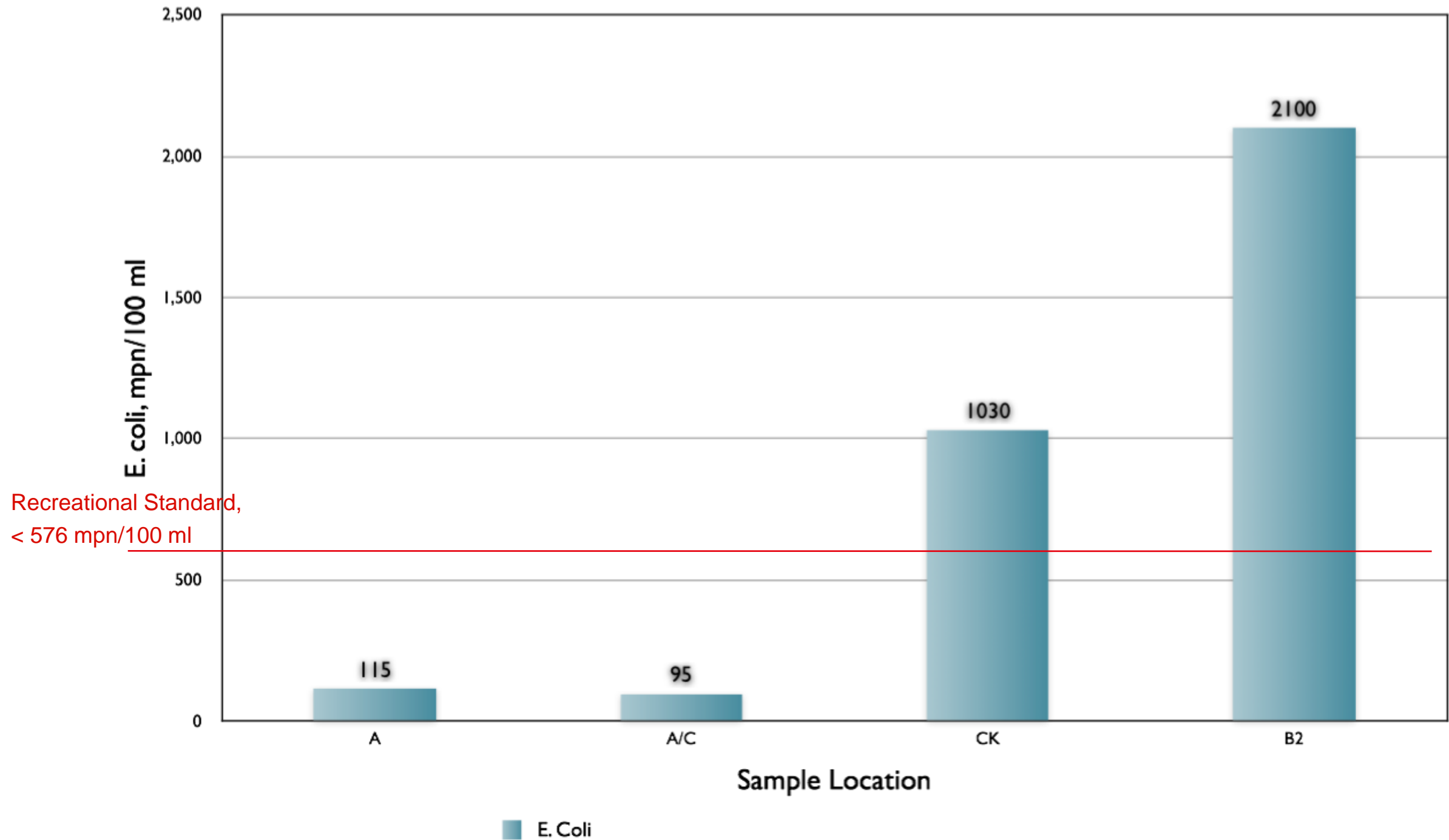
Google



Mand River, October 2012



Mand River, March 2012



Awak River, U

Water flow



Sample Sites

Distance A to B: 0.85 mi.

A

B1

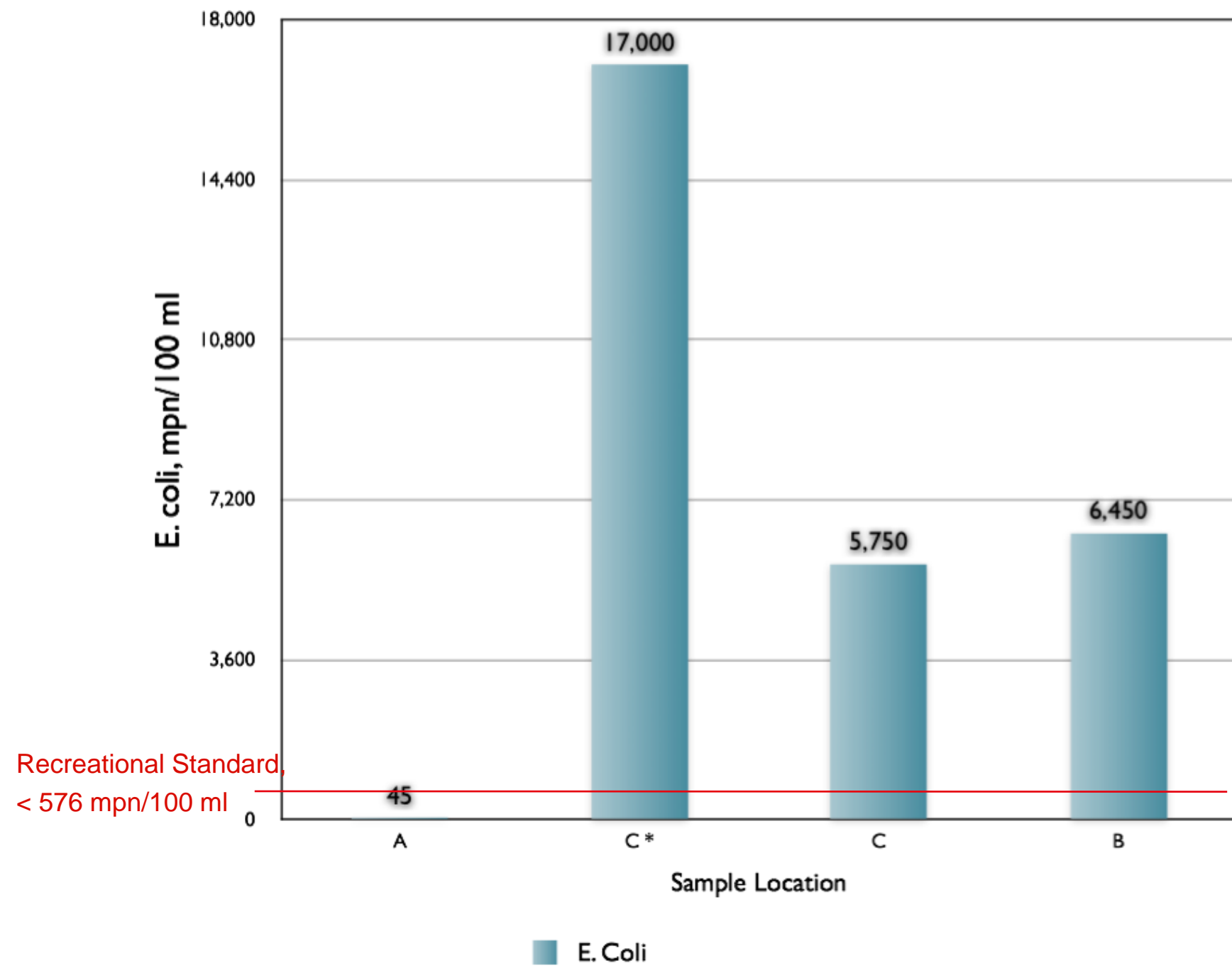
B2



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Google e



Nanpil River Nett

Length: 3.58 miles
Flow: 1.20 mph

Nanpil A

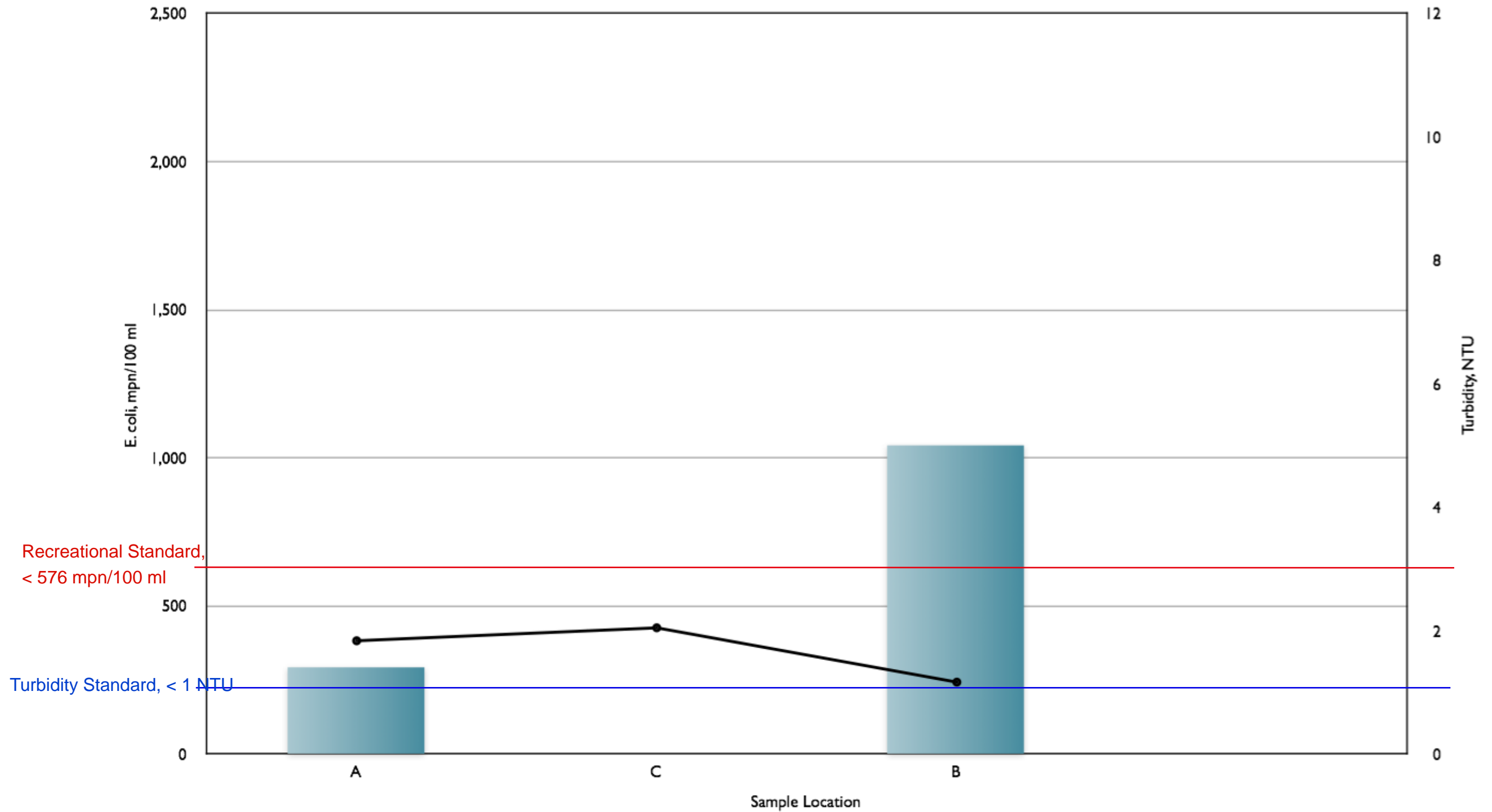
Nanpil C

Nanpil B

Image © 2012 DigitalGlobe

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Nanpil River



Soukirouhn Stream

Kitti

Soukirouhn A

Soukirouhn C

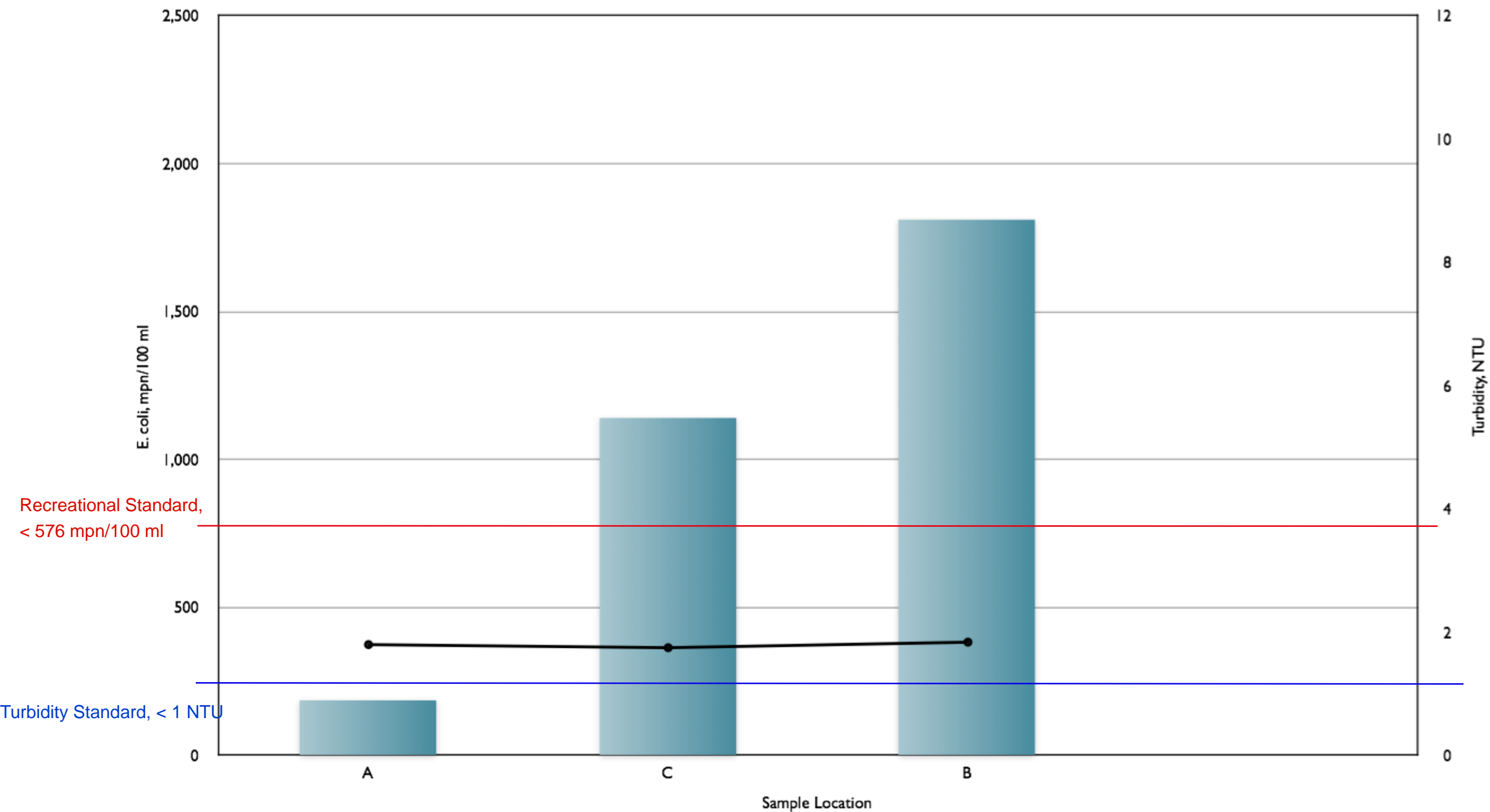
Soukirouhn B

Length: 1.58 miles
Flow: 1.19 mph

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Soukirouhn Stream, Kitti



Kipar River, Kitt

Water flow

Sample Sites

Distance A to B: 0.32 mi.



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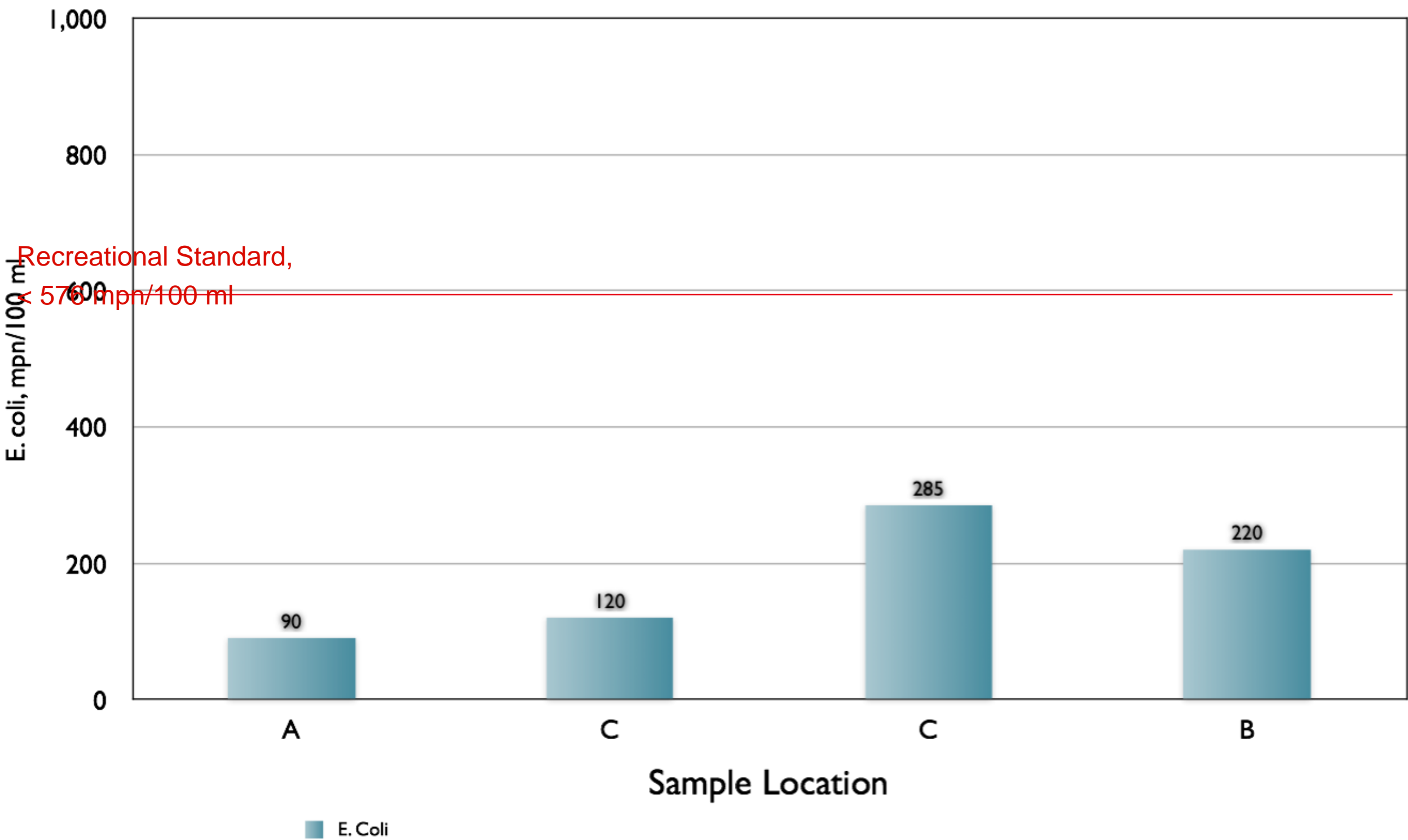
Image © 2012 DigitalGlobe

Google earth

/2005 2002

6°49'01.26" N 158°10'46.42" E elev 20 ft

Eye alt 10002 ft



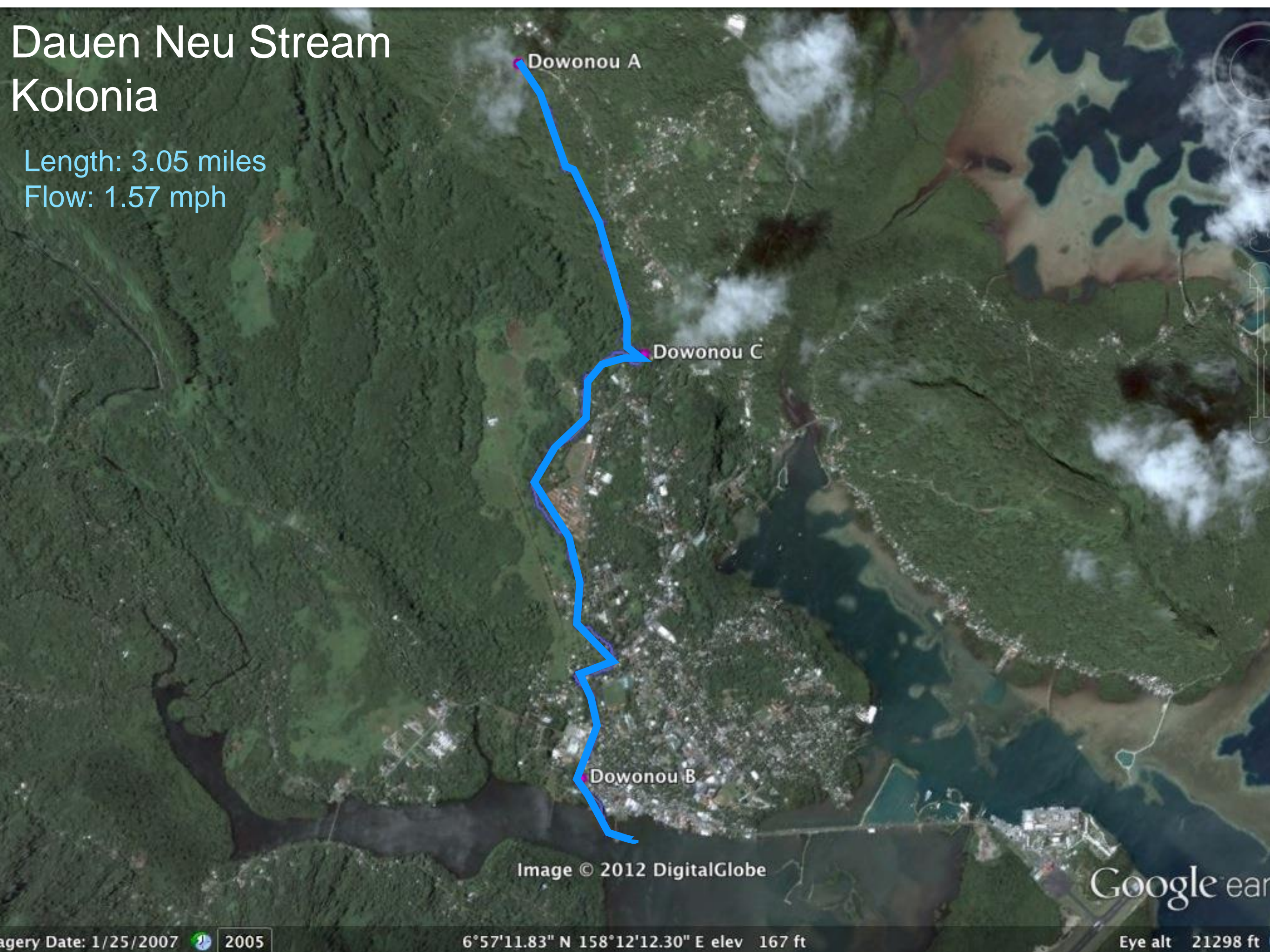
Kipar

- One piggery
- Located about 50 ft from stream
- 12 animals = 0.81 AU

Dauen Neu Stream Kolonias

Length: 3.05 miles

Flow: 1.57 mph



Dowonou A

Dowonou C

Dowonou B

Image © 2012 DigitalGlobe

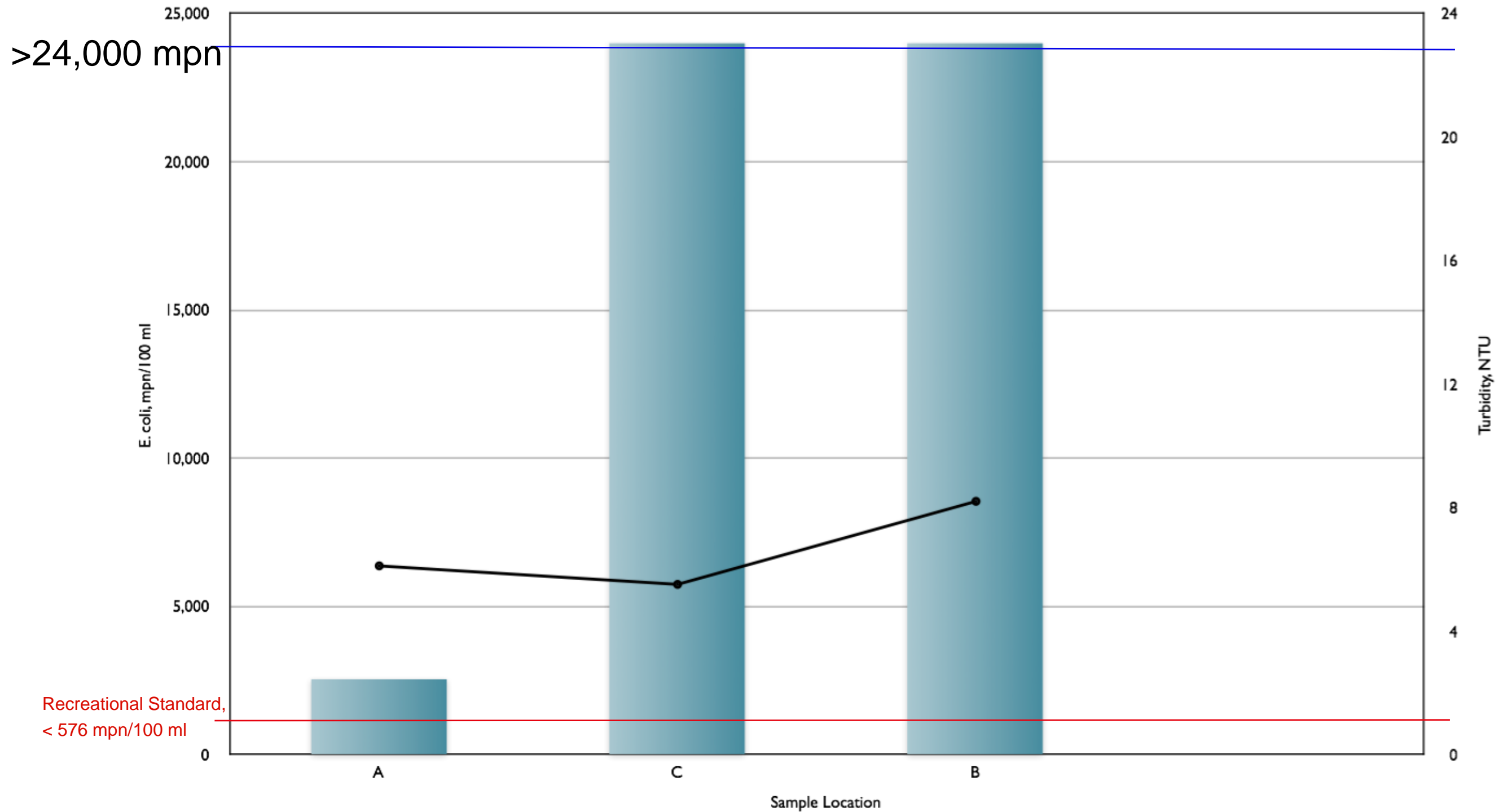
Google ear

agery Date: 1/25/2007 2005

6°57'11.83" N 158°12'12.30" E elev 167 ft

Eye alt 21298 ft

Dowonou Stream



ntu (Seidonokawa) Stream lonia

Length: 0.87 miles

Flow: 1.24 mph

Seidonokawa A/C

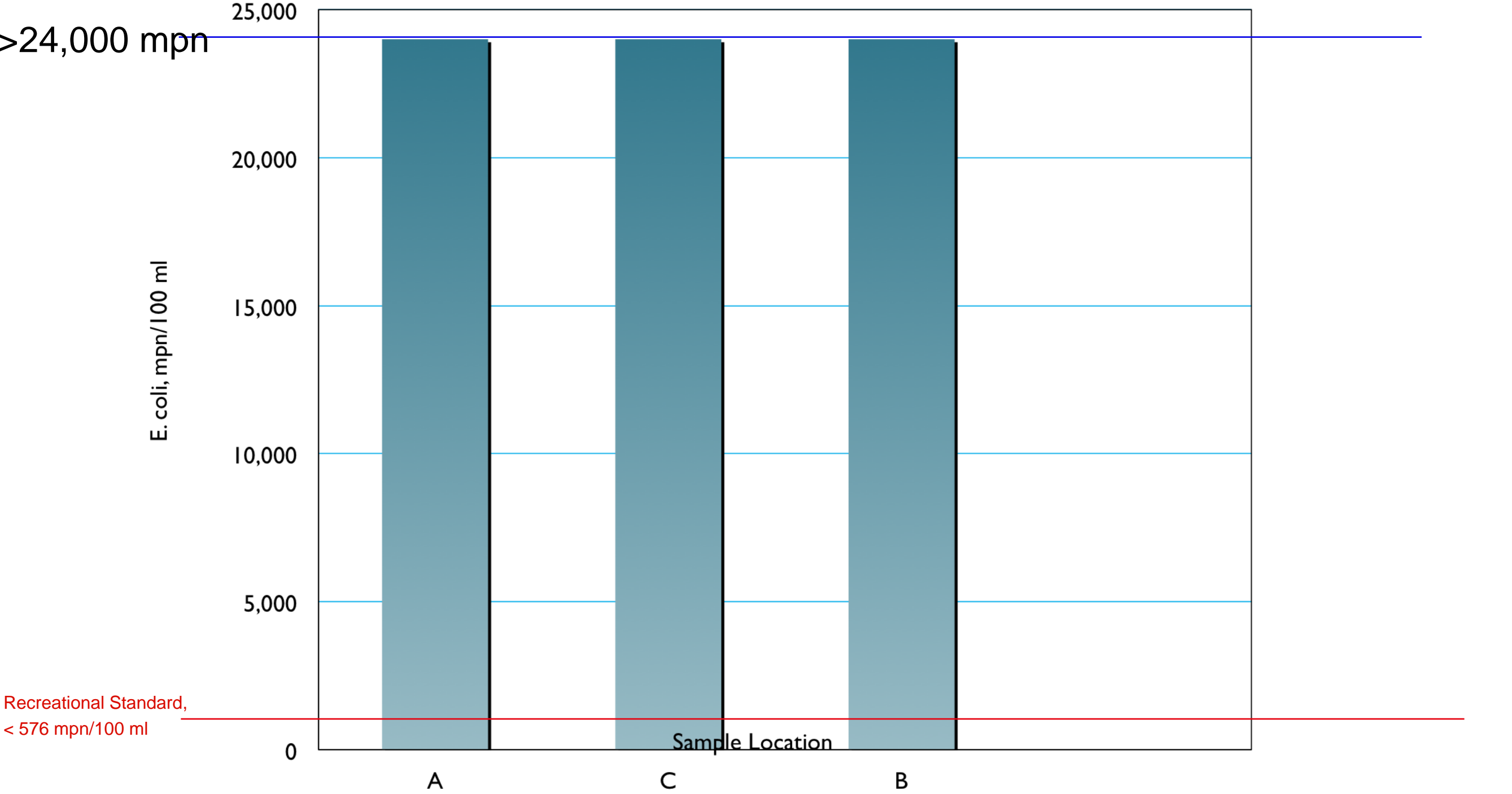
Seidonokawa C'

Seidonokawa B

Image © 2012 DigitalGlobe

Google e

Seidonokawa Stream

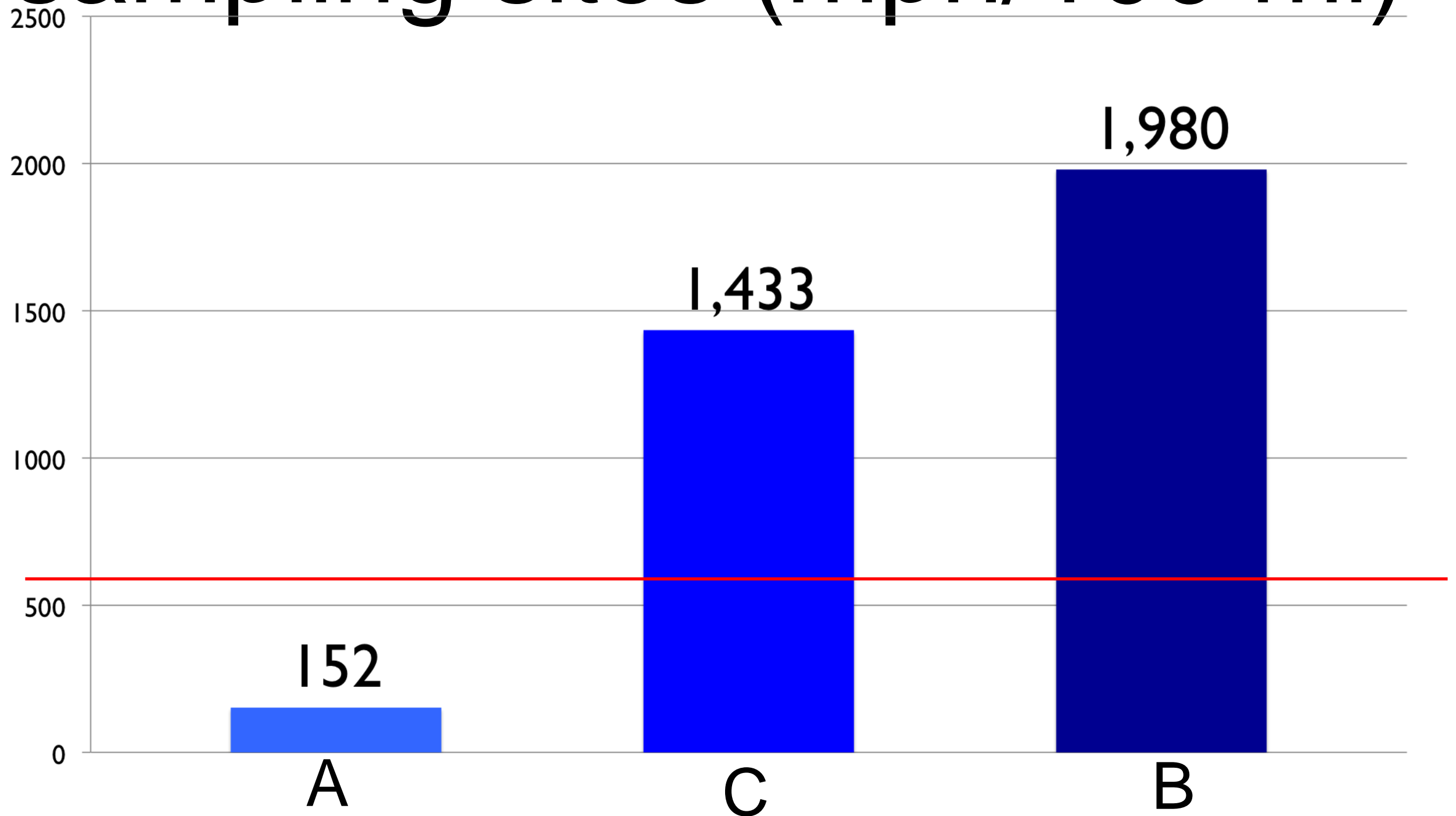


Stream Hot Spots

(Recreational Standard = 576 mpn/100 ml)

Stream/River	Above	C Zone	Below
Mand	115/180	1,030/270	2,100/250
Kipar	90	120/285	220
Awak	45	5,750	6,450
Nanpil	294	na	1,043
Soukirouhn	187	1,141	1,819
Dauen Neu	2,550	>24,000	>24,000
Seidonokawa	>24,000	>24,000	>24,000
Palikir Crossing	-	-	820

E. coli levels at stream profile sampling sites (mpn/100 ml)



Study #2

Timed Sampling

- 12-hour timed samples, Awak Village
- Coordinated flush time with homes on kasang (tributary).

Awak Stream, U Timed Collection

Water flow

Concentration of
piggery operations (n=6)
discharging into
tributary (*casang*)

Secondary Sampling Site, Main (M)

Secondary Sampling Site, Kasang (K)

Collection Pt.
Merge

Primary Sampling Site, Below (B)

B1

B2

© 2012 Google

Image © 2012 DigitalGlobe

Google earth

Piggeries on stream ^{kasang,} Awak Timed Sampling

6 piggeries (66% occupied)

70 pigs = 9.01 animal units

(Nursery - 32, Grower - 16, Breeder - 22)

Manure/Nutrient production/Yr

76 tons, 16,623 gallons

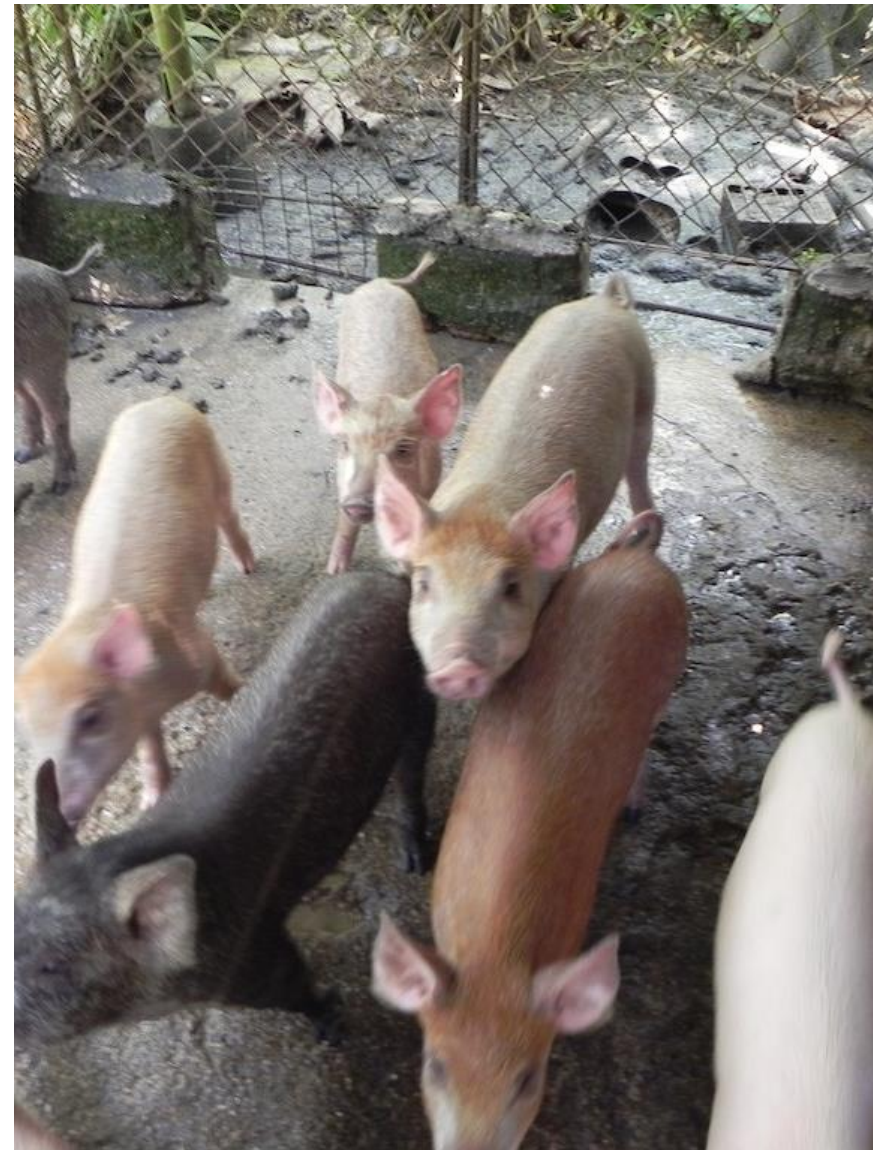
1,542 lbs N (105)

536 lbs, P (367)

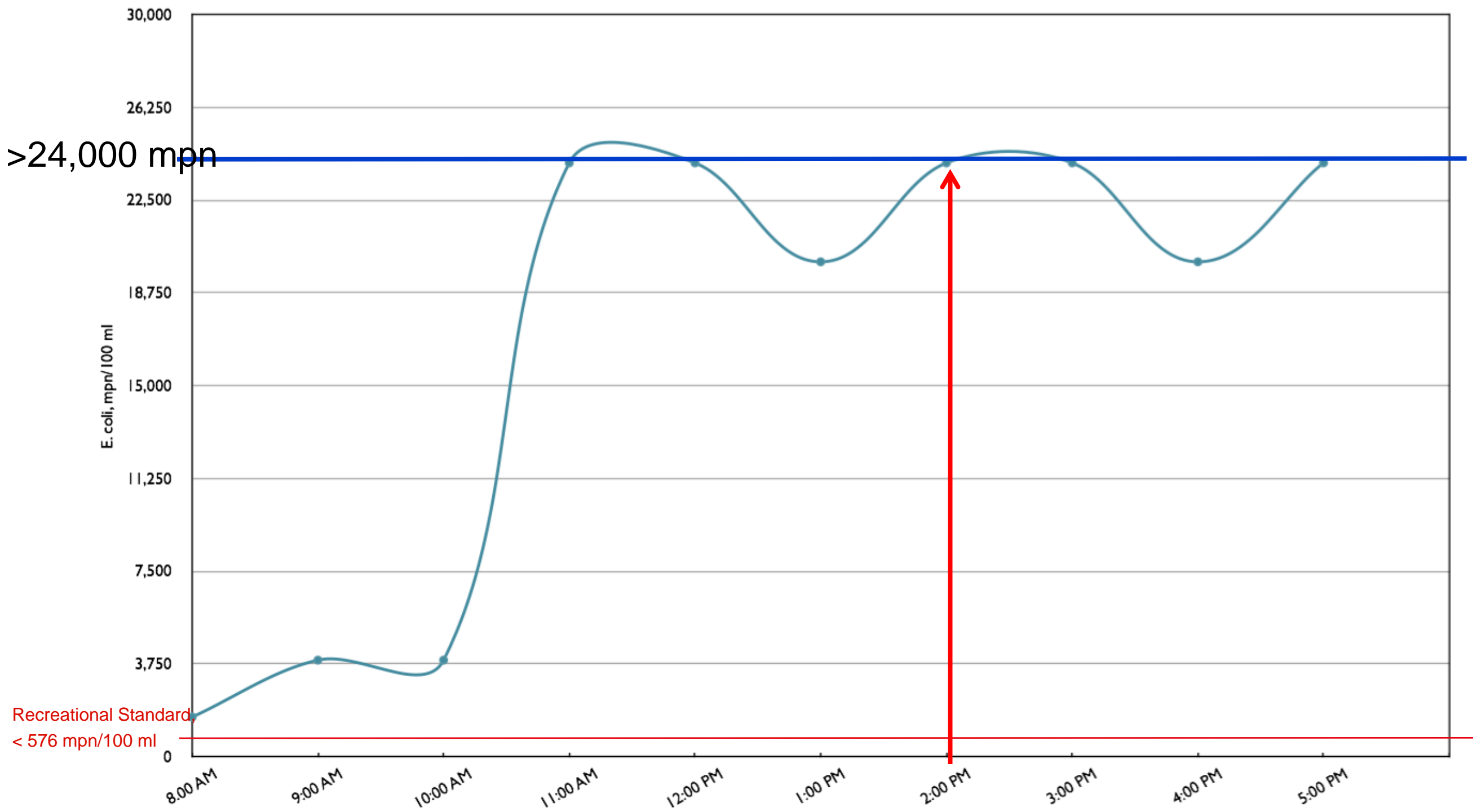
919 lbs. K (179)

Estimated water use (92,380
g/f/y)

554,280 gal, water into 16,623 gal.
manure



Fluctuation of sample site K: Kasang



Awak Summary

- Concentration of human impacts increase contamination in the streams
- Daily variations based on management (time of pen washing in Awak)

Recommendations

- Install warning signs in highly contaminated streams in populated areas.
- Regular (quarterly) and consistent sampling of key sites are needed to continue in Pohnpei, for example Kepirohi Falls.
- More stream systems need to be screen for human health safety.

Study #3

Island-wide Stream Survey

- April 9-11, 2013
- Bridge crossings
- 41 sampled out of an estimated 65+ crossings







Help from the community





Municipalities

- Madolenihmw 12
- Kitt 13
- Sokehs 3
- Nett 4
- U 7
- Kolonia 2

Madolenihmw, 7/12

Stream	Turbidity	E. Coli mpn/100 ml
Tuweri	3.19	450
Ipwitek	5.01	3,150
Lehnpwus	6.39	1,600
Pahnahdo	5.72	410
Kitapw	2.92	245
Lehdau	1.71	485
Lehn Diadi	1.91	880
Peiai	1.72	2,050
Nankep	2.44	390
Sapwehrek	2.22	1,450
Parahu/Mahnd	2.19	2,900
Pohndau	3.24	680

Kitti, 6/13

Stream	Turbidity	E. coli mpn/100 ml
Dauen Kopil	2.75	430
Sounkroun	2.32	1,700
Enpein Powe	1.97	385
Enpein Pah	2.61	120
Pwok 1	0.88	125
Pahnkati	1.58	210
Kipar	3.38	1,050
Lehn Mesi	0.8	195
Diadi	5.34	18,000
Sekeren Lapahu	2.41	770
Pehleng	1.86	1,330
Kepin Mwomwi	1.88	115
Paies	1.62	885

U, 7/7

Stream	Turbidity	E. coli mpn/100 ml
Diadi	2.9	580
Nihmoak	4.21	> 24,000
Dien	2.77	1,850
Pahlap	2.19	4,250
Metipw	6.25	5,650
Awak	2.68	20,000
Awak kasang	6.21	2,300

Sokehs, Nett, Kolonia,

8/9

Stream	Municipality	Turbidity	E. coli (mpn/100 ml)
Soundau	Sokehs	1.39	480
Dolon	Sokehs	3.43	17,000
Sekere	Sokehs	6.20	> 24,000
Luhke	U/Nett	3.07	765
Meitik	Nett	1.58	3,000
Kahmar	Nett	0.98	745
Lowetik	Nett	1.04	2,300
Dauen Neu	Kolonia	1.52	58,500
Nintu	Kolonia	6.69	19,500

Summary

- 41 streams tested
- 28 streams not safe to swim in (68%)
- Range 115 – 58,500 mpn/100 ml
- Continue testing annually



Data SIO, NOAA, U.S. Navy, NGA, GEBCO

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Well Sampling in Laura Village. Majuro, RMI



Well sampling



Municipal Wells

Private Well
NO Pigs

Private Wells
w/ Pigs

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Data LDEO-Columbia, NSF, NOAA
Image © 2012 GeoEye

Google earth

3/3/2011 2002

7°08'58.27" N 171°02'10.94" E elev 16 ft

Eye alt 14504 ft

Municipal Wells

There are 7 municipal well, only three are in operation due to contamination and salt intrusion.

- Well #1 – E. coli = 5 mpn/100 ml
- Well #2 – E. coli = 0 mpn/100 ml
- Well #7 – E. coli = 280 mpn/100 ml

Private Wells

- 5 Private wells were selected
- 1 well site (W4) had no pig operation
- 4 well sites had pig operations
 - 2 operations (W3-1, W5-4) were small
 - 2 operations (W1-21, W2-80) were large

Private Well
NO Pigs

Private Wells
w/ Pigs

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Data LDEO-Columbia, NSF, NOAA
Image © 2012 GeoEye

Google earth

3/3/2011

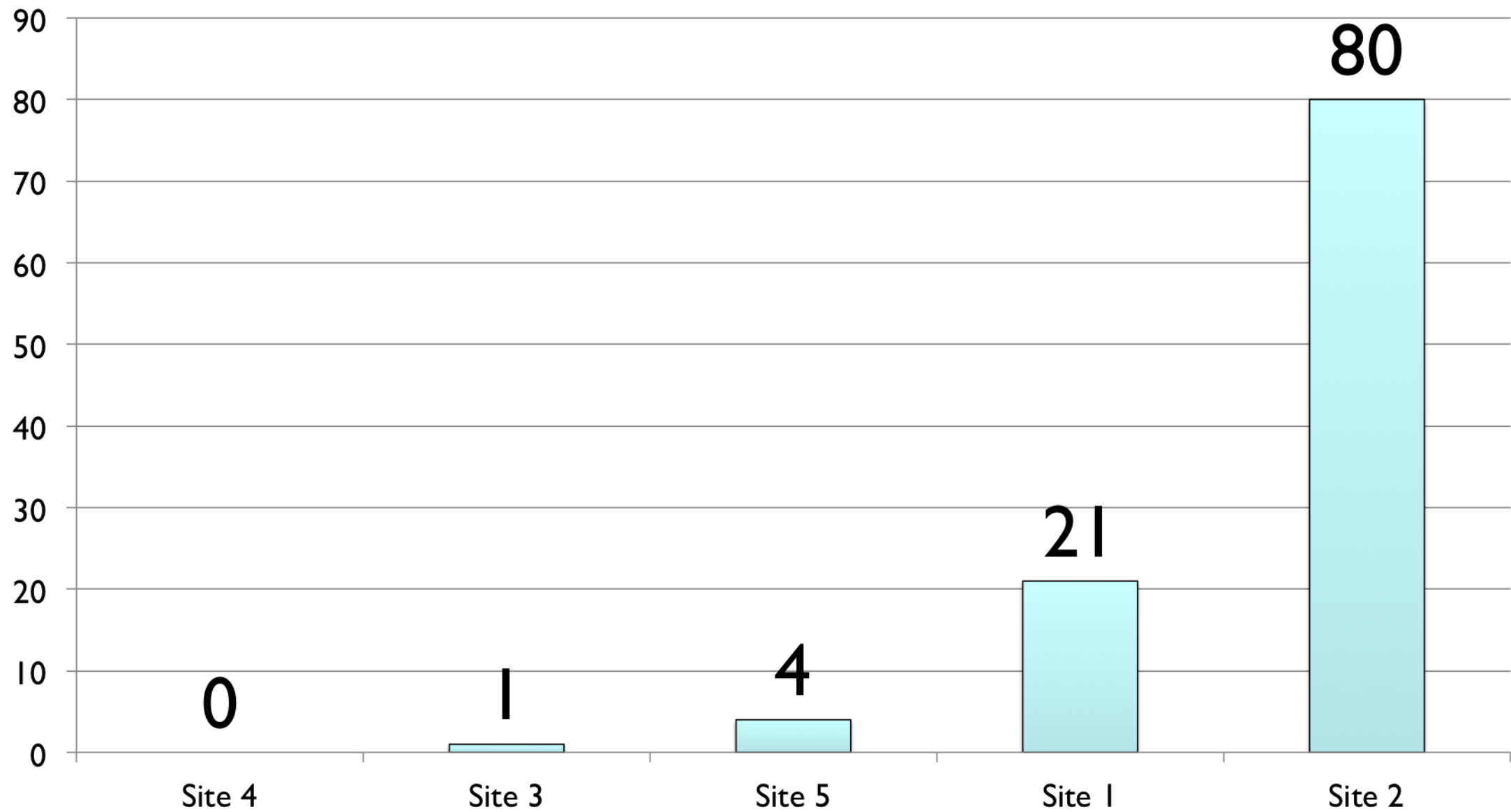


2002

7°08'58.27" N 171°02'10.94" E elev 16 ft

Eye alt 14504 ft

No. of Pigs



Results: Private Wells

- No piggery, W4
- 6 mpn/100 ml

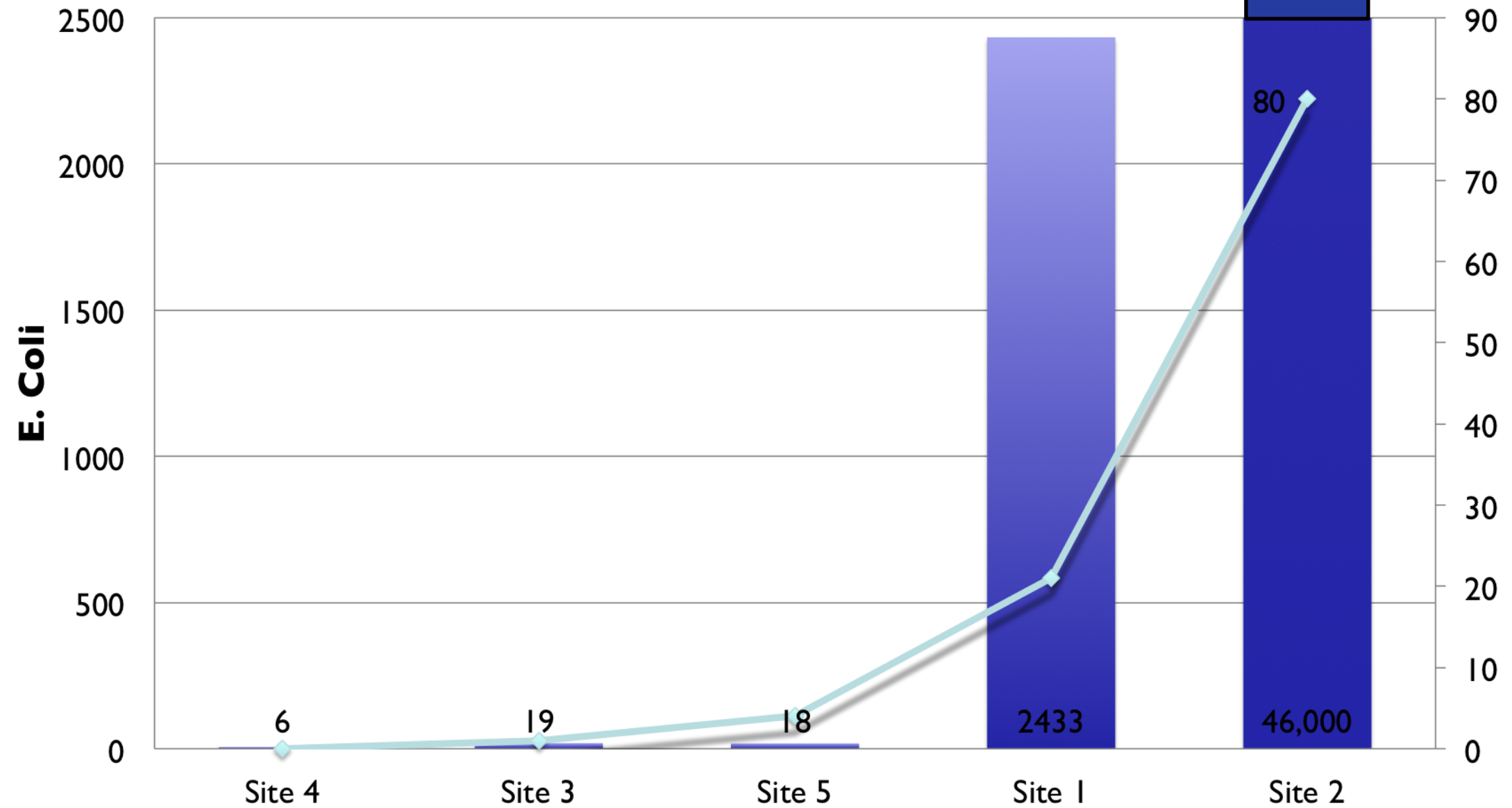
Results: Private Wells

- Small Piggeries
 - W3(1) – 19 mpn/100 ml
 - W5(4) – 18 mpn/100 ml

Results: Private Wells

- Large Piggeries
 - W1(21) – 2,433 mpn/100 ml
 - W2(80) – 46,000 mpn/100 ml

Piggery Size & E. coli



6 mpn

Small 19 mpn

Private Well
NO Pigs

Small 18 mpn

Private Wells
w/ Pigs

Large 46,000 mpn

Large 2,433 mpn

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Data LDEO-Columbia, NSF, NOAA
Image © 2012 GeoEye

Google earth

3/3/2011



2002

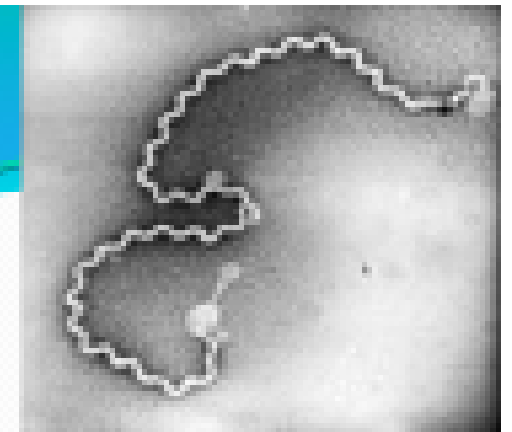
7°08'58.27" N 171°02'10.94" E elev 16 ft

Eye alt 14504 ft

What can be done?

- Many pieces of the puzzles are in place.
- Need better coordination among the agencies and PAC and to set priorities.
- Continue educational outreach to all ... school children, NGOs, agencies, newspaper, legislators, traditional leaders.
- My greatest fear





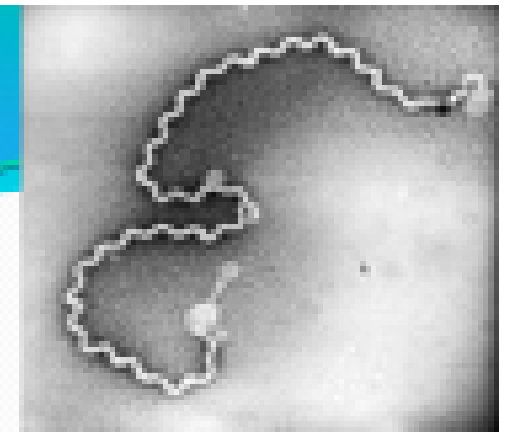
Leptospirosis

- Affects people!!!
- Lives in streams, lakes, rivers, and waters around island
 - Swimming, walking in water or puddles with a cut on foot/leg
- Pig waste washed into water – huge problem!
- Dogs and rats too (found especially in urine)
- Not possible to vaccinate all animals in Pohnpei
- In people - signs – flu-like symptoms, fever, depression, muscle pain



Leptospirosis

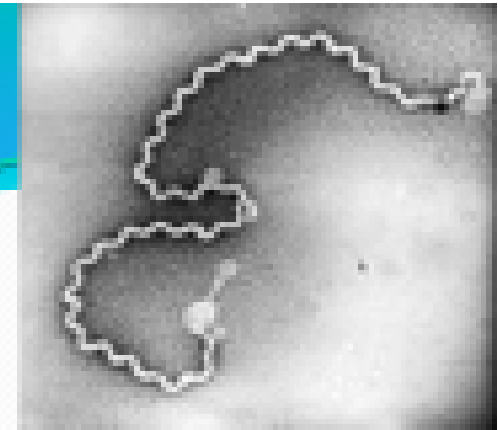
- First found in Kosrae 1990
- 1991 study found many cases in Pohnpei
- 1995-1996 found bacteria in rats, pigs, and dogs in Chuuk, Kosrae, Yap, Pohnpei
 - 794 pig blood samples collected



Leptospirosis Results from Pigs 1995-1996:

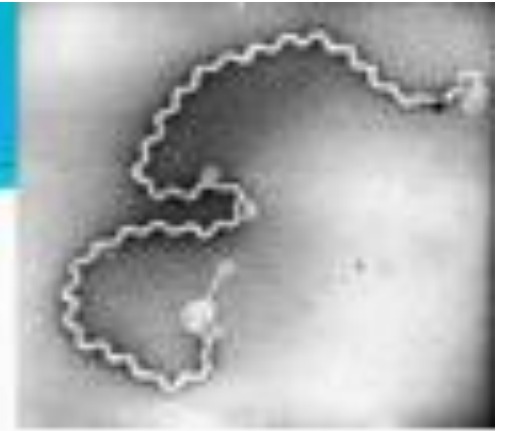
Disease	Result	Test type	Testing lab	Sample size	Est. pig population
Main Island, Pohnpei					
Leptospirosis	81 Positive	MAT	WHO, LRL, Aus	256	16,000 - 20,000
Mwokilloa, Pohnpei State					
Leptospirosis	13 Positive	MAT	WHO, LRL, Aus	63	200
Kapingamarangi, Pohnpei State					
Leptospirosis	6 Positive	MAT	WHO, LRL, Aus	20	400
Nukuro, Pohnpei State					
Leptospirosis	4 Positive	MAT	WHO, LRL, Aus	15	400
Sapwuahfik, Pohnpei State					
Leptospirosis	7 Positive	MAT	WHO, LRL, Aus	9	500

Leptospirosis



- Conclusion of 1996 animal study:
 - Of the diseases detected by the swine disease survey, leptospirosis is the most damaging to human and animal health within the FSM.
- Colt study here in Pohnpei.
 - Study for 16 weeks
 - Patients with signs of Lepto – flu-like signs
 - Blood sample and 2-week a second sample
 - **Almost 1 in 4 people** with symptoms of fever and another symptom are diagnosed as having a probable case of Leptospirosis

Leptospirosis

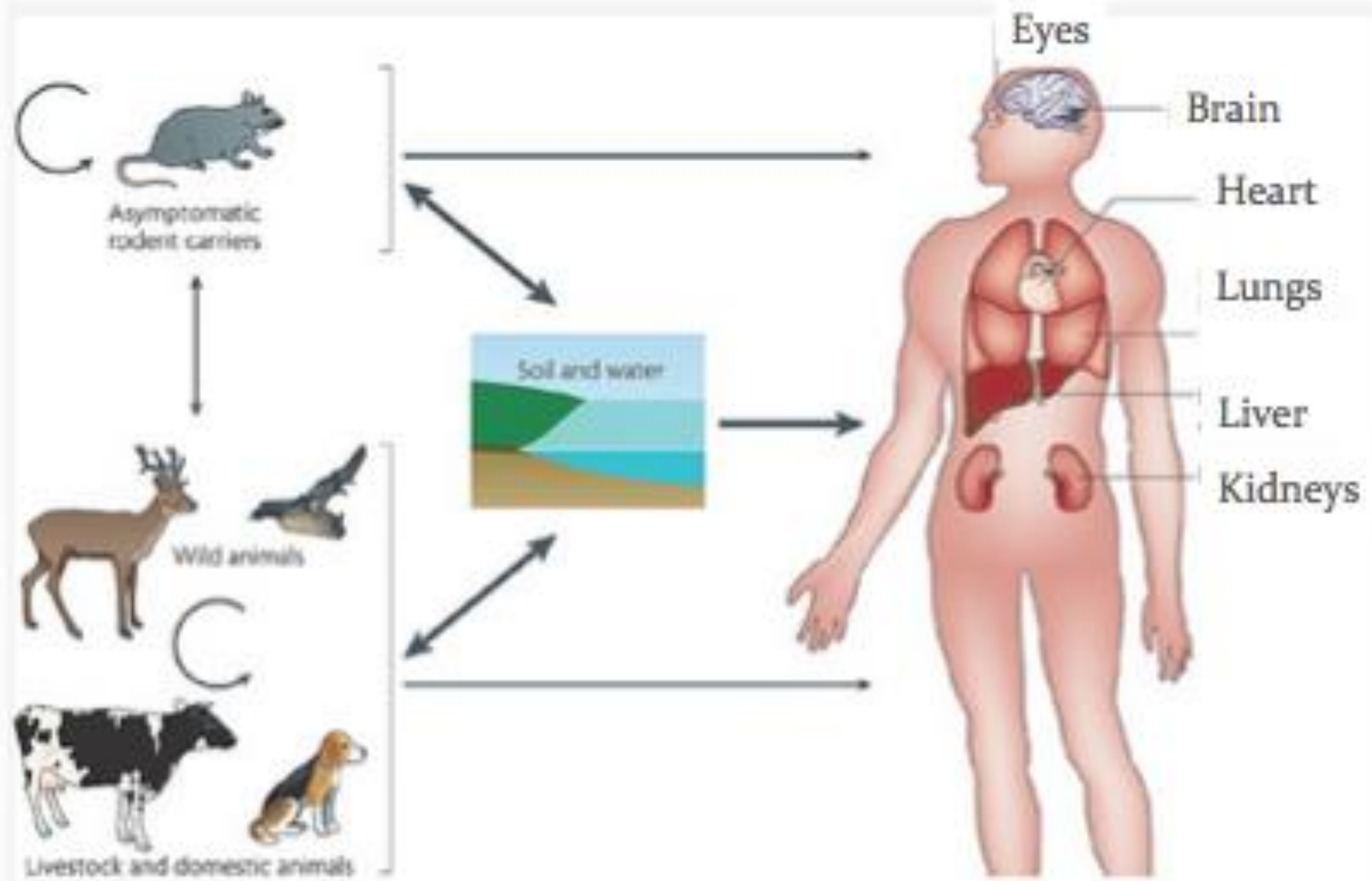


- Many types of Lepto.
- Rats, wild *and* farm pigs, dogs other animals, and people.
- Can cause kidney damage.
- Need to get to doctor within the first week to get medication!!!
Don't wait!
- **PREVENTION: VERY Important reason to keep animal waste runoff away from water sources/ swimming areas.**



Leptospirosis

Can Cause Severe Problems and Inflammation of:



Leptospirosis section prepared and presented by Dr. Ashley M. Stokes,
Extension Specialist in Veterinary Medicine, UH-Manoa

Leptospirosis



- **PREVENTION:**
VERY
Important
reason to keep
animal waste
away from
water sources &
swimming
areas.

“we will not change our culture, but we can change our ways of doing things”



Summary

- Drinking water standard is 0 mpn/100 ml.
- Piggery discharges into water resources negatively affects water quality.
- Contaminated fresh water exceeded standards from 2, 10, up to 100 times the recreational standards.
- Contamination increase with increasing pig biomass and/or other human impacts.

Solving the Problem

- Continue water quality monitoring on select “hot” spots (many piggeries)
- Implement Alternative Piggery Waste/Nutrient Management Systems ... focusing on the Dry Litter Technology.



Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat
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GOO



Kalangan

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du