

Groundwater Survey - Nauru

March - April 2010



Groundwater Survey – Nauru - 2010

Survey Objectives

Information used to improve understanding, access, supply and protection of freshwater resources in Nauru.

- Where wells are located and how they are constructed
- What they are used for and the reliance placed upon them.
- Baseline well water quality.
- Assess risk to wells from contamination – sanitary survey.
- Develop GIS database for use in future water resource management and assessment



Groundwater Survey - Nauru

Acknowledgements



SOPAC



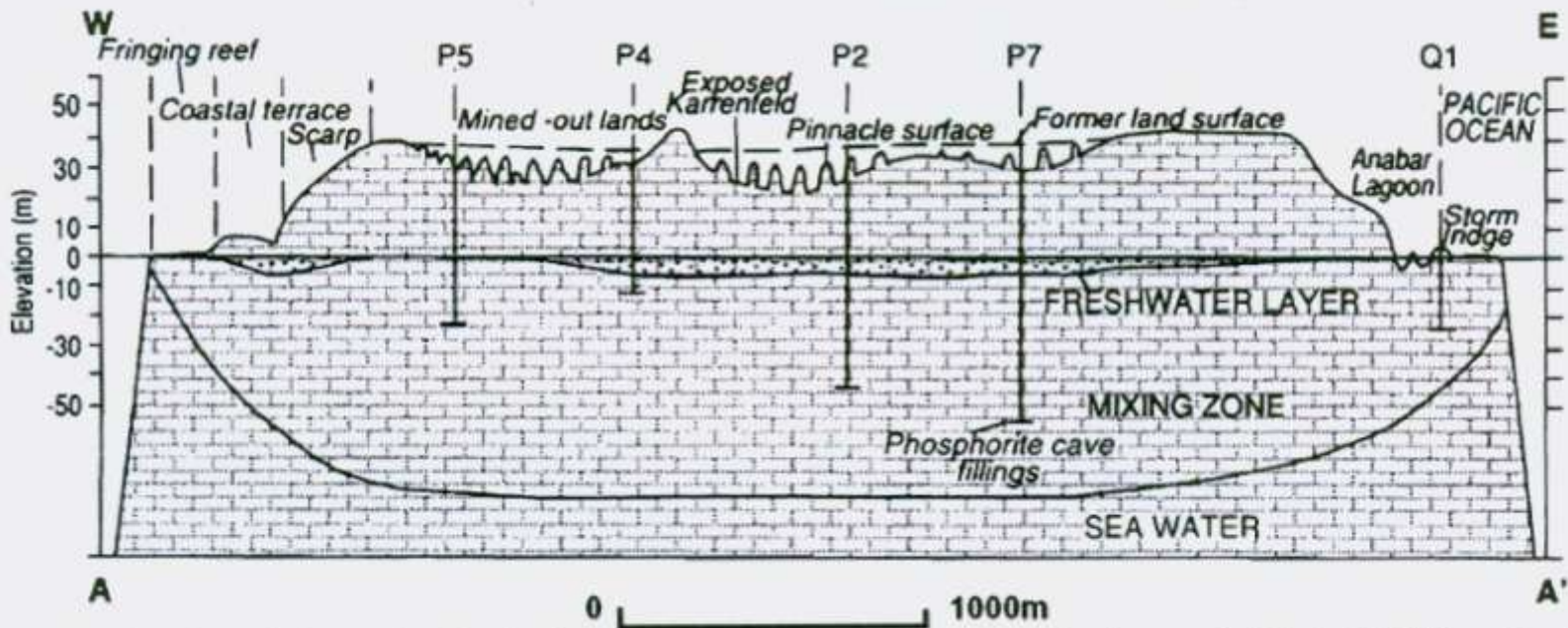
Background - Physiography

- Located close to equator
- Uplifted Coral island - 22 km²
- Coastal plain 150- 300m wide
5mASL with coral sand soil
- Coral limestone escarpment 30m
ASL “Topside” central plateau
- Highest point is 70mASL
- Fringing reef 120-300m wide
dropping sharply, 40degrees to sea
floor 4,000m
- Population – 2006 census approx 9,100
- Phosphate mantle up to 24m thick over limestone pinnacles.
Phosphate mined from 1950s -1995 with secondary mining carried out
today



Background - Geology

- coastal terrace much younger than topside plateau
- dolomitised limestone makes up bulk of island
- Thin and variable freshwater lens supports highly fractured karst limestone of connected dissolution cavities.

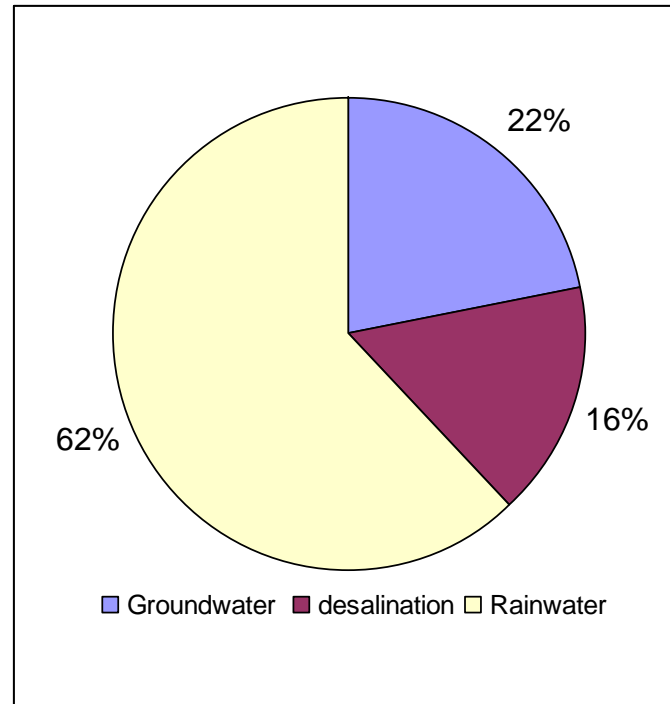


Cross section through Nauru showing freshwater and mixing (transition) zones after heavy rainfalls in 1987 [from Jacobsen et al. 1991]. Recent work in a degraded area found no more viable freshwater lens.

Background – dominant water sources

- Rainwater Harvesting
- Groundwater
- Desalination water

Estimate of reliance from different water sources

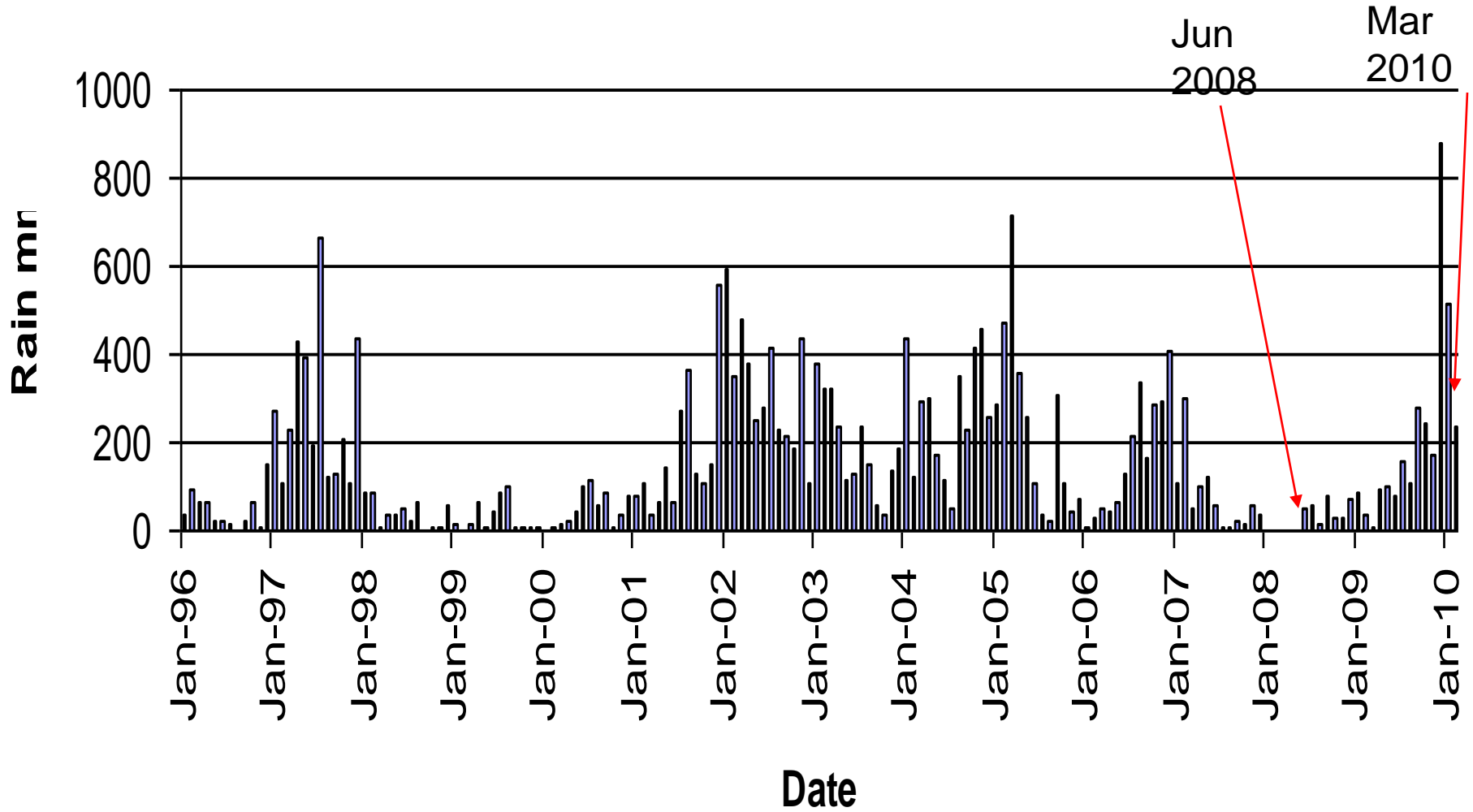


Background – Climate

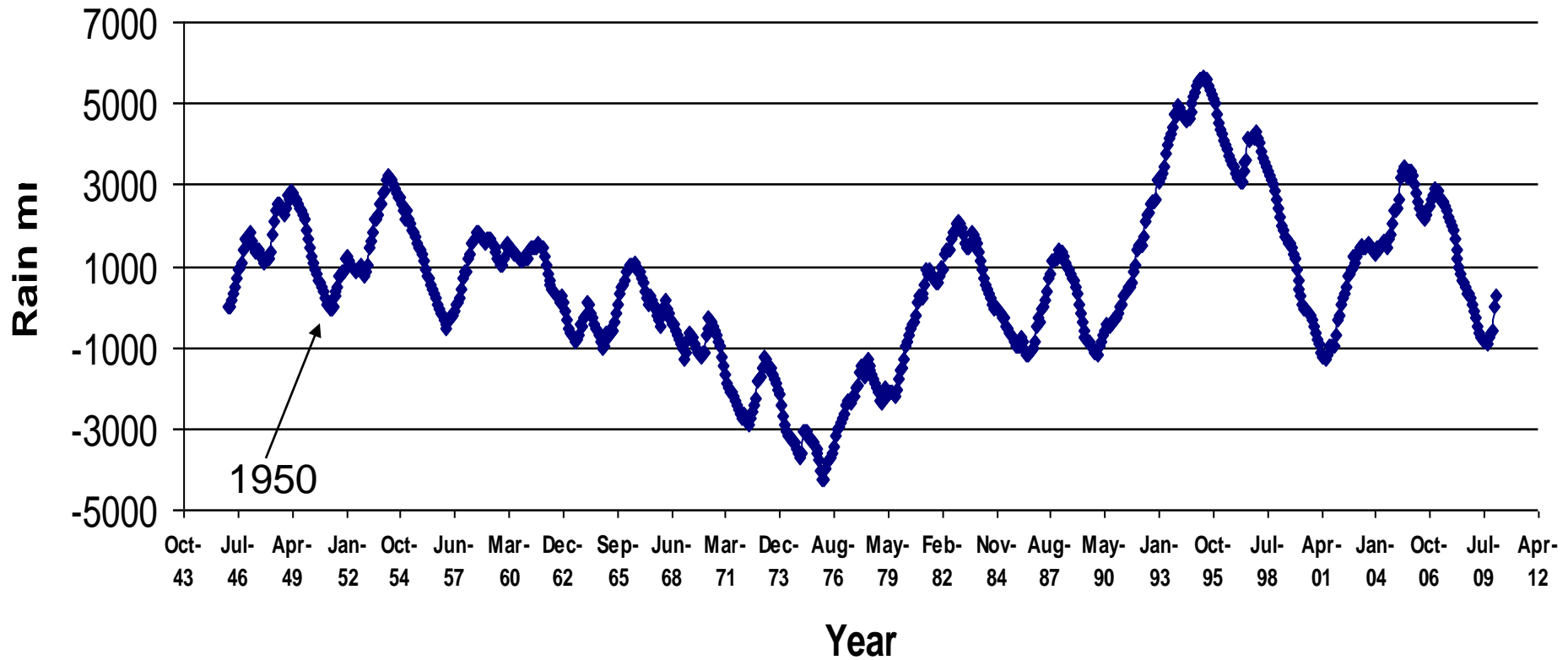
- Temperatures 23⁰-35⁰C
- Rainfall in Nauru is very variable. Extended dry periods with out rain are common
- “Dry” season May to October
- “Wet” season November to April
- Average rainfall is 2108mm
- Wettest year 1930 with 4,590mm
- Driest year 1950 with 280mm
- Strong correlation with SOI La Nina is dry and El Nino is wet



Rainfall 1996 - 2010



Rainfall residual Mass curve Nauru 1946 -2010



Survey Methodology

Survey questionnaire

- Developed at SOPAC and modified in Nauru
- Captures data on well location, construction and quality of well water, bacteriological and salinity
- Identifies approximate location of septic - **field maps**
- Usage data, population and households relying on wells, uses and appliances using water
- Sanitary survey data – assessment of individual well and its risk to contamination.
- Two teams of two for 5 weeks (2 Nauruan casual labour and Env Health officer and Louis)



Groundwater surveys



Groundwater wells

Summary

Total no of wells survey : 336 wells

No of households surveyed: 423 (1,538)

Domestic well **total depth** for all districts

Max: 12.2m

Min: 1.1m

Average: 4.4m

Domestic well **depth to water**

Max: 11.2m

Min: 0.6m

Average: 3.2m

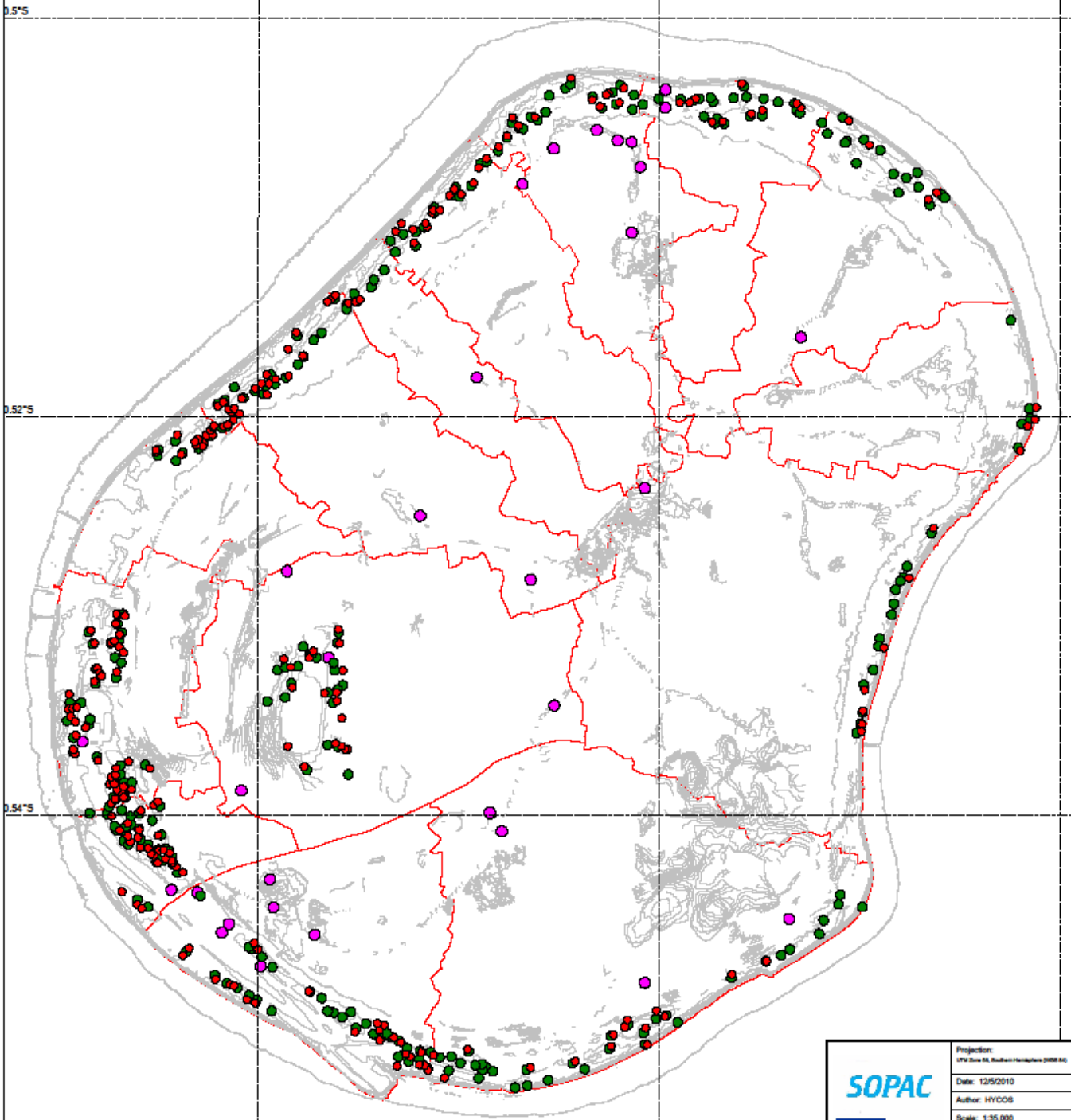
Domestic well **Salinity $\mu\text{S}/\text{cm}$**

Max: 20,300 $\mu\text{S}/\text{cm}$

Min: 300 $\mu\text{S}/\text{cm}$

Average: 2,505 $\mu\text{S}/\text{cm}$ (freshwater limit 2,500 $\mu\text{S}/\text{cm}$)



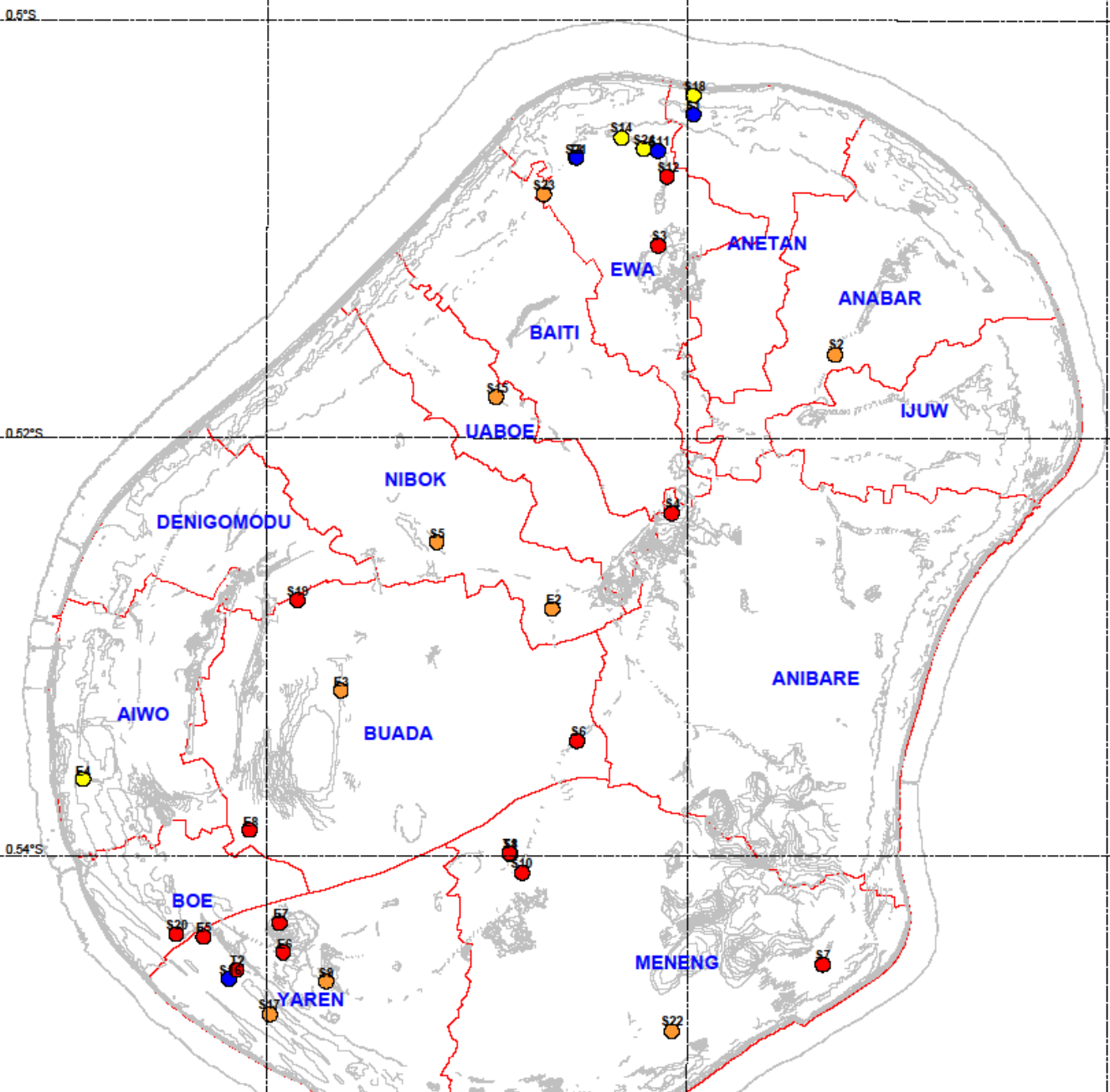


Domestic wells
Monitoring wells
Septic tanks
Mar- April 2010

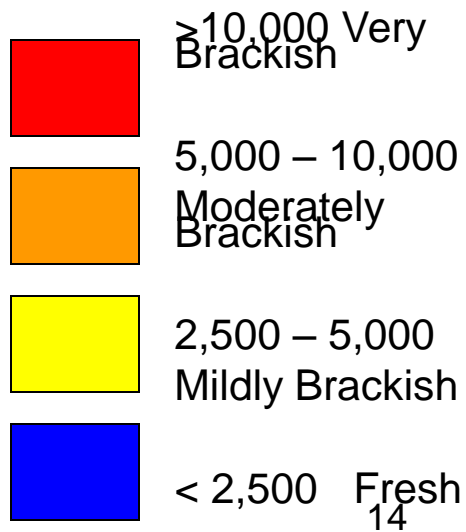
	Projection:
	Date: 12/5/2010
	Author: HYCOS
	Scale: 1:35,000

Salinity of monitoring well water EC $\mu\text{S}/\text{cm}$

June 2008

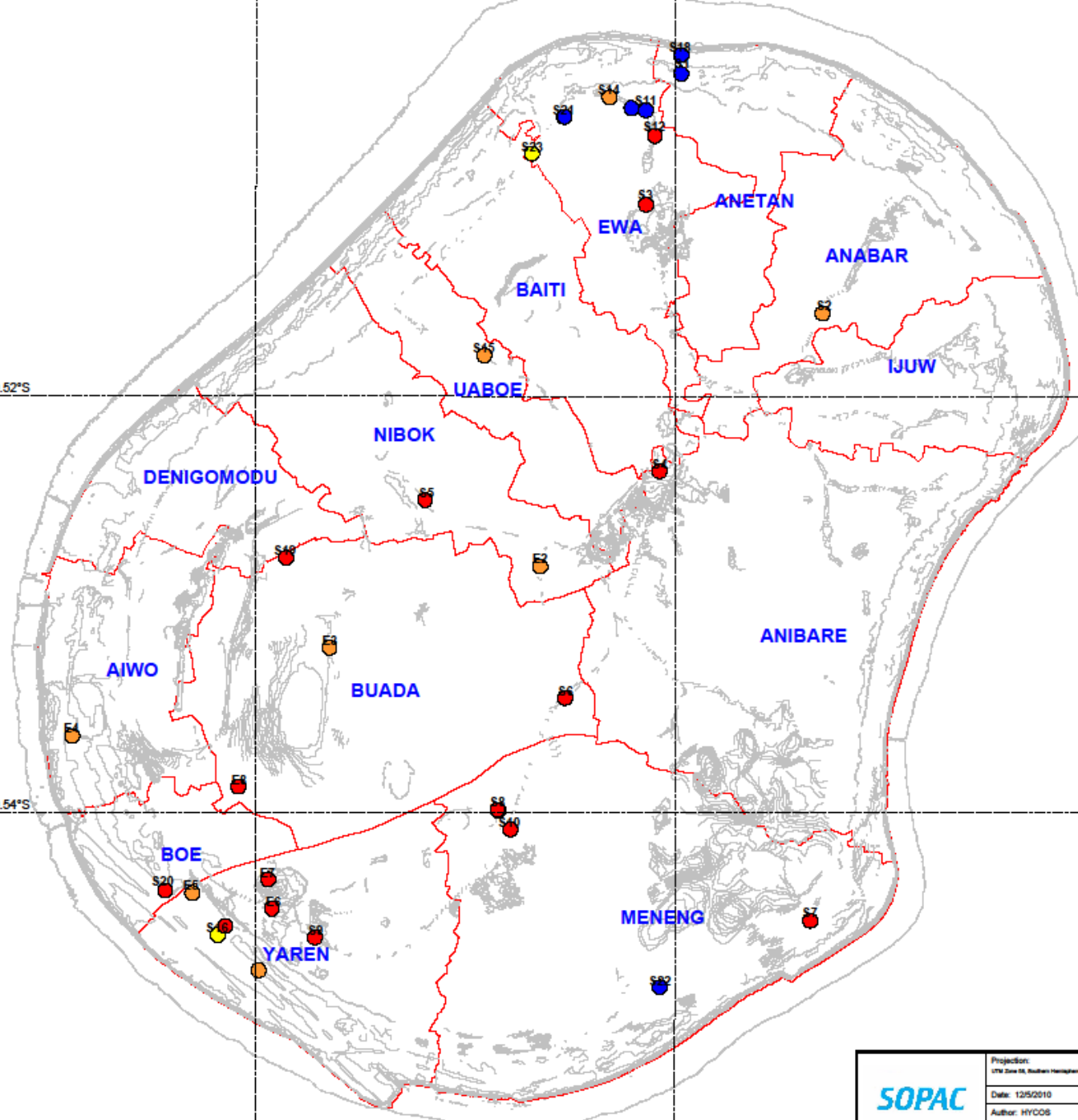


Salinity - EC $\mu\text{S}/\text{cm}$

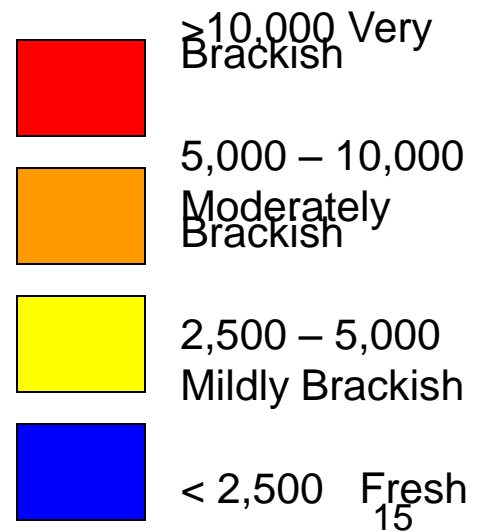


Salinity of monitoring well water EC $\mu\text{S}/\text{cm}$

April 2009



Salinity - EC $\mu\text{S}/\text{cm}$



SOPAC
SOUTH PACIFIC OCEANOGRAPHIC PROGRAM

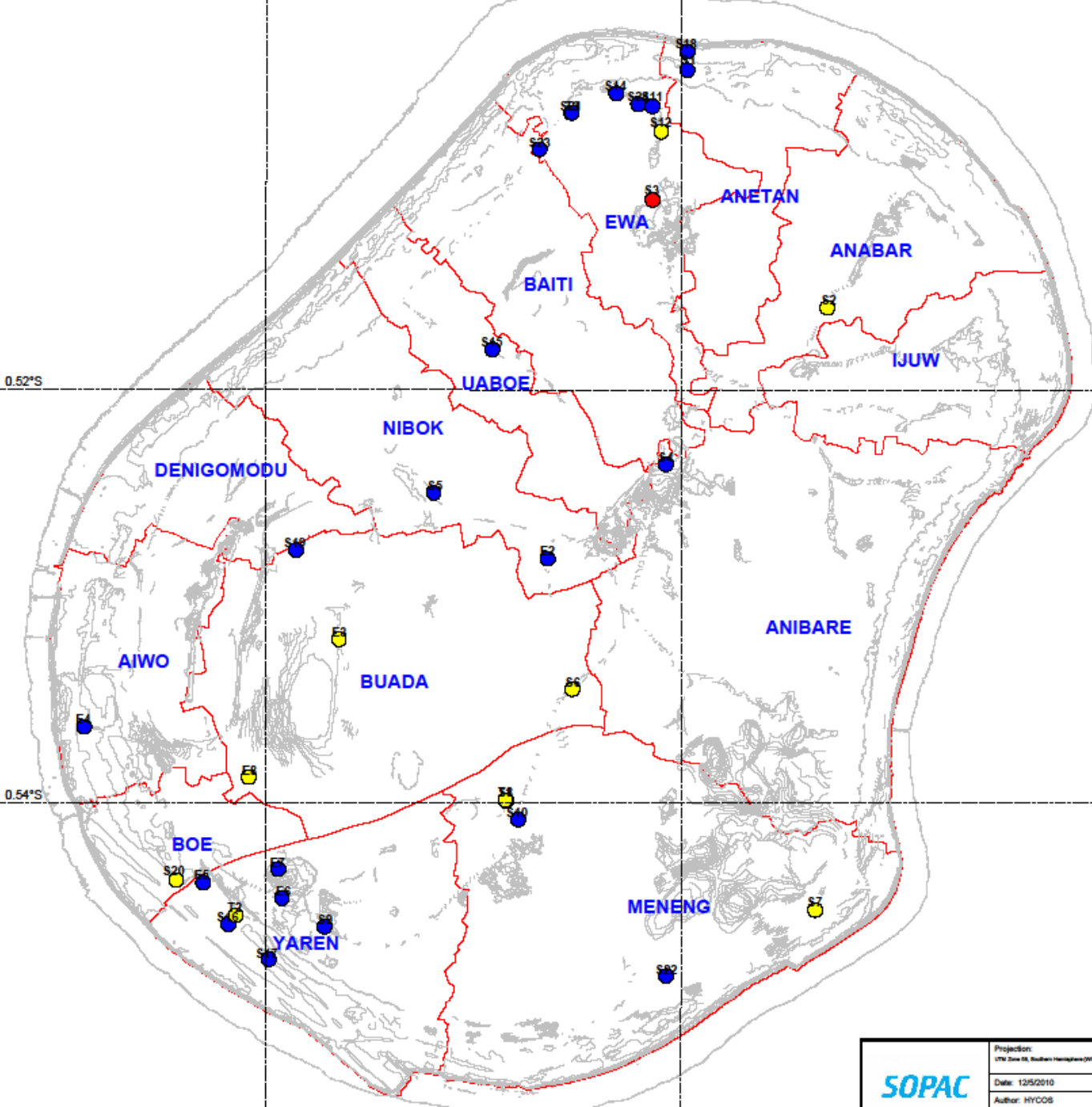
HYCOS
HYDROLOGICAL CYCLES OBSERVATION SYSTEM

Projection:	UTM Zone 68, Southern Hemisphere (EPSG:31468)
Date:	12/5/2010
Author:	HYCOS
Scale:	1:35,000

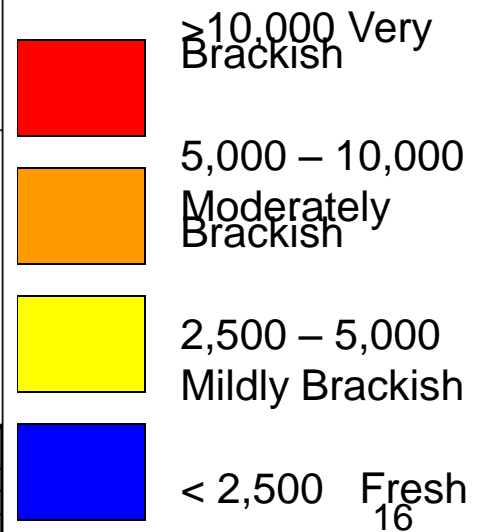
0 100.0 200.0 300.0

Salinity of monitoring well water EC $\mu\text{S}/\text{cm}$

April 2010



Salinity - EC $\mu\text{S}/\text{cm}$






Projection:
UTM Zone 58, Southern Hemisphere (2011 eq.)

Date: 12/5/2010

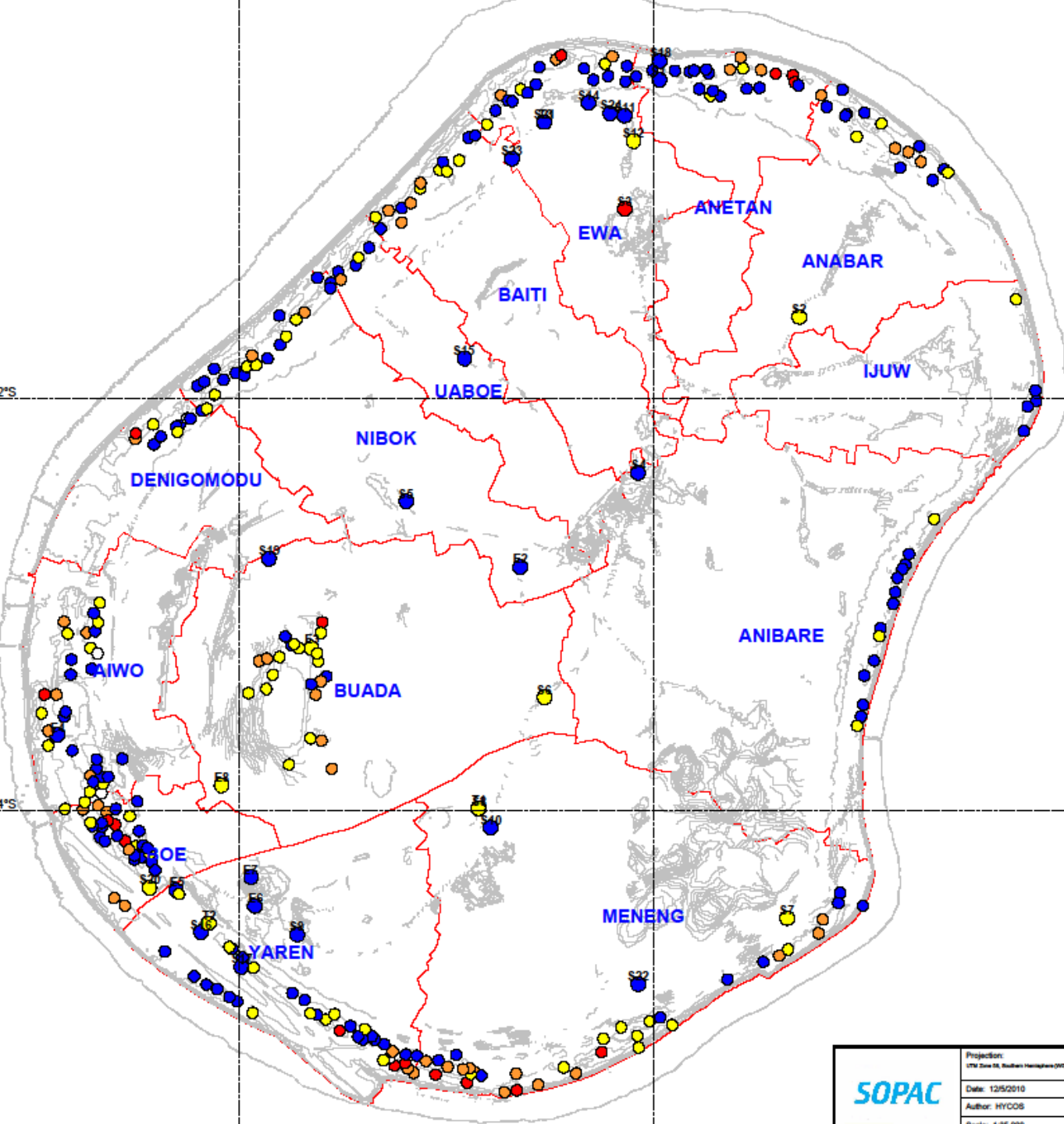
Author: HYCOS

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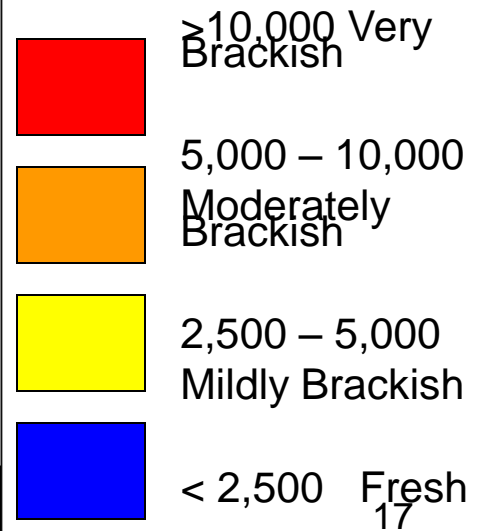


Salinity of domestic well water EC $\mu\text{S/cm}$

April 2010



Salinity - EC $\mu\text{S/cm}$

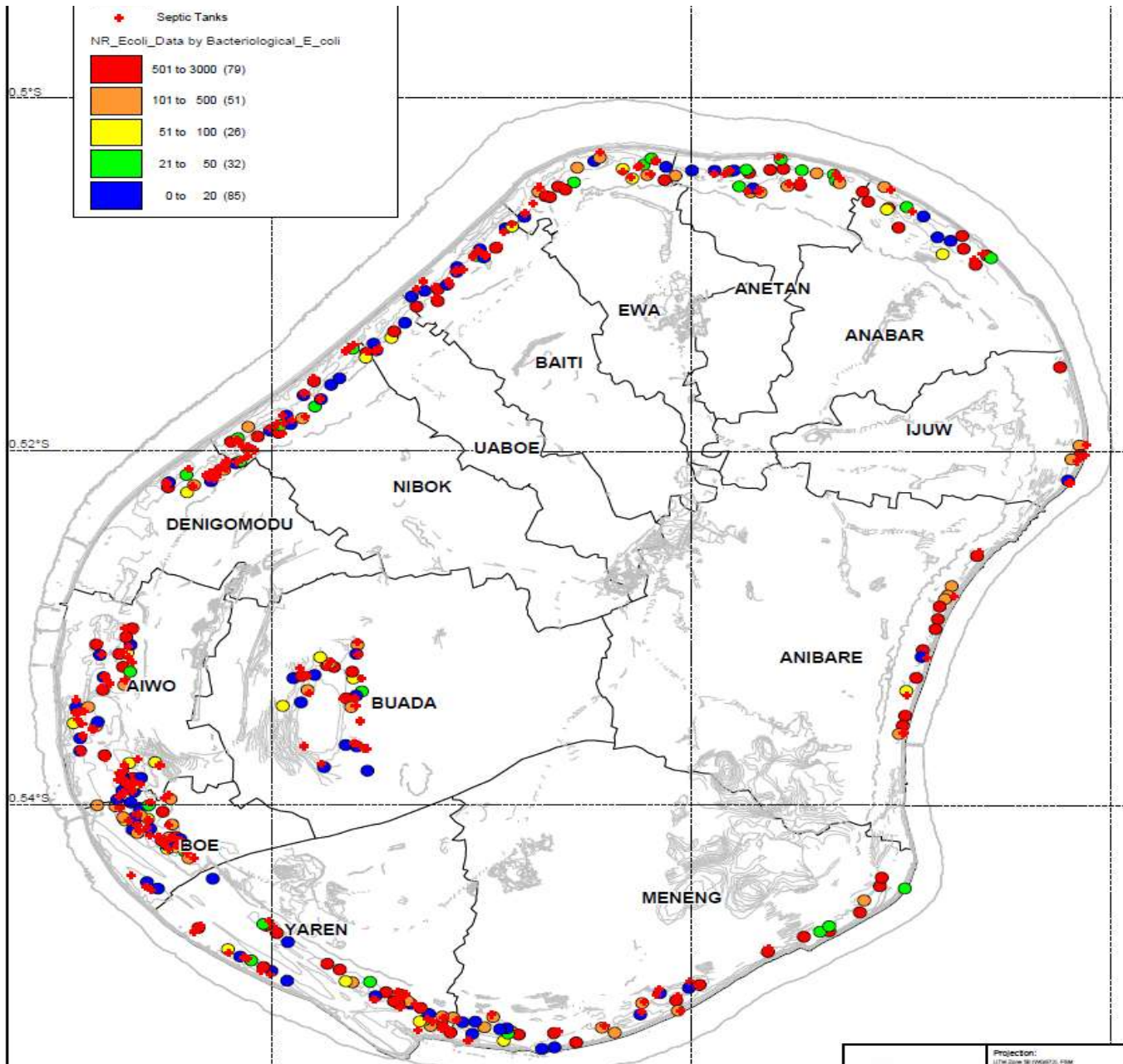


Survey results – E coli

Faecal contamination risk

Risk	MPN	No. samples	% of samples
Low	0-20	85	31%
Low- moderate	20-50	33	12%
moderate	51-100	26	9.5%
moderate- high	101-500	52	18.5%
high	>500	79	29%
TOTAL		275	



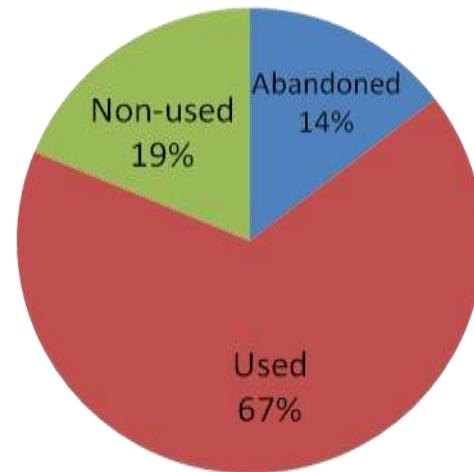


AIWO Hydrocarbon Contamination



Groundwater use March April 2010

- **38.5% of the population use** well water (including 3 schools)
- **46% of the population have access** to well water (incl 3 schools)
- 22.2 % of the households are **using** groundwater



Total well use

Groundwater survey summary Mar- Apr 2010 – Preliminary Results

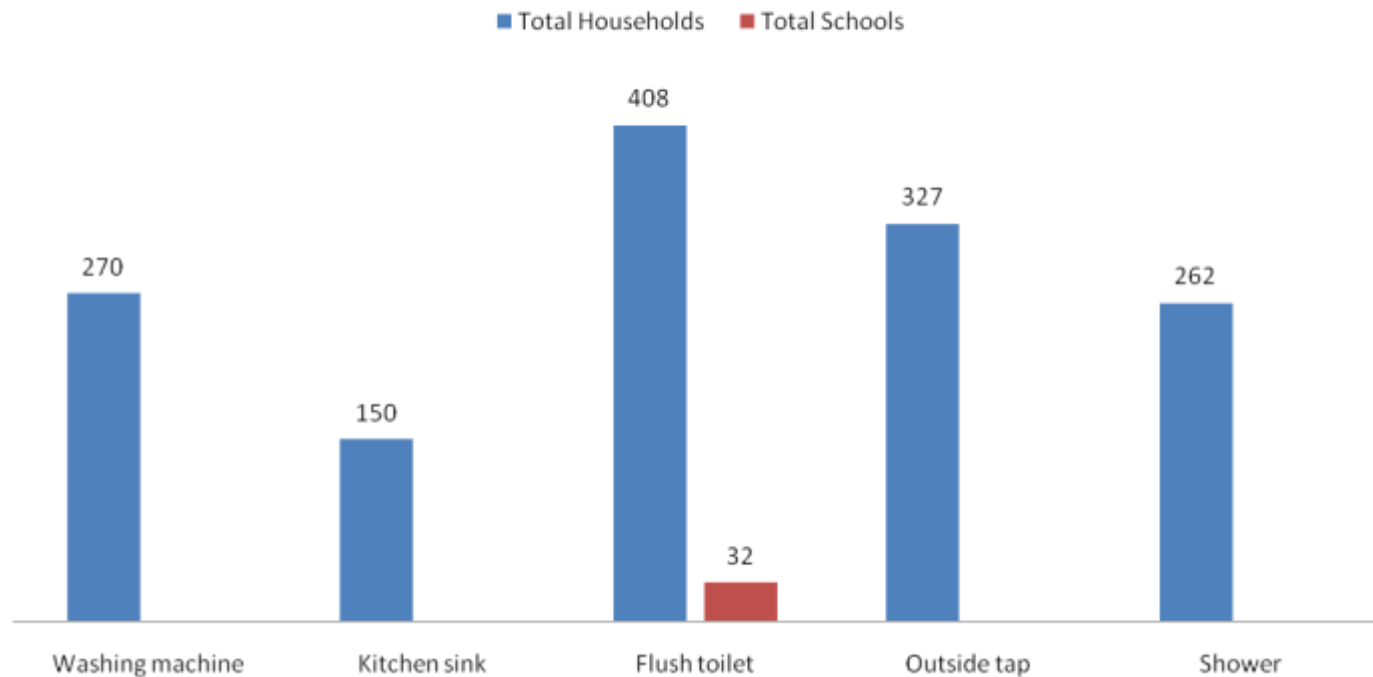
District	No .of wells	No. of house holds using wells	No Of house holds with access but not using	Total no of house holds with access	2006 No Of Households	% of Household s using wells	% of Household s with access to wells	No of people using wells	2006 total pop.	% of pop using wells	no of pop access to wells
Nibok	24	24	10	34	63	38.1%	54.0%	331	378	87.6%	
Anibare	16	14	3	17	23	60.9%	73.9%	118	157	75.2%	
Boe	38	51	15	66	107	47.7%	61.7%	416	761	54.7%	
Yaren	38	41	6	47	100	41.0%	47.0%	367	684	53.7%	
Ewa	21	21	3	24	57	36.8%	42.1%	187	371	50.4%	
Baitsi	18	20	5	25	63	31.7%	39.7%	207	508	40.7%	
Denig	13	23	1	24	76	30.3%	31.6%	188	473	39.7%	
Uaboe	7	15	2	17	45	33.3%	37.8%	123	328	37.5%	
Anetan	23	18	9	27	74	24.3%	36.5%	181	500	36.2%	
Buada	32	34	9	43	103	33.0%	41.7%	254	704	36.1%	
Anabar	21	13	2	15	64	20.3%	23.4%	146	408	35.8%	
Aiwo	32	35	9	44	202	17.3%	21.8%	369	1165	31.7%	
Meneng	43	31	6	37	251	12.4%	14.7%	229	1355	16.9%	
Ijuw	10	1	2	3	34	2.9%	8.8%	8	235	3.4%	
Location	0	0	0	0	276	0.0%	0.0%	0	1135	0.0%	
Total	336	341	82	423	1538	22.2%	27.5%	3037 (houses only)	9086	33.4%	3758 (houses only) 41.3%
								3499 total (3 schools)		38.5%	4218 total (3 schools) 46.4%

Groundwater use

Estimation of the groundwater abstraction

338 Households and 3 schools are using well water

Total number of items using groundwater



Groundwater use

Estimation of the groundwater abstraction

Items	Consumption MIN (L/min)	Consumption MAX (L/min)	Consumption MIN per use (L)	Consumption MAX per use (L)	Usage MIN (min/capita/day)	Usage MAX (min/capita/day)	Consumption MIN(L/capita/day)	Consumption MAX(L/capita/day)
Shower	7.00	9.00	NA	NA	3.00	5.00	21	45
Kitchen tap	8.00	10.00	NA	NA	NA	NA	8	12
Outside Tap	8.00	10.00	NA	NA	2.00	5.00	16	50
Washing machine	NA	NA	90.00	150.00	NA	NA	18	30
Flush toilet Dual C1	NA	NA	6.00	6.00	NA	NA	9	9
Flush toilet Dual C2	NA	NA	10.00	10.00	NA	NA	15	15



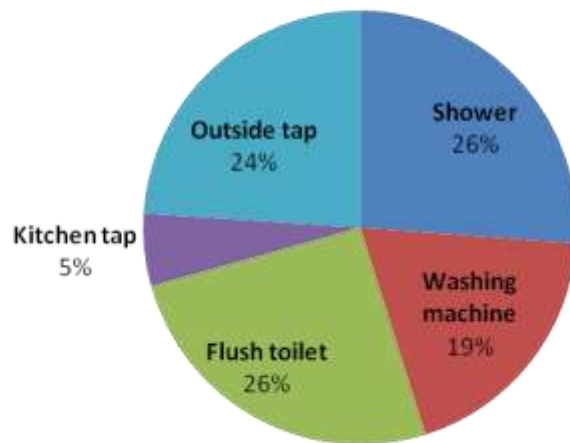
Groundwater use

Estimation of the groundwater abstraction

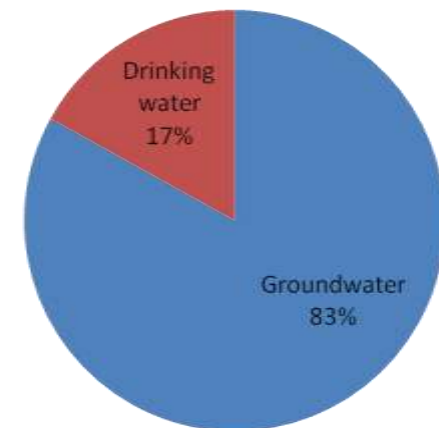
Range of abstraction per capita: 70.8 to 125L/p/day (HH only)
Range of total abstraction: 236 to 402 KL/day (HH + schools)

Average groundwater abstraction: **98L/p/day** Total= **319KL/day**

Average household groundwater consumption



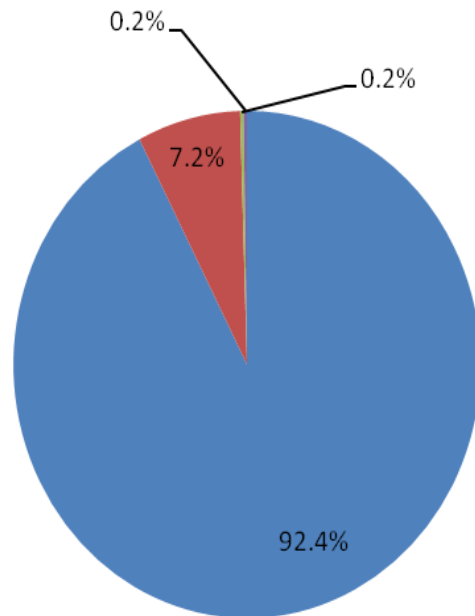
Total water consumption estimate for household using groundwater



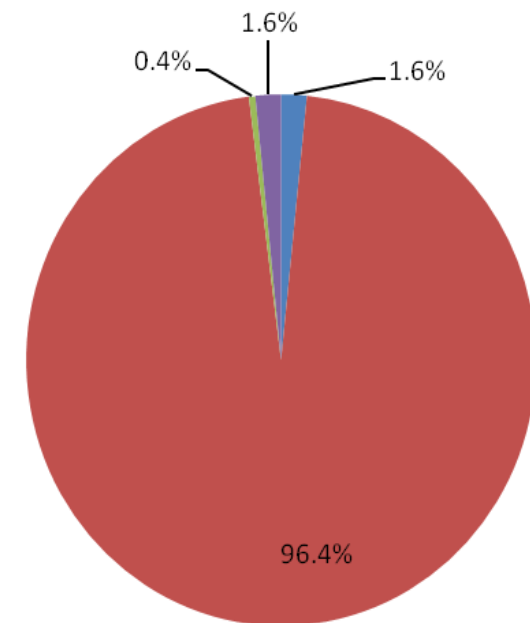
Drinking water sources

Primary and secondary water sources for drinking purpose

Primary Drinking water source



Secondary drinking water source



- Rainwater
- RO water
- Domestic Groudwater
- Bottled water



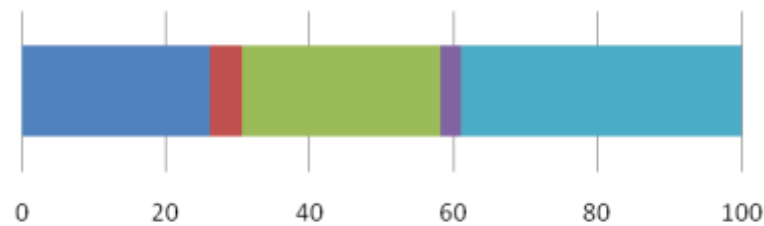
Drinking water sources

Water treatment

- Boiling :97% of HH
- Filter: 3% of HH

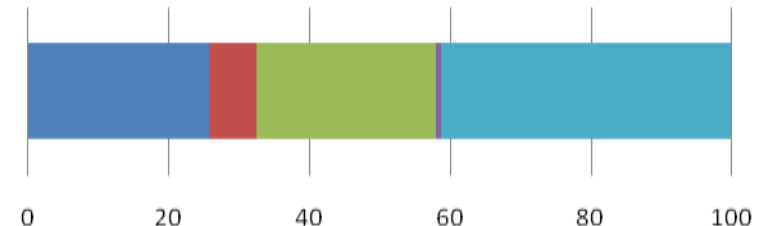


Frequency of treatment for rainwater



■ Never ■ Rarely ■ Quite often ■ Mostly ■ Always

Frequency of treatment for RO water



■ Never ■ Rarely ■ Quite often ■ Mostly ■ Always

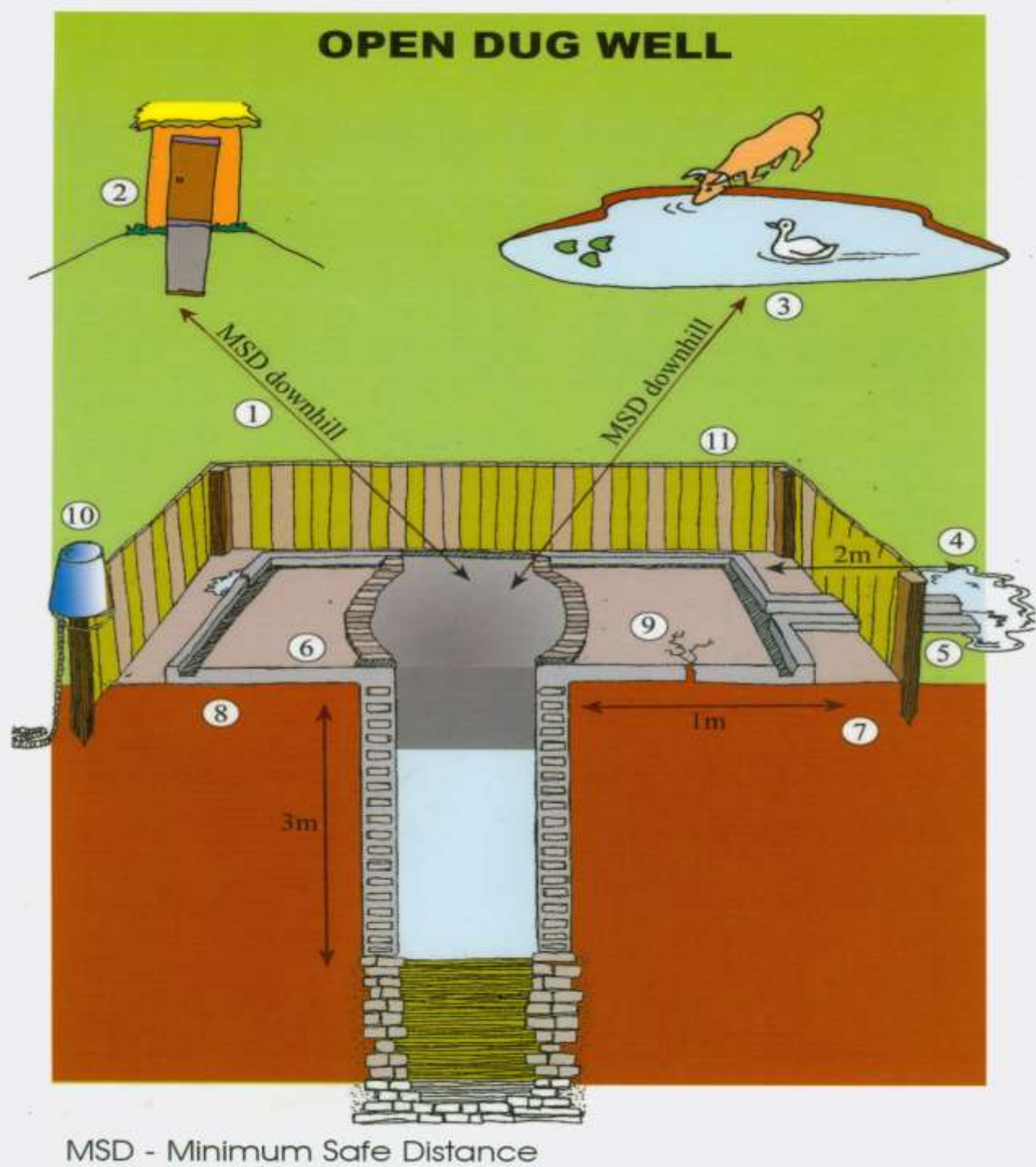
Sanitary surveys

- A sanitary survey is an **on-site inspection** of the water supply system assessing the risk or threat from contamination.
- The survey the **site conditions, set up, and practices** in a water supply system that pose an **actual or potential danger** to the health and well-being of the consumer.



Sanitary Survey

Open Dug well
Example



Sanitary surveys summary

- Very high rate of co-operation with landholders.
- Generally most wells were in poor condition and in need of general maintenance to reduce risk of contamination. Only small % were properly constructed and maintained.
- Community was interested in survey results and water sampling and recommendations.
- Summary Sheet on how to improve wells should be considered for future surveys during time of survey.



Workshops – Feedback to the Community

Workshop Objectives

- Feedback on survey purpose and preliminary results.
- Understanding of sanitary surveys and water quality.
- Advice on improved well protection and reducing risk of contamination.
- Sanitation – issues and options

What we planned to do:

- 14 workshop- 1 for each district
- 20-50 people per workshop

What we achieved:

- 4 workshops
- 40 people attendance
- Positive feedback from the attendance

Lessons learnt

- Logistics need to be checked beforehand
- Advertising is critical. House to house targeted leaflet drops worked well
- Summary sheet on “how to improve your well” useful



Summary

- Identification and recording of 336 domestic wells and septics in Nauru. Information available in spatial database - GIS
- Groundwater very variable and dependent on rains – salinity maps
- 41% of population have access to wells and 33 % rely on the well water
- Groundwater has high level of bacteriological contamination, improving the disposal of septic will improve groundwater quality and reduce potential for illness.
- Survey information useful for future project activities eg sanitation, improved water access/reliance





TUBWA KOR THANK YOU