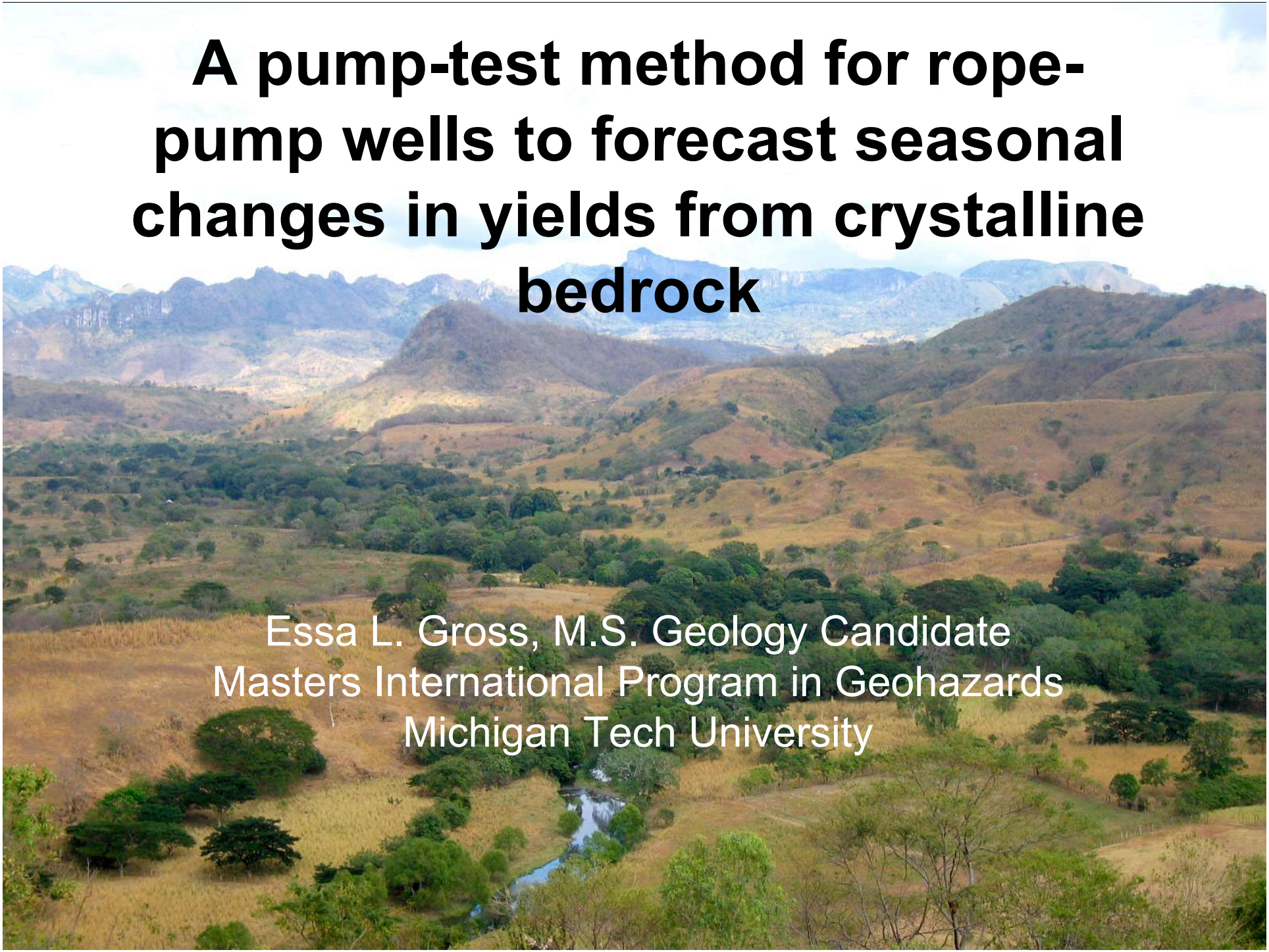
# A pump-test method for rope-pump wells to forecast seasonal changes in yields from crystalline bedrock



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Michigan Tech University


Honduras
Patuca R.
Coco R.
Waspam
Leimus
Wawa R.
Puerto Cabezas
Bocay
Teotecacinte
Bonanza
La Rosita
Siuna
Kukalaya
Bambana R.
Prinzapolka
Prinzapolka R.
Choluteca R.
Guayape R.
Tegucigalpa
El Salvador
Coco R.
Ocotal
Wiwilí
Somoto
Condega
Esteli
Tuma R.
Matagalpa R.
La Cruz de Río Grande
Potosí
Somtillo
Jinotega
Matagalpa
Río Blanco
Muy Muy
Nicaragua
Chinandega
León
Lago de Managua
Boaco
Siquia R.
Tipitapa
Managua
Mico R.
Rama
Masaya
Juigalpa
Bluefields
Granada
Masachapa
Lago de Nicaragua
Nueva Guinea
Caribbean Sea
Pacific Ocean
Rivas
San Juan del Sur
San Carlos
Indio R.
San Juan del Norte
San Juan R.
Costa Rica
Chirripó R.
N
88°
86°
84°
14°
12°
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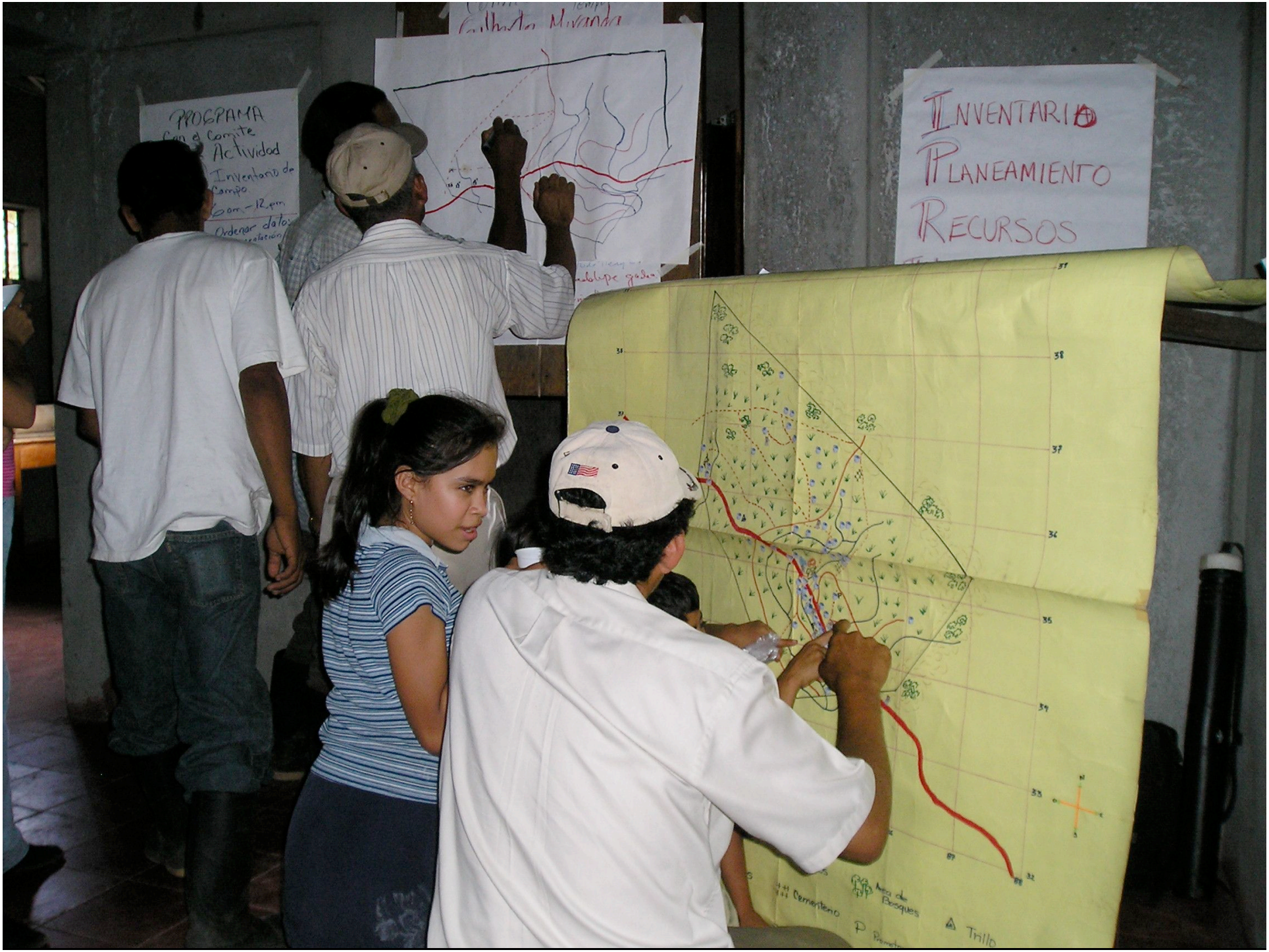
(805) 685-3100 www.maps.com
0
75 km
0
50 mi

# Water resource inventory



PROGRAMA
Actividad
Inventario de
Campo
Ordenar datos
INVENTARIO
PLANEAMIENTO
RECURSOS
Area de
Bosques
Trillo

# MAPA SANTA RITA
## (RECURSOS HÍDRICOS)

# Project Motivation

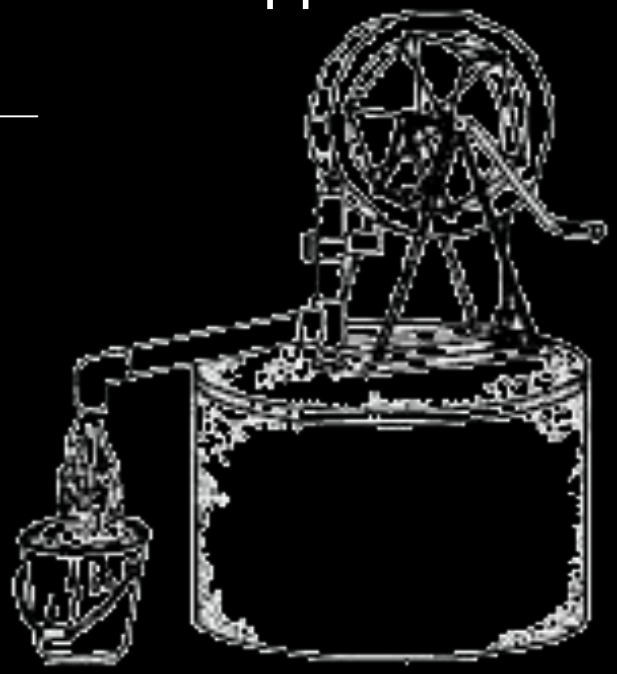
Little/no groundwater monitoring in rural parts of developing world

Wells tend to dry up at end of dry season; severe seasonal variations in Central America

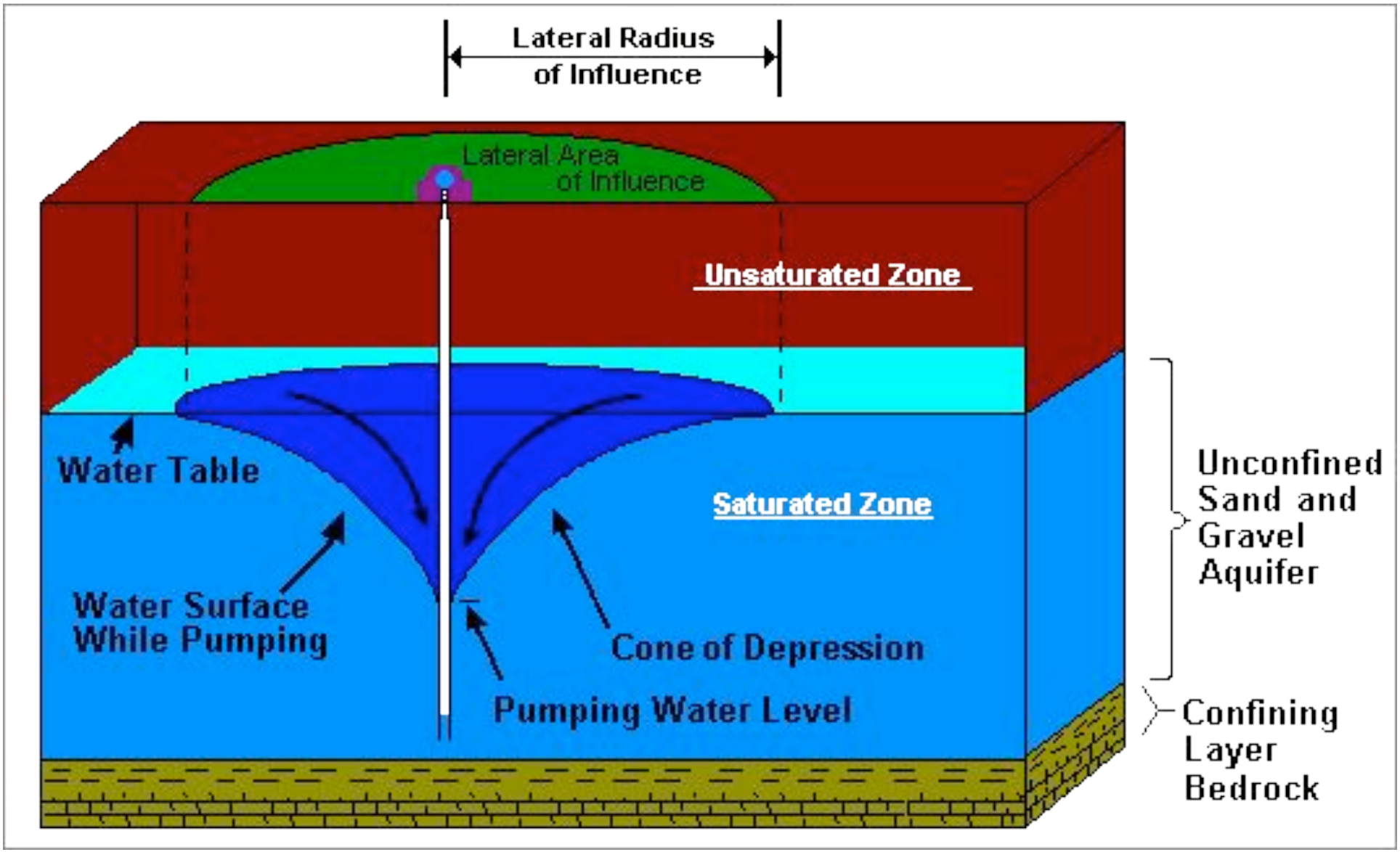
No technologically appropriate characterization approach for monitoring these areas

Can an appropriate method to manage use be developed to

1. Maximize yield
2. Ensure productivity year round?



# Effects of Well-Pumping



# The Basics - Previous Work

## Example data from Herbert et al., 1992:

*New approaches to pumping test interpretation for dug wells constructed on hard rock aquifers*

Pumping regime:

Daily 06:00-08:00; 11:00-13:00; 16:00-18:00

Pumping rate: 4 l/s

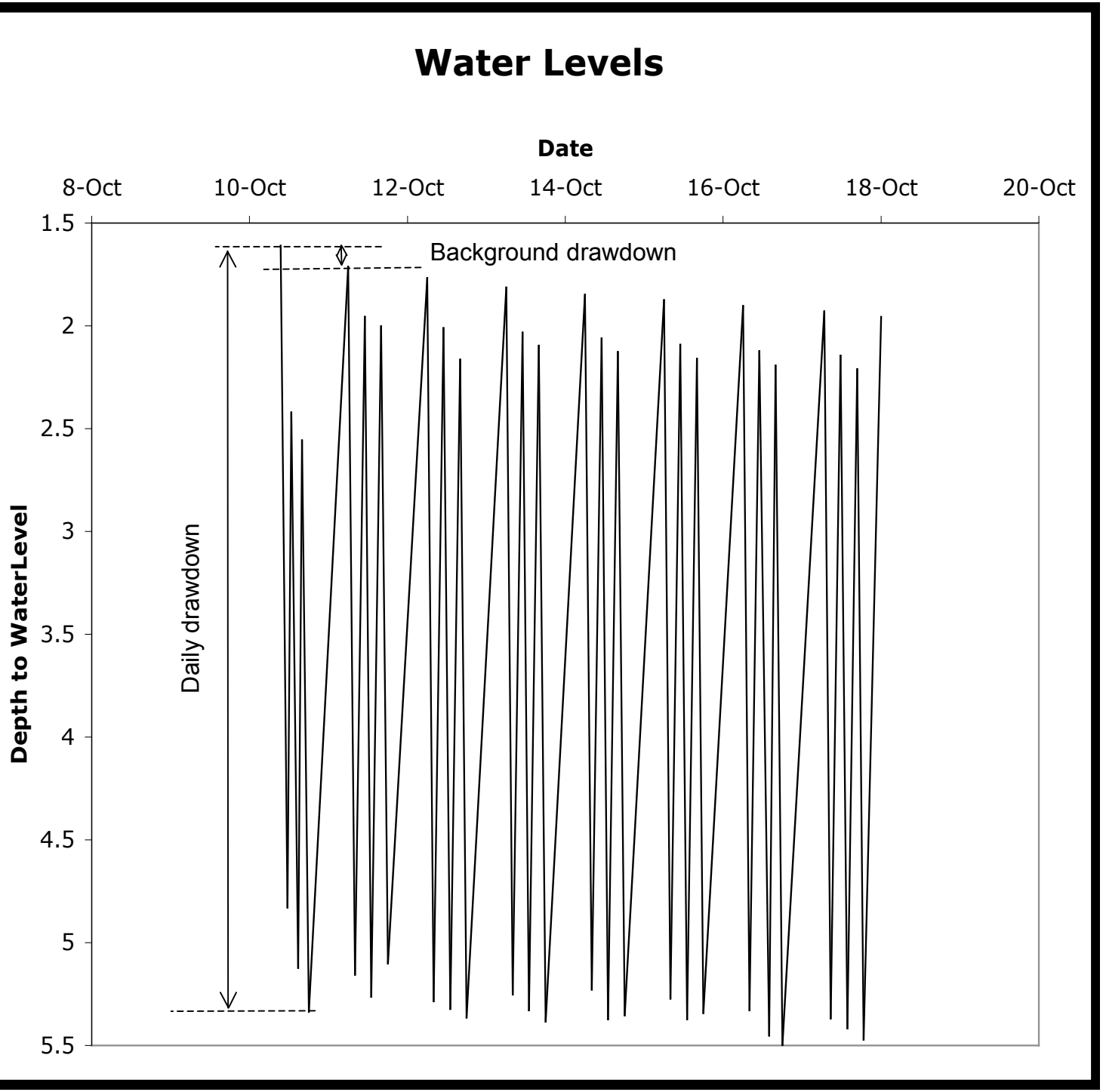
Depth to water table measurements were taken before and after each pumping cycle.

Time-drawdown graph shows drawdown occurs in two parts:

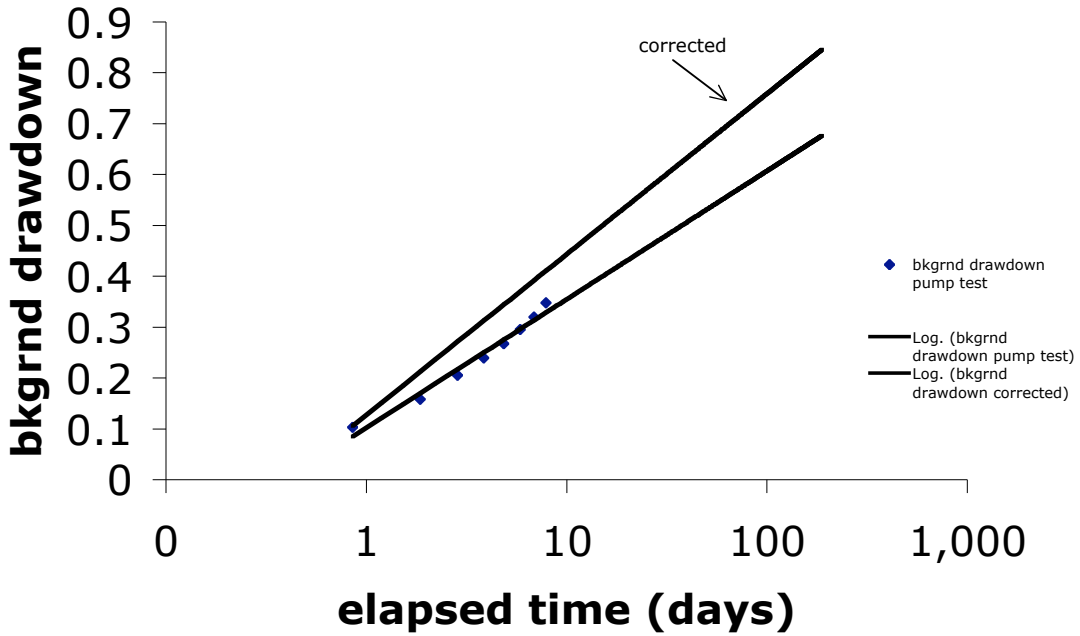
1) drawdown from start to end of pumping each day

2)“background” drawdown

Adapted from Herbert et al., 1992

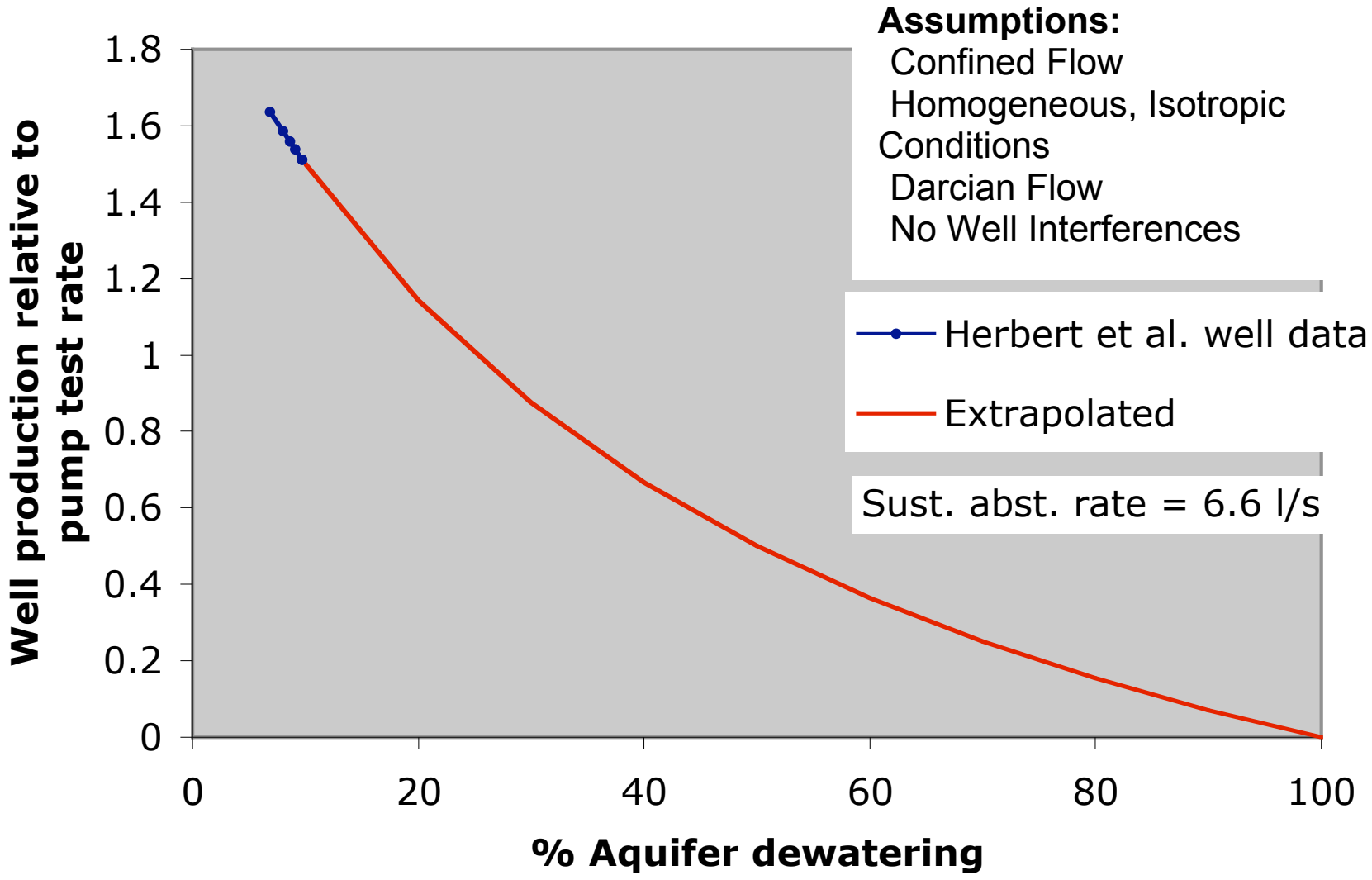


Background drawdown is plotted as a function of time to establish a trend that can be extrapolated for the remaining dry season




| Month | Projected backgrnd drawdown (m) |
|---|---|
| Jan | 0.59 |
| Feb | 0.69 |
| Mar | 0.74 |
| Apr | 0.78 |
| May | 0.81 |
| Jun | 0.84 |

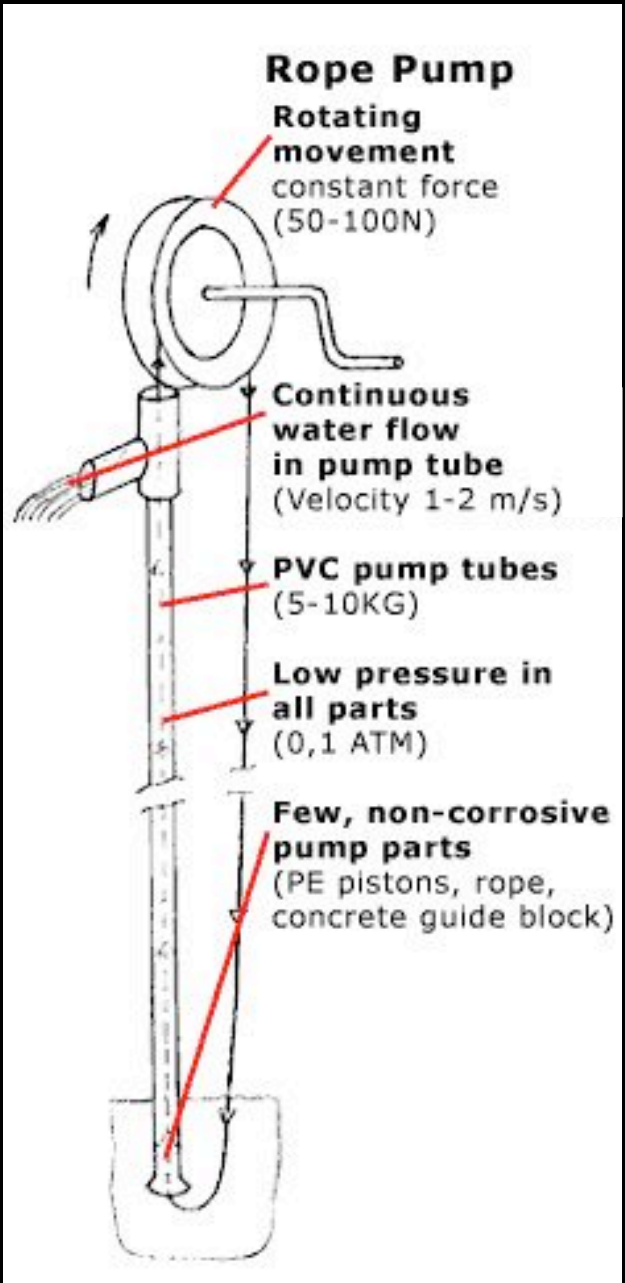
# Well productivity with declining water table



# Dry season well monitoring

| Month | Projected background drawdown (m) | Actual drawdown (m) |
|---|---|---|
| Jan | 0.59 | ? |
| Feb | 0.69 | ? |
| Mar | 0.74 | ? |
| Apr | 0.78 | ? |
| May | 0.81 | ? |
| Jun | 0.84 | ? |

Measurements taken over the course of summer will determine the validity of the extrapolated trend.




# Rope pump

<u>How rope pumps work:</u>

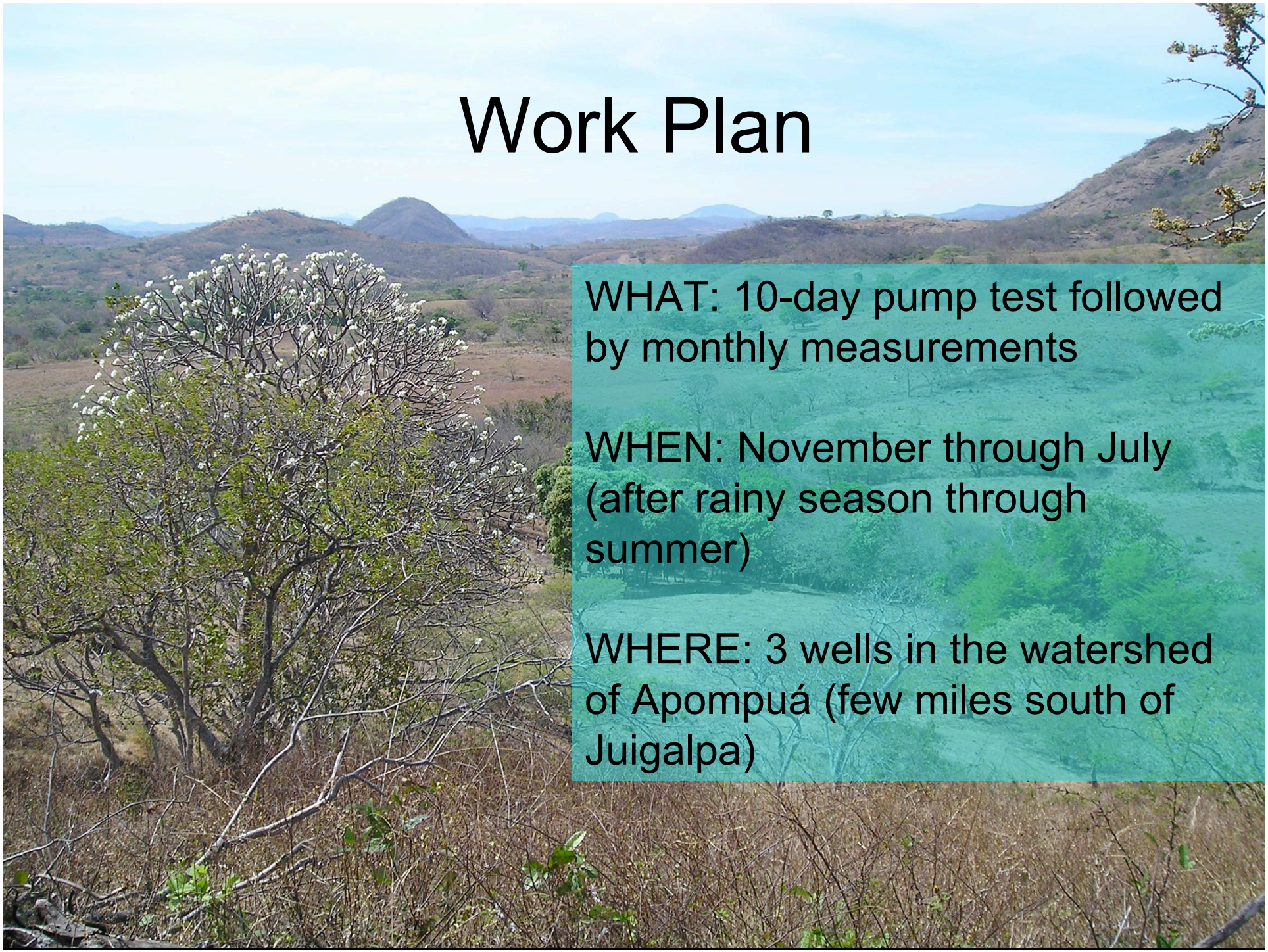
An rope loop with conical rubber pistons placed at intervals of ~1 meter that passes through a PVC raising main tube to lift the water to the surface.

Pump rate ~4-5 gal/min (1 bucketfull)

# Objectives

1. Determine pump test method accuracy
2. Estimate sustainable abstraction rates
3. Equip rope-pump wells with affordable, practical system to monitor water level and well production

# Work Plan



WHAT: 10-day pump test followed by monthly measurements

WHEN: November through July (after rainy season through summer)

WHERE: 3 wells in the watershed of Apompuá (few miles south of Juigalpa)

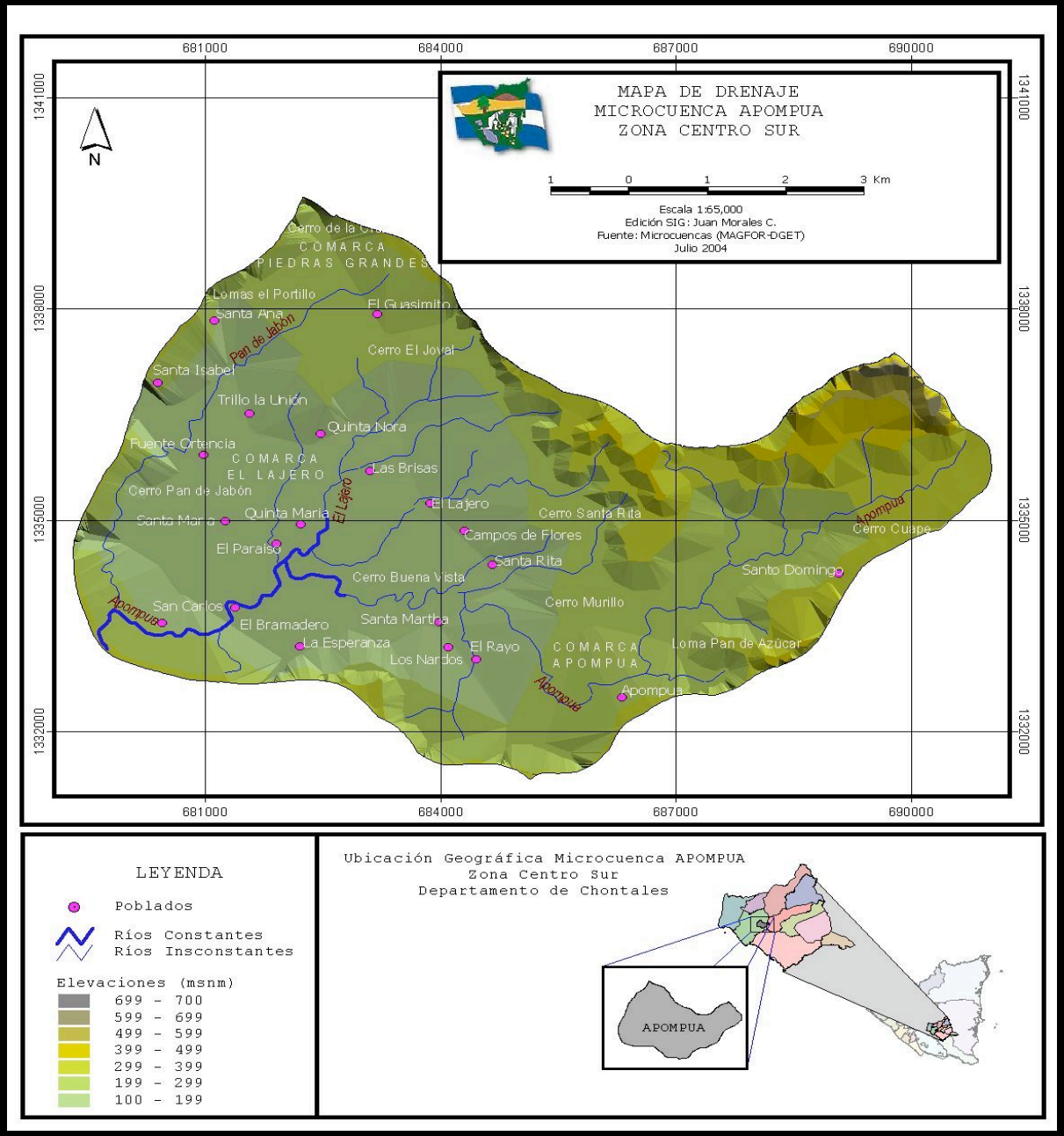
# Site selection

Watershed of Apompuá

Located near Juigalpa

10 rope-pump wells described by ENACAL (water company)

Topographic & hydrogeologic variations

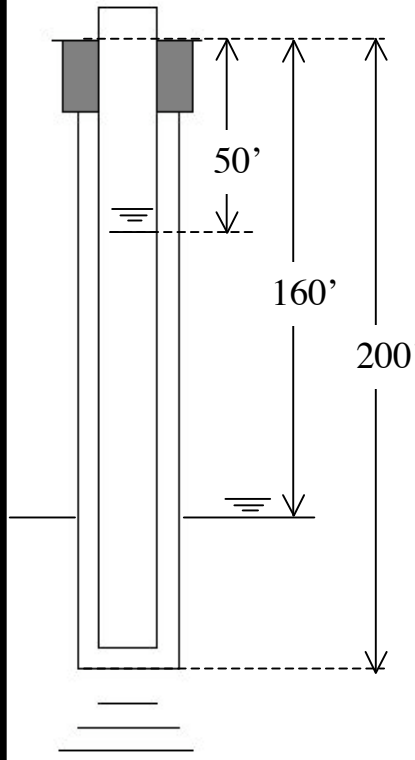


# Hydrogeology

**EMPRESA NICARAGUENSE DE ACUEDUCTOS RURALES Y ALCANTARILLADOS**
**Gerencia de Acueductos Rurales**
**REGISTRO DE POZOS**

**No de Pozo:** 126/02/02

**REVESTIMIENTO**




**PERFIL GEOLOGICO**

0'-20' Basalto erocionado Gris(GR)

20'-30 Basalto Compacto

30'-60' Toba Calcitica (Mr)

60'-90' Basalto (GR)

90'-100' Toba Aglomeratica (MR)

00'-150' Basalto con pigmentaciòn cristalin

150'-160' Basalto Fracturado

60'-200' Basalto (Gr) con presencia de crist

**DATOS GENERALES**

| | | | |
|---|---|---|---|
| Departamento: | | Chontales | |
| Municipio: | | Juigalpa | |
| Comunidad: | | Santa Rita | |
| Coordenadas: | L. Nort | L.Oest | |
| Elevacion (msnm): | | | |
| Perforador: | | Carlos Largaespada | |
| Supervisor-Geologo: | | Luis Meza Hurtado | |
| Fecha de inicio: | | 2/14/06 | |
| Fecha de finalizacion: | | 2/15/06 | |
| Metodo(s): | | Rotativo | |
| Diametro(s) de perforacion: | | 77/8" y 51/4" | |
| No de barras: | | 20 | |
| Profundidad total: | 200 pies | | 60.96 m |
| NEA: | 50 pies | | 15.24 m |
| NFA: | 160 pies | | 48.768 m |
| Caudal: | 5 gpm | | 1.1354 m3/h |
| Metodo de bombeo: | | | |
| Tiempo de bombeo: | horas | | |
| Profundidad del agua al final del bombeo: | 50 pies | | 15.24 m |

**DISTRIBUCCION DEL TIEMPO**

| | |
|---|---|
| Total de horas trabajadas | 18:19 |
| Tiempo de perforacion | 6:57 |
| Total de Tiempo muerto: | 1:34 |
| **Causas del tiempo muerto:** | |
| Lluvias | |
| Reparacion y mantenimiento | 0:34 |
| Falta de materiales | |
| Fuerza mayor | |
| Falta de acceso | |
| Problemas de perforacion | |
| Alimentacion | 1:00 |
| Desarrollo | 1:45 |
| Otras actividades | 8:03 |

**CONSUMO DE DIESEL**

| | | | |
|---|---|---|---|
| Sonda de perforacion | 18 gal. | | 68.13 litros |
| Compresor | 46 gal. | | 174.11 litros |
| Camion Portasonda | 8 gal. | | 30.28 litros |
| Camion del compresor | gal. | | 0 litros |
| Camioneta de apoyo | 8 gal. | | 30.28 litros |
| Camioneta supervision | gal. | | 0 litros |
| TOTAL | 80 gal. | | 302.8 litros |

**NOTAS:**

**La perforacón se desarrollo sin ningún problema, los tubos que se usaron para el encamisado del pozo, fueron de los que se sacaron en la salida de Apompua El Portillo, para el mismo se utilizaron un total de 22 tubos de 4" x 3 Mtrs.**

# Hydrogeology

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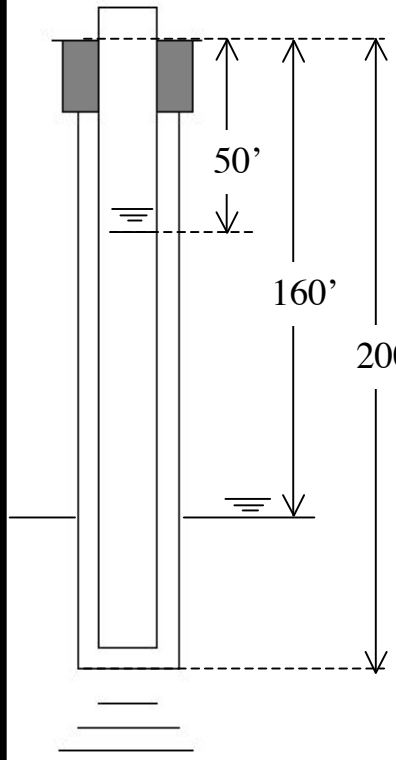
| REVESTIMIENTO | PERFIL GEOLOGICO | DATOS GENERALES |
|---|---|---|

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| | |
|---|---|
| 0-20’ | Weathered Basalt |
| 20-30’ | Compacted Basalt |
| 30-60’ | Tuff (cemented ash deposit) |
| 60-90’ | Basalt |
| 90-100’ | Tuff |
| 100-150’ | Basalt |
| 150’-160’ | Fractured basalt |
| 160-200’ | Basalt |


Localización
Legend

## Well selection:

Sole source of water

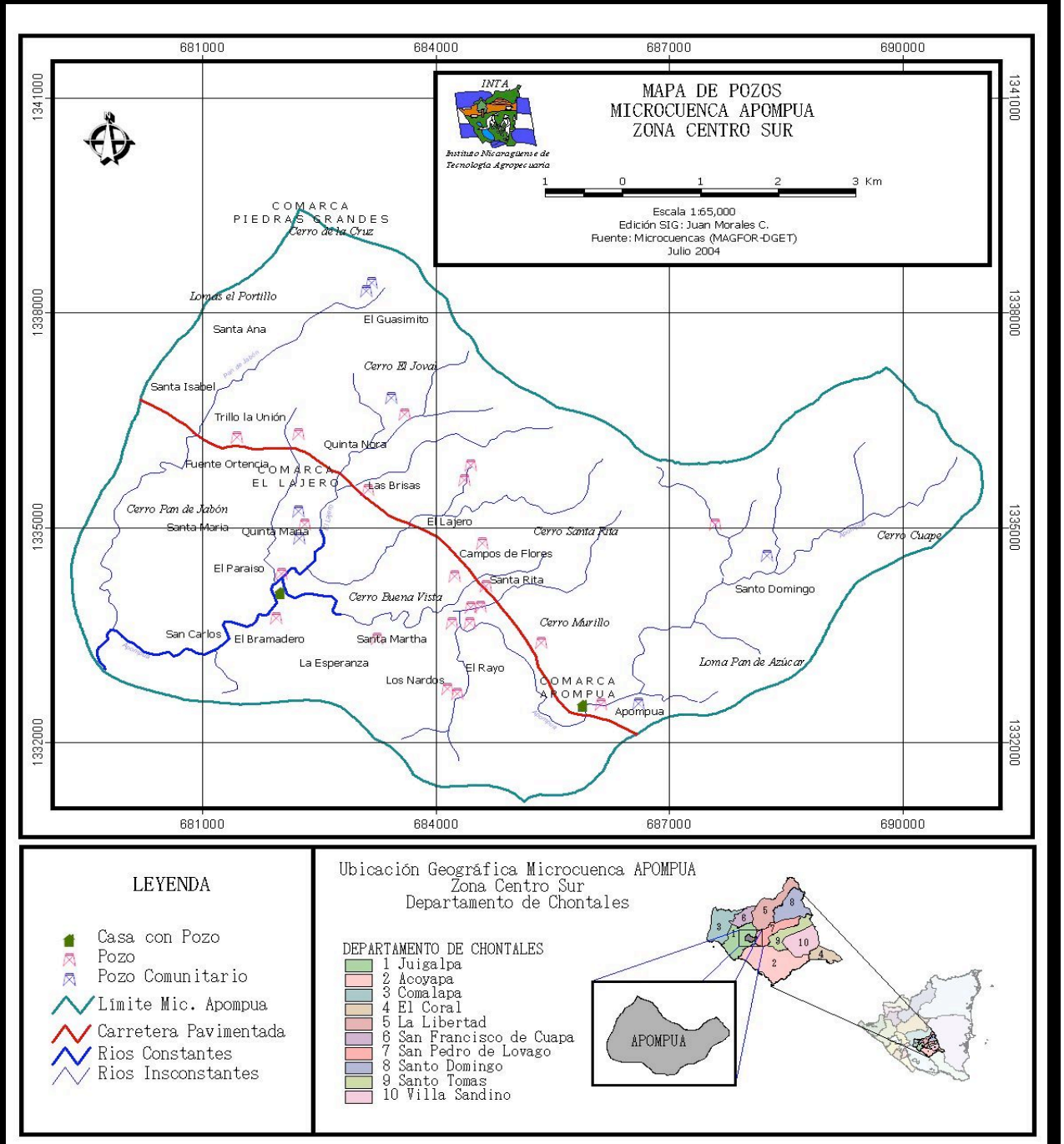
Geographically proximal but not to close

At least one well will have a history of drying up

Wells with known total depth and depth to pumping mechanism

Well users appear to be cooperative and willing to record daily water use

Accessibility (but not too close to the carretera)



# Approximate timeline

| | |
|---|---|
| Oct-Nov 2006 | Well user interviews<br>Well selection<br>Pipe, storage tank install<br>1-day monitoring for abstraction est. |
| Dec 2006 | Pump tests<br>Data processing, forecast |
| Jan-July 2007 | Monthly field measurements<br>Collection of user abstraction est. |
| Aug-Nov 2007 | Study assessment<br>Write up results |

# Special Needs

Politics:  ENACAL help, well use agreement, well repairs

Hardware:  PVC, tubes, connectors, tanks, paving stones

Security:  chains and locks; everything fits in the 4” diameter pump well casing

# Anticipated benefits for well users

- ❖ Better management of ground water supplies
- ❖ Estimate well capacity and “safe” yield abstraction rate during the dry season
- ❖ Improve definition and regulate equal use of extracted well water in order to avoid conflicts among well users