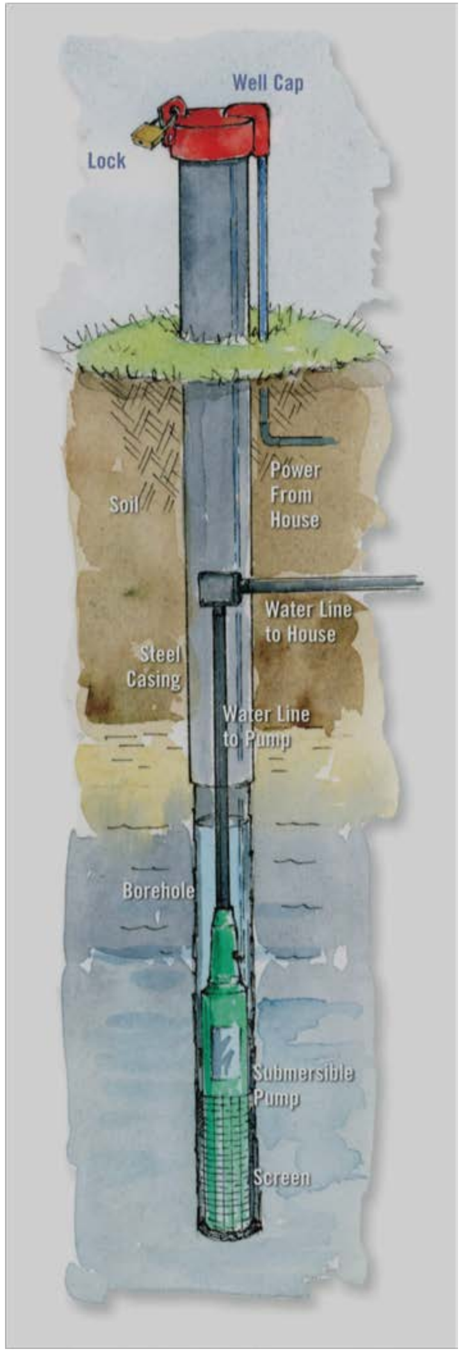
Tracking Well Performance through the 100-year life of a Water Well

Kathy Tixier, GM
Jim Clark, Fraser Valley Regional Director



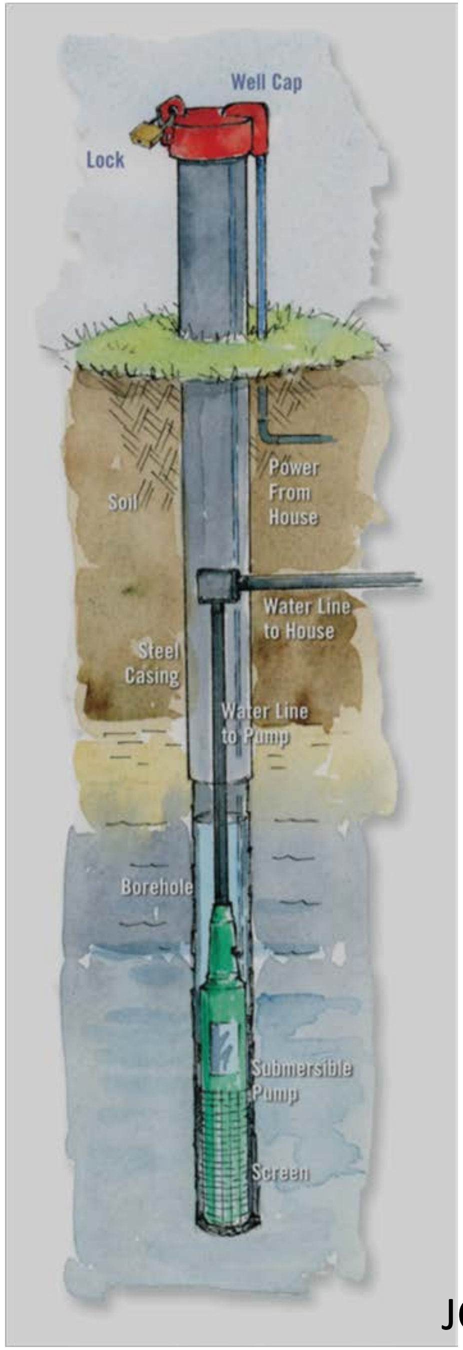
- Less than 10% of Fraser Valley farmers know what their pumping water level is..

- Lack of good record keeping makes it difficult for well owners and their contractors to make good decisions

- Routine installation of sounding tubes and repeated water level and specific capacity measurements would improve the situation

Objectives

- Educate people working with wells about the lifecycle of a well
- Identify contractors’ and owners roles in the process
- Promote record keeping to inform good management decisions
  - e.g. locating, deepening, rehabilitating, licensing a well



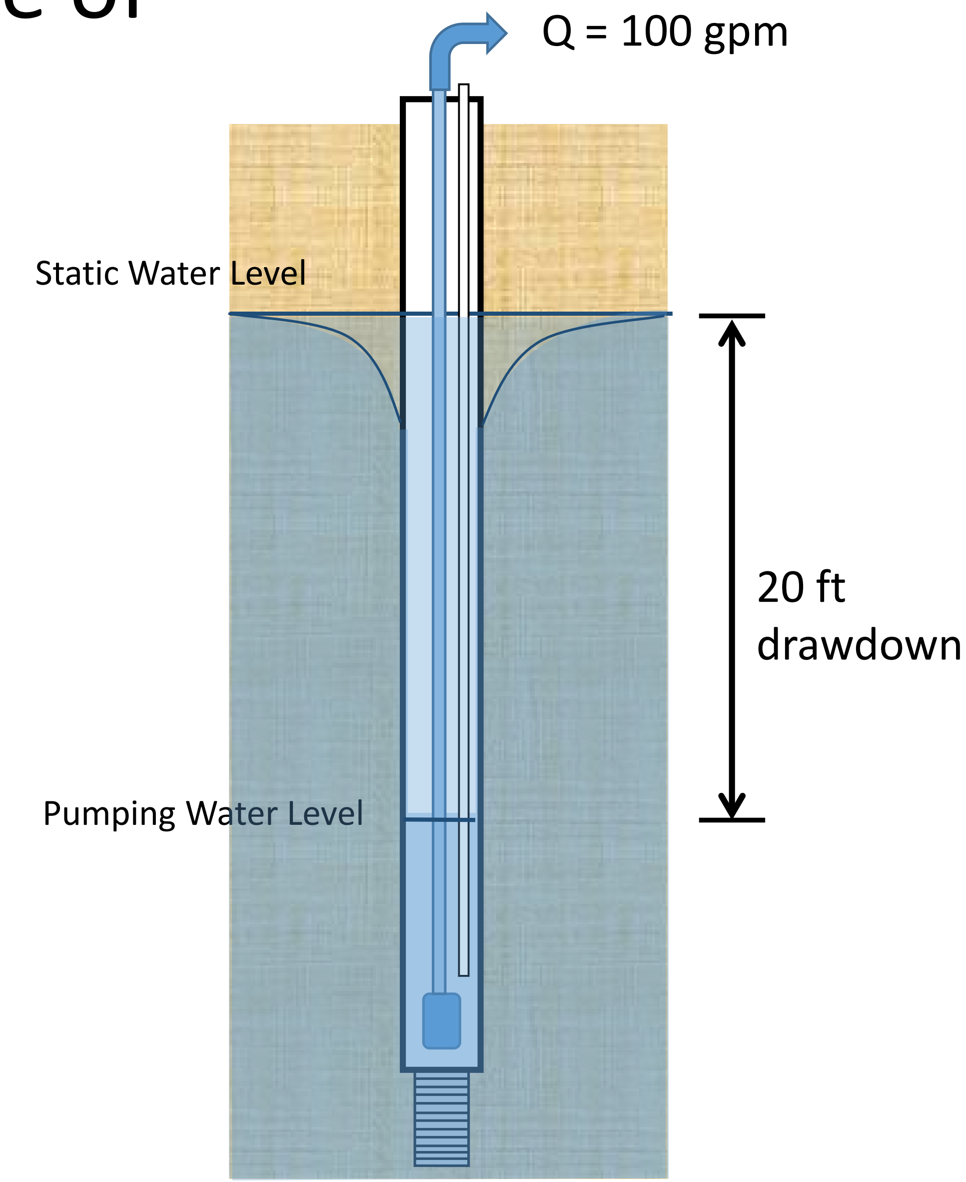
JC

Specific Capacity is a measure of well efficiency

= pumping rate ÷ drawdown
(bang for your buck)

e.g. 100 USgpm / 20 ft drawdown
= 5 Usgpm/ft

Can range from <1 to >100 Usgpm/ft



Contractors can make SC measurements possible by installing a **Sounding tube**

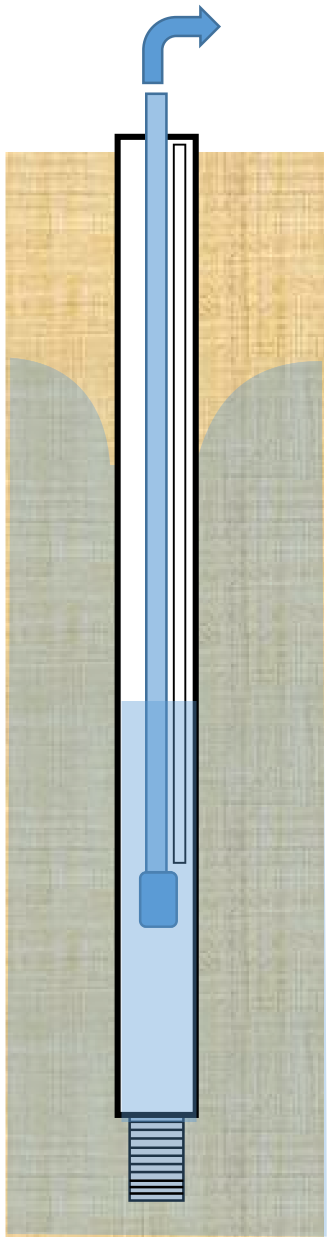
- A 1¼ inch tube certified for use for drinking water
- Secure tube to riser pipe
- Extend to the top of pump
- Put elbow on bottom of tube to prevent loss of down-hole equipment

Good

Not so Good

A Sounding Tube can also be used to:

1. Measure water levels during a flow test
2. Monitor pumping level when the well is operating
3. Monitor static water level when the well is at rest
4. House a permanent water level transducer and other sensing equipment
5. Measure drawdown interference from when neighboring well are operated
6. Inject chlorine to bottom of well during well disinfection
7. And so on…



Water Well Life Cycle Stages

- Each stage represented by an orb

Pump Installer

Well Driller

- Each trade represented by a colour

The Well Construction Stage

Pump installer recommends pump size (and well diameter) to meet target flows

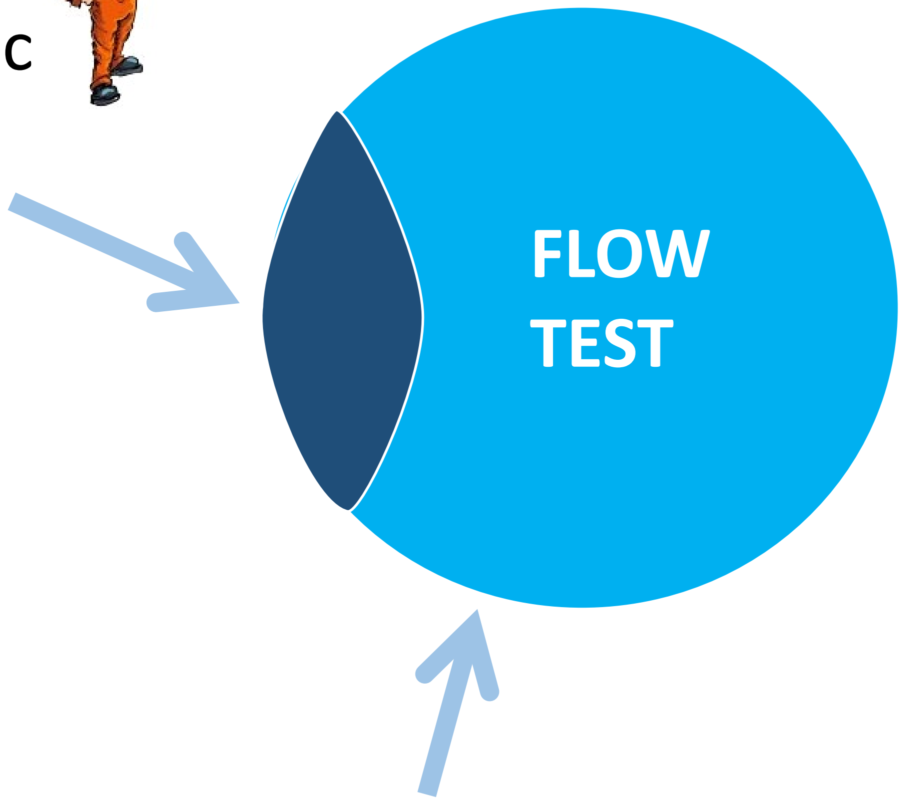
Consultants may be involved in siting the well

Driller designs and constructs well, conducts short flow tests during well development

The Flow Testing Stage

Driller roughly estimates specific capacity to help size pump for flow test

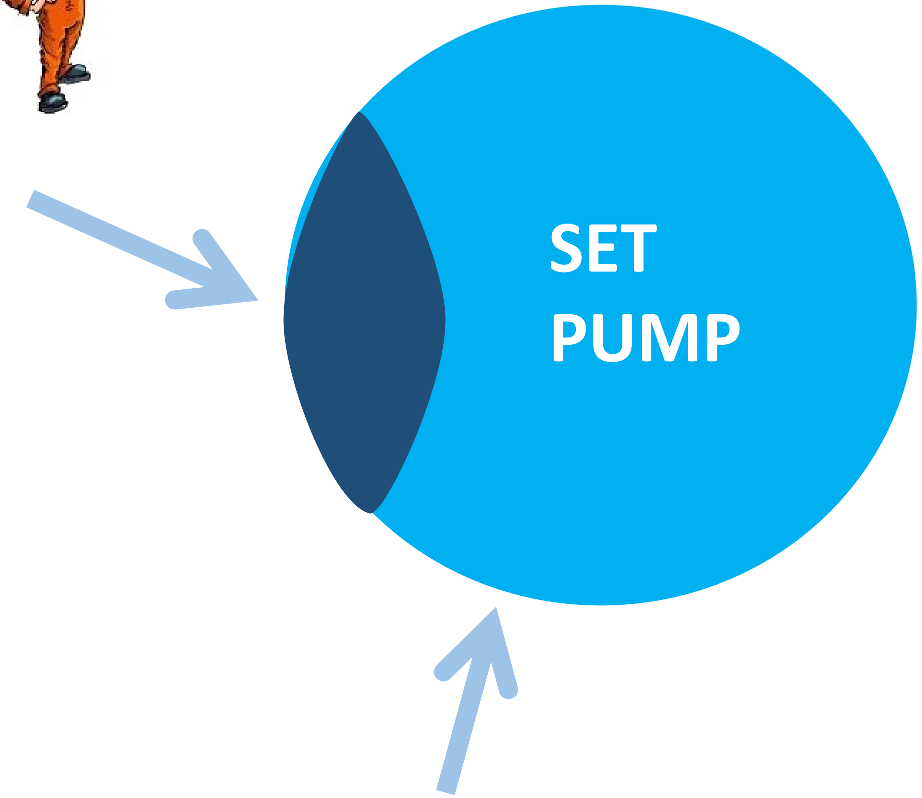
Water samples may also be collected at this step to evaluate water quality



Pump Installer conducts variable-rate flow test to properly measure baseline specific capacity

The setting of the Permanent Pump Stage

Driller / consultant works with pump installer to select optimum pump set level

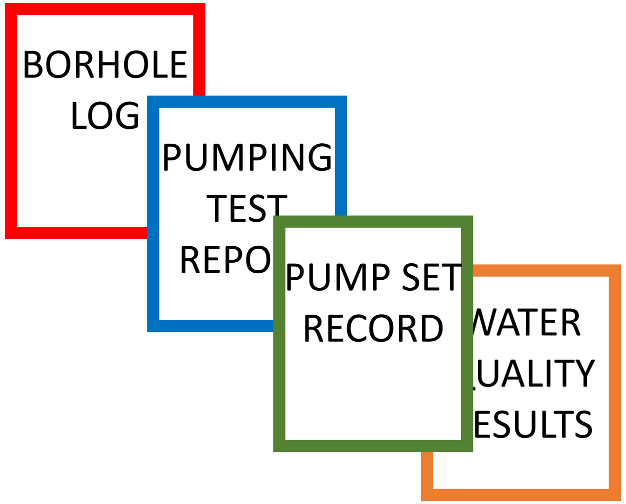


Pump Installer sets permanent pump, installs sounding tube, disinfects well

WELL IS NOW OPERATIONAL

Well owner is given important documentation:

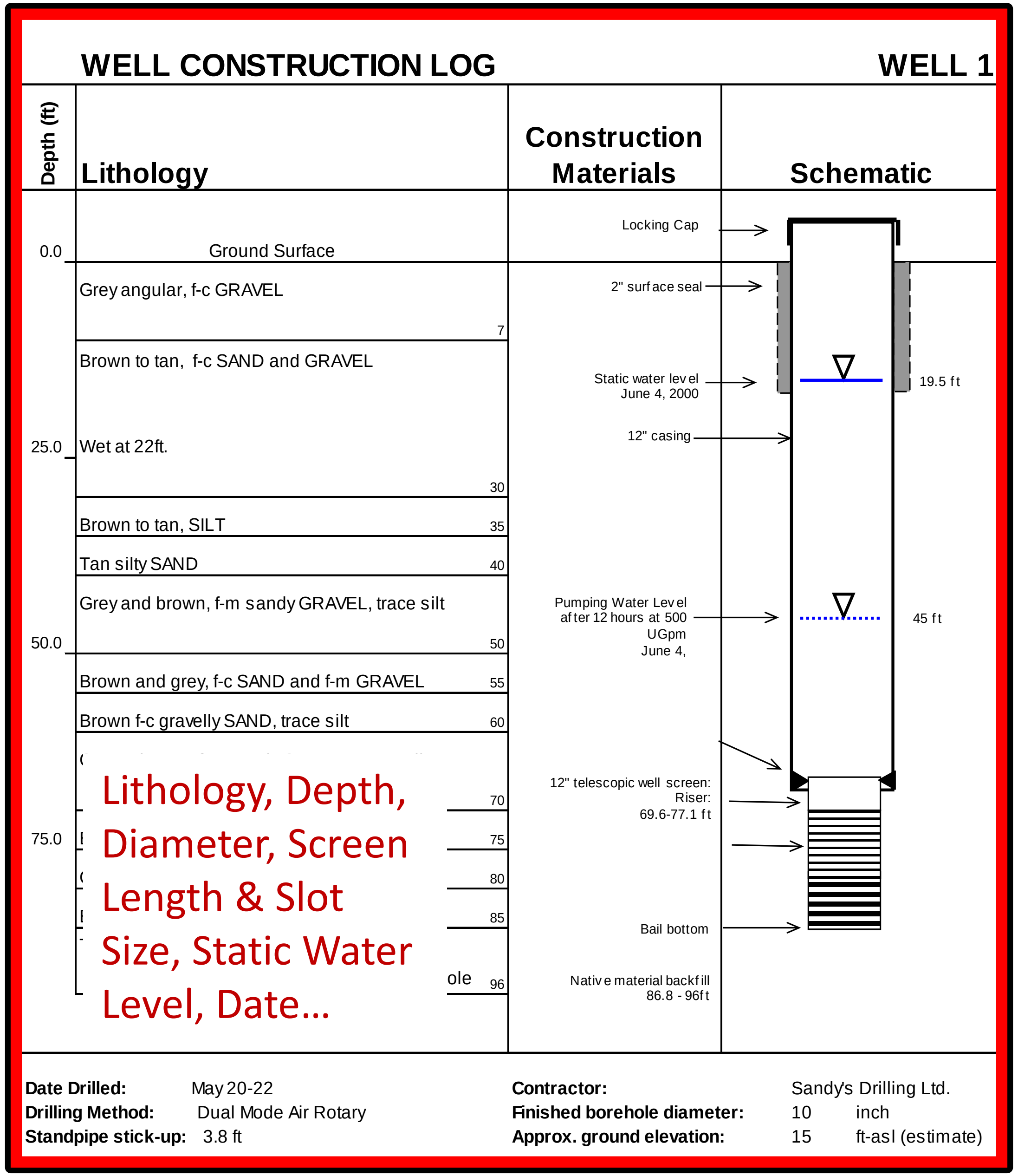
- Water well record
- Flow test results
- Permanent pump set record
- Water quality lab results



And should monitor static and pumping water levels

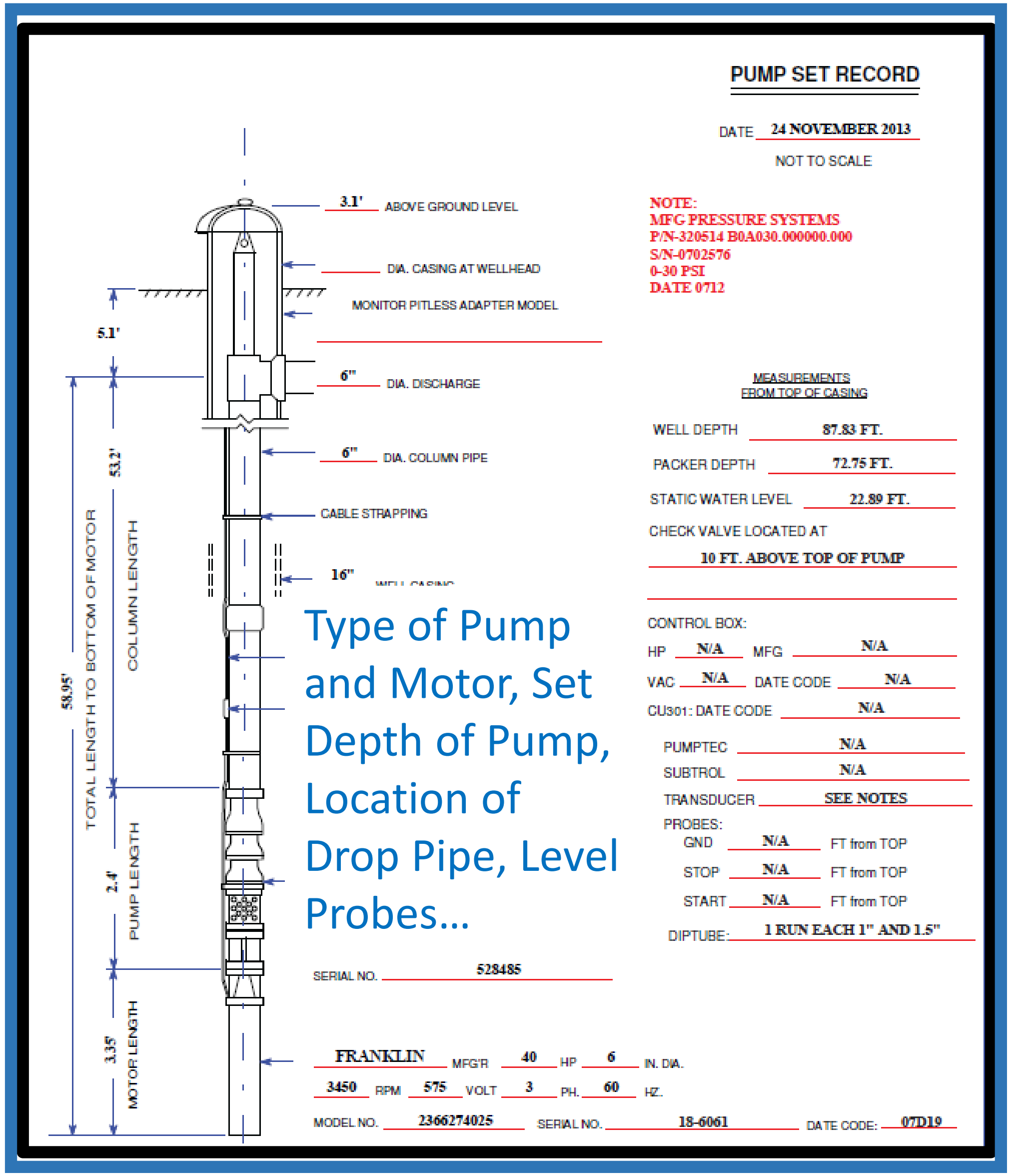
OPERATIONAL RECORDS

Borehole / Well Construction Log



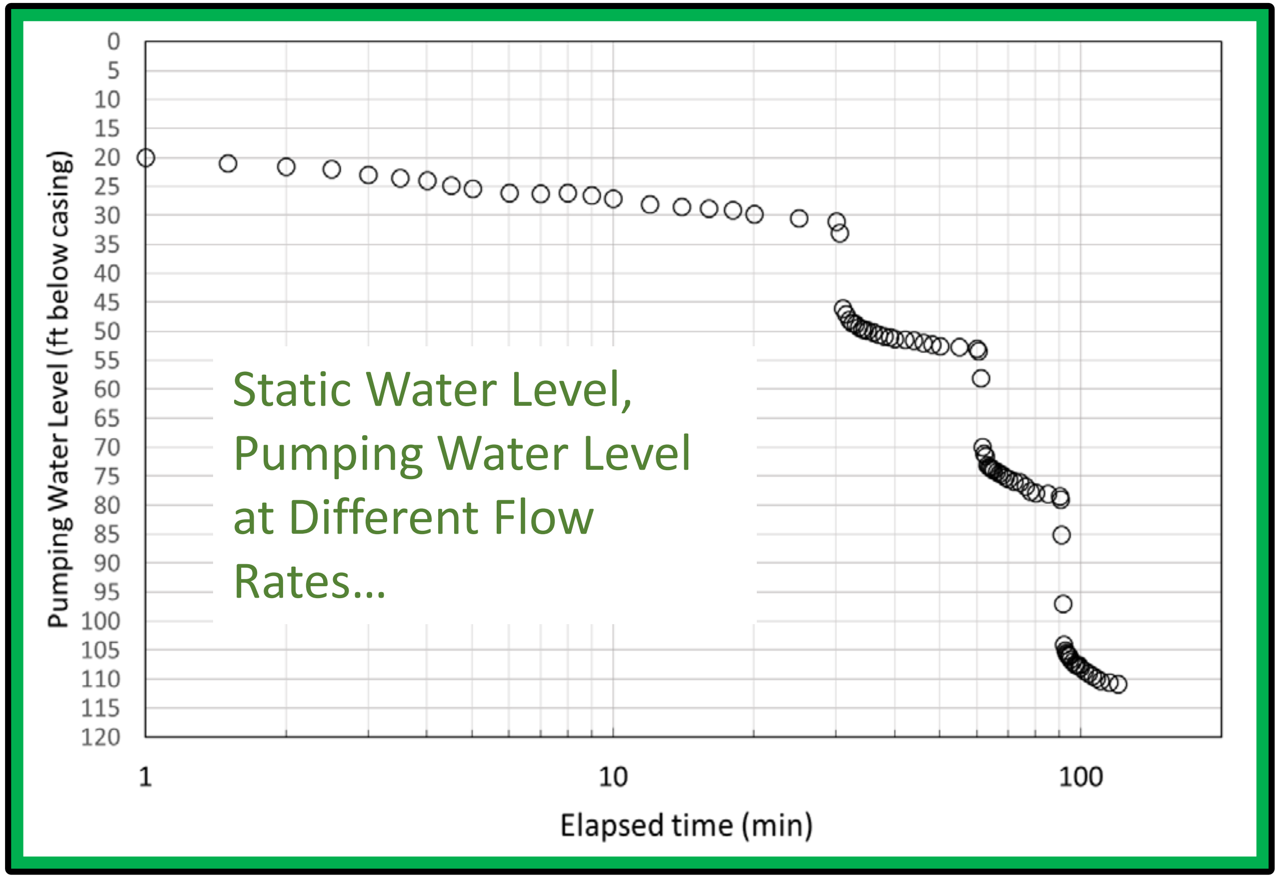
Lithology, Depth, Diameter, Screen Length & Slot Size, Static Water Level, Date…

Pump Set Record



Type of Pump and Motor, Set Depth of Pump, Location of Drop Pipe, Level Probes…

Well Pumping Test Data



Water Quality Testing Laboratory Report

Reference Number	1031309-1
Sample Date	October 07, 2014
Sample Time	07:45
Sample Location	
Sample Description	3233 Celtic Ave. Vancouver BC
Sample Matrix	Drinking Water

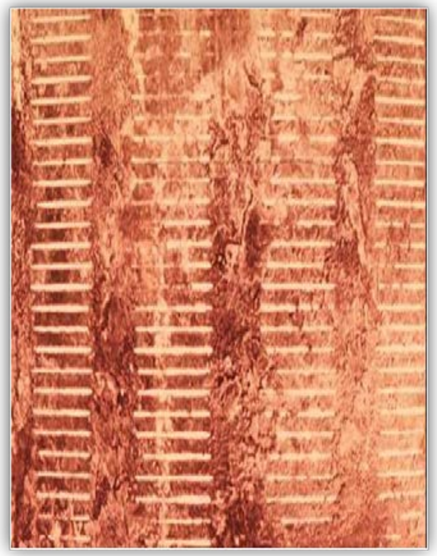
Analyte		Units	Result	Nominal Detection Limit	Guideline Limit	Guideline Comments
Inorganic Nonmetallic Parameters						
Tannin & Lignin	as Tannic Acid	mg/L	12.9	0.1		
Metals Extractable						
Aluminum	Extractable	mg/L	0.073	0.005	0.1	Below OG
Antimony	Extractable	mg/L	<0.0002	0.0002	0.006	Below MAC
Arsenic	Extractable	mg/L	0.0022	0.0002	0.010	Below MAC
Barium	Extractable	mg/L	0.021	0.001	1	Below MAC
Boron					5	Below MAC
Cadmium					0.005	Below MAC
Chromium					0.05	Below MAC
Copper					1.0	Below AO
Lead					0.01	Below MAC
Selenium					0.01	Below MAC
Uranium					0.02	Below MAC
Vanadium	Extractable	mg/L	0.0245	0.0001		
Zinc	Extractable	mg/L	0.004	0.001	5.0	Below AO
Physical and Aggregate Properties						
Colour	Apparent	Colour units	>150	5		
Turbidity		NTU	3.2	0.02		
Routine Water						
pH	at 25 °C		7.18		6.5-8.5	Within AO
Electrical Conductivity		µS/cm at 25 C	2750	1		
Calcium	Extractable	mg/L	17.7	0.1		
Iron	Extractable	mg/L	4.08	0.005	0.3	Above AO
Magnesium	Extractable	mg/L	53.9	0.1		
Manganese	Extractable	mg/L	0.119	0.001	0.05	Above AO
Potassium	Extractable	mg/L	26.6	0.1		
Silicon	Extractable	mg/L	20.7	0.05		
Sodium	Extractable	mg/L	535	0.1	200	Above AO
T-Alkalinity	as CaCO3	mg/L	583	5		
Chloride	Dissolved	mg/L	205	0.05	250	Below AO
Fluoride	Dissolved	mg/L	0.63	0.01	1.5	Below MAC
Nitrate - N	Dissolved	mg/L	<0.10	0.01	10	Below MAC
Nitrite - N	Dissolved	mg/L	<0.10	0.01	1	Below MAC
Sulfate (SO4)	Dissolved	mg/L	611	0.5	500	Above AO
Hardness	as CaCO3	mg/L	266	1		
Total Dissolved Solids	Extractable	mg/L	1850	1		

Parameters required by local Health Authority…

MONITORING DATA IDENTIFIES DECLINING WELL PERFORMANCE

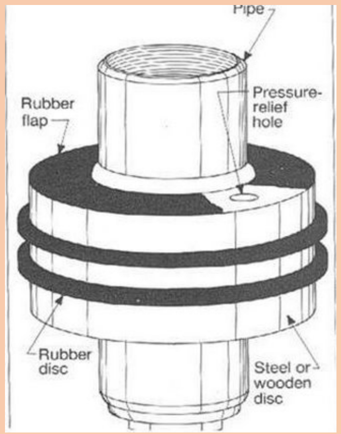
Causes of performance decline vary…

- **Sediment packing**
- **Biofouling**
- **Chemical encrustation**

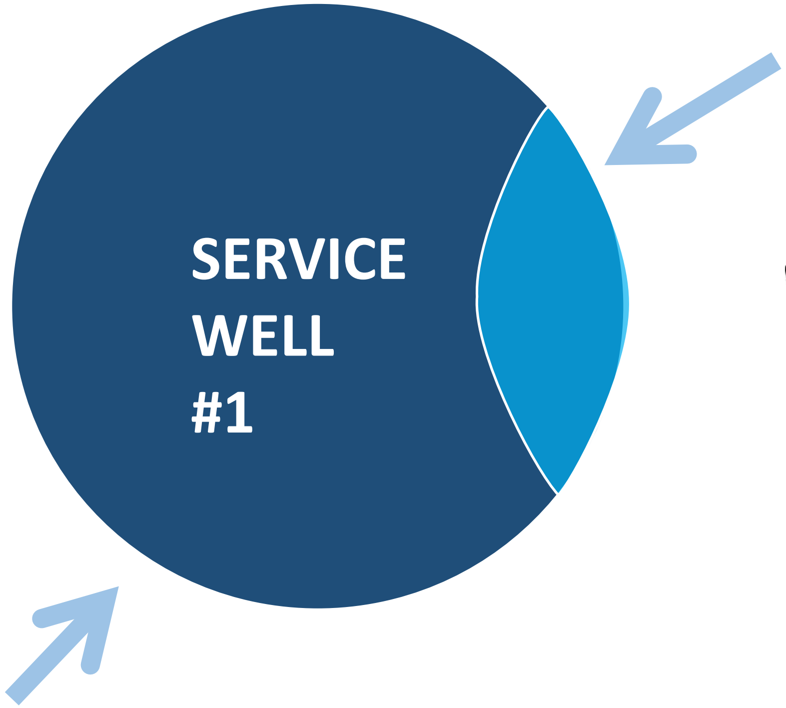


… As do the remedies to these causes

- **Mechanical**
- **Chemical**
- **Impulse Generation**



Owner and consultant identify problem and formulate a plan to service the well



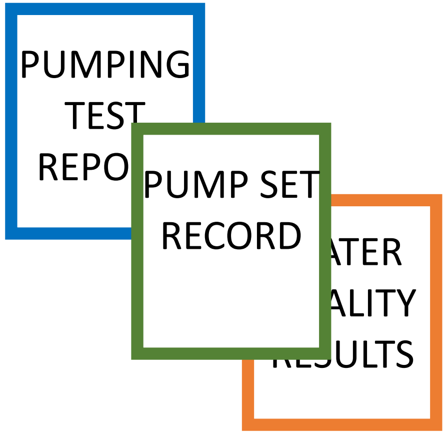
Pump installer conducts flow tests to gauge rehabilitation success

Well rehabilitator (Pump Installer or Driller) services the well

WELL OPERATION RESUMES

Well owner is given important documentation:

- Current specific capacity measurements
- Recent flow test results
- Permanent pump set record, if changed
- Water quality lab results, if additional

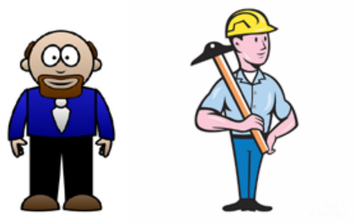


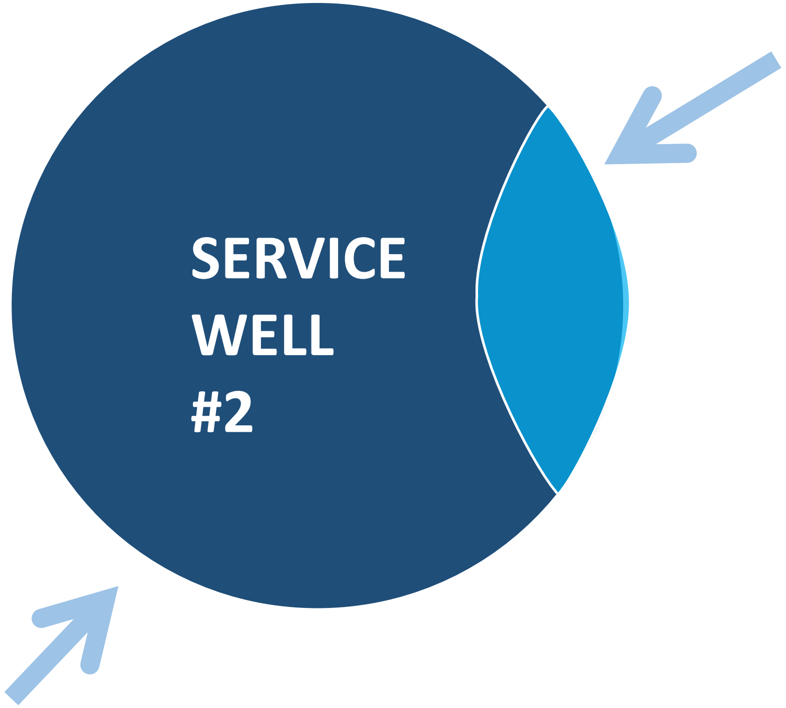
And should continue collecting operational data

OPERATIONAL RECORDS

MONITORING DATA IDENTIFIES DECLINING WELL PERFORMANCE (AGAIN)

Owner and consultant identify problem and formulate a plan to service the well





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PUMPING TEST REPO

PUMP SET RECORD

WATER UALITY RESULTS

And should continue collecting operational data

OPERATIONAL RECORDS

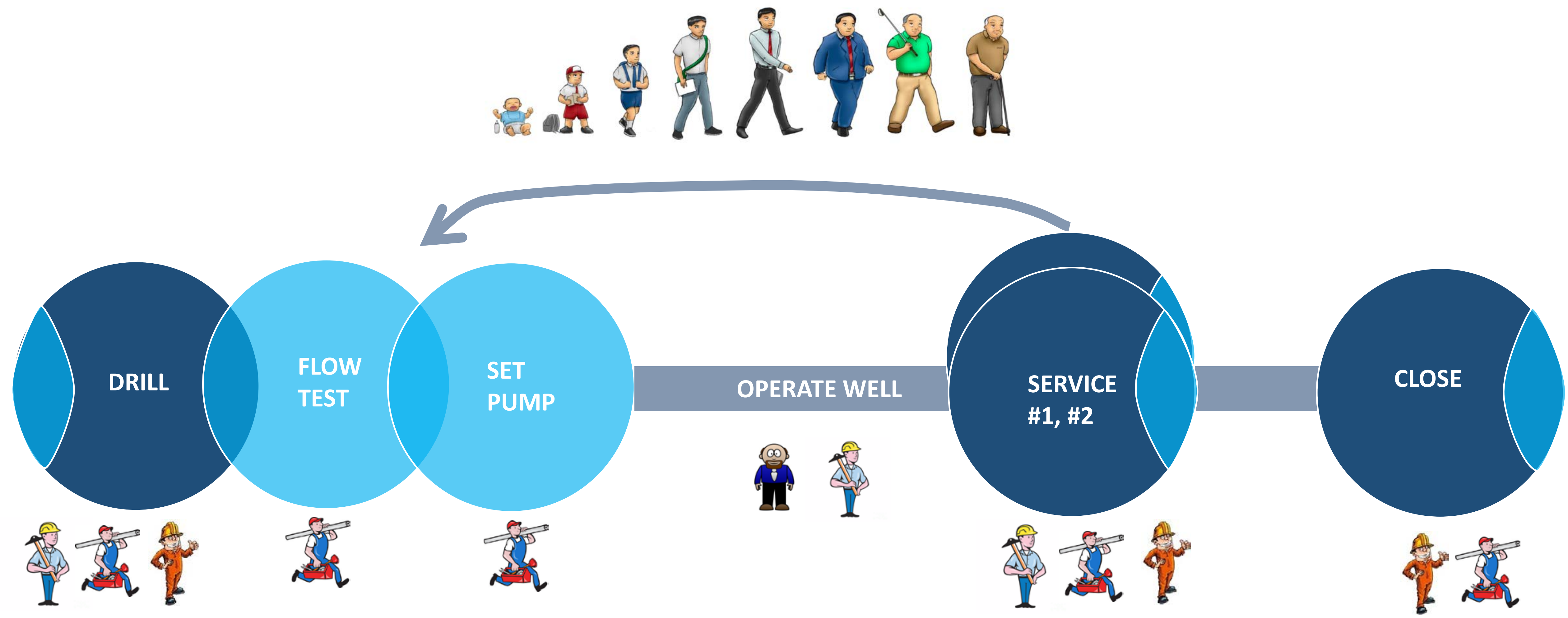
MONITORING DATA IDENTIFIES DECLINING WELL PERFORMANCE (AGAIN)

Owner and consultant decide to decommission the well

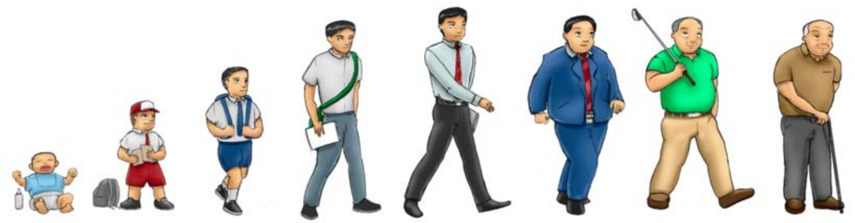
Owner submits closure report to the Ministry

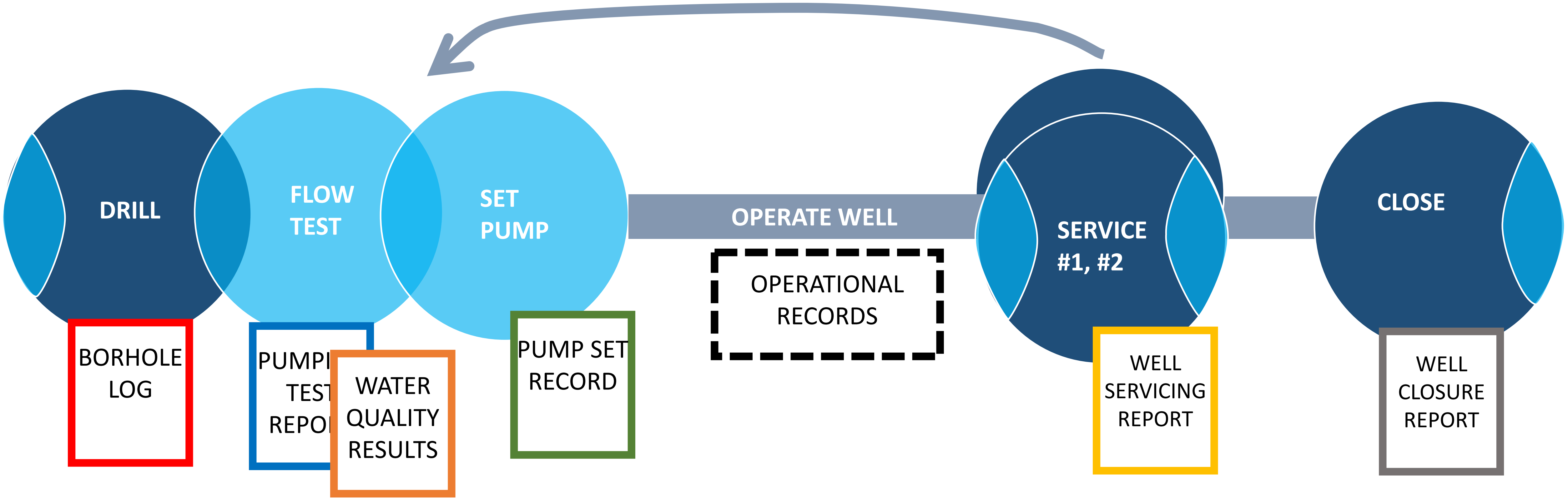
Pump Installer or Driller decommission the well

The Complete Water Well Life Cycle (60 – 100 years)

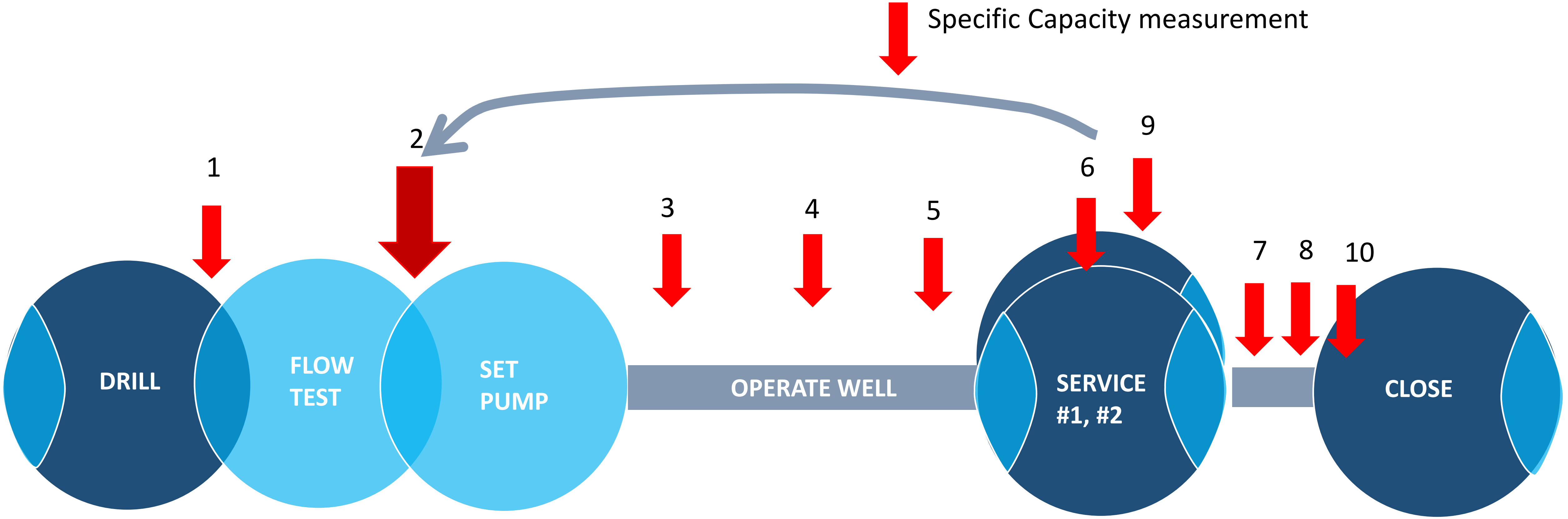


The Complete Water Well Life Cycle (60 – 100 years)





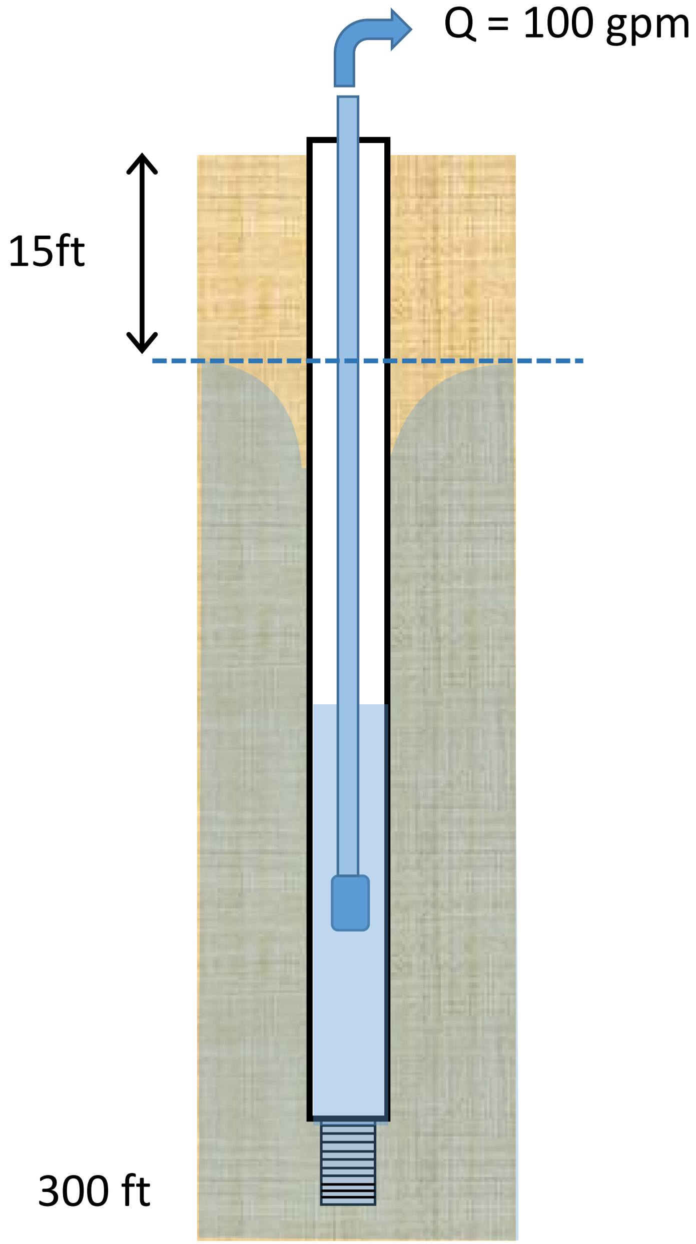
Specific Capacity should be measured and recorded throughout this cycle….



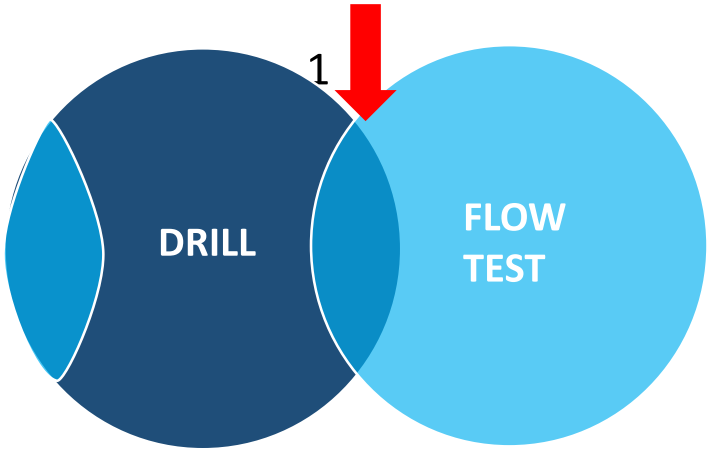
CASE EXAMPLE

- 300 foot well
- Client wants to pump the well at 100 gpm
- Static water 15ft below top of casing

HOW DO WE DETERMINE
WHERE TO SET THE PUMP?



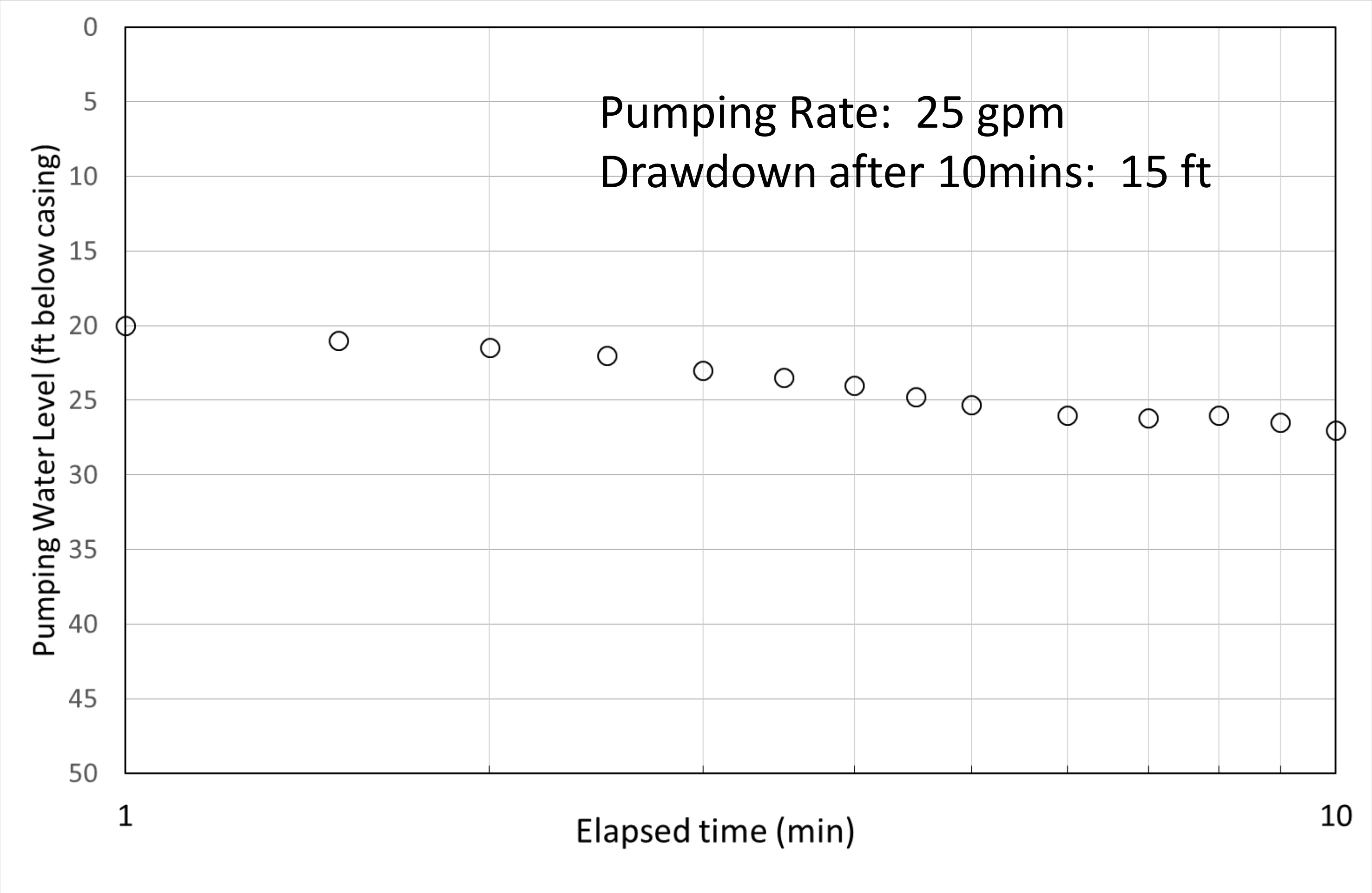
Driller’s Well Yield Test



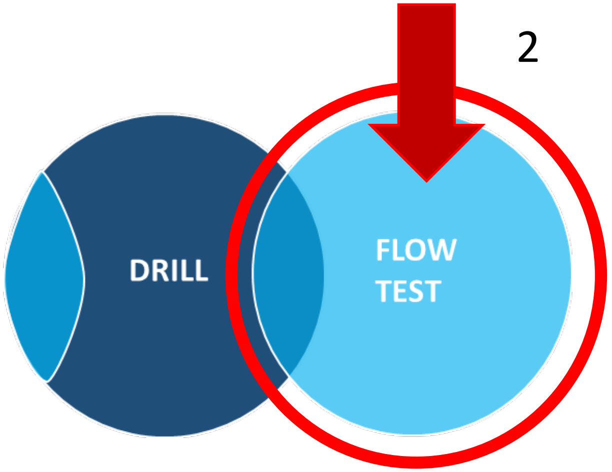
Specific Capacity at 25 gpm:
= 25 gpm / 15 ft drawdown
= **1.6** gpm/ft

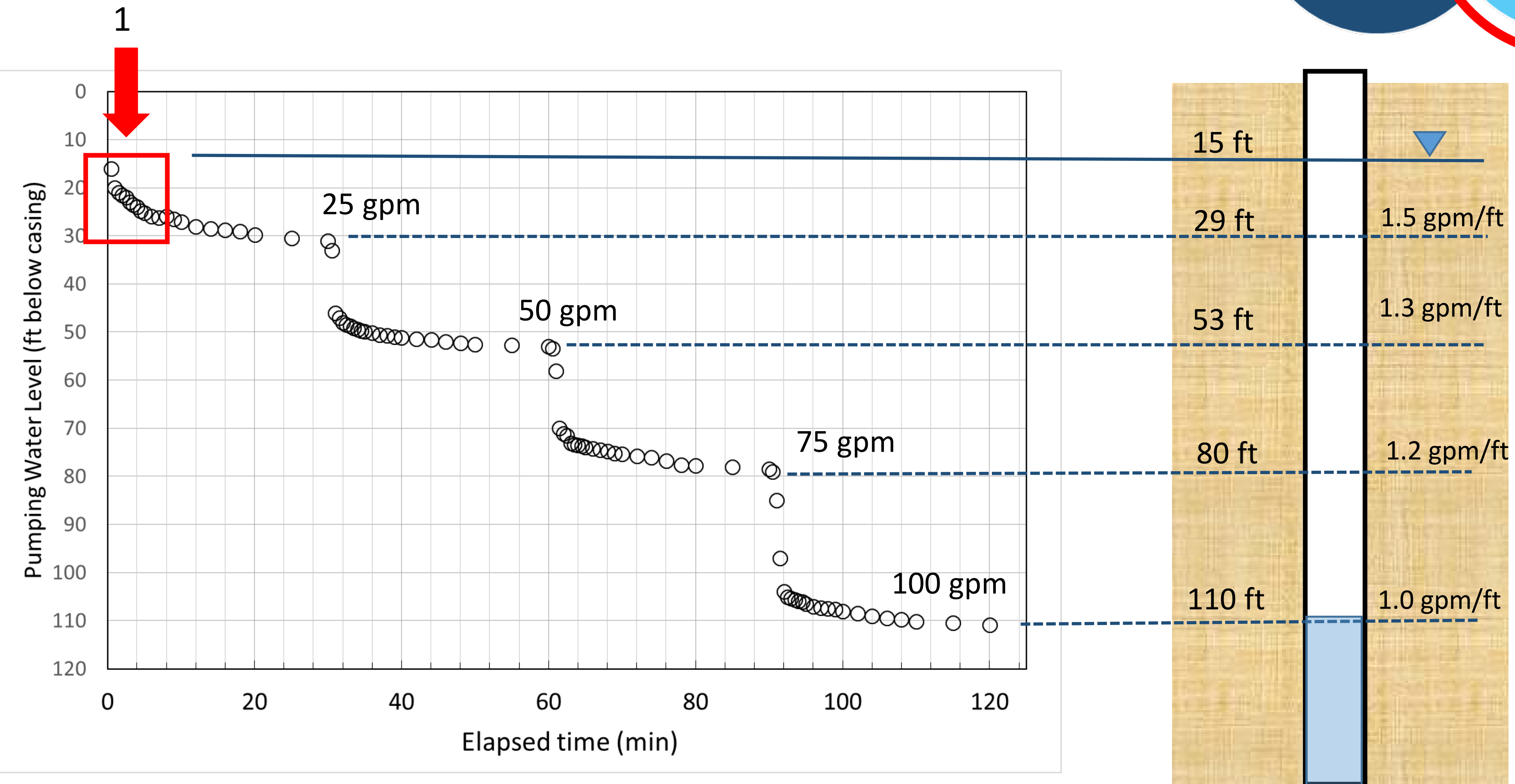
Estimated drawdown at 100 gpm:
= 100 gpm / 1.6 gpm/ft
= 63 ft

Estimated Pumping water level
= 63 + 15 = **78 ft** below casing



Pump Installer's Variable Rate Test

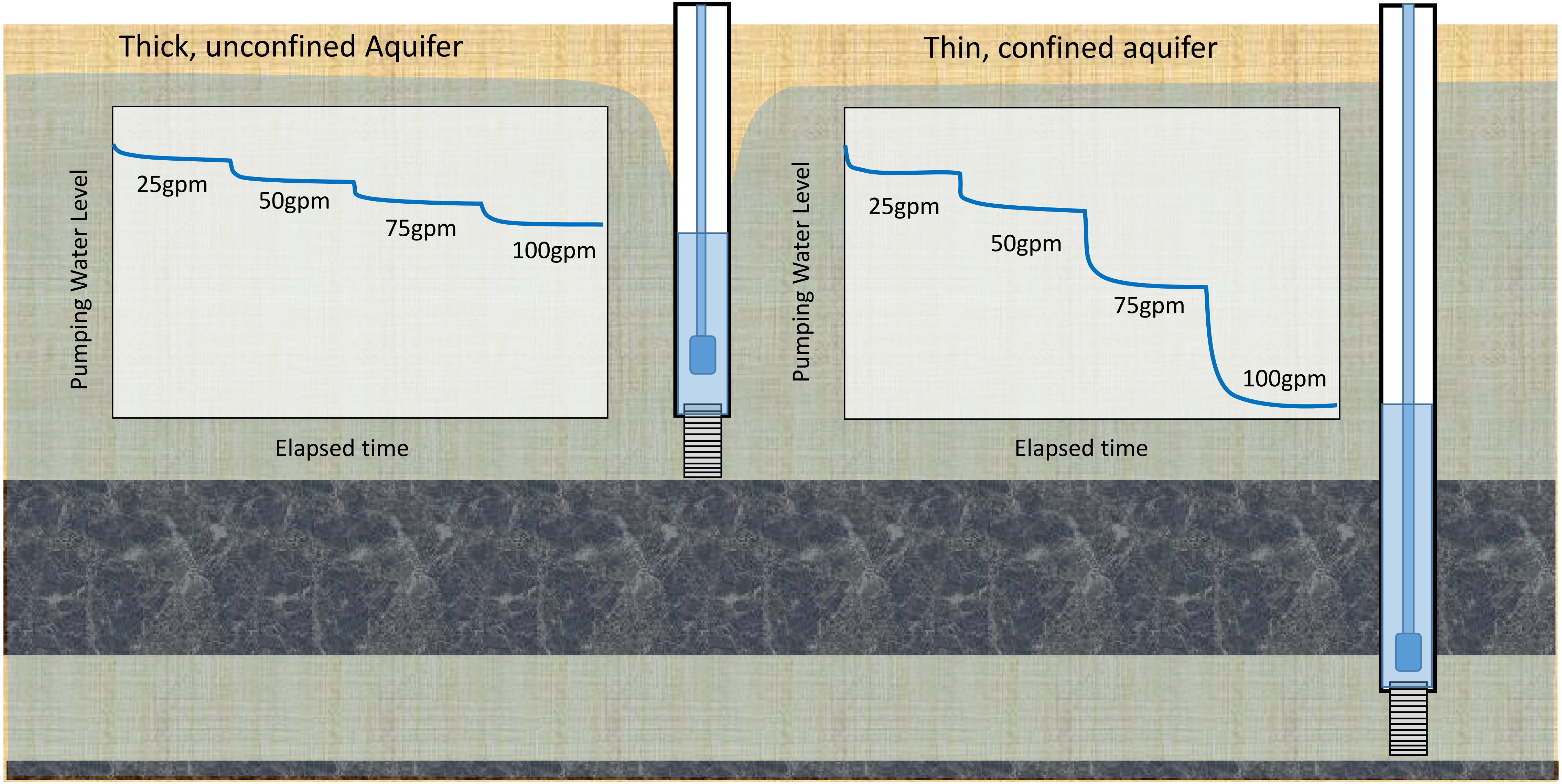




Pumping Water Level at 100 gpm
= **110 ft** below casing
>> 78 ft

Specific Capacity at 100 gpm
= 100gpm / (110 – 15ft)
= **1.0** gpm/ft

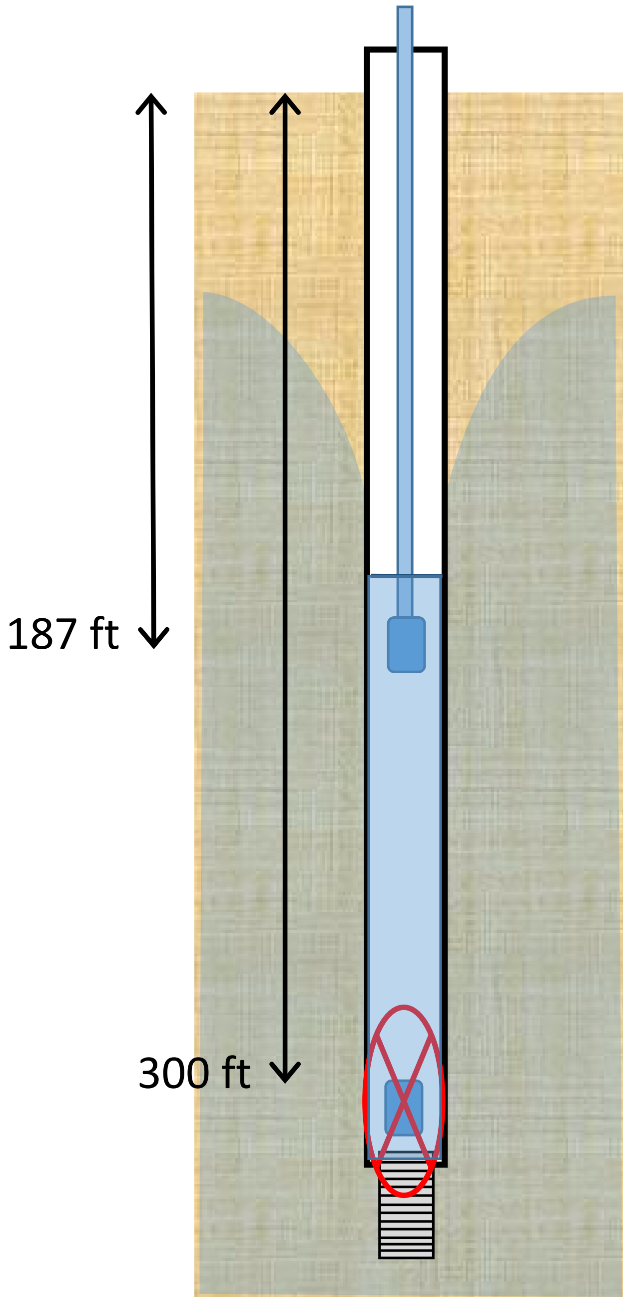
SC can drop significantly with increasing pumping rate in some settings



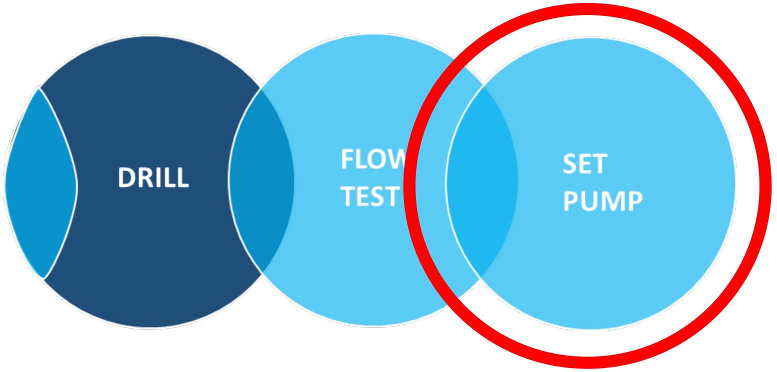
Where to Set Permanent Pump?

Desired yield: 100 gpm

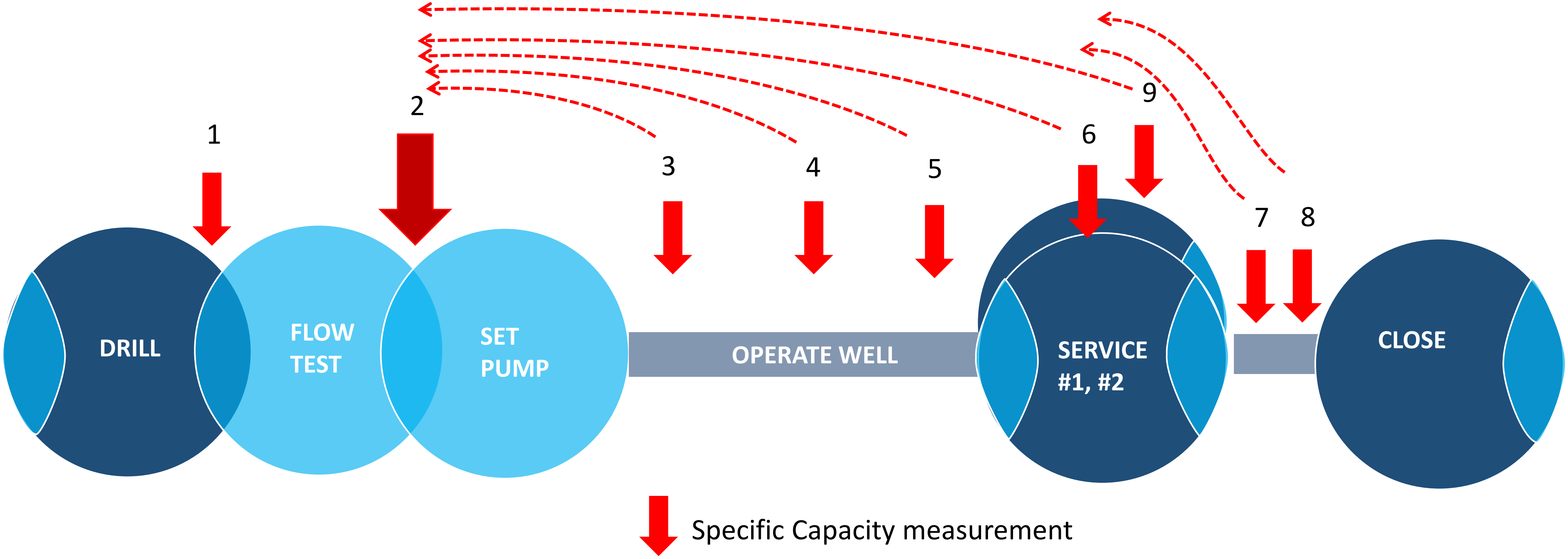
Pumping Water Level at 100gpm:	120 ft
Well Interferences:	2 ft
Seasonal Variation in Water Level:	5 ft
Aquifer Water Level Decline:	15 ft over 30 years
Minimum pump submergence	5 ft
Factor of safety:	40 ft
Pump should be set at	**187 ft**

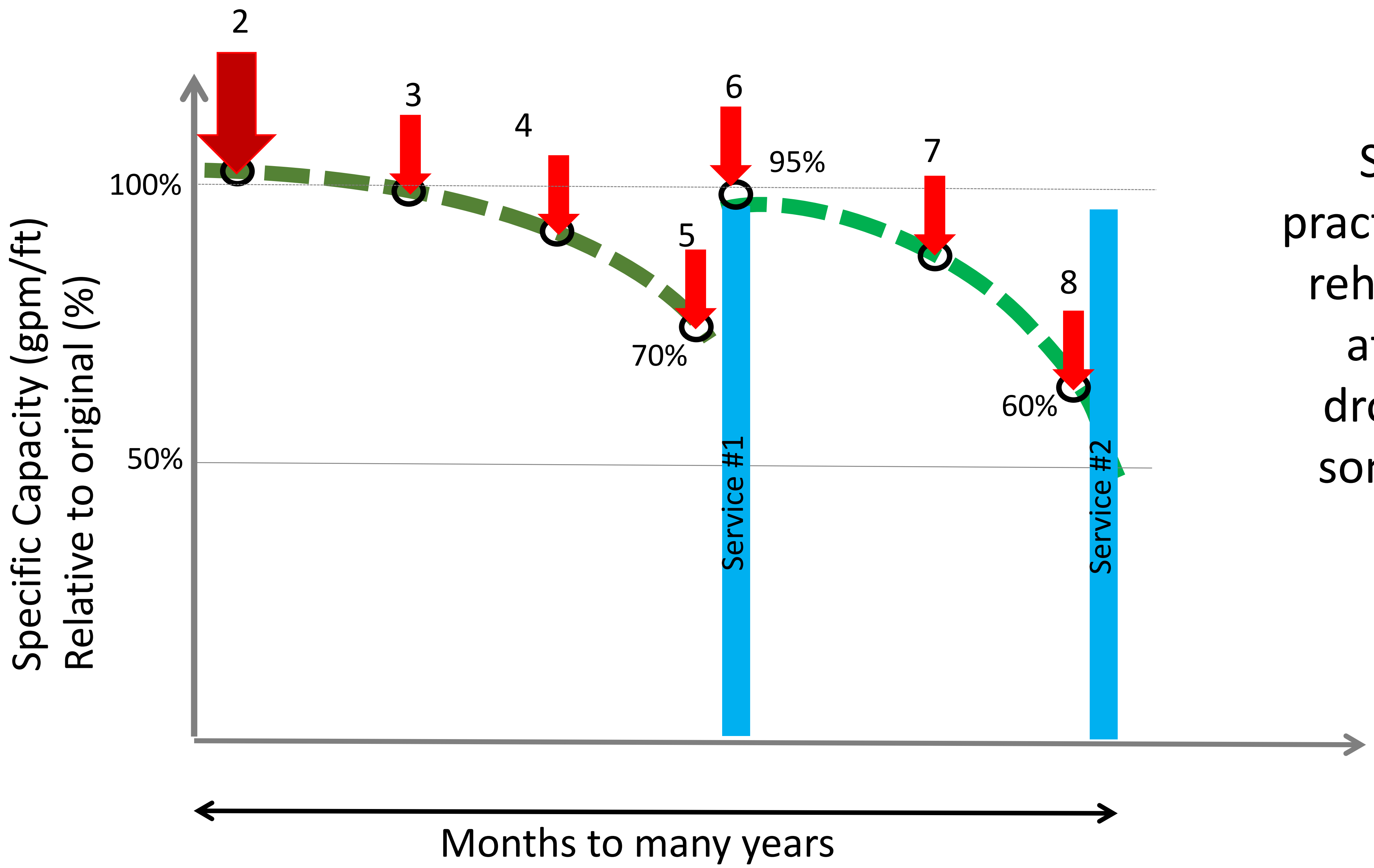


…. And <u>not</u> at top of screen



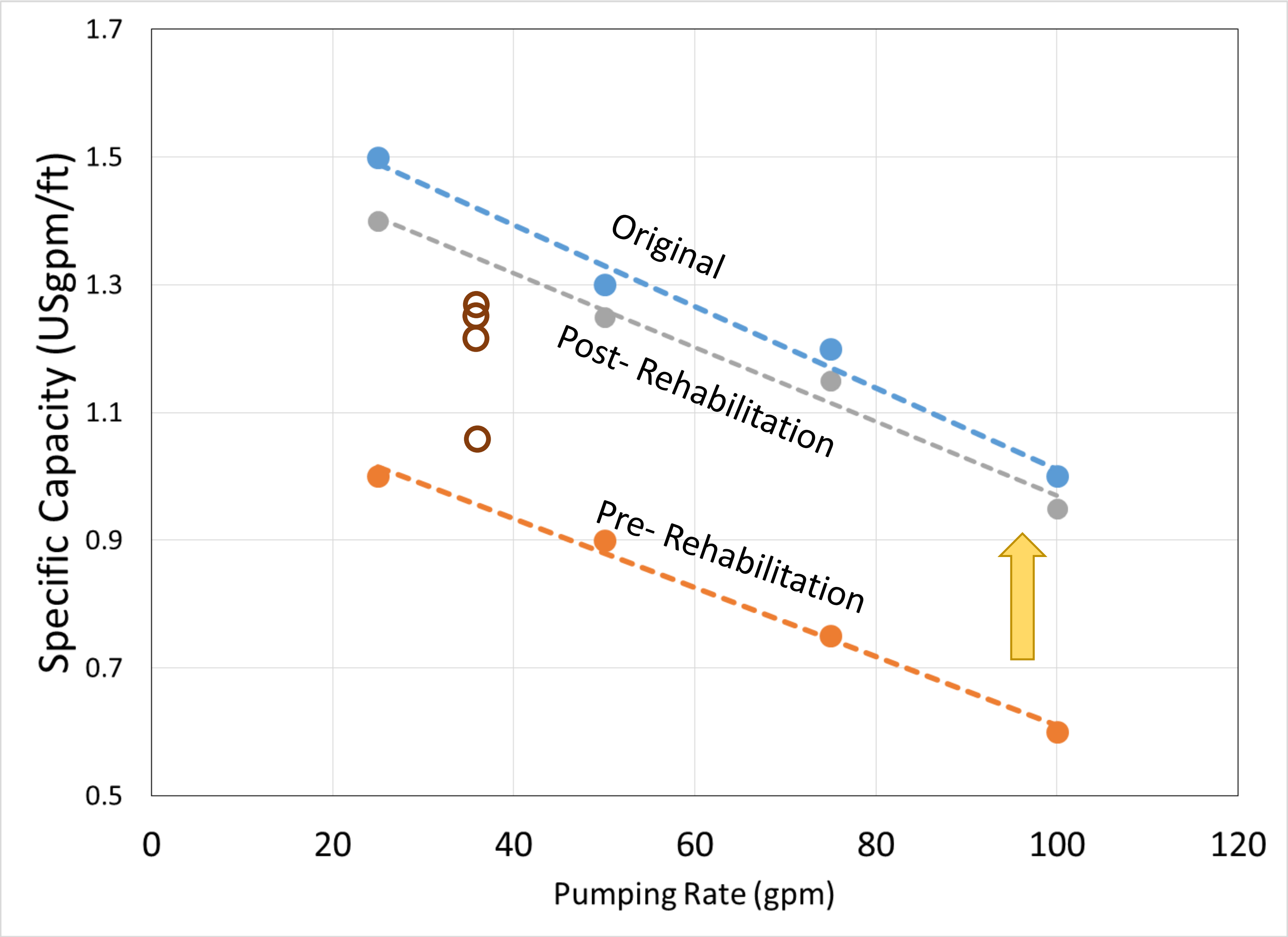
Specific Capacity values should be compared to the original to SC's to gauge changes in well performance





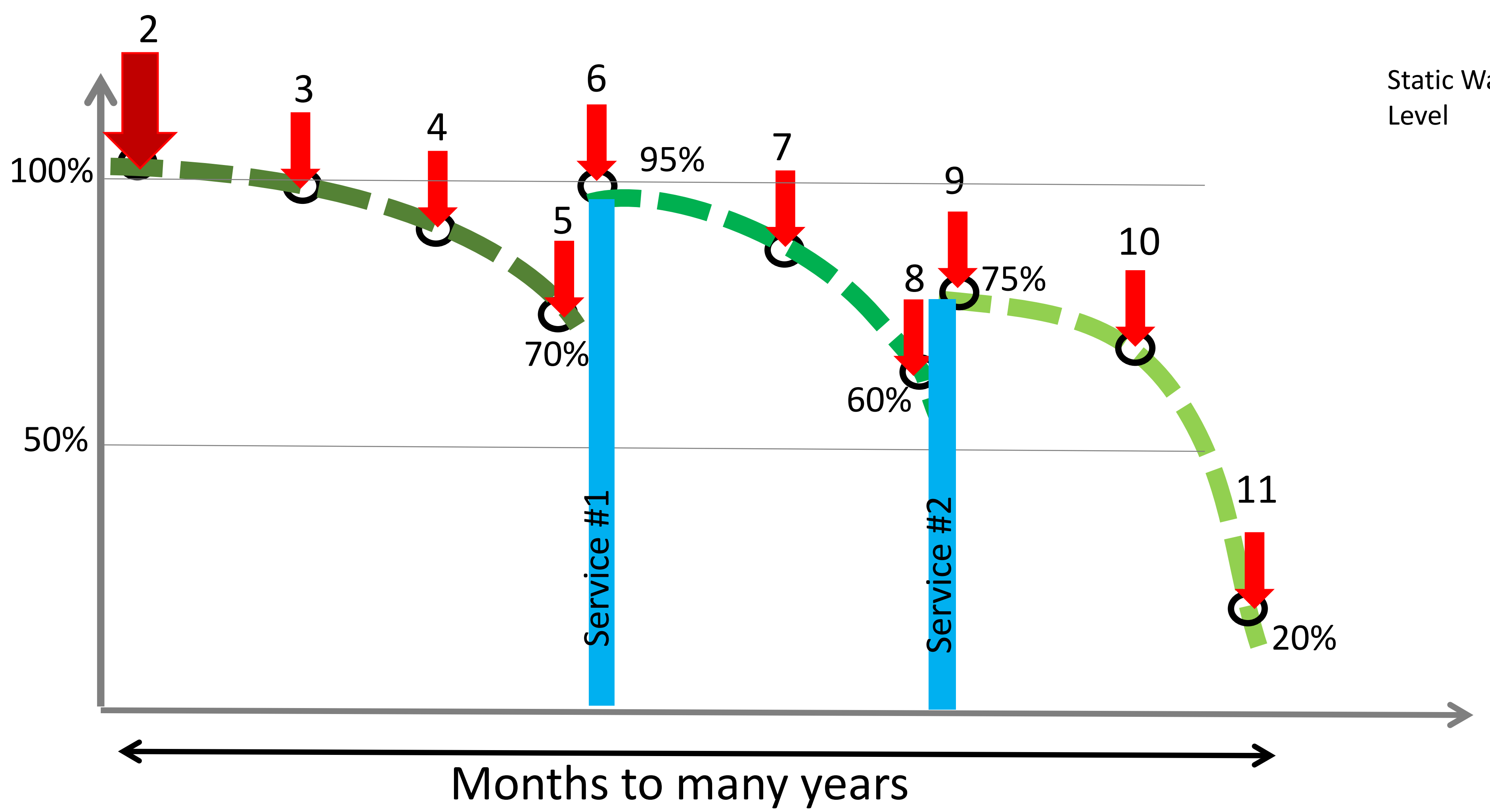
Standard practice is to rehabilitate after 25% drop in SC, sometimes sooner

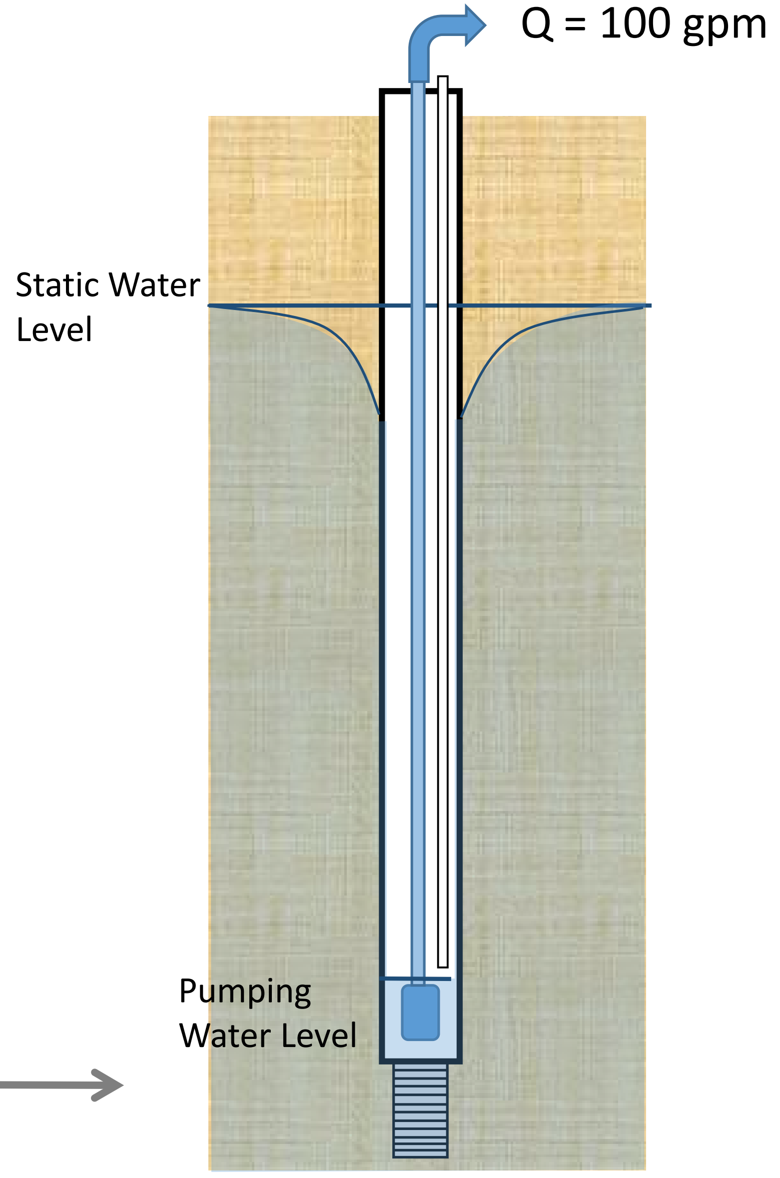
Specific Capacity measurements before, during and after well rehabilitation help to gauge rehabilitation success



RECORD OF WELL SERVICE #1

Specific capacity measurements also show when well closure is more appropriate…



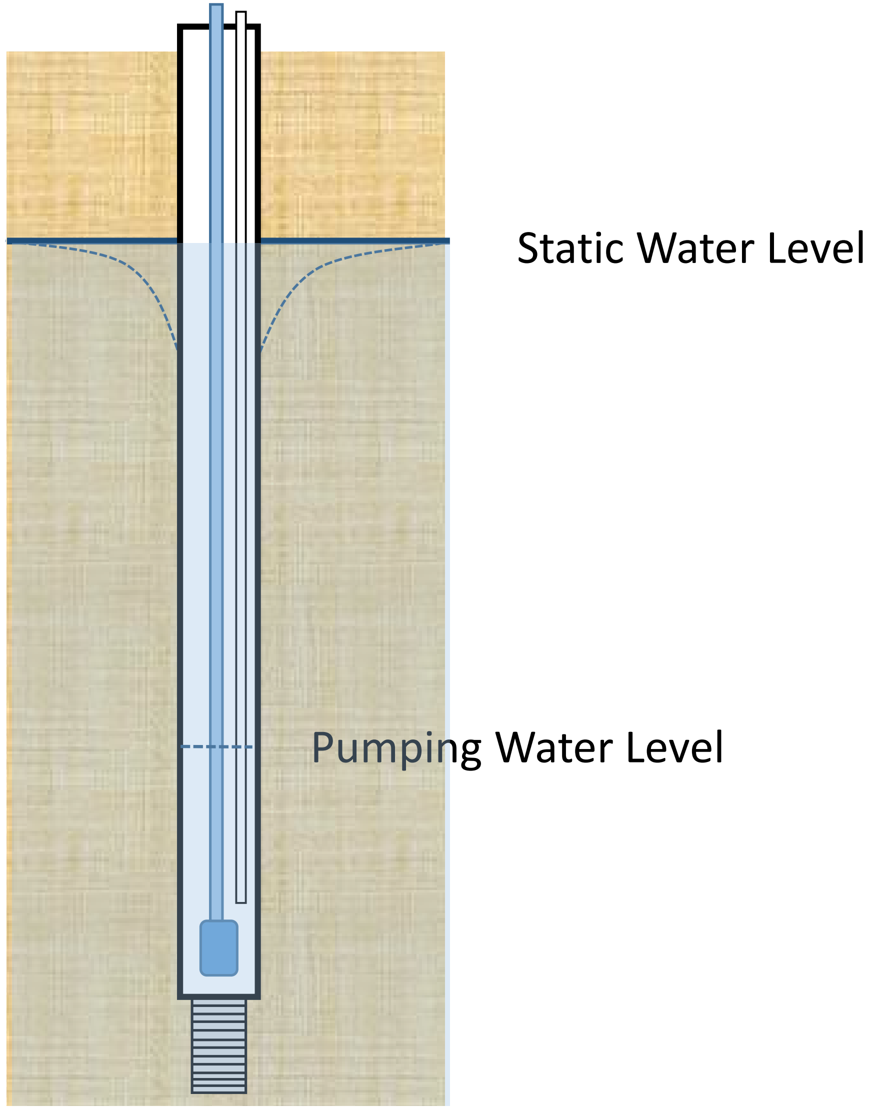


Static (non-pumping) water level measurements tell us what is happening in aquifer

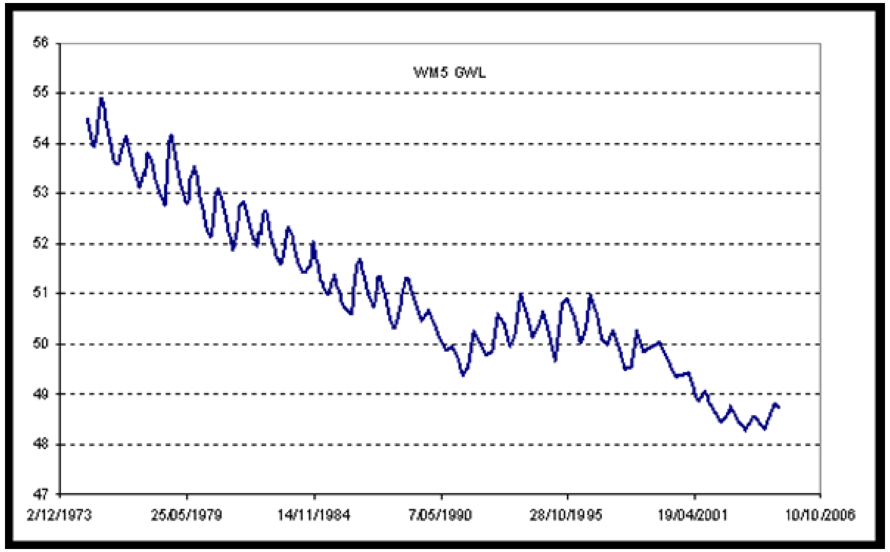
Measure frequently or continuously

Measure with a water level sounder or similar device

Record datum from which level is measured (e.g. top of well casing)



Aquifer Depletion

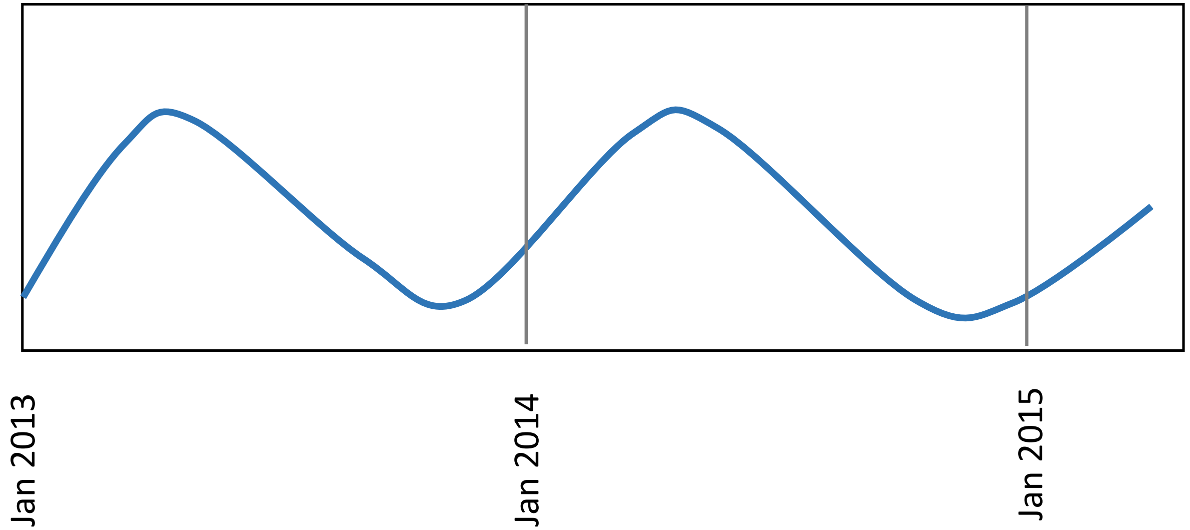


15 ft over 30 years

?? RESOURCE SUSTAINABILITY ??

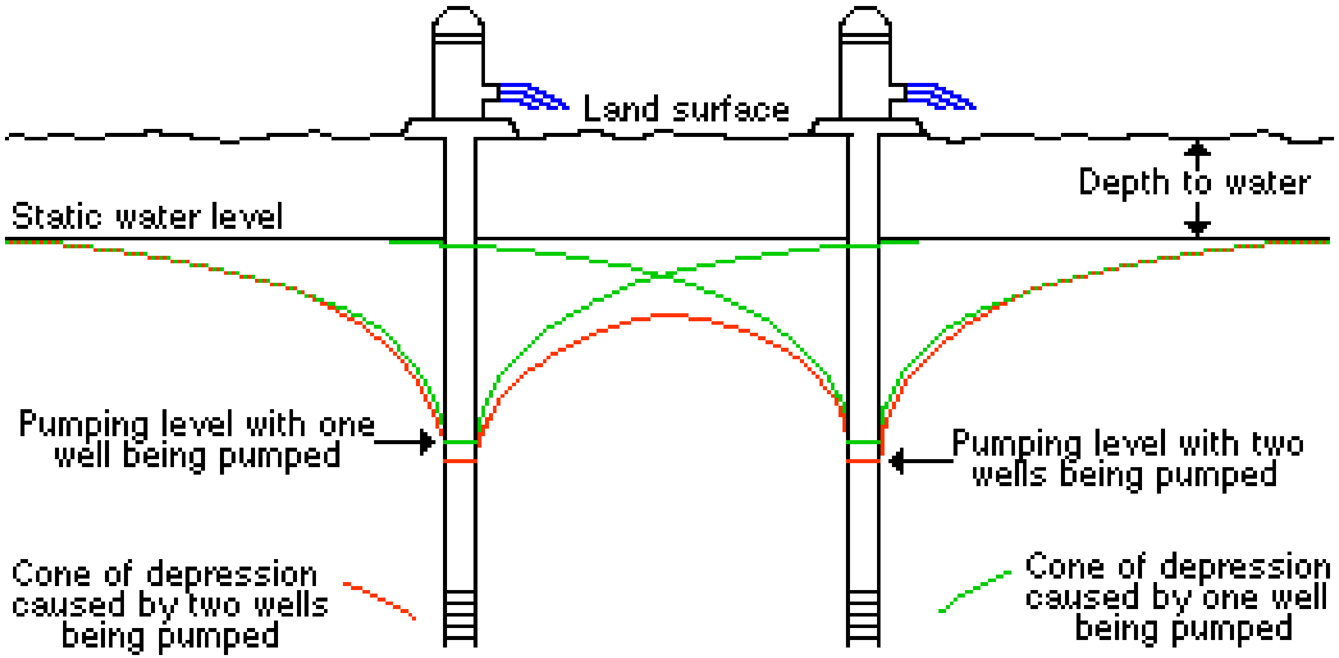
Seasonal WL Changes

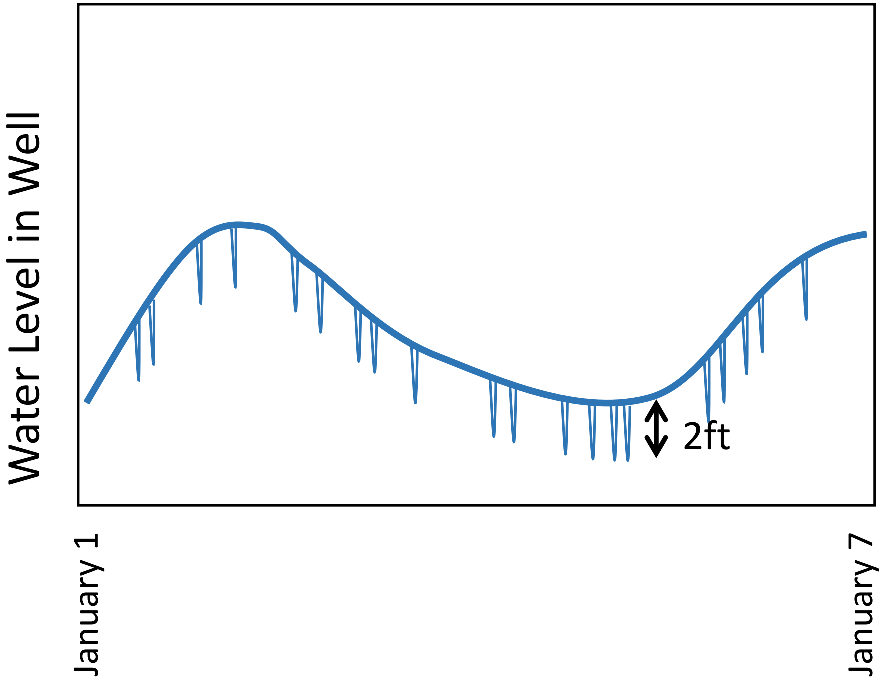
5 ft over one year



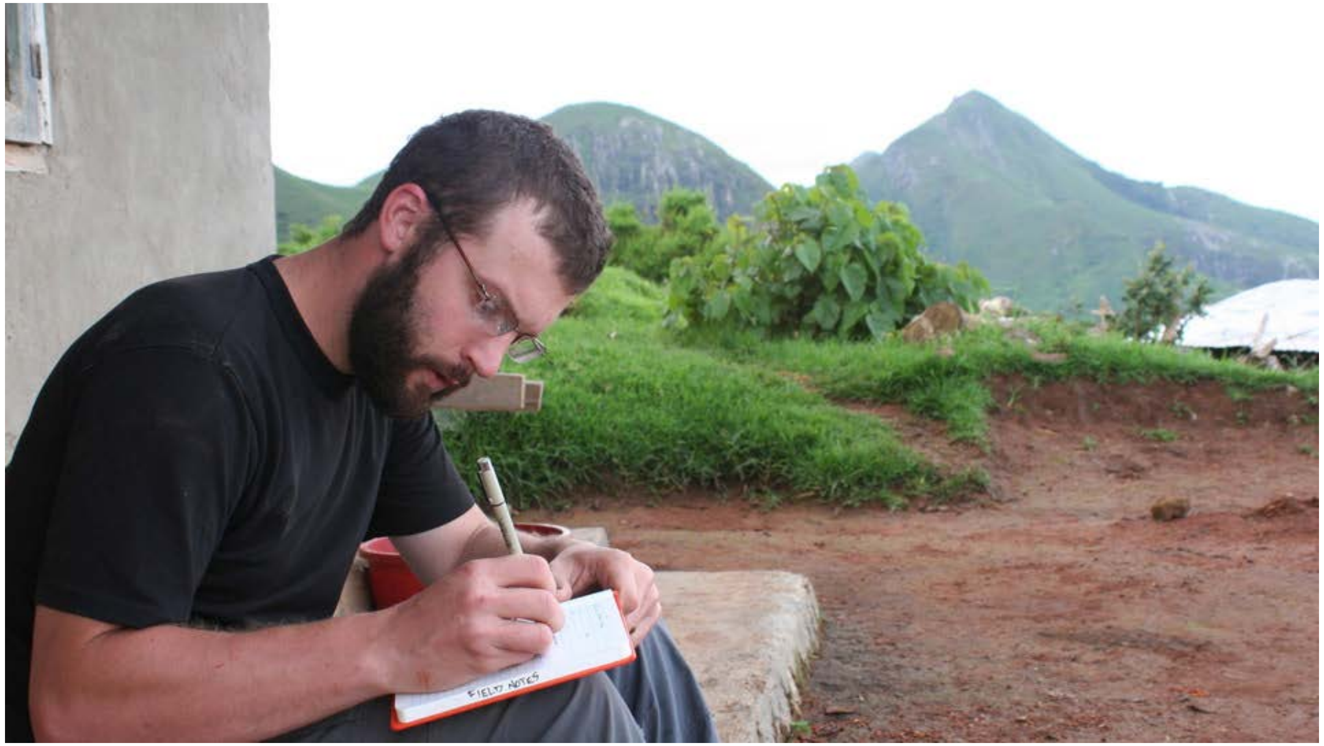
?? LICENSING ??

Interwell drawdown interferences from neighbouring wells





Contractors and consultants record information for the file, and educate well owners on the importance of continuing to monitor water levels and specific capacity



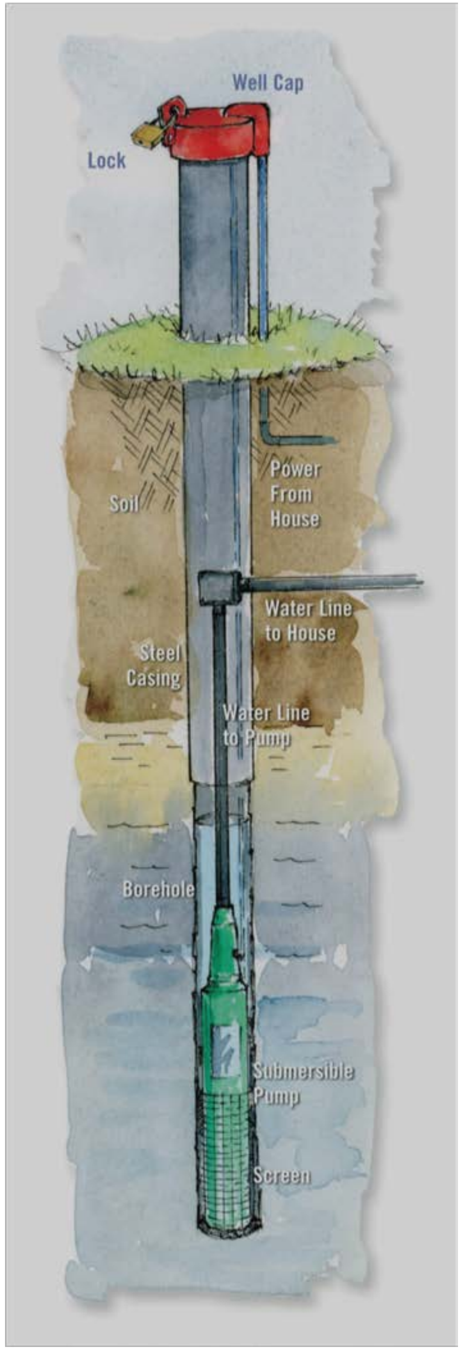
Well Owners need to keep track of this information

- Well logs, construction reports
- Pump test records
- Pump set records
- Static / Pumping Water Level Data
- Past invoices, contact info
- Water quality analyses
- Photos / videos
- Equipment model and serial numbers (pump, transducers, electrical components)

Closing Remarks

- Drillers and Pump Installers are on the ‘front lines’ with well owner
- Water levels and specific capacity are important indicators of well and aquifer health
- Good information makes for good decision-making
- We each have a role to play in the water well life cycle

THANK YOU


Well Cap
Lock
Soil
Power From House
Water Line to House
Steel Casing
Water Line to Pump
Borehole
Submersible Pump
Screen