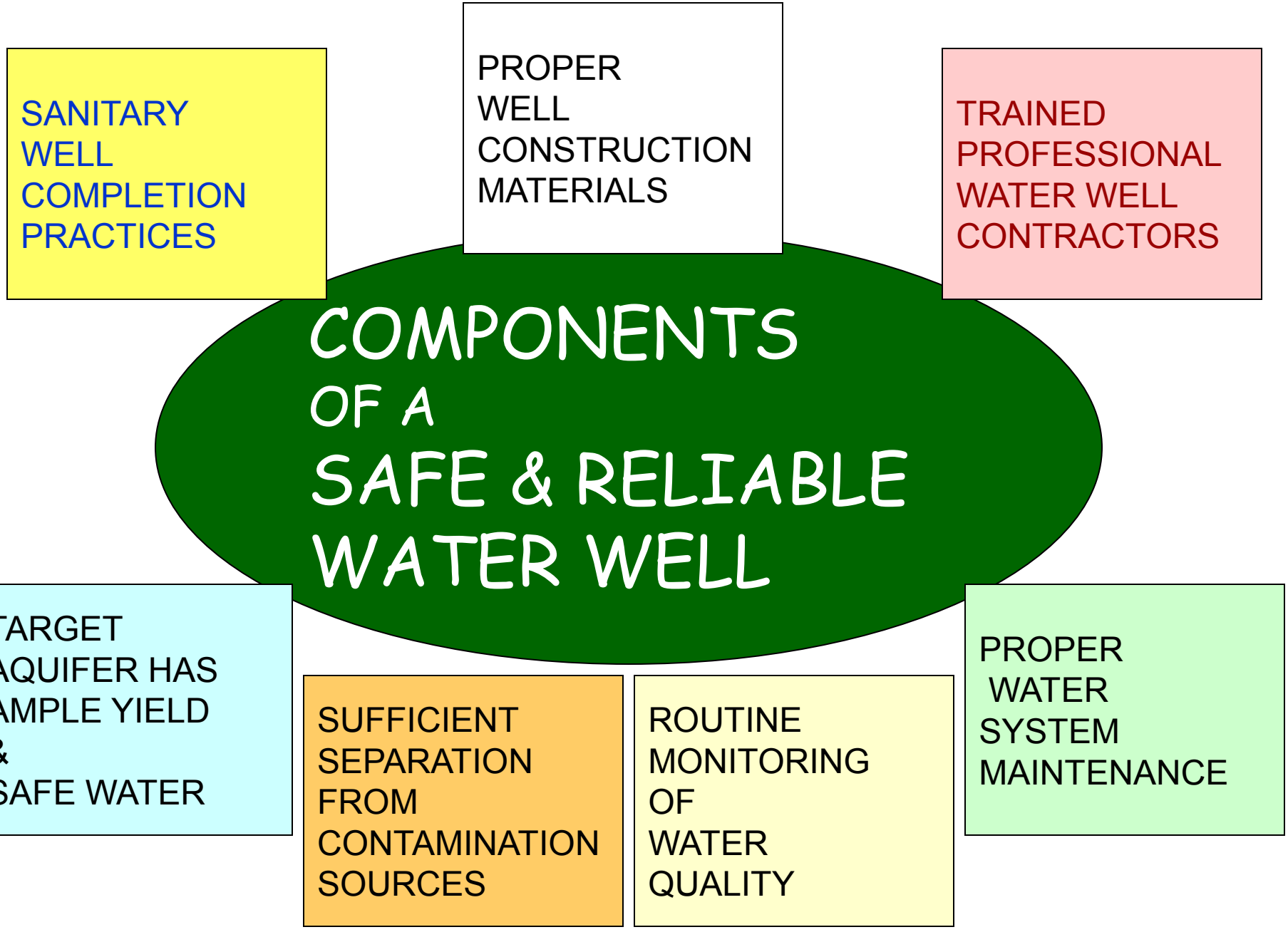
DACAAR

Well Drilling Methods and Construction

29 September 2013

M.Hassan Saffi


SANITARY WELL COMPLETION PRACTICES
PROPER WELL CONSTRUCTION MATERIALS
TRAINED PROFESSIONAL WATER WELL CONTRACTORS
COMPONENTS OF A SAFE & RELIABLE WATER WELL
TARGET AQUIFER HAS AMPLE YIELD & SAFE WATER
SUFFICIENT SEPARATION FROM CONTAMINATION SOURCES
ROUTINE MONITORING OF WATER QUALITY
PROPER WATER SYSTEM MAINTENANCE

Steps of Tube well construction:

- **Site selection for drilling well**
- **Operation of well drilling**
- **Logging (sampling)**
- **Well log design**
- **Construction of well(Lowering of filter and casing pipes, Gravel packing)**
- **Cleaning and developing of well**
- **Pumping test for finding well hydraulic properties**

Well Site Selection

Well Site Selection

- Desired yield;
- Desired water quality;
- Availability and restrictions of water rights;
- Vulnerability to known natural risks
- Distance from potential contaminant sources (e.g.,septic tanks, oil wells);
- Potential for interference with other wells, surface water flows, or environmentally important waters (e.g., wetlands or springs)
- Potential for interference with utilities;
- Accessibility for rigs and equipment,

Site selection for drilling well

- Subsurface geology and hydrogeology
- Depth and productivity of target aquifer
- Cost, equipment availability, labor availability
- Local suitability and sustainability
- Well drilling method according to the geological condation

Drilling method application according to the Geological- technical condation

Type of formation	Cable tool drill	Auger *	Rotary air	Rotary mud	High-pressure rotary air with down-hole hammer
Sand	Suitable	Fair	Not suitable	Suitable	Not suitable
Loose sand and gravel	Difficult – fair (if casing driven)	Not suitable	Difficult – not suitable	Suitable (with fluid control)	Not suitable (see ** below)
Loose coarse gravels and boulders	Suitable (if casing driven)	Not suitable	Not suitable	Difficult – slow sometimes impossible	Not suitable (see ** below)
Loam and silt	Suitable	Fair	Fair	Suitable	Not suitable
Clays	Suitable	Fair	Suitable	Suitable	Fair
Puggy shale and mudstone	Fair	Slow	Fair	Suitable	Slow
Shale	Fair	Slow	Suitable	Suitable	Suitable
Sandstone	Fair	Slow	Suitable	Suitable	Suitable

Drilling method application according to the Geological- technical condation

Type of formation	Cable tool drill	Auger *	Rotary air	Rotary mud	High-pressure rotary air with down-hole hammer
Conglomerate	Slow	Not suitable	Suitable	Slow	Suitable
Limestone and dolomite	Slow	Not suitable	Suitable	Fair	Suitable
Limestone with small cracks or fissures	Fair – slow	Not suitable	Suitable	Fair	Suitable
Cavernous limestone	Slow	Not suitable	Suitable	Difficult	Suitable
Weathered basalts	Slow	Difficult	Suitable	Suitable	Suitable
Thick layered basalts	Not suitable	Not suitable	Slow	Slow	Suitable
Schists and Gniess	Not suitable	Not suitable	Slow	Slow	Suitable
Granite	Not suitable	Not suitable	Suitable	Suitable	Suitable

LEGEND	
Not suitable:	Normally cannot drill formation type.
Difficult:	Generally not suitable but can sometimes be adapted.
Slow:	Can be used but drilling progress is usually slow.
Fair:	Suitable with some care and/or special technique suggested in brackets.
Suitable:	Normally used to drill formation type economically.

WATER WELL DRILLING METHODS
IN MICHIGAN

MOST COMMON:

ROTARY
(Mud & Air)

84%

LESS COMMON:

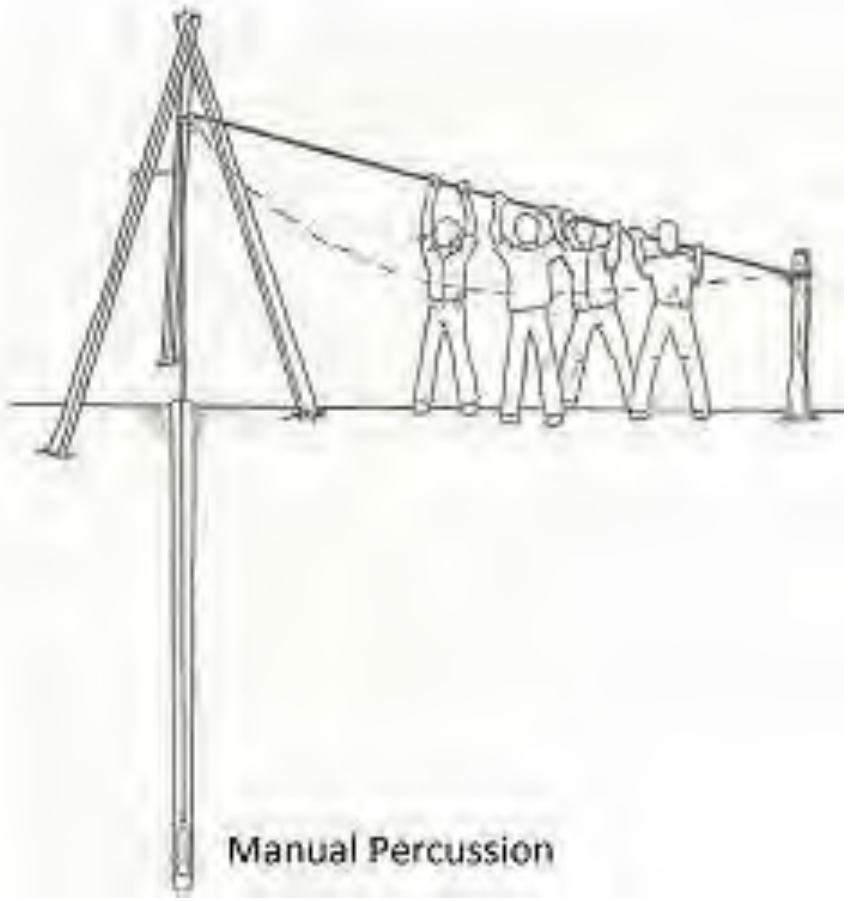
CABLE TOOL
10%

AUGER
2.5%

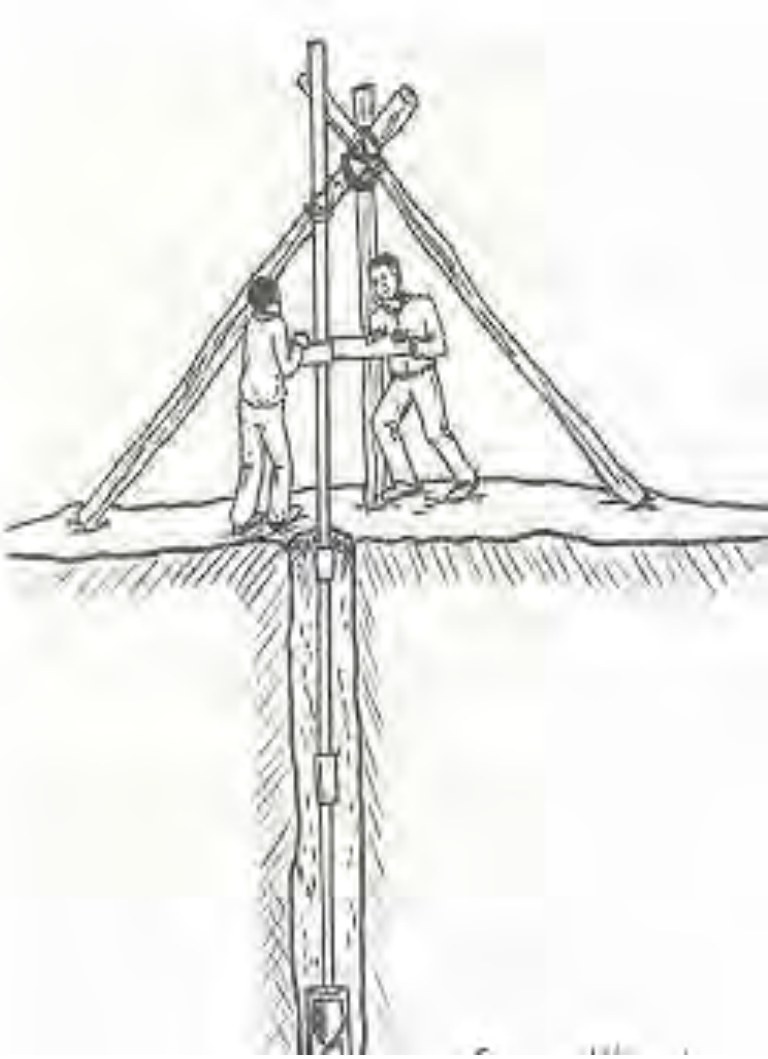
JETTING
1%

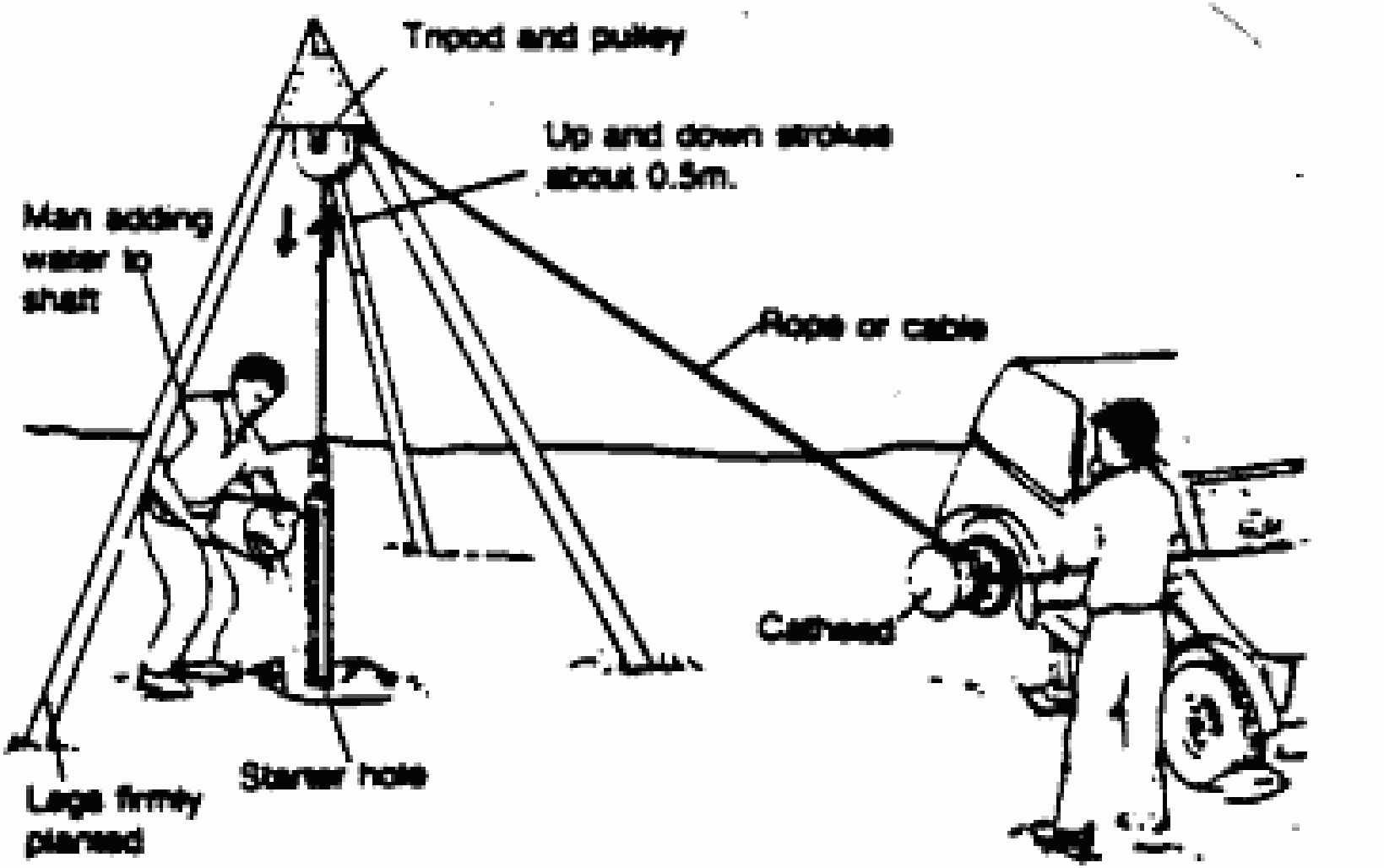
HOLLOW ROD
0.5%

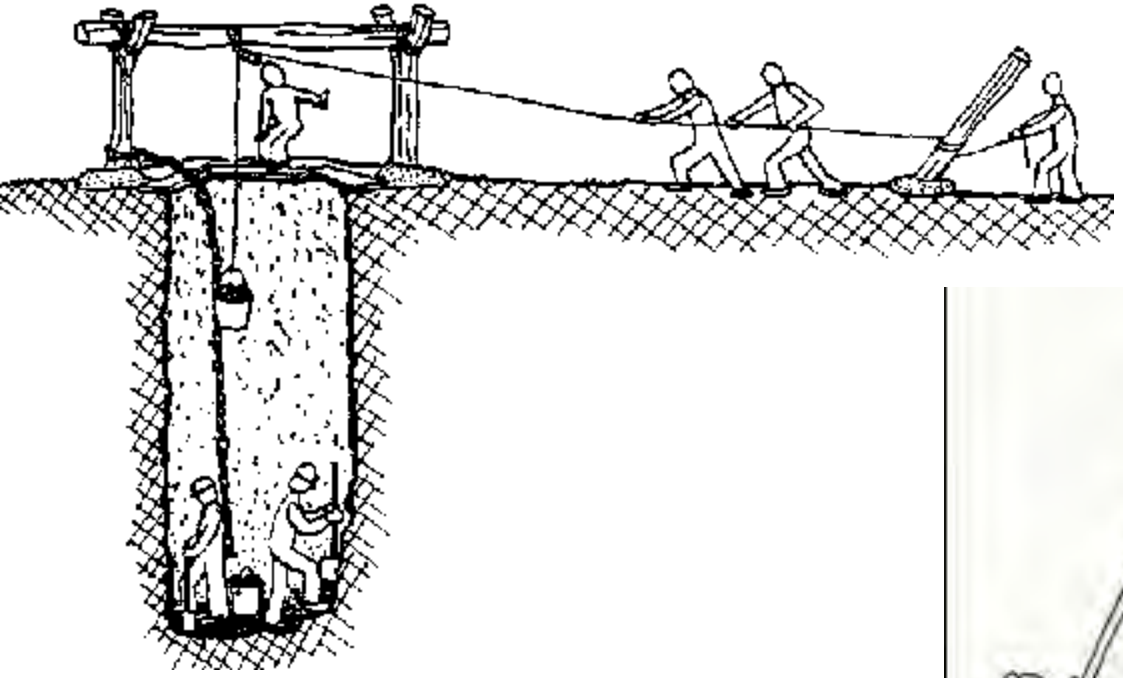
OTHER
2%

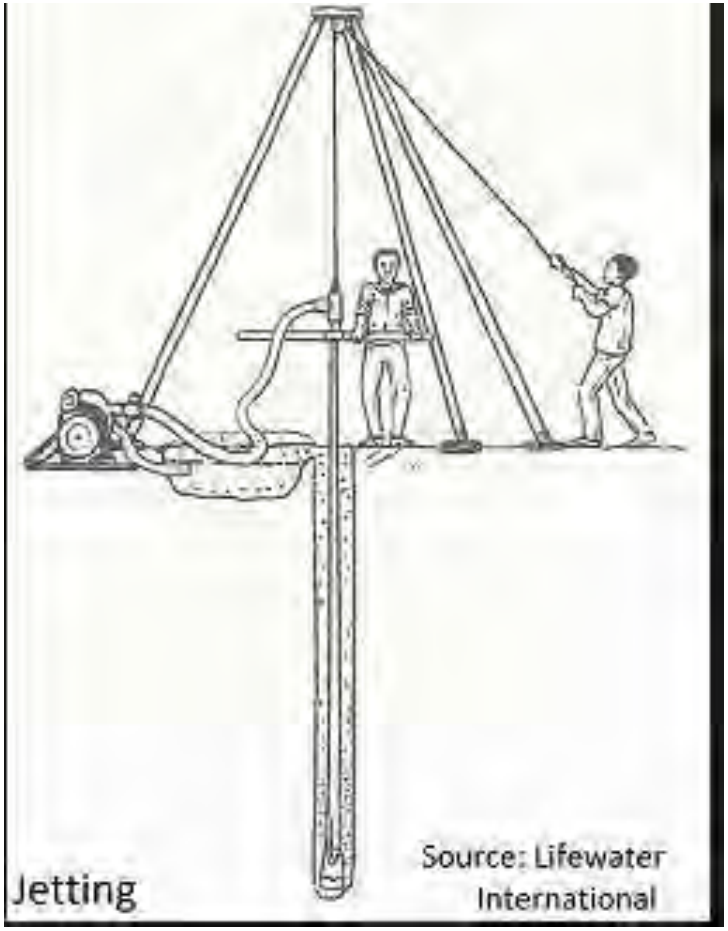


Manual Percussion



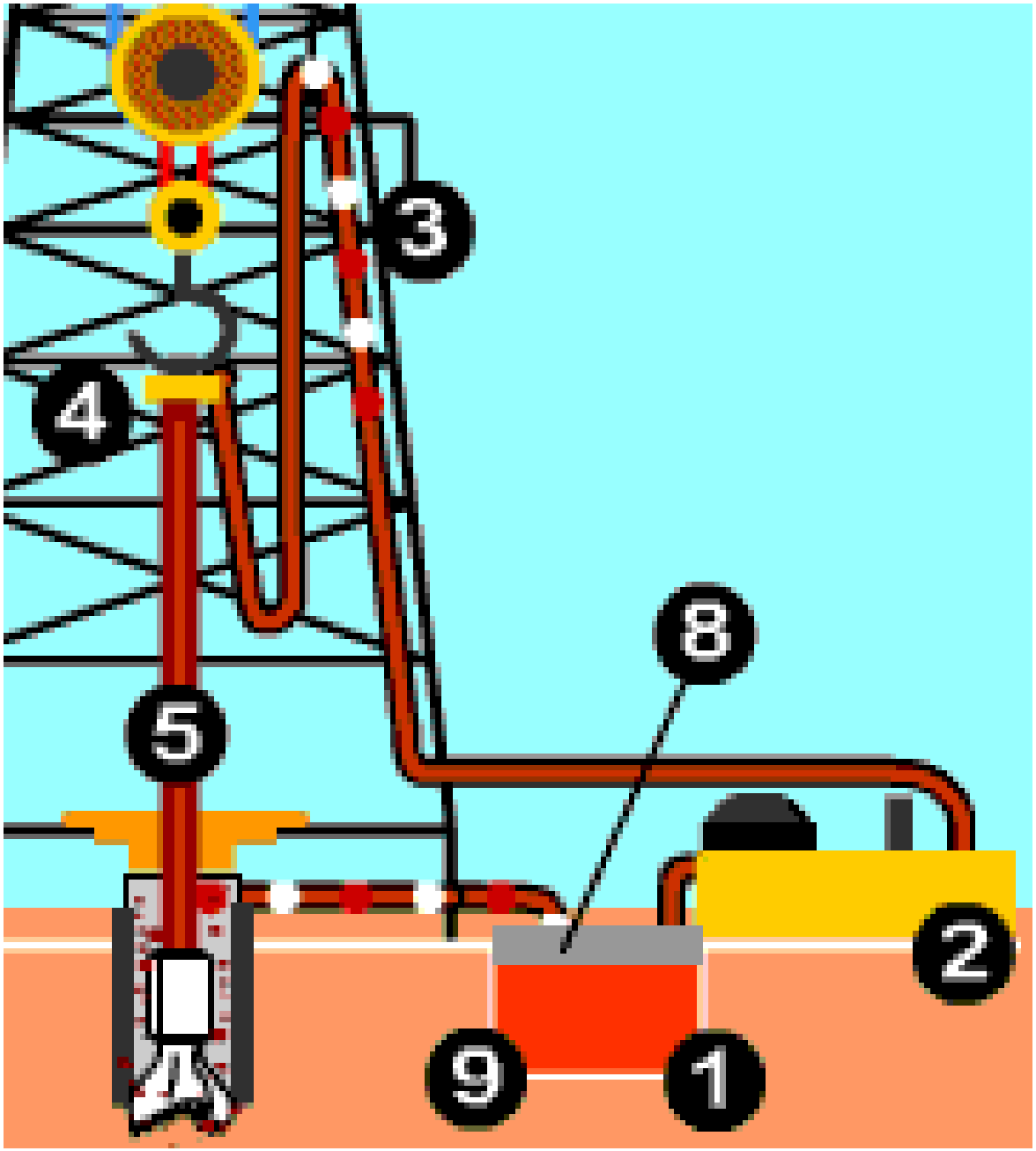

Tripod and pulley
Up and down strokes about 0.5m.
Man adding water to shaft
Rope or cable
Cathead
Starter hole
Legs firmly planted




Jetting
Source: Lifewater International

Mud Rotary Drilling Method

- **Open hole stabilized with drilling mud**
- Mud circulation brings cuttings to surface
- May require conductor and intermediate casings
- Requires powerful equipment, bits, rods, pumps, pits, etc.
- Drilling fluid additives (facilitate cutting removal and prevent recirculation, weight borehole walls, reduce fluid loss to formation, prevent swelling clays)


3
4
8
5
2
9
1

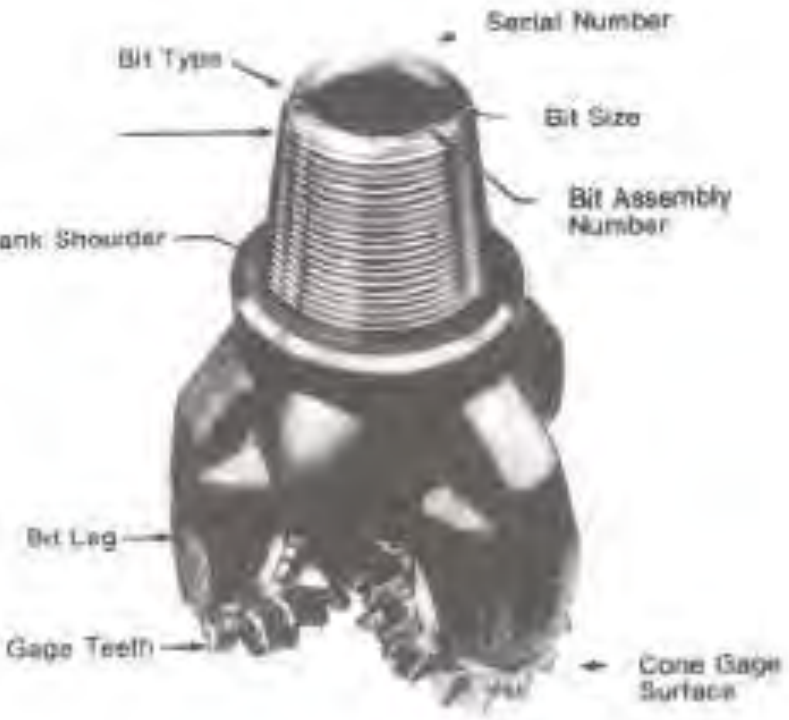
Advantages of Rotary Method

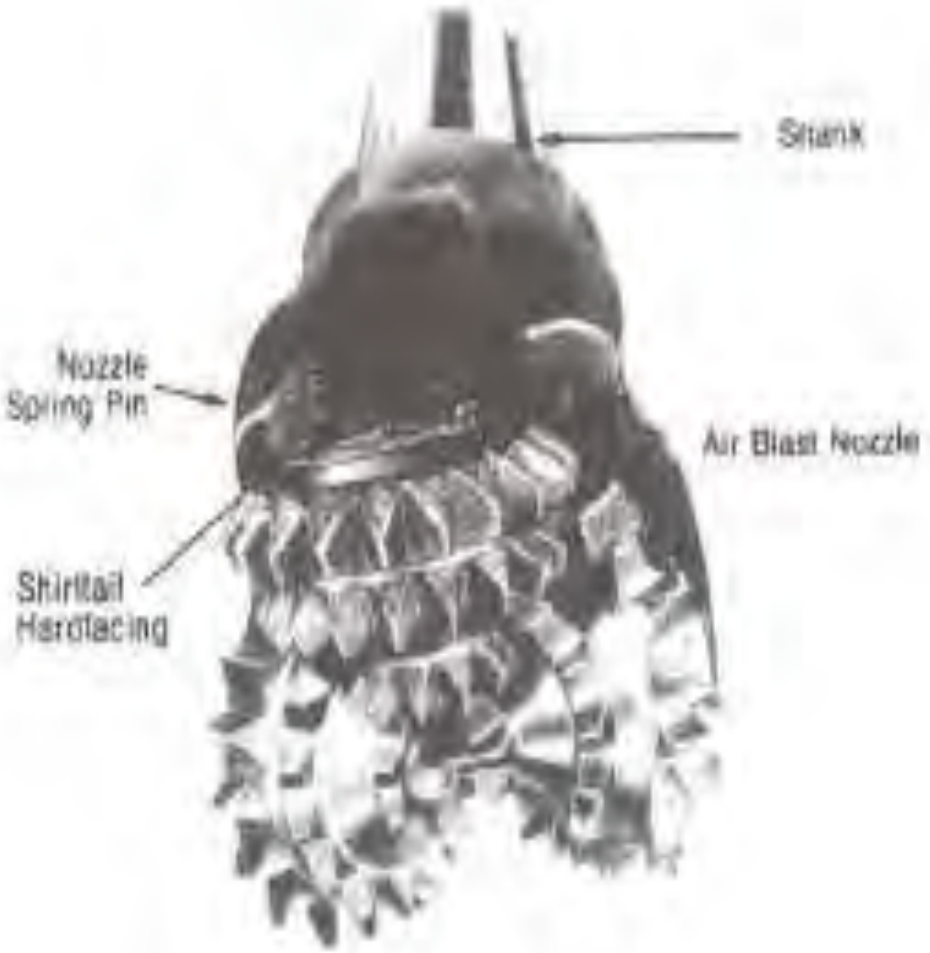
- **Fast**
- **Facilitates**
  - **Geophysical logging**
  - **Grouting**
  - **Screen placement**
  - **Gravel pack placement**

Disadvantages of Rotary Method

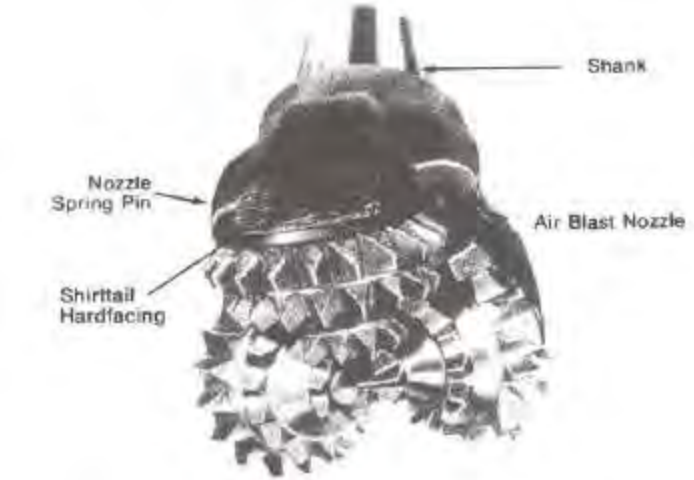
- Invasion of drilling mud
- Potential borehole instability
- Potential lost circulation problems
- Lithologic samples may not be from distinct zone; geophysical logs help
- Difficult to sample formation water during drilling
- Major equipment and material requirements
- Well development more difficult
- Higher cost

Drillings pipe (Drilling Rod)

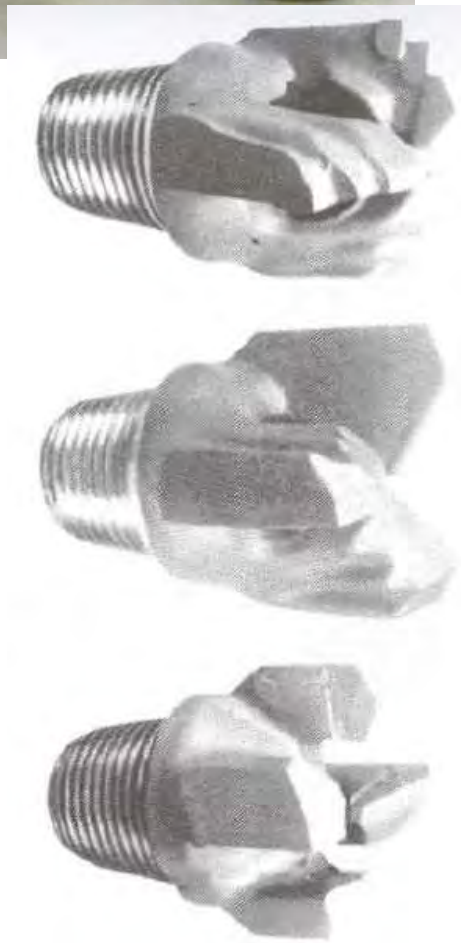

Serial Number
Bit Type
Bit Size
Bit Assembly Number
ank Shoulder
Bit Leg
Gage Teeth
Cone Gage Surface

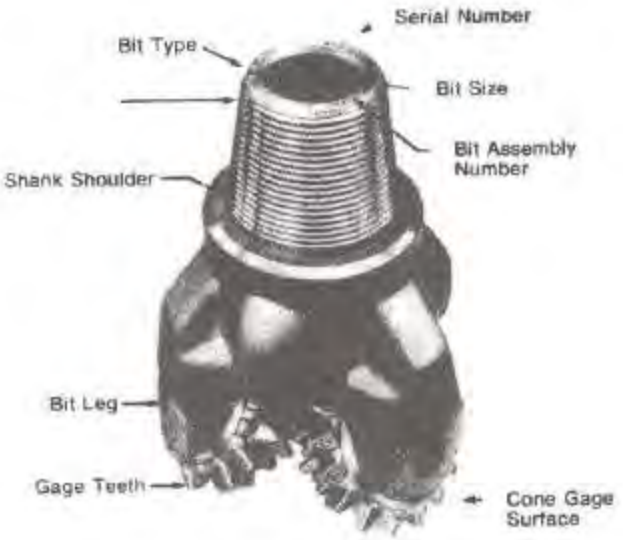

Shank
Nozzle Spring Pin
Air Blast Nozzle
Shirttail Hardfacing


Don't let anyone tell you
what heavy duty is.
Toy Rig
1 1/2"
2 3/8"
Oil Field Size


Shank
Nozzle
Spring Pin
Air Blast Nozzle
Shirttail
Hardfacing


2 3/8"
1 1/2"
CA-21
3/4"
1/2
Mayhew JR
Toy Rig Pipe




Serial Number
Bit Type
Bit Size
Bit Assembly
Number
Shank Shoulder
Bit Leg
Gage Teeth
Cone Gage
Surface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SNUDRILLS


ZZLIUDING


www.bnsbit.com

قطر نل ها ویل های برمه

قطر سامی به (ملی متر)	قطرراد برمه به (ملی متر)		قطرپل برمه به (ملی متر)	
	قطر داخلی	قطر خارجی		
80	46	60	76 93 97 112 118	
95	59	73	132 135 140 145	
108	75	89	151 161 190 214 243	
127	87.6	102	269 295	
140	100	114	346	
			370	14"
152	113	127	394	16"
171	139	140	445	18"
197	145	168	490	20"

اتصالات (کنکشن ها)

شماره	راسته چوری(ملی متر)	چپه چوری(ملی متر)
1	37x63	63x73
2	89x76	76x89
3	114x102	102x114
4	168x102	127x141
5	141x127	152x168
6	168x127	152x166
7	168x152	

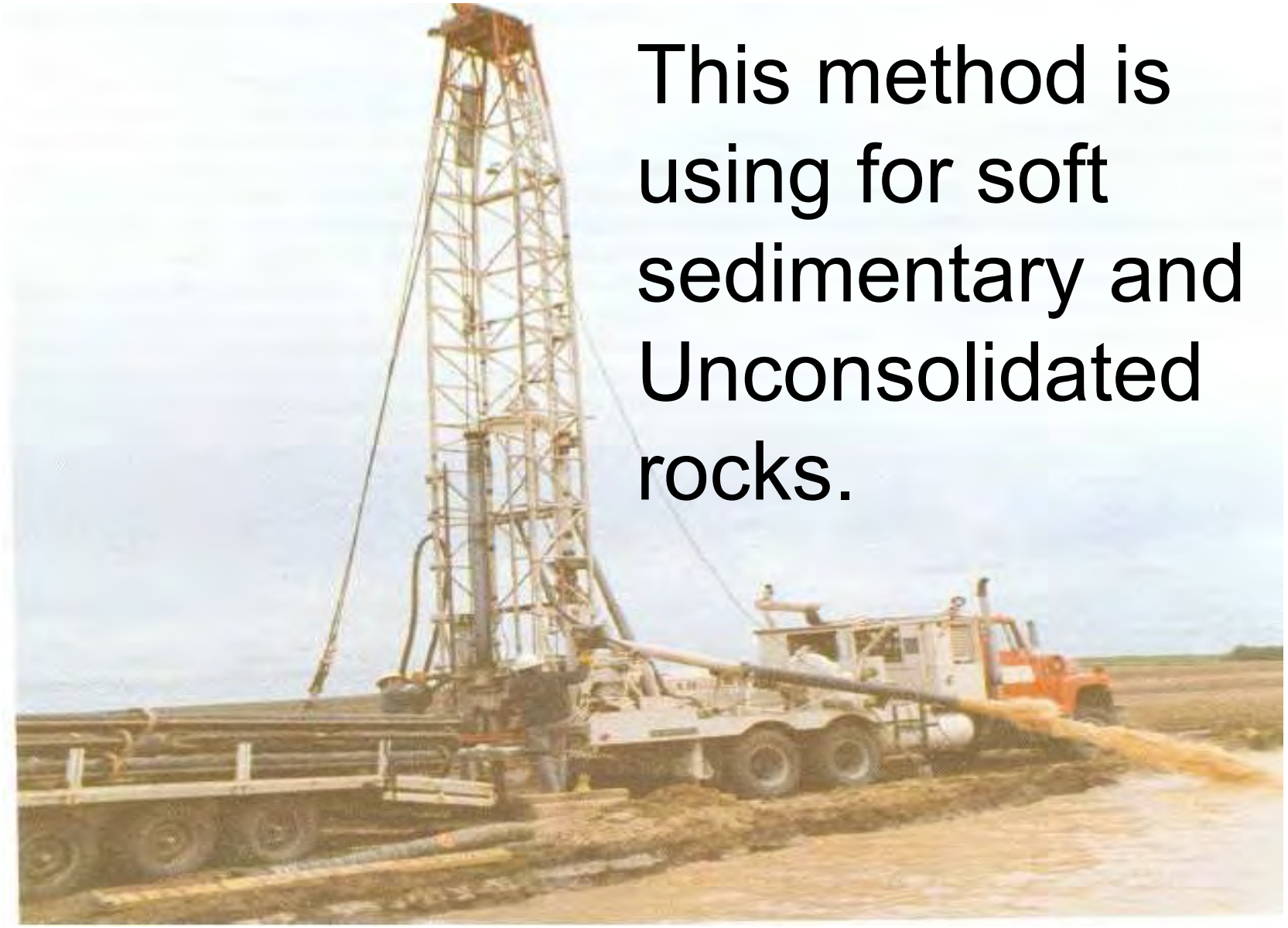
انواع پل برمه نظربه سختی احجار

نوع پل	بسیار مستحکم	مستحکم	سخت مستحکم	سخت	سخت متوسط	متوسط	نرم متوسط	نرم
رنگ خارجی	نارنجی	سرخ	یاسمندی	سبز	خاکستری	آبی	سیاه	زرد

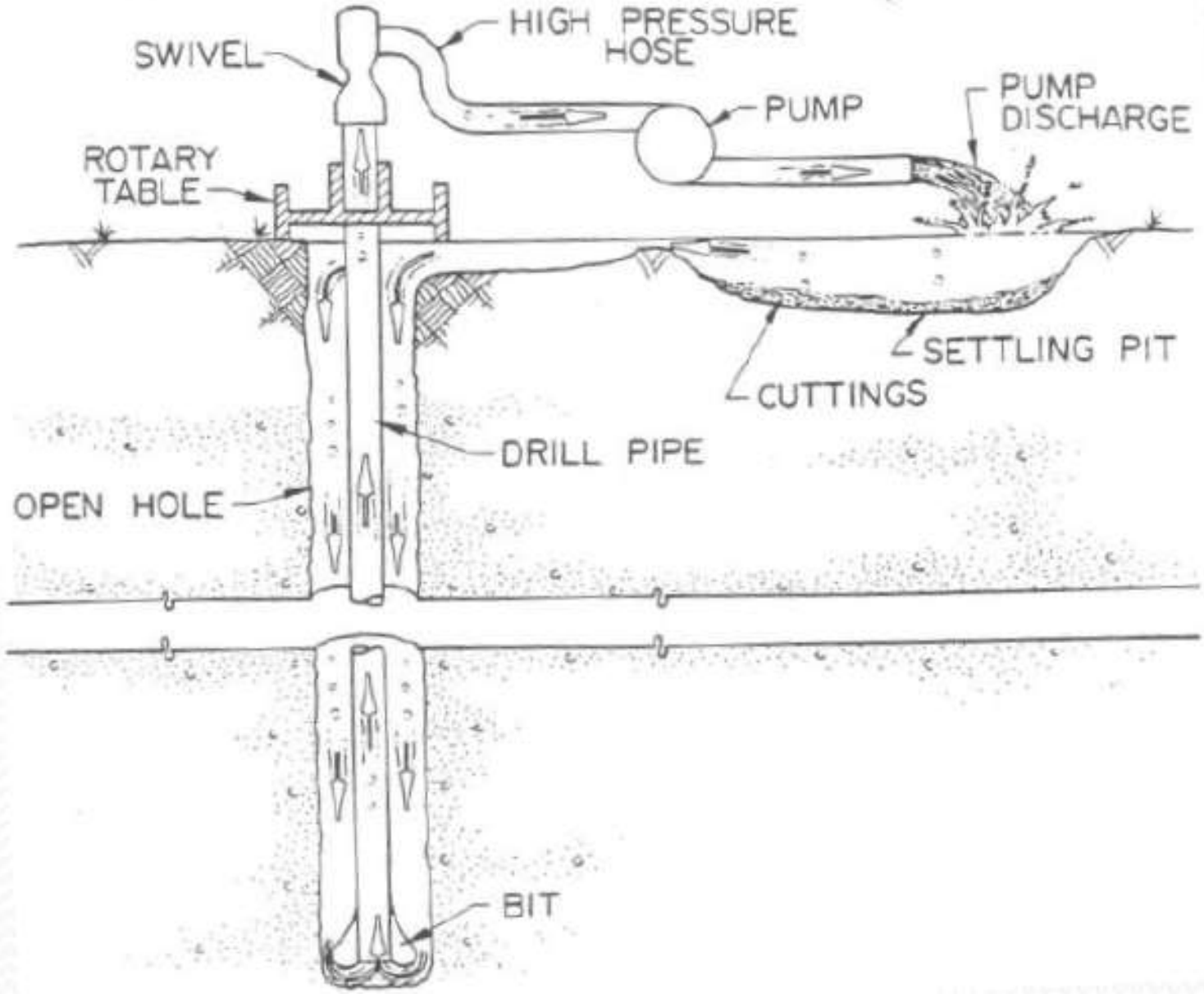
Principal Functions of Drilling Fluids

- Subsurface pressure control
- Cuttings removal and transport
- Suspension of solid particles
- Sealing of permeable formations
- Stabilizing the wellbore
- Preventing formation damage
- Cooling the bit and drill string
- Transmitting hydraulic horsepower to the bit
- Facilitating the collection of formation data
- Controlling corrosion

Reverse air drilling



This method is using for soft sedimentary and Unconsolidated rocks.


SWIVEL
HIGH PRESSURE HOSE
PUMP
PUMP DISCHARGE
ROTARY TABLE
SETTLING PIT
CUTTINGS
DRILL PIPE
OPEN HOLE
BIT

Cable Tool Drilling Method

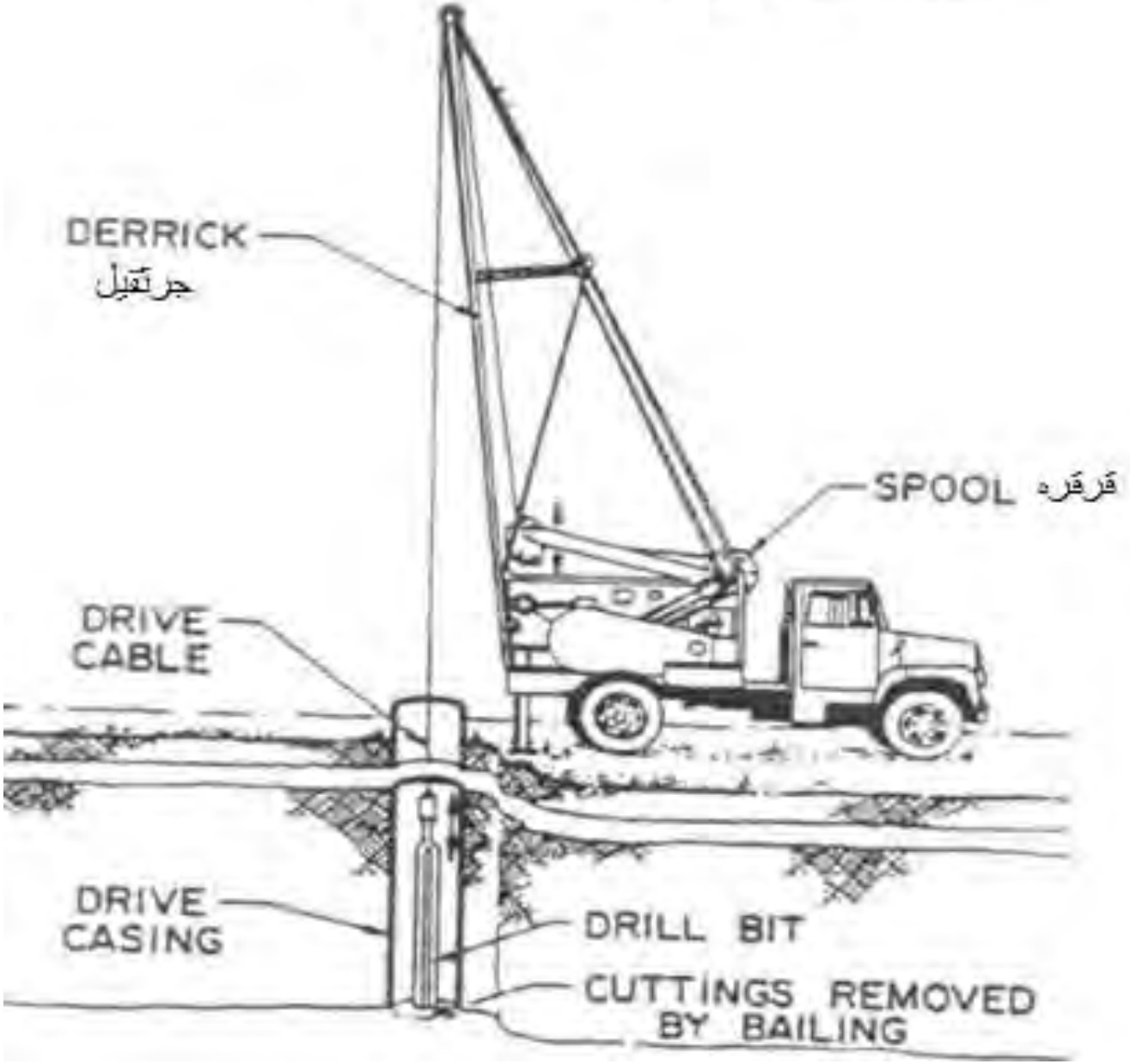
- Drill bit is raised and lowered - percussion
- Drill loosens smaller, uncemented particles
- Drill bit breaks or crushes larger particles
- Cuttings mixed into slurry and bailed
- Casing advanced (driven/pounded) with drilling
- Casing prevents borehole collapse

Cable Tool Procedure

- Drill, drive casing
- Drive different diameter casings
- Direct observations while drilling
  - Lithology
  - Water quality
  - Potential yield
- Alternate: set screen while pulling back (removing) casing
- Develop well


Cable tool rig

Cable Tool Drilling System



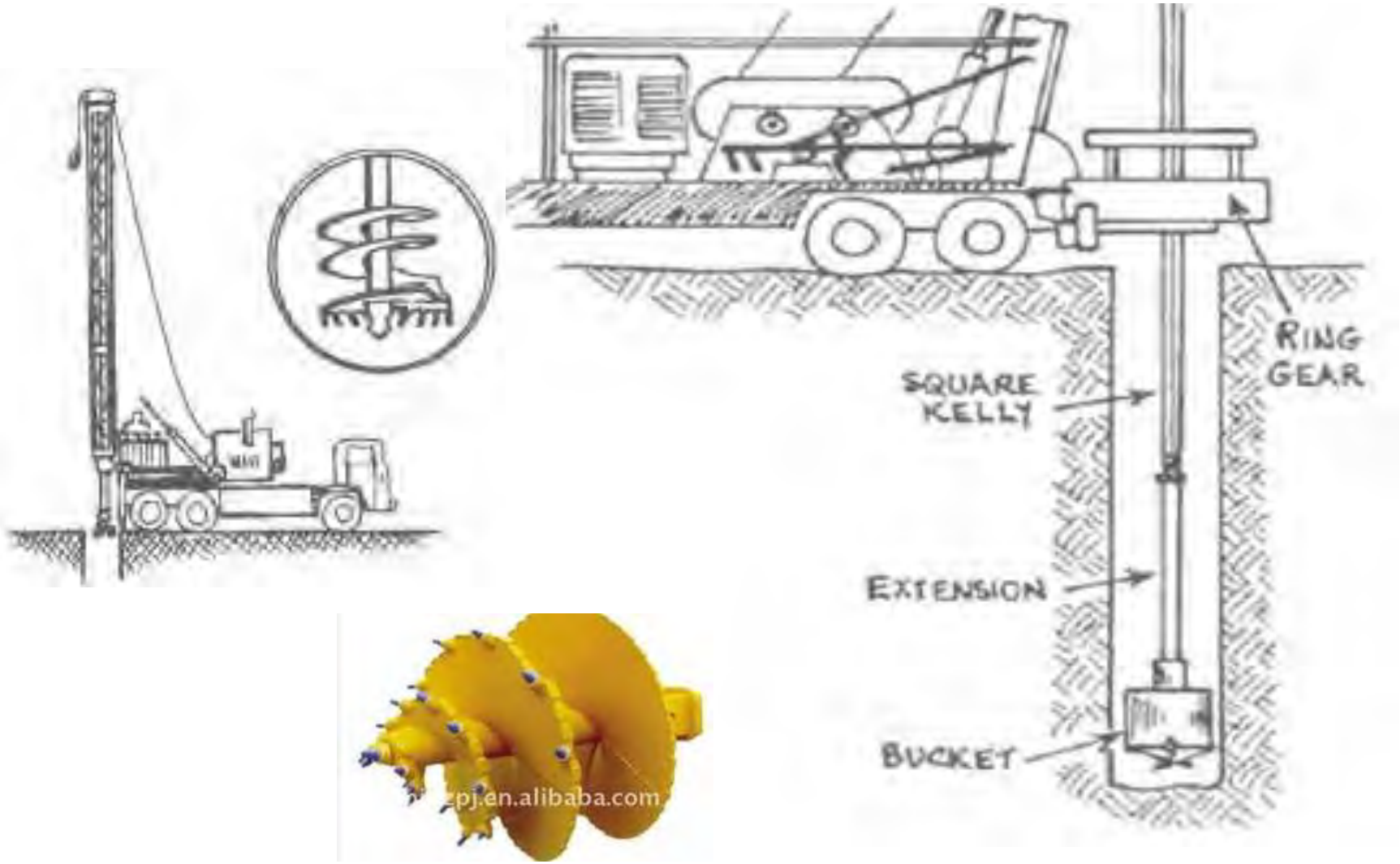
Advantages of Cable Tool

- Easier to keep well straight and plumb
- Minimal invasion of drilling mud
- Cuttings and water samples from distinct depths
- Equipment simpler
- Reduced material and fuel requirements
- Well development better
- Lower costs

Auger drilling method

Auger drilling method is used for the following:

- Site investigation
- Geotechnical investigation and soil sampling
- Construction purposes

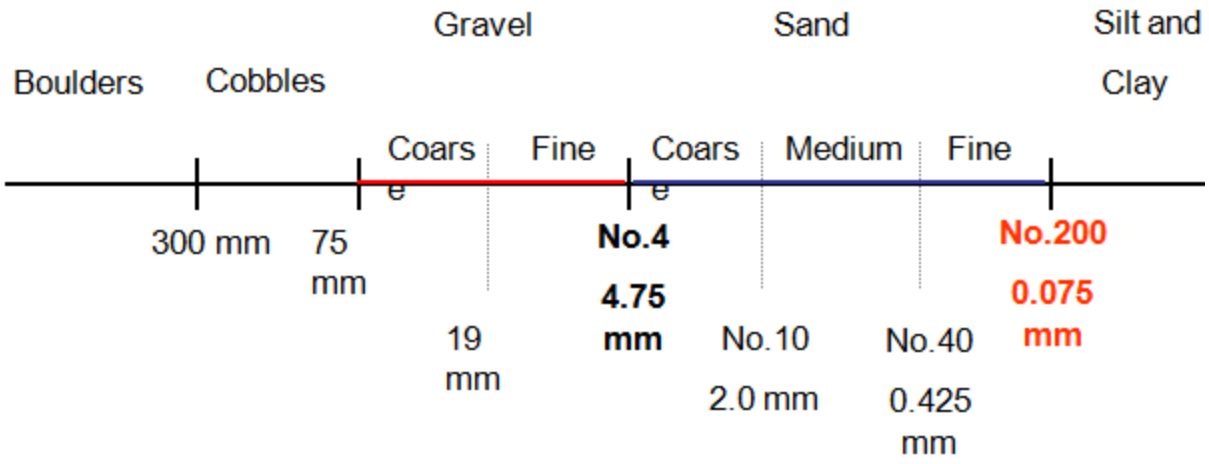

RING GEAR
SQUARE KELLY
EXTENSION
BUCKET
zpj.en.alibaba.com

Well Design

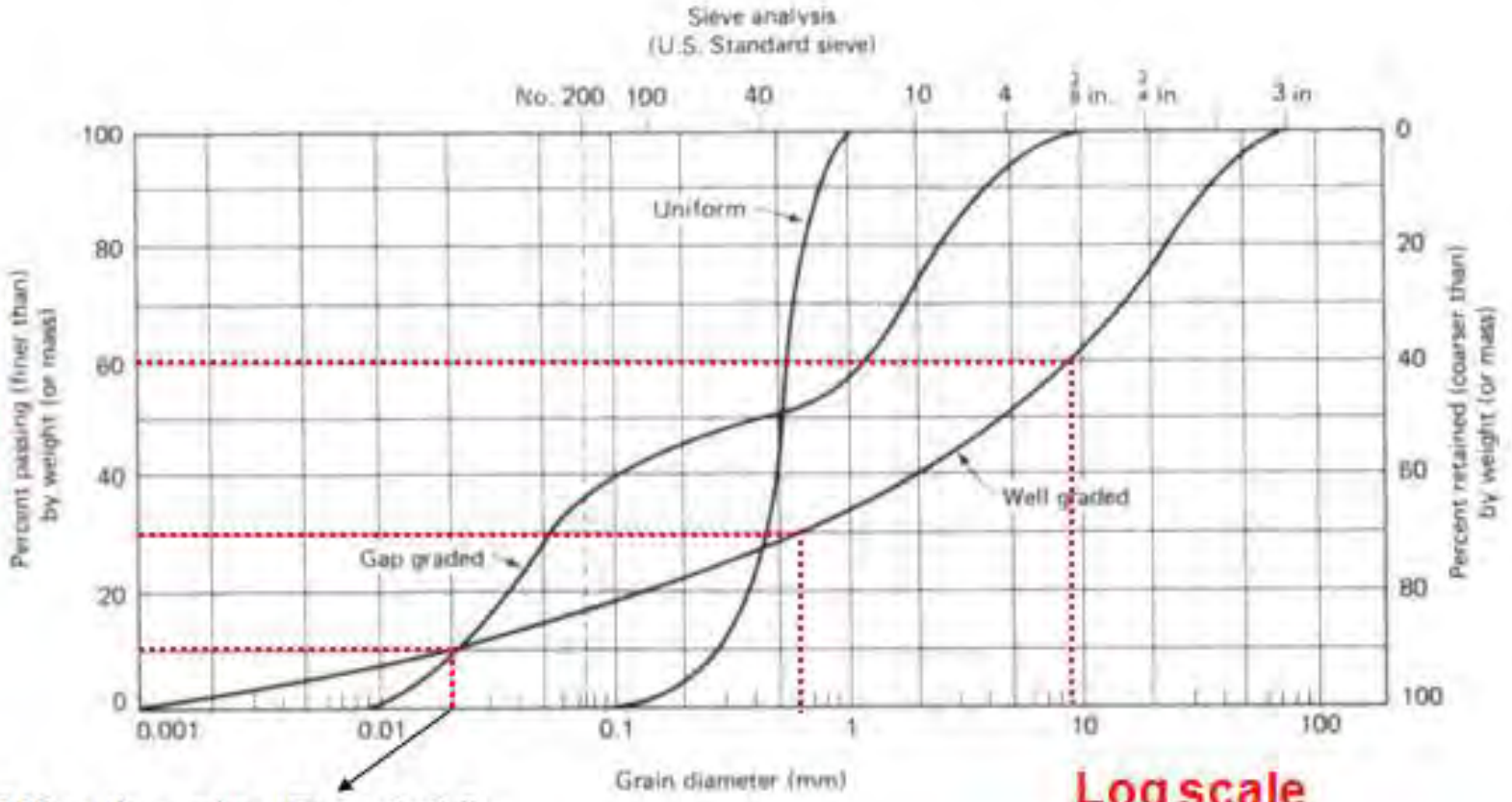
Logging (Sampling)

Cutting Samples

Definition of Grain Size



Grain Size Distribution



Finer

Log scale

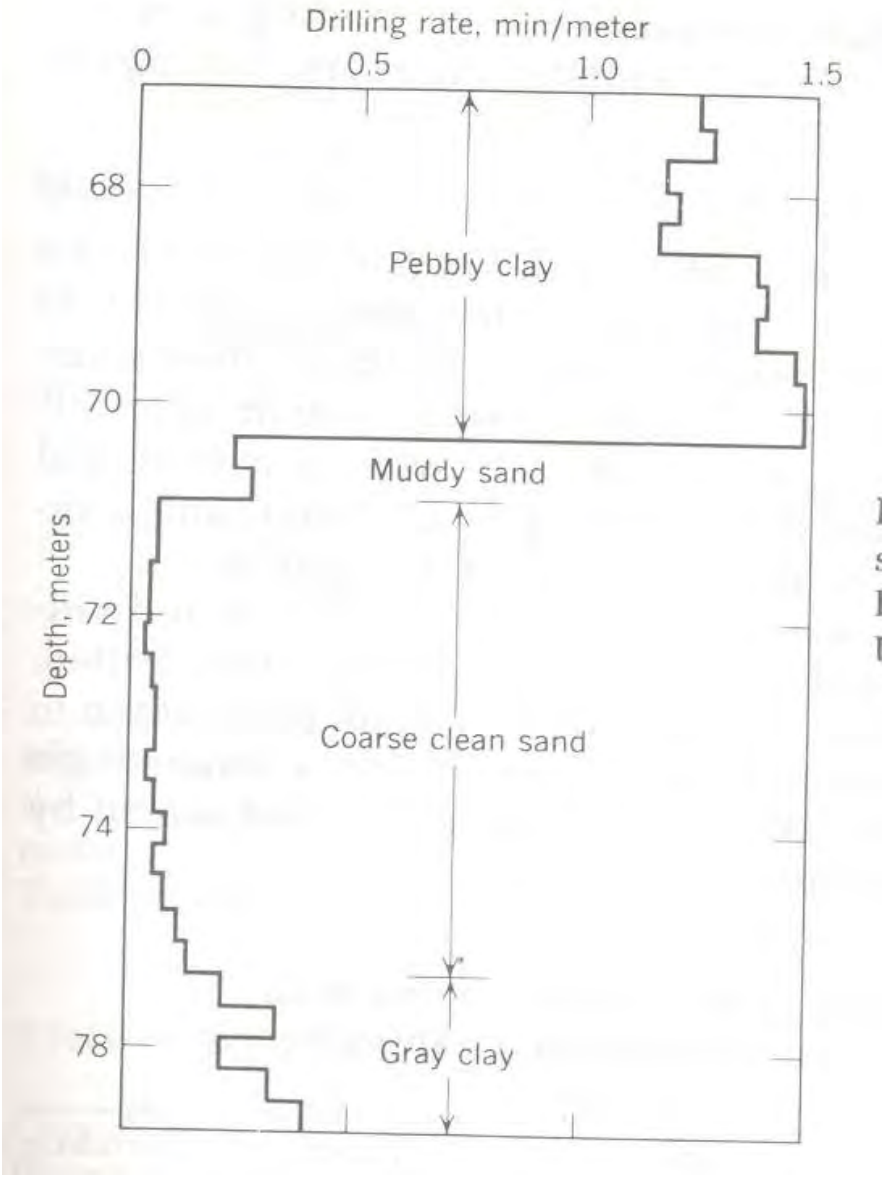
Effective size D_{10}: 0.02 mm

D_{30}:

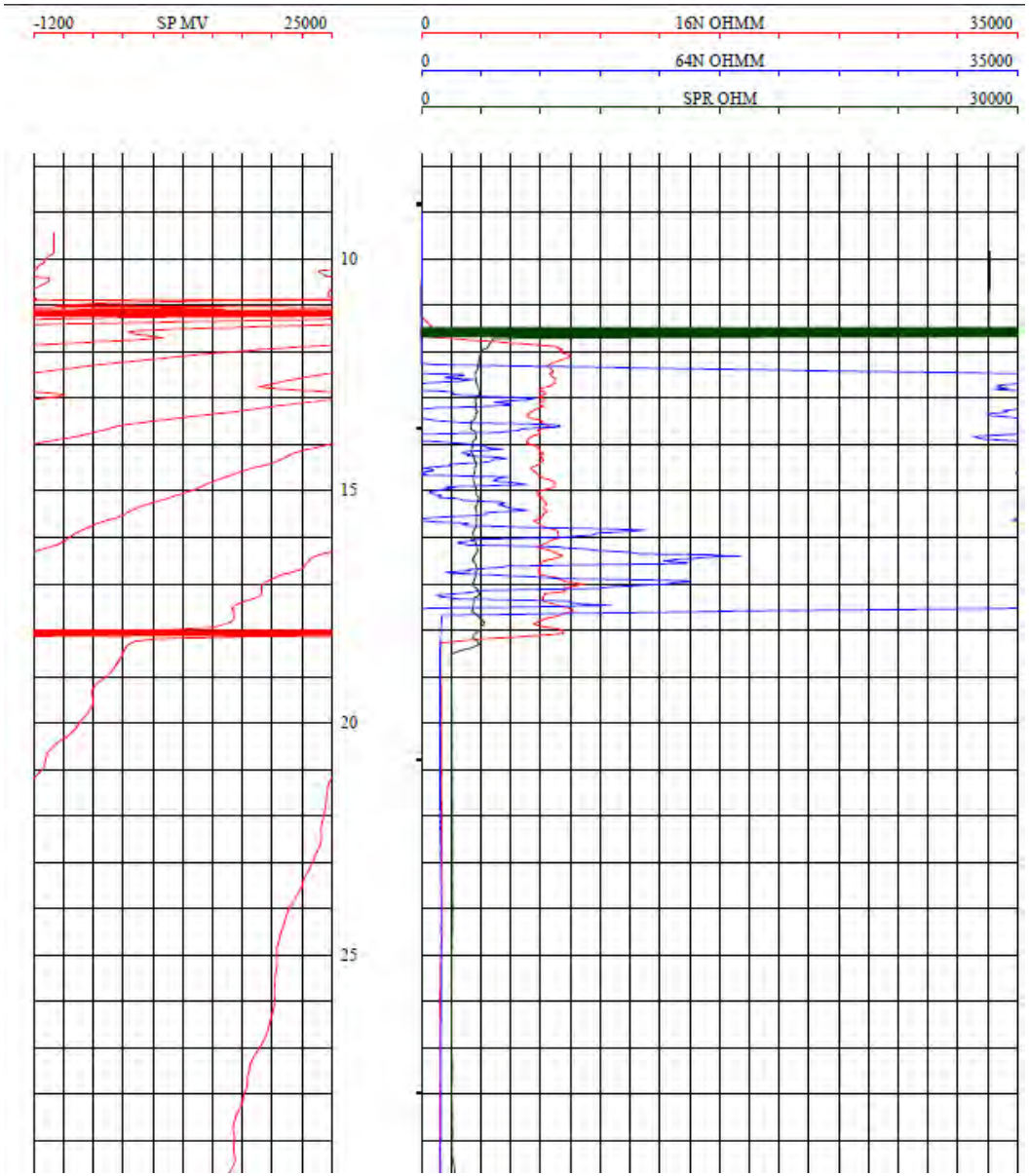
D_{60}:

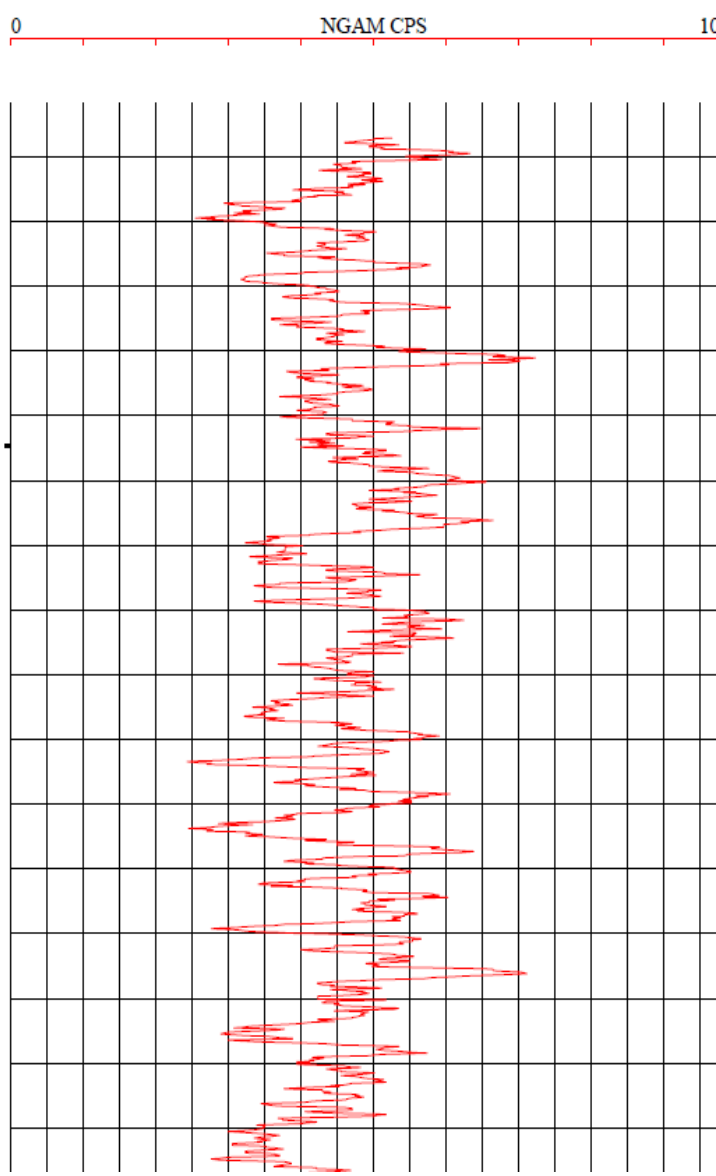
Drilling time log

- Useful supplement to test drilling
- Consists of an accurate record of the time, in minutes and seconds required to drill each unit of depth of the hole.
- Because the texture of a stratum being penetrated largely governs the drilling rate, a drilling time log may be readily interpreted in terms of formation types and depths.

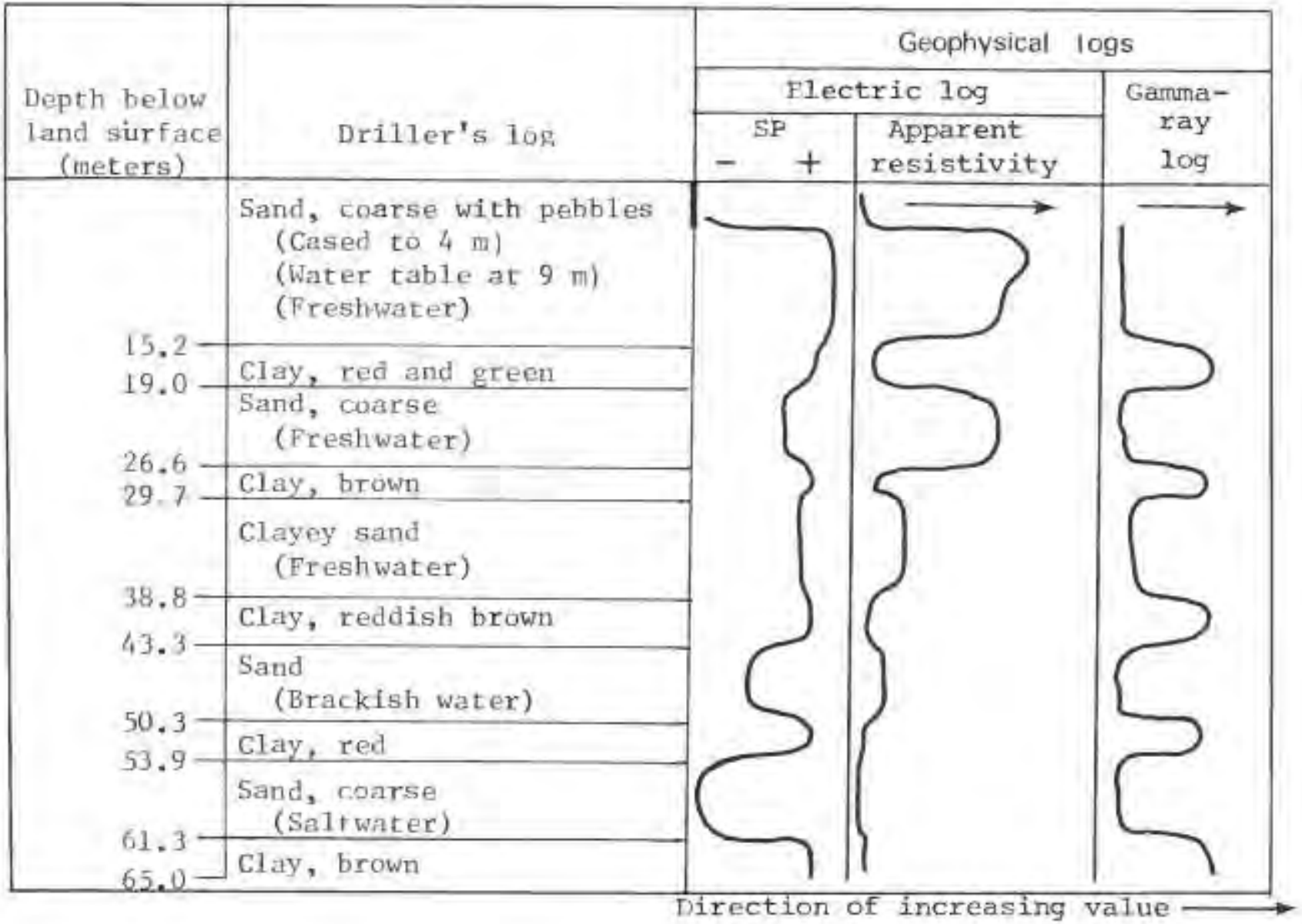


Geophysic Well Logging



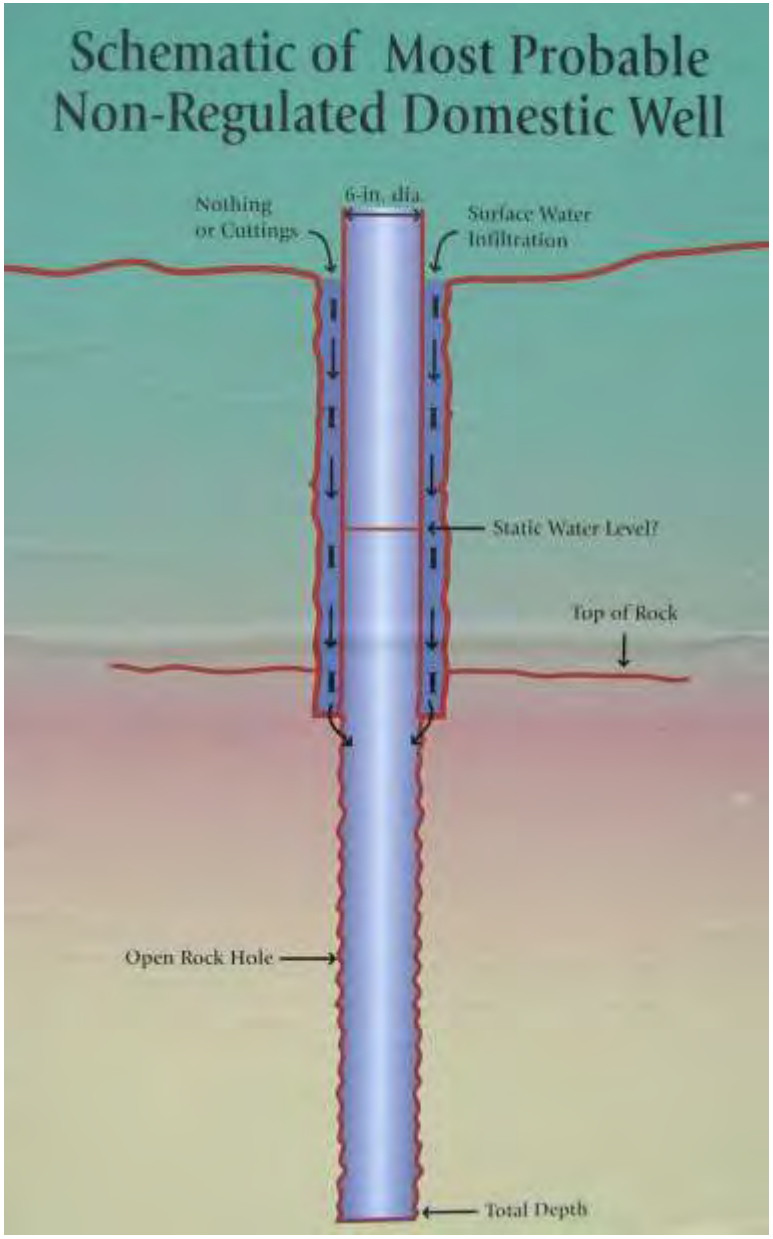


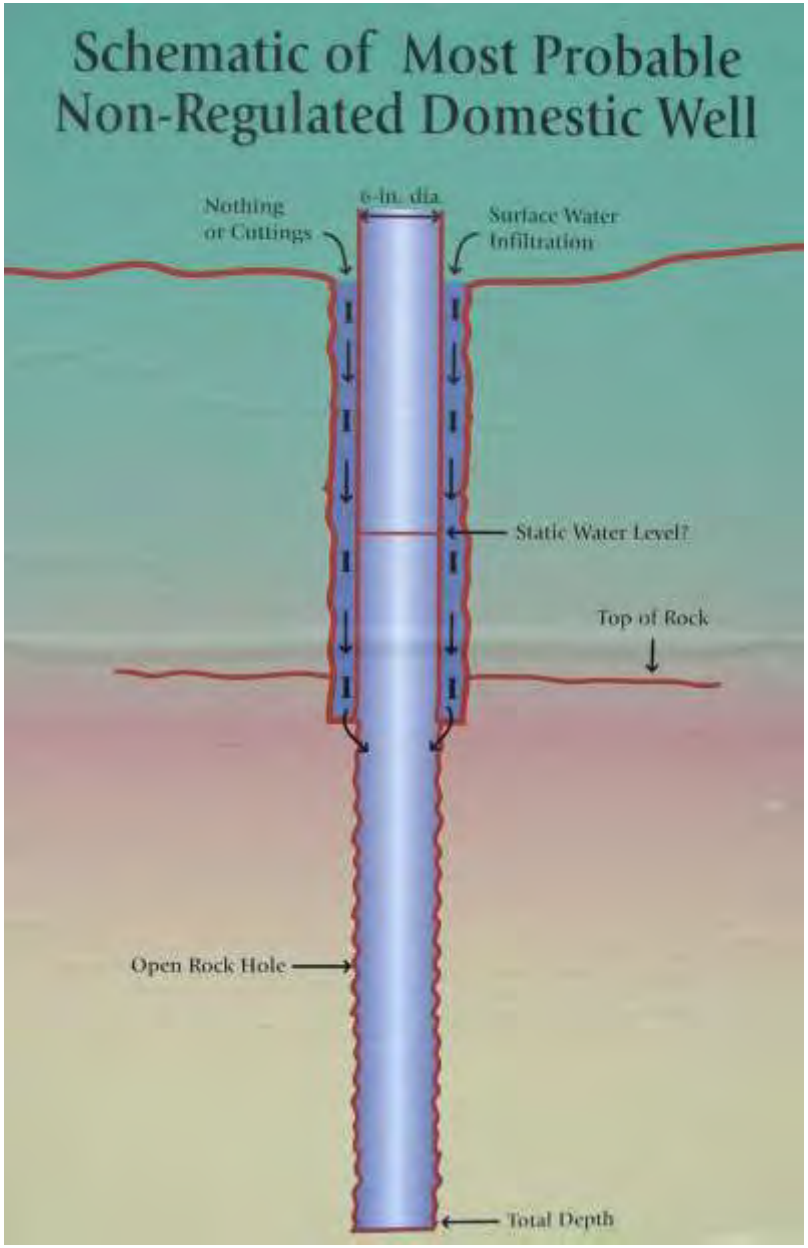
Geophysic Well Logging



Well Completion

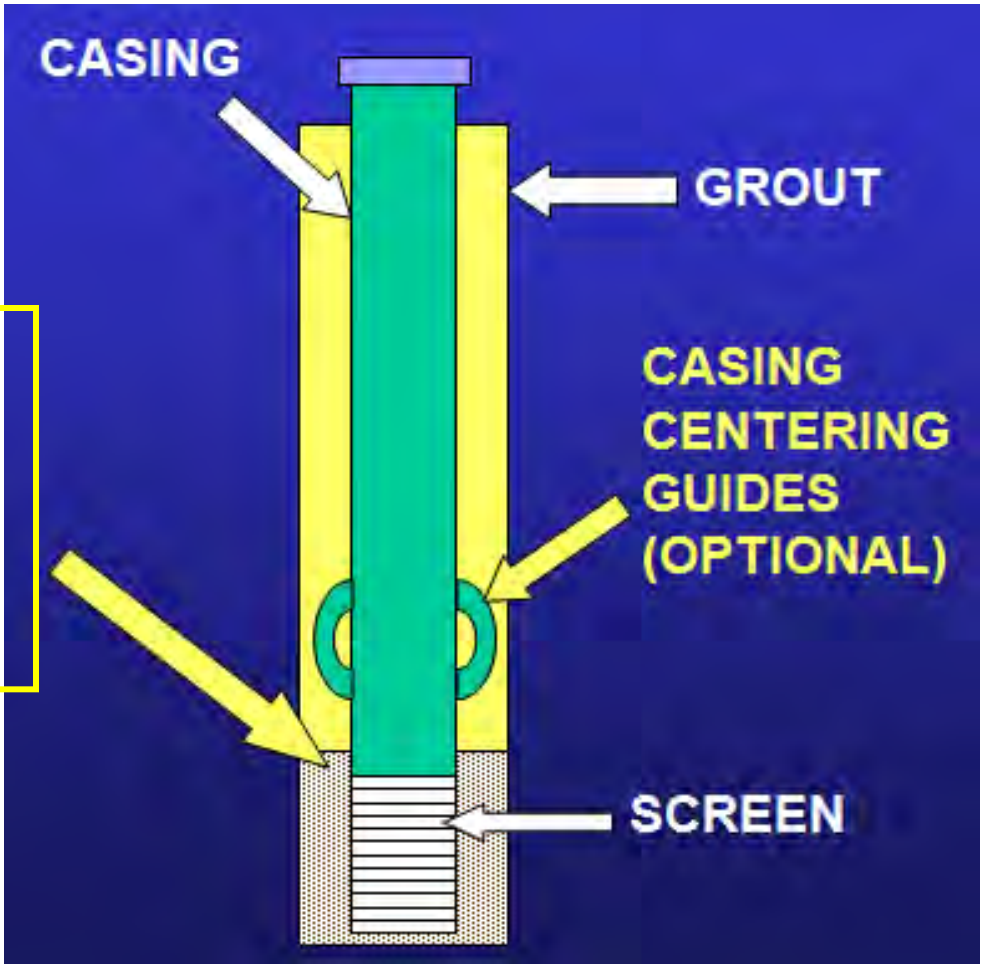

JAN 14 2008


Schematic of Most Probable
Non-Regulated Domestic Well
Nothing
or Cuttings
6-in. dia.
Surface Water
Infiltration
Static Water Level?
Top of Rock
Open Rock Hole
Total Depth


Schematic of Most Probable
Non-Regulated Domestic Well
Nothing
or Cuttings
6-in. dia.
Surface Water
Infiltration
Static Water Level?
Top of Rock
Open Rock Hole
Total Depth

Filter – packed well construction

Grave pack placed between borehole and screen



Temporary well cap - installed between well drilling and pump hook-up

Well Development

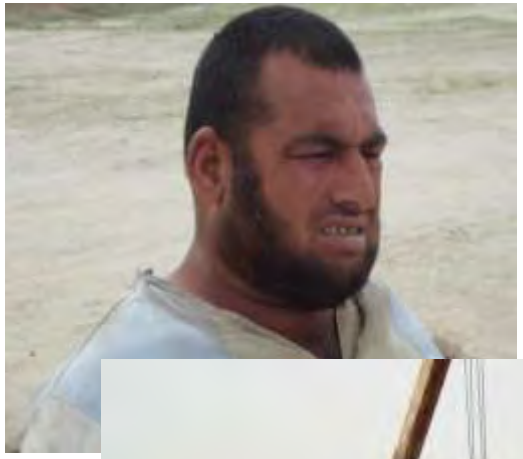
انتخاب نل های آب وهوا برای پاک کاری چاه توسط کمپرسور

درصورتیکه نل هوا داخل نل آب پایئن شود

بهره دهی (مترمکعب فی ساعت)	قطر نل آب و هوا به (ملی متر)		قطرچاه
	نل هوا	نل آب	
2.5	10	32	75
15	15	50	112
20 - 25	25	70	150
70 - 100	50	150	200
100 -150	70	200	250
150 -200	80	250	300

در صورتیکه نل هوا در پهلوی نل آب پایئن شده باشد

بهره دهی (مترمکعب فی ساعت)	قطر نل آب و هوا به (ملی متر)		قطرچاه
	نل هوا	نل آب	
3	15	32	75
8.5	20	50	112
20 - 25	30	70	150
30 -40	40	100	200
75 - 100	50	125	250
125 -175	80	150	300

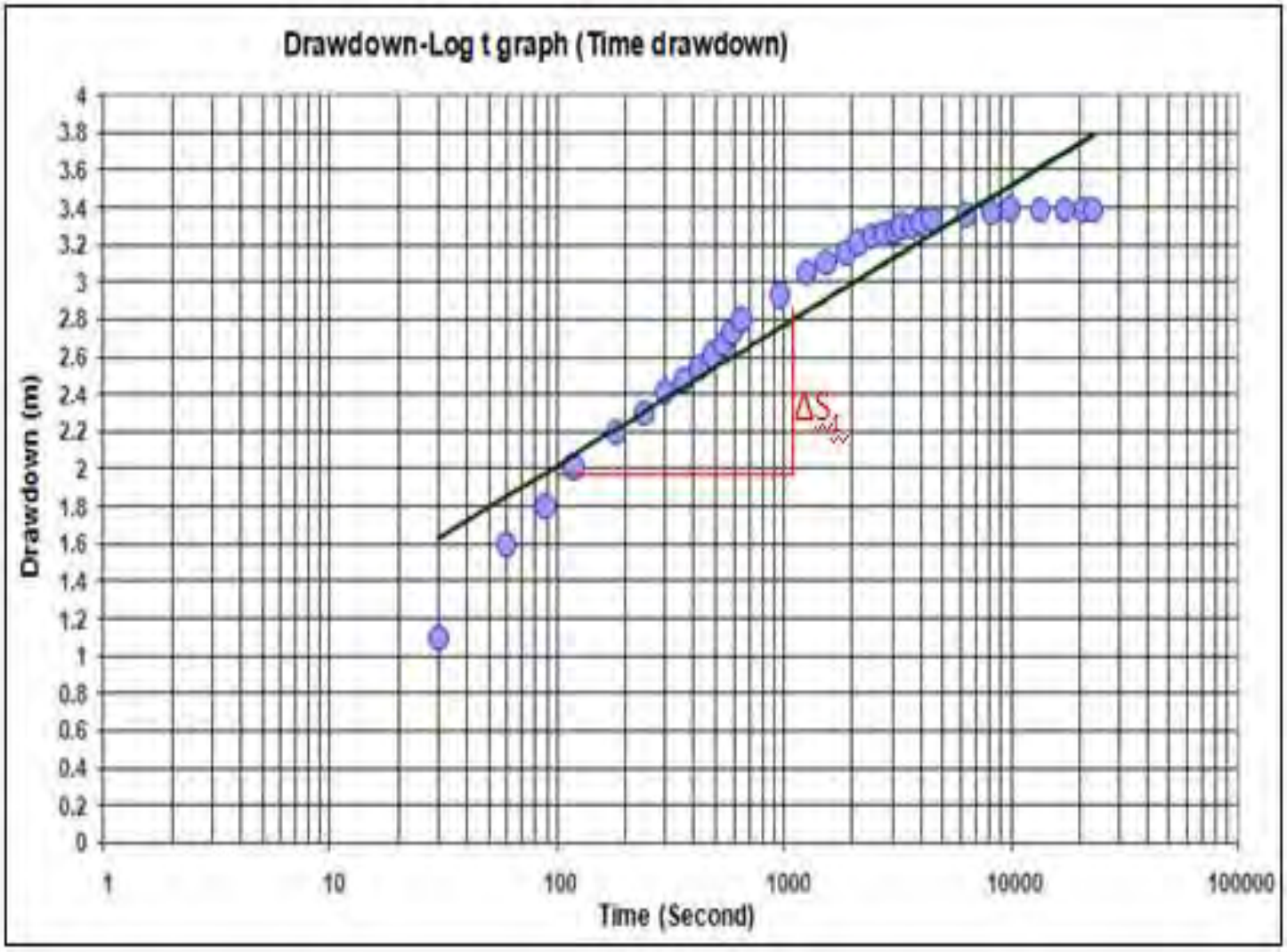


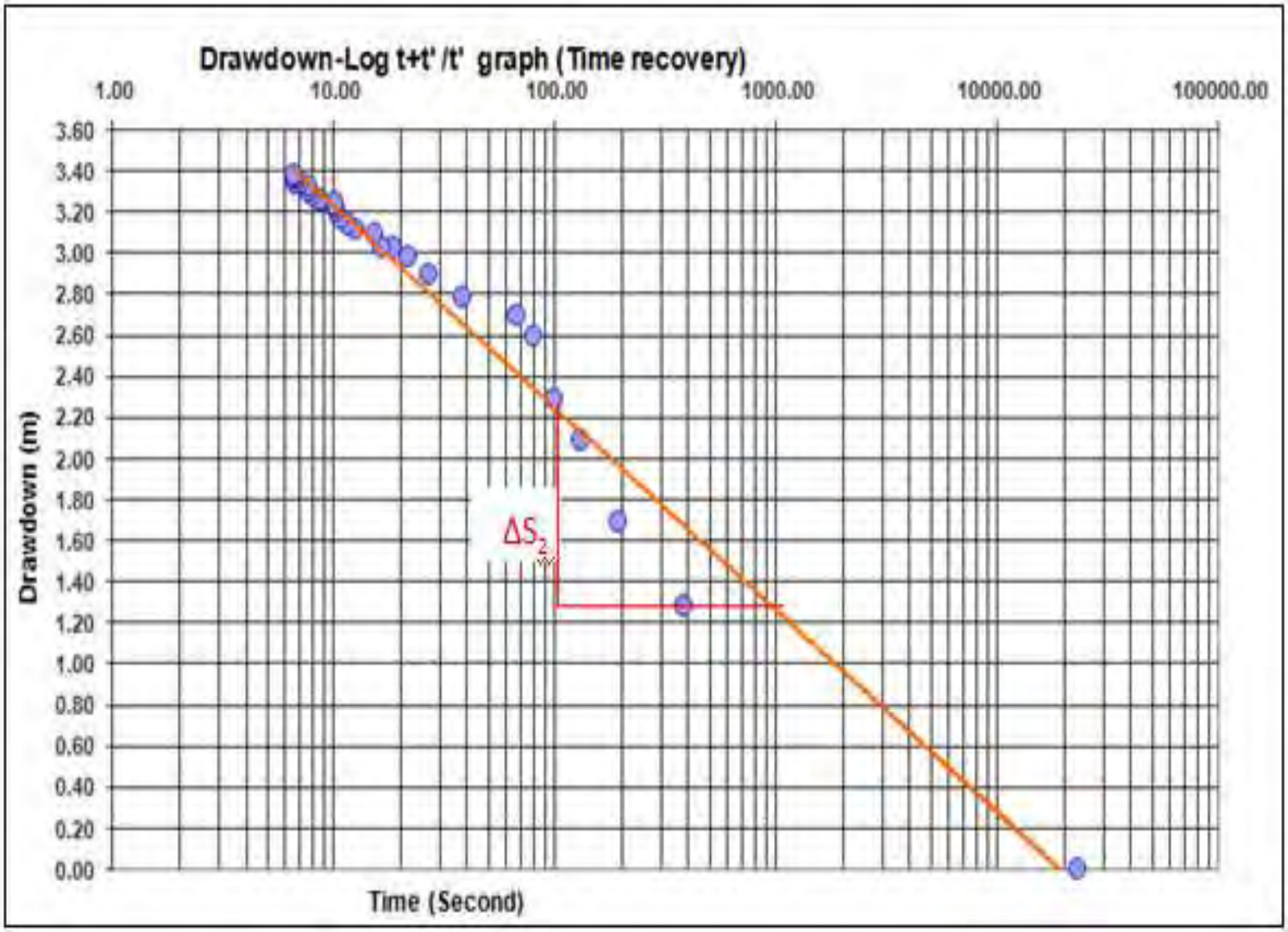
Pumping Test

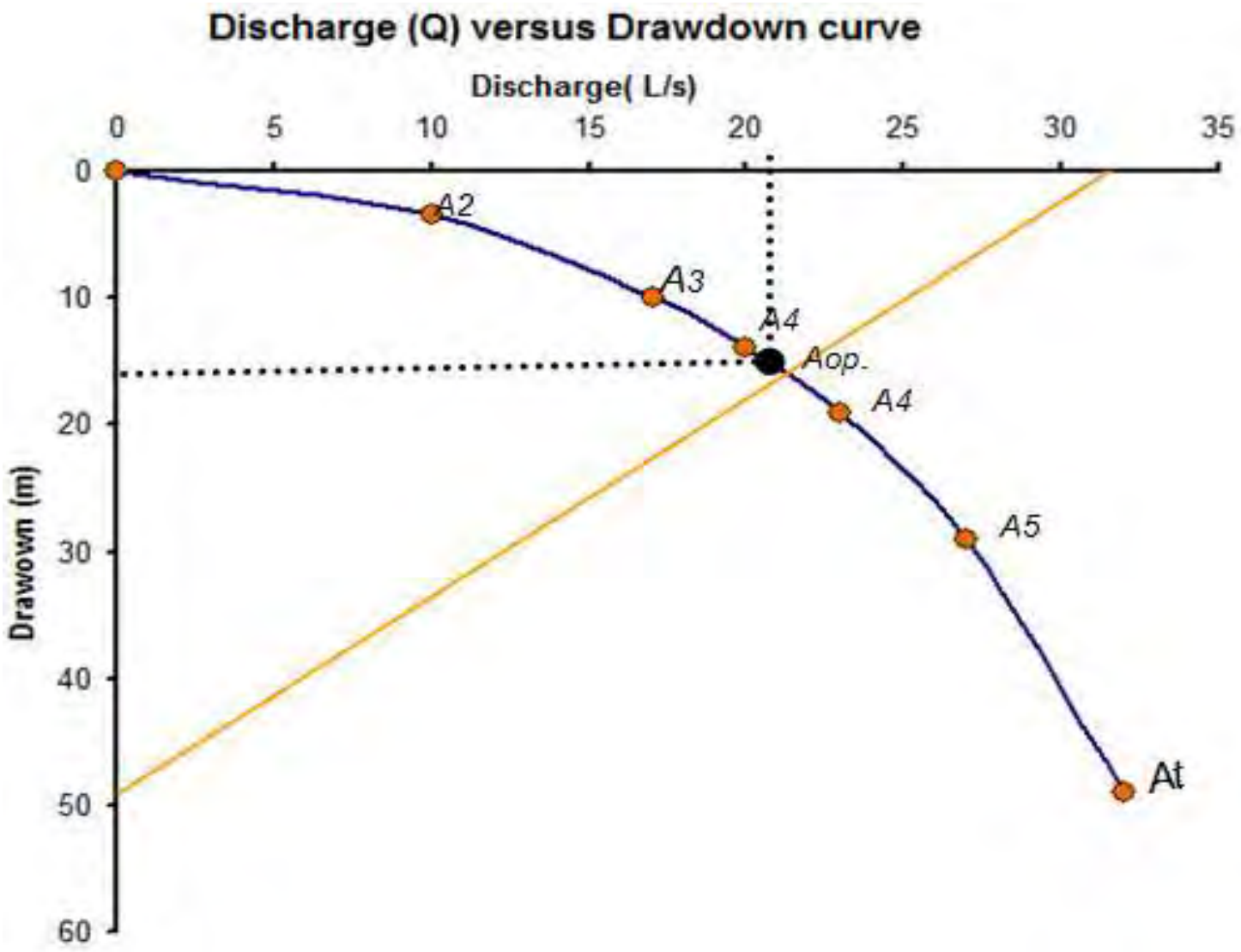
Pumping Test Data (Time Drawdown)

Well Location										
Province:		Balkh		Latitute:	36.64000					
District:		Chemtal		Longitute:	66.35125					
Village:		Mir Qasim Jan Agha		Elevation:	423					
No	Date	Time			Water Level (m)	Drawdown (m)	Discharge Q (L/s)	EC (µS/cm)	pH	T°C
		Hour	Min	Sec						
1	01/06/2012	8:30:00	0	0	70.9	0	10	916.00	7.17	17.5
2		8:30:30	0.5	30	72	1.1				
3		8:31:30	1	60	72.5	1.6				
4		8:33:00	1.5	90	72.7	1.8				
5		8:35:00	2	120	72.9	2				
6		8:38:00	3	180	73.1	2.2				
7		8:42:00	4	240	73.2	2.3				
8		8:47:00	5	300	73.31	2.41				
9		8:53:00	6	360	73.38	2.48				
10		9:00:00	7	420	73.44	2.54				
11		9:08:00	8	480	73.5	2.6				
12		9:09:00	9	540	73.57	2.67				
13		9:10:00	10	600	73.63	2.73				
14		9:11:00	11	660	73.7	2.8				
15		9:16:00	16	960	73.82	2.92				
16		9:21:00	21	1260	73.95	3.05				
17		9:26:00	26	1560	74.01	3.11				
18		9:31:00	31	1860	74.06	3.16				
19		9:36:00	36	2160	74.1	3.2				
20		9:41:00	41	2460	74.15	3.25				
21		9:46:00	46	2760	74.16	3.26				

Well Location										
Province:		Balkh		Latitute:		36.64000				
District:		Chemtal		Longitute:		66.35125				
Village:		Mir Qasim Jan Aghe		Elevation:		423				
No	Date	Time			Recovery (m)	t (min)	t' (min)	t/t' (min)	S' (m)	
		Hour	Min	t' (Sec)						
34	6/1/2012	6:26:00	0	0	74.29	23160	0	23160.00	0.00	
35		6:27:00	1	60	73.01	23220	60	387.00	1.28	
36		6:28:00	2	120	72.60	23340	120	194.00	1.69	
37		6:29:00	3	180	72.20	23520	180	130.00	2.09	
38		6:30:00	4	240	72.00	23760	240	99.00	2.29	
39		6:30:00	5	300	71.70	24060	300	80.20	2.59	
40		6:31:00	6	360	71.60	24420	360	67.80	2.69	
41		6:03:00	11	660	71.51	25080	660	38.00	2.78	
42		6:37:00	16	960	71.40	26040	960	27.12	2.89	
43		6:47:00	21	1260	71.31	27300	1260	21.60	2.98	
44		6:52:00	26	1560	71.27	28860	1560	18.50	3.02	
45		6:57:00	31	1860	71.26	30720	1860	16.50	3.03	
46		7:02:00	36	2160	71.20	32880	2160	15.22	3.09	
47		7:02:00	46	2760	71.18	35640	2760	12.55	3.11	
48		7:12:00	56	3360	71.15	39000	3360	11.60	3.14	
49		7:22:00	66	3960	71.12	42960	3960	10.80	3.17	
50		7:32:00	76	4560	71.09	47520	4560	10.42	3.20	
51		7:42:00	86	5160	71.07	52680	5160	10.20	3.22	
52		7:52:00	96	5760	71.05	58440	5760	10.14	3.24	
53		8:22:00	126	7560	71.03	66000	7560	8.73	3.26	
54		8:52:00	156	9360	71.01	75360	9360	8.05	3.28	
55		9:22:00	186	11160	70.99	86520	11160	7.75	3.30	
56		9:52:00	216	12960	70.97	99480	12960	7.67	3.32	
57		9:52:00	276	16560	70.96	116040	16560	7.00	3.33	
58		10:52:00	336	20160	70.95	136200	20160	6.75	3.34	
59		11:52:00	396	23760	70.93	159960	23760	6.73	3.36	
60		12:52:00	456	27360	70.92	187320	27360	6.72	3.37	
61		13:52:00	510	30600	70.90	217920	30600	6.63	3.38	

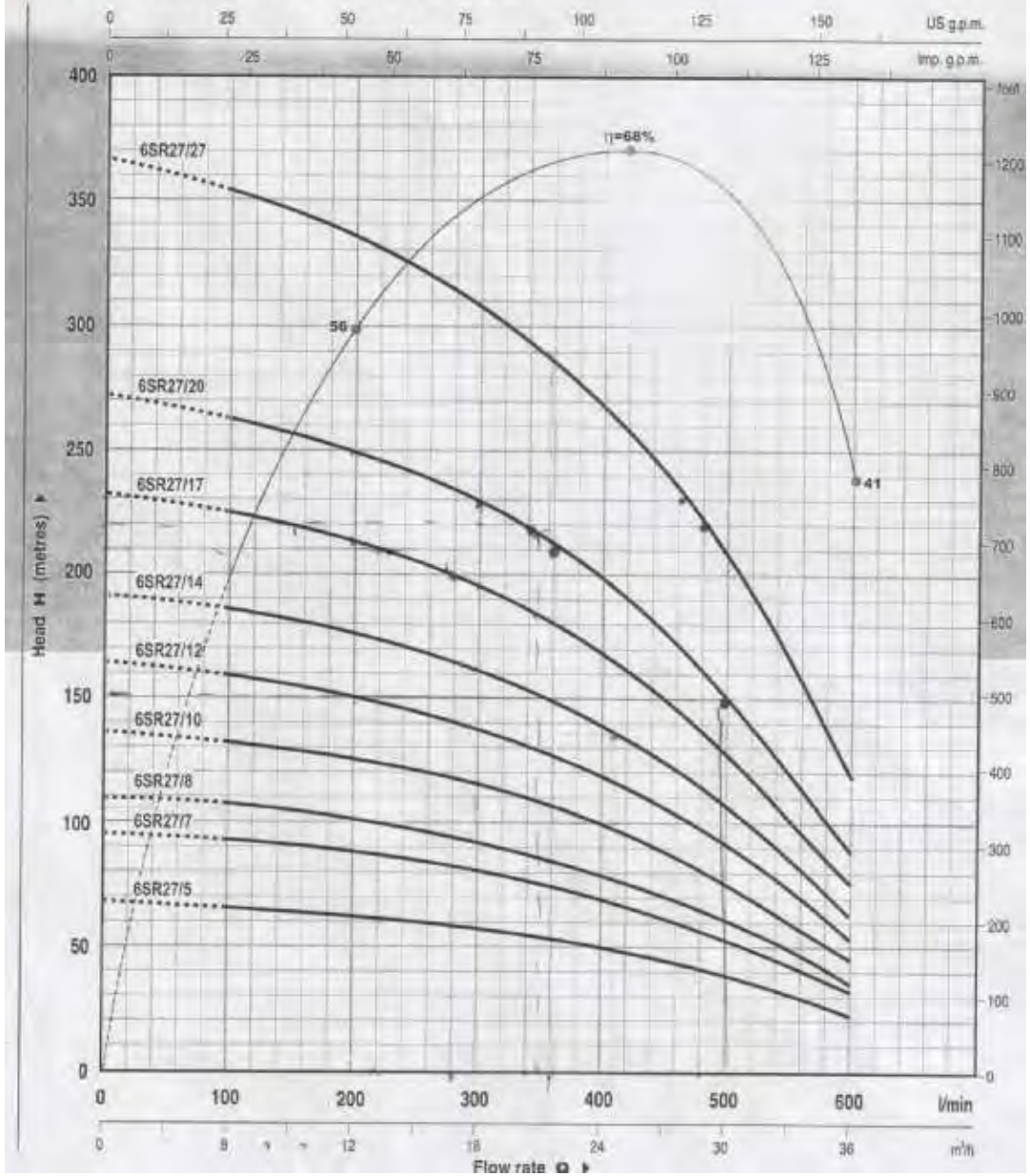

Drawdown-Log t graph (Time drawdown)
Drawdown (m)
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
ΔS
1
10
100
1000
10000
100000
Time (Second)


Drawdown-Log t+t' /t' graph (Time recovery)
1.00
10.00
100.00
1000.00
10000.00
100000.00
3.60
3.40
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Drawdown (m)
ΔS2
Time (Second)


Discharge (Q) versus Drawdown curve
Discharge(L/s)
0
5
10
15
20
25
30
35
Drawown (m)
0
10
20
30
40
50
60
A2
A3
A4
Aop.
A4
A5
At

6SR27

CURVES AND PERFORMANCE DATA AT n= 2900 1/min



TYPE	POWER		Q m³/h	0	6	12	18	24	30	36
Three-phase	KW	HP	l/min	0	100	200	300	400	500	600
6SR27/5	5.5	7.5	H metres	68	66	62	57	50	37	22
6SR27/7	7.5	10		95	92	87	80	70	52	31
6SR27/8	9.2	12.5		109	106	99	91	80	59	35
6SR27/10	(11)	15		135	132	124	114	100	74	44
6SR27/12	13	17.5		164	159	149	137	120	89	53
6SR27/14	(15)	20		191	185	(174)	160	140	104	62
6SR27/17	18.5	25		231	224	211	194	170	126	75
6SR27/20	22	30		272	264	249	228	200	148	88
6SR27/27	30	40		357	346	325	300	270	205	119

Q = Flow rate H = Total manometric head

Tolerances of the performance curves according to EN ISO 9906 App. A

Thank your for your attention