Ventura River Basin: Surface and Groundwater Interaction The MOWD Study, Winter-Spring 2012

Ventura River Watershed Council

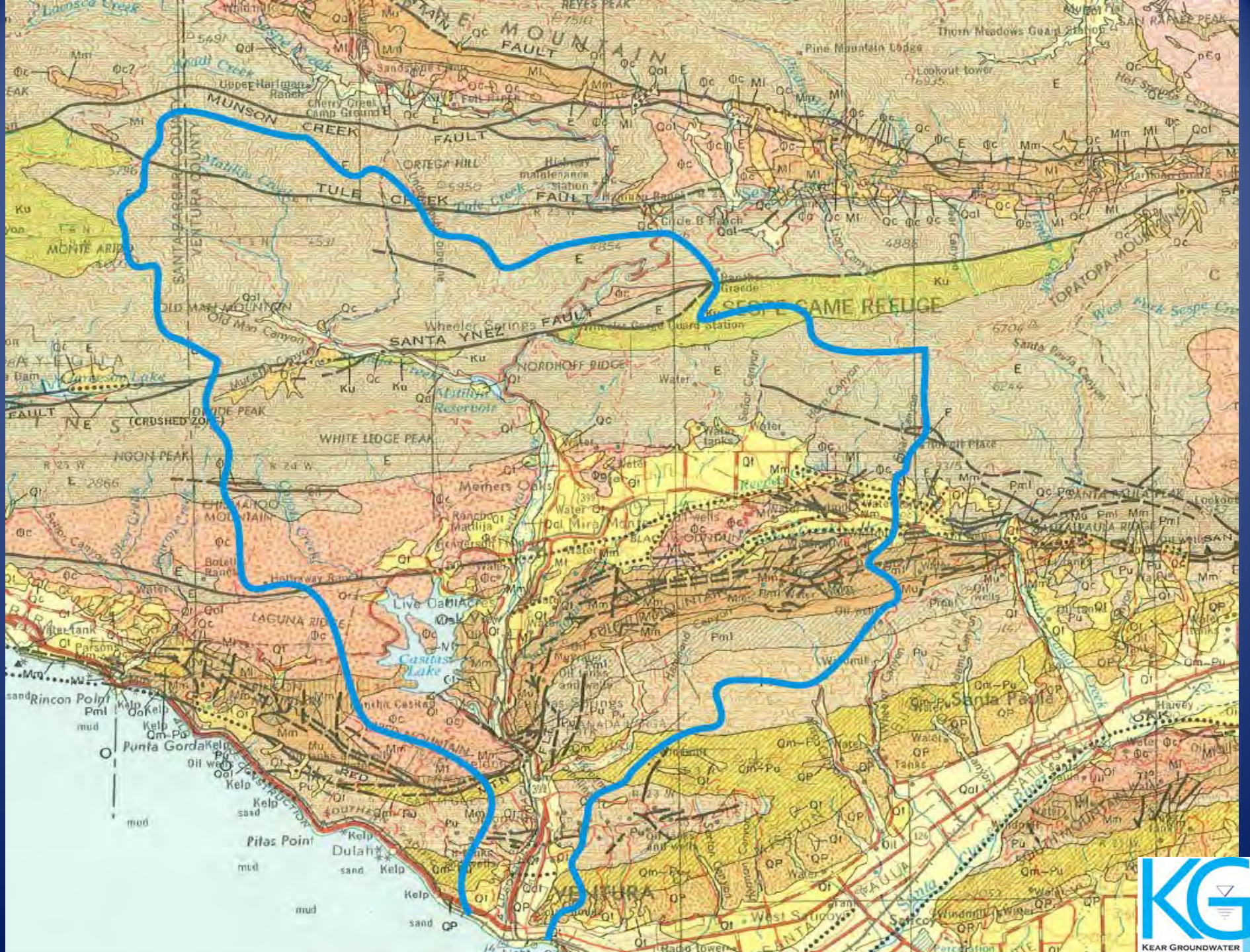
Jordan Kear, PG, CHG

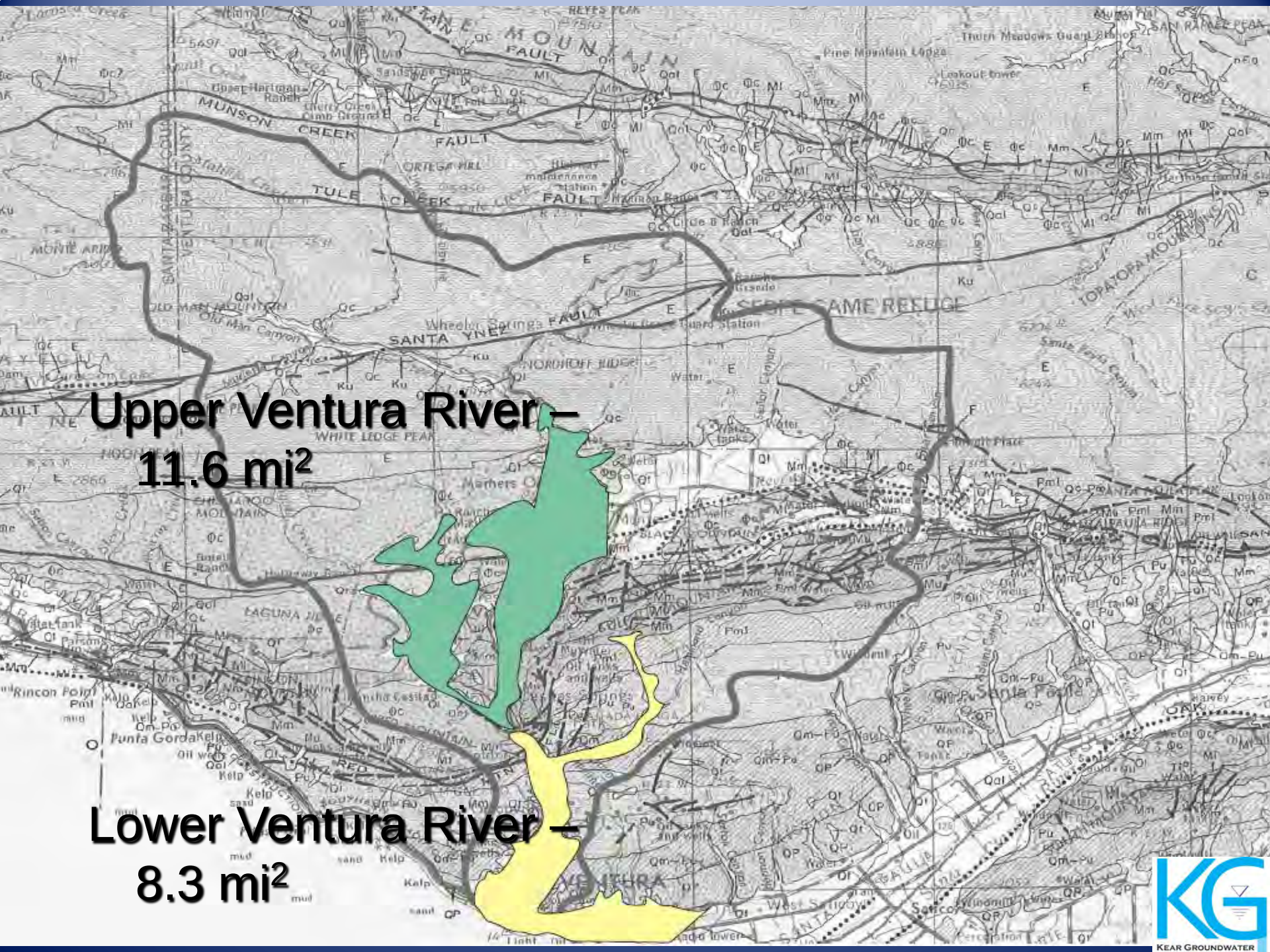
17 July 2012

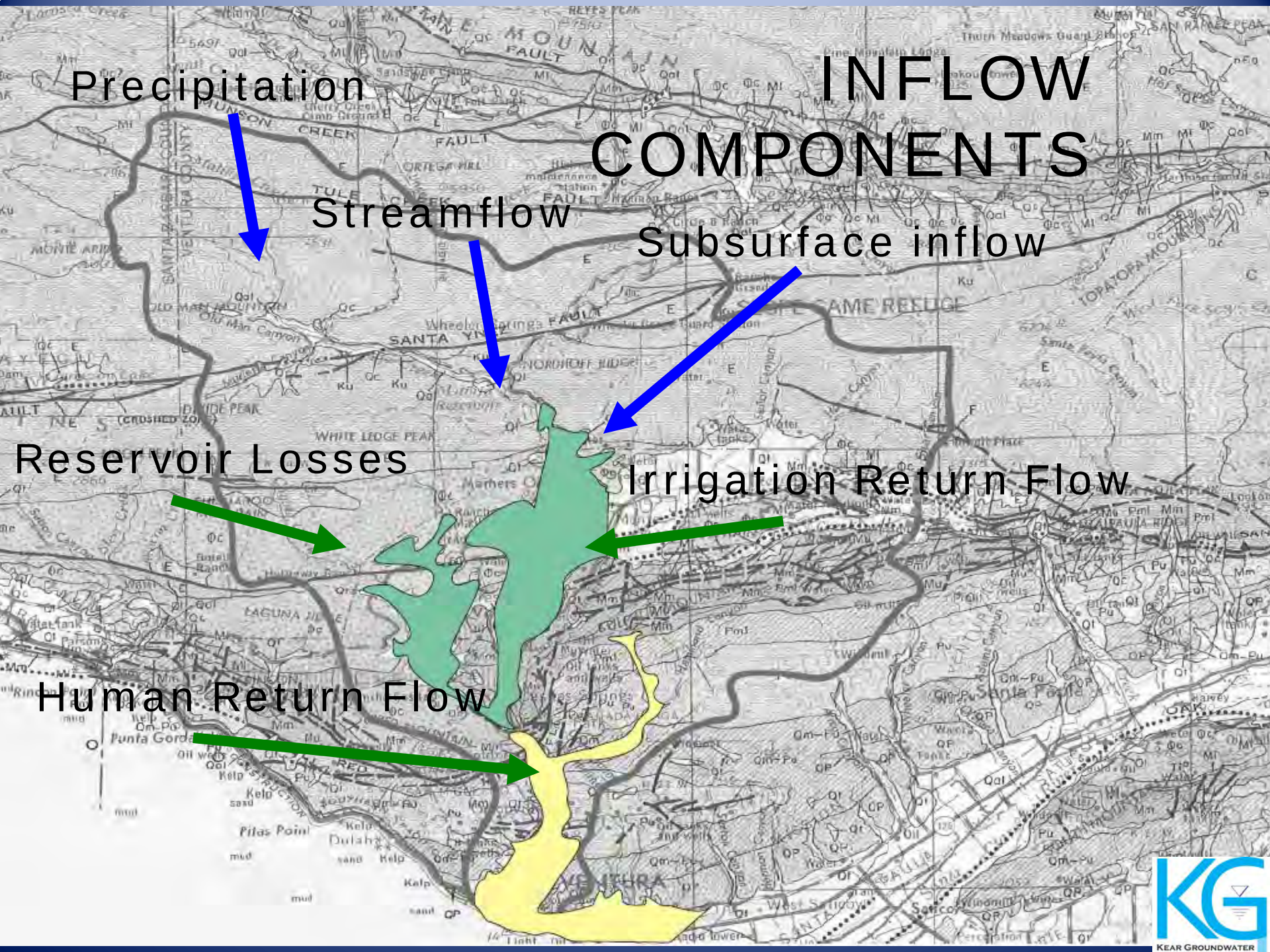
Summary and Conclusions

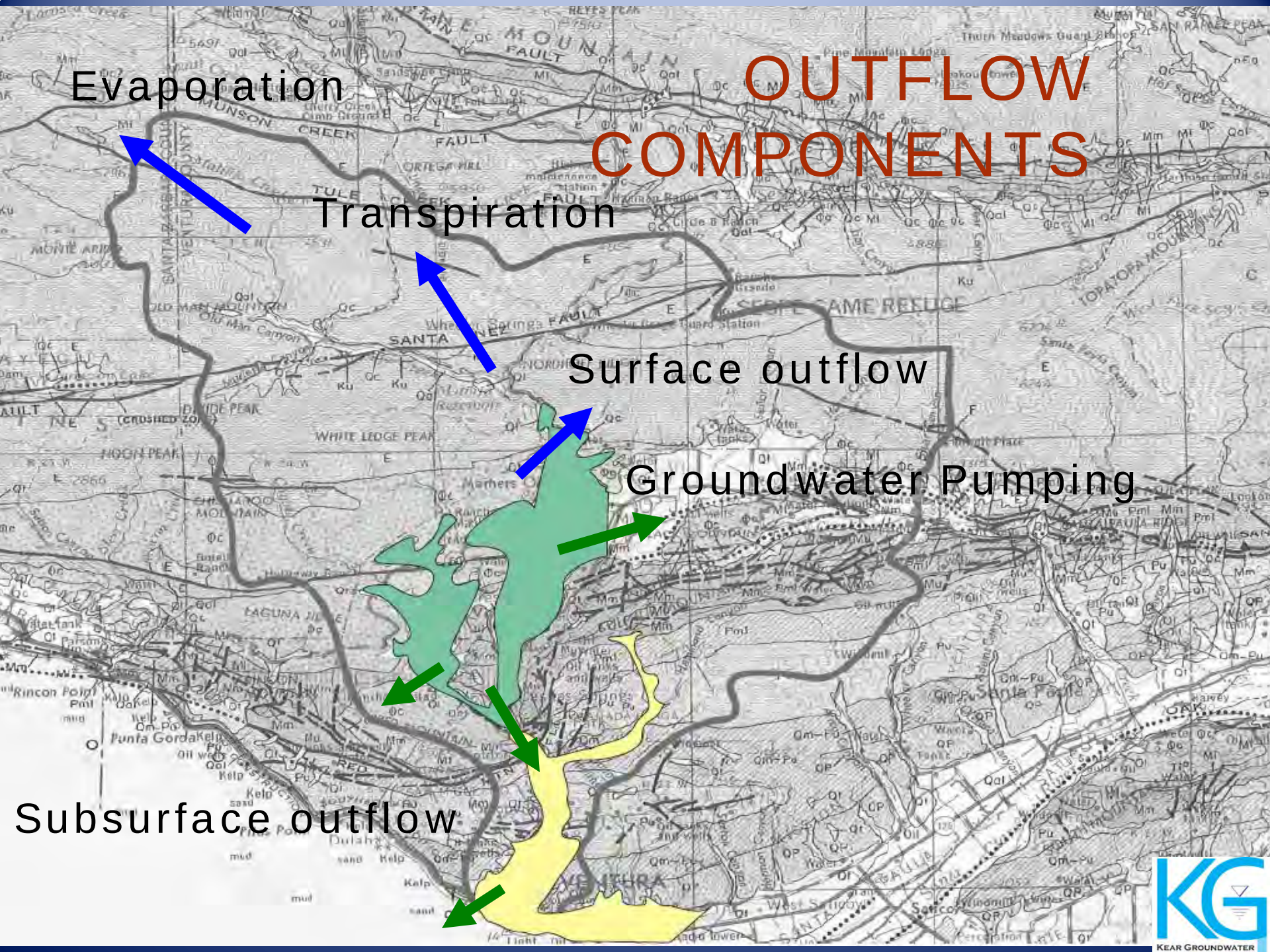
- Pumping of wells has relatively minor acute effect on river flow
- Diurnal temperature changes have significant effect on river flow
- River flow and saturated groundwater body shape appears to be more influenced by aquifer morphology than any other single factor
- River will go dry in Robles Reach each year regardless of pumping practices via groundwater wells

KEAR GROUNDWATER

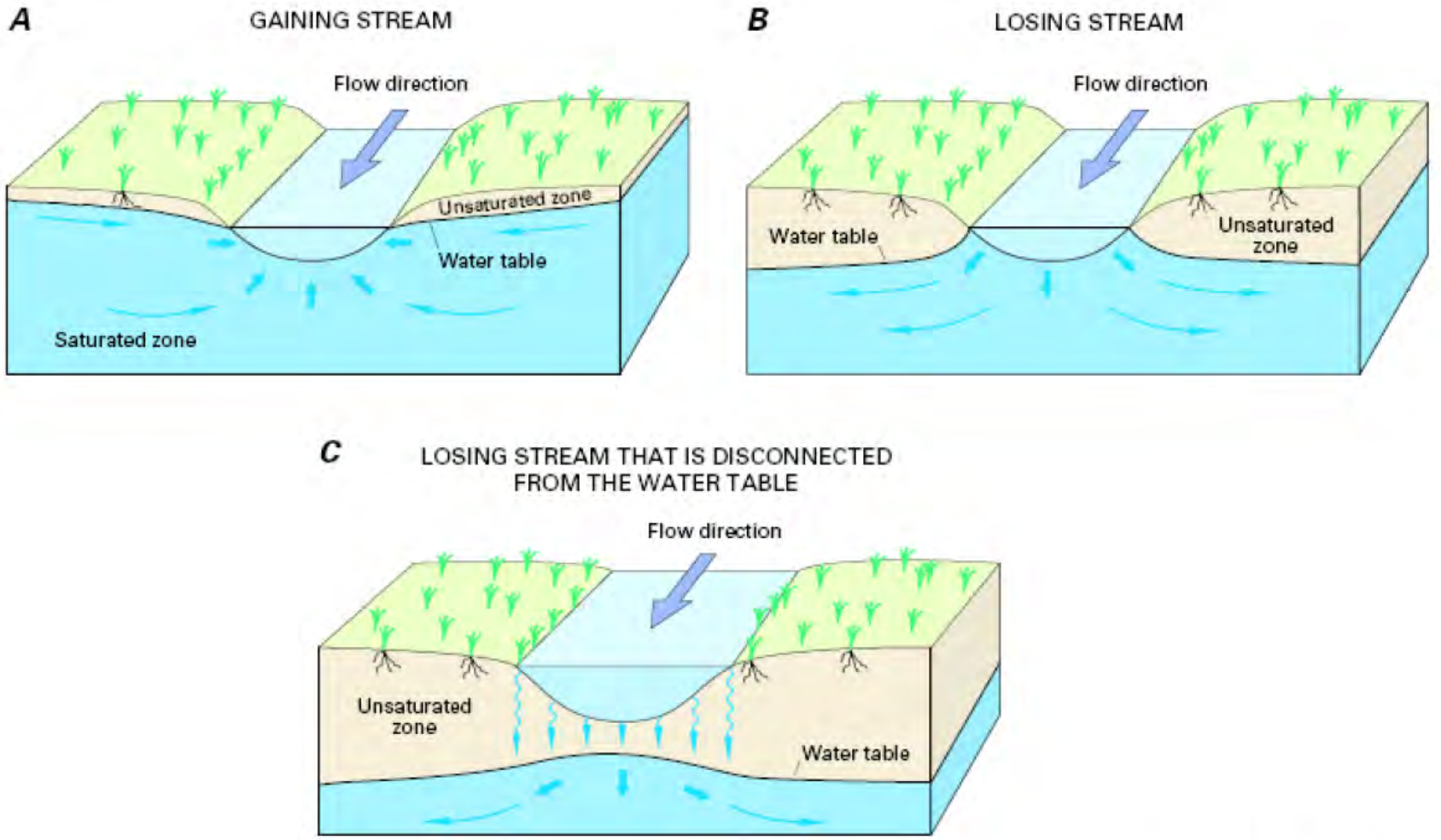

MUNSON CREEK FAULT
TULE CREEK FAULT
Wheeler Springs FAULT
SANTA YNEZ FAULT
SANTA BARBARA COUNTY
VENTURA COUNTY
ORTEGA HILL
NORDHOFF RIDGE
WHITE LEDGE PEAK
NOON PEAK
Lake Casitas
Rincon Point
Punta Gorda
Pitas Point
Dulah
VENTURA
Santa Paula
SESPE GAME REFUGE
TOPATOPA MOUNTAINS
Pine Mountain Lodge
Thorn Meadows Guard Station
Lookout tower
Upper Harlmann Ranch
Cherry Creek Camp Ground
Sandspring Camp
Clyde B Ranch
Old Man Canyon
Matilija Reservoir
Live Oak Place
Mothers Oaks
Rancho Matilija
Hathaway Ranch
Botell Ranch
LAGUNA RIDGE
Casitas Lake
Harvey
OAK
Kelp
mud
sand


Upper Ventura River – 11.6 mi²
Lower Ventura River – 8.3 mi²


INFLOW COMPONENTS
Precipitation
Streamflow
Subsurface inflow
Reservoir Losses
Irrigation Return Flow
Human Return Flow


OUTFLOW COMPONENTS
Evaporation
Transpiration
Surface outflow
Groundwater Pumping
Subsurface outflow

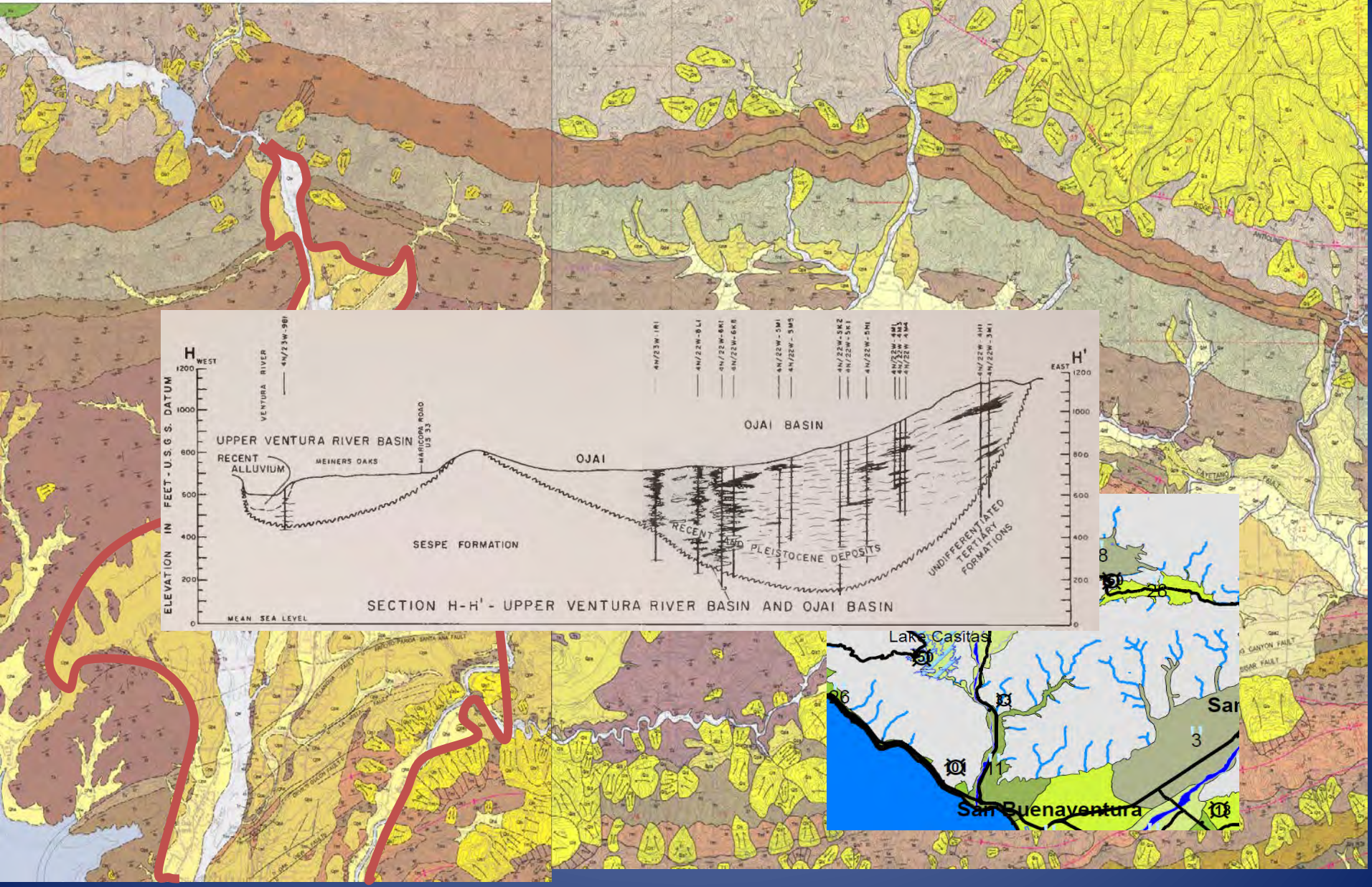
Basic Types of
Surface & Groundwater Interaction



(USGS Circular 11

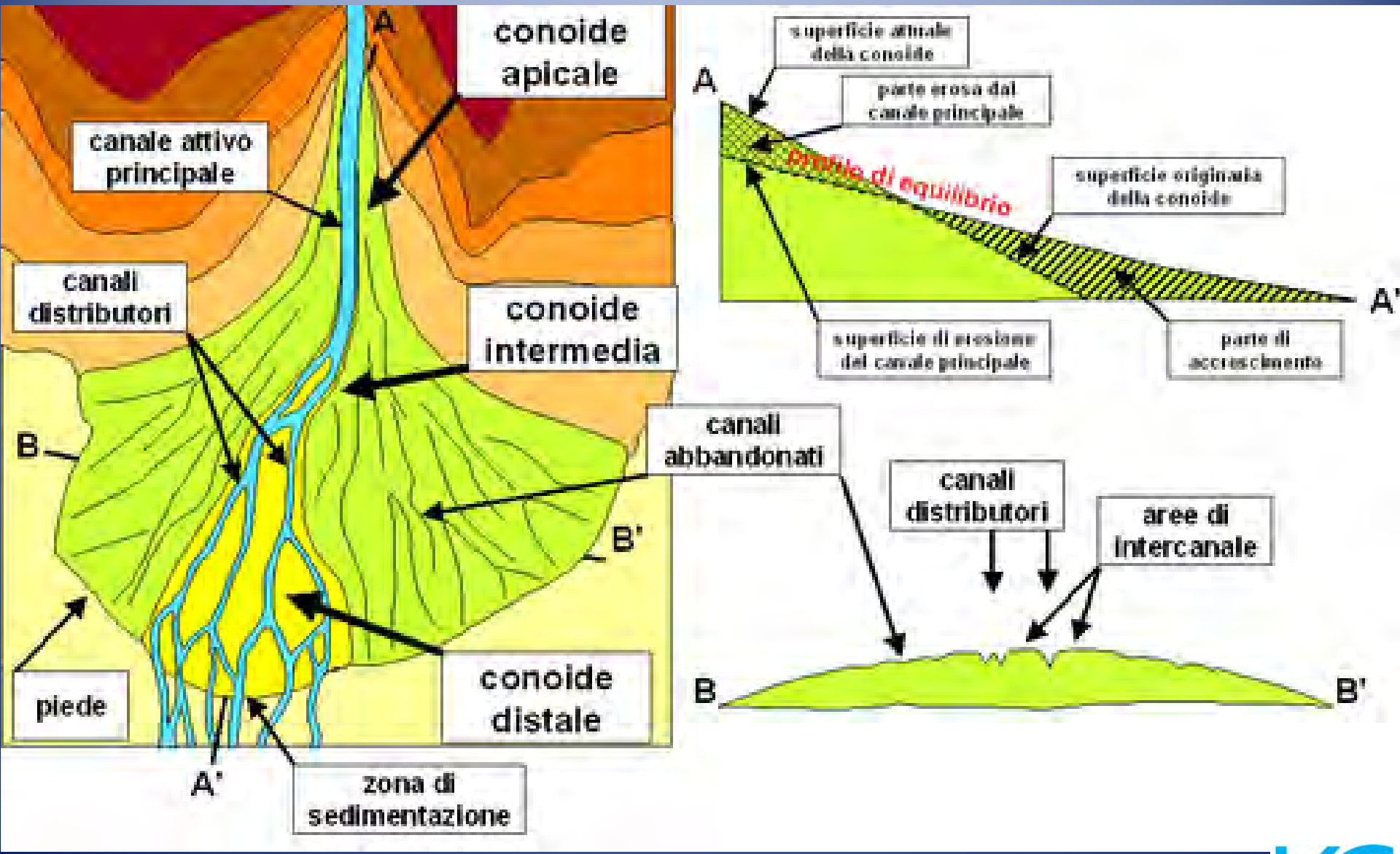
KEAR GROUNDWATER

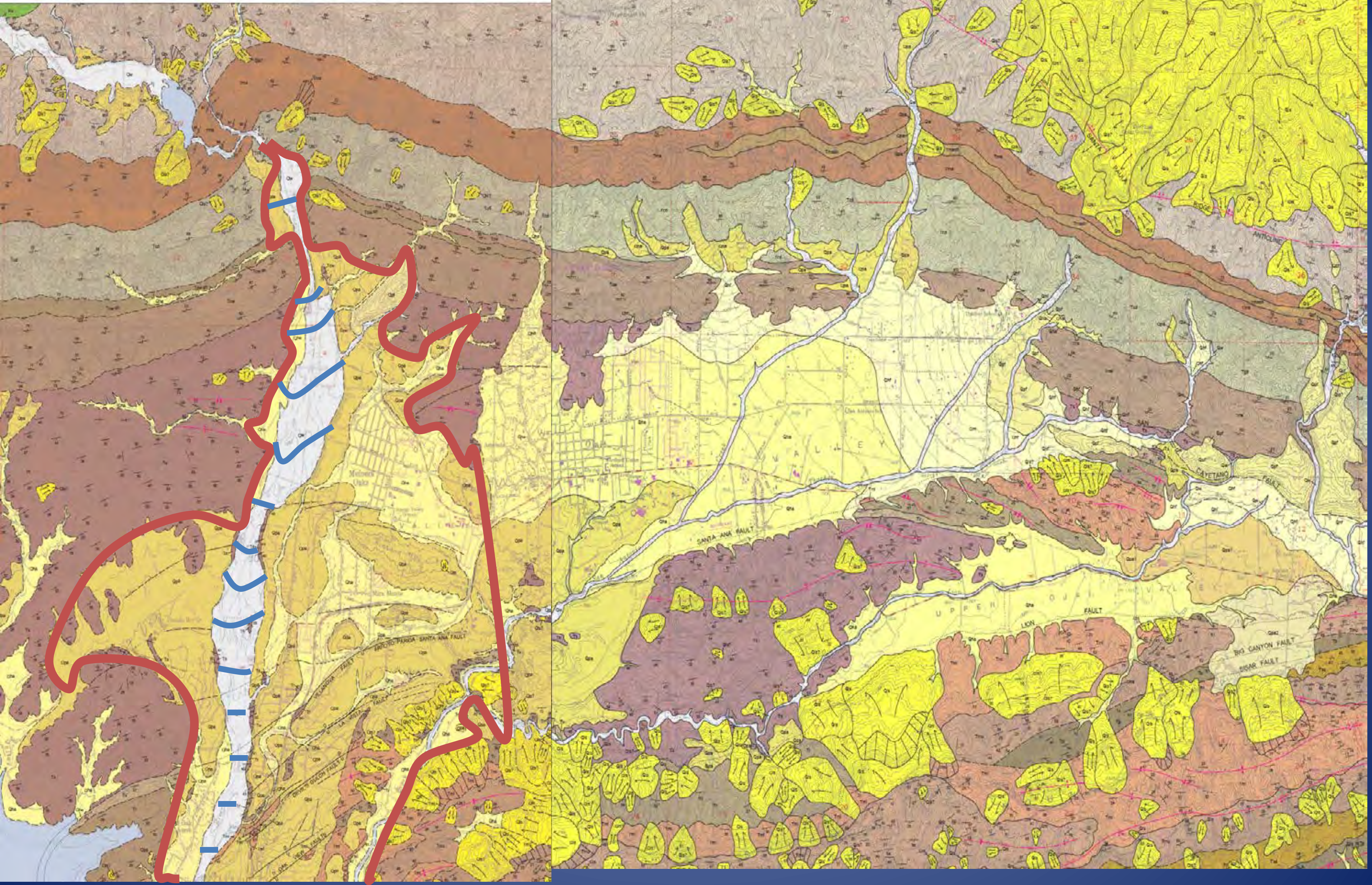

Gaining Stream
Losing Stream
Disconnected Stream
Absent Stream
Robles Reach
Gaining Stream



After Tan and Jones, 2006 and Tan and Irvine, 2005

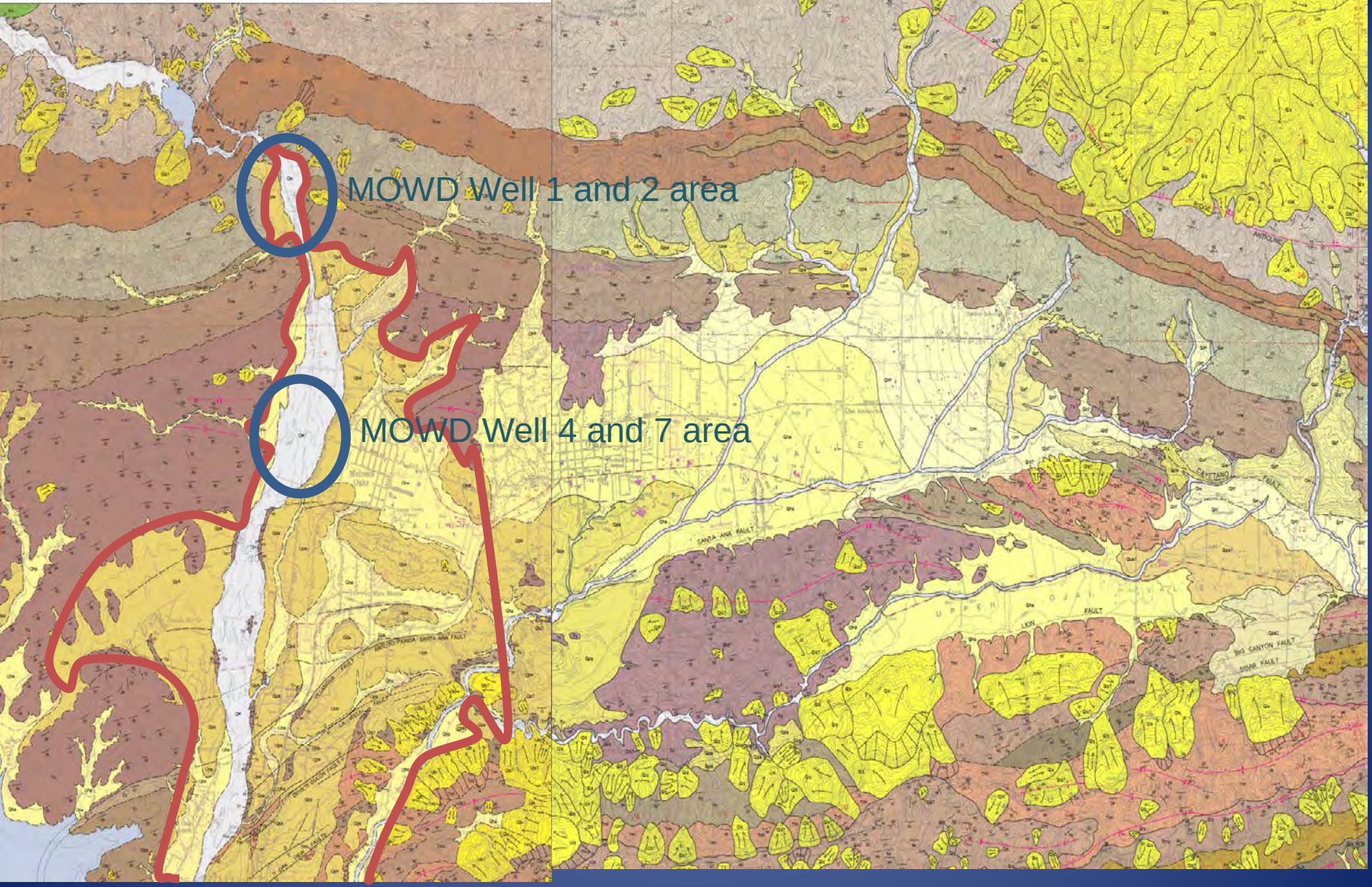
KEAR GROUNDWATER


A
conoide apicale
canale attivo principale
canali distributori
conoide intermedia
B
B'
canali abbandonati
piede
conoide distale
A'
zona di sedimentazione
superficie attuale della conoide
A
parte erosa dal canale principale
profilo di equilibrio
superficie originaria della conoide
A'
superficie di erosione del canale principale
parte di accrescimento
canali distributori
aree di intercanale
B
B'



After Tan and Jones, 2006 and Tan and Irvine, 2005

KEAR GROUNDWATER

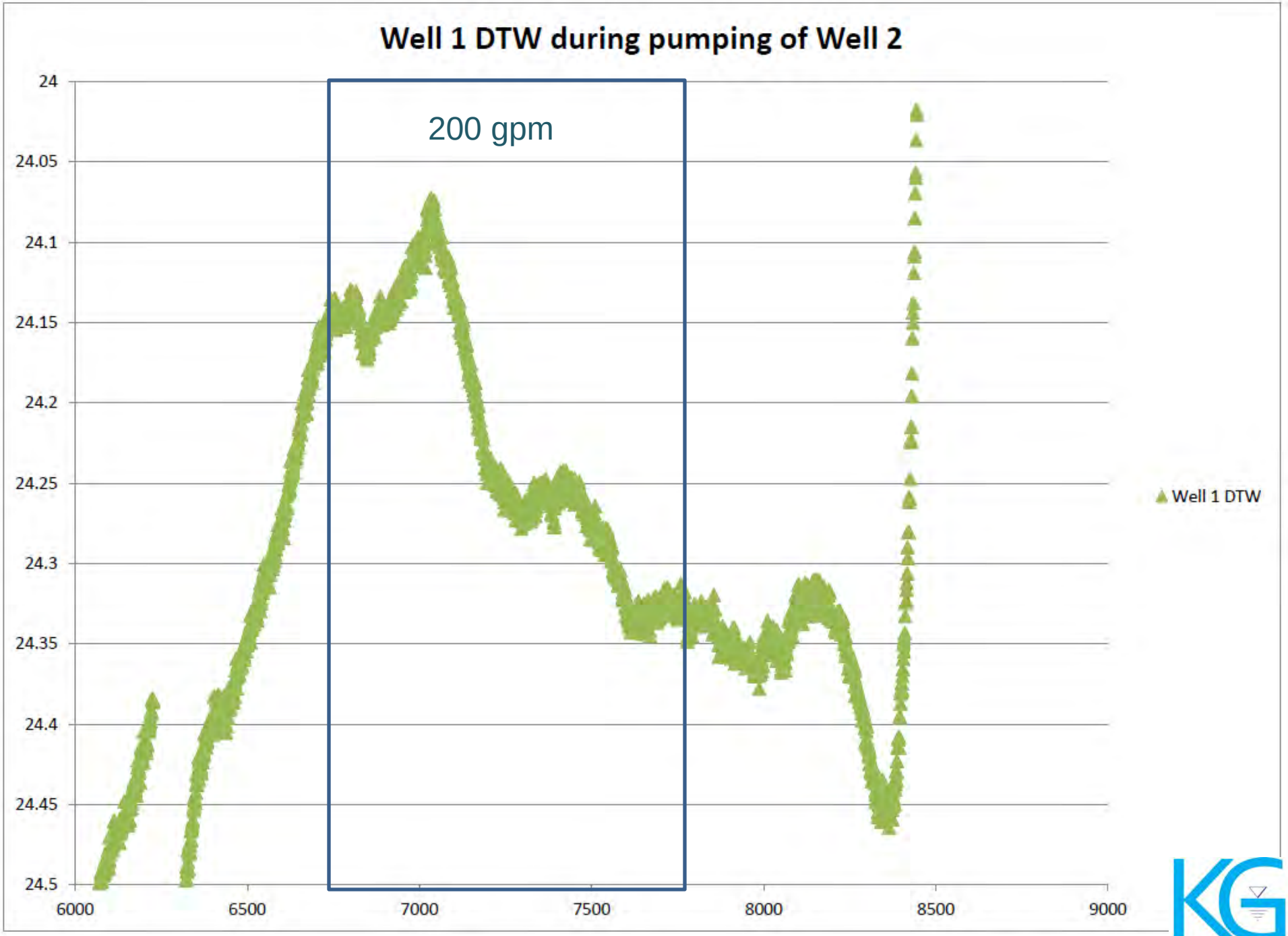


After Tan and Jones, 2006 and Tan and Irvine, 2005

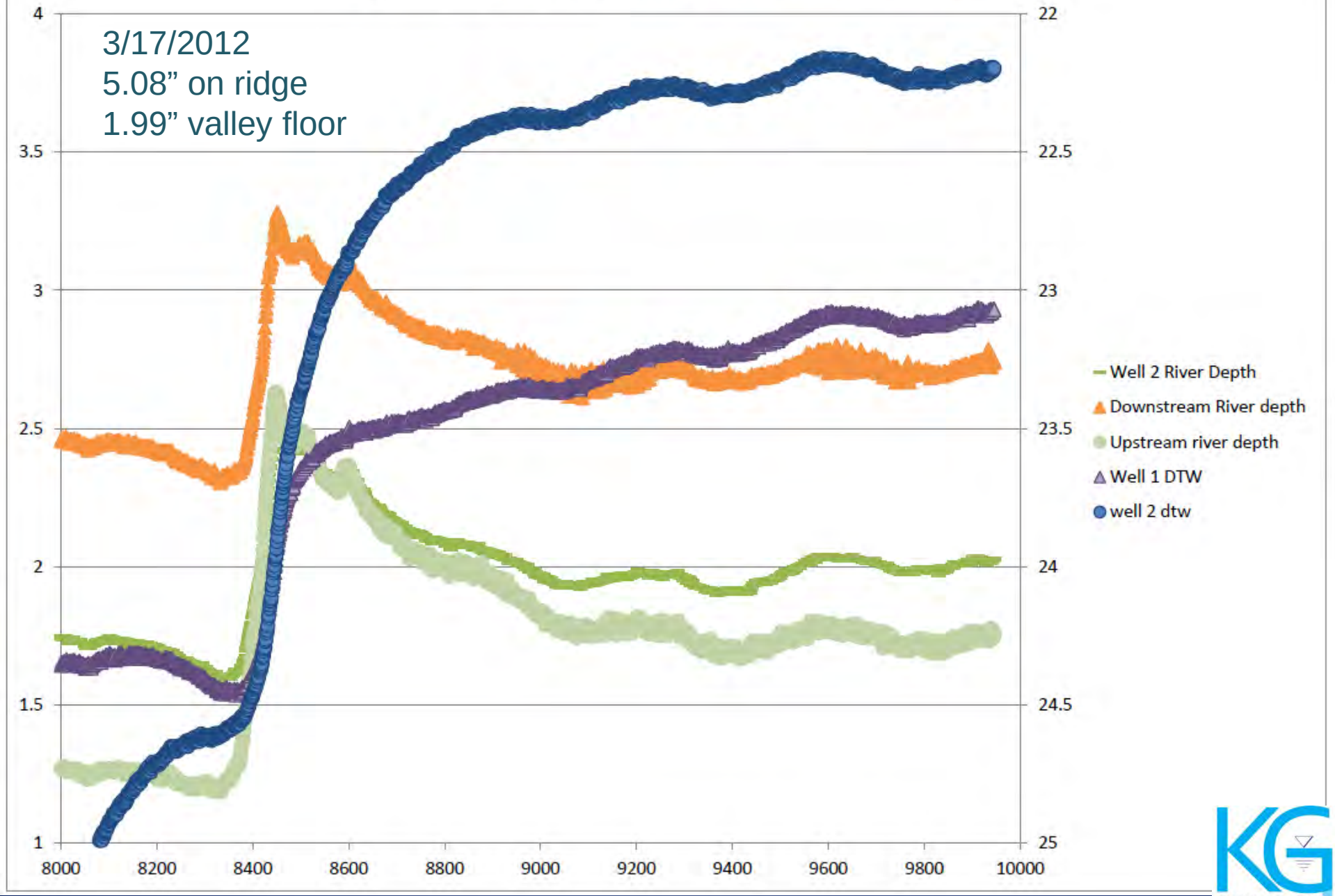
KEAR GROUNDWATER


Change
in storage
29
28
27
32
33
34
Matilija Dam
SPILLWAY 1125
Matilija Hot Sprs
BM 959
Ojala
Sopers Ranch
BM 880
MARICOPA
North
Gaging Sta
ROAD
Well
Spring
CIELO
Ventura
BM 1451
CAMINO
Canyon
1331
Kennedy
FOOTHILL
1810
KG
KEAR GROUNDWATER

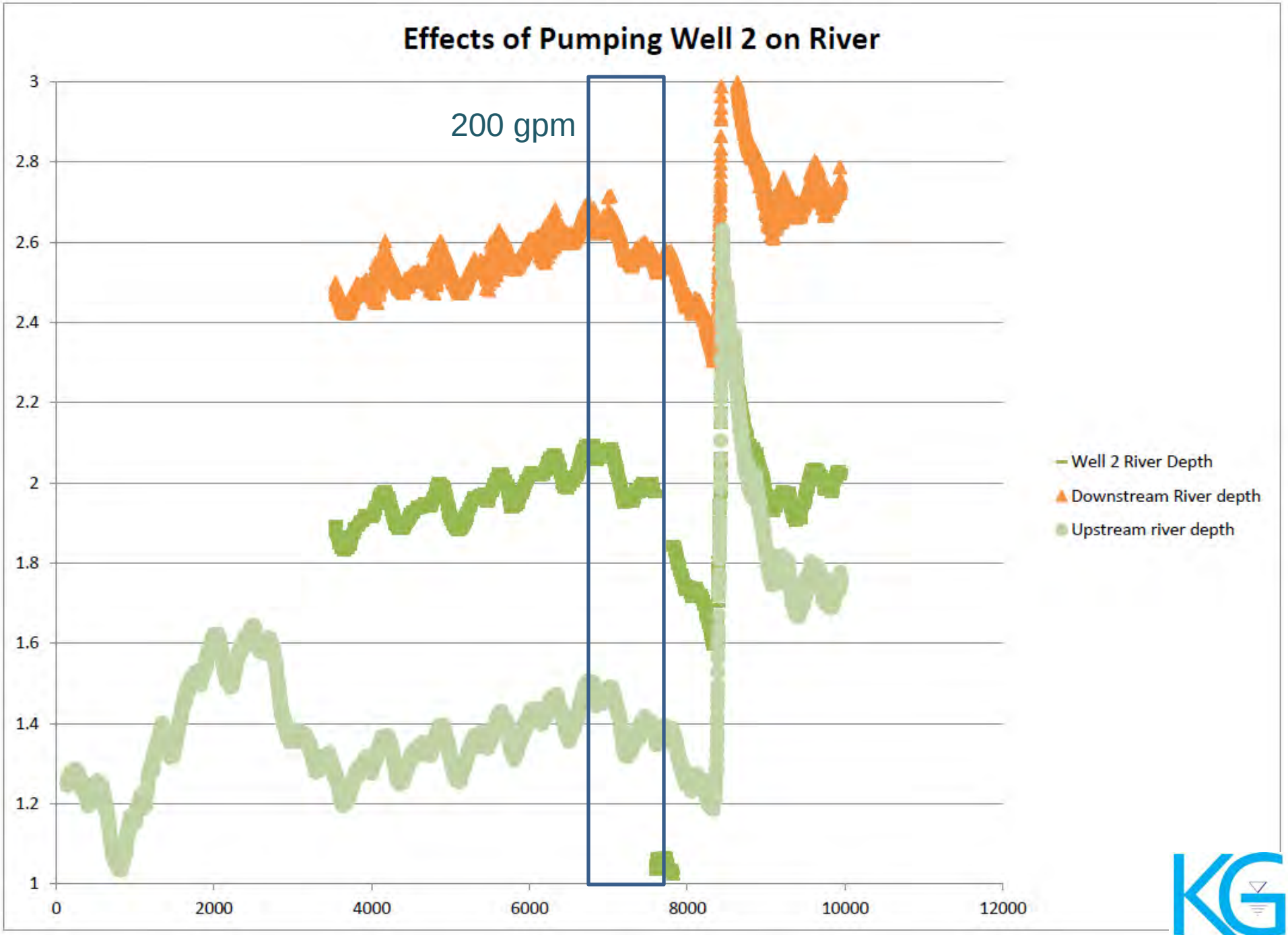

120 ft
1
0.07 ft
509 ft
0.14 ft
0.24 ft
80 ft
2
18 ft


Well 1 DTW during pumping of Well 2
200 gpm
24
24.05
24.1
24.15
24.2
24.25
24.3
24.35
24.4
24.45
24.5
6000
6500
7000
7500
8000
8500
9000
Well 1 DTW

Effect of Rain on Surface and Groundwater



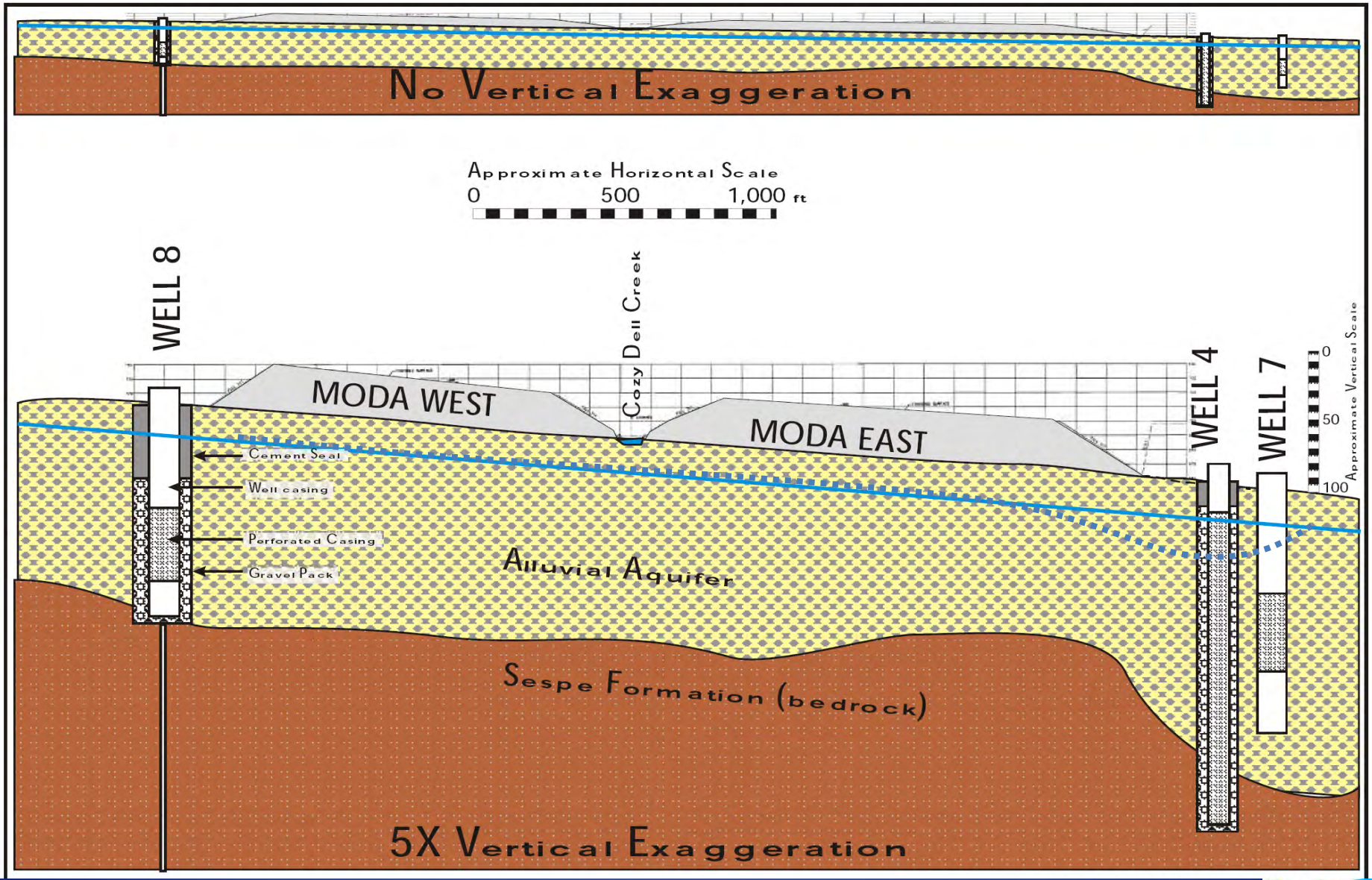
KEAR GROUNDWATER



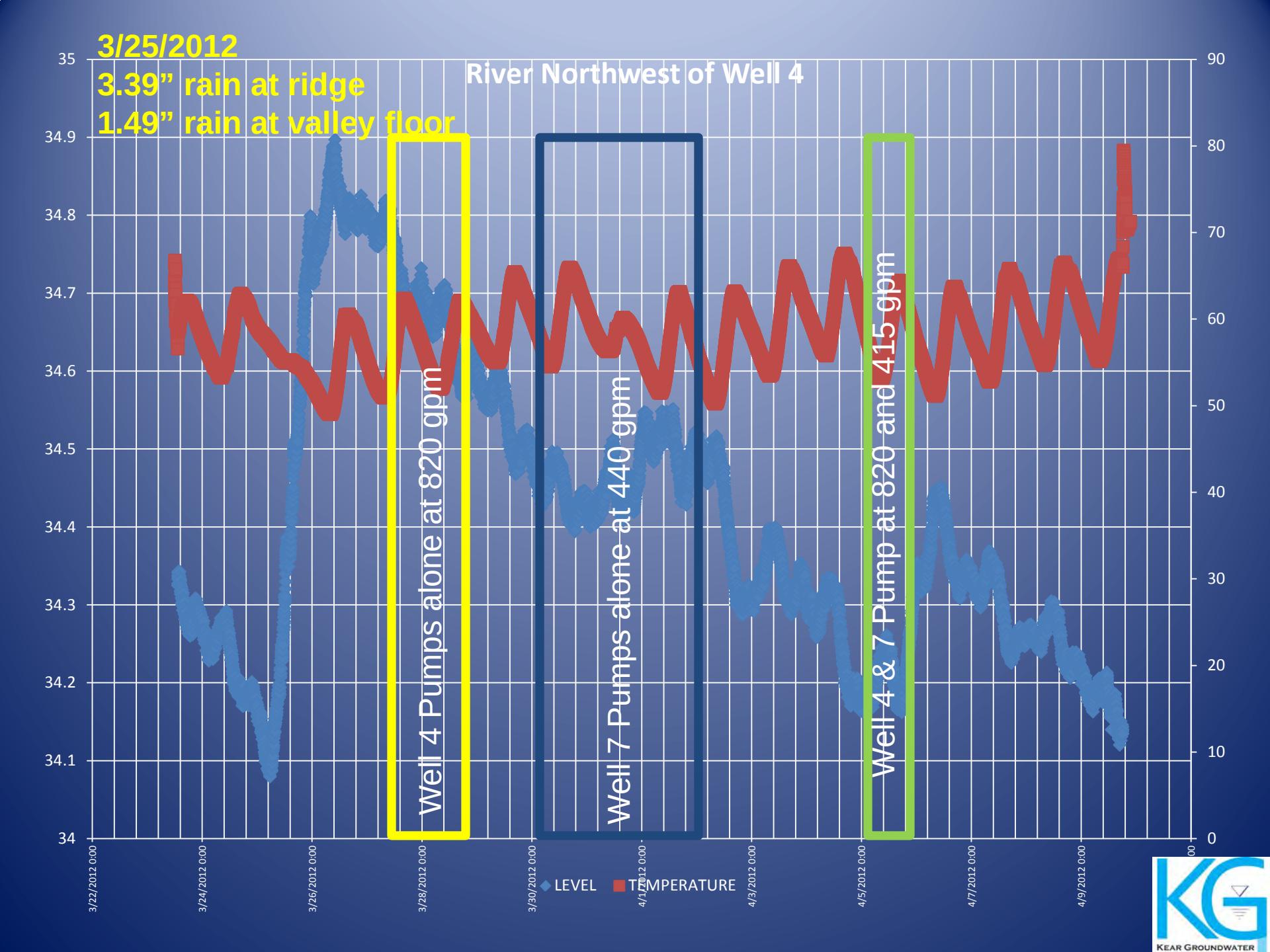
Acute effects of pumping in Well 1 and 2 area

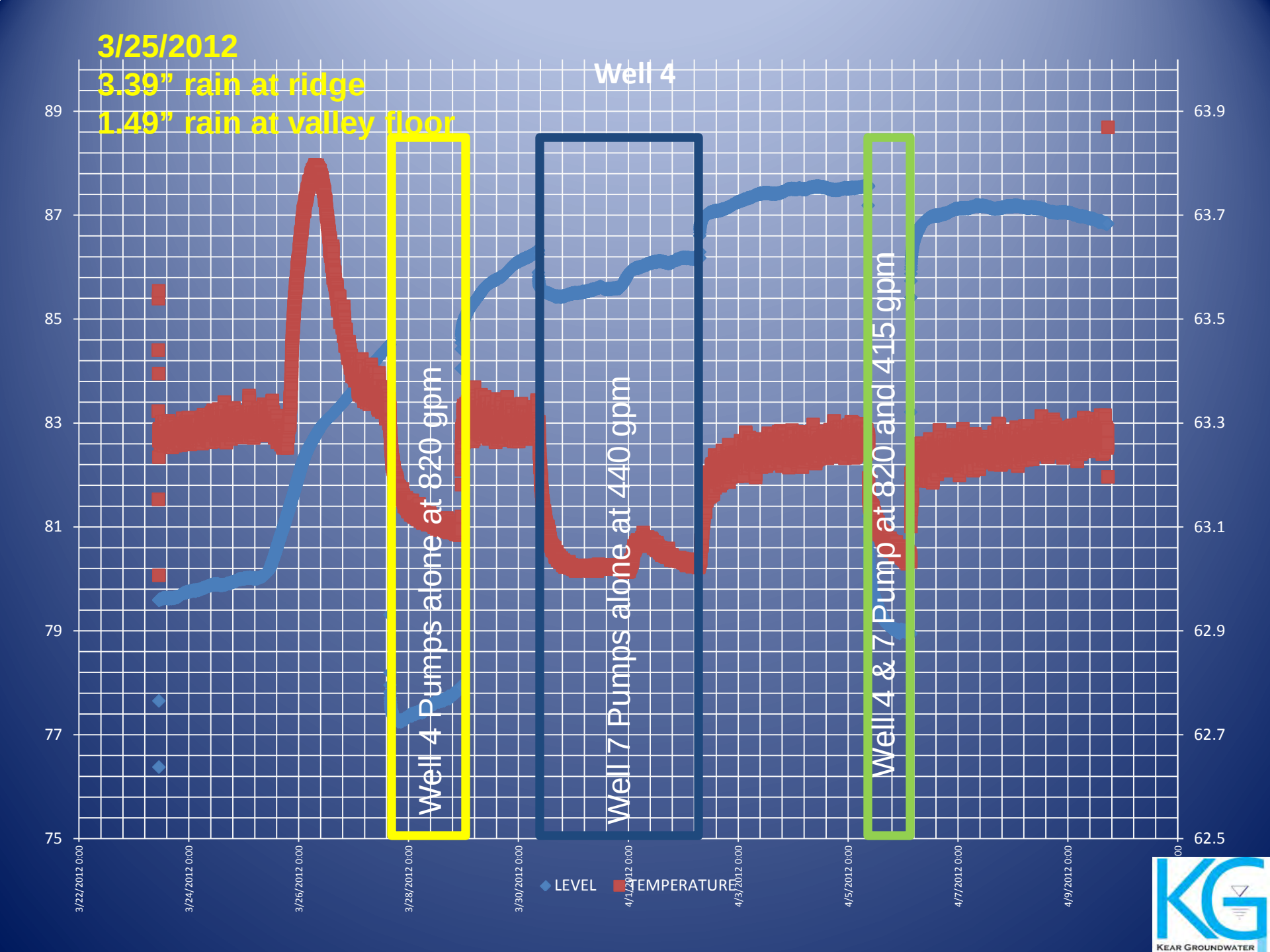
- Wells 1 and 2 appear to have an effect of drawing down river levels of less than 2 inches each in typical operations
- Recovery of river levels follows pumping
- Well balanced flow constrained by narrow river channel

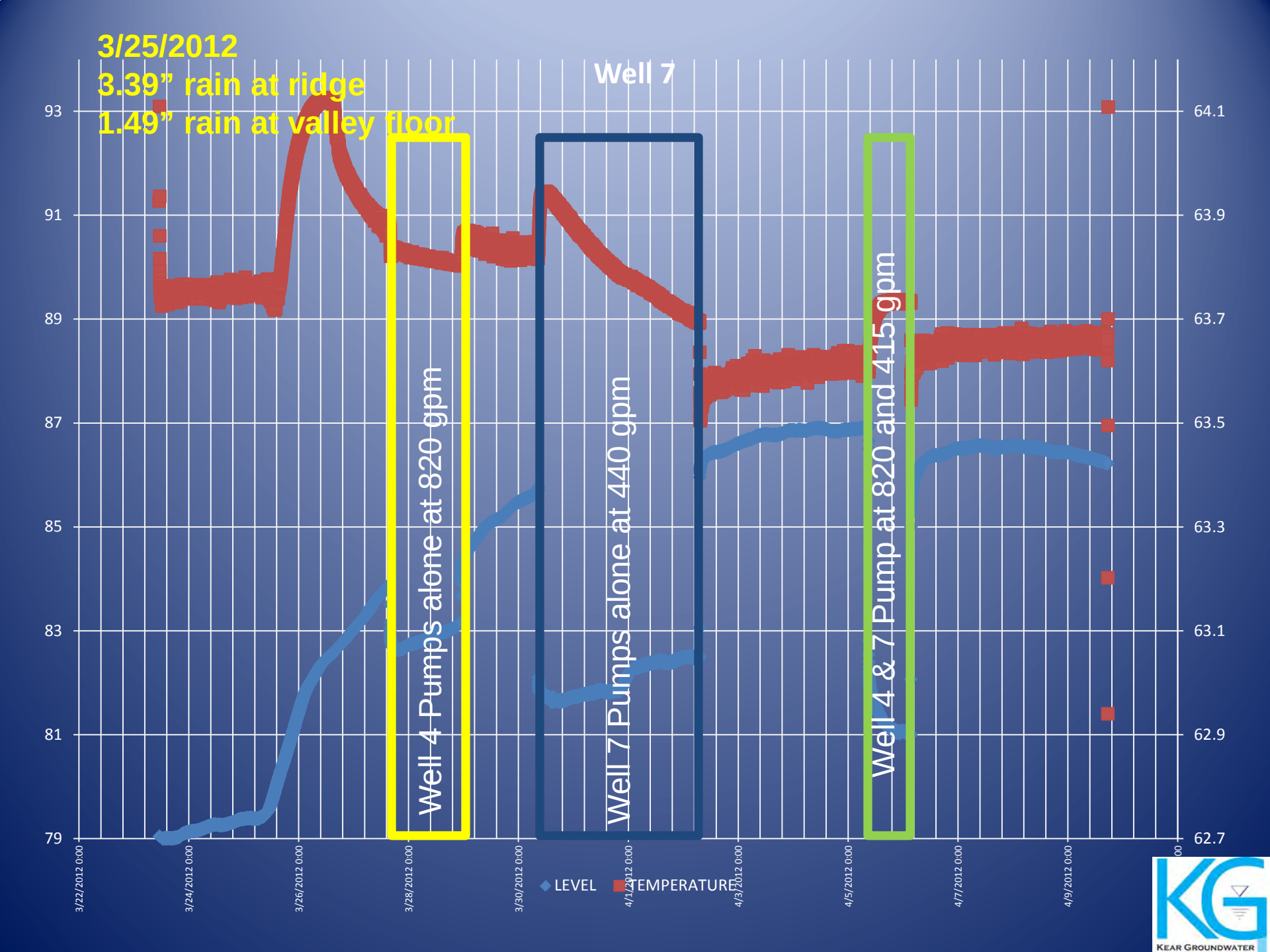
KEAR GROUNDWATER

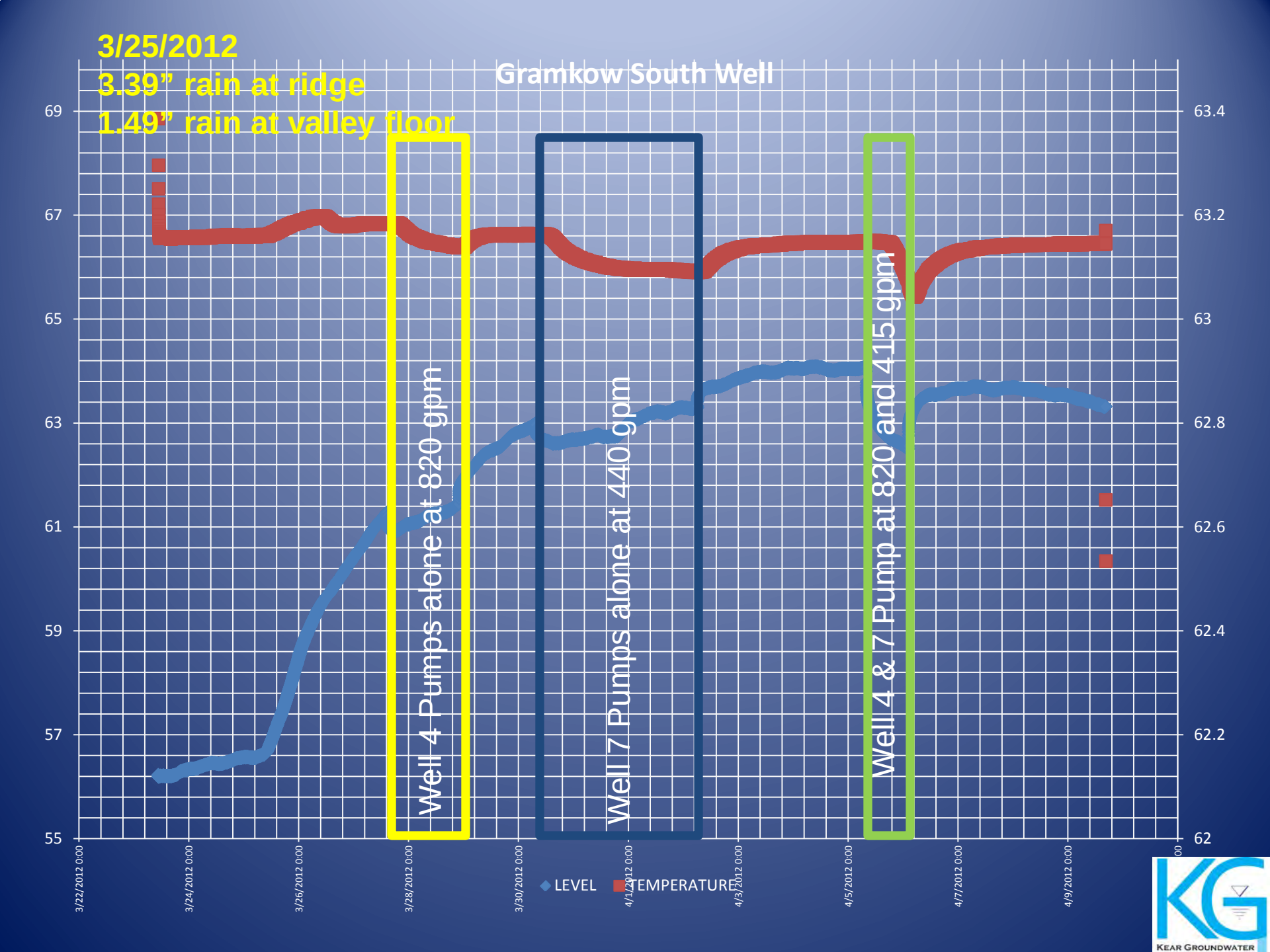

No Vertical Exaggeration
Approximate Horizontal Scale
0
500
1,000 ft
WELL 8
Cozy Dell Creek
MODA WEST
MODA EAST
WELL 4
WELL 7
Approximate Vertical Scale
0
50
100
Cement Seal
Well casing
Perforated Casing
Gravel Pack
Alluvial Aquifer
Sespe Formation (bedrock)
5X Vertical Exaggeration

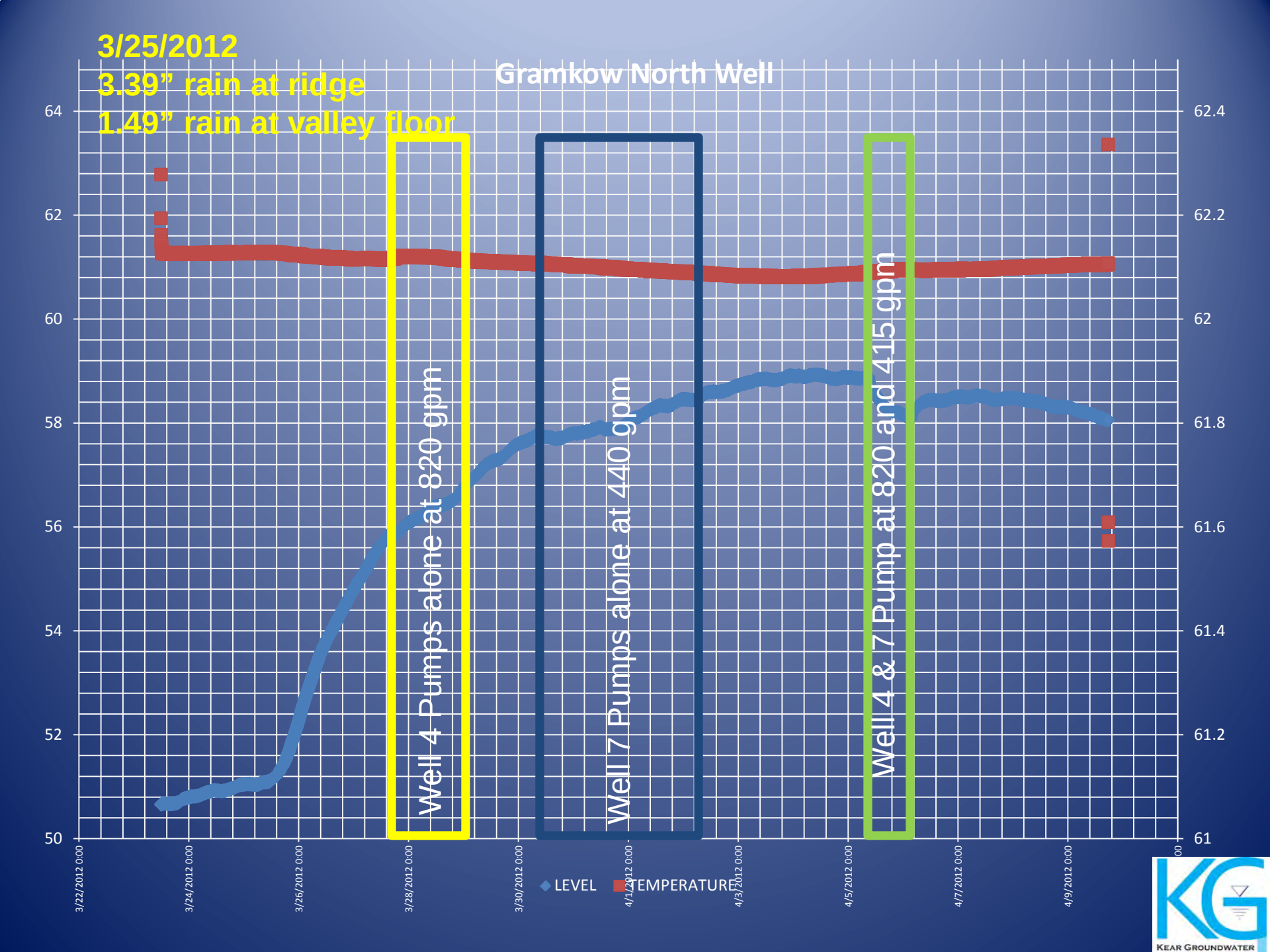

0.1
0.5
601 ft
1.0
1.5
2
5
4
56 ft
7
271 ft
KG
Kear Groundwater


3/25/2012
3.39” rain at ridge
1.49” rain at valley floor
River Northwest of Well 4
Well 4 Pumps alone at 820 gpm
Well 7 Pumps alone at 440 gpm
Well 4 & 7 Pump at 820 and 415 gpm
LEVEL
TEMPERATURE
35
34.9
34.8
34.7
34.6
34.5
34.4
34.3
34.2
34.1
34
90
80
70
60
50
40
30
20
10
0
3/22/2012 0:00
3/24/2012 0:00
3/26/2012 0:00
3/28/2012 0:00
3/30/2012 0:00
4/1/2012 0:00
4/3/2012 0:00
4/5/2012 0:00
4/7/2012 0:00
4/9/2012 0:00
KEAR GROUNDWATER

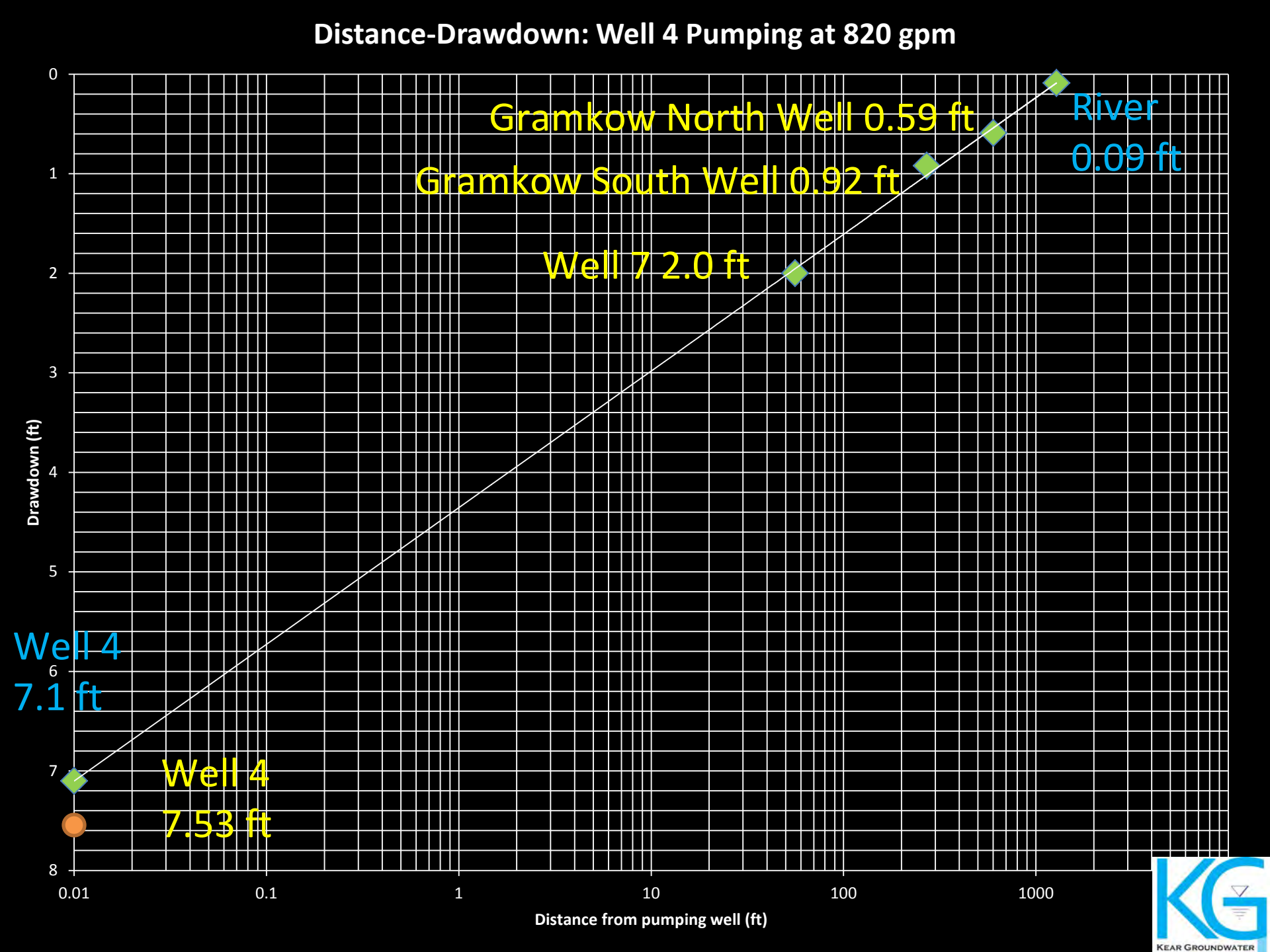

3/25/2012
3.39” rain at ridge
1.49” rain at valley floor
Well 4
Well 4 Pumps alone at 820 gpm
Well 7 Pumps alone at 440 gpm
Well 4 & 7 Pump at 820 and 415 gpm
89
87
85
83
81
79
77
75
63.9
63.7
63.5
63.3
63.1
62.9
62.7
62.5
3/22/2012 0:00
3/24/2012 0:00
3/26/2012 0:00
3/28/2012 0:00
3/30/2012 0:00
4/1/2012 0:00
4/3/2012 0:00
4/5/2012 0:00
4/7/2012 0:00
4/9/2012 0:00
LEVEL
TEMPERATURE
KEAR GROUNDWATER

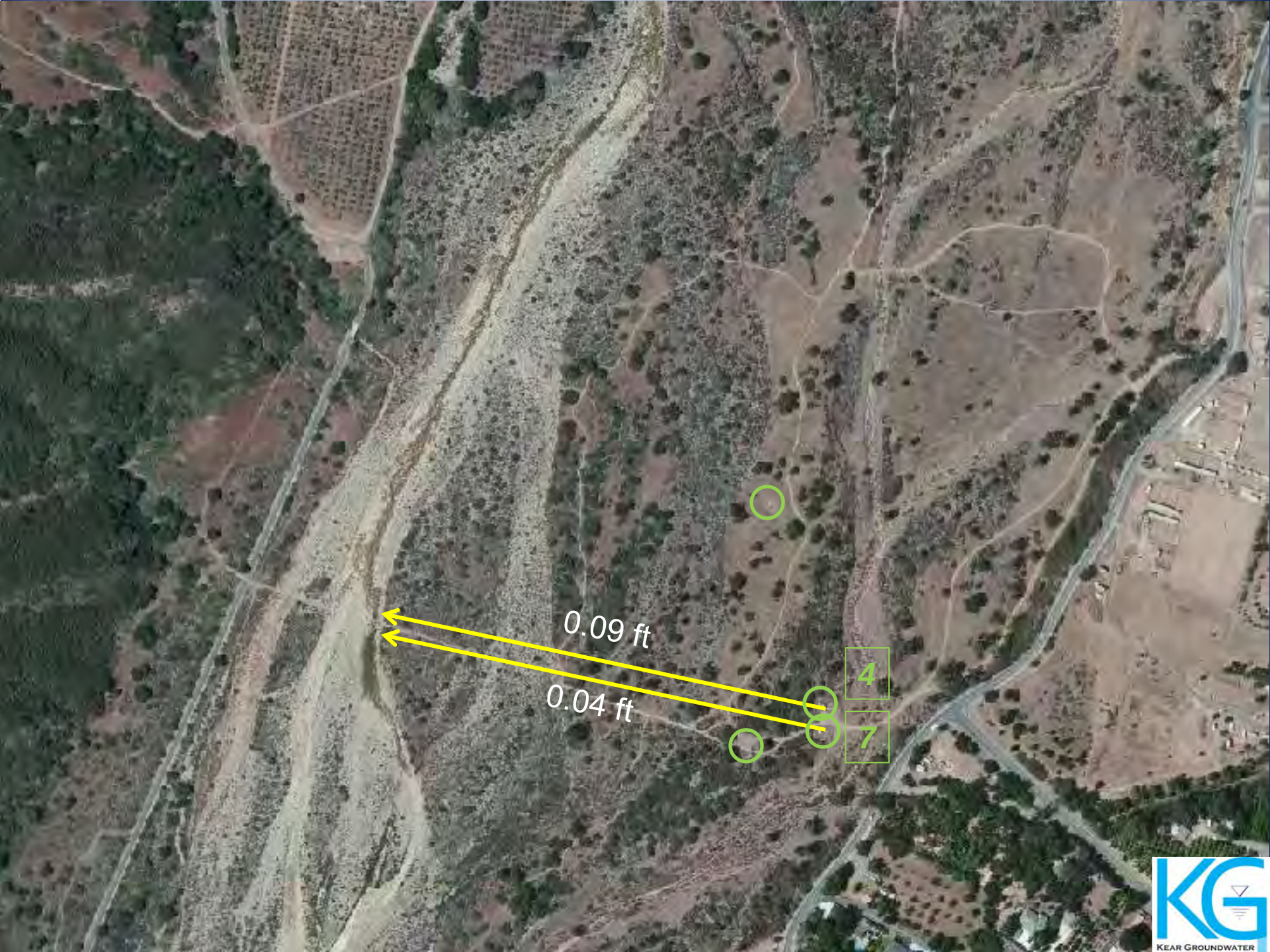

3/25/2012
3.39” rain at ridge
1.49” rain at valley floor
Well 7
Well 4 Pumps alone at 820 gpm
Well 7 Pumps alone at 440 gpm
Well 4 & 7 Pump at 820 and 415 gpm
93
91
89
87
85
83
81
79
64.1
63.9
63.7
63.5
63.3
63.1
62.9
62.7
3/22/2012 0:00
3/24/2012 0:00
3/26/2012 0:00
3/28/2012 0:00
3/30/2012 0:00
4/1/2012 0:00
4/3/2012 0:00
4/5/2012 0:00
4/7/2012 0:00
4/9/2012 0:00
LEVEL
TEMPERATURE
KEAR GROUNDWATER

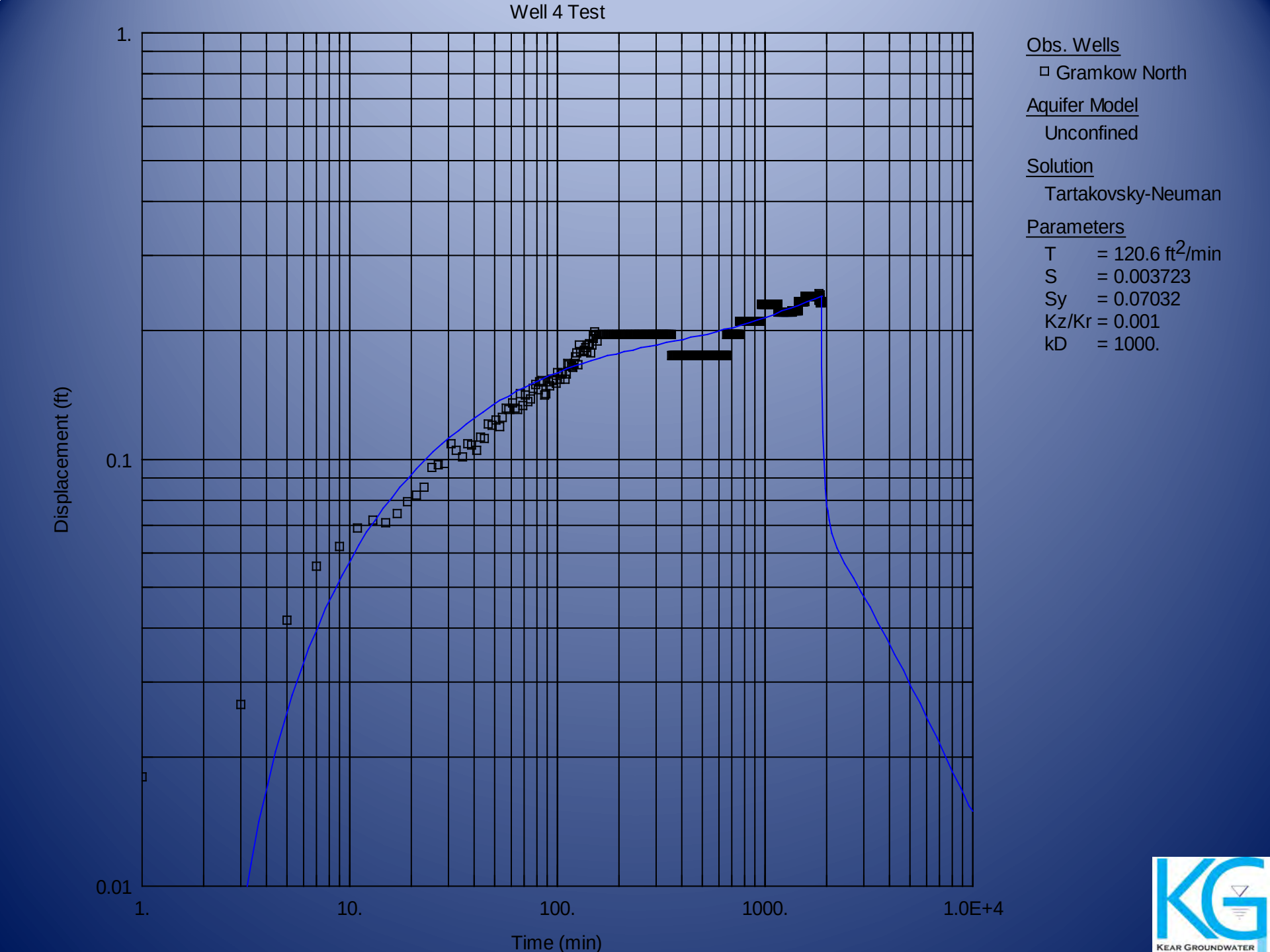

3/25/2012
3.39” rain at ridge
1.49” rain at valley floor
Gramkow South Well
Well 4 Pumps alone at 820 gpm
Well 7 Pumps alone at 440 gpm
Well 4 & 7 Pump at 820 and 415 gpm
69
67
65
63
61
59
57
55
63.4
63.2
63
62.8
62.6
62.4
62.2
62
3/22/2012 0:00
3/24/2012 0:00
3/26/2012 0:00
3/28/2012 0:00
3/30/2012 0:00
4/1/2012 0:00
4/3/2012 0:00
4/5/2012 0:00
4/7/2012 0:00
4/9/2012 0:00
LEVEL
TEMPERATURE
KEAR GROUNDWATER

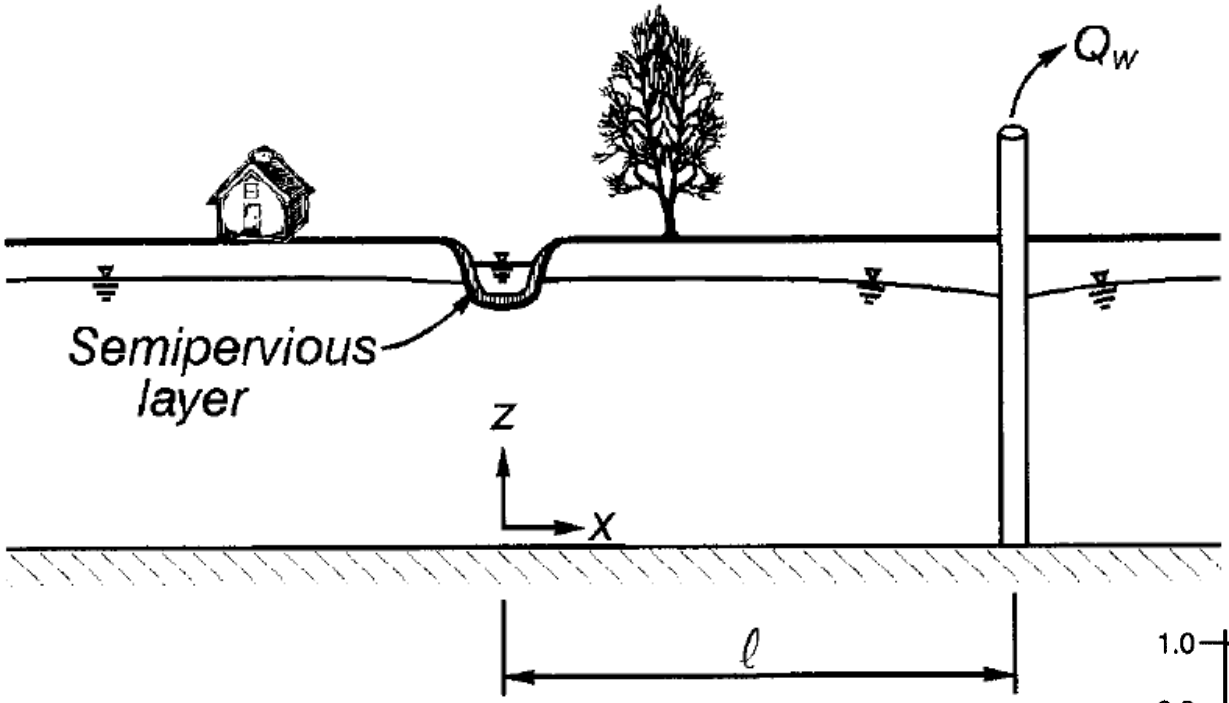

3/25/2012
3.39” rain at ridge
1.49” rain at valley floor
Gramkow North Well
Well 4 Pumps alone at 820 gpm
Well 7 Pumps alone at 440 gpm
Well 4 & 7 Pump at 820 and 415 gpm
64
62
60
58
56
54
52
50
62.4
62.2
62
61.8
61.6
61.4
61.2
61
3/22/2012 0:00
3/24/2012 0:00
3/26/2012 0:00
3/28/2012 0:00
3/30/2012 0:00
4/1/2012 0:00
4/3/2012 0:00
4/5/2012 0:00
4/7/2012 0:00
4/9/2012 0:00
LEVEL
TEMPERATURE
KEAR GROUNDWATER

Distance-Drawdown: Well 4 Pumping at 820 gpm



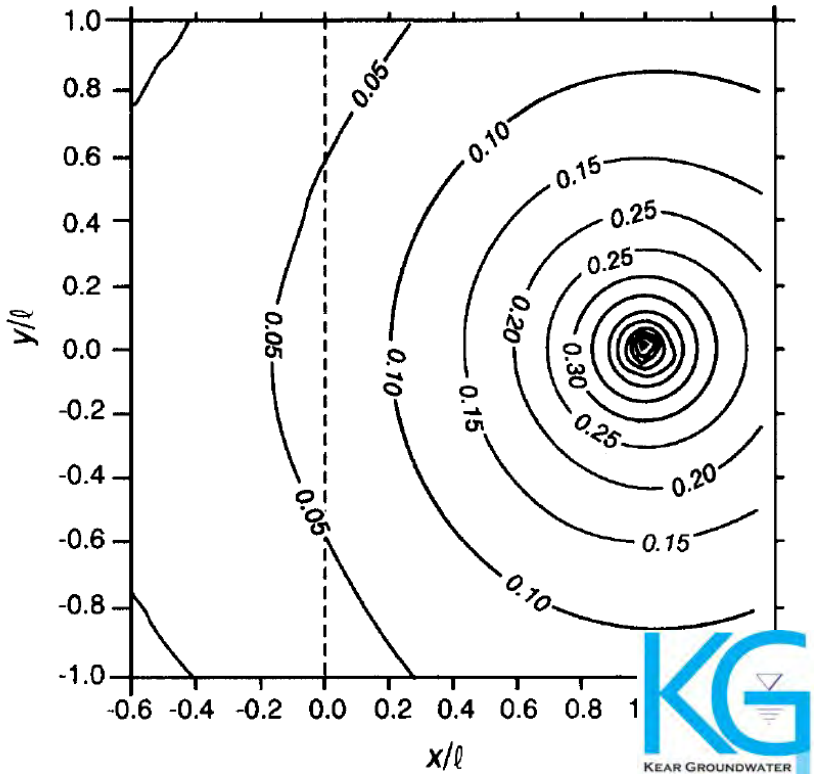

0.09 ft
0.04 ft
4
7
KG
Kear Groundwater


Well 4 Test
1.
0.1
0.01
Displacement (ft)
1.
10.
100.
1000.
1.0E+4
Time (min)
Obs. Wells
Gramkow North
Aquifer Model
Unconfined
Solution
Tartakovsky-Neuman
Parameters
T = 120.6 ft2/min
S = 0.003723
Sy = 0.07032
Kz/Kr = 0.001
kD = 1000.



$$T\left(\frac{\partial^2\phi}{\partial x^2} + \frac{\partial^2\phi}{\partial y^2}\right) = S\frac{\partial\phi}{\partial t} - Q_w\,\delta(x - \ell)\,\delta($$

$$\Delta Q = \lambda\int_{-\infty}^{\infty}\phi(0, y, t)dy$$



After Hunt, 1999

STRMDEPL08

- Using estimates of T and S based on aquifer testing
- Indicates full day of pumping at
- Well 4 = 1.56 cfs depletion
- Well 7 = 0.78 cfs depletion
- Well 1 = 0.43 cfs depletion
- Well 2 = 0.33 cfs depletion

KEAR GROUNDWATER

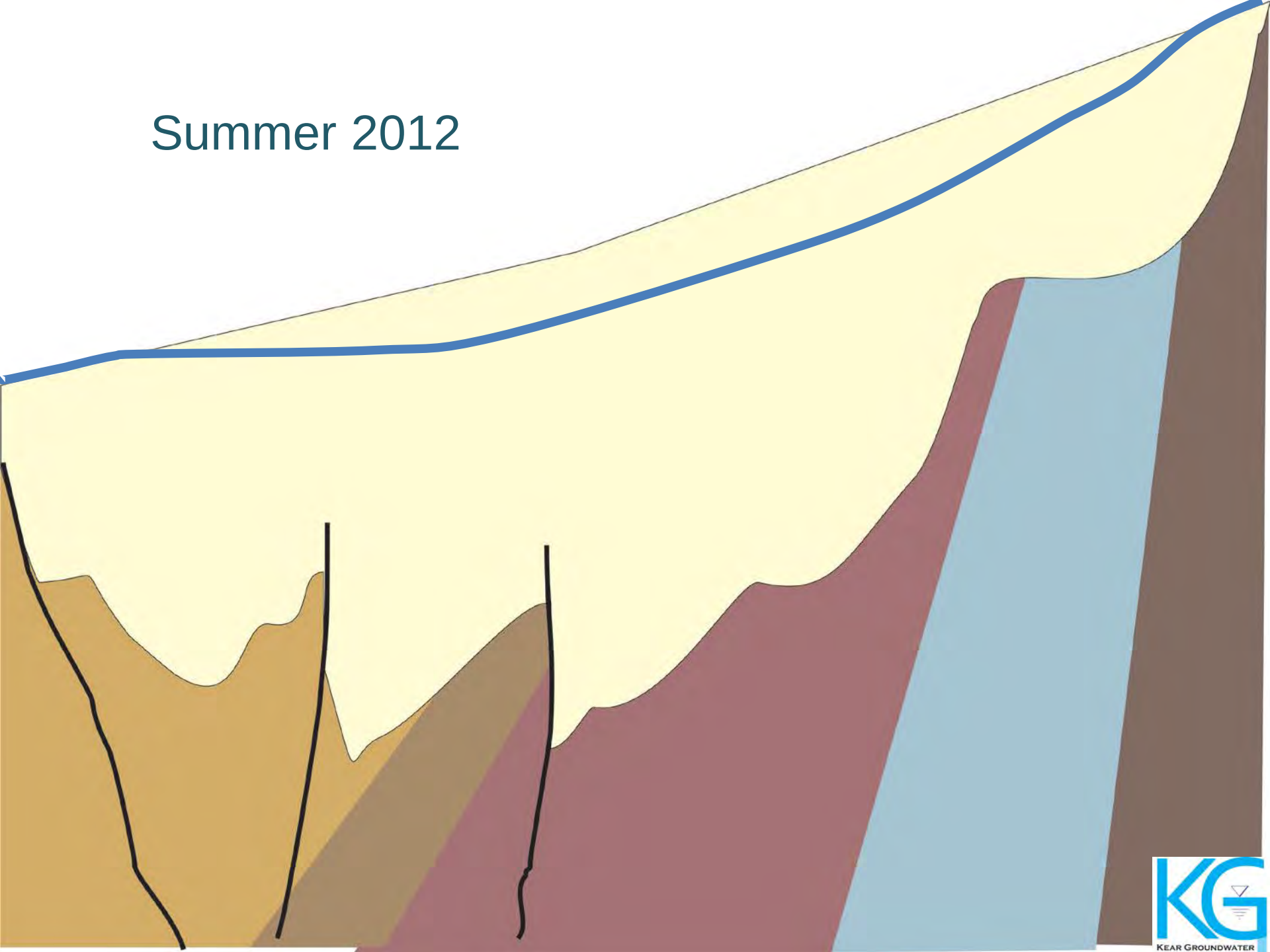
Southern Wet Edge Of Surface Flow

Moves constantly

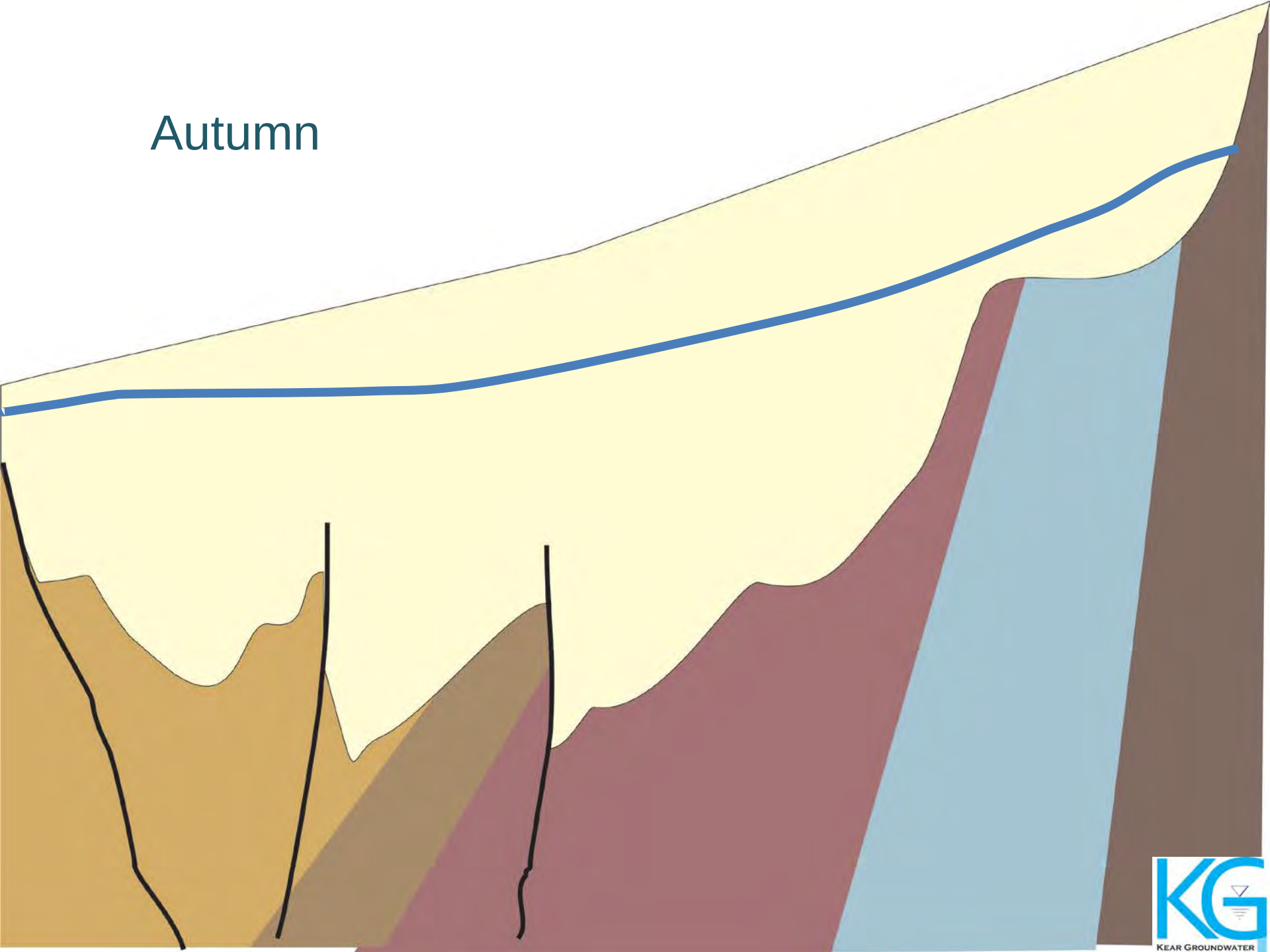
-Advances southward with:
increase surface water and loss
or increased groundwater
storage and gain

-Recedes northward with:
decreased surface water and loss
or decreased groundwater
in storage in balance with surface
water

Summer 2012

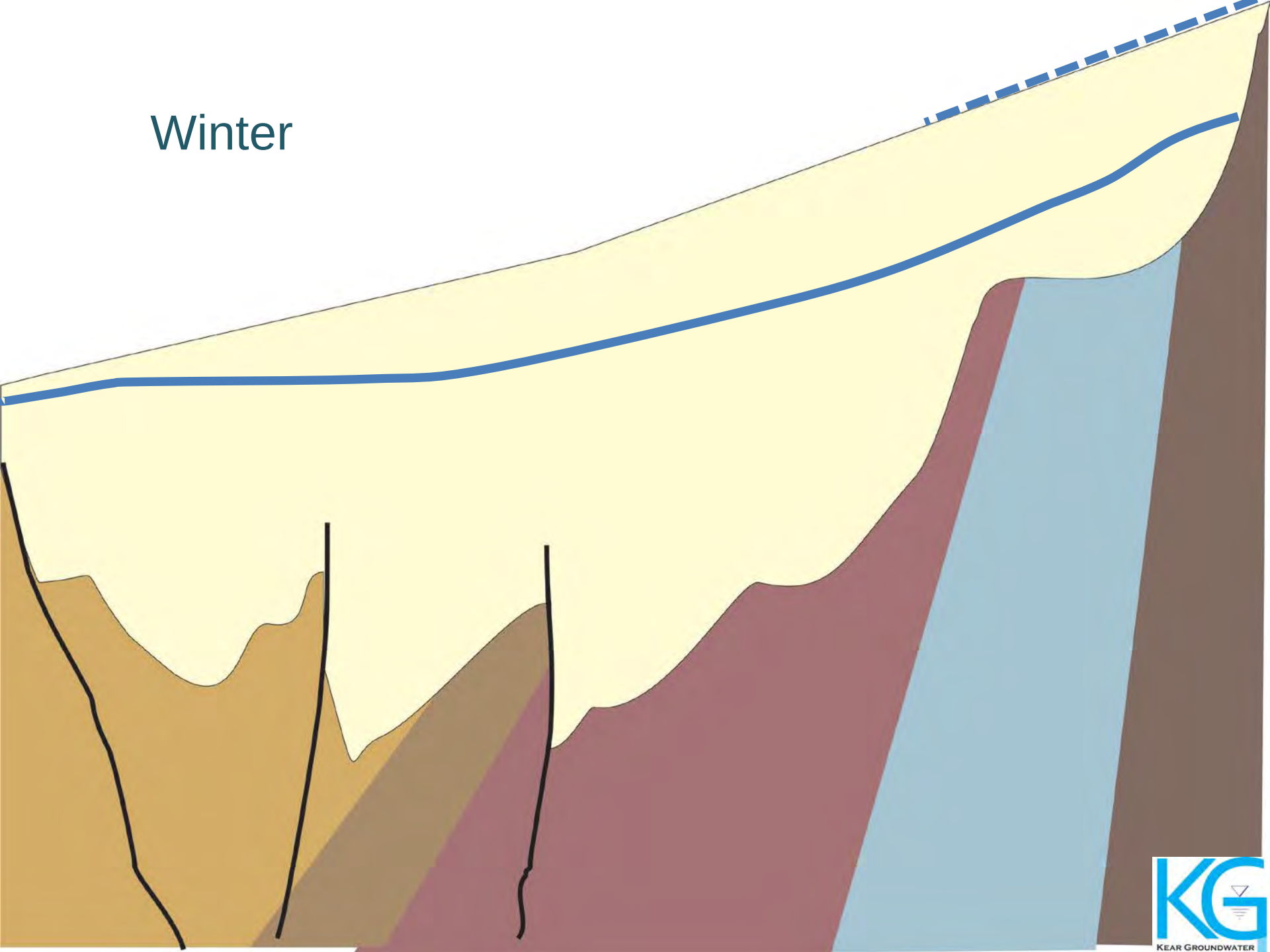


Autumn



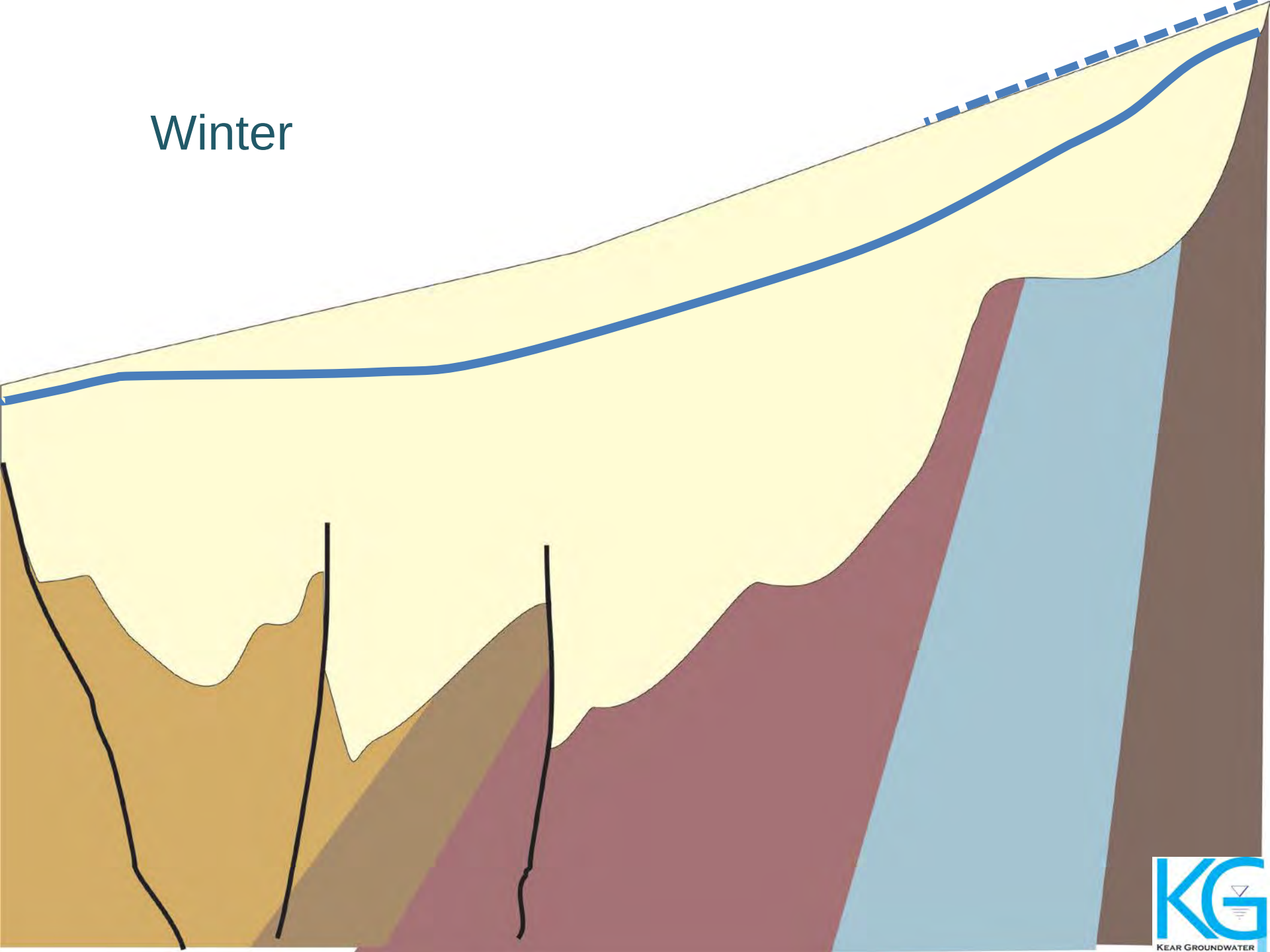
KEAR GROUNDWATER

Winter



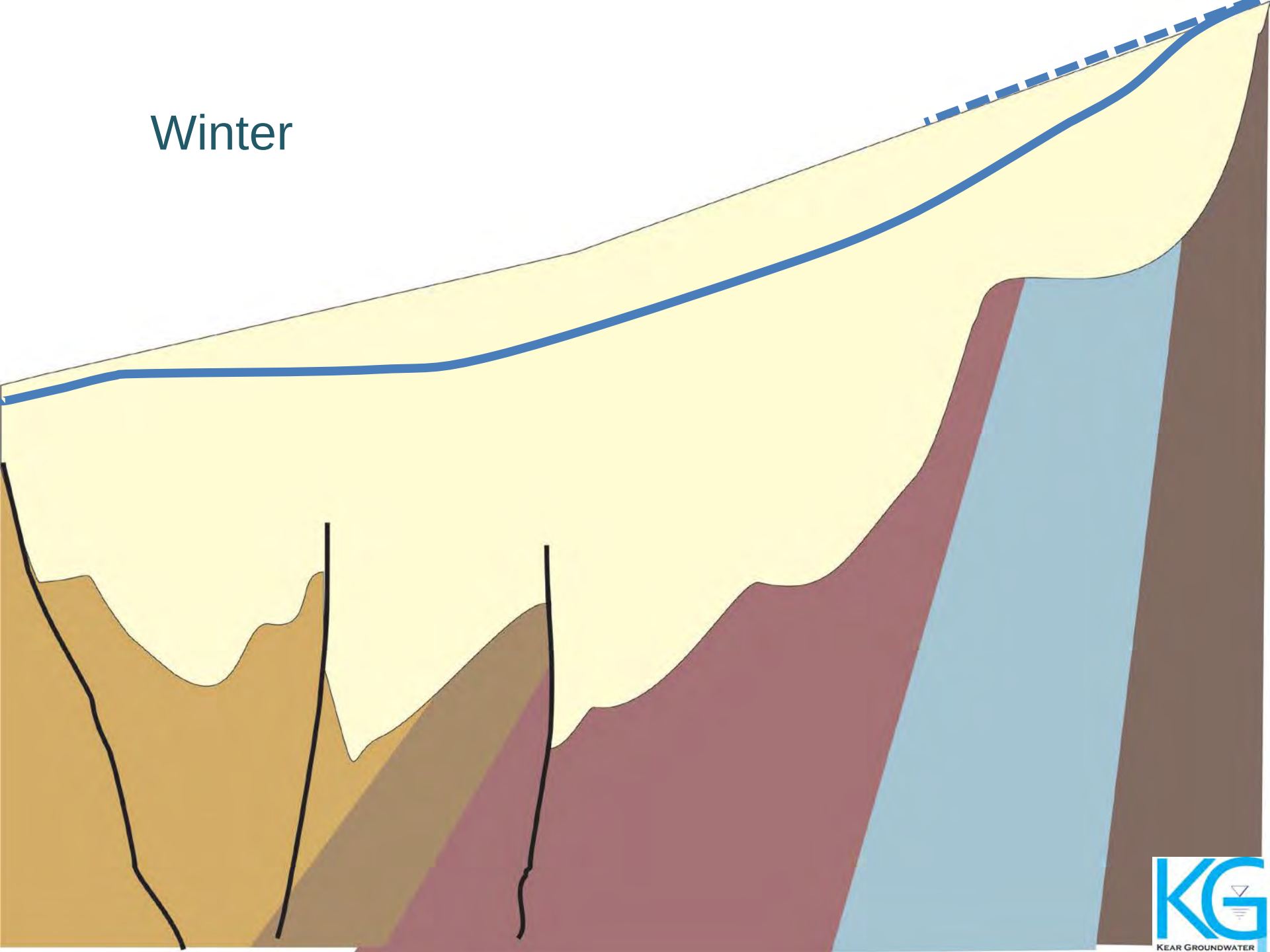
KEAR GROUNDWATER

Winter



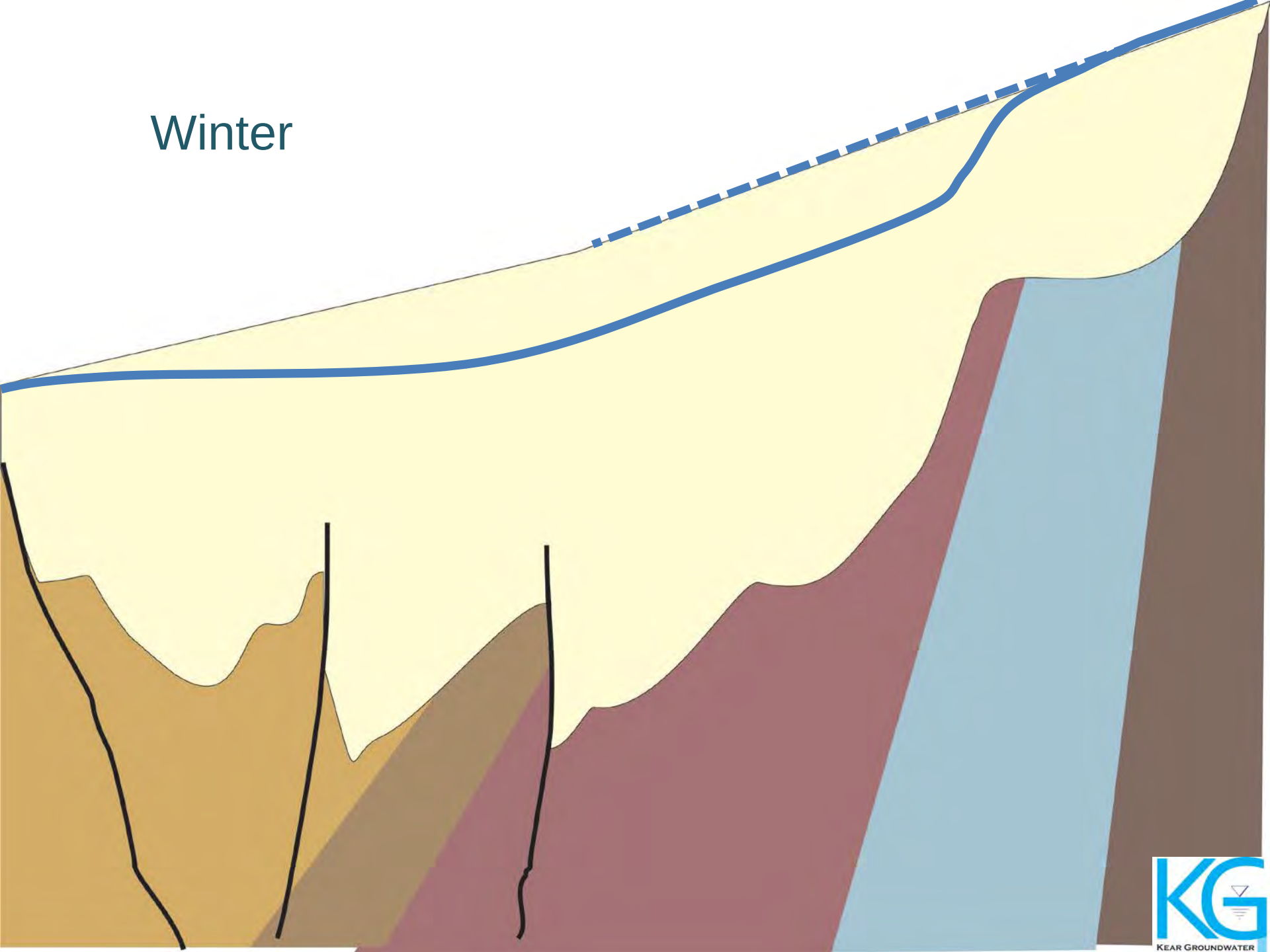
KEAR GROUNDWATER

Winter

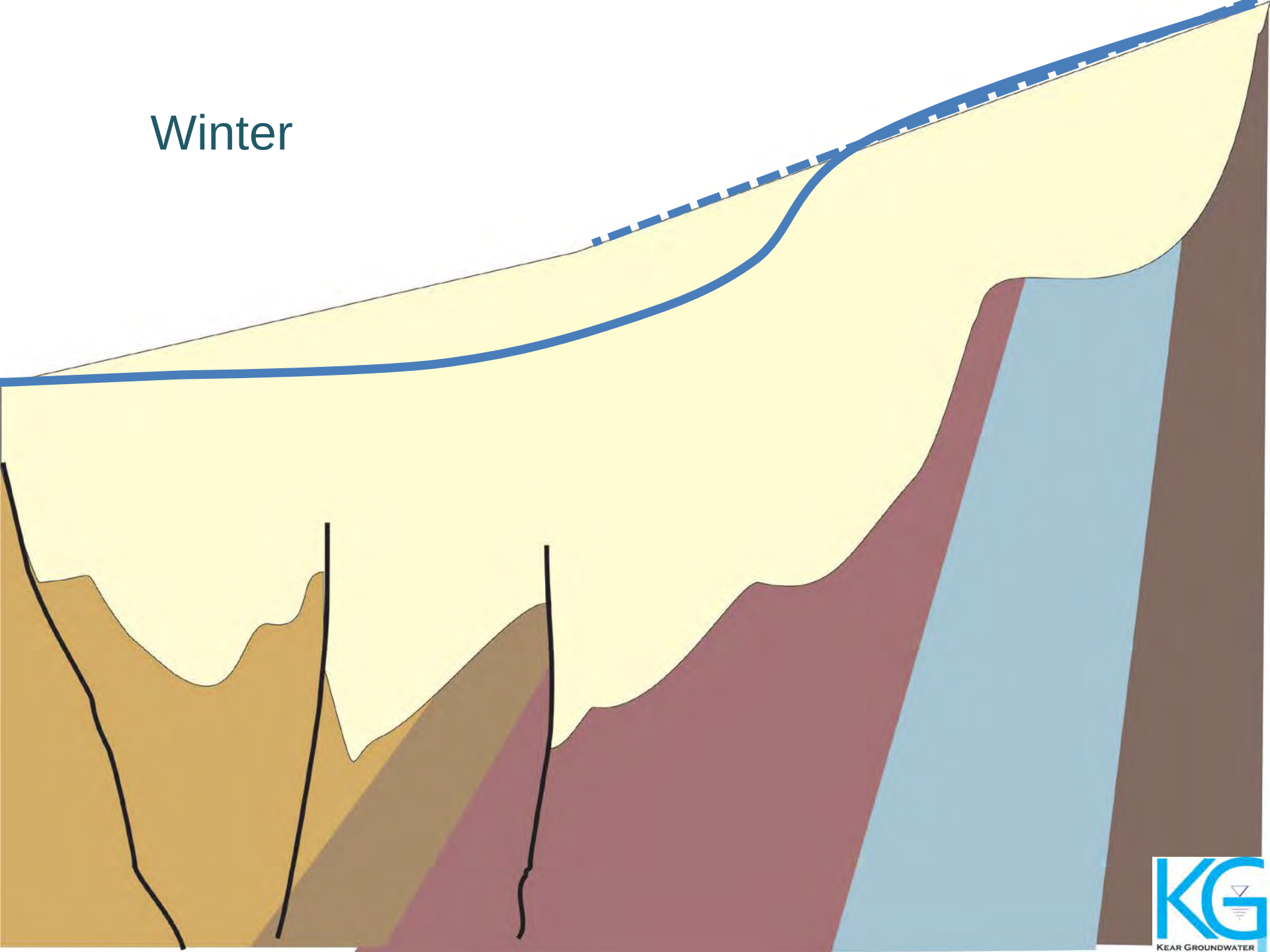


KEAR GROUNDWATER

Winter

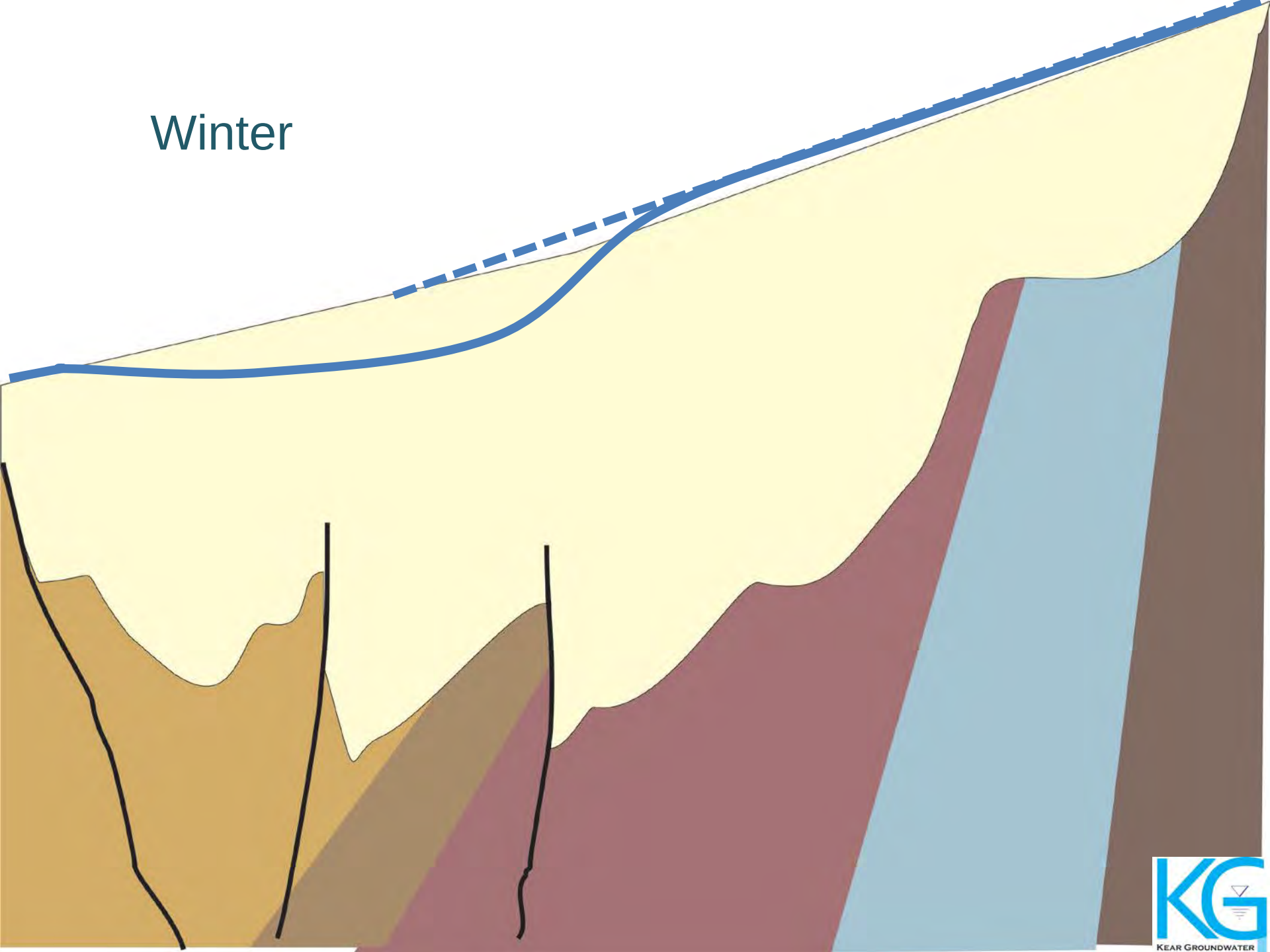


Winter



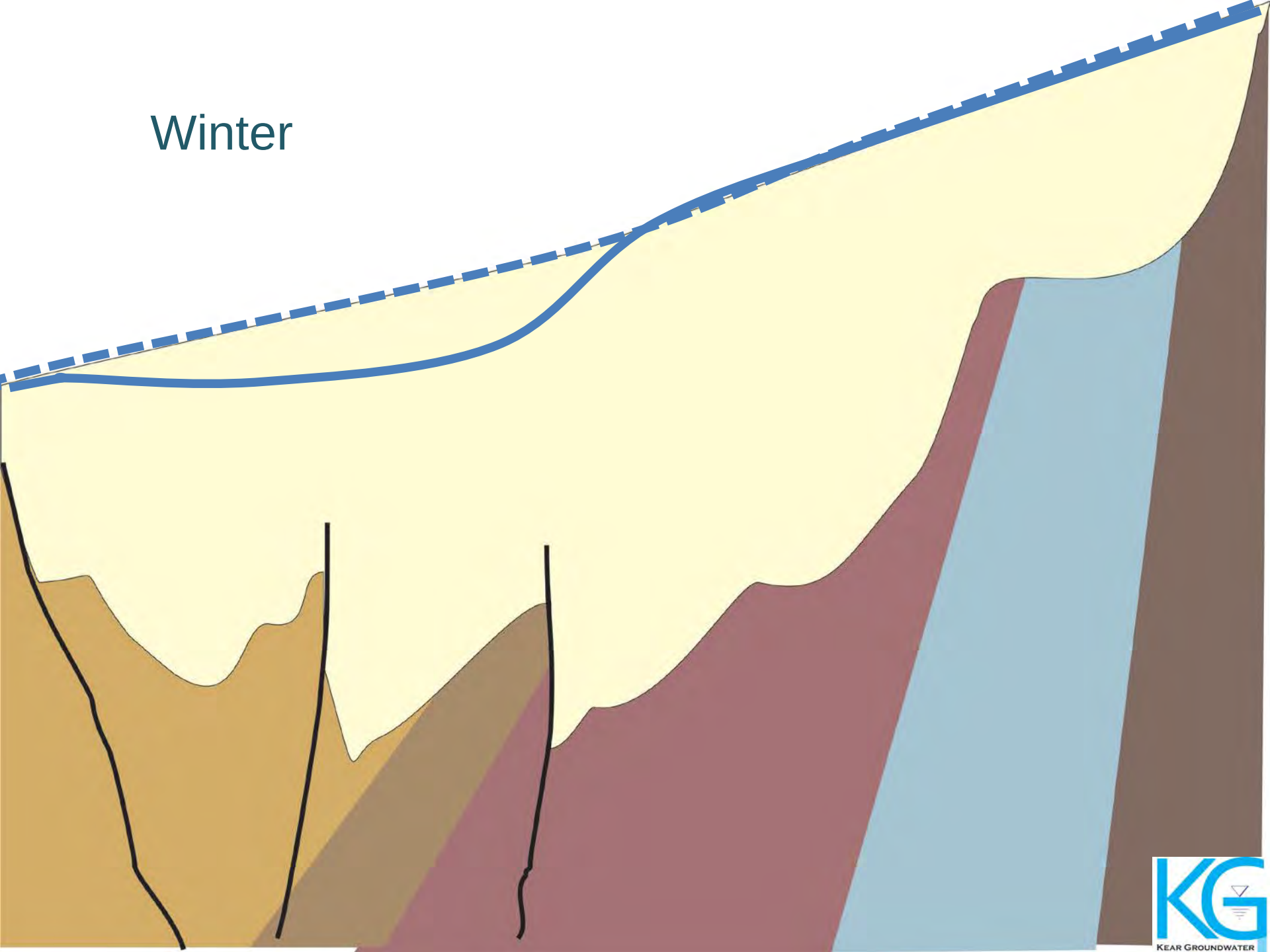
KEAR GROUNDWATER

Winter

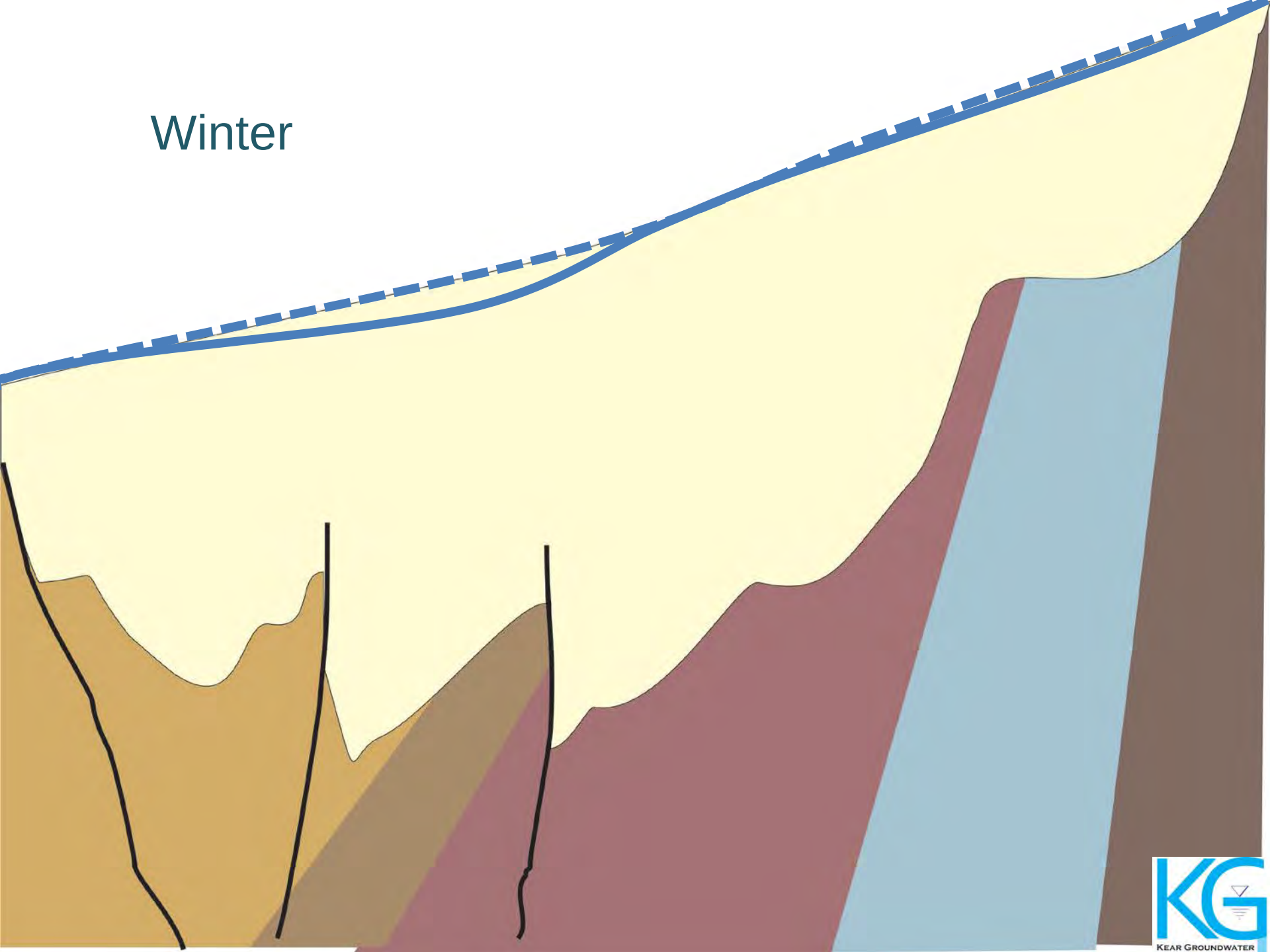


KEAR GROUNDWATER

Winter

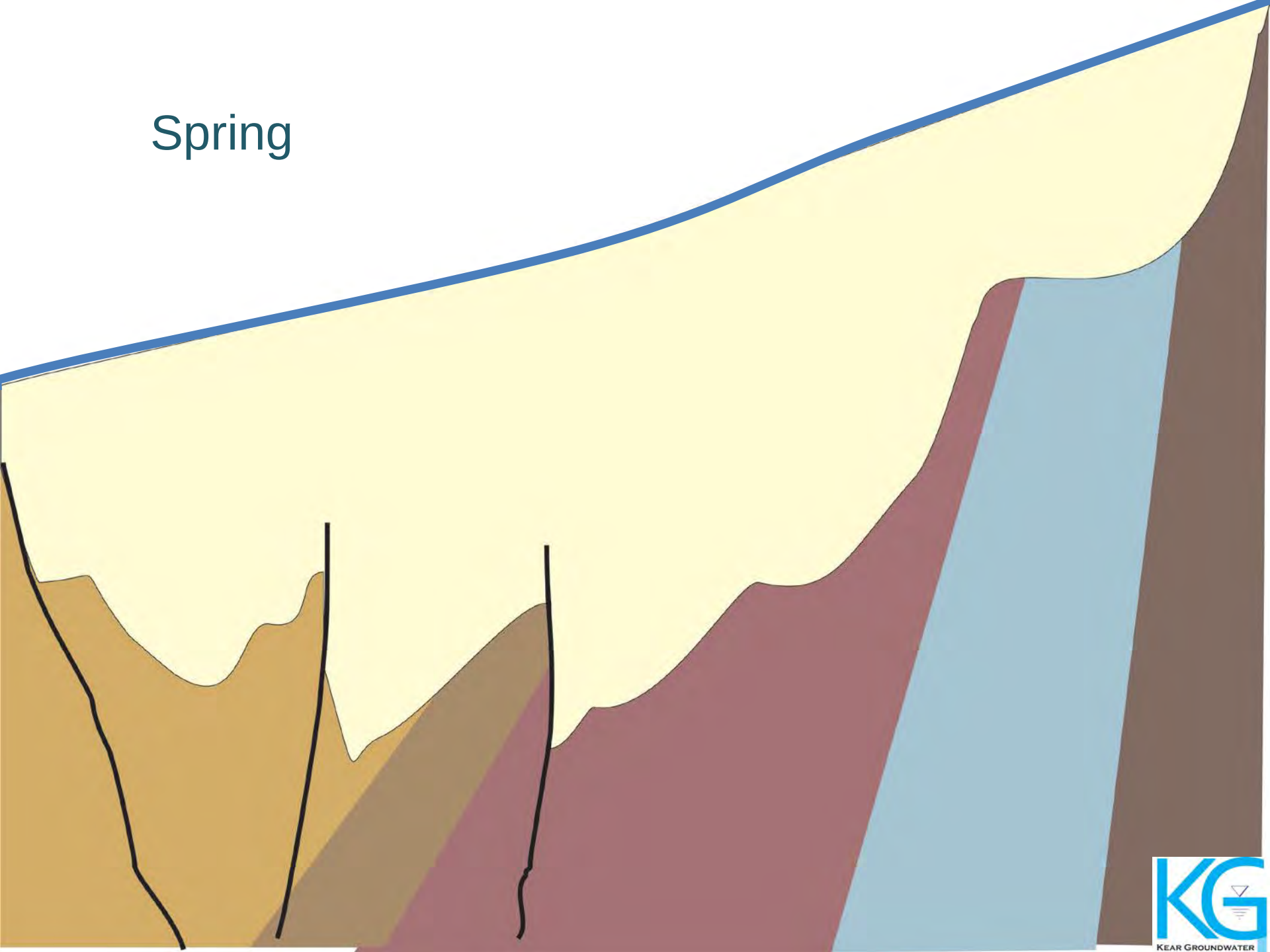


Winter

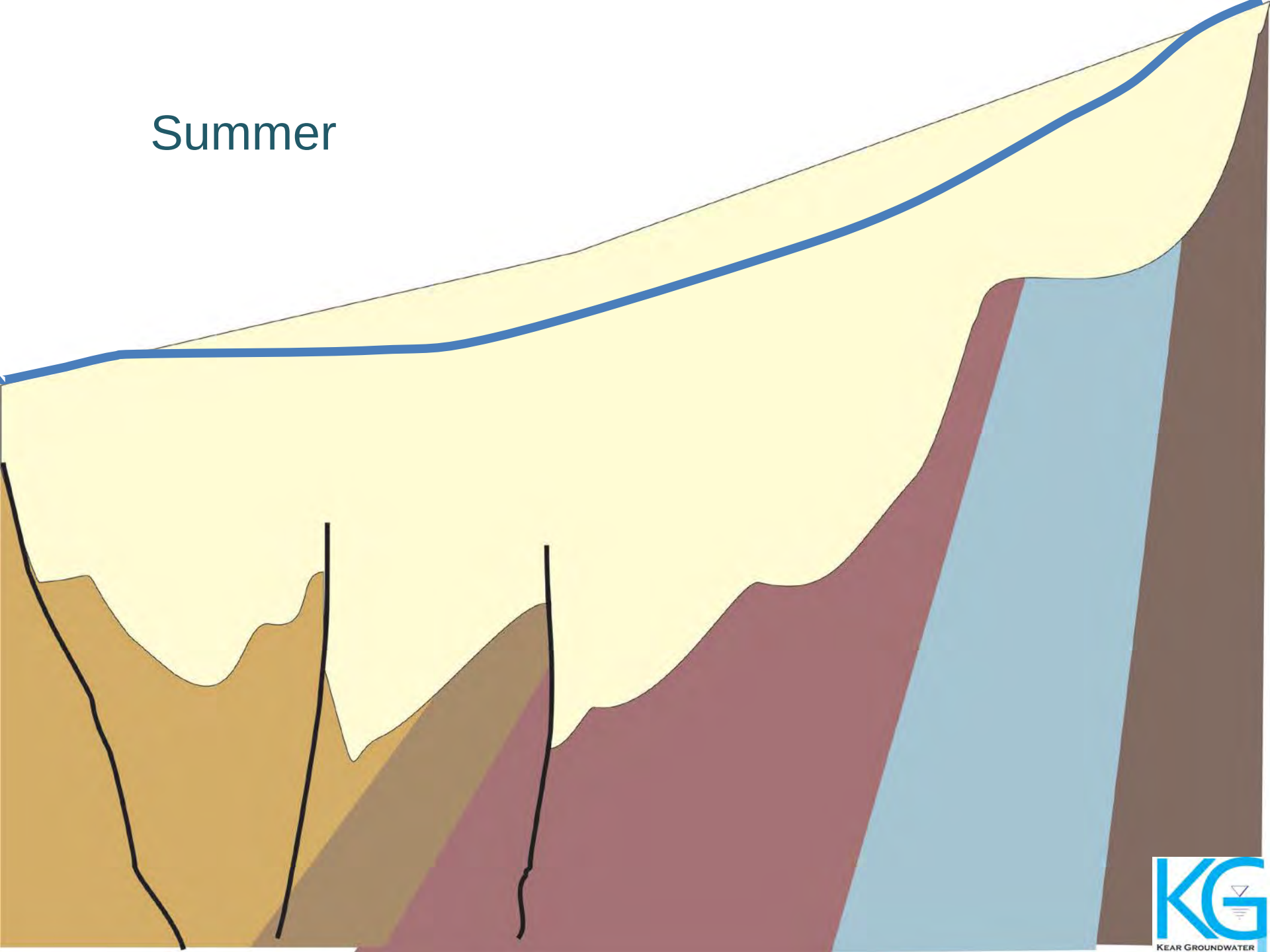


KEAR GROUNDWATER

Spring



Summer



Summary and Conclusion

- Pumping of wells has minor acute effect on river flow
- Diurnal temperature changes have significant effect on river flow
- River flow and saturated groundwater body shape appears to be more influenced by aquifer morphology than any other single factor
- River will go dry in Robles Reach each year regardless of pumping practices via groundwater wells

KEAR GROUNDWATER

Recommendations

- Pumping of wells has minor acute effect on river flow
- *Continue monitoring water levels in wells and river flow*
- *Conduct more detailed monitoring of surface flow and transmission losses*
- Diurnal temperature changes have significant effect on river flow
- *Continue monitoring temperature and river responses over several seasons*

KEAR GROUNDWATER

Recommendations

- River flow and saturated groundwater body shape appears to be more influenced by aquifer morphology than any other single factor
- *Survey well head elevations and conduct coordinated groundwater measurements in many pubic and private wells*

KEAR GROUNDWATER

Recommendations

- River will go dry in Robles Reach each year regardless of pumping practices via groundwater wells
- *Continue to monitor pumping rates and extractions. Observe and record southern wet edge of flow at the losing reach and northern wet edge of flow at the gaining reach*

KEAR GROUNDWATER

"In rivers, the water that you touch is the last of what has passed and the first of that which comes; so with present time…"

-Leonardo da Vinci

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KEAR GROUNDWATER