Evaluation of Groundwater Conditions and Land Subsidence in the Borrego Valley, California

- Borrego Water District
- United States Geological Survey

PRELIMINARY
FOR INFORMATION ONLY

Problem:

- Annual groundwater pumping exceeds natural recharge by about four times
  - Recharge about 5,000 acre-feet/year
  - Pumping about 20,000 acre-feet/year
- Pumping has resulted in water level declines on the order of 180 feet (about 3 feet per year)
- Water-level declines in areas with significant clay deposits could result in land subsidence
- As the more permeable upper aquifer is dewatered, water-level declines may accelerate and water quality may deteriorate

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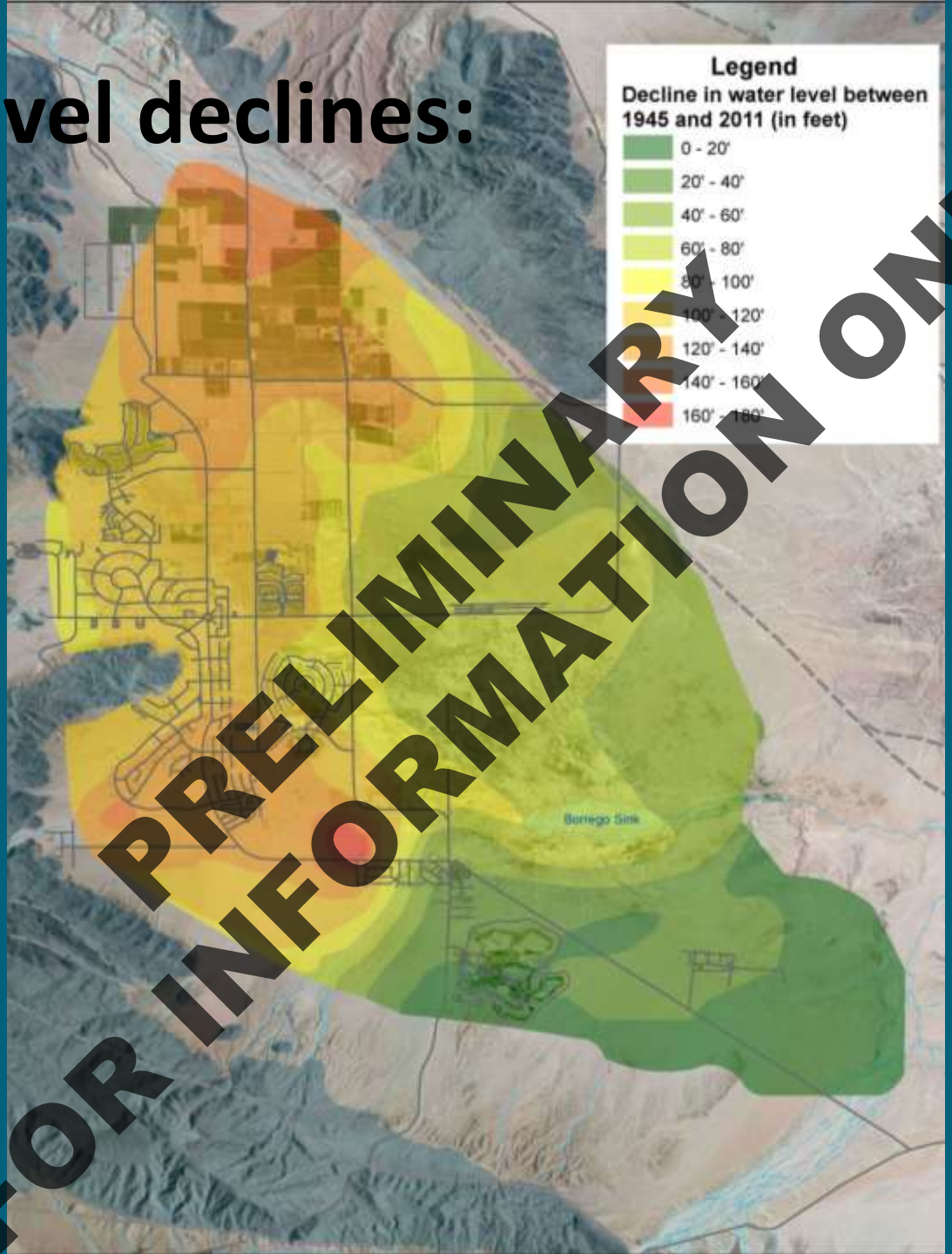
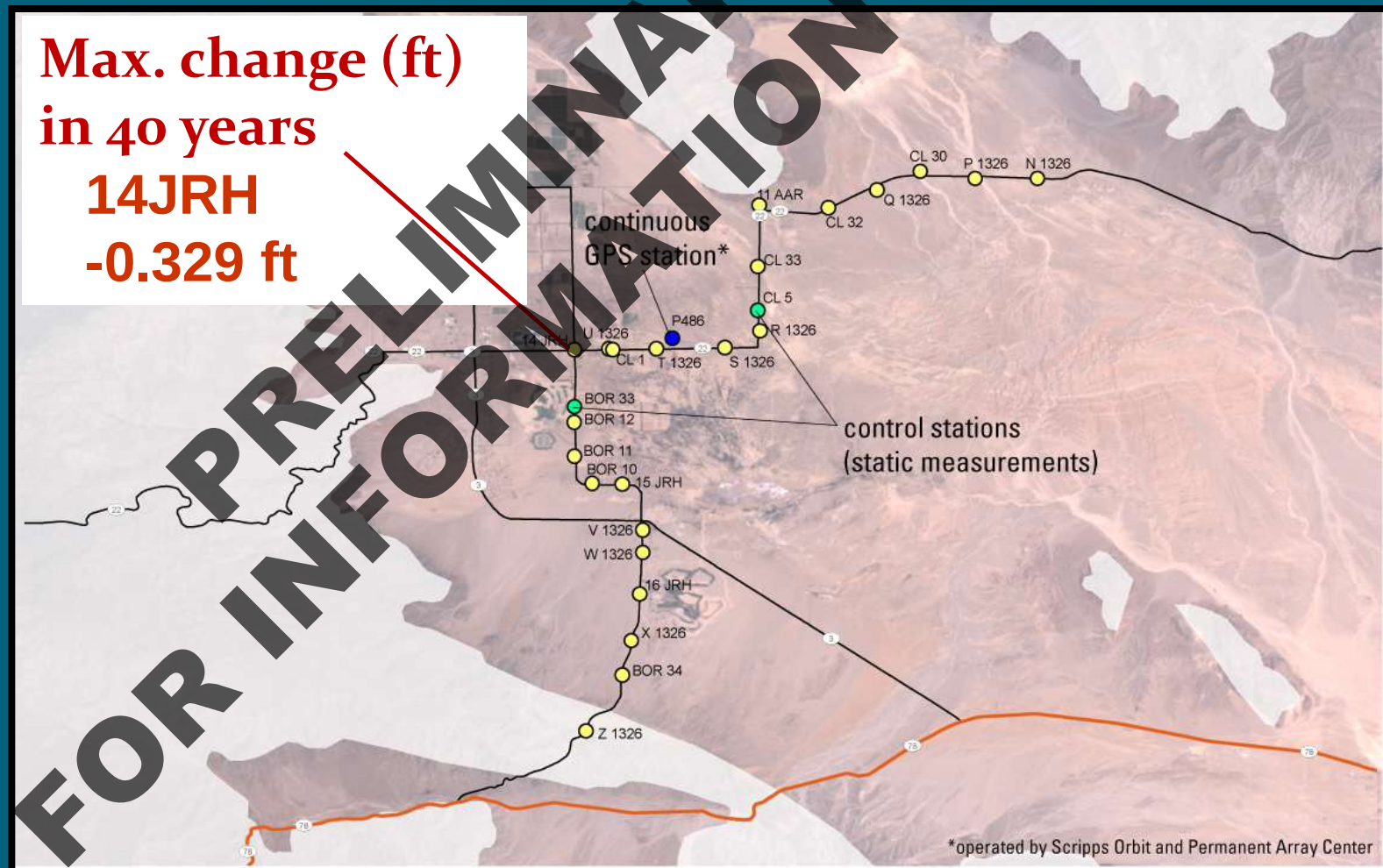
Water level declines:



Land Subsidence

- Elevations for all 25 benchmarks are stable (< 6”) compared to elevations derived from leveling measurements in 1978 (23 benchmarks) or 1969 (2 benchmarks)



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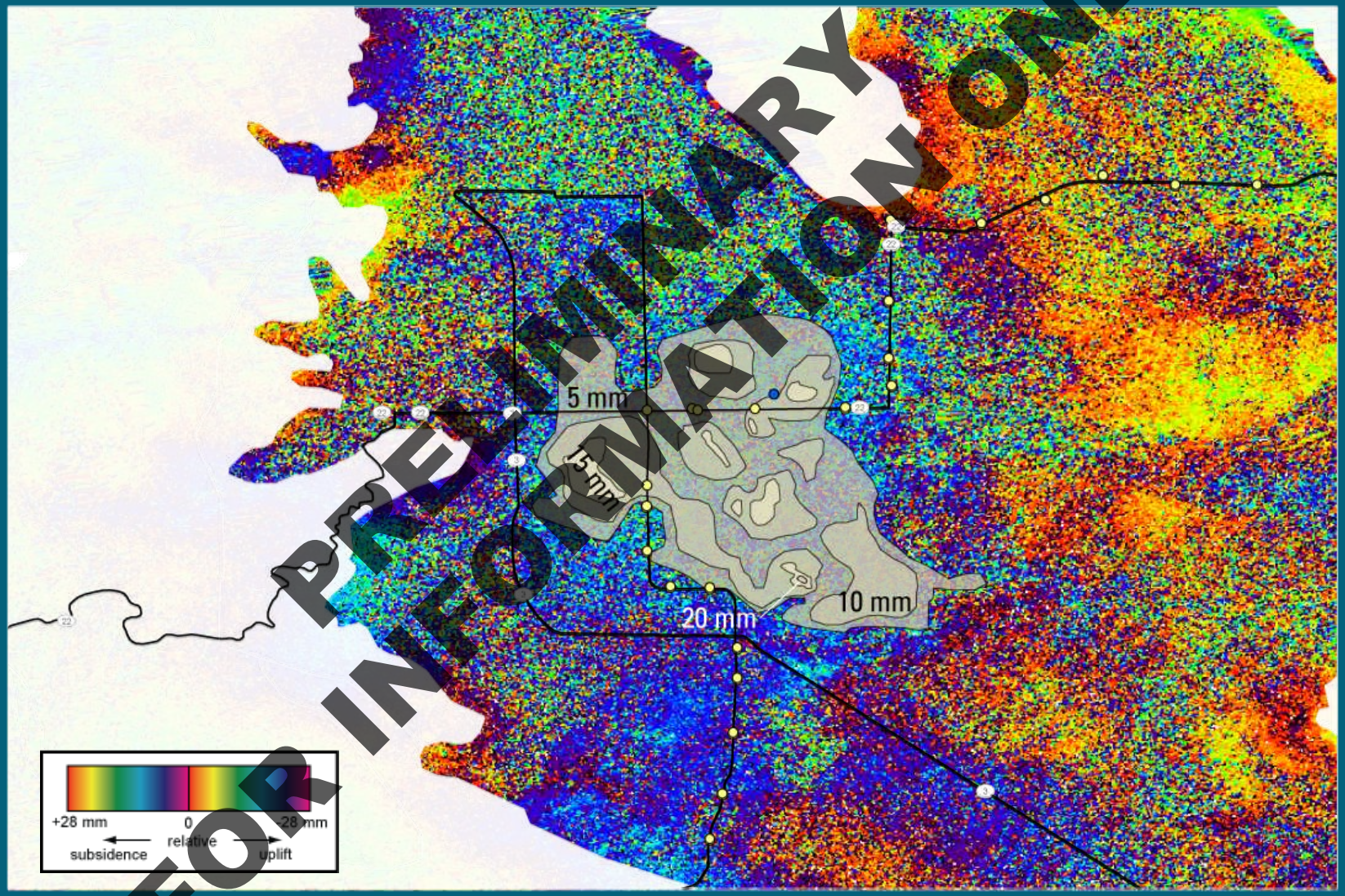
InSAR

- **Interferometric synthetic aperture radar**



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4/3/05-9/30/07 (2.5 years) max. < 1 inch

Problem:

- Annual groundwater pumping exceeds natural recharge by about four times
  - Recharge about 5,000 acre-feet/year
  - Pumping about 20,000 acre-feet/year
- Pumping has resulted in water level declines on the order of 120 feet (about 3 feet per year)
- Water-level declines in areas with significant clay deposits could result in land subsidence
- **As the more permeable upper aquifer is dewatered, water-level declines may accelerate and water quality may deteriorate**

PRELIMINARY
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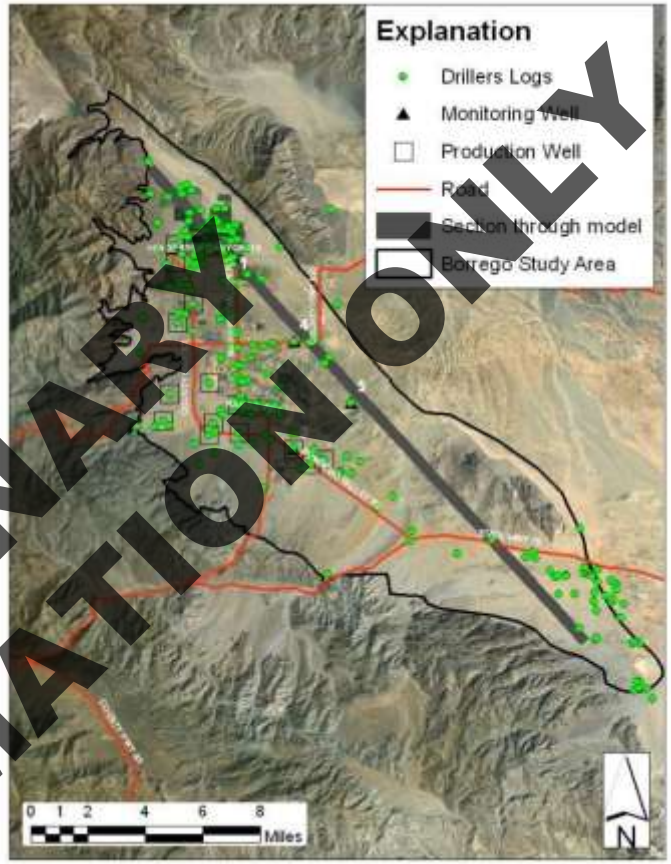
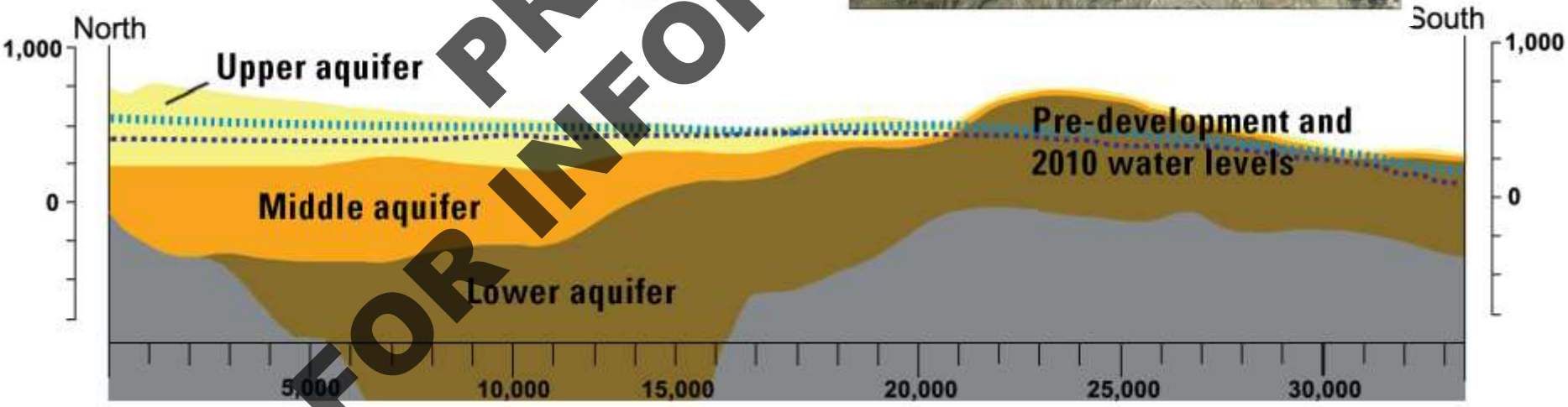
Water level declines:





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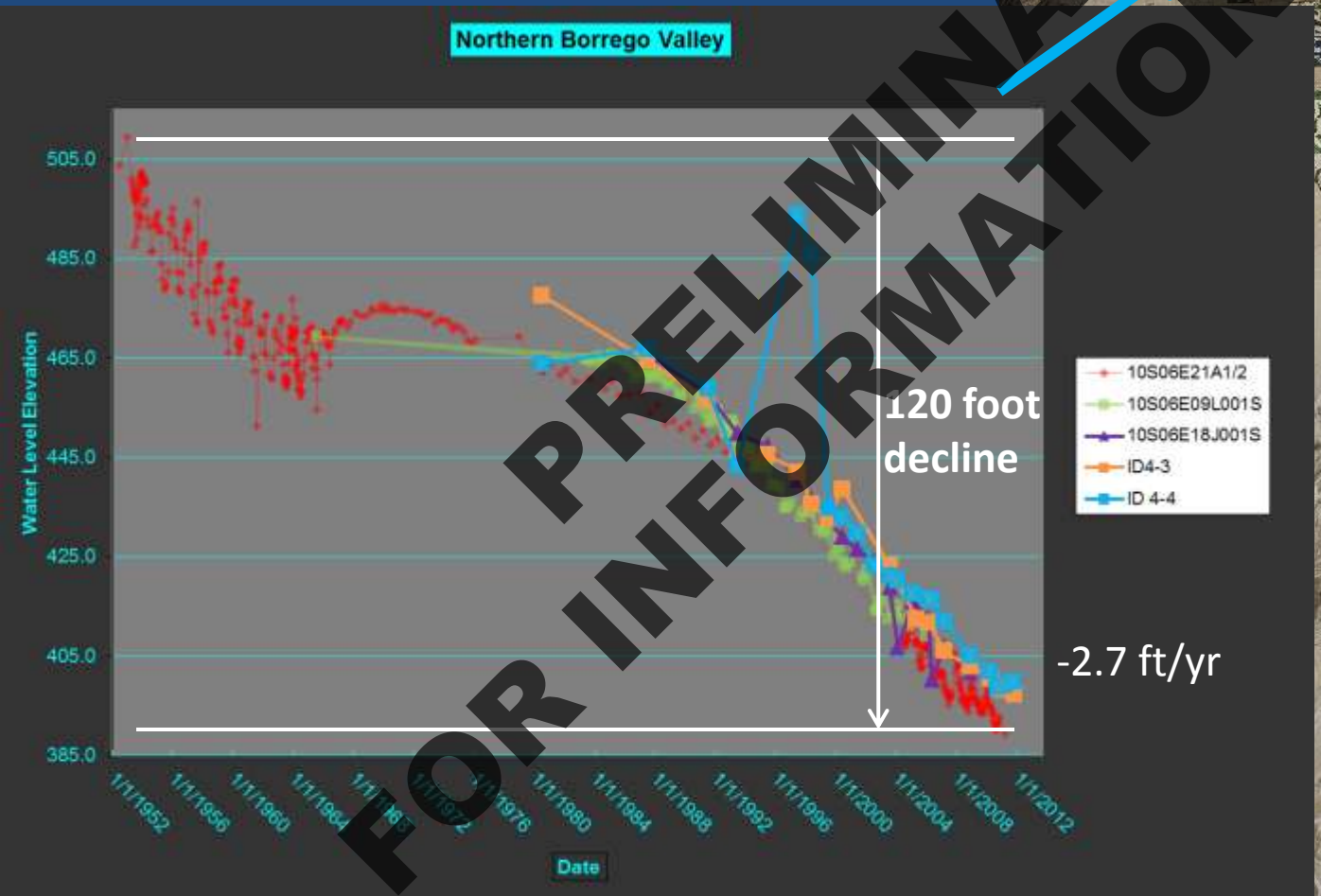

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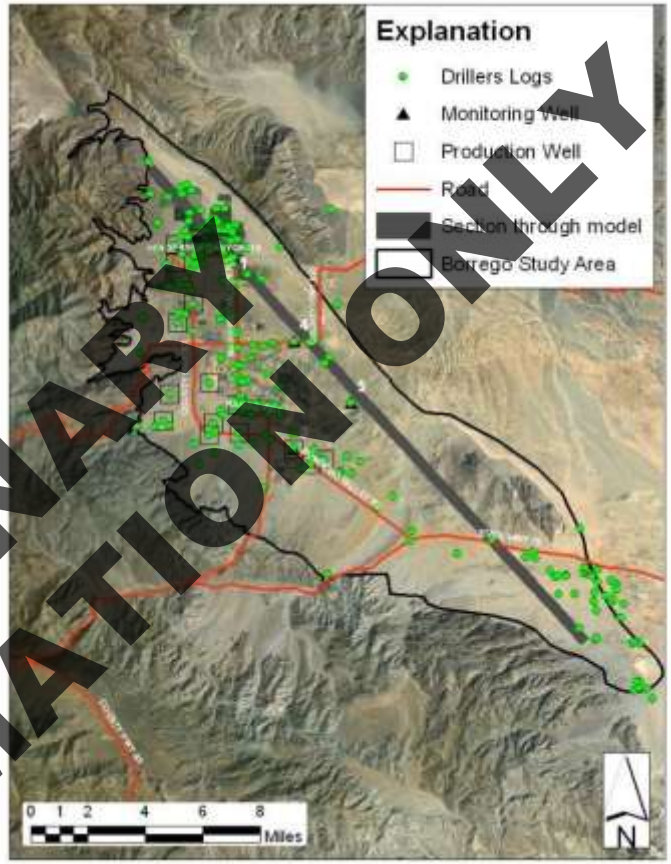
Hydrogeologic characterization:

Horizontal hydraulic conductivity (Permeability)

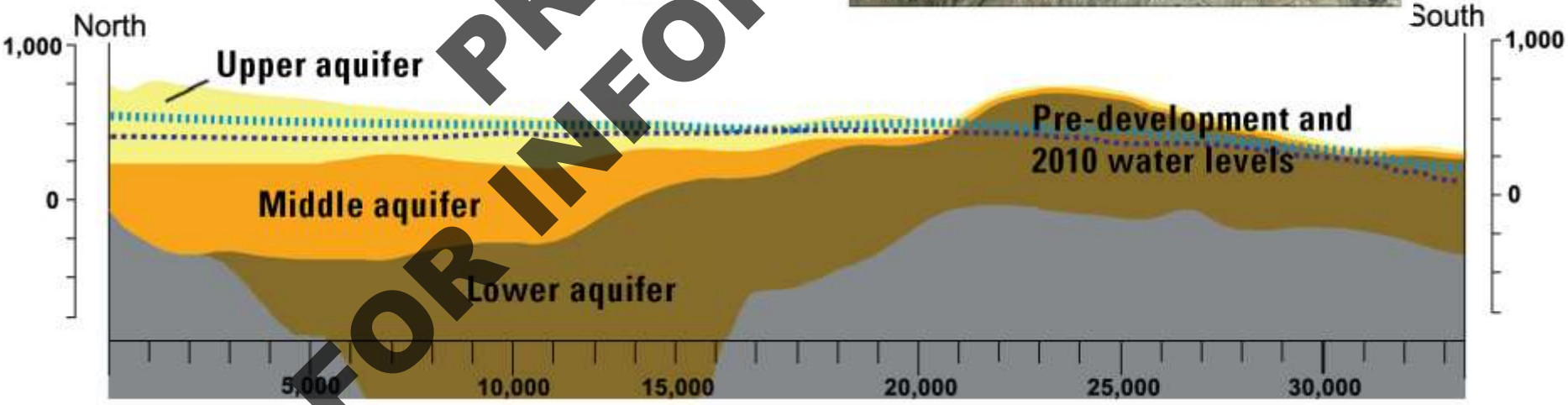
- Upper aquifer 43-81 feet/day
- Middle aquifer 1-10 feet/day
- Lower aquifer 0.1-2 feet/day

Specific Yield (Storage)

- Upper aquifer 14%
- Middle aquifer 7%
- Lower aquifer 3%



Preliminary Estimates



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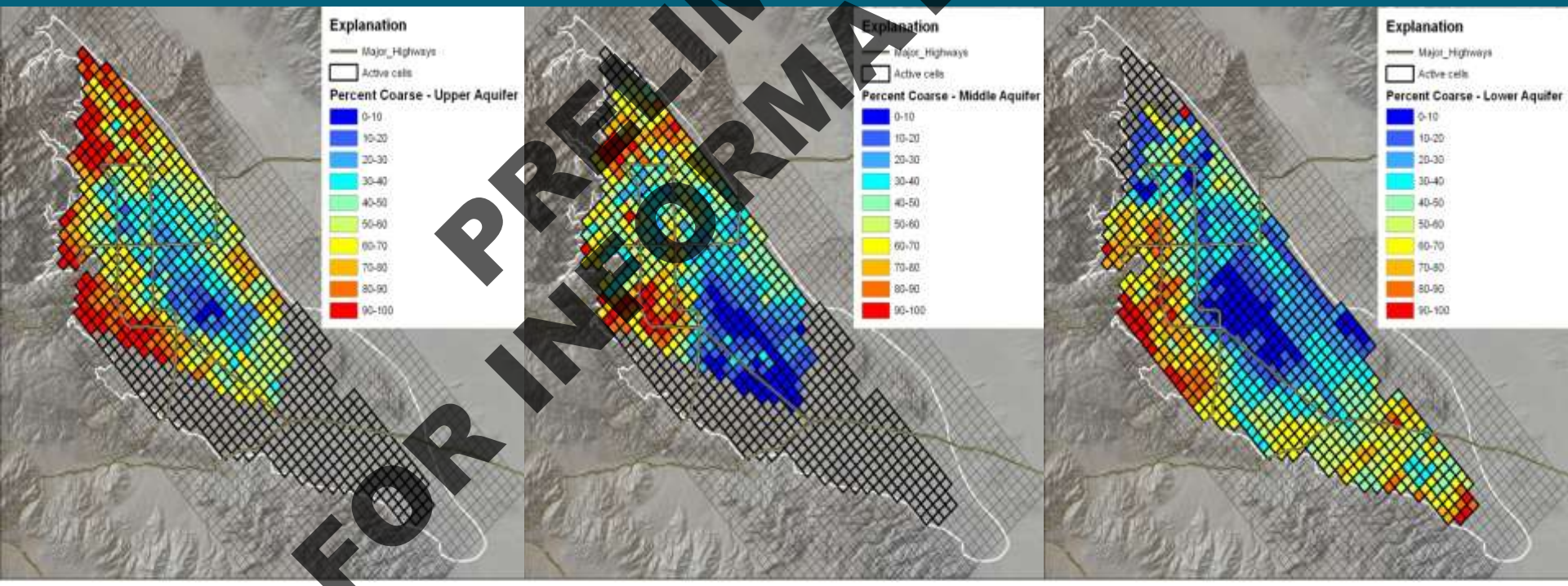
Hydrogeologic characterization



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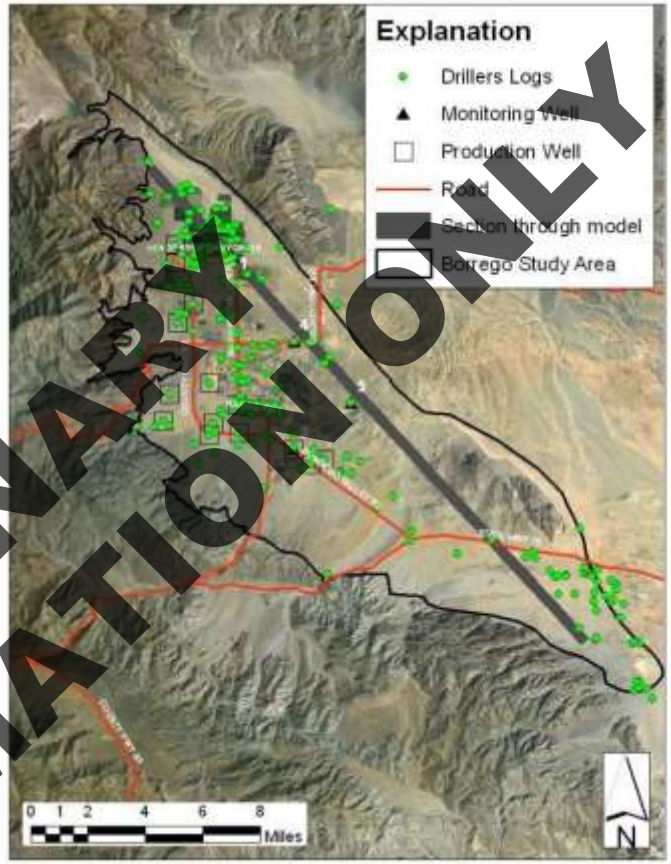

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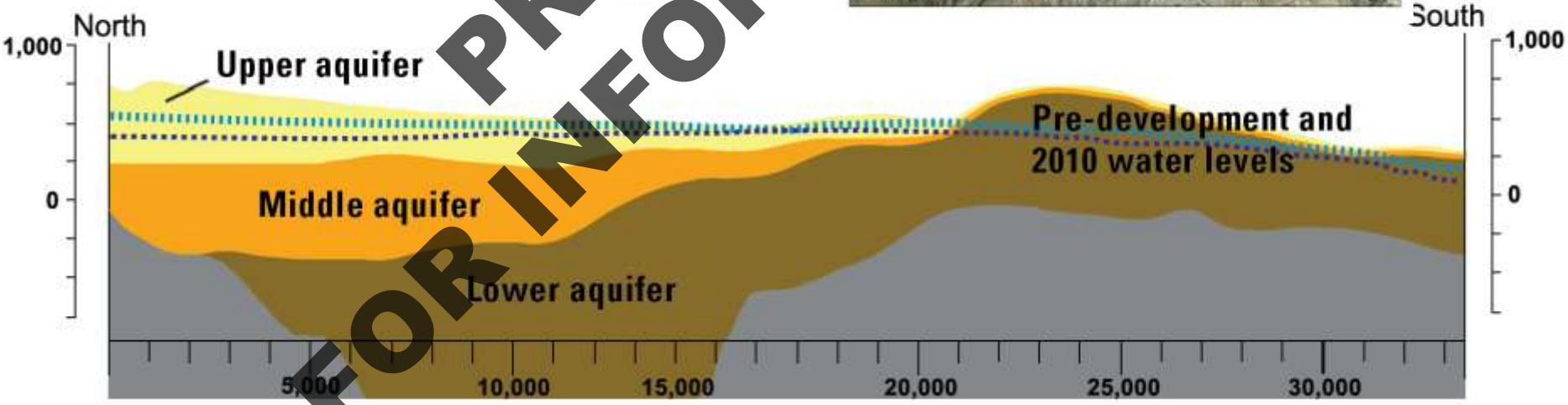

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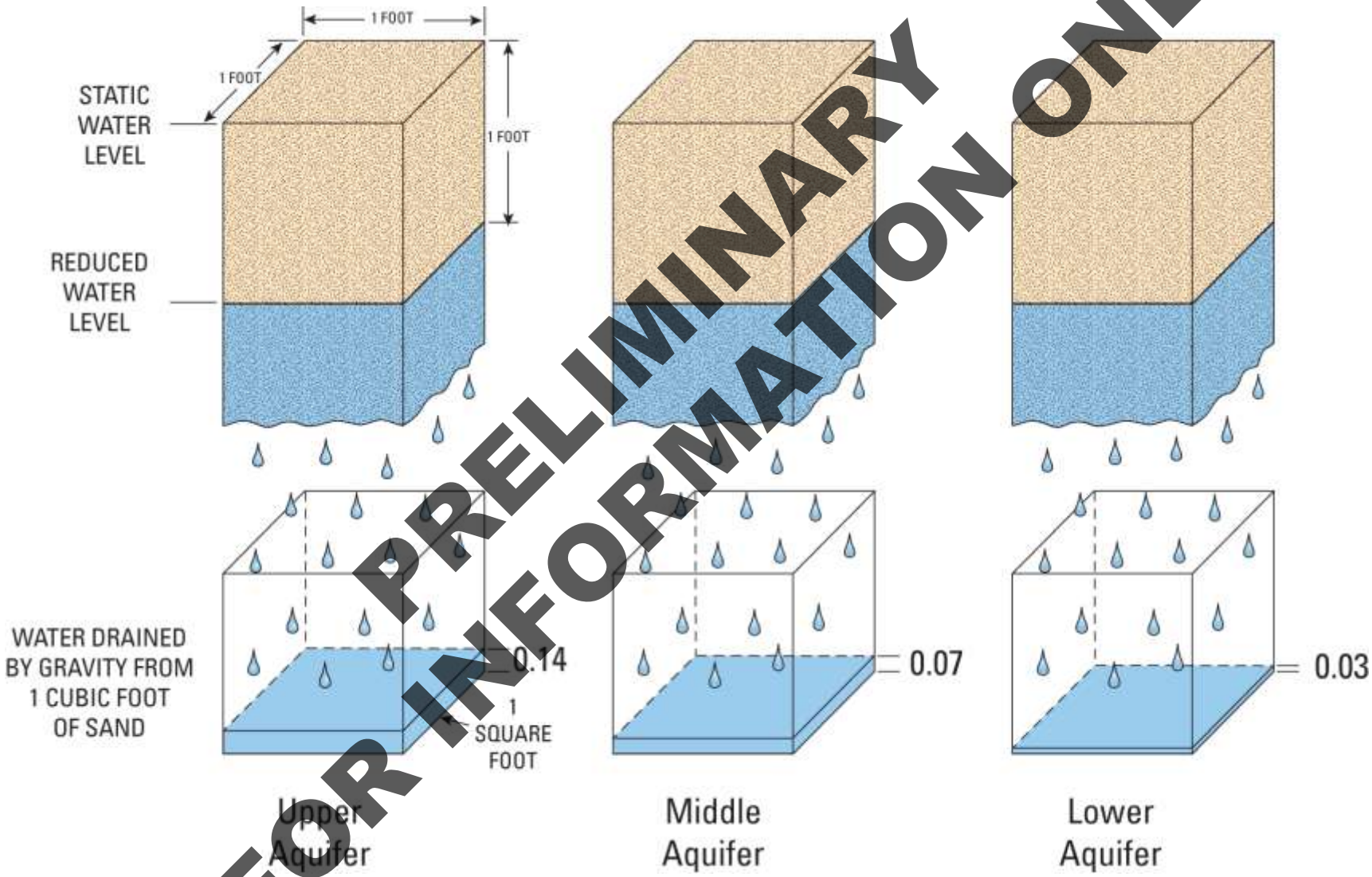
Specific yield of sediments



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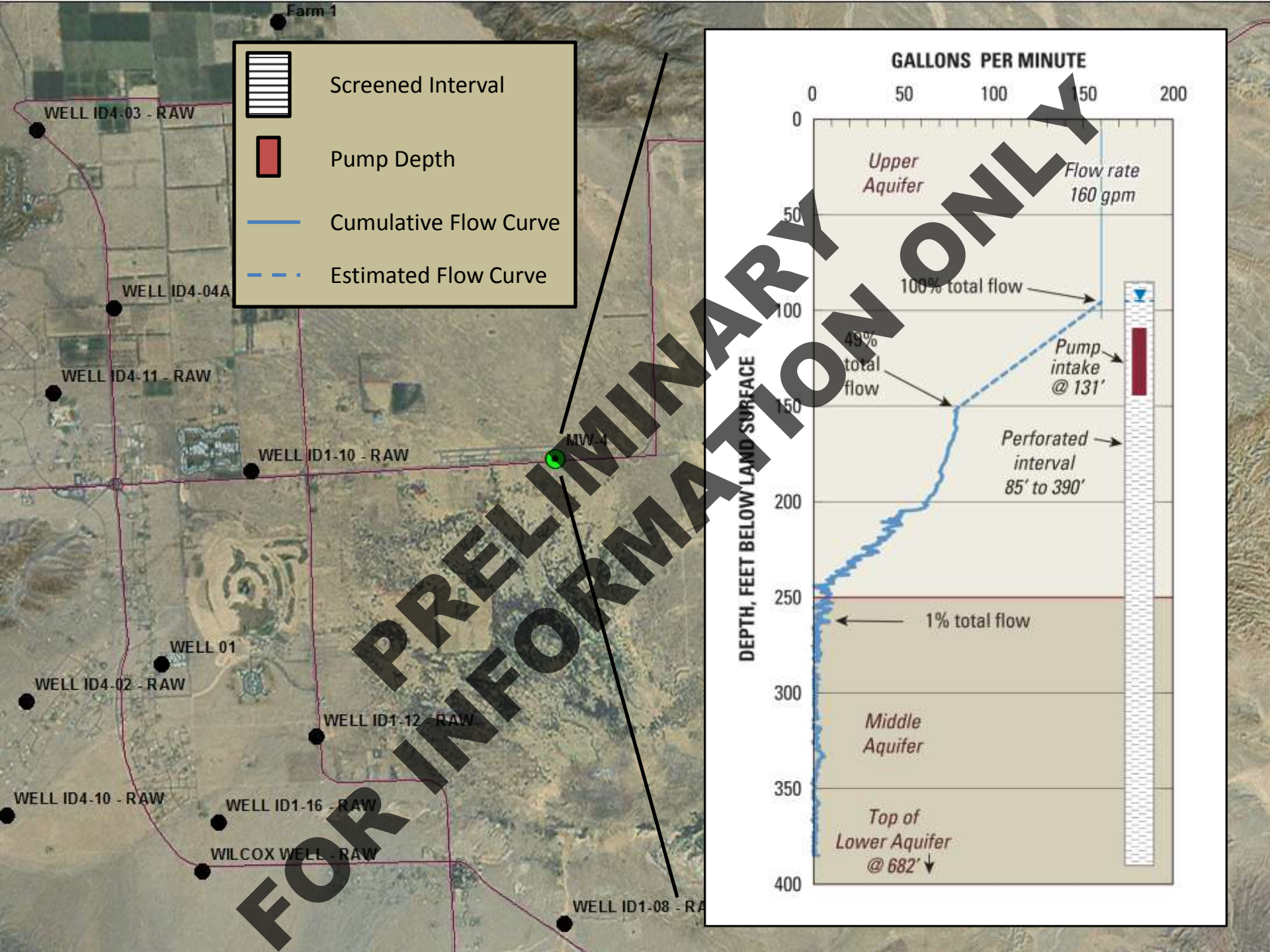
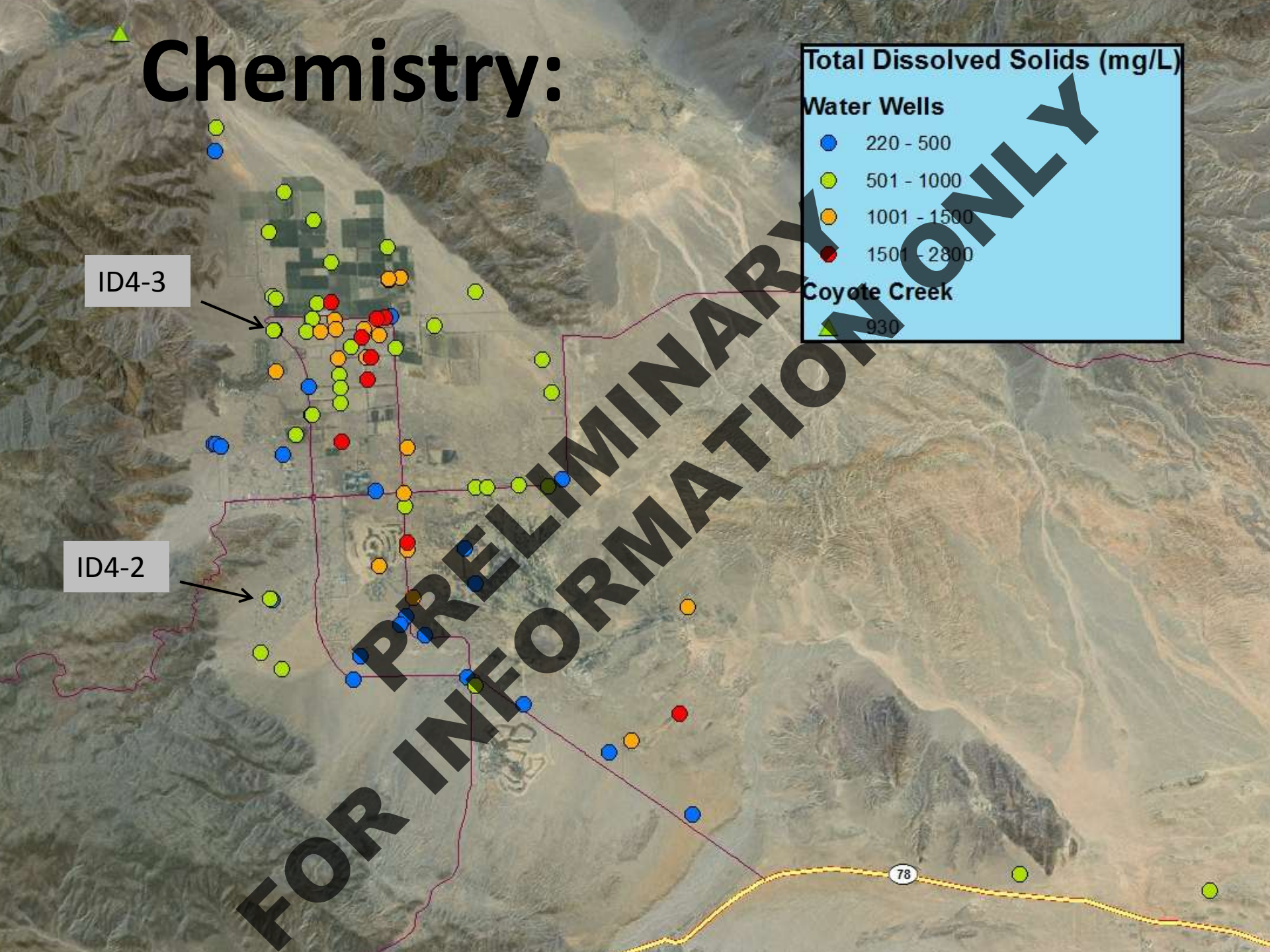
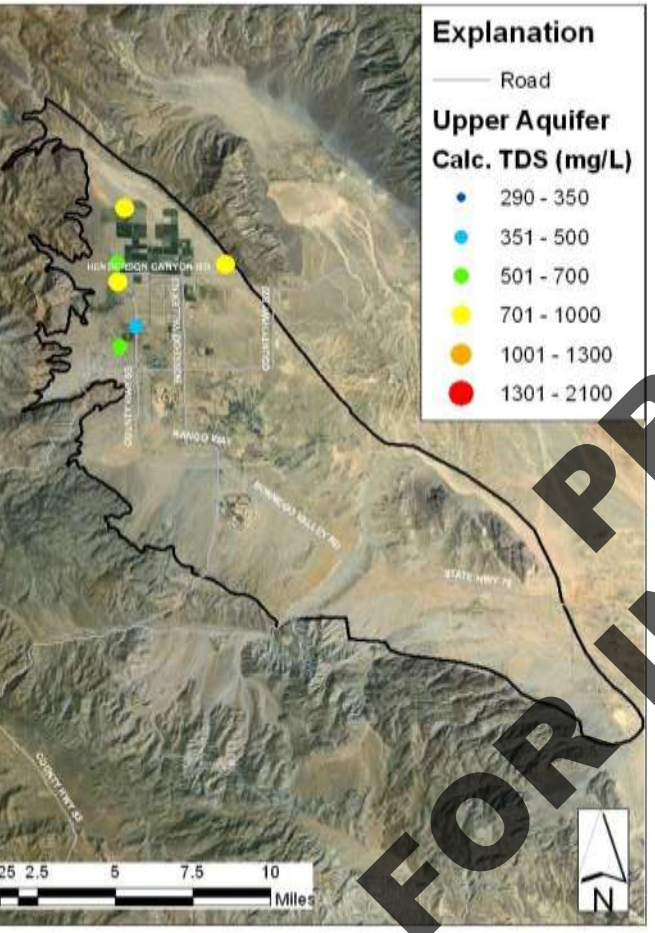
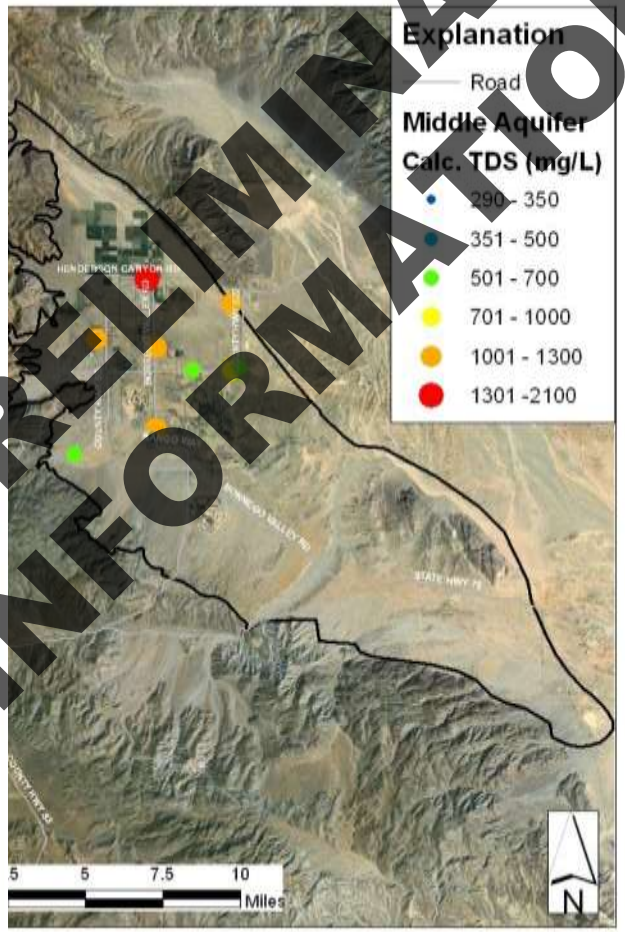

Farm 1
Screened Interval
Pump Depth
Cumulative Flow Curve
Estimated Flow Curve
WELL ID4-03 - RAW
WELL ID4-04A
WELL ID4-11 - RAW
WELL ID1-10 - RAW
MW-4
WELL 01
WELL ID4-02 - RAW
WELL ID1-12 - RAW
WELL ID4-10 - RAW
WELL ID1-16 - RAW
WILCOX WELL - RAW
WELL ID1-08 - RA
GALLONS PER MINUTE
0
50
100
150
200
DEPTH, FEET BELOW LAND SURFACE
0
50
100
150
200
250
300
350
400
Upper Aquifer
Flow rate 160 gpm
100% total flow
49% total flow
Pump intake @ 131'
Perforated interval 85' to 390'
1% total flow
Middle Aquifer
Top of Lower Aquifer @ 682'
PRELIMINARY FOR INFORMATION ONLY

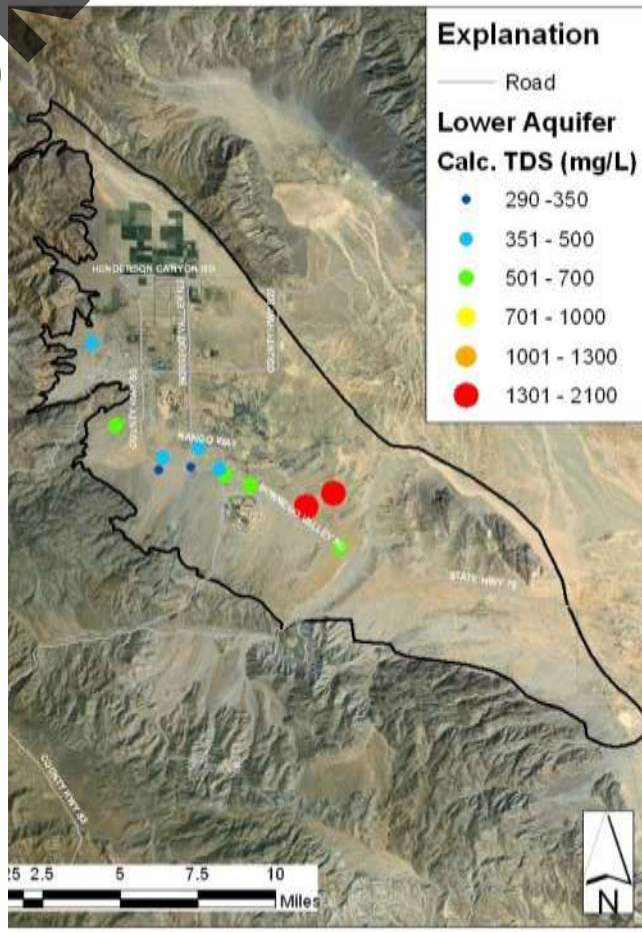
Chemistry:


Total Dissolved Solids (mg/L)
Water Wells
220 - 500
501 - 1000
1001 - 1500
1501 - 2800
Coyote Creek
930
ID4-3
ID4-2
78
PRELIMINARY
FOR INFORMATION ONLY

Chemistry by aquifer:







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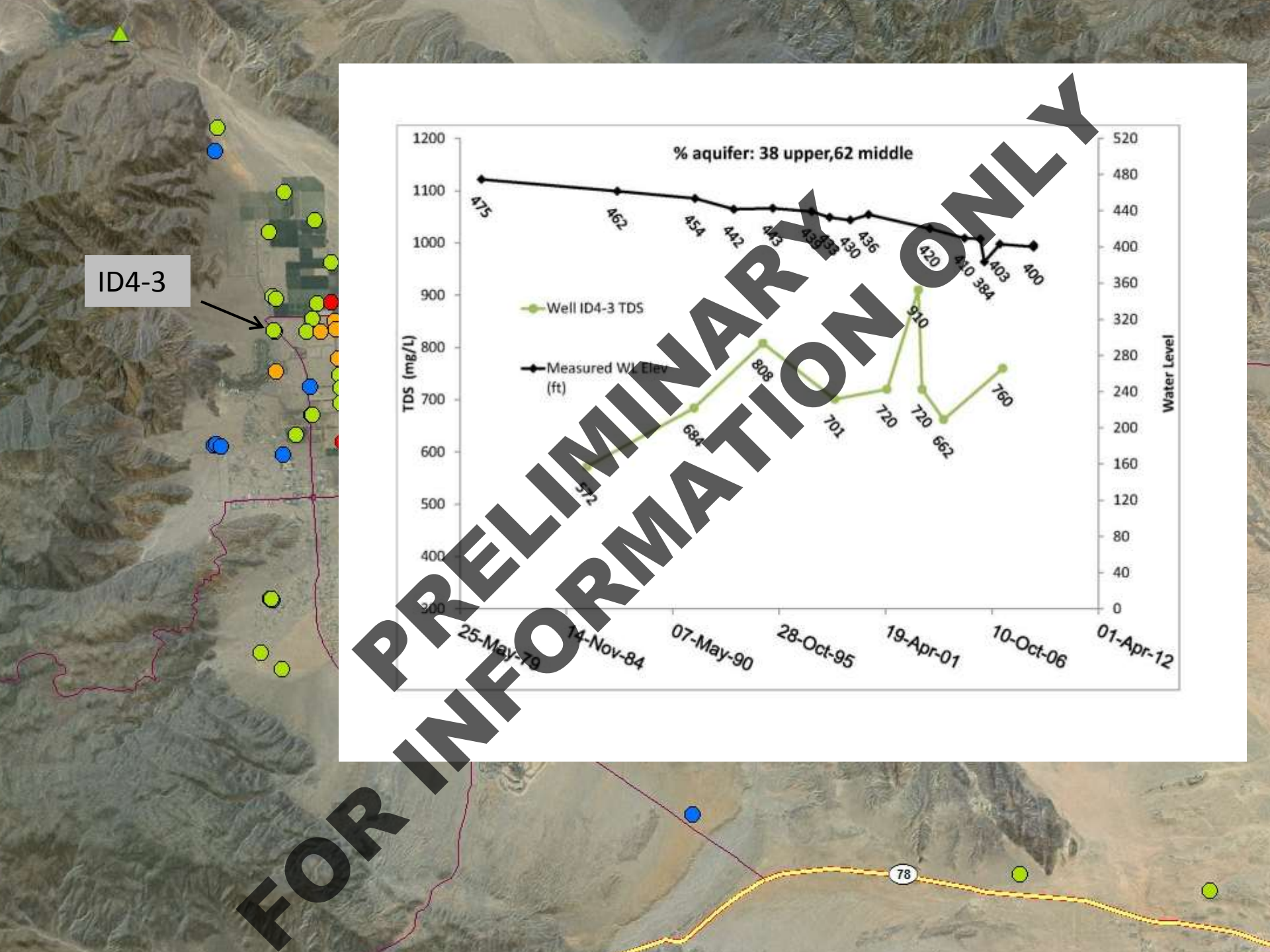
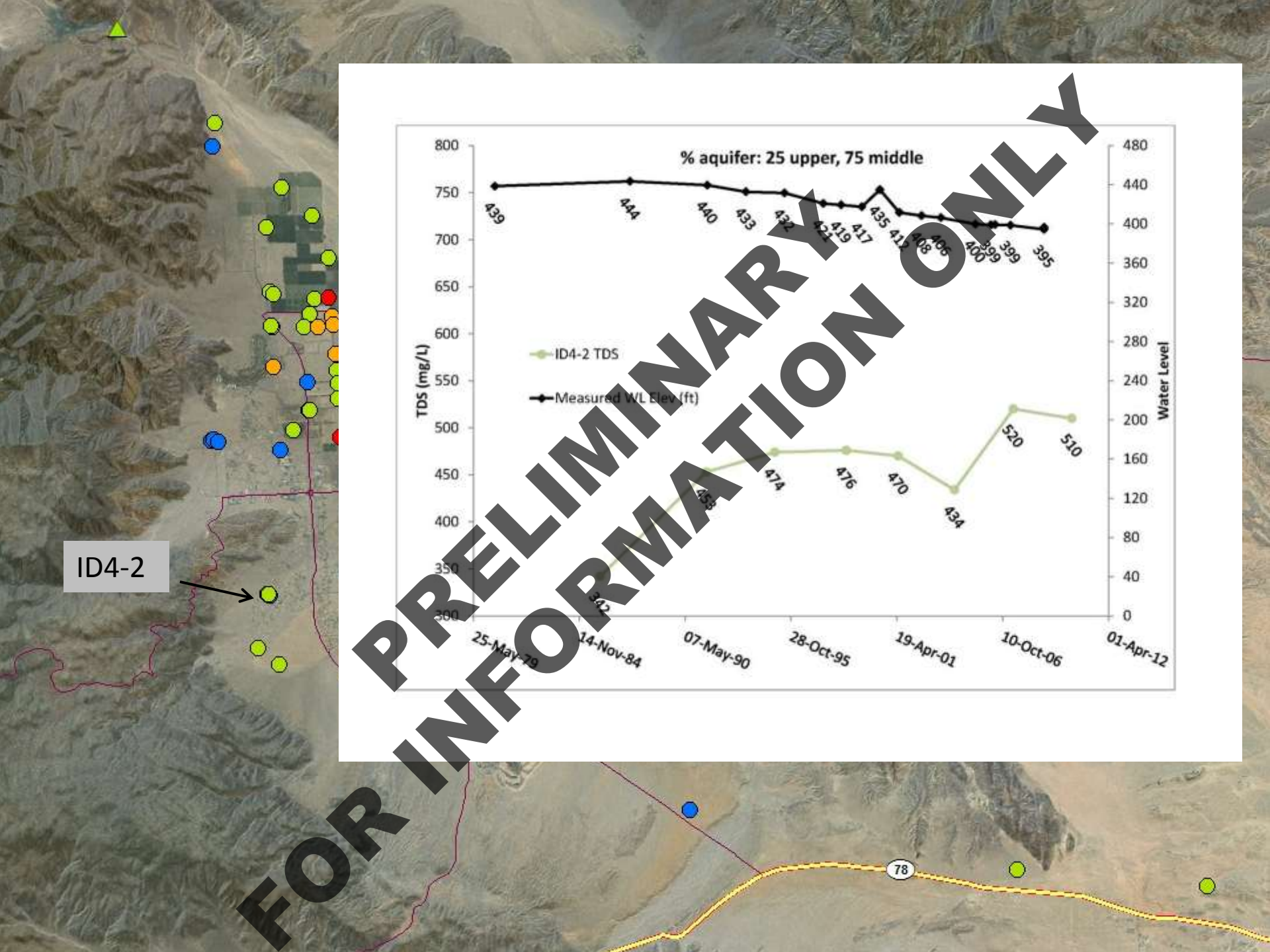

ID4-3
% aquifer: 38 upper,62 middle
Well ID4-3 TDS
Measured WL Elev (ft)
TDS (mg/L)
Water Level
1200
1100
1000
900
800
700
600
500
400
300
520
480
440
400
360
320
280
240
200
160
120
80
40
0
475
462
454
442
443
438
433
430
436
420
410
384
403
400
572
684
808
701
720
720
910
662
760
25-May-79
14-Nov-84
07-May-90
28-Oct-95
19-Apr-01
10-Oct-06
01-Apr-12
PRELIMINARY
FOR INFORMATION ONLY
78


ID4-2
% aquifer: 25 upper, 75 middle
TDS (mg/L)
Water Level
ID4-2 TDS
Measured WL Elev (ft)
800
750
700
650
600
550
500
450
400
350
300
480
440
400
360
320
280
240
200
160
120
80
40
0
439
444
440
433
432
421
419
417
435
411
408
406
400
399
399
395
342
453
474
476
470
434
520
510
25-May-79
14-Nov-84
07-May-90
28-Oct-95
19-Apr-01
10-Oct-06
01-Apr-12
78
PRELIMINARY
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Groundwater Age Dates
(Tritium/Carbon-14)
Age Category
Modern
Pre-modern
~ 1/58
< 1/1,982
< 1/--
--/3,422
--/16,372
1.2/0
< 1/873
< 1/10,702
< 1/1,948
< 1/13,949
< 1/7,092
<1/--
< 1/25,321
78
PRELIMINARY
FOR INFORMATION ONLY

Predictive simulations:

5 Scenarios

(1) No action 50 years
(2)LOW GROWTH (Ag red. 50%; Golf red. 50%; Muni inc. 75%)
(3)MEDIUM GROWTH (Ag red. 75%; Golf red. 50%; Muni inc. 133%)
(4)HIGH GROWTH (Ag red. 100%; Golf red. 50%; Muni inc. 280%)
(5)WATER USAGE REDUCTION TO REACH SUSTAINABILITY (Ag red. 80%; Golf red. 80%; Muni red. 48%)

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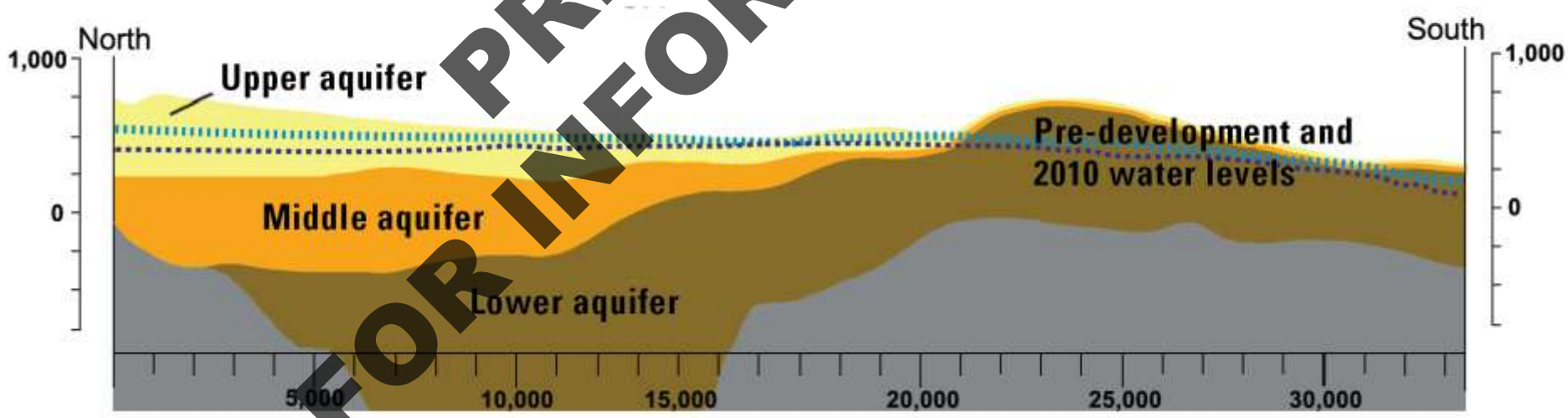
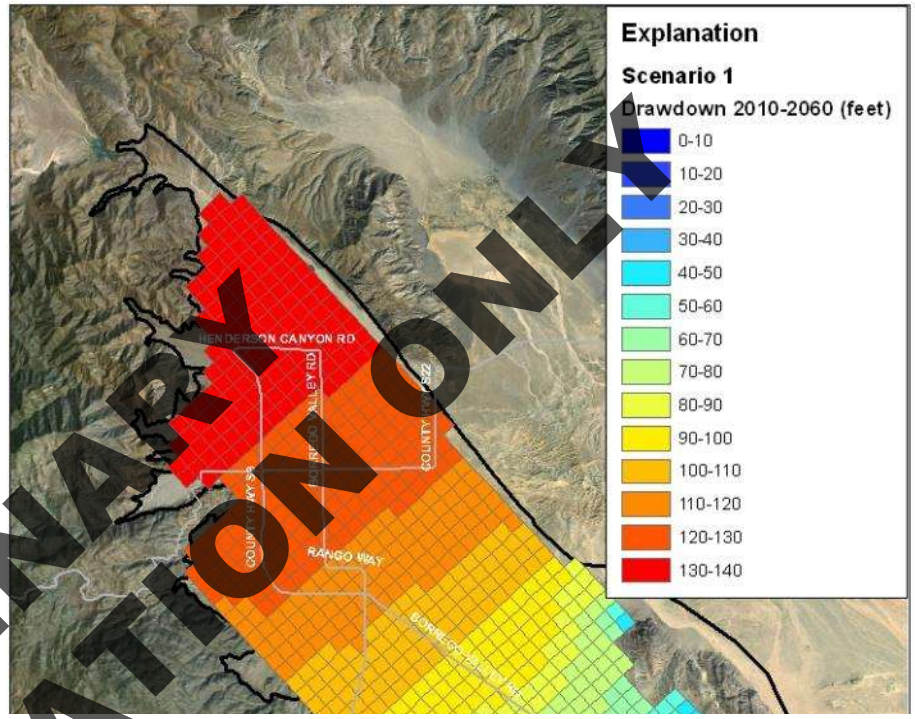


Scenario 1:

No action 50 years
Continue current pumping rates



PRELIMINARY
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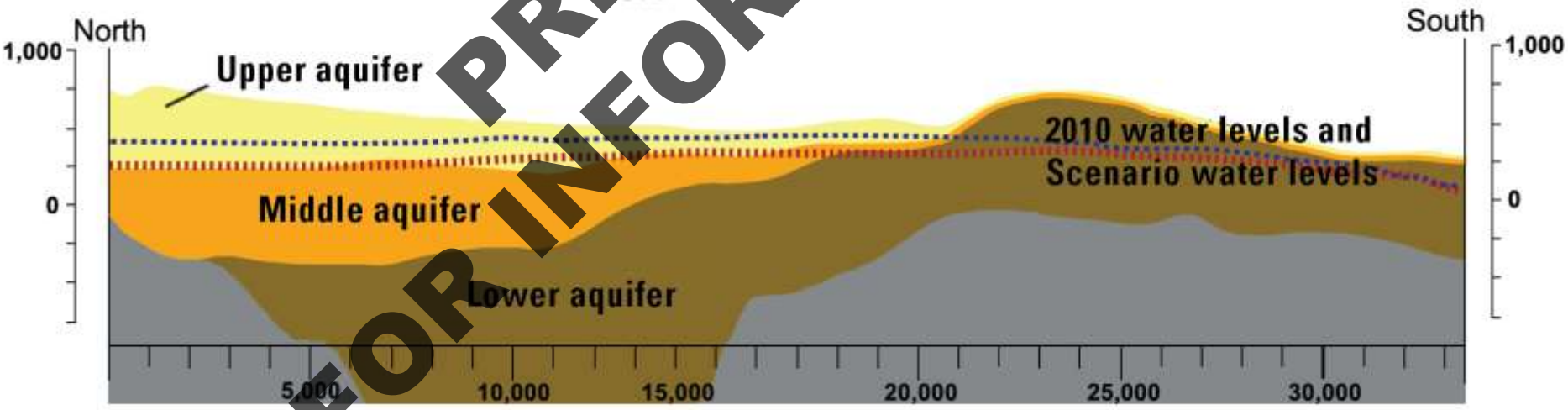
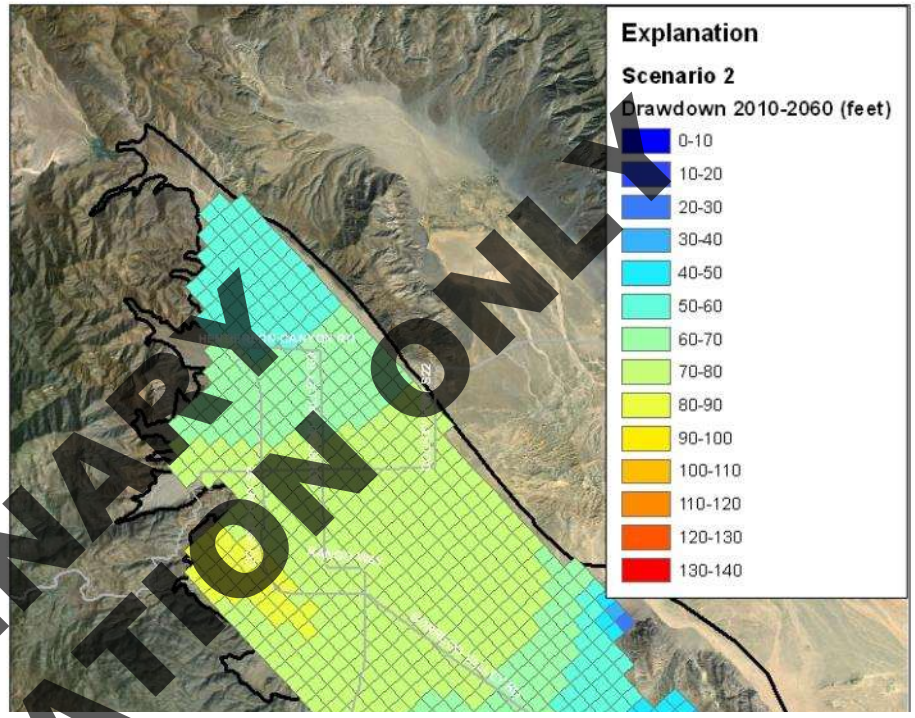
Scenario 1

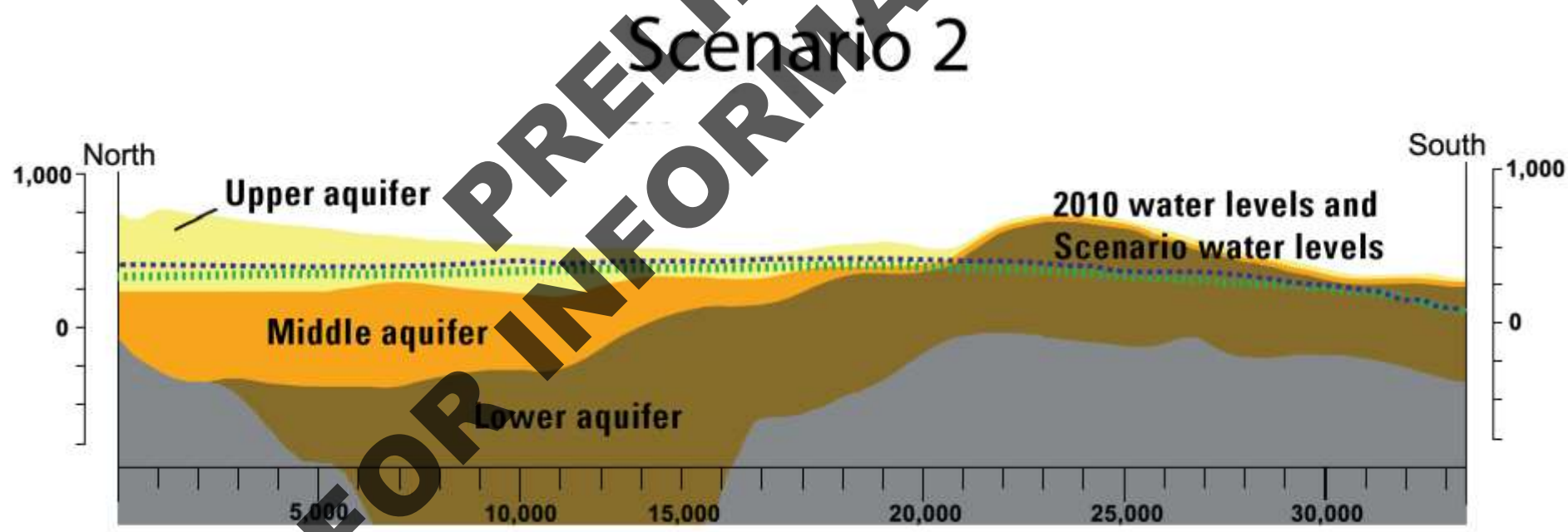


Scenario 2:

LOW GROWTH

- Agriculture reduced 50%
- Golf reduced 50%
- Municipal increased 75%





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Change in storage through time

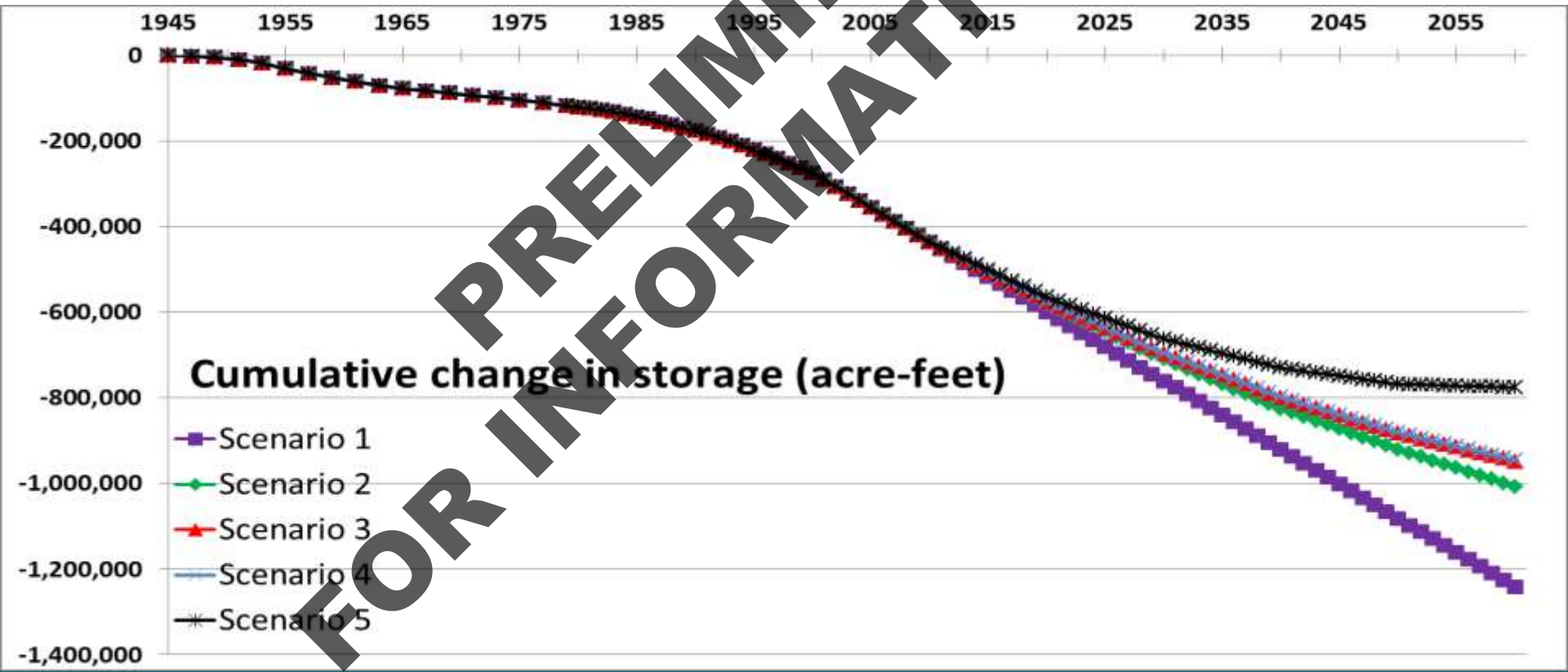
(1) No action 50 years

(2)LOW GROWTH (Ag red. 50%; Golf red. 50%; Muni inc. 75%)

(3)MEDIUM GROWTH (Ag red. 75%; Golf red. 50%; Muni inc. 133%)

(4)HIGH GROWTH (Ag red. 100%; Golf red. 50%; Muni inc. 280%)

(5) WATER USAGE REDUCTION TO REACH SUSTAINABILITY (Ag red. 80%; Golf red. 80%; Muni red. 48%)



PRELIMINARY FOR INFORMATION ONLY

Plans:

(1) Complete updating and calibrating MODFLOW,

(2) Construct and analyze predictive simulations identified by Borrego Water District such as, and

- Artificial recharge
- Reduced municipal or recreational pumpage
- Fallow agriculture land
- Import water and change pumping patterns

(4) Complete interpretive report

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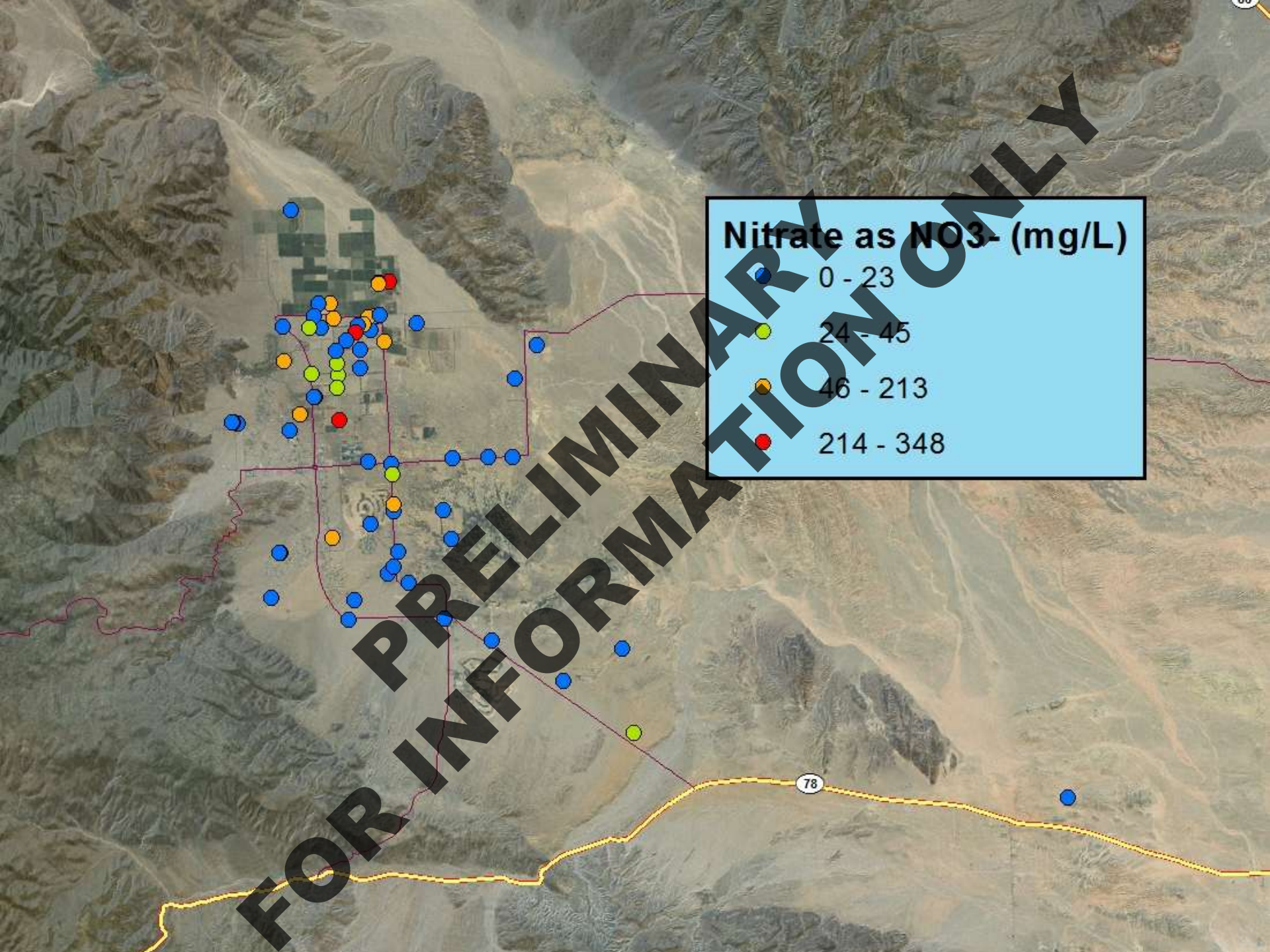
Nitrate as NO3- (mg/L)
0 - 23
24 - 45
46 - 213
214 - 348
78
PRELIMINARY
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