The Big Creek Research & Extension Team Project: Progress Update

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University of Arkansas System

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Our charge

- ✓ Farm owner contacted Newton Co. Extension Office for assistance in mid 2013
- ✓ Gov. Beebe charged us with monitoring the fate & transport of nutrients & bacteria from land-applied slurry – September 2013
- ✓ Assess impact of farm operations on water quality of springs, streams, & ground water
- ✓ Monitor long-term accumulation of nutrients in permitted fields

The scientific team

Andrew Sharpley	Soil & water quality, watershed mgt.
Brian Breaker (USGS)	Hydrology, data collection, & analysis
Kris Brye	Soil physics, pedology, sustainability, nutrient leaching
Mike Daniels	Extension water quality & nutrient mgt. specialist
Ed Gbur	Statistical applications to agriculture, expt. design
Brian Haggard	Ecological engineering, water quality monitoring
Phil Hays (USGS)	Karst hydrogeology and groundwater quality
Tim Kresse (USGS)	Ground and stream water quality
Mary Savin	Structure & function of microbial communities
Thad Scott	Water quality, stream ecology and response
Karl VanDevender	Extension engineer, manure mgt. & planning
Adam Willis	County Extension Agent - Agriculture
Jun Zhu	Manure treatment technologies, ag. sustainability
Field technicians	Equipment construction, soil & water sampling experts

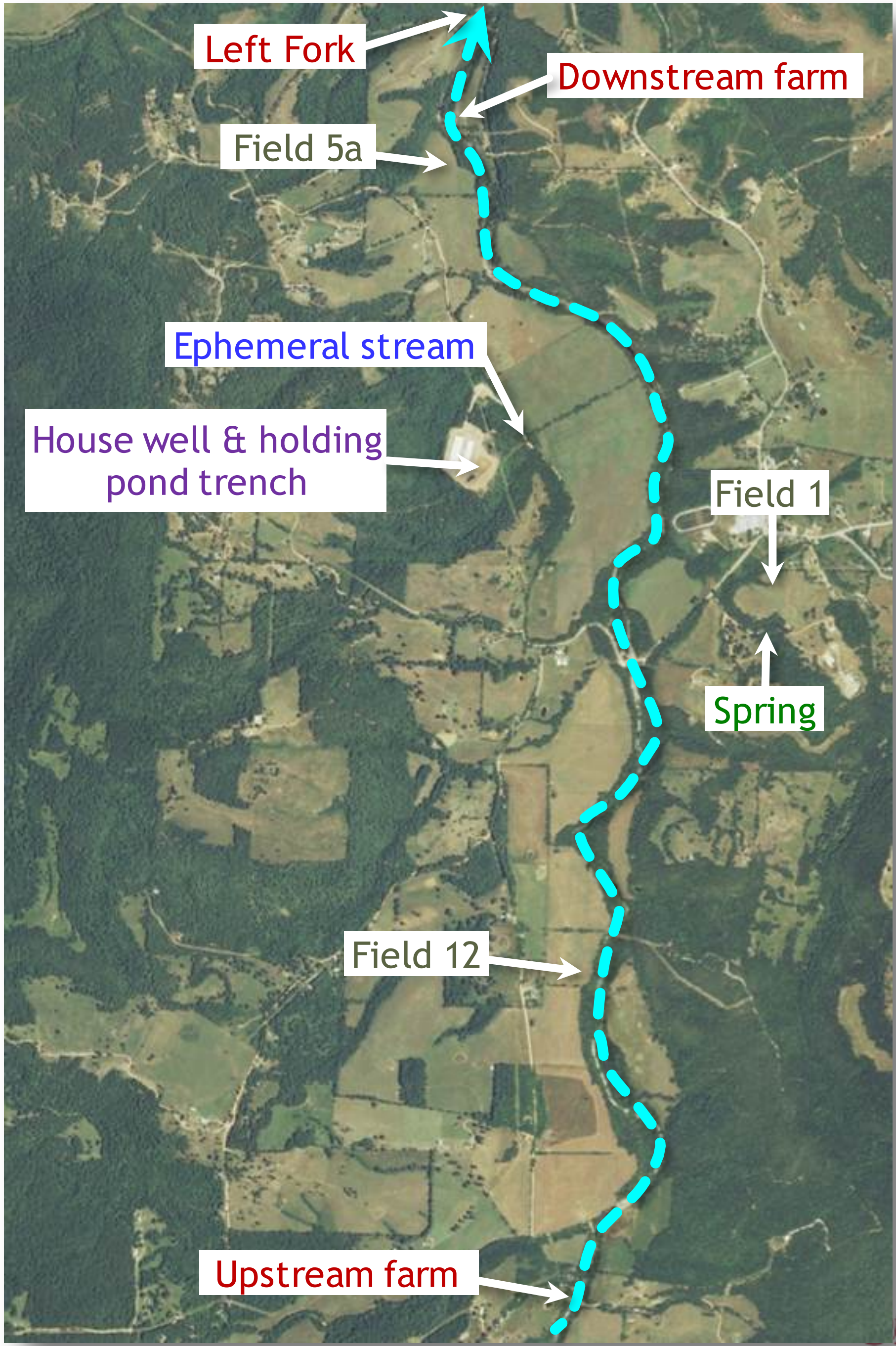
Today's focus

- ✓ Where & what we measure
- ✓ Holding pond assessment
- ✓ Trends

Nutrients, sediment, & coliform measured

- ✓ Storms & weekly base flow in Big Creek, ephemeral creek, Left Fork, & spring
- ✓ House well & holding pond trenches
- ✓ Field runoff on 2 application fields & 1 control
- ✓ Grid-soil sampling in 3 fields

Current active water sample collection locations



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Base flow
weekly
grab samples

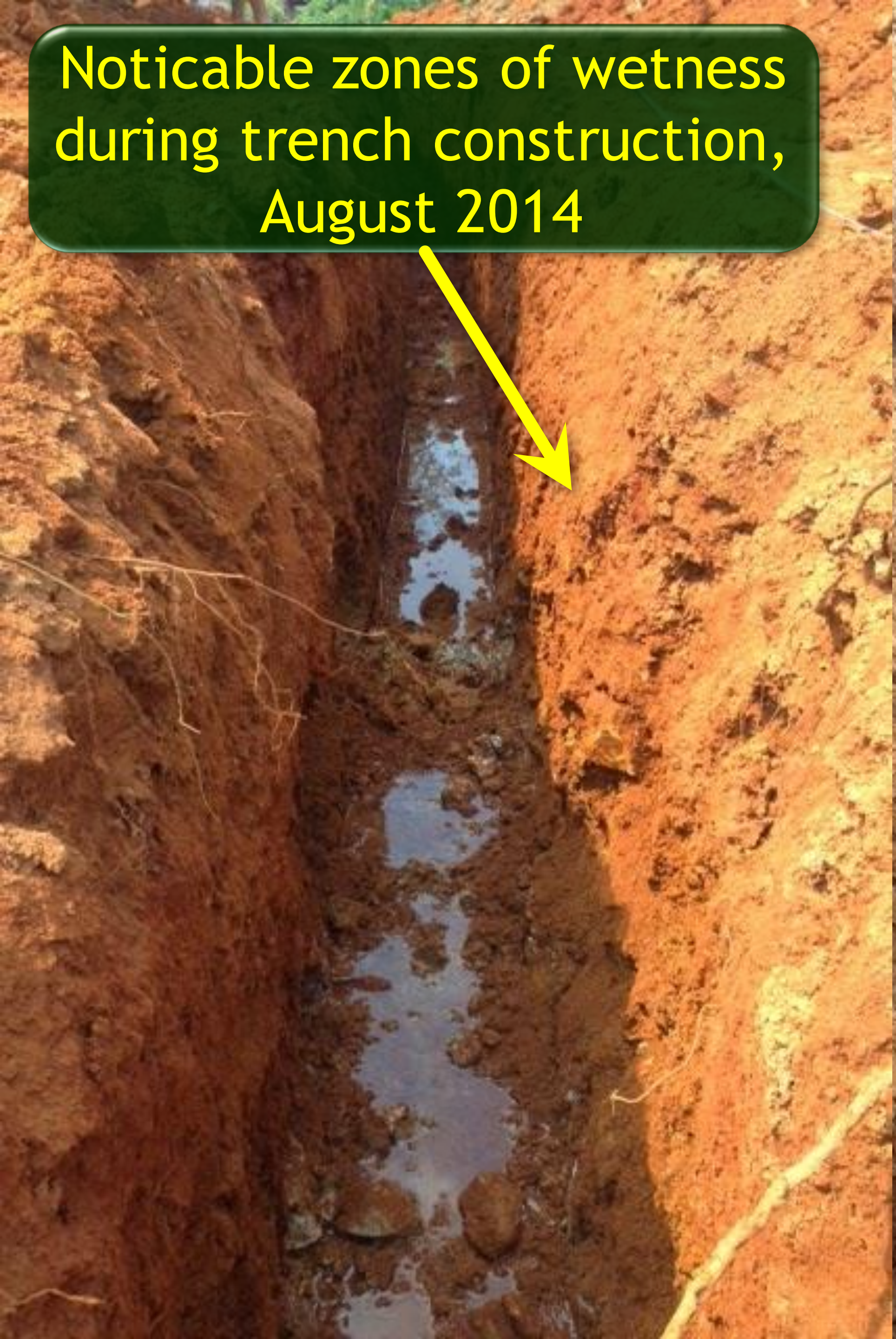
Storm flow
ISCO autosampler

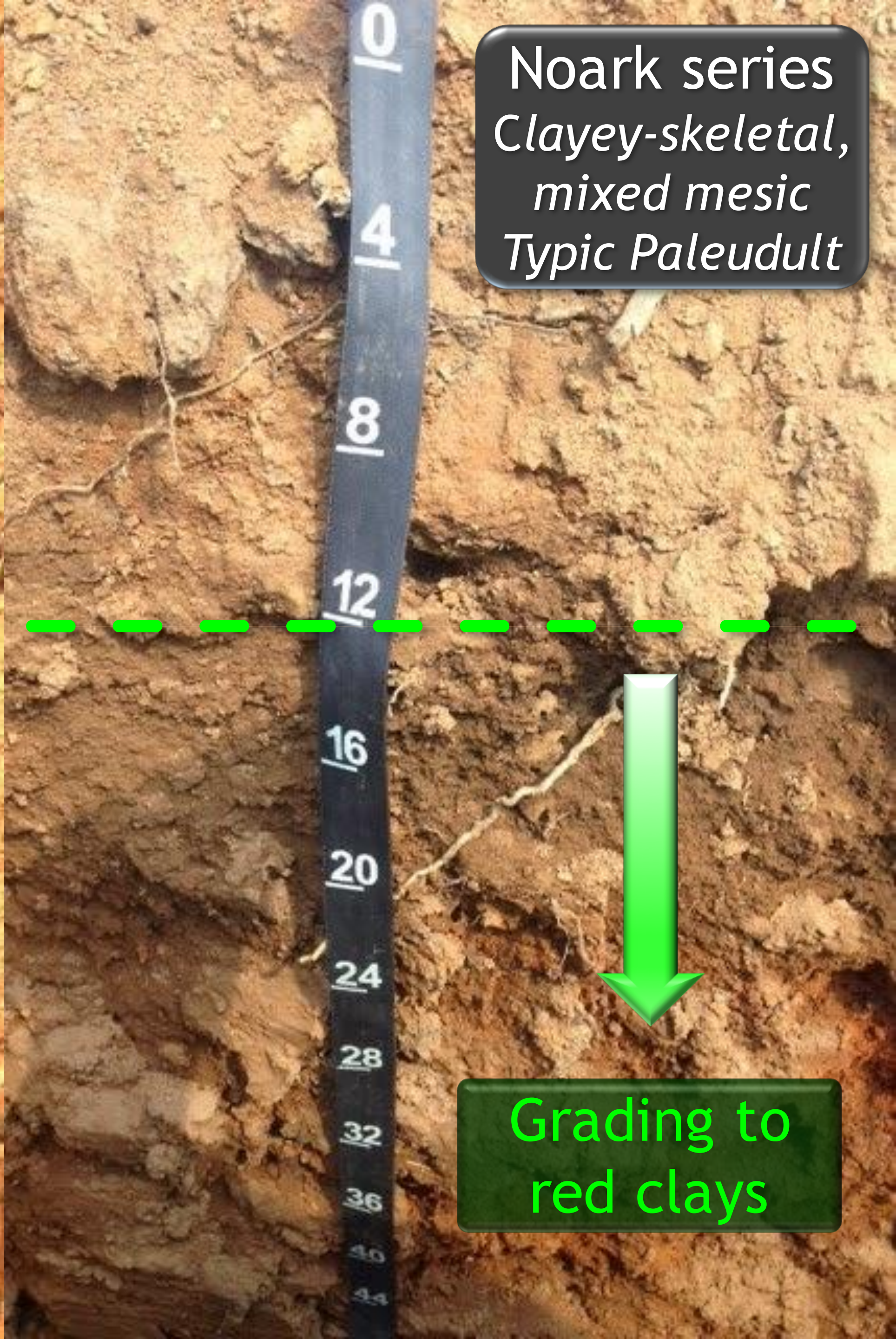
What have we learnt?

Assessing holding pond integrity

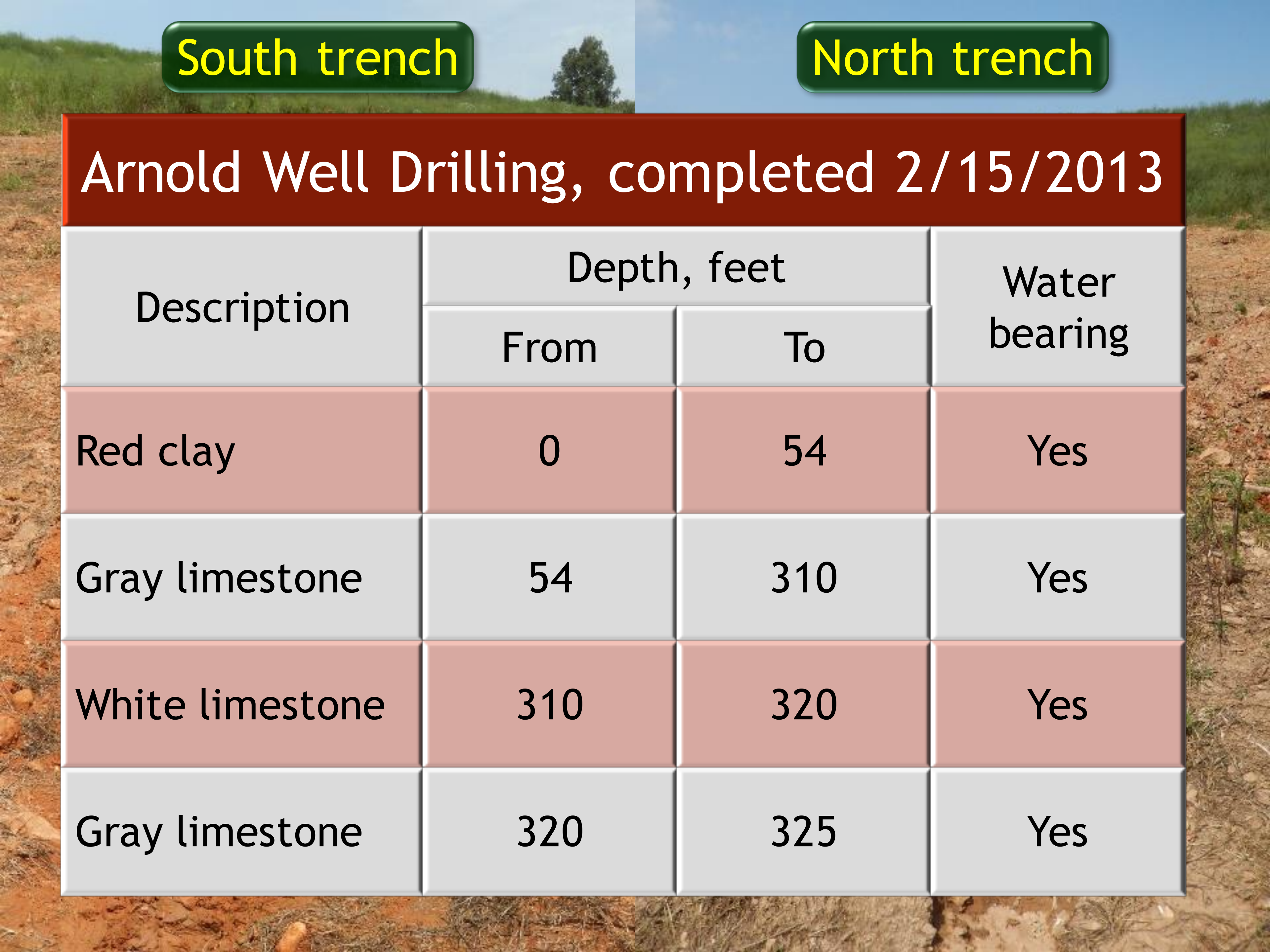
- Use of several direct methods
  - Soil profile surveys
  - Trench flow chemistry
  - House well chemistry
  - Ephemeral creek chemistry
  - Well-drilling logs


North trench #2
South trench #1


Noticable zones of wetness during trench construction, August 2014

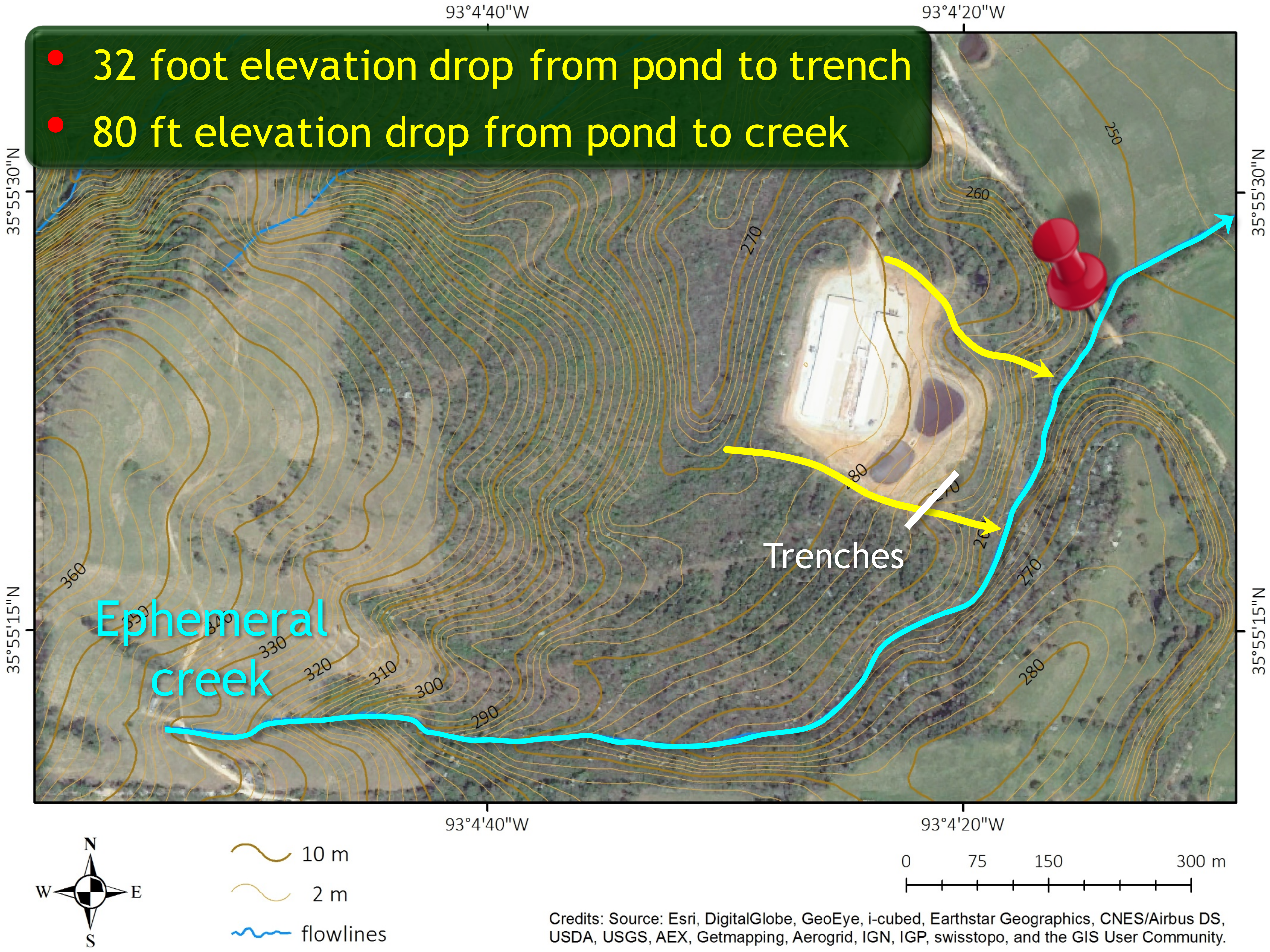

Noark series
Clayey-skeletal, mixed mesic Typic Paleudult
0
4
8
12
16
20
24
28
32
36
Grading to red clays


Holding pond
Trench



Arnold Well Drilling, completed 2/15/2013

Description	Depth, feet		Water bearing
	From	To	
Red clay	0	54	Yes
Gray limestone	54	310	Yes
White limestone	310	320	Yes
Gray limestone	320	325	Yes



32 foot elevation drop from pond to trench
80 ft elevation drop from pond to creek
Trenches
Ephemeral creek
93°4'40"W
93°4'20"W
35°55'30"N
35°55'15"N
250
260
270
280
360
330
320
310
300
290
N
S
E
W
10 m
2 m
flowlines
0
75
150
300 m
Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community.

Median concentration to date, mg/L

	#	Total P	Total N	E. coli	Chloride
Manure pond 1	7	527.5	2,590	- -	391
Manure pond 2	5	160.0	1,396	- -	372
Liquid waste - published KS & Manitoba ponds	162	579 60 – 1,209	2,460 610 – 10,140	- -	390 73 – 1,149
South trench [1]	34	0.018	0.83	8.4	1.77
North trench [1]	13	0.054	2.33	51.7	0.96
House well [2]	23	0.016	0.570	1.0	5.24
E. Creek baseflow	36	0.024	0.60	75.3	- -
Upstream baseflow	85	0.026	0.19	67.0	1.63
Downstream baseflow	91	0.026	0.34	42.0	2.14

[1] Since August 2014 [2] Since Sept. 2015

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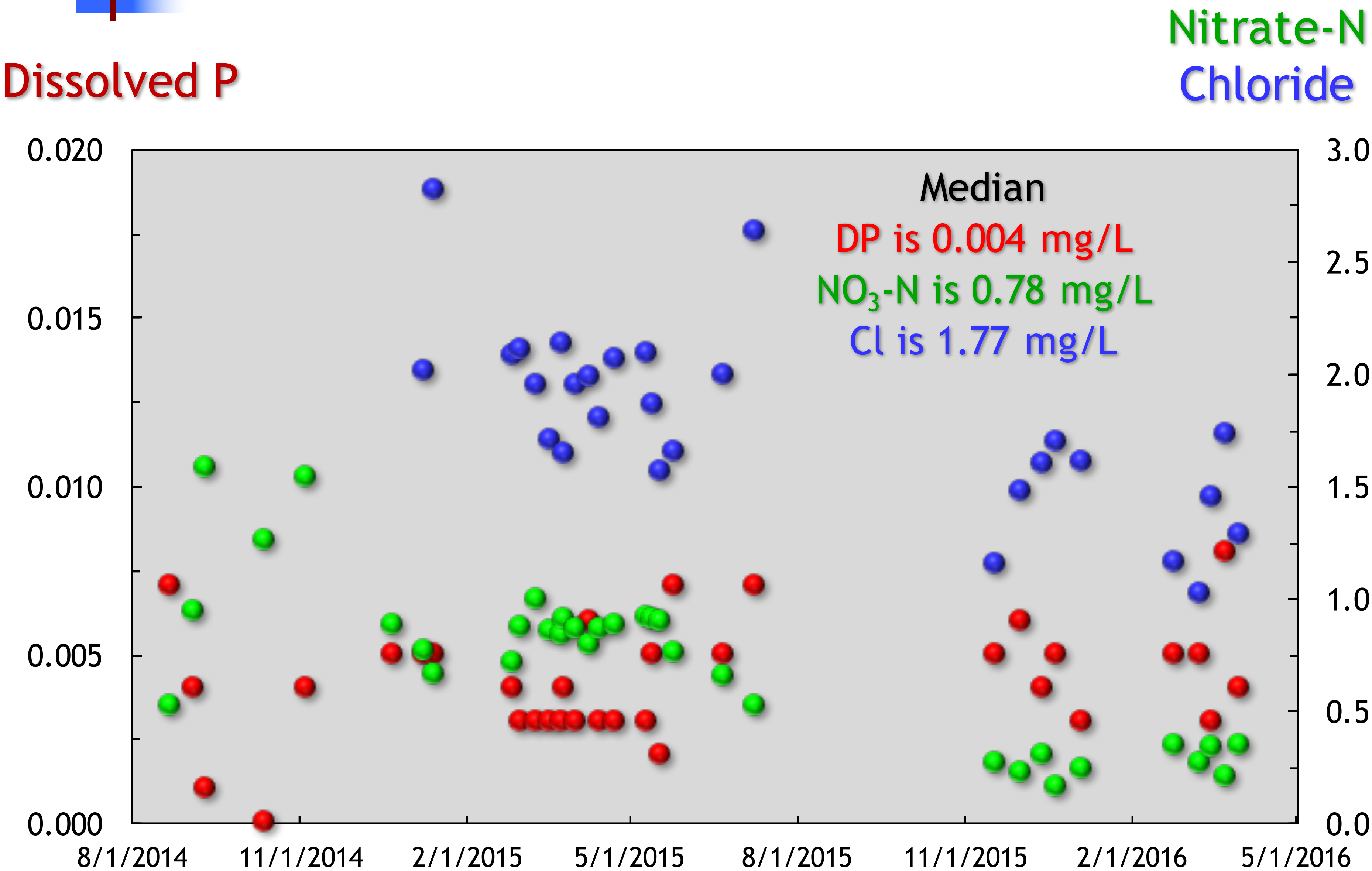
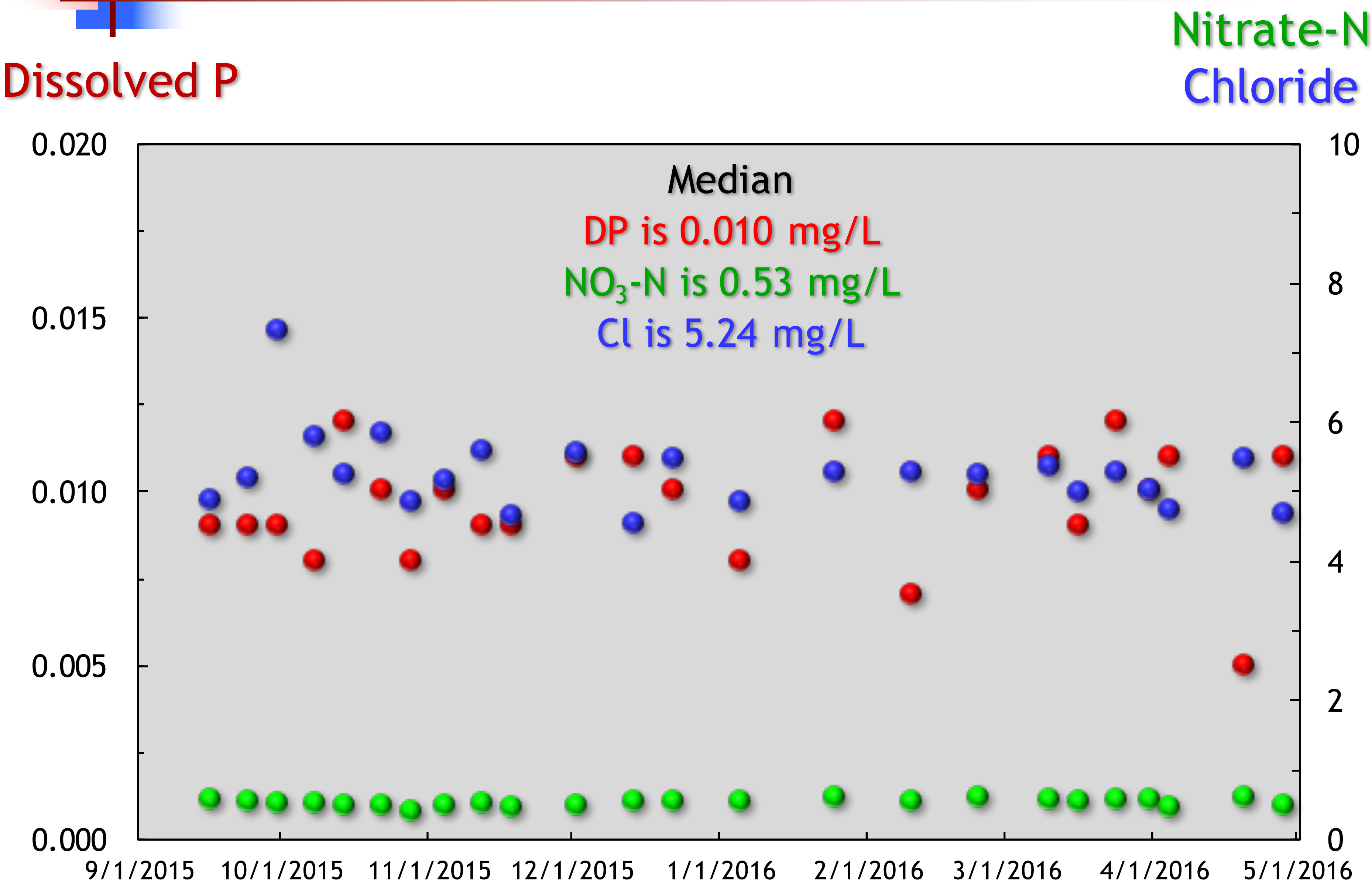
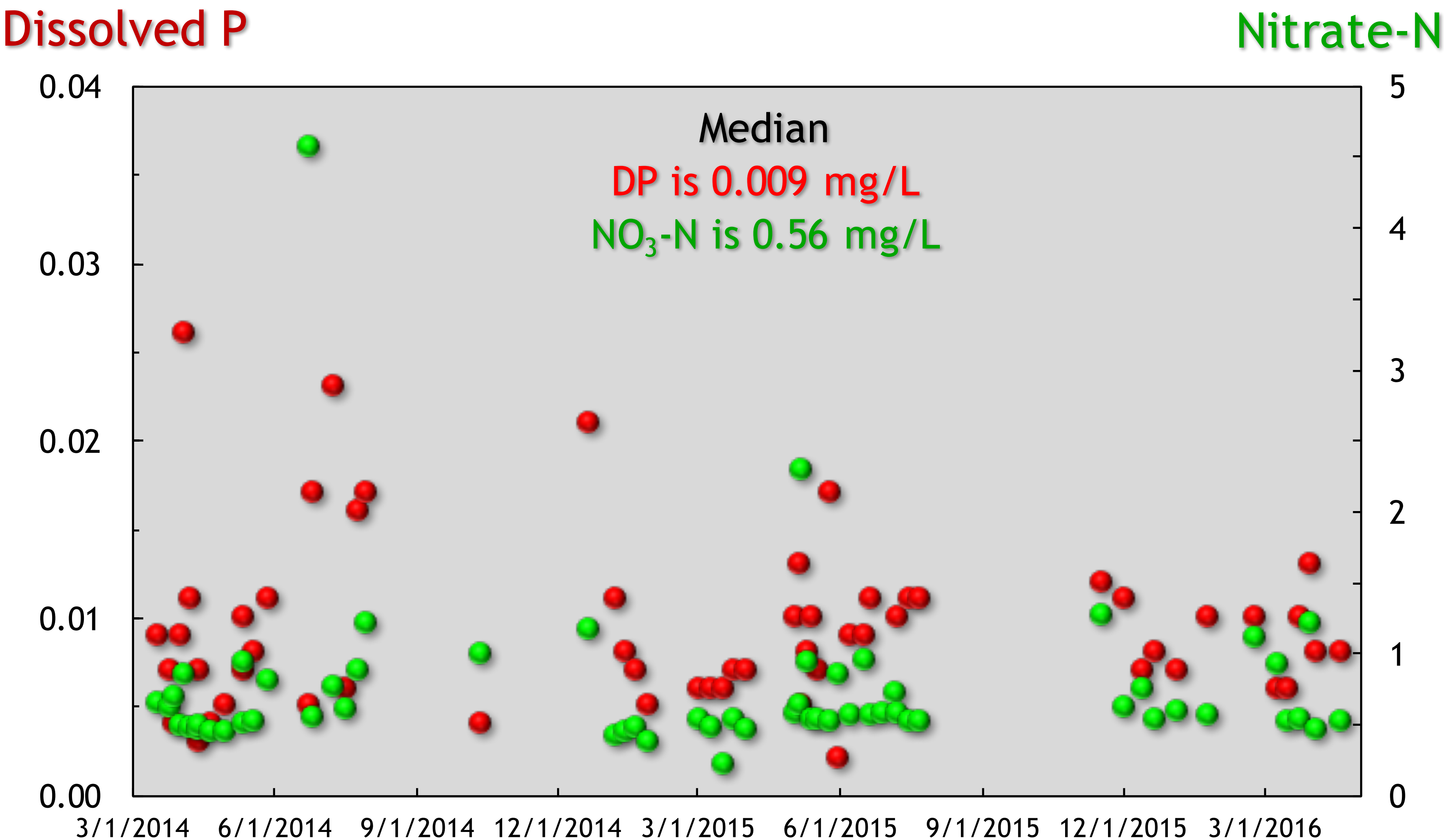
South trench, mg/L



House well, mg/L



Ephemeral creek, mg/L



Electrical Resistivity Imaging - ERI

- Contract was for Fields 1, 5a & 12 - timelines
  - Phase 1 – Fields 5a & 12 mid-December, 2014
  - Decision to assess around ponds made early March, 2015
  - Fields 1, 5a, 12, and pond area completed late-March, 2015
  - Draft ERI report for contracted fields only was received mid-August, 2015

Electrical Resistivity Imaging - ERI

- Timelines continued:
  - Conversation with Dr. Halihan, October 2015
  - Provided additional ground truthing data – soil analysis for fields & manure applied
  - Farm manure records made available by ADEQ January 31, 2016
  - Final ERI report for fields received April 1, 2016
  - We then requested pond ERI data & received it June 10, 2016

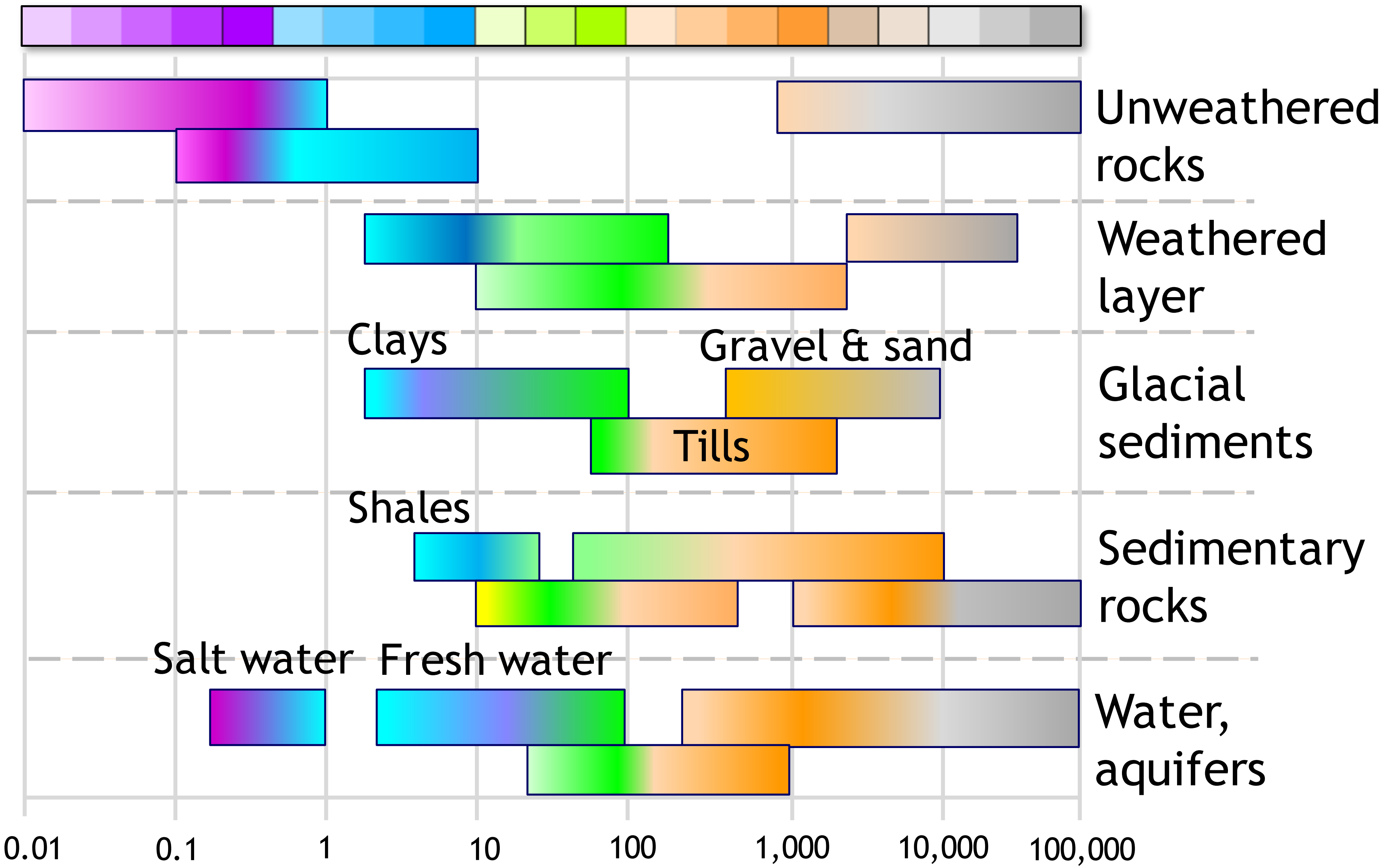
Electrical Resistivity Imaging - ERI

- A geophysical technique for imaging subsurface features from electrical resistivity measurements made at surface
- Graphical results are simply an image of contrasting resistivity of various materials with varying resistance/conductance in the subsurface
- Dry sand or clay has greater resistivity than wet sand/clay because pore water has a higher conductivity than that of solids & air

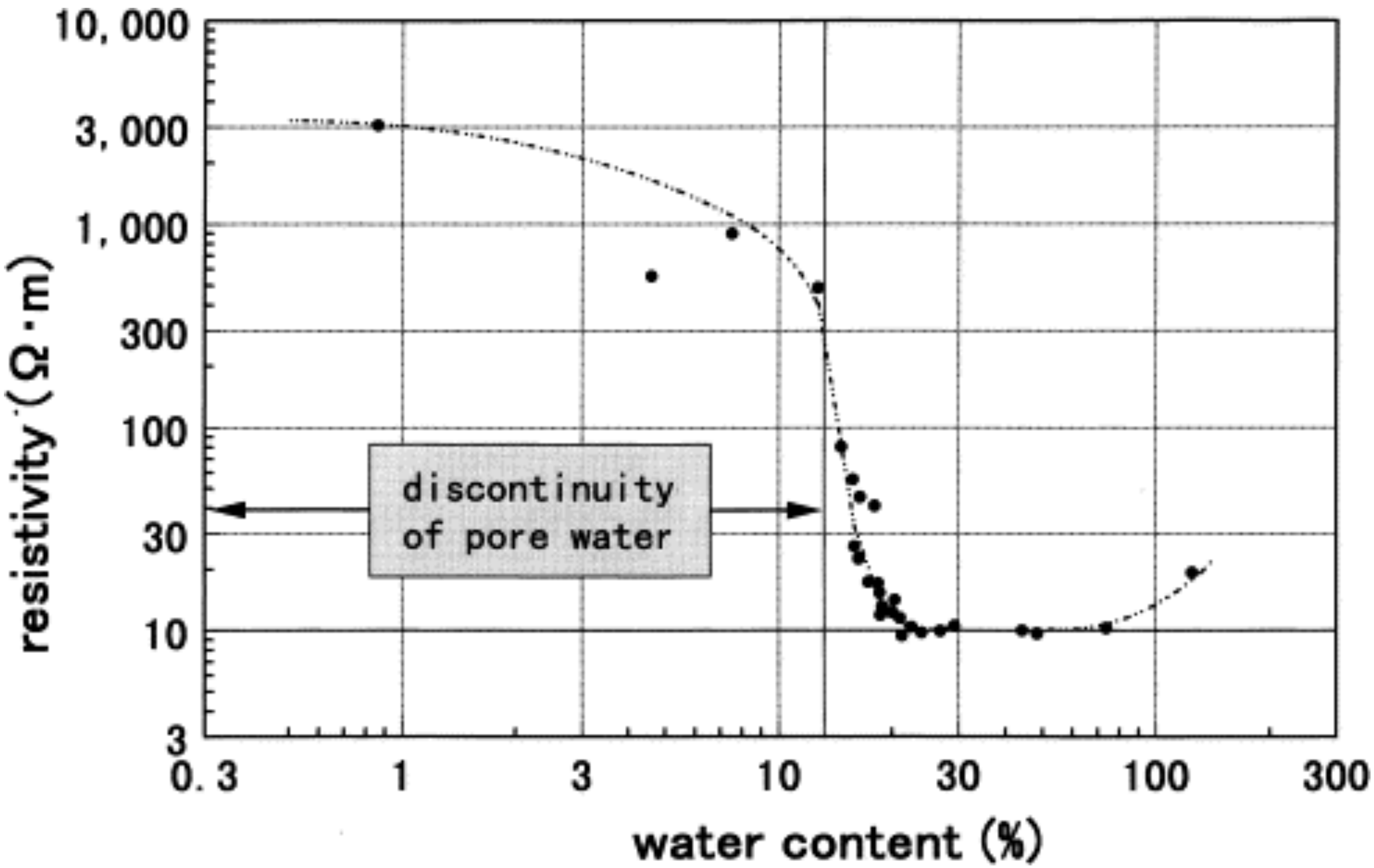
Electrical Resistivity Imaging - ERI

- Technique is an indirect secondary tool for measuring large areas inexpensively but without direct, ground-truthing measurements, remains inconclusive

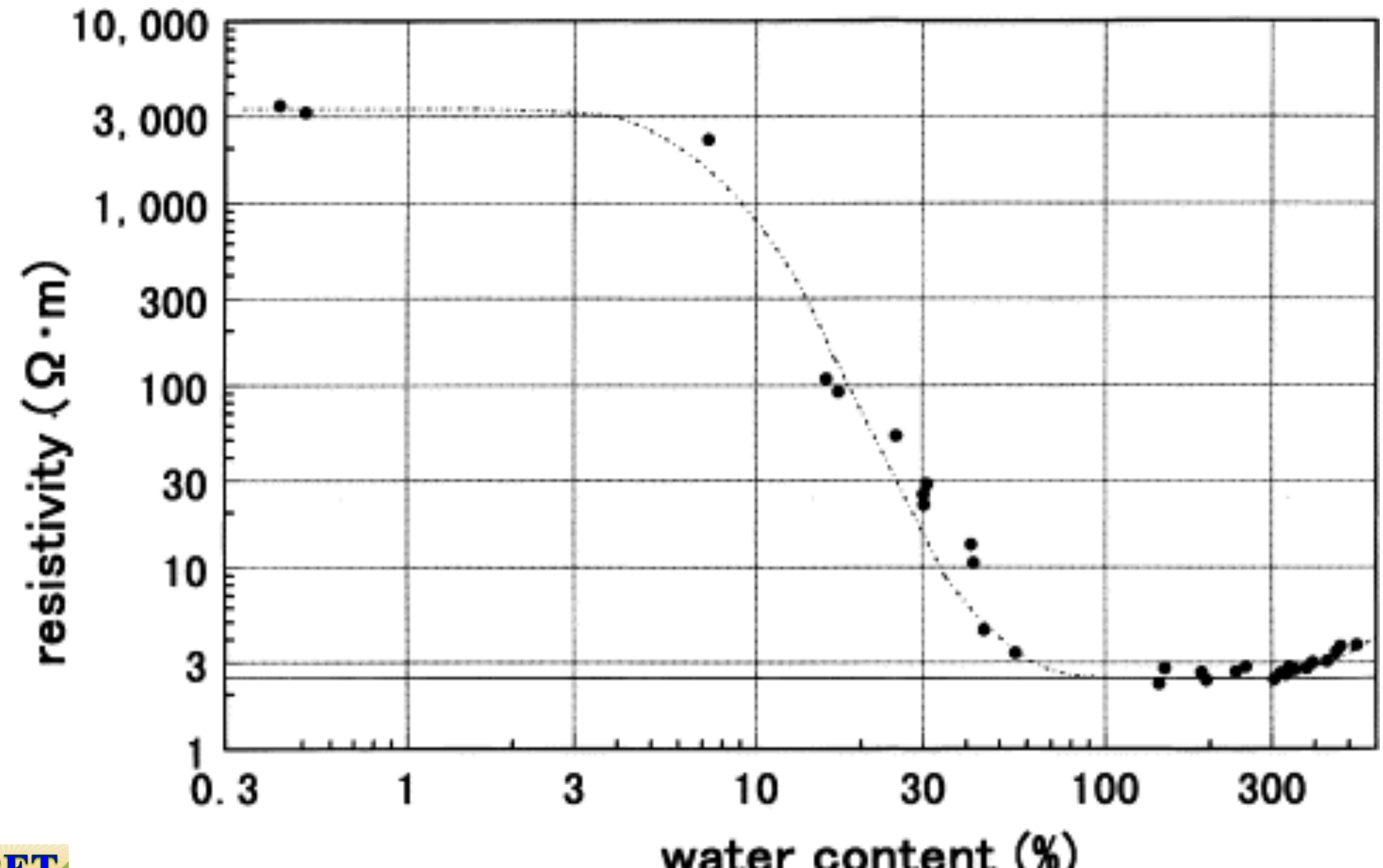
Resistivity of various materials



Affects of water content on resistivity of Kibushi clay



Affects of water content on resistivity of Bentonite clay



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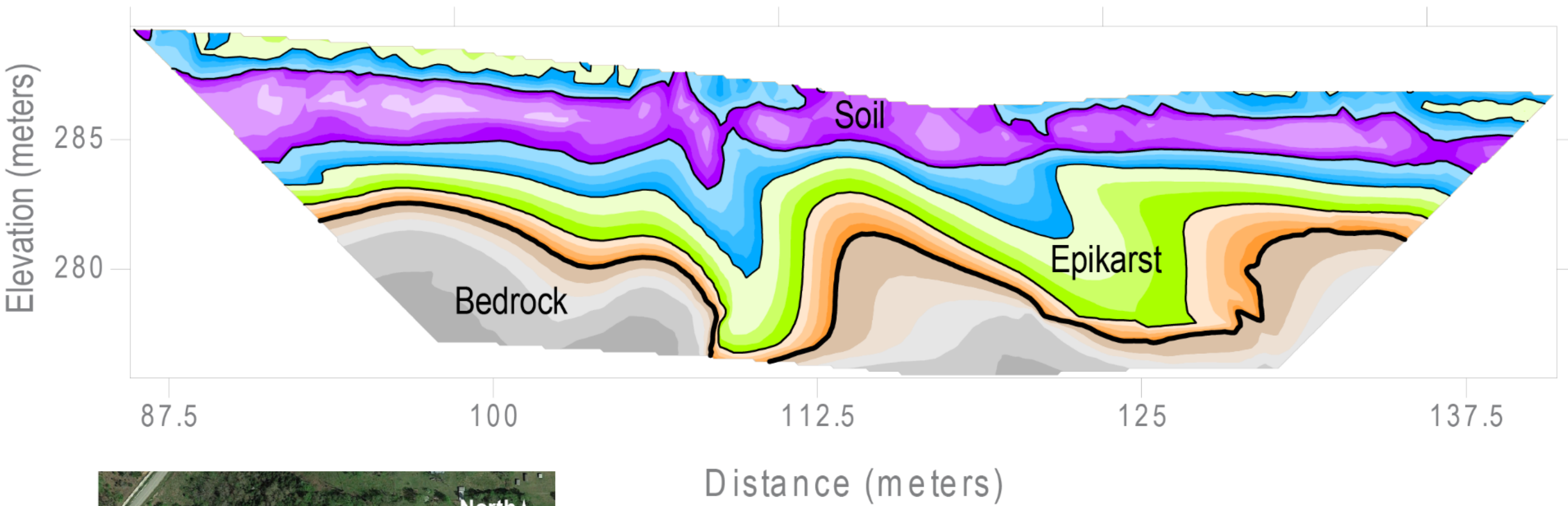
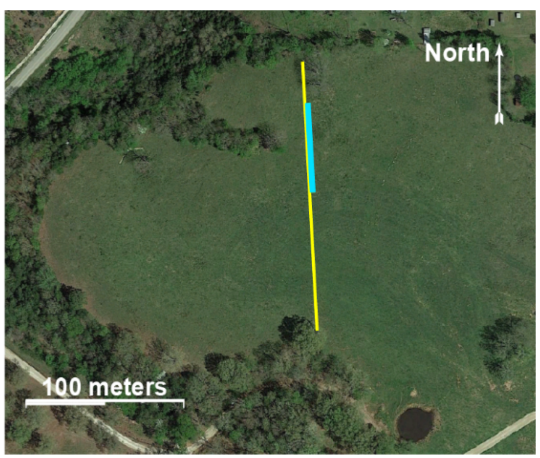
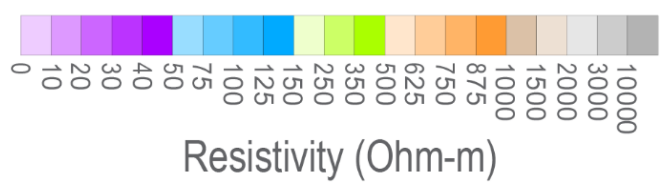
Use of ERI for BCRET

- Gain an deeper understanding of soil/regolith thickness & depth to bedrock
- To determine below-ground permeability contrasts
- Contract was transects on 3 application fields
- Decision made later to perform transects near pond to identify bedrock, epikarst, & clay layers; no ground-truthing borings
- Primary method for identifying potential leakage is via installation of trench to capture shallow interflow zone below pond – a standard method widely used in karst settings

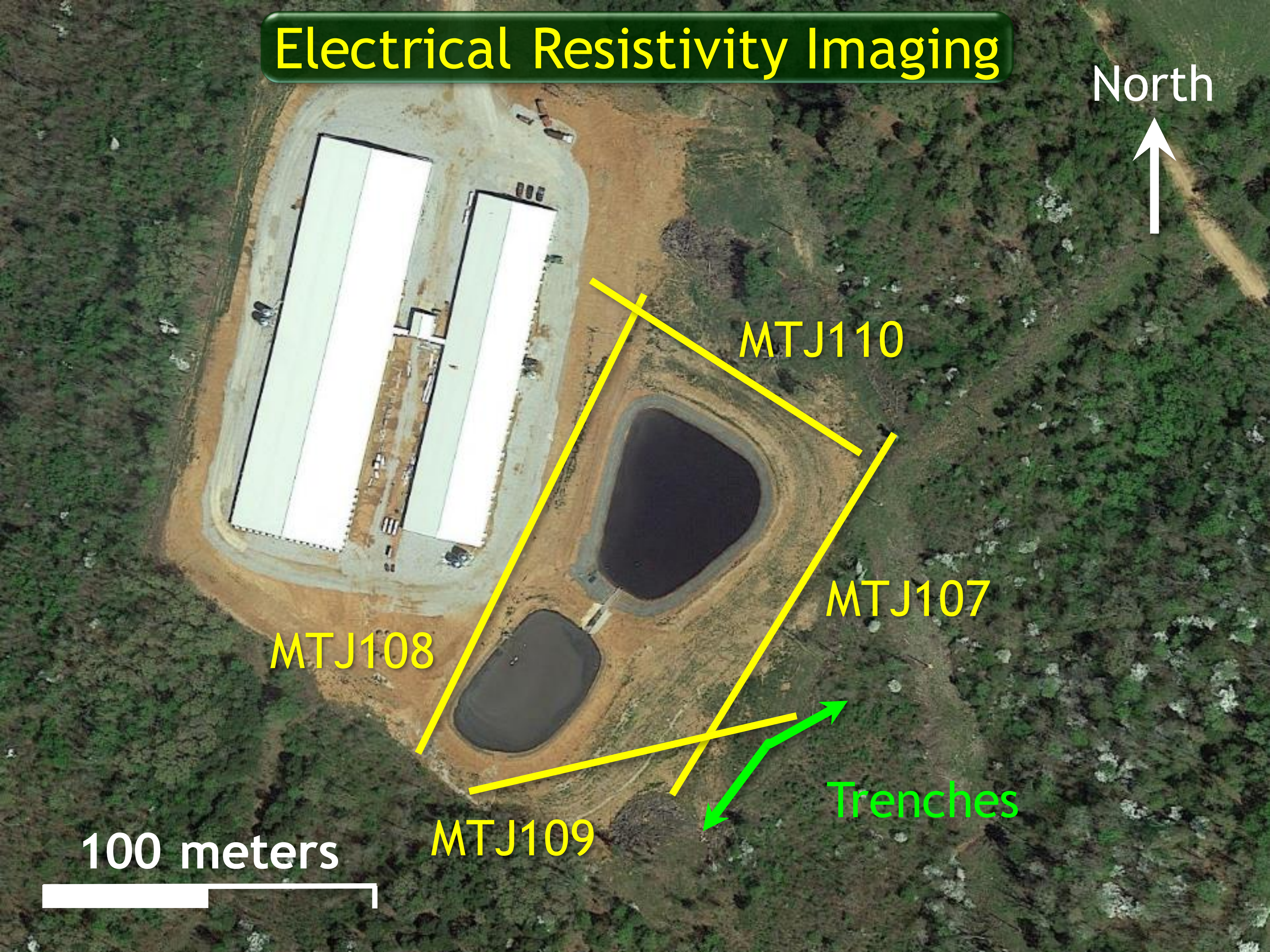
ERI for Field 1



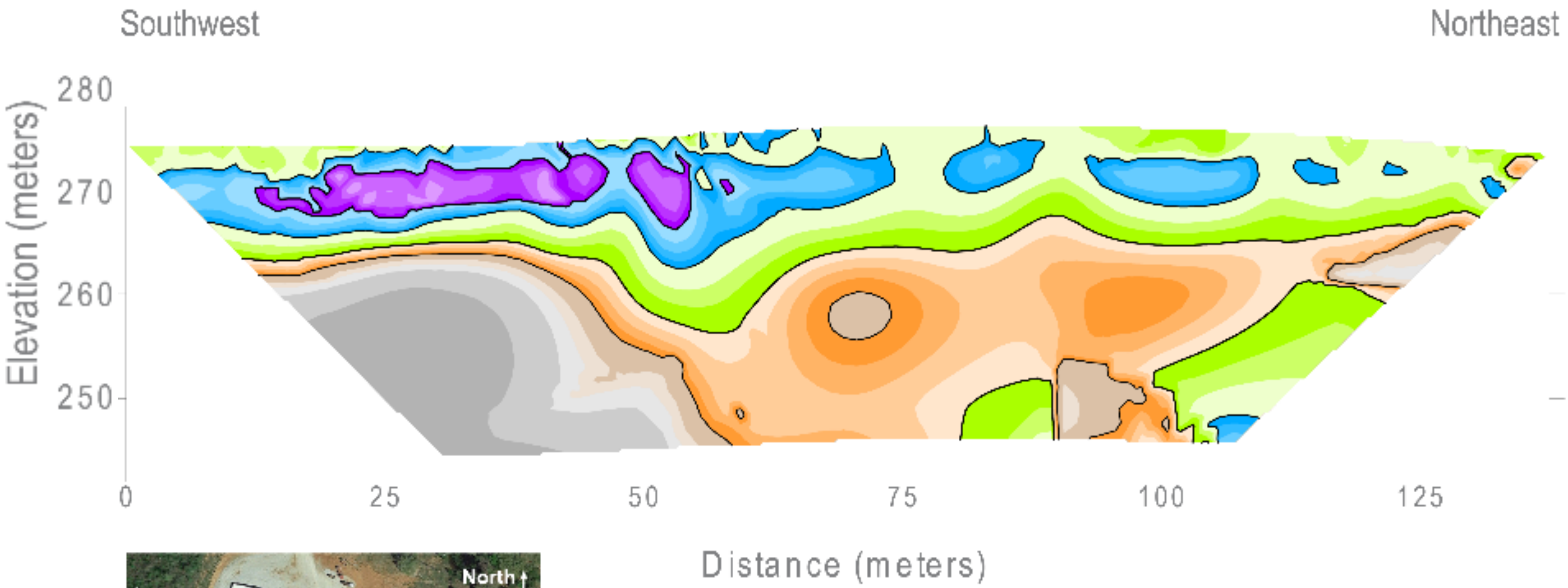


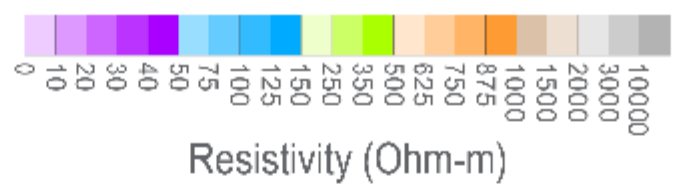


Field 1	Transect MTJ112	This transect has a 1.0 meter spacing between the electrodes (0.5 meter resolution) and runs parallel to the stream.	Figure A3.25

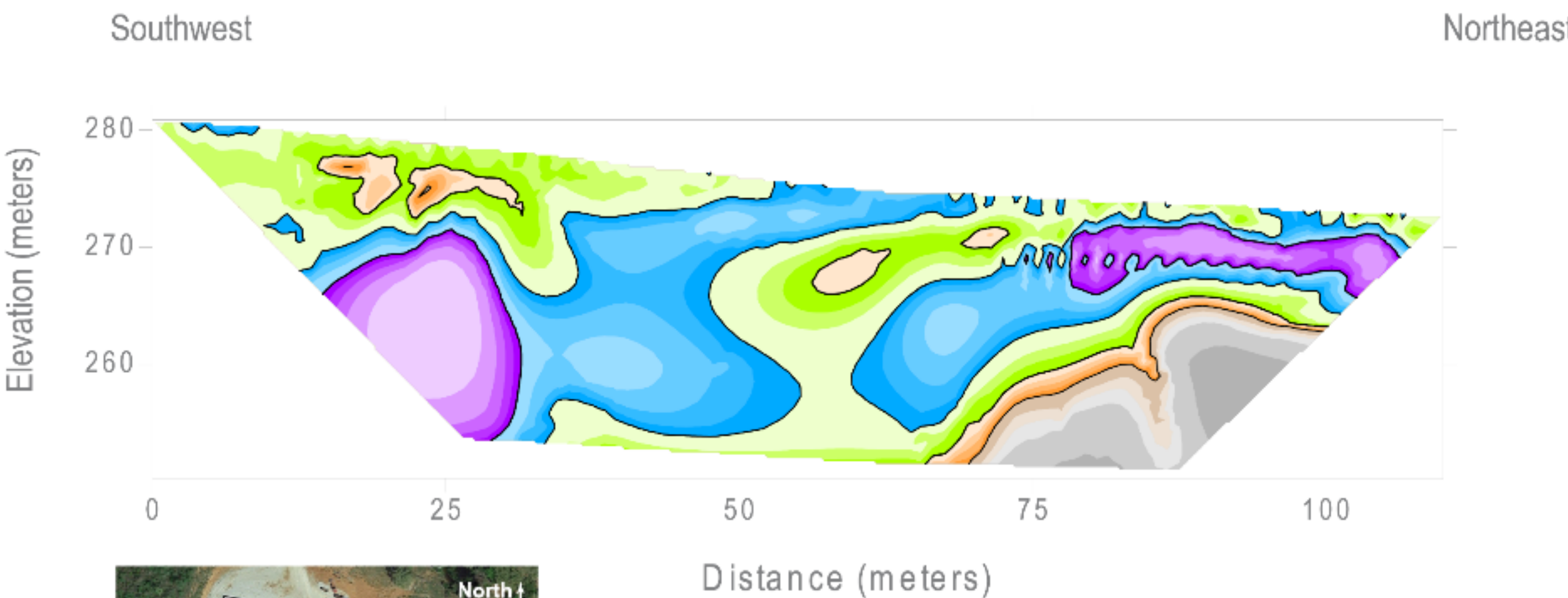


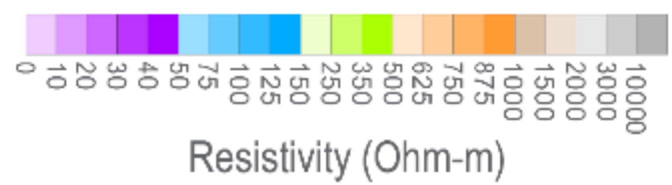
Electrical Resistivity Imaging
North
MTJ110
MTJ107
MTJ108
MTJ109
Trenches
100 meters



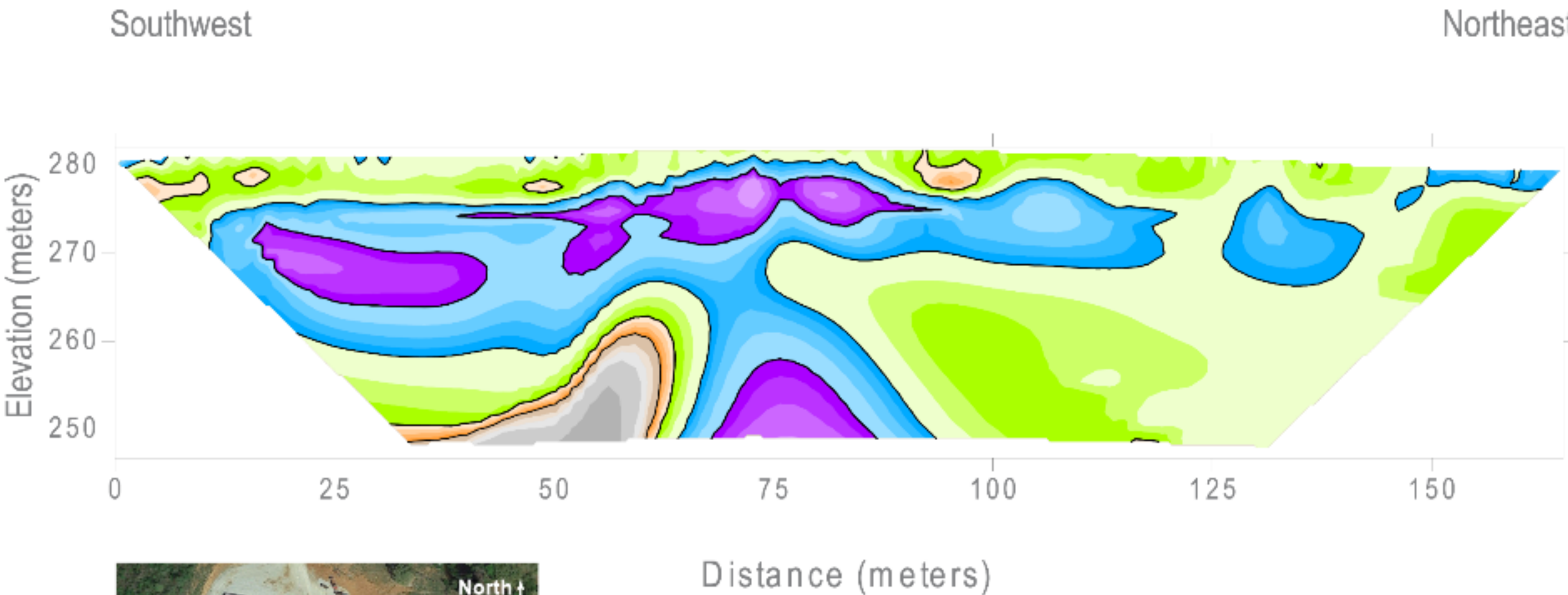


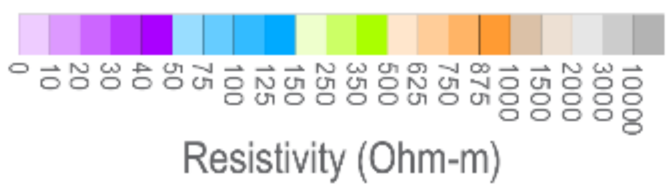
Holding Ponds	Transect MTJ107	This transect has a 2.5 meter spacing between the electrodes (1.25 meter resolution).	Figure A107



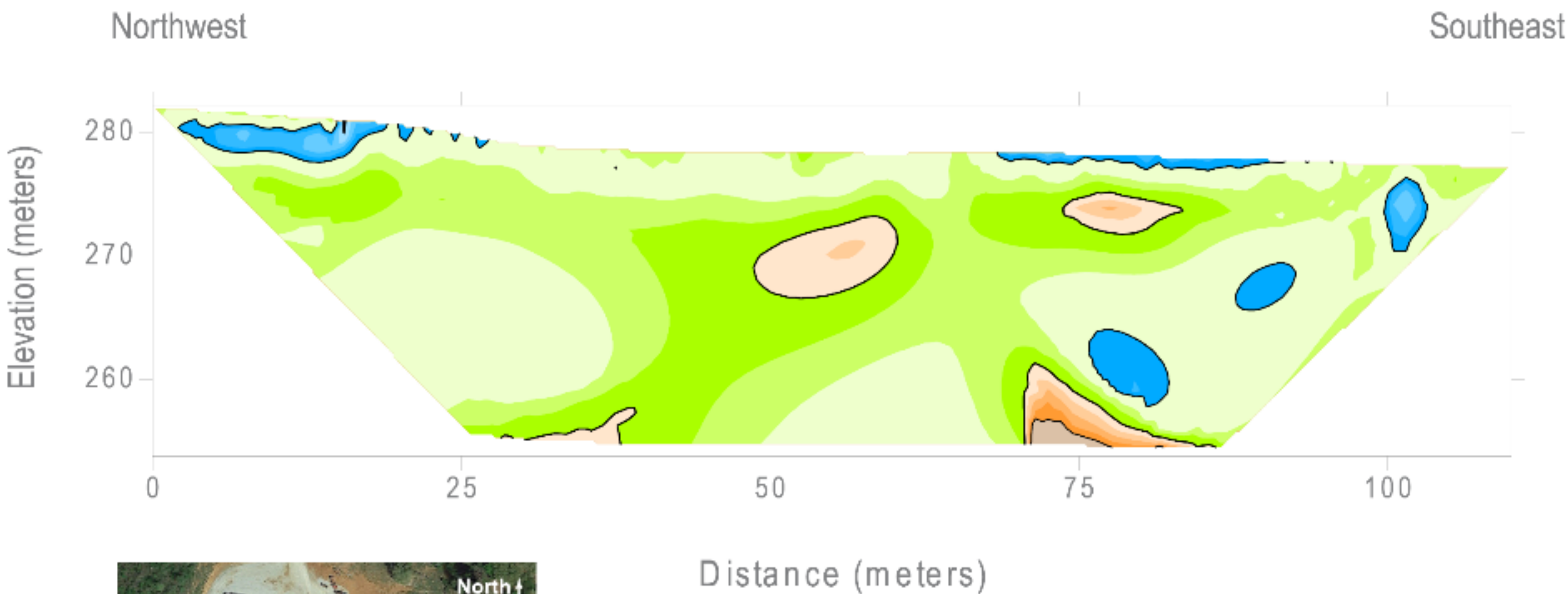


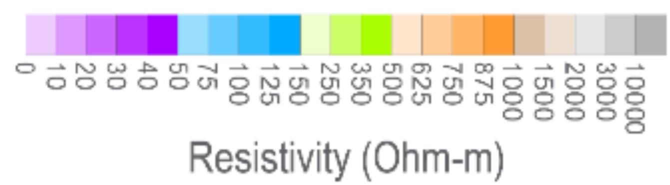
Holding Ponds	Transect MTJ109	This transect has a 2.0 meter spacing between the electrodes (1.0 meter resolution).	Figure A109





Holding Ponds	Transect MTJ108	This transect has a 3.0 meter spacing between the electrodes (1.5 meter resolution).	Figure A108





Holding Ponds	Transect MTJ110	This transect has a 2.0 meter spacing between the electrodes (1.0 meter resolution).	Figure A110

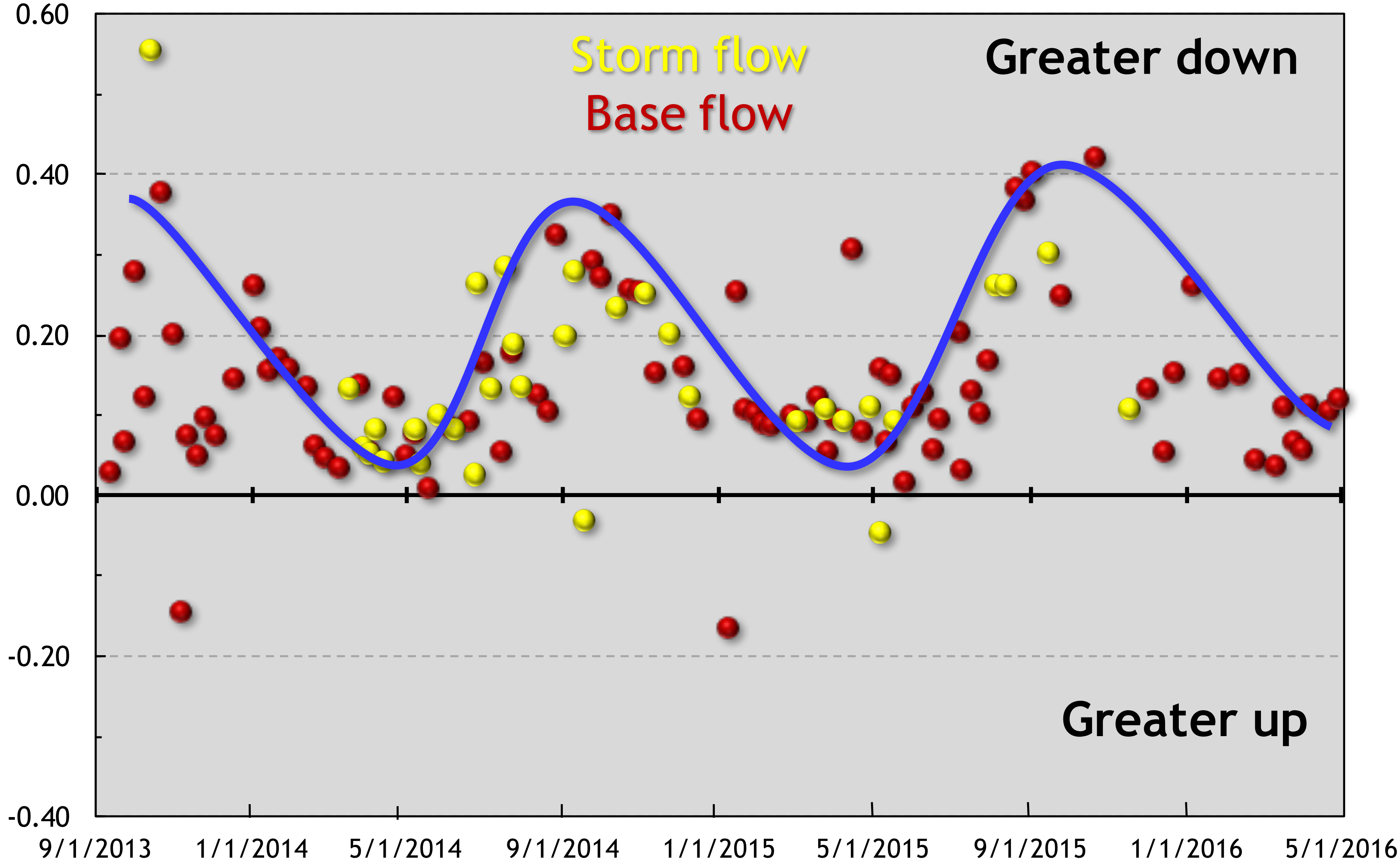
Trends?

- Trenches, house well, & ephemeral creek show no elevated levels of any tracer
  - Chloride is conservative tracer
  - EC, N, P, & E. coli show no consistent elevation
  - Resistivity of clays ranges from 12 to 25 Ohm-m, matches ERI values
  - Other national experts report that resistivity of manure plumes is much less than 1 Ohm-m

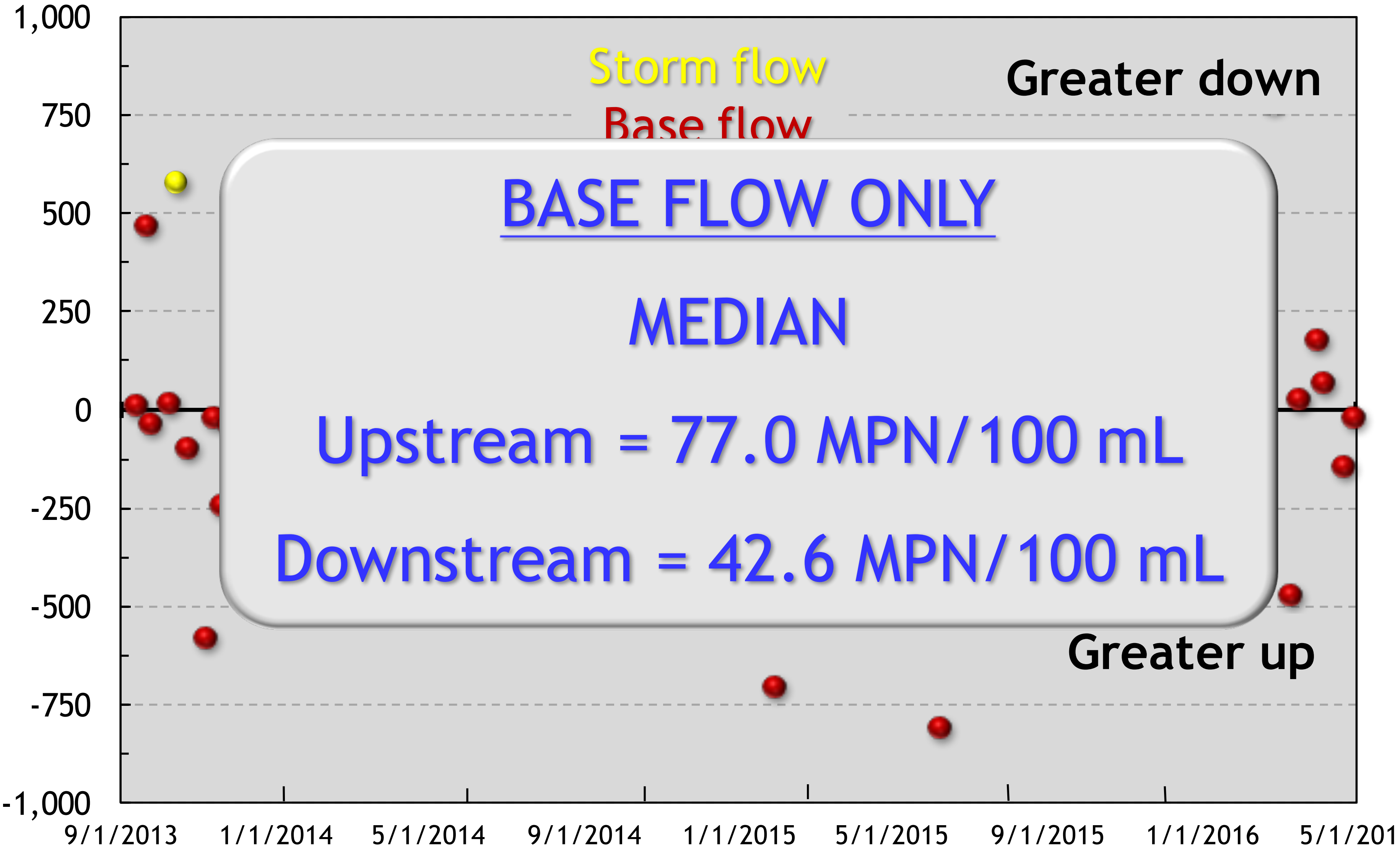
Trends?

- No scientific evidence that the ponds are leaking manure
- We are increasing our level of monitoring
  - Installed protective shelters on trenches, flow measuring equipment, & auto-samplers for water quality
- If drilling is conducted
  - Must be done & sealed by expert driller
  - Drill in <u>agreed</u> position to ground-truth the signal
  - After <u>agreeing</u> to the measurements needed

Nitrate-N (mg/L) difference between down & upstream sites



E. coli (MPN/100 mL) difference between down & upstream sites



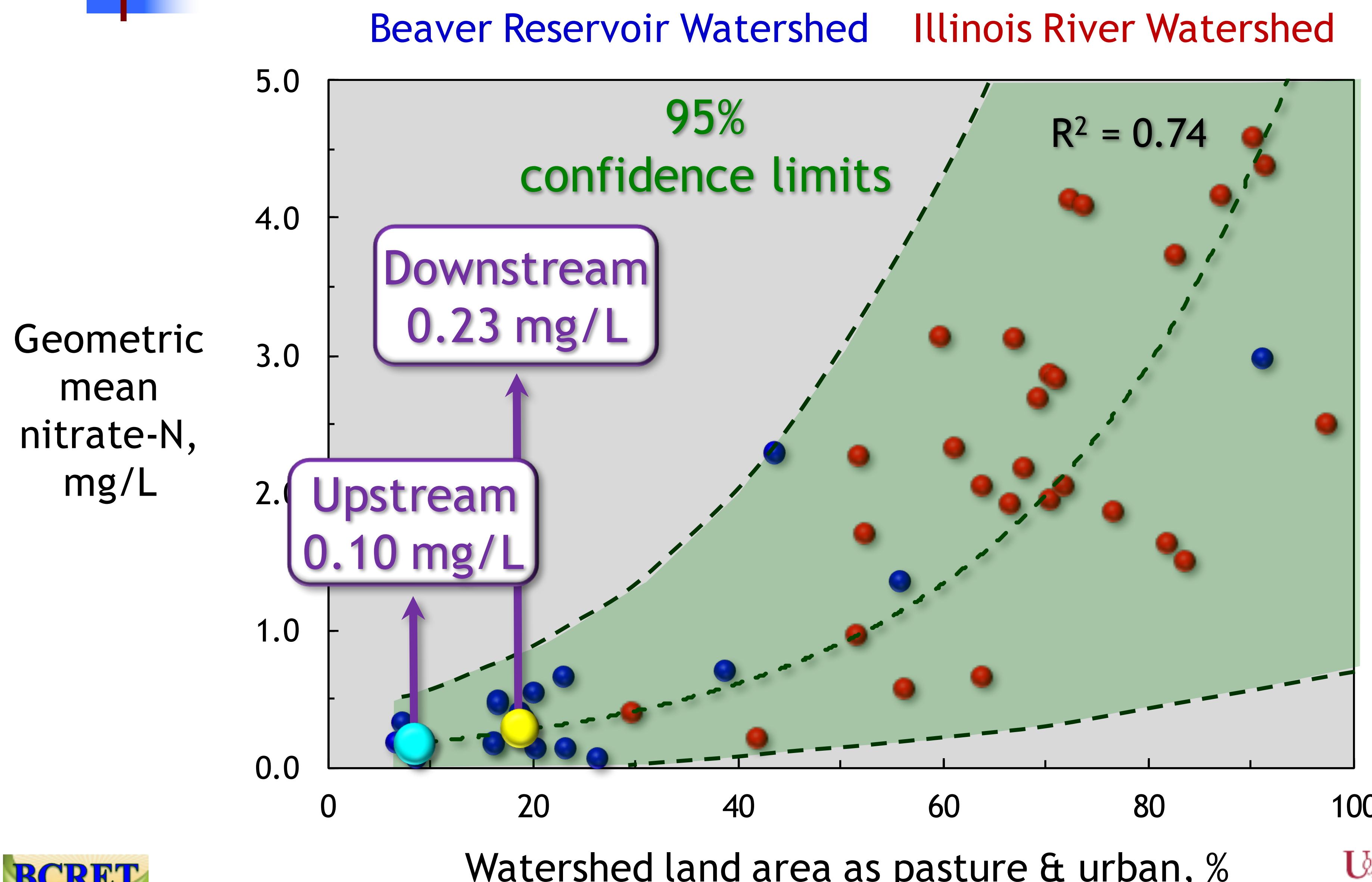
BASE FLOW ONLY

MEDIAN

Upstream = 77.0 MPN/100 mL

Downstream = 42.6 MPN/100 mL

Putting this into context



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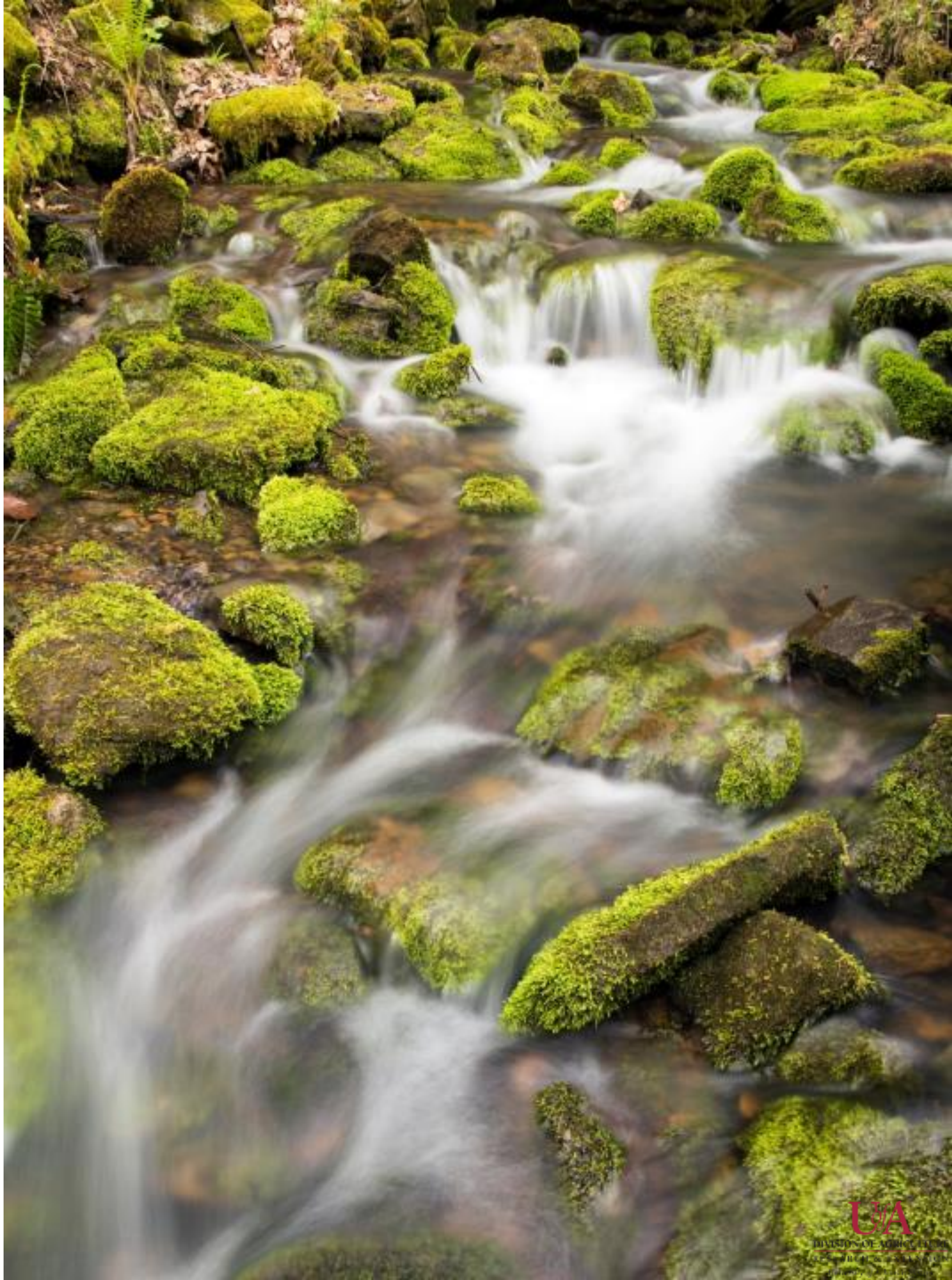
Current status

- ✓ Direct measurements do not indicate pond leakage
- ✓ No consistent trends to date
- ✓ We will continue to provide transparent, unbiased, sound science for landowner & State to make decisions
- ✓ Quarterly reports provided to ADEQ & Governor
- ✓ System variability creates uncertainty
- ✓ To address variability, monitoring over least 5 years is needed

http://www.bigcreekresearch.org/

Thank you

Big Creek
With permission:
Barbara Hinton,
Prof. Emeritus, U of A



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