AMEC MMR GROUNDWATER MODELING PROGRAM: Central Impact Area and Demo 1 Status Reports

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MMR Modeling Summit
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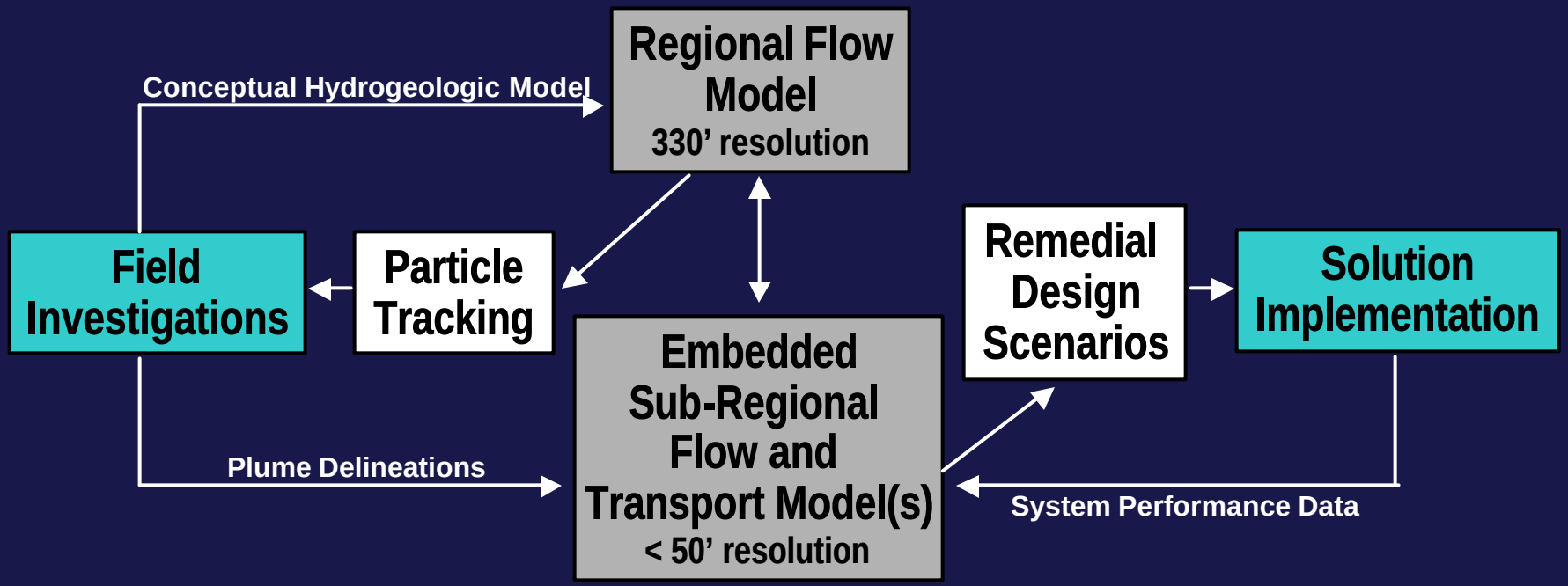
CURRENT PROGRAM ACTIVITIES

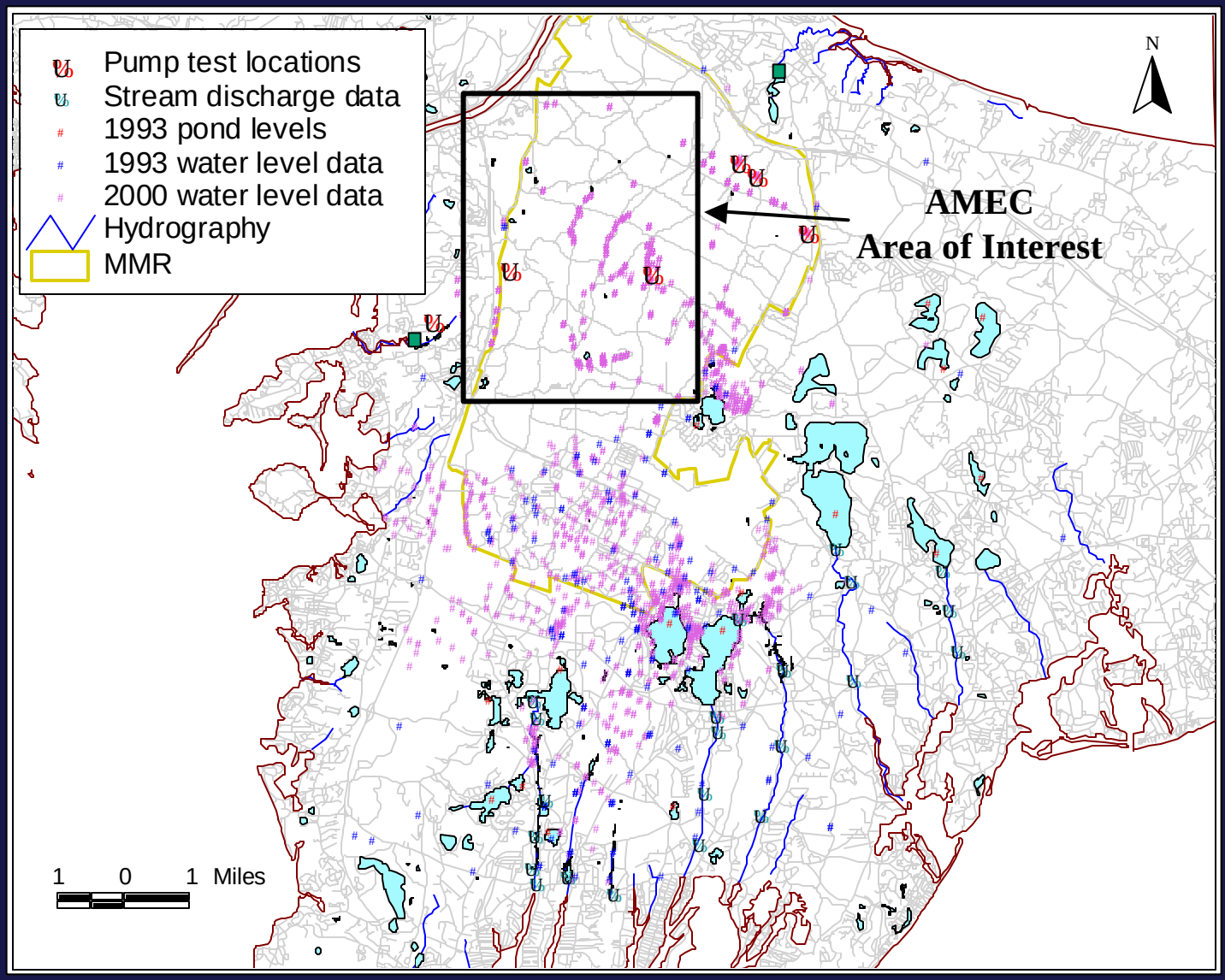
- Central Impact Area Feasibility Study/Remedial Design
  - Artillery/Rocket target clusters primary source
  - RDX, Perchlorate, HMX, TNT, 2,4 DNT, 2A DNT, 4A DNT
- Demo 1 Feasibility Study/Remedial Design
  - Kettle depression OB/OD activities primary source
  - Perchlorate, RDX, HMX, TNT, 2,4 DNT
- Bourne Response Plan: Perchlorate
- SE Ranges Workplans: Perchlorate, RDX, HMX
- Northwest Corner: Perchlorate

FS DESIGN MODELING PROCESS

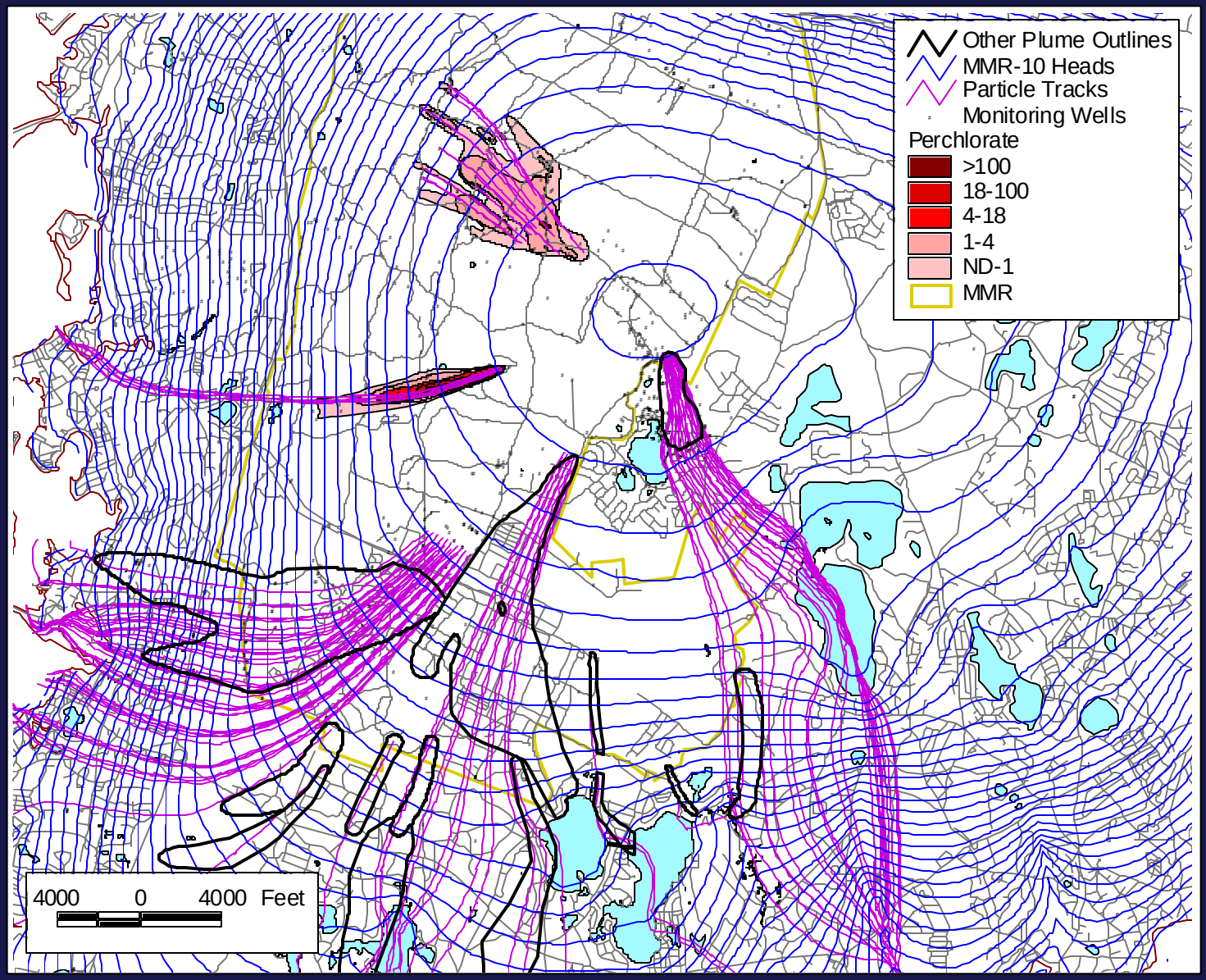


- 3-D Plume Shell Development
- MODFLOW Flow Simulations
- MT3D Fate & Transport Simulations
- BRUTEFORCE Weighted Particle Track Optimization

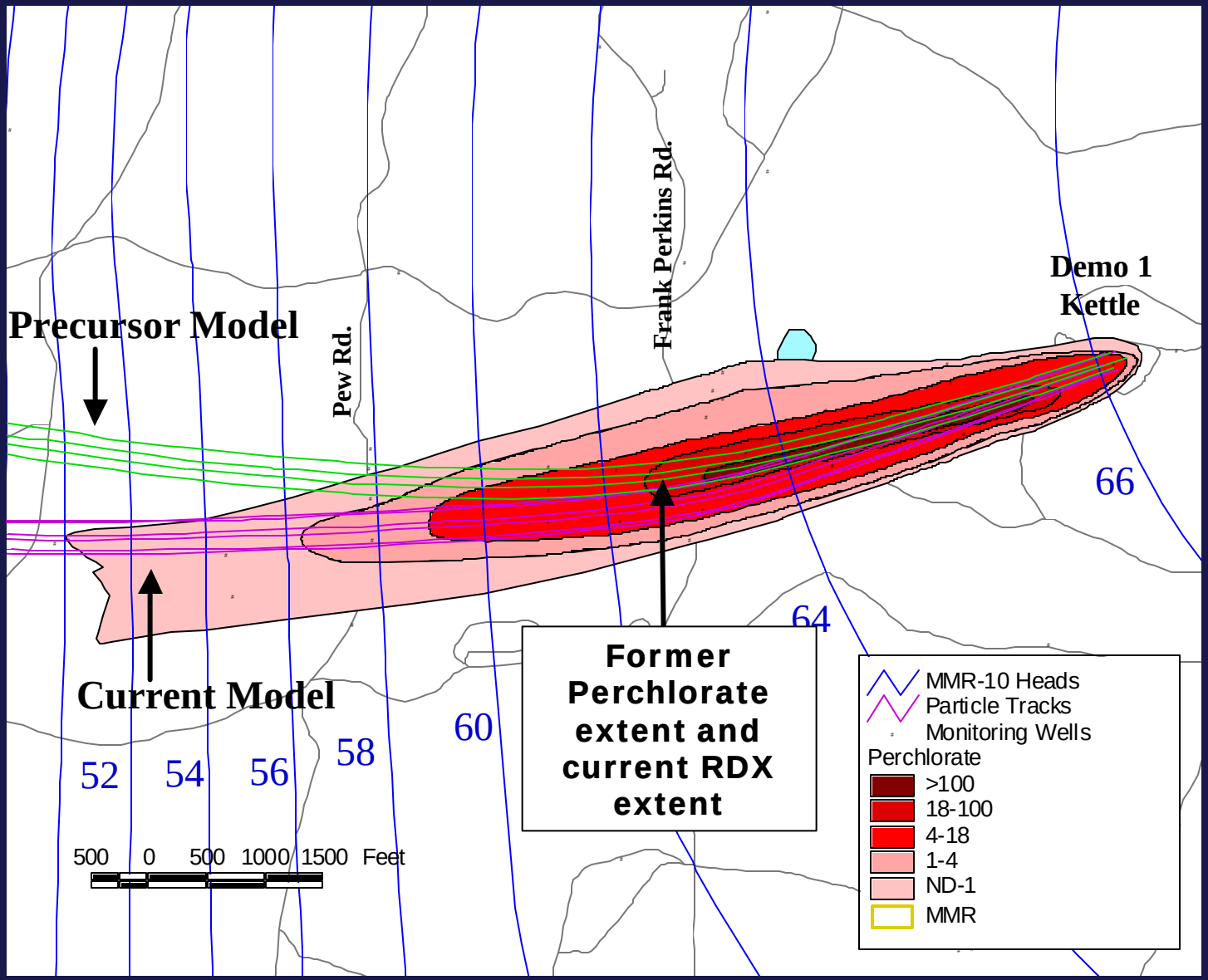
MMR-10 REGIONAL CALIBRATION DATA



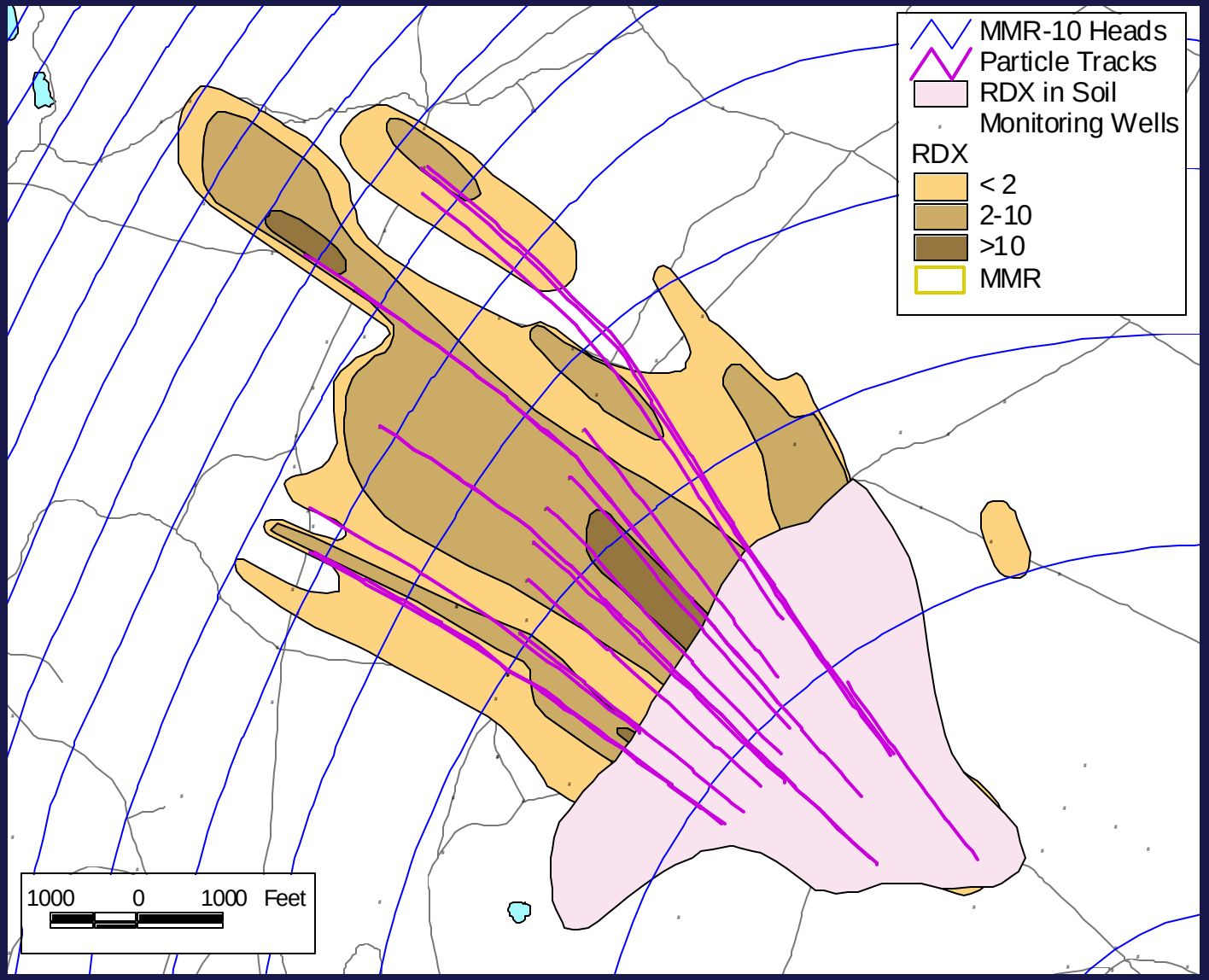
REGIONAL CALIBRATION: Plume Trajectories



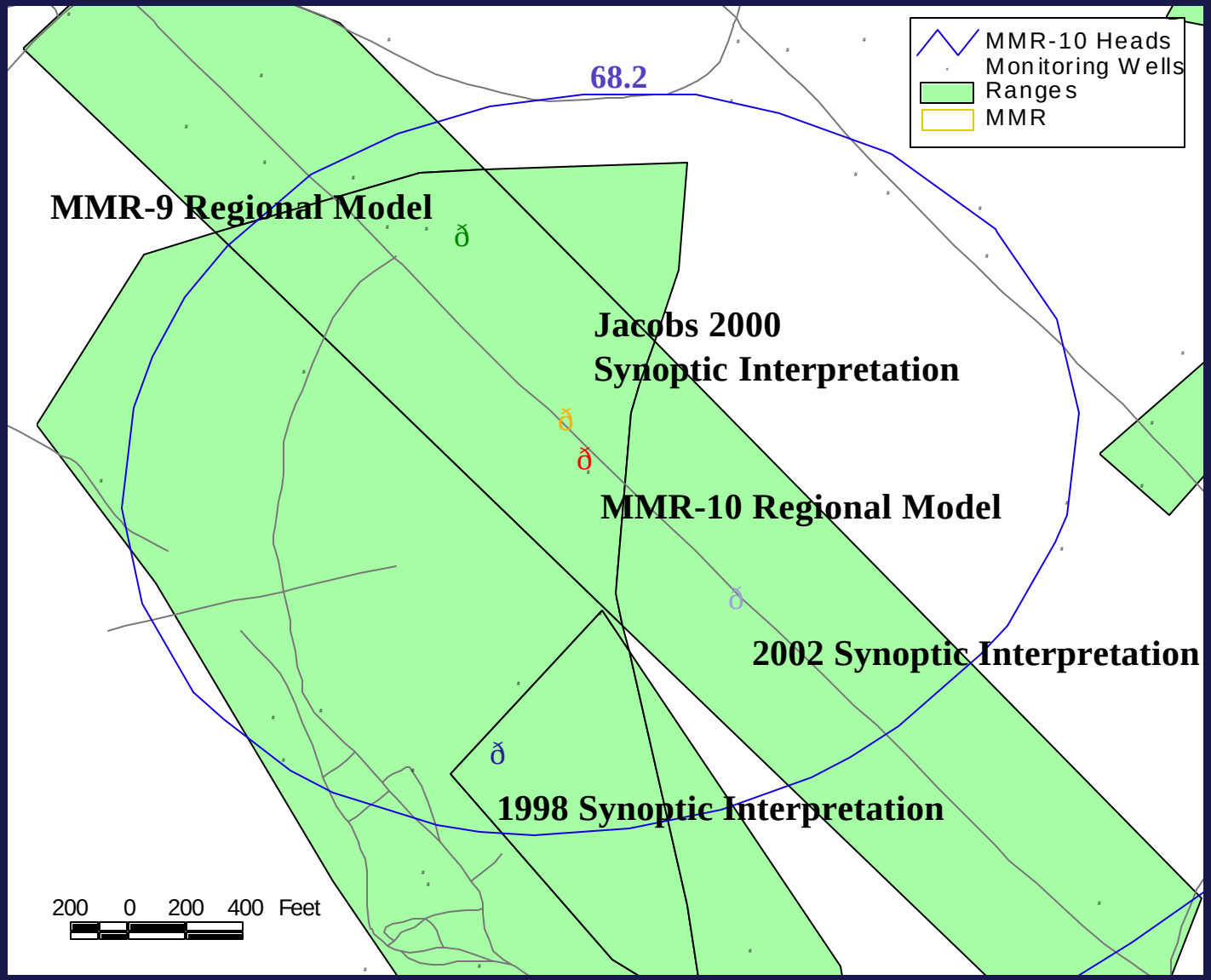
DEMO 1: Revised Plume Trajectory



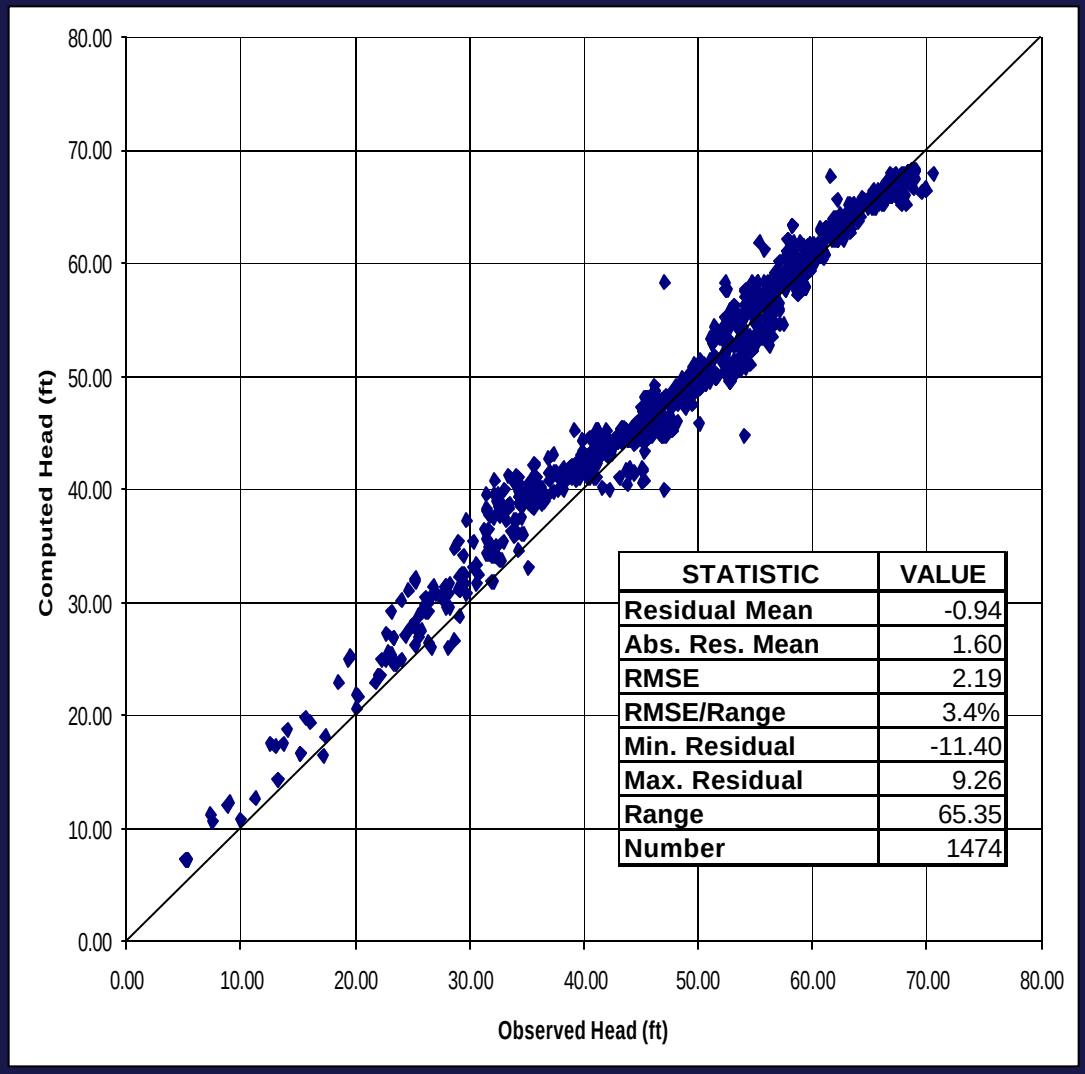
IMPACT AREA: Reverse Particle Trajectory



REGIONAL CALIBRATION: Top of Mound



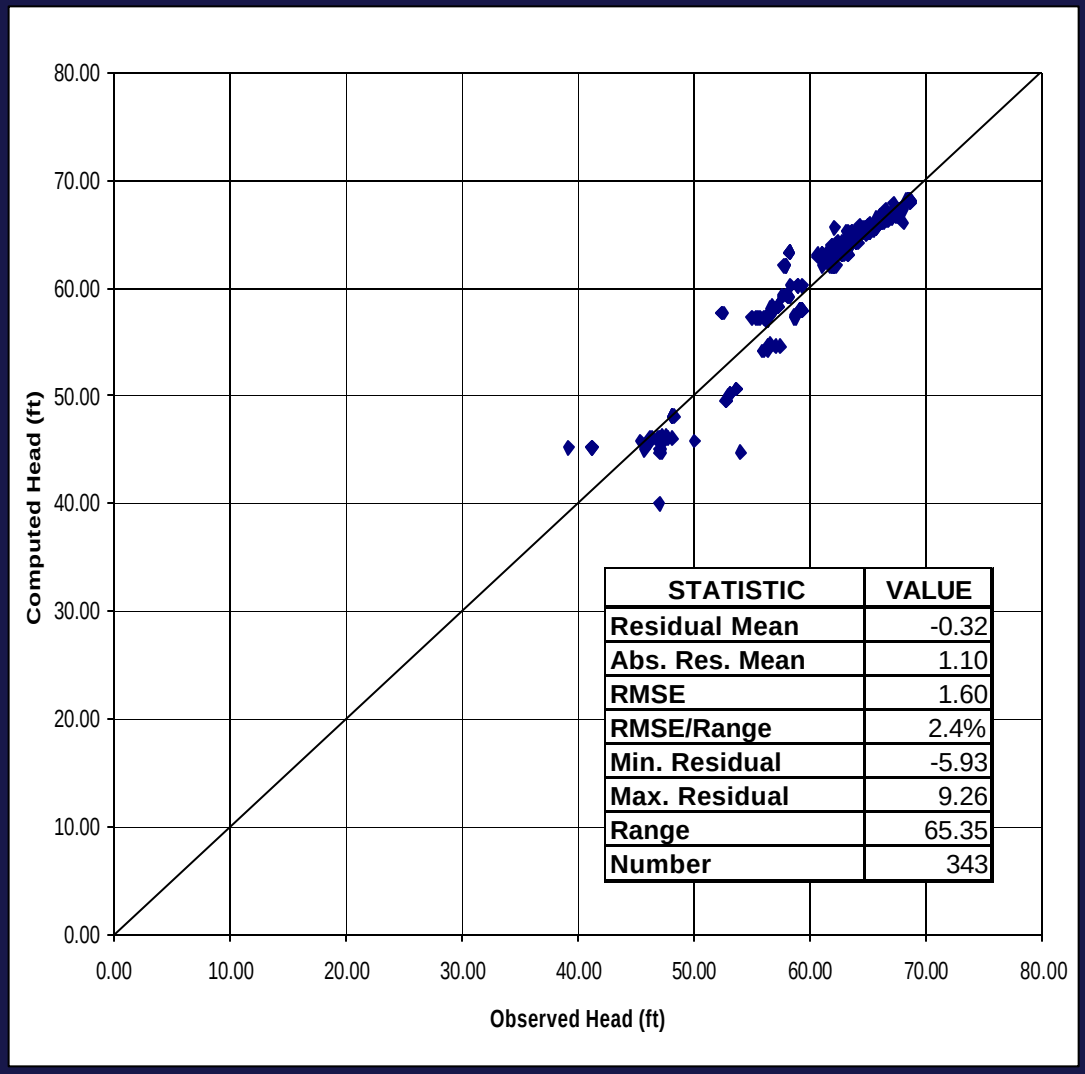
REGIONAL CALIBRATION: All Well Levels



STATISTIC	VALUE
Residual Mean	-0.94
Abs. Res. Mean	1.60
RMSE	2.19
RMSE/Range	3.4%
Min. Residual	-11.40
Max. Residual	9.26
Range	65.35
Number	1474

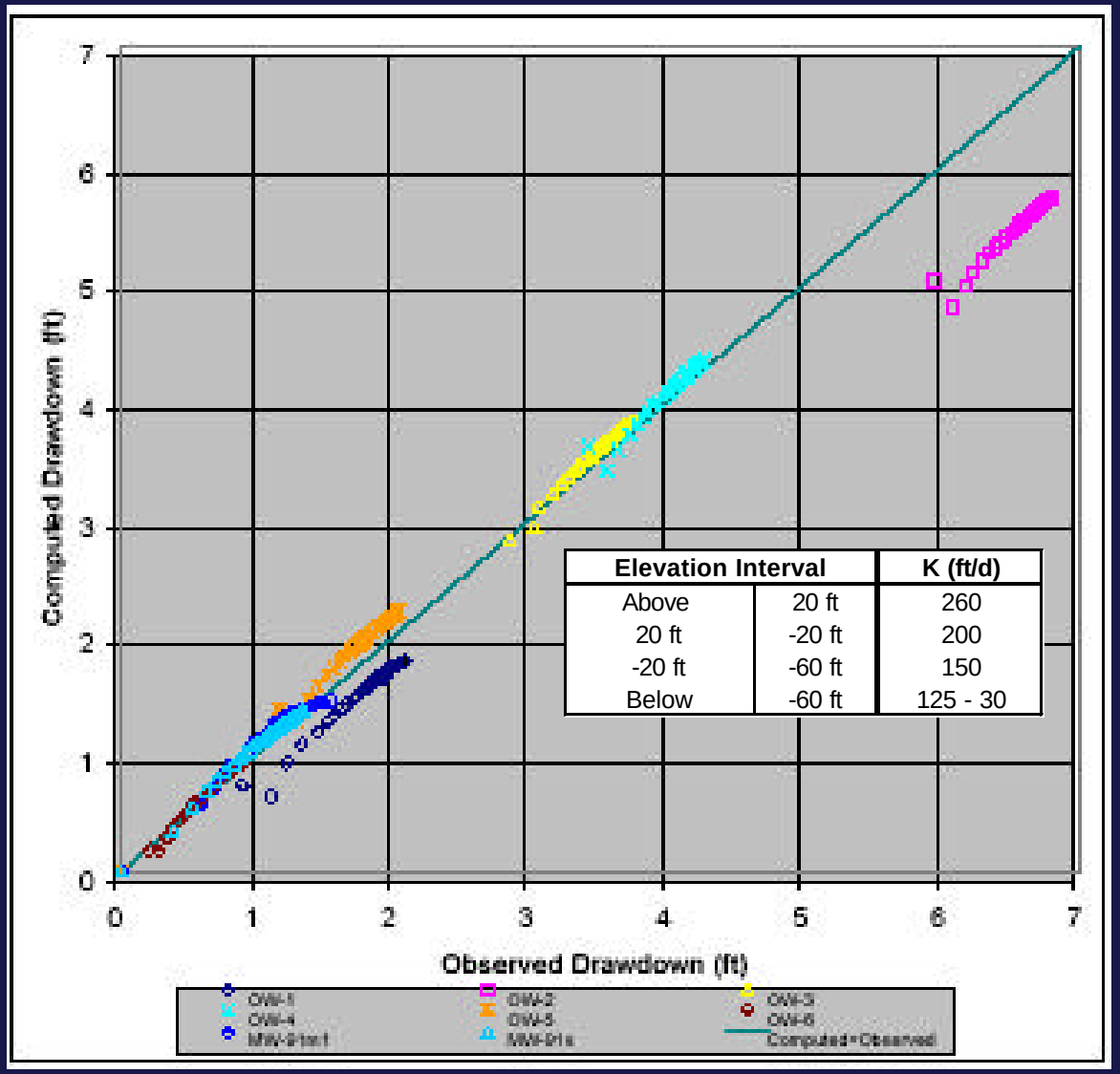
REGIONAL CALIBRATION:

Well Levels within AMEC Area of Interest

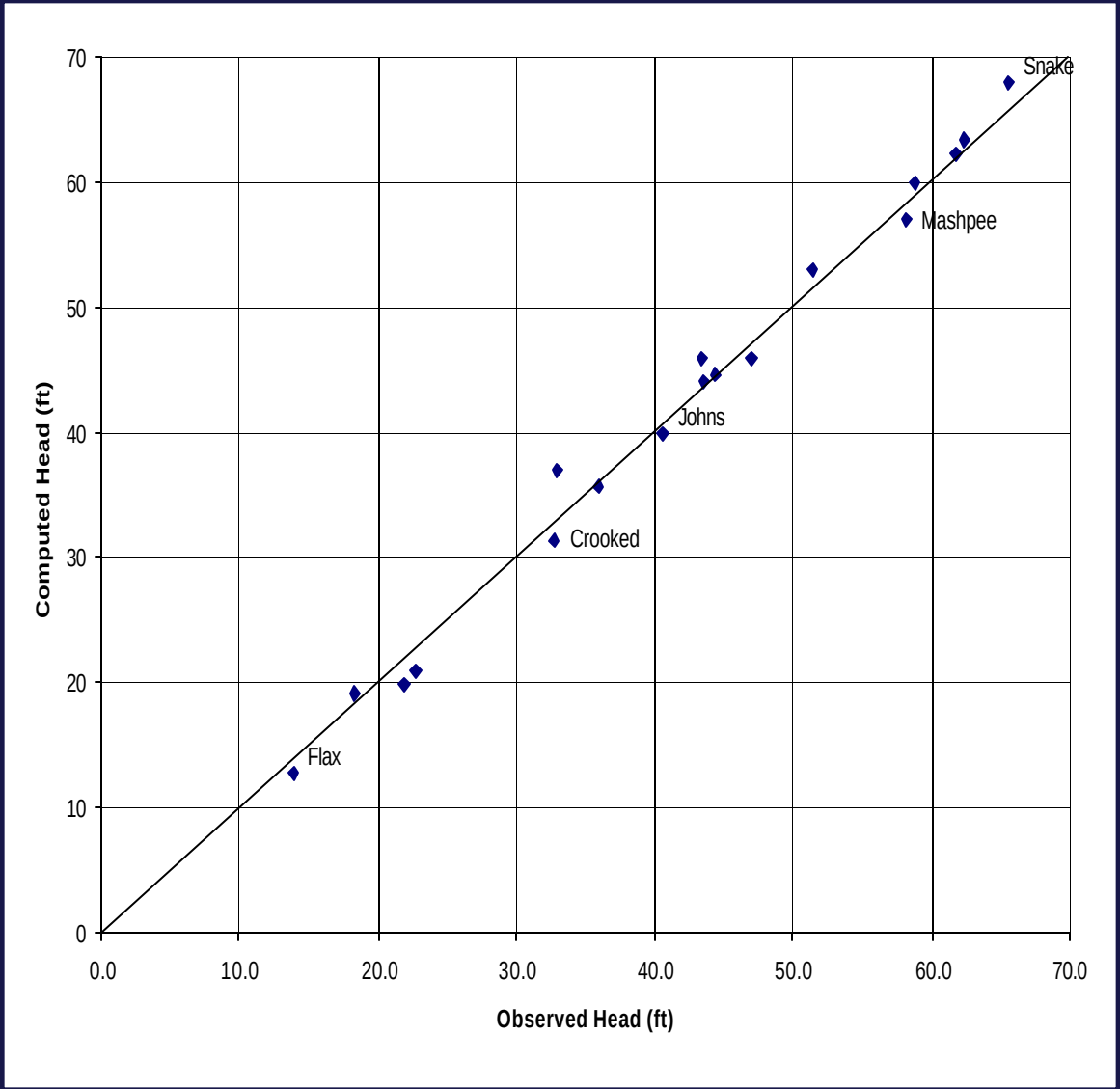


REGIONAL CALIBRATION: Pump Tests

Transient simulation of PW-1 72-hr test



REGIONAL CALIBRATION: Pond Levels



REGIONAL CALIBRATION: Stream Flows

NAME	MMR-10 (cfs)	MMR-8 (cfs)	Observed (cfs)	Observed Date
Backus @ rt28	**3.9**	**2.8**	**7**	1993
Bourne @ rt28	**2.2**	**1.7**	**4.2**	1993
Childs @ Barrows Rd	**3.4**	**8.6**	**12.9**	1993
Coonamessett @ rt28	**13.4**	**15.6**	**16.6**	1993
Mashpee @ rt28	**12.4**	**22.6**	**22.9**	1993
Quashnet @ rt28	**15.0**	**15.3**	**18.8**	1993
Santuit @ Old Kings Rd	**5.3**	**9.4**	**8.7**	1993
Lower Shawme Pond outlet	**4.8**	**-**	**7**	2002
Pocasett @ County Rd	**0.2**	**-**	**3.8**	2003

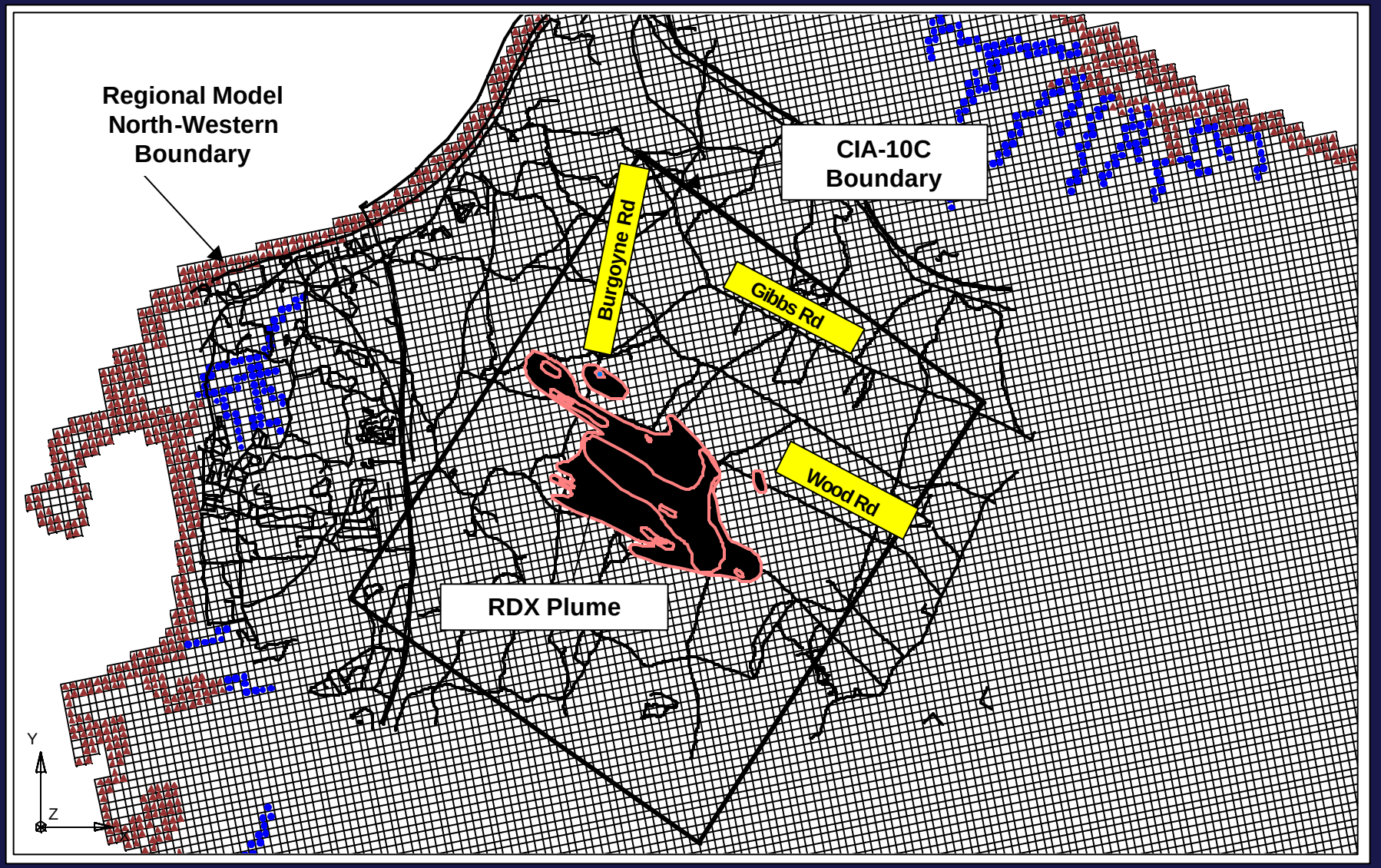
REGIONAL CALIBRATION: 3H-He Radiometric Isotope Ages

Well ID	Screen Elevation	Isotope Age (yrs) *	Modeled Age (yrs)	Difference
MW-7M1	-65.70	*60.8*	50.9	-9.9
MW-81M3	22.85	13.3	4.3	-9.0
MW-5M2	11.71	*20.2*	11.9	-8.3
58MW0010B	-32.89	36.0	28.2	-7.8
90MW0022	-9.40	24.8	19.7	-5.1
58MW0011D	13.33	14.4	11.3	-3.1
MW-80M1	-40.63	25.5	22.8	-2.7
MW-5M1	-28.29	*27.2*	26.3	-0.9
MW-1M2	24.53	9.6	8.8	-0.8
MW-33S	14.98	*12.5*	11.7	-0.8
MW-1M1	-35.89	*30.8*	30.9	0.1
MW-7M2	4.30	13.7	14.4	0.7
MW-2M2	34.88	4.5	5.9	1.4
MW-80M2	-10.53	11.1	12.8	1.7
MW-47M3	36.00	3.0	5.1	2.1
MW-80M3	19.47	2.5	5.1	2.6
MW-23M3	24.78	3.6	6.7	3.1
MW-23M2	-8.22	11.4	16.4	5.0
MW-2M1	-7.12	11.9	17.4	5.5
MW-33D	-20.02	*14.9*	22.9	8.0
MW-18M1	-70.68	31.1	52.6	21.5

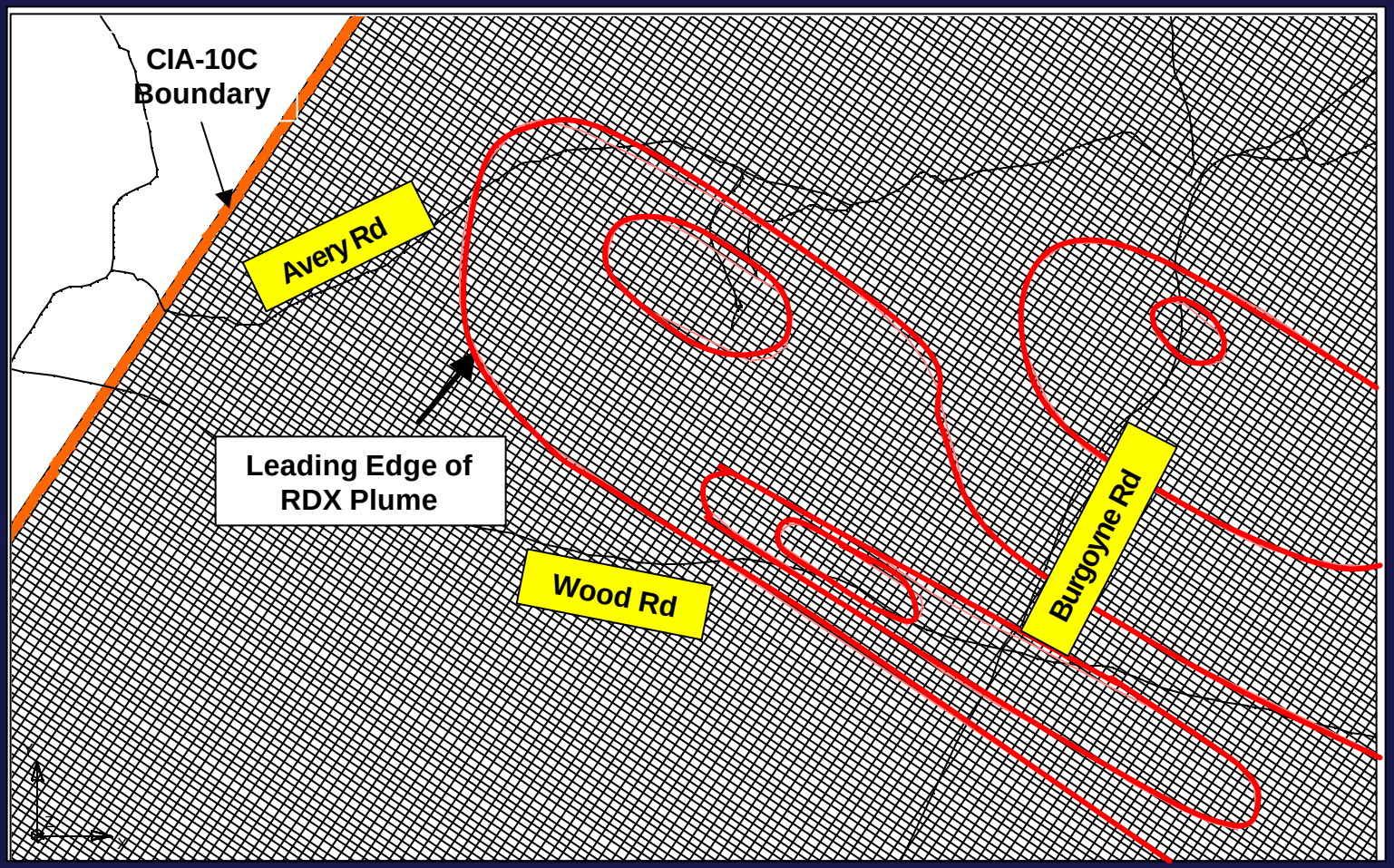
***Source: USGS 2003**

Note: values in italics to be confirmed

IMPACT AREA : Subregional Model Domain

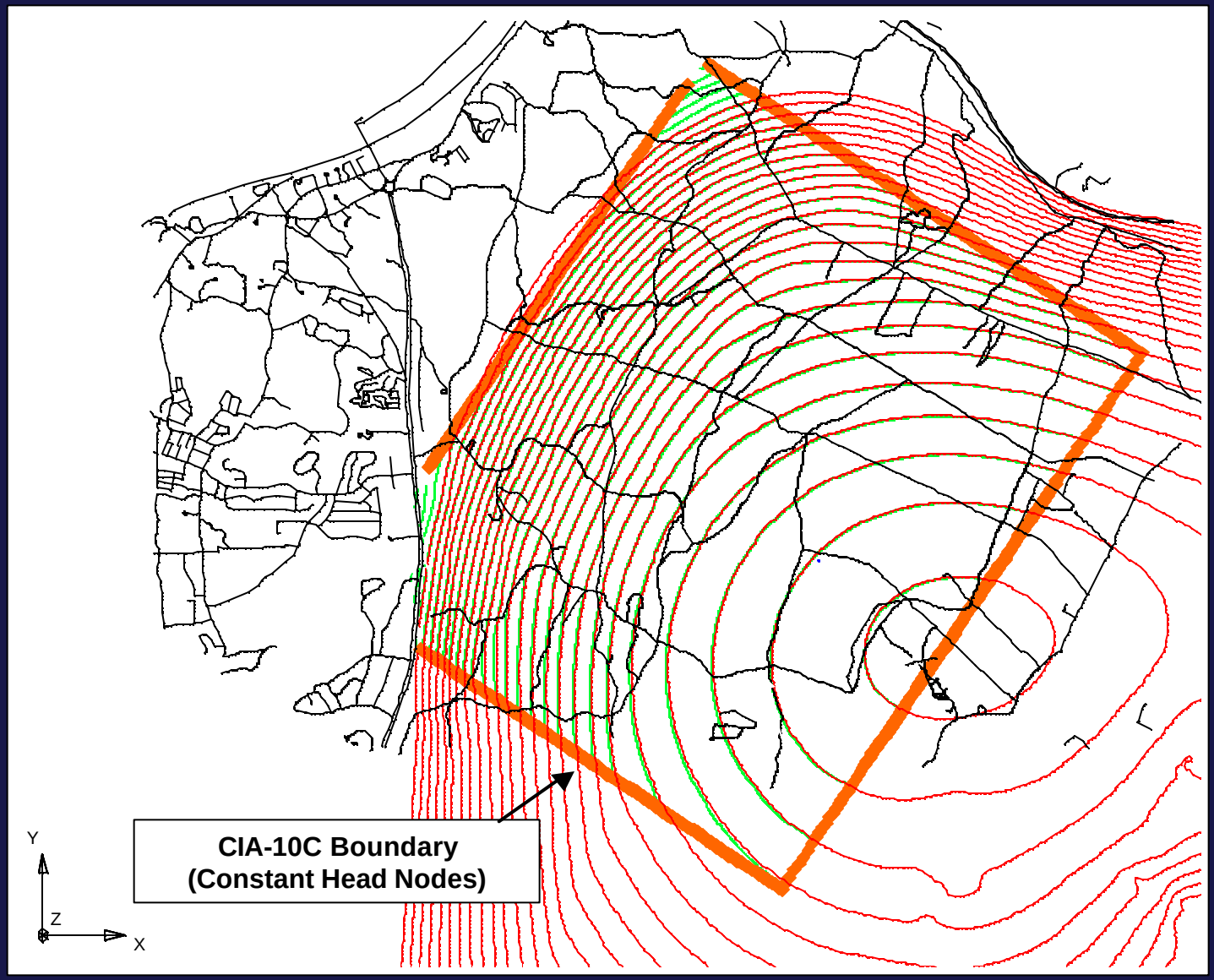


IMPACT AREA : Subregional Grid Spacing

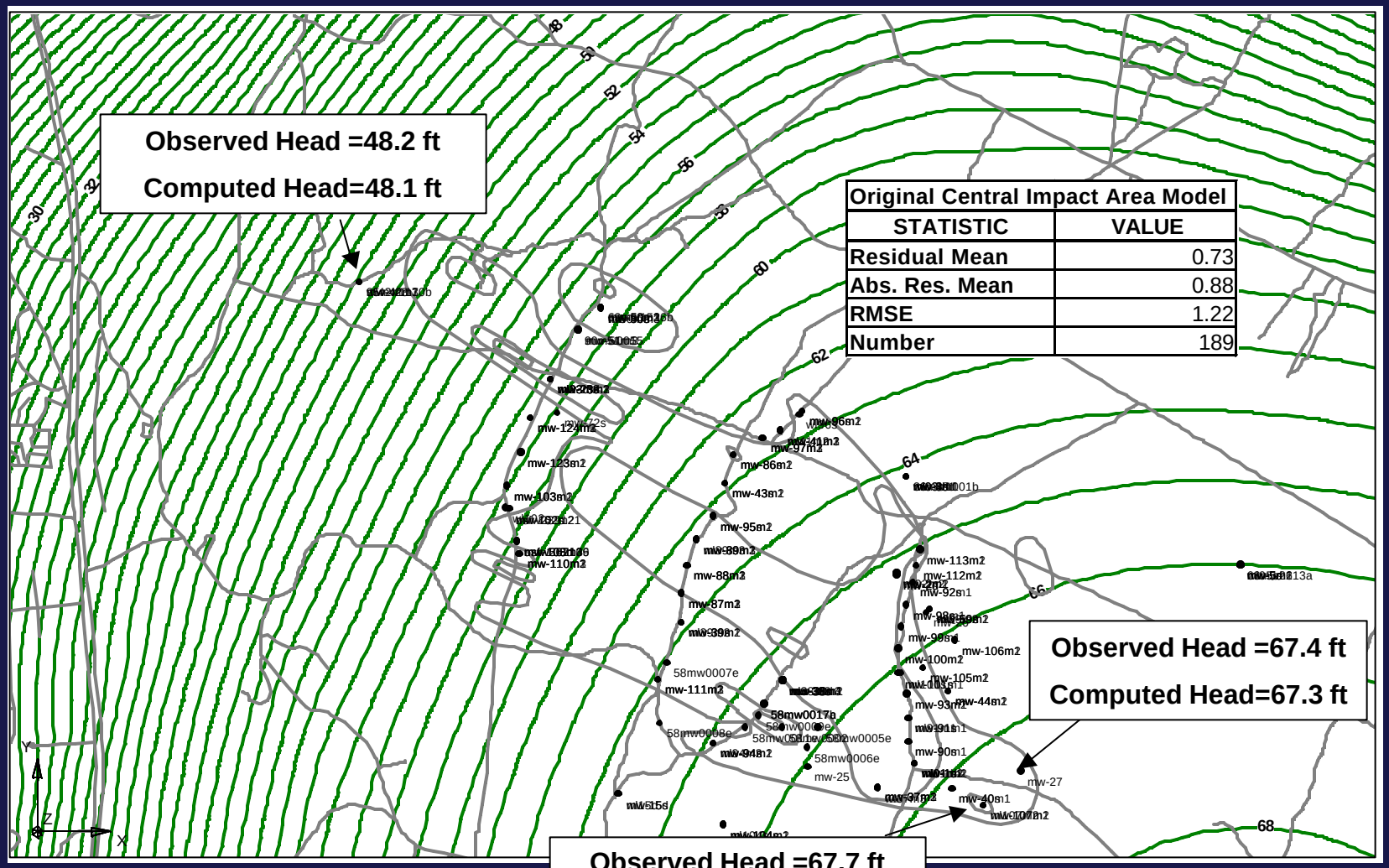


Cell Size: 30 x 45 ft

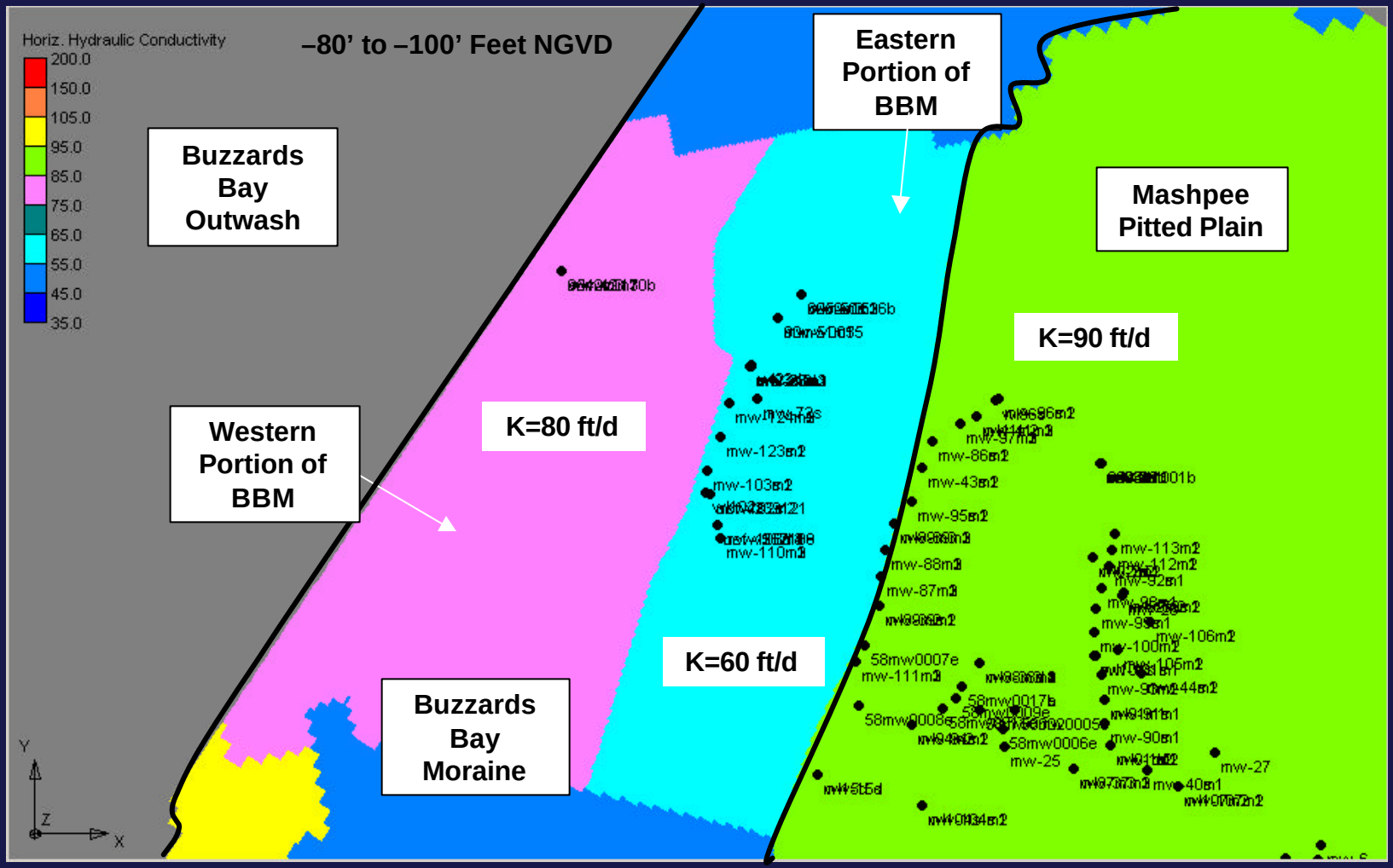
IMPACT AREA : Subregional Watertable



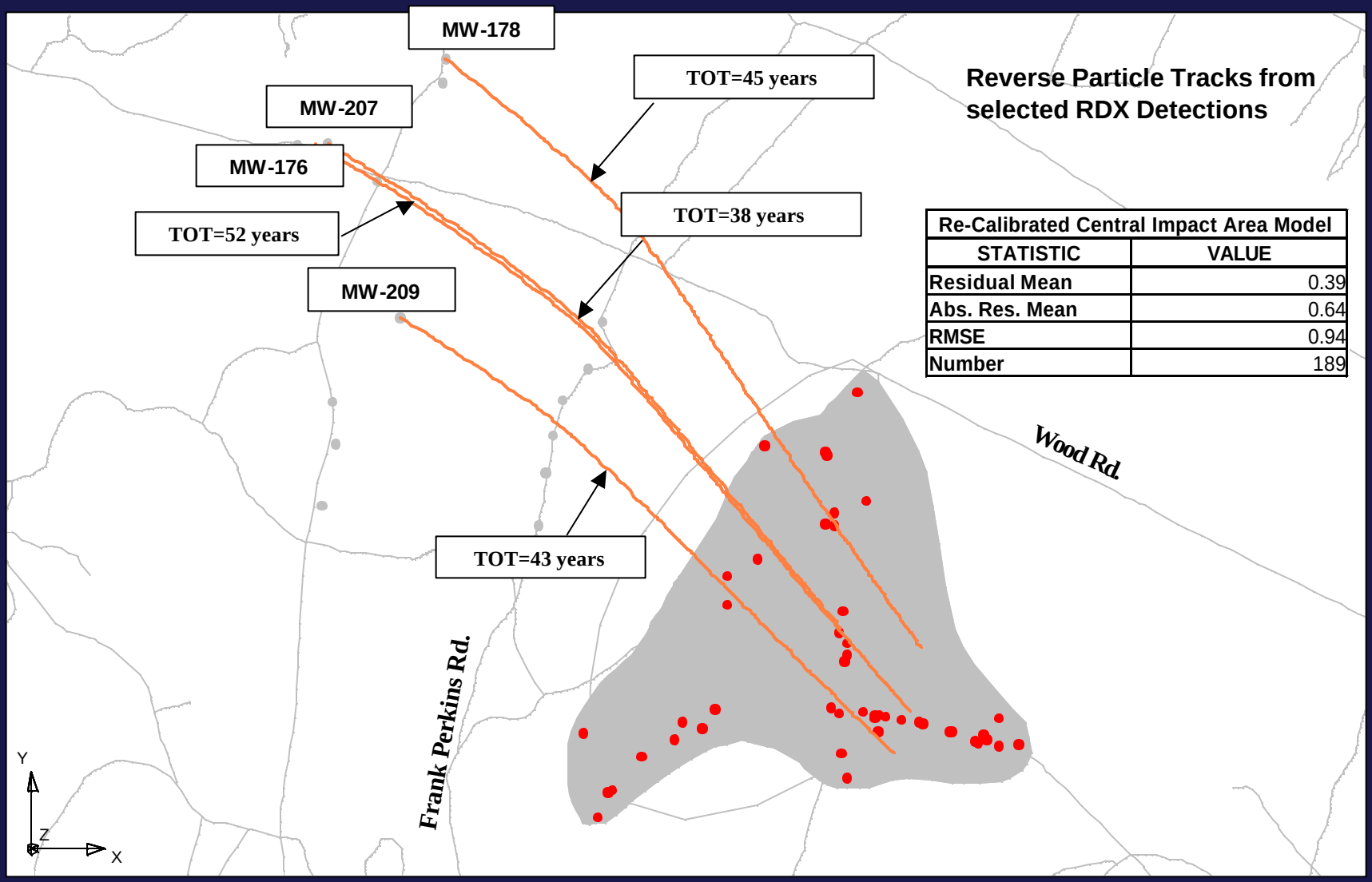
IMPACT AREA : Hydraulic Gradients



IMPACT AREA : Subregional Permeabilities

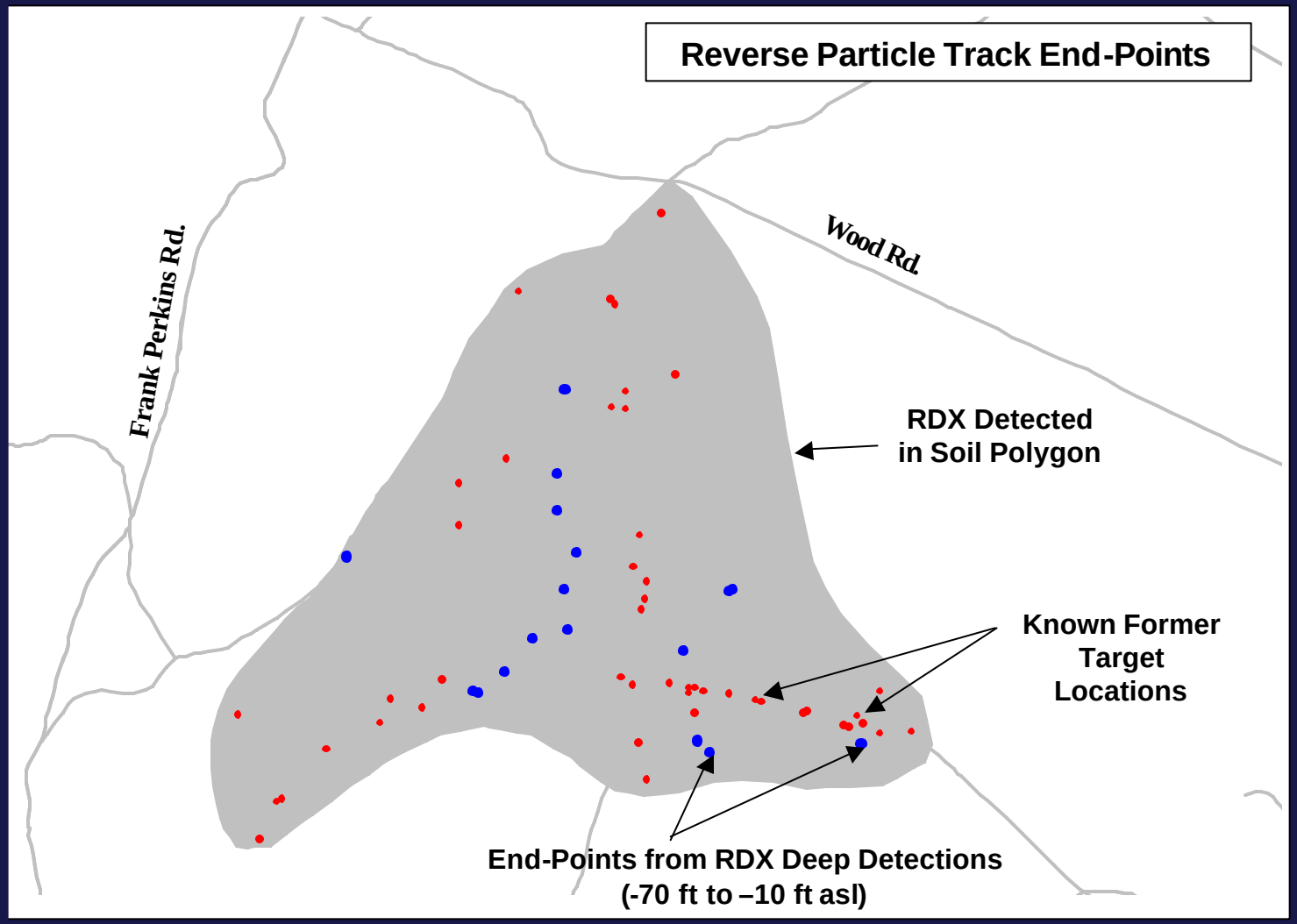


IMPACT AREA : Travel Time Calibration



Re-Calibrated Central Impact Area Model	
STATISTIC	VALUE
Residual Mean	0.39
Abs. Res. Mean	0.64
RMSE	0.94
Number	189

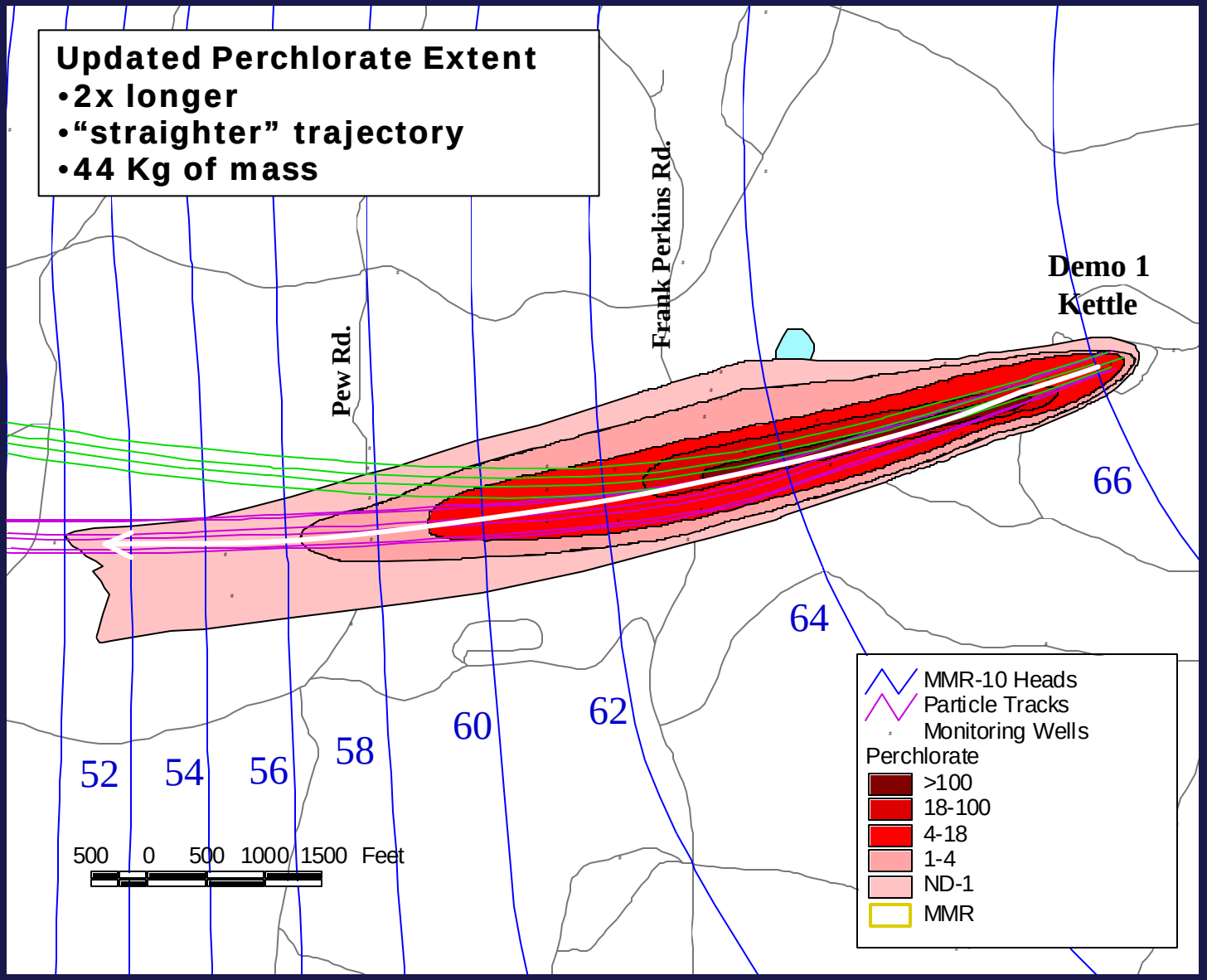
IMPACT AREA : Source Area Calibration

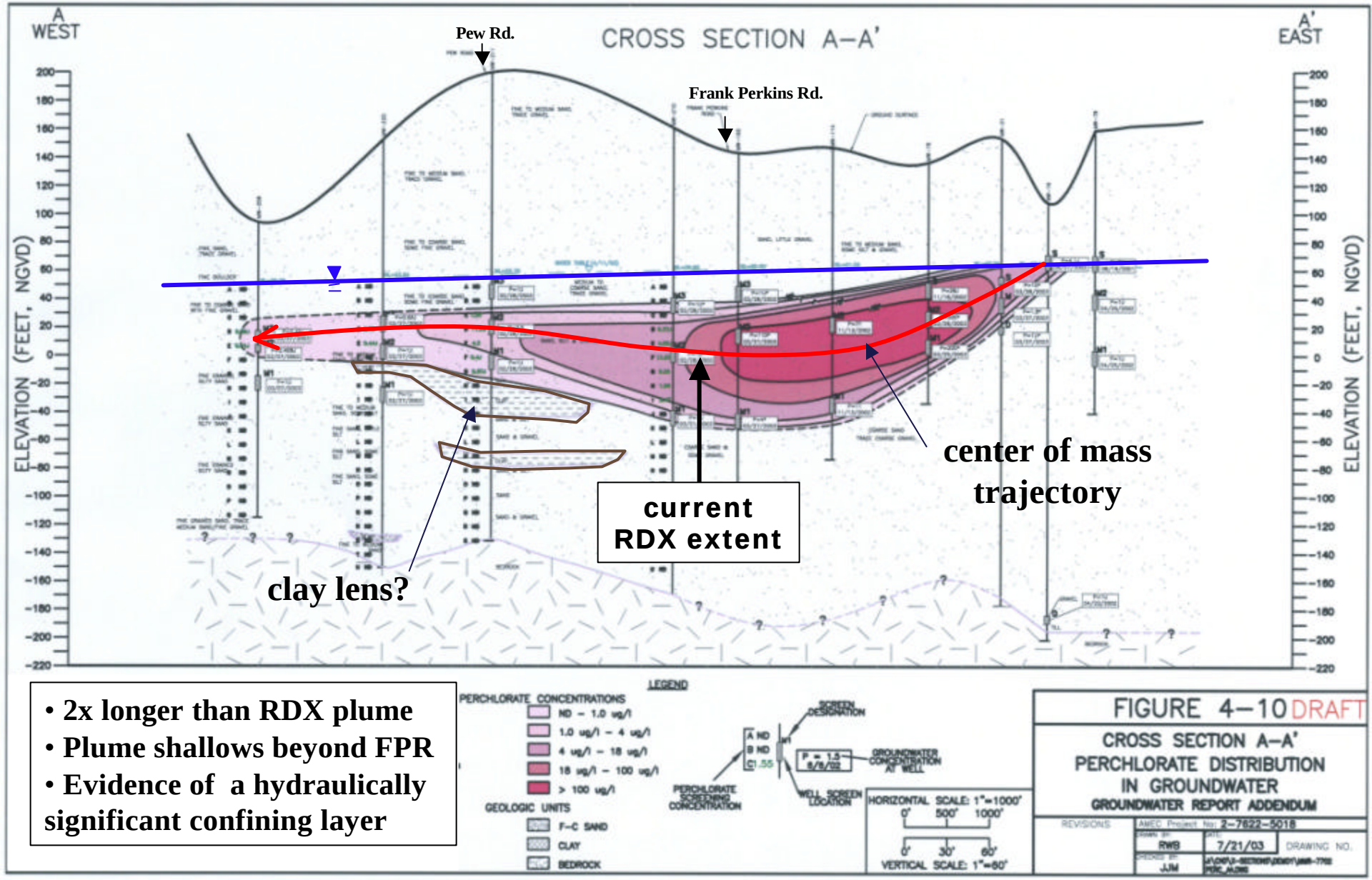


DEMO 1 FEASIBILITY STUDY GOALS

- Develop Final Remedial Design which incorporates RRA Extraction Systems
  - Frank Perkins Road extraction/injection system
  - Pew Road extraction/injection system
- Simulate Fate & Transport of multiple COCs emanating from similar source areas
- Simulate No Action, 10 Year Cleanup, and Longer Term Cleanup scenarios
- Develop Cost/Benefit Analysis

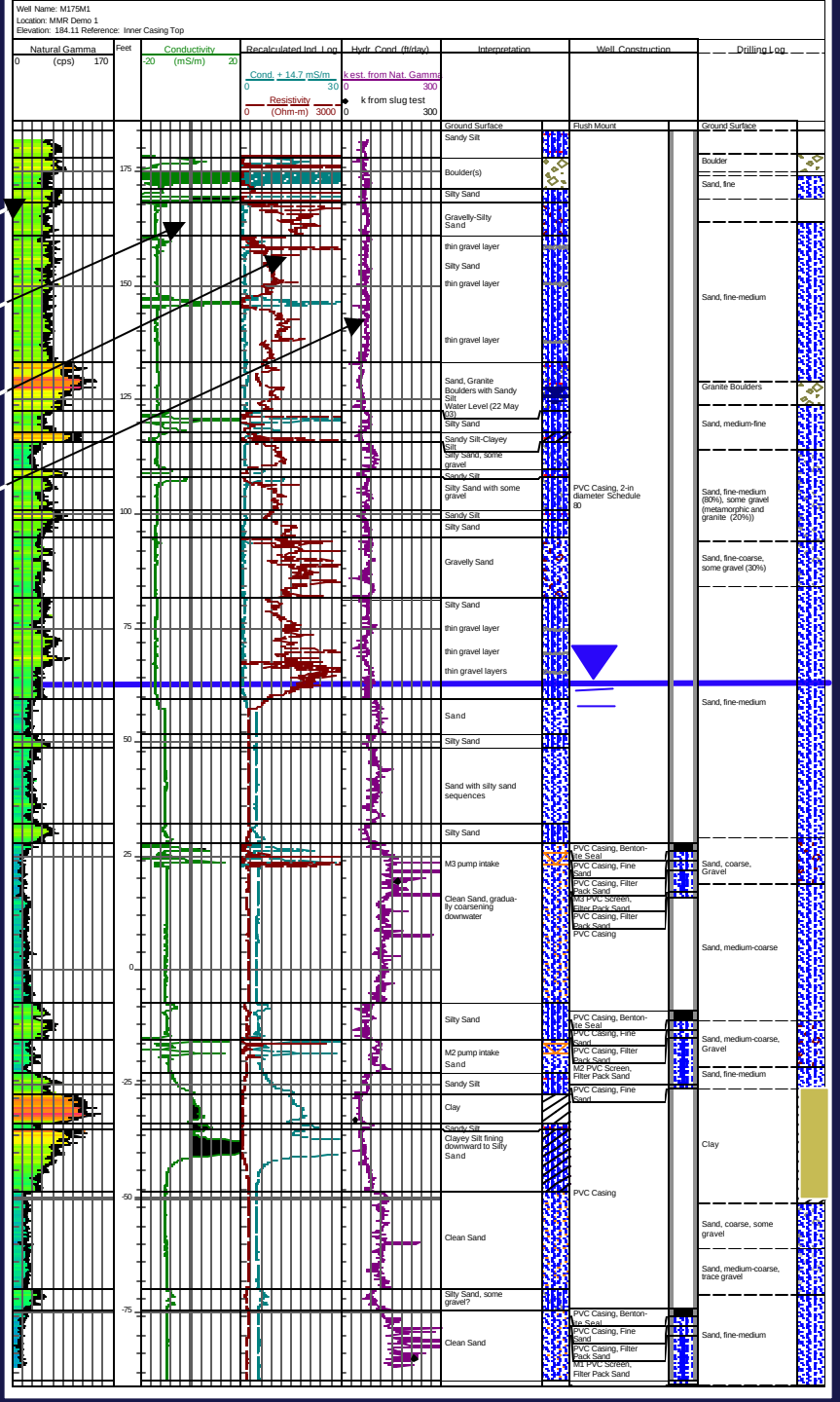
DEMO 1: Revised Plume Trajectory





- 2x longer than RDX plume
- Plume shallows beyond FPR
- Evidence of a hydraulically significant confining layer

MW-175



Gamma

Conductance

Resistivity

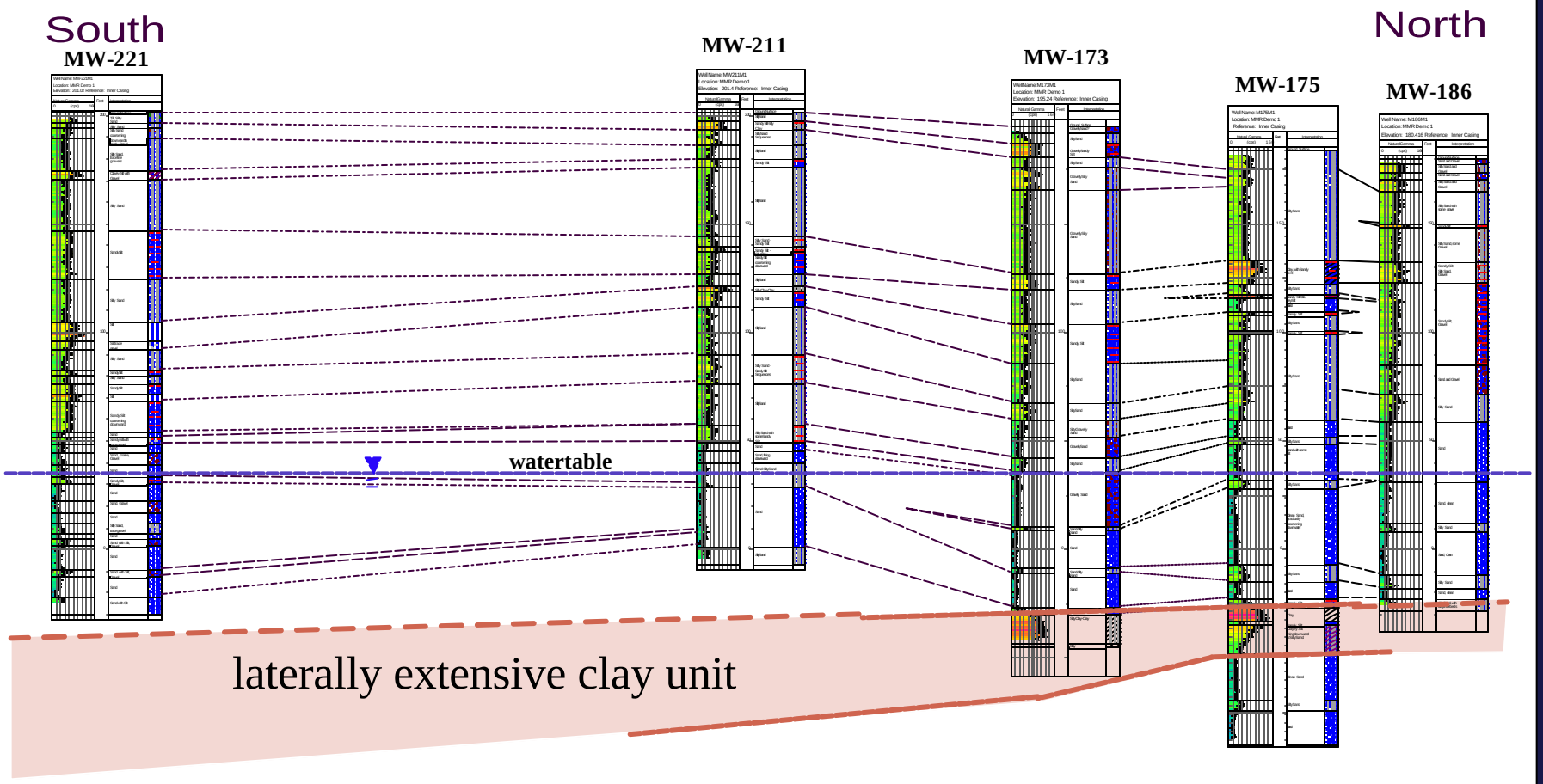
K

amec

NATURAL GAMMA LOGGING

- gamma, conductance, resistivity, K profile, and drill log coplotted
- reveals increased stratification of moraine relative to outwash
- signal muted below watertable but strong anomalies still evident
- correlation to K testing pending (COE)

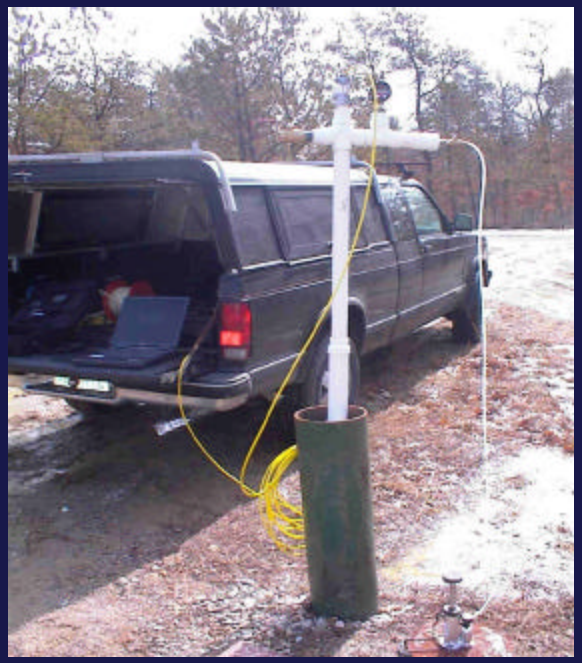
Profile E-E' (Pew Road)



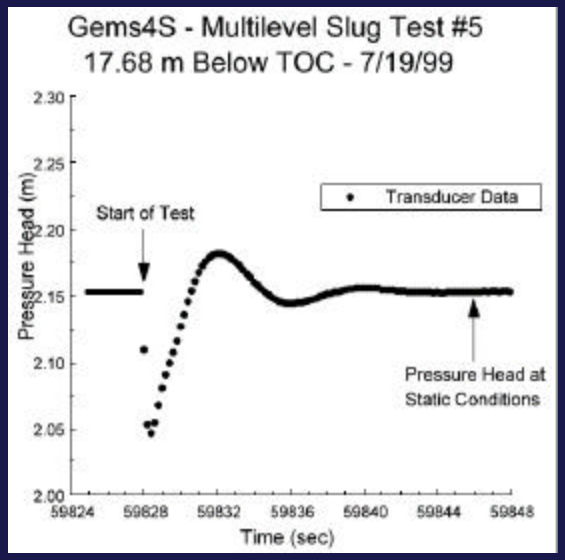
PNEUMATIC SLUG TESTING

Butler Method - Groundwater v.41 n.5 Sept-Oct 2003:

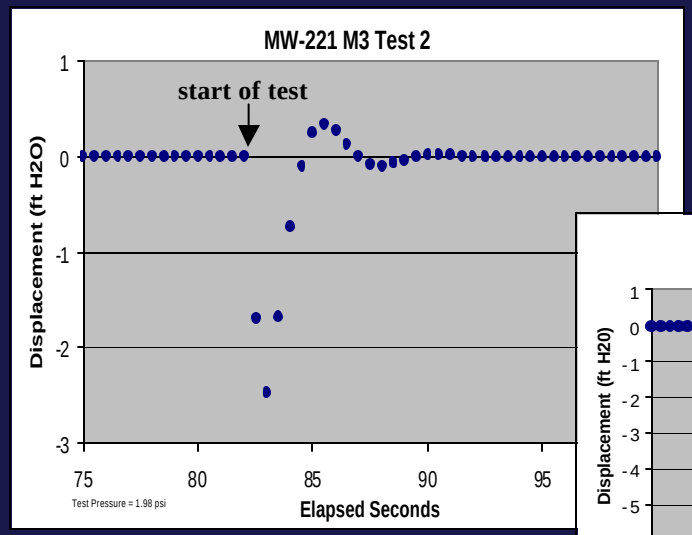
- Reliable for high permeabilities
- No extraction or injection water, no permits
- Very little contact with contaminated well water
- Can be executed quickly in the field
- Relatively quick processing time



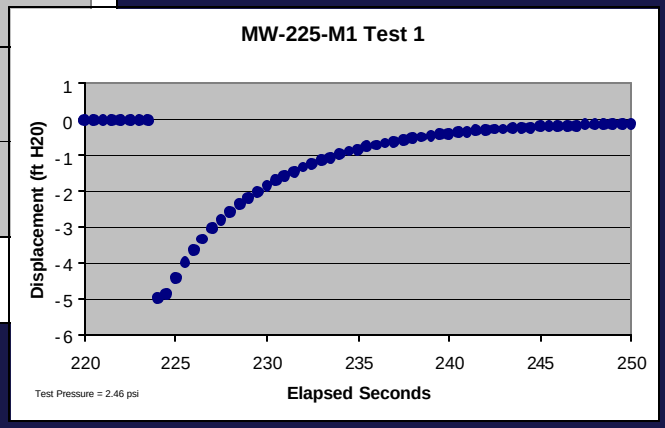
Butler Raw Data

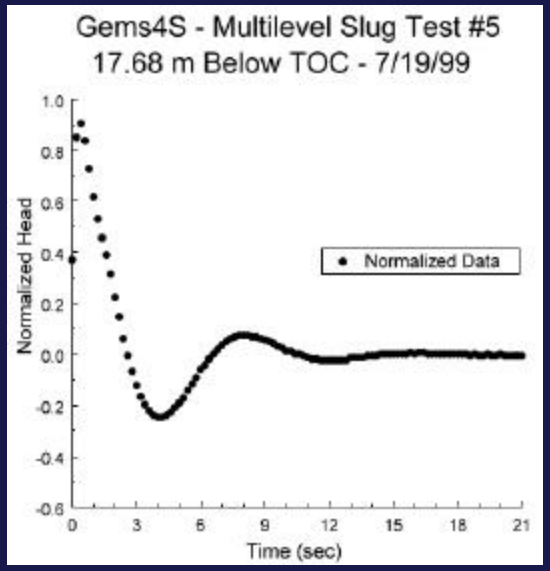


Demo 1 Raw Data

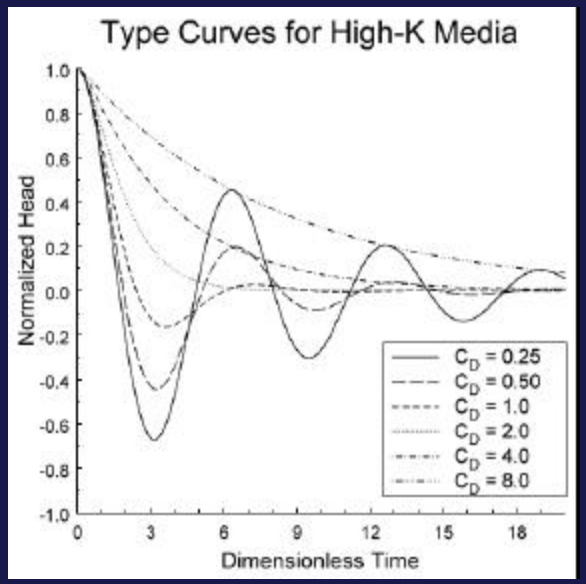


Demo 1 Raw Data

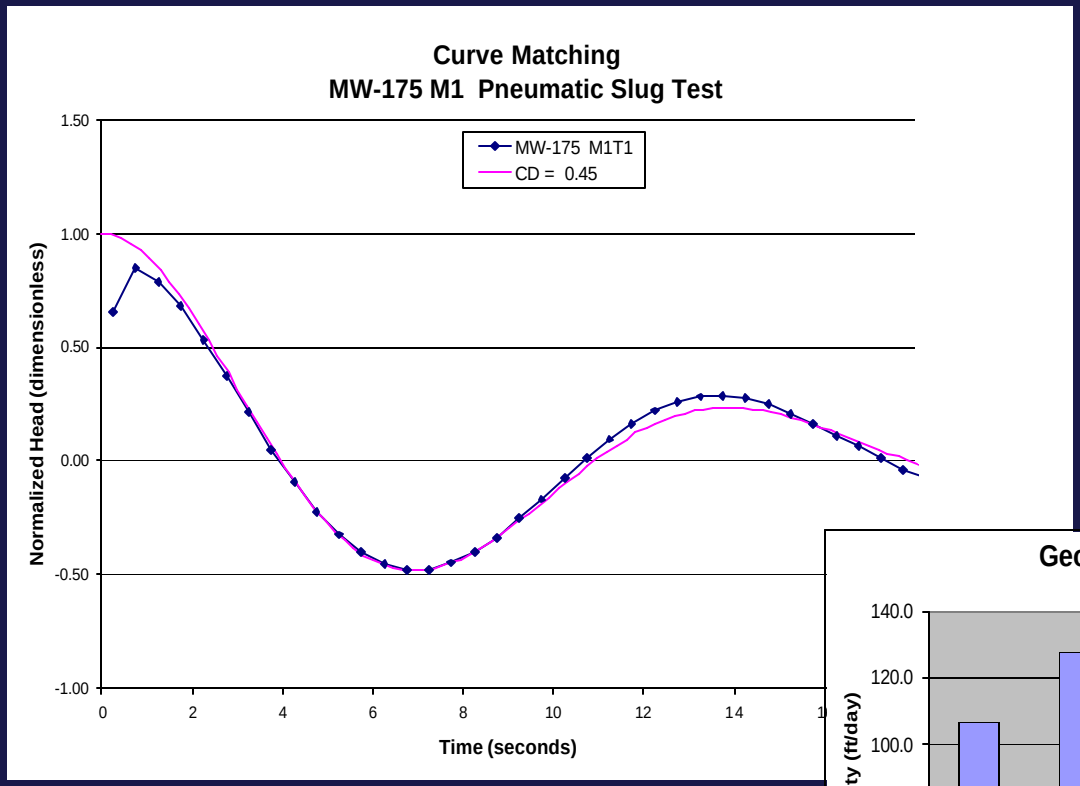




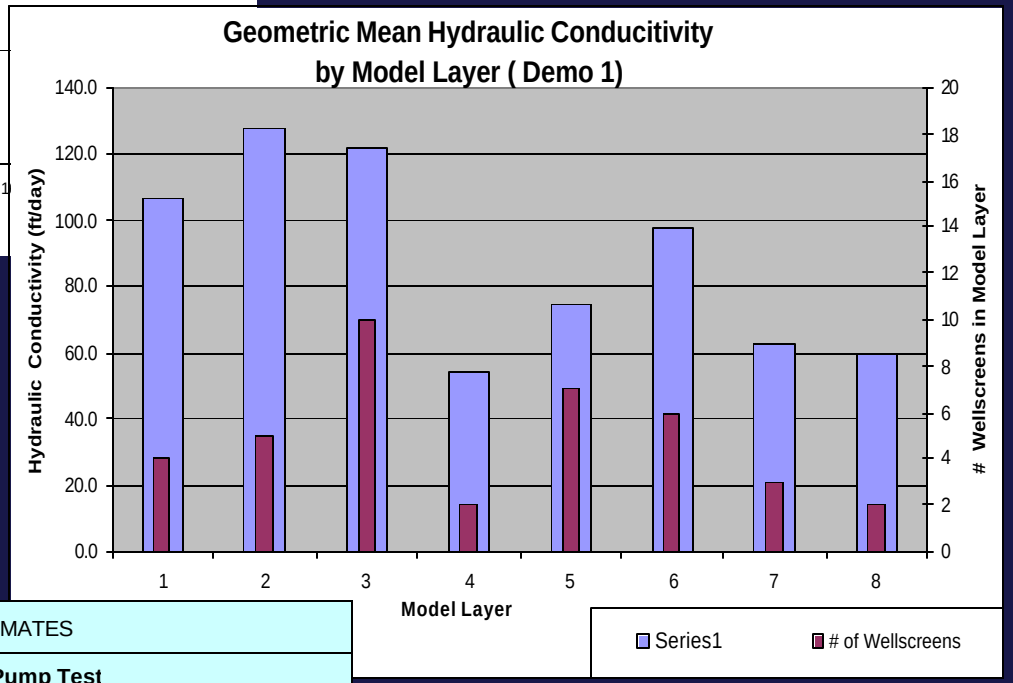
Butler Normalized Data



Butler Type Curves

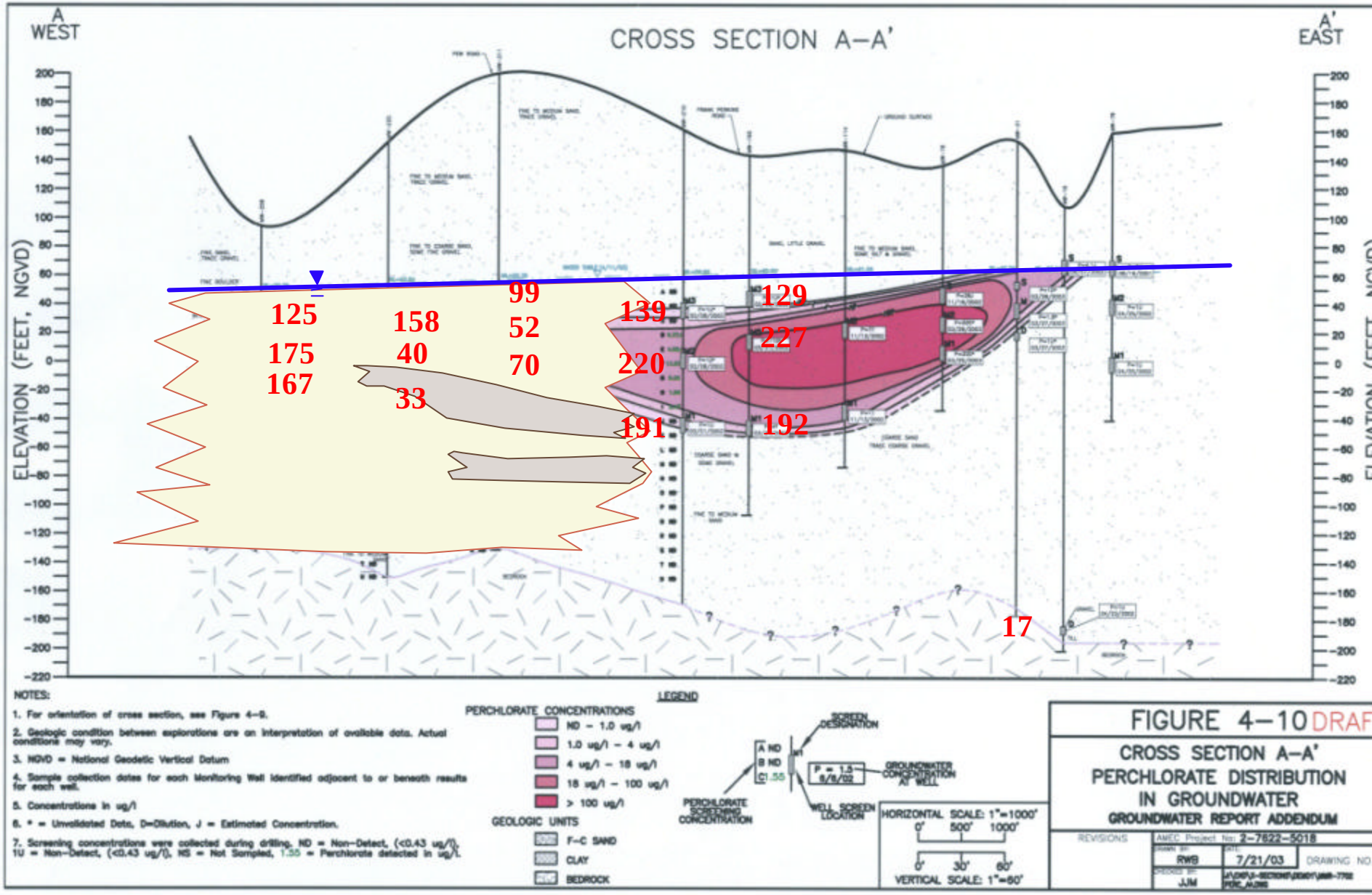


- 34 Demo 1 Screens Tested
- Max Value 227 Ft/Day
- Min Value 17 Ft/Day (D screen at bedrock)

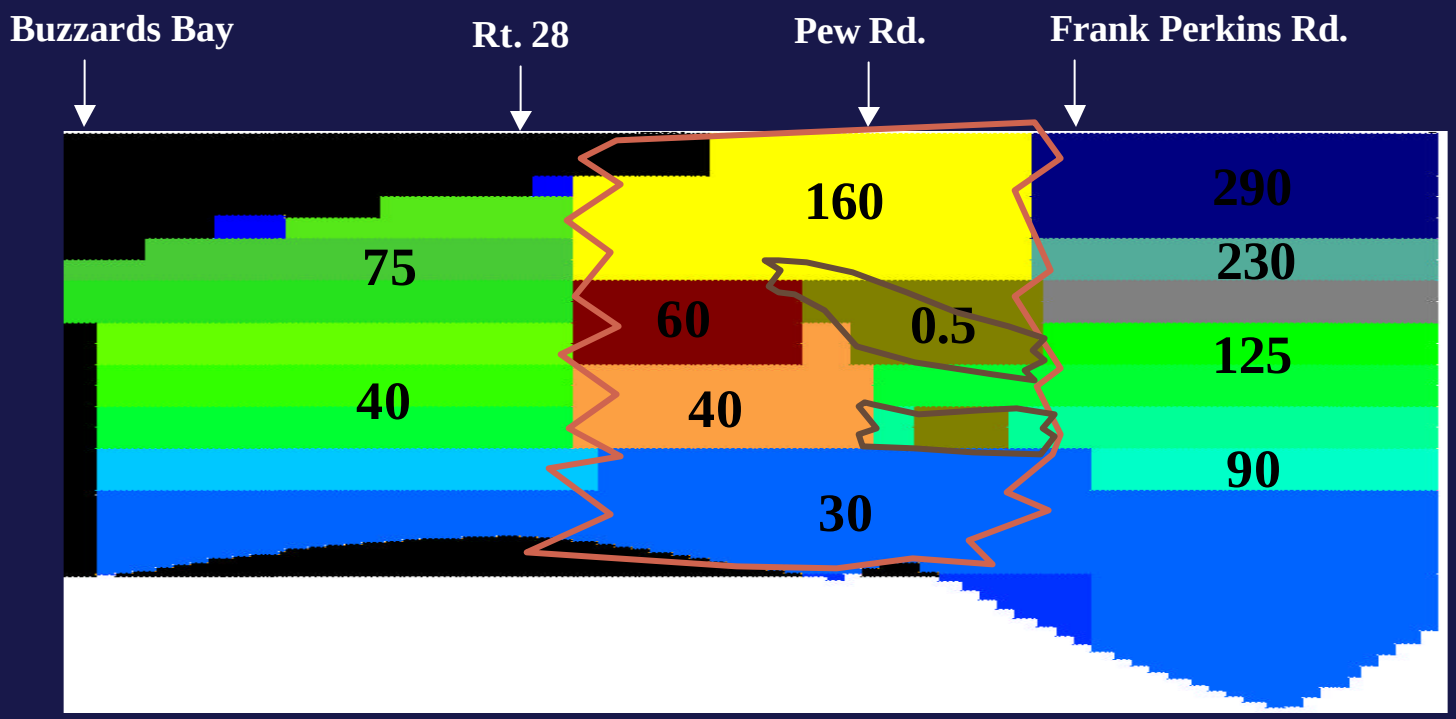


WELL NAME	HYDRAULIC CONDUCTIVITY ESTIMATES			
	Pnuematic Slug Test	CIA Area Pump Test		
	Butler, 2003 (ft/day)	Neuman (ft/day)	Cooper- Jacobs (ft/day)	Recovery Data (ft/day)
OW-4	150	169	155	158
OW-5	137	160	143	155

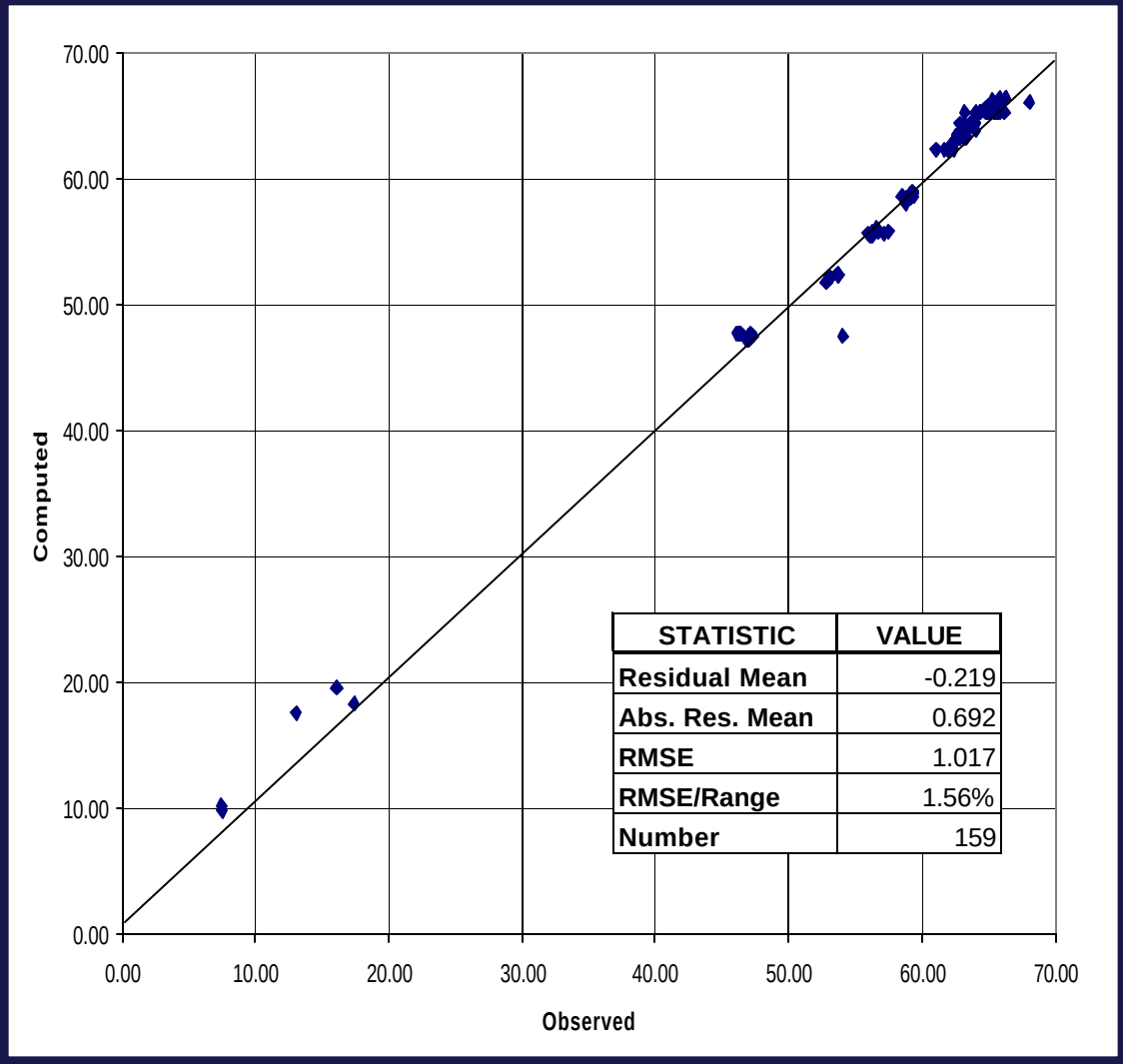
DEMO 1: Hydrostratigraphic Conceptual Model



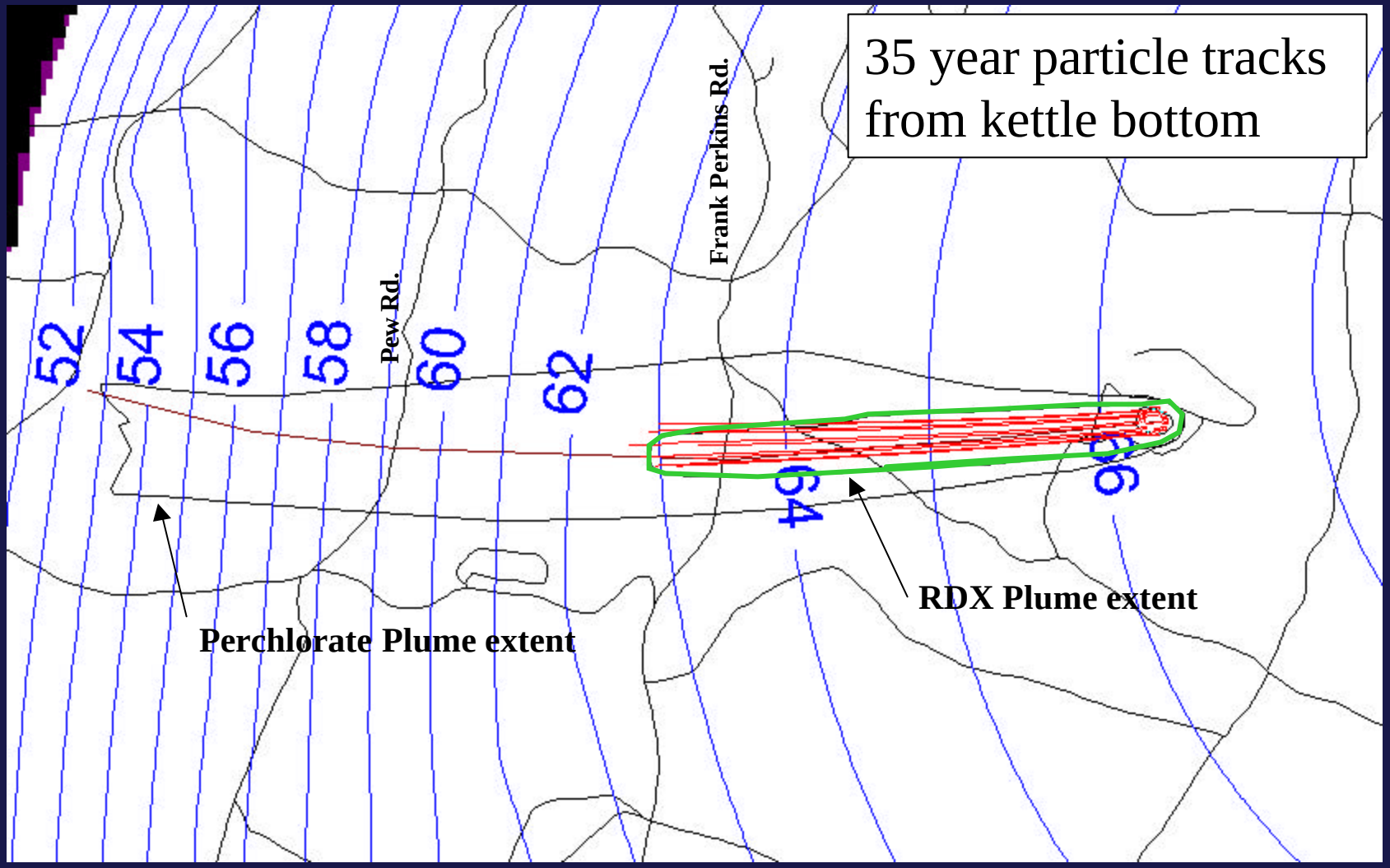
DEMO 1: Hydrostratigraphic Conceptual Model



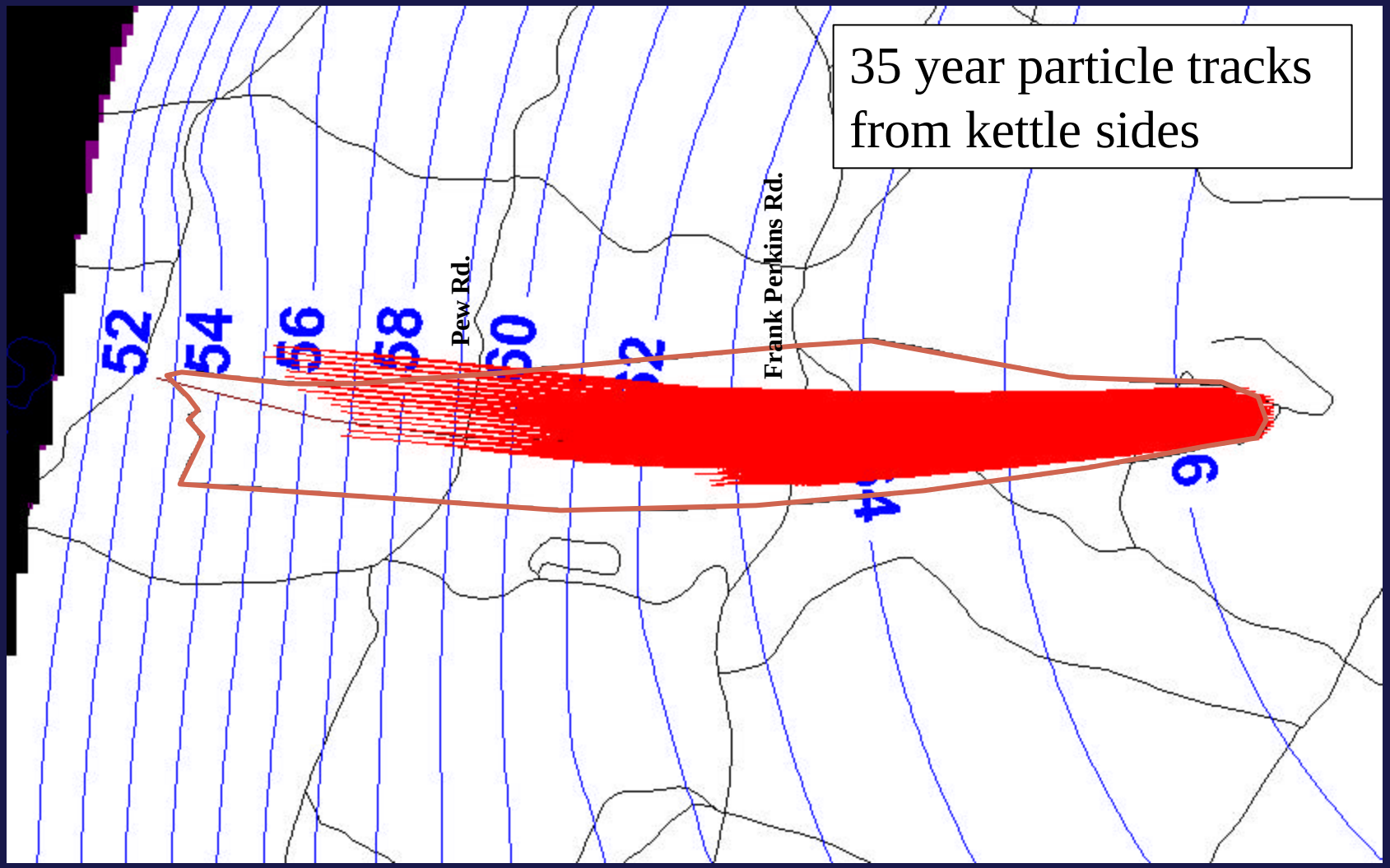
DEMO 1: Water Level Calibration



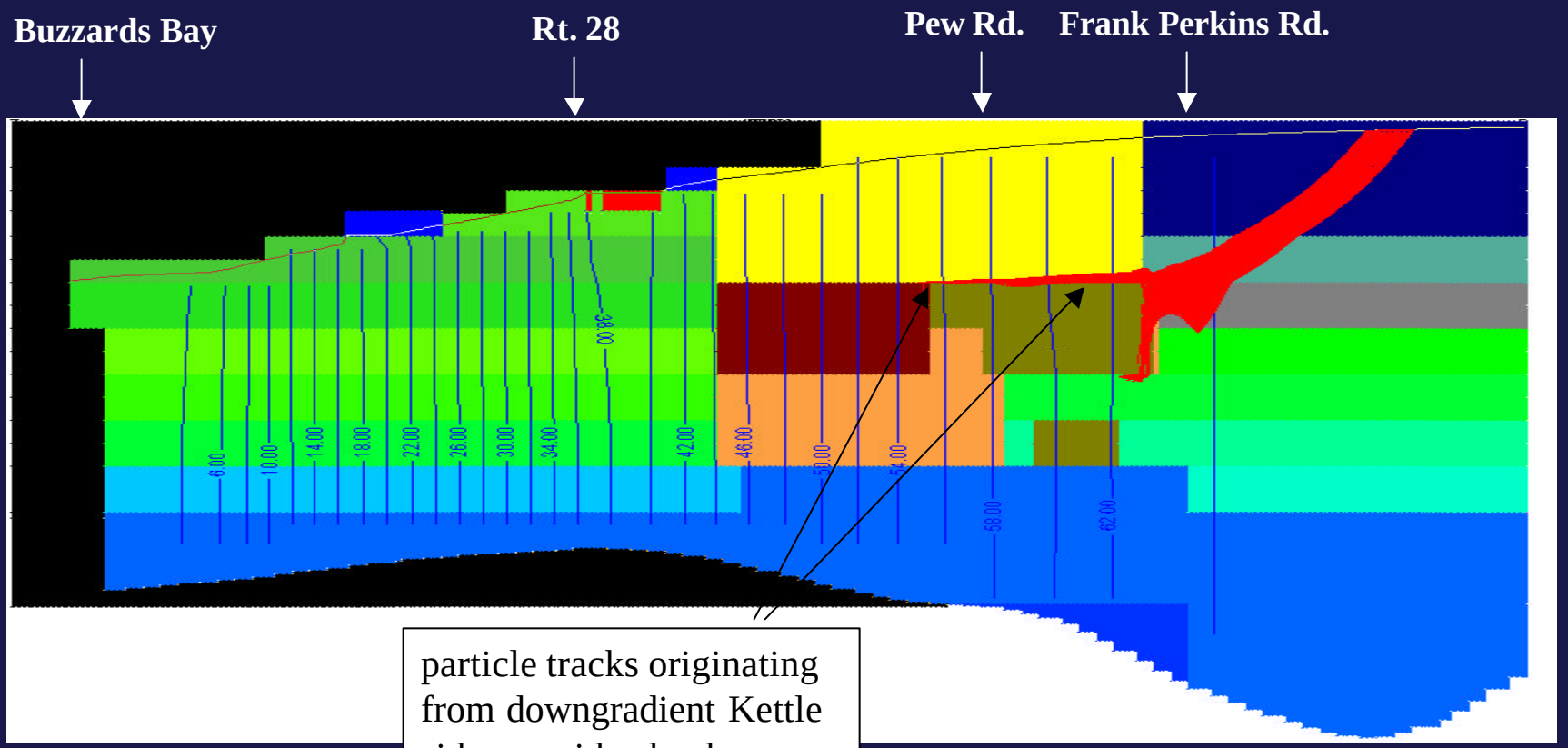
DEMO 1: RDX Travel Time Calibration



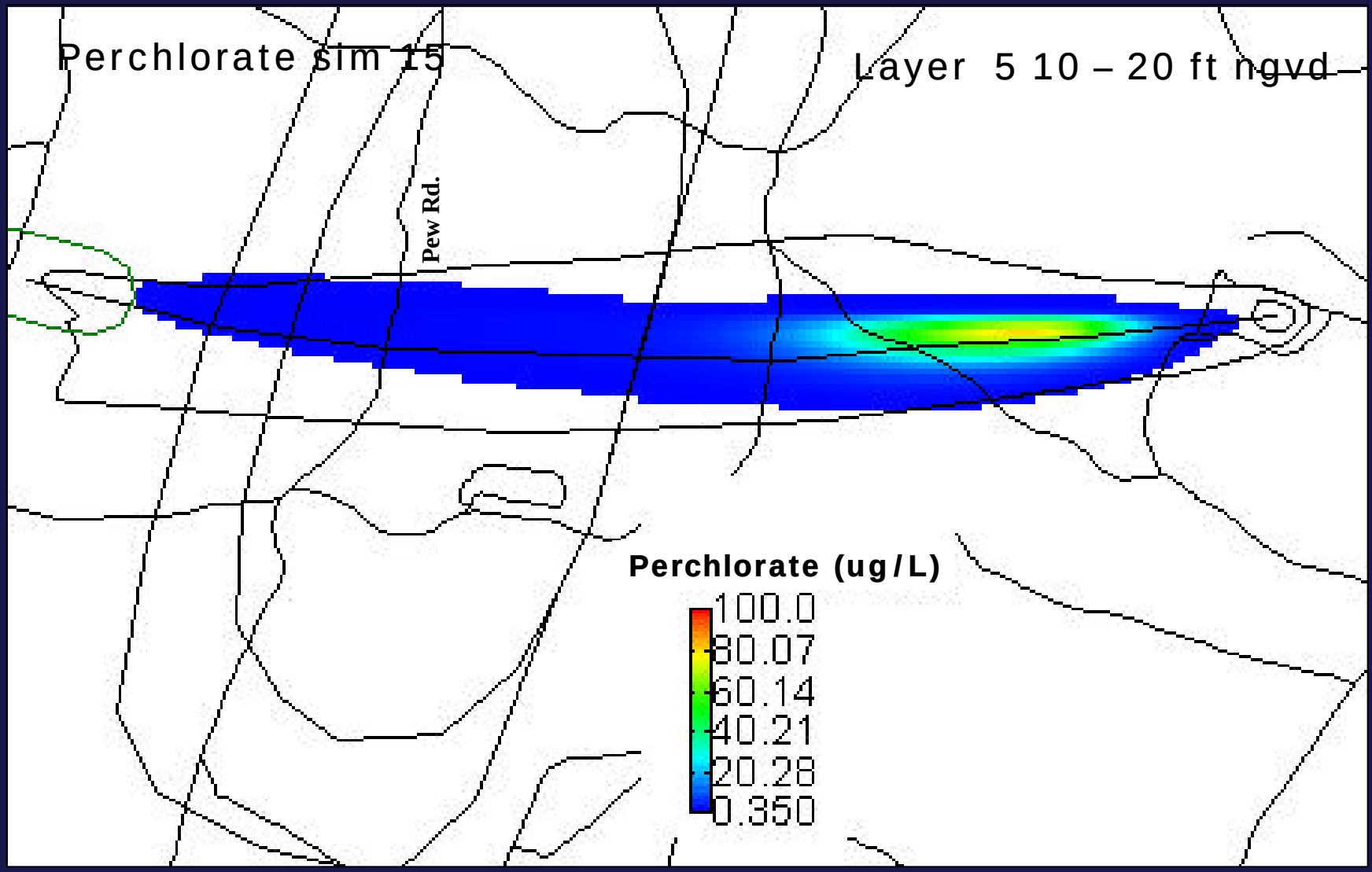
DEMO 1: Perchlorate Travel Time Calibration



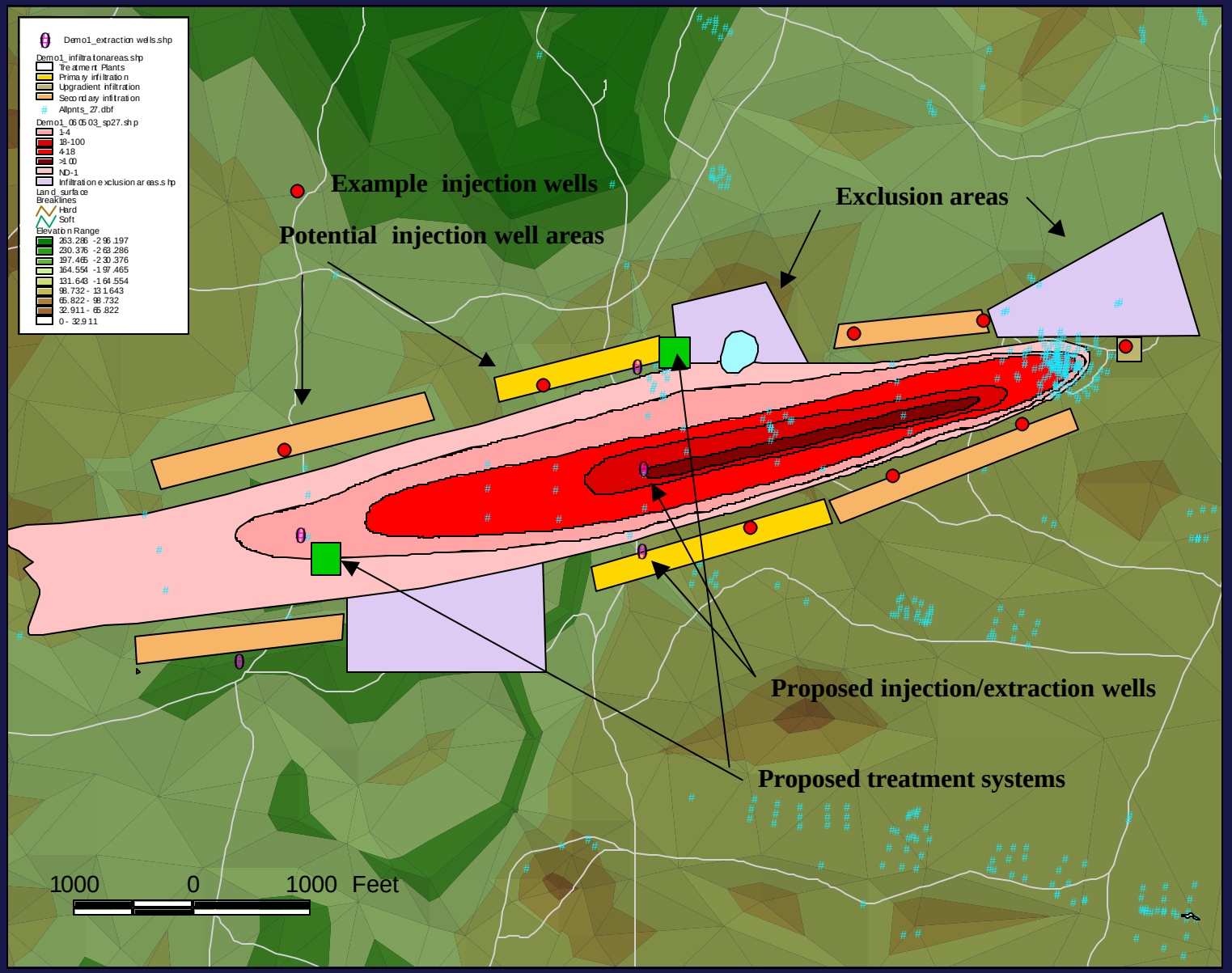
DEMO 1: Perchlorate Travel Time Calibration



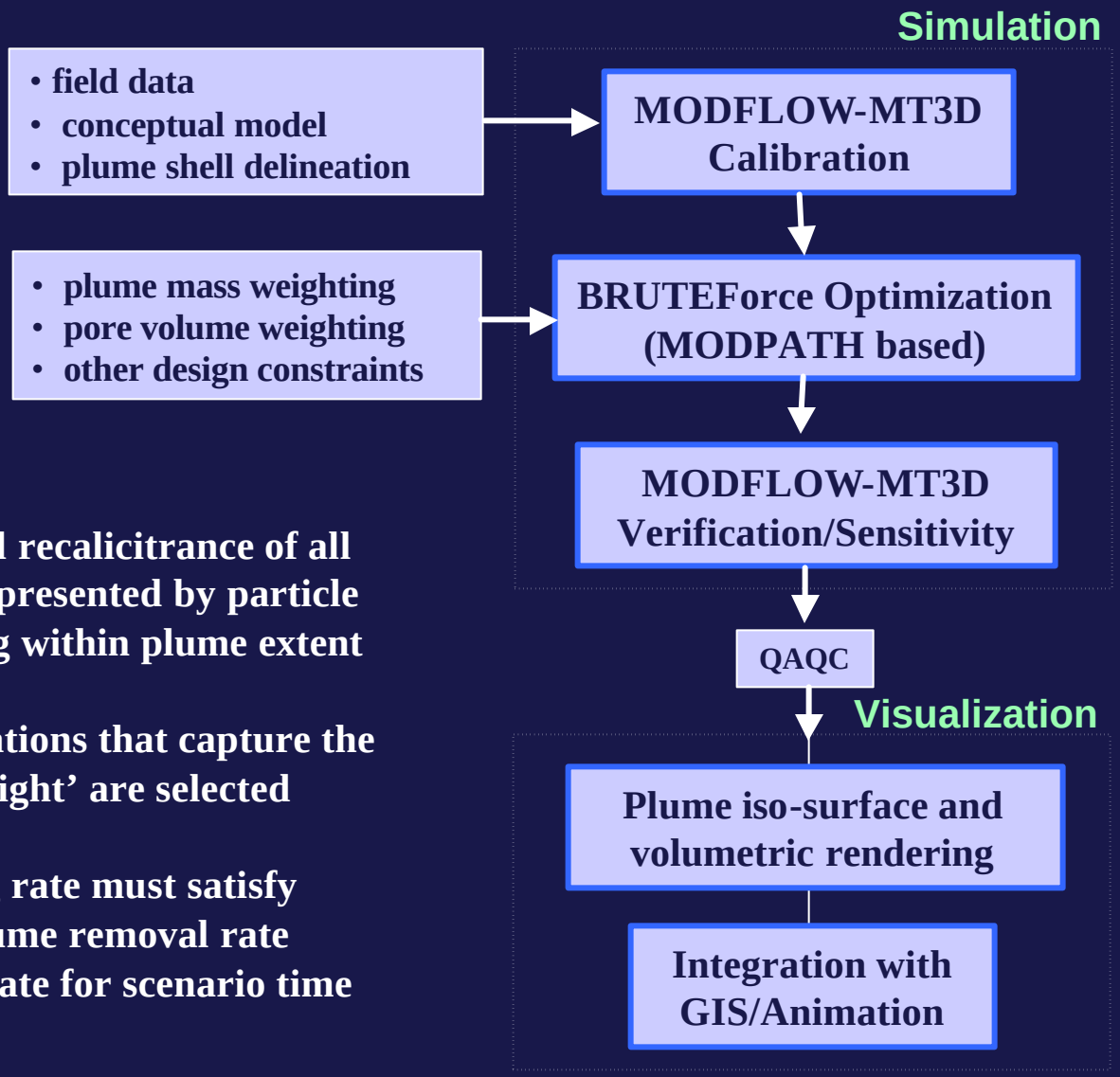
DEMO 1: Fate & Transport Calibration



Final System Conceptual Layout



Design Optimization Process



- Mass and recalicitrance of all COCs represented by particle weighting within plume extent
- Well locations that capture the most 'weight' are selected
- Pumping rate must satisfy pore volume removal rate appropriate for scenario time criteria

Plume Pore Volume Weighting

$n = \ln(C_s/C_i)/\ln(1-1/R)$ (Duetsch 1997)

where:

n = number of pore volumes required removing to achieve standard

C_s = groundwater standard

C_i = initial concentration

R = retardation factor

Contaminant	Initial Concentration (ug/L)	Groundwater Standard (ug/L)	Retardation Factor	Pore Volumes Requiring Removal	Required Days to Remove 1 Pore Volume for 10-Year Cleanup
Perchlorate	500	0.35	1	-	3650
RDX	220	0.25	1.2	3.8	964.6
TNT	5.2	0.25	8.658	24.7	147.6
2,4 DNT	0.52	0.25	2.955	1.8	2058.9

Figure 5-4

Optimization Model Results: 100-300 gpm

RRA/RAM Plan: Demo 1 Groundwater Operable Unit: Frank Perkins Road ETR System