KOPPERS SITE
PRESENTATION TO USEPA
MEETING MINUTES
ATLANTA, GA
AUGUST 28, 2008

Attendees:

David Richardson, GRU
Ronald Herget, GRU
Rick Hutton, GRU
Richard Jackson, Intera Engineering
Stanley Feenstra, Applied Groundwater Research, Ltd.
John Herbert, Jones Edmunds & Associates, Inc.
Kelsey Helton, FDEP/Tallahassee
Zoe Kulakowski, FDEP, Tallahassee
Scott Miller, EPA, Region IV
Ed Bates, USEPA
Ralph Ludwig, EPA/ORD
Bill OSteen, USEPA, Region IV
Adrian Gonzalez, Black & Veatch
Amy Callaway, Black & Veatch
John Mousa, Alachua County EPD

Rick Hutton gave an introduction - GRU wants to provide EPA their conceptual model of the Cabot/Koppers Superfund Site, state of knowledge of the extent of contamination and migration of contaminants, and to learn what EPA thinks about certain issues and the Feasibility Study. Scott Miller clarified that all of the EPA, Black & Veatch and FDEP members present at the meeting are on the collaborative Feasibility Study Team.

Stanley Feenstra presented information related to GRU's conceptual model (geology and migration pathways, distribution of mobile and residual DNAPL). Dick Jackson discussed factors affecting DNAPL mobility and reasons mobile DNAPL may be present and may not appear in monitor wells. John Herbert discussed issues related to remedial options and presented an abbreviated discussion of GRU's view of the Cabot Carbon Site.

Major Discussion Points

GRU holds the following opinions (GRU position is presented in bold font with EPA and Beazer positions - as interpreted by EPA - presented in regular font):

The lateral extent of DNAPL zones is not fully defined in any of the 3 aquifer units.
Beazer and EPA agree. EPA has told Beazer more evaluation will be required and Beazer is preparing to undertake such work. The Process Area, Former Drip Track, and off-site area east of Koppers are of concern.

Potentially mobile DNAPL is present in all strata.
Beazer will strenuously disagree. EPA is uncertain about the potential mobility of DNAPL in the three aquifers; however, EPA will take a worst-case approach when selecting a remedy.

Contaminants in Floridan aquifer resulted from DNAPL and/or groundwater migration via natural pathways.
Beazer believes that most detections of organic contaminants in the Floridan are due to leakage. EPA believes that Beazer can test the leakage hypothesis via the proposed low volume pumping

of FW-6 and FW-21B. EPA believes that at least some of the contamination in the Floridan resulted from migration through the Lower Hawthorn Clay.

There is very large uncertainty regarding the effectiveness and feasibility of in situ remedial technologies that could be applied in the Hawthorn.
Beazer will ask how much benefit will be derived from remedial action. EPA is concerned that conditions not be worsened by remediation. EPA also believes that remedial measures in the Hawthorn which would reduce contaminant flux into the Floridan would be worthwhile, even if they cannot completely prevent contamination from reaching the Floridan. FDEP is concerned about deliverability issues (practicality) of remediation in the Hawthorn.

Hydraulic containment in the Floridan is the most predictable and effective alternative to protect groundwater in the Floridan aquifer.
EPA's position is that hydraulic containment is still being considered ("on the table") – that position was made clear at the last Feasibility Study meeting (minutes have not yet been distributed). GRU noted that hydraulic containment needs to be included in a Feasibility Study alternative so the technology can be evaluated relative to others. EPA will also evaluate chemical oxidation of contamination in the Floridan.

Specific performance criteria and points of compliance must be included in the final remedy. EPA has not yet defined compliance points and performance criteria. FDEP's position is that any remedy must achieve the following in the Floridan:

1. Must meet Natural Attenuation Default Criteria (NADC) at all locations
2. Must include interior compliance points to meet NADCs.
3. Must also, at a minimum, meet GCTLs at property boundary.

FDEP can grant a temporary offsite Points of Compliance (POC) with the agreement that the PRP will pull the plume back onsite. That temporary POC would require institutional controls. The PRP must secure agreement from all landowners affected before FDEP will agree to the temporary POC.

Discussion
The following notes are compiled from the discussion of the topics presented above.

David Richardson stressed that GRU needs to know if EPA agrees with GRU positions specified on slides #3 and #4 of GRU's presentation (generally the positions presented in bold font above). The Gainesville City Commission is very anxious about this site and the potential impact to Gainesville's only water supply and water treatment plant.

Adrian Gonzalez: Feasibility Study Team – heard many times that the goal is to protect the water supply. One goal is to not make things worse – one concern is the potential to enhance vertical migration of contaminants by penetrating clay layers.

Site Conceptual Model
Stan Feenstra presented GRU's view of the geologic and hydrogeologic model of the site – see the attached PowerPoint presentation.

Ed Bates and Bill O'Steen stated that EPA believes that:

- Mobile DNAPL is present in the surficial aquifer (SA).
- Upper Hawthorn Group (UHG) – some DNAPL
- Lower Hawthorn Group (LHG) – some DNAPL
- If you have DNAPL, then there is some potential for mobile DNAPL but whether mobile DNAPL is present is very much uncertain.

Bill Osteen: DNAPL is potentially mobile but how likely is it that the DNAPL is mobile? Bill believes the potential for having mobile DNAPL is less as you go deeper. Many things are potential, but not likely. EPA will take a worst case approach when selecting a remedy.

GRU believes the Lower Hawthorn Clay cannot be expected to be a barrier to downward migration of contaminants leaked. Stan Feenstra pointed out that there is not much difference between vertical conductivity (K) in UHG & LHG clays. Bill wants to see calculated numbers and not relative numbers.

EPA's view of LHG Clay Competence:
The LHG clay is an impediment to downward migration – but not perfect.
Analytical data show contamination in Floridan and DNAPL in LHG. Contamination must have gotten into Floridan via migration, not solely through leakage through poorly constructed wells.

Ed Bates asked how would GRU prepare to monitor for horizontal solution pipes as shown on slides #15 and #16. Dick Jackson responded that this would be accomplished by pumping and monitoring concentrations in the pumped wells and in monitoring wells.

Stan Feenstra presented slides providing evidence that the oatmeal-like consistency of FLA borings are the result of the sonic drilling technique and do not indicate that the FLA is unconsolidated under the Koppers site.

Robin Hallbourg agreed that the Ocala core – oatmeal consistency (unconsolidated appearance) recovered at the Koppers Site - is an artifact of the sonic-drilling technique. She indicated that she has seen this at other locations. Robin noted that the Lower Hawthorn Clay is not always present as continuous and solid clay and that it commonly contains carbonates and facies changes.

Ed Bates: Hydraulic head across LHG clay is a measure of bulk vertical K.
Dick Jackson disagreed stating that it is also a function of the high K in Ocala and referred EPA to the current issue of the Ground Water journal in which the issue of natural hydraulic gradients greater than unity is discussed.

Extent of DNAPL Contamination

Bill OSteen stated that Beazer and EPA agree there remains great uncertainty regarding the extent of DNAPL in the SA, UHG, and LHG. Before a remedy is selected – additional characterization will be required in the SA, UHG, LHG. EPA will select a remedy based on the worst case. Beazer is scheduled to deliver a Work Plan for additional characterization of

Hawthorn shortly – the work plan will address the east property boundary and offsite. Bill Osteen indicated that EPA needs more information on DNAPL source areas and can't move forward with the Feasibility Study with current data.

Regarding the extent of contamination near the eastern property boundary – and extending offsite - GRU is concerned primarily about the extent of contamination near the Operations Area and Former Drip Track.

Bill OSteen: EPA intends to nail down more definitive DNAPL characterization in the SA along the eastern property boundary. EPA will require more soil borings and soil chemistry data; not more wells. Dick Jackson discussed the need to specify a minimum for soil recovery (%) from soil cores in order to draw conclusions as to DNAPL presence - otherwise DNAPL could drain with loss of core.

John Mousa indicated that ACEPD is concerned about the poor data coverage at the Process Area in the Hawthorn. Bill Osteen stated that, in the absence of data in the LHG, EPA will consider the LHG to be as-or-more contaminated than source areas to the north.

Vertical Migration

Stan Feenstra presented data (focusing on ratios of contaminants rather than absolute concentrations) that indicates organic contaminants detected in the Floridan aquifer are derived from seepage though the LHG clay and not leakage through improperly installed wells. Generally, the GRU DNAPL team assumes an effective solubility for naphthalene from creosote DNAPL of approximately 13,000 ug/L.

Ed Bates has seen very high Naphthalene concentrations where no DNAPL is present. He has also observed that Naphthalene travels a long way and may become separated from DNAPL.

GRU believes that the principal sources of dissolved plumes are the DNAPL zones –both zones where DNAPL is potentially mobile and zones where it is residual. And that a good deal of mass is diffused into the limestone matrix and sorbed thereby forming secondary sources.

Bill OSteen: Dragdown at FW-6: EPA stated their official position in a letter to Beazer (approximately 2 years ago): Dragdown may have occurred, but it is EPA's position that all groundwater data from that point forward [i.e., 2 yrs past] reflect conditions in the Floridan. EPA is highly skeptical of Beazer's conclusion that vertical leakage down wells is the cause of the Floridan contamination. EPA is dubious, but told Beazer to test that scenario.

Beazer will test the leakage theory by pumping at FW-6 and FW-21B.
If Beazer cuts off the source to deeper zones in FW-21B by pumping in the shallow zone – then concentrations in deeper zones should drop in FW-21B.

Stan Feenstra brought up the prohibition of penetrating middle clay by drilling and the impact to future characterization and remediation efforts.

Ed Bates stated that it is not EPA's intent to absolutely prohibit penetrating the middle clay. EPA would like to avoid drilling where there is significant mobile DNAPL- that drilling through HG middle clay will be done only if there is a good reason to do it

DNAPL Mobility
Stan Feenstra pointed out that sustained DNAPL recovery from a well cannot be the sole indicator of potentially mobile DNAPL and discussed several other indicators of potentially mobile DNAPL.

Dick Jackson addressed the mobility of DNAPL and reasons that it may not appear in a well even though it may be present nearby. Creosote DNAPL can continue moving for decades after release – and not appear in a well.

Dick Jackson and Ed Bates agreed that it will be difficult to break a continuous DNAPL flow path. We don't know where these DNAPL flow paths are.

Remedial Alternatives and Metrics
John Herbert discussed potential remedial alternatives, metrics for evaluating performance of corrective actions, and the need for additional monitoring wells in the Floridan aquifer.

Kelsey believes remediation will be limited by deliverability issues, i.e., those related to the permeability of the Hawthorn Group sediments, and is interested to know if GRU can suggest any alternatives not previously identified.

GRU believes that hydraulic containment in Floridan will provide the most predictable and effective alternative to protect Floridan.
Ed Bates believes that something needs to be done in Floridan now. We need to start cleaning what you know to be contaminated now.
EPA and DEP agree that containment needs to be further evaluated and compared in Feasibility Study.

The focus on groundwater extraction from the Floridan could take one of two approaches:
1. concentrate on known 'hot-spots" or
2. full site containment.

Focusing on capturing contaminated groundwater at hot spots will require additional Floridan characterization – to identify the bounds of the contaminant plumes.

Additional Floridan Wells:
Bill OSteen confirmed that there is a need for more Floridan wells but where and when should they be installed?

Ed Bates suggested that well clusters #29 and #30 (see page 97 of the presentation) may be an issue regarding drilling through the LHG clay. John Mousa stated that these wells are a high priority for ACEPD.

Bill OSteen: One issue that remains unresolved –

1. Are additional Floridan wells needed to define the leading edge of plume and conditions at interior points of compliance; or
2. Do wells already demonstrate an out-of-compliance situation in which case active remediation is needed now?

Additional wells will follow remediation. EPA has not yet defined the points of compliance.

Kelsey stated that any selected alternative:

1. Must meet Natural Attenuation Default Criteria (NADC) at all locations
2. Must include interior compliance points to meet NADCs.
3. Must also, at a minimum, meet GCTLs at property boundary.

FDEP can grant a temporary offsite Points of Compliance (POC) with the agreement that the PRP will pull the plume back onsite. That temporary POC would require institutional controls. The PRP must secure agreement from all landowners affected before FDEP will agree to the temporary POC.

Kelsey Helton stated that it must be demonstrated geochemically that MNA will work before FDEP will agree to allow that.

Cabot Site

John Herbert briefly presented information relative to the state of knowledge at the Cabot Site and the need for additional characterization at that site.

PROTECTION OF THE MURPHREE WELL FIELD

GRU Concerns Regarding Progress on the FS
for the Koppers Site
Presentation to USEPA August 28, 2008, Atlanta, GA

Topics to be Discussed:

- Purpose of this Meeting
- Review of Site Conceptual Model and Extent of Contamination
- DNAPL Mobility
- Floridan Aquifer Monitoring Results
- Remedial Alternatives
- Performance Monitoring and Metrics
- Cabot-Carbon Site

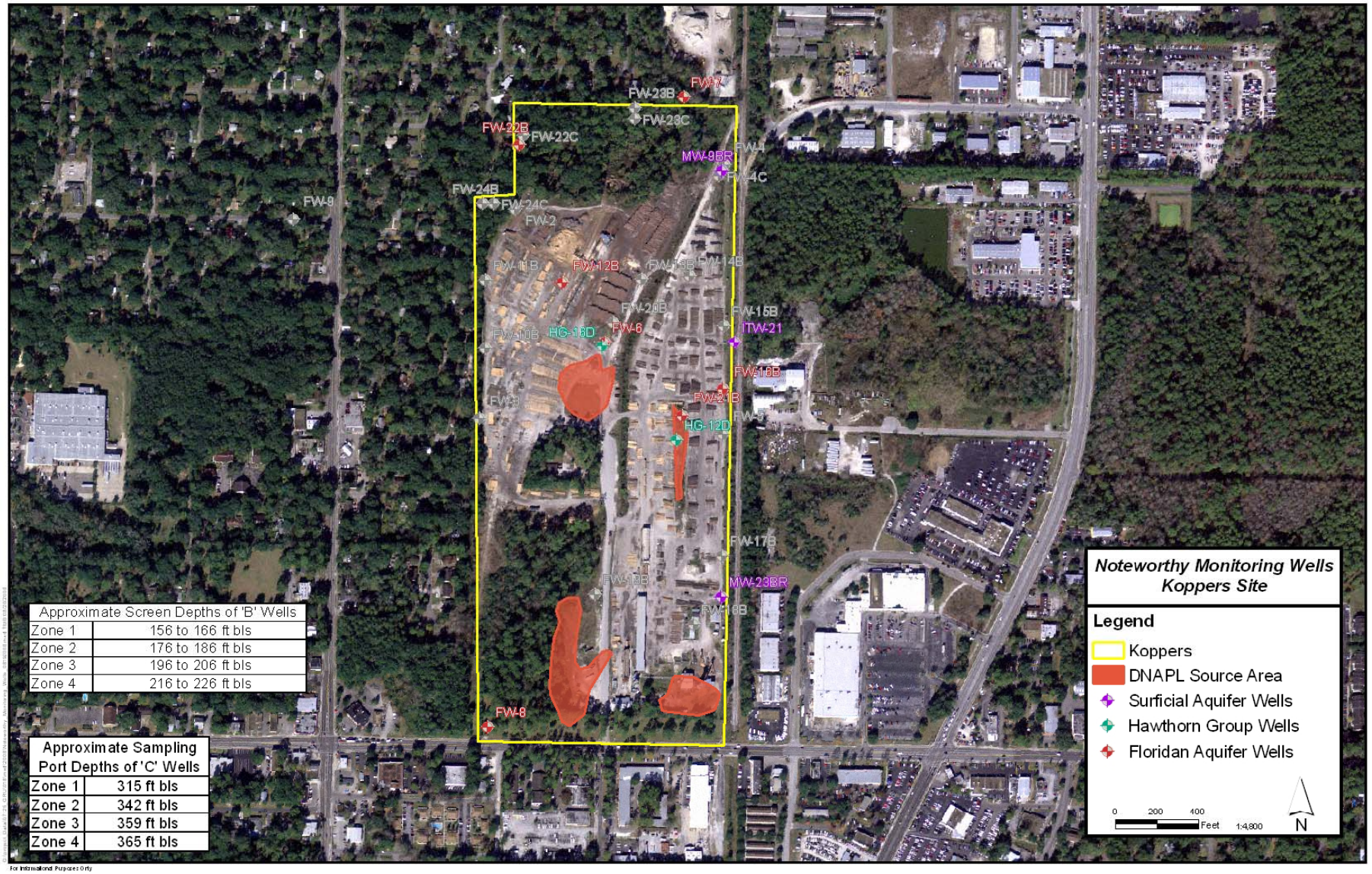
Primary Points:
Site Conceptual Model Incomplete

- Lateral extent of DNAPL zones not fully defined.
- Potentially mobile DNAPL in all strata.
- Off-site migration of Koppers contaminants in all strata.
- Contaminants in Floridan from DNAPL and/or groundwater migration via natural pathways.

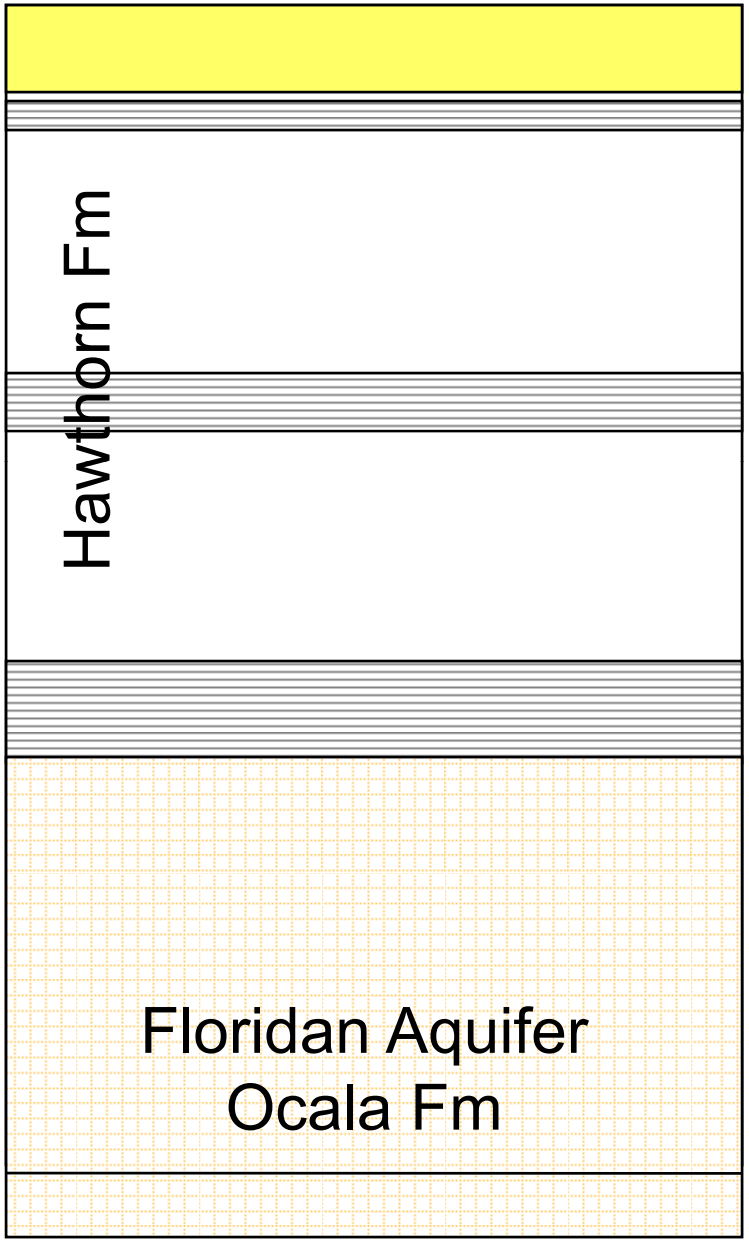
Primary Points:
Limitations of Remedial Alternatives

- Huge uncertainty in effectiveness, feasibility of in situ remedial technologies in Hawthorn.

- Hydraulic containment in Floridan most predictable and effective alternative to protect Floridan.


FW-23B
FW-7
FW-23C
FW-22B
FW-22C
MW-9BR
FW-4
FW-4C
FW-24B
FW-24C
FW-9
FW-2
FW-11B
FW-12B
FW-13B
FW-14B
FW-20B
FW-15B
ITW-21
FW-10B
HG-16D
FW-6
FW-16B
FW-21B
FW-3
FW-5
HG-12D
FW-17B
FW-19B
MW-23BR
FW-18B
FW-8
Approximate Screen Depths of 'B' Wells
Zone 1 156 to 166 ft bls
Zone 2 176 to 186 ft bls
Zone 3 196 to 206 ft bls
Zone 4 216 to 226 ft bls
Approximate Sampling Port Depths of 'C' Wells
Zone 1 315 ft bls
Zone 2 342 ft bls
Zone 3 359 ft bls
Zone 4 365 ft bls
Noteworthy Monitoring Wells
Koppers Site
Legend
Koppers
DNAPL Source Area
Surficial Aquifer Wells
Hawthorn Group Wells
Floridan Aquifer Wells
0 200 400
Feet
1:4,800
N
For Informational Purposes Only

Site Conceptual Model: Geology



Surficial Aquifer

3’-10’ Upper Clay

5’-20’ Middle Clay

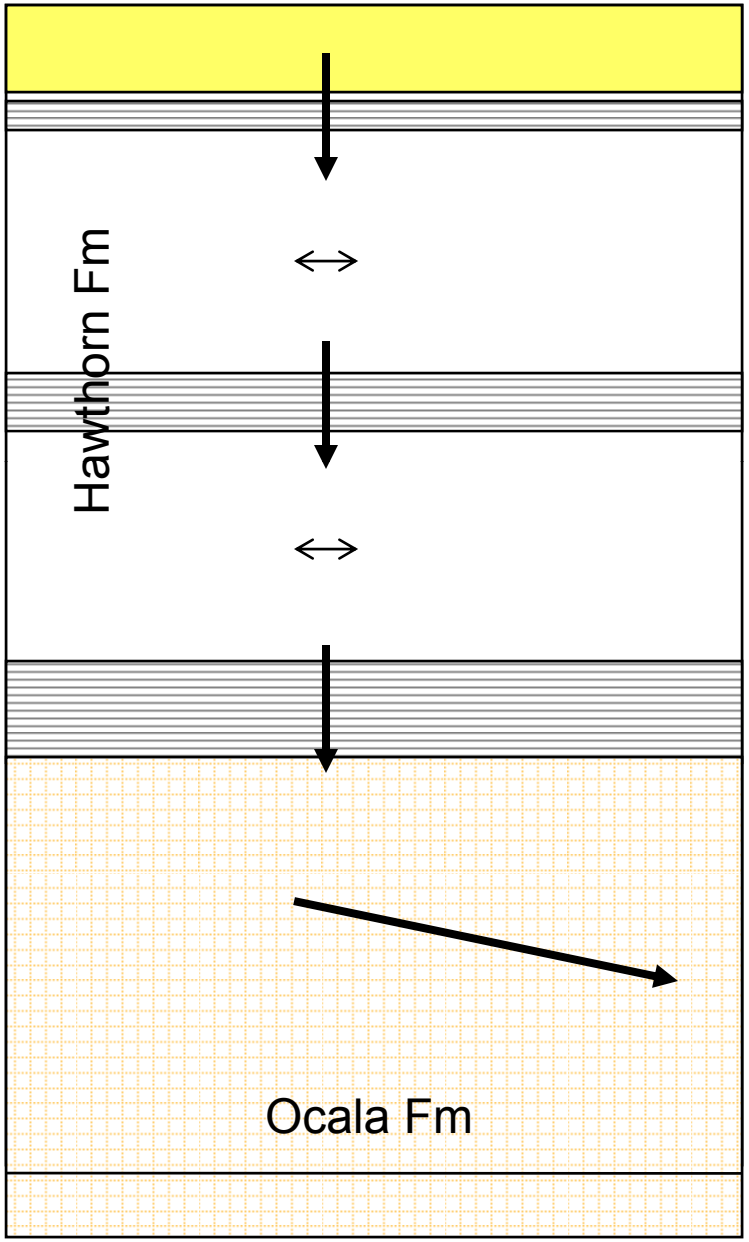
20’-38’ Lower Clay

~100’ Upper Transmissive Zone

Semi-Confining Unit?

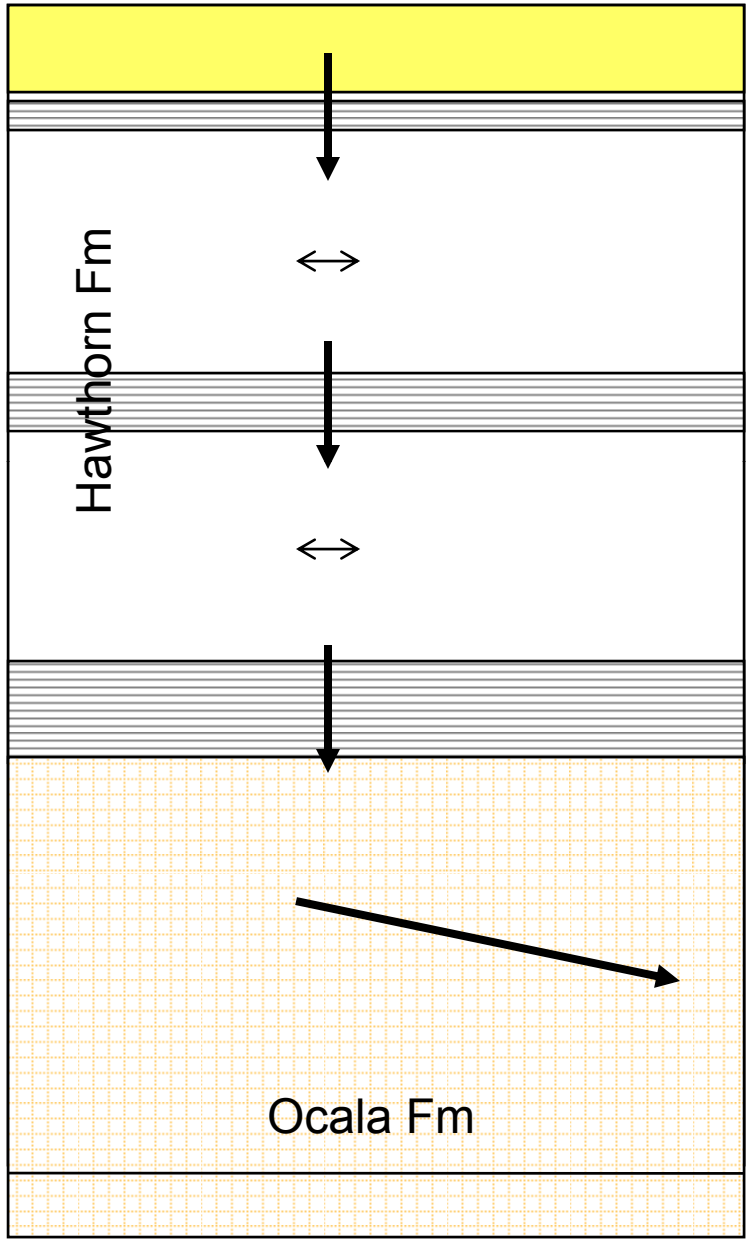
Lower Transmissive Zone

Site Conceptual Model: Flow Pathways



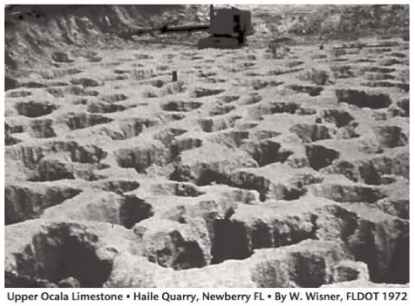
Fissures/ bioturbation	Visual evidence in cores
Solution pipes/ channels	Evident from loss of Circulation in FW-wells
Fractures/solution channels	Evident as water-bearing zones in Murphree wells

Site Conceptual Model: Flow Pathways



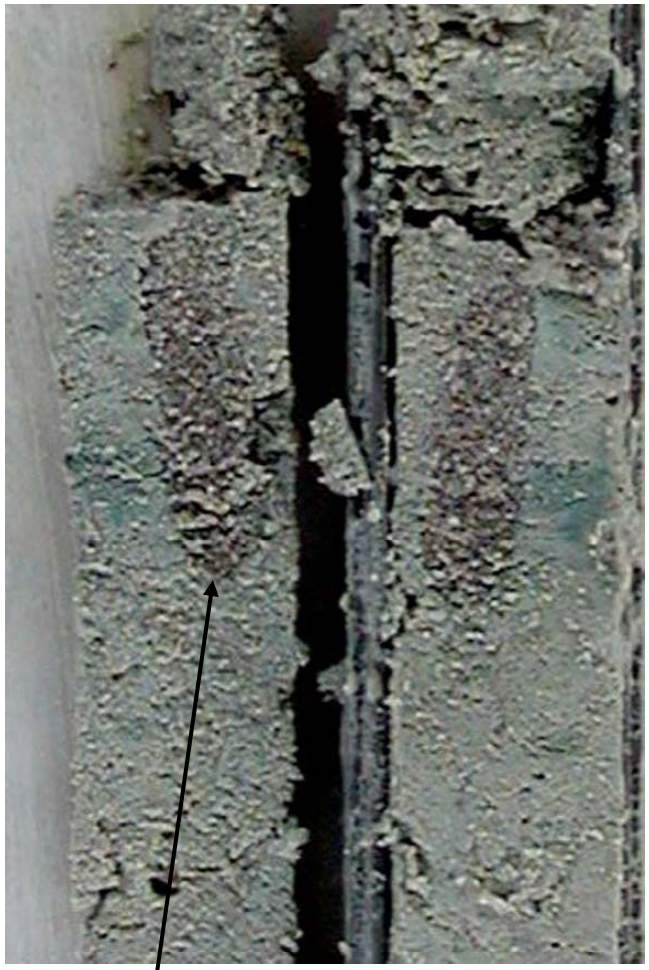
Fissures/ bioturbation

Solution pipes/ channels



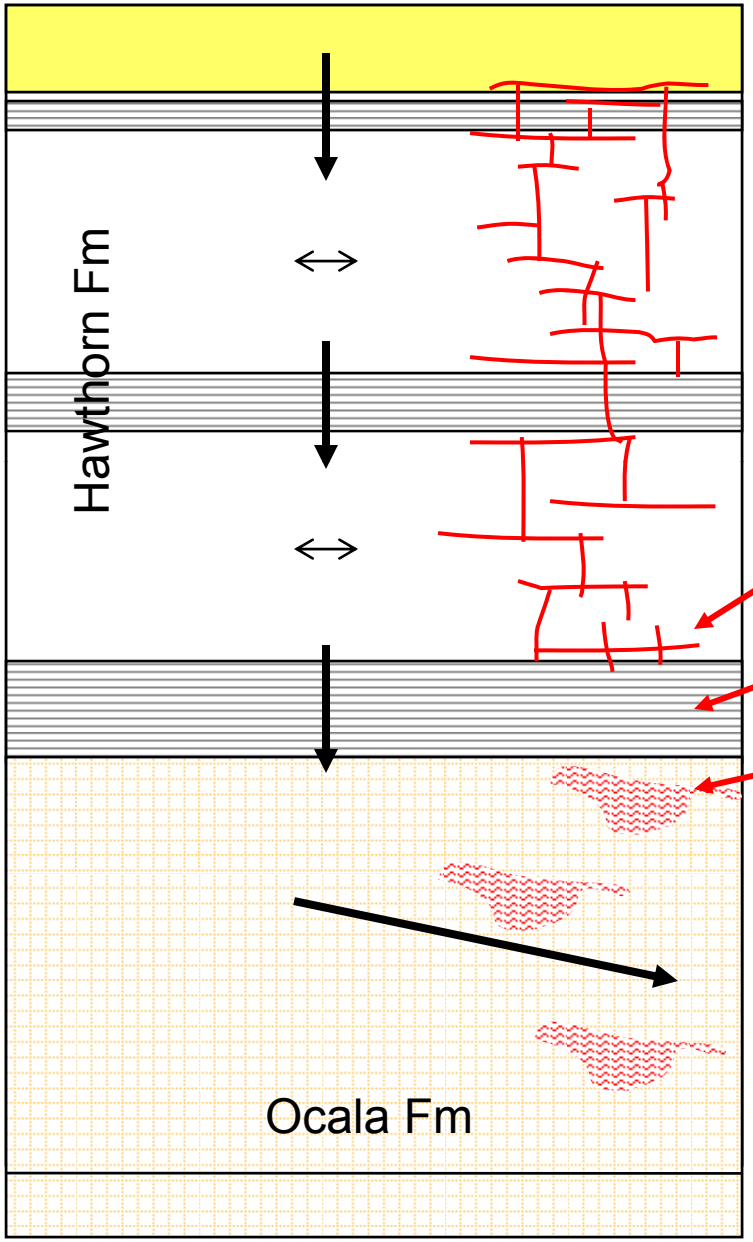
Fractures/solution channels

NAPL staining, in Upper Clay,
CPT-60s 23’



Bioturbation, HG-9S 48’-50’
In Clayey Sand: “2-in long by 1/2-in diameter vertical ‘wormtube?’ infilled with medium-coarse-grained sand”

Site Conceptual Model: Creosote Pathways



Fissures/ bioturbation

Visible as creosote migration pathways as deep as Lower Clay

Creosote probable in Lower Clay also

Evidence of creosote in Floridan GW concentrations (>10% eff. solubility FW-6) (~5% eff. solubility FW-12B deepest zones)

Solution pipes/ channels

Fractures/solution channels

Descriptions of bioturbation or vertical wormtubes are common in Hawthorn:

HG-9S	49’-50’ in clayey sand
HG-10D	99’-101’ in sand (creosote)
HG-12S	45’-47’ in clayey sand (creosote)
HG-12D	68’-70’ in clay
HG-15S	60’-62’ in silty sand
HG-16S	43’-47’ in sand

They must be abundant in Upper Hawthorn to be encountered so frequently in vertical borings.

No reason to believe absent in Lower Hawthorn.

Matrix of Ocala Fm limestone

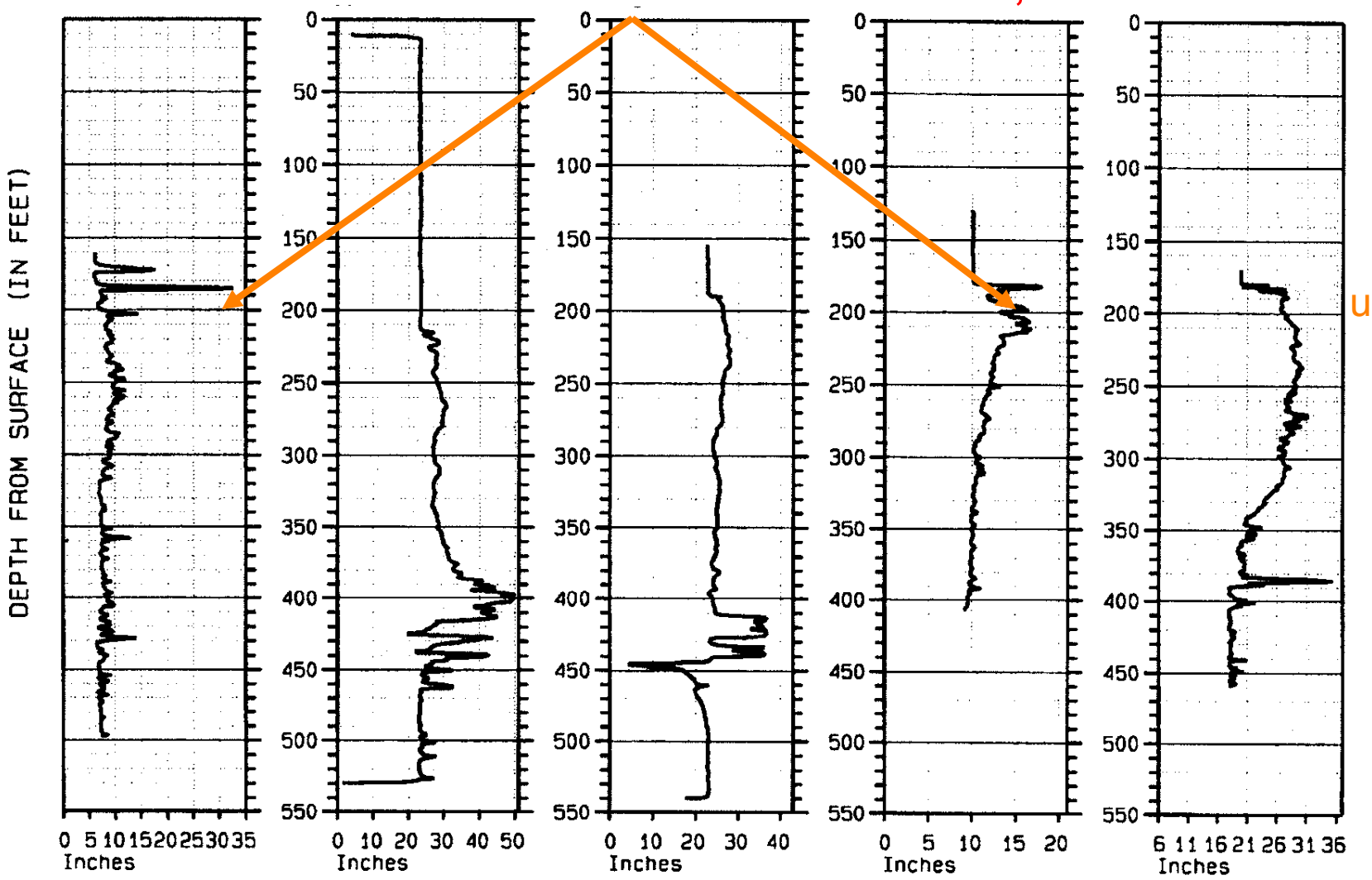
Solution pipes at top of Ocala Fm, Haile Quarry

Upper Ocala Limestone • Haile Quarry, Newberry FL • By W. Wisner, FLDOT 1972

Solution pipes and possible channels, Haile Quarry

Possible solution channels, Upper Ocala Fm, Haile Quarry

Probable solution cavities in some wells, not others



Caliper logs from Murphee wells

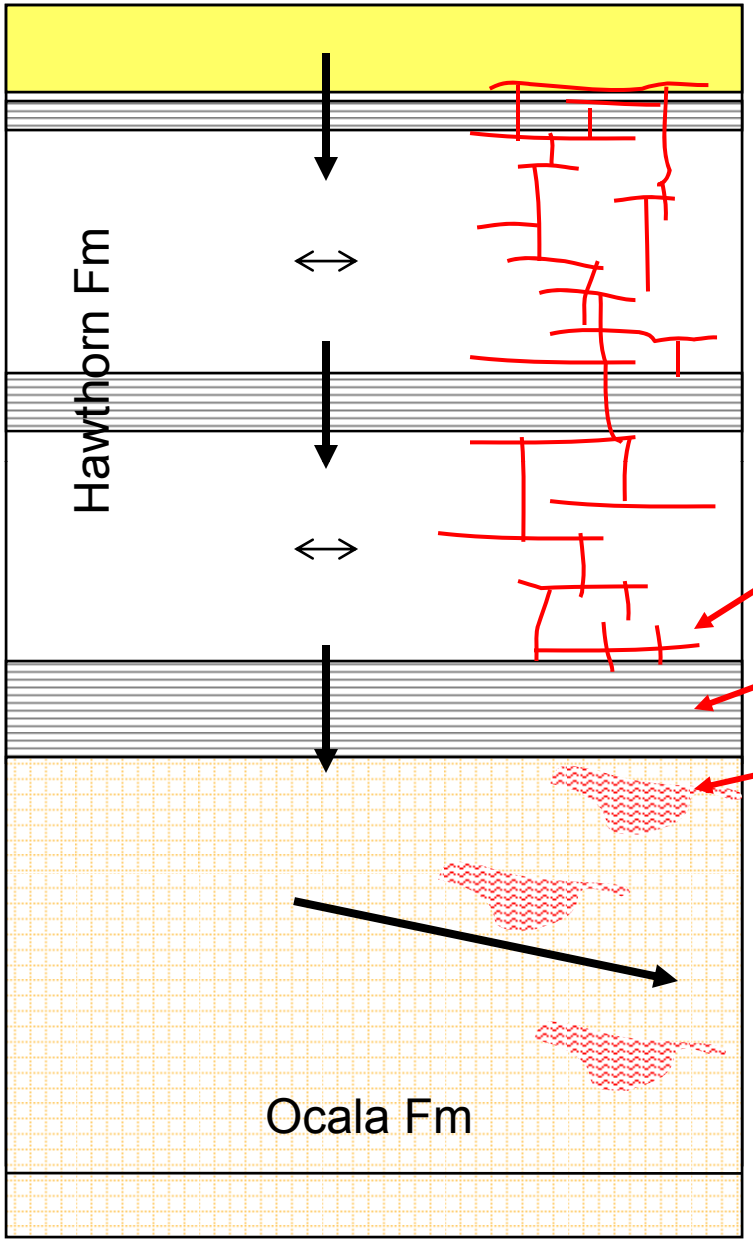
Sonic Core, Upper Ocala, FL-28D

- This sonic core has an oatmeal-like consistency similar to that observed at the Koppers site.
- FL-28D is located essentially in the southeast corner of the Murphree Well Field.

Conclusions:

- Fissures/bioturbation are vertical flow pathways through the clay units of the Hawthorn Fm.
- Upper clay and middle clay are not barriers to creosote or groundwater flow.
- Lower clay not expected to be a barrier.
- Floridan is karstic.
- Fractures/solution channels are flow pathways.

Site Conceptual Model: Creosote Pathways



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Creosote probable in Lower Clay also.

Evidence of creosote in Floridan GW concentrations (>10% eff. solubility FW-6) (~5% eff. solubility FW-12B deepest zones).

Solution pipes/ channels

Fractures/solution channels

Nature and Extent of Contamination:

- Principal sources of dissolved plumes are the DNAPL zones, potentially mobile and residual.
- DNAPL is potentially mobile in Surficial, Upper Hawthorn, Lower Hawthorn, maybe Floridan.
- Lateral extent of DNAPL zones have not been fully defined (particularly in Upper and Lower Hawthorn).

Nature and Extent of Contamination:

- Contamination in Floridan originates from dissolved plume and/or DNAPL migration through Lower Hawthorn.
- Contamination in FW-6 and FW-21B not likely due to “drag-down” or borehole leakage.
- Contamination in FW-12B not likely due to “drag-down” or borehole leakage.

Evidence of DNAPL Presence:

- Sustained recovery from wells.
- Initial recovery from wells.
- Free-product observed in soil cores.
- Staining observed in soil cores.
- Soil concentrations above threshold estimated from chemical partitioning calculations.
- Groundwater concentration above % effective solubility criterion (EPA value 1%).

Evidence of Potentially Mobile DNAPL Presence at a Well or Boring:

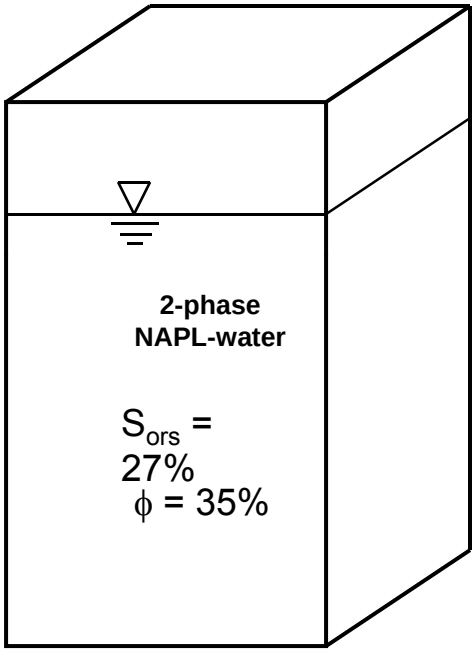
- Sustained recovery from wells (certain presence).
- Initial recovery from wells (very likely presence).
- Free-product observed in soil cores (very likely presence).
- Staining observed in soil cores (unlikely presence).
- Groundwater concentration above % effective solubility criterion (EPA value 1%) (cannot be determined).

Evidence of Potentially Mobile DNAPL Presence at a Well or Boring:

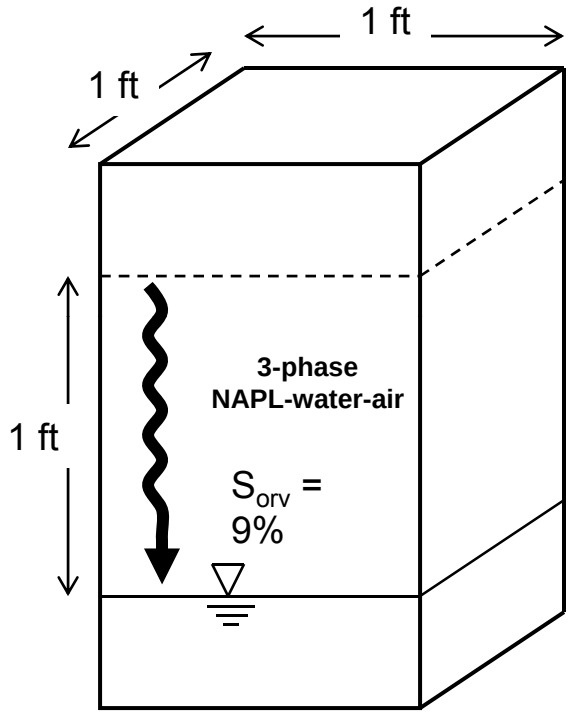
- Sustained DNAPL recovery from a well cannot be the sole indicator of potentially mobile DNAPL.

- Fluid properties and geologic variability mean that in many (most?) circumstances potentially mobile DNAPL will not be recoverable in wells.

Vertical drainage due to pumping PW-1



high water table



low water table

½ gallon of DNAPL drains per cubic foot
Or 63 L/m^3

Mobility of Creosote DNAPL Below the Water Table

- In a two-phase system the Darcy flux of water and oil (creosote) flow is controlled by the relative permeability functions, k_{rw} and $k_{ro,}$ and the viscosity difference between oil and water :

$$q_w = -\frac{kk_{rw}}{\mu_w} A \frac{\Delta p_w}{\Delta L} \qquad q_o = -\frac{kk_{ro}}{\mu_o} A \frac{\Delta p_o}{\Delta L}$$

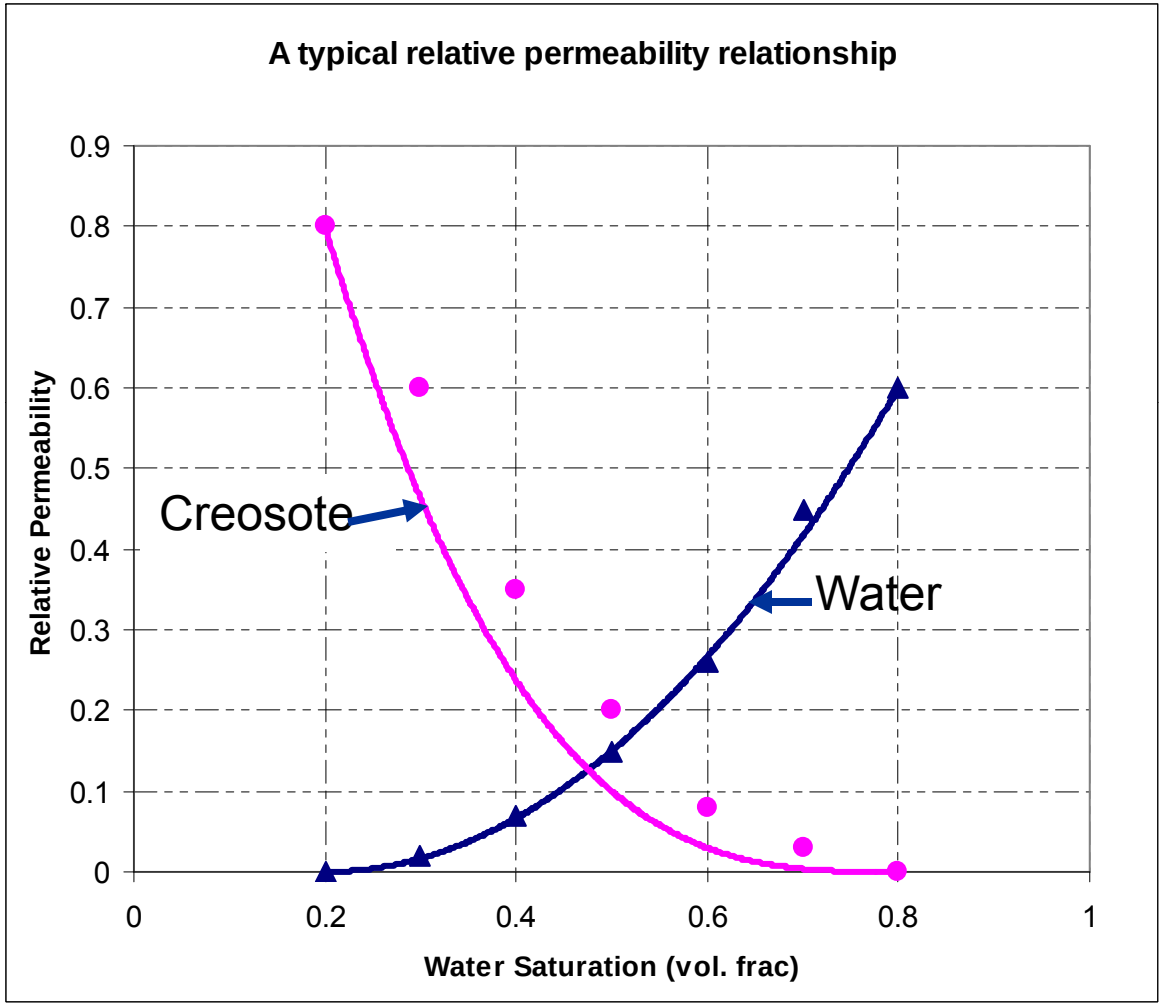
Physical Properties of Koppers Creosote

- Average Specific gravity: 1.088 (60ºF)
- Kinematic Viscosity: 4.6 -- 23 cSt (40ºC)
  - Convert to absolute or dynamic viscosity
  - Adjust temperature to 20-25ºC
  - Absolute viscosity range = 10-50 cp
  - Assume avg. absolute viscosity = **25 cp**
  - That is, Koppers creosote is, conservatively, 20-30 times as viscous as ground water.

Effect of high viscosity

$$q_o = -\frac{k k_{ro}}{\mu_o} A \frac{\Delta p_o}{\Delta L}$$

If μ_o = 25 cp, creosote flux is low relative to gw flux and k_{ro} will decline, all other conditions being equal


A typical relative permeability relationship
Relative Permeability
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Creosote
Water
0
0.2
0.4
0.6
0.8
1
Water Saturation (vol. frac)

Effect of lowered k_{ro}

$$q_o = -\frac{k k_{ro}}{\mu_o} A \frac{\Delta p_o}{\Delta L}$$

Therefore $k_{ro}/\mu_o \div k_{rw}/\mu_w \ll 1$,

and $q_w \gg q_o$

Consequently creosote can still be mobile in the HG but its viscosity and relative permeability will slow its flow relative to ground water and into wells.

P_e: Entry Pressure

- P_e = the capillary pressure required to overcome the resistance to penetration of sediments by DNAPL and of silts within the well screen

- P_{DNAPL} = the pressure head of DNAPL due to a continuously connected zone of creosote from shallow aquifer to some MW screen

- Criterion to enter MW: $P_{DNAPL} > P_e(MW)$

Pressure head on the Lower HG clay

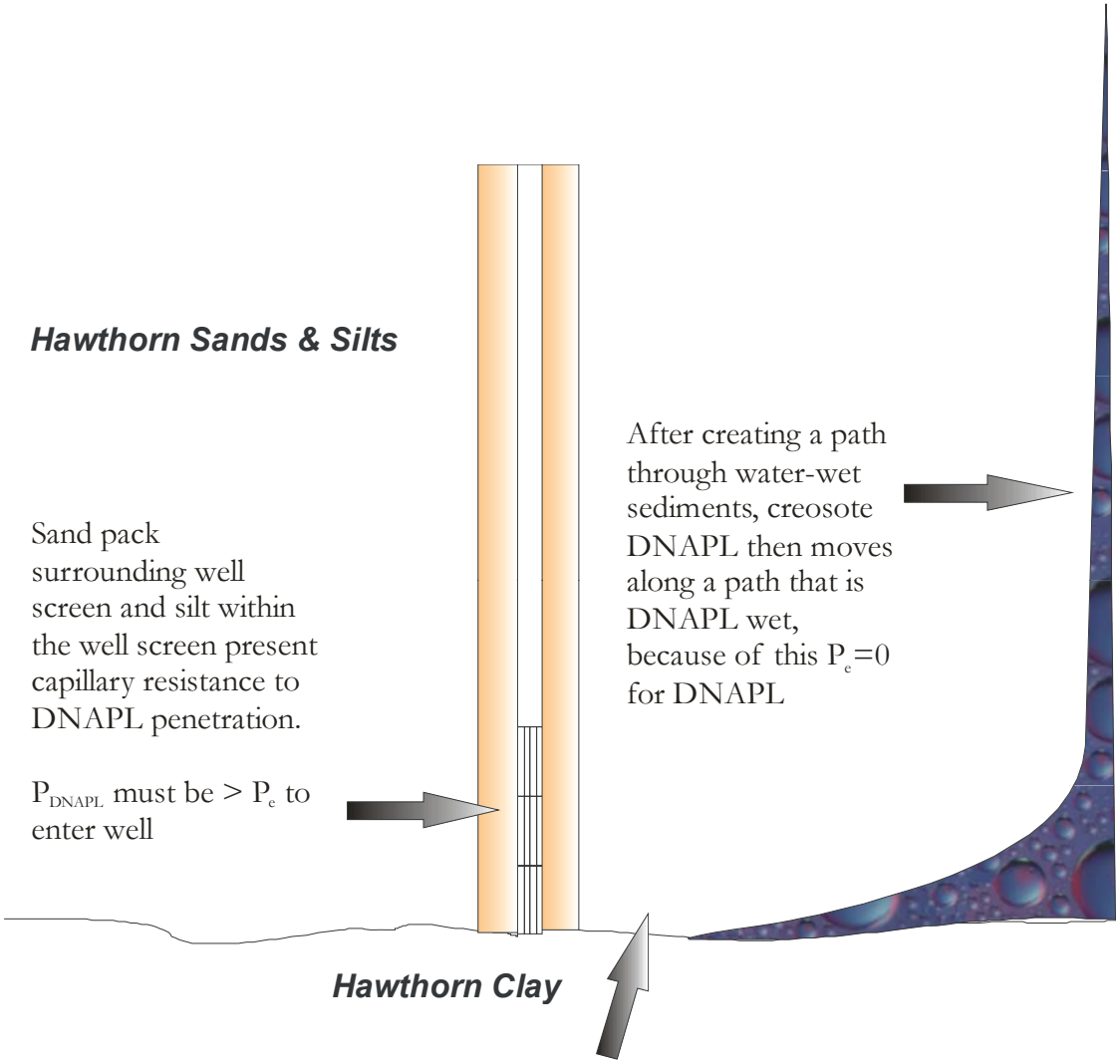
The depth from the Surficial aquifer to the top of the LHG clay is ~ 30 meters, therefore

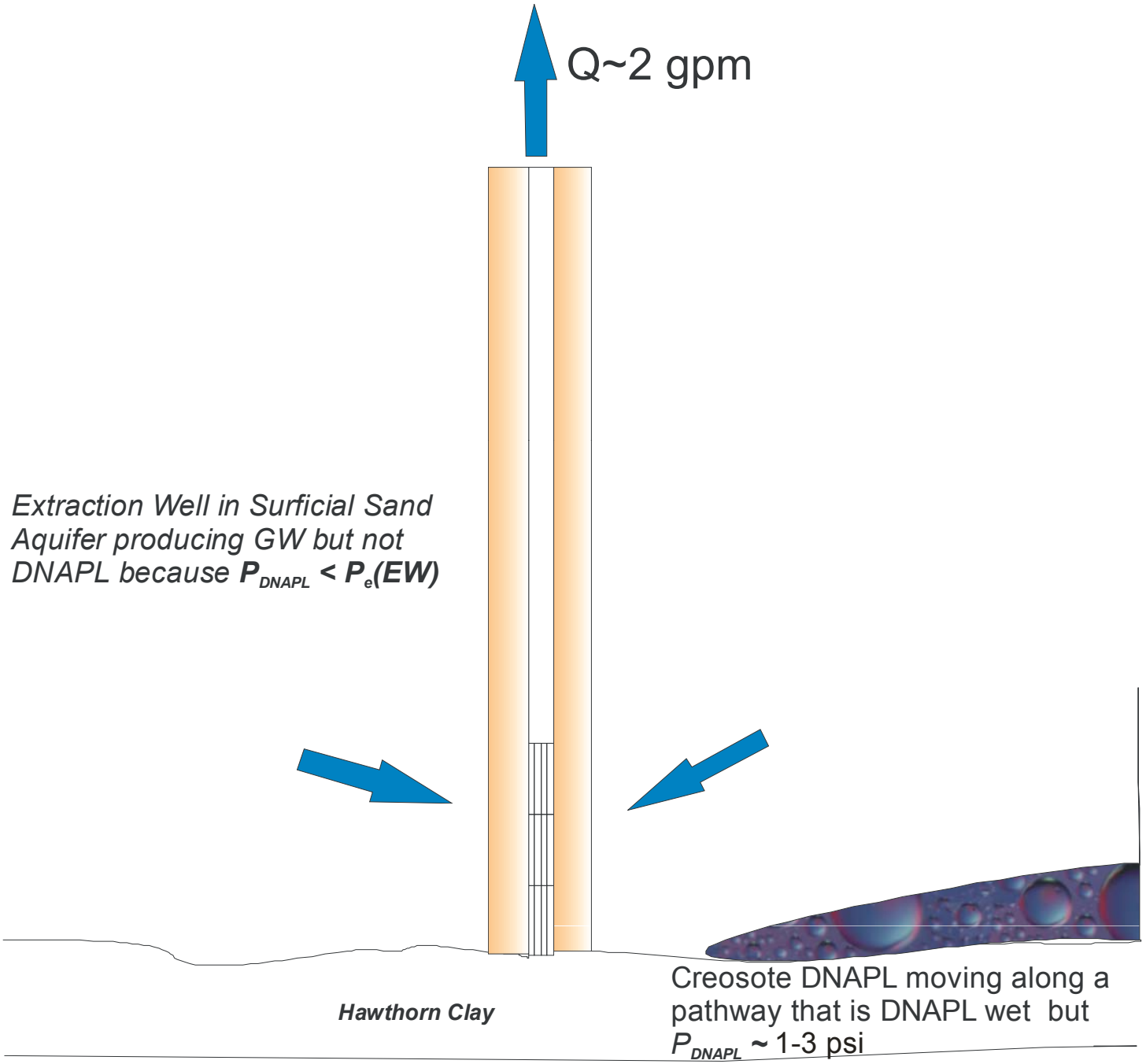
$$P = \frac{1.1kg/L \cdot 1000L/m^3 \cdot 9.8m/s^2 \cdot 30m \cdot cm^2}{cm^2} =$$

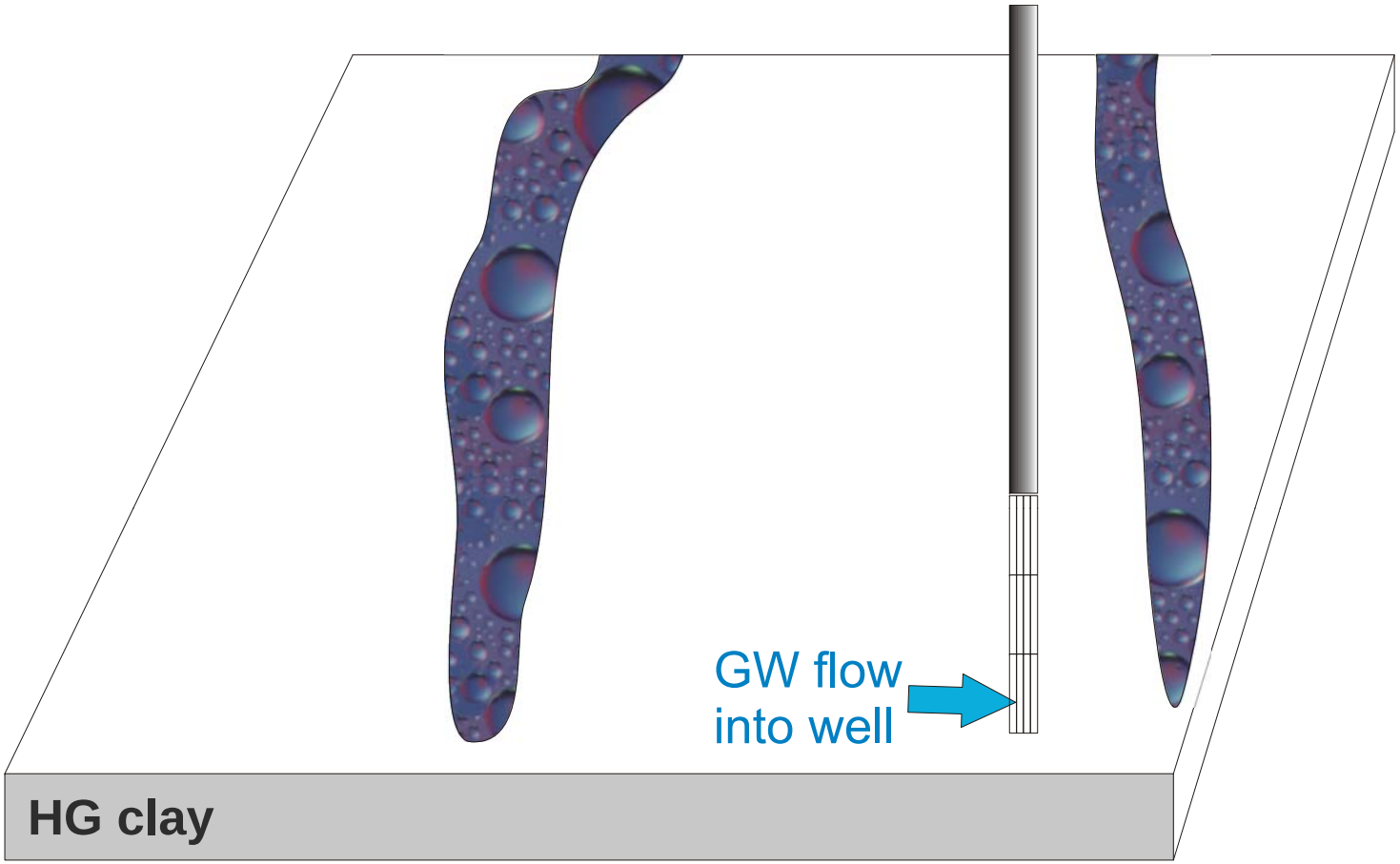
$$P = \frac{330{,}000kg}{m \cdot s^2} \cdot \frac{N}{kg \cdot m/s^2} = \frac{330{,}000N}{m^2} = 330kPa$$

Creosote in monitoring wells

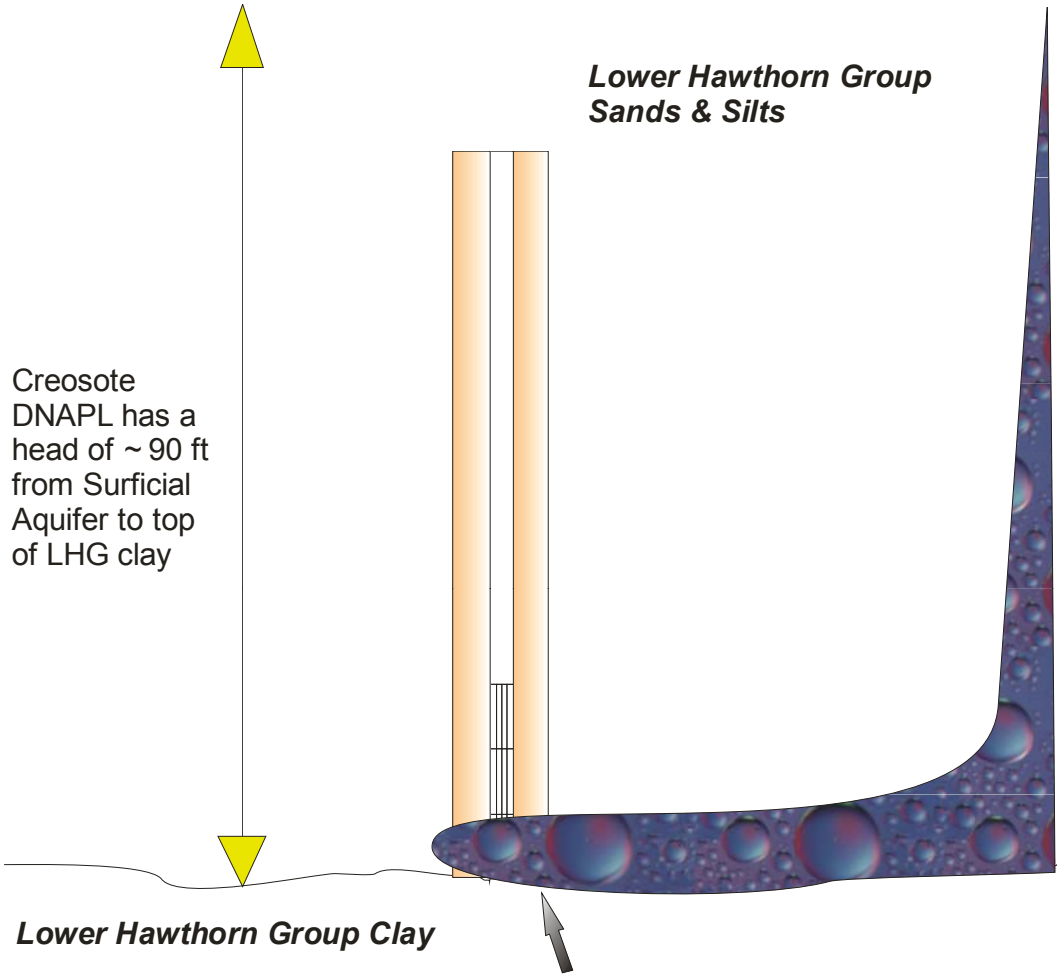
- Creosote DNAPL will tend follow a path in the subsurface that it has already wetted because the entry pressure (P_e) along that path is zero, P_e=0 psi.
- If you put in a well near mobile creosote, the creosote has to overcome the P_e of the new path to that well screen.
- $P_{DNAPL} = \rho gh$,
  - ρ=1.1 kg/L
  - h=90 ft from Surficial Aq to base of LHG
  - h=2-3 ft at base of Surficial Aq

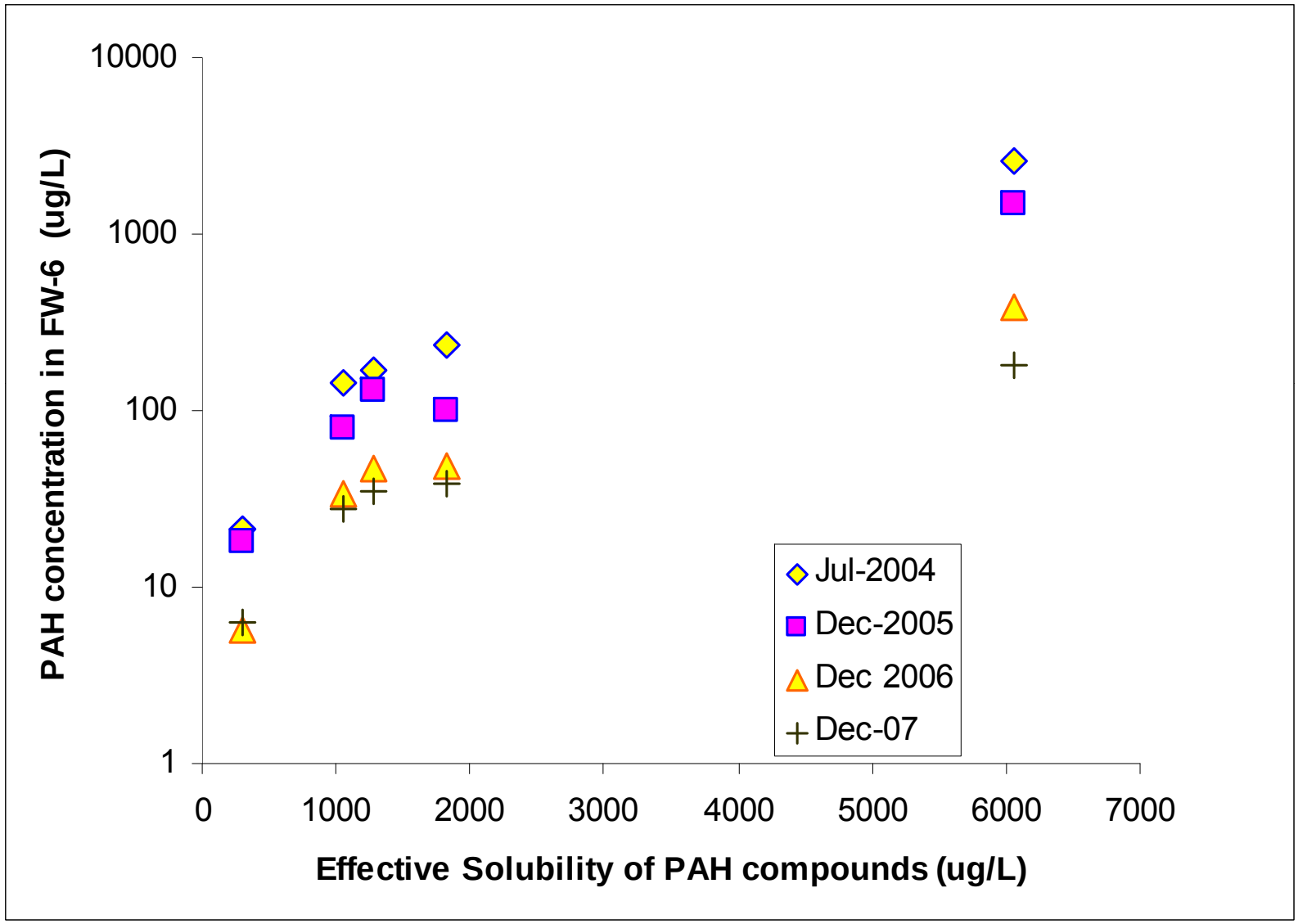

Hawthorn Sands & Silts
Sand pack surrounding well screen and silt within the well screen present capillary resistance to DNAPL penetration.
P_{DNAPL} must be > P_e to enter well
After creating a path through water-wet sediments, creosote DNAPL then moves along a path that is DNAPL wet, because of this P_e=0 for DNAPL
Hawthorn Clay
Water wet sediments present capillary resistance to DNAPL migration. To penetrate them, P_{DNAPL} must be > P_e


Q~2 gpm
Extraction Well in Surficial Sand Aquifer producing GW but not DNAPL because $P_{DNAPL} < P_e(EW)$
Hawthorn Clay
Creosote DNAPL moving along a pathway that is DNAPL wet but P_{DNAPL} ~ 1-3 psi

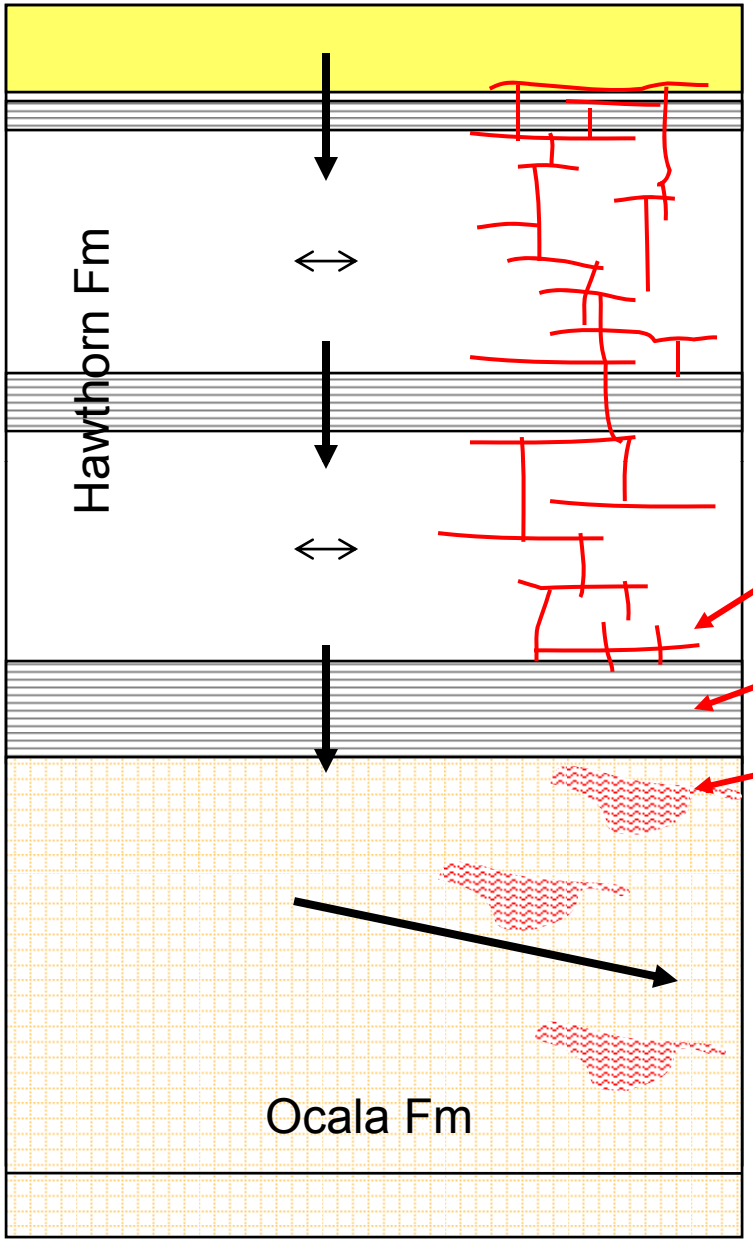


DNAPL migration along the top of the Hawthorn Group Clay will follow a path of least capillary resistance, e.g., an old stream channel containing high perm sediments, and not necessarily flow into a well.


Lower Hawthorn Group
Sands & Silts
Creosote
DNAPL has a
head of ~ 90 ft
from Surficial
Aquifer to top
of LHG clay
Lower Hawthorn Group Clay
P_{DNAPL}~50 psi,
Because P_e<P_{DNAPL},
Well is penetrated
by DNAPL


10000
1000
100
10
1
PAH concentration in FW-6 (ug/L)
0
1000
2000
3000
4000
5000
6000
7000
Effective Solubility of PAH compounds (ug/L)
Jul-2004
Dec-2005
Dec 2006
Dec-07

Site Conceptual Model: Creosote Pathways



Fissures/
bioturbation

Visible as creosote migration pathways as deep as Lower Clay

Creosote probable in Lower Clay also

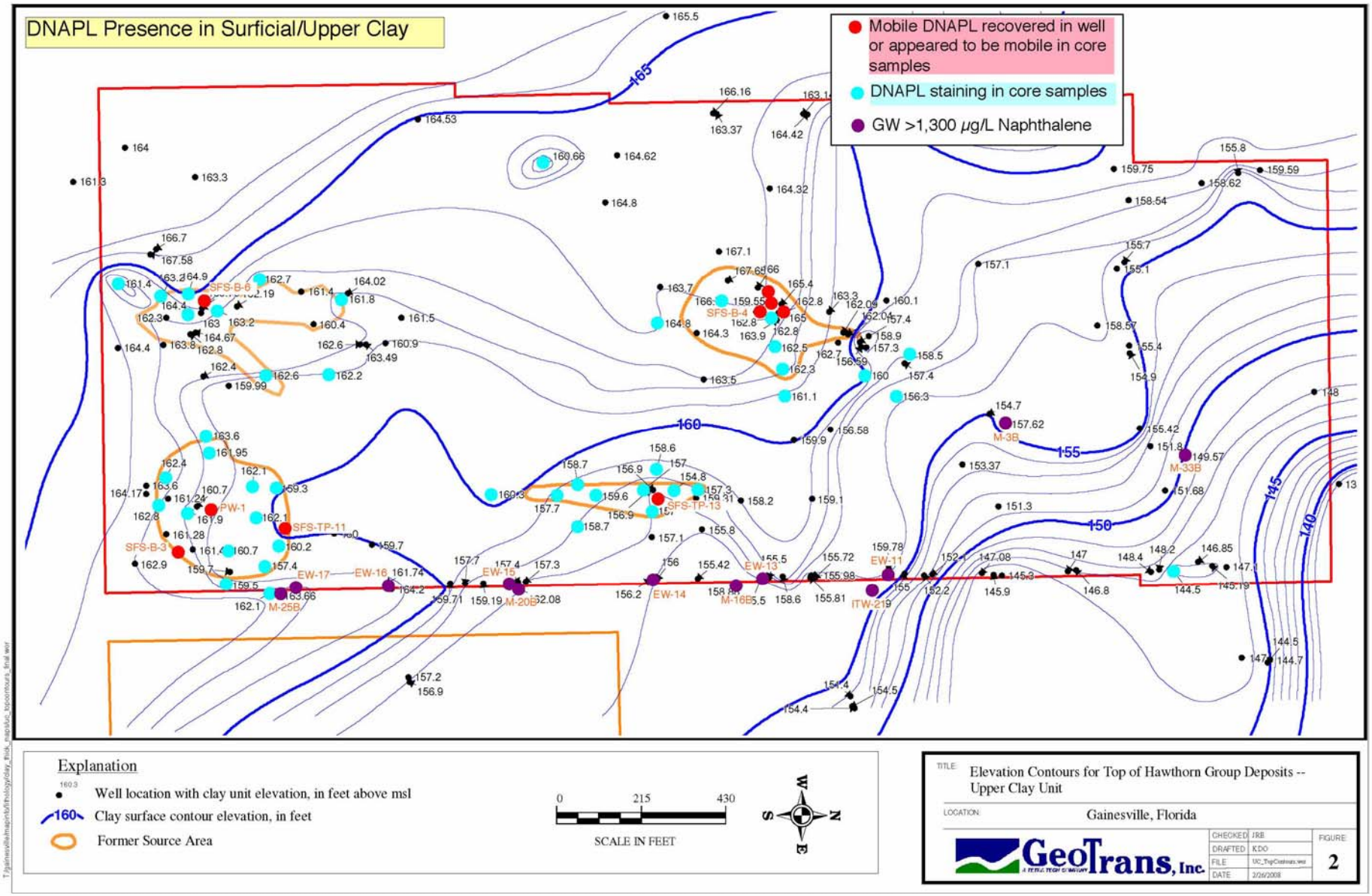
Evidence of creosote in Floridan GW concentrations (>10% eff. solubility FW-6) (~5% eff. solubility FW-12B deepest zones)

DNAPL Presence at Koppers Site:

From examination of field notes, boring logs, well sampling records, and groundwater chemistry:

- Potentially mobile and residual DNAPL in Surficial.
- Potentially mobile and residual DNAPL in Upper Hawthorn.
- Potentially mobile and residual DNAPL in Lower Hawthorn.
- DNAPL in Floridan, mobility not determined.

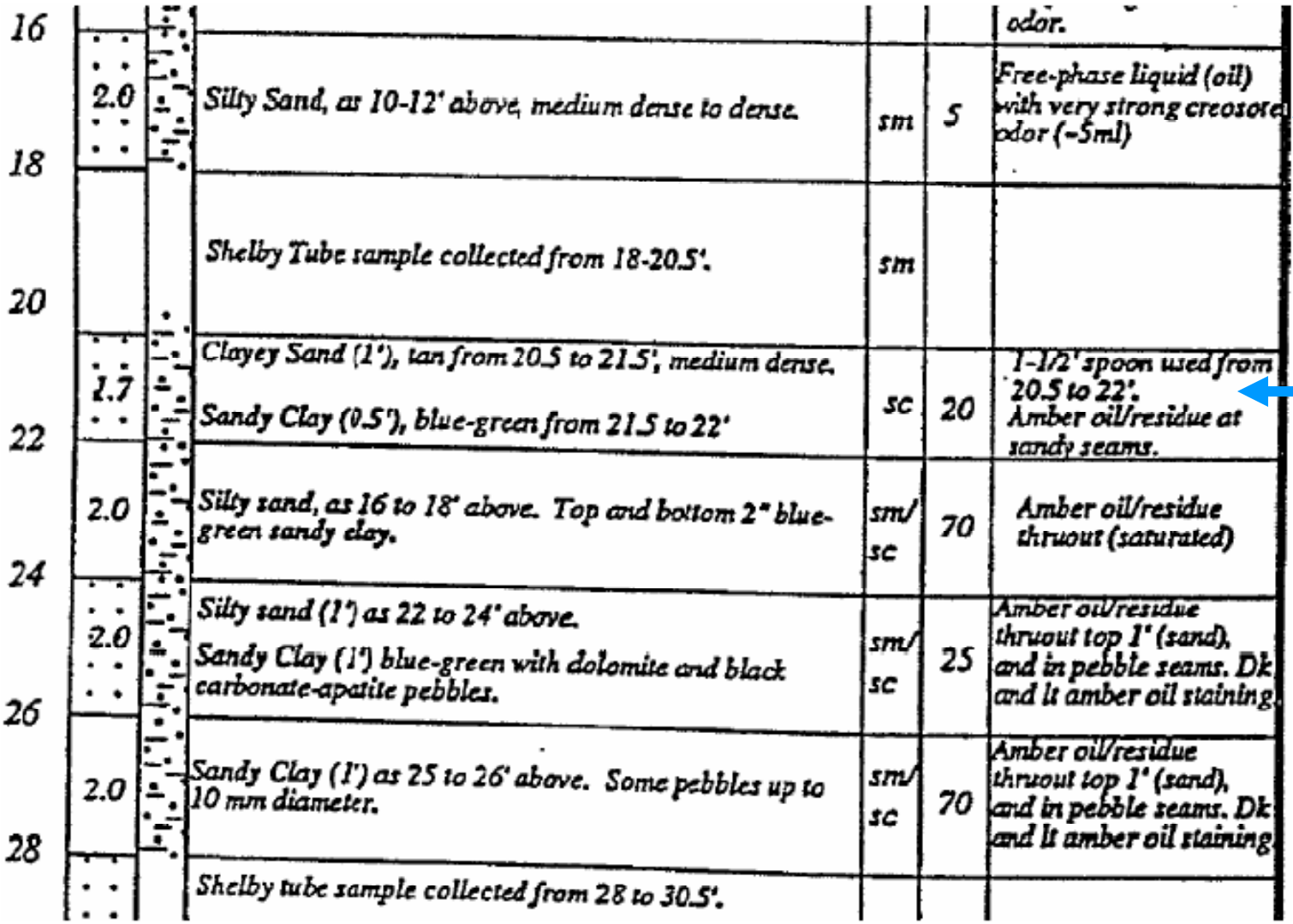
Lateral extent of DNAPL zones have not been fully defined (particularly in Upper and Lower Hawthorn).



Potentially mobile DNAPL present
Source Zones larger than depicted by Beazer

Modified from Figure 2, GeoTrans, Inc. April 2, 2008.
Response to Recommendation 6.

SFS-B4, Fmr. North Lagoon, August 1995



16		odor.		
2.0	Silty Sand, as 10-12' above, medium dense to dense.	sm	5	Free-phase liquid (oil) with very strong creosote odor (~5ml)
18				
	Shelby Tube sample collected from 18-20.5'.	sm		
20				
1.7	Clayey Sand (1'), tan from 20.5 to 21.5', medium dense.	sc	20	1-1/2' spoon used from 20.5 to 22'. Amber oil/residue at sandy seams.
22	Sandy Clay (0.5'), blue-green from 21.5 to 22'			
2.0	Silty sand, as 16 to 18' above. Top and bottom 2" blue-green sandy clay.	sm/ sc	70	Amber oil/residue thruout (saturated)
24				
2.0	Silty sand (1') as 22 to 24' above. Sandy Clay (1') blue-green with dolomite and black carbonate-apatite pebbles.	sm/ sc	25	Amber oil/residue thruout top 1" (sand), and in pebble seams. Dk and lt amber oil staining.
26				
2.0	Sandy Clay (1') as 25 to 26' above. Some pebbles up to 10 mm diameter.	sm/ sc	70	Amber oil/residue thruout top 1" (sand), and in pebble seams. Dk and lt amber oil staining.
28				
	Shelby tube sample collected from 28 to 30.5'.			

Mobile DNAPL

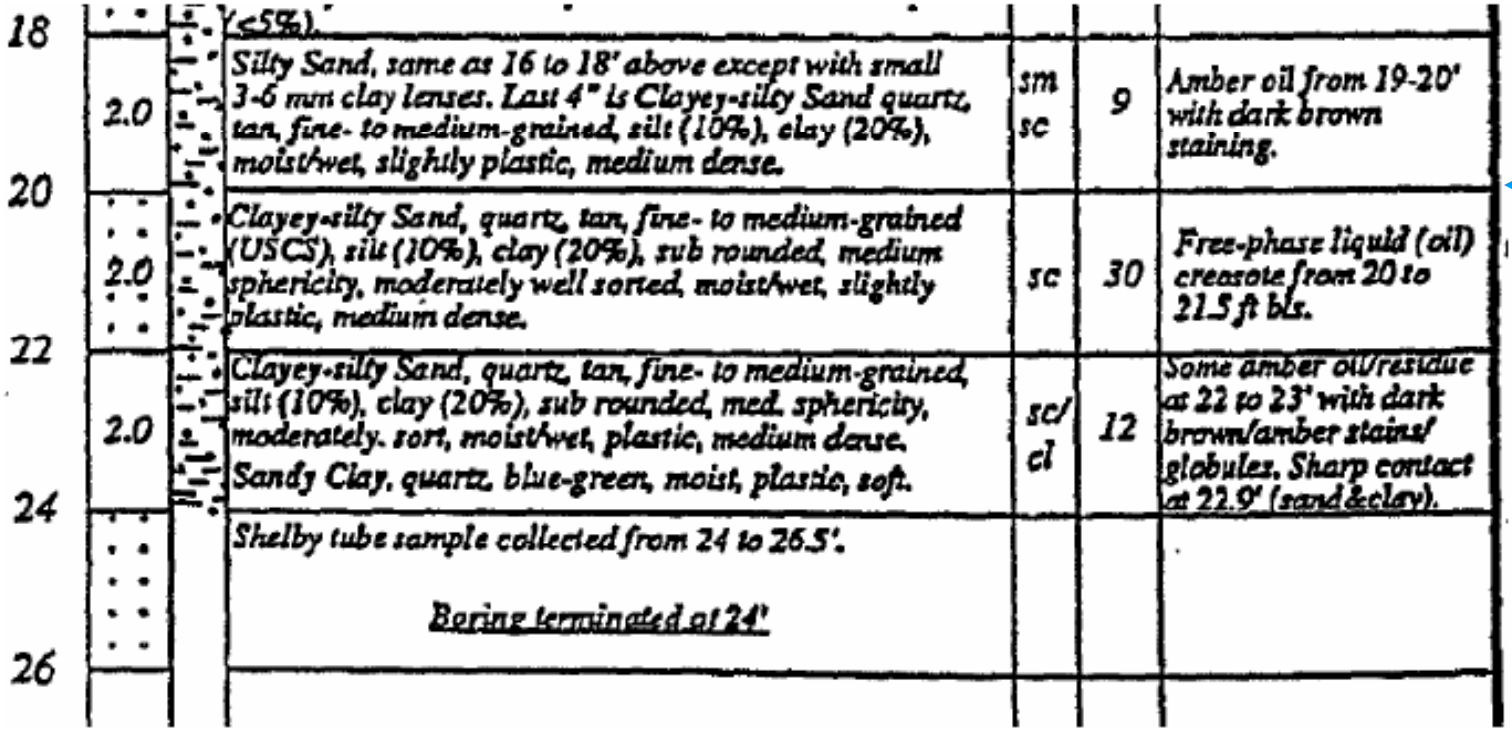
Sample from 22.5 ft

DNAPL present throughout sand/clay contact

Log from Supplemental Feasibility Study, 1995 by TRC

SFS-B6,

Fmr. South Lagoon, August 1995



18		(≤5%).			
	2.0	Silty Sand, same as 16 to 18' above except with small 3-6 mm clay lenses. Last 4" is Clayey-silty Sand quartz, tan, fine- to medium-grained, silt (10%), clay (20%), moist/wet, slightly plastic, medium dense.	sm sc	9	Amber oil from 19-20' with dark brown staining.
20	2.0	Clayey-silty Sand, quartz, tan, fine- to medium-grained (USCS), silt (10%), clay (20%), sub rounded, medium sphericity, moderately well sorted, moist/wet, slightly plastic, medium dense.	sc	30	Free-phase liquid (oil) creasote from 20 to 21.5 ft bls.
22	2.0	Clayey-silty Sand, quartz, tan, fine- to medium-grained, silt (10%), clay (20%), sub rounded, med. sphericity, moderately. sort, moist/wet, plastic, medium dense. Sandy Clay, quartz, blue-green, moist, plastic, soft.	sc/ cl	12	Some amber oil/residue at 22 to 23' with dark brown/amber stains/ globules. Sharp contact at 22.9' (sand&clay).
24		Shelby tube sample collected from 24 to 26.5'. Boring terminated at 24'			
26					

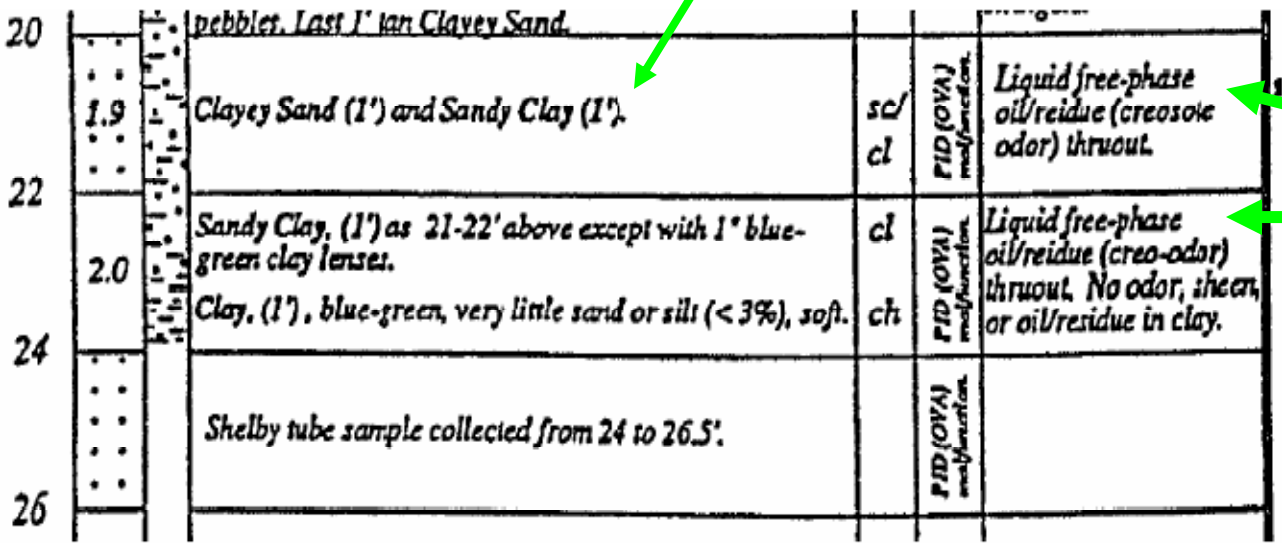
Sample from 20 ft

Mobile DNAPL at contact between Surficial Aquifer & UHG Clay

Log from Supplemental Feasibility Study, 1995 by TRC

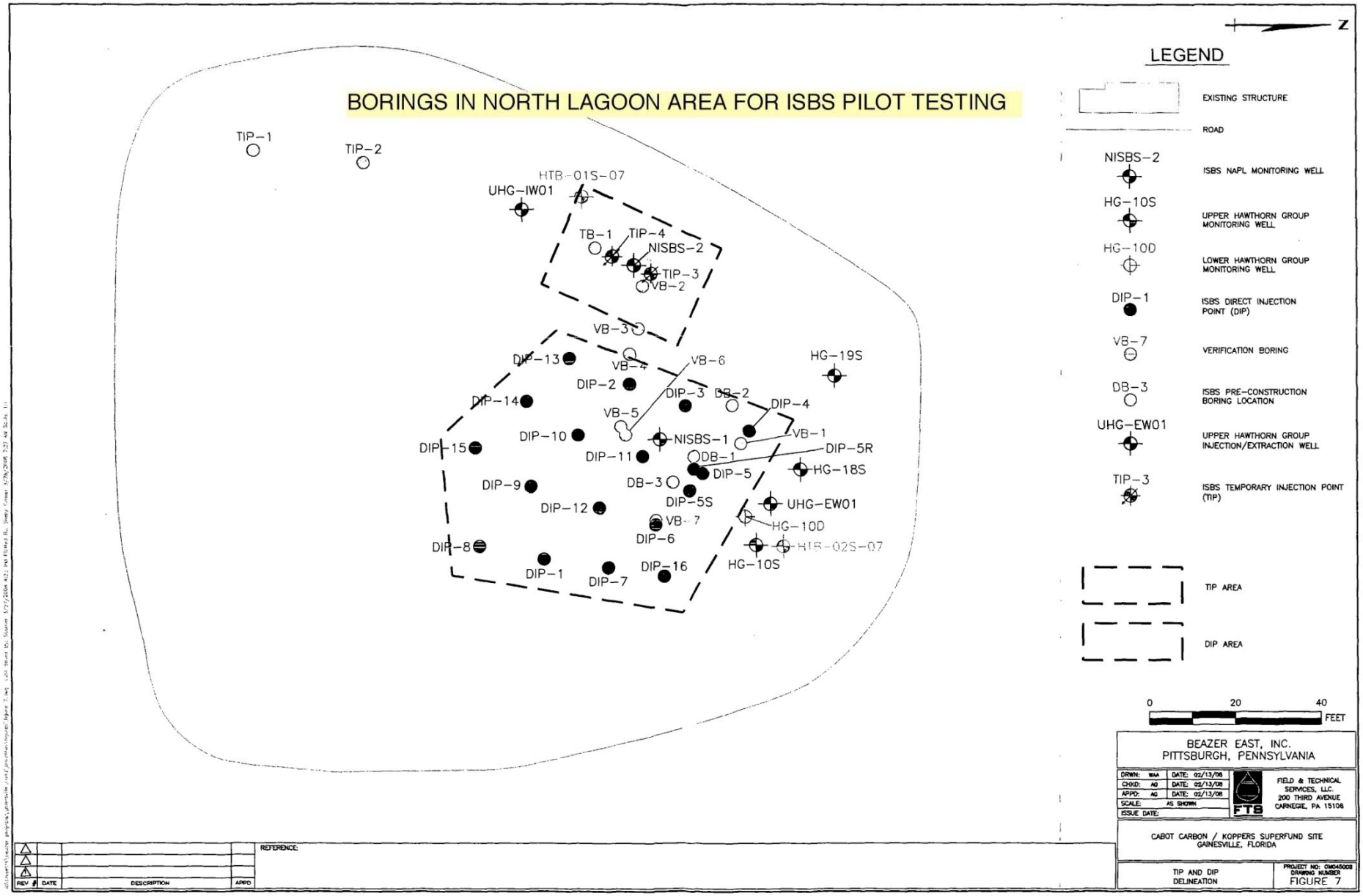
SFS-B3, Process Area, August 1995

Sample collected from 21.5 ft



"Liquid free-phase oil"

Log from Supplemental Feasibility Study, 1995 by TRC



Modified from Figure 7, Adventus Americas, Inc. March 31, 2008. ISBS Field Pilot Study Report.

Borehole ID: DB-1

Project: Adventus ISBS Support
Project No.: 2201.125.02
Site: Koppers, Inc. - Former North Lagoon
Location: Gainesville, Florida

Coordinates: 253379 N, 2658552 E
System: NAD 83 State Plane, Zone Florida North
TOC Elevation (ft): N/A
Ground Surface Elevation (ft): 184.5
Project Manager: J. Erickson

SUBSURFACE LITHOLOGY

Depth (ft bgs)	Elevation (ft)	USCS Symbol	Lithologic Description	PID reading (ppm)
0	185.2		Ground Surface	
			0 ft. - 4.6 ft. - Sand, olive black to yellow brown, medium grained, well graded, some gravel, little silt and clay, very strong organic odor from 0.75 ft. to 4.6 ft. bgs, NAPL staining from 0.75 ft to 4.6 ft. bgs.	56.8 129 235 171
	180.6			173
5			4.6 ft. - 5.0 ft. - Sand as above, fine to medium grained, no gravel, very strong organic odor, NAPL staining.	315
	179.2			76.4
			5.0 ft. - 6.0 ft. - Sand as above, medium grained, some silt, trace clay, very strong organic odor, NAPL staining.	263
	177.2		6.0 ft. - 8.0 ft. - Sand as above, fine grained, very strong organic odor, NAPL staining.	75.9
			8.0 ft. - 15.0 ft. - Sand as above, fine to medium grained, very strong organic odor, NAPL staining.	70.0 134 165 238 86.0
10				
	170.2			220
15			15.0 ft. - 19.0 ft. - Sand as above, poorly graded, coarse grained to well graded, medium grained with increasing depth, very strong organic odor, NAPL staining.	301 310 115
	166.2			238
20			End of boring = 19.0 ft. bgs.	
25			No notations of free product on any final logs	

Logged By: J. Toth
Drilled By: Miller Drilling
Drill Method: Sonic
Drill Date: September 7, 2007

GeoTrans, Inc.

From ISBS Pilot Test Report, 2008, by Adventus

CODES - SOIL CORE SECTION LOG FORM

GeoTrans, Inc.

PROPERTY	DESCRIPTION	LOG CODE
RELATIVE DRILLING RATES		
Very Slow		1
	grading to:	↓
Very Fast		5
ODOR (enter letter and number codes)		
Odorless		O
Hydrogen Sulfide		HS
Creosote		Cr
Petroleum		P
Septic		Se
Natural Organic		Nat Org
Qualifiers:	Faint	1
	Slight	2
	Moderate	3
	Strong	4
	Very Strong	5
NAPL		
Absent	none observed	A
Staining	Faint	Ft
	Distinct	Ds
	Prominent	Pr
NAPL	NAPL appears immobile	R
	NAPL appears mobile	FP
HCl REACTION - Dilute 10%		
None	no visible reaction	N
Weak	slow bubble formation	W
Moderate	Moderate bubble formation	M
Strong	immed. & vigorous bubbles	S
MOISTURE		
Dry	absence of moisture	D
Moist	damp but no visible water	M
Wet	visible free water	W
CEMENTATION		
Weak	crumbles or breaks with handling or little pressure	W
Moderate	crumbles or breaks with moderate pressure	M
Strong	will not crumble or break with finger pressure	S
ANGULARITY		
Angular	refer to chart	A
SubAngular	refer to chart	SA
SubRounded	refer to chart	SR
Rounded	refer to chart	R
MATRIX / CLAST		
Clast supported		C
Matrix supported		M
GRAIN TYPE		
Qtz=quartz, Sh=shells, LS=limestone fragments, DF=dolomite fragments, C=unspecified carbonate PhF = phosphate rock fragments		

Proportions:
TRACE (0-10%)
LITTLE (10-20%)
SOME (20-35%)
AND (35-50%)

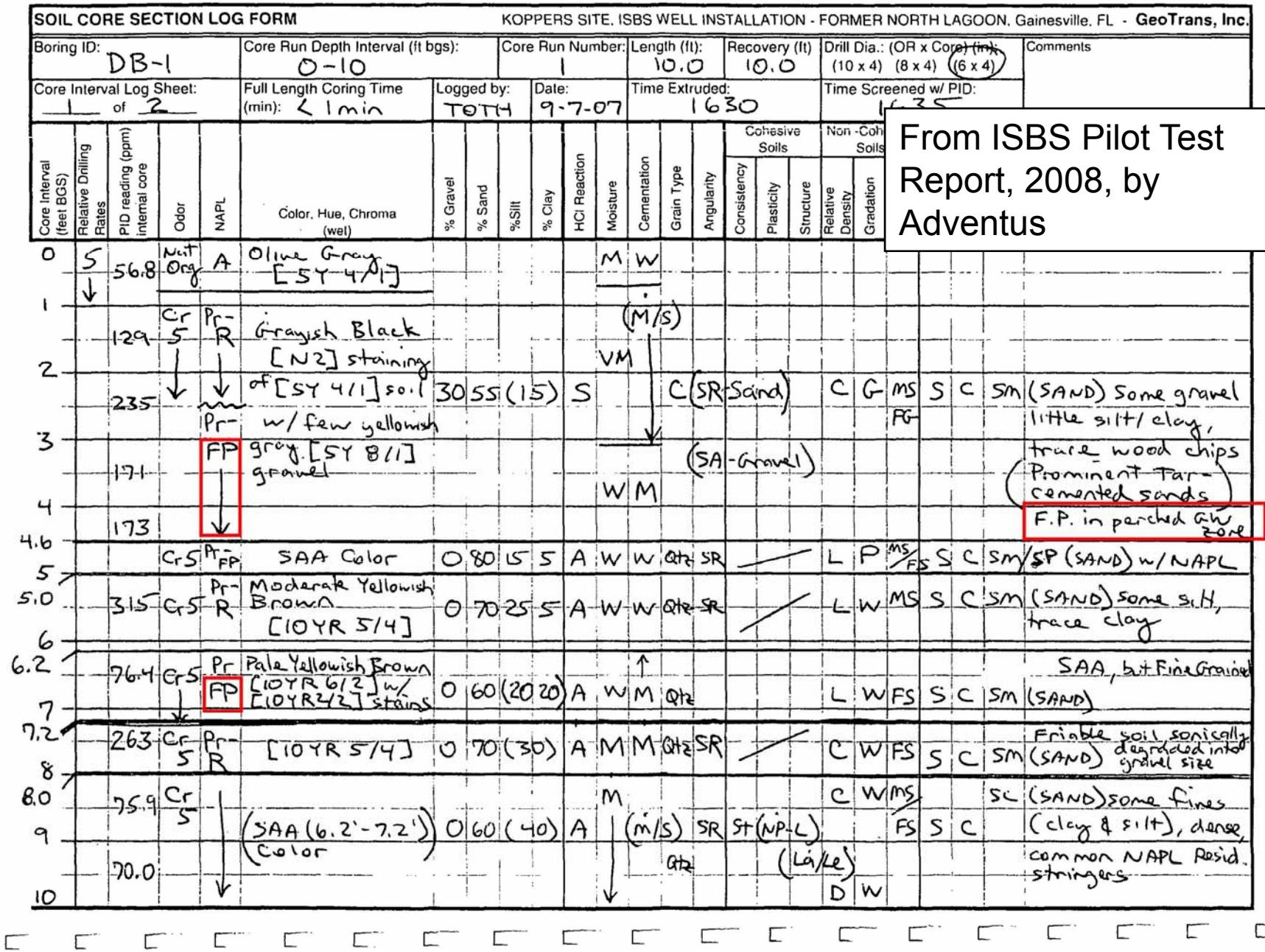
PROPERTY	DESCRIPTION	LOG CODE
COHESIVE SOILS		
CONSISTENCY		
Very Soft	thumb will penetrate soil >1"	VS
Soft	thumb will penetrate soil ~1"	So
Firm	thumb will indent soil ~1/4"	F
Stiff	thumb won't indent soil, thumbnail will	St
Hard	thumbnail will not readily indent soil	H
PLASTICITY (if fine-grained)		
Non-Plastic	a 1/8" thread can' be rolled at any water content	NP
Low	a 1/8" thread can barely be rolled	L
Medium	a 1/8" thread is easy to roll and not much time is required to reach the plastic limit, but the thread cannot be rerolled after reaching the plastic limit	M
High	a 1/8" thread is easily rolled, takes a long time to reach the PL, and can be re-rolled after reaching the PL	H
STRUCTURE		
Stratified	alternating layers of varying material color with layers at least 1/4" thick	S
Laminated	alternating layers of varying material color with layers <1/4" thick	La
Fissured	breaks along defined planes of fracture with little resistance to fracturing	F
Slickensided	fracture planes appear polished	Sl
Blocky	cohesive soil that can be broken down into small angular fragments	B
Lenses	inclusion of small pockets of different soil	Le
Homogeneous	same color and appearance throughout	H
Platty, Nuggety, Friable, Varved, Massive, Prismatic, Columnar, Cemented, Cluster, Dispersed, Flocculated (Cardhouse), Single-Grained, Skeleton		
NON COHESIVE SOILS		
RELATIVE DENSITY (Estimated Compactness)		
Loose	Estimate, consider drilling rates	L
Compact	Estimate, consider drilling rates	C
Dense	Estimate, consider drilling rates	D
GRADATION		
Poorly Graded	poorly-graded soil consists primarily of 1 size or has missing intermediate grain size fractions	P
Gap Graded		G
Well Graded	well-graded soil has a wide range of particle sizes and a substantial amount of intermediate sizes	W
DOMINANT GRAIN SIZE		
Gravel = **G** / Coarse Sand = **CS** / Medium Sand = **MS** Fine Sand = **FS** / Very Fine Sand = **VFS** / Silt = **Si** / Clay = **C**		
ORGANIC MATERIAL (typ. dk brown to black color, possesses organic odor, will not have a high toughness or plasticity)		
Peat	>50% organic matter	P
Organic	15-50% organic matter	O
Some	5-15% organic matter	S

Abundance: Few, Common, Many
Contrast: Faint, Distict, Prominent
NR Not Recorded
NA Not Applicable
SAA Same as Above

GeoTrans Soil Core Logging Codes From ISBS Pilot Test Report, 2008, by Adventus

	Very Strong	5
NAPL		
Absent	none observed	**A**
Staining	Faint	**Ft**
	Distinct	**Ds**
	Prominent	**Pr**
NAPL	NAPL appears immobile	**R**
	NAPL appears mobile	**FP**

GeoTrans Soil Core Logging Codes From ISBS Pilot Test Report, 2008, by Adventus

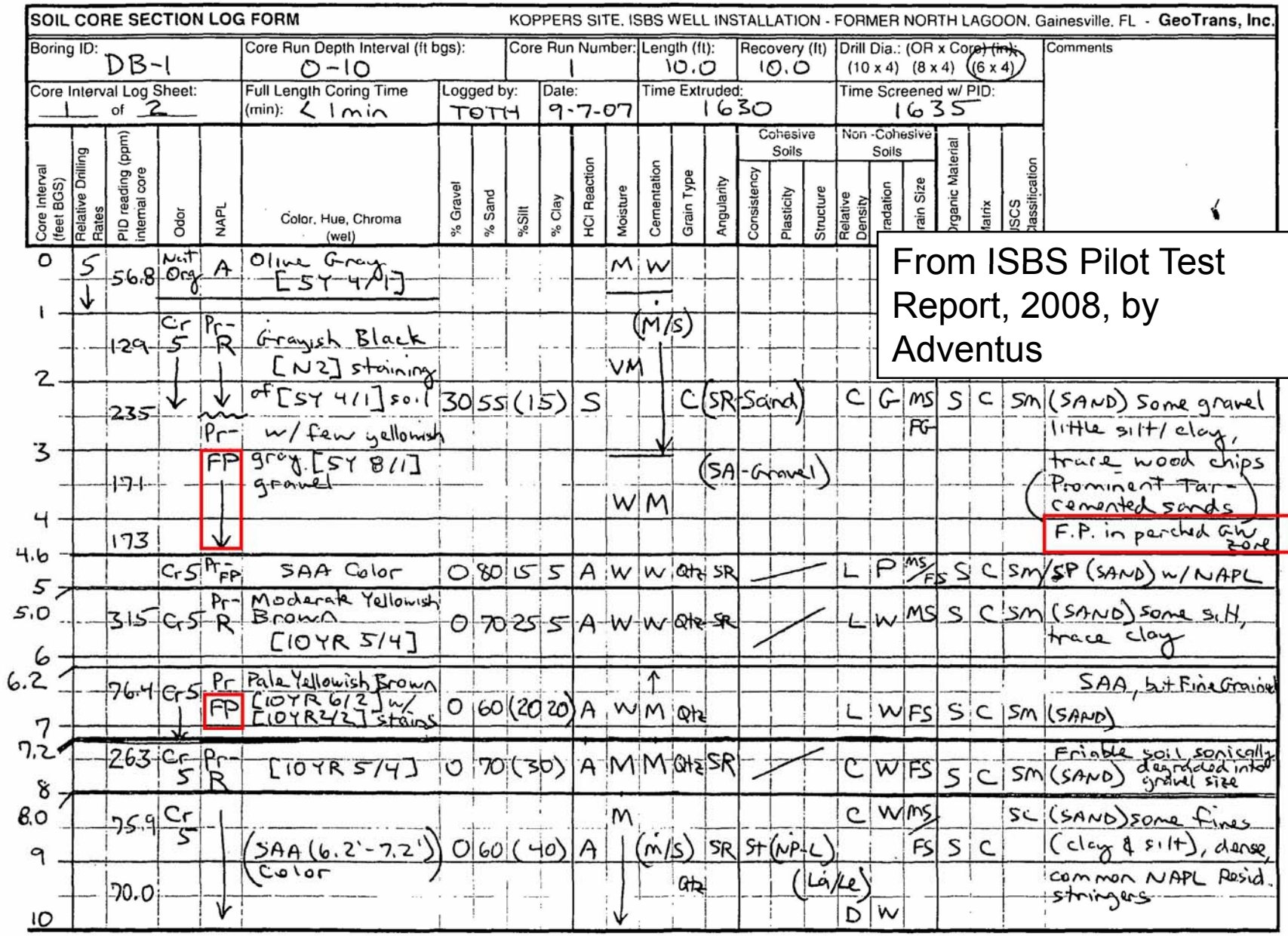


SOIL CORE SECTION LOG FORM — KOPPERS SITE, ISBS WELL INSTALLATION - FORMER NORTH LAGOON, Gainesville, FL - GeoTrans, Inc.

Boring ID: DB-1 | Core Run Depth Interval (ft bgs): 0-10 | Core Run Number: 1 | Length (ft): 10.0 | Recovery (ft): 10.0 | Drill Dia.: (OR x Core) (in): (10 x 4) (8 x 4) (6 x 4) | Comments

Core Interval Log Sheet: 1 of 2 | Full Length Coring Time (min): < 1 min | Logged by: TOTH | Date: 9-7-07 | Time Extruded: 1630 | Time Screened w/ PID: 1635

From ISBS Pilot Test Report, 2008, by Adventus



SOIL CORE SECTION LOG FORM — KOPPERS SITE. ISBS WELL INSTALLATION - FORMER NORTH LAGOON, Gainesville, FL - GeoTrans, Inc.

Boring ID: DB-1 | Core Run Depth Interval (ft bgs): 0-10 | Core Run Number: 1 | Length (ft): 10.0 | Recovery (ft): 10.0 | Drill Dia.: (OR x Core) (in): (10 x 4) (8 x 4) (6 x 4) | Comments

Core Interval Log Sheet: 1 of 2 | Full Length Coring Time (min): < 1 min | Logged by: TOTH | Date: 9-7-07 | Time Extruded: 1630 | Time Screened w/ PID: 1635

Core Interval (feet BGS)	Relative Drilling Rates	PID reading (ppm) internal core	Odor	NAPL	Color, Hue, Chroma (wet)	% Gravel	% Sand	%Silt	% Clay	HCl Reaction	Moisture	Cementation	Grain Type	Angularity	Cohesive Soils: Consistency	Plasticity	Structure	Non-Cohesive Soils: Relative Density	Gradation	Grain Size	Organic Material	Matrix	USCS Classification	
0	5	56.8	Nat Org	A	Olive Gray [5Y 4/1]						M	W												
1	↓											(M/S)												
2		129	Cr 5	Pr-R	Grayish Black [N2] staining						VM													
		235	↓	↓	of [5Y 4/1] so.1	30	55	(15)		S		C	(SR-Sand)					C	G	MS FG	S	C	SM	(SAND) Some gravel little silt/clay,
3				Pr-	w/ few yellowish																			
		171		FP	gray. [5Y 8/1] gravel								(SA-Gravel)											trace wood chips Prominent Tar-cemented sands
4				↓							W	M												F.P. in perched GW zone
4.6		173																						
5			Cr5	Pr-FP	SAA Color	0	80	15	5	A	W	W	Qtz	SR				L	P	MS/FS	S	C	SM/SP	(SAND) w/ NAPL
5.0		315	Cr5	Pr-R	Moderate Yellowish Brown [10YR 5/4]	0	70	25	5	A	W	W	Qtz	SR				L	W	MS	S	C	SM	(SAND) some silt, trace clay
6																								
6.2		76.4	Cr5	Pr	Pale Yellowish Brown [10YR 6/2] w/ [10YR 4/2] stains	0	60	(20 20)		A	W	M	Qtz					L	W	FS	S	C	SM	SAA, but Fine Grained (SAND)
7			↓	FP								↑												
7.2		263	Cr 5	Pr-R	[10YR 5/4]	0	70	(30)		A	M	M	Qtz	SR				C	W	FS	S	C	SM	Friable soil sonically degraded into gravel size (SAND)
8																								
8.0		75.9	Cr 5								M							C	W	MS/FS			SC	(SAND) some fines
9					(SAA (6.2'-7.2') Color)	0	60	(40)		A	(M/S)			SR	St (NP-L)						S	C		(clay & silt), dense, common NAPL Resid. stringers
		70.0											Qtz		(La/Le)									
10																		D	W					

From ISBS Pilot Test Report, 2008, by Adventus

Borehole ID: DB-1

Project: Adventus ISBS Support
Project No.: 2201.125.02
Site: Koppers, Inc. - Former North Lagoon
Location: Gainesville, Florida

Coordinates: 253379 N, 2658552 E
System: NAD 83 State Plane, Zone Florida North
TOC Elevation (ft): N/A
Ground Surface Elevation (ft): 184.5
Project Manager: J. Erickson

SUBSURFACE LITHOLOGY

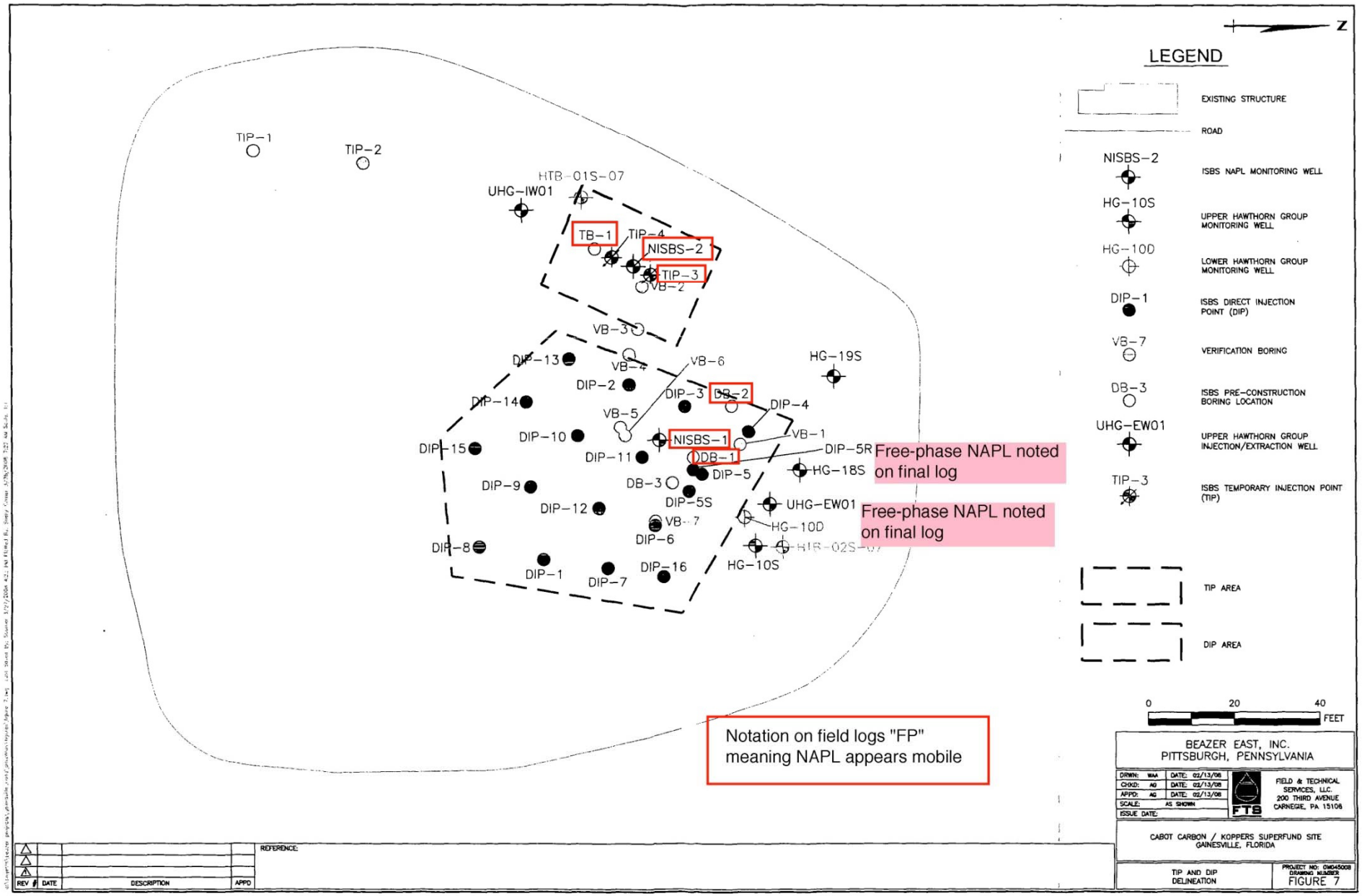
Depth (ft.bgs)	Elevation (ft)	USCS Symbol	Lithologic Description	PID reading (ppm)
0	185.2		Ground Surface	
			0 ft. - 4.6 ft. - Sand, olive black to yellow brown, medium grained, well graded, some gravel, little silt and clay, very strong organic odor from 0.75 ft. to 4.6 ft. bgs, NAPL staining from 0.75 ft to 4.6 ft. bgs.	56.8
			FP- 3.0' - 4.6'	129
			FP- 4.6' - 5.0'	235
	180.6			171
5			4.6 ft. - 5.0 ft. - Sand as above, fine to medium grained, no gravel, very strong organic odor, NAPL staining.	173
	179.2		FP- 6.2' - 7.2	315
			5.0 ft. - 6.0 ft. - Sand as above, medium grained, some silt, trace clay, very strong organic odor, NAPL staining.	76.4
	177.2		6.0 ft. - 8.0 ft. - Sand as above, fine grained, very strong organic odor, NAPL staining.	263
			8.0 ft. - 15.0 ft. - Sand as above, fine to medium grained, very strong organic odor, NAPL staining.	75.9
10			FP- 10.0' - 11.5'	70.0
			FP- 13.0' - 14.0'	134
				165
				238
				86.0
	170.2			220
15			15.0 ft. - 19.0 ft. - Sand as above, poorly graded, coarse grained to well graded, medium grained with increasing depth, very strong organic odor, NAPL staining.	301
				310
			FP- 16.0' - 17.0'	115
	166.2			238
20			End of boring = 19.0 ft. bgs.	
25				

Logged By: J. Toth
Drilled By: Miller Drilling
Drill Method: Sonic
Drill Date: September 7, 2007

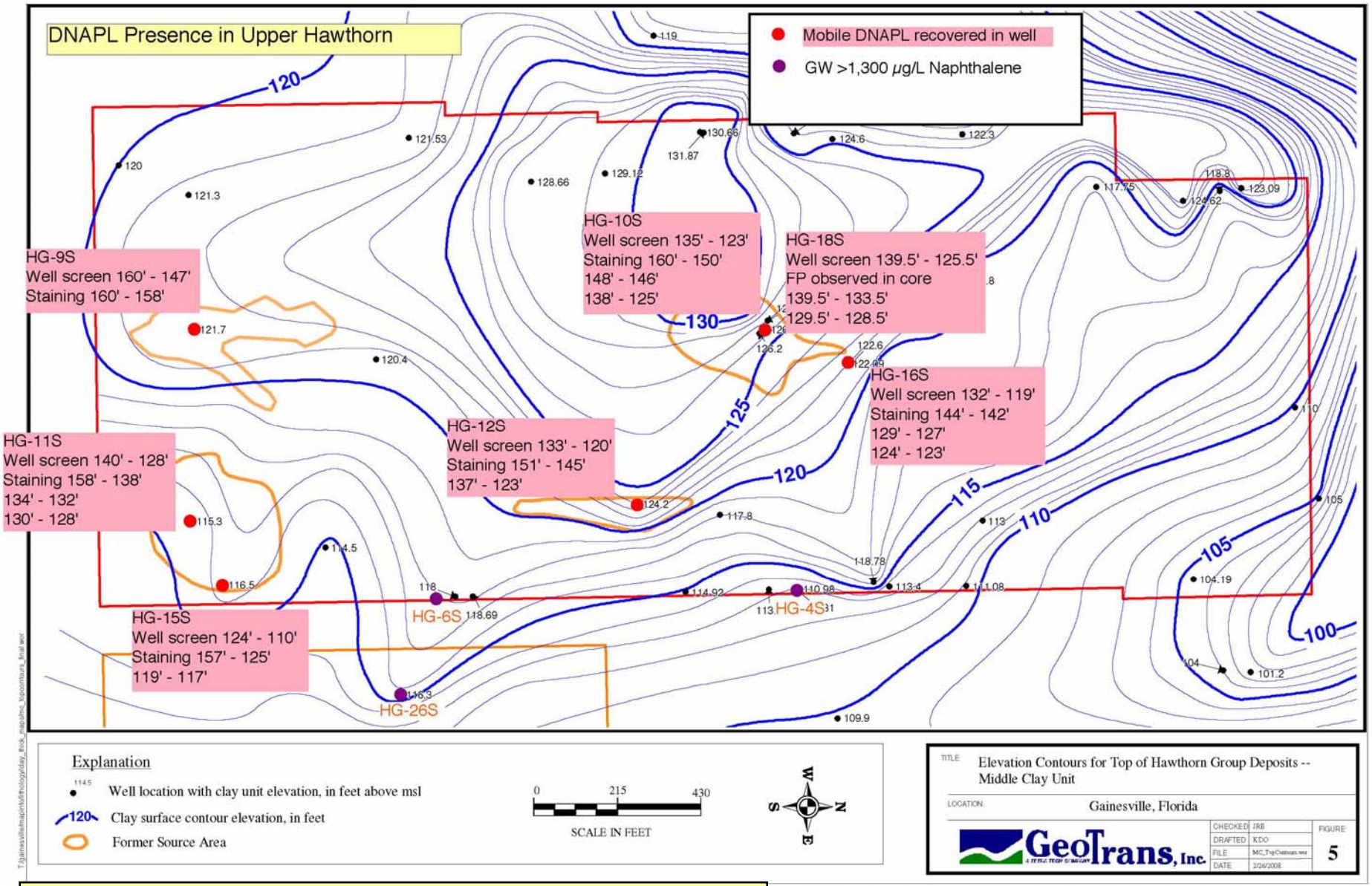
GeoTrans, Inc.

From ISBS Pilot Test Report, 2008, by Adventus

Notations in Red added to original log

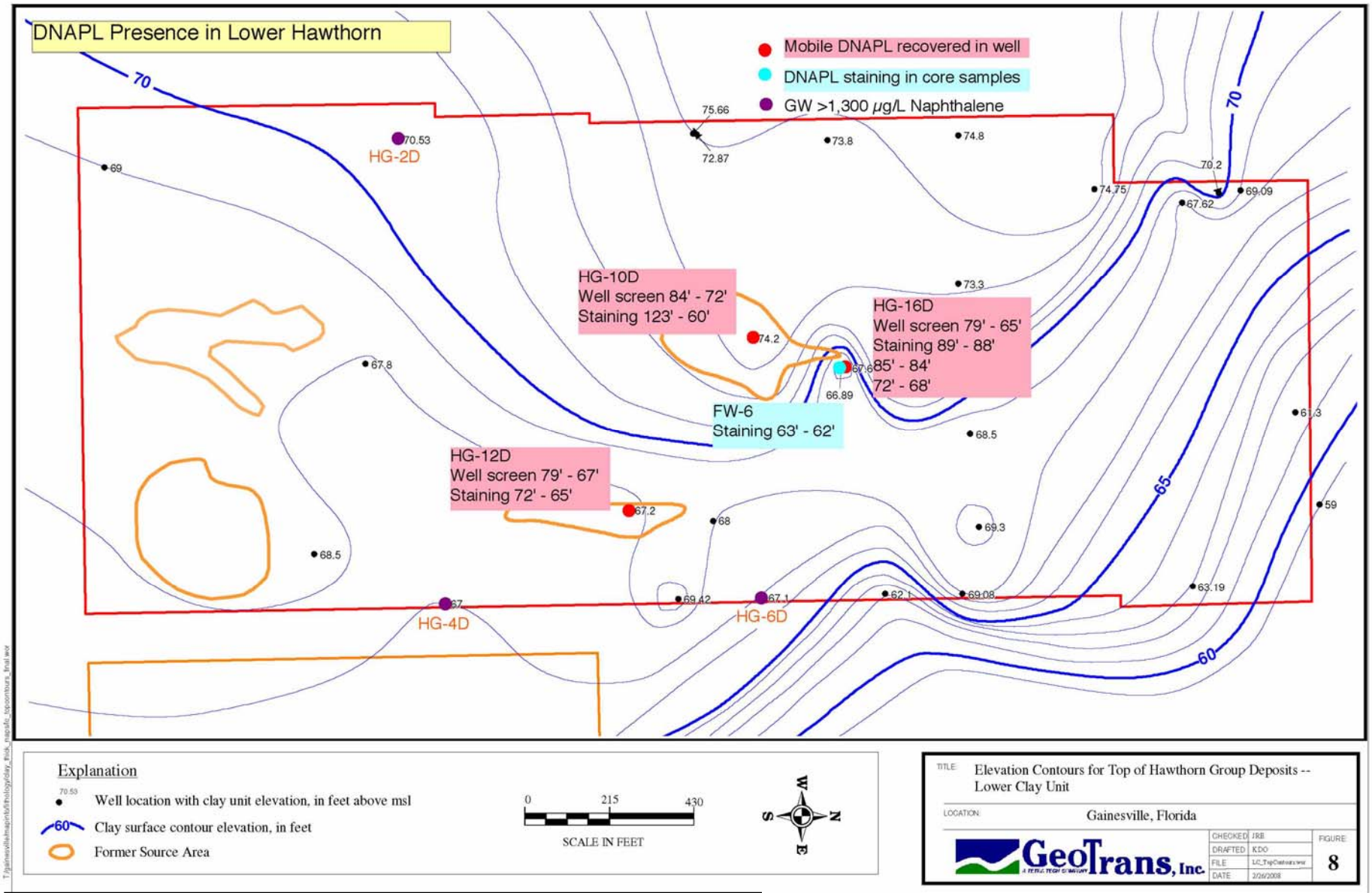


Modified from Figure 7, Adventus Americas, Inc. March 31, 2008. ISBS Field Pilot Study Report.



Potentially mobile DNAPL present
Source Zones larger than depicted by Beazer

Modified from Figure 5, GeoTrans, Inc. April 2, 2008.
Response to Recommendation 6.

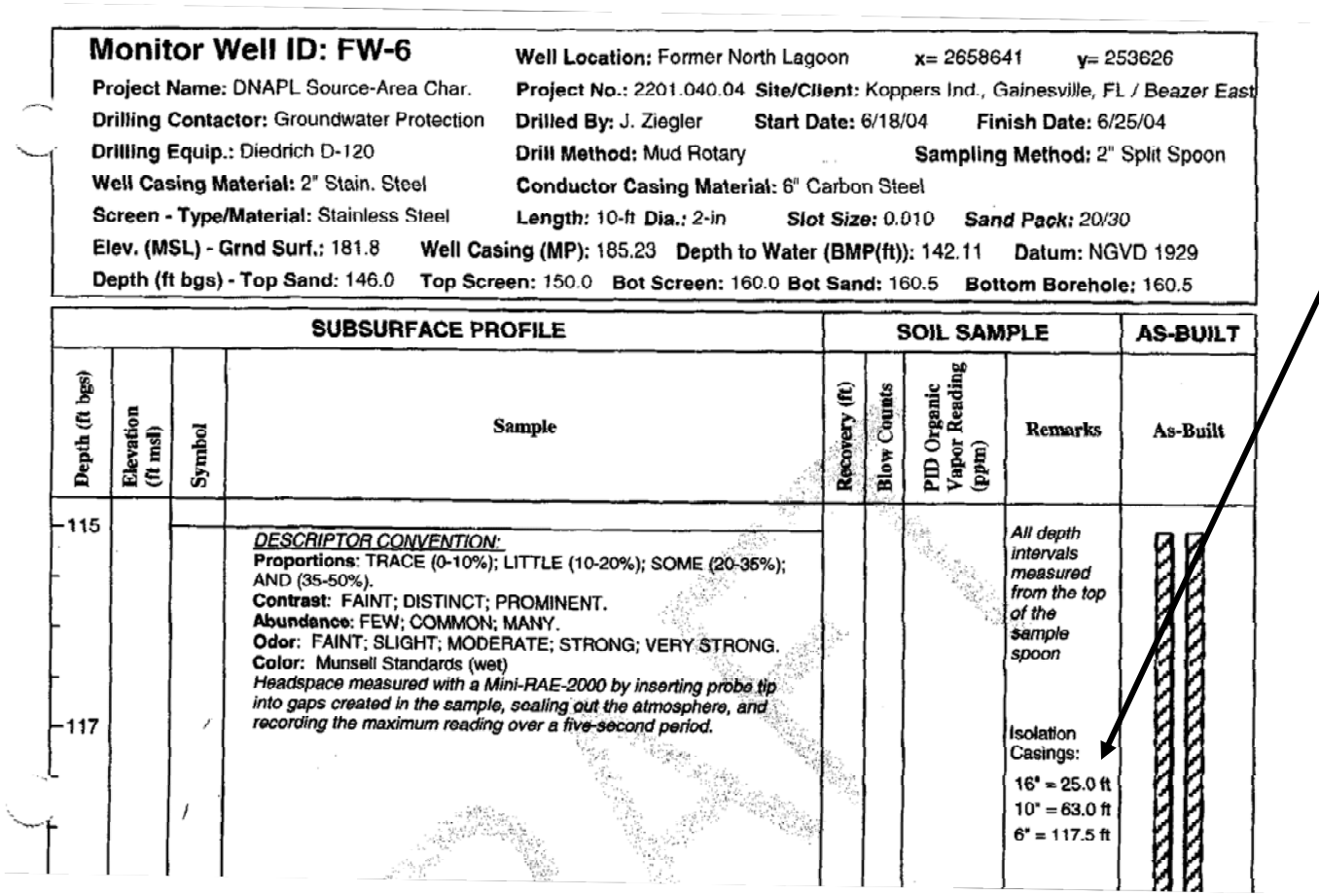


Potentially mobile DNAPL present
Source Zones larger than depicted by Beazer

Modified from Figure 8, GeoTrans, Inc. April 2, 2008.
Response to Recommendation 6.

Creosote in FW-6 not likely caused by drag down:

FW-6 was triple-cased: 16 inch to 25 ft bgs
10 inch to 63 ft bgs
6 inch to 117.5 ft bgs

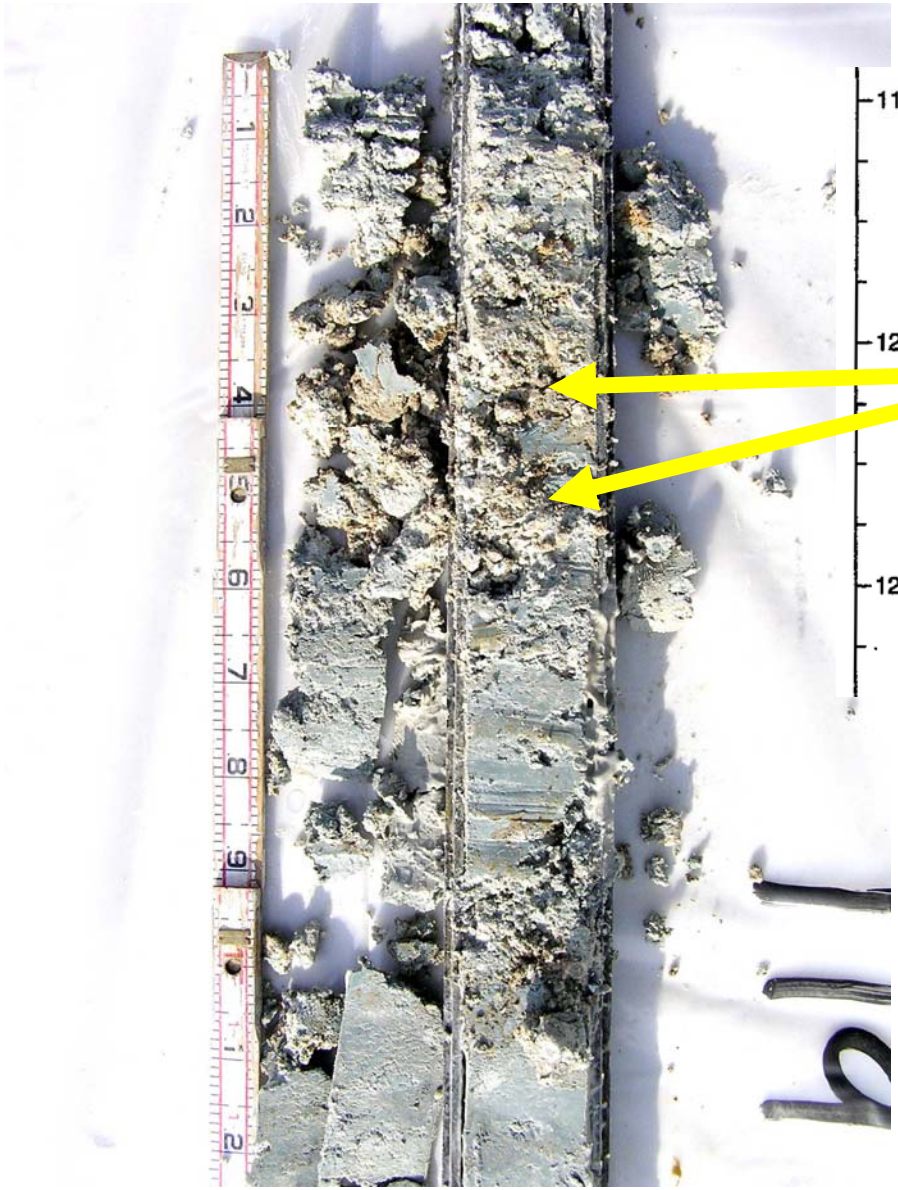


Monitor Well ID: FW-6

Well Location: Former North Lagoon x= 2658641 y= 253626
Project Name: DNAPL Source-Area Char. **Project No.:** 2201.040.04 **Site/Client:** Koppers Ind., Gainesville, FL / Beazer East
Drilling Contactor: Groundwater Protection **Drilled By:** J. Ziegler **Start Date:** 6/18/04 **Finish Date:** 6/25/04
Drilling Equip.: Diedrich D-120 **Drill Method:** Mud Rotary **Sampling Method:** 2" Split Spoon
Well Casing Material: 2" Stain. Steel **Conductor Casing Material:** 6" Carbon Steel
Screen - Type/Material: Stainless Steel **Length:** 10-ft **Dia.:** 2-in **Slot Size:** 0.010 **Sand Pack:** 20/30
Elev. (MSL) - Grnd Surf.: 181.8 **Well Casing (MP):** 185.23 **Depth to Water (BMP(ft)):** 142.11 **Datum:** NGVD 1929
Depth (ft bgs) - Top Sand: 146.0 **Top Screen:** 150.0 **Bot Screen:** 160.0 **Bot Sand:** 160.5 **Bottom Borehole:** 160.5

SUBSURFACE PROFILE				SOIL SAMPLE				AS-BUILT
Depth (ft bgs)	Elevation (ft msl)	Symbol	Sample	Recovery (ft)	Blow Counts	PID Organic Vapor Reading (ppm)	Remarks	As-Built
115			*DESCRIPTOR CONVENTION:* **Proportions**: TRACE (0-10%); LITTLE (10-20%); SOME (20-35%); AND (35-50%). **Contrast**: FAINT; DISTINCT; PROMINENT. **Abundance**: FEW; COMMON; MANY. **Odor**: FAINT; SLIGHT; MODERATE; STRONG; VERY STRONG. **Color**: Munsell Standards (wet) *Headspace measured with a Mini-RAE-2000 by inserting probe tip into gaps created in the sample, sealing out the atmosphere, and recording the maximum reading over a five-second period.*				*All depth intervals measured from the top of the sample spoon*	
117							Isolation Casings: 16" = 25.0 ft 10" = 63.0 ft 6" = 117.5 ft	

Creosote in FW-6 not likely caused by drag down:



119	62.9	CL (Gravelly CLAY), stiff, low plasticity, massive (1/2-in to 3-in thick layers) moist, friable, grayish blue-green [5BG 5/2] mottled with very fine sand/silt stringers, chaotically interfingered with sandy gravel seams, comprised of fine sand, fossiliferous limestone fragments (angular to subangular), and trace silt, trace
	61.9	clay, very moist with prominent dark yellowish brown [10YR 4/2] DNAPL staining. Very strong creosote od and prominent DNAPL staining in all sandy gravel seams and adjoining stingers for approximately 1-2 inches, occupying approximately 20% of the total sample volume.
121	60.9	
	59.4	CL (CLAY), stiff, low plasticity, massive, slightly moist, friable, grayish blue-green [5BG 5/2] with greenish gray [5G 6/1] and light olive gray [5Y 6/1] mottling, common nearly horizontal silt stringers. Refusal on lithified clay, same as above, hard, brittle, platey chips (likely fractured during spoon advancement). Faint creosote odors. Diffuse DNAPL staining absent in clay. DNAPL staining absent in stringers.
123		

Only DNAPL reported below last casing at 119 ft to 120 ft bgs

Top of Ocala 142 ft bgs

Naphthalene in FW-6

July 12, 2004	2,560 µg/L
Purged Nov 20-24	5,359 gal.
July 26, 2004	1,240 µg/L
Purged Nov 8	1,965 gal.
November 17, 2004	1,400 µg/L
	1,300 µg/L
	1,940 µg/L
	1,890 µg/L
Total Purged	7,324 gal.

Naphthalene Removed from FW-6:

7,324 gallons purged during sampling

average naphthalene= 1,700 µg/L
(persistent, no declining trend to mid-2005)

Mass removed= 48 grams
and plenty remaining

Possible mass contained in NAPL layer in soil:

6-in boring, NAPL zone 2-in thick

soil density= 1.89 g/cm^3

naphthalene conc.=13,000 µg/g (highest measured at site)

In soil intersected by boring-

naphthalene mass= 23 grams

smaller than mass already removed from FW-6

Contamination in FW-6 and FW-21B not likely caused by leakage from Hawthorn along boreholes:

- Beazer Expert Panel concluded source was leakage of estimated 0.16 gpm along borehole, travel time from Hawthorn in <2 minutes.

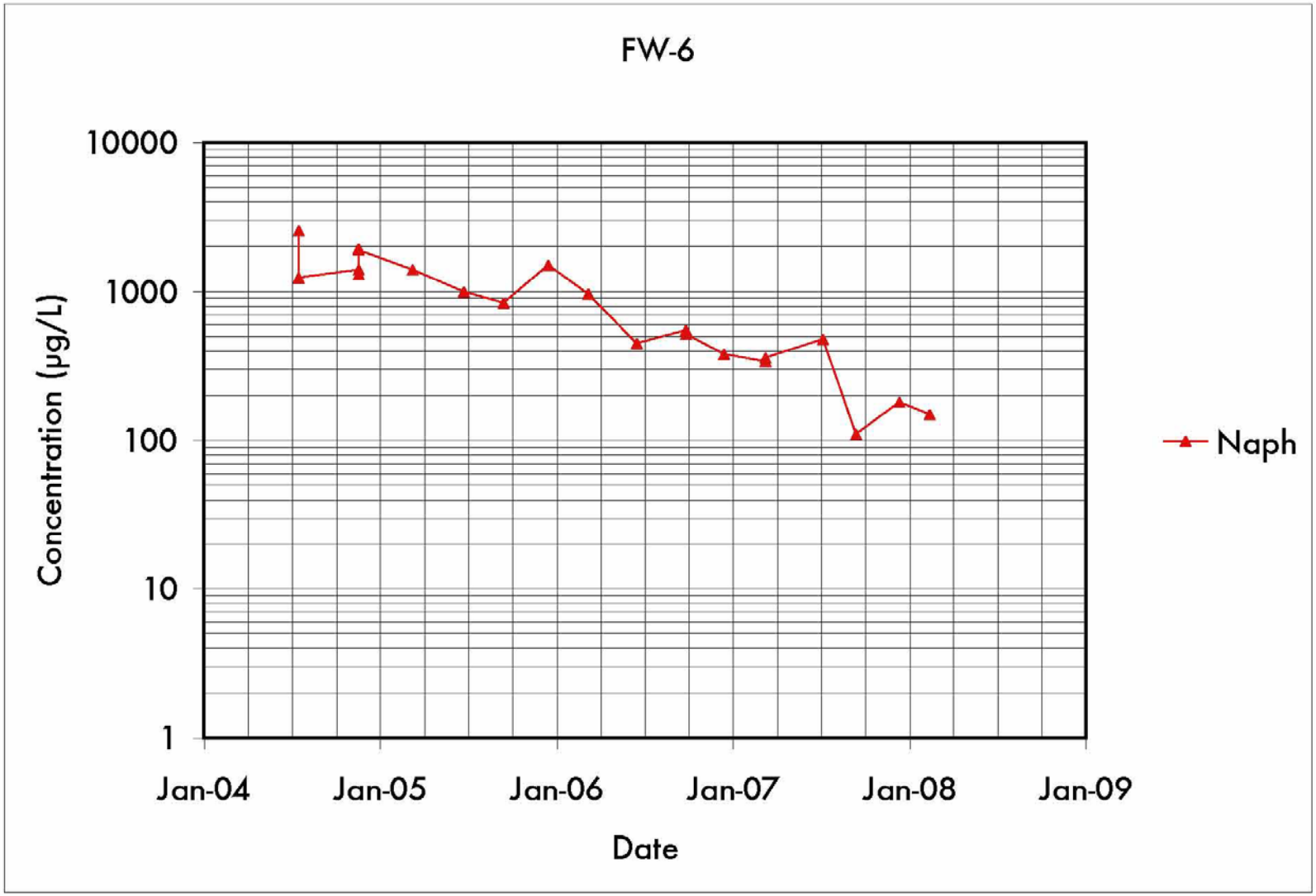
- If so, there should be no reason for FW-6 chemical ratios to be different from Hawthorn groundwater above or to change over time.

- If so, there should be no reason for FW-21B chemical ratios to be different from Hawthorn, different between zones, or change over time.

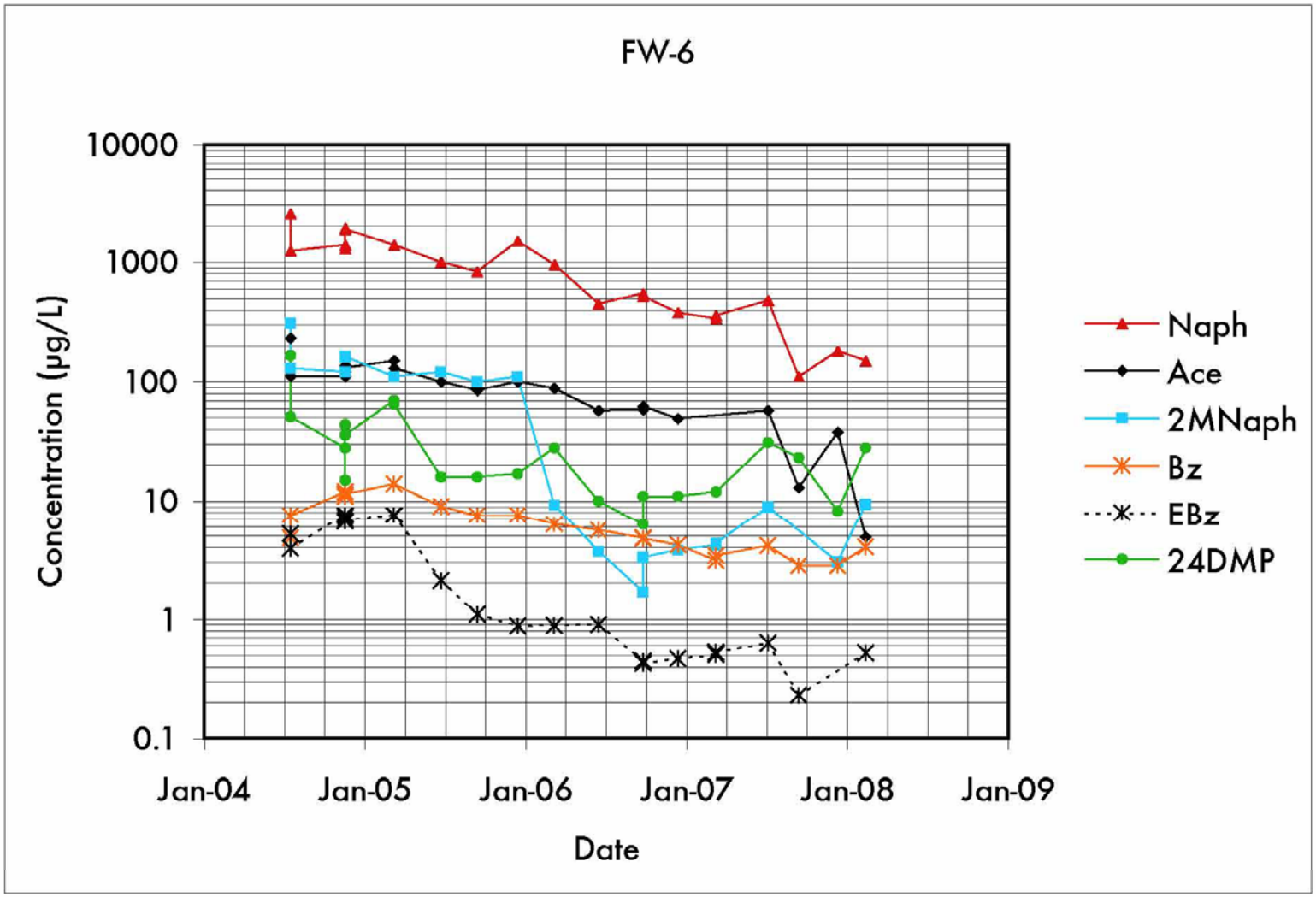
Contamination in FW-6 and FW-21B should be similar to Hawthorn above and similar in depth and over time, if due to leakage

- However, chemical ratios in FW-6 are substantially different from HG-16D above and change over time.

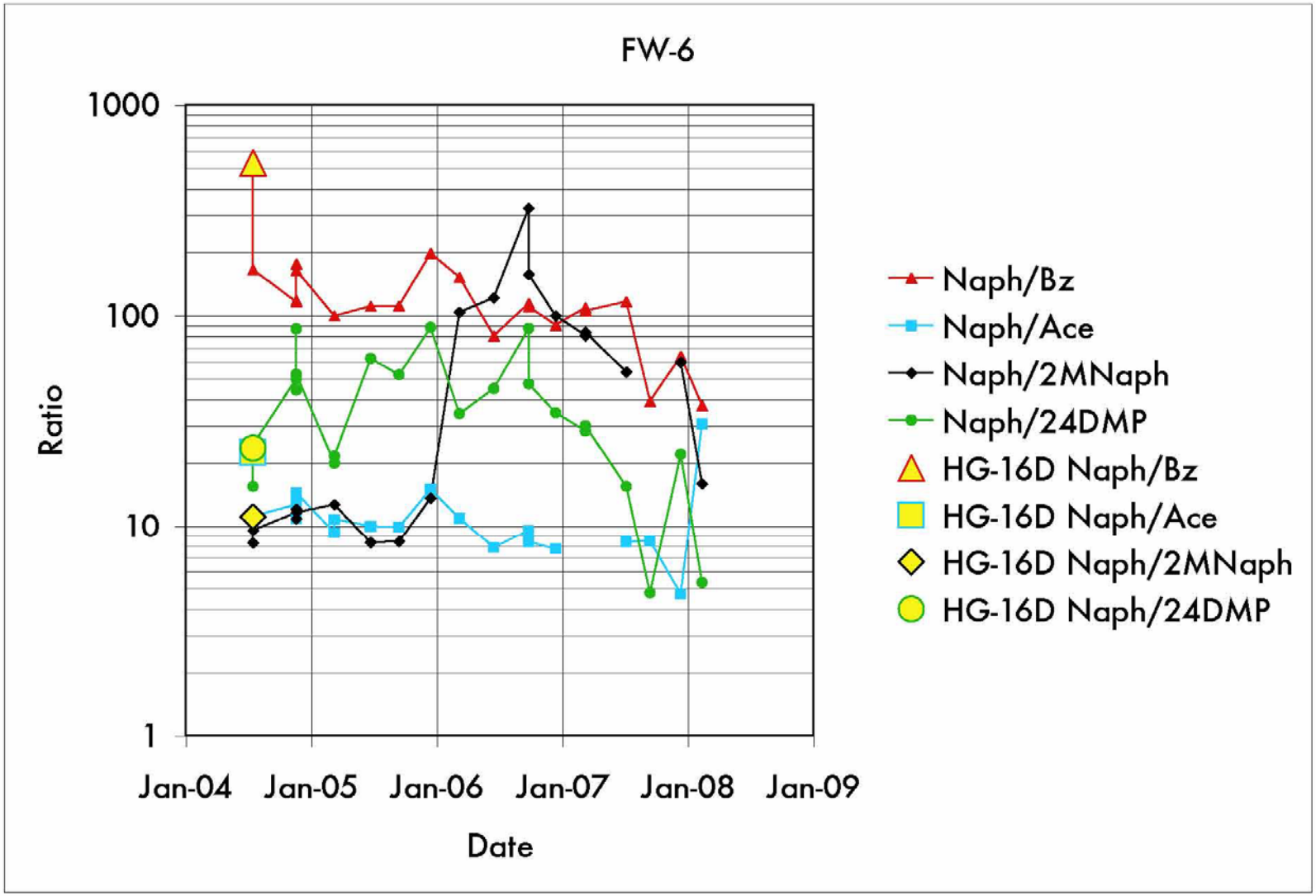
- Chemical ratios in FW-21B are substantially different from HG-12D above and different in the different zones of the multi-depth well.



Naphthalene has declined since 2004-2005



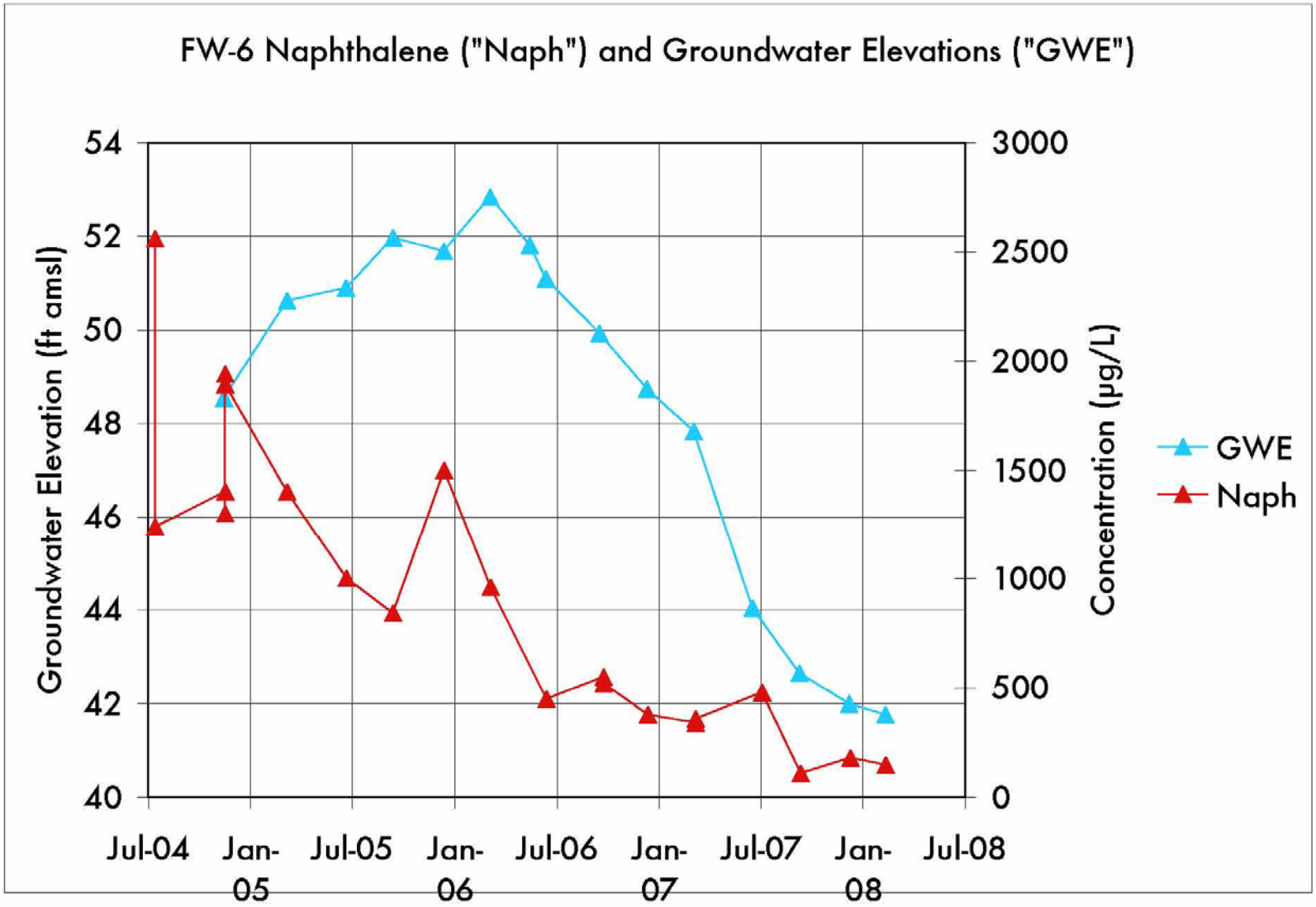
Not all contaminants show same pattern of decline



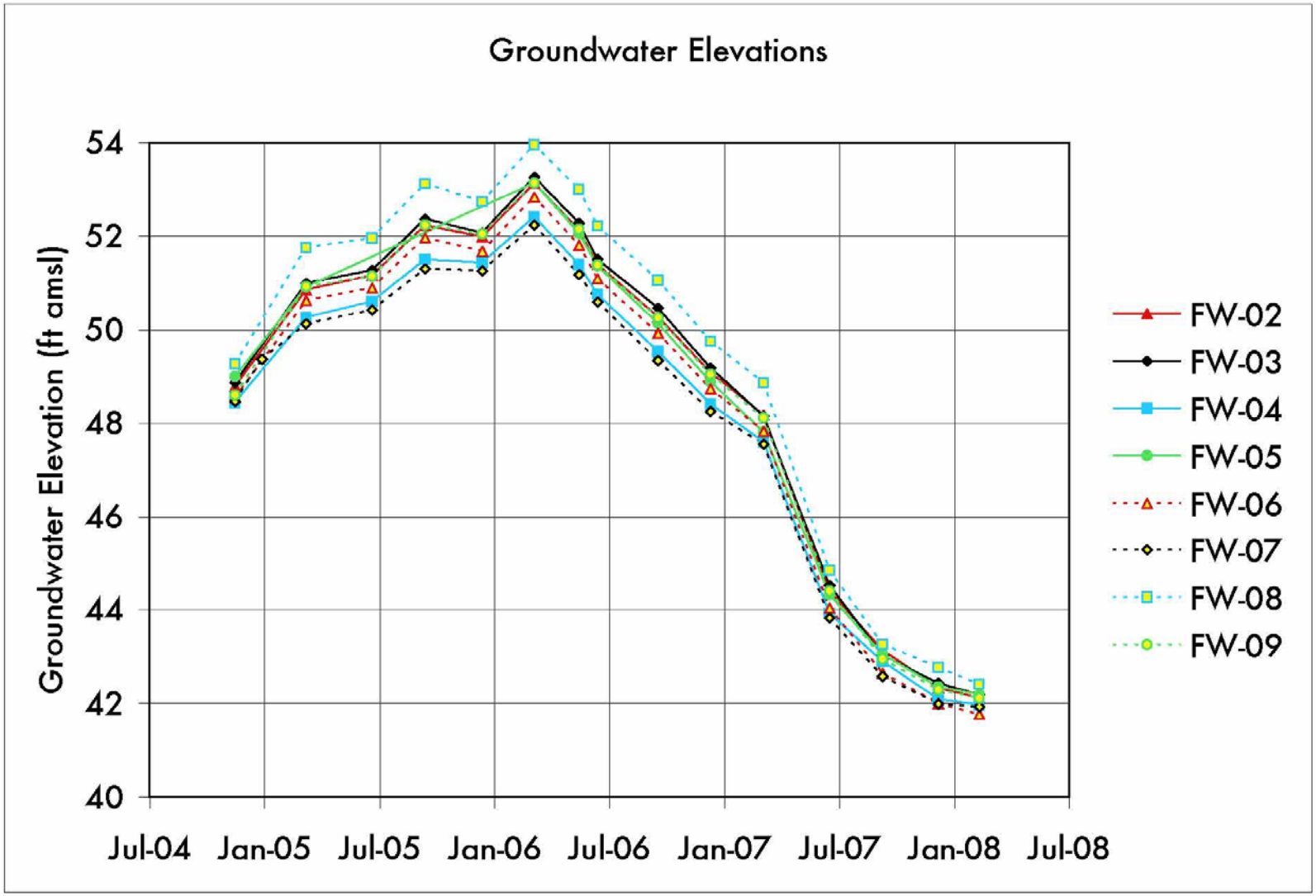
Ratios not same as LHG, change over time, with different trends

Comparison of Other Ratios:

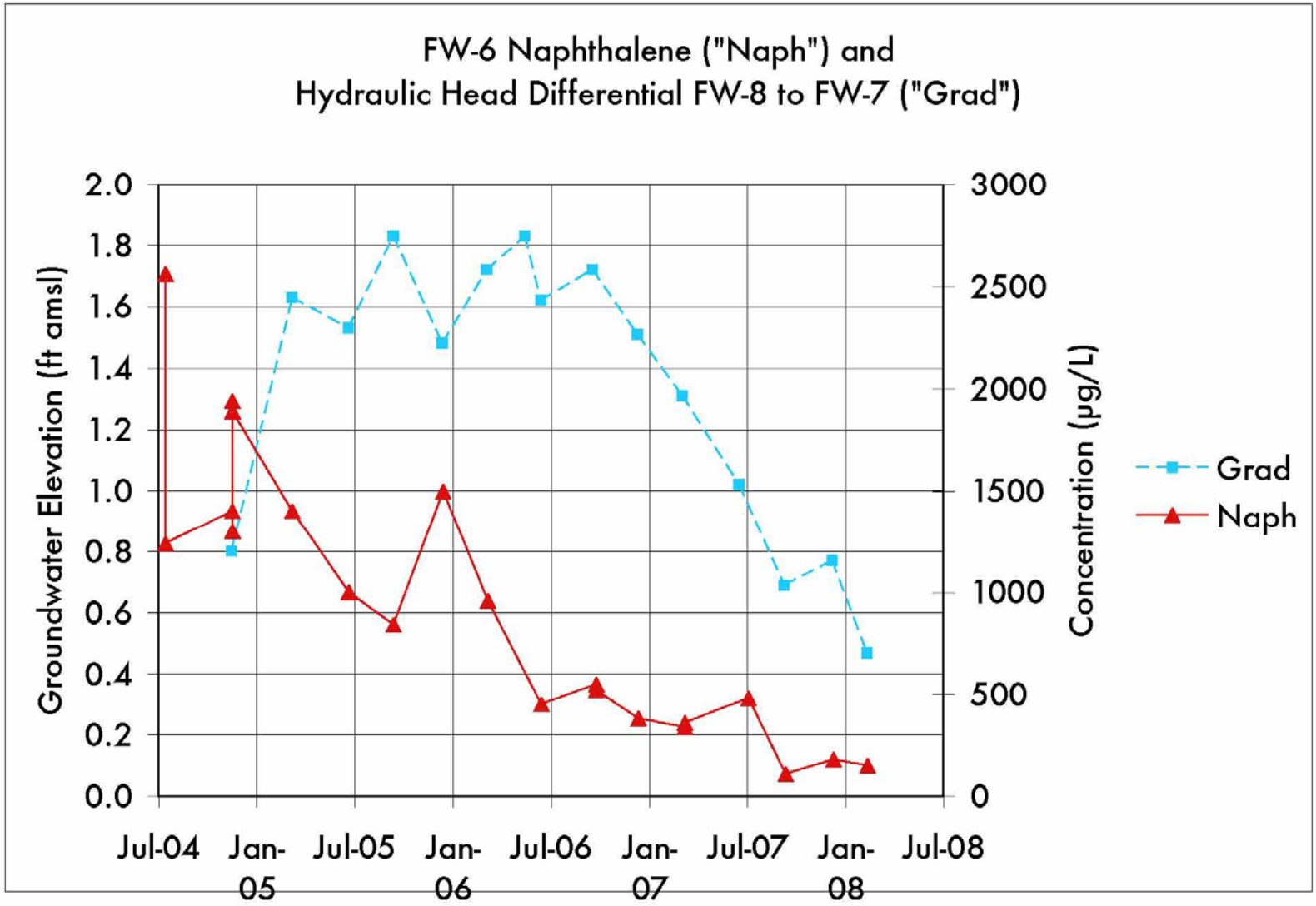
Ratio	HG-16D	Initial FW-6	Range FW-6
Naph/Bz	536	533	38 - 533
Naph/Flr	43	18	6 - 47
FlrAnth/Bz	0.9	4.4	0.4 - 5.1
Ace/Xyl	3.8	14	2.5 - 17
Flr/24DMP	0.51	0.81	0.11 - 7.0



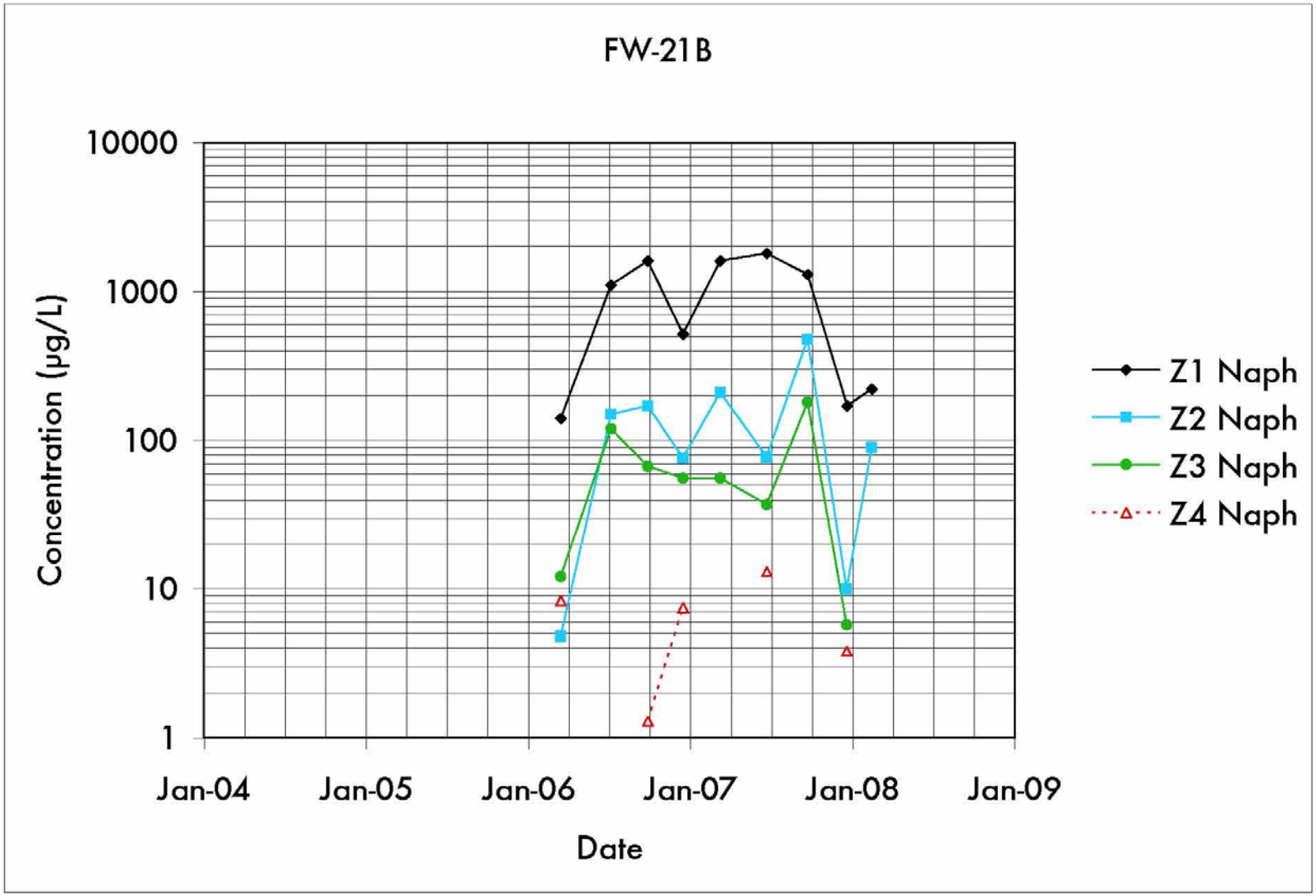
GWE in FW-6 have declined by >10 feet since early 2006



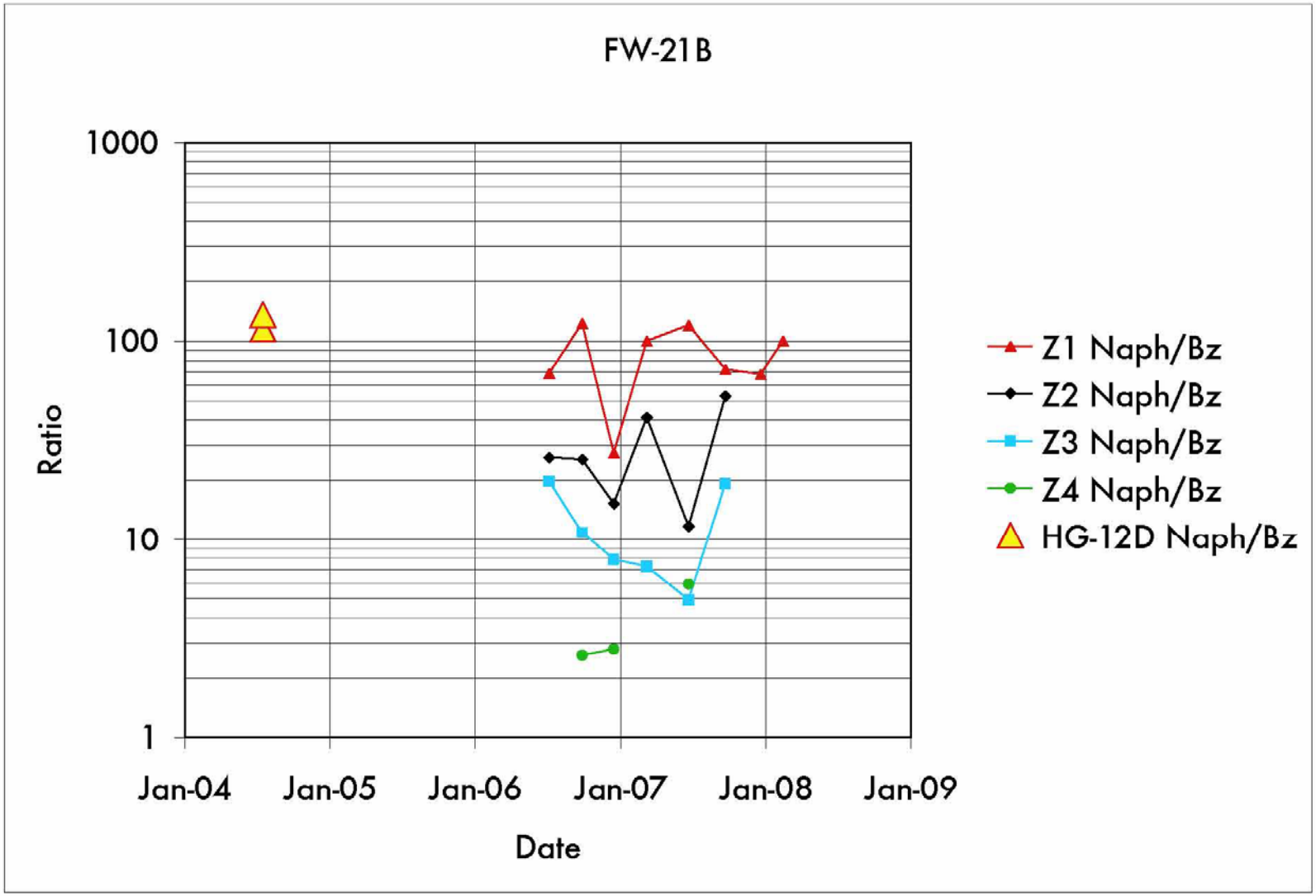
GWE in all Floridan wells have declined by 10-12 feet since early 2006



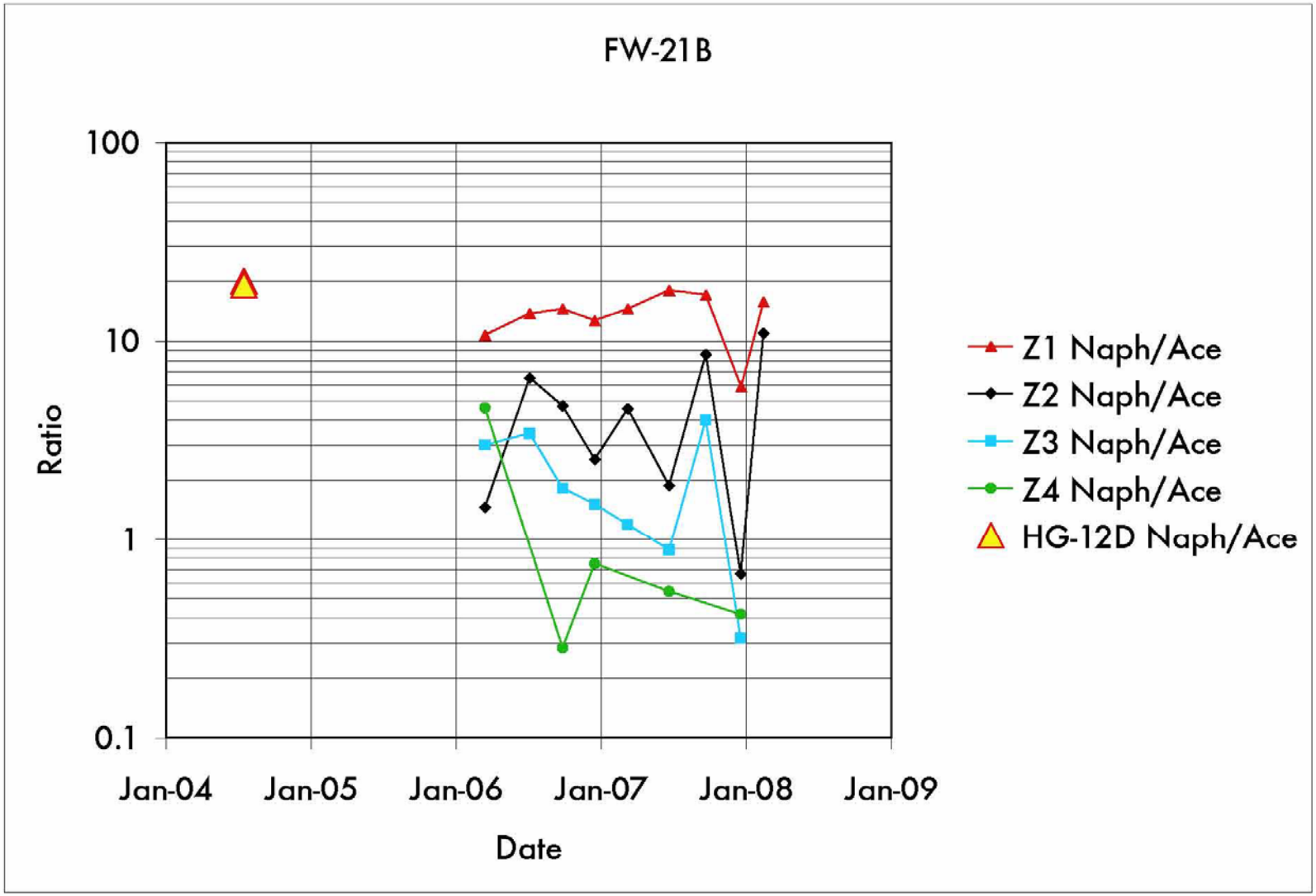
Hydraulic gradient across the site has declined by ~3 to 4-fold



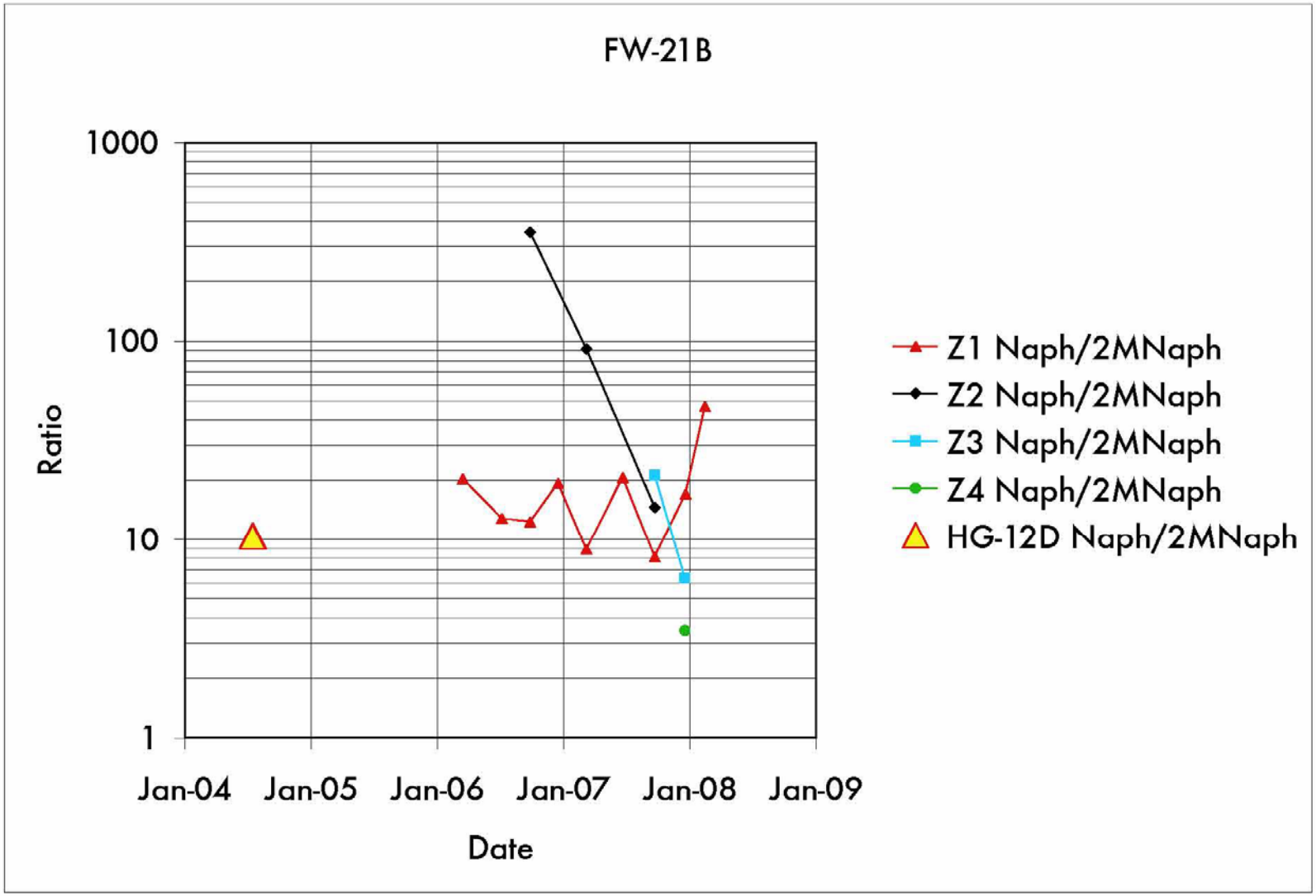
Concentrations in FW-21B decline with depth and have fluctuated



Ratios in FW-21B vary with depth and fluctuate over time



Ratios in FW-21B vary with depth and fluctuate over time



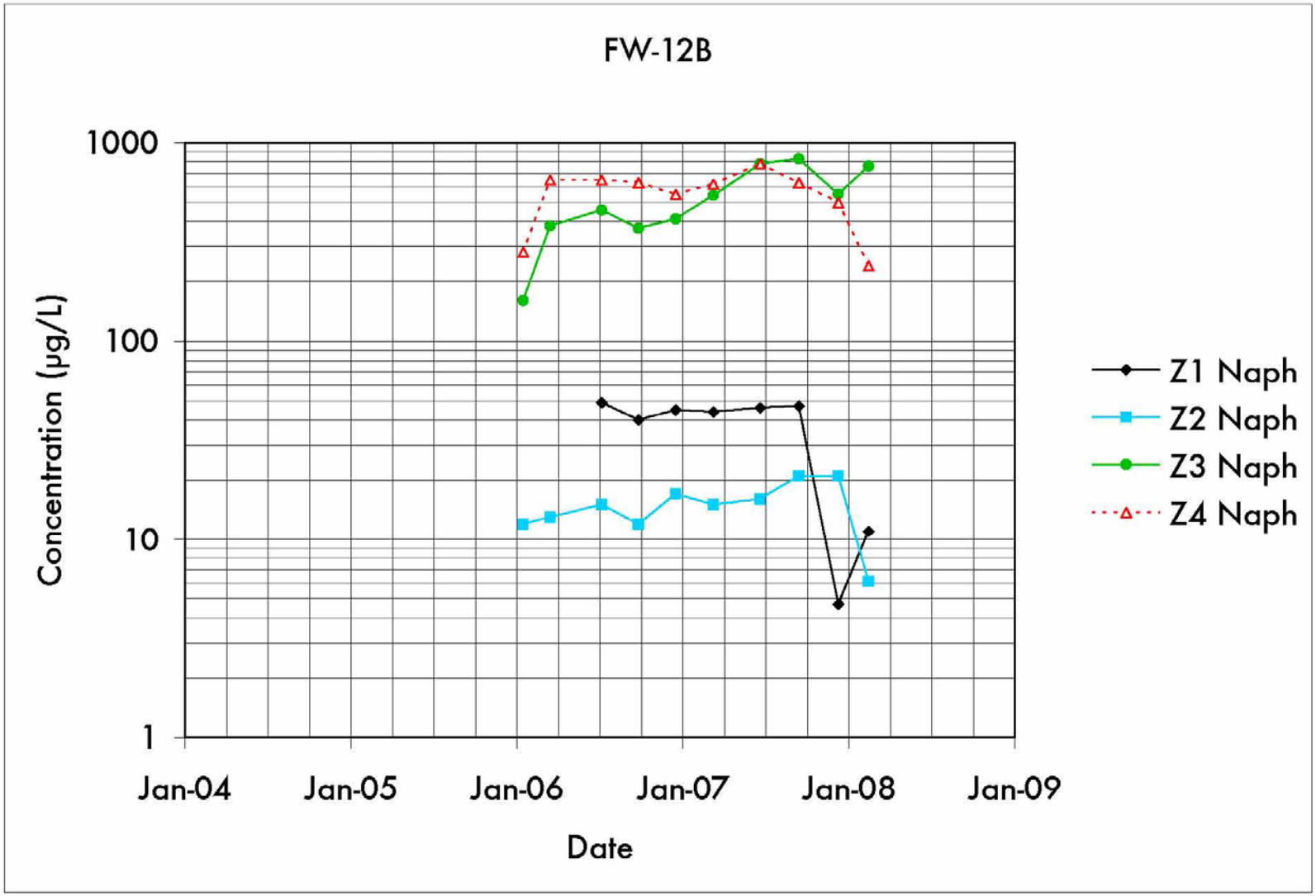
Ratios in FW-21B vary with depth and fluctuate over time

High Concentrations of Phenolics in HG-12D Not Evident in FW-21B:

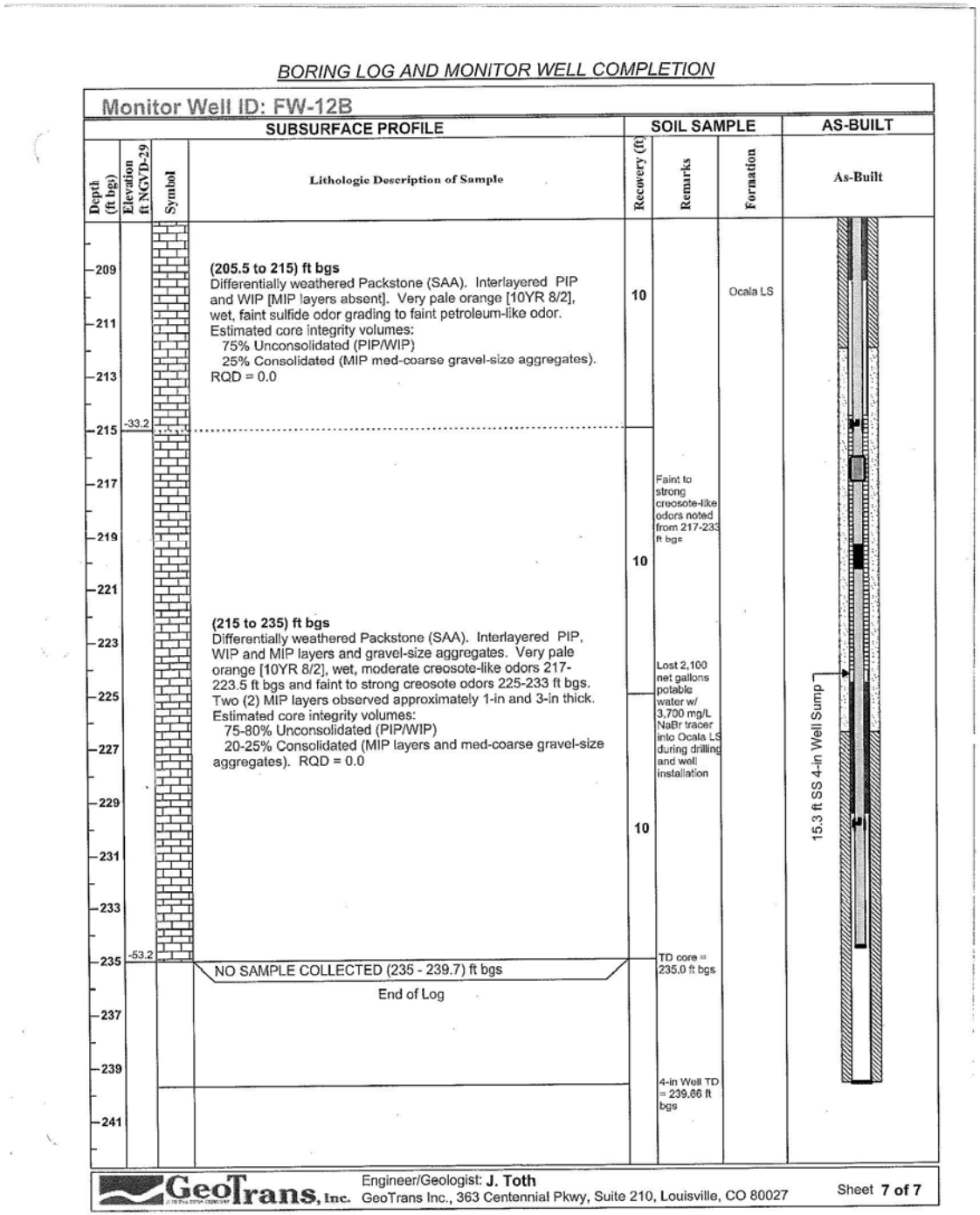
HG-12D	Phenol	148 - 572 µg/L
	MPhenols	1,872 - 6,970 µg/ L
	24DMPhenol	2,710 - 7,060 µg/L
FW-21B	Phenol	<2.1 - <1.8 µg/L
	MPhenols	<1 µg/L
	24DMPhenol	1.0 - 4.0 µg/L

Contamination in FW-12B does not result from drag-down or borehole leakage:

- Relative low concentrations found in two upper monitoring intervals.
- Only faint creosote odor noted in core samples.
- Highest concentrations are found in two lower monitoring intervals.
- Moderate to strong creosote odor noted in lower interval during drilling.



Concentrations in FW-12B highest at depth



BORING LOG AND MONITOR WELL COMPLETION

Monitor Well ID: FW-12B

Depth (ft bgs)	Elevation ft NGVD-29	Symbol	Lithologic Description of Sample	Recovery (ft)	Remarks	Formation	As-Built
209			**(205.5 to 215) ft bgs** Differentially weathered Packstone (SAA). Interlayered PIP and WIP [MIP layers absent]. Very pale orange [10YR 8/2], wet, faint sulfide odor grading to faint petroleum-like odor. Estimated core integrity volumes: 75% Unconsolidated (PIP/WIP) 25% Consolidated (MIP med-coarse gravel-size aggregates). RQD = 0.0	10		Ocala LS	
211							
213							
215	-33.2			10	Faint to strong creosote-like odors noted from 217-233 ft bgs		
217							
219							
221			**(215 to 235) ft bgs** Differentially weathered Packstone (SAA). Interlayered PIP, WIP and MIP layers and gravel-size aggregates. Very pale orange [10YR 8/2], wet, moderate creosote-like odors 217-223.5 ft bgs and faint to strong creosote odors 225-233 ft bgs. Two (2) MIP layers observed approximately 1-in and 3-in thick. Estimated core integrity volumes: 75-80% Unconsolidated (PIP/WIP) 20-25% Consolidated (MIP layers and med-coarse gravel-size aggregates). RQD = 0.0				
223							
225					Lost 2,100 net gallons potable water w/ 3,700 mg/L NaBr tracer into Ocala LS during drilling and well installation		
227							
229				10			
231							
233							
235	-53.2		NO SAMPLE COLLECTED (235 - 239.7) ft bgs		TD core = 235.0 ft bgs		
237			End of Log				
239					4-in Well TD = 239.66 ft bgs		
241							

15.3 ft SS 4-in Well Sump

GeoTrans, Inc. Engineer/Geologist: **J. Toth** GeoTrans Inc., 363 Centennial Pkwy, Suite 210, Louisville, CO 80027 Sheet **7 of 7**

Moderate creosote odor 217-223.5 feet
Faint to strong creosote odor 225-233 feet

CODES - SOIL CORE SECTION LOG FORM

GeoTrans, Inc.

PROPERTY	DESCRIPTION	LOG CODE
RELATIVE DRILLING RATES		
Very Slow		1
	grading to:	↓
Very Fast		5
ODOR (enter letter and number codes)		
Odorless		O
Hydrogen Sulfide		HS
Creosote		Cr
Petroleum		P
Septic		Se
Natural Organic		Nat Org
Qualifiers:	Faint	1
	Slight	2
	Moderate	3
	Strong	4
	Very Strong	5
NAPL		
Absent	none observed	A
Staining	Faint	Ft
	Distinct	Ds
	Prominent	Pr
NAPL	NAPL appears immobile	R
	NAPL appears mobile	FP
HCl REACTION - Dilute 10%		
None	no visible reaction	N
Weak	slow bubble formation	W
Moderate	Moderate bubble formation	M
Strong	immed. & vigorous bubbles	S
MOISTURE		
Dry	absence of moisture	D
Moist	damp but no visible water	M
Wet	visible free water	W
CEMENTATION		
Weak	crumbles or breaks with handling or little pressure	W
Moderate	crumbles or breaks with moderate pressure	M
Strong	will not crumble or break with finger pressure	S
ANGULARITY		
Angular	refer to chart	A
SubAngular	refer to chart	SA
SubRounded	refer to chart	SR
Rounded	refer to chart	R
MATRIX / CLAST		
Clast supported		C
Matrix supported		M
GRAIN TYPE		
Qtz=quartz, Sh=shells, LS=limestone fragments, DF=dolomite fragments, C=unspecified carbonate PhF = phosphate rock fragments		

Proportions:

TRACE	(0-10%)
LITTLE	(10-20%)
SOME	(20-35%)
AND	(35-50%)

PROPERTY	DESCRIPTION	LOG CODE
COHESIVE SOILS		
CONSISTENCY		
Very Soft	thumb will penetrate soil >1"	VS
Soft	thumb will penetrate soil ~1"	So
Firm	thumb will indent soil ~1/4"	F
Stiff	thumb won't indent soil, thumbnail will	St
Hard	thumbnail will not readily indent soil	H
PLASTICITY (if fine-grained)		
Non-Plastic	a 1/8" thread can' be rolled at any water content	NP
Low	a 1/8" thread can barely be rolled	L
Medium	a 1/8" thread is easy to roll and not much time is required to reach the plastic limit, but the thread cannot be rerolled after reaching the plastic limit	M
High	a 1/8" thread is easily rolled, takes a long time to reach the PL, and can be re-rolled after reaching the PL	H
STRUCTURE		
Stratified	alternating layers of varying material color with layers at least 1/4" thick	S
Laminated	alternating layers of varying material color with layers <1/4" thick	La
Fissured	breaks along defined planes of fracture with little resistance to fracturing	F
Slickensided	fracture planes appear polished	Sl
Blocky	cohesive soil that can be broken down into small angular fragments	B
Lenses	inclusion of small pockets of different soil	Le
Homogeneous	same color and appearance throughout	H
Platty, Nuggety, Friable, Varved, Massive, Prismatic, Columnar, Cemented, Cluster, Dispersed, Flocculated (Cardhouse), Single-Grained, Skeleton		
NON COHESIVE SOILS		
RELATIVE DENSITY (Estimated Compactness)		
Loose	Estimate, consider drilling rates	L
Compact	Estimate, consider drilling rates	C
Dense	Estimate, consider drilling rates	D
GRADATION		
Poorly Graded	poorly-graded soil consists primarily of 1 size or has missing intermediate grain size fractions	P
Gap Graded		G
Well Graded	well-graded soil has a wide range of particle sizes and a substantial amount of intermediate sizes	W
DOMINANT GRAIN SIZE		
Gravel = **G** / Coarse Sand = **CS** / Medium Sand = **MS** Fine Sand = **FS** / Very Fine Sand = **VFS** / Silt = **Si** / Clay = **C**		
ORGANIC MATERIAL (typ. dk brown to black color, possesses organic odor, will not have a high toughness or plasticity)		
Peat	>50% organic matter	P
Organic	15-50% organic matter	O
Some	5-15% organic matter	S

Abundance: Few, Common, Many
Contrast: Faint, Distict, Prominent

NR Not Recorded
NA Not Applicable
SAA Same as Above

ROCK CORE SECTION LOG FORM — KOPPERS SITE, UPPER FLORIDAN INVESTIGATION PROGRAM, GeoTrans, Inc.

Boring ID: FW-12B	Core Run Depth Interval (ft bgs): 215-225	Core Run Length (ft): 10	Core Run No. 18	Core Type: 4x7	Comments: Circulation maintained
Core Interval Log Sheet 1 of 1	Date: 11/19/05	Full length Coring Time (min): 1 min	Logger: JT	Core Recovery (ft): 10	

Core Interval (feet BGS)	Relative Drilling Rates	PID internal core (ppm)	Odor	NAPL	Color, Hue, Chroma (wet)	Rock Type (Dunham's Classification, Mineralogy...)	HCl Reaction	Moisture	Fracture Frequency	Bedding	RQD	USCS Classification	Induration: Poor	Induration: Weak	Induration: Moderate	Comments
215	4	0.0	O	A												
	↑	0.0	O	↑												
216		0.0	O													
		0.0	O													
217		1.7	Cr-3		Very Pale Orange [10YR 8/2]	Packstone (SAA)	S	W	NA	NA	O	GM GW				
		0.3	Cr-3													
218		9.1	Cr-3													
		0.3	Cr-3													
219		6.3	Cr-3													
		5.6	Cr-3													
220		3.3	Cr-3													
		5.1	Cr-3													
221		5.7	Cr-3													
		4.2	Cr-3													
222		3.9	Cr-3													
		6.1	Cr-3		Approx. Core Recovery Volume:											
223		3.2	Cr-3		~80 % Unconsolidated PIP & WIP											
		0.0	O		~20 % Consolidated MIP Gravels											predominantly VF Sand
224	↓	0.0	O	↓	(Layers Absent)											
225	4	—	O	A												

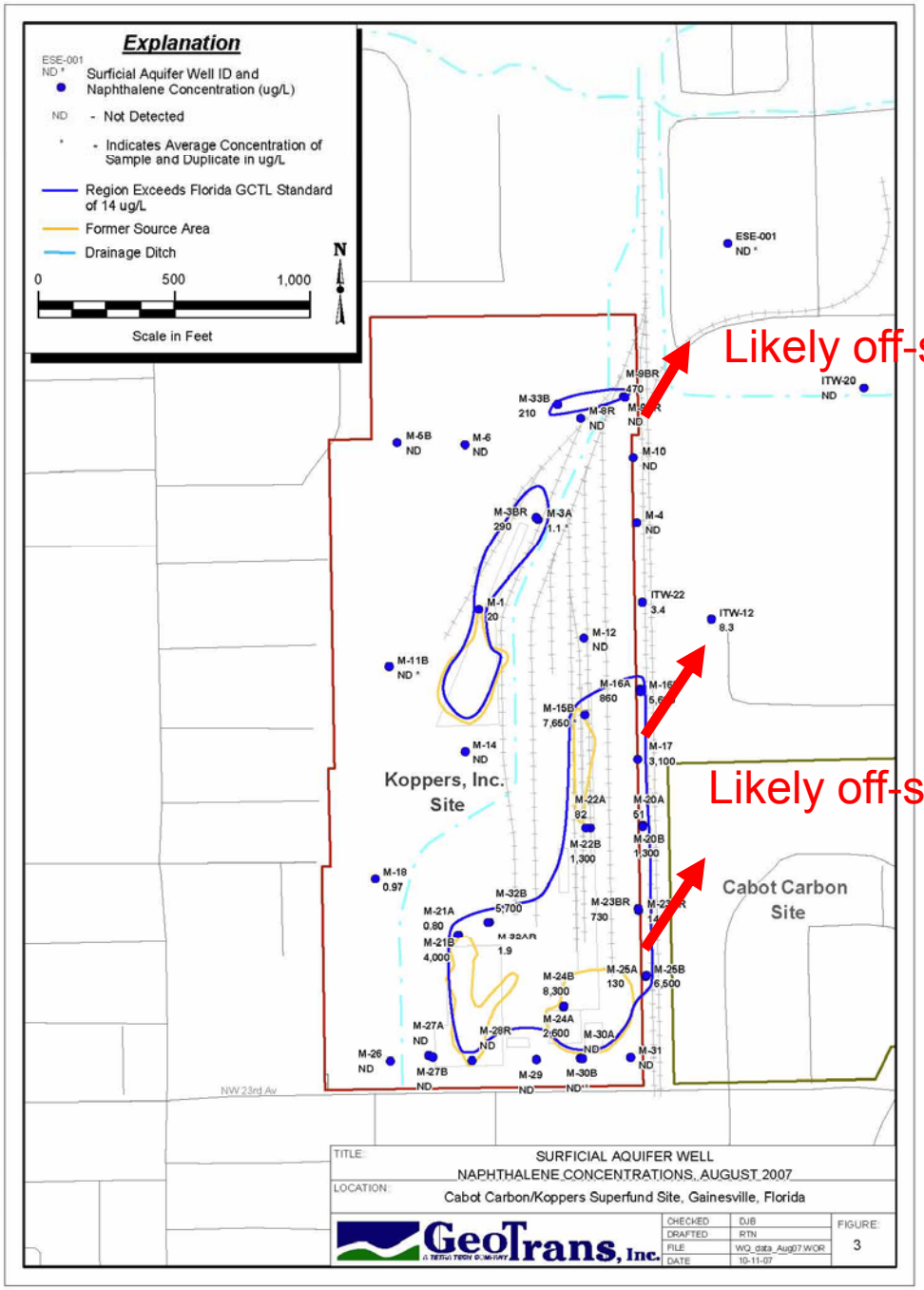
ROCK CORE SECTION LOG FORM — KOPPERS SITE, UPPER FLORIDAN INVESTIGATION PROGRAM, GeoTrans, Inc.

Boring ID: FW-12B	Core Run Depth Interval (ft bgs): 225-235	Core Run Length (ft): 10	Core Run No. 19	Core Type: 4x7	Comments: Used Photovac 2020 Pro 11.7eV (175'-235')
Core Interval Log Sheet 1 of 1	Date: 11/19/05	Full length Coring Time (min): 2min*	Logger: JT	Core Recovery (ft):	

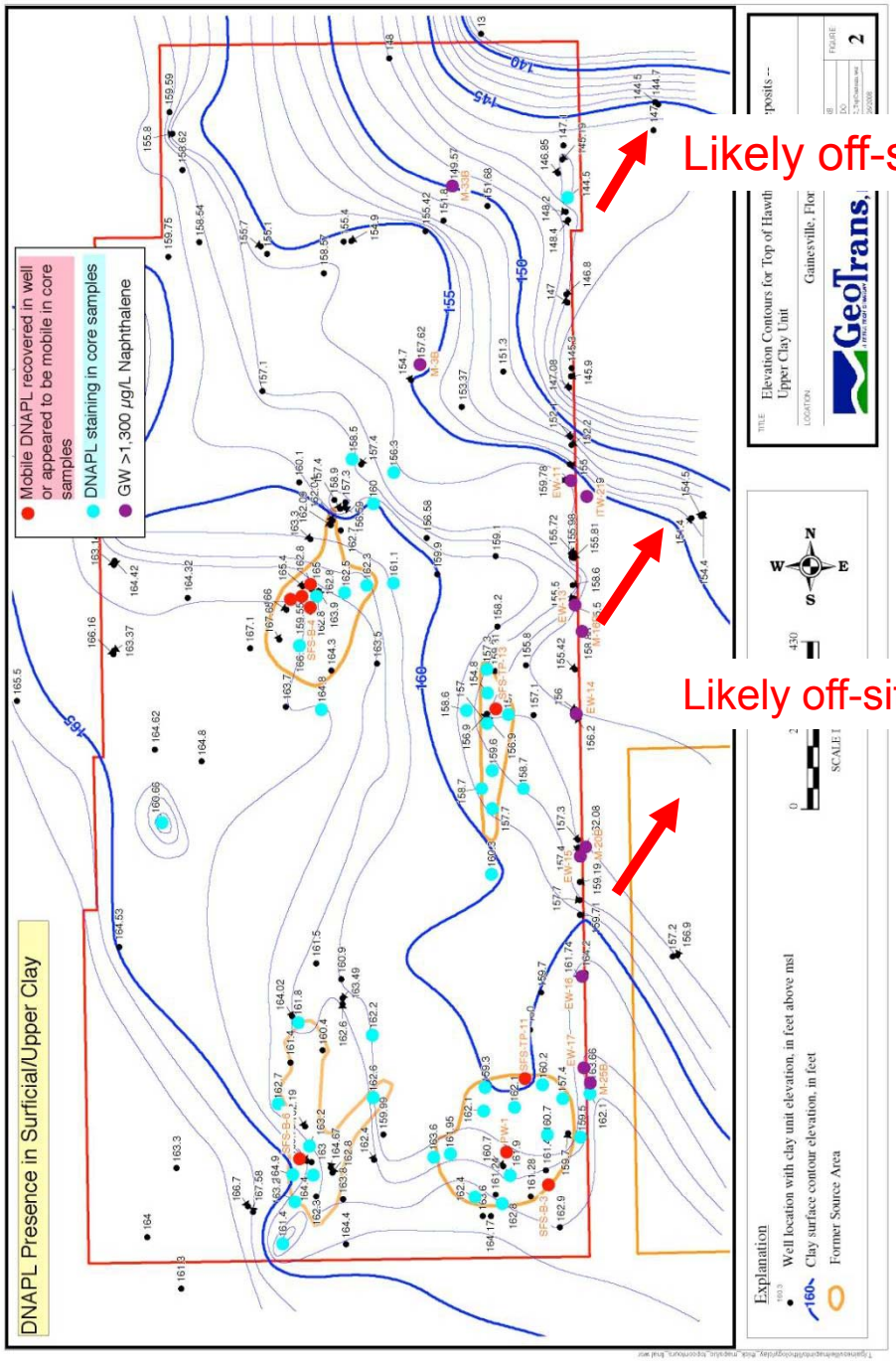
Core Interval (feet BGS)	Relative Drilling Rates	PID internal core (ppm)	Odor	NAPL	Color, Hue, Chroma (wet)	Rock Type (Dunham's Classification, Mineralogy...)	HCl Reaction	Moisture	Fracture Frequency	Bedding	RQD	USCS Classification	Induration: Poor	Induration: Weak	Induration: Moderate	Comments
225	5	0.0	Cr-1	A												* Override casing Drilling rates from
		0.0	Cr-1													175'-235' were longer
226	5	0.0	Cr-1													than expected, likely due
		0.0	Cr-1													to the fine silica sand
227	5	0.0	Cr-1		S.A.A. Color	Packstone (SAA)	S	W	NA	NA	O	GM				engineered sand pack
		0.0	Cr-1									GW				backfill that sand-
228	3	0.0	Cr-1													locked rotation if
		0.3	Cr-1													feed rate was high & slowed
229	3	0.0	Cr-1													
		1.0	Cr-3													
230	3	1.2	Cr-3													
		0.9	Cr-3													
231	3	7.6	Cr-3													
		16.0	Cr-4													
232	3	23.8	Cr-4													
		7.2	Cr-3													
233	3	0.0	0		Approx. Core Recovery Volume: ~75 % Unconsolidated PIP & WIP ~25 % Consolidated MIP Layers & Gravels / Lenses											
		0.0	0													
234	3	0.0	0													
235		—	0	A												

Koppers Contaminants Extend Off-Site:

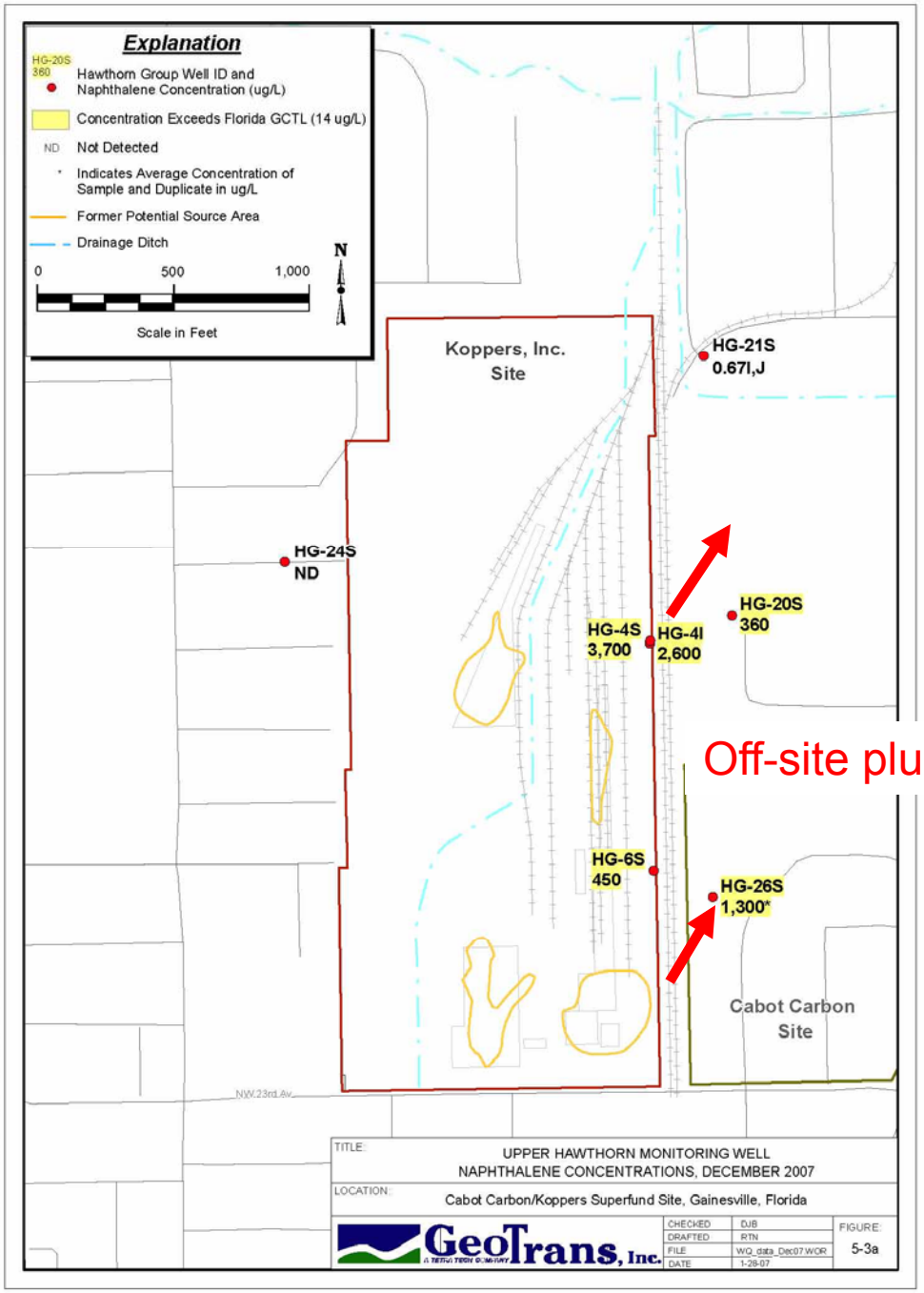
- Surficial Aquifer (east beyond extraction wells, ITW-21).
- Upper Hawthorn (east HG-26S, HG-20S).
- Lower Hawthorn (east HG-4D, HG-6D, west HG-2D, maybe HG-5D).
- Floridan Aquifer (east FW-16B-Z1, west FW-11B-Z1, FW-24B-Z1/Z2/Z3, FW-22B-Z1/Z2/Z3/Z4).



From Surficial Well Redevelopment and Sampling Report, 2007, GeoTrans

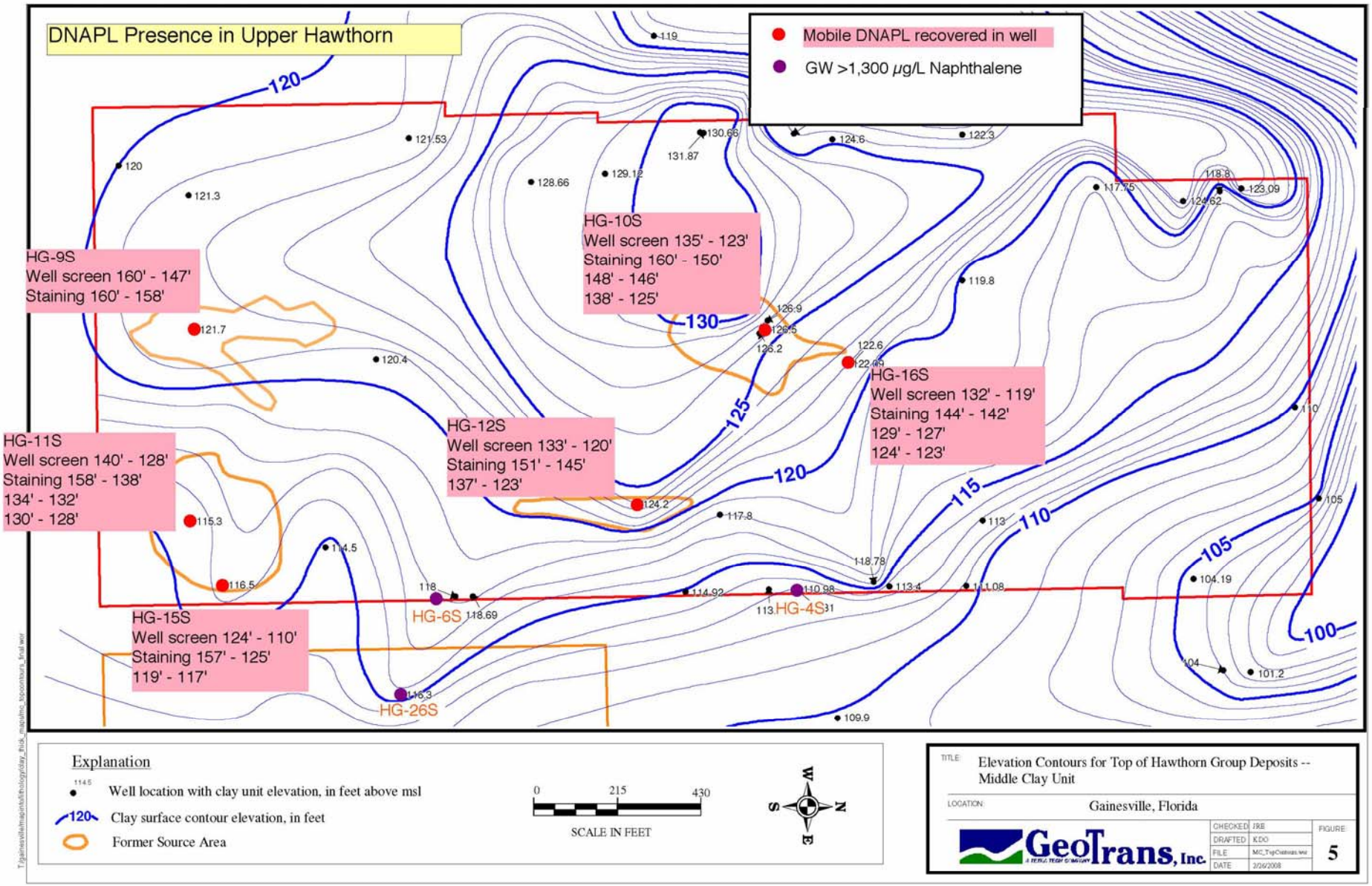


Modified from Figure 2, GeoTrans, Inc. April 2, 2008.
Response to Recommendation 6.

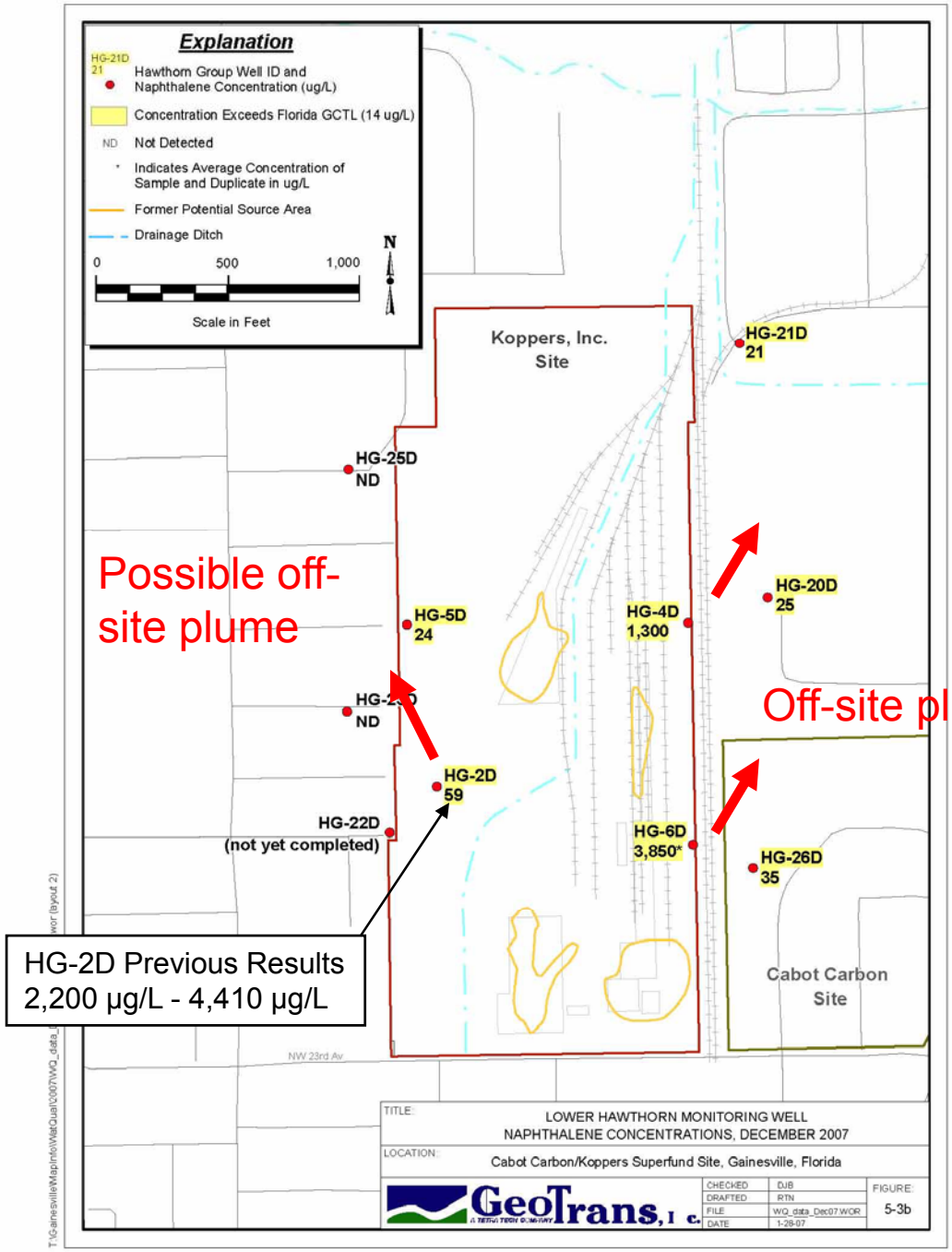


Off-site plume

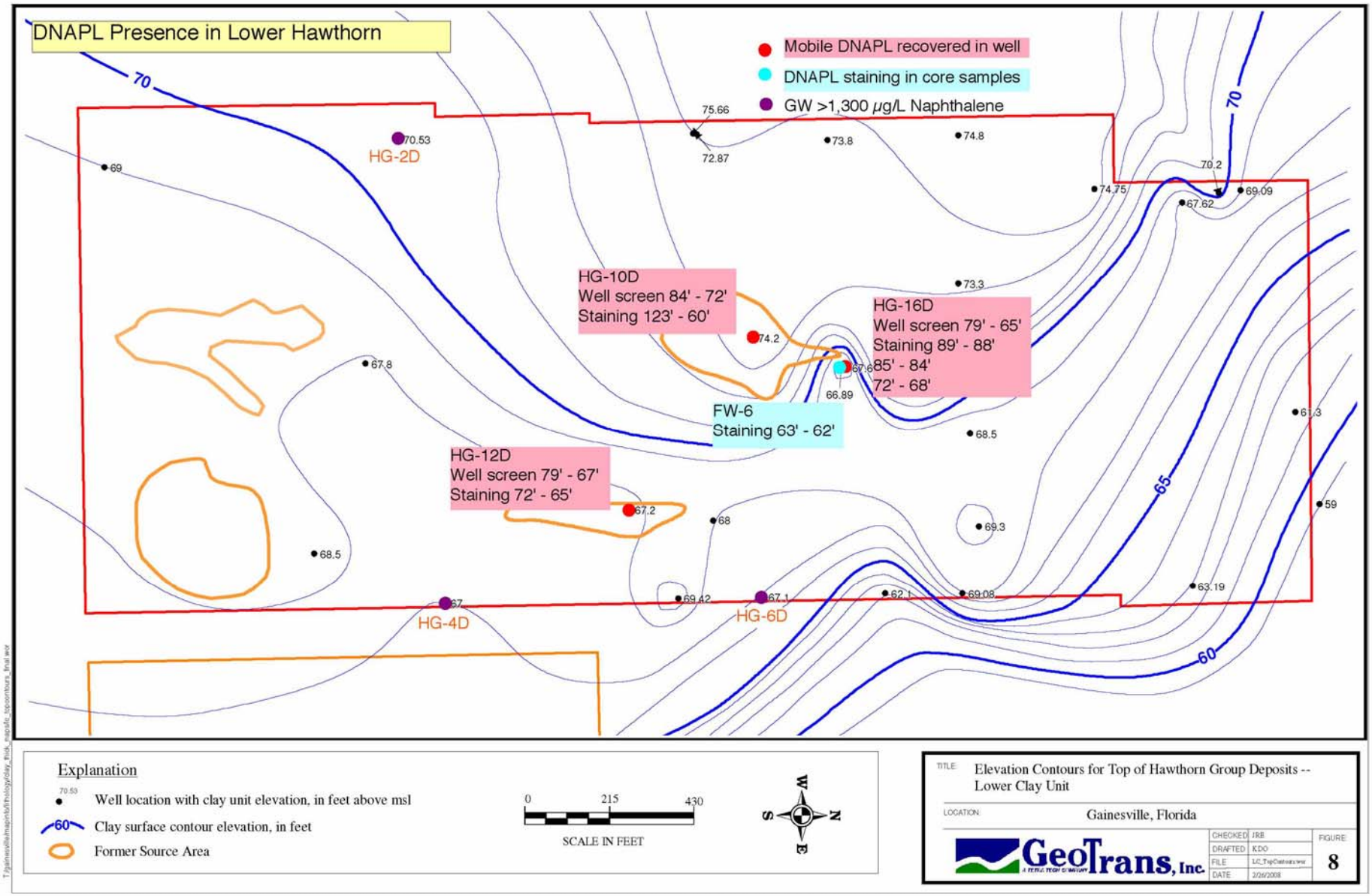
Modified from Figure 5-3a, GeoTrans, Inc. March 18, 2008. Supplemental Hawthorn Group Report.



Modified from Figure 5, GeoTrans, Inc. April 2, 2008. Response to Recommendation 6.

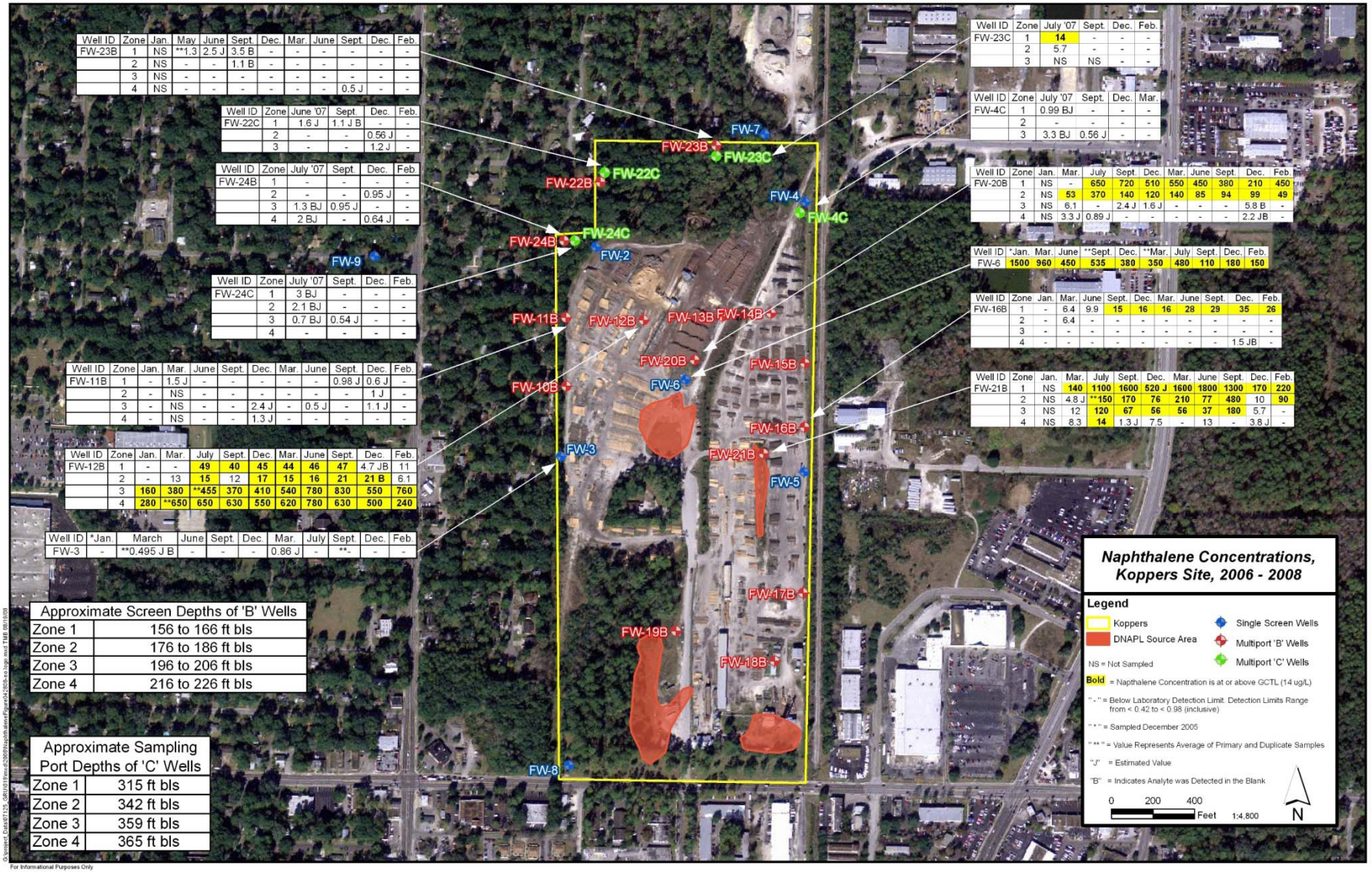


Modified from Figure 5-3b, GeoTrans, Inc. March 18, 2008. Supplemental Hawthorn Group Report.

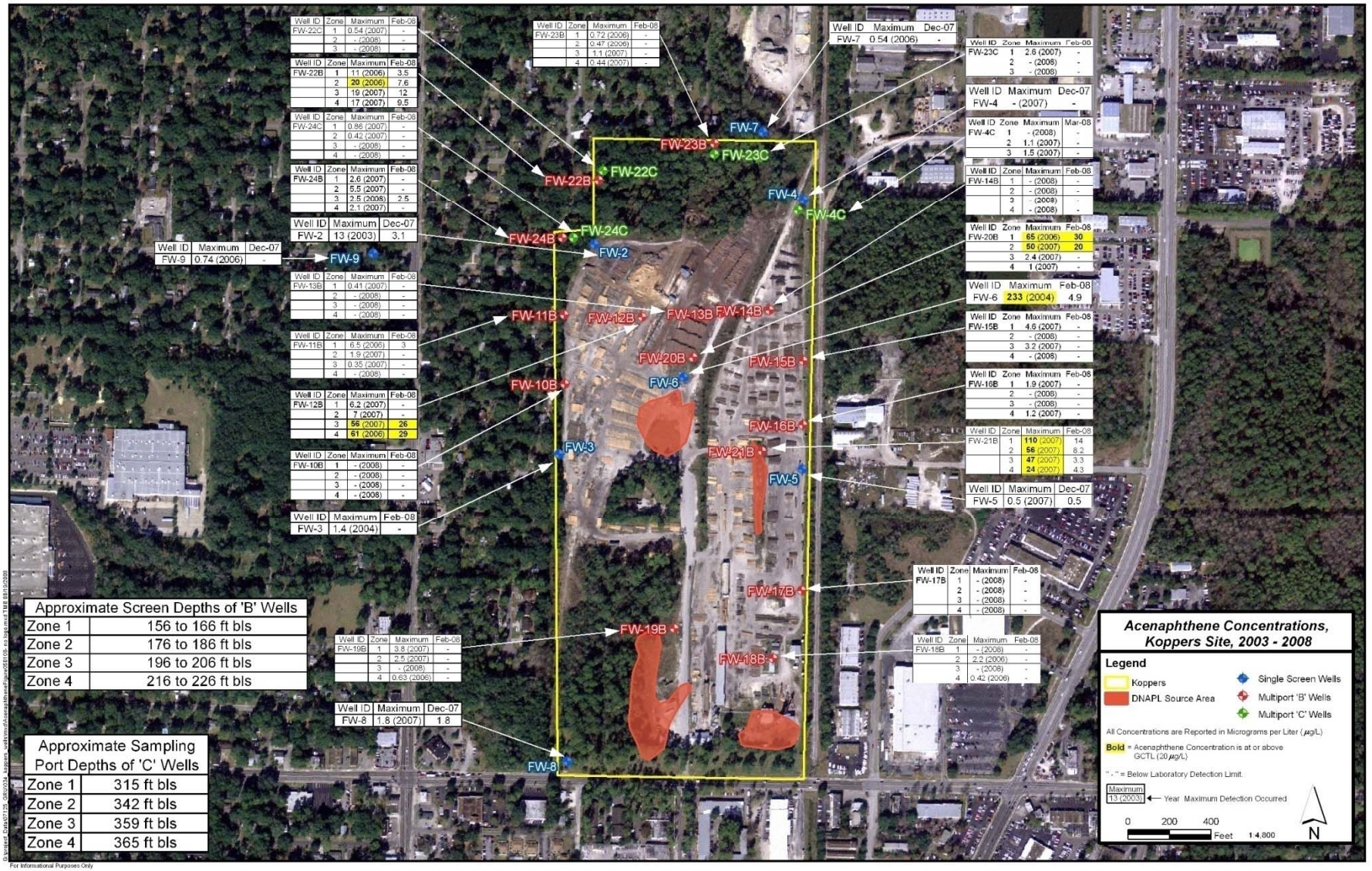


Modified from Figure 8, GeoTrans, Inc. April 2, 2008. Response to Recommendation 6.

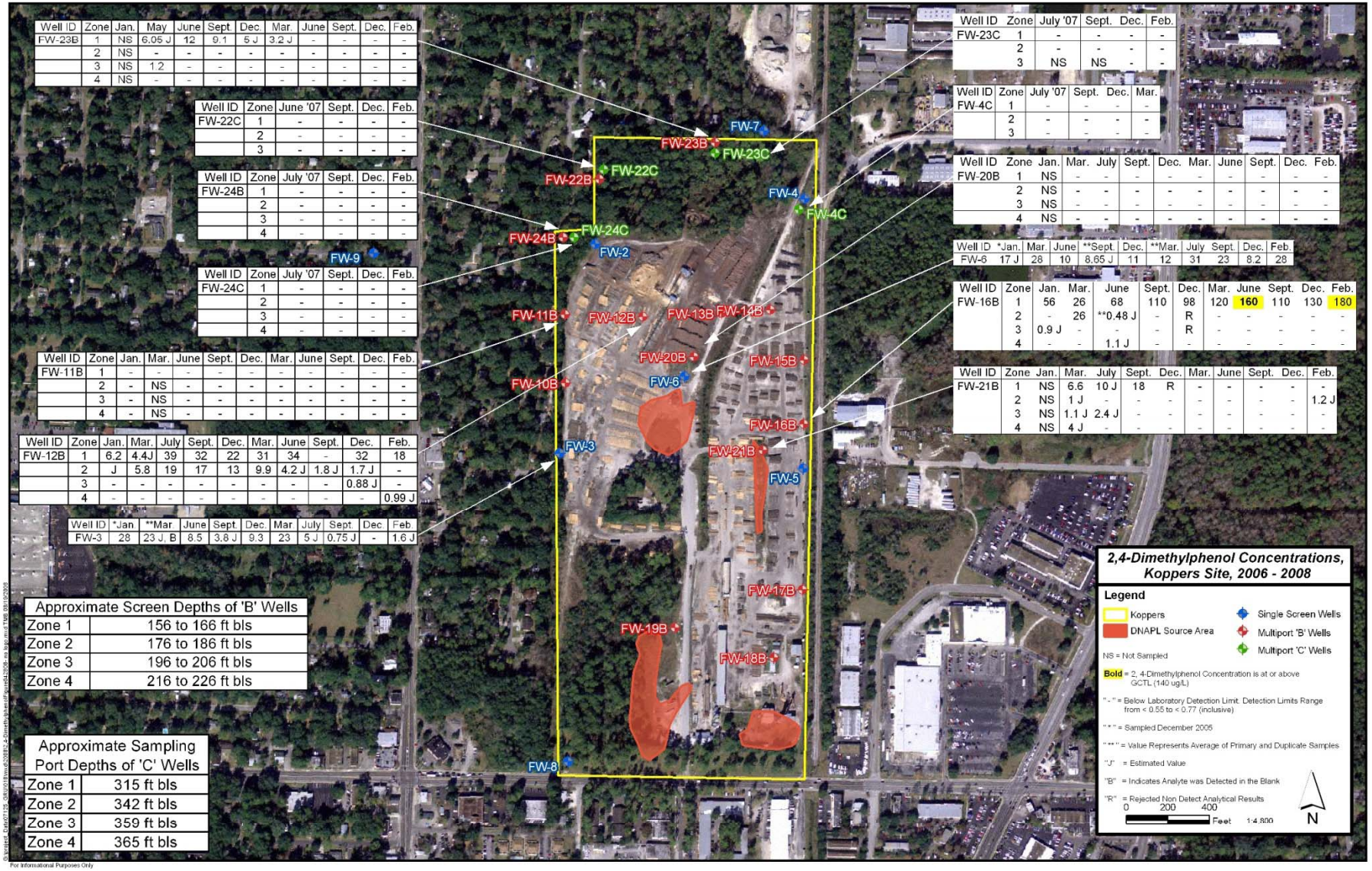
Floridan Aquifer—Naphthalene



Floridan Aquifer—Acenaphthene



Floridan Aquifer—2,4-Dimethylphenol



Well ID	Zone	Jan.	May	June	Sept.	Dec.	Mar.	June	Sept.	Dec.	Feb.
FW-23B	1	NS	6.05 J	12	9.1	5 J	3.2 J	-	-	-	-
	2	NS	-	-	-	-	-	-	-	-	-
	3	NS	1.2	-	-	-	-	-	-	-	-
	4	NS	-	-	-	-	-	-	-	-	-

Well ID	Zone	June '07	Sept.	Dec.	Feb.
FW-22C	1	-	-	-	-
	2	-	-	-	-
	3	-	-	-	-

Well ID	Zone	July '07	Sept.	Dec.	Feb.
FW-24B	1	-	-	-	-
	2	-	-	-	-
	3	-	-	-	-
	4	-	-	-	-

Well ID	Zone	July '07	Sept.	Dec.	Feb.
FW-24C	1	-	-	-	-
	2	-	-	-	-
	3	-	-	-	-
	4	-	-	-	-

Well ID	Zone	Jan.	Mar.	June	Sept.	Dec.	Mar.	June	Sept.	Dec.	Feb.
FW-11B	1	-	-	-	-	-	-	-	-	-	-
	2	-	NS	-	-	-	-	-	-	-	-
	3	-	NS	-	-	-	-	-	-	-	-
	4	-	NS	-	-	-	-	-	-	-	-

Well ID	Zone	Jan.	Mar.	July	Sept.	Dec.	Mar.	June	Sept.	Dec.	Feb.
FW-12B	1	6.2	4.4J	39	32	22	31	34	-	32	18
	2	J	5.8	19	17	13	9.9	4.2 J	1.8 J	1.7 J	-
	3	-	-	-	-	-	-	-	-	0.88 J	-
	4	-	-	-	-	-	-	-	-	-	0.99 J

Well ID	*Jan.	**Mar.	June	Sept.	Dec.	Mar.	July	Sept.	Dec.	Feb.
FW-3	28	23 J, B	8.5	3.8 J	9.3	23	5 J	0.75 J	-	1.6 J

Well ID	Zone	July '07	Sept.	Dec.	Feb.
FW-23C	1	-	-	-	-
	2	-	-	-	-
	3	NS	NS	-	-

Well ID	Zone	July '07	Sept.	Dec.	Mar.
FW-4C	1	-	-	-	-
	2	-	-	-	-
	3	-	-	-	-

Well ID	Zone	Jan.	Mar.	July	Sept.	Dec.	Mar.	June	Sept.	Dec.	Feb.
FW-20B	1	NS	-	-	-	-	-	-	-	-	-
	2	NS	-	-	-	-	-	-	-	-	-
	3	NS	-	-	-	-	-	-	-	-	-
	4	NS	-	-	-	-	-	-	-	-	-

Well ID	*Jan.	Mar.	June	**Sept.	Dec.	**Mar.	July	Sept.	Dec.	Feb.
FW-6	17 J	28	10	8.65 J	11	12	31	23	8.2	28

Well ID	Zone	Jan.	Mar.	June	Sept.	Dec.	Mar.	June	Sept.	Dec.	Feb.
FW-16B	1	56	26	68	110	98	120	160	110	130	180
	2	-	26	**0.48 J	-	R	-	-	-	-	-
	3	0.9 J	-	-	-	R	-	-	-	-	-
	4	-	-	1.1 J	-	-	-	-	-	-	-

Well ID	Zone	Jan.	Mar.	July	Sept.	Dec.	Mar.	June	Sept.	Dec.	Feb.
FW-21B	1	NS	6.6	10 J	18	R	-	-	-	-	-
	2	NS	1 J	-	-	-	-	-	-	-	1.2 J
	3	NS	1.1 J	2.4 J	-	-	-	-	-	-	-
	4	NS	4 J	-	-	-	-	-	-	-	-

Approximate Screen Depths of 'B' Wells	
Zone 1	156 to 166 ft bls
Zone 2	176 to 186 ft bls
Zone 3	196 to 206 ft bls
Zone 4	216 to 226 ft bls

Approximate Sampling Port Depths of 'C' Wells	
Zone 1	315 ft bls
Zone 2	342 ft bls
Zone 3	359 ft bls
Zone 4	365 ft bls

Remedial Alternatives:

- Protection of Murphree Wellfield and Floridan Aquifer should be primary goal.

- Huge uncertainty in effectiveness and feasibility for in situ treatment and containment options because of geologic variability and because extents of Source Zones not fully defined, particularly for Hawthorn.

Remedial Alternatives:

Prohibition of further drilling through Middle Clay in Source Zones will likely:

- Prevent full delineation of Source Zones in the Lower Hawthorn

Remedial Alternatives:

Prohibition of further drilling through Middle Clay in Source Zones will likely:

- Preclude remediation of Source Zones in Lower Hawthorn such as:
  - in situ treatment such as Chemox. Injection from perimeter of Source Zones likely infeasible.
  - DNAPL recovery or groundwater pumping.
- Restrict possibility of characterization and hydraulic containment of “hot-spots” in Floridan.

Remedial Alternatives:

Because remedies in the Hawthorn will be uncertain, unpredictable, and likely of limited success, we propose:

Include hydraulic containment of dissolved plume(s) in Floridan as main component of an additional alternative in the FS.

- Focus could be on known “hot-spots” in Floridan or full site containment.

- Containment in Floridan could combine other technologies in Hawthorn.

Remedial Action Objectives:

The FS must:

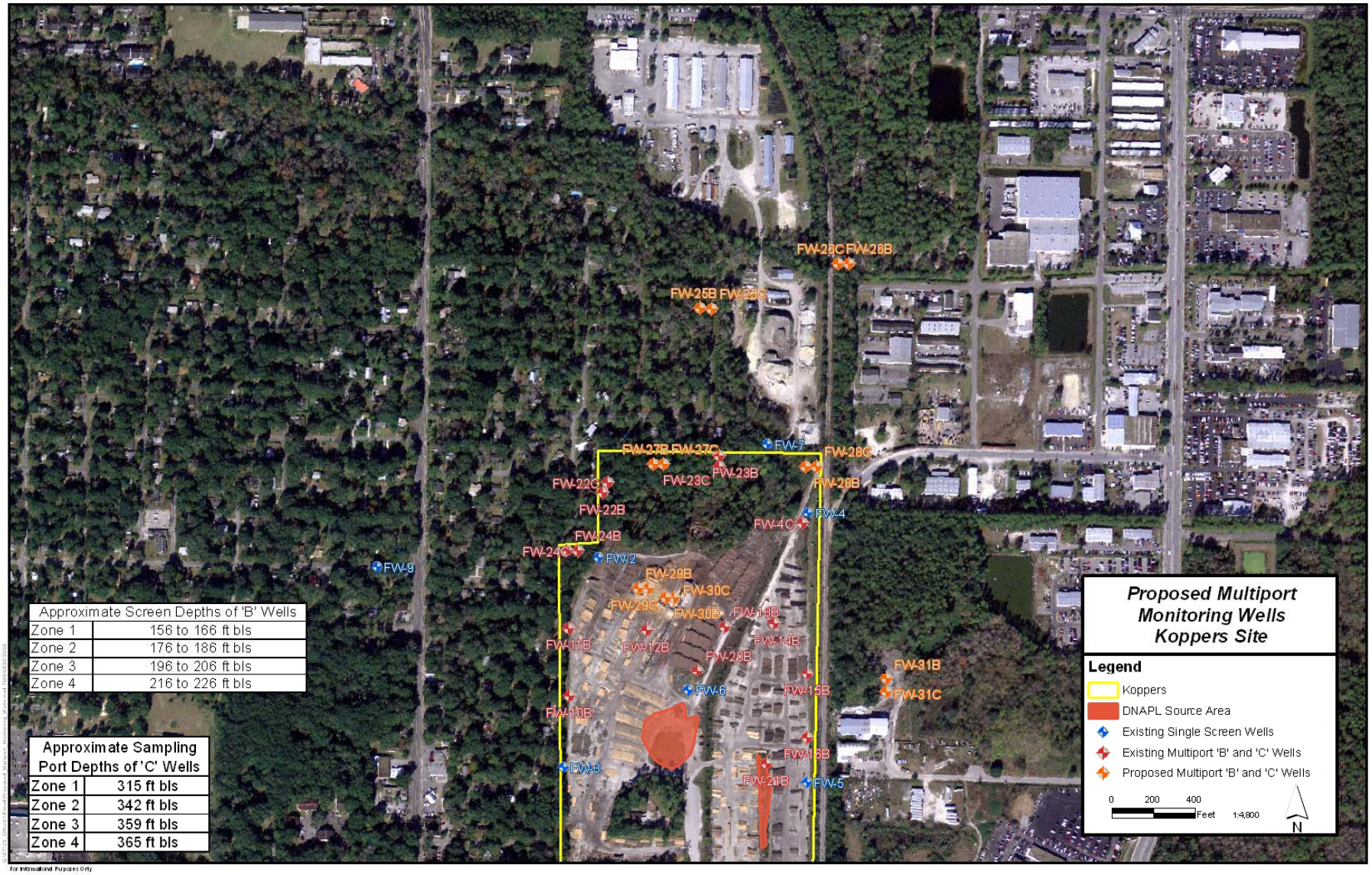
- Clearly specify RAOs for all media and all aquifer units.
- Must address aesthetic as well as health-based issues:
  - Phenol - organoleptic issues at 0.1ug/L or lower (WHO, 2004)

Performance Monitoring and Metrics:

Dissolved plume stability can only be determined with monitoring wells located close to leading edges of plumes.

- Insufficient monitoring wells off site to define leading edges of plume in Surficial, Upper Hawthorn and Lower Hawthorn.

- Perimeter multi-depth wells in Floridan nearly sufficient, but because of flowpath variability due to karst, some additional locations required to fill gaps.


FW-26C FW-26B
FW-25B FW-25C
FW-27B FW-27C
FW-7
FW-28C
FW-23B
FW-23C
FW-28B
FW-22C
FW-22B
FW-4
FW-4C
FW-24B
FW-24C
FW-2
FW-9
FW-29B
FW-30C
FW-29C
FW-30B
FW-13B
FW-11B
FW-12B
FW-14B
FW-20B
FW-31B
FW-6
FW-15B
FW-31C
FW-10B
FW-16B
FW-3
FW-21B
FW-5
Approximate Screen Depths of 'B' Wells
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Zone 1 315 ft bls
Zone 2 342 ft bls
Zone 3 359 ft bls
Zone 4 365 ft bls
Proposed Multiport Monitoring Wells Koppers Site
Legend
Koppers
DNAPL Source Area
Existing Single Screen Wells
Existing Multiport 'B' and 'C' Wells
Proposed Multiport 'B' and 'C' Wells
0 200 400
Feet
1:4,800
N
For Informational Purposes Only

Performance Monitoring and Metrics:

"Trigger" Concentrations at Points of Compliance:

- Exceedance of "trigger" level should initiate contingency (such as more similar monitoring, more investigation, more similar remediation, additional remedial measures).

- Triggers for beginning action and ending action must be specified.

- Should allow for post-remediation monitoring (rebound).

Performance Monitoring and Metrics:

"Trigger" Concentrations at Points of Compliance:

- Should be some factor (i.e. 0.50x, 0.25x) less than CGTLs or MCLs.

- Analytical detection limits should be sufficiently low to confidently report concentrations at "trigger" levels.

Performance Monitoring and Metrics:

Points of Compliance:

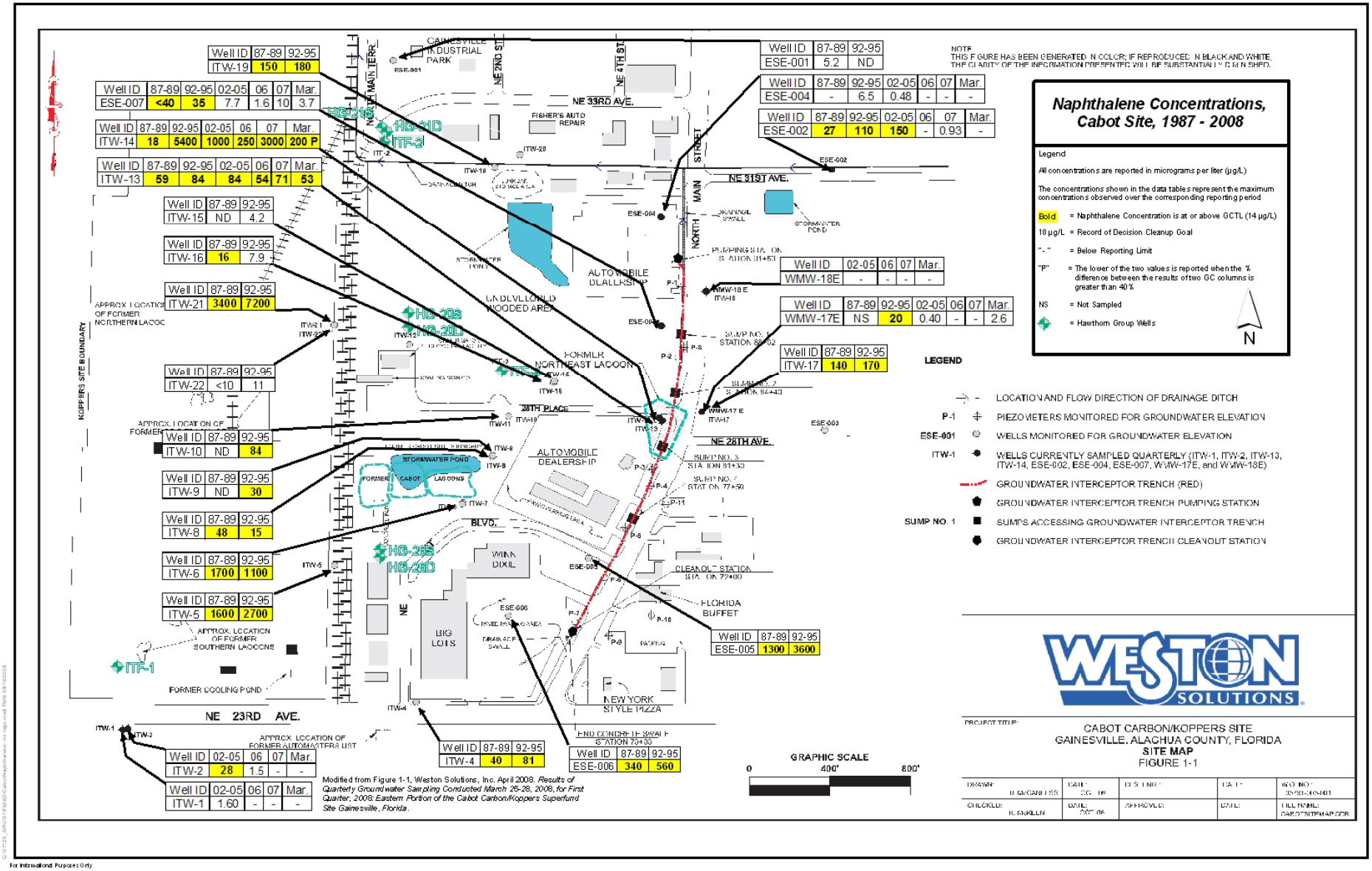
- Must not be located beyond Koppers site boundary for the Floridan Aquifer.

Cabot-Carbon Site:

- Shown to be migration from Koppers to beneath Cabot site in Upper Hawthorn, Lower Hawthorn, Floridan, likely Surficial.
- Monitoring locations inadequate on Cabot adjacent to Koppers.
- Monitoring locations inadequate on Cabot in Hawthorn and Floridan.
- Cannot determine if Northeast Lagoon is a source different from Cabot.

Cabot Carbon Groundwater Analytical Results

- The First Quarter 2008 report summary tables used to prepare the following slides. Those data include:
  - 3/27/2008 Data
  - Recent Post-Remedial Action Data: Quarterly Results from Jun-02 through Dec-07
  - Pre-Remedial Action Data: Results from 1987 and 1989, and Quarterly Results from June 1992 through April 1995
- Post-April 1995 Data are limited to only nine wells.



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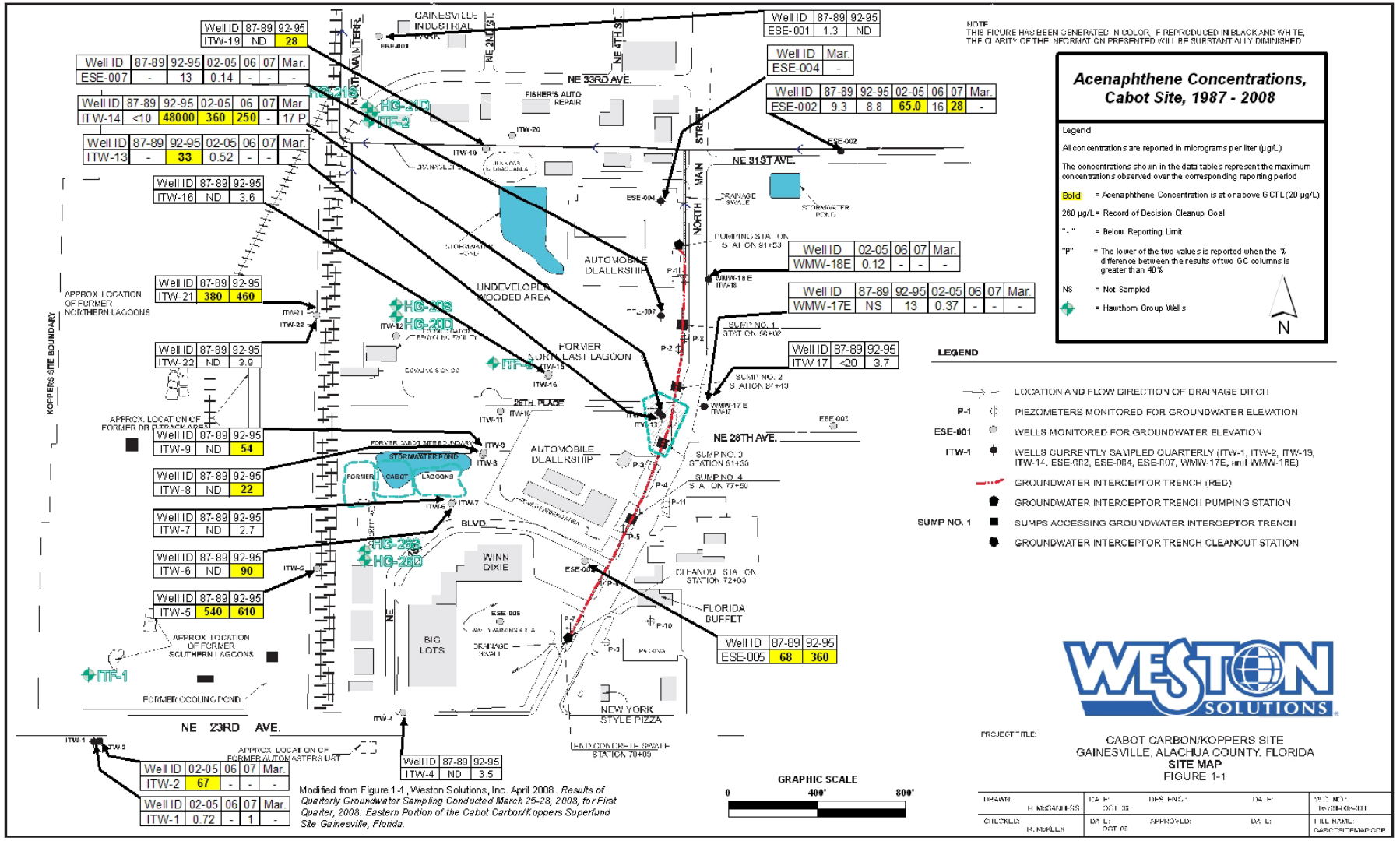

Modified from Figure 1-1, Weston Solutions, Inc. April 2008. *Results of Quarterly Groundwater Sampling Conducted March 25-28, 2008, for First Quarter, 2008: Eastern Portion of the Cabot Carbon/Koppers Superfund Site Gainesville, Florida.*

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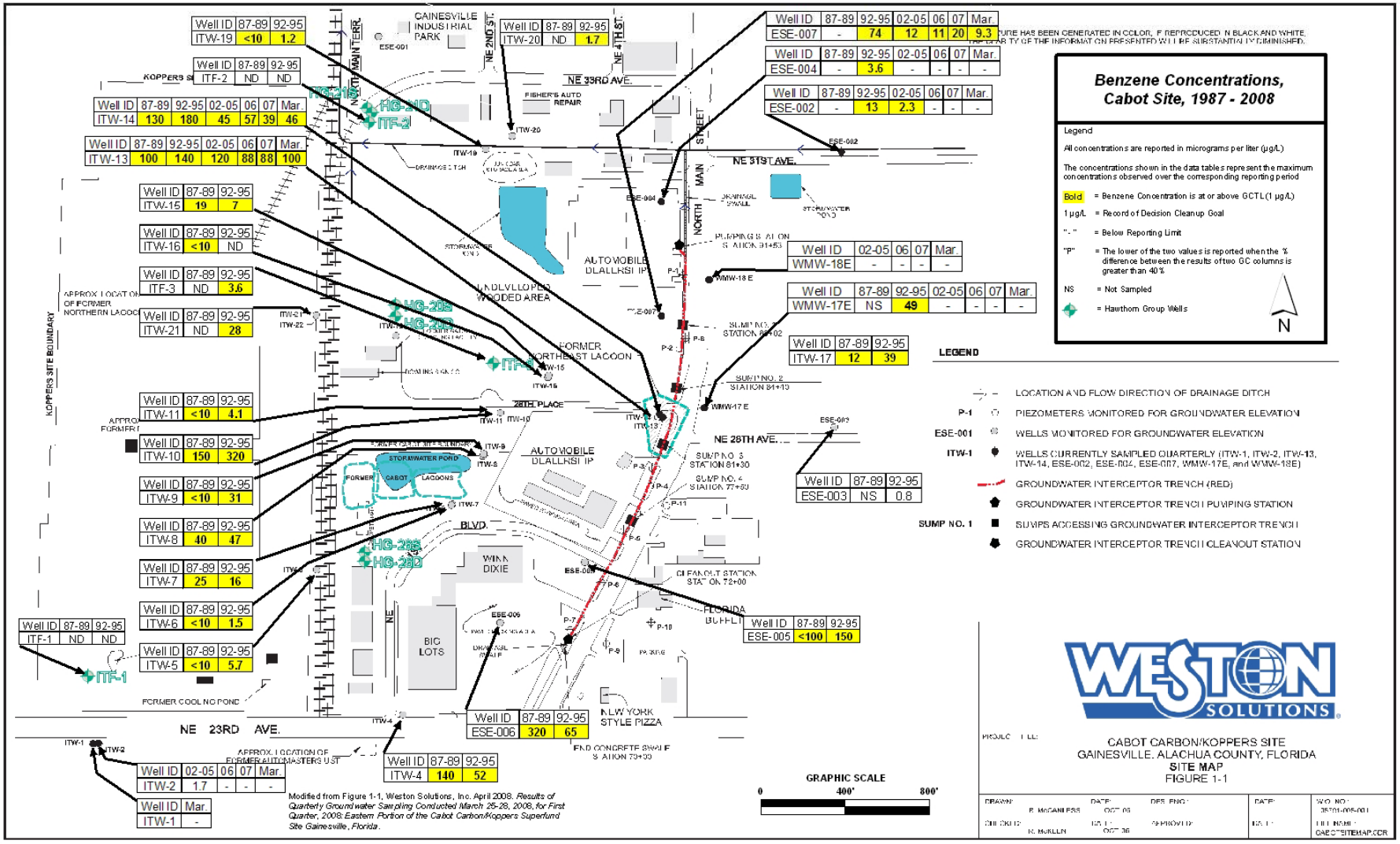

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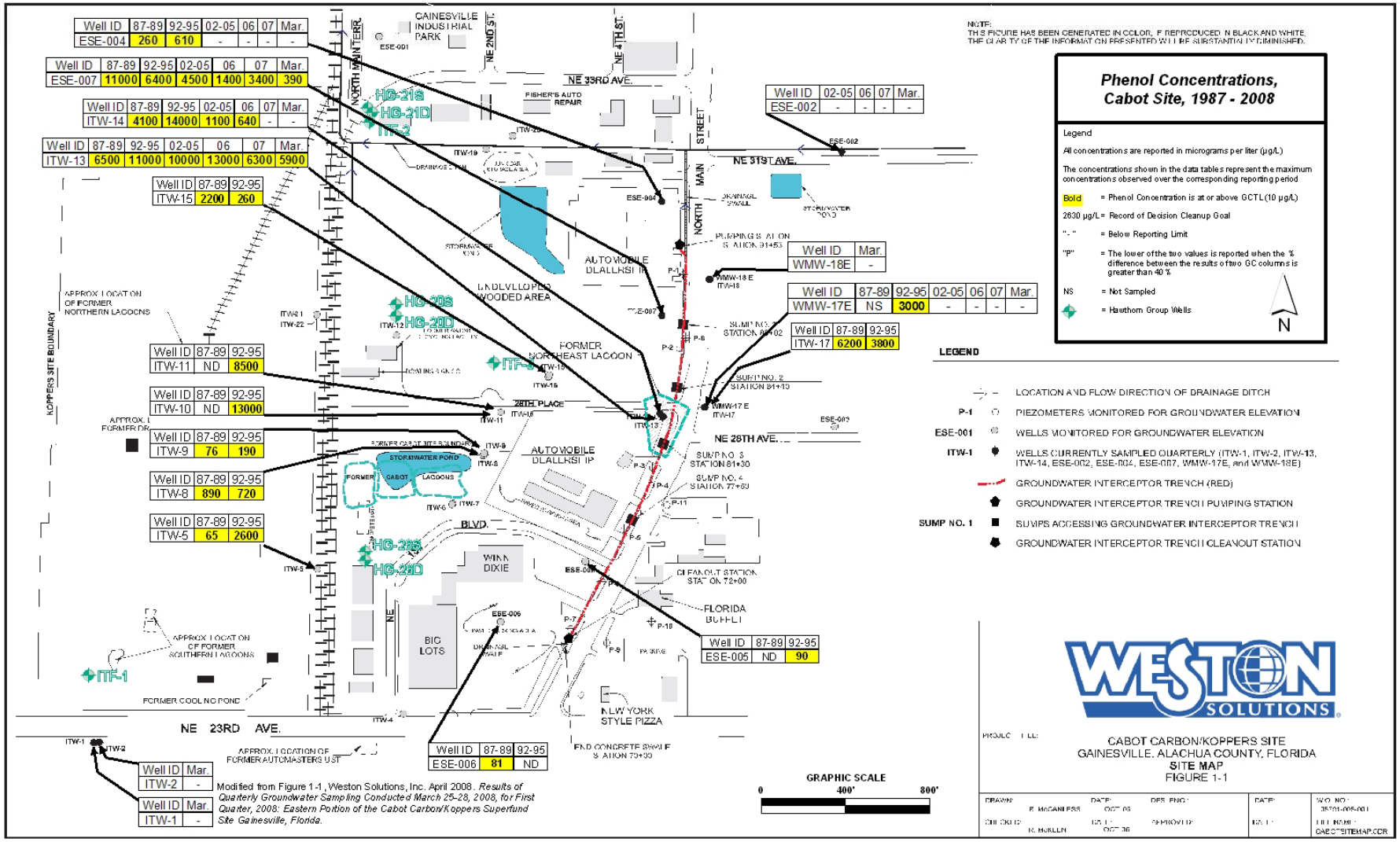

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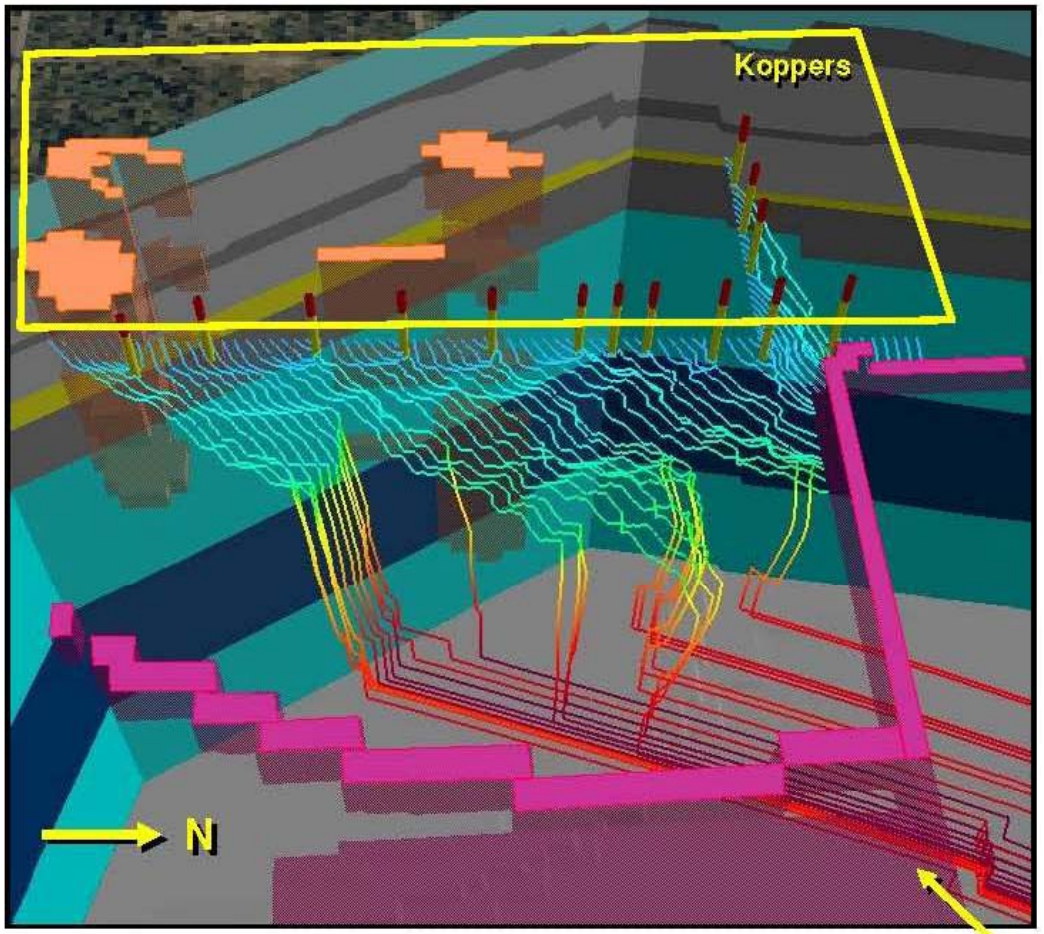


Modified from Figure 5c,
Waterloo Hydrogeologic, Inc.
November 2, 2005.
Tech Memo #2.

100 particles were released from Layer 4:

Captured by:

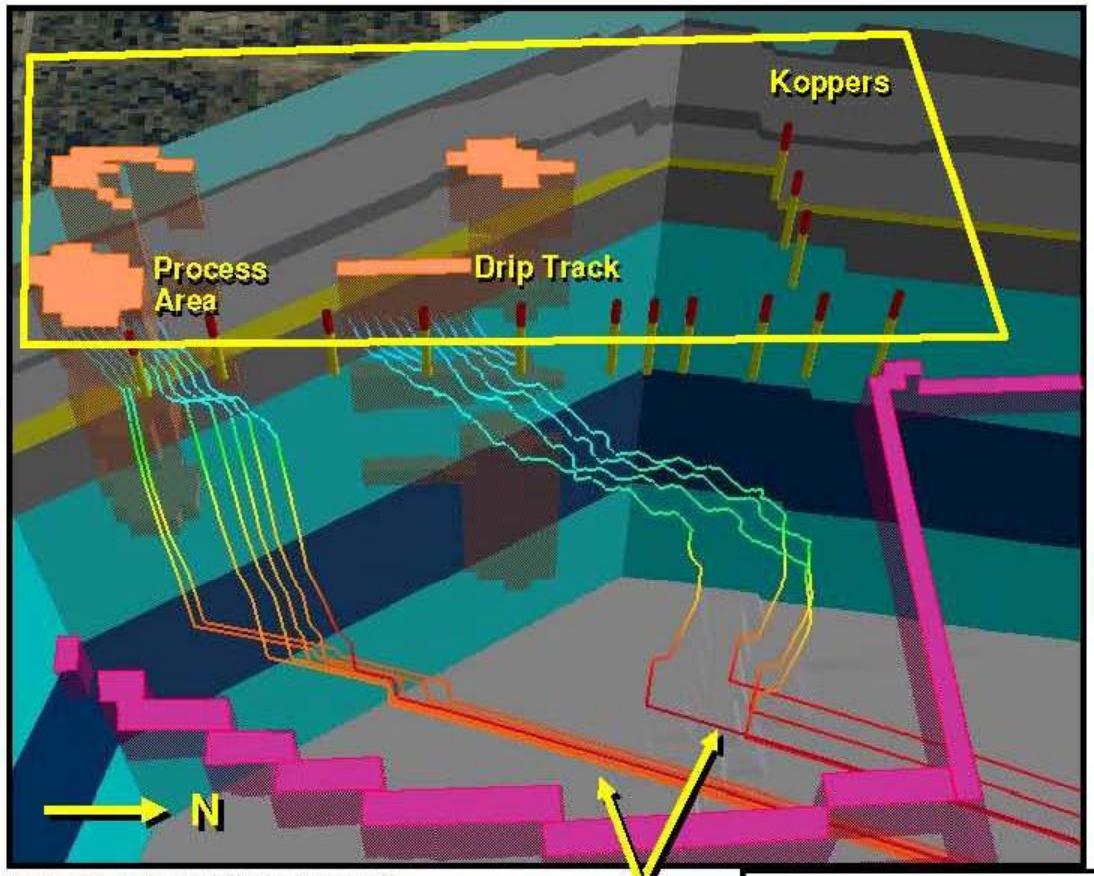
Extraction well system	43
Drainage ditches/trench	30
Murphree Wellfield	27

Particles travel below the trench and eventually arrive at Murphree Wellfield.

Legend

- Approximate Border of Koppers Portion of Cabot/Koppers Site
- Source Zones at Surface
- Drainage Ditches/Interceptor Trench

Figure 5c: 3D pathlines for particles released from Surficial Aquifer Layer 4 after 500 days, adjacent to East-West and North-South Extraction Wells.



20 particles were released from Layer 4:

Captured by:

Extraction well system	9
Drainage ditches/trench	0
Murphree Wellfield	11

Particles travel below the trench and eventually arrive at Murphree Wellfield.

Legend

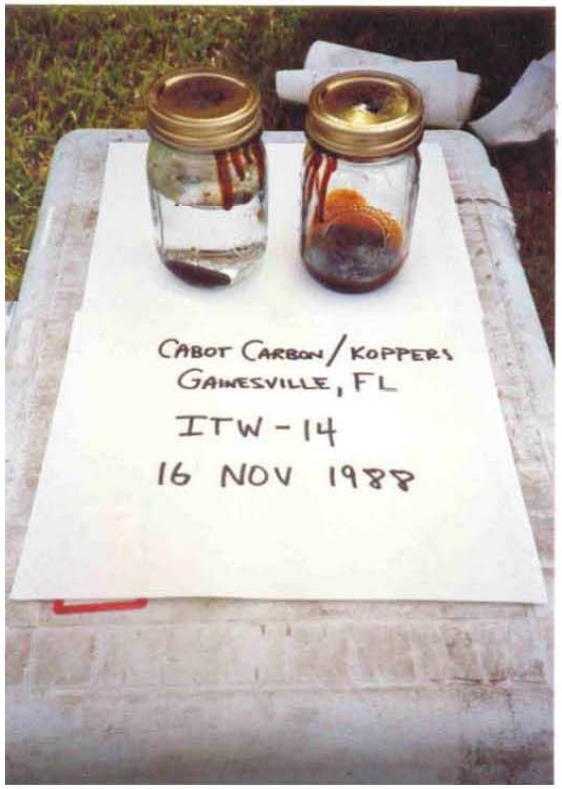
- Approximate Border of Koppers Portion of Cabot/Koppers Site
- Source Zones at Surface
- Drainage Ditches/Interceptor Trench

Figure 8c: 3D pathlines for particles released from Surficial Aquifer Layer 4 after 500 days, below the Former Drip Track and Former Process Area.

Modified from Figure 8c, Waterloo Hydrogeologic, Inc. November 2, 2005. Tech Memo #2.

DNAPL Collected from the Northeast Lagoon well

14-9a: DNAPL clinging to/dripping off an interface probe after it was removed from well ITW-14. Note that the apparent DNAPL thickness is approximately five feet.



14-9b: DNAPL from ITW-14 collected in Mason Jars

Figure 4-19

DNAPL at Cabot Site:

Well ITW-14, Northeast Lagoon

JONES EDMUNDS

Modified from Figure 4-19, GRU DNAPL Team, February, 2006. R&R Report.

Conclusions

Koppers

- DNAPL Zones not fully delineated.
- “Source Areas” must include Residual DNAPL as source to Groundwater.
- Remedial Alternatives for Hawthorn uncertain re: effectiveness and feasibility.
- FS must include a Hydraulic Containment Alternative for the Floridan.

Conclusions

Koppers

The FS must clearly specify:

- RAOs for all media and all aquifers.
- Triggers for starting and stopping activities.
- Aesthetic criteria as well as health-based criteria.

Conclusions

Cabot Carbon

- Need to Characterize Hawthorn Aquifer.
- Need to Characterize NE Lagoon.
- Phenols are a major water quality concern.